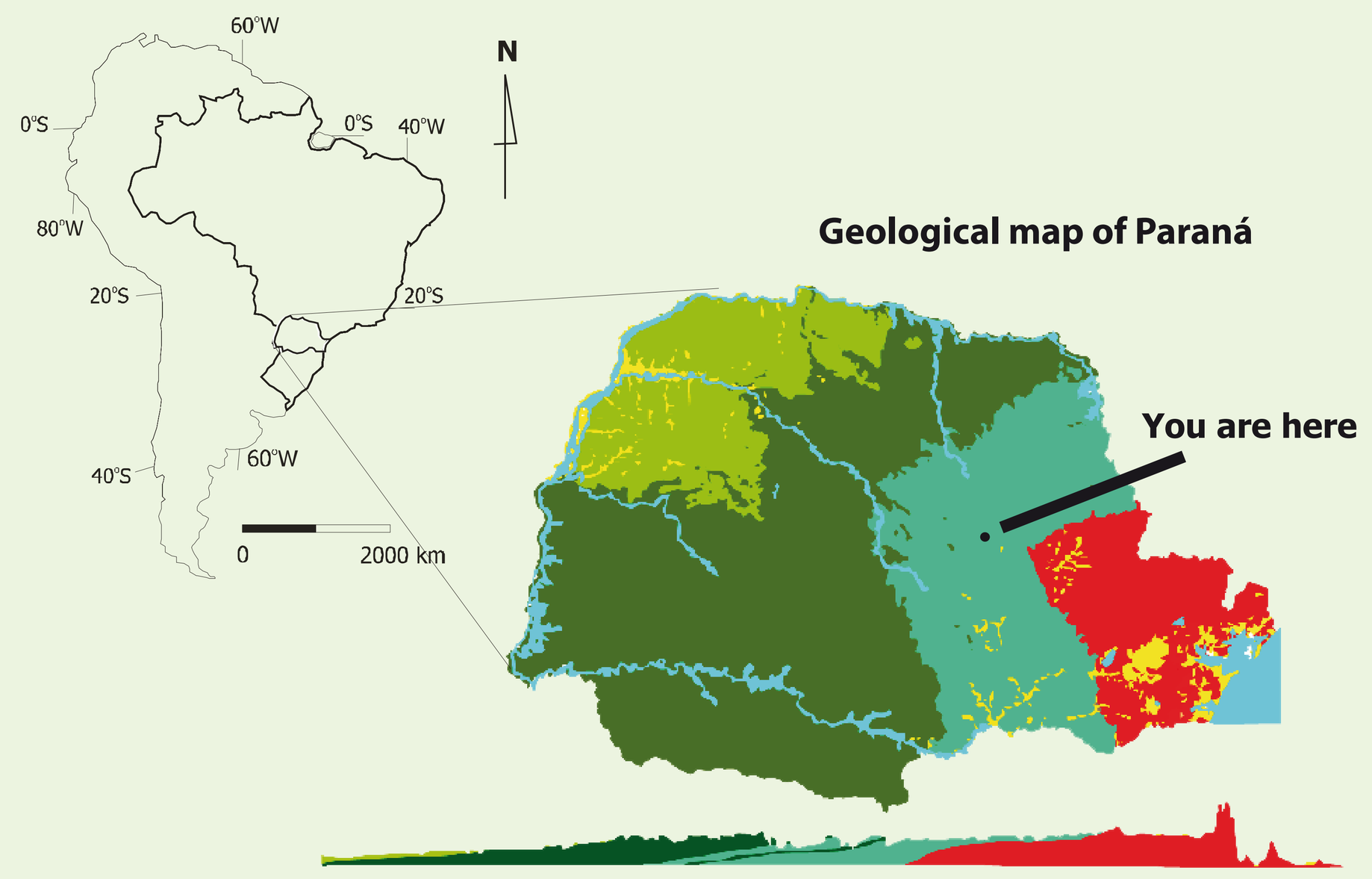
Geology of Paraná



EON	ERA	PERIOD	EPOCH	Age (million years)	Features	Geology
Phanerozoic	Cenozoic	Quaternary	Holocene	Today / 1,1	[illegible] Hemisphere	Sediments
			Pleistocene	1,8		
		Tertiary	Pliocene	5,3		Sediments
			Miocene	23		
			Oligocene	34	Primates proliferate	
			Eocene	53		
			Paleocene	65	First horses appear	
	Mesozoic	Cretaceous		142	Dinosaurs appear; flowers	Sedimentary rocks / Magmatic rocks
		Jurassic		206	First birds and mammals appear	Paraná Basin: Sedimentary rocks
		Triassic		248	First Dinosaurs appear	
	Paleozoic	Permian		290	Trilobites disappear	
		Carboniferous		354	[illegible] primitive large	
		Devonian		417	Amphibians appear	
		Silurian		443	Terrestrial plants appear	
		Ordovician		495	First fishes	Paraná Shield
		Cambrian		545	First shells; trilobites prevail	
Pre-cambrian	Proterozoic			2500	First pluricellular organisms	
	Archean			4000	First unicellular organisms	
	Hadean			4560	Earth forms	

The geological evolution of Paraná is followed when the state is crossed westward. The oldest rocks, formed more than three billion years ago, are found on the coastal plain. There, and all over Serra do Mar and the First Plateau, igneous and metamorphic rocks of Archean to early Paleozoic age outcrop in the region known as the PARANÁ SHIELD, whose strong relief reflects how resistant to weathering its rocks are.

From the Devonian scarp known as São Luiz do Purunã to the western border of the state, the Paraná Shield is overlain by the PARANÁ BASIN, a massive sequence of sedimentary and volcanic rocks of Silurian to Cretaceous age that sustains the state's second and third plateaus. In the early stages of the basin´s evolution, South America and Africa were still unseparated parts of a supercontinent called Gondwana, and their geographic locations were very different from today's.

The PARANÁ BASIN evolved for more than 300 million years, in long transgression-regression cycles of an ancient sea that surrounded Gondwana. These cycles, immensely slow as compared to human lifetime, resulted in different marine, lacustrine, fluvial, and glacial rocks in Paleozoic times.

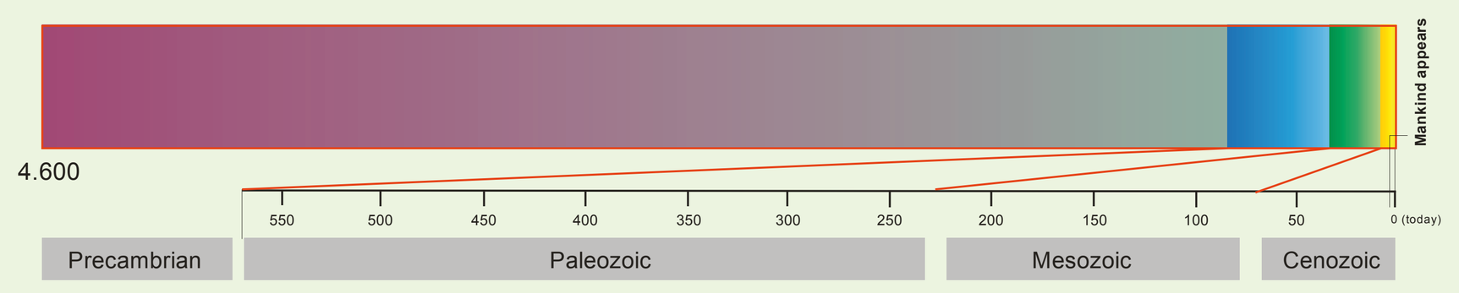
In Jurassic times, a desert named Botucatu, that spread for more than 1,500,000 km2, covered parts of southern Brazil, Paraguay, Uruguay, and Argentina.

The breakup of Gondwana, and the consequent separation of South America and Africa as the South Atlantic Ocean spread, took place in the Cretaceous. As part of the breakup process, extensive, up to 1,500 m of superposed basalt flows covered more than 1,200,000 km2 of the Paleozoic sedimentary rocks of the Paraná Basin. The remarkably fertile soil known as Terra Roxa derives from weathering of such basalt flows. By the end of the Cretaceous, desertic terrains (the Bauru Basin) spread over the basalt flows in northwestern Paraná as recorded by the Caiuá sandstone. Unlike the Terra Roxa, however, soils formed from these rocks are poorly fertile and highly susceptible to erosion.

The youngest geological units in Paraná are sediments of Quaternary age. Most representative examples are those generated under arid to semi-arid conditions over parts of Curitiba and Tijucas do Sul, those formed from weathering of crystalline rocks along the Serra do Mar range, marine sand deposits along the eastern coast, and also countless alluvial deposits along water streams in the state.

Geological time

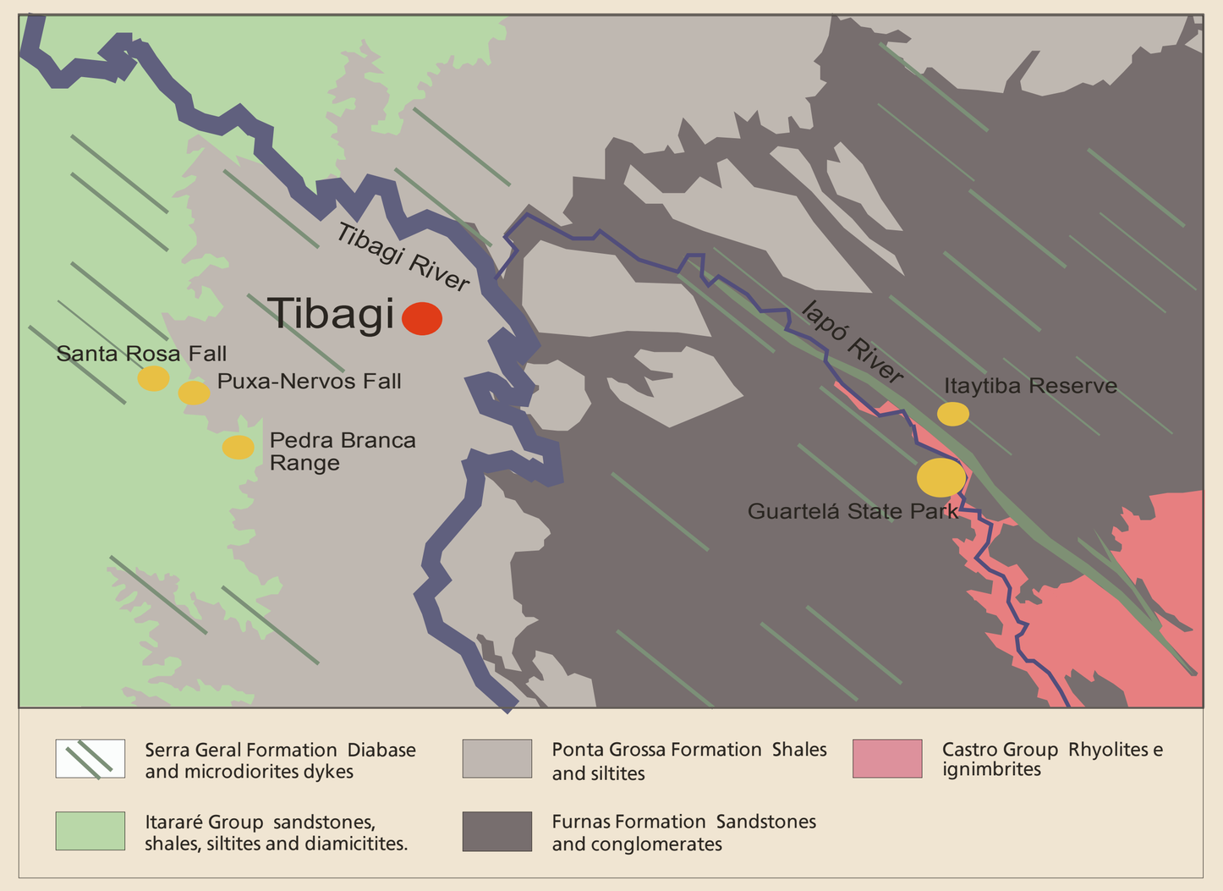
If the 4.6 billion years of geological history were scaled to one single year, Mankind would have been on Earth since 8:14 p.m. December 31 i.e., within the last 3h ours and 46 minutes. Dinosaurs, that lived for 100 million years, would have lived no more than 8 days and 12 hours.



Geological Site

Tibagi

The Rocks of this Region



Regional geological map of Tibagi depicting the main rock units. Notice the NW-SE structural control of the rivers segments (canyons and diabase dykes).

The rocks of Tibagi are classified into four groups according to their stratigraphical position: Castro, Rio Ivaí, Paraná, and Itararé. The Cambro-ordovician Castro Group, with ignimbrites and rhyolites at the lower parts of the Guartelá Canyon, represents the change from a tectonically intense period to a relatively calm one when sediments of the Paraná Basin started to deposit. Stratigraphically above these rocks are thin-layered and sparsely outcropping Silurian diamictites of the Rio Ivaí Group (Iapó Formation), possibly of glacial origin, that evidence an ice age when continents were closer to the South Pole.

The Devonian (or Silurian, according to some researchers) Paraná Group is the most widely outcropping unit in the region, with massive layers of marine conglomerates and whitish sandstones of the Furnas Formation on the canyon's walls, and fossil-rich shelf shales and siltites of the Ponta Grossa Formation. All these rocks mark the presence of a sea inlet at the time their original sediments deposited.

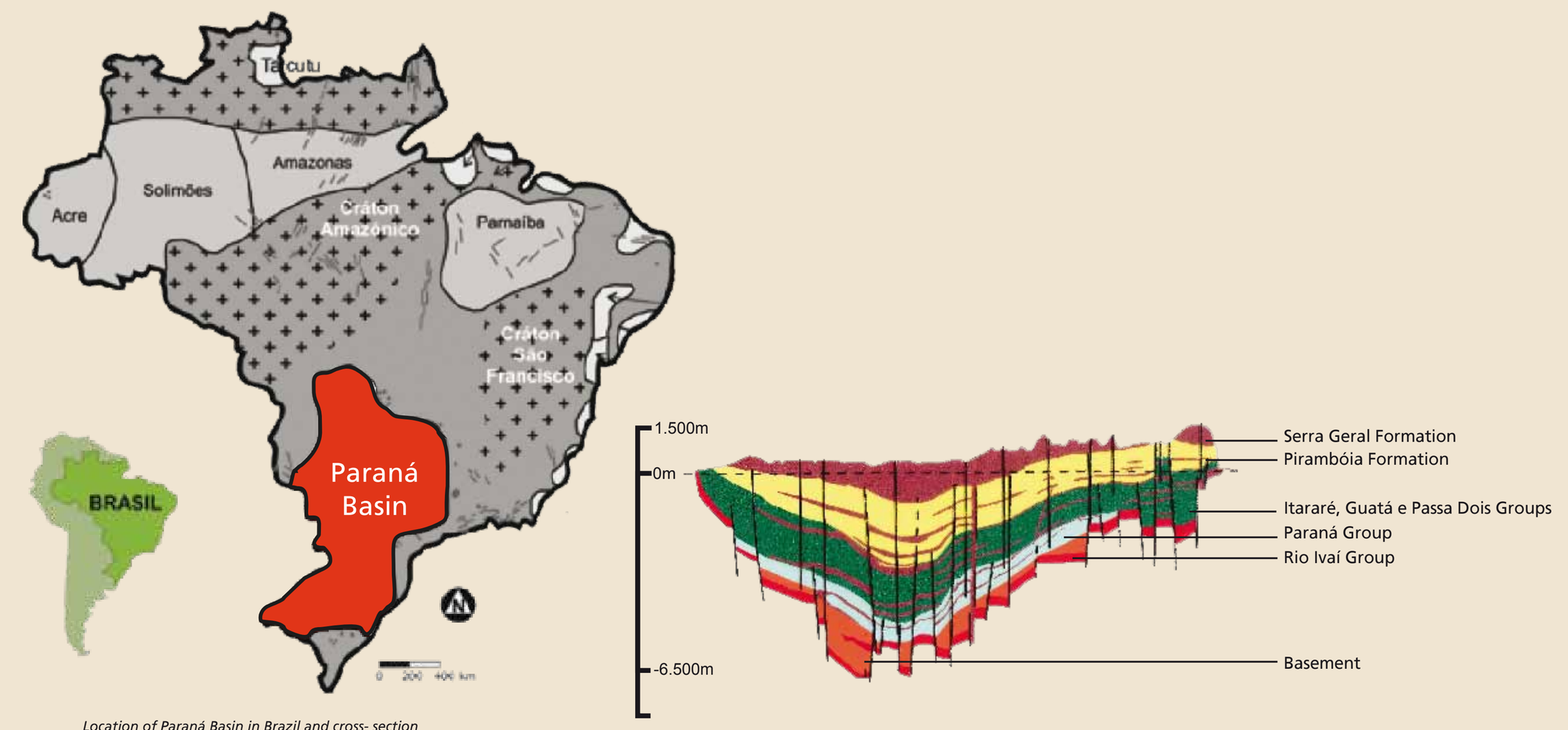
Diamictites and red sandstones of the glacial Permocarboniferous Itararé Group overlap all these rocks.

All these sedimentary rocks are cut by Mesozoic diabase and microdiorite dykes that formed from magmas related to the separation of Africa and South America.

The Paraná Basin

The Paraná Basin is a vast elongated depression filled with sediments piling up to six kilometer thick in some places. Part of its total extension of approximately 1,400,000 km2 correspond to the second and the third plateaus in the State of Paraná. Early in the evolution of the basin, the global distribution of continents was quite different from the current one. The landmasses now corresponding to South America and Africa were still parts of a megacontinent named Gondwana.

The long and relatively calm evolution of the Paraná basin allowed sediments to deposit from a variety of environments such as marine, deltaic, lacustrine fluvial, glacial, and desertic ones. When Africa and South America separated, most of he basin's extension was covered with basaltic lava flows.



Location of Paraná Basin in Brazil and cross- section

The Tibagi River

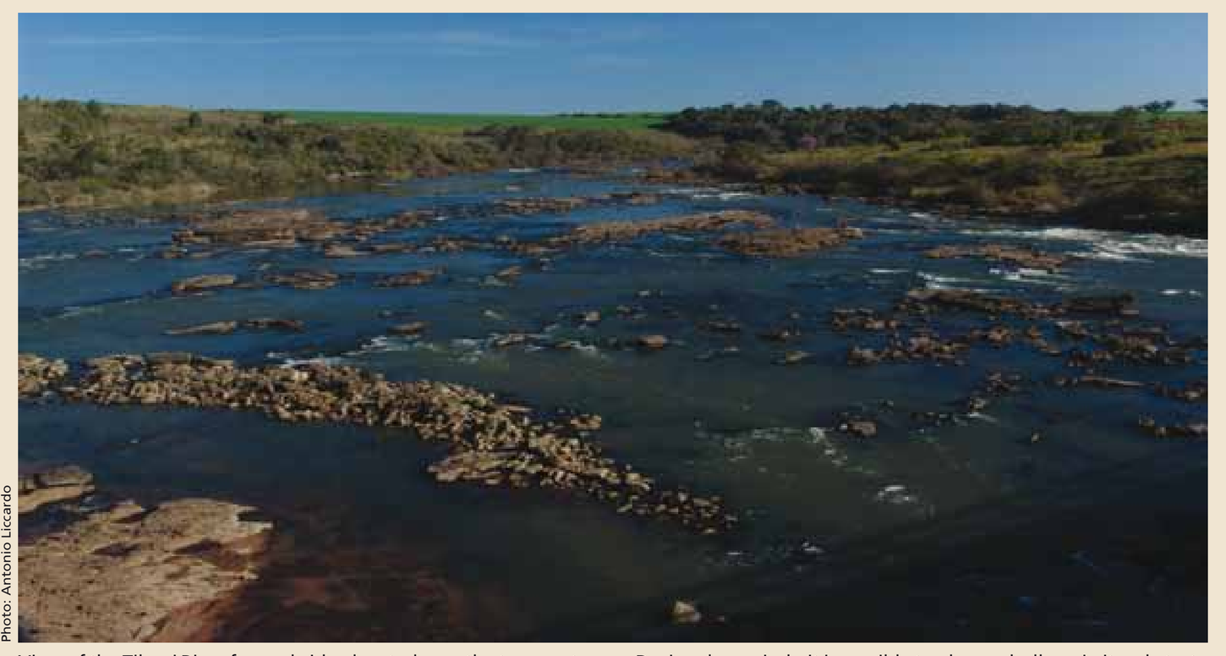


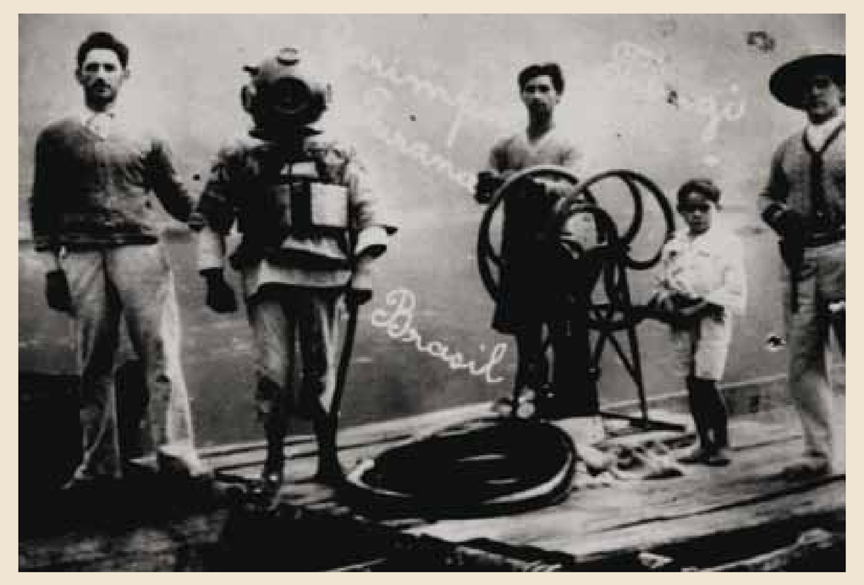
Photo: Antonio Liccardo

View of the Tibagi River from a bridge located near the town entrance. During dry periods, it is possible to observe hollows in its substrate where heavier minerals such as gold and diamonds are trapped.

The Tibagi is a voluminous river that in this region flows over sandstones and conglomerates of the Itararé Group and over shales of the Ponta Grossa Formation. After the separation of Africa and South America and the rise of the Andes, the southeastern border of South America underwent a slow uplift that caused the Tibagi, Iguaçu, Piquiri, and Ivaí, the main rivers of Paraná, to flow inward the continent. The Ribeira River is an exception to that rule.

The riverbed of the Tibagi is quite irregular, with hollows carved by the erosive action of water. Such features, where diabase dykes are also present to form rapids, are favorable sites for the presence of diamonds.

Historically and geographically speaking, the Tibagi and its banks had been an important landmark in Paraná's second plateau for troopers (notably the bandeirantes) departing São Paulo southward to hunt indigenous populations and to search for ores.



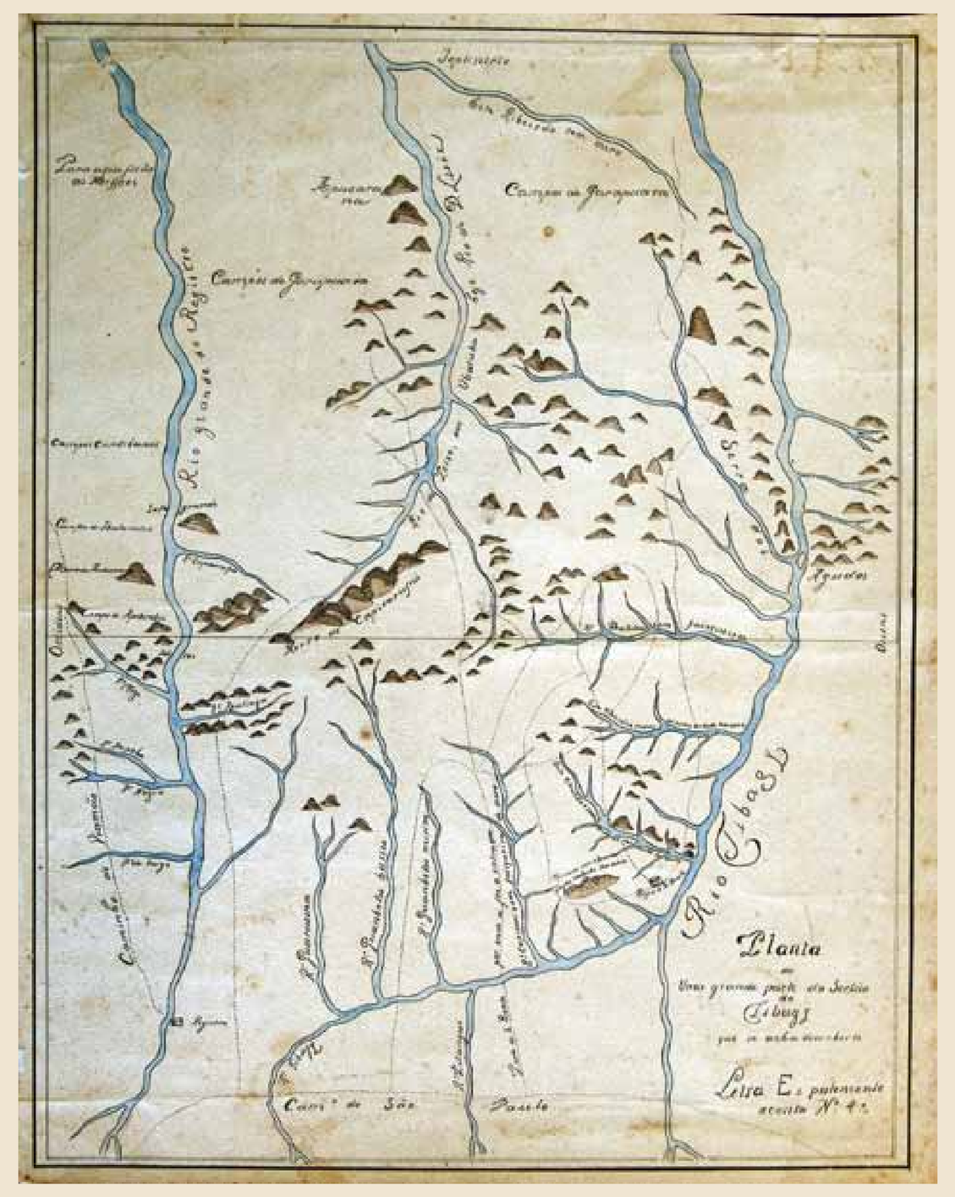
Diamond exploitation by divers and the use of diving suits in the 30s. This activity has been held in the region for over 200 years. (The Diamond Museum Tibagi)

Gold and Diamond

Until the mid-eighteenth century, all the western countryside of Curitiba was know as the "Tibagy Inland." Little was known of the region's geography at that time. Primary documentation records the activity of washers at Pedra Branca and the establishment of the first farms around 1720.

The first diamond report in the region dates from 1754, when Anselmo, a slave of explorers Ângelo Pedroso de Lima and Marcelino Rodrigues de Oliveira, found a shiny crystalline pebble while washing from a local stream.

In 1820, a report from Auguste de Sain-Hilaire, an European explorer serving the Portuguese Crown, mentions gold and diamond smuggling and washing of diamond-bearing gravel from local streams by the few ones who lived in the region. In 1880, Bigg-Whiter remarks on the virtual extinction of diamond washing, especially as compared to the production from by Minas Gerais.



"Map of the Tibagy inland with its abounding goods, gold, fine tin, excellent antimony and fertile fields for raising animals" (1755) - Museum Paranaense

During the first half of the twentieth century, diamonds from the Tibagi River were famous for their quality. At that time, there was a gold rush to the river by prospectors form Bahia and Minas Gerais, mainly in the late 30s and early 40s. Diving suits became a popular prospecting device and thus it was possible to prospect the bottom of the Tibagi River.

Nowadays, gold and diamonds are only sporadically searched for in this region, sometimes only during periods of low rainfall. Always found here in alluvionar deposits or in older terraces, their original hosting rocks remain unknown.

Serra da Pedra Branca

The Pedra Branca Mountain Range, where stands the Jacaré Hill, is a peculiar elevation approximately 200 meter high. It consists of whitish-reddish glacial Itararé sandstones that stand out in the landscape for its peculiar conformation, that can be viewed form afar. The differential relief is due to the fact that the sandstone is more resistant to weathering than its neighboring shales.

This range served as the main landmark in old maps of the region, was possibly a reference for ancient populations. It was part of the Peabirú Way, the main Precolumbian route between Guarani and Inca populations, and was also used by early European explorers such as Cabeza de Vaca, and explorers from Portugal and São Paulo.

Photo: Antonio Liccardo

The Guartelá Canyon

The Guartelá Canyon is a 30 km-long pass gorge carved up to 450 m deep by the Iapó River. This river runs across the Devonian scarp that delimits the First and the Second plateaus carving Furnas sandstones, Iapó Formation diamictites, and also volcanic rocks of the Castro Group on its way to its mouth, the Tibagi River.

The canyon is determined by long NW-SE fractures that are sometimes filled with diabase. These fractures are related to the uplift of the Ponta Grossa Arch, a structure formed when Africa and South America started to separate. The gorge formed from differential erosion as diabase is less resistant to the erosive action of water than sandstone. Where the diabase-filled fractures reach Ponta Grossa shales to the northwest, the canyon disappears because these rocks are similar in their resistance to erosion.

The Guartelá State Park is a protected area that is open for visitation. Among its main attractions are ruiniform relief forms, rupestrian paintings, falls, caves and huge stone walls.

Additional information is displayed on panels inside the park.

Photo: Antonio Liccardo

Santa Rosa and Puxa-Nervos Falls

Photo: Antonio Liccardo

Santa Rosa

The Santa Rosa and the Puxa Nervos falls, both near the Pedra Branca Mountain Range, mark abrupt relief steps in Itararé sandstones. The steps are caused by the existence of weathered diabase dykes, in the Santa Rosa Fall, and by fractures and faults in the Puxa-Nervos Fall. The rocks tend to be coarser at the base of the falls, with sporadic presence of conglomerates.

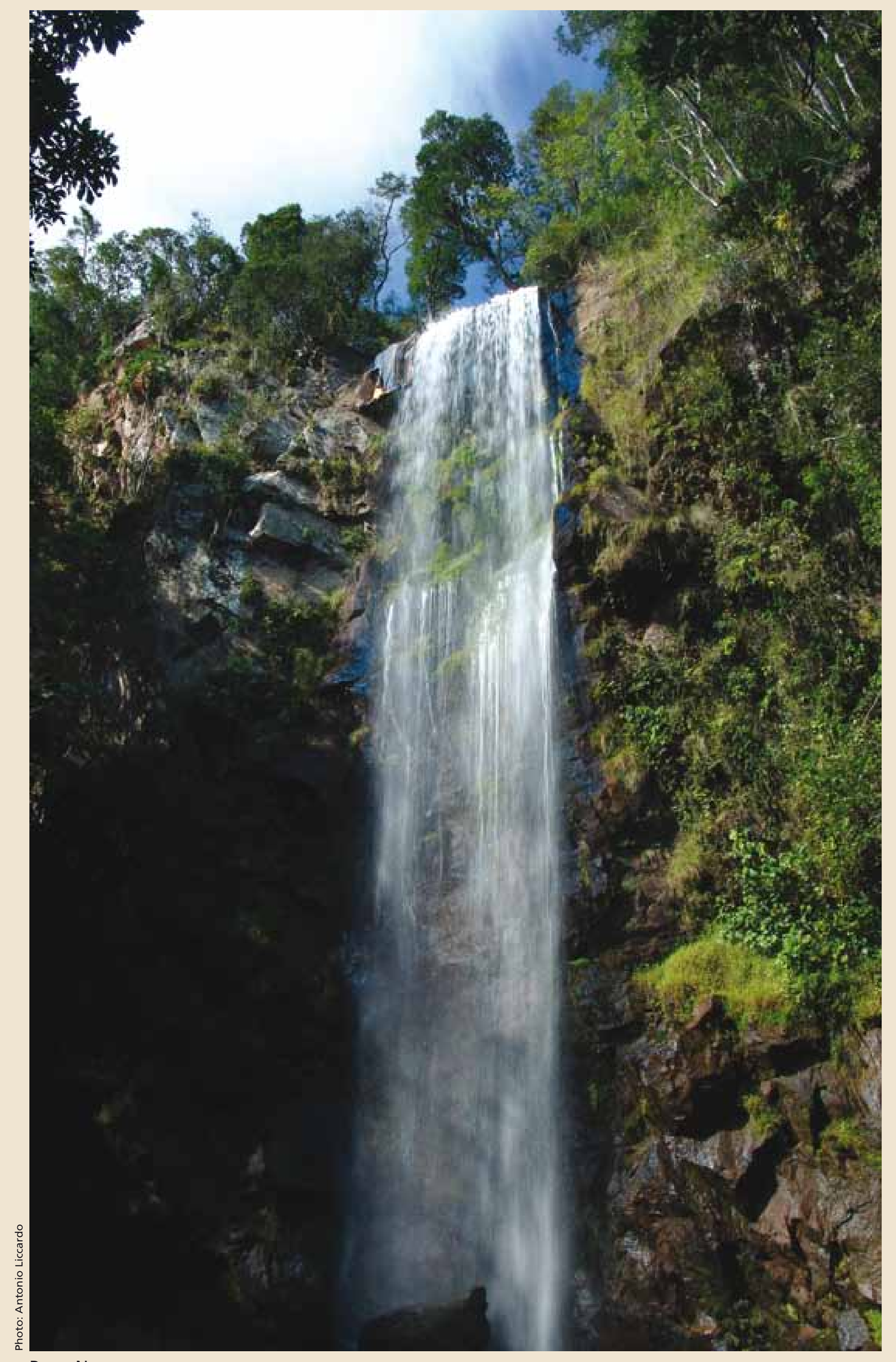


Photo: Antonio Liccardo

Puxa-Nervos

Fossils

Fossils are precious records of past epochs, in that their generation requires a precise set of conditions without which organisms would decompose after they died. When organisms die, they are normally buried by mud that deposits in lakes or by sediments that reach the sea floor. Although their soft parts soon decompose, bones, teeth, shields, shells, and also wooden fragments (in case of vegetals) take longer to disappear. When buried under low oxygen conditions, these parts can be preserved even for millions of years in sedimentary rocks.

Other forms of fossils result from evidences of the presence of living organisms, such as footprints or wormholes. The Ponta Grossa Formation, which outcrops in Tibagi, bears a large amount of fossils. Its siltites and shales formed from sediments deposited under environmental conditions that allowed a large variety of invertebrate fossils, among them trilobites, gastropods, bivalves, micro-organisms and icnofossils.

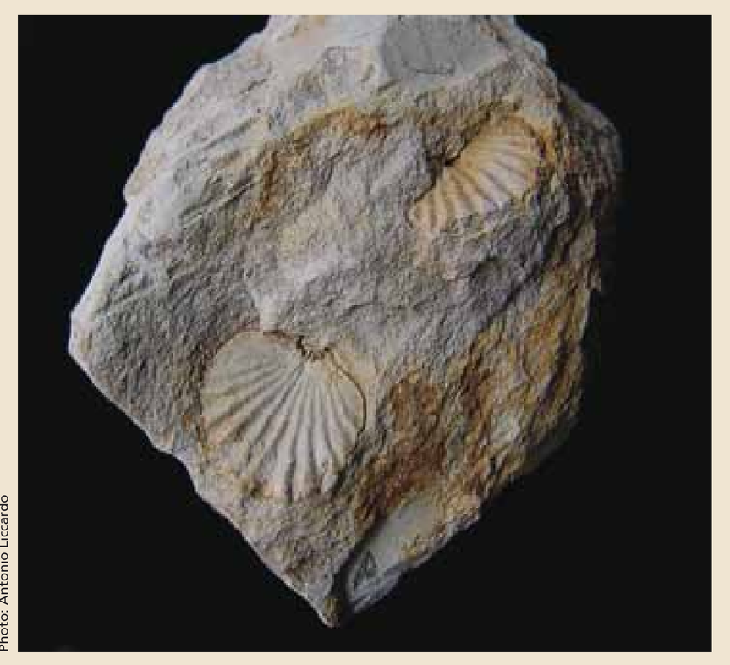


Photo: Antonio Liccardo

Bivalve fossil typical of the Ponta Grossa Formation. This specimen was found in the Rivadávia Farm in the municipality of Ponta Grossa and is displayed at the Cenpáleo, in Mafra.

Realization:

GOVERNO DO PARANÁ – SECRETARIA DE ESTADO DA INDÚSTRIA, DO COMÉRCIO E ASSUNTOS DO MERCOSUL

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