Mineral chemistry of gahnite from the Lalor deposit, Snow Lake, MB E. A. Wehrle, D. K. Tinkham, & A. M. McDonald Harquail School of Earth Sciences, Laurentian University, Sudbury, ON

INTRODUCTION

The Lalor deposit is a Paleoproterozoic metamorphosed VMS deposit. Lower-amphibolite facies metamorphism has produced accessory gahnite (ZnAl₂O₄) through the breakdown of sphalerite and zincian silicates (staurolite and biotite). Understanding possible controls on gahnite chemistry (e.g. host-mineral assemblage, ghn-forming reaction, ghn-texture, whole-rock chemistry) will help constrain the mechanisms by which it develops and provide a chemical context for the analysis of detrital gahnite.



Figure 1 - Location of the Lalor deposit in the Flin Flon greenstone belt. Modified after Galley et al. 2007.

BACKGROUND GEOLOGY AND PETROGRAPHY

Lalor is part of the Snow Lake VMS camp in the eastern part of the Flin Flon greenstone belt (Fig. **1**). It is hosted in bimodal felsic and mafic metavolcanics. Metamorphism of host rocks affected by primary, VMS-related hydrothermal alteration has produced distinct metamorphic assemblages. Gahnite occurs in quartz-rich, talc-chlorite-rich, biotite-chlorite-rich, and sphalerite-rich assemblages. It may present as pophyroblastic or poikiloblastic grains, and as corona rims to sphalerite, staurolite, or biotite (Fig. 2).



Figure 2 - gahnite of different textures and assemblages from Lalor: porphyroblastic ghn in sph-rich assemblages (a, b); poikiloblastic ghn in tlc-chl-rich (c) and qtz-rich (d) assemblages; and corona ghn forming from st (e) and bt (f) in bt-chl-rich assemblages. All images PPL.



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Major elements were analyzed using SEM-EDS. All grains cluster within Ghn₍₆₃₋₇₅₎ - Her₍₁₅₋₂₂₎ -Spl(10-18) (Fig. 3a). Variations in host mineral assemblage, ghn-texture, and ghn-forming reaction are not reflected. This suggests metamorphic grade is the primary control. A moderately-negative correlation (R = -0.72) exists between Zn *apfu* and Fe# (Fe²⁺/[Fe²⁺+Fe³⁺] *apfu*) (**Fig. 3b**). Mg is the only major element in gahnite that shows a correlation with the whole-rock concentration of that element (Fig. 3c). This is due to the influence of sphalerite on the concentrations of Zn and Fe in gahnite. Figure 3d shows the Zn# (Zn/[Zn+Fe] apfu) of reactant sphalerite and product gahnite. All gahnites have lower Zn#, and are within 0.1. This indicates that in assemblages with co-existing sphalerite and gahnite, Zn preferentially partitions into sphalerite over gahnite. Mg is not present in sphalerite, so its concentration in gahnite is more readily affected by whole-rock MgO and partitioning with other Fe-Mg phases.



MINOR- AND TRACE-ELEMENT CHEMISTRY

Select minor and trace elements were analyzed using EPMA-WDS. Mn (500 - 2,500ppm), V (<25 -250ppm), and Si (<25 - 250ppm) are present in the Lalor gahnite. All grains are unzoned with respect to these elements, or show weak oscillatory zoning (Fig. 4a). Gahnite forming from silicate breakdown has relatively higher V and relatively lower Mn and Si compared to gahnite forming from sphalerite, indicating reaction type may have a control on the gahnite minor- and trace-element chemistry (Fig. 4b). More data are being collected to investigate this possibility.



MAJOR-ELEMENT CHEMISTRY



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Figure 4 - trace-element chemistry of ghn from Lalor: (a) concentrations of Mn, Si, and V along EPMA-transect; and (b) Mn vs. V/Mn.

CONCLUSIONS

1) Metamorphic grade is interpreted to be the primary control on gahnite major-element chemistry in these systems. The Zn-Fe content of sphalerite may influence the concentration of these elements in gahnite; whole-rock MgO has a moderately-positive correlation with Mg in gahnite. 2) Using the Fe# (Fe²⁺/[Fe²⁺+Fe³⁺] *apfu*) in gahnite as a proxy for fO_2 conditions, Zn-rich gahnites appear to be more stable at higher fO₂. The presence of anhydrite (S⁶⁺) in some assemblages indicates fO₂ may have a role in the breakdown of sphalerite (S^{2-}).

3) The minor- and trace-element chemistry of gahnite from Lalor is dominated by Mn, Si and V. Plotting Mn vs. V/Mn may help differentiate gahnites formed by the desulfidation of sphalerite (high Mn, low V/Mn) and gahnites formed from the destabilization of zincian biotite or staurolite (low Mn, high V/Mn).

4) The homogenous spatial distribution of major, minor, and trace elements in gahnite from Lalor suggests these grains formed under remarkably consistent physio-chemical conditions.

5) Future research on detrital gahnite as an indicator mineral for metamorphosed VMS deposits should build on 3 concepts addressed in this study: (1) the possible correlation between the Zn# of reactant sphalerite and product gahnite; (2) linking metamorphic grade and gahnite majorelement chemistry to assist in identifying deposit host rocks; and (3) fingerprinting the ghn-forming reaction using Mn and V concentrations.

RERENCES

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