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ORIGINAL PAPER - EXPLORATION ENGINEERING

Mineralogical assemblage of Cambay Shale of North Cambay Basin, Gujarat, India

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Abstract
Shale Gas exploration and production plays an important role in terms of energy security and economic stability. Tapping these reserves using cost-effective technologies can really change the India's energy supply and value chain. Cambay Shale of Cambay Basin has been proved as the most prominent Indian Shale reserve and in this work an attempt has been made to understand the geographical and mineralogical distribution of this Shale. A sample study on Cambay Shale of North Tectonic Block of Cambay Basin has been ascertained to understand the mineralogy, porosity and pore structure with respect to depth. The study involves the use of integrated measurement techniques mainly high-pressure porosity (HPP), scanning electron microscopy (SEM) and Fourier transform electron microscopy (FTIR). Approximately, 13 samples were analysed to understand the mineralogy of this shale and it was observed that it is very clayey in nature with major traces of Illite and minor traces of rutile and kaolinite. The other measurements (i.e., SEM and HPP) were done on two specific samples which confirm the presence of clay-rich porous minerals with high organic matter content.

Keywords Pore size · Mineralogy · SEM · Shale porosity

Introduction

Shale gas prospects are emerging rapidly as a promising energy source globally (Dayal et al. 2013). However, its exploration and exploitation in India is in nascent stage. A resource potential of around 2000 TCF of Shale Gas has been prognosticated in Indian Shales and according to preliminary data analysis by Directorate General of Hydrocarbons (DGH), Gondwana, Cambay Basin, Krishna—Godavari, Cauvery, Assam-Arakan, Rajasthan, Vindhyan and Bengal are the most promising shale gas plays in India. The present study is an attempt to understand the mineralogical characteristics of one of the prominent shale basins (i.e., Cambay Basin) of India.

Shale brittleness and its association with mineralogy and rock fabric plays is one of the factors suggested important with respect to a shale becoming significant resource play (Dargahi et al. 2013). Brittleness plays a significant role in effective hydraulic fracturing for shale gas production and is related to mineralogy, mechanical properties and pore features in shale (Guo et al. 2012). A high clay abundance indicates low material brittleness and fracability. Therefore, it is important to understand the clay composition in shale which is quite challenging as shales are chemically complex and heterogeneous in nature. It has been observed through the open source literature (Hosterman and Loferski (1981), Dargahi et al. 2013, Kendall and Nortan (1974), Yang et al. 2015, Abouelresh et al. 2016, Guerra et al. 2017, Akbar et al. (2017), Yang et al. 2018) that physical properties, chemical properties, water content clay type, distribution and size are the key important parameters for identifying mineralogical and elemental distribution and their effect on shale brittleness and fracability.

Numerous characterization techniques have been used to understand the mineralogy qualitatively and quantitatively. Thin section analysis, X-Ray diffraction (XRD) and Fourier transform infrared spectroscopy (FTIR) are the primary quantitative methods used for the mineral characterization (Ballard 2007). Diaz et al. (2013) presented a detailed mineralogy based description for organic mudstones using inorganic mineralogy, primarily X-ray diffraction and

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