GEOCHEMISTRY OF SURFICIAL SEDIMENTS NEAR THE CHESAPEAKE BAY IMPACT STRUCTURE AND THE SEARCH FOR SOURCE ROCKS OF THE NORTH AMERICAN TEKTITES.

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Introduction: The North American tektite strewn field is the oldest known tektite field, at about 35 Ma. The first North American tektites were known from an area near Bedias, Texas (since 1936), and from Georgia. Two individual finds were reported to be from Martha's Vineyard and from Cuba. The extent of the North American strewn field was defined by findings of microtektites in a number of deep sea sediments (see, e.g., Glass et al. [1]). On the basis of stratigraphic, compositional, isotopic, and age data they were identified to be part of the North American tektite field. Other spherules of clinopyroxene composition, which were found in several cores throughout the Caribbean Sea and even the Pacific, were earlier thought to be associated with the North American tektite strewn field, but were later shown to belong to a different event. Microtektites, tektite fragments, and impact debris occur together in relatively thick layers at DSDP Site 612, and shocked rock and mineral fragments were found at ODP Sites 903C and 904A. The chemical composition of the DSDP 612 tektites and microtektites is similar to that of other North American tektites, with some differences, e.g., lower Na and higher K contents in the 612 tektites (e.g., [2]). Stecher et al. [3] noted that the Rb-Sr/Sm-Nd isotopic compositions of the 612 tektites show a wider scatter than that of the North American tektites. More recently, microtektites were found as far south as the Southern Ocean, at ODP site 689, Maude Rise, and were interpreted to be part of the North American tektite strewn field [e.g., 4].

Source Crater of the North American Tektites: Over the years, many locations have been suggested as the North American tektite source crater, mainly based on similarity in age. Among the suggestions were, for example, Popigai, Siberia; Wanapitei, Canada; Mistastin, Canada; Bee Bluff, Texas; and Montagnais, off-shore Canada - all of which were later discounted on basis of distance, exact age, isotopic constrains, size, and other criteria (see review in [5]).

The Chesapeake Bay structure (centered at 37°16.5' N and 76°0.7' W), a complex peak-ring feature buried 300-500 m beneath lower Chesapeake Bay, its surrounding peninsulas, and the adjacent inner continental shelf, was recently identified as a large (ca. 85-km-diameter) impact structure (e.g., [6,7]). The pre-formational coastal plain rocks consist of a seaward-thickening wedge (300-1200 m thick) of mainly Lower Cretaceous to upper Eocene, poorly lithified, sedimentary rocks, which is underlain by a crystalline basement complex comprising granitic and metasedimentary rocks of Proterozoic to Paleozoic age. Based on age and chemical data, it has been suggested (e.g., [6, 7]) that Chesapeake Bay is the source crater of the North American tektites.

Source Rocks of North American Tektites: From their Rb-Sr/Sm-Nd isotopic studies, Shaw and Wasserburg (1982) concluded that the source rocks from which the North American tektites were derived were crustal material that formed very late in the Precambrian (Sm-Nd model age 0.62 - 0.67 Ga), which excludes most of the Precambrian shield areas of North America, as well as sediments derived from these areas. The data obtained by Stecher et al. [3] on DSDP site 612 tektite fragments showed a wider scatter. In the present study, we analyzed the chemical and isotopic composition of some possible pre-impact target rocks near the Chesapeake Bay structure, in an attempt to constrain the target rocks of the North American tektite strewn field.

Samples: For analysis, we selected seven samples (P1 to P7, by decreasing age) from the environs of the Chesapeake Bay structure: samples from the Piscataway and Paspotansa Members of the Aquia Formation (Paleocene; from Pamunkey River outcrops and the Haynesville core, respectively); Potapaco Member of the Nanjemoy Formation (lower Eocene; from Pamunkey River outcrops); Woodstock Member of the Nanjemoy Formation (lower Eocene; Haynesville core), and Piney Point Formation, Bed A (middle Eocene; from both Pamunkey River outcrops and the Haynesville core). The samples from the Haynesville core come from a borehole 50 km NW of the crater outer rim. All of the samples are siliciclastic sediments (silts, sands and clays, but dominantly shelly quartz sands)--no consolidated rocks such as sandstones, shales, or limestones, etc. The samples were selected to represent the near-surface components of the likely target rocks of the Chesapeake Bay impact event.

Analytical methods: Major elements and selected trace elements were analyzed by X-ray fluorescence (XRF), and trace elements were determined using instrumental neutron activation analysis (INAA), following standard methods.

Isotopic analyses were performed in the Hugh Allsopp Laboratory of the Bernard Prince Institute at the

University of the Witwatersrand, South Africa. Natural isotopic compositions of $^{143}Nd/^{144}Nd$ and $^{87}Sr/^{86}Sr$ were determined from samples digested under clean room conditions, and chemical separations were made using HDP resin cation exchange columns. Methods utilized are similar to those described by Smith et al. [8] and Brown et al. [9]. A single-collector Micromass 30 mass spectrometer and a multiple collector VG 354 mass spectrometer were used to determine the abundances of Rb, Sr, Sm, and Nd by isotope dilution, and the isotopic ratios of Sr and Nd. Due to the low elemental contents, some of the isotope ratio measurements were repeated without spiking.

Results: The samples show a wide range in major and trace element composition (Table 1). The compositions for the target sediments have been recalculated on a volatile-free basis to allow for a comparison with average compositions of bediasites and georgiaites.

Table 1. Major and trace element composition of target rock samples of Middle Eocene to Paleocene age from the Chesapeake Bay crater area.

	P1	P2	P3	P4	P5	P6	P7	bedi. avg.	georg. avg.
SiO_2	48.63	70.26	62.51	59.38	64.42	86.80	65.09	76.37	81.5
TiO_2	0.24	0.71	0.38	0.69	0.53	1.21	1.38	0.76	0.49
Al_2O_3	4.55	12.78	8.10	13.93	4.56	7.06	5.17	13.78	10.71
Fe_2O_3	13.02	8.00	16.28	9.93	5.38	2.04	7.36	4.38	2.75
MnO	0.04	0.02	<0.01	<0.01	<0.01	<0.01	0.02	0.03	0.02
MgO	2.59	2.57	3.76	3.16	1.22	0.61	1.08	0.63	0.55
CaO	26.87	0.95	2.92	8.88	22.26	0.34	18.08	0.65	0.51
Na_2O	0.11	0.79	0.20	<0.01	0.11	0.23	0.28	1.54	1.19
K_2O	3.67	3.76	5.53	3.33	1.40	1.56	1.42	2.08	2.39
P_2O_5	0.28	0.18	0.30	0.65	0.16	0.14	0.08		
Total	99.99	100.02	99.98	99.95	100.04	99.99	99.96	100.22	100.11
V	127	134	139		70	136	120	87	45
Cr	340	133	226		76	133	115	49	24
Co	<9	<9	<9	<9	<9	<9	<9	14	7.4
Ni	30	40	32		23	<9	18	13	18
Cu	<2	<2	<2	<2	<2	<2	<2	12	3.2
Zn	108	95	100		52	31	50		13
Rb	117	142	213		65	58	72	66	73
Sr	448	343	157		929	54	832	125	173
Y	11	38	24		16	30	36	21	18
Zr	85	372	178		418	890	1428	230	207
Nb	8	21	12		14	21	24	17	8.1
Ba	92	285	107		70	243	150	470	377

Major elements in wt%, trace elements in ppm. bed= bediasite, georg= georgiaite (refs. in [4,5], and [11]). Total Fe for tektites is given as Fe_2O_3 recalculated from FeO).

Unfortunately, no immediate similarity between the tektite compositions and the sediments is apparent. The tektites are richer in Si and Al than most, and higher in Na than all, sediments. Similar discrepancies exist for the trace elements measured so far.

Isotopic compositions are of key importance to link impact melts to their source rocks. The results for the present samples are shown in Fig. 1, in which the Sr and Nd isotopic compositions of the known tektites are plotted. It is immediately apparent that the sediments (represented by the open triangles) do not overlap the fields defined by the North American tektites (bediasites and georgiaites) and the DSDP Site 612 samples. In fact, the present samples plot closer to the (certainly unrelated) Australasian tektites. This means that none of the rocks in the present suite can be considered a likely source rock for the North American tektites, but the Cretaceous section, which represents by far the bulk of the preimpact sediments, has not yet been analyzed.

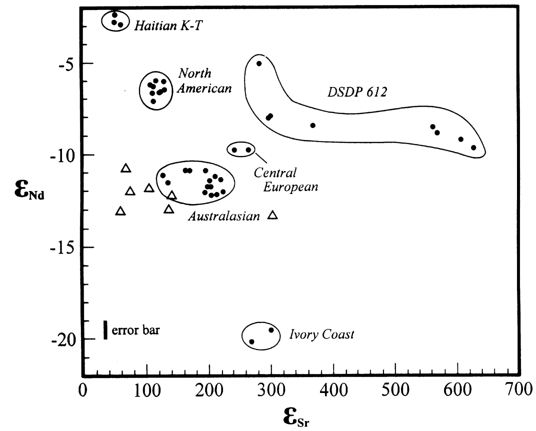

Fig. 1. Sr and Nd isotopic composition of sediments from the Chesapeake Bay area (open triangles) in comparison with data for the various tektite strewn fields (after [10]).

Conclusions: We analyzed a suite of sedimentary samples from near the Chesapeake Bay impact structure, which are near-surface pre-impact target rocks, and were thought to represent possible source rocks for the North American tektites. Major and trace element, as well as Sr and Nd isotopic compositions, of these samples do not show a close similarity with those of North American tektites. Thus, the search for the North American tektite source rocks goes on.

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