Detrital zircon provenance of the Late Triassic Songpan-Ganzi complex: Sedimentary record of collision of the North and South China blocks: Comment and Reply

COMMENT

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The majority of the Songpan-Ganzi Triassic flysch sequence is believed to have derived from denudation of the Dabie and Sulu ultrahigh-pressure (UHP) metamorphic belt in eastern China (e.g., Nie et al., 1994; Zhou and Graham, 1996); however, intense debate still exists on the sources of these rocks. Many authors have suggested various sources, including the Kunlun magmatic arc (e.g., Gu, 1994; Zhang, 2002), the North and South China blocks (e.g., Bruguier et al., 1997), or the Central Qiangtang UHP metamorphic belt (Zhang et al., 2006). Recently, Weislogel et al. (2006) presented 870 single grain U-Pb detrital-zircon ages coupled with 250 paleocurrent measurements to shed new light on the origin of the Songpan-Ganzi complex and its link to Qinling-Dabie orogen unroofing. They suggested that a southern Songpan-Ganzi deposystem initially was sourced solely by erosion of the Qinling-Dabie orogen during early Late Triassic time, then, during middle to late Late Triassic time, by the Qinling-Dabie orogen, the North China block, and the South China block. A northern Songpan-Ganzi system was sourced by erosion of the Qinling-Dabie orogen and the North China block throughout its deposition. These separate deposystems were later tectonically amalgamated to form one complex.

However, the background ages of the North China block, the South China block, and the Qinling Orogen that Weislogel et al.'s interpretations were based on are incomplete, which may have somewhat undermined their conclusions about the accumulation of the Songpan-Ganzi turbidites and the tectonic evolution of the basin. Clearly, the two oldest populations, 2.4–2.5 Ga and 1.85–1.95 Ga, exist not only in the North China block (Weislogel et al., 2006, and references therein) but also in the South China block. For example, Qiu et al. (2000) reported >3.2 Ga and ~1.9 Ga zircons in the Kongling metamorphics in the northernmost South China margin near the Qinling Mountains. Importantly, there are two clusters of ~1.9 Ga and 2.4–2.5 Ga U-Pb SHRIMP-dated zircons in the Kangding Metamorphic Complex, which is located to the east of the Songpan-Ganzi basin (Chen et al., 2005). Even in the southern margin of the North China block, there are ~820 Ma zircon ages (Li et al., 2005), and in the North Qinling orogen there is a cluster of ~950 Ma zircons (e.g., Chen et al., 2004; Wang et al., 2005). Therefore, these zircon background ages should be included in the database when modeling the accumulation of the Songpan-Ganzi turbidites and the tectonic evolution of the basin.

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REPLY

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We appreciate the points made by Zhang et al. in their Comment and recognize the challenge involved in interpreting detrital zircon geochronometric provenance in an area as complex as eastern Asia. Because the Qinling-Dabie orogen records multiple Paleozoic collisions between the North China block and the South China block, or between rifted fragments of continental crust thereof (Meng and Zhang, 2000), the orogen contains an amalgamation of North China-affinity rocks and South China-affinity rocks. In addition, supracrustal rocks that were ultimately uplifted due to orogenesis also contain recycled zircon grains originally derived from the crystalline basement rocks of these two cratons. Thus, it is not always possible to definitively determine the unique or absolute source terrane for a zircon grain of a particular age.

However, we were able to use zircon U-Pb age data from the literature to define detrital-zircon age distribution signatures for likely source terranes surrounding the Songpan-Ganzi complex. For example, although Zhang et al. point out that some Neoproterozoic zircon-grain ages can be found in the North China block (e.g.,~820 Ma, Li et al., 2005; ~950 Ma, Chen et al., 2004; Wang et al., 2005), other Neoproterozoic zircon-grain ages are not recognized in the North China block but are reported in the South China block (e.g., 764 Ma Miyi complex, Zhou et al., 2002; 797–795 Ma Kangding complex, Zhou et al., 2002; 840–770 Ma Bikou arc, Yan et al., 2004). This allowed us to identify a South China block provenance for two of our samples. In their comment, Zhang et al. also note that the Kangding gneissic complex, part of the western South China block, contains Paleoproterozoic zircon grains (~1.9 Ga and 2.5–2.4 Ga; Chen et al., 2005); however, it also contains younger Neoproterozoic zircon grains (~796 Ma; Zhou et al., 2002), and therefore the presence of Paleoproterozoic zircon grains derived from this source would be accompanied by Neoproterozoic zircon grains as well. This combination of zircon-grain ages was observed in only a few samples, and where present was interpreted to indicate derivation from the South China block. Finally, even though the Archean and Proterozoic ages cited by Zhang et al. for the South China area (> 3.2 Ga and ~1.9 Ga ; Qiu et al., 2000; Chen et al., 2005) do overlap with ages known from the North China block (Kusky and Li, 2003), the North China block contains rocks with zircon-grain ages that range between 2.7 and 2.3 Ga (e.g., Li et al., 2000, Kroener et al., 1998; Darby and Gehrels, 2006); zircon grains of this age were found in several samples of the Songpan-Ganzi complex. In contrast, recent data from Zheng et al. (2006) indicate that although rare occurrences of 2.7–2.3 Ga zircon grains can be found in the South China block, the South China block is characterized by a more robust population of 2.9–2.7 Ga zircon-grain ages, a population which is not present in Songpan-Ganzi complex samples, decreasing the likelihood of the South China block as a source of detritus.

Our evaluation of likely source areas was also guided by spatial variation of the detrital zircon-grain age distribution, syndepositional tectonism, and bedrock age distribution of areas adjacent to the Songpan-Ganzi complex. For example, despite the current proximity of the Songpan-Ganzi complex to the South China block, Neoproterozoic zircon grains occur in significant abundance in only a few samples of Songpan-Ganzi sandstones, indicating South China-affinity rocks were not a primary source of detritus to the Songpan-Ganzi basin during the early Late Triassic. This interpretation is also supported by the intact Carboniferous through early Late Triassic passive margin sedimentary succession present along the western margin of the South China block (Chinese Geological Society, 2004) and results from basin analysis of the western Sichuan basin that indicate tectonic loading and shortening of this margin did not occur until late Late Triassic (Yong et al., 2003). Thus, material from the western margin of the South China block was likely not available as a source during the early stages of Songpan-Ganzi turbidite deposition.

Ultimately, detrital zircon-age data alone cannot completely elucidate the provenance record of the Songpan-Ganzi complex; however, our data contribute to a vastly improved assessment. The fundamental conclusion of the paper remains that the variation in the detrital zircon-grain age signature of coeval deposits across the basin requires multiple sediment feeder systems, and the Songpan-Ganzi complex cannot be viewed as a singular depositional entity. Given the immense size of the Songpan-Ganzi complex, additional field observations and sampling are required in order to wholly characterize its provenance and understand the association between production of this large volume of sediment and regional collisional tectonics.

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