Point of Geological Interest: Imboassica Lagoon

The **Imboassica Lagoon** is one of the most beautiful landscapes of Macaé. This wonderful water mirror is strategically placed between the **wildness of the sea** at its front and the **quietness of the hills** at its back. When we walk on the sand bar that separates the lagoon from the sea, we can perceive the huge contrast between the **fury of the waves** and the **serenity of the lagoon**. The lagoon is placed in this coastal context, as a natural formation that gracefully seeks to harmonize the continent with the sea.

SCULPTURING THE LAGOON

Nature, with all of its patience, took a long time to draw what today is our Lagoon of Imboassica. The story began **earlier than 20 thousand years ago**. At that time, the planet was going through an ice age and the sea level was 120 meters below its present position. The sea-level change is a natural processe in the Earth. See in **Figure 1** how the level of the sea has varied in the last 65 million years.

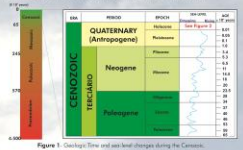

Figure 1 - Geologic Time and sea-level changes during the Cenozoic.
Source: CENPES/PETROBRAS - modified from Mosses & Emeis, 2001

From where you stand, it was not possible to see the beach, which was **more than 100 km away**, next to the **oil fields** of Campos Basin. A fragile zone in the local rocks aligned in an east-west direction, became a preferential pathway for surface water flow, forming the **Imboassica River**.

The Santana Archipelago is formed by Francês, Ilhote SJ and Santana islands (Photo: Arnaldo Campos).

Initially running across a narrow valley, after thousand of years the erosion has widened it, shaping the large bed of the present lagoon. This river must have flowed into the Macaé River, around the proximity of the present **Santana Archipelago**, on the plain that is now submerged by the sea.

The sea level reached its maximum **5 thousand years ago**, and the estuary that had been formed was completely flooded, resulting in a **marine inlet** (a small bay). Surrounding areas were also flooded, forming **mangroves** and **small lagoons**.

The hills in the background started to receive the direct impact of the sea waves. The work of the waves made the collapse of the slopes, shaping an alignment of sea cliffs (abandoned nowadays) in the place where today the district of São Marcos is located. The railroad that is there today is positioned right at the foot of these old cliffs.

THE ORIGIN OF THE LAGOON

Around **3 thousand years ago**, the sea was around 3 meters higher than today. A first sand bar was formed, lasting until one thousand year ago (see paleobar on the **figure 3**). The sand bar separates the lagoon from the sea and since then, this individualized body of water has started to live in a semi-isolated **lagoon-type system**. The natural communication with the sea followed regular cycles.

During the **fluvial floods**, the lagoons would naturally overflow, draining its excess water and life into the sea, thus fulfilling its mission of **fish and shellfish breeder**. At a rather slower frequency, the bar could be disrupted by extraordinary high waves, even higher than 10 meters, associated with the so-called secular storms.

So the lagoon has operated in this way for 3 thousand years, among storms and doldrums, providing an abundance of life to the sea. Meanwhile, the process of shoaling was taking place unhurriedly, at the pace nature prefers. The lagoons in the region were one of the first sources of food for the natives who inhabited the region, as recorded by the **sambaquis** that can be found near some coastal lagoons.

TODAY'S AGONY

Satellite image (Horus)- december 2002 - compare with the aerial photo of 1976.

Problems come along with urban occupation. The first one of them was the occupation of the margins of the lagoon, through **earthwork** in areas that belonged naturally to the water body. When the level of the lagoon rises, the population have to make a forced opening through the bar, leading the waters to the sea. If this happens when the hatches are not ready yet to reach the open sea, the natural dynamics of the lagoon is broken.

Another problem is in the discharge of **sewage**. The abundance of nutrients initially causes an explosion of life in the lagoon. This leads to loss of oxygen in its waters, with the consequent death of fish and shellfish. With the excess organisms dying, the process of decomposition starts to use up so much oxygen that some organic mud is deposited on the bottom, typical of environments with little oxygen, enriched by poisonous sulphide acid.

Seventeen thousand years ago, global heating caused partial melting of the polar glaciers, wich caused a dramatic increase in the volume of the sea water, rising as a rate of **1 meter each century**. Around **7 thousand years ago**, the sea level reached its present position and the valleys in the region were flooded. The outlet of the Imboassica River was dammed up in the position of the present lagoon, there forming a small **estuary** (the location where a river runs into the sea). See, in **Figure 2**, the sea level variation in the last 7 thousand years.

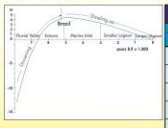

Figure 2 - Schematic curve of relative sea-level changes during the last 7.000 years (modified from Martin et al., 1987 in Suguio, 1999), with the several evolution stages that originated the lagoon (see table to the right).

ORIGIN AND EVOLUTION OF IMBOASSICA LAGOON			
AGE (Years Before Present)	Evolution Stage	SEA-LEVEL (related to present level)	CHARACTERISTIC
17,000 to 7,000	FLUVIAL VALLEY	Rising from -120 to 0m	Imboassica River in East-West Axis
7,000 to 5,000	ESTUARY	Rising from 0 to 5m	Marginal Plain
5,000 to 3,000	MARINE INLET	Lowering from 5 to 2m	São Marcos Paleocliffs
3,000 to 1,000	SMALLER LAGOON	Lowering from 3 to 1m	Paleobar (elict in the right margin)
1,000 to nowaday	LARGER LAGOON	Lowering from 1m to present level	Present sand bar
Next Stage	SWAMP	Close to present sea-level (?)	It will be similar to Balneário das Garças

Figure 3

ENVIRONMENTAL SETS:

- Imboassica Lagoon (coastal lagoon formed 3,000 years ago)
- Sand bar (it controls the lagoon water level)
- Paleobar (ancient bar that was active from 3,000 to 1,000 years ago)
- São Marcos Paleocliffs (cliffs formed 5,000 years, when the sea-level was 5m higher than the present)
- São João Hill (5,9 Million years alkaline rocks, root of an eroded volcano)
- Pote Mountais (more than 500 million years rocky massif)

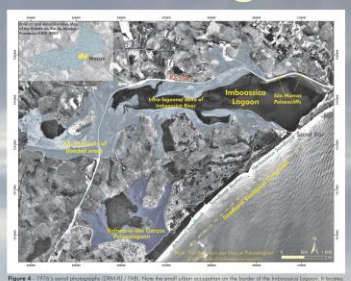

Figure 4 - 1976's aerial photography (DRM-RJ / FAB). Note the small urban occupation on the border of the Imboassica Lagoon. It locates, also, several features described in the text.

WHAT WILL TOMORROW BRING?

Every lagoon has a useful life cicle. After all, it is a basin where the sediments of its margins converge to. In Imboassica, this process has been largely accelerated.

Deforestation in the area goes back to colonial times. Thus, we have a super-intensified blocking up process shortening the useful life of the lagoon. A preliminary estimative permits us to guess that the lagoon would be able to last around 10 thousand years, which means a life expectancy of more **5 thousand years from now**. However, at the present pace of shoaling, the lagoon may have its life shortened, cut to just a few centuries from today.

A good way for us to forecast the future of the Imboassica Lagoon is observing the present situation of the **Balneário das Garças** (see **figure 4**). This refers to a swampy area that was blocked up (filled up with debris) just few centuries ago. It used to be a lagoon as Imboassica is today, although shallower. As the lagoon becomes a **swamp**, there is a modification in the vegetation that takes place in the bar that separates it from the sea. Today, Imboassica has a mobile bar with no vegetation cover, while in Balneário das Garças, we can find a bar with an exuberant forest sandbank.

It is worth remembering that the environmental situation is the reflection of the awareness of the community that inhabits that location. **The revitalization of our still beautiful Imboassica Lagoon depends on our concrete actions. Let's get to work.**

"Earth has taken a few billion years to build the rocks, the minerals, the mountains and the oceans. Protect this masterpiece!"

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