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Three dimensional distribution of metal content in pyrite

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The content of trace metals in pyrite has received an increasing amount of attention, particularly in economic geology and minerals processing [1, 2]. Pyrite often occurs as a relatively pure mineral with trace element substitutions for Fe (e.g. Ag, Au, Cu) or for S (e.g. Se, Te), being some of the most widely studied. By contrast to these trace metals, arsenic can substitute 6.0 wt% as a solid solution for sulphur [3] into the pyrite lattice.

Trace metals that occur in pyrite at the ppm level cannot easily be analysed by electron beam techniques and are more regularly quantified using laser-ablation quadrupole ICP-MS techniques (LA-Q-ICP-MS). This analytical method is sufficiently sensitive to measure trace metal content from analytical spot sizes as small as 25 µm. Multiple analyses of individual grains have revealed that trace metal substitution into pyrite can be heterogeneous and that the spatial distribution of metals may contain genetic or other important information. The 2-dimensional metal distribution can be illustrated with trace element maps obtained by LA-Q-ICP-MS [4, 5]. However, since pyrite can have complex recrystallisation histories, it is preferable to obtain 3-dimensional information on composition to better understand the principles of metal incorporation into pyrite.

Here we illustrate a new method for 3-dimensional metal mapping of pyrite by superimposing 2-dimensional maps of serial slices through grains of partly re-crystallised detrital pyrite from a 2.4 Ga quartz pebble conglomerate from the Huronian Supergroup, Ontario, Canada. Individual 2-dimensional maps distinguish between original detrital and recrystallised rims and overgrowths through concentration contrasts in Co, Bi, Te, Ag, Sb and Au. Stacked together, the resulting 3-dimensional image helps to reconstruct the originally rounded spheroidal shape of the detrital pyrite. We propose that 3-dimensional images are particularly helpful for understanding the distribution of precious metals (i.e. Au) in pyrite related to crystal habit, and provide additional information about possible recovery rates of Au from pyrite-bearing ore systems

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