The Source and timing of Gold in Orogenic Gold Deposits; a Case Study from the Giant Sukhoi Log Sediment-Hosted Deposit in Siberia.

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ABSTRACT

Current models of orogenic gold deposits place the timing of gold mineralization late in the tectonic evolution of the host terranes; typically syn- to post-peak metamorphism. The source of the gold is considered to be from deep fluids related to metamorphic dehydration or igneous intrusions. Recent research on the giant orogenic gold deposit at Sukhoi Log, Siberia, suggests an early timing and shallow host-rock source for gold contrary to these models.

Sukhoi Log is a world-class sediment-hosted gold deposit, containing over 50 million ounces of gold at an average grade of about 2 g/t Au (Wood and Popov, 2006, Goldfarb et al., 2005, Distler et al., 2004). The deposit is hosted by Neoproterozoic organic-rich sediments, located in the Lena Goldfield, a major alluvial gold district, on the eastern margin of the Siberian Craton, 850km north east of Irkutsk. The main gold resource at Sukhoi Log is hosted by pyritic black shales and siltstones in the core of an overturned anticline. Gold mineralisation occurs both within the pyritic shales and in thin bedding-parallel pyrite-quartz veins which have been folded by the main deformation.

LA-ICPMS trace element analyses on pyrite from Sukhoi Log indicate that the early syngenetic and diagenetic py1 and py2 are enriched in lattice-bound gold and a suite of other trace elements (Mo, Sb, Ni, Co, Se, Te, Ag, Cu, Pb, Zn, Mn, Ba, Cr, U, V) which are similar to those metals concentrated by organic processes in euxinic sedimentary environments. Later generations of pyrite, from py3 to py5, including pyrite in bedding parallel quartz veins, contain progressively lower contents of lattice-bound gold and most other trace elements. However these syn-metamorphic and post-peak metamorphic pyrites contain micro inclusions of free gold, pyrrhotite, sphalerite and chalcopyrite. The paragenetic textural and chemical relationships at Sukhoi Log suggest that gold was initially introduced during sedimentation of the organic-rich shales and fixed during diagenesis within the structure of diagenetic arsenian pyrite. Subsequently, accompanying metamorphism and deformation, the gold was released from the diagenetic pyrite to become concentrated and up-graded as free gold and gold tellurides within metamorphic pyrites and bedding-parallel pyrite-quartz veins.

This multi-stage process of gold concentration was probably critical to the formation of the Sukhoi Log deposit. An early stage of synsedimentary and diagenetic gold-pyrite deposition (py1 &

py2) was following by syn-metamorphic up-grading, with location of the higher grade gold within py3 & py4 in the anticlinal core of the deposit. Other black shale-hosted “orogenic gold” deposits (eg. Kumtor, Muruntau, Zarmitan, Amantaitau, Natalka, Nezhdaninskoye, Bakyrichik and Macreas Flat) may have a similar multi-stage origin that commenced with syngenetic gold accumulation in black shales.

KEYWORDS: sediment-hosted gold, orogenic gold, gold in pyrite, syngenetic gold, Sukhoi Log