Influence of alkalinity on the magnesium composition of amorphous calcium carbonate

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An increasing number of studies are showing that many calcifying organisms form skeletons by nonclassical growth. This biomineralization process begins with the accumulation of an amorphous precursor phase that subsequently transforms to an organic-mineral composite. Little is known about mineralization by this pathway because the last 50 years of research have focused almost entirely on traditional, step-growth processes.

To investigate the factors that influence the composition of amorphous calcium carbonate (ACC) and quantify their effects, we have developed a procedure for synthesizing this phase under controlled chemical conditions. The method uses a flow through reactor and high precision syringe pumps to prepare ACC from solutions that maintain a constant supersaturation and a well-characterized solution chemistry. This approach confers significant advantages over previous approaches such as the "Koga" method [1], that uses very high pH solutions (11.2–13.5), and the "ammonium carbonate" method [2], that produces highly variable supersaturation conditions and introduces significant amounts of ammonium ion to the mineralizing solution.

Using the new flow-through method, we are investigating the effect of alkalinity on the magnesium content of calcite that forms via the ACC intermediate phase. Previous studies have suggested that the magnesium levels in biogenic calcite may be correlated with the alkalinity of local growth environment [3]. The first phase of this project determined the effect of alkalinity on the magnesium content of the ACC at 24–25°C. The experiments were conducted by preparing two sets of syringes that contained solutions of 1) variable alkalinity using 40mM–150mM $NaHCO_3$ and 2) a 5:1 ratio of Mg:Ca (modern seawater) using $MgCl_2{\bullet}6H_2O$ and $CaCl_2{\bullet}2H_2O$. For the range of alkalinities used in this study, the effluent pH was 9.0–9.3. After achieving steady state output conditions, the ACC products were collected on 0.20 micron nylon mesh filter and characterized using SEM, Raman Spectroscopy, and ICP-OES. Future work will also determine the effect of alkalinity on the composition and structure of calcite that forms by the ACC pathway.

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Magmatic vs crustal volatiles: a reconnaisance tool for geothermal energy exploration

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Volcanically-hosted geothermal energy is an important resource in Indonesia of which Salak Geothermal Field in W Java is the largest developed one [1]. All 5 power-producing plants on Java are located in the western and central crustal sectors [1] and there appears to be a correlation between the location of commercially-viable geothermal systems, such as Salak Geothermal Field, and the thickness of the local upper crust and/or the volume of sediment on the downgoing plate [2]. This implies that crustal input from the subducting slab or from upper crust is central to the development of productive geothermal resources in this part of the world. Java's upper crust can be divided into three lateral segments: thick crust of continental affinity in the west [3], grading into arc-type and oceanic crust in central Java into increasingly oceanic affinity eastwards [3; 4].

Here we combine He isotope data from gas, fluids, pyroxene separates and whole rock Sr and Nd isotope values from volcanoes along the Sunda Arc (from Anak Krakatau to Bali, East of Java) with literature data to further understand sources to the crustal contamination signals and their influence on geothermal systems.

Helium isotope values (in R/R_A notation) are lower in both crystal and geothermal samples (down to $3.4R_A$ in pyroxene at Gede volcano) in the central and western crustal sectors, when compared to the eastern sector (7.46 R_A from fumaroles at Kawah Ijen volcano). Equally, Sr (as demonstrated by [5]) and Nd vary systematically eastwards along the arc, with values showing a significant crustal influence in central and western Java. East of the Progo-Muria fault, which delineates the central and eastern crustal sectors, volcanic rocks and geothermal samples give a more mantle-like signal (i.e. in eastern Java and Bali). The correlation between upper crustal type and crustal contamination is present in all three isotope systems (He-Sr-Nd). Together with the location of all commercially productive geothermal plants in west and central Java we propose that regional crustal influences may be highly relevant in understanding the development of geothermal systems with exploitation potential in Indonesia.

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