Amphibole mineral chemistry of rocks of Karavanke Granitic Massif

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The Triassic Karavanke Granitic Massif (northern Slovenia) is constituted of a bimodal magmatic association of predominant acidic (syenogranite) and contemporaneous mafic (gabbro and monzogabbro) and intermediate (monzonite and monzodiorite) rocks, locally cut by veins of porphyry syenite. Intermediate rocks and porphyry syenite show field, textural and geochemical features (Bole et al. 2001, Visona & Zanferrari, 2000) suggesting they formed by interaction between acid and mafic magmas.

Syenogranite is fine to coarse grained, contains of rare idiomorphic amphibole (Fe-hornblende and Fe-edenite), biotite (annite 25%-35%), plagioclase (An_3), K-feldspar and quartz of two generations. Gabbro is fine to medium grained, contains olivine ($Fo_{73\text{-}79}$), ortho pyroxene ($Fs_{22\text{-}31}$), amphibole (Mg- hornblende) and plagioclase ($An_{45\text{-}70}$). Monzogabbro is fine to coarse grained, contains clinopyroxene, amphibole (edenite, Fe-pargasite) biotite and plagioclase ($An_{25\text{-}40}$). Monzodiorite is fine to coarse grained, contains clinopyroxene, amphibole (Mg- to Fe-hornblende, edenite) biotite and plagioclase ($An_{61\text{-}21}$). Monzonite, generally fine grained, consists of rare clinopyroxene, amphibole (Fe-hornblende, edenite), biotite, plagioclase (An_{30}), rare K-feldspar and quartz of two generations. Porphyry syenite contains phenocrysts of biotite, plagioclase ($An_{15\text{-}20}$), quartz, and euhedral plagioclase-mantled K-feldspar in a fine grained matrix of rare clinopyroxene, Fe-hornblende, biotite, plagioclase, K-feldspar and quartz.

Amphibole in rocks of intermediate composition displays a significantly wider compositional range than amphibole in mafic and acidic end members. Its chemical zoning is consistent with the hypothesis that intermediate rocks formed by interaction of mafic and acid end members.

References

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Formation of lower continental crust by tectonic emplacement of oceanic crust. An example:The Pannonian Basin

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Mafic granulite xenoliths from the lower crust of the Pannonian Basin are dominated by LREE-depleted bulk rock compositions. Many of these have MORB-like $^{143}Nd/^{144}Nd$. Their $\delta^{18}O$ values cover a wide range from +3.8 to +9.5‰. A group of LREE-enriched mafic granulites have higher $^{87}Sr/^{86}Sr$ (0.704-0.708) and lower $^{143}Nd/^{144}Nd$ (0.5128-0.5124), with higher $\delta^{18}O$ values on average (+7.8 to +10.6‰) than the LREE-depleted granulites

The wide range in $\delta^{18}O$ over a restricted range in Nd and Sr isotope values, in combination with the predominance of LREE-depleted trace element compositions, is consistent with an origin as a package of hydrothermally altered oceanic basalts. The existence of low $\delta^{18}O$ values less than average MORB and/or mantle peridotite requires that at least some of these rocks were hydrothermally altered at high temperature, presumably in the oceanic lower crust. The low $^{143}Nd/^{144}Nd$ of the LREE-enriched mafic granulites cannot be explained by simple mixing between a LREE-depleted melt and an enriched component, represented by the recovered metasediments. Instead, we interpret these rocks as the metamorphic equivalent of the shallowest levels of the ocean crust where pillow basalts are intimately intercalated with oceanic sediments. A possible model is accretion of oceanic crustal slices during subduction and convergence followed by high grade metamorphism during the Alpine orogeny.