Variations of $^{107}Ag/^{109}Ag$ isotope ratio in ore deposits by high-precision MC-ICP-MS

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We present results of a $^{107}Ag/^{109}Ag$ isotope study for different Au and Ag hydrothermal deposits. Analyses were performed using a NEPTUNE multi-collector -ICP-MC with 3% HNO_3 solutions spiked by Pd. The measured $^{107}Ag/^{109}Ag$ ratio were on-line corrected for mass-discrimination using $^{108}Pd/^{106}Pd$=0.97533±7(±2SD) as an "internal" standard isotope ratio. The precision of the method (±2SD) was assessed by replicate analyses (n=23) of the SRM 978a Ag standard as ±0.007% (±0.7ε_{Ag}) at a mean $^{107}Ag/^{109}Ag$ value of 1.07634±8 (±2SD).

We studied native Au and Ag from well known deposits: the Precambrian Kidd Creek (Canada), Kolar (India) and Maiskoe (Russia), the Paleozoic Sukhoi Log (Russia), Karabash (Russia), Kongsberg (Norway), Aktepe (Uzbekistan), the Mesozoic Ducat (Russia) and the Cenozoic Hodrusha and Kremnica (Slovakia). The revealed isotope variations in $^{107}Ag/^{109}Ag$ is up to 5.3 ε_{Ag} which is similar to a variation range of 7.5ε_{Ag} presented for some terrestrial objects – Hawaiian basalts and Ag-deposits [1, 2]. Among our data the lowest ε_{Ag} value of (-5.8) was obtained for the Karabash Au-deposit, and the highest ε_{Ag} values (- 0.5 and - 0.4) were measured in the Kongsberg Ag-deposit and Kremnica Au-Ag deposit. All other deposits under study show a narrow range of ε_{Ag} values (from –1.9 to -4.0).

The obtained ε_{Ag} values do not correlate with the geological position, genesis and age of deposits. The latter varies from 2700 to 12 Ma. The most probable reason for $^{107}Ag/^{109}Ag$ variations is Ag isotope fractionation in ore-forming processes. Its leading mechanism is connected with changes in Ag valency state during mineral formation. These processes will be a topic of future studies.

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Preeruptive conditions and dynamic processes in magmatic systems: The example of Unzen 1991-1995 eruption

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The compositional and morphological characteristics of rocks produced during volcanic eruptions provide constraints on the magma storage conditions prior to eruption and on the dynamic processes occuring in magma chamber and during magma ascent. However, the quantitative interpretation of chemical and morphological variations in terms of eruptive dynamics requires an accurate calibration via experimental approaches. In the particular example of the Unzen eruption in 1991-95, a variety of experimental studies (phase relations, solubility of volatiles in melts, viscosity and decompression experiments) have been combined with petrological, geochemical and geophysical approaches for the erupted rocks as well as for rocks in magmatic conduit drilled by the ICDP (Unzen Scientific Drilling Project), leading to a general overview of the magmatic processes prior to and during the eruption. The eruption was triggered by the mixing/mingling of a low-temperature (~770°C) rhyolitic magma with a high-temperature (~1050°C) andesitic magma at pressures of 300-400 MPa. The rhyolitic magma was rich in H_2O (7-8 wt%) and Cl (up to 0.1 wt%) while andesite was a main source for CO_2 and S (0.04 wt%). The mixed dacitic melt (T=930°C) might have contained about 6 wt% H_2O, 0.09 wt% CO_2, 0.02 wt% S and about 0.05 wt% Cl. The interpretation (and experimental calibration) of zoning of amphiboles indicate that influxes of volatiles and degassing events occurred in the magma chamber prior to mixing. Experiments aimed at understanding the rheology of Unzen magmas indicate that the viscosity of the two end-member melts (water-poor andesite and water-rich rhyolite) were nearly identical, leading to an effective mixing. Using decompression experiments modelling the magma ascent and the concomitant degassing (exsolution of H_2O- or H_2O+CO_2-bearing fluids), it is demonstrated that microlites can only form at decompression rates <0.1 MPa/s. The size and shape of plagioclase microlites in Unzen rhyodacitic groundmass could be reproduced at decompression rates of 0.0002 MPa/s, corresponding to an average magma ascent rate in the Unzen conduit of ~ 20 m/h.