Melt inclusions from the Galápagos plume: Mirrors and mirages of the deep

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Melt inclusions provide an advantage over erupted magmas because they are samples of very small amounts of melt commonly trapped at pressures exceeding the pressure of eruption, and their chemical compositions have remained unchanged since entrapment. Thus, melt inclusions are an invaluable tool to characterize the composition of pre-aggregated lavas prior to differentiation and mixing in magma chambers, and to determine the pre-eruptive volatile contents of basalts. However, there are two serious disadvantages to using melt inclusions to evaluate mantle melting processes: 1) the composition of melt inclusions can reflect localized, grainscale, wall-rock reaction processes within the shallow magmatic plumbing system, and 2) the host crystal may not effectively isolate the inclusion as a closed system (e.g., preventing H_2O diffusion).

We have analysed major, trace element, and volatile contents in more than 100 olivine-hosted (Fo81-87) melt inclusions in submarine and subaerial lavas from the Galapagos Islands. Our results indicate that enriched and ultra-depleted melt compositions coexist in the magmatic plumbing system beneath Galapagos volcanoes. Furthermore, the trace element compositional variations found in melt inclusions from a single sample reproduce the total geochemical variation defined by the whole rock data for the Galapagos lavas. Establishing the processes responsible for such variations will therefore have direct implications on the origin of the compositional variation of basalts throughout the Archipelago. Our new volatile data provide limits on the concentration of CO_2, H_2O, F, S, and Cl for the high $^3He/^4He$ and depleted mantle components beneath the Archipelago. The CO_2- H_2O data give an entrapment pressure of ~1 kbar, corresponding to a depth of ~3 km. A subgroup of inclusions is characterized by significant depletion in incompatible trace elements with unusual $(Sr/Nd)_{PM}$ and $(Ba/Th)_{PM}$ ratios greater than unity, suggesting the interaction of melts with a plagioclase-rich cumulate during melt percolation within the oceanic lithosphere. The volatile data for these inclusions suggest that a) the interaction of melt with lithospheric gabbros decreases the S and Cl content of the melt, and b) the H_2O and F content in these inclusions have been modified by open system behavior due to diffusion of H and F through the olivine host.

Mercury, trace elements, and organic constituents: A combined approach to sampling atmospheric particulate matter (PM)

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Compliance with USA air quality PM regulatory standards (PM_{10} and $PM_{2.5}$) is based on meeting average 24-hour and yearly mass-per-unit-volume limits, regardless of PM composition. In the present work, we combine filter-based sampling of particulate-bound mercury, trace elements, and organic constituents to determine compositional variation of atmospheric aerosols in three contrasting environments in the USA, and assess potential human health impacts.

Along the U.S. Gulf of Mexico coast, Hg wet deposition is especially elevated. PM sampling conducted together with a mobile lab Hg speciation unit shows a significant portion of particulate Hg bound to particles larger than 2.5 μm, including sea-salt aerosols derived from marine air masses. Mercury speciation results show a diel pattern of photochemical Hg oxidation. Adsorption of oxidized and elemental Hg on NaCl aerosols increases Hg available for deposition in this Hg-sensitive coastal ecosystem.

At an inland suburban site in the eastern USA, trace element enrichment factors in $PM_{2.5}$ show elevated ratios of Se, Sb, Ag, Bi, Cd, Mo, Pb, Zn, and Tl, vs. Zr (crustal affinity), compared to crustal abundance ratios of these elements, suggesting influence from industrial, transportation, and fossil fuel combustion sources.

Studies in the Navajo Nation of New Mexico focus on human exposure to domestic coal combustion, shown to be correlated with the incidence of respiratory difficulties. Extractable organic compounds in $PM_{2.5}$ include abundant alkanes and low abundances of various polycyclic aromatic hydrocarbons (PAHs). The predominance of low molecular weight alkyl-substituted PAHs is indicative of a coal source.