The origin of gravity anomalies in zones of folded orogens is connected mainly with thick under-compacted sedimentary series that fill deep basement depressions. The other source of gravity anomalies in the study area is a low-density zone in the upper mantle (Bojdys and Lemberger 1986). The qualitative analysis of residual gravity anomalies computed for selected depth intervals enabled extreme zones of horizontal gradients connected with vertical or steep density boundaries to be evaluated. Such gradient zones are probably related with tectonic contacts.

Based on the above mentioned results of magnetotelluric and gravity data interpretation, a spatial model of the basement was constructed. The model includes a structural map of the top of the Precambrian basement related to main regional resistivity boundary, a structural map of the top of Mesozoic and Paleozoic basement and major tectonic zones. The map of refraction horizon related to the top of sub-Paleogene basement was also used in model construction.

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Application of Paleomagnetic Methods for the Tectonic Study of Northern Variscan Thrust Front

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Paleomagnetic study has been carried out within a 150 km long segment of the Variscan external fold–and–thrust belt of N France and S Belgium. Main target was about its tectonic development and particularly the origin of its curved shape. The carbonate rocks have been sampled in numerous locations in the Ardennes Massif. The sites have been localized along the fold-belt at the similar distance from its front in order to compare the paleomagnetic records from the tectonic structures characterized by different orientations of the fold axes but with a same age of deformations. Some others carbonate sites has been spotted inside specific tectonic structures in single outcrop (Bettrechies) in order to compare relative age of deformation and remanence acquisition. The sandstones have been collected in the Ardennes and in the Artois Massif. In the Ardennes the sites containing sandstones have been located both in the middle part of the thrust-belt and in its marginal part.

Within magnetite and pyrrhotite bearing Devonian and Carboniferous carbonates, two secondary components were evidenced. Inclination-only tests indicate the synfolding origin of both components: the high temperature component (HT) was acquired during the early stage of deformation while the low temperature component (LT) appears during the late stage. Results from Bettrechies enable to correlate diagenesis events with remagnetizations episodes and progressive folding. Outcomes obtained for the Lower Devonian reddish sandstones indicate presence of a hematite carrier and syn- or post-folding magnetization, depending on the sampling site location.

Paleomagnetic directions from the carbonates display dependence on the local tectonic trend. Declinations of the HT component are similar to the directions known for Laurussia in regions of NE-SW orientation of the fold axis. Conversely, ar-

eas characterized by E-W to WNW-ESE structural trends show declinations rotated clockwise. Declinations show a correlation with the structural trend for both HT and LT components, but in the case of the LT component the magnitude of the declinations deviation is smaller. Results from the sandstones confirm the presented outcomes and additionally prove the heterochronic age of the deformations that differ between the marginal and the internal zone of the fold–and–thrust belt.

The presented declination data support only local oroclinal bending which give rise to the strike deviations in the thrust-belt. In the Ardennes clockwise rotations of the thrust occurred only within narrow transpressive zones, active during the propagation of the thrusts. It is also suggested that the long segment of WNW-ESE trending thrust-belt, that includes the Massive Artois, represents the oblique transfer zone between the Ardenno-Rhenish and SW England frontal belts.

Mechanics of Large-Scale Sand Injection – Understanding the Hamsun Giant Sand Injectite Complex

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Sandstone intrusions (injectites) are intriguing features as, despite their widespread occurrence, their origin is poorly constrained. The lack of process understanding poses a challenge to anyone dealing with post-depositional sediment remobilization. The formation of large-scale sand injectites has been attributed to various factors and processes such as: overpressure build-up, fracture propagation, fluidization, etc. Overpressure build-up can be caused by a variety of mechanisms such as disequilibrium compaction, loading by mass transport deposits, earthquakes, bolide impacts, or injection of fluids external to the sand body, such as, for example, hydrocarbons. Fractures start to propagate when pore-fluid pressure in a sand body exceeds the vertical or horizontal stress and the tensile strength of the host rock. Pressure-differential forces sediments to flow and fill fractures in the host rock. Depending on pressure conditions in the source bed and the seal and on the rheological properties of the host rock, sand injectites may form a range of geometries.

Clastic injectites occurring in the form of sills or dykes have been described for many decades. The size of clastic intrusions varies on a scale from sub centimetre to hundreds of metres. Recently, they have been recognized not only in outcrops but also on seismic data. A spectacular example is the Hamsun giant sand injectite complex that is located in the Paleogene of the North Sea. This complex is believed to be world's first sand injectite that was deliberately (and successfully) drilled by Marathon Oil UK as a hydrocarbon prospect, adding several tens of millions of barrels of oil to their Alvheim development. The Hamsun complex is sourced from the Hermod sand which occurs in Sele Formation and is believed to be of early Eocene age. The injectite complex was investigated by means of multi-volume-based 3D seismic interpretation and visualization in order to gain detailed characterization of the complex body. Overall shape of the body was analyzed, including its thicknesses, angles, depths, heights and relation to faults. Borehole core from two locations along the injectite were examined and constitute the ground truthing of the 'remote sensing' 3D seismic datasets. The investigations enabled drawing some conclusions about the Hamsun complex, like for example multi – phase injection.

Sand injectites are currently the subject of a concerted research effort at the University of Aberdeen, drawing on data from key outcrop analogues and selected sand injectite oil fields to catalogue the range of injectite styles, grain size variations, geometries and sizes, in order to establish genetic models and assist in reservoir modelling of sand injectite oil fields.

Record of Motion Along the Red River Fault Zone in Provenence Studies, Northern Vietnam

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Provenance studies and, clast analysis in particular, are a valuable source of information on timing of uplift and denudation in source area. These studies may also document motion of a source area for basins related to strike-slip faulting. In this paper we present first results of clasts analysis from sedimentary basins adjoining the Red River Fault Zone (RRFZ) in Northern Vietnam.