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Tectonic evolution of the Songpan Garzê and adjacent areas (NE Tibet) from Triassic to Present : a synthesis.

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The 12th May 2008 Wenchuan earthquake in the Longmen Shan occurred on a large thrust fault largely inherited from an Indosinian structure itself probably controlled by an older structural heritage of the South China block continental margin. Within the whole northeast Tibet region, such a structural inheritance has had a major impact on the Tertiary deformation. It appears of primary importance to assess the pre-Tertiary tectonic evolution of the main blocks involved to understand the actual deformation in the eastern edge of Tibet. Over the past decades, the Proterozoic to Cenozoic tectonic, metamorphic and geochronologic history of the Longmen Shan and Songpan Garzê area have been largely studied. We present a synthesis of the tectonic evolution of the Songpan Garzê fold and thrust belt from Triassic to present.

The Songpan-Garzê belt was formed during closure of a wide oceanic basin filled with a thick (5 to 15 km) sequence of Triassic flyschoid sediments [10]. Closure of the basin due to Triassic subduction involved strong shortening, intense folding and faulting of the Triassic series. A large-scale décollement, that presently outcrops along the eastern boundary of the belt (Danba area), allowed the growth of a wide and thick accretionary wedge [9]. It develops in the Paleozoic and Triassic series and separates the accretionary prism from an autochthonous crystalline basement [5, 12, 6] which shares many similarities with the basement of the Yangtze Craton (0.7-0.9 Ga). To the north and northwest, below the thickened Triassic series of the belt, the composition (oceanic or continental) of the basement remains unknown. During the Indosinian orogeny the emplacement of orogenic granites (220 – 150 Ma) was associated to crustal thickening [12, 13, 17, 15]. The isotopic composition of granitoids shows that their magma source were predominantly derived from melting of the proterozoic basement with varying degrees of sedimentary material and negligible mantle source contribution.

In the Danba area, the décollement outcrops in a large tertiary antiform with a NNW-SSE axis [6, 12, 18]. It has been exhumed too in the hanging wall of the NE-SW faults of the Tertiary Longmen-Shan belt that marks the present day transition from the Tibetan plateau to the Sichuan basin. These faults have episodically absorbed significant shortening since the Late Triassic [3]. The amount and precise timing of post-triassic deformation are difficult to constrain especially because of the difficulty to isolate the tertiary thermochronological signal from the protracted late Triassic – Cretaceous thermal history (e.g. [14]). Nonetheless it is generally accepted that Jurassic – Cretaceous tectonism did not modified the general Triassic architecture of eastern Tibet contrarily to the Tertiary deformation (e.g. [2, 12, 5, 14]).

The long-term cooling histories obtained on Mesozoic granites and on the metamorphic series of the Danba dome are very similar showing a very slow and regular cooling during Jurassic and Cretaceous, confirming the absence of major tectonic event between c.a. 150 and 30 Ma [16, 7, 6, 12, 18].

Low temperature thermochronology data indicate that final exhumation and cooling occurred in the Tertiary with an acceleration between 10 and 5 Ma along the major tectonic structures [11, 12, 1, 16, 7,14, 8]. Within the Longmen Shan range, a total denudation of 7 to 10 km is estimated for the late Cenozoic period [1, 7, 4]. Similar amounts of late Tertiary denudation have been estimated along an east-west section across the Xianshuihe fault [16].

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