Ph.D. Thesis

Petrology and Geochemistry of the Palaeozoic–Lower Triassic Siliciclastic Rocks from Southern Transdanubia, Hungary

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I. GENERAL BACKGROUND

In southern Transdanubia, Upper Carboniferous and Permian siliciclastic formations are relatively subordinate in areal extent, but they have a great thickness (FÜLÖP 1994; BARABÁS & BARABÁSNÉ STUHL 1998; JÁMBOR 1998). On the surface, the Upper Carboniferous rocks are not exposed in the area studied (FÜLÖP 1994; JÁMBOR 1998; VARGA et al. 2001, 2003). On the other hand, the Permian rocks are cropped out in the western part of the Mecsek Mountains only. They are followed by the Lower Triassic Jakabhegy Sandstone, which entirely covered the Permian and, spreading over an even larger area, deposited directly onto the crystalline basement (FÜLÖP 1994; BARABÁS & BARABÁSNÉ STUHL 1998). The Palaeozoic–Lower Triassic formations studied in this thesis are the (1) Téseny Sandstone (Upper Carboniferous), (2) Túrony (Upper Devonian?–Lower Permian?), (3) Korpád Sandstone (Lower Permian), (4) Cserdi (Upper Permian), (5) Boda Siltstone (Upper Permian), (6) Kővágószőlős Sandstone (Upper Permian–Lower Triassic) and (7) Jakabhegy Sandstone (Lower Triassic) Formations.

Previous research on Palaeozoic siliciclastic rocks in southern Transdanubia has been restricted to conventional sedimentological and petrographic analyses (FÜLÖP 1994; BARABÁS & BARABÁSNÉ STUHL 1998; JÁMBOR 1998). Recently, MÁTHÉ (1998), ÁRKAI et al. (2000), KOVÁCS et al. (2000), VARGA et al. (2001, 2003). VARGA et al. (2001, 2003), ÁRGYELÁN (2004, 2005), BODOR (2009) reported the mineralogy, provenance and chemical composition of the Téseny, Korpád, Cserdi and Boda sedimentary rocks.

The goals of this work are to characterize the mineralogical features of the Palaeozoic sandstones and mudrocks from different boreholes, to describe the petrographic composition and relative proportion of clasts of the Palaeozoic sandstones, to examine the geochemistry of the Palaeozoic–Lower Triassic siliciclastic sediments, to provide further information about chemical weathering and diagenetic processes of sandstones and mudrocks, and to deduce the provenance of the Palaeozoic–Lower Triassic formations. Detailed mineralogy, petrography and geochemistry of the studied samples have made important contributions to interpretations of Palaeozoic plate tectonic setting, provenance and palaeoclimate of the Tisza unit.

References

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II. METHODS

Petrography

Petrographic observations were made at the Department of Petrology and Geochemistry, Eötvös Loránd University, Budapest.

Analytical methods

Mineralogical composition

A total of 77 sandstone and mudrock (claystone and siltstone) samples were selected for mineralogy. The mineralogical analyses of the whole rocks and their clay-size fraction were performed at the Department of Earth and Environmental Sciences of the University of Pannonia (Veszprém) by X-ray diffraction (XRD) using a Philips PW 1710 diffractometer.

A total of 9 samples were selected for preliminary SEM observation; it was performed at the Institute of Materials Engineering of the University of Pannonia (Veszprém) for Téseny Sandstone, Túrony, Korpád Sandstone and Cserdi samples, and at the Department of Petrology and Geochemistry, Eötvös Loránd University, Budapest for Boda Siltstone samples.

Whole-rock geochemistry

A total of 131 representative rock samples were used for geochemistry. Major and trace element abundances were established by X-ray fluorescence (XRF) analysis using a Bruker AXS S4 Pioneer instrument in the laboratory of the University of Tübingen (Department of Geochemistry, Germany). Chemical analyses of some minor elements were performed at the ACME Analytical Laboratories (Vancouver, Canada) using the following techniques: REE, Zr and Nb were quantified by inductively coupled plasma-mass spectrometry (ICP MS); Sc, Th, U, Ta, Hf and Cr were quantified by neutron activation analysis (NAA). Additionally, the previous published geochemical results of the Téseny sedimentary rock samples and extracted clasts have been included to this study. Their composition was determined at the Department of Earth and Environmental Sciences of University of Pannonia (Veszprém, Hungary) by X-ray fluorescence (XRF) analysis, using a Philips PW 2404 X-ray spectrometer equipped with a 4-kW Rh anode tube. REE abundances of 11 Téseny samples collected from the borehole Sb–1 were established by ICP MS in the laboratory of the Bálint Analitika Kft. (Budapest).

III. CONCLUSIONS

In this thesis, mineralogical, petrographic and geochemical characteristics of the Palaeozoic–Lower Triassic siliciclastic successions from southern Transdanubia, Hungary are discussed. The present study led to the following conclusions:

1. With respect to the supposed Carboniferous–Permian boundary between the Téseny and Korpád Formations at a depth of 700 m of borehole Siklósbodony–1, neither

lithostratigraphic boundary nor geochemical boundary is recognized in the depth interval 673.0–712.0 m. Provenance of sediments studied was the same source area dominated by quartz-rich metamorphic rocks. Based on previous petrological studies, the position of the lithostratigraphic boundary showing tectonic contact could be placed at a depth of 642.0 m.

2. The clay-mineral assemblage of the Téseny samples consists predominantly of illite±muscovite suggesting a potassium metasomatism in the Téseny clastics. Intermediate to intense chemical weathering of the source areas is indicated by premetasomatized CIA values of 77–84 for the samples from borehole Siklósbodony–1, suggesting that these rocks have gained about 6–7% K_2O (in A–CN–K space) during metasomatism.

3. The mineralogy and geochemistry of the Túrony, Korpád, Cserdi and Boda sandstone samples is strongly overprinted by diagenetic albitization. As a result of the post-depositional alteration processes (e.g., albitization, illitization, chloritization, pedogenic carbonate precipitation) recognized in the Palaeozoic–Lower Triassic siliciclastic successions from southern Transdanubia, the major and trace element relations of the samples do not reflect the primary composition of detritus entering the depositional basin, and cannot be used to interpret the provenance area and tectonic setting.

4. In the Korpád detrital grains, embayed quartz crystals together with splinter- and thorn-shaped quartz and feldspar grains are a significant indication of volcanogenic provenance due to fracturing through contemporary explosive volcanic activity.

5. With respect to the lower part of the Cserdi Formation, petrography and geochemistry of the samples previously interpreted as alluvial fan deposits suggest a volcaniclastic origin (moderately welded ignimbrite). Furthermore, this result indicates that the underlying Gyűrűfű Rhyolite rocks have a strongly welded (high-grade) ignimbrite origin in the western part of the Mecsek Mountains, instead of lava flow.

6. The Túrony samples are predominantly composed of albite, quartz, illite±muscovite, chlorite (mixed chlorite–smectite) and hematite. The samples have relatively high MgO, CaO and, especially, Na_2O contents. Mineralogical and geochemical composition of these rocks suggests a relatively felsic provenance area and reflects the cumulative effects of the early and

subsequent burial diagenetic processes such as albitization in an open system, illitization and chloritization during warm and arid climatic conditions in a playa lake.

7. Based on the strongly similar mineralogical, petrographic and geochemical features, the previously described macroscopic differences between the Túrony and Boda Siltstone samples are caused by very low-grade metamorphism proved in the Túrony clastics.

As a result of my research, a major revision of the Permian litostratigraphic units in southern Transdanubia (Hungary) is needed.

IV. REFERRED ARTICLES RELATED TO THE PH.D. THESIS

1. **Varga, A.R.**, Raucsik, B., Szakmány, Gy. „A Siklósbodony Sb–1 mélyfúrás feltételezett karbon–perm határképződményeinek ásványtani, kőzettani és geokémiai jellemzői", *Földtani Közlöny* **134/3**, 2004, 321–343.
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