STRUCTURAL MAPPING OF GRANITOIDS IN THE PEAK RING OF THE CHICXULUB CRATER: DAMAGE DISTRIBUTION AND BLOCK SIZES. M. H. Poelchau[1], M. Ebert[1], B. Schuster[1], T. Kenkmann[1], O. Karagöz[1], [1]University of Freiburg, Geology, Freiburg, Germany (michael.poelchau@geologie.uni-freiburg.de)

Introduction: Over 500 m of deformed granitoid rocks have been recovered from Chicxulub's peak ring at the IODP-ICDP Expedition 364 [1]. The identification of discrete structural units within the peak ring drill core is essential for the understanding of the deformation processes that occur during cratering and peak-ring formation.

Methods: High resolution line scan images of the halved cores of the basement rocks (~747-1334 mbsf) were screened and mapped every 10 cm for deformational characteristics. This included an estimation of the percentage of rock affected by fracturing, cataclasis and crenulated mineral fabrics.

A general classification scheme was applied for each core section that describes the amount and type of deformation. Furthermore, intrusions of impact melt rocks and suevites into the granitoids were characterized based on the deformation mode, i.e., pure tensile fracturing, shearing, or mixed mode. On the basis of this classification, a structural map was created in order to locate subdivisions within the granitoid rocks.

Microanalysis of 26 thin sections was additionally carried out to determine the orientation of feather features (FFs) in shocked quartz. FFs are microstructural elements found in quartz that consist of a planar fracture (PF) and a set of lamellae that emanate in one direction from the PF. FFs indicate the orientation of the principal stress axis σ_1 of the attenuated shock wave [2]. We analyzed the orientation of FF lamellae in the borehole to infer the orientation of the stress tensor.

Structural Mapping Results: Figure 1 (left column) summarizes the deformation intensity mapped in the core. Here, large stretches of basement rocks can be recognized with no important deformation. Other portions consist of moderately deformed rocks that show a high density of shear fractures are marked by blue vertical lines. Stronger deformed zones, which are often pervasively penetrated by localized cataclasites or crenulated foliation are marked with a green signature.

Of particular interest are the regions that have impact melt rock intrusions with an additional shear component within the melt. These regions often occur together with thick localized cataclasites. We interpret these regions as zones of higher strain relative to the surrounding basement rocks.

The most obvious zone is found as a basal unit of the drill core, below ~1216 mbsf. Here, massive melt rock and strongly deformed granitoid units occur, indicating a zone that may have accommodated large amounts displacement of the granitoids during peak ring formation. A second zone occurs between ~916 and 1074 mbsf. Here several melt intrusions of up to 4 m thickness and regions of strong deformation, including cataclasite zones dominate. Deformation styles suggest less intense shearing and displacement relative to the basal unit. Further deformation zones are found in the top 100 m of the granitoids but are less dominant than the zones below.

Figure 1 (right column) shows the percentage of macroscopic deformation features characteristic for each of the 590 core segments recovered below 744.2 mbsf. For every 10 cm of segment, a dominant deformation style was mapped, i.e. shear faults, crenulated cleavage, cataclasites etc. If macroscopic deformation types were lacking, the rock was mapped as "intact". In total, 28% of the basement rocks are intact, 15% have tensile fractures, 28% have shear fractures, cataclasites and ultracataclasites, 14% have crenulated foliation and 14% have impact melt rock and suevite intrusions as the dominant feature.

A very rough four-fold division of the basement rocks becomes apparent through this analysis. From ~750 to ~916 mbsf and from ~1074 to ~1216 mbsf, two comparatively intact segments of granitoids occur with subdued deformation. They are intersected by a zone of increased shear fracturing and crenulated foliation from ~916 to ~1074 mbsf which coincides with the second deformation zone described above. The strongly deformed basal unit is easily recognized below ~1216 mbsf.

Microstructural results/feather features: 26 thin sections of granitoid samples were analyzed for feather feature (FF) orientation (Fig. 2). We found that in individual thin sections, the majority of the FF lamellae emanate from the PFs in the same direction. A lower number of FFs point to the opposite direction of the main orientation. Subordinately, 1 to 2 additional FF orientations can occur. However, the most important result is that we could not find an interrelated trend between the different thin sections. Only in a few cases where the distance between the thin sections was <25 m the FF orientations show a similar trend (Fig. 2). We see two possible explanations for this problem: (i) The general hemispherical propagation of the shock wave front differs and scatters strongly in relatively small regions due to the heterogeneity within the felsic basement rocks, which leads to an irregular FF orientation pattern. (ii) The peak ring itself experienced deformation in the form of small-scale rotational movements in the peak ring units, which is reflected by the varying FF orientations. We intend to perform additional microscope analyses of further core samples in order to cover a larger area of the drill core.

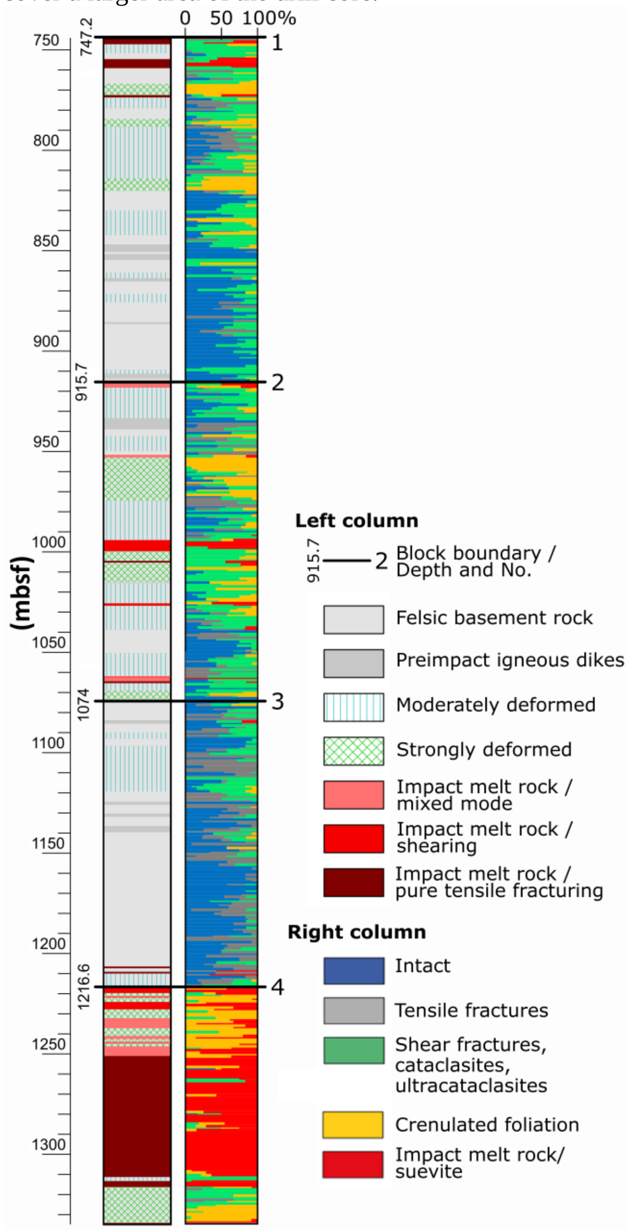

Fig 1. Left column: Simplified column of the characteristic deformation features within granitoids drilled from Chicxulub's peak ring. Right column: Percentage of the main deformation characteristic for each core segment. A basic four-fold division is postulated. (Depth units are meters below sea floor; msbf.)

Discussion of block sizes: Structural mapping indicates structural subunits within the basement. The largest structural unit consists of the majority of the granitoids from 750 to ~1250 mbsf and is bounded by the thick impact melt and suevite sequence at the bottom of the core (as well as melts and suevites above it). These basal melts and suevites may have either been injected between the granitoids during an early stage of cratering, or they were overridden as a basal glide sheet during crater modification. Thus, a ~500 m block can be postulated that forms this part of the peak ring. This block may be subdivided into two ~150-200 m units that are separated by a ~150 m thick zone of higher deformation. The degree to which displacement and internal deformation took place in this zone remains to be quantified and will be the focus of future studies.

In comparison, block sizes of 100 m have been reported from a drill core of the 40 km Puchezh-Katunki structure, while block sizes of 50-100 m were mapped in Upheaval Dome (7 km) and Waqf as Suwwan (6 km) [3]. Block sizes for the 200 km Chicxulub crater of either 150-200 m or ~500 m thus seem feasible. More detailed studies are planned to unravel the deformation history of these granitoids during peak ring formation.

References: [1] Morgan J. V. et al. (2016) *Science*, 354:878–882, [2] Poelchau M. H. & Kenkmann T. (2011), JGR *Solid Earth*, 116(B2), [3] Kenkmann T., et al. (2014) *Journal of Structural Geology* 62:156-182.

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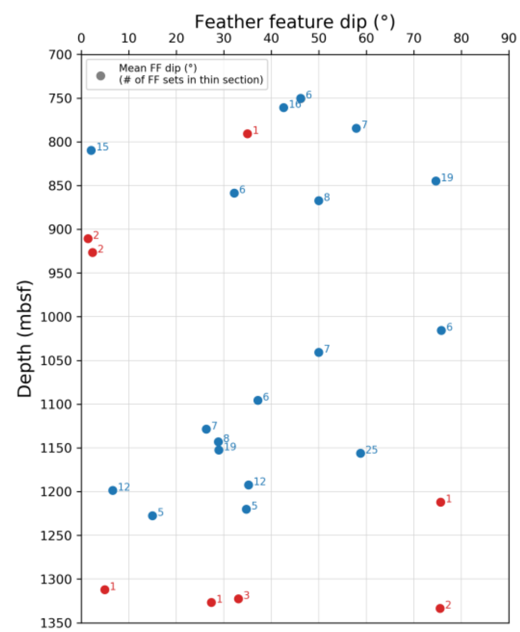

Fig. 2. Dip of feather feature lamellae measured in 26 thin sections of shocked granitoids from Chicxulub's peak ring. 0° indicates vertical lamellae orientation.