Laser ICP-MS magnetite analyses: a tool to discriminate hydrothermal gold-associated from other magnetites

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Introduction

A range of samples from the Revenge and Victory-Defiance areas in the St. Ives gold camp and the New Celebration deposit were selected for microanalyses of hydrothermal magnetite. The aim of the study is to test whether magnetites have a distinct chemical signature which distinguishes them from magnetites which are not associated with gold.

Sample selection and analytical method

Initial analyses were performed using a scanning electron microscope fitted with an EDS detector at the University of Western Australia and an electron microprobe at the University of Tasmania. The bulk of the magnetites was analyzed on a laser ICP-MS at the University of Tasmania. The samples, which were analyzed using laser ICP-MS, were selected from diamond drill holes CD7069 and CD10095W2. Hydrothermal magnetite in these diamond holes covered four settings:

- CD7069: magnetite in Kapai Slate (samples: CD7069 – 359, 360, 367, 368, 369),
- CD7069: magnetite in mafic and ultramafic host rocks, not associated with any gold lodes (samples: CD7069 – 229.8, 291.5, 322.7, 592.1, 593.3),
- CD10095W2: magnetite halo around a gold bearing structure (magnetite-pyrite assemblage; samples: CD10095W2 – 370.6, 372.2, 378.2),
- CD10095W2: magnetite halo around a gold bearing structure (magnetite-pyrrhotite assemblage; sample: 301.0).

Prior to data analyses and plotting, the analyses have been filtered for:

- Ti>500ppm assuming that high Ti concentrations in magnetites indicate a magmatic origin for the magnetites (e.g., differentiation of dolerite intrusions),
- Mn>3000ppm assuming that high Mn concentrations indicate mineral inclusions,
- Cr>4000ppm assuming that high Cr concentrations indicate chromite inclusions.
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Results

Discrimination of gold-associated and gold-unrelated magnetite

Magnetites which form an alteration halo around gold bearing structures in the Conqueror area (short: gold-associated magnetites) but petrographically slightly pre-date gold mineralization are distinct in a number of elements. These mangetites have higher Mn and Zn concentrations, but do not contain any significant Ti concentrations (Fig. 1). In a V/Ti versus Al/Ti plot the gold-associated magnetites plot at high V/Al ratios (Fig. 1), although the actual V and Al concentrations are low. The laser ICP-MS V/Al ratios from gold-associated magnetites from the Conqueror area are very similar to SEM data for gold-associated magnetite from the Revenge and Belleisle area (Fig. 2). Unfortunately detection limits at the SEM are for most trace elements quite

high and the areas cannot be compared for further elements until laser ICP-MS data are obtained for these samples.

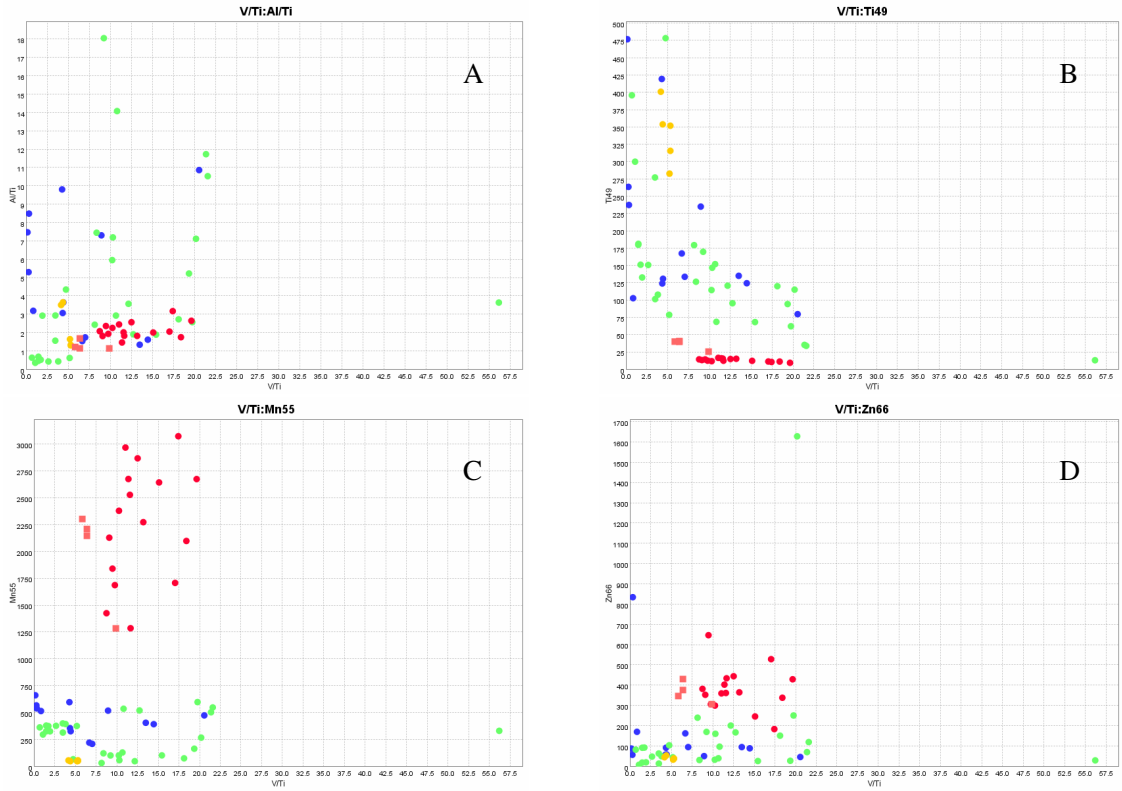

Fig. 1: Laser ICP-MS analyses of Victory-Defiance and Conqueror magnetites.

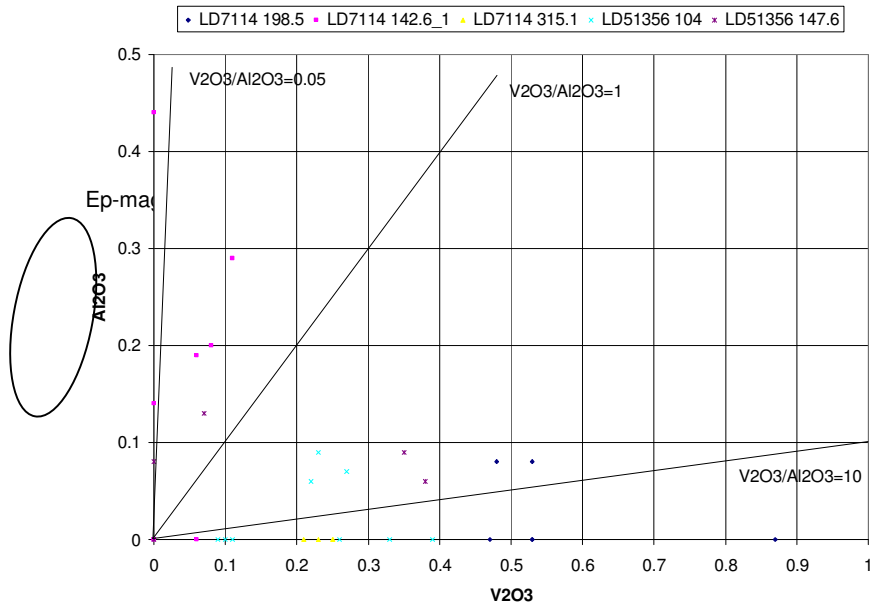

Fig. 2: SEM analyses of different magnetite types from the Revenge and Belleisle area.

Germanium appears to discriminate all other magnetites from gold-associated magnetites which have insignificant Ge concentrations (Fig. 3). Arsenic, Sb (Fig. 4) and to a lesser degree Pb and Bi (Fig. 5) discriminate magnetites in Kapai Slate from the other magnetites. Nickel identifies magnetites hosted in mafic and ultramafic rocks in CD 7069 (unrelated to gold). Higher concentrations of cobalt identify Kapai Slate and gold-unrelated magnetites from gold-related magnetites (Fig. 4). Barium correlates positively with Mg, Al, Ti, Sn and As in magnetites from the Kapai Slate possibly indicating a similar chemical transport of the elements (Figs 6, 7, 8).

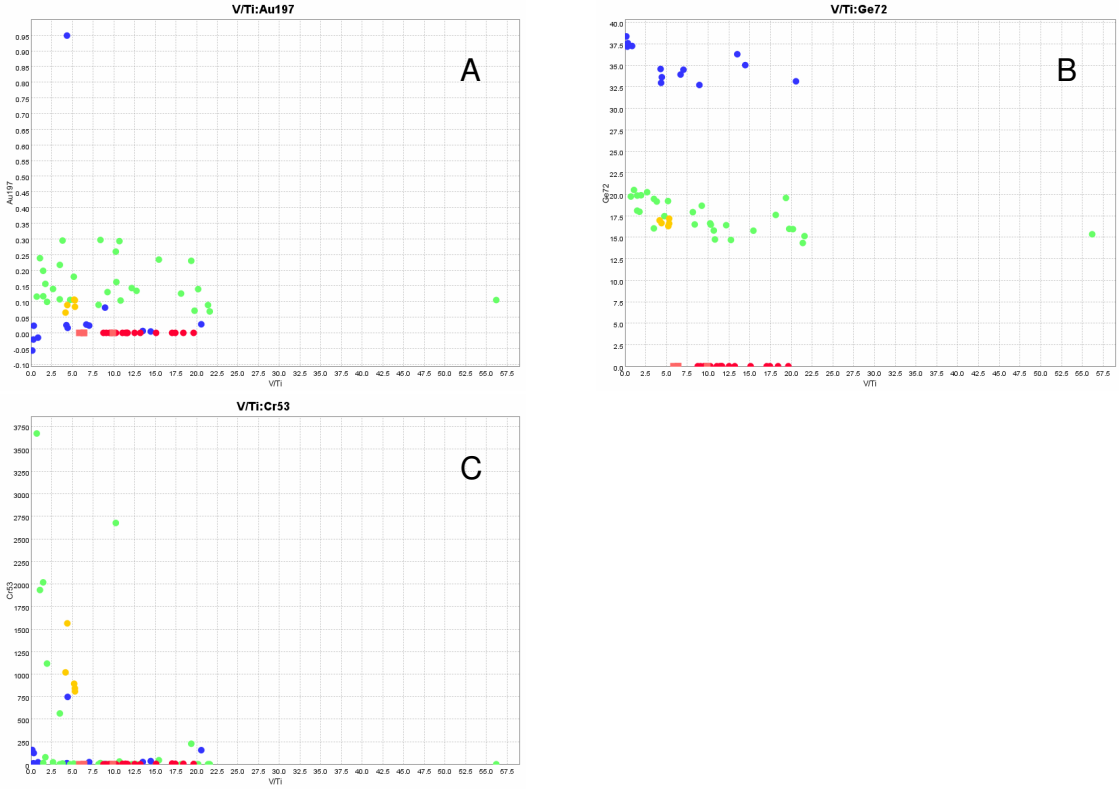

Fig. 3: Laser ICP-MS analyses of Victory-Defiance and Conqueror magnetites.

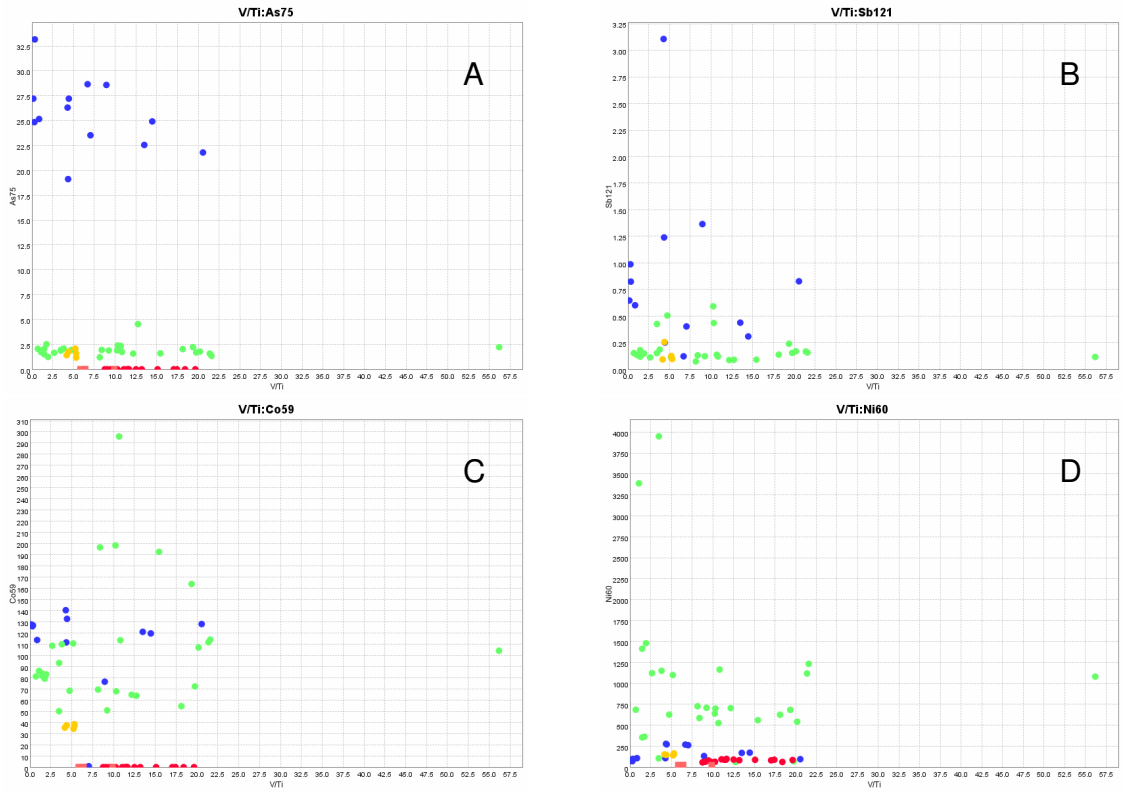

Fig. 4: Laser ICP-MS analyses of Victory-Defiance and Conqueror magnetites.

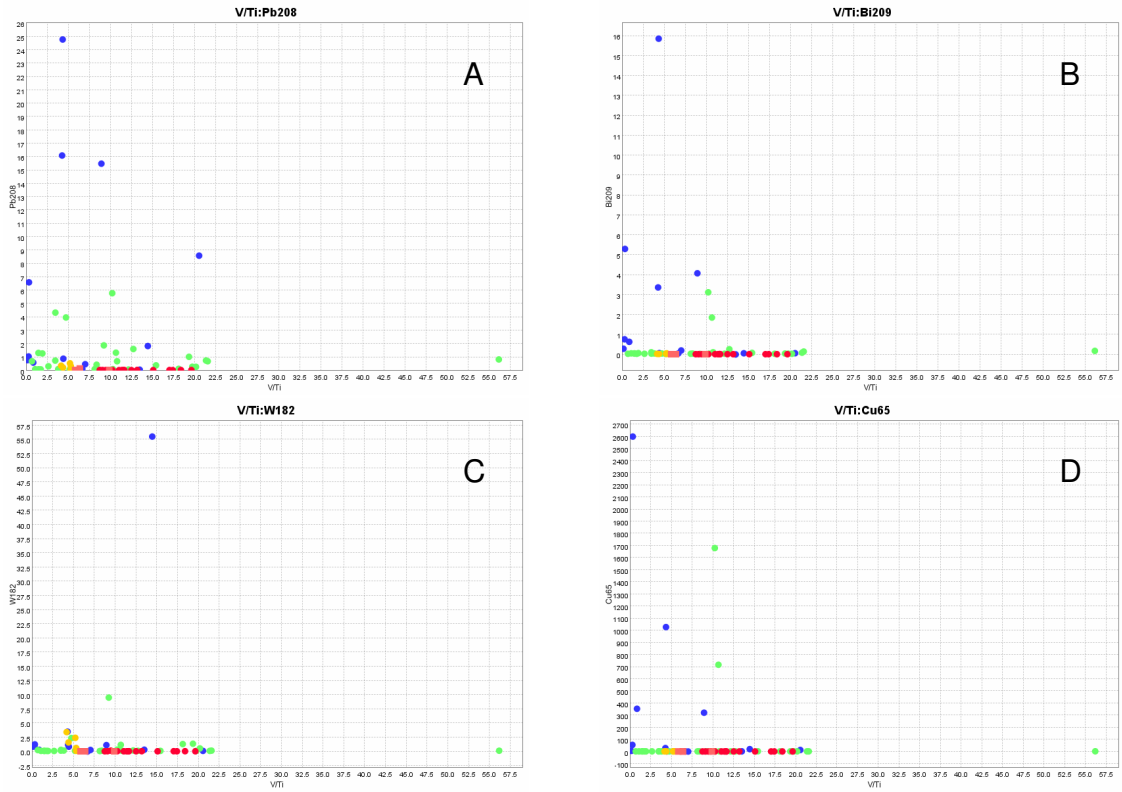

Fig. 5: Laser ICP-MS analyses of Victory-Defiance and Conqueror magnetites.

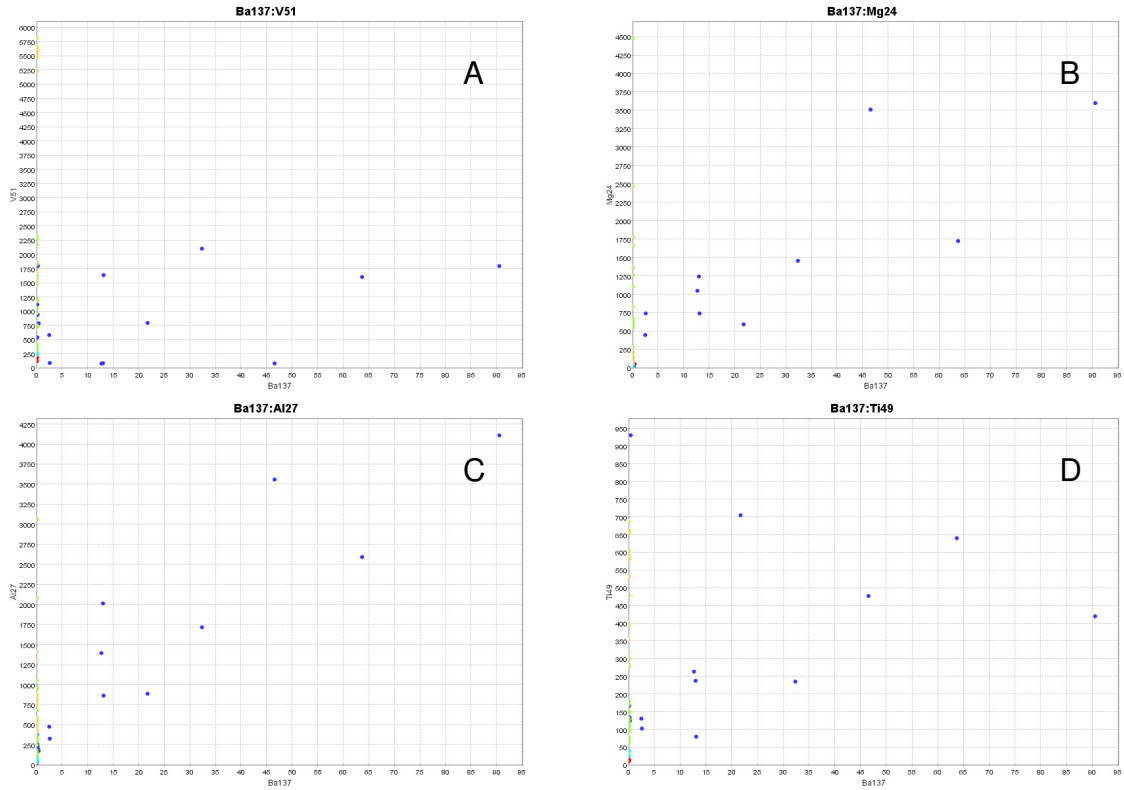

Fig. 6: Laser ICP-MS analyses of Victory-Defiance and Conqueror magnetites.

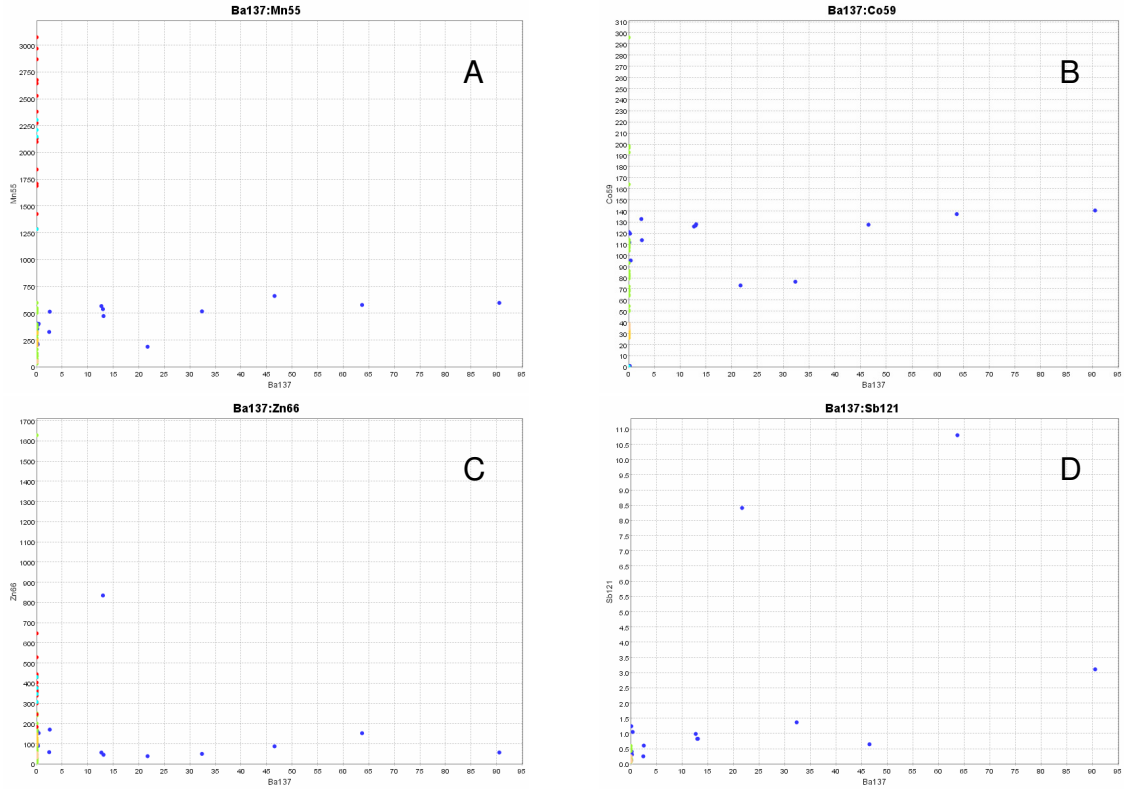

Fig. 7: Laser ICP-MS analyses of Victory-Defiance and Conqueror magnetites.

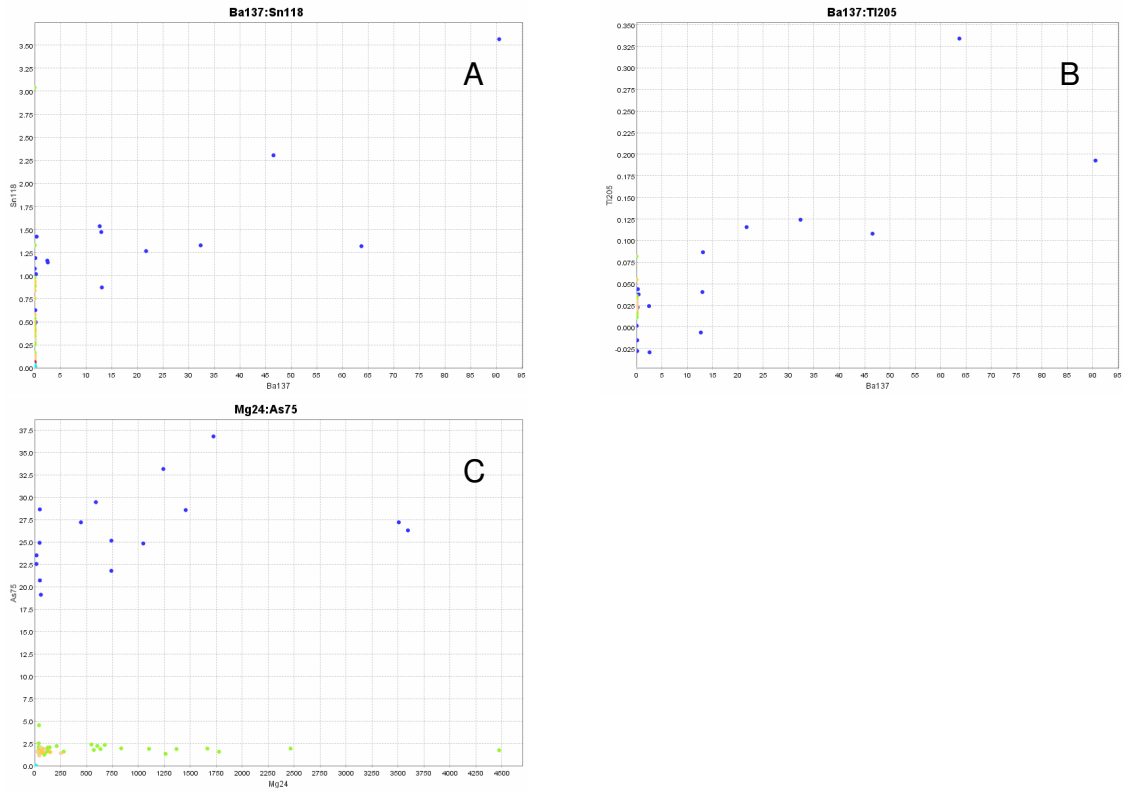

Fig. 8: Laser ICP-MS analyses of Victory-Defiance and Conqueror magnetites.

Further tests to verify results

The analyses to date comprise a small sample set which allowed to develop the analytical procedure and standardization for the magnetite analyses using the laser ICP-MS technique. At least for elements analyzed by microprobe techniques the data from Victory-Defiance and Revenge/Belleisle correlate well. It is proposed that the sample set is expanded in the St. Ives area to test initial correlations and discriminations. In a second phase, magnetites from other deposits should be analyzed to test whether discriminations are camp specific or can be transferred into other camps/deposits.

Assessment of methodology for exploration

Given the discrimination of gold-related magnetites in various elements, the method is in the first pass successful. Further test have to be conducted in an expanded sample set to confirm the initial results. The problem in application for exploration is footed in the laser ICP.

Conclusions