EGU General Assembly 2024

EGU24-9404, updated on 25 Jan 2025
https://doi.org/10.5194/egusphere-egu24-9404
EGU General Assembly 2024

Experimental insights into fluid and melt generation by dehydration reactions of micas with implications for crustal processes

Maria M. Repczynska, Aitor Cambeses, Jose Francisco Molina, Pilar Montero, and Fernando Bea
University of Granada, Department of Mineralogy and Petrology, Spain (maria.repczynska@ugr.es)

It is now widely known that the fluids play a major role in the formation and evolution of the Earth´s crust. Fluids and melts formed by dehydration-melting reaction of muscovite, biotite and amphibole during prograde metamorphism can have a profound effect on the trace element and isotope composition on the crustal sources of magmas.

However, while the phase relations of these reactions as well as the textural and mineralogical evidence of fluid-rock interaction in high-grade metamorphic complexes are well studied, the mechanisms of the onset of fluid and melt generation by the dehydration melting along with the transport and geochemical impact of these mobile phases onto anhydrous minerals at the grain scale remain unclear.

We investigated the mechanisms of local reactions involved in the incipient dehydration/melting processes at different temperatures, the sequence of reactions and the interaction of the fluid and/or melt with the anhydrous mineral phases, by conducting analogue heating experiments of rock cylinders in a vertical furnace. The rock samples used in the experiments were granitoids and gneisses from the Iberian Massif (Spain) with variable content of biotite and muscovite. They were cut into cylinders with dimensions of about 3x20 cm and placed into a vertical furnace. The experiments were done under thermal gradient at sub- and supersolidus conditions (600-1200^{o}C) at ambient pressure in an inert atmosphere of N_2 and last up to 8 days.

First results show that significant compositional and textural changes in biotite and muscovite were produced in experimental runs at temperatures >850^{o}C. Muscovite experienced dehydration melting breakdown to ultrabasic, very peraluminous melts with higher Na and lower K than the starting muscovite, small grains of aluminosilicates and large vesicles. Biotite underwent subsolidus dehydration, resulting in the formation of spinel and/or Fe-Ti oxides and alkali-rich aqueous fluid. Notably, K-feldspar did not nucleate at the dehydration site; instead, excess K and other incompatible elements (Li, Rb, Cs, Ba) were transported by fluids released from biotite and muscovite. These fluids subsequently induced metasomatic reactions in plagioclase, transforming it into K-feldspar. Additionally, Ca released from plagioclase contributed to the formation of titanite after ilmenite. The metasomatic changes were facilitated by fluid migration along micropores that were present in the starting plagioclase, highlighting the intricate processes involved in mica driven metamorphism and metasomatism. A second type of melt was generated with increasing temperature, characterized by higher silica and more granitic-like compositions, suggesting the involvement of quartz and feldspars in the melting reactions.

Although the experimental pressure conditions are much lower than those inside the crust, these analogous experiments allow us to investigate the mechanism by which fluids and melts are segregated from the reaction sites and the influence of rock texture. In these analogue experiments the breakdown of hydrous minerals is enhanced because they are outside their P-T stability fields. Besides, the formation of gas is maximized since its solubility in the melt is very low. Therefore, it allows us to investigate the importance of vesiculation in the creation of pathways for fluid and melt migration.