NUMERICAL MODELLING OF THE VARGEÃO IMPACT STRUCTURE, SOUTHERN BRAZIL M. A. R. Vasconcelos[1], K. Wünnemann[2], W. U. Reimold[2,3], D. Elbeshausen[2] and A. P. Crósta[1], Institute of Geosciences, University of Campinas, Campinas, SP, Brazil (vasconcelos@ige.unicamp.br,), [2]Museum für Naturkunde, Leibniz Institute for Evolution and Biodiversity Research, Berlin, Germany; [3]Humboldt-Universität zu Berlin, Berlin, Germany.

Introduction: Vargeão impact crater, located in Southern Brazil, is a circular feature of ~12 km diameter, formed in lava flows of the Lower Cretaceous Serra Geral Formation and in sandstones of the Paraná Basin. Although the presence of a central peak is not clear, an uplift is suggested by the occurrence of deformed sandstone strata of the Botucatu/ Pirambóia formations, which stratigrafically are beneath the basalts. The atypical occurrence of these rocks lead us towards numerical modeling in order to understand the genetic process of the formation of this structure. Furthermore, the comprehension of the arrangement of these formations allows to understand more about impact crater formation in lava flows on Mars. Of particular interest is the unusual target configuration of strong consolidated rocks (basalts) over softer and porous strata (sandstone) underneath that may cause deviations from our classical understanding of crater formation mechanics. Here, we review the results of numerical simulations of Vargão, carried out with the iSALE code.

Geological setting In portions of the rim of Vargeão that are somewhat protected from erosion, such as in the Southern section, four different lava flows can be recognized. The topographic gradient between the external plateau outside the rim and the lower part in the area of the town of Vargeão is approximately 180 m, indicating an average thickness of approximately 45 m for individual lava flows. In addition, in several places around the rim, in the inner part of the structure, large blocks of undeformed to tilted rocks from the volcanic formations can be seen. Tilting, suggests that they collapsed from the rim into the interior of the structure [1]. Sandstones crop out at the the central part of the structure as blocks of up to several hundred meters size; they are arranged in a circular ring around the center of the structure. These sandstones have been attributed by [2] and [3] to the Botucatú or Pirambóia formations, which in this portion of the Paraná Basin lie normally at a depth of approximately 1000 m. The rocks found in the interiort of Vargeão comprise slightly to moderately fractured basalt and rhyodacite in a collar-like ridge near the crater rim.

Modeling constraints: As the lithological packages at Vargeão are comprised essentialy of basalts and sandstones, we used only two different layers in the model (granitic basement was not considered, implying that it was not affected by the impact). The first layer comprises a basaltic package about 1.3 km thick (considering ~300 m of erosion) , and the second is a sedimentary layer below the basalts. We assumed the same rheological properties for the whole basaltic package and used the ANEOS [4] to calculate the thermodynamic behavior of the material upon impact. The second layer was matched with the equation-of-state for quartzite [5] coupled with the porosity compaction model [6]. The relative ease of the rocks to succumb to plastic deformation was modeled by the strength model [7]. We assumed also a temporary weakening of the target rocks during crater formation and applied the acoustic fluidization model [8,9,10].

Results: The model that best matches the final morphology of the crater, shows a transient crater that reaches ~2.5 km depth and is ~8 km diameter. The projectile in this model is ~900 m in diameter and an impact velocity of 12 km/s was applied. The final crater size is ~14 km diameter, and considering ~0.3 km of erosion should result in a crater of ~12 km, as observed by remote sensing. The model shows that the sandstone layer below the basalt should have flowed towards the center where it came to the surface. It also shows that there is no uplift of the basalt layer, which is a reasonable explanation for the non-occurrence of a proper central uplift. According to the model rocks of the innermost area have undergone ~1000 m uplift. Models are still running and additional conclusions will be presented at the conference.

References:

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