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TRACE-ELEMENT COMPOSITION OF CHICXULUB CRATER MELT ROCK, K/T TEKTITES AND YUCATAN BASEMENT; A.R. Hildebrand, D.C. Grégoire, Geological Survey of Canada, 1 Observatory Crescent, Bldg. 3, Ottawa, Canada K1A 0Y3; M. Attrep, Jr., Los Alamos National Laboratory, Los Alamos, NM 87545; P. Claeys, Department of Geology, University of California, Davis, CA 95616; C.M. Thompson and W.V. Boynton, Department of Planetary Sciences, University of Arizona, Tucson, AZ 85721

The Cretaceous/Tertiary (K/T) boundary Chicxulub impact is the best preserved large impact in the geologic record. The Chicxulub crater has been buried with no apparent erosion of its intracrater deposits and its ejecta blanket is known and is well preserved at hundreds of localities globally. Although most of the molten material ejected from the crater has been largely altered, a few localities still preserve tektite glass. Availability of intra- and extracrater impact products as well as plausible matches to the targeted rocks allows the comparison of compositions of the different classes of impact products to those of the impacted lithologies.

Determination of trace-element compositions of the K/T tektites, Chicxulub melt rock and the targeted Yucatán silicate basement and carbonate/evaporite lithologies have been made using instrumental neutron activation analysis (INAA) and inductively coupled plasma mass spectrometry (ICP-MS). Some sample splits were studied with both techniques to ensure that inter-laboratory variation was not significant or could be corrected. The concentration of a few major and minor elements was also was also checked against microprobe results. Radiochemical neutron activation analysis (RNAA) was used to determine Ir abundances in some samples.

Beloc, Haiti K/T localities: Trace-element concentrations obtained for the Haitian tektites were in fair agreement with those of two previous studies (1, 2) but were substantially different from those of a third (3) suggesting that the latter study's results are invalid. The distinction of green vs. yellow glasses has been previously reported for the Haitian localities and 1 grain of lechatelierite-bearing glass has also been described (2). In this study two different types of green glasses with different trace-element compositions were found among the 6 grains analyzed. The most common glass type is a light to moderately dark green glass that alters forming a coarsely fluted surface. However, occasional grains of darker green glass have greater degrees of sphericity and a "wormy" surface texture similar to that found on tektites from other strewnfields. Although the rare-earth element (REE) pattern exhibited by the less common glass type is similar to that of the other Haitian tektites it is of slightly lower abundance. Relative to the typical glass the dark green grain had incompatible elements Na, K, Rb, Sr, Cs, Ba, and U depleted by up to 3 times, the chalcophiles Zn and Sb also strongly depleted, and the siderophile elements Cr, Co and Ni variably enriched although the Fe concentration is typical of Haitian glasses. In general, W displays the most variable concentrations (up to 4 times variation) of any element analyzed in the green glasses. The Ir concentration of the Haitian tektites is reported as <30 ppt (4).

Mimbral, Mexico K/T locality: The 6 grains of Mimbral green glass analyzed show greater variations in trace-element concentrations than the Haitian examples and, despite their similar appearance, define a different trace-element signature. Their REE pattern is lower and flatter than that of the Haitian tektites. The Mimbral glasses display lower Zn, Rb, Zr, Hf, Ta and Th concentrations, greater Sc, Cr, and Co concentrations and highly variable Sr, Cs, and Ba concentrations (up to 10 times variation). The Mimbral locality has occasional grains with the "wormy" texture as found at Beloc but none of these grains were analyzed in this study. On some grains it appears that the channels are controlled by compositional banding (manifested as slight colour variations) within the glass.

Chicxulub crater melt rock: The 6 chips analyzed from the Y6 N17 core sample of the Chicxulub crater show minor compositional variability which presumably reflects varying compositions and proportions of entrained inclusions. The REE pattern is slightly steeper than that of the Beloc and Mimbral tektites although the abundances are similar. The melt rock displays higher Na, Ca, W, Th and U than the tektites, and lower Fe, Sc, Ni, As, and Cs. All other trace-element concentrations are similar to those of the tektites and the chips show relatively consistent concentrations as expected for chips from a single core sample. No Ir was found in the melt rock to an INAA detection limit of ~1 ppb so the result of (5) was not confirmed, but Au was found in concentrations varying from 1 to 7 ppb. Whether the varying Au concentrations reflect contamination of the samples from previous handling is unknown. In this context we note that a concentration of only 1 ppt Ir was determined (by RNAA) for a sample of the proximal ejecta blanket from the Y2 N6 core (composed of carbonate and evaporite fragments) suggesting that in addition to the Haitian tektites at least some proximal impact products do not contain anomalous quantities of Ir.

Yucatán basement: The Quintana Roo-1 well bottomed in the silicate basement of the Yucatán peninsula ~200 km south of the Chicxulub crater. The QR1 N4 sample (from 2390-2394 m depth) is a coarse-grained equigranular metamorphic rock. Its REE abundances are roughly similar to those of the Chicxulub melt rock but the pattern is different indicating that this rock is not representative of the bulk of the lithologies impacted at Chicxulub. Other trace-element abundances are generally different from those of the melt rock and tektites indicating that at least some significant variation in upper crustal composition occurs across the Yucatán platform. This rock contains 71 ppt Ir, a typical background value for continental crust.

Discussion: Despite the obvious geochemical similarities of the Haitian and Mimbral glasses, they display distinct signatures that would allow separation in a blind test. The trace-element patterns are typical of the upper continental crust as was apparently excavated at the Chicxulub crater. The differences presumably reflect crustal compositional variations from opposite sides of the crater. The "Mimbral" side of the crater sampled more variable silicate crust than the "Beloc" side based on the modest number of samples analyzed although a distinct general character is also exhibited. Because the Chicxulub crater's transient cavity, the crater of excavation, was 90 to 100 km in diameter, it is not surprising that compositional variation occurs between impact products thrown out from opposite sides of the crater. (This transient crater size is derived from the size of the thick melt pool as inferred from the magnetic field anomaly associated with the crater (6).) In fact, given the large size of the transient cavity, the upper crust targeted by the Chicxulub impact must have been relatively homogenous or more dramatic compositional variations in tektite compositions would be observed. Alternatively, the alteration process could preferentially replace all but a certain class of compositions. More completely preserved samples will be required to explore this possibility. The different types of green glass may reflect a layering in the crust or a mixture of lithologies regionally.

Chalcophile element anomaly origin: The K/T fireball layer, as preserved in both marine and nonmarine environments, has an associated chalcophile-element (e.g. Zn, As, Se, Sb) anomaly of an as yet unknown origin. The low abundances of the chalcophile elements in the tektites relative to those expected in typical marine sediments allow the possibility that the fireball-layer chalcophile anomalies were produced by impact devolatization of the impacted lithologies (7). The problem with this mechanism is the requirement that a large volume of rock need be outgassed to produce the observed fluence of chalcophiles. In this scenario the chalcophile elements' subsequent condensation and precipitation would have led to their association with the fireball layer rather than the ejecta layer.

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