FIELD CONSTRAINTS ON DIVERSE IGNEOUS PROCESSES IN THE IRON MASK BATHOLITH (92I/9, 10)

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INTRODUCTION

The Iron Mask batholith is an Early Jurassic composite alkaline intrusion located southwest of Kamloops in south-central British Columbia (Figure 2-6-1). It lies in the southern portion of the Quesnel trough in the Intermontane tectonic belt. It is a northwest-trending body approximately 22 kilometres long and 5 kilometres wide intruding volcanic and sedimentary rocks of the eastern belt of the Upper Triassic Nicola Group (Preto, 1979). Emplacement is interpreted to have been controlled by major northwesterly and northeasterly trending fault systems and previous workers have suggested that the batholith is subvolcanic and coeval with the Nicola Group (Northcote, 1977b).

Two plutons comprise the batholith; the Iron Mask pluton in the southeast, and the smaller Cherry Creek pluton in the northwest (Figure 2-6-1). The two plutons are separated by a belt 6 kilometres wide, probably a graben structure, containing Tertiary volcanics of the Kamloops Group (Kwong, 1987). Erosional remnants of these same Tertiary rocks are found overlying the batholith.

The Iron Mask batholith has historically and recently been a focus of mineral exploration for porphyry copper-gold deposits. Major deposits include the Afton and Ajax orebodies although there have also been numerous smaller producers within the batholith (Carr, 1957; Preto, 1968; Kwong, 1987). Surrounding Nicola rocks are also host to abundant copper showings.

The current nomenclature of the Iron Mask intrusive rocks derives from Preto (1968) and Northcote (1975, 1977a,b) who divided the batholith into four comagmatic intrusive rock types and a single unrelated intrusion. Their comagmatic intrusive units, listed from oldest to youngest, include Iron Mask hybrid, Pothook diorite, Sugarloaf diorite and Cherry Creek diorite-syenite. Previous workers also delineated small amounts of serpentinized picrite basalt, inferred to have intruded the Iron Mask batholith between emplacement of the Pothook and Sugarloaf phases (Northcote, 1977b). This paper maintains the names and basic subdivisions of these five map units. However, in two of the units, the Iron Mask hybrid and the Sugarloaf diorite, important mineralogical and textural variations necessitate further subdivision.

One of the main objectives of this fieldwork is to corroborate, re-evaluate and strengthen the relative age relationships between the intrusions comprising the Iron Mask batholith. Additionally, field observations and mapping have been directed at detailing the nature and origins of the enigmatic hybrid and picrite units. During the 1992 season, fieldwork by the senior author comprised reconnaissance mapping of the batholith and surrounding Nicola Group rocks and detailed mapping (1:300 and 1:2500) of five selected areas (Figure 2-6-1). These detailed geological maps (Figures 2-6-3 to 2-6-7) address several broad questions concerning the Nicola - Iron Mask relationship and the magmatic history of the batholith, which includes the formation of the hybrid and the petrologic relationships between the intrusive phases.

MAP UNITS

The five geological maps (Figures 2-6-3 to 2-6-7) portray seven major map units. A composite legend for these maps is provided in Figure 2-6-2. The following descriptions pertain to the rocks located in these map areas and also reflect reconnaissance observations.

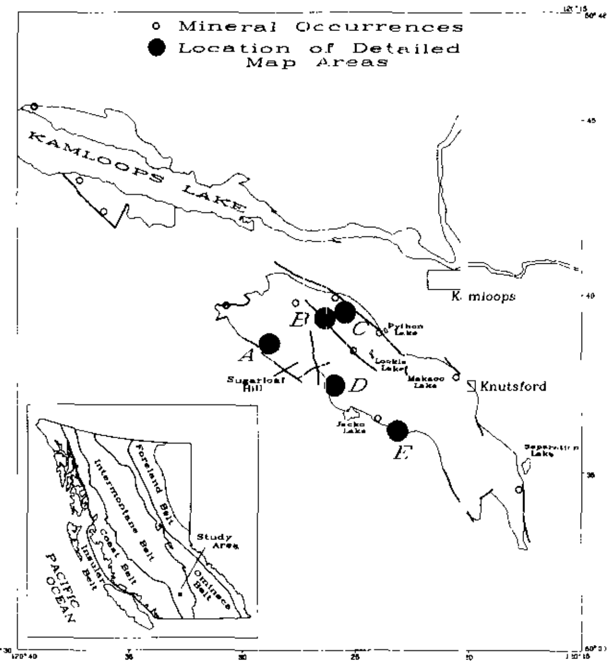

Figure 2-6-1. Location of the Iron Mask batholith showing the two separate plutons which make up the batholith and main geographical features (modified from Kwong, 1987). Inset shows tectonic setting within the Canadian Cordillera.

Nicola Group

Nicola Group rocks in the vicinity of the Iron Mask batholith consist primarily of green and purple andesitic flows, flow breccias, massive tuffs, and medium and fine-grained bedded tuffs. All rock types are metamorphosed to greenschist facies. Typical assemblages include chlorite, epidote, actinolite and calcite; locally, well-developed cleavage is observed. Nicola rocks are hornfelsed adjacent to the batholith. In contrast to other workers (*e.g.*, Cockfield, 1948; Northcote, 1977b) no plutonic rock clasts with definite Iron Mask affinities were seen in Nicola Group lithologies.

Picrite(?)

A volumetrically minor amount of serpentinized picrite basalt is found within the Iron Mask batholith. The rock consists of 15 to 30 per cent olivine phenocrysts and subordinate, rarely preserved clinopyroxene microphenocrysts in a groundmass of iron oxides and serpentine and/or talc. These serpentinized picrites occur as small pods and lenses associated with fault zones. The serpentinization is pervasive and pseudomorphic and in some instances totally replaces the original mineral assemblage.

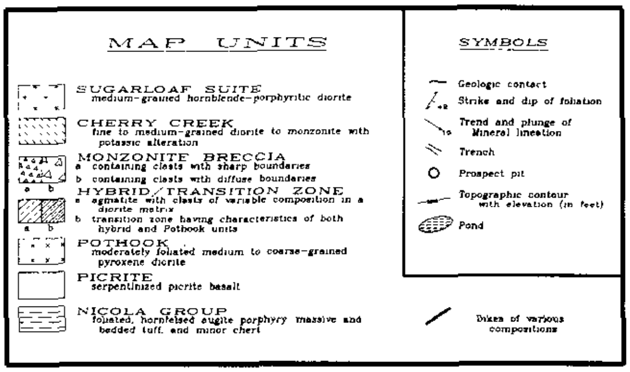

Figure 2-6-2. Map units and symbols for Figures 2-6-3 to 2-6-7.

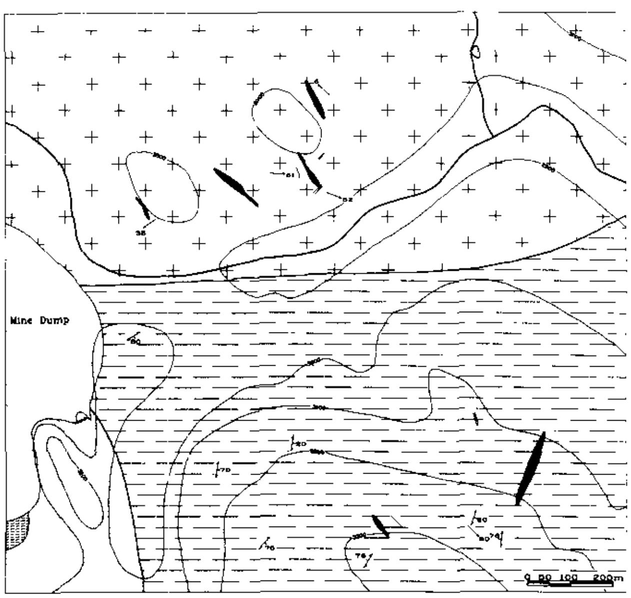

Figure 2-6-3. Map area E. This location establishes the relationship between picrite found outside the boundary of the Iron Mask batholith, Nicola Group rocks, and the Sugarloaf suite. Dikes shown on this map have been assigned to the Sugarloaf suite.

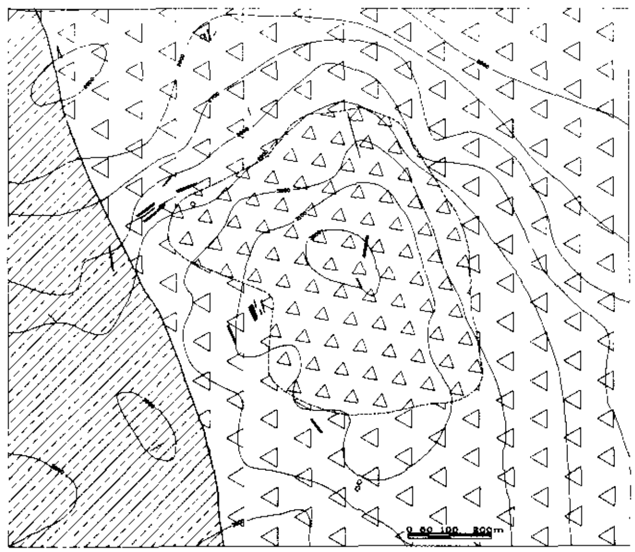

Figure 2-6-4. Map area C. This map area comprises the monzonite breccia unit. The dashed line shows the approximate boundary between clasts with sharp boundaries and clasts with diffuse boundaries.

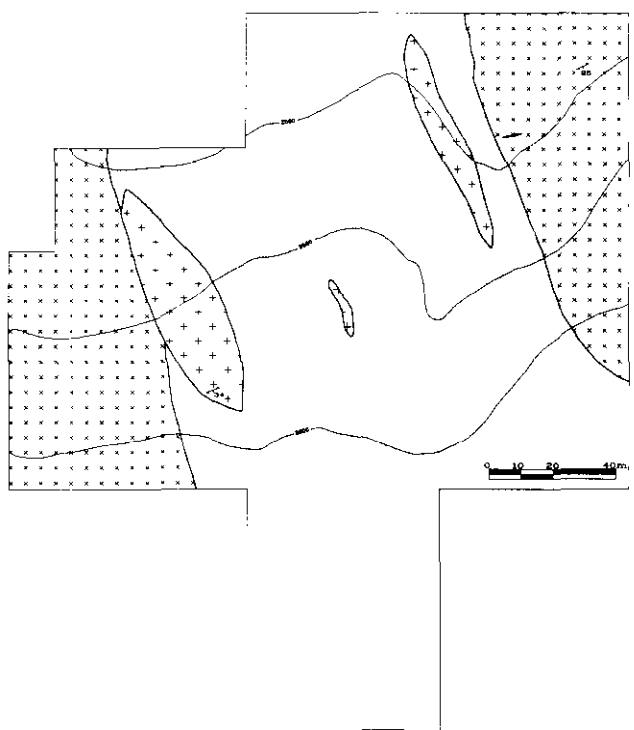

Figure 2-6-5. Map area B. Located in the north-central part of the Iron Mask pluton, this area comprises picrite basalt within the Pothook diorite. Small volumes of Sugarloaf rocks intrude the picrite.

Outside of the batholith, mineralogically and texturally similar picrite basalt is exposed at three localities. These rocks have the attribute that they are much less serpentinized and modal phenocrystic pyroxene is more commonly preserved. The first is located just outside the margin of the batholith on a small, isolated knoll southeast of Jacko Lake (Figure 2-6-3). This occurrence was mapped by Mathews (1941) as a peridotite which: "may conceivably be a part of the Nicola Formation, although similar rocks have not yet been found elsewhere in this volcanic series. On the other hand, it may represent a phase of the Ironmask batholith . . . The writer is, however, inclined to consider the peridotite as a minor intrusive unrelated to either the Nicola or Ironmask rocks." Two other occurrences are along Carabine Creek and Watching Creek on the north side of Kamloops Lake (Cockfield, 1948). Both localities are approximately 20 kilometres north-northwest of the northern contact of the Iron Mask pluton.

POTHOOK UNIT

The Pothook unit is a greenish coloured, moderately foliated, medium to coarse-grained pyroxene diorite. It generally contains poikilitic biotite on which basis it was defined. Potassic alteration in this unit is widespread and occurs mainly as well defined, potassium feldspar veinlets and, less commonly, as pervasive potassic alteration. Pothook rocks always contain abundant magnetite, mainly as disseminations and centimetre-sized veinlets. Locally, magnetite and apatite accumulations occur as dikes creating lode deposits such as the Magnet showing (Cann, 1979).

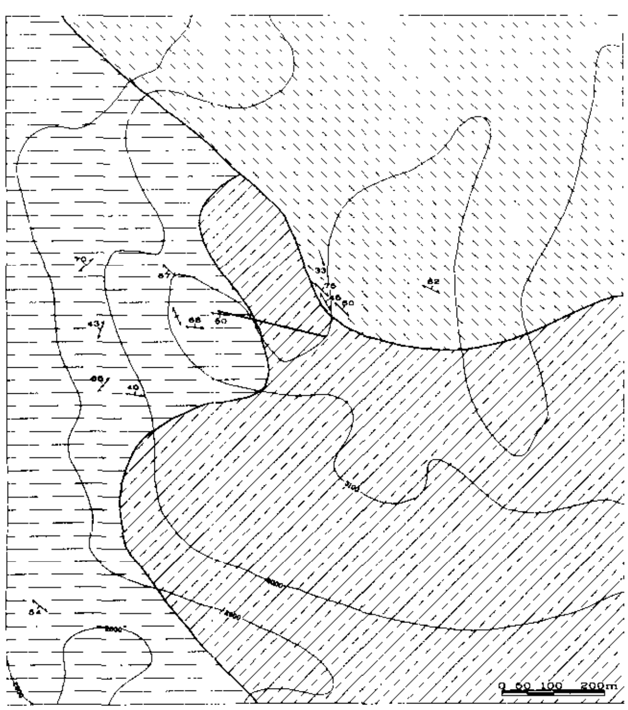

Figure 2-6-6. Map area D. Situated north of Jacko Lake, this location has exposures of the hybrid unit, Nicola Group rocks and Cherry Creek diorite which elucidate the nature of the batholith margin.

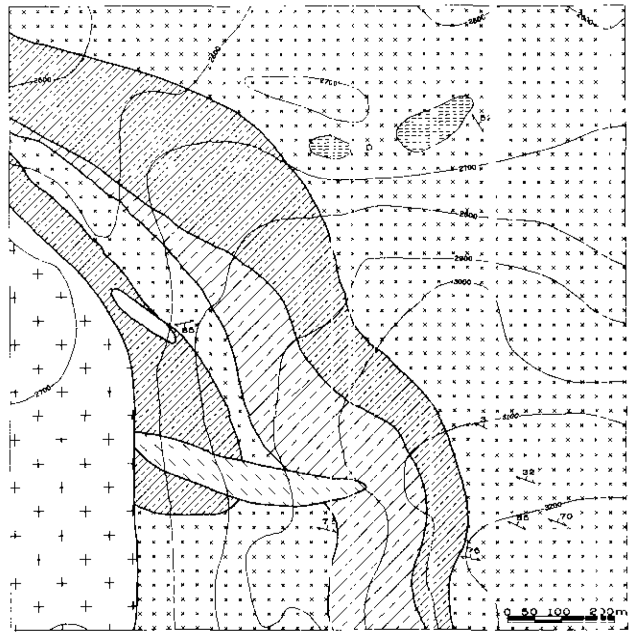

Figure 2-6-7. Map area A. This area delineates a gradational zone between the Pothook and hybrid units. Both of these units are intruded by Sugarloaf diorite.

This unit occurs as fairly small bodies in the northern part of the Iron Mask pluton roughly along the northern margins of the exposures of the Iron Mask hybrid unit. The contacts between the Pothook unit and the hybrid and Cherry Creek units are gradational.

IRON MASK HYBRID UNIT

The Iron Mask hybrid unit is of dioritic to gabbroic composition with pyroxene or hornblende ± biotite as the dominant mafic components. The textural variation in this unit is striking, ranging from fine grained to pegmatitic on an outcrop scale. In the western and central parts of the batholith, this unit is agmatitic, with clasts of coarse gabbro, medium and coarse-grained diorite, and fine-grained amphibolite in a diorite matrix. Locally, the interclast material is almost exclusively fine to coarse-grained plagioclase. In the eastern part of the batholith, the unit is more consistent in texture and composition; here it is a fine to medium-grained, unfoliated light grey diorite which contains very few clasts.

The hybrid unit is areally extensive, covering approximately one-half of the surface area of the batholith, according to Kwong's (1987) compilation. One of the results of this fieldwork is that the hybrid unit has been subdivided to allow recognition of a transitional member.

CHERRY CREEK UNIT

Rocks of the Cherry Creek unit are diorite to monzonite in composition. Generally, they are fine to medium grained and characterized by prominent, tabular, interlocking feldspar crystals. Mineralogically Cherry Creek rocks carry pyroxene, hornblende or biotite as the principle mafic phase but never contains all three phases. Fine-grained disseminated magnetite and epidote are characteristic accessory minerals.

In addition to any primary igneous compositional variations within the Cherry Creek unit there is apparent chemical variation induced by extreme potassium metasomatism. The secondary alteration is manifest as partial replacement of the ferromagnesian minerals, complete replacement of plagioclase, and a pervasive pink coloration of weathered outcrop surfaces.

The Cherry Creek unit is distributed throughout the Iron Mask batholith but the two main bodies are the Cherry Creek pluton and along the northern margin of the Iron Mask pluton. The latter area hosts the Afton copper-gold deposit which is situated on the extreme northern contact of the Iron Mask pluton.

Sugarloaf Suite

The Sugarloaf unit is a suite of hornblende-porphyritic diorites occurring as lenticular bodies and dikes along the western margin of the Iron Mask pluton and in the nearby Nicola rocks. We have subdivided the suite on the basis of texture. On Sugarloaf Hill, the Sugarloaf rocks are light grey in colour, hornblende and plagioclase porphyritic with an aphanitic groundmass. Texturally the rocks are characterized by trachytic plagioclase and aligned stubby euhedral hornblende phenocrysts. A similar sized body of Sugarloaf rocks is exposed south of Sugarloaf Hill near Jacko Lake. These rocks are light tan in colour, and contain abundant, bladed hornblende phenocrysts commonly occurring as radial aggregates with rare anhedral plagioclase phenocrysts. These diorites are themselves intruded by numerous northwest-trending dikes which, on the basis of mineralogy, have also been assigned to the Sugarloaf suite (Figure 2-6-3). The dikes are dark grey, fine-grained diorite with abundant magnetite veinlets and disseminated chalcopyrite. Secondary alteration of this suite is generally minimal except within the Ajax deposit where albitization is extensive (Ross *et al.*, in press).

Monzonite Breccia Unit

The monzonite breccia unit is a volumetrically minor part of the Iron Mask batholith which has not been reported previously. The relative age relationship and chemical affinity to the rest of the batholith is uncertain. The unit consists of fragments of hybrid unit rocks ranging in size from 0.03 to 1 metre in a fine to medium-grained biotite monzonite matrix. The boundaries between fragments and matrix are sharp or diffuse with the sharpest contacts found in exposures at the highest elevations. This difference in the nature of the boundaries forms the basis of subdivision for the breccia unit as seen in Figure 2-6-4. The breccia is cut by northwest and northeast oriented, fine-grained, light grey, biotite monzonite dikes 0.5 to 15 metres wide, which generally contain clasts of hybrid rocks at their margins.

The monzonite breccia body is somewhat teardrop shaped, trending northwest and tapering off to the south near Lockie Lake (Figure 2-6-1).

DISCUSSION

Detailed geological maps for five selected areas of the Iron Mask batholith are shown in Figures 2-6-3 to 2-6-7. These areas were chosen because of relationships within the map areas that were critical to resolving a number of key research questions concerning the units and genesis of the Iron Mask batholith. Among these questions are: the nature and origin of the picrite; the nature and variation of the spatially dominant Iron Mask hybrid unit; the relationship of the batholithic units to the host Nicola Group rocks; and, the age and genetic relationships between the major batholithic units. Preliminary results are discussed below.

Picrite – Iron Mask Relationship

The picrite unit occurs as septa, pendants and xenoliths within Iron Mask batholithic rocks and has been intruded by Sugarloaf suite rocks (Figure 2-6-5). In addition, it has been observed that the inclusions of picrite occur in the Iron Mask hybrid unit (Northcote, 1977b) and that it predates mineralization at the Ajax East pit (Ross *et al.*, in press). Therefore, the picrite unit is interpreted to be older than the batholith.

The occurrences of picrite outside the batholith have not been subjected to greenschist facies metamorphism, lack a penetrative fabric and are always found structurally overlying Nicola Group rocks (*e.g.*, Figure 2-6-3). North of Kamloops Lake picrite basalts are overlain by Tertiary Kamloops Group rocks. These observations indicate that the picrite basalts cannot be correlated with the Nicola Group and that they are probably younger. The age of this unit is therefore postulated to be post-Nicola and pre-Sugarloaf.

These interpretations conflict with several previous ideas. Firstly, the tentative correlation between the Watching Creek - Carabine Creek ultramafic rocks and the Iron Mask batholith made on the 1:250 000 Ashcroft map sheet (Monger and McMillan, 1989) is not supported. Secondly, the picrite basalts do not represent a series of plutonic bodies intruding the Iron Mask (*e.g.*, Northcote, 1977b).

Nature of the Iron Mask Hybrid

The Iron Mask hybrid unit comprises approximately 40 per cent of the outcrop of the batholith. The contact features of Nicola rocks and hybrid unit are illustrated by Figure 2-6-6. At this location, the Nicola rocks are hornfelsed fine-grained tuffs and augite porphyry. Closer to the contact, the Nicola rocks are coarsely recrystallized and contain abundant secondary(?) magnetite. Finally, at the contact, coarsely recrystallized Nicola rocks are intruded and brecciated by diorite.

Figure 2-6-7 illustrates the nature of the relationship between the Iron Mask hybrid unit and the Pothook unit. The spatial association and mineralogical similarity of these two units has already been described. Typically, they are separated by a zone of intermediate characteristics, which, if present, may be up to 250 metres wide. This transition zone comprises two end-members: partially digested mafic igneous fragments hosted in a diorite (Pothook) matrix; and foliated, fine to coarse-grained, biotite hornblende diorite with fewer fragments. The latter end-member is distinguished from the Pothook unit by the presence of hornblende and from the hybrid unit by the presence of poikilitic biotite.

Textural and mineralogical variation within the hybrid unit is dramatic and increases with clast abundance. The clast boundaries are generally nebulous and irregular with plagioclase grains commonly growing across them. The matrix can be granitic to pegmatitic in texture. Matrix material is highly variable in plagioclase content and locally is anorthositic.

These field observations record a sequence of steps associated with the generation of hybrid rocks. These steps include: the interaction of Nicola Group rocks with intrusive rocks of the Iron Mask batholith, the incorporation and disaggregation of older (Nicola?) materials into the batholith, the partial assimilation and recrystallization of these materials and, finally, the contamination and crystallization of the original magmatic material.

Youngest Phase of the Iron Mask Pluton

Previous workers have argued that the Cherry Creek unit is the youngest phase of the Iron Mask batholith (*e.g.*, Preto, 1968; Northcote, 1977b). This premise was founded on the presence of fine-grained dioritic dikes which were observed to cut all other intrusive rocks. These dikes, especially prominent in the vicinity of the Ajax property northeast of Jacko Lake, have historically been correlated with the Cherry Creek unit, thereby giving the Cherry Creek a young age by association. The correlation between these late felsic dikes and rocks of the Cherry Creek unit is subjective in that it is based on macroscopic features alone. The affinity of these late dikes can be tested further with petrography, mineral and rock chemistry, and isotopes (MDRU, in preparation). The implication is that the Cherry Creek unit probably is not as young as the late felsic dikes commonly referred to as Cherry Creek dikes (*e.g.*, Ross *et al.*, 1992).

Contacts between the Cherry Creek and Pothook units are not commonly exposed, however, there is sufficient exposure in areas near Makaoo Lake and north of Sugarloaf Hill to suggest that the contacts are gradational. This observation, together with the mineralogical and textural similarities of these units, implies a closer petrologic relationship than previously described. This would suggest that these two units are close together in age and previous workers have always considered the Pothook unit to be one of the older intrusive phases of the batholith. Furthermore, if the Cherry Creek and the Pothook are similar in age and character it is unlikely that the age of Sugarloaf suite, which is petrologically dissimilar, lies between them in time.

CONCLUSION

In view of the work conducted during the field season, a tentative reordering of the relative age relationships of the Iron Mask units is proposed. The proposed sequence of events for the major phases of the batholith is; 1) Nicola volcanic phase, 2) magmatism generating rocks of picritic composition, 3) Pothook/hybridization event followed very shortly by or consanguineous with, 4) the Cherry Creek event, and 5) intrusion of the Sugarloaf phases.

Further data in the form of detailed petrography, major, minor, trace, and rare-earth element chemistry of each of the above described units is in progress. Relevant mineral compositions will also be determined. These laboratory data will aid in describing and constraining the processes involved in the genesis of the Iron Mask batholith. Tests for cogenetic affinity and the processes of differentiation, partial melting and assimilation will be investigated using these data.

ACKNOWLEDGMENTS

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