PETROGRAPHY AND GEOCHEMISTRY OF UPPER EOCENE SPHERULES FROM ODP 709C (INDIAN OCEAN) AND DSDP 612 (NW ATLANTIC). D. Rajmon, A. M. Reid, and P. Copeland, Department of Geosciences, University of Houston, Houston, Texas 77204-5007, USA; drajmon@yahoo.com.

Introduction: There is a good agreement among researchers that the Upper Eocene microtektites and microkrystites found in the Caribbean and the Gulf of Mexico represent ejecta from Chesapeake Bay (NAT layer) and Popigai (CPX layer) impact structures separated by 10-15 ky [1]. Microtektites and microkrystites found elsewhere in the world are variously correlated to the same two impact events [2; 3] or they are thought to represent 2-7 additional impact events [4-6]. These divergent interpretations are due to uncertainties in biostratigraphic correlation of individual sampling sites and lack of consistent high precision isotopic dates for spherules. We decided to test the hypothesis that spherules in SE Asia and NW Atlantic are one million years older than the well-established ejecta couplet [4-6]. Data presented here where acquired in support of planned Ar isotopic dating. Details of this study can be found in [7].

Analytical methods: Samples were acquired from ODP leg 115, site 709, hole C, core 31X, section 4W, interval 133-138 cm, and DSDP leg 95, site 612, core 21X, section 5W, interval 112-115 cm. The ODP 709C sample was ~10 cm3 of mostly soft carbonate mud with visible dark spherules less then 1 mm in diameter. The DSDP 612 sample consisted of several hard dry pieces (total ~ 2-3 cm3) of mostly clay and carbonate mud with pieces of glass up to 2-3 mm in diameter.

Both core samples were disintegrated in water and carbonate was removed with 1 N HCl in an ultrasonic bath. The samples were then wet sieved through 230-mesh sieve. The coarse fractions were processed via density separation in bromoform-acetone solution (2.15 g/cm3). The heavier separated fraction was then studied with optical microscope and classified into several groups of grains. Several grains of each type were sampled, mounted on a polished thin section and studied with optical microscope, SEM and electron microprobe.

Results: Petrography and composition of the DSDP 612 glass (“612clear”) corresponds to the earlier published data.

The ODP 709C sample yielded estimated thousands of microtektites and microkrystites, which were classified in four groups based on their visual appearance: “709BWcryst”, “709BGtransp”, “709clear “and “709milky“ with estimated relative proportions 15, 17, 5 and 63 %, respectively.

“709BWcryst” are mostly brown spherules with medium to light yellow-brown glass and dark brown to black, elongated, dendritic crystals, presumably clinopyroxenes. Several spherules are whitish with white crystals. The glass shows dense dendritic/wormy crystalline texture visible with crossed polarizers and almost invisible with parallel polarizers. In some spherules, the wormy texture occurs close to surface only, in others penetrates the whole spherule. The texture could be the result of glass devitrification and/or alteration but Glass et al. [8] interpreted this crystalline texture as primary. Many spherules contain small opaque crystals, occurring on and just below the spherule surface. “709BWcryst” apparently correspond to cpx-spherules of Glass et al. [8] and dark microkrystites of Liu and Glass [9]. Glass contains less Al, Cr, Mn, S and K but more Ca, Mg, Fe and Ti then the crystals. “709BWcryst” compositions more closely resemble the spherules from DSDP 216 (SE Asia layer) than those from DSDP 292 or from the CPX-layer (Popigai event).

“709BGtransp” are brown-green translucent to transparent spherules. The spherules appear brown to light yellow-brown with greenish hue in thin section. They commonly display the dendritic/wormy crystalline texture, sometimes radially oriented with respect to the spherule. The composition is much richer in Ca and Mg and poorer in Al, K, Na and Si as compared to “612clear”.

“709milky” are brown-green milky spherules. They look very much like “709BGtransp” except the color and any texture is mostly obscured by cloudy haze. They are completely filled with the dendritic/wormy crystalline material. In one spherule, the haze appears to be caused by <1 µm densely distributed dendritic/wormy inclusions/crystals. “709milky” (as well as “709BGtransp”) apparently correspond to cryptocrystalline spherules of Glass et al. [8] and light microkrystites of Liu and Glass [9].

“709clear” are colorless tektite fragments and spherules, in some cases with yellowish hue. Some grains contain 1-5 µm bubbles. Appearance and composition of this glass looks indistinguishable from “612clear” and the glass corresponds to microtektites from ODP 709C core described by Liu and Glass [9]. One grain is almost pure silica glass.

Average chemical compositions of analyzed grains are shown in the plot. All data were normalized to 100 wt.% totals. Compositional fields for the glass and microkrystites of the NAT layer (solid), the CPX (microkrystite) layer (long dashed) and two sites of the proposed SE Asia layer (short dashed) are shown for comparison and are based on published data [10-14].

In summary, the major oxide compositions of the spherules from ODP 709C are most similar to compositions of the spherules from DSDP 216 (in both average values and variation) but have somewhat lower K2O content. The compositions of microkrystites ("709BWcryst, BGtransp and milky") also partially overlap composition of spherules from the CPX layer. The light microkrystites ("709BGtransp and milky") have distinctly higher CaO and MgO and lower FeO, Al2O3 and K2O content than the dark microkrystites ("709BWcryst"). The colorless microtektites ("709clear") correspond to material from DSDP 216 core, which overlaps the composition of the NAT related microtektites. Contrary to [5, 14], we conclude that the chemical and petrographic data neither clearly support nor reject the hypothesis of separate ejecta layer in SE Asia.

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