Archean gneiss at Lake Arbutus Dam, Jackson County, Wisconsin

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LOCATION

SE¼,Sec.3,T.22N.,R.3W., Hatfield 7½-minute Topographic Quadrangle. Outcrop along the Black River below the eastern half of Arbutus Dam (Fig. 1). Approach is on a 0.2-mi-long (0.3 km) gravel road that intersects Clay School Road 0.1 mi (0.2 km) west of the Green Bay and Western Railroad tracks. Additional outcrop occurs for 0.6 mi (1 km) downstream from dam.

SIGNIFICANCE

The main outcrop area immediately below the dam is one of the largest, if not the largest, outcrop of Archean rocks in Wisconsin (Brown and others, 1983). The principal unit is the Hatfield Gneiss, an interlayered sequence of quartzo-feldspathic gneisses and minor amphibolite. The rocks are interpreted as a metavolcanic sequence that was formed about 2,815 Ma and deformed at least twice, with the latest deformation and metamorphism occurring during the Penokean orogeny, about 1,850 Ma. Postdeformational cross-cutting mafic dikes are also present at this locality.

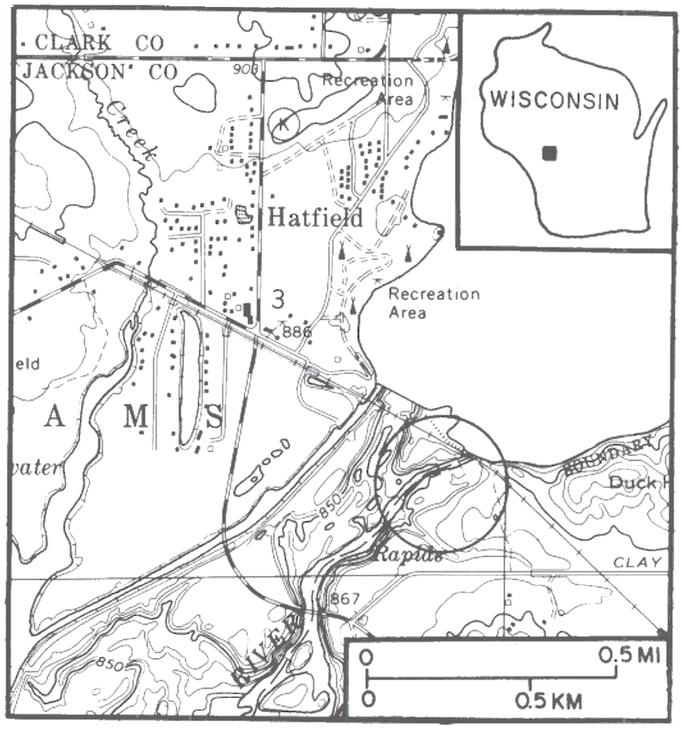

Figure 1. Map showing location of site at Arbutus Dam (circle).

DESCRIPTION

The principal unit exposed (Fig. 2) is the Hatfield Gneiss, an interlayered sequence of granitic to tonalitic gneiss with concordant layers of amphibolite. Over much of the outcrop the layers are 0.1 to 3 cm thick, pink to gray, quartzo-feldspathic gneiss. In some parts the layers are thicker, approaching several meters of massive gneiss. Folding and foliation are best displayed in the more thinly banded portions. The quartzo-feldspathic gneiss has a granoblastic texture and consists of equal amounts of quartz, plagioclase, and microcline. Mafic minerals represent less than 10 percent in most instances. Normative abundances based on bulk chemical analyses show that the amount of quartz is approximately constant and that plagioclase/orthoclase ratios vary from about 1:1 (adamellite) to primarily plagioclase (tonalite).

The amphibolite is interlayered with the quartzo-feldspathic gneiss and consists primarily of hornblende with about 20 percent epidote. The amphibolite has been deformed along with the rest of the gneiss and is interpreted as originally concordant. The entire assemblage is interpreted as having formed from an interlayered sequence of volcanic flows, pyroclastic rocks, or sills (DuBois and Van Schmus, 1978). The major metamorphism currently recorded by the rocks is amphibolite facies. Relict pyroxene has been found in some of the quartzo-feldspathic gneiss samples, suggesting either primary volcanic pyroxene or an earlier, higher grade period of metamorphism.

The Hatfield Gneiss has been subjected to an isoclinal folding event (F_1), which produced an axial planar foliation parallel to the layering, except in fold hinges where the foliation transects the layering. The foliation was then tightly to openly folded during F_2 deformation; the axial planes of these folds are at high angles to the foliation. F_1 folds are rarely visible, but F_2 folds are conspicuous wherever the banding is readily apparent.

Lineations (fold axes, crenulations, mineral lineations) and foliations were measured in the gneiss along a 0.4-mi-long (0.6 km) stretch of the river. Poles to foliation define a β axis, which is essentially identical to the orientation of the main grouping of the linear structural elements (Fig. 3). Fold axes, when plotted separately, fall into the two groups in the southeast quadrant of the stereonet, with the vast majority plotting in the main group.

A group of F_1 fold axes in the core of a large, tight F_2 fold were plotted separately from the rest of the linear structural elements. The folding in this vicinity is highly complex, resulting in numerous and diverse interference patterns from the folding of F_1 axes. The axes of these F_1 folds plot in all four quadrants of the stereonet with plunges ranging from horizontal to vertical. Girdles that would indicate a later simple folding pattern of the F_1 axes do not exist, and the interference patterns are therefore believed

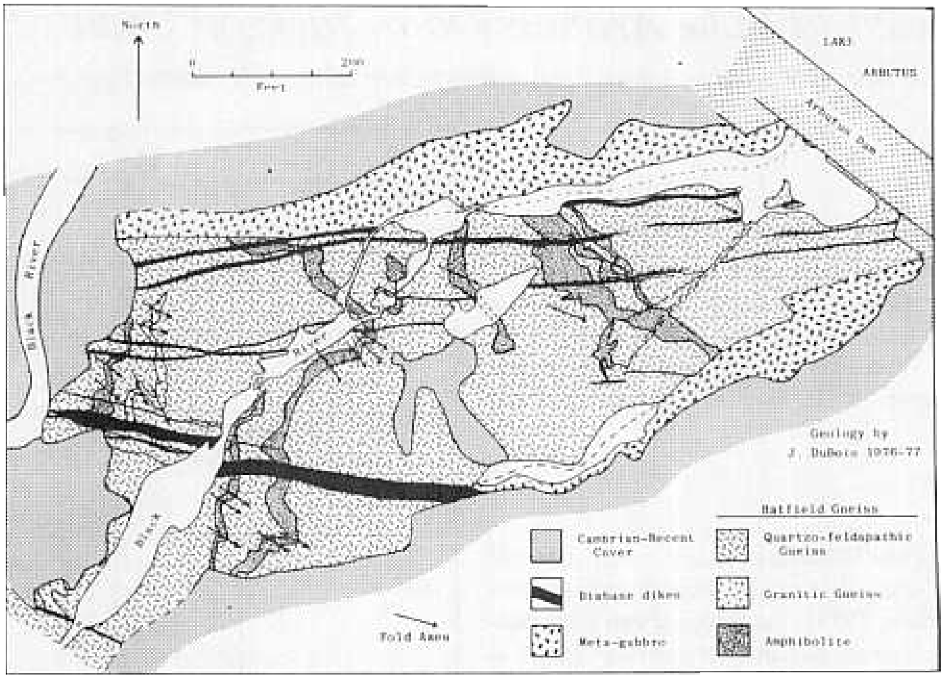

Figure 2. Geologic map of Archean bedrock exposed south of Arbutus Dam.

to be the result of inhomogeneous deformation in the core of the F_2 fold.

Although F_2 deformation is inhomogeneous in this relatively small area of the outcrop, the outcrop as a whole exhibits homogeneous deformation, as demonstrated by the tight distribution of 94.5 percent of the linear structural elements. F_1 fold axes are never exposed in three dimensions (except in the anomalous area just discussed); thus their trend and plunge are unknown. The age of F_1 folding is unclear, but F_2 folding is probably Penokean.

Zircon has been separated from a tonalitic layer of the gneiss on the west bank of the Black River, about 0.6 mi (1 km) downstream from the dam. The zircon crystals are brown, euhedral with normal igneous zoning and no signs of significant overgrowths or relict cores. U-Pb analyses on several fractions show that this unit is essentially the same age (2,815 ± 20 Ma) as other Archean gneisses in central Wisconsin. This age is interpreted as the time of crystallization (volcanism) of the protolith of the Hatfield Gneiss. Rb-Sr analyses from several samples collected in the area of this stop and further downstream do not plot coherently on an isochron diagram, indicating partial resetting during subsequent metamorphism.

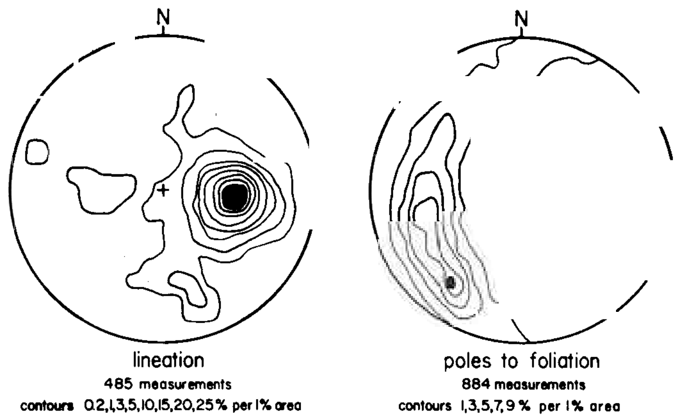

Figure 3. (Maass and Van Schmus, 1980, Fig. 11). Lower hemisphere stereographic projections of structures in the Hatfield Gneiss. (left) Lineations defined by fold axes, crenulations, and mineral elongations. The mean orientation of the lineations is S.84°E. with a plunge of 51°ESE. (right) Plot of poles to foliation yields a mean for β trending S.84°E. with a plunge of 52°ESE, virtually identical to the mean orientation for the lineations.

REFERENCES CITED

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