A note on preliminary lithogeochemistry of the Fire Lake area

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ABSTRACT

The Fyre Lake volcanic-hosted massive sulphide (VMS) deposit is located about 160 km northwest of Watson Lake in the Finlayson Lake district of southeastern Yukon. The deposit is hosted by Devonian (?) and Mississippian rocks of the Yukon-Tanana Terrane and occurs close to the contact between chlorite schist and overlying carbonaceous phyllite. Copper-cobalt-gold mineralization occurs in two parallel zones: West Kona and East Kona.

The chemical composition and rare earth element (REE) pattern of chlorite schist which hosts the Kona zones is unique in the Fire Lake area. The data indicate that the protolith of these meta-volcanic rocks has a boninitic affinity and was likely derived from a depleted source region. Mafic meta-volcanic rocks (chlorite schist) elsewhere in this area are tholeiitic and may have developed in an arc or rift-related setting. Analyses of psammitic schists in the hanging wall of the West Kona zone indicate the rocks are felsic in composition and were likely deposited in a mature arc or continental-margin setting.

RÉSUMÉ

Le gisement Fyre Lake de sulfures massifs d'origine volcanique (SMV) est situé à environ 160 km au nord-ouest de Watson Lake dans le district de Finlayson Lake au sud-est du Yukon. Le gisement se trouve dans les roches dévoniennes (?) et mississippiennes du terrane de Yukon-Tanana à proximité du contact entre le chloritoschiste et la phyllite carbonée sus-jacente. Deux zones parallèles sont minéralisées en cuivre, en cobalt et en or : les zones West Kona et East Kona.

La composition chimique et le profil en éléments du groupe des terres rares du chloritoschiste renfermant les zones Kona sont particuliers dans la région du lac Fyre. Les données indiquent que le protolithe de ces roches métavolcaniques présente une affinité boninitique et provenait vraisemblablement d'une région source appauvrie. Les roches métavolcaniques (chloritoschiste) ailleurs dans cette région sont tholéiitiques et se sont vraisemblablement formées dans un cadre de guirlande continentale ou de guirlande océanique. Des analyses des micaschistes arénacés dans la lèvre supérieure de la zone West Kona indiquent que les roches sont de composition felsique et ont vraisemblablement été déposées dans un cadre continental à maturité avec un apport mineur d'une source davantage primitive.

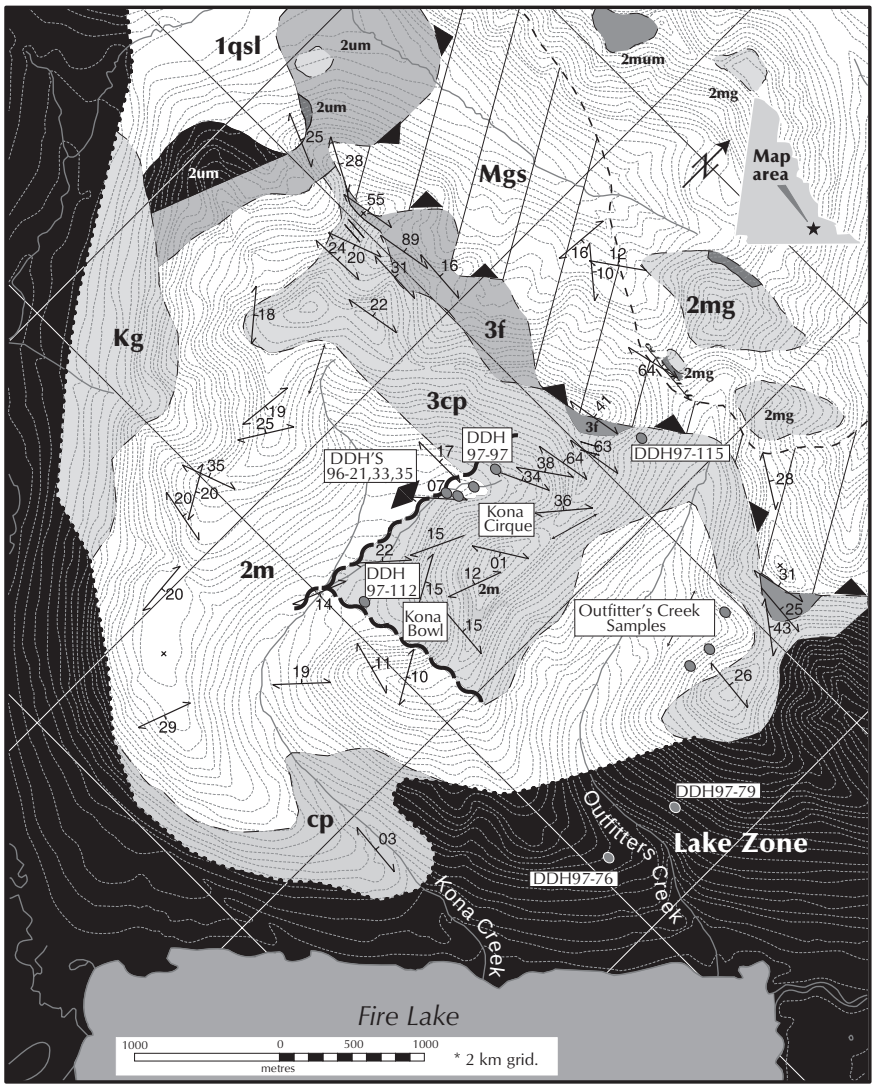

Figure 1. *Location of the Fire Lake area plus the Kona Cirque, Outfitter's Creek, Lake Zone and Kona Bowl areas. Black diamond is the Fyre Lake deposit, and black triangles on over-riding plate of a thrust fault. Black area is vegetated and unmapped.*

Kg *- Cretaceous age, weakly foliated, generally equigranular, medium- to coarse-grained biotite-muscovite granite*
Mgs *- Mississippian medium- to coarse-grained, variably strained granite.*
2mg *- fine- to coarse-grained gabbro*
3f *- light grey, tan to white platy quartz-muscovite schist, locally with mm-scale quartz and feldspar augen (at least in part felsic metavolcanic rocks)*
3cp *- medium to dark grey carbonaceous muscovite-quartz schist or phyllite, quartzite, uncommon light grey marble*
cp *- lithologically similar to 3cp, but stratigraphic position is unclear (may underlie unit 2)*
2m *- massive calcareous actinolite-plagioclase- chlorite-biotite schist, subtly layered plagioclase-actinolite-chlorite schist, and lesser carbonaceous phyllite and quartzite.*
1qsl *- lower quartzose metaclastic unit: biotite-quartz- muscovite schist and lesser biotite-muscovite quartz schist and plagioclase-quartz-chlorite-biotite schist*

INTRODUCTION

The Fyre Lake deposit (Foreman, 1998; Blanchflower et al., 1997; Yukon Minfile 105G 034; 61°13'35"N, 130°30'49"W) is located on the east side of Fire Lake about 160 km northwest of the town of Watson Lake in the Finlayson Lake VMS district of southeastern Yukon (Fig. 1). Copper-cobalt-gold mineralization is hosted by Devono(?)-Mississippian rocks of the Yukon-Tanana Terrane. This mineralization is known as the Kona Zone and occurs close to the contact between chlorite schist and overlying carbonaceous phyllite (Blanchflower et al., 1997; Hunt and Murphy, 1998).

During fieldwork in 1996 and 1997, samples were collected for a lithogeochemical study of the Fyre Lake deposit in an attempt to define the signature of ore-bearing strata. Samples were collected from the Kona Cirque, Kona Bowl, Lake Zone and Outfitter's Creek areas (Fig. 1). Preliminary results from these analyses are presented in this paper; more detailed results will be presented in Sebert et al. (in prep.). These results complement an ongoing lithogeochemical study of the Finlayson Lake area by Piercey et al. (this volume).

GEOCHEMISTRY

CHLORITE SCHIST

In general, chlorite schist from the Fire Lake area has a silica content similar to basaltic and andesitic rocks (Fig. 2a), and Zr/TiO_2 ratios typical of subalkalic rocks (Fig. 2b).

Kona Cirque chlorite schist which hosts the Kona deposit contains between 53 and 58% SiO_2 and is highly mafic. It can easily be distinguished from chlorite schist in the Lake Zone, Outfitter's Creek and Kona Bowl areas (Fig. 1) on the basis of major and trace element chemistry. The Kona Cirque chlorite schist has higher MgO, SiO_2 and Cr, and lower TiO_2 and Zr contents. Chondrite-normalized REE patterns for the Kona Cirque chlorite schists have a distinctive spoon-shaped pattern. The major and trace elements chemistry suggests that these rocks are of boninitic affinity. The Rare Earth Element (REE) patterns of the Kona Cirque chlorite schist are similar to Type C boninites from the Upper

Pillow lavas of the Troodos Ophiolite (Fig. 3; Cameron, 1985).

Lake Zone chlorite schist displays whole rock chemistry typical of basaltic volcanic rocks (Fig. 2a and b). Samples from the Outfitter's Creek area range from basaltic to andesitic in composition and that from the Kona Bowl is andesitic. Nb and Ta are depleted relative to Light Rare Earth Elements (LREE) and Large Ion Lithophile Elements (LILE) in the rocks from the Lake Zone and Outfitter's Creek area, which is suggestive of eruption in an arc setting. The REE profiles of chlorite schist samples from the Lake Zone, Outfitter's Creek area and Kona Bowl are similar to those of arc-related tholeiitic rocks and to tholeiites erupted in response to rifting of marginal basins (Fig. 4).

PSAMMITIC SCHIST AND FELSIC META-VOLCANIC ROCKS

Samples of quartz-biotite schist from the hanging wall of the West Kona zone are felsic in composition and display a similar chondrite normalized REE pattern to the North American Shale Curve and average upper crust (Fig. 5). One sample of potassium feldspar phyric metavolcanic rock, collected on the east side of Kona Cirque, is rhyolitic in composition and has a similar REE profile to the psammitic schists.

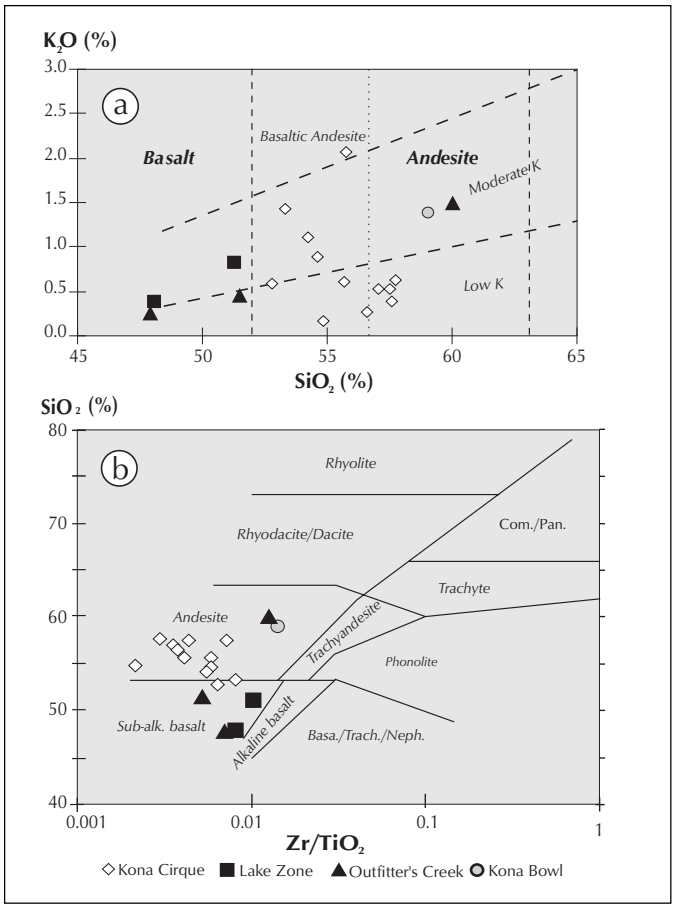

Figure 2. *a: K_2O versus SiO_2 plot (Peccerillo and Taylor, 1976), b: SiO_2 versus Zr/TiO_2 diagram (Winchester and Floyd, 1977).*

CONCLUSIONS

The application of lithogeochemistry at the Fyre Lake property has yielded significant results with regards to mineral exploration and the understanding of the tectonic origin of the host Yukon-Tanana Terrane rocks.

On the property there are distinct chemical differences between chlorite schist which hosts the copper-cobalt-gold Kona zone mineralization and those in other areas which are barren. Lithogeochemical sampling and analysis can thus be used as a tool to aid in separating schist units which are not readily distinguishable in outcrop or drill core.

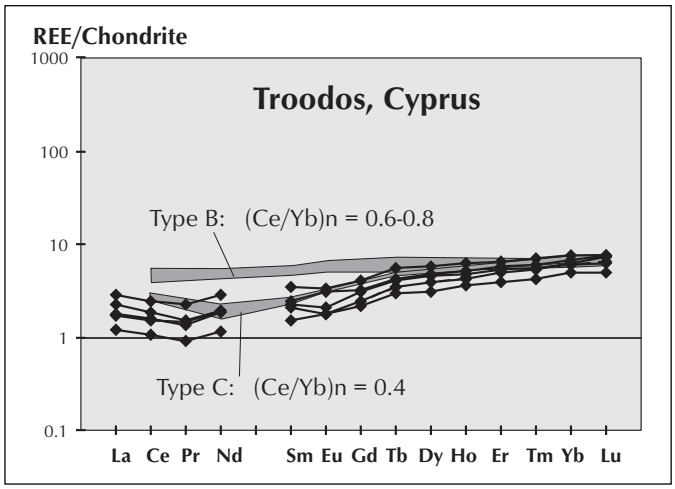

Figure 3. *Comparison of REE patterns of the Kona Cirque mafic schists to boninitic rocks from Troodos Ophiolite, Cyprus (Cameron, 1985). Chondrite composition is from Evensen et al. (1978).*

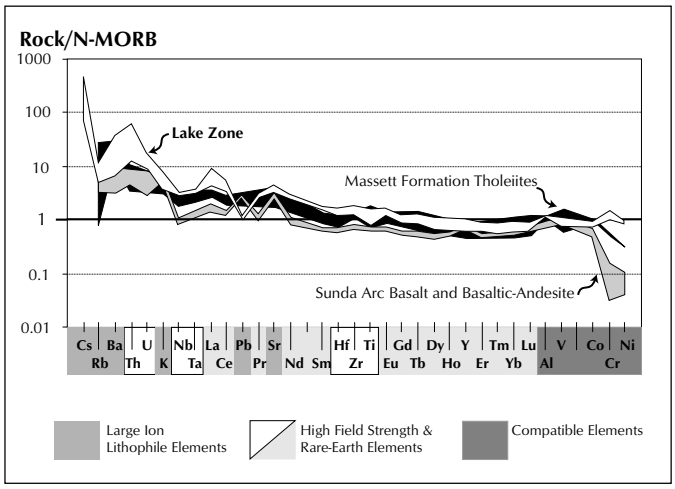

Figure 4. *Comparison of chlorite schist samples from the Lake zone to average Sunda Arc tholeiite (Whitford et al., 1979) and rift-related tholeiitic rocks from the Massett Formation, Queen Charlotte Islands (Hamilton and Dostal, 1993). N-MORB composition from Hofmann (1988).*

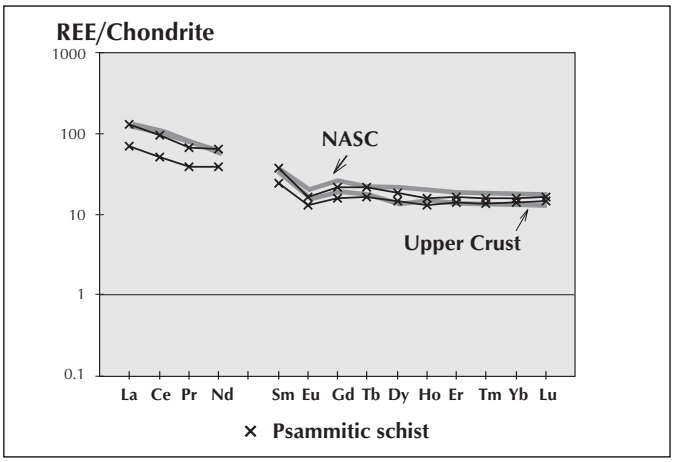

Figure 5. *Chondrite-normalized REE plots for psammite samples. The North American Shale Curve (Grommet et al., 1984) and Upper Crust (Taylor and McLennan, 1985) are shown for reference (thick grey). Chondrite composition is from Evensen et al. (1978).*

Major and trace element chemistry suggests that the Kona Cirque chlorite schists have a boninitic affinity, while samples from the Lake Zone, Outfitter's Creek and Kona Bowl areas are similar to arc-related tholeiitic rocks.

Psammites in the hanging wall of the West Kona zone have major and trace element chemistry that suggests they were originally sediments deposited in an advanced tectonic setting such as a continental margin or arc.

Overall, it is suggested that rocks in the Fire Lake area were deposited in an arc-related environment influenced by subduction processes.

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