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Regional Isotopic Variations in Granitic Rocks of Southern Tibet and Magmatic Contributions to Crustal Thickening during the Indo-Asian Collision

Donald J. DEPAOLO[1,*], T. Mark HARRISON[2], ZHU Di-Cheng[3], ZHAO Zhidan[3] and MO Xuanxue[3]

1 University of California, Berkeley, CA 94720 USA
2 University of California, Los Angeles, CA 90095 USA
3 China University of Geosciences, Beijing, 100083 PRC

Tibet is of course a most dramatic example of continental collision tectonics, but Southern Tibet is also noteworthy because it hosts one of the largest and youngest examples of a continental-margin composite granitic batholith, the Gangdese Batholith. This batholith is located immediately north of the Indus-Tsangpo Suture (ITS), has a scale that is larger than the Sierra Nevada or Peninsular Ranges batholiths of western North America, and is inferred to have formed largely during the pre-collision subduction period (pre-50 Ma) when it was located adjacent to the southern edge of the Asian continent. The Gangdese region also hosts an extensive suite of ignimbrites and other volcanic deposits that are rarely preserved even in only slightly older batholiths, a peculiar result of the relatively low erosion rates in Tibet despite its high elevation. Crystallization ages of the Gangdese granitoids extend from Cretaceous to Miocene, so magmatism spanned the collision time and reaches almost to the present. Isotopic and trace element compositions of granitoids are known to reflect both mantle magma processes and crustal age and thickness, so regional variations in the Nd, Sr, Hf and Pb isotopic compositions provide essential information about the precollision Tibetan crustal structure and the syn- and post-collisional modifications due to magmatic additions from the mantle and from intracrustal magmatism.

Granitoids in a N-S traverse near Lhasa and north of the ITS show a gradient in ε_{Nd}, with mantle-like values adjacent to the ITS (+2 to +6) and much lower values (-5 to -14) at 80 to 120 km north of the ITS. This type of spatial gradient in ε_{Nd} is found in other continental margin batholiths that are associated with subduction but not continental collision. Positive ε_{Nd} values usually indicate granitoids emplaced into a continental margin consisting of oceanic crust with sedimentary cover. There is a 60 km-wide zone north of the ITS where this type of thin, transitional crust hosted the batholith even though the magmatism occurred slightly after the beginning of collision. Decreasing ε_{Nd} northward indicates a decreasing ratio of mantle input/crustal melting due to progressively thickened crust. A discontinuity at about 29.8N latitude (just N. of Lhasa) may be the southern edge of precollision Tibetan basement. Peraluminous (2-mica) granites from this northern area can be used to develop a crude map of pre-batholithic basement ages; the basement is otherwise mostly inaccessible. Both younger Proterozoic (ca. 1.3Ga) and mid-Proterozoic (ca. 1.8Ga) basement terranes occur, sequentially, northward from Lhasa. The Nd-isotope-defined basement edge is also exhibited to the West and East in Hf isotope ratios on zircon (Zhu et al., 2011). A thin southern edge of Tibet could have affected the early stages of development of the collision, perhaps promoting subduction of India.

Postcollision Miocene granites near the ITS differ from the Paleocene-Eocene granitoids in that they have lower ε_{Nd}, suggesting that the southern Tibetan crust had thickened substantially by Miocene time. These younger granitoids tend to have REE evidence of deep crustal sources (Hou et al., 2004) and probably were derived by melting of lower crust that was a mixture of pre-collision sedimentary rocks and mantle magmatic additions. Mantle magmatic additions in the early Cenozoic and Late Cretaceous to the originally thin edge of southern Tibet could have increased the crustal thickness by as much as 20 to 30 km. At distances greater than about 100km north from the ITS, it appears that there were no significant magmatic additions to the crust, either before or after collision, so although there is a limited-width zone just north of the ITS where there may have been substantial thickening of the crust due to pre- and syn-collisional

* Corresponding author. E-mail: depaolo@eps.berkeley.edu

mantle magmatism, crustal thickening farther to the north must be tectonic.

Key words: isotope geochemistry, granitic rocks, crustal thickening, magmatism, continental collision

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