THE BOSUMTWI IMPACT STRUCTURE, GHANA: COMPARISON BETWEEN WITHIN-CRATER AND OUT-OF-CRATER SUEVITES, WITH PARTICULAR FOCUS ON MELT PARTICLE COMPOSITIONS. L. Coney[1], W.U. Reimold[2], R.L. Gibson[1], C. Koeberl[3], P. Czaja[2] and K. Born[2]. [1]Impact Cratering Research Group, School of Geosciences, University of the Witwatersrand, Private Bag 3, P.O. WITS, Johannesburg, 2050, South Africa (louise.coney@gmail.com), [2]Museum for Natural History (Mineralogy), Humboldt-University, Invalidenstrasse 43, D-10115 Berlin, Germany, [3]Department of Lithospheric Research, University of Vienna, Althanstrasse 14, A-1090 Vienna, Austria.

Introduction: The Bosumtwi impact structure, Ghana [1-2] is one of only a few craters at which suevites - both within and outside the crater - as well as distal ejecta (the Ivory Coast tektite strewn field [1, 3-4]) occur. The crater was excavated 1.07 Ma ago [3] in lower greenschist-facies rocks of the 2.1-2.2 Ga Birimian Supergroup [5-7]. It is filled almost entirely by Lake Bosumtwi, which is ~8 km in diameter and up to 80 m deep [2]. The impact crater was the subject of an interdisciplinary drilling program undertaken by the International Continental Scientific Drilling Progam (ICDP) in late 2004, which led to the recovery of two hard-rock cores from the central part of the crater structure, through the impact breccia fill and underlying crater basement [2]. The results of detailed lithostratigraphic, petrographic, geochemical and geophysical analysis of both cores were reported in a special issue of Meteoritics and Planetary Science (vol. 42, nos. 4/5) in 2007.

This study: The present study is focused on rocks from core LB-07A, which intersected the moat surrounding the central uplift [8-9]. In early 2007, a field visit to Ghana to collect samples of the suevites from the exterior to the north and south of the crater was undertaken. The suevite samples were examined using optical and scanning electron microscopy (SEM). Additionally, XRF was used to determine bulk major element compositions and ICP-MS was used to determine bulk trace element compositions of selected samples. Electron microprobe analysis was performed on melt particles to determine their major element compositions.

Petrographic differences: The suevites from within the crater are substantially different from the out-of-crater suevites. The within-crater suevites are derived from dominantly metasedimentary precursors: particularly metagreywacke and shale, with a previously unidentified small carbonate component [8]. Only a minor (<0.1 vol%) granitoid component is present. This is supported by studies on the suevites from core LB-08A [10], where no granitoid component was found, but carbonate is present as a discrete clastic phase in the suevites. In contrast, the out-of-crater suevites contain large volumes (up to 18 vol%) of granite clasts, and crystalline clasts as large as 25 cm have been recorded in the suevites from north of the crater (<1 cm diameter in the within-crater suevites). Hardly any clastic calcite was identified in the out-of-crater suevites.

Even more striking is the contrast in melt particle volumes. In the within-crater suevites, a maximum of 18 vol% melt was recorded in one sample only, whereas the average abundance is only 5.4 vol%. In contrast, in the out-of-crater suevites, a maximum of 60 vol% melt is noted in selected samples, and an average of 37 vol% (for comparison, 20 vol% was measured by [11]) was calculated for suevites from north of the crater and 18 vol% for suevites from outside the crater to the south. Melt particles are larger (up to 40 cm size) than those within the crater (< 1 cm). Additionally, relatively more quartz grains contain shock metamorphic features, and contain more PDF sets per host grain (6.7 rel% of all quartz grains contain ≥2 PDF sets), on average, than those from the within-crater suevites (0.9 rel% of all quartz grains contain ≥2 PDF sets). In out-of-crater suevites, diaplectic quartz glass is common, and ballen quartz is also noted; the former is rare in within-crater suevite and the latter was not noted in either core from within the crater at all [8, 10]. Thus, substantial differences exist between the out-of-crater and within-crater suevites.

In contrast to work performed by [12] on the Ries suevites, SEM has revealed that the groundmass of the suevites is not formed by a melt phase; instead it consists of the common clastic phases (metagreywacke, shale, quartz, feldspars) in addition to a limited (<10 vol%) component of partially altered melt particles. These locally seem to form aggregates of apparently welded-together particles.

Geochemical differences: The within-crater and out-of-crater suevites have major and trace element differences directly related to the differences in the lithological compositions of their precursors. The within-crater suevites are relatively depleted in Al_2O_3 and enriched in CaO in comparison to the out-of-crater suevites, as a direct consequence of the differing granitoid and calcite proportions.

Trace element abundances are very similar in the impactites from both cores – enrichment in Cr, Ni and As are noted owing to significant amounts of sulphides in the samples from the crater interior and in the out-of-crater suevites. Other trace element abundances are also directly comparable. In terms of rare earth ele-

ments (REE), some differences between the suevites from south and north of the crater are apparent. The suevites from south of the crater display small Ce anomalies (not observed in the suevites from within the crater and from north of the crater). This is explained by the larger proportion of organic (C-rich) material that is present within a distinct graphitic shale component, and which could not be dissolved during the ICP-MS sample preparation. This material will preferentially absorb all REE except Ce, thus leaving a higher proportion of Ce in the residue that is analyzed [13]. However, the normalized overall abundances [14] of the REEs for the suevites from south of the crater are very similar to those from the north and within the crater.

Melt particle compositions. A number of melt particles were analysed from different stratigraphic positions in core LB-07A and from the out-of-crater suevites. The melt particles of the within-crater suevites are variably roundish or angular in shape and belong to a strongly different size class of the out-of-crater suevites. The melt particles in the out-of-crater suevites contain flow structures, and are aerodynamically shaped, indicating that they were airborne. Their size and shape differences imply that they were emplaced from different parts of the ejecta cloud. The melt particles from the out-of-crater suevites are more altered than those from within the crater. Element mapping of melt particles from outside the crater revealed that the individual melt particles themselves are somewhat heterogeneous with regards to their major element composition. The melt particles either have compositions of individual minerals or are composed of mixtures of minerals. The within-crater melt particles are comparatively more enriched in FeO and MgO than those from north of the crater, but similar to the melt particles from the suevites from south of the crater. This could represent comparatively more shale being incorporated in the high Fe, Mg melt particles (supported petrographically by relative enrichment in shale clasts in these two sets of impact-produced breccias). The melt particles from both north and south of the crater are more enriched in Na_2O in comparison to those from within the crater – consistent with their higher granitoid clast content. Additionally, the Al_2O_3 contents are slightly higher in the out-of-crater melt particles. Most intriguing, however, is the observation that the CaO content in the melt particles of the out-of-crater suevites is higher than in the particles from within the crater: this may be a consequence of the previously unidentified carbonate component being preferentially incorporated into the melt phases of the out-of-crater suevites.

Interpretation: A model for the formation of the crater needs to take into account the differences in lithic clast and melt particle sizes and compositions; and the different relative shock states of the clasts in the suevites. The traditional model of Stöffler (1977) [15] distinguished between "ground-surged suevite" deposited as the lower part of the suevite inside the crater and "fallback/fallout suevite" shed by the rising and collapsing ejecta plume. More work is currently underway refining a model that will satisfy all the parameters of the Bosumtwi suevites, and results will be presented at the conference.

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