The Cretaceous of the Elbe valley in Saxony (Germany) - a review

Karl-Armin TRÖGER[1]

Abstract: In Central Europe one of the most important interchanges between the North Temperate Realm and the Tethyan Realm took place during the Cenomanian along the course of the Elbe Valley Geosuture that separates the Erzgebirge block (part of the Mid European Island during the Cretaceous) from the Lusatian block (West Sudetic Island). Strata of the Lower Cretaceous and the basal portion of Lower Cenomanian are absent in the Elbe Valley Geosuture but a marine transgression in a NW-SE direction occupied a portion of this tract during the late Early Cenomanian and a second incursion from SE to NW occurred during the Late Cenomanian. These transgressions are known to have occurred because of faunal migrations southwards from the North Temperate Realm and northwards from the Tethyan Realm across the Bohemian Basin. Sediments of the first transgression (Lower Cenomanian, *dixoni* zone) are restricted to the northwestern part of the Elbe Valley Geosuture in the Meissen area for at that time the fluvial Niederschöna Formation occupied the southern part of the Elbe Valley Geosuture and the adjacent Erzgebirge block. Most of the rivers in this system ran eastward but drained toward northern Bohemia. This fluvial environment predominated in the southern part of the Elbe Valley Geosuture and on the adjacent Erzgebirge block.

But the uppermost levels of the fluviatile Niederschöna strata are influenced by marine ingressions. The main transgression from the North Temperate Realm toward the Tethyan Realm took place in the basal Upper Cenomanian (*naviculare* zone) along the Elbe Valley Geosuture. A small regression followed (*plenus* event, *geslinianum* zone): Indications of this regression are visible on the flanks of small islands in the Elbe Valley Geosuture. Four marine sequences are recognized in strata dated Late Cenomanian - earliest Turonian.

These sequences are important for the comparison of Upper Cretaceous formations in Saxony with those of the Upper Cretaceous in northern Bohemia and in the peripheral areas of the NW German-Polish Basin, in the Münsterland, Subhercynian, Eichsfeld regions and in the Anglo-Paris Basin. These sequences are described and their influence on the changes in the paleogeography in the Elbe Valley Geosuture is discussed. Slight variations in sea level as a consequence of local tectonic movements in the Elbe Valley Geosuture cannot be precluded.

Key Words: Cretaceous; Cenomanian; Germany; Saxony; Elbe valley; transgression

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Résumé : ***Le Crétacé de la vallée de l'Elbe en Saxe (Allemagne).-*** En Europe centrale, une importante zone de communication entre le domaine téthysien et le domaine boréal tempéré s'est constituée le long de la géosuture de la vallée de l'Elbe qui sépare le bloc des Monts Métallifères de l'Erzgebirge (partie de l'ile médio-européenne au Crétacé) du bloc lusatien (ile sudétique occidentale). Les dépôts du Crétacé inférieur et du Cénomanien inférieur basal sont absents de la géosuture de la vallée de l'Elbe, mais des trangressions marines se sont effectuées dans ce sillon d'abord selon une direction NW-SE (partie supérieure du Cénomanien inférieur), puis plus tard du SE vers le NW (Cénomanien supérieur). Ces dernières sont surtout documentées par des migrations faunistiques qui alternent. La première transgression marine se situe dans la partie supérieure du Cénomanien inférieur : Zone à *dixoni*. Les sédiments associés à cette transgression ne se rencontrent qu'aux environs de Meissen dans la partie nord-occidentale de la géosuture de la vallée de l'Elbe. Une connexion marine avec le Crétacé supérieur de la Bohême septentrionale est à exclure à cette époque. Le système fluviatile de direction E-W de la Formation Niederschöna (Formation Peruc dans la Bohême septentrionale) avec un drainage vers la Bohême septentrionale occupait à cette époque la région de la Vallée de l'Elbe et la partie nord du bloc des Monts Métallifères et de celui, adjacent, de l'Erzgebirge.

Les termes ultimes de cette formation fluviatile comportent localement des influences marines. Les principales transgressions qui conduisirent à une connexion des deux provinces faunistiques en suivant la géosuture de la vallée de l'Elbe ont eu lieu au Cénomanien supérieur. De manière générale, il s'agit d'une très importante transgression basale (Zone à *naviculare*) et d'une légère transgression ("*plenus* event", Zone à *geslinianum*) qui seront suivies d'une très petite régression. Cette dernière n'est en effet reconnaissable que sur les flancs des îlots continentaux et autour des seuils à l'intérieur de la vallée de l'Elbe. Quatre séquences marines sont reconnues jusqu'à la base du Turonien inférieur.

Ces séquences mettent en relation, d'une part, le Crétacé supérieur de la Bohême septentrionale et, d'autre part, le Crétacé supérieur du Bassin allemand nord-occidental avec ses bordures dans le sud du Münsterland, dans la partie méridionale du Bassin subhercynien et dans le Bassin d'Eichfeld, ainsi que dans le Bassin anglo-parisien. L'intérêt de ces séquences cénomaniennes et des changements de la paléogéographie qu'elles impliquent doit être souligné. Une légère variation du niveau eustatique due aux mouvements tectoniques n'est pourtant pas à exclure.

Mots-Clefs : Crétacé ; Cénomanien ; Allemagne ; Saxe ; vallée de l'Elbe ; transgression

[1] *Geologisches Institut BAF, Meißer-Bau, Zeunerstr. 12, Freiberg /Sa. D-09596 (Germany)*
e-mail: troeger@geo.tu-freiberg.de
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Kurzfassung: Kreide im sächsischen Elbtalgebiet (Deutschland).- Eine der wesentlichen Verbindungen des tethyalen Faunenreiches mit dem nördlichen gemäßigten Faunenreich liegt in der Elbtalzone zwischen den Blöcken des Erzgebirges (Teil der Mitteleuropäischen Insel) und der Lausitz (Westsudetische Insel). In der Elbtalzone fehlen marine Sedimente des tieferen Unter-Cenomans und der Unterkreide. Transgressionen in die Elbtalzone erfolgten im Cenoman von NW nach SE (höheres Unter-Cenoman) sowie vom SE nach NW (Ober-Cenoman). Das wird vor allem durch wechselnde Faunen - Migrationen belegt. Die erste marine Transgression erfolgte im höheren Unter-Cenoman: *dixoni* Zone Sedimente dieser Transgression befinden sich nur im nordwestlichen Teil der Elbtalzone in der Umgebung von Meißen. Eine marine Verbindung mit der Nordböhmischen Oberkreide ist zu dieser Zeit auszuschließen. Das etwa E-W verlaufende Flußsystem der Niederschöna Formation (Peruc Formation in Nordböhmen) mit einer Entwässerung nach Nordböhmen beherrschte zu dieser Zeit den Raum der Elbtalzone und des Nordteiles des Erzgebirges-Blockes.

Die obersten Teile dieser Formation sind teilweise marin beeinflußt. Die wesentlichen Transgressionen,die zu einer Verbindung beider Faunenreiche unter Nutzung der Geosutur der Elbtalzone führten, fanden im Ober-Cenoman statt. Insgesamt gesehen handelt es sich um eine basale größere Transgression (*naviculare* Zone) und eine kleinere Transgression ("*plenus* event", *geslinianum* Zone), die durch eine kleinere Regression getrennt werden. Diese Regression ist allerdings nur an Insel- und Schwellenzonen innerhalb der Elbtalzone zu erkennen. Bis zur Basis des Unter-Turons lassen sich 4 marine Sequenzen erkennen.

Diese Sequenzen erlauben einerseits eine Anbindung an die Oberkreide Nordböhmens und andererseits an die Oberkreide des Nordwestdeutschen Beckens mit seinen Randbereichen im südlichen Münsterland, dem S Rand des Subherzynen Beckens und im Eichsfeld sowie des Anglo-Pariser Beckens. Im einzelnen soll besonderer Wert auf die Besprechung der cenomanen Sequenzen und der mit ihnen im Zusammenhang stehenden Veränderungen der Paläogeographie gelegt werden. Eine mögliche geringfügige Variierung der "sea level changes" durch tektonische Bewegungen ist dabei nicht auszuschließen.

Schlüsselwörter: Kreide; Cenomans; Deutschland; Sachsen; Elbtalgebiet; Transgression

Introduction

In Saxony strata of Cenomanian age crop out in the Elbe valley between Meissen, Dresden, Pirna and the boundary of the Czech Republic (Lower Cenomanian through Middle Coniacian), in erosional outliers south of the Elbe Valley (Cenomanian through Lower Turonian: the most important erosional outliers are the Tharandt Forest and the Dippoldiswalde Heath), in the Zittau Mountains (Cenomanian through Lower Coniacian) and N of Görlitz (Upper Cenomanian through Upper Santonian): Fig. 1.

The Cretaceous of the Elbe Valley is similar to that of North Bohemia. Figure 2 is based mainly on a table in PRESCHER (1981) that compares the Cretaceous stratigraphy of the Elbe valley in Saxony with that of northern Bohemia. The Cretaceous of the Zittau Mountains is an extension of the North Bohemian Cretaceous whereas the Cretaceous N of Görlitz is a western prolongation of the North Sudetic Cretaceous succession of Poland. The Cretaceous of the Elbe Valley and that of erosional outliers nearby is confined to the NW-SE trending Elbe Valley Geosuture that separates the Lusatian block (Precambrian: West Sudetic Island in SCUPIN (1937)) and the Erzgebirge Block (Precambrian but including parts of the Hercynian Saxothuringian zone: Mid European Island): Fig. 1.

The Cretaceous of the Elbe Valley is fundamental for demonstrating migrations of fauna and flora between the North Temperate Realm in the north and the Tethyan Realm in the south for the Elbe Valley Geosuture was one of the most important connections between the two. Faunal migrations took place initially from NW to the SE and later from SE to NW successively during Early and Late Cenomanian times. The deposition of Cenomanian strata in the Cretaceous of the Elbe Valley and adjacent southern erosional outliers was influenced by tectonic movements within the Elbe Geosuture as well as by global changes in sea level. The effects of these discrete phenomena can best be studied on the islands and submarine swells (basement highs rising above surrounding sea-floor sediments) in the central portion of the Elbe valley Cretaceous.

The following chapters give an overview of the biostratigraphy of Cenomanian formations and of sequence stratigraphy in the Cretaceous of the Elbe Valley including the development of a marginal trough south of the Lusatian block.

Biostratigraphy

Niederschöna Formation

The mainly fluviatile Niederschöna Formation yields a megaflora with several species of *Credneria* described by GÖPPERT (1865), ETTINGSHAUSEN (1867), ENGELHARDT (1885, 1891), and PRESCHER (1957). All plant relics, including spores and pollens, are poorly preserved in Saxony. Using pollen grains KRUTZSCH (1963, 1966) demonstrated the Albian-Cenomanian age of the Niederschöna Formation. In the adjacent Czech Republic the basal levels of the Peruc Formation yielded tricolpate and tricolporate forms of pollen and in the upper part contained tricolporate pollens together with rare *Normapolles*, all indicating a Cenomanian age (PACLTOVÁ, 1971, 1977, 1978, 1981). In Saxony the marine influence in the uppermost Niederschöna Formation is confirmed by an

ichnofauna - *Thalassinoides saxonicus* (GEINITZ) - and small glauconitic lenses.

Meissen Formation

The type locality of the Meissen Formation (LEONHARD, 1834; PRESCHER & TRÖGER, 1989) in Meissen-Zscheila (Fig. 3, 4) yields an assemblage containing key fossils of the *dixoni* zone (uppermost Lower Cenomanian: Fig. 3) including the *virgatus* event of the NW German-Polish Basin with *Turrilites* cf. *scheuchzerianus* BOSC (KÖHLER, 2001), *Schloenbachia subtuberculata* (SHARPE), *Schloenbachia costata* (SHARPE) (KÖHLER, 1991), *Scaphites* (*Scaphites*) *obliquus* (J. SOWERBY), *Neohibolites ultimus* (d'ORBIGNY) (SPAETH & KÖHLER, 1997) and *Inoceramus virgatus* Schlüter (PRESCHER & TRÖGER, 1989).

Oberhäslich and Mobschatz formations

A stratigraphically significant assemblage in the marine basal Upper Cenomanian is present in the Oberhäslich and Mobschatz formations. It includes *Calycoceras naviculare* (MANTELL), *Inoceramus pictus pictus* J. SOWERBY, *I. pictus bannewitzensis* TRÖGER, *Merklinia aspera* (LAMARCK) and *Neithea* (*Neithea*) *aequicostata* LAMARCK. This last species is very common. Ammonites and inoceramids are very rare. But some near-shore localities, such as the so-called Götzenbüschchen, south of Oelsa (Dippoldiswalde Heath), include tempestites consisting mainly of inoceramids of the *I. pictus* group. A small microfauna with *Gavelinella cenomanica* (BROTZEN), *Hedbergella delrioensis* (CARSEY) and *Rotalipora cushmani* (MORROW) was observed at Meissen Zscheila in silty marls of the Mobschatz Formation: Fig. 3, 5 (TRÖGER, 1989).

Dölzschen Formation

Fossils are rare in the basal and uppermost levels of the Dölzschen Formation with the exception of an ichnofauna in association with *Chondrites* events 1 and 2 (Fig. 2). These events permit a comparison with the NW German - Polish basin. A rich fauna (Fig. 2) was found in the basal part of the *plenus* Pläner[1] in the Pennrich Sandstone and in the "Klippen-" biofacies. *Praeactinocamax plenus* (BLAINVILLE), the key fossil of the *plenus* event, is rare. The species was observed in the upper part of the Pennrich Sandstone and in the adjacent "Klippenfazies"[2]. Ammonites are very rare. *Metoicoceras geslinianum* (d'ORBIGNY), *Euomphaloceras septemseriatum* (CRAGIN) and *Pseudocalycoceras dentonense* (MOREMAN) were found in the basal *plenus* Pläner and in some cliff sections.

Key fossils in the Pennrich Sandstone are the common *Hepteris septemsulcata* (RÖMER) and *Inoceramus pictus bohemicus* LEONHARD. A local *bohemicus* event is situated in the basal part of the *plenus* Pläner. According to ORTMANN (1994) *Rotalipora cushmani* (MORROW) is present in the *plenus* Marl and in the lower part of the *plenus* Pläner. The uppermost portion of the *plenus* Pläner contains only ichnofauna.

Briessnitz Formation

The first Lower Turonian inoceramids (*Mytiloides* cf. *hattini* ELDER) - together with poorly preserved specimens of *Praeglobotruncana* sp. - were observed a few meters above the base of the Lohmgrund Marl, the lowermost member of the Briessnitz Formation (Fig. 2, 3). The exact position of the Cenomanian - Turonian boundary cannot be fixed.

Remarks concerning palaeobiogeography

The Cenomanian strata of the Elbe Valley exhibit remarkable changes owing to incursions northwestward of the fauna from the Tethyan realm and a move southeastward of biota from the Northern Temperate Realm. The fauna of the Meissen Formation (Lower Cenomanian) is comparable to that of the fauna of the north-western portion of the German-Polish Basin (DIETZE, 1961; PRESCHER & TRÖGER, 1989; LÖSER, 1989; KÖHLER, 1991, 1996, 2001) and demonstrates a connection with a sea to the north. Tethyan influences (gastropods - genus ? *Diptyxis* -) are very rare (KOLLMANN, PEZA & CECH, 1998).

A strong southern influence is clearly present in the Oberhäslich Formation (basal Upper Cenomanian) as shown by the common occurrence of *Rhynchostreon suborbiculatum* (LAMARCK), formerly recorded as beds with *Exogyra columba* LAMARCK (HÄNTZSCHEL, 1927): Fig. 2, 3. This species is widespread in the Tethyan Realm and in the Bohemian Basin. The remaining fauna consists of brachiopods, bivalves (especially oysters, pectinids, limids, rare rudists), (near shore) ammonites (rare) and echinoids. *Neithea* (*Neithea*) *aequicostata* LAMARCK is a common bivalve in the so-called Sudetic Cretaceous (Cretaceous of the Elbe

[1] *In this discussion "Pläner" refers to a siliciclastic facies near Dresden in Saxony (GEINITZ, 1839-1842). It consists of an offshore deposit of more or less argillaceous calcareous siltstone with thin parallel bedding. Hence the name "Pläner" (Latin* planus *= smooth, flat, level, plane, even (Courtesy J.M. HANCOCK))*

[2] *"Klippenfazies" refers to a biofacies characteristic of wave-cut shelves and cliffs, i.e. of a cliffed shore (DIETZE, 1961; TRÖGER, 1969). It is generally a well bedded and unfossiliferous limestone; however it becomes sandy close to the underlying igneous rock ("syenite") and even glauconitic and fossiliferous at the base between crags of "syenite" (Courtesy J.M. HANCOCK).*

Valley, the Middle Sudetic and North Sudetic Basins, the North Bohemian Basin and the Regensburg region) and in the Anglo-Paris basin (DHONDT, 1973b).

A remarkable change took place in the uppermost Upper Cenomanian (Dölzschen Formation). Two almost completely discrete faunas have been found in these strata. A "Klippen"- and "Schwellenfazies", that is a cliff and submarine swell facies (according to PETRASCHECK, 1900; SEIFERT, 1955; PIETZSCH, 1962), with a very diverse fauna (over 320 species excluding foraminifers and ostracods: GEINITZ 1871-1875, 1877; DENINGER, 1905; HÄNTZSCHEL, 1933, 1940; SEIFERT, 1955; TRÖGER, 1956; GRÜNDEL, 1982a, 1982b; E. VOIGT, 1989) has been described. This fauna is restricted to the small islands, cliffs and submarine swells in the north-western portion of the Cretaceous of the Elbe Valley yielding algae (WANDERER, 1911), sponges, corals, bryozoa, brachiopods, bivalves (oysters, pectinids, limids, spondylids, small rudists), gastropods, echinoids, microcrinoids, fish (especially shark teeth), and rare *Praeactinocamax plenus* (BLAINVILLE) and *Metoicoceras geslinianum* (d'ORBIGNY).

The second biofacies is represented by the offshore Pennrich fauna. *Praeactinocamax plenus* (BLAINVILLE) and *Metoicoceras geslinianum* (d'ORBIGNY) occur in both the cliff and offshore biofacies. The oyster *Rhynchostreon suborbiculatum* (LAMARCK) is absent in the Pennrich fauna and rare in the "Klippenfazies" (TRÖGER, 1956). An additional minor Tethyan influence is shown by several gastropod genera: *Italoptygmatis*, *Haplotyxis*, *Eliatorella* (KOLLMANN, PEZA & CECH, 1998) at the base of the Upper Cenomanian "Klippen"-biofacies. These gastropods are accompanied by oysters, pectinids and small rudists (*Agriopleura saxoniae* (RÖMER)).

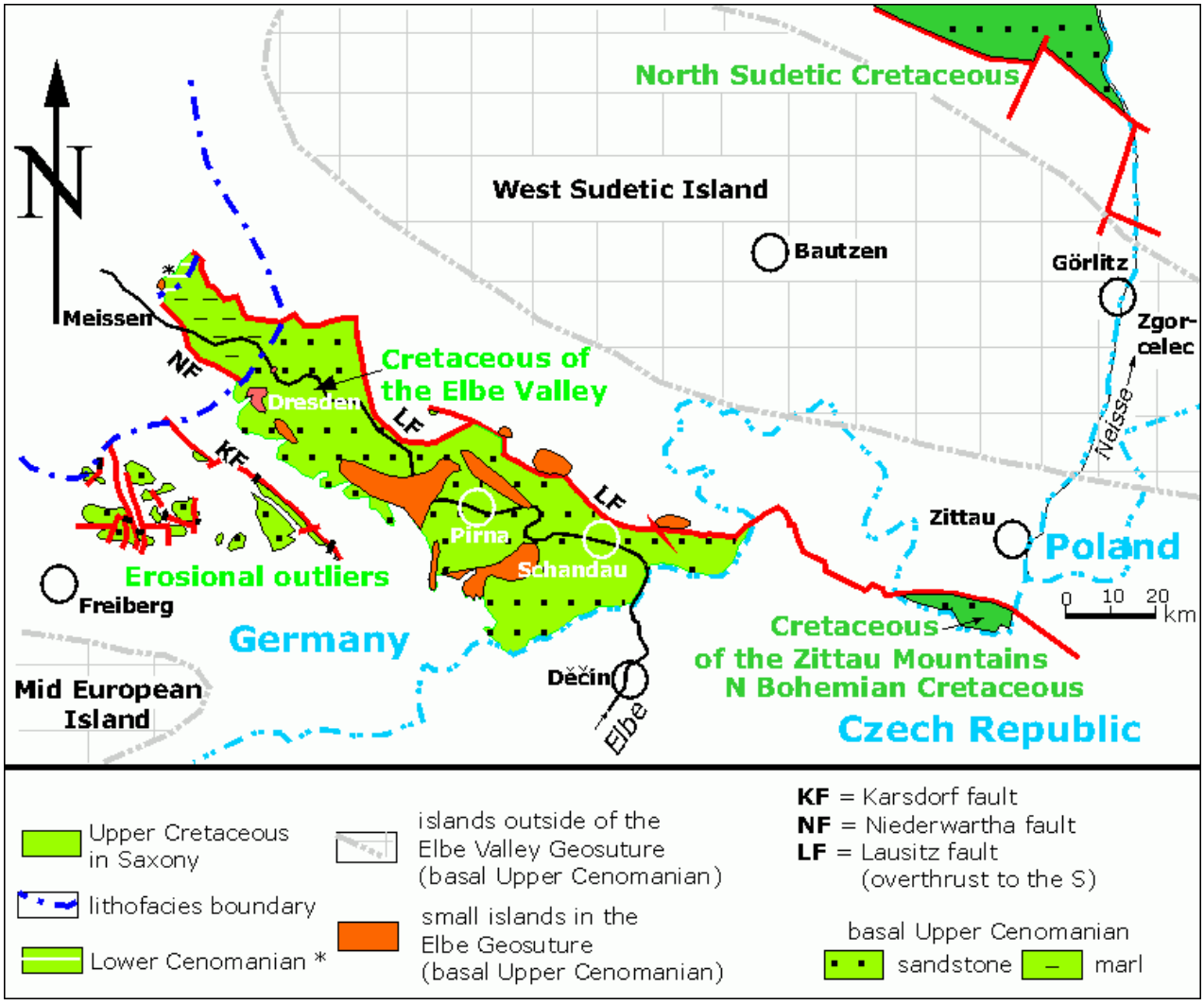

Figure 1 : Generalized map of the Cretaceous of Saxony.

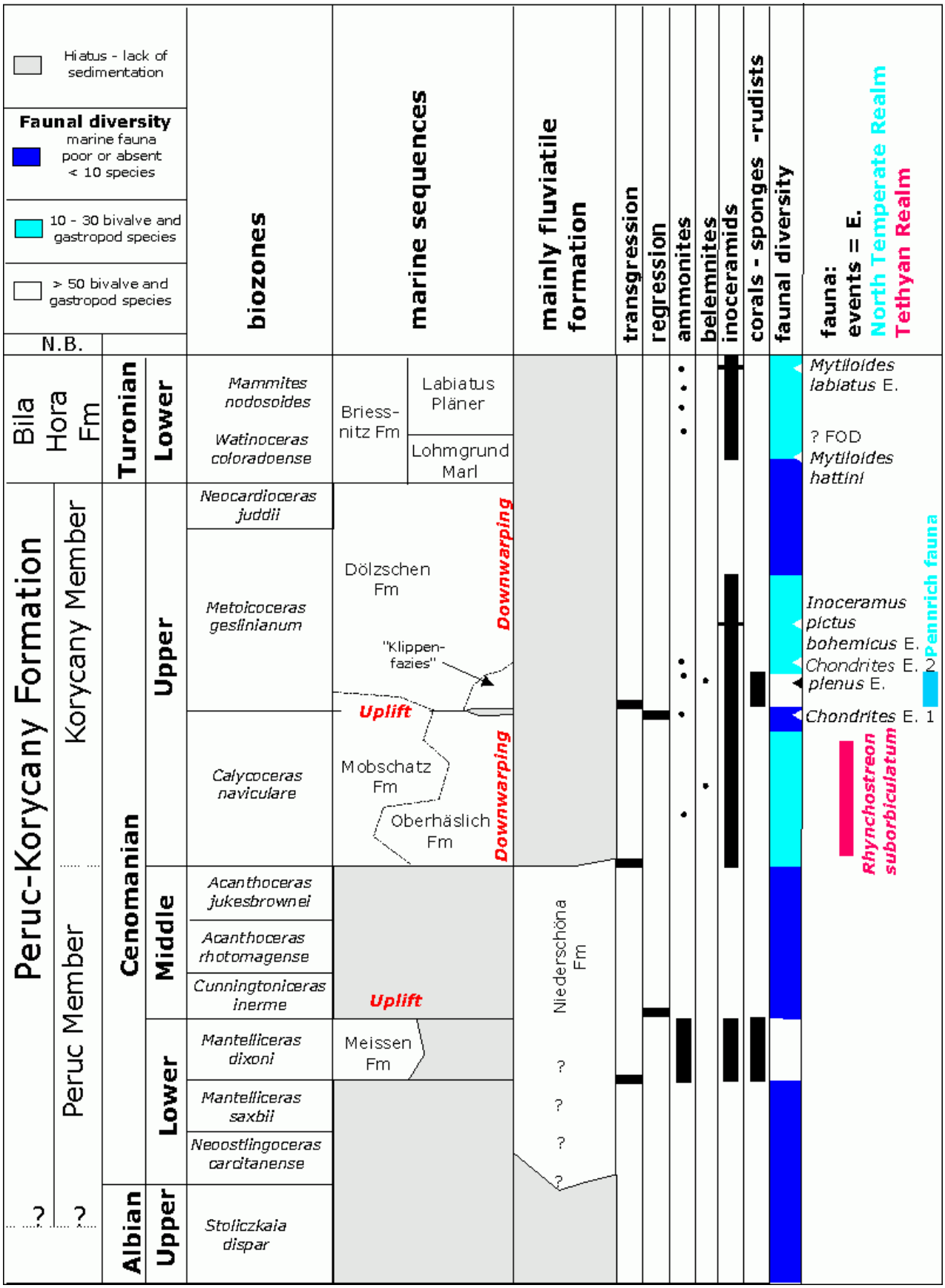

Figure 2: Stratigraphy and fauna of the Cretaceous of the northwestern Elbe valley compared to that of Bohemia as described by CECH *et alii* (1980) = N.B.

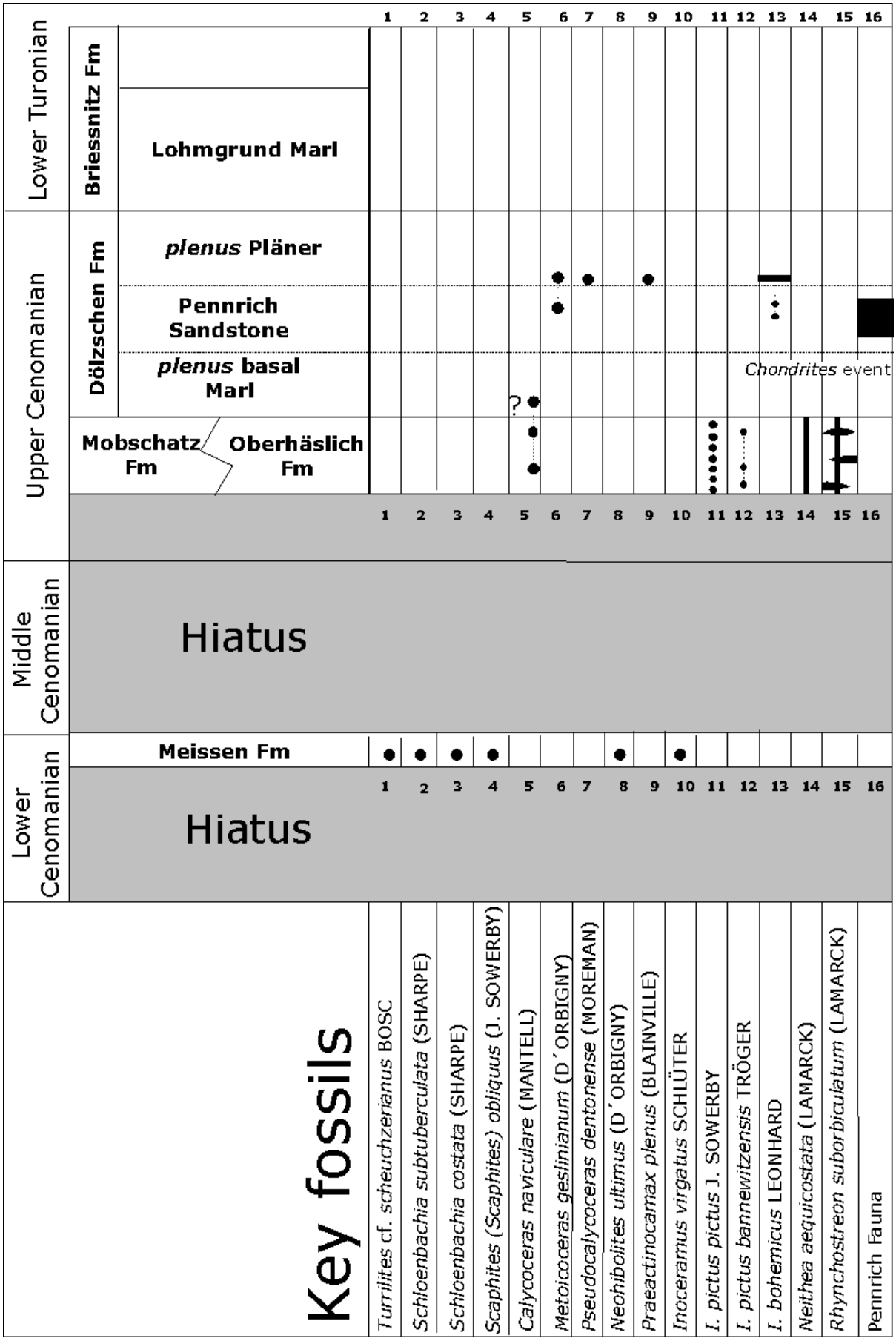

Figure 3: Key fossils in the Cenomanian strata of the NW part of the Elbe valley based on the work of PRESCHER & TRÖGER (1989), SPAETH & KÖHLER (1997), and KÖHLER (2001).

Metoicoceras geslinianum (d'ORBIGNY) is a cosmopolitan species according to KLINGER & WIEDMANN (1983). *Praeactinocamax plenus* (BLAINVILLE) is found only in the Central European sub-province and the Central Russian sub-province, both in the southern part of the North Temperate Realm (CHRISTENSEN, 1976). The bivalves *Neithea* (*Neithella*) *notabilis* (MUENSTER *in* GOLDFUSS), *Entolium membranaceum* (NILSSON), *Camptonectes virgatus* (NILSSON), *Lyropecten* (*Aequipecten*) *arlesiensis* (WOODS) and *Limea* (*Pseudolimea*) *granulata* (NILSSON) are significant components of the Pennrich fauna. They are widely distributed in the uppermost Cenomanian of the Sudetic Upper Cretaceous (DHONDT, 1971, 1972a and b, 1973a and b, 1976, 1989; HÄNTZSCHEL, 1933; UHLIG, 1941), in the southern part of the NW German-Polish Basin and in the Anglo-Paris Basin (JEFFERIES, 1962; KENNEDY, 1969); all five are of the Northern Temperate Realm. It must be concluded that a mixture of Tethyan and Boreal (Northern Temperate Realm) faunas exists in the basal beds of the Dölzschen Formation.

The next important faunal change took place in the uppermost Lower Turonian and in the basal beds of the Middle Turonian. *Rhynchostreon suborbiculatum* (LAMARCK) is common in this interval and widespread in the southern part of the Cretaceous of the Elbe Valley again demonstrating a strong Tethyan Realm influence.

Sequence stratigraphy and palaeogeographical changes

Niederschöna Formation

Uppermost Jurassic and most Lower Cretaceous strata are absent in the Elbe Valley. The uppermost Lower Cretaceous (?) through Cenomanian Niederschöna Formation is underlain by soils of pre-Cenomanian age (PIETZSCH, 1914; ENGERT, 1959; NEBE, 1961; WÜNSCHE & NEBE, 1965; FIEDLER & SCHMIEDEL, 1969). The basal units of the predominantly fluviatile Niederschöna Formation are gravels and coarse-grained sandstones overlain by sandstones that in the type section at Niederschöna are intercalated with several clay and silt lenses. The gravels and the clay lenses may be absent in other sections. They are accompanied by small coal seams (GEINITZ, 1882). The clay and silt lenses contain the Niederschöna flora. Unconformities, cross bedding and soil horizons have been reported in the Niederschöna sandstones (PRESCHER, 1957; Th. VOIGT, TRÖGER & FÖLISCH, 1996; Th. VOIGT, 1998). Changes in lithofacies are common both vertically and horizontally.

The Niederschöna Formation was laid down by a river system flowing almost east - west (Niederschöna River and its tributaries with sources both to the North and to the South: Fig. 4). Some tributaries extended into northern Bohemia. It may be classed as a braided system that evolved to a meandering system in the upper portion of the Niederschöna Formation (Th. VOIGT, 1998). The drainage system lay between the northern part of the Erzgebirge block and the southeastern portion of the Elbe Valley. The uppermost parts of the Niederschöna Formation show evidence of marine influences (glauconitic layers and marine ichnofauna). Marine near-shore strata of Early Cenomanian age are present in the Meissen region (Fig. 4).

Four marine transgressions into the Elbe Geosuture occurred during the Cenomanian and earliest Turonian. The rhythm of transgressions and regressions in the Elbe Valley Geosuture was regulated by global changes in sea level (Th. VOIGT & TRÖGER, 1995) modified by weak tectonism (Fig. 2) in part caused by movements of blocks of pre-Cretaceous basement that were most active during Late Cenomanian times.

The following formations are involved in this series of incursions: Meissen Formation (*dixoni* zone - Lower Cenomanian), Mobschatz and Oberhäslich formations (*naviculare* zone - basal Upper Cenomanian), Dölzschen Formation including a cliff and swell facies (*geslinianum* zone, *juddii* ? zone), Briessnitz Formation (Lower Turonian through basal Middle Turonian).

Meissen Formation

The Lower Cenomanian Meissen Formation (first marine sequence : Fig. 4) is the product of the first transgression. Its deposits are located between Meissen and Oberau, NNE of Meissen. They consist of near shore green sandstones and red conglomerates laid down along a rocky shoreline (Hercynian monzogranites) at Meissen.

The rich fauna consists of sponges, corals, brachiopods, bryozoa, bivalves (especially oysters), echinoids, belemnites (very rare), ammonites (rare) (DIETZE, 1961; PRESCHER & TRÖGER, 1989). This first transgression was terminated by a regression during Medial Cenomanian times (Middle Cenomanian event of the NW German Polish basin). This sequence (Meissen Formation) can be compared with sequence 3 in the Anglo-Paris Basin (ROBASZYNSKI *et alii*, 1998).

Marine beds of Medial Cenomanian age are not present in this region.

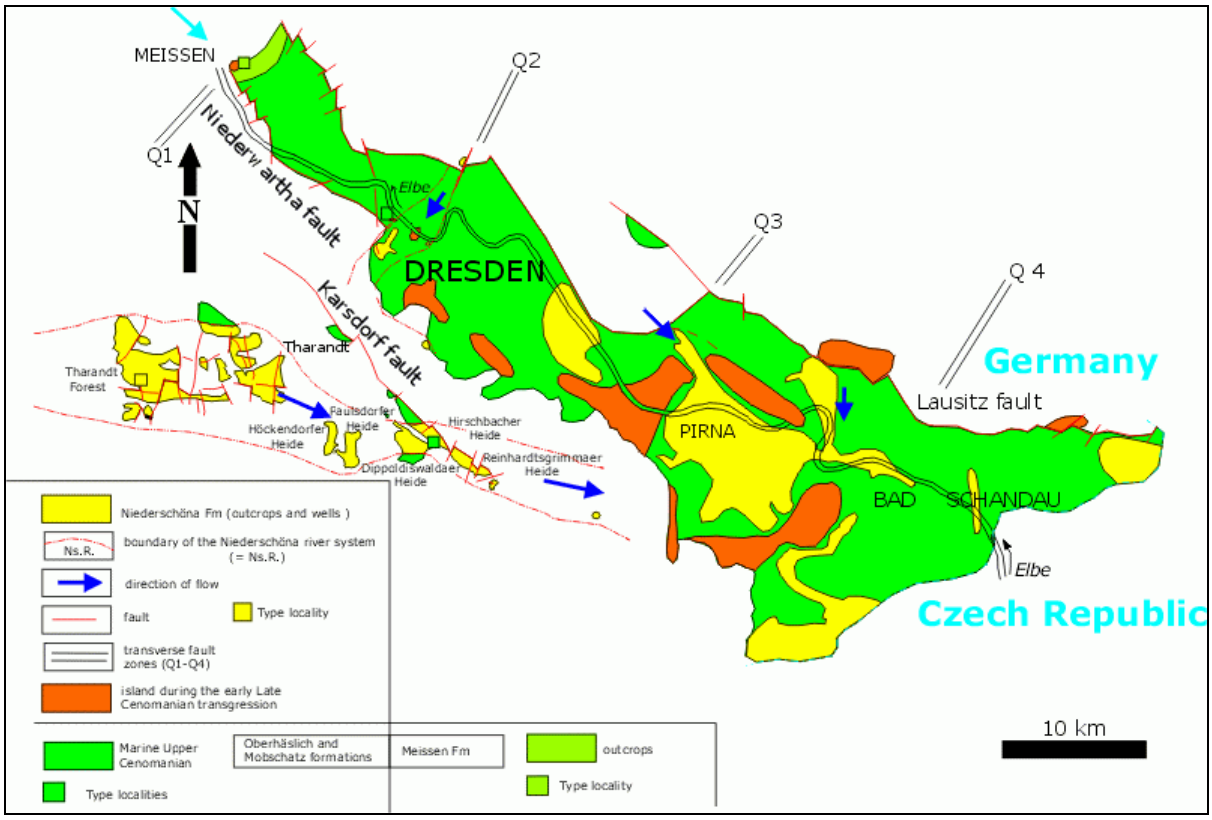

Figure 4: Distribution of the Niederschöna Formation as mapped by PRESCHER (1957), DECKER (1963), Th. VOIGT, S. VOIGT & TRÖGER (1994), and the author's unpublished work.

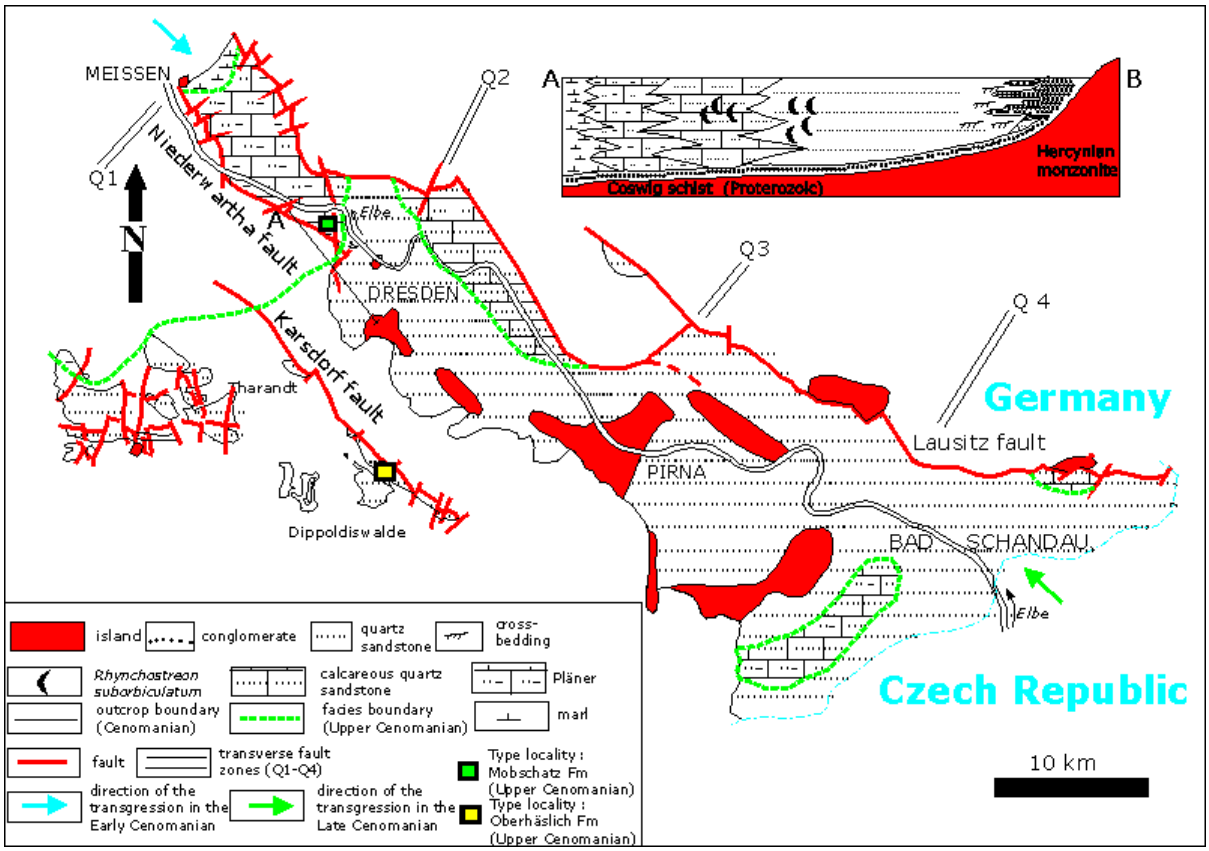

Figure 5: Upper Cenomanian (*Calycoceras naviculare*) lithofacies based on the work of HÄNTZSCHEL (1933), UHLIG (1941), SEIFERT (1955), PIETZSCH (1962), DECKER (1963), TRÖGER (1969), and MIBUS (1975).

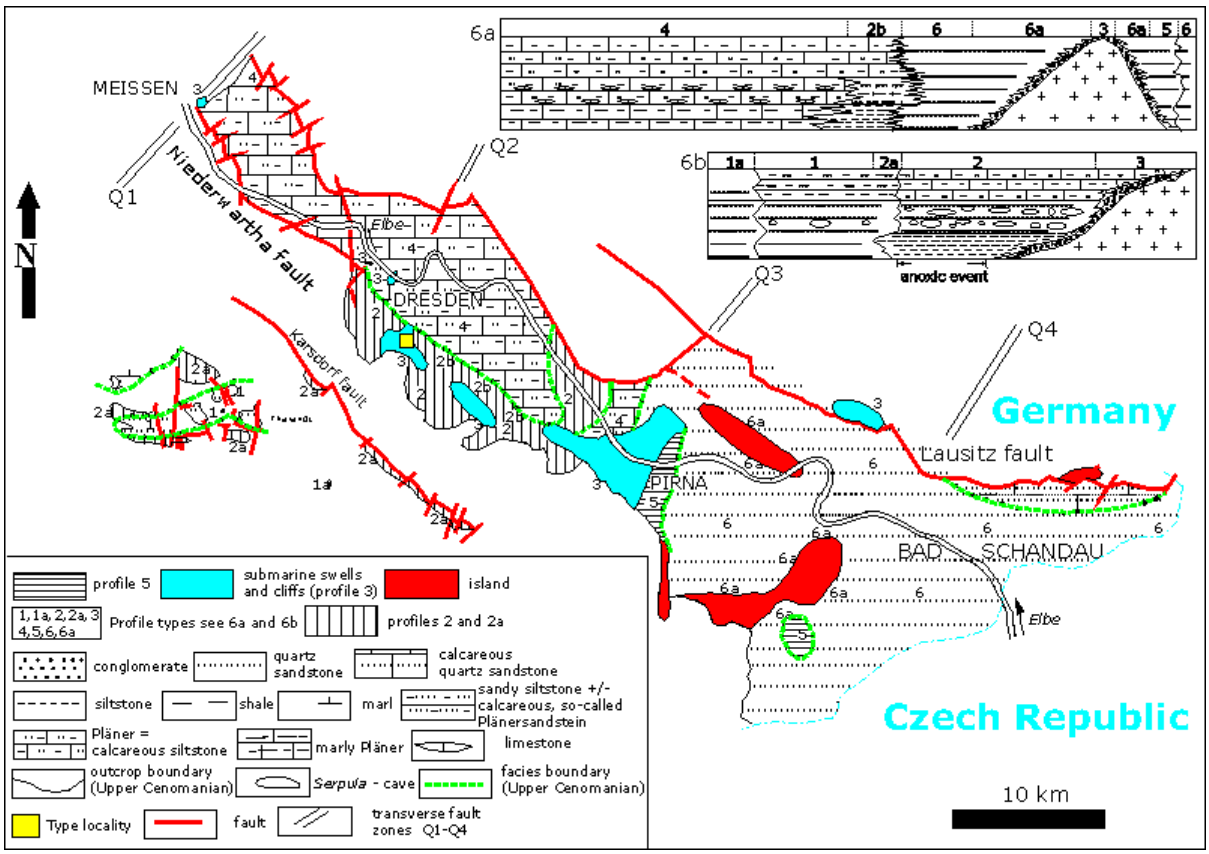

Figure 6: Upper Cenomanian (*Metoicoceras geslinianum*) lithofacies based on the work of HÄNTZSCHEL (1933), UHLIG (1941), TRÖGER (1956, 1961), DIETZE (1961), PIETZSCH (1962), DECKER (1963), and Th. VOIGT, S. VOIGT & TRÖGER (1994).

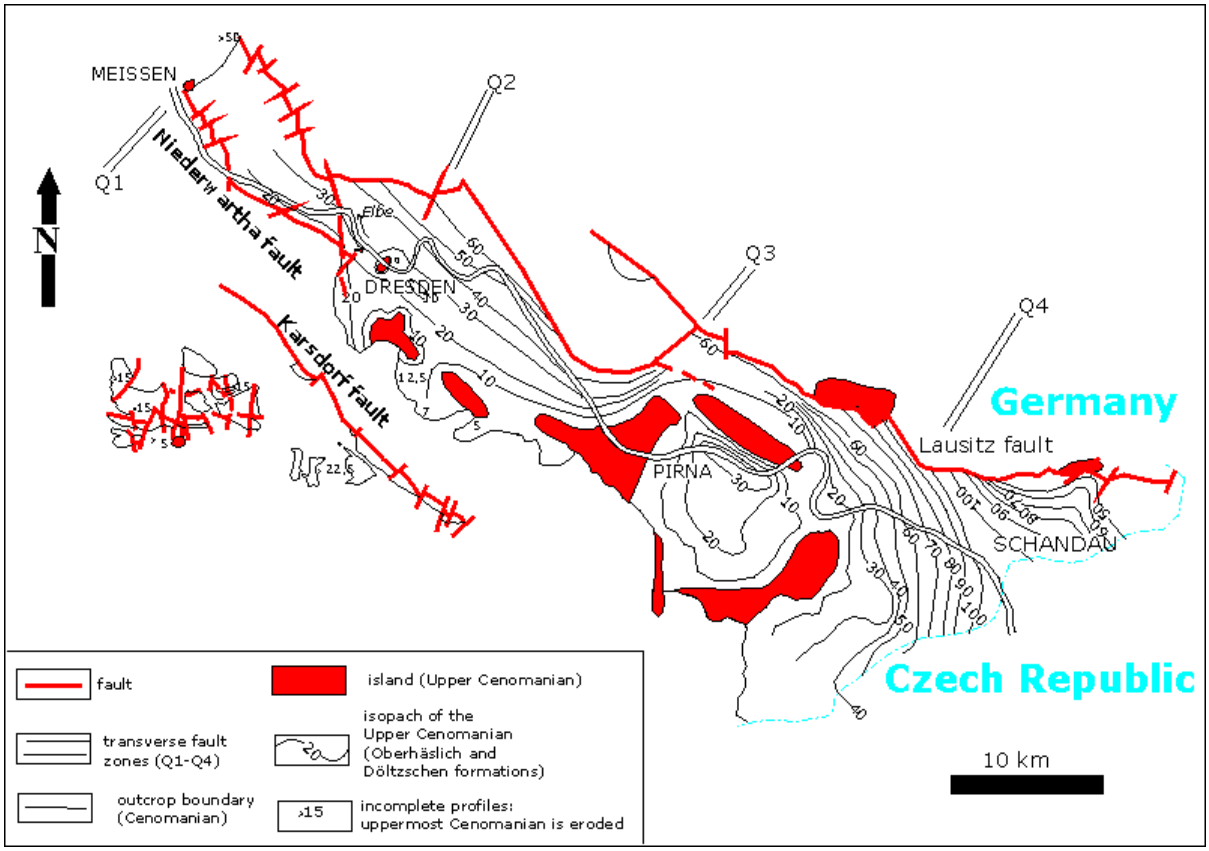

Figure 7: Isopach map of the Upper Cenomanian strata in the Elbe valley according to TRÖGER (1961, 1969), DECKER (1963), and the author's unpublished work.

Mobschatz and Oberhäslich formations

The second main transgression at the base of the Upper Cenomanian linked the North Temperate Realm and the Tethyan Realm through the Elbe Valley Geosuture. Deposition in this seaway in the Elbe Valley Geosuture was controlled mainly by island chains (Fig. 1) that were uplifted to some extent during the Late Cenomanian, and by the two great border islands, the West Sudetic Island and the Mid European Island, respectively southwest and northeast of the Elbe Valley Geosuture. We distinguish two main lithofacies (Fig. 5): a marly-calcareous-silty offshore lithofacies -- the Mobschatz Formation -- exists only in the north-western part of the Elbe Valley Cretaceous sequence. A sandy lithofacies -- the Oberhäslich Formation -- in the central and south-eastern portions of the Cretaceous of the Elbe Valley bounds the islands in the Elbe Valley Geosuture and flanks the West Lusatian Island and the Mid European Island (Fig. 1). Other facies can be distinguished: sandstones of the Oberhäslich Formation with *Rhynchostreon suborbiculatum* (LAMARCK) are typical of the area between Dresden and Bad Schandau and of most of the erosional outliers. The chains of islands are surrounded by conglomeratic beds with intercalations of calciferous sandstones with abundant fossils, mainly *Glycymeris*, rare rudists and gastropods (WANDERER, 1911, WALTER & SUHR, 1997).

The island chains separate two discrete basins: the Pirna - Struppen basin and a basin south of the NW-SE trending island chain south of Dresden and Pirna that includes all the southern erosional outliers (Fig. 7). A marginal trough lay south of the Lausitz fault (E. VOIGT, 1963) between Meissen - Dresden - Bad Schandau. This marginal trough is connected with the N Bohemian basin south of Bad Schandau. Calcareous sandstones are restricted to the central part of the trough.

The sequence described may be compared to the highstand of sequence 5 in the Anglo-Paris Basin (ROBASZYNSKI *et alii*, 1998).

A small regression occurred at the base of the *geslinianum* zone. The influence of this regression is particularly marked around the island chains between Meissen - Dresden and Pirna where minor unconformities exist between the Oberhäslich and Dölzschen formations.

Dölzschen Formation

The Dölzschen Formation (third sequence: Fig. 6) initiated a small transgression. Differentiation in facies was particularly well developed in the NW part of the Cretaceous sequence in the Elbe Valley in the Pirna-Dresden-Meissen area. All islands between Meissen and Pirna were submerged. Elsewhere, numerous cliffs, small islands and submarine swells with a particular litho- and biofacies formed. The conglomerates, limestones and cliff marls yield a diverse fauna consisting of sponges, corals, brachiopods, bryozoa, oysters, rudists, pectinids, spondylids, echinoids and sharks. Ammonites and belemnites are rare. To the S and SW the swell and cliff zone is bounded by a transitional facies. This transitional facies (lithotypes 2, 2b) consists of basal marls and silts (*plenus* Marl) overlain by the Pennrich Sandstone with *Serpula* tubes and calcareous siltstones ("Pläner") or by silty sandstones ("Plänersandsteine"). Farther to the SW the Dölzschen Formation consists of sandstones and silty sandstones (lithotypes 1, 1a, 2a). The Pennrich Sandstone is abundantly fossiliferous (rare solitary corals - *Micrabacia coronula* -, sponges, serpulids, brachiopods, small oysters, limids, and pectinids): the "Pennrich fauna" (HÄNTZSCHEL, 1933; UHLIG, 1941). Lithotype 4 (Fig. 6) is situated N of the cliff zone. This lithotype consists of marls at the base, followed by calcareous siltstones with calcareous concretions containing a Pennrich fauna and by calciferous clayey siltstones.

This sequence is the equivalent of sequence 6 (ROBASZYNSKI *et alii*, 1998) in the Anglo-Paris Basin.

The Dölzschen Formation is overlain by the Briessnitz Formation (sequence 4 in the Cretaceous of the Elbe Valley -- mainly Pläner) with a basal "Lohmgrund" marl (Fig. 2) consisting of interbedded marls and calcareous siltstones.

Tectonic movements and facies changes

The Cenomanian succession in the Elbe valley is incomplete and condensed when compared with the Cenomanian sequences in the Anglo-Paris Basin (ROBASZYNSKI *et alii*, 1998) and the NW German-Polish Basin (WILMSEN & NIEBUHR, 2002). This is demonstrated by the complete absence of sequences 1, 2, 4 and parts of 5 in the Cretaceous of the Elbe Valley. The first transgression (sequence 3) reached the area of Meissen and was interrupted by uplift (Fig. 2) during the latest Early Cenomanian and the Medial Cenomanian. Middle Cenomanian marine strata are absent. The principal strike slip movements took place during the time represented by the early Late Cenomanian (*naviculare* zone). Strong downwarping south of the Lausitz (Lusatian) fault (Fig. 7) resulted in a long NW-SE striking marginal trough in some portions of which the uppermost Cenomanian beds are thickened to as much as 100 m. South of this marginal trough two other asymmetric basins were formed: the Struppen basin near Pirna; and a basin to the SW along the Karsdorf fault. The basins are separated by NW-SE and NE-SW trending island chains (Fig. 5, 6). A slight

regression took place at the base of the *geslinianum* zone. The influence of this regression is visible at the periphery of the island chains between Meissen, Dresden and Pirna. It may have been caused by changes in sea level, but weak local uplift is also a possible explanation.

Both the lithofacies and the thickness of the Upper Cenomanian succession were influenced by the block structure of the pre-Cenomanian basement made up mainly of Proterozoic and Hercynian intrusives and metamorphics. The boundaries of the blocks are defined by NW-SE and NE-SW striking faults (transverse fault zones Q1, Q2, Q3, Q4 and the "Erzgebirgesrandbruch" in the northern part of the Bohemian Basin).

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