

U-Pb STUDY OF SHOCKED ZIRCONS FROM THE NORTH AMERICAN MICROTEKTITE LAYER . S. L. Kamo¹, T. E. Krogh¹, B. P. Glass², and S. Liu², ¹Geochronology Laboratory, Royal Ontario Museum, 100 Queen's Park, Toronto, Ontario M5S2C6, Canada, sandrak@rom.on.ca, ²Geology Department, University of Delaware, Newark, DE 19716, U.S.A.

Introduction: Unmelted impact ejecta have been found in upper Eocene sediments at three Deep Sea Drilling Project/Ocean Drilling Program sites on the upper continental slope in the NW Atlantic Ocean off New Jersey (DSDP Site 612, ODP sites 903 and 904) and Bath Cliff, Barbados [1-4]. The ejecta are associated with microtektites at three of the sites (612, 904 & Barbados), but not at Site 903 [3, 4]. It is generally accepted that the microtektite layer belongs to the North American tektite strewn field and was derived from the Chesapeake Bay structure [e.g., 4, 5]; however, some authors have proposed that the layer at Site 612 (and presumably at sites 903 and 904) is older than the layer on Barbados [6, 7]

The heavy mineral assemblage in the ejecta layer at all three of the sites off New Jersey is similar, consisting primarily of Fe-Ti oxides, staurolite, garnet, epidote, zircon, sphene, and Al₂SiO₅ phases in approximate order of decreasing abundance [4]. Zircons were also found in the microtektite layer on Barbados. The zircons at all of the sites exhibit various degrees of shock metamorphism.

The purpose of this study was to determine the U-Pb ages of the zircons from the ejecta layer at all four sites in order to determine: 1) if the zircon ages are consistent with the microtektite layer in Barbados being from the same source crater as the layer in the NW Atlantic Ocean and 2) if the zircon ages support the Chesapeake Bay structure as the source crater.

Methods: The zircons were handpicked from heavy liquid fractions of the 63-125 μm size fractions. Confirmation of their identification and determination of the degree of shock metamorphism were accomplished using a combination of X-ray diffraction analysis and scanning electron microscopy/energy dispersive X-ray (SEM/EDX) analysis. Some of the zircons were etched, prior to SEM studies, following the procedure of Bohor et al. [8]. U-Pb dating was done following the methods discussed by Krogh et al. [9].

Results: A total of 68 zircons was recovered. Most of the zircons exhibited some evidence of shock metamorphism including planar features and/or granular structures [10]. In addition, some of the more heavily shocked zircons had been partly or totally converted to

a high-pressure zircon polymorph which had not previously been identified in naturally-occurring samples [10]. This phase has been accepted as a new mineral and named reidite [11].

U and Pb isotopic data have been obtained for 8 zircons from Bath Cliff, 5 from Site 612, 4 from Site 903, and 7 from Site 904 (Table 1). Interpretation of the data is not straightforward, but we can make a few generalizations. The maximum age of the microtektite layer at Barbados appears to be 35.4 Ma based on concordant data for an unshocked grain that is probably volcanic (volcanic ash is common at the Bath Cliff site). The most intensely shock-metamorphosed grains (mostly reidite) from Bath Cliff and sites 903 and 904 appear to plot along a line with a lower intercept age of 35.4 Ma and an upper intercept of 400 \pm 32 Ma. This indicates that the most highly shocked grains are from a source rock with an age of 400 Ma. An exception to this is one grain from Site 904 which has a trace of reidite, but falls on a line from 35 Ma to 1000 Ma. The minimum age of the source rock for the remainder of the unshocked grains is indicated by lines anchored at 35 Ma and projected up to the curve (these ages range from 1.1 to 1.8 Ga). Three apparently unshocked grains from Site 612 seem to define a line from 1021 Ma to 400 Ma. This may indicate that the source rock for these grains is 1 Ga old rock that was metamorphosed 400 Ma ago.

Discussion and Conclusions: The fact that the highly shocked grains from Bath Cliff and sites 903 and 904 appear to plot along a line with a lower intercept of 35.4 Ma and an upper intercept of 400 Ma is consistent with the ejecta (and microtektites) from these sites all being from the same source crater. Since (based on biostratigraphic data) the ejecta and microtektites at Site 612 seem to be the same age as the ejecta and microtektites at sites 903 and 904, the microtektites at Site 612 appear to be from the same impact event and thus the same age as the microtektites at Bath Cliff, Barbados.

Nd isotopic studies indicate that the tektite fragments and microtektites from Bath Cliff have a Nd model age (T_{CHUR}) of 630 Ma [12] and the tektite fragments and microtektites from Site 612 generally have Nd model ages (T_{CHUR}) of 800 to 980 Ma [13]. However, one microtektite from Site 612 had a Nd model age of 403 Ma. The

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late Precambrian Nd model ages of most of the microtektites from these sites are consistent with their derivation from sediments eroded from source rocks with ages similar to those in the Appalachian orogenic belt [12, 13]. This is consistent with a derivation from the Chesapeake Bay structure.

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Table 1. U-Pb isotopic data for individual zircons.

Analysis No.	Zircon Type§	Weight (mg)	U (ppm)	Th/U	Pb* (pg)	207Pb/204Pb	206Pb/238U	2σ	207Pb/235U	2σ	206/238 Age(Ma)	2σ	207/235 Age(Ma)	2σ	207/206 Age(Ma)	2σ	% Disc.
DSDP 612																	
1	UZ	0.002	432	0.25	0.6	1289.1	0.18272	0.00059	1.9435	0.0067	1081.8	3.2	1096.2	2.3	1124.9	2.5	4.2
2	UZ	0.002	71	0.48	4.4	42.7	0.17406	0.00073	1.7741	0.0425	1034.4	4.0	1036.0	15.6	1039.4	44.2	0.5
3	UZ	0.002	115	0.33	0.8	173.3	0.15752	0.00065	1.5683	0.0094	943.0	3.6	957.8	3.7	991.9	9.9	5.3
4	UZ	0.005	545	0.21	1.2	1545.1	0.14769	0.00045	1.4555	0.0048	888.0	2.5	912.2	2.0	971.2	2.2	9.2
5	GZ	0.001	272	1.16	0.3	126.2	0.03112	0.00024	0.2538	0.0042	197.6	1.5	229.7	3.4	572.7	30.5	66.5
ODP 904																	
6	UZ	0.001	153	0.40	0.4	426.4	0.19624	0.00072	2.2705	0.0139	1155.1	3.9	1203.2	4.3	1290.6	9.2	11.5
7	UZ	0.001	106	0.44	0.3	305.6	0.17536	0.00139	1.7935	0.0156	1041.6	7.6	1043.1	5.7	1046.3	10.4	0.5
8	UZ	0.003	195	0.38	1.1	367.6	0.16631	0.00106	1.6759	0.0101	991.7	5.9	999.4	3.8	1016.4	7.5	2.6
9	UZ	0.001	470	0.24	0.8	434.8	0.15493	0.00101	1.6036	0.0102	928.5	5.6	971.6	4.0	1070.3	5.9	14.2
10	UZ	0.001	402	0.73	1.0	290.8	0.15059	0.00063	1.5041	0.0094	904.3	3.5	932.1	3.8	998.3	9.4	10.1
11	TR,PF	0.001	214	0.44	0.9	182.5	0.14413	0.00069	1.4272	0.0091	868.0	3.9	900.4	3.8	980.7	8.3	12.3
12	RG	0.001	322	0.12	18.0	17.1	0.02416	0.00068	0.1742	0.0751	153.9	4.3	163.0	66.0	298.4	618.0	49
ODP 903																	
13	OW	0.001	158	0.45	0.6	45.0	0.03427	0.00032	0.2461	0.0136	217.2	2.0	223.4	11.1	288.9	117.1	25.2
14	RG	0.001	276	0.42	0.9	40.5	0.02438	0.00020	0.1797	0.0061	155.3	1.3	167.8	5.2	348.3	70.2	56.1
15	RG	0.003	83	0.50	1.2	22.1	0.01214	0.00016	0.0816	0.0100	77.8	1.0	79.6	9.4	135.4	273.9	42.8
16	ZG	0.002	541	0.34	0.5	58.1	0.00613	0.00005	0.0416	0.0008	39.4	0.3	41.4	0.8	157.9	38.9	75.3
Bath Cliff																	
17	UZ	0.005	25	0.39	0.5	316.4	0.18541	0.00069	2.7616	0.0132	1096.5	3.7	1345.2	3.6	1766.4	5.9	41.2
18	UZ	0.001	264	0.22	1.1	240.6	0.18142	0.00064	1.9399	0.0109	1074.7	3.5	1095.0	3.8	1135.4	8.1	5.8
19	ZR	0.002	72	0.46	2.0	54.5	0.09702	0.00030	1.1357	0.0190	596.9	1.8	770.5	9.1	1313.2	32.3	57.1
20	R	0.002	160	0.34	2.2	43.3	0.05373	0.00016	0.4026	0.0093	337.4	1.0	343.5	6.7	385.1	52.0	12.7
21	RZ	0.003	50	0.66	11.0	18.3	0.05307	0.00088	0.4167	0.0980	333.3	5.4	353.7	71.5	489.5	565.4	32.7
22	R	0.003	56	0.22	0.9	48.3	0.04930	0.00016	0.3782	0.0100	310.2	1.0	325.7	7.3	437.7	54.5	29.8
23	UZ	0.001	540	0.22	0.5	72.1	0.01694	0.00009	0.1204	0.0031	108.3	0.5	115.4	2.8	265.7	54.6	59.8
24	UZ	0.001	1041	0.11	0.4	57.2	0.00551	0.00003	0.0357	0.0016	35.4	0.2	35.6	1.5	50.0	97.7	29.2

§ U=unshocked, G=granular, TR=zircon with trace reidite, R=reidite, PF=planar feature, OW=opaque white, Z=zircon.

* total common Pb (assuming blank isotopic composition up to 10 pg).

Model Th/U calculated from radiogenic 208Pb/206Pb ratio and 207Pb/206Pb age assuming concordance.

207Pb/204Pb corrected for fractionation and spike; Pb/U ratios corrected additionally for blank and initial Pb [14].

% Disc. Is percent discordance for the given 207Pb/206Pb age.

Decay constants from Jaffey et al.[15].