What can magmatic sulphides tell us about magma fertility in porphyry systems?

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We investigate the role of sulphide saturation on magma fertility in porphyry systems by comparing, for both mineralized and barren systems, magmatic sulphide and chalcophile metal behaviour during evolution of compositionally different magmas in diverse geodynamic settings. The study areas are: (a) the Quaternary Ecuadorian volcanic arc (host to the Miocene Llurimagua Cu-Mo and Cascabel Cu-Au porphyry deposits) (Subduction), (b) the Miocene Konya magmatic province (hosting the Doganbey Cu-Mo-W and Inlice Au-epithermal deposits) (Post-Subduction) and (c) the Miocene Usak basin (Elmadag, Itecektepe and Beydagi volcanoes, the latter associated with the Kisladag Au porphyry) in Western Turkey (Post-Subduction). For comparison we also investigate (d) the barren Plio-Quaternary Kula volcanic field, west of Usak (Intraplate).

The volcanism of the studied areas displays a wide range of SiO_2 ranging from basalts to andesites/dacites and from high K-calc-alkine to shoshonitic series. The main host phenocryst for sulphides is magnetite for Ecuador, Konya and Beydagi, amphibole for Itecektepe and Kula, and pyroxene for Elmadag. Sulphides are also hosted in plagioclase and rarely appear in the groundmass. Multiphase sulphides occur in all studied areas and are composed of a Cu-poor/Ni-rich (mss) and one/two Cu-rich (iss) phases making up 84 and 16 area % of the sulphide, respectively. This suggests that, independently of the geodynamic setting and whether or not the system has generated an ore deposit in the surface, the initial metal contents of the magmas for all areas are similar.

With magmatic evolution the sulphide Ni/Cu (proxy for mss/iss) ratio decreases, starting with Ni-richer/Cu-poorer sulphides hosted by olivine/pyroxene and ending with Cu-richer sulphides hosted by magnetite. These late sulphides, consisting of Cu-rich phases (iss) hosted exclusively by magnetite, are only found in magmatic provinces associated with porphyry Cu (Konya and Ecuador) and porphyry Au (Beydagi) deposits. Preliminary EPMA results show higher Au contents in sulphides of Beydagi compared to other areas.

Further investigation, including LA-ICP-MS, analysis is needed to assess whether texturally and compositionally different magmatic sulphides can be used as a proxy for magma fertility for porphyry-Cu deposits.