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Mo-isotope composition of molybdenites: Implications for magmatic and hydrothermal isotope fractionation

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We measured molybdenites (MoS_2) from two different locations; (i) a small subeconomic late Variscan MoS_2 mineralization from the Swiss Alps and (ii) MoS_2 from the Questa porphyry-type ore deposit (USA).

As molybdenite often crystallises from exsolved late hydrothermal fluids of granitic intrusions, the investigation of their Mo isotope composition can identify isotope fractionation effects and potentially increase the knowledge of Mo enrichment and MoS_2 crystallization processes. Another aspect of Mo isotope composition of MoS_2 is that their average is used to model the mean $\delta^{98/95}$Mo value of the earth crust.

The MoS_2 from the Swiss Alps show a bimodal $\delta^{98/95}$Mo distribution with centres at 0.2 ‰ and 1.1 ‰. This bimodality has been proposed to document two discrete pulses of fluid exsolution (Greber et al., 2011). The mean $\delta^{98/95}$Mo value of 0.4 ‰ is significantly heavier than that of the granite source rock (0.0 ‰).

Based on LA-ICP-MS trace-element fluid inclusion data, the evolution of the Questa porphyry has also been attributed to two hydrothermal fluid exsolution events (Klemm et al., 2008). The Mo isotope composition of the first event range from -0.3 ‰ to 0.1 ‰, those from the second event from 0.1 ‰ to 0.4 ‰.

Our results suggest that processes in the magma chamber are responsible for the evolving $\delta^{98/95}$Mo values of the ore, indicating that the ore-forming fluid becomes heavier with successive batches of fluid exsolution. Interestingly, the Mo isotope compositions of the two MoS_2 populations from the small mineralization from the Swiss Alps differ much more than those from the Questa deposit. This larger Mo isotope variation can be interpreted to represent a more pronounced evolutionary gap between different fluid exsolution pulses. Partial isotope disturbance during Alpine metamorphic overprinting of this late-Variscan mineralization cannot be ruled out, however. Thus, Mo isotope studies of MoS_2 bear a high potential to investigate and differentiate different pulses of MoS_2 formation and possible effects of later overprinting within one deposit.

References:

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