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Establishing Volcanic Litho-Stratigraphy In A Tight-Gas Reservoir In Barmer Basin, Rajasthan

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ABSTRACT

The Raageshwari Deep Gas (RDG) field in the Barmer Basin of Rajasthan, India comprises a tight gas-condensate reservoir within the clastic Fatehgarh Formation and the underlying >1000m thick Volcanic Complex. The Volcanic Complex comprises two major units – upper Prithvi Member (basic lava flows or basalts) and lower Agni Member (stacked silicic pyroclastic flows or felsics interbedded with older basalts). Normal faulting of the RDG rocks has led to formation of a complex network of fractures within the brittle volcanics. These tight reservoirs host approximately 70 per cent of the RDG field Gas-In-Place and vary in thickness and extent across the field owing to variable volcanic emplacement and subsequent erosional controls. Stratigraphic principles established for sedimentary sequences may have limited applicability in volcanics which require an alternative approach. Hence, building a geological concept around a robust stratigraphic correlation is key to the construction of a realistic static reservoir model for input to history matching and production forecasting.

In this poster, we demonstrate how core data and advanced logs (like ECS and image logs) are interpreted and tied with conventional wireline logs in a complex, heterogeneous volcanic rock system to achieve field-wide correlation. These well-based lithostratigraphic tops are further translated to macro-scale by horizon mapping on 3D seismic, wherever the imaging resolution allowed, before being carried forward to the static reservoir model.

Presence of locally-derived volcano-clastic sediments as observed in core provides insight into the fluvio-lacustrine nature of the Fatehgarh Formation that onlaps onto the Prithvi Member (basalt unit) of the Volcanic Complex on an erosional unconformity. This erosional control is manifested as extreme variation in Prithvi Member thickness from 0 to >700m across the field making the volcanic litho-stratigraphic correlation and sub-zonation challenging. Compositional analysis of core plugs in the Prithvi Member shows mafic lava flows of trachy-basalt to trachy-andesitic mineralogy, with typical textural variations from amygdaloidal, porphyritic to brecciated basalt. The older basalts of Agni Member, however, indicate a reduced SiO2 percentage falling within the tephrite/ basanite category of mafic rocks. It is also observed from the core data that the silicic pyroclastic rocks of Agni Member are mostly high-alkali trachytes characterized as weakly to strongly-welded lapilli tuffs and agglomerates.

Pooling the available core data, well logs and advanced log data, diagnostic ‘Tuff’ markers (or ash beds) within the Prithvi Member are identified. These Tuff markers serve as significant geo-chronological events within the volcanic succession and guide sub-zonation and correlation of stratigraphic packages within this unit. Further, within the Agni Member, core study reveals some sub-horizons to be clear interfaces between the interbedded pyroclastic sub-units and older basalts. This is subsequently tied to well log responses and carried forward

in all wells across the field. Impedance contrast between basic and acidic sub-units together with the well-picked markers is used for guidance in seismic mapping of the volcanic sub-horizons.

The resultant sub-zonation within the Volcanic Complex has helped impart robust structural control in the 3D reservoir model. This ultimately impacts reservoir property distribution within the sub-zone framework to better reflect the geological heterogeneity of the reservoir. The correlation scheme may also be tied to well production behavior to better characterize the zone-wise dynamic reservoir parameters during history matching.