Sources of metals in the orogenic Au deposits of the Central Lapland Greenstone Belt, Finland

[1]Clifford Patten, [2]Ferenc Molnar, [3]Iain Pitcairn, [1]Jochen Kolb

[1]Karlsruhe Institute of Technology, clifford.patten@kit.edu, Adenauerring 20, 76131 Karlsruhe, Germany

[2]Geological Survey of Finland, P.O. Box 96, FI-02151 Espoo, Finland

[3] Department of Geological Sciences, Stockholm University, SE-106 91 Stockholm, Sweden

Orogenic Au deposits are structurally controlled hydrothermal ore deposits that form in metamorphic orogenic belts and account for a significant proportion of the present and past global Au production. These deposits are the product of complex large scale processes which include the production of metal-rich fluids and their migration through the Earth's crust to the site of metal precipitation (Goldfarb and Groves, 2015). Production of these metal-rich fluids is of paramount importance in the formation of any hydrothermal ore deposit (Tomkins, 2010) and recognition of geological formations as sources of metals is an important step for the investigation of hydrothermal ore deposit formation. Although the mechanisms responsible orogenic Au deposits formation are well constrained, the sources of the metals and the mineral reactions leading to the formation of Au-rich hydrothermal fluids are still debated (Goldfarb and Groves, 2015).

The Central Lapland Greenstone Belt (CLGB) is a Paleoproterozoic aged sequence of oceanic crustal rocks and marine sedimentary rocks in Northern Finland. The CLGB is one of the largest known Paleoproterozoic greenstone belt (Hanski and Huhma, 2005) and is an excellent target to study the source of metals in Precambrian orogenic Au deposits. The CLGB is dominated by two main groups: the Kittilä group and the Savukoski groups which are separated by the Sirkka Shear Zone (SSZ; Fig. 1). The Kittilä group is dominated by tholeiitic metavolcanics while the Savukoski group is characterized metapelitic sediments (Hanski and Huhma, 2005). The CLGB displays a relatively complex metamorphism pattern but it can be simplified into a zonation where the core of the belt is metamorphosed to greenschist facies while the borders are metamorphosed to mid-amphibolite facies up to granulite facies (Hanski and Huhma, 2005). The CLGB hosts numerous orogenic Au deposits preferentially located along the SSZ which are characterized by typical (Au-only) and atypical (Au-Cu ± Co, Ni, Mo, U) metal associations (Eilu et al., 2007). The various orogenic Au deposits appear to have formed under similar physico-chemical conditions suggesting that the differences in the composition of the various ores are most likely controlled by the geochemical peculiarities of the source areas rather than trapping mechanisms. Preliminary mass balance calculations highltights that the Kittilä group metavolcanic units have the highest Au fertility with ≈2800 t Au available for metamorphic fluid mobilisation, suggesting that they are the best suited source areas for the orogenic Au-only deposits. On the opposite the Savukoski metasedimentary units have high fertility for S, As, Cu, Co and Ni which are commonly enriched in atypical Au deposits suggesting that they are the best suited source areas for these deposits.

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