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Subsidence analysis of Upper Cretaceous deposits of the Transdanubian Central Range (Hungary)

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with 3 Text-Figures

Ungarn
Transdanubisches Mittelgebirge
Oberkreide
Subsidenzanalyse

Abstract

Backstripped tectonic subsidence histories were reconstructed for Upper Cretaceous deposits of the Transdanubian Central Range in Hungary. One phase of tectonic subsidence is recognized, resulting in the deposition of one major sedimentary cycle from terrestrial to bathyal sediments. Chronostratigraphic correlations and subsidence patterns show significant similarities to the evolution of Central-Alpine Gosau deposits (Kainach near Graz, Krappfeld/Carinthia), whereas the Gosau Group of the Northern Calcareous Alps is characterized by a strongly different subsidence history which may be compared to the Cretaceous evolution of the Great Hungarian Plain.

Subsidenzanalyse von oberkretazischen Ablagerungen des Transdanubischen Mittelgebirges (Ungarn)

Zusammenfassung

In den oberkretazischen Ablagerungen des Transdanubischen Mittelgebirges Ungarns wurde die Subsidenzgeschichte mit Hilfe der Backstripping-Methode rekonstruiert. Es kann eine tektonische Absenkungsphase rekonstruiert werden, die zur Ablagerung eines Sedimentationszyklus von terrestrischen zu bathyalen Sedimenten führt.e. Chronostratigraphische Korrelationen und die Subsidenzkurven zeigen signifikante Ähnlichkeiten zur Entwicklung der Zentralalpinen Gosauablagerungen (Kainach bei Graz, Krappfeld/Kärnten). Dagegen ist die Gosau Gruppe der Nördlichen Kalkalpen durch eine stark unterschiedliche Subsidenzgeschichte charakterisiert, ebenso wie die Kreide der Grossen Ungarischen Tiefebene.

Összefoglalás

Visszarendező módszer alkalmazásával történt a középhegységi felső kréta képződmények tektonikus sȇllyedési történetének rekonstrukciója. A módszer szerint egy sűllyedési ciklus rekonstruálható, amelyben a szárazföldtől a batiális képződményekig követhetők a formációk. A kronosztratigráfiai adatok és a sűllyedési rendszer határozott hasonlóságot mutat a Közép-alpi gosau képződményekkel (Kainach és Krappfeld környéke), ugyanakkor az Északi Mészkő Alpok Gosau Csoportjának süllyedési történetétől erősen különbözik. Ehhez inkább hasonló az alföldi felső kréta képződmények többfázisos-süllyedésű fejlődéstörténete.

1. Introduction

Upper Cretaceous sedimentary successions of the Transdanubian Central Range (TCR) are known from a few outcrops and several boreholes sourrounding the area of the Bakony Mountains (e.g. HAAS, 1983). The lithostratigraphy and sedimentology of the Upper Cretaceous deposits was described by HAAS (1983, 1995), dividing the successions into a lower, terrestrial/lacustrine part, including bauxites and coals, overlain by marine marlstones, marly limestones and rudist limestones.

During the Austrian-Hungarian cooperation integrated stratigraphic methods were applied to these successions (LANTOS et al., 1997; SIEGL-FARKAS & WAGREICH, 1997) for a concise chronostratigraphic framework of the Hungarian Upper Cretaceous and for a correlation to the Austrian Gosau Group. This study compares, based on stratigraphic and sedimentologic data, the subsidence evolution of the TCR Upper Cretaceous with subsidence data from the Gosau Group of the Eastern Alps. New data both on the Hungarian and the Austrian sections give further evidence for a common evolution of the Central Alpine Gosau Group and the

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Upper Cretaceous strata of the TCR (comp. OBERHAUSER, 1968; FAUPL et al., 1997).

2. Lithostratigraphy

The lower, terrestrial part of the successions of the TCR includes karst bauxites (MINDESZENTY et al., 1987), the Ajka Coal-Formation and the Csehbánya Formation, which consists of fluvial sandstones and pelites (HAAS et al., 1992). These sedimentary rocks of variable thicknesses up to 150 m are overlain by marine strata, mainly the Jákó Marl Formation (e.g. LANTOS et al., 1997; BODROGI et al., 1997), rudist-bearing limestones of the Ugod Limestone Formation (HAAS, 1986, 1995), and the Polány Marl Formation. The Ganna Siltstone Member forms the upper part of the Polány Marl Formation, comprising the youngest known strata (SIEGL-FARKAS, 1997; SIEGL-FARKAS & WAGREICH, 1997b; BODROGI et al., 1998). The total thickness of the marine part of the successions may exceed 600 m. Palaeowater depths increase from the Jako Marl Formation to the Polány Marl Formation, which has a high proportion of planktonic foraminifera, giving evidence for outer neritic to bathyal depositional environments. Dinoflagellate studies confirmed shallow marine, neritic to open marine environment (SIEGl-FARKAS, 1997). Within the Polány Marl Formation deep-water breccias and limestone intercalations of the Jákóhegy Breccia Member are known from several cores (e.g. HAAS, 1995; BODROGI et al., 1998).

3. Biostratigraphic framework

The Late Cretaceous age of the cover of the TCR has been established by integration of several fossil groups. Based on palynostratigraphy 9 palynozones and several subzones could be distinguished (GÓCZÁN & SIEGL-FARKAS, 1990; SIEGL-FARKAS, 1983; 1993). Within the last years this palynostratigraphic scheme was integrated with data on nannoplankton (FÉLEGYHÁZY, 1985; SIEGL-FARKAS & WAGREICH, 1997a, b; BODROGI et al., 1998), dinoflagellates (SIEGL-FARKAS, 1997; SIEGL-FARKAS & WAGREICH, 1997a, b), foraminifera (BODROGI et al., 1998), a few ammonite specimen (e.g. BODROGI et al., 1997; SIEGL-FARKAS & SUMMESBERGER, 1998) and magnetostratigraphy (LANTOS et al., 1997) into a chronostratigraphic framework, being especially detailed within the marine part of the successions. However, some uncertainties still exist about the chronostratigraphic correlations of the lower, terrestrial-lacustrine part of the sections (see e.g. SIEGL-FARKAS & WAGREICH, 1997b and BODROGI et al., 1998)

Based on these data the Upper Cretaceous marine formations of the TCR can be assigned to the late Santonian to late Late Campanian, comprising the standard calcareous nannofossil zones CC17 to CC22c of SISSINGH (1977) and PERCH-NIELSEN (1985). No indications for a Maastrichtian age in any of the investigated cores could be found (SIEGL-FARKAS, 1997; SIEGL-FARKAS & WAGREICH, 1997a, b). The terrestrial part of the succession is assigned to the Santonian (SIEGL-FARKAS & WAGREICH, 1997b).

For comparison with the Hungarian sections two Central Alpine Gosau sections, the Kainach area northwest of Graz (e.g. GOLLNER et al., 1987; SIEGL-FARKAS et al., 1994; NEUBAUER et al., 1995) and the Krappfeld area in Carinthia (NEUMANN, 1989) were incorporated into this study. Previous biostratigraphic data was integrated with magnetostratigraphy (AGNOLI et al., 1989) and new nannofossil data. In both areas marine sedimentation started in the late Santonian to early Early Campanian and the youngest sediments, the "Zementmergel" near St. Bartholomae and the top of the Cretaceous section of the Wietersdorf cement quarry near Pemberger could be dated as late Late Campanian (CC22). For a comparison with the Gosau Group of the Northern Calcareous Alps (NCA) see recent overviews by WAGREICH & FAUPL (1994) and SANDERS et al. (1997).

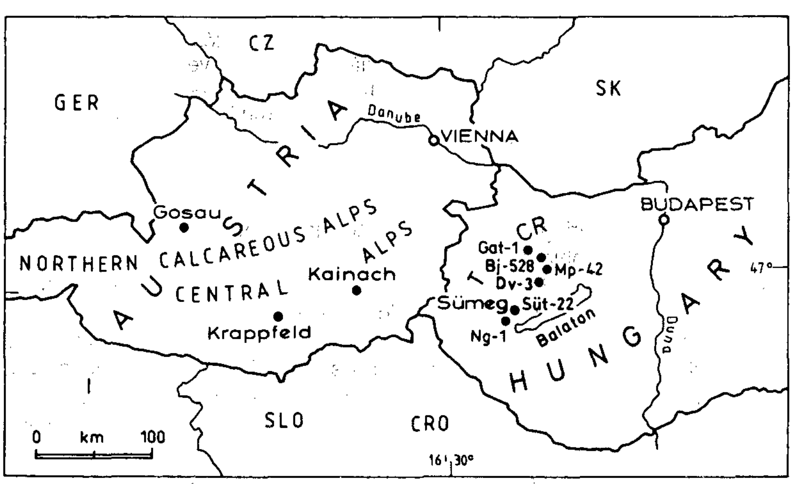
4. Investigated Sections

Data from the following cores were used for construction of tectonic subsidence curves for combined sections (for locations see Fig. 1): Mp-42 near Magyarpolány, Gat-1 near Ganna, Ng-1 near Nagygörbö in the Keszthely Mountains (SIEGL-FARKAS & WAGREICH, 1994, 1997a, b). Data published by HAAS (1983, 1995) on the boreholes Devecser Dv-3 and data by BODROGI et al. (1998) on the borehole Sümeg Süt-22 were also considered.

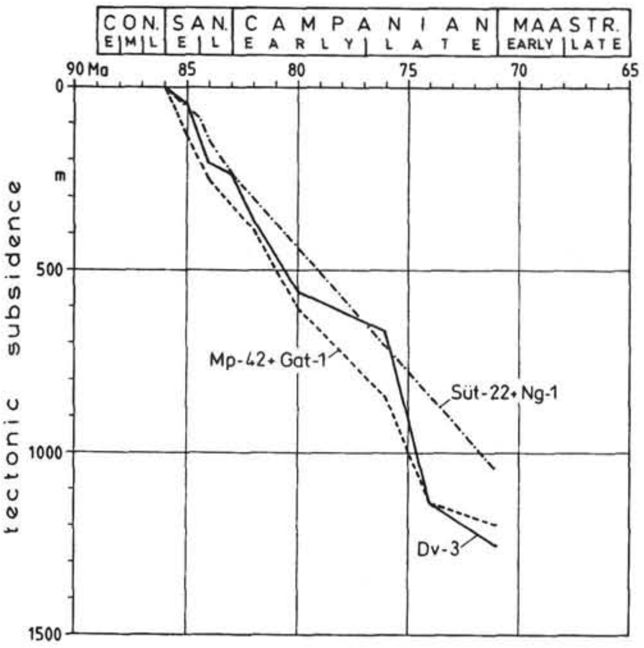
The cores of the bore hole Mp-42 give a continous, more than 600 m thick section through the Upper Cretaceous of the TCR (SIEGL-FARKAS & WAGREICH, 1997b; BODROGI et al., 1998). The nonmarine Ajka Coal Formation and the Csebánya Formation are overlain by the first marine marls and marly limestones of the Jákó Marl Formation and the younger Polány Marl Formation. The first marine intercalations could be dated as Late Santonian/early Early Campanian, similar to the dating in the Bj-528 core (LANTOS et al., 1997). The top of Polány Marl Formation in the Mp-42 core was assigned to the nannofossil standard zone CC21. The section is combined with the data from the bore holes Ng-1 and Gat-1, where nannofossil subzone CC22c prooves a late Late Campanian age for the youngest Cretaceous sediments in the TCR (SIEGL-FARKAS, 1997; SIEGL-FARKAS & WAGREICH, 1997a, b).

5. Subsidence analysis

Subsidence curves (Fig. 2) were constructed by the backstripping method (WAGREICH,



Text-Fig. 1.
Investigated localities and cores of the Upper Cretaceous of the Transdanubian Central Range (TCR) of Hungary, the Central Alpine Gosau localities of Kainach and Krappfeld and the Gosau Group of the Northern Calcareous Alps (NCA) of Austria.



Text-Fig. 2.
Tectonic subsidence curves for the Upper Cretaceous of the Transdanubian Central Range. core Devecser Dv-3 (HAAS, 1983: Fig. 8); combined section of borehole Magyarpolány Mp-42 and Ganna Gat-1; combined section Sümeg Süt-22 and Nagygörbö Ng-1 (BODROGI et al., 1998: Fig. 3; SIEGL-FARKAS & WAGREICH, 1997b).

1991). Lithologies were decompacted using algorithms given by BOND & KOMINZ (1984). A computer program was used for decompaction and backstripping using local Airy-isostasy. Basement and tectonic subsidence curves (WAGREICH, 1991) and decompacted sedimentation rates are drawn based on facies interpretations and palaeo-water depth estimations by HAAS (1983, 1995; comp. WAGREICH & FAUPL, 1994). As these curves were constructed only for comparison of subsidence patterns with Austrian sections the effects of eustatic sea-level changes were not incorporated. However, their influence on the curves would be minor considering the relative insignificant 2nd order sea-level fall during the Late Cretaceous time interval (HAQ et al., 1987).

The resulting subsidence curves show a simple subsidence pattern, characterized by deepening from the Santonian onwards until the middle Campanian, when the sediment supply seemed to equal subsidence, and the basins stayed in a stable position. No indications for upfilling of the basin could be found. At the Campanian-Maastrichtian boundary, the sedimentation was stopped probably due to tectonism, as no younger sediments than Upper Campanian could be found. The next sedimentary cycle starts in the Paleocene/ /Eocene, again with bauxites at their base, indicating a significant period of non-deposition within the TCR during Maastrichtian to Eocene times.

These subsidence curves show significant differences to the subsidence histories reconstructed for the Gosau Group of the Northern Calcareous Alps (WAGREICH, 1991, 1995). The main differences are:

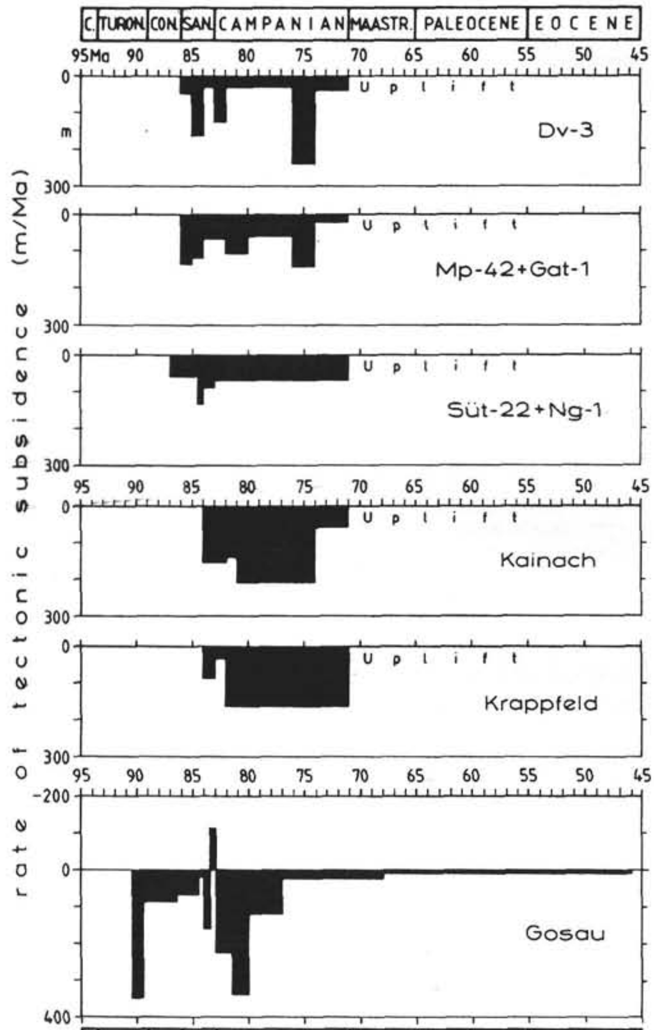
a) Subsidence histories in the NCA show a polyphase evolution with at least two main subsidence events, one in the Late Turonian-Coniacian, one diachronous from the Late Santonian onwards, whereas the TCR curves show a more uniform subsidence.

b) The first strong subsidence phase of the NCA, resulting in deposition of thick alluvial conglomerates in the Late Turonian to Early Coniacian (WAGREICH & FAUPL, 1994), is missing from the TCR sections, where subsidence started significantly later in the Santonian.

c) Total subsidence of the NCA during the second pulse is considerably higher (up to 3000 m) than that of the TCR.

d) Continous subsidence and deep-water sedimentation within the NCA lasted until the early Eocene, whereas the sedimentation in the TCR ended already during the Late Campanian, followed by uplift during the Maastrichtian?/ /Paleocene.

On the contrary remarkable similarities exist between the subsidence histories of the TCR Upper Cretaceous and the Central Alpine Gosau Group in the Kainach and Krappfeld areas. Although uncertainties exist in the dating of the basal terrestrial intervals, the first marine incursions are dated in both areas as latest Santonian to early Early Campanian. During this time relatively high subsidence rates up to 200 m/Ma are recorded both in the TCR and in the Central Alpine area (Fig. 3), leading to the deposition of outer neritic/bathyal marls or turbidites. In both areas the sedimentation ended already in the late Late Campanian. Disconformably overlying



Text-Fig. 3.
Rates of tectonic subsidence for the Gosau Group of the Northern Calcareous Alps at Gosau type locality, the Gosau Group of the Central Alps (Kainach and Krappfeld) and the Upper Cretaceous of the Transdanubian Central Range.

terrestrial deposits both in TCR and the Krappfeld are dated as late Paleocene to Eocene and give evidence for uplift during Maastrichtian to Paleocene.

Within the Great Hungarian Plain (Komádi area) Cretaceous strata give evidence for at least two significant subsidence cycles during Turonian-Coniacian and Late Santonian times (e.g. SIEGL-FARKAS, 1999), thus indicating some similarities to the NCA.

Based on these data and current models for the Late Cretaceous evolution of the Eastern Alps (WAGREICH, 1993, 1995, NEUBAUER et al., 1995; WILLINGSHOFER et al., 1998), it is suggested, that the TCR together with the Central Alpine units formed a southeastern block relative to the NCA, characterized by sinistral wrenching and orogen-parallel extension (NEUBAUER et al., 1995). The NCA, together with parts of the Central West Carpathians (WAGREICH & MARSCHALKO, 1995; FAUPL et al., 1997) were separated from this block and subsidence was primarely controlled by oblique subduction processes of the Penninic oceanic domain northward of the NCA and by dextral strike-slip faulting (Wagreich, 1993, 1995).

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