Geodynamic consequences of Tertiary structural development in SW-Pannonian inselbergs (Mecsek and Villány Mts, SW Hungary)

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The aim of this study was to gain and analyse detailed structural data on the Tertiary evolution of SW Hungary, in order to compare them to similar data in the area to the east: the Great Hungarian Plain and the Apuseni Mts/Transylvanian Basin. All these areas are members of an Intra-Carpathian microplate, which suffered a very complicated Tertiary evolution with major rotations. This comparison was used to find some geodynamic reasons for this complex structural development and in a broader sense to explain the formation of the Carpathian arc.

Three independent methods: paleomagnetic investigation, analysis of reflection seismic sections and structural study of outcrops has been applied on Mesozoic-Tertiary rocks of SW Hungary exposed in the Mecsek and Villány Mts. All three methods gave a similar structural history. Both paleomagnetic and structural data indicate that the main phase of rotation and complex transpressional deformation was in Late Oligocene-Ottnangian (until 18 Ma), followed by a more quiescent period in this part of the Pannonian Basin. Several strong reactivations, perhaps with incipient rotation are experienced from Late Miocene (ca 11.5 and ca 7 Ma) on and probably are still in vigour. Local flexural basin development accompanied these inversions. On the other hand major transversal tear faults and huge grabens developed in the Middle Miocene to the east, in an area between the Mecsek and Apuseni Mts. On the eastern side of the Apuseni, a limited amount of Early Miocene rotation and consequent inversion was followed by a major clockwise rotation during the Middle Miocene.

Comparison of our and regional structural data and rotation pattern strongly modifies the original concepts about microplate behaviour in the Carpathian realm. The concept of uniform rigid microplates gives way to internally deformed, flexible ones. The geodynamic history is dominated by the opposite rotation and consequent interplay of two major blocks: Alcapa and Tisza. Differential Early Miocene rotations and deformations within Tisza are explained by major tears or thrusts across this block. Left lateral wrench zones within the clockwise rotating Tisza block are explained by differential movements due to this rotation. Major transversal extensional faults in the Middle Miocene are also explained by differential rotations. Local flexural and extensional basins are located along the major transversal structures across the microplate. The driving force of this complex interplay is the nothwards propagation of Apulia vs. Europe and the subduction-rollback in the East Carpathians.

Deformation and sedimentary pattern propagation in the Transdanubian Central Range, Hungary

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The Transdanubian Central Range (TCR) is an inselberg of Alpine origin within the Pannonian Basin, W. Hungary. It is a broad Mesozooic synform, in the axis of which Cretaceous deposits are preserved. From the many deformational events, linked to sedimentary cycles, our main interest here is the Cretaceous tectono-sedimentary history. Many stress the importance of Albian-Late Cretaceous NW–SE shortening. We put emphasis on an earlier structural phase. Two lines of evidence were examined: sedimentary pattern of Cretaceous deposits and structural analysis of exposed areas and mine works. Naturally, many observations from the litterature were also integrated.

Early Creteceous sedimentary pattern suggests a forebulge-type elevation (Mindszenty et al. 1994 and Tari 1994) across the TCR. The forebulge area is characterised by non-deposition, then transgression of a Rudistid buildup complex of latest Aptian-Early Albian. Although the exposures are limited, the facies distribution suggets a N–S to NW–SE trending topography/structural background. This pattern of terrestrial deposits (bauxite formation), lagoonal and reef complex with a similar orientation shifts westwards during the Albian. A different sedimentary pattern and facies orientation, parallel to the main NE-SW structures is valid for the Senonian deposits (Haas 1979, Mindszenty et al in press).

The structural record shows NE–SW and NW–SE oriented fold axes. Dating of these folds is often very hard, since even Eocene, Early Miocene folds exist in the area. Analysis of pre-Albian unconformity structures suggests that the main fold axes trend NNW–SSE to NW–SE, with local deflections towards NE-SW. Both the NNW–SSE oriented folds and the deflected portions are covered by the Late Albian sedimentary complex. This is on its turn folded into NE-SW oriented folds. The Senonian deposits cover all preceding formations relatively flat and are only slightly, locally undulating.

Interpretation of the sedimentary and structural data can give a conscise story of progressing deformation. The original forebulge-like elevation in the eastern part of the mountain is possibly the result of a northeastern load excerted by an ophiolitic nappe (Bagoly-Árgyelán and Császár 1996) emplaced in the latest Jurassic–Early Cretaceous. This original shortening should have prevailed for quite a long time, to provide the NW–SE trending topography for the terrestrial-coastal-near shore deposits in the Aptian-Albian. During this longer shortening period broad NW–SE oriented anticlines with bauxite formation and synclines with shallow marine deposition were formed. Internal nappe stacking may be possible, but no direct proofs exist yet. The main deformation area possibly shifted westwards with the lateral shift of the facies pattern, too. Local NE–SW trending, pre-unconformity folds are interpreted as caught in local shear zones, or formed on lateral ramps. The structural and sedimentary pattern changed drastically during Cenomanian-Turonian, when the major NE–SW trending folds were formed. Rudistid buildups occupied the topographic highs above anticlines or thrust fronts (Tari 1994), parallel to this main structural trend.

3D geological map of Sheet 280 – Fossombrone: visualisation of orogenic structures and the evolving foreland basin system in the northern Marche sector of the Apennines (Italy)

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The visualisation techniques are used to create a 3D model of the area of Sheet 280 – Fossombrone. In this sector, the carbonate multilayer of Umbro-Marche succession and the mainly terrigenous deposits of a complex Neogene foredeep crop out. The structures are related to the pre-, syn- and post-orogenic settings. In this context, the 3D visualisation techniques are usefull and powerfull for understanding the complex geological frame.

The methodology consists of combining the available geological and geophysical data within 3D structural modelling and visualisation tools. The 3D model integrates the Digital Elevation Model for the surface and its geomorphological aspects. Results from analogue modelling experiments, together with satellite imagery, are also integrated in the 3D model, in order to find possible solutions for interpreting complex structural problems. Linkages between the 3D structural and visualisation tools and GIS are also investigated.

In this way it is possible to build and validate 3D geological models of the study area, addressing geological uncertainties at various scales. The models is also users friendly, directed not only to scientists, but also to technicians and people who want to learn about geology without any esoteric knowledge of it.