

## **Exploring the Infra-Cambrian Petroleum System in Punjab Platform, Pakistan: Lessons Learned From Bahawalpur X-1**

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### **Abstract**

Many fruitless efforts have been made for testing the Infra-Cambrian Play in Punjab Platform, before and after the discovery of heavy oil from Baghewala-1 in 1991 from the Late Riphean-Vendian strata, in Bikaner-Nagaur Basin, India. Twelve wells have been drilled in Punjab platform and the Bahawalpur X-1 (BX-1) well was the latest attempt to test the hydrocarbon potential of Infra-Cambrian of a four-way dip closure, Lal Suhanra prospect.

Upper Carbonate and Upper Nagaur sequences/ formations of Late Infracambrian period are encountered in Bahawaupur X-1 while Lower Nagaur, Hanseran, Bilara and Jodhpur formation of Early Infra-Cambrian period are missing. The absence of Lower Infra-Cambrian indicates the presence of basement high at the time of deposition of Lower Infra-Cambrian sequences, resulted in absence of two source rocks interval (Lower Nagaur shale and Bilara Carbonates) and two reservoirs (Bilara Dolomite and Jodhpur sandstone). Hanseran Evaporite, which provides top seal in Baghewala-1, is also missing in BX-1. Baghanwala, Jutana and Kussak Formations of Early to Middle Cambrian age are also missing/ eroded at Bahawalpur X-1 and Tobra Fm is directly overlain by only 95m thick Khewra Sandstone.

Basement was encountered 430m shallower than the prognosis in BX-1. The seismic data and VSP log of BX-1 show distinct reflectors apparently look like sedimentary package in the upper part of the basement, which can be correlated with Milani Suite rocks penetrated by number of wells drilled in the Indian side. Milani Suite is generally composed of granitoid – granodiorite associated with acidic and minor basic volcanic-plutonic and dykes. Two samples analyzed from BX-1, are classified as granodiorite with small, assimilated xenoliths. The folding in Milani Suite (upper basement) and the Infra-Cambrian/Early Cambrian strata are synchronous and probable developed during Late Paleozoic compressional event. Thick skin deformation produced harmonic folding from upper part of basement to overlying Infra-Cambrian/Early Cambrian sequences, which resulted in erosion of most part of the Cambrian sequence.

Maturity data and Basin study indicate that Infra-Cambrian reached maximum generated/ expelled hydrocarbon during the Devonian time. Subsequent burial is insufficient to recommence the generation of hydrocarbons. No oil and gas shows were observed during drilling and minor indication of bituminite type of organic matter was observed in Upper Carbonate during petrographic study of BX-[1]. The absence of HC in Upper Carbonate is attributed to lack of charging or absence of structure at the time of main phase of oil generation from Infra-Cambrian source. Accurate picking of top basement on seismic, presence of structure at the time of HC generation and proximity to Kitchen should be considered of Infra-Cambrian Plays in Punjab Platform for future exploration.