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Different ways to produce peraluminous granitoids and implications for evolution of the continental crust in Proto-Tethys subduction zone, Western Kunlun, NW China

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Granitoids, especially peraluminous granitoids, are unique in the continental crust and consequently some petrogenetic models have been proposed. We investigated three peraluminous intrusions in the western Kunlun orogenic belt. Although they are tectonically related to the evolution of the Proto-Tethys Ocean, they exhibit markedly different petrogenesis. The Yutian complex is composed of gabbro, diorite and granodiorite, containing dioritic enclaves. These different petrological units have identical ages (440-447 Ma) and similar mineral assemblages (hornblende + plagioclase $\pm$ pyroxene $\pm$ biotite $\pm$ quartz). Except for the gabbro, other intermediate and felsic samples exhibit similarity in geochemical characteristics, as exemplified by broadly parallel rare and trace patterns ([La/Yn]N of $\sim$13, enrichments in Th, U, Zr and Hf, and depletions in Ta and Nb), low Mg# values (most < 45), Cr (most < 30) and Ni (< 35) contents. In contrast, the gabbro is characterized by relative depletions in Zr and Hf. Moreover, all samples display homogeneous zircon Hf-isotope compositions, with εHf(t) values ranging from -1 to -4. In addition, different units also exhibit limited variations in whole-rock Sr-Nd-Pb isotopes, with (87Sr/86Sr)t values of 0.714, εNd(t) values of $\sim$ -4.7, 206Pb/204Pb of $\sim$19, 207Pb/204Pb of $\sim$16 and 208Pb/204Pb of $\sim$38. Thus, it is inferred that they were sourced from the same source (subducted slab and metasediments) and evolved into different units through fractional crystallization of hornblende and plagioclase. The primary magma parental to the Yutian complex is dioritic and formed under eclogite-facies conditions. The north Yutian gabbroic diorite is close to the Yutian complex, with an age of $\sim$440 Ma. However, it shows rare and trace patterns similar to the upper continental crust. Thus, we propose that it was sourced from the upper continental crust, without remarkable material contribution from the subduction of processes. The primary granitic melting experienced slight fractional crystallization of hornblende to form the gabbroic diorite. Comparatively, the Aqiang granodiorite ($\sim$470 Ma) shows mineral, geochemical and isotopic heterogeneities. In particular, some samples contain more biotite and are more relatively enriched in LREE, Th, U and Sr-Nd-Pb isotopes. These differences are attributed to variable degrees of partial melting and contents of water. The primary magma resulted from the partial melting of the subducted slab and lower continental crust, and formed under amphibolite-facies conditions, with fluid inputs derived from dehydration of the subducted slab. The Yutian complex belongs to fractional I-type and Aqiang granodiorite is transitional between I- and S-type granites. The gabbroic diorite resulted from the recycling upper continental crust, without net mass to the continental crust. The Yutian complex and Aqiang granodiorite led to net growth and fractionation of the continental crust.