Subsurface Geological Insights from Deep Boreholes in the Framework of the Einstein Telescope Feasibility Study (Belgium–Netherlands–Germany border)

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Résumé

The Einstein Telescope (ET) is a proposed third-generation gravitational wave observatory designed to detect spacetime distortions with unprecedented sensitivity. Its operation requires an exceptionally quiet and stable underground environment, prompting extensive subsurface investigations at candidate sites across Europe. As part of the technical feasibility assessment for a proposed ET site near the Belgium–Netherlands–Germany border, thirteen deep boreholes-each approximately 400 meters-were drilled to characterize the local geological and geotechnical conditions.
Core logging and structural analyses reveal a subsurface dominantly composed of Famennian and Namurian sedimentary rocks. Borehole televiewer (BHTV) data provide critical insight into structural orientations, highlighting a predominant N70∘E structural grain. At borehole scale, macrostructural analysis of tectonic blocks suggests thrust and back-thrust fault systems aligned with this structural trend. Mesostructural observations show evidence of sediments ductile to ductile-brittle deformation with dominant reverse kinematics. The ductile character of deformation is interpreted as fluid saturated deformation conditions in yet not fully consolidated sediments.

Brittle features such as joints and faults, and crushed zones, locally disturb the overall structural continuity.
These findings have direct implications for the understanding of the regional Variscan suture geometry and timing in this poorly known area at the border of the three countries. The integration of geological, structural, and geotechnical data from these boreholes contributes valuable constraints on the tectonic evolution of the area and informs the site's suitability for the Einstein Telescope infrastructure.

Mots-Clés: Einstein Telescope, Variscan, Tectonics, Boreholes, Sediment, Deformation

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