Bara Thrust Zone, Southern Khyber Agency, Northern Pakistan: Insight for the tectonic boundary between the Attock-Cherat-Khyber and the Kalachitta-Samana Hill Ranges

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This study presents the first geological map for Survey of Pakistan topographic sheets of 38-O/1 and 38-O/5. The studied area falls at the south-western margin of the Peshawar Basin covering parts of the administrative units of the Peshawar District, Khyber Agency and FR Kohat. The area marks the junction between two tectonic blocks; Khyber in the north and the Samana block in the south, characterized by three sub-parallel thrusts in the vicinity of the Bara River, which we term as the Bara Thrust Zone. The Khyber block in the mapped area consists of three major units including Shagai Formation, Khyber Limestone and Landikotal Slate, with minor Carboniferous-Permian limestone in the NW part of the mapped area and some undifferentiated ?Jurassic-Cretaceous rocks in the middle. The Kotal-Samana block consists of the Jurassic Samana Suk Formation and the Paleocene Hangu, Lockhart and Patala Formations. The two tectonic blocks do not have direct contact exposed in the area. Rather, this contact is concealed under the Miocene Murree Formation. Presumably, the Murree Formation was unconformable deposited on rocks belonging to the two blocks. However, subsequently the Murree Formation was involved in the MBT related and younger deformation phases. The original unconformable contact at the base of the Murree Formation is preserved at a few places in the mapped area including Shin Qamar, and Tapu Killi, where it is deposited on top of the Patala Formation. Elsewhere, the Murree Formation occurs in the footwall of thrust faults. The most northerly exposure of the Murree Formation is along a NW trending line from Azarai Khandarai in the east, through Malik Din Khel, Mir Baz Garhi to Sara Palai, at the southern banks of the Bazar Nala. Much of the margin of the Murree Formation at the eastern parts of the mapped area is covered by alluvial fans related with the Bara River and its tributaries. From Mir Baz Garhi towards the NW, the Murree Formation is thrust over by the Precambrian Shagai Formation. This thrust is termed here as the Bazar Thrust and has a SSW vergence. Southern most exposures of the Murree Formation are in the footwall of the Bara Thrust. Unlike the Bazara Thrust, here Murree Formation is thrust over by Paleocene Lockhart Formation of the Kotal-Samana Block along a north-vergent thrust. About 10 km wide exposures of the Murree Formation between the Bazar Thrust in the north and the Bara Thrust in the south is internally breached by another prominent thrust on the northern banks of the Bara River, termed here as the Shin Qamar Thrust. This thrust is also north vergent like the Bara Thrust and likewise thrusts Samana block i.e., Paleocene Lockhart Formation over the Murree Formation. However, unlike the Bara Thrust, the Shin Qamar Thrust carries Palaeocene units as well as the Murree Formation in its hangingwall with the original unconformable contact being the Palaeocene and the Miocene being intact. Amongst all the major thrust faults exposed in the studied area, the Bara Thrust is most complicated in terms of its kinematics, vergence and stratigraphy involved in thrusting. Whereas the eastern half of the Bara Thrust is between Lockhart Formation and the Murree Formation, the segment west of Isakai, has Jurassic Samana Suk thrust over Lockhart-

Patala Formations. Another prominent thrust (Tazikhel Thrust) trending NE joins the Bara Thrust from the SW parts of mapped area forming a thrust wedge comprising Samana Suk Formation. Unlike the Bara Thrust, the Tazikhel Thrust has a south-southwest vergence. It is notable that Dara-Adam khel part of the Kotal-Samana Block has characteristic mushroom-shaped fold structures cored by Samana suk Formation with their divergent overturned limbs breached by oppositely verging thrust faults. We interpret the Isakai structure to be a mushroom-shaped east plunging fold structure with Bara-Tazikhel thrusts as the breached divergent limbs of this fold structure.

Our major results of this study are as under:

1. Four major faults occupy the junction between the Khyber and Kotal-Samana blocks SW of Peshawar, collectively defining the Bara Thrust Zone.
2. Of these, the south-verging Bazar Thrust, with hanging wall comprising Precambrian Shagai Formation (equivalent of the Dhakhner-Hazara Formations) and the footwall comprising the Murree Formation together with the underlying Kotal-Samana lithologies (Palaeocene Lockhart and Patala Formations) marks the extension of the Hissartang Thrust of the Attock-Cherat Ranges.
3. With the recognition of the Bazar Thrust as the extension of the Hissartang Thrust, this study completes the delineation of the hinterland-foreland boundary in the NW Himalayas of Pakistan.
4. The presence of the Murree Formation at the northern flanks of the Hill Ranges and its involvement in thrust faults confirms post-Miocene development of the Hill Ranges related with Main Boundary Thrust phase of deformation.
5. The Isakai triangular Samana suk faulted block between Bara and Tazi khel faults is a fault-breached mushroom fold structure characteristic of the Kotal-Samana Hill ranges.