Unravelling the geology beneath the Meso-Cenozoic sedimentary cover of the intracratonic Paris Basin -Part 2: geological mapping of the buried Variscan basement combining aeromagnetic, gravity and petrophysical data

Julien Baptiste, Guillaume Martelet, Michel Faure, Laurent Beccaletto, Yan Chen, Pierre-Alexandre Reninger

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Baptiste, J.[1], Martelet, G.[1], Faure M.[2], Beccaletto, L.[1], Chen, Y.[2], and Reninger, P-A[1].

[1] BRGM - French Geological Survey, Orléans, France. l.beccaletto@brgm.fr
[2] Institut des Sciences de la Terre, Université d'Orléans, Campus Géosciences, France

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Under large basins, deciphering the geometries (structure and nature) of the buried basement is a key for targeting resources (such as fossil and geothermal energy) and, on a scientific perspective, for better understanding of the tectonic evolution of an ancient mountain belt. Potential field data (aeromagnetic and gravity) have proven to be among the most effective methods for mapping a deeply buried basin/basement interface. However, their interpretation generally suffers from ambiguities, due to the non-uniqueness of the gravity and magnetic signatures. Here, we tie the gravity/magnetic signatures on a detailed petrophysical characterization of the units outcropping around the basin. This methodology is demonstrated to investigate the lithology and structure of a hidden Variscan substratum in the southwestern part of the Paris Basin, at the junction between the Armorican Massif and Massif Central to the northwest and the southeast, respectively.

We propose an approach based on the combination of potential field data, magnetic susceptibilities measured in the field with a hand-held susceptibility meter, density values of sample rocks, and information documented in boreholes, in order to propose a new interpretative geological map of the buried basement. Rock properties measured on sample picked up from the field are compiled and organized in order to highlight the variations of petrophysical signatures within geological sub-domains. This petrophysical description is combined with a first-order geophysical pattern of the substratum lithology mapped through statistical unsupervised classification of suitably selected gravity and magnetic maps (Figure 1). The first step of interpretation consists in extending the major structures outcropping in the Armorican massif and the Massif Central, below the Mesozoic sedimentary cover of the Paris Basin. The geological sub-domains in between these major structures are then interpreted separately. The second step, within each sub-domain, consists in assigning a lithology with respect to its density/magnetization (as derived from the petrophysical compilation), in order to propose an interpretative geological map of the Pre-Mesozoic infilling of Paris Basin, supported by punctual borehole information.

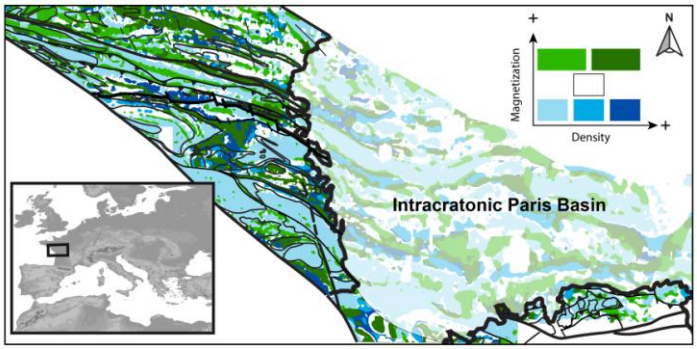

Figure 1 - Synthetic classified map of the geophysical signatures of the Paris Basin substratum (into 6 classes represented by the 6 colors)

Overall, with a special emphasis on relating geophysical signatures and petrophysical characteristics of geological units, our approach allows structural and lithological delineation of a segment of buried substratum. In the southwest of the Paris Basin, this reveals the architecture of the Variscan substratum, with an unprecedented resolution.