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Geophysical survey of the Målingen structure, a proposed marine-target impact crater.

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1. Introduction

Målingen is a 700m wide circular structure situated about 15km to SW of Lockne impact crater (central Sweden). Its circular shape and exposed sedimentary breccias resembling the resurge deposits at Lockne of the same age, strongly points towards a formation in relation to Lockne. The existence of shocked quartz grains in the lower parts of the about 149m long MAL-1 drill core retrieved from the center of the structure provides evidence for an impact origin [1]. The core showed a breccia- and sediment –filled depression of about 115 m depth. The basement in the Lockne/ Målingen area is mainly constituted by Precambrian granitoids (Revsund Granite and a slightly foliated rock that we refer to as “older granite”), but sporadic occurrences of mafic rocks are also of interest for this study. The basement is covered by about 30m of Cambrian dark shale and about 50m of Ordovician limestones. The aim of this study is to develop a mutually constrained gravity and magnetic model to determine the dimensions and shape of the Målingen structure and evaluate its impact origin.

2. Methodology

A Geophysical survey was performed during the summer field campaigns of 2010, 2011 and 2012. It has provided a complete data collection for the ongoing geophysical modeling. The gravity survey of the structure comprises 325 measurements with a spacing of about 25m along the survey lines over the structure as well as some sporadic points in the vicinity. It is connected to an existing gravity grid over Lockne crater [2]. Data correction was carried out following established protocol neglecting terrain correction, which is a reasonable assumption due to the low topography of the area. Wet bulk densities of 84 samples from the MAL-1 core were measured as constrains for the gravity model.

The magnetic survey covers the whole structure and extends about one diameter outside the apparent rim where the terrain allows it. It includes 702 measurements in a grid with a line spacing of about 100-150m and about 50m separation between measurement points. The correction for diurnal variation was done with readings obtained from the Lycksele and Abisko observatories. In order to estimate susceptibility values for main lithologies around Målingen structure, a total of 2131 susceptibility measurements were taken with a field kappabridge KT-6 instrument from several outcrops located in different areas. Additionally, the magnetic survey was complemented with 726 susceptibility measurements along the MAL-1 core.

The geophysical modeling is performed using the software ModelVision Pro by XXXX. At this stage the modeled results are preliminary and not presented in this paper.

3. Results and discussions

The residual Bouguer anomaly map (Fig 1) shows a concentric gravity low over and slightly beyond the apparent rim of the Målingen structure. Some high anomalies in the topographic rim are visible. To the NW of the structure there is a strong gravity low that we interpret to be a consequence of larger, pre-existing variations in the basement. However, a general gravity low is obtained over the interior of the crater which is consistent with the gravity signatures of known, bowl-shaped, simple impact craters [3]. There is also a weaker gravity low following the outside of the rim (most obvious on the SW side), which may indicate a zone of increased damage of the target rocks.

The magnetic anomaly map (Fig 2) shows distinct positive anomalies distributed along the topographic rim, as well as negative anomalies both over its centre and in a concentric pattern around the structure. This supports the geological interpretation of a circular structure as well as the hint of an exterior damaged zone as observed in the gravity anomalies. However, there is strong influence on the magnetic anomaly pattern from the small but high magnetic mafic rocks occurring in the area. For instance, the anomaly associated with the SE part of the apparent topographic rim of the structure coincides with an outcrop of a relatively high magnetic mafic rock. We are compensating for this by making separate models of the known mafic rocks of the area, as well as regional variations of the field. The result is a residual map that forms the base for the modelling of the crater structure.

The current gravity and magnetic modeling process is being developing with six different units, where the "older granite" is used as background. The physical properties of each unit listed in Table 1 are calculated as an average of the values obtained by the measurements in the field and in the core.

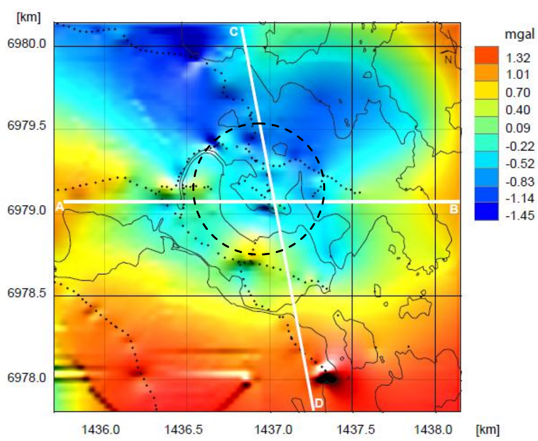

Figure 1: Residual Bouguer anomaly map.

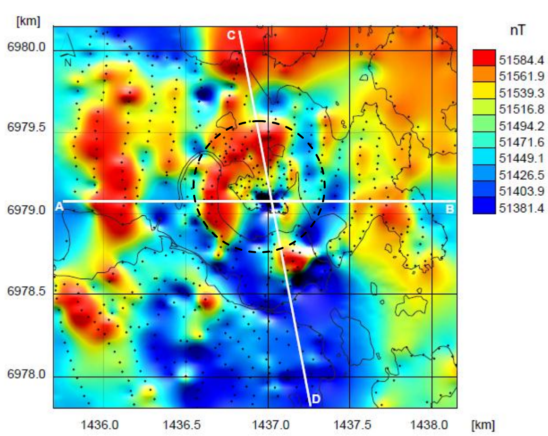

Figure 2: Magnetic anomaly map.

Table1: Physical properties of the units used in the model.

Unit	**ρ(g/cc)**	**χ($\cdot 10^{-3}$ SI)**
Dark shale	2.739	0.191
Revsund Granite	2.666	0.050
Older granite	2.672	0.126
Granitic breccia (general)	2.633	0.037
Fractured granite (general)	2.675	0.253
Mafic rock	2.91	32,68

4. Conclusions

The geophysical data displayed in the residual Bouguer anomaly map and the magnetic anomaly map are consistent with an impact origin of the Målingen structure, i.e. a mainly negative gravity signature over the interior of the structure, and the circular distribution of the magnetic anomalies along the topographic rim.

The ongoing magnetic and gravity modeling give us more information about the dimensions of the Målingen structure and the distribution of some mafic rocks in the area. This will allow us to analyze in more detail the impact origin for the Målingen structure and give support to the geological interpretation and future numerical simulation.

Acknowledgements

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References

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