Source Potential and Reservoir Fabric of the Cambay Shale, Cambay Basin: A Potential Tight Gas/Tight Oil Resource for India

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ABSTRACT

The Eocene Cambay Shale is the principal source rock for conventional hydrocarbons and a prime target for tight gas/tight oil exploration in the Cambay Basin (western India). In this study, samples of the Cambay Shale from 4 wells and 2 open-cast coal mines were examined for total organic carbon (TOC) content, visual kerogen analysis (VKA) and thermal maturity (Ro). The mineralogy and texture of the shale were quantified using X-Ray Diffraction (XRD) and Quantitative Evaluation of Minerals by SCANning Electron Microscopic (QEMSCAN) techniques and the reservoir fabric, pore types and networks were analysed using Field Emission Gun – Scanning Electron Microscopic (FEG-SEM) imaging. The Cambay Shale samples are organic rich (0.37-10.68 wt.% TOC and avg. 2.43 wt.%), with fair to excellent source potential from dominantly type III kerogen, deposited in dysoxic to anoxic bottom water conditions in a brackish environment. The Ro values range from 0.58% to 0.7%, indicating that the organic matter is in oil generation window. The XRD and QEMSCAN data show that kaolinite, illite and quartz are the major constituents of the shale, with an average content of 33, 15 and 11 wt.% respectively. This implies a very low Brittleness Index (BI) with an average value of 0.15. The SEM images show the dominance of organic matter hosted pores (organopores), but also an abundance of intraparticle and interparticle pores of varying shapes associated with mineral matrix. The pores are generally less than 1 µm across, but some of the organopores are more than 1 µm in size. The organopores, interparticle and intercrystalline-intraparticle pores within pyrite framboids and concretions are the primary contributors to the effective fluid storage and, potentially, to hydrocarbon flow. The integration of geochemical and petrophysical data confirms that the Cambay Shale has all the essential source and reservoir characteristics necessary for tight gas/tight oil production, but that the high clay content and consequent low brittleness of the formation may reduce the ability to hydraulically fracture the shale and so limit well productivity.