The Trace Element Content of Sedimentary Pyrite in the Neoarchean, an Example from the Mineralized St Ives Au District and the Unmineralized Bee Gorge Member: Implications for Future Gold Exploration

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Recent new models for orogenic Au mineralization suggest that sedimentary pyrite enriched in Au, As, Te, and Ag during diagenesis may be a significant source of Au and other associated trace elements in orogenic deposits. These models were developed while studying several orogenic deposits hosted in Phanerozoic stratigraphy (e.g., Sukhoi Log, Russia; Bendigo, Australia). In this study we examine the mineralized Neoarchean Kapai Slate within the St. Ives gold district and compare the results of the sedimentary pyrite analyses with those from the Neoarchean Hamersley basin. We use the results to assess whether the Hamersley basin, which has no major known Au deposits, deserves further exploration.

The Kambalda sequence, Yilgarn craton, has produced over 12 million ounces of Au from several deposits in the St. Ives gold camp. The Kapai Slate (2692 ± 4 Ma) is a persistent sedimentary unit within the Kambalda sequence and is among the host units of the Au mineralization. LA-ICP-MS analyses of sedimentary pyrite from the Kapai Slate show that there was early enrichment in several elements, such as As, Au, Te, and Ag, which are often related to gold mineralization (median values of 741 ppm As, 1.67 ppm Mo, 13 ppm Se, 0.28 ppm Au, 7.66 ppm Te, and 3.61 ppm Ag). While the volume of rock of the Kapai Slate was determined to be insufficient for it to be the main source of Au for the deposit, SHRIMP-SI in situ S isotope and LA-ICP-MS data suggest that the Kapai Slate may have contributed some S and Au and locally upgraded the Au mineralization.

The Hamersley Group, Pilbara craton, Western Australia, contains younger Neoarchean carbonaceous shale, which shows a similar early enrichment in gold in sedimentary pyrite. Specifically, the Bee Gorge Member (2506–2570 Ma) has elevated As, Mo, Se, Au, Te, and Ag concentrations (median values of separate samples ranging from 384 to 5,778 ppm As, 0.9 to 3.7 ppm Mo, 12.6 to 98.4 ppm Se, 0.191 to 0.624 ppm Au, 2.99 to 87.56 ppm Te, and 5.32 to 31.23 ppm Ag). To date, no major Au deposits have been discovered in the Bee Gorge Member or immediately above. The elevated trace elements (similar to those of the mineralized Kapai Slate) in the sedimentary pyrite within the Bee Gorge Member and the thickness of the sequence (>100 m) suggest that it is a prospective source stratigraphy for sediment-hosted orogenic Au mineralization.