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Olivine-gabbros and olivine-rich troctolites genesis through melt-rock reactions in oceanic spreading lithosphere: an experimental study up to 0.7 GPa

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Extensive melt-rock reaction and melt impregnation significantly affect not only the physical and chemical properties at mantle-crust transition, but also control the evolution of migrating melts. We performed reactive dissolution and crystallization experiments at pressure $\leq$ 0.7 GPa in a piston-cylinder apparatus to provide experimental constraints on genesis of olivine-rich troctolites and olivine-gabbros at mantle-crust transition in oceanic spreading lithosphere by melt-rock reaction. Our experiments are carried out by using Salt-Pyrex-Graphite-Magnesium assemblies and graphite-lined platinum capsules. Experimental charges are prepared with three layers: (1) basalt powder, (2) fine powder (1-10μm) of San Carlos olivine (Fo90.1), and (3) carbon spheres used as a melt trap. Three synthetic MORB-type melts have been used, two tholeiitic basalts (Mg#: 0.62, SiO_2: 47.70 wt%, Na2O: 2.28 wt% and Mg#: 0.58, SiO_2: 49.25 wt%, Na2O: 2.49 wt%) and a primitive one (Mg#: 0.74, SiO_2: 48.25 wt%, Na2O: 1.80 wt%), in order to investigate the effect of melt composition. A rock/melt ratio of 0.7 has been kept fixed. Experiments have been conducted at temperatures from 1200 to 1300°C, at both step cooling and isothermal conditions for different run durations (from 12 to 72 hrs). They resulted in layered samples in which all the initial San Carlos olivine powder, analog of a dunitic pluton infiltrated by basaltic melt, is replaced by different lithologies from olivine-rich troctolite to olivine gabbro. In isothermal experiments, reacted melts have been successfully trapped in the carbon spheres allowing their chemical analysis; as expected the reacted melt has a higher Mg# than the initial one (e.g. from Mg#=0.62 to 0.73). Across the different lithologies Mg# of olivine is decreasing from the olivine-rich troctolite to the gabbro. Replacive olivine-rich troctolite has a poikilitic texture with rounded euhedral olivine and interstitial poikilitic plagioclase and clinopyroxene; contacts between both are sharp and comparable with natural samples from Atlantis Massif (IODP Hole U1309D), Godzilla Megamullion core complex, Monte Maggiore (Corsica), Erro Tobbio Massif (Ligurian Ophiolite). Mineral chemistry of all phases is also consistent with natural occurences.