GEOPHYSICAL INVESTIGATIONS OF IMPACT-INDUCED POROSITY

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Background: Recent gravity observations of the Moon and Mars indicate that the crusts of both planets are highly porous. This is presumably a result of a long history of asteroid bombardment, but the details of how a bolide impactor introduces porosity into a target are still being worked out. In order to understand the mechanisms of impact-induced fracturing and dilatancy, we investigate a pair of terrestrial craters as analogues for the millions of comparable craters on other Solar System bodies.

Meteor Crater, AZ: Meteor Crater is one of the most pristine craters of its size in the world, and it gives us an important opportunity to characterize fracture-induced porosity in simple craters throughout the Solar System. We performed gravity survey inside Meteor Crater [1] to supplement data previously reported by Regan and Hinze [2] in order to generate a newly compiled a residual gravity anomaly map (Figure 1). We generated a precise terrain correction with LiDAR data [3].

The interior of the crater displays a bulls-eye pattern, with a relatively low gravity anomaly at the center surrounded by an anulus of higher gravity, which is encircled by another low-gravity annulus. The interpretation of this anomaly is complicated by the fact that measurements on the floor of the crater are affected by the terrain effect of the nearby crater walls. Nevertheless, the clear patterns present in the residual gravity anomaly demonstrate that a single density is insufficient to explain the observed gravity data [4].

Kentland Crater, Indiana: In an upcoming survey, we will measure gravity anomalies in a grid over Kentland Crater near Kentland, IN. At each station, we will record gravity for 60 seconds and measure the position with RTK GPS. These measurements will be complemented with passive seismic methods to constrain the thickness of the local glacial till layer.

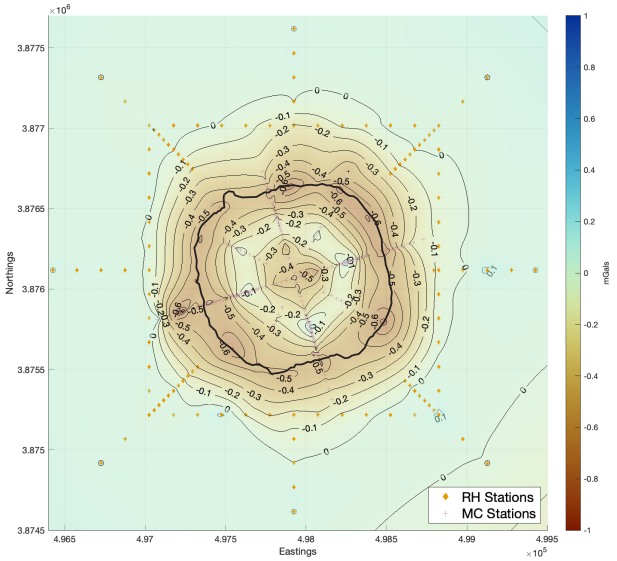

Figure 1. Residual Gravity Anomaly of Meteor Crater, AZ. Stations used to generate the Regional Correction are circled. Crater rim outlined in black. Reference density of 2300 kg/m^3.

Other geophysical techniques: While gravimetry provides a direct measurement of porosity, other techniques may be complementary. In particular, we are planning to incorporate magnetotelluric observations at the Kentland site in order to detect resistivity changes in the upper crust under this crater.

References: [1] Mitchell C. D. and James P. B. (2020) *LPS L*, Abstract #2868. [2] Regan R. D. and Hinze W. J. (1975) *JGR, 80*, 776–778. [3] Palucis M. and McEnulty T. (2010) *NCALM Mapping Project Report: Meteor Crater, Az*. [4] Mitchell C. D., James P. B., & Kring D. A. (2021). LPI Contributions, 2621, 2034.