THE COLLISIONAL EVOLUTION OF OBJECTS CAPTURED IN THE OUTER ASTEROID BELT DURING THE LATE HEAVY BOMBARDMENT. W. F. Bottke, H. F. Levison, D. Nesvorný, *Southwest Research Institute, 1050 Walnut St, Suite 400, Boulder, CO 80302; bottke@boulder.swri.edu*, A. Morbidelli, *Obs. de la Côte d'Azur, B.P. 4229, 06034 Nice Cedex 4, France*, M. Gounelle, *Museum National d'Histoire Naturelle, 75 005 Paris, France*.

Introduction. Levison *et al.*, in a companion ACM 2008 abstract, describe how the dynamical reorganization of the outer solar system ~ 3.9 Gy ago (i.e., the so-called *Nice model*) led to the capture of numerous comets within the Trojan [1], Hilda, and outer main belt (MB) regions. A problem with this scenario, however, is that the Nice model predicts that dormant comet-like objects, referred to here as P/D-type objects [e.g., 2], should dominate these populations. This is true for the Trojans and Hildas but not for the outer main belt, whose P/D-type population is only $\sim 20\%$ of the total [2]. To probe this discrepancy, we examined a process missing in the dynamical calculations, namely how the implanted comets would have been affected by impacts over the last 3.9 Gy.

Collision Model. To estimate the total number of P/D-type objects in the aforementioned populations and compare these values to observations, we used CoDDEM, a self-consistent code capable of following the collisional evolution and dynamical depletion of multiple interacting size-frequency distributions (SFDs) [3]. We tracked five populations in our code: (1) indigenous inner MB ($a < 2.82$ AU), (2) indigenous outer MB, (3) captured outer MB, (4) Hildas, and (5) Trojans.

The collision probabilities and impact velocities of the objects with both themselves and each other were computed from the observed objects or, in the case of the Trojans, were taken from the literature [4]. Objects in pop. 1 and 2, which represent native asteroids, were given a bulk density (ρ) of 2.7 and 2.0 g cm^{-3}, respectively, and were assumed to follow the same disruption scaling law of undamaged basalt [5]. We also assumed that the inner and outer MB SFDs initially had the same shape 3.9 Gy ago as they do today [3]. The captured populations (3-5) were assigned $\rho = 0.5$ g cm^{-3}, the same as many observed comets/Trojans/KBOs, and a disruption scaling law consistent with fragmented ice [6]. Note that this implies that implanted comets are easier to break up than indigenous asteroids. Their initial SFDs were determined by scaling the observed Trojan population to the dynamical results of Levison *et al.*

Results. Fig. 1 shows the initial and final states of the captured outer MB. Because of our choice of a weak disruption scaling law, a much larger fraction of the captured objects are destroyed by impacts than their stronger indigenous counterparts. As a result, the remaining population only makes up $\sim 15\%$ of the current outer MB with diameters $D > 40$ km. This is consistent with the fraction of D/P-types within the outer MB over the same size range ($\sim 20\%$; [2]). The model also predicts that the SFD of the primitive bodies is steeper than that of the indigenous population for $D > 20$ km, so that the fraction of D/P-types should increase for decreasing diameter. Though bias-corrected data at smaller sizes is limited, this also appears to match observations [2]. Finally, our model reproduces the Trojan and Hilda SFDs for $D > 40$ km objects fairly well given our uncertainties. This match provides a critical consistency check on our model's assumptions.

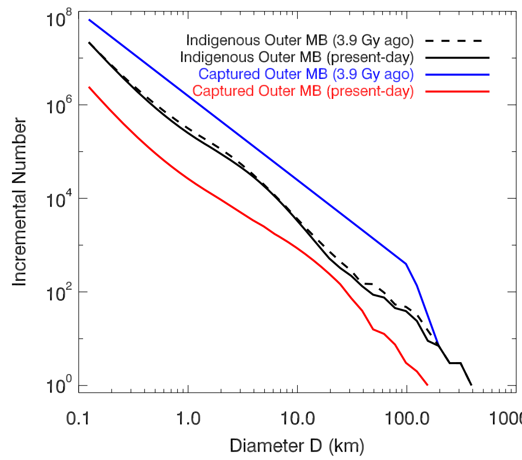

Figure 1: The indigenous and captured component of the outer main belt (2.8-3.8 AU) both 3.9 Gy ago and today according to CoDDEM modeling results.

Implications. We find the captured outer MB comets, at the present epoch, produce 3 times as many micrometeorites (MMs) as the rest of the main belt, despite the fact that they are only 20% of the outer MB population. We believe this explains why the vast majority of unmelted MMs found in Antarctica are reminiscent of primitive meteorites like CIs and Tagish Lake. Note that Tagish Lake itself has been spectroscopically linked to low albedo D-type objects, which as described above, are excellent candidates to be captured comets. It also helps explain why some meteorites (e.g., CR chondrites) are surprisingly similar to the cometary materials returned by the STARDUST mission [7].

References. [1] Morbidelli *et al.* (2005) *Nature* **435**, 462. [2] Burbine *et al.* (2008) In *Rev. Min. Geochem.* **68**, 273. [3] Bottke *et al.* (2005) *Icarus* **179**, 63. [4] Dahlgren (1998) *AA*, **336**, 1056. [5] Benz and Asphaug (1999) *Icarus* **142**, 5. [6] Leinhardt *et al.* (2007) *ArXiv e-prints* **705**. [7] Weisberg *et al.* (2008) *LPSC* **39**, 1981.