DIAGENETIC STUDIES OF THE MID-TRIASSIC TREDIAN FORMATION IN THE SALT AND TRANS INDUS SURGHAR RANGES, PAKISTAN: IMPLICATIONS FOR RESERVOIR CHARACTERIZATION

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Abstract

Distinguished into two members (namely, the lower Landa Member and the upper Khatkiara Member), the Mid-Triassic Tredian Formation is well exposed in the Nammal Nala section of the Salt Range and the Landa Pasha and Gulakhel Nala sections of the Surghar Range. All the three sections are measured, logged and sampled in detail to elucidate the diagenetic changes and assess reservoir potentials of the Tredian Formation. Twenty-nine samples were selected for diagenetic investigation, while representative samples were examined with Scanning Electron Microscope (SEM) and energy dispersive X-ray (EDX) analysis to determine their clay mineralogy.

The Tredian sandstone has undergone intense and complex diagenetic processes. The chemical and mechanical compaction, cementation, replacement, grain fracturing and dissolution are the major diagenetic signatures. Major authigenic cements in the sandstone include calcite (both early and late diagenetic), dolomite, quartz, iron oxide/hydroxide and clay minerals. The two Members of the Tredian Formation underwent compaction differently. The lower Landa Member shows variable grain contacts (point to long) and early calcite cementation which stopped mechanical compaction and led to loose packing of grains. However, the upper Khatkiara Member displays tight packing (concavo-convex grain contacts) and significant mechanical compaction. Chemical compaction and pressure induced dissolution of quartz grains provided silica that precipitated as cement thereby reducing inter-granular porosity.

The paragenetic sequence is interpreted with relative diagenetic timings. The process of compaction continued from early through to late diagenesis and produced closer packing of grains. The precipitation of chlorite on grain surfaces helped in preserving some of the micro-porosity by preventing quartz cementation as overgrowth; however, well-developed quartz overgrowths do occur in some of the studied samples. The feldspars show partial to complete alteration to clay minerals and dissolution during diagenesis. The clay minerals identified with the help of SEM/EDX are illite and chlorite. The SEM studies reveal both rosettes and honey-comb like morphology of chlorite occurring as grain coating and pore filling cement. Dissolution of feldspars may be the possible source of chlorite formation. Authigenic illite is present in the studied samples with hair-like fibrous and ribbon crystal habit. A markedly greater abundance of illite in the vicinity of altered detrital grains of feldspar strongly suggests formation of illite by alteration of feldspar. Iron oxide/hydroxide cementation took place during telogenesis and led to reduction of primary porosity. Thin sections stained with blue epoxy were used to estimate the visual porosity of sandstone using point counting and SEM images. The estimated visual porosity values vary between 0.5 and 8%; averaging 5%. The primary porosity was reduced mainly by compaction and cementation however, grain fracturing, dissolution of framework grains and authigenic cements have produced secondary porosity to make the Tredian sandstone a potentially good reservoir rock.