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THE STRATIGRAPHIC SIGNIFICANCE OF GRAPTOLITES  
IN ROMANIA

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Cambro-Ordovician, Silurian, Devonian and Carboniferous sediments have been identified from the base of the sedimentary cover of the Moesian Platform. Graptolites play an important rôle in their identification. The Arenig, Wenlock, Ludlow and Pridoli Series are present. The lower part of the Silurian consists of graptolite shale facies whilst the upper part is of mixed facies.

Key words: Graptolites, stratigraphy, Ordovician Silurian, Romania.

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## INTRODUCTION

During the last twenty years the drilling programme over the Moesian and Moldavian Platform has led to the discovery of graptolite faunas. The Tuzla borehole yielded the first Ludlovian specimens (Grigoraș 1956) and further Ludlovian material was described from the Călărăși borehole by Răileanu, Iordan and Săndulescu (1967). Murgeanu and Spasov (1968) identified the first Arenigian graptolites from the Bordeiu Verde borehole, which also yielded Wenlockian graptolites. Iordan and Rickards (1971) described the Upper Wenlockian graptolites from the Ianca-Berlescu borehole and Ludlovian assemblages from the Mangalia and Zăvcaia boreholes and they revised previous records. In 1972, Iordan described the Lower Wenlockian and Ludlovian graptolites of the Țândărei borehole and Iordan and Rickards (1975) identified fourteen species new to Romania and refined the stratigraphy of the Moesian Platform. Iordan (1977) revised all previous records of Romanian graptolites. This author has also recorded a Lower Ludlovian assemblage from the western part of the Moesian Platform (*in*: Paraschiv and Mușiu 1976). Sicular debris was identified in 1965 by Macarovici, Beju and Olaru from the Moldavian Platform. In 1973 Iordan identified an *Bohemograptus bohemicus* (Barr.) from the Radauti borehole (*in*: Paraschiv and Mușiu 1973).

## STRATIGRAPHY

On the Moesian Platform the Precambrian basement deposits are overlain unconformably by possible Lower — Middle Cambrian beds and by Ordovician beds. The only positive Ordovician rocks are in the Bordeiu Verde borehole where graptolitic (Arenig) and shelly faunas have been found. Murgeanu and Spasov (1968) described and figured: *Didymograptus hirundo* Salter, *D. cf. extensus* (Hall) and *Lingullela davisii* McCoy.

The Silurian has been demonstrated only by graptolites, which indicate the presence of Wenlock, Ludlow and Pridolian beds. The Llandovery has not yet been recorded.

Low Wenlock strata have been proved in the Țândărei, and Bordeiu Verde boreholes. In the Țândărei borehole assemblages characteristic of the *C. insectus*, *C. centrifugus* and *C. murchisoni* Zones of England are recorded with *Monograptus priodon* (Bronn), *M. pseudocultellus* Bouč., *M. kolihai* Bouč., *Monoclimacis vomerina vomerina* Nich., *M. vomerina basilica* (Lapw.), *Retiolites geinitzianus* Barr., *Barrandeograptus pulchellus* (Tullb.), *Pristiograptus cf. praedubius* (Bouč.), *Cyrtograptus ex gr. murchisoni* Carr., ?*C. sp. 1*, *C. div. sp.* (Jordan 1972; Jordan and Rickards 1975; Rickards and Jordan 1975). In the Bordeiu Verde borehole, Murgeanu and Spasov (1968) recorded graptolite species which attest the *M. firmus* Zone of Bohemia (*Monograptus cf. firmus* Bouč., *M. priodon* (Bronn), *Pristiograptus praedubius* (Bouč.), *Monoclimacis sp.*).

The Upper Wenlock is found only in the Ianca-Berlescu borehole (Jordan and Rickards 1971, 1975; Rickards and Jordan 1975; Jordan 1977b). The presence of the *C. radians* and *C. lundgreni* Zones of England is attested by species such as: *Monograptus flemingi* (Salt.), *Pristiograptus dubius* (Suess), *P. pseudodubius* (Bouč.), *Monoclimacis flumendosae* (Gort.), *Cyrtograptus lundgreni* Tullb., *C. lundgreni gracilis* Bouč., *C. trilleri* Eisel, *C. div. sp.*

Ludlow strata have been identified in the Tuzla, Mangalia, Călărași, Zăvoaia and Țândărei boreholes, all on the south-eastern part of the Moesian Platform.

In the "d" borehole of Tuzla-Constanța, Grigoraș (1956) identified *Saetograptus colonus* (Barr.), *Pristiograptus dubius* (Suess), *Bohemograptus bohemicus* (Barr.), *Lobograptus cf. crinitus* Wood., *Neodiversograptus sp.*, which confirm the low Ludlow *nilssoni-scanicus* Zone age.

In the Călărași borehole we recorded (Răileanu, Jordan and Săndulescu 1967; Jordan 1971, 1973, 1977b; Jordan and Rickards 1971, 1975) *Saetograptus colonus* (Barr.), *S. chimaera* (Barr.), *Bohemograptus bohemicus* (Barr.), *Lobograptus scanicus* Tullb., *Monoclimacis micropoma* Jaekel, *Monograptus?* sp., *Plectograptus macilentus* Törnq., species specific to the *nilssoni-scanicus* Zone. In the Țândărei borehole *Monograptus uncinatus* Tullb., "*M*" *incipiens* Wood, *Saetograptus colonus* (Barr.), *Bohemograptus*

*bohemicus* (Barr.), *Neodiversograptus nilssoni* (Lapw.), *Holoretiolites* (*Balticograptus*) cf. *balticus* Eis., *Plectograptus macilentus* (Törnq.) have been identified (Jordan and Rickards 1971; Jordan 1977b).

The Upper Ludlow has been identified in the Călărași, Zăvoaia and Tândărei boreholes. Unlike the Wenlock and Lower Ludlow, identification of the Upper Ludlow has been made not only on the basis of the graptolites, found only sporadically, but also on the bivalves and orthocone nautiloids. In the Zăvoaia borehole we identified *Monograptus* ex gr. *formosus* Bouč., and *Linograptus posthumus* (Rich.) indicating the *M. formosus* Zone of the Upper Ludlow of Bohemia. Jaeger (1977) includes this species in the *ultimus* Zone, i.e. Low Pridoli. In the Călărași borehole the Lower Ludlow (*nilssoni-scanicus* Zone; with dips of about 30°) is overlain by horizontal black argillites which contain a macrofaunal assemblage of graptolites (*Monograptus* sp.), juvenile and small bivalves, various flattened orthocone nautiloids (*Parakionoceras* sp., *Geisonoceras* sp., "*Orthoceras*" cf. *primaevum* (Forbes), *Michelinoceras* sp.), small brachiopods, columnals of crinoids and common fragments of chitinous hydroids. The fragments of monograptids present characteristics specific to the monograptids of the terminal Silurian (curvature of the rhabdosome, thecal type and protracted proximal end) described by Jackson and Lenz (1972). The bivalves and cephalopods, in particular "*O.*" *primaevum*, are specific to the Upper Ludlow. In the Tândărei boreholes the same assemblage rests conformably on the Lower Ludlow.

The Pridoli has been recently recognised in the Călărași, Tândărei and Zăvoaia boreholes (Jordan and Rickards 1975; Křiž and Jordan 1975; Rickards and Jordan 1975; Iliescu 1976; Jordan 1977a, b). In the Călărași borehole, a faunal assemblage comprising fragments of *Monograptus* sp. (with affinities either with *M.* aff. *uniformis angustidens* Přibyl from Bohemia and Poland or with late Silurian monograptids), trilobites, brachiopods and orthocone nautiloids has been identified within a pile of argillites (100 m thick); it conformably overlies the Upper Ludlow. In the Tândărei borehole the boundary between the Upper Ludlow and Pridoli is not accurately delimited. Jordan and Rickards (1975), Rickards and Jordan (1975), Jordan (1977a, b) identified: *Saetograptus* cf. *rarus* Tell., *S.* ex gr. *colonus* (Barr.), *Monograptus* sp. 1, *Pristiograptus grigorasii* Jordan, ?*Linograptus* sp. 1, bivalves (*Cardiolita* cf. *bohemica* (Barr.), *C.* cf. *fortis* (Barr.), "*Cardiola insolita* Barr.: Křiž, and Jordan 1975) characteristic of the Pridolian in Bohemia, fragments of orthocone nautiloids and crinoids (*Crotalocrinus* sp.). In the Zăvoaia borehole, bivalves typical of the Bohemian Pridolian ("*Cardiola*" *insolita* Barr., *Cardiolita* sp., *Lunulacardium* cf. *undulatum* Barr.) and orthocone nautiloids ("*Orthoceras*" cf. *primaevum* (Forbes), "*O.*" *vertebratum* (Barr.), *Geisonoceras* cf. *rivale* Barr.) have been recorded (Křiž and Jordan 1975).

## CONCLUSIONS

Cambro-Ordovician, Silurian, Devonian and Carboniferous sediments have been identified from the base of the sedimentary cover of the Moesian Platform. Graptolites play an important rôle in their identification. The Arenig, Wenlock, Ludlow and Pridoli Series are present. The Silurian begins with either the Lower or Upper Wenlock or with the Lower Ludlow and overlies the Green Shales of the basement eastwards and the crystalline schists of the basement westwards, though also, in places, the Ordovician. The Silurian is followed by Devonian, or rarely, by Mesozoic sediments. The lower part of the Silurian consists of graptolite shale facies whilst the upper part is of mixed facies.

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