Fault tectonics of the Ukrainian Carpathian foredeep and its basement

Andrij Bubniak¹ & Ihor Bubniak¹

¹Institute of Geology and Geochemistry of Fuels NAS, Lviv, Ukraine

The development of the fault tectonics of the Ukrainian Carpathian Foredeep (UCF) and its basement from the passive continental margin to neotectonic stage is discussed. The investigations are based on the geophysical data, well sections, subcrop maps, the maps of thickness of Jurassic, Cretaceous and Miocene deposits. By the study of paleostresses that caused the fault formation we have used their kinematic characteristics. It was created the charts of Δd across several profiles to determine the synsedimentary character of fault development. Neotectonic investigations of the UCF were carried out for the study of the influence of active fault structures on relief forming processes. Among them are the creation of relief maps, the maps of neotectonic elevation measuring the strike of linear stream system on topographic maps.

The results of the investigations mentioned above are: On the stage of passive continental margin the faults of the UCF developed as synsedimentary central faults. This is suggested by the thickness changes of the contemporaneous deposits in hanging and footwalls of the faults. The changes of the thickness of Jurassic and Cretaceous deposits along strike of the Ukrainian Carpathian Foredeep indicate the existence of three segments within basement: NW, central and SE ones. These segments different had geological history. On the stage of the transition from passive continental margin to the foredeep some of the faults of the UCF acted post-tectonic. These peculiarities of the fault development were distinguished by the analysis of Δd charts.

The forming of the Miocene faults is connected with the development of the UCF. Some of the faults are inherited from previous stages. The Miocene faults are characterized as synsedimentary once. Their amplitudes increase toward the Carpathians. The main forces that caused the fault formation are shown on the base of the plane dips and strikes of the faults and movement directions along them.

The main plane of the extension dips to the west under 70°-80°. These faults are probably connected with development of the retreating subduction zone in studied area. The reflection of thrust nappes and strike-slip faults in relief is typical for the neotectonic stage. This is visible on ΔH maps, neotectonic amplitude map and on the map of the strike of linear stream systems. The activity of faults (thrusts) decreases toward the foredeep. The most active was the NW segment of the UCF. The UCF consists of two parts: outer-autoclinal and inner — alloclinal ones which have different fault history. In the outer zone faults are inherited from the basement while thrusts and strike-slip faults are newly formed.

Structural evolution of the NE part of Hungary

László Csontos¹ & Kinga Hips¹

¹Geological Department, ELTE University of Budapest, Múzeum krt 4/a, 1088 Budapest, Hungary

Three Mesozoic structural units are exposed in N Hungary: the lowermost Torna-Bükk unit, the overriding oceanic Meliata-Szárvaskő unit, and the topmost Szilice-Bődva unit. These are covered by Tertiary strata. We were mainly interested in the structural evolution of the Mesozoic units, because Tertiary strata have already been investigated. We measured structural elements in main outcrops, caves and quarries near the Hungarian/Slovakian border. Dating of the structures is relative and questionable.

A first E-W tensional phase was recorded by syndepositional, mostly W dipping normal faults in early Middle Triassic limestones. A first ductile shear phase was recorded in the lower Torna and Meliata units. This comprises SE striking stretching lineations with top to SE rotated clasts. The proposed age for this deformation is Late Jurassic, coeval with high pressure metamorphism.

The next phase was recorded in the Szilice units with
reactivated faults, flat S dipping thrust faults and folds, giving a north-vergent overthrust. Based on similar structures across the border, the age of the deformation is inferred to be Albian. Two ductile-brittle phases follow, both giving spectacular structures. Depending on lithology they are characterized by folds or strike slip faults. A supposedly first phase has NE–SW fold axes and a SE vergence, while the second has NW–SE fold axes and a NE vergence. Both might be related to Paleogene–Early Miocene deformations and their relative positions or successions might be explained by large rotations during the Early Miocene. These rotations affect large areas in N Hungary–SE Slovakia.

Two more brittle tensional phases were recorded. A NE–SW extension and a NW–SE extension. The former might be Miocene in age, while the latter might be recent, because of the structures on cavity fillings in the caves. The found structures might be fitted in a complex model in the contact area of the Austroalpine, Dinaric, Meliatic plates and complete previous data on the Hungarian and Slovakian side.

**Ongoing orogeny? Comparing Miocene and recent dynamics of the Eastern Alps for seismic risk assessment**

Kurt Decker¹, Georg Gangl² & Herwig Peresson¹

¹Institut für Geologie, Althanstr. 14, A-1090 Wien, Austria
²Donaukraft Engineering, Parkring 12, A-1010 Wien, Austria

Miocene as well as active tectonics in the Eastern Alps and the surrounding areas are triggered by the plate convergence between Europe and the Adriatic plate. A comparison of reconstructed Miocene convergence rates with GPS data (H. Sünkel, Technical University of Graz) serving as a snap-shot on recent plate motion indicates continuous convergence with a velocity similar to the Miocene average. We report on a first approach of a geologic study which is carried out to discriminate faults in the Alpine thrust belt which could account for this shortening and to assess the seismic potential of such faults. The Austrian Alps show moderate seismicity and maximum intensities of historical quakes of 7. Until now, seismic hazard assessment relied on the probabilistic analysis of historical earthquake catalogues, which, however, are extremely short compared to any geological process and which may be incomplete.

The fault pattern in the Eastern Alps is dominated by Miocene thrusts and strike-slip faults which formed in a N–S to NW–SE-compressive paleostress field. The paleostress directions are comparable to recent NNW- to NW-directed compression indicated by focal solutions and in-situ stress measurements. The comparison of the Miocene fault pattern in the Eastern Alps with the location of earthquake hypocenters and with the orientations of nodal planes of focal solutions indicates a good agreement of Miocene and recent kinematics. Neotectonic slip may dominantly occur on (JN)NE- and NNW-striking strike-slip fault zones which are favourably oriented with respect to the compression direction. Frequency analyses of faults lengths show that most faults have lengths between 10 and 30 km. Large fault zones like the Inntal-, Salzach-Ennstal-, Mur-Mürz-, Vienna Basin-, Lavanttal and Periadriatic faults display variable segmentation with about 100 km maximum lengths of individual segments. Faults in the northern parts of the Eastern Alps root in the Alpine floor thrust and do not penetrate to the basement, thus only dissecting the uppermost 10 km of the crust. Information about the depth range of faults in the Central Eastern Alps comes from rheological modeling of the Alpine lithosphere which indicates that, due to the thermal structure of the lithosphere, brittle fracturing is restricted to the uppermost 10–15 km of the crust. This matches the observed distribution of hypocenter depths. This reasoning allows to estimate maximum strike-slip fault surfaces which are in the order of 500 to 1000 km, and which could be used to constrain the magnitude of the hypothetical largest possible earthquake.

**Heteroaxial shortening, strike-slip faulting and displacement transfer in the Polish Carpathians**

Kurt Decker¹, Piotr Nescieruk², Franz Reiter³, Jacek Rubinkiewicz⁴, Wojciech Rylko² & Antoni K. Tokarski⁵

¹Institut für Geologie, Universität Wien, Althanstr. 14, A-1090 Wien, Austria
²Polish Geological Survey, Skrzatów 1, 31-560 Kraków, Poland
³Institut für Geologie, Universität Innsbruck, Innrain 52, A-6020 Innsbruck, Austria
⁴Faculty of Geology, Warsaw University, Żwirki i Wigury 93, 02-089 Warszawa, Poland
⁵Institute of Geology, Polish Academy of Sciences, Senacka 1, 31-002 Kraków, Poland

The Oligocene–Miocene tectonic evolution of the Outer Carpathian nappes in the Beskidy Mountains (Poland) is characterized by the superposition of two distinct thrust events, by the reactivation of thrusts during sinistral wren-