DISTRIBUTION OF SHOCKED QUARTZ GRAINS ALONG THE LB-08A CORE THROUGH THE CENTRAL UPLIFT OF THE BOSUMTWI IMPACT STRUCTURE, GHANA - IMPLICATIONS FOR NUMERICAL MODELS. L. Ferrière[1], C. Koeberl[1], and W. U. Reimold[2], [1]Department of Geological Sciences, University of Vienna, Althanstrasse 14, A-1090 Vienna, Austria. (ludovic.ferriere@univie.ac.at; christian.koeberl@univie.ac.at). [2]Mineralogy, Museum of Natural History, Humboldt-University, Invalidenstrasse 43, D-10115 Berlin, Germany (uwe.reimold@museum.hu-berlin.de).

Introduction: The 1.07 Myr old, 10.5-km-diameter Bosumtwi structure in Ghana (West Africa) is a very well preserved, complex impact crater with a pronounced rim and a small central uplift [1]. During the 2004 International Continental Scientific Drilling Program (ICDP) at the Bosumtwi impact structure [2], the LB-08A borehole was drilled into the crater fill and the underlying basement at the outer flank of the central uplift [3]. This drill core, recovered between 235.6 and 451.33 m below lake level, consists of (from the top to the bottom) approximately 25 m of polymict, clast-supported lithic breccia intercalated with suevite, which overlies fractured/brecciated basement composed of metasediment (mainly meta-greywacke).

Here, we present the results of a detailed petrographic study of eighteen different meta-greywacke samples from the basement. This work was carried out using an optical microscope and a 4-axis universal stage. It comprised three distinct steps:

1) Detailed modal analysis by point-counting; ~960 grains counted, on average, per thin section.

2) Systematic analysis of the properties of ~500 quartz grains per thin section; e.g., unshocked, shocked (with planar fractures [PFs] and planar deformation features [PDFs]), number of sets, decoration, toasted appearance, etc. (~9000 quartz grains investigated in total).

3) Analysis of the crystallographic orientation of the PDF sets in all PDF-bearing quartz grains per section.

Results and Discussion: The investigated samples show some variation with regard to abundance of major minerals (mostly quartz and feldspar), groundmass (mineral grains with apparent diameter <50 µm) mode, and phyllosilicate minerals; however, these variations are not major and were only determined for reference and in order to investigate possible limitations on interpretation of the final data.

Shocked quartz grains observed in meta-graywacke samples display PFs (usually 1 set) and PDFs (1, 2, or rarely 3 to 4 sets; Fig. 1), some of which are decorated with abundant tiny fluid inclusions. Some of the shocked grains have a "toasted appearance" (see [3] for more information). The relative abundances of quartz grains with decorated planar features and of those with "toasted appearance" indicate a moderate, but significant correlation (R=0.64). Furthermore, this study demonstrates that no correlation exists between the presence of decorated PDFs and fluid content (i.e., LoI) in the samples, which is contrary to a suggestion by [4].

Our work has revealed an obvious decrease of the abundance of shocked quartz grains with increasing depth (see Fig. 2). Surprisingly, the abundance of PDF sets per grain (denoted D) is rather constant with depth, averaging 1.32 ± 0.07 (excluding samples KR8-29-30-31, for which D is between 1.5 and 1.8 - due to the occurrence of PDF with 3 and extremely rarely 4 sets per host grain in these samples from the top of the section; Fig. 2). Those values of D, directly calculated from our systematic analyses, follow the same trend as the values of D determined from U-stage investigations; considering the fact that in the latter case, D values are, on average, 27 ± 8 rel% higher than values directly calculated from systematic analysis. This difference/shift is only due to the fact that some PDFs not visible under horizontal stage examination were observed during U-stage analysis. The systematic shift in the D values permits to confirm that our U-stage measurements seem to be representative of the full thin sections (even though only a restricted part of the section can be investigated using the U-stage).

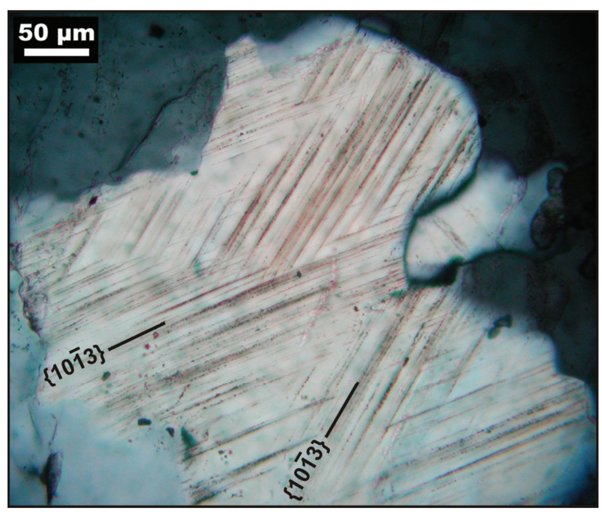

Fig. 1: Microphotograph of a typical shocked quartz grain with 2 symmetrical equivalent sets of PDFs (sample KR8-080, depth = 384.54 m).

The crystallographic orientations of 211 PDF sets in 116 quartz grains were analyzed in four thin sections of meta-graywacke samples (KR8-030, KR8-036, KR8-066, and KR8-101; depths = 272.00, 281.32, 353.95, and 414.28 m, respectively). A large proportion (83 to 91 rel% for the various thin sections) of the poles to PDF planes measured form angles of ~23° (corresponding to the $\omega\{10\bar{1}3\}$) with the c-axis orientation). Only a small proportion of basal PDFs was found (0 to 6 rel% per section) and planes parallel to the $\{10\bar{1}2\}$, $\{10\bar{1}1\}$, $\{10\bar{1}0\}$, $\{11\bar{2}2\}$, $\{11\bar{2}1\}$, $\{11\bar{2}0\}$, $\{51\bar{6}1\}$, and $\{21\bar{3}1\}$ orientations occur (1 to 6 rel% per section). This corresponds to shock stage 3 of [5], moderately shocked, according to observations from other impact craters [summary table in 5], which means that the studied section experienced a range of peak shock pressures up to ~20 GPa [e.g., 5]. Surprisingly, no significant differences of crystallographic orientations of PDF sets in quartz grains have been observed in the four investigated samples (the preliminary observations need to be confirmed with further investigations of other samples).

Conclusions: It is obvious that the observed distribution of shocked quartz grains (Fig. 2) reflects the variation of shock pressure in the uppermost part of the central uplift. However, based on the crystallographic orientations of PDF sets in quartz grains, it is not evident that the shock pressure differs significantly over the about two hundred meters of core investigated. It is not clear why this obvious decrease of PDFs abundance with depth is not clearly associated with significant differences of crystallographic orientations in quartz grains. The amount of shock-wave attenuation in this part of the uplifted target was apparently not strong.

In addition, this study provides an indication of the shock history of the rocks uplifted (and collapsed?) to the actual position of their occurrence. Such data may be useful for modeling of the zone of origin of these rocks in the target prior to crater modification, and provide constraints that need to be taken into account in future numerical modeling of the Bosumtwi structure.

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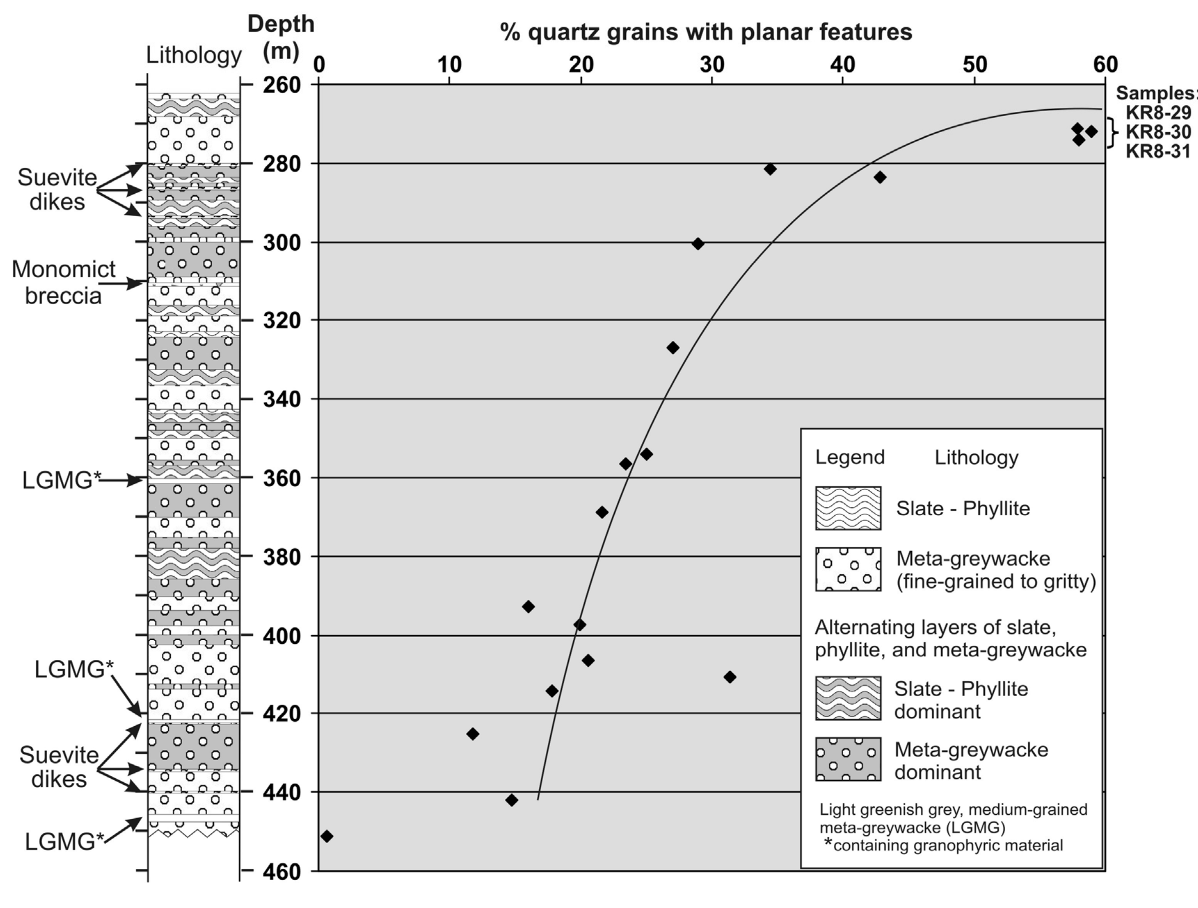

Fig. 2: Detailed lithostratigraphic column of the basement section of core LB-08A with the relative abundance of shocked quartz grains (with planar fractures and planar deformation features) in meta-greywacke samples.