Quantitative LA-ICP-MS mapping of diagenetic pyrite at two major Canadian Archean Au deposits

S. JACKSON[1*], B. DUBÉ[2], W. OSWALD[3] AND Z. YANG[1]

[1]Geological Survey of Canada, Ottawa, ON, K1A 0E8, Canada (*correspondence: simon.jackson@nrcan.gc.ca)
[2]Geological Survey of Canada, Québec City, QC, G1K 9A9
[3]Institut National de la Recherche Scientifique, centre Eau-Terre-Environnement, Québec City, QC, G1K 9A9

LA-ICP-MS element mapping is providing extraordinary insights into the fluid histories of hydrothermal mineral deposits. In this study, quantitiative LA-ICP-MS element concentration mapping of multi-phase mineral assemblages in petrographic sections was achieved using discrete edge-to-edge square spots, each pre-ablated, allowing spot-size limited sampling resolution. Standardisation was performed via external calibration against USGS GSE-1G, coupled with ablation yield correction via normalisation to 100% total element abundance. Standardisation was extended to C and S via surrogate calibration. This methodology provides quantitative analysis without prior knowledge and input of internal standard contents for each mineral. Lead isotope maps were generated via calibration against GSE-1G.

The methods have been used to investigate the genesis of the archean Musselwhite gold mine and selected deposits from the world-class Porcupine orogenic Au district, Ontario, Canada. Musselwhite is a structurally-controlled, pyrrhotite-rich deposit mainly hosted by a silicate facies BIF in volcano-sedimentary rocks metamorphosed at amphibolite grade. Local carbonaceous argillaceous units in the deposit area bear mm-cm diagenetic pyrite nodules. LA-ICP-MS mapping provides clear evidence of mobilisation of concentrically zoned, syngenetic Au (20-100 ppb) and associated elements in the nodules during metamorphic recrystallisation. Nodule and ore Pb isotopic compositions are indistinguishable.

Greenstone-hosted quartz-carbonate-Au veins of the Porcupine mining camp occur mostly in greenschist facies mafic volcanic and sedimentary rocks. These sediments include local carbonaceous argillites containing mm-cm diagenetic pyrite nodules. Element maps of nodules from the Owl Creek mine show cores with very strong syngenetic metal enrichments (3-9 ppm Au) rimmed by radial overgrowths of metal-depleted metamorphic pyrite.

These preliminary data are consistent with a model where Au remobilised from auriferous diagenetic pyrite in C-rich argillites during metamorphism contributed to the deposits. That these units supplied a large percentage of the ore Au is only likely if there are additional auriferous argillites at depth.