Geophysical Imaging of the Roter Kamm Crater in the Sperrgebiet National Park, Namibia, using TEM and AMT

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SUMMARY

The Roter Kamm Crater is a 3.7-million-year-old meteoritic impact crater in the Sperrgebiet National Park in southern Namibia. The Sperrgebiet National Park, officially Tsau ǁKhaeb (Sperrgebiet) National Park, is a national park and former diamond mining area in southern Namibia. Since 1908 the public has had no access to the area and even when it was proclaimed a national park in 2008 most of the restrictions remained, leaving the environment mainly undisturbed and unexplored.

The geophysical exploration of the Roter Kamm Crater can lead to valuable information about its internal structure, as only a very limited number of geophysical studies had been carried out at this site. Prior gravimetry and (airborne-)magnetic measurements indicate a bowl-shaped anomaly underneath the crater, which was expected for an impact crater with a diameter of 2.5 km. However, the estimated depths of the basement vary between 100 m and 400 m.
To be able to image the basement in the crater in this wide range of possible target depths, two electromagnetic methods were selected: the Transient Electromagnetic (TEM) and the Audiomagnetotelluric (AMT) method. TEM is an active time domain method and has already proven its capability imaging sedimentary deposits. It is suited for investigations in shallow (up to 200 m) subsurface. AMT, on the contrary, is a passive, frequency domain method that can reach penetration depths up to a few kilometres. Both methods are sensitive to good conductive structures.

Within two weeks of fieldwork at the Roter Kamm Crater 153 TEM and 15 AMT soundings were carried out along three profiles. We used the TEM-FAST 48 (AEMR) for all TEM measurements with a coincidence-loop setup for quadratic transmitter/receiver loops with an edge length of 50 m (58 soundings) and 100 m (11 soundings). Additionally, TEM measurements were carried out in a fixed-loop-setup using 4 large transmitter loops (edge length: 200 m). At each transmitter loop 11 soundings were conducted in profile and perpendicular to profile direction with a maximum offset of 400 m. We used the ZT-30 Transmitter (Zonge) with the SMARTem24 (EMIT) + 3D LF induction coil triple (Geonics Limited)/KMS 820 (KMS Technologies) + 2 TEM-3 induction coils (Zonge). For the AMT measurements the SPAM MK IV system from the Geophysical Instrument Pool Potsdam (GIPP) was used to measure the horizontal electric and magnetic fields.
The 1D inversion models of the TEM data showed a good conducing anomaly in a depth of 100 m, but was not capable of imaging its lower boundary. The 2D inversion model of the AMT data, on the other hand, has a good resolution in higher depths and could resolve the basement at a maximum depth of over 300 m in the centre of the Roter Kamm Crater. Overall, AMT and TEM are in very good agreement with each other and show the expected bowl-shaped anomaly in the impact. These results proved, that both methods complement each other well and it was necessary to use AMT for resolving the basement within the crater and to use TEM for resolving structures within the upper 100 m of sediments.

Keywords: Transient Electromagnetics, Audiomagnetotelluric, Sedimentary Deposit, Impact Crater