

BRAZILIAN IMPACT CRATERS: A REVIEW. R. Romano¹ and A. P. Crósta². ¹Department of Geology, Federal University of Ouro Preto, 35400-000, Ouro Preto, MG, romano@opala.degeo.ufop.br; ²Geosciences Institute, University of Campinas, P.O. Box 6152, 13083-970, Campinas, SP, Brazil, alvaro@ige.unicamp.br.

Introduction: The Brazilian territory covers 8.5 million km², a significant proportion of which comprises terrains older than Mesozoic that represent quite stable tectonic regimes for the past 500 million years. Considering this scenario, it should be expected that a large number of eroded impact craters would be known in Brazil, as in other countries that have similar geological conditions, such as Canada and Australia.

However, the current record of proven and possible impact sites in Brazil does not go beyond a dozen, almost all of them being well exposed circular structures. The reasons for this modest number are the lack of basic geological mapping at scales that would allow the recognition of such structures and the fact that no specific surveys for impact sites were ever conducted in the country. Also, most of the country is subject to tropical climate, favoring the occurrence of intense weathering processes. This does not favor the preservation of geomorphologically prominent features and allows the development of dense vegetation cover, making the recognition of candidate impact sites even more difficult.

A brief review of the currently known astroblemes in Brazil, and of some possible ones, is presented here.

Proven Brazilian Impact Craters: There are four proven impact craters in Brazil known at present. The number of proven sites has remained the same for the past years [1], whereas the number of possible sites has increased, suggesting that not enough detailed work has been conducted in order to investigate the origin by impact of the suspected sites.

The best known Brazilian impact structure is Araguainha (16°47'S/52°59'W), which is also the largest in South America. This 40 km wide complex crater, with a 7 km wide central uplift, was formed 245 Ma ago, in Paleozoic sediments of the Paraná Basin and underlying basement rocks. Widespread impact deformation features were recognized by [2], [3], [4] and [5], including several types of impact breccias, shatter cones in sandstones, planar deformation features (PDFs) in several minerals, and microspherules. This impact event occurred at a time close to the Permian-Triassic boundary [6], when the largest mass extinction event took place.

Serra da Cangalha (8°04'S/46°51'W) is a 12 km complex impact crater (3 km wide central uplift) formed in Paleozoic sediments of the Parnaíba Basin, formerly known as the Maranhão Basin. A number of impact features were described by [7] and [8], including shatter cones, suevite and PDFs. The age of the

impact was estimated by [7] as Triassic. A remote sensing study of this structure is reported by [9].

Riachão (7° 42'S/46° 38'W), with a diameter of 4.5 km, is located only 43 km from Serra da Cangalha. This complex crater has a 1 km wide central uplift and could have been formed simultaneously with Serra da Cangalha. Impact features found by [7] and [8] include polymict impact breccia and PDFs in ejecta clasts and rocks from the central uplift.

Vargeão (26°50'S/52°07'W) is the fourth proven Brazilian crater, formed in Cretaceous basalt flows of the Paraná Basin. This multi-ring complex astrobleme has a diameter of 12 km, with a 3 km wide central uplift where Jurassic-Triassic sandstones (Botucatu/Pirambóia Fm.) are exposed. Deformation features recognized by [10] and [11] include monomict and polymict breccias of basalt/diabase and sandstones, shatter cones in basalt and sandstone, and PDFs in quartz and feldspar in sandstone.

Other Candidate Impact Sites in Brazil: There are currently seven suspected impact sites in Brazil. Their origin has been associated with impact events mostly by their geomorphologic appearance, as little or no specific work has been conducted in order to determine impact metamorphic features and diagnostic shock deformation. In addition, two of these structures are only partially exposed.

São Miguel do Tapuio (5°37'S/41°23'W) is a 20 km wide multi-ring structure, with a 4 km wide central uplift formed in Devonian sedimentary rocks of the Parnaíba Basin. Little information is available on shock metamorphic features at this site, although there mention of features similar to shatter cones and PDFs in deformed sandstones has been made [12].

Colônia (23°52'S/46°42'W) is a 3.6 km wide circular depression formed in Precambrian metamorphic rocks of the Açungui group, with an outer rim standing 125 m above the inner portion, suggesting a simple (bowl-shaped) crater. Its interior is filled with young (Quaternary) sediments, preventing access to possible impact breccia fill and shock metamorphic features therein. From geophysical data, the crater floor depth has been estimated at 440 m below the present surface [13]. [14] estimated the age of the impact at around 36 Ma.

Cerro Jarau (30°12'S/56°32'W), with a diameter of 10 km [15], and Piratininga (22°28'S/49°09'W), 12 km wide, constitute circular structures similar to Vargeão. They are formed in basalts and sandstones of the Paraná Basin. Both these structures show morphologic

features of complex craters, with central uplift and annular graben. The apparent similar age of these three structures and their alignment along N30E led [16] to point out that they could represent the scars of a multiple impact event. It is estimated that this occurred around 117 Ma ago. Unconfirmed reports by [16] of PDFs in quartz grains in sandstones from the central uplift of Piratininga, together with shock-metamorphosed rocks in Cerro Jarau, suggest their possible origin by impact.

Santa Marta (10°11'S/45°15'W) was first nominated as a possible impact crater by [12]. Based on remote sensing observations (MSS Landsat), [17] indicated this site as a possible new impact structure and named it Gilbués. It is a 10 km wide complex structure, with a 2.5 km central uplift, formed in Carboniferous sedimentary rocks of the Parnaíba Basin of northeast Brazil. The age of this structure is estimated as Late Paleozoic to Mesozoic.

Inajah (8°40'S/50°58'W) is a 6 km wide circular depression, suggestive of a simple (bowl-shaped) crater, with an elevated outer rim and inner annular depression, with a topographic gradient of 50 m. It was formed in metamorphic rocks and seems to have been subject of significant erosion and is now filled with young sediments (similar to Colonia). No field data are available yet for this site [18].

The small (1 km in diameter) subtle circular feature known as Curuçá (5°11'S/71°38'W) is thought to be the result of a Tunguska-like event that occurred in the Amazon region, not far from the Brazil-Peru border. The event took place on 13 August 1930 and was recorded by a seismic station in Peru, together with some oral reports from local people about three fireballs. An expedition to the presumed site of the phenomenon was carried out in 1997 and found an elliptical depression with elevated rim a few meters above the ground. No conclusive evidence for an impact event was found at the site, although traces of Ir and Os reportedly were recently identified [19].

Concluding Remarks: The information presented here shows how vast the territory of Brazil is for impact-related research. The limited (considering the size of the Brazilian territory) list of only four proven impact craters and seven suspected sites is very likely to be enlarged in upcoming years, if specific surveys are conducted, not only for exposed craters, but also with geophysical methods for buried ones. It should be pointed out that buried craters in sedimentary basins represent a favorable site for hydrocarbon concentrations, a fact that may induce specific surveys in the near future.

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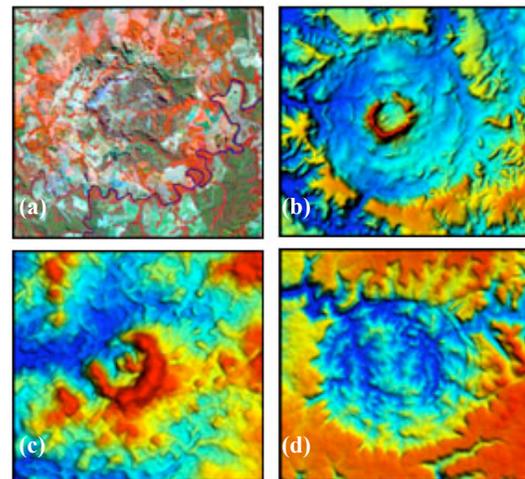


Figure 1. (a) Landsat/ETM+ image showing the central uplift of Araguainha. Digital elevation models of some Brazilian impact craters, based on the Shuttle Radar Topography Mission: (b) Serra da Cangalha; (c) Riachão; (d) Vargeão.