THE TYPE-LOCALITY OF THE PLASSEN FORMATION (KIMMERIDGIAN - BERRIASIAN) – NEW DATA ON STRATIGRAPHY, FACIES AND SEDIMENTOLOGY AND IMPLICATIONS FOR THE INTERPRETATION OF THE JURASSIC TECTONIC HIOSTORY OF THE NORTHERN CALCAREOUS ALPS

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Abstract: Reinvestigation of the type locality of the Plassen Formation (Kimmeridgian – Berriasian) in the Northern Calcareous results in: 1) The stratigraphic range is Kimmeridgian to Lower Berriasian, 2) The sedimentation starts with a prograding platform (Kimmeridgian) with a southeastern margin, 3) In Tithonian to Lower Berriasian times a transgressive/regressive controlled sedimentation dominates, 4) In Lower Berriasian subsidence increase forming a northwestern margin.

Key words: Plassen Formation, Northern Calcareous Alps, Upper Jurassic

The onset of the Upper Jurassic carbonate platform in the Northern Calcareous Alps after the diachronous genesis of the carbonate clastic radiolaritic flysch basins in connection with the closure of the Tethys Ocean is still poorly known. Generally, the Upper Jurassic carbonate platform is interpreted as neoautochthonous cover (Late Oxfordian to Late Berriasian) after the late Middle to early Upper Jurassic tectonic event representing a phase of tectonic quiescence. New investigations show, that cherty sediments, partly with allodapic material from the shallow water areas occur until early Tithonian. The onset of shallow water carbonates has also been diachronous due to basin and rise formation during Upper Jurassic times.

According to the present-state of knowledge, the type-locality of the Plassen Formation (PF) is still poorly known with respect to its biostratigraphic range, facies and facies evolution in the geodynamic context. Based on new sampling, a synoptic profile, ranging from the lowermost Kimmeridgian to the Lower Berriasian, can be reconstructed by means of microfacies analysis combined with biostratigraphic data. On the basis of an idealized profile from the SE of Mount Plassen towards the summit, the following facies zones can be distinguished

- 1) slope facies (Lower/Upper Kimmeridgian)

- 2) Platform margin and back-„reef" facies (Upper Kimmeridgian/lower Tithonian)
- 3) Tidal Flat (Lower Tithonian)
- 4) Open lagoon (Lower, ? Middle Tithonian)
- 5) Tidal Flat (Middle Tithonian)
- 6) Open Lagoon (Middle?-Upper Tithonian)
- 7) Closed Lagoon (Upper Tithonian, ? lowermost Berriasian)
- 8) „Reef-debris facies (Lower Berriasian)
- 9) Upper slope facies (Lower Berriasian) (end of the section)

Facies 1)-2): The initiation of the carbonate platform evolution can be observed at the outcropping limestones at the southeastern slope of Mount Plassen (Tab. 1).

Microfacies	**Sample (example)**	**Facies interpretation**	**Stratigraphy**
Grainstones with trocholinas, *Salpingoporella* gr. *pygmaea* (GUEMBEL), Rivulariacean algae, *P. striata* WEYNSCHENK, *„Kilianina" rahonensis* FOURY & VINCENT, *Kurnubia palasiniensis* HENSON, coral-/ hydrozoa remains	PL 12	Back-„reef" facies"	Uppermost Kimmeridgium, ? p.p. Lowermost Tithonian
Grainstones with *Labyrinthina mirabilis*WEYNSCHENK, *Protopeneroplis striata* WEYNSCHENK, coral-/ hydrozoa remains, lituolid foraminifera	PL 9	Platform margin (swell facies)	Upper Kimmeridgian
Rudstones with hydrozoa, *Labyrinthina mirabilis* WEYNSCHENK	A 41		
Packstones with *Labyrinthina mirabilis* WENSCHENK, *T. morronensis* CRESCENTI, *Mercierella*? *dacica* DRAGASTAN	PL 6 A 39	Upper slope	
Packstones with echinoids, *Tubiphytes morronensis* CRESCENTI, lenticulinas	PL 5	Middle ? lower slope	Lower or Upper Kimmeridgian
Wackestones, fine-grained packstones with Echinoids, „Protoglobigerinas" (reddish limestones), occassionally *Protopeneroplis striata* WEYNSCHENK, *Carpathiella* sp.	PL 4, 4a	Lower, middle? slope	Lower Kimmeridgian
Wackestones with „Protoglobigerinas" without resedimented neritic detritus	postulated	Lower slope, basin transition	

Tab. 1. Initial stadium of the platform evolution of the Plassen Formation of the type locality

Noteworthy, that in the older Alpine literature the „Protoglobigerinas" have most often been refered to *Globigerina oxfordiana* GRIGELIS with special stratigraphic implications. These forms, however, known since the Bajocian are prominent throughout the whole Upper Jurassic and only occassionally these can be attributed to the generic or even species level in thin-sections (WERNLI & GÖRÖG 2000). The studied samples typically reflect a shallowing upwards sequence from the lower slope to the internal platform. With the occurrence of *Labyrinthina mirabilis* WEYNSCHENK and rarely also *Clypeina sulcata* (ALTH) the upper slope deposits can be attributed to the Upper Kimmeridgian. This is in good accordance with biostratigraphic data obtained from the strata underlying the PF. These are represented by cherty limestones/radiolarites of Upper Oxfordian to Lowermost Kimmeridgian age. The intial high-energetic swell areas of the *Labyrinthina* grainstones were the source area for bioclastic debris transported into the adjacent radiolarite basins (MISSONI et al. 2001). Within these breccias the characteristic association of *Protopeneroplis* and *Labyrinthina* can also be observed.

Facies 3) and 5): Within this facies we find algal-bindstones, mud-conglomerates and intraformational erosional structures, breccias (? tidal channel deposits or signs of emersion) fenestral limestones and mudstones with idiomorphic dolomites. The latter can either occur as peloidal packstones or as wacke- to mudstones. Within the wackestone typus the sparitic vugs also display fine-grained internal sediment at the base and also elongated sparite-filled structures interpreted as air bubbles trapped within the sediment. The tidal flat deposits occur twice within the reconstructed profile separated by open lagoonal limestones. Microfossils include anomuran coprolites, rivulariacean alga and *Lithocodium*-thaumatoporellacean globules. Dasycladales are rare.

Facies 4) and 6): These biosparitic limestones that are widespread along the eastern slope of Mount Plassen, are characterized by the dominance of rivulariacean algae (former „Porostromata“). Within this facies oncoids typically occur and occassionally also idiomorphic dolomites can be observed. Amongst the dasycladales, *Clypeina sulcata* (ALTH) and *Salpingoporella annulata* CAROZZI are the most frequent ones. Benthic foraminifera comprise *Protopeneroplis striata* WEYNSCHENK, *Nautiloculina oolithica* MOHLER and *Troglotella incrustans* WERNLI & FOOKES just to name a few. The open lagoonal limestones of facies 6) include monospecific packstones with *Cambelliella striata* (CAROZZI), *Clypeina sulcata* (ALTH) and an association of both mentioned taxa. Foraminiferal packstones with abundant *Pseudocyclammina lituus* (YOKOYAMA) *and Redmondiella lugeoni* (SEPTFONTAINE) and small miliolids also occur.

Facies 7): The closed lagoon is dominanted almost exclusively by micritic microfacies types. These include gastropod limestones (floatstones, wackestones, densely packed lumachelle), mudstones, foraminiferal and dasycladalean wackestones. The latter show different types that can be distinguished by their dominance of certain taxa or associations. Thus we find monospecific wackestones with *Clypeina sulcata* (ALTH), association of *Salpingoporella annulata* CAROZZI with *Rajkaella* cf. *bartheli* (BERNIER) and *Clypeina parasolkani* FARINACCI & RADOICIC. Within foraminiferal-dasycladalean wackestones, sometimes *Otternstella lemmensis* (BERNIER) is the dominating floral element. Foraminiferal wackestones contain *Bramkampella arabica* REDMOND, *Nautiloculina oolithica* MOHLER and *Ammobaculites* sp. The topmost parts of the internal laggonal facies consists of fine-grained packstones already showing a certain increase of hydrodynamic with *Pseudocyclammina lituus* (YOKOYAMA) together with *Salpingoporella sellii* CRESCENTI and the thalli of *Thaumatoporella parvovesiculifera* (RAINERI). The next samples taken near the summit of Mount Plassen already are reefal debris limestones.

Facies 8): By means of an abrupt facies change, the continuation of the profile shows typical debris facies (e.g. rudstones, bioclastic packstones) with abundant corals, calcisponges, solenoporacean algae, dasycladales with *Terquemella*? *concava* BERNIER, *Epimastoporella*? *jurassica* ENDO and *Linoporella* sp. and foraminifera including *Coscinophragma cribrosa* (REUSS) und *Protopeneroplis ultragranulata* (GORBATCHIK). A characteristic microproblematica is represented by *Carpathiella triangulata* MISIK et al., interpreted as serpulid tubes. Biolithic facies has not been observed in our samples, but the richness of coral debris points to the occurrence of small patch-reef areas. In accordance with FENNINGER & HÖTZL (1965), the PF of the type-locality as a whole can not be regarded as „reefal limestones".

Facies 9): From microfacies point of view this facies is directly comparable to the Upper Kimmeridgian slope deposits, but with taxa, e.g. *Protopeneroplis ultragranulata* (GORBATCHIK) indicating a Lower Berriasian age in the reconstructed profile. These packstones rich in echinoid debris and *Tubiphytes morronensis* CRESCENTI are the topmost samples taken. Younger deposits, assumed as middle and deeper slope facies, however, can be expected on the northwestern slope of Mount Plassen.

Discussion and Conclusions: The succession of the PF at the type-locality reflects a complete sedimentary succession from the installation of a carbonate platform by a shallowing-upwards sequence (Kimmeridgian), with more or less stable conditions during the Tithonian followed by a final drowning (Berriasian). The shallowing-upwards sequence (facies 1-5) is terminated by tidal flat deposits exhibiting indications of emersion. This first progradational cycle above cherty limestones is characterized by a short trangressive pulse during the lower Tithonian between facies 3) and 4). The timing of the lowest sea-level (LST) can be placed approximately in the Middle Tithonian. The upper part of the PF (upper Tithonian-Lower Berriasian) is represented by a transgressive succession (facies 7-9) comparable with the results obtained from the locality Trisselwand (SCHLAGINTWEIT & EBLI 1999a). Noteworthy the obvious missing of a real transition between the closed lagoon and the reefal facies expressed by an abrupt facies change. This telescoping of facies zones might be explained by the platform paleomorphology and/or tectonism. Moreover, the Kimmeridgian slope deposits, filling up a radiolaritic basin, seem to have reduced thicknesses in comparison to the equivalent facies occuring during the final drowning (Berriasian) indicating increasing subsidence. Differences are the obvious missing of the *Tubiphytes-Terebella* association co-occurring with siliceous sponges in the Kimmeridgian. Taking into account the field situation exposed, a northwestern paleoslope can be assumed during the Berriasian. In this context, the transgressive character during a time of global sea level lowering points to decreasing carbonate production being in general accordance with an increasing of clastic influx in the adjacent basin areas (Oberalm Formation - Schrambach Formation). This deepening succession starting in the Middle/Upper Tithonian indicates a tectono-sedimentary control during the upper part of the PF genetically linked with ongoing tectonic shortening in the Tethyan realm.

The new observations made contradict previous assumptions that the Plassen Formation rests with basal conglomerates on Triassic carbonates and that a large gap existed during the Lower/Middle Jurassic. Based on the microfacies analysis and the field-occurrences it is concluded, that the sedimentation took place on a plateau like block probably assymetric with a more gentle southern/southeastern slope. From a morphological point of view, these conditions are different from the Lofer area, where the Plassen-Formation occurs on a southward dipping ramp (SCHLAGINTWEIT & EBLI 1999b). These differences accounted for varying microbiota and lithological features (clastic Lofer Member).

The up to now prefered distinction of a lower micritic and upper sparitic part of the PF (e.g. FENNINGER 1967) is an incorrect approach for the type-locality. The micritic facies of the closed lagoon (type I, FENNINGER & HÖTZL 1965) of Upper Tithonian age is definitely younger than the sparitic type II. This misinterpretation based on determinations of hydrozoa shows that this group cannot or only with little significance be used for biostratigraphic purposes.

The analysis of the type locality shows a tectonic and sea-level change controlled sedimentaion of the Plassen Formation starting with high sedimentation rates in the Kimmeridgian (prograding platform) filling up a radiolaritic basin (Sillenkopf Basin).

For a complete reconstruction of the Late Jurassic to Early Cretaceous shallow water carbonte platform in the Northern Calcareous Alps in time and space, further large-scale investigations of stratigraphy and facies of both, the platform carbonates itselfes, the adjacent basin sediments and the underlying strata are strongly needed. Only on the basis of this, it will be possible in the future to establish reliable facies and paleogeographic reconstructions during the Upper Jurassic besides the polyphase evolution of radiolarite basins (Callovian-Tithonian) (GAWLICK et al. in press).

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