SHOCK METAMORPHIC EFFECTS OF THE PEAK RING GRANITES WITHIN THE CHICXULUB CRATER.

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Introduction: Shock metamorphism occurs in impact events and has been studied for decades. Quartz and plagioclase are two major rock-forming minerals on Earth and their shock metamorphic effects have been studied extensively [1-3]. In the case of the K/Pg boundary Chicxulub multi-ring impact crater, drill cores recovered impact breccias, in which shock metamorphic effects of quartz, plagioclase and other minerals have been reported [4-10]. However, the samples of these studies are from suevite and impact melt rocks rather than un-brecciated target basement rocks. The IODP-ICDP Expedition 364 project drilled the peak ring of the Chicxulub crater and recovXRD ered basement granitoid [11]. This basement granitoid has been interpreted as over-heightened central peak collapsed into the peak-ring structure [11]. The entire section of felsic basement exhibits impact-induced deformation on multiple scales, such as macro-scale foliated shear zones, cataclasites and shatter cones of fine-grained mafic dikes, micro-scale quartz crystals displaying up to four sets of decorated planar deformation features. However, as a key parameter, the shock pressure need to be quantified to further test the model for peak-ring formation. Thus, as major rock-forming minerals of the basement felsic rocks, quartz and plagioclase have been studied for their shock metamorphic effects and we report the preliminary results in this paper.

Samples and methods: 36 thin sections have been made from the basement granitic drill cores from 750 to 1300 mbsf. These samples are roughly equal interval. 48 samples were crushed for separating quartz and plagioclase for X-ray diffraction (XRD) analysis. These thin sections have been systematically observed for identifying shock metamorphic features using optical microscope, especially for identifying and statistical sets of planar deformation features (PDFs) for quartz and plagioclase. Separated quartz and plagioclase are further crushed to make powders for XRD analysis, in order to study their reductions in peak heights and compare these features with whole rock XRD data obtained at the Universität Bremen, Germany, by the IODP-ICDP 364 science party. To avoid uncertainty and reduction of precision due to mixing with other mineral phases, we separated quartz and plagioclase crystals and milled them for XRD analysis. Polished thick sections were produced for 15 samples to measure the refractive index of quartz.

Results: *PDFs of quartz*. We have observed and measured PFs and PDFs of 262 quartz grains in the 36 thin-sections (Fig. 1). These data suggest that most of the quartz (>90%) developed 1 set (21-64%) and 2 sets (22-58%) of PDFs. So far, quartz crystals with 3 sets of PDFs were only observed in 7 of the 11 samples. No correlation of the number of PDFs sets in quartz with depth is observed.

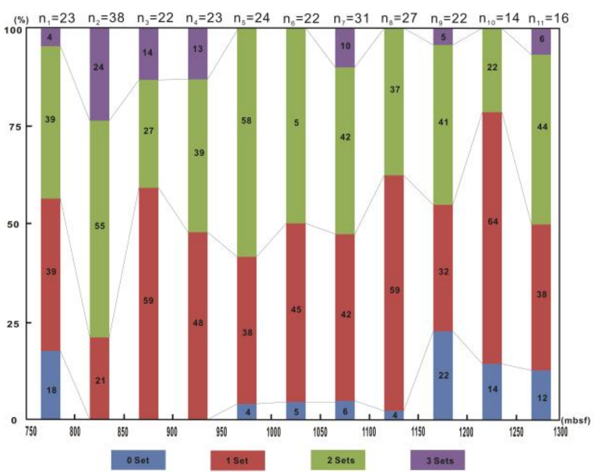

Figure 1. Histograms of frequency percent of PDFs and PFs sets observed in quartz, from the top (~750 mbsf) to bottom (~1320 mbsf) of the basement granites. 36 thin-sections have been grouped in every 50m interval.

XRD features of whole rocks and quartz X-ray diffractometer (XRD) scan of 147 whole rock samples analyzed at Bremen by the Onshore Science Party and 10 at CUG. There is remarkable variation of their peak heights, which is a possible indicator to estimate the shock pressure they experienced [1-2]. Analysis of the peak-heights at half-width for all 157 samples from top to bottom, revealed a slight reduction of this parameter for the four peaks. The regression lines of quartz is Y

= -28.59x + 13185 (R2 = 0.0445) and of plagioclases is Y = -22.253x + 7857.3 (R2 = 0.1148).

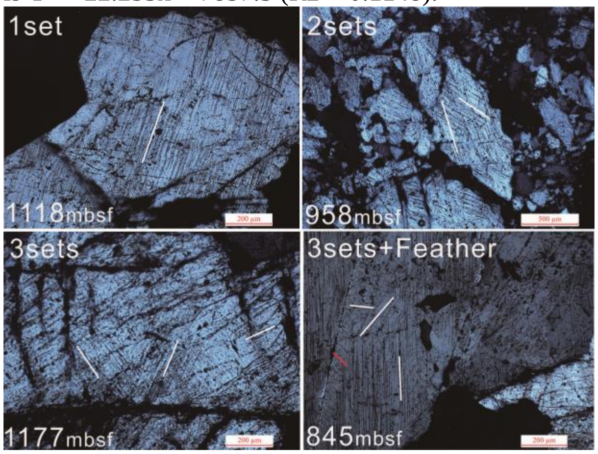

Figure 2. Four typical examples of PDFs and feather feature in quartz of granitic rocks under cross-polarized light (white line represent PDFs, red lines represent feathers).

XRD intensities of quartz are generally consistent from 750 to 1350mbsf (Fig. 3), although there is local sharp variation. Meanwhile, the FWHM of quartz is consistently 0.04 from top to bottom, suggesting that diaplectic quartz glass is not present. This is consistent with microscope observation. These XRD results all together indicate that there is no remarkable shock pressure changes recorded in these samples.

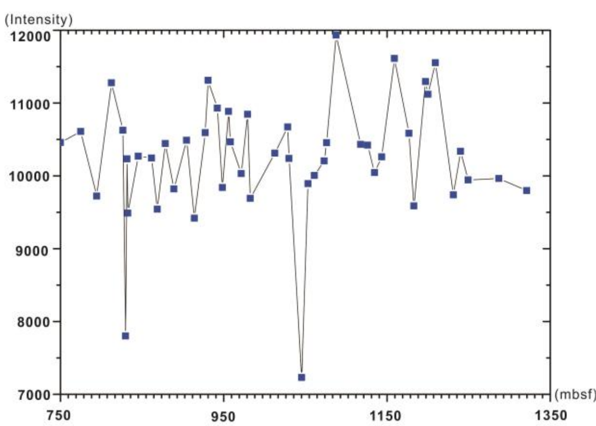

Figure.3 X-ray diffraction scan results for quartz from the basement granites of Chicxulub crater.

Discussion: PDFs sets, their crystallographic planes and diaplectic glass of quartz are most important indices for shock pressure estimation [1-2]. In these granite samples, most quartz crystals have one or two sets of PDFs, no diaplectic quartz glass, nor coesite have been found. The little variation of number of PDFs sets (Fig. 1) and very small XRD reduction from top to bottom together indicate the shock pressures are generally homogeneous. The slight decrease of XRD reduction in general imply the lower part granite experienced relatively higher shock pressure metamorphism. This is consistent with the dynamic collapse model, in which the peak ring is composed of overturned stratigraphy with the more highly-shocked target rocks ending up deeper in the peak ring.

The estimated shock pressures of the granites are preliminary results. To further and better determine the shock metamorphic effects and estimate shock pressure quantitatively, we are also doing infrared absorption spectra of quartz and plagioclase, and measure crystallographic planes of PDFs of quartz. We hope these integrated study can provide reliable shock pressure estimation of the basement rocks.

It should be noted that, due to post impact alteration, some PDFs are not pristine and display decorated features, so the measured refractive index could not provide precise original impact induced reduction. We will further study the relationships among the shock metamorphic effects in different minerals.

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