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OCCURRENCE OF A HETEROGENEOUS PEGMATITE IN FLORENCE COUNTY, WISCONSIN

by

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Occurrence of a Heterogeneous Pegmatite in Florence County, Wisconsin

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ABSTRACT

A mineralogically and texturally zoned pegmatite dike approximately 1.5 meters thick and exposed for more than 50 meters along strike occurs southwest of Florence, Wisconsin. The pegmatite contains pink and green tourmaline (elbaite), spodumene, lepidolite, and beryl in association with more common coarsely crystalline quartz, microcline, and albite. The dike semi-discordantly intrudes metavolcanic rocks of the 1.9 b.y. old Quinnesec Formation and is probably related to the 1.8 b.y. old Hoskins Lake Granite, a nearby pluton emplaced during or immediately following the Penokean Orogeny. No other similar pegmatites are known to occur in the vicinity.

INTRODUCTION

Dutton (1971) reported the occurrence of pink tourmaline (variety elbaite) in a pegmatite dike located a short distance west of the Pine River in Fern Township, Section 22, T.39N., R.17E., Florence County, Wisconsin. Re-examination and detailed mapping reveal that the pegmatite is zoned and contains a mineral suite that is characteristic of a heterogeneous or complex pegmatite. The Pine River pegmatite is apparently the first known occurrence of this important class of pegmatites in the Penokean orogenic belt of the upper midwestern United States.

Pegmatites are very coarsely crystalline tabular or irregular granitic intrusions formed when late-stage, water-rich magmas migrate from larger magma bodies and crystallize. Guilbert and Park (1986) classify pegmatites as homogeneous or heterogeneous. The more common homogeneous pegmatites are generally unzoned and consist solely of quartz, alkali feldspar, with lesser amounts of muscovite, black tourmaline (schrolite) and almandite/spessartite garnet. In contrast, heterogeneous pegmatites, including the Pine River pegmatite, contain relatively high concentrations of large-ion lithophile elements and gaseous constituents including Li, Be, Zr, Nb, Mo, Sn, Ta, W, Th, U, S, F, and Cl. These elements are incompatible with common igneous rock-forming minerals and are partitioned during magmatic differentiation into deep-seated residual water-rich melts at the end stages of magma crystallization (Best, 1982). Heterogeneous pegmatites are commonly mineralogically zoned and usually found intruding plutons and host country rock in deeply eroded orogenic belts. Heterogeneous pegmatites are a source of gems, mica, feldspar, and ores of rare earth elements.

DESCRIPTION

Most of the Pine River pegmatite consists of both coarse and aplitic quartz and gray microcline. Tourmaline is common and found in a variety of colors including pink, green, blue-green, and black. Occasionally tourmaline is bi-colored with a green outer zone on a pink interior. Several other unusual minerals characteristic of heterogeneous pegmatites have been identified in the Pine River dike (Table). Spodumene, a lithium pyroxenoid, occurs in translucent white, clear, and pink (kunzite) splintery masses. Smaller quantities of apatite, beryl, columbite-tantalite, and lepidolite occur in association with tourmaline.

The pegmatite varies from less than 10 centimeters to more than 1.5 meters thick (Figure 2). At least 3 distinct textural-mineralogical zones are present within the pegmatite. At the margins of the pegmatite, coarse pink tourmaline, generally oriented with the crystallographic c-axis perpendicular to the walls of the dike, are set in an aplitic quartz-alkali feldspar matrix (Figure 3). Within a few centimeters of the wall of the pegmatite, tourmaline becomes less abundant, but does occur in bi-colored crystals up to 1 centimeter in diameter. The second zone has an aplitic groundmass associated with lepidolite, anhedral quartz, and alkali feldspar phenocrysts. At the center of the dike, a third zone consisting of coarse masses of gray microcline and quartz occur with occasional masses of spodumene and albite (variety cleavelandite). Textural and mineralogical zonation is symmetrical on either side of the center and is generally consistent through the entire length of the pegmatite dike. No apparent alteration of the host rock at the margins of the pegmatite has occurred.

The Pine River pegmatite is exposed for a length of approximately 50 meters and semi-discordantly intrudes intensely deformed quartz sericite schist, pyritic schist, and amphibolite (Fig. 2). The host rocks near the pegmatite are isoclinally folded and exhibit strong axial plane foliation that strikes approximately N.10°W. and dips about 65 degrees to the west. Fold axes appear to plunge steeply to the north. No other pegmatites occur in the immediate area, although a small exposure of identical pegmatite, presumably the continuation of the main part ~~for~~ of the pegmatite body, occurs about 100 meters south of the main mass. Hence, the pegmatite dike appears to have a minimum length of 150 meters.

REGIONAL GEOLOGICAL SETTING

The Pine River pegmatite is located within the southeast-northwest trending Quinnesec Formation metavolcanic belt (Fig. 1). The gneisses and schists of the belt were originally deposited approximately 1.85 to 1.9 billion years ago and were deformed during the Penokean Orogeny, a major mountain building event in the upper midwest that occurred about 1.8 billion years ago (Van Schmus, 1980). Approximately two kilometers north of the pegmatite lies the Niagara Fault, a major structural feature that separates the rocks of the Quinnesec belt from metamorphic rocks of the Marquette Supergroup (Michigamme Slate) to the north. The abrupt change in lithology and structural character across the fault suggests that the Niagara Fault was active following the Penokean Orogeny and has accommodated sufficient displacement to bring crustal blocks of different character in contact with one another. The nature of the Niagara Fault is not well understood at the present time.

During and immediately following the Penokean Orogeny, the Quinnesec belt was intruded by calc-alkaline granitic magmas. One of the intrusions, the Hoskins Lake Granite (Cain, 1962), isotopically-dated at 1.8 billion years, is exposed several kilometers to the southeast of the pegmatite (Fig. 1) and is associated with numerous homogeneous pegmatites. In at least one area these pegmatites contain small quantities of tourmaline, garnet, molybdenite, and other sulfides (Greenberg, 1983). Presumably, the Pine River pegmatite is an outlier of the Hoskins Lake Granite (Dutton, 1971), although additional Penokean-age plutons may have occurred immediately north of the Niagara Fault, but have been displaced far from their original position.

SIGNIFICANCE

The Pine River pegmatite is similar in size, shape, and mineralogy to several of the famous gem tourmaline-producing dikes of the Pala and Mesa Grande, California districts (Jahns, 1979), although most of the gem-grade tourmaline from Pala is obtained from original gas cavities or "pockets" that formed in the pegmatite during crystallization. No similar cavities are exposed in the Pine River dike.

An unusual characteristic of the Pine River pegmatite is that it is not associated with other similar heterogeneous pegmatite dikes. Generally, pegmatites in other areas occur in association with numerous other dikes all related to a particular structural feature and host pluton (examples include Pala, White Mountains, New Hampshire, Albemarle, North Carolina, Black Hills, South Dakota, etc.). It is therefore likely that additional heterogeneous pegmatites occur beneath glacial cover, or, at one time, occurred in the terrain displaced by the Niagara Fault.

Table. Minerals identified in the Pine River pegmatite (in order of approximate decreasing abundance)

quartz	SiO_2
microcline	$(K,Na)AlSi_3O_8$
tourmaline	$(Na,Ca)(Li,Mg,Al)(Al,Fe,Mn)_6$-
(var. schrolite)	$(BO_3)_3(Si_6O_{18})(O,OH,F)_4$
(var. elbaite)	
muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$
lepidolite	$K(Li,Al)_{2-3}(AlSi_3O_{10})(O,OH,F)_2$
spodumene	$LiAlSi_2O_6$
biotite	$K(Mg,Fe)_3(AlSi_3O_{10})(OH)_2$
albite (var. cleavelandite)	$NaAlSi_3O_8$
beryl	$Be_3Al_2(Si_6O_{18})$
apatite	$Ca_5(PO_4)_3(F,Cl,OH)$
columbite-tantalite	$(Fe,Mn)Nb_2O_6$ - $(Fe,Mn)Ta_2O_6$
epidote	$Ca_2(Al,Fe)Al_2O(SiO_4)(Si_2O_7)(OH)$

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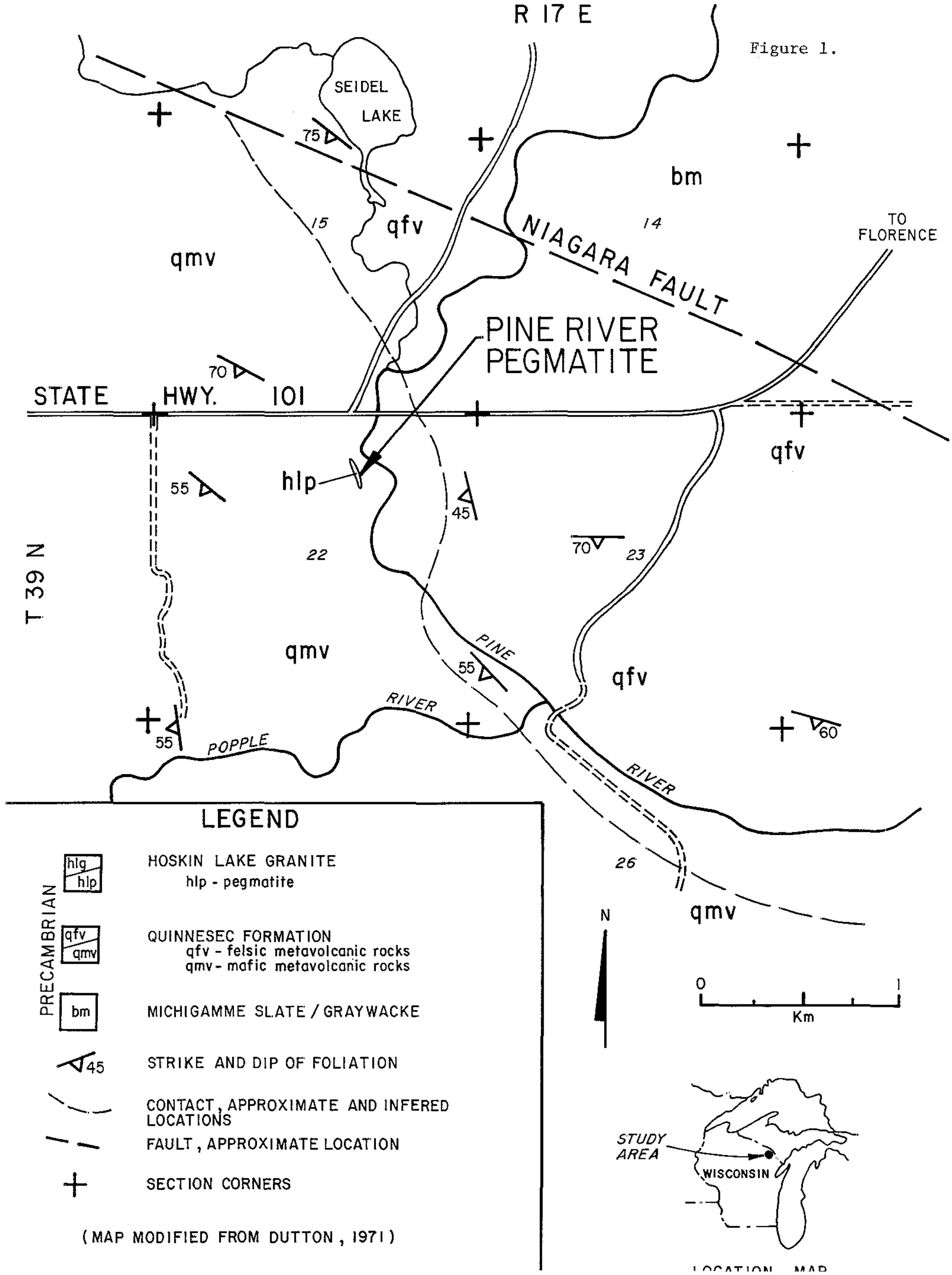
FIGURE CAPTIONS

Figure 1. Location and generalized geological map of the Pine River pegmatite vicinity.

Figure 2. Map showing the structure and geometry of the exposed portions of the Pine River pegmatite.

Figure 3. Detail of mineralogical relationships and pegmatite zonation (locations are shown on Fig. 2); abbreviations are: ab - albite var. cleavelandite, apl - aplite, bct - bi-colored tourmaline, bgt - blue green tourmaline, lep - lepidolite, mic - microcline, mus - muscovite, pt - pink tourmaline, q - quartz, and spd - spodumene.

Figure 1.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hlp - pegmatite
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qfv - felsic metavolcanic rocks
qmv - mafic metavolcanic rocks
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STRIKE AND DIP OF FOLIATION
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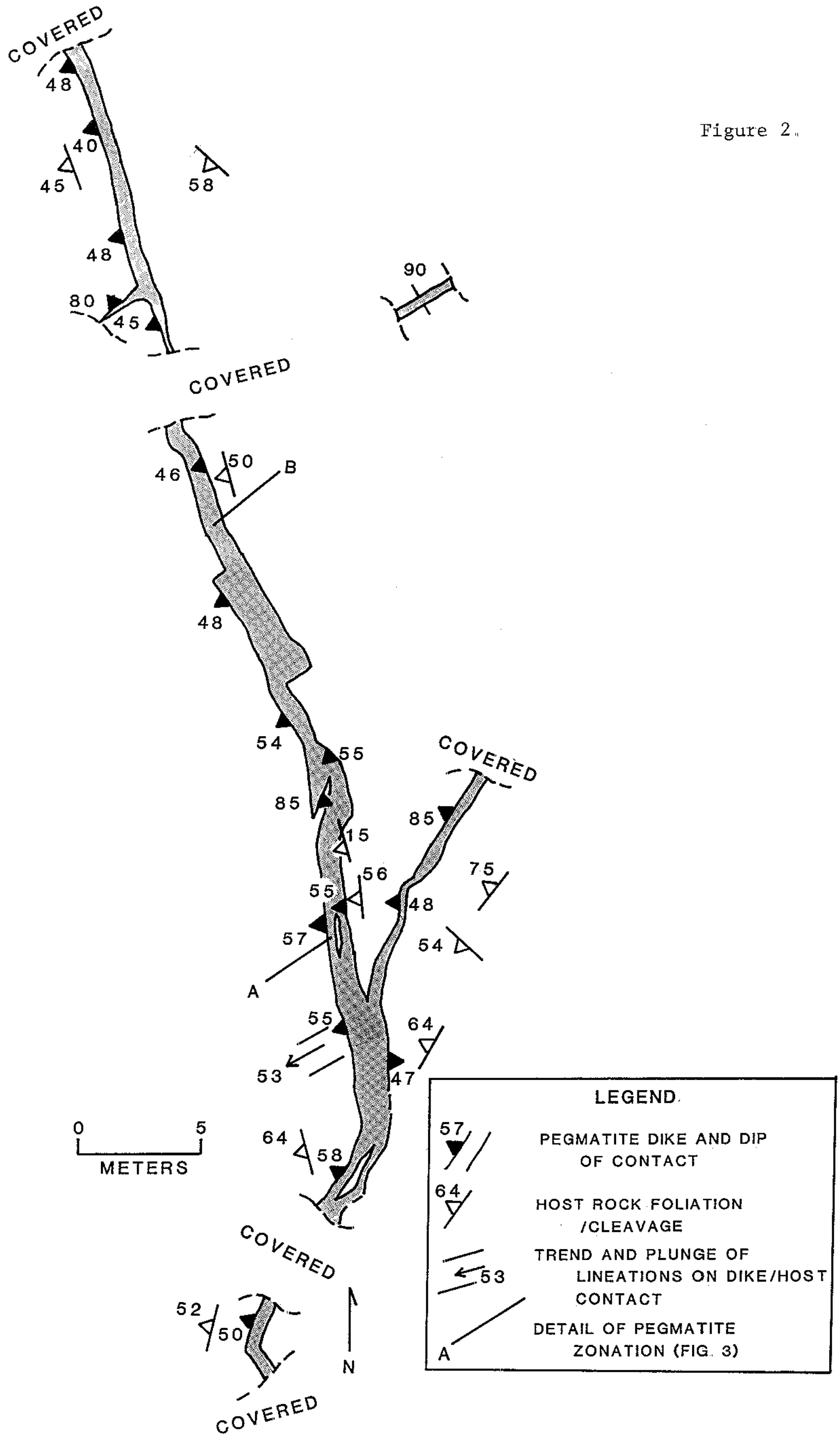
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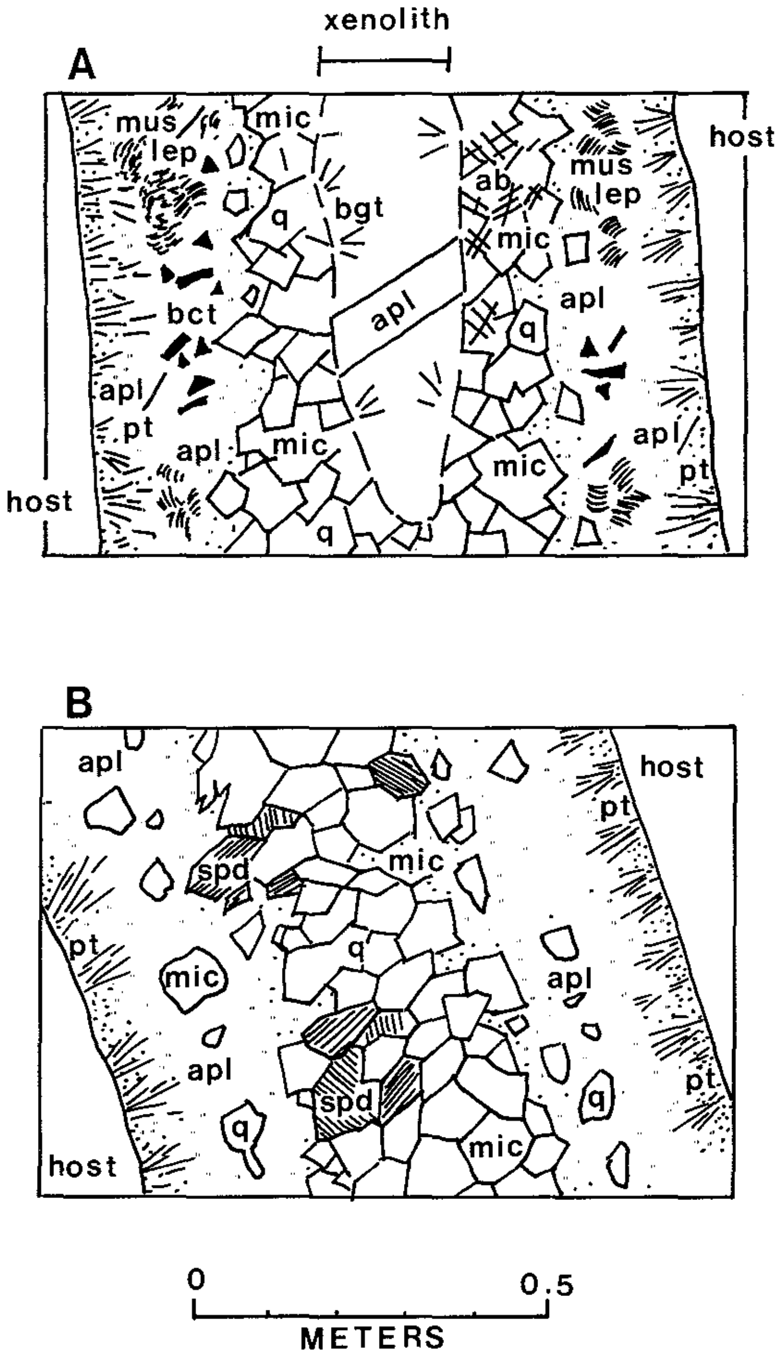
LEGEND
57
PEGMATITE DIKE AND DIP OF CONTACT
64
HOST ROCK FOLIATION /CLEAVAGE
53
TREND AND PLUNGE OF LINEATIONS ON DIKE/HOST CONTACT
A
DETAIL OF PEGMATITE ZONATION (FIG. 3)

Figure 2.

Figure 3.



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