Paper Number: 1874

Mobility of gold during metamorphism: links between fertility, efficiency and endowment

Pitcairn, I.K.[1]

[1]Department of Geological Sciences, Stockholm University, 10691 Stockholm, Sweden. iain.pitcairn@geo.su.se

---

Metamorphic fluids are widely accepted to have formed many of the world's orogenic gold deposits, at least those of Phanerozoic age. The classic metamorphic model suggests that Au, As, Sb, and other metals are mobilised by H_2O-CO_2±CH_4±N_2±H_2S fluids produced dominantly at the greenschist amphibolite transition due to breakdown of chlorite and metamorphic recrystalisation of organic matter and sulfide minerals[1, 2, 3]. Focussed flow of these fluids in major fault zones during seismic events leads to formation of the gold ores in shallower level rocks that are actively exhuming and commonly on their retrograde metamorphic path. The gold is carried in solution by the H_2S with both components being produced by conversion of pyrite to pyrrhotite[2].

Recent research has tested this model through quantification of the metals mobilised in a number of different orogenic belts such as the Otago and Alpine Schists of New Zealand[2], The Dalradian of Scotland[4], The Lachlan orogen of Australia. Mobility of Au during alteration of the oceanic crust has also been recently quantified[5], and the metamorphic mobility of gold and related elements from different rock types has also been thermodynamically modelled[6]. The results of these studies invariably show that large masses of Au are mobilised during metamorphism, but that there is considerable variation in the primary metal contents of the sedimentary and volcanic rocks prior to metamorphism and the extent of mobilisation of gold and other elements. The terranes investigated also show variability in the endowment of orogenic gold deposits from poorly mineralised belts such as the Dalradian of Scotland to world-class gold terranes such as the Victoria goldfields in Australia. These results allow us to investigate the links between source rock fertility, efficiency of metal mobilisation and precipitation and the degree of endowment in orogenic gold terranes.

The balance between protolith fertility and source to sink efficiency controls the overall endowment of gold deposits in the terranes and settings investigated settings. Even in terranes with relatively Au-poor source rocks such as The Dalradian of Scotland and The Otago and Alpine Schist's of New Zealand there has been sufficient Au mobility during metamorphism to form many world-class deposits but only if the source to sink efficiency of the mineralising system was very high. The only world-class deposits in either of these terranes is the Macraes deposit in Otago and the mineralised structure at Macraes is likely to be an example of a high efficiency system. In terranes with more Au-rich source rocks such as the Victoria goldfields, world-class Au deposits that are more abundant in this terrane may still form even at low levels of source-sink efficiency. In the MORB[6] and ophiolitic oceanic crust, gold mobility (from the altered lower parts of the sheeted dyke sequence) is proportional to enrichments in VMS deposits occurring in these settings. Mass balance investigations indicate that the trapping efficiency of gold (and base metals) in these systems is low.

References:

[1] Goldfarb R et al. (2005) Econ Geol 100th Ann Vol: 407-450
[2] Pitcairn IK et al. (2006) Econ Geol 101: 1525-1546
[3] Phillips GN and Powell R (2010) J Met Geol 28: 689-718
[4] Pitcairn IK et al. (2015) Lithos 105:443-798
[5] Zhong et al. (2015) Geochim Cosmochim Acta 171: 338-352
[6] Patten C. et al. (2015) Min Dep *doi:10.1007/s00126-015-0598-8*