# Heat capacity of high pressure minerals and phase equilibria of Cretan blueschists

by

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# Chapter I

# Introduction

Knowledge of thermodynamics is key to understanding the physical and chemical changes taking place in the Earth's crust, producing metamorphic rocks. Observation of systematic changes in a mineral assemblage, or in its mineral compositions are useful only so far as they can be applied to and compared with other data. On the other hand, the application of complicated models and powerful computer programs is meaningless if based on flawed interpretations. During tectonic processes the chemical components of a rock system will generally rearrange themselves into a set of phases representing the lowest possible energy state, known as the equilibrium assemblage. The ability of the rock system to record changes in temperature, pressure and composition allows the rock assemblage to be a sensitive probe into the tectonic history of a sample. In order to provide tectonic insight, these thermodynamic data are most often used to predict changing minerals assemblages in pressure-temperature (PT) space. How sensitive and useful this approach is depends to a large degree on the quality of determinations of known thermodynamic parameters. In addition to better constraints on thermodynamic properties of minerals, metamorphic petrology relies heavily on the subtle interpretation of equilibria both in experiments and natural assemblages.

Due to the slow kinetics of most mineral transformations it is not feasible to experimentally determine many phase equilibria of interest in producing observed mineral assemblages. This is especially true in the low temperature blueschist and greenschist metamorphic facies. Many of these reactions also have low enthalpies of reaction ($\Delta H(r)$), such that uncertainties typical of laboratory determinations (~1-4 kJ/mol) are larger than the total enthalpy change for the reaction. To combat these issues, and allow calculation of all equilibria between a set of mineral end-members, thermodynamic databases are created which combine calorimetrically determined mineral properties with experimental reversals (Helgeson et al. 1978; Perkins et al. 1980). They are known as internally consistent because the thermodynamic parameters regressed for each phase depend on the others to produce equilibria which best fit the experimental determinations. The two most commonly used internally consistent databases in metamorphic petrology are Berman (1988) and Holland and Powell (1985, updated 1998). Many phases with incomplete or provisional data are included out of the desire to create complete petrogenetic grids for a chemical system or to calculate compositional slices through phase diagrams (dubbed pseudosections by Holland and Powell,1985) which represent all the minerals found in an assemblage. Although better than the alternative of supplementing the database with other data (thereby removing the constraint of internal consistency), the presence of provisional data can be hazardous. Workers who take a black box approach to the datasets will often assume any phase in the dataset produces well-located equilibria.

This thesis is organized around the idea that many minerals are included in the thermodynamic databases with poorly known or estimated thermodynamic data. Continued work is necessary to improve the calculations made with the datasets, and more accurately determine the conditions of metamorphism. The following chapters explore some edges of the databases and suggest ways to improve calculations made with the dataset of Holland and Powell (1998).

Chapter II investigates the consequences of an uncertainty in basic thermodynamic parameters for the calculation of thermobarometric reactions. Sphene is a relatively common rock-forming mineral, and one of only a handful of phases (rutile, ilmenite, titanian magnetite, biotite) which host significant titanium in crustal rocks. It is one of the minerals in a valuable barometer for eclogite facies rocks (Page et al. 2003).

The presence of sphene, rather than rutile has been used to suggest very low $CO_2$ activities in blueschists (Ernst, 1972). The Zr content in sphene is the potential basis of for a new trace element thermobarometer (Hayden et al. 2008). This chapter presents a study of the low-temperature heat capacity of sphene, in order to resolve the discrepancy between the previously measured standard entropy ($S^{\circ}_{298.15}$) and a lower value, proposed by Xirouchakis and Lindsley (1998). This value was suggested to be consistent with enthalpy of formation ($\Delta H_f$) measurements of Xirouchakis et al. (1997b) and phase equilibria experiments by Manning and Bohlen (1991) on the reaction kyanite + sphene = anorthite + rutile. The measured heat capacity data allow calculation of the standard entropy of sphene, which is in agreement with the previous determination (King et al. 1954). Combining this value with literature data on the high-temperature Cp and volume allows a partial resolution of the problem, and suggest the calorimetrically determined $\Delta H_f$ is in error. This data is applied to allow calculation of various sphene-bearing equilibria, useful especially in high-pressure rocks such as those in the blueschist and eclogite facies rocks.

Chapter III includes the first ever data on the heat capacity of $TiO_2$-II, a high pressure polymorph of rutile, isostructural with $\alpha$-$PbO_2$. This mineral has been found in many experimental studies of the $TiO_2$ system (e.g. Arashi 1992; Wang et al. 2008). $TiO_2$-II is also observed both in rocks shocked by meteorite impacts (Hwang et al. 2000), and as along twin boundaries in rutile from ultra high-pressure (UHP) rocks (El Goresy et al. 2000; Jackson et al. 2006). The occurrences of this mineral at high pressures, suggests it may be useful as a lower limit on the pressures obtained for some UHP rocks. Several experimental studies of the rutile = $TiO_2$-II equilibrium boundary (Akaogi et al. 1992, Olsen et al. 1999, Withers et al. 2002) find the transition located in the coesite-diamond stability field. There is some disagreement between the studies about the slope of the curve, and as temperatures increase above 900˚C, the pressures determined from the Akaogi et al. (1992) and Withers (2002) boundary diverge.

Although the latter study fits more datapoints and appears more reliable, resolving this issue would allow for more confidence in using the polymorphic reaction to determine a lower pressure bound for $TiO_2$-II-bearing UHP rocks. In order to estimate this slope using the Clapeyron equation ($\Delta S/\Delta V = dP/dT$) the low-temperature heat capacity of $TiO_2$-II was measured. Heat capacity determinations were made with two different instruments, a physical properties measurement system (PPMS) and differential scanning calorimeter (DSC) to cover different temperature ranges. The standard entropy is calculated as before, with the added complication of interpolating into an area with no data. The chapter also addresses the difficulties in extrapolating thermodynamic data above where they are measured. In particular, the heat capacity curves of rutile and $TiO_2$-II are similar, and cross at ~150 K, suggesting an overturn at higher temperatures, which is unusual, and requires $TiO_2$-II to be stable at higher temperatures, in conflict with all of the experiments. Therefore, there may be issues with the heat capacity data.

In Chapter IV thermodynamic data are applied to metabasaltic rocks from the island of Crete, in order to estimate the conditions at which these rocks were metamorphosed. On Crete, high-pressure blueschist-facies rocks are juxtaposed against unmetamorphosed carbonate units along a detachment. The metabasalts on Crete contain lawsonite, glaucophane and omphacite, evidence of a high-pressure history, resulting from their burial and heating while entrained in the nearby Hellenic subduction zone in the late Oligocene. The PT conditions estimated by Theye et al. (1992) for phyllites from Crete were based on provisional thermodynamic data for the mineral magnesiocarpholite (Vidal et al. 1992). These estimates were used by various workers (Jolivet et al. 1996; Küster and Stöckhert 1997; Thomson et al. 1998; Ring et al. 2001; Chatzaras et al 2006; Van Hinsbergen et al. 2006) to suggest exhumation models for the blueschists of Crete. This study compares new estimates made on metabasalts with glaucophane/lawsonite/pumpellyite reactions to those from the literature made with carpholite/chloritoid equilibria. The impact on many tectonic models of changing the max PT estimates for Crete illustrates how greatly the tectonic models rely on accurate thermobarometry. This work also suggests that the use of provisional data in internally consistent database of Holland and Powell (1998) is subject to unknown errors, and rocks from the same area can produce highly contrasting PT estimates within the database, when the thermodynamic properties of the minerals used in thermobarometry are not well known.

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# Chapter II

## Low-temperature heat capacity measurements and new entropy data for sphene (titanite): implications for thermobarometry of high-pressure rocks

### Introduction

Two sets of values for the entropy of sphene, $CaTiSiO_5$, have been proposed at standard pressure and temperature (STP). One value ($S°_{298}$ = 129.3 J/mol·K) is derived from the low-temperature adiabatic calorimetry of King et al. (1954). The other is a series of proposals to lower the entropy at STP to something around 110 J/mol·K, and results from the combination of enthalpy measurements (Xirouchakis et al. 1997b) with calculations based on phase equilibrium experiments (Manning and Bohlen 1991). The large disparity in these values leads to great uncertainty in calculations of phase equilibria involving sphene, both in traditional thermobarometry and the calculation of petrogenetic grids and pseudosections for systems involving titanium. In order to resolve this discrepancy the specific heat of a pure synthetic sample was measured with a new calorimeter by Quantum Designs. It is the same sample synthesized and analyzed by Xirouchakis et al. (1997a), and which was also used for their enthalpy measurements.

The heat capacity of sphene was first measured by King et al. (1954), who performed adiabatic heat capacity measurements on 252.17 g of polycrystalline synthetic sphene from 52.3 to 298 K (Fig. 2.1). They calculated $S°_{298}$ as 129.3±0.8 J/mol·K. This value was determined by Simpson-rule integration of the Cp data vs. log T from 51 to 298 K. The contribution to the entropy of sphene between 0 and 51 K was calculated using the sum of one Debye and three Einstein functions empirically fit to the measured data and extrapolated down to 0 K, yielding 7.11 J/mol·K (King et al. 1954).

Xirouchakis et al. (1997b) measured the heat of solution and calculated a value of -2610.1 ± 2.9 kJ/mol·K for the enthalpy of formation of pure, well-characterized synthetic sphene. This value is significantly more negative than that determined by Todd and Kelley (1956) and those refined in internally consistent thermodynamic databases. A revision of the standard entropy of sphene to a much lower value was suggested in order to fit with the experiments of Manning and Bohlen (1991).

Manning and Bohlen (1991) obtained experimental reversals (<1 kbar wide) at 900, 1000, 1050 and 1100 ˚C on the reaction:

$$CaTiSiO_5 + Al_2SiO_5 = CaAl_2Si_2O_8 + TiO_2 \quad (2.1)$$

sphene + kyanite = anorthite + rutile

which they designated with the acronym TARK. Analysis of the run products suggests that the rutile and sphene deviated somewhat from ideal stoiciometry as $Ti_{0.97}Al_{0.02}Ca_{0.01}O_2$ and $Ca_{1.00}Ti_{1.05}Si_{0.95}O_5$, respectively. The presence of Ca in rutile is unexpected and may be an artifact related to excitation of matrix Ca by Ti X-rays (a similar effect was noted by Essene et al. 2005, for fluorescence of Ca in matrix calcite by Ba L$\alpha$ X-rays in hyalophane). The apparent substitution of Ti in the IV site of sphene is also unanticipated, although excess Si for Ti in the VI site has been well documented at ultra-high pressure conditions (UHP) in “supersilicic” sphene (Knoche et al. 1998; Angel et al. 1999).

The current study was undertaken in order to evaluate whether or not there is a large error in the Cp of sphene by King et al. (1954), in order to provide more confidence in thermodynamic calculations with sphene and systems involving titanium.

## Methods

Specific heat measurements were made by Edgar Dachs in his laboratory at the Universität de Salzburg with the heat capacity option of the Quantum Designs Physical Properties Measurement System (PPMS). The sample measured was kindly provided by Dimitris Xirouchakis, and is a pure polycrystalline synthetic sphene. The heat capacity was measured on 21.38 mg of the sample (96-1) used by Xirouchakis and coworkers (Xirouchakis et al. 1997a, 1997b; Tangeman and Xirouchakis 2001). Electron microprobe measurements obtained by Xirouchakis et al. (1997b) on the sample yield a composition of $Ca_{1.00}Ti_{1.01}Si_{0.99}O_{5.00}$ with errors given as ± 0.02 atoms/mol. The sample powder was sealed in an aluminum pan, and the heat capacity measured from 5 to 303 K in increments that varied from 0.5 K to 20 K at the highest temperatures (Fig. 2.1, Table 2.1). Each data point is the average of three measurements.

The Quantum Designs PPMS is a new, commercially available heat-pulse calorimeter that is able to precisely measure the specific heats of 10-50 mg of sample. The PPMS can determine heat capacities on milligram sized samples because the response of the calorimeter to an applied heat-pulse is fit as a function of time (Hwang et al. 1997). The temperature of the sample platform through time is recorded as the whole system responds to the heat-pulse applied at a fixed temperature. The data are then fit with nonlinear least squares to a model derived by Hwang et al. (1997), which, in the PPMS implementation, includes five variables: the specific heats of the sample and platform; the background temperature; and two time constants of heat decay, one for the sample platform as well as the sample (Dachs and Geiger 2006). In general, the error from these measurements is dominated by the relative values of the measured specific heat, the sample platform specific heat and the time constant of heat decay between the sample and the sample platform.

Recent studies have evaluated the accuracy and precision of the PPMS. Lashley et al. (2003) and Dachs and Bertoldi (2005) were both able to reproduce heat capacities of standard materials to better than 1% above 100 K and 5 - 3%, respectively below 100 K.

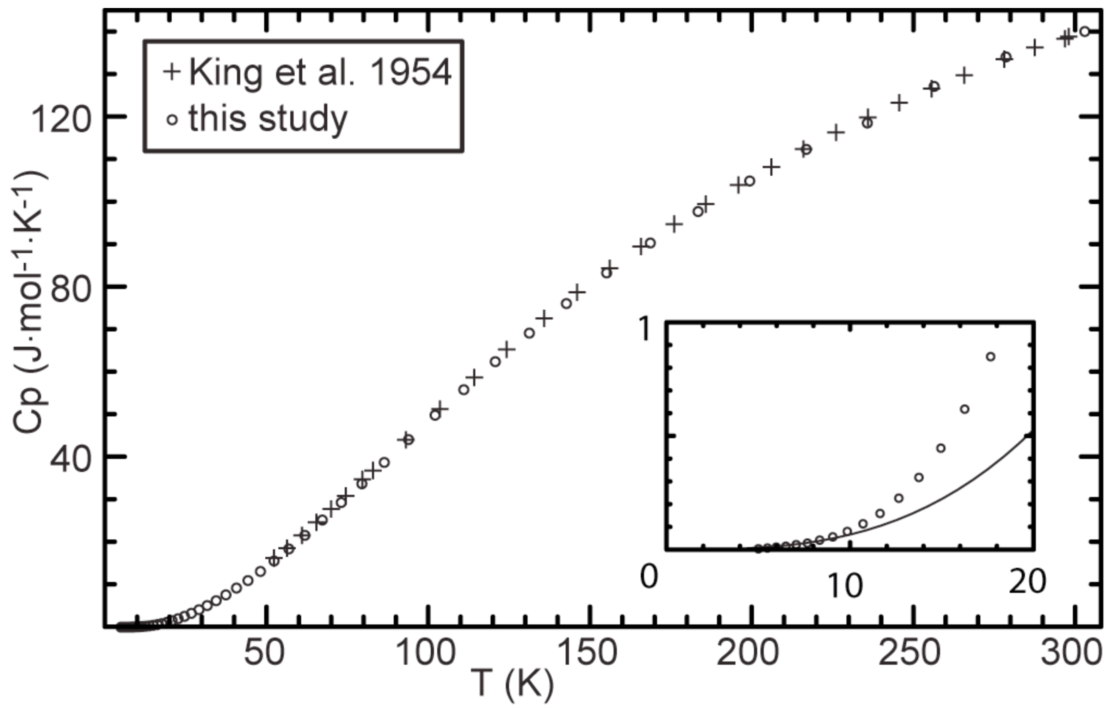


**Fig. 2.1.** Low-temperature Cp data of sphene. Points are from King et al. (1954, *crosses*) and this study (*circles*). The data show good agreement, diverging most at the lowest temperatures. 2s errors are smaller than the size of the symbol. *Inset* shows data near 0 K, along with the best-fitting function of the form Cp = $T^3$ used to extrapolate below the range of measurements.

## Results

The new low-temperature specific heat of sphene (Table 2.1) agrees quite well (Fig. 2.1) with the adiabatic measurements of King et al. (1954). The agreement is better than 1% above 100 K, and it rises to 5% at the lowest of King's measurements, which tend to be slightly higher than the present measurements. The reproduction of the earlier study is encouraging for the continued use of heat capacity data determined on large, potentially impure samples. It refutes the suggestion made in Xirouchakis et al. (1997b) and also Tangeman and Xirouchakis (2001) that an impurity of the King sample contributed to a highly erroneous standard entropy for sphene. The suggestion is surprising, since all specific heat curves on the same bulk composition are to a first approximation the same. A 1% dilution of sphene with its constituent oxides would result in only a very small overestimation of the measured specific heat, an amount well within the experimental uncertainty, for example 0.01% at 298 K. At low temperatures (T < 50 K) the sum of the specific heats of the constituent oxides, $SiO_2$ (Hemingway 1991), CaO (Gmelin 1969) and $TiO_2$ (McDonald and Seltz 1939; Dugdale et al. 1954; Sandin and Keeson 1969; deLigny et al. 2002) is negligibly different from that measured for sphene in this study. At higher temperatures, the effect of a stoichiometric admixture of oxides is in the wrong direction (a lower value), so oxide contamination cannot account for the small difference between the present study and that of King et al. (1954).

**Table 2.1** Cp data for sphene. Points represent the average of three measurements.

| T (K) | 2σ (K) | Cp (J/mol/K) | 2σ (J/mol/K) | T (K) | 2σ (K) | Cp (J/mol/K) | 2σ (J/mol/K) |
|---|---|---|---|---|---|---|---|
| 5.0236 | 0.0038 | 0.00672 | 0.00033 | 40.733 | 0.044 | 9.211 | 0.093 |
| 5.5139 | 0.0077 | 0.01004 | 0.00047 | 44.288 | 0.049 | 10.98 | 0.11 |
| 5.9963 | 0.0084 | 0.0139 | 0.0006 | 48.149 | 0.052 | 13.11 | 0.13 |
| 6.5149 | 0.0084 | 0.0178 | 0.0005 | 52.350 | 0.056 | 15.58 | 0.15 |
| 7.078 | 0.010 | 0.0249 | 0.0007 | 56.916 | 0.060 | 18.42 | 0.17 |
| 7.691 | 0.011 | 0.0316 | 0.0009 | 61.876 | 0.063 | 21.61 | 0.19 |
| 8.358 | 0.011 | 0.0447 | 0.0009 | 67.272 | 0.069 | 25.22 | 0.21 |
| 9.072 | 0.015 | 0.0590 | 0.0013 | 73.139 | 0.067 | 29.33 | 0.22 |
| 9.860 | 0.016 | 0.0825 | 0.0016 | 79.519 | 0.074 | 33.74 | 0.24 |
| 10.718 | 0.017 | 0.1163 | 0.0020 | 86.444 | 0.076 | 38.76 | 0.25 |
| 11.644 | 0.013 | 0.1616 | 0.0027 | 93.947 | 0.082 | 44.14 | 0.26 |
| 12.666 | 0.019 | 0.2286 | 0.0031 | 102.172 | 0.084 | 49.88 | 0.28 |
| 13.761 | 0.019 | 0.3195 | 0.0040 | 111.041 | 0.086 | 55.88 | 0.28 |
| 14.954 | 0.020 | 0.4477 | 0.0049 | 120.771 | 0.088 | 62.47 | 0.29 |
| 16.252 | 0.022 | 0.6189 | 0.0065 | 131.309 | 0.100 | 69.19 | 0.31 |
| 17.664 | 0.024 | 0.8492 | 0.0084 | 142.765 | 0.104 | 76.14 | 0.31 |
| 19.199 | 0.024 | 1.145 | 0.011 | 155.222 | 0.107 | 83.35 | 0.31 |
| 20.863 | 0.022 | 1.522 | 0.014 | 168.719 | 0.100 | 90.39 | 0.30 |
| 22.673 | 0.027 | 1.989 | 0.018 | 183.492 | 0.099 | 97.79 | 0.33 |
| 24.648 | 0.030 | 2.560 | 0.024 | 199.465 | 0.116 | 104.98 | 0.33 |
| 26.798 | 0.029 | 3.264 | 0.031 | 216.974 | 0.107 | 112.42 | 0.35 |
| 29.134 | 0.032 | 4.104 | 0.038 | 235.839 | 0.102 | 118.62 | 0.36 |
| 31.676 | 0.033 | 5.095 | 0.050 | 256.488 | 0.081 | 127.22 | 0.35 |
| 34.446 | 0.036 | 6.244 | 0.060 | 278.724 | 0.059 | 134.17 | 0.39 |
| 37.459 | 0.039 | 7.606 | 0.073 | 303.106 | 0.049 | 140.15 | 0.44 |

**Table 2.2** Parameters used to model the experimental data between 0 and 298 K.

| T range (˚C) | 1 | T | $T^2$ | $T^3$ | $T^{-0.5}$ | $T^{-2}$ | $T^{-3}$ |
|---|---|---|---|---|---|---|---|
| 5.0-19.2 | 26.0513 | -1.37863 | 0.0476856 | -4.83118E-4 | -57.3855 | 202.379 | -339.517 |
| 19.2-40.7 | -550.012 | 9.979202 | -0.114109 | 6.21366E-4 | 2093.97 | -38765.3 | 198835 |
| 40.7-131.3 | -279.036 | 2.57658 | -0.00805509 | 1.14530E-5 | 1448.91 | -66855.9 | 616945 |
| 131.3-303.2 | 19101.8 | -52.5533 | 0.103277 | -8.72401E-5 | -185230 | 56522100 | -1.87368E+9 |

The standard entropy, 127·2 J/mol·K, of sphene is calculated according to the equation

$$S_T = \int_0^T \frac{Cp}{T} dT \tag{2.2}$$

The integration was performed by fitting the data with an equation of the form $Cp = k_0 + k_1 T^{-0.5} + k_2 T^{-2} + k_3 T^{-3} + k_4 T + k_5 T^2 + k_6 T^3$ by the method of least squares. Since no single fitting polynomial accurately describes the heat capacity curve, the data is fit over several temperature ranges (5-19 K, 19-41 K, 41-131 K, 131-303 K) and fitting parameters are given in Table 2.2. The uncertainty in the calculated entropy is approximated by determining the error of each fit coefficient, and then calculating the error associated with the curve after integrating the equation. The entropy below 5 K is calculated according to a $T^3$ model, and has a total magnitude of 0.002 J/mol·K, and therefore any uncertainty associated with this approximation is trivial. The 2.1 J/mol·K difference between the entropy calculated from the data of King et al. (1954) and those of this study is partially explained by the extrapolation of the King data below 52 K. Calculation of the entropy from the data of this study from 4 to 52 K is 1 J/mol·K less than was estimated by King with a combination of Debye and Einstein functions fit to their experimental data.

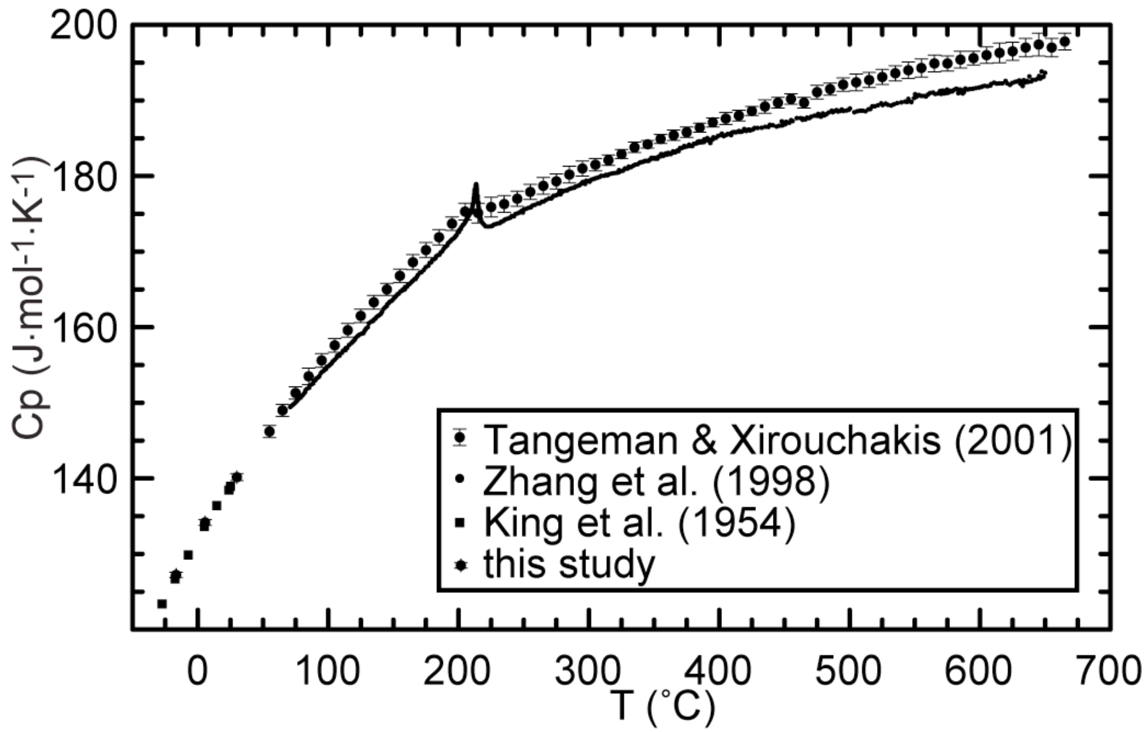


**Fig. 2.2.** Cp of sphene from various authors. Zhang et al. (1995), dots; Tangeman and Xirouchakis (2001), filled circles; and this study, stars. The data of this study merge smoothly with the data above 298 K. Though the data of Zhang is lower than that of Tangeman and Xirouchakis (2001) both data sets show the anomaly associated with the phase transition at 214 ˚C. The data of Zhang is likely less accurate than the averaged data of Tangeman and Xirouchakis (2001), but it can more precisely represent the form of the heat-capacity anomaly. 2$\sigma$ error bars are shown for datasets other than Zhang.

## Heat capacity data

King et al. (1954) measured the heat content of crystalline sphene from 375 to 1665 K, and above the room pressure melting point at 1670 K up to 1811 K. These values were used to obtain the entropy and heat capacity above 298.15 K (Fig. 2.2), and formed the basis for values used by most workers since that time (e.g., Robie and Hemingway 1995; Holland and Powell 1998). Tangeman and Xirouchakis (2001) undertook a detailed differential scanning calorimetry (DSC) study of the specific heat of sphene between 328 and 938 K on the sample characterized in Xirouchakis et al. (1997b), which yielded their preferred enthalpy of formation. Above 300 ˚C the heat capacity determined in that study is about 2% greater than the function given in Robie and Hemingway (1995), which was derived from the King data (Fig. 2.2*).* In a paper focused on phase transitions in sphene, Zhang et al. (1995) included a DSC determination of specific heat, which contains a sharp $\lambda$-anomaly at 486 K. Unfortunately, they did not tabulate their measurements, and the authors have not been able to retrieve the original Cp data for us to apply. The Zhang data exists only as a figure in the paper. Scanned data used by Hayward et al. (2000) in a study of the enthalpy of transition in sphene (Hayward, personal communication, 2005) agrees well with data scanned and digitized by the authors (Fig. 2.2).

The DSC measurements of Tangeman and Xirouchakis (2001) merge smoothly (Fig. 2.1), with the low temperature data of this study and those of King et al. (1954). However, when plotted against the data of Zhang et al. (1995), they disagree, especially at higher temperature (Fig. 2.2). The Tangeman data were used for the absolute determination of a heat capacity equation because they represent the average of a large number of measurements and therefore should be more precise. A Berman and Brown (1985) type equation of the form $Cp = k_0 + k_1T^{-0.5} + k_2T^{-2} + k_3T^{-3}$ is used to fit to the data above 487 K so that the equation is reasonable upon extrapolation above 940 K. An attempt was made to require that this equation approach the theoretical Dulong-Petit limit of $3nR + V^*Cp^*\alpha/\beta$. However, inclusion of this limit resulted in an equation biased against the highest temperature data points. The current equation is less than 2% different than the theoretical value at 1000 K. The Cp equation from Tangeman and Xirouchakis (2001) is not used, because it involves a large number of coefficients, and does no better at fitting the observed data than the simpler equation (Fig. 2.3). The maximum difference in derived thermodynamic properties ($\Delta H - T\Delta S$) between the equation of Tangeman and Xirouchakis (2001) and that derived in this study does not exceed 0.075 kJ/mol until 1200 ˚C. The use of a Berman-type equation also allows easy incorporation into internally consistent thermodynamic databases.

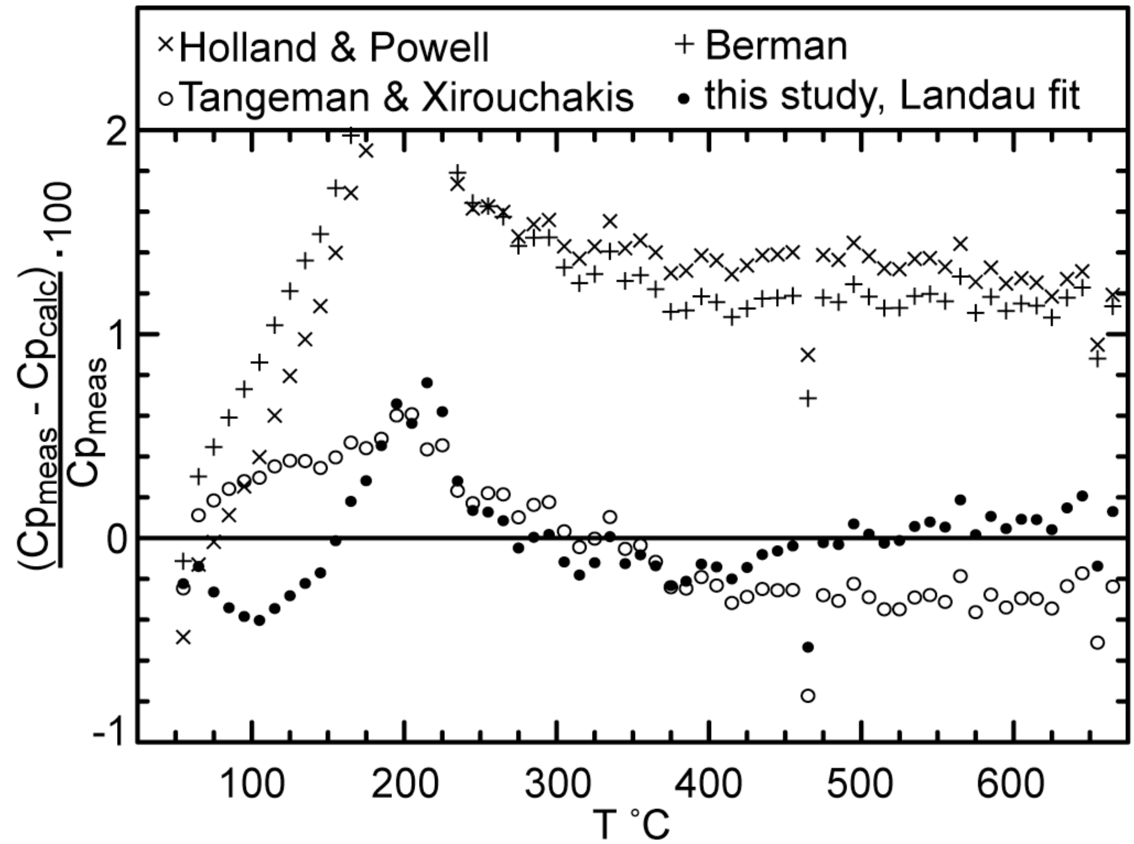


**Fig. 2.3.** Residuals for published Cp equations. Data were generated by comparing the dataset of Tangeman and Xirouchakis (2001) combined with several heat capacity equations for sphene. Data symbols are calculated with equations from Holland and Powell (1998), x symbols; Berman (1988), crosses; Tangeman and Xirouchakis (2001), open circles; and this study, filled circles. The equation used in this study is a combination of a Berman-type equation for extrapolating to high temperatures, and a Landau-type fit to model the phase transition (Holland and Powell, 1998).

Sphene undergoes a structural phase transformation at around 500 K (Higgins and Ribbe 1976; Malcherek et al. 2001) where its symmetry changes from $P2_1/a$ to A2/a. This transition is evident in the heat capacity data (Fig. 2.2). It occurs at a relatively low temperature, so that for most geologic conditions the A2/a form is the relevant phase for most geologic conditions. From a number of structural studies (Bismayer et al. 1992; Chrosch et al. 1997; Malcherek et al. 2001) the break in the curve due to the phase transition should be located at 487 K, between data points at 478 and 488 K in the Tangeman dataset. The sharp anomaly seen in the Zhang data is consistent with the data of Tangeman and Xirouchakis (2001) due to the 10˚C step size in the latter data.

The Cp anomaly in Zhang's dataset was integrated to determine 0.4 J/mol·K as a reasonable $\Delta S$ of transition. Those data sample the anomaly every 1 K and better record the peak for integration. The break in the heat capacity is treated as a $\lambda$ transition for the sake of implementation into the internally consistent thermodynamic dataset of Holland and Powell (1998). The equation is:

$$Cp = a + bt + \frac{c}{t^2} + \frac{d}{\sqrt{t}} + \frac{S_{max}t}{2\sqrt{t_c}\sqrt{t_c - t}} \tag{2.3}$$

where a = 0.2370 kJ, , b = 0, c = -3256.5 kJ, d = -1.094 kJ, $S_{max}$ = 3.946*$10^{-4}$ kJ/K, $t_c$ = 485 K. Despite the more accurate description of the transition by a Bragg-Williams than a Landau model (Hayward, 2000), the Landau approximation fits the experimental heat capacity data adequately because the integrated values of entropy and enthalpy are not appreciably affected.

Heat content measurements made by King et al. (1954) and Thieblot (1997) can be used to constrain the heat capacity at temperatures above the 940 K measured by Tangeman and Xirouchakis (2001) but below the room pressure melting point of sphene (1670 K). Since the heat content measurements are of the form $H_T - H_{298}$ they are related to the heat capacity by the equation,

$$H_T - H_{298} = \int_{298}^{T} Cp\, dT \tag{2.4}$$

It is possible to assume a polynomial form for the Cp and perform the integration, so the coefficients may be determined from a least squares fit to the data. Unfortunately, the heat capacity equation generated is highly dependent on the polynomial form chosen for integration, and so provides little real constraint of the value of Cp at higher temperatures. However, the enthalpy generated with the heat capacity equation used in this chapter neatly bisects the two heat content data at the highest temperatures of measurement (1600 K), indicating that the equation used in this chapter represents all data well.

### Volume data

The effect of pressure and temperature on the unit cell volume of sphene was not measured until recently. As a result, both Berman (1988) and Holland and Powell (1988) estimated the values of expansivity and compressibility. The interest in structural phase transformations of sphene prompted determinations of the unit cell volume of sphene up to 1000 K in a single crystal X-ray diffractometer (Malcherek 2001) up to 76 kbar in a diamond cell (Angel et al. 1999b) and from 275 to 650 K and 0.001 to 49 kbar in a diamond cell (Kunz et al. 2000). As a result of these studies, it is now possible to interpolate the volume behavior of sphene to conditions relevant for the calculation of phase equilibria, although extrapolation is still required above 700˚C. Surprisingly, the approximation used in Holland and Powell (1998) needs only a slight modification of the thermal expansion parameter and the standard state molar volume to describe the volume behavior of sphene as well as is possible for an equation of this form (Fig. 2.4). This modified Murgnahan equation of state is:

$$V_{P,T} = V^{\circ}_{298}*[1+a^{\circ}(T-298)-20a^{\circ}(T-298)]*[1-4P/(K_{298}*[1-1.5*10^{4}\ (T-298)]+4P)]^{1/4} \quad (2.5)$$

For sphene the fit parameters are $V^{\circ}_{298}$ = 5.568 kJ/kbar, a˚ = $3.1*10^{-5}$ $K^{-1}$, and K = 1100 kbar, which will be used in all further calculations in this chapter. The coefficients listed in Holland and Powell (1998) are 5.565, $4.20*10^{-5}$ and 1100 respectively. The new coefficients fit the measured volume data within 0.4%. It can be seen (Fig. 2.4) that the equation is inadequate to describe the volume behavior of sphene at the highest pressures (> 50 kbar). This is not due to the failure of the high-pressure EOS, but to the attempt to fit both thermal expansion and compressibility with a single equation. The compressibility data alone can be fit quite well with the second order Murgnahan EOS, and use of the more complicated Birch-Murgnahan equation does not improve the fit. It

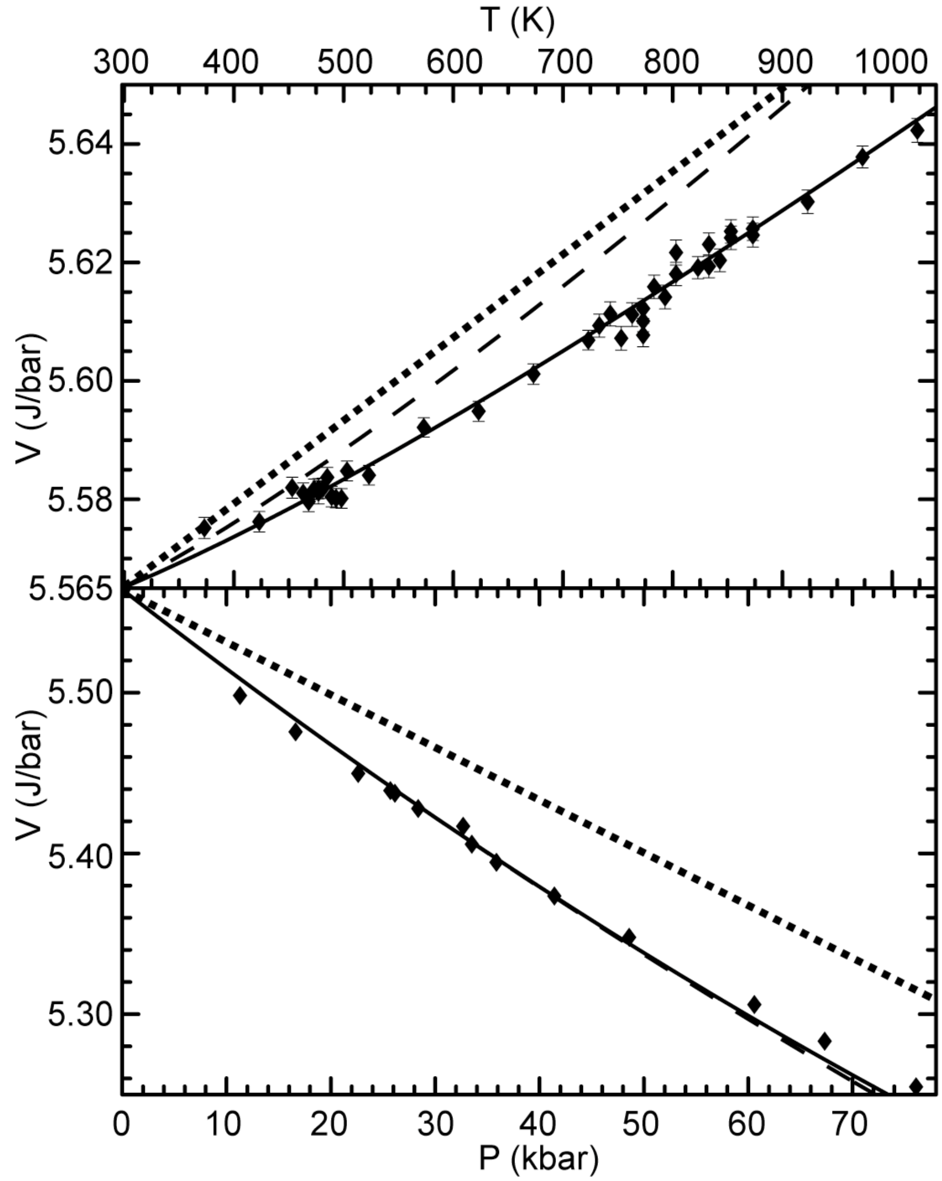


**Fig. 2.4.** Volume data and equations for sphene. Points are determined from lattice parameter measurements of Angel et al. (1999), Kunz et al. (2000) and Malcherek (2001). Equations used to calculate volumes are from Berman (1988), dotted; Holland and Powell (1998), dashed; and this study, solid. Note that the Murgnahan equation of state used in Holland and Powell (1998), and in this study, is not adequate to describe the data of Angel et al. (1999) at pressures greater than 50 kbar.

is possible to fit the experimental data with a simple polynomial, quadratic in both T and P, as employed in the internally consistent database of Berman (1988). The impact of volume data was noted by Tangeman and Xirouchakis (2001), but unfortunately they did not provide the coefficients or even the form of the volume equation they employed. In addition, they only show how their equation compares to that of Berman (1988) for which (Fig. 2.4) the volume fit is much worse than that obtained with the coefficients of Holland and Powell (1998).

### Enthalpy of formation

Todd and Kelley (1956) measured the enthalpy of solution of several titanates to calculate enthalpy of formation from the oxides, including the sample of sphene measured by King et al. (1954). Their enthalpy is -2602.9 ± 2.1 kJ/mol, when converted to formation from the elements, computed using the same cycles as Xirouchakis et al. (1997b) to allow for direct comparison. The enthalpy of formation value (-2610.1 ± 2.9 kJ/mol) determined by Xirouchakis et al. (1997b) is 7.2 kJ/mol more negative than the determination of Todd and Kelley (1956), outside the range of experimental uncertainty of both determinations. Akaogi et al. (2004) measured the drop solution enthalpies at 978 K for pure $CaTiSiO_5$ as well as five supersilicic sphenes on the join $CaTiSiO_5$—$CaSi_2O_5$. They determined a value of -2607.1 ± 4.6 kJ/mol for end-member sphene, when corrected for the small difference in temperature between the two studies (978 and 975 K), within error of both Todd and Kelley's determination and the measurements by Xirouchakis et al. (1997b).

Figure 2.5 illustrates the problem with combining the Xirouchakis et al. (1997b) enthalpy of –2610 kJ/mol with an entropy of 127.2 J/mol·K at STP. The value of $\Delta H^{\circ}_{298}$ at 1 bar, which best fits the experiments of Manning and Bohlen (1991) is –2598.4 kJ/mol (Table 2.3), 11 kJ/mol less negative than that measured by Xirouchakis et al. (1997b). The slight deviations from pure end-member sphene present in the experimental charges were accounted for by using an ideal molecular mixing model for the activity of sphene ($aCaTiSiO_5$ = XTi, Tropper et al. 2002). The best fit lies just outside the experimental brackets because the new entropy and volume data yield a Clapeyron slope slightly too large to fit the Manning and Bohlen (1991) experiments for any value of $\Delta G^{\circ}_{298}$, 1 bar (Fig. 2.5).

**Table 2.3** Summary of published thermodynamic data for $CaTiSiO_5$ sphene

| | $\Delta Gf^{\circ}_{298}$ (J/mol.K) | $2\sigma$ | $\Delta Hf^{\circ}_{298}$ (J/mol.K) | $2\sigma$ | $S^{\circ}_{298}$ (J/mol.K) | $2\sigma$ | $V^{\circ}_{298}$ (J/mol.K) |
|---|---|---|---|---|---|---|---|
| King et al. (1954) | — | — | — | — | 129.3 | 0.8 | — |
| Todd and Kelley (1956) | — | — | -2602.9 | 2.1 | — | — | — |
| Robie and Hemingway (1995) | -2454.6 | | -2596.6 | 3 | 129.2 | | 5.574 |
| Berman (1988) | -2455.13 | | -2596.65 | | 129.29 | | 5.565 |
| Holland and Powell (1998) | -2454.15 | | -2595.55 | 2.08 | 131.2 | | 5.565 |
| Xirouchakis et al. (1997b) | — | — | -2610.1 | 2.9 | — | — | — |
| Akaogi et al. (2004) | — | — | -2607.1 | 4.6 | — | — | — |
| this study | -2456.2 | 2.0 | -2598.4 | 2.0 | 127.2 | 0.2 | 5.568 |

The entropy determination in this study appears to be robust, especially in light of its agreement with the data of King et al. (1954), and yet there is no *a priori* reason to doubt the $\Delta H_f$ value of Xirouchakis et al. (1997b) and Akaogi et al. (2004). Assuming that there are no large errors in the thermodynamic properties of kyanite, anorthite and quartz, either the reversal brackets on the locus of TARK or the enthalpy of formation must require revision. Another sphene-bearing reaction has been the focus of several studies, and can provide some light on the subject.

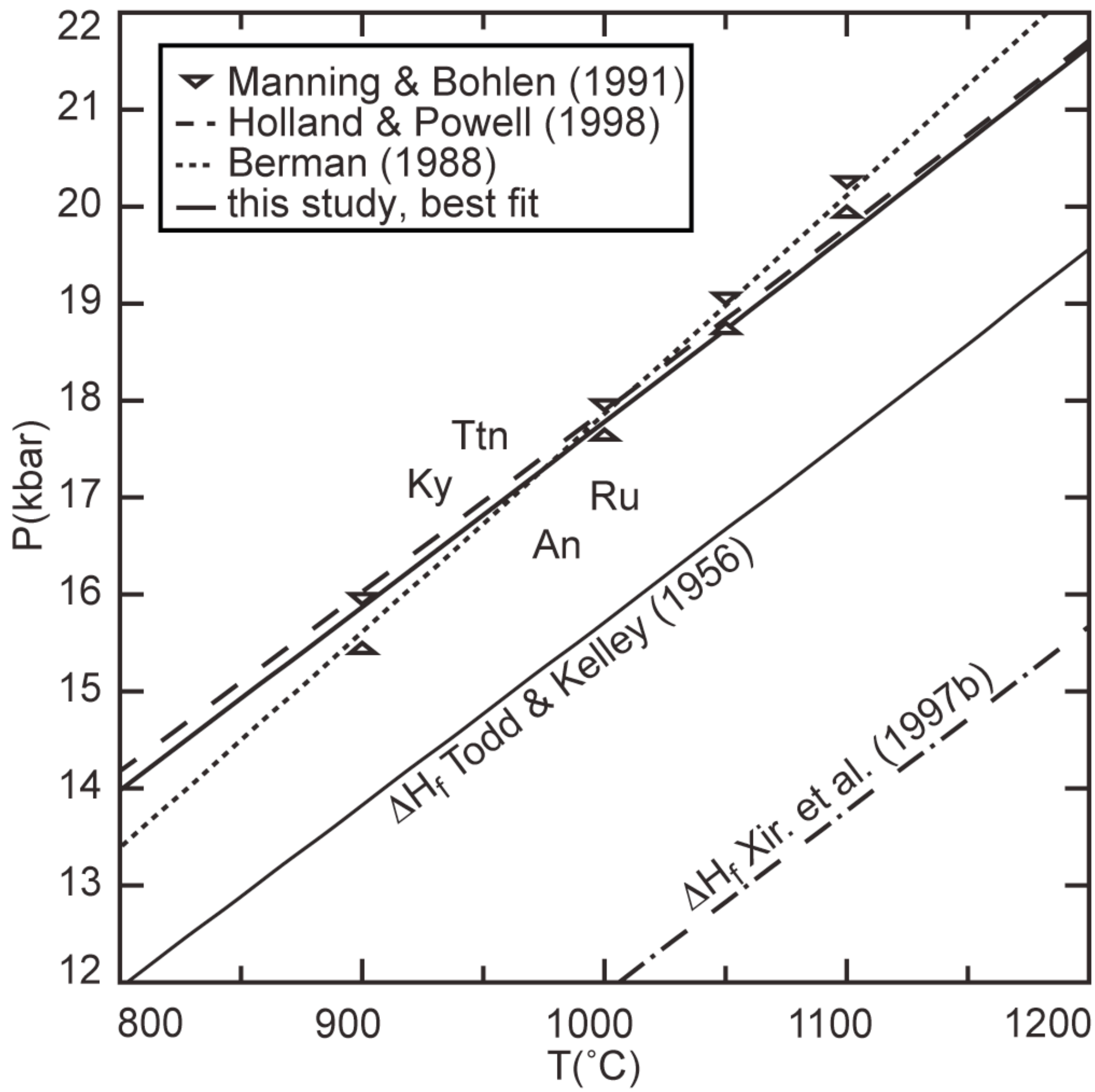


**Fig. 2.5.** Experimental reversals of TARK by Manning and Bohlen (1991). The reaction is calculated with datasets of Berman (1988) and Holland and Powell (1998). Additional curves show the entropy determined in this study, combined with enthalpies of formation from Todd and Kelley (1956), Xirouchakis et al. (1997b) and a least squares fit to the reversals. The improved Cp and V data prevent the equilibria from completely fitting the experimental brackets, which is permitted in the dataset of Berman. This differences in slope leads to large differences in calculated pressures for low temperatures, e.g., in the greenschist facies.

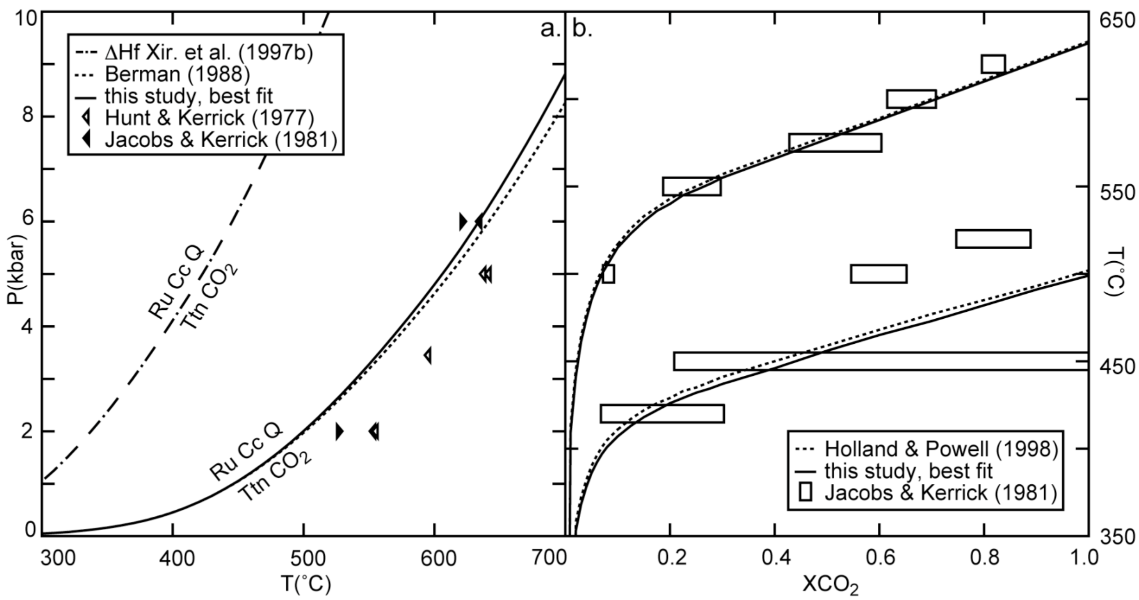


**Fig. 2.6.** Constraints on the reaction rutile+quarz+calcite=sphene+$CO_2$ a. Experimental half-reversals of Hunt and Kerrick (1977) and Jacobs and Kerrick (1981), extrapolated to $XCO_2$ = 1. The reaction is calculated with the datasets of Berman (1988) and Holland and Powell (1998). In addition, curves have been plotted with the new entropy value combined with enthalpies of formation from Xirouchakis et al. (1997b) and refined in this study. The curve calculated from Holland and Powell (1998) directly overlaps the one derived in this study. b. Experiments of Jacobs and Kerrick (1981) at 2 and 6 kbar, plotted with reaction (2.6) calculated using THERMOCALC. The experimental brackets have been reinterpreted using strict reversals in an attempt to fit the curves.

Hunt and Kerrick (1977) investigated the formation of sphene according to the reaction,

$$TiO_2 + CaCO_3 + SiO_2 = CaTiSiO_5 + CO_2 \quad (2.6)$$

$$\text{rutile + calcite + quartz = sphene} + CO_2$$

They used weight gain - weight loss methods at 2, 3.45 and 5 kbar to bound the locus of equilibrium based on the growth or dissolution of rounded quartz spheres in cold-seal pressure vessels. To thwart kinetic issues engendered by the use of $CO_2$, they used mixed $CO_2/H_2O$ fluids. Jacobs and Kerrick (1981) monitored the locus of this reaction at 2 and 6 kbar diluted with variable amounts of $H_2O$ by observing changes in the $CO_2$ content of the experimental fluid at the end of the run. The experiments were performed in both cold-seal (2 kbar) and internally-heated (6 kbar) pressure vessels. Figure 2.6a shows the studies of Hunt and Kerrick (1977) and Jacobs and Kerrick (1981) as “reversals” in temperature space; however, they are really brackets derived from different extrapolations of experiments with mixed fluids to pure $CO_2$. Reaction (2.6) is shown calculated with the ΔHf measured by Xirouchakis et al. (1997b) and the fit to the TARK brackets. There is a large difference in the calculated curves; that calculated with the measured enthalpy is almost 200 K lower. All reactions are calculated at $XCO_2 = 1$. Partly because these experiments were used in the derivation of Holland and Powell’s database, the fit to the 6 kbar data point is quite good. However the calculated curves are in obvious disagreement with the experimental brackets at 2 kbar. Because part of the purpose of the study of Kerrick and Jacobs (1981) was to investigate $H_2O$-$CO_2$ mixing properties, an attempt was made to obtain an unbiased fit of the experimental brackets. The data were originally fit to an Arrhenius-type equation consistent with all of the experimental brackets. On Figure 2.6a, the limits of these two fits at $XCO_2 = 1$ are presented as the “reversal” brackets of the data. In an attempt to reevaluate all the data, the brackets were re-analyzed with a more traditional approach of strict reversals. The Holland and Powell dataset used their CORK equation of state for $H_2O$-$CO_2$ mixtures, but other $H_2O$-$CO_2$ mixing models similarly will not fit all four data points at 2 kbar, regardless of any modifications made to the ΔG of other phases in the reaction. At 450 K, only one reversal was within 2 sigma of the calculations. It is strange that the higher temperature data are less reliable, but that may be due to the increase in $XCO_2$ of the fluid phase. It has been noticed before that these data are problematic. In an investigation into the effect of NaCl on the fluid, Bower and Helgeson (1983) used an MRK equation of state and calculated curves for reaction (2.6) that do not fit the 2 kbar, high $XCO_2$ data. The least-squares regression of Holland and Powell (1998) was also unable to fit the lower T experiments on sphene.

Sphene forms via reaction (2.6) in greenschist facies marbles (Schuiling and Vink 1967; Sobol 1973; Essene et al. 2005) but variations in $X(H_2O)/X(CO_2)$ are commonplace, such that the pure reaction only provides an upper bound to the stability of sphene in marbles. The $\Delta H_f$ value of Xirouchakis et al. (1997b) combined with the current sphene heat capacity places the calcite breakdown reaction at temperatures too low for greenschist facies occurrences of rutile-calcite-quartz. The assemblage rutile-calcite-quartz±sphene in upper greenschist facies rocks from Madoc, Ontario, attained 470±30°C at 4-5 kbar during Grenville metamorphism (Sobol, 1973; Rathmell et al. 1999; Essene et al. 2005). Therefore, the end-member reaction with pure $CO_2$ must be stable to at least these P-T conditions. The Manning and Bohlen (1991) experiments therefore are favored in determining the $\Delta H_f$ of sphene and in calculating sphene-bearing equilibria over the value of Xirouchakis et al. (1997b). Within uncertainties, the enthalpy of formation derived in this study almost overlaps with that determined by Todd and Kelley (1956). Direct experimental work on other sphene-bearing equilibria, for example: grossular + rutile = sphene + corundum, which occurs at ~30 kbar at 900˚C or

$$5\ CaTiSiO_5 + 2\ Ca_2Al_3Si_3O_{12}(OH) = 3\ Ca_3Al_2Si_3O_{12} + 5\ TiO_2 + 2\ SiO_2 + H_2O \qquad (2.7)$$

sphene + clinozoisite = grossular + rutile + coesite + $H_2O$,

could further elucidate the correct choice of an optimized $\Delta H°_{f,298}$ for sphene.

## Thermobarometry

Following the experimental determination of Manning and Bohlen (1991) several authors (Page et al., 2003; King et al., 2004; Topuz et al., 2004) have used sphene-bearing reactions for thermobarometry. The effect of the new parameters for sphene on the calculated locus of these equilibria is examined in Figure 2.7. Values of $\log_{10}K$ are shown for reactions (2.1), (2.7) and

$$Ca_3Al_2Si_3O_{12} + 3\ TiO_2 + SiO_2 = 3\ CaTiSiO_5 + Al_2SiO_5 \qquad (2.8)$$

grossular + rutile + coesite = sphene + kyanite

$$2Ca_2Al_3Si_3O_{12}(OH) + SiO_2 + TiO_2 = 3\ CaAl_2Si_2O_8 + CaTiSiO_5 + H_2O \qquad (2.9)$$

clinozoisite + quartz + rutile = anorthite + sphene + $H_2O$.

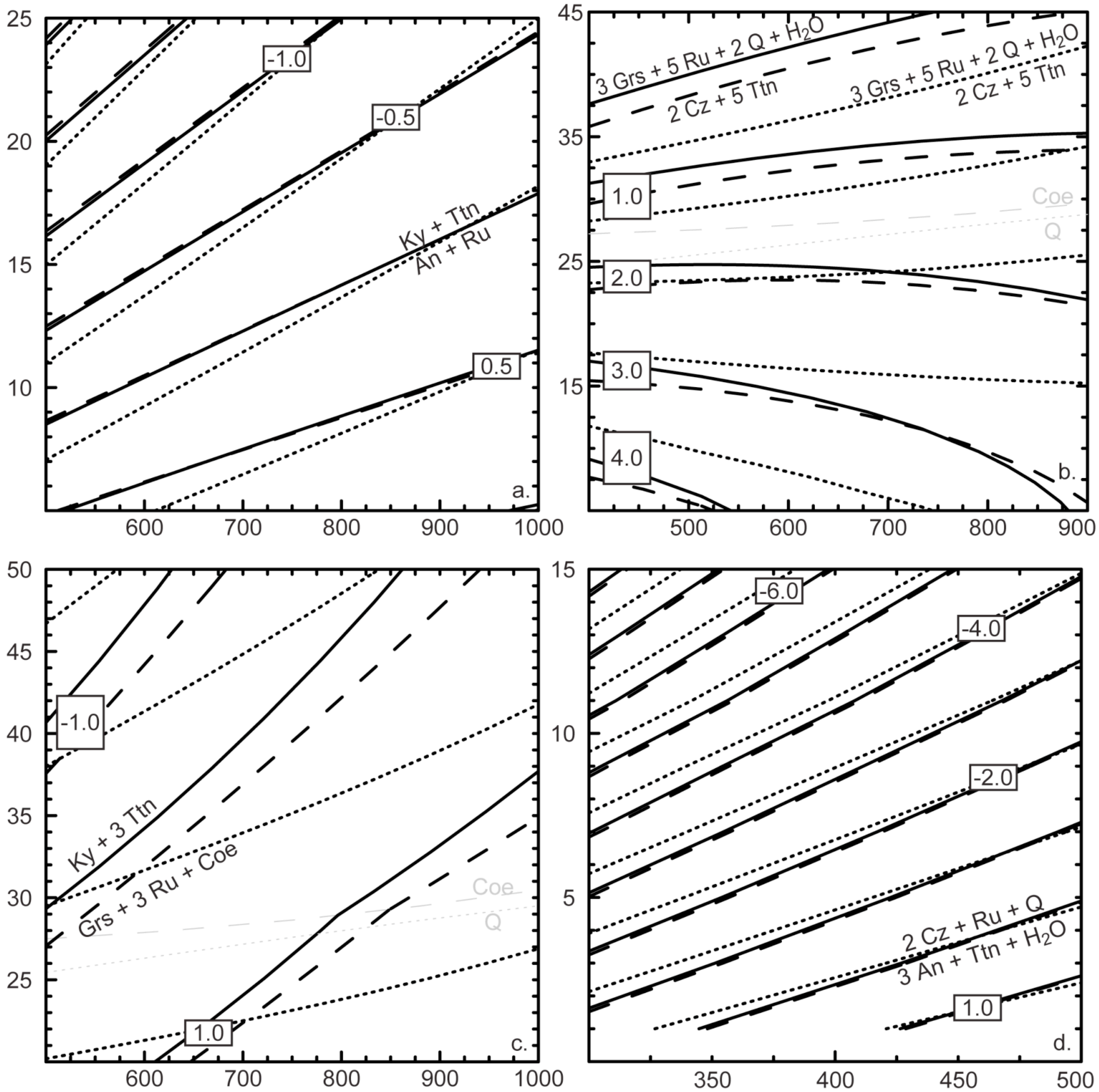


**Fig. 2.7.** $Log_{10}K$ diagrams of sphene-bearing barometers used in the literature. Curves are calculated for the datasets of Berman (1988), dotted; Holland and Powell (1988), dashed; and this study, solid. The Berman dataset was used in the study of Manning and Bohlen (1991). The calculated quartz = coesite boundary is shown (light gray) for each dataset. Units are T in ˚C and P in kbar. Individual reactions are discussed further in the text.

The values employed for sphene are those determined in this study (Table 2.3), and the volume and heat capacity equations in equations (3) and (5) using the coefficients derived above. The data for all other phases is from Holland and Powell (1998). The dotted and dashed curves are calculated with the data internally consistent databases of Berman (1988) and Holland and Powell (1998), respectively. The activity of sphene was determined with the molecular activity model from Tropper et al. (2002), with the assumption that substituting Fe(OH,F) for TiO has the same effect on $CaTiSiO_5$ activity as the AlF component studied in their experiments. Inspection of Figure 2.7 shows that there is little difference in the curves calculated close to the experimental reversals for reaction (2.1), (Fig. 2.7a). However, especially at pressures in the coesite stability field, for both reactions (2.7) and (2.8), of interest in high-pressure eclogites and UHP rocks, the effect is quite dramatic (Fig. 2.7b-c).

Sanders (1988) reported the assemblage of reaction (2.1), and reported garnet, plagioclase and sphene compositions for one sample in the kyanite-bearing eclogites from Glenelg, Scotland. Equilibrium textures were not demonstrated for this assemblage, because Sanders did not consider this reaction, so caution or further study is needed to fully interpret the results. Figure 2 from Sanders (1988) shows kyanite inclusions in the rim of the garnet oriented parallel to the aligned grains in the matrix. Unfortunately, the lack of quartz in these sections prevents the use of GASP barometry, as well as reaction (2.8) in these rocks, except as a limit. Garnet compositions are from the kyanite-bearing rims on garnet porphyroblasts, which matches the smaller euhedral matrix garnets. The sphene grain pictured in the figure is aligned with the kyanite, perhaps suggesting equilibrium. The matrix to the kyanite and sphene crystals is oligoclase, a common product of retrograde metamorphism in eclogites (e.g. Anderson and Moecher 2005; Page et al. 2007). Rutile is stated to occur in the rock, but is not evident from the figure. Manning and Bohlen (1991) determined pressures of 16.0 and 15.7 kbar for reaction (2.1) at temperatures of 758 and 745 ˚C, calculated using garnet-clinopyroxene Fe/Mg exchange as calibrated by Powell (1985) and Krogh (1988) respectively. The new data yields slightly higher pressures for this reaction of 17.1 and 16.8 ± 1.7 kbar (Fig. 2.7a).

Eclogites from the Tauren Window contain garnet+epidote+rutile+quartz+sphene (Franz and Spear 1985), the assemblage of reaction (2.7). Manning and Bohlen (1991) used compositions from Franz and Spear (1985) for sphene and grossular and gathered clinozoisite compositions in Franz and Spear (1983) from siliceous dolomites about a kilometer to the west of the sphene-bearing kyanite eclogites, stating that zoisite compositions vary little in eclogite localities. However, this statement should be questioned due to the presence of pure zoisite in kyanite-zoisite marbles from approximately the same area (Spear and Franz, 1986). Manning and Bohlen (1991) constrained temperatures in the absence of lawsonite, using the limit of the reaction lawsonite = clinozoisite + kyanite + quartz + fluid. In the presence of sphene and rutile, a more restrictive reaction is lawsonite + sphene = clinozoisite + rutile + quartz + fluid (Shau et al. 1991). Manning and Bohlen (1991) found that calculations on other rocks from the Tauren Window (Holland 1979) using the reaction paragonite = jadeite + kyanite + fluid yielded pressures similar to those obtained with reaction (2.7). Manning and Bohlen (1991) estimated pressures between 21.2 and 19.2 kbar for the temperature range 570-650 ˚C. When determined with the data of this study at the same temperatures, pressures are 28.0-24.8 ± 1.1 kbar. An increase in zoisite activity would shift the reaction to slightly higher pressures.

Page et al. (2003) applied reaction (2.7) to calculate prograde conditions from garnet inclusion assemblages in two eclogites from the Eastern Blue Ridge in North Carolina, U.S.A. Pressures of 6-10 and 8-12 kbar were determined for these rocks over a temperature range of 200˚C (Fig. 2.7b). Temperature is limited by the presence of epidote and quartz, which dehydrate to anorthite and garnet at high T, and react with water to form garnet and lawsonite at low T. Page et al. (2003) used the dataset from Holland and Powell (1998), which underestimates pressures of reaction (2.7) compared with the results of this study by about a kilobar (Fig. 2.7b). The updated the updated thermodynamic data from this study were used by Page et al. (2007) to calculate the prograde pressures in Franciscan eclogites. King et al. (2004) applied reaction (2.7) on garnets to a coesite-bearing eclogite from Lago di Cignana. The single microprobe analysis of sphene in the paper has a low total, only 95 wt %. They estimated a bracket on $\log_{10}K$ for the reaction between -2.0 and -2.5, and unlike other workers, assumed a reduced $H_2O$ activity, between 0.3 and 0.6. Though not explicitly stated, they used the Berman (1988) database for their determination (King, personal communication, 2005). Fortunately, when calculated using their estimated activities the pressure estimates are almost unchanged, because the calculated pressure of ~22 kbar is where the two curves cross each other (Fig. 2.7b).

The ultrahigh pressure rocks described by Sobolev and Shatsky (1990), were examined by Manning and Bohlen (1991) using reaction (2.8) (Fig. 2.7c). They calculated pressures of 45 - 46.5 kbar, again using garnet-clinopyroxene thermometry to determine temperatures (840 - 860 ˚C). According to Sobolev and Shatsky (1990) the kyanite is sometimes observed in garnet schists, whereas the sphene and rutile occurred in garnet-pyroxene rocks. Unfortunately, the rutile and sphene analysis in the paper are included in garnets from different samples and kyanite is not analyzed. However, even in the absence of kyanite, the reaction provides a lower pressure limit for the rocks. Manning and Bohlen (1991) stressed that the use of the Berman (1988) database at UHP conditions could be quite imprecise, since the expansivity and compressibility coefficients were unconstrained above 15 kbar. The present calculations using the high-pressure volume data should be more accurate, and are almost 10 kbar higher than the previous estimates. The major difference in the two sets of results is that Manning and Bohlen (1991) used the Berman (1988) dataset. The offset between the equation calculated with Holland and Powell (1998) and in this study is much reduced (~1 kbar), less than the estimated error of ± 1.8 kbar. Tropper et al. (2002) found that the choice of activity model was vitally important for these highly substituted sphenes and affected the results by as much as 30 kbar. A more thorough study of the UHP assemblages should focus on application of the sphene reactions for individual samples rather than using analyses from different rocks.

Topuz et al. (2004) applied reaction (2.9) to metabasaltic greenschists where the reaction assemblage was preserved as inclusions in sphene. This reaction was proposed for application to blueschist facies rocks by Kapp et al. (2000), but its application involves an independent knowledge of water activity, in addition to the extreme anorthite dilutions generated by the common occurrence of nearly pure albite in blueschists. The greenschist facies plagioclase analyzed by Topuz et al. (2004) has an XAn of 0.03. A 1 mol % error in the determination of the Ca in plagioclase at this concentration leads to an approximate displacement of equilibria by 2 kbar at 400 ˚C. Estimated pressures using this dehydration reaction are almost unaffected by the new thermodynamic data for sphene (Fig. 2.7d).

## Conclusions

The low-temperature heat capacity data presented in this chapter supports and refines the previous determination of the standard entropy of sphene. Its thermodynamic properties, however, are still subject to some uncertainty. When combined with the low-temperature heat capacity data, the measured values of the enthalpy of drop solution do not yield reasonable results for the reaction of rutile + calcite + quartz = sphene + $CO_2$, which necessitates estimation of the Gibbs energy of formation for sphene from experimental constraints (Manning and Bohlen 1991). Moreover, for sphene the benefits of incorporation in an internally consistent thermodynamic dataset are precluded by the paucity of experimental data on sphene-bearing reactions. This study is not able to further evaluate the quality of the Manning and Bohlen (1991) experiments, except to conclude that they are consistent with constraints on reaction (2.6). The enthalpy determined in the experimental study of Xirouchakis et al. (1997b) is too large to be consistent with reversed phase equilibria or natural greenschist facies constraints on rutile stability. There is likely a systematic error in the measurements, or somewhere in the cycles of enthalpy determinations used to extract the enthalpy of formation from the elements. Further experiments on additional sphene-bearing reactions should help to further improve the data. The dataset of Holland and Powell (1998) produces results which are generally within the error of the calculations, but which are increasingly inaccurate at temperatures less than 800˚C. Sphene-bearing calculations performed with Berman (1988) should be viewed with caution and avoided in future work.

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# Chapter III

# Low-temperature heat capacity of $TiO_2$-II and the rutile/$TiO_2$-II phase boundary

## Introduction

Polymorphic reactions are the simplest kind of solid-solid reaction, yet they play an important role in defining the grades of metamorphism. From the early use of the aluminosilicates as index minerals in pelitic schists, to models of kinetic controls on aragonite and coesite inversion, polymorphic transitions have been important to petrology. Because detailed information on exchange reactions at high pressures is scarce, the polymorphic transitions in the $SiO_2$ and C systems have been instrumental in identifying and understanding ultrahigh pressure metamorphism in the crust. Identification of coesite is typically used as the boundary between the ordinary eclogite-facies and ultra-high pressure (UHP) metamorphism. Rutile undergoes a similar phase transition to a denser structure at high pressures:

$$TiO_2\text{-II} = \text{rutile} \qquad (3.1)$$

This transition converts rutile to a $TiO_2$ polymorph that is isostructural with $\alpha$-$PbO_2$ (sometimes designated $TiO_2$-II) and that occurs between the graphite to diamond and coesite to stishovite reactions (Withers et al., 2003). As a consequence, it may be used to further refine pressure estimates in the UHP rocks. In addition, the $TiO_2$ system is sometimes used in analogy to the $SiO_2$ system, because stishovite is isostructural with rutile. Beyond stishovite (and an intervening phase with $CaCl_2$ structure), $SiO_2$ also converts to a phase with the $\alpha$-$PbO_2$ structure (Murakami et al. 2003). A high pressure polymorph of $SiO_2$ with the $\alpha$-$PbO_2$ structure (as well as several others) has been found in the meteorite Shergotty (El Goresy, 2000).

To have confidence using the boundary for $TiO_2$ II-rutile as a barometer in UHP rocks, its locus must be well constrained. Various workers have experimentally investigated the phase transition (Akaogi et al. 1992; Olsen et al. 1999; Withers et al. 2003). Withers et al. (2003) presented a curve consistent with all but two of the experimental reversals. However, recent papers continue publishing the curve of Akaogi or show both curves on their figures (Okamoto et al. 2006, Fig. 1; Jackson et al. 2006). This chapter presents the results of the first heat capacity study of $TiO_2$-II, and a thermodynamic evaluation of the experimental reversals.

## Previous Work

Many investigations into the polymorphs of $TiO_2$ have focused on *in situ* determinations, because $TiO_2$-II is the only high-pressure structure which is metastable upon decompression (Wang et al. 2008). In a diamond anvil cell, Arashi (1992) observed transformation of rutile to $TiO_2$-II at ~100 kbar with Raman spectroscopy. A baddeleyite structured phase was found above 200 kbar. Arlt et al. (2000) observed a single crystal of anatase going to $TiO_2$-II at 45 kbar with a diamond-anvil cell which was built to allow a diffractometer as a detector. The denser baddeleyite ($ZrO_2$) structured phase was found in their experiments above 200 kbar. They measured the unit cell parameters of anatase, $TiO_2$-II and baddeleyite-structured $TiO_2$. Wang et al. (2008) also observed the formation of $TiO_2$-II from the metastable anatase, this time in an in-situ synchrotron XRD experiment. The observed transformation was around 160 kbar at room temperature. Dubrovinsky et al. (2001) and Dubrovinskaia (2001) reported the synthesis of two $TiO_2$ polymorphs even more dense than the baddeleyite structure, with seven and nine coordinated Ti.

Hwang et al. (2000) described a nanometer thin inclusion of $TiO_2$-II along a twin boundaries in rutile from diamondiferous rocks in Saxonian Erzgeberge, Germany. In addition to the discovery by Hwang in UHP crustal rocks, $TiO_2$ polymorphs are found in rocks shocked by meteorite impacts. The dense high-pressure $TiO_2$ (baddeleyite structure)polymorph as well as $TiO_2$-II was described in shocked garnet-gneiss breccias from the Ries Crater in Germany (El Goresy et al. 2000). $TiO_2$-II, along with rutile and anatase, has also been found in breccias from the drill hole into the Chesapeake Bay impact structure, Virginia (Jackson et al. 2006).

Akaogi et al. (1992) investigated the boundary between rutile and $TiO_2$-II in a series of *in situ* diamond anvil experiments. Olsen et al. (1999) performed multi-anvil, *in situ* X-ray diffraction on powdered rutile starting materials, calculating pressure by observing the lattice parameters of NaCl. Experiments were done at constant pressure, with increasing temperature, observing the phase present at 100˚C intervals. Unfortunately, they used rutile as a starting material for all experiments, so the preservation of rutile at low temperature may represent lack of reaction and metastable persistence of the starting materials rather than true stability of rutile, especially for runs at low temperature (Withers et al. 2003). Due to their misunderstanding, Olsen et al. (1999) erroneously proposed a doubly curved phase boundary, which was used by several authors in an attempt to constrain temperatures as well as pressures with the inference of $TiO_2$-II. Two reversal brackets exist in the data, indicated by the first appearance of $TiO_2$-II, and the first appearance of rutile with increasing temperature (Withers et al. 2003). Inspection of Olsen's Figure 1 shows that their wide brackets (75 kbar, 600-1100˚C and 70 kbar 700-1100˚C) are completely compatible with the proposed curve of Akaogi et al. (1992) if reaction kinetics is considered. Withers et al. (2003) pointed out the failure of Olsen et al. (1999) to account for the potential metastability of rutile, and they performed reversed phase equilibrium experiments on this reaction in a multi-anvil cell. These experiments achieved a higher T and P than those of Akaogi et al. (1992), and yielded a substantially steeper slope which pushes the formation of $TiO_2$-II to deeper levels in the earth's mantle. In addition to the widened pressure range, the phase diagram of Withers et al. (2003) is preferred because they were able to take advantage of the experimental data of various other authors in their fit, and the regression fits all but two of the reversals of other workers. However, the use of the experiments by Akaogi et al. (1992) persists, and recent papers have published both curves on their figures (Okamoto et al. 2006, Jackson et al. 2006).

### Experimental Methods

In this study heat capacity measurements were made by two different methods on fine-grained synthetic samples of $TiO_2$-II collected from the high purity run products of Withers et al. (2003). Electron microprobe analyses presented in that study showed the $TiO_2$-II to be stoichiometric within 0.3 atom percent.

The heat capacity of 30.3 mg of this material was investigated from 2.1 to 126.4 K with a Quantum Designs physical properties measurement system (PPMS) in the lab of Prof. Megan Aronson at the University of Michigan. The PPMS achieves high precision on such low sample volumes by modeling the relaxation of the calorimeter temperature after an applied heat pulse as a function of time, rather than directly measuring the heat capacity as in traditional adiabatic calorimetry (Hwang et al. 1997). Heat capacity values determined by the PPMS have been found to compare favorably to those produced with adiabatic calorimetry. Agreement better than 5 - 3 % at T < 100 K and 1% above that was found by Lashley et al. (2003) and Dachs and Bertoldi (2005) on silicate samples. For additional information about the PPMS, see the discussion presented above in Chapter II.

The heat capacity of $TiO_2$-II at higher temperatures was investigated using the Netszsch STA 449c a cryogenic differential scanning calorimeter (DSC) in the lab of Phil Neuhoff at the University of Florida, Gainesville. DSC data were collected in two separate runs, each of which included a heating and then cooling scan. Each run consisted of three scans, a blank, a standard and the unknown measurement. Before each run a blank background scan on the empty calorimeter pans was performed, which was later subtracted from the data. The known heat capacity of synthetic sapphire was used to calibrate the response of the calorimeter. The resulting data were then averaged over ten-degree intervals, to minimize the effects of potential background spikes. At this stage, the averaged data points from each of the four runs were compared, and any point which disagreed with the majority of the data by more than 1% were discarded, and the remaining points were used to determine the heat capacity. Each DSC data point on Fig. 2 and in Table 2 represents the mean of at least three out of the four scans. Data were discarded if the agreement was not good enough, resulting in useable data over the range, 230 – 370 K. The error bars on Fig. 2 represent two times the sample standard deviation about the mean.

## Results

The PPMS data are presented in Table 1 and Figure 3.1. Each point represents the average of three measurements. The heat capacity data can be fit to the simple Cp = k $T^3$ from 0-15 K. The parameter k = $2.32*10^{-5}$ fits the data very well up to 17.5 K. There is a large gap between the highest temperature recorded in the PPMS dataset and the DSC data (Table 2, Fig. 2).

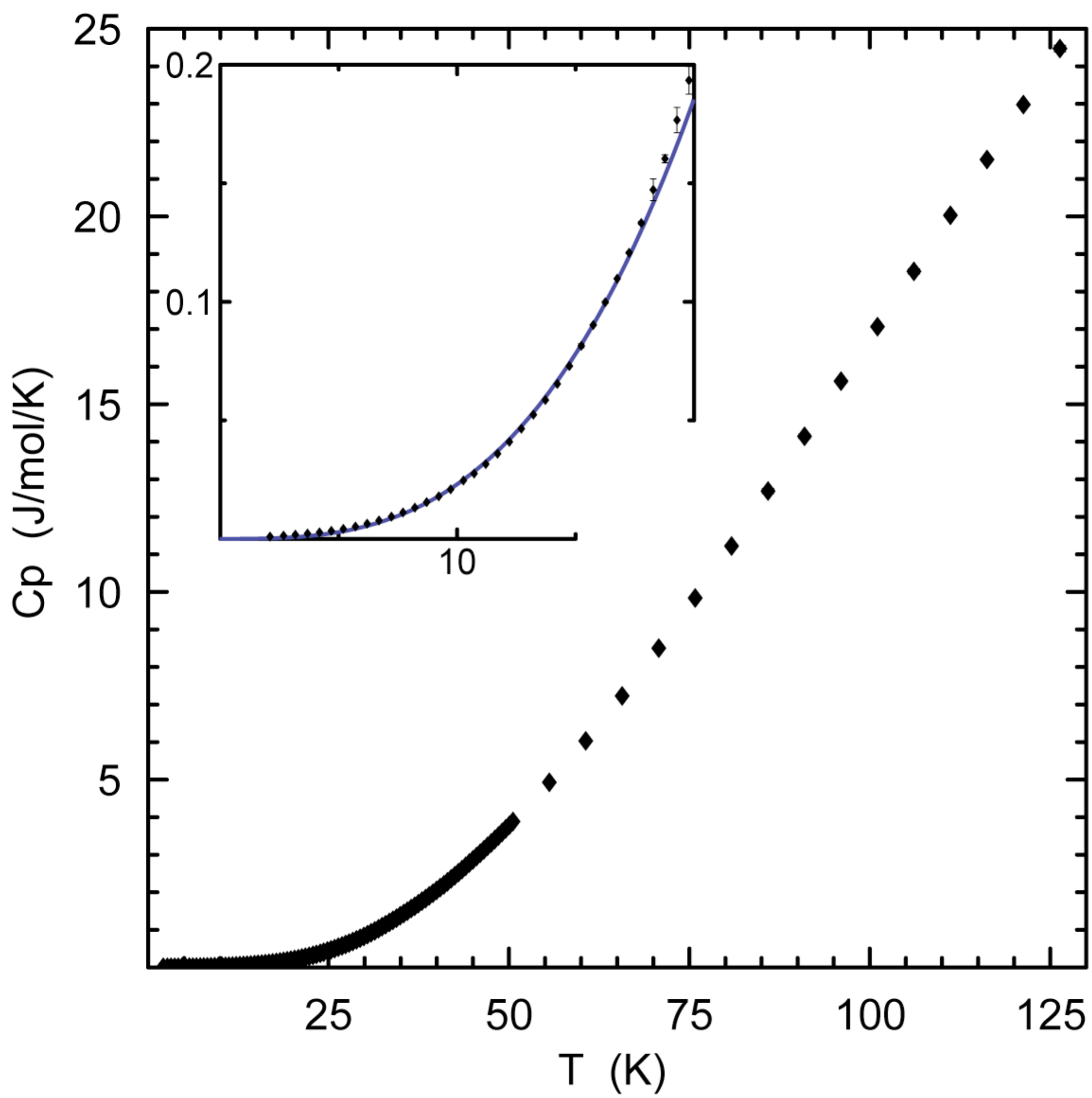


**Fig. 3.1.** Low-temperature Cp data for $TiO_2$-II. A sample standard deviation error at $2\sigma$ is almost impossible to see at this scale. The inset shows the data from 0 to 20 K, along with a $T^3$ fit up to 17.5 K.

**Table 3.1** PPMS data for $TiO_2$-II, from 2.1 to 126 K.

| T (K) | 2S (T) | Cp (J/mK) | 2S (Cp) | T (K) | 2S (T) | Cp (J/mK) | 2S (Cp) | T (K) | 2S (T) | Cp (J/mK) | 2S (Cp) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.102 | 0.005 | 0.00097 | 0.00004 | 21.31 | 0.02 | 0.251 | 0.005 | 39.97 | 0.03 | 2.050 | 0.019 |
| 2.673 | 0.004 | 0.00136 | 0.00002 | 21.80 | 0.02 | 0.271 | 0.001 | 40.48 | 0.05 | 2.124 | 0.012 |
| 3.168 | 0.009 | 0.00177 | 0.00001 | 22.32 | 0.03 | 0.295 | 0.002 | 40.99 | 0.04 | 2.197 | 0.018 |
| 3.683 | 0.012 | 0.00225 | 0.00005 | 22.84 | 0.05 | 0.322 | 0.010 | 41.49 | 0.03 | 2.276 | 0.012 |
| 4.190 | 0.008 | 0.00275 | 0.00001 | 23.33 | 0.05 | 0.346 | 0.003 | 41.99 | 0.03 | 2.358 | 0.008 |
| 4.689 | 0.010 | 0.00336 | 0.00003 | 23.86 | 0.02 | 0.375 | 0.001 | 42.50 | 0.03 | 2.441 | 0.004 |
| 5.196 | 0.013 | 0.00421 | 0.00006 | 24.32 | 0.02 | 0.402 | 0.000 | 43.00 | 0.03 | 2.522 | 0.005 |
| 5.708 | 0.015 | 0.00520 | 0.00007 | 24.85 | 0.03 | 0.436 | 0.012 | 43.50 | 0.02 | 2.604 | 0.005 |
| 6.201 | 0.009 | 0.00642 | 0.00005 | 25.34 | 0.08 | 0.466 | 0.006 | 44.01 | 0.02 | 2.690 | 0.009 |
| 6.701 | 0.011 | 0.00775 | 0.00008 | 25.84 | 0.05 | 0.499 | 0.003 | 44.51 | 0.03 | 2.777 | 0.003 |
| 7.226 | 0.006 | 0.00938 | 0.00008 | 26.36 | 0.05 | 0.538 | 0.015 | 45.02 | 0.03 | 2.863 | 0.004 |
| 7.714 | 0.009 | 0.01114 | 0.00008 | 26.87 | 0.04 | 0.572 | 0.004 | 45.52 | 0.03 | 2.953 | 0.005 |
| 8.214 | 0.013 | 0.01318 | 0.00004 | 27.36 | 0.08 | 0.609 | 0.006 | 46.02 | 0.03 | 3.041 | 0.006 |
| 8.712 | 0.015 | 0.0155 | 0.0001 | 27.85 | 0.06 | 0.647 | 0.005 | 46.53 | 0.03 | 3.130 | 0.008 |
| 9.223 | 0.017 | 0.0179 | 0.0002 | 28.36 | 0.05 | 0.689 | 0.003 | 47.03 | 0.05 | 3.223 | 0.006 |
| 9.724 | 0.022 | 0.0209 | 0.0003 | 28.88 | 0.04 | 0.733 | 0.003 | 47.54 | 0.04 | 3.312 | 0.014 |
| 10.262 | 0.015 | 0.0246 | 0.0003 | 29.38 | 0.05 | 0.776 | 0.003 | 48.04 | 0.01 | 3.406 | 0.006 |
| 10.717 | 0.009 | 0.0276 | 0.0002 | 29.89 | 0.04 | 0.821 | 0.004 | 48.55 | 0.01 | 3.500 | 0.007 |
| 11.207 | 0.009 | 0.0315 | 0.0002 | 30.40 | 0.09 | 0.870 | 0.010 | 49.05 | 0.01 | 3.594 | 0.009 |
| 11.71 | 0.01 | 0.0359 | 0.0003 | 30.90 | 0.09 | 0.920 | 0.009 | 49.55 | 0.01 | 3.690 | 0.007 |
| 12.21 | 0.01 | 0.0409 | 0.0003 | 31.41 | 0.09 | 0.972 | 0.008 | 50.06 | 0.01 | 3.784 | 0.003 |
| 12.71 | 0.02 | 0.0465 | 0.0003 | 31.93 | 0.05 | 1.028 | 0.001 | 50.56 | 0.01 | 3.885 | 0.000 |
| 13.22 | 0.02 | 0.0524 | 0.0004 | 32.41 | 0.03 | 1.082 | 0.006 | 55.60 | 0.09 | 4.93 | 0.02 |
| 13.72 | 0.02 | 0.0586 | 0.0004 | 32.91 | 0.09 | 1.136 | 0.008 | 60.64 | 0.10 | 6.03 | 0.03 |
| 14.23 | 0.02 | 0.0654 | 0.0003 | 33.43 | 0.06 | 1.196 | 0.004 | 65.69 | 0.09 | 7.23 | 0.03 |
| 14.74 | 0.02 | 0.0729 | 0.0004 | 33.92 | 0.09 | 1.252 | 0.011 | 70.76 | 0.11 | 8.50 | 0.04 |
| 15.24 | 0.02 | 0.0814 | 0.0009 | 34.43 | 0.03 | 1.311 | 0.004 | 75.81 | 0.09 | 9.84 | 0.05 |
| 15.74 | 0.02 | 0.0902 | 0.0004 | 34.93 | 0.00 | 1.374 | 0.003 | 80.85 | 0.12 | 11.22 | 0.05 |
| 16.25 | 0.02 | 0.0998 | 0.0005 | 35.42 | 0.03 | 1.435 | 0.003 | 85.90 | 0.11 | 12.69 | 0.07 |
| 16.75 | 0.02 | 0.1098 | 0.0003 | 35.93 | 0.04 | 1.496 | 0.007 | 90.96 | 0.09 | 14.14 | 0.06 |
| 17.26 | 0.02 | 0.1207 | 0.0004 | 36.45 | 0.03 | 1.567 | 0.009 | 96.01 | 0.12 | 15.61 | 0.05 |
| 17.77 | 0.03 | 0.1333 | 0.0007 | 36.95 | 0.07 | 1.628 | 0.011 | 101.07 | 0.12 | 17.06 | 0.03 |
| 18.28 | 0.03 | 0.147 | 0.005 | 37.44 | 0.08 | 1.694 | 0.014 | 106.11 | 0.11 | 18.54 | 0.07 |
| 18.77 | 0.04 | 0.160 | 0.002 | 37.95 | 0.08 | 1.764 | 0.015 | 111.17 | 0.11 | 20.03 | 0.05 |
| 19.28 | 0.03 | 0.177 | 0.005 | 38.45 | 0.08 | 1.830 | 0.008 | 116.24 | 0.09 | 21.52 | 0.05 |
| 19.78 | 0.05 | 0.193 | 0.006 | 38.95 | 0.08 | 1.904 | 0.007 | 121.28 | 0.16 | 22.98 | 0.01 |
| 20.30 | 0.04 | 0.212 | 0.007 | 39.46 | 0.04 | 1.974 | 0.009 | 126.34 | 0.11 | 24.47 | 0.09 |
| 20.82 | 0.06 | 0.230 | 0.003 | | | | | | | | |

**Table 3.2** DSC data for $TiO_2$-II, from 230 to 370 K.

| T (K) | 2S (T) | Cp (J/mol/K) | 2S (Cp) | T (K) | 2S (T) | Cp (J/mol/K) | 2S (Cp) | T (K) | 2S (T) | Cp (J/mol/K) | 2S (Cp) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 228.28 | 0.75 | 49.66 | 1.02 | 278.27 | 0.61 | 57.67 | 0.27 | 328.42 | 0.29 | 62.39 | 0.51 |
| 238.28 | 0.75 | 51.31 | 0.80 | 288.27 | 0.61 | 58.84 | 0.47 | 338.42 | 0.29 | 63.35 | 0.48 |
| 248.28 | 0.75 | 52.96 | 0.92 | 298.27 | 0.61 | 59.94 | 0.64 | 348.38 | 0.35 | 64.18 | 0.57 |
| 258.28 | 0.75 | 54.57 | 0.75 | 308.42 | 0.29 | 60.71 | 0.52 | 358.38 | 0.35 | 65.15 | 0.50 |
| 268.28 | 0.75 | 56.05 | 0.52 | 318.42 | 0.29 | 61.58 | 0.64 | 368.38 | 0.35 | 66.00 | 0.28 |

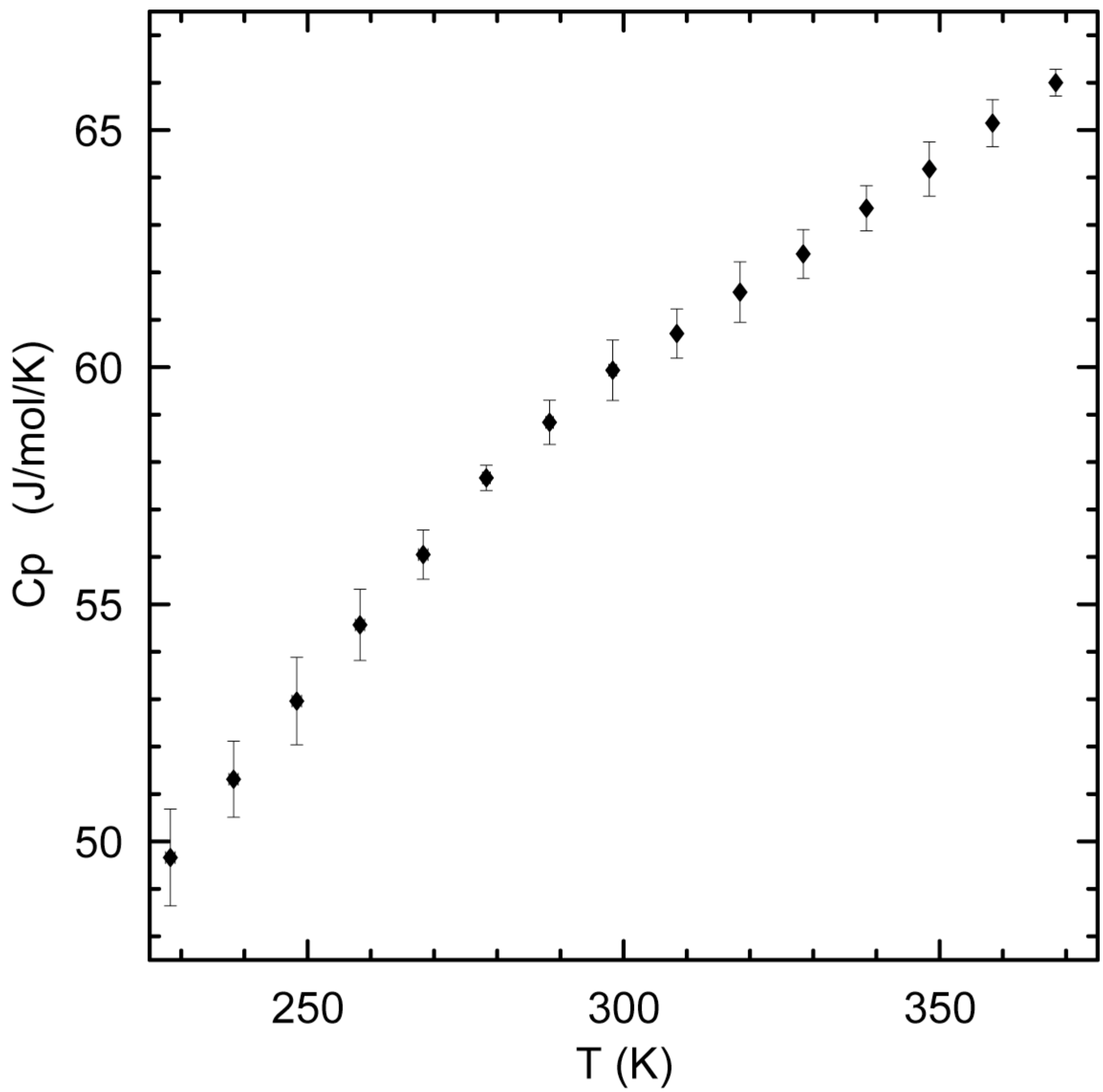


Fig. 3.2. DSC heat capacity measured for $TiO_2$-II. Error bars represent $2\sigma$ error.

In order to fit the gap between the two methods a function that preserves the form of a heat capacity equation was fit to the data:

$$Cp = a_1\ \mathrm{Debye}(\Theta_1/T) + a_2\ \mathrm{Debye}(\Theta_2/T) + a_3\ \mathrm{Einstein}(\Theta_3/T) + a_4\ \mathrm{Einstein}(\Theta_4/T) \quad (3.2)$$

The Debye and Einstein functions have the same form as in classic heat capacity literature where

$$\text{Einstein}(\Theta_E/T) = 3R\left(\frac{\Theta_E}{T}\right)^2 \frac{e^{\left(\frac{\Theta_E}{T}\right)}}{\left(e^{\left(\frac{\Theta_E}{T}\right)}-1\right)^2}, \text{ and} \quad (3.3)$$

$$\text{Debye}(\Theta_D/T) = 3R\left(\frac{\Theta_D}{T}\right)^3 3\int_0^{\frac{\Theta_D}{T}} \frac{x^4 e^x}{\left(e^x-1\right)^2}dx \quad (3.4)$$

The use of Debye and Einstein functions as fitting parameters allows the regressed heat capacity curve to follow the behavior expected of heat capacity data. Fitting the experimental data with a curve of this nature should accurately model the change in slope of the heat capacity curve between the two datasets. At very high temperatures the Cp equation should become a linear function of temperature, where the constant volume heat capacity approaches the 3nR Dulong-Petit limit. This occurs after its slope is dramatically reduced, a behavior also modeled by the Debye/Einstein equation. The fitting algorithm used was NonlinearFit in the program Mathematica, a least squares method. In order to obtain the best possible estimate of entropy, the fit was calculated to minimize the deviations from Cp/T rather than Cp. It was calculated for one equation describing the whole temperature range. This fit, along with the residuals calculated by ratioing the difference between the fit and the data points to the value of the data points, is shown in Figure 3.3. The regressed parameters for equation (2) are $\Theta_1$ = 522.02, $\Theta_2$ = 2261.0, $\Theta_3$ = 184.38, $\Theta_4$ = 816.01, $a_1$ = 1.5869, $a_2$ = -0.45573, $a_3$ = 0.12582 and $a_4$ = 1.7607. Given the obvious structure in the residuals, and the difficulty of avoiding local minima in fitting parameters to this equation, it was determined that a better fit to the experimental data could be obtained by fitting simple polynomial equations to the data. In addition, this approach aided in calculating the standard error of the entropy, as discussed below. Because the polynomial equations cannot deal with

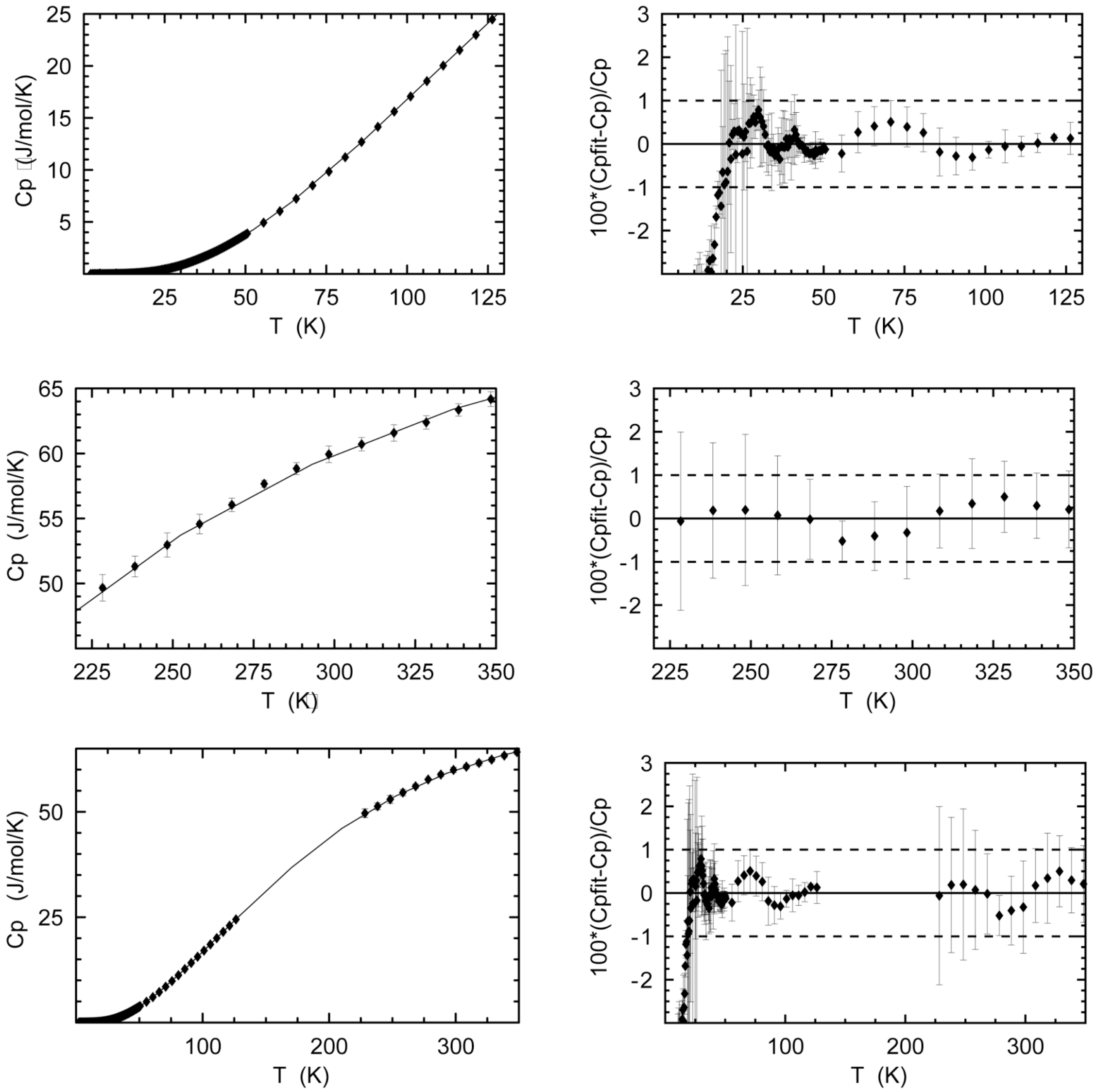


**Fig. 3.3.** Fits and residuals calculated from fitting the Cp data for $TiO_2$-II to the Debye/Einstein equation (Eqs 3.2-3.4)

the gap between the datasets the Debye/Einstein equation was used to generate data points every five degrees from 130 to 260 K. An arbitrary estimate of error was made for these points by linearly interpolating between the error of the highest PPMS data point and that of the lowest DSC point. Seven separate temperature intervals with overlapping endpoints were used and fit to the equation

$$Cp = a_0 + a_1T^{-0.5} + a_2T^{-2} + a_3T^{-3} + a_4T + a_5T^2 + a_6T^3. \qquad (3.5)$$

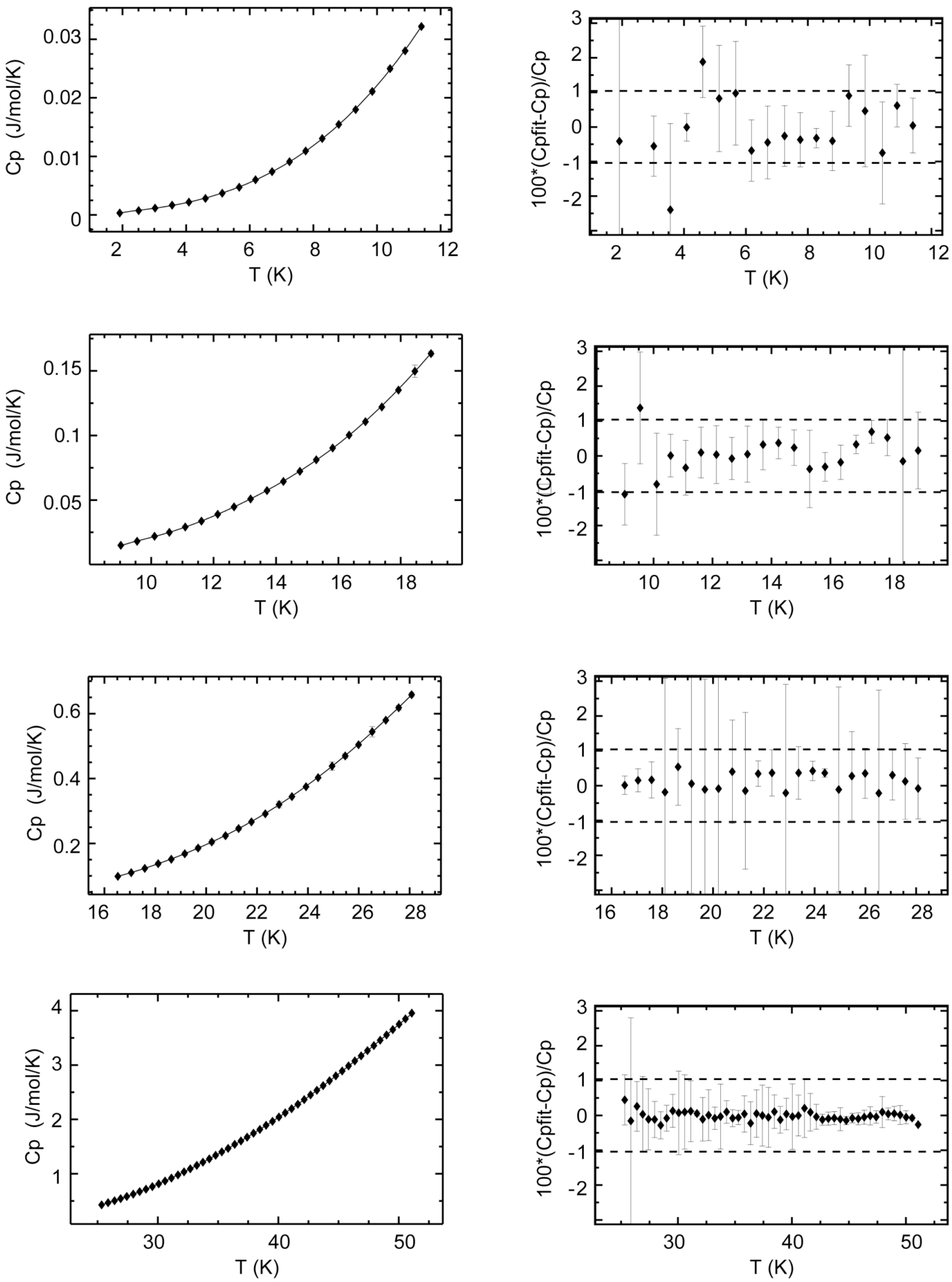


**Fig. 3.4.** Polynomial regressions along with residuals for $TiO_2$-II fit to Eq 3.5 at low temperatures

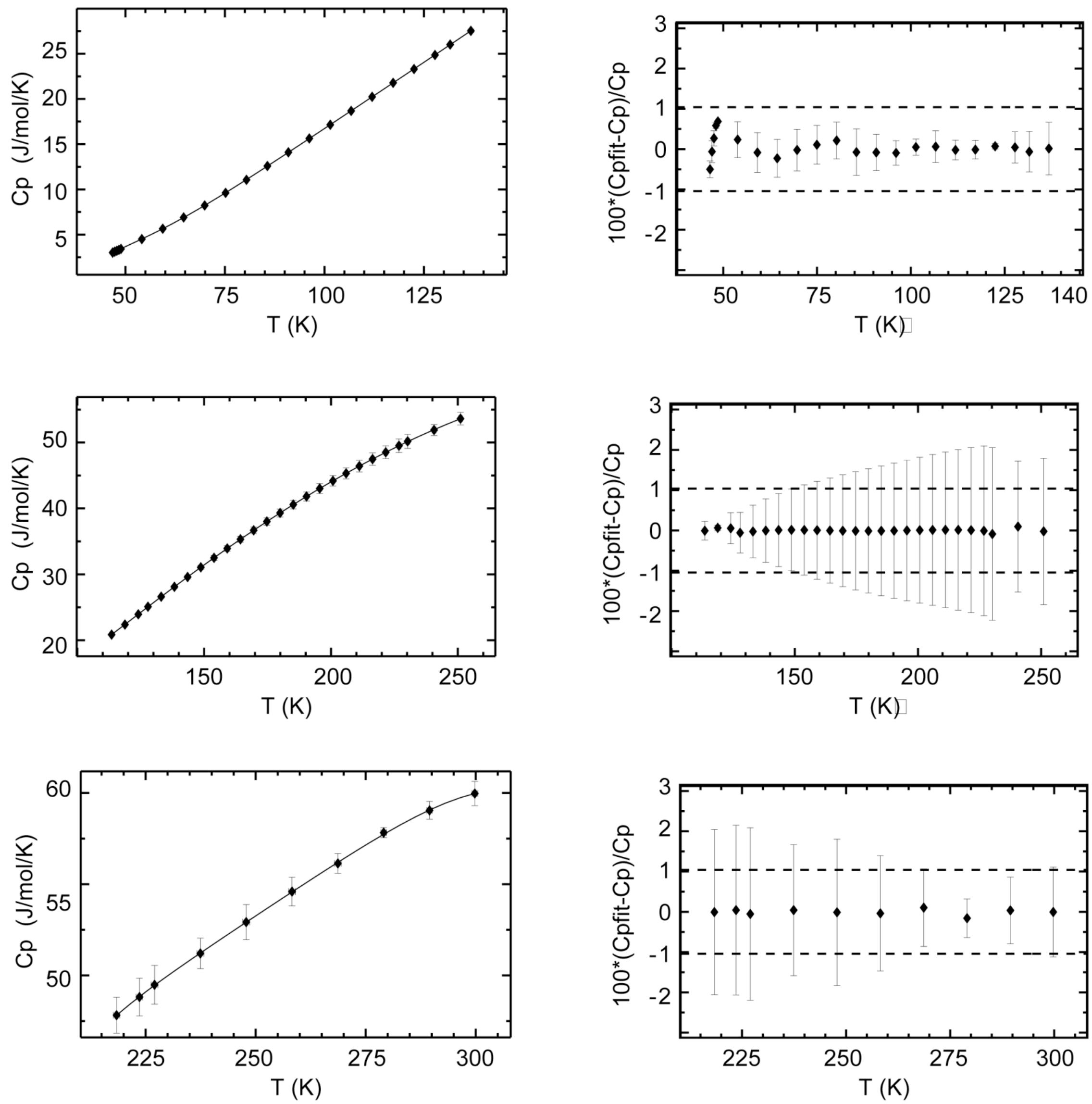


**Fig. 3.5.** Polynomial regressions along with residuals for $TiO_2$-II fit to Eq 3.5 at high temperatures. Note that the third range, 120-260 K is the placeholder data created from the Debye/Einstein fit.

**Table 3.3** Fit parameters used to determine the entropy of $TiO_2$-II with Eq 3.5

| T Range | 1 | $t^{-0.5}$ | $t^{-2}$ | $t^{-3}$ | $t$ | $t^{2}$ | $t^{3}$ |
|---|---|---|---|---|---|---|---|
| 2.10-10.3 | 0.0140 | -0.02624 | 0.05237 | -0.05483 | -4.856E-04 | -2.228E-05 | 2.361E-05 |
| 10.3-17.8 | 141.8 | -377.7 | 2442 | -6277 | -5.281 | 0.1393 | -1.566E-03 |
| 17.8-26.9 | -385.5 | 1385 | -21516 | 98035 | 7.770 | -0.1082 | 6.630E-04 |
| 26.9-49.6 | 2543 | -10990 | 304452 | -2068667 | -36.174 | 0.3678 | -1.611E-03 |
| 49.6-126.3 | 375.9 | -2883 | 380374 | -6709679 | -1.535 | 0.00595 | -8.129E-06 |
| 126.3-228.2 | -653.0 | 6243 | -2097897 | 7.708E+07 | 2.121 | -0.00357 | 2.084E-06 |
| 228.3-298.15 | 555572 | -6425283 | 3.489E+09 | -1.757E+11 | -1113 | 1.612 | -1.031E-03 |

The regression parameters for the heat capacity of $TiO_2$-II over different temperature ranges are presented in Table 3.3. Figs. 3.4 and 3.5 show the calculated curve plotted with the experimental data, and residuals, which show much less structure than with the simpler Debye/Einstein equation. The entropy of $TiO_2$-II at 298.15 K was determined by integrating the regression polynomials according to the equation

$$S^{\circ}_{298} = \int_{0}^{298.15} \frac{Cp}{T}. \quad (3.6)$$

The value obtained in this manner is 48.80 J/mol/K, identical to the value obtained by integrating the fit to equation 3.2.

To assess the confidence with which the standard entropy is known, a method similar to the Monte Carlo approach used by Dachs and Geiger (2006) was employed. This approach includes the error present in the Cp determination and the dependence of entropy on the equations used to fit the data. A large number of synthetic heat capacity datasets were created from the experimental data, where each data point was randomly calculated to vary about itself with a Gaussian distribution. The width of the distribution was determined by the experimental uncertainly at that temperature. This was accomplished using the Mathematica functions NormalDistribution and RandomArray. Each dataset was then fit using the same polynomial procedure outlined above, and the standard entropy was calculated for each dataset. As the number of synthetic datasets (n) becomes large, the standard deviation of the standard entropy of $TiO_2$-II is approached by the standard deviation of the population of synthetic entropy estimates. Several values of n were calculated to show convergence in the estimates. Plots of n versus the mean and deviation of $S^{\circ}_{298}$, are presented in Figure 3.6 for n = 5, 10, 20, 30, 40, 50, 100, 200, 300, 400, 500 and 1000. At n = 1000 the deviation has approached a limiting value of 0.052 J/mol·K. Therefore, the estimated $S^{\circ}_{298.15}$ of $TiO_2$-II is 48.8 ± 0.1 J/mol·K (2 $\sigma$ error).

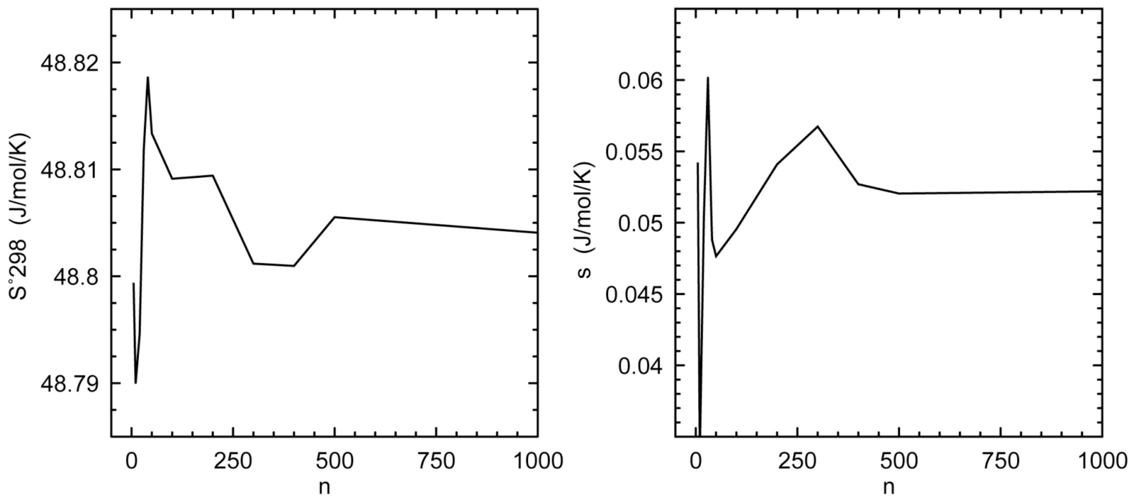


Fig. 3.6. The mean $S^{\circ}_{298}$ and sample standard deviation calculated for different sized populations of dataset created by normally varying data points according to their uncertainty

As a check for the above computational procedure, the entire process was repeated on the low temperature heat capacity data of rutile (deLigny et al. 2002), with an artificial gap imposed on the data between 126 and 224 K. The standard entropy calculated in this way is 50.00 ± 0.09, almost exactly the same as the 50.0 ± 0.1 reported by deLigny et al. (2002).

## STP Estimation

With the standard entropy constrained by these new measurements, simple calculations may be undertaken on the polymorphic phase transition from rutile to $TiO_2$-II. The simplest calculation to make, assumes that the values of $\Delta V$ and $\Delta S$ do not change much over the pressure range of interest, so that they can be approximated with known data at STP (pure phases at 1 bar, 298.15 K). The Clausius-Clapeyron relation ($dP/dT = \Delta S/\Delta V$) is used to map the slope of the phase boundary in PT space. For reaction (1), if the value generated in this study and that from deLigny et al. (2002) is used, the $\Delta S$ at STP is 48.8 - 50.0 = 1.2 ± 0.1 J/mol/K. Olsen et al. (1999) included density values at STP for rutile and $TiO_2$-II, which result in a $\Delta V$ of 0.038 ± 0.003 J/bar. The Clausius-Clapeyron slope at STP therefore would be 31.6 ± 2.9 bar/K. This value is plotted on Figure 3.7, where the location of a line with this slope has been fit to the reversal data by least squares. The envelope surrounding the slope calculation shows the 2$\sigma$ error applied to the slope of the line. The slope is much closer to that determined by Akaogi et al. (1992). However, what are the potential errors arising from that simplification of the thermodynamic data?

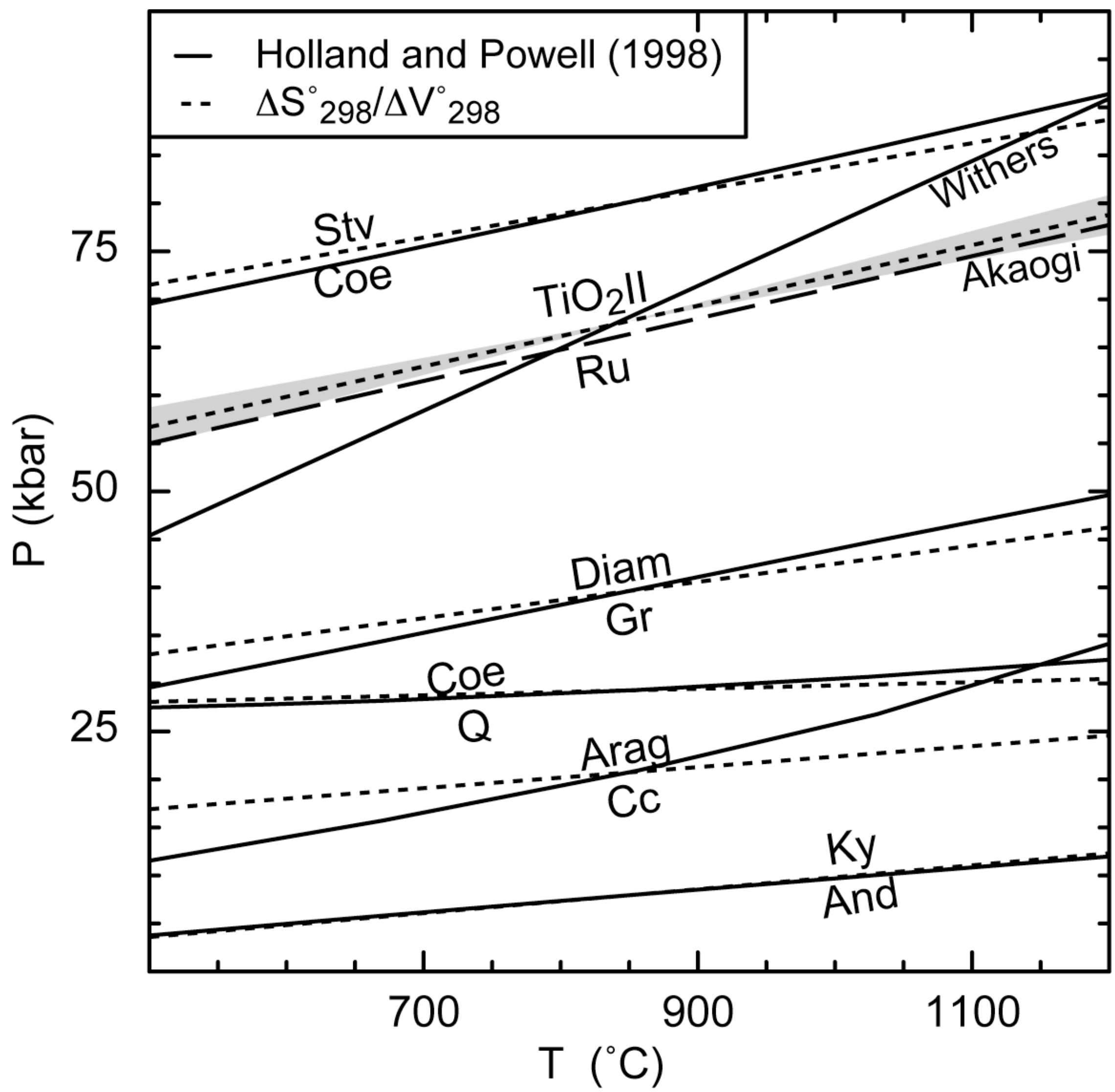


**Fig. 3.7.** A comparison of the locus of several polymorphic reactions (solid lines), with their Clausius-Clapeyron slopes calculated at STP (dotted lines). The solid and dashed lines near the rutile/$TiO_2$-II boundary are the experimental slopes of Withers et al. (2003) and Akaogi et al. (1992) respectively. The shaded region represents a 2s confidence interval for the slope calculated in this study.

As a way of investigating the assumption that the slope $dP/dT = \Delta S/\Delta V$ does not change much with pressure, several polymorphic reactions are also plotted in Fig. 3.7 as well as the slope generated by making the same assumption, namely a straight line pinned to the calculated curve at 850 ˚C, with slope $\Delta S/\Delta V$ at STP. The aragonite/calcite transition has a significant slope change, which is due to the structural disordering of the $CO_3$ groups in calcite with increasing temperature (Redfern et al. 1989). The data used to generate these slopes come from the internally consistent thermodynamic database of Holland and Powell (1998). This may be a flawed approach, however, because although $V^{\circ}_{298}$ and $S^{\circ}_{298}$ are generally taken as input parameters for the regression; almost all of them were adjusted in the production of the dataset (Table A1). These changes have been undertaken to fit experimental phase boundaries, because that is the method of obtaining the internally consistent database, but it is surprising that the volume and heat capacity extrapolations necessary at high temperatures and pressures have canceling effects on each other and consequently do not change the $\Delta S/\Delta V$ slope very much. Energy differences are generally small for polymorphic reactions, and small differences in volume or Cp behavior or small uncertainties in $S^{\circ}_{298}$ or $\Delta_f H^{\circ}_{298}$ should have a large effect on the calculated phase boundary. The $\Delta S/\Delta V$ slope at 1 bar and 298.15 K supports for the slope of Akaogi et al. (1992) over that of Withers et al (2002), although that support is tenuous given other unresolved issues with the measured thermodynamic data.

Even though other polymorphic reactions suggest that the simple slope approximation may have some value, the disagreement with the slope consistent with most reversals for the $TiO_2$ system (Withers et al. 2003) prompts a more rigorous treatment of the thermodynamics. Unfortunately, at 1 atm $TiO_2$-II is not stable above 450 K (Navrotsky et al. 1967), so heat capacity and thermal expansion data at or above these temperatures cannot be obtained. Compressibility data exist from the study of Olsen et al. (1999). They used a third-order Birch-Murgnahan equation of state to describe the compressibility of various $TiO_2$ polymorphs. The use of such a complex equation is certainly useful for extrapolating to pressures to UHP conditions above those explored in the study. However, up to 100 kbar the highest P measured by Olsen et al. (1999) for rutile and $TiO_2$II, when the data are reformulated into V(P) space, it was possible to fit the volume equation for both rutile and $TiO_2$-II to a simple second order polynomial of the form

$$V = V^{\circ}(1 + aP + bP^2) \tag{3.7}$$

which may be more useful than the P(ρ) form. The coefficients a, b are $-4.58*10^{-4}$, $5.03*10^{-7}$ and $-3.82*10^{-4}$, $2.80*10^{-7}$ for rutile and $TiO_2$-II respectively. At 298.15 K and the pressures of interest for the phase transition (40 - 100 kbar) the ΔV of reaction changes from -3.2 to -2.7 J/bar.

Navrotsky et al. (1967) investigated the ΔH of reaction (1) by measuring the difference between heat content measurements of rutile and $TiO_2$-II. The $TiO_2$-II sample was dropped from room T into a calorimeter held at 965 K, and the measured heat resulting from the sample represents the sum of the heat from the conversion of the sample into rutile, and the $H_{965}$-$H_{298}$ of rutile. The sample (now rutile) was run through a repeat of the drop procedure, which should only measure the $H^{\circ}_{965}$-$H^{\circ}_{298}$ for rutile. The difference in measured heat between the first and second steps of the procedure, should represent the ΔH(r) for $TiO_2$-II = rutile. The value determined from four replicate measurements was -3.2 ± 1.2 kJ/mol (2 σ).

Now that the standard entropy and volume equations are known for both phases, the ΔH(r) and ΔG(r) are calculated at STP, and the pressure of the equilibrium phase boundary at 298.15 K is solved with the equation

$$\Delta G^{P}_{298}(r) = \Delta G^{\circ}_{298}(r) + \int_0^P VdP. \tag{3.8}$$

Using the polynomial volume equation (3.7), the integration becomes trivial and the now cubic polynomial can be solved for the pressure at which $\Delta G$ goes to zero. The phase boundary at 298.15 K calculates to be 110 ± 40 kbar. This value, along with the experimental reversals and phase boundaries of Akaogi (1992) and Withers (2003) is plotted in Figure 3.8. Given the known experimental conditions at which rutile transforms to $TiO_2$-II, such a value is unreasonable, unless the reaction were to have a negative slope at low T, which it does not, from the thermodynamic data, because both $\Delta V$ and $\Delta S$ are negative for reaction (1). Therefore, something appears to be wrong with the data for $\Delta S$, $\Delta V$ or $\Delta H$. The experimental slope of Withers et al. (2003) gives an intercept of 32 kbar (Fig. 3.8), which results in a $\Delta G^{\circ}_{298}(r)$ of ~ 1 kJ, much lower than the $\Delta G^{\circ}_{298}$ of 3.5 kJ calculated with the measured $S^{\circ}_{298}$ and the $\Delta H(r)$ of 3.2 kJ measured by Navrotsky et al. (1967). The slope of Akaogi et al. (1991) gives an intercept of 48 kbar, which calculates as ~1.5 kJ for $\Delta G^{\circ}_{298}(r)$.

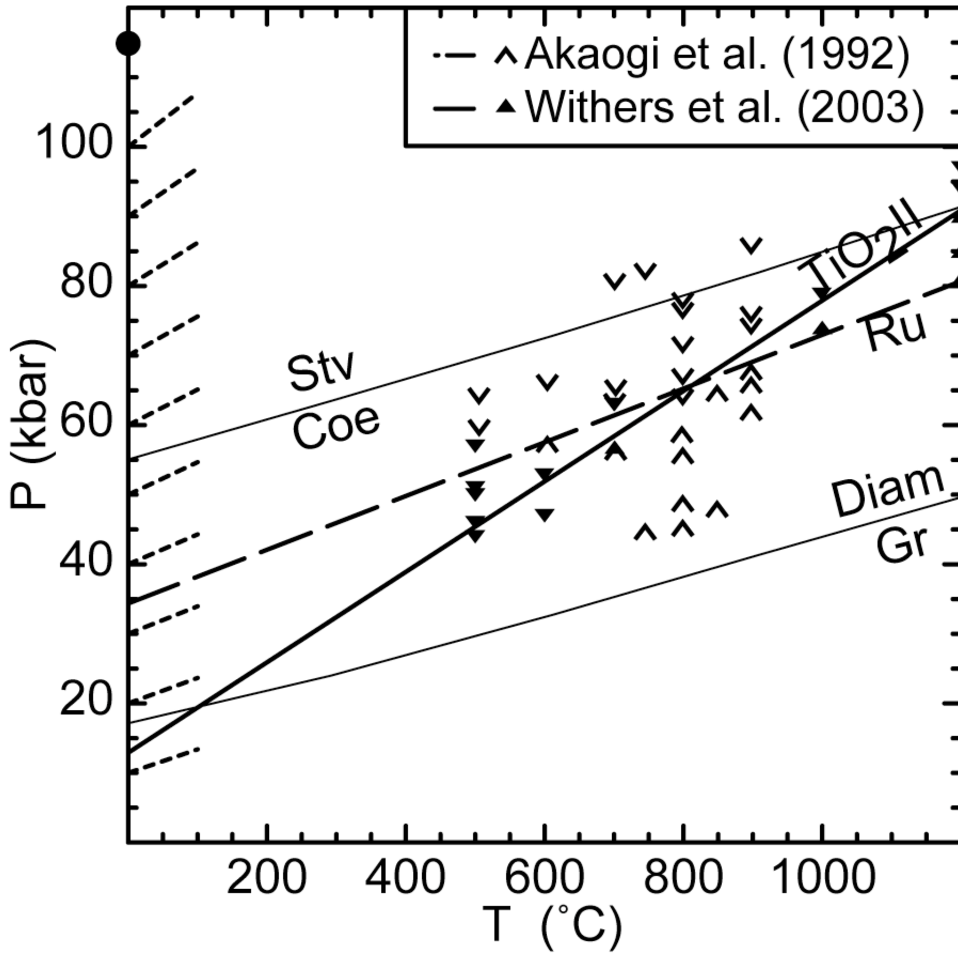


**Fig. 3.8.** Experimentally determined slopes and reversals on the rutile/$TiO_2$-II phase boundary from Akaogi et al. (1992) and Withers et al. (2003). The dashed lines starting at 25 ˚C show the Clausius-Clapeyron slope calculated at 25˚C and varying pressures, with $\Delta V$ and $\Delta S$ calculated at pressure with the volume equations from Olsen et al. (1999). The large dot at 0 ˚C and ~115 kbar is the intercept calculated by solving for $\Delta G = 0$ using the $\Delta H$ measured by Navrotsky combined with $\Delta V(P)$ and $\Delta S$ measured in this study.

The existence of good compressibility data allows calculation of the $\Delta S/\Delta V$ at 298.15 K and high pressure. This is shown on Fig. 3.8. If the value of $\Delta S/\Delta V$ does not change much as temperature increases, the value supports the slope determined by Akaogi et al. (1992). In order to examine the temperature dependence of this reaction, we must extrapolate heat capacity, and entropy above their measured range.

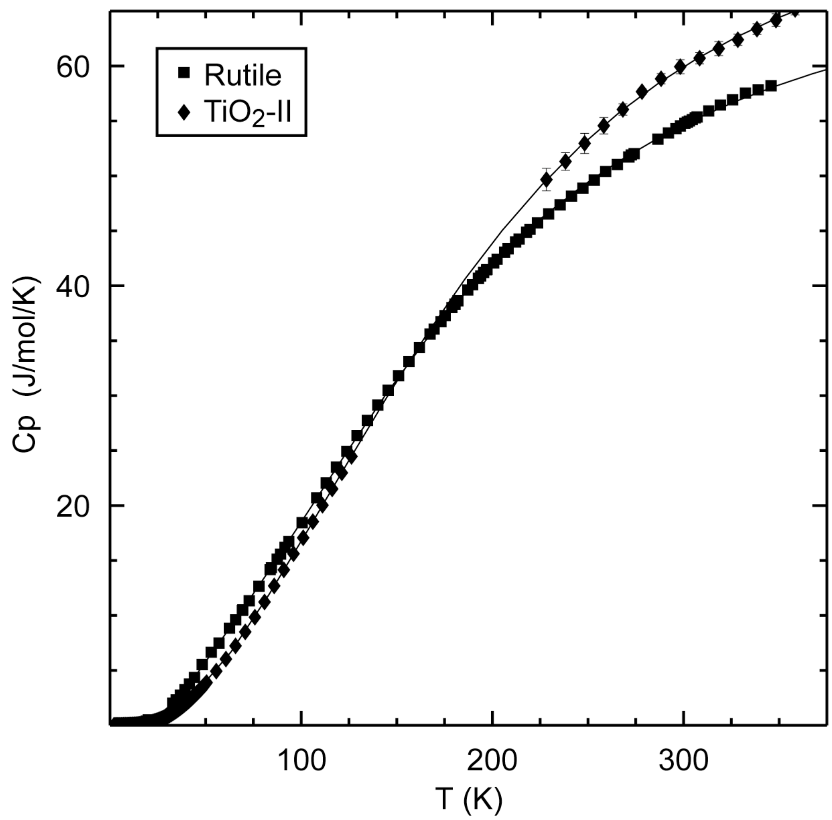


**Fig. 3.9.** The Cp of $TiO_2$-II (diamonds) compared with that of rutile (squares). Errors of $2\sigma$ are shown where they are larger than the symbols.

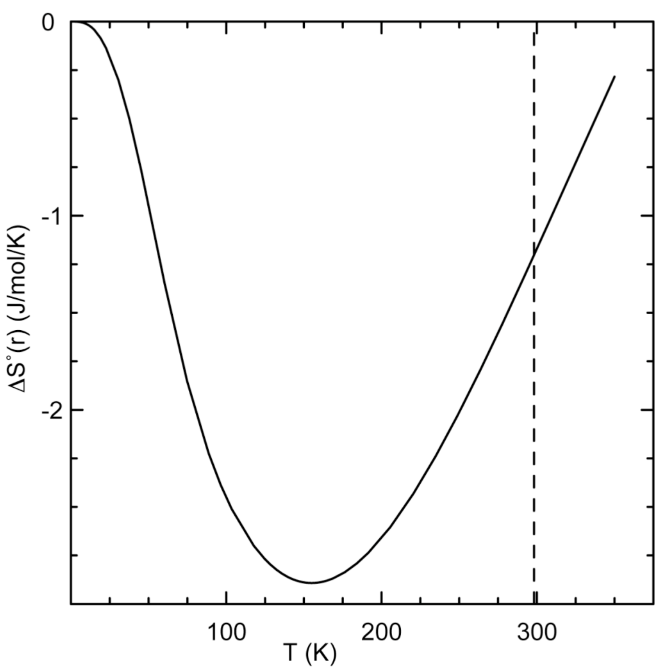


**Fig. 3.10.** $\Delta S(r)$ calculated for Eq (3.1), based on the data shown in Fig. 3.9 illustrating the imminent crossover predicted by the data

## Conclusions

The heat capacity curves of rutile and $TiO_2$-II are very close to each other, (Fig. 3.9). They cross, near 150 K, and $TiO_2$-II becomes the larger Cp. This shows up as a local minimum in $\Delta S$ (Fig. 3.10). The dashed line on this figure illustrates the $\Delta S^{\circ}_{298}$ value of -1.2 J/mol·K. It is predicted from this figure that the $\Delta S$ of reaction will become positive at about 320 K. This reversal in $\Delta S$ occurs without a corresponding change in $\Delta V$ as no such change is predicted by the V data from Olsen et al. (1999) at STP. Therefore, the Clapeyron slope must go from positive to negative. This is in exactly the opposite orientation than that inferred by Olsen (1999). Therefore, there appears to be a problem with the DSC data. How quickly the $\Delta S$ of reaction approaches zero is be sensitive to the difference between heat capacity curves. However, the crossover in heat capacity appears to be a real feature of this system, because even in the PPMS data the two curves very nearly cross. Therefore a decreasing $\Delta S$ of reaction with increasing temperature is likely, even if observed phase equilibria suggest a change in sign of $\Delta S$ is impossible. The DSC data in this study should be re-examined. There may have been partial inversion of the metastable high pressure $TiO_2$-II to rutile, or anatase. In the light of such difficulties, the entropy determined in this study could support either the slope for the rutile/$TiO_2$-II phase boundary determined by Akaogi et al. (1992) or that of Withers et al. (2003). Further work is required on the heat capacity of $TiO_2$-II and rutile, including measurements of the low-temperature Cp for both phases on the same machine, and characterization of the run products.

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# Chapter IV

## Mineral assemblages, phase equilibria and the conditions of metamorphism in Cretan metabasites

### Introduction

Blueschist facies rocks occur on the island of Crete just north of the Hellenic subduction zone between the African and European tectonic plates. The exhumation of blueschist facies rocks along the margins of subduction zones is a classic observation of metamorphic petrology. The Cretan blueschists of the Phyllite-Quartzite unit (PQ) contain metamorphic aragonite, which is expected to form during the metamorphism in most blueschist facies rocks but is rarely observed. This is because the kinetics of the aragonite = calcite transition are very fast even with no fluid phase in the rock. Aragonite is not expected to survive exhumation in the calcite field at temperatures greater than 180˚C (Carlson, 1980). Published PT paths (Küster and Stöckhert 1997, Thomson et al. 1998) for the PQ do not conform to this requirement, and therefore should not preserve metamorphic aragonite. The pressures and temperatures of peak metamorphism in the PQ were estimated by Theye et al. (1992), using preliminary data for magnesiocarpholite from Vidal et al. (1992) added to the internally consistent database of Berman et al. (1988). This study determines the PT of metamorphism for metabasalts, rather than the pelites studied by most other workers in the PQ. This allows for a comparison between the estimates obtained using phengite+quartz+chlorite ±carpholite±chloritoid±pyrophyllite assemblages and the provisional carpholite thermodynamics with those using the eptiote+albite+chlorite+quartz+glaucophane ±lawsonite±pumpellyite±omphacite assemblages found in the metabasalts. Tectonic interpretations of many workers are based on the peak PT estimates and disregard the significance of preserved metamorphic aragonite (Jolivet et al. 1996; Thomson et al. 1998; Ring et al. 2001; Chatzaras et al. 2006; Van Hinsburgen et al. 2006) are re-examined.

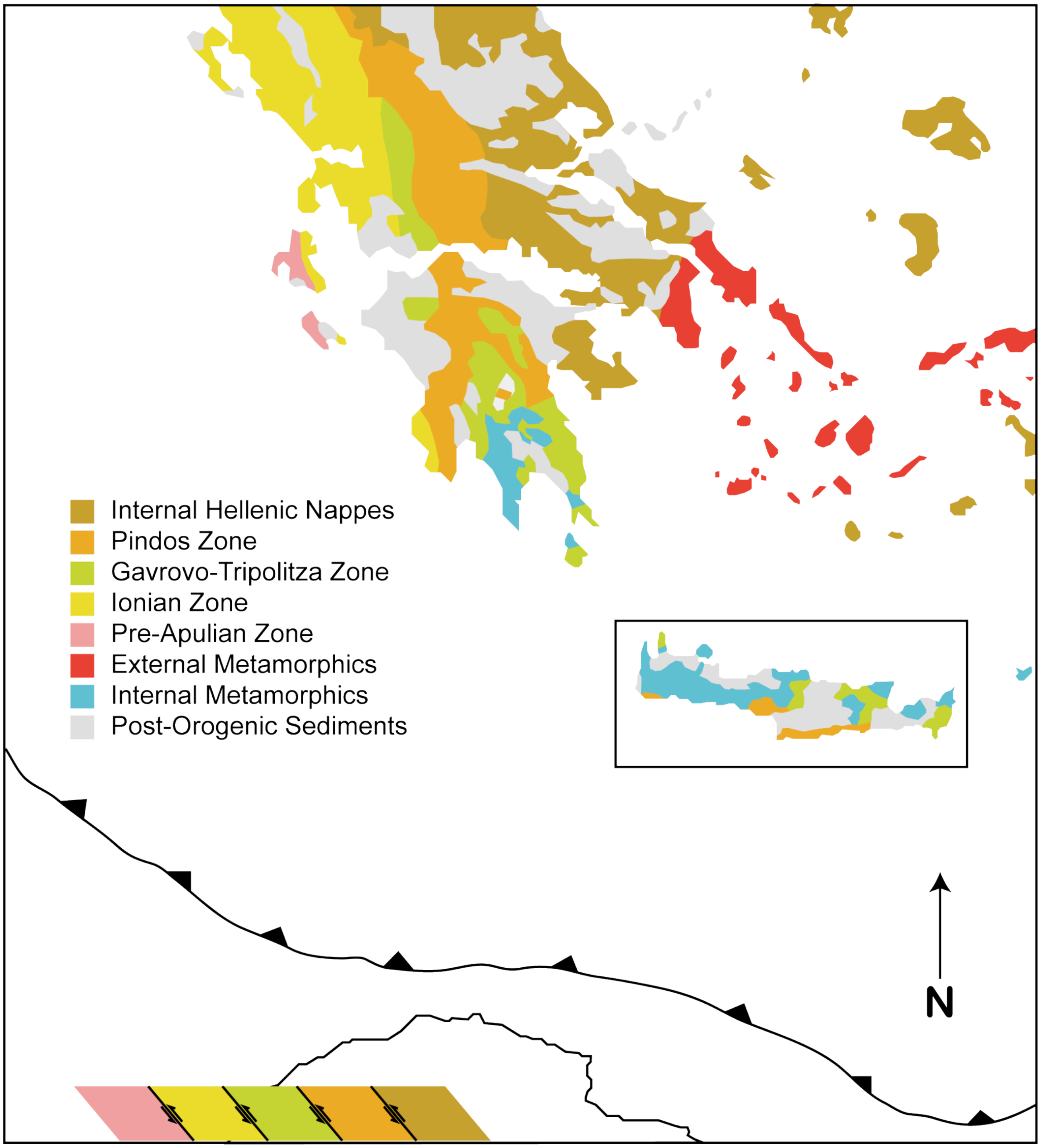


**Fig. 4.1.** Generalized geologic map of Greece. The sedimentary nappe units of mainland Greece are thrust over each other in a N-S alignment. Two blueschist belts exist in Greece associated with subduction of the African plate. The Cycladic blueschists of the back arc region have a high temperature overprint not present in the metamorphism in the forearc, the external Hellenides metamorphic belt. The box around Crete shows the area in Fig. 4.2 Modified after Van Hinsburgen et al. 2006

## Geologic Setting

The subduction of one lithospheric plate beneath another results in a tectonic regime that subjects rocks to high pressure at relatively low temperatures. Blueschist facies metamorphism is commonly found in the rocks neighboring such boundaries, or used to infer their presence when a subduction zone is no longer present. Convergence of the African plate with the European plate has produced many mountain belts in the Mediterranean Sea. The island of Crete is located just inside the Hellenic trench, an area of active subduction on the edge of the Aegean Sea (Fig. 1). Crete is in the position of a fore-arc high between the trench and back arc basin and volcanic arc in the inner Hellenides.

Since before the advent of plate tectonics, the geology of Mainland Greece has been described with the concept of Isopic Zones. These zones extend north-south and consist of a series of carbonate sedimentary packages in thrust contact with each other. Known as nappes, the individual zones were once part of the Tethyan seaway, an ocean that existed between Europe and Asia after the breakup of Pangaea. As the Tethys was consumed by being subducted under Europe, its carbonate platforms and sedimentary basins were thrust onto each other over Mainland Greece, resulting in a series of sedimentary packages with similar but distinct oceanic lithologies. The sediments are of a similar age (Cretaceous-Tertiary) with the hanging walls of the thrusts generally to the west. Since the Jurassic at least 3000 km of sediment has been consumed at the Hellenic subduction zone, and stacked over Greece (van Hinsburgen et al. 2005).

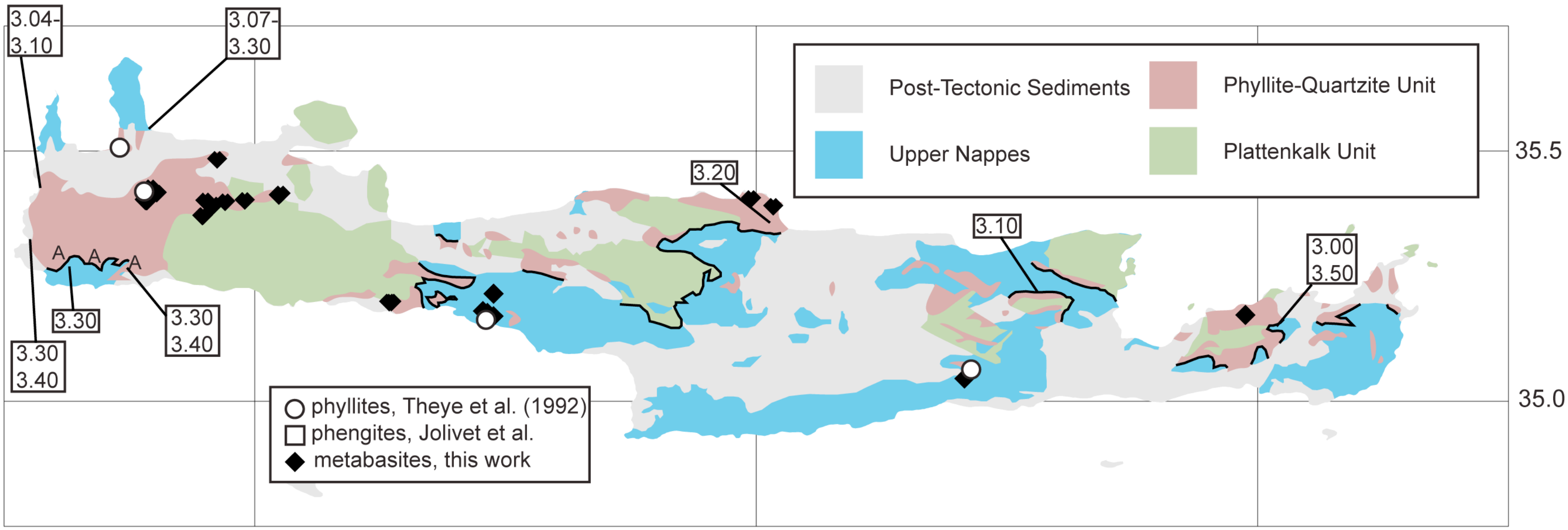


**Fig. 4.2.** Simplified geologic map of Crete, Greece. The metamorphic nappes are in green (PK) and red (PQ). Black diamonds represent the metabaasites collected in this study. Also shown are carpholite/chloritoid sample localities from Theye et al. (1992) and Si in phengite measurements from Jolivet et al. (1996). The definition of Western Crete by Theye et al. (1992) consistents of the westernmost two points from their study, and they identify the the other two points as Central Crete.

The geology of Crete has been mapped with an eye towards the general structure of the Grecian Isopic Zones (Fig. 4.1). On Crete, however, the simple north-south delineation of lithologies is no longer present. The island is mostly made up of carbonate units in thrust contact with each other. While many of the limestones on Crete remain unrecrystallized, two of the nappes show evidence of regional metamorphism. They show pervasive ductile folding as well as significant carbonate recrystallization. These units are correlated with metamorphic rocks of similar lithology from the Peloponessus, known as the Plattenkalk (PK) and Phyllite-Quartzite units. The Phyllite-Quartzite is structurally overlying the Plattenkalk, in thrust contact. The rocks of the Plattenkalk are pure marbles, consisting mostly of dolomite and calcite, without any preserved metamorphic aragonite. An outcrop with lawsonite- and aragonite-bearing marbles was described by Theye (1988), suggesting metamorphism in the blueschist facies. The Phyllite-Quartzite unit contains lawsonite and glaucophane, minerals indicative of the blueschist facies in metabasic rocks (Seidel et al. 1975). The phyllites contain magnesiocarpholite, a proposed index mineral (de Roever 1951) for pelitic rocks exposed to metamorphic gradients higher than typical Barrovian metamorphism. The high-pressure units contact the unmetamorphosed nappes along what is known as the Cretan detachment (Fassoulas et al. 1994), an extensional structure visible across the width of the island. The distribution of high-pressure nappe units is shown in Fig. 4.2. The island of Crete is currently being exhumed, with river and beach terraces visible in the southwest as well as the island's famous gorges.

## Previous Work

They metamorphic rocks of the Phyllite-Quartzite series have been the subject of several previous studies. Seidel et al. (1975) studied the rocks in Western Crete, and described the distribution of lawsonite blueschists as distinct from epidote blueschists. They ascribed chloritoid in phyllites coexisting with the metabasalts to a later greenschist facies overprint. Lawsonite, glaucophane and omphacite were known in the meta-igneous rocks of the Phyllite-Quartzite in West Crete (Seidel et al. 1982) but most later work has focused primarily on the phyllites and quartzites. Theye and Seidel (1991) described albite + chlorite and paragonite + chlorite assemblages in the metapelites of Eastern and Central Crete, whereas in the West, they reported albite + paragonite, as well as pseudomorphs after blue amphiboles. How the original color of a pseudomorphed grain is retained after it is replaced was left unexplained. The thermobarometry in Theye and Seidel (1991) only addresses garnet and pyroxene bearing rocks from the PQ of the Peloponnesian Peninsula in south-west mainland Greece. Theye et al. (1992) focused on phase relationships between carpholite, sudoite and chloritoid to investigate the metamorphism in Crete. They highlighted sudoite found in eastern Crete, and carpholite in western and central Crete, occurring in assemblages with chloritoid, albite and chlorite. Sudoite was distinguished from other chlorite species by XRD. They cited Theye and Seidel (1991) for estimates of PT conditions in Crete, although that that paper only derives estimates for the Peloponnesus. Chloritoid is described in the phyllites over the entire island, except for in Eastern Crete. The authors also documented carpholite in many assemblages. Distribution coefficients ($K_D = [Mg_a/(Mg_a+Fe_a)]/[Mg_b/(Mg_b+Fe_b)]$) calculated for coexisting minerals increase very slightly, but within error are nearly the same across the island. Such calculations implicitly assume that all iron as 2+. Quantitative estimates of a gradual increase in metamorphism rely on an increase in XMg of carpholite, chloritoid and chlorite from east to west. The reaction

$$MgAl_2Si_2O_6(OH)_4 = MgAl_2SiO_5OH)_2 + SiO_2 + H_2O \qquad (4.1)$$

$$\text{magnesiocarpholite} = \text{magnesiochloritoid} + \text{quartz} + H_2O$$

was calculated with data from the internally consistent database of Berman for quartz and water, combined with carpholite and chloritoid data from Vidal et al. (1991) (Fig.

4.3). In the paper, they stated that their conclusions must be tentative, because the data are still provisional. Over time, however, workers simply cited that paper (Küster and Stöchkhert 1997; Thomson et al. 1998). The internally consistent thermodynamic database of Holland and Powell (1998) used the asserted conditions of metamorphism in Crete as a “reversal” experiment on the exchange reaction

$$MgAl_2Si_2O_6(OH)_4 + Fe_2Al_4Si_2O_{10}(OH)_4 = FeAl_2Si_2O_6(OH)_4 + Mg_2Al_4Si_2O_{10}(OH)_4$$

magnesiocarpholite + ferrochloritoid = ferrocarpholite + magnesiochloritoid (4.2)

Therefore any calculation of magnesiocarpholite and magnesiochloritoid-bearing reactions in Crete using the dataset of Holland and Powell (1998) would be somewhat circular.

Jolivet et al. (1996) determined $^{40}Ar$-$^{39}Ar$ ages on single grains of white mica from Crete. Their study concentrated mostly on a transect on the very westernmost side of Crete. Ages ranged from 18-24 Ma in Western Crete, and yielded very old ages, interpreted to be unreset by metamorphism, in Eastern Crete. They estimated the temperatures of metamorphism with reaction 4.1, and therefore obtained similar results to Theye et al. (1992). Pressure estimates were much higher than those obtained previously, 17 kbar in Western Crete. These estimates were made using the excess Si content of phengites in the area following the approach of Massone and Schreyer (1987, 1989). This approachhas been shown to produce much higher estimates than other thermobarometers in other HP rocks (Page et al. 2007). In addition, pressures were based on uncalibrated celadonite reactions with magnesiocarpholite + magnesiochloritoid. Pressures of 17 kbar are also at least 5 kbar above the point where albite decomposes to jadeite + quartz (Fig 4.3). Therefore, the pressure estimates of Jolivet et al. (1996) are likely in error.

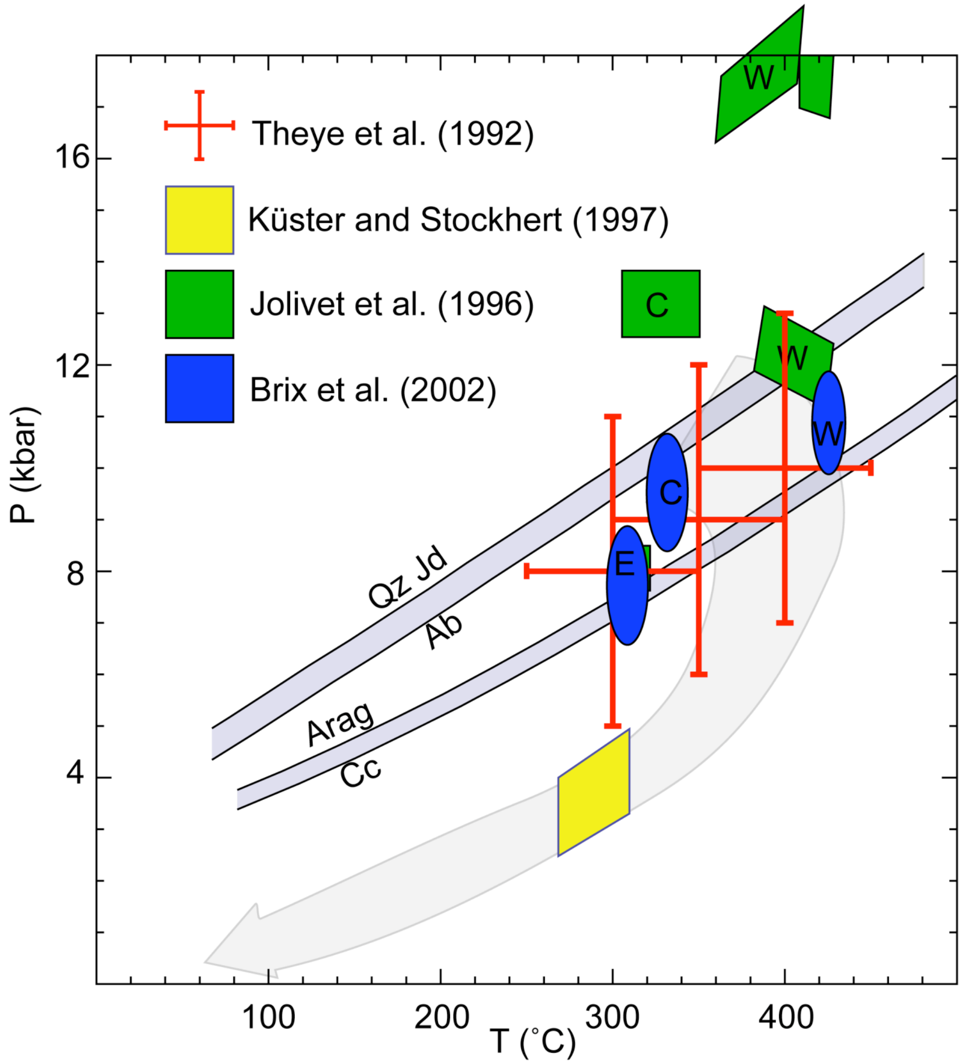


**Fig. 4.3.** Estimates of the metamorphism in the PQ unit on Crete made by other workers. The general trend is for PT to increase to the west. The different pressures estimated in west Crete by Jolivet et al. are based on different Si-content in phengites (see Fig. 2). Shows is a schematic PT-loop (after Thomson et al. 1998) that uses the fluid inclusion work of Küster and Stockhert as a point on the retrograde path.

In a paper mostly focused on fission tracks in zircons from Eastern Crete, Brix et al. (2002) re-examined the PT estimates from Theye et al. (1992). The thermodynamic dataset of Berman (1988) was again supplemented with carpholite and chloritoid data from Vidal et al. (1992). They determined low-pressure limits on the assemblages describe by Theye et al. (1992) with the reaction

$$5Mg_2Al_4Si_3O_{10}(OH)_8 + 23SiO_2 = 2Mg_5Al_2Si_3O_{10}(OH)_4 + 8Al_2Si_4O_{10}(OH)_2 + 8H_2O$$

$$\text{sudoite + quartz = clinochlore + pyrophyllite + } H_2O \quad (4.3)$$

This curve is almost flat as presented in their Fig. 2. To determine temperatures they again used reaction 4.1 and consequently obtained results similar to Theye et al. (1992).

Küster and Stöckhert (1997) measured the composition of fluid inclusions in syn-metamoprhic quartz veins from western Crete, where Theye and Seidel (1993) reported metamorphic aragonite. They argued that dislocation creep in quartz will stop at T = 300˚C, and the volume and composition of fluid inclusions trapped within the quartz crystal will be trapped. Assuming that the volume of the fluid in the quartz inclusion was in equilibrium with the PT of the bulk rock, they used the composition of the fluid to extrapolate an isochore from 300*C in PT space. Küster and Stöchkert argued that this approach should pin a point in the retrograde path at T = 300˚C. For western Crete, which had $CO_2$-free inclusions, they estimated 3-4 kbar (Fig. 4.3).

Thomson et al. (1998) combined the retrograde path of Küster and Stöckhert (1997) with zircon fission track data they collected. Their zircon ages showed the same spread of ages as the Ar/Ar work of Jolivet et al. (1996). The fission tracks should start to accumulate at temperatures slightly less than 300˚C, so Thomson et al. (1998) argued that they had dated the point on the retrograde path. By assuming that the Ar/Ar ages from Jolivet et al. (1996) formed at the PT conditions from Theye et al. (1992), Thomson et al. (1998) calculated a very fast exhumation rate for the PQ, 4 km/Ma. Though Küster and Stöckhert acknowledged the existence of metamorphic aragonite on Crete, both of these proposed PT paths should destroy any metamorphic aragonite.

Chatzaras et al. (2006) proposed that the Cretan detachment did not accommodate much extension, unlike the work of Fassoulas et al. (1994) and Ring et al. (2001). In order to explain differences between metamorphism in the PK and PQ, they suggest the exhumation of the PQ along a channel, driven by erosion at the surface, similar to some models for the Himalaya. This would retain the same structural relationships between units, but juxtapose higher-grade rocks in the PQ against far lower grade PK rocks.

## Sample Descriptions

Metamorphosed igneous rocks were sampled in order to cover the PQ unit across Crete (Fig 4.2). Igneous rocks are not abundant within the PQ lithology, and coverage is not uniform across the island. The samples are concentrated largely in the Lefka Ori (White Mountains) of West-Central Crete. The protoliths of the rocks were not all of the same composition, ranging from alkali basalts to andesites (Seidel et al. 1982). This bulk composition effect accounts for some of the observed variation in mineralogy. Still, the meta-igneous rocks from the PQ can be separated into a few groups on the basis of their most abundant mineralogy. Samples vary in appearance from fine-grained glaucophane schists to coarser schists containing large relict igneous clinopyroxene and plagioclase. The phenocrysts have varying degrees of alteration, and are sometimes replaced with chlorite and epidote. Many of the schists are blue in hand sample and contain visible blades of glaucophane. Rocks without obvious glaucophane are also common, and resemble greenschists. The most abundant metamorphic minerals within the studied rocks are epidote, chlorite, albite and sphene. Almost every sample contains these minerals, although in variable proportion. Other rock-forming minerals include lawsonite, glaucophane, pumpellyite, sodic pyroxene, quartz, tremolite, muscovite, calcite and apatite. The most obvious change in the assemblages across the island is the absence of glaucophane in the easternmost two samples studied (cr04-81a cr04-81b). Lawsonite has been found, mostly in samples with albite and pumpellyite, and with greater distribution than indicated by Seidel et al. (1975, Fig. 1).

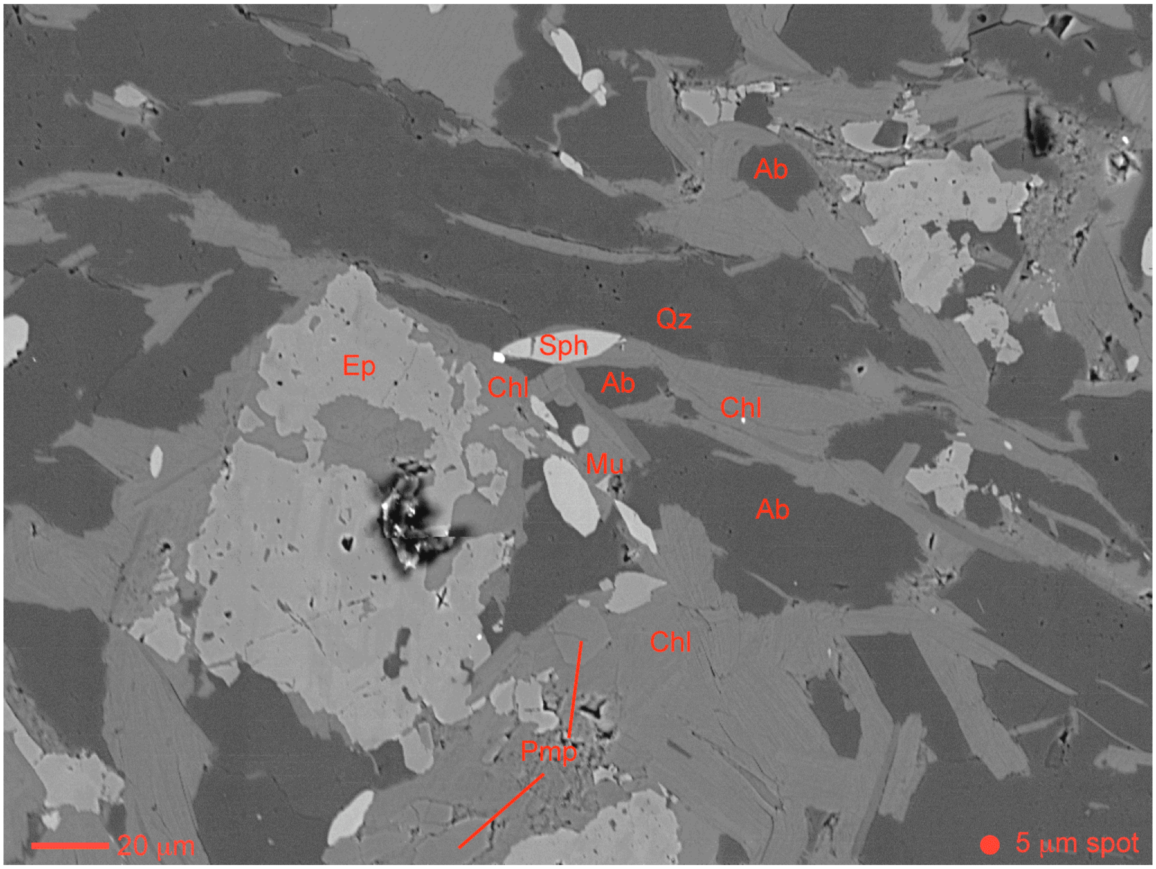


**Fig. 4.4.** Typical pumpellyite-bearing assemblage form the Cretan metabasalts with chlorite (Chl) and muscovite (Mu) from sample cr04-62. In the pumpellyite-bearing schists, minerals are often found in small domains, which center around a larger relict grain or porphyroblasts. Note assemblage of minerals growing around a blastic epidote (Ep). The elongated chlorites define a local foliation. Quartz (Qz), albite (Ab), somewhat zoned epidote and even sphene (Sph) crystals are intergrown in this alignment. The chlorite also contains equant diamonds of pumpellyite (Pmp).

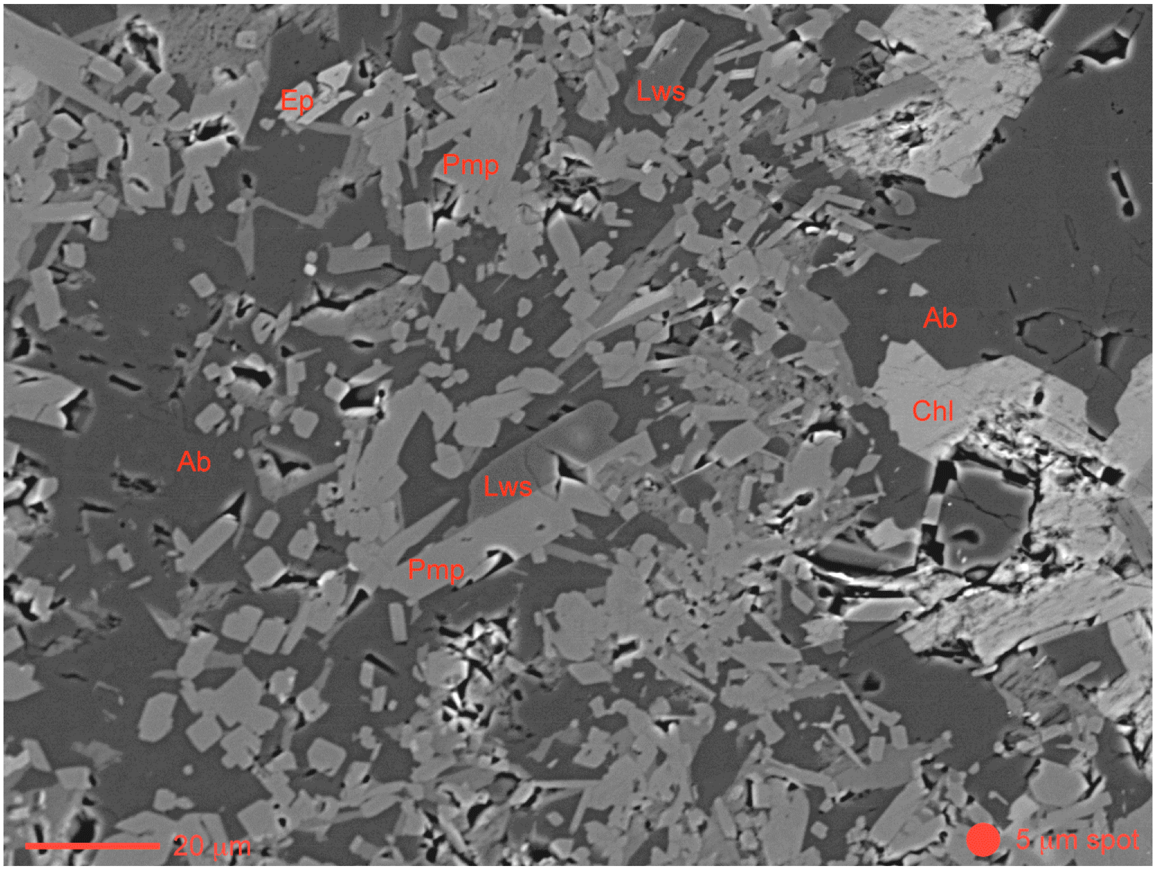


**Fig. 4.5.** Closeup of a tabular domain, inferred to be former igneous plagioclase, from sample cr04-28b. The pumpellyite appears as equant diamond-shaped crystals most commonly surrounded by albite. Lawsonite (Lws) is not as abundant as pumpellyite, but forms tabular laths in contact with it. Blades of chlorite and epidote can also be found inergrown with albite and pumpellyite in this area.

The metabasite samples often contain tabular domains, inferred to be former igneous plagioclase. These areas commonly contain assemblages of minerals in textural equilibrium. An example is shown in Fig. 4.4, which contains lawsonite, pumpellyite, albite, epidote and chlorite. Aside from lawsonite, one of the most characteristic features of the blueschist facies is the presence of a sodium-rich blue amphibole. An example of the coexistence of both of these minerals is shown in Fig. 4.5.

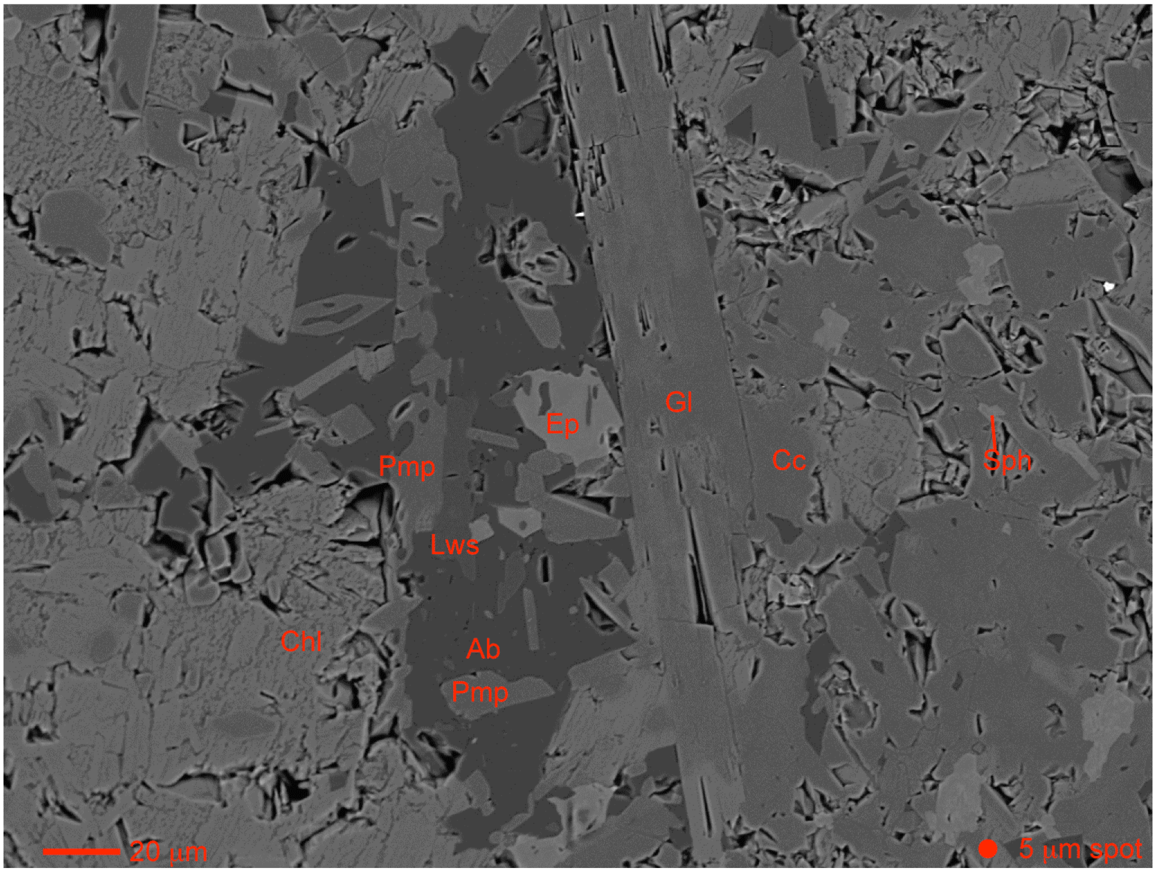

**Fig. 4.6.** A large glaucophane (Gl) crystal coexisting with albite, pumpellyite, lawsonite, epidote, chlorite and calcite (Cc) in sample cr03-14a. The brighter areas within the glaucophane are rims and patches of Ca-rich amphibole (Tr).

In low-grade blueschist rocks, as in Crete, the low temperatures of metamorphism often lead to only a partial re-equilibration of the system. Thus, there is always the difficulty of distinguishing minerals that may be relicts from protolith, or may be due to hydrothermal alteration. In addition, signs of overprinting by a later amphibolite or greenschist facies event is commonplace in some areas, such as the Alps and the Cyclades. Use of minerals with complex textures in determining the rock's metamorphic history is obviously a problem. In the Cretan metabasalts pyroxene is the most common relict phase. It is often diopsidic in composition with significant Ti and Al. Intermediate plagioclase (labradorite-andesine) is rarely found in the samples. Generally igneous plagioclase is present only as pseudomorphs, which are now often made up of epidote, albite, chlorite and pumpellyite.

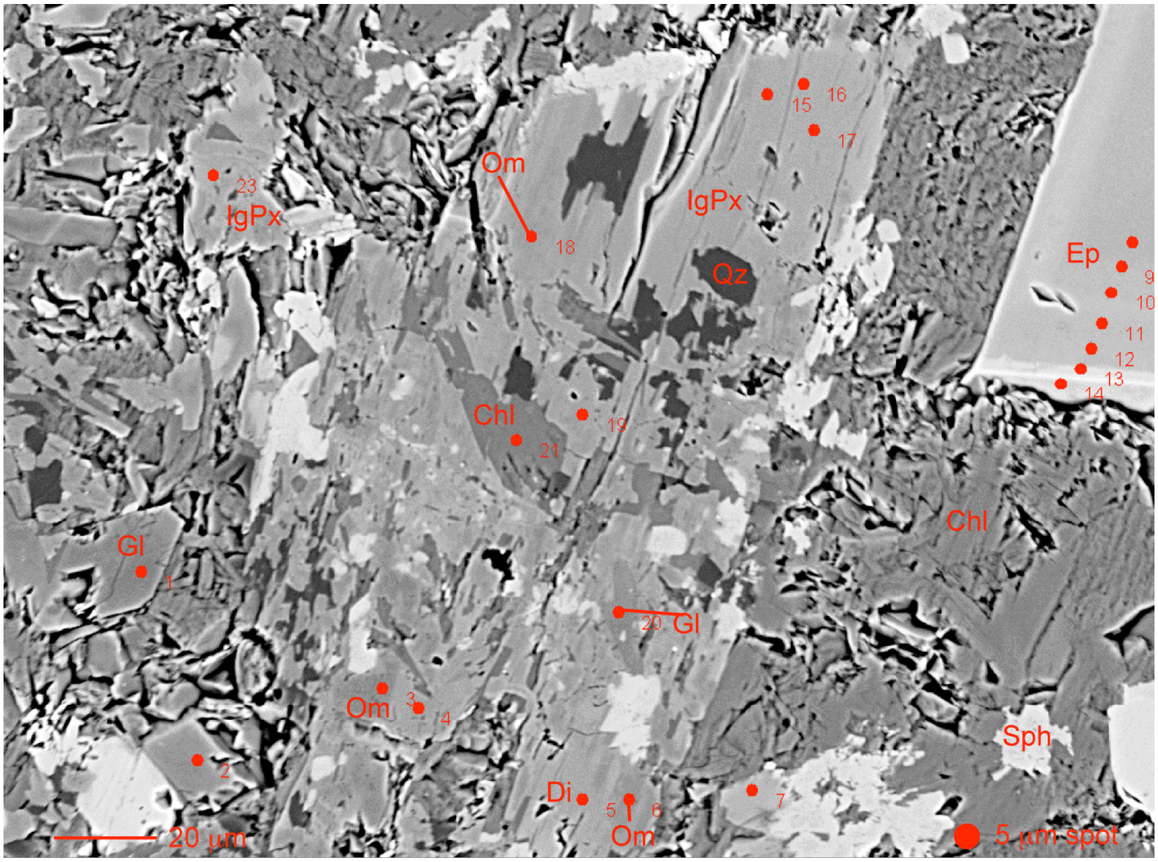


**Fig. 4.7.** Relict igneous pyroxene replaced with the stable mineral assemblage glaucophane, omphacite (Om), quartz, epidote, chlorite. Note extreme zoning on the edge of the large epidote, due to REE substitution for Ca. Sample cr04-38

Figure 4.6 illustrates a common texture, where the main assemblage of the rock replaces a relict grain. The central crystal (spots 16,17,18) is an augitic pyroxene with significant Ti and AlIV, and containing almost no sodium. At spots 3,6, and 18 the augite is replaced with pyroxene containing subequal amounts of Na and Ca (i.e. omphacite). Equant diamonds of glaucophanitic amphibole are present surrounding the relict grain. Amphibole also replaces the pyroxene at spot 20. In addition to the sodic pyroxene, quartz, chlorite, glaucophane, epidote and sphene are all present within the boundaries of the old igneous clinopyroxene. The poorly polished matrix to the grains is largely chlorite. A large epidote is present at the edge of the image, which grows increasingly bright towards its rim. The iron content of the epidote increases with the brightness.

There is a corresponding decrease in the analytical totals, which likely represents (unanalyzed) REE incorporation into the epidote.

A list of metamorphic minerals found in the Cretan metabasites is given in Table 4.1. Samples were collected from about seven different areas in Western Crete. These areas are presented on a map in Fig. 4.7 along with symbols indicating which index minerals are present. Rocks from the same area were typically from the same town or set of outcrops, and are indistinguishable from each other on a map scale. Fig. 4.7 also contains localities where Theye et al. (1992) studied chloritoid±carpholite-bearing phyllites. In order to perform thermobarometric calculations with a given assemblage of minerals, chemical analyses of these minerals were obtained with the electron microprobe.

Table 4.1 Observed metamorphic minerals from Cretan metabasites

| area | sample | minerals | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | cr03-14a | Ab | Chl | Ep | - | Sph | Qz | Gl | - | - | Lws | Pmp | - | - | - | Cc | - |
| | cr04-22b | Ab | Chl | Ep | - | Sph | Qz | Gl | Tr | - | - | - | - | - | - | - | Ap |
| 7 | cr04-28b | Ab | Chl | Ep | cz | Sph | Qz | Gl | Tr | - | Lws | Pmp | - | - | Mu | - | Ap |
| | cr04-29 | Ab | Chl | Ep | cz | Sph | Qz | Gl | Tr | - | Lws | Pmp | - | - | - | - | - |
| | cr04-30a | Ab | Chl | Ep | - | Sph | - | Gl | Tr | - | - | Pmp | - | Om | - | - | - |
| 6 | cr04-34 | Ab | Chl | Ep | - | Sph | - | Gl | Tr | - | Lws | Pmp | - | Om | - | - | - |
| | cr04-33 | Ab | Chl | Ep | - | Sph | - | Gl | - | - | - | - | - | - | - | - | Ap |
| | cr04-38 | Ab | Chl | Ep | - | Sph | Qz | Gl | - | Wi | - | - | Aeg | Om | - | Cc | Ap |
| 5 | cr04-39a | Ab | Chl | Ep | - | Sph | Qz | Gl | - | - | - | - | - | - | Mu | Cc | - |
| | cr04-40a | Ab | Chl | Ep | - | Sph | Qz | Gl | - | - | - | - | - | - | - | Cc | - |
| | cr04-43 | Ab | Chl | Ep | - | Sph | - | Gl | Tr | Wi | - | - | - | - | - | Cc | - |
| | cr03-18c | Ab | - | Ep | - | - | Qz | Gl | Tr | Wi | - | - | Di | Om | Mu | - | - |
| 4 | cr03-18d | Ab | Chl | Ep | - | Sph | Qz | Gl | Tr | Ts | - | Pmp | Di | - | Mu | Cc | Ap |
| | cr04-44 | Ab | - | Ep | - | Sph | Qz | Gl | Tr | Ts | - | Pmp | - | - | Mu | Cc | - |
| 3 | cr04-551 | Ab | Chl | Ep | - | Sph | Qz | Gl | Tr | - | - | - | Di | Om | - | Cc | - |
| | cr04-552 | Ab | Chl | Ep | - | Sph | Qz | Gl | Tr | - | - | - | Di | Om | Mu | Cc | Ap |
| 2 | cr04-59a | - | Chl | Ep | - | Sph | - | - | Tr | - | - | - | - | Om | - | - | - |
| | cr04-62 | Ab | Chl | Ep | - | Sph | - | - | - | - | Lws | Pmp | - | - | Mu | Cc | Ap |
| 1 | cr04-81a | Ab | Chl | Ep | - | Sph | Qz | - | - | - | - | - | - | - | Mu | Cc | Ap |
| | cr04-81b | Ab | Chl | Ep | - | Sph | Qz | - | - | - | - | - | Di | - | Mu | Cc | - |

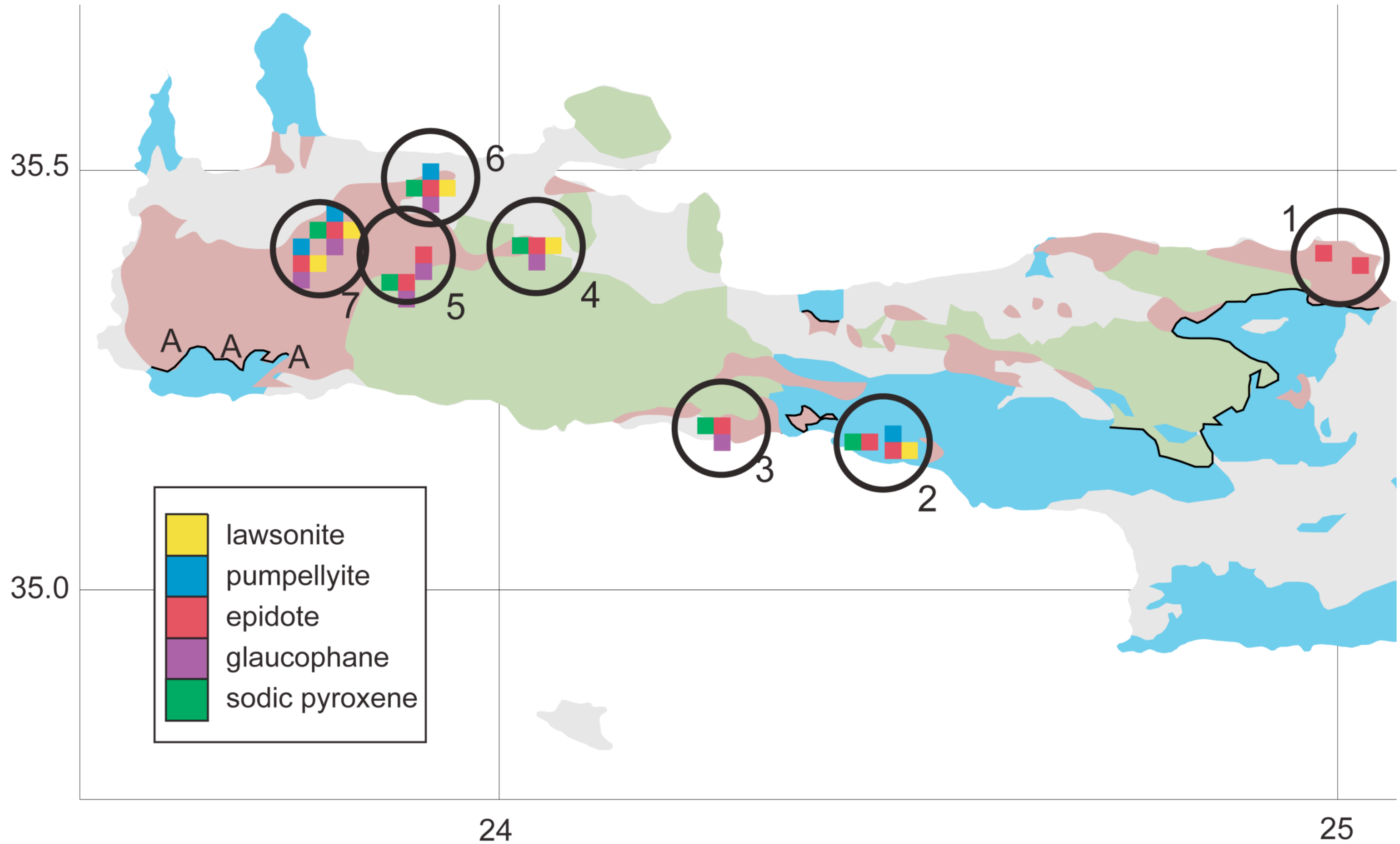


**Fig. 4.7.** Map of western Crete, showing index minerals found in the metabasites of the PQ. There is no obvious spatial distribution to the minerals which would suggest an increase in grade from E to W. The circled areas are locations where more than one rock was collected from a single outcrop, and should have experienced similar PT paths. The symbol A represents the locations of metamorphic aragonite found by Theye and Seidel (1993) and confirmed in this study. The geologic units in Crete are depicted in the same manner as on Fig. 4.2

## Electron Microprobe Analysis Procedures

Mineral analyses were collected on meta-igneous samples from the PQ unit on Crete (Fig. 4.2). Electron microprobe data were obtained on the Cameca SX100 in the Electron Microbeam Analysis Laboratory (EMAL) at the University of Michigan. The elements analyzed in the Cretan metabasalts are F, Na, Mg, Al, Si, Cl, K, Ca, Ti, Cr, Mn, and Fe. Representative analyses are given in Tables 4.4 to 4.8. Errors given for individual microprobe analyses plotted in Fig. 4.7-4.11 are based on the counting statistics of the Cameca output program. They represent the precision uncertainty associated with the number of X-ray counts in the measurement of the standard and the sample. Accuracy is difficult to evaluate for the correction procedure used to account for the differences in X-ray absorption, atomic number and fluorescence between the matrix and the unknown. To minimize the correction factors, an attempt was made to use standards which were close to the unknowns in average atomic number.

Standardizations were performed on a combination of synthetic and natural standards in the collection of the Electron Microbeam Analysis Laboratory (EMAL) at the University of Michigan. Even more important than attempting to closely match the atomic number or type of silicate to the unknowns is that the standard have a high enough concentration of the element in question to avoid extrapolating to higher weight percent in any of the unknowns. Fluorine was standardized on a fluorine-rich topaz. Sodium was most commonly measured on a natural jadeite. Magnesium and calcium were determined on a natural diopside. Determinations of Ca were sometimes made on natural wollastonite. Aluminum (and sometimes Ca) was determined on natural grossular or synthetic almandine. Chlorine was standardized with a synthetic alforsite (chlorine-rich barium apatite). Potassium was measured on an orthoclase feldspar, or if the concentration was not expected to be high, a less beam-sensitive potassian hornblende. Titanium was determined on ilmenite or geikielite, manganese on natural rhodonite, and chromium on synthetic uvarovite. Iron was measured on a number of different samples including pyroxenes, almandine and synthetic ferrosilite. Silicon was measured during many of the standardizations since many silicates contain sufficient Si, and the data which yielded the lowest standard deviation was generally used, commonly wollastonite or grossular.

In order to excite X-rays efficiently from the desired elements within the unknown, an accelerating voltage of 15 kV was applied in generating the electron beam. It is well known that the heating by too large a flux of electrons into the sample can cause a rearrangement of the elements in the unknown, leading to highly erroneous results. The most common result of this is the migration of alkali elements (Na,K) away from the beam spot, resulting in low measurements for these elements. For minerals which are not particularly sensitive to this effect (sphene, pyroxene, amphibole, epidote and quartz) a spot beam with a current of 15 nA was employed during analysis. Other minerals required more delicate treatment to avoid alkali migration. The current was reduced to 4 nA for all reliable analyses of albite, lawsonite, pumpellyite, chlorite, muscovite and calcite. In some cases the beam was defocused to a 5 μm wide circle to further reduce the accumulation of charge during the analysis. This was found to be an adequate solution to the problem, as consecutive measurements on the same spot yielded alkali analyses that were the same within error. In addition a subcounting routine was run, which assumes that there will be loss, and divides the total analysis time for Na into several parts. These measurements are extrapolated back to time zero which should represent the initial concentration. When this procedure was employed there was no discernable change in each time step, so the added precaution was not necessary, and not in general employed.

Due to widespread presence of relict grains in some samples, mineral analyses were collected within small domains in a given thin section. The positions were recorded on BSE images collected during the probing sessions. Figures 4.3-4.6 show examples of representative mineral assemblages, and the textures as they appear in BSE. In general, mineral compositions were similar across the scale of a thin section. The zoning which is apparent in BSE was present in some minerals particularly epidote and sodic amphibole.

If all elements present in a given mineral are analyzed, within counting errors, the sum of the weight percents of all elements should total 100. However, if important elements are unanalyzed, the total will be lower. In general, it is hard to accurately measure or estimate the second row elements such as oxygen, and hydrogen cannot be analyzed on the electron microprobe. Their low energies (and corresponding long wavelengths) are not effectively excited by the electron beam, and they are strongly absorbed by the detector window. Nonetheless, the light elements are important constituents of a rock, and so must be determined. With current electron microprobes and detectors, direct measurement of oxygen tends to produce unacceptably high errors. It is more reliable to calculate oxygen by assuming valences on all measured cations and calculating enough oxygen to balance that charge. Stoichiometric OH may also be estimated from the preliminary analyses and back-calculated to the equivalent wt % H2O. Even with the calculated O and H, analytical totals can differ from 100 wt % in several ways. An error in calibration can lead to either positive or negative deviations. If the assumed valence of Fe, and in some cases Mn, is incorrect generally by assuming all 2+ cations, totals may be low. If anions other than $O^{2-}$ are present in the mineral, the total will be incorrect. Common anions other than oxygen are $OH^-$ $F^-$, $Cl^-$ $CO_3^{2-}$ and are generally accounted for by stoichiometry for specific minerals. In this study, F and Cl were generally measured, and adjustments can be made to totals. Charge balanced molecules, such as structural $H_2O$ in the mineral will lead to low totals. In general, hydrous minerals, and those with substantial ferric iron should produce analytical totals predictably less than 100 wt%.

## Mineral Normalizations

To understand a chemical analysis in the context of petrologically important substitutions it is important to normalize the formula. In order to keep from drawing incorrect or spurious conclusions it is also important to understand the confidence with which a given formula is known. Alternative schemes are available to calculate the formula for crystallographic sites in a mineral, especially for minerals with complex chemical substitutions or site disorder. Normalizations tend to fall into two categories, assigning the mineral an assumed number of either oxygen, or cations. The general practice of cation normalization was followed in this work because variations in site occupancy are not as common as those in oxidation state. The practices followed for each individual mineral are given below.

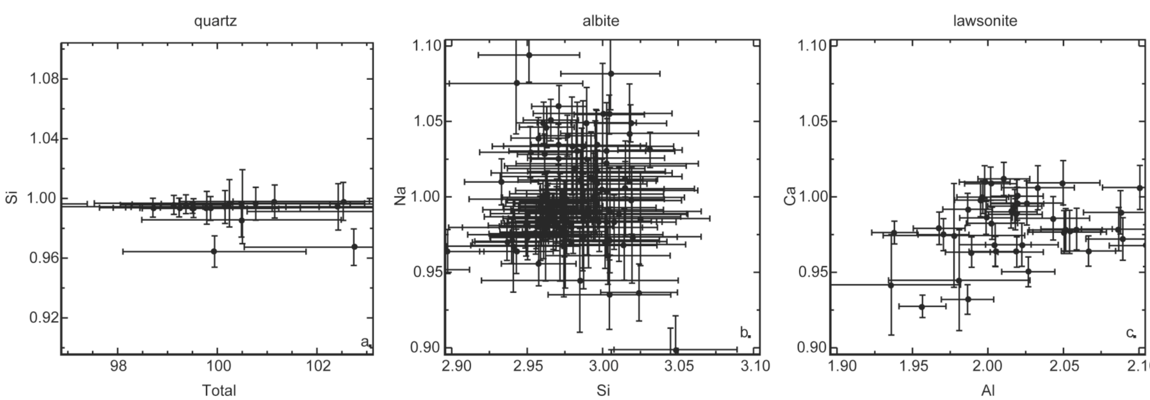


**Fig. 4.9.** Results of normalization on some simple minerals. a. All quartz analyses from Crete, normalized to a single cation. Many analyses have unacceptably high totals. b. All analyses of albite, which did not show significant sodium migration. Since the analysis was normalized to small cations, the calculated value of sodium very near its stoichiometric value of one shows almost no sign of beam damage, and gives confidence in using the same beam conditions for other beam sensitive minerals. c. Lawsonite analyses from Crete also appear very pure. Error bars represent 1 $\sigma$

Quartz is normalized to one cation. Albite is normalized to 4 small cations, (Si, Al, Ti, Fe, Mg, Mn, Cr). It allows the sum of large cations (Na, K, Ca) to be used as a check of the mineralogical consistency of the analysis. Lawsonite was normalized to four small cations in the same manner as albite. Chlorite is assumed to be trioctahedral, and is normalized to ten cations, resulting in reasonable formulae. Sudoite (dioctahedral chlorite), found by Theye et al. (1991) in metapelites in Eastern Crete would normalize to much higher Al values and AlVI>>AlIV.

Pumpellyite is a hydrous sorosilicate, commonly found in blueschist facies rocks (as well as the aptly named prehnite-pumpellyite facies). It has the cations Si, Al, Ca, Fe, Mg ± Mn. A general formula is $Ca_8(Fe,Mg,Al,Fe^{3+})_4(Fe^{3+},Al,Ti)_8Si_{12}O_{56-n}(OH)_n$ (Passagli and Gottardi, 1973). The seven-fold coordinated site contains mostly Ca, but can have minor Na, Mn (Yoshiasa and Matsumoto, 1985). The tetrahedral site is dominated by Si. The smaller of two octahedtral sites is termed Y and there are twice as many sites as for the larger site (X, Passagli and Gottardi, 1973). The occupancy of the octahedral sites is discussed below. Experiments were conducted on the stability of Mg-pumpellyite (NItsch, 1971; Schiffman and Liou, 1980). Schiffman and Liou (1980) used a formula for their syntheses of $Ca_4MgAlAl_4Si_6O_{21}(OH)_7$, then known as Mg-Al pumpellyite. This is the same as half of the unit cell formula used by Passagli and Gottardi (1973). They assume the X site is half filled with Mg and half with Al. Because the data of Schiffman and Liou (1980) were the only reversals used in the database of Holland and Powell (1998), it is the formula they use and will be adopted in this chapter. Pumpellyites are normalized to 12 small cations.

Artioli and Geiger (1994) determined site occupancies in three natural pumpellyites by combining Mössbauer spectroscopy with Rietveld analyses of X-ray powder diffraction. They found ferric iron was restricted to the Y octahedral site. In contrast Nagashima et al. (2006) suggested ferric iron was present in both the X and Y octahedral sites also using Mössbauer and X-ray Rietveld data on two natural pumpellyite samples from the Shimane Peninsula, Japan. The total of trivalent cations in their analyses is not strictly 5, but ranges from 4.9-5.6, suggesting simple charge balance with 21 $O^{2-}$ and 7 $OH^-$ is not a good assumption. There is a slight preference of $Fe^{3+}$ for the X-site in the study of Nagashima et al. (2006). Calculation of $Fe^{3+}/(Al+Fe^{3+})$ for the X,Y sites yields 0.32,0.31 and 0.22,0.16.

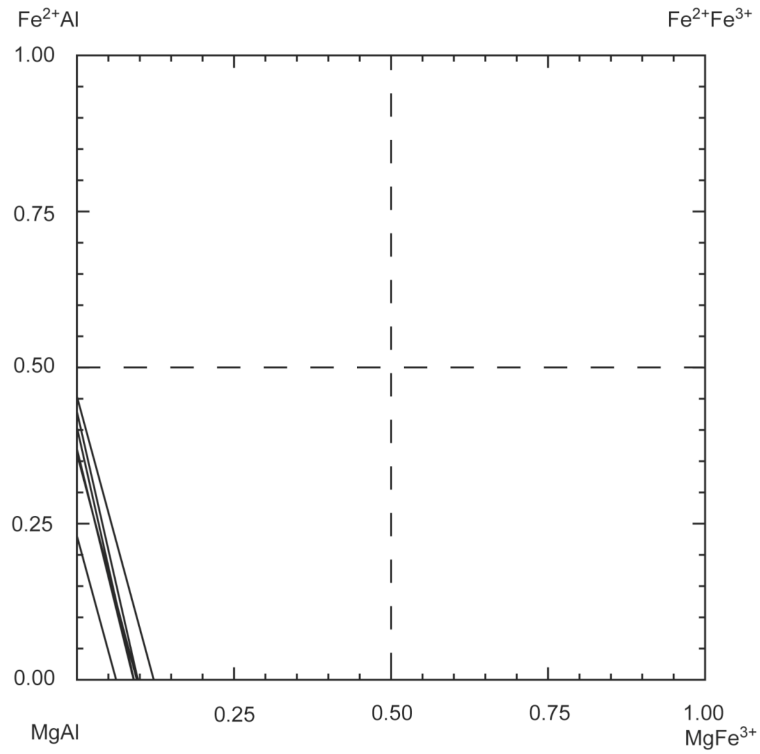


**Fig 4.10.** Cation assignments in the X octahedral site for pumpellyites analyzed from Crete. The diagram shows $Fe^{3+}/(Al+Fe^{3+})$ vs $Fe^{2+}/(Mg+Fe^{2+})$. A line is drawn between the mean of the two endmember estimates for each sample, all $Fe^{2+}$ or All $Fe^{3+}$.

Clinopyroxene were normalized to four cations. In blueschists, any excess Al is thought to charge balance with sodium in the jadeite component. Ferric iron can be estimated by charge balancing the rest of the sodium with aegirine. In the omphacite analyzed in this study, there is almost no tetrahedral aluminum, in sharp contrast to the relict igneous augite (Fig. 4.11). All Al will therefore be assigned to the jadeite component in omphacite.

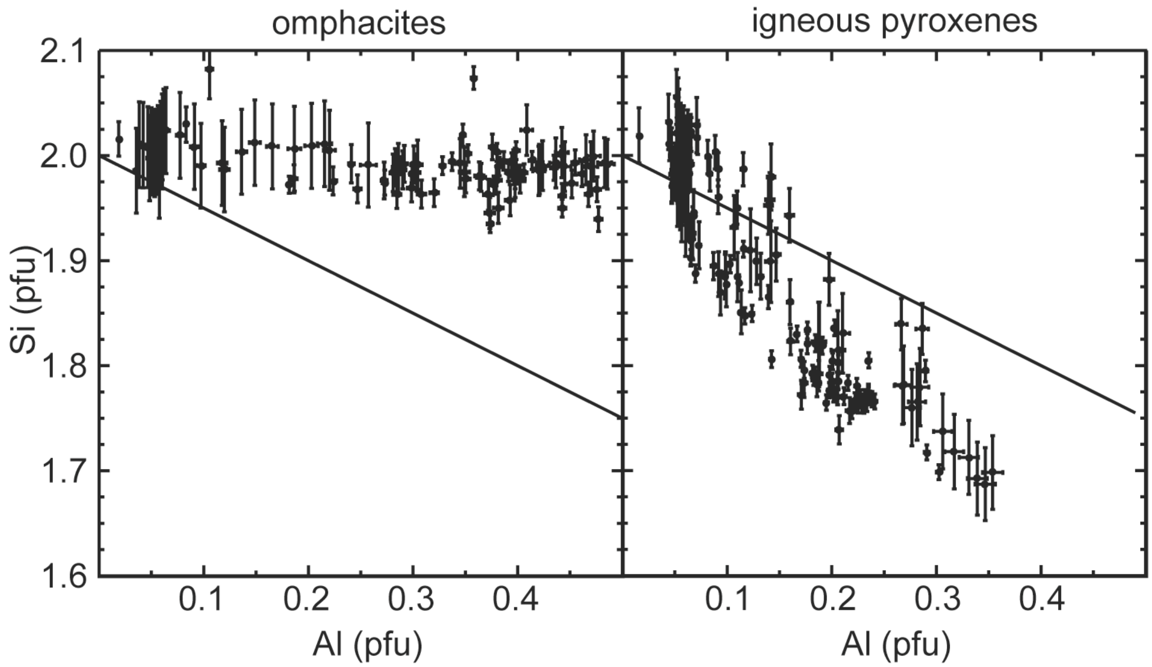


**Fig. 4.11.** Tetrahedral site compositions in pyroxenes. This figure shows the lack of Tschermak's substitution in the sodium pyroxenes, compared to that in the relict igneous pyroxenes. The inclined line is that for Di-CaTs

Due to the large range of chemical compositions that form minerals with the amphibole structure, normalizing amphibole analyses is not straightforward. There are six distinct crystal chemical sites for cations in the typical amphibole. A generalized formula can be defined as $A_{0\text{-}1}M4_2M13_3M2_2T1_4T2_4O_{22}W_2$ (Hawthorne and Oberti, 2007). The tetrahedral sites mostly contain $Si^{4+}$ but may also have a good deal of $Al^{3+}$. The A site is commonly vacant in glaucophane, but can be partially to completely filled with large cations, $Na^+$, $K^+$ in horblende. The M4 site is the largest of the three octahedrally coordinated sites and contains Ca, Na, and Fe or Mg in the case of ferromagnesian amphiboles (Hawthorne and Oberti 2007). The M13 site mostly contains $Fe^{2+}$ and $Mg^{2+}$, wheras the M2 site usually has Al, Ti, $Fe^{3+}$, $Fe^{2+}$, Mg. Due to the very common vacancy in the A site, it is difficult to normalize to all cations. However, if the assumption is made that the larger cations, Ca, Na and K are only present in the A and M4 sites, the smaller cations can be normalized to 13 M13+M2+T (Cosca et al. 1991). After proceeding with normalizations, it is important to examine the calculated elements for any obvious stoichiometric problems. Table 4.2 shows an example for a typical sodic amphibole, from sample cr04-40a. If there were problems with the analyses the Si might be greater than eight, or the Na + Ca + K greater than three or less than two. From here it is possible to estimate the ferric iron that is consistent with this analysis. Assuming there is nothing else we're missing, such as unmeasured lithium or a lot of Fe in the M4 site, the $Fe^{3+}$ can be calculated which would bring the oxygen total to 23. Assigning ferric iron can have a large effect on calculated Fe/Mg ratios. Figure 4.12 shows four plots illustrating different compositional parameters of normalized amphiboles. Complete tables of analyses are available in Appendix 1. Plots of minerals broken out by sample are available in the appendices that follow.

Table 4.2 Normalization and precision for a glaucophane analysis

| | Wt % | $\sigma$ | At % | $\sigma$ | a.p.f.u. | $\sigma$ |
|---|---|---|---|---|---|---|
| Si | 26.55 | 0.60 | 20.99 | 0.38 | 7.93 | 0.19 |
| Ti | 0.09 | 0.02 | 0.04 | 0.01 | 0.01 | 0.00 |
| Al | 4.93 | 0.46 | 4.06 | 0.25 | 1.53 | 0.10 |
| Cr | −0.01 | 0.04 | 0.00 | 0.01 | 0.00 | 0.00 |
| Fe | 10.58 | 1.09 | 4.21 | 0.29 | 1.59 | 0.11 |
| Mn | 0.11 | 0.05 | 0.04 | 0.01 | 0.02 | 0.00 |
| Mg | 5.57 | 0.19 | 5.08 | 0.13 | 1.92 | 0.06 |
| Ca | 0.39 | 0.06 | 0.21 | 0.02 | 0.08 | 0.01 |
| Ba | −0.03 | 0.06 | 0.00 | 0.01 | 0.00 | 0.00 |
| K | 0.02 | 0.02 | 0.01 | 0.99 | 0.00 | 0.52 |
| Na | 5.30 | 0.27 | 5.11 | 0.01 | 1.93 | 0.00 |
| O | 43.41 | | 60.25 | 0.18 | 22.76 | 0.07 |
| Cl | −0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.00 |
| F | −0.03 | 0.12 | 0.00 | 0.09 | 0.00 | 0.00 |

(sample cr0440a). The 1 $\sigma$ error is propagated into atoms per formula unit (a.p.f.u.)

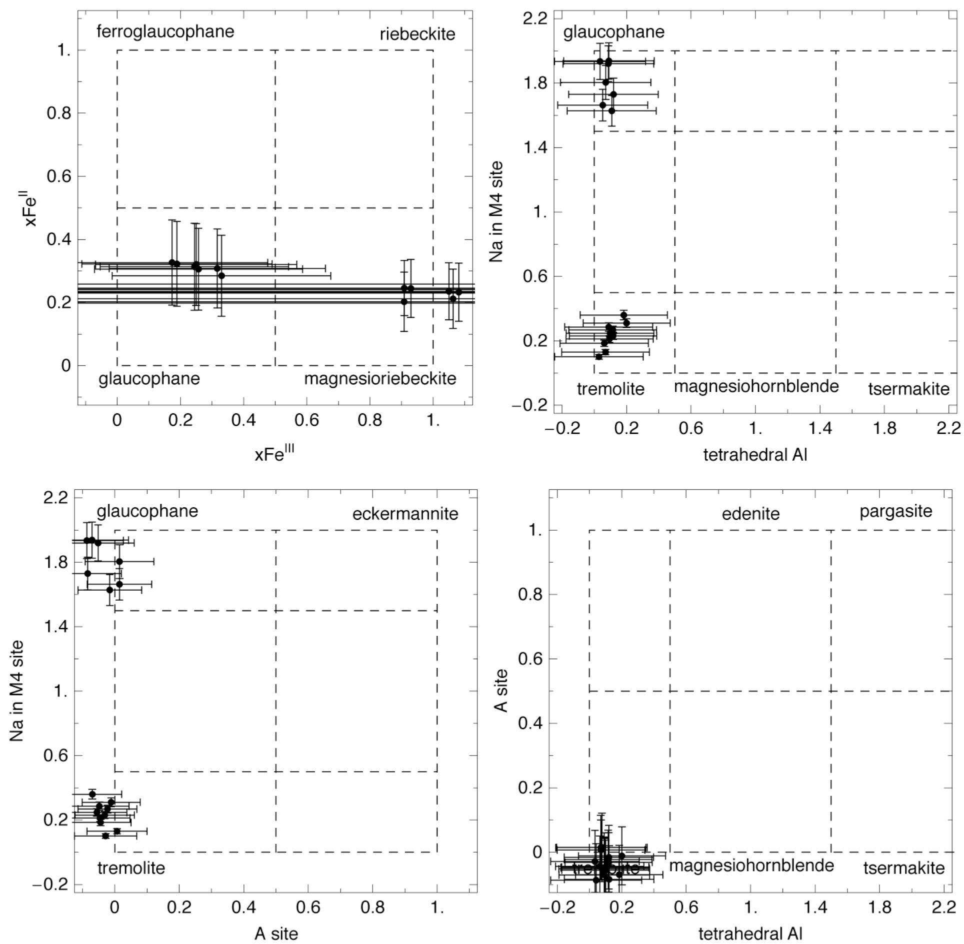


**Fig. 4.12.** Coexisting amphiboles from sample cr04-33

Table 4.3 Average analyses for albite and lawsonite

| | Ab | | | | Lws | | | |
|---|---|---|---|---|---|---|---|---|
| | cr0314a | cr0318c | cr0318d | cr0440a | cr0314a | cr0428b | cr0429 | cr0462 |
| | 13 | 3 | 3 | 5 | 9 | 21 | 10 | 4 |
| SiO2 | 68.31 | 69.09 | 68.68 | 68.98 | 38.03 | 36.52 | 38.44 | 37.82 |
| TiO2 | 0.02 | 0.02 | 0.03 | 0.00 | 0.15 | 0.31 | 0.04 | 0.02 |
| Al2O3 | 19.99 | 19.80 | 19.67 | 19.33 | 32.40 | 32.54 | 32.19 | 32.81 |
| CrO | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.04 |
| FeO | 0.19 | 0.22 | 0.32 | 0.33 | 0.54 | 0.37 | 1.10 | 0.35 |
| MnO | 0.00 | 0.00 | 0.03 | 0.01 | 0.00 | 0.00 | 0.09 | 0.00 |
| MgO | 0.00 | 0.00 | 0.11 | 0.01 | 0.01 | 0.00 | 0.48 | 0.00 |
| CaO | 0.13 | 0.06 | 0.08 | 0.07 | 17.51 | 17.30 | 17.88 | 18.01 |
| K2O | 0.01 | 0.02 | 0.06 | 0.02 | 0.00 | 0.00 | 0.01 | 0.00 |
| Na2O | 11.74 | 11.58 | 11.59 | 11.81 | 0.03 | 0.01 | 0.17 | 0.01 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 100.40 | 100.78 | 100.59 | 100.57 | 88.70 | 87.06 | 90.41 | 89.05 |
| Si | 2.97 | 2.98 | 2.97 | 3.00 | 1.98 | 1.94 | 1.97 | 1.97 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 |
| Al | 1.02 | 1.01 | 1.00 | 0.99 | 1.99 | 2.03 | 1.94 | 2.01 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.05 | 0.02 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.04 | 0.00 |
| Ca | 0.01 | 0.00 | 0.00 | 0.00 | 0.98 | 0.98 | 0.98 | 1.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.99 | 0.97 | 0.97 | 0.99 | 0.00 | 0.00 | 0.02 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 7.98 | 7.98 | 7.97 | 7.99 | 7.96 | 7.95 | 7.93 | 7.98 |

Table 4.4 Average analyses of epidote and pumpellyite in Cretan metabasites

| | Pmp | | | | |
|---|---|---|---|---|---|
| | cr0314a | cr0318d | cr0428b | cr0429 | cr0434 |
| | 23 | 9 | 18 | 12 | 11 |
| SiO2 | 37.17 | 37.39 | 35.63 | 36.81 | 37.64 |
| TiO2 | 0.09 | 0.09 | 0.10 | 0.11 | 0.12 |
| Al2O3 | 25.99 | 24.60 | 26.11 | 26.63 | 25.62 |
| CrO | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| FeO | 3.93 | 4.83 | 3.32 | 3.74 | 3.58 |
| MnO | 0.63 | 0.21 | 0.61 | 0.59 | 0.84 |
| MgO | 2.76 | 2.89 | 3.09 | 3.01 | 3.06 |
| CaO | 22.36 | 22.54 | 21.95 | 22.01 | 21.96 |
| K2O | 0.00 | 0.01 | 0.00 | 0.04 | 0.01 |
| Na2O | 0.23 | 0.07 | 0.25 | 0.23 | 0.28 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.02 | 0.00 | 0.09 |
| Total | 93.17 | 92.66 | 91.10 | 93.17 | 93.21 |
| Si | 5.96 | 6.03 | 5.82 | 5.89 | 6.04 |
| Ti | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Al | 4.91 | 4.68 | 5.03 | 5.02 | 4.84 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.09 | 0.32 | 0.00 | 0.00 | 0.16 |
| Fe2+ | 0.44 | 0.33 | 0.45 | 0.50 | 0.32 |
| Mn | 0.08 | 0.03 | 0.09 | 0.08 | 0.11 |
| Mg | 0.66 | 0.70 | 0.75 | 0.72 | 0.73 |
| Ca | 3.84 | 3.90 | 3.84 | 3.78 | 3.78 |
| K | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| Na | 0.07 | 0.02 | 0.08 | 0.07 | 0.09 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.02 | 0.00 | 0.08 |
| O | 24.51 | 24.56 | 24.38 | 24.46 | 24.56 |
| Mg♯ | 0.61 | 0.72 | 0.62 | 0.59 | 0.71 |
| Al♯ | 0.98 | 0.94 | 1.00 | 1.00 | 0.97 |

| | Ep | | |
|---|---|---|---|
| | cr0314a | cr0318c | cr0428b |
| | 8 | 5 | 1 |
| SiO2 | 37.31 | 37.58 | 37.16 |
| TiO2 | 0.18 | 0.08 | 0.22 |
| Al2O3 | 24.54 | 23.12 | 22.01 |
| CrO | 0.00 | 0.01 | 0.01 |
| FeO | 10.91 | 11.84 | 12.42 |
| MnO | 0.34 | 0.33 | 0.05 |
| MgO | 0.01 | 0.01 | 0.00 |
| CaO | 22.04 | 21.83 | 21.71 |
| K2O | 0.00 | 0.06 | 0.00 |
| Na2O | 0.01 | 0.01 | 0.01 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 |
| Total | 95.33 | 94.88 | 93.59 |
| Si | 2.95 | 3.00 | 3.02 |
| Ti | 0.01 | 0.01 | 0.01 |
| Al | 2.29 | 2.18 | 2.11 |
| Cr | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.72 | 0.79 | 0.85 |
| Mn | 0.02 | 0.02 | 0.00 |
| Mg | 0.00 | 0.00 | 0.00 |
| Ca | 1.87 | 1.87 | 1.89 |
| K | 0.00 | 0.01 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 |
| O | 11.98 | 11.97 | 11.99 |

Table 4.5 Average analyses of chlorite and sphene from Crete

| | Chl | | | | | | Sph | | |
|---|---|---|---|---|---|---|---|---|---|
| | cr0429 | cr0434 | cr0440a | cr0459a | cr0481a | | cr0434 | cr0443 | cr0459a |
| | 10 | 26 | 15 | 12 | 15 | | 20 | 9 | 19 |
| SiO2 | 26.10 | 26.64 | 27.64 | 29.03 | 27.28 | SiO2 | 30.89 | 31.10 | 31.82 |
| TiO2 | 0.03 | 0.05 | 0.05 | 0.00 | 0.06 | TiO2 | 37.37 | 36.48 | 37.47 |
| Al2O3 | 18.85 | 18.73 | 19.04 | 19.41 | 17.82 | Al2O3 | 1.82 | 1.38 | 0.93 |
| CrO | 0.06 | 0.04 | 0.02 | 0.52 | 0.03 | CrO | 0.04 | 0.06 | 0.00 |
| FeO | 28.02 | 29.54 | 19.42 | 11.88 | 26.24 | FeO | 0.57 | 0.45 | 0.55 |
| MnO | 0.22 | 0.29 | 0.42 | 0.20 | 0.48 | MnO | 0.02 | 0.01 | 0.00 |
| MgO | 14.41 | 12.32 | 19.59 | 25.64 | 15.22 | MgO | 0.02 | 0.06 | 0.00 |
| CaO | 0.20 | 0.15 | 0.06 | 0.07 | 0.13 | CaO | 28.92 | 29.13 | 28.89 |
| K2O | 0.01 | 0.04 | 0.00 | 0.00 | 0.03 | K2O | 0.00 | 0.01 | 0.00 |
| Na2O | 0.02 | 0.01 | 0.01 | 0.01 | 0.30 | Na2O | 0.02 | 0.04 | 0.00 |
| Cl2O−1 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | Cl2O−1 | 0.00 | 0.01 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | F2O−1 | 0.11 | 0.08 | 0.09 |
| Total | 87.93 | 87.81 | 86.26 | 86.76 | 87.60 | Total | 99.77 | 98.80 | 99.75 |
| Si | 2.79 | 2.89 | 2.88 | 2.88 | 2.92 | Si | 1.00 | 1.02 | 1.03 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | Ti | 0.91 | 0.90 | 0.92 |
| Al | 2.38 | 2.40 | 2.34 | 2.27 | 2.25 | Al | 0.07 | 0.05 | 0.04 |
| Cr | 0.01 | 0.00 | 0.00 | 0.05 | 0.00 | Cr | 0.00 | 0.00 | 0.00 |
| Fe | 2.51 | 2.68 | 1.69 | 0.99 | 2.35 | Fe3+ | 0.02 | 0.01 | 0.01 |
| Mn | 0.02 | 0.03 | 0.04 | 0.02 | 0.04 | Mn | 0.00 | 0.00 | 0.00 |
| Mg | 2.30 | 1.99 | 3.04 | 3.80 | 2.43 | Mg | 0.00 | 0.00 | 0.00 |
| Ca | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | Ca | 1.00 | 1.03 | 1.01 |
| K | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | K | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | Na | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | Cl | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | F | 0.02 | 0.02 | 0.02 |
| O | 14.01 | 14.11 | 14.06 | 14.03 | 14.10 | O | 4.94 | 4.98 | 4.96 |

Table 4.6 Average glaucophane analyses

| | cr0314a | cr0318c | cr0430a | cr0433 | cr0438 | cr0439a | cr0440a | cr0444 |
|---|---|---|---|---|---|---|---|---|
| | 5 | 12 | 15 | 18 | 5 | 19 | 30 | 13 |
| SiO2 | 55.94 | 56.36 | 55.12 | 57.55 | 55.59 | 56.54 | 56.92 | 58.57 |
| TiO2 | 0.11 | 0.13 | 0.05 | 0.13 | 0.04 | 0.09 | 0.07 | 0.05 |
| Al2O3 | 10.29 | 6.21 | 11.11 | 7.52 | 6.88 | 7.75 | 8.87 | 9.83 |
| CrO | 0.00 | 0.02 | 0.00 | 0.05 | 0.00 | 0.01 | 0.02 | 0.01 |
| FeO | 15.66 | 15.08 | 18.53 | 15.80 | 17.07 | 15.54 | 13.90 | 15.43 |
| MnO | 0.10 | 0.21 | 0.10 | 0.14 | 0.12 | 0.14 | 0.14 | 0.18 |
| MgO | 7.05 | 10.77 | 5.26 | 9.45 | 9.48 | 9.12 | 9.25 | 8.05 |
| CaO | 1.08 | 1.91 | 1.09 | 0.71 | 1.19 | 0.45 | 0.61 | 1.53 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.03 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 |
| Na2O | 6.59 | 6.16 | 6.59 | 6.91 | 6.57 | 7.07 | 7.01 | 6.55 |
| Cl2O−1 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.02 | 0.00 |
| Total | 96.83 | 96.89 | 97.88 | 98.31 | 96.95 | 96.72 | 96.83 | 100.22 |
| Si | 7.92 | 7.91 | 7.82 | 7.96 | 7.83 | 7.95 | 7.96 | 7.99 |
| Ti | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 |
| Al | 1.72 | 1.03 | 1.86 | 1.23 | 1.14 | 1.28 | 1.46 | 1.58 |
| Cr | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.26 | 0.83 | 0.32 | 0.71 | 0.98 | 0.75 | 0.52 | 0.16 |
| Fe2+ | 1.60 | 0.94 | 1.87 | 1.12 | 1.03 | 1.08 | 1.10 | 1.60 |
| Mn | 0.01 | 0.03 | 0.01 | 0.02 | 0.01 | 0.02 | 0.02 | 0.02 |
| Mg | 1.49 | 2.25 | 1.11 | 1.95 | 1.99 | 1.91 | 1.93 | 1.64 |
| Ca | 0.16 | 0.29 | 0.17 | 0.11 | 0.18 | 0.07 | 0.09 | 0.22 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 1.81 | 1.68 | 1.81 | 1.85 | 1.80 | 1.93 | 1.90 | 1.73 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.02 | 0.00 |
| O | 22.99 | 22.98 | 22.98 | 22.96 | 22.98 | 23.00 | 22.99 | 22.96 |
| Mg♯ | 0.48 | 0.71 | 0.37 | 0.63 | 0.66 | 0.64 | 0.64 | 0.51 |
| Al♯ | 0.86 | 0.50 | 0.82 | 0.62 | 0.45 | 0.61 | 0.72 | 0.90 |
| Ts | 0.08 | 0.09 | 0.18 | 0.04 | 0.17 | 0.05 | 0.04 | 0.01 |
| A−site | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Table 4.7 Average composition of calcic and sodic-calcic amphiboles

| | Fact | Tr | | | | Winch | | Ts | |
|---|---|---|---|---|---|---|---|---|---|
| | cr0318c | cr0428b | cr0429 | cr0443 | cr0444 | cr0318c | cr0438 | cr0318d | cr0444 |
| | 1 | 8 | 39 | 10 | 6 | 1 | 3 | 2 | 4 |
| SiO2 | 51.91 | 51.96 | 51.84 | 56.25 | 54.93 | 54.94 | 54.40 | 48.08 | 49.52 |
| TiO2 | 0.05 | 0.05 | 0.04 | 0.03 | 0.07 | 0.09 | 0.06 | 0.90 | 0.60 |
| Al2O3 | 0.64 | 1.59 | 2.26 | 1.15 | 1.72 | 5.60 | 4.88 | 5.15 | 5.63 |
| CrO | 0.02 | 0.00 | 0.08 | 0.03 | 0.00 | 0.05 | 0.00 | 0.03 | 0.01 |
| FeO | 22.29 | 16.84 | 15.68 | 11.29 | 16.63 | 15.25 | 15.84 | 16.91 | 17.29 |
| MnO | 0.26 | 0.18 | 0.20 | 0.17 | 0.44 | 0.36 | 0.17 | 0.42 | 0.37 |
| MgO | 9.17 | 12.43 | 12.97 | 17.05 | 13.38 | 11.19 | 11.54 | 12.75 | 12.63 |
| CaO | 11.39 | 11.39 | 11.52 | 12.08 | 11.44 | 3.94 | 4.15 | 10.58 | 11.43 |
| K2O | 0.11 | 0.06 | 0.06 | 0.07 | 0.11 | 0.18 | 0.01 | 0.51 | 0.59 |
| Na2O | 0.31 | 0.68 | 0.82 | 0.86 | 0.64 | 4.91 | 5.34 | 1.27 | 1.11 |
| Cl2O−1 | 0.00 | 0.01 | 0.00 | 0.01 | 0.05 | 0.00 | 0.00 | 0.00 | 0.36 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.22 |
| Total | 96.16 | 95.18 | 95.47 | 99.03 | 99.41 | 96.49 | 96.39 | 96.60 | 99.77 |
| Si | 7.92 | 7.80 | 7.73 | 7.89 | 7.83 | 7.82 | 7.79 | 7.07 | 7.14 |
| Ti | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.10 | 0.07 |
| Al | 0.12 | 0.28 | 0.40 | 0.19 | 0.29 | 0.94 | 0.82 | 0.89 | 0.96 |
| Cr | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.15 | 0.32 | 0.39 | 0.26 | 0.23 | 0.78 | 1.08 | 1.32 | 1.08 |
| Fe2+ | 2.70 | 1.79 | 1.57 | 1.06 | 1.75 | 1.03 | 0.81 | 0.76 | 1.00 |
| Mn | 0.03 | 0.02 | 0.03 | 0.02 | 0.05 | 0.04 | 0.02 | 0.05 | 0.05 |
| Mg | 2.08 | 2.78 | 2.88 | 3.57 | 2.84 | 2.37 | 2.46 | 2.80 | 2.71 |
| Ca | 1.86 | 1.83 | 1.84 | 1.82 | 1.75 | 0.60 | 0.64 | 1.67 | 1.77 |
| K | 0.02 | 0.01 | 0.01 | 0.01 | 0.02 | 0.00 | 0.00 | 0.10 | 0.11 |
| Na | 0.09 | 0.20 | 0.24 | 0.23 | 0.18 | 0.03 | 0.00 | 0.36 | 0.31 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 1.35 | 1.48 | 0.00 | 0.12 |
| F | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.17 |
| O | 22.97 | 23.04 | 23.09 | 23.04 | 22.93 | 22.98 | 23.13 | 23.18 | 23.05 |
| Mg♯ | 0.44 | 0.61 | 0.65 | 0.77 | 0.62 | 0.70 | 0.75 | 0.79 | 0.73 |
| Al♯ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.42 | 0.27 | 0.00 | 0.00 |
| Ts | 0.08 | 0.20 | 0.27 | 0.11 | 0.17 | 0.18 | 0.21 | 0.93 | 0.86 |
| A−site | 0.00 | 0.03 | 0.08 | 0.05 | 0.00 | 0.00 | 0.12 | 0.03 | 0.07 |

Table 4.8 Representative analyses of sodic pyroxenes

| | 30a | 30a | 30a | 34 | 34 | 34 | 38 | 38 | 38 |
|---|---|---|---|---|---|---|---|---|---|
| SiO2 | 54.90 | 56.49 | 57.01 | 55.07 | 55.71 | 55.82 | 53.89 | 50.79 | 50.88 |
| TiO2 | 0.13 | 0.10 | 0.13 | 0.01 | 0.14 | 0.20 | 0.13 | 3.30 | 1.83 |
| Al2O3 | 10.51 | 10.48 | 11.04 | 6.72 | 10.06 | 11.19 | 4.31 | 0.70 | 1.14 |
| FeO | 8.59 | 7.52 | 7.47 | 7.36 | 6.92 | 6.52 | 12.49 | 26.06 | 29.70 |
| MnO | 0.14 | 0.12 | 0.10 | 0.15 | 0.13 | 0.14 | 0.18 | 0.38 | 0.43 |
| MgO | 6.64 | 6.72 | 6.46 | 9.20 | 7.26 | 6.50 | 7.95 | 0.04 | 0.37 |
| CaO | 12.86 | 12.92 | 12.48 | 16.47 | 13.09 | 11.91 | 13.70 | 1.56 | 2.79 |
| K2O | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.02 | 0.04 |
| Na2O | 6.98 | 7.44 | 7.71 | 5.12 | 6.94 | 7.74 | 6.60 | 12.75 | 12.30 |
| Cl2O−1 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 100.82 | 101.85 | 102.42 | 100.36 | 100.34 | 100.06 | 99.25 | 95.60 | 99.48 |
| Si | 1.96 | 1.99 | 1.99 | 1.99 | 1.99 | 1.99 | 1.98 | 1.98 | 1.92 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.10 | 0.05 |
| Al | 0.44 | 0.43 | 0.45 | 0.29 | 0.42 | 0.47 | 0.19 | 0.03 | 0.05 |
| Fe3+ | 0.04 | 0.07 | 0.07 | 0.07 | 0.06 | 0.06 | 0.28 | 0.93 | 0.85 |
| Fe2+ | 0.22 | 0.15 | 0.15 | 0.15 | 0.15 | 0.13 | 0.10 | 0.00 | 0.09 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 |
| Mg | 0.35 | 0.35 | 0.34 | 0.49 | 0.39 | 0.35 | 0.44 | 0.00 | 0.02 |
| Ca | 0.49 | 0.49 | 0.47 | 0.64 | 0.50 | 0.45 | 0.54 | 0.07 | 0.11 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.48 | 0.51 | 0.52 | 0.36 | 0.48 | 0.53 | 0.47 | 0.96 | 0.90 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 5.97 | 5.99 | 6.00 | 5.99 | 5.99 | 5.99 | 5.98 | 6.08 | 5.97 |
| Jd | 0.45 | 0.44 | 0.46 | 0.29 | 0.43 | 0.47 | 0.18 | 0.03 | 0.05 |
| Aeg | 0.04 | 0.07 | 0.07 | 0.07 | 0.06 | 0.07 | 0.28 | 0.91 | 0.84 |
| Mg# | 0.62 | 0.70 | 0.69 | 0.77 | 0.72 | 0.73 | 0.81 | 1.00 | 0.19 |

## Thermodynamic Data and Metamorphic Reactions

Data for most of the mineral compositions used in thermobarometry represents the average of a large number of microprobe measurements, so that the 1$\sigma$ reported is the sample standard deviation. Analyses where the sample standard deviation is much larger than the microprobe counting errors for major elements represent more than one population of a given mineral, and are evaluated on a case by case basis for potential mineral solid solution. For example, many sodic pyroxenes are zoned, with Jd content increasing towards the rim. Rather than use an average to determine PT, the highest Jd value is used.

The most confidence in calculated conditions is obtained when a reversed phase equilibrium experiment is directly available and applicable to a given rock assemblage. Lawsonite equilibria have been reversed by several authors (Newton and Kennedy 1963; Crawford and Fyfe 1965; Nitsch 1972; Schmidt and Poli 1994), on reactions

$$CaAl_2Si_2O_7(OH)_2{\cdot}H_2O = CaAl_2Si_2O_8 + 2\ H_2O \quad (4.4)$$

lawsonite = anorthite + H2O

$$4CaAl_2Si_2O_7(OH)_2{\cdot}H_2O + 2SiO_2 = 2Ca_2Al_3Si_3O_{12}(OH) + AlSi_2O_5(OH) + 6H_2O \quad (4.5)$$

lawsonite + quartz = zoisite + pyrophyllite + $H_2O$

$$12CaAl_2Si_2O_7(OH)_2{\cdot}H_2O = 6Ca_2Al_3Si_3O_{12}(OH) + 2Al_2SiO5 + AlSi_2O_5(OH) + 20H_2O \quad (4.6)$$

lawsonite = zoisite + kyanite + pyrophyllite + $H_2O$

$$5CaAl_2Si_2O_7(OH)_2{\cdot}H_2O = 2Ca_2Al_3Si_3O_{12}(OH) + CaAl_4Si_2O_{10}(OH)_2 + 2SiO_2 + 8H_2O \quad (4.7)$$

lawsonite = zoisite + margarite + quartz + $H_2O$

$$4CaAl_2Si_2O_7(OH)_2{\cdot}H_2O = 2Ca_2Al_3Si_3O_{12}(OH) + Al_2SiO5 + SiO_2 + 7H_2O \quad (4.8)$$

lawsonite = zoisite + kyanite + quartz + $H_2O$

The full assemblage of reactions 4.4-4.8 is not present in any of the samples from Crete but, lawsonite is stable on the low temperature side of all of them. They limit the stability of lawsonite to < 400 ˚C at 10 kbar (Perkins et al. 1980), which can be used as high temperature limits in the lawsonite-bearing Cretan metabasalts (Seidel et al. 1975). Lawsonite is found across most of the study area in areas 2, 6 and 7 (Table 4.1, Fig. 4.3). A more severely limiting reaction in the presence of albite is

$$4CaAl_2Si_2O_7(OH)_2{\cdot}H_2O + NaAlSi_3O_8 = 2NaAl_3Si_3O_{10}(OH)_2 + Ca_2Al_3Si_3O_{12}(OH) + 2SiO_2 + 6H_2O \quad (4.9)$$

lawsonite + albite = paragonite + clinozoisite + quartz + $H_2O$

The PT conditions previously estimated in Western Crete are consistent with lawsonite stability, but are at slightly higher temperatures (25 ˚C) than the limit from the assemblage lawsonite + albite (Fig. 4.13). The shaded regions in Figure 4.13 and subsequent figures show the curve generated by THERMOCALC ± 1$\sigma$. One of the great benefits of the least-squares fitting routine used in the Holland and Powell (1998) datset, is that it produces estimates of the uncertainty in the fit parameter, in this case $\Delta$H. The error comes from the $\Delta$H generated by the fit and the errors introduced by the equilibrium constant K. As a result the diluted curves have larger errors than the pure reaction. THERMOCALC requires any temperature-dependent activity model to be calculated at a specific pressure and temperature. In this study, all activities were calculated at 8 kbar and 300 ˚C. For some calculations this was varied by 50 ˚C and 3 kbar, and there was almost no effect on calculated equilibria.

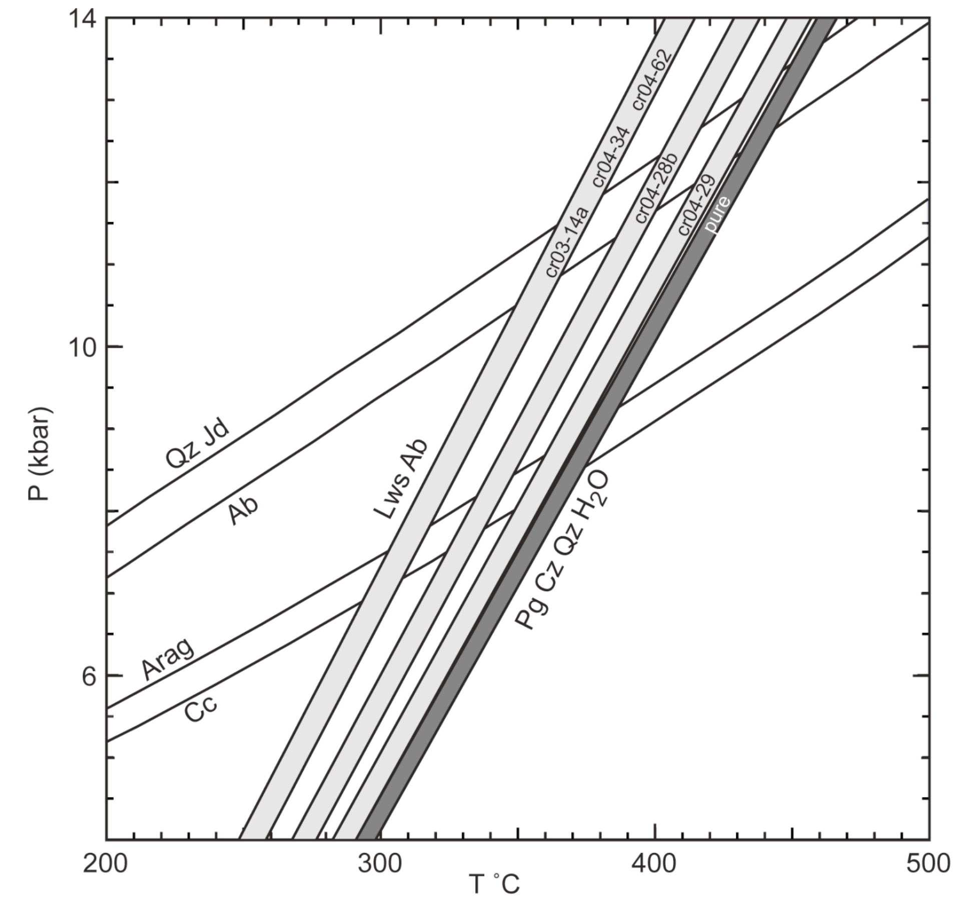


**Fig. 4.13.** Stability of lawsonite + albite. The reaction was calculated for pure paragonite (Pg). This reaction provides a limit for the temperatures to which Cretan metabasalts could have been exposed. The data for cr03-14a, cr04-34 and cr04-62 overlap at almost the same curve. Note that for samples cr03-14a and cr04-34 from west Crete, the maximum temperatures are consistent with, but on the low end of, the reported error from Theye et al. 1992 (400 ± 50 ˚C at 12 kbar).

The thermodynamic data for pumpellyite found in Holland and Powell (1990) rely on the single experimental study of Schiffman and Liou (1980). Reversed experiments were performed on the reaction,

$$25Ca_4MgAlAl_4Si_6O_{21}(OH)_7 = 29Ca_2Al_3Si_3O_{12}(OH) + 14Ca_3Al_2Si_3O_{12} + 5Mg_5Al_2Si_3O_{10}(OH)_8 + 6SiO_2 + 53H_2O \quad (4.10)$$

pumpellyite = clinozoisite + grossular + clinochlore + quartz + $H_2O$

Schiffman and Liou (1990) balanced the reaction, not with clinochlore, but with a more aluminous chlorite. Nitsch (1971) also conducted experimental phase equilibria on pumpellyite stability using natural starting materials, but they are not well-documented experiments, and were not used in creating the thermodynamic database. The database of Holland and Powell (1990) estimated all of the thermodynamic parameters for pumpellyite, since none have been measured, which suggests that pumpellyite-bearing reactions should be used with caution. In this work, due to the large uncertainty involved in determining the thermodynamics of pumpellyite, only reaction 4.9, a directly measured equilibrium, is used.

Figure 4.14 shows the experimental reversals of Schiffman and Liou (1980), along with the pure reaction calculated in THERMOCALC. This equilibrium represents a maximum temperature for samples with pumpellyite + chlorite + epidote + quartz (e.g. Fig. 4.4). The reaction is also shown calculated with activities determined from the analyses of pumpellyite, epidote and chlorite in cr0314a.

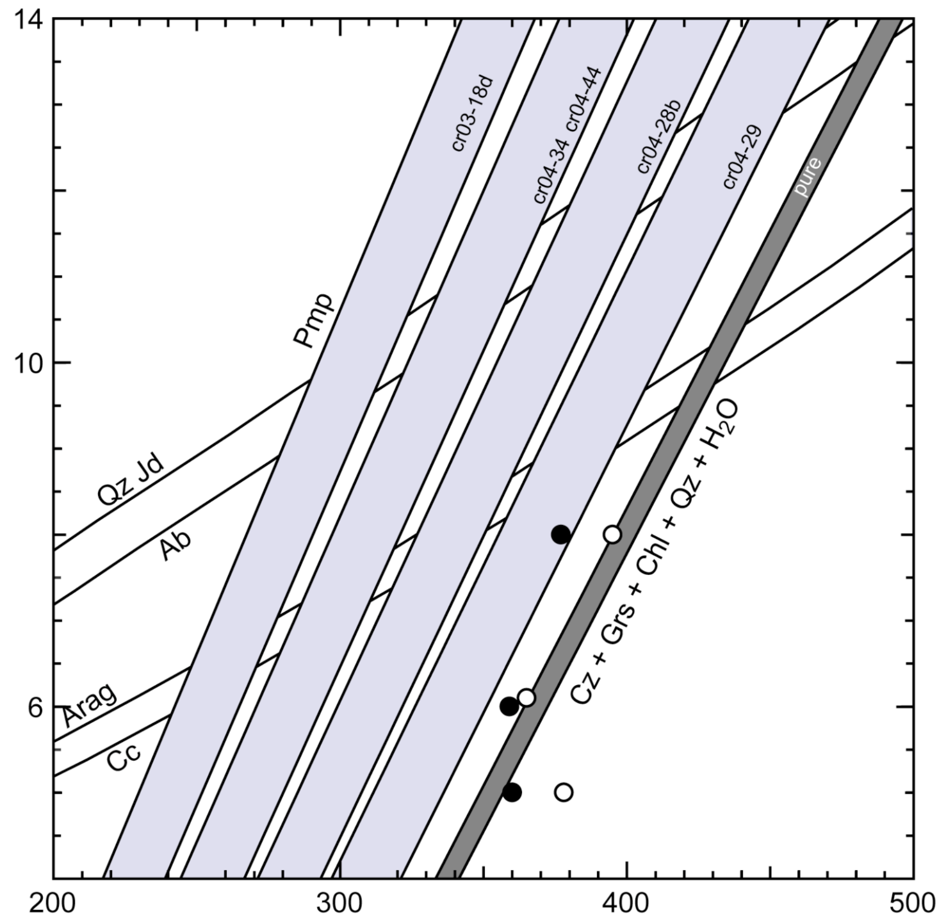


**Fig. 4.14.** Limits on the stability of pumpellyite in reaction 4.10. The calculations for the rocks assumed pure grossular in the absence of garnet. The open and closed circles represent the reversals of Schiffman and Liou (1980). For clarity, calculations with mineral compositions from cr04-30a and cr03-14a are not shown. They plot between the second two lowest temperatures shown on this diagram. Shaded regions represent 1$\sigma$ uncertainty in the equilibria.

Figure 4.12 shows reaction 4.9 calculated for the pure end-members, and with activities calculated from the analyses of pumpellyite, epidote and chlorite from several samples. The activity of clinochlore in chlorite was determined using a model for ordered chlorites (Holland et al. 1998). This model is based on the iron-free experiments of Baker and Holland (1996). Activity of clinozoisite in epidote was modeled with an order parameter allowing $Fe^{3+}$ to mix on two sites following the treatment in Holland and Powell (1998). The activity of Mg-Al pumpellyite can be calculated without directly determining $Fe^{3+}$, by estimating a range in Mg-Al pumpellyite for the analyses from Crete. Although no estimation of the Fe-Al or Mg-Fe components in pumpellyite is possible, limits are placed on Mg-Al pumpellyite (Fig. 4.9). If all $Fe^{3+}$ is in the Y site, as suggested by Artioli and Geiger (1994), $Fe^{3+}$ can be estimated from the difference between measured Al , the total trivalent cation sum is 5. On Crete, this results in Mg/(Mg + $Fe^{2+}$) of between 0.2 and 0.5. Assuming all ferric iron, the range is much more limited, the value for Al/(Al + $Fe^{3+}$) in X ranges from 0.05 - 0.15 (Fig. 4.9). These numbers assume equipartition of Fe3+ and Al over the two octahedral sites. Using the maximum partitioning between Fe and Al found by Nagashima et al. (2006) over the X and Y sites (Fe[X]/Fe[Y] = 0.22/0.16 = 1.4) extends this range to 0.20 XAl in the X site. In the phase equilibrium calculations below, the mean of the two estimates is used, with an error equal half to the difference between them. For example, in cr03-14a, the mean is 0.74 and the range 0.57-0.91. The activity of pumpellyite is then assumed to be 0.74 ± 0.17. In calculating metabasaltic petrogenetic grids Evans et al. (1990) and Frey et al. (1991) assumed the same activity model for Mg-Al pumpellyites, $a_{MgAlPmp} = 4X_{Mg}X_{Al}$. Reaction 4.9 calculated with the activity models described is a maximum temperature estimates for all samples containing pumpellyite, chlorite, epidote and quartz in equilibrium.

The most common assemblage in the rocks is glaucophane + chlorite + albite + epidote ± quartz ± omphacite ± tremolite. Dale et al. (2005) formulated an activity model based on coexisting metamorphic Na and Ca amphiboles. The model used in this work is from Diener et al. (2007), which updated Dale’s model to account for different partitioning of Fe and Mg between crystallographic sites, and extends it to orthoamphiboles. The activity of jadeite in omphacite was determined with the activity model of Green et al. (2007) which allows for the ordering in omphacite, and also incorporates ferric iron with the acmite component.

The presence of omphacite in several samples allows for pressure determinations with the classical reaction

$$NaAlSi_3O_8 = NaAlSi_2O_6 + SiO_2 \qquad (4.11)$$

albite = jadeite + quartz

The temperatures in this study are below those of most experimental investigations (Holland, 1980; Liu and Bohlen, 1995), and are in the stability range of low albite. The calculations with Holland and Powell (1998) were conducted with ordered albite. In the absence of quartz, this reaction is only a low-pressure limit, but several samples (cr03-18c, cr0438 and cr04-551, Fig. 4.15) contain the full assemblage. Jadeite, aegirine, and Mg# (Mg/Mg+$Fe^{2+}$) used in the activity model are given in Table 4.6. The calculated reactions using the activity model of Green et al. (2007) for the samples with the full assemblage are shown in Fig. 4.16.

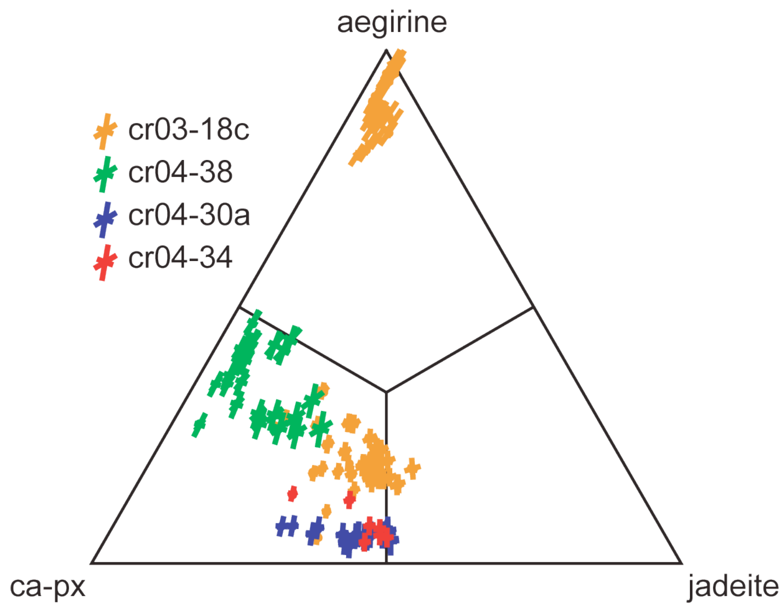


**Fig. 4.15.** Sodic pyroxene compositions plotted on a pyroxene ternary

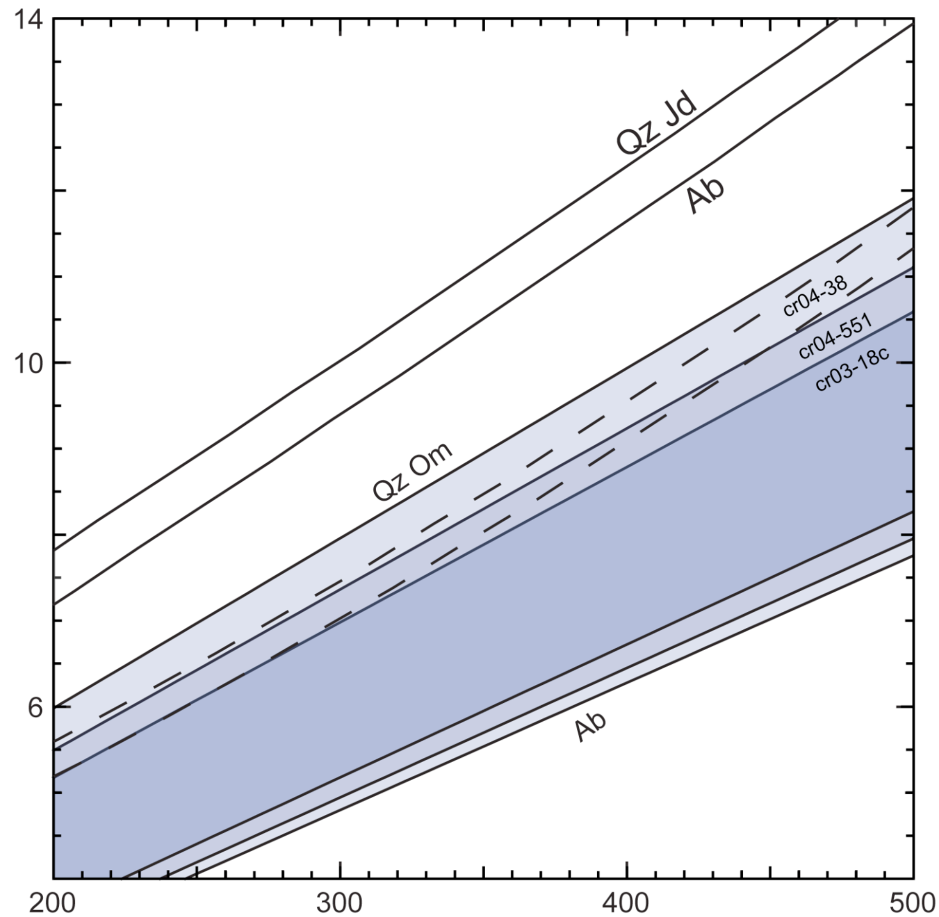


**Fig. 4.16.** Reaction 4.11 calculated with sodic pyroxenes from samples with Ab + Qz + Om. Data are plotted for cr03-18c (dark grey), cr04-551 (medium gray) and cr04-38 (light gray). The pure reaction, appears above the other three, with a much smaller uncertainty, because no mixing model is necessary. Dashed lines delimit the reaction calcite = aragonite.

Glaucophane is abundant in the metabasalts in Crete, and it is easy to calculate many glaucophane-bearing equilibria. However, in order to minimize the uncertainty created by dilute solid solutions, it is best to identify reactions where solid solutions are not a huge issue, and reactions that involve only one amphibole. The reaction

$$5\ NaMg_3Al_2Si_8O_{22}(OH)_2 + 12\ CaAl_2Si_2O_7(OH)_2.H_2O = 10NaAlSi_3O_8 + 6Ca_2Al_3Si_3O_{12}(OH) + 3Mg_5Al_2Si_3O_{10}(OH)_8 + 7SiO_2 + 14H_2O \quad (4.12)$$

glaucophane + lawsonite = albite + clinozoisite + clinochlore + quartz + $H_2O$

will more tightly constrain metamorphic temperatures than the stability of lawsonite alone.

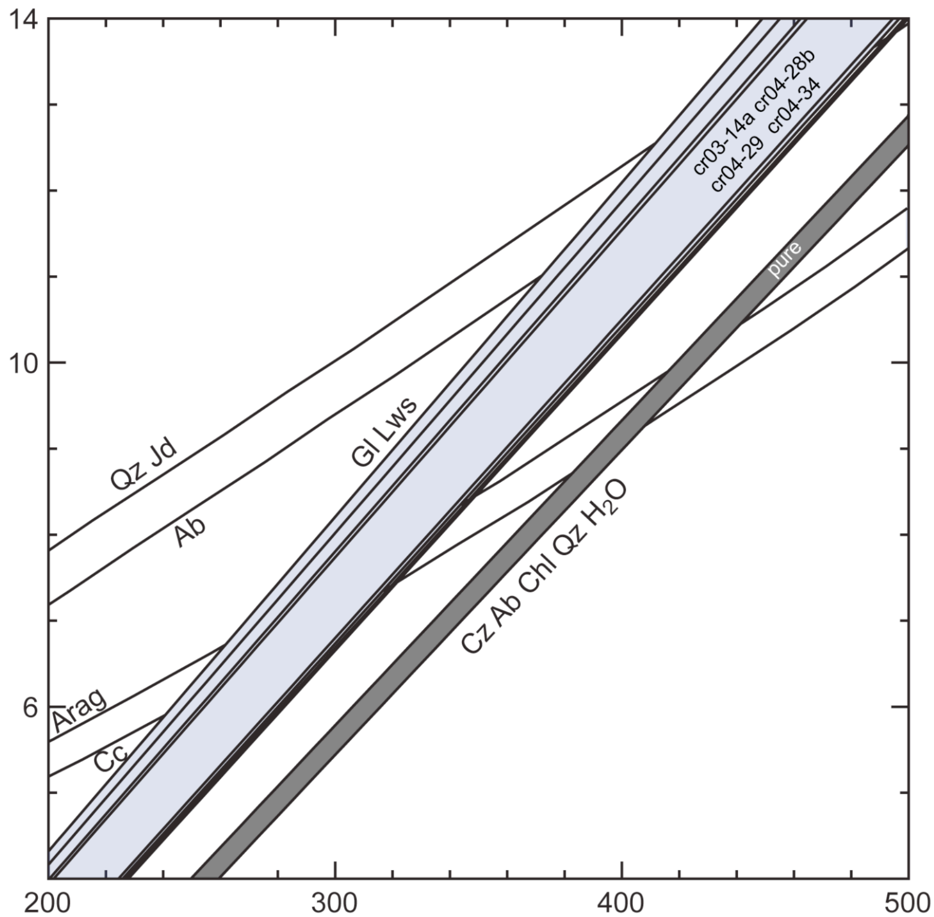


**Fig. 4.17.** Reaction 4.12 plotted for lawsonite-bearing assemblages. The curves for all four samples are approximately equivalent, and are not distinguished here. Shaded area represents 1$\sigma$ around the calculated equilibria.

This equilibrium is one of the many describing the transition from lawsonite blueschists to epidote blueschists (Evans 1990). In the Cretan metabasalts, all observed lawsonite was present with epidote.

Combining the reactions listed above, gives constraints on the pressures and temperatures at which the Phyllite-Quartzite was metamorphosed. Of the areas in Crete listed in Table 4.1, area 7 has the most assemblages amenable to thermobarometry. Fig. 4.18 shows the PT determined for several samples from that area. The yellow curves are a high temperature limit in the presence of pumpellyite and absence of grossular, and show a range of temperatures. Pressures in this assemblage from reactions 4.10 (green) and 4.11 (blue) are in good agreement.

If some assessment of the $XCO_2$ in the fluid phase is available, a constraint can be made based on the reactions

$$TiO_2 + CaCO_3 + SiO_2 = CaTiSiO_5 + CO_2 \quad (4.13)$$

rutile + calcite + quartz = sphene + $CO_2$

$$3CaAl_2Si_2O_7(OH)_2{\cdot}H_2O + CaCO_3 = 2Ca_2Al_3Si_3O_{12}(OH) + CO_2 + 5H_2O \quad (4.14)$$

lawsonite + calcite = clinozoisite + $CO_2$ + $H_2O$

In the presence of sphene, and absence of rutile, reaction 4.13 can be used as a lower temperature limit. Therefore the assemblage lawsonite + sphene + quartz + calcite can be used as a lower limit to estimate the temperatures of formation of the assemblage in the absence of rutile. Lawsonite limits fluid composition to be very rich in $H_2O$ and poor in $CO_2$ (Ernst 1972). Lawsonite + calcite + epdote is present in sample cr03-14a and also requires low $CO_2$. Reaction 4.14 is shown as the shaded pink region on Figure 4.18a calculated for $XCO_2$ ranging from 0.001 to 0.1 (highest T). The limit from reaction 4.10 in the same rock is still at lower T, and suggests $XCO_2$ values must have been lower than 0.001.

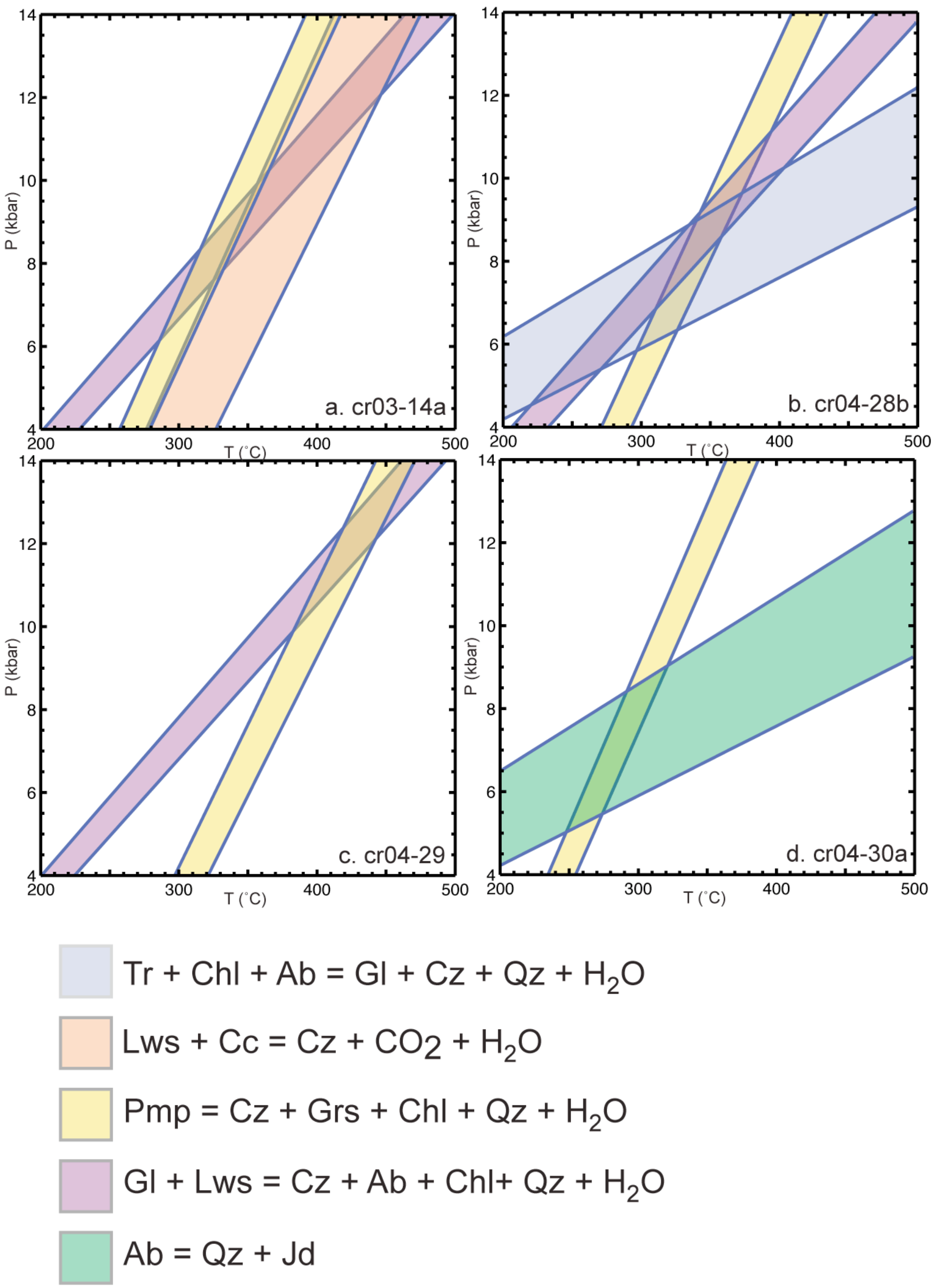


**Fig. 4.18.** Intersections of calculated equilibria. The four samples are from the same area (7 on Fig. 4.7). Reactions 4.9, 4.10, 4.11 and 4.12 were calculated with mineral compositions from the studied samples. These rocks were from the westernmost outcrop of metabasalts studied in Crete.

Fig 4.19 shows a plot of the estimated formation conditions for the metabasites from zones 6 and 7. The shaded area represents the intersection of phase equilibria as determined above, at one sigma confidence intervals. Red crosses represent PT from Theye et al. (1992), ellipses represent the estimates made by Brix et a. (2002) and the green polygons are from the study of Jolivet et al. (1996). The estimates obtained for metabasalts from Western Crete are significantly lower in temperature than those from previous studies.

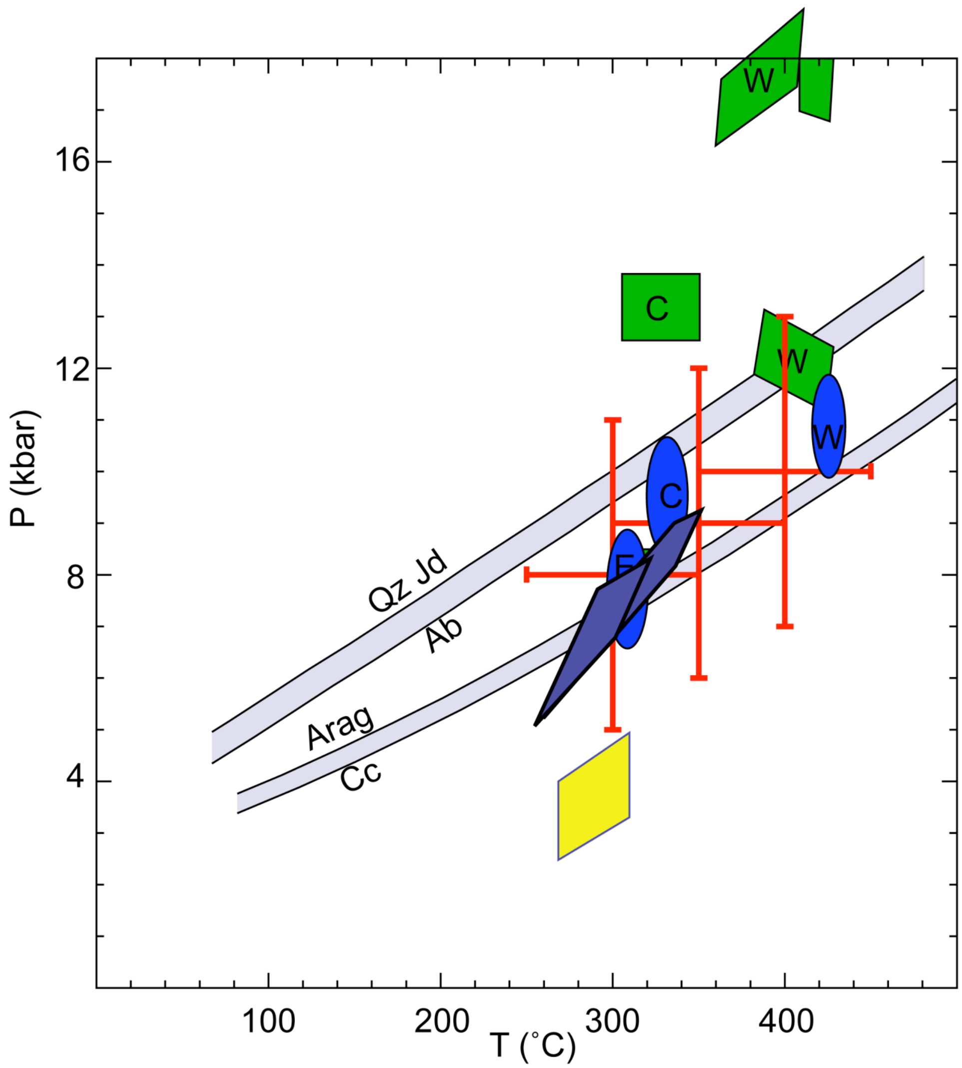


**Fig. 4.19.** Estimate of PT conditions for Western Crete. The diamond shaped fields represent the intersection of at least three rock assemblages at 1 σ confidence interval. The determinations are 305 ± 35 ˚C, 7.5 ± 1.5 kbar and 290 ± 3 ˚C, 7.5 ± 1.5 kbar. The previous estimates for metamorphism in the PQ are the same as in Fig. 4.3.

## Conclusions

The metabasaltic rocks from the Phyllite-Quartzite unit on Crete, record differing temperatures and pressures of formation. They range from 290 ± 30 ˚C and 7.0 ± 1.5 kbar in area 6 to 305 ± 35 ˚C and 7.5 ± 1.5 kbar in area 7. A slight increase in grade is detected, but overall, the metabasalts studied could have formed at the same conditions.

There is very little difference between the estimate made by Brix et al. (2002) for Eastern and Central Crete, and the estimate made on the Cretan metabasalts furthest to the west. The Theye et al. (1992) and Brix et al. (2002) estimate for Western Crete, on the other hand, is ca. 100 ˚C higher than derived here. The discrepancy between this result and the earlier determinations of Theye et al. (1992) could result from overestimating the stability of Mg-Fe carpholite, and therefore the temperature. In the absence of any activity data or experimental reversals, chloritoid and carpholite were both treated with molecular activity models (a = XMg), which may or may not be a good assumption. The locus of the curve itself is based mostly on a carpholite-chloritoid equilibrium, derived from unreversed experiments on magnesiocarpholite by Chopin and Schreyer (1993).

Due to the predominance of carbonate sediments in the nappes of the Tethyan sea it is likely that the PQ was subducted underneath a carbonate unit. A simple density-pressure calculation suggests that about 26-28 km of carbonate overburden is required to produce pressures of 7-7.5 kbar. Therefore the Cretan blueschists of the PQ must still have been exhumed almost 30 km in less than 10 Ma (3 km/Ma), along a steep geothermal gradient 11 ˚C/km.

The discrepancy between the estimate of Theye et al. (1992) and that of this work suggests two alternate conclusions. The numerous normal and reverse faults dissecting Crete may have brought different grades of metamorphism within the Phyllite-

Quartzite to the surface, even on a local scale. In such a scenario, the rocks from which PT estimates were determined may have followed each followed separate PT paths and all estimates of metamorphism are valid. Estimates from this work, and that of Theye et al. (1992) lie along similar geothermal gradients, and could represent two points on the same subduction zone. Aragonite-bearing rocks only outcrop at the very western edge of the island, which is also experiencing the most modern exhumation. A lack of glaucophane in the rocks studied furthest to the east suggests lower pressures may have prevailed in Central Crete, but there is no evidence of lower temperatures which were found in the metamorphosed phyllites. If anything, higher temperatures would lead to glaucophane-free assemblages. It is possible that the rocks from the PQ contain a record of many different PT conditions.

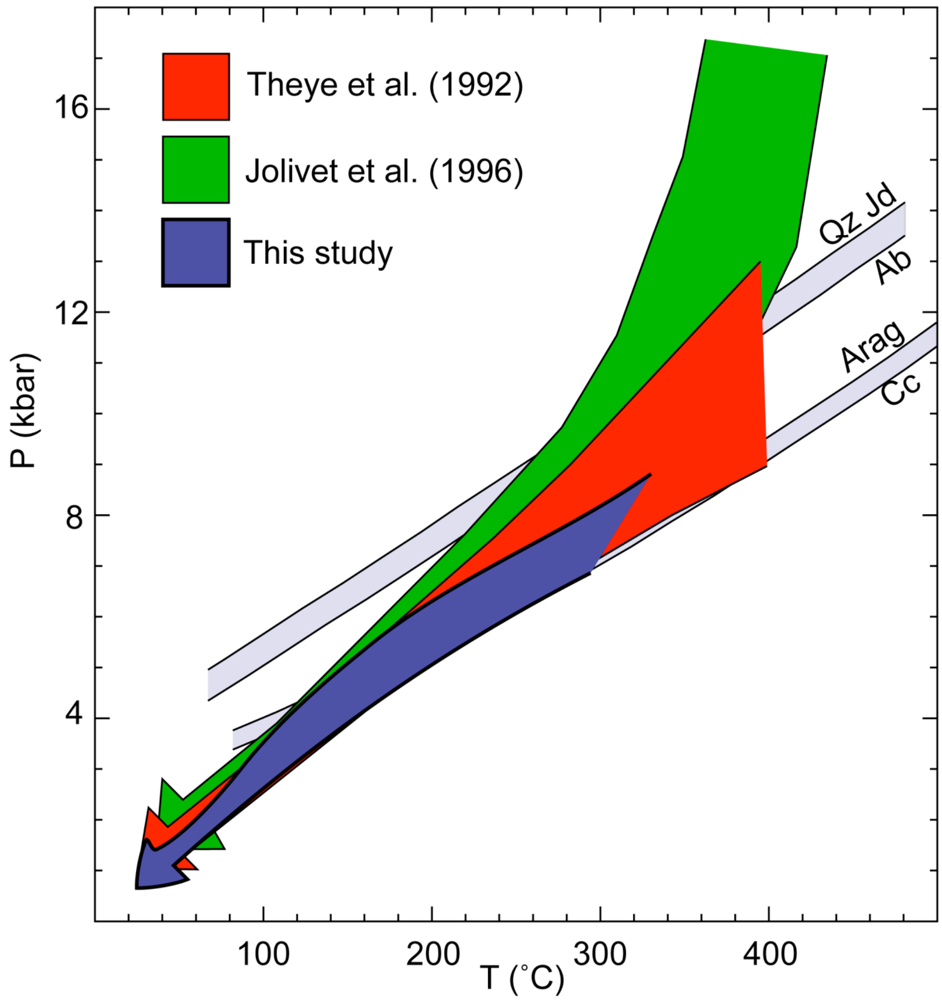


**Fig. 4.20.** Retrograde PT paths consistent with the preservation of metamorphic aragonite on Crete. Paths are based on maximum PT determined by Theye et al. (1992), Jolivet et al. (1996) and in this study. They pass beneath the calcite/aragonite boundary at temperatures less than 180˚C

The alternate conclusion is that there is a single metamorphic grade in western Crete, and the estimates of Theye et al. (1992) based on carpholite equilibria are in error. In this case, the metamorphic aragonite tightly constrains the exhumed path of the Cretan blueschists. PT estimates presented in this work, are significantly lower than previous temperature estimates for PQ metamorphism on Crete. However, for a retrograde PT path which includes the fluid inclusion point of Küster and Stöckhert (date), it is still impossible to preserve metamorphic aragonite. The presence of aragonite was confirmed by XRD analyses of marble samples from the same outcrop as in Theye and Seidel (1993). Metastable aragonite preservation requires dry uplift to beneath the calcite-aragonite boundary at temperatures less than 180 ˚C. The simplest tectonic explanation for aragonite preservation involves a counterclockwise PT loop. To achieve this, the PQ must have been cooled before it was decompressed, and it is likely that a more recently subducted cold slab was underthrust beneath the PQ before exhumation. PT paths for the various estimates made for the metamorphism on Crete which could preserve metamorphic aragonite are presented in Figure 4.19. They suggest that, whatever the maximum PT condition, exhumation down to 180 ˚C occurred without additional heating. If the PT estimates of Jolivet et al. (1996) are accurate, a clockwise PT path, with a very low initial geothermal gradient is viable. However, the presence of albite in many parageneses from Crete (Theye and Seidel, 1991) suggests pressures should be below in the stability field of albite. Where exposed, the contact between the PQ and underlying PK is a thrust, consistent with underthrusting of the PK beneath the PQ.

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# Chapter V

# Conclusions

The present vogue in metamorphic petrology is to use complicated activity models to calculate phase diagrams for very specific parageneses and bulk compositions. This is largely a response to the now overwhelming speed and power of personal computers to do what are relatively simple phase diagram calculations, and their application to larger chemical systems. The sum of the work in this volume shows that there is still significant work to be done improving the knowledge of thermodynamic parameters. In addition, there is much to be done in assessing the confidence with which the data for an individual phase are known.

The low temperature heat capacity of sphene is now very well constrained to be 129.2 J/mol.K in Chapter II. The agreement of the Cp data with earlier work by King et al. (1954) supports entropy determinations made with the PPMS, suggesting that they are comparable to adiabatic determinations, and may be incorporated into existing datasets without worry. Furthermore, the study suggests that the data collected by King et al. (1954) at the US Bureau of Mines is still relevant over fifty years later. The use of entropies determined this way is common in all thermodynamic databases, and should certainly be continued.

In contrast, great care must still be taken when attempting to apply experimentally determined heats of formation to phase equilibrium calculations. The enthalpy data of Xirouchakis et al. (1997) appears to be inconsistent with experimental reversals. Their conclusion that the synthesis that yielded the lowest overall heat of formation is the correct value should also be questioned. Calculations of sphene-bearing equilibria with the database of Holland and Powell (1998) is encouraged, with the caution that highly substituted sphenes have the ability to dramatically displace equilibria. Limits imposed by reactions calculated in the presence of either rutile or sphene are extremely useful as indicators of metamorphism, and can be readily applied to already known reactions.

The determination of the heat capacity of the high-pressure phase $TiO_2$-II in Chapter III suggests several practical conclusions. It applies the PPMS to determine previously unknown heat capacities. It is also shown that interpolating between high and low-temperature Cp data can be a reliable process. If done carefully, the results are just as accurate as those determined with a complete data set, as shown artificially in this dissertation with the rutile data of deLigny et al. (2002). Extrapolating heat capacities above their measured range however is fraught with difficulty, especially if attempting to use the difference for a reaction. The small numbers involved when the phases are close to equilibrium magnifies any small error. Experimental determinations are still likely to be more accurate for measuring polymorphic equilibria. The current work can neither support nor reject either of the two experimental slopes (Akaogi et al. 1992; Withers et al. (2003). The author only suggests that the slope of Withers et al. (2003) is consistent with the majority of known data, a conclusion made in that work.

The study of Cretan blueschists In Chapter IV shows rocks from different lithologies in the same area. A critical application of thermobarometers leads to new PT estimates for blueschist facies rocks. Poorly known thermodynamic data introduces large uncertainty into calculation reactions, and must be addressed. This is especially true in the blueschist facies, where many important minerals have unknown properties, due to low temperatures inhibiting reaction rates in experiments. Mineral analyses, commonly presented only as points on composition plots, should always include a discussion of uncertainty. Even very well constrained analyses may not yield activity coefficients, which are as well constrained as desired for acceptable estimates of equilibrium conditions. Lawsonite-bearing reactions show the most promise for thermobarometry. Most occurrences of rock-forming lawsonite in blueschists are close to the end-member formula and so require little to no dilution when calculating phase boundaries. However, lawsonite remains stable to very high pressures, and additional thermobarometers are necessary to constrain P limits of blueschists. In contrast, the thermodynamic data for pumpellyite remain very uncertain. The presence of Ca, Mg, Fe and Al in its chemical formula makes it a highly useful phase for calculating a variety of reactions in CFMASH and NCFMASH that may be useful for blueschists lacking garnet. However, dilution of even well known reactions for minerals with extensive solid solution may introduce a very large error into equilibrium curves. If this error is reduced, however, it will be possible to improve the PT constraints of HP metamorphism with multiple equilibria.

The pressure and temperature calculated for the Cretan metabasites in this study are on average 300 ± 35 ˚C and 7.3 ± 1.5 kbar, significantly lower than the 400 ± 50 ˚C and 10 ± 3 kbar estimated by Theye et al. (1992). The revision of metamorphic conditions to temperatures at 300˚C suggests that white mica Ar/Ar ages (Jolivet et al. 1996) and zircon-fission track ages (Thomson et al. 1998) record the same time. Therefore, the overlap in ages does not constrain the exhumation rate as suggested by Thomson et al. (1998). The PT conditions determined in this work imply a geothermal gradient in the subduction zone of 11 ˚C/km, about the same as determined by Theye et al. (1992). The preservation of metamorphic aragonite in the Cretan rocks requires a counter-clockwise PT path, even for the estimates of Theye et al. (1992). A proposed path for the Cretan blueschists is shown on Figure 5.1. A counter-clockwise PT path suggests that the PQ unit was cooled after being accreted onto the upper plate of the subduction zone.

Counter-clockwise PT paths from other workers are shown for comparison (Willner et al. 2004; Page et al. 2007). These studies show comparable geothermal gradients, but were metamorphosed to much higher grade. The path of Willner et al. (2004) was based on a blueschist facies overprint of a greenschist facies assemblage. The path of Page et al. (2007) was determined by based on garnet-inclusion thermobarometry. Also shown on Figure 5.1 is the clockwise PT loop for the Franciscan jadeite-bearing metagreywackes from Ernst (1988). The max PT from the aragonite-bearing Franciscan greywackes is quite similar to that estimated for Crete, except at slightly higher P, due to the assemblage quartz+jadeite. On Crete, given the lower pressures there is no room for a clockwise PT path consistent with aragonite stability. Given the similarities to the path observed in Crete for similar rocks, a counterclockwise path for the jadeite-bearing metagreywackes of the Franciscan should not be ruled out. The PT path for Crete suggests that the subducted PQ unit was cooled after being accreted onto the upper plate. This implies that the rocks must be cooled before they are exhumed.

A counterclockwise P-T path suggests refrigeration at least in the initial stages while maintaining pressure. That mechanism is possible during channel extrusion if a colder subducted slab steps back over time and continues to underride the overlying rocks, especially if the channel decompression is delayed until the upper slab is cooled. That would require hesitation in the channeled rocks at Crete to allow them to cool down by ca. 100°C before decompression. That process would be facilitated in the portion of the upper slab closest to the subduction zone. That model could be tested in some terranes by obtaining well-constrained temperature-time (Tt) paths away from and toward the presumed subduction zone active at the time of early blueschist cooling.

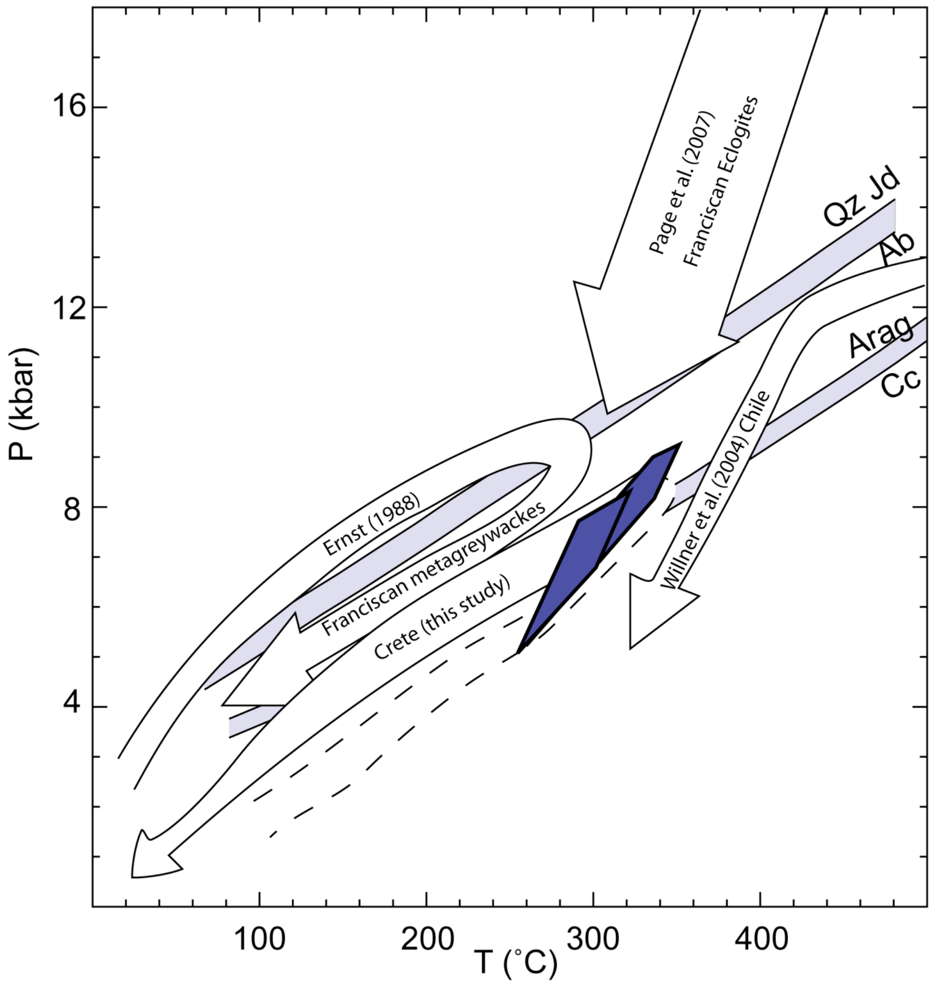


**Fig. 5.1.** Subduction zone counter clockwise PT paths determined in this study and by other workers. The prograde portions of the Franciscan and Cretan paths are speculative.

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# Appendix 1 Tables of Electron Microprobe Analyses

| sample | cr0314a | cr0429 | cr0429 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0439a | cr0439a | cr0440a | cr0444 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Qz−1 | Qz−1 | Qz−2 | Qz−1 | Qz−2 | Qz−3 | Qz−4 | Qz−5 | Qz−6 | Qz−1 | Qz−2 | Qz−1 | Qz−1 |
| SiO2 | 99.91 | 96.38 | 98.90 | 99.21 | 98.09 | 98.63 | 98.74 | 98.93 | 98.94 | 103.58 | 102.68 | 99.19 | 101.78 |
| TiO2 | 0.04 | 0.02 | 0.01 | 0.07 | 0.01 | 0.09 | 0.00 | 0.02 | 0.06 | 0.02 | 0.06 | 0.05 | 0.08 |
| Al2O3 | 0.05 | 0.05 | 0.09 | 0.06 | 0.05 | 0.02 | 0.00 | 0.07 | 0.02 | 0.05 | 0.01 | 0.19 | 0.06 |
| Cr2O3 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.01 | 0.00 | 0.00 |
| FeO | 0.34 | 0.21 | 0.32 | 0.27 | 0.33 | 0.28 | 0.13 | 0.16 | 0.27 | 0.28 | 0.18 | 0.57 | 0.41 |
| MnO | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.03 |
| MgO | 0.00 | 0.01 | 0.10 | 0.03 | 0.02 | 0.04 | 0.04 | 0.09 | 0.01 | 0.00 | 0.00 | 0.22 | 0.00 |
| CaO | 0.12 | 0.06 | 0.08 | 0.14 | 0.10 | 0.10 | 0.18 | 0.24 | 0.07 | 0.05 | 0.06 | 0.08 | 0.06 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.01 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 |
| Na2O | 0.01 | 0.00 | 0.00 | 0.06 | 0.04 | 0.04 | 0.02 | 0.01 | 0.01 | 0.11 | 0.33 | 0.13 | 0.01 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 100.51 | 96.75 | 99.50 | 99.86 | 98.71 | 99.23 | 99.13 | 99.52 | 99.37 | 104.12 | 103.32 | 100.48 | 102.43 |
| Si | 0.99 | 1.00 | 0.99 | 0.99 | 0.99 | 0.99 | 1.00 | 0.99 | 1.00 | 0.99 | 0.99 | 0.99 | 0.99 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 1.99 | 2.00 | 1.99 | 1.99 | 1.99 | 1.99 | 2.00 | 1.99 | 2.00 | 1.99 | 1.99 | 1.99 | 2.00 |

| sample | cr0444 | cr0444 | cr04552 | cr04552 | cr04552 | cr0481a | cr0481a | cr0481a | cr0481a | cr0481a | cr0481b |
|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Qz−2 | Qz−3 | Qz−1 | Qz−2 | Qz−3 | Qz−1 | Qz−2 | Qz−3 | Qz−4 | Qz−5 | Qz−1 |
| SiO2 | 103.33 | 104.60 | 99.73 | 102.29 | 106.21 | 99.77 | 100.96 | 100.50 | 99.30 | 96.63 | 99.93 |
| TiO2 | 0.06 | 0.01 | 0.00 | 0.02 | 0.04 | 0.00 | 0.00 | 0.01 | 0.02 | 0.00 | 0.00 |
| Al2O3 | 0.02 | 0.12 | 0.69 | 0.00 | 0.25 | 0.03 | 0.00 | 0.07 | 0.03 | 0.06 | 0.12 |
| Cr2O3 | 0.00 | 0.00 | 0.00 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| FeO | 0.19 | 0.13 | 1.32 | 0.13 | 0.20 | 0.08 | 0.13 | 0.03 | 0.09 | 0.07 | 0.14 |
| MnO | 0.01 | 0.01 | 0.03 | 0.02 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |
| MgO | 0.00 | 0.00 | 0.88 | 0.00 | 0.05 | 0.01 | 0.02 | 0.09 | 0.03 | 0.02 | 0.00 |
| CaO | 0.01 | 0.03 | 0.06 | 0.03 | 0.01 | 0.02 | 0.00 | 0.01 | 0.18 | 3.13 | 0.01 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.01 | 0.02 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.02 | 0.00 | 0.00 | 0.01 |
| Na2O | 0.20 | 0.03 | 0.02 | 0.00 | 0.00 | 0.21 | 0.02 | 0.04 | 0.13 | 0.01 | 0.02 |
| Cl2O−1 | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 103.83 | 105.01 | 102.74 | 102.53 | 106.78 | 100.16 | 101.15 | 100.77 | 99.79 | 99.95 | 100.24 |
| Si | 0.99 | 1.00 | 0.97 | 1.00 | 0.99 | 0.99 | 1.00 | 1.00 | 0.99 | 0.96 | 1.00 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 1.99 | 2.00 | 1.97 | 2.00 | 2.00 | 1.99 | 2.00 | 2.00 | 1.99 | 1.96 | 2.00 |

| sample | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ab−1 | Ab−2 | Ab−3 | Ab−4 | Ab−5 | Ab−6 | Ab−7 | Ab−8 | Ab−9 | Ab−10 | Ab−11 | Ab−12 | Ab−13 |
| SiO2 | 68.67 | 68.72 | 68.63 | 67.90 | 68.01 | 68.04 | 68.05 | 68.15 | 68.24 | 68.30 | 68.31 | 68.51 | 68.57 |
| TiO2 | 0.00 | 0.03 | 0.00 | 0.00 | 0.05 | 0.01 | 0.10 | 0.05 | 0.00 | 0.01 | 0.01 | 0.09 | 0.00 |
| Al2O3 | 19.67 | 19.84 | 19.96 | 19.97 | 20.16 | 19.97 | 20.13 | 20.14 | 20.09 | 19.97 | 19.88 | 20.03 | 20.10 |
| Cr2O3 | 0.04 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.00 | 0.01 | 0.00 | 0.05 | 0.03 | 0.03 |
| FeO | 0.10 | 0.23 | 0.26 | 0.24 | 0.10 | 0.30 | 0.08 | 0.09 | 0.25 | 0.27 | 0.27 | 0.08 | 0.23 |
| MnO | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.02 | 0.00 | 0.01 | 0.00 | 0.00 |
| MgO | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 |
| CaO | 0.04 | 0.04 | 0.13 | 0.07 | 0.19 | 0.05 | 0.24 | 0.20 | 0.14 | 0.15 | 0.07 | 0.24 | 0.15 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.01 | 0.00 | 0.00 | 0.01 | 0.04 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.02 |
| Na2O | 11.70 | 11.89 | 11.67 | 11.79 | 11.84 | 11.79 | 11.65 | 11.77 | 11.68 | 11.59 | 11.81 | 11.66 | 11.73 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 | 0.00 | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 |
| Total | 100.25 | 100.79 | 100.66 | 99.98 | 100.39 | 100.17 | 100.51 | 100.43 | 100.44 | 100.36 | 100.42 | 100.66 | 100.86 |
| Si | 2.99 | 2.98 | 2.97 | 2.96 | 2.96 | 2.96 | 2.96 | 2.96 | 2.96 | 2.97 | 2.97 | 2.97 | 2.96 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 1.01 | 1.01 | 1.02 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.99 | 1.00 | 0.98 | 1.00 | 1.00 | 1.00 | 0.98 | 0.99 | 0.98 | 0.98 | 1.00 | 0.98 | 0.98 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| O | 7.99 | 7.99 | 7.98 | 7.98 | 7.99 | 7.98 | 7.96 | 7.99 | 7.97 | 7.97 | 7.98 | 7.99 | 7.98 |

| sample | cr0318c | cr0318c | cr0318c | cr0318d | cr0318d | cr0318d | cr0422b | cr0422b | cr0422b | cr0428b | cr0428b | cr0428b | cr0428b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ab−1 | Ab−2 | Ab−3 | Ab−1 | Ab−2 | Ab−3 | Ab−1 | Ab−2 | Ab−3 | Ab−1 | Ab−2 | Ab−3 | Ab−4 |
| SiO2 | 68.88 | 68.93 | 69.46 | 68.88 | 69.00 | 68.15 | 71.64 | 74.07 | 71.57 | 68.68 | 68.42 | 68.15 | 68.40 |
| TiO2 | 0.03 | 0.01 | 0.03 | 0.04 | 0.02 | 0.04 | 0.00 | 0.00 | 0.00 | 0.02 | 0.05 | 0.07 | 0.04 |
| Al2O3 | 19.80 | 19.91 | 19.67 | 20.00 | 19.74 | 19.28 | 19.83 | 19.50 | 19.62 | 19.81 | 20.31 | 19.88 | 20.12 |
| Cr2O3 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.03 | 0.00 | 0.03 | 0.01 | 0.05 | 0.11 | 0.03 |
| FeO | 0.07 | 0.30 | 0.28 | 0.14 | 0.12 | 0.71 | 0.28 | 0.16 | 0.26 | 0.52 | 0.44 | 0.41 | 0.47 |
| MnO | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.06 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 |
| MgO | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.31 | 0.05 | 0.00 | 0.03 | 0.02 | 0.01 | 0.03 | 0.01 |
| CaO | 0.06 | 0.04 | 0.08 | 0.05 | 0.08 | 0.11 | 0.03 | 0.07 | 0.07 | 0.03 | 0.06 | 0.04 | 0.05 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.03 | 0.05 | 0.05 | 0.08 | 0.06 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 |
| Na2O | 11.24 | 11.65 | 11.85 | 11.56 | 11.60 | 11.63 | 11.50 | 11.26 | 11.86 | 11.89 | 11.74 | 11.80 | 11.66 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 100.08 | 100.88 | 101.42 | 100.75 | 100.65 | 100.37 | 103.40 | 105.11 | 103.43 | 100.98 | 101.09 | 100.54 | 100.78 |
| Si | 2.98 | 2.98 | 2.99 | 2.97 | 2.99 | 2.96 | 3.00 | 3.05 | 3.01 | 2.97 | 2.95 | 2.96 | 2.96 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 1.01 | 1.01 | 1.00 | 1.02 | 1.01 | 0.99 | 0.98 | 0.95 | 0.97 | 1.01 | 1.03 | 1.02 | 1.02 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.03 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.01 | 0.02 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.94 | 0.97 | 0.99 | 0.97 | 0.97 | 0.98 | 0.94 | 0.90 | 0.97 | 1.00 | 0.98 | 0.99 | 0.98 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 7.97 | 7.97 | 7.99 | 7.97 | 7.98 | 7.95 | 7.96 | 7.97 | 7.99 | 7.97 | 7.96 | 7.97 | 7.96 |

| sample | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ab−5 | Ab−6 | Ab−7 | Ab−8 | Ab−9 | Ab−10 | Ab−11 | Ab−12 | Ab−13 | Ab−14 | Ab−15 | Ab−16 | Ab−17 |
| SiO2 | 69.28 | 67.86 | 67.98 | 69.16 | 69.55 | 67.89 | 69.79 | 68.96 | 69.12 | 68.45 | 68.81 | 69.00 | 68.94 |
| TiO2 | 0.00 | 0.00 | 0.04 | 0.06 | 0.10 | 0.04 | 0.02 | 0.08 | 0.05 | 0.06 | 0.09 | 0.03 | 0.04 |
| Al2O3 | 20.67 | 20.44 | 19.86 | 20.45 | 19.89 | 19.84 | 20.39 | 20.81 | 19.89 | 20.59 | 20.50 | 22.11 | 20.39 |
| Cr2O3 | 0.07 | 0.09 | 0.02 | 0.00 | 0.07 | 0.11 | 0.05 | 0.02 | 0.13 | 0.01 | 0.03 | 0.06 | 0.08 |
| FeO | 0.54 | 0.51 | 0.52 | 0.22 | 0.44 | 0.28 | 0.49 | 0.31 | 0.31 | 0.08 | 0.25 | 0.14 | 0.18 |
| MnO | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 |
| MgO | 0.01 | 0.03 | 0.04 | 0.01 | 0.02 | 0.02 | 0.00 | 0.00 | 0.02 | 0.00 | 0.01 | 0.01 | 0.02 |
| CaO | 0.07 | 0.07 | 0.11 | 0.10 | 0.12 | 0.09 | 0.06 | 0.08 | 0.06 | 0.36 | 0.08 | 0.07 | 0.08 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.03 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.02 | 0.07 |
| Na2O | 11.70 | 12.05 | 11.33 | 11.88 | 11.76 | 11.84 | 11.84 | 11.74 | 11.87 | 11.68 | 11.70 | 11.84 | 11.79 |
| Cl2O−1 | 0.00 | 0.00 | 0.02 | 0.01 | 0.02 | 0.02 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 102.38 | 101.14 | 99.93 | 101.89 | 101.97 | 100.13 | 102.65 | 102.03 | 101.45 | 101.25 | 101.47 | 103.28 | 101.64 |
| Si | 2.94 | 2.93 | 2.96 | 2.96 | 2.97 | 2.96 | 2.96 | 2.94 | 2.97 | 2.95 | 2.95 | 2.90 | 2.96 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 1.03 | 1.04 | 1.02 | 1.03 | 1.00 | 1.02 | 1.02 | 1.05 | 1.01 | 1.05 | 1.04 | 1.09 | 1.03 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe | 0.02 | 0.02 | 0.02 | 0.01 | 0.02 | 0.01 | 0.02 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.96 | 1.01 | 0.96 | 0.99 | 0.98 | 1.00 | 0.97 | 0.97 | 0.99 | 0.98 | 0.97 | 0.96 | 0.98 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 7.95 | 7.96 | 7.95 | 7.97 | 7.97 | 7.98 | 7.96 | 7.95 | 7.98 | 7.98 | 7.96 | 7.93 | 7.97 |

| sample | cr0428b | cr0428b | cr0429 | cr0429 | cr0429 | cr0429 | cr0429 | cr0429 | cr0429 | cr0429 | cr0429 | cr0430a | cr0430a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ab−18 | Ab−19 | Ab−1 | Ab−2 | Ab−3 | Ab−4 | Ab−5 | Ab−6 | Ab−7 | Ab−8 | Ab−9 | Ab−1 | Ab−2 |
| SiO2 | 68.61 | 68.58 | 67.28 | 67.35 | 67.46 | 67.56 | 67.56 | 67.70 | 67.74 | 67.92 | 67.96 | 55.95 | 56.74 |
| TiO2 | 0.21 | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 |
| Al2O3 | 19.99 | 19.89 | 19.75 | 20.07 | 19.90 | 19.88 | 20.03 | 19.72 | 19.78 | 19.66 | 19.79 | 16.99 | 17.04 |
| Cr2O3 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.04 |
| FeO | 0.14 | 0.13 | 0.22 | 0.10 | 0.26 | 0.24 | 0.09 | 0.26 | 0.18 | 0.22 | 0.26 | 0.08 | 0.04 |
| MnO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.00 |
| MgO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 |
| CaO | 0.17 | 0.16 | 0.06 | 0.18 | 0.00 | 0.07 | 0.35 | 0.13 | 0.07 | 0.21 | 0.24 | 0.06 | 0.08 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.02 | 0.02 | 0.01 | 0.03 | 0.00 | 0.01 | 0.04 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.00 |
| Na2O | 11.82 | 11.62 | 12.30 | 12.20 | 12.33 | 12.30 | 12.10 | 12.05 | 12.46 | 12.24 | 12.21 | 11.44 | 10.85 |
| Cl2O−1 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 101.00 | 100.51 | 99.61 | 99.94 | 99.96 | 100.08 | 100.16 | 99.86 | 100.24 | 100.26 | 100.47 | 84.62 | 84.80 |
| Si | 2.97 | 2.97 | 2.97 | 2.96 | 2.96 | 2.96 | 2.96 | 2.97 | 2.97 | 2.98 | 2.97 | 2.94 | 2.95 |
| Ti | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 1.02 | 1.02 | 1.03 | 1.04 | 1.03 | 1.03 | 1.04 | 1.02 | 1.02 | 1.02 | 1.02 | 1.05 | 1.04 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.02 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.99 | 0.98 | 1.05 | 1.04 | 1.05 | 1.05 | 1.03 | 1.03 | 1.06 | 1.04 | 1.03 | 1.17 | 1.09 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 7.99 | 7.98 | 8.01 | 8.01 | 8.00 | 8.00 | 8.01 | 8.00 | 8.02 | 8.01 | 8.01 | 8.05 | 8.02 |

| sample | cr0430a | cr0430a | cr0433 | cr0433 | cr0433 | cr0434 | cr0434 | cr0438 | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ab−3 | Ab−4 | Ab−1 | Ab−2 | Ab−3 | Ab−1 | Ab−2 | Ab−1 | Ab−1 | Ab−2 | Ab−3 | Ab−4 | Ab−5 |
| SiO2 | 56.96 | 57.10 | 70.11 | 69.71 | 69.88 | 70.02 | 71.24 | 64.70 | 69.69 | 70.19 | 70.38 | 70.79 | 70.93 |
| TiO2 | 0.00 | 0.02 | 0.01 | 0.02 | 0.03 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 |
| Al2O3 | 17.00 | 16.98 | 19.56 | 19.68 | 19.47 | 19.45 | 19.81 | 18.91 | 19.75 | 19.62 | 20.07 | 20.22 | 20.04 |
| Cr2O3 | 0.05 | 0.01 | 0.02 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 |
| FeO | 0.09 | 0.06 | 0.17 | 0.21 | 0.16 | 0.21 | 0.37 | 1.31 | 0.06 | 0.48 | 0.12 | 0.26 | 0.22 |
| MnO | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.04 | 0.02 | 0.00 | 0.01 | 0.02 | 0.00 |
| MgO | 0.02 | 0.00 | 0.04 | 0.19 | 0.03 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| CaO | 0.08 | 0.04 | 0.03 | 0.08 | 0.05 | 0.06 | 0.15 | 3.20 | 0.08 | 0.16 | 0.26 | 0.08 | 0.08 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.03 | 0.02 | 0.03 | 0.04 | 0.03 | 0.03 | 0.02 |
| Na2O | 10.25 | 9.70 | 12.31 | 12.23 | 11.88 | 11.81 | 11.88 | 11.02 | 12.20 | 12.39 | 12.05 | 12.61 | 12.24 |
| Cl2O−1 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| Total | 84.51 | 83.93 | 102.27 | 102.15 | 101.52 | 101.58 | 103.51 | 99.21 | 101.84 | 102.88 | 102.96 | 104.09 | 103.56 |
| Si | 2.95 | 2.96 | 3.00 | 2.99 | 3.00 | 3.01 | 3.00 | 2.94 | 3.00 | 3.00 | 2.99 | 2.98 | 3.00 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 1.04 | 1.04 | 0.99 | 0.99 | 0.99 | 0.98 | 0.98 | 1.01 | 1.00 | 0.99 | 1.00 | 1.00 | 1.00 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.05 | 0.00 | 0.02 | 0.00 | 0.01 | 0.01 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.16 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 1.03 | 0.97 | 1.02 | 1.02 | 0.99 | 0.98 | 0.97 | 0.97 | 1.02 | 1.03 | 0.99 | 1.03 | 1.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 7.99 | 7.97 | 8.01 | 7.99 | 8.00 | 8.00 | 7.99 | 8.08 | 8.01 | 8.01 | 8.00 | 8.01 | 8.00 |

| sample | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0440a | cr0440a | cr0440a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ab−6 | Ab−7 | Ab−8 | Ab−9 | Ab−10 | Ab−11 | Ab−12 | Ab−13 | Ab−14 | Ab−15 | Ab−1 | Ab−2 | Ab−3 |
| SiO2 | 71.09 | 71.25 | 71.54 | 71.65 | 71.66 | 71.77 | 71.95 | 72.41 | 68.69 | 68.07 | 68.14 | 68.61 | 68.79 |
| TiO2 | 0.00 | 0.00 | 0.01 | 0.00 | 0.10 | 0.00 | 0.01 | 0.01 | 0.07 | 0.02 | 0.00 | 0.00 | 0.03 |
| Al2O3 | 21.42 | 19.60 | 19.98 | 19.64 | 20.31 | 19.44 | 19.69 | 22.00 | 18.52 | 18.38 | 19.15 | 19.30 | 19.32 |
| Cr2O3 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 |
| FeO | 0.30 | 0.09 | 0.13 | 0.23 | 0.34 | 0.21 | 0.07 | 0.11 | 0.08 | 0.66 | 0.65 | 0.21 | 0.32 |
| MnO | 0.09 | 0.00 | 0.04 | 0.01 | 0.00 | 0.01 | 0.02 | 0.00 | 0.01 | 0.01 | 0.06 | 0.00 | 0.00 |
| MgO | 0.01 | 0.00 | 0.05 | 0.04 | 0.00 | 0.02 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 |
| CaO | 0.23 | 0.13 | 0.12 | 0.08 | 0.15 | 0.16 | 0.03 | 0.21 | 0.01 | 0.04 | 0.05 | 0.10 | 0.08 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 |
| K2O | 0.02 | 0.01 | 0.01 | 0.01 | 0.04 | 0.01 | 0.00 | 0.03 | 0.01 | 0.02 | 0.02 | 0.02 | 0.01 |
| Na2O | 12.06 | 12.69 | 12.66 | 12.32 | 12.17 | 12.06 | 11.96 | 13.65 | 12.05 | 11.78 | 11.91 | 11.61 | 11.98 |
| Cl2O−1 | 0.00 | 0.01 | 0.03 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 |
| F2O−1 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.03 | 0.01 | 0.00 | 0.00 | 0.00 | 0.02 | 0.03 |
| Total | 105.25 | 103.80 | 104.55 | 103.99 | 104.77 | 103.70 | 103.82 | 108.41 | 99.44 | 99.00 | 100.01 | 99.90 | 100.60 |
| Si | 2.94 | 3.02 | 3.00 | 3.02 | 2.99 | 3.03 | 3.02 | 2.94 | 3.03 | 3.02 | 2.99 | 3.00 | 2.99 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 1.04 | 0.98 | 0.99 | 0.97 | 1.00 | 0.97 | 0.97 | 1.05 | 0.96 | 0.96 | 0.99 | 0.99 | 0.99 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.02 | 0.02 | 0.01 | 0.01 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.97 | 1.04 | 1.03 | 1.01 | 0.98 | 0.99 | 0.97 | 1.08 | 1.03 | 1.01 | 1.01 | 0.98 | 1.01 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| O | 7.96 | 8.03 | 8.02 | 8.01 | 7.99 | 8.01 | 7.99 | 8.02 | 8.03 | 8.00 | 7.99 | 7.99 | 8.00 |

| sample | cr0440a | cr0440a | cr0443 | cr0443 | cr0443 | cr0443 | cr0443 | cr0443 | cr0444 | cr04551 | cr0462 | cr0462 | cr0462 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ab−4 | Ab−5 | Ab−1 | Ab−2 | Ab−3 | Ab−4 | Ab−5 | Ab−6 | Ab−1 | Ab−1 | Ab−1 | Ab−2 | Ab−3 |
| SiO2 | 69.46 | 69.89 | 69.19 | 69.43 | 69.44 | 69.45 | 69.54 | 69.58 | 70.21 | 73.66 | 68.49 | 68.96 | 68.98 |
| TiO2 | 0.01 | 0.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.01 | 0.04 | 0.01 | 0.01 | 0.02 | 0.00 | 0.00 |
| Al2O3 | 19.45 | 19.42 | 19.59 | 19.64 | 19.76 | 19.45 | 19.42 | 19.71 | 20.10 | 20.09 | 20.11 | 20.32 | 20.04 |
| Cr2O3 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.00 |
| FeO | 0.25 | 0.20 | 0.20 | 0.12 | 0.22 | 0.19 | 0.17 | 0.12 | 0.30 | 0.10 | 0.06 | 0.08 | 0.09 |
| MnO | 0.02 | 0.01 | 0.03 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| MgO | 0.00 | 0.08 | 0.01 | 0.30 | 0.05 | 0.13 | 0.02 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 |
| CaO | 0.05 | 0.09 | 0.03 | 0.19 | 0.02 | 0.01 | 0.06 | 0.03 | 0.07 | 0.13 | 0.10 | 0.12 | 0.11 |
| BaO | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.02 | 0.02 | 0.02 | 0.05 | 0.02 | 0.02 | 0.02 | 0.02 | 0.05 | 0.02 | 0.01 | 0.01 | 0.10 |
| Na2O | 12.01 | 11.53 | 12.09 | 11.91 | 12.39 | 12.21 | 12.00 | 11.98 | 12.37 | 11.77 | 11.79 | 11.88 | 11.75 |
| Cl2O−1 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.02 | 0.00 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 |
| Total | 101.29 | 101.25 | 101.19 | 101.73 | 101.95 | 101.50 | 101.27 | 101.51 | 103.12 | 105.78 | 100.66 | 101.41 | 101.08 |
| Si | 3.00 | 3.00 | 2.99 | 2.98 | 2.99 | 3.00 | 3.00 | 2.99 | 2.98 | 3.02 | 2.97 | 2.97 | 2.98 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 0.99 | 0.98 | 1.00 | 0.99 | 1.00 | 0.99 | 0.99 | 1.00 | 1.01 | 0.97 | 1.03 | 1.03 | 1.02 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| Na | 1.01 | 0.96 | 1.01 | 0.99 | 1.03 | 1.02 | 1.00 | 1.00 | 1.02 | 0.94 | 0.99 | 0.99 | 0.98 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| O | 8.00 | 7.98 | 8.00 | 7.99 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 7.98 | 7.98 | 7.98 | 7.99 |

| sample | cr0462 | cr0462 | cr0462 | cr0462 | cr0462 | cr0481a | cr0481a | cr0481a | cr0481a | cr0481a | cr0481a | cr0481b | cr0481b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ab−4 | Ab−5 | Ab−6 | Ab−7 | Ab−8 | Ab−1 | Ab−2 | Ab−3 | Ab−4 | Ab−5 | Ab−6 | Ab−1 | Ab−2 |
| SiO2 | 69.00 | 69.01 | 69.11 | 69.12 | 69.50 | 68.81 | 69.18 | 69.25 | 69.15 | 70.40 | 69.24 | 70.35 | 36.73 |
| TiO2 | 0.04 | 0.03 | 0.00 | 0.02 | 0.00 | 0.02 | 0.01 | 0.05 | 0.01 | 0.02 | 0.00 | 0.02 | 0.05 |
| Al2O3 | 20.13 | 20.19 | 20.15 | 20.18 | 20.06 | 18.83 | 19.20 | 19.23 | 19.05 | 19.26 | 20.11 | 19.67 | 20.63 |
| Cr2O3 | 0.00 | 0.00 | 0.04 | 0.03 | 0.00 | 0.00 | 0.02 | 0.00 | 0.02 | 0.02 | 0.00 | 0.00 | 0.00 |
| FeO | 0.25 | 0.21 | 0.11 | 0.33 | 0.19 | 0.57 | 0.51 | 0.43 | 0.45 | 0.10 | 0.12 | 0.25 | 14.33 |
| MnO | 0.00 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.02 | 0.00 | 0.00 | 0.01 | 0.00 | 0.05 | 0.18 |
| MgO | 0.00 | 0.00 | 0.00 | 0.02 | 0.01 | 0.05 | 0.06 | 0.09 | 0.08 | 0.03 | 0.05 | 0.00 | 0.00 |
| CaO | 0.05 | 0.01 | 0.06 | 0.03 | 0.04 | 0.03 | 0.02 | 0.08 | 0.05 | 0.06 | 0.25 | 0.10 | 21.68 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.02 | 0.00 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.03 | 0.03 | 0.32 | 0.03 | 0.00 |
| Na2O | 11.69 | 11.82 | 11.92 | 11.85 | 11.80 | 10.38 | 12.32 | 12.02 | 11.68 | 12.00 | 11.87 | 12.76 | 0.05 |
| Cl2O−1 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.02 | 0.01 | 0.00 | 0.00 | 0.01 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 |
| Total | 101.18 | 101.29 | 101.42 | 101.62 | 101.61 | 98.72 | 101.38 | 101.17 | 100.53 | 101.93 | 102.00 | 103.23 | 93.63 |
| Si | 2.97 | 2.97 | 2.97 | 2.96 | 2.98 | 3.01 | 3.00 | 3.00 | 3.00 | 3.02 | 2.97 | 3.00 | 2.01 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 1.02 | 1.02 | 1.02 | 1.02 | 1.01 | 0.97 | 0.98 | 0.98 | 0.98 | 0.97 | 1.02 | 0.99 | 1.33 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.00 | 0.00 | 0.01 | 0.65 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| Mg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 1.27 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 |
| Na | 0.98 | 0.99 | 0.99 | 0.99 | 0.98 | 0.88 | 1.03 | 1.01 | 0.98 | 1.00 | 0.99 | 1.06 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| O | 7.97 | 7.97 | 7.98 | 7.97 | 7.98 | 7.93 | 8.01 | 8.00 | 7.98 | 8.01 | 7.99 | 8.03 | 7.94 |

| sample | cr0481b | cr0481b | cr0481b | cr0481b |
|---|---|---|---|---|
| point | Ab−3 | Ab−4 | Ab−5 | Ab−6 |
| SiO2 | 36.55 | 36.23 | 36.63 | 36.61 |
| TiO2 | 0.05 | 0.01 | 0.05 | 0.09 |
| Al2O3 | 20.60 | 21.31 | 21.32 | 19.61 |
| Cr2O3 | 0.03 | 0.00 | 0.05 | 0.00 |
| FeO | 14.38 | 14.01 | 13.50 | 14.80 |
| MnO | 0.22 | 0.28 | 0.30 | 0.09 |
| MgO | 0.00 | 0.00 | 0.00 | 0.02 |
| CaO | 21.78 | 22.13 | 22.54 | 21.23 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.00 | 0.00 | 0.00 |
| Na2O | 0.00 | 0.01 | 0.02 | 0.01 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.03 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 93.59 | 93.98 | 94.42 | 92.47 |
| Si | 2.00 | 1.98 | 2.00 | 2.03 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 1.33 | 1.37 | 1.37 | 1.28 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe | 0.66 | 0.64 | 0.62 | 0.69 |
| Mn | 0.01 | 0.01 | 0.01 | 0.00 |
| Mg | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 1.28 | 1.29 | 1.32 | 1.26 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 7.94 | 7.96 | 8.00 | 7.93 |

| sample | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0428b | cr0428b | cr0428b | cr0428b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Lws−1 | Lws−2 | Lws−3 | Lws−4 | Lws−5 | Lws−6 | Lws−7 | Lws−8 | Lws−9 | Lws−1 | Lws−2 | Lws−3 | Lws−4 |
| SiO2 | 38.67 | 37.52 | 38.13 | 37.54 | 37.80 | 37.83 | 37.90 | 38.28 | 38.62 | 38.47 | 38.47 | 36.15 | 35.50 |
| TiO2 | 0.30 | 0.12 | 0.06 | 0.32 | 0.04 | 0.03 | 0.08 | 0.04 | 0.35 | 0.03 | 0.40 | 0.57 | 0.80 |
| Al2O3 | 31.42 | 31.65 | 32.19 | 32.39 | 32.96 | 33.01 | 32.59 | 32.98 | 32.39 | 31.66 | 31.35 | 33.05 | 34.36 |
| Cr2O3 | 0.00 | 0.00 | 0.02 | 0.00 | 0.02 | 0.04 | 0.06 | 0.08 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 |
| FeO | 0.68 | 0.61 | 0.54 | 0.61 | 0.36 | 0.52 | 0.53 | 0.44 | 0.57 | 0.55 | 0.52 | 0.48 | 0.40 |
| MnO | 0.03 | 0.02 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.02 | 0.05 | 0.01 | 0.03 | 0.00 | 0.00 |
| MgO | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.05 | 0.01 | 0.01 |
| CaO | 16.81 | 17.16 | 16.89 | 17.84 | 17.86 | 17.84 | 17.69 | 17.80 | 17.73 | 16.51 | 17.37 | 17.33 | 17.38 |
| K2O | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.00 |
| Na2O | 0.19 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.03 | 0.01 | 0.02 | 0.12 | 0.09 | 0.00 | 0.00 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.23 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 88.11 | 87.09 | 87.86 | 88.71 | 89.08 | 89.34 | 89.14 | 89.66 | 89.76 | 87.34 | 88.30 | 87.61 | 88.45 |
| Si | 2.02 | 1.99 | 1.99 | 1.96 | 1.96 | 1.96 | 1.97 | 1.97 | 1.99 | 2.02 | 2.02 | 1.90 | 1.85 |
| Ti | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.02 | 0.03 |
| Al | 1.94 | 1.98 | 1.98 | 2.00 | 2.02 | 2.02 | 2.00 | 2.00 | 1.97 | 1.96 | 1.94 | 2.05 | 2.10 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 0.03 | 0.03 | 0.02 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 0.94 | 0.97 | 0.94 | 1.00 | 0.99 | 0.99 | 0.99 | 0.98 | 0.98 | 0.93 | 0.98 | 0.98 | 0.97 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 7.95 | 7.96 | 7.93 | 7.97 | 7.97 | 7.95 | 7.93 | 7.96 | 7.97 | 7.93 | 7.98 | 7.93 | 7.90 |

| sample | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0429 | cr0429 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Lws−5 | Lws−6 | Lws−7 | Lws−8 | Lws−9 | Lws−10 | Lws−11 | Lws−12 | Lws−13 | Lws−14 | Lws−15 | Lws−1 | Lws−2 |
| SiO2 | 36.23 | 35.87 | 36.08 | 35.85 | 35.67 | 36.29 | 36.21 | 37.79 | 37.97 | 38.57 | 38.16 | 37.42 | 36.95 |
| TiO2 | 0.82 | 0.11 | 0.37 | 0.09 | 0.31 | 0.05 | 0.08 | 0.35 | 0.18 | 0.21 | 0.39 | 0.00 | 0.03 |
| Al2O3 | 31.74 | 33.55 | 31.83 | 31.48 | 32.44 | 32.45 | 33.95 | 32.49 | 32.42 | 32.21 | 32.46 | 34.19 | 32.58 |
| Cr2O3 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.00 | 0.00 | 0.00 |
| FeO | 0.44 | 0.30 | 0.39 | 0.28 | 0.37 | 0.36 | 0.35 | 0.39 | 0.35 | 0.37 | 0.37 | 0.34 | 0.74 |
| MnO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.03 | 0.00 | 0.06 |
| MgO | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 |
| CaO | 16.87 | 17.49 | 16.76 | 17.02 | 16.97 | 17.22 | 17.37 | 18.07 | 17.84 | 17.53 | 17.83 | 17.55 | 17.55 |
| K2O | 0.00 | 0.01 | 0.02 | 0.00 | 0.02 | 0.00 | 0.01 | 0.02 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 |
| Na2O | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.03 | 0.04 | 0.01 | 0.01 | 0.00 |
| Cl2O−1 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.18 | 0.04 | 0.00 | 0.00 |
| Total | 86.14 | 87.33 | 85.45 | 84.75 | 85.79 | 86.38 | 88.00 | 89.13 | 88.81 | 89.18 | 89.29 | 89.51 | 87.96 |
| Si | 1.94 | 1.89 | 1.95 | 1.96 | 1.92 | 1.94 | 1.89 | 1.97 | 1.98 | 2.00 | 1.98 | 1.92 | 1.94 |
| Ti | 0.03 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.02 | 0.00 | 0.00 |
| Al | 2.00 | 2.09 | 2.02 | 2.03 | 2.05 | 2.04 | 2.09 | 2.00 | 2.00 | 1.97 | 1.99 | 2.07 | 2.02 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 0.02 | 0.01 | 0.02 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.03 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 0.97 | 0.99 | 0.97 | 1.00 | 0.98 | 0.99 | 0.97 | 1.01 | 1.00 | 0.97 | 0.99 | 0.96 | 0.99 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.05 | 0.01 | 0.00 | 0.00 |
| O | 7.94 | 7.93 | 7.94 | 7.97 | 7.93 | 7.95 | 7.91 | 7.99 | 7.98 | 7.95 | 7.98 | 7.92 | 7.94 |

| sample | cr0429 | cr0429 | cr0429 | cr0429 | cr0429 | cr0462 | cr0462 | cr0462 | cr0462 |
|---|---|---|---|---|---|---|---|---|---|
| point | Lws−3 | Lws−4 | Lws−5 | Lws−6 | Lws−7 | Lws−1 | Lws−2 | Lws−3 | Lws−4 |
| SiO2 | 37.84 | 38.43 | 38.47 | 38.62 | 38.75 | 37.60 | 37.73 | 37.85 | 38.11 |
| TiO2 | 0.03 | 0.02 | 0.03 | 0.04 | 0.00 | 0.02 | 0.00 | 0.04 | 0.02 |
| Al2O3 | 33.01 | 32.80 | 33.99 | 33.21 | 32.69 | 32.85 | 32.61 | 32.58 | 33.20 |
| Cr2O3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.05 | 0.07 | 0.00 |
| FeO | 0.36 | 0.67 | 0.60 | 0.37 | 0.36 | 0.33 | 0.31 | 0.45 | 0.31 |
| MnO | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 |
| MgO | 0.00 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CaO | 17.32 | 17.47 | 17.53 | 17.56 | 16.87 | 17.90 | 18.05 | 18.06 | 18.01 |
| K2O | 0.02 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na2O | 0.04 | 0.01 | 0.02 | 0.00 | 0.02 | 0.00 | 0.01 | 0.02 | 0.01 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.00 |
| Total | 88.63 | 89.46 | 90.67 | 89.80 | 88.70 | 88.81 | 88.77 | 89.17 | 89.67 |
| Si | 1.96 | 1.98 | 1.95 | 1.98 | 2.00 | 1.96 | 1.97 | 1.97 | 1.97 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 2.02 | 1.99 | 2.03 | 2.00 | 1.99 | 2.02 | 2.01 | 2.00 | 2.02 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 0.02 | 0.03 | 0.03 | 0.02 | 0.02 | 0.01 | 0.01 | 0.02 | 0.01 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 0.96 | 0.96 | 0.95 | 0.96 | 0.93 | 1.00 | 1.01 | 1.01 | 1.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 |
| O | 7.94 | 7.94 | 7.91 | 7.95 | 7.92 | 7.97 | 7.99 | 7.98 | 7.97 |

| sample | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Pmp−1 | Pmp−2 | Pmp−3 | Pmp−4 | Pmp−5 | Pmp−6 | Pmp−7 | Pmp−8 | Pmp−9 | Pmp−10 | Pmp−11 | Pmp−12 | Pmp−13 |
| SiO2 | 37.28 | 37.87 | 37.42 | 37.12 | 37.36 | 37.09 | 36.48 | 36.63 | 36.64 | 36.78 | 36.89 | 36.99 | 37.04 |
| TiO2 | 0.08 | 0.00 | 0.10 | 0.13 | 0.27 | 0.15 | 0.11 | 0.08 | 0.11 | 0.08 | 0.06 | 0.11 | 0.09 |
| Al2O3 | 25.89 | 26.08 | 25.73 | 25.69 | 26.25 | 25.44 | 25.28 | 25.96 | 25.75 | 25.86 | 26.00 | 25.91 | 26.22 |
| Cr2O3 | 0.06 | 0.05 | 0.00 | 0.02 | 0.01 | 0.07 | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 | 0.04 | 0.03 |
| FeO | 3.72 | 3.61 | 3.56 | 4.01 | 3.44 | 3.78 | 3.70 | 3.96 | 3.94 | 4.33 | 3.88 | 3.85 | 4.03 |
| MnO | 0.59 | 0.57 | 0.58 | 0.61 | 0.75 | 0.69 | 0.69 | 0.63 | 0.62 | 0.65 | 0.62 | 0.69 | 0.68 |
| MgO | 2.71 | 2.77 | 2.89 | 2.70 | 2.94 | 2.76 | 2.67 | 2.89 | 2.79 | 2.76 | 2.87 | 2.84 | 2.62 |
| CaO | 22.52 | 22.02 | 22.22 | 21.90 | 22.07 | 21.92 | 21.74 | 22.40 | 22.47 | 22.53 | 22.56 | 22.62 | 22.53 |
| K2O | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| Na2O | 0.18 | 0.26 | 0.28 | 0.21 | 0.28 | 0.20 | 0.23 | 0.24 | 0.21 | 0.20 | 0.23 | 0.22 | 0.23 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.04 | 0.00 | 0.30 | 0.00 |
| Total | 93.05 | 93.22 | 92.78 | 92.39 | 93.38 | 92.10 | 90.91 | 92.80 | 92.81 | 93.23 | 93.15 | 93.58 | 93.47 |
| Si | 5.92 | 5.96 | 5.94 | 5.91 | 5.87 | 5.93 | 5.91 | 5.83 | 5.86 | 5.84 | 5.85 | 5.87 | 5.86 |
| Ti | 0.01 | 0.00 | 0.01 | 0.02 | 0.03 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Al | 4.85 | 4.84 | 4.81 | 4.82 | 4.86 | 4.79 | 4.83 | 4.87 | 4.85 | 4.84 | 4.86 | 4.84 | 4.89 |
| Cr | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.15 | 0.16 | 0.19 | 0.18 | 0.14 | 0.21 | 0.17 | 0.13 | 0.15 | 0.16 | 0.14 | 0.16 | 0.11 |
| Fe2+ | 0.34 | 0.31 | 0.29 | 0.35 | 0.31 | 0.30 | 0.33 | 0.39 | 0.38 | 0.41 | 0.38 | 0.35 | 0.42 |
| Mn | 0.08 | 0.08 | 0.08 | 0.08 | 0.10 | 0.09 | 0.09 | 0.09 | 0.08 | 0.09 | 0.08 | 0.09 | 0.09 |
| Mg | 0.64 | 0.65 | 0.68 | 0.64 | 0.69 | 0.66 | 0.64 | 0.68 | 0.66 | 0.65 | 0.68 | 0.67 | 0.62 |
| Ca | 3.83 | 3.71 | 3.78 | 3.73 | 3.71 | 3.75 | 3.78 | 3.82 | 3.85 | 3.83 | 3.83 | 3.84 | 3.82 |
| K | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.06 | 0.08 | 0.09 | 0.06 | 0.08 | 0.06 | 0.07 | 0.07 | 0.06 | 0.06 | 0.07 | 0.07 | 0.07 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.22 | 0.03 | 0.00 | 0.26 | 0.00 |
| O | 24.30 | 24.21 | 24.27 | 24.19 | 24.16 | 24.23 | 24.24 | 24.19 | 24.14 | 24.20 | 24.23 | 24.13 | 24.22 |
| Mg♯ | 0.67 | 0.70 | 0.73 | 0.67 | 0.71 | 0.72 | 0.68 | 0.65 | 0.66 | 0.63 | 0.66 | 0.68 | 0.61 |
| Al♯ | 0.97 | 0.97 | 0.96 | 0.96 | 0.97 | 0.96 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.98 |

| sample | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0318d | cr0318d | cr0318d |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Pmp−14 | Pmp−15 | Pmp−16 | Pmp−17 | Pmp−18 | Pmp−19 | Pmp−20 | Pmp−21 | Pmp−22 | Pmp−23 | Pmp−1 | Pmp−2 | Pmp−3 |
| SiO2 | 37.10 | 37.12 | 37.16 | 37.19 | 37.29 | 37.33 | 37.34 | 37.37 | 37.56 | 37.81 | 37.33 | 36.89 | 37.24 |
| TiO2 | 0.08 | 0.09 | 0.05 | 0.14 | 0.03 | 0.12 | 0.11 | 0.08 | 0.08 | 0.06 | 0.09 | 0.15 | 0.05 |
| Al2O3 | 25.86 | 26.37 | 25.96 | 26.11 | 26.33 | 26.01 | 26.10 | 26.10 | 26.33 | 26.49 | 24.08 | 24.32 | 24.71 |
| Cr2O3 | 0.00 | 0.04 | 0.00 | 0.00 | 0.02 | 0.01 | 0.00 | 0.01 | 0.05 | 0.00 | 0.01 | 0.02 | 0.00 |
| FeO | 4.34 | 3.86 | 4.43 | 4.05 | 3.87 | 4.08 | 4.14 | 3.95 | 3.99 | 3.84 | 5.20 | 5.48 | 5.21 |
| MnO | 0.64 | 0.60 | 0.61 | 0.66 | 0.68 | 0.55 | 0.52 | 0.52 | 0.61 | 0.59 | 0.13 | 0.21 | 0.30 |
| MgO | 2.44 | 2.98 | 2.54 | 2.76 | 2.56 | 2.74 | 2.73 | 2.84 | 2.81 | 2.86 | 2.68 | 2.75 | 2.72 |
| CaO | 22.41 | 22.46 | 22.35 | 22.51 | 22.29 | 22.48 | 22.55 | 22.63 | 22.42 | 22.79 | 22.85 | 22.38 | 22.43 |
| K2O | 0.02 | 0.00 | 0.00 | 0.00 | 0.02 | 0.01 | 0.00 | 0.00 | 0.02 | 0.01 | 0.00 | 0.01 | 0.01 |
| Na2O | 0.20 | 0.26 | 0.23 | 0.24 | 0.28 | 0.23 | 0.21 | 0.23 | 0.24 | 0.21 | 0.06 | 0.05 | 0.04 |
| Cl2O−1 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.23 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 93.09 | 93.78 | 93.57 | 93.65 | 93.38 | 93.56 | 93.68 | 93.74 | 94.12 | 94.68 | 92.44 | 92.26 | 92.71 |
| Si | 5.90 | 5.82 | 5.88 | 5.86 | 5.89 | 5.89 | 5.88 | 5.89 | 5.87 | 5.89 | 6.03 | 5.94 | 5.95 |
| Ti | 0.01 | 0.01 | 0.01 | 0.02 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 |
| Al | 4.85 | 4.88 | 4.84 | 4.85 | 4.90 | 4.84 | 4.85 | 4.85 | 4.85 | 4.86 | 4.59 | 4.61 | 4.66 |
| Cr | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.15 | 0.12 | 0.16 | 0.15 | 0.10 | 0.16 | 0.15 | 0.15 | 0.15 | 0.14 | 0.41 | 0.39 | 0.34 |
| Fe2+ | 0.42 | 0.38 | 0.43 | 0.38 | 0.41 | 0.38 | 0.39 | 0.37 | 0.37 | 0.36 | 0.29 | 0.35 | 0.35 |
| Mn | 0.09 | 0.08 | 0.08 | 0.09 | 0.09 | 0.07 | 0.07 | 0.07 | 0.08 | 0.08 | 0.02 | 0.03 | 0.04 |
| Mg | 0.58 | 0.70 | 0.60 | 0.65 | 0.60 | 0.64 | 0.64 | 0.67 | 0.66 | 0.66 | 0.65 | 0.66 | 0.65 |
| Ca | 3.82 | 3.78 | 3.79 | 3.80 | 3.77 | 3.80 | 3.81 | 3.82 | 3.76 | 3.80 | 3.96 | 3.86 | 3.84 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.06 | 0.08 | 0.07 | 0.07 | 0.08 | 0.07 | 0.06 | 0.07 | 0.07 | 0.06 | 0.02 | 0.02 | 0.01 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 24.26 | 24.15 | 24.11 | 24.22 | 24.20 | 24.24 | 24.24 | 24.24 | 24.18 | 24.23 | 24.51 | 24.33 | 24.31 |
| Mg♯ | 0.59 | 0.66 | 0.60 | 0.65 | 0.61 | 0.65 | 0.64 | 0.67 | 0.66 | 0.66 | 0.76 | 0.71 | 0.70 |
| Al♯ | 0.97 | 0.98 | 0.97 | 0.97 | 0.98 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.92 | 0.92 | 0.93 |

| sample | cr0318d | cr0318d | cr0318d | cr0318d | cr0318d | cr0428b | cr0428b | cr0428b | cr0428b | cr0429 | cr0429 | cr0429 | cr0429 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Pmp−4 | Pmp−5 | Pmp−6 | Pmp−7 | Pmp−8 | Pmp−1 | Pmp−2 | Pmp−3 | Pmp−4 | Pmp−1 | Pmp−2 | Pmp−3 | Pmp−4 |
| SiO2 | 37.29 | 38.05 | 37.85 | 37.55 | 37.12 | 37.13 | 37.28 | 37.59 | 37.24 | 36.12 | 36.39 | 36.46 | 36.49 |
| TiO2 | 0.07 | 0.00 | 0.10 | 0.18 | 0.25 | 0.14 | 0.13 | 0.08 | 0.15 | 0.09 | 0.08 | 0.15 | 0.09 |
| Al2O3 | 24.60 | 24.98 | 25.00 | 24.61 | 24.48 | 26.50 | 27.45 | 26.74 | 26.22 | 26.55 | 26.39 | 27.20 | 26.15 |
| Cr2O3 | 0.05 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.02 | 0.03 | 0.00 |
| FeO | 4.14 | 4.94 | 4.79 | 4.78 | 4.84 | 3.90 | 3.91 | 4.11 | 4.29 | 4.30 | 3.52 | 3.57 | 3.78 |
| MnO | 0.21 | 0.17 | 0.18 | 0.23 | 0.22 | 0.70 | 0.35 | 0.45 | 0.40 | 0.37 | 0.70 | 0.72 | 0.56 |
| MgO | 3.07 | 3.02 | 3.01 | 2.83 | 2.91 | 2.78 | 1.61 | 2.08 | 2.19 | 2.81 | 2.98 | 3.18 | 2.94 |
| CaO | 22.34 | 23.06 | 22.88 | 22.56 | 22.67 | 22.34 | 23.07 | 22.26 | 22.67 | 22.45 | 22.03 | 21.50 | 22.27 |
| K2O | 0.01 | 0.03 | 0.01 | 0.03 | 0.00 | 0.02 | 0.02 | 0.03 | 0.05 | 0.03 | 0.02 | 0.01 | 0.01 |
| Na2O | 0.09 | 0.05 | 0.11 | 0.08 | 0.07 | 0.23 | 0.15 | 0.27 | 0.21 | 0.14 | 0.25 | 0.21 | 0.23 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 91.88 | 94.30 | 93.99 | 92.83 | 92.56 | 93.90 | 93.96 | 93.62 | 93.44 | 92.87 | 92.36 | 93.04 | 92.54 |
| Si | 6.00 | 5.99 | 5.97 | 6.00 | 5.96 | 5.83 | 5.91 | 5.93 | 5.92 | 5.74 | 5.78 | 5.68 | 5.81 |
| Ti | 0.01 | 0.00 | 0.01 | 0.02 | 0.03 | 0.02 | 0.02 | 0.01 | 0.02 | 0.01 | 0.01 | 0.02 | 0.01 |
| Al | 4.66 | 4.63 | 4.65 | 4.63 | 4.63 | 4.90 | 5.13 | 4.97 | 4.91 | 4.97 | 4.94 | 5.00 | 4.90 |
| Cr | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.34 | 0.37 | 0.35 | 0.37 | 0.37 | 0.10 | 0.00 | 0.03 | 0.09 | 0.03 | 0.06 | 0.00 | 0.10 |
| Fe2+ | 0.22 | 0.28 | 0.28 | 0.27 | 0.28 | 0.41 | 0.52 | 0.51 | 0.48 | 0.54 | 0.41 | 0.46 | 0.41 |
| Mn | 0.03 | 0.02 | 0.02 | 0.03 | 0.03 | 0.09 | 0.05 | 0.06 | 0.05 | 0.05 | 0.09 | 0.09 | 0.08 |
| Mg | 0.74 | 0.71 | 0.71 | 0.67 | 0.70 | 0.65 | 0.38 | 0.49 | 0.52 | 0.66 | 0.71 | 0.74 | 0.70 |
| Ca | 3.85 | 3.89 | 3.87 | 3.86 | 3.90 | 3.76 | 3.92 | 3.76 | 3.86 | 3.82 | 3.75 | 3.59 | 3.80 |
| K | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| Na | 0.03 | 0.02 | 0.03 | 0.02 | 0.02 | 0.07 | 0.05 | 0.08 | 0.06 | 0.04 | 0.08 | 0.06 | 0.07 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 24.37 | 24.38 | 24.37 | 24.40 | 24.40 | 24.07 | 24.43 | 24.24 | 24.34 | 24.09 | 24.08 | 23.82 | 24.15 |
| Mg# | 0.83 | 0.77 | 0.77 | 0.77 | 0.77 | 0.62 | 0.42 | 0.49 | 0.53 | 0.56 | 0.64 | 0.62 | 0.64 |
| Al# | 0.93 | 0.93 | 0.93 | 0.93 | 0.93 | 0.98 | 1.00 | 0.99 | 0.98 | 0.99 | 0.99 | 1.00 | 0.98 |

| sample | cr0429 | cr0429 | cr0429 | cr0429 | cr0429 | cr0429 | cr0429 | cr0429 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Pmp−5 | Pmp−6 | Pmp−7 | Pmp−8 | Pmp−9 | Pmp−10 | Pmp−11 | Pmp−12 | Pmp−1 | Pmp−2 | Pmp−3 | Pmp−4 | Pmp−5 |
| SiO2 | 36.57 | 36.58 | 36.79 | 36.90 | 36.96 | 37.42 | 37.44 | 37.54 | 37.28 | 37.43 | 37.53 | 37.59 | 37.64 |
| TiO2 | 0.15 | 0.11 | 0.12 | 0.12 | 0.08 | 0.08 | 0.10 | 0.15 | 0.14 | 0.19 | 0.11 | 0.11 | 0.11 |
| Al2O3 | 26.16 | 26.50 | 26.16 | 27.47 | 26.48 | 27.38 | 26.42 | 26.67 | 25.40 | 25.92 | 25.77 | 25.55 | 25.68 |
| Cr2O3 | 0.03 | 0.00 | 0.01 | 0.03 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeO | 3.50 | 3.66 | 3.59 | 3.88 | 3.56 | 3.86 | 3.79 | 3.83 | 3.60 | 3.48 | 3.26 | 3.63 | 3.67 |
| MnO | 0.75 | 0.40 | 0.63 | 0.63 | 0.79 | 0.57 | 0.39 | 0.56 | 1.15 | 0.77 | 0.75 | 0.67 | 0.82 |
| MgO | 3.20 | 3.09 | 3.29 | 2.93 | 3.02 | 2.87 | 2.72 | 3.03 | 3.06 | 2.92 | 3.03 | 3.10 | 3.01 |
| CaO | 22.36 | 22.65 | 21.81 | 21.35 | 21.95 | 22.00 | 21.66 | 22.13 | 21.81 | 22.14 | 22.23 | 22.41 | 22.26 |
| K2O | 0.01 | 0.01 | 0.00 | 0.04 | 0.03 | 0.20 | 0.02 | 0.05 | 0.02 | 0.00 | 0.00 | 0.02 | 0.01 |
| Na2O | 0.20 | 0.15 | 0.41 | 0.29 | 0.22 | 0.25 | 0.23 | 0.23 | 0.30 | 0.30 | 0.27 | 0.21 | 0.21 |
| Cl2O−1 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 0.06 | 0.12 | 0.11 | 0.10 |
| Total | 92.93 | 93.17 | 92.84 | 93.64 | 93.09 | 94.63 | 92.77 | 94.19 | 92.86 | 93.20 | 93.08 | 93.40 | 93.52 |
| Si | 5.78 | 5.78 | 5.80 | 5.71 | 5.81 | 5.78 | 5.90 | 5.83 | 5.90 | 5.91 | 5.94 | 5.94 | 5.92 |
| Ti | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 |
| Al | 4.88 | 4.94 | 4.86 | 5.01 | 4.90 | 4.98 | 4.90 | 4.88 | 4.74 | 4.82 | 4.80 | 4.75 | 4.76 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.12 | 0.06 | 0.14 | 0.00 | 0.10 | 0.02 | 0.10 | 0.12 | 0.26 | 0.18 | 0.20 | 0.25 | 0.24 |
| Fe2+ | 0.34 | 0.42 | 0.33 | 0.50 | 0.37 | 0.48 | 0.40 | 0.38 | 0.21 | 0.28 | 0.24 | 0.23 | 0.25 |
| Mn | 0.10 | 0.05 | 0.08 | 0.08 | 0.10 | 0.07 | 0.05 | 0.07 | 0.15 | 0.10 | 0.10 | 0.09 | 0.11 |
| Mg | 0.76 | 0.73 | 0.77 | 0.67 | 0.71 | 0.66 | 0.64 | 0.70 | 0.72 | 0.69 | 0.71 | 0.73 | 0.71 |
| Ca | 3.79 | 3.84 | 3.68 | 3.54 | 3.70 | 3.64 | 3.65 | 3.68 | 3.70 | 3.74 | 3.77 | 3.79 | 3.75 |
| K | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.04 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.06 | 0.05 | 0.13 | 0.09 | 0.07 | 0.08 | 0.07 | 0.07 | 0.09 | 0.09 | 0.08 | 0.06 | 0.06 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | 0.05 | 0.10 | 0.10 | 0.09 |
| O | 24.12 | 24.16 | 24.06 | 23.82 | 24.05 | 23.98 | 24.10 | 24.07 | 24.11 | 24.19 | 24.21 | 24.22 | 24.18 |
| Mg# | 0.71 | 0.64 | 0.72 | 0.57 | 0.67 | 0.58 | 0.63 | 0.66 | 0.82 | 0.74 | 0.78 | 0.80 | 0.78 |
| Al# | 0.98 | 0.99 | 0.97 | 1.00 | 0.98 | 1.00 | 0.98 | 0.98 | 0.95 | 0.96 | 0.96 | 0.95 | 0.95 |

| sample | cr0434 | cr0434 | cr0434 | cr0434 | cr0444 | cr0462 | cr0462 | cr0462 | cr0462 | cr0462 | cr0462 | cr0462 | cr0462 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Pmp−6 | Pmp−7 | Pmp−8 | Pmp−9 | Pmp−1 | Pmp−1 | Pmp−2 | Pmp−3 | Pmp−4 | Pmp−5 | Pmp−6 | Pmp−7 | Pmp−8 |
| SiO2 | 37.64 | 37.72 | 37.74 | 37.90 | 39.03 | 37.28 | 37.32 | 37.38 | 37.48 | 37.50 | 37.30 | 37.59 | 37.78 |
| TiO2 | 0.08 | 0.11 | 0.09 | 0.12 | 0.09 | 0.11 | 0.09 | 0.07 | 0.10 | 0.10 | 0.08 | 0.11 | 0.11 |
| Al2O3 | 25.49 | 25.86 | 25.99 | 25.70 | 26.11 | 26.02 | 25.95 | 25.56 | 26.00 | 26.16 | 26.03 | 25.67 | 25.94 |
| Cr2O3 | 0.01 | 0.02 | 0.01 | 0.02 | 0.04 | 0.12 | 0.04 | 0.11 | 0.11 | 0.03 | 0.15 | 0.01 | 0.12 |
| FeO | 3.42 | 3.21 | 3.47 | 3.47 | 3.41 | 2.23 | 2.39 | 2.53 | 2.24 | 2.35 | 2.23 | 2.97 | 2.48 |
| MnO | 0.75 | 0.99 | 0.97 | 1.04 | 1.05 | 1.35 | 1.09 | 1.10 | 1.29 | 0.99 | 1.19 | 1.14 | 1.17 |
| MgO | 3.02 | 3.04 | 2.97 | 2.97 | 3.00 | 3.83 | 3.90 | 3.84 | 3.98 | 3.83 | 3.82 | 3.92 | 3.88 |
| CaO | 22.10 | 21.95 | 22.05 | 21.79 | 21.79 | 21.91 | 22.41 | 22.22 | 21.99 | 22.61 | 22.18 | 22.08 | 22.25 |
| K2O | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 |
| Na2O | 0.21 | 0.25 | 0.32 | 0.29 | 0.17 | 0.22 | 0.14 | 0.23 | 0.21 | 0.16 | 0.22 | 0.16 | 0.22 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.08 | 0.10 | 0.06 | 0.09 | 0.00 | 0.00 | 0.36 | 0.25 | 0.45 | 0.00 | 0.38 | 0.14 | 0.20 |
| Total | 92.82 | 93.26 | 93.69 | 93.40 | 94.72 | 93.08 | 93.72 | 93.31 | 93.85 | 93.74 | 93.59 | 93.78 | 94.18 |
| Si | 5.96 | 5.93 | 5.91 | 5.94 | 6.00 | 5.82 | 5.84 | 5.87 | 5.83 | 5.85 | 5.83 | 5.84 | 5.86 |
| Ti | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Al | 4.76 | 4.79 | 4.80 | 4.75 | 4.73 | 4.79 | 4.78 | 4.73 | 4.76 | 4.81 | 4.80 | 4.70 | 4.74 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.00 | 0.01 | 0.01 | 0.00 | 0.02 | 0.00 | 0.01 |
| Fe3+ | 0.24 | 0.21 | 0.20 | 0.25 | 0.27 | 0.21 | 0.22 | 0.27 | 0.24 | 0.19 | 0.20 | 0.30 | 0.26 |
| Fe2+ | 0.21 | 0.21 | 0.25 | 0.21 | 0.17 | 0.08 | 0.10 | 0.06 | 0.06 | 0.12 | 0.09 | 0.09 | 0.06 |
| Mn | 0.10 | 0.13 | 0.13 | 0.14 | 0.14 | 0.18 | 0.14 | 0.15 | 0.17 | 0.13 | 0.16 | 0.15 | 0.15 |
| Mg | 0.71 | 0.71 | 0.69 | 0.70 | 0.69 | 0.89 | 0.91 | 0.90 | 0.92 | 0.89 | 0.89 | 0.91 | 0.90 |
| Ca | 3.75 | 3.70 | 3.70 | 3.66 | 3.59 | 3.66 | 3.75 | 3.74 | 3.66 | 3.78 | 3.72 | 3.68 | 3.70 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.06 | 0.08 | 0.10 | 0.09 | 0.05 | 0.07 | 0.04 | 0.07 | 0.06 | 0.05 | 0.07 | 0.05 | 0.06 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.07 | 0.09 | 0.05 | 0.08 | 0.00 | 0.00 | 0.31 | 0.22 | 0.38 | 0.00 | 0.32 | 0.12 | 0.17 |
| O | 24.22 | 24.13 | 24.15 | 24.13 | 24.12 | 24.04 | 23.97 | 24.05 | 23.85 | 24.16 | 23.94 | 23.99 | 24.03 |
| Mg# | 0.81 | 0.81 | 0.77 | 0.82 | 0.86 | 0.96 | 0.95 | 0.99 | 0.99 | 0.92 | 0.95 | 0.97 | 0.99 |
| Al# | 0.95 | 0.96 | 0.96 | 0.95 | 0.95 | 0.96 | 0.96 | 0.95 | 0.95 | 0.96 | 0.96 | 0.94 | 0.95 |

| sample | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ep−1 | Ep−2 | Ep−3 | Ep−4 | Ep−5 | Ep−6 | Ep−7 | Ep−8 | Ep−1 | Ep−2 | Ep−3 | Ep−4 | Ep−5 |
| SiO2 | 36.85 | 37.11 | 37.14 | 37.30 | 37.37 | 37.40 | 37.62 | 37.64 | 37.29 | 37.42 | 37.61 | 37.57 | 38.01 |
| TiO2 | 0.18 | 0.27 | 0.20 | 0.22 | 0.15 | 0.18 | 0.06 | 0.19 | 0.03 | 0.13 | 0.04 | 0.10 | 0.12 |
| Al2O3 | 24.92 | 24.86 | 24.94 | 24.80 | 24.17 | 25.01 | 22.82 | 24.77 | 22.50 | 22.43 | 23.47 | 22.91 | 24.29 |
| Cr2O3 | 0.06 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.01 | 0.03 | 0.02 |
| FeO | 10.51 | 10.46 | 10.47 | 10.60 | 11.25 | 10.44 | 13.10 | 10.45 | 12.71 | 12.55 | 11.39 | 11.62 | 10.91 |
| MnO | 0.39 | 0.33 | 0.33 | 0.36 | 0.41 | 0.43 | 0.10 | 0.37 | 0.44 | 0.34 | 0.34 | 0.21 | 0.34 |
| MgO | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.02 |
| CaO | 22.18 | 22.14 | 21.93 | 22.02 | 21.80 | 22.07 | 22.16 | 22.03 | 20.28 | 21.60 | 22.23 | 22.22 | 22.84 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.08 | 0.10 | 0.09 | 0.00 |
| Na2O | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.02 | 0.03 | 0.00 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.19 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 95.09 | 95.22 | 95.22 | 95.34 | 95.16 | 95.57 | 95.90 | 95.47 | 93.29 | 94.55 | 95.23 | 94.79 | 96.56 |
| Si | 2.93 | 2.94 | 2.94 | 2.95 | 2.96 | 2.95 | 2.99 | 2.97 | 2.99 | 3.00 | 3.00 | 3.02 | 2.99 |
| Ti | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 |
| Al | 2.33 | 2.32 | 2.33 | 2.31 | 2.26 | 2.32 | 2.13 | 2.30 | 2.13 | 2.12 | 2.21 | 2.17 | 2.25 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 0.70 | 0.69 | 0.69 | 0.70 | 0.75 | 0.69 | 0.87 | 0.69 | 0.85 | 0.84 | 0.76 | 0.78 | 0.72 |
| Mn | 0.03 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.01 | 0.02 | 0.03 | 0.02 | 0.02 | 0.01 | 0.02 |
| Mg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 1.89 | 1.88 | 1.86 | 1.87 | 1.85 | 1.86 | 1.88 | 1.86 | 1.74 | 1.86 | 1.90 | 1.91 | 1.93 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.08 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 12.00 | 12.00 | 11.94 | 11.98 | 11.95 | 11.99 | 11.94 | 12.00 | 11.80 | 11.94 | 12.02 | 12.04 | 12.06 |

| sample | cr0318d | cr0318d | cr0318d | cr0422b | cr0422b | cr0422b | cr0428b | cr0428b | cr0428b | cr0428b | cr0429 | cr0429 | cr0429 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ep−1 | Ep−2 | Ep−3 | Ep−1 | Ep−2 | Ep−3 | Ep−1 | Ep−2 | Ep−3 | Ep−4 | Ep−1 | Ep−2 | Ep−3 |
| SiO2 | 37.05 | 37.18 | 36.90 | 41.58 | 39.98 | 41.09 | 37.16 | 38.10 | 38.17 | 38.26 | 37.78 | 38.31 | 38.82 |
| TiO2 | 0.07 | 0.01 | 0.04 | 0.02 | 0.08 | 0.11 | 0.22 | 0.05 | 0.14 | 0.07 | 0.03 | 0.09 | 0.07 |
| Al2O3 | 21.84 | 21.74 | 21.03 | 23.73 | 22.88 | 21.14 | 22.01 | 27.68 | 27.34 | 27.67 | 25.49 | 27.36 | 25.60 |
| Cr2O3 | 0.00 | 0.00 | 0.09 | 0.00 | 0.02 | 0.05 | 0.01 | 0.00 | 0.00 | 0.02 | 0.02 | 0.07 | 0.26 |
| FeO | 13.21 | 13.73 | 13.80 | 11.95 | 13.52 | 13.26 | 12.42 | 7.56 | 7.83 | 7.52 | 11.00 | 9.03 | 9.69 |
| MnO | 0.08 | 0.10 | 0.21 | 0.18 | 0.20 | 0.14 | 0.05 | 0.21 | 0.19 | 0.11 | 0.06 | 0.06 | 0.09 |
| MgO | 0.04 | 0.02 | 0.00 | 0.03 | 0.45 | 0.48 | 0.00 | 0.01 | 0.03 | 0.00 | 0.02 | 0.01 | 0.70 |
| CaO | 21.54 | 22.28 | 21.28 | 22.52 | 21.08 | 21.85 | 21.71 | 23.45 | 23.43 | 23.47 | 23.61 | 23.00 | 22.56 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 |
| Na2O | 0.02 | 0.04 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.05 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 93.85 | 95.12 | 93.35 | 100.00 | 98.22 | 98.12 | 93.59 | 97.15 | 97.15 | 97.14 | 98.04 | 97.94 | 97.85 |
| Si | 3.00 | 3.00 | 3.01 | 3.13 | 3.03 | 3.16 | 3.02 | 2.96 | 2.96 | 2.97 | 2.94 | 2.94 | 2.97 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 2.09 | 2.07 | 2.02 | 2.10 | 2.04 | 1.91 | 2.11 | 2.53 | 2.50 | 2.53 | 2.34 | 2.47 | 2.31 |
| Cr | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 |
| FeIII | 0.90 | 0.93 | 0.94 | 0.75 | 0.86 | 0.85 | 0.85 | 0.49 | 0.51 | 0.49 | 0.72 | 0.58 | 0.62 |
| Mn | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 |
| Mg | 0.01 | 0.00 | 0.00 | 0.00 | 0.05 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 |
| Ca | 1.87 | 1.92 | 1.86 | 1.82 | 1.71 | 1.80 | 1.89 | 1.95 | 1.95 | 1.95 | 1.97 | 1.89 | 1.85 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 11.92 | 11.96 | 11.89 | 12.00 | 11.77 | 11.92 | 11.99 | 12.17 | 12.17 | 12.19 | 12.08 | 12.07 | 11.98 |

| sample | cr0430a | cr0433 | cr0433 | cr0433 | cr0433 | cr0433 | cr0433 | cr0433 | cr0433 | cr0434 | cr0434 | cr0434 | cr0434 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ep−1 | Ep−1 | Ep−2 | Ep−3 | Ep−4 | Ep−5 | Ep−6 | Ep−7 | Ep−8 | Ep−1 | Ep−2 | Ep−3 | Ep−4 |
| SiO2 | 37.82 | 37.99 | 38.13 | 38.29 | 38.29 | 38.34 | 38.40 | 38.45 | 38.55 | 37.93 | 37.60 | 37.96 | 38.17 |
| TiO2 | 0.03 | 0.10 | 0.01 | 0.07 | 0.57 | 0.07 | 0.09 | 0.05 | 0.07 | 0.04 | 0.03 | 0.11 | 0.06 |
| Al2O3 | 23.92 | 22.45 | 22.27 | 22.99 | 22.77 | 22.96 | 23.02 | 22.99 | 22.45 | 23.51 | 21.42 | 24.43 | 23.91 |
| Cr2O3 | 0.00 | 0.07 | 0.01 | 0.04 | 0.00 | 0.04 | 0.06 | 0.01 | 0.00 | 0.00 | 0.01 | 0.13 | 0.04 |
| FeO | 12.63 | 12.94 | 12.96 | 12.53 | 12.10 | 12.29 | 12.54 | 12.41 | 12.70 | 11.93 | 14.22 | 10.90 | 11.40 |
| MnO | 0.24 | 0.18 | 0.41 | 0.38 | 0.24 | 0.27 | 0.17 | 0.19 | 0.15 | 0.06 | 0.03 | 0.08 | 0.11 |
| MgO | 0.34 | 0.03 | 0.04 | 0.05 | 0.00 | 0.05 | 0.25 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.03 |
| CaO | 21.73 | 23.33 | 22.88 | 22.98 | 23.08 | 23.17 | 23.73 | 23.73 | 23.14 | 23.44 | 22.48 | 22.94 | 23.04 |
| BaO | 0.00 | 0.02 | 0.02 | 0.04 | 0.00 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na2O | 0.37 | 0.00 | 0.00 | 0.00 | 0.05 | 0.06 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.02 |
| Cl2O−1 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.03 | 0.00 | 0.01 | 0.01 | 0.02 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 |
| Total | 97.09 | 97.11 | 96.77 | 97.37 | 97.12 | 97.26 | 98.30 | 97.83 | 97.10 | 96.93 | 95.82 | 96.58 | 96.79 |
| Si | 2.93 | 3.02 | 3.02 | 3.01 | 3.03 | 3.02 | 3.01 | 3.03 | 3.05 | 3.01 | 3.02 | 2.99 | 3.01 |
| Ti | 0.00 | 0.01 | 0.00 | 0.00 | 0.03 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| Al | 2.19 | 2.10 | 2.08 | 2.13 | 2.12 | 2.13 | 2.12 | 2.14 | 2.09 | 2.20 | 2.02 | 2.27 | 2.22 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| FeIII | 0.82 | 0.86 | 0.86 | 0.82 | 0.80 | 0.81 | 0.82 | 0.82 | 0.84 | 0.79 | 0.95 | 0.72 | 0.75 |
| Mn | 0.02 | 0.01 | 0.03 | 0.03 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 |
| Mg | 0.04 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 1.81 | 1.98 | 1.94 | 1.94 | 1.96 | 1.96 | 1.99 | 2.00 | 1.96 | 1.99 | 1.93 | 1.94 | 1.95 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.06 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 11.87 | 12.06 | 12.00 | 12.02 | 12.08 | 12.06 | 12.06 | 12.10 | 12.06 | 12.10 | 11.96 | 12.07 | 12.07 |

| sample | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ep−1 | Ep−2 | Ep−3 | Ep−4 | Ep−5 | Ep−6 | Ep−7 | Ep−8 | Ep−9 | Ep−10 | Ep−11 | Ep−12 | Ep−13 |
| SiO2 | 36.43 | 36.55 | 36.57 | 36.63 | 36.68 | 36.71 | 36.74 | 36.87 | 36.91 | 36.93 | 36.94 | 36.95 | 36.99 |
| TiO2 | 0.07 | 0.13 | 0.04 | 0.08 | 0.08 | 0.05 | 0.18 | 0.06 | 0.14 | 0.07 | 0.08 | 0.05 | 0.14 |
| Al2O3 | 21.80 | 23.63 | 22.90 | 21.53 | 21.49 | 22.21 | 23.36 | 21.75 | 21.81 | 22.11 | 22.65 | 23.43 | 23.04 |
| Cr2O3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeO | 14.57 | 12.41 | 13.63 | 15.06 | 14.85 | 13.72 | 11.80 | 14.59 | 14.27 | 13.92 | 13.34 | 11.58 | 12.80 |
| MnO | 0.27 | 0.25 | 0.26 | 0.21 | 0.21 | 0.30 | 0.20 | 0.21 | 0.09 | 0.27 | 0.21 | 0.15 | 0.32 |
| MgO | 0.02 | 0.02 | 0.00 | 0.00 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.00 | 0.02 |
| CaO | 23.33 | 23.43 | 23.50 | 22.59 | 23.16 | 23.21 | 23.33 | 23.19 | 23.61 | 23.23 | 23.28 | 23.86 | 22.87 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.03 | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| Na2O | 0.03 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 |
| Cl2O−1 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.00 |
| F2O−1 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 96.53 | 96.49 | 96.92 | 96.11 | 96.51 | 96.21 | 95.65 | 96.71 | 96.84 | 96.55 | 96.53 | 96.05 | 96.16 |
| Si | 2.93 | 2.92 | 2.92 | 2.94 | 2.95 | 2.95 | 2.96 | 2.95 | 2.96 | 2.96 | 2.95 | 2.98 | 2.95 |
| Ti | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 |
| Al | 2.07 | 2.22 | 2.15 | 2.03 | 2.03 | 2.10 | 2.22 | 2.05 | 2.06 | 2.09 | 2.13 | 2.23 | 2.17 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 0.98 | 0.83 | 0.91 | 1.01 | 1.00 | 0.92 | 0.80 | 0.98 | 0.96 | 0.93 | 0.89 | 0.78 | 0.85 |
| Mn | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.02 |
| Mg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 2.01 | 2.00 | 2.01 | 1.94 | 1.99 | 2.00 | 2.01 | 1.99 | 2.03 | 1.99 | 1.99 | 2.06 | 1.95 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 11.98 | 12.04 | 12.00 | 11.90 | 11.96 | 12.00 | 12.09 | 11.97 | 12.03 | 12.00 | 12.02 | 12.16 | 11.99 |

| sample | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ep−14 | Ep−15 | Ep−16 | Ep−17 | Ep−18 | Ep−19 | Ep−20 | Ep−21 | Ep−22 | Ep−23 | Ep−24 | Ep−25 | Ep−26 |
| SiO2 | 37.03 | 37.03 | 37.05 | 37.09 | 37.09 | 37.12 | 37.20 | 37.25 | 37.29 | 37.37 | 37.49 | 37.38 | 37.65 |
| TiO2 | 0.13 | 0.13 | 0.11 | 0.13 | 0.06 | 0.04 | 0.05 | 0.06 | 0.06 | 0.08 | 0.08 | 0.07 | 0.08 |
| Al2O3 | 23.46 | 22.68 | 22.74 | 23.29 | 23.08 | 23.92 | 23.40 | 23.37 | 23.76 | 22.93 | 22.17 | 22.23 | 21.42 |
| Cr2O3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeO | 12.14 | 13.13 | 13.34 | 12.77 | 13.08 | 12.29 | 12.38 | 12.41 | 11.70 | 13.07 | 12.70 | 13.45 | 12.90 |
| MnO | 0.26 | 0.25 | 0.22 | 0.19 | 0.19 | 0.20 | 0.17 | 0.20 | 0.26 | 0.26 | 0.29 | 0.20 | 0.22 |
| MgO | 0.01 | 0.01 | 0.02 | 0.02 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.24 |
| CaO | 23.71 | 23.82 | 23.59 | 23.83 | 23.60 | 23.86 | 23.67 | 23.67 | 23.83 | 23.48 | 22.53 | 23.52 | 22.66 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 |
| Na2O | 0.01 | 0.00 | 0.00 | 0.01 | 0.03 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.36 |
| Cl2O−1 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 96.75 | 97.06 | 97.08 | 97.33 | 97.13 | 97.46 | 96.88 | 96.97 | 96.94 | 97.21 | 95.26 | 96.85 | 95.53 |
| Si | 2.96 | 2.96 | 2.95 | 2.95 | 2.95 | 2.94 | 2.96 | 2.96 | 2.97 | 2.97 | 3.02 | 2.99 | 3.04 |
| Ti | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 2.21 | 2.14 | 2.14 | 2.18 | 2.16 | 2.23 | 2.20 | 2.19 | 2.23 | 2.14 | 2.10 | 2.09 | 2.04 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 0.81 | 0.88 | 0.89 | 0.85 | 0.87 | 0.81 | 0.82 | 0.83 | 0.78 | 0.87 | 0.85 | 0.90 | 0.87 |
| Mn | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 |
| Mg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 |
| Ca | 2.03 | 2.04 | 2.01 | 2.03 | 2.01 | 2.02 | 2.02 | 2.02 | 2.03 | 2.00 | 1.94 | 2.01 | 1.96 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 12.10 | 12.07 | 12.04 | 12.08 | 12.05 | 12.08 | 12.08 | 12.08 | 12.12 | 12.04 | 12.02 | 12.05 | 12.06 |

| sample | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ep−27 | Ep−28 | Ep−29 | Ep−30 | Ep−31 | Ep−1 | Ep−2 | Ep−3 | Ep−4 | Ep−5 | Ep−6 | Ep−7 | Ep−8 |
| SiO2 | 33.84 | 35.22 | 35.44 | 35.78 | 36.07 | 38.48 | 38.49 | 38.53 | 38.65 | 38.69 | 38.71 | 38.80 | 38.98 |
| TiO2 | 0.04 | 0.04 | 0.03 | 0.04 | 0.02 | 0.07 | 0.16 | 0.02 | 0.14 | 0.17 | 0.05 | 0.05 | 0.08 |
| Al2O3 | 20.80 | 22.81 | 23.41 | 23.45 | 22.68 | 24.20 | 22.26 | 23.80 | 23.37 | 22.22 | 22.51 | 23.21 | 23.21 |
| Cr2O3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.00 | 0.04 | 0.03 | 0.01 | 0.04 | 0.07 |
| FeO | 14.74 | 13.67 | 13.00 | 13.55 | 14.86 | 11.31 | 12.27 | 11.78 | 12.39 | 11.96 | 12.08 | 12.37 | 11.91 |
| MnO | 0.26 | 0.22 | 0.24 | 0.26 | 0.23 | 0.25 | 0.25 | 0.19 | 0.31 | 0.29 | 0.46 | 0.53 | 0.39 |
| MgO | 0.06 | 0.01 | 0.01 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.03 | 0.04 | 0.00 | 0.00 | 0.00 |
| CaO | 21.72 | 23.34 | 23.35 | 23.59 | 23.74 | 22.44 | 22.45 | 22.97 | 22.29 | 21.48 | 22.20 | 22.20 | 22.62 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 |
| Na2O | 0.02 | 0.01 | 0.01 | 0.01 | 0.00 | 0.06 | 0.01 | 0.00 | 0.00 | 0.05 | 0.84 | 0.00 | 0.04 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.01 | 0.00 | 0.00 | 0.02 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 91.48 | 95.32 | 95.50 | 96.70 | 97.60 | 96.84 | 95.95 | 97.30 | 97.24 | 94.93 | 96.86 | 97.22 | 97.29 |
| Si | 2.86 | 2.86 | 2.87 | 2.86 | 2.87 | 3.01 | 3.07 | 3.02 | 3.01 | 3.08 | 3.07 | 3.02 | 3.05 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| Al | 2.07 | 2.19 | 2.23 | 2.21 | 2.13 | 2.23 | 2.09 | 2.20 | 2.15 | 2.09 | 2.10 | 2.13 | 2.14 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 1.04 | 0.93 | 0.88 | 0.91 | 0.99 | 0.74 | 0.82 | 0.77 | 0.81 | 0.80 | 0.80 | 0.81 | 0.78 |
| Mn | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.02 | 0.02 | 0.03 | 0.04 | 0.03 |
| Mg | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 1.97 | 2.03 | 2.02 | 2.02 | 2.02 | 1.88 | 1.92 | 1.93 | 1.86 | 1.83 | 1.88 | 1.85 | 1.89 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.13 | 0.00 | 0.01 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 11.86 | 11.99 | 12.01 | 11.99 | 11.96 | 12.01 | 12.03 | 12.04 | 11.96 | 11.97 | 12.07 | 11.94 | 12.02 |

| sample | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ep−9 | Ep−10 | Ep−11 | Ep−12 | Ep−13 | Ep−14 | Ep−15 | Ep−16 | Ep−17 | Ep−18 | Ep−19 | Ep−20 | Ep−21 |
| SiO2 | 39.05 | 39.05 | 39.07 | 39.09 | 39.17 | 39.25 | 39.28 | 39.28 | 39.31 | 39.36 | 39.41 | 39.45 | 39.53 |
| TiO2 | 0.01 | 0.13 | 0.09 | 0.00 | 0.12 | 0.05 | 0.01 | 0.09 | 0.06 | 0.04 | 0.05 | 0.04 | 0.03 |
| Al2O3 | 22.20 | 22.84 | 22.77 | 21.86 | 23.34 | 23.11 | 23.82 | 22.96 | 22.58 | 23.28 | 24.10 | 23.55 | 23.56 |
| Cr2O3 | 0.02 | 0.00 | 0.03 | 0.03 | 0.02 | 0.03 | 0.07 | 0.05 | 0.00 | 0.01 | 0.03 | 0.07 | 0.01 |
| FeO | 12.65 | 12.37 | 12.46 | 13.96 | 11.68 | 12.02 | 11.30 | 12.20 | 11.59 | 12.16 | 10.97 | 11.36 | 11.14 |
| MnO | 0.52 | 0.31 | 0.44 | 0.11 | 0.22 | 0.22 | 0.25 | 0.50 | 0.24 | 0.38 | 0.14 | 0.17 | 0.28 |
| MgO | 0.03 | 0.02 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.02 | 0.17 | 0.01 |
| CaO | 22.18 | 22.66 | 22.37 | 22.20 | 22.68 | 22.15 | 22.89 | 22.44 | 22.61 | 22.67 | 22.72 | 19.66 | 22.44 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.02 | 0.01 | 0.00 | 0.01 | 0.02 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 1.27 | 0.00 |
| Na2O | 0.00 | 0.06 | 0.00 | 0.89 | 0.20 | 0.05 | 0.10 | 0.00 | 0.02 | 0.02 | 0.00 | 0.61 | 0.58 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.02 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| Total | 96.67 | 97.46 | 97.22 | 98.15 | 97.46 | 96.90 | 97.75 | 97.52 | 96.43 | 97.91 | 97.44 | 96.34 | 97.60 |
| Si | 3.07 | 3.05 | 3.05 | 3.06 | 3.06 | 3.07 | 3.06 | 3.06 | 3.11 | 3.05 | 3.06 | 3.07 | 3.08 |
| Ti | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 2.06 | 2.11 | 2.10 | 2.02 | 2.15 | 2.13 | 2.18 | 2.11 | 2.10 | 2.13 | 2.21 | 2.16 | 2.17 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 0.83 | 0.81 | 0.81 | 0.91 | 0.76 | 0.79 | 0.74 | 0.79 | 0.77 | 0.79 | 0.71 | 0.74 | 0.73 |
| Mn | 0.03 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.02 | 0.03 | 0.02 | 0.02 | 0.01 | 0.01 | 0.02 |
| Mg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 |
| Ca | 1.87 | 1.90 | 1.87 | 1.86 | 1.90 | 1.85 | 1.91 | 1.87 | 1.92 | 1.89 | 1.89 | 1.64 | 1.88 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.13 | 0.00 |
| Na | 0.00 | 0.01 | 0.00 | 0.14 | 0.03 | 0.01 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | 0.09 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 11.97 | 12.02 | 11.98 | 12.00 | 12.06 | 11.99 | 12.07 | 11.99 | 12.08 | 12.01 | 12.06 | 11.90 | 12.09 |

| sample | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ep−22 | Ep−23 | Ep−24 | Ep−25 | Ep−26 | Ep−27 | Ep−1 | Ep−2 | Ep−3 | Ep−4 | Ep−5 | Ep−6 | Ep−7 |
| SiO2 | 39.55 | 39.84 | 36.11 | 37.05 | 37.07 | 37.33 | 37.22 | 37.30 | 37.32 | 37.33 | 37.37 | 37.38 | 37.38 |
| TiO2 | 0.03 | 0.05 | 0.07 | 0.07 | 0.05 | 0.10 | 0.05 | 0.31 | 0.03 | 0.06 | 0.05 | 0.07 | 0.12 |
| Al2O3 | 23.76 | 23.13 | 22.09 | 21.52 | 21.31 | 22.05 | 22.43 | 22.55 | 22.62 | 23.03 | 22.81 | 22.80 | 22.67 |
| Cr2O3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.01 | 0.01 | 0.03 | 0.01 | 0.02 | 0.02 |
| FeO | 11.72 | 12.47 | 13.60 | 14.32 | 14.36 | 13.23 | 12.46 | 12.53 | 11.88 | 12.08 | 12.16 | 11.84 | 11.90 |
| MnO | 0.24 | 0.18 | 0.12 | 0.48 | 0.26 | 0.31 | 0.23 | 0.14 | 0.33 | 0.37 | 0.22 | 0.28 | 0.31 |
| MgO | 0.00 | 0.00 | 0.03 | 0.02 | 0.03 | 0.00 | 0.02 | 0.01 | 0.02 | 0.02 | 0.00 | 0.02 | 0.00 |
| CaO | 22.78 | 22.19 | 23.41 | 23.16 | 22.70 | 23.06 | 23.05 | 23.29 | 22.30 | 22.77 | 22.78 | 22.87 | 22.79 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.02 |
| K2O | 0.02 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 |
| Na2O | 0.13 | 0.40 | 0.00 | 0.00 | 0.03 | 0.03 | 0.01 | 0.02 | 0.02 | 0.01 | 0.02 | 0.01 | 0.00 |
| Cl2O−1 | 0.00 | 0.00 | 0.02 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| F2O−1 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.13 | 0.00 | 0.02 | 0.01 |
| Total | 98.24 | 98.25 | 95.47 | 96.62 | 95.82 | 96.10 | 95.51 | 96.18 | 94.54 | 95.84 | 95.42 | 95.33 | 95.22 |
| Si | 3.06 | 3.08 | 2.94 | 2.97 | 2.99 | 3.00 | 3.00 | 2.99 | 3.02 | 2.99 | 3.00 | 3.01 | 3.01 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| Al | 2.17 | 2.10 | 2.12 | 2.03 | 2.02 | 2.09 | 2.13 | 2.13 | 2.15 | 2.17 | 2.16 | 2.16 | 2.15 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 0.76 | 0.80 | 0.93 | 0.96 | 0.97 | 0.89 | 0.84 | 0.84 | 0.80 | 0.81 | 0.82 | 0.80 | 0.80 |
| Mn | 0.02 | 0.01 | 0.01 | 0.03 | 0.02 | 0.02 | 0.02 | 0.01 | 0.02 | 0.03 | 0.02 | 0.02 | 0.02 |
| Mg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 1.89 | 1.84 | 2.04 | 1.99 | 1.96 | 1.98 | 1.99 | 2.00 | 1.93 | 1.95 | 1.96 | 1.97 | 1.97 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.02 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.06 | 0.00 | 0.01 | 0.00 |
| O | 12.04 | 12.00 | 12.04 | 11.98 | 11.96 | 12.03 | 12.07 | 12.08 | 12.03 | 12.00 | 12.05 | 12.07 | 12.07 |

| sample | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ep−8 | Ep−9 | Ep−10 | Ep−11 | Ep−12 | Ep−13 | Ep−14 | Ep−15 | Ep−16 | Ep−17 | Ep−18 | Ep−19 | Ep−20 |
| SiO2 | 37.42 | 37.44 | 37.44 | 37.48 | 37.49 | 37.50 | 37.53 | 37.54 | 37.56 | 37.61 | 37.62 | 37.62 | 37.71 |
| TiO2 | 0.14 | 0.03 | 0.04 | 0.09 | 0.01 | 0.15 | 0.01 | 0.01 | 0.02 | 0.01 | 0.03 | 0.03 | 0.02 |
| Al2O3 | 22.07 | 22.78 | 23.00 | 22.14 | 23.03 | 22.97 | 22.66 | 22.31 | 23.03 | 22.78 | 23.36 | 22.74 | 22.69 |
| Cr2O3 | 0.05 | 0.02 | 0.02 | 0.08 | 0.02 | 0.00 | 0.06 | 0.02 | 0.03 | 0.00 | 0.02 | 0.00 | 0.03 |
| FeO | 12.87 | 12.26 | 11.72 | 12.44 | 11.80 | 11.72 | 12.03 | 12.45 | 12.10 | 12.09 | 11.68 | 12.59 | 12.07 |
| MnO | 0.17 | 0.23 | 0.34 | 0.22 | 0.23 | 0.23 | 0.18 | 0.27 | 0.27 | 0.28 | 0.30 | 0.24 | 0.22 |
| MgO | 0.13 | 0.05 | 0.09 | 0.00 | 0.01 | 0.00 | 0.03 | 0.00 | 0.00 | 0.08 | 0.00 | 0.00 | 0.00 |
| CaO | 22.34 | 23.52 | 22.69 | 23.05 | 22.94 | 23.13 | 23.25 | 22.71 | 22.97 | 22.89 | 23.36 | 23.16 | 22.95 |
| BaO | 0.00 | 0.02 | 0.00 | 0.03 | 0.00 | 0.02 | 0.00 | 0.00 | 0.05 | 0.00 | 0.00 | 0.03 | 0.01 |
| K2O | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |
| Na2O | 0.01 | 0.00 | 0.02 | 0.02 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.03 | 0.02 | 0.01 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 | 0.01 | 0.02 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.01 | 0.05 | 0.02 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.03 | 0.01 | 0.04 | 0.00 | 0.00 |
| Total | 95.21 | 96.39 | 95.37 | 95.57 | 95.55 | 95.73 | 95.78 | 95.34 | 96.09 | 95.79 | 96.45 | 96.44 | 95.71 |
| Si | 3.01 | 3.00 | 3.00 | 3.03 | 3.01 | 3.01 | 3.02 | 3.02 | 3.00 | 3.01 | 3.00 | 3.00 | 3.03 |
| Ti | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 2.09 | 2.15 | 2.17 | 2.11 | 2.18 | 2.17 | 2.15 | 2.12 | 2.17 | 2.15 | 2.20 | 2.14 | 2.15 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 0.86 | 0.82 | 0.79 | 0.84 | 0.79 | 0.79 | 0.81 | 0.84 | 0.81 | 0.81 | 0.78 | 0.84 | 0.81 |
| Mn | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 |
| Mg | 0.02 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| Ca | 1.92 | 2.02 | 1.95 | 1.99 | 1.97 | 1.99 | 2.01 | 1.96 | 1.97 | 1.96 | 2.00 | 1.98 | 1.97 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.01 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 |
| O | 11.98 | 12.09 | 12.04 | 12.08 | 12.07 | 12.10 | 12.10 | 12.04 | 12.05 | 12.05 | 12.09 | 12.06 | 12.08 |

| sample | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0443 | cr0443 | cr0443 | cr0444 | cr0444 | cr04551 | cr04551 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ep−21 | Ep−22 | Ep−23 | Ep−24 | Ep−25 | Ep−26 | Ep−1 | Ep−2 | Ep−3 | Ep−1 | Ep−2 | Ep−1 | Ep−2 |
| SiO2 | 37.81 | 37.89 | 37.96 | 38.04 | 38.33 | 39.56 | 37.74 | 38.04 | 38.17 | 38.34 | 38.46 | 38.34 | 39.61 |
| TiO2 | 0.09 | 0.05 | 0.02 | 0.03 | 0.08 | 0.12 | 1.67 | 0.05 | 0.09 | 0.01 | 0.46 | 0.05 | 0.04 |
| Al2O3 | 23.28 | 23.46 | 22.89 | 21.88 | 22.77 | 19.94 | 21.93 | 22.40 | 22.89 | 21.85 | 20.86 | 20.10 | 20.91 |
| Cr2O3 | 0.03 | 0.03 | 0.01 | 0.03 | 0.01 | 0.02 | 0.10 | 0.10 | 0.22 | 0.02 | 0.02 | 0.00 | 0.06 |
| FeO | 11.99 | 11.32 | 12.28 | 12.18 | 12.76 | 12.99 | 11.36 | 12.19 | 12.12 | 13.76 | 13.97 | 16.21 | 15.28 |
| MnO | 0.47 | 0.37 | 0.29 | 0.26 | 0.20 | 0.47 | 0.06 | 0.09 | 0.10 | 0.30 | 0.11 | 0.13 | 0.33 |
| MgO | 0.00 | 0.08 | 0.01 | 0.40 | 0.03 | 0.12 | 0.00 | 0.05 | 0.05 | 0.00 | 0.13 | 0.00 | 0.00 |
| CaO | 22.99 | 22.81 | 23.12 | 21.78 | 23.11 | 20.36 | 23.44 | 22.38 | 21.37 | 21.75 | 22.67 | 22.51 | 22.27 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 | 0.02 | 0.00 | 0.00 |
| Na2O | 0.02 | 0.00 | 0.03 | 0.30 | 0.01 | 0.73 | 0.01 | 0.00 | 0.01 | 0.03 | 0.00 | 0.52 | 0.00 |
| Cl2O−1 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.02 | 0.03 | 0.00 | 0.00 |
| F2O−1 | 0.06 | 0.00 | 0.01 | 0.00 | 0.02 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 96.75 | 96.01 | 96.63 | 94.92 | 97.33 | 94.38 | 96.32 | 95.32 | 95.03 | 96.08 | 96.73 | 97.86 | 98.51 |
| Si | 2.99 | 3.01 | 3.02 | 3.05 | 3.02 | 3.18 | 3.04 | 3.05 | 3.03 | 3.03 | 3.06 | 3.04 | 3.07 |
| Ti | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.10 | 0.00 | 0.01 | 0.00 | 0.03 | 0.00 | 0.00 |
| Al | 2.17 | 2.20 | 2.14 | 2.07 | 2.12 | 1.89 | 2.08 | 2.11 | 2.14 | 2.04 | 1.96 | 1.88 | 1.91 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 0.79 | 0.75 | 0.82 | 0.82 | 0.84 | 0.87 | 0.77 | 0.82 | 0.80 | 0.91 | 0.93 | 1.07 | 0.99 |
| Mn | 0.03 | 0.02 | 0.02 | 0.02 | 0.01 | 0.03 | 0.00 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.02 |
| Mg | 0.00 | 0.01 | 0.00 | 0.05 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 |
| Ca | 1.95 | 1.94 | 1.97 | 1.87 | 1.95 | 1.75 | 2.02 | 1.92 | 1.82 | 1.84 | 1.93 | 1.91 | 1.85 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| F | 0.02 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 12.03 | 12.06 | 12.06 | 11.98 | 12.03 | 11.94 | 12.21 | 12.03 | 11.92 | 11.89 | 12.00 | 11.93 | 11.88 |

| sample | cr04551 | cr04551 | cr04551 | cr04551 | cr04551 | cr04551 | cr04551 | cr04551 | cr04551 | cr04551 | cr04551 | cr04551 | cr04551 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ep−3 | Ep−4 | Ep−5 | Ep−6 | Ep−7 | Ep−8 | Ep−9 | Ep−10 | Ep−11 | Ep−12 | Ep−13 | Ep−14 | Ep−15 |
| SiO2 | 39.24 | 38.05 | 39.46 | 39.45 | 38.92 | 38.44 | 38.18 | 39.80 | 39.32 | 39.44 | 38.32 | 38.12 | 39.49 |
| TiO2 | 0.04 | 0.02 | 0.03 | 0.04 | 0.08 | 0.07 | 0.04 | 0.04 | 0.04 | 0.01 | 0.05 | 0.01 | 0.05 |
| Al2O3 | 21.18 | 20.70 | 20.58 | 20.69 | 20.65 | 21.10 | 21.37 | 21.58 | 21.65 | 21.08 | 21.46 | 20.63 | 20.72 |
| Cr2O3 | 0.04 | 0.08 | 0.06 | 0.07 | 0.01 | 0.09 | 0.02 | 0.02 | 0.04 | 0.00 | 0.00 | 0.01 | 0.11 |
| FeO | 14.67 | 15.39 | 15.65 | 15.06 | 15.07 | 15.13 | 14.86 | 14.09 | 14.18 | 14.77 | 14.90 | 14.83 | 15.13 |
| MnO | 0.12 | 0.10 | 0.14 | 0.18 | 0.03 | 0.14 | 0.22 | 0.17 | 0.17 | 0.15 | 0.21 | 0.08 | 0.19 |
| MgO | 0.03 | 0.02 | 0.00 | 0.27 | 0.00 | 0.01 | 0.09 | 0.03 | 0.06 | 0.26 | 0.28 | 0.02 | 0.11 |
| CaO | 21.90 | 21.92 | 22.30 | 21.87 | 22.65 | 22.85 | 22.27 | 22.38 | 22.23 | 21.97 | 22.07 | 22.44 | 22.31 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na2O | 0.00 | 0.00 | 0.05 | 0.00 | 0.11 | 0.00 | 0.00 | 0.10 | 0.00 | 0.25 | 0.00 | 0.00 | 0.22 |
| Cl2O−1 | 0.02 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 97.25 | 96.30 | 98.28 | 97.64 | 97.53 | 97.84 | 97.07 | 98.23 | 97.71 | 97.92 | 97.29 | 96.14 | 98.32 |
| Si | 3.07 | 3.02 | 3.07 | 3.07 | 3.07 | 3.03 | 3.01 | 3.09 | 3.06 | 3.07 | 3.00 | 3.05 | 3.08 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 1.95 | 1.94 | 1.89 | 1.90 | 1.92 | 1.96 | 1.98 | 1.98 | 1.99 | 1.93 | 1.98 | 1.95 | 1.90 |
| Cr | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| FeIII | 0.96 | 1.02 | 1.02 | 0.98 | 1.00 | 1.00 | 0.98 | 0.91 | 0.92 | 0.96 | 0.97 | 0.99 | 0.99 |
| Mn | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Mg | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.03 | 0.03 | 0.00 | 0.01 |
| Ca | 1.84 | 1.87 | 1.86 | 1.82 | 1.92 | 1.93 | 1.88 | 1.86 | 1.86 | 1.83 | 1.85 | 1.93 | 1.86 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 | 0.01 | 0.00 | 0.04 | 0.00 | 0.00 | 0.03 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 11.89 | 11.86 | 11.89 | 11.85 | 11.97 | 11.94 | 11.88 | 11.95 | 11.92 | 11.88 | 11.84 | 11.95 | 11.91 |

| sample | cr04551 | cr04551 | cr04551 | cr04551 | cr04551 | cr04551 | cr04551 | cr04551 | cr04551 | cr04551 | cr04551 | cr04552 | cr04552 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ep−16 | Ep−17 | Ep−18 | Ep−19 | Ep−20 | Ep−21 | Ep−22 | Ep−23 | Ep−24 | Ep−25 | Ep−26 | Ep−1 | Ep−2 |
| SiO2 | 38.46 | 38.59 | 40.97 | 38.80 | 38.40 | 38.93 | 38.17 | 38.97 | 39.40 | 38.82 | 38.26 | 37.65 | 37.99 |
| TiO2 | 0.02 | 0.12 | 0.01 | 0.08 | 0.06 | 0.03 | 0.05 | 0.03 | 0.05 | 0.05 | 0.06 | 0.05 | 0.03 |
| Al2O3 | 21.11 | 20.20 | 21.04 | 20.86 | 21.84 | 20.51 | 21.00 | 20.44 | 20.60 | 21.72 | 21.47 | 21.07 | 20.68 |
| Cr2O3 | 0.02 | 0.02 | 0.03 | 0.14 | 0.04 | 0.04 | 0.09 | 0.03 | 0.09 | 0.10 | 0.05 | 0.13 | 0.05 |
| FeO | 14.53 | 15.66 | 14.33 | 14.99 | 14.08 | 15.15 | 15.27 | 15.22 | 15.08 | 14.49 | 14.95 | 15.25 | 15.28 |
| MnO | 0.06 | 0.05 | 0.10 | 0.14 | 0.21 | 0.25 | 0.28 | 0.17 | 0.28 | 0.21 | 0.11 | 0.28 | 0.11 |
| MgO | 0.00 | 0.11 | 0.03 | 0.00 | 0.00 | 0.03 | 0.00 | 0.14 | 0.05 | 0.03 | 0.00 | 0.25 | 0.03 |
| CaO | 22.88 | 22.35 | 22.54 | 22.51 | 22.71 | 21.72 | 22.39 | 22.03 | 21.69 | 22.39 | 22.31 | 22.17 | 22.51 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.02 | 0.00 | 0.01 | 0.00 | 0.00 | 0.02 | 0.02 | 0.00 |
| Na2O | 0.00 | 0.00 | 0.37 | 0.02 | 0.30 | 0.02 | 0.00 | 0.29 | 0.21 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl2O−1 | 0.02 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.02 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 97.10 | 97.12 | 99.43 | 97.54 | 97.68 | 96.71 | 97.26 | 97.33 | 97.44 | 97.82 | 97.23 | 96.88 | 96.69 |
| Si | 3.05 | 3.05 | 3.15 | 3.05 | 3.02 | 3.07 | 3.01 | 3.07 | 3.08 | 3.03 | 3.01 | 2.97 | 3.03 |
| Ti | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 1.98 | 1.88 | 1.91 | 1.94 | 2.03 | 1.91 | 1.95 | 1.90 | 1.90 | 2.00 | 1.99 | 1.96 | 1.94 |
| Cr | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 |
| FeIII | 0.96 | 1.04 | 0.92 | 0.99 | 0.93 | 1.00 | 1.01 | 1.00 | 0.99 | 0.95 | 0.98 | 1.01 | 1.02 |
| Mn | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.01 | 0.02 | 0.01 | 0.01 | 0.02 | 0.01 |
| Mg | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.01 | 0.00 | 0.00 | 0.03 | 0.00 |
| Ca | 1.95 | 1.89 | 1.86 | 1.90 | 1.92 | 1.84 | 1.89 | 1.86 | 1.82 | 1.87 | 1.88 | 1.88 | 1.92 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.06 | 0.00 | 0.05 | 0.00 | 0.00 | 0.04 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 11.99 | 11.90 | 12.00 | 11.93 | 11.98 | 11.86 | 11.89 | 11.90 | 11.87 | 11.91 | 11.89 | 11.84 | 11.92 |

| sample | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ep−3 | Ep−4 | Ep−5 | Ep−6 | Ep−7 | Ep−8 | Ep−9 | Ep−10 | Ep−11 | Ep−12 | Ep−13 | Ep−14 | Ep−15 |
| SiO2 | 38.34 | 38.35 | 38.50 | 38.60 | 38.79 | 38.81 | 39.34 | 39.34 | 40.39 | 40.50 | 40.58 | 40.91 | 36.27 |
| TiO2 | 0.06 | 0.01 | 0.09 | 0.02 | 0.05 | 0.04 | 0.05 | 0.09 | 0.06 | 0.01 | 0.11 | 0.06 | 0.09 |
| Al2O3 | 20.86 | 21.28 | 19.74 | 20.77 | 20.57 | 20.86 | 20.70 | 20.83 | 21.08 | 22.06 | 20.39 | 21.15 | 19.23 |
| Cr2O3 | 0.05 | 0.02 | 0.00 | 0.03 | 0.06 | 0.05 | 0.02 | 0.10 | 0.10 | 0.00 | 0.00 | 0.05 | 0.06 |
| FeO | 15.68 | 14.88 | 15.74 | 15.94 | 14.91 | 15.40 | 14.88 | 15.07 | 15.00 | 14.28 | 15.94 | 13.30 | 18.24 |
| MnO | 0.03 | 0.26 | 0.07 | 0.17 | 0.13 | 0.15 | 0.12 | 0.23 | 0.11 | 0.14 | 0.10 | 0.42 | 0.11 |
| MgO | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.03 | 0.00 | 0.01 | 0.00 | 0.11 | 0.37 | 0.01 |
| CaO | 22.31 | 22.22 | 22.29 | 22.58 | 22.13 | 23.01 | 22.24 | 22.60 | 22.67 | 22.75 | 22.74 | 22.05 | 23.39 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.02 | 0.00 | 0.01 | 0.02 | 0.01 |
| Na2O | 0.00 | 0.00 | 0.14 | 0.00 | 0.11 | 0.00 | 0.04 | 0.00 | 0.00 | 0.00 | 0.02 | 0.08 | 0.02 |
| Cl2O−1 | 0.00 | 0.02 | 0.08 | 0.01 | 0.00 | 0.00 | 0.00 | 0.02 | 0.01 | 0.00 | 0.00 | 0.02 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 |
| Total | 97.32 | 97.06 | 96.70 | 98.12 | 96.77 | 98.32 | 97.42 | 98.27 | 99.44 | 99.74 | 99.99 | 98.45 | 97.42 |
| Si | 3.02 | 3.02 | 3.08 | 3.02 | 3.07 | 3.04 | 3.09 | 3.07 | 3.11 | 3.09 | 3.11 | 3.15 | 2.92 |
| Ti | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 |
| Al | 1.94 | 1.98 | 1.86 | 1.92 | 1.92 | 1.93 | 1.92 | 1.92 | 1.91 | 1.99 | 1.84 | 1.92 | 1.83 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 1.03 | 0.98 | 1.05 | 1.04 | 0.99 | 1.01 | 0.98 | 0.98 | 0.96 | 0.91 | 1.02 | 0.86 | 1.23 |
| Mn | 0.00 | 0.02 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.03 | 0.01 |
| Mg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.04 | 0.00 |
| Ca | 1.88 | 1.88 | 1.91 | 1.90 | 1.88 | 1.93 | 1.87 | 1.89 | 1.87 | 1.86 | 1.87 | 1.82 | 2.02 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| Cl | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| O | 11.88 | 11.89 | 11.91 | 11.88 | 11.93 | 11.95 | 11.93 | 11.93 | 11.94 | 11.95 | 11.91 | 11.93 | 11.87 |

| sample | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ep−16 | Ep−17 | Ep−18 | Ep−19 | Ep−20 | Ep−21 | Ep−22 | Ep−23 | Ep−24 | Ep−25 | Ep−26 | Ep−27 | Ep−28 |
| SiO2 | 36.42 | 36.52 | 36.61 | 36.66 | 36.75 | 36.78 | 36.86 | 36.89 | 36.90 | 36.97 | 36.98 | 37.02 | 37.02 |
| TiO2 | 0.06 | 0.02 | 0.10 | 0.00 | 0.03 | 0.03 | 0.05 | 0.00 | 0.03 | 0.02 | 0.06 | 0.05 | 0.02 |
| Al2O3 | 21.08 | 20.82 | 20.51 | 20.40 | 18.76 | 20.15 | 20.79 | 21.35 | 20.08 | 20.63 | 21.05 | 20.84 | 21.31 |
| Cr2O3 | 0.08 | 0.05 | 0.00 | 0.14 | 0.05 | 0.05 | 0.00 | 0.06 | 0.00 | 0.13 | 0.03 | 0.05 | 0.04 |
| FeO | 16.47 | 17.59 | 16.69 | 17.02 | 18.82 | 17.69 | 16.73 | 15.71 | 17.83 | 17.28 | 16.85 | 16.49 | 15.65 |
| MnO | 0.14 | 0.16 | 0.12 | 0.18 | 0.07 | 0.15 | 0.11 | 0.14 | 0.26 | 0.15 | 0.20 | 0.32 | 0.19 |
| MgO | 0.18 | 0.03 | 0.44 | 0.02 | 0.03 | 0.00 | 0.04 | 0.04 | 0.01 | 0.00 | 0.02 | 0.00 | 0.16 |
| CaO | 23.11 | 23.19 | 22.67 | 23.14 | 23.06 | 23.03 | 23.22 | 23.65 | 22.23 | 22.96 | 23.07 | 23.57 | 23.38 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.03 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.02 | 0.02 | 0.01 |
| Na2O | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.03 | 0.02 | 0.00 | 0.00 | 0.02 | 0.02 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 97.58 | 98.39 | 97.14 | 97.57 | 97.57 | 97.88 | 97.86 | 97.88 | 97.35 | 98.14 | 98.28 | 98.38 | 97.79 |
| Si | 2.89 | 2.88 | 2.91 | 2.92 | 2.95 | 2.92 | 2.93 | 2.94 | 2.92 | 2.92 | 2.91 | 2.93 | 2.94 |
| Ti | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 1.97 | 1.94 | 1.92 | 1.92 | 1.77 | 1.89 | 1.95 | 2.00 | 1.88 | 1.92 | 1.96 | 1.95 | 1.99 |
| Cr | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| FeIII | 1.09 | 1.16 | 1.11 | 1.14 | 1.26 | 1.18 | 1.11 | 1.05 | 1.18 | 1.14 | 1.11 | 1.09 | 1.04 |
| Mn | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.02 | 0.01 |
| Mg | 0.02 | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 |
| Ca | 1.97 | 1.96 | 1.93 | 1.98 | 1.98 | 1.96 | 1.98 | 2.02 | 1.89 | 1.94 | 1.95 | 2.00 | 1.99 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 11.86 | 11.82 | 11.80 | 11.87 | 11.82 | 11.83 | 11.88 | 11.96 | 11.75 | 11.83 | 11.84 | 11.91 | 11.92 |

| sample | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr0459a | cr0459a | cr0459a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ep−29 | Ep−30 | Ep−31 | Ep−32 | Ep−33 | Ep−34 | Ep−35 | Ep−36 | Ep−37 | Ep−38 | Ep−1 | Ep−2 | Ep−3 |
| SiO2 | 37.09 | 37.10 | 37.10 | 37.11 | 37.12 | 37.13 | 37.15 | 37.19 | 37.34 | 37.37 | 39.13 | 39.22 | 39.22 |
| TiO2 | 0.00 | 0.02 | 0.06 | 0.00 | 0.01 | 0.02 | 0.06 | 0.02 | 0.00 | 0.01 | 0.04 | 0.04 | 0.02 |
| Al2O3 | 20.62 | 20.84 | 20.62 | 21.07 | 20.80 | 20.86 | 21.51 | 20.67 | 20.09 | 21.29 | 23.22 | 23.38 | 23.12 |
| Cr2O3 | 0.03 | 0.07 | 0.02 | 0.02 | 0.09 | 0.04 | 0.03 | 0.06 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 |
| FeO | 16.87 | 16.12 | 16.80 | 16.27 | 16.71 | 17.23 | 15.80 | 17.21 | 16.54 | 15.96 | 11.37 | 10.02 | 10.36 |
| MnO | 0.17 | 0.12 | 0.17 | 0.12 | 0.44 | 0.14 | 0.15 | 0.23 | 0.08 | 0.19 | 0.00 | 0.00 | 0.00 |
| MgO | 0.00 | 0.14 | 0.02 | 0.00 | 0.00 | 0.02 | 0.28 | 0.02 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |
| CaO | 23.82 | 23.18 | 23.82 | 23.81 | 22.75 | 23.28 | 23.16 | 23.76 | 23.78 | 23.40 | 24.02 | 24.34 | 24.06 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.00 | 0.00 | 0.02 | 0.02 | 0.00 | 0.01 | 0.00 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 |
| Na2O | 0.01 | 0.01 | 0.01 | 0.02 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 98.61 | 97.61 | 98.62 | 98.44 | 97.98 | 98.72 | 98.13 | 99.16 | 97.84 | 98.32 | 97.78 | 96.99 | 96.77 |
| Si | 2.94 | 2.95 | 2.94 | 2.94 | 2.93 | 2.92 | 2.92 | 2.93 | 2.99 | 2.95 | 3.09 | 3.13 | 3.13 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 1.93 | 1.95 | 1.93 | 1.97 | 1.93 | 1.93 | 1.99 | 1.92 | 1.90 | 1.98 | 2.16 | 2.20 | 2.18 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 1.12 | 1.07 | 1.11 | 1.08 | 1.10 | 1.13 | 1.04 | 1.13 | 1.11 | 1.05 | 0.75 | 0.67 | 0.69 |
| Mn | 0.01 | 0.01 | 0.01 | 0.01 | 0.03 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| Mg | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 2.02 | 1.97 | 2.02 | 2.02 | 1.92 | 1.96 | 1.95 | 2.00 | 2.04 | 1.98 | 2.03 | 2.08 | 2.06 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 11.93 | 11.90 | 11.93 | 11.95 | 11.82 | 11.85 | 11.87 | 11.89 | 11.98 | 11.92 | 12.20 | 12.31 | 12.28 |

| sample | cr0459a | cr0462 | cr0462 | cr0462 | cr0462 | cr0462 | cr0462 | cr0462 | cr0462 | cr0462 | cr0462 | cr0462 | cr0462 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ep−4 | Ep−1 | Ep−2 | Ep−3 | Ep−4 | Ep−5 | Ep−6 | Ep−7 | Ep−8 | Ep−9 | Ep−10 | Ep−11 | Ep−12 |
| SiO2 | 39.23 | 38.82 | 39.03 | 39.03 | 39.05 | 39.08 | 39.09 | 39.13 | 39.17 | 39.19 | 39.21 | 39.21 | 39.22 |
| TiO2 | 0.05 | 0.05 | 0.10 | 0.15 | 0.07 | 0.62 | 0.04 | 0.06 | 0.00 | 0.08 | 0.37 | 0.08 | 0.08 |
| Al2O3 | 22.75 | 22.59 | 22.79 | 22.01 | 22.79 | 21.25 | 22.92 | 22.49 | 22.85 | 23.08 | 22.78 | 23.24 | 23.32 |
| Cr2O3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeO | 10.88 | 11.99 | 11.60 | 12.92 | 12.52 | 12.54 | 11.90 | 11.37 | 12.06 | 10.99 | 11.54 | 11.01 | 10.74 |
| MnO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| MgO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CaO | 23.39 | 23.88 | 23.88 | 24.08 | 23.24 | 24.32 | 24.39 | 23.80 | 23.87 | 23.90 | 24.13 | 23.68 | 24.23 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na2O | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 96.29 | 97.33 | 97.40 | 98.19 | 97.67 | 97.81 | 98.34 | 96.84 | 97.95 | 97.24 | 98.04 | 97.22 | 97.59 |
| Si | 3.13 | 3.08 | 3.09 | 3.09 | 3.07 | 3.12 | 3.08 | 3.12 | 3.09 | 3.11 | 3.10 | 3.10 | 3.11 |
| Ti | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 |
| Al | 2.14 | 2.12 | 2.13 | 2.05 | 2.11 | 2.00 | 2.13 | 2.12 | 2.12 | 2.16 | 2.12 | 2.17 | 2.18 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 0.73 | 0.80 | 0.77 | 0.85 | 0.82 | 0.84 | 0.78 | 0.76 | 0.79 | 0.73 | 0.76 | 0.73 | 0.71 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 2.00 | 2.03 | 2.03 | 2.04 | 1.95 | 2.08 | 2.06 | 2.03 | 2.01 | 2.03 | 2.04 | 2.01 | 2.06 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 12.20 | 12.18 | 12.19 | 12.16 | 12.08 | 12.24 | 12.21 | 12.22 | 12.16 | 12.22 | 12.22 | 12.20 | 12.26 |

| sample | cr0462 | cr0462 | cr0462 | cr0462 | cr0462 | cr0462 | cr0462 | cr0462 | cr0462 | cr0481a | cr0481a | cr0481a | cr0481a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ep−13 | Ep−14 | Ep−15 | Ep−16 | Ep−17 | Ep−18 | Ep−19 | Ep−20 | Ep−21 | Ep−1 | Ep−2 | Ep−3 | Ep−4 |
| SiO2 | 39.28 | 39.28 | 39.33 | 39.33 | 39.46 | 39.74 | 38.69 | 38.79 | 39.79 | 37.77 | 37.72 | 37.73 | 38.15 |
| TiO2 | 0.10 | 0.07 | 0.20 | 0.04 | 0.03 | 0.07 | 0.06 | 0.08 | 0.05 | 0.10 | 0.01 | 0.02 | 0.09 |
| Al2O3 | 23.87 | 23.62 | 22.85 | 23.33 | 23.67 | 22.26 | 23.53 | 24.12 | 24.61 | 21.96 | 22.36 | 19.03 | 22.06 |
| Cr2O3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.00 | 0.01 | 0.03 |
| FeO | 10.60 | 11.28 | 11.62 | 10.64 | 10.52 | 12.16 | 10.27 | 2.35 | 9.57 | 13.36 | 12.48 | 15.78 | 13.08 |
| MnO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.23 | 1.16 | 0.08 | 0.23 |
| MgO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 | 0.11 | 0.05 |
| CaO | 24.18 | 23.58 | 24.04 | 23.96 | 24.06 | 23.90 | 23.45 | 22.20 | 24.26 | 22.94 | 21.88 | 22.73 | 23.12 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| Na2O | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.01 | 0.19 | 0.03 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 98.03 | 97.83 | 98.05 | 97.31 | 97.74 | 98.13 | 95.99 | 87.76 | 98.28 | 96.56 | 95.65 | 95.67 | 96.85 |
| Si | 3.09 | 3.08 | 3.10 | 3.11 | 3.11 | 3.13 | 3.09 | 3.36 | 3.11 | 3.01 | 3.00 | 3.08 | 3.03 |
| Ti | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 |
| Al | 2.21 | 2.18 | 2.12 | 2.18 | 2.20 | 2.07 | 2.22 | 2.46 | 2.27 | 2.06 | 2.09 | 1.83 | 2.07 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 0.70 | 0.74 | 0.77 | 0.70 | 0.69 | 0.80 | 0.69 | 0.17 | 0.62 | 0.89 | 0.83 | 1.08 | 0.87 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.08 | 0.01 | 0.02 |
| Mg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 |
| Ca | 2.04 | 1.98 | 2.03 | 2.03 | 2.03 | 2.02 | 2.01 | 2.06 | 2.03 | 1.96 | 1.86 | 1.99 | 1.97 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.03 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 12.23 | 12.15 | 12.20 | 12.24 | 12.24 | 12.18 | 12.21 | 12.61 | 12.27 | 12.01 | 11.91 | 11.99 | 12.05 |

| sample | cr0481a | cr0481a | cr0481a | cr0481a | cr0481a | cr0481a | cr0481a | cr0481a | cr0481a | cr0481a | cr0481a | cr0481b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ep−5 | Ep−6 | Ep−7 | Ep−8 | Ep−9 | Ep−10 | Ep−11 | Ep−12 | Ep−13 | Ep−14 | Ep−15 | Ep−1 |
| SiO2 | 37.87 | 37.34 | 36.97 | 37.52 | 38.92 | 36.88 | 38.29 | 38.41 | 38.24 | 37.61 | 37.32 | 36.99 |
| TiO2 | 0.08 | 0.02 | 0.05 | 0.04 | 0.05 | 0.01 | 0.01 | 0.08 | 0.04 | 0.32 | 4.06 | 0.07 |
| Al2O3 | 21.96 | 19.03 | 20.22 | 22.16 | 20.74 | 21.06 | 24.17 | 24.64 | 23.65 | 22.33 | 20.00 | 22.09 |
| Cr2O3 | 0.01 | 0.00 | 0.01 | 0.04 | 0.00 | 0.09 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.08 |
| FeO | 13.42 | 16.03 | 14.34 | 12.13 | 13.52 | 13.67 | 10.76 | 10.59 | 11.33 | 12.47 | 12.08 | 13.63 |
| MnO | 0.16 | 0.24 | 0.36 | 0.15 | 0.23 | 0.24 | 0.20 | 0.18 | 0.31 | 0.23 | 0.15 | 0.32 |
| MgO | 0.00 | 0.00 | 0.00 | 0.01 | 0.03 | 0.06 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| CaO | 23.22 | 21.75 | 22.89 | 23.27 | 21.69 | 22.99 | 23.54 | 23.46 | 23.24 | 22.73 | 23.58 | 22.53 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.00 | 0.01 | 0.00 | 0.03 | 0.02 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 |
| Na2O | 0.29 | 0.00 | 0.41 | 0.00 | 0.08 | 0.10 | 0.63 | 0.03 | 0.04 | 1.12 | 0.00 | 0.00 |
| Cl2O−1 | 0.00 | 0.02 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 |
| Total | 97.02 | 94.43 | 95.27 | 95.31 | 95.31 | 95.13 | 97.61 | 97.39 | 96.85 | 96.83 | 97.23 | 95.71 |
| Si | 3.02 | 3.05 | 3.03 | 3.04 | 3.12 | 3.01 | 3.02 | 3.01 | 3.02 | 3.02 | 3.02 | 2.97 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.25 | 0.00 |
| Al | 2.07 | 1.83 | 1.95 | 2.12 | 1.96 | 2.03 | 2.25 | 2.28 | 2.20 | 2.11 | 1.91 | 2.09 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 0.90 | 1.10 | 0.98 | 0.82 | 0.90 | 0.93 | 0.71 | 0.69 | 0.75 | 0.84 | 0.82 | 0.91 |
| Mn | 0.01 | 0.02 | 0.03 | 0.01 | 0.02 | 0.02 | 0.01 | 0.01 | 0.02 | 0.02 | 0.01 | 0.02 |
| Mg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 1.99 | 1.91 | 2.01 | 2.02 | 1.86 | 2.01 | 1.99 | 1.97 | 1.97 | 1.95 | 2.04 | 1.94 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.04 | 0.00 | 0.07 | 0.00 | 0.01 | 0.02 | 0.10 | 0.00 | 0.01 | 0.17 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| O | 12.07 | 11.87 | 12.06 | 12.13 | 11.96 | 12.05 | 12.19 | 12.13 | 12.10 | 12.13 | 12.26 | 11.95 |

| sample | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0318d | cr0422b | cr0422b | cr0422b | cr0422b | cr0428b | cr0428b | cr0429 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Sph−1 | Sph−2 | Sph−3 | Sph−4 | Sph−5 | Sph−1 | Sph−1 | Sph−2 | Sph−3 | Sph−4 | Sph−1 | Sph−2 | Sph−1 |
| SiO2 | 30.21 | 30.04 | 30.13 | 30.16 | 30.41 | 30.58 | 33.96 | 32.13 | 31.73 | 32.45 | 30.31 | 30.62 | 29.53 |
| TiO2 | 36.18 | 37.29 | 36.83 | 36.70 | 36.94 | 36.70 | 33.35 | 37.56 | 35.64 | 35.60 | 38.37 | 36.28 | 38.06 |
| Al2O3 | 1.85 | 1.41 | 1.47 | 1.46 | 1.53 | 1.46 | 3.23 | 1.72 | 2.56 | 2.55 | 0.84 | 1.48 | 1.42 |
| Cr2O3 | 0.05 | 0.02 | 0.00 | 0.03 | 0.08 | 0.00 | 0.00 | 0.03 | 0.02 | 0.00 | 0.00 | 0.00 | 0.02 |
| FeO | 1.02 | 0.45 | 0.50 | 0.65 | 0.51 | 0.74 | 1.40 | 0.94 | 1.32 | 1.03 | 0.21 | 0.92 | 0.89 |
| MnO | 0.06 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 | 0.03 | 0.04 | 0.01 | 0.02 |
| MgO | 0.03 | 0.04 | 0.03 | 0.05 | 0.04 | 0.01 | 0.54 | 0.03 | 0.09 | 0.01 | 0.05 | 0.62 | 0.01 |
| CaO | 28.06 | 28.78 | 28.90 | 29.08 | 29.01 | 27.95 | 26.35 | 28.34 | 28.48 | 28.24 | 28.16 | 27.64 | 28.42 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.00 | 0.01 | 0.02 | 0.00 | 0.03 | 0.18 | 0.01 | 0.04 | 0.01 | 0.01 | 0.01 | 0.00 |
| Na2O | 0.02 | 0.02 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.15 | 0.00 | 0.00 | 0.03 |
| Cl2O−1 | 0.00 | 0.01 | 0.02 | 0.00 | 0.00 | 0.00 | 0.09 | 0.01 | 0.02 | 0.00 | 0.02 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.27 | 0.00 | 0.29 | 0.11 | 0.00 | 0.36 | 0.12 | 0.28 | 0.44 | 0.07 | 0.10 | 0.00 |
| Total | 97.48 | 98.35 | 97.89 | 98.46 | 98.65 | 97.47 | 99.49 | 100.90 | 100.19 | 100.50 | 98.07 | 97.69 | 98.40 |
| Si | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.01 | 1.05 | 1.02 | 1.01 | 1.03 | 1.00 | 1.00 | 0.97 |
| Ti | 0.90 | 0.93 | 0.92 | 0.92 | 0.92 | 0.91 | 0.77 | 0.89 | 0.85 | 0.85 | 0.96 | 0.89 | 0.94 |
| Al | 0.07 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.12 | 0.06 | 0.10 | 0.10 | 0.03 | 0.06 | 0.06 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 0.03 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.04 | 0.02 | 0.04 | 0.03 | 0.01 | 0.03 | 0.02 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 |
| Ca | 0.99 | 1.02 | 1.03 | 1.04 | 1.03 | 0.99 | 0.87 | 0.96 | 0.97 | 0.96 | 1.00 | 0.97 | 1.00 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.05 | 0.00 | 0.05 | 0.02 | 0.00 | 0.06 | 0.02 | 0.05 | 0.08 | 0.01 | 0.02 | 0.00 |
| O | 4.92 | 4.96 | 4.99 | 4.96 | 4.97 | 4.94 | 4.72 | 4.89 | 4.86 | 4.85 | 4.97 | 4.87 | 4.95 |

| sample | cr0429 | cr0429 | cr0430a | cr0430a | cr0433 | cr0433 | cr0433 | cr0433 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Sph−2 | Sph−3 | Sph−1 | Sph−2 | Sph−1 | Sph−2 | Sph−3 | Sph−4 | Sph−1 | Sph−2 | Sph−3 | Sph−4 | Sph−5 |
| SiO2 | 30.04 | 30.22 | 30.77 | 30.86 | 31.10 | 31.22 | 31.30 | 31.34 | 30.50 | 30.80 | 30.81 | 30.91 | 31.05 |
| TiO2 | 32.85 | 35.69 | 37.23 | 37.05 | 36.44 | 35.56 | 36.49 | 36.00 | 39.40 | 36.82 | 38.42 | 38.61 | 36.42 |
| Al2O3 | 3.90 | 1.72 | 2.86 | 2.96 | 1.41 | 1.59 | 1.49 | 1.69 | 1.01 | 2.34 | 1.44 | 1.20 | 2.63 |
| Cr2O3 | 0.02 | 0.00 | 0.00 | 0.02 | 0.16 | 0.12 | 0.01 | 0.04 | 0.02 | 0.02 | 0.01 | 0.03 | 0.00 |
| FeO | 2.67 | 1.26 | 0.56 | 0.47 | 0.98 | 1.42 | 0.89 | 0.98 | 0.24 | 0.83 | 0.36 | 0.55 | 0.70 |
| MnO | 0.04 | 0.04 | 0.00 | 0.04 | 0.07 | 0.05 | 0.01 | 0.05 | 0.04 | 0.02 | 0.00 | 0.02 | 0.03 |
| MgO | 0.05 | 0.26 | 0.01 | 0.03 | 0.03 | 0.30 | 0.03 | 0.02 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 |
| CaO | 28.31 | 28.27 | 28.61 | 28.87 | 28.85 | 28.12 | 28.89 | 29.10 | 28.66 | 29.18 | 29.09 | 28.76 | 29.21 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.02 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na2O | 0.05 | 0.17 | 0.03 | 0.01 | 0.05 | 0.18 | 0.00 | 0.00 | 0.04 | 0.01 | 0.03 | 0.02 | 0.01 |
| Cl2O−1 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.25 | 0.18 | 0.32 | 0.03 | 0.11 | 0.02 | 0.06 | 0.11 |
| Total | 97.96 | 97.66 | 100.10 | 100.30 | 99.34 | 98.82 | 99.30 | 99.55 | 99.96 | 100.14 | 100.18 | 100.17 | 100.16 |
| Si | 0.97 | 1.00 | 0.98 | 0.98 | 1.02 | 1.01 | 1.02 | 1.02 | 0.99 | 0.99 | 1.00 | 1.00 | 1.00 |
| Ti | 0.80 | 0.89 | 0.89 | 0.89 | 0.90 | 0.87 | 0.90 | 0.88 | 0.96 | 0.89 | 0.94 | 0.94 | 0.88 |
| Al | 0.15 | 0.07 | 0.11 | 0.11 | 0.05 | 0.06 | 0.06 | 0.06 | 0.04 | 0.09 | 0.06 | 0.05 | 0.10 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 0.07 | 0.03 | 0.02 | 0.01 | 0.03 | 0.04 | 0.02 | 0.03 | 0.01 | 0.02 | 0.01 | 0.01 | 0.02 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 0.98 | 1.00 | 0.98 | 0.99 | 1.01 | 0.98 | 1.01 | 1.02 | 1.00 | 1.01 | 1.01 | 1.00 | 1.01 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.05 | 0.03 | 0.06 | 0.01 | 0.02 | 0.00 | 0.01 | 0.02 |
| O | 4.83 | 4.92 | 4.91 | 4.92 | 4.93 | 4.87 | 4.94 | 4.93 | 4.97 | 4.93 | 4.97 | 4.95 | 4.93 |

| sample | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Sph−6 | Sph−7 | Sph−8 | Sph−9 | Sph−10 | Sph−11 | Sph−12 | Sph−13 | Sph−14 | Sph−15 | Sph−16 | Sph−17 | Sph−18 |
| SiO2 | 31.60 | 30.57 | 30.71 | 30.71 | 30.72 | 30.74 | 30.78 | 30.79 | 30.85 | 30.85 | 30.85 | 30.91 | 31.02 |
| TiO2 | 36.48 | 37.95 | 38.24 | 37.61 | 38.29 | 38.23 | 37.53 | 38.83 | 37.88 | 38.07 | 38.16 | 38.21 | 37.70 |
| Al2O3 | 2.17 | 1.04 | 1.15 | 1.33 | 1.42 | 1.14 | 1.84 | 1.01 | 1.29 | 1.34 | 1.24 | 1.37 | 1.74 |
| Cr2O3 | 0.00 | 0.05 | 0.03 | 0.01 | 0.07 | 0.00 | 0.02 | 0.08 | 0.06 | 0.10 | 0.00 | 0.00 | 0.02 |
| FeO | 0.58 | 0.44 | 0.69 | 0.47 | 0.33 | 0.54 | 0.44 | 0.37 | 0.41 | 0.42 | 0.47 | 0.63 | 0.84 |
| MnO | 0.00 | 0.02 | 0.03 | 0.03 | 0.01 | 0.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.02 | 0.00 | 0.03 |
| MgO | 0.18 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.01 | 0.01 | 0.01 |
| CaO | 28.98 | 28.88 | 28.88 | 28.65 | 28.95 | 28.80 | 28.91 | 28.97 | 28.79 | 28.94 | 28.99 | 28.87 | 28.90 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 |
| Na2O | 0.04 | 0.01 | 0.01 | 0.03 | 0.00 | 0.01 | 0.01 | 0.01 | 0.03 | 0.02 | 0.02 | 0.02 | 0.03 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.11 | 0.06 | 0.12 | 0.07 | 0.07 | 0.03 | 0.09 | 0.09 | 0.04 | 0.08 | 0.06 | 0.05 | 0.06 |
| Total | 100.15 | 99.04 | 99.87 | 98.93 | 99.88 | 99.49 | 99.63 | 100.17 | 99.38 | 99.86 | 99.84 | 100.09 | 100.34 |
| Si | 1.01 | 1.01 | 1.00 | 1.01 | 1.00 | 1.00 | 1.00 | 1.00 | 1.01 | 1.00 | 1.00 | 1.00 | 1.00 |
| Ti | 0.88 | 0.94 | 0.94 | 0.93 | 0.94 | 0.94 | 0.92 | 0.95 | 0.93 | 0.93 | 0.93 | 0.93 | 0.91 |
| Al | 0.08 | 0.04 | 0.04 | 0.05 | 0.05 | 0.04 | 0.07 | 0.04 | 0.05 | 0.05 | 0.05 | 0.05 | 0.07 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 0.02 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 1.00 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.00 | 1.00 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.02 | 0.01 | 0.02 | 0.01 | 0.01 | 0.00 | 0.02 | 0.02 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 |
| O | 4.92 | 4.98 | 4.95 | 4.96 | 4.96 | 4.97 | 4.95 | 4.97 | 4.97 | 4.96 | 4.97 | 4.95 | 4.93 |

| sample | cr0434 | cr0434 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Sph−19 | Sph−20 | Sph−1 | Sph−2 | Sph−3 | Sph−4 | Sph−5 | Sph−6 | Sph−7 | Sph−8 | Sph−9 | Sph−10 | Sph−11 |
| SiO2 | 31.08 | 31.61 | 30.17 | 30.25 | 30.77 | 30.17 | 30.29 | 30.36 | 30.54 | 30.54 | 30.62 | 30.66 | 30.68 |
| TiO2 | 27.52 | 36.98 | 35.28 | 34.09 | 29.80 | 35.30 | 33.22 | 29.87 | 33.99 | 34.97 | 33.04 | 29.33 | 35.13 |
| Al2O3 | 7.53 | 2.13 | 1.91 | 2.58 | 4.44 | 1.91 | 3.32 | 5.49 | 2.56 | 1.90 | 3.25 | 6.32 | 1.95 |
| Cr2O3 | 0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeO | 1.65 | 0.55 | 1.01 | 1.33 | 2.21 | 0.74 | 0.90 | 1.08 | 1.03 | 0.93 | 1.12 | 0.90 | 0.87 |
| MnO | 0.01 | 0.02 | 0.01 | 0.03 | 0.02 | 0.07 | 0.00 | 0.01 | 0.07 | 0.00 | 0.02 | 0.00 | 0.02 |
| MgO | 0.02 | 0.04 | 0.21 | 0.43 | 0.05 | 0.09 | 0.05 | 0.02 | 0.19 | 0.04 | 0.01 | 0.08 | 0.15 |
| CaO | 29.18 | 28.80 | 28.85 | 28.56 | 28.38 | 29.06 | 28.76 | 29.16 | 28.99 | 28.84 | 29.17 | 29.66 | 28.68 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.01 | 0.00 | 0.04 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.01 |
| Na2O | 0.01 | 0.06 | 0.01 | 0.03 | 0.15 | 0.03 | 0.04 | 0.06 | 0.01 | 0.14 | 0.08 | 0.07 | 0.09 |
| Cl2O−1 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 | 0.04 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 |
| F2O−1 | 0.76 | 0.08 | 0.39 | 0.41 | 0.60 | 0.30 | 0.58 | 0.93 | 0.44 | 0.35 | 0.54 | 1.24 | 0.17 |
| Total | 98.11 | 100.27 | 97.88 | 97.73 | 96.44 | 97.68 | 97.16 | 97.05 | 97.82 | 97.72 | 97.87 | 98.30 | 97.74 |
| Si | 1.00 | 1.01 | 1.00 | 1.00 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.02 | 1.02 | 1.00 | 1.02 |
| Ti | 0.66 | 0.89 | 0.88 | 0.84 | 0.74 | 0.89 | 0.83 | 0.75 | 0.85 | 0.88 | 0.82 | 0.72 | 0.88 |
| Al | 0.28 | 0.08 | 0.08 | 0.10 | 0.17 | 0.08 | 0.13 | 0.21 | 0.10 | 0.07 | 0.13 | 0.24 | 0.08 |
| Cr | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 0.04 | 0.01 | 0.03 | 0.04 | 0.06 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.00 | 0.00 | 0.01 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 |
| Ca | 1.00 | 0.99 | 1.03 | 1.01 | 1.01 | 1.04 | 1.03 | 1.04 | 1.03 | 1.03 | 1.04 | 1.04 | 1.02 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.13 | 0.01 | 0.07 | 0.07 | 0.11 | 0.06 | 0.11 | 0.17 | 0.08 | 0.06 | 0.10 | 0.22 | 0.03 |
| O | 4.74 | 4.93 | 4.92 | 4.86 | 4.81 | 4.95 | 4.88 | 4.81 | 4.90 | 4.94 | 4.89 | 4.78 | 4.94 |

| sample | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Sph−12 | Sph−13 | Sph−14 | Sph−15 | Sph−16 | Sph−17 | Sph−18 | Sph−19 | Sph−1 | Sph−2 | Sph−3 | Sph−4 | Sph−5 |
| SiO2 | 30.68 | 30.76 | 30.90 | 32.89 | 29.85 | 29.89 | 30.81 | 30.33 | 30.98 | 31.11 | 31.32 | 31.33 | 31.41 |
| TiO2 | 33.79 | 31.12 | 31.03 | 33.36 | 35.76 | 37.02 | 36.17 | 37.97 | 38.20 | 32.88 | 37.86 | 37.42 | 0.01 |
| Al2O3 | 3.17 | 3.75 | 5.27 | 2.18 | 2.27 | 1.68 | 2.41 | 1.71 | 2.10 | 3.81 | 1.68 | 1.54 | 16.68 |
| Cr2O3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.02 | 0.00 | 0.08 | 0.05 |
| FeO | 0.94 | 1.16 | 0.83 | 1.13 | 1.03 | 0.94 | 1.05 | 0.73 | 0.81 | 1.41 | 0.79 | 0.82 | 10.96 |
| MnO | 0.01 | 0.04 | 0.00 | 0.01 | 0.05 | 0.03 | 0.05 | 0.01 | 0.04 | 0.03 | 0.04 | 0.00 | 0.47 |
| MgO | 0.11 | 0.09 | 0.02 | 0.46 | 0.02 | 0.00 | 0.05 | 0.24 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 |
| CaO | 29.09 | 28.89 | 29.36 | 26.71 | 28.79 | 28.51 | 29.25 | 29.49 | 27.81 | 28.41 | 27.67 | 27.53 | 28.35 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.04 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.00 | 0.01 | 0.00 |
| Na2O | 0.03 | 0.04 | 0.02 | 0.57 | 0.02 | 0.02 | 0.05 | 0.01 | 0.02 | 0.09 | 0.18 | 0.00 | 0.64 |
| Cl2O−1 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 |
| F2O−1 | 0.40 | 0.58 | 0.99 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.27 | 0.45 | 0.16 | 0.26 | 0.00 |
| Total | 98.27 | 96.44 | 98.44 | 97.44 | 97.79 | 98.08 | 99.85 | 100.50 | 100.29 | 98.25 | 99.71 | 99.07 | 88.58 |
| Si | 1.01 | 1.03 | 1.01 | 1.06 | 0.99 | 0.99 | 1.00 | 0.98 | 0.98 | 1.01 | 1.00 | 1.01 | 1.04 |
| Ti | 0.84 | 0.78 | 0.76 | 0.81 | 0.89 | 0.92 | 0.88 | 0.92 | 0.91 | 0.80 | 0.91 | 0.91 | 0.00 |
| Al | 0.12 | 0.15 | 0.20 | 0.08 | 0.09 | 0.07 | 0.09 | 0.07 | 0.08 | 0.15 | 0.06 | 0.06 | 0.65 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 0.03 | 0.03 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.04 | 0.02 | 0.02 | 0.30 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| Mg | 0.01 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 1.03 | 1.04 | 1.03 | 0.92 | 1.02 | 1.01 | 1.01 | 1.02 | 0.95 | 0.99 | 0.95 | 0.95 | 1.00 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.04 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.07 | 0.11 | 0.18 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.08 | 0.03 | 0.05 | 0.00 |
| O | 4.90 | 4.87 | 4.82 | 4.83 | 4.95 | 4.95 | 4.94 | 4.96 | 4.86 | 4.84 | 4.89 | 4.87 | 4.38 |

| sample | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Sph−6 | Sph−7 | Sph−8 | Sph−9 | Sph−10 | Sph−11 | Sph−1 | Sph−2 | Sph−3 | Sph−4 | Sph−5 | Sph−6 | Sph−7 |
| SiO2 | 31.49 | 31.68 | 31.84 | 32.24 | 30.21 | 30.27 | 28.93 | 30.20 | 30.21 | 30.26 | 30.39 | 30.42 | 30.46 |
| TiO2 | 36.27 | 37.72 | 31.92 | 36.44 | 35.39 | 35.36 | 37.77 | 36.63 | 35.50 | 33.74 | 37.62 | 35.32 | 37.05 |
| Al2O3 | 2.23 | 1.46 | 4.27 | 1.82 | 1.98 | 2.55 | 1.88 | 1.68 | 2.32 | 2.99 | 1.73 | 2.09 | 1.11 |
| Cr2O3 | 0.07 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| FeO | 1.46 | 0.72 | 3.71 | 1.32 | 0.82 | 0.68 | 0.92 | 0.89 | 0.71 | 0.92 | 0.83 | 0.91 | 0.77 |
| MnO | 0.03 | 0.03 | 0.06 | 0.01 | 0.00 | 0.01 | 0.05 | 0.00 | 0.02 | 0.04 | 0.04 | 0.07 | 0.01 |
| MgO | 0.00 | 0.00 | 1.71 | 0.00 | 0.02 | 0.00 | 0.03 | 0.01 | 0.07 | 0.01 | 0.07 | 0.43 | 0.02 |
| CaO | 27.88 | 27.82 | 25.85 | 27.96 | 29.36 | 29.45 | 26.57 | 28.31 | 28.40 | 27.99 | 28.13 | 28.00 | 27.52 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.02 | 0.01 | 0.03 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 |
| Na2O | 0.00 | 0.22 | 0.10 | 0.06 | 0.05 | 0.03 | 0.04 | 0.00 | 0.01 | 0.03 | 0.03 | 0.03 | 0.02 |
| Cl2O−1 | 0.02 | 0.01 | 0.02 | 0.00 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.33 | 0.24 | 0.38 | 0.28 | 0.34 | 0.43 | 0.32 | 0.28 | 0.30 | 0.61 | 0.44 | 0.31 | 0.24 |
| Total | 99.80 | 99.95 | 99.90 | 100.13 | 98.17 | 98.80 | 96.51 | 98.03 | 97.55 | 96.60 | 99.32 | 97.60 | 97.20 |
| Si | 1.00 | 1.01 | 0.96 | 1.02 | 1.01 | 1.00 | 0.96 | 1.00 | 1.00 | 1.01 | 0.99 | 1.00 | 1.01 |
| Ti | 0.87 | 0.91 | 0.72 | 0.87 | 0.89 | 0.88 | 0.94 | 0.91 | 0.88 | 0.85 | 0.92 | 0.87 | 0.92 |
| Al | 0.08 | 0.06 | 0.15 | 0.07 | 0.08 | 0.10 | 0.07 | 0.07 | 0.09 | 0.12 | 0.07 | 0.08 | 0.04 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 0.04 | 0.02 | 0.09 | 0.04 | 0.02 | 0.02 | 0.03 | 0.02 | 0.02 | 0.03 | 0.02 | 0.03 | 0.02 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.00 | 0.00 | 0.08 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 |
| Ca | 0.95 | 0.95 | 0.83 | 0.95 | 1.05 | 1.04 | 0.94 | 1.00 | 1.01 | 1.00 | 0.98 | 0.98 | 0.98 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.06 | 0.04 | 0.06 | 0.05 | 0.06 | 0.08 | 0.06 | 0.05 | 0.05 | 0.11 | 0.08 | 0.05 | 0.04 |
| O | 4.84 | 4.89 | 4.56 | 4.86 | 4.96 | 4.94 | 4.85 | 4.92 | 4.91 | 4.86 | 4.88 | 4.87 | 4.91 |

| sample | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0443 | cr0443 | cr0443 | cr0443 | cr0443 | cr0443 | cr0443 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Sph−8 | Sph−9 | Sph−10 | Sph−11 | Sph−12 | Sph−13 | Sph−1 | Sph−2 | Sph−3 | Sph−4 | Sph−5 | Sph−6 | Sph−7 |
| SiO2 | 30.48 | 30.57 | 30.58 | 30.96 | 31.32 | 32.04 | 30.97 | 30.98 | 30.99 | 31.10 | 31.11 | 31.14 | 31.16 |
| TiO2 | 33.63 | 37.28 | 35.00 | 33.45 | 36.49 | 34.14 | 36.32 | 36.70 | 36.98 | 37.02 | 36.48 | 35.96 | 37.19 |
| Al2O3 | 3.61 | 1.34 | 2.08 | 3.47 | 2.03 | 2.42 | 1.57 | 0.94 | 1.32 | 1.41 | 1.52 | 1.61 | 0.97 |
| Cr2O3 | 0.00 | 0.00 | 0.02 | 0.01 | 0.00 | 0.03 | 0.04 | 0.03 | 0.04 | 0.05 | 0.00 | 0.20 | 0.03 |
| FeO | 1.00 | 0.74 | 0.68 | 1.14 | 0.85 | 1.88 | 0.45 | 0.51 | 0.49 | 0.61 | 0.28 | 0.26 | 0.39 |
| MnO | 0.03 | 0.06 | 0.01 | 0.02 | 0.04 | 0.05 | 0.00 | 0.02 | 0.01 | 0.00 | 0.00 | 0.03 | 0.00 |
| MgO | 0.05 | 0.07 | 0.00 | 0.18 | 0.05 | 0.30 | 0.06 | 0.01 | 0.01 | 0.12 | 0.09 | 0.04 | 0.00 |
| CaO | 28.40 | 28.47 | 27.80 | 25.95 | 28.84 | 27.04 | 29.15 | 29.28 | 28.98 | 29.42 | 28.71 | 29.49 | 28.99 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.01 | 0.00 | 0.01 | 0.02 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.02 | 0.00 | 0.01 | 0.00 |
| Na2O | 0.05 | 0.04 | 0.01 | 0.58 | 0.04 | 0.42 | 0.04 | 0.00 | 0.05 | 0.09 | 0.09 | 0.05 | 0.02 |
| Cl2O−1 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.01 |
| F2O−1 | 0.55 | 0.30 | 0.23 | 0.35 | 0.29 | 0.36 | 0.15 | 0.03 | 0.09 | 0.09 | 0.14 | 0.09 | 0.05 |
| Total | 97.81 | 98.87 | 96.42 | 96.12 | 99.97 | 98.69 | 98.77 | 98.52 | 98.98 | 99.93 | 98.42 | 98.90 | 98.82 |
| Si | 1.00 | 1.00 | 1.02 | 1.01 | 1.01 | 1.02 | 1.02 | 1.03 | 1.02 | 1.01 | 1.02 | 1.03 | 1.03 |
| Ti | 0.83 | 0.92 | 0.88 | 0.82 | 0.89 | 0.82 | 0.90 | 0.92 | 0.91 | 0.91 | 0.90 | 0.89 | 0.92 |
| Al | 0.14 | 0.05 | 0.08 | 0.13 | 0.08 | 0.09 | 0.06 | 0.04 | 0.05 | 0.05 | 0.06 | 0.06 | 0.04 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| FeIII | 0.03 | 0.02 | 0.02 | 0.03 | 0.02 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| Ca | 1.00 | 1.00 | 0.99 | 0.90 | 1.00 | 0.92 | 1.03 | 1.04 | 1.02 | 1.03 | 1.01 | 1.04 | 1.02 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.04 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.10 | 0.05 | 0.04 | 0.06 | 0.05 | 0.06 | 0.03 | 0.01 | 0.02 | 0.02 | 0.03 | 0.02 | 0.01 |
| O | 4.85 | 4.92 | 4.91 | 4.79 | 4.91 | 4.79 | 4.97 | 5.00 | 4.97 | 4.97 | 4.96 | 4.99 | 4.99 |

| sample | cr0443 | cr0443 | cr0444 | cr0444 | cr04551 | cr04551 | cr04551 | cr04552 | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Sph−8 | Sph−9 | Sph−1 | Sph−2 | Sph−1 | Sph−2 | Sph−3 | Sph−1 | Sph−1 | Sph−2 | Sph−3 | Sph−4 | Sph−5 |
| SiO2 | 31.17 | 31.27 | 31.78 | 32.01 | 33.05 | 31.46 | 31.51 | 30.65 | 31.46 | 31.47 | 31.50 | 31.52 | 31.94 |
| TiO2 | 36.48 | 35.23 | 37.45 | 37.37 | 29.95 | 31.69 | 33.78 | 30.63 | 37.43 | 37.34 | 38.34 | 38.13 | 37.51 |
| Al2O3 | 1.07 | 1.98 | 1.31 | 1.40 | 5.50 | 4.70 | 2.23 | 4.11 | 0.91 | 1.06 | 0.72 | 0.52 | 0.69 |
| Cr2O3 | 0.01 | 0.20 | 0.01 | 0.05 | 0.04 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeO | 0.49 | 0.53 | 1.26 | 1.00 | 1.93 | 2.05 | 1.98 | 2.56 | 0.52 | 0.44 | 0.32 | 0.35 | 0.60 |
| MnO | 0.01 | 0.01 | 0.05 | 0.03 | 0.00 | 0.01 | 0.02 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| MgO | 0.00 | 0.29 | 0.00 | 0.00 | 0.04 | 0.21 | 0.10 | 0.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CaO | 28.99 | 29.14 | 28.17 | 28.46 | 28.17 | 27.77 | 27.11 | 28.65 | 29.05 | 28.93 | 29.04 | 29.01 | 28.81 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.01 | 0.01 | 0.00 | 0.03 | 0.04 | 0.01 | 0.09 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na2O | 0.06 | 0.02 | 0.00 | 0.12 | 0.09 | 0.02 | 0.00 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl2O−1 | 0.00 | 0.01 | 0.00 | 0.00 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.01 | 0.10 | 0.05 | 0.03 | 0.30 | 0.21 | 0.26 | 0.00 | 0.14 | 0.09 | 0.05 | 0.06 | 0.10 |
| Total | 98.29 | 98.79 | 100.08 | 100.46 | 99.13 | 98.17 | 97.05 | 97.04 | 99.51 | 99.34 | 99.97 | 99.58 | 99.66 |
| Si | 1.03 | 1.02 | 1.02 | 1.02 | 1.04 | 1.00 | 1.03 | 1.00 | 1.03 | 1.03 | 1.03 | 1.03 | 1.04 |
| Ti | 0.91 | 0.87 | 0.90 | 0.90 | 0.71 | 0.76 | 0.83 | 0.75 | 0.92 | 0.92 | 0.94 | 0.94 | 0.92 |
| Al | 0.04 | 0.08 | 0.05 | 0.05 | 0.20 | 0.18 | 0.09 | 0.16 | 0.04 | 0.04 | 0.03 | 0.02 | 0.03 |
| Cr | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 0.01 | 0.01 | 0.03 | 0.03 | 0.05 | 0.05 | 0.05 | 0.07 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 1.03 | 1.02 | 0.96 | 0.97 | 0.95 | 0.95 | 0.95 | 1.00 | 1.02 | 1.01 | 1.01 | 1.02 | 1.00 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.02 | 0.01 | 0.01 | 0.05 | 0.04 | 0.05 | 0.00 | 0.03 | 0.02 | 0.01 | 0.01 | 0.02 |
| O | 5.00 | 4.94 | 4.90 | 4.92 | 4.77 | 4.78 | 4.82 | 4.84 | 4.97 | 4.97 | 4.99 | 4.99 | 4.97 |

| sample | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Sph−6 | Sph−7 | Sph−8 | Sph−9 | Sph−10 | Sph−11 | Sph−12 | Sph−13 | Sph−14 | Sph−15 | Sph−16 | Sph−17 | Sph−18 |
| SiO2 | 31.63 | 31.65 | 31.66 | 31.69 | 31.73 | 31.82 | 31.82 | 31.52 | 31.87 | 31.89 | 31.94 | 31.96 | 31.97 |
| TiO2 | 38.28 | 37.47 | 38.07 | 36.14 | 36.85 | 37.36 | 37.40 | 39.06 | 36.53 | 36.97 | 37.74 | 37.59 | 38.30 |
| Al2O3 | 0.57 | 1.13 | 0.68 | 1.44 | 0.77 | 1.14 | 1.35 | 0.56 | 1.37 | 1.12 | 1.11 | 1.08 | 0.69 |
| Cr2O3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeO | 0.44 | 0.51 | 0.50 | 0.95 | 0.63 | 0.55 | 0.53 | 0.36 | 0.84 | 0.79 | 0.39 | 0.46 | 0.29 |
| MnO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| MgO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CaO | 29.34 | 28.67 | 28.79 | 28.23 | 29.09 | 29.10 | 28.88 | 29.03 | 28.60 | 28.98 | 29.16 | 29.26 | 29.21 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na2O | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.07 | 0.12 | 0.07 | 0.09 | 0.08 | 0.12 | 0.14 | 0.04 | 0.15 | 0.10 | 0.05 | 0.16 | 0.06 |
| Total | 100.33 | 99.55 | 99.77 | 98.54 | 99.14 | 100.09 | 100.12 | 100.57 | 99.36 | 99.84 | 100.39 | 100.51 | 100.53 |
| Si | 1.03 | 1.03 | 1.03 | 1.03 | 1.04 | 1.03 | 1.03 | 1.02 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 |
| Ti | 0.94 | 0.92 | 0.93 | 0.89 | 0.91 | 0.91 | 0.91 | 0.95 | 0.89 | 0.90 | 0.92 | 0.91 | 0.93 |
| Al | 0.02 | 0.04 | 0.03 | 0.06 | 0.03 | 0.04 | 0.05 | 0.02 | 0.05 | 0.04 | 0.04 | 0.04 | 0.03 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 0.01 | 0.01 | 0.01 | 0.03 | 0.02 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ca | 1.02 | 1.00 | 1.00 | 0.99 | 1.02 | 1.01 | 1.00 | 1.01 | 0.99 | 1.01 | 1.01 | 1.01 | 1.01 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.01 | 0.02 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.03 | 0.02 | 0.01 | 0.03 | 0.01 |
| O | 4.99 | 4.95 | 4.97 | 4.92 | 4.98 | 4.96 | 4.95 | 4.98 | 4.93 | 4.96 | 4.97 | 4.97 | 4.99 |

| sample | cr0459a | cr0462 | cr0462 | cr0462 | cr0481a | cr0481b | cr0481b | cr0481b | cr0481b |
|---|---|---|---|---|---|---|---|---|---|
| point | Sph−19 | Sph−1 | Sph−2 | Sph−3 | Sph−1 | Sph−1 | Sph−2 | Sph−3 | Sph−4 |
| SiO2 | 33.60 | 31.43 | 31.64 | 31.65 | 29.53 | 31.65 | 31.53 | 29.75 | 31.47 |
| TiO2 | 35.33 | 32.81 | 31.95 | 32.64 | 40.60 | 32.37 | 35.25 | 34.67 | 36.86 |
| Al2O3 | 0.75 | 2.39 | 3.68 | 3.09 | 0.78 | 3.26 | 2.53 | 2.68 | 1.91 |
| Cr2O3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.39 | 0.02 | 0.07 | 0.05 | 0.03 |
| FeO | 0.95 | 1.58 | 1.38 | 1.49 | 0.62 | 2.33 | 2.04 | 1.97 | 1.18 |
| MnO | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.04 | 0.05 | 0.01 | 0.00 |
| MgO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.49 | 0.45 | 0.00 |
| CaO | 27.74 | 28.99 | 29.15 | 29.27 | 27.14 | 26.56 | 27.64 | 27.38 | 28.22 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| Na2O | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.20 | 0.00 | 0.04 | 0.00 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.00 | 0.00 |
| F2O−1 | 0.04 | 0.18 | 0.29 | 0.23 | 0.16 | 0.38 | 0.26 | 0.30 | 0.33 |
| Total | 98.41 | 97.38 | 98.10 | 98.37 | 99.30 | 96.84 | 99.88 | 97.29 | 99.99 |
| Si | 1.09 | 1.04 | 1.03 | 1.04 | 0.96 | 1.02 | 0.99 | 0.97 | 1.01 |
| Ti | 0.86 | 0.82 | 0.79 | 0.80 | 0.99 | 0.79 | 0.83 | 0.85 | 0.89 |
| Al | 0.03 | 0.09 | 0.14 | 0.12 | 0.03 | 0.12 | 0.09 | 0.10 | 0.07 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeIII | 0.03 | 0.04 | 0.04 | 0.04 | 0.02 | 0.06 | 0.05 | 0.05 | 0.03 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.02 | 0.00 |
| Ca | 0.96 | 1.03 | 1.02 | 1.03 | 0.94 | 0.92 | 0.93 | 0.96 | 0.97 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.01 | 0.03 | 0.05 | 0.04 | 0.03 | 0.07 | 0.04 | 0.05 | 0.06 |
| O | 4.92 | 4.92 | 4.89 | 4.91 | 4.89 | 4.77 | 4.78 | 4.80 | 4.87 |

| sample | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0422b | cr0422b | cr0422b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Chl−1 | Chl−2 | Chl−3 | Chl−4 | Chl−5 | Chl−6 | Chl−7 | Chl−8 | Chl−9 | Chl−10 | Chl−1 | Chl−2 | Chl−3 |
| SiO2 | 25.98 | 26.58 | 26.23 | 26.37 | 26.39 | 26.42 | 26.44 | 26.56 | 26.73 | 27.10 | 27.10 | 28.09 | 28.53 |
| TiO2 | 0.23 | 0.00 | 0.00 | 0.02 | 0.00 | 0.02 | 0.04 | 0.00 | 0.03 | 0.01 | 0.06 | 0.02 | 0.02 |
| Al2O3 | 19.01 | 18.94 | 19.29 | 19.26 | 19.42 | 19.60 | 19.50 | 19.45 | 18.86 | 18.76 | 15.80 | 17.98 | 17.48 |
| Cr2O3 | 0.05 | 0.00 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.10 | 0.02 | 0.00 |
| FeO | 25.99 | 26.70 | 26.46 | 25.62 | 25.76 | 26.42 | 26.69 | 26.68 | 26.51 | 26.40 | 26.13 | 24.87 | 24.98 |
| MnO | 0.32 | 0.22 | 0.29 | 0.25 | 0.24 | 0.31 | 0.25 | 0.24 | 0.26 | 0.27 | 0.31 | 0.26 | 0.27 |
| MgO | 14.70 | 14.60 | 15.01 | 14.93 | 15.05 | 14.67 | 14.48 | 14.66 | 14.94 | 15.04 | 14.14 | 16.57 | 17.07 |
| CaO | 0.10 | 0.02 | 0.05 | 0.09 | 0.02 | 0.04 | 0.07 | 0.09 | 0.07 | 0.07 | 0.17 | 0.02 | 0.09 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.03 | 0.02 | 0.00 | 0.01 | 0.00 | 0.03 | 0.00 | 0.01 | 0.02 | 0.03 | 0.01 | 0.00 |
| Na2O | 0.04 | 0.00 | 0.00 | 0.00 | 0.02 | 0.01 | 0.04 | 0.03 | 0.01 | 0.03 | 0.00 | 0.00 | 0.00 |
| Cl2O−1 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.01 | 0.01 | 0.02 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 86.41 | 87.09 | 87.41 | 86.56 | 86.93 | 87.49 | 87.54 | 87.73 | 87.44 | 87.73 | 83.85 | 87.88 | 88.43 |
| Si | 2.81 | 2.85 | 2.80 | 2.84 | 2.82 | 2.82 | 2.83 | 2.83 | 2.85 | 2.88 | 3.04 | 2.96 | 2.98 |
| Ti | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| Al | 2.42 | 2.40 | 2.42 | 2.44 | 2.45 | 2.46 | 2.46 | 2.44 | 2.37 | 2.35 | 2.09 | 2.23 | 2.15 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| Fe3+ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe2+ | 2.35 | 2.40 | 2.36 | 2.30 | 2.30 | 2.36 | 2.39 | 2.38 | 2.37 | 2.35 | 2.45 | 2.19 | 2.18 |
| Mn | 0.03 | 0.02 | 0.03 | 0.02 | 0.02 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.02 | 0.02 |
| Mg | 2.37 | 2.34 | 2.39 | 2.39 | 2.40 | 2.33 | 2.31 | 2.33 | 2.38 | 2.39 | 2.37 | 2.60 | 2.66 |
| Ca | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.00 | 0.01 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 14.06 | 14.05 | 14.02 | 14.06 | 14.05 | 14.06 | 14.07 | 14.06 | 14.05 | 14.07 | 14.12 | 14.07 | 14.07 |
| Mg# | 0.50 | 0.49 | 0.50 | 0.51 | 0.51 | 0.50 | 0.49 | 0.49 | 0.50 | 0.50 | 0.49 | 0.54 | 0.55 |

| sample | cr0422b | cr0422b | cr0422b | cr0422b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Chl−4 | Chl−5 | Chl−6 | Chl−7 | Chl−1 | Chl−2 | Chl−3 | Chl−4 | Chl−5 | Chl−6 | Chl−7 | Chl−8 | Chl−9 |
| SiO2 | 28.92 | 29.14 | 27.66 | 29.79 | 27.69 | 26.77 | 25.52 | 25.85 | 26.07 | 26.33 | 26.60 | 26.63 | 25.58 |
| TiO2 | 0.05 | 0.27 | 0.03 | 0.06 | 0.05 | 0.02 | 0.02 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.18 |
| Al2O3 | 18.97 | 18.92 | 18.37 | 17.29 | 17.40 | 17.80 | 19.09 | 18.95 | 18.59 | 17.75 | 18.34 | 18.63 | 19.18 |
| Cr2O3 | 0.00 | 0.04 | 0.00 | 0.07 | 0.02 | 0.02 | 0.00 | 0.01 | 0.00 | 0.00 | 0.02 | 0.03 | 0.02 |
| FeO | 25.68 | 24.84 | 25.32 | 22.17 | 27.40 | 27.48 | 28.18 | 27.75 | 28.26 | 27.86 | 28.72 | 28.36 | 29.09 |
| MnO | 0.23 | 0.29 | 0.31 | 0.25 | 0.21 | 0.25 | 0.24 | 0.22 | 0.19 | 0.17 | 0.21 | 0.21 | 0.18 |
| MgO | 16.39 | 16.99 | 16.86 | 16.10 | 13.99 | 15.14 | 13.47 | 13.36 | 13.46 | 13.68 | 13.20 | 13.44 | 12.42 |
| CaO | 0.07 | 0.12 | 0.11 | 0.17 | 0.11 | 0.15 | 0.02 | 0.05 | 0.01 | 0.03 | 0.03 | 0.04 | 0.13 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.02 |
| Na2O | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | 0.01 | 0.00 | 0.01 | 0.00 | 0.03 | 0.04 |
| Cl2O−1 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 90.33 | 90.62 | 88.65 | 85.92 | 86.87 | 87.64 | 86.63 | 86.22 | 86.60 | 85.86 | 87.13 | 87.40 | 86.84 |
| Si | 2.97 | 2.97 | 2.88 | 3.20 | 3.00 | 2.86 | 2.78 | 2.82 | 2.84 | 2.89 | 2.89 | 2.88 | 2.80 |
| Ti | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| Al | 2.30 | 2.27 | 2.26 | 2.19 | 2.22 | 2.24 | 2.45 | 2.44 | 2.39 | 2.30 | 2.35 | 2.37 | 2.48 |
| Cr | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe2+ | 2.20 | 2.12 | 2.21 | 1.99 | 2.49 | 2.42 | 2.57 | 2.54 | 2.57 | 2.56 | 2.61 | 2.56 | 2.66 |
| Mn | 0.02 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| Mg | 2.51 | 2.58 | 2.62 | 2.58 | 2.26 | 2.41 | 2.19 | 2.18 | 2.18 | 2.24 | 2.14 | 2.16 | 2.03 |
| Ca | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 14.13 | 14.15 | 14.03 | 14.32 | 14.13 | 14.02 | 14.01 | 14.05 | 14.03 | 14.04 | 14.07 | 14.07 | 14.07 |
| Mg# | 0.53 | 0.55 | 0.54 | 0.56 | 0.48 | 0.50 | 0.46 | 0.46 | 0.46 | 0.47 | 0.45 | 0.46 | 0.43 |

| sample | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0429 | cr0429 | cr0429 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Chl−10 | Chl−11 | Chl−12 | Chl−13 | Chl−14 | Chl−15 | Chl−16 | Chl−17 | Chl−18 | Chl−19 | Chl−1 | Chl−2 | Chl−3 |
| SiO2 | 25.73 | 26.01 | 26.14 | 26.22 | 26.43 | 26.57 | 26.58 | 26.63 | 26.82 | 27.49 | 25.15 | 25.94 | 26.04 |
| TiO2 | 0.03 | 0.00 | 0.03 | 0.04 | 0.03 | 0.03 | 0.00 | 0.19 | 0.03 | 0.04 | 0.01 | 0.03 | 0.02 |
| Al2O3 | 20.11 | 18.84 | 19.16 | 19.46 | 18.63 | 19.40 | 19.13 | 18.97 | 18.41 | 18.46 | 16.19 | 19.03 | 18.94 |
| Cr2O3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.02 | 0.00 | 0.05 | 0.00 | 0.29 | 0.03 | 0.00 |
| FeO | 27.92 | 29.75 | 28.38 | 27.80 | 28.37 | 27.48 | 27.85 | 28.59 | 27.92 | 28.92 | 24.61 | 28.09 | 28.21 |
| MnO | 0.26 | 0.21 | 0.28 | 0.27 | 0.26 | 0.25 | 0.25 | 0.29 | 0.26 | 0.26 | 0.17 | 0.21 | 0.22 |
| MgO | 13.72 | 12.29 | 13.30 | 13.47 | 13.64 | 13.74 | 13.93 | 13.23 | 13.63 | 12.99 | 13.54 | 14.67 | 14.36 |
| CaO | 0.03 | 0.05 | 0.05 | 0.09 | 0.00 | 0.13 | 0.07 | 0.08 | 0.17 | 0.05 | 0.15 | 0.00 | 0.03 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.02 | 0.01 | 0.02 | 0.02 | 0.00 | 0.02 | 0.02 | 0.00 | 0.02 | 0.02 | 0.00 | 0.01 | 0.00 |
| Na2O | 0.00 | 0.04 | 0.03 | 0.03 | 0.02 | 0.01 | 0.02 | 0.00 | 0.02 | 0.09 | 0.01 | 0.02 | 0.10 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.03 | 0.02 | 0.02 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.01 | 0.01 |
| F2O−1 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 87.86 | 87.20 | 87.40 | 87.42 | 87.40 | 87.68 | 87.91 | 88.01 | 87.32 | 88.35 | 80.11 | 88.03 | 87.93 |
| Si | 2.75 | 2.84 | 2.82 | 2.83 | 2.85 | 2.85 | 2.85 | 2.86 | 2.90 | 2.95 | 2.95 | 2.76 | 2.78 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 2.54 | 2.42 | 2.44 | 2.47 | 2.37 | 2.45 | 2.41 | 2.40 | 2.35 | 2.34 | 2.24 | 2.39 | 2.39 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 |
| Fe3+ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | 0.05 |
| Fe2+ | 2.50 | 2.72 | 2.56 | 2.51 | 2.56 | 2.47 | 2.49 | 2.57 | 2.53 | 2.60 | 2.41 | 2.41 | 2.47 |
| Mn | 0.02 | 0.02 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| Mg | 2.19 | 2.00 | 2.14 | 2.17 | 2.19 | 2.20 | 2.22 | 2.12 | 2.20 | 2.08 | 2.36 | 2.33 | 2.29 |
| Ca | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.02 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.00 | 0.00 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.02 |
| Cl | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| F | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 14.02 | 14.06 | 14.06 | 14.08 | 14.04 | 14.10 | 14.05 | 14.09 | 14.10 | 14.14 | 14.10 | 14.00 | 14.01 |
| Mg# | 0.47 | 0.42 | 0.46 | 0.46 | 0.46 | 0.47 | 0.47 | 0.45 | 0.47 | 0.44 | 0.50 | 0.49 | 0.48 |

| sample | cr0429 | cr0429 | cr0429 | cr0429 | cr0429 | cr0429 | cr0433 | cr0433 | cr0433 | cr0433 | cr0433 | cr0433 | cr0434 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Chl-4 | Chl-5 | Chl-6 | Chl-7 | Chl-8 | Chl-9 | Chl-1 | Chl-2 | Chl-3 | Chl-4 | Chl-5 | Chl-6 | Chl-1 |
| SiO2 | 26.09 | 26.59 | 27.06 | 25.38 | 25.78 | 27.15 | 27.86 | 28.23 | 28.24 | 28.43 | 29.12 | 30.12 | 25.97 |
| TiO2 | 0.01 | 0.05 | 0.02 | 0.07 | 0.05 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.05 | 0.06 | 0.01 |
| Al2O3 | 19.38 | 18.70 | 18.81 | 19.94 | 20.12 | 19.52 | 20.09 | 19.14 | 19.30 | 18.91 | 19.04 | 18.15 | 18.89 |
| Cr2O3 | 0.02 | 0.02 | 0.01 | 0.02 | 0.00 | 0.28 | 0.01 | 0.41 | 0.41 | 0.54 | 0.05 | 0.05 | 0.02 |
| FeO | 28.34 | 28.24 | 27.42 | 28.14 | 30.55 | 27.18 | 18.97 | 20.07 | 19.72 | 19.68 | 18.36 | 18.50 | 30.16 |
| MnO | 0.29 | 0.19 | 0.18 | 0.30 | 0.22 | 0.18 | 0.44 | 0.48 | 0.43 | 0.47 | 0.49 | 0.37 | 0.27 |
| MgO | 14.44 | 15.39 | 14.26 | 14.83 | 13.09 | 16.23 | 20.21 | 19.99 | 19.93 | 20.17 | 20.84 | 18.49 | 11.95 |
| CaO | 0.02 | 0.00 | 1.36 | 0.04 | 0.08 | 0.13 | 0.08 | 0.02 | 0.02 | 0.02 | 0.09 | 0.15 | 0.05 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.02 | 0.01 | 0.00 |
| K2O | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 |
| Na2O | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.18 | 0.05 | 0.00 |
| Cl2O-1 | 0.01 | 0.02 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O-1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.03 | 0.02 | 0.04 | 0.04 | 0.07 | 0.00 |
| Total | 88.61 | 89.21 | 89.13 | 88.76 | 89.91 | 90.70 | 87.75 | 88.38 | 88.08 | 88.32 | 88.29 | 86.05 | 87.31 |
| Si | 2.76 | 2.79 | 2.89 | 2.68 | 2.72 | 2.79 | 2.85 | 2.88 | 2.88 | 2.90 | 2.96 | 3.17 | 2.84 |
| Ti | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| Al | 2.42 | 2.31 | 2.37 | 2.48 | 2.50 | 2.36 | 2.42 | 2.30 | 2.32 | 2.27 | 2.28 | 2.25 | 2.43 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.03 | 0.03 | 0.04 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.05 | 0.12 | 0.00 | 0.17 | 0.06 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe2+ | 2.45 | 2.36 | 2.45 | 2.31 | 2.64 | 2.26 | 1.62 | 1.71 | 1.69 | 1.68 | 1.56 | 1.63 | 2.76 |
| Mn | 0.03 | 0.02 | 0.02 | 0.03 | 0.02 | 0.02 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.03 | 0.02 |
| Mg | 2.28 | 2.41 | 2.27 | 2.33 | 2.06 | 2.48 | 3.08 | 3.04 | 3.04 | 3.07 | 3.15 | 2.90 | 1.95 |
| Ca | 0.00 | 0.00 | 0.16 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.01 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.01 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.01 | 0.01 | 0.02 | 0.02 | 0.04 | 0.00 |
| O | 14.00 | 14.00 | 14.23 | 14.01 | 14.01 | 14.03 | 14.05 | 14.04 | 14.06 | 14.05 | 14.12 | 14.31 | 14.06 |
| Mg# | 0.48 | 0.50 | 0.48 | 0.50 | 0.44 | 0.52 | 0.66 | 0.64 | 0.64 | 0.65 | 0.67 | 0.64 | 0.41 |

| sample | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Chl-2 | Chl-3 | Chl-4 | Chl-5 | Chl-6 | Chl-7 | Chl-8 | Chl-9 | Chl-10 | Chl-11 | Chl-12 | Chl-13 | Chl-14 |
| SiO2 | 26.05 | 26.11 | 26.26 | 26.29 | 26.38 | 26.48 | 26.54 | 26.73 | 26.94 | 27.03 | 27.05 | 27.08 | 27.33 |
| TiO2 | 0.01 | 0.07 | 0.06 | 0.01 | 0.01 | 0.04 | 0.01 | 0.00 | 0.00 | 0.02 | 0.01 | 0.02 | 0.07 |
| Al2O3 | 19.15 | 18.57 | 19.55 | 18.72 | 18.50 | 18.93 | 19.41 | 19.11 | 18.32 | 19.12 | 19.24 | 18.71 | 19.50 |
| Cr2O3 | 0.01 | 0.04 | 0.00 | 0.01 | 0.06 | 0.02 | 0.06 | 0.00 | 0.02 | 0.05 | 0.02 | 0.01 | 0.07 |
| FeO | 29.37 | 31.16 | 28.98 | 29.97 | 29.93 | 30.47 | 26.77 | 29.26 | 29.70 | 27.22 | 27.87 | 29.63 | 28.39 |
| MnO | 0.28 | 0.28 | 0.29 | 0.33 | 0.31 | 0.27 | 0.33 | 0.26 | 0.30 | 0.32 | 0.29 | 0.32 | 0.31 |
| MgO | 12.08 | 11.66 | 12.89 | 12.21 | 12.30 | 11.99 | 14.00 | 11.98 | 12.67 | 13.85 | 13.50 | 11.75 | 13.00 |
| CaO | 0.07 | 0.10 | 0.05 | 0.12 | 0.13 | 0.09 | 0.13 | 0.14 | 0.13 | 0.24 | 0.16 | 0.20 | 0.27 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.03 | 0.06 | 0.00 | 0.00 | 0.05 | 0.00 |
| Na2O | 0.00 | 0.02 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 | 0.00 | 0.01 | 0.05 |
| Cl2O-1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O-1 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.03 | 0.01 | 0.03 | 0.00 | 0.03 | 0.00 | 0.00 | 0.03 |
| Total | 87.02 | 88.01 | 88.10 | 87.68 | 87.64 | 88.33 | 87.27 | 87.54 | 88.17 | 87.88 | 88.15 | 87.78 | 89.03 |
| Si | 2.85 | 2.85 | 2.82 | 2.86 | 2.87 | 2.87 | 2.85 | 2.91 | 2.91 | 2.90 | 2.90 | 2.95 | 2.91 |
| Ti | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| Al | 2.47 | 2.38 | 2.48 | 2.40 | 2.37 | 2.41 | 2.46 | 2.45 | 2.33 | 2.42 | 2.43 | 2.40 | 2.45 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| Fe3+ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe2+ | 2.69 | 2.84 | 2.60 | 2.73 | 2.72 | 2.76 | 2.41 | 2.67 | 2.68 | 2.44 | 2.49 | 2.70 | 2.53 |
| Mn | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.03 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| Mg | 1.97 | 1.89 | 2.07 | 1.98 | 2.00 | 1.93 | 2.24 | 1.95 | 2.04 | 2.21 | 2.15 | 1.91 | 2.07 |
| Ca | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.03 | 0.02 | 0.02 | 0.03 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.01 | 0.02 | 0.00 | 0.02 | 0.00 | 0.00 | 0.02 |
| O | 14.09 | 14.06 | 14.07 | 14.08 | 14.08 | 14.08 | 14.10 | 14.15 | 14.10 | 14.13 | 14.13 | 14.18 | 14.17 |
| Mg# | 0.42 | 0.40 | 0.44 | 0.42 | 0.42 | 0.41 | 0.48 | 0.42 | 0.43 | 0.48 | 0.46 | 0.41 | 0.45 |

| sample | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0438 | cr0438 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Chl−15 | Chl−16 | Chl−17 | Chl−18 | Chl−19 | Chl−20 | Chl−21 | Chl−22 | Chl−23 | Chl−24 | Chl−25 | Chl−1 | Chl−2 |
| SiO2 | 26.07 | 26.13 | 26.21 | 26.28 | 26.32 | 26.47 | 26.53 | 26.54 | 26.57 | 26.76 | 27.81 | 28.11 | 27.18 |
| TiO2 | 0.01 | 0.02 | 0.01 | 0.00 | 0.04 | 0.02 | 0.02 | 0.04 | 0.02 | 0.69 | 0.02 | 0.02 | 0.03 |
| Al2O3 | 18.96 | 18.58 | 18.47 | 18.68 | 18.58 | 17.95 | 18.69 | 18.51 | 18.63 | 18.23 | 19.06 | 17.66 | 18.59 |
| Cr2O3 | 0.04 | 0.12 | 0.03 | 0.01 | 0.03 | 0.12 | 0.04 | 0.04 | 0.14 | 0.02 | 0.28 | 0.00 | 0.00 |
| FeO | 30.13 | 30.41 | 30.39 | 30.36 | 31.23 | 30.10 | 30.67 | 30.61 | 29.91 | 29.64 | 27.41 | 20.80 | 19.44 |
| MnO | 0.26 | 0.30 | 0.27 | 0.26 | 0.31 | 0.28 | 0.31 | 0.28 | 0.27 | 0.25 | 0.29 | 0.35 | 0.35 |
| MgO | 12.33 | 12.10 | 11.97 | 12.07 | 11.40 | 11.58 | 11.73 | 11.94 | 11.78 | 12.36 | 13.66 | 21.57 | 20.07 |
| CaO | 0.06 | 0.11 | 0.07 | 0.10 | 0.07 | 0.18 | 0.10 | 0.10 | 0.14 | 0.58 | 0.18 | 0.17 | 0.08 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.02 | 0.00 | 0.01 | 0.03 | 0.08 | 0.02 | 0.01 | 0.03 | 0.02 | 0.03 | 0.01 | 0.00 |
| Na2O | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.03 | 0.01 | 0.00 | 0.01 | 0.01 | 0.02 | 0.00 | 0.00 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 |
| F2O−1 | 0.03 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 |
| Total | 87.90 | 87.80 | 87.43 | 87.79 | 88.02 | 86.81 | 88.13 | 88.08 | 87.49 | 88.56 | 88.78 | 88.70 | 85.73 |
| Si | 2.83 | 2.84 | 2.87 | 2.86 | 2.87 | 2.93 | 2.88 | 2.88 | 2.91 | 2.90 | 2.96 | 2.85 | 2.84 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 |
| Al | 2.42 | 2.38 | 2.38 | 2.39 | 2.39 | 2.34 | 2.39 | 2.37 | 2.40 | 2.33 | 2.39 | 2.11 | 2.29 |
| Cr | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 |
| Fe3+ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 | 0.02 |
| Fe2+ | 2.73 | 2.77 | 2.78 | 2.76 | 2.85 | 2.78 | 2.79 | 2.78 | 2.74 | 2.69 | 2.44 | 1.56 | 1.68 |
| Mn | 0.02 | 0.03 | 0.03 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 |
| Mg | 1.99 | 1.96 | 1.95 | 1.96 | 1.85 | 1.91 | 1.90 | 1.93 | 1.92 | 2.00 | 2.16 | 3.26 | 3.13 |
| Ca | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.02 | 0.07 | 0.02 | 0.02 | 0.01 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 |
| O | 14.04 | 14.06 | 14.06 | 14.07 | 14.08 | 14.13 | 14.10 | 14.08 | 14.13 | 14.19 | 14.18 | 14.02 | 14.01 |
| Mg# | 0.42 | 0.41 | 0.41 | 0.41 | 0.39 | 0.41 | 0.41 | 0.41 | 0.41 | 0.43 | 0.47 | 0.68 | 0.65 |

| sample | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Chl−3 | Chl−4 | Chl−5 | Chl−6 | Chl−7 | Chl−8 | Chl−9 | Chl−10 | Chl−11 | Chl−12 | Chl−13 | Chl−14 | Chl−15 |
| SiO2 | 27.53 | 27.68 | 27.74 | 27.87 | 27.87 | 27.92 | 27.94 | 27.95 | 27.98 | 28.08 | 28.20 | 28.33 | 29.07 |
| TiO2 | 0.00 | 0.09 | 0.03 | 0.09 | 0.02 | 0.20 | 0.26 | 0.08 | 0.08 | 0.15 | 0.00 | 0.13 | 0.07 |
| Al2O3 | 18.91 | 18.31 | 17.86 | 17.81 | 18.01 | 17.92 | 18.06 | 18.33 | 18.20 | 17.91 | 17.36 | 17.54 | 16.15 |
| Cr2O3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeO | 20.90 | 19.30 | 19.69 | 19.11 | 18.39 | 18.52 | 18.89 | 19.49 | 19.57 | 18.56 | 20.92 | 18.59 | 19.07 |
| MnO | 0.34 | 0.33 | 0.37 | 0.42 | 0.37 | 0.34 | 0.28 | 0.36 | 0.30 | 0.41 | 0.28 | 0.35 | 0.20 |
| MgO | 19.21 | 21.13 | 20.76 | 20.73 | 21.81 | 21.43 | 21.40 | 20.73 | 20.66 | 21.24 | 19.71 | 21.13 | 22.07 |
| CaO | 0.06 | 0.11 | 0.29 | 0.12 | 0.07 | 0.08 | 0.13 | 0.16 | 0.09 | 0.19 | 0.05 | 0.23 | 0.18 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.01 | 0.01 | 0.03 | 0.03 | 0.00 | 0.00 | 0.04 | 0.01 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 |
| Na2O | 0.00 | 0.04 | 0.02 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.00 | 0.00 | 0.02 | 0.01 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.01 | 0.02 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 86.97 | 87.00 | 86.78 | 86.21 | 86.56 | 86.43 | 87.04 | 87.16 | 86.91 | 86.54 | 86.55 | 86.32 | 86.81 |
| Si | 2.86 | 2.85 | 2.87 | 2.90 | 2.86 | 2.88 | 2.87 | 2.88 | 2.89 | 2.90 | 2.94 | 2.94 | 2.99 |
| Ti | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 |
| Al | 2.32 | 2.22 | 2.18 | 2.18 | 2.18 | 2.18 | 2.19 | 2.22 | 2.21 | 2.18 | 2.14 | 2.14 | 1.96 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.00 | 0.09 | 0.07 | 0.02 | 0.09 | 0.06 | 0.07 | 0.02 | 0.01 | 0.02 | 0.00 | 0.00 | 0.06 |
| Fe2+ | 1.82 | 1.57 | 1.63 | 1.64 | 1.49 | 1.54 | 1.55 | 1.66 | 1.68 | 1.58 | 1.83 | 1.61 | 1.58 |
| Mn | 0.03 | 0.03 | 0.03 | 0.04 | 0.03 | 0.03 | 0.02 | 0.03 | 0.03 | 0.04 | 0.02 | 0.03 | 0.02 |
| Mg | 2.98 | 3.24 | 3.21 | 3.21 | 3.34 | 3.30 | 3.28 | 3.18 | 3.18 | 3.27 | 3.07 | 3.27 | 3.39 |
| Ca | 0.01 | 0.01 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.01 | 0.03 | 0.02 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 14.03 | 14.02 | 14.04 | 14.02 | 14.01 | 14.02 | 14.04 | 14.02 | 14.02 | 14.03 | 14.02 | 14.05 | 14.03 |
| Mg# | 0.62 | 0.67 | 0.66 | 0.66 | 0.69 | 0.68 | 0.68 | 0.66 | 0.65 | 0.67 | 0.63 | 0.67 | 0.68 |

| sample | cr0438 | cr0438 | cr0438 | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0440a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Chl−16 | Chl−17 | Chl−18 | Chl−1 | Chl−2 | Chl−3 | Chl−4 | Chl−5 | Chl−6 | Chl−7 | Chl−8 | Chl−9 | Chl−1 |
| SiO2 | 28.28 | 27.24 | 27.59 | 28.46 | 28.71 | 28.77 | 29.44 | 29.56 | 26.46 | 26.93 | 27.17 | 27.38 | 29.49 |
| TiO2 | 0.05 | 0.06 | 0.01 | 0.03 | 0.01 | 0.04 | 0.03 | 0.06 | 0.00 | 0.00 | 0.00 | 0.05 | 0.03 |
| Al2O3 | 18.78 | 18.06 | 18.71 | 18.26 | 21.07 | 18.44 | 18.46 | 19.74 | 18.37 | 18.21 | 18.97 | 18.71 | 18.85 |
| Cr2O3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 |
| FeO | 19.13 | 21.26 | 19.49 | 25.23 | 21.90 | 25.64 | 21.98 | 20.84 | 25.31 | 24.51 | 22.13 | 21.95 | 18.53 |
| MnO | 0.33 | 0.36 | 0.34 | 0.44 | 0.45 | 0.45 | 0.24 | 0.35 | 0.50 | 0.39 | 0.40 | 0.45 | 0.37 |
| MgO | 20.73 | 18.85 | 19.90 | 16.00 | 14.33 | 15.76 | 18.89 | 19.35 | 16.32 | 17.35 | 17.98 | 17.71 | 18.62 |
| CaO | 0.14 | 0.36 | 0.33 | 0.10 | 1.76 | 0.16 | 0.05 | 0.08 | 0.04 | 0.00 | 0.07 | 0.07 | 0.04 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| K2O | 0.00 | 0.00 | 0.00 | 0.02 | 0.01 | 0.00 | 0.02 | 0.02 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 |
| Na2O | 0.01 | 0.04 | 0.04 | 0.15 | 0.07 | 0.77 | 0.00 | 0.16 | 0.01 | 0.03 | 0.00 | 0.01 | 0.37 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 |
| Total | 87.45 | 86.23 | 86.41 | 88.72 | 88.31 | 90.05 | 89.15 | 90.18 | 87.02 | 87.42 | 86.71 | 86.36 | 86.45 |
| Si | 2.90 | 2.87 | 2.88 | 2.98 | 3.07 | 3.00 | 3.00 | 2.97 | 2.81 | 2.83 | 2.85 | 2.89 | 3.09 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 2.27 | 2.25 | 2.30 | 2.26 | 2.65 | 2.27 | 2.22 | 2.34 | 2.30 | 2.26 | 2.35 | 2.33 | 2.33 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.08 | 0.00 | 0.00 | 0.00 |
| Fe2+ | 1.64 | 1.87 | 1.70 | 2.21 | 1.96 | 2.24 | 1.88 | 1.75 | 2.18 | 2.08 | 1.94 | 1.94 | 1.63 |
| Mn | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 | 0.04 | 0.02 | 0.03 | 0.05 | 0.03 | 0.04 | 0.04 | 0.03 |
| Mg | 3.16 | 2.97 | 3.09 | 2.50 | 2.28 | 2.45 | 2.87 | 2.90 | 2.59 | 2.72 | 2.82 | 2.79 | 2.91 |
| Ca | 0.02 | 0.04 | 0.04 | 0.01 | 0.20 | 0.02 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.01 | 0.01 | 0.03 | 0.01 | 0.16 | 0.00 | 0.03 | 0.00 | 0.01 | 0.00 | 0.00 | 0.07 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 |
| O | 14.05 | 14.05 | 14.07 | 14.14 | 14.60 | 14.23 | 14.12 | 14.17 | 14.01 | 14.00 | 14.04 | 14.07 | 14.29 |
| Mg♯ | 0.66 | 0.61 | 0.65 | 0.53 | 0.54 | 0.52 | 0.61 | 0.62 | 0.54 | 0.57 | 0.59 | 0.59 | 0.64 |

| sample | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Chl−2 | Chl−3 | Chl−4 | Chl−5 | Chl−6 | Chl−7 | Chl−8 | Chl−9 | Chl−10 | Chl−11 | Chl−12 | Chl−13 | Chl−14 |
| SiO2 | 29.57 | 27.10 | 27.26 | 27.30 | 27.42 | 27.52 | 27.55 | 27.64 | 27.67 | 27.74 | 27.75 | 27.89 | 28.15 |
| TiO2 | 0.00 | 0.01 | 0.01 | 0.06 | 0.01 | 0.22 | 0.08 | 0.14 | 0.00 | 0.03 | 0.01 | 0.07 | 0.02 |
| Al2O3 | 19.80 | 19.38 | 19.25 | 19.17 | 19.69 | 19.16 | 19.46 | 18.85 | 19.18 | 18.80 | 18.81 | 18.59 | 19.23 |
| Cr2O3 | 0.06 | 0.01 | 0.00 | 0.02 | 0.02 | 0.05 | 0.03 | 0.03 | 0.05 | 0.04 | 0.03 | 0.02 | 0.05 |
| FeO | 18.46 | 19.89 | 19.30 | 19.74 | 19.45 | 19.29 | 19.86 | 19.53 | 19.40 | 19.64 | 19.39 | 18.97 | 19.10 |
| MnO | 0.44 | 0.50 | 0.43 | 0.42 | 0.39 | 0.40 | 0.50 | 0.45 | 0.40 | 0.38 | 0.42 | 0.38 | 0.39 |
| MgO | 18.86 | 19.15 | 19.46 | 19.52 | 19.44 | 19.17 | 19.34 | 19.44 | 19.74 | 19.46 | 19.59 | 19.71 | 20.35 |
| CaO | 0.04 | 0.04 | 0.02 | 0.07 | 0.06 | 0.15 | 0.08 | 0.07 | 0.07 | 0.07 | 0.05 | 0.09 | 0.04 |
| BaO | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.03 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 |
| K2O | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| Na2O | 0.46 | 0.02 | 0.02 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.02 | 0.00 | 0.01 | 0.02 |
| Cl2O−1 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.04 | 0.02 | 0.00 | 0.00 | 0.06 | 0.07 | 0.01 | 0.04 | 0.01 | 0.03 | 0.06 | 0.04 | 0.02 |
| Total | 87.74 | 86.12 | 85.75 | 86.33 | 86.55 | 86.05 | 86.92 | 86.24 | 86.52 | 86.22 | 86.13 | 85.77 | 87.37 |
| Si | 3.05 | 2.84 | 2.85 | 2.85 | 2.85 | 2.89 | 2.86 | 2.89 | 2.87 | 2.90 | 2.90 | 2.92 | 2.89 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| Al | 2.41 | 2.39 | 2.38 | 2.36 | 2.41 | 2.37 | 2.38 | 2.32 | 2.35 | 2.31 | 2.32 | 2.30 | 2.32 |
| Cr | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe2+ | 1.59 | 1.74 | 1.69 | 1.72 | 1.69 | 1.69 | 1.72 | 1.71 | 1.69 | 1.72 | 1.69 | 1.66 | 1.64 |
| Mn | 0.04 | 0.04 | 0.04 | 0.04 | 0.03 | 0.04 | 0.04 | 0.04 | 0.03 | 0.03 | 0.04 | 0.03 | 0.03 |
| Mg | 2.90 | 2.99 | 3.04 | 3.03 | 3.01 | 3.00 | 2.99 | 3.03 | 3.06 | 3.03 | 3.05 | 3.08 | 3.11 |
| Ca | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.09 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.02 | 0.01 | 0.00 | 0.00 | 0.03 | 0.04 | 0.00 | 0.02 | 0.01 | 0.01 | 0.03 | 0.02 | 0.01 |
| O | 14.30 | 14.03 | 14.05 | 14.04 | 14.05 | 14.09 | 14.06 | 14.06 | 14.05 | 14.06 | 14.05 | 14.08 | 14.05 |
| Mg♯ | 0.65 | 0.63 | 0.64 | 0.64 | 0.64 | 0.64 | 0.63 | 0.64 | 0.64 | 0.64 | 0.64 | 0.65 | 0.66 |

| sample | cr0440a | cr0443 | cr0443 | cr0443 | cr0443 | cr0443 | cr0443 | cr0443 | cr0443 | cr0443 | cr0443 | cr0443 | cr0443 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Chl−15 | Chl−1 | Chl−2 | Chl−3 | Chl−4 | Chl−5 | Chl−6 | Chl−7 | Chl−8 | Chl−9 | Chl−10 | Chl−11 | Chl−12 |
| SiO2 | 28.29 | 28.19 | 28.85 | 29.37 | 29.40 | 29.58 | 29.65 | 29.66 | 29.73 | 29.78 | 29.96 | 31.37 | 31.32 |
| TiO2 | 0.00 | 0.06 | 0.00 | 0.02 | 0.09 | 0.05 | 0.06 | 0.02 | 0.04 | 0.03 | 0.04 | 0.03 | 0.12 |
| Al2O3 | 18.52 | 17.93 | 18.69 | 18.48 | 18.09 | 18.34 | 18.07 | 18.04 | 18.24 | 18.09 | 17.96 | 17.26 | 18.45 |
| Cr2O3 | 0.03 | 0.25 | 0.06 | 0.14 | 0.20 | 0.22 | 0.14 | 0.01 | 0.09 | 0.12 | 0.09 | 0.05 | 0.25 |
| FeO | 19.37 | 19.93 | 20.37 | 18.87 | 18.79 | 19.01 | 18.43 | 18.69 | 19.28 | 18.78 | 18.22 | 18.88 | 19.81 |
| MnO | 0.38 | 0.29 | 0.25 | 0.28 | 0.25 | 0.23 | 0.24 | 0.23 | 0.24 | 0.25 | 0.25 | 0.26 | 0.26 |
| MgO | 19.78 | 19.21 | 19.85 | 21.41 | 20.70 | 21.13 | 20.42 | 20.22 | 20.65 | 20.38 | 21.49 | 19.97 | 19.00 |
| CaO | 0.06 | 0.18 | 0.13 | 0.08 | 0.18 | 0.12 | 0.16 | 0.13 | 0.12 | 0.17 | 0.14 | 0.61 | 0.15 |
| BaO | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.00 | 0.02 | 0.01 | 0.03 | 0.00 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 |
| Na2O | 0.01 | 0.00 | 0.00 | 0.01 | 0.03 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.02 | 0.11 | 0.36 |
| Cl2O−1 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| F2O−1 | 0.01 | 0.01 | 0.03 | 0.02 | 0.04 | 0.04 | 0.00 | 0.07 | 0.02 | 0.02 | 0.02 | 0.00 | 0.04 |
| Total | 86.48 | 86.05 | 88.26 | 88.69 | 87.79 | 88.74 | 87.18 | 87.12 | 88.46 | 87.63 | 88.21 | 88.56 | 89.75 |
| Si | 2.94 | 2.96 | 2.95 | 2.96 | 3.01 | 2.99 | 3.05 | 3.06 | 3.02 | 3.05 | 3.03 | 3.22 | 3.18 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| Al | 2.27 | 2.22 | 2.25 | 2.20 | 2.18 | 2.18 | 2.19 | 2.19 | 2.18 | 2.19 | 2.14 | 2.08 | 2.21 |
| Cr | 0.00 | 0.02 | 0.00 | 0.01 | 0.02 | 0.02 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.02 |
| Fe3+ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe2+ | 1.68 | 1.75 | 1.74 | 1.59 | 1.61 | 1.61 | 1.59 | 1.61 | 1.64 | 1.61 | 1.54 | 1.62 | 1.68 |
| Mn | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| Mg | 3.07 | 3.01 | 3.03 | 3.22 | 3.16 | 3.18 | 3.13 | 3.11 | 3.13 | 3.12 | 3.25 | 3.05 | 2.88 |
| Ca | 0.01 | 0.02 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.01 | 0.01 | 0.02 | 0.02 | 0.07 | 0.02 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.02 | 0.07 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.00 | 0.04 | 0.01 | 0.01 | 0.01 | 0.00 | 0.02 |
| O | 14.08 | 14.11 | 14.09 | 14.07 | 14.13 | 14.09 | 14.18 | 14.16 | 14.13 | 14.17 | 14.13 | 14.34 | 14.35 |
| Mg# | 0.65 | 0.63 | 0.63 | 0.67 | 0.66 | 0.66 | 0.66 | 0.66 | 0.66 | 0.66 | 0.68 | 0.65 | 0.63 |

| sample | cr0443 | cr04551 | cr04551 | cr04551 | cr04551 | cr04551 | cr04551 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Chl−13 | Chl−1 | Chl−2 | Chl−3 | Chl−4 | Chl−5 | Chl−6 | Chl−1 | Chl−2 | Chl−3 | Chl−4 | Chl−5 | Chl−6 |
| SiO2 | 30.97 | 28.46 | 27.96 | 28.90 | 27.68 | 28.46 | 27.08 | 27.82 | 28.41 | 29.06 | 29.45 | 26.34 | 26.94 |
| TiO2 | 0.00 | 0.03 | 0.03 | 0.00 | 0.03 | 0.00 | 0.02 | 0.13 | 0.01 | 0.01 | 0.04 | 0.03 | 0.02 |
| Al2O3 | 17.86 | 17.88 | 17.92 | 17.25 | 18.54 | 17.12 | 17.82 | 18.22 | 17.50 | 18.52 | 18.18 | 17.27 | 17.79 |
| Cr2O3 | 0.07 | 0.09 | 0.06 | 0.01 | 0.01 | 0.09 | 0.17 | 0.14 | 0.04 | 0.03 | 0.02 | 0.11 | 0.02 |
| FeO | 18.73 | 24.94 | 25.31 | 24.84 | 24.52 | 24.38 | 25.68 | 24.78 | 24.63 | 25.04 | 24.49 | 28.55 | 27.97 |
| MnO | 0.23 | 0.47 | 0.49 | 0.45 | 0.42 | 0.48 | 0.48 | 0.46 | 0.42 | 0.47 | 0.52 | 0.43 | 0.45 |
| MgO | 20.24 | 16.63 | 16.76 | 17.20 | 17.89 | 17.55 | 16.41 | 16.84 | 17.51 | 16.92 | 16.93 | 15.36 | 15.74 |
| CaO | 0.53 | 0.09 | 0.04 | 0.05 | 0.18 | 0.14 | 0.12 | 0.17 | 0.06 | 0.20 | 0.06 | 0.04 | 0.20 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.01 | 0.02 | 0.00 | 0.00 | 0.01 | 0.02 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 |
| Na2O | 0.00 | 0.12 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.02 | 0.00 |
| Cl2O−1 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 88.67 | 88.72 | 88.65 | 88.71 | 89.30 | 88.25 | 87.79 | 88.56 | 88.59 | 90.26 | 89.72 | 88.16 | 89.13 |
| Si | 3.16 | 2.97 | 2.92 | 3.01 | 2.85 | 2.97 | 2.86 | 2.91 | 2.96 | 2.98 | 3.03 | 2.80 | 2.83 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 2.15 | 2.20 | 2.21 | 2.12 | 2.25 | 2.11 | 2.22 | 2.24 | 2.15 | 2.24 | 2.21 | 2.17 | 2.20 |
| Cr | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| Fe3+ | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.23 | 0.14 |
| Fe2+ | 1.60 | 2.18 | 2.21 | 2.16 | 2.06 | 2.13 | 2.22 | 2.16 | 2.14 | 2.15 | 2.11 | 2.31 | 2.32 |
| Mn | 0.02 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | 0.04 | 0.04 |
| Mg | 3.08 | 2.59 | 2.61 | 2.67 | 2.75 | 2.74 | 2.59 | 2.62 | 2.72 | 2.59 | 2.60 | 2.44 | 2.47 |
| Ca | 0.06 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.01 | 0.02 | 0.01 | 0.02 | 0.01 | 0.00 | 0.02 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 14.28 | 14.10 | 14.04 | 14.07 | 14.02 | 14.05 | 14.02 | 14.06 | 14.04 | 14.12 | 14.15 | 14.01 | 14.03 |
| Mg# | 0.66 | 0.54 | 0.54 | 0.55 | 0.57 | 0.56 | 0.54 | 0.55 | 0.56 | 0.55 | 0.55 | 0.51 | 0.51 |

| sample | cr04552 | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Chl−7 | Chl−1 | Chl−2 | Chl−3 | Chl−4 | Chl−5 | Chl−6 | Chl−7 | Chl−8 | Chl−9 | Chl−10 | Chl−11 | Chl−12 |
| SiO2 | 27.03 | 28.60 | 28.72 | 28.87 | 29.03 | 29.04 | 29.04 | 29.05 | 29.07 | 29.10 | 29.14 | 29.31 | 29.40 |
| TiO2 | 0.03 | 0.00 | 0.06 | 0.00 | 0.02 | 0.03 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.03 |
| Al2O3 | 17.78 | 19.66 | 19.35 | 19.34 | 19.42 | 19.46 | 19.04 | 19.28 | 19.22 | 19.64 | 19.38 | 19.61 | 19.51 |
| Cr2O3 | 0.05 | 0.80 | 0.90 | 0.64 | 0.53 | 0.58 | 0.59 | 0.38 | 0.38 | 0.51 | 0.51 | 0.46 | 0.63 |
| FeO | 27.44 | 11.89 | 11.82 | 11.83 | 11.88 | 12.29 | 11.71 | 12.01 | 11.78 | 11.96 | 11.87 | 11.94 | 11.54 |
| MnO | 0.52 | 0.19 | 0.18 | 0.21 | 0.24 | 0.22 | 0.13 | 0.28 | 0.16 | 0.24 | 0.20 | 0.18 | 0.15 |
| MgO | 16.29 | 25.49 | 25.12 | 25.61 | 25.85 | 25.70 | 25.60 | 25.73 | 25.61 | 25.56 | 25.66 | 25.83 | 25.99 |
| CaO | 0.01 | 0.10 | 0.07 | 0.06 | 0.06 | 0.06 | 0.05 | 0.08 | 0.15 | 0.03 | 0.07 | 0.05 | 0.04 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| Na2O | 0.03 | 0.00 | 0.03 | 0.00 | 0.00 | 0.02 | 0.01 | 0.02 | 0.01 | 0.02 | 0.00 | 0.00 | 0.00 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.03 | 0.03 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.13 | 0.00 | 0.09 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 89.19 | 86.73 | 86.26 | 86.58 | 87.04 | 87.55 | 86.18 | 86.91 | 86.40 | 87.11 | 86.83 | 87.39 | 87.30 |
| Si | 2.82 | 2.85 | 2.88 | 2.88 | 2.87 | 2.87 | 2.90 | 2.88 | 2.90 | 2.88 | 2.89 | 2.89 | 2.90 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 2.19 | 2.31 | 2.29 | 2.27 | 2.27 | 2.27 | 2.24 | 2.26 | 2.26 | 2.29 | 2.27 | 2.28 | 2.27 |
| Cr | 0.00 | 0.06 | 0.07 | 0.05 | 0.04 | 0.05 | 0.05 | 0.03 | 0.03 | 0.04 | 0.04 | 0.04 | 0.05 |
| Fe3+ | 0.16 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe2+ | 2.23 | 0.99 | 0.99 | 0.98 | 0.98 | 1.02 | 0.98 | 1.00 | 0.98 | 0.99 | 0.99 | 0.98 | 0.95 |
| Mn | 0.05 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.02 | 0.01 | 0.02 | 0.02 | 0.01 | 0.01 |
| Mg | 2.54 | 3.78 | 3.75 | 3.80 | 3.81 | 3.78 | 3.82 | 3.81 | 3.81 | 3.77 | 3.80 | 3.80 | 3.82 |
| Ca | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.00 | 0.01 | 0.01 | 0.00 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 14.01 | 14.04 | 14.07 | 14.04 | 14.04 | 14.00 | 14.06 | 14.02 | 14.06 | 14.05 | 14.05 | 14.05 | 14.06 |
| Mg♯ | 0.53 | 0.79 | 0.79 | 0.79 | 0.80 | 0.79 | 0.80 | 0.79 | 0.79 | 0.79 | 0.79 | 0.79 | 0.80 |

| sample | cr0462 | cr0462 | cr0462 | cr0481a | cr0481a | cr0481a | cr0481a | cr0481a | cr0481a | cr0481a | cr0481a | cr0481a | cr0481b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Chl−1 | Chl−2 | Chl−3 | Chl−1 | Chl−2 | Chl−3 | Chl−4 | Chl−5 | Chl−6 | Chl−7 | Chl−8 | Chl−9 | Chl−1 |
| SiO2 | 30.17 | 30.64 | 31.25 | 27.14 | 26.88 | 27.12 | 27.53 | 27.15 | 27.64 | 27.01 | 27.50 | 27.40 | 28.10 |
| TiO2 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.02 | 0.01 | 0.03 | 0.06 | 0.07 | 0.01 | 0.01 | 0.00 |
| Al2O3 | 17.82 | 17.70 | 17.88 | 17.71 | 17.53 | 18.19 | 17.90 | 18.50 | 17.75 | 18.13 | 18.14 | 17.54 | 17.43 |
| Cr2O3 | 0.05 | 0.07 | 0.06 | 0.00 | 0.00 | 0.05 | 0.03 | 0.02 | 0.05 | 0.06 | 0.02 | 0.00 | 0.01 |
| FeO | 17.16 | 17.27 | 17.24 | 27.12 | 27.30 | 26.24 | 26.57 | 26.22 | 26.11 | 25.93 | 26.83 | 26.01 | 23.99 |
| MnO | 0.33 | 0.28 | 0.32 | 0.50 | 0.50 | 0.45 | 0.46 | 0.45 | 0.52 | 0.52 | 0.46 | 0.49 | 0.40 |
| MgO | 21.69 | 21.15 | 21.44 | 13.83 | 15.05 | 15.29 | 15.05 | 15.52 | 15.72 | 15.41 | 15.52 | 15.46 | 16.65 |
| CaO | 0.42 | 0.52 | 0.44 | 0.15 | 0.06 | 0.08 | 0.17 | 0.05 | 0.09 | 0.15 | 0.06 | 0.08 | 0.19 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.03 | 0.04 | 0.05 | 0.03 | 0.00 | 0.03 | 0.01 | 0.04 | 0.03 | 0.08 | 0.03 | 0.02 | 0.02 |
| Na2O | 0.01 | 0.00 | 0.00 | 0.01 | 0.03 | 0.08 | 0.08 | 0.05 | 0.02 | 0.10 | 0.00 | 0.04 | 0.03 |
| Cl2O−1 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 |
| Total | 87.68 | 87.67 | 88.68 | 86.50 | 87.35 | 87.56 | 87.82 | 88.04 | 88.00 | 87.45 | 88.61 | 87.05 | 86.83 |
| Si | 3.07 | 3.13 | 3.16 | 2.96 | 2.88 | 2.89 | 2.94 | 2.87 | 2.93 | 2.89 | 2.90 | 2.94 | 2.99 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| Al | 2.14 | 2.13 | 2.13 | 2.27 | 2.22 | 2.29 | 2.25 | 2.31 | 2.22 | 2.28 | 2.25 | 2.22 | 2.19 |
| Cr | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe2+ | 1.46 | 1.48 | 1.46 | 2.47 | 2.43 | 2.34 | 2.37 | 2.32 | 2.31 | 2.32 | 2.37 | 2.33 | 2.14 |
| Mn | 0.03 | 0.02 | 0.03 | 0.05 | 0.05 | 0.04 | 0.04 | 0.04 | 0.05 | 0.05 | 0.04 | 0.04 | 0.04 |
| Mg | 3.29 | 3.22 | 3.23 | 2.25 | 2.41 | 2.43 | 2.39 | 2.45 | 2.48 | 2.45 | 2.44 | 2.47 | 2.64 |
| Ca | 0.05 | 0.06 | 0.05 | 0.02 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.02 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.02 | 0.01 | 0.00 | 0.02 | 0.00 | 0.01 | 0.01 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| O | 14.19 | 14.26 | 14.27 | 14.12 | 14.01 | 14.06 | 14.09 | 14.04 | 14.06 | 14.07 | 14.03 | 14.06 | 14.11 |
| Mg♯ | 0.69 | 0.69 | 0.69 | 0.48 | 0.50 | 0.51 | 0.50 | 0.51 | 0.52 | 0.51 | 0.51 | 0.51 | 0.55 |

| sample | cr0481b | cr0481b | cr0481b | cr0481b | cr0481b | cr0481b | cr0481b | cr0481b | cr0481b | cr0481b | cr0481b | cr0481b | cr0481b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Chl−2 | Chl−3 | Chl−4 | Chl−5 | Chl−6 | Chl−7 | Chl−8 | Chl−9 | Chl−10 | Chl−11 | Chl−12 | Chl−13 | Chl−14 |
| SiO2 | 28.05 | 27.17 | 27.96 | 28.49 | 27.43 | 27.10 | 26.71 | 27.11 | 27.70 | 27.96 | 27.42 | 27.17 | 27.05 |
| TiO2 | 0.03 | 0.02 | 0.01 | 0.04 | 0.01 | 0.01 | 0.04 | 0.01 | 0.03 | 0.01 | 0.02 | 0.03 | 0.04 |
| Al2O3 | 18.06 | 18.24 | 17.97 | 17.57 | 18.80 | 18.73 | 18.25 | 18.36 | 17.87 | 18.44 | 18.39 | 18.05 | 18.16 |
| Cr2O3 | 0.02 | 0.00 | 0.02 | 0.00 | 0.00 | 0.03 | 0.03 | 0.02 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 |
| FeO | 24.89 | 24.92 | 24.97 | 24.70 | 24.79 | 24.38 | 24.70 | 24.37 | 24.43 | 24.70 | 24.74 | 24.65 | 24.75 |
| MnO | 0.45 | 0.42 | 0.43 | 0.49 | 0.52 | 0.53 | 0.44 | 0.55 | 0.46 | 0.38 | 0.44 | 0.41 | 0.41 |
| MgO | 16.23 | 16.53 | 16.97 | 16.66 | 17.06 | 16.94 | 16.62 | 16.48 | 17.09 | 17.26 | 16.84 | 16.82 | 16.84 |
| CaO | 0.17 | 0.10 | 0.10 | 0.16 | 0.14 | 0.10 | 0.14 | 0.10 | 0.07 | 0.08 | 0.11 | 0.14 | 0.23 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.03 | 0.01 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.02 | 0.01 | 0.00 |
| Na2O | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.03 | 0.03 | 0.03 | 0.04 | 0.06 | 0.04 | 0.00 | 0.00 |
| Cl2O−1 | 0.01 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.02 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 87.91 | 87.41 | 88.45 | 88.13 | 88.83 | 87.84 | 86.96 | 87.05 | 87.72 | 88.89 | 88.06 | 87.29 | 87.50 |
| Si | 2.96 | 2.87 | 2.92 | 2.99 | 2.85 | 2.84 | 2.84 | 2.88 | 2.91 | 2.90 | 2.88 | 2.88 | 2.86 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 2.25 | 2.27 | 2.21 | 2.18 | 2.30 | 2.32 | 2.29 | 2.30 | 2.21 | 2.25 | 2.27 | 2.25 | 2.26 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 |
| Fe2+ | 2.20 | 2.21 | 2.18 | 2.17 | 2.15 | 2.14 | 2.16 | 2.16 | 2.15 | 2.14 | 2.17 | 2.18 | 2.16 |
| Mn | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | 0.05 | 0.04 | 0.05 | 0.04 | 0.03 | 0.04 | 0.04 | 0.04 |
| Mg | 2.55 | 2.61 | 2.64 | 2.61 | 2.64 | 2.65 | 2.63 | 2.61 | 2.68 | 2.67 | 2.63 | 2.65 | 2.65 |
| Ca | 0.02 | 0.01 | 0.01 | 0.02 | 0.02 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.03 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 14.11 | 14.02 | 14.04 | 14.11 | 14.02 | 14.02 | 14.02 | 14.04 | 14.03 | 14.04 | 14.03 | 14.02 | 14.03 |
| Mg# | 0.54 | 0.54 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 |

| sample | cr0481b | cr0481b | cr0481b |
|---|---|---|---|
| point | Chl−15 | Chl−16 | Chl−17 |
| SiO2 | 27.68 | 27.93 | 28.07 |
| TiO2 | 0.02 | 0.01 | 0.02 |
| Al2O3 | 18.07 | 17.79 | 19.09 |
| Cr2O3 | 0.02 | 0.00 | 0.00 |
| FeO | 24.59 | 24.78 | 23.25 |
| MnO | 0.42 | 0.45 | 0.42 |
| MgO | 17.26 | 17.43 | 17.16 |
| CaO | 0.32 | 0.07 | 0.17 |
| BaO | 0.00 | 0.00 | 0.00 |
| K2O | 0.01 | 0.02 | 0.03 |
| Na2O | 0.02 | 0.00 | 0.03 |
| Cl2O−1 | 0.00 | 0.00 | 0.01 |
| F2O−1 | 0.00 | 0.00 | 0.00 |
| Total | 88.41 | 88.48 | 88.27 |
| Si | 2.89 | 2.91 | 2.93 |
| Ti | 0.00 | 0.00 | 0.00 |
| Al | 2.23 | 2.18 | 2.34 |
| Cr | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.00 | 0.00 | 0.00 |
| Fe2+ | 2.15 | 2.16 | 2.03 |
| Mn | 0.04 | 0.04 | 0.04 |
| Mg | 2.69 | 2.71 | 2.66 |
| Ca | 0.04 | 0.01 | 0.02 |
| Ba | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.00 | 0.01 |
| Cl | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 |
| O | 14.05 | 14.01 | 14.12 |
| Mg# | 0.56 | 0.56 | 0.57 |

| sample | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Gl−1 | Gl−2 | Gl−3 | Gl−4 | Gl−5 | Gl−1 | Gl−2 | Gl−3 | Gl−4 | Gl−5 | Gl−6 | Gl−7 | Gl−8 |
| SiO2 | 56.42 | 56.38 | 55.69 | 55.71 | 55.50 | 56.28 | 56.07 | 55.87 | 56.71 | 56.85 | 57.46 | 54.91 | 55.66 |
| TiO2 | 0.07 | 0.00 | 0.06 | 0.23 | 0.24 | 0.05 | 0.13 | 0.17 | 0.12 | 0.08 | 0.14 | 0.19 | 0.17 |
| Al2O3 | 9.88 | 9.99 | 9.80 | 10.73 | 11.05 | 6.85 | 6.58 | 5.88 | 6.87 | 4.99 | 6.12 | 5.70 | 5.73 |
| Cr2O3 | 0.00 | 0.00 | 0.02 | 0.00 | 0.06 | 0.00 | 0.01 | 0.01 | 0.02 | 0.05 | 0.05 | 0.02 | 0.00 |
| FeO | 16.02 | 15.07 | 17.39 | 14.63 | 15.17 | 13.68 | 14.74 | 15.63 | 14.89 | 15.57 | 14.88 | 16.75 | 15.69 |
| MnO | 0.09 | 0.12 | 0.11 | 0.06 | 0.12 | 0.28 | 0.27 | 0.26 | 0.20 | 0.17 | 0.20 | 0.17 | 0.25 |
| MgO | 7.72 | 7.66 | 6.12 | 7.03 | 6.71 | 11.14 | 10.84 | 10.53 | 10.61 | 11.18 | 11.33 | 9.83 | 10.62 |
| CaO | 1.37 | 1.36 | 0.73 | 1.06 | 0.88 | 1.86 | 1.72 | 1.89 | 1.79 | 2.36 | 2.11 | 2.02 | 1.78 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.03 | 0.00 | 0.02 | 0.00 | 0.02 | 0.03 | 0.08 | 0.02 | 0.03 | 0.02 | 0.06 | 0.03 |
| Na2O | 6.43 | 6.32 | 6.69 | 6.77 | 6.75 | 5.94 | 6.26 | 6.00 | 6.25 | 6.06 | 6.08 | 6.30 | 6.43 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 98.00 | 96.93 | 96.61 | 96.25 | 96.49 | 96.12 | 96.65 | 96.33 | 97.48 | 97.33 | 98.41 | 95.95 | 96.36 |
| Si | 7.88 | 7.94 | 7.95 | 7.93 | 7.88 | 7.89 | 7.87 | 7.90 | 7.90 | 7.98 | 7.92 | 7.88 | 7.89 |
| Ti | 0.01 | 0.00 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 |
| Al | 1.63 | 1.66 | 1.65 | 1.80 | 1.85 | 1.13 | 1.09 | 0.98 | 1.13 | 0.83 | 0.99 | 0.96 | 0.96 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 |
| Fe3+ | 0.36 | 0.18 | 0.30 | 0.20 | 0.25 | 0.70 | 0.88 | 0.86 | 0.76 | 0.87 | 0.79 | 1.03 | 1.03 |
| Fe2+ | 1.51 | 1.59 | 1.78 | 1.54 | 1.55 | 0.91 | 0.85 | 0.98 | 0.97 | 0.96 | 0.92 | 0.98 | 0.83 |
| Mn | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 |
| Mg | 1.61 | 1.61 | 1.30 | 1.49 | 1.42 | 2.33 | 2.27 | 2.22 | 2.20 | 2.34 | 2.33 | 2.10 | 2.25 |
| Ca | 0.20 | 0.21 | 0.11 | 0.16 | 0.13 | 0.28 | 0.26 | 0.29 | 0.27 | 0.35 | 0.31 | 0.31 | 0.27 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 |
| Na | 1.74 | 1.73 | 1.85 | 1.87 | 1.86 | 1.62 | 1.70 | 1.64 | 1.69 | 1.65 | 1.63 | 1.75 | 1.77 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 22.95 | 22.94 | 22.97 | 23.06 | 23.02 | 22.90 | 22.98 | 22.96 | 22.97 | 23.02 | 22.96 | 23.09 | 23.06 |
| Mg# | 0.52 | 0.50 | 0.42 | 0.49 | 0.48 | 0.72 | 0.73 | 0.69 | 0.69 | 0.71 | 0.72 | 0.68 | 0.73 |
| Al# | 0.79 | 0.89 | 0.84 | 0.89 | 0.87 | 0.57 | 0.48 | 0.47 | 0.55 | 0.47 | 0.51 | 0.41 | 0.42 |
| Ts | 0.12 | 0.06 | 0.05 | 0.07 | 0.12 | 0.11 | 0.13 | 0.10 | 0.10 | 0.02 | 0.08 | 0.12 | 0.11 |
| A−site | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.04 |

| sample | cr0318c | cr0318c | cr0318c | cr0318c | cr0318d | cr0318d | cr0422b | cr0422b | cr0422b | cr0422b | cr0422b | cr0428b | cr0428b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Gl−9 | Gl−10 | Gl−11 | Gl−12 | Gl−1 | Gl−2 | Gl−1 | Gl−2 | Gl−3 | Gl−4 | Gl−5 | Gl−1 | Gl−2 |
| SiO2 | 57.33 | 56.21 | 56.02 | 56.96 | 56.51 | 56.40 | 58.93 | 59.30 | 59.45 | 59.98 | 61.20 | 56.03 | 54.12 |
| TiO2 | 0.07 | 0.13 | 0.17 | 0.17 | 0.11 | 0.09 | 0.07 | 0.07 | 0.07 | 0.05 | 0.07 | 0.05 | 0.00 |
| Al2O3 | 6.13 | 6.46 | 6.12 | 7.07 | 8.52 | 7.60 | 8.98 | 7.74 | 8.90 | 8.21 | 9.87 | 11.46 | 13.18 |
| Cr2O3 | 0.00 | 0.05 | 0.02 | 0.06 | 0.01 | 0.02 | 0.00 | 0.00 | 0.00 | 0.04 | 0.01 | 0.04 | 0.02 |
| FeO | 15.32 | 14.76 | 15.10 | 13.97 | 14.73 | 14.62 | 15.39 | 14.67 | 15.46 | 16.67 | 14.40 | 16.96 | 14.00 |
| MnO | 0.12 | 0.13 | 0.25 | 0.24 | 0.30 | 0.15 | 0.11 | 0.10 | 0.10 | 0.09 | 0.13 | 0.07 | 0.14 |
| MgO | 10.95 | 10.56 | 10.74 | 10.92 | 8.95 | 9.78 | 8.56 | 10.20 | 8.68 | 8.01 | 8.27 | 6.47 | 8.89 |
| CaO | 1.80 | 1.79 | 2.05 | 1.78 | 1.45 | 1.34 | 2.19 | 3.69 | 2.04 | 2.44 | 1.40 | 0.67 | 1.43 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.03 | 0.00 | 0.02 | 0.04 | 0.05 | 0.00 | 0.03 | 0.00 | 0.03 | 0.00 | 0.00 | 0.04 | 0.01 |
| Na2O | 6.22 | 5.98 | 5.95 | 6.49 | 6.26 | 6.56 | 5.73 | 4.72 | 5.60 | 5.08 | 4.40 | 6.78 | 6.52 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 |
| Total | 97.97 | 96.06 | 96.45 | 97.70 | 96.89 | 96.57 | 100.00 | 100.51 | 100.33 | 100.59 | 99.77 | 98.58 | 98.32 |
| Si | 7.94 | 7.93 | 7.90 | 7.91 | 7.94 | 7.94 | 8.04 | 8.03 | 8.05 | 8.15 | 8.17 | 7.79 | 7.43 |
| Ti | 0.01 | 0.01 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 |
| Al | 1.00 | 1.07 | 1.02 | 1.16 | 1.41 | 1.26 | 1.44 | 1.23 | 1.42 | 1.31 | 1.55 | 1.88 | 2.13 |
| Cr | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.79 | 0.70 | 0.82 | 0.77 | 0.42 | 0.65 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.37 | 0.75 |
| Fe2+ | 0.99 | 1.04 | 0.96 | 0.85 | 1.31 | 1.07 | 1.76 | 1.66 | 1.75 | 1.89 | 1.61 | 1.60 | 0.85 |
| Mn | 0.01 | 0.02 | 0.03 | 0.03 | 0.04 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 |
| Mg | 2.26 | 2.22 | 2.26 | 2.26 | 1.87 | 2.05 | 1.74 | 2.06 | 1.75 | 1.62 | 1.65 | 1.34 | 1.82 |
| Ca | 0.27 | 0.27 | 0.31 | 0.27 | 0.22 | 0.20 | 0.32 | 0.54 | 0.30 | 0.36 | 0.20 | 0.10 | 0.21 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| Na | 1.67 | 1.64 | 1.63 | 1.75 | 1.70 | 1.79 | 1.51 | 1.24 | 1.47 | 1.34 | 1.14 | 1.83 | 1.74 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |
| O | 22.95 | 22.92 | 22.96 | 23.04 | 22.94 | 23.00 | 22.85 | 22.80 | 22.81 | 22.83 | 22.72 | 22.94 | 22.95 |
| Mg# | 0.70 | 0.68 | 0.70 | 0.73 | 0.59 | 0.66 | 0.50 | 0.55 | 0.50 | 0.46 | 0.51 | 0.46 | 0.68 |
| Al# | 0.53 | 0.57 | 0.50 | 0.56 | 0.75 | 0.63 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.80 | 0.57 |
| Ts | 0.06 | 0.07 | 0.10 | 0.09 | 0.06 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.21 | 0.57 |
| A−site | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| sample | cr0429 | cr0429 | cr0429 | cr0429 | cr0430a | cr0430a | cr0430a | cr0430a | cr0433 | cr0433 | cr0433 | cr0433 | cr0433 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Gl−1 | Gl−2 | Gl−3 | Gl−4 | Gl−1 | Gl−2 | Gl−3 | Gl−4 | Gl−1 | Gl−2 | Gl−3 | Gl−4 | Gl−5 |
| SiO2 | 54.70 | 54.75 | 55.68 | 55.34 | 54.66 | 54.95 | 55.55 | 56.54 | 55.56 | 55.88 | 55.92 | 56.88 | 57.20 |
| TiO2 | 0.01 | 0.09 | 0.05 | 0.08 | 0.03 | 0.08 | 0.08 | 0.07 | 0.09 | 0.13 | 0.15 | 0.03 | 0.09 |
| Al2O3 | 11.74 | 11.41 | 12.59 | 11.57 | 10.51 | 10.38 | 10.31 | 10.56 | 4.39 | 4.96 | 4.64 | 7.09 | 8.01 |
| Cr2O3 | 0.02 | 0.02 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.42 | 0.01 |
| FeO | 15.37 | 15.83 | 15.44 | 15.58 | 22.16 | 21.62 | 20.43 | 15.44 | 22.63 | 21.57 | 20.89 | 16.08 | 14.84 |
| MnO | 0.10 | 0.07 | 0.09 | 0.13 | 0.12 | 0.13 | 0.12 | 0.11 | 0.13 | 0.11 | 0.13 | 0.19 | 0.11 |
| MgO | 7.43 | 7.57 | 7.22 | 7.79 | 4.04 | 4.06 | 4.94 | 6.92 | 7.26 | 7.55 | 8.17 | 9.69 | 9.55 |
| CaO | 0.83 | 0.82 | 0.54 | 0.89 | 1.15 | 0.97 | 1.12 | 2.54 | 0.76 | 0.92 | 1.12 | 1.22 | 0.50 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| K2O | 0.01 | 0.02 | 0.01 | 0.01 | 0.03 | 0.03 | 0.01 | 0.01 | 0.02 | 0.01 | 0.03 | 0.01 | 0.00 |
| Na2O | 6.76 | 6.86 | 6.74 | 6.82 | 6.72 | 6.62 | 6.56 | 6.64 | 6.57 | 6.55 | 6.62 | 6.56 | 6.91 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.04 | 0.04 | 0.03 |
| Total | 96.97 | 97.44 | 98.39 | 98.20 | 99.42 | 98.84 | 99.13 | 98.83 | 97.45 | 97.71 | 97.75 | 98.21 | 97.26 |
| Si | 7.68 | 7.66 | 7.67 | 7.67 | 7.75 | 7.81 | 7.82 | 7.96 | 7.97 | 7.96 | 7.96 | 7.90 | 7.96 |
| Ti | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.00 | 0.01 |
| Al | 1.94 | 1.88 | 2.05 | 1.89 | 1.76 | 1.74 | 1.71 | 1.75 | 0.74 | 0.83 | 0.78 | 1.16 | 1.31 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 |
| Fe3+ | 0.54 | 0.65 | 0.41 | 0.60 | 0.60 | 0.47 | 0.43 | 0.14 | 1.15 | 1.05 | 1.12 | 0.81 | 0.64 |
| Fe2+ | 1.27 | 1.20 | 1.37 | 1.21 | 2.03 | 2.10 | 1.97 | 1.67 | 1.56 | 1.52 | 1.37 | 1.05 | 1.09 |
| Mn | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.02 | 0.01 |
| Mg | 1.56 | 1.58 | 1.48 | 1.61 | 0.85 | 0.86 | 1.04 | 1.45 | 1.55 | 1.60 | 1.74 | 2.01 | 1.98 |
| Ca | 0.13 | 0.12 | 0.08 | 0.13 | 0.17 | 0.15 | 0.17 | 0.38 | 0.12 | 0.14 | 0.17 | 0.18 | 0.07 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| Na | 1.84 | 1.86 | 1.80 | 1.83 | 1.85 | 1.82 | 1.79 | 1.81 | 1.83 | 1.81 | 1.83 | 1.77 | 1.86 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.03 | 0.03 | 0.02 |
| O | 22.97 | 23.00 | 22.89 | 22.97 | 23.03 | 22.98 | 22.97 | 23.20 | 22.95 | 22.95 | 23.00 | 22.96 | 22.94 |
| Mg# | 0.55 | 0.57 | 0.52 | 0.57 | 0.30 | 0.29 | 0.34 | 0.46 | 0.50 | 0.51 | 0.56 | 0.66 | 0.65 |
| Al# | 0.71 | 0.65 | 0.77 | 0.67 | 0.68 | 0.74 | 0.76 | 0.92 | 0.37 | 0.42 | 0.39 | 0.54 | 0.66 |
| Ts | 0.32 | 0.34 | 0.33 | 0.33 | 0.25 | 0.19 | 0.18 | 0.04 | 0.03 | 0.04 | 0.04 | 0.10 | 0.04 |
| A−site | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.19 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| sample | cr0433 | cr0433 | cr0433 | cr0433 | cr0433 | cr0433 | cr0433 | cr0433 | cr0433 | cr0433 | cr0433 | cr0433 | cr0433 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Gl−6 | Gl−7 | Gl−8 | Gl−9 | Gl−10 | Gl−11 | Gl−12 | Gl−13 | Gl−14 | Gl−15 | Gl−16 | Gl−17 | Gl−18 |
| SiO2 | 57.40 | 57.55 | 57.77 | 57.78 | 57.86 | 57.93 | 58.18 | 58.20 | 58.26 | 58.31 | 58.34 | 58.38 | 58.56 |
| TiO2 | 0.03 | 0.08 | 0.06 | 0.00 | 1.12 | 0.10 | 0.06 | 0.05 | 0.06 | 0.03 | 0.10 | 0.06 | 0.05 |
| Al2O3 | 7.00 | 8.21 | 8.20 | 7.44 | 8.97 | 7.71 | 8.81 | 9.11 | 8.01 | 8.04 | 7.71 | 8.52 | 8.52 |
| Cr2O3 | 0.21 | 0.00 | 0.01 | 0.01 | 0.04 | 0.01 | 0.04 | 0.01 | 0.16 | 0.03 | 0.00 | 0.04 | 0.00 |
| FeO | 15.88 | 14.87 | 14.93 | 15.32 | 13.14 | 14.86 | 14.12 | 13.61 | 14.45 | 13.86 | 15.17 | 14.10 | 14.10 |
| MnO | 0.21 | 0.18 | 0.15 | 0.14 | 0.12 | 0.14 | 0.16 | 0.15 | 0.11 | 0.11 | 0.17 | 0.15 | 0.12 |
| MgO | 10.20 | 9.41 | 9.60 | 9.77 | 9.40 | 9.93 | 9.91 | 9.73 | 9.77 | 10.69 | 10.12 | 9.74 | 9.67 |
| CaO | 1.19 | 0.62 | 0.58 | 0.69 | 1.22 | 0.58 | 0.47 | 0.44 | 0.41 | 0.81 | 0.54 | 0.42 | 0.28 |
| BaO | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.01 | 0.00 | 0.01 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| Na2O | 6.71 | 6.89 | 7.07 | 6.92 | 6.89 | 7.30 | 7.03 | 7.08 | 6.95 | 6.86 | 7.10 | 7.13 | 7.23 |
| Cl2O−1 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.03 | 0.04 | 0.02 | 0.04 | 0.06 | 0.04 | 0.01 | 0.04 | 0.03 | 0.06 | 0.01 | 0.02 | 0.00 |
| Total | 98.89 | 97.87 | 98.41 | 98.13 | 98.84 | 98.59 | 98.81 | 98.43 | 98.20 | 98.80 | 99.26 | 98.57 | 98.53 |
| Si | 7.90 | 7.97 | 7.95 | 7.99 | 7.97 | 7.97 | 7.93 | 7.96 | 8.00 | 7.94 | 7.95 | 7.99 | 8.02 |
| Ti | 0.00 | 0.01 | 0.01 | 0.00 | 0.12 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 |
| Al | 1.13 | 1.34 | 1.33 | 1.21 | 1.46 | 1.25 | 1.41 | 1.47 | 1.30 | 1.29 | 1.24 | 1.38 | 1.38 |
| Cr | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.86 | 0.57 | 0.65 | 0.67 | 0.45 | 0.75 | 0.58 | 0.48 | 0.55 | 0.64 | 0.74 | 0.53 | 0.51 |
| Fe2+ | 0.97 | 1.15 | 1.07 | 1.10 | 1.07 | 0.96 | 1.03 | 1.08 | 1.12 | 0.94 | 0.99 | 1.08 | 1.11 |
| Mn | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.02 | 0.02 | 0.01 |
| Mg | 2.09 | 1.94 | 1.97 | 2.01 | 1.93 | 2.04 | 2.01 | 1.99 | 2.00 | 2.17 | 2.06 | 1.99 | 1.97 |
| Ca | 0.18 | 0.09 | 0.09 | 0.10 | 0.18 | 0.09 | 0.07 | 0.07 | 0.06 | 0.12 | 0.08 | 0.06 | 0.04 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 1.79 | 1.85 | 1.89 | 1.86 | 1.84 | 1.95 | 1.86 | 1.88 | 1.85 | 1.81 | 1.87 | 1.89 | 1.92 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.02 | 0.03 | 0.01 | 0.03 | 0.04 | 0.03 | 0.01 | 0.03 | 0.02 | 0.04 | 0.01 | 0.02 | 0.00 |
| O | 22.97 | 22.93 | 22.97 | 22.95 | 23.12 | 23.03 | 22.93 | 22.93 | 22.92 | 22.91 | 22.96 | 22.95 | 22.96 |
| Mg# | 0.68 | 0.63 | 0.65 | 0.65 | 0.64 | 0.68 | 0.66 | 0.65 | 0.64 | 0.70 | 0.68 | 0.65 | 0.64 |
| Al# | 0.52 | 0.69 | 0.66 | 0.64 | 0.76 | 0.61 | 0.69 | 0.74 | 0.71 | 0.65 | 0.61 | 0.72 | 0.74 |
| Ts | 0.10 | 0.03 | 0.05 | 0.01 | 0.03 | 0.03 | 0.07 | 0.04 | 0.00 | 0.06 | 0.05 | 0.01 | 0.00 |
| A−site | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| sample | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Gl−1 | Gl−2 | Gl−3 | Gl−4 | Gl−5 | Gl−6 | Gl−7 | Gl−8 | Gl−9 | Gl−10 | Gl−11 | Gl−12 | Gl−13 |
| SiO2 | 55.21 | 55.50 | 55.62 | 55.84 | 55.97 | 56.51 | 56.83 | 57.43 | 57.72 | 53.62 | 54.95 | 55.15 | 55.49 |
| TiO2 | 0.74 | 0.09 | 0.08 | 0.10 | 0.04 | 0.04 | 0.07 | 0.01 | 0.08 | 0.04 | 0.05 | 0.10 | 0.07 |
| Al2O3 | 11.12 | 10.19 | 10.91 | 10.22 | 11.33 | 10.64 | 11.47 | 12.29 | 11.61 | 9.63 | 8.93 | 10.35 | 10.11 |
| Cr2O3 | 0.03 | 0.01 | 0.02 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.41 | 0.03 | 0.07 |
| FeO | 16.76 | 19.10 | 18.78 | 19.46 | 18.73 | 15.44 | 14.42 | 14.26 | 14.50 | 21.36 | 20.47 | 18.99 | 18.98 |
| MnO | 0.12 | 0.12 | 0.11 | 0.11 | 0.14 | 0.24 | 0.13 | 0.09 | 0.07 | 0.14 | 0.11 | 0.12 | 0.08 |
| MgO | 5.98 | 5.40 | 4.84 | 4.99 | 4.72 | 7.54 | 7.27 | 6.77 | 7.13 | 4.72 | 4.77 | 4.99 | 4.96 |
| CaO | 2.23 | 1.29 | 0.75 | 0.97 | 0.82 | 1.09 | 0.94 | 0.53 | 0.54 | 1.73 | 0.99 | 1.03 | 0.65 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.03 | 0.05 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.09 | 0.04 | 0.02 | 0.03 |
| Na2O | 6.01 | 6.19 | 6.46 | 6.44 | 6.65 | 6.14 | 6.67 | 6.80 | 6.71 | 6.17 | 6.27 | 6.29 | 6.50 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.03 | 0.00 | 0.00 | 0.02 | 0.01 | 0.02 | 0.02 | 0.01 |
| Total | 98.23 | 97.94 | 97.59 | 98.18 | 98.42 | 97.67 | 97.81 | 98.23 | 98.40 | 97.52 | 97.03 | 97.08 | 96.95 |
| Si | 7.81 | 7.87 | 7.90 | 7.91 | 7.89 | 7.86 | 7.91 | 7.94 | 7.96 | 7.74 | 7.92 | 7.89 | 7.94 |
| Ti | 0.08 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 |
| Al | 1.85 | 1.70 | 1.83 | 1.71 | 1.88 | 1.74 | 1.88 | 2.00 | 1.89 | 1.64 | 1.52 | 1.75 | 1.70 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.01 |
| Fe3+ | 0.18 | 0.27 | 0.16 | 0.24 | 0.15 | 0.19 | 0.10 | 0.00 | 0.00 | 0.60 | 0.39 | 0.22 | 0.22 |
| Fe2+ | 1.80 | 2.00 | 2.07 | 2.06 | 2.06 | 1.61 | 1.58 | 1.65 | 1.67 | 1.98 | 2.08 | 2.05 | 2.06 |
| Mn | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.03 | 0.02 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 |
| Mg | 1.26 | 1.14 | 1.03 | 1.05 | 0.99 | 1.56 | 1.51 | 1.40 | 1.46 | 1.02 | 1.03 | 1.06 | 1.06 |
| Ca | 0.34 | 0.20 | 0.11 | 0.15 | 0.12 | 0.16 | 0.14 | 0.08 | 0.08 | 0.27 | 0.15 | 0.16 | 0.10 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.01 | 0.00 | 0.01 |
| Na | 1.65 | 1.70 | 1.78 | 1.77 | 1.82 | 1.66 | 1.80 | 1.82 | 1.79 | 1.73 | 1.75 | 1.74 | 1.80 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 | 0.02 | 0.01 | 0.02 | 0.02 | 0.01 |
| O | 23.07 | 22.91 | 22.90 | 22.92 | 22.95 | 22.81 | 22.95 | 22.94 | 22.88 | 23.00 | 22.93 | 22.91 | 22.91 |
| Mg# | 0.41 | 0.36 | 0.33 | 0.34 | 0.32 | 0.49 | 0.49 | 0.46 | 0.47 | 0.34 | 0.33 | 0.34 | 0.34 |
| Al# | 0.89 | 0.84 | 0.91 | 0.86 | 0.92 | 0.89 | 0.94 | 1.00 | 1.00 | 0.65 | 0.78 | 0.87 | 0.88 |
| Ts | 0.19 | 0.13 | 0.10 | 0.09 | 0.11 | 0.14 | 0.09 | 0.06 | 0.04 | 0.26 | 0.08 | 0.11 | 0.06 |
| A−site | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| sample | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0438 | cr0438 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Gl−14 | Gl−15 | Gl−16 | Gl−17 | Gl−18 | Gl−19 | Gl−20 | Gl−21 | Gl−22 | Gl−23 | Gl−24 | Gl−1 | Gl−2 |
| SiO2 | 55.74 | 55.75 | 55.87 | 55.89 | 56.02 | 56.16 | 56.19 | 56.40 | 56.60 | 56.97 | 58.56 | 55.59 | 55.90 |
| TiO2 | 0.10 | 0.11 | 0.10 | 0.01 | 0.02 | 0.00 | 0.00 | 0.10 | 0.00 | 0.04 | 0.03 | 0.07 | 0.02 |
| Al2O3 | 10.38 | 8.27 | 9.41 | 11.32 | 11.56 | 12.04 | 11.86 | 9.24 | 11.14 | 10.79 | 10.40 | 6.31 | 6.59 |
| Cr2O3 | 0.14 | 0.01 | 0.02 | 0.00 | 0.03 | 0.00 | 0.02 | 0.04 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 |
| FeO | 17.83 | 17.95 | 17.22 | 18.57 | 18.20 | 18.12 | 17.07 | 14.09 | 17.30 | 16.98 | 13.09 | 19.59 | 18.68 |
| MnO | 0.13 | 0.15 | 0.14 | 0.12 | 0.13 | 0.11 | 0.10 | 0.12 | 0.11 | 0.13 | 0.10 | 0.05 | 0.17 |
| MgO | 5.67 | 7.18 | 6.86 | 4.65 | 4.58 | 4.25 | 5.24 | 9.27 | 5.71 | 6.17 | 8.84 | 8.88 | 9.27 |
| CaO | 0.91 | 2.10 | 1.41 | 0.41 | 0.37 | 0.22 | 0.59 | 3.27 | 0.75 | 0.77 | 1.02 | 0.81 | 1.05 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.01 | 0.03 | 0.03 | 0.01 | 0.00 | 0.01 | 0.00 | 0.02 |
| Na2O | 6.43 | 5.57 | 6.02 | 6.29 | 6.66 | 6.79 | 6.78 | 5.33 | 6.58 | 6.69 | 6.37 | 7.05 | 6.84 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |
| Total | 97.35 | 97.09 | 97.06 | 97.26 | 97.60 | 97.71 | 97.88 | 97.91 | 98.22 | 98.56 | 98.43 | 98.36 | 98.55 |
| Si | 7.91 | 7.93 | 7.91 | 7.91 | 7.93 | 7.94 | 7.91 | 7.87 | 7.93 | 7.94 | 8.01 | 7.79 | 7.79 |
| Ti | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| Al | 1.74 | 1.39 | 1.57 | 1.89 | 1.93 | 2.01 | 1.97 | 1.52 | 1.84 | 1.77 | 1.68 | 1.04 | 1.08 |
| Cr | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.22 | 0.29 | 0.26 | 0.01 | 0.04 | 0.00 | 0.06 | 0.17 | 0.09 | 0.15 | 0.00 | 1.29 | 1.18 |
| Fe2+ | 1.90 | 1.84 | 1.78 | 2.19 | 2.12 | 2.14 | 1.95 | 1.47 | 1.93 | 1.83 | 1.50 | 1.01 | 0.99 |
| Mn | 0.02 | 0.02 | 0.02 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 |
| Mg | 1.20 | 1.52 | 1.45 | 0.98 | 0.97 | 0.90 | 1.10 | 1.93 | 1.19 | 1.28 | 1.80 | 1.85 | 1.93 |
| Ca | 0.14 | 0.32 | 0.21 | 0.06 | 0.06 | 0.03 | 0.09 | 0.49 | 0.11 | 0.12 | 0.15 | 0.12 | 0.16 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 1.77 | 1.53 | 1.65 | 1.73 | 1.83 | 1.86 | 1.85 | 1.44 | 1.79 | 1.81 | 1.69 | 1.92 | 1.85 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |
| O | 22.93 | 22.87 | 22.88 | 22.79 | 22.89 | 22.91 | 22.94 | 22.94 | 22.90 | 22.92 | 22.85 | 23.04 | 23.01 |
| Mg# | 0.39 | 0.45 | 0.45 | 0.31 | 0.31 | 0.29 | 0.36 | 0.57 | 0.38 | 0.41 | 0.55 | 0.65 | 0.66 |
| Al# | 0.88 | 0.81 | 0.84 | 0.99 | 0.98 | 1.00 | 0.97 | 0.88 | 0.95 | 0.92 | 1.00 | 0.33 | 0.36 |
| Ts | 0.09 | 0.07 | 0.09 | 0.09 | 0.07 | 0.06 | 0.09 | 0.13 | 0.07 | 0.06 | 0.00 | 0.21 | 0.21 |
| A−site | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.01 |

| sample | cr0438 | cr0438 | cr0438 | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a | cr0439a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Gl−3 | Gl−4 | Gl−5 | Gl−1 | Gl−2 | Gl−3 | Gl−4 | Gl−5 | Gl−6 | Gl−7 | Gl−8 | Gl−9 | Gl−10 |
| SiO2 | 55.81 | 55.91 | 54.72 | 57.62 | 58.37 | 58.82 | 59.12 | 59.42 | 59.79 | 56.48 | 56.48 | 56.67 | 56.82 |
| TiO2 | 0.05 | 0.00 | 0.06 | 0.01 | 0.05 | 0.09 | 0.04 | 0.09 | 0.06 | 0.10 | 0.00 | 0.10 | 0.15 |
| Al2O3 | 7.97 | 4.43 | 9.08 | 8.29 | 8.01 | 8.71 | 8.48 | 8.50 | 8.93 | 7.88 | 7.77 | 7.97 | 8.16 |
| Cr2O3 | 0.00 | 0.00 | 0.00 | 0.05 | 0.06 | 0.01 | 0.04 | 0.05 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeO | 14.75 | 16.63 | 15.70 | 14.65 | 14.97 | 13.90 | 14.25 | 14.82 | 14.62 | 16.42 | 15.67 | 16.57 | 16.04 |
| MnO | 0.19 | 0.09 | 0.12 | 0.20 | 0.18 | 0.16 | 0.10 | 0.15 | 0.21 | 0.08 | 0.13 | 0.04 | 0.17 |
| MgO | 9.36 | 11.19 | 8.71 | 9.59 | 9.83 | 9.45 | 9.98 | 9.75 | 9.54 | 8.56 | 8.36 | 8.13 | 8.59 |
| CaO | 1.01 | 1.65 | 1.43 | 0.73 | 0.82 | 0.65 | 0.20 | 0.43 | 0.49 | 0.43 | 0.32 | 0.42 | 0.39 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.02 | 0.02 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.01 | 0.02 | 0.00 | 0.00 | 0.02 | 0.00 |
| Na2O | 6.18 | 6.43 | 6.35 | 7.10 | 6.86 | 6.92 | 7.22 | 6.81 | 7.21 | 7.17 | 6.63 | 7.16 | 7.01 |
| Cl2O−1 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.01 | 0.01 | 0.02 | 0.02 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 95.32 | 96.36 | 96.17 | 98.28 | 99.15 | 98.74 | 99.46 | 100.04 | 100.90 | 97.13 | 95.37 | 97.08 | 97.33 |
| Si | 7.91 | 7.92 | 7.76 | 7.95 | 7.97 | 8.05 | 8.00 | 8.00 | 8.01 | 7.95 | 8.04 | 8.00 | 7.95 |
| Ti | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.02 |
| Al | 1.33 | 0.74 | 1.52 | 1.35 | 1.29 | 1.40 | 1.35 | 1.35 | 1.41 | 1.31 | 1.30 | 1.33 | 1.35 |
| Cr | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.54 | 1.19 | 0.71 | 0.64 | 0.59 | 0.33 | 0.54 | 0.44 | 0.44 | 0.76 | 0.44 | 0.64 | 0.66 |
| Fe2+ | 1.21 | 0.78 | 1.15 | 1.05 | 1.12 | 1.26 | 1.07 | 1.23 | 1.20 | 1.18 | 1.42 | 1.31 | 1.22 |
| Mn | 0.02 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.01 | 0.02 | 0.02 | 0.01 | 0.02 | 0.00 | 0.02 |
| Mg | 1.98 | 2.36 | 1.84 | 1.97 | 2.00 | 1.93 | 2.01 | 1.96 | 1.91 | 1.79 | 1.77 | 1.71 | 1.79 |
| Ca | 0.15 | 0.25 | 0.22 | 0.11 | 0.12 | 0.10 | 0.03 | 0.06 | 0.07 | 0.07 | 0.05 | 0.06 | 0.06 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 1.70 | 1.76 | 1.75 | 1.90 | 1.82 | 1.84 | 1.89 | 1.78 | 1.87 | 1.96 | 1.83 | 1.96 | 1.90 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 22.86 | 23.02 | 22.97 | 23.00 | 22.94 | 22.94 | 22.93 | 22.85 | 22.95 | 23.03 | 22.88 | 23.03 | 22.98 |
| Mg# | 0.62 | 0.75 | 0.62 | 0.65 | 0.64 | 0.61 | 0.65 | 0.61 | 0.61 | 0.60 | 0.56 | 0.57 | 0.59 |
| Al# | 0.68 | 0.32 | 0.59 | 0.66 | 0.68 | 0.82 | 0.71 | 0.75 | 0.77 | 0.61 | 0.76 | 0.67 | 0.65 |
| Ts | 0.09 | 0.08 | 0.24 | 0.05 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.00 | 0.05 |
| A−site | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 |

| sample | cr0439a | cr0439a | cr0439a | cr0439a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Gl−11 | Gl−12 | Gl−13 | Gl−14 | Gl−1 | Gl−2 | Gl−3 | Gl−4 | Gl−5 | Gl−6 | Gl−7 | Gl−8 | Gl−9 |
| SiO2 | 56.86 | 57.08 | 57.42 | 55.19 | 56.00 | 56.43 | 56.43 | 56.48 | 56.54 | 57.91 | 56.62 | 56.63 | 56.61 |
| TiO2 | 0.08 | 0.03 | 0.08 | 0.12 | 0.07 | 0.01 | 0.27 | 0.13 | 0.05 | 0.02 | 0.07 | 0.06 | 0.14 |
| Al2O3 | 7.07 | 8.48 | 8.37 | 2.00 | 8.92 | 8.16 | 7.63 | 8.47 | 9.66 | 9.78 | 9.32 | 8.10 | 9.50 |
| Cr2O3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.04 | 0.03 | 0.03 | 0.01 | 0.02 | 0.00 | 0.07 |
| FeO | 16.57 | 15.80 | 15.97 | 25.99 | 14.10 | 15.22 | 14.94 | 14.69 | 13.35 | 13.53 | 13.35 | 13.86 | 13.56 |
| MnO | 0.18 | 0.12 | 0.15 | 0.09 | 0.16 | 0.20 | 0.12 | 0.21 | 0.15 | 0.12 | 0.13 | 0.09 | 0.13 |
| MgO | 8.77 | 8.46 | 8.64 | 8.03 | 9.15 | 9.65 | 9.29 | 8.93 | 9.03 | 9.17 | 9.20 | 9.68 | 8.98 |
| CaO | 0.53 | 0.41 | 0.18 | 0.42 | 1.05 | 1.34 | 0.82 | 0.83 | 0.97 | 0.25 | 0.39 | 0.75 | 0.37 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| K2O | 0.01 | 0.01 | 0.02 | 0.01 | 0.00 | 0.02 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.00 | 0.00 |
| Na2O | 7.14 | 7.02 | 7.41 | 7.05 | 6.98 | 6.92 | 6.75 | 6.74 | 7.05 | 7.32 | 7.26 | 6.89 | 7.07 |
| Cl2O−1 | 0.02 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.08 | 0.00 | 0.03 | 0.03 | 0.01 | 0.05 | 0.03 | 0.00 |
| Total | 97.25 | 97.41 | 98.25 | 98.91 | 96.49 | 98.03 | 96.32 | 96.55 | 96.87 | 98.13 | 96.44 | 96.07 | 96.43 |
| Si | 8.01 | 7.98 | 7.97 | 7.85 | 7.90 | 7.86 | 7.96 | 7.95 | 7.93 | 7.96 | 7.94 | 7.98 | 7.93 |
| Ti | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.03 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 |
| Al | 1.17 | 1.40 | 1.37 | 0.34 | 1.48 | 1.34 | 1.27 | 1.40 | 1.60 | 1.58 | 1.54 | 1.34 | 1.57 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| Fe3+ | 0.77 | 0.55 | 0.69 | 1.91 | 0.62 | 0.81 | 0.65 | 0.53 | 0.47 | 0.44 | 0.55 | 0.58 | 0.49 |
| Fe2+ | 1.18 | 1.29 | 1.16 | 1.18 | 1.04 | 0.96 | 1.11 | 1.20 | 1.10 | 1.11 | 1.02 | 1.05 | 1.10 |
| Mn | 0.02 | 0.01 | 0.02 | 0.01 | 0.02 | 0.02 | 0.01 | 0.02 | 0.02 | 0.01 | 0.02 | 0.01 | 0.02 |
| Mg | 1.84 | 1.76 | 1.79 | 1.70 | 1.92 | 2.00 | 1.96 | 1.87 | 1.89 | 1.88 | 1.92 | 2.03 | 1.87 |
| Ca | 0.08 | 0.06 | 0.03 | 0.06 | 0.16 | 0.20 | 0.12 | 0.12 | 0.15 | 0.04 | 0.06 | 0.11 | 0.06 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 1.95 | 1.90 | 1.99 | 1.94 | 1.91 | 1.87 | 1.85 | 1.84 | 1.92 | 1.95 | 1.97 | 1.88 | 1.92 |
| Cl | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.06 | 0.00 | 0.03 | 0.02 | 0.00 | 0.04 | 0.02 | 0.00 |
| O | 23.04 | 22.97 | 23.03 | 23.02 | 23.06 | 23.04 | 23.00 | 22.97 | 23.06 | 22.99 | 23.02 | 22.99 | 22.99 |
| Mg# | 0.61 | 0.58 | 0.61 | 0.59 | 0.65 | 0.68 | 0.64 | 0.61 | 0.63 | 0.63 | 0.65 | 0.66 | 0.63 |
| Al# | 0.61 | 0.71 | 0.65 | 0.02 | 0.67 | 0.57 | 0.65 | 0.71 | 0.76 | 0.77 | 0.72 | 0.69 | 0.74 |
| Ts | 0.00 | 0.02 | 0.03 | 0.15 | 0.10 | 0.14 | 0.04 | 0.05 | 0.07 | 0.04 | 0.06 | 0.02 | 0.07 |
| A−site | 0.03 | 0.00 | 0.02 | 0.01 | 0.07 | 0.07 | 0.00 | 0.00 | 0.06 | 0.00 | 0.03 | 0.00 | 0.00 |

| sample | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Gl−10 | Gl−11 | Gl−12 | Gl−13 | Gl−14 | Gl−15 | Gl−16 | Gl−17 | Gl−18 | Gl−19 | Gl−20 | Gl−21 | Gl−22 |
| SiO2 | 56.65 | 56.66 | 56.77 | 56.79 | 56.80 | 56.82 | 56.89 | 56.92 | 57.02 | 57.04 | 57.05 | 57.12 | 57.16 |
| TiO2 | 0.01 | 0.09 | 0.07 | 0.14 | 0.06 | 0.12 | 0.05 | 0.07 | 0.02 | 0.04 | 0.08 | 0.08 | 0.05 |
| Al2O3 | 8.78 | 8.70 | 8.32 | 9.32 | 8.94 | 8.56 | 9.05 | 9.53 | 9.64 | 9.51 | 8.39 | 9.20 | 8.28 |
| Cr2O3 | 0.00 | 0.02 | 0.03 | 0.00 | 0.01 | 0.06 | 0.04 | 0.00 | 0.02 | 0.00 | 0.00 | 0.03 | 0.02 |
| FeO | 14.07 | 13.59 | 13.99 | 13.61 | 14.30 | 14.42 | 13.82 | 13.59 | 13.03 | 13.33 | 14.51 | 13.18 | 14.12 |
| MnO | 0.12 | 0.11 | 0.14 | 0.14 | 0.16 | 0.18 | 0.15 | 0.16 | 0.13 | 0.15 | 0.14 | 0.15 | 0.12 |
| MgO | 9.38 | 9.43 | 9.42 | 9.23 | 9.07 | 9.08 | 8.88 | 9.14 | 9.26 | 8.92 | 9.63 | 9.18 | 9.59 |
| CaO | 0.58 | 0.53 | 0.78 | 0.54 | 0.65 | 0.68 | 0.43 | 0.71 | 0.24 | 0.37 | 0.48 | 0.50 | 0.71 |
| BaO | 0.00 | 0.01 | 0.03 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 |
| K2O | 0.00 | 0.01 | 0.02 | 0.02 | 0.01 | 0.00 | 0.01 | 0.02 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 |
| Na2O | 7.00 | 7.04 | 6.84 | 7.14 | 6.92 | 6.88 | 7.12 | 7.06 | 7.15 | 7.13 | 7.10 | 7.11 | 7.00 |
| Cl2O−1 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.03 | 0.02 | 0.02 | 0.00 | 0.01 | 0.02 | 0.00 | 0.03 | 0.01 | 0.03 | 0.06 | 0.03 | 0.02 |
| Total | 96.62 | 96.21 | 96.44 | 96.92 | 96.94 | 96.83 | 96.45 | 97.23 | 96.53 | 96.54 | 97.44 | 96.61 | 97.08 |
| Si | 7.93 | 7.96 | 7.98 | 7.93 | 7.94 | 7.96 | 7.99 | 7.93 | 7.95 | 7.99 | 7.92 | 7.99 | 7.97 |
| Ti | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 |
| Al | 1.45 | 1.44 | 1.38 | 1.53 | 1.47 | 1.41 | 1.50 | 1.56 | 1.58 | 1.57 | 1.37 | 1.52 | 1.36 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.59 | 0.55 | 0.53 | 0.54 | 0.52 | 0.53 | 0.46 | 0.48 | 0.45 | 0.39 | 0.69 | 0.42 | 0.58 |
| Fe2+ | 1.06 | 1.04 | 1.11 | 1.04 | 1.15 | 1.16 | 1.17 | 1.10 | 1.07 | 1.17 | 0.99 | 1.12 | 1.06 |
| Mn | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 |
| Mg | 1.96 | 1.98 | 1.97 | 1.92 | 1.89 | 1.90 | 1.86 | 1.90 | 1.92 | 1.86 | 1.99 | 1.92 | 1.99 |
| Ca | 0.09 | 0.08 | 0.12 | 0.08 | 0.10 | 0.10 | 0.06 | 0.11 | 0.04 | 0.06 | 0.07 | 0.07 | 0.11 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 1.90 | 1.92 | 1.86 | 1.93 | 1.87 | 1.87 | 1.94 | 1.91 | 1.93 | 1.93 | 1.91 | 1.93 | 1.89 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.03 | 0.02 | 0.01 | 0.00 | 0.01 | 0.02 | 0.00 | 0.02 | 0.01 | 0.02 | 0.04 | 0.02 | 0.02 |
| O | 22.97 | 23.00 | 22.99 | 23.03 | 22.98 | 22.98 | 23.01 | 23.01 | 22.97 | 22.99 | 22.97 | 23.00 | 23.00 |
| Mg# | 0.65 | 0.65 | 0.64 | 0.65 | 0.62 | 0.62 | 0.61 | 0.63 | 0.64 | 0.61 | 0.67 | 0.63 | 0.65 |
| Al# | 0.69 | 0.71 | 0.71 | 0.72 | 0.72 | 0.71 | 0.76 | 0.75 | 0.77 | 0.80 | 0.64 | 0.78 | 0.69 |
| Ts | 0.07 | 0.04 | 0.02 | 0.07 | 0.06 | 0.04 | 0.01 | 0.07 | 0.05 | 0.01 | 0.08 | 0.01 | 0.03 |
| A−site | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| sample | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0440a | cr0443 | cr0443 | cr0443 | cr0443 | cr0444 | cr0444 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Gl−23 | Gl−24 | Gl−25 | Gl−26 | Gl−27 | Gl−28 | Gl−29 | Gl−1 | Gl−2 | Gl−3 | Gl−4 | Gl−1 | Gl−2 |
| SiO2 | 57.17 | 57.35 | 57.42 | 57.47 | 57.48 | 57.54 | 57.63 | 57.54 | 57.57 | 57.66 | 57.73 | 56.37 | 57.27 |
| TiO2 | 0.13 | 0.00 | 0.03 | 0.11 | 0.01 | 0.07 | 0.11 | 0.07 | 0.02 | 0.04 | 0.06 | 0.06 | 0.05 |
| Al2O3 | 8.74 | 8.75 | 8.35 | 9.04 | 9.24 | 9.18 | 8.71 | 9.30 | 10.18 | 10.95 | 10.17 | 7.60 | 8.77 |
| Cr2O3 | 0.02 | 0.01 | 0.03 | 0.02 | 0.02 | 0.04 | 0.04 | 0.06 | 0.04 | 0.01 | 0.06 | 0.02 | 0.00 |
| FeO | 13.12 | 14.01 | 14.00 | 13.38 | 13.13 | 14.36 | 14.18 | 12.53 | 12.19 | 11.37 | 11.57 | 17.57 | 17.35 |
| MnO | 0.12 | 0.13 | 0.16 | 0.14 | 0.10 | 0.19 | 0.14 | 0.07 | 0.08 | 0.10 | 0.08 | 0.23 | 0.19 |
| MgO | 9.79 | 9.24 | 9.76 | 9.33 | 9.16 | 8.96 | 9.03 | 10.25 | 9.91 | 9.79 | 9.90 | 8.96 | 7.04 |
| CaO | 0.51 | 0.32 | 0.74 | 0.40 | 0.20 | 0.81 | 0.47 | 1.33 | 1.00 | 1.05 | 1.17 | 3.21 | 1.42 |
| BaO | 0.00 | 0.00 | 0.02 | 0.02 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.01 | 0.00 | 0.00 | 0.02 | 0.01 | 0.01 | 0.02 | 0.08 | 0.08 | 0.13 | 0.11 | 0.02 | 0.03 |
| Na2O | 6.98 | 7.16 | 6.83 | 7.15 | 7.12 | 7.03 | 6.97 | 6.76 | 7.27 | 7.22 | 7.24 | 5.72 | 6.76 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 |
| F2O−1 | 0.00 | 0.04 | 0.03 | 0.00 | 0.02 | 0.05 | 0.07 | 0.07 | 0.05 | 0.09 | 0.08 | 0.00 | 0.00 |
| Total | 96.59 | 97.01 | 97.38 | 97.09 | 96.49 | 98.23 | 97.35 | 98.09 | 98.38 | 98.40 | 98.17 | 99.77 | 98.90 |
| Si | 7.97 | 7.99 | 7.97 | 8.00 | 8.02 | 7.96 | 8.02 | 7.92 | 7.91 | 7.91 | 7.96 | 7.83 | 8.02 |
| Ti | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 |
| Al | 1.44 | 1.44 | 1.36 | 1.48 | 1.52 | 1.50 | 1.43 | 1.51 | 1.65 | 1.77 | 1.65 | 1.24 | 1.45 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| Fe3+ | 0.51 | 0.51 | 0.54 | 0.45 | 0.36 | 0.47 | 0.42 | 0.45 | 0.47 | 0.33 | 0.37 | 0.64 | 0.35 |
| Fe2+ | 1.02 | 1.12 | 1.08 | 1.10 | 1.18 | 1.19 | 1.23 | 0.99 | 0.93 | 0.97 | 0.97 | 1.40 | 1.69 |
| Mn | 0.01 | 0.02 | 0.02 | 0.02 | 0.01 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.03 | 0.02 |
| Mg | 2.03 | 1.92 | 2.02 | 1.93 | 1.91 | 1.85 | 1.87 | 2.10 | 2.03 | 2.00 | 2.03 | 1.85 | 1.47 |
| Ca | 0.08 | 0.05 | 0.11 | 0.06 | 0.03 | 0.12 | 0.07 | 0.20 | 0.15 | 0.15 | 0.17 | 0.48 | 0.21 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.02 | 0.02 | 0.00 | 0.00 |
| Na | 1.89 | 1.94 | 1.84 | 1.93 | 1.93 | 1.89 | 1.88 | 1.80 | 1.94 | 1.92 | 1.93 | 1.54 | 1.84 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.03 | 0.03 | 0.00 | 0.02 | 0.04 | 0.05 | 0.05 | 0.04 | 0.07 | 0.06 | 0.00 | 0.00 |
| O | 22.98 | 22.97 | 22.94 | 23.00 | 22.95 | 23.00 | 22.94 | 22.99 | 23.07 | 23.05 | 23.10 | 23.03 | 23.05 |
| Mg# | 0.67 | 0.63 | 0.65 | 0.64 | 0.62 | 0.61 | 0.60 | 0.68 | 0.69 | 0.67 | 0.68 | 0.57 | 0.47 |
| Al# | 0.73 | 0.74 | 0.71 | 0.76 | 0.81 | 0.75 | 0.78 | 0.75 | 0.76 | 0.83 | 0.81 | 0.58 | 0.81 |
| Ts | 0.03 | 0.01 | 0.03 | 0.00 | 0.00 | 0.04 | 0.00 | 0.08 | 0.09 | 0.09 | 0.04 | 0.17 | 0.00 |
| A−site | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.08 | 0.07 | 0.11 | 0.02 | 0.05 |

| sample | cr04551 | cr04552 |
|---|---|---|
| point | Gl−1 | Gl−1 |
| SiO2 | 57.00 | 57.24 |
| TiO2 | 0.10 | 0.05 |
| Al2O3 | 1.75 | 2.71 |
| Cr2O3 | 0.00 | 0.00 |
| FeO | 20.74 | 21.72 |
| MnO | 0.20 | 0.13 |
| MgO | 10.24 | 8.76 |
| CaO | 4.47 | 1.80 |
| BaO | 0.00 | 0.00 |
| K2O | 0.04 | 0.00 |
| Na2O | 4.66 | 5.91 |
| Cl2O−1 | 0.02 | 0.00 |
| F2O−1 | 0.00 | 0.00 |
| Total | 99.22 | 98.31 |
| Si | 8.06 | 8.11 |
| Ti | 0.01 | 0.00 |
| Al | 0.29 | 0.45 |
| Cr | 0.00 | 0.00 |
| Fe3+ | 0.86 | 0.96 |
| Fe2+ | 1.59 | 1.61 |
| Mn | 0.02 | 0.02 |
| Mg | 2.16 | 1.85 |
| Ca | 0.68 | 0.27 |
| Ba | 0.00 | 0.00 |
| K | 0.01 | 0.00 |
| Na | 1.28 | 1.62 |
| Cl | 0.01 | 0.00 |
| F | 0.00 | 0.00 |
| O | 22.97 | 22.90 |
| Mg# | 0.58 | 0.53 |
| Al# | 0.33 | 0.41 |
| Ts | 0.00 | 0.00 |
| A−site | 0.00 | 0.00 |

| sample | cr0314a | cr0314a | cr0318c | cr0318c | cr0318c | cr0429 | cr0429 | cr0429 | cr0429 | cr0429 | cr0434 | cr0439a | cr0443 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Gl2−1 | Gl2−2 | Gl2−1 | Gl2−2 | Gl2−3 | Gl2−1 | Gl2−2 | Gl2−3 | Gl2−4 | Gl2−5 | Gl2−1 | Gl2−1 | Gl2−1 |
| SiO2 | 55.24 | 54.90 | 56.82 | 57.02 | 57.36 | 53.31 | 53.45 | 54.17 | 54.66 | 55.80 | 55.61 | 56.59 | 57.15 |
| TiO2 | 0.05 | 0.15 | 0.01 | 0.06 | 0.04 | 0.03 | 0.09 | 0.04 | 0.72 | 0.07 | 0.06 | 0.08 | 0.03 |
| Al2O3 | 9.47 | 9.33 | 7.51 | 8.88 | 9.05 | 11.71 | 10.76 | 10.59 | 12.49 | 11.33 | 9.42 | 7.03 | 9.42 |
| Cr2O3 | 0.04 | 0.00 | 0.04 | 0.03 | 0.02 | 0.00 | 0.02 | 0.00 | 0.00 | 0.07 | 0.06 | 0.00 | 0.05 |
| FeO | 15.56 | 17.24 | 14.88 | 13.57 | 13.35 | 18.23 | 18.96 | 18.91 | 15.63 | 15.45 | 18.96 | 16.35 | 12.15 |
| MnO | 0.06 | 0.16 | 0.12 | 0.31 | 0.27 | 0.09 | 0.08 | 0.08 | 0.08 | 0.10 | 0.12 | 0.17 | 0.10 |
| MgO | 7.57 | 7.12 | 9.84 | 9.54 | 9.85 | 6.13 | 6.09 | 5.86 | 7.15 | 7.91 | 5.31 | 8.74 | 10.57 |
| CaO | 2.13 | 2.12 | 0.78 | 0.79 | 0.69 | 2.09 | 1.40 | 0.98 | 1.69 | 0.96 | 1.04 | 1.18 | 2.59 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.00 | 0.02 | 0.01 | 0.03 | 0.00 | 0.03 | 0.02 | 0.02 | 0.02 | 0.01 | 0.02 | 0.02 | 0.17 |
| Na2O | 5.92 | 5.73 | 6.92 | 6.65 | 6.88 | 6.12 | 6.44 | 6.45 | 6.49 | 6.15 | 6.04 | 7.08 | 6.47 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 |
| Total | 96.03 | 96.76 | 96.94 | 96.88 | 97.53 | 97.74 | 97.30 | 97.11 | 98.92 | 97.86 | 96.64 | 97.25 | 98.80 |
| Si | 7.91 | 7.83 | 7.95 | 7.94 | 7.92 | 7.57 | 7.62 | 7.71 | 7.58 | 7.71 | 7.97 | 8.02 | 7.88 |
| Ti | 0.01 | 0.02 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.08 | 0.01 | 0.01 | 0.01 | 0.00 |
| Al | 1.60 | 1.57 | 1.24 | 1.46 | 1.47 | 1.96 | 1.81 | 1.78 | 2.04 | 1.85 | 1.59 | 1.17 | 1.53 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 |
| Fe3+ | 0.23 | 0.36 | 0.74 | 0.46 | 0.53 | 0.59 | 0.73 | 0.58 | 0.54 | 0.38 | 0.14 | 0.74 | 0.44 |
| Fe2+ | 1.63 | 1.69 | 1.00 | 1.12 | 1.01 | 1.57 | 1.53 | 1.67 | 1.28 | 1.41 | 2.13 | 1.20 | 0.96 |
| Mn | 0.01 | 0.02 | 0.01 | 0.04 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 |
| Mg | 1.62 | 1.51 | 2.05 | 1.98 | 2.03 | 1.30 | 1.29 | 1.24 | 1.48 | 1.63 | 1.14 | 1.85 | 2.17 |
| Ca | 0.33 | 0.32 | 0.12 | 0.12 | 0.10 | 0.32 | 0.21 | 0.15 | 0.25 | 0.14 | 0.16 | 0.18 | 0.38 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 |
| Na | 1.64 | 1.59 | 1.88 | 1.79 | 1.84 | 1.68 | 1.78 | 1.78 | 1.74 | 1.65 | 1.68 | 1.94 | 1.73 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 |
| O | 22.98 | 22.93 | 23.00 | 22.92 | 22.95 | 23.01 | 23.00 | 22.93 | 23.07 | 22.80 | 22.85 | 23.13 | 23.10 |
| Mg# | 0.50 | 0.47 | 0.67 | 0.64 | 0.67 | 0.45 | 0.46 | 0.43 | 0.54 | 0.54 | 0.35 | 0.61 | 0.69 |
| Al# | 0.86 | 0.77 | 0.60 | 0.74 | 0.71 | 0.65 | 0.59 | 0.68 | 0.69 | 0.77 | 0.92 | 0.62 | 0.74 |
| Ts | 0.09 | 0.17 | 0.05 | 0.06 | 0.08 | 0.43 | 0.38 | 0.29 | 0.42 | 0.29 | 0.03 | 0.00 | 0.12 |
| A−site | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.12 | 0.11 |

| sample | cr0443 | cr0443 |
|---|---|---|
| point | Gl2−2 | Gl2−3 |
| SiO2 | 57.44 | 57.89 |
| TiO2 | 0.12 | 0.18 |
| Al2O3 | 8.24 | 7.91 |
| Cr2O3 | 0.00 | 0.03 |
| FeO | 12.69 | 13.30 |
| MnO | 0.13 | 0.10 |
| MgO | 11.28 | 10.95 |
| CaO | 2.82 | 2.33 |
| BaO | 0.03 | 0.02 |
| K2O | 0.15 | 0.11 |
| Na2O | 6.12 | 6.26 |
| Cl2O−1 | 0.00 | 0.00 |
| F2O−1 | 0.03 | 0.03 |
| Total | 99.03 | 99.11 |
| Si | 7.88 | 7.93 |
| Ti | 0.01 | 0.02 |
| Al | 1.33 | 1.28 |
| Cr | 0.00 | 0.00 |
| Fe3+ | 0.54 | 0.53 |
| Fe2+ | 0.92 | 1.00 |
| Mn | 0.01 | 0.01 |
| Mg | 2.31 | 2.24 |
| Ca | 0.41 | 0.34 |
| Ba | 0.00 | 0.00 |
| K | 0.03 | 0.02 |
| Na | 1.63 | 1.66 |
| Cl | 0.00 | 0.00 |
| F | 0.02 | 0.02 |
| O | 23.06 | 23.03 |
| Mg# | 0.72 | 0.69 |
| Al# | 0.67 | 0.68 |
| Ts | 0.12 | 0.07 |
| A−site | 0.04 | 0.00 |

| sample | cr0318c | cr0318d | cr0318d | cr0422b | cr0428b | cr0428b | cr0428b | cr0429 | cr0429 | cr0429 | cr0429 | cr0429 | cr0429 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Act−1 | Act−1 | Act−2 | Act−1 | Act−1 | Act−2 | Act−3 | Act−1 | Act−2 | Act−3 | Act−4 | Act−5 | Act−6 |
| SiO2 | 51.91 | 55.27 | 54.64 | 58.61 | 51.40 | 51.95 | 55.23 | 53.64 | 56.32 | 51.93 | 52.05 | 52.20 | 52.69 |
| TiO2 | 0.05 | 0.01 | 0.00 | 0.01 | 0.05 | 0.06 | 0.12 | 0.02 | 0.03 | 0.08 | 0.06 | 0.06 | 0.08 |
| Al2O3 | 0.64 | 0.77 | 0.48 | 0.12 | 2.77 | 0.96 | 1.81 | 2.02 | 4.58 | 3.48 | 2.30 | 3.54 | 3.36 |
| Cr2O3 | 0.03 | 0.00 | 0.03 | 0.02 | 0.02 | 0.01 | 0.00 | 0.19 | 0.00 | 0.04 | 0.00 | 0.00 | 0.03 |
| FeO | 22.29 | 14.49 | 14.08 | 13.01 | 15.66 | 17.78 | 16.08 | 14.80 | 14.21 | 15.85 | 18.40 | 16.03 | 15.50 |
| MnO | 0.26 | 0.35 | 0.45 | 0.19 | 0.22 | 0.23 | 0.20 | 0.19 | 0.16 | 0.19 | 0.13 | 0.25 | 0.18 |
| MgO | 9.17 | 14.45 | 14.83 | 16.10 | 13.12 | 12.82 | 12.50 | 15.27 | 13.00 | 14.15 | 13.18 | 14.14 | 13.64 |
| CaO | 11.39 | 11.64 | 12.00 | 11.97 | 10.59 | 11.08 | 11.36 | 12.41 | 7.20 | 12.11 | 12.22 | 10.94 | 12.81 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.11 | 0.03 | 0.08 | 0.01 | 0.09 | 0.04 | 0.08 | 0.06 | 0.04 | 0.14 | 0.06 | 0.07 | 0.04 |
| Na2O | 0.31 | 0.47 | 0.38 | 0.63 | 1.23 | 0.71 | 1.27 | 0.49 | 2.75 | 0.68 | 0.47 | 1.29 | 0.44 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.02 | 0.01 | 0.02 | 0.02 | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 96.16 | 97.47 | 96.96 | 100.68 | 95.15 | 95.65 | 98.67 | 99.09 | 98.29 | 98.65 | 98.86 | 98.52 | 98.78 |
| Si | 7.92 | 7.97 | 7.94 | 8.12 | 7.63 | 7.74 | 8.00 | 7.62 | 7.86 | 7.45 | 7.52 | 7.45 | 7.60 |
| Ti | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| Al | 0.12 | 0.13 | 0.08 | 0.02 | 0.48 | 0.17 | 0.31 | 0.34 | 0.75 | 0.59 | 0.39 | 0.60 | 0.57 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.15 | 0.06 | 0.15 | 0.00 | 0.61 | 0.57 | 0.04 | 0.55 | 0.27 | 0.70 | 0.69 | 0.87 | 0.36 |
| Fe2+ | 2.70 | 1.69 | 1.56 | 1.51 | 1.34 | 1.65 | 1.91 | 1.21 | 1.39 | 1.20 | 1.53 | 1.05 | 1.51 |
| Mn | 0.03 | 0.04 | 0.06 | 0.02 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.02 |
| Mg | 2.08 | 3.11 | 3.21 | 3.33 | 2.90 | 2.84 | 2.70 | 3.23 | 2.70 | 3.02 | 2.84 | 3.01 | 2.93 |
| Ca | 1.86 | 1.80 | 1.87 | 1.78 | 1.68 | 1.77 | 1.76 | 1.89 | 1.08 | 1.86 | 1.89 | 1.67 | 1.98 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.02 | 0.00 | 0.01 | 0.00 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.03 | 0.01 | 0.01 | 0.01 |
| Na | 0.09 | 0.13 | 0.11 | 0.17 | 0.35 | 0.20 | 0.36 | 0.13 | 0.74 | 0.19 | 0.13 | 0.36 | 0.12 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 22.97 | 22.93 | 22.98 | 22.99 | 23.05 | 22.98 | 23.14 | 23.04 | 22.83 | 23.07 | 23.03 | 23.04 | 23.12 |
| Mg# | 0.44 | 0.65 | 0.67 | 0.69 | 0.68 | 0.63 | 0.59 | 0.73 | 0.66 | 0.72 | 0.65 | 0.74 | 0.66 |
| Al# | 0.00 | 0.56 | 0.00 | 1.00 | 0.00 | 0.00 | 0.89 | 0.00 | 0.64 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ts | 0.08 | 0.03 | 0.06 | 0.00 | 0.37 | 0.26 | 0.00 | 0.38 | 0.14 | 0.55 | 0.48 | 0.55 | 0.40 |
| A−site | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.00 | 0.12 | 0.02 | 0.00 | 0.05 | 0.02 | 0.03 | 0.10 |

| sample | cr0429 | cr0429 | cr0429 | cr0429 | cr0429 | cr0429 | cr0429 | cr0430a | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Act−7 | Act−8 | Act−9 | Act−10 | Act−11 | Act−12 | Act−13 | Act−1 | Act−1 | Act−2 | Act−3 | Act−4 | Act−5 |
| SiO2 | 52.86 | 53.14 | 53.24 | 53.62 | 53.70 | 53.73 | 53.82 | 51.14 | 53.36 | 53.45 | 53.83 | 54.26 | 54.27 |
| TiO2 | 0.08 | 0.04 | 0.10 | 0.04 | 0.06 | 0.03 | 0.04 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.02 |
| Al2O3 | 1.71 | 2.97 | 2.74 | 1.86 | 2.49 | 2.85 | 1.87 | 1.50 | 1.83 | 1.67 | 1.45 | 1.64 | 2.01 |
| Cr2O3 | 0.00 | 0.10 | 0.00 | 0.04 | 0.20 | 0.29 | 0.20 | 0.04 | 0.02 | 0.01 | 0.00 | 0.00 | 0.01 |
| FeO | 14.81 | 16.78 | 15.02 | 16.86 | 15.57 | 15.66 | 15.91 | 16.19 | 18.58 | 17.04 | 16.96 | 17.51 | 18.48 |
| MnO | 0.19 | 0.23 | 0.26 | 0.24 | 0.22 | 0.25 | 0.22 | 0.22 | 0.22 | 0.19 | 0.16 | 0.17 | 0.22 |
| MgO | 15.28 | 13.47 | 14.84 | 13.78 | 14.24 | 14.06 | 14.48 | 11.74 | 12.11 | 12.70 | 12.72 | 12.42 | 11.65 |
| CaO | 11.09 | 11.61 | 10.38 | 11.63 | 11.54 | 10.84 | 11.89 | 11.92 | 12.05 | 12.04 | 11.98 | 12.07 | 10.87 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.04 | 0.09 | 0.04 | 0.06 | 0.06 | 0.05 | 0.06 | 0.08 | 0.07 | 0.08 | 0.05 | 0.07 | 0.04 |
| Na2O | 1.01 | 0.77 | 1.37 | 0.72 | 0.74 | 1.13 | 0.53 | 0.77 | 0.66 | 0.56 | 0.55 | 0.62 | 1.04 |
| Cl2O−1 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.01 | 0.00 | 0.00 |
| Total | 97.08 | 99.19 | 97.99 | 98.84 | 98.83 | 98.87 | 99.02 | 93.60 | 98.92 | 97.77 | 97.71 | 98.76 | 98.61 |
| Si | 7.61 | 7.59 | 7.57 | 7.68 | 7.65 | 7.62 | 7.66 | 7.90 | 7.77 | 7.83 | 7.88 | 7.88 | 7.87 |
| Ti | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 0.29 | 0.50 | 0.46 | 0.31 | 0.42 | 0.48 | 0.31 | 0.27 | 0.31 | 0.29 | 0.25 | 0.28 | 0.34 |
| Cr | 0.00 | 0.01 | 0.00 | 0.00 | 0.02 | 0.03 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.77 | 0.54 | 0.78 | 0.52 | 0.49 | 0.58 | 0.50 | 0.16 | 0.34 | 0.22 | 0.15 | 0.13 | 0.21 |
| Fe2+ | 1.02 | 1.47 | 1.00 | 1.50 | 1.36 | 1.28 | 1.39 | 1.93 | 1.92 | 1.87 | 1.93 | 1.99 | 2.03 |
| Mn | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.03 |
| Mg | 3.28 | 2.87 | 3.15 | 2.94 | 3.02 | 2.98 | 3.07 | 2.70 | 2.63 | 2.77 | 2.78 | 2.69 | 2.52 |
| Ca | 1.71 | 1.78 | 1.58 | 1.79 | 1.76 | 1.65 | 1.81 | 1.97 | 1.88 | 1.89 | 1.88 | 1.88 | 1.69 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 |
| Na | 0.28 | 0.21 | 0.38 | 0.20 | 0.21 | 0.31 | 0.15 | 0.23 | 0.19 | 0.16 | 0.16 | 0.17 | 0.29 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |
| O | 23.00 | 23.01 | 22.97 | 23.00 | 22.99 | 22.98 | 22.98 | 23.21 | 23.07 | 23.05 | 23.04 | 23.06 | 22.99 |
| Mg# | 0.76 | 0.66 | 0.76 | 0.66 | 0.69 | 0.70 | 0.69 | 0.58 | 0.58 | 0.60 | 0.59 | 0.57 | 0.55 |
| Al# | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.30 | 0.00 | 0.00 | 0.06 | 0.25 | 0.27 |
| Ts | 0.39 | 0.41 | 0.43 | 0.32 | 0.35 | 0.38 | 0.34 | 0.10 | 0.23 | 0.17 | 0.12 | 0.12 | 0.13 |
| A−site | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 | 0.07 | 0.05 | 0.03 | 0.05 | 0.00 |

| sample | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0443 | cr0443 | cr0443 | cr0443 | cr0443 | cr0443 | cr0443 | cr0443 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Act−6 | Act−7 | Act−8 | Act−9 | Act−10 | Act−1 | Act−2 | Act−3 | Act−4 | Act−5 | Act−6 | Act−7 | Act−8 |
| SiO2 | 54.82 | 51.81 | 52.98 | 53.65 | 54.09 | 55.26 | 55.31 | 56.09 | 56.10 | 56.11 | 56.42 | 56.48 | 56.60 |
| TiO2 | 0.01 | 0.03 | 0.01 | 0.01 | 0.00 | 0.02 | 0.01 | 0.04 | 0.06 | 0.01 | 0.03 | 0.05 | 0.02 |
| Al2O3 | 1.65 | 3.29 | 2.34 | 2.61 | 1.28 | 1.85 | 1.61 | 1.10 | 1.28 | 1.11 | 1.36 | 0.47 | 0.72 |
| Cr2O3 | 0.02 | 0.03 | 0.00 | 0.03 | 0.03 | 0.00 | 0.03 | 0.07 | 0.02 | 0.00 | 0.06 | 0.04 | 0.07 |
| FeO | 16.94 | 19.63 | 17.89 | 16.49 | 16.96 | 13.26 | 12.87 | 11.41 | 11.80 | 11.69 | 10.49 | 10.86 | 11.15 |
| MnO | 0.18 | 0.20 | 0.18 | 0.19 | 0.20 | 0.16 | 0.25 | 0.15 | 0.13 | 0.14 | 0.15 | 0.19 | 0.16 |
| MgO | 12.82 | 10.65 | 12.13 | 12.82 | 12.86 | 15.59 | 16.09 | 16.89 | 16.51 | 16.90 | 17.50 | 17.33 | 17.27 |
| CaO | 11.66 | 11.71 | 12.00 | 11.64 | 12.26 | 11.44 | 11.38 | 12.07 | 11.80 | 11.79 | 12.10 | 12.79 | 12.43 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 |
| K2O | 0.01 | 0.17 | 0.10 | 0.07 | 0.07 | 0.13 | 0.10 | 0.07 | 0.11 | 0.11 | 0.06 | 0.03 | 0.05 |
| Na2O | 0.84 | 0.94 | 0.83 | 0.96 | 0.47 | 1.31 | 1.13 | 0.91 | 1.05 | 0.98 | 0.85 | 0.37 | 0.68 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 |
| F2O−1 | 0.02 | 0.01 | 0.00 | 0.02 | 0.01 | 0.04 | 0.07 | 0.02 | 0.05 | 0.09 | 0.09 | 0.03 | 0.00 |
| Total | 98.96 | 98.48 | 98.46 | 98.50 | 98.22 | 99.06 | 98.88 | 98.81 | 98.93 | 98.95 | 99.14 | 98.65 | 99.15 |
| Si | 7.90 | 7.64 | 7.74 | 7.77 | 7.89 | 7.82 | 7.80 | 7.90 | 7.90 | 7.88 | 7.88 | 7.97 | 7.94 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 |
| Al | 0.28 | 0.57 | 0.40 | 0.44 | 0.22 | 0.31 | 0.27 | 0.18 | 0.21 | 0.18 | 0.22 | 0.08 | 0.12 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 |
| Fe3+ | 0.15 | 0.42 | 0.34 | 0.29 | 0.14 | 0.42 | 0.45 | 0.27 | 0.27 | 0.32 | 0.25 | 0.09 | 0.19 |
| Fe2+ | 1.89 | 2.00 | 1.84 | 1.70 | 1.93 | 1.15 | 1.07 | 1.08 | 1.13 | 1.06 | 0.98 | 1.19 | 1.11 |
| Mn | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| Mg | 2.75 | 2.34 | 2.64 | 2.77 | 2.80 | 3.29 | 3.38 | 3.55 | 3.47 | 3.54 | 3.64 | 3.64 | 3.61 |
| Ca | 1.80 | 1.85 | 1.88 | 1.80 | 1.92 | 1.73 | 1.72 | 1.82 | 1.78 | 1.77 | 1.81 | 1.93 | 1.87 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.00 | 0.03 | 0.02 | 0.01 | 0.01 | 0.02 | 0.02 | 0.01 | 0.02 | 0.02 | 0.01 | 0.00 | 0.01 |
| Na | 0.23 | 0.27 | 0.24 | 0.27 | 0.13 | 0.36 | 0.31 | 0.25 | 0.29 | 0.27 | 0.23 | 0.10 | 0.18 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.01 | 0.00 | 0.00 | 0.02 | 0.01 | 0.03 | 0.05 | 0.02 | 0.04 | 0.07 | 0.07 | 0.02 | 0.00 |
| O | 23.03 | 23.14 | 23.13 | 23.07 | 23.05 | 23.09 | 23.01 | 23.07 | 23.06 | 23.02 | 23.02 | 23.03 | 23.06 |
| Mg# | 0.59 | 0.54 | 0.59 | 0.62 | 0.59 | 0.74 | 0.76 | 0.77 | 0.76 | 0.77 | 0.79 | 0.75 | 0.76 |
| Al# | 0.34 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.00 | 0.00 | 0.09 | 0.00 |
| Ts | 0.10 | 0.36 | 0.26 | 0.23 | 0.11 | 0.18 | 0.20 | 0.10 | 0.10 | 0.12 | 0.12 | 0.03 | 0.06 |
| A−site | 0.03 | 0.12 | 0.11 | 0.07 | 0.05 | 0.09 | 0.03 | 0.07 | 0.07 | 0.04 | 0.04 | 0.03 | 0.05 |

| sample | cr0443 | cr0443 | cr0444 | cr0444 | cr04551 | cr04552 | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Act−9 | Act−10 | Act−1 | Act−2 | Act−1 | Act−1 | Act−1 | Act−2 | Act−3 | Act−4 | Act−5 | Act−6 | Act−7 |
| SiO2 | 56.94 | 57.18 | 53.63 | 53.75 | 57.00 | 57.25 | 54.84 | 55.29 | 55.78 | 55.83 | 56.23 | 56.37 | 56.57 |
| TiO2 | 0.03 | 0.02 | 0.07 | 0.07 | 0.10 | 0.01 | 0.02 | 0.03 | 0.05 | 0.02 | 0.00 | 0.00 | 0.01 |
| Al2O3 | 1.32 | 0.67 | 2.97 | 2.15 | 1.75 | 1.12 | 2.87 | 2.41 | 2.31 | 2.42 | 1.60 | 1.79 | 1.96 |
| Cr2O3 | 0.05 | 0.04 | 0.01 | 0.00 | 0.00 | 0.01 | 0.40 | 0.30 | 0.27 | 0.26 | 0.19 | 0.90 | 0.12 |
| FeO | 9.80 | 9.56 | 16.83 | 16.66 | 20.74 | 14.85 | 8.39 | 7.75 | 7.52 | 7.76 | 6.35 | 7.34 | 6.68 |
| MnO | 0.17 | 0.20 | 0.38 | 0.40 | 0.20 | 0.26 | 0.20 | 0.20 | 0.25 | 0.19 | 0.21 | 0.14 | 0.16 |
| MgO | 17.96 | 18.49 | 13.25 | 13.09 | 10.24 | 14.80 | 18.22 | 18.47 | 18.53 | 18.59 | 19.69 | 18.66 | 19.72 |
| CaO | 12.39 | 12.57 | 10.49 | 11.40 | 4.47 | 10.29 | 10.65 | 10.24 | 10.45 | 10.35 | 10.94 | 10.54 | 11.57 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.05 | 0.03 | 0.08 | 0.19 | 0.04 | 0.08 | 0.07 | 0.05 | 0.07 | 0.07 | 0.06 | 0.07 | 0.06 |
| Na2O | 0.79 | 0.49 | 0.93 | 0.90 | 4.66 | 1.38 | 1.86 | 1.86 | 1.83 | 2.11 | 1.43 | 1.78 | 1.28 |
| Cl2O−1 | 0.01 | 0.00 | 0.04 | 0.08 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.01 | 0.01 | 0.00 |
| F2O−1 | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.18 | 0.00 |
| Total | 99.50 | 99.30 | 98.67 | 98.68 | 99.22 | 100.04 | 97.53 | 96.61 | 97.06 | 97.62 | 96.72 | 97.78 | 98.14 |
| Si | 7.90 | 7.93 | 7.63 | 7.75 | 8.06 | 7.98 | 7.67 | 7.76 | 7.81 | 7.78 | 7.85 | 7.86 | 7.81 |
| Ti | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 0.22 | 0.11 | 0.50 | 0.36 | 0.29 | 0.18 | 0.47 | 0.40 | 0.38 | 0.40 | 0.26 | 0.29 | 0.32 |
| Cr | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.03 | 0.03 | 0.03 | 0.02 | 0.10 | 0.01 |
| Fe3+ | 0.19 | 0.16 | 0.49 | 0.38 | 0.86 | 0.23 | 0.68 | 0.58 | 0.50 | 0.61 | 0.42 | 0.47 | 0.39 |
| Fe2+ | 0.94 | 0.95 | 1.51 | 1.63 | 1.59 | 1.50 | 0.30 | 0.33 | 0.38 | 0.30 | 0.32 | 0.38 | 0.38 |
| Mn | 0.02 | 0.02 | 0.05 | 0.05 | 0.02 | 0.03 | 0.02 | 0.02 | 0.03 | 0.02 | 0.03 | 0.02 | 0.02 |
| Mg | 3.72 | 3.82 | 2.81 | 2.81 | 2.16 | 3.07 | 3.80 | 3.87 | 3.87 | 3.86 | 4.10 | 3.88 | 4.06 |
| Ca | 1.84 | 1.87 | 1.60 | 1.76 | 0.68 | 1.54 | 1.60 | 1.54 | 1.57 | 1.55 | 1.64 | 1.57 | 1.71 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.01 | 0.00 | 0.01 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Na | 0.21 | 0.13 | 0.26 | 0.25 | 1.28 | 0.37 | 0.51 | 0.51 | 0.50 | 0.57 | 0.39 | 0.48 | 0.34 |
| Cl | 0.00 | 0.00 | 0.01 | 0.03 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.00 |
| O | 23.06 | 22.98 | 22.87 | 23.03 | 22.97 | 22.92 | 23.13 | 23.07 | 23.09 | 23.13 | 23.04 | 23.04 | 23.07 |
| Mg# | 0.80 | 0.80 | 0.65 | 0.63 | 0.58 | 0.67 | 0.93 | 0.92 | 0.91 | 0.93 | 0.93 | 0.91 | 0.91 |
| Al# | 0.09 | 0.00 | 0.00 | 0.00 | 0.33 | 0.38 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 |
| Ts | 0.10 | 0.07 | 0.37 | 0.25 | 0.00 | 0.02 | 0.33 | 0.24 | 0.19 | 0.22 | 0.15 | 0.14 | 0.19 |
| A−site | 0.05 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.10 | 0.05 | 0.06 | 0.12 | 0.02 | 0.06 | 0.05 |

| sample | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a |
|---|---|---|---|---|---|---|---|---|---|
| point | Act−8 | Act−9 | Act−10 | Act−11 | Act−12 | Act−13 | Act−14 | Act−15 | Act−16 |
| SiO2 | 56.58 | 56.60 | 56.60 | 56.62 | 56.62 | 56.67 | 56.73 | 56.78 | 56.83 |
| TiO2 | 0.05 | 0.06 | 0.00 | 0.05 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 |
| Al2O3 | 2.09 | 2.44 | 0.86 | 0.58 | 1.63 | 1.05 | 1.41 | 1.15 | 0.82 |
| Cr2O3 | 0.23 | 0.26 | 0.02 | 0.00 | 0.23 | 0.04 | 0.03 | 0.06 | 0.10 |
| FeO | 7.29 | 7.50 | 6.52 | 8.80 | 6.61 | 6.99 | 7.14 | 6.67 | 5.84 |
| MnO | 0.17 | 0.21 | 0.15 | 0.21 | 0.13 | 0.15 | 0.20 | 0.17 | 0.15 |
| MgO | 18.98 | 18.71 | 20.12 | 19.03 | 19.92 | 19.75 | 19.53 | 19.92 | 20.61 |
| CaO | 10.57 | 10.06 | 12.30 | 11.61 | 11.26 | 11.85 | 11.45 | 12.10 | 12.39 |
| BaO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 0.04 | 0.06 | 0.04 | 0.04 | 0.04 | 0.06 | 0.06 | 0.03 | 0.05 |
| Na2O | 1.79 | 2.15 | 0.80 | 1.06 | 1.45 | 1.10 | 1.27 | 0.95 | 0.69 |
| Cl2O−1 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.01 | 0.01 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 | 0.00 | 0.00 | 0.07 |
| Total | 97.80 | 98.06 | 97.42 | 98.00 | 97.98 | 97.70 | 97.83 | 97.85 | 97.56 |
| Si | 7.84 | 7.82 | 7.89 | 7.89 | 7.83 | 7.89 | 7.87 | 7.89 | 7.89 |
| Ti | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 0.34 | 0.40 | 0.14 | 0.10 | 0.27 | 0.17 | 0.23 | 0.19 | 0.13 |
| Cr | 0.03 | 0.03 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.01 | 0.01 |
| Fe3+ | 0.46 | 0.53 | 0.29 | 0.40 | 0.47 | 0.34 | 0.37 | 0.30 | 0.27 |
| Fe2+ | 0.39 | 0.33 | 0.47 | 0.62 | 0.29 | 0.47 | 0.46 | 0.48 | 0.41 |
| Mn | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| Mg | 3.92 | 3.85 | 4.18 | 3.95 | 4.10 | 4.10 | 4.04 | 4.12 | 4.27 |
| Ca | 1.57 | 1.49 | 1.84 | 1.73 | 1.67 | 1.77 | 1.70 | 1.80 | 1.84 |
| Ba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Na | 0.48 | 0.58 | 0.22 | 0.29 | 0.39 | 0.30 | 0.34 | 0.26 | 0.18 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.05 |
| O | 23.07 | 23.09 | 23.06 | 23.03 | 23.04 | 23.07 | 23.05 | 23.06 | 23.01 |
| Mg# | 0.91 | 0.92 | 0.90 | 0.86 | 0.93 | 0.90 | 0.90 | 0.90 | 0.91 |
| Al# | 0.05 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ts | 0.16 | 0.18 | 0.11 | 0.11 | 0.17 | 0.11 | 0.13 | 0.11 | 0.11 |
| A−site | 0.05 | 0.06 | 0.05 | 0.02 | 0.05 | 0.07 | 0.04 | 0.06 | 0.03 |

| sample | cr0318d | cr0318d | cr0444 | cr0444 |
|---|---|---|---|---|
| point | Mhbl−1 | Mhbl−2 | Mhbl−1 | Mhbl−2 |
| SiO2 | 47.94 | 48.22 | 49.17 | 51.28 |
| TiO2 | 0.86 | 0.95 | 0.30 | 0.09 |
| Al2O3 | 5.05 | 5.24 | 5.77 | 3.87 |
| Cr2O3 | 0.08 | 0.00 | 0.01 | 0.02 |
| FeO | 16.99 | 16.84 | 19.01 | 17.98 |
| MnO | 0.42 | 0.41 | 0.46 | 0.49 |
| MgO | 12.77 | 12.73 | 11.06 | 12.05 |
| CaO | 10.50 | 10.66 | 11.86 | 12.03 |
| K2O | 0.49 | 0.53 | 0.42 | 0.29 |
| Na2O | 1.20 | 1.34 | 0.69 | 0.47 |
| Cl2O−1 | 0.00 | 0.00 | 0.53 | 0.35 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 96.30 | 96.93 | 99.28 | 98.92 |
| Si | 7.07 | 7.08 | 7.18 | 7.46 |
| Ti | 0.10 | 0.10 | 0.03 | 0.01 |
| Al | 0.88 | 0.91 | 0.99 | 0.66 |
| Cr | 0.01 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 1.34 | 1.31 | 0.83 | 0.54 |
| Fe2+ | 0.76 | 0.76 | 1.49 | 1.64 |
| Mn | 0.05 | 0.05 | 0.06 | 0.06 |
| Mg | 2.81 | 2.79 | 2.41 | 2.61 |
| Ca | 1.66 | 1.68 | 1.86 | 1.88 |
| K | 0.09 | 0.10 | 0.08 | 0.05 |
| Na | 0.34 | 0.38 | 0.19 | 0.13 |
| Cl | 0.00 | 0.00 | 0.17 | 0.11 |
| F | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 23.15 | 23.21 | 23.04 | 22.99 |
| Mg♯ | 0.79 | 0.79 | 0.62 | 0.61 |
| Al♯ | 0.00 | 0.00 | 0.00 | 0.00 |
| Ts | 0.93 | 0.92 | 0.82 | 0.54 |
| A−site | 0.00 | 0.06 | 0.05 | 0.01 |

| sample | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Om−1 | Om−2 | Om−3 | Om−4 | Om−5 | Om−6 | Om−7 | Om−8 | Om−9 | Om−10 | Om−11 | Om−12 | Om−13 |
| SiO2 | 53.65 | 53.49 | 53.04 | 54.07 | 53.31 | 53.78 | 52.89 | 54.63 | 54.67 | 53.74 | 53.13 | 53.98 | 53.75 |
| TiO2 | 0.18 | 0.28 | 0.15 | 0.11 | 0.09 | 0.08 | 0.04 | 0.06 | 0.12 | 0.21 | 0.16 | 0.12 | 0.13 |
| Al2O3 | 4.60 | 4.22 | 3.33 | 1.37 | 1.36 | 1.39 | 1.04 | 4.97 | 5.09 | 2.75 | 2.66 | 0.96 | 1.21 |
| Cr2O3 | 0.08 | 0.00 | 0.00 | 0.03 | 0.00 | 0.01 | 0.02 | 0.05 | 0.04 | 0.03 | 0.04 | 0.00 | 0.01 |
| FeO | 15.28 | 15.55 | 15.29 | 16.34 | 16.11 | 15.65 | 16.04 | 13.03 | 11.59 | 15.77 | 16.19 | 16.88 | 15.73 |
| MnO | 0.39 | 0.41 | 0.60 | 0.20 | 0.20 | 0.20 | 0.19 | 0.19 | 0.42 | 0.17 | 0.09 | 0.19 | 0.16 |
| MgO | 5.41 | 5.83 | 6.31 | 7.84 | 7.89 | 7.72 | 7.83 | 7.07 | 7.68 | 6.84 | 6.73 | 7.81 | 7.94 |
| CaO | 12.49 | 12.98 | 13.58 | 12.44 | 12.39 | 12.86 | 12.64 | 11.21 | 12.89 | 11.66 | 11.52 | 13.01 | 13.26 |
| K2O | 0.02 | 0.03 | 0.04 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 | 0.00 |
| Na2O | 6.69 | 6.19 | 5.73 | 6.47 | 6.50 | 6.31 | 6.40 | 7.47 | 6.69 | 7.75 | 7.34 | 6.38 | 6.61 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 98.80 | 98.99 | 98.06 | 98.89 | 97.84 | 98.00 | 97.10 | 98.67 | 99.21 | 98.91 | 97.88 | 99.33 | 98.79 |
| Si | 2.01 | 2.01 | 2.01 | 2.02 | 2.01 | 2.02 | 2.01 | 2.01 | 2.01 | 1.99 | 1.99 | 2.01 | 2.00 |
| Ti | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| Al | 0.20 | 0.19 | 0.15 | 0.06 | 0.06 | 0.06 | 0.05 | 0.22 | 0.22 | 0.12 | 0.12 | 0.04 | 0.05 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.28 | 0.26 | 0.27 | 0.41 | 0.41 | 0.40 | 0.42 | 0.32 | 0.26 | 0.44 | 0.42 | 0.42 | 0.42 |
| Fe2+ | 0.20 | 0.22 | 0.21 | 0.10 | 0.09 | 0.09 | 0.08 | 0.08 | 0.10 | 0.05 | 0.09 | 0.11 | 0.07 |
| Mn | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 |
| Mg | 0.30 | 0.33 | 0.36 | 0.44 | 0.44 | 0.43 | 0.44 | 0.39 | 0.42 | 0.38 | 0.38 | 0.43 | 0.44 |
| Ca | 0.50 | 0.52 | 0.55 | 0.50 | 0.50 | 0.52 | 0.51 | 0.44 | 0.51 | 0.46 | 0.46 | 0.52 | 0.53 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.49 | 0.45 | 0.42 | 0.47 | 0.47 | 0.46 | 0.47 | 0.53 | 0.48 | 0.56 | 0.53 | 0.46 | 0.48 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 6.02 | 6.02 | 6.02 | 6.02 | 6.01 | 6.03 | 6.01 | 6.01 | 6.01 | 5.99 | 6.00 | 6.01 | 6.01 |
| Jd | 0.21 | 0.19 | 0.15 | 0.06 | 0.06 | 0.06 | 0.05 | 0.22 | 0.22 | 0.12 | 0.12 | 0.04 | 0.05 |
| Aeg | 0.29 | 0.27 | 0.28 | 0.42 | 0.42 | 0.41 | 0.43 | 0.33 | 0.26 | 0.43 | 0.42 | 0.43 | 0.42 |
| Mg♯ | 0.61 | 0.59 | 0.63 | 0.81 | 0.83 | 0.82 | 0.84 | 0.82 | 0.81 | 0.88 | 0.80 | 0.80 | 0.87 |

| sample | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Om−14 | Om−15 | Om−16 | Om−17 | Om−18 | Om−19 | Om−20 | Om−21 | Om−22 | Om−23 | Om−24 | Om−25 | Om−26 |
| SiO2 | 53.24 | 54.43 | 54.12 | 54.37 | 53.73 | 53.27 | 53.52 | 54.26 | 53.06 | 53.53 | 53.08 | 53.58 | 54.04 |
| TiO2 | 0.17 | 0.05 | 0.07 | 0.00 | 0.00 | 0.09 | 0.11 | 0.03 | 0.13 | 0.03 | 0.03 | 0.07 | 0.00 |
| Al2O3 | 0.86 | 5.97 | 1.45 | 1.27 | 1.13 | 1.27 | 1.33 | 1.76 | 2.20 | 1.15 | 0.81 | 1.10 | 2.08 |
| Cr2O3 | 0.01 | 0.06 | 0.00 | 0.01 | 0.01 | 0.05 | 0.04 | 0.04 | 0.04 | 0.02 | 0.03 | 0.01 | 0.01 |
| FeO | 17.21 | 11.69 | 15.35 | 13.71 | 13.74 | 15.55 | 15.02 | 13.31 | 16.12 | 15.38 | 13.37 | 12.62 | 12.81 |
| MnO | 0.10 | 0.42 | 0.16 | 0.18 | 0.12 | 0.18 | 0.22 | 0.17 | 0.12 | 0.16 | 0.28 | 0.35 | 0.29 |
| MgO | 7.24 | 6.99 | 8.20 | 9.41 | 9.39 | 8.18 | 8.25 | 9.00 | 7.07 | 8.40 | 9.80 | 10.32 | 9.18 |
| CaO | 11.96 | 12.16 | 12.70 | 14.90 | 14.35 | 12.91 | 13.24 | 13.81 | 11.93 | 13.29 | 15.43 | 16.41 | 14.64 |
| K2O | 0.02 | 0.00 | 0.00 | 0.04 | 0.01 | 0.00 | 0.01 | 0.03 | 0.01 | 0.00 | 0.00 | 0.02 | 0.00 |
| Na2O | 6.94 | 7.33 | 6.34 | 5.70 | 5.76 | 6.25 | 6.20 | 5.98 | 7.19 | 6.29 | 5.32 | 4.40 | 5.57 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 97.75 | 99.10 | 98.38 | 99.60 | 98.24 | 97.75 | 97.93 | 98.41 | 97.87 | 98.26 | 98.13 | 98.88 | 98.63 |
| Si | 2.01 | 1.99 | 2.02 | 2.00 | 2.00 | 2.01 | 2.01 | 2.02 | 1.99 | 2.00 | 1.99 | 2.00 | 2.01 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 0.04 | 0.26 | 0.06 | 0.06 | 0.05 | 0.06 | 0.06 | 0.08 | 0.10 | 0.05 | 0.04 | 0.05 | 0.09 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.47 | 0.26 | 0.40 | 0.35 | 0.37 | 0.40 | 0.39 | 0.35 | 0.43 | 0.41 | 0.35 | 0.27 | 0.31 |
| Fe2+ | 0.07 | 0.10 | 0.08 | 0.07 | 0.06 | 0.09 | 0.08 | 0.06 | 0.08 | 0.08 | 0.07 | 0.12 | 0.09 |
| Mn | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| Mg | 0.41 | 0.38 | 0.46 | 0.52 | 0.52 | 0.46 | 0.46 | 0.50 | 0.40 | 0.47 | 0.55 | 0.57 | 0.51 |
| Ca | 0.48 | 0.48 | 0.51 | 0.59 | 0.57 | 0.52 | 0.53 | 0.55 | 0.48 | 0.53 | 0.62 | 0.66 | 0.58 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.51 | 0.52 | 0.46 | 0.41 | 0.42 | 0.46 | 0.45 | 0.43 | 0.52 | 0.46 | 0.39 | 0.32 | 0.40 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 6.02 | 5.99 | 6.03 | 6.00 | 6.01 | 6.01 | 6.01 | 6.02 | 5.99 | 6.00 | 5.99 | 6.00 | 6.01 |
| Jd | 0.04 | 0.26 | 0.07 | 0.06 | 0.05 | 0.06 | 0.06 | 0.08 | 0.10 | 0.05 | 0.04 | 0.05 | 0.09 |
| Aeg | 0.47 | 0.26 | 0.41 | 0.35 | 0.37 | 0.41 | 0.40 | 0.36 | 0.42 | 0.41 | 0.35 | 0.28 | 0.31 |
| Mg# | 0.85 | 0.80 | 0.84 | 0.88 | 0.89 | 0.84 | 0.85 | 0.89 | 0.83 | 0.86 | 0.89 | 0.82 | 0.85 |

| sample | cr0318c | cr0318c | cr0318c | cr0430a | cr0430a | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Om−27 | Om−28 | Om−29 | Om−1 | Om−2 | Om−1 | Om−2 | Om−3 | Om−4 | Om−5 | Om−6 | Om−7 | Om−8 |
| SiO2 | 53.88 | 54.13 | 53.04 | 54.90 | 56.49 | 55.33 | 56.57 | 56.69 | 56.83 | 55.07 | 55.25 | 55.35 | 55.46 |
| TiO2 | 0.08 | 0.04 | 0.12 | 0.13 | 0.10 | 0.03 | 0.08 | 0.07 | 0.12 | 0.01 | 0.05 | 0.04 | 0.10 |
| Al2O3 | 3.11 | 3.79 | 1.31 | 10.51 | 10.48 | 9.41 | 11.71 | 9.71 | 11.40 | 6.72 | 8.12 | 8.26 | 10.39 |
| Cr2O3 | 0.00 | 0.06 | 0.04 | 0.06 | 0.05 | 0.04 | 0.02 | 0.08 | 0.07 | 0.29 | 0.07 | 0.18 | 0.10 |
| FeO | 12.42 | 12.70 | 16.86 | 8.59 | 7.52 | 8.22 | 6.05 | 6.46 | 6.18 | 7.36 | 7.50 | 7.34 | 6.28 |
| MnO | 0.25 | 0.21 | 0.20 | 0.14 | 0.12 | 0.22 | 0.10 | 0.15 | 0.13 | 0.15 | 0.17 | 0.17 | 0.12 |
| MgO | 8.65 | 8.18 | 7.72 | 6.64 | 6.72 | 7.42 | 6.66 | 7.58 | 6.76 | 9.20 | 8.35 | 8.28 | 6.91 |
| CaO | 13.97 | 12.94 | 12.67 | 12.86 | 12.92 | 13.38 | 12.19 | 13.37 | 11.99 | 16.47 | 14.93 | 14.94 | 12.68 |
| K2O | 0.02 | 0.00 | 0.04 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 |
| Na2O | 5.93 | 6.32 | 6.74 | 6.98 | 7.44 | 6.52 | 7.75 | 6.50 | 7.78 | 5.12 | 5.75 | 6.02 | 7.05 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 98.31 | 98.37 | 98.72 | 100.82 | 101.86 | 100.59 | 101.14 | 100.62 | 101.27 | 100.39 | 100.18 | 100.58 | 99.11 |
| Si | 2.00 | 2.01 | 1.98 | 1.96 | 1.99 | 1.98 | 1.99 | 2.02 | 2.00 | 1.99 | 1.99 | 1.98 | 2.00 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 0.14 | 0.17 | 0.06 | 0.44 | 0.43 | 0.40 | 0.49 | 0.41 | 0.47 | 0.29 | 0.35 | 0.35 | 0.44 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 |
| Fe3+ | 0.29 | 0.29 | 0.43 | 0.04 | 0.07 | 0.06 | 0.04 | 0.04 | 0.06 | 0.07 | 0.06 | 0.07 | 0.05 |
| Fe2+ | 0.09 | 0.10 | 0.10 | 0.22 | 0.15 | 0.19 | 0.14 | 0.15 | 0.12 | 0.15 | 0.17 | 0.15 | 0.14 |
| Mn | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 |
| Mg | 0.48 | 0.45 | 0.43 | 0.35 | 0.35 | 0.40 | 0.35 | 0.40 | 0.35 | 0.49 | 0.45 | 0.44 | 0.37 |
| Ca | 0.56 | 0.51 | 0.51 | 0.49 | 0.49 | 0.51 | 0.46 | 0.51 | 0.45 | 0.64 | 0.58 | 0.57 | 0.49 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.43 | 0.45 | 0.49 | 0.48 | 0.51 | 0.45 | 0.53 | 0.45 | 0.53 | 0.36 | 0.40 | 0.42 | 0.49 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 6.01 | 6.01 | 5.99 | 5.97 | 5.99 | 5.98 | 5.99 | 6.03 | 6.00 | 5.99 | 6.00 | 5.99 | 6.01 |
| Jd | 0.14 | 0.17 | 0.06 | 0.45 | 0.44 | 0.41 | 0.49 | 0.43 | 0.48 | 0.29 | 0.35 | 0.35 | 0.45 |
| Aeg | 0.30 | 0.30 | 0.43 | 0.04 | 0.07 | 0.06 | 0.04 | 0.04 | 0.06 | 0.07 | 0.06 | 0.07 | 0.05 |
| Mg# | 0.84 | 0.81 | 0.82 | 0.62 | 0.70 | 0.67 | 0.72 | 0.73 | 0.74 | 0.77 | 0.73 | 0.75 | 0.73 |

| sample | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0434 | cr0438 | cr0438 | cr0438 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Om−9 | Om−10 | Om−11 | Om−12 | Om−13 | Om−14 | Om−15 | Om−16 | Om−17 | Om−18 | Om−1 | Om−2 | Om−3 |
| SiO2 | 55.58 | 55.64 | 55.71 | 55.74 | 55.75 | 55.77 | 55.82 | 55.96 | 56.46 | 56.70 | 54.23 | 54.64 | 54.67 |
| TiO2 | 0.04 | 0.01 | 0.14 | 0.12 | 0.11 | 0.07 | 0.20 | 0.10 | 0.11 | 0.10 | 0.15 | 0.20 | 0.20 |
| Al2O3 | 8.17 | 7.22 | 10.06 | 10.36 | 10.02 | 10.02 | 11.19 | 10.62 | 11.17 | 11.66 | 7.92 | 9.30 | 9.07 |
| Cr2O3 | 0.00 | 0.02 | 0.09 | 0.08 | 0.12 | 0.00 | 0.05 | 0.14 | 0.20 | 0.01 | 0.00 | 0.00 | 0.00 |
| FeO | 7.29 | 7.34 | 6.92 | 6.38 | 6.63 | 6.92 | 6.52 | 6.43 | 6.22 | 6.26 | 10.50 | 10.55 | 10.70 |
| MnO | 0.14 | 0.12 | 0.13 | 0.14 | 0.16 | 0.13 | 0.14 | 0.11 | 0.11 | 0.10 | 0.15 | 0.08 | 0.14 |
| MgO | 8.50 | 8.99 | 7.26 | 7.26 | 7.38 | 7.58 | 6.50 | 7.12 | 6.84 | 6.65 | 6.58 | 6.16 | 6.47 |
| CaO | 15.12 | 16.25 | 13.09 | 12.91 | 13.52 | 13.77 | 11.91 | 12.76 | 12.18 | 12.09 | 12.11 | 10.58 | 10.85 |
| K2O | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 |
| Na2O | 5.81 | 5.44 | 6.94 | 7.05 | 6.86 | 6.59 | 7.74 | 7.27 | 7.60 | 7.78 | 6.22 | 8.50 | 8.40 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.14 | 0.00 | 0.00 |
| F2O−1 | 0.02 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.03 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| Total | 100.67 | 101.02 | 100.35 | 100.04 | 100.58 | 100.85 | 100.07 | 100.54 | 100.89 | 101.35 | 98.00 | 100.04 | 100.50 |
| Si | 1.99 | 1.99 | 1.99 | 1.99 | 1.99 | 1.99 | 1.99 | 1.99 | 2.00 | 1.99 | 2.02 | 1.96 | 1.95 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 |
| Al | 0.35 | 0.30 | 0.42 | 0.44 | 0.42 | 0.42 | 0.47 | 0.44 | 0.47 | 0.48 | 0.35 | 0.39 | 0.38 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.06 | 0.07 | 0.06 | 0.05 | 0.05 | 0.03 | 0.06 | 0.06 | 0.06 | 0.05 | 0.10 | 0.20 | 0.20 |
| Fe2+ | 0.16 | 0.15 | 0.15 | 0.14 | 0.14 | 0.17 | 0.13 | 0.13 | 0.13 | 0.14 | 0.23 | 0.12 | 0.12 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.45 | 0.48 | 0.39 | 0.39 | 0.39 | 0.40 | 0.35 | 0.38 | 0.36 | 0.35 | 0.37 | 0.33 | 0.34 |
| Ca | 0.58 | 0.62 | 0.50 | 0.49 | 0.52 | 0.53 | 0.45 | 0.49 | 0.46 | 0.46 | 0.48 | 0.41 | 0.41 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.40 | 0.38 | 0.48 | 0.49 | 0.47 | 0.46 | 0.53 | 0.50 | 0.52 | 0.53 | 0.45 | 0.59 | 0.58 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 5.99 | 5.99 | 6.00 | 6.00 | 5.99 | 5.99 | 6.00 | 5.99 | 6.00 | 6.00 | 6.02 | 5.96 | 5.96 |
| Jd | 0.35 | 0.30 | 0.43 | 0.44 | 0.42 | 0.43 | 0.47 | 0.45 | 0.47 | 0.49 | 0.37 | 0.39 | 0.38 |
| Aeg | 0.06 | 0.07 | 0.06 | 0.05 | 0.05 | 0.04 | 0.07 | 0.06 | 0.06 | 0.05 | 0.11 | 0.20 | 0.20 |
| Mg♯ | 0.74 | 0.77 | 0.72 | 0.74 | 0.73 | 0.70 | 0.73 | 0.74 | 0.74 | 0.72 | 0.62 | 0.74 | 0.74 |

| sample | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Om−4 | Om−5 | Om−6 | Om−7 | Om−8 | Om−9 | Om−10 | Om−11 | Om−12 | Om−13 | Om−14 | Om−15 | Om−16 |
| SiO2 | 54.75 | 54.85 | 54.91 | 53.89 | 53.98 | 54.25 | 54.26 | 54.30 | 54.51 | 54.66 | 54.99 | 55.07 | 55.07 |
| TiO2 | 0.16 | 0.45 | 0.15 | 0.13 | 0.11 | 0.08 | 0.04 | 0.27 | 0.02 | 0.11 | 0.15 | 0.11 | 0.12 |
| Al2O3 | 8.81 | 8.82 | 8.94 | 4.31 | 5.18 | 7.50 | 6.67 | 5.78 | 7.01 | 8.55 | 9.49 | 8.28 | 8.57 |
| Cr2O3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeO | 10.14 | 11.08 | 10.55 | 12.49 | 13.65 | 9.61 | 11.15 | 12.32 | 10.76 | 9.52 | 8.95 | 10.22 | 9.22 |
| MnO | 0.15 | 0.10 | 0.12 | 0.18 | 0.14 | 0.16 | 0.17 | 0.18 | 0.14 | 0.16 | 0.10 | 0.13 | 0.18 |
| MgO | 6.55 | 6.01 | 6.62 | 7.95 | 6.80 | 7.18 | 7.52 | 7.55 | 6.97 | 6.72 | 6.31 | 6.34 | 6.71 |
| CaO | 10.96 | 10.46 | 11.08 | 13.70 | 11.33 | 12.66 | 12.55 | 12.19 | 11.73 | 11.41 | 10.47 | 11.05 | 11.77 |
| K2O | 0.00 | 0.03 | 0.01 | 0.00 | 0.00 | 0.01 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 |
| Na2O | 8.36 | 8.60 | 8.60 | 6.60 | 7.89 | 7.67 | 7.37 | 7.36 | 8.18 | 7.90 | 8.64 | 8.53 | 7.99 |
| Cl2O−1 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.02 |
| F2O−1 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 99.89 | 100.42 | 100.98 | 99.25 | 99.08 | 99.11 | 99.75 | 99.96 | 99.34 | 99.03 | 99.10 | 99.73 | 99.65 |
| Si | 1.96 | 1.96 | 1.95 | 1.98 | 1.98 | 1.96 | 1.96 | 1.97 | 1.97 | 1.98 | 1.98 | 1.98 | 1.98 |
| Ti | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 0.37 | 0.37 | 0.37 | 0.19 | 0.22 | 0.32 | 0.28 | 0.25 | 0.30 | 0.37 | 0.40 | 0.35 | 0.36 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.21 | 0.22 | 0.22 | 0.28 | 0.34 | 0.22 | 0.23 | 0.27 | 0.27 | 0.19 | 0.20 | 0.24 | 0.19 |
| Fe2+ | 0.10 | 0.11 | 0.09 | 0.10 | 0.08 | 0.07 | 0.10 | 0.10 | 0.05 | 0.10 | 0.07 | 0.06 | 0.08 |
| Mn | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| Mg | 0.35 | 0.32 | 0.35 | 0.44 | 0.37 | 0.39 | 0.41 | 0.41 | 0.38 | 0.36 | 0.34 | 0.34 | 0.36 |
| Ca | 0.42 | 0.40 | 0.42 | 0.54 | 0.44 | 0.49 | 0.49 | 0.47 | 0.45 | 0.44 | 0.40 | 0.43 | 0.45 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.58 | 0.60 | 0.59 | 0.47 | 0.56 | 0.54 | 0.52 | 0.52 | 0.57 | 0.55 | 0.60 | 0.59 | 0.56 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 5.97 | 5.97 | 5.95 | 5.98 | 5.98 | 5.97 | 5.96 | 5.98 | 5.97 | 5.98 | 5.98 | 5.98 | 5.98 |
| Jd | 0.37 | 0.37 | 0.37 | 0.18 | 0.22 | 0.31 | 0.28 | 0.25 | 0.29 | 0.37 | 0.40 | 0.34 | 0.36 |
| Aeg | 0.21 | 0.23 | 0.22 | 0.28 | 0.33 | 0.21 | 0.23 | 0.27 | 0.27 | 0.19 | 0.20 | 0.24 | 0.19 |
| Mg♯ | 0.79 | 0.75 | 0.79 | 0.81 | 0.82 | 0.84 | 0.79 | 0.80 | 0.88 | 0.79 | 0.83 | 0.84 | 0.81 |

| sample | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Om−17 | Om−18 | Om−19 | Om−20 | Om−21 | Om−22 | Om−23 | Om−24 | Om−25 | Om−26 | Om−27 | Om−28 | Om−29 |
| SiO2 | 55.17 | 55.53 | 55.44 | 54.86 | 54.87 | 56.11 | 52.66 | 54.42 | 54.43 | 54.94 | 54.86 | 55.36 | 55.43 |
| TiO2 | 0.16 | 0.09 | 0.28 | 0.21 | 0.23 | 0.21 | 1.15 | 0.21 | 0.18 | 0.25 | 0.45 | 0.35 | 0.23 |
| Al2O3 | 10.72 | 9.05 | 8.93 | 7.88 | 7.68 | 8.39 | 8.63 | 9.28 | 9.33 | 9.54 | 6.75 | 9.03 | 9.12 |
| Cr2O3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeO | 9.09 | 9.33 | 9.16 | 9.94 | 9.38 | 9.42 | 9.93 | 9.27 | 9.08 | 9.40 | 10.91 | 10.64 | 10.47 |
| MnO | 0.12 | 0.18 | 0.10 | 0.16 | 0.13 | 0.14 | 0.14 | 0.14 | 0.12 | 0.12 | 0.19 | 0.14 | 0.13 |
| MgO | 5.42 | 6.35 | 6.44 | 6.61 | 7.32 | 7.05 | 6.75 | 6.55 | 6.27 | 6.18 | 6.95 | 5.75 | 5.81 |
| CaO | 9.65 | 11.01 | 11.01 | 11.93 | 12.41 | 11.84 | 11.78 | 10.93 | 10.83 | 10.72 | 13.66 | 11.10 | 11.12 |
| K2O | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na2O | 9.18 | 8.71 | 7.94 | 7.56 | 7.22 | 7.62 | 7.25 | 7.86 | 8.08 | 8.12 | 6.60 | 8.02 | 7.92 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 99.54 | 100.26 | 99.30 | 99.14 | 99.25 | 100.78 | 98.29 | 98.67 | 98.33 | 99.28 | 100.38 | 100.39 | 100.22 |
| Si | 1.97 | 1.98 | 2.00 | 1.99 | 1.99 | 2.00 | 1.93 | 1.98 | 1.98 | 1.98 | 1.99 | 1.99 | 2.00 |
| Ti | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.03 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| Al | 0.45 | 0.38 | 0.38 | 0.34 | 0.33 | 0.35 | 0.37 | 0.40 | 0.40 | 0.41 | 0.29 | 0.38 | 0.39 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.18 | 0.22 | 0.18 | 0.20 | 0.18 | 0.17 | 0.14 | 0.16 | 0.17 | 0.16 | 0.18 | 0.18 | 0.17 |
| Fe2+ | 0.09 | 0.06 | 0.10 | 0.11 | 0.10 | 0.11 | 0.16 | 0.13 | 0.11 | 0.12 | 0.16 | 0.14 | 0.15 |
| Mn | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| Mg | 0.29 | 0.34 | 0.35 | 0.36 | 0.40 | 0.37 | 0.37 | 0.35 | 0.34 | 0.33 | 0.38 | 0.31 | 0.31 |
| Ca | 0.37 | 0.42 | 0.43 | 0.46 | 0.48 | 0.45 | 0.46 | 0.43 | 0.42 | 0.41 | 0.53 | 0.43 | 0.43 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.64 | 0.60 | 0.56 | 0.53 | 0.51 | 0.53 | 0.52 | 0.55 | 0.57 | 0.57 | 0.46 | 0.56 | 0.55 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 5.98 | 5.98 | 6.01 | 6.00 | 6.00 | 6.01 | 5.97 | 5.98 | 5.99 | 5.99 | 6.00 | 6.00 | 6.00 |
| Jd | 0.45 | 0.37 | 0.39 | 0.34 | 0.33 | 0.36 | 0.38 | 0.41 | 0.40 | 0.41 | 0.29 | 0.39 | 0.39 |
| Aeg | 0.18 | 0.22 | 0.18 | 0.20 | 0.18 | 0.18 | 0.15 | 0.16 | 0.17 | 0.17 | 0.18 | 0.18 | 0.17 |
| Mg♯ | 0.77 | 0.86 | 0.78 | 0.77 | 0.79 | 0.78 | 0.70 | 0.74 | 0.76 | 0.73 | 0.71 | 0.68 | 0.68 |

| sample | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr04551 | cr04551 | cr04552 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Om−30 | Om−31 | Om−32 | Om−33 | Om−34 | Om−35 | Om−36 | Om−37 | Om−38 | Om−39 | Om−1 | Om−2 | Om−1 |
| SiO2 | 55.44 | 53.79 | 53.41 | 54.01 | 54.08 | 54.39 | 55.63 | 55.12 | 55.32 | 54.41 | 54.39 | 54.32 | 55.76 |
| TiO2 | 0.18 | 0.23 | 0.19 | 0.30 | 0.21 | 0.13 | 0.20 | 0.23 | 0.24 | 0.34 | 0.05 | 0.02 | 0.05 |
| Al2O3 | 9.33 | 10.36 | 8.67 | 6.91 | 9.18 | 4.25 | 10.43 | 9.70 | 9.92 | 9.10 | 1.89 | 0.43 | 2.40 |
| Cr2O3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.02 | 0.00 |
| FeO | 10.24 | 10.18 | 10.36 | 10.09 | 9.17 | 12.47 | 9.06 | 9.37 | 9.34 | 10.38 | 18.71 | 15.62 | 19.69 |
| MnO | 0.11 | 0.14 | 0.10 | 0.18 | 0.12 | 0.18 | 0.14 | 0.12 | 0.15 | 0.14 | 0.22 | 0.65 | 0.14 |
| MgO | 5.63 | 5.18 | 5.86 | 7.35 | 6.16 | 8.30 | 5.50 | 5.85 | 5.63 | 5.54 | 5.68 | 8.49 | 4.97 |
| CaO | 10.83 | 10.55 | 10.96 | 12.95 | 10.92 | 14.58 | 10.05 | 10.44 | 10.39 | 10.38 | 11.39 | 16.55 | 9.73 |
| K2O | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na2O | 8.26 | 8.51 | 7.91 | 6.80 | 7.99 | 6.31 | 8.51 | 8.21 | 8.44 | 8.32 | 7.23 | 4.61 | 7.25 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 100.01 | 98.94 | 97.46 | 98.59 | 97.83 | 100.61 | 99.52 | 99.05 | 99.43 | 98.60 | 99.59 | 100.71 | 100.00 |
| Si | 1.99 | 1.95 | 1.97 | 1.98 | 1.98 | 1.97 | 2.00 | 2.00 | 1.99 | 1.98 | 2.03 | 2.02 | 2.08 |
| Ti | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| Al | 0.40 | 0.44 | 0.38 | 0.30 | 0.40 | 0.18 | 0.44 | 0.41 | 0.42 | 0.39 | 0.08 | 0.02 | 0.11 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.18 | 0.16 | 0.19 | 0.18 | 0.17 | 0.26 | 0.15 | 0.16 | 0.17 | 0.20 | 0.44 | 0.31 | 0.42 |
| Fe2+ | 0.13 | 0.15 | 0.13 | 0.13 | 0.11 | 0.12 | 0.12 | 0.12 | 0.11 | 0.12 | 0.14 | 0.17 | 0.20 |
| Mn | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.00 |
| Mg | 0.30 | 0.28 | 0.32 | 0.40 | 0.34 | 0.45 | 0.29 | 0.32 | 0.30 | 0.30 | 0.32 | 0.47 | 0.28 |
| Ca | 0.42 | 0.41 | 0.43 | 0.51 | 0.43 | 0.57 | 0.39 | 0.40 | 0.40 | 0.41 | 0.46 | 0.66 | 0.39 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.58 | 0.60 | 0.57 | 0.48 | 0.57 | 0.44 | 0.59 | 0.58 | 0.59 | 0.59 | 0.52 | 0.33 | 0.53 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 6.00 | 5.96 | 5.98 | 5.99 | 5.99 | 5.98 | 6.01 | 6.00 | 6.00 | 5.99 | 6.03 | 6.02 | 6.08 |
| Jd | 0.40 | 0.44 | 0.38 | 0.30 | 0.40 | 0.18 | 0.45 | 0.42 | 0.43 | 0.39 | 0.08 | 0.02 | 0.12 |
| Aeg | 0.18 | 0.15 | 0.19 | 0.19 | 0.17 | 0.26 | 0.15 | 0.17 | 0.17 | 0.20 | 0.45 | 0.32 | 0.46 |
| Mg♯ | 0.70 | 0.65 | 0.71 | 0.76 | 0.75 | 0.79 | 0.71 | 0.72 | 0.73 | 0.72 | 0.69 | 0.73 | 0.59 |

| sample | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a | cr0459a |
|---|---|---|---|---|---|---|---|---|
| point | Om−1 | Om−2 | Om−3 | Om−4 | Om−5 | Om−6 | Om−7 | Om−8 |
| SiO2 | 54.51 | 54.82 | 54.85 | 54.92 | 55.05 | 55.21 | 55.50 | 55.54 |
| TiO2 | 0.05 | 0.07 | 0.06 | 0.05 | 0.06 | 0.02 | 0.04 | 0.03 |
| Al2O3 | 6.38 | 5.63 | 6.62 | 6.60 | 7.05 | 7.17 | 6.88 | 6.90 |
| Cr2O3 | 1.10 | 1.07 | 0.99 | 0.99 | 1.13 | 0.77 | 1.05 | 1.12 |
| FeO | 7.80 | 6.84 | 8.00 | 8.31 | 8.31 | 7.66 | 8.03 | 7.77 |
| MnO | 0.12 | 0.10 | 0.17 | 0.14 | 0.10 | 0.13 | 0.15 | 0.12 |
| MgO | 9.05 | 10.61 | 9.03 | 8.55 | 8.06 | 8.61 | 8.47 | 8.57 |
| CaO | 13.80 | 15.28 | 13.46 | 13.22 | 12.68 | 13.50 | 13.20 | 13.25 |
| K2O | 0.01 | 0.01 | 0.01 | 0.00 | 0.03 | 0.02 | 0.00 | 0.00 |
| Na2O | 6.44 | 5.02 | 6.25 | 6.84 | 7.04 | 6.81 | 7.05 | 6.89 |
| Cl2O−1 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.23 | 0.00 | 0.00 | 0.13 | 0.00 | 0.00 | 0.15 | 0.00 |
| Total | 99.49 | 99.45 | 99.45 | 99.75 | 99.51 | 99.90 | 100.54 | 100.19 |
| Si | 1.98 | 1.99 | 1.99 | 1.98 | 1.99 | 1.98 | 1.99 | 1.99 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 0.27 | 0.24 | 0.28 | 0.28 | 0.30 | 0.30 | 0.29 | 0.29 |
| Cr | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.03 | 0.03 |
| Fe3+ | 0.18 | 0.11 | 0.16 | 0.20 | 0.19 | 0.17 | 0.20 | 0.19 |
| Fe2+ | 0.06 | 0.10 | 0.09 | 0.05 | 0.06 | 0.06 | 0.04 | 0.05 |
| Mn | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.49 | 0.57 | 0.49 | 0.46 | 0.43 | 0.46 | 0.45 | 0.46 |
| Ca | 0.54 | 0.59 | 0.52 | 0.51 | 0.49 | 0.52 | 0.51 | 0.51 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.45 | 0.35 | 0.44 | 0.48 | 0.49 | 0.47 | 0.49 | 0.48 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.05 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.03 | 0.00 |
| O | 5.97 | 6.01 | 6.00 | 5.99 | 6.01 | 6.00 | 5.99 | 6.01 |
| Jd | 0.28 | 0.25 | 0.29 | 0.28 | 0.31 | 0.31 | 0.29 | 0.29 |
| Aeg | 0.18 | 0.12 | 0.16 | 0.20 | 0.20 | 0.17 | 0.20 | 0.19 |
| Mg♯ | 0.90 | 0.86 | 0.85 | 0.90 | 0.88 | 0.89 | 0.92 | 0.91 |

| sample | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Om2−1 | Om2−2 | Om2−3 | Om2−4 | Om2−5 | Om2−6 | Om2−7 | Om2−8 | Om2−9 | Om2−10 | Om2−11 | Om2−12 | Om2−13 |
| SiO2 | 52.74 | 53.06 | 53.10 | 53.37 | 53.87 | 53.12 | 53.14 | 53.36 | 53.46 | 56.85 | 54.45 | 52.61 | 53.38 |
| TiO2 | 0.00 | 0.18 | 0.67 | 0.05 | 0.11 | 0.15 | 0.06 | 0.07 | 0.35 | 0.07 | 0.11 | 0.04 | 0.13 |
| Al2O3 | 4.80 | 3.95 | 4.24 | 4.86 | 4.21 | 2.43 | 3.71 | 2.63 | 6.85 | 3.97 | 6.59 | 6.14 | 4.69 |
| FeO | 13.27 | 16.69 | 14.90 | 14.65 | 16.14 | 13.64 | 13.07 | 15.35 | 12.62 | 13.15 | 13.75 | 13.62 | 13.60 |
| MnO | 0.16 | 0.25 | 0.24 | 0.17 | 0.20 | 0.30 | 0.21 | 0.16 | 0.18 | 0.15 | 0.10 | 0.16 | 0.19 |
| MgO | 7.61 | 6.59 | 7.33 | 7.54 | 7.20 | 8.96 | 8.12 | 8.23 | 6.09 | 6.67 | 5.14 | 8.31 | 7.11 |
| CaO | 13.06 | 12.74 | 14.05 | 12.94 | 12.25 | 15.89 | 15.00 | 11.63 | 11.33 | 10.58 | 9.17 | 11.02 | 11.80 |
| K2O | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| Na2O | 6.65 | 7.01 | 6.66 | 7.35 | 7.73 | 5.27 | 5.75 | 7.50 | 8.51 | 7.51 | 8.81 | 6.75 | 7.17 |
| Cl2O−1 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.03 | 0.03 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 98.31 | 100.46 | 101.20 | 100.93 | 101.71 | 99.80 | 99.08 | 98.94 | 99.39 | 98.96 | 98.11 | 98.65 | 98.08 |
| Si | 1.96 | 1.95 | 1.93 | 1.93 | 1.93 | 1.96 | 1.97 | 1.96 | 1.94 | 2.10 | 2.01 | 1.94 | 1.98 |
| Ti | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 0.21 | 0.17 | 0.18 | 0.21 | 0.18 | 0.11 | 0.16 | 0.11 | 0.29 | 0.17 | 0.29 | 0.27 | 0.21 |
| Fe3+ | 0.27 | 0.33 | 0.29 | 0.31 | 0.36 | 0.27 | 0.25 | 0.42 | 0.31 | 0.36 | 0.34 | 0.22 | 0.31 |
| Fe2+ | 0.14 | 0.18 | 0.16 | 0.13 | 0.13 | 0.15 | 0.15 | 0.05 | 0.08 | 0.04 | 0.08 | 0.20 | 0.11 |
| Mn | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 |
| Mg | 0.42 | 0.36 | 0.40 | 0.41 | 0.39 | 0.49 | 0.45 | 0.45 | 0.33 | 0.37 | 0.28 | 0.46 | 0.39 |
| Ca | 0.52 | 0.50 | 0.55 | 0.50 | 0.47 | 0.63 | 0.60 | 0.46 | 0.44 | 0.42 | 0.36 | 0.43 | 0.47 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.48 | 0.50 | 0.47 | 0.51 | 0.54 | 0.38 | 0.41 | 0.53 | 0.60 | 0.54 | 0.63 | 0.48 | 0.52 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 5.96 | 5.95 | 5.95 | 5.93 | 5.94 | 5.96 | 5.97 | 5.96 | 5.95 | 6.10 | 6.01 | 5.94 | 5.99 |
| Jd | 0.21 | 0.17 | 0.18 | 0.20 | 0.18 | 0.11 | 0.16 | 0.11 | 0.28 | 0.18 | 0.29 | 0.29 | 0.21 |
| Aeg | 0.27 | 0.33 | 0.28 | 0.30 | 0.36 | 0.27 | 0.25 | 0.42 | 0.29 | 0.38 | 0.35 | 0.23 | 0.32 |
| Mg♯ | 0.75 | 0.66 | 0.71 | 0.75 | 0.75 | 0.77 | 0.74 | 0.90 | 0.81 | 0.90 | 0.78 | 0.69 | 0.78 |

| sample | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Om2−14 | Om2−15 | Om2−16 | Om2−17 | Om2−18 | Om2−19 | Om2−20 | Om2−21 | Om2−22 | Om2−23 | Om2−24 | Om2−25 | Om2−26 |
| SiO2 | 53.61 | 53.78 | 53.91 | 54.02 | 54.07 | 54.13 | 54.17 | 54.19 | 54.35 | 54.54 | 55.19 | 55.36 | 52.60 |
| TiO2 | 0.20 | 0.32 | 0.16 | 0.03 | 0.06 | 0.15 | 0.12 | 0.14 | 0.06 | 0.05 | 0.18 | 0.13 | 1.45 |
| Al2O3 | 3.83 | 5.54 | 5.55 | 3.46 | 4.79 | 5.33 | 5.36 | 5.69 | 5.18 | 4.10 | 5.84 | 5.77 | 5.01 |
| FeO | 13.25 | 13.68 | 13.82 | 14.36 | 14.02 | 13.72 | 13.74 | 12.32 | 14.27 | 14.83 | 12.61 | 11.86 | 12.09 |
| MnO | 0.20 | 0.14 | 0.15 | 0.13 | 0.13 | 0.15 | 0.14 | 0.19 | 0.11 | 0.17 | 0.18 | 0.14 | 0.13 |
| MgO | 7.66 | 6.48 | 6.21 | 7.20 | 6.53 | 6.15 | 6.42 | 7.06 | 6.75 | 7.00 | 6.94 | 7.68 | 6.80 |
| CaO | 13.34 | 11.37 | 10.72 | 12.06 | 11.49 | 11.07 | 10.91 | 12.46 | 11.55 | 12.04 | 12.13 | 12.70 | 13.35 |
| K2O | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na2O | 6.33 | 7.31 | 7.69 | 7.07 | 7.40 | 7.85 | 7.65 | 7.03 | 7.46 | 7.36 | 7.24 | 7.02 | 6.63 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 98.42 | 98.62 | 98.21 | 98.34 | 98.48 | 98.55 | 98.51 | 99.08 | 99.72 | 100.10 | 100.30 | 100.65 | 98.06 |
| Si | 1.99 | 1.99 | 2.00 | 2.01 | 2.00 | 2.00 | 2.00 | 1.99 | 1.99 | 1.99 | 2.00 | 2.00 | 1.96 |
| Ti | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 |
| Al | 0.17 | 0.24 | 0.24 | 0.15 | 0.21 | 0.23 | 0.23 | 0.25 | 0.22 | 0.18 | 0.25 | 0.25 | 0.22 |
| Fe3+ | 0.29 | 0.28 | 0.31 | 0.36 | 0.32 | 0.33 | 0.31 | 0.25 | 0.31 | 0.34 | 0.26 | 0.25 | 0.26 |
| Fe2+ | 0.12 | 0.14 | 0.12 | 0.09 | 0.11 | 0.09 | 0.11 | 0.12 | 0.13 | 0.11 | 0.12 | 0.11 | 0.12 |
| Mn | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 |
| Mg | 0.42 | 0.36 | 0.34 | 0.40 | 0.36 | 0.34 | 0.35 | 0.39 | 0.37 | 0.38 | 0.38 | 0.41 | 0.38 |
| Ca | 0.53 | 0.45 | 0.43 | 0.48 | 0.46 | 0.44 | 0.43 | 0.49 | 0.45 | 0.47 | 0.47 | 0.49 | 0.53 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.46 | 0.52 | 0.55 | 0.51 | 0.53 | 0.56 | 0.55 | 0.50 | 0.53 | 0.52 | 0.51 | 0.49 | 0.48 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 6.00 | 6.00 | 6.00 | 6.01 | 6.00 | 6.00 | 6.00 | 5.99 | 5.99 | 5.99 | 6.01 | 6.00 | 6.01 |
| Jd | 0.17 | 0.25 | 0.25 | 0.15 | 0.21 | 0.23 | 0.24 | 0.25 | 0.23 | 0.18 | 0.25 | 0.25 | 0.22 |
| Aeg | 0.29 | 0.29 | 0.32 | 0.36 | 0.33 | 0.33 | 0.32 | 0.26 | 0.31 | 0.35 | 0.26 | 0.25 | 0.26 |
| Mg♯ | 0.77 | 0.72 | 0.74 | 0.82 | 0.76 | 0.78 | 0.76 | 0.76 | 0.74 | 0.78 | 0.75 | 0.79 | 0.76 |

| sample | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Om2−27 | Om2−28 | Om2−29 | Om2−30 | Om2−31 | Om2−32 | Om2−33 | Om2−34 | Om2−35 | Om2−36 | Om2−37 | Om2−38 | Om2−39 |
| SiO2 | 52.88 | 53.19 | 53.62 | 53.67 | 53.77 | 53.99 | 60.02 | 53.25 | 53.73 | 53.83 | 54.39 | 54.62 | 54.73 |
| TiO2 | 0.81 | 0.05 | 0.14 | 0.18 | 0.20 | 0.07 | 0.12 | 0.12 | 0.14 | 0.09 | 0.07 | 0.05 | 0.14 |
| Al2O3 | 3.08 | 3.71 | 3.79 | 6.40 | 6.03 | 5.38 | 3.69 | 4.74 | 4.92 | 2.53 | 5.00 | 5.45 | 6.32 |
| FeO | 14.37 | 12.11 | 14.26 | 11.37 | 12.68 | 12.98 | 12.30 | 14.83 | 14.27 | 13.84 | 13.93 | 12.80 | 13.51 |
| MnO | 0.15 | 0.19 | 0.19 | 0.19 | 0.15 | 0.16 | 0.17 | 0.24 | 0.17 | 0.25 | 0.18 | 0.16 | 0.15 |
| MgO | 7.57 | 8.52 | 7.20 | 7.11 | 6.45 | 6.82 | 7.85 | 8.04 | 6.69 | 8.45 | 6.85 | 6.95 | 6.11 |
| CaO | 13.34 | 14.68 | 13.02 | 12.51 | 11.65 | 11.42 | 13.68 | 13.24 | 13.00 | 16.39 | 13.40 | 13.22 | 11.61 |
| K2O | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na2O | 6.68 | 5.90 | 6.72 | 6.96 | 7.37 | 7.23 | 5.72 | 6.37 | 6.62 | 5.06 | 6.54 | 6.60 | 7.59 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 98.89 | 98.35 | 98.94 | 98.38 | 98.30 | 98.06 | 103.55 | 100.84 | 99.54 | 100.43 | 100.34 | 99.86 | 100.16 |
| Si | 1.96 | 1.97 | 1.99 | 1.98 | 1.99 | 2.00 | 2.14 | 1.94 | 1.98 | 1.98 | 1.99 | 2.00 | 1.99 |
| Ti | 0.02 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 0.13 | 0.16 | 0.17 | 0.28 | 0.26 | 0.24 | 0.15 | 0.20 | 0.21 | 0.11 | 0.22 | 0.24 | 0.27 |
| Fe3+ | 0.35 | 0.26 | 0.32 | 0.22 | 0.27 | 0.28 | 0.24 | 0.25 | 0.26 | 0.25 | 0.25 | 0.23 | 0.26 |
| Fe2+ | 0.10 | 0.11 | 0.12 | 0.13 | 0.13 | 0.12 | 0.13 | 0.21 | 0.18 | 0.17 | 0.18 | 0.16 | 0.15 |
| Mn | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 |
| Mg | 0.42 | 0.47 | 0.40 | 0.39 | 0.36 | 0.38 | 0.42 | 0.44 | 0.37 | 0.46 | 0.37 | 0.38 | 0.33 |
| Ca | 0.53 | 0.58 | 0.52 | 0.49 | 0.46 | 0.45 | 0.52 | 0.52 | 0.51 | 0.65 | 0.52 | 0.52 | 0.45 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.48 | 0.42 | 0.48 | 0.50 | 0.53 | 0.52 | 0.40 | 0.45 | 0.47 | 0.36 | 0.46 | 0.47 | 0.54 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 5.98 | 5.98 | 5.99 | 5.98 | 5.99 | 6.01 | 6.14 | 5.94 | 5.99 | 5.98 | 5.99 | 6.00 | 5.99 |
| Jd | 0.13 | 0.16 | 0.17 | 0.28 | 0.27 | 0.24 | 0.17 | 0.21 | 0.22 | 0.11 | 0.22 | 0.24 | 0.27 |
| Aeg | 0.34 | 0.26 | 0.32 | 0.22 | 0.27 | 0.29 | 0.26 | 0.25 | 0.26 | 0.25 | 0.25 | 0.24 | 0.27 |
| Mg♯ | 0.81 | 0.81 | 0.76 | 0.75 | 0.74 | 0.76 | 0.77 | 0.68 | 0.67 | 0.73 | 0.68 | 0.70 | 0.69 |

| sample | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Om2−40 | Om2−41 | Om2−42 | Om2−43 | Om2−44 | Om2−45 | Om2−46 | Om2−47 | Om2−48 | Om2−49 | Om2−50 | Om2−51 | Om2−52 |
| SiO2 | 49.71 | 51.98 | 52.39 | 53.03 | 51.58 | 52.84 | 52.95 | 53.26 | 53.46 | 53.56 | 53.67 | 53.71 | 53.94 |
| TiO2 | 0.57 | 0.19 | 0.20 | 0.14 | 0.82 | 0.13 | 0.11 | 0.22 | 0.13 | 0.09 | 0.11 | 0.18 | 0.04 |
| Al2O3 | 5.39 | 5.53 | 6.64 | 5.48 | 3.60 | 3.68 | 3.29 | 4.78 | 3.54 | 5.16 | 5.56 | 3.41 | 2.12 |
| FeO | 13.01 | 15.41 | 13.78 | 15.12 | 13.40 | 14.14 | 13.12 | 17.37 | 12.30 | 14.37 | 14.02 | 11.34 | 12.71 |
| MnO | 0.11 | 0.15 | 0.20 | 0.14 | 0.18 | 0.13 | 0.24 | 0.11 | 0.20 | 0.13 | 0.12 | 0.32 | 0.30 |
| MgO | 7.39 | 6.11 | 5.63 | 5.75 | 8.56 | 7.71 | 8.20 | 4.63 | 8.44 | 5.98 | 5.90 | 9.26 | 9.56 |
| CaO | 15.04 | 11.38 | 12.30 | 11.24 | 17.38 | 12.83 | 14.48 | 8.27 | 14.79 | 11.12 | 10.64 | 16.74 | 17.22 |
| K2O | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na2O | 5.89 | 7.70 | 7.84 | 7.65 | 4.43 | 6.64 | 5.69 | 8.97 | 5.75 | 7.86 | 7.99 | 4.64 | 4.47 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 97.11 | 98.45 | 98.99 | 98.55 | 99.95 | 98.10 | 98.07 | 97.61 | 98.61 | 98.26 | 98.00 | 99.59 | 100.35 |
| Si | 1.88 | 1.93 | 1.93 | 1.97 | 1.91 | 1.97 | 1.98 | 1.99 | 1.98 | 1.99 | 1.99 | 1.98 | 1.98 |
| Ti | 0.02 | 0.01 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 0.24 | 0.24 | 0.29 | 0.24 | 0.16 | 0.16 | 0.15 | 0.21 | 0.15 | 0.23 | 0.24 | 0.15 | 0.09 |
| Fe3+ | 0.19 | 0.31 | 0.27 | 0.31 | 0.16 | 0.32 | 0.27 | 0.44 | 0.26 | 0.34 | 0.33 | 0.18 | 0.23 |
| Fe2+ | 0.22 | 0.17 | 0.15 | 0.16 | 0.25 | 0.12 | 0.14 | 0.10 | 0.12 | 0.11 | 0.10 | 0.17 | 0.16 |
| Mn | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 |
| Mg | 0.42 | 0.34 | 0.31 | 0.32 | 0.47 | 0.43 | 0.46 | 0.26 | 0.47 | 0.33 | 0.33 | 0.51 | 0.52 |
| Ca | 0.61 | 0.45 | 0.48 | 0.45 | 0.69 | 0.51 | 0.58 | 0.33 | 0.59 | 0.44 | 0.42 | 0.66 | 0.68 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.43 | 0.55 | 0.56 | 0.55 | 0.32 | 0.48 | 0.41 | 0.65 | 0.41 | 0.56 | 0.57 | 0.33 | 0.32 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 5.89 | 5.93 | 5.93 | 5.97 | 5.94 | 5.97 | 5.99 | 6.00 | 5.99 | 5.99 | 5.99 | 5.99 | 5.99 |
| Jd | 0.23 | 0.24 | 0.28 | 0.24 | 0.16 | 0.16 | 0.15 | 0.21 | 0.15 | 0.22 | 0.24 | 0.15 | 0.09 |
| Aeg | 0.18 | 0.31 | 0.26 | 0.31 | 0.16 | 0.32 | 0.27 | 0.45 | 0.26 | 0.34 | 0.33 | 0.18 | 0.23 |
| Mg# | 0.65 | 0.67 | 0.67 | 0.67 | 0.65 | 0.78 | 0.76 | 0.71 | 0.79 | 0.76 | 0.76 | 0.75 | 0.76 |

| sample | cr0438 | cr0438 | cr0438 | cr0438 |
|---|---|---|---|---|
| point | Om2−53 | Om2−54 | Om2−55 | Om2−56 |
| SiO2 | 54.04 | 54.76 | 54.37 | 55.44 |
| TiO2 | 0.07 | 0.40 | 0.23 | 0.14 |
| Al2O3 | 5.15 | 9.04 | 4.46 | 6.94 |
| FeO | 11.58 | 9.62 | 17.88 | 15.78 |
| MnO | 0.20 | 0.13 | 0.13 | 0.07 |
| MgO | 7.53 | 5.98 | 5.08 | 4.15 |
| CaO | 13.84 | 10.75 | 9.05 | 7.70 |
| K2O | 0.00 | 0.00 | 0.00 | 0.00 |
| Na2O | 6.43 | 8.13 | 9.10 | 9.74 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 98.83 | 98.81 | 100.29 | 99.96 |
| Si | 1.99 | 1.99 | 1.98 | 2.01 |
| Ti | 0.00 | 0.01 | 0.01 | 0.00 |
| Al | 0.22 | 0.39 | 0.19 | 0.30 |
| Fe3+ | 0.24 | 0.19 | 0.45 | 0.39 |
| Fe2+ | 0.12 | 0.11 | 0.09 | 0.09 |
| Mn | 0.01 | 0.00 | 0.00 | 0.00 |
| Mg | 0.41 | 0.32 | 0.28 | 0.22 |
| Ca | 0.55 | 0.42 | 0.35 | 0.30 |
| K | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.46 | 0.57 | 0.64 | 0.69 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 5.99 | 6.00 | 5.99 | 6.01 |
| Jd | 0.22 | 0.39 | 0.19 | 0.30 |
| Aeg | 0.23 | 0.19 | 0.45 | 0.39 |
| Mg# | 0.77 | 0.75 | 0.75 | 0.71 |

| sample | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Aeg−1 | Aeg−2 | Aeg−3 | Aeg−4 | Aeg−5 | Aeg−6 | Aeg−7 | Aeg−8 | Aeg−9 | Aeg−10 | Aeg−11 | Aeg−12 | Aeg−13 |
| SiO2 | 50.00 | 50.28 | 50.79 | 50.88 | 50.89 | 50.95 | 50.99 | 51.09 | 51.17 | 50.28 | 51.21 | 51.20 | 51.28 |
| TiO2 | 4.10 | 4.37 | 3.30 | 1.83 | 4.73 | 3.75 | 4.87 | 1.90 | 4.28 | 4.37 | 0.76 | 3.71 | 4.38 |
| Al2O3 | 0.75 | 0.60 | 0.70 | 1.14 | 0.79 | 0.78 | 0.61 | 0.97 | 0.61 | 0.60 | 1.12 | 0.70 | 0.58 |
| FeO | 28.29 | 26.11 | 26.06 | 29.70 | 28.25 | 29.22 | 28.97 | 30.01 | 29.39 | 26.11 | 31.22 | 25.87 | 29.03 |
| MnO | 0.54 | 0.44 | 0.38 | 0.43 | 0.29 | 0.38 | 0.35 | 0.52 | 0.38 | 0.44 | 0.49 | 0.50 | 0.50 |
| MgO | 0.13 | 0.18 | 0.04 | 0.37 | 0.24 | 0.06 | 0.15 | 0.37 | 0.05 | 0.18 | 0.24 | 0.08 | 0.09 |
| CaO | 2.55 | 2.08 | 1.56 | 2.79 | 1.92 | 1.29 | 2.02 | 2.10 | 1.47 | 2.08 | 1.87 | 1.56 | 1.60 |
| K2O | 0.01 | 0.04 | 0.02 | 0.04 | 0.04 | 0.02 | 0.08 | 0.02 | 0.01 | 0.04 | 0.00 | 0.00 | 0.00 |
| Na2O | 12.47 | 12.68 | 12.75 | 12.30 | 12.92 | 13.43 | 12.84 | 12.62 | 12.89 | 12.68 | 12.70 | 12.85 | 13.23 |
| Cl2O−1 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.02 | 0.01 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 98.85 | 96.78 | 95.60 | 99.48 | 100.07 | 99.88 | 100.88 | 99.61 | 100.26 | 96.78 | 99.64 | 96.50 | 100.71 |
| Si | 1.90 | 1.94 | 1.98 | 1.92 | 1.91 | 1.91 | 1.90 | 1.92 | 1.92 | 1.94 | 1.92 | 1.98 | 1.91 |
| Ti | 0.12 | 0.13 | 0.10 | 0.05 | 0.13 | 0.11 | 0.14 | 0.05 | 0.12 | 0.13 | 0.02 | 0.11 | 0.12 |
| Al | 0.03 | 0.03 | 0.03 | 0.05 | 0.03 | 0.03 | 0.03 | 0.04 | 0.03 | 0.03 | 0.05 | 0.03 | 0.03 |
| Fe3+ | 0.89 | 0.92 | 0.93 | 0.85 | 0.90 | 0.94 | 0.90 | 0.88 | 0.91 | 0.92 | 0.87 | 0.93 | 0.93 |
| Fe2+ | 0.01 | 0.00 | 0.00 | 0.09 | 0.00 | 0.00 | 0.00 | 0.07 | 0.01 | 0.00 | 0.11 | 0.00 | 0.00 |
| Mn | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 |
| Mg | 0.01 | 0.01 | 0.00 | 0.02 | 0.01 | 0.00 | 0.01 | 0.02 | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 |
| Ca | 0.10 | 0.09 | 0.07 | 0.11 | 0.08 | 0.05 | 0.08 | 0.08 | 0.06 | 0.09 | 0.08 | 0.06 | 0.06 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.92 | 0.95 | 0.96 | 0.90 | 0.94 | 0.97 | 0.93 | 0.92 | 0.94 | 0.95 | 0.92 | 0.96 | 0.95 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 6.02 | 6.07 | 6.08 | 5.97 | 6.04 | 6.01 | 6.04 | 5.97 | 6.04 | 6.07 | 5.94 | 6.08 | 6.03 |
| Jd | 0.03 | 0.03 | 0.03 | 0.05 | 0.03 | 0.03 | 0.03 | 0.04 | 0.03 | 0.03 | 0.05 | 0.03 | 0.03 |
| Aeg | 0.87 | 0.89 | 0.91 | 0.84 | 0.89 | 0.92 | 0.89 | 0.87 | 0.91 | 0.89 | 0.88 | 0.91 | 0.91 |
| Mg# | 0.35 | 1.00 | 1.00 | 0.19 | 1.00 | 1.00 | 0.80 | 0.24 | 0.21 | 1.00 | 0.11 | 1.00 | 1.00 |

| sample | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Aeg−14 | Aeg−15 | Aeg−16 | Aeg−17 | Aeg−18 | Aeg−19 | Aeg−20 | Aeg−21 | Aeg−22 | Aeg−23 | Aeg−24 | Aeg−25 | Aeg−26 |
| SiO2 | 51.29 | 50.14 | 50.74 | 51.04 | 51.04 | 51.09 | 51.09 | 51.27 | 51.83 | 49.94 | 50.79 | 51.04 | 51.13 |
| TiO2 | 0.70 | 2.83 | 4.76 | 3.19 | 1.08 | 4.07 | 4.29 | 5.09 | 3.65 | 3.32 | 1.94 | 3.24 | 0.90 |
| Al2O3 | 1.52 | 0.83 | 0.80 | 0.48 | 1.32 | 0.73 | 0.57 | 0.51 | 0.66 | 1.37 | 1.37 | 1.15 | 1.78 |
| FeO | 30.94 | 26.92 | 24.93 | 26.16 | 27.35 | 25.26 | 25.68 | 25.00 | 26.10 | 25.66 | 27.14 | 26.44 | 27.61 |
| MnO | 0.63 | 0.48 | 0.61 | 0.50 | 0.57 | 0.47 | 0.54 | 0.55 | 0.62 | 0.36 | 0.36 | 0.39 | 0.49 |
| MgO | 0.43 | 0.44 | 0.10 | 0.04 | 0.37 | 0.07 | 0.10 | 0.17 | 0.04 | 0.37 | 0.20 | 0.38 | 0.15 |
| CaO | 1.85 | 2.68 | 1.14 | 0.94 | 2.23 | 0.99 | 1.01 | 1.37 | 0.85 | 3.55 | 3.03 | 4.09 | 1.01 |
| K2O | 0.03 | 0.04 | 0.05 | 0.03 | 0.03 | 0.04 | 0.03 | 0.04 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na2O | 13.10 | 12.05 | 13.27 | 13.19 | 12.36 | 13.21 | 13.25 | 13.15 | 13.53 | 11.46 | 11.68 | 11.40 | 12.51 |
| Cl2O−1 | 0.00 | 0.00 | 0.05 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 100.49 | 96.41 | 96.44 | 95.57 | 96.37 | 95.95 | 96.57 | 97.15 | 97.30 | 96.04 | 96.50 | 98.12 | 95.56 |
| Si | 1.90 | 1.95 | 1.96 | 1.98 | 1.97 | 1.98 | 1.97 | 1.97 | 1.98 | 1.95 | 1.97 | 1.96 | 1.99 |
| Ti | 0.02 | 0.08 | 0.14 | 0.09 | 0.03 | 0.12 | 0.12 | 0.15 | 0.10 | 0.10 | 0.06 | 0.09 | 0.03 |
| Al | 0.07 | 0.04 | 0.04 | 0.02 | 0.06 | 0.03 | 0.03 | 0.02 | 0.03 | 0.06 | 0.06 | 0.05 | 0.08 |
| Fe3+ | 0.87 | 0.87 | 0.96 | 0.97 | 0.86 | 0.96 | 0.96 | 0.95 | 0.97 | 0.81 | 0.82 | 0.80 | 0.86 |
| Fe2+ | 0.08 | 0.01 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.06 | 0.05 | 0.04 |
| Mn | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.02 |
| Mg | 0.02 | 0.03 | 0.01 | 0.00 | 0.02 | 0.00 | 0.01 | 0.01 | 0.00 | 0.02 | 0.01 | 0.02 | 0.01 |
| Ca | 0.07 | 0.11 | 0.05 | 0.04 | 0.09 | 0.04 | 0.04 | 0.06 | 0.03 | 0.15 | 0.13 | 0.17 | 0.04 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.94 | 0.91 | 0.99 | 0.99 | 0.92 | 0.99 | 0.99 | 0.98 | 1.00 | 0.87 | 0.88 | 0.85 | 0.94 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 5.92 | 6.03 | 6.09 | 6.08 | 6.00 | 6.10 | 6.09 | 6.11 | 6.08 | 6.05 | 6.03 | 6.05 | 6.01 |
| Jd | 0.07 | 0.04 | 0.04 | 0.02 | 0.06 | 0.03 | 0.02 | 0.02 | 0.03 | 0.06 | 0.06 | 0.05 | 0.08 |
| Aeg | 0.86 | 0.85 | 0.92 | 0.94 | 0.85 | 0.93 | 0.93 | 0.92 | 0.94 | 0.79 | 0.81 | 0.78 | 0.87 |
| Mg# | 0.22 | 0.83 | 1.00 | 1.00 | 0.54 | 1.00 | 1.00 | 1.00 | 1.00 | 0.40 | 0.15 | 0.29 | 0.19 |

| sample | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 |
|---|---|---|---|---|---|
| point | Aeg−27 | Aeg−28 | Aeg−29 | Aeg−30 | Aeg−31 |
| SiO2 | 51.29 | 51.49 | 52.07 | 52.19 | 50.92 |
| TiO2 | 0.83 | 0.94 | 1.40 | 1.35 | 3.07 |
| Al2O3 | 1.32 | 1.83 | 1.21 | 5.63 | 1.57 |
| FeO | 27.99 | 27.15 | 27.23 | 18.89 | 24.44 |
| MnO | 0.49 | 0.44 | 0.83 | 0.06 | 0.61 |
| MgO | 0.12 | 0.19 | 0.09 | 2.45 | 1.08 |
| CaO | 1.29 | 1.44 | 1.21 | 5.39 | 2.84 |
| K2O | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na2O | 12.22 | 12.24 | 12.28 | 10.79 | 12.10 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 95.55 | 95.72 | 96.31 | 96.75 | 96.63 |
| Si | 2.00 | 2.00 | 2.02 | 1.97 | 1.96 |
| Ti | 0.02 | 0.03 | 0.04 | 0.04 | 0.09 |
| Al | 0.06 | 0.08 | 0.06 | 0.25 | 0.07 |
| Fe3+ | 0.86 | 0.84 | 0.87 | 0.54 | 0.83 |
| Fe2+ | 0.05 | 0.04 | 0.01 | 0.06 | 0.00 |
| Mn | 0.02 | 0.01 | 0.03 | 0.00 | 0.02 |
| Mg | 0.01 | 0.01 | 0.01 | 0.14 | 0.06 |
| Ca | 0.05 | 0.06 | 0.05 | 0.22 | 0.12 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.92 | 0.92 | 0.92 | 0.79 | 0.90 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 6.03 | 6.03 | 6.06 | 6.01 | 6.04 |
| Jd | 0.06 | 0.09 | 0.06 | 0.25 | 0.07 |
| Aeg | 0.88 | 0.85 | 0.89 | 0.54 | 0.82 |
| Mg♯ | 0.12 | 0.20 | 0.27 | 0.71 | 1.00 |

| sample | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a | cr0314a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | IgPx−1 | IgPx−2 | IgPx−3 | IgPx−4 | IgPx−5 | IgPx−6 | IgPx−7 | IgPx−8 | IgPx−9 | IgPx−10 | IgPx−11 | IgPx−12 | IgPx−13 |
| SiO2 | 45.21 | 46.94 | 49.05 | 44.37 | 47.99 | 46.82 | 45.34 | 48.47 | 45.66 | 46.27 | 45.41 | 48.83 | 47.61 |
| TiO2 | 2.96 | 2.25 | 1.80 | 3.00 | 1.95 | 2.23 | 2.46 | 1.53 | 2.31 | 2.56 | 2.98 | 1.65 | 2.17 |
| Al2O3 | 7.99 | 6.26 | 4.28 | 7.74 | 6.14 | 6.34 | 7.10 | 4.67 | 7.49 | 6.92 | 7.72 | 4.28 | 6.07 |
| Cr2O3 | 0.00 | 0.07 | 0.00 | 0.03 | 0.00 | 0.00 | 0.02 | 0.04 | 0.03 | 0.03 | 0.06 | 0.00 | 0.01 |
| FeO | 7.77 | 7.55 | 7.39 | 8.63 | 7.53 | 7.95 | 7.68 | 7.86 | 8.02 | 7.51 | 7.99 | 7.14 | 7.36 |
| MnO | 0.16 | 0.12 | 0.14 | 0.14 | 0.09 | 0.16 | 0.12 | 0.12 | 0.17 | 0.05 | 0.10 | 0.21 | 0.13 |
| MgO | 11.92 | 12.65 | 14.43 | 11.88 | 12.95 | 12.42 | 12.53 | 13.52 | 12.15 | 12.76 | 12.30 | 14.50 | 13.08 |
| CaO | 22.70 | 22.76 | 22.19 | 21.38 | 22.85 | 22.36 | 22.37 | 22.51 | 22.84 | 22.34 | 22.91 | 22.08 | 22.27 |
| K2O | 0.04 | 0.02 | 0.00 | 0.00 | 0.00 | 0.03 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na2O | 0.47 | 0.49 | 0.32 | 0.76 | 0.45 | 0.45 | 0.42 | 0.39 | 0.50 | 0.45 | 0.45 | 0.32 | 0.47 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 99.22 | 99.12 | 99.59 | 97.93 | 99.96 | 98.75 | 98.04 | 99.10 | 99.16 | 98.89 | 99.92 | 99.01 | 99.17 |
| Si | 1.70 | 1.76 | 1.82 | 1.69 | 1.78 | 1.77 | 1.72 | 1.81 | 1.71 | 1.74 | 1.69 | 1.82 | 1.78 |
| Ti | 0.08 | 0.06 | 0.05 | 0.09 | 0.05 | 0.06 | 0.07 | 0.04 | 0.07 | 0.07 | 0.08 | 0.05 | 0.06 |
| Al | 0.35 | 0.28 | 0.19 | 0.35 | 0.27 | 0.28 | 0.32 | 0.21 | 0.33 | 0.31 | 0.34 | 0.19 | 0.27 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.25 | 0.20 | 0.17 | 0.28 | 0.17 | 0.19 | 0.25 | 0.16 | 0.24 | 0.22 | 0.28 | 0.17 | 0.17 |
| Fe2+ | 0.00 | 0.03 | 0.06 | 0.00 | 0.07 | 0.06 | 0.00 | 0.08 | 0.01 | 0.02 | 0.00 | 0.06 | 0.06 |
| Mn | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 |
| Mg | 0.67 | 0.71 | 0.80 | 0.67 | 0.72 | 0.70 | 0.71 | 0.75 | 0.68 | 0.71 | 0.68 | 0.81 | 0.73 |
| Ca | 0.91 | 0.91 | 0.88 | 0.87 | 0.91 | 0.90 | 0.91 | 0.90 | 0.92 | 0.90 | 0.91 | 0.88 | 0.89 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.03 | 0.04 | 0.02 | 0.06 | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 | 0.03 | 0.03 | 0.02 | 0.03 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 6.07 | 6.05 | 6.04 | 6.06 | 6.04 | 6.05 | 6.06 | 6.03 | 6.05 | 6.06 | 6.07 | 6.03 | 6.04 |
| Mg♯ | 1.00 | 0.96 | 0.93 | 1.00 | 0.92 | 0.92 | 1.00 | 0.90 | 0.99 | 0.98 | 1.00 | 0.93 | 0.92 |

| sample | cr0314a | cr0314a | cr0318c | cr0318c | cr0318d | cr0422b | cr0422b | cr0422b | cr0422b | cr0422b | cr0422b | cr0422b | cr0428b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | IgPx−14 | IgPx−15 | IgPx−1 | IgPx−2 | IgPx−1 | IgPx−1 | IgPx−2 | IgPx−3 | IgPx−4 | IgPx−5 | IgPx−6 | IgPx−7 | IgPx−1 |
| SiO2 | 46.55 | 48.51 | 50.59 | 51.20 | 50.71 | 50.33 | 50.94 | 51.47 | 52.73 | 53.82 | 54.18 | 55.61 | 51.75 |
| TiO2 | 2.13 | 1.68 | 0.53 | 0.41 | 0.21 | 2.77 | 2.15 | 1.67 | 1.53 | 1.47 | 1.59 | 1.48 | 1.26 |
| Al2O3 | 6.31 | 4.73 | 2.75 | 3.24 | 1.34 | 6.66 | 6.26 | 4.58 | 3.45 | 3.75 | 3.31 | 3.37 | 2.43 |
| Cr2O3 | 0.05 | 0.03 | 0.00 | 0.00 | 0.00 | 0.06 | 0.03 | 0.00 | 0.12 | 0.08 | 0.04 | 0.11 | 0.00 |
| FeO | 7.23 | 7.44 | 9.28 | 9.47 | 12.18 | 8.36 | 7.04 | 8.81 | 6.61 | 6.29 | 6.82 | 6.27 | 11.57 |
| MnO | 0.10 | 0.12 | 0.32 | 0.23 | 0.39 | 0.13 | 0.07 | 0.22 | 0.12 | 0.11 | 0.12 | 0.17 | 0.22 |
| MgO | 12.25 | 13.47 | 14.07 | 13.22 | 12.89 | 12.10 | 13.80 | 12.74 | 15.03 | 14.53 | 14.56 | 15.87 | 13.42 |
| CaO | 22.16 | 21.78 | 20.53 | 19.31 | 20.27 | 22.64 | 22.68 | 22.38 | 22.22 | 22.73 | 22.27 | 22.50 | 20.30 |
| K2O | 0.00 | 0.01 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 |
| Na2O | 0.44 | 0.45 | 0.38 | 2.07 | 0.29 | 0.00 | 0.00 | 0.38 | 0.40 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.08 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 97.23 | 98.23 | 98.46 | 99.15 | 98.27 | 103.06 | 102.99 | 102.28 | 102.30 | 102.79 | 102.93 | 105.38 | 100.96 |
| Si | 1.78 | 1.83 | 1.91 | 1.90 | 1.94 | 1.83 | 1.84 | 1.88 | 1.91 | 1.94 | 1.96 | 1.95 | 1.93 |
| Ti | 0.06 | 0.05 | 0.02 | 0.01 | 0.01 | 0.08 | 0.06 | 0.05 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |
| Al | 0.28 | 0.21 | 0.12 | 0.14 | 0.06 | 0.29 | 0.27 | 0.20 | 0.15 | 0.16 | 0.14 | 0.14 | 0.11 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.16 | 0.13 | 0.06 | 0.06 | 0.06 | 0.04 | 0.05 | 0.04 | 0.04 | 0.00 | 0.00 | 0.00 | 0.03 |
| Fe2+ | 0.07 | 0.11 | 0.23 | 0.23 | 0.33 | 0.21 | 0.16 | 0.23 | 0.16 | 0.19 | 0.21 | 0.18 | 0.33 |
| Mn | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| Mg | 0.70 | 0.76 | 0.79 | 0.73 | 0.74 | 0.66 | 0.74 | 0.69 | 0.81 | 0.78 | 0.78 | 0.83 | 0.75 |
| Ca | 0.91 | 0.88 | 0.83 | 0.77 | 0.83 | 0.88 | 0.88 | 0.88 | 0.86 | 0.88 | 0.86 | 0.85 | 0.81 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.03 | 0.03 | 0.03 | 0.15 | 0.02 | 0.00 | 0.00 | 0.03 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 6.05 | 6.03 | 6.00 | 5.94 | 6.00 | 6.08 | 6.06 | 6.03 | 6.02 | 6.06 | 6.07 | 6.06 | 6.03 |
| Mg# | 0.90 | 0.88 | 0.77 | 0.76 | 0.69 | 0.76 | 0.82 | 0.75 | 0.84 | 0.80 | 0.79 | 0.82 | 0.69 |

| sample | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0428b | cr0429 | cr0429 | cr0429 | cr0430a | cr0430a | cr0434 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | IgPx−2 | IgPx−3 | IgPx−4 | IgPx−5 | IgPx−6 | IgPx−7 | IgPx−8 | IgPx−1 | IgPx−2 | IgPx−3 | IgPx−1 | IgPx−2 | IgPx−1 |
| SiO2 | 50.74 | 48.10 | 48.12 | 48.15 | 48.59 | 48.85 | 49.18 | 49.15 | 50.76 | 50.92 | 50.54 | 48.49 | 50.78 |
| TiO2 | 1.35 | 1.04 | 1.08 | 1.23 | 0.84 | 1.08 | 1.14 | 1.20 | 0.87 | 0.85 | 1.32 | 1.28 | 0.94 |
| Al2O3 | 3.09 | 2.04 | 2.16 | 2.51 | 2.01 | 2.16 | 2.17 | 3.29 | 2.73 | 2.89 | 6.92 | 3.07 | 3.71 |
| Cr2O3 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.06 | 0.18 | 0.13 | 0.03 | 0.01 | 0.34 |
| FeO | 10.99 | 12.09 | 11.41 | 11.07 | 12.24 | 11.86 | 11.35 | 9.65 | 8.70 | 9.30 | 9.32 | 8.97 | 7.02 |
| MnO | 0.23 | 0.30 | 0.25 | 0.27 | 0.25 | 0.26 | 0.26 | 0.21 | 0.17 | 0.20 | 0.20 | 0.19 | 0.17 |
| MgO | 10.76 | 12.97 | 13.03 | 13.72 | 12.26 | 13.09 | 13.40 | 15.77 | 16.48 | 15.80 | 15.00 | 13.42 | 15.77 |
| CaO | 20.25 | 19.80 | 19.74 | 19.92 | 19.95 | 19.62 | 19.78 | 20.89 | 20.99 | 21.00 | 20.30 | 20.99 | 21.39 |
| K2O | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na2O | 0.00 | 0.37 | 0.37 | 0.37 | 0.67 | 0.35 | 0.47 | 0.38 | 0.34 | 0.54 | 0.43 | 0.39 | 0.31 |
| Cl2O−1 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 97.44 | 96.72 | 96.20 | 97.25 | 96.82 | 97.28 | 97.75 | 100.61 | 101.23 | 101.65 | 104.07 | 96.80 | 100.45 |
| Si | 1.98 | 1.87 | 1.88 | 1.85 | 1.89 | 1.89 | 1.88 | 1.81 | 1.85 | 1.85 | 1.79 | 1.87 | 1.86 |
| Ti | 0.04 | 0.03 | 0.03 | 0.04 | 0.02 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.04 | 0.04 | 0.03 |
| Al | 0.14 | 0.09 | 0.10 | 0.11 | 0.09 | 0.10 | 0.10 | 0.14 | 0.12 | 0.12 | 0.29 | 0.14 | 0.16 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 |
| Fe3+ | 0.00 | 0.17 | 0.15 | 0.18 | 0.13 | 0.13 | 0.13 | 0.25 | 0.19 | 0.18 | 0.12 | 0.13 | 0.12 |
| Fe2+ | 0.36 | 0.23 | 0.23 | 0.17 | 0.26 | 0.26 | 0.23 | 0.05 | 0.08 | 0.11 | 0.16 | 0.16 | 0.10 |
| Mn | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Mg | 0.63 | 0.75 | 0.76 | 0.79 | 0.71 | 0.75 | 0.77 | 0.86 | 0.89 | 0.86 | 0.79 | 0.77 | 0.86 |
| Ca | 0.85 | 0.82 | 0.82 | 0.82 | 0.83 | 0.81 | 0.81 | 0.82 | 0.82 | 0.82 | 0.77 | 0.86 | 0.84 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.03 | 0.03 | 0.03 | 0.05 | 0.03 | 0.04 | 0.03 | 0.02 | 0.04 | 0.03 | 0.03 | 0.02 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 6.09 | 6.02 | 6.02 | 6.02 | 6.00 | 6.02 | 6.02 | 6.02 | 6.01 | 6.01 | 6.02 | 6.02 | 6.02 |
| Mg# | 0.64 | 0.77 | 0.77 | 0.82 | 0.73 | 0.75 | 0.77 | 0.94 | 0.92 | 0.89 | 0.84 | 0.83 | 0.90 |

| sample | cr0434 | cr0434 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | IgPx−2 | IgPx−3 | IgPx−1 | IgPx−2 | IgPx−3 | IgPx−4 | IgPx−5 | IgPx−6 | IgPx−7 | IgPx−8 | IgPx−9 | IgPx−10 | IgPx−11 |
| SiO2 | 51.45 | 51.80 | 47.50 | 47.76 | 48.19 | 50.00 | 47.52 | 47.99 | 48.05 | 48.43 | 50.46 | 48.76 | 48.89 |
| TiO2 | 0.67 | 0.85 | 2.44 | 2.00 | 1.88 | 1.58 | 2.37 | 1.90 | 2.13 | 1.64 | 1.00 | 1.83 | 2.36 |
| Al2O3 | 2.95 | 3.08 | 4.80 | 3.91 | 3.98 | 4.11 | 4.98 | 4.26 | 4.25 | 3.62 | 1.97 | 3.77 | 5.22 |
| Cr2O3 | 0.48 | 0.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeO | 6.84 | 6.85 | 7.29 | 8.03 | 7.79 | 9.76 | 6.12 | 7.44 | 6.51 | 8.15 | 9.53 | 7.46 | 6.32 |
| MnO | 0.13 | 0.15 | 0.18 | 0.19 | 0.18 | 0.15 | 0.10 | 0.15 | 0.11 | 0.14 | 0.17 | 0.18 | 0.06 |
| MgO | 15.13 | 16.06 | 14.01 | 13.41 | 13.43 | 12.01 | 14.05 | 13.07 | 13.86 | 12.74 | 12.31 | 12.85 | 13.89 |
| CaO | 21.55 | 21.68 | 24.60 | 24.45 | 24.58 | 21.87 | 24.24 | 24.29 | 24.36 | 22.92 | 23.57 | 24.01 | 24.41 |
| K2O | 0.01 | 0.02 | 0.00 | 0.01 | 0.02 | 0.00 | 0.00 | 0.00 | 0.04 | 0.01 | 0.00 | 0.00 | 0.00 |
| Na2O | 0.56 | 0.30 | 0.41 | 0.44 | 0.39 | 2.15 | 0.46 | 0.42 | 0.43 | 0.95 | 0.66 | 0.38 | 0.42 |
| Cl2O−1 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.01 | 0.02 | 0.01 | 0.01 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 99.77 | 101.09 | 101.25 | 100.22 | 100.46 | 101.62 | 99.87 | 99.52 | 99.75 | 98.62 | 99.67 | 99.23 | 101.56 |
| Si | 1.90 | 1.89 | 1.74 | 1.77 | 1.78 | 1.82 | 1.76 | 1.79 | 1.78 | 1.82 | 1.89 | 1.83 | 1.78 |
| Ti | 0.02 | 0.02 | 0.07 | 0.06 | 0.05 | 0.04 | 0.07 | 0.05 | 0.06 | 0.05 | 0.03 | 0.05 | 0.06 |
| Al | 0.13 | 0.13 | 0.21 | 0.17 | 0.17 | 0.18 | 0.22 | 0.19 | 0.19 | 0.16 | 0.09 | 0.17 | 0.22 |
| Cr | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.07 | 0.10 | 0.32 | 0.28 | 0.26 | 0.18 | 0.27 | 0.23 | 0.25 | 0.19 | 0.12 | 0.17 | 0.21 |
| Fe2+ | 0.14 | 0.11 | 0.00 | 0.00 | 0.00 | 0.12 | 0.00 | 0.00 | 0.00 | 0.06 | 0.18 | 0.06 | 0.00 |
| Mn | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 |
| Mg | 0.83 | 0.87 | 0.76 | 0.74 | 0.74 | 0.65 | 0.77 | 0.73 | 0.77 | 0.72 | 0.69 | 0.72 | 0.75 |
| Ca | 0.85 | 0.85 | 0.96 | 0.97 | 0.97 | 0.85 | 0.96 | 0.97 | 0.97 | 0.92 | 0.95 | 0.97 | 0.95 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.04 | 0.02 | 0.03 | 0.03 | 0.03 | 0.15 | 0.03 | 0.03 | 0.03 | 0.07 | 0.05 | 0.03 | 0.03 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 6.01 | 6.02 | 6.05 | 6.04 | 6.04 | 5.97 | 6.05 | 6.04 | 6.04 | 6.01 | 6.00 | 6.04 | 6.05 |
| Mg# | 0.86 | 0.89 | 1.00 | 1.00 | 1.00 | 0.85 | 1.00 | 0.99 | 1.00 | 0.92 | 0.80 | 0.92 | 1.00 |

| sample | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | IgPx−12 | IgPx−13 | IgPx−14 | IgPx−15 | IgPx−16 | IgPx−17 | IgPx−18 | IgPx−19 | IgPx−20 | IgPx−21 | IgPx−22 | IgPx−23 | IgPx−24 |
| SiO2 | 48.46 | 43.12 | 45.39 | 45.98 | 47.22 | 47.31 | 47.32 | 47.36 | 47.41 | 47.41 | 47.51 | 47.66 | 47.73 |
| TiO2 | 2.38 | 2.11 | 3.00 | 2.85 | 2.24 | 2.41 | 2.29 | 2.48 | 2.29 | 2.38 | 2.31 | 2.36 | 2.36 |
| Al2O3 | 4.97 | 4.56 | 6.86 | 6.60 | 5.30 | 5.32 | 5.26 | 5.42 | 5.06 | 5.22 | 5.19 | 5.16 | 5.31 |
| Cr2O3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeO | 7.12 | 6.35 | 6.72 | 6.51 | 6.59 | 6.34 | 6.29 | 6.62 | 6.55 | 6.37 | 6.25 | 6.23 | 6.26 |
| MnO | 0.09 | 0.09 | 0.09 | 0.07 | 0.10 | 0.08 | 0.07 | 0.10 | 0.10 | 0.10 | 0.08 | 0.08 | 0.08 |
| MgO | 13.45 | 11.86 | 12.66 | 12.80 | 13.11 | 13.43 | 13.44 | 12.90 | 13.43 | 13.51 | 13.46 | 13.53 | 13.68 |
| CaO | 23.72 | 22.09 | 24.04 | 24.00 | 23.37 | 23.99 | 24.12 | 24.00 | 24.02 | 24.21 | 24.17 | 24.29 | 24.36 |
| K2O | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na2O | 0.56 | 0.70 | 0.42 | 0.45 | 0.56 | 0.43 | 0.40 | 0.50 | 0.48 | 0.41 | 0.40 | 0.41 | 0.42 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 100.75 | 90.87 | 99.18 | 99.27 | 98.49 | 99.29 | 99.20 | 99.37 | 99.33 | 99.60 | 99.37 | 99.72 | 100.20 |
| Si | 1.78 | 1.76 | 1.70 | 1.72 | 1.77 | 1.76 | 1.77 | 1.77 | 1.77 | 1.76 | 1.77 | 1.77 | 1.76 |
| Ti | 0.07 | 0.06 | 0.08 | 0.08 | 0.06 | 0.07 | 0.06 | 0.07 | 0.06 | 0.07 | 0.06 | 0.07 | 0.07 |
| Al | 0.22 | 0.22 | 0.30 | 0.29 | 0.23 | 0.23 | 0.23 | 0.24 | 0.22 | 0.23 | 0.23 | 0.23 | 0.23 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.22 | 0.27 | 0.30 | 0.27 | 0.22 | 0.24 | 0.24 | 0.23 | 0.24 | 0.25 | 0.23 | 0.24 | 0.25 |
| Fe2+ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.74 | 0.72 | 0.71 | 0.71 | 0.73 | 0.75 | 0.75 | 0.72 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 |
| Ca | 0.94 | 0.96 | 0.96 | 0.96 | 0.94 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.97 | 0.96 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.04 | 0.06 | 0.03 | 0.03 | 0.04 | 0.03 | 0.03 | 0.04 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 6.05 | 6.04 | 6.07 | 6.06 | 6.04 | 6.05 | 6.05 | 6.05 | 6.05 | 6.05 | 6.05 | 6.05 | 6.05 |
| Mg# | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

| sample | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | lgPx−25 | lgPx−26 | lgPx−27 | lgPx−28 | lgPx−29 | lgPx−30 | lgPx−31 | lgPx−32 | lgPx−33 | lgPx−34 | lgPx−35 | lgPx−36 | lgPx−37 |
| SiO2 | 47.84 | 47.85 | 48.23 | 49.33 | 47.46 | 47.72 | 48.04 | 48.54 | 47.56 | 48.24 | 48.34 | 48.38 | 48.66 |
| TiO2 | 2.28 | 2.33 | 2.50 | 2.22 | 2.24 | 2.16 | 2.14 | 2.28 | 2.04 | 2.20 | 2.30 | 2.10 | 1.81 |
| Al2O3 | 5.18 | 5.30 | 5.59 | 4.62 | 4.48 | 4.25 | 4.71 | 4.68 | 4.63 | 4.69 | 5.44 | 4.57 | 4.34 |
| Cr2O3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeO | 6.25 | 6.24 | 6.82 | 6.31 | 6.53 | 6.54 | 7.32 | 6.46 | 7.30 | 7.31 | 7.17 | 6.94 | 7.75 |
| MnO | 0.10 | 0.09 | 0.12 | 0.07 | 0.11 | 0.12 | 0.12 | 0.12 | 0.11 | 0.11 | 0.07 | 0.11 | 0.15 |
| MgO | 13.64 | 13.54 | 13.14 | 13.20 | 13.54 | 13.55 | 13.14 | 13.87 | 12.46 | 12.37 | 12.76 | 12.63 | 12.13 |
| CaO | 24.32 | 24.27 | 24.54 | 23.40 | 24.20 | 24.35 | 23.19 | 24.69 | 24.63 | 24.44 | 25.00 | 24.63 | 24.60 |
| K2O | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na2O | 0.41 | 0.41 | 0.44 | 0.49 | 0.39 | 0.42 | 0.94 | 0.43 | 0.42 | 0.42 | 0.40 | 0.42 | 0.42 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 100.02 | 100.04 | 101.38 | 99.64 | 98.95 | 99.11 | 99.59 | 101.07 | 99.15 | 99.77 | 101.49 | 99.78 | 99.86 |
| Si | 1.77 | 1.77 | 1.77 | 1.84 | 1.78 | 1.78 | 1.78 | 1.78 | 1.79 | 1.80 | 1.77 | 1.80 | 1.82 |
| Ti | 0.06 | 0.06 | 0.07 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.05 |
| Al | 0.23 | 0.23 | 0.24 | 0.20 | 0.20 | 0.19 | 0.21 | 0.20 | 0.21 | 0.21 | 0.24 | 0.20 | 0.19 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.24 | 0.23 | 0.23 | 0.13 | 0.25 | 0.25 | 0.22 | 0.24 | 0.22 | 0.19 | 0.22 | 0.19 | 0.17 |
| Fe2+ | 0.00 | 0.00 | 0.00 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.04 | 0.00 | 0.03 | 0.07 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.75 | 0.75 | 0.72 | 0.73 | 0.76 | 0.75 | 0.73 | 0.76 | 0.70 | 0.69 | 0.70 | 0.70 | 0.68 |
| Ca | 0.96 | 0.96 | 0.96 | 0.93 | 0.97 | 0.98 | 0.92 | 0.97 | 0.99 | 0.98 | 0.98 | 0.98 | 0.99 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.03 | 0.03 | 0.03 | 0.04 | 0.03 | 0.03 | 0.07 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 6.05 | 6.05 | 6.05 | 6.04 | 6.05 | 6.05 | 6.03 | 6.05 | 6.04 | 6.05 | 6.05 | 6.04 | 6.04 |
| Mg# | 1.00 | 1.00 | 1.00 | 0.91 | 1.00 | 1.00 | 1.00 | 1.00 | 0.99 | 0.95 | 1.00 | 0.97 | 0.90 |

| sample | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | lgPx−38 | lgPx−39 | lgPx−40 | lgPx−41 | lgPx−42 | lgPx−43 | lgPx−44 | lgPx−45 | lgPx−46 | lgPx−47 | lgPx−48 | lgPx−49 | lgPx−50 |
| SiO2 | 48.79 | 50.61 | 45.98 | 46.09 | 46.64 | 47.25 | 47.35 | 48.88 | 49.04 | 47.33 | 47.77 | 47.84 | 48.02 |
| TiO2 | 1.98 | 1.22 | 1.89 | 2.06 | 1.53 | 1.52 | 1.92 | 0.86 | 1.70 | 2.24 | 2.16 | 2.06 | 2.08 |
| Al2O3 | 4.19 | 2.33 | 4.66 | 4.54 | 3.82 | 3.79 | 4.44 | 1.53 | 4.01 | 4.43 | 4.55 | 4.15 | 4.13 |
| Cr2O3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FeO | 7.35 | 9.67 | 7.82 | 7.70 | 8.76 | 8.54 | 7.67 | 11.61 | 8.32 | 6.55 | 6.78 | 6.92 | 6.96 |
| MnO | 0.14 | 0.23 | 0.11 | 0.13 | 0.22 | 0.19 | 0.14 | 0.28 | 0.19 | 0.12 | 0.14 | 0.15 | 0.14 |
| MgO | 12.44 | 11.60 | 11.89 | 11.91 | 11.45 | 11.69 | 12.24 | 10.49 | 11.74 | 13.62 | 13.33 | 13.24 | 13.24 |
| CaO | 24.62 | 24.04 | 23.29 | 24.25 | 24.48 | 24.53 | 24.04 | 23.88 | 24.78 | 24.55 | 23.81 | 24.52 | 24.46 |
| K2O | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na2O | 0.38 | 0.59 | 0.85 | 0.43 | 0.41 | 0.39 | 0.61 | 0.55 | 0.40 | 0.43 | 0.58 | 0.41 | 0.41 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 99.89 | 100.29 | 96.51 | 97.11 | 97.30 | 97.90 | 98.40 | 98.09 | 100.18 | 99.28 | 99.10 | 99.29 | 99.44 |
| Si | 1.82 | 1.90 | 1.77 | 1.77 | 1.80 | 1.81 | 1.79 | 1.89 | 1.83 | 1.76 | 1.79 | 1.79 | 1.79 |
| Ti | 0.06 | 0.03 | 0.05 | 0.06 | 0.04 | 0.04 | 0.05 | 0.03 | 0.05 | 0.06 | 0.06 | 0.06 | 0.06 |
| Al | 0.18 | 0.10 | 0.21 | 0.21 | 0.17 | 0.17 | 0.20 | 0.07 | 0.18 | 0.19 | 0.20 | 0.18 | 0.18 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.17 | 0.10 | 0.25 | 0.25 | 0.23 | 0.22 | 0.22 | 0.16 | 0.16 | 0.28 | 0.23 | 0.24 | 0.23 |
| Fe2+ | 0.06 | 0.20 | 0.01 | 0.00 | 0.05 | 0.06 | 0.02 | 0.22 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mn | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.69 | 0.65 | 0.68 | 0.68 | 0.66 | 0.67 | 0.69 | 0.60 | 0.65 | 0.76 | 0.74 | 0.74 | 0.74 |
| Ca | 0.98 | 0.97 | 0.96 | 1.00 | 1.01 | 1.00 | 0.97 | 0.99 | 0.99 | 0.98 | 0.95 | 0.98 | 0.98 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.03 | 0.04 | 0.06 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 | 0.03 | 0.03 | 0.04 | 0.03 | 0.03 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 6.04 | 6.01 | 6.02 | 6.04 | 6.03 | 6.03 | 6.03 | 6.00 | 6.03 | 6.05 | 6.04 | 6.04 | 6.04 |
| Mg# | 0.92 | 0.76 | 0.99 | 1.00 | 0.93 | 0.92 | 0.97 | 0.73 | 0.86 | 1.00 | 1.00 | 1.00 | 1.00 |

| sample | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr0438 | cr04551 | cr04551 | cr04551 | cr04551 | cr04552 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | lgPx−51 | lgPx−52 | lgPx−53 | lgPx−54 | lgPx−55 | lgPx−56 | lgPx−57 | lgPx−58 | lgPx−1 | lgPx−2 | lgPx−3 | lgPx−4 | lgPx−1 |
| SiO2 | 48.05 | 48.10 | 48.46 | 48.53 | 50.11 | 50.12 | 50.20 | 50.25 | 54.02 | 55.17 | 52.53 | 52.33 | 52.05 |
| TiO2 | 2.42 | 2.15 | 2.28 | 2.08 | 1.78 | 1.01 | 1.06 | 1.04 | 0.24 | 0.20 | 0.33 | 0.16 | 0.25 |
| Al2O3 | 5.21 | 4.19 | 4.68 | 4.22 | 5.55 | 1.46 | 2.58 | 2.52 | 2.14 | 1.47 | 1.45 | 1.06 | 1.30 |
| Cr2O3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.32 | 0.18 | 0.09 | 0.14 | 0.11 |
| FeO | 6.82 | 6.48 | 6.53 | 7.53 | 7.94 | 10.27 | 13.35 | 10.02 | 6.14 | 6.03 | 13.27 | 13.41 | 15.11 |
| MnO | 0.12 | 0.09 | 0.11 | 0.16 | 0.14 | 0.28 | 0.33 | 0.25 | 0.17 | 0.26 | 0.32 | 0.37 | 0.30 |
| MgO | 13.30 | 13.52 | 13.88 | 13.15 | 11.89 | 11.69 | 9.67 | 12.05 | 17.52 | 16.02 | 12.65 | 11.79 | 11.95 |
| CaO | 24.36 | 24.55 | 24.81 | 24.82 | 21.88 | 23.48 | 19.82 | 23.26 | 20.38 | 20.90 | 19.78 | 18.81 | 17.87 |
| K2O | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 |
| Na2O | 0.69 | 0.40 | 0.44 | 0.43 | 2.65 | 0.70 | 2.03 | 0.77 | 0.00 | 0.29 | 0.00 | 1.63 | 0.00 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.03 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| Total | 100.98 | 99.49 | 101.19 | 100.91 | 101.92 | 99.01 | 99.05 | 100.16 | 100.93 | 100.56 | 100.41 | 99.73 | 98.95 |
| Si | 1.76 | 1.79 | 1.77 | 1.79 | 1.81 | 1.90 | 1.91 | 1.88 | 1.96 | 2.02 | 1.98 | 1.97 | 2.01 |
| Ti | 0.07 | 0.06 | 0.06 | 0.06 | 0.05 | 0.03 | 0.03 | 0.03 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 |
| Al | 0.23 | 0.18 | 0.20 | 0.18 | 0.24 | 0.07 | 0.12 | 0.11 | 0.09 | 0.06 | 0.06 | 0.05 | 0.06 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.25 | 0.23 | 0.25 | 0.24 | 0.15 | 0.13 | 0.06 | 0.13 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| Fe2+ | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.20 | 0.36 | 0.18 | 0.19 | 0.18 | 0.42 | 0.41 | 0.49 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Mg | 0.73 | 0.75 | 0.76 | 0.72 | 0.64 | 0.66 | 0.55 | 0.67 | 0.95 | 0.87 | 0.71 | 0.66 | 0.69 |
| Ca | 0.96 | 0.98 | 0.97 | 0.98 | 0.84 | 0.96 | 0.81 | 0.93 | 0.79 | 0.82 | 0.80 | 0.76 | 0.74 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.05 | 0.03 | 0.03 | 0.03 | 0.19 | 0.05 | 0.15 | 0.06 | 0.00 | 0.02 | 0.00 | 0.12 | 0.00 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 6.04 | 6.05 | 6.05 | 6.04 | 5.96 | 6.00 | 5.96 | 6.00 | 6.02 | 6.05 | 6.03 | 5.95 | 6.05 |
| Mg# | 1.00 | 1.00 | 1.00 | 1.00 | 0.88 | 0.77 | 0.60 | 0.79 | 0.84 | 0.83 | 0.63 | 0.62 | 0.58 |

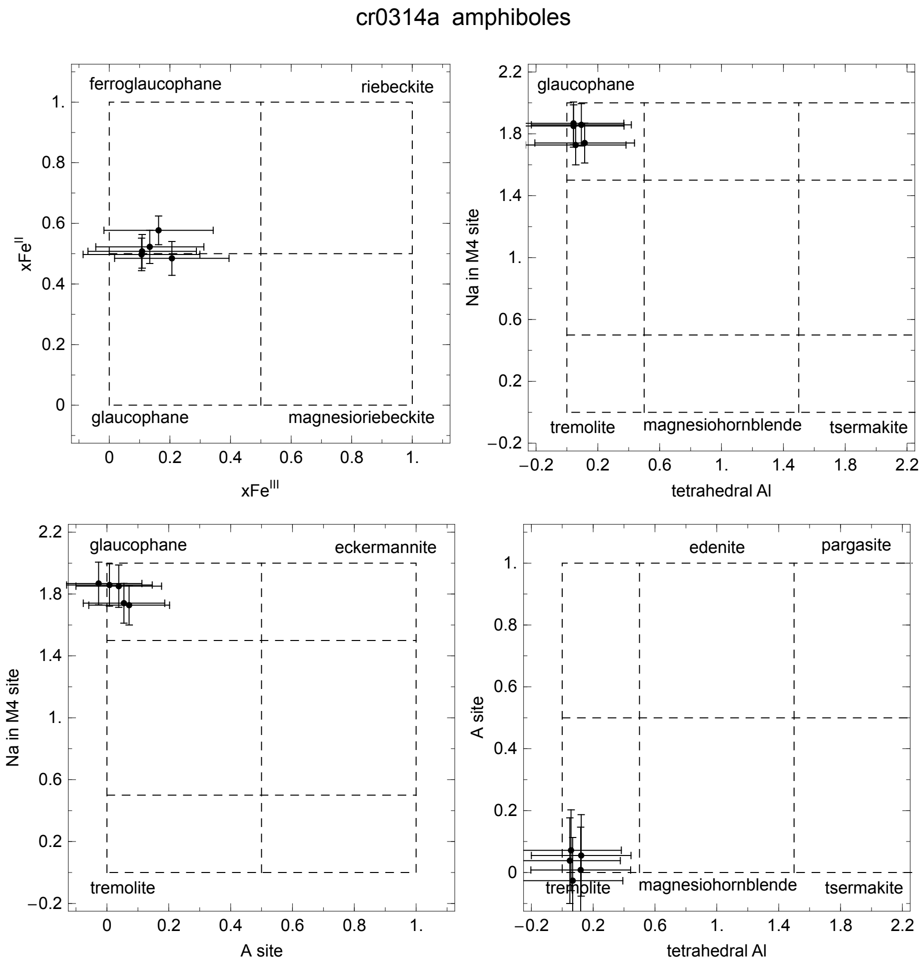
| sample | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 | cr04552 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | lgPx−2 | lgPx−3 | lgPx−4 | lgPx−5 | lgPx−6 | lgPx−7 | lgPx−8 | lgPx−9 | lgPx−10 | lgPx−11 | lgPx−12 | lgPx−13 | lgPx−14 |
| SiO2 | 52.39 | 52.95 | 53.13 | 53.29 | 54.02 | 54.26 | 54.33 | 55.41 | 56.23 | 51.10 | 51.32 | 51.61 | 51.64 |
| TiO2 | 0.28 | 0.30 | 0.32 | 0.37 | 0.31 | 0.32 | 0.29 | 0.16 | 0.16 | 0.37 | 0.26 | 0.20 | 0.25 |
| Al2O3 | 1.19 | 1.13 | 1.39 | 1.32 | 1.25 | 1.34 | 1.42 | 1.30 | 0.37 | 1.66 | 1.49 | 1.53 | 1.24 |
| Cr2O3 | 0.10 | 0.19 | 0.09 | 0.09 | 0.09 | 0.07 | 0.08 | 0.79 | 0.03 | 0.10 | 0.11 | 0.12 | 0.11 |
| FeO | 11.54 | 17.27 | 12.85 | 10.38 | 13.92 | 11.90 | 11.84 | 5.69 | 5.56 | 12.78 | 13.25 | 12.18 | 14.80 |
| MnO | 0.28 | 0.24 | 0.32 | 0.32 | 0.36 | 0.33 | 0.30 | 0.13 | 0.77 | 0.28 | 0.28 | 0.24 | 0.37 |
| MgO | 13.05 | 10.33 | 13.12 | 13.22 | 11.88 | 12.94 | 13.03 | 16.95 | 16.93 | 12.77 | 12.89 | 12.72 | 11.97 |
| CaO | 20.88 | 15.36 | 19.60 | 21.00 | 19.77 | 20.76 | 20.41 | 21.48 | 20.52 | 21.43 | 21.27 | 21.37 | 20.14 |
| K2O | 0.01 | 0.00 | 0.00 | 0.03 | 0.03 | 0.00 | 0.03 | 0.03 | 0.00 | 0.00 | 0.01 | 0.02 | 0.00 |
| Na2O | 0.00 | 2.85 | 0.00 | 1.26 | 0.08 | 0.00 | 0.00 | 0.00 | 1.06 | 0.22 | 0.17 | 0.18 | 0.17 |
| Cl2O−1 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.02 | 0.04 | 0.00 | 0.03 | 0.00 | 0.00 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 99.73 | 100.64 | 100.86 | 101.29 | 101.74 | 101.94 | 101.75 | 101.96 | 101.65 | 100.72 | 101.03 | 100.16 | 100.68 |
| Si | 1.98 | 1.99 | 1.99 | 1.96 | 2.02 | 2.01 | 2.02 | 2.00 | 2.02 | 1.91 | 1.92 | 1.94 | 1.95 |
| Ti | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| Al | 0.05 | 0.05 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.02 | 0.07 | 0.07 | 0.07 | 0.06 |
| Cr | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe3+ | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.10 | 0.05 | 0.04 |
| Fe2+ | 0.36 | 0.54 | 0.40 | 0.30 | 0.44 | 0.37 | 0.37 | 0.17 | 0.17 | 0.30 | 0.32 | 0.34 | 0.43 |
| Mn | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 |
| Mg | 0.74 | 0.58 | 0.73 | 0.72 | 0.66 | 0.72 | 0.72 | 0.91 | 0.91 | 0.71 | 0.72 | 0.71 | 0.67 |
| Ca | 0.85 | 0.62 | 0.79 | 0.83 | 0.79 | 0.82 | 0.81 | 0.83 | 0.79 | 0.86 | 0.85 | 0.86 | 0.82 |
| K | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.00 | 0.21 | 0.00 | 0.09 | 0.01 | 0.00 | 0.00 | 0.00 | 0.07 | 0.02 | 0.01 | 0.01 | 0.01 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 6.02 | 5.92 | 6.03 | 5.97 | 6.06 | 6.05 | 6.06 | 6.04 | 5.99 | 6.00 | 6.00 | 6.00 | 6.00 |
| Mg# | 0.67 | 0.52 | 0.65 | 0.71 | 0.60 | 0.66 | 0.66 | 0.84 | 0.84 | 0.70 | 0.69 | 0.68 | 0.61 |

| sample | cr04552 | cr04552 | cr04552 | cr0481b |
|---|---|---|---|---|
| point | lgPx−15 | lgPx−16 | lgPx−17 | lgPx−1 |
| SiO2 | 51.71 | 51.79 | 51.85 | 50.87 |
| TiO2 | 0.32 | 0.33 | 0.24 | 0.28 |
| Al2O3 | 1.28 | 1.53 | 1.41 | 2.52 |
| Cr2O3 | 0.10 | 0.13 | 0.11 | 0.27 |
| FeO | 13.56 | 12.01 | 13.60 | 6.97 |
| MnO | 0.27 | 0.29 | 0.24 | 0.19 |
| MgO | 12.72 | 12.79 | 12.42 | 17.17 |
| CaO | 20.76 | 21.29 | 21.02 | 20.45 |
| K2O | 0.00 | 0.00 | 0.01 | 0.00 |
| Na2O | 0.15 | 0.20 | 0.21 | 0.13 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.01 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 100.86 | 100.37 | 101.12 | 98.84 |
| Si | 1.94 | 1.94 | 1.94 | 1.88 |
| Ti | 0.01 | 0.01 | 0.01 | 0.01 |
| Al | 0.06 | 0.07 | 0.06 | 0.11 |
| Cr | 0.00 | 0.00 | 0.00 | 0.01 |
| Fe3+ | 0.06 | 0.04 | 0.05 | 0.12 |
| Fe2+ | 0.36 | 0.33 | 0.37 | 0.09 |
| Mn | 0.01 | 0.01 | 0.01 | 0.01 |
| Mg | 0.71 | 0.72 | 0.69 | 0.95 |
| Ca | 0.83 | 0.86 | 0.84 | 0.81 |
| K | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.01 | 0.01 | 0.02 | 0.01 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 6.01 | 6.00 | 6.00 | 6.01 |
| Mg♯ | 0.66 | 0.68 | 0.65 | 0.91 |

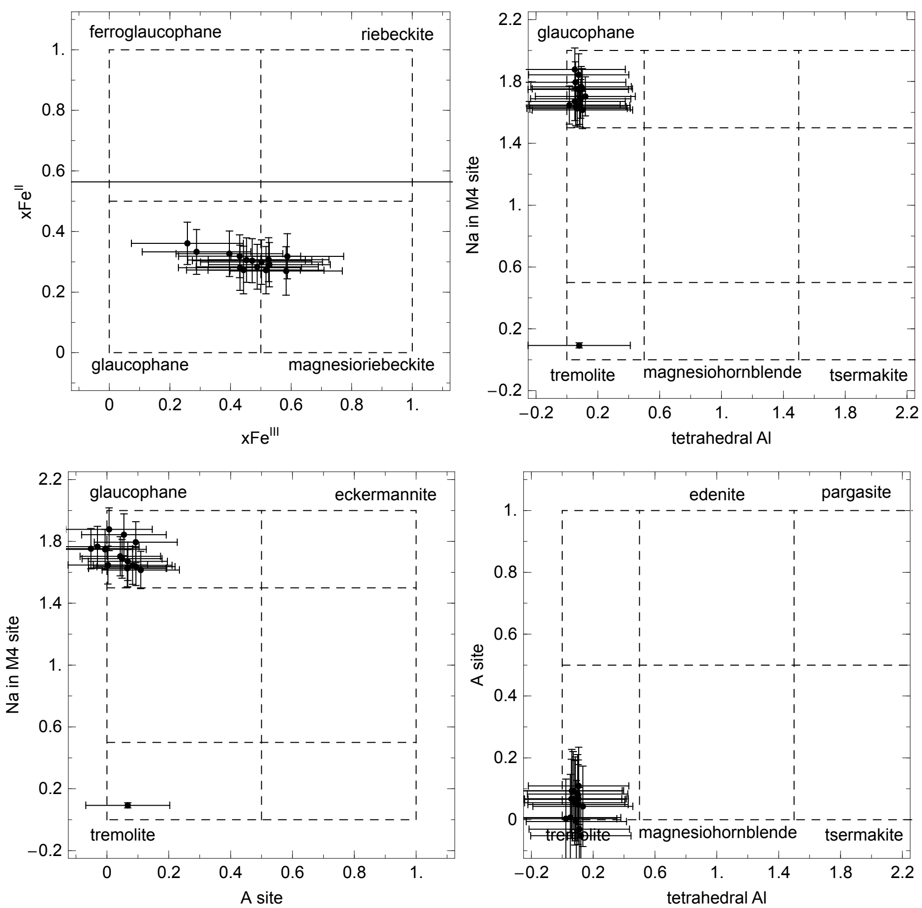
| sample | cr0318c | cr0318c | cr0318c | cr0318c | cr0318c | cr0428b | cr0428b | cr0428b | cr0428b | cr0462 | cr0462 | cr0462 | cr0462 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | Ms−1 | Ms−2 | Ms−3 | Ms−4 | Ms−5 | Ms−1 | Ms−2 | Ms−3 | Ms−4 | Ms−1 | Ms−2 | Ms−3 | Ms−4 |
| SiO2 | 51.31 | 52.31 | 53.07 | 52.03 | 52.21 | 50.45 | 50.50 | 50.77 | 50.84 | 51.05 | 51.46 | 52.32 | 52.94 |
| TiO2 | 0.06 | 0.14 | 0.00 | 0.03 | 0.10 | 0.07 | 0.62 | 0.07 | 0.05 | 0.04 | 0.05 | 0.04 | 0.03 |
| Al2O3 | 21.75 | 20.32 | 24.54 | 21.50 | 23.81 | 26.15 | 25.48 | 26.20 | 26.34 | 26.39 | 26.51 | 22.99 | 23.30 |
| Cr2O3 | 0.05 | 0.07 | 0.03 | 0.06 | 0.00 | 0.00 | 0.02 | 0.07 | 0.03 | 0.05 | 0.07 | 0.00 | 0.01 |
| FeO | 5.15 | 6.51 | 2.66 | 5.88 | 3.86 | 3.58 | 3.27 | 3.19 | 3.26 | 2.41 | 2.59 | 3.75 | 3.71 |
| MnO | 0.05 | 0.11 | 0.02 | 0.11 | 0.03 | 0.01 | 0.02 | 0.03 | 0.04 | 0.07 | 0.03 | 0.01 | 0.01 |
| MgO | 4.41 | 5.17 | 4.34 | 4.65 | 4.03 | 3.29 | 3.31 | 3.38 | 3.42 | 3.97 | 3.92 | 4.90 | 4.91 |
| CaO | 0.12 | 0.07 | 0.05 | 0.09 | 0.03 | 0.00 | 0.41 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K2O | 11.33 | 10.59 | 10.36 | 10.78 | 10.76 | 11.43 | 10.86 | 11.18 | 10.70 | 11.42 | 11.12 | 11.64 | 11.00 |
| Na2O | 0.06 | 0.05 | 0.11 | 0.04 | 0.10 | 0.19 | 0.18 | 0.20 | 0.20 | 0.27 | 0.22 | 0.05 | 0.05 |
| Cl2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| F2O−1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.22 |
| Total | 94.29 | 95.34 | 95.19 | 95.17 | 94.92 | 95.19 | 94.66 | 95.10 | 94.88 | 95.68 | 95.99 | 95.77 | 96.17 |
| Si | 3.50 | 3.50 | 3.51 | 3.49 | 3.50 | 3.39 | 3.42 | 3.40 | 3.40 | 3.40 | 3.40 | 3.49 | 3.50 |
| Ti | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 1.75 | 1.60 | 1.91 | 1.70 | 1.88 | 2.07 | 2.03 | 2.07 | 2.07 | 2.07 | 2.06 | 1.81 | 1.81 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe | 0.29 | 0.36 | 0.15 | 0.33 | 0.22 | 0.20 | 0.18 | 0.18 | 0.18 | 0.13 | 0.14 | 0.21 | 0.20 |
| Mn | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.45 | 0.52 | 0.43 | 0.47 | 0.40 | 0.33 | 0.33 | 0.34 | 0.34 | 0.39 | 0.39 | 0.49 | 0.48 |
| Ca | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| K | 0.99 | 0.90 | 0.87 | 0.92 | 0.92 | 0.98 | 0.94 | 0.96 | 0.91 | 0.97 | 0.94 | 0.99 | 0.93 |
| Na | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.03 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.01 | 0.01 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.08 |
| O | 10.89 | 10.77 | 10.91 | 10.82 | 10.91 | 10.93 | 10.97 | 10.93 | 10.91 | 10.93 | 10.92 | 10.89 | 10.83 |

| sample | cr0481a | cr0481a | cr0481a | cr0481b |
|---|---|---|---|---|
| point | Ms−1 | Ms−2 | Ms−3 | Ms−1 |
| SiO2 | 52.04 | 49.40 | 48.72 | 54.46 |
| TiO2 | 0.00 | 0.02 | 0.01 | 0.04 |
| Al2O3 | 25.18 | 28.06 | 34.11 | 25.35 |
| Cr2O3 | 0.01 | 0.00 | 0.02 | 0.03 |
| FeO | 5.13 | 3.90 | 1.26 | 5.42 |
| MnO | 0.04 | 0.06 | 0.08 | 0.07 |
| MgO | 2.59 | 1.50 | 0.72 | 4.03 |
| CaO | 0.03 | 0.04 | 0.09 | 0.11 |
| K2O | 10.51 | 10.94 | 10.22 | 6.54 |
| Na2O | 0.71 | 0.78 | 0.01 | 0.06 |
| Cl2O−1 | 0.01 | 0.00 | 0.01 | 0.01 |
| F2O−1 | 0.04 | 0.02 | 0.03 | 0.05 |
| Total | 96.30 | 94.73 | 95.25 | 96.17 |
| Si | 3.47 | 3.37 | 3.21 | 3.44 |
| Ti | 0.00 | 0.00 | 0.00 | 0.00 |
| Al | 1.98 | 2.25 | 2.65 | 1.89 |
| Cr | 0.00 | 0.00 | 0.00 | 0.00 |
| Fe | 0.29 | 0.22 | 0.07 | 0.29 |
| Mn | 0.00 | 0.00 | 0.00 | 0.00 |
| Mg | 0.26 | 0.15 | 0.07 | 0.38 |
| Ca | 0.00 | 0.00 | 0.01 | 0.01 |
| K | 0.90 | 0.95 | 0.86 | 0.53 |
| Na | 0.09 | 0.10 | 0.00 | 0.01 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 |
| F | 0.01 | 0.01 | 0.01 | 0.02 |
| O | 10.95 | 11.02 | 10.96 | 10.65 |

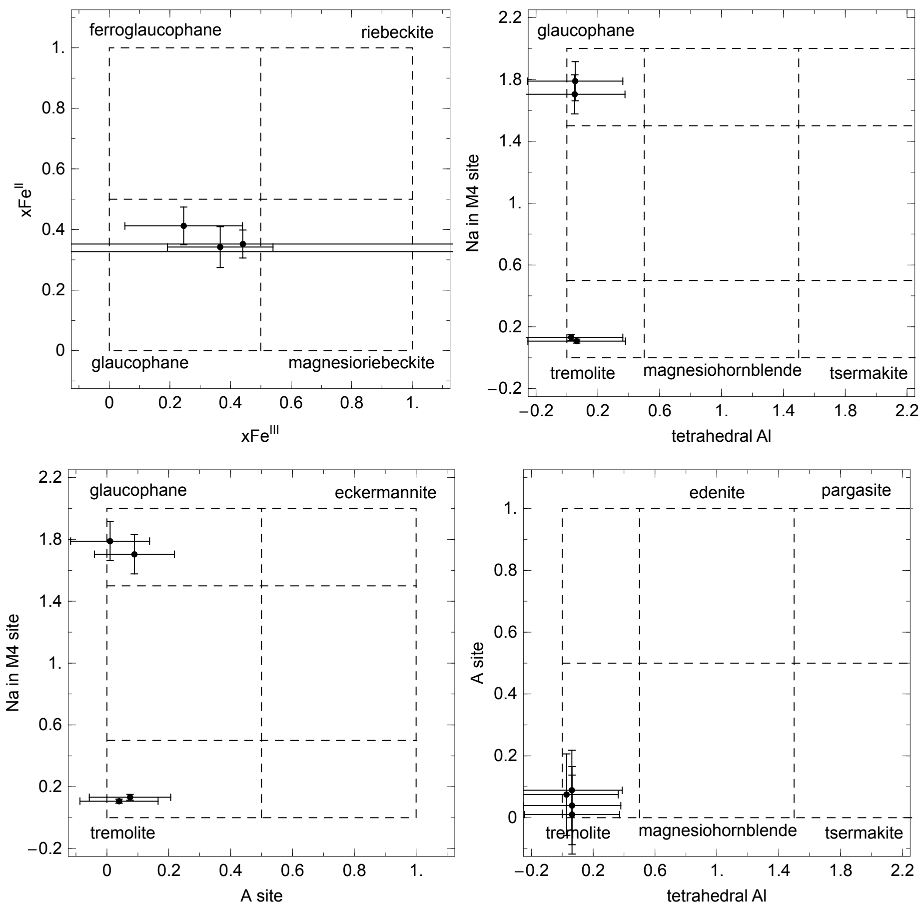
# Appendix 2 Plots of amphiboles analyzed from Crete



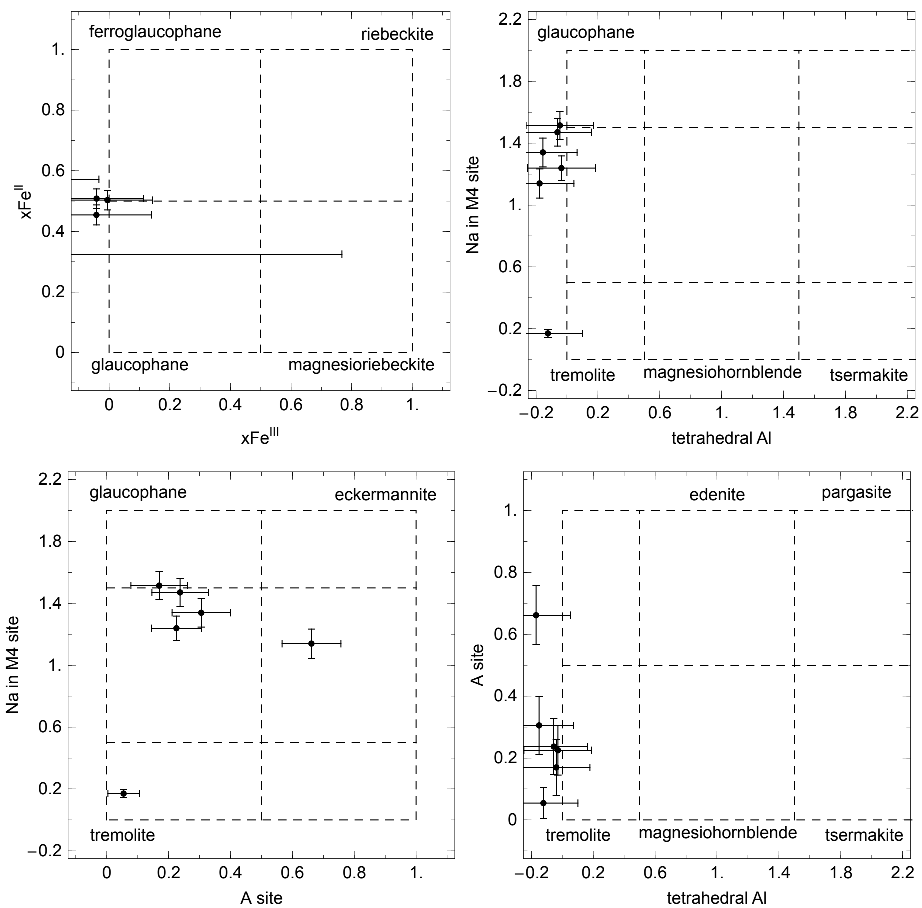
cr0318c amphiboles



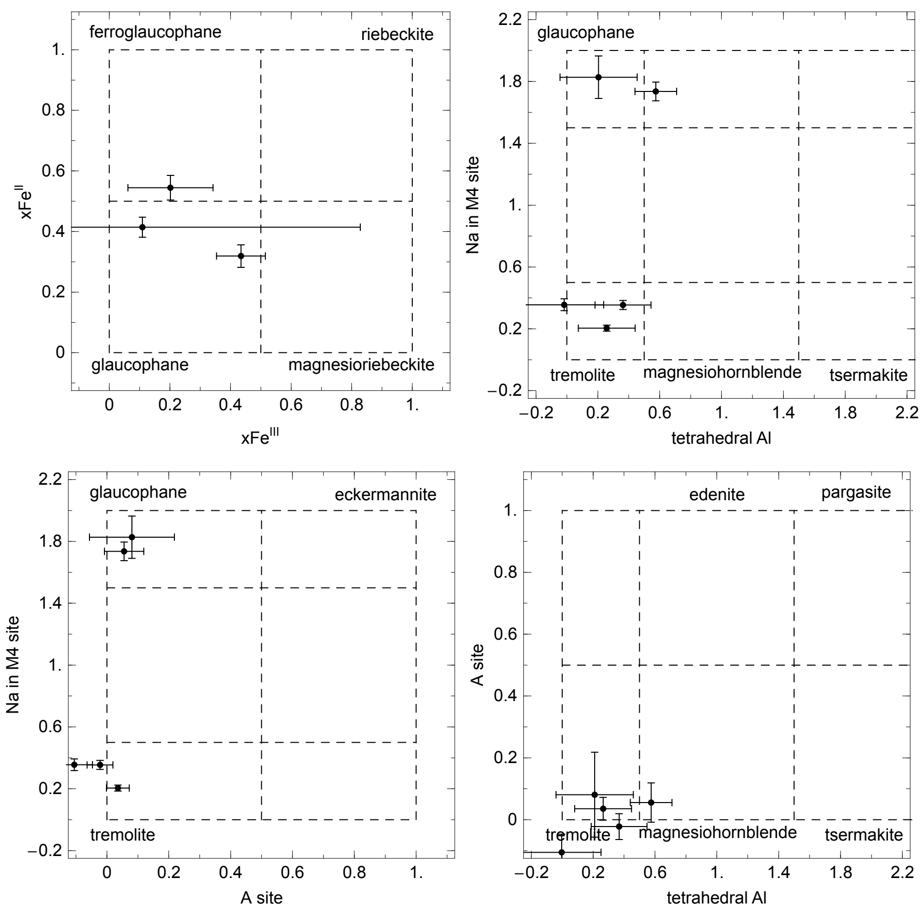
cr0318d amphiboles



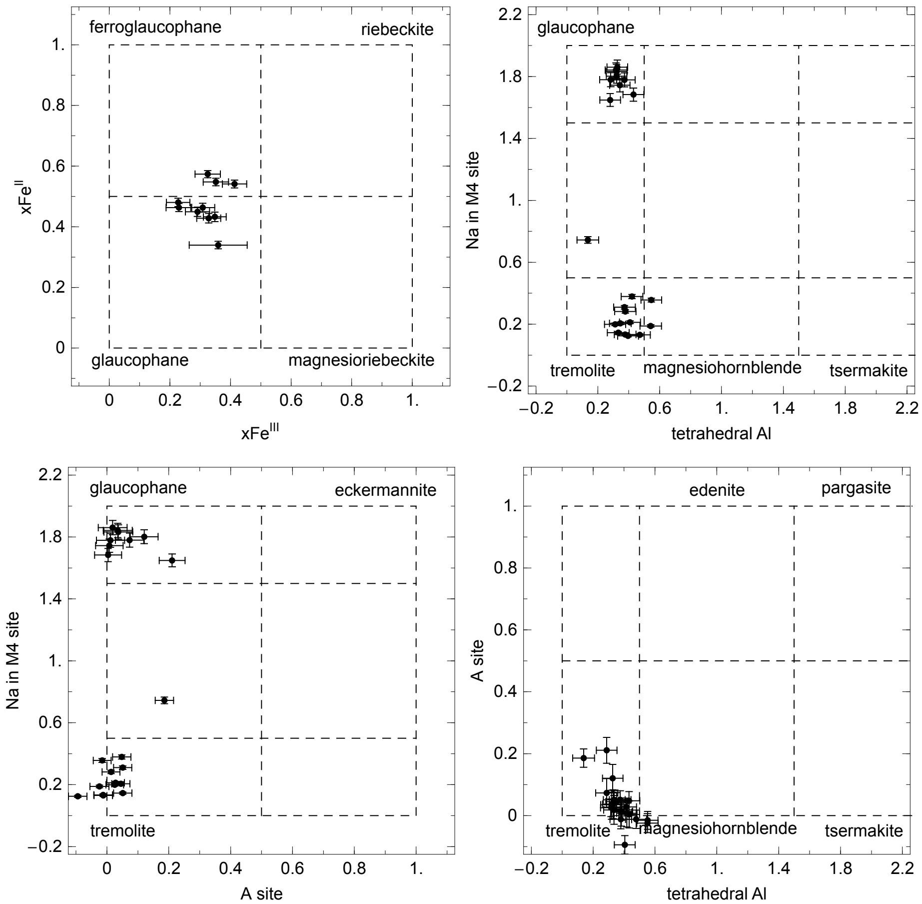
cr0422b amphiboles



cr0428b amphiboles



cr0429 amphiboles



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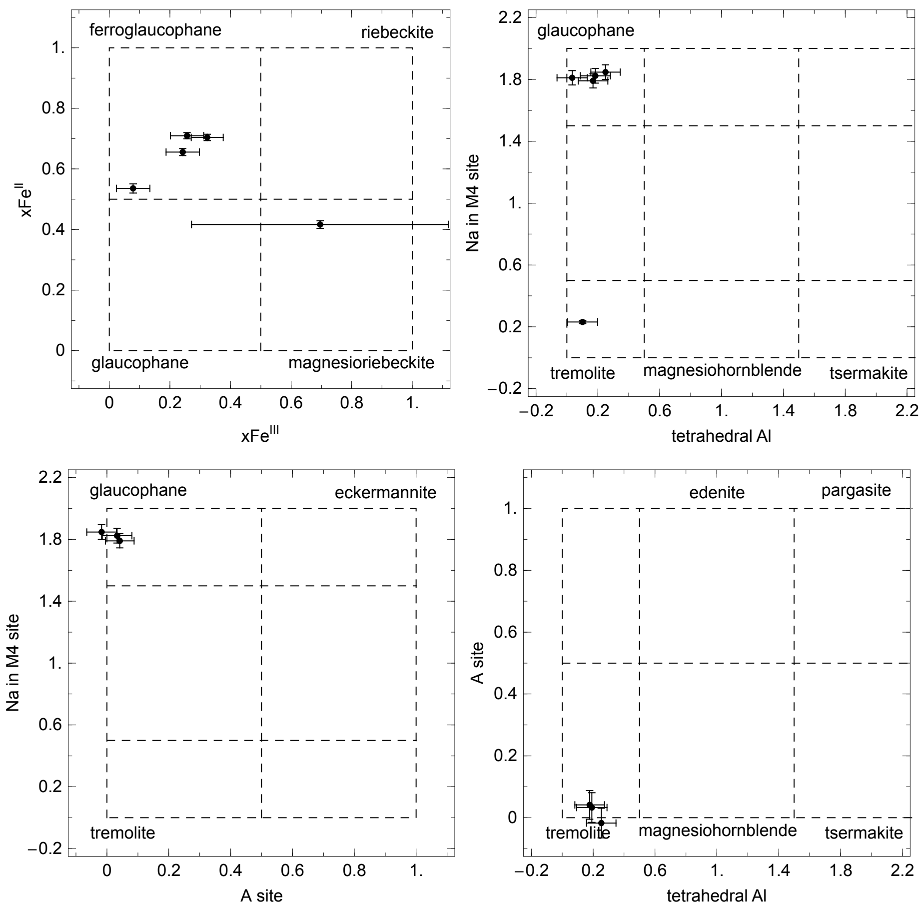
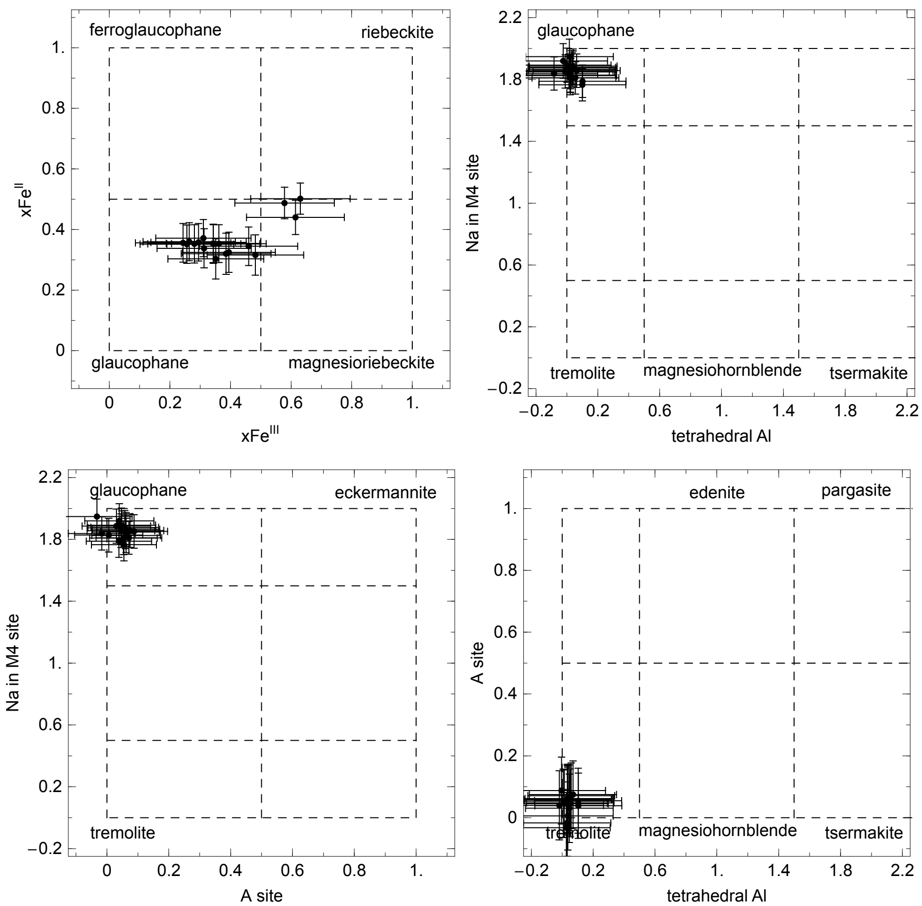
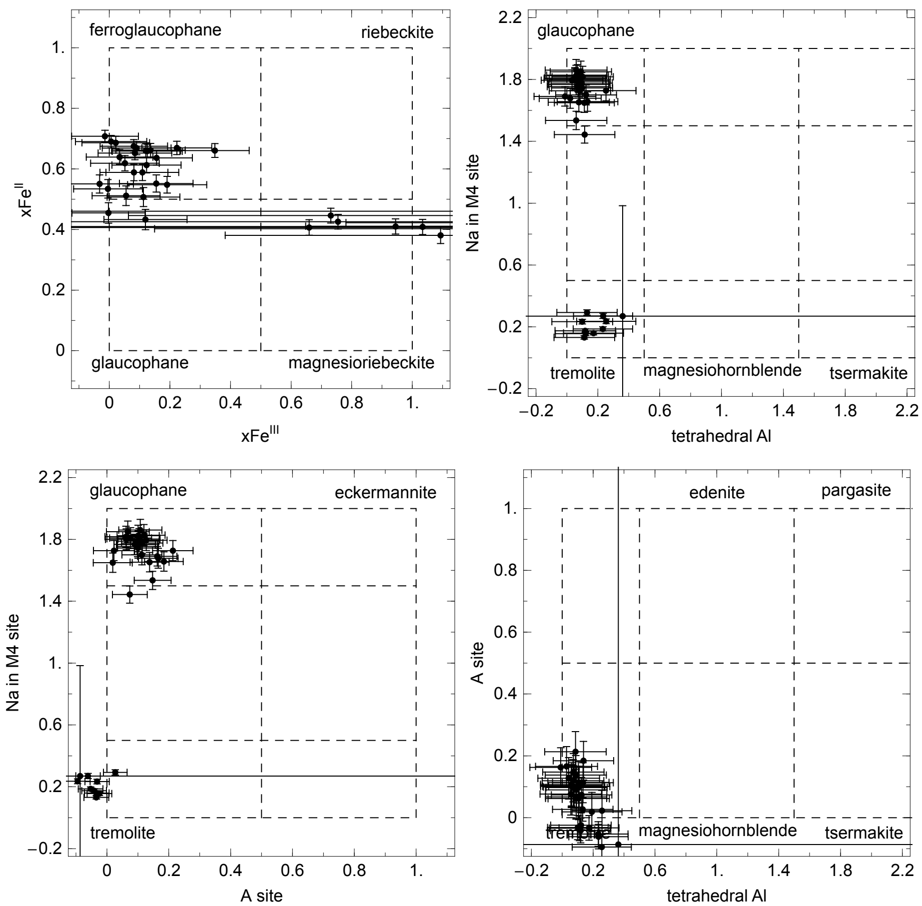


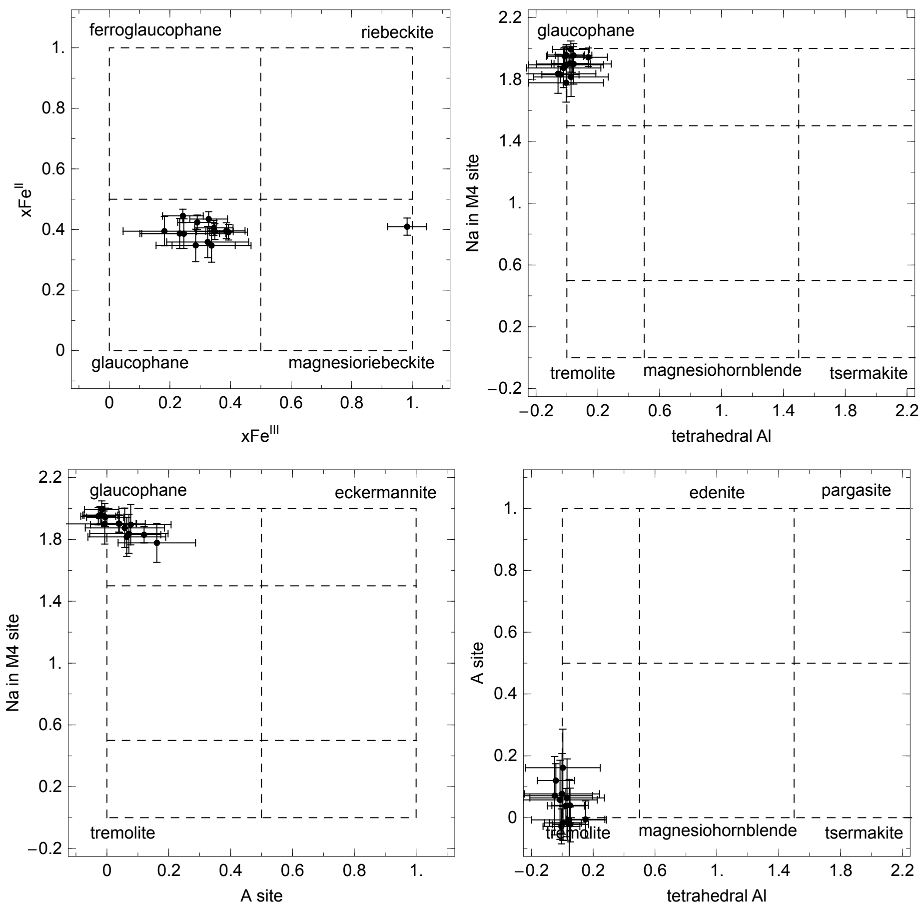
cr0433 amphiboles



cr0434 amphiboles



cr0439a amphiboles



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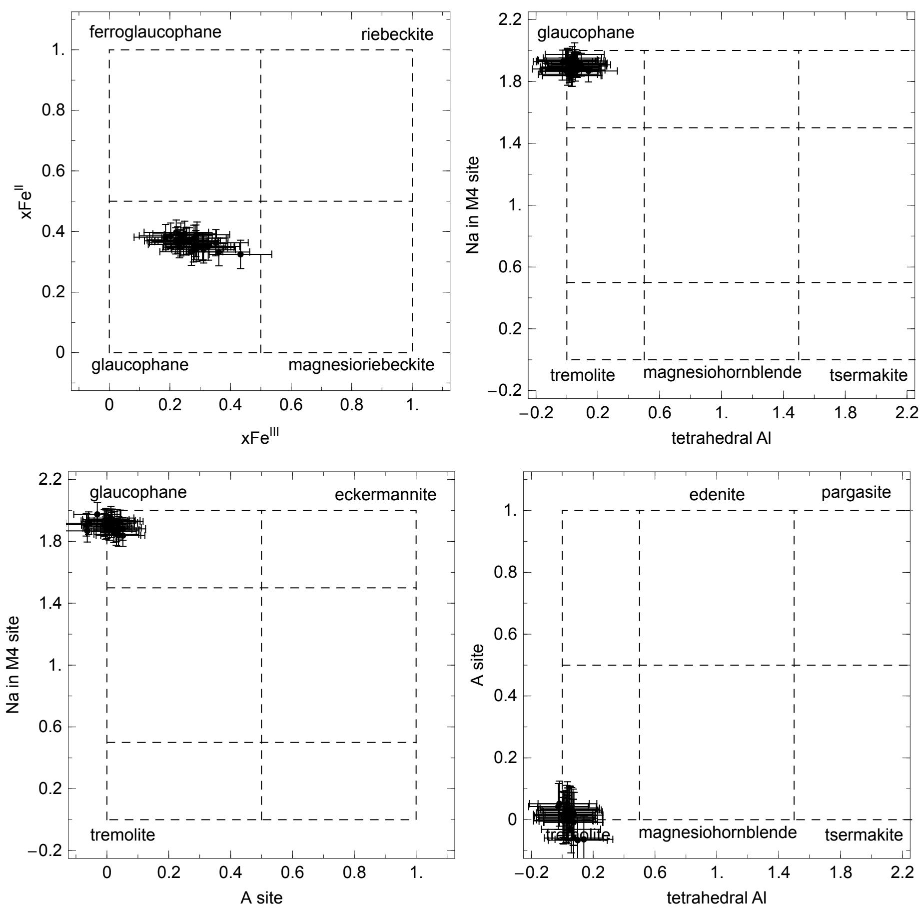
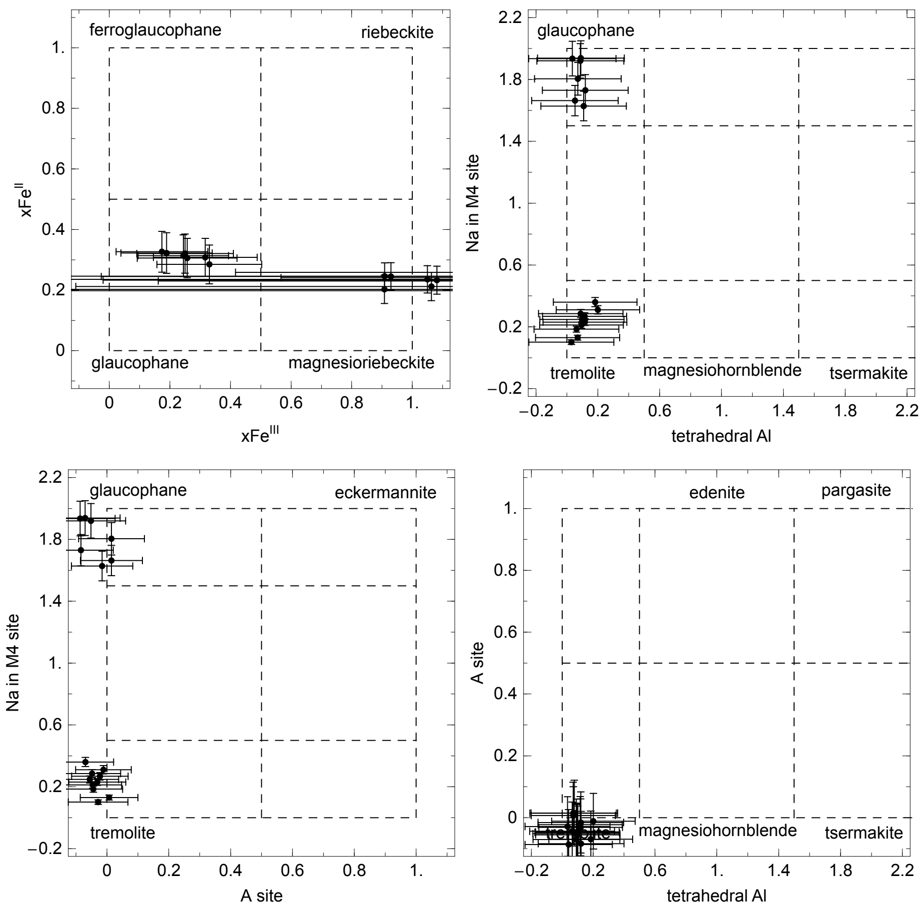
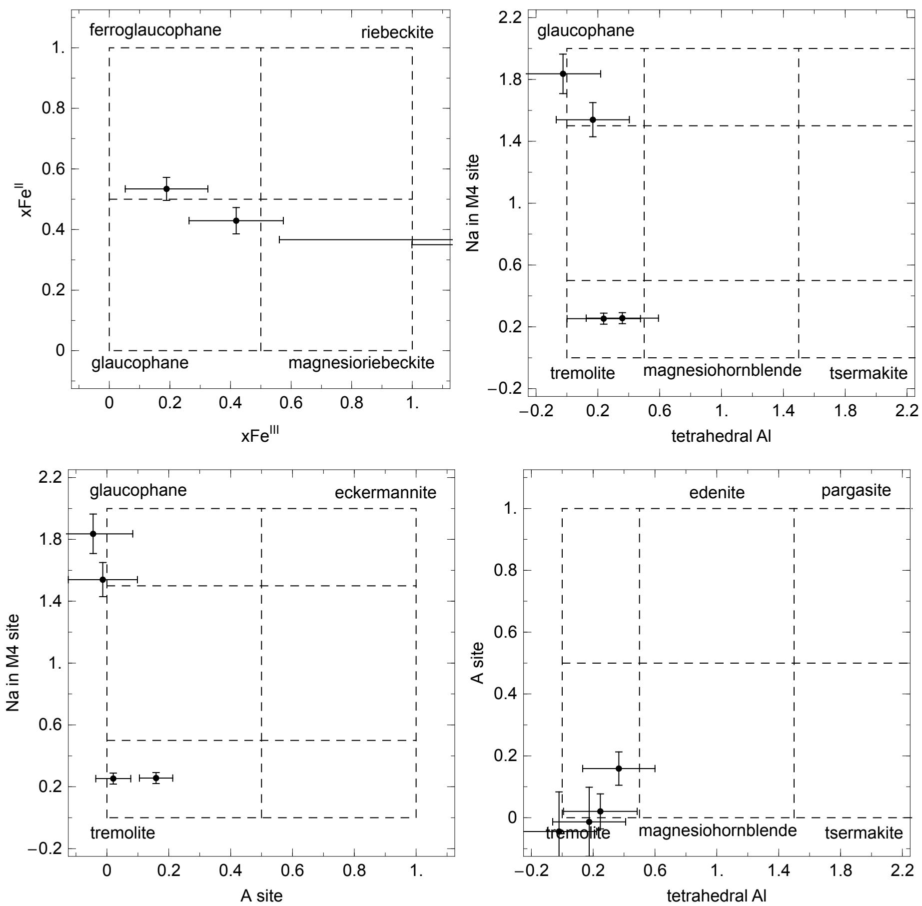


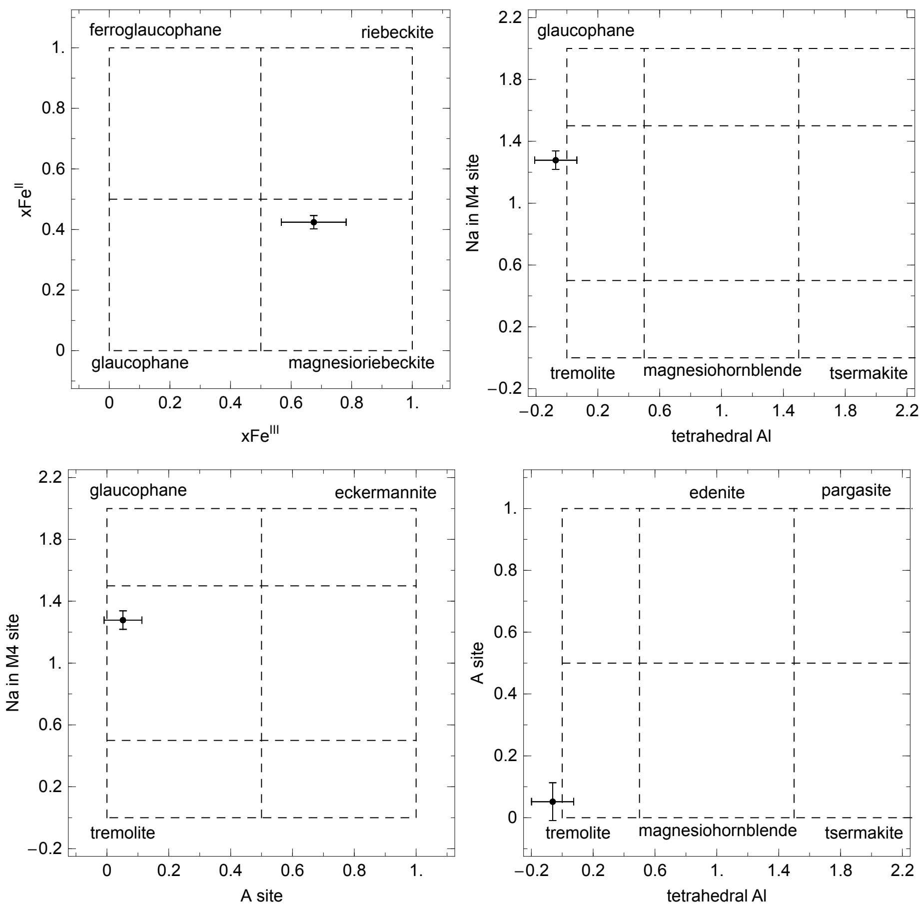
cr0443 amphiboles



cr0444 amphiboles



cr04551 amphiboles



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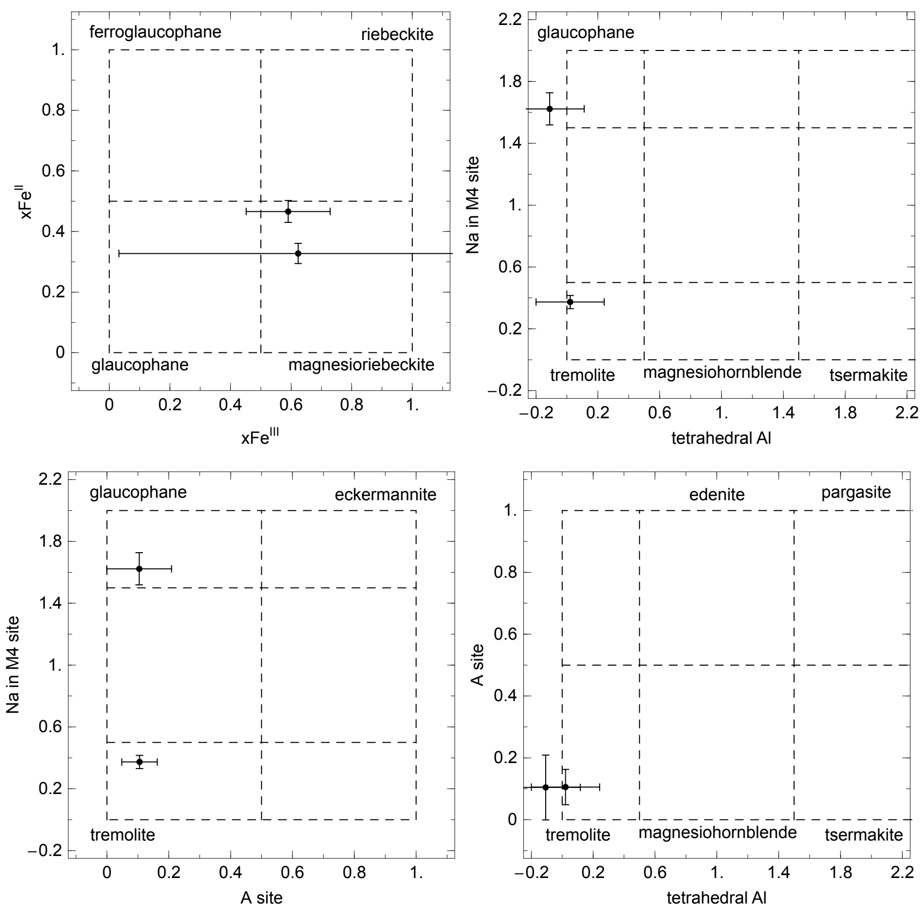

cr0459a amphiboles