Petrophysical Characterization of the Core Samples of the Bosumtwi Meteorite Impact Crater (Ghana).
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Introduction: One basic objective of this investigation was to compare the available log and field data with laboratory measurements on core samples from boreholes B07 and B08, centered in the Bosumtwi Meteorite Impact Crater (Ghana).

Additionally, study into the question of if and how differences in petrophysical behavior relate to specific characteristics of the impact event need to be pursued. We expected the impact and its influence on the internal structure and mineralogy of the rocks could be characterized by petrophysics. In particular anisotropy, i. e. directional variations of physical properties, was expected to act as measure of these effects.

Lateral and vertical variations should correlate with the degree of deformation associated with the intrinsic impact and subsequent rock discharge.

Sample Description: A total of 19 samples were selected during field investigations by Geoforschungszentrum (GFZ) Potsdam (Germany). Cores were cut in half with six samples taken from borehole LB07 and 9 samples from borehole LB08.

Boreholes LB07 and LB08 are located within the impact crater, which presently is water filled and called Lake Bosumtwi. A compressional wave velocity model [1] crossing the impact structure from northwest to southeast was developed (Figure 1). In the seismic model the consolidated rocks below the sediments have velocities higher than 3000 m/s. Within this model LB07 is situated at the edge of the central uplifted zone about 1 km northwest of the crater's center and LB08 is located within the basement rebound zone.

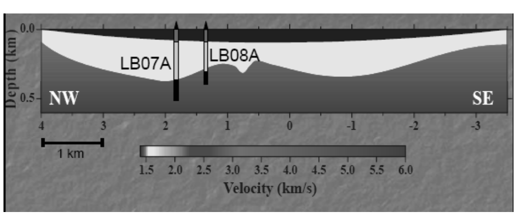

Figure 1: Compressional wave velocity model (after [1]) with borehole locations

Borehole LB07 sampled rocks with a wide spectrum of lithologies including Suevite, Greywacke, Breccia, Sandstone, Graphitic Shale. Identified in LB08 samples are mainly Greywacke complemented by Black Shale and Graphitic Shale. Greywacke and Graphitic Shale were the only consistent lithologies from both boreholes.

Sample Preparation and Applied Methods: Prior to the laboratory measurements cylindrical samples with a diameter and height of 20 mm were drilled in the axial and radial direction (Fig. 2). Additionally, approximately 30 mm thick, semi-circular slices were cut from the cores. Due to low rigidity only 12 out of the 19 samples could be prepared in this fashion.

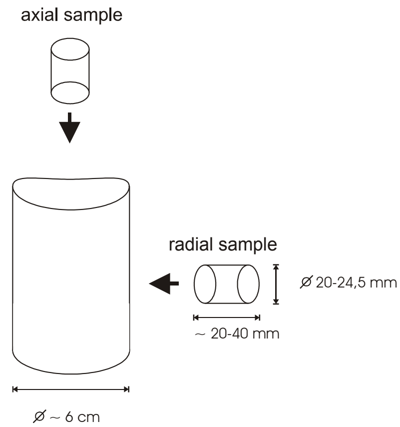

Figure 2: Sample Preparation

The remaining samples included the full suite of lithologies (Table 1).

ID	Sample	Depth (m)	Lithology
B7A	7-13-11-2 73TB	371,42	Suevite
B7C	7-16-14-3 123TB	380,76	Greywacke
B7D	7-19-17-5 28BB	392,03	Polymict Breccia
B7E	7-19-17-5 19BB	391,99	Sandstone
B7F	7-20-18-2 40TR	390,53	Graphitic Shale
B8A	8-14-14-1 17TB	277,4	Granitoid Rock
B8C	8-33-33-2 80TB	334,74	Black Shale
B8E	8-38-38-1 35TB	350,36	Graywacke
B8F	8-49-49-1 49TB	382,89	Graphitic Shale
B8G	8-52-53-1 6TB	392,86	Greywacke
B8H	8-54-55-5 25BB	400,2	Graywacke
B8I	8-55-76 100TB	402,2	Graywacke

Table 1: Sample list including the macroscopic description of their lithology.

Laboratory investigations included measurements of porosity, grain density, compressional wave velocity (V_p), shear-wave velocity, electrical resistivity and magnetic susceptibility. Air-dried samples were measured first followed by brine-saturated samples at two different salinities (0.058 and 0.2 % NaCl).

Compressional wave velocity was measured to evaluate the influence of density, pore volume and grain contact. Magnetic susceptibility is mainly influenced by the mineral composition whereas the electrical resistivity of saturated rocks yields information about the pore volume and connectivity of the pores.

For these cylindrical samples, all parameters were measured along at least two perpendicular axis to derive the anisotropy coefficients as a measure of the internal rock structures, e.g. bedding planes, foliation, joints and flow directions (e. g. [2], [3], [4]).

Results: Promising results have been obtained from measuring the previously mentioned parameters on these semi-circular slices.. The two core samples can clearly be distinguished by correlating the electrical resistivity and ultrasonic compressional wave velocity (V_p) of the core samples with the porosity (Fig 3. and Fig. 4). Although comparable porosities were measured from both boreholes, samples from LB08 are characterised by lower resistivities and lower Vp values than samples from LB07.

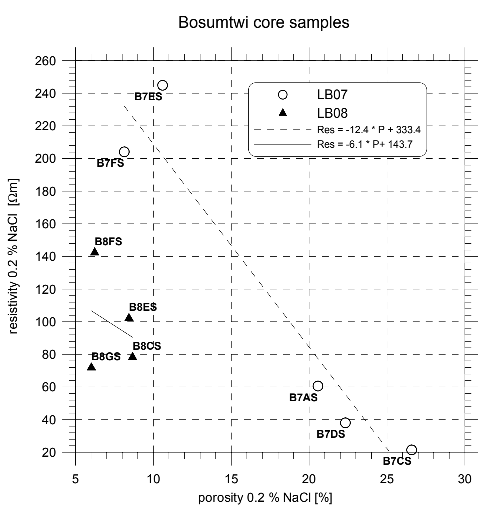

Figure 3: Electrical resistivity of the saturated core samples (0.2 wt.-% NaCl) vs. porosity including linear fits.

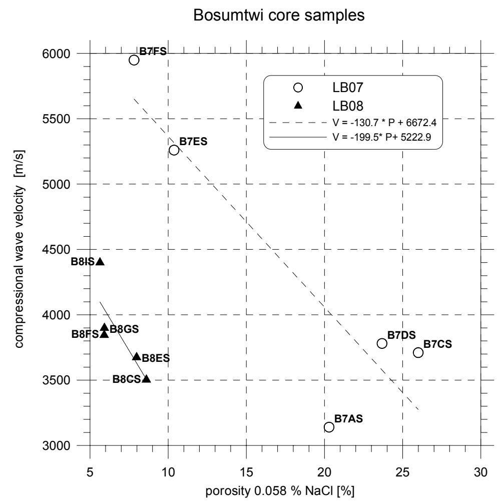

Figure 4: Compressional wave velocity of the saturated core samples (0.058 wt.-% NaCl) vs. porosity including linear fits.

Conclusions: Since resistivity is dependent on porosity and the connectivity of the pores and Vp is more influenced by grain boundary contacts than by porosity one can conclude that the grain contacts are weaker and pores/cracks are better connected in LB08.

An explanation of this behaviour is the presence of microcracks and /or microfissures within these samples. Microscopic studies of the internal structure of these core samples are in progress. In case the presence of microcracks can be confirmed, they will likely correlate with the final uplift associated with the basement rebound zone.

Considering the observations presented here and the fact that borehole LB08 is near the center and LB07 at the edge of this structure, methods described here might be used to estimate the degree of microfracturing due to pressure discharge. Of course, the number of samples investigated so far is rather small but additional samples outside the impact crater and laboratory simulations might help to improve confidence in this observation.

References:

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