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GEOLOGY OF THE AVERILL PLUTONIC COMPLEX, FRANKLIN MINING CAMP*

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INTRODUCTION

The Averill plutonic complex is located in the Franklin mining camp situated 70 kilometres north of Grand Forks, British Columbia; the area is accessed by road. This paper summarizes the map relationships of the Eocene rocks of the Averill pluton as established in the 1987 field season. A geological map of the Averill plutonic complex is presented and preliminary research addresses the petrography of the rocks that comprise the Averill intrusions.

A comprehensive understanding of the petrology of the Averill suite will further the tectonic and petrologic knowledge of the area, as well as adding to our understanding of alkali intrusive rocks in general, thus forming a good base from which to further explore petrological, chemical and structural problems. Work which remains to be done includes dating the pluton, petrological studies and investigation of the mineralization in the area.

PREVIOUS WORK

The Averill plutonic complex and surrounding areas have been the site of mineral exploration since the turn of the century. The earliest claims were staked in 1896 over the Averill complex and along its contacts. By 1915 the area was being actively explored for gold. The only mine to be established was the Union mine, which exploited a gold-bearing quartz vein. This mine has now ceased to operate.

Thomlinson (1920) and Freeman (1920) reported high platinum concentrations from the pyroxenite bodies in the Averill complex. Current exploration of the Averill intrusions is focused on the platinum group metal potential.

REGIONAL GEOLOGY

The Averill plutonic complex lies at the southern end of the Omineca crystalline belt (Figure 1-3-1) which includes rocks of the Shuswap terrane and associated gneiss domes and metamorphic rocks (Jones, 1959). At its southern end the belt comprises Jurassic, Cretaceous and Tertiary plutonic rocks, with Jurassic granite batholiths being the most common.

Structurally the area has been affected by tectonism characterized by fractures, joints and dykes oriented subparallel to each other with azimuths varying between 360 and 020 degrees. The Republic graben to the south is one manifestation of the Tertiary tectonic activity.

Detailed mapping of the Averill complex has delineated seven phases of intrusive activity and has determined the nature of their mutual contacts (Figure 1-3-2). Mineralogy, mineral proportions and textural relationships have been established through petrographic work and have been used to determine a tentative crystallization history of the body and a preliminary view of the genetic relationships of the individual phases. However, radiometric age determinations will, in addition to giving absolute ages, help establish the intrusive history.

GENERAL GEOLOGY

The area mapped is underlain by a large northwest-trending alkalic pluton which has been intruded through

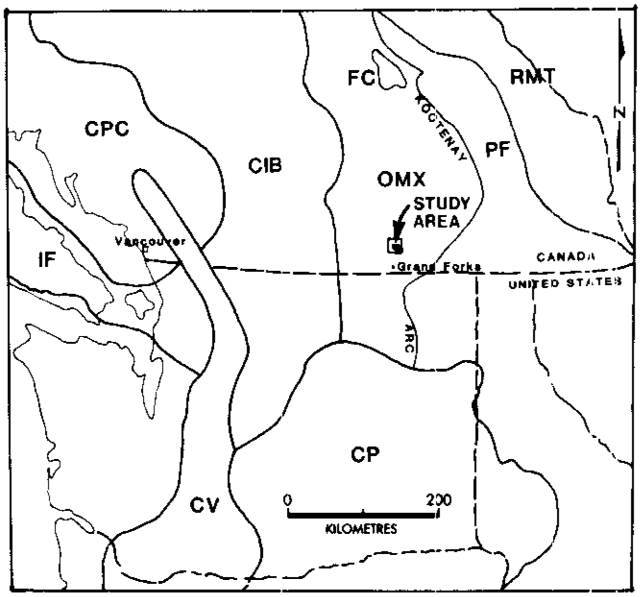

Figure 1-3-1. Index map showing major geologic provinces in the Pacific Northwest [modified from Fox *et al.* (1976) after Wheeler (1970)]. CPC–Coast plutonic complex; IF–Insular fold belt; CIB–Columbian intermontane belt; FC–Frenchmans Cap gneiss dome; OMX–Omineca crystalline belt; PF–Purcell fold belt; RMT–Rocky Mountain thrust belt; CP–Columbia Plateau province; CV–Cascade volcanic province.

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British Columbia Ministry of Energy, Mines and Petroleum Resources, Geological Fieldwork, 1987, Paper 1988-1.

Permo-Carboniferous sediments (Franklin Group) and Mesozoic granites (Figure 1-3-2). The pluton is rimmed by a band of hornfelsed rocks and is concentrically zoned, with a central core of coarsely crystalline alkalic syenite surrounded by an envelope of much finer grained syenite. Lenses of pyroxenite occur within the syenite body. These pyroxenite bodies all have a general northwesterly orientation and some are enveloped by lenses of monzogabbro or monzodiorite. The main syenite body is partially surrounded by monzodiorites. To the southwest the monzodiorites form the margin of the pluton while to the northeast they are transitional to a less mafic alkalic unit, the monzonite. The contacts between the monzonites, monzodiorites, monzogabbros and pyroxenites are gradational and based on an increase in mafic content. This alkalic complex is cut by two later sets of dykes, a trachyte and a feldspar porphyry.

PETROLOGY

The main lithologies of the Averill alkaline suite are described following. These are preliminary results and further detailed thin section, X-ray diffraction and probe work are planned to determine the compositions of the various phases in the rocks.

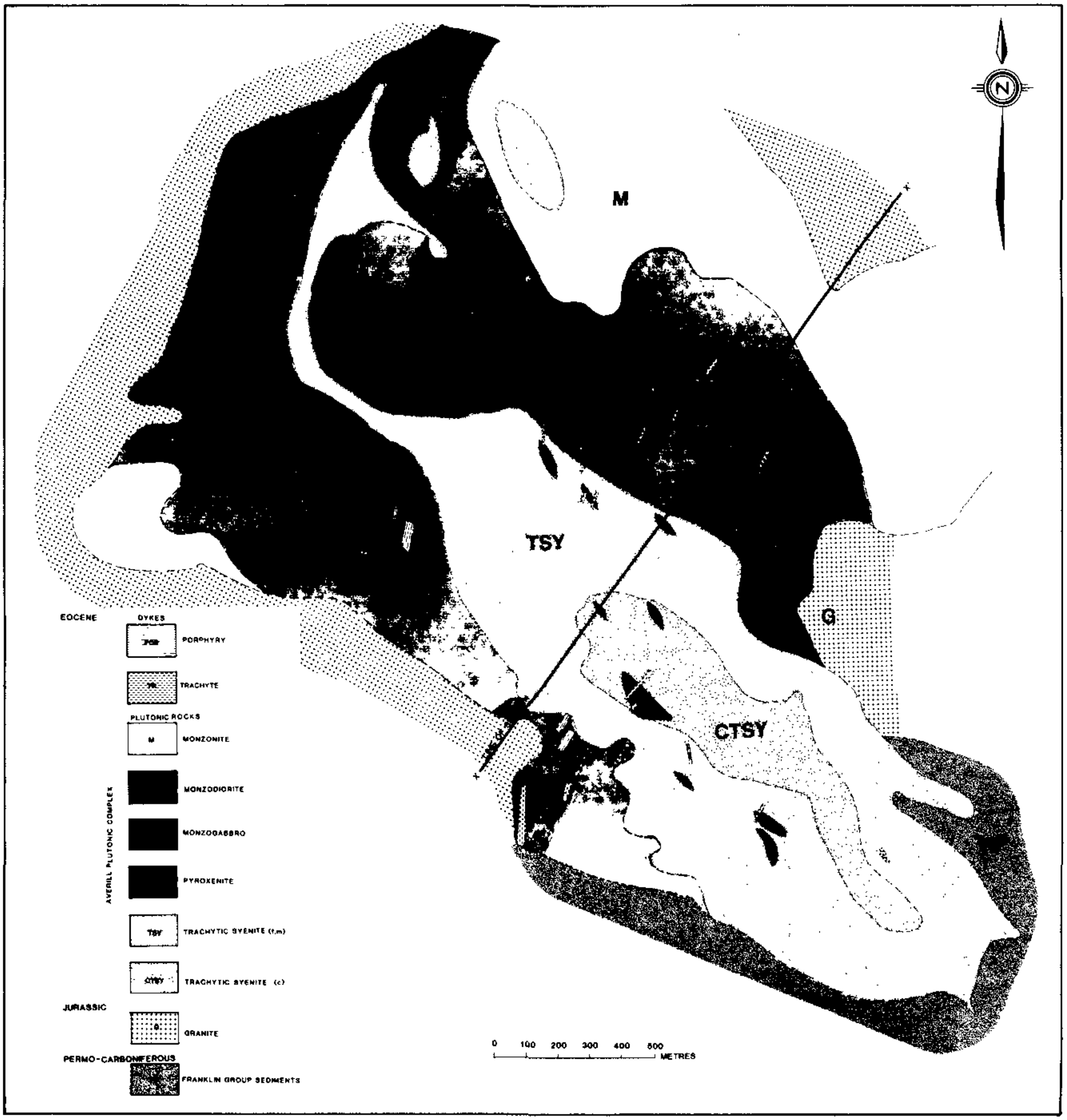

Figure 1-3-2. Geologic map of the Averill plutonic complex, showing line of section X-X'.

TRACHYTIC SYENITE

The trachytic syenites form the central part of the complex and can be crudely subdivided in terms of grain size. The field terms "fine", "medium", "coarse" and "very coarse" trachytic syenite are defined by feldspar laths less than 1 centimetre, 1 to 2 centimetres, 2 to 4 centimetres and greater than 4 centimetres respectively.

The mineralogy of these syenites, as seen in the field, is uniform and the series grades from fine grained at the margin to a core of coarse, slowly cooled trachytic syenite. The syenites consist mainly of euhedral laths of alkali feldspar which define a well-developed foliation. In thin section, many of these alkali feldspar grains are seen to be perthitic, containing coarse (millimetre scale) exsolution lamellae. The proportion of alkali feldspars can be as high as 80 per cent by volume. Plagioclase occurs only as exsolution lamellae.

Clinopyroxene (aegirine augite and/or acmite), hornblende, biotite and epidote occur as interstitial grains; opaque minerals including pyrite, chalcopyrite and magnetite are always seen in close association with these minerals. In the fine-grained syenite some of the groundmass is replaced by carbonate. The coarser grained syenites are characterized by an increase in modal abundance of amphibole and the presence of garnet. These garnets may be primary or hydrothermal. Sphene, occurring as millimetre-sized euhedral crystals, and apatite are very common as accessory minerals. A visual estimate of the mode of the trachytic syenite is given in Table 1-3-1.

MONZONITE, MONZODIORITE AND MONZOGABBRO

The monzonites, monzodiorites and monzogabbros form a gradational sequence which was subdivided in the field on the basis of the proportions of mafic minerals (colour index), and the terminology follows Streckeisen (1976). They may represent a comagmatic suite.

The monzonite is generally a fine-grained rock containing two feldspars with mafic groundmass grains commonly filling interstices. Plagioclase is the most abundant mineral, often showing original compositional zoning, modified by antiperthite exsolution. A few individual grains of alkali feldspar are also present. Mafic phases include clinopyroxene phenocrysts which are partially replaced by hornblende and biotite. Opaque minerals such as pyrite and chalcopyrite are present and apatite and sphene are very common accessory minerals. One or two grains of quartz with undulatory extinction were observed. The mode is given in Table 1-3-1.

TABLE 1-3-1.
MODAL PROPORTIONS OF MINERALS IN ROCKS OF THE AVERILL COMPLEX (VISUALLY ESTIMATED)

	Primary Mineralogy									Secondary Mineralogy				
	qz	alk	pl	amph	px	ov	gnt	bi	ep	clc	chl	apt	ti	op
TSY		60		10	10			(10)					(10)	
M	(10)		50	10	5			10				10		5
MD		15	30	10	20			10				5		10
MG			5		35	5		25	5	20				5
PYX		5		15	70								(10)	
TR	5	45						<5		45				<5
POR	<		15					15	<5	30	35			

The monzodiorite has essentially the same mineralogy but displays a weak foliation and has an increased amount of mafic minerals. As yet it is unclear whether the foliation is igneous or tectonic. The original clinopyroxene phenocrysts are large, display strong zoning and simple twinning, and are better preserved than the pyroxenes in the monzonites. The plagioclase laths in the monzodiorite groundmass are smaller than in the monzonites, and the amount of antiperthite has decreased while phenocrysts of alkali feldspar are more abundant. Quartz is no longer part of the mineral assemblage.

The monzogabbro is generally coarse grained and has pyroxene-rich schlieren running through it. There are also many small veins and veinlets of alkali feldspar which cut the schlieren with visible offset. The mineralogy of these rocks is slightly different from the monzonites and the monzodiorites. Olivine is a primary mafic phase in the rock and amphibole is absent. The amount of plagioclase is much less and alkali feldspar and antiperthites are not observed. Secondary replacement of the groundmass by carbonate is pervasive. The mode is given in Table 1-3-1.

PYROXENITES

The pyroxenite varies in character throughout the area. It is seen as both very fine-grained pyroxenite with minor biotite, and as a very coarse-grained friable biotite-rich rock. The biotite-rich variety contains up to 90 per cent biotite and may represent either the effects of hydrothermal alteration of the original pyroxenite or a primary igneous assemblage. The biotite-poor phase is comprised of amphibole and clinopyroxene, with a small amount of alkali feldspar occurring mainly as veins. Apatite, sphene and opaque minerals form the accessory phases, and secondary carbonate veins cut the rock. The modal mineralogy is listed in Table 1-3-1.

LATE DYKE ROCKS

TRACHYTE

Trachyte dykes are vertical in orientation and trend from northeasterly in the northeast part of the complex, to northerly in the southwest. The trachyte weathers to a buff colour. The mode (Table 1-3-1) consists of alkali feldspar which forms most of the groundmass and the phenocrysts. In places the feldspar is replaced by carbonate, although pseudomorphs of the original large laths are present. The remainder of the rock consists of biotite, opaque minerals and sparse grains of quartz. The biotite and the opaques are interstitial.

PORPHYRY

This rock has a distinctive spotted appearance and consists of secondary calcite and chlorite after plagioclase phenocrysts and biotite microphenocrysts, in a grey aphanitic groundmass. Plagioclase and biotite are almost completely replaced, although ghosts of the original lath-shaped plagioclase grains are still visible. The groundmass consists of the replacement minerals chlorite and calcite, together with epidote and quartz (Table 1-3-1).

MINERALIZATION

Sulphide mineralization is present in all rocks of the plutonic suite and also in the later dykes. Pyrite and chalcopyrite are ubiquitous, and other minerals such as bornite, malachite, azurite and magnetite are sometimes present. Their concentration on fracture surfaces and in and around crosscutting veins of alkali feldspar suggests that at least one phase of hydrothermal mineralization has occurred.

Many occurences of platinum were reported during early exploration of the pyroxenite bodies. Assay values obtained during the 1920s exploration period range from 0.69 gram per tonne (Thomlinson, 1920) to 15.4 grams per tonne (Freeland, 1920). These assays were obtained from pyroxenites in the general vicinity of the Averill intrusions. Assays from pyroxenite bodies within the pluton ranged from 2.74 to 6.51 grams per tonne (Thomlinson, 1920). More recent soil geochemical work is reported to indicate a tendency for platinum/palladium soil anomalies to be associated with areas of high copper concentration. One objective of studying the petrology of the Averill rocks is to ascertain the causes and controls of platinum mineralization.

GEOLOGICAL HISTORY

The Averill intrusive complex consists of a mineralogically gradational plutonic suite ranging in composition from pyroxenite to monzonite. Pyroxenite bodies occur as lenses in the centre. The outcrop pattern can be explained by topography and suggests vertical zonation, with pyroxenite at the base and monzodiorite at the top (Figure 1-3-3).

As this suite of mafic to ultramafic rocks cooled, it was intruded by a body of alkalic syenite. The nature of the contacts between the ultramafic pluton and the syenites suggests that the two intrusions were almost contemporaneous. The intrusion of the syenites into an unsolidified pyroxenite caused the pyroxenite and syenite to mix mechanically, generating a variety of textures. Slow cooling of the syenite body produced the coarsely crystalline core of the intrusion (Figure 1-3-4). The syenites may be the source of subsequent hydrothermal mineralization in the area.

The syenites and ultramafic rocks were cut by two later phases of dyke intrusion. These dykes do not intersect, have a close spatial relationship, have similar trends and contact relationships and are probably coeval. They also contain disseminated sulphides including pyrite and chalcopyrite.

The last phase of igneous activity in the area is volcanic and comprises trachytes, rhyolites and volcaniclastics which are exposed at higher topographic elevations.

SUMMARY

A vertically zoned ultramafic pluton, ranging in composition from pyroxenite to monzonite, is intruded by a body of alkali syenite. This intrusion caused the remobilization of the lower layers of the ultramafic pluton. All intrusions are cut by later dykes.

Future work is directed along two lines. Firstly, analytical data, including whole-rock and mineral chemistry are being acquired to characterize the intrusive rocks and constrain the igneous processes. Secondly, the relationships between alkali magmatism and platinum group metal mineralization will be investigated to determine whether the mineralization derives from magmatic processes or late-stage hydrothermal activity.

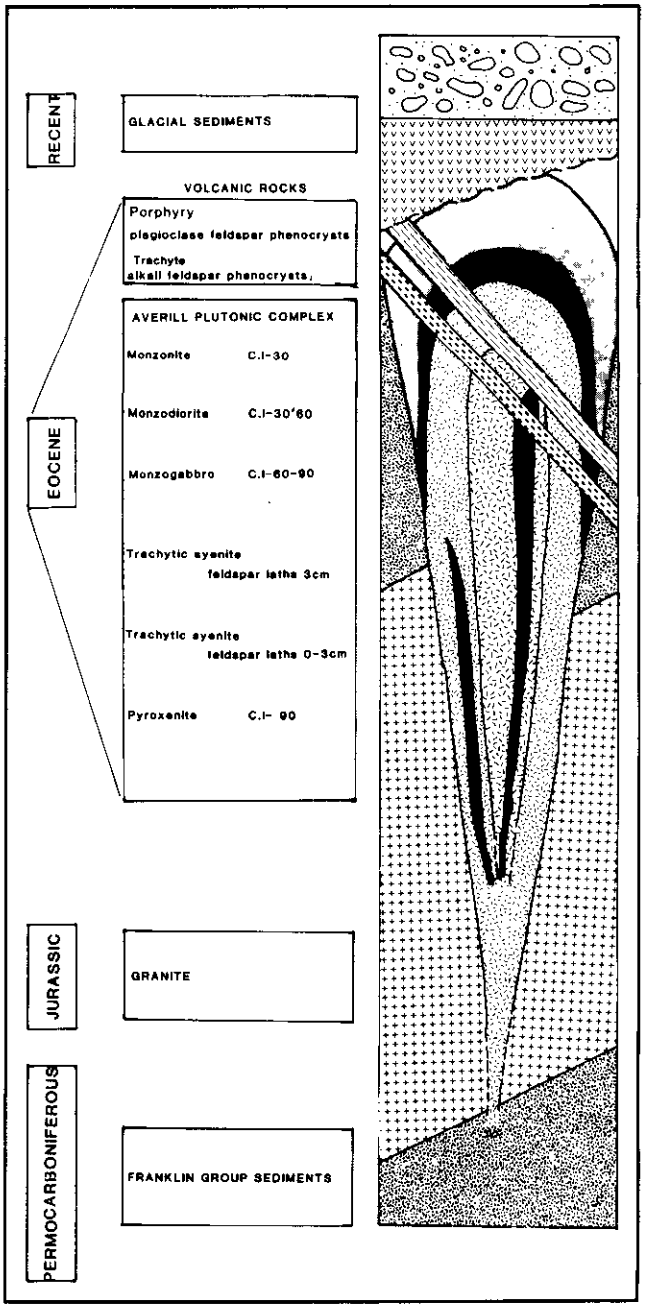

Figure 1-3-3. Schematic stratigraphic section through the Averill plutonic complex showing relative age and contact relationships.

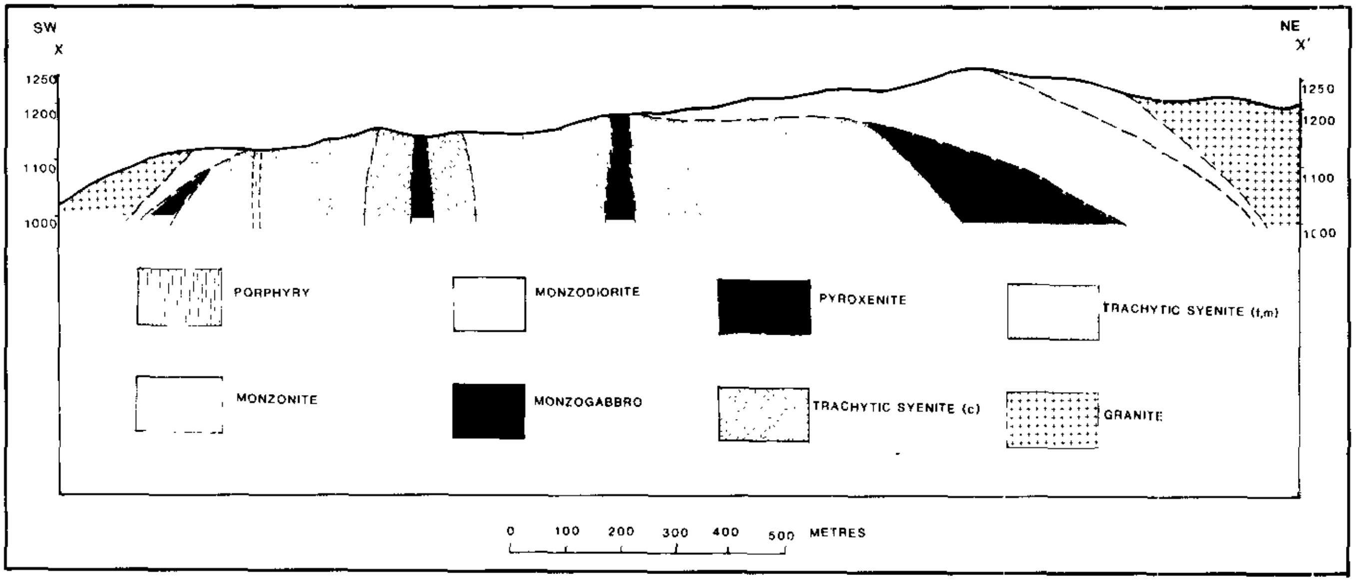

Figure 1-3-4. Schematic cross-section through the Averill plutonic complex from southwest to northeast along line X-X'.

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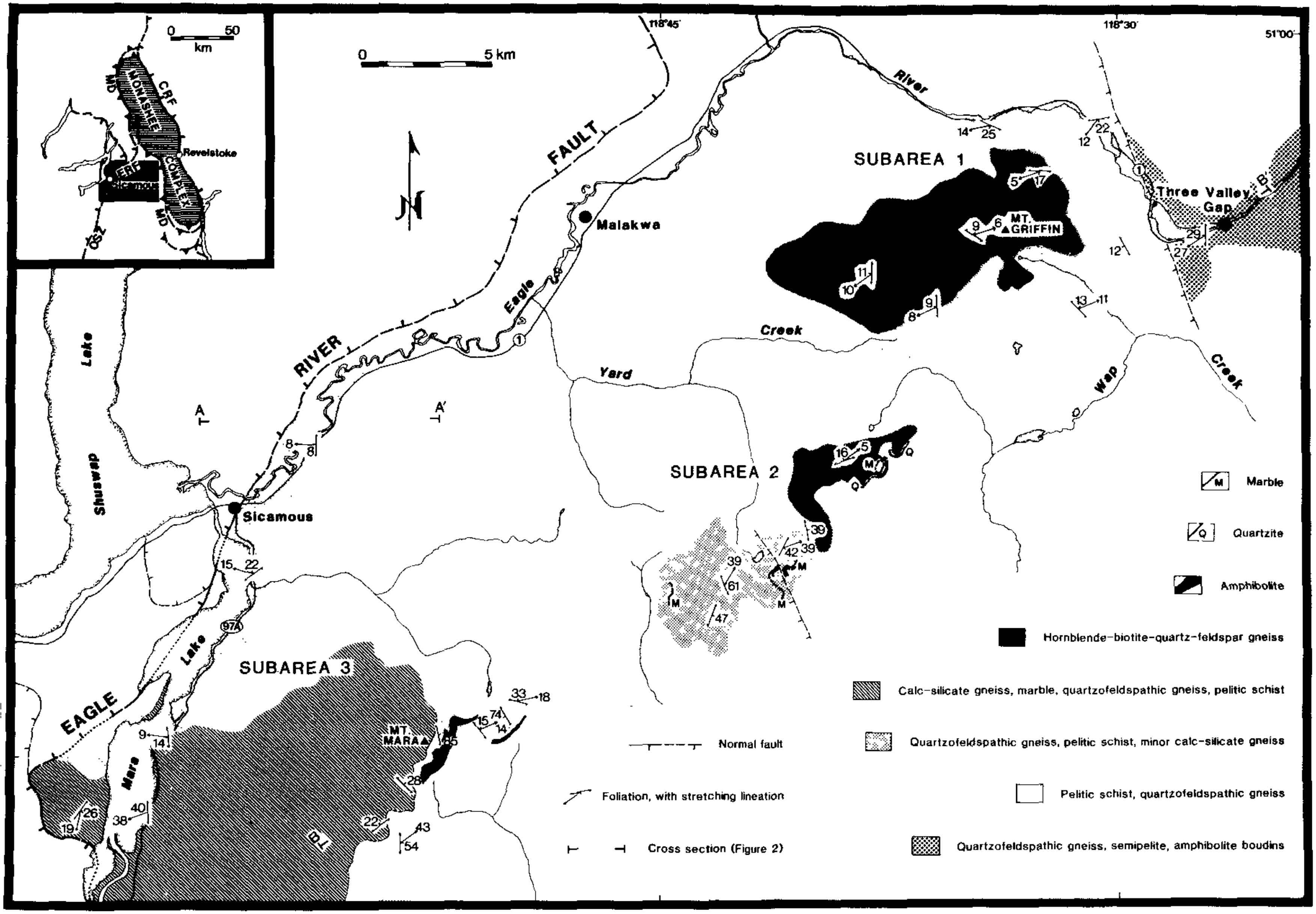

Figure 1-4-1. Geological map of the northern Hunters Range; location shown (black) in inset. Inset: Regional tectonic map, modified after Journeay and Brown (1986). CRF: Columbia River fault zone; ERF: Eagle River fault; MD: Monashee décollement; OSZ: Okanagan shear zone.