Microchemical characterization of native gold from orogenic gold deposits

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Native gold is considered to be the most significant indicator mineral among other minerals in gold deposits, such that native gold trace element geochemical signature could be useful to recognize the source deposit(s) of detrital gold in overburden. In this work, we present the quantitative geochemical characterization of native gold samples from orogenic gold deposits worldwide by using in-situ electron probe micro-analysis (EPMA). 172 gold grains (10~30 μm) were selected and observed from thin sections with optical microscope. Gold grains were chemically analyzed for their major (Au, Ag) and trace elements (Zn, Cu, Ni, Co, Fe, Rh, Pb, S, Hg, Pt, Se, As) with a CAMECA SX-100 Electron Probe Micro-Analyzer (EPMA) at Université Laval, Quebec, equipped with 5 wavelength dispersive spectrometers, using a 25 kV accelerating voltage with 100 nA beam current for trace elements and 20 nA for major elements, and a 5 μm beam size. Standard materials were oxides and pure metals from the Astimex company. The native gold samples were collected from orogenic gold deposits of the Abitibi belt (Lapa, Sigma, Goldex, Beaufor, Lac Herbin, Lucien Beliveau, New Beliveau), Nunavut (Meliadine), and James Bay region (Éléonore, Orfée) in Canada; from Jinchangyu in China; from Kittilä in Finland. Native gold in these deposits commonly occurs in three forms: (1) isolated, angular to rounded grains in inclusions within arsenopyrite, pyrite and quartz; (2) free grains along margins of arsenopyrite, pyrite and pyrrhotite; (3) veinlets in the fractures in arsenopyrite and/or pyrite. The gold grains show homogeneous concentration of Au (average 92.79 ± 0.33 wt%) and Ag (average 5.95 ± 0.05 wt%). The fineness values range from 836.13 to 993.18, which is a tight value bracket compared to other mineralization systems. The most common minor elements found in gold grains are Cu (average 0.05 ± 0.003 wt%), Co (average 0.006 ± 0.002 wt%), Fe (average 0.24 ± 0.002 wt%), and S (average 0.1 ± 0.004 wt %). The less frequent trace elements are Zn, Ni, Rh, Pb, Hg, Pt and Se, which are rarely measured at the detection limit of EPMA. The gold grains contain inclusions of arsenopyrite, aurostibite, sylvanite and calaverite. Overall, the trace chalcophile and siderophile elements contained in native gold can provide the most compelling fingerprints to distinguish gold deposits from one type to another type.