UNIVERSITY OF PÉCS
Doctoral School of Earth Sciences

Tectonic geomorphological analysis of the Western Mecsek Mts. and their surroundings

PhD thesis abstract

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1. Introduction, aims of the research

The earliest research concerning both structural geology and geomorphology of the Western Mecsek Mts. dates back to the 1930s. The importance and strike-slip character of the boundary faults were already recognised by VADÁSZ. The major folds and boundary faults dominating the structure of the mountains were formed in the Mesozoic, mostly in the Cretaceous. These features were considerably modified by later, predominantly Pannonian (Late Miocene) and post-Pannonian tectonic movements. The movements often happened by the reactivation of previously existing structures.

After the Miocene extension, from the Late Miocene the dominant stress field in the Carpathian Basin gradually transformed into a compressional or strike-slip one; the change propagated from the west to the east. The main tectonic features are usually strike-slip fault zones, the majority of which show neotectonic activity as well. The Mecsekalja Dislocation Zone (MDZ) along the southern margin of the Mecsek Mts. is one of these important fault zones.

Since the Western Mecsek was considered as one of the potential disposal areas for high-level radioactive waste, special attention has been paid to the tectonic activity of the geological environment. The age of the youngest sediments studied both in older and in more recent geological investigations (the latter also included microtectonic and geophysical methods) was Pannonian (Late Miocene). Quaternary tectonic activity of the area was primarily deduced from geomorphological observations, but the dating and correlation of the surface remnants used for detecting displacement is usually very difficult or impossible.

The spread of digital elevation models (DEMs) and of geographic information systems in general opened new possibilities in the earth sciences as well. Though the methodology of DEM analysis from a tectonic aspect is still developing, these models are promising tools in structural geological studies. In the present work, I integrated geological, geomorphological, geophysical and GIS data and methods to investigate a topic difficult to study with direct geological methods alone, namely the young (post-Pannonian to recent) tectonic processes of the Western Mecsek area and their impact on the evolution of the morphology.

The aims of the work were the following:

- to collect data on the existence and intensity of neotectonic activity in the Western Mecsek Mts. and in their foreland and to assess the role of movements in affecting present-day and future landscape evolution;

- to study atectonic factors shaping the landscape and to distinguish their impact from the effects of tectonic activity:
  - firstly, to detect the results of wind erosion and
  - secondly, to analyse the influence of lithology on the landscape, to study the area from a structural geomorphological aspect and to attain a geological explanation of the morphology.
- to compare the applicability of DEMs of different types in morphotectonic studies and to evaluate the model types.

I wished to achieve these goals by collecting and integrating geological, geomorphological and geophysical data, that is

- by investigating exposures of young sediments from tectonic and geomorphological aspects,
- by interpreting seismic reflexion profiles and
- by a mathematical and geomorphological analysis of DEMs (by studying the morphology and hydrology of the area and the relationship between geological buildup and landscape).

2. Study area and research methods

Study area

The study area included the Western Mecsek Mountains, the eastern part of the Zselic region and the southern foreland of these two. During the field work I investigated exposures along the major tectonic zones bounding and crossing the mountains and also further away from these zones, within the mountains and in the foreland. The exposures included sites where neotectonic phenomena had previously been recorded and places where the occurrence of these phenomena was expected. I studied primarily Late Pannonian or younger sediments but also some Middle Miocene formations which were supposed to provide information on the activity of nearby faults.

Data sources

Basic data integrated in the GIS included the following:

- a contour-based DEM with 50 m horizontal and 1 m vertical resolution (Hungarian Ministry of Defense Mapping Company) and a photogrammetric DEM with a nominal horizontal resolution of 1 m (Eurosense Ltd.);
- topographical coverages;
- geological maps between the scales 1:500 000 and 1:10 000;
- borehole data (Mecsekérc Ltd., Geological Institute of Hungary);
- seismic reflection profiles (Eötvös Loránd Geophysical Institute of Hungary, MOL Hungarian Oil and Gas Company).

Methods

I have carried out field work in geology and geomorphology since 1998. The exposures were documented by drawings, photographs and descriptions, data of tectonic features were recorded and samples were collected if necessary. Structural data were displayed and evaluated by the software „Tector 1994" of J. ANGELIER.

The majority of geoinformatic processing was carried out by the software group ArcGIS. From the DEM data hillshade, 3D view, aspect, slope, surface curvature, profile curvature and hydrological characteristics were calculated. Data gained exclusively from DEM processing were integrated into one geographycal information system with geological maps, geophysical data and field recordings and analysed together. Results were interpreted visually and by statistical methods. The two DEM types were compared from the aspect of morphotectonic applicability after a review of their basic characteristics, a description of their error types and test analyses.

3. Results

The most important scientific results of the work can be summarised as follows:

1. From the analysis of DEMs and geological maps I concluded that the basic characteristics of the morphology in the Western Mecsek are controlled by the structural buildup; the impact of the various rock types is manifested only indirectly.
2. By collecting and analysing the available data referring to wind erosion I showed that during the Pleistocene and at the beginning of the Holocene, wind was able to considerably shape the landscape. I described a new ventifact occurrence in the Western Mecsek. In my opinion, the scarcity of ventifacts is not due to the low intensity of wind erosion but to the rarity of the appropriate rock types.
3. I pointed out that the N–S to NNW–SSE striking linear valleys dominating the drainage network of the region can not be explained by tectonic features, their strike is independent of the general slope of the surface, but they fit in the radial valley system of the Carpathian Basin. Their direction must therefore have been controlled by the prevailing winds, presumably during the Pleistocene. The valleys last acted as wind channels around the Pleistocene/Holocene boundary; between and after deflational periods they evolved as erosional valleys and were dissected by tectonic movements.
4. I detected tectonic movement and seismic activity up to the Late Pleistocene along the fault zones bounding the Western Mecsek, primarily along the MDZ and possibly also along the Hetvehely–Magyarszék Zone. I showed that the movements had both horizontal and vertical components, happened in several phases since the Late Pannonian and – as shown by morphological and hydrological data – are still going on at least in the southern foreland. The date of the last proven activity changes along the zone, presumably as a result of the zone's segmented character.
5. In the studied exposures of young sediments within the Western Mecsek Anticline, no signs of neotectonic activity were detected. These observations indicate that the Western Mecsek acted as a uniform block during the Pannonian–Quaternary movements, a conclusion also supported by DEM analysis.
6. At present the Pécs Basin is not evolving as a pull-apart basin but as a result of the thrusting of the Görcsöny Hills onto the basin. This north-vergent thrusting also controls the drainage network. The block of the

Görcsöny Hills has been laterally tilted and its northern margin has been folded above the thrust.

7. The Pécs Basin appeared in the landscape in the Middle Pleistocene. Its subsidence was not uniform either spatially or temporally. The basin was probably formed by the merging of smaller sub-basins. At times when the incision of the Pécs Stream, which drains the basin, was slower than basin subsidence, temporarily an internal drainage network developed. At the moment the Pécs Basin is expanding to the east along the MDZ.
8. By systematic error analysis and processing tests I showed that the contour-based and the photogrammetric DEMs can be used differently in morphotectonic studies but they both provide substantial new information to supplement geological data. I outlined the advantages and disadvantages of the two model types and presented methods for their analysis together with geological data.

4. Possibilites for the utilization of the results

According to the presently operative legal provisions (Decree of the Ministry of Industry and Trade No 67/1997 (18 December)), to assess the geological suitability of a repository for the final disposal of high-level and long half-life radioactive wastes, it is essential to study the long-term geodynamic stability of the area. The present paper is part of the various research projects investigating one of the potential disposal sites, the Western Mecsek Mts. and their surroundings.

Besides the direct practical utilization, the paper also includes aspects related to basic research, e.g. the applied DEM analysis methods can be used in morphotectonic studies of other areas, or the characteristics of the DEM types shown in the paper can help in choosing or producing the appropriate model type for a given project.

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