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NEPHELINE SYENITE GNEISS COMPLEXES IN BRITISH COLUMBIA* (82M, N; 83D; 93I)

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INTRODUCTION

Nepheline and sodalite syenites in British Columbia can be divided into two main categories. The first comprises pre-orogenic, generally peralkaline agpaitic (agpaitic rocks have Na + K:Al ratio of >1:1, in miaskitic rocks Na + K:Al<1:1) syenites and/or nephelinites which may or may not be associated with carbonatites. Syenites of the Perry River (McMillan and Moore, 1974) and the Mount Copeland areas (Currie, 1975a; 1976) are of this type. The second group consists of miaskitic syenites which are generally post orogenic and not commonly associated with carbonatites. Miaskitic syenites are described by Currie (1976) as 'normal' alkaline rocks. The syenites at Kruger Mountain, Copper Mountain, and Galore Creek (*see Currie, 1975*) are in this class. This study deals with the agpaitic types as part of a project assessing the industrial mineral potential of carbonatites and related rocks throughout the province.

GEOLOGICAL SETTING

A northwest-trending belt, approximately 150 kilometres wide and encompassing the Rocky Mountain Trench, contains all known occurrences of peralkaline syenites in British Columbia (Fig. 39-1). Within this belt, carbonatites and diatreme breccias of possible kimberlitic affinity are also found (Pell, 1985; Pell, this volume; Hoy and Pell, this volume).

Many of the syenite gneisses occur west of the trench and are contained in high-grade multi-deformed metasedimentary rocks. In the Monashee Complex, north of Revelstoke, syenites occur at Mount Copeland (Fyles, 1970; Currie, 1975a) and in the Perry River area (McMillan, 1970; McMillan and Moore, 1974; Hoy and Pell, 1986). In both these areas the syenites occur within a pelitic and calcsilicate, paragneiss succession, the autochthonous mantling gneisses of the Frenchmans Cap dome. The age of this succession is not strictly known; however a U/Pb date of 773 Ma (Okulitch *et al.*, 1981) was obtained from the syenite gneisses at Mount Copeland. At Perry River syenites occur both with and without associated carbonatites. The syenite gneisses at Mount Copeland have no recognized associated carbonatites.

In the Northern Monashee Mountains alkalic rocks intrude metasedimentary rocks of the Hadrynian Horsethief Creek Group, marginal to the Shuswap Metamorphic Complex.

Northeast of Blue River, near Paradise Lake, nepheline syenite gneisses are associated with carbonatites (Pell, 1985) which have been dated at 325 Ma (U/Pb zircon date, Parrish and White, personal communication). On Trident Mountain, southeast of Mica Creek, very similar nepheline and sodalite syenites crop out but significant carbonatites have not been found.

East of the Rocky Mountain Trench there are three main areas in which nepheline syenites are found: the Ice River Complex, southeast of Golden (Currie, 1975b); the Kinbasket Lake/Sullivan River area, east of Trident Mountain (Fyles, 1959; Currie, 1976); and on Bearpaw Ridge, east of Prince George (Pell, 1985; Taylor and Stott, 1980). In these areas the syenites are hosted in Cambrian to Silurian sedimentary rocks which have been weakly to moderately metamorphosed and deformed. The only age dates available for these rocks are from the Ice River Complex. K/Ar dates range from 220 to 390 Ma, while whole rock Rb/Sr dates range from 220 to 280 Ma (*see Currie 1975b*). Currie (1975b) favours an age of approximately 245 Ma. Recently, a U/Pb zircon date of 380 Ma (Parrish, personal communication) was obtained. This latter date most likely represents the true age of the Ice River Complex.

A minor amount of carbonatite is present in the Ice River Complex. The sodalite syenite on Bearpaw Ridge is not associated with carbonatite. Syenites in the Sullivan River area have been poorly documented and the presence of carbonatites has not, as yet, been verified. Fyles (1959) reports "Geiger counter field tests (of the syenites) gave counts only as high as twice the normal background count. Highest counts were obtained from altered limestones near the syenite . . .". The possibility exists that the 'altered limestones' could in fact be carbonatites.

GEOLOGY AND PETROLOGY OF THE SYENITIC ROCKS

The syenitic gneisses in the Mount Copeland (Fyles, 1970; Currie, 1975a), Perry River (McMillan, 1970; McMillan and Moore, 1974), and Ice River (Currie, 1975b) areas have been described in detail and need not be reviewed here. The first two areas have been sampled for zircon extraction, additional geochemistry, and detailed petrography (scanning electron microscopy) but results are not yet available. Fieldwork was concentrated in the Trident Mountain area (1985 field season) and at Paradise Lake and Bearpaw Ridge (1984 field season).

TRIDENT MOUNTAIN (82M/16)

Nepheline syenites were first recognized in the Trident Mountain area by Wheeler (1965) and subsequently mapped by Perkins (1982). A few days were spent sampling and remapping these syenitic gneisses during the field season. The area is very rugged, the syenites are exposed on cliffs at 2 200 to 3 000 metres elevation adjacent to large icefields.

The syenite gneisses at Trident Mountain (Fig. 39-2) are white to grey weathering, medium grained and composed of pink and white feldspars (orthoclase and plagioclase), nepheline and biotite with locally abundant amphibole, sodalite, sphene, ilmenite, apatite, and zircon (crystals up to 1.5 centimetres in size). Very coarse-grained pegmatitic segregations are sporadically developed. They are concordant with hosting psammitic and kyanite-bearing pelitic schists of the Hadrynian Horsethief Creek Group and are exposed in the core of an early isoclinal antiform which is refolded by late upright to overturned structures (Perkins, 1982). The syenites have compositional layering and a foliation parallel to the margins of the body and also parallel to the axial plane of the antiform and the

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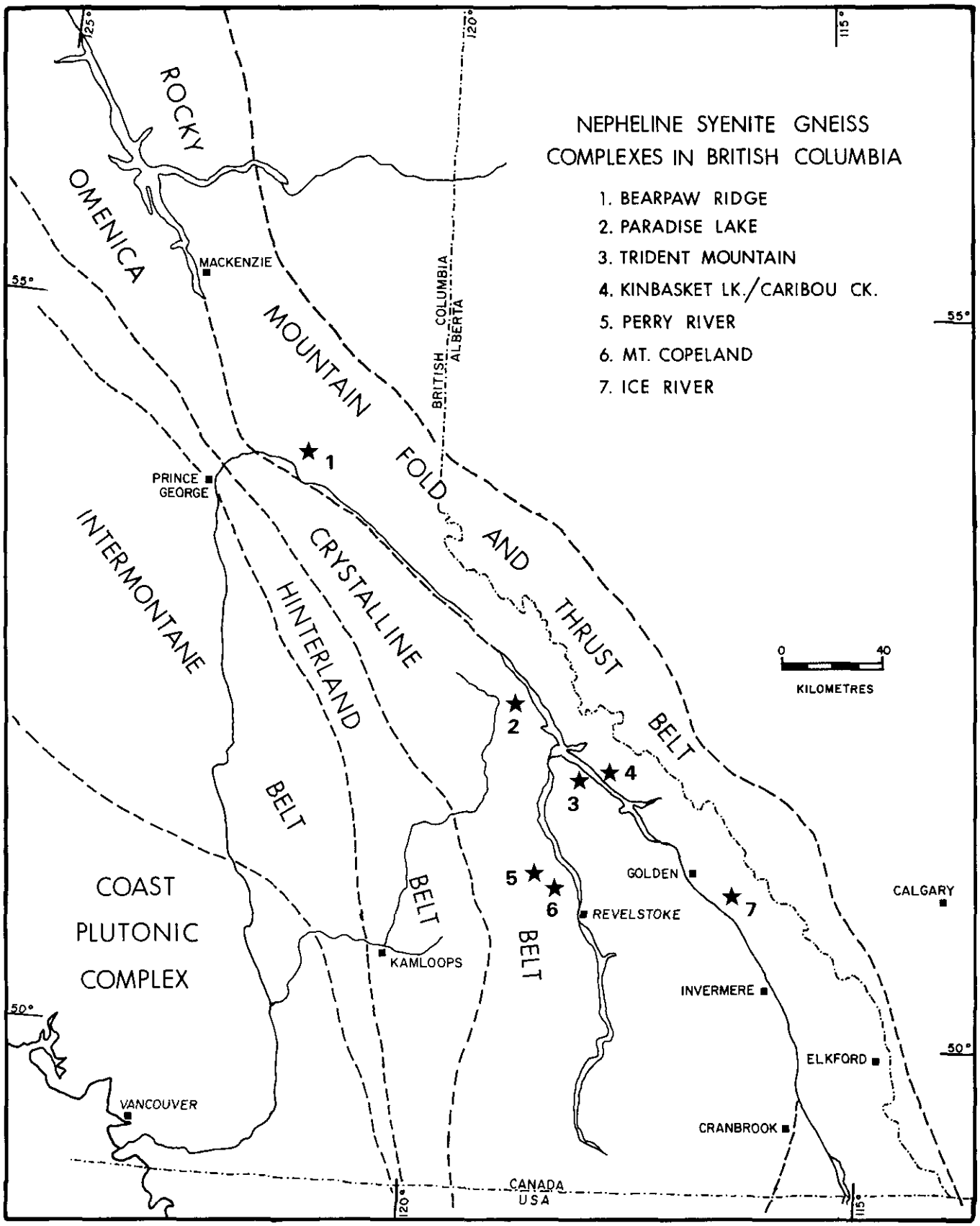

Figure 39-1. Distribution of nepheline syenites and related rocks in British Columbia.

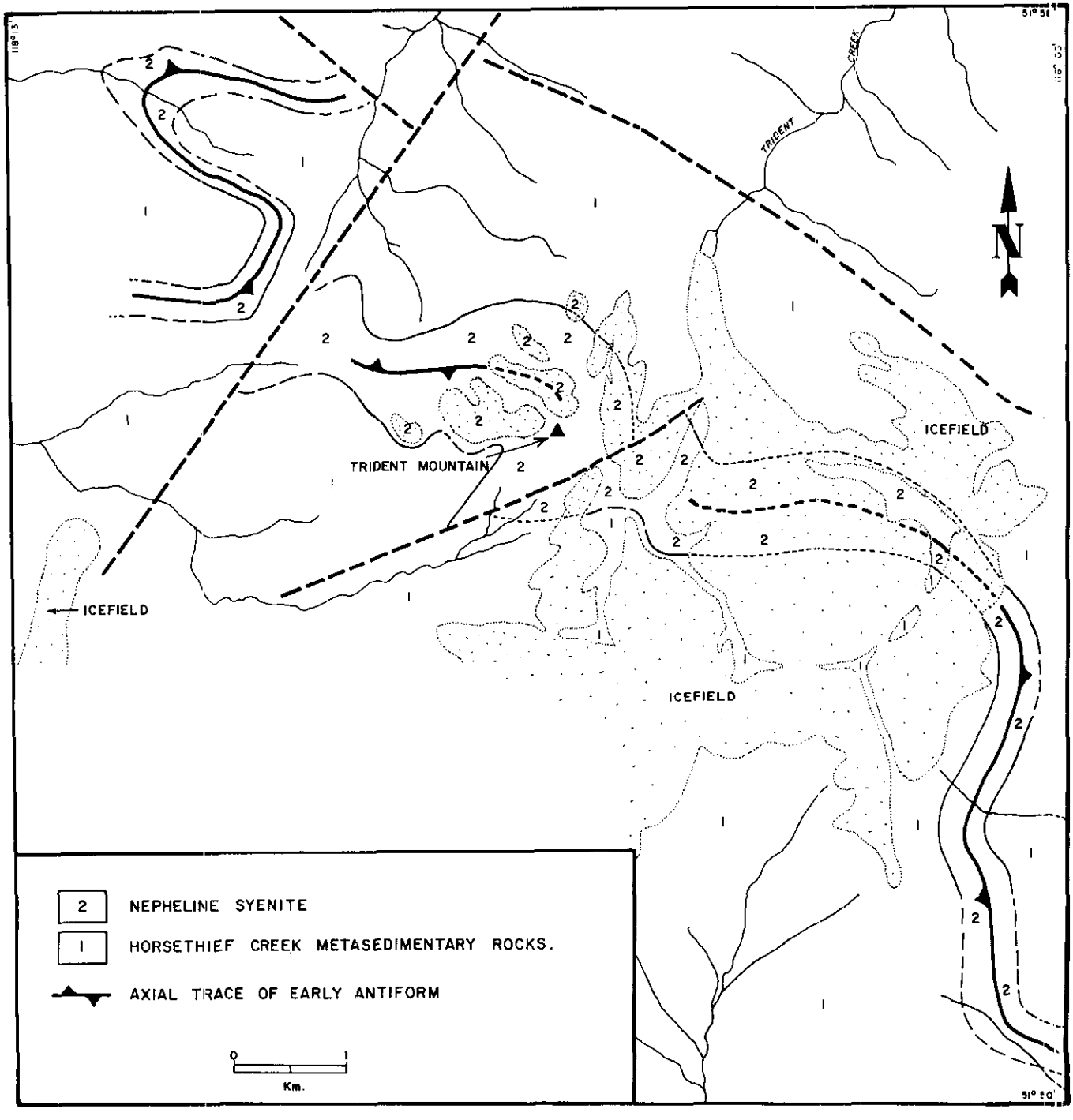

Figure 39-2. Geology of the Trident Mountain area, Selkirk Mountains, British Columbia (modified from Perkins, 1983).

Plate 39-1. Trident Mountain, banded syenite.

Plate 39-2. Trident Mountain, leucocratic syenite cutting more mafic phase.

Plate 39-3. Mafic inclusions in a biotite-rich phase of the Trident Mountain syenite.

bedding in the metasedimentary rocks. The layering (Plate 39-1) is defined by leucocratic (biotite approximately 10 per cent) and melanocratic (biotite approximately 40 per cent) phases with occasional calcareous layers (sovite sweats ?). Mafic gneisses rich in amphibole, biotite, and sphene are also present at Trident Mountain but were not observed in outcrop. These mafic gneisses are cut by dykes of leucosyenite (Plate 39-2). Contacts between mafic gneisses and syenite dykes are sharp. Xenoliths of country rock or mafic gneisses were also observed (Plate 39-3). They have very diffuse borders suggesting reaction with or partial digestion by the syenitic magma. Neither dykes nor syenite crosscutting host metasedimentary rocks were observed.

The nepheline and sodalite syenite gneisses at Trident Mountain are very similar to those at Paradise Lake (Pell, 1985), 90 kilometres to the northwest; however, at Trident Mountain they intrude a slightly lower part of the Horsethief Creek Group stratigraphic succession.

PARADISE LAKE (83D/6)

The syenite gneisses at Paradise Lake have been described previously (Pell, 1985) so only a brief review and some additional notes on their petrography will be presented here. The Paradise Lake syenites are white to grey-weathering, medium-grained, layered and foliated gneisses concordant with hosting Hadrynian Horsethief Creek Group rocks. Layering and foliation are parallel to the margins of the gneiss, to bedding in surrounding metasedimentary rocks, and to the regional foliation. The contact between the syenite and metasedimentary rocks is, in places, gradational.

The syenites are typically composed of 25-35 per cent plagioclase ($An_{?}0$-40), 25-35 per cent orthoclase, 15-30 per cent nepheline, 7-15 per cent biotite, and 1-10 per cent muscovite. Accessory minerals may include calcite, pyrrhotite, ilmenite, magnetite, cancrinite, sodalite, zircon, pyrochlore [$(Na,Ca,Ce)_2(Nb,Ti,Ta)_2O_6(OH,F)$] and uranopyrochlore.

BEARPAW RIDGE (93I/4)

Sodalite syenite on the northwest end of Bearpaw Ridge intruded volcaniclastic rocks of the Silurian Nonda Formation prior to the Jura-Cretaceous Orogeny. It was first mapped by Taylor (1980) and subsequently remapped by Pell (1985). During the 1985 field season the syenite was sampled to allow separation of zircons for age determinations.

The syenite occurs in low rounded outcrops on the crest of Bearpaw Ridge north of Sinclair Mills. It is a medium-grained rock with a white to grey fresh surface. It is composed of 40-50 per cent plagioclase, 30-40 per cent orthoclase, 5-10 per cent mafic minerals (either secondary chlorite after biotite and epidote or amphibole and aegirine and biotite), 2-5 per cent magnetite and local ilmenite. Accessory minerals include sodalite, muscovite, zircon, allanite, apatite, monazite, thorite ($ThSiO_4$), and pyrochlore.

A second, distinctly different and clearly post-orogenic syenite crops out on the lower slopes of Bearpaw Ridge along an old logging road north of Sinclair Mills. It is pink to white weathering and has a pink fresh surface. The primary constituents are randomly oriented coarse feldspars, often greater than 5 millimetres in size, which make up 70-80 per cent of the rock (20-25 per cent plagioclase, 30-35 per cent orthoclase, and 10-20 per cent microperthite). Other phases present are aegirine-augite (10 per cent), hornblende (5-10 per cent) rimmed by a prussian blue sodic amphibole, and magnetite (5-8 per cent). Accessory minerals include apatite, biotite, ilmenite, pyrite, arsenopyrite, sphalerite, barite, and monazite. This syenite is lithologically similar to Cretaceous alkaline intrusions and dissimilar to the pre-orogenic sodalite syenite on the crest of Bearpaw Ridge.

CONCLUSION

There are many lithologic similarities between the various syenites included in this study. Biotite is the most commonly developed mafic mineral, except at Ice River and in some phases of the Mount Copeland gneisses where pyroxenes dominate. Peralkaline minerals such as sodalite are common. Accessory phases often include zircon, sphene, and pyrochlore.

There were apparently at least two periods during which the intrusion of peralkine and carbonatite-related syenites occurred. The first is around 770 Ma but is based on a single U/Pb age; it may be related to a Hadrynian rifting or extensional episode. The second is apparently much younger, 380-325 Ma and suggests that extensional tectonics were active along the western North American continental margin during Devonian to Mississippian times. Further work will include detailed petrography, geochemistry, and age dating in order to assess the economic potential of syenite complexes.

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REFERENCES

Currie, K. L. (1975a): Notes on the Petrology of Nepheline Gneisses near Mount Copeland, British Columbia, *Geol. Surv., Canada*, Bull. 265, 31 pp.

————(1975b): Geology and Petrology of the Ice River Alkaline Complex, British Columbia, *Geol. Surv., Canada*, Bull. 245, 65 pp.

————(1976): The Alkaline Rocks of Canada, *Geol. Surv., Canada*, Bull. 239, 228 pp.

Fyles, James T. (1959): Geological Reconaissance, Columbia River, 1958, *B.C. Ministry Energy, Mines & Pet. Res.*, Open File Rept., pp. 27-29.

————(1970): The Jordan River Area, near Revelstoke, British Columbia, *B.C. Ministry Energy, Mines & Pet. Res.*, Bull. 57, 64 pp.

Höy, T. and Pell, J. (1986): Carbonatites and Associated Alkalic Rocks, Perry River and Mount Grace Areas, Shuswap Complex, Southeastern B.C., *B.C. Ministry Energy, Mines & Pet. Res.*, this issue.

McMillan, W. J. (1970): West Flank, Frenchmans Cap Gneiss Dome, Shuswap Terrane, British Columbia; *Geol. Assoc. Can.*, Special Paper 6, pp. 99-106.

————(1974): Gneissic Alkalic Rocks and Carbonatites in the Frenchmans Cap Gneiss Dome, Shuswap Complex, British Columbia, *Cdn. Jour. Earth Sci.*, Vol. 11, pp. 304-318.

Okulitch, A. V., Loveridge, W. D., and Sullivan, R. W. (1981): Preliminary Radiometric Analyses of Zircons from the Mount Copeland Syenite Gneiss, Shuswap Metamorphic Complex, British Columbia, *Geol. Surv., Canada*, Current Research, Pt A, Paper 81-1A, pp. 33-36.

Pell, J. (1986): Diatreme Breccias in British Columbia, this issue.

————(1985): Carbonatites and Related Rocks in British Columbia, *B.C. Ministry Energy, Mines & Pet. Res.*, Geological Fieldwork, 1984, Paper 1985-1, pp. 84-94.

Perkins, M. J. (1983): Structural Geology and Stratigraphy of the Northern Big Bend of the Columbia River, Selkirk Mountains, Southeastern British Columbia, Unpublished Ph.D. Thesis, *Carleton University*, Ottawa, Ontario, 238 pp.

Taylor, G. C. and Stott, D. F. (1980): Monkman Pass (93I) Map-Area British Columbia, *Geol. Surv., Canada*, Open File 630.

Wheeler, J. O. (1965): Big Bend Map-Area, B.C., *Geol. Surv., Canada*, Paper 64-32.