

## Saturation state of $\text{CaCO}_3$ precipitation from seawater at raised alkalinity

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Spontaneous abiotic carbonate precipitation in the oceans is substantially inhibited by the presence of dissolved magnesium and sulphate [1] so that seawater is  $\approx$ supersaturated with respect to calcite and aragonite without precipitation occurring. Concern over ocean acidification has led to considerable efforts to understand the impact of lower seawater saturation on (particularly biogenic) carbonate precipitation. But there has been less effort to constrain the impact of increased saturation levels on carbonate precipitation since the early 1990s [e.g. 2]. This issue remains important, however. Recent ideas have suggested a role for changing ocean alkalinity (and therefore saturation state) as a mechanism to drive past glacial-interglacial atmospheric  $\text{CO}_2$  changes. And a range of geoengineering schemes rely on increased ocean alkalinity through carbonate, hydroxide or silicate mineral addition to the surface ocean to induce uptake of atmospheric  $\text{CO}_2$  into seawater [3]. The efficacy of these geoengineering approaches is dependent on a comprehensive understanding of abiotic carbonate precipitation.

Here we present results from laboratory experiments which are specifically designed to investigate the spontaneous precipitation of  $\text{CaCO}_3$  as saturation state increases in seawater under controlled  $\text{P}_{\text{CO}_2}$  and alkalinity. Solutions of seawater were continuously dosed with  $\text{Ca}(\text{OH})_2$  and  $\text{Mg}(\text{OH})_2$  over an extended period in a closed system in which the  $\text{CO}_2$  concentration in the gas phase was continuously monitored.  $\text{CO}_2$  was drawn into solution and pH was measured at discrete intervals. Through analysis of trace-metal incorporation into carbonate phases, we determine the saturation state and rate at which carbonate precipitation occurs, complementing existing techniques that analyse changes in major element composition.

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[2] Morse, J.W., Shiliang, H. (1993), Influences of T, S and  $\text{P}_{\text{CO}_2}$  on the pseudo-homogeneous precipitation of  $\text{CaCO}_3$  from seawater: implications for whiting formation, *Marine Chemistry*, **41**, 4, 291-297

[3] Kheshgi, H.S. (1995) Sequestering atmospheric carbon dioxide by increasing ocean alkalinity, *Energy*, **20**, 9, 915-922,

## Mesoarchean TTG melt formation and migration in the Skjoldungen region of South-East Greenland

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The Skjoldungen region of South-East Greenland exposes a well-preserved section of Mesoarchean mid- to lower-continental crust that provides a unique window into crustal evolution and differentiation processes during the Archean. The central portion of the region comprises a sequence of mafic granulite rocks exhibiting clear textural evidence for having been subjected to in-situ partial melting, and subsequent generation of TTG melt. These rocks exhibit an aerially extensive network of former melt-bearing veins that preserve evidence of TTG melt generation in the lower crust and transport from mm-scale leucosomes within the mafic granulite to m-scale dikes that are structurally discordant to the mafic granulites and appear to be feeding larger-scale mid-crustal TTG bodies.

The Px-Pl-bearing mafic granulites have a LREE-enriched calc-alkaline basaltic protolith. Metamorphism and TTG-melt formation and migration occurred either during a crustal differentiation event at ca. 2.86 Ga or during collisional orogenesis at 2.8 – 2.7 Ga [1]. Leucocratic layers within the mafic granulite are characterized by cm-scale peritectic Opx, and form a large-scale network of former melt-bearing veins, in which smaller mm-scale foliation-parallel leucosomes are petrographically continuous with larger cm-scale structurally-discordant former melt-bearing channels which are texturally consistent with having fed large TTG sheets. The cm-m scale TTG layers exhibit enrichment in the most incompatible elements, HREE depletion, and are characterized by strong Pb enrichment, a subchondritic Nb/Ta ratio and higher Mg-number ( $\sim 50$ ). Trace element systematics are broadly consistent with these TTGs falling in the medium-(to high-) pressure sodic TTG groups of Moyen [2], suggesting partial melting of the mafic granulites occurred at pressures around  $\sim 1.5$  GPa. Some of the larger-scale TTG dikes in exposures of structurally higher crustal levels exhibit similar geochemical characteristics, suggesting that partial melting of Px-Pl mafic granulites is one source of TTGs in South-East Greenland.

[1] Kolb, J., Thrane, K., Bagas, L., (in press) *Gondwana Research*

[2] Moyen, J.F. (2011) *Lithos* **123**, 21-36.