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Forum Reply

Formation of high $\delta^{18}O$ fayalite-bearing A-type granite by high-temperature melting of granulitic metasedimentary rocks, southern China

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We welcome Clemens and Finger's (2012) comments on our paper regarding the metasedimentary source for the Jiuyishan high $\delta^{18}O$ fayalite-bearing A-type granite in southern China (Huang et al., 2011). They concur with our classification of the Jiuyishan granite as A-type, but question our interpretation of a metasedimentary source for these rocks. Instead, they propose an old, felsic, meta-igneous protolith for the granite.

Clemens and Finger state that evolved Sr and Nd isotopes are the chief reasons for us proposing a sedimentary source; alternatively, they propose that fluid-absent melting of older granitoids can also account for the crustal isotope feature, as well as the high-temperature, A-type character of the Jiuyishan granite. In fact, the most compelling evidence for a metasedimentary source for the Jiuyishan granite is its high $\delta^{18}O_{zircon}$ of 8.0‰–9.8‰ (Huang et al., 2011), rather than the evolved Sr and Nd isotopes. Melting of older granitoids cannot account for the ^{18}O-enriched feature of the Jiuyishan granite, unless the protolith itself has a sedimentary origin. Besides, melting of older granitoids does not always produce high-temperature, A-type rocks, and when it does, the melts are always highly felsic (e.g., Patiño Douce, 1997), incompatible with a low-SiO_2 (64 wt%) magma parental to the Jiuyishan A-type granite. In addition, low-volume melt proportions derived from a granitoid protolith probably would not produce granitic plutons as large as the Jiuyishan granite (>1000 km^2 outcrop).

Clemens and Finger propose that "Fa_{90} would be stable at ~1.4 times the f_{O_2} of FMQ" and suggest that the relatively reduced condition of the Jiuyishan granite would be satisfied by melting of an ilmenite-series granitoid; therefore, relatively low f_{O_2} does not unambiguously support a metasedimentary source. Indeed, low f_{O_2} equivalent to that of the Jiuyishan fayalite-bearing granite could be met by many sources, including the ilmenite-series granitoid noted here and metasedimentary rocks exemplified by Clemens et al. (2011). However, as noted above, melts of any granitoid are incomparable with the low SiO_2 nature of the parental magma for the Jiuyishan A-type granite.

On the basis of Sr, Nd, Hf, and O isotopes, Clemens and Finger suggest an I-type connection for Mesozoic granitoids in the South China Block, including the Jiuyishan granite. They propose that these rocks could have been formed from re-melting of large-volume, crustal-derived Early Paleozoic felsic igneous rocks. We emphasize that radiogenic isotopes cannot be used to unambiguously distinguish an I-type source, whereas O isotope ratios of the Jiuyishan granite support a sedimentary source. First, zircon $\delta^{18}O$ results for the Jiuyishan granite overlap entirely with those of the S-type Hawkins dacite-Cootralantra granodiorite (7.5‰–10‰) and Violet Town ignimbrite-Strathbogie granite (7.1‰–12.9‰) in southeastern Australia (Kemp et al., 2008). Second, the estimated whole-rock $\delta^{18}O$ values of 9.5‰–11.6‰ for the Jiuyishan granite are comparable with S-type granites worldwide (>10‰), but higher than I-types (5.3‰–10‰) (e.g., Eiler, 2001). It is noted that the whole-rock $\delta^{18}O$ of 10.8‰ for a magnetite-series granite sample cited by Anderson and Morrison (2005) is much higher than the rest of the group (<9.6‰). We interpret that this could be a result of alteration and/or input of sedimentary components. Melting of the Early Paleozoic felsic igneous rocks cannot reproduce the low-SiO_2 Jiuyishan granite. The fact that the Jiuyishan granite outcrops at the same level as the Early Paleozoic granites casts further doubt on a melt-source connection.

Clemens and Finger propose that "felsic magmas derived from metasedimentary sources are strongly peraluminous." Therefore, the metaluminous to weakly peraluminous Jiuyishan rocks are similar to many I-types, but different from the strongly peraluminous high-temperature, metasediment-derived volcanic rocks referred to by Clemens et al. (2011). However, an examination of Clemens et al.'s data reveals that many relatively low-SiO_2 samples of the metasediment-derived fayalite-bearing Toombullup ignimbrite are weakly peraluminous, with a lowest ASI value of 1.0, comparable with the Jiuyishan rocks in the same SiO_2 range.

To conclude, we contend that the Jiuyishan high $\delta^{18}O$ fayalite-bearing A-type granite most likely originated from melting of a granulitic metasedimentary source (Huang et al., 2011), rather than an old, felsic, meta-igneous protolith.

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