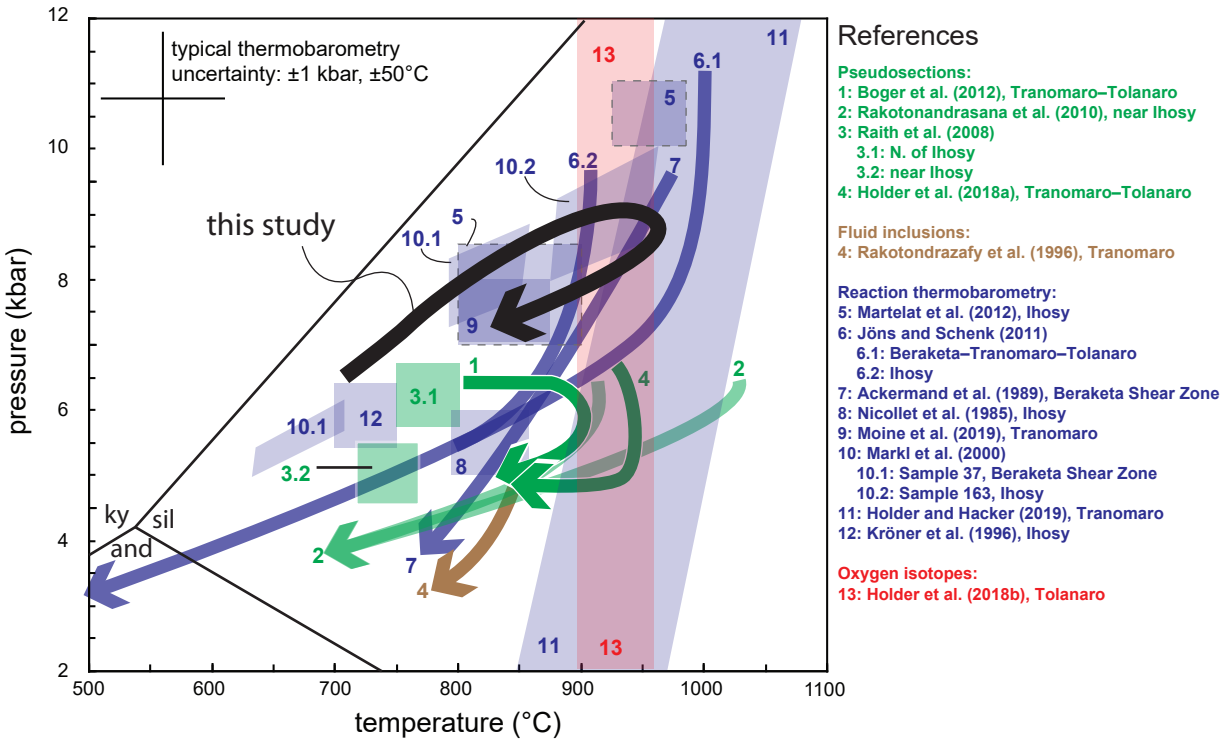

Figure S1. *P–T* estimates from the Anosyen domain & Beraketa shear zone.

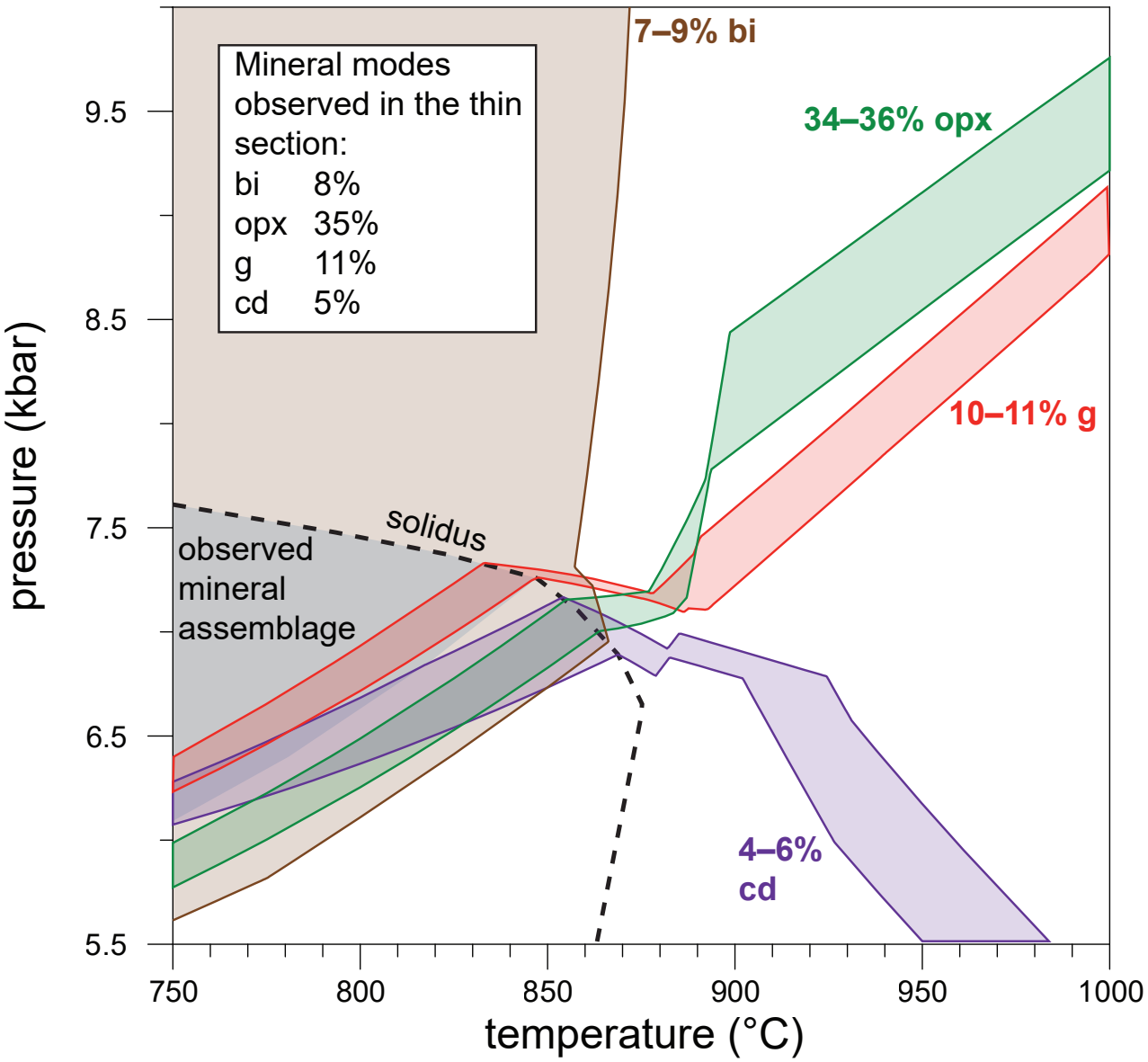

Figure S2. Comparison of mineral modes and the interpreted solidus mineral assemblage as calculated in the equilibrium assemblage diagram. Mineral modes, as observed in thin section, agree well with the predictions from the calculations. Slight offset of the orthopyroxene and cordierite modes to higher temperature (a few 10's of degrees) is attributed to the late formation of orthopyroxene-cordierite symplectites around garnet.

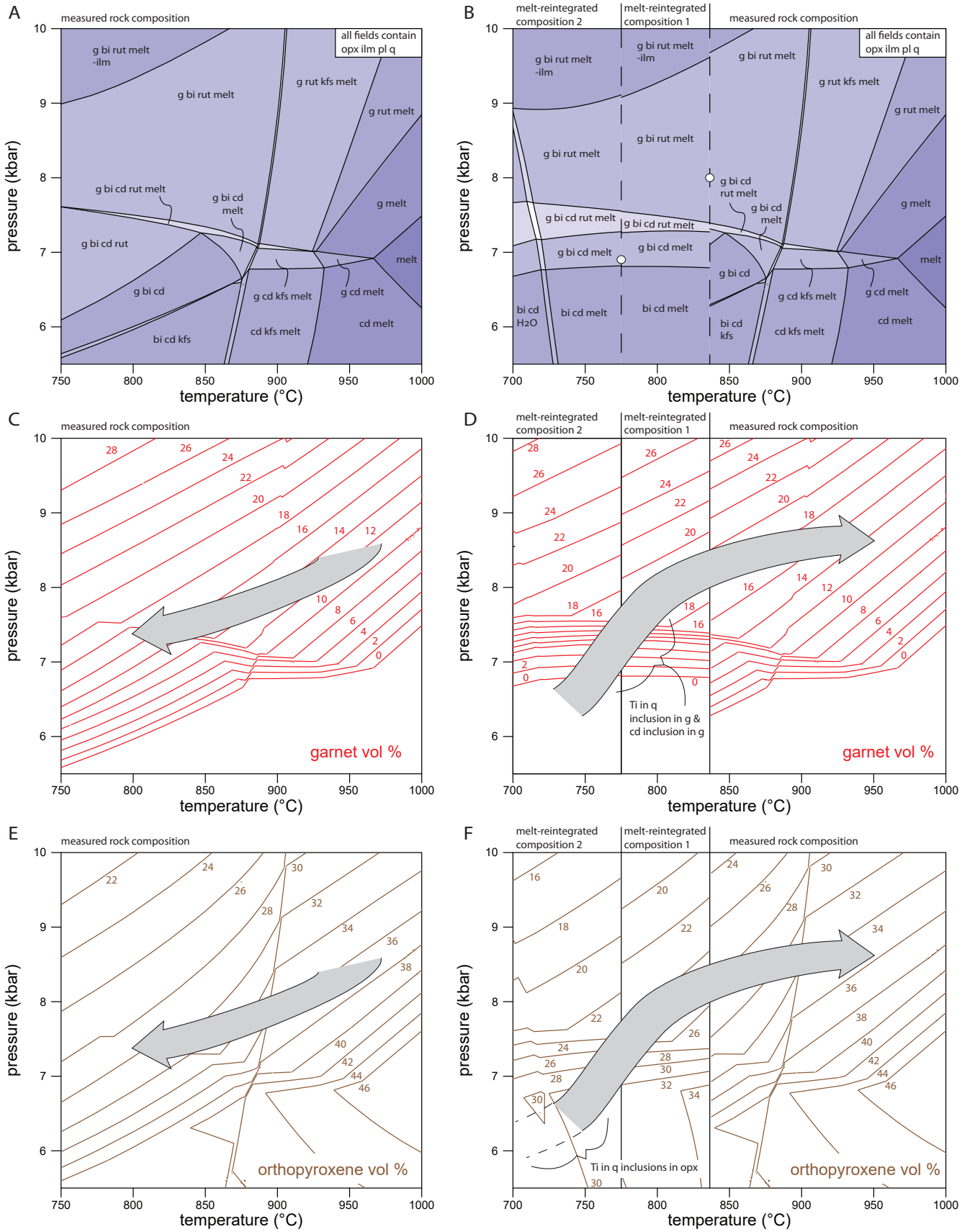

Figure S3. Calculated modes of each phase in the equilibrium assemblage diagrams.

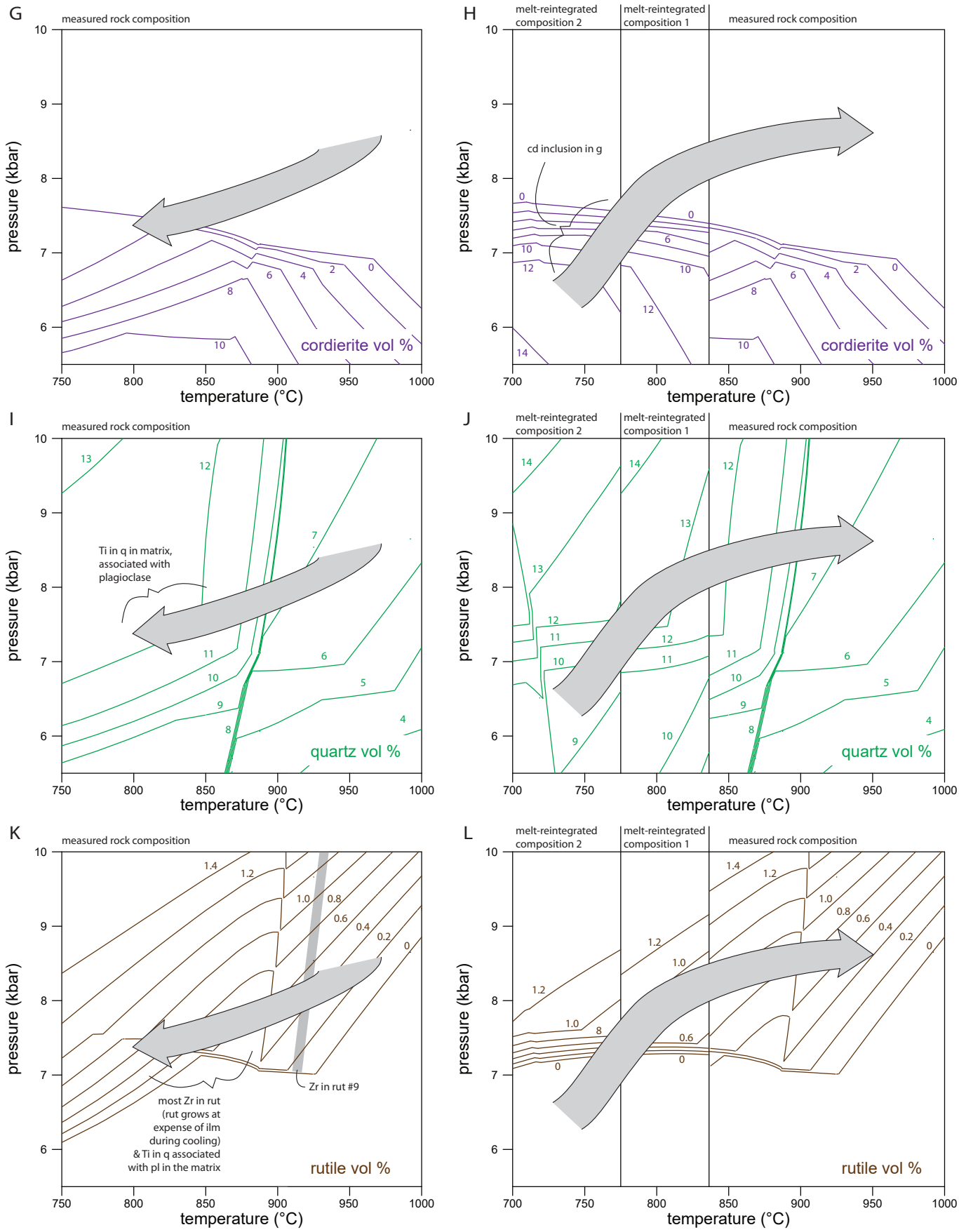

Figure S3. Continued.

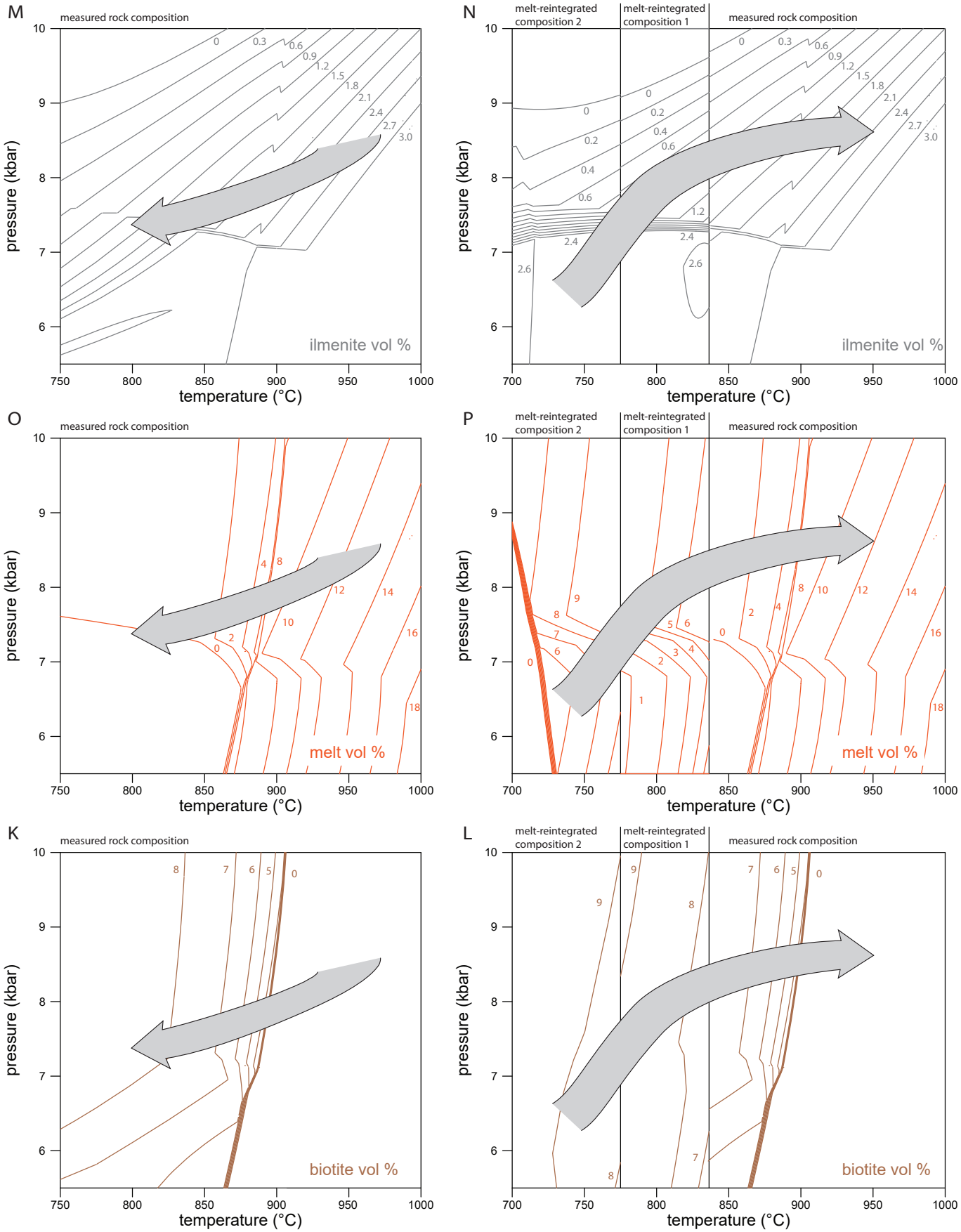

Figure S3. Continued.

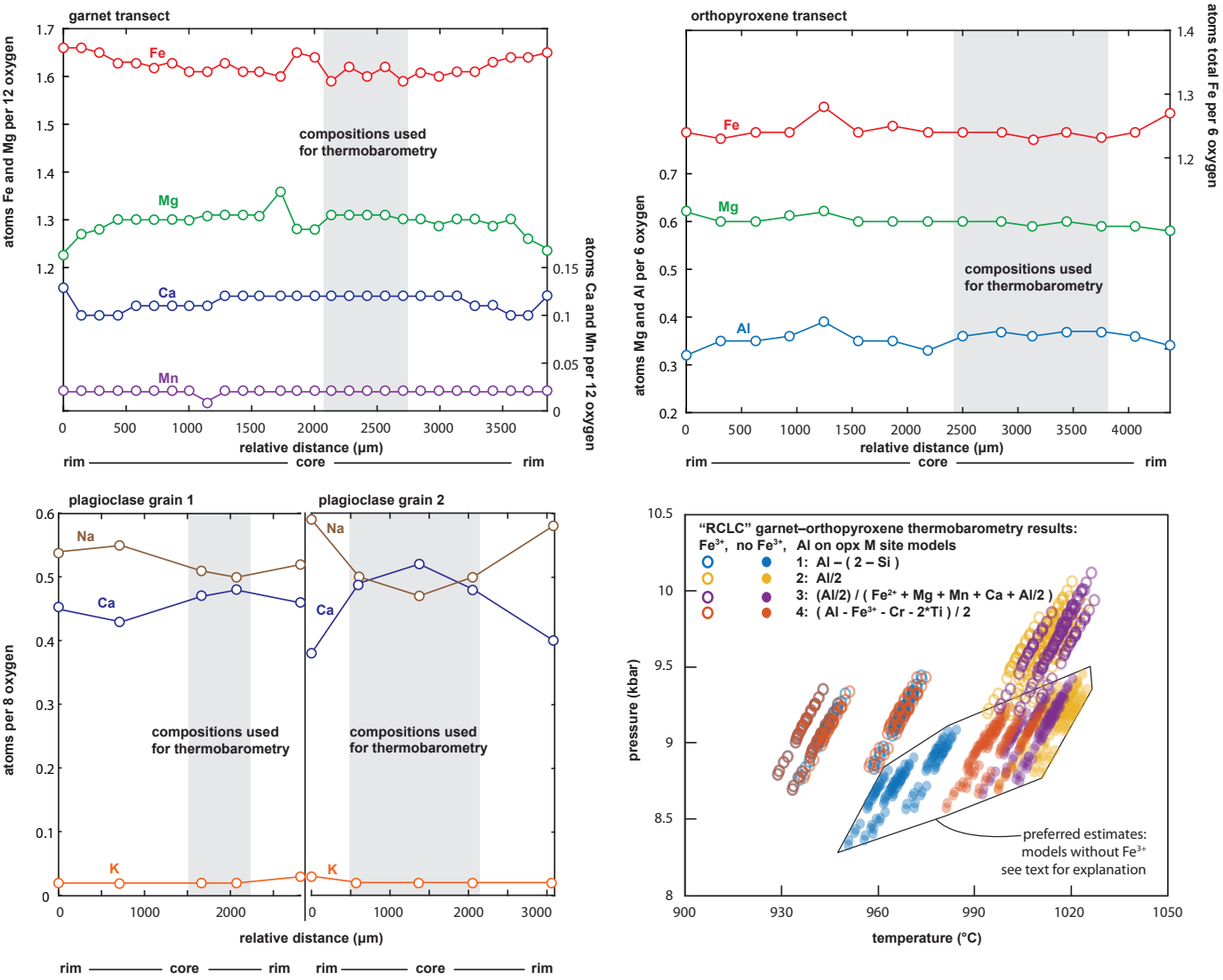

Figure S4. Mineral composition transects, showing input data used for RCLC thermobarometry, and variability in RCLC thermobarometry results as a function of input data, Al-in-orthopyroxene site model, and whether ferric iron was considered (as estimated by stoichiometry from EPMA data). The results without ferric iron are preferred for reasons discussed in the main text.

SUPPORTING FIGURES REFERENCES

Ackermand, D., Windley, B. F., & Razafiniparany, A. (1989). The Precambrian mobile belt of southern Madagascar. In *Evolution of metamorphic belts* (Vol. 43, pp. 293–296). Geological Society London.

Boger, S. D., White, R. W., & Schulte, B. (2012). The importance of iron speciation (Fe+ 2/Fe+ 3) in determining mineral assemblages: An example from the high-grade aluminous metapelites of southeastern Madagascar. *Journal of Metamorphic Geology*, *30*(9), 997–1018.

Holder, R. M., & Hacker, B. R. (2019). Fluid-driven resetting of titanite following ultrahigh-temperature metamorphism in southern Madagascar. *Chemical Geology*, *504*, 38–52.

Holder, R. M., Hacker, B. R., Horton, F., & Rakotondrazafy, A. M. (2018). Ultrahigh-temperature osumilite gneisses in southern Madagascar record combined heat advection and high rates of radiogenic heat production in a long-lived high-T orogen. *Journal of Metamorphic Geology*, *36*(7), 855–880.

Holder, R. M., Sharp, Z. D., & Hacker, B. R. (2018). LinT, a simplified approach to oxygen-isotope thermometry and speedometry of high-grade rocks: An example from ultrahigh-temperature gneisses of southern Madagascar. *Geology*, *46*(11), 931–934.

Jöns, N., & Schenk, V. (2011). The ultrahigh temperature granulites of southern Madagascar in a polymetamorphic context: Implications for the amalgamation of the Gondwana supercontinent. *European Journal of Mineralogy*, *23*(2), 127–156. https://doi.org/10.1127/0935-1221/2011/0023-2087

Kröner, A., Braun, I., & Jaeckel, P. (1996). Zircon geochronology of anatectic melts and residues from a highgrade pelitic assemblage at Ihosy, southern Madagascar: Evidence for Pan-African granulite metamorphism. *Geological Magazine*, *133*(03), 311–323.

Markl, G., Bäuerle, J., & Grujic, D. (2000). Metamorphic evolution of Pan-African granulite facies metapelites from Southern Madagascar. *Precambrian Research*, *102*(1), 47–68.

Martelat, J.-E., Malamoud, K., Cordier, P., Randrianasolo, B., Schulmann, K., & Lardeaux, J.-M. (2012). Garnet crystal plasticity in the continental crust, new example from south Madagascar. *Journal of Metamorphic Geology*, *30*(4), 435–452. https://doi.org/10.1111/j.1525-1314.2012.00974.x

Moine, B., de Parseval, P., Rakotondrazafy, M., & Ramambazafy, A. (2019). Fluorine-controlled composition of biotite in granulites of Madagascar: The effect of fluorine on thermometry of biotite–garnet gneisses. *Contributions to Mineralogy and Petrology*, *174*(9), 1–19.

Nicollet, C. (1985). Les gneiss rubanés à cordiérite et grenat d'Ihosy: Un marqueur thermo-barométrique dans le sud de Madagascar. *Precambrian Research*, *28*(2), 175–185.

Raith, M., Rakotondrazafy, R., & Sengupta, P. (2008). Petrology of corundum-spinel-sapphirine-anorthite rocks (sakenites) from the type locality in southern Madagascar. *Journal of Metamorphic Geology*, *26*(6), 647–667.

Rakotonandrasana, N. O. T., Arima, M., Miyawaki, R., & Rambeloson, R. A. (2010). Widespread Occurrences of Högbomite-2N2S in UHT Metapelites from the

Betroka Belt, Southern Madagascar: Implications on Melt or Fluid Activity during Regional Metamorphism. *Journal of Petrology*, *51*(4), 869–895.

Rakotondrazafy, M. A. F., Moine, B., & Cuney, M. (1996). Mode of formation of hibonite (CaAl 12 O 19) within the U-Th skarns from the granulites of SE Madagascar. *Contributions to Mineralogy and Petrology*, *123*(2), 190–201.