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3D geometry and kinematics of the Northern Variscan Thrust Front in Northern France: new insights based on reprocessing and interpretation of seismic reflection profiles.

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In NW Europe, the Upper Carboniferous Variscan collision between Avalonia and the Armorica-Gondwana accretion complex led to the progressive tectonic inversion of the southern Avalonian margin and the development of a crustal-scale north-vergent thrust system propagating outward from the Late Mississippian to the Middle Pennsylvanian (330-305 Ma). The northern Variscan thrust front spreads over 2,000 km across NW Europe. In the Nord-Pas-de-Calais (NPC) coal district area (northern France), its 3D geometry and kinematics have been investigated through the reprocessing and interpretation of 532 km in length of industrial seismic reflection profiles acquired in the 1980s. The seismic interpretations point out the major compressional and extensional tectonic features affecting this fossil, deeply eroded, mountain front, highlighting its very atypical structure and kinematics.

The deformation front is characterized by a main frontal thrust zone localizing most of the northward displacement (i.e. several tens of kilometers) of the Ardennes Allochthonous Unit above the slightly-deformed part of the Avalonian margin, referred to as the Brabant Para-autochthonous Unit. This large displacement induced the underthrusting of the molassic foreland basin (NPC coal basin) over nearly 20 km and was associated to the out-of-sequence dislocation of the mountain front. The underthrust Brabant Para-autochthonous Unit, made of both the Namurian-Westphalian (330-305 Ma) molassic foreland basin and the underlying Mid-Upper Devonian (390-360 Ma) and Dinantian (360-330 Ma) carbonate platform, is deformed by a series of second-order north-vergent thrust faults, often associated with ramp-related folds. These thrust faults are rooted in décollement zones located either at the transition between the Namurian shales and the Dinantian carbonates or in the Famennian shales.

The 3D integration of the seismic interpretations led to the characterization of a major lateral ramp oriented NW-SE, affecting both the main frontal thrust zone and the basal thrust of some Overturned Thrust Sheets developed at its footwall. This lateral ramp represents a major zone of relay along the thrust front, in between two major segments, oriented respectively ENE-WSW to the east and WNW-ESE to the west. At the base of the underthrust Brabant Para-autochthonous

Unit, the Mid-Upper Devonian platform is shown to be structured by synsedimentary normal faults responsible for the southward deepening and thickening of the southern Avalonian margin. These faults are oriented along two main directions i.e. N060-080° and N110-130°, that is the general orientation of the future Variscan structures. Overall, the results indicate that the Devonian pre-structuration of the southern Avalonian margin exerted a primary control on the dynamics and segmentation of the Northern Variscan Front in northern France by localizing both the frontal and lateral ramps within the thrust wedge.