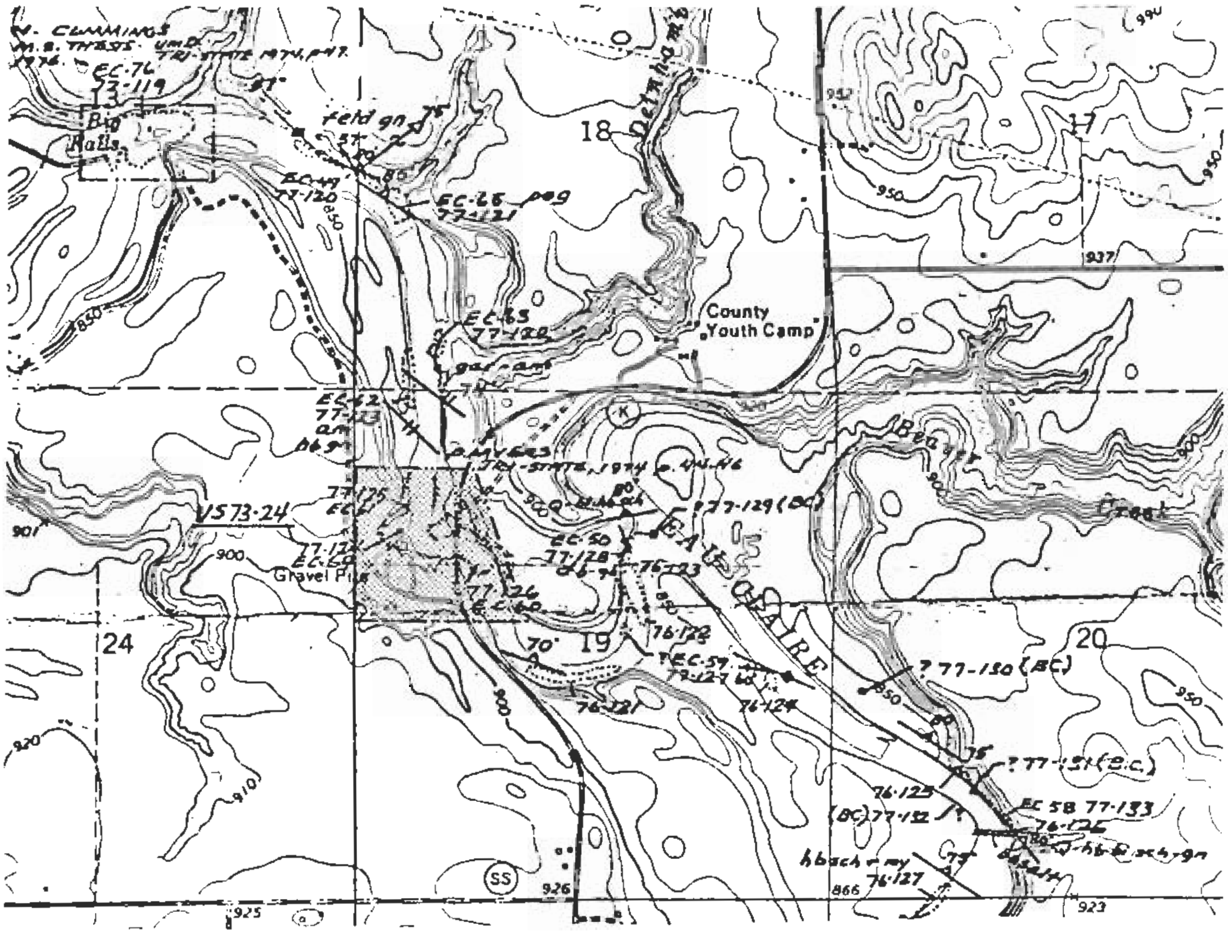
TITLE: Little Falls Breccia

LOCATION: Hwy K at Eau Claire River, SW 1/4, NW 1/4 Sec. 19, T.27 N., R.8 W.
Fall Creek 7.5' Quadrangle



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SUMMARY OF FEATURES:

A flow-laminated, mafic intrusion breccia comprising xenoliths of banded amphibolite, hornblendite, porphyritic basalt(?), and porphyroblastic, foliated biotite granite in a groundmass of flow-lineated hornblende gabbro and/or tonalite (1840 ± 50 m.y.) is cut by muscovite granite pegmatite and diabase dikes and overlain unconformably by Late Cambrian Mt. Simon Sandstone. A green, clay paleosol(?) of residual origin separates the sandstone from underlying amphibolite on a surface of 5 meters relief. This surface dips west-southwest at about the same angle as the gradient of Eau Claire River. Numerous springs feed the river from a sandstone aquifer just above the clay paleosol(?).

DESCRIPTION:

THE BRECCIA

Flow-oriented xenoliths in the breccia are predominantly massive and banded amphibolite (Figure 2-C and D). Some are angular, and some are rounded. Their long dimensions lie in a nearly vertical plane which strikes north-northwest. (See Figure 1.) Since xenolith angularity is roughly proportional to hornblende content, it is thought that the mobile phase in the rock is represented by the feldspathic fraction. In addition to amphibolite xenoliths, the breccia also contains clasts of amphibolitized pyroxenite(?) and porphyritic basalt or lamprophyre as well as a large fragment of foliated, porphyroblastic biotite granite whose composition, texture, and contact relations will be discussed separately below.

Several stages in the intrusion sequence are represented by portions of the outcrop shown in the Geologic Map, Figure I. The earliest intrusion phase (Figure 2-A) is represented by thin, breccia dikes which spread laterally into pre-existing lamination in the amphibolite. With increasing fluid phase the stoped xenoliths become detached, rotated, and displaced. At an intermediate stage, the breccia contains 30 to 60 percent xenoliths in a flow-laminated, gabbroic matrix (Figure 2-C). Further from the intrusive contact, the gabbro (Location J in Figure 1) contains only occasional xenoliths which show gradational boundaries. Gabbro from Location J was deemed sufficiently uncontaminated to warrant U/Pb-zircon dating by W.R. Van Schmus (oral communication). An age of 1840 ± 50 m.y. was obtained.

Although the amphibolites at Little Falls closely resemble those at Big Falls, the breccia is unique to Little Falls. The breccia was not seen in a traverse upstream where nearly continuous exposure of tonalite and biotite amphibolite displays the lithologic heterogeneity of these rocks.

A large fragment of foliated, porphyroblastic biotite granite is exposed at Locality E. The fragment was mapped in detail (Figure 3). The granite contains 1-3 cm porphyroblasts of K-feldspar in a foliated granoblastic matrix of microcline, quartz, and brown biotite. Sodic plagioclase is accessory. Lenticular form of the K-feldspar porphyroblasts indicates recrystallization before and/or during cataclasis. The gradational contact between the fragment and enclosing breccia is marked by an inward substitution of K-feldspar for plagioclase and biotite for hornblende and by an increase in abundance of quartz. The gradational contact along at least the west side of the fragment indicates that it is a xenolith and not a fault slice, although its shape and position were probably modified by post-intrusive shearing. What are the age and origin of the foliation in the granite? Was the granite intruded into amphibolite? If so, when? Under what temperature-pressure conditions (depth) did these events take place? Evidence?

PEGMATITE DIKES

Biotite-muscovite granite pegmatite with K-feldspar crystals up to 30 cm in maximum dimension cut at nearly right angles across flow lamination in enclosing breccia. Orientation of the dikes suggests that they were intruded during stress release and/or thermal contraction of the intrusion breccia. Quartz veins and lenses of similar orientation and origin are exposed at the east end of the outcrop here at Little Falls. The best pegmatite exposure is a Location F, where the one to three-meter dike contains very large, bent and marginally crushed K-feldspars. Although not visibly offset by shear zones at Little Falls, the internal deformation in the dike indicates it was intruded prior to major shearing.in the Middle Precambrian.

SHEAR ZONES

Interlensing, west-northwest-trending shear zones involving modest right-lateral displacement and conspicuous drag folding (Locations D and G, Figure 2-E and F) have segmented and transposed primary flow lamination in the intrusion breccia. Where small shear zones converge, the breccia is converted to a zoned, laminated dike-like body with walls of hornblende schist and a core of quartz-epidote mylonite up to 1.5 meters wide. If this small scale transposition of primary lamination is expanded to map scale, one can readily see how primary layering may be

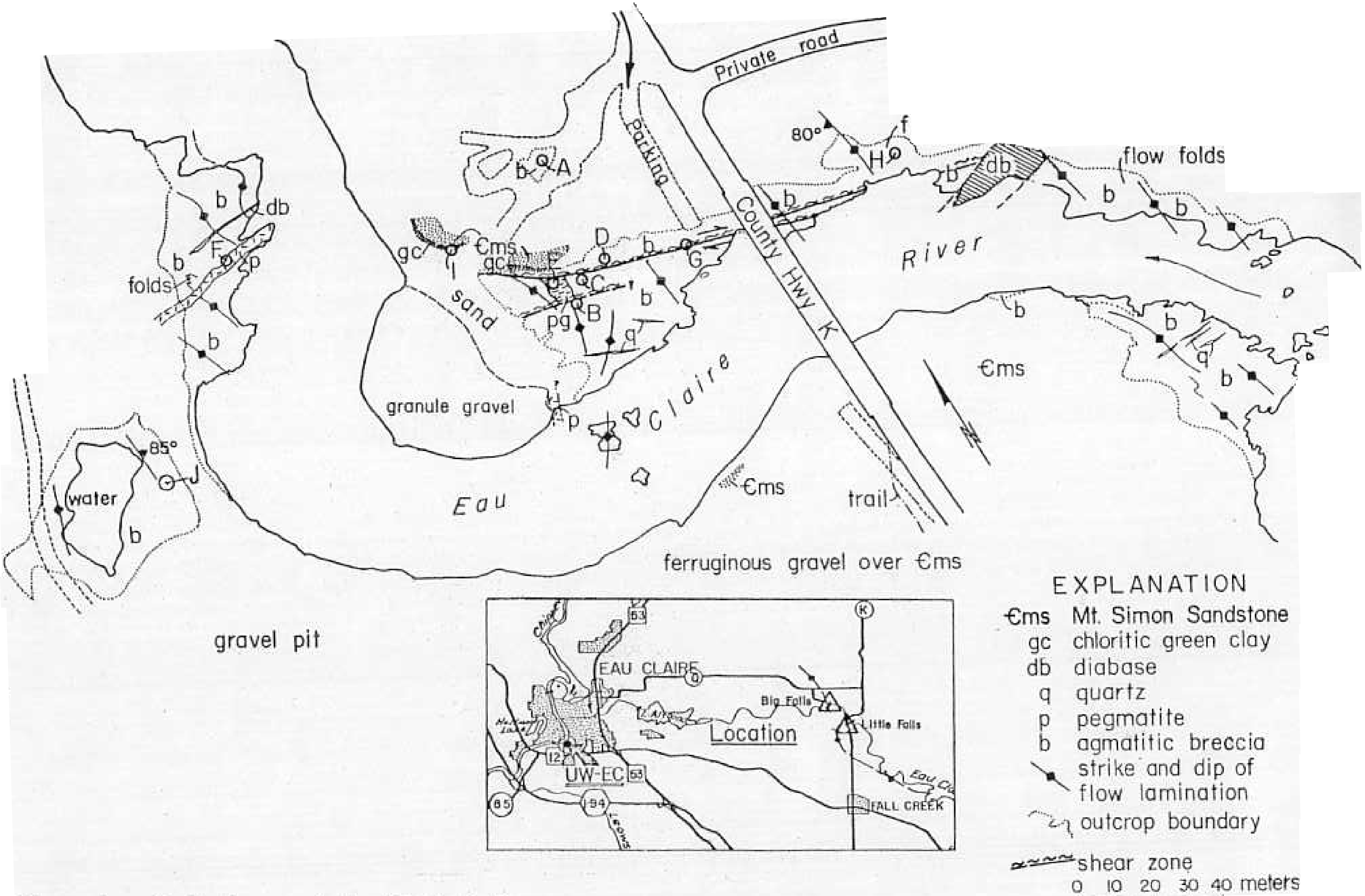


Figure 1 -- Geologic map of the Little Falls area

totally obliterated and replaced by a secondary lamination parallel to shear dislocation in the rock. Many of the interlensing structures of the Precambrian terrane of central Wisconsin may represent large-scale tectonic transposition by shearing.

The shearing seen at Locations D and G probably offsets pegmatites but not the diabase dikes. Its age is therefore probably Late Middle Precambrian (Penokean?)

A much earlier deformation produced the banding in the amphibolites before intrusion of the gabbro 1840 ± 50 m.y. ago.

DIABASE DIKES

East-northeast-trending, Late Precambrian (Keweenawan?) basalt-diabase dikes cut the breccia near locations F and H. Their chilled margins indicate shallow intrusion after considerable erosion.

THE PRECAMBRIAN-CAMBRIAN UNCONFORMITY

A surface of deep weathering and erosion with about 20 meters of relief dips gently west-southwest beneath Late Cambrian Mt. Simon Sandstone throughout the region. The Eau Claire River flows approximately down the dip of this major unconformity. Chemical weathering of underlying amphibolitic rocks engendered a highly impermeable green, illitic clay. Some of this weathering may have occurred after deposition of the sandstone by reaction of circulating groundwater with ferromagnesian minerals in the amphibolites. Groundwater circulating downward through the Mt. Simon Sandstone flows laterally along the clay layer until it comes out at the surface as a spring. Since the Precambrian-Cambrian unconformity is generally just above or below the level of the Eau Claire River, the river's major discharge is major from groundwater systems. Its discharge varies only slightly even during prolonged periods of drought

Figure 2 -- Structures in tonalite intrusion breccia at Little Falls

A. Breccia "dike" in amphibolite at location A (Fig. 1) Note rotation of amphibolite xenoliths when they become detached. Thin veinlets of tonalite penetrate layering in amphibolite. Is the light-colored, feldspathic fraction of anatectic origin? Scale is 6 inches long.

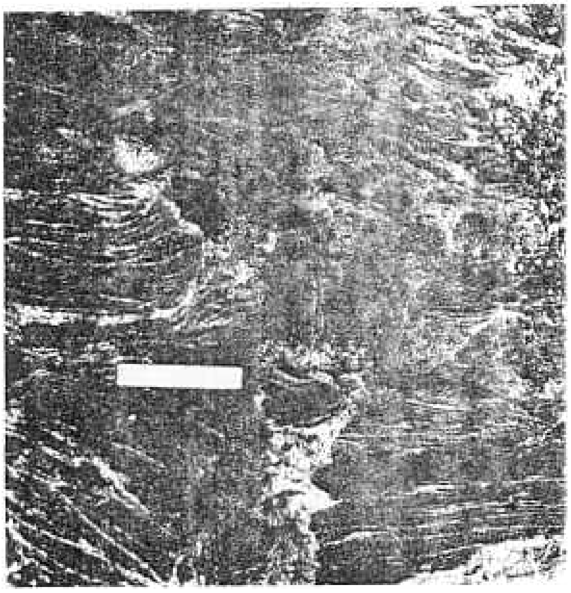
B. Anastomosing feldspathic stringers in amphibolite. Local contortion of cmphibolite and stringers suggests synkinematic anatexis and/or tonalite intrusion. Location H

C. Detail of massive and laminated amphibolite xenoliths in tonalite intrusion breccia at location D (Fig. 1)

D. Detail of mafic amphibolite xenoliths in hornblende tonalite matrix at location D (Fig. 1)

E. Fault zone cutting flow lamination in intrusion breccia at location C (Fig. 1) Right-lateral movement on this fault is indicated by drag of lamination into concordance with the fault. Quartz and epidote are concentrated along the zone of mylonite in the fault zone

F. Detail of shear displacement (right-lateral) of amphibolite xenolith at location C. (This structure is also visible in right side of photo E)



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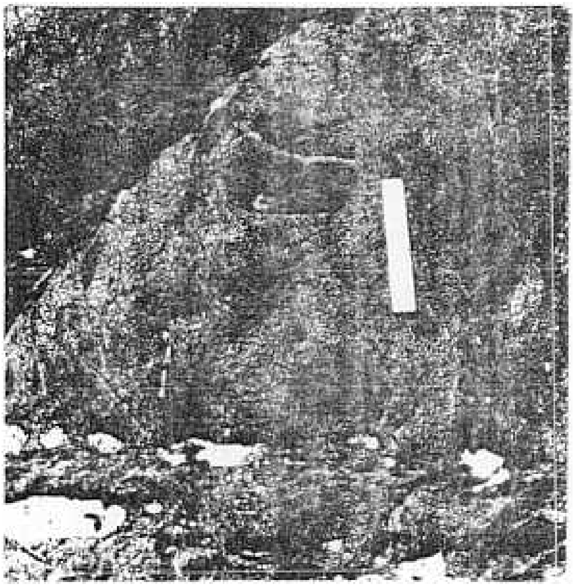
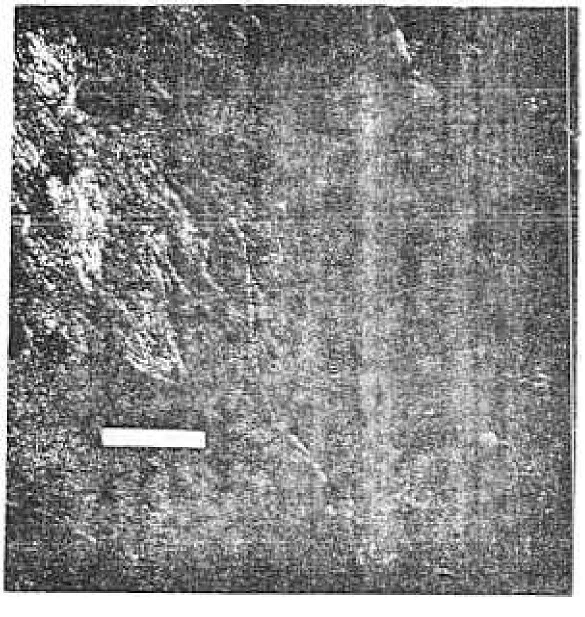


E.



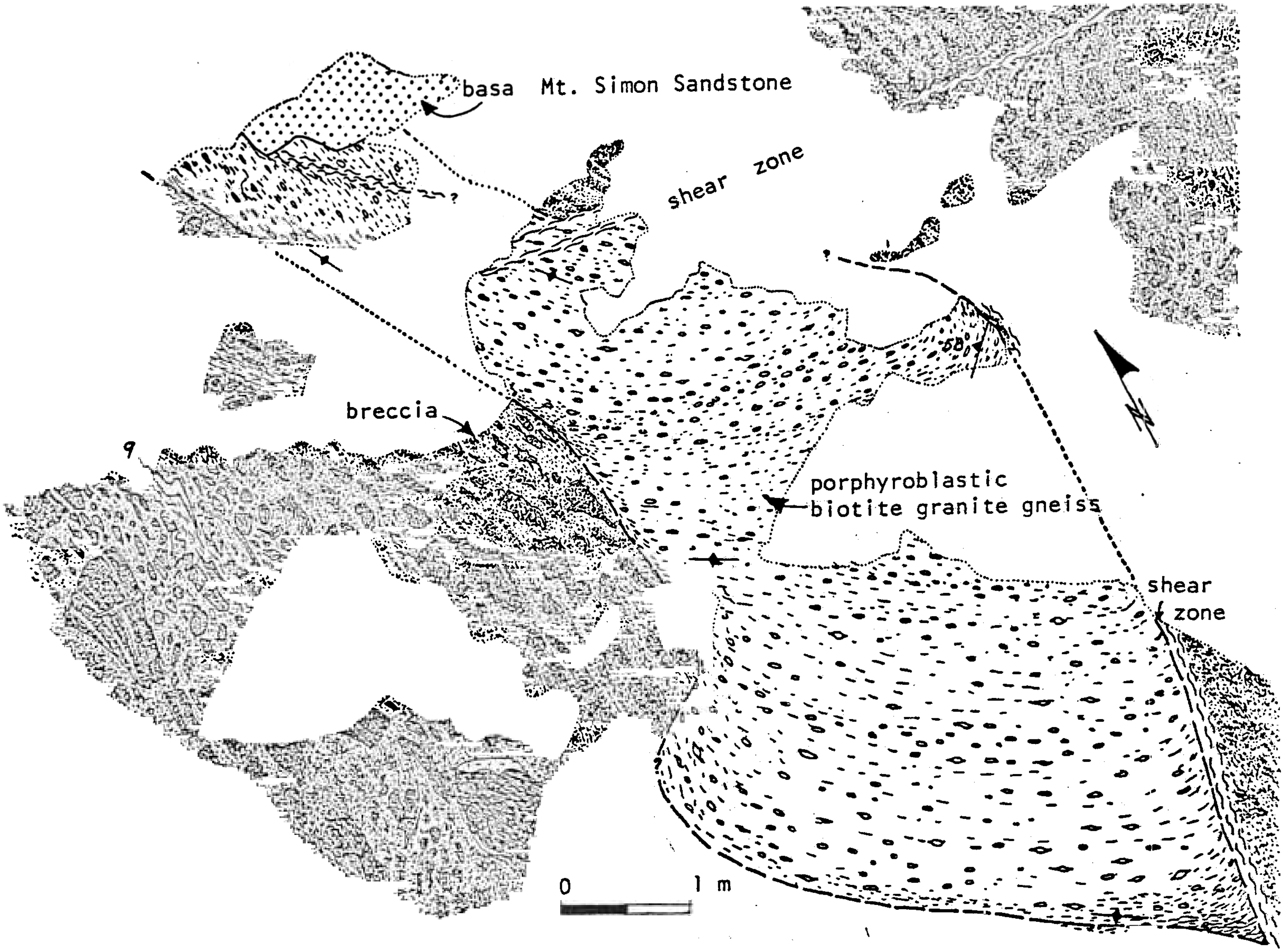


Figure 3 -- Deformed xenolith of porphyroblastic biotite granite gneiss in hornblende tonalite intrusion breccia (Location E on Fig. 2) Drag folded foliation along granite gneiss xenolith suggests frictional contact between the xenolith and flowing intrusion breccia. Note alignment of amphibolite xenoliths in the flow-laminated tonalite.