

2. GEOLOGICAL AND TECTONIC SETTING OF THE SULAIMAN RANGE

General. The geological history of the terrain covered by Pakistan is very complex as it is situated along the contact between the Indo-Pakistan and the Eurasian Plates. Depositional history of the Indo-Pakistan Plate along with volcanic events, pre- and post-collision events, and accretion of the Arabian Plate are reflected by stratigraphic sequence exposed in Pakistan. Sedimentary sequences that range from Precambrian to Recent were deposited along the western wedge of the Indian Shield (Figure).

The tectonic evolution of South Asia as a result of which world's largest mountain (The Himalayas) were formed, presents excellent examples of academic interest related to head on continent-continent collision. It has received an exceptional attention by geologist from around the world (e.g. Ganser, 1964; 1979; Powel, 1979; Farah et al., 1984; Dewey et al., 1989; Kazmin, 1991, Treloar and Searl , 1993; Metcalfe, 1995; Bender, 1995 etc).

The Tethys Ocean occupied the region between the southern margin of the Eurasian Plate and north of the Indo-Pakistan Plate. Recently, Tethys Ocean has been divide into three ocean systems: the Paleo-Tethys, the Meso-Tethys, and the Ceno-Tethys (Kazmin, 1991; Metcalfe, 1995). The Tethys Ocean closed gradually as result of northward movement of the Indo-Pakistan Plate and several microplates (China-Turan and Tarim Plates ets.) lying in between were attached to

Eurasian Plate, along with the sedimentary sequences of the Indo-Pakistan Plate (Bender, 1995). In the Pakistani-Himalayas, the Eurasian Plate is separated by Main Karakoram Thrust (MKT) in the north and the Indo-Pakistan Plate by Main Mantle Thrust (MMT) in the south of the famous Kohistan Island Arc (Tahirikheli et al., 1979, Coward et al. 1982, Searle et al. 1987) (Fig. 5).

The Mesozoic to Paleogene sedimentary sequence is widely exposed along the northwestern margin of the Indian Subcontinent, Central Pakistan. This is the sedimentary cover of the Indo-Pakistan Plate that was folded during the continent-to-continent collision with Eurasian Plate and several fold and thrust belts were formed such as Kirthar, Sulaiman and Salt Ranges (Fig. 1).

Bannert and Raza (1992) has proposed that the basement of the continental Indo-Pakistan Plate segmented into three different basement blocks during the collision of the Indo-Pakistan Plate with Eurasian Plate. They identified the Khuzdar Block, the Sulaiman Block, and the Hazara Block (Figure). Moreover, the style of deformation above these three basement blocks has been reported different from each block. Summarising the results of Bannert and Raza (1992), when the Indo-Pakistan Plate approached the Afghan Block at the end of Cretaceous, a considerable amount of the Tethyan sea floor had already been consumed under the northern zone. The Khuzdar Block was the leading edge that collided first with the Afghan Block (Sarwar and Dejong, 1984). This happened during the late Maestrichtian or, at the latest, during the Paleocene (Allemann,

1979), when the Bela, Muslim Bagh, Zhob, and Waziristan ophiolites were obducted above the Mesozoic sediments of the Indo-Pakistan Plate.

The Sulaiman-basement Block is in the east of the Khuzdar Block and is separated from the later by the Kirthar basement assumed as strike-slip fault (Fig. 5). Now according to Bannert, 1995 (in Geology of Pakistan, edited by Bender, F. K and Raza, H. A., 1995) the Sulaiman Block underwent a different deformation history compared to that of the Khuzdar Block. After the initial collision of the Indo-Pakistan Plate with the Afghan Block, the Khuzdar Block was slowed, however, the Sulaiman Block continued its flight towards north forming new leading edge of the Indo-Pakistan Plate, and during Oligocene it started underthrusting after colliding with Afghan Block. The Sulaiman Block was bent towards the north along the Sulaiman basement fault in the east and overlying sediments were detached, moved southwards as nappes and large lobes forming the Mari Bughti Hills and the Sulaiman Range. Regarding the style of deformation, Banks and Warburton (1986) were the first to apply the modern concept of detachment tectonics to the nappes and identified passive-roof duplexes.

Sulaiman Range: The festoon (lobe) shaped Sulaiman Range along with Kirthar Range was formed due to oblique collision of the Indo-Pakistan Plate with Afghan Block in a transpressional zone on the northwest and western margin of the Indo-Pakistan Plate, respectively (Yeats and Lawrence, 1984). The Sulaiman Range is the broadest (>300km) foreland fold and thrust belt of the Himalayan mountain system. Sulaiman Range is bordered by ophiolite and flysch belt in the

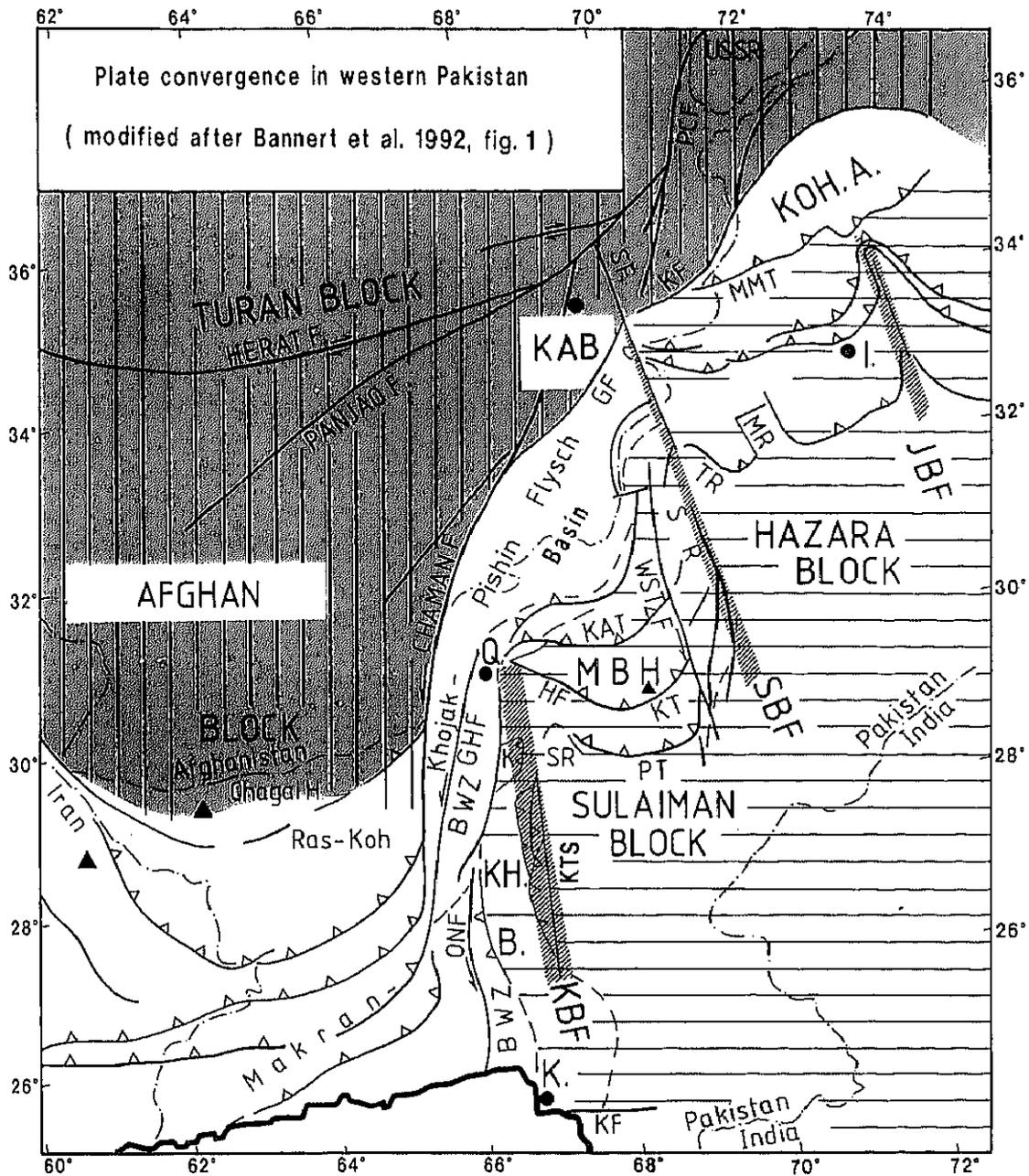


Figure 5. Regional tectonic map of Pakistan and adjoining areas showing main tectonic features such as major tectonic blocks, faults and structure of the fold and thrust belt (Modified after Bannert et al, 1992, Bender, 1995). Here BWZ: Bela Waziristan Ophiolite Zone, I: Islamabad, KBF: Kirthar Basement Fault, KHB: Khuzdar Block, KOHA: Kohistan Island Arc, KTS: Kirthar Thrust Sheet, MBH: Mari Bugti Hills, MMT: Main Mantle Thrust, ONF: Ornach-Nal Fault, SBF: Sulaiman Basement Fault, SR: Sulaiman Range, WSTF: Western Sulaiman Transform Fault

western side whereas it forms the continuation of the Kirthar Range around the tight arc of the Sibi Trough; it is separated by a broad fold abutting the alluvial deposits of the Indus River system in the east.

Huge work has been done on the Sulaiman Range because of its hydrocarbon potential such as Hydrocarbon Development Institute of Pakistan, Geological Survey of Pakistan and other private oil companies. Many individuals from Pakistan as well as from other parts of the world have also published a great deal of work, especially related to structural development and tectonic set up of the Sulaiman Range. Blandford (1883), Oldham (1890), Davies (1939), Pinfold (1939) and Eames (1952b) have done basic stratigraphic work whereas Shah (1977; 1987, 1990) has compiled updated stratigraphy. Hemphill and Kidwai (1973) did initial mapping in northern Sulaiman Range while the major reconnaissance mapping was carried out by Hunting Survey of Pakistan. Sarwar

and Dejong (1979), Banks and Warburton (1986), Lillie et al. (1989), Jadoon et al. (1989; 1992; 1993), Jadoon (1991; 1992), Humayon et al. (1991), Davis and Lillie (1994), Warraich et al. (1995), and Warwik et al. (1998) has discussed the structural and tectonic development of different parts of Sulaiman Range. Jones (1997) has thrown some light on the Cenozoic stratigraphy of the northern Sulaiman Range.