Structures and tectonics of the western margin of the Indian Plate

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Abstract

Ongoing collision of the Indian and Eurasian plates since about 55 Ma has led to the development of the spectacular Himalayan mountain system. Western margin of this system is characterized with a zone of transpression marked by the Chaman fault system and the development of an arcuate and broad ((~500 km) Sulaiman fold belt. This area is recognized with huge petroleum reserves. Therefore, better understanding of geological structures is considered as a key to successful exploration. In this article, combined surface geology (field geology and Landsat image interpretation) and subsurface geophysical (seismic reflection, gravity, and seismicity) data is used to depict, analyse, and interpret the deformation and the evolution of the active western margin of the Indian plate (Jadoon et al. 1992, 1994; Jadoon and Khurshid 1996).

A regional 800 km long, NNW-SSE crustal-section, shows tectonic units across the margin (N to S) as the Afghan block, the left-lateral strike-slip Chaman fault (since the early Tertiary), the Khojak flysch basin (Eocene-Miocene), the Muslimbagh ophiolites (late Paleocene-early Eocene), and the Sulaiman fold belt (Triassic-Eocene platform and Neogene molasses sedimentation). The broad (>300 km) and gentle (<1°) Sulaiman fold belt is characterized with the presence of about 10 km strata of stratigraphic thickness, without any thrust fault, at the deformation front. Absence of a thrust at the mountain front is interpreted with, thin-skinned, duplex-style of deformation over a weak detachment. The detachment is interpreted with a depth of about 10 km at the mountain front as Paleozoic to Recent stratigraphic section is buckled as folds (Sui and Loti) over the basement. The duplex structures are interpreted starting from the Pirkoh northwards. The duplex sequence, is comprised of Paleozoic to Jurassic strata, which is topped by a hinterland vergent roof-sequence, of Cretaceous and younger strata. The roof sequence extends over a considerably long distance (~149 km) emerging in the Loralia valley. Along its length, it is breached by a set of exposed thrust faults, of limited displacement, both with foreland and hinterland vergence in the internal part of the system, unlike nappe structures (Bannert). Thus, it is interpreted to deform with active out-of-sequence deformation evidenced with very high degree of seismic activity in the central Sulaiman fold belt. Critical review of this deformation with the Landsat data shows the presence of right-lateral strike-slip faults of EW orientation, obliterating former fold-and-thrust structures. These strike-slip faults are interpreted to represent the youngest Quaternary deformation with anticlockwise block-rotation in the system, possibly due to transpression. We have calculated shortening of about 349 km with convergence rates of about 18mm/yr, since about 20 Ma across the Sulaiman fold belt, south of the Muslimbagh ophiolites and the Khojak flysch basin along the margin.

With gravity data, the curst is modeled as thinner (15-27 km thick) along the Sulaiman fold belt and thicker (~57 km) along the Afghan block across the Chaman fault. This implies presence of a preserved passive margin along the western terminus of the Indian plate. The modeling suggests the Chaman fault to be generally vertical, with juxt-opposition of basement (Afghan Block) towards north and flysch Khojak) towards south. It is interpreted to be restricted at depth to about 15 km with mergence in the decollement over the subducting passive margin of the Indian plate. Thus, the Afghan block is interpreted as an oblique indenter with dominant left-lateral strike-slip along the Chaman fault and thrusting in the Sulaiman fold belt. Deformation partitioning, with transpression in the sedimentary wedge above a decollement and pure translation of the lithosphere with indentation of the Afghan block is considered in our model.