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Geological cross-sections

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Explanatory notes to the geological cross-sections

The geological setting of the related area is introduced in the explanatory notes of the surface geological and the pre-Tertiary basement maps. Therefore only some special features of the cross sections will be discussed below.

Geological cross-section across the Vienna and Kisalföld Basins (A–B section)

by G. Császár, G. Wessely & L. Nemesi

The section crosses all tectonic zones from the undisturbed molasse on the Eastern Alps to the Pelso Unit (Transdanubian Range). The knowledge and exposure conditions of the formations older than Tertiary are well reflected in the exhaustiveness of categories distinguished along the profile.

Information about the deeper geologic structure along the Austrian part of the section has been provided by extensive drilling, by seismic surveys and by gravity measurements [Brix & Schultz (eds) 1993, Janoschek *et al.* 1996]. A magnetotelluric profile was measured in the framework of the DANREG programme. Some of the wells were spudded down to the subalpine autochtonous basement. The deepest of them, Aderklaa UT1 is situated in the Vienna Basin and reached a final depth of 6300 m in 1985.

The basement, dipping downwards from NW under the Alpine-Carpathian nappes is constituted by the European platform. It is covered by remnants of Palaeozoic and well developed Mesozoic sediments (Brix *et al.* 1977, Elias & Wessely 1990). The latter consist of deltaic deposits in the Middle Jurassic (Gresten Group) covered by carbonatic cherty sandstone of the uppermost Middle Jurassic (Höflein Fm — Sauer *et al.* 1992). The Upper Jurassic carbonates of platform and slope character (Altenmarkt Fm) grade into marls (Mikulov Fm — former "Klentnitz beds") basinward towards the NE. The Gresten Group fills halfgrabens caused by synsedimentary, east dipping rift faults which were sealed in the latest Middle Jurassic. They point to a Middle Jurassic rifting event in the Tethy region involving marginal parts of the European platform. The gas-condensate field Höflein within the Middle Jurassic is situated on the elevated eastern part of one of these halfgrabens. The Upper Cretaceous sediments (Klement Group) occur as remnants.

The Molasse Zone is represented by an autochtonous and to a larger deal by an allochtonous part of the Palaeogene to Neogene Molasse sequence (Steininger *et al.* 1986, Wagner 1998). Toward the orogene this molasse is more and more deformed, finally totally removed and accumulated under the frontal nappes. Parts of the autochtonous Mesozoic were sheared out of their sequence and emplaced as klippen into the autochtonous Molasse, especially in the Waschberg Zone. Within the Molasse thrust slices the gasfield of Stockerau occur in Oligocene sandstones (Grün 1984).

The Flysch Zone consists of several nappes containing uppermost Lower Cretaceous to Middle Eocene turbidites. Base of the external unit corresponding to an Ultrahelvetic nappe was proved by wells.

The Flysch nappes have been pushed by the Austroalpine nappe complex and are accumulated in front of it. Below the NCA they are thinned out to a great deal. The prolongation towards the south is established by the well Berndorf 1 out of the section (Wachtel & Wessely 1981).

The Northern Calcareous Alps are resting rootless upon the Flysch Zone on the one hand and the Central Alps on the other. They are subdivided into three systems of nappes each of them with a stratigraphic range from the Upper Permian to Upper Cretaceous, in a northern "Gosau syncline" even to the Middle Palaeocene (Wessely 1992; Kröll *et al.* 1993, Zimmer & Wessely 1996). Here a sliding event of a frontal part of the Ötscher Nappe took place during the Middle Palaeocene (Raasdorf T3). Beside the thrust planes of the nappes steep upthrusts, presumably with strike slip components have also been proved. The Greywacke Zone with its Palaeozoic sediments is interpreted to be connected with the highest units of the NCA.

The Central Alps are represented by crystalline complexes as they crop out in the Leitha Hills. Permo-Triassic quartzites (Gerhaus 1) and a slightly metamorphosed Mesozoic sequence (Regelsbrunn 1), slightly metamorphosed, were encountered.

The Vienna Basin was subsiding from the Eggenburgian to the Pliocen/Quaternary time interval (Hamilton *et al.* 2000). It has been filled by terrigenous sediments. The western boundary is formed by the Bisamberg fault with a displacement of about 2000 m. Some depressions and the Aderklaa elevation are bound by faults with smaller displacements. A young graben system strikes the area of Orth and Regelsbrunn and turned out to be due to a young strike slip fault system, accompanying the eastern flank of the basin in continuation of the Mürz furrow. The nearby Mur–Mürz Line, indicated by shallow electromagnetic and deep magnetotelluric soundings as well represents the south-eastern rim of the European continent.

Most remarkable differences have been recognised between the Vienna Basin and the Kisalföld Basin. The main subsidence and thickness of basin fill shifts from the Early and Middle Miocene in the Vienna Basin to the Late and Middle Miocene, Pliocene and Quaternary in the Kisalföld Basin (Hámor 1998). The pre-Neogene substratum of the Vienna Basin is made up by a complicated nappe structure and even the deep-seated Bohemian Massif has also been reached by a few wells.

In the basement of the Kisalföld formations of high magnetic susceptibility are supposed to be located under the Rába Metamorphic Group (Nemesi *et al.* 1997) and in part stuffed therein. A high gravity anomaly is also known there (Nemesi *et al.* 1997). The peculiarity of the situation is that the surface projections of these two different types of anomalies do not coincide. This situation can be explained by the following process: high density mantle material intruded into the crust and this is not the source of the gravity anomaly. In the final stage of intrusion an other body of similar density but high susceptibility penetrated the marginal part of the former intrusion. According to the inversion of gravity and magnetic data, and partly based on crustal seismic profiles the depth of this intrusion is about 10–12 km.

The Rába Line (or Zone) is one of the most significant and important tectonic element cross cut by the profile (Balla 1984). Unfortunately this line can not be recognised in the seismic profiles measured in the closer surroundings of the cross section. However, it is well represented in a few seismic profiles situated in the south-western part of the Kisalföld Basin. It inclines to the south-east there. The existence of the Rába Line is evidenced by magnetotelluric profiles that usually run together with the seismic profile (Nemesi *et al.* 1997). The conductivity changes fundamentally along this cross section exactly in the same way as it does along several other profiles in the Kisalföld Basin.

The Kisalföld Basin is filled by an extraordinarily thick, tectonically gently disturbed Neogene succession covering both sides of the Rába Line. The thick Quaternary succession in the western part of the basin is an evidence for a north-westward shifted intensive subsidence of the basement during the last two million years.

Lower Palaeozoic, Permian and Triassic formations are assumed to be located in imbricated structures on the north-eastern margin of the Pelso Unit, east of the Rába Line (Mattick *et al.* 1996, Matura *et al.* 1999). The marginal imbrication is followed by a monoclinal structure. In separated troughs, close to the axial part of the syncline of the Transdanubian Range Jurassic and Cretaceous formations have been preserved (Fülöp *et al.* 1987). Eocene (Kecskeméti 1998) and Oligocene (Korpás 1981) sediments in the Pelso Unit are restricted to the central part of the Transdanubian Range.

Geological cross-section between Vel'ké Záluzie and Vértessomló (C–D section)

by G. Császár & J. Vozár

The ruling element of the north-south oriented cross-section is the Rába–Hurbanovo Line/Zone (RHD) separating the Southern Veporic (Inner Carpathians) and the Pelso Units below the Neogene sedimentary cover. There are no sufficient data on the width and orientation of the RHD Zone but following Balla's idea (1989, 1994) the present authors are also convinced that RHD Zone is basically a strike-slip fault that is steeply dipping southwards. At the same time the ophiolite fragments and the dominant chrome spinel in the heavy mineral fraction of the Lower Cretaceous Gerecse Group transported into the foreland basin from the obducted oceanic basement is a clear evidence that the ancestor of the line must have been a subduction zone in the Late Jurassic (B. Árgyelán & Császár 1998) and Early Cretaceous (Császár & Árgyelán 1994). Opposite to the flat listric fault of Tari *et al.* (1992) its strike-slip character was also emphasised by Nemesi *et al.* (1995) as a consequence of a thorough study of the seismic and magnetotelluric measurements in the framework of the DANREG programme. The flower structure in the Neogene succession nearby the RHZ is a clear evidence that the strike-slip movement is continued also after the Palaeogene.

A slice of dark grey Devonian limestone and shale of Pelso Unit character have been evidenced within the RHD Zone by the borehole Zeleny Haj 1 (Biely & Kullmanová 1979, Kullmanová & Biely 1981). South of the RHZ a typical structure of the Pelso Unit is indicated in the cross-section. The contact zone with the RHD Zone must have been folded and a significant imbrication with southern vergency is seen at Vértessomló, south of Tatabánya. The age of the overthrust is older than Middle Eocene. In site of these structures the main tectonic character of the cross section is given by the Tertiary normal faults. No data on the Lower Palaeozoic formations and in addition to the fluvial Balatonfelvidék Sandstone marine Tabajd Evaporite and Dinnyés Dolomite also can be supposed in the Permian. Above the complete Triassic condensed successions of the Jurassic and the Lower Cretaceous are known at Tata and Vértessomló (Fülöp 1975) and both continuous and lacunose Jurassic (Császár *et al.* 1998) and a Gerecse type Lower and Middle Cretaceous are revealed from the Tatabánya Basin (Császár 1995). Coal-bearing Middle Eocene succession is preserved in the Tatabánya and the Vértessomló Basins. The most wide-spread Palaeogene formation the fluvial Csatka Fm, in which brackish-water beds also intercalate.

The cross-section is supports the idea that after the docking of the Pelso Unit there was a fundamental change in the location of the sedimentary basin which is developed northwards of the RHD Zone. Only Pannonian *s.l.*, the youngermost part of the Neogene succession is deposited on the erosional surface of the Pelso Unit.

The RHD fault zone represents not only a significant boundary of the Inner Western Carpathians and Mid Hungarian zone units, but also northern delimitation of the Komárno horst, which is distinctly uplifted in relation to the Tatro-veporic basement.

The pre-Tertiary basement is built up of the Southern and Northern Veporicum here and also of the Tatricum in the northern part of the profile. The Southern Veporicum as the Variscan basement is formed by metamorphites and granitoids correlated with the occurrences in the Veporské vrchy Mts. The envelope sequences are not particularly delimited in the profile, but their presence may be supposed on the basis of correlation with other profiles of this area. The Southern Veporicum is pierced by Alpine granite, the intrusion of which has left contact–metamorphic effects.

The Northern Veporicum is prevailingly represented by Hercynian metamorphites, we suppose gneisses, mica schists, acid and basic metavolcanics, amphibolites. Analogously as in the Southern Veporicum, the envelope sequence is not delimited in the profile.

The Tatricum builds up the pre-Tertiary basement in the northern part of the profile and is mainly represented by granitoids and gneisses, migmatites with intercalations of amphibolites.

The Tertiary filling north of the RHD Zone is within the range of the Middle Badenian to Dacian/Romanian.

Fault tectonics distinstly affected also the pre-Tertiary basement and tectonic contacts inside the Veporicum, but also the contact with the Tatricum is rejuvenated in the Tertiary.

Geological cross-section between Komjatice Depression and Zsámbék (E–F section)

by G. Császár & J. Vozár

The Rába–Hurbanovo–Diósjenõ Zone/Line (Balla 1994 — RHD) halves the Palaeozoic to Palaeogene interval of the cross-section. The northern part of the section is composed of the Inner Carpathian units (Gemericum, Southern and Northern Veporicums, Hronicum and Silicicum) while the southern one is of the Pelso Unit. (For a short characterisation of the RHD Zone see the explanation of the E–F section).

The Pelso Unit forms a dissected asymmetric syncline structure the axial zone of which lies on the environs of Danube, in the northern part of the unit. The Mesozoic succession along the RHD Zone is folded and gently imbricated (Mattick *et al.* 1996). Close to the southern end of the section an overthrust with southern vergency closes the syncline southwards [Matura (ed.) 1999]. This overthrust is the eastern continuation of the Vértessomló overthrust indicated in the C–D cross-section. The rest of the cross-section is dissected by normal faults.

There is no direct evidence for the lithologic composition of the Lover Palaeozoic formations that supposed to be slate, sandstones with some volcanic intercalations like in the Balaton Highland and at the environs of village Tét in the northern limb of the Transdanubian Range syncline. The Balatonfelvidék Sandstone of fluvial origin is the dominant part of the Permian succession but Tabajd Evaporite and Dinnyés Dolomite Formations also must have been included. The thickness of the Dachstein Limestone increased at the expense of Hauptdolomit in comparison with those in the Bakony Mountains. The largest extent of the condensed Jurassic (Császár *et al.* 1998) and siliciclastic Lower and Middle Cretaceous (Császár 1995) succession along this section is preserved on the northern side of the Danube. Palaeogene is represented by an independent Eocene sedimentary cycle with coal measures, limestones and sandstones and an Oligocene one with exclusively siliciclastic beds.

Similarly as in the C–D section the depocenter of the Neogene system is situated on the northern side of the RHD Zone although it is also found on the northern edge of the Pelso Unit. As a thin blanket Pannonian rests on the Oligocene beds southwards of Zsámbék.

The RHD fault zone represents one of the fundamental tectonic boundaries in the Western Carpathians. In its significance this zone is at the level of the contact of the Outer and Inner Carpathians, *i.e.* the Peripieninic–Klippen lineament. The RHD Zone is the tectonic contact of the Inner Western Carpathians formed on the Tatroveporic terrane and the innermost South Alpine—Dinaric units, to which we also range the Gemeric—Bükk domain including the Meliaticum and higher nappes (Silicicum, Turnaicum). Common for these units is the basement of the Pelso Megaunit.

Directly in the area to the north of the RHD fault zone we suppose remnants of the highly reduced Northern Gemericum, probably the Ochtiná Group (Upper Tournaisian–Lower Visean).

In the pre-Tertiary basement in the Danube basin we interpret units of the Inner Western Carpathians. In the deeper horizon it is the crystalline basement, in the profile represented by the Southern Veporicum, in the frame of which we delimit piercement of Alpine granites, which are described from the surface in the contact area of the Gemericum and Veporicum. As part of the Southern Veporicum we interpret its envelope sequence — Upper Palaeozoic of the Revúca Group and in reduced form also remnants of the Mesozoic correlated with the Foederata Group. The envelope sequence is contact–metamorphosed by the effect of Cretaceous granites.

Above the Southern Veporicum we interpret higher nappe units the Hronicum, mainly represented by the Upper Palaeozoic (volcanic-sedimentary MaluΩiná Formation and incidentally also the NiΩná Boca Fm.) and Silicicum, exclusively formed by Middle Triassic carbonates. We interpret this succession on this basis of borehole profiles and comparisons with the area of the Veporské vrchy Mts.

The Tertiary filling in proximity of the RHD Zone is represented by the Middle–Upper Eocene and Oligocene, in the remaining part by the Lower Badenian to Upper Miocene and/or Pliocene sediments.

References

B. Árgyelán G. & Császár G. 1998: Detrital chrom spinels in the Jurassic formations of Gerecse Mountains, Hungary. — *Földtani Közlöny* **128/2–3,** 321–360.

Balla, Z. 1984: The Carpathian loop and the Pannonian Basin: a kinematic analysis. — *Geophysical Transactions* **30/4,** 313–353.

Balla Z. 1989: A diósjenõi diszlokációs öv újraértékelése. — *Magyar Állami Eötvös Loránd Geofizikai Intézet Évi Jel. 1987-rõl,* 45–57.

Balla Z. 1994: An Ivrea-type structure in the Alpine-Carpathian junction area? In: Lobitzer, H., Császár, G. & Daurer, A. (eds): Jubiläumsschrift 20 Jahre Geologische Zusammenarbeit Österreich–Ungarn, Teil 2, Geologische Bundesanstalt, Wien, 385–402.

BIELY, A. & KULLMANOVÁ, A. 1979: V″skyt devónskych sedimentov v podlo?í podunajskej panvy. *Geol. Práce, Spr.* **73,** 29–37.

BRIX, F., KRÖLL, A. & WESSELY, G. 1977: Die Molassezone und deren Untergrund in Niederösterreich — *Erdöl-Erdgas* **93,** 12–35.

BRIX,F. & SCHULTZ, O. (eds) 1993: Erdöl und Erdgas in Österreich. — 17 Beilagen Naturhistorisches Museum Wien und F. Berger, Horn, 688 p.

CSÁSZÁR, G. 1995: An overview of the Cretaceous research in the Gerecse Mountains and the Vértes Foreland. — *Általános Földtani Szemle* **27,** 133–152.

CSÁSZÁR, G. & B. ÁRGYELÁN, G. 1994: Stratigraphic and micromineralogic investigations on Cretaceous Formations of the Gerecse Mountains, Hungary and their palaeogeographic implications. — *Cretaceous Research* **15,** 417–434.

CSÁSZÁR G., GALÁCZ A. & VÖRÖS A. 1998: Jurassic of the Gerecse Mountains, Hungary: facies and Alpine analogies. — *Földtani Közlöny* **128/2–3,** 397–435.

ELIAπ, M. & WESSELY, G. 1990: The autochthonous Mesozoic on the eastern flank of the Bohemian Massif — an object of mutual geological efforts between Austria and CSR. In: MINAØIKOVA, D. & LOBITZER, H.(eds): 30 years of geol. cooperation between Austria and Czechoslowakia. — Geol. Survey Prague, Geol. Survey Vienna, 78–83,

FÜLÖP, J. 1975: The Mesozoic basement horst blocks of Tata. — *Geologica Hungarica series Geologica* **16,** 121 p.

FÜLÖP J., DANK V., BARABÁS A., BARDÓCZ B., BREZSNYÁNSZKY K., CSÁSZÁR G., HAAS J. HÁMOR G., JÁMBOR Á., KILÉNYI É., NAGY E., RUMPLER J., SZEDERKÉNYI T. & VÖLGYI L. 1987: Magyarország földtani térképe a kainozoikum elhagyásával. (Geological Map of Hungary without Cenozoic) 1:500 000. — MÁFI, Budapest.

GRÜN, W. 1984: Die Erschließung von Lagerstätten im Untergrund der alpin-karpathischen Stirnzone, Niederösterreich — *Erdöl–Erdgas* **100/9,** 292–295.

HAMILTON, W., WAGNER, L. & WESSELY, G. 2000: Oil and Gas in Austria. — *Mitt. Österr. Geol. Ges,* **92,** 235–262,

HÁMOR G. 1998: A magyarországi miocén rétegtana. (Stratigraphy of the Mioce in Hungary) In: BÉRCZI I. & JÁMBOR Á. (eds): Magyarország geológiai képzõdményeinek rétegtana. (Stratigraphy of the geological formations of Hungary.) — MOL Rt. & MÁFI, Budapest, 437–452.

JANOSCHEK, W. R., MALZER, O. & ZIMMER, W. 1996: Hydrocarbons in Austria: past, present and future. In: WESSELY, G. & LIEBL, W. (eds): Oil and Gas in Alpidic Thrustbelts and Basins of Central and Eastern Europe. — *EAEG Spec. Publ.* **5,** 43–63.

KECSKEMÉTI T. 1998: Magyarország epikontinentális eocén képzõdményeinek rétegtana. (Stratigraphy of the epicontinental Eocene formations of Hungary) In: BÉRCZI I. & JÁMBOR Á. (eds): Magyarország geológiai képzõdményeinek rétegtana. (Stratigraphy of the geological formations of Hungary.) — MOL Rt. & MÁFI, Budapest, 403–417.

KORPÁS L. 1981: A Dunántúli-középhegység oligocén–alsómiocén képzõdményei. (Oligocene and Lower Miocene formations of the Transdanubian Range.) — *MÁFI Évk.* **64,** 140 p.

KRÖLL, A., HEINZ, H., JIRIÈEK, R., MEURERS, B., SEIBERL, W., STEINHAUSER, P., WESSELY, G. & ZYCH, D. 1993: Karten 1:200 000 über den Untergrund des Wiener Beckens und der angrenzenden Gebiete (mit Erläuterungen 1–22). — Geologische Bundesanstalt, Wien.

KULLMANOVÁ, A. & BIELY, A. 1981: Tentakuliten in Assoziation mit Globochaete alpina Lombard, Gemetidella minuta Borza et Misik. — *Západné Karpaty ser. Paleont.* **6,** 7–14.

MATTICK, R. E., TELEKI, P. G., PHILLIPS, R. L., CLAYTON, J. L., DÁVID, GY., POGÁCSÁS, GY., BARDÓCZ, B. & SIMON, E. 1996: Structure, Stratigraphy, and Petroleum Geology of the Little Hungarian Basin, Northwestern Hungary. — *AAPG Bulletin* **80/11,** 1780–1800.

MATURA, A, (ed. in-chief), WESSELY, G., CSÁSZÁR, G. & VOZÁR, J. 1999: Map of the Pre-Teriary basement (including Palaeogene in the Austroalpine–Carpatian belt). 1:200 000. — Danube Region Environmental Geology Programme, MÁFI, Budapest.

NEMESI L., HOBOT J., KOVÁCSVÖLGYI, S., MILÁNKOVICH A., PÁPA S., STOMFAI R. & VARGA G. 1995: A kisalföldi medence aljzatának és kéregszerkezetének kutatása az ELGI-ben 1982–90 között. — *Geophysical Transaction* **39/2–3,** 193–223.

NEMESI, L. ˇEFARA, J, VARGA, G. & KOVÁCSVÖLGYI, S. 1997: Results of deep geophysical survey within the framework of the DANREG project. — *Geophysical Transactions* **41/3–4,** 143–159.

SAUER, R., SEIFERT, P. & WESSELY, G. 1992: Guidebook to Excursions in the Vienna Basin and the adjacent Alpine-Carpathian thrustbelt in Austria. — *Mitt. Österr. Geol. Ges.,* **85,** 5–39.

STEININGER, F. F., WESSELY, G., RÖGL, F. & WAGNER, L. 1986: Tertiary sedimentary history and tectonic evolution of the eastern Alpine foredeep. — *Giornale Geol., ser. 3.* **48/1–2,** 285–297.

TARI, G., HORVÁTH, F. & RUMPLER, I. 1992: Style of extension in the Pannonian Basin. — *Tectonophysics* **208,** 203–219.

WACHTEL, G. & WESSELY, G. 1981: Die Tiefbohrung Berndorf 1 in den östlichen Kalkalpen und ihr geologischer Rahmen — *Mitt. Österr. Geol. Ges.* **74/75,** 1137–1165, Wien.

WAGNER, L. 1998: Tectono-stratigraphy and hydrocarbons in the Molasse Foredeep of Salzburg, Upper and Lower Austria. In: MASCLE, A., PUIGDEFABREGAS, C., LUTERBACHER, H. P. & FERNANDEZ, M. (eds): Cenocoic Foreland Basins of Western Europe. — *Geol. Soc. Spec. Publ.* **134,** 339–369.

WESSELY, G. 1990: Geological results of deep exploration in the Vienna Basin. — *Geol. Rundschau* **79/2,** 513–520.

WESSELY, G. 1992: The Calcarous Alps below the Vienna Basin in Austria and their structural and facial development in the Alpine-Carpathian borderzone. — *Geologica Carpathica* **43/6,** 347–353.

ZIMMER, W. & WESSELY G. 1996: Exploration results in the thrust and subthrust complexes in the Alps and below the Vienna Basin in Austria. — In: WESSELY, G. & LIEBL, W. (eds): Oil and Gas in Alpidic Thrustbelts and Basins of Central and Eastern Europe. — *EAEG Special Publication* **5.**