

## The Scandian folds on the Paleozoic sedimentary cover of Estonia

Y.J. SYSTRA

*Department of Mining, Tallinn University of Technology,  
Ehitajate tee 5, 19086, Tallinn, ESTONIA  
(ulo.sostra@ttu.ee)*

The Scandian orogenic event from Cambrian to Silurian is studied in Estonia. Folding of the sedimentary rocks usually occur in the sequences, where harder rocks alternate with softer layers. Several folds and faults have been documented in the oil shale deposit, in underground mines and surface quarries. The density of pure oil shale is 1450–1680 kg/m<sup>3</sup>, but in limestone layers with some kerogen the densities vary between 2160–2410 kg/m<sup>3</sup>. The oil shale layers with limestone nodules have densities between limestone and oil shale. One anticlinal fold is studied in the Cambrian bedrock in the Tallinn city near the SE shore of the Kopli Bay. The axial plane of the fold and related faults indicate the orientation of regional pressure. In this anticline axial plane the orientation is to NE 65°, inclined to SE at angle 82°. It means that pressure came from NW 335° and the lower layers moved faster than the upper layers. Three subhorizontal drag folds up to 30–40 cm long were found in the aleorolite layers, which proves horizontal movement of the layers.

Numerous folds, faults and karst zones are documented in the Estonian oil shale deposit. Recent studies in the Põhja-Kiviõli near surface quarry gave new data about folds and folding in the oil shale. In the centre of the quarry the first Sonda deformed zone with width about 205 m was observed, containing 10 uplifted anti-clines with synclines between. As a rule the synclines do not have fault zones and the anticlines have a karst clay with thickness of 0.5–5.0 m. Their upper parts are turned 160° SE, the pressure at folding being from NW. Some hydrothermal minerals like calcite, dolomite, marcasite, pyrite, galenite were found in one of the anti-cline. It proved the age of the Scandian event here. The main observation is that most synclines are very wide and do not have faults, but all anticlines have faults with karst clay fillings. Typically the synclines lie on the Middle Ordovician hard limestones and the anticlines formed in soft seam on the oil shale.

In 2008-2014 the first folds in the Silurian Llandovery series of the central Estonia were found. In the quarries of Otisaare, Koigi and Sopimetsa dipping of the carbonates is often up to 6–10°. The typical inclination of undeformed bedrock of Cambrian, Ordovician and Silurian is 3 m per one km or 0.1–0.2°. The folds may be single with a width of 25–30 m or open wide folds, some hundred meters long on the quarries walls, where the flat anti-clines and synclines alternate. The axial plane orientations are near NE 60° and may be with open faults with karst clay fillings.

All studied structures have very similar pressure orientation and moving direction, the main pressure being from NW to SE, the axial planes of the folds turning to NE 50–65°. The uplifted Precambrian basement on the Valmiera–Mõniste–Lokno zone belongs most likely also to the Scandian event.

The last Middle and Upper Devonian epochs of Estonian geology and tectonics began after the Late Silurian and Lower Devonian break in sedimentation.

*The study is funded by Estonian Scientific Foundation grant No 8999.*