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[PS] Integrated Petrographic-Stratigraphic Characterization of Complex Albian Reservoirs in the Espírito Santo Basin, Eastern Brazil*

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Abstract

In the northern onshore portion of the Espírito Santo Basin, eastern Brazil, fluvial and platform sandstones and shales of the Albian São Mateus Formation grade northward and towards offshore into shallow-marine carbonates of the Regência Formation. Three stratigraphic sequences were identified in these units, comprising six depositional cycles characterized by increase and decrease of fluvial channel amalgamation. Carbonate rocks display in general low porosities due to fine texture and intense recrystallization. In the southern, dominantly clastic area, reservoir quality and heterogeneity of the medium to very coarse, feldspathic fluvial sandstones were strongly impacted by diagenetic processes, involving mostly cementation and grain replacement by kaolinite, smectite, calcite, pyrite and sulfates, limited mechanical compaction and feldspar grain dissolution. Early calcite cementation was the most voluminous diagenetic product, especially at the base of the succession, where cemented levels constitute barriers to fluid flow. Smectitic clays coatings, rims and microcrystalline, intergranular and grain-replacement aggregates also reduced intensely the permeability. Fifteen reservoir petrofacies were recognized and related to five calibrated wireline log facies (evaporitic, carbonatic, smectitic, calcitic and paleosol), that allowed mapping reservoir quality across the area.

Statistical correlation analysis of the major petrographic parameters was carried out to unravel the patterns of major diagenetic processes, reservoir quality and heterogeneity distribution. The weak correlation between intergranular volume and porosity is due to the early, pre-compactional (even displacive) character of smectite and mostly calcite cementation. Calcite and smectite show complementary distribution, as calcite precipitation was inhibited in sandstones with more smectite, with retention of some porosity. The less permeable, basal interval is dominated by the calcitic log facies, while the more porous, upper interval is characterized by the smectitic log facies. There is a clear correlation between the distribution of kaolinite and micas, concentrated at finer-grained cycle tops, as well as with macroporosity, suggesting a preferential circulation of meteoric fluids. The characterization of these patterns and their spatial and stratigraphic distribution contribute to decrease the exploration risks and to optimize the production of these reservoirs.

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