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Plagiogranites from Markov Deep, Mid-Atlantic Ridge (MAR): physical conditions and alternative modes of origin

Leonid Aranovich
IGEM RAS, Physical Geochemistry, Moscow, Russian Federation (lyaranov@igem.ru)

Very fresh samples of plagiogranites (PG) hosted by gabbro and peridotite, were collected from the slopes of slow spreading MAR within the Markov Deep area. The PG form pockets, lenses and veins ranging in size from a few mm to first few cm, and are structurally very similar to the migmatites found in ophiolite complexes. The PG veinlets in peridotite contain no quartz (Qtz) and are separated from the host by clearly seen reaction zones. Their bulk composition (56-58 wt.% $SiO2$) plots at the extreme $SiO2$-poor end of the PG compositional range from literature, what could be related to the consumption of $SiO2$ due to reaction with the host. The PG hosted by gabbro are characterized by the presence of Qtz, and, correspondingly, much higher bulk $SiO2$ (70-76 wt.%). Some PG-containing gabbro samples show textures indicative of the incipient felsic melt formation via partial melting of the host. In both gabbroic and peridotite samples certain textural and mineral composition changes point to interaction with the PG melt. Pressure (P)–temperature (T) estimates for the melt-forming conditions based on the microprobe analyses of coexisting minerals and multi-mineral thermobarometry approach (TWQ; Berman, 1990) along with the Berman and Aranovich (1996) thermodynamic data set correspond to 2-2.5 kbar and 800-830. The consistent (in the sense of TWQ) results could be obtained only taking into account a decreased silica activity in the rocks, which was estimated (relative to the beta-Qtz standard state) at $a(SiO2)=0.7$ for gabbro and at $a(SiO2)=0.5$ for peridotite. Under these P-T, generation of felsic melt is only possible in the presence of a water-rich fluid phase. Water activity values (a2) were evaluated with two independent methods: (1) TWQ calculations (at a constant P=2.2 kbar and $a(SiO2)=0.5$) employing compositions of orthopyroxene, clinopyroxene and pargasitic amphibole coexisting in the reaction zones between the PG veinlets and peridotite; (2) model granite melt calculations at fixed T=820oC, P=2.2 kbar using THERIAK-DOMINO software (de Capitani, 1994) and starting bulk rock composition corresponding to the average of 5 analyses of the gabbro-hosted PG containing almost no host-rock impurities. For the second method, the agreement between the calculated and observed plagioclase composition in the PG segregates (An20-An22) served as a criterion for the correctness of calculations. The resulting a2 by the two methods agree well and range from 0.87-0.93. The calculated physical conditions for the generation of the PG are in good agreement with experimental hydrous melting of basalt, and predict no more than about 5-10% PG melt to be produced by partial melting, which compares well with the amount of felsic segregates present in the samples. One possible scenario for the generation of PG melt corresponds to partial melting of gabbro caused by penetration of oceanic water. In this case, to assume the required activity values oceanic water should have gotten concentrated in salt relative to normal seawater salinity (a2 =0.9 corresponds to the $H2O$-NaCl solution with the salt concentration of ca. 28 wt.% NaCl at these P-T; Aranovich and Newton, 1997). The increased salinity might result from consumption of water due to various hydration reactions occurring in the overlying oceanic crust. This mode of the PG origin requires a steady state temperature distribution in the vicinity of MAR corresponding to about 800oC at a depth of 7-9 km within the crust. Alternatively, partial melting could be induced by addition of a new portion of hot mafic magma that expels fluid on crystallization, which in turn causes re-melting of pre-existed gabbro. A combination of the two modes also seems to be possible.

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