Nd-Sr ISOTOPIC SIGNATURE OF TEKTITES FROM THE K-T BOUNDARY ON HAITI; Premo, W.R. and Izett, G.A., U.S. Geological Survey, Box 25046, Denver Federal Center, Denver, CO 80225

Small (<4 mm), corroded, glassy droplets occurring as cores in clay spherules recovered from Cretaceous-Tertiary (K-T) boundary rock on Haiti are thought to be tektites based on the following evidence: 1) The glass lacks microlites and crystallites indicative of volcanic glasses; 2) Shock-metamorphosed quartz grains are found at the same horizon; 3) Ir anomalies have been measured in the boundary marl; and 4) The clay spherules that enclose the glassy objects have shapes identical to known tektites [1].

Approximately 25 mg (~10-15 microtektites) of dark-brown to black, glassy droplets were analyzed for Rb-Sr and Sm-Nd isotopes to possibly determine the type or provenance of the target rocks. It is commonly accepted that the majority of the ejected material formed during impact events is derived from the target and not from the impactor [2]; thus, the chemistry and isotopic signature of tektites should be indicative of the target material. The major and trace element geochemistry on these particular tektites are reported elsewhere [1], and indicate that the average compositional range is quite restricted and, in terms of volcanic rocks, is similar to andesite or dacite with SiO_2 = ~62% and Al_2O_3 = ~15%.

Previous isotopic work [3,4,5] helped to establish and illustrate the usefulness of Sr-Nd isotopes in tektites, the signatures of which may help identify the provenance of the target material, melted and ejected during a terrestrial impact event. Presently, there exists enough Sr-Nd isotopic data from both continental and oceanic crustal rocks to provide us with a first-order approximation for a target region. Their isotopic data showed that all five major groups of tektites (australites, moldavites, Ivory Coast tektites, North American tektites, and irghizites) have distinct isotopic signatures (Fig. 1). Their data indicate that these groups were derived from separate impact events involving continentally-derived sediments.

The procedures used to prepare our tektite sample (90G15-2) are conventional [6], but briefly, these tektites were ultrasonically washed in distilled ethanol and rinsed several times in ultrapure water to insure that any unwanted surficial particles of the host clay were removed from cracks and embayments of each grain. The washes were saved and analyzed separately. Our isotopic data are listed below and both the Rb-Sr and Sm-Nd concentration data are consistent with an andesitic-dacitic composition for the source material.

Sample	Wgt. (g)	Rb (ppm)	Sr (ppm)	$^{87}Rb/^{86}Sr$†	$^{87}Sr/^{86}Sr$†	$^{87}Sr/^{86}Sr_i$§	ε_{Sr}§
90G15-2	.0254	44.9	350	0.3714±5	0.709117±25	0.708769±192	62±1.5
wash	"	0.01	0.10	0.310±25	0.7058±68	0.7055±91	16±64

† - Isotopic ratios corrected for blank and mass fractionation, $^{87}Sr/^{86}Sr$ data are normalized to $^{86}Sr/^{88}Sr$ = 0.1194 and adjusted for instrumental bias to $^{87}Sr/^{86}Sr$ = 0.710265 for NBS SRM 987 standard. Uncertainties correspond to the last significant figure(s) at the 95% confidence level.

§ - Initial $^{87}Sr/^{86}Sr$ ratios and ε_{Sr} are calculated assuming an age of 66 Ma; $\lambda = 1.42 \times 10^{-11}$/yr; present day $(^{87}Sr/^{86}Sr)_{UR}$ = 0.7045, and $(^{87}Rb/^{86}Sr)_{UR}$ = 0.0824, where UR = uniform reservoir.

Sample	Wgt. (g)	Sm (ppm)	Nd (ppm)	$^{147}Sm/^{144}Nd$†	$^{143}Nd/^{144}Nd$†	$^{143}Nd/^{144}Nd_i$§	ε_{Nd}§
90G15-2	.0254	4.62	21.4	0.1301±2	0.512464±15	0.512408±31	-2.83±.34
wash	"	0.001	0.008	0.058±69	0.5137±62	0.5137±51	22±26

† - Isotopic ratios corrected for blank and mass fractionation, $^{143}Nd/^{144}Nd$ data are normalized to $^{146}Nd/^{144}Nd$ = 0.7219 and adjusted for instrumental bias to $^{143}Nd/^{144}Nd$ = 0.511860 for the La Jolla Nd standard. Uncertainties correspond to the last significant figure(s) at the 95% confidence level.

§ - Initial $^{143}Nd/^{144}Nd$ ratios and ε_{Nd} are calculated assuming an age of 66 Ma; $\lambda = 6.54 \times 10^{-12}$/yr; present day $(^{143}Nd/^{144}Nd)_{CHUR}$ = 0.512638, and $(^{147}Sm/^{144}Nd)_{CHUR}$ = 0.1967, where CHUR = chondritic uniform reservoir.

Present day ε_{Nd} and ε_{Sr} values (-3.39 and 65.5, respectively) for tektite 90G15-2 (Haiti KT) are plotted in Fig. 1 below and compared with other Nd-Sr data for tektites from the literature [3,4,5]. The relatively tight clustering of the Nd-Sr data from all tektite groups (except DSDP-612) may indicate that the target material was uniform in composition. As we only have one analysis thus far, it is impossible to tell whether the target material for the Haiti K-T tektites was uniform in composition or not; our one analysis may not represent the entire K-T tektite field. More tektites from this horizon are currently being processed for Pb-Sr-Nd isotopic work. However, for the time being, if we assume that the single analysis is representative, then we can say that K-T tektites do not plot within the presently-defined fields for any of the other tektite groups, indicating that they were derived from target material unlike target material of the younger impact events.

Our Nd-Sr results can be interpreted to indicate that the target material for Haiti K-T tektites was composed of either relatively young rock (<400 Ma) of andesitic to dacitic composition, or sediments derived from such a source, or a mixture of oceanic-derived material and a small amount of an older continental crustal component, as the Haiti K-T tektite isotopic signature lies along possible mixing curves between the mantle array and continental crustal components (Fig. 1). The Nd model age (T_{CHUR}) for our K-T tektites is 400 Ma, which is considerably younger than those of the other groups [3,4,5], suggesting that the target material had significantly less (if any) old continental crust component. But perhaps more importantly, the negative ε_{Nd} value and relatively high Rb and Sm-Nd concentrations do argue against an impact site composed purely of oceanic-derived material.

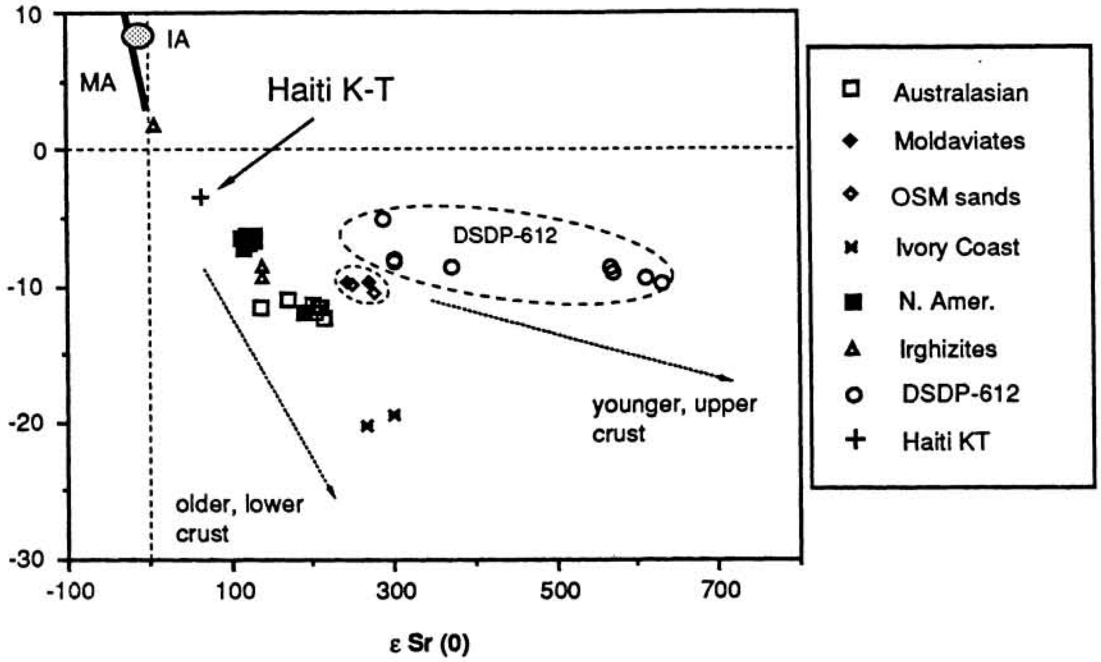

Figure 1: Present-day ε_{Nd} and ε_{Sr} values for all tektite groups, including the Haiti K-T tektites, illustrate distinct isotopic signatures for each (except for DSDP-612), indicating that each group was derived from a unique target material and therefore separate impact events. MA = mantle array; IA = island arcs.

Of the two sites currently under consideration as sources for the Haitian K-T boundary rocks (the Yucatan impact site of [7] and the Manson structure of central Iowa), only one appears to satisfy most of the evidence. If the Paleozoic Nd model age of 400 Ma is an average crustal residence age for the target material, then we can perhaps eliminate the Manson structure as the source of the Haitian tektites, as the sediments deposited at 66 Ma must have contained appreciable amounts of Middle Proterozoic to Middle Archean detritus capable of providing large negative ε_{Nd} and positive ε_{Sr} values, and correspondingly older model ages. Although the geology of the southern Caribbean region is poorly understood, an impact on the relatively new oceanic crust of the Cretaceous Colombian basin with only a thin veneer of fine-grain shales should have provided a positive, depleted mantle ε_{Nd} value. Moreover, an oceanic crustal target is not consistent with the abundance of shocked quartz and the absence of shocked calcic plagioclase in the K-T boundary rocks. Our best guess therefore is the newly-proposed Yucatan impact site at Chicxulub that could have provided the observed Nd-Sr isotopic signature as well as the reported impact debris. The stratigraphy of the proposed site during the Cretaceous includes sandstones, marls, carbonates, tuffs, and andesitic rocks [7], some of which could easily have been derived from the Paleozoic-Mesozoic orogenic belt of central and southern Mexico. Very similar Nd results of lower crustal xenoliths from central Mexico [8] suggest that these rocks or sediments derived from them could be the target material for the Haiti K-T tektites.

References: [1] Izett, G.A., Maurrasse, F.J.-M.R., Lichte, F.E., Meeker, G.P., and Bates, Robin (1990): USGS Open-File Report 90-635. [2] Chapman, D.R.and Scheiber, L.C. (1969) JGR 74, 6737. [3] Shaw, H.F. and Wasserburg, G.J. (1982) EPSL 60, 155. [4] Ngo, H.H., Wasserburg, G.J., and Glass, B.P. (1985) GCA 49, 1479. [5] Stecher, O., Hgo, H.H., Papanastassiou, D.A., and Wasserburg, G.J. (1989) Meteoritics 24, 89. [6] Premo, W.R. and Tatsumoto, M. (1989) PLPSC XIX, 61. [7] Hildebrand, A.R. and Penfield, G.T. (1990) EOS 71, 1425. [8] Ruiz, J., Patchett, P.J., and Ortega-Gutierrez, F. (1988) GSA Bull 100, 274.