Grain boundary diffusion rates dependence upon water activity in high pressure experiments

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The role played by water as a catalyst of metamorphic reactions is a major issue although it has not been clearly quantified yet. We propose here to study the effects of water content variations on the kinetics of the reaction $Ca(OH)_2$ + $MgCO_3$ = $CaCO_3$ + $Mg(OH)_2$. Synchrotron time-resolved X-ray diffraction data were acquired from 300°C to 600°C at high pressure (1.8 GPa), using a MAX80 multi-anvil apparatus. The Avrami fits of the reaction kinetic curves show a strong dependence of the reaction rates with the water activity: similar kinetics are observed at 400°C for samples containing initially 1wt.% water ('ambient' conditions) and at 600°C for samples where the water activity has been lowered to 10^{-2} ('dry' conditions). Further experiments performed with a piston-cylinder apparatus revealed equivalent kinetic at only 150°C under water-saturated conditions.

The FE-SEM study of the recovered samples suggests that the reaction is limited by the Ca-Mg grain boundary interdiffusion and is characterized by high nucleation rates. Thus, we have developed a reactive-transport model to simulate the experimental kinetic curves and retrieve each corresponding diffusion coefficient. Preliminary results confirm that the reaction is diffusion limited and that the diffusion rates are enhanced by many orders of magnitude from 'dry' to 'ambient' water conditions. Even though water has been also proposed to enhance nucealtion rates, it is clear from our results, that small changes in the water content have a great impact on transport properties. These results should contribute to the understanding of many natural observations where fluids are thought to play a key role, such as overstepping of metamorphic assemblages.

Evidence for transition from the Roman to the Tuscan Magmatic Provinces in Mts. Cimini olivinlatites

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The volcanic complex of Mts. Cimini (~1.35-0.90 Ma) represents the geographical and chronological transition between the Tuscan and the Roman Magmatic Provinces (TMP and RMP; central Italy). The olivinlatites of Mts. Cimini, the most mafic magmas which belong to the last phase of volcanic activity, group into two different main types, showing peculiar highly incompatible element ratios and Sr-isotope compositions. They also differ in terms of mineral chemistry and petrographic features. In particular, reversed zoned clinopyroxenes, the green cores of which show compositional similarity to the Roman-type clinopyroxenes, characterize only one of the two group of olivinlatites. By contrast, the second group of olivinlatites hosts clinopyroxenes which display chemical composition in the range of variation of those occurring in Tuscan lamproites. Such heterogeneity reflects the occurrence of a marble-cake mantle beneath central Italy, in which different portions, e.g., the TMP and the RMP mantle sources, are characterized by peculiar geochemical and petrographic features [1]. The last phase of activity of Mts. Cimini, in which parental magmas of both ultrapotassic alkaline and sub-alkaline magmas coexist in close spatial and temporal association, might sign a fundamental change of the marble-cake mantle portion undergoing partial melting. In this scenario, about 900ka ago, early Roman-type magma batches could have interacted with the Tuscan-type pristine magmas by mixing/mingling processes, before becoming predominant in central Italy. Thus, the Mts. Cimini olivinlatites marked the extinguishment of the TMP magma production in favour of partial melting of the RMP mantle region.This work was partially funded by the PEGEFA Research Group (2005SGR-00795) and the Spanish Project CGL2007-63727.

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