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Experimental studies of interaction between mantle-derived magmas and wall rocks at deep crustal levels

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Mantle-derived magmas interact with surrounding rocks during their generation, ascent and storage in the upper mantle and lower continental crust, leading to open system processes as wall rock partial melting, mineral dissolution in melt and mineral-melt reaction, that regulate composition, volatile content, physical-chemical properties and mobility of melt. Taking advantage of the innate temperature gradient of the piston cylinder apparatus we experimentally explored how melt-rock reactions work and how they change the compositions of both magma and rock-minerals in presence of a thermal gradient. Experiment was carried out at the isobaric pressure of 0.8 GPa, dwell time of 1 h and, under natural water conditions. The hotter area of the 12 mm length capsule was set at 1250 °C. As starting materials, we used powder of a natural K-basalt (Mg# = 0.66, $\Sigma_{alkalis}$ = 4.4 wt%) placed in contact with a 2x3x3 mm block melanosome included in migmatitic hornfels of the Gennargentu Igneous Complex (Sardinia, Italy). Results show that in the K-basaltic portion the experimental product consists of glass and crystals of clinopyroxene, olivine, plagioclase and Cr-spinel. Here on the basis of textures five zones were recognized: four zones with different degree of crystallization and a holocrystalline zone. In particular, melt composition ranges from basaltic trachyandesite to phono-tephrite moving from the hotter, slightly crystalline zone (T = 1250-1210 °C; crystal fraction = ~35 vol%) towards the cooler, highly crystalline zone (T = 1160-1140 °C; crystal fraction = ~60 vol%). The holocrystalline zone spans from the highly crystalline zone to the rounded contacts with partially melted melanosome ($T_{liquidus}$ = ~1150 °C). The composition of glass is characterized by silica decrease passing from slightly (SiO_2 = ~51 wt%) to highly (SiO_2 = ~50 wt%) crystalline zone, due to a strong increase of plagioclase degree of crystallization (up to ~24 vol%) compared to equilibria experiments performed at similar run conditions. The increment of plagioclase stability field is caused by the increase of alumina content in melt, thanks to the partial melting of alumina-rich minerals in the melanosome, and the preferential partitioning of aluminium into plagioclase.