MAGNETIC AND GRAVITY MODELING OF THE PROPOSED TSENKHER IMPACT STRUCTURE, GOBI ALTAI, MONGOLIA.

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Introduction: The Tsenkher structure was recently proposed to have formed by a cosmic impact [1]. Satellite imagery reveals a circular structure with about 3.6–3.7 km rim-to-rim diameter for the apparent rim (Fig.1). In satellite radar images a putative ejecta field is visible that stretches to a distance of about one crater radius outside the apparent rim. For the eastern and southern parts of the circumference of the crater the putative ejecta terminates with a distinct ridge, which has been suggested to be analogous to martian rampart craters (i.e., craters with fluidized ejecta with a terminal ridge) [1].

We visited the Tsenkher structure during September-October 2007 for a general geological mapping, sampling of potential impactites and target rocks, and a geophysical survey. The aim of the geophysical survey is to provide information that can assist in the discrimination of different alternatives for the formation of the structure. Forward computer modeling of magnetic and gravity data is useful when analysing the subsurface morphology of a crater structure [2], and if it is “rootless”, which would favor the impact hypothesis, or “rooted” (i.e., connected with deep-seated igneous rocks), which would indicate an intrusive or volcanic origin.

The geological setting of the crater is within a 10-20 km wide basin flanked by low mountain ranges. Some mainly granitic intrusions exist in the region [1], but the basin area does not show any obvious volcanic features or lithologies. Sedimentary rocks of probable Paleozoic and Mesozoic ages are exposed in windows through Quaternary alluvial deposits in the basin. Stream channels breach the crater rim and the interior of the crater structure is covered by alluvium. The probable Paleozoic bedrock in the vicinity of the crater is generally made up of sandstones and siltstones with occasional chert horizons. They have been tectonised and are now commonly steep standing with a general NW strike and NE dip. These sedimentary rocks represent components of the breccias that form the putative ejecta. Other lithic components in the breccia resemble volcanites [3]. Suevite-like breccias with glassy fragments were found in the breccia bed (putative ejecta) on the south-western side of the crater structure. The age of the structure is subject to a separate study.

Methods: We used a Geometrics G-856 Proton Precession Magnetometer configured as a gradiometer with two vertically separated sensors to measure two profiles crossing the crater structure. Both profiles are approximately 12 km long to extend at least one crater diameter beyond the rim. The spacing between measurement points is 50 m. Profile-1 was measured with beginning at the southern end and Profile-2 with beginning at the eastern end. The bottom sensor was 1.2 m above ground and the sensor separation was 1.22 m.

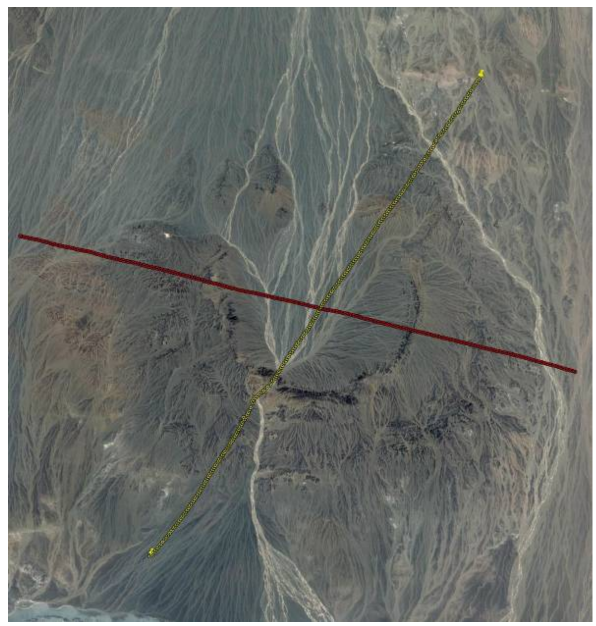

Fig. 1. Satellite image over the Tsenkher structure with the measured profiles indicated. Each profile is approximately 12 km long. They cross at the center of the studied crater structure which apparent rim is visible as a ring of hills with sharp, dark shadows at a radial distance of about 1.8 km. Profile-1 is yellow (SW-NE), and Profile-2 is red (WNW-ESE). North is up.

Topography variation along the profiles was measured with the built in altimeter/barometer of the Garmin GPS60CS Global Positioning System unit used to provide coordinates for the measurement points. The altimeter was corrected daily to a base point. The air pressure remained fairly stable (+/- 2 mb) throughout the survey. Reference data for the separation of the magnetic diurnal variation was measured with a stationary PMP-5 Proton Magnetometer with the sensor 0.5 m above ground. Susceptibility values were measured with a Satisgeo Kappameter KT-6 for the main rock types in the area: “polymict breccia” (generally occuring in the elevated rim and putative ejecta layer), “sandstones”, “limestone and calc-cemented sandstone/siltstone”, and “suevite-like rock”. Most lithologies show the same low susceptibilities, but with one order of magnitude higher values for some samples of the suevite-like rock. The low susceptibility contrast between the lithologies hampers detailed modeling, but makes it easier to distinguish any influence from possible volcanic or intrusive bodies that can be expected to have much higher magnetic properties than the sediments encountered during our study.

The gravity data was measured with a Lacoste&Romberg Model G gravimeter following standard procedures for terrain correction and reference measurements [4]. Topography data was provided by the Garmin altimeter and SRTM (Shuttle Radar Topography Mission) DEMs. The gravity profile follows Profile-1, with beginning in the SW with 23 measurement points with approximately 500 m spacing (tighter over visible structures such as the rim). Repeated readings of some stations revealed an instrument problem that forced us to remove some spurious readings from the original dataset, mainly some of the first readings in the SW part. Only the readings showing consistent values were used for the modeling. The modeling software is GM-SYS version 5.01from Geosoft.

Modeling results: Geophysical modeling is an iterative process that takes a long time until a reliable result is achieved. At the time of submission of this abstract the models are very preliminary. What we can see is that the magnetic field lacks major anomalies over the crater structure. Both profiles show a slight rise over the crater. This is not strong enough to indicate any intrusive body (e.g., volcanic pipe) below the structure. Likewise, the gravity data does not indicate any body of relatively higher mass below the structure. A best fit is received for a bowl-shaped crater partially filled with a material of slightly higher susceptibility, but similar density, as the bedrock and the polymict breccias of the rim and surroundings. In analogy with known impact craters of this size this material could be suevite. This can also be inferred from the suevite-like rock found outside the southern rim. In contrast, profile-2 shows the rim area to be slightly lower magnetic. This may be due to the fractured bedrock nearer to the surface at these locations, fractured rock generally having lower magnetic properties than the intact bedrock [cf. 2].

At this stage the modeling supports a “rootless” structure and, thus, the impact crater hypothesis.

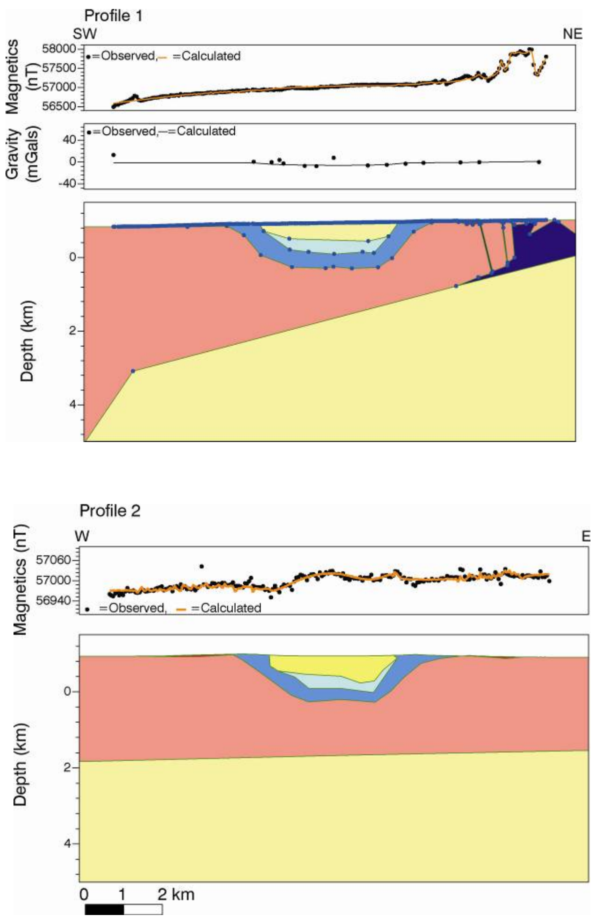

Fig. 2. Geophysical profiles and models along the profiles indicated in Fig.1. Figure legend for introduced bodies:

- *very thin red unit at the rim of the crater structure (fairly visible due to the scale of the figure), putative ejecta, 5×10^{-3} SI and 2670 kg/m^3.*
- *yellow unit inside the crater structure, fluvial material, 1×10^{-4} SI and 2400 kg/m^3.*
- *light blue unit inside the crater structure, breccia with putative suevite, 1×10^{-2} SI and 2650 kg/m^3.*
- *dark blue unit below the crater structure, fractured host rocks, 1×10^{-4} SI and 2660 kg/m^3.*
- *pink extensive unit, unaffected host rock, 1×10^{-3} SI and 2670 kg/m^3.*
- *yellow extensive unit, an introduced body to compensate for the regional trend, 1×10^{-1} SI and 2670 kg/m^3.*
- *very dark blue unit at the NE end of Profile-1, possible volcanites (occur frequently in the alluvium of this area), 4×10^{-2} SI and 2750 kg/m^3.*

References: [1] Komatsu G. et al. (2006) Geomorphology, 74, 164–180. [2] Ormö et al. (1996) Tectonophysics, 262, 191-300. [3] Komatsu G. et al. (2008) *LPS XXXIX*, Abstract. [4] Telford W.M. et al. (1991) Applied geophysics (second edition), Cambridge University Press, Cambridge, 770 pp.