

# **Acoustic properties of microporous carbonate reservoirs: implication of micrite particle size and morphology. Example of the Late Jurassic limestones of the Paris Basin (France)**

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Micritic limestones exhibit large variation of (1) sedimentary texture from mudstone to packstone, (2) facies composition and (3) petrophysical properties (porosity, acoustic velocity). Those heterogeneities imply a complex distribution of fluid flow properties and a complex petrophysical signature. In the Eastern Paris Basin, Late Jurassic micritic carbonate deposits constitute a main aquifer located directly above the Callovian-Oxfordian clay-rich formation studied by the French National Radioactive Waste Management Agency (Andra) as a potential host rock for a deep geological disposal of high level radioactive wastes. A precise understanding of the factors controlling the petrophysical properties within carbonate aquifers is thus essential for rock-typing studies and fluid flow modelling. The first objective of this study is to better characterize the vertical distribution of both petrographical characteristics (texture, facies and composition) and petrophysical properties (porosity, permeability and acoustic velocity) on about 100 plugs sampling along 230 m of cores in well EST205, located at the top of the Underground Research Laboratory at Bure, France. The secondary aim is to better understand the influence of micrite type and grain to grain contact on acoustic velocity-porosity relationships by a rock typing approach.

Microfacies observations reveal 7 facies, which can be grouped into 4 facies associations ranging from upper offshore to supratidal environments. Those facies are stacked into 7 third-order depositional sequences. Most of the samples are (1) oncoid-peloid packstones (45 samples, n=45) and (2) bioclastic wackestones (n=25), both deposited in low energy environmental settings. Oolitic grainstone facies are not well-developed in these limestones (n=14) and macroporosity is absent. SEM observations reveal 3 micrite particle types both in matrix and clasts. (1) Fine (~ 1 µm) rounded micrites with very punctate inter-crystalline contacts, (2) Fine to coarse (1 µm ? 2 µm) subrounded micrite particles with partially coalescent contacts and (3) coarse (> 2 µm) anhedral crystals with sutured contacts (mostly indistinct) forming a dense and fused matrix. Types 1 and 2 are observed in porous levels (15 - 25% porosity) and display low to moderate P-wave velocities (3000 to 4500 m/s) whereas type 3 is observed in very low to non-porous units (

The micritic particle types allow us to define 3 typical class or 3 «acoustic fabrics» on a porosity-velocity diagram, demonstrating a clear influence of micrite size and morphology on acoustic and porosity properties. The origin and development of such micritic matrixes is related to porosity creation by mineralogical stabilisation of carbonates through freshwater-related diagenesis. In the Oxfordian, such a relationship between porous horizons and exposures also exists. Indeed, porous levels are located in inner ramp low energy facies below sequence boundaries, where exposure evidences are abundant and widespread from the Andra laboratory to local outcrop section.