PRELIMINARY CHEMICAL DATA FOR IODP-ICDP EXPEDITION 364 DRILL CORES OF THE CHICXULUB IMPACT STRUCTURE'S PEAK RING.

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Introduction: The International Ocean Discovery Program (IODP) and the International Continental Scientific Drilling Project (ICDP) drilled the peak ring of the end-Cretaceous 66 Ma, ~200 km Ø Chicxulub impact structure to determine the composition and emplacement of this prominent feature of large impact craters [1]. We report preliminary chemical data for the 1335 m long core and characterize the recovered lithological units.

Samples and Methods: Using the analytical laboratories of MARUM/Universitiät Bremen we produced whole rock X-ray fluorescence (XRF) data for 281 powdered samples from core M0077A that were taken in ~3 m intervals. For the K-Pg boundary section, we produced an XRF linescan and µXRF maps of relative element concentrations.

Results: Drill core M0077A recovered three major lithological units. The uppermost unit from 506–617 mbsf comprises the Post-Impact section of carbonate-rich sedimentary rocks. This section exhibits a transition to size-sorted suevite and impact melt rocks of the Upper Peak Ring between 617–747 mbsf. The Lower Peak Ring section between 747–1335 mbsf is mainly composed of deformed granite intruded by subvolcanic dikes, granitoids, and intercalations of <1 mm to >50 m thick impact melt rock and suevite.

Post impact sedimentary rocks: The 37 samples from the section between 506.17–614.91 mbsf are dominated by marlstones. Trace element concentration spikes of Zn, Cr, Ni, and Cu correlate with dark layers enriched in organic matter.

Core 40R Section 1: We analyzed the halfcore between 616.24–617.67 mbsf along a traverse with 140 XRF spot analyses. Total count rates for the elements Ca, Fe, S, Ni, Pb, Zn, Br, Rb, Zr, K, Si, Al, Sr, Ti, Ba, and Mn versus depth were thus obtained. The uppermost unit until 616.58 mbsf is a packstone that is succeeded by a siltstone until 617.33 mbsf and a sorted suevite below. These limestones show localized sulfide mineralizations in which Fe, Ni, and Pb correlate with spikes in S, suggesting that these are mostly mineralizations of pyrite and related assemblages. In contrast, Ca is distinctly anti-correlated with S, which suggests that Ca-sulfates are not the sources of the S excursions. The two units are chemically distinct due to relatively higher Mn, Fe, and Sr concentrations in the siltstone that contrast with relatively higher concentrations of Ba, Si, K, Rb, and Pb in the packstone.

The transitional section between the packstone and the siltstone is characterized by a relative increase in Zr, Rb, Br, S, K, Pb, S, Fe, Ti, and Ba, and a significant relative decrease in Ca. Across a distance of 3 to 5 cm (616.54 to 616.59 mbsf), sulfide mineralization is evident through concentration spikes in Fe, S, and Pb. This mineralization is accompanied by a moderate relative enrichment in Rb, Zr, and Ti, and a weak relative enrichment in Si, Al, Sr, Ni, and K.

The 3 to 5 cm wide transitional zone between the siltstone and the size-sorted suevite is characterized by a depletion in Ca similar in magnitude to the Ca depletion at the boundary between the packstone and the siltstone above. In this K-Pg boundary interval, Ba, Sr, and Pb appear relatively enriched and a conspicuous, localized, relative Ni enrichment occurs, which does not correspond to an enrichment in S.

The sorted suevite shows enrichment in Zr, Rb, Br, Al, Si, K, Ti, Sr, and Ba, with a depletion in Mn compared to the siltstone above. In the sorted suevite, Ca is relatively depleted compared to the units above, yet still abundant.

µXRF mapping of Core 40R, Section 1 (616.24–617.68 mbsf): <u>Sub-section 1 (616.54–616.60 mbsf) – lithological boundary between packstone and siltstone</u>. The packstone is relatively enriched in Si and K compared to the siltstone, which shows a relatively larger concentration of Mn and Mg. Iron-sulfide mineralizations occur as 1 cm nodules and as ~1 mm grains in 0.5 mm thick layers in the packstone. Chromium is enriched in the boundary layer between the siltstone and the greenish transition layer at the bottom of the packstone. A 0.5 mm thick, green, sandy layer that is inclined in the upper part of the siltstone displays a relative enrichment in K, Si, and Cr.

<u>Sub-section 2 (~617.00–617.08 mbsf) – siltstone</u>. Carbonate rock that shows a pronounced Mn concen-

tration and mm-thick layers that are enriched in Fe, Si, and Ti.

Sub-section 3 (617.27–617.36 mbsf) – major lithological boundary between siltstone and sorted suevite. The basal part of the brown siltstone exhibits contorted pipe-structures or burrows near the contact with the 2.5 cm thick, sandy layers (617.315–617.34 mbsf) that transition to cross-bedded, size-sorted suevite with sand-size components. In 0.5 cm thick layers in the siltstone and especially in the sandy transition layers, sub-mm mineral components occur that are relatively enriched in Cr, Fe, Mg, Ti, and Ni. Nickel is also enriched in mm-thick, discontinuous sub-layers in the sandy transition zone. The siltstone also contains <0.5 mm layers that are enriched in Fe and S and some that are very thin and enriched in Si. The contorted pipe structures near the bottom of the siltstone are relatively enriched in Mn, while they appear relatively depleted in Si. Our X-ray intensity maps show a relatively sharp boundary between the siltstone and the underlying suevite that is characterized by a strong relative enrichment in Si and K along with a relative depletion of Ca in the suevite, compared to the siltstone.

Sub-section 4 (617.44–617.54 mbsf) – size-sorted suevite with diffuse, sub-vertical pipe structures that are a few mm to 3 cm wide. Compared to the host suevite, the interiors of these pipes are relatively depleted in Si and K and enriched in Ca, Mg, and Mn, similar to the overlying siltstone.

Upper Peak Ring: The 50 samples from the 130 m thick section of suevite and impact melt rocks between 618.22–744.07 mbsf show pronounced vertical variation in their major and minor element concentrations. Based on these chemical variations, the Upper Peak Ring section can be subdivded into an upper sorted suevite section from 617.34–684 mbsf that is grossly chemically homogenous. A lower sorted suevite section from 687–718 mbsf shows more chemical variation compared to the subsection above, while average concentrations are grossly similar. The lowermost section between 720–744 mbsf is dominated by impact melt rocks and is chemically distinct with higher concentrations of SiO_2, TiO_2, Al_2O_3, FeO, Ba, Zr, Rb, V, and Zn compared to the suevite sub-sections and notably, oxide totals that are typically 20 wt% higher than those of the suevite subunits above.

Lower Peak Ring: We analyzed 194 samples from the 586 m thick section of granite, sub-volcanic dikes, suevite and impact melt rocks between 747.89–1332.75 mbsf. The granite lithologies in this section are remarkably similar in composition, suggesting compositions of granites and syenites in the total-alkali silica (TAS) diagram of [2] and metasedimentary protoliths [3]. Subtle differences are present, though, for example Na_2O concentrations from 748.89–948.39 mbsf are lower than in the section between 948.39 and 1332.75 m. Very low incompatible trace element compositions suggest a volcanic arc setting for the emplacement of these granites [4], which is also supported by their magnesian character [3].

Compared to the granitic rocks, the most common intrusive rock, a dark, aphanitic, sub-volcanic lithology, has much lower SiO_2 and K_2O contents, while MgO, FeO, CaO, MnO, TiO_2, Cr, Ni, Cu, V, Y, Nb, and Zn are significantly enriched. A less common, brown, fine-grained subvolcanic lithology that exhibits shatter cones displays a chemical affinity to the dark subvolcanic dike lithology in that it shows similar depletion and enrichment trends for the major, minor and trace element concentrations compared to their granite host rocks. In the TAS diagram of [5], it plots in the field for phonotephrite, while the dark subvolcanic dikes plot in the fields for foidite and basanite.

Intercalcations of suevite and impact melt rocks show variable compositions but tend to be relatively depleted in K_2O and enriched in TiO_2, CaO, FeO, MgO, and MnO compared to the granitic rocks.

Summary: Expedition 364 recovered a continuous section of impact rocks from the peak ring of the Chicxulub impact structure. Preliminary observations suggest that a complete K-Pg section with evidence for siderophile element enrichments was recovered that overlies sorted suevite. The sorted suevite contains pipe structures that may relate to dewatering or degassing features in a rapidly emplaced deposit. The thick, size-sorted suevite deposit has a carbonate matrix and is fining upwards. It is underlain by silicate impact melt rocks that drape over deformed granite, which was intruded by subvolcanic dikes and is intercalated with suevite and impact melt rock.

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