The Porcellanite Member of the Barmer Hill Formation, Barmer Basin, Rajasthan, India: an integrated study from outcrop and well data and implications for reservoir characterization

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The Barmer Basin is a NNW-SSE rift basin situated in the northwestern part of India in the state of Rajasthan. Normal fault growth in the basin occurred mainly during the Paleocene–Eocene. The sediments of the Barmer Basin are classified as pre-rift, syn-rift and post-rift. The pre-rift stratigraphy consists of Mesozoic and older rocks. The Fatehgarh Formation were deposited as early syn-rift deposits whereas the Barmer Hill and Dharvi Dungar Formations were deposited in the main rift phase. The Thumbli and Akli formations represent the late syn-rift sequence.

The Barmer Hill Formation was deposited directly over the Fatehgarh Formation and underlies the Dharvi Dunger Formation, which is the regional seal to both these formations. The Barmer Hill Formation is interpreted to have been deposited in a lacustrine setting, supplied by a river system from the north and north east, with subsidiary marginal fluvial fans and fan deltas along the western and eastern margins of the rift.

This Barmer Hill Formation outcrops at the northern margin of the basin, where it consists of a highly siliceous porcellanite with a mudstone texture and up to 65% porosity but 1mD permeability. XRD and SEM analysis of representative outcrop samples confirm the presence of Opal-CT and diatom tests in this sequence. Conventional core data from nearby shallow oil fields (ca 1km current burial depths) indicates the equivalent subsurface lithological unit is composed of microcrystalline quartz and is characterized by high porosity, low permeability and (where oil bearing) low water saturations. Integration of outcrop sampling with conventional whole core data confirms the diagenetic alteration of diatomite silica from Opal-A through Opal-CT to microcrystalline quartz (chalcedony). The porcellanite facies of the Barmer Hill Formation is a hydrocarbon-bearing reservoir, where favourable source, migration and trap conditions exist. However, like analogous low permeability diatomite reservoirs of the world, the Barmer Hill porcellanite reservoir will present challenges, which require an integrated geoscience and engineering approach in order to achieve commercial oil production.