**GEOPHYSICAL MODELING OF IMPACT STRUCTURES.** H. Henkel, Department of Geodesy and Photogrammetry, Royal Institute of Technology, SE-100 44 Stockholm, Sweden (herbert@geomatics.kth.se)

Geophysical modeling utilizes geophysical measurements, especially of the gravity and magnetic field, to simulate geological structures. The derived model represents a possible 3-d configuration of lithologies with defined physical properties. Such models are not unique and various independent constraints are needed, like surface geology, reflection and refraction seismics, and most importantly *petrophysical* data. As geophysical anomalies relate to contrasts in petrophysical properties, lack of such data makes it impossible to correctly scale the models. Compared to the costs involved in geophysical and geological mapping, still a surprisingly small effort is put into collection of such fundamental constraints.

For gravity modeling, *density* data are essential, either from measurements on samples, from litho-stratigraphic information, seismic p-wave velocities, or by calculations based on mineral or chemical composition. For magnetic modeling, data of magnetic *susceptibility* and *remanent magnetization* are required. Such data are more site specific and complementary measurements, in-situ or on samples, are often needed.

The gravity modeling of the Manicouagan structure [1], for the first time clearly brought out the significance of the central uplift in large impact structures. Since then, a lot more gravity data on impact structures have been published, summarized in [2,3]. A few more models exist which fully account for the potential to learn more about the 3-d-structure of impacts, due lack of sufficient density data. Examples are the Mien [3], the Lappajärvi [4] and the Vredefort [5] structure. Many eroded simple craters have negative gravity anomalies, except when a relatively denser fill occurs. Negative gravity anomalies are also typical for complex craters until their central uplift involves denser basement and the erosion has reached deeper into the structure, resulting in a centered positive gravity anomaly. The subsided annular ring in complex craters may have variable gravity expressions, depending on the density contrast of the fill material. In the Vredefort structure, typically positive gravity anomalies are related to the ring synform [5].

In large craters, post-impact thermal overprints may include large volumes of basement rocks within the central uplift, resulting in increased magnetic complexity. In the study of the Vredefort structure [6], it was found that shock created magnetite carries the imprint of such a thermal event, resulting in a characteristic annular pattern of reversed magnetic anomalies. Very few magnetic modeling approaches have so far been attempted restricted mainly by the lack of sufficient magnetization data, but also by a lack of general concepts on impact related magnetization, discussed in [2,3,6,7,10]. Impact related rock magnetic properties have been published for Lappajärvi [8], Clearwater [9], and a few other structures. The integration of such data with magnetic measurements by modeling has been tried for the Mien [3], Tvären [11], and Morokweng [12] structures.

Combined modeling would take full advantage of the mutually constraining potential of various sets of geophysical data. For very large craters, the entire crustal section must be modeled, which needs information about deeper unexposed crustal lithologies. Refraction seismics provide information of p-wave velocities, which can be converted to densities, and reflection seismics constrain the extent of cover rocks. Thermal models of the impacts constrain the depth to which magnetization had occurred. Any combination of such data will reduce the inherent ambiguity considerably. An example of an elaborate combined model of gravity, magnetic, petrophysic and seismic data exists for the Vredefort crater [5]. Magnetic, gravity and petrophysical data have been integrated in the analysis of the Morokweng [12] and the Hummeln [13] structures.

**Conclusions.** There is an increasing wealth of geophysical data useful for geophysical modeling of impact structures. To succeed, constraining data need to be introduced, with highest priority given to petrophysics. Knowledge is needed about the impact cratering process as derived from mechanical modeling, and what kinds of structures and overprints of physical properties that might occur. The magnetic modeling of the central rise of the Vredefort structure [6] showed that post-impact thermal overprint, not shock magnetization (or demagnetization) causes its characteristic magnetic pattern. The correlation between negative gravity anomaly and crater size is valid for a restricted subset of impact structures with a limited range of erosion levels. Geophysical modeling will increase our knowledge about what impact craters of different erosion levels may look like at depth, and this knowlege constrains also the mechanical properties of geological materials under impact conditions.

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