Results of recent petrographic and geochemical studies of the ICDP drill cores from the interior of the Bosumtwi impact structure, Ghana. W.U. Reimold[1], C. Koeberl[2], L. Coney[3], L. Ferriere[2], and R.L. Gibson[3]. [1]Museum for Natural History, Humboldt-University, Invalidenstrasse 43, 10115 Berlin, Germany (uwe.reimold@museum.hu-berlin.de); [2]Geological Sciences, Univ. Vienna, Althanstr. 14, A-1099 Vienna, Austria; [3]Impact Cratering Res. Group, Geosciences, Univ. Witwatersrand, Johannesburg 2050, RSA.

Summary: Petrographic-geochemical studies of impactites and country rocks of drill cores LB-07A and LB-08A into the interior of the Bosumtwi impact structure are evaluated with regard to implications for the understanding of the formation and modification of this structure, and processes related to distribution of impact materials in the cratering process.

Introduction: The Bosumtwi impact crater, Ghana, is associated with one of only four known tektite strewn fields. Bosumtwi is arguably the best-preserved, complex, young impact structure in the terrestrial impact record. The structure was excavated in 2.1-2.2 Ga metasediments and -volcanics of the Birimian Supergroup. Seismic reflection and refraction data defined a 1.9-km-wide central uplift. Within the framework of an international, multidisciplinary ICDP drilling project, aimed at investigating the 1 Ma paleoenvironmental record of the lake sediments, as well as the impactite crater fill, 16 drill cores were obtained in 2004 at 6 locations on Lake Bosumtwi. Two hard rock cores (LB-07A and LB-08A) were drilled into the deepest section of the annular moat (to 540 m depth) and into the flank of the central uplift (450 m), respectively.

Results: Drill core LB-07A [1,2] comprises in its upper part lithic (in the uppermost part) and suevitic (with appreciable amounts of impact melt fragments) impact breccia. The lithic clast content is dominated by greywacke, besides various metapelites, quartzitic rocks, and a small carbonate target component. Shock deformation in the form of quartz grains with planar microdeformations is abundant. There are two possibilities for the formation of the breccia deposits: the lithic and suevitic breccias could represent a single breccia deposit, or the two types of breccia were deposited independently and in an interfingering way (in this scenario, the lithic breccia could represent debris flows). However, even after further sampling, this question could not yet be resolved due to the locally disaggregated nature of the core. However, as this coexistence of breccia types was also observed by Morrow [3], it appears less of a sampling bias than a true aspect of the deposit. This impact breccia section is underlain by monomict clastic breccia formed from metagreywacke > metapelite, which, in turn is followed with increasing depth by coherent, although locally strongly fractured and disaggregated, basement of shale/schist >

metagreywacke. Several narrow suevite intercalations in the monomict breccia and basement sequences are interpreted as injections of impact breccia into the crater floor. They are also melt-fragment poor and generally similar to the suevites of the uppermost impact breccia interval [4]. Suevites in general only have a few vol% of melt fragments, with locally higher modal abundances resulting from unrepresentative sampling of larger (half to 1-cm-sized) clasts. Melt fragments are also generally of microscopic size, in distinct contrast to the up to 40 cm large fragments observed in suevite outside of the crater structure. First chemical results indicate a number of suevite samples that are strongly enriched in the siderophile elements and in Mg. The fallout suevites have comparable major element abundances, except for MgO contents, which are lower in the fallout suevites than in the fallback suevites. The average composition of the Ivory Coast tektites (ICT) is similar to that of the LB-07A suevites, except that wider ranges in MgO and CaO contents are observed for the LB-07A suevites.

Core LB-08A [4, 5] comprises a thinner (than LB-7A) interval of suevitic breccia in the uppermost part, underlain by a thick sequence of greywacke-dominated metasediment with a few suevite and granitoid intercalations. The metasediment package likely represents bedrock of the central uplift. Initial shock investigations indicate a slight decrease in shock pressure of the target rocks with depth. Samples from the central uplift display a variety of alteration effects including alteration of plagioclase to sericite, biotite to chlorite, fractures that are filled with iron oxides, secondary pyrite, and secondary calcite veinlets and local pods, and the matrices of polymict impact breccias are composed to a large degree of very fine-grained phyllosilicate. Calcite veinlets and pods in suevite samples from the fallback deposit have been interpreted as the result of hydrothermal circulation in the rock after the impact event [2,5,6]. No systematic change regarding the intensity of secondary alteration throughout the core has been identified. Chemical compositions of LB-08A lithologies is affected by secondary alteration. However, as for the LB-07A suevites, the overall compositions of LB-08A suevite samples are similar to those of fallout suevites, and also compare well with the ICT average.

Both the 7A and 8A suevites differ from suevites outside of the northern crater rim in the lack of significant amounts of ballen quartz and in showing different abundances and size ranges of melt fragments. No meteoritic component could be confirmed due to high indigenous PGE abundances. PGE content and Os isotopic compositions of selected suevite and country rock samples failed to reveal any meteoritic signature [7,8].

In addition to these two drill core intersections, a 30 cm thick layer of fallback breccia was recovered at the base of sediment core LB-5A. It contains, in the top 10 cm, accretionary lapilli-like particles, glass spherules and fragments, and shocked quartz. Glass particles (mostly of splash form, with <1 mm max. size) make up the bulk of the grains (~70 to 78 % by number) in the >125 μm size fraction from the top of the layer [9]. One third of all quartz grains in the uppermost part of the layer have PDFs; almost half of these grains have 3 or more sets of PDFs. K-feldspar also occurs and some grains show shock deformation. The abundance of shocked quartz grains and the average shock level, as indicated by the number of sets of PDFs for both quartz and K-feldspar, seemingly decreases with depth into the layer. This material is strongly enriched in melted and shocked material, in comparison to the lithic and suevitic breccias of the uppermost parts of cores LB-07A and LB-08A.

Conclusions: The nature of the target to the Bosumtwi impact structure, previously only estimated based on limited field evidence from the environs of the crater, was confirmed, with metagreywacke and metapelites being the most prominent target rock types, followed by minor quartzite, carbonate and granite components. Contrary to the 2% granitoid estimated by Reimold et al. [10] and seemingly consistent with granite clasts in suevite from outside of the crater, only traces of this component were observed in suevite from within the structure. However, granophyric-textured felsic granitoid does occur in the drill cores from there as well, in very minor amount. The reason for this apparent, but small discrepancy could lie in the geological [11] and geophysical [e.g., 12] observations that within the crater area, larger granitoid bodies seem to occur preferentially to the north/northeast of Bosumtwi, whereas the Bansu intrusion is located further away from the crater structure, to the southwest. Similar local enrichment of target rock material in ejecta sectors has been remarked upon for Popigai and ought to be tested around the Ries Crater. Why the interval of impact breccia in the uppermost part of LB-07A is thicker than the top section of core LB-08A is a matter of debate. One can think of slumping resulting in accumulation of a thicker impact breccia section

along the flank of the central uplift, or incorporation of clastic debris from debris flows into the crater moat.

Prior to drilling, numerical modeling [13] estimated melt and tektite production using different impact angles and projectile velocities. The most suitable conditions for the generation of tektites are high-velocity impacts (>20 km/s) with an impact angle between 30 and 50° from the horizontal. Not all the melt is deposited inside the crater. In the case of a vertical impact at 15 km/s, 68% of the melt is deposited inside the crater. Results of the numerical modeling agreed well with the then-available geophysical data, crater size, and the distribution of tektites and microtektites of the ICT strewn field. The now observed situation for breccias within and around the crater is very different from these model results. The predicted amount of melt is much higher than the meager amounts observed. Also, the lack of coherent bodies of impact melt rock requires other explanations for the observed geophysical anomalies. Clearly, much more melt has been incorporated in the suevite ejected outside of the structure, in comparison with the low amounts measured in the within-crater suevite occurrences.

Analysis of the clast contents in melt fragments from suevite within and outside of the crater structure is currently in progress. These results will have strong bearing on the understanding of mixing of the melt phase in the ejecta plume. Similar to the melt distribution, material shocked to different degrees is not distributed homogeneously within and outside of the crater structure. Diaplectic and isotropized, as well as melted, clasts are by an order of magnitude more abundant in the ejected suevite, both with regard to mineral and lithic clasts. This, together with a distinct change in the melt fragment size statistics for samples from these two suevite occurrences, must provide further constraint on the modeling of ejecta plume processes (mixing and distribution of clasts).

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