Stratigraphy of the Thermal Water Area (Baden - Bad Vöslau) at the Western Border of the Southern Vienna Basin

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Abstract

Geology and biostratigraphy of the thermal water area along the southwestern border of the Vienna Basin are discussed. Source rock of the water are Triassic limestones of the Göller nappe of Calcareous-Alpine units. The flow of waters is strongly depending on the Merkenstein fault system, perpendicular to the NNE-SSW running Baden fault. Water boreholes, building sites and outcrops clarified the stratigraphic succession of the Mesozoic underground and the Neogene facies development from the border to the deeper basin. The Neogene sedimentation started with probably Karpatian breccia, followed by a first marine Badenian transgression with conglomerates within calcareous nannoplankton zone NN4. With a sedimentary gap followed Badenian Formation of zone NN5 with co-occurring *Praeorbulina circularis* and *Orbulina suturalis*. The younger sedimentation corresponds to the well known basin filling of the Vienna Basin.

Geological situation

Along the south-western border of the Vienna Basin a series of spars mark the so-called "Thermenlinie". Thermal waters at Bad Vöslau and the town Baden are used since Roman time. The spars are situated at the Calcareous Alpine western border of the Vienna Basin (Figure 1), built up by carbonates of the Göller nappe. Upon a lower main unit of this nappe, a higher slice of the Harzberg is thrust. The border of the Vienna Basin forms a spur by the incision of the Bay of Gainfarn, which is caused by the Merkenstein fault system. The Harzberg fault and the Gainfarn fault belong to this system, which runs transverse to the striking of the Vienna Basin faults, which is represented by the NNE-SSW running Baden fault east of Vöslau. Information by boreholes, geophysical measurements were available and extended outcrops existed. As a classical object of investigation the occurrence of thermal water is the opportunity for actual interpretations (comp. Wessely 2006, Wessely et al. 2007).

The border of Northern Calcareous Alps and the nearby drilled sections below the basin consist of Triassic carbonates, which contain the aquifers of thermal and mineral waters. By circulation systems cold waters from Alpine recharging areas flow deep under the basin. Heated, mineralised and over-pressured they descend along tight faults and are forced back to the border, where discharging in springs and boreholes takes place in Baden and Bad Vöslau along so-called "Thermenlinie".

Stratigraphic interpretation (Figure 2)

The stratigraphic results in the area of Baden and Bad Vöslau are based on boreholes drilled for production of thermal and mineral water and on natural and artificial outcrops. They opened the opportunities for investigations of micro- and nannofossils, as important contributions to the stratigraphy of the Neogene in general and to that of the Southern Vienna Basin in particular.

The Mesozoic basement is formed at Vöslau in the Harzberg scale by the Triassic (Anisian) Reichenhall-Steinalm Formation. It is overlaid by Wetterstein limestone and - dolomite (Ladinian – ?Lower Carnian). The underlying main unit of the Göller Nappe consists of Triassic "Hauptdolomit", Kössen Formation, and



Figure 1. Tectonic situation of the Vienna pullapart Basin, with location of investigated areas Baden and Bad Vöslau at the southwestern border of the basin (contributed by K. Decker, University Vienna).

Quartär			Holozăn Pleistozăn
Badenium	Sandschaler- zone		"Sand - Schotter
	ienzone	Obere	Vöslauer Konglomerat
	tenic	ere	"Mergelgruppe"
	Laç	5	Gainfarner Brekzie
? Karpatium			"Polymiktkonglomerat" VÖ 6/1,2
Jura			Dogger/Lias-Rotkalk von Gainfarn
		Rhät	Dachsteinkalk, Riffkalk, Oolith
5	n		Kössen - Fm. 🕰
i a s	_	Nor	Hauptdolomit
	α	Korn	Opponitz - Fm.
		Nam	Lunz - Fm. 🗸
	<u>۲</u>	Karn- Ladin	Wettersteinkalk
H	-		Wettersteindolomit
3742		Anis	Steinalmkalk Reichenhall - Fm.

Figure 2. Stratigraphy of the Bad Vöslau sections (Wessely et al. 2007).

Rhaetian oolites and reefal limestones. Jurassic red limestones of the "Klauskalk" and probably Enzesfeld beds form the top of the nappe (Plate 1). In the town Baden the drilling for thermal water, Josephsplatz-1 encountered Wetterstein limestone at a drill depth of 243 m.

At the western border of the basin, the transition of the Neogene margin facies to the basinal development takes place. A special advantage of the paleontological studies is to enable correlations of the near shore sediments with a well founded stratigraphic scheme of the basin (Wessely et al. 2007). Monomict Gainfarn breccia is placed into a lower horizon of the Badenian Lagenidae Zone. Gainfarn breccia from borehole Vö7 and conglomerates of building site "Kurzentrum" contain calcareous nannofossils with Helicosphaera ampliaperta and Sphenolithus heteromorphus and can be placed into nannoplankton zone NN4 (Martini, 1971). Coarse clastics as the "Vöslau Conglomerate", the "Lindabrunn Conglomerate" and similar conglomerates can be correlated with the

Lower to Upper Lagenidae Zone (Grill 1941, Papp and Turnovsky 1953) of the Badenian. All these coarse clastics reach back far into the hinterland, where shallow bays produced carbonate breccias and rivers brought gravel also over far distances, even from the Flysch units. Along the coast line further marine reworking and transportation took place. According seismic profiles gravel fans extend far into the Vienna Basin. The younger Badenian, with the Zone of agglutinated Foraminifera (Spirorutilus carinatus Zone) consists of sand, marl, some gravel and some coal. Within the closer area no corallinacean limestone (Leithakalk) is developed. Eastward, toward the interior of the Vienna Basin Sarmatian and Pannonian sediments appear, subsided mainly by faults. They were encountered by some exploration wells for hydrocarbons also.

Nannofossils and microfauna of marly sediments in drill sites and outcrops of the Baden Formation (*Badener Tegel*) are rich and typically developed (Plate 2). Nannoplankton zone NN5



Plate 1. Microfacies of Mesozoic limestones

1. Steinalm limestone of Harzberg with Maeandrospira.

- 2. Wetterstein limestone of Harzberg with sectioned sponge.
- 3. Lumachelle from Kössen Formation, main unit of Göller nappe SE Harzberg.
- 4. Rhaetian oolites from the main unit of Göller nappe.
- 5. Filament limestone of "Klauskalk", N of the church in Gainfarn.
- 6. Protoglobogerina-limestone of "Klauskalk", N of the church in Gainfarn.



Plate 2. (previous page)

Foraminifera

- 1. Praeorbulina curva (Blow), Vöslau, Badenian, Lower Lagenidae Zone.
- 2. Orbulina suturalis Brönnimann, Vöslau, Badenian, Lower Lagenidae Zone.
- 3. Globoquadrina altispira Cushman, Vöslau, Badenian, Lower Lagenidae Zone.
- 4. Vaginulina legumen (Linné), Water drill hole Vöslauer 7, 220 m, Badenian, Lower Lagenidae Zone.
- 5. Lenticulina echinata (d'Orbigny), Vöslau, Badenian, Upper Lagenidae Zone.
- 6. Uvigerina pygmoides Papp & Turnovsky, Water drill hole Vöslauer 7, 220 m, Badenian, Lower Lagenidae Zone.
- 7. Uvigerina grilli Schmid, Water drill hole Vöslauer 7, 235 m, Badenian, Lower Lagenidae Zone.

8. Spirorutilus carinatus (d'Orbigny), Water drill hole Vöslauer 7, 10 m, Badenian, Spirorutilus carinatus Zone (Zone of agglutinated foraminifera).

9. Planularia cassis (Fichtel & Moll) Vöslau, Badenian, Lagenidae Zone.

Calcareous Nannoplankton

10.-11. Coccolithus miopelagicus Bukry, 1971, Vöslau, sample "Schurf 10".

12.-14. Sphenolithus heteromorphus Deflandre, 1953, Vöslau, sample "Schurf 10".

15. Geminilithella rotula Kamptner, 1956, Vöslau, sample "Schurf 10".

- 16. Helicosphaera ampliaperta Bramlette & Wilcoxon, 1967, Vöslau, sample 2b.
- 17. Helicosphaera scissura Miller, 1971, Vöslau, sample 2b.
- 18. Helicosphaera walbersdorfensis Müller, 1974, Vöslau, sample "Schurf 8".
- 19. Reticulofenestra pseudoumbilica (Gartner, 1967) Gartner, 1969, Vöslau, sample "Schurf 8".
- 20. Discoaster variabilis Martini & Bramlette 1963, Vöslau, sample 2b.
- 21. Discoaster adamanteus Martini & Bramlette 1967, Vöslau, sample 2b.
- 22. Rhabdosphaera clavigera Murray & Blackman 1898, Vöslau, sample "Schurf 8".
- 23. *Rhabdosphaera sicca* Stradner 1963, Vöslau, sample no.1.
- 24. Helicosphaera carteri (Wallich 1877) Kamptner, 1954, Vöslau, sample 2b.

Ostracoda

25. Cytherella cercinata Aiello et al. 1996, Vöslau, sample no. 1.

- 26. Callistocythere daedalea (Reuss 1850), Vöslau, sample "Schurf 8".
- 27. Acanthocythereis hystrix (Reuss 1850), Vöslau, sample No. 1.
- 28. Costa batei (Brady 1866), Vöslau, sample No. 1.
- 29. Xestoleberis glabrescens (Reuss 1850), Vöslau, sample No. 1.
- 30. Buntonia subulata (Ruggieri 1954), Vöslau, sample No. 1.

31. Cytheropteron sagittaeferrum Aiello & Szczechura 2004, Vöslau, sample No. 1.

is characterized by the absence of H. ampliaperta and the occurrence of S. heteromorphus. The distinct horizon of Helicosphaera waltrans (lower part of NN5) was not encountered in Baden and Vöslau section. Planktonic foraminifera show the presence of Praeorbulina circularis and Orbulina suturalis. The record of a basal Badenian conglomerate in nannoplankton zone NN4, and the following sedimentation of higher parts of zone NN5 demonstrate that a distinct sedimentary gap, with erosion and new transgression took place in the area of Bad Vöslau. Important for local stratigraphy, the benthic species Uvigerina grilli, U. pygmoides are recorded in Vöslau and Baden localities (Papp & Steininger 1978).

Among ostracod assemblages characteristic species are *Cytherella cercinata*, *C. vulgata* and *Henryhowella asperrima*. The rare occurrence of *Cytheridea acuminata* indicates Lower Badenian age.

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