RECONSTRUCTING THE CALEDONIAN STRUCTURAL COMPLEX DEFORMATION THROUGH THICKNESS ANALYSIS

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ABSTRACT

The major issue that we address in this study is to interpret the deformationthat occurred in Early Paleozoic time known as Caledonian tectonic event which compared to other tectonic events had most significant impact. Theoretical material have been collected and analyzed from previous studies during this research, as well as considerable published material have been gathered about tectonic structures within Latvia territory. Based on these data, rough resolution 3D geological tectonic block model is developed. Although previously many geophysical researches has been carried out by Geological Survey, studies offer insight of structures in general but does not determine their kinematics or possible evolution except some local scale structures (Brangulis & Kaņevs, 2002).

MATERIALS AND METHODS

To reach the aim MOSYS modeling system was used for the geological structure modeling, developed within the PUMA project (Seņņikovs et al, 2011). Algorithmic genetic approach was applied to interpolate data of well logs as strata volume and sequentially to reconstruct the post-deformation situation. This approach allows modifying model construction in any step and all processes are fully documented and are repeatable. To establish the model only data of well logs and fault settings was used. Overall about 5000 well logs were taken into account but fault data were taken from previously published tectonic maps in 1 : 500 000 scale issued by State Geology Survey. Fault orientation was done by extracting data by Direction Mean function in *ArcGis* software and further processed and visualized in *RockWorks*.

RESULTS

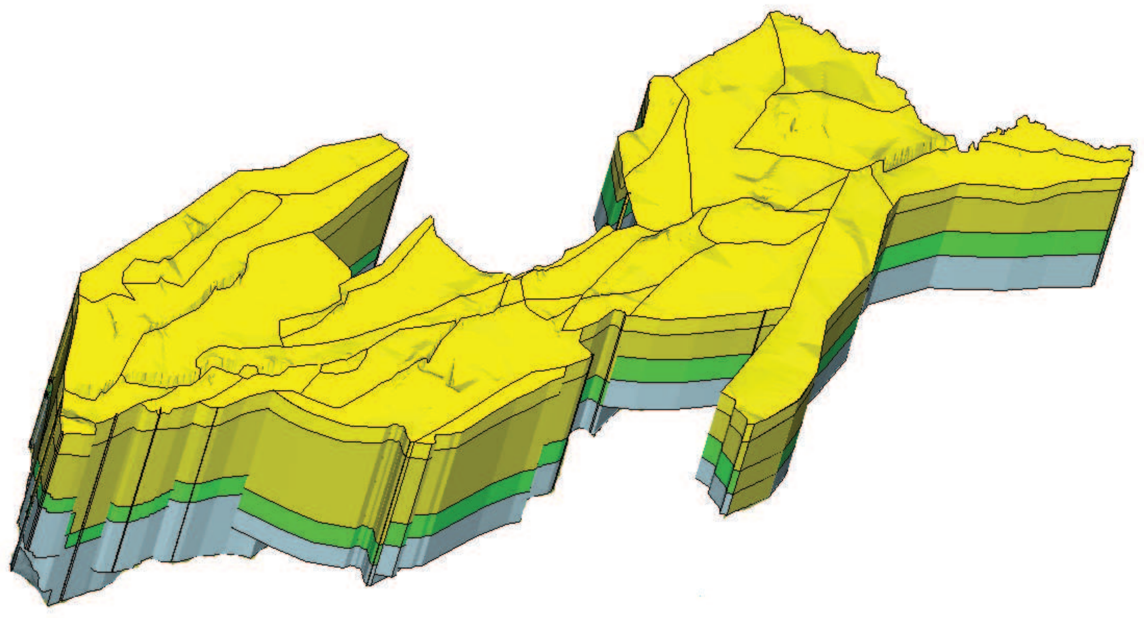

Figure 1. Block-type model 3D view.

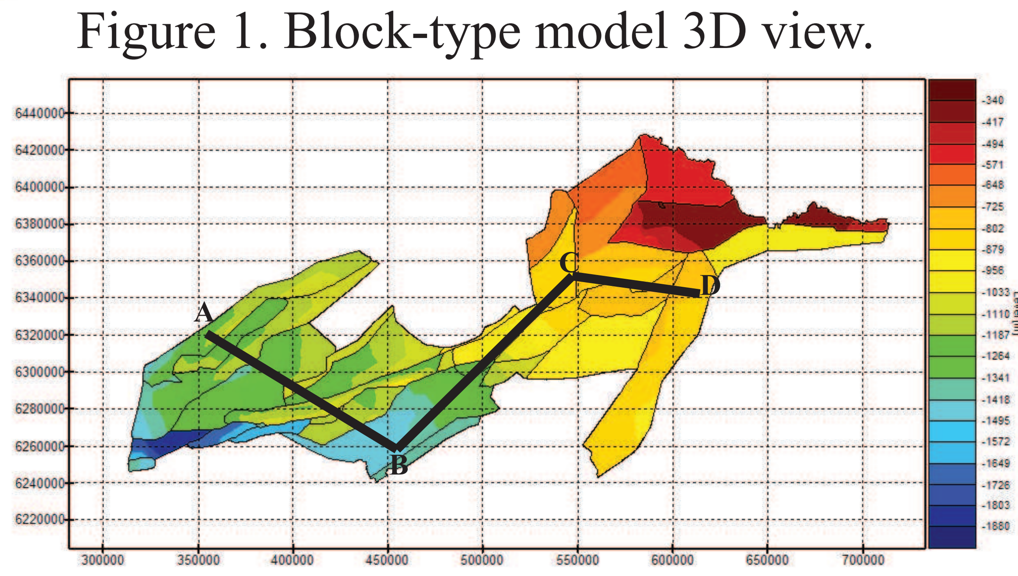

Figure 2. Crystalline basement surface of 3D model.

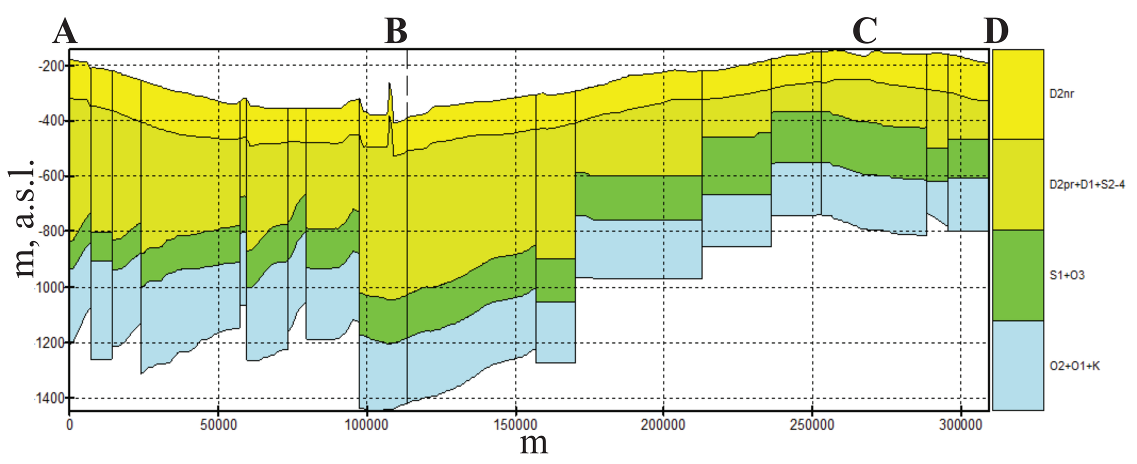

Figure 3. Model cross-section along A-B-C-D (setting showed at Fig. 2).

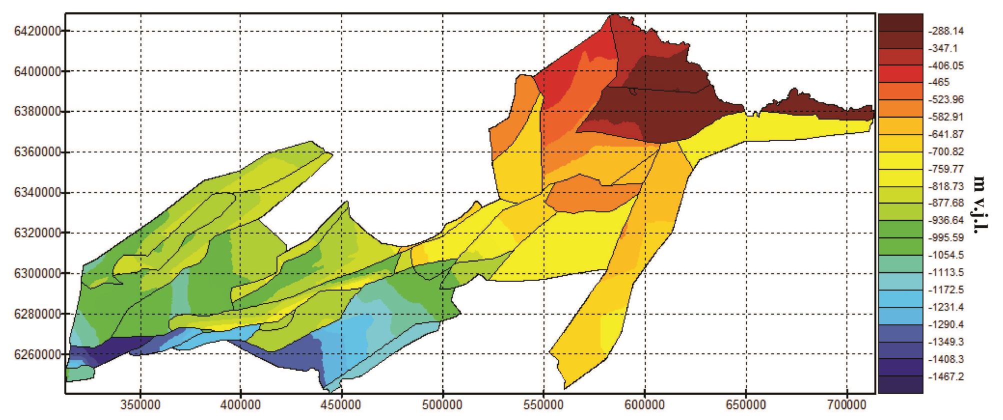

Figure 4. Surface of Middle Ordovician.

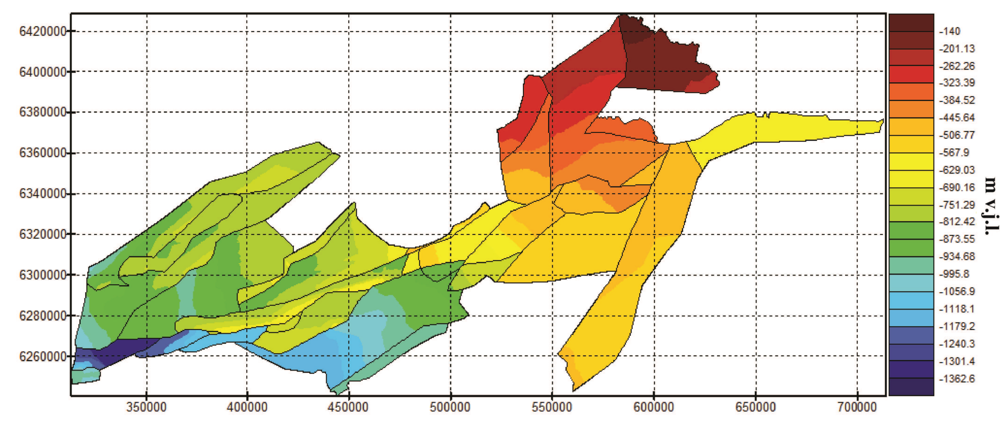

Figure 5. Surface of Llandovery.

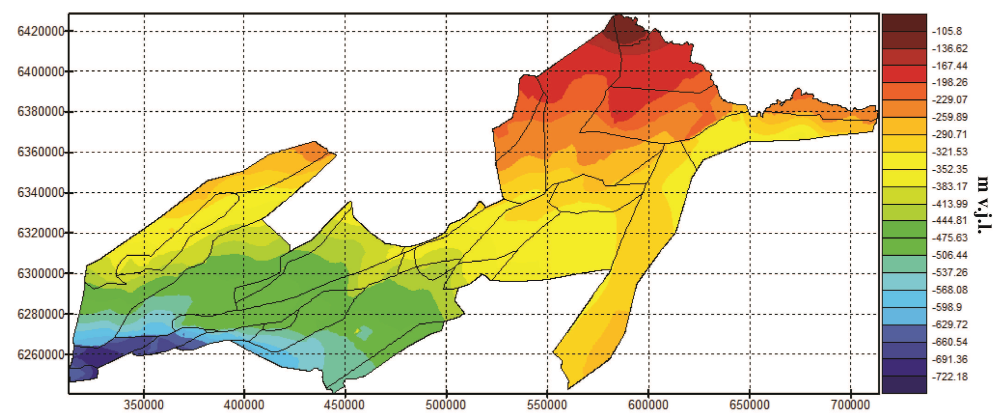

Figure 6. Surface of D_2pr.

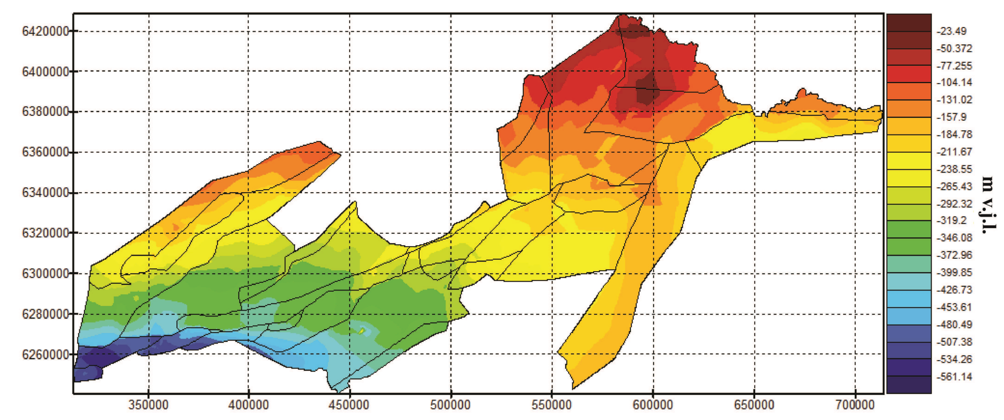

Figure 7. Surface of D_2nr.

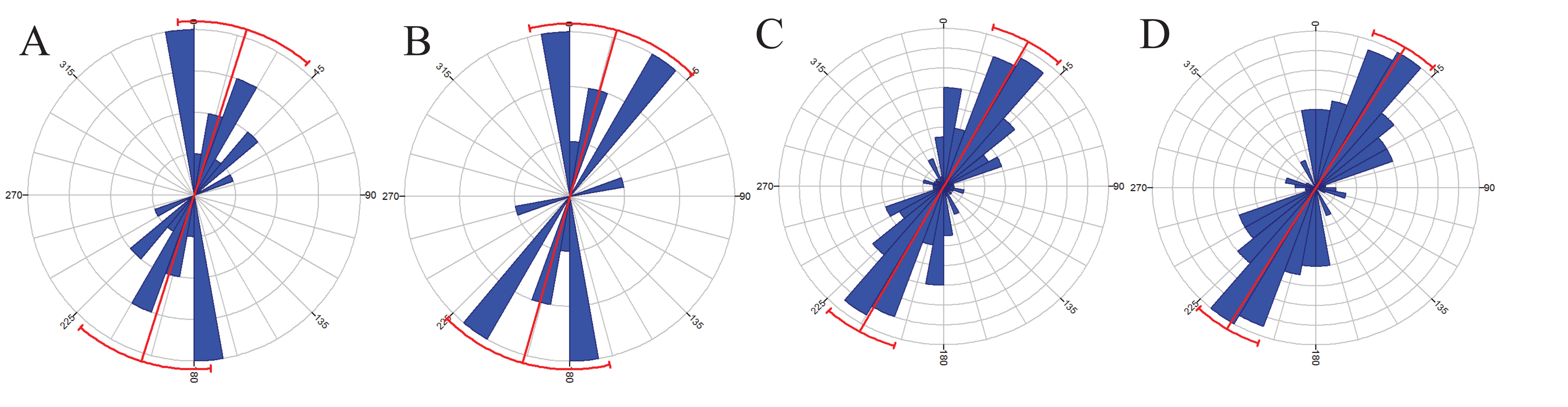

Figure 8. Orientation of faults in D_3am (**A**), D_2pr series (**B**), Ordovician (**C**) and Crystalline basment (**D**).

Structure of rough-resolution 3D block-type model consists of 269190 mesh points and 4 layers which are divided in 33 tectonic blocks bordered by the faults which were distributed by interpreting displacement amount of the blocks along the faults providing an opportunity to characterize common tectonic evolution. To gain general notions and to control reconstruction also Hercynian complex was taken into account and middle Devonian series also were included.

Taken from structual maps 139 fault data was used to construct rose diagrams. Both complexes slightly differ but one complex borders data shows high compatibility but in general faults are oriented in SW - NE direction.

DISCUSSION / CONCLUSIONS

As research this is first attempt to characterize deformation structures altogether by rough resolution 3D geometrical model and through thickness analysis. This methodology allowed to reach good model strata surfaces and well logs compatibility which was no larger than 3 meters and indicated that model is reliable for strata analyses. Although research data is sparse and dip angles of fault structures are unknown and fault planes in model are vertical, it still indicates major characteristic of deformation and strata thickness changes which for insight as preliminary study in tectonic evolution is enough to draw first major conclusions.

Thickness analysis was done to determine tectonic events which lead to define uplift or sinking events by comparing volume in each tectonic block and eroded amount of strata. This method showed that the smallest strata thickness change is in Ordovician and Llandovery, Wenlock epochs of Silurian but the largest changes of strata thickness and erosion has occurred at the end of Silurian and in the Early Devonian.

Established model showed that commonly surface level of tectonic block is increasing SE what joined with orientation of fault data indicates deformation under compressive regime. By determining direction mean of fault structures was possible to define main stress orientation (NW – SE) and both thickness changes and erosion shows that processes occurred very rapidly and it was major thrusting at Calodenian event and should be linked to Scandian orogeny.

References

1. Brangulis, A.J. & Kaņevs, S. 2002. Tectonics of Latvia. Riga, State Geology Survey (in Latvian).
2. Juris Sennikovs, Janis Virbulis, and Uldis Bethers 2011. Mathematical model of the Baltic artesian basin. Geophysical Research Abstracts, Vol. 13, EGU2011-8155, EGU General Assembly 2011

This Project was supported by ESF project „Establishment of interdisciplinary scientist group and modeling system for Groundwater research” (Project Nr. 2009/0212/1DP/1.1.1.2.0/APIA/VIAA/060).