



Distinguishing depositional from diagenetic facies: a crucial step towards understanding unconventional carbonate reservoirs like the complex Brazil Pre-Salt

Ana C. Azerêdo (1), Alexandre P. Silva (1,2), Luís V. Duarte (3), and M. Olho-Azul Martins (4)

(1) Universidade de Lisboa, Faculdade de Ciências, Departamento de Geologia and Instituto Dom Luiz, Lisboa, Portugal (acazeredo@fc.ul.pt), (2) Universidade Federal Fluminense, Niterói, Brasil, (3) Universidade de Coimbra, Faculdade de Ciências e Tecnologia, Departamento de Ciências da Terra and MARE, Coimbra, Portugal, (4) Petrogal Brasil

The complexity of carbonate reservoirs results from a range of factors, among which diagenesis stands out as a crucial one. Core and thin-section studies of some wells in the very unusual Brazilian Pre-Salt (PS) reservoirs allowed unravelling some critical factors and their interaction leading to the final sedimentological products, shedding light on the need to further address these issues beyond conventional knowledge. The marked heterogeneities existing at different scales in the studied carbonate units result from a complex combination of high-frequency variations of facies types and intricate mutual influence between depositional textures and multi-phased diagenesis. Diagenetic processes include dolomitization (common), dedolomitization, recrystallisation (common), silicification, compaction (uncommon), dissolution (intense) and fracturing (uncommon). Six main facies types (F), with a few subtypes, were identified and characterized in the studied wells of the PS: (F1) argillaceous limestone with incipient to marked lamination, whose laminae are mostly silty-argillaceous, some maybe microbial; (F2) limestone dominantly formed by in-situ bounded structures with a range of specific singular morphologies, sub-divided into: F2A, clearly laminated (planar, wavy, crenulated), namely stromatolitic fabric; F2B, shrubby columnar/tree-like/finger-like structures, either showing robust, ramified and well preserved framework or a fine, “lacy” and amalgamated/collapsed fragments; (F3) apparently intraclastic grainstones/packstones, whose clasts are interpreted mostly as in-situ to slightly collapsed/reworked remnants of F2 material, so are classified as diagenetic, not depositional grainstones; (F4) spherulitic grainstones/packstones; (F5) Intraclastic grainstones and packstones (locally rudstones) with heterogeneous, massive arrangement and common dark clasts; (F6) Oncoidal grainstones/rudstones and packstones/floatstones.

Subtle to clear transitions from the robust to finely lacy-structures of F2B were recognized, interpreted as gradual corrosional stages of the original facies; further development of the dissolution and spalling processes leads to a “ghost shrub framework” where the remnants appear as “clasts”, thus forming a residual fabric resembling a grain-supported one (F3). The interpretation of this case as presented here, together with other singularities of the Brazil PS facies also rise terminology/classification issues challenging previous nomenclature.

These results highlight the key role of detailed microscale analysis coupled with the macroscale core study, namely to avoid possible misunderstanding of, and hence distinction between depositional and diagenetic facies. Recognizing these phenomena has obvious implications in unravelling diagenetic pathways and in paleoenvironmental interpretation. Consequently, it may bear high relevance when predicting spatial distribution, porosity trends, rock-type patterns and quality of the PS singular reservoirs and may be useful in similar complex exploration/exploitation situations.

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