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Granite genesis in dying arc systems of the Pamirs - the missing link to arc-type magmatism

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Arc magmatism is supposed to be the crucial process for Phanerozoic growth of continental crust. Primary arc magmas are typically basaltic to andesitic and cannot simply evolve to granitic compositions through fractional crystallization and/or crustal assimilation. Nevertheless, voluminous amounts of granites occur in formerly subduction dominated regions of crustal shortening, and may have formed during or after collision following the late stages of arc activity [1]. Fourty-one samples of Cretaceous to Miocene granitoids and volcanic rocks are studied in the Central and Southern Pamirs, a region that experienced multiple subduction and accretion cycles during the Paleozoic and Mesozoic, leading to the formation of extremely thickened crust.

Zircon U-Pb dating revealed that Cretaceous magmatism occurred in two time intervals with peaks at about 100-110 Ma and 65-75 Ma, producing peraluminous (A/CNK: 1.0-1.5), (high-K) calc-alkaline diorites, granodiorites and granites with initial eNd values of -8 to -11 and -4.6 to -6.5, respectively. Their initial $^{87}Sr/^{86}Sr$ values show a great variability ranging from 0.7080 to 0.7278. A general feature of all the granitoid samples is the pronounced negative Nb-Ta-Ti anomaly. The Cenozoic granodiorites, granites and leucogranites are slightly peraluminous to metaluminous (A/CNK: 0.95-1.07), high-K calc-alkaline, with initial eNd values of -6.4 to -8.3, with the exception of one late Eocene granodiorite with an initial eNd value of -2.6. In the Early Miocene, bimodal volcanism was active. The erupted basalts show slightly negative Nb-Ta-Ti and Eu anomalies, have initial eNd values of -4.2 to -8.3 and initial $^{87}Sr/^{86}Sr$ values of 0.7064-0.7105. The coevally intruded leuco- and biotite-granites are slightly peraluminous to metaluminous (A/CNK: 0.99-1.07), have initial eNd values of -6.4 and -7.3 and initial $^{87}Sr/^{86}Sr$ of 0.7073 and 0.7093.

The overall negative initial eNd values of the analyzed samples indicate that none of them were derived directly from the (depleted) mantle by multi-stage processes. Addition of various amounts of preexisting (continental) crustal material is required to explain the isotopic compositions. A remarkable feature is the shift from almost pure continental crustal eNd values observed in the Mid-Cretaceous granitoids to higher values that suggests a higher degree of a primary mantle component for Late Cretaceous granitoid rocks. This indicates that there was a change in the melting regime and/or the source of the granitoids. Such a temporal variation is not observed for the Cenozoic granitoids.

[1] Bonin, Lithos 78 (2004), p. 1-24