# Pyrite Compositions from Orogenic Gold and VHMS Deposits from Western Australia

Ivan Belousov,[1*] Ross Large,[1] Sebastien Meffre,[1] Leonid Danyushevsky,[1] Jeffrey Steadman,[1] and Trevor Beardsmore[2]

[1]Centre of Excellence in Ore Deposits, University of Tasmania, Hobart, Australia
[2]Geological Survey Division, Department of Mines and Petroleum, Perth, Australia

*E-mail, ivan.belousov@utas.edu.au

The trace element composition of pyrite and, in some cases, coexisting pyrrhotite, arsenopyrite, and loellingite from more than 30 orogenic gold and 5 VHMS deposits were analyzed using the LA-ICPMS technique. These compositions were then examined to investigate the differences in composition between the two deposit types. Pyrites from VHMS deposits tend to have higher Cu, Pb, Bi, Sn, Se, and lower Ni relative to orogenic gold deposits. Pyrite from VHMS deposits tend have Co>Ni, As>100Au, Se>Te>Au, contrasting with those from orogenic deposits, which have variable Co/Ni, As/Au, Se/Te and Se/Au ratios.

Orogenic gold deposits could be subdivided into two groups based on As and Te contents of pyrite. Pyrites from Au-As ores (pyrite As/Te>200) generally have Pb/Bi>5, Se/Te>5, Pb/Sb<5 and Tl/Te>100 and major part of Au is refractory (in the pyrite structure). Examples of deposits from Au-As association include Wiluna, Sunrise Dam, Kanowna Belle, Paddington, Lancefield, Meekatharra Prohibition, Minjar and Youanmi. Pyrites from Au-Te association (pyrite As/Te<10) are characterized by lower Pb/Bi, Se/Te and Tl/Te, and higher Pb/Sb. In the Au-Te association Au is mostly hosted in a range of micro-inclusions. Examples of deposits from Au-Te association include Granny Smith, Hunt, Porphyry, Darlot and Songvang. Some deposits (e.g Golden Mile, Chalice, St.Ives (Mars Pit), Redeemer, Wallaby) display mixed As-Te association (10<As/Te<200). For all studied deposits, micro-inclusion populations were characterized.

All studied orogenic gold deposits display multistage pyrite growth histories that are evidenced by the presence of several generations of pyrite grains and/or zonation within pyrite. Those generations can be distinguished based on a combination of the Co/Ni values and the contents of Au, As, Co, Ni, Te, Sb, Bi, Se and Tl. Some of pyrite generations from the same deposit were found to have different Pb isotope ratios, likely reflecting different metal sources. However, only a few of the larger orogenic Au deposits contained pyrite with multiple high-Au pyrite generations (Golden Mile, Sunrise Dam, Kanowna Belle, and possibly Chalice and Paddington). Unlike VHMS deposits, where pyrites are mostly characterized by Co/Ni>1, different generations of pyrites from orogenic gold deposits can have very different Co/Ni ratios, however, we have not found any pyrite with Au>10 ppm that have Co/Ni>5.

The results of this study can be used during exploration to distinguish between VHMS vs orogenic gold mineralization signatures and to help constrain the physical and chemical condition leading to ore genesis. Such an approach was tested on several EIS holes and proved to be very successful—two out of five holes showed promising pyrite compositions, while whole-rock compositions didn't show any anomalies.