TEKTITES FOUND IN THE RUINS OF THE MAYA CITY OF TIKAL, GUATEMALA;

A.R. Hildebrand, Geological Survey of Canada, 1 Observatory Crescent, Bldg. 3, Ottawa, ON, Canada K1A 0Y3; H. Moholy-Nagy, Museum of Anthropology, University of Michigan, Ann Arbor, MI, USA 48109; C. Koeberl, Institute of Geochemistry, University of Vienna, Dr.-Karl-Lueger-Ring 1, A-1010, Vienna, Austria; L. May, Department of Chemistry, Catholic University, Washington, D.C., USA, 20064; F. Senftle, A.N. Thorpe, Department of Physics and Astronomy, Howard University, Washington, D.C., USA, 20059; P.E. Smith, D. York, Department of Physics, University of Toronto, Toronto, ON, Canada, M5S 1A7

Tektites are natural glasses quenched from superheated melts produced, and ejected at relatively large velocities, by impacts on the surface of the Earth. Some of their most obvious petrologic characteristics (e.g. reduction, volatile depletion, and lack of crystallites) are a consequence of this superheating. To date, tektites have been reported from 5 strewnfields, in some cases associated with known source craters, but tektites are probably produced in all sufficiently large terrestrial impacts. Unusual glass nodules discovered by archeological studies in the Maya city of Tikal, Guatemala show petrologic signatures characteristic of tektites and may represent products of an as yet unknown impact.

Provenance: During sorting and classification of glass artifacts found in excavation of the Maya ruins at Tikal, Guatemala, 11 unworked glass nodules were separated on the basis of their shape, size (See Figure 1) and colour (clear brownish green) from the commonly found obsidian artifacts (1). The nodules were found in general excavations widely scattered through the city, mostly in small structure groups that are presumed to have been residences. We assume that the nodules were collected at points unknown and transported by the Maya to the city of Tikal; no other similar nodules have yet been reported from other Maya archeological sites.

Petrography: The 3 nodules studied to date are composed of clear glass lacking any phenocrysts, microlites or schlieren visible to optical or SE microscopes. On this basis a possible impact origin had been previously suggested (2). Spherical vesicles ranging up to ~0.5 mm occur similar in abundance and size to those found in philippinites. Although the nodules' surfaces are pitted from presumed dissolution, no surficial alteration rims were obvious in cross section.

Composition: The tektites' composition has been studied by electron microprobe, INAA, ICP-MS and XRF. All 3 samples yield similar compositions of major, minor and trace elements and results are consistent with previous work (2). The silica abundance is ~62%, a value lower than those exhibited by most tektites excepting those of Cretaceous/Tertiary (K/T) age. Indeed, the major and minor element abundances are similar to those of the K/T tektites causing us to speculate that the Tikal tektites might have been transported from K/T boundary sections that outcrop near Tikal. However, trace elements, such as the REE, revealed patterns distinct from those displayed by the K/T tektites (3,4). In general, all lithophile incompatible elements are depleted relative to abundances found in the other four tektite groups consistent with the depletion in Si although an upper crustal affinity is evidenced.

Water Content: Tektites are depleted in all volatiles relative to other natural glasses; water contents are of the order of 100 ppm which is more than an order of magnitude less than found in the driest volcanic glasses (5). The water content of the 3 samples was studied using IR spectrometry yielding water contents of 60 to 80 ppm, values typical of tektites.

Fe^{+3}/Fe^{+2} ratio: Because of superheating, tektites display reduced chemistry such as Fe^{+3}/Fe^{+2} ratios approaching zero in contrast to terrestrial volcanic glasses that exhibit ratios of near unity or above. Mossbauer studies of one of the samples detected no Fe^{+3} consistent with extreme reduction. Magnetic studies of all 3 samples reveal magnetic susceptibilities, magnetizations and Curie constants generally consistent with reduction levels as found in other tektites (6). The temperature-independent susceptibility is higher than that of most tektites, but is similar to those of Haitian K/T tektites. The Curie constants are also similar to those of the Haitian glasses.

Age: The age of the tektites was expected to be 10 to 100 million years so an Ar-Ar study was planned with an irradiation optimized for an age of this order. However, a much younger age of

© Lunar and Planetary Institute • Provided by the NASA Astrophysics Data System

TEKTITES FROM TIKAL, GUATEMALA: Hildebrand, A.R. et al.

800,000 ± 100,000 years (2σ) was found based on an isochron defined by the 3 samples. This experiment will be repeated with an irradiation optimized for this younger age and larger samples to provide more radiogenic ^{40}Ar.

Conclusions: The Tikal nodules are of impact origin based on their petrologic character and represent fusion of an upper crustal target of intermediate composition. No natural occurrences of tektites are known in the region excepting the potential occurrence of tektites produced by the Chicxulub impact of K/T boundary age or from the North American tektite strewn field of Late Eocene age. Both of these tektite producing events are excluded as possible sources for the Tikal tektites because of their greater ages. The remaining possibilities are that these tektites represent transported individuals (of unusual composition) from 1 of the 2 youngest tektite strewnfields (Ivory Coast or Australasian) or are products from an as yet unknown impact in the region. The former is regarded as unlikely based on available compositional constraints but the preliminary age datum does overlap the age of the Australasian strewn field which also exhibits considerable compositional variation (7). Additional studies will discriminate between these possibilities.

Acknowledgements: We are grateful to M. Thompson (Dept. of Planetary Sciences, Univ. of Arizona) for help with INAA studies, Dr. A. Beran (Institute of Mineralogy, Univ. of Vienna) for help with the IR water measurements and the Analytical Chemistry Laboratories of the GSC.

References: (1) Moholy-Nagy, H. & Nelson, F.W. (1990) *Ancient Mesoamerica, 1*, 71; (2) Essene, E.J. et al. (1987) *Eos, 68*, 462; (3) Koeberl, C. & Sigurdsson, H. (1992) *GCA, 56*, 2113; (4) Hildebrand et al. (1993) *XXIV LPSC*, 657; (5) Koeberl, C. & Beran, A. (1988), *Proc. 18th LPSC*, 403; (6) Thorpe, A.N. & Senftle, F.E. (1964) *GCA, 28*, 981; (7) Chapman, D.R. & Scheiber, L.C. (1969) *JGR, 74*, 6737.

Figure 1: Six of the irregular nodules recovered from archeological excavations at Tikal, Guatemala. The nodules range from 1.3 to 3.0 cm in greatest dimension. The nodules' shapes are apparently the result of pitting and spalling from originally comparatively equant to teardrop shapes (Courtesy of Tikal Project, University Museum).

© Lunar and Planetary Institute • Provided by the NASA Astrophysics Data System