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Application of Pyrite Trace Element Chemistry using LA-ICP-MS in exploration for stratiform Zn-Pb deposits: An example from the McArthur Basin, Australia

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Trace element (TE) geochemistry has been widely used as a tool for understanding origin and evolution of earth (core, mantle and crust) in the past. Advancement in analytical techniques has broadened its applicability even further, in other fields such as ocean & atmospheric sciences and ore deposit studies. For instance, laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) now allows determination of low-level trace elements present in certain mineral phases for better quantification. This paper attempts to show how application of pyrite trace element chemistry using LA-ICP-MS can aid in stratiform Zn-Pb exploration with the help of a case study on the McArthur Basin. The McArthur basin in Northern Territory, Australia is known to host various types of sediment hosted ore deposits, including world class SEDEX-style Zn-Pb deposits such as the McArthur River Deposit. Exploration companies are continuing to explore the basin for deposits similar to the McArthur River deposit. A number of prospects have been identified in close proximity to the deposit using geochemical and geophysical exploration techniques. Because the Barney Creek Formation, particularly its HYC Pyritic Shale Member, is the prime host for various stratiform Zn-Pb deposits, characterizing pyrite trace element chemistry in both barren and mineralised black shales from the Barney Creek Formation was the main focus of the study. It builds on the work of Maier [1] in testing the potential of sedimentary pyrite TE chemistry as a vector to Zn-Pb SEDEX-style deposits in the McArthur Basin.

Our work involves analysing sedimentary pyrites in black shales of the Barney Creek Formation (hosting McArthur River deposit) using the LA-ICP-MS facility at CODES, University of Tasmania. Three drill holes from varying proximity to the ore body were selected and samples were analysed down-hole to see effects of mineralisation and hydrothermal activity recorded by pyrite trace element chemistry. Prior to laser-based analyses, pyrite textural studies were carried out to not only ensure its suitability for analyses but to note variability. Results so far suggest that trace element adsorption into pyrite varies with varying distances to the ore body. For instance, Ni and Co show a decreasing trend and Zn, Pb and Tl show an increasing trend as we move closer to the ore deposit. Ratios of certain trace elements such Zn/Ni in pyrite could also prove to be a useful guide to such stratiform mineralisation. A comparison has also been made between conventional techniques and the LA-ICP-MS approach in order to highlight advantages and disadvantages of both techniques. This paper presents results of the extensive data analyses undertaken and its implications including favourable circumstances when the technique can be applied.

References:

[1] Maier, R. C., 2011 Pyrite Trace Element Haloes to Northern Australian SEDEX Deposits, PhD thesis, University of Tasmania.