Origin of Grande Ronde Basalts, Columbia River Basalt Group

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The Grande Ronde Basalt lavas contain 0-5% phenocrysts of plagioclase, augite, pigeonite, and olivine. Plagioclase hygrometry shows that the erupted lavas contained less than 0.3% dissolved H_2O. The presence of rare An_{96} plagioclase megacrysts suggests ~4.5wt% dissolved H_2O in some parent magmas. All magmas degassed during ascent and eruption. Size of plagioclase phenocrysts suggests an average phenocryst residence time in magna of 160 years. Ignoring hiatuses between eruptions, we estimate that the 110 flows of the GRB erupted over a cumulative time of 17,600 years, with an average eruption rate of about 8.6 km^3/year. The average interval between eruptions is estimated to be 3658 years. Model simulations and petrological reasoning indicate that the primary melts were generated from spinel peridotite at 1.5 GPa, perhaps under hydrous conditions. Extensive melting of lithospheric eclogite may have played a role as well; however, this is not constrained by our simulations. Magmas underwent contamination, mixing, and partial crystallization during and prior to their short residence within shallow (6 km) intrusives. Our petrologic conclusions lead us to present a petrotectonic model that supports the hypothesis that the CRBG magma generation was greatly aided by a thinned lithosphere and H_2O that may have come off the mantle wedge.

The role and effect of Mg on the formation of carbonates

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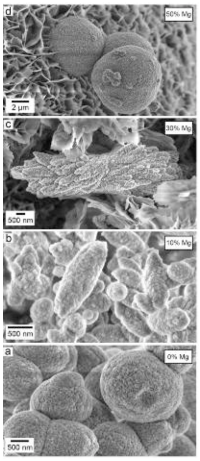
Mg is the most abundant divalent cation in seawater. It plays an important role in the crystallization of $CaCO_3$-based biominerals that control the marine global carbon cycle. However, the mechanisms of $CaCO_3$ crystallization from solution in the presence of Mg are still poorly understood. Here we show that a spherulitic growth mechanism often controls the nucleation, growth and crystallization of Ca-Mg carbonate polymorphs produced with variable Mg contents (0-50%) and at different temperatures (7.5-220°C). Combining *in situ* and realtime synchrotron-based diffraction and scattering with time-resolved UV-Vis spectrophotometry and high-resolution imaging we quantitatively evaluated the kinetics and mechanisms of the formation and crystallization reactions in the Ca-Mg-CO_3 system.



Under all conditions an initial, variable Mg containing, poorly-ordered, nanoparticulate precursor (amorphous calcium carbonate, ACC) forms from solution and transforms to various nanocrystalline intermediates via a spherulitic growth mechanism. In turn these intermediates crystallize via a dissolution and reprecipitation mechanisms to end products. The composition, kinetics of formation, local structure and stability of the ACC are dependent on the initial Mg/Ca/CO_3 ratio, the temperature, supersaturation and pH of the reactions. At 0% Mg, pure ACC rapidly (<2 min at 21°C) crystallizes to vaterite via spherulitic growth (image ***a***, bottom) and later transforms slower (hours) into calcite through dissolution-reprecipitation [1,2]. With 10% Mg, ACC is ~1 order of magnitude more stable than pure ACC, and transforms to Mg-calcite with no vaterite intermediate [3] (***b***). Higher Mg contents further stabilize the ACC for hours to days. These high Mg-ACC phases crystallize spherulitically either to monohydrocalcite (***c***; Mg/Ca> 0.25; T<60°C; [4]), dolomite (***d***; at Mg/Ca ~1; T>60°C; [5]) or various Mg-rich carbonates (e.g., at Mg/Ca>1 hydromagnesite).

[1] Rodriguez-Blanco *et al* (2011) *Nanoscale* **3:**265-271; [2] Bots *et al* (2012) *Cryst. Growth Des.* **12:**3806-3814 [3] Rodriguez-Blanco *et al* (2012) *J. Alloy. Compd*, **536:**S477-S479; [4]+[5] Rodriguez-Blanco *et al* (2013) *GCA* in review.