Volatile phase variations in metal concentrations and redox states during Merapi volcano eruptive cycles: Insights into the genesis of porphyry systems

NADEAU, OLIVIER[1], STIX, JOHN[2] AND WILLIAMS-JONES, ANTHONY E.[3]

[1]University of Ottawa, Ottawa, Canada. onadeau@uottawa.ca
[2]McGill University, Montreal, Quebec, Canada. john.stix@mcgill.ca
[3]McGill University, Montreal, Quebec, Canada. anthony.williams-jones@mcgill.ca

Porphyry systems are closely related to volcanoes. Although it is commonly believed that porphyry and epithermal stages predate volcanic stages [1], it has been shown that ore deposition may be synchronous with volcanic activity [2]. In order to study variations in metal content and redox state during volcanic activity, volcanic vapors were sampled at Merapi volcano, Indonesia, during quiescent degassing and after an explosive eruption. The results show that during quiescent degassing, the magmas and their volatile phases are enriched in high field strength (HFSE), rare earth (REE) and large ion lithophile (LILE) elements, as well as Mo, Au and U, and are relatively oxidized. By contrast, immediately after explosive eruptions, the magmas and their volatile phases are enriched in Cu-Zn-Pb and S-Cl, and are relatively reduced. A model is proposed whereby cyclic injections of reduced mafic magmas trigger explosive eruptions that depressurize the porphyry environments, leading to deposition of reduced Cu-Zn-Pb sulfide minerals. Periods of eruptive activity alternate with periods of quiescence, during which magmas become enriched in HFSE, REE, LILE, Mo, Au and U and are oxidized. These results provide evidence for variations in metal concentrations and redox state during magmatic evolution, linking them with eruptive activity and ore deposition.

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