

Anhydrite as a tracer of sub-seafloor hydrothermal circulation and vent deposit formation

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The mineral assemblage and geochemistry of seafloor hydrothermal vent deposits are dictated by temperature, pH and redox conditions, and by concentrations of aqueous species in circulating fluids, during deposition. These variables are, in turn, influenced by near-seafloor fluid circulation and mixing of fluids of distinct origin (e.g., high-temperature seawater-derived hydrothermal fluid, locally entrained seawater, magmatically-derived volatile-rich fluid). Anhydrite (CaSO₄) is a useful tracer of these processes and conditions, being precipitated during mixing of high-temperature hydrothermal fluid with seawater.

Abundant anhydrite has been recovered from the PACMANUS hydrothermal system, eastern Manus Basin, both at the seafloor [Tivey *et al.* 2006] and from depth subsurface (ODP Leg 193 [Binns *et al.*, 2007]). This affords the first opportunity to directly explore subsurface processes associated with hydrothermal activity in a back-arc basin.

In situ microbeam techniques (laser ablation-ICP-MS) are used to explore fine-scale variability in isotopic (Sr, S) and elemental (Mg, Sr, Ba, REE, Y, etc.) signatures of anhydrite, from various depths and locations at PACMANUS. First analyses indicate significant differences in Sr-isotope (⁸⁷Sr/⁸⁶Sr > 1000 ppm), S-isotope (δ³⁴S > 5 ‰) and REE content of anhydrite are observed between and within sites at PACMANUS over scales ranging from m's to mm's. Variable and light δ³⁴S (+16.6 to 19.0 ‰) in anhydrite from depths ~ 300 mbsf indicate possible contribution from an isotopically-light magmatic source in the high-temperature fluid. Large grain-scale variability in ⁸⁷Sr/⁸⁶Sr (0.7043 to 7.089) indicates significant variation in the extent of mixing between the hydrothermal fluid and seawater. REE patterns range from light-REE enriched to light-REE depleted, both with positive and negative Eu-anomalies, to flat, non-fractionated REE. While the majority of data is still to be collected, the patterns recorded thus far suggest fractionation of REE during anhydrite precipitation or differences in fluid compositions. Isotopic data indicate three end-member mixing, including a possibly magmatic component. Comprehensive coupled elemental and isotopic microanalyses will enable us infer the effects of fluid source versus fractionation process during anhydrite precipitation.

References

- Binns, R. *et al.* (2007) Leg 193 Synthesis. *Proc. ODP. Sci. Res.* **193**, 1-17.
Tivey, M.A. *et al.* (2006), *Cruise Rept. R/V Melville, Leg Magellan-06, Manus Basin*, 67pp.

Geochemical and isotopic variation of Mt. Etna volcanic rocks: The role of a heterogeneously metasomatized source region of magmas

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New clues for investigating on some features not yet clarified at Mt. Etna (Italy), such as the genesis of magmas and the intrinsic characteristics of the source region, come from an extensive sampling of historic (pre-1971) and recent (1971-2007) volcanic rocks, carried out prevalently on the southern flank of the volcano. In spite of the relatively similar major element compositions, recent volcanic rocks are clearly distinct in terms of incompatible trace elements and Sr – Nd – Pb isotope ratios from the historic ones. Post-1971 volcanics, and especially those later than 2001 eruption, show enrichment trends for K, Rb and ⁸⁷Sr/⁸⁶Sr and a progressive decrease especially for Th contents and Pb isotope ratios. The role of crustal contamination at shallow levels in generating such a variation has been ruled out on the basis of trace elements and of the restricted δ¹⁸O variability within the entire examined sequence. In alternative, we suggest a geochemical and isotopic evolution of the source region of magmas highly consistent with the presence of an increasingly amount of hydrous phases, prevalently phlogopite, involved in the partial melting process. A reason for the short-term evolution of magmas may then be found by considering a partial melting process which occurs in mantle domains affected by variable and increased degree of metasomatism with time, revealing the heterogeneous nature of the source at the melting scale.

Trace element geochemistry provides also evidence that the generation of recent magmas would derive from a higher degree of partial melting in respect to the previously emitted products. This feature may be connected with the higher amounts of metasomatic influxes that have stabilized fluids into the mantle, enhancing in turn the extent of partial melting. In such an articulated context, a limited mantle upwelling, related to the intrinsic convective processes (plume-like) and/or to the lithospheric stretching due to extensional deep faults, could rather easily trigger partial melting processes of these metasomatized peridotites, generating melts different in composition depending on heterogeneities. Furthermore, since the increased extent of partial melting will result in an increased melt production at the source, such a geochemical evolution of the mantle with time is consistent with the development of volcanic phenomena at the surface. The occurrence of such a heterogeneously metasomatized mantle would therefore explain the increased frequency of events and emission rates of volatile-rich magmas observed just following the 1971 and especially during the 2001-2007 eruptive period.