Jb. Geol. B.-A.	ISSN 0016-7800	Band 133	Heft 2	S. 401-404	Wien, August 1990

Answer to K. WEIDICH's Reply*)

Von WILFRIED WINKLER**)

Vorarlberg
Allgäu
Lechtaler Alpen
Oberkreide
Flysch
Biostratigraphie

Inhalt

Zusammenfassung

Nach WEIDICH's Erwiderung erscheint es notwendig, seine früheren biostratigraphischen Kalibrierungen einiger kretazischer synorogener Sedimente in den Nördlichen Kalkalpen noch einmal auf einer objektiven Basis zu diskutieren. Im weiteren wird ihm vorgeschlagen, den Begriff „Olisthostrom" mit mehr Sorgfalt und im Sinne der ursprünglichen Definition zu verwenden.

Answer to K. WEIDICH's Reply

Abstract

From WEIDICH's reply it appears necessary to discuss again his earlier biostratigraphic calibrations of some Cretaceous synorogenic sediments in the Northern Calcareous Alps on an objective base. Further, it is suggested to him to apply the term "olisthostrome" with more care and in accordance with the original definition.

1. Introduction

Recently, K. WEIDICH and I have worked in Cretaceous synorogenic sediments in the Northern Calcareous Alps. Whereas K. WEIDICH dealt essentially with the biostratigraphy and palaeoecology (e. g. WEIDICH, 1984), I concentrated on sedimentary petrography, sedimentology and inferred palaeotectonic consequences. My original starting points were the complex South Penninic and Austroalpine melanges comprised in the Arosa and Walsertal zones (WINKLER & BERNOULLI, 1986; WINKLER, 1988). We met as my work extended structurally upward and geographically eastward; I mention this, because we have applied different approaches and I was probably more sensitive to tectonic problems.

WEIDICH's discussion is focussed on two outcrop areas treated in both papers (WEIDICH, 1984; WINKLER, 1988). I shall respond to his discussion separately and in so doing give supplementary information I was not able to include in WINKLER (1988). However, I shall not go into detail concerning the biostratigraphic value of the benthic foraminifera indicated by WEIDICH (1984), because of the great uncertainties involved. WEIDICH (1984) and in the present reply discusses thoroughly the arguments for planktic foraminifera, but completely leaves open the even more difficult benthic calibrations!

2. Stoffel-Mühle Area

WEIDICH (1984) gives a too much simplified picture of the tectonic situation in this area, and after my own inspection I concluded that the inferred ages of the undated dolomite breccias enveloped by dated marlstones can be considered only as apparent ages. Generally, the tectonic trend of the beds in the Stoffel-Mühle area does not seem compatible with a simple E-W trending syncline. In detail, the incompetent marlstones and fine grained sandstones are folded on a small scale and lenticulary disrupted, especially near the contacts with the competent, several meters thick, dolomite breccias. With such a high deformation the presence of discordant tectonic planes between competent and incompetent units must be considered as probable. For example the breccia beds in sections A and B in WEIDICH (1984, p. 34) are not necessarily two individual beds, but may represent the same bed separated by a tectonic plane ramping up from Early to Late

*) The reply of K. WEIDICH which is published in the same volume refers to a paper by W. WINKLER „Mid- to Early Late Cretaceous Flysch and Melange Formations in the Western Part of the Eastern Alps. Palaeotectonic Implications" in Jb. Geol. B.-A., **131**/2, S. 341-389, Wien 1988.

**) Author's address: PD Dr. WILFRIED WINKLER, Geologisches Institut, ETH Zürich, Sonneggstraße 5, CH-8092 Zürich.

Cenomanian marlstones. The "erosive" contact could be due to tectonic erosion as clearly seen in isolated outcrops. GAUPP (1980) has described some evident examples of sedimentary erosion by "Blockbrekzien" in the Branderfleck-Schichten, but these facts cannot be inferred a priori to any occurrence of this rock type, especially in the case of bad outcrop conditions and clear tectonic overprint. Such relation should only be revealed by detailed tectonic analysis and petrographic correlation between breccia beds. WEIDICH (e. g. 1984) makes conclusions based solely on his stratigraphic data, disregarding the dominant tectonic overprint which is clear, if one looks close to the rocks.

Concerning the Campanian age for the youngest sediments in the Stoffel-Mühle area (WEIDICH, 1984) general uncertainties arise from the correlation of ammonite zones with foraminiferal zones at the Santonian–Campanian transition (see discussion in BIRKELUND et al., 1983, 15–16). I think we have still to accept that stage boundaries are defined by ammonites and in the present case it is *Placenticeras bidorsatum*, which is very rare. This fact demands more prudence in biostratigraphic calibrations. WEIDICH (1984) reports *Dicarinella asymetrica* and *Globotruncanita elevata*. But, depending on the interpretation, the common occurrence may indicate a Late Santonina (ROBASZYNSKI et al., 1983; CARON, 1985) or Early Campanian age (WEIDICH, 1984; HAQ et al., 1987). MARK's proposition to define the Santonian–Campanian boundary by the extinction of *D. asymetrica* is difficult to prove in the present series, because of the high degree of turbiditic reworking. *Rosita fornicata* (*Globotruncana thalmanni* in WEIDICH, 1984) is not indicative for Campanian (ROBASZYNSKI et al., 1983; CARON, 1985). *Globotruncana calciformis* figured in WEIDICH (1984, plate 18, figures 7–9) appears to represent, after taxonomic revisions, a transitional form between *R. fornicata* and *R. patelliformis* for which a Late Santonian to Early Campanian age is tentatively assumed (ROBASZYNSKI et al., 1983). Therefore, at the moment, an assured Campanian age could only be indicated by *Globotruncana ventricosa* which is not reported by WEIDICH. This is an unsatisfactory situation, but must be accepted.

3. Branderfleck Area

Olistostrome is a rather well defined term introduced by FLORES (FLORES in BENEO, 1955; FLORES, 1959). It appeared in the literature at the early advent of the gravity flow concept and FLORES could convincingly explain how, in Oligocene to Pleistocene series of Sicily, huge and chaotic rock masses could occur without postdepositional tectonic imbrication. Other well documented examples were described e. g. by ABBATE et al. (1981). Tectonics is thought to be responsible, indeed, but as a triggering force leading to catastrophic margin failures by unlocking big rock masses at the basin margin. Immense masses of blocks are supposed to have rolled and slid down to the deeper basin. After FLORES's (1959) definition olistostromes are outstandingly thick and therefore mapable chaotic complexes containing blocks and pebbles of variable size (a few cm to hundreds of meters in diameter) and age (in Sicily, Carboniferous to Oligocene) comprised in a predominantly pelitic, but heterogeneous matrix. I would like to stress in particular the characteristics "mapable" and "heterogenous matrix" and that GAUPP (1980) and consequently WEIDICH (1984) have applied a modified version of the term olistostrome. In my opinion quite unfortunately, FLORES (1959) also added the unprecise meaning "exotic" (exotic blocks etc.) to the definiton, though he well identified their facies and age. About the "exotic" nature of the reworked material comprised in the Austroalpine synorogenic sediments see WINKLER (1988, p. 372). It appears that they all can be derived from older and coeval Australpine and South Penninic sedimentary cover and basement rocks.

In the Turonian to Early Coniacian Branderfleck section (GAUPP, 1980; WEIDICH, 1984; WINKLER, 1988) besides normal turbidite and hemipelagic beds and dolomite breccias. Two somewhat special sediment types occur for which WEIDICH claims the term "olistostrome": These are several meters thick grain supported breccias and one chaotic irregular complex cutting an earlier deposited breccia bed and several turbidites. The latter complex is the "olistromatic bed" in GAUPP (1980) and WEIDICH (1984). This consists essentially of softly deformed and boudinaged (disrupted) turbidite beds and dissociated breccia pebbles all comprised in a pelitic matrix of former turbiditic marls. The close similarity of the adjacent normally layered sediments is evident and therefore the classification as a (mildly displaced) slump is appropriate (WINKLER, 1988, p. 370).

The discussed breccia beds are composed of *Orbitolina*-bearing limestone pebbles (cm to dm in size and well sorted) and a void filling sandy matrix. The pebbles are of variable nature as *Orbitolina*-bearing limestones with considerable amounts of Jurassic and Tithonian radiolarite and calpionella limestone grains (approx. 25 %) obviously derived from an extrabasinal source. There are also associated sparitic limestone pebbles with green algae and miliolids. From thin section it appears that the transition from the *Orbitolina*-bearing pebble to the matrix is very gradational and it can be assumed that the pebbles at the time of reworking were not completely lithified but still soft. The chromite-bearing matrix is qualitatively of the same composition as the associated sandy turbidite beds and the turbidites contain isolated reworked *Orbitolina* ssp. This indicates that the two sediments were derived from at least a similar source. However, it is still to be explained why weakly lithified Orbitolina limestones were reworked.

It is noteworthy that, in the Austroalpine realm, the late Early to late Cretaceous detrital sedimentation occurred in an ever changing scenario of deep basins, shallow water areas and swells. Since e. g. AMPFERER (1924) it is already well known that the Aptian–Cenomanian basinal Kreideschiefer of the Lechtal nappe contains *Orbitolina* ssp. in sandstones and conglomerates (see also WINKLER, 1988). They were obviously transported by turbidites from the shallow water to the deeper basin. In other places transgressive "massive" (WEIDICH, 1984) *Ortbitolina*-bearing deposits occur, discordantly overlying Triassic and Early Jurassic carbonates (e. g. Regau and Wetzstein-Laine sections [WEIDICH, 1984; WINKLER, 1988]). In the transgressive *Orbitolina*-bearing limestones of the Wetzstein-Laine section in comparison with the Branderfleck debris flows there is a similar amount of Triassic extrabasinal dolomite grains. By rapid deepening these

shallow water deposits were covered by marly hemipelagic and later turbiditic deposits. It is therefore reasonable to interprete the *Orbitolina*-bearing limestone pebbles in the Branderfleck section as weakly lithified intrabasinal (sensu ZUFFA, 1980) material reworked by slump and debris flow processes, even though they do not show exactly the same microfacies as in the above quoted sections. The close similarty of matrix and turbidite sands implies that the breccias represent the proximal equivalents of sandy turbidites (see e. g. PRICE, 1977, for a model). If we would follow WEIDICH's suggestion, we should have to consider any coarse grained debris flow or slump intercalated with turbidites in a proximal fan environment as an "olistostrome". WEIDICH's criticism therefore fails, because the sediments discussed can by no means be compared in size, composition and derivation with olistostromes in the original description. I suppose that we can replace FLORES' (1955, 1959) meaning of "exotic" today by the term "extrabasinal" (e. g. ZUFFA, 1980) which is much clearer and more to the point. Flysch turbidite series are in general composed of extrabasinal (terrigeneous) and intrabasinal (allochemical and rip-up) material. Also the dominant occurrence of one of these components and especially those of intrabasinal provenance is no reason to call such beds olistostromes. This therm should be reserved for chaotic masses which are in size and origin comparable with the originally defining complexes.

For the discussion of biostratigraphic evidence in the Branderfleck section we have to include also the nearby Branderschrofen section, because of the close interrelation of the arguments (WEIDICH, 1984). From WEIDICH's criticism above some fundamental differences in working philosophy between him and the group around F. ROBASZYNSKI, M. CARON, J. M. GONZALES DONSO and A. H. WONDERS arise. This is not intended to say that he is wrong, but that there are also other arguments which must be considered. In the Branderfleck and Branderschrofen section a Coniacian to Early Santonian (the latter partly sure, partly with question marks in WEIDICH [1984]) age seemed to me problematic, firstly, because of the really rare presence of *Dicarinella concavata* (one rare and one cf-occurrence out of 21 examples). But WEIDICH (1984) assumes that in the Eastern Alps *Marginotruncana paraconcavata* (PORTHAULT) replaces *D. concavata*. Its combined occurrence with *Dicarinella primitiva*, indeed reasonably points to an Early Coniacian age (ROBASZYNSKI et al., 1983). The Early Santonian (and consequently Late Coniacian) in the Branderschrofen section is inferred by WEIDICH (1984) by the supposed ("working hypothesis", p. 112) lineage: *Hedbergella simplex* – *Rugoglobigerina hoelzli* – *Ru. hexacamerata*. In the Branderfleck section the presence of the agglutinated foraminifera *Tritaxia trilatera* (CUSHMAN or REUSS in WEIDICH [1984, p. 40 or 27]) should be indicative for Santonian. For this benthic foraminifer serious taxonomic uncertainties exist and we cannot find in WEIDICH's papers or the above reply the evidence from which the Santonian age is inferred. Concerning the supposed lineage there seem to me two solutions:

1) The genus *Rugoglobigerina* develops from *Archaeoglobigerina* in Campanian and earlier similar forms have to be considered as *Falsotruncana* (CARON [1966], but not accepted by WEIDICH [1984]) or in particular *F. maslaskovae* (CARON, 1985) or
2) WEIDICH's lineage is correct but in contradiction to other zonations indicating an appearance of *Ru. hexacamerata* in Late Maastrichtian.

This is an experts' dilemma and cannot be solved here. But from objective criteria, i. e. accepted markers, no Late Coniacian or Santonian age can be interpreted (see CARON, 1985). Therefore WEIDICH's evidence for an age younger than Early Coniacian is based on a stack of hypothetical assumptions which one day could prove to be right or wrong. In conclusion we have to admit that WEIDICH's critiques are in part justified (Early Coniacian in the Branderfleck section, indicated as possible in WINKLER, 1988), but younger ages are not satisfactorily proved.

The work of WINKLER (1988) was by no means intended to revise WEIDICH's biostratigraphic data, but to study the relations between provenance and supposed palaeotectonics in the Austroalpine palaeogeographic realm. However, the different approaches we have applied should not prevent their combination.

Acknowledgements

This is a contribution to the Swiss Science Foundation Grant, no. 2.083-0.83. I am indebted to M. CARON and J. P. BECKMANN for biostratigraphic advice. M. CASEY kindly improved the English text.

References

ABBATE, B., BORTOLOTTI, V. & SAGRI, M.: An approach to olistostrome interpretation. – In: RICCHI LUCCHI, F. (Ed.): Excursion guidebook with contributions on sedimentology of some Italian basins, 2nd Europ. Regional Meet. IAS, Bologna, 165–203, 1981.

BIRKELUND, T., HANCOCK, J. M., HART, M. B., RAWSON, P. F., REMANE, J., ROBASZYNSKI, F., SCHMID, F. & SURLYK, F.: Cretaceous stage boundaries – Proposals. – Bull. Geol. Soc. Denmark, **33**, 3–20, 1984.

CARON, M.: Globotruncanidae du Crétacé superieur du synclinal de la Gruyère (Préalpes médianes, Suisse). – Rev. Micropaleont., **9**, 68–93, 1966.

CARON, M.: Cretaceous planktic foraminifera. – In: BOLLI, H. M., SAUNDERS, J. B. & PERCH-NIELSEN, K. (Eds.): Plankton Stratigraphy, 17–86, Cambridge (Cambridge University Press) 1985.

FLORES, G.: Discussion. – In: BENEO, E.: Les résultats des études pour la recherche pétrolifère en Sicilie, Proc. 4th world Petroleum Congr. I, A/2, 121–122, 1955.

FLORES, G.: Evidence of Slump phenomena (olistostromes) in the areas of hydrocarbon exploration in Sicily. – Proc. 5th World Petroleum Congr. I, 259–275, 1959.

GAUPP, R. H.: Sedimentpetrographische und stratigraphische Untersuchungen in den oberostalpinen Mittelkreide-Serien des Westteils der Nördlichen Kalkapen. – Diss. Techn. Univ. München, 282 p., 1980.

HAQ, D., HARDENBOL, J. & VAIL, P.: The new chronostratigraphic basis of Cenozoic and Mesozoic sea level changes. – Cushman Found. Foram. Res., Spec. Publ., **24**, 1987.

MARKS, P.: Proposal for the recognition of boundaries between Cretaceous stages by means of planktonic foraminiferal biostratigraphy. – Bull. Geol. Soc. Denmark, **33**, 163–169, 1984.

PRICE, I.: Deposition and derivation of clastic carbonates on a Mesozoic continental margin, Othris, Greece. – Sedimentology, **24**, 529–546, 1977.

ROBASZYNSKI, F., CARON, M., GONZALES DONOSO, J. M. & WONDERS, A. H.: Atlas of Late Cretaceous Globotruncanids. – Revue Micropal., **26**, 145–305, 1983/1984.

WEIDICH, K. F.: Feinstratigraphie, Taxonomie planktonischer Foraminiferen und Palökologie der Foraminiferengesamtfauna der kalkalpinen tieferen Oberkreide (Untercenoman–Untercampan) der Bayrischen Alpen. – Abh. Bayer. Akad. Wiss., math.-naturw. Kl., N. F., **162**, 151 p., 1984.

WINKLER, W.: Mid to early Late Cretaceous flysch and melange formations in the Western part of the Eastern Alps. Palaeotectonic implications. – Jb. Geol. B.-A., **131**, 341–389, Wien 1988

WINKLER, W. & BERNOULLI, D.: Detrital high-pressure/low temperature minerals in a Late Turonian flysch sequence of the eastern Alps (western Austria): Implications for early Alpine tectonics. – Geology, **14**, 598–601, 1986.

ZUFFA, G. G.: Hybrid arenites: their composition and classification. – J. Sediment. Petrol., **50**, 21–29, 1980.

Manuskript bei der Schriftleitung eingelangt am 15. März 1990.