Pathways of redox state and sulfur release track the shift from low-energy to highly-explosive basaltic eruptions at Mt. Etna

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Basaltic magmas can transport and release large amounts of volatiles into the atmosphere, especially in subduction zones, where slab-derived fluids enrich the mantle wedge. Mt. Etna in Sicily, is one typical basaltic volcano where the volatile control on variable activity (effusive to Plinian) can be investigated. Based on a melt inclusion study of sulfur in products from Strombolian or lava-fountain activity to Plinian eruptions, here we show that different eruptive styles correspond to distinct sulfur degassing paths. Depending on their initial water content, oxidation state, and extent of CO_2-fluxing, Etnean magma batches can soon reach the limit of sulfide saturation or get rid of sulfur on degassing only. Melt inclusion data indicate that the magma involved in the powerful 122 BC Plinian eruption is richer in sulfate ($S^{6+}/S_{tot} > 0.65$) than the magmas erupted during less energetic explosive February 1999 and Strombolian effusive 1997-98 eruptions. We propose a direct relationship between the high sulfate (SO_4^{2-}) content in melts and hence high oxidation state of the melts and the magnitude of an eruption. Highly oxidized conditions ($[S^{6+}/S_{tot}]$melt and $SO_{2,gas}/[H_2S+SO_2]_{gas} > 0.6$) in Etnean magma batches enhance the probability of violent explosive eruptions, such as the 122 BC Plinian event. The different patterns of sulfur release (oxidized vs reduced) of Etnean magmas are discussed and modeled.

Bend-Faulting, Serpentinization, and Mantle Recarbonation at Trenches

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It is well known that mid-ocean ridges are a key site for chemical interactions between oceanic crust and the hydrosphere, and that these interactions modulate the chemistry of the oceans. Subduction forearcs are also key sites of chemical fluid-rock exchanges. These fields are likely to still have many surprises to reveal, but are relatively mature. However, it is becoming increasingly evident that the oceanic lithosphere may also strongly interact with the hydrosphere during plate subduction, as it bends — by bend-faulting — when it enters a trench. I briefly review recent seismic evidence collected by the SFB574 and others that suggests that bend-faulting is associated with ~10-20% serpentinization in a layer extending at least 5km below the Moho. If this serpentine forms with a 1% carbonate fraction (note that at least this degree of carbonitization occurs during mid-ocean-ridge serpentinization processes), then bend-faulting-linked serpentinization will consume an atmosphere's worth of CO_2 every 40,000 years, and it is likely that the carbonate storage in serpentinized subducting lithosphere exceeds that in overlying oceanic crust and sediments. This poorly-understood geological process clearly merits further study, with significant potential implications for the global carbon cycle, for the geochemical evolution of the mantle, and for human exploitation for potential carbon sequestration at oceanic trenches. CO_2-rich fluids released by deserpentinization reactions may even play a role in 'lubricating' the subduction channel, and in the volatilization of the forearc. While bend-faulted Moho lies within the potential drilling window for the Chikyu marine drilling platform, it may prove to be much easier to gain constraints on bend-fault-related serpentinization from observations on Alpine serpentinites. Another critical observation to begin to document this interaction would be to find and study an active site of bend-fault fluid venting at the seafloor — with candidate sites evident in swath-mapping and deep-bottom photos offshore Central America.

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DOI:10.1180/minmag.2013.077.5.13