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Single-grain white mica ^{40}Ar/^{39}Ar ages of the Triassic Songpan-Garze Flysch, China: significance for accretion models of Inner Asian orogens

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The Triassic Songpan-Garze basin of the eastern Tibetan plateau covers a triangular area bounded by the North China, South China and Tibetan continental blocks. The basin holds a 5-15 km thick flyschoid sequence with a volume of about $2{\cdot}10^6$ km^3 and so requires a huge amount of erosion of adjacent continental material. Basin formation is coeval with the collision between the North and South China blocks. It is situated at the southern front of the Indosinian (Triassic) Dabie-Qinling-Kunlun orogen with conspicuous UHP terranes that were exhumed at the same time. Consequently, it could be expected that the basin fill comprise erosional products with dominant latest Permian-Lower Triassic age of the uplifting UHP metamorphic wedge. In the late Triassic to early Jurassic ongoing shortening and subduction of the South China beneath the North China block led to shortening and overthrust of the basin fill.

Single detrital white mica grains from unmetamorphic turbiditic sandstones of three locations along the road from Songpan to Lanzhou from distinct stratigraphic levels and distant localities of the Triassic Songpan Flysch, China, were dated by the ^{40}Ar/^{39}Ar single grain technique in order to complement earlier studies with U-Pb zircon ages of another working group (Bruguier et al., 1997, EPSL 152, 217–231). Their samples are from a region south to our study area, however, closer to the Yangtze craton. ^{40}Ar/^{39}Ar ages of white mica represent the time of regional heating that could be missed by the U-Pb zircon method because of lack of zircon growth or resetting during tectono-metamorphic events.

We dated white mica in the size range 0.25-0.35 mm from two samples and in the size range 0.16-0.2 mm from one sample from each of the three locations. Most grains were heated up to fusion in one step, some in multiple steps in order to detect thermal overprint.

From a total number of 186 grains we got a minimum age of 250 Ma and a maximum age of 2075 Ma. In addition, 16 samples released more gas than the upper measurement limit of the machine (for average large grains this represents ages > 1 Ga). Samples from all locations gave consistent, similar age groups, which include:

A youngest group from 250 to 270 Ma (n=11), a group between 290 and 310 Ma (n=10); the bulk of the grains fall in the range 350-460 Ma (n=130) with subpeaks at 385 and 415 Ma (40 grains in 370-400 Ma and 64 grains in 400-430 Ma, respectively). Older groups occur at 550 Ma (n=3), 650 Ma (n=3), and 1280 Ma (n=3). Between the two latter groups only 3 grains occur. 15 grains fall almost evenly into the range from 1400 to 1950 Ma, but not more than two overlap in their errors; two grains display ages at 2075 Ma.

Stepwise heating of single grains gave homogeneous release patterns, which indicate that no reheating occurred after deposition (in accordance with the unmetamorphic nature of the sandstones). This does not rule out reheating in the source region, however, and thus a partial younging of some older grains. Therefore, we regard only ages as significant, which are represented by at least three grains.

The identical age spectra from the three locations indicate similar source regions. About 2/3 of the grains display ages between the Late Ordovician and Early Carboniferous with peaks at the Silurian/Devonian and the Middle/Late Devonian boundaries. Older age groups fall into the latest Proterozoic, the late Neoproterozoic, and the mid-Mesoproterozoic. A number of grains (12) are Paleoproterozoic in age. Conspicious is the absence of ages between ca. 1200 and 700 Ma. In contrast to the detrital zircon age spectra of Bruguier et al. (1997), with the main age groups between 1.7 and 2.0 Ga and from 2.1 to 2.5 Ga, respectively, and minor groups at 410-520 Ma and 230-260 Ma, the ^{40}Ar/^{39}Ar mica ages indicate a wide-spread Silurian-Devonian tectono-thermal event. Combining the two studies, a Proterozoic basement with Caledonian overprint can be inferred for the source region – a setting which can be found in the Altun, Qilian and Qinling orogenic belts and their Proterozoic hinterland, hence the southern margin of the North China block. The age group around 750 Ma, which Bruguier et al. (1997) found in an Upper Triassic sample and which they derived from a South China source region, is absent in the mica age spectrum.

The Late Permian age group and the group about the Carboniferous/Permian boundary represent ca. 5 percent of the grains each. Therefore, the proportion of detrital white mica grains from the UHP wedge is subordinate or absent. This means that exhumation of continental crust was limited, that during sedimentation no rocks from depths of more than 10-15 km were exhumed in adjacent orogenic belts. Most rocks in the source regions cooled below ca. 350˚C at least 100 Ma before erosion. To account for the huge amount of sediment in the basin we infer uplift, brittle reactivation and thrusting of the upper continental crust of the over-riding plate (southern margin of the northern continent) with widespread erosion – a scenario similar to the present uplift and reactivation of the area due to the indentation of India without exhumation of mid-crustal rocks.