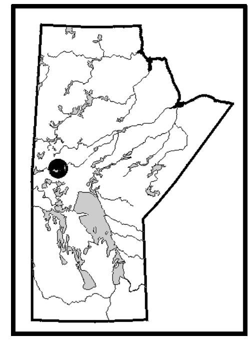
GS-7 RARE EARTH GEOCHEMISTRY OF THE SNEATH LAKE MINERAL OCCURRENCE (NTS 63K16), MANITOBA

by G.H. Gale



Gale, G.H. 2002: Rare earth geochemistry of the Sneath Lake mineral occurrence (NTS 63K16), Manitoba; *in* Report of Activities 2002, Manitoba Industry, Trade and Mines, Manitoba Geological Survey, p. 63–68.

SUMMARY

Examination of drill core from two holes drilled into an electromagnetic conductor at Sneath Lake indicates that the holes intersected different types of sulphide mineralization. Drillhole CMB-1 intersected layered solid sulphide and exhalite-bearing felsic sandstone. Drillhole CMB-2, located approximately 100 m along the strike of the same conductor, intersected sections of solid sulphide, but much of that sulphide is sheared. Within the sheared sulphides and associated biotite-chlorite schist are blocks of recrystallized earthy pyrite and a block of layered sphalerite-bearing, medium-grained pyrite derived from a solid sulphide lens of volcanogenic massive sulphide (VMS) type. Positive Eu anomalies are associated only with the exhalite-bearing rocks and layered zinc-bearing sulphide mineralization, whereas negative to flat Eu anomalies are associated with sheared mafic rocks and recrystallized earthy pyrite. The geochemical data illustrate the application of rare earth elements (REE) in the correlation of sulphide-bearing strata.

INTRODUCTION

The Sneath Lake property of Callinan Mines Ltd. is situated 10 km southwest of the volcanogenic massive sulphide deposits at Anderson Lake and 5 km southeast of those at Chisel Lake. The volcanic rocks at Sneath Lake are either at the same stratigraphic level as, or slightly below, those that host the Anderson mine (A.H. Bailes, pers. comm., 2002). A major fault separates the volcanic rocks from a younger, high-level felsic intrusion. Previous exploration in the Sneath Lake area included a number of holes drilled to investigate electromagnetic conductors.

Callinan Mines Ltd. optioned the property and conducted an electromagnetic survey that identified a previously untested conductor. This conductor, intersected by hole CMB-1 in 2000, was explained by a short section of near-solid pyrite with trace to minor metal values. The author analyzed a number of samples of the sulphides and silicate hostrocks as part of an ongoing program to test the use of REE data, specifically an increase in Eu relative to other REE, to vector VMS mineralization (Gale et al., 1997).

A positive Eu^d anomaly[1] was detected in the sulphides and silicic hostrocks adjacent to the sulphide intersection. This anomaly prompted the company to drill hole CMB-2 along the same conductor in 2001. Hole CMB-2 intersected near-solid sulphides, altered rocks and minor base-metal concentrations, but the sulphides are different than those intersected in drillhole CMB-1. This report documents the geochemistry of core and pulp samples and observations made on the drill cores, and shows how REE data can be used to establish that there are differences in origin of the sulphides in the two drillholes.

GEOLOGY

The Sneath Lake area is underlain predominantly by felsic volcanic rocks that range from aphyric to quartz-feldspar phyric with up to 15% phenocrysts. The area of interest is separated from the dominantly mafic volcanic rocks to the west by the Edwards Lake Fault; however, it appears from the geological maps (Fig. GS-7-1) that the felsic volcanic rocks continue westward on the west side of that fault (Bailes and Galley, 1992, 1996).

Mineralogical studies indicate that rocks west and north of Sneath Lake are locally intensely altered; these rocks include quartz-biotite-chlorite-garnet and amphibole-quartz±biotite±garnet±chlorite±sulphide mineral assemblages (Paradis et al., 1998). Several regional, east-striking faults and splays dissect the felsic rocks and may, to some extent, control the overall distribution of stratigraphic units.

MINERALIZATION

Disseminated sulphides are associated with some of the altered felsic rocks, and small areas of rusty-weathered rocks occur west of Sneath Lake. Solid sulphide, near-solid sulphide and sulphide-bearing chlorite-biotite schist are present in drill cores. The mineralization in the two drillholes, CMB-1 and CMB-2, is described and compared below.

[1] Eu^d = % deviation chondrite normalized Eu from Eu* (*see* Gale et al., 1997)

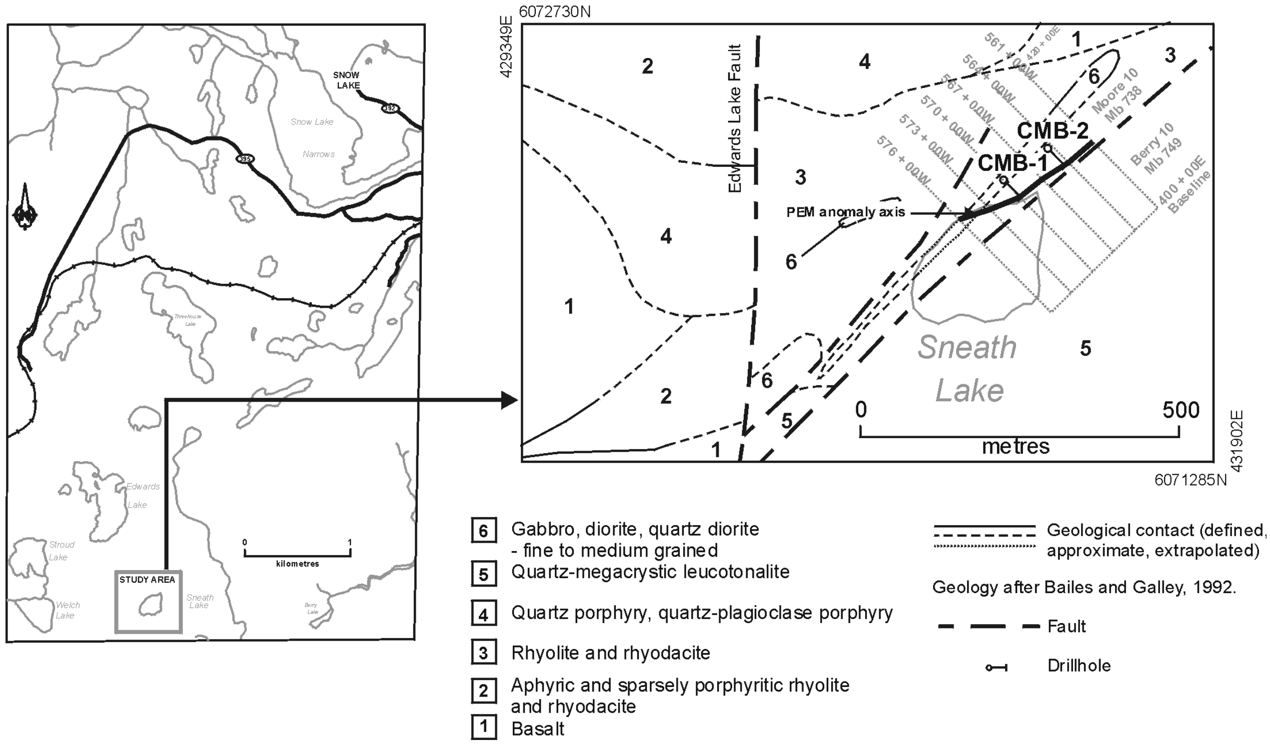


Figure GS-7-1: Geological setting of the Sneath Lake occurrence.

Drillhole CMB-1

Drillhole CMB-1 intersected 25 cm of medium-grained, near-solid sulphide mineralization comprising 75 to 80% pyrite, 5 to 7% pyrrhotite and trace chalcopyrite and sphalerite. This is underlain by a 70 cm thick unit of quartz-rich rock containing 10 to 15% pyrrhotite, 5 to 7% pyrite, trace chalcopyrite and sphalerite and 1 to 3 mm biotiteporphyroblasts. Assays indicated maximum values of 0.10% Cu and 0.25% Zn over a 35 cm interval. This mineralization is hosted in 'altered rhyolite'.

Drillhole CMB-2

Drillhole CMB-2 intersected a 7.5 m thick zone of mineralized rocks that include biotite-chlorite schist, quartz-carbonate rock and near-solid sulphide. Assays indicated maximum concentrations of 0.10% Cu and 0.43% Zn in a 1.3 m section. This mineralization is hosted by felsic volcanic rocks and 'overlies' basalt.

The sulphide-bearing section contains:

4.6 m[2] felsic volcanic rocks

62.6 quartz-biotite-sericite schist

63.2 coarse-grained pyrite and pyrrhotite, with coarse-grained biotite

63.7 75 to 90% pyrite, minor pyrrhotite and sphalerite; banded and/or layered

64.1 chlorite-biotite schist with sheared pyrite and pyrrhotite; includes coarse biotite books with pyrite pressure shadows

65.2 quartz-vein fragments in sheared sulphides and chlorite-biotite schist; late brittle deformation textures include pyrite-pyrrhotite veinlets around rock fragments

[2] start of core section (in metres)

67.2 solid sulphide: layered pyrite and minor sphalerite

68.3 earthy pyrite, fine grained, in a block with diffuse boundaries resulting from recrystallization of pyrite at block boundaries

68.4 grey-green quartz vein with sulphide mobilizate

68.5 solid sulphide, sheared

68.8 quartz vein

68.9 sheared biotite and chlorite with recrystallized and mobilized pyrite and pyrrhotite

69.6 earthy pyrite block

69.7 quartz vein and sheared volcanic rocks

69.8 (?)layered mafic rocks with biotite-rich sections.

70.1 basalt, (?)unaltered, foliated, biotite books in 'veins'

72.5 basalt; includes breccia and massive portions

Shear textures in the sulphides, biotite-chlorite schist and blocks of quartz-vein material all suggest that the sulphide-rich section in CMB-2 is part of a late brittle-ductile deformation zone. Thus, the CMB-2 sulphide-rich section has an origin that is quite different from the layered exhalite and sulphides intersected in drillhole CMB-1, even though the geophysical survey indicates that they form part of the same conductor.

GEOCHEMISTRY

Samples of hostrocks, exhalite and sulphide-bearing rocks were analyzed from drill cores CMB-1 and CMB-2 for major elements, trace elements and REE.

Samples from CMB-1

Samples of layered silicate rocks from CMB-1 plot on a feldspar model diagram (Fig. GS-7-2a) above the sericite line (slope 1/3), even though many of them contain chlorite as a mineral species; in altered rocks with chlorite as an alteration product, they should plot below the sericite line (Madeisky and Stanley, 1993). Addition of K and moderate depletion of Na and Ca are indicated by the potassium alteration diagram (Fig. GS-7-2b), where a number of the samples plot to the left of the vertical line, which separates altered rocks on the left from unaltered rocks on the right. Therefore, the silicate rocks are not the products of intense footwall hydrothermal alteration, and probably represent a mixture of altered rocks and exhalite. The K-metasomatism indicated by Figure GS-7-2b may be an indication of either the outer margins of a VMS alteration zone or K-rich exhalite. The widely different Al/Zr ratios (Fig. GS-7-2a) indicate that the silicate rocks and the silicate matrices to the sulphide-bearing rocks have more than one protolith. In addition, samples with Al/Zr ratios that plot well outside the fields for felsic and mafic volcanic rocks on Figure GS-7-2a appear, on visual examination, to be chemical sedimentary rocks.

Samples from CMB-2

Samples from CMB-2 contain intensely altered K-rich rocks with moderate Na and Ca depletion and plot close to the line with a slope of 1 (Fig. GS-7-2a). These chlorite-rich rocks plot close to the sericite line on Figure GS-7-2b, but do not appear to have undergone addition of Mg during alteration. The two samples that are relatively unaltered in alkali elements (i.e., plot to the right of the vertical line on the potassium alteration diagram in Fig. GS-7-2b) are sulphide-rich rocks with blocks of earthy pyrite. The wide range in Al/Zr ratios indicates that these rocks also do not have a common protolith.

The REE chemistry for samples from CMB-2 is distinctly different than that for CMB-1 (Fig. GS-7-3), in that the

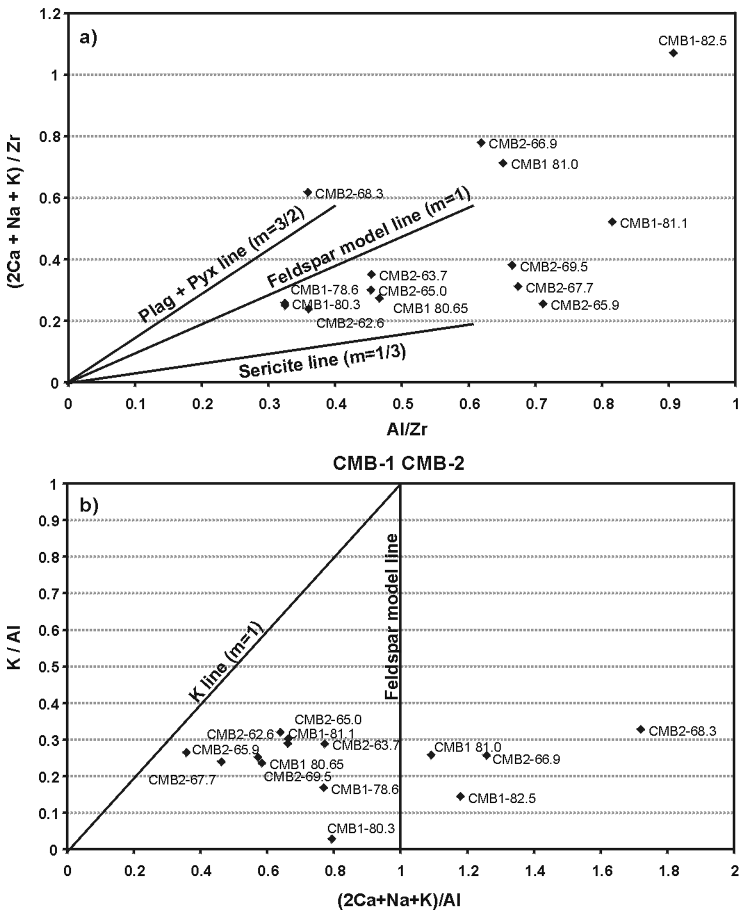


Figure GS-7-2: a) Feldspar model diagram for samples from Sneath Lake drill core. Unaltered felsic rocks generally plot along the feldspar model line on this diagram and basaltic rocks plot between the feldspar model line and the plag+cpx line. b) Potassium alteration diagram for samples from the Sneath Lake drill core. Unaltered rocks normally plot to the right of the vertical line on this diagram and mafic rocks plot well to the right, whereas rhyolite plots along or close to the vertical line.

silicate rocks do not have positive Eu^d values. The one sample from CMB-2 (CMB2-63.7) with a distinctive positive Eu^d anomaly is a sample of layered, near-solid sulphides typical of the layered sulphide lenses in VMS deposits. Three other sulphide-rich samples (CMB2-65.0, -65.9 and -66.9) with weakly negative to near-zero Eu^d values are a mixture of different types of sulphides in the shear zone and contain blocks of earthy pyrite, recrystallized earthy pyrite, pyrite-pyrrhotite-chalcopyrite mobilizate and (?)layered sulphide. The differences in their Eu^d values from that of sample CMB2-63.7 is a reflection of the different type of sulphide present in the samples.

The REE geochemistry is consistent with observations on other sulphide deposits, in that the sample with blocks of exhalite-derived layered sulphides has a definite positive Eu^d anomaly, whereas samples with earthy pyrite and sulphide mobilizate do not show this anomaly. In general, earthy pyrite has negative Eu^d values and sulphide mobilizate has weakly negative to near-zero Eu^d values. The REE data also suggest that the chlorite-biotite schist in CMB-2 represents sheared basalt because it does not have the strong negative Eu^d values of chlorite schist in the footwall alteration zones of VMS deposits.

CONCLUSIONS

Both the major-element and the REE data confirm differences between the sulphides and the immediate hostrocks intersected in drillholes CMB-1 and CMB-2, and substantiate the visual observations that these are not parts of a single contiguous sulphide lens, even though they appear to be part of the same conductor. This illustrates one of the uses of REE data in correlating metalliferous strata.

Drillhole CMB-1 intersected metal-poor, solid sulphides associated with chemical and clastic sedimentary rocks

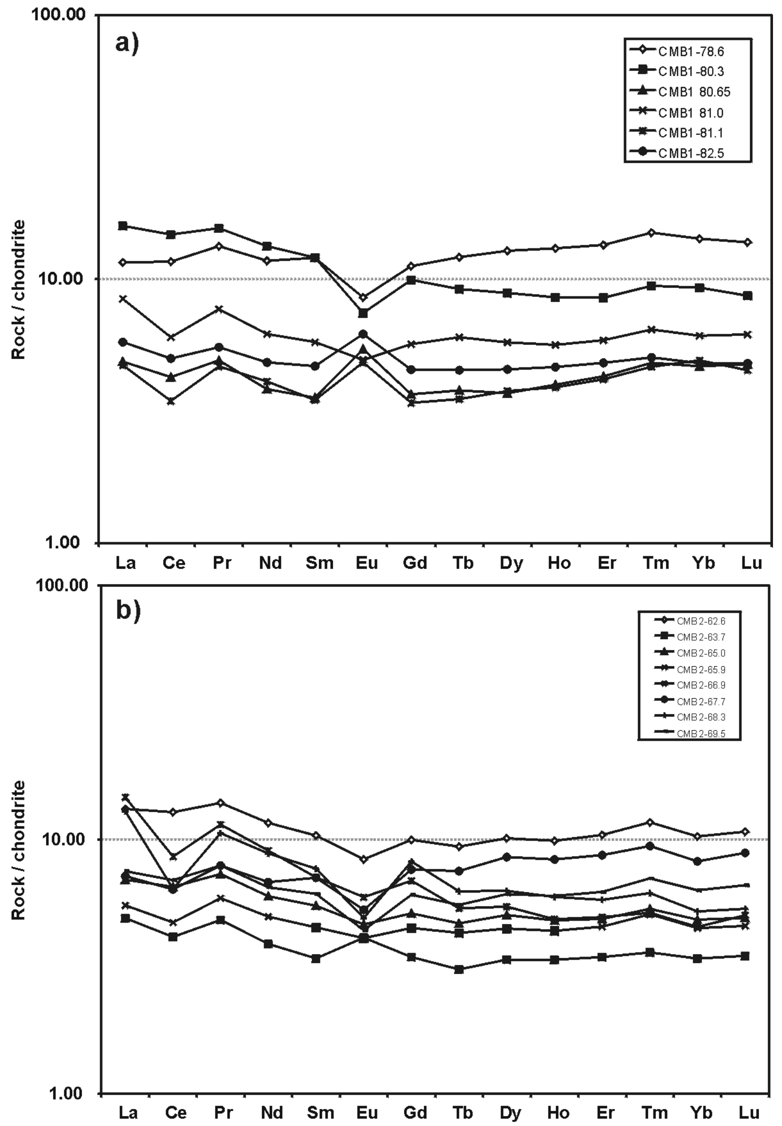


Figure GS-7-3: REE profiles for samples from drill cores CMB-1 (GS-7-3a) and CMB-2 (GS-7-3b).

derived, in part, from a VMS-type hydrothermal vent. These rocks are characterized by the presence of layered pyrite, alkali alteration and Eu^d >0 in the associated sedimentary rocks. Drillhole CMB-2, drilled along the same conductor, intersected sheared sulphides that included blocks of layered VMS-type sulphides, as indicated by the layered sphalerite-bearing sulphides and the presence of Eu^d >0 in the sample with sphalerite. The chlorite-biotite–rich rocks in the shear zone contain stringers of sulphides mobilized partly from earthy pyrite and partly from a source that included material from a VMS-type sulphide lens. The chemistry of the chlorite-bearing samples suggests that they are not the intensely altered and magnesium-enriched rocks commonly found in the immediate footwall of VMS deposits.

The blocks of sphalerite-bearing, near-solid sulphide in CMB-2 have been sheared from an undiscovered metal-rich sulphide body. In addition, the presence of Eu^d >0 values in some of the sulphides and exhalites indicate that the hydrothermal fluids were sufficiently hot and low in pH to form metal-rich VMS deposits. Further exploration should focus on the geology and geochemistry of the hostrocks, in order to establish viable drill targets.

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