



SIGEP

Geological and Paleontological Sites of Brazil

SIGEP 028

Peirópolis and Serra da Galga Site, Uberaba, State of Minas Gerais *Land of Brazilian dinosaurs*

Luiz Carlos Borges Ribeiro^{1, 2}
Ismar de Souza Carvalho³

¹ Fundação Municipal de Ensino Superior de Uberaba-FUMESU/Centro de Ensino Superior de Uberaba – CESUBE/Centro de Pesquisas Paleontológicas L. I. Price. Av. Randolpho Borges Jr., nº 1.250. Univerdecidade, 38.066-005, Uberaba - MG. Brasil. E-mail: cpplip@cesube.edu.br

² Universidade de Uberaba - UNIUBE/Instituto de Formação de Educadores - Departamento de Biologia. Av. Nenê Sabino, nº 1801. Universitário, 38.055-500, Uberaba - MG. Brasil. E-mail: lcbmrg@terra.com.br

³ Universidade Federal do Rio de Janeiro. Departamento de Geologia, CCMN/IGEO. 21.949-900 Cidade Universitária - Ilha do Fundão. Rio de Janeiro - RJ. Brasil. E-mail: ismar@geologia.ufrj.br

© Ribeiro,L.C.B.; Carvalho,I.S. 2007. Peirópolis and Serra da Galga Site, Uberaba, State of Minas Gerais - Land of Brazilian dinosaurs. *In*: Winge,M.; Schobbenhaus,C.; Souza,C.R.G.; Fernandes,A.C.S.; Berbert-Born,M.; Queiroz,E.T.; (*Edit.*) Sítios Geológicos e Paleontológicos do Brasil. Available on line 23/07/2007 at the address <http://www.unb.br/ig/sigep/sitio028/sitio028english.pdf> [actually <http://sigep.cprm.gov.br/sitio028/sitio028english.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)

Peirópolis and Serra da Galga Site, Uberaba, State of Minas Gerais

Land of Brazilian dinosaurs

SIGEP 028

Luiz Carlos Borges Ribeiro^{1, 2}
Ismar de Souza Carvalho³

The Peirópolis and Serra da Galga paleontological site reveals one of the richest vertebrate and invertebrate fauna of the Brazilian Upper Cretaceous. The fossiliferous outcrops are stratigraphically contextualized in the Marília Formation (Bauru Basin), encompassing a wide geographical area in the municipality of Uberaba, Minas Gerais State. Many crocodylomorphs, dinosaurs and other reptiles, and even amphibians from this region, are described in scientific literature. The fossils are well-preserved specimens and along with the rocks in this region, they portray the earth ecosystems that preceded the great environmental transformations at the end of the Mesozoic era.

Key words: Peirópolis, Serra da Galga, Dinosaurs, Dinosaur Museum, Cretaceous.

INTRODUCTION

Since mid-XX century, the municipality of Uberaba has become the object of intense paleontological investigations. This is because one of the biggest and most important paleontological sites in Brazil is found in this region, with registered fossils dating from 80 to 65 million years.

The first findings happened by chance in 1945, when workers were building a section of the railway near the railway station of Mangabeira in the Serra da Galga, north of Uberaba. The paleontologist Llewellyn Ivor Price from the National Department of Mineral Production – DNPM was invited to conduct the studies, and carried out excavations in various places around Uberaba up to 1974. A great deal of investigation work was done near Peirópolis due to the great paleontological potential revealed by work fronts digging out limestone for the production of quicklime, which is the village's main product of economy. All the fossils discovered were transferred to the National Department of Mineral Production in Rio de Janeiro, which led to a lack of emotional 'bonding' between the scientific discoveries and the residents of the region.

Since the establishment of the Dinosaur Museum in 1992, an attempt was made to recover this identity between the residents in Peirópolis and nearby villages and the thematic collection of fossils from the Triângulo Mineiro. Thus, work was carried out in the sense of restoring local identity values, as well as educating on the importance of the paleontological studies and protection of the fossiliferous patrimony. Today, nearly all of the workers at Price Center and the Dinosaur Museum are residents in Peirópolis. They believe that the project is not only a means of

worthy work, but it is also a way of being part of the actions that lead to scientific and educational development and also diffusion of the geology and paleontology of their native community. The whole Peirópolis community is very proud of what has been done in the last 15 years on behalf of science and the preservation of the fossils and has sought out institutions aiming at improving and offering more prominence to the projects under development. Among these, is the project for including the site in the SIGEP register, and in the future, the recognition of the site as Human Natural Patrimony – UNESCO, by means of the foundation of the GEOPARQUE – Uberaba Terra dos Dinossauros (GEOPARK – Uberaba Land of Dinosaurs).

After more than 60 years since the first paleontological discovery in Uberaba, not only the people, but also enterprises, have a much better understanding in comparison to 15 years ago, before the establishment of the Dinosaur Museum. Almost as a whole, the community sees the need to preserve the fossiliferous deposits, as well as translate all the technical data originated from the discoveries into an easy access language, which may allow for understanding of its real meaning, the popularization of geo-sciences and consequently the democratization of knowledge.

Among the localities from which fossil specimens were recovered, the Peirópolis (Figures 1 and 2) and Serra da Galga (Figures 3 and 4) Sites are worth mentioning, for bringing to light relevant information in a series of new discoveries specially in the last 7 years.

Even though a lot of work has already been carried out, the whole region is still practically untouched. It has immense potentially fossiliferous areas which,

with the advancement of investigation, may reveal new data to stimulate scientific, educational and tourist actions, which will bring economic

development and consequently social benefits for the whole community.



Figure 1 – Paleontological Site of Peirópolis - Point 1 Price, 1946 a 1970 (Caieira)



Figure 2 - *Uberabasuchus terrificus* fossil found at Point 1 (Caieira) of the Peirópolis Site



Figure 3 – Paleontological Site of Serra da Galga - BR 050 - km 153



Figure 4 – Paleontological excavations performed in km 153 of BR 050 road

LOCALIZATION

The areas with fossil occurrences in Peirópolis are inside a polygon with the following coordinates as vertices: 19°45'00"S - 47°47'30"W; 19°45'00"S - 47°42'30"W; 19°40'00"S - 47°42'30"W and 19°40'00"S - 47°47'30"W. The main sites are Price's Point 1 (Caieira: 19°43'44" S - 47°45'10"W) and Point 2 (19°43'21"S - 47°45'10"W). These were excavated from the 1940s to the 1970s, and both are in the Serra do Veadinho. The Peirópolis district is situated in the southern part of the described area, 25km away from Uberaba, alongside the BR 262 (Uberaba - Vitória) highway, at km 784.

The findings at Serra da Galga are inside a polygon with the following coordinates as vertices: 19°34'00"S - 47°55'00"W; 19°37'00"S - 47°55'00"W; 19°34'00"S - 48°05'00"W and 19°37'00"S - 48°05'00"W. The km 153 (19°35'33"S - 48°01'42"W) and 153.5 (19°35'17"S - 48°01'48"W) stand out due to their great paleontological potential (Fig. 5).

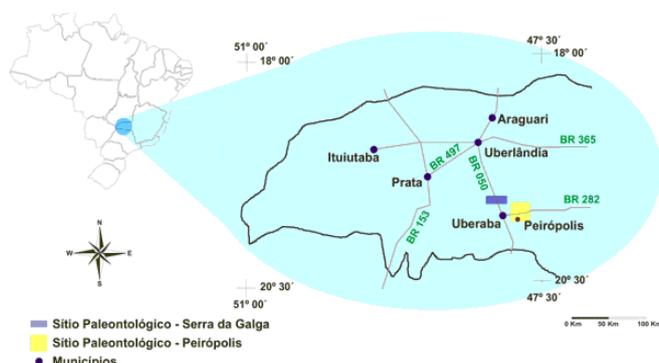


Figure 5 – Location map of the Paleontological Site of Peirópolis and Serra da Galga

DESCRIPTION OF THE SITE

Geological Context

The Peirópolis and Serra da Galga Paleontological Site is located in a great geological unit known as Bauru Basin, which occupies the mid-southern area of the South American Platform. In Brazil, it spreads over many states: great part of the São Paulo western Plateau, northwest of Paraná, eastern part of Mato Grosso and Mato Grosso do Sul and south of Goiás. On the southeast, it crosses over the frontier into Paraguay, occurring in the northwestern region of that country (Fernandes & Coimbra, 1996, 1999). The basement is composed of effusive basic rocks, represented mainly by basalts from the Serra Geral Formation, with a history of approximately 130 million years. At that geological moment, (Lower Cretaceous), the Earth crust was submitted to intense break-up, with magmatism of unknown proportions in the history of the Earth. The mega continent

Gondwana (formed by South America, Africa, India, Antarctic and Australia), broke up and the South Atlantic Ocean was formed.

The origin of the Bauru Basin, with approximately 370,000 km², happened during the Turonian-Maastrichtian (Upper Cretaceous). The various litho-stratigraphic units of the post-basaltic covering, dated as from the Upper Cretaceous, had their geographical distribution controlled by the regional structural framework (Suguio, 1980; Fernandes & Coimbra, 1998). These sediments were deposited on the northeastern border of the Paraná Basin in a basin delimited by the arches of Ponta Grossa at south-southeast, Serra do Mar at east-southeast and Canastra (Parnaíba Heights) at northeast. The Bauru Basin occupies the greatest part of the Western Paulista Plateau, and spreads also into the Triângulo Mineiro, south of Goiás, Mato Grosso and Mato Grosso do Sul. The average thickness is around 227 metres (Poxoréu, MT), but the maximum preserved thickness reaches 300 metres (Fernandes & Coimbra, 1999).

The first depositional cycle happened over irregular projections made up of the Botucatu and Serra Geral formations and by its own crystalline basement (Suguio, 1980). In the region of the Triângulo Mineiro, the morphological configuration of the pre-Bauru surface was relatively even, with ample and not very deep valleys (Davino, 1983). The Bauru Basin is made up of siliciclastic rocks, mainly psamitic rocks, deposited in the endorreic draining basin with a gradual desertification to the depocenter. It is composed of two chrono-correlated rock successions, known as Caiuá and Bauru Groups (Coimbra & Fernandes, 1995).

The Uberaba depression in the Triângulo Mineiro had its formation associated to the rising of the Parnaíba Heights (Canastra), and limited by the Goiânia flexure and by the structural control of Araxá-Rio Grande (Barcelos, 1984). The clastic sedimentation gave origin to the Uberaba and Marília formations.

The Uberaba Formation is restricted to the Triângulo Mineiro, from the region of Veríssimo as far as Sacramento, passing by Uberaba, Peirópolis and Ponte Alta. Northwards the area is unknown, due to the fact that it is covered by the Marília Formation (Hasui & Cordani, 1968; Barbosa *et al.*, 1970; Suguio, 1973; Suguio, 1980; Ferreira Jr. & Guerra, 1995).

The Marília Formation was initially proposed for the epiclastic deposits that occur in the state of São Paulo; later, Barcelos (1984) extended the occurrence to the Triângulo Mineiro. It has a concordant and defined contact with the Uberaba Formation, and, locally, has been sub-divided: Ponte Alta and Serra da Galga (Fig. 6) (Barcelos, 1984; Fulfaro & Barcelos,

1991). The siliclastic sediments were deposited in an environment of braided rivers and alluvial fans.

The Marília Formation has an average thickness of 60 meters and is constituted by sandstone and conglomeratic sandstone with frequent channel cross-stratifications (grooved and plane) and by polymictic clast-supported conglomerates, containing rounded quartz and quartzite pebbles, schists, rare fragments of chert and basalt, as well as pelitic and carbonate intraclasts. In some limestone quarries (Caieira in Peirópolis, Partezan and Triângulo on the BR-050 and Minas Oeste in Ponte Alta) there are occurrences of thin and extensive pelite lenses, with a thickness that ranges from centimeters to meters, which contain conchostraca, ostracodes, gastropods, fish scales and carophytes (Campanha *et al.*, 1994; Senra & Silva e Silva, 1999). The coarse-grained sediments appear in tabular layers revealing lenticular sections and erosive base, forming cycles with ascendant fining-up grains of metric thickness. The stratigraphic analysis and its relation with the carbonatic intercalations, allowed the

establishment of the fact that all of the detritic deposits were developed in a fluvial interlaced system, mainly sandy, in a permanent stream, formed exclusively by channel facies (linguoid or sinuous or straight tip bars), and in a more localized manner, by abandoned channel pelitic facies (Etchehebere, 1993, 1999; Silva *et al.*, 1994; Fernandes, 1998; Goldberg & Garcia, 2000).

The Marília Formation is considered of Maastrichtian age (Castro *et al.*, 1999; Gobbo-Rodrigues *et al.*, 2001; Dias Brito *et al.*, 2001), mainly due to the fossiliferous content in vertebrates (chelonians, crocodilians, dinosaurs, anurans, fish scales, eggs and egg shells), invertebrates, (bivalves, gastropods, ostracodes, conchostraca) and vegetal fragments (charophyitt girogonites) (Bertini *et al.*, 1993; Campanha *et al.*, 1994; Fernandes, 1998; Magalhães Ribeiro, 1999, 2000 a,b). See also Mezzalira (1989) and Mezzalira *et al.* (1989) for the register of fossiliferous occurrences.

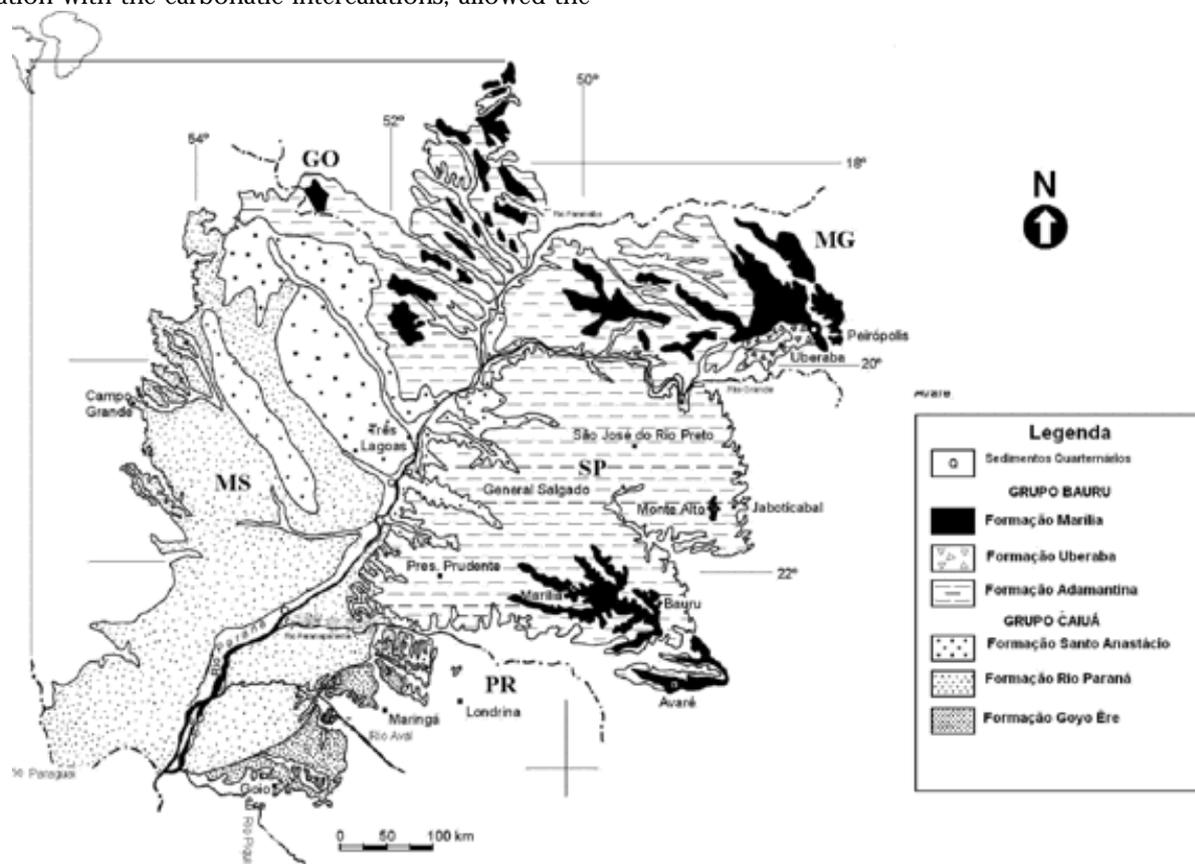


Figure 6 – Geological Map with stratigraphic section of the Bauru basin in the Uberaba area

Paleontology

The main fossiliferous unit in the region of the sites is the Marília Formation, notably the Serra da Galga. The main fossiliferous sites from the Brazilian continental Cretaceous are found there, in the municipality of Uberaba. Various specimens of

macrofossils and also microfossils, which are scientifically relevant, have been identified in the region. Charophyte algae, pteridophyte sporocarpus (Marsiliaceae), ostracods, gastropods, bivalves, ichnofossils of invertebrates and vertebrates (Magalhães Ribeiro & Ribeiro, 1999), as well as a diversified fauna of fish, amphibians, reptiles, (lizards,

tortoises, crocodylomorphs and Dinosauria). (Barbosa, 1955; Petri, 1955; Suarez & Arruda, 1968; Arid & Vizotto, 1965; 1971; Estes & Price, 1973; Baez & Peri, 1989; Kischlat *et al.*, 1994; Bertini, 1994 a,b; Bertini & Carvalho, 1999; Castro *et al.*, 1999; Senra & Silva e Silva, 1999). The fossils are found in a paleo-environmental context of fine sandstone deposited during sudden flooding in alluvial plains after long droughts. Fresh water lakes and rivers were rare, normally drying out during long dry seasons. This was a restrictive factor to the fauna and flora in this region, which should have been adapted to the severe conditions of this very arid environment.

Many fossils of scientifically relevant vertebrates come from the Marília Formation, specially the region of Peirópolis. There is an important amphibian - *Baurubatrachus pricei* Baez & Peri, 1989 – which is practically complete (Baez & Peri, 1989). Among the crocodylomorphs we have *Itasuchus jesuinoi* (Price, 1955), *Peirosaurus tormini* (Price, 1955) and *Uberabasuchus terrificus* (Carvalho, *et al.*, 2004). There are other reptiles, such as: an iguanid lizard *Pristiguana brasiliensis* (Estes & Price, 1973) and a maniraptora dinosaur related to the dino-birds (Novas *et al.*, 2005). Fossil eggs have also been found in this region (Magalhães Ribeiro, 1999). (Fig. 7)



Figure 7 – Environmental reconstruction of Uberaba region at 70 million years ago.

The fresh water chelonian paleofauna from the Bauru Basin, includes only Podocnemidae (*Pleurodira*, *Pelomedusoides*), and in the region of the Triângulo Mineiro, only one specimen was described - *Cambaremys langertoni*. This is extremely important for understanding the evolution of the chelonians, for it belongs to the basis of the lineage which leads to the clade which encompasses all the living Podocnemidae. This taxon is distinguished from the other Podocnemidae from the South-America Upper Cretaceous, by one only set of diagnostic shell characteristics (França & Langer, 2005).

Dinosaurs are also frequently found in rocks of the Marília Formation. In the municipality of Uberaba two species of Titanosauridae have already been described: *Baurutitan britoi* and *Trigonosaurus pricei* (Kellner *et al.*, 2005; Campos *et al.*, 2005). The *Baurutitan britoi* (Kellner *et al.*, 2005) has sacral and tail vertebrae which show peculiar aspects that enabled the definition of this dinosaur. The second species is characterized by a set of cervical, dorsal, sacral, tail and ileum vertebrae. Both species are relevant for they show the diversity of titanosauridea in Brazilian territory during the Upper Cretaceous. Apart from these two species described formally, hundreds of occurrences of bones, osteoderms, teeth and ichnofossils, discovered in natural and artificial outcrops (road cuts, excavations for wells and civil engineering activities), are known from literature and from collections, such as those at the L. I. Price Paleontological Research Centre (Peirópolis, state of Minas Gerais) and from the National Department for Mineral Production (Paleontological Section, Rio de Janeiro).

LLEWELYN IVOR PRICE PALEONTOLOGICAL RESEARCH CENTER AND DINOSAUR MUSEUM

In continuity to the scientific investigation carried out by Llewellyn Price from the 1940s to the 1970s, Uberaba Town Hall gave the first steps to the implantation of the Llewellyn Ivor Price Paleontological Research Centre in 1991. Situated in the Peirópolis district, 25 km away from Uberaba – MG, the headquarters occupy the old railway station building (Fig. 8) which was totally restored to harbour accommodation for the researchers, laboratories, technical reserves, administration and also the Paleontological Museum better known as the Dinosaur Museum.

The Price Center and the Museum are currently integrated to the Municipal Foundation for Higher Education – **FUMESU** and the Uberaba Center for Higher Education – **CESUBE**, both supported by the municipality.

Since its establishment, the Price Center has steered its actions in order to fulfill three basic aims: protect the fossils and fossiliferous deposits, promote, support and carry out geo-paleontological research, and spread knowledge. In order to speed up the work and make possible the growth of the fossil collection, the institution has excavation crews, with regular annual collections during 6 months, something quite unique in this work in Brazil.



Figure 8 – Museum of the Dinosaurs of Peirópolis - Uberaba- state of Minas Gerais

Among the actions carried out in the research area, the regular excavations (Fig. 9) carried out every year; make all the difference for this institution when compared to other sites in the country. It is a unique work which has allowed for an increase in the growth of the collection, leading to better knowledge of the sites in Uberaba, among which are Peirópolis and Serra da Galga, where the largest part of the investigations and new discoveries are centered.



Figure 9 – Systematic paleontological excavations performed in km 153 of BR 050 road

Work dynamics, developed between the processes of collection and preparation of the samples, in a continuous manner, has granted great agility to studies. In the more than two thousand pieces of the collection, there can be found samples related to the following groups: carnivore and herbivore dinosaurs, tortoises, crocodiles, anurans, fish, fresh water mammal crustaceans as well as plant microfossils.

The interchange programmes and technical-scientific cooperation projects with some of the biggest research institutions in this area, have allowed for a better understanding of the continental biota and its paleoenvironmental context in the Upper Cretaceous. Among the institutions that are our partners, we can name: Rio de Janeiro Federal University – UFRJ, Rio de Janeiro University – UNIRIO, Paulista State University – UNESP, Uberlândia Federal University – UFU, Minas Gerais Federal University – UFMG, Ouro Preto Federal University – UFOP, São Paulo University – USP, Rio de Janeiro State University – UERJ, Universidad Nacional del Patagônia San Juan Bosco, Argentinian Museum of Natural Science and National University del Comahue.

In the last fifteen years, approximately 80 papers about the fossils and their life environments have been published in specialized magazines and scientific

events. Descriptions at undergraduate and graduate levels (master and doctorate), have contributed, in a significant manner, to the advancement of scientific knowledge in this region, by means of offering opportunities for the qualification of researchers in the various areas of paleontology and geology.

The Dinosaur Museum was created (Fig. 10) in order to share knowledge with the laymen public in a simple and didactic manner. It functions next to the Research Centre, and its samples include: casts, scenarios, dioramas, apart from quite a representative collection of various fossils that make up the biota of this region, mainly the dinosaurs.



Figure 10 – Exposition of the Dinosaurs Museum (Museu dos Dinossauros)

Trained guides are at hand to offer explanations and clear doubts. The Museum has already received more than one million visitors from approximately 1,198 Brazilian municipalities and 44 countries.

Among the educational programmes we can highlight PROTEU – Training Programme for University Students and the Dinosaur Week. The first one is an immersion course in paleontology and geology, emphasizing the local aspects and enabling a practical-theoretical experience of the context in which the Price Center actions are carried out. The results have been surprising, for, in the last years, various undergraduate students who took part in this course, are today concluding graduate courses in master and doctorate level in renowned Brazilian universities.

The Dinosaur Week (Fig. 11) is dedicated to the teaching of paleontology. It is aimed specially at High School students, and teaches, in a pleasurable manner, the science of fossils. The students can experience all the stages of research, right from the moment of the discovery of the fossil in the excavations, up to the public showing at the Dinosaur Museum. This scientific-educational-cultural initiative has become the biggest event in the country dedicated to the

teenage public. In 2006, 6,970 students from 103 schools in 18 municipalities in the states of Minas Gerais, São Paulo and Goiás were received.



Figure 11 – Pedagogic workshops during the Dinosaurs week

The great interest in the subject, as well as the magic that dinosaurs exert over people, have rapidly transformed Peirópolis into a regional center for tourism and leisure. This reflects in local economy by means of the commercial exploitation of services and handcraft goods, thus offering a significant improvement in the quality of life of the local residents.

Thanks to the activities carried out by the Price Center and Dinosaur Museum, the fossils have attained, in Uberaba, a new application and appreciation, which transcend even their scientific importance. They are essential elements in the social-economic-cultural revitalization of the local communities where significant fossiliferous deposits have been discovered. It is an example to be established in areas that have important fossiliferous sites, but go through serious problems with loss and illegal trade of fossils.

SYNOPSIS ON THE ORIGIN, GEOLOGICAL EVOLUTION AND IMPORTANCE OF THE SITE

The fossils of the region of Uberaba, where the Peirópolis and Serra da Galga paleontological site is situated, occur in arenites which tell a long story of environmental and climatic transformations in the Brazilian territory. 80 million years ago, the environment in which the animals and vegetation of Uberaba lived in, was much hotter and drier than now. There were rainy and humid moments, in which sudden flooding, after long dry spells, led to catastrophic events of death and burial of the organisms. There used to be fresh water lakes and rivers, which usually dried up during the long periods of drought.

The Peirópolis and Serra da Galga Paleontological Site is situated in a great geological unit known as the Bauro Basin, which occupies the mid-southern portion of the South American Platform. In Brazil, it spreads over a great part of the São Paulo western plateau, the northwest of Paraná, eastern part of Mato Grosso and Mato Grosso do Sul and south of Goiás. At southeast, it crosses the frontier into Paraguay, occurring in the northwestern region of that country. It is established on basalts of the Serra Geral Formation, which has a history starting at approximately 130 million years ago. At that geological moment (Lower Cretaceous), the earth's crust was submitted to intensive cracking, with magmatism of such proportions with nothing similar in the history of the Earth. The mega continent Gondwana (formed by South America, Africa, India, Antarctic and Australia) came apart, giving place to the South Atlantic Ocean.

The Peirópolis and Serra da Galga Paleontological Site, situated on this sedimentary basin, has one of the richest vertebrate and invertebrate faunas from the Brazilian Upper Cretaceous. The fossiliferous deposits are stratigraphically contextualized in the Marília Formation (Bauro Basin), ranging over a wide geographical area of the municipality of Uberaba, Minas Gerais. Scientific literature describes various crocodylomorphs, dinosaurs and other reptiles, and even amphibians from this region.

The fossils from this area are well-preserved specimens, and along with the existent rocks, portray the earth ecosystems that preceded the great environmental transformations at the end of the Mesozoic era. Since the establishment of the Dinosaur Museum in 1992, an attempt has been made to raise appreciation of local identity and bring awareness to visitors and the local population about the importance of the paleontological studies and the protection of the fossiliferous patrimony.

PROTECTION MEASURES

The Price Center has carried out incisive actions in the field of protection of the fossil heritage and of the fossiliferous sites in the region of Uberaba, as well as in the bordering municipalities in the whole of the Triângulo Mineiro.

By means of a protectionist policy and always alert to the needs of a regular monitoring of civil engineering works, it has, at various moments, saved innumerable fossils in construction plants in the town of Uberaba and region. A good example can be mentioned, which happened in 2004 at the time of the duplication of the BR 050 highway at km 153 inside the paleontological site of Serra da Galga. Hundreds of fossils of Titanosauria dinosaurs were recovered.

In 2006, important specimens of fossils associated with the pleistocenic megafauna were saved inside the urban area of Uberaba. They represent unique samples and are relevant, due to the inexistence of this type of paleontological material up to that moment, as those that normally occur are dated from the Upper Cretaceous.

Current Measures

Since the implantation of the new environmental legislation, in force in the municipality of Uberaba in October 2006, all the enterprises that cause any impact in the environment with digging in places where there may be fossil occurrences, are being monitored by the technical team from the Price Center, as well as undergoing preliminary diagnostic studies, in order to guarantee the total integrity of the paleontological heritage in the area. Under this approach, studies and paleontological assessments have been carried out in construction sites such as sewage treatment plants, asphalt highways, implantation of industries, projects for draining pluvial water, etc..

Today, the reality experienced in Uberaba concerning the protection of fossils is quite comfortable and different from various problematic regions in the country. This is due to the fact that the actions that have already been mentioned, not only permit the recovery and preservation of fossil occurrences, but they also inhibit any initiative of illegal trade and loss of the paleontological documentary.

Public Municipal Protection Policies concerning the Paleontological Collection

The municipal public authorities and the organized society of Uberaba are alert to the necessity of implementing urgent municipal measures, as well as

those already in existence, in order to guarantee the preservation and integrity of the fossiliferous sites inside the limits of the municipality. They understand that such sites represent scientific-cultural values of worldwide importance, and they will permit, by means of the studies carried out, a better understanding concerning the evolution of the planet and life on Earth.

1- Decree 1.234/98 that ratifies the listing of the “Architectural and Landscape Project of Peirópolis – Uberaba/MG”, registered in Listed Book II, according to article no. 1, Law 5.349, 19/05/94, approved by the Municipal Deliberative Council for Historical and Artistic Heritage of Uberaba.

2- The Directive Plan of the town of Uberaba, constituted in 2006 makes the following mentions concerning the Paleontological Sites of the municipality as well as Price Center/Dinosaur Museum:

COMPLEMENTARY LAW 186

“Define strategies for protection, associated to rational and tourist use of the Paleontological Site, in order to transform the Peirópolis District into a center for ecological, cultural and educational tourism”;

“Develop and implement policies and programmes aiming at sustainable, economic and social development of the Peirópolis District, as well as research, rational and tourist use of the paleontological site and Caeira do Meio. Determine area policies and the allocation of public investments that should give priority to the directives foreseen in this Chapter”;

“Make feasible the implantation of paleontology courses at technical and graduate levels, by means of partnerships between the Center for Paleontological Research and universities with similar interests”;

“Maintain the building that houses the Paleontological Museum in good condition, allowing for repair works, painting and restoration, according to relevant legislation”;

“Establish a right of way in third party areas, for free access to the area of paleontological research”;

“Make possible partnerships and agreements with private and institutional enterprises in order to guarantee financial, material and human resources for the paleontological research”;

“Promote constant maintenance of the public areas, of the Paleontological Museum, and the Research Center, by means of development of architectural, landscape and urban projects, including the anticipation of accessibility for all citizens”;

“Offer incentive to the implantation of the Dinosaur Park, with a Paleo-botanic Park”;

“Make public the existence of the Paleontological Museum and the Research Center, as well as the great

tourism potential of Peirópolis District in local, national and international media”;

“Make possible the project “Open air Museum”, aiming at promoting eco-tourism and monitored visitation to the research area, safeguarding the good development of the scientific research activities and excavations”;

“Promote visitation programmes to the Peirópolis District, in partnership with schools from Uberaba and neighbouring towns, in order to make the project known and bring about interest in paleontological research”.

COMPLEMENTARY LAW 359

The following are referential elements of the natural heritage of Uberaba:

“Special Protection Area – APE Peirópolis or any other name it may be given, according to current environmental legislation”;

Directives for the Peirópolis environmentally protected area:

“Appreciation and advertising of the Peirópolis paleontological site”.

“Guarantee of ownership and local monitoring, administered by the Llewellyn Ivor Price Paleontological research Center”.

“Adjustment of the Peirópolis environmentally protected area according to current environmental laws”.

“The adjustment of the Peirópolis environmentally protected area should be carried out inside the term of 1 (one) year, as from the publication date of this Law, by means of partnerships between the Llewellyn Ivor Price Paleontological Research Center and technicians from the qualified municipal agency”.

“In the Peirópolis environmentally protected area, the following projects will be implemented:

Special Live Fossil Project. (This is part of the Live Water Project carried out by the water and sewage company in Uberaba – CODAU, to be financed by the BIRD World Bank. It aims at guaranteeing the integrity of the fossil sites which come to light during digging for the implementation of urban works).

“Monitored visits to the sites Project, aiming at research, leisure, education and tourism, involving similar minded municipality departments”.

In order to safeguard the paleontological heritage of the Municipality of Uberaba, the following measures should be adopted:

Reconnaissance of areas or paleontological potential in the Municipality, by means of:

“Partnerships and agreements with national and international education and research institutions, as well as other government and non-government areas, in order to carry out research and demarcation of new paleontological sites”.

“Programmes that offer explanation and education concerning paleontology, to local land-owners and producers”.

“Declaration which nominates the Llewellyn Ivor Price Paleontological Research Centre, the managing organ and monitor of paleontological research in the Municipality of Uberaba”.

“Integration with various agents who are active in the area, for protection of the zones with fossil occurrences”.

3- The directive plan for the Peirópolis District anticipates restrictive actions that are not related to cattle raising and paleontological research, above the quota of 870m, aiming at the preservation of the various points of fossil collection in the Peirópolis Paleontological Site. This height matches the first appearances of the Marília Formation, mainly in Serra do Veado and BR 262, from where the majority of the fossils deposited among the collection of the Price Center and the Earth Sciences museum in Rio de Janeiro were removed.

REFERENCES

- Arid, F.M.; Vizotto, L.D. 1965. Crocodilídeos fósseis nas proximidades de Santa Adélia (SP). *Ciência e Cultura*, 17(2): 138-139.
- Arid, F.M.; Vizotto, L.D. 1971. Traços paleogeográficos e paleobiológicos do Cretáceo Superior da região norte-ocidental do Estado de São Paulo. *Ciência e Cultura*, 23(3)(3): 229-236.
- Azevedo, S.A.K. & Campos, D.A. 1993. Um novo crocodilídeo (Mesosuchia) do Cretáceo de Minas Gerais, Brasil. *Anais da Academia Brasileira de Ciências*, 65(4): 460.
- Baez, A.M.; Peri, S. 1989. *Baurubatrachus pricei*, nov. gen. et sp., un anuro del Cretacico Superior de Minas Gerais, Brasil. *Anais da Academia Brasileira de Ciências*, 61(4): 447-458.
- Barbosa, O. 1955. Situação geológica das charophyta de Machado de Melo, Estado de São Paulo. *Boletim da Sociedade Brasileira de Geologia*, 4: 73-74.
- Barbosa, O.; Braun, O.P.G.; Dyer, R.C.; Cunha, C.A.B.R. 1970. Geologia da região do Triângulo Mineiro. DNPM/DFPM, Rio de Janeiro, Boletim 136, 140 p.
- Barcelos, J.H. 1984. Reconstrução paleogeográfica da sedimentação do Grupo Bauru baseada na sua redefinição estratigráfica parcial em território paulista e no estudo preliminar fora do Estado de São Paulo. Tese de Livre Docência. IGCE-UNESP/ Campus de Rio Claro, 1984, 190 p., 4 anexos.
- Bertini, R.J. 1994a. Comments on the fossil amniotes from the Adamantina and Marília formations, continental Upper Cretaceous of the Paraná Basin, Southeastern Brazil (Part 1): Introduction, Testudines, Lacertilia, Crocodylomorpha). *Boletim do 3º Simpósio sobre o Cretáceo do Brasil*, Rio Claro, 1994, UNESP - Campus de Rio Claro/SP, p. 97-100.
- Bertini, R.J. 1994b. Comments on the fossil amniotes from the Adamantina and Marília formations, continental Upper Cretaceous of the Paraná Basin, Southeastern Brazil (Part 2): Saurischia, Ornithischia, Mammalia, Conclusions and final considerations. *Boletim do 3º Simpósio sobre o Cretáceo do Brasil*, Rio Claro, 1994, UNESP - Campus de Rio Claro/SP, p. 101-104.
- Bertini, R.J.; Carvalho, I.S. 1999. Distribuição cronológica dos crocodilomorfos notossúquios e ocorrências nas bacias cretácicas brasileiras. *Boletim do 5º Simpósio sobre o Cretáceo do Brasil*, Serra Negra, 1999, UNESP - Campus de Rio Claro/SP, p. 517-523.
- Bertini, R.J.; Marshall, L.G.; Gayet, M.; Brito, P. 1993. Vertebrate faunas from the Adamantina and Marília Formations (Upper Bauru Group, Late Cretaceous, Brazil) in their stratigraphic and paleobiogeographic context. *N. Jb. Palaeont. Abh*, 188 (1): 71-101.
- Campanha, V.A.; Etchebehere, M.L.; Saad, A.R.; Fulfaro, V.J. 1994. Novas ocorrências fossilíferas no Grupo Bauru na região do Triângulo Mineiro. *Geociências*, São Paulo, 12(2): 353-372.
- Campos, D.A.; Kellner, A.W.A.; Bertini, R.J.; Santucci, R.M. 2005. On a titanosaurid (Dinosauria, Sauropoda) vertebral column from the Bauru Group, Late Cretaceous of Brazil. *Arquivos do Museu Nacional*, 63(3): 565-593.
- Carvalho, I.S.; Ribeiro, L.C.B.; Avilla, L.S. 2004. *Uberabasuchus terrificus* sp. nov., a new Crocodylomorpha from the Bauru Basin (Upper Cretaceous), Brazil. *Gondwana Research*, 7(4): 975-1002.
- Castro, J.C.; Dias-brito, D.; Musacchio, E.A.; Suarez, J.; Maranhão, M.S.A.S.; Rodrigues, R. 1999. Arcabouço estratigráfico do Grupo Bauru no oeste Paulista. *Boletim do 5º Simpósio sobre o Cretáceo do Brasil*, Serra Negra, 1999, UNESP - Campus de Rio Claro/SP, p. 509-515.
- Coimbra, A.M.; Fernandes, L.A. 1995. Paleogeografia e Considerações Paleoecológicas Sobre a Bacia Bauru (Cretáceo Superior do Brasil). In: *Congreso Argentino de Paleontologia y Bioestratigrafia*, 4, Trelew. Actas: Argentina, 1995, p. 85-90.
- Davino, A. 1983. Configuração topográfica pretérita à sedimentação da Formação Uberaba na região de

- Romaria, Estrela do Sul e Monte Carmelo (MG). *Revista Brasileira de Geociências*, 13(1): 37-40.
- Dias-Brito, D.; Musacchio, E.A.; Castro, J.C.; Maranhão, M.S.A.S.; Suárez, J.M.; Rodrigues, R. 2001. Grupo Bauru: uma unidade continental do Cretáceo no Brasil - concepções baseadas em dados micropaleontológicos, isotópicos e estratigráficos. *Revue Paleobiologie*, 20(1): 245-304.
- Etchehebere, M.L.C.; Silva, R.B.; Saad, A.R.; Resende, A.C. 1993. Reavaliação do potencial do Grupo Bauru para evaporitos e salmouras continentais. *Geociências*, São Paulo, 12(2): 333-352.
- Etchehebere, M.L.C.; Fulfaro, V.J.; Saad, A.R.; Perinotto, J.A.J. 1999. O significado estratigráfico da calcritização por água subterrânea no Triângulo Mineiro, sudoeste do Estado de Minas Gerais, Brasil. In: *Simpósio sobre o Cretáceo do Brasil*, 5, Serra Negra (SP), 1999, Boletim, p. 427-431.
- Estes, R.; Price, L.I. 1973. Iguanid lizard from the Upper Cretaceous beds of Brazil. *Science*, 180: 748-751.
- Fernandes, L.A. 1998. Estratigrafia e evolução geológica da parte oriental da Bacia Bauru (Ks, Brasil). Tese de Doutorado, Universidade São Paulo, Instituto de Geociências, 215 p.
- Fernandes, L.A.; Coimbra, A.M. 1996. A Bacia Bauru (Cretáceo Superior, Brasil). *Anais da Academia Brasileira de Ciências*, 68(2): 195-205.
- Fernandes, L.A.; Coimbra, A.M. 1998. Estratigrafia e evolução geológica da Bacia Bauru (Ks, Brasil). In: *Congresso Brasileiro de Geologia*, 40, Belo Horizonte, 1998, Anais, Belo Horizonte, SBG, p. 101.
- Fernandes, L.A.; Coimbra, A.M. 1999. Paleocorrentes da parte oriental da Bacia Bauru (Ks, Brasil). In: *Simpósio sobre o Cretáceo do Brasil*, 5, Serra Negra (SP), 1999, Boletim, p. 51-57.
- Ferreira Jr, P.D.; Guerra, W.J. 1995. Análise de elementos arquiteturais na caracterização do sistema fluvial da Formação Uberaba, Cretáceo Superior da Bacia do Paraná, no Triângulo Mineiro. In: *Simpósio de Geologia de Minas Gerais*, 8, Anais, Boletim 13, p. 104-106.
- Fulfaro, V.J.; Barcelos, J.H. 1991. Grupo Bauru no Triângulo Mineiro: uma nova visão litoestratigráfica. In: *Simpósio do Sudeste*, 2, São Paulo, 1991. Atas, São Paulo, SBG/SP-RJ, p. 59-66.
- França, M.A.G.; Langer, M.C. 2005. A new freshwater turtle (Reptilia, Pleurodira, Podocnemidae) from the Upper Cretaceous (Maastrichtian) of Minas Gerais, Brazil. *Geodiversitas*, 27(3) : 391-411.
- Gobbo-Rodrigues, S.R.; Santucci, R.M.; Bertini, R.J. 2001. Considerações sobre a idade da Formação Marília (Grupo Bauru, Cretáceo Superior) na região de Peirópolis, Estado de Minas Gerais. In: *Congresso Brasileiro de Paleontologia*, 17 Rio Branco, Boletim de Resumos, Universidade Federal do Acre, p. 48.
- Goldberg, K.; Garcia, A.J.V. 2000. Palaeobiogeography of the Bauru Group, a dinosaur-bearing Cretaceous unit, northeastern Paraná Basin, Brazil. *Cretaceous Research*, 21: 241-254.
- Hasui, Y.; Cordani, U.G. 1968. Idade Potássio-Argônio de rochas eruptivas Mesozóicas do Oeste Mineiro e sul de Goiás. In: *Congresso Brasileiro de Geologia*, 22, Belo Horizonte, 1968. Anais, Belo Horizonte, SBG, p. 139-143.
- Kellner, A.W.A.; Campos, D.A.; Trotta, M.N.F. 2005. Description of a titanosaurid caudal series from the Bauru Group, Late Cretaceous of Brazil. *Arquivos do Museu Nacional*, 63 (3): 529-564.
- Kischlat, E.E.; Barberena, M.C.; Timm, L.L. 1994. Considerações sobre a queloniofauna do Grupo Bauru, Neocretáceo do Brasil. *Boletim do 3º Simpósio sobre o Cretáceo do Brasil*, Rio Claro. UNESP - Campus de Rio Claro/SP, p. 105-107.
- Magalhães Ribeiro, C.M. 1999. Ovos fósseis da Formação Marília (Bacia Bauru, Cretáceo Superior). *Academia Brasileira de Ciências*, 71(4): 850.
- Magalhães Ribeiro, C.M.; Ribeiro, L.C.B. 1999. Um ovo de dinossauro em sucessões fluviais da Formação Marília (Cretáceo Superior), em Peirópolis (Uberaba, Minas Gerais). *Boletim de Resumos do 6º Simpósio de Geologia do Sudeste*, São Pedro, p. 76.
- Magalhães Ribeiro, C.M. 2000a. Microstructural analysis of dinosaur eggshells from Bauru Basin (Late Cretaceous), Minas Gerais, Brasil. *Extended Abstracts of the First International Symposium on Dinosaur Eggs and Babies*, p. 117-121.
- Magalhães Ribeiro, C.M., 2000b. Nuevo hallazgo de huevo fósil y fragmentos de cáscaras de huevos en la Formación Marília (Cretácico tardío), Uberaba, Minas Gerais, Brasil. *XV Jornadas Argentinas de Paleontología de Vertebrados*, San Luis, Argentina, 2000. Resúmenes, p. 33.
- Mezzalana, S. 1989. Os fósseis do Estado de São Paulo, 2a. Ed., Serie Pesquisa, Instituto Geologia, São Paulo, 141 p.
- Mezzalana, S.; Maranhão, M.S.A.S.; Vieira, P.C. 1989. Bibliografia analítica da Paleontologia do Estado de São Paulo. Instituto Geológico, São Paulo, Boletim 8, 235 p.
- Novas, F.E.; Ribeiro, L.C.B.; Carvalho, I.S. 2005. Maniraptoran theropod ungual from the Marília Formation (Upper Cretaceous), Brazil. *Rev. Mus.*

- Argentino Cienc. Nat., n. s. 79(1) Bueno Aires p.31-36.
- Petri,S. 1955. Carophytas cretácicas de São Paulo. Boletim da Sociedade Brasileira de Geologia, 4: 67-74.
- Price,L.I. 1955. Novos crocodilídeos dos arenitos da Série Bauru. Cretáceo do Estado de Minas Gerais. Anais da Academia Brasileira de Ciências, 27(4): 487-498.
- Senra,M.C.E.; Silva e Silva,L.H. 1999. Moluscos dulçaqüícolas e microfósseis vegetais associados da Formação Marília, Bacia Bauru (Cretáceo Superior), Minas Gerais, Brasil. In: Simpósio sobre o Cretáceo do Brasil, 5, Serra Negra (SP), 1999, Boletim, p. 497-500.
- Silva,R.B.; Etchebehere,M.L.C.; Saad,A.R. 1994. Ground water calcretes: uma interpretação alternativa para os calcários da Formação Marília no Triângulo Mineiro. In: Simpósio sobre o Cretáceo do Brasil, 3, Rio Claro, 1994. Boletim, Rio Claro, UNESP, p. 85-89.
- Suarez,J.M.; Arruda,M.R. 1968. Jazigo fossilífero no Grupo Bauru, contendo lamelibrânquios. Anais do 22º Congresso Brasileiro de Geologia, Belo Horizonte, 1968, Sociedade Brasileira de Geologia, p. 209-212.
- Suguo,K. 1973. Formação Bauru: calcários e sedimentos detríticos associados. Tese de Livre Docência. São Paulo, Universidade de São Paulo, Instituto de Geociências.
- Suguo,K. 1980. Fatores paleoambientais e paleoclimáticos e subdivisão estratigráfica do Grupo Bauru. In: Mesa redonda: a Formação Bauru no Estado de São Paulo e regiões adjacentes, São Paulo, 1980. Coletânea de trabalhos e debates. São Paulo, SBG, Publicação Especial, 7: 15-26.

¹ Fundação Municipal de Ensino Superior de Uberaba-FUMESU/Centro de Ensino Superior de Uberaba - CESUBE/Centro de Pesquisas Paleontológicas L. I. Price. Av. Randolpho Borges Jr., nº 1.250. Univerdecidade, 38.066-005, Uberaba - MG. Brasil. E-mail: cpplip@cesube.edu.br

² Universidade de Uberaba - UNIUBE/Instituto de Formação de Educadores - Departamento de Biologia. Av. Nenê Sabino, nº 1801. Universitário, 38.055-500, Uberaba - MG. Brasil. E-mail: lcbmg@terra.com.br

³ Universidade Federal do Rio de Janeiro. Departamento de Geologia, CCMN/IGEO. 21.949-900 Cidade Universitária - Ilha do Fundão. Rio de Janeiro - RJ. Brasil. E-mail: ismar@geologia.ufrj.br

AUTHOR's SYNOPTIC CURRÍCULUM VITAE



Luiz Carlos Borges Ribeiro

Director of the Llewellyn Ivor Price Paleontological Research Center and the Dinosaur Museum, Peirópolis, Uberaba, carrying out activities related to research, teaching and sharing knowledge.

He is a Professor of Geology, Paleontology and Geomorphology in the Geology undergraduate course at the Uberaba Center for Higher Education (Centro de Ensino Superior de Uberaba) and Geology and Paleontology in the graduate Biological Sciences course at Uberaba University (Universidade de Uberaba). He holds a BSc in Geology from the Federal University of Minas Gerais. He is a consultant in geology and paleontology in fields of environment projects for paleontological conservation.



Ismar de Souza Carvalho -

Associated Professor at the Federal University of Rio de Janeiro (Universidade Federal do Rio de Janeiro), Geology Department. He lectures on subjects related to paleontology and geology of the

Brazilian sedimentary basins in the Geology undergraduate and graduate courses. He holds a BSc from Coimbra University (Portugal), MSc and DSc from the Federal University of Rio de Janeiro and his post doctorate studies were at UNESP (Rio Claro) in Geology. He is active in research related to Cretaceous terrestrial ecosystems. He is a researcher member of CNPq (Brazilian National Research Council) and FAPERJ (Rio de Janeiro Research Council).