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Estimates of chemical compaction and maximum burial depth from bedding parallel stylolites

Marta Gasparrini (1), Nicolas Beaudoin (2), Olivier Lacombe (3), Marie-Eleonore David (4), Souhail Youssef (5), and Daniel Koehn (6)

(1) IFP Energies Nouvelles, Rueil, France (marta.gasparrini@ifpen.fr), (2) University of Glasgow, UK (nicolas.beaudoin@glasgow.ac.uk), (3) Université Pierre et Marie Curie - UPMC, Institut des Sciences de la Terre de Paris - ISTeP, CNRS UMR 7193, Paris Cedex 05, France (olivier.lacombe@upmc.fr), (4) Université Pierre et Marie Curie - UPMC, Institut des Sciences de la Terre de Paris - ISTeP, CNRS UMR 7193, Paris Cedex 05, France, (5) IFP Energies Nouvelles, Rueil, France, (6) University of Glasgow, UK

Chemical compaction is a diagenetic process affecting sedimentary series during burial that develops rough dissolution surfaces named Bedding Parallel Stylolites (BPS). BPS are related to the dissolution of important rock volumes and can lead to porosity reduction around them due to post-dissolution cementation. Our understanding of the effect of chemical compaction on rock volume and porosity evolution during basin burial is however too tight yet to be fully taken into account in basin models and thermal or fluid-flow simulations.

This contribution presents a novel and multidisciplinary approach to quantify chemical compaction and to estimate maximum paleodepth of burial, applied to the Dogger carbonate reservoirs from the Paris Basin sub-surface. This succession experienced a relatively simple burial history (nearly continuous burial from Upper Jurassic to Upper Cretaceous, followed by a main uplift phase), and mainly underwent normal overburden (inducing development of BPS), escaping major tectonic stress episodes. We considered one core from the depocentre and one from the eastern margin of the basin in the same stratigraphic interval (Bathonian Sup. – Callovian Inf.; restricted lagoonal setting), and analysed the macro- and micro-facies to distinguish five main depositional environments. Type and abundance of BPS were continuously recorded along the logs and treated statistically to obtain preliminary rules relying the occurrence of the BPS as a function of the contrasting facies and burial histories. The treatment of high resolution 2D images allowed the identification and separation of the BPS to evaluate total stylolitization density and insoluble thickness as an indirect measure of the dissolved volume, with respect to the morphology of the BPS considered. Based on the morphology of the BPS roughness, we used roughness signal analysis method to reconstruct the vertical paleo-stress (paleo-depth) recorded by the BPS during chemical compaction.

The comparison between amount of compaction and dissolved volume as a function of the macro- and micro-facies, as well as estimates of maximum paleodepth of burial, deepen our knowledge of the factors controlling BPS development, the total thickness of carbonate dissolved and the occurrence of induced cementation in sedimentary basins.