

# **Sandstone Provenance for the Paleogene Units of the Pienides in Maramures (Eastern Carpathians – Northern Romania)**

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## THE PIENIDES AS PART OF THE TETHYAN SUTURE

The Carpathian orogen is a thrust and fold belt that includes deformed remnants of the Mesozoic Tethyan oceanic crust and its strongly deformed continental margins, the European and the Pre-Apulian. The orogen is the result of several tectogenetic compressive movements which deformed the inner zones (Dacides) during Early Cretaceous and the outer zones (Moldavides) during Early Miocene. The units of the Main Tethyan Suture zone were deformed both during Cretaceous and Miocene times. During the Upper Cretaceous and/or Paleogene, the inner zones (Dacides) were characterised by deposition of a post-tectogenetic sedimentary cover, developed above the deformed units (Sandulescu, 1984).

At present, the Tethys is considered an oceanic crust-bearing domain opened, by a divergent movement during Permian (Paleo-Tethys) and Triassic - Jurassic (Neo-Tethys), with a progressive propagation from east to west, preceded by an intense rift activity. Several data allow the reconstruction of the direction and rate of the relative movements of the different plates (Dercourt et al., 1986; Savostin et al., 1986).

The Tethyan Suture is represented, in the northern part of the Eastern Carpathians, by a supergroup of units, the Pienides. The Pienides are represented by deep-water sedimentary rocks consisting of Middle Jurassic-Oligocene successions, lacking any direct evidence of oceanic crust. The oceanic origin of Pienides in Maramures was deduced only by structural extrapolations based on geophysical data (Sandulescu et al., 1993) and by stratigraphic correlations with analogue sequences from Slovakia, Poland and Ukraine. The Pienides form a narrow and elongate belt from the Slovakian Western Carpathians to Poiana Botizei, in Maramures, which represents the easternmost outcrop of this type in the Eastern Carpathians.

In the Maramures area, the Pienides are formed by cover nappes subdivided in four groups of tectonic units (from the outermost): a) the Magura Group, formed by the Petrova, Leordina and Lapus nappes; b) the Pieniny Klippen Zone; c) the Botiza and Kricevo units; d) the Babesti - Tijacovo Unit. The latter was only identified in subsurface, both in Romania and in Subcarpathian

Ukraine (Sandulescu et al., 1993).

## PETROFACIES AND LOCATION OF THE SOURCE AREAS FOR THE PIENIDES IN MARAMURES

The Inner Dacides, which are equivalent of the Austroalpine Units of the Eastern Alps, formed a portion of the Pre-Apulian continent. They represent the most probable source area for clastics in the Pienides of Maramures because both sedimentological and petrographic observations. The Inner Dacides are made up by several superimposed tectonic units, characterised by the presence of a continental basement made of Palaeozoic and pre-Palaeozoic crystalline rocks, covered by Permo-Mesozoic sedimentary deposits. The tectonic boundary between the Inner Dacides and the ocean domain is not found in the studied area, where the Inner Dacides extend under the Transylvanian and Pannonian basins and are partially covered by the Neogene sedimentary formations and by the Neogene Volcanic Arc. The presence of a Paleocene - Eocene carbonatic platform is documented by the abundant intraclasts found in the arenites and in the chaotic deposits present in the western part of the study area (Lapus Nappe).

Examining data of modal analysis for the Lapus Nappe and considering the vertical petrofacies trend, a gradual transition from litharenitic to arkosic types can be observed. A progressive unroofing of a continental crust with fine-grained metasedimentary rocks at the top and granite-gneissic lithotypes in the deeper part, which produced a reverse succession in the arenites of the basin, can be assumed. For this nappe, paleocurrents data confirm a provenance of clastic detritus from the Inner Dacides outcropping at present in the Maramures area, or from a western part forming now the tectonic basement of the Pienides.

The sandstones of the Botiza Nappe (the innermost outcropping tectonic unit belonging to the Pienides of Maramures) and of the Lapus Nappe show a litharenitic composition with abundant fragments of basalts and ocean-domain sedimentary clasts (radiolarites, calpionellid limestones). Paleocurrent analyses show a general northward trend, although a radial distribution can also be noticed. By combining all these data, we consider realistic the source of the sediment supply from an innermost area, represented by the buried Babesti-Tijacovo Unit, which shows a typical ophiolitic succession.

## DISCUSSION AND CONCLUSIONS

The combined petrographic, stratigraphic, tectonic and sedimentological data allow to depict a paleogeographic scenario and a geodynamic model for the Palaeogene evolution of the Pienides in Maramures. This attempt is based on the present arrangement of the structural units, acquired only by Neogene tectonic displacements. There is few evidence of the presence of the ophiolitic complexes in the Pienidic Suture Zone. Nevertheless, the presence of analogue units in Eastern Alps

and in Western Carpathians, the existence of basic and ultrabasic rocks in the Babesti- Tijacovo Unit and the modal analyses made in the sandstones of several nappes in the study area, showing the presence of abundant oceanic crust detritus which confirm the hypothesis of a clastic supply from an already uplifted oceanic terrane, prove the existence of an oceanic domain ranging from the Eastern Alps to the Pienides in Maramures. The existence of an ocean-crust bearing basin can be framed in an overall context of a trench-slope basin.

## **References**

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