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SIGEP 073

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Dolomitic constructions by cyanobacteria in the Proterozoic

Marcel Auguste Dardenne

dardenne@tba.com.br

Instituto de Geociências, Universidade de Brasília, (61) 3072830. Brasília, DF - Brasil. CEP 70910-900.

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***Conophyton* of Cabeludo, Vazante Group, State of Minas Gerais**

Dolomitic constructions by cyanobacteria in the Proterozoic

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Marcel Auguste Dardenne*¹

*The Paleontological Site of Cabeludo, localized in the northwestern portion of the Minas Gerais State, shows exceptional outcrops of columnar stromatolites with conical laminations classified as *Conophyton cylindricus* Maslov. Stromatolites occur in dolomites of the Vazante Group, in the external zone of the Brasilia Fold Belt. These stromatolites are considered as typical of the Middle to Upper Proterozoic. The sedimentary environment is marine subtidal, relatively deep and quiet, possibly influenced by tidal currents.*

Keywords: bioherm, stromatolites, *Conophyton*, Vazante Group, Neoproterozoic.

INTRODUCTION

The extraordinary expositions of columnar stromatolites with conical laminations have been discovered by Ernst Moeri in 1971 and identified in the field by Marcel A. Dardenne as *Conophyton*, an index fossil of the Proterozoic (Dardenne *et al.* 1971, 1972). The quality of the outcrops and the importance of this occurrence regarding its paleontological, stratigraphic and paleoenvironmental aspects, render its preservation as fundamental and its classification as world reference for the study of Proterozoic stromatolites.

Stromatolites are structures of organic origin due to the activity of algae and/or cyanobacteria colonies which retain solid carbonate particles in suspension and/or precipitate the carbonates dissolved in the sea water. During Precambrian times, these structures were built almost exclusively by cyanobacteria activity, which was responsible firstly for the elevation of the oxygen rates in the sea water and later for the presence of oxygen in the atmosphere and consequently for the formation of the ozone strata, allowing the beginning of life on Earth since the Cambrian. The fundamental element of the stromatolitic structure consists of the intercalation of dark gray and light gray laminations. The dark gray lamina was produced by microbial colonies, while the light gray one represent the product of mechanical particle trapping and/or chemical carbonate precipitation. The main stromatolitic structures are plane parallel laminae, undulated laminae, domes and columnar constructions with convex or conical laminae. Recent and actual stromatolitic constructions have been recognized in marine littoral and lagunar sediments in various regions of the world, the most famous being known in the Bahamas, in the Gulf of Mexico, on the coast of Australia and of the Red Sea.

LOCALIZATION

The Cabeludo site is localized about 1 km north of the Cabeludo village, Vazante municipality, in the northwestern portion of the State of Minas Gerais (Fig. 1).

The access can be made from Vazante town in direction to Vazamor at north, or from Paracatu in direction to Vazamor at south. The geographic coordinates are 17°43'54"S and 46°45'53" W.

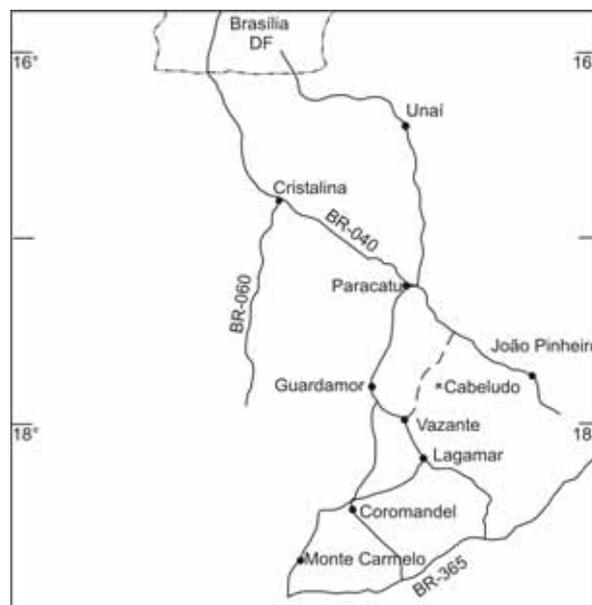


Figure 1 - Localization of the Site of Cabeludo.

GEOLOGICAL CONTEXT

In the Cabeludo area, the paleontological site occurs in dolomites of the Vazante Group (Dardenne 2000, 1979, Campos Neto 1984), which are sub-horizontal and involved by two assemblages of slates intensively folded: the Serra do Garrote Formation at east, at the base, and the Serra da Lapa Formation at west, at the top (Figs. 2 and 3). The slates of the lower unit are greenish with yellow to orange alteration, while the dark gray slates of the upper unit are carbonaceous and contain layers of dark dolomite and chert. The dolomites, locally siliceous, show a massive aspect with incipient lamination and abundant microbial structures. Various types of dolomites have been

distinguished: laminated dolomite with microbial mats; organic rounded intraclast rich dolomite, cemented by microcrystalline sparite and showing vugs filled by crystalline sparite; dark gray to black dolomite with siliceous patches; reddish dolomitic breccias with angular fragments of micritic dolomite and chert showing anomalous concentrations of hematite and pyrite.

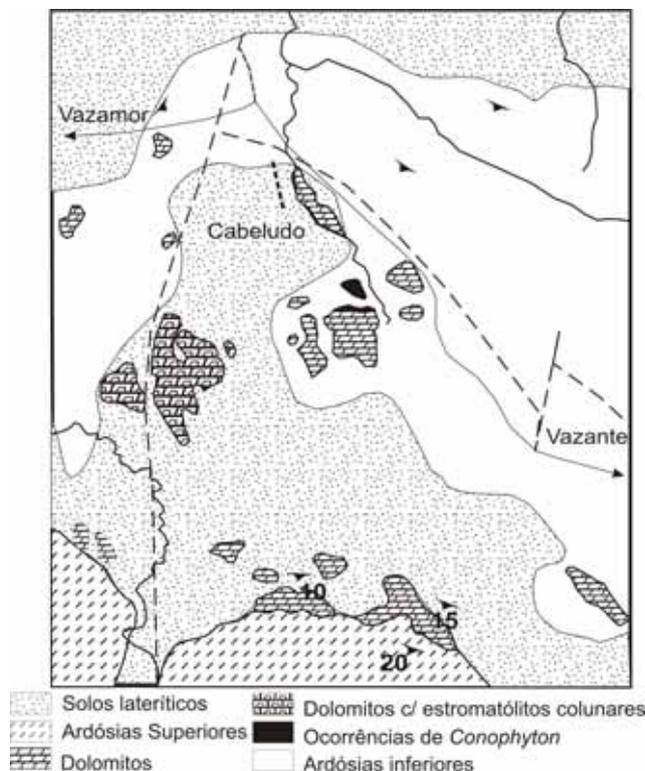


Figure 2 - Simplified geological map of the Cabeludo area (after Dardenne 1979).

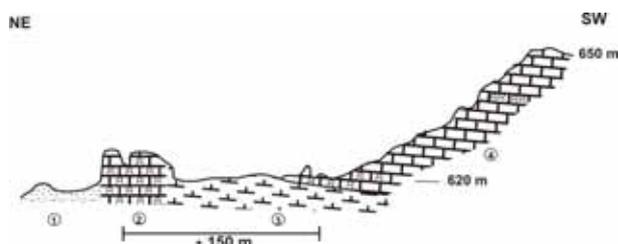


Figure 3 - Schematic cross-section of the Cabeludo area, MG (modified from Moeri, 1972)

1 - lateritic soil; 2 - dolomites with *Conophyton*; 3 - marls; 4 - laminated dolomites.

DESCRIPTION OF THE CABELUDO SITE

The description of the site is a resume the main observations made by Moeri (1972), Dardenne & al. (1972), Cloud & Dardenne (1973) and Dardenne (1979).

The columnar stromatolites with cylinder-conical lamina occur as small and isolated groups, visible in three dimensions, involved by dolomitic marls weathered and less resistant to erosion, allowing the perfect exposition of the stromatolitic constructions.

The stromatolites form columns up to three or four meters high with diameters from 30 to 80 cm at the base.

The columns are vertical or slightly inclined, parallel between them, with the bases touching each other (Fig. 4). In the upper portion, the intercolumnar space is more evident and filled by micritic dolomitic mud. In vertical longitudinal section, the alternate dark and light gray lamina are perfectly visible, forming in the apical portion a 30 to 50° angle, being interrupted on the column border and without showing any significant recovering. Exceptionally, it is possible to observe the linking of some conical laminae from a column to another, especially at the top of the construction. In the center of the columns, an axial zone with around 0,8 to 1,0 cm width is individualized, on which the conical laminae support themselves.

In transversal section, the stromatolitic columns offer an elliptical geometry (Fig. 5) and more rarely a circular one. In the center of these sections stands out the axial zone defined before. Some isolated outcrops show a divergent and radial development of the stromatolitic columns from a focus of expansion.

On polished surfaces and thin sections, the stromatolitic structure is well defined and shows a banded aspect with alternate dark and white laminae (Fig. 6). The dark laminae, with thickness between 0,1 and 1,0 mm up to 2,0 mm, are almost continuous, being sometimes interrupted and fragmented, showing frequently a pelloidal texture (Fig. 7). Sometimes, these laminations, which result of the bacterial activity, contain internal sediments with light gray color. The white laminae, with larger thickness than the dark ones, between 0,2 and 2,5 mm, are composed by crystalline dolomite. They can represent the product of recrystallization of an old carbonate mud captured or precipitated by microbial colonies, or more probably the products of dissolution and filling of the open spaces by coarse dolomite sparite. A brownish fibrous texture is developed with growth of the crystals in direction to the center, where it is succeeded by coarse sparite and quartz. These light laminae can contain fragments more or less elongated of the dark laminae.

CLASSIFICATION

The striated structure of the laminae and the width ratio of the dark and light laminae (Fig. 8), between 0,2 and 1,5, allow to classify these stromatolitic constructions as *Conophyton cylindricus* Maslov (Moeri 1972, Moeri & Cloud 1973) or *Conophyton metula* Kirichenko (Cloud & Dardenne, 1973), following the binomial nomenclature of Russian authors (Komar *et al.* 1965, Raaben 1964, Cloud & Semikhatov 1969).



Figure 4 - Outcrop showing various vertical longitudinal sections of Conophyton.



Figure 5 - Outcrop showing a transversal elliptical section of Conophyton.

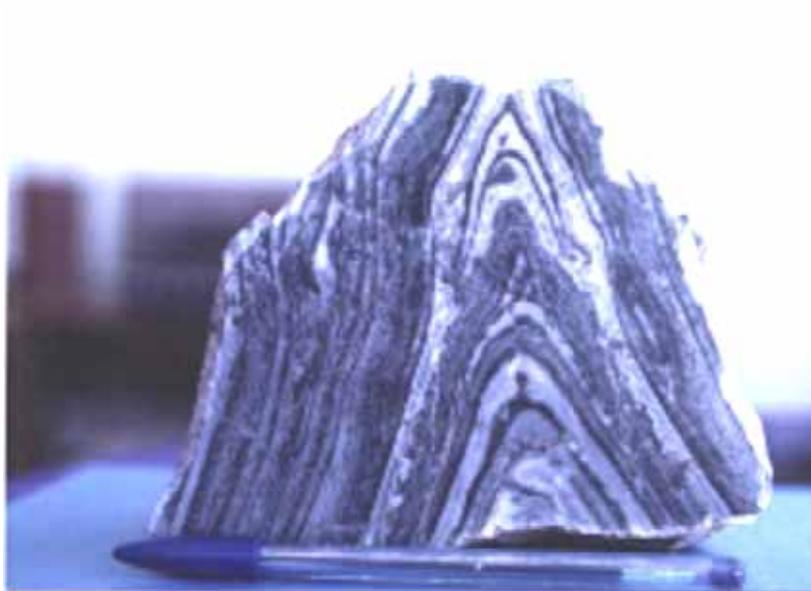


Figure 6 - Longitudinal polished section of Conophyton showing the characteristic banding of the dark and light laminations.

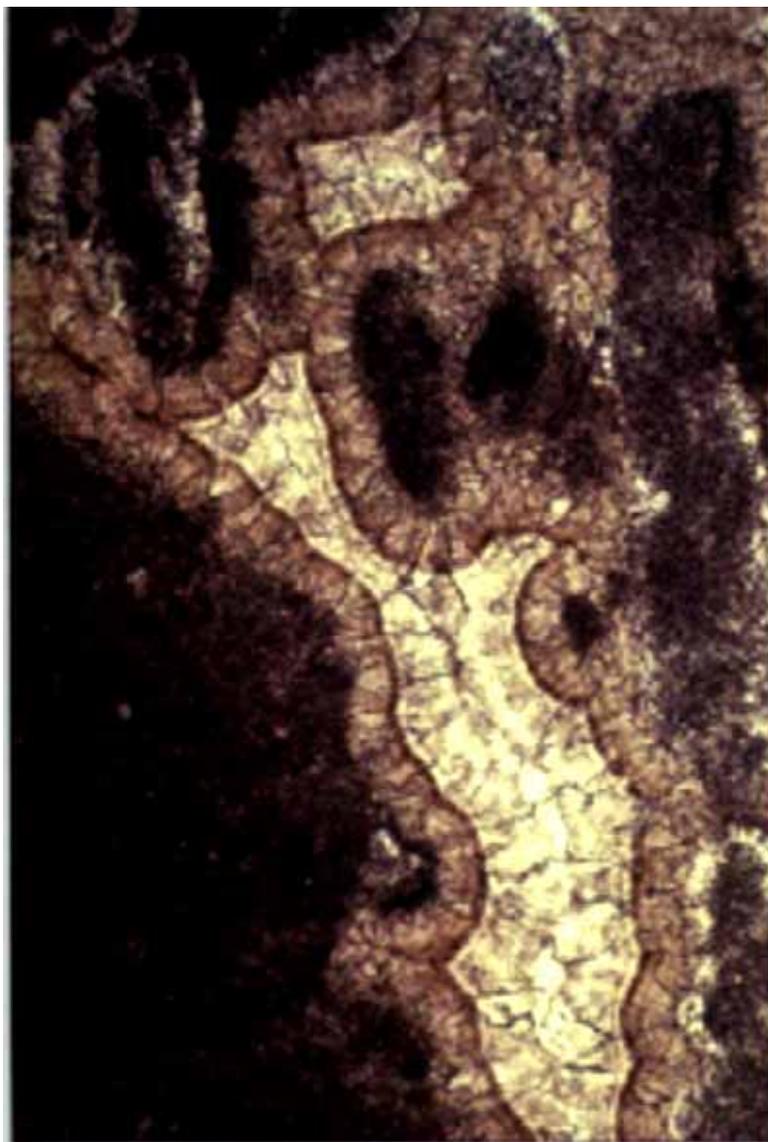


Figure 7 - Microstructure of *Conophyton cylindricus* Maslov.



Figure 8 - Relative thickness of dark and light laminations of *Conophyton* (after Moeri 1972).

AGE

Following the Russian authors, the *Conophyton* genus is considered as characteristic of Middle and Upper Proterozoic. This fact has been confirmed in other parts of the world, as in Australia (Walter & Preiss 1972), in Canada (Hoffmann 1969, 1972), in the United States of America (Cloud & Semikhatov 1969), and in Africa (Bertrand-Sarfati 1972; Trompette 1969). In Brazil, the genus *Conophyton* was first found in dolomites of the Itaiacoca Group (Almeida 1964) and after in dolomites of the Bambuí/Vazante groups (Moeri 1972; Cloud & Dardenne 1973; Dardenne *et al.* 1971, 1972, Dardenne & Campos Neto 1976, Dardenne 1979, Nogueira 1993, Nogueira & Dardenne 1992), in dolomites of the Paranoá Group (Dardenne *et al.* 1973, 1976, Guimarães & Dardenne 1994, Laranjeira & Dardenne 1993, Laranjeira 1992), and in dolomites of the Macaúbas Group (Schöll 1976). Generally, the authors consider an age between 1650 and 950 Ma for *Conophyton cylindricus* Maslov or a Middle Riphean age. Actually, this nomenclature has fallen in disuse due to the difficulty encountered for objective descriptions of the stromatolitic constructions and to the emphasis given to the influence of environmental conditions on the stromatolite morphology. However, the genus *Conophyton* is still considered as characteristic of Middle and Upper Proterozoic. In Brazil, this type of stromatolite is used informally, together with other geologic arguments, to distinguish the Vazante and the Paranoá groups from the Bambuí Group.

SEDIMENTARY ENVIRONMENT

The geological observations made in macroscopic and microscopic scales in the area of the site, allow to extract some important conclusions for the sedimentary environment where the stromatolitic columns have grown:

- the dolomitization is penecontemporaneous with the sedimentation;
- the outstanding height reached by the stromatolitic columns needs an early lithification of these columns and a high rate of sedimentation. In some places, it is possible to observe slumps and local fractures in the upper portion

of the columns induced by overload of sediments. This early lithification is probably contemporaneous with the dolomitization;

- the absence of intraclasts and the presence of micritic mud in the intercolumnar space signify that the columns have grown in a relatively deep and quiet environment;

- however, the preferential orientation N20E to NS of the elliptic transversal sections allows inferring the presence of strong and active tidal currents, which induce the formation of dense and isolated bioherms where the deposition of micritic mud is still possible under the protection of the columns;

- in some rare cases, the occurrence of fractured and broken stromatolitic columns is probably due to the action of storm or strong episodic tidal currents provoking the erosion of columns not still completely lithified;

- in direction to the top of the stromatolitic sequence, the presence of laminated and undulate to domical dolomites associated with intraclast rich dolarenites traduces a return to shallow tidal environment.

CONCLUSIONS

The discovery of stromatolites of the *Conophyton* type in the dolomites belonging to the Vazante and Paranoá groups permits to correlate these units to the Middle/Upper Proterozoic and to differentiate them from the Bambuí Group, in which are recognized only stromatolites belonging to the *Gymnosolenides* group and correlated to the Upper Proterozoic (Marchese, 1975; Dardenne, 1979).

RECOMMENDATIONS FOR THE PRESERVATION OF THE SITE

The preservation of the site is of fundamental importance for the study of columnar stromatolites of the *Conophyton* type, for the solution of correlations in regional and world scale, and for the conservation of Brazilian paleontological sites.

Consequently, it is suggested to put an explicative outdoor for underlining the main attributes of the Cabeludo Site, its importance for the geological history of Brazil and the fundamental paper played by these organisms for the formation of the terrestrial atmosphere and for the evolution of life on the earth.

It is suggested to call the CMM (Companhia Mineira de Metais) for responsibility of preservation of the site and instruction of the local farmers to maintain the outcrops intact.

REFERENCES

- Almeida, F.F.M. 1944. *Collenia Itapevensis*-Um fóssil Precambriano no Estado de São Paulo. *Fac. Fil. Ciênc. Letras, USP, Boletim* 45, Geol., Vol. 1, p. 29-106.
- Bertrand-Sarfati, J. 1972. Stromatolites colonnaires du Précambrien Supérieur, Sahara Nord-occidental: inventaire, morphologie et microstructure des laminations; corrélations stratigraphiques. CNRS, C.R.Z.A., série Geologie, n°14, 245p.
- Cloud, P.; Dardenne, M.A. 1973. Proterozoic age of the Bambuí Group in Brazil. *Geol. Soc. Am. Bull.*, 84:1673-1676.
- Cloud, P.; Moeri, E. 1973. Conophyton in the Bambuí Group: What form and age? *Geol.*, 1(3): 127.
- Cloud, P.; Semikhatov, M.A. 1969. Proterozoic stromatolitic zonation. *Am. Journ. Sci.*, 267: 1017-1061.
- Dardenne, M.A. 1979. Les minéralisations de plomb, zinc, fluor du Protérozoïque Supérieur dans le Brésil Central. Thèse de Doctorat d'Etat, Université de Paris 6, 251 p.
- Dardenne, M.A.; Campos Neto, M. 1976. Geologia da região de Lagamar, Minas Gerais. *Cong. Bras. Geol.*, 29, Ouro Preto, SBG, Resumos, p.17.
- Dardenne, M.A.; Faria, A.; Andrade, G.F. 1973. Ocorrências de estromatólitos colonares na região de São Gabriel, Goiás. *Cong. Bras. Geol.*, 27, SBG, Aracaju, Bol. Esp. n° 1, p. 139-141.
- Dardenne, M.A.; Faria, A.; Andrade, G.F. 1976. Occurrence de stromatolithes colonnaires dans le Groupe Bambuí (Goiás-Brésil). *An. Acad. Brás. Cienc.*, 48 (3): 555-566, Rio de Janeiro.
- Dardenne, M.A. 2000. The Brasília Fold Belt. In Cordani U.G., Milani E.J., Thomaz Filho A., Campos D.A. (Edts.), *Tectonic Evolution of South America*, 31 Int. Geol. Congress, Rio de Janeiro, Brazil 2000, p.231-264.
- Dardenne, M.A.; Mello, S.M.G.; Moeri, E. 1972. Les stromatolithes du Groupe Bambuí, Brésil: classification et conditions du milieu de sédimentation. *Cong. Geol. Intern. Canadá*, Abstract n° 8.
- Dardenne, M.A.; Mello, S.M.G.; Moeri, E. 1971. Os estromatólitos do Grupo Bambuí: classificação, importância estratigráfica e metalogênica. *Cong. Brás. Geologia*, 25, São Paulo, SBG, Bol. Res. Com. Esp., N° 1, p.88.
- Dardenne, M.A.; Mello, S.M.G.; Moeri, E. 1972. Conophyton: um fóssil index do Precambriano no Grupo Bambuí. *Ciênc. Cult.*, 24 (2): 199-203.
- Guimarães, E.M.; Dardenne, M.A. 1994. Proterozoic stromatolites from Cabeceiras, Goiás, Brazil. 14 Intern. Sedim. Congress., Recife, Abstracts, p. 38-39.
- Hofmann, H.J. 1969. Attributes of stromatolites. *Geol. Surv. Canadá*, Paper 69-39, 43p.
- Hofmann, H.J. 1972. Stromatolites from the Proterozoic Animikie and Sibley Groups, Ontario. *Geol. Surv. Can.*, Paper 68-69.
- Komar, V.A.; Raaben, M.E.; Semikhatov, M.A. 1965. Conophyton in the Riphean of the URSS and their stratigraphic importance. *Akad. Nauk SSSR Geol. Inst. Trudy*, v. 131, 72p.
- Laranjeira, N.P.F. 1992. Geologia do Grupo Paranoá na região de Unaí: uma plataforma siliciclástica-carbonática no Proterozóico de Minas Gerais. *Dissertação de Mestrado*, IG/UnB, Brasília, 165p.
- Laranjeira, N.P.F.; Dardenne, M.A. 1993. Litoestratigrafia do Grupo Paranoá na região de Unaí, MG. *Anais 2° Simp. Cráton São Francisco*, SBG, Salvador, p. 282-284.
- Marchese, H.G. 1975. Estromatolites "Gymnosolenidos" en el lado oriental de Minas Gerais, Brasil. *Rev. Bras. Geociências*, 4 (4): 257-271.
- Moeri, E. 1972. On a columnar stromatolite in the Precambrian Bambuí Group of Central Brazil. *Ecl. Geol. Helv.*, 65 (1): 185-195.
- Nogueira, G.M.S. 1993. Enquadramento estratigráfico, sedimentologia e evolução geoquímica do depósito fosfático de Lagamar, MG- Formação Vazante-Proterozóico Médio. *Dissertação de Mestrado*, IG/UnB, Brasília, 134p.
- Nogueira, G.M.S.; Dardenne, M.A. 1992. Caracterização dos dolomitos biohermais estromatolíticos da região de Lagamar, MG. *Bol. Res. Exp., Cong. Brás. Geol.*, 37, SBG, São Paulo, 1, p. 70-71.
- Preiss, W.V. 1972. The systematics of South Australia Precambrian and Cambrian stromatolites. Part. 1. *Trans. R. Soc. Aust.*, 96, part.2, 67-100.
- Raben, M.E. 1969. Columnar stromatolites and Late Precambrian stratigraphy. *Am. J. Sci.*, 267/1: 1-18.
- Schöll, W.R. 1976. Estromatólitos (Conophyton) em dolomitos do Grupo Macaúbas. *Cong. Bras. Geol.*, 29, Ouro Preto, SBG, Resumos, p. 363.
- Trompette, R. 1969. Les stromatolites du Précambrien Supérieur de l'Adrar de Mauritanie (Sahara occidental). *Sedimentology* 13/1 and 2.
- Walter, M.R.; Preiss, W.V. 1972. Distribution of stromatolites in the Precambrian and Cambrian of Australia. 24th IGC, Section 1, p. 85-93.

* Instituto de Geociências. Universidade de Brasília.
1 dardenne@tba.com.br