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Correlating Marine Palynomorph Variations with Sequence Boundaries of Upper Jurassic Sediments in a Basin of Northern Switzerland

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Abstract

Variations in the number of dinoflagellate cysts species recovered from the Rhodano-Swabian sedimentary basin in northern Switzerland have been correlated with sequence and sedimentary cycles established for this basin. The variation in dinoflagellate cyst abundance corroborates the sequence boundaries erected by Gygi *et al*. (1988) using other parameters such as lithology and macrofossil content of the sediments. Highstands of sea level are marked by a sharp increase in species diversity (sometimes up to 50). In contrast, lowstands are indicated by a sharp decline in the abundance of species: in a case only 3 species.

Keywords: *Dinoflagellates, Upper Jurassic, Sequence boundaries, Switzerland.*

Introduction

In 1992 ten different localities across the Rhodano-Swabian sedimentary basin in northern Switzerland were sampled (Fig. 1) and over 120 samples from Upper Jurassic sediments were collected. A comprehensive project was undertaken to study the palynomorph content and the paleoenvironment of this basin from 1992 to 1995. The results were published in a voluminous monograph by the author and his colleagues in 1999 (Ghasemi Nejad *et. al*. 1999). When this monograph was in press, sequence stratigraphy of the same sediments was published and sequences, cycles and boundaries were established by Gygi and his colleagues (Gygi *et al*. 1998). This recent work of Gygi and colleagues brought the question to my mind "whether or not marine palynomorphs can confirm the sequence boundaries erected for the sediments". Thanks to my computer who had kept all the data handy and available. I was in a position to re-examine and correlate the results obtained from the variation in the abundance of marine palynomorphs with the sequence boundaries erected by Gygi and colleagues by using other characters such as lithology and paleontology. This paper is therefore the result of statistical calculations on dinoflagellate cyst abundances and a comparison with the results published by Gygi *et al*. in 1998.

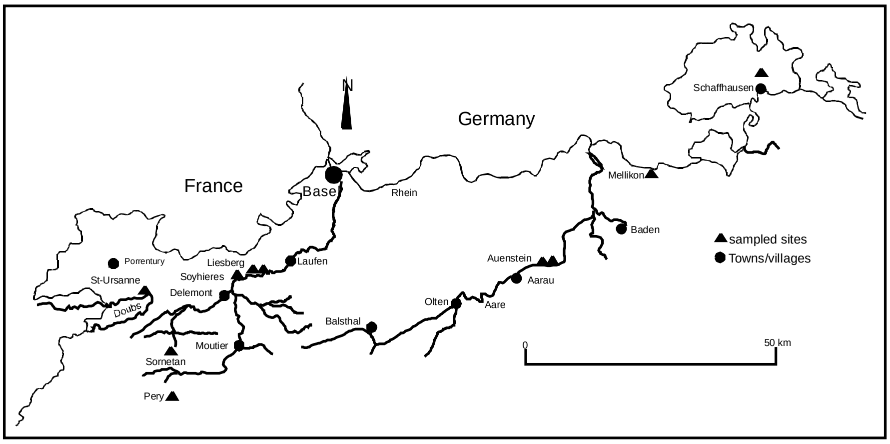

Figure 1 - Location map of the studied area and the sampled sites.

Stratigraphy

Sedimentation in northern Switzerland began in an epicontinental sea adjacent to the Tethys. The depth of this sea was least in the northwestern and greatest in the south-eastern part (Gygi, 1990)

The rate of sediment supply has been about zero just before the end of the Middle Jurassic. Consequently, this sea was a starved basin from mid Callovian to earliest Oxfordian time. Sedimentation recommenced slowly at the beginning of the Oxfordian and produced a thin, widespread marker bed of iron-oolitic marl of the upperrmost Herznach Formation (Gygi 2000).

Gygi (1986) concluded that, from a palaeodepth of about 80 meters downward, cephalopods comprised more than 80% of the macrofauna. The macrofauna of the iron-oolitic horizon at the base of the Renggeri Member near Péry is 84% cephalopods (Gygi & Persoz, 1986). These iron oolites and the cephalopod fauna dominating this layer therefore indicate a water depth of less than 100 meters (Gygi 1981, Gygi & Persoz 1986).

The abundance of iron ooids decreases towards the top of the marker bed and fades away completely at the base of the Renggeri Member as a result of an increasing rate of sedimentation where the blue-gray marl-clay of the member begins. The boundary between the Middle and Upper Jurassic in northern Switzerland is therefore placed within the ferruginous marl-clay below the Renggeri Member (Gygi *et al*. 1998, Ghasemi-Nejad *et al*. 1999).

The thin ferruginous layer is overlain by a mass of blue-gray marl-clay of the Renggeri Member that is several tens of meters thick in the Clay Pit at Ampthil near Liesberg (Fig. 2). The macrofauna of the lower Renggeri Member consists mostly of cephalopods, although other organisms such as bivalves, gastropods, brachiopods and crinoids have also been reported (Gygi 1986, Gygi & Persoz 1986).

In northwestern Switzerland, the Renggeri Member is overlain by the Terrain à Chailles Member, composed of 40 to 50 meters of gray marls with bands of limestone concretions and, in some areas, bands of marly limestone (Gygi *et al*. 1998).

The gray marls, with bands of limestone concretions, of the Liesberg Member overlie the Terrain à Chailles Member. The Liesberg Member differs from the Terrain à Chailles in having less interspace between the nodule bands and in the irregular shape of the nodules (Gygi & Persoz 1986).

The carbonate platform deposits of the St-Ursanne Formation, whose thickness varies between 35 and 95 meters in different areas, overlie the Liesberg Member. At the distal margin, the formation contains coral bioherms that are in turn replaced further basinward (eastward) by a succession of well-bedded limestones and lime mudstones of the Pichoux Limestone. The Pichoux limestone, a sediment of the platform slope, is transitional between the platform deposits of the St-Ursanne Formation with corals and the basinal Birmenstorf Member that belongs to the ammonite facies (Gygi 1986). The Birmenstorf Member in the east is a biostrome of siliceous sponges with abundant ammonites and has an average thickness of about 5 meters (Gygi 1992, Gygi & Persoz, 1986).

Figure 2 - Time stratigraphic position of Callovian-Oxfordian lithostratigraphic units of the northern Switzerland sedimentary basin (from Gygi 2000 with some changes)

Sequence boundaries versus variations in Palynomorph abundances

A carbonate platform was established in the northwestern Switzerland sedimentary basin by Middle Oxfordian time. This platform continued to exist throughout the Late Jurassic. Recent studies by Gygi and colleagues (Gygi *et. al*. 1998) have indicated that the Oxfordian sediments as a whole represent a 2nd-order regression- transgression cycle, punctuated by eight 3rd-order cycles.

The start of transgression is marked by a decrease in the terrigenous influx and retrogradation of the carbonate facies across the carbonate platform. Maximum flooding is characterized by a slowdown or even termination of the growth of coral reefs on the platform, condensation of the beds and some times by the deposition of a condensed fossiliferous horizon in the basin (Gygi *et al*. 1998).

The top of the Lamberti Bed in the upper Herznach Formation (Callovian-Oxfordian boundary) is interpreted as a maximum flooding surface because of the rich macrofauna and condensed nature of the bed (Gygi *et al*. 1998). The overlying 20 cm calcareous, slightly silty claystone with scattered iron ooids of the uppermost Herznach Formation (Gygi, 2000) directly below the Renggeri Member and the lower part of the overlying slightly silty calcareous claystones of the Renggeri Member comprise the highstand system tract (Gygi *et al*. 1998). Sample #2 of Ghasemi Nejad *et al*. (1999) was taken from the calcareous claystone with iron ooids directly below the Renggeri Member and contains 58 species of dinoflagellate cysts (Fig. 3).

The Renggeri Member comprises about 70 m of monotonous poorly bedded, silty claystone with scattered ammonites, belemnites, and brachiopods. There is a sharp color change in the middle of the member from a light bluey-gray below to a more uniform light gray above, that is coincident with an increase in silt content and is interpreted as sequence boundary O1 (Gygi *et al*. 1998). Sample #7 of Ghasemi Nejad *et al*. (1999) was taken from the layer forming the upper boundary of the first cycle, O1. Only 12 dinoflagellate cyst species were recorded from sample #7, whereas 50 species were found in the preceding sample #6. This confirms the results obtained from lithological and paleontological studies by Gygi *et al*. (1998).

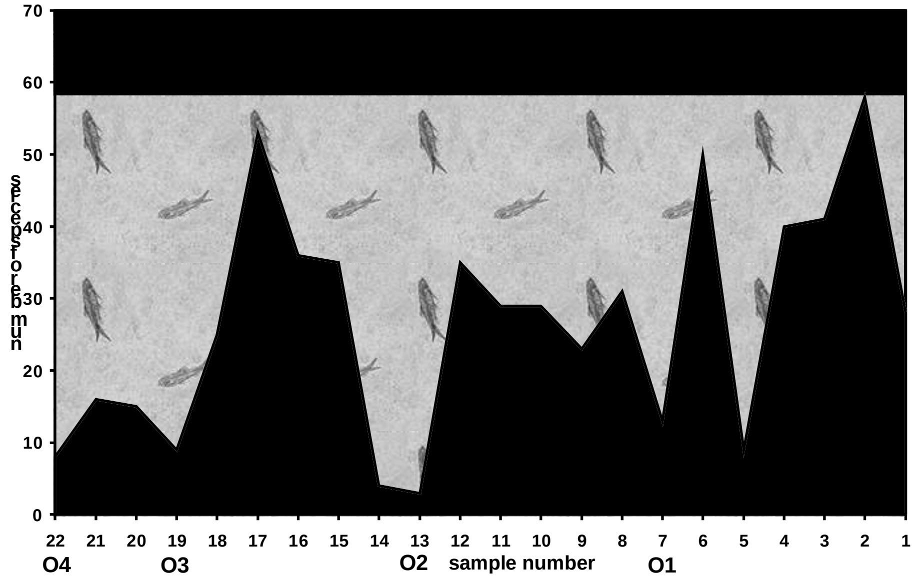

Figure 3 - Number of marine palynomorph species versus sample number for Upper Jurassic strata of the northern Switzerland sedimentary basin.
O1 - O4: Boundary of cycles
Sample #1: Calcair Roux Sableux unit
Sample #2: Iron oolitic unit
Sample #3 - #11: Renggeri Member
Sample #12 - #19: Terrain à Chailles Member
Sample #20 - #21: Liesberg Member
Sample #22: St-Ursanne Formation

The Renggeri Member is overlain by the more calcareous Terrain à Chailles Member. The sharp change to more carbonate-rich facies at the base of the Terrain à Chailles Member represents a shallowing of the sea water and is interpreted as representing the upper boundary of the second cycle, O2, at its correlative conformity (Gygi *et. al*. 1998). Unfortunately data and palynological slides from the base of the Terrain a Chailles Member were not available for re-examination. However, sample #13 of Ghasemi Nejad *et al*. (1999) taken from about

13 meters above the border between the Renggeri and Terrain à Chailles Members indicates a sharp decline in number of species with only 3 recorded species. The number of species is especially important when compared with that of the preceding sample (#12) taken from four metes below in which 35 species have been recorded. This therefore may indicate existence of a boundary that has not been detected by Gygi and his colleagues (1998). In the present paper this boundary has been marked as O2 (Fig. 3). However, if future studies confirm existence of this boundary then the formerly determined cycle boundaries have to be changed accordingly.

The upper part of the carbonate-rich Terrain à Chailles Member contains several thick, well-defined limestone beds interbedded with marl-clay. The first thick tabular limestone is interpreted as the upper boundary of the third cycle, O3. This boundary corresponds with the layer from which sample #19 was taken. Only nine species of dinoflagellate cysts are recorded from this sample and compared with the preceding sample (#18) with 53 species, confirm the layer as of being the boundary.

Samples #20 and #21 were taken from the Liesberg Member overlying the Terrain à Chailes Member. Only a smooth increase in number of dinoflagellate cysts recorded from these samples is visible on Fig. 3. The Liesberg Member is overlain by the St-Ursanne Formation with a basal oncolitic and oolitic grainstone. The base of the St-Ursanne Formation is interpreted as the sequence boundary O4 (Gygi *et al*. 1998). The lower part of this formation is interpreted as shelf-margin systems tract.

Sample #22 was taken from the base of the St-Ursanne Formation. Only seven species have been recorded from this sample while, sample #21 includes 17 species. This also confirms the base of the St-Ursanne Formation as being the sequence boundary O4.

Conclusion

Increases and decreases in the number of dinoflagellate cyst species recorded from the Upper Jurassic sediments of the Rhodano-Swabian basin in northern Switzerland can be correlated with sequence boundaries established for these sediments. Variations in the number of species confirm the erected boundaries by using other characters such as lithology and paleontology. The upper boundary of the second cycle of Gygi and his colleagues could not be confirmed because data and palynological slides of the samples from the layers forming this border were not available for re-examination. However, a sharp decrease in number of dinoflagellate cyst species was recorded within 13 meters from the base of the Renggeri Member and this may also be marked as a boundary that was not detected by Gygi and his colleagues (1998).

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