Diagenetic Patterns and Pore Space Distribution along a Platform to Outer-Shelf Transect (Urgonian Limestone, Barremian-Aptian, South-East France)*

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Abstract

An outcrop study based on high-resolution stratigraphical and sedimentological analyses of the Urgonian carbonate platform of the Monts-de-Vaucluse area (Late Barremian - Early Aptian) allows us to reconstruct a high-resolution stratigraphic architecture of the outer platform. The reservoir-scale stratigraphic anatomy and the diagenesis of a Barremian-Aptian carbonate platform (Mont-de-Vaucluse, South-East France) is based on 1) high-resolution measured sections in outcrops, 2) detailed microfacies analyses, 3) paleoenvironmental interpretations, 4) biostratigraphy, 5) sequence stratigraphic interpretations, 6) diagenetical and geochemical analyses.

Stratigraphic Heterogeneities

The Provence platform developed on the southern margin of the Vocontian Basin, which represents the western extent of the Alpine basin. In the Valanginian-Aptian interval, the development history of the Provence carbonate platform can be subdivided into three main stages of platform growth that are separated by drowning events. During the Early Aptian, the progradation of the Northern Provence Platform was asymmetric, significant to the north and limited to the south.

The platform succession consists of subtidal (mainly infralittoral) deposits with rare inter- to supratidal intercalations. The 2D architecture of the depositional sequences, geometries, thickness and facies variations within depositional systems tracts, and the morphology of the shelf reflect a strong interaction between tectonic processes, mainly differential subsidence, and sediment production.

The evolution of the various paleo-environments together with the development of the critical stratigraphic surfaces (emersion, erosion and drowning surfaces) allows the definition of five stratigraphic sequences (UB1, UB2, UB3, UB-LA, LA1, LA2 and MA) from Late Barremian to earliest Aptian times (Figure 1).

These depositional sequences can be grouped into two different and diachronous carbonate sedimentary systems: 1) Flat-topped platform with more or less inclined slope leading a) a flat-topped platform with no marked shelf break and very gentle slope (large bioclastic belt) and b) a flat-topped platform with steepening of outer shelf slope (reduced bioclastic belt) during Late Barremian and Early Aptian; 2) Mesotrophic ramp dominated by orbitolinids fine-grained facies, including an elongated high energy shoal with oolites during the two main episodes of drowning (latest Barremian and Mid Bedoulian).

Diagenesis of Porous Versus Tight Carbonates

Examination of petrographical characteristics (sediment texture, facies) and diagenesis (cement stratigraphy, porosity and isotope geochemistry) of more than 300 core plugs provides insight into the parameters controlling the genesis and preservation of microporous-dominated versus tight carbonate rocks, $\Phi<25\%$ (Figure 2).

Early cementation is interpreted to be one the main controlling factors of the preservation of microporosity units within the sediments of this carbonate platform. The distribution of the porosity, cement types and isotopes values highlight the strong relationship between porosity type (tight to microporous), early diagenesis and sequence stratigraphy.

First, tight limestones (high $\delta^{13}C$) are systematically situated just below a sequence boundary S2 and S3 (Figure 2). Second, microporous limestones are correlated to negative shift in $\delta^{13}C$. Finally, major sequence boundary S4 (regional emersion surface) is associated with high porosity and high negative peak of $\delta^{13}C$ (Figure 2).

Conclusions

An outcrop study based on high-resolution stratigraphical and sedimentological analyses of the Urgonian carbonate platform of the Monts-de-Vaucluse area (Late Barremian - Early Aptian) allows us to reconstruct a high-resolution stratigraphic architecture of the outer platform. Vertical and lateral compartimentalization of porous versus tight units exists within the platform and is related to early diagenesis associated with the major sequence boundaries. Early cementation (associated to sequence boundaries) seems to have influenced the preservation of tight / microporous units within the sediments of this carbonate platform. Petrographical, diagenetic and isotope geochemistry analyses of the Urgonian limestone established the link between pore type distributions, micrite diagenetic pattern and sequence stratigraphy in dominated-microporous carbonates reservoir analogues.

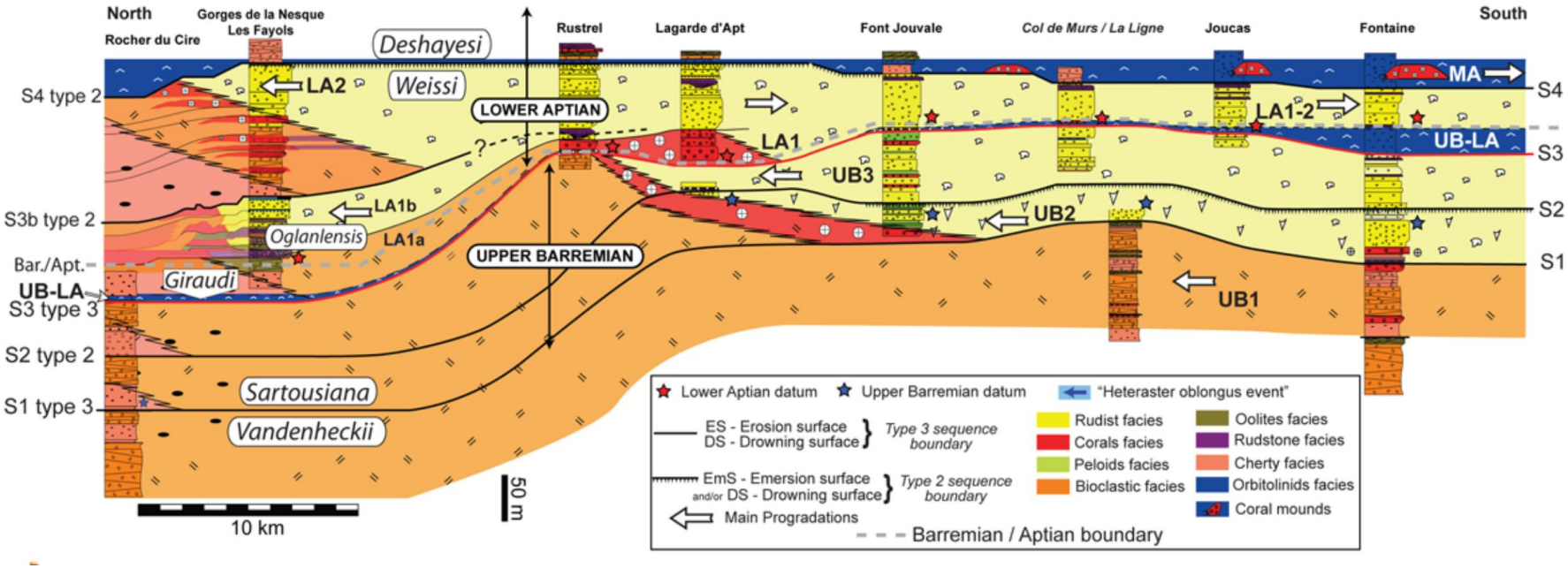

Figure 1. Reconstructed overall geometries, of the Upper Barremian - Lower Aptian of the Mont de Vaucluse area showing the different steps of northward progradation of the platform.

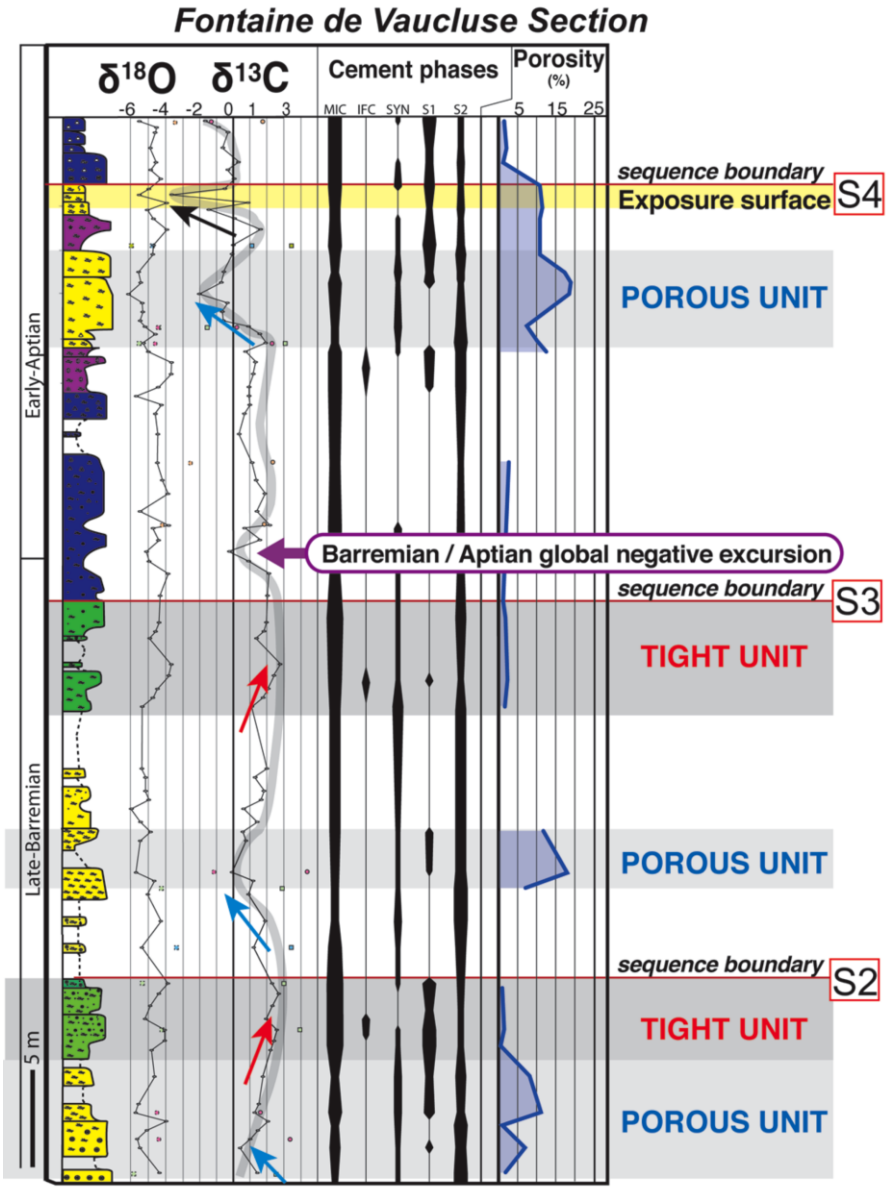

Figure 2. Sedimentological log, stable isotope ($\delta^{18}O$ and $\delta^{13}C$) values, semi-quantitative distribution of cement stages and porosity on Fontaine section, highlighting diagenetic patterns of tight versus porous units.