Petrographical and Geochemical Features of the Mafic Microgranuler Enclaves in the Torul (Gumushane) and Sarihan (Bayburt) Granitoids, NE Turkey

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In this study, we presented petrographical and geochemical data of mafic granular enclaves (MME) of two fairly well studied Upper Cretaceous granitic batholiths in the Gumushane and Bayburt region of the eastern Pontides. The Sarihan Granitoid has simple petrography with quartz-monzodiorite, granodiorite and quartzdiorite, which contains dioritic and quartz dioritic MMEs. MMEs have very sharp contacts with host rocks, and are oval shaped with 3-5 cm in diameters. There is biotite enrichment and some large K-feldspar growths around contact of enclaves. The composite zoned Torul Granitoid is made up from quartz diorite, granodiorite, monzogranite, quartz monzodiorite, monzodiorite and siyenogranite. Along the zones, each member contains more basic members enclaves for example dioritic enclaves are seen in quartzdiorite and monzogranites includes granodioritic and quartz monzodioritic enclaves.

MMEs of the Sarihan and Torul Granitoids show similar geochemical characteristics with host rocks. While MMEs of Sarihan Granitoid contain 58.0-60.1 wt% SiO_2, 15.4-16.1 Al_2O_3, 4.1-6.2 Na_2O, 1.2-3.1 K_2O, the MMEs of Torul samples yield 52.4-55.9 % SiO_2, 16.4-19.0 Al_2O_3, 3.2-4.1 Na_2O, 1.2-2.5 K_2O. All of the Sarihan and Torul Granitoid samples are subalkalic and calc-alkaline. All MMEs in both plutons have the ratio of A/CNK>1 and the MMEs of Sarihan are somewhat more aluminous in character than the MMEs of Torul. They also show characteristics of CAFEM_C trend and volcanic arc granitoid. Rb varies in both suites from ~25-100 ppm. Zr is between 55-180 ppm in both granitoids. Similar LIL enrichment with host rocks is seen ORG normalized trace element compositions of the MMEs of Sarihan and Torul Granitoids. Chondrite normalized rare patterns of Torul Granitoids are smooth and moderately enriched in the light REE; $(La/Yb)_N$ ranges from 3.0-8.5 and noticeable Eu anomaly is present.

Although general petrographical characteristics of MMEs of the Sarihan Granitoid and Torul Granitoid, MME are more basic and fine-grained compared to host rocks. The mineralogical features of MMEs indicate magmatic origin. Oval but not elongated shapes of MMEs suggest little internal flow within parental magma during emplacement. Although all MMEs show chemical and mineralogical related with the host rocks as a differentiation processes, some mineralogical features of MMEs of Sarihan may keep some evidences of magma mixing processes during Newtonian and visco-plastic stage.

Timescale of melt differentiation from ^{231}Pa-^{226}Ra data

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Constraints on time-scale of melting, melt transport and melt differentiation are critical to our understanding of mantle melting processes. U-series isotopes have the potential to provide quantitative constraints on timing and time-scale of melting and melt differentiation, while at the same time giving extent of chemical fractionation. ^{231}Pa and ^{226}Ra, with half-lives of 32ky and 1.6ky respectively, present the greatest opportunity. Results from the Luzon Arc, the Philippine Archipelago, suggest a melt differentiation timescale of about 27 ky. Moreover, the ^{231}Pa and ^{226}Ra data indicate two contrasting time-scales, with the ^{226}Ra chronometer giving much shorter apparent timescale.

Historical eruption in Taal (Luzon Arc) range from undifferentiated lavas (basalts with <52 wt.% SiO_2) to more differentiated ones (dacites with up to 68 wt. % SiO_2). A basalt sample has the highest (^{231}Pa/^{235}U) and (^{226}Ra/^{230}Th) (activity ratios), both at 1.5. (^{231}Pa/^{235}U) is strongly positively correlated with MgO (an index of differentiation), with an R^2 value of 0.995. If one assumes that lavas originated from a parent magma with similar initial (^{231}Pa/^{235}U) (not necessarily the same parent magma), then it is possible to calculate differentiation model ages for the various degrees of differentiation relative to an assumed parent initial or relative to the least-differentiated erupted lava. Using the later approach, we calculate differentiation from our least-evolved sample to the most evolved one to be around 27 ky. The (^{230}Th/^{238}U) data, although with much less spread (given the much longer half-life of ^{230}Th and small initial deviation from secular equilibrium), support the (^{231}Pa/^{235}U) chronology. Alternatively, the trend may reflect mixing between mafic magma and old felsic crust. However his is unlikely as the lavas have a very restricted range of long-lived isotopic values. For example, the ^{87}Sr/^{86}Sr ratios of the whole suite range from 0.70452 to 0.70459, while the ^{143}Nd/^{144}Nd ratios (normalized to ^{146}Nd/^{144}Nd =0.7219) vary between 0.51281 and 0.51283. A timescales of magma differentiation in the range of 27 ky, inferred from (^{231}Pa/^{235}U) data, is considerably longer than that inferred from our (^{226}Ra/^{230}Th) data or estimates by other workers also based on ^{226}Ra data. The ^{231}Pa timescale more likely to represents the full differentiation history, while the ^{226}Ra timescale may represent the last phase of differentiation, analogous to the notion of different closure timescales in long-lived radiongenic isotopes.