STRUCTURAL ANALYSIS OF A SW-NE TRANSECT THROUGH THE ARAGUAINHA IMPACT STRUCTURE, BRAZIL – A FIRST REPORT. R. B. Bernardes[1], W. U. Reimold[1], R. L. Gibson[2], P. Pavanetto[3], N. Hauser[1], C. S. M. Souza[1], D. A. G. Gutierrez[1], [1]Institute of Geosciences, University of Brasilia, Brasilia, Brazil (renato.bernardes@unb.br), [2]School of Geosciences, University of the Witwatersrand, PO WITS, Johannesburg 2050, South Africa, [3]Institute of Geography, Federal University of Uberlândia, Monte Carmelo Campus, Monte Carmelo, Brazil.

Introduction: The Araguainha impact structure (AIS) in central Brazil is a rare example of a large (D ~ 40 km) complex impact structure in a mixed crystalline-sedimentary target. The structure has experienced only minor erosion (250–350 m, [1–3]). Recent roadworks along the MT-100 state road crossing the AIS have provided extensive new exposures for detailed structural analysis, especially along a SW-NE transect. In this way, the structure offers an opportunity to document the structural effects associated with complex crater formation at various scales, which assists in further developing our understanding of the kinematics of crater formation and impact-induced strain patterns, as well as refining crater diameter estimates and investigating (a)symmetry.

Geologic setting: The ca. 251–259 Ma [4] AIS was formed close to the northeastern edge of the cratonic Paraná Basin (inset of Fig. 1). The impact excavated rocks of the Rio Ivaí (Ordovician-Silurian), Paraná (Furnas and Ponta Grossa formations, Devonian), and Gondwana I (Aquidauana Fm. and Passa Dois Grp., Carboniferous-Permian) supersequences [5] of the basin, which totals a ~1580–1760 m [2] sedimentary pile in the AIS region. Phyllite and metasedimentary strata that have been assigned to the Neoproterozoic Cuiabá Grp. and the Cambrian Serra Negra alkali granite form the crystalline basement core of the central uplift [6].

Previous structural geology work on the AIS: The studies that aimed to elucidate first-order structural aspects also provide a general morphology of the structure [1–3] that allows its division into different zones: a 10–12 km diameter central uplift enveloped by a 7.5–10 km-wide zone that comprises the annular basin, two concentric rings defined by antiformal hinges at 10–12 km and 14–18 km from the center, and the crater rim region. More recent work [7] interpreted the large-scale folding observed in the Furnas Fm. strata within the inner collar (e.g., at Serra da Arnica) of the central uplift as constrictional in origin.

Methodology for the present study: Virtually all accessible outcrops along the MT-100 and to a radial distance (R) of up to ~33 km to both SW and NE, from the center of the structure, were registered, described, and measured in detail (Fig. 1).

First observations and discussion: Many small, excavated roadcuts are already covered but have been examined. In addition, a suite of large road cuts of tens to hundreds of meters in extent allows continuous observation of different rocks and structures in the differentiated impact structure zones (i.e., in the outer rim, annular basin, and central uplift).

The new lithological observations help update the existing maps of the AIS concerning the extension of and contacts between the rock units, including new localities with shatter cones within the central uplift.

Outside of the impact structure, i.e., beyond the proposed outer rim (R = ~26–20 km), on both SW and NE sides of the profile, the dips of Aquidauana Fm. strata are horizontal to subhorizontal. Brittle-to-ductile deformed strata of the Passa Dois Grp. have been observed in an additional outcrop way beyond the assumed SW outer edge of the impact structure (at R = ~56 km, not plotted in Fig. 1). These deformed rocks still need to be assessed concerning the origin of the deformation (i.e., by regional tectonics or impact).

Imbricated duplexes occur in a Passa Dois Grp. outcrop that today is regarded as belonging to the SW rim area of the impact structure (R = ~19 km, region A in Fig. 1, and Fig. 2). At a similar distance in the NE rim area (R = ~19.5 km, region B in Fig. 1), a similar structural configuration was also identified (i.e., asymmetrically folded strata with a general centripetal vergence) in the Passa Dois Grp. However, the formation of these structures seems to be inconsistent with an outer rim environment [8], where extensional structures would be expected [9].

The folding pattern of the strata in the concentric ring regions is highly variable. However, from preliminary analysis, it appears that in the SW region (R = ~18–11 km, region C in Fig. 1), the dips tend to be horizontal to subhorizontal, with a predominant NE dip direction. On the other hand, in the NE region (R = ~18–10 km, region D in Fig. 1), the dips of the strata appear to show bimodality, with dips mainly to the S and SW, from low to high angles, making this NE region folding pattern more complex than its SW counterpart.

Asymmetric, folded (at the meter scale) strata of the Ponta Grossa Fm. showing a general centripetal vergence are recognized at the outer side of the collar

of the central uplift, on the SW section of the transect (R = ~5–6 km, region E in Fig. 1). However, at a similar distance (R = ~6 km), the folds verge centrifugally in the NE collar (region F in Fig. 1, and Fig. 3). This geometry may be evidence for a heterogeneous, asymmetric central uplift, possibly resulting from oblique impact and/or asymmetric modification (i.e., collapse) of the collar of the central uplift.

Road cuts in the central uplift indicate dynamic interaction among the crystalline basement, Furnas Fm., and impact breccia: e.g., ~1.9 km N-NE of the center, a decametric slab of deformed basement or Furnas Fm. appears thrust centripetally over green polymict impact breccia, generating a shear foliation in the latter (region G in Fig. 1).

Conclusions: We conclude that: i) to date, no evidence has been found to justify the extension of the size of the AIS, which was one of the points of discussion during the October 2019 *Large Meteorite Impacts VI* field trip; ii) the Passa Dois Grp. deformed slivers appear to be a recurring feature along the outer rim area. However, the conditions and mechanisms that controlled their formation must be further analyzed and modeled; iii) the inner and outer concentric rings [2, 3] may not be ubiquitous, nor may they have a consistent, simple asymmetric, long-wavelength (up to 4 km-wide) geometry (as shown in Fig. 2 of [3]); iv) our preliminary observations do not disallow the discussion of asymmetry within the AIS and, thus, the possibility of an oblique impact. However, more data need to be obtained and additional analysis conducted to assess this hypothesis further.

This is a work in progress. These data are still being evaluated, and a more detailed presentation will be possible at the conference.

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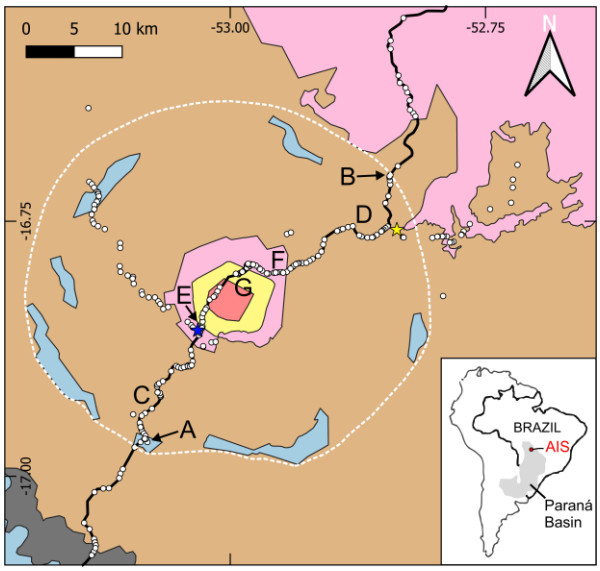

Fig. 1 – Simplified geologic map of the AIS (after [10]) with the stations (white dots) investigated along the MT-100 road (black line) and elsewhere during the fieldwork of 2021. Legend: red – Basement; yellow – Furnas Fm.; pink – Ponta Grossa Fm.; brown – Aquidauana Fm.; light blue – Passa Dois Grp.; gray – Serra Geral Fm. (basaltic flows, sills, and dikes); blue star – Araguainha town; yellow star – Ponte Branca town; white dashed line – AIS apparent diameter. For detail on locations A–G, refer to the text.

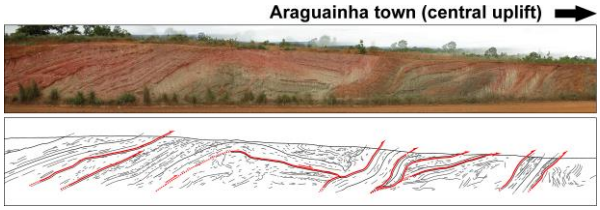

Fig. 2 – Outcrop within a Passa Dois Grp. sliver on the inside of the SW outer rim region of the structure (region A in Fig. 1) (after [8]). This deformation style resembles a contractional duplex geometry, which is atypical for a crater rim environment.

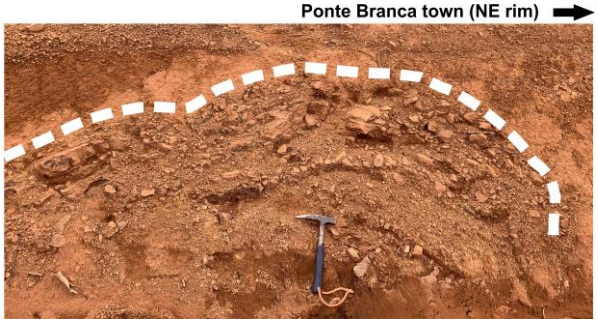

Fig. 3 – Asymmetric, metric-folded ferruginous strata of the Ponta Grossa Fm. in the NE outer collar of the central uplift (region F in Fig. 1).