Isochoric ascent of lithostatically-pressured, dense magmatic vapor during gold-enargite ore formation

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Metalliferous magmatic vapors that exsolve from melts below volcanic geothermal systems transport volatile metal complexes through the lithostatically-pressured rock column to a hydrostatically-pressured regime of meteoric ground water in the volcanic edifice, where they condense and mix with ambient groundwater [1] to precipitate metals as high-sulphidation Cu-Au ores [2]. We have studied the palaeohydrology of the giant Pliocene Tampakan high-sulphidation Cu-Au deposit in Mindanao, Philippines. The deposit is associated with andesitic stratovolcanoes of Miocene to Quaternary age. We use hydrothermal and igneous mineral thermobarometry, H and O isotopes, fluid inclusions, and thermodynamic calculations to constrain the flow-path of ore-forming fluids at several points in fluid P-T-enthalpy-salinity-density co-ordinates: at the site of 2-phase magmatic fluid exsolution (~900°C, ~800 bars, >99% vapor with ~4.4 wt.% NaCl equiv.); at the lithostatic-hydrostatic interface from ~500°C, $P_{Lith} \cong$ 550 b, 96.9% vapor that holds 85% of the systems Cl, to ~375°C, $P_{Hyd} \cong$ 200 b, 61.7% vapor that holds 4% of the systems Cl after decompression; and at points along the mixing path in the hydrostatic domain (375-100°C, P_{Sat}). Magmatic vapor ascended along a nearly isochoric path through the lithostatic rock column by propagating self-sealing hydraulic fractures that open at the top while closing at the bottom. The magmatic vapor density increased slightly (~0.2→0.3 g/cc) during ascent over ~1100 metres from the stock to the base of the deposit. The *near-isochoric* ascent requires transport by transient, self-sealing hydrofractures, with intimate contact between the vapor and the wall rocks allowing substantial conductive cooling (~900→500°C). Thermal contraction of the vapor balanced the tendency to expand with decompression, and sustained its metal-chloride carrying capacity during ascent to the fluid-mixing site in the deposit. The vapor cooled rapidly (~500-375°C) during isoenthalpic decompression of the vapor-charged mobile hydrofractures at the brittle/ductile interface at the base of the deposit. The condensed vapor was modestly saline (~5 wt.% NaCl) and mixed with meteoric water at ~2 km depth. Most of the exsolved magmatic chloride (~81-85%, and metal) was transported through the ductile rock column to the site of ore deposition by a dense vapor phase.

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References

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Late Quaternary Paleoclimatology of the western equatorial Pacific

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The fundamental question of the past variability of tropical sea surface temperatures and climate has been controversial for a long time. New perspectives on the importance of equatorial Pacific variability to the global climate are now emerging, largely due to two significant advancements in paleoceanographic research: 1) the availability of long high-resolution records from the western Pacific obtained by the IMAGES program; and 2) the development of Mg/Ca paleothermometry, which allows an accurate assessment of the relative amplitude and phasing of past climate interactions between the tropical Pacific and higher-latitudes and thus provides insights into the mechanisms of climate change on both orbital and shorter time-scales. In this talk we will present new $\delta^{18}O$ and Mg/Ca records in planktonic foraminifera from three IMAGES cores: MD972141 a high-resolution record from the Sulu Sea (0-400ky) showing significant variability both on orbital and sub-orbital time-scales and the lower resolution records of MD972138 (0-250ky) and 2140 (0-1.6My) from the Western Pacific Warm Pool (WPWP). The records provide new insights into the thermal and hydrological evolution of the WPWP during the Pleistocene. We also will examine the interactions between the tropical systems of El Niño and the East Asian Monsoon and their link to climate variability in the high-latitudes oceans on different time scales.