Geophysical Research Abstracts
Vol. 12, EGU2010-7466, 2010
EGU General Assembly 2010

How does pre-impact rheology affect the geomorphology of impact craters? Resistivity tomographic constraints on melt emplacement

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Impact craters are ubiquitous and prominent features shaping the landform of all solid planetary bodies in the Solar System. The surface morphology of impact craters is influenced by the emplacement of impact melt, which forms the uppermost layers of impact craters and directly affects the post-impact modification of crater morphology. It is therefore important to study the emplacement geometry of impact melt during the cratering process and its relationship with pre-impact rheology. Although numerical modelling and other geological constraints have enhanced our understanding of the impact cratering process, there has hitherto been little empirical evidence linking pre-impact rheology to melt emplacement.

We here present new results from the novel application of electrical resistivity tomography that show how lithological boundaries in central parts of impact craters influence the flow of impact melt (Tong et al., Geology, 2010). In particular, we demonstrate how this new application of the tomographic method has allowed us to determine the centripetal flow of impact melt near the centre of the largest known impact structure in South America, the Araguainha impact structure in Brazil. Our geophysical models from five profiles in different parts of the central region of the impact structure show consistent dipping structures towards the centre. These models are interpreted together with complementary direct geological observations and previously published mineralogical data.

On the basis of the joint analysis of our resistivity and gravity data, we propose a generic model that links pre-impact rheology to the geomorphology of impact craters found on the surface of solid planetary bodies. We will show empirical evidence that well-defined subsurface lithological boundaries are found in the central part of the impact structure from pre-impact rocks. Using our empirical model, we will explain how these boundaries can affect the local flow of impact melt and breccia deposition. In addition, we will also discuss the implications of this model in the context of how planetary geomorphology can act as a marker for pre-impact rheology of solid planetary bodies.

In summary, by highlighting the key results of a novel remote-sensing field study of the shallow subsurface, we aim to show how the relationship between terrestrial landforms and cratering processes can be applied to the study of the geomorphology of other planetary bodies.

Reference: Tong, C. H., C. Lana, Y. R. Marangoni and V. R. Elis, Geology, 38, 91, 2010