Tracing crustal contamination along the Java segment of Sunda Arc, Indonesia

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Arc magmas typically display chemical and petrographic characteristics indicative of crustal input. Crustal contamination can take place either in the mantle source region or as magma traverses the crust (e.g. [1]). While source contamination is generally considered the dominant process (e.g. [2, 3, 4]), crustal contamination in high level magma chambers has also been recognised at volcanic arcs (e.g. [5, 6]). In light of this, we aim to test the extent of upper crustal versus source contamination along the Java segment of the Sunda arc, which, because of its variable upper crustal structure, is ideal for the task.

We present a detailed geochemical study of 7 volcanoes along a traverse from Anak-Krakatau in the Sunda strait through Java (Gede, Slamet, Merapi, Kelut, Kawah-Ijen) and Bali (Batur). Using rock and mineral elemental geochemistry and radiogenic (Sr, Nd and Pb) and, stable (O) isotopes, we show a correspondence between changes in composition of the upper crust and the apparent degree of upper crustal contamination. There is an increase in $^{87}Sr/^{86}Sr$ and $\delta^{18}O$, and a decrease in $^{143}Nd/^{144}Nd$ from Krakatau towards Merapi, indicating substantial input from the thick quasi-continental basement beneath East and Central Java. Volcanoes to the east of Merapi, and the Progo-Muria fault zone, where the upper crust is thinner and increasingly oceanic in nature have lower $^{87}Sr/^{86}Sr$ and $\delta^{18}O$, and higher $^{143}Nd/^{144}Nd$ indicating a stronger influence of the mantle source [7]. Our new data represent a systematic and high-resolution arc-wide sampling effort that allows us to distinguish the effects of the upper crust on the compositional spectrum of individual volcanic systems along the Sunda arc.

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Multi-scale modeling of transverse reactive mixing in a coastal aquifer

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The transverse mixing between freshwater and seawater in coastal aquifers is a key process controlling the chemistry of submarine groundwater discharge (SGD). The quantification of such mixing and its effects on the fate of reactive chemical compounds in coastal waters are still the subject of debate. We developed reactive transport model approaches to study the mechanisms responsible for controlling reactive mixing processes in coastal aquifers. These models employ hybrid numerical methods for solving flow and transport [1,2], and benefit from utilizing the biogeochemical reaction network simulator (BRNS) [3].

Critical to advancing our understanding is the study of the interplay between reaction and flow. We particularly investigated the impact of dispersion, heterogeneity induced velocity variations and biogeochemical reactivities on reactive transport for density driven flow scenarios representing seawater-groundwater-interface in coastal aquifers. Our numerical observation showed e.g., that for highly reactive dissolved organic carbon (DOC) degradation processes are limited by the porous media properties controlling dispersion, whereas for relatively less reactive DOC degradation is controlled by reaction kinetics.

In general, we found three reactive flow regimes: reaction controlled, reaction-dispersion controlled and dispersion controlled transport. This is supported by further simulations utilizing pore-scale models to investigate these regimes at the smaller scale. Our results suggest that the chemical reactivity as well as dispersivity are important parameters governing the biogeochemical dynamics of SGD. Hence, an adequate representenation of these processes in the macro-scale models is essential.

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