Geophysical Research Abstracts
Vol. 13, EGU2011-7408, 2011
EGU General Assembly 2011

Reaction softening of the deeper crust: an example from Baja California (Mexico)

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Mafic xenoliths hosted by Quaternary Mg-andesitic lavas from La Purisima Volcanic Field provide compelling evidence for a reaction-softening processes active in the lower crust underneath Baja California peninsula (Mexico). Microchemical and microstructural SEM-based investigations prove that grain size reduction of plagioclase is triggered by chemical potential gradients that have built-up during heating of the thinning lithosphere underneath the Gulf of California region. In-situ infiltration of alkali-bearing Si-rich melts causes resorption of clino- and orthopyroxene and their breakdown to olivine plus alkali-rich plagioclase (oligoclase-andesine). Newly-formed mineral phases form either as intergrown microcrystal-aggregates or arrange in coronas around pyroxene phenocrysts or align along grain boundaries separating calcic-plagioclase phenocrysts. These cristallisation microstructures are frequently associated with glass pockets inside pyroxene embayements, suggesting that crystallisation of the new mineral phases is accompanied by partial melting of pyroxene.

Pyroxene phenocrysts are dispersed in a matrix composed of millimetre-sized plagioclase crystals having an anorthite content of 90 mole percent. During pyroxene breakdown matrix plagioclase recrystallises to a new and fine-grained plagioclase (An97) that ranges from 3 to 10 micrometers in size. In some samples plagioclase of the matrix is completely recrystallised and EBSD measurements reveal that its primary crystallographic orientation has become partially destroyed during recrystallisation. Deformation played no role in the obliteration of the primary microtexture, and we can show that grain size reduction is induced only by chemical driving forces.

The recognition of transient fine-grained reaction products together with the micrometric recrystallisation of calcic-plagioclase in the Baja California deeper crust rise the question of the importance of reaction softening for the deeper crustal rheology. We present our inferences born by a systematic microstructural, microchemical and microtextural study of the lower crust telescoped by the gabbroic xenoliths of the Quaternary La Purisima Volcanic Field.