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Ostracods, rock facies and magnetic susceptibility of the Givetian / Frasnian transition at Ave-et-Auffe (Dinant Synclinorium, Belgium)

CASIER, J.-G.^{1,2}, DEVLEESCHOUWER, X.^{1,2}, MAILLET, S.³, PETITCLERC, E.¹ & PRÉAT, A.²

(1) Institut royal des Sciences naturelles de Belgique, rue Vautier, 29, B-1000 Bruxelles, Belgique; casier@naturalsciences.be, Xavier.Devleeschouwer@naturalsciences.be, estelle.petitclerc@naturalsciences.be

(2) Département des Sciences de la Terre et de l'Environnement, Université libre de Bruxelles, av. F. Roosevelt, 50, B-1000 Bruxelles, Belgique; apreat@ulb.ac.be

(3) Laboratoire de Paléontologie Stratigraphique, Université de Lille 1, 41 rue du Port, F-59046 Lille Cedex, France; sebastien.maillet@icl-lille.fr

The Sourd d'Ave section at Ave-et-Auffe exposes the upper part of the Moulin Boreux Mbr (8 m of built-up limestones with massive and branched stromatoporoids) and the Fort Hulobiet Mbr (28 m of calcareous shales and argillaceous limestones) belonging to the Fromelennes Fm (Givet Group). The section exposes also the Pont d'Avignon Mbr (45 cm-thick nodular argillaceous limestone), the Sourd d'Ave Mbr (9.3 m-thick and made up of calcaro-argillaceous nodular shales with rare small argillaceous limestone beds) and the base of the La Prée Mbr (shales with rare calcaro-argillaceous nodules) belonging to the Nismes Fm (Frasnes Group). The position of the G/F boundary in the Dinant Synclinorium is still in debate, and is fixed arbitrary in the Sourd d'Ave section at the Givet Group / Frasnies Group boundary where the first *Ancyrodella* have been identified by BULTYNCK (1974), after a 15 m-thick episode without any conodonts.

Systematic sampling has been carried out in order to establish the evolution of the environments and to detail the G/F transition. This led to the examination of 254 thin sections which allowed recognition of 13 microfacies types paralleling the standard sequence of MAMET & PRÉAT (1989) from open marine shallow subtidal to restricted supratidal near emersion. The Boreux Mbr and the Fort Hulobiet Mbr display restricted facies (*Amphipora*, spongiostromid and algal bafflestones and bindstones, loferites with desiccation lumps) with poorly fossiliferous beds interbedded with higher energy peloidal and sometimes oolitic grainstone facies. Laminite horizons, sometimes with small-sized LLH-stromatolites are uncommon, and they are associated with dolomicrites showing pseudomorphs of evaporite minerals. These evaporitic facies become common in the upper part of the Hulobiet Mbr suggesting the paleoclimate may be becoming more arid at the G/F transition. The boundary between the Givet Group and the Frasnies Group which is very distinctive on the field, is therefore characterized by a transition from restricted evaporative lagoonal facies to open marine interbedded marly shales and nodular limestones. A meter-scale cyclicity is very pervasive throughout the Givetian part of the section. Cyclicity was determined by assessing the vertical stacking of facies, the base of a cycle being identified by the initial backstepping of less restricted facies-type over a restricted facies-type. Cycles have open or semi-restricted subtidal bases with stromatopores, crinoids, corals and restricted supratidal tops with common "algal chips". They record a decrease in circulation, a decrease in diversity of organisms, which are endemic (cynaobacteria, stromatolites, ostracods, gastropods, umbellids), and increase in salinity upwards through the cycles. Horizons rich in ostracods are commonly seen representing the impingement of storms in the low energy restricted lagoons. Oncoids are locally abundant in specific horizons. The upper part of the Fort Hulobiet Mbr consists of interbedded biostromes (semi-restricted stromatopoid boundstones) followed by *Amphipora* floatstones, then of fossil-poor units and restricted supratidal laminites with well-developed fenestral fabrics. The Frasnian Pont d'Avignon Mbr shows a rich faunal assemblage (bryozoans brachiopods, molluscs, nautiloids, tentaculitids) suggesting an abrupt deepening of the Frasnian from the marginal Givetian carbonate platform to a deep basinal environment below or near the storm wave base.

For the study of ostracods, 47 new samples were collected in the Sourd d'Ave section, and approximately 1,130 carapaces, valves and fragments have been extracted. More than 500 ostracods collected by CASIER (1977, 1987) and MILHAU (1983) in the Sourd d'Ave section were also reviewed. Approximately 45 ostracod species are recognized in the Fromelennes Fm and 27 in the Nismes Fm, and they belong exclusively to the Eifelian Mega-Assemblage.

In the Moulin-Boreux Mbr, ostracods are generally poorly preserved, and frequently coated. In two samples, the monospecificity occurs with the genus *Cryptophyllus*, indicative of semi-restricted

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environments. These environmental conditions occurred also in the Fort Hulobiet Mbr except during a short interval during which ostracods are indicative of an open-marine environment. In this interval the fauna is more diversified and *Bairdia paffrathensis* and *Polyzygia neodevonica* are present. The transition Givet Group / Frasnies Group is abrupt in the Sourd d'Ave section, and the environment becomes exclusively and durably marine. In the Pont d'Avignon Mbr, the relative proportion of podocopids and metacopids indicates a well oxygenated marine environment a little below fair-weather wave-base level. In the Sourd d'Ave Mbr, the depth increases as showed by the ascendance of metacopids comparatively to podocopids, and in the base of the La Prée Mbr, with the deepening, ostracods became more rare. Finally in an other section located in the prolongation of the Sourd d'Ave section, CASIER (1987) recorded the presence of entomozoid ostracods (*Franklinella*) proxy for hypoxic water conditions (CASIER 2004). However the exact dating of this last section is controversial.

The Frasnies Group / Givet Group transition has been recently studied at Nismes by CASIER & PRÉAT (2009), and at Flohimont close to Givet by MAILLET (2010). The only significant change as deduced from the ostracod fauna and the sedimentology in the three sections is the transition from lagoonal and semi-restricted environments to open-marine environments close to the Givet Group / Frasnies Group boundary. But at Sourd d'Ave, this change is abrupt and takes place exactly at this boundary. On the contrary, in the Nismes and Flohimont sections, this change corresponding to the entry of *Polyzygia beckmanni beckmanni*, occurred in the upper part of the Fromelennes Fm. In fact, the Sourd d'Ave section is condensed by comparison with the Nismes and Flohimont sections and there is a hiatus at the contact Givet Group / Frasnies Group boundary emphasized by an irregular contact (BULTYNCK & COEN in BOULVAIN *et al.* 1999).

339 samples were collected for low-field magnetic susceptibility (X_{LF}) analyses in the Sourd d'Ave section. The X_{LF} values were measured with a Kappabridge MFK1-A with a CS-3 furnace. The MS values range between $6.0 \times 10^{-10} \text{ m}^3/\text{kg}$ and $4.52 \times 10^{-7} \text{ m}^3/\text{kg}$. The highest X_{LF} values are present in the Fort Hulobiet Mbr and are observed at the top of each magnetic susceptibility evolutions. A clear decreasing trend of the X_{LF} is discernible at the end of the Fort Hulobiet Mbr and the X_{LF} values remain weaker in the sediments at the base of the Frasnian.

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