Composition and assemblage of minerals associated with the porphyry Cu-Mo mineralization at the Gibraltar deposit, south central British Columbia, Canada

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Introduction:
Porphyry Cu mineralization is accompanied by valuable alteration within the host rocks and surrounding country rocks. Some alteration minerals are resistant against weathering and erosion. They are dispersed by glaciers and streams and may occur in glacial and stream sediments. Therefore, the assemblage of minerals common in porphyry Cu deposits in these sediments may be used as a tool for detection and identification of regional ore-bearing deposits. Among heavy minerals, epidote appears to be a useful mineral in mineral exploration. Coakley et al. (2014) demonstrated that epidote associated with Cu mineralization occurs up to 2 km outside the ore body and suggested that epidote chemistry may be useful in exploration. We initiated the study in the summer of 2015 to investigate the assemblage and chemistry of alteration minerals associated with the Gibraltar deposit.

Study area:
As part of the TSE program of the Geological Survey of Canada (GSC), 811 composition surveys were completed at four Cu-porphyry deposits in a 300x200km grid from Kamloops to Quesnel, south central BC (Fig. A). This grid contains over 100 current and past porphyry copper mineral deposits (Plouffe and Ferbey 2013). The Gibraltar Cu-Mo porphyry deposit is one of these deposits (Schwartz, 2014). Till in the area contain epidote and rutile (Fig. B). Locations of hardrock samples containing abundant epidote (Fig. C) and locations of all samples collected in this study (Fig. D).

Igneous assemblage:
Rocks range from leucocratic tonalites to dioritic compositions and are composed of plagioclase + quartz ± biotite ± hornblende ± apatite ± zircon ± rutile. Leucocratic tonalite (Fig. A) is common near the mine site. Leucocratic tonalite contains over 75 vol% quartz plus plagioclase. (Fig. B). Dioritic rocks (Fig. C) are abundant away from the mine site. Large subhedral grains of almost 90 mm and spilitic ± f. f. (Fig. D) are common in dioritic rocks (Fig. E).

Methodology:
1. Petrographic study using petrographic microscopy
2. SEM with energy dispersive spectroscopy for identification of minerals and semi-quantitative analysis of mineral chemistry
3. Electron microprobe analysis for quantitative chemical analysis of minerals
4. Bulk rock analysis after sodium peroxide fusion

Results
Geochemistry:
Epidote, titanite and rutile in the sample show compositional variations.

Epiludnite:
Epiludnites with the general formula A(MgAl)2[(Fe,Al)6Si3O12](OH,F)4, has a large compositional variation as the sites of A, M, and T can accommodate a variety of elements. Several types of epidote are identified in our samples. (i) Epidote minerals are common in the matrix of the porphyry Cu-Mo veinlets (Fig. A). (ii) Chlorite after epidote. (iii) Epidote pseudomorph after biotite (Fig. B). (iv) Epidote in veins along quartz (Fig. C). (v) Arfvedsonite pseudomorph after epidote (Fig. D). (vi) Light REE-rich epidote occurs in isolated epidote grains that show variable high La and Ce (Fig. E). (vii) Epidote forms more epidote-rich cores away from plagioclase and also along fractures of quartz grains (Fig. F). The concentrations of total Fe as FeO and Al2O3 of epidote are shown in Fig. F.

Alteration assemblage:
Alteration near the mine site is extensive and produced epidote + chlorite + white mica + titanite, rutile ± magnetite ± calcite. Alteration is intense along veins containing chlorite (Figs A, C), epidote (Fig. D) and quartz. Plagioclase pseudomorphically replaced by epidote (Fig. E). Chlorite (Fig. F) and epidote forming a veinlet (Fig. G). Chlorite (Fig. H) and epidote replacing biotite (Fig. I). Relict plagioclase pseudomorphically replaced by epidote and minor titanite. (Fig. J). White mica (Fig. K) replacing titanite (Fig. L). (Fig. M) Epidote replaces plagioclase pseudomorphically. (Fig. N) Epidote in veins cross cutting host granite. (Fig. O) Chlorite replacing plagioclase. (Fig. P) Relict plagioclase pseudomorphically replaced by epidote and minor titanite. (Fig. Q) Chlorite replacing plagioclase. (Fig. R) Relict plagioclase pseudomorphically replaced by epidote and minor titanite. (Fig. S) Chlorite replacing plagioclase. (Fig. T) Relict plagioclase pseudomorphically replaced by epidote and minor titanite.

Trace elements abundance of epidote-rich tonalite samples

Summary
This study shows alteration assemblage of epidote-chlorite-chlorite is a magnetite ± epidote associated with the Gibraltar porphyry Cu-Mo deposits. Among these alteration minerals, epidote is ubiquitous throughout the host Granite Mountain rock.

Acknowledgements
We thank Teck Gibraltar for approving the publication of our results and allowing access and sampling of the Gibraltar deposit. Jeffrey Hedenquist is thanked for his help during the field work in July, 2015.

References: