Mayfield, C. F., Tailleur, I. L., Mull, C. G., and Sable, E. G., 1978, Bedrock geologic map of the south half of National Petroleum Reserve in Alaska: U. S. Geological Survey Open-File Report 78-70-B, scale 1:500,000, two sheets.

Nilsen, T. H., and Moore, T. E., 1982a, Stratigraphy and sedimentology of the Kanayut Conglomerate, central and western Brooks Range, Alaska—report of 1981 field season: U. S. Geological Survey Open-File Report 81-674, 64 p.

Nilsen, T. H., and Moore, T. E., 1982b, Fluvial-facies model for the Upper Devonian and Lower Mississippian(?) Kanayut Conglomerate, Brooks Range, Alaska, in Embry, A. F., and Balkwill, H. R., eds., Arctic Geology and Geophysics: Canadian Society of Petroleum Geologists Memoir 8, p. 1-12.

Nilsen, T. H., and Moore, T. E., 1984, Stratigraphic nomenclature for the Upper Devonian and Lower Mississippian(?) Kanayut Conglomerate, Brooks Range, Alaska: U. S. Geological Survey Bulletin 1529-A, p. A1-A64.

Nilsen, T. H., Moore, T. E., Dutro, J. T., Jr., Brosgé, W. P., and Orchard, D. M., 1980, Sedimentology and stratigraphy of the Kanayut Conglomerate and associated units, central and eastern Brooks Range, Alaska—report of 1978 field season: U. S. Geological Survey Open-File Report 80-888, 40 p.

Smith, P. S., 1913, The Noatak-Kobuk region, Alaska: U. S. Geological Survey Bulletin 536, 160 p.

Smith, P. S., and Mertie, J. B., Jr., 1930, Geology and mineral resources of northwestern Alaska: U. S. Geological Survey Bulletin 815, 351 p.

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WEST-CENTRAL ALASKA

(Figure 9 shows study areas described.)

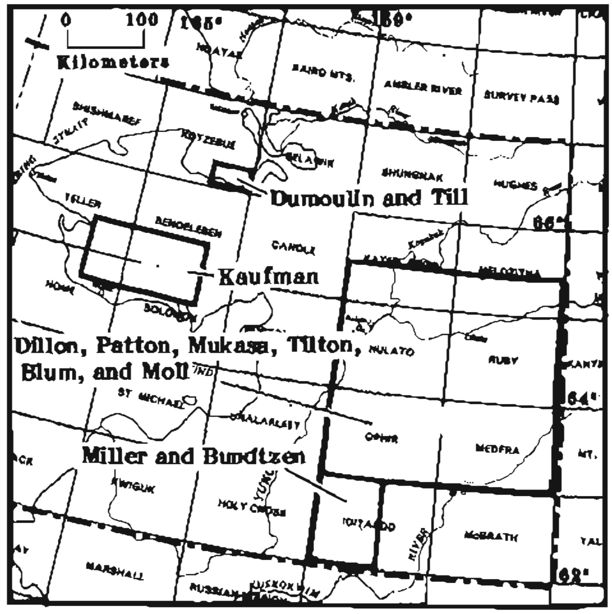

Figure 9.—Areas in west-central Alaska discussed in this circular. Outlines define the areas described by the indicated authors.

NEW RADIOMETRIC EVIDENCE FOR THE AGE AND THERMAL HISTORY OF THE METAMORPHIC ROCKS OF THE RUBY AND NIXON FORK TERRANES, WEST-CENTRAL ALASKA

by John T. Dillon, William W. Patton, Jr., Samuel B. Mukasa, George R. Tilton, Joel Blum, and Elizabeth J. Moll[1]

Metamorphic rocks in central Alaska have been assigned to several tectonostratigraphic terranes by Jones and others (1981), but the protolith ages and histories of these rocks are poorly known. Sufficient radiometric data do not presently exist to adequately define these terranes. In this report, new U-Pb and K-Ar evidence is presented that characterizes and delimits the assemblages of metamorphic rocks in two of these terranes, the Ruby and Nixon Fork.

The Ruby terrane consists of greenschist- and amphibolite-facies metasedimentary and felsic metaplutonic rocks. These metamorphic rocks compose the so-called "Ruby geanticline" that borders the southeastern edge of the Yukon-Koyukuk basin from the Brooks Range in the north to at least the Kaiyuh Mountains in the south. The southeastern limit of the Ruby terrane along most of the length of the "Ruby geanticline" is poorly defined because of lack of exposures and definitive geologic map data. However, in the region between the Yukon and upper Kuskokwim Rivers (fig. 10), the metamorphic rocks have been traced southeastward from the margin of the Yukon-Koyukuk basin to the Susulatna fault, where they appear to be juxtaposed with the Nixon Fork terrane (Patton and Moll, 1982).

Scattered fossil collections from carbonate rocks intercalated with pelitic schist of the Ruby terrane (Mertie and Harrington, 1924; Brosgé and others, 1973; Chapman and others, 1982; Patton,

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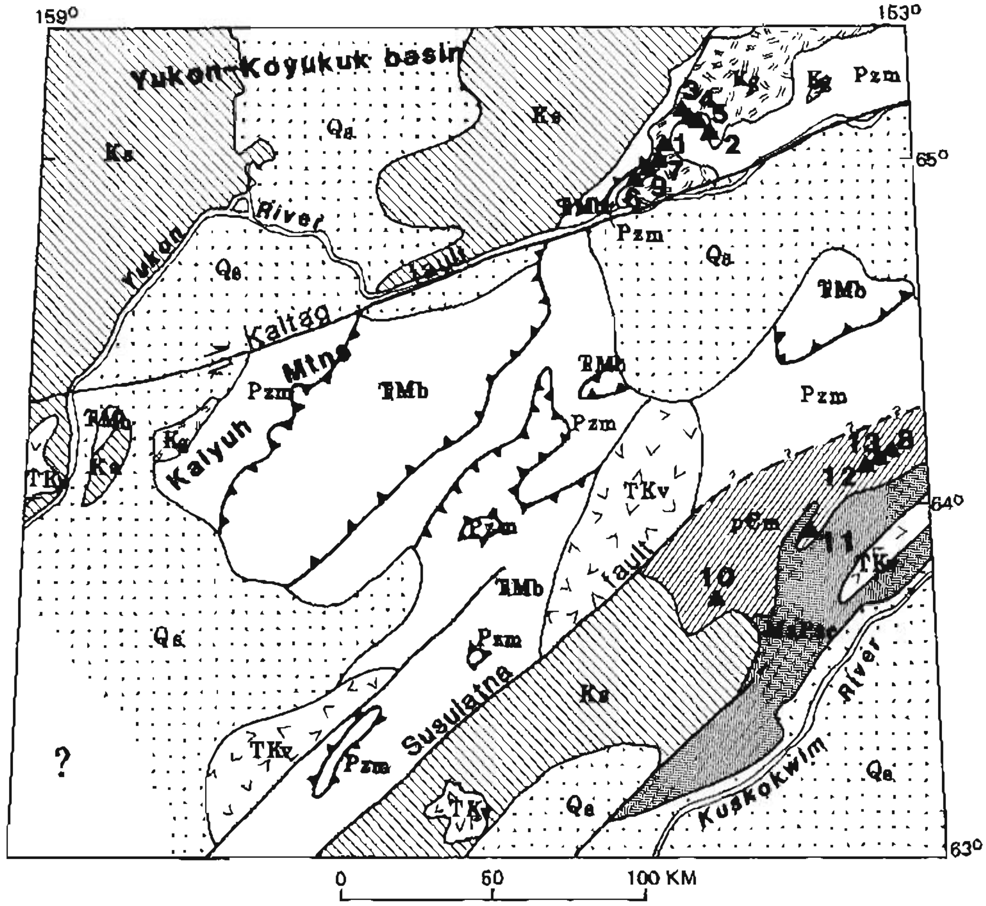

EXPLANATION

Qa — Surficial deposits (Quaternary)

TKv — Volcanic rocks (Tertiary and Cretaceous)

Ks — Terrigenous sedimentary rocks -- Yukon-Koyukuk and Kuskokwim basins (Cretaceous)

Kg — Granitic rocks (Cretaceous)

TrMb — Basalt, chert, gabbro, and ultramafic rocks -- Angayucham, Innoko, and Tozitna terranes (Triassic to Mississippian)

MzPzc — Carbonate rocks and terrigenous sedimentary rocks -- Nixon Fork terrane (Mesozoic and Paleozoic)

Pzm — Metasedimentary and metaplutonic rocks -- Ruby terrane (Paleozoic)

pCm — Metasedimentary and metavolcanic rocks -- Nixon Fork terrane (Precambrian)

▲8 Sample localities, number refers to list in tables 3 and 4

Contact

High angle fault

Thrust fault

Figure 10.—Sketch map of the geology of the Yukon-upper Kuskokwim Rivers region.

Table 3. —K-Ar isotopic analyses by Alaska Division of Geological and Geophysical Surveys, University of Alaska, Fairbanks Co-operative Geochronology Laboratory. Site numbers correspond to those shown on figure 10.

Site no.	Sample number	Rock type	Mineral	Age	Ar radio-genic/ Ar total	Quad-rangle
Ruby terrane — Quartz monzonite and associated hornfelses of Melozitna pluton						
1	82Dn437b	Biotite granite	Biotite	107.4±3.2	0.957	Melozitna
2	82Dn481a	Biotite quartz monzonite	Biotite	108.1±3.2	0.813	Melozitna
3	82Dn493	Biotite quartz monzonite	Biotite	111.5±3.3	0.736	Melozitna
4	82Dn491B	Hornfelsic biotite amphibolite	Amphibole	104.3±3.1	0.567	Melozitna
5	82Dn490a	Hornfelsic biotite amphibolite	Amphibole	106.4±3.2	0.663	Melozitna
	82Dn490a	Hornfelsic biotite amphibolite	Biotite	109.9±3.3	0.864	Melozitna
Ruby terrane -- Pre-Cretaceous						
6	82Dn424	Granitic orthogneiss	Biotite	110.2±3.3	0.611	Melozitna
	82Dn424	Granitic orthogneiss	White mica	119.6±3.6	0.330	Melozitna
7	81Dn76	Granitic orthogneiss	Biotite	112.6±3.4	0.847 0.847	Melozitna
Nixon Fork terrane (North) -- Metamorphic						
8	81Dn87	β-quartz K-feld-spar porphyry	White mica	697.0±20	0.964	Ruby

unpub. data, 1984) show that most of the metasedimentary rocks have Paleozoic protolith ages. The possibility that some protoliths may be as old as Precambrian cannot be ruled out, however.

The Ruby terrane is structurally overlain by allochthonous sheets of Mississippian to Jurassic oceanic crustal rocks that appear to have been emplaced in Late Jurassic or Early Cretaceous time. The oceanic rocks have locally been assigned to the Innoko, Tozitna, and Angayucham terranes (Patton, 1978; Jones and others, 1981). K-Ar metamorphic muscovite ages of 135 m.y. obtained from the Ruby terrane (Patton and others, 1984) are thought to represent a major regional metamorphic event related to overthrusting of these oceanic rocks. Both the metamorphic rocks and the oceanic rocks are intruded by granitic plutons that yield ages of about 110 m.y. (Patton and others, 1978; Patton and others, 1984).

Six new K-Ar ages from mineral separates from quartz monzonite and associated hornfels of the Melozitna pluton in the Ruby terrane (table 3, nos. 1-5) confirm the 110-m.y. cooling ages obtained previously from the Melozitna pluton. Nearby amphibolite-facies orthogneiss (table 3, nos. 6-7) yielded three K-Ar ages of 110 to 120 m.y. U-Pb data from two samples of orthogneiss (table 4, nos. 7 and 9) are insufficient to determine the protolith age and subsequent thermal history of the rocks, but the data do indicate that: (1) the parent magma of the aplitic orthogneiss contained a Paleozoic or Precambrian component, as evidenced by the 680-

Table 4.--U-Pb isotopic ages from analyses using a mixed ^{235}U-^{205}Pb spike and methods described in Krogh (1973) and Dillon and others (1979). Site numbers correspond to those shown on figure 10.

Site no.*	Sample number	Rock type	Zircon description	$^{206}Pb^*/^{238}U$	$^{207}Pb^*/^{235}U$	$^{207}Pb^*/^{206}Pb$	Quadrangle
			Ruby terrane				
7	81Dn76	Aplitic orthogneiss	Clear, less than 170 mesh	147.8	183.8	679.0	Melozitna
9	81Dn77	Fine-grained granitic orthogneiss	Clear, less than 230 mesh	120.5	129.1	292.0	Melozitna
			Nixon Fork terrane (South)				
10	81Dn78	Slightly foliated quartz porphyry	Translucent-beige, non-magnetic	388.3	447.7	765.6	Medfra
	81Dn78	Slightly foliated quartz porphyry	Translucent-beige, moderately magnetic	263.0	314.3	714.6	Medfra
	81Dn78	Slightly foliated quartz porphyry	Translucent-beige, magnetic	212.8	256.1	673.0	Medfra
11	81Dn81	Slightly foliated brecciated felsic volcanic	Translucent-pink, 100-230 mesh, non-magnetic	765.9	783.8	835.0	Medfra
	81Dn81	Slightly foliated brecciated felsic volcanic	Translucent-pink, 100-230 mesh, magnetic	731.3	758.7	840.5	Medfra
	81Dn81	Slightly foliated brecciated felsic volcanic	Translucent-pink, 100-230 mesh, M11	668.4	708.9	839.3	Medfra
			Nixon Fork terrane (North)				
12	81Dn85	Metamorphosed beta quartz-Kspar porphyry	Reddish-brown, translucent, M25-27	756.8	813.2	970.6	Ruby
	81Dn85	Metamorphosed beta quartz-Kspar porphyry	Reddish-brown, translucent, non-magnetic	933.4	1008.5	1189.1	Ruby
	81Dn85	Metamorphosed beta quartz-Kspar porphyry	Reddish-brown, translucent, moderately magnetic	831.2	917.5	1131.2	Ruby
	81Dn85	Metamorphosed beta quartz-Kspar porphyry	Reddish-brown, translucent, magnetic	692.5	790.3	1077.0	Ruby
13	81Dn86	Metamorphosed beta quartz-Kspar porphyry	Reddish-brown, translucent, non-magnetic	937.6	999.3	1137.1	Ruby
	81Dn86	Metamorphosed beta quartz-Kspar porphyry	Reddish-brown, translucent, moderately magnetic	857.6	932.8	1114.1	Ruby
	81Dn86	Metamorphosed beta quartz-Kspar porphyry	Reddish-brown, translucent, magnetic	789.4	859.2	1043.6	Ruby

m.y. $^{207}Pb/^{206}Pb$ age, and (2) zircon from both orthogneiss samples lost lead during Cretaceous time. Episodic lead loss probably occurred during the proposed Late Jurassic or Early Cretaceous metamorphic event and (or) later, during intrusion of the adjacent Melozitna pluton. No evidence for inherited zircon was found in these samples.

The Nixon Fork terrane, situated southeast of the Ruby terrane between the Susulatna fault and the upper Kuskokwim River, is shown as units p€m

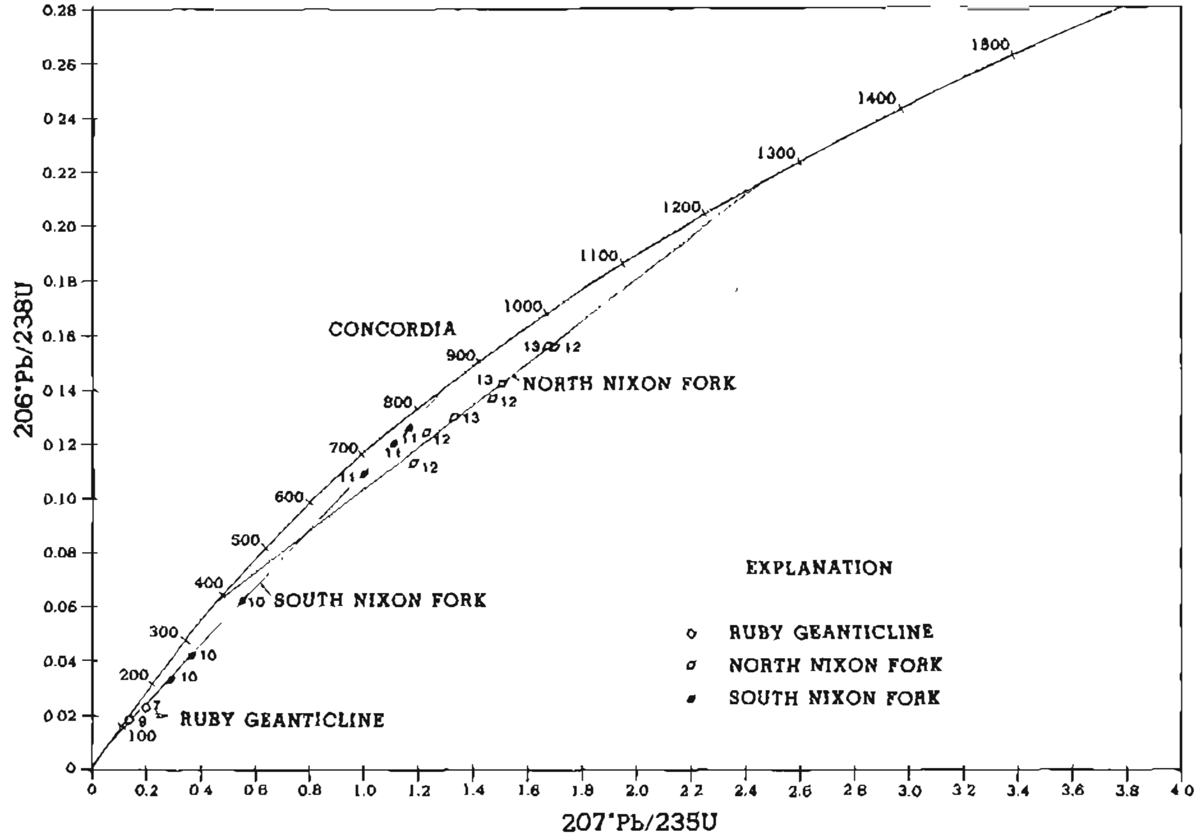

Figure 11.—Concordia diagram for zircon samples from the Ruby geanticline and Nixon Fork terrane.

and MzPzc in figure 10. It consists of metasedimentary and felsic metavolcanic and metaplutonic rocks overlain by unmetamorphosed Ordovician through Devonian shelf carbonates and Permian to middle Cretaceous terrigenous sedimentary rocks (Patton and others, 1980). Late Cretaceous and early Tertiary volcanism and plutonism were widespread throughout the terrane (Moll and others, 1981).

Six K-Ar cooling ages from the Nixon Fork metamorphic rocks, previously reported by Silberman and others (1979), range from 296 to 921 m.y. We have obtained an additional K-Ar age of 697 m.y. from this metamorphic assemblage (table 3, no. 8). Discordant U-Pb ages of metavolcanic rocks (table 4) define two chords (fig. 11). Six zircon fractions from the two more southerly areas (fig. 10) yield a chord with a correlation coefficient of 0.99998. The data indicate that these zircons, which come from slightly foliated quartz porphyry flows, crystallized at 850±30 m.y. (upper intercept) and lost lead at 73±10 m.y. (lower intercept), probably due to the Late Cretaceous and early Tertiary magmatic event. Seven zircon fractions from the more northerly of the two sample areas yield a chord with a correlation coefficient of 0.99989. Zircon recovered from a quartz-K-feldspar metaporphyry is interpreted to have been emplaced at 1,265±50 m.y. (upper intercept) and metamorphosed to greenschist facies at 390±40 m.y. (lower intercept). The early to mid-Paleozoic regional metamorphism of the northern samples apparently did not affect the southern samples. Therefore, we suspect that the Nixon Fork terrane itself may be an amalgamation of several Precambrian terranes.

Our radiometric data and the previously reported isotopic and paleontologic data indicate the following differences between the Ruby and Nixon Fork terranes:

(1) The Ruby terrane was regionally metamorphosed in Late Jurassic or Early Cretaceous time, whereas, in the Nixon Fork terrane, regional metamorphism was confined to pre-mid-Paleozoic time.

(2) Most of the metamorphic rocks in the Ruby terrane appear to have a Paleozoic protolith age, whereas most of the metamorphic rocks in the Nixon Fork terrane have a Precambrian protolith age.

REFERENCES CITED

Brosgé , W. P., Reiser, H. N., and Yeend, Warren, 1973, Reconnaissance geologic map of the Beaver Quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-525, 1 sheet, scale 1:250,000.

Chapman, R. M., Yeend, Warren, Brosgé, W. P., and Reiser, H. N., 1982, Reconnaissance geologic map of the Tanana Quadrangle, Alaska: U.S. Geological Survey Open-File Report 82-734, 1 sheet, scale 1:250,000.

Dillon, J. T., Pessel, G. H., Chen, J. H., and Veach, N. C., 1979, Tectonic and economic significance of Late Devonian and late Proterozoic U-Pb zircon ages from the Brooks Range, Alaska: Alaska Division of Geological and Geophysical Surveys Geologic Report 61, p. 36-41.

Jones, D. L., Silberling, N. J., Berg, H. C., and Plafker, George, 1981, Map showing tectonostratigraphic terranes of Alaska, columnar sections, and summary descriptions of terranes: U.S. Geological Survey Open-File Report 81-792, 21 p., 2 sheets.

Krogh, T. E., 1973, A low contamination method for hydrothermal decomposition of zircon and extraction of U-Pb for isotopic age determinations: Geochimica et Cosmochimica Acta, v. 37, p. 485-494.

Mertie, J. B., Jr., and Harrington, G. L., 1924, The Ruby-Kuskokwim region, Alaska: U.S. Geological Survey Bulletin 754, 129 p.

Moll, E. J., Silberman, M. L., and Patton, W. W., Jr., 1981, Chemistry, mineralogy, and K-Ar ages of igneous and metamorphic rocks of the Medfra Quadrangle, Alaska: U.S. Geological Survey Open-File Report 80-811C, 2 sheets, scale 1:250,000.

Patton, W. W., Jr., 1978, Juxtaposed continental and oceanic-island arc terranes in the Medfra Quadrangle, west-central Alaska, in Johnson, K. M., ed., The United States Geological Survey in Alaska—Accomplishments during 1977: U.S. Geological Survey Circular 772-B, p. B38-B39.

Patton, W. W., Jr., Miller, T. P., Chapman, R. M., and Yeend, Warren, 1978, Geologic map of the Melozitna Quadrangle, Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map I-1071, 1 sheet, scale 1:250,000.

Patton, W. W., Jr., and Moll, E. J., 1982, Structural and stratigraphic sections along a transect between the Alaska Range and Norton Sound, in Coonrad, W. L., ed., The United States Geological Survey in Alaska—Accomplishments during 1980: U.S. Geological Survey Circular 844, p. 76-78.

Patton, W. W., Jr., Moll, E. J., Dutro, J. T., Jr., Silberman, M. L., and Chapman, R. M., 1980, Preliminary geologic map of the Medfra Quadrangle, Alaska: U.S. Geological Survey Open-File Report 80-811A, 1 sheet, scale 1:250,000.

Patton, W. W., Jr., Moll, E. J., Lanphere, M. A., and Jones, D. L., 1984, New age data for the Kaiyuh Mountains, in Coonrad, W. L., and Elliott, R. L., eds., The United States Geological Survey in Alaska—Accomplishments during 1981: U.S. Geological Survey Circular 868, p. 30-32.

Silberman, M. L., Moll, E. J., Patton, W. W., Jr., Chapman, R. M., and Connor, C. L., 1979, Precambrian age of metamorphic rocks from the Ruby province, Medfra and Ruby Quadrangles—Preliminary evidence from radiometric age data, in Johnson, K. M., and Williams, J. R., eds., The United States Geological Survey in Alaska—Accomplishments during 1978: U.S. Geological Survey Circular 804-B, p. B66-B68.

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SEACLIFF EXPOSURES OF METAMORPHOSED CARBONATE AND SCHIST, NORTHERN SEWARD PENINSULA

by Julie A. Dumoulin and Alison B. Till

Extensive seacliff exposures of marble, metadolostone, and schist occur on the north shore of Seward Peninsula in the Kotzebue A-1 and A-2 Quadrangles (fig. 12). Some of the exposed units have no analogs when compared to rocks mapped to the south in the Bendeleben and Solomon Quadrangles. Others are similar to units exposed to the south, but they differ in metamorphic grade and minor, though significant, compositional characteristics. Carbonate rocks predominate from Ninemile Point westward; schists of varying composition occur with carbonate rocks to the east. The carbonate-dominated section is separated in the vicinity of Ninemile Point from the schist-dominated section by a major fault zone, thought to be the northern extension of the Kugruk fault zone of Sainsbury (1974).

The schistose rocks include those of intermediate to mafic composition, carbonaceous pelitic schist, and marble (fig. 12). The marble is intimately folded in with the intermediate to mafic schists; pelitic schist forms homogeneous outcrops. The intermediate to mafic schist is composed predominantly of actinolite, albite, epidote, and garnet. Variation in amount of each mineral type imparts a layered fabric, with layers a few centimeters to a meter in thickness. Massive medium-grained metabasite pods and lenses contain barroisite, actinolite, plagioclase, epidote, and