Muruntau, Uzbekistan: a giant thermal aureole gold (TAG) system

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Muruntau, with production and resources exceeding 3000 tonnes at more than 2g/t gold, (Kuchersky, 2003), is the largest gold deposit known outside the Witwatersrand and the subject of a vast literature, mainly by Russian and Uzbek workers. In this contribution we examine the nature and evolution of the Muruntau auriferous system, developing genetic and exploration targeting models. These are based on our and previous work on the Muruntau pit, deep drill holes and surrounds, plus geochemical, gold grade distribution and petrological data integrated with regional geology and geophysics.

Muruntau is hosted by a distinctive metasediment (hornfelsed) lithostratigraphic package in which gold ores occur in moderately to steeply south dipping (and also some shallowly dipping) zones contiguous with or enveloped by lower grade material. High grade zones comprise stockworks and sheeted quartz±feldspar vein networks and enveloping biotite-Kfeldspar-quartz rich metasomatised metasediments with minor arsenopyrite, pyrite and pyrrhotite. Lower grade material has lower vein densities, veins and veinlets being mostly shallowly dipping, but commonly discordant with foliation (S_1) and layering (S_0). The auriferous vein systems and metasomatites developed late in the deformation history, cross cutting/overprinting S_1 (the main regional foliation) as well as D_2, D_3 and D_4 crenulations and folds during an essentially brittle, low strain, N-S shortening. Ore zones are offset by NE- and ENE-trending fault/shear zones which are accompanied by retrograde (sericite-chlorite-carbonate) alteration. Muruntau is not a shear zone-hosted or related system (cf Drew and others, 1996), but is better described as localised in a fold-fault system similar to those hosting several other giant gold deposits.

Main stage gold mineralisation is accompanied by anomalous As, Sb, Bi, Mo and W and biotite-stable, potassic alteration which is thermally compatible with host rock thermal metamorphic assemblages. The latter overprint D_1-D_4 fabrics as well as outlining a broad thermal aureole related to underlying granitoid plutons. Revyakin's (1988, in Shayakubov and others, 1998) modelling of district scale gravity indicates that Muruntau is located 3-4km above the margin of such a pluton, confirmed by the intersection (4-4.3km depth) of granite in SG-10 as well as metamorphic patterns in this, other deep drillholes and surrounds.

Key factors in the localisation and size of the giant Muruntau deposit were (i) its situation in the roof zone thermal aureole, above the appropriately oriented margin of a late orogenic (270-280Ma) granitoid pluton; (ii) medium grade thermal metamorphism which produced massively textured hornfelses amenable to fracturing during weak, syn-thermal metamorphic deformation; (iii) a carbonate-dominated lithostratigraphic unit forming a district wide system cap above a shallowly dipping and well layered metasedimentary package containing highly carbonaceous units (a source of reductant and strain partitioning) interlayered with psammites and psammopelites in a broad structural culmination resulting from the interference of fold sets; (iv) development of fold and fault systems prior to and during thermal metamorphism in a belt transverse, transpressional zone which may reflect reactivation of basement fault systems; (v) fault/fracture controlled infiltration of medium temperature, presumably pluton-derived, auriferous (As, Sb, Bi, Mo and W enriched) fluids into highly reduced and altered metasediments.

In these respects Muruntau resembles several other giant auriferous systems, providing an exploration model useful in targeting similar gold deposits from local to regional scales.

Acknowledgements

We thank Navoi Mining and Metallurgical Combine (N.I. Kuchersky, S.B. Inosemzev) and IMR, State Committee on Geology and Mineral Resources (N.A. Akhmedov, B.A. Isakhodaev, I.M. Golovanov) for facilitating this study.

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