

# Liquids from $\text{CaCO}_3$ in the presence of $\text{H}_2\text{O}$ and the mobility of carbon in subduction zones

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Phase transformations in the system  $\text{CaCO}_3$  and in the join  $\text{CaCO}_3$  -  $\text{H}_2\text{O}$  have been of primary concern for Earth scientists since the early XIX century. Sir J. Hall successfully investigated the decarbonation reactions and the melting of calcite with water in externally heated gun barrels. Despite two centuries passed, the experimental results on phase transformations in this system are still contradictory. Discrepancy between ex-situ and in-situ determination of the reaction calcite = aragonite is in the order of 3 GPa at 1200 °C. Experimental data on the melting of calcite with an aqueous fluid differ by 300 °C. Uncertainties on the phase diagram for  $\text{CaCO}_3$  and  $\text{CaCO}_3$  -  $\text{H}_2\text{O}$  -  $\text{CO}_2$  have profound consequences in predicting the fate of altered oceanic crust and of metasedimentary materials re-introduced in the mantle at subduction zones.

Multianvil experiments were performed at 4.2 GPa on model bulk compositions in the system  $\text{CaO}$ - $\text{Al}_2\text{O}_3$ - $\text{SiO}_2$ - $\text{H}_2\text{O}$ - $\text{CO}_2$ , obtained from calcite,  $\text{Al}(\text{OH})_3$  and silica. Stoichiometric proportions are intended to produce at run conditions kyanite +  $\text{CaCO}_3$  + a “fluid” or/and a “melt”.  $\text{Al}_2\text{SiO}_5$  saturation prevents the formation of portlandite and dellaite, and offers a basis for modelling liquids formed from impure marbles. Furthermore the usage of  $\text{Al}(\text{OH})_3$  in the starting material allows an accurate control of  $\text{H}_2\text{O}$  added.

Aragonite + kyanite + fluid, and minor lawsonite form at 700 °C, replaced by zoisite at 800 °C. At 850 °C and 900 °C, a complex sequence of textural features is observed upon quenching; “chains” and dendrites of  $\text{CaCO}_3$  grow nucleating from liquid-solid interface; they are followed by growth of Si-Al-bearing fibres; spheres of silica precipitate from the residual fluid exsolved from the liquid carbonate phase. Textures and composition of quench products vary as a function of silica added. Estimates of liquid – solid proportions, retrieved by image analysis, at known bulk  $\text{H}_2\text{O}$  content, provide constraints for  $\text{H}_2\text{O}$  solubility in  $\text{CaCO}_3$  liquid. Chemographic analysis support a continuous transition from dissolution to melting at 4.2 GPa, i.e. the coalescence of the liquidus and the vaporous in wet-carbonate-silicate systems. Hydrous liquids enriched in Ca-carbonate at 850-900 °C are efficient media for scavenging volatiles from the subducted slab and for metasomatizing the mantle wedge.