PETROGRAPHIC CHARACTERISTICS OF QUARTZ IN SUEVITIC IMPACT BRECCIA, DRILLCORE LB07A, BOSUMTWI CRATER, GHANA. J. R. Morrow[1], [1]School of Chemistry, Earth Sciences, & Physics, Campus Box 100, University of Northern Colorado, Greeley, CO 80639 (jared.morrow@unco.edu).

Introduction: Individual grains and small lithic clasts in thin-sectioned suevitic breccia samples from the International Continental Scientific Drilling Program (ICDP) Bosumtwi impact crater drillcore LB07A were examined petrographically to evaluate the occurrence, abundance, and characteristics of unshocked and shock-metamorphosed quartz. The analyzed samples were taken across a ~42-m-long (138-ft-long) interval of the core, from a drilling depth of ~341 m (1120 ft) to ~383 m (1256 ft) (Table 1). To facilitate analyses, samples were chosen from an interval in the core containing a relatively high amount of fine-grained particles and small lithic clasts within polymict, matrix-rich suevitic breccia and micro-breccia (Fig. 1). A petrographic microscope with point-counting stage was used to obtain a semi-quantitative measure of (a) the overall quartz abundance and distribution, and (b) the relative proportion of unshocked to shocked-quartz grains within the interval (Table 1). Individual grains and lithic clasts recorded during the analysis ranged from 60 µm (coarse silt) to ~4 mm (granule) in diameter.

Occurrence of quartz: Within the suevitic breccia, quartz occurs most commonly as isolated, relatively small (silt- to medium sand-sized) monocrystalline grains; as isolated polycrystalline quartz and composite quartz-feldspar grains; and as inclusions within larger lithic clasts. Potential target-rock sources for the quartz, quartz-feldspar, and heterolithic quartz-bearing lithic grains within the impact breccia include (a) 2.2-2.1 Ga Birimian Supergroup mica schist, quartz-feldspathic banded schist, sedimentary and meta-sedimentary rock fragments (greywacke, meta-greywacke, quartzite), phyllite, and meta-volcanic grains; (b) 2.13-2.12 Ga Tarkwaian Supergroup clastic sedimentary and meta-sedimentary rock fragments, quartz-feldspar porphyry, and meta-volcanic grains; and (c) granitic fragments derived from post-Tarkwaian intrusions [1]. Quartz comprises an estimated 10-20 vol. % of the examined thin sections, with the remaining constituents dominated by feldspar grains, lithic clasts, very fine- to fine-grained clastic matrix, cryptocrystalline to very fine-grained altered and devitrified impact melt/glass, clay minerals, and other accessory minerals (mica, mafic, and opaque grains) within the matrix [cf. 1, text figs. 24-25].

Shock-metamorphic features: Common microscopic shock-metamorphic effects identified in the quartz grains include (a) irregular sub-planar and curvilinear fractures, associated with comminuted grains and possible grain-margin percussion features; (b) grain mosaicism and irregular petrographic extinction patterns; (c) "toasted" regions within grains, comprising dark, cloudy, nonpleochoic patches containing abundant micrometer- to submicrometer-scale fluid inclusions [2], often associated with denser concentrations of planar fractures (PFs) and planar deformation features (PDFs) (Fig. 2); (d) PFs, typically 5-10 µm wide and spaced >15 µm apart; (e) PDFs, discussed below; (f) diaplectic glass, evidenced by optically isotropic grains and patches within grains; and (g) micrometer- to submicrometer-scale, optically high-relief crystals, present within highly shocked grains, which may potentially be the high-pressure polymorphs stishovite or coesite.

PDFs are present in up to ~31 vol. % of grains within the shocked-quartz populations (Table 1). One to three PDF sets per grain are most common, although grains with more numerous sets are present. Qualitative evaluation of the PDF crystallographic orientations indicate that planes parallel to $c(0001)$, $\omega\{10\bar{1}3\}$, $\pi\{10\bar{1}2\}$, $r,z\{10\bar{1}1\}$, and $m\{10\bar{1}0\}/a\{11\bar{2}0\}/k\{51\bar{6}0\}$ are most common, although this must be verified by additional U-stage or TEM indexing. Typically, the PDFs are 1-2 µm wide and spaced <5 µm apart, and are moderately to highly decorated with fluid inclusions (Fig. 3). Another distinguishing feature of many grains is the often heterogeneous and localized distribution of such shock features as "toasting", PFs, and PDFs within individual monocrystalline grains; unlike planar microstructures in grains documented commonly from other impacts [3], many of the Bosumtwi PDFs do not extend to the grain margins. Rarely, short, poorly developed PDF sets appear to radiate from prominent PFs, producing features similar to documented "feather textures" (Fig. 4) [4-5].

Discussion: The wide variability and localized development of shock-metamorphic features documented in the Bosumtwi quartz grains evidence that they were sourced from multiple levels in the excavated transient crater, and experienced variable and heterogeneous shock levels, even at a microscopic scale. Preliminary results presented in this study (Table 1) further suggest that the relative abundance of shock-metamorphosed quartz increases upwards within suevitic breccia of the LB07A core. This observation, which is also consistent with previous theoretical and empirical models of crater and suevite formation [6-7], may have bearing on future studies describing crater evolution and suevite emplacement during the Bosumtwi event.

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References: [1] Koeberl C. and Reimold W. U. (2005) *Jb. Geol. B.-A.*, *145*, 31–70. [2] Whitehead J. et al. (2002) *Geology*, *30(5)*, 431–434. [3] French B. M. (1998) *LPI Contribution 954*, 120 p. [4] Stöffler D. and Langenhorst F. (1994) *Meteoritics*, *29*, 155–181. [5] French B. M. et al. (2004) *GSA Bull.*, *116(1-2)*, 200–218. [6] Grieve R. A. F. (1987) *Ann. Rev. Earth Planet. Sci.*, *15*, 245–270. [7] Melosh H. J. (1989) *Impact cratering, a geological process*, *Oxford Univ. Press*, 245 p.

Core:	LB07A			
Sample ID:	BOS-3	BOS-4	BOS-5	BOS-8
Depth, m (ft):	341 (1120)	355 (1164)	362 (1186)	383 (1256)
n =	200	180	154	123
Vol. % relative to total quartz population within sample				
Unshocked	31	78	78	91
Shocked	69	22	22	9
Vol. % relative to shocked-quartz population only within sample				
PDF sets:				
>3	4	3	3	0
2-3	21	23	24	9
1	31	18	29	9
PFs	56	54	56	75
"Toasted"	72	77	82	36
Mosaicism	66	72	68	27

Table 1. Petrographic point-count summary of quartz grains in thin sections of suevitic breccia, ICDP drillcore LB07A, Bosumtwi crater; '*n*' denotes number of grains examined.

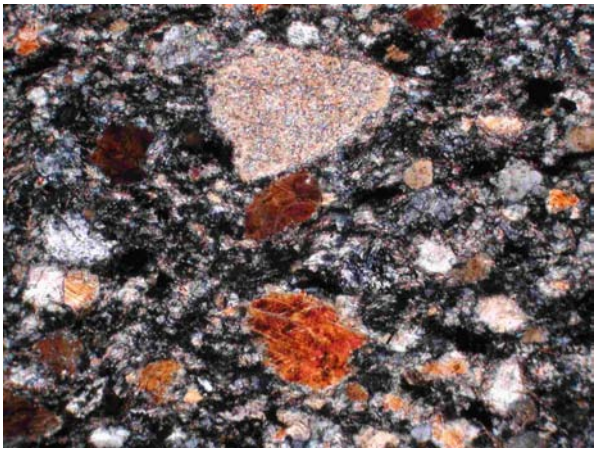

Figure 1. Photomicrograph of fine-grained suevitic breccia with polymict quartz, feldspar, and lithic grains in dark, very fine-grained, clastic- and melt-rich matrix. View is 1.7 mm across; crossed polars; sample BOS-3.

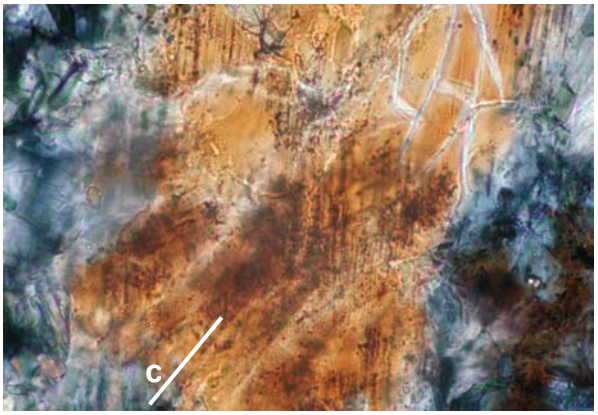

Figure 2. Photomicrograph of shocked-quartz grain showing typical patchy distribution of shock effects comprising highly decorated PDFs associated with dark "toasted" regions. View is 0.25 mm across; crossed polars; c(0001) orientation is indicated; sample BOS-3.

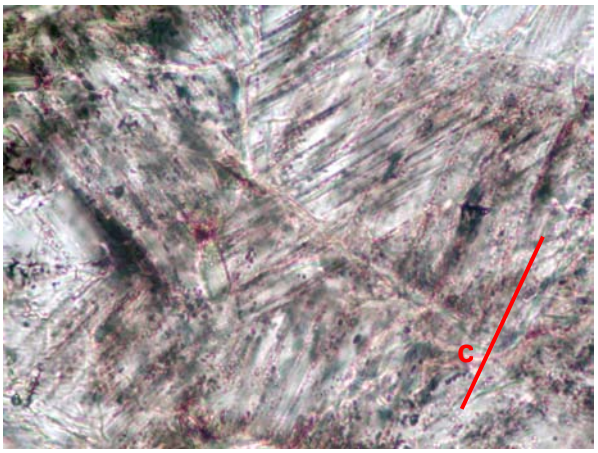

Figure 3. Photomicrograph showing multiple sets of variably decorated PDFs within polycrystalline quartz clast. View is 0.14 mm across; c(0001) orientation is indicated; plane light; sample BOS-3.

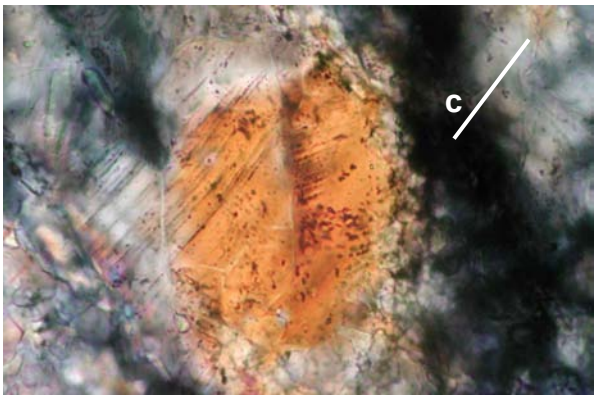

Figure 4. Photomicrograph of quartz grain with poorly developed, decorated PDF set in right half of grain, radiating from prominent vertical PF in grain center. A second PDF set is also visible. View is 0.3 mm across; c(0001) orientation is indicated; crossed polars; sample BOS-3.