Age of sedimentation, plutonism, and regional metamorphism in the Clearwater Mountains region, Central Alaska

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Isochron/West, Bulletin of Isotopic Geochronology, v. 2, pp. 17-21

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AGE OF THE SEDIMENTATION, PLUTONISM, AND REGIONAL METAMORPHISM IN THE CLEARWATER MOUNTAINS REGION, CENTRAL ALASKA[1]

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This paper summarizes major implications of radiometric and faunal age data in the Clearwater Mountains and adjacent parts of the Talkeetna Mountains and Alaska Range. Geologic mapping of the Clearwater Mountains at a scale of 1:31,680 was begun in 1968, concurrently with mineral resource investigations sponsored by the U. S. Geological Survey. K-Ar dates determined for the project have revised most previous ages inferred for the major rock units. The age determinations were made in the laboratories of the U. S. Geological Survey, Menlo Park, Calif., using procedures described in Isochron/West, no. 1, p. 15. Potassium and argon measurements are by Lois Schlocker and Jarel Von Essen, respectively. Constants used are: $\lambda_\epsilon = 0.585 \times 10^{-10}\ yr^{-1}$; $\lambda_\beta = 4.72 \times 10^{-10}\ yr^{-1}$; K^{40}/K total = 1.22×10^{-4} gm/gm.

GEOLOGIC DISCUSSION

K-Ar and faunal age determinations in the Clearwater Mountains establish that the thick section of pelitic sediments exposed there was deposited between the middle Late Triassic and Late Jurassic. The sediments were intruded by alkali gabbro in the Late Jurassic and by a magma series of intermediate composition in the Late Cretaceous-Paleocene. Development of a compressed metamorphic belt, of the Barrovian type, was contemporaneous with Late Cretaceous plutonism.

The southern part of the mapped area (fig. 1) is underlain by a unit of metamorphosed lavas consisting dominantly of metabasalts or basaltic andesites of tholeiitic affinity, dipping generally northwestward. Thin beds of water-laid tuff and argillite, and discontinuous limestone lenses, are present at several horizons in the unit. The marine fauna Halobia cf. H. "Superba" and Tropites sp. were collected from such a limestone lens near the upper contact of the unit and are middle Late Triassic in age (Moffit, 1912, p. 30; N. J. Silberling, written commun., 1969). Thus, the thick section of lavas stratigraphically below may be assigned to the Triassic and possibly in part to the pre-Triassic(?).

Metamorphosed pelitic rocks conformably overlie the metavolcanic unit and border it on the north. These rocks are subdivided by textural characteristics into three metamorphic units (fig. 1). Abundant sedimentary structures are preserved in argillites just north of Windy Creek, and the unit includes minor strata of tuff, conglomerate, and non-fossiliferous limestone. North of the argillite unit, pelitic rocks grade through phyllites and schists into sillimanite-bearing gneisses southeast of the Susitna River (Smith, 1970a; U. S. Geol. Survey, 1970). A thrust fault of minor dislocation separates the almandine-biotite schists from kyanite- and sillimanite-bearing gneisses on the north.

The pelitic sequence has been affected by two episodes of plutonism. The earliest episode is represented by a heterogeneous alkali gabbro stock, exposed just north of Windy Creek and varying in composition from theralite to monzonite. A K-Ar determination on hornblende from a monzonitic variant in the intrusive yielded an age of 143±4 m.y. (sample USGS(M)-69Ast252), whereas large biotite crystals from theralite in the stock gave an age of 130±4 m.y. (sample USGS(M)-69Ast252A). Inasmuch as the pluton and adjoining pelitic country rocks have been regionally metamorphosed in the pumpellyite-prehnite-quartz facies, the minor discordance in hornblende and biotite dates may be interpreted as a partial "resetting" of the biotite age in the approximate temperature range 100°-200° C. The hornblende probably was not significantly affected by this low-grade metamorphism, although the hornblende age should be considered a minimum value. These K-Ar dates and the faunal age men-

[1]Publication authorized by Director, U. S. Geological Survey and Director, Geological Survey Division, State of Alaska.

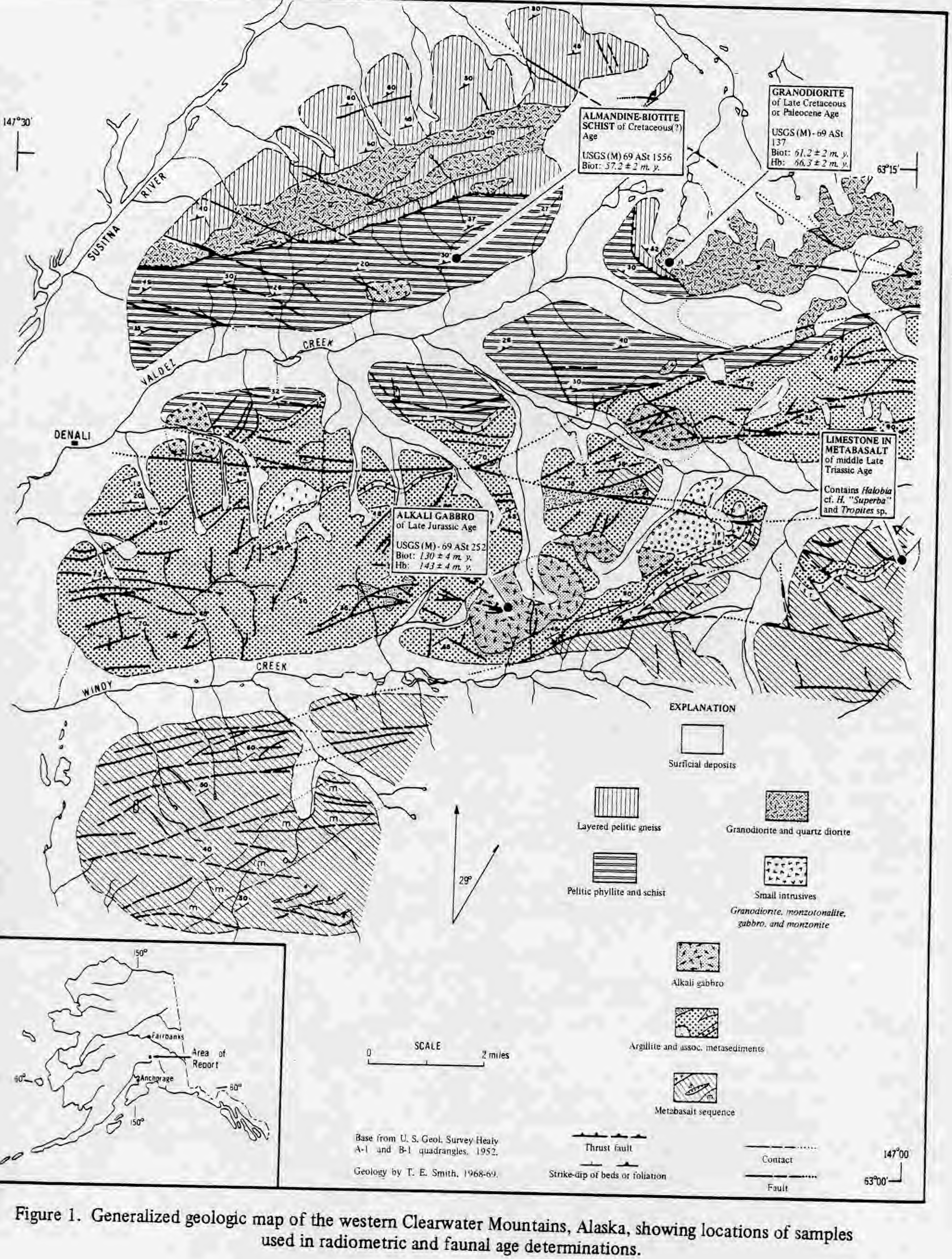

Figure 1. Generalized geologic map of the western Clearwater Mountains, Alaska, showing locations of samples used in radiometric and faunal age determinations.

tioned above bracket the age of sedimentation of the pelitic sequence between middle Late Triassic and Late Jurassic.

Most previous reports have represented the non-fossiliferous pelitic sequence as Triassic, though acknowledging that its exact age was uncertain (Moffit, 1912, p. 13; Ross, 1933, p. 436). Similarly, all intrusive rocks of the area were assigned to the Jurassic, with a range of uncertainty between late Triassic and late Eocene (Moffit, 1912, p. 35) or Quaternary (Ross, 1933, p. 442). The new K-Ar data show that for those rocks that have been dated, only the alkali gabbro may be of Jurassic age.

Several intrusives of mafic-to-intermediate composition crop out in the northern part of the mapped area. All of these bodies, including those shown as "small stocks" on figure 1, appear to belong to a single magmatic series. Chemical plots for these intrusives display a smooth variation from the small gabbroic stocks to the large granodiorite pluton in the northeastern part of the area. Field and petrographic criteria show that all intrusives except the granodiorite body (labeled on figure 1) have been involved in the latest dynamothermal episode of metamorphism and were probably emplaced synkinematically or interkinematically. The post-kinematic granodiorite body has discordantly intruded the high-grade metamorphic rocks and has produced local retrograde effects at places along its margin. Hornblende and biotite from sample USGS(M)-69Ast137 in the granodiorite give K-Ar dates of 66.3±2 m.y. and 61.2±2 m.y. respectively. The age of the granodiorite is interpreted as Late Cretaceous or Paleocene, although the discordance between the minerals suggests that the pluton may be slightly older. Development of the metamorphic belt is therefore restricted to the interval between Late Jurassic and Late Cretaceous. Fine-grained biotite from schist (sample USGS(M)-69Ast 1556) in the belt gives a K-Ar age of 57.2±2 m.y., which is slightly younger than the age of biotite from the post-kinematic granodiorite; this discordance probably reflects argon loss under prolonged thermal influence of the waning metamorphism. Since all intrusives except the alkali-gabbro appear genetically related, whether co- or post-metamorphic, their emplacement is inferred to be nearly time synchronous—occurring during the Late Cretaceous. The onset of metamorphism is not precisely determinable within the Late Jurassic-Paleocene limits, but by this interpretation, major dynamothermal effects would be confined mainly to the Late Cretaceous.

SAMPLE DESCRIPTIONS

A. Intrusive Rocks—Central Alaska

Clearwater Mountains

1. USGS(M)-69Ast137 — K-Ar — (biotite) 61.2±2 m.y.
(hornblende) 66.3±2 m.y.

Unnamed biotite-hornblende granodiorite pluton (Sec. 34 unsurveyed, T19S, R3E; 63°14′N, 147°08′W; 2 mi WNW of Grogg Lake, Healy A-1 quadrangle, AK). Previously considered as Jurassic (Moffic, 1912; Ross, 1933). Analytical data: (Biotite) K_2O = 9.20%; $\overset{*}{Ar}{}^{40}$ = 8.453 x 10^{-10} mole/gm; $\overset{*}{Ar}{}^{40}/\Sigma Ar^{40}$ = 0.36. (Hornblende) K_2O = 0.835%; $\overset{*}{Ar}{}^{40}$ = 8.332 x 10^{-10} mole/gm; $\overset{*}{Ar}{}^{40}/\Sigma Ar^{40}$ = 0.54. Collected by: T. E. Smith, Alaska Geological Survey. Comment: Post-kinematic pluton which establishes upper age limit of regional metamorphism.

2. USGS(M)-69Ast252 — K-Ar — (hornblende) 143±4 m.y.

Unnamed alkali gabbro pluton. Monzonite (Sec. 31, T20S, R3E; 63°09′N, 147°14′W; pluton underlies headwaters of Eldorado Creek, Healy A-1 quadrangle, AK). Analytical data: K_2O = 1.055% $\overset{*}{Ar}{}^{40}$ = 2.313 x 10^{-10} mole/gm; $\overset{*}{Ar}{}^{40}/\Sigma Ar^{40}$ = 0.88. Collected by: T. E. Smith, Alaska Geological Survey. Comment: Monzonite forms latest phase of heterogeneous alkali gabbro pluton, comprising about 5% of volume. Establishes upper age limit of sediments as Late Jurassic.

3. USGS(M)-69Ast252A — K-Ar — (biotite) 130±4 m.y.

Unnamed alkali gabbro pluton. Coarse-grained biotite-pyroxene theralite (Sec. 31, T20S, R3E; 63°09′N, 147°14′W; pluton underlies headwaters of Eldorado Creek, Healy A-1 quadrangle, AK). Analytical data:

K_2O = 8.62%; $\overset{*}{Ar}{}^{40}$ = 1.707 x 10^{-9} mole/gm; $\overset{*}{Ar}{}^{40}/\Sigma Ar^{40}$ = 0.93. Collected by: T. E. Smith, Alaska Geological Survey. Comment: Theralite is early phase of alkali gabbro pluton. Discordance between this sample and USGS(M)-69Ast252 (above) due to metamorphism in pumpellyite-prehnite-quartz facies.

B. Metamorphic Rocks–Central Alaska

Clearwater Mountains

4. USGS(M)-69Ast1556 K-Ar (biotite) 57.2±2 m.y.

Schist unit of Maclaren metamorphic belt. Fine-grained almandine-biotite schist (Sec. 31, T29S, R3E; 63°14'N, 147°15'W; near E Fork of Craig Creek, Healy A-1 quadrangle, AK). Previous maps show this unit as Triassic in age (Moffit, 1912; Ross, 1933). Analytical data: K_2O = 8.93%; $\overset{*}{Ar}{}^{40}$ = 7.659 x 10^{-10} mole/gm; $\overset{*}{Ar}{}^{40}/\Sigma Ar^{40}$ = 0.73. Collected by: T. E. Smith, Alaska Geological Survey. Comment: Apparent early Tertiary age of this specimen probably due to waning thermal effects of regional metamorphism.

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