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RE-INTERPRETATION OF THE FRASNIAN CLASSICAL "REEFS" OF THE SOUTHERN ARDENNES, BELGIUM (Extended Abstract) [1]

by

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Frasnian carbonate built ups from Southern Belgium have commonly been interpreted as ecological reefs *sensu stricto* resulting from the growth of frame builders, namely corals and stromatoporoids, up to or near to surficial turbulent waters (Lecompte, 1960). Recently, Tsien (1977) admitted that the uppermost red build ups ("F_2j") had formed in deeper waters than the underlying ones and called them mud mounds. Re-evaluation of the participation of so-called reef building organisms in the three successive biohermal horizons ("F_2d", "F_2h", "F_2j"), and of the environmental significance of coral and stromatoporoid morphologies by Bernet & Maurin (1975) and Monty (1975), led to the conclusions that these "reefs" had formed in quiet rather deep waters and that they were mostly made of calcitic muds and occluded cavities. This was confirmed by the detailed sampling by Cornet (1975) with respect to the grey F_2h "reef" of the Lion Quarry and much of the red "F_2d" red one where only very few massive stromatoporoids seem to appear on the top of the build up of the Arche Quarry.

In the major part of the observed bioherms, lamellar or platy corals and stromatoporoids definitely grew resting on the muddy seafloor whereas branched colonies of *Disphyllum* or *Phacellophyllum* are found in growth position or just tilted and burried from all sides in the mud.

At times, small coral and/or stromatoporoid reefs may have developped at the base or near the top or the mounds but these are minor features with respect to the overall mass of the mud bioherm (Lion and North Quarries).

All these mounds share several features :

1. They are made of almost pure carbonates ; the grey "F_2h" mounds average 99 % $CaCO_3$ (Lion Quarry, North Quarry) whereas the red "F_2d" and "F_2j" bioherms yielded results around 95 % $CaCO_3$; the bulk of the insolubles consists here of *in situ* microbial hematite (see Monty, 1982), authigenic quartz and eventual phyllosilicates generally concentred in seams.

   There is hence a strong discrepancy between these plain carbonate build ups and the shales which surround them from all stratigraphical sides. Accordingly, these hectometric to kilometric (basal diameter) anomalies must have grown during periods of very low influxes of terrigenous sediments. This is confirmed by conodont biostratigraphy which revealed sharp and rapid condensation of zones when these are traced laterally outside of the mounds into the thin adjacent nodular limestones and shales (Coen *et al.,* 1976).

2. The bulk of these mounds is made of fine-grained biomicrites, micrites with microbial structures, both associated with stromatactis and zebra developments, and sandy to gravelly often fenestral muds (crinoids, brachiopods, ostracods).

   The bioclastic grains originate in the *in situ* decay (crinoids) or in the bioerosion of skelettons of invertebrates colonizing the surface of the growing mounds.

   On sedimentological grounds, the mud itself (calcitic micrite) has also to be interpreted in terms of local production the more that it is limited to the mounds ; its association with "blue-green algae", in more general terms, microbial features, led us to conclude that it resulted from local microorganic precipitation (Monty, 1976, p. 249 ; 1977, p. 27). Similarly, it has been shown elsewhere (Monty, 1982) that much of the hematite found in the red mud mounds also resulted from original microbial fixation of iron.

   At places coarser bioclastic stretches are found along the flanks or near the base of the slopes of the mounds as usual.

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3. These mud bioherms originally had a very strong cohesion as shown by the dips of the constructionnal slopes (40° to 50° are common features) and by the relief they could reach over the surrounding seafloor (30 to 40 m in the case of the Petit Mont mud mound, for a base diameter of 150 m (Coen *et al.,* 1976.

   That this micrite was originally a soft mud, and not a micritic cement as postulated by Mountjoy (1978) is shown by the abundance of small scale plastic deformations, sedimentary injections, melanges due to water escape or syneresis, and on a larger scale by the common presence of slumps eventually sealed by further mud accretions. Field, petrographical and experimental evidences, converge to the conclusion that this cohesion was due to the abundance of organic matter within the mud, and the presence of surficial microbial films stabilizing the surface, so that the accreting deposit could have properties comparable to those of gels.

4. These originally soft muds appear however to have known an early consolidation and even lithification as indicated by the presence of straight uncollapsed fractures eventually inhabited by a variety of microbial communities (Monty, 1982), and/or specialized invertebrates (sponges, etc . . .), the formation and preservation of unsqueezed breccias or of small olistoliths that went down the flanks. This rapid evolution towards lithification can in its turn be related to the microbial diagenesis of interstitial organic matter eventually associated with the development of fenestrae *s.l.*.

5. The last two points and their corollaries can account for the fact much of the cavities (stromatactis, zebra, fenestrae, irregular and random cavities, etc . . .) were in fact poorly affected by mud infillings. Furthermore, as briefly reported in Monty 1982 many of the cavities and fissures were invaded by non photosynthetic microorganic communities leading to the formation of micritic, sparitic (radiaxial), or yet hematic endostromatolites, and a variety of arborescent or tuffaceous microbial structures due to bacterial growth including *Renalcis* and *Epiphyton* ones.

6. As is the rule in mud mound formation, the Belgian Frasnian ones did not form in one single phase but resulted from the superposition of lenticular, often sigmoidal mud scales as cas be seen in the Arche or the Lion Quarries for example. Such muddy build ups were by no means able to resist the energy of agitated environments ; waves and swell would have tended to elutriate the muds, leaving sorts of lag deposits, whereas the impact of (storm) waves would most probably have transferred the accreting mounds into slumpled and redeposited sediments. Also as the overall scarcity of reefal invertebrates and the oligospecificity of the recorded fauna can be no more explained by high turbidity (mud is not detrital but originated *in situ*) ; the only remaining valid environmental characters are water depths and/or temperatures.

Sedimentological and paleontological evidences agree toward a deep water origin of these mounds that would have formed well below wave base, that is below 60-70 m. The local occurrence of dasyclad remains does not contradict this interpretation as these can abundantly grow down to 100-120 m depending on latitude and transparency of the sea. As already pointed out by Desbordes & Maurin (1974) temperature could be another interesting factor controlling the particular ecology of mud mounds ; without invoking an overall climatic control at this stage, cooler temperatures could have been due to the action of cold upwelling currents or a thermostratification of the water body. These interpretations seem more and more justified by observations carried in the Recent by our team.

BIBLIOGRAPHY

BERNET-ROLLANDE, M.C. & MAURIN, A.F., 1975. Réévaluation du rôle des coélentérés dans le phénomène récifal fossile. Exemples du Dévonien Supérieur. Second Symp. Intern. sur les Coraux et Récifs Coralliens Fossiles, Paris 1975.

COEN, M., COEN-AUBERT, M. & CORNET, P., 1976. Distribution et extension stratigraphique des récifs à "Phillipsastrea" dans le Frasnien de l'Ardenne. Ann. Soc. géol. du Nord, 96 : 325-331.

DESBORDES, B. & MAURIN, A.F., 1974. Trois exemples d'étude du Frasnien d'Alberta, Canada. Compagnie Française des Pétroles, Notes et Mémoires, 11 : 293-336.

LECOMPTE, M., 1960. Compte-rendu de la session extraordinaire de la Société Géologique de Belgique et de la Société Belge de Géologie. Ann. Soc. géol. Belg., 83, 134 pp.

MONTY, C.L.V., 1975. Paleoecological significance of reef builders morphological zonations : past and present confronted. Second Symp. Intern. sur les Coraux et Récifs Coralliens Fossiles, Paris 1975.

MONTY, C.L.V., 1976. The origin and development of cryptalgal fabrics. *In :* "Stromatolites", M. Walter, Ed. Elsevier Scientific Publ. Comp., chap. 5.1 : 193-249.

MONTY, C.L.V., 1977. Evolving concepts on the nature and the ecological significance of stromatolites : A Review *in* "Fossil Algae" E. Flügel Ed. Springer-Verlag, Berlin, Heidelberg, N.Y. : 15-36.

MONTY, C.L.V., 1982. Cavity or fissure dwelling stromatolites (endostromatolites) from Belgian Devonian Mud Mounds. Ann. Soc. géol. Belg.

MOUNTJOY, E.W. & TULL, R.K., 1978. Fore-reef carbonate mud bioherms and associated reef margin, Upper Devonian, Ancient Wall Reef Complex, Alberta. Canadian Journal of Earth Sciences, 15 (8) : 1304-1325.

TSIEN, H.H., 1977. Morphology and developments of Devonian reefs and reef complexes in Belgium. Proc. 3rd Intern. Coral Reef Symposium, Miami, Florida, 2 : 191-200.