Diagenesis of the Permian Ecca Group Sandstones and Mudstones in the Eastern Cape Province, South Africa: Implications for the Shale Gas Potential in the Karoo Basin

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ABSTRACT

Diagenesis is the most important factor that affects or impact the reservoir rock property. Despite the fact that published data gives a vast amount of information on the geology, sedimentology and lithostratigraphy of the Ecca Group in the Karoo Basin of South Africa, little is known of the diagenesis of the potentially feasible shales and sandstones of the Ecca Group. The study aims to provide a general account of the diagenesis of sandstones and mudstone of the Ecca Group. Twenty-five diagenetic textures and structures are identified and grouped into three regimes or stages that include syn-diagenesis, early diagenesis and late diagenesis. Clay minerals are the most common cementing materials in the Ecca sandstones. Smectite, kaolinite and illite are the major clay minerals that act as pore lining rims and pore-filling cement. Most of the clay minerals and detrital grains were strongly replaced by calcite. Calcite precipitates locally in pore spaces and partly or completely replaced clay matrix, feldspar and quartz grains at or around their margins. Precipitation of cements and formation of pyrite and authigenic minerals occurred during the syn- and early-diagenetic stages. This regime was followed by lithification and compaction which brought about an increase in tightness of grain packing, loss of pore spaces and thinning of bedding thickness due to overloading sediments and selective dissolution of framework grains. Mineral overgrowths, mineral replacement, clay-mineral transformation, dissolution, deformation and pressure solution occurred during late diagenetic stage. After rocks were uplifted, weathered and unroofed by erosion, this resulted in additional grain fracturing, decementation and oxidation of iron-rich minerals. The rocks of Ecca Group were subjected to moderate-intense mechanical and chemical compaction during its progressive burial. Intergranular pores, secondary dissolution and fractured pores are well developed in the Ecca Group. The presence of fractured and dissolution pores tend to enhance reservoir quality. However, the isolated nature of the pores makes them unfavourable producers of hydrocarbons, which at best would require stimulation. The understanding of the space and time distribution of diagenetic processes in these rocks will allow the development of predictive models of their reservoir quality, which may contribute to the reduction of risks involved in the hydrocarbon (oil and gas) exploration.