Unravelling the geology beneath the Meso-Cenozoic sedimentary cover of the intracratonic Paris Basin -Part 3: using seismic data to decipher the structural evolution and sedimentary record of the Stephano-Permian basins

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Stephanian to Permian post-orogenic basins (SPB) outcrop in several limited locations in and around the present-day French Variscan basement. Little is known about their subsurface occurrences under the post-depositional sedimentary cover. Our work intends to decipher the structural evolution of the hidden SPB in the south-western Paris Basin, where only a few regional studies have aimed to determine their location beneath the Mesozoic sedimentary cover.

Our approach is based on the reprocessing and interpretation of 36 seismic lines (1480 km) acquired by the oil industry in the 1980s. We first obtain a comprehensive view of the geometry of the SPB (Figure 1), based on (i) the interpretation of the base of the Stephano-Permian surface (lower limit) and the erosional base of the surface of the Triassic layers (upper limit) and (ii) the recognition of specific internal geometries and seismic facies. The interpreted faults are grouped into different categories according to their period of activity, with a focus on synsedimentary faults related to thickness variations of the Stephano-Permian deposits.

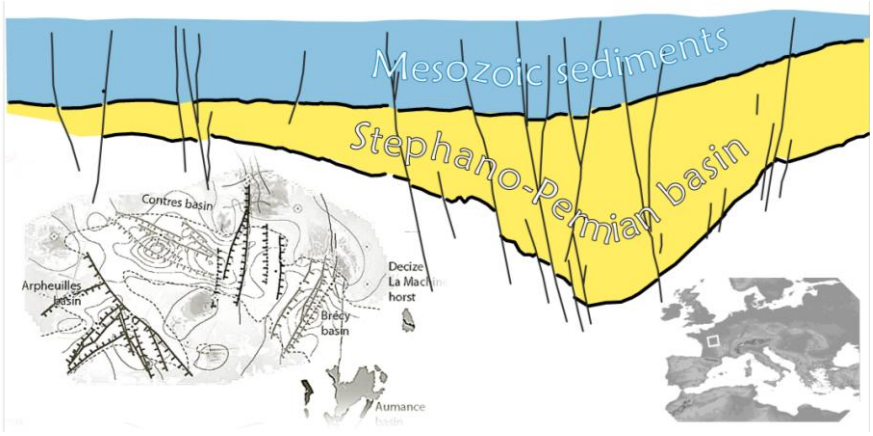

Figure 1 - The Stephano-Permian basins beneath the Mesozoic sediments of the intracratonic Paris Basin

We then propose a structural scheme containing faults that were active during the Stephano-Permian period, in relation to the late-Variscan structural scheme. Based on the seismic interpretation, thickness maps are calculated both in time and in meters, allowing a pseudo-3D view of the three identified SPB (Contres, Brécy and Arpheuilles basins) with thicknesses up to 3000 m; these maps indicate that the preserved extents and thicknesses of the basins in the subsurface are systematically greater than those observed at outcrop.

Finally, we show that the SPB were filled during two different tectonic phases: (i) an initial period of opening of the Arpheuilles, Contres and Brécy basins, during which Stephanian conglomeratic/coal facies were deposited under a strong structural control (normal faulting with certainly a strike-slip component, wedge-shaped geometry of the sediments); (ii) a consecutive pre-Triassic tectonic activity, at the origin of a significant part of the sedimentary filling of the basins; this vertical uplift may have reached 2000 m.

Our study shows that these geological objects still have much to teach us about the transition from the Paleozoic Variscan cycle to the Mesozoic Alpine cycle - not to mention their industrial applications, which were the initial motivation for studying them.