

Depositional History Of Cretaceous To Paleocene Fluvial Sandstone Reservoirs, Barmer Basin, Rajasthan

Arpita Mandal¹, Hriday Jyoti Bora¹, Priyabrata Chatterjee¹, Premanand Mishra¹, and Pinakadhar Mohapatra¹

¹Cairn Oil & Gas (Vedanta Limited)

ABSTRACT

Fluvial-dominated systems are amongst the most prevalent of continental environments. They constitute the proximal edge of a basin and interact with contemporaneous depositional systems such as alluvial fans, lacustrine systems or the shallow marine environment. In NW-SE oriented intracratonic Barmer Basin, the most prolific and well explored reservoir belongs to the Fatehgarh fluvial system. Until recent times, Fatehgarh Formation was considered as an undifferentiated continental depositional unit of Paleocene age with initial stages of high energy braided fluvial packages followed by lower energy sinuous channel complexes (FM5 to FM3 and FM2 to FM1 respectively in Mangala field). In the northern Barmer Basin, these two fluvial complexes are separated by a highly cemented diagenetically altered “white sand” unit, a volcanic derived trap wash deposit, totally devoid of oil stains even though has same contact with upper and lower fluvial packages. From the fossil records and zircon/apatite fission track studies, the upper Fatehgarh Formation is confirmed as Palaeocene and Lower Fatehgarh is attributed to Lower Cretaceous age respectively. In the revised stratigraphy, lower clastic sequence of erstwhile known Fatehgarh Formation is defined as Ghaggar-Hakra Formation.

Fluvial Ghaggar-Hakra Formation is deposited in rift grabens created due to northeast–southwest stresses resulting from Indian Plate rotations and the first phase of rifting between India and Madagascar. Paleo-flow direction of Ghaggar-Hakra Formation is NNE-SSW and it is coeval with shallow marine Bhuj formation in Kutch basin. The Ghaggar-Hakra Formation unconformably overlies the Neo-proterozoic Malani Igneous Complex (Saraswati-4); forms an angular unconformity with the Jurassic Lathi Formation (in Lordi Nala) and conformably overlies middle Cretaceous Karentia volcanics (in Sarnu).

At KT boundary, Deccan equivalent volcanism was prevalent primarily in the southern Barmer Basin (as Raageshwari volcanics) along with sporadic events in central and north (in Airfield High). Petrographic studies have indicated volcanogenic trapwash deposits (in Dhandlawas) in Raageshwari field in the south whereas in northern fields the facies changes to immature lithic rich quartz-wackes (op. cited “white sand”). With the onset of Tertiary rift in Paleocene early syn-rift sediments started depositing fluvial Fatehgarh Formation sourced from the incipient Aravalli drainage and also from recycled Jodhpur and Lathi sandstones. Fatehgarh facies varies significantly from north to south of the basin; clean matured fluvial sandstones in the north, and poor silty low energy facies while in the south.

Both Ghaggar Hakra Formation and fluvial Fatehgarh Formation are characterized by high quality fluvial / fluvio-lacustrine reservoirs with excellent porosity and permeability. However, unlike Ghaggar Hakra Formation, which exhibit uniform lithology across the basin, Fatehgarh shows varied lithological characteristics largely controlled by local inputs, especially in the central and southern Barmer Basin. Fatehgarh is also found to be bypassed in areas of existing topographic reliefs. In area of little or no volcanic influence, significant time gap between

Ghaggar Hakra and Fatehgarh Formation is represented by red paleosol (duricrust). The youngest Fatehgarh is represented by lake-margin deposits indicating initiation of lacustrine environment. This is followed by basin-wide flooding event of Barmer Hill TST and Tertiary syn-rift deposits.

Present stratigraphic understanding has changed future exploration strategy significantly. Conclusions emanating from recent studies, warrant a separate formation status for Ghaggar-Hakra and recommend a different approach and work flow for Ghaggar-Hakra and Fatehgarh which were earlier clubbed within a unified "Fatehgarh Formation".