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Biostratigraphic data of the German Cambrian - present state of knowledge

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Abstract

On the international scene the results of research on the German Cambrian (above all on the Lower Cambrian) are still poorly known.
Possible reasons for this are, firstly, that the bulk of the publications have been in the German language and secondly, that the journals used for publication have not been widely distributed outside Germany.
Thus the present paper is primarily addressed to foreign colleagues. It represents a compilation of biostratigraphic data as well as of the general lithological successions of the German Cambrian. The illustrations and explanations of these deposits are consciously made in a generalised style.
The Lower Cambrian strata from the Görlitz and Leipzig areas are presented and correlated with the Mediterranean region. Deposits in Thuringia are critically discussed.
Middle Cambrian sections discribed from the Leipzig area and the Franconian Forest (Frankenwald) are compared with the Mediterranean and Scandinavian regions. Problematic deposits in the environs of the Saxonian Granulite Massif (Sächsisches Granulitgebirge) are also discussed.
The occurence of the ichnofossil *Cruziana* in the Leipzig area is discussed with respect to its biostratigraphic value.

Zusammenfassung

Die Ergebnisse der Erforschung der deutschen Kambriumvorkommen (insbesondere des Unterkambriums) sind international mitunter noch immer wenig bis gar nicht bekannt. Dies liegt wohl vor allem daran, daß einerseits hauptsächlich in deutscher Sprache veröffentlicht wurde und andererseits die für die Veröffentlichung genutzten Zeitschriften außerhalb Deutschlands wenig verbreitet waren.
Der vorliegende Artikel wendet sich insbesondere an ausländische Kollegen. Er repräsentiert eine Zusammenstellung der biostratigraphischen Daten und der prinzipiellen Profilabfolgen der deutschen Vorkommen. Letztere werden zum besseren Verständnis vereinfacht dargestellt.

Für das Unterkambrium werden die Vorkommen bei Görlitz und im Raum Leipzig vorgestellt und biostratigraphisch mit dem Mediterran korreliert. Die Vorkommen in Thüringen werden in diesem Zusammenhang diskutiert.
Für das Mittelkambrium werden die Profilabfolgen aus dem Raum Leipzig und aus dem Frankenwald dargestellt und mit dem mediterranen sowie mit dem skandinavischen Bereich verglichen. Fragliche Vorkommen in der Umrandung des Sächsischen Granulitgebirges werden diskutiert.
Das Auftreten von Cruzianen im Raum südlich Leipzig wird hinsichtlich der stratigraphischen Aussagefähigkeit bewertet.

1 Introduction

Studies on the Cambrian of Germany have a long tradition. Initially, investigations were focused on Middle Cambrian successions in the Franconian Forest (Frankenwald) and in the Leipzig area (Fig. 1). However, the dicovery of Early Cambrian deposits (RICHTER & RICHTER 1923) in the Görlitz area (Fig. 1) served to broaden interest in the German Cambrian. In particular, the investigations of A. WURM and K. SDZUY in the Franconian Forest, and the studies of E. SCHMIDT and K. SDZUY on the Middle Cambrian of the Leipzig area (Doberlug) and of M. SCHWARZBACH, G. HIRSCHMANN, G. FREYER, and O. ELICKI on the Lower Cambrian of the Görlitz area have generated new data on the palaeontology, biofacies, stratigraphy, palaeogeography, and depositional history of Central Europe.
Nevertheless, the results of studies on the Cambrian of Germany performed during the last two decades (e.g. FREYER 1981; FREYER & SUHR 1987, 1992; ELICKI 1992 - 1996), are generally poorly known. These articles include biostratigraphic data that contribute to a more significant portrayal of the palaeogeography of the region and that are, therefore, compiled herein together with sketches of relevant stratigraphic columns (Figs. 2-4, 6-7). Additional compilations have been published for the so-called Acadobaltic Faunal Province (SDZUY 1972), for the Lower Cambrian of the Görlitz area (FREYER 1977), and for the German Lower Cambrian (ELICKI 1995b). For detailed information and for discussion of specific problems, the reader is referred to the cited literature.

1 - Görlitz area
2 - Leipzig area
3 - Franconian Forest
4 - Thuringia
5 - Hainichen (southeast of Leipzig)
6 - Saxonian Granulite Massif

Fig. 1 Cambrian deposits in Germany

2 Early Cambrian

Fossiliferous Lower Cambrian strata in Germany are known from the Görlitz and the Leipzig areas (Fig. 1) . These are very different in their biofacies and biostratigraphic position.

Görlitz area

The Early Cambrian age of some siliciclastic sediments in the Görlitz area was recognised for the first time by RICHTER & RICHTER (1923). Further palaeontological data and a more detailed stratigraphy of the section were published by SCHWARZBACH (1932, 1934, 1939). However, that author interpreted some problematic

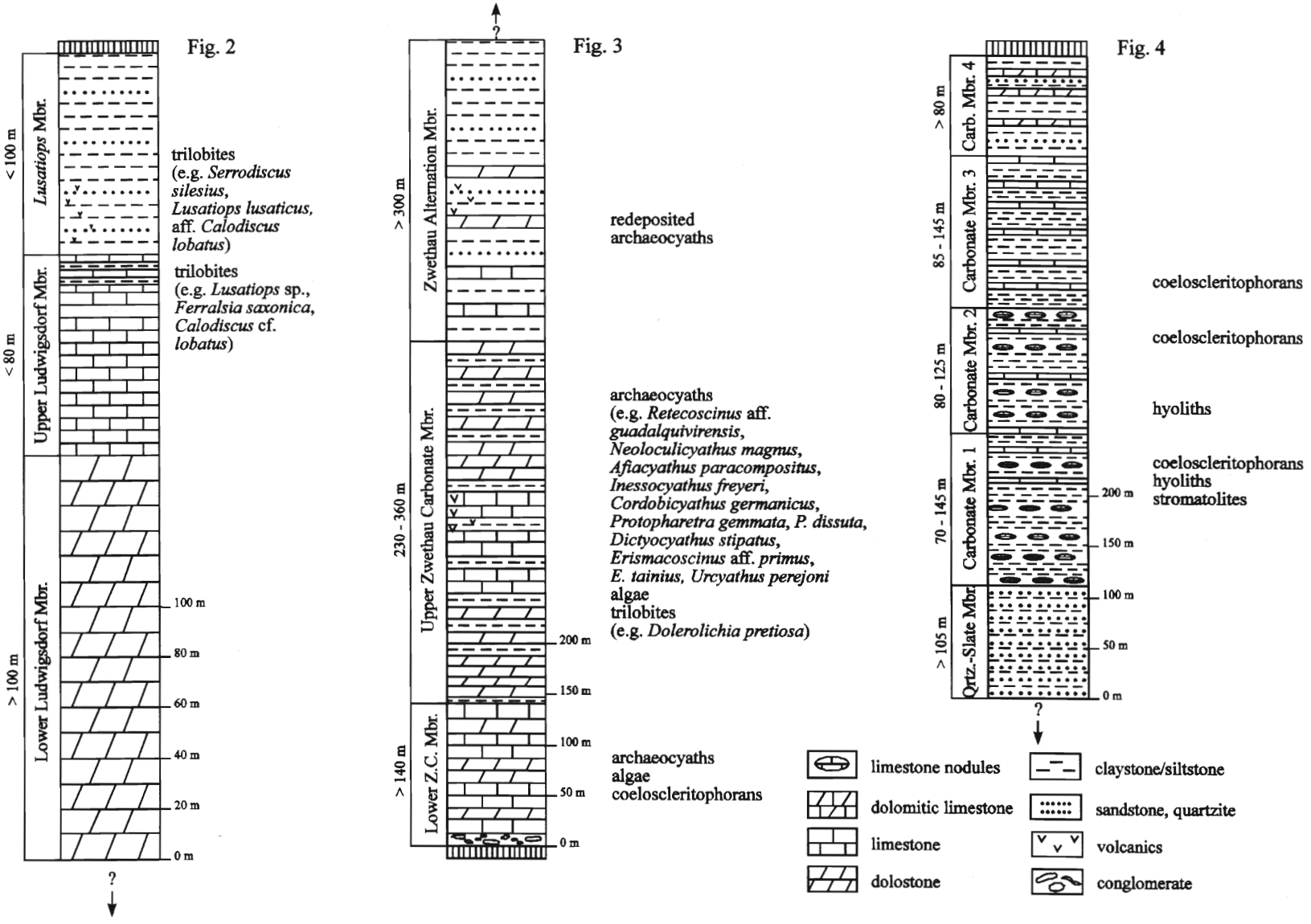

Fig. 2 - 4 Lower Cambrian sequences of the Görlitz area (Fig. 2) and Leipzig area (Fig. 3) as well as the Cambrian sequence of Thuringia

fossil structures from the carbonate part of the succession as archaeocyaths - an assumption which has never been confirmed by fresh finds. In fact, these problematics found by SCHARZBACH are not archaeocyaths. Unfortunately SCHWARZBACH's inaccurate assumption has been uncritically cited up to the present time, and this has frequently led to misleading facies interpretations.
RICHTER & RICHTER (1941) published on the Early Cambrian trilobites. They identified the age of the fauna as late Early Cambrian.
ROZANOV (1973) mentioned a small microfauna from the carbonates of the Upper Ludwigsdorf Member for the first time. FREYER (1981) has described poorly preserved brachiopods from the overlying siliciclastic *Lusatiops* Member.
Systematic studies on the Görlitz Lower Cambrian have been conducted at the Freiberg University since the end of the last decade (ELICKI & SCHNEIDER 1992, ELICKI 1992a, 1992b, ELICKI 1994, ELICKI 1995a, 1995b, GEYER & ELICKI 1995, ELICKI 1996).

The Lower Cambrian section (Fig. 2) consists of a succession of shallow water carbonates (massive dolostones = Lower Ludwigsdorf Member; overlying bedded and partly nodular limestones = Upper Ludwigsdorf Member) and siliciclastic rocks (claystone/siltstone with sandstone intercalations = *Lusatiops* Member). The biostratigraphic age can be defined as upper Marianian by reference to Spanish faunas (Fig. 5). Due to the tectonic situation the stratigraphic continuations above and below are unknown. The thickness of the section is about 250 - 300 m.

Leipzig area

Lower Cambrian strata have been known from the Leipzig area (Doberlug-Torgau, Delitzsch, Schladebach) for over 35 years (SDZUY 1957a, BLÜHER 1966).
The lithological succession of some drillcores in the vicinity of Doberlug has been described by FREYER & SUHR (1987). In this paper they published on archaeocyaths which were revised and fully described by ELICKI & DEBRENNE (1993).
Further investigations on the Lower Cambrian of the Leipzig area have been published by SDZUY (1962 - trilobites), by FREYER & SUHR (1992 - algae), by ELICKI (1992a, 1995a, 1995b; palaeontology, biostratigraphy, depositional history), and by ELICKI & DEBRENNE (1993 - palaeontology and biostratigraphy of the archaeocyaths, palaeogeography) as well as by BUSCHMANN et al. (in press - regional geology).

The Lower Cambrian succession (Fig. 3) begins (after a hiatus over Precambrian rocks) with basal debris flow deposits, overlain by siliciclastic-influenced limestone and dolostone (subtidal to intertidal). The section continues with an alternation of shallow water carbonates (dolostone and limestone) and siliciclastics (claystone and siltstone). The uppermost part of the section is represented mainly by siliciclastic rocks (siltstone and sandstone) with intercalations of redeposited carbonate (subtidal). Biostratigraphic data are provided by the archaeocyaths, which indicate the presence of archaeocyathan zones I to III of MORENO-EIRIS et al. (1995), corresponding to the Spanish lower Ovetian (Fig. 5). In the Leipzig area, faunal elements of Marianian and Bilbilian age are to date unknown (possibly due to their original absence).
A direct transition between Lower Cambrian and Middle Cambrian sediments has been never exposed.
The total thickness of the Lower Cambrian succession is about 700 m - (?) 1000 m.

Thuringia

In 1980, BLUMENSTENGEL published on a very small microfauna of chancelloriids and hyoliths from a carbonate section (Fig. 4) of the Thuringian Slate Mountain (Thüringer Schiefergebirge, Lobenstein horst; research drillholes „Heinersdorf 1 and 2"; see WUCHER 1965). Due to the very meagre fossil content and poor preservation of the fauna, a more precise biostratigraphic dating than Cambrian age is not possible. However, the lithological character of the sequence (carbonates, partly nodular), seen in the context with the great thickness of the section, as well as with the fossil content and using regional comparisons (Germany, Sardinia, Spain) may point to an Early Cambrian age for these sediments.

The Cambrian sequence consists of basal siliciclastic rocks (quatzite and claystone) followed by an alternation of claystones and siltstones with thin carbonate layers. The carbonates in the lower part of the section are more nodular, with only very thin carbonate horizons intercalated. Toward the top of the section the nodular

lithotypes are progressively reduced. Here, the thickest intercalated carbonate horizons attain a thickness of 10 - 15 cm. The sequence is overlain (after a hiatus) by the Lower Ordovician „Frauenbach Quartzite".

Based mainly on lithostratigraphic data, a sequence of siliciclastic rocks (Goldisthal Fm.) from the Thuringian Slate Mountain (Schwarzburg Anticline) has been interpreted in the past as a continous succession from the Proterozoic into the Lower Ordovician (BANKWITZ 1970). Bud following new investigations (ESTRADA et al. 1994 - acritarchs, LINNEMANN & BUSCHMANN 1995), these sediments are recognised as entirely Lower Ordovician. The formerly published ichnotaxa *Tigillites* (*Monocraterion*) and *Diplocraterion parallelum* (BANKWITZ 1970) are not very useful for precise dating, yet in the context of acritarch and lithological data, an Early Ordovician age can be assumed (GAMEZ VINTANED, pers. comm).

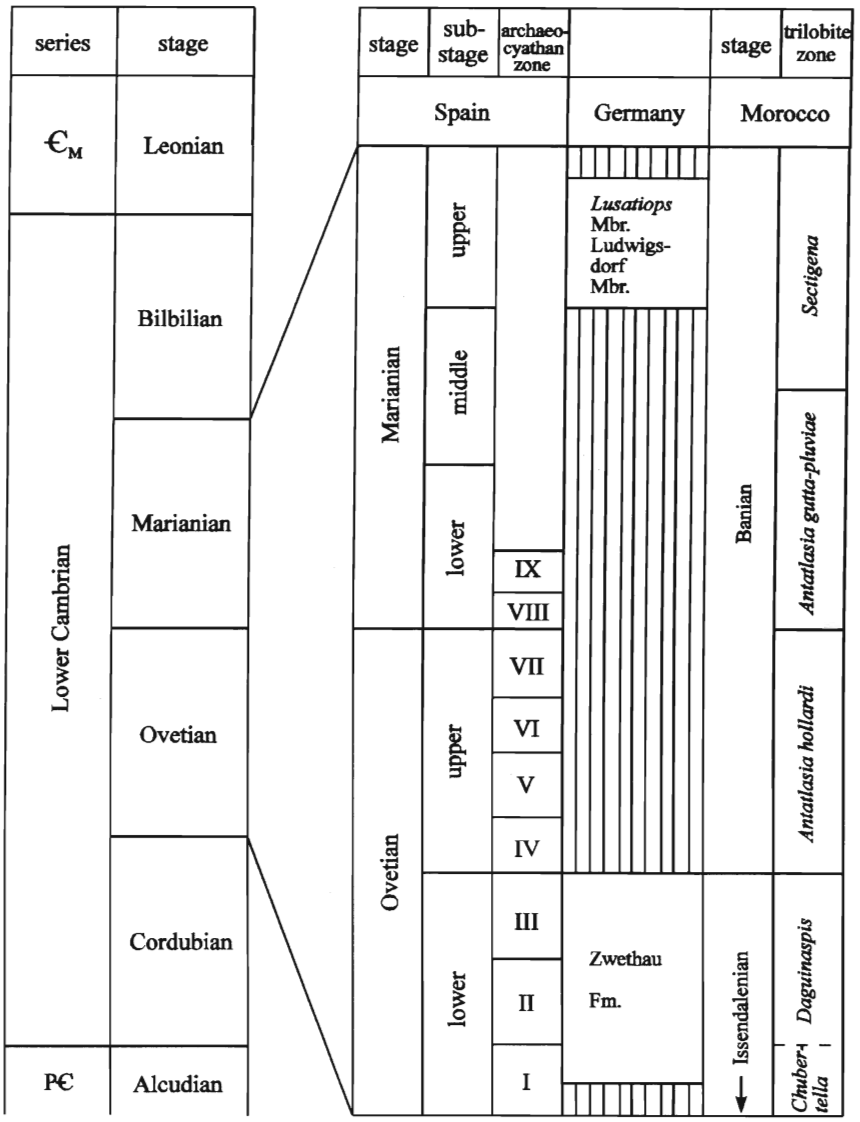

Fig. 5 Biostratigraphic position of the German Lower Cambrian

3 Middle Cambrian

Sediments of Middle Cambrian age are known from the Leipzig area (Doberlug, Delitzsch) as well as from the Franconian Forest (Fig. 1).

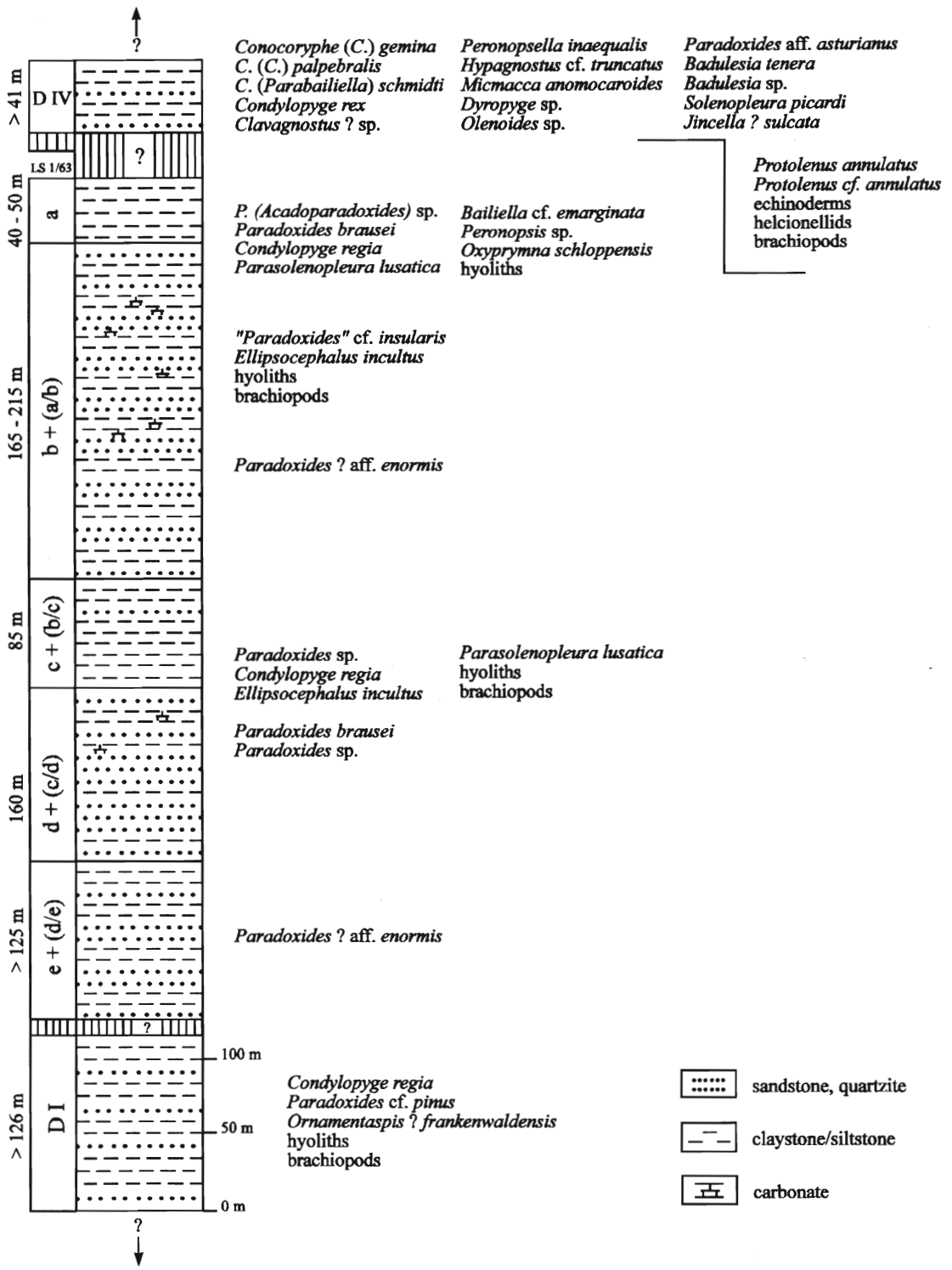

Fig. 6 Middle Cambrian succession of the Leipzig area (composed by the drillsections DI, LS 1/63 and DIV)

Leipzig area

SCHMIDT (1942) described faunas from drillholes sunk during the period 1927 - 1931 (PICARD & GOTHAN 1931). These faunas were revised by SDZUY (1957a) fifteen years later. BRAUSE (1969, 1970 - includes references to older literature) investigated aspects of the regional geology and lithology of the Middle Cambrian strata. In 1970 he published a cored drillhole section showing what is to date the greatest known thickness in the area (well LS 1/63, maximum thickness about 600 m).
SDZUY (1957b, 1958, 1970, 1972) has published on the palaeontology, biostratigraphy, and palaeogeography of the Middle Cambrian faunas. He recognised two biostratigraphic levels (Fig. 8): drillholes „D I" and „LS 1/63" („*P.* " *insularis* zone) and „D IV" (corresponding to the lowest zone of the *P. paradoxissimus* level of the Scandinavian succession).

The Middle Cambrian sequence (Fig. 6) is represented by an alternation of sandstone, quartzite, and claystone with intercalated very thin carbonate layers (BRAUSE 1970). Sedimentary rocks underlaying the Middle Cambrian sections are not known, while overlaying sediments are veriously Carboniferous or Tertiary in age. The total thickness of the Middle Cambrian can be estimated as (?) 1000 m.

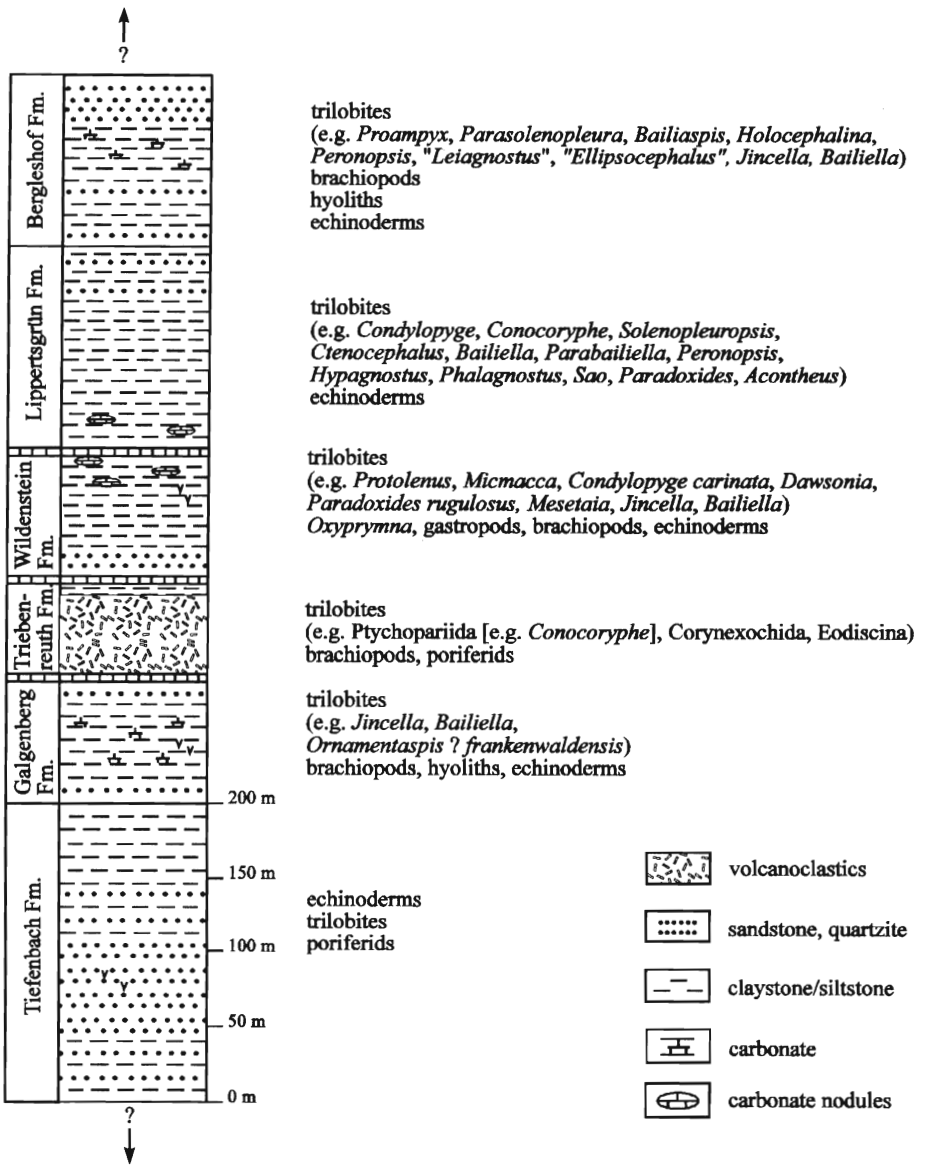

Fig. 7 Middle Cambrian succession of the Franconian Forest

Franconian Forest

SDZUY (1964) has illustrated the history of research of the Franconian Middle Cambrian, as well as the verious lithostratigraphic units and the stratigraphic position of the deposits. In the same paper one can find references to the older literature.

The Franconian Cambrian (Fig. 7) is represented by a siliciclastic succession of sandstones, quartzites and quartziferous shales (LUDWIG 1969, SDZUY 1970). SDZUY (1970) has estimated the total thickness of the Cambrian as 500 - 1000 m. For large parts of the Lower Cambrian (below the Tiefenbach Formation), SDZUY has assumed a hiatus. Likewise the Upper Cambrian (above the Bergleshof Formation) seems to have been originally absent due to a significant regression event.
From the Franconian Middle Cambrian the following biostratigraphic levels are known (Fig. 8): *„P". insularis*, *„P." pinus*, middle *P. paradoxissimus*, middle *P. forchhammeri*.

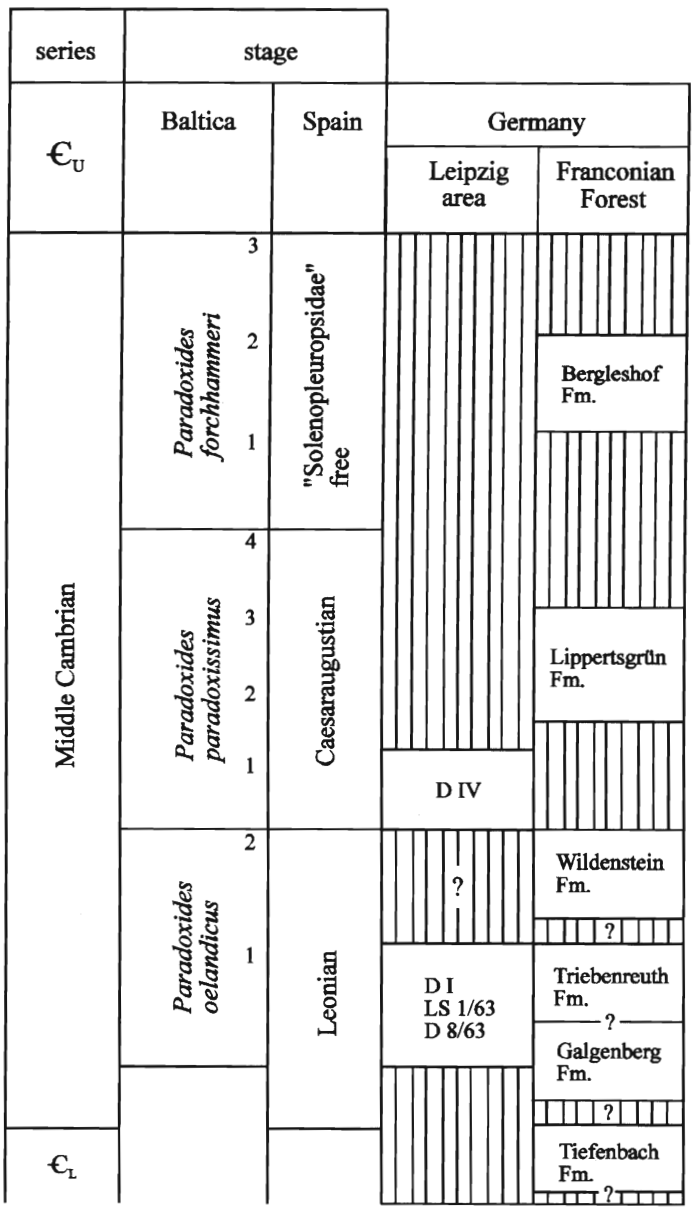

Fig. 8 Biostratigraphic position of the German Middle Cambrian

As well, a Middle Cambrian age has been assumed by FREYER et al. (1982) for a small metamorphic sequence of carbonate and siliciclastic rocks in the environs of the Saxonian Granulite Massif (Sächsisches Granulitgebirge). The stratigraphic dating is based on both lithostratigraphic and regional aspects and on palaeontological material. However, the contained fauna is very poorly preserved and has no real biostratigraphic value. Thus for example, the illustrated „archaeocyaths" and „radiolarians" as well as some of the „algae" must be reinterpreted as echinoderm remains. Furthermore, the sporomorphs and acritarchs are problematic due to their poor preservation. The described sponge spicules, stromatolites, and problematica have only a low biostratigraphic value. So the assumption of a Cambrian age for the succession (mainly based on the supposed „archaeocyaths") is highly speculative. Nevertheless, a Cambrian age cannot be excluded.

4 Late Cambrian

Upper Cambrian sediments have been reported to date only from an area southeast of Leipzig (Hainichen near Borna; FREYER 1981b) where several ichnotaxa occur in sandstone (Fig. 1). The relevant outcrops have not existed since the beginning of this century.
According to FREYER the ichnospecies *Cruziana semiplicata* points to an Late Cambrian age. However, for the peri-Gondwana region the stratigraphic range of this ichnospecies extends upward into the Lower Ordovician (GAMEZ VINTANED, pers. comm.). Hence a Late Cambrian to Early Ordovician dating for these samples is preferred.
Following BRAUSE (1970), an original absence of Upper Cambrian sediments is possible for the Leipzig area.

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