

**Giant Stromatolites field of Santa Rosa de  
Viterbo, State of São Paulo***Excellent record of the Irati Permian sea coastal environment,  
Paraná basin***Fresia Ricardi-Branco<sup>1</sup>  
Edgar Taveiros de Caires<sup>2</sup>  
Adalene Moreira Silva<sup>3</sup>**

<sup>1</sup>DGRN, IG, Universidade Estadual de Campinas Cp.6152, CEP 13083-970, Campinas, SP, Brasil.

End. eletrônico: [fresia@ige.unicamp.br](mailto:fresia@ige.unicamp.br)

<sup>2</sup>Geólogo (CREA-SP 5062380663), Rua Hungria, N° 275, CEP 13318-000, Cabreúva, SP, Brasil.

End. eletrônico: [edcaires@gmail.com](mailto:edcaires@gmail.com)

<sup>3</sup>GRM, IG, Univ. de Brasília . Darcy Ribeiro S/N, Asa Norte, CEP 70910-900 - Brasília, DF, Brasil.

End. eletrônico: [adalene@unb.br](mailto:adalene@unb.br)

© Fresia Ricardi-Branco,F.; Caires,E.T.; Silva,A.M.. 2006. Giant Stromatolites field of Santa Rosa de Viterbo, State of São Paulo - Excellent record of the Irati Permian sea coastal environment, Paraná basin. *In*: Winge,M.; Schobbenhaus,C.; Berbert-Born,M.; Queiroz,E.T.; Campos,D.A.; Souza,C.R.G. ; Fernandes,A.C.S. (*Edit.*) Geological and Palaeontological Sites of Brazil. Available on line 24/11/2006 at the address: <http://www.unb.br/ig/sigep/sitio125/sitio125english.pdf>  
[Actually <https://sigep.eco.br/sitio125/sitio125english.pdf> ]

(The above bibliographic reference of author copy right is required for any use of this article in any media, being forbidden the use for any commercial purpose)

# Giant Stromatolites field of Santa Rosa de Viterbo, State of São Paulo

*Excellent record of the Irati Permian sea coastal environment, Paraná basin*

SIGEP 125

Fresia Ricardi-Branco<sup>1</sup>  
Edgar Taveiros de Caires<sup>2</sup>  
Adalene Moreira Silva<sup>3</sup>

Stromatolites are biosedimentary structures formed by the physiologic activity of microorganisms, and are of great importance to the palaeoenvironmental study. They occur in a wide variety of situations, especially along the sea coast environments. The Irati Subgroup comprises sedimentary rocks laid under euxinic conditions, with increasing salt concentrations as one moves up from base to top. It composed of oil shales, sandstones, limestone, carbonates and anhydrite, indicative of a very complex basin geometry, whit gulfs and bays revealing great variations in depth and salinity. In the northeastern portion of state São Paulo, near the town of Santa Rosa de Viterbo region, is an area covered with a giant stromatolites, formed under coastal conditions during the Permian (Guadalupian), whit the domes attaining heights of over three meters. This area is the site of a rock quarry wich has been extracted carbonates, especially that making up the stromatolites, for approximately forty years. Given the importance of this paleoenvironmental register for the study of the Paraná basin, as well as the excellent visibility of the stromatolites within the quarry, it is imperative that this area be designated a palaeontological site. Moreover, the owners of the quarry have agreed to preserve this outstanding record of the Irati sea coast, and they have encourage the present request.

**Keywords:** Irati Subgroup, Stromamatolite , mesosaurids, Paraná basin, Permian.

## INTRODUCCION

Fossils play a fundamental role in the understanding of the appearance and evolution of life on our planet throughout its long geologic history, since they provide information about the ecology and environment of the original organism, as well as about the period of time in which they lived (Carvalho, 2000) .The Santa Rosa de Viterbo site has been designated for the preservation of the gigantic stromatolites found there (Irati Subgroup - *sensu* Hachiro *et al.*, 1993). These finely-layered biosedimentary domes were formed in a subaquatic environment and provide a register of the coast of the Irati sea in what is now the central portion of the state of São Paulo. Such structures have been recognized since the 19<sup>th</sup> century, although until the 1960s they were erroneously interpreted as biologic concretions. During the sixties, modern stromatolites were found in a hypersaline environment off the western coast of Australia, and these were then recognized as equivalent to their Precambrian ancestors. These fossils constitute some of the oldest evidence of life on the planet, and they have been found on almost all of the continents after the Arquean (Knoll, 2003). Although a single stromatolite, in itself, has no stratigraphic importance. Large groups of

stromatolites, such as that found at Santa Rosa de Viterbo do have stratigraphic and paleoenvironmental significance.

There are many things we can learn from stromatolites. We can use them to identify where biologic activity took place in the past and locate microfossils; moreover, they can be used for the dating of biostratigraphic, environmental and temporal variation,, as well as the analysis of facies and depositional processes, and the interpretation of the paleoenvironment and paleosalinity. They can also be used to determine the direction of flow of paleocurrents and the boundaries of layers in tectonically folded rocks, as well as to evaluate sedimentation rate and to map ancient coastal zones. They can also be used to measure the height of tides and in the prospection of minerals, like in the Irati Subgroup.

## LOCALIZATION

The site here describe is located in the northeastern portion of São Paulo State on Paleozoic terrains of Paraná Basin, in the municipality of Santa Rosa de Viterbo (Fig. 2A and B), approximately 5 km from the city of the same name (21°49'03"S - 47°32'11"W).

## REGIONAL GEOLOGY

The Irati Subgroup, base unit of the Passa Dois Group, which covers some one million square kilometers of the Paraná Basin; equivalent layers of sedimentary rocks have been found in various regions of Brazil (states of Mato Grosso, Goiás, Mato Grosso do Sul, São Paulo, Paraná, Santa Catarina and Rio Grande do Sul), as well as in Paraguay, Uruguay, and possibly Argentina (Zalán, et al., 1990; Hachiro, 1996). The characteristic layers were deposited in restricted ocean conditions, progressively saltier (and drier) from

the base to the top. The unit is composed of a quite complex set of facies, including shale, bituminous shale, sandstone, margo, carbonates, and anhydrites, indicating the equally complex geometry of the basin involving ancient gulfs and bays of extremely varying depths and salinities (Daemon et al., 1991). At present, the Irati Subgroup comprises a package of sedimentary rocks which reaches thicknesses of about 70 meters in the central part of the basin; the stratigraphic sequence can easily be recognized in various locations around the state of São Paulo.

Subgroup	Formation	Member	Bed
	Serra Alta / <i>Corumbataí</i>		
IRATI	Assistência	Ipeúna	<i>Upper Rhythmits</i>
			<i>Thin Rhythmits</i>
			<b>Bairrinho</b> ( <i>Giant stromatolites of Santa Rosa de Viterbo</i> )
		Morro do Alto	<i>Laje Azul</i>
			<i>Lower Rhythmits</i>
			<i>Evaporitics</i>
			<i>Bituminous shales</i>
<i>Taquaral</i>			
Tatuí			

Figure 1 - Stratigraphy division of Irati Subgroup (Hachiro et al., 1993)

The Irati Subgroup in the state of São Paulo covers a wide geographic area, with relatively continuous outcrops from the northeast of the state in Santa Rosa de Viterbo to the southern border with Paraná. Its identification is facilitated by the distinctive lithologic and paleontologic characteristics (Fig. 1).

The Assistência Formation of the Irati Subgroup has been subdivided into the Morro Alto Member (at the base) and the Ipeúna Member (at the top). The thickness of these members varies from 10-40 meters and was divided into the biozones *Pygaspis brasiliensis*, *Mesosaurus brasiliensis* and *Paulocaris pachecoi* (Hachiro, 1996).

In the northeastern part of the state, the Ipeúna Member is composed of a dolomitic bank with layers of dololites and dolosandstones superposed on layers of breccia containing frequent nodules and lenses of chert and alternating, gradually upward-fining thin, regular light grey shale/carbonate and dark grey to black silt/clay layers interspersed with lenses of calcilutites. The top layer is comprised of inter-stratified rhythmic shale/carbonate layers similar to the others, but three times as thick, and the formation of partially lenticular and not always tabular horizontal layers (Hachiro, 1996).

The basal portion of the Ipeúna Member is known as the Bairrinho Bed; it is the portion quarried in the state of São Paulo. It has three distinct [sub-] beds, and is rich in fossils. This bed is constituted of an average 3- cm. thick banks of dolomitic carbonate

with two distinct texturally differentiated dolomitic facies, revealing cyclicity in the interior of the bed. The more finely textured facies is characterized by millimetric laminae and centimetric layers of light grey dololite intercalated with millimetric dark grey laminae of dololite containing organic impurities and clay (Hachiro, 1996). The other facies is composed of light grey to cream dolosandstone containing clastic material in parallel centimetric horizontal layers. The allochems are generally peloids, bioclasts, intraclasts and ooids. The central portion of the bank consists of three to four flat, five- to thirty-cm beds of intraformational breccia containing flat fragments of dolomites, algal mats, and rare fragments of shale.

Contact with the neighboring Formations (Serra Alta and Corumbataí) is concordant, except that in the northern part of the state of São Paulo (region of Santa Rosa de Viterbo) the depositional conditions reveal sedimentation in a coastal area and the disappearance of the bituminous shale of the Irati (Hachiro, 1996).

The Irati Subgroup has been quarried continuously since the middle of the 20<sup>th</sup> century for the exploitation of the minerals found in its carbonate layers. These are the main quarries found in the state of São Paulo. The extraction faces are the source of paleontological data which aids in the study and comprehension of various geological aspects of the Taquaral and Assistência formations. These quarries

also represent important sources for the collection of fossil data, since extraction exposes large fronts where

the rock strata have not yet suffered the weathering and erosion typically found in road cuts.

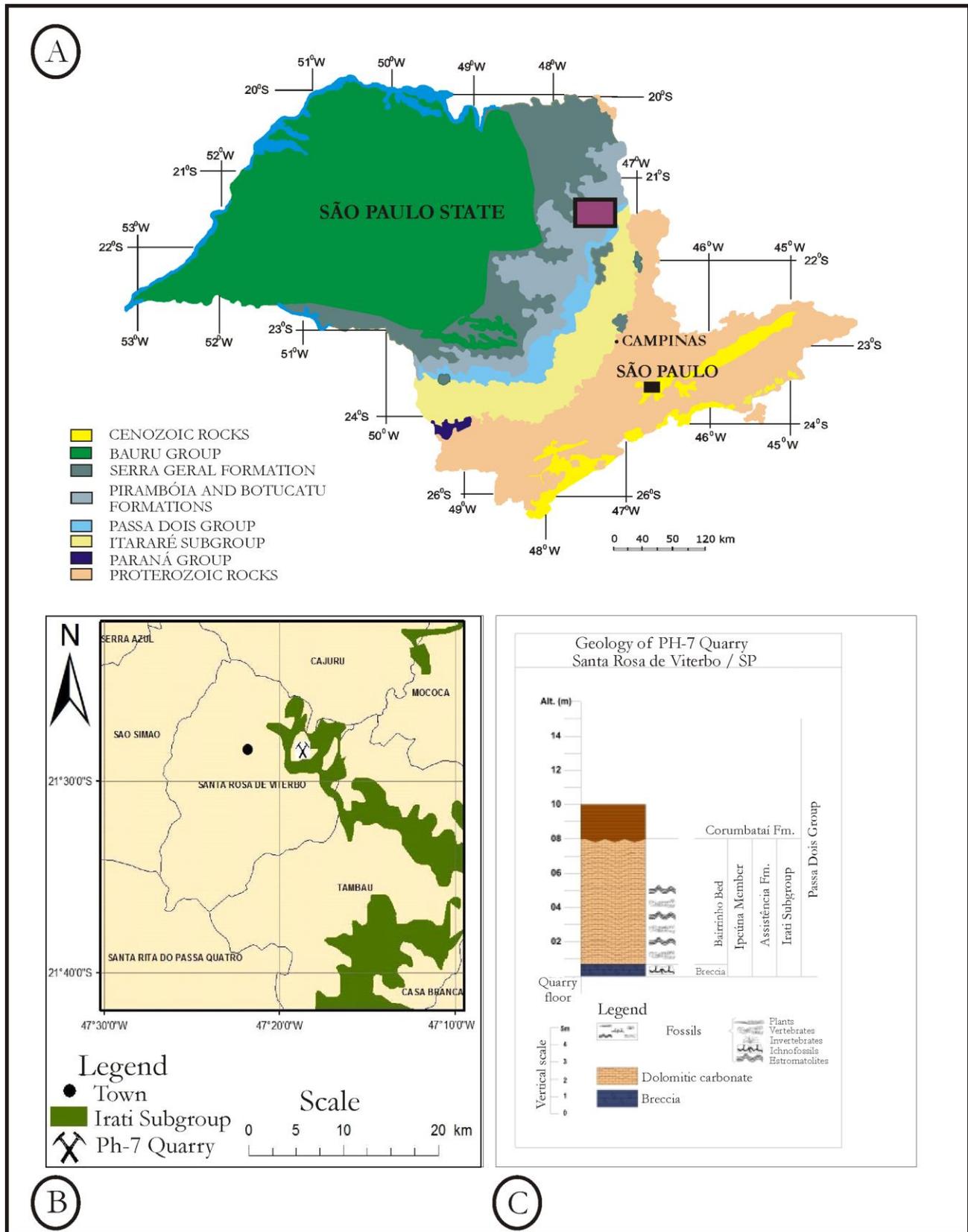


Figure 2 – Localization of Santa Rosa de Viterbo (A), PH 7 quarry (B) and stratigraphic column (C)

## DESCRIPTION OF THE SITE

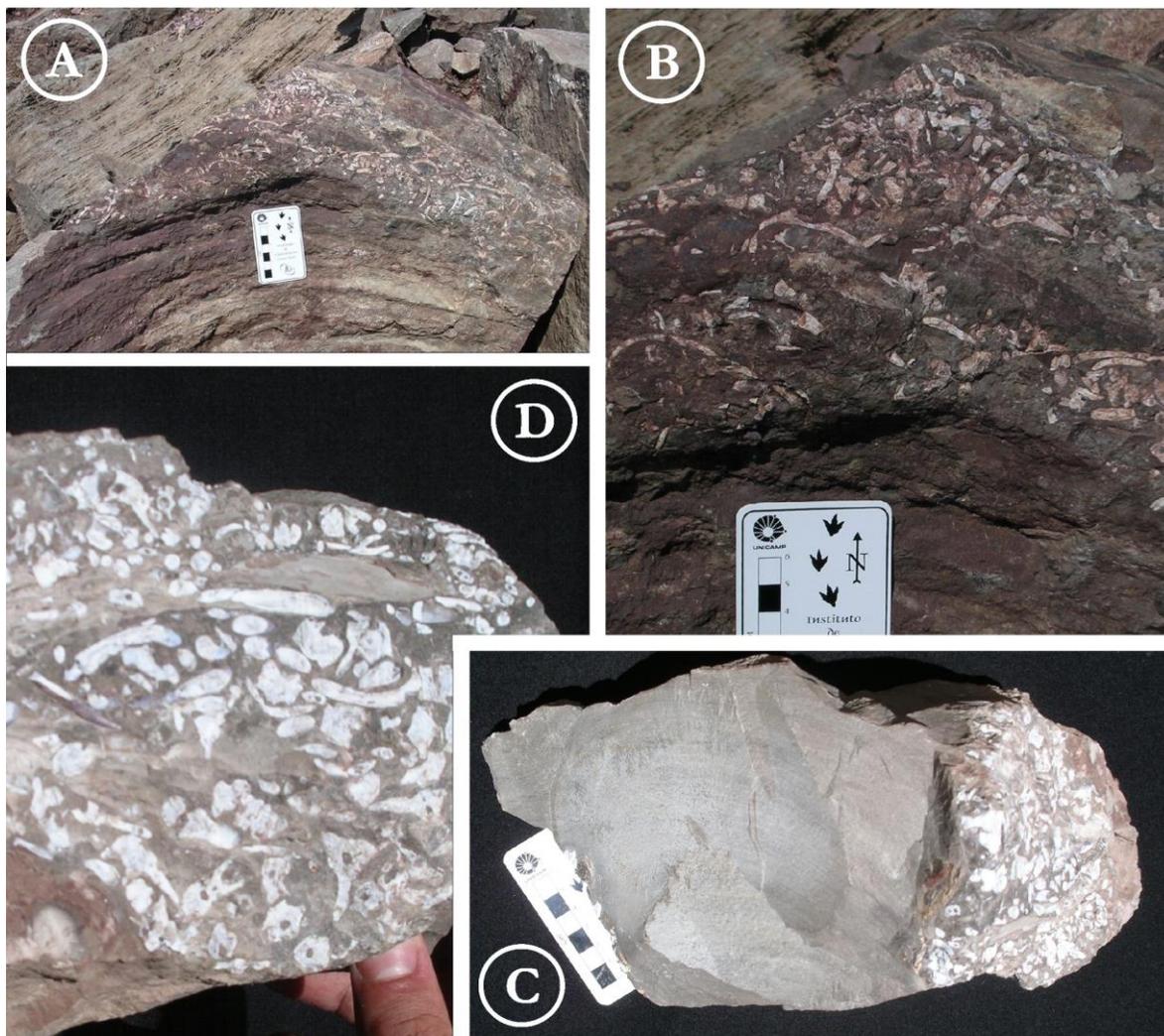
The site is a quarry which has been exploited since the 1970s, largely for the carbonate yielded by the stromatolites.

The sedimentary rocks present in the area are part of the upper portion of the Irati Subgroup, specifically the Bairrinho Bed of the Ipeúna Member of the Assistência Formation (Hachiro, 1996). At present, the exposed front reveals a cut from the base of the stromatolites to their contact with the overlying Corumbataí Formation (Fig. 2C). The most important fossil registers are the towering three-meter tall domes of the stromatolites themselves, (Figs. 3 and 4), where ripple marks are clearly visible (Fig. 5B). Associated

with the domes are abundant fragments of the skeletons of mesosaurs, especially vertebrae and ribs (Fig. 4), although some entire vertebral columns have also been found, as well as vertebrae with their hypofyses (Fig. 5D). Such fossils are frequently found deposited in the spaces between stromatolites, or even between the layers of a single stromatolite, indicating that both communities existed simultaneously, although it is difficult to know if they occupied the same environment. The lower limit of the stromatolite level is marked by an intensely bioturbated interformational breccia throughout the extraction area. The ichnofossils in this breccia can be interpreted as traces of the movement and alimentation of invertebrates (Figs. 5C and E).



**Figure 3** – Giant stromatolites (A), contact between Irati Subgroup and Corumbataí Formation (B); profile of a stromatolite with disarticulate bones of mesosaurids at base (C) and calcite geode between two stromatolites



**Figure 4** – Stromatolites fragments associated with disarticulated mesosaurid bones (A, B, C and D), check the well preserved hypophysis (D).

Initially, the location was described by Suguio and Sousa (1985) as belonging to the Corumbataí Formation. These authors considered the structures found in two quarries in Santa Rosa de Viterbo to be possible stromatolitic structures representing deposits in an intertidal environment at the basal portion and in low seas for the upper portion.

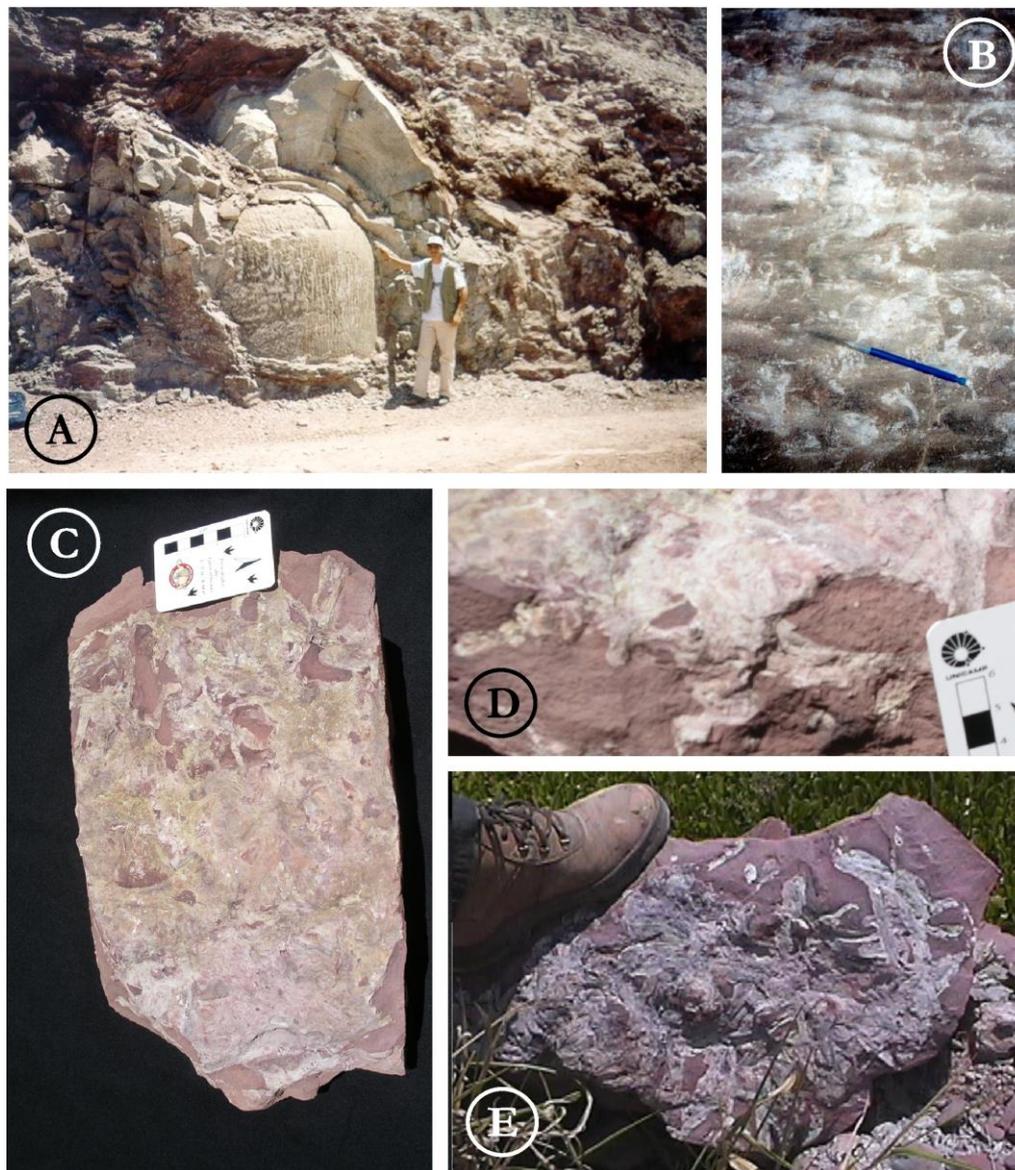
Suguio and Sousa (1985) also linked the mesosaur fossils found to calm-water deposition, since entire vertebral columns were found. Later, Hachiro (1991, 1996) and Hachiro & Coimbra (1992) re-evaluated the site and concluded that it belonged to the Irati Subgroup. The location was interpreted by Hachiro (1996) as a tidal plain on which the fragmented remains of the mesosaurs would correspond to bone beds resulting from storms, equivalent to the shell beds formed from fragments of crustacean carapaces found in quarries in the Irati Subgroup in the southwestern part of the state. The linking of such concentrations of fossil remains to storms is typical of other areas of the Irati Subgroup between Rio Claro and Angatuba, also within the Assistência Formation. More recently, Caires (2005) and Caires et al. (2005)

resumed the study of the site and collected abundant paleontological material which confirmed the correlation of the site to the Irati Subgroup in the state of São Paulo.

Since the 1970s, various quarries (Pedreira PH7, Pedreira Calcário Cruzeiro and Mineração Itaite) have been exploiting the limestone, one front at a time. After the removal of the economically valuable material, the remaining sterile rock is abandoned, to be covered eventually by the results of programs of revegetation and reforestation undertaken in conformity with the reigning legislation. The active front of the quarry today has an extension of approximately 400 meters, and a height of some 10 meters. Figure 6 shows the present area of extraction, in which numerous fossils have been found. Various researchers have visited the site over the years and published scientific papers referring to samples from the different faces exposed at the time. The work developed in the 1980s, for example, referred to samples collected in the areas being exploited at that time (Suguio & Sousa, 1985), whereas the work of the 1990s may have used samples collected from a

different area (Hachiro 1991, Hachiro et al., 1993). The work of Caires (2005) and Caires et al. (2005) used samples from the area shown in Figure 6, where

extraction is taking place today, and which reveals the presence of a large concentration of gigantic stromatolites.



**Figure 5** - A giant stromatolite (A) associated to ripple marks (B) and icnofossils (C, D and E)

## RECOMMENDED PROTECTIVE MEASURES

At present, the quarry PH-7 is still being worked. Fig. 6 provides satellite images of the present site, taken from the site Google Earth; it involves a total extension of some 400 meters. An analysis of the satellite images in Figure 6 shows the abundance of stromatolites and their wide distribution. It is essential to preserve part of this presently exposed section of the quarry (Fig. 6).

The owners of the quarry have offered to collaborate by preserving a portion of the quarry if there is sufficient interest on the part of the geologic and paleontologic communities. Efforts should be made to expose a clear cut of the vertical wall at the

location in Figure 6 and cordon it off; moreover, paths for the transit of individuals (research workers and other visitors) should be laid out. Self-explanatory panels providing information about the stromatolites should also be erected

The stromatolites are important in the evolution of life on earth and they could serve to attract tourists. Modern-day stromatolites serve as tourist destinations in the coastal regions of the state of Rio de Janeiro in Brazil, as well as in Australia, and these Permian stromatolites of Santa Rosa de Viterbo/SP could also be exploited in this way. The establishment of such a protected site would certainly facilitate the continuing study and increasing comprehension of the history of the Irati Subgroup in the Paraná Basin.



**Figure 6** – Satellite images of under exploration area at the present (A and B), entire area under mining activities and limestone exploration; (C and D) air view of potential preservation area, the best exposition with stromatolites (almost 200 m of extension) \* Satellite images: Google Earth System Online, 2006

#### ACKNOWLEDGEMENTS

The authors would like to acknowledge the support of the Foundation for the Support of Research of the State of São Paulo (FAPESP) (project for Scientific Initiation 03/078490-0), and the collaboration of Marco Antonio Cornetti and the PH7 Quarry, who have continuously opened the area to researchers, as well as offering to set aside the area of the proposed paleoenvironmental site. They would also like to acknowledge the assistance of the research workers and collaborators of the Institute of Geosciences of the State University of Campinas (UNICAMP), who helped furnish the information and technical support necessary for the project

#### REFERENCES

Caires, E.T. 2005. Tratamento espacial dos dados paleontológicos do Subgrupo Irati no Estado de São Paulo – Brasil. Trabalho de Conclusão de Curso. Instituto de Geociências, UNICAMP. 59p.

Caires, E.T.; Ricardi-Branco, F.; Silva, A.M. 2005. Levantamento de dados paleontológicos do Subgrupo Irati (Neopermiano) no Estado de São Paulo – Brasil. In: Congresso Brasileiro de Paleontologia, XIX, 2005, Aracaju. CD Resumos, SBP, p. 1.

Carvalho, I.S. (Ed.) 2000. Paleontologia. Ed. Interciência. Rio de Janeiro, 628pp.

Daemon, R.F.; Casaletti, P.; Ciguel, J.H.G. 1991. *Biopaleogeografia de Bacia do Paraná*. Curitiba, PETROBRÁS. Relatório interno.

Hachiro, J. 1991. Litotipos, associações faciológicas e sistemas deposicionais da Formação Irati no Estado de São Paulo. Dissertação de mestrado, IG-USP, São Paulo, 175 p.

Hachiro, J. 1996. O Subgrupo Irati (Neopermiano) da bacia do Paraná. Tese de Doutorado, IG-USP, São Paulo, 196 p.

Hachiro, J.; Coimbra, A.M. 1992. *Bone beds e shell beds* como feições diagnósticas de tempestitos da Formação Irati no Estado de São Paulo. In:

- Congresso Brasileiro de Geologia, 37, 1992, São Paulo. Anais: 511-512.
- Hachiro, J.; Coimbra, A.M.; Matos, S.L.F. 1993. O Caráter cronoestratigráfico da Unidade Irati. In: Simpósio sobre Cronoestratigrafia da Bacia do Paraná, 1, 1993, Rio Claro. Resumos, IG-UNESP, p. 62-63
- Knoll, A. 2003. Life on a Young Planet: The First Three Billion Years of Evolution on Earth. Princeton University Press. 277p
- Sugio, K.; Sousa, S.H.M. 1985. Restos de mesossaurídeos na Formação Corumbataí, Permiano da bacia do Paraná, no Estado de São Paulo. Anais da Academia Brasileira de Ciências, 57:339-347.
- Zalán, P.V.; Wolff, S.; Astolfi, M.A.; Vieira, I.S.; Concelção, J. C.; Appi, V.; Neto, E.; Cerqueira, J. R.; Marques, A. 1990. The Paraná Basin. In: Leighton; Kolata; Oltz; Eidel (eds) Interior Cratonic Basins. American Association Petroleum Geologists, Memoir, 51: 681-702.
- [www.earth.google.com](http://www.earth.google.com) \*Créditos das imagens de satélite: *Google Earth System Online*, 2006.

<sup>1</sup>DGRN, IG, Universidade Estadual de Campinas  
Cp.6152, CEP 13083-970, Campinas, SP, Brasil.  
End. eletrônico: [fresia@ige.unicamp.br](mailto:fresia@ige.unicamp.br)

<sup>2</sup>Geólogo (CREA-SP 5062380663), Rua Hungria,  
Nº 275, CEP 13318-000, Cabreúva, SP, Brasil.  
End. eletrônico: [edcaires@gmail.com](mailto:edcaires@gmail.com)

<sup>3</sup>GRM, IG, Univ. de Brasília . Darcy Ribeiro S/N,  
Asa Norte, CEP 70910-900 - Brasília, DF, Brasil.  
End. eletrônico: [adalene@unb.br](mailto:adalene@unb.br)