Geochemistry and Age of Magmatic Rocks from the Pamirs: Implications on Tectonic Processes

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Differentiated tectonic views about the origin of magmatism on the Pamir-Tibet plateau exist. Those comprise, among others, convective thinning of ancient, enriched mantle lithosphere followed by asthenospheric upwelling and melting, slab breakoff, and magmatism along multiple belts of intra-continental subduction. Little is known about the age and origin of magmatism in the Pamir, but our reconnaissance work demonstrates that it occurred during most of the Mid-Paleozoic to Cenozoic period (˜370 to 10 Ma), is regionally confined to distinct belts, and has a breathtaking compositional variation. This magmatism therefore offers an unprecedented potential to get insights into the processes that proceed within all crustal levels as well as in the lithospheric and asthenospheric mantle under Pamir and Tibet.

Here we present preliminary geochemical and Ar-Ar age data from volcanic and plutonic rocks of the Pamir-Tibet plateau to assess their age relationships, their origin and the nature of their sources.

REE patterns of volcanic rocks from the Cenozoic Central Pamir (CP) are enriched ($(La/Yb)_n$=7.0-13.5) and steep for the LREE ($(La/Sm)_n$=2.8-4.4), but relatively flat and depleted for the HREE ($(Tb/Lu)_n$=1.5-1.1) at unradiogenic $^{143}Nd/^{144}Nd$ ratios (ε_{Nd}˜-8), indicative for a refertilized, moderately depleted mantle source and assimilation of a crustal component. In contrast, Paleozoic volcanic rock samples from the Northern Pamirs (NP) are less enriched with variable $(La/Yb)_n$ and $(La/Sm)_n$ ratios (0.7-9.1 and 0.6-4.2, respectively), and have strongly depleted, flat HREE patterns ($(Tb/Lu)_n$=0.9-1.1) and radiogenic $^{143}Nd/^{144}Nd$ ratios (ε_{Nd}˜+3), indicative for a variably refertilized but multiply-depleted, refractory mantle source. All samples share negative Nb-anomalies, consistent with a subduction and/or crustal related origin.

Calculated melt compositions fit the observed trace-element patterns in the volcanic rocks if a primitive to depleted mantle composition and 3 - 8% melting in the spinel stability field is assumed for the NP samples, but an enriched source for the CP samples. To fit the Nb and Zr compositions in both groups, the sources are required having negative Nb, but positive Zr anomalies. This decoupling of the HFSE elements (Nb-Ta vs. Zr-Hf) suggests the influence of a specific crustal source component, possibly crustal melting during continental subduction.

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