

Molybdenite deposits: Time markers for orogenic processes, example from SW Scandinavia

B. BINGEN¹, H.J. STEIN², F. CORFU³, M. A. HAMILTON⁴,
J.L. HANNAH² AND I.H.C. HENDERSON¹

¹Geological Survey of Norway, 7491 Trondheim, Norway,
(bernard.bingen@ngu.no)

²AIRIE program, Dept of Geosciences, Colorado State
University, Fort Collins, CO80523-1482, USA

³Institute of Geology, University of Oslo, 0316 Oslo, Norway

⁴Geological Survey of Canada, Ottawa, Canada, now at Earth
Sciences Centre, University of Toronto, M5S 3B1
Toronto, Canada

Re-Os data on molybdenite and U-Pb data on zircon and monazite demonstrate that 16 molybdenite deposits in the Sveconorwegian orogen of SW Scandinavia formed during the Sveconorwegian orogeny. High-grade metamorphism related to convergence ranges from 1.14 to 0.97 Ga. Extensional gravitational collapse of the orogen took place between 0.97 and 0.91 Ga. In the Rogaland-Vest Agder (RVA) sector, 0.93-0.91 Ga HT-LP metamorphism centered around the 0.93 Ga Rogaland anorthosite complex and overprinted 1.04-0.97 Ga regional metamorphism. Molybdenite from 10 small Mo deposits in the RVA gneiss complex yields Re-Os model ages between 1023 ±3 and 939 ±3 Ma. The Øvre Myssa deposit, in direct vicinity of the Rogaland anorthosite complex, yields a younger age of 917 ±3 Ma. These ages reflect molybdenite crystallization during the waning stage of high-grade metamorphism. The deposits are associated with quartz veins, aplite-pegmatite veins or leucosomes hosted in biotite-magnetite-ilmenite-sulfide bearing gneiss. Molybdenite is regarded as a reaction product between these phases and an aqueous fluid or silicate melt. Trace amount of Mo (and Re) hosted in biotite, magnetite and ilmenite was liberated, either due to decreasing solubility with decreasing temperature, or to dehydration melting breakdown of biotite (Ørsdalen). The large Knaben II deposit is hosted in leucocratic syn-orogenic granite. Molybdenite in this deposit ranges from 1021 ±4 to 975 ±3 Ma. In some of the deposits, several generations of molybdenite are recorded (Konstali, Knaben, Kvina) implying several deposition events and/or dissolution-reprecipitation of molybdenite. All molybdenite deposits in Rogaland-Vest Agder are deformed. Molybdenite oriented in the gneiss fabric provides a maximum age for ductile deformation. The data document a decreasing age for deformation from 947 ±3 to 931 ±3 to 917 ±3 Ma towards the Rogaland anorthosite complex, reflecting mid-crustal flow during orogenic collapse.

Why golden fingers point to the arc?

W.D. SUN¹, R.J. ARCULUS², V.S. KAMENETSKY³
AND R.A. BINNS^{2,4}

¹Max-Planck Institut f. Chemie, Postfach 3060, Mainz, 55020,
Germany

²Department of Earth and Marine Sciences, The Australian
National University, Canberra, ACT 0200, Australia

³Center for Ore Deposit, Research and School of Earth
Sciences, University of Tasmania, Hobart, Australia

⁴CSIRO Exploration and Mining, North Ryde, NSW 1670,
Australia

Many Cu-Au ore deposits are closely associated with high fO_2 magmas at convergent margins [1, 2]. The genetic mechanisms, however, have been hard to track. Many models favoured addition of Au to the arc magmas either due to that additional sulphide is dissolved in the form of sulphate from the mantle into the magmas by high oxygen fugacity (fO_2) melts and fluids released from subducted slabs, or that gold is mobile and thus transferred from the subducting slab to the overlying mantle wedge and subsequently to the magmas.

We show here, in contrast to Re, the Au/Yb ratios are roughly the same for two suits of arc-type volcanic glasses and melt inclusion from Valu Fa Ridge with different subduction effects [3, 4], suggesting that Au is not significantly mobile during subduction. Detailed studies on a cogenetic fractionation series of submarine, subduction-related volcanic glasses from the eastern Manus Basin, Papua New Guinea, show abrupt decreases of Au and Cu abundances, coupled with a switch in behaviour of Ti and Fe from concentration increases to decreases as SiO_2 rises at the commencement of titanomagnetite crystallisation. No obviously coupled changes between Cl and Au (Cu) were observed. Given the studied samples are sulfide undersaturated, all the above observations can be plausibly interpreted by that the abrupt depletion in Au and Cu results from concurrent sulphur reduction ($SO_4^{2-} \rightarrow S^{2-}$) as a result of fO_2 buffering, causing enhanced formation of Cu-Au hydrosulphide complexes that become scavenged from crystallising melts into cogenetic magmatic aqueous fluids². The reduction of sulphate to sulphide also implies that this process is particularly efficient in oxidised arc magmas with substantial sulphate, which conceivably explains the relation between high fO_2 and Cu-Au ore mineralizations².

References

- [1] Mungall, J. E. *Geology* **30**, 915-918 (2002).
- [2] Sun, W. D., Arculus, R. J., Kamenetsky, V. S. & Binns, R. A. *Nature*, **431**, 975-978 (2004).
- [3] Kamenetsky, V. S., Crawford, A. J., Eggins, S. M. & Muehe, R. *EPSL* **151**, 205-223 (1997).
- [4] Sun, W. D., Bennett, V. C. & Kamenetsky, V. S. *EPSL*. **222**, 101-114 (2004).