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DEVELOPMENT OF ARCHEAN CRUST IN THE WIND RIVER MOUNTAINS,
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The Wind River Mountains are a NW-SE trending range composed almost entirely of high-grade Archean gneisses and granites which were thrust to the west over Phanerozoic sediments during the Laramide orogeny. Late Archean granites make up over 50% of the exposed crust and dominate the southern half of the range, while older orthogneisses and migmatites form most of the northern half of the range (Fig. 1). Locally these gneisses contain enclaves of supracrustal rocks, which appear to be the oldest preserved rocks in the range. Detailed work in the Medina Mountain area of the central Wind river Mountains and reconnaissance work throughout much of the northern part of the range has allowed us to define the sequence of events, described briefly below, which marked crustal development in this area.

I. Sequence of events in the Medina Mountain area

The oldest rocks present in the Medina Mountain area consist of a paragneiss-rich migmatite and a supracrustal succession (Fig. 2). At least two discrete sedimentation events are preserved. The older sequence consists of mafic rocks (metavolcanics?), calc-silicates, iron formation and rare pelites and occurs as melanosomes in a migmatitic gneiss. Also found within the migmatitic gneiss are enclaves of metamorphosed peridotites, pyroxenites,

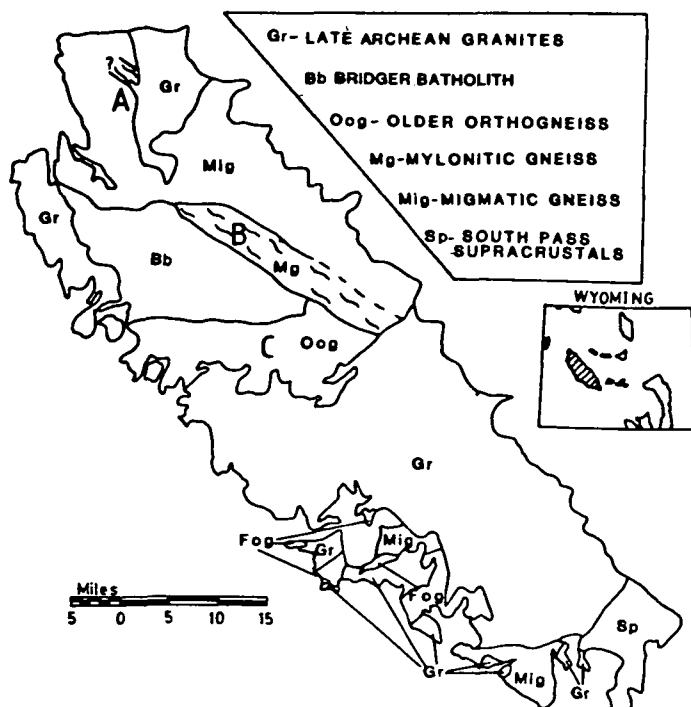


Fig. 1. Regional Geology of the Wind River Range, Wyoming.

A = Downs Mountain Area;
B = N. Fork Bull Lake
Creek Area; C = Medina
Mountain Area.

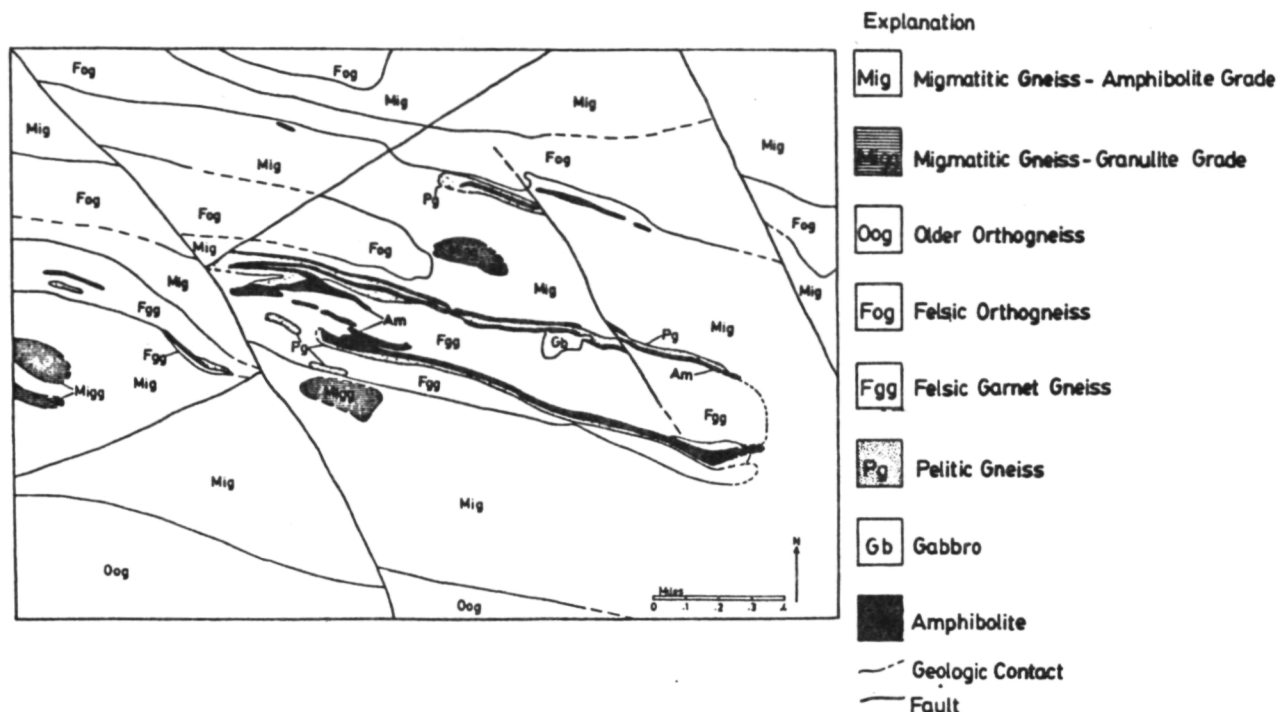


Fig. 2. Geology of the Medina Mountain Area.

gabbros and leucogabbros. These rocks seem to have suffered the same complex metamorphic and intrusive history as the older supracrustal rocks but the age relations between them and the supracrustal rocks are not known.

This sequence of rocks was injected and migmatized by an early set of granitoid dikes, isoclinally folded and subjected to regional metamorphism that reached granulite facies in this area. Following these events, thin, porphyritic mafic dikes and volumetrically minor amounts of tonalite were intruded. Because these dikes and tonalite sheets cross-cut the migmatitic gneiss and do not cross-cut the younger supracrustal sequence, they form an important marker in the geologic evolution of the area.

The younger supracrustal sequence consists of banded amphibolites (metavolcanic?), calc-silicates, semipelitic and pelitic gneisses. The succession defines a large-scale synformal structure that is locally migmatized by sheets and irregular layers of felsic garnet gneiss.

Portions of the felsic garnet gneiss are interpreted to be a partial melt of the metasediments and formed during the last regional metamorphism of the Medina Mountain area.

Late Archean granitoid plutons intrude and locally crosscut the entire Medina Mountain sequence. These late plutons range from granodiorite to granite, are weakly deformed, and retain igneous textures. The Bridger batholith to the north is strongly to weakly foliated and has a metamorphic mineralogy, but locally retains igneous textures. The batholith crosscuts older orthogneisses and migmatitic gneisses.

II. Archean Lithologies Elsewhere in the Wind River Range

Blocks and pods of supracrustal rocks are found in orthogneisses in many areas of the northern and central Wind Rivers, although nowhere are they as coherent as near Medina Mountain. Lithologically, these rocks are very similar to the Medina Mountain supracrustals, consisting of fine grained, banded mafic gneisses thought to be of metavolcanic origin, pelitic and semi-pelitic metasediments, quartzite, and iron-formation. As in the Medina Mountain area, metaperiodotites and metagabbros are intimately associated with the supracrustals in many places in the northern part of the range. Many of these supracrustal enclaves are found within the Mt. Helen Structural Belt (mylonitic gneiss, Fig.1) which is a major orogenic feature associated with the latest regional metamorphism and deformation. Tonalitic gneiss, though present in the northern part of the range and to the west of Medina Mountain does not make up the major portion of the older rocks, as appears to be the case in many other Archean terranes.

III. Metamorphism

At least two Archean high-grade regional metamorphic events have affected the Wind River Mountains. The last regional metamorphism attained amphibolite grade over most of the range. Metamorphic conditions for this event were around 700°C and 4.5 kilobars in the Downs Mountain area in the northern part of the range (1) and in the N. Fork Bull Lake Creek area (2) (Fig.1). In the Medina Mountain area the younger supracrustal rocks are locally upgraded to granulite facies.

In the North Fork Bull Lake Creek area, the supracrustal inclusions

commonly have cores with granulite mineralogies. Field relations indicate that this granulite metamorphism preceded emplacement of many of the orthogneisses and hence is older than the second regional metamorphism. Conditions for this metamorphism are difficult to determine because ion-exchange geothermometers and geobarometers were reset during the second high-grade metamorphic event. The widespread occurrence of the assemblage garnet-orthopyroxene-cordierite, however, allows one to establish that the pressure was 6kb or less and that the maximum temperature was below 780°C (Fig.3).

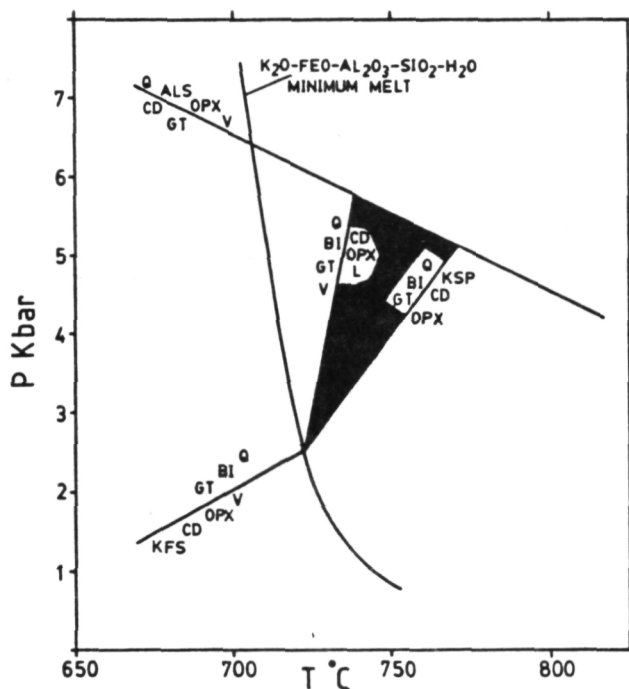


Fig. 3. P-T diagram showing stability field for garnet-cordierite-orthopyroxene. Shaded area indicates probable equilibrium conditions for first metamorphic event. From Grant, (6).

IV. Isotope geochemistry and geochronology

Of the sequence of events outlined above, absolute ages are known only for the Late Archean intrusions. Stuckless et al. (3) have obtained U-Pb and Rb-Sr dates on two granitoid lithologies of $2.63 \pm 0.02\text{Ga}$ and $2.50 \pm 0.04\text{Ga}$. The Bridger batholith, which outcrops immediately to the north of the Europe canyon area, has been dated at $2.67 \pm 0.04\text{Ga}$ (C.

Frost, unpublished Rb-Sr data). Since this pluton is interpreted as having been intruded during the waning stages of metamorphism and deformation, its age provides an upper limit on the time of latest regional metamorphism.

Nd crustal residence ages, which provide an estimate of the average period of time the protoliths of a particular unit have resided in the crust (4), have been calculated for samples of the Bridger batholith. All of the samples yield crustal residence ages of around 2.9 Ga, only around 200 Ma in excess of intrusive ages. The difference between crustal residence and intrusive ages for Bridger batholith gneisses is small compared to other late Archean granitoids (5) and indicates either that the rocks are derived mainly from mantle materials with a small proportion of significantly older crustal component, or that the intrusives are derived mainly from crustal materials which are on average only slightly older than the intrusives themselves. Field and textural evidence indicates that significant portions of the supracrustal sequence had begun to melt under conditions of peak metamorphism; however, it is uncertain how much of this melt has been incorporated into the Bridger batholith.

V. Summary

The essential features of Archean crustal development in the Wind River Mountains are as follows:

1. Supracrustal rocks and paragneiss-rich migmatites are the oldest materials preserved in the range.
2. Unlike many other Archean terranes, tonalitic rocks are volumetrically minor.
3. The Archean crust of the Wind River Mountains was subject to multiple deformation and metamorphism prior to 2.7 Ga.
4. Late Archean granitoid intrusions comprise a large proportion of the range. They have been derived in part from crustal melts produced during the last Archean metamorphism.

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