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

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Diagenesis is the most important factor that affects or impact the reservoir 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 eogenesis, mesogenesis and telogenesis. Clay minerals are the most common cementing materials in the Ecca sandstones and mudstones. 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 seriously attacked and replaced by calcite. Calcite precipitates locally in pore spaces and partly or completely replaced feldspar and quartz grains, mostly at their margins. Precipitation of cements and formation of pyrite and authigenic minerals as well as little lithification occurred during the eogenesis. This regime was followed by mesogenesis which brought about an increase in tightness of grain packing, loss of pore spaces and thinning of beds due to weight of overlying sediments and selective dissolution of framework grains. Compaction, mineral overgrowths, mineral replacement, clay-mineral authigenesis, deformation and pressure solution structures occurred during mesogenesis. During rocks were uplifted, weathered and unroofed by erosion, this resulted in additional grain fracturing, decementation and oxidation of iron-rich volcanic fragments and ferromagnesian minerals. The rocks of Ecca Group were subjected to moderate-intense mechanical and chemical compaction during its progressive burial. Intergranular pores, matrix micro pores, secondary intragranular, dissolution and fractured pores are the observed pores. 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 quality, which may contribute to the reduction of risks involved in their exploration.