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GEOCHRONOLOGY OF THE MACLAREN METAMORPHIC BELT, SOUTH-CENTRAL ALASKA: A PROGRESS REPORT

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Geologic studies in the Clearwater Mountains and vicinity were begun in 1968 concurrently with mineral resource investigations sponsored by the U. S. Geological Survey. Detailed mapping in the Valdez Creek area, a former gold producing district, has disclosed that bedrock underlying that part of the Clearwater Mountains forms a remarkably complete metamorphic sequence of the Barrovian series, now called the Maclaren metamorphic belt. Radiometric dates determined for the study in 1970 were integrated with existing faunal ages to revise previously inferred ages of major rock units (Smith and Lanphere, 1971). This paper reports five additional new K-Ar dates in the Clearwater Mountains and preliminary results of continued mapping in the surrounding Alaska Range and Talkeetna Mountains (fig. 1).

The age determinations were made in the geochronology laboratory at the Geophysical Institute, University of Alaska. Potassium was analyzed with an Instrumentation Laboratories Model 343 digital flame photometer, using the $LiBO_2$ fluxfusion technique and mineral calibration standards (Suhr and Ingamells, 1966; Engels and Ingamells, 1970; Ingamells, 1970). Argon was determined by isotope dilution using Ar^{38} tracers and a six inch radius Nuclide mass spectrometer equipped with automated peak stepping and digital data acquisition system. Argon measurements are by D. L. Turner and Wilfrid D. Davis. Potassium was determined by Genevieve Edsall. Constants used are: $\lambda_e = 0.585 \times 10^{-10} yr^{-1}$; $\lambda_\beta = 4.72 \times 10^{-10} yr^{-1}$; $K^{40}/K_{total} = 1.22 \times 10^{-4}$ gm/gm.

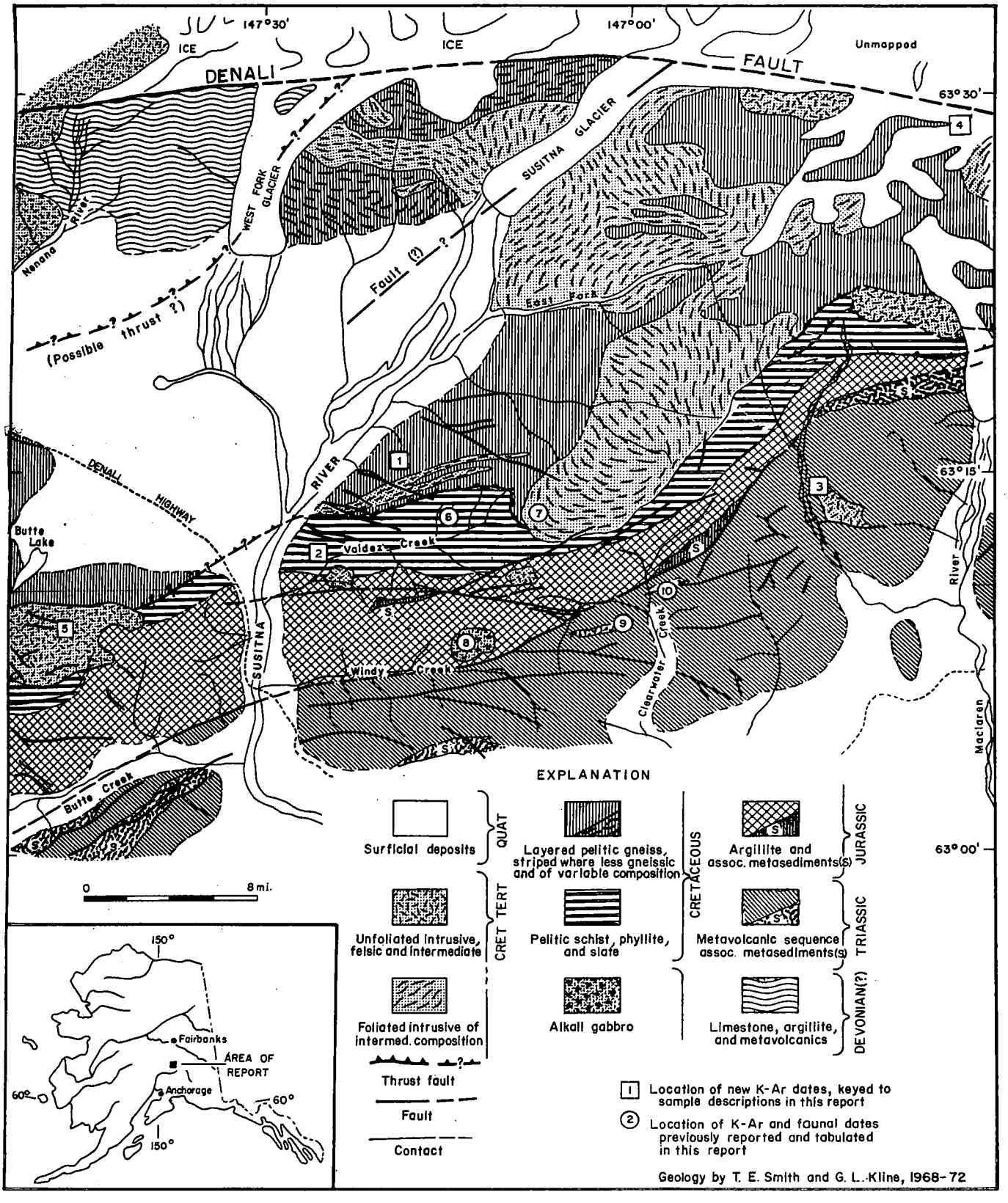
GEOLOGIC DISCUSSION

Reconnaissance mapping during the 1972 field season using helicopter support has established that the Maclaren belt, a zonal sequence of metamorphic rocks, forms an extensive terrane which trends northeasterly into and is truncated by the Denali Fault. Bedrock in the southern part of Figure 1 consists of weakly metamorphosed subaerial tholeiitic lavas of the Amphitheatre Group, with minor interstratified sedimentary lenses of limestone, argillite, volcaniclastic debris, and chert. The lavas of the Amphitheatre Group are correlative with the "Amphitheatre Basalt" of Rose (1966); the entire unit is being elevated to group status in a current report by Smith (manuscript in process, 1973).

Correlative metavolcanic rocks form a continuous and complexly deformed belt from the central Talkeetna Mountains to Paxson Lake—a distance of 120 miles or more. Previous work has assumed a Triassic age for these rocks based on faunal assemblages collected at localities 9 and 10 (fig. 1 and table 1). These sites are stratigraphically at the upper part of the volcanic section in the headwaters of Clearwater Creek, where the rocks form a simple north-dipping monocline. Thus the fossils record a minimum age for the unit in that area.

Continued mapping since 1969 however has demonstrated complex deformation along the length of the volcanic unit as well as the presence of an important shear zone (trending through Butte and Windy Creek valleys) that structurally separates the metavolcanic terrane in most areas from pelitic metasediments to the north (fig. 1). It appears possible that significant portions of the volcanic unit may have been tectonically removed along this structure. The oldest rocks of the Amphitheatre Group may correlate temporally with Permian volcanics in the eastern Alaska Range, interpreted to represent a late Paleozoic island arc built on oceanic crust (Richter and Jones, 1971). A lower Cretaceous K-Ar hornblende age obtained from the granodiorite stock near the Maclaren River (sample UA-71H224, locality 3 on fig. 1) is consistent with a model involving offset along the Butte-Windy Creek shear zone (i. e., it does not agree with dates on plutonic bodies north of the structure).

Although offsetting along parts of the boundary structure appears likely, it may have been minimal in the area near the head of Windy Creek. There, minor exposures of similar metabasalts occur north of the structure


147°30'
147°00'
ICE
ICE
Unmapped
DENALI
FAULT
63°30'
WEST FORK GLACIER
SUSITNA GLACIER
Nenana River
Fault (?)
(Possible thrust ?)
East Fork
DENALI HIGHWAY
RIVER
63°15'
Butte Lake
Valdez Creek
SUSITNA
Windy Creek
Clearwater Creek
River
Maclaren
Butte Creek
63°00'
0
8 mi.
150°
Fairbanks
AREA OF REPORT
Anchorage
60°
150°
EXPLANATION
Surficial deposits
QUAT
Layered pelitic gneiss, striped where less gneissic and of variable composition
Argillite and assoc. metasediments(s)
JURASSIC
Unfoliated intrusive, felsic and intermediate
TERT
CRET
Pelitic schist, phyllite, and slate
CRETACEOUS
Metavolcanic sequence assoc. metasediments(s)
TRIASSIC
Foliated intrusive of intermed. composition
Alkali gabbro
Limestone, argillite, and metavolcanics
DEVONIAN(?)
Thrust fault
Fault
Contact
1 Location of new K-Ar dates, keyed to sample descriptions in this report
2 Location of K-Ar and faunal dates previously reported and tabulated in this report
Geology by T. E. Smith and G. L. Kline, 1968-72

and are overlain conformably by argillite and conglomerate of the Maclaren metamorphic belt. These lavas, like those just south of the structure, have been interpreted as Upper Triassic in age on the basis of lithologic equivalence and a similar north-dipping attitude. The depositional age of the overlying pelites would thus be post-Upper Triassic as discussed by Smith and Lanphere (1971). Alternatively, if the volcanics on opposite sides of the structure are of different age, the parent sediments of the Maclaren belt may have been deposited somewhat earlier. Their youngest age limit is established by the small alkali gabbro pluton of Late Jurassic age which intrudes the argillite unit discordantly north of Windy Creek (locality 8 in fig 1 and table 1).

Table 1: Summary of previously reported age determinations in the Clearwater Mountains (Smith and Lanphere, 1971; Moffit, 1912). (Numbers are keyed to circled localities of Figure 1).

Locality	Method		Unit	Age
	K-Ar	Faunal		
6	Biotite	–	Schist	57.2 ± 2 m.y.
7	Biotite	–	Granodiorite	61.2 ± 2 m.y.
	Hornblende		"	66.3 ± 2 m.y.
8	Biotite	–	Alkali gabbro	130 ± 4 m.y.
	Hornblende		" "	143 ± 4 m.y.
9	–	*Halobia* cf	Limestone bed	mid-Upper
	–	*H. "Superba"*	in metabasalt	Triassic
		and *Tropites* sp	sequence	
10	–	*Monotis*	Limestone bed	late Upper
		Subcircularis	in metabasalt	Triassic
		and *M. Salinaria*	sequence	

Principal features of the zonational metamorphic terrane north of the Amphitheatre group were extended by reconnaissance mapping over 80 miles along the length of the belt during the 1972 field season. A steep metamorphic gradient along the southern margin of the terrane during kinematic metamorphism is evident in the remarkably complete progression of mineral zones from pumpellyite-prehnite in argillite along Windy Creek through kyanite-sillimanite in layered gneisses north of Valdez Creek. Textural development, on which field mapping is based, varies from argillite with well preserved sedimentary features through slates, phyllites, and schists to layered and migmatitic gneisses, representing the culmination of dynamothermal activity. This zonal pattern, modified locally by faulting, is present along most of the southern margin of the belt.

Northerly parts of the metamorphic terrane consist mainly of well developed gneisses, including pelitic and amphibole-bearing variants, that are undifferentiated on figure 1. Between the West Fork and Susitna Glaciers, however, other lithologies including calc-schists and calc-gneisses and siliceous schists are abundant. Textural advancement is also less apparent in this part of the belt.

All metamorphites of pelitic composition were derived from parent rocks essentially equivalent to the argillite unit of Figure 1. Subordinate basic horizons are distributed through all grades of metamorphism, representing interstratified volcaniclastic beds in the original sediments. Like their enclosing pelitic hosts, the basic horizons display textural variations, ranging from greenish metasediments to amphibolite gneisses, depending on metamorphic grade. K-Ar amphibole ages were obtained from such horizons in the gneiss unit (locality 1, 66.2±4 m.y.) and the phyllite-schist unit (locality 2, 64.1±1.9 m.y.) of Figure 1. Both dates provide confirmatory evidence for Late Cretaceous development of the Maclaren belt, with a thermal decline persisting into the Early Tertiary as recorded in the discordancy between mineral ages at locality 7 (hornblende, 66.3±2 m.y.; biotite, 61.2±2 m.y.) and in the 57±2 m.y. age of fine-grained biotite schist at locality 6.

The granodiorite plutons at localities 5 and 7 are slightly post-Kinematic and have intruded the thrust contact between phyllite-schist and gneiss units. Their hornblende K-Ar ages (64.3±1.9 and 66.3±2 m.y.) indicate that movement on the structure was essentially coeval with metamorphism, probably confined to the Late Cretaceous.

Younger thermal events of mid-Tertiary age have apparently been important in the northeastern part of Figure 1. Biotite from porphyroclastic pelitic gneiss at locality 4 yielded an age of 32.8±1 m.y., suggesting that this portion of the metamorphic belt has been thermally overprinted since development. A series of post-metamorphic granites of Tertiary age intrude the belt west of Figure 1, and thus the cluster of Late Cretaceous-Early Tertiary K-Ar ages obtained near Valdez Creek and Butte Lake may represent a thermal "island", unmodified by later events. This area may well preserve the only record of original metamorphic age in the Maclaren belt.

The regional tectonic significance of the Maclaren belt, a dated linear feature truncated by the Denali Fault, has been reported recently by Forbes and others (1973). A right-lateral displacement of 250 miles along the fault is suggested by correlation of the Maclaren belt with a similar metamorphic belt north of the fault at Kluane Lake, Y. T., Canada.

SAMPLE DESCRIPTIONS

(Numbers of recently dated samples keyed to those shown in squares on Figure 1)

Clearwater Mountains-Alaska Range

1. UA-69ASt199 K-Ar (hornblende) 66.2±4.0 m.y.

Amphibolite gneiss interstratified with pelitic gneisses of Maclaren metamorphic belt (Sec. 14 unsurveyed, T19S, R2E; 63°16'N, 147°19.5'W; 1.5 mi SE of Susitna River, Healy B-2 quadrangle, AK). Analytical data: K_2O = 0.188%, mean of 0.182 and 0.194; $\overset{*}{A}r^{40}$ = 1.872 x 10^{-11} mole/gm; $\overset{*}{A}r^{40}/\Sigma Ar^{40}$ = 0.43. Collected by: T. E. Smith, Alaska Geological Survey. Comment: Confirms Late Cretaceous age of metamorphism in Clearwater Mountains. Plus-or-minus value quoted represents one standard deviation of analytical precision.

2. UA-68ASb638 K-Ar (actinolitic hornblende) 64.1±1.9 m.y.

Amphibole-bearing horizon in phyllite unit of Maclaren metamorphic belt (Sec. 7 unsurveyed, T20S, R2E; 63°12.4'N, 147°26'W; 1.5 mi N of confluence of Valdez and Timberline Creeks, Healy A-1 quadrangle, AK). Analytical data: K_2O = 0.307%, mean of 0.304 and 0.310; $\overset{*}{A}r^{40}$ = 2.958 x 10^{-11} mole/gm; $\overset{*}{A}r^{40}/\Sigma Ar^{40}$ = 0.85. Collected by: T. E. Smith, Alaska Geological Survey. Comment: Confirms Late Cretaceous age of major dynamothermal metamorphism in Clearwater Mountains. Plus-or-minus value quoted represents one standard deviation of analytical precision.

3. UA-71H224 K-Ar (hornblende) 125.8±3.8 m.y.

Unnamed hornblende granodiorite stock that intrudes metabasalts of Amphitheatre Group (63°14.5'N, 146°44'W; near West Fork, Maclaren River, Mt. Hayes A-6 quadrangle, AK). Analytical data: K_2O = 0.717%, mean of 0.716 and 0.718; $\overset{*}{A}r^{40}$ = 1.379 x 10^{-10} mole/gm; $\overset{*}{A}r^{40}/\Sigma Ar^{40}$ = 0.85. Collected by: T. E. Smith, Alaska Geological Survey. Comment: Previously thought to be Jurassic in age. Age of this body is not correlative with plutons of similar composition intruding pelitic rocks of Maclaren belt. Plus-or-minus value quoted represents one standard deviation of analytical precision.

4. UA-72DT39A K-Ar (biotite) 32.8±1 m.y.

Pelitic gneiss exposed in outcrop where Black Rapids and East Fork Glaciers join (SW corner Sec. 14 unsurveyed, T16S, R6E; 63°29'N, 146°34'W; Mt. Hayes B-6 quadrangle, AK). Analytical data: K_2O = 8.408%, mean of 8.365 and 8.452; $\overset{*}{A}r^{40}$ = 4.113 x 10^{-10} mole/gm; $\overset{*}{A}r^{40}/\Sigma Ar^{40}$ = 0.714. Collected by: D. L. Turner, Geophysical Institute, University of Alaska. Comment: Apparent mid-Tertiary age of this part of Maclaren belt probably due to thermal overprinting during emplacement of nearby plutons. Metamorphic age of gneiss is assumed to be similar to age of metamorphites in Clearwater Mountains. Plus-or-minus value quoted represents one standard deviation of analytical precision.

5. UA-72Ast 165A K-Ar (hornblende) 64.3±1.9 m.y.

Unnamed composite pluton intruding Maclaren metamorphic belt. Dated phase consists of hornblende granodiorite with directionless fabric (SE corner Sec. 25 unsurveyed, T20S, R2W; 63°09'N, 147°50.5'W; 2 mi SE of Butte Lake, Healy A-2 quadrangle, AK). Analytical data: K_2O = 0.975%, mean of 10 determinations with mean dev. of 0.4%; $\mathring{A}r^{40}$ = 9.432 x 10^{-11} mole/gm; $\mathring{A}r^{40}/\Sigma Ar^{40}$ = 0.866. Collected by: T. E. Smith, Alaska Geological Survey. Comment: This is only known post-Kinematic pluton with directionless fabric of this age which intrudes Maclaren belt. Provides confirmatory evidence for youngest movement (late Cretaceous-early Tertiary) on ductile thrust separating gneiss and schist units of belt. Plus-or-minus value quoted represents one standard deviation of analytical precision.

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