Low-temperature metamorphic and geochronology data of the Songpan-Garzê flysch in the NE Tibetan Plateau

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Triassic flysches of the Songpan-Garzê orogen in Sichuan Province, China, cover a large area within the northeastern Tibetan Plateau. It contains the largest on-land flysch occurrence in the world [1] and was formed by the exhumation of the Kunlun, Qinglin and Dabie Shan orogens from deep crustal levels. The investigated area is bordered to the southeast by the Longmenshan fault (Sichuan basin), to the southwest by the Jinshajiang suture zone (Qiangtang terrane) and to the north by the Muztagh- Anyemaqen Suture zone (Kunlun terrane). Accumulated flysch sediments reach thicknesses of 15 km [1] and have undergone an upper diagenetic to greenschist facies overprint after deposition and accretion between the North China, Qaidam and Qiangtang tectonic blocks. The metamorphic and post-metamorphic exhumation history of the flysches was investigated by means of illite (IC) and chlorite crystallinities (CC) [2, 3] and apatite fission track (FT) dating, with sample profiles extending across the Longmenshan and Anyemaqen fault systems.

Boundaries separating zones of equal metamorphic grade crosscut Triassic fold and fault lines. While most of the areas away from the principal fault lines are of diagenetic grade, areas of anchizonal and greenschist facies overprint occur along principal fault lines, and there is a regional increase from diagenesis to greenschist (locally amphibolite) facies towards the Longmenshan fault, which underlines the regional influence on long-term exhumation of this fault far into the Tibetan Plateau. Across the Longmenshan and the Anyemaqen fault system IC/CC data point to a total offset of more than 3 km of post-metamorphic vertical displacement with respect to the Sichuan basin and Kunlun terrane, respectively. The offset of the metamorphic zone pattern across the Xianxuihe fault indicates some 60 km of post-metamorphic horizontal strike-slip displacement.

Apatite FT samples were collected within Provinces Sichuan, Gansu and Qinghai. They cover an age range between 3 and 136 Ma, suggesting that the ages of many samples (the youngest dated sediments are of Jurassic sedimentation age) vary from an early Cretaceous exhumation event to Miocene exhumation along active fault lines. A marked correlation between IC/CC and FT data reveal that the differences in recorded metamorphic grade at the present-day surface were significantly caused by differential exhumation, i.e. the late structural evolution of the former flysch basin. Miocene FT ages within the flysch coincide with increased metamorphic grade up to greenschist facies conditions towards and along active fault lines (Longmenshan, Anyemaqen).

With growing distance to major active fault lines, apatite ages increase to Cretaceous values. One vertical profile (2400-4100 m) shows a strong linear trend. Regarding its track length and age data, the profile pattern is recognized as the lower part of an exhumed partial annealing zone. The lower end of the partial annealing zone can be estimated at appr. 15 Ma, which is in line with similar ages along the Longmenshan fault. From the vertical thickness of the partial annealing zone (> 3km), the thermal gradient during apatite age reset must have been < 20°/km. The Cretaceous cooling event occurs at around the time of the youngest magmatic intrusions [4]. Rather than representing a major exhumation event, this cooling is interpreted as the large-scale effect of crustal plateau thickening. Accordingly, the northeastern Tibetan Plateau is interpreted to have formed in the Cretaceous, i.e. much earlier than collision between India and Asia.

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Key words: Illite crystallinity, fission track dating, Songpan-Garzê flysch, exhumation