

**DISCOVERY OF COESITE AND SHOCKED QUARTZ ASSOCIATED WITH THE UPPER EOCENE CPX SPHERULE LAYER.** S. Liu<sup>1</sup>, Frank T. Kyte<sup>2</sup> and B.P. Glass<sup>1</sup>,  
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At least two major impact ejecta layers have been discovered in upper Eocene strata [1]. The upper layer is the North American microtektite layer. It consists tektite fragments, microtektites, and shocked mineral grains (e.g., quartz and feldspar with multiple sets of PDFs, coesite and reidite (a high-pressure polymorph of zircon)) [2-4]. The slightly older layer contains clinopyroxene-bearing (cpx) spherules and microtektites associated with an Ir anomaly [5-7]. The North American tektite layer may be derived from the Chesapeake Bay impact structure, and the cpx spherule layer may from the Popigai impact crater [8-9]. A cpx spherule layer associated with a positive Ir anomaly was recently found at ODP Site 709, western Indian Ocean [10].

A large sample (Hole 709C, core 31, section 4, 145-150 cm), originally used for a study of interstitial water by shipboard scientists, was acquired for the purpose of recovering a large number of spherules for various petrographic and geochemical studies. A split of the sample (50.35 g) was disaggregated and wet-sieved. More than 17,000 cpx spherules and several hundred microtektites (>125  $\mu\text{m}$ ) were recovered from the sample. Rare white opaque grains were observed in the 125-250  $\mu\text{m}$  size fraction after removal of the carbonate component using dilute HCl. Seven of the white opaque grains were X-rayed using a Gandolfi camera and six were found to be coesite (probably mixed with lechatelierite). Eighty translucent colorless grains from the 63-125  $\mu\text{m}$  size fraction were studied with a petrographic microscope. Four of the grains exhibit one to two sets of planar deformation features (PDFs).

The only other possible known occurrence of shocked minerals associated with the cpx spherule layer is at Massignano, Italy, where pancake-shaped clay spherules (thought to be diagenetically altered cpx spherules [11]) are associated with a positive Ir anomaly and Ni-rich spinel crystals. Shocked quartz grains with multiple sets of PDFs also occur at this site [12]. Until now, unmelted impact ejecta have not been found associated with the cpx spherules at any of the other 20 sites around the world and this is the first time that coesite has been found associated with the cpx spherule layer. The discovery of coesite and shocked quartz associated with the cpx spherules at Site 709 in Indian Ocean is further evidence for the impact origin of the cpx spherule layer. We hope that future discovery of other unmelted minerals from this sample may provide materials to establish constraints on the provenance of this late Eocene ejecta.

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**References:** [1] Glass B.P. & Burns C.A. (1987) *Meteoritic* 22, 265. [2] Thein J.E. (1987) *Initial Reports of DSDP 95*, 565. [3] Glass B.P. et al. (1998) *MAPS* 33, 2, 229. [4] Glass B.P. & Liu S. (2001) *Geology* 29, 4, 3371. [5] Glass B.P. et al (1985) *JGR*, B. 90, Suppl. D175. [6] Montanari et al (1993) *Palaios*. 8, 5, 420. [7] Kyte F.T. (2001) *Proc. ODP, Sci. Results*, 177. [8] Koeberl C. et al. (1996) *Science*, 271, 1263. [9] Grieve R.A.F (1996) *MAPS* 331, 166. [10] Kyte F.T. & Liu S. (2002) *LPSC XXXIII* (abs), #1981. [11] Pierrard O. et al. (1998) *Geology* 26, 4, 307. [12] Clymer A.K. et al. (1996) *Geology* 24, 6, 483.