Frontal structural style of the Khisor Range, northwest of Bilot: Implications for hydrocarbon potential of the northwestern Punjab Fore Deep, Pakistan

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Khisor Range of the Trans-Indus ranges is a south-vergent fold-thrust belt that defines an east-west to north-northeast trending structural geometries and protrudes southward into the northwestern Punjab foreland deep. This range is characterized by eastwest to north-northeast trending parallel to en echelon, plunging anticline and syncline pairs that appear asymmetric to overturn in the form of fold train and dominantly south vergent. The frontal foothills of the Khisor Range comprise a latest partially emergent thrust fault named as Khisor Thrust. Surface projection of the emergent structural elements to depth suggests a thin-skinned structural mechanism for evolution of the Khisor Range where gliding horizon for the frontal thrust sheet has been located within the Nilawahan Group rocks of Permian age at a maximum depth of 3~4 km. The structural growth of the Khisor Range is dominantly attributed to the south directed transferal deformation mechanism along the basal detachment horizon being exposed at the foot of the Permian Warchha Sandstone. Along this basal detachment surface the Warchha Sandstone is emplaced over the Siwalik Group rocks southward on top of the northwestern frontier of the Punjab Foreland. Thrusting, generally commenced subsequent to deposition of the Siwalik Group rocks, for the reason that these rocks are involved in the latest thrusting phase of deformation. The Khisor Range front is the latest and dynamic frontal fracture zone of the northwestern Himalaya where deformation still continues in the course of southward progression. The Khisor Thrust demarcates the northwestern proximity of the Punjab Foreland and is predominantly underlain by the shallow marine rocks of Permian to Triassic age in the vicinity of Bilot. The stratigraphic framework of the Khisor Range is significantly associated and correlative with the Surghar and Salt ranges with some exceptions. Permian strata of the Khisor Range comprise of Nilawahan and Zaluch groups rocks, where the top of the Nilawahan Group consists of the Sardhai Formation and bottom of the Zaluch Group consists of the Amb Formation. The Sardhai Formation observed 40m thick and consists of dark gray to blackish gray and black carbonaceous shale while the basal parts of the Amb Formation consists of dark gray carbonaceous and calcareous shale of more than 20m thick, which is conflicting to the stratigraphic setting of the Surghar and Salt ranges. The structural geometries and stratigraphic framework of the Khisor Range suggests that the northwestern Punjab fore deep is pertinent for the hydrocarbon exploration as thick carbonaceous shale facies of both formations are possible potential source rocks.