Integrated Interpretation of Potential Field and Reflection Seismic Data from the Orsa Area of the Siljan Impact Crater, Central Sweden

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Abstract

The Siljan Ring impact structure is the largest known impact structure in Europe and of Late Devonian age. It contains a central uplift that is about 20-30 km in diameter and is surrounded by a ring-shaped depression. In this study we will focus on the northwestern part of the impact with the main objective to better map the subsurface Precambrian crystalline rocks and Paleozoic successions along the Orsa seismic profile. The latter are partly well preserved, albeit poorly exposed.

The 12 km long NE-SW oriented Orsa seismic profile was acquired in 2011. The seismic data have been reprocessed in this study. In addition to the main previous processing steps, cross-dip corrections were also applied. Cross-dip angles ranging between +85° to -85° were tested. The best result was obtained when utilizing a constant velocity of 6000 m/s and a cross-dip angle of -15° to the west.

A total of 69 gravity point measurements were made along the Orsa seismic profile in 2013 using a Lacoste-Romberg G-786 gravimeter. These data were corrected and merged with other gravity data points provided by the Geological Survey of Sweden (SGU). The gravity data were reduced to a 170 m datum following the standard data reduction procedure to obtain the subsurface mass effect only. Additionally, we used aeromagnetic data provided by SGU to generate a total-field aeromagnetic map and residual map for the study area. Furthermore, we applied a 2D forward modeling approach to the potential field data along the seismic profile using commercial software. We assumed a zero contrast in density and susceptibility for the background in the forward modeling.

Reprocessing of the seismic data resulted in improved stacked and migrated sections and better identification of the depth to the crystalline basement than the previous processing. Forward modeling of the potential field data showed that the Paleozoic rocks have low-density contrasts (-0.15 g/cm^3) to the background while the basement rocks have a higher density contrast (0.026 g/cm^3) to it. The potential field modeling along the seismic profile shows a thickness of the sedimentary successions that differs from the interpretation of the reflection seismic data. The seismic data indicate a thickness of about 200-500 m, while the gravity modeling suggests a thickness ranging between 100 to 700 m.