British Columbia Geological Survey
Geological Fieldwork 1987

GEOLOGY OF THE MOUNT SHEBA IGNEOUS COMPLEX* (92O/03)

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KEYWORDS: Regional geology, Mount Sheba, Chilcotin Range, subvolcanic system, felsic volcanic rocks, basalt flows, feldspar biotite porphyry.

INTRODUCTION

The Mount Sheba volcanic complex is located within the Chilcotin Range on the eastern margin of the Coast Mountains. The map area is located between 123°00′ and 123°07′ east longitude, and 51°00′ and 51°04′ north latitude, on the southeast corner of the Warner Pass map sheet (92O/03).

The Mount Sheba area was remapped at a scale of 1:15 000, providing detail not found in pre-existing maps (Glover and Schiarizza, 1986; Tipper, 1978). Particular attention was paid to outcrops of Tertiary volcanic and plutonic rocks. This study addresses the nature of the volcanic assemblage and the Mount Sheba intrusive bodies, as well as the relationship between these two suites. The Mount Sheba complex is well exposed and the volcanic rocks are well preserved, providing a rare opportunity to observe the roots of a subvolcanic system, as well as part of the overlying volcanic stratigraphy. This research establishes stratigraphic relationships between the Tertiary units, and documents the petrologic variations in these rocks.

At this point in the project, a preliminary description of the stratigraphic section and the distribution of lithologies are complete. The age relationships between the units of the Mount Sheba complex are established, together with the nature of the contacts between the units. Absolute ages of the plutonic suite are currently being determined by D. Archibald at Queen's University. Future work will expand the present field map around Mount Sheba and concentrate on the rock and mineral chemistry of the volcanic-plutonic suite.

GENERAL GEOLOGY

The regional geology of the Warner Pass map sheet (Figure 1-10-1) involves Mesozoic sedimentary and volcanic rocks which are overlain and intruded by Tertiary volcanic and plutonic rocks. The Mesozoic strata record the change in sedimentation in the northwest-trending Tyaughton basin from marine to nonmarine conditions. This change accompanied the uplift of the Coast plutonic complex in mid-Cretaceous time (Kleinspehn, 1985). The dominant northwest structural trend in these rocks is manifest in numerous strike-slip faults which are related primarily to the post-Albian northwest-trending Yalakom–Hozameen fault system, and also to the later Fraser–Straight Creek right-lateral strike-slip fault, believed to be late Cretaceous to early Tertiary in age (Monger, 1985).

Tertiary rocks in the region are primarily volcanic, volcaniclastic, or shallow intrusive, and unconformably overlie or intrude the Early Cretaceous Taylor Creek sedimentary rocks, Late Cretaceous Battlement Ridge volcanic rocks, and a Late Cretaceous to Early Eocene sedimentary unit. Felsic volcanic flows and volcaniclastic deposits of probable Eocene age (Glover and Schiarizza, 1986) are unconformably overlain by Miocene plateau basalts. Several groups of intrusive rocks occur throughout the area and exhibit contact relationships which suggest ages from possibly mid-Cretaceous to Eocene. In the Mount Sheba area, a feldspar biotite porphyry, ubiquitous throughout the field area, intrudes all of the units.

Locally sinuous faults offset the Eocene volcanic assemblage, for instance the Chita Creek fault. Although they are not well defined in the Mount Sheba area, it is suggested that these structures control the distribution of the Eocene rocks in the region (Glover and Schiarizza, 1986). The Miocene basalts often cover fault traces, implying that there has been little post-Miocene structural movement.

GEOLOGY OF MOUNT SHEBA

Three lithologic units dominate the Mount Sheba map area (Figures 1-10-2; 1-10-3): a series of felsic to intermediate flows and pyroclastic deposits; a sequence of mafic volcanic flows; and a subvolcanic highly porphyritic intrusion or series of intrusions, intermediate in composition. There are four other distinct lithologies in the study area, three of which comprise underlying Mesozoic strata, and the fourth a suite of late dykes, sills or stocks which form a mappable unit.

LITHOLOGIC DESCRIPTIONS

TAYLOR CREEK GROUP (UNIT 1)

Early Cretaceous Taylor Creek sediments are predominantly comprised of dark shales, medium to thickly bedded siltstones and sandstones and poorly bedded chert-pebble conglomerate, with sedimentary features indicative of deposition by turbidity currents in a marine environment (Glover and Schiarizza, 1986). In the Mount Sheba area, this unit is characterized by siltstones with tabular crosslaminations, mud-draping, and some soft-sediment deformation. One section has thin coal beds (approximately 5 to 10 centimetres

* This project is a contribution to the Canada/British Columbia Mineral Development Agreement.

thick) intercalated with siltstones and shales. A debris flow consisting of poorly sorted lithic and volcanic clasts with a very fine-grained to sandy matrix is found near the upper contact between this unit and the unconformably overlying Unit 4, along the northern boundary of the map area.

Battlement Ridge Group (Unit 2)

The Battlement Ridge Group, formerly the Kingsvale Group (Glover and Schiarizza, 1986; Tipper, 1978), comprises primarily volcanic and volcaniclastic rocks of Middle to Late Cretaceous age. In the Mount Sheba area it is generally a massive, purple-weathering volcanic feldspar porphyry which forms large cliffs. In some areas volcanic flows are interbedded with coarse flow breccias comprised of angular lapilli-sized feldspar porphyry clasts and a matrix of the same composition. In less massive sections, flow banding is defined by alignment of feldspar phenocrysts. Locally the unit is altered to the extent that primary mineralogy is completely replaced, and the rock weathers a

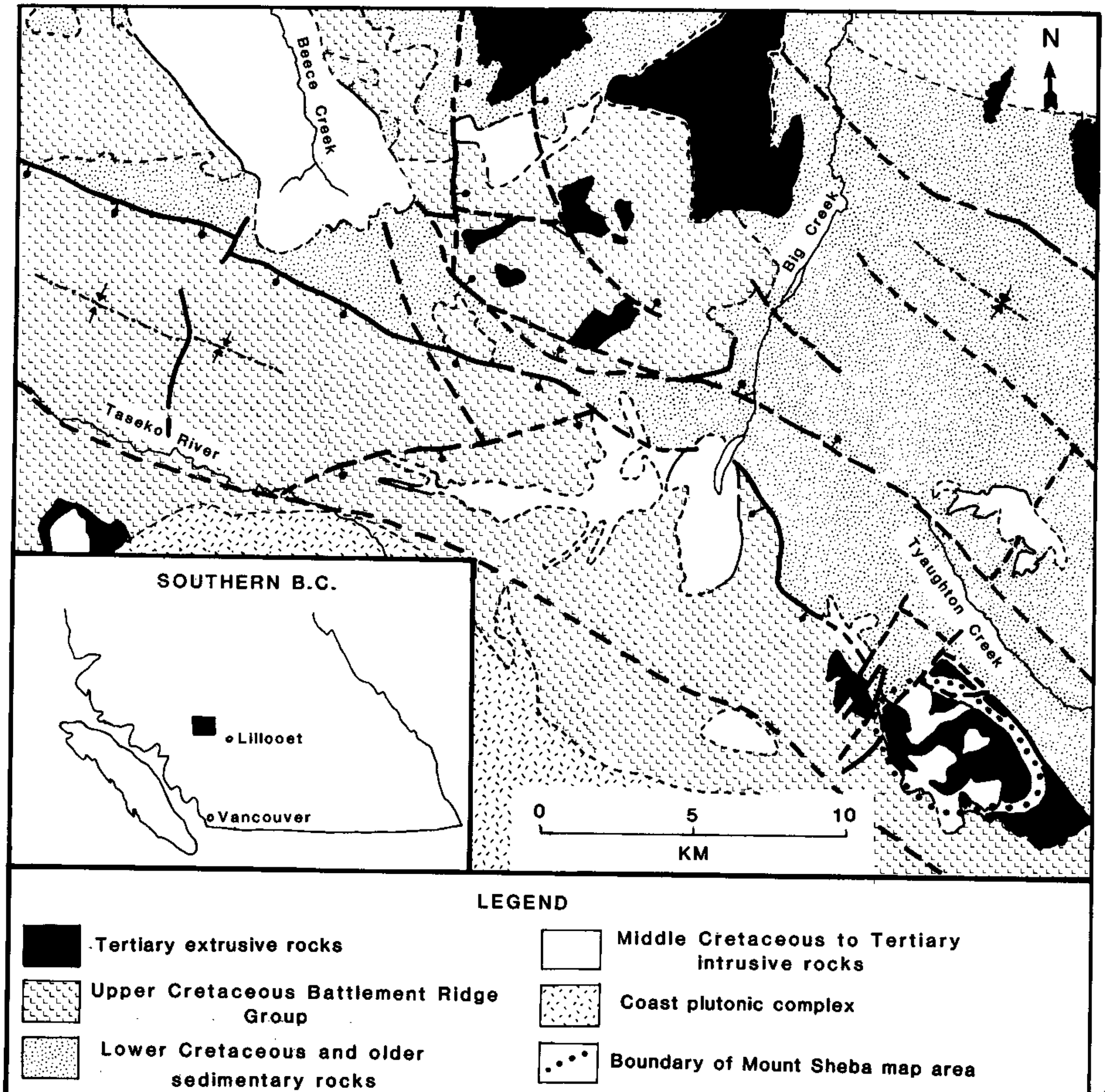

Figure 1-10-1. Location map, southern British Columbia, and generalized geology of the Warner Pass map sheet (modified from Glover and Schiarizza, 1986).

rusty colour. The Battlement Ridge Group is unconformably overlain by boulder conglomerates and arkosic sandstones of Unit 3 and intruded by the plagioclase biotite porphyry of Unit 7.

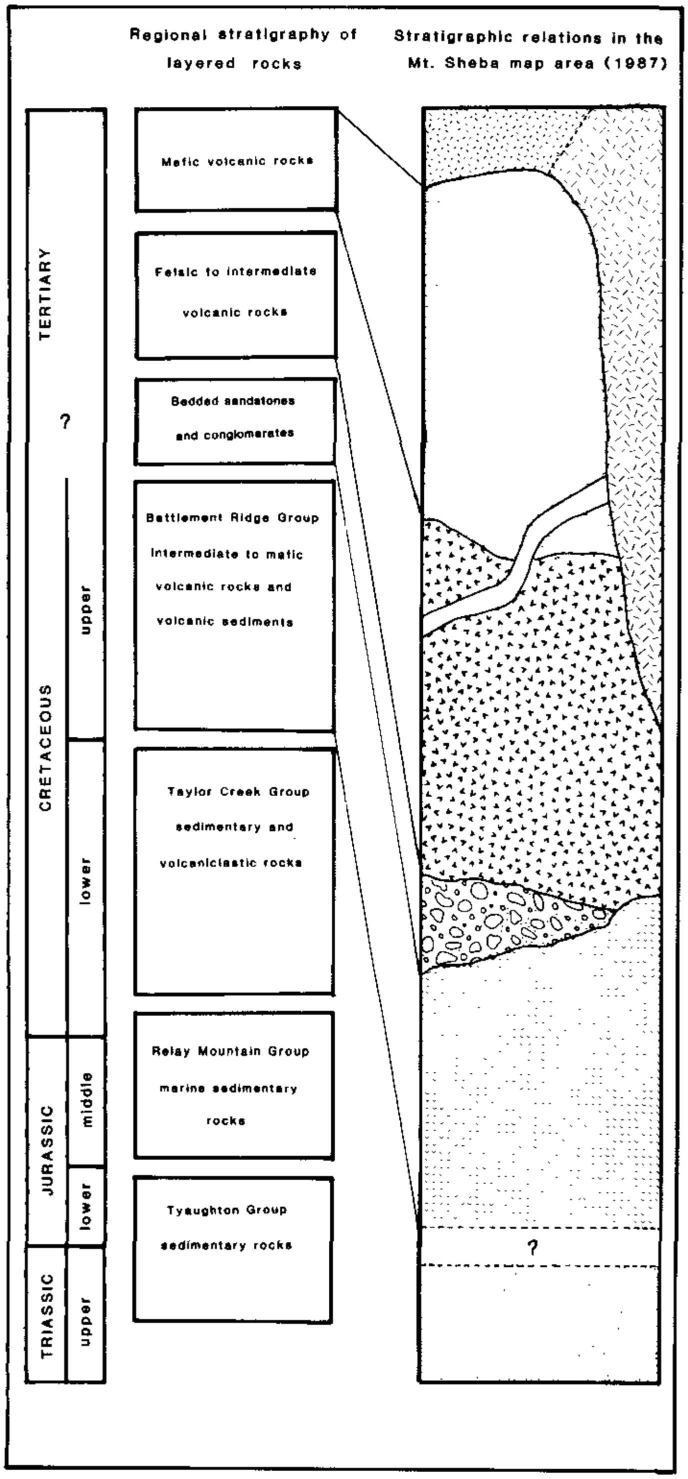

Figure 1-10-2. Regional stratigraphy of layered rocks and stratigraphic relationships in the Mount Sheba map area.

Arkosic Sandstones and Conglomerates (Unit 3)

Unit 3 is a discontinuous package of interbedded epiclastic conglomerates and sandstones which varies in thickness across the map sheet. Clasts vary in size from pebbles to boulders, are generally very well rounded and poorly sorted, and are predominantly lithic and granitic in composition. The sandstones are often lenticular and normally graded. This unit is limited to the immediate vicinity of the western part of the Mount Sheba map sheet, and is not well exposed. Locally the clastic unit pinches out. Unit 3 unconformably overlies the Battlement Ridge volcanic rocks and is overlain by Unit 4 felsic volcanic rocks, and therefore is inferred to be post-Late Cretaceous to Early Eocene in age.

Eocene Felsic Volcanic Rocks (Unit 4)

Felsic volcanic rocks are ubiquitous throughout the study area. They generally comprise felsic aphanitic flows and pyroclastic deposits. These rocks have a distinct appearance in the field, characterized by well-defined flow banding. The flow banding is on a scale of 5 to 50 millimetres and ranges from highly contorted to parallel bands. The unit weathers light green or purple and alters to a rusty or buff colour. The felsic volcanic rocks can be subdivided into three mappable subunits: light green-weathering fissile volcanic flows (Subunit 4a); massive purple-weathering volcanic flows (Subunit 4b); and a pyroclastic unit (Subunit 4c). The age of this unit is thought to be Eocene (Glover and Schiarizza, 1986).

Subunit 4a is comprised of massive cliff-forming purple-weathering volcanic flows, sometimes flow banded and often brecciated. These flow breccias are porphyritic and contain lapilli-sized fragments with feldspar phenocrysts. The breccias do not appear to delineate bedding or flow surfaces. This subunit is restricted to the central part of the field area.

Subunit 4b is light green weathering, fissile, and has prominent fine flow banding defined by thin bands of variable composition. In general this lithology is aphanitic, but some sections are porphyritic with small phenocrysts of amphibole, feldspar and quartz. At the margins of flows, particularly toward the top of the unit, flow breccias are quite common. These are characterized by angular lapilli-sized purple-weathering clasts within a green-weathering matrix on the flow surface. This subunit outcrops in the central part of the map area and stratigraphically overlies the more massive volcanic flows of Subunit 4a.

Subunit 4c is a pyroclastic deposit recognized at only one locality in the northwestern part of the map area, and its field relationships to other subunits of the Eocene volcanic rocks are uncertain. The unit is purple weathering and glassy with moderately well-developed fiammé and is generally quite weathered. Parts of the outcrop contain small biotite, amphibole and plagioclase crystals, as well as lapilli-sized pumice fragments in a glassy groundmass. It is interpreted as a welded crystal-lapilli ash flow tuff.

Layered Basalt Flows (Unit 5)

Basalt flows of Unit 5 are comprised of interbedded, fine-grained massive flows and flow breccias, 1 to 2 metres thick.

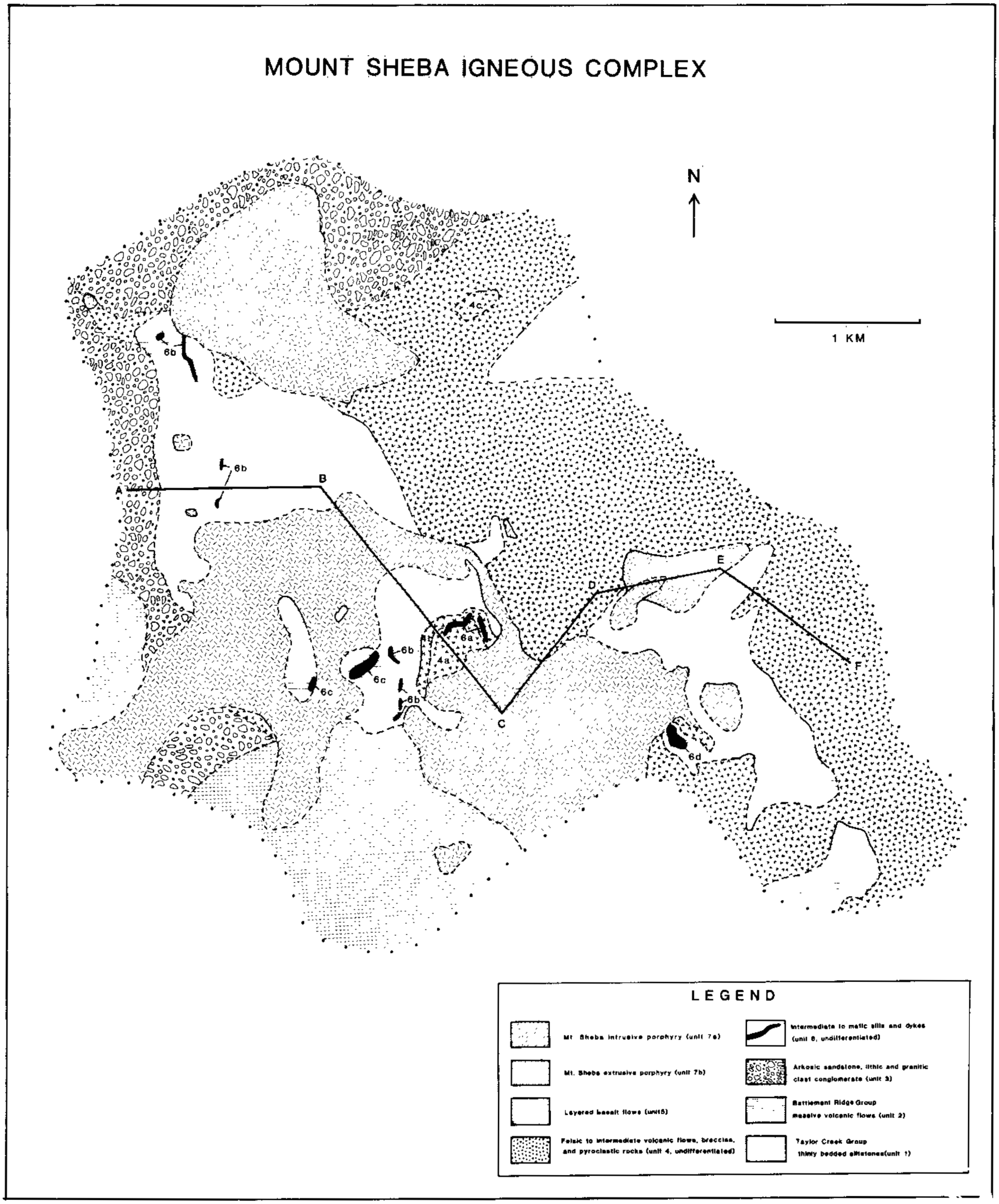

Figure 1-10-3. Geology of the Mount Sheba igneous complex.

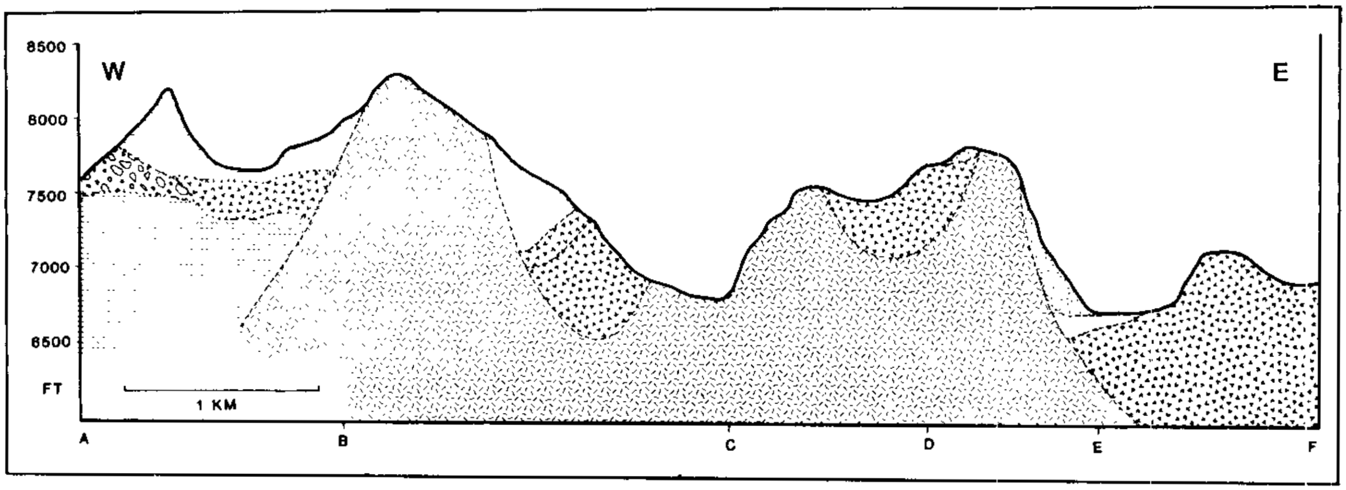

Figure 1-10-4. Cross-section A-B-C-D-E-F through the Mount Sheba map area. (*See* Figure 1-10-3 for legend.)

The massive flows are vesicular or amygdaloidal with calcite, chlorite and quartz amygdules. Interlayered flow breccias are fine grained, strongly oxidized and weather a bright red colour. The clasts appear to be of the same composition as the groundmass. Rocks of this unit are commonly cut by intermediate to mafic dykes, sills and stocks of Unit 6.

In general, the basalt flows and breccias are unfolded and dip gently westward. Close to intrusive bodies, bedding may steepen. The total thickness of the basalt flows varies across the map sheet. In several locations there are significant accumulations of flows, giving a "layer cake" appearance, while in other areas the basalts form a thin veneer covering underlying units. The thicker accumulations of layered flows appear to fill paleotopographic lows in Unit 4 rocks. Unit 5 may also occur as pendants within the Mount Sheba intrusion. It is superficially similar in outcrop appearance to other basalt units in the region dated as probable Miocene (Glover and Schiarizza, 1986). However the correlation between Miocene basalts and Unit 5 is uncertain. Unit 5 occurs throughout the map area, and unconformably overlies the Eocene felsic volcanic rocks and the arkosic sandstones and conglomerates of Unit 3.

Intermediate to Mafic Intrusive Rocks (Unit 6)

Intrusive rocks of intermediate to mafic composition occur as sills, dykes or stocks. Subunits 6a, 6b and 6c may be related to each other, whereas Subunit 6d is quite different. The intrusive subunits have been grouped together because all intrude Unit 4 or Unit 5 and in one location are truncated by Unit 7.

Subunit 6a is composed of intermediate to mafic porphyry dykes. Typically the unit has a greenish grey mesocratic aphanitic groundmass with green amphibole and feldspar phenocrysts. The dykes are 3 to 5 metres thick and cut flow banding in the Eocene volcanic rocks and the contact between Subunits 4a and 4b, but do not extend into nearby overlying layered basalts.

Subunit 6b is comprised of amphibole porphyry sills and dykes, 3 to 5 metres thick, which intrude layered basalt flows. They generally have a light grey-weathering aphanitic groundmass with small green amphibole phenocrysts and occasional feldspar phenocrysts. There is some flow banding and vesiculation at the margins of these intrusions.

Subunit 6c is comprised of amphibole porphyry stocks intruding layered basalt flows. It has a greyish green aphanitic groundmass with green amphibole phenocrysts. It is flow banded and vesicular or amygdaloidal near the margins and is similar in appearance to sills and dykes of Subunit 6b, except that it occurs as a large irregular body cutting well-layered basalt flows. Its proximity to outcrops of Subunit 6a also suggests that it may be related, perhaps as a feeder stock to the sills and dykes.

Subunit 6d intrudes the layered basalt flows only, and is different mineralogically from other intermediate to mafic intrusions. It is an altered medium-grained equigranular rock containing primarily biotite, plagioclase feldspar and secondary chlorite. It is cut by small dykes of porphyritic rock, 3 to 10 centimetres thick, with a leucocratic aphanitic groundmass and euhedral green amphibole and anhedral biotite phenocrysts.

Mount Sheba Plutonic Porphyry (Unit 7)

The Mount Sheba plutonic porphyry intrudes all of the other units in the map area and is therefore interpreted to be the youngest rock unit. It is generally a plagioclase biotite porphyry, with some amphibole and quartz phenocrysts, and has a light-coloured aphanitic groundmass. The Mount Sheba porphyry has been divided into subunits, based upon the nature of emplacement. Subunit 7a, the dominant unit, is comprised of flow-banded, generally crystalline plagioclase biotite porphyry. Subunit 7b is also a plagioclase biotite porphyry, but is more glassy in appearance and also includes breccias and possibly pyroclastic deposits.

Subunit 7a is porphyritic with plagioclase, biotite, hornblende and quartz phenocrysts in a leucocratic grey groundmass. Plagioclase phenocrysts are always present, are usually euhedral to subhedral, and are sometimes zoned. Biotite phenocrysts are common and usually occur as euhedral hexagonal prisms. Tiny (less than 2 millimetres) acicular, black amphibole phenocrysts are sometimes present. Quartz is the least common phenocryst; it occurs as small (approximately 5 millimetres) subrounded grains. The groundmass is generally aphanitic and is more crystalline toward the interior of the pluton and increasingly fine grained near the margins. Petrologically, this rock is a diorite.

A predominant physical characteristic of the unit is the presence of well-defined flow banding at the margins of the pluton. The flow banding parallels the intrusive contact and, in some cases, remains distinct well into the interior of the body. The intrusive bodies have well-defined chilled margins, indicated by decreasing phenocryst size and abundance, by a more glassy groundmass, and by xenoliths of the surrounding country rock. Autobreccias, probably due to internal magma flow, occur in a few locations. This unit also contains roof pendants of the surrounding country rock. The irregular nature of the intrusive contact is reflected in the map pattern as well as in small apophyses of this unit visible through the country rock.

The Mount Sheba diorite has an extrusive phase (Subunit 7b) which occurs in a single location in the eastern part of the field area, adjacent and partially surrounding a small body of the intrusive porphyry. The extrusive unit is a purplish weathering porphyry, similar in appearance to the intrusive unit, with plagioclase, biotite, and sometimes amphibole phenocrysts, set in glassy groundmass. Several types of breccia occur in this unit. A basal flow breccia is subparallel to flow banding and the clasts and matrix are of the same composition. Some breccias contain angular lapilli-sized pumice and tuff fragments. Other breccias are characterized by flattened glass fragments in the matrix. These features, together with the geometry, suggest that this unit is the extrusive equivalent of the intrusive Subunit 7a. There is also a tectonic breccia which is discordant to flow banding and is heterolithic with a buff-coloured grainy matrix.

FIELD RELATIONSHIPS

Field relationships do not indicate conclusively that the Mount Sheba intrusive porphyry is the source for the Eocene felsic to intermediate volcanic deposits. The layered basalt flows stratigraphically overlie the Eocene volcanic rocks and both are intruded by the porphyry. There must have been some time interval between the deposition of the Eocene volcanic rocks and the intrusion of the porphyry during which the basalt flows were deposited. Therefore, unless the felsic volcanic rocks, the basalts, and the Mount Sheba porphyry were all emplaced coevally, it is unlikely that the Mount Sheba porphyry is the direct source for the felsic volcanic rocks. Previous work on the Mount Sheba igneous assemblage suggests that perhaps the Mount Sheba porphyry is a volcanic centre for the Eocene felsic to intermediate volcanic rocks (Glover and Schiarizza, 1986). This hypothesis requires that the felsic volcanic rocks and basalts of Unit 5 be approximately coeval. If such is the case, then the felsic volcanic rocks and the basalt flows might be complementary units of a bimodal volcanic suite with separate but related eruptive centres. An alternative to the Glover-Schiarizza hypothesis is that the deposition of the felsic volcanic unit and the basalt unit, and the intrusion of the Mount Sheba porphyry, are all separate events. However, the close spatial association and similarities in composition and mineralogy argue that they may be related.

Field relationships suggest that the basalts and the felsic volcanic rocks are not coeval. The orientations of flow banding in the felsic volcanic rocks and flow tops in the basalts are usually discordant. In some locations the geometry of the units suggests that the basalt flows were deposited on an uneven paleosurface of the felsic volcanic rocks. For instance, the contact between these two units can be steeply dipping, while the basalt flows are subhorizontal and undisturbed, with no evidence of a fault contact. This suggests an interval of inactivity and erosion, and possibly structural tilting, between deposition of the felsic volcanic rocks and deposition of the basalts.

CONCLUSIONS

This study permits conclusive statements to be made on several aspects of the Mount Sheba igneous complex. The project has thus far produced a detailed stratigraphic section and a field map, and has elucidated the nature of the contacts and relative ages of the mappable units. Based on the observations to date, the Mount Sheba igneous complex comprises three distinct phases of plutonic and volcanic activity.

However, several important questions remain unanswered. At this point absolute ages of members of the complex are unknown. Relative ages are known from field relationships, but the timing of igneous events is uncertain. Several regional age relationships and the chemical and mineralogical character of the Mount Sheba igneous complex remain to be determined.

Planned future work includes petrographic and chemical analyses of rocks from the Mount Sheba igneous complex. Potentially, this will determine whether or not members of the Mount Sheba igneous complex are related. Also the petrography and chemistry of the Mount Sheba porphyry, both Subunits 7a and 7b, may provide information about the genesis and emplacement of a high-level pluton and its extrusive equivalents.

ACKNOWLEDGMENTS

This project has been made possible by field support from the British Columbia Ministry of Energy , Mines, and Petroleum Resources. The funding for the 1987 field season was provided by mineral research grant under the Canada/ British Columbia Mineral Development Agreement, while field support was provided by J.K. Glover. I am grateful to J. Riddell for the benefit of her knowledge and feedback during the field research.

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