POSSIBLE FORMATION OF THE VESTA-FAMILY ASTEROIDS AND THE MAIN IRAS DUST BAND BY AN OBLIQUE IMPACT ON VESTA. J. T. Wasson[1], C. R. Chapman[2], K. Grogan[3] and S. F. Dermott[3]. [1]Univ. of California, Los Angeles, CA 90095, [2]Southwest Research Institute, Boulder, CO 80302, and [3]Univ. of Florida, Gainesville, FL 32611

Spectroscopic studies by Binzel and Xu [1] showed that a large fraction of the asteroids linked to Vesta on the basis of similar orbits share Vesta's unique, sharply defined basaltic reflection spectrum. These asteroids, which we will call vestoids, have diameters ≤10 km. Galileo studies of Gaspra and Ida show that spectral properties of FeO-rich surfaces degrade quickly; it appears that an ordinary-chondrite surface may resemble a typical S-asteroid within about 100 Ma [2], and the degradation of FeO-rich basaltic surfaces would be comparable. It follows that the nearly unweathered surfaces of Vesta and the vestoids may be <10 Ma old, in which case the vestoids were probably formed in the same collisional event that resurfaced Vesta [3]. The semimajor axes of the vestoid orbits show a remarkably wide range from smaller than that of Vesta at 2.36 AU to 2.47 AU, near the 3:1 period resonance with Jupiter that appears to be responsible for bringing most stony meteorites from the Asteroid Belt to Earth . Cratering mechanics predicts small mean ejection velocities for 4-10 km asteroids excavated from the crust and launched from Vesta, much less than the 470 m s^{-1} observed for the vestoids [1]. A grazing impact offers a straightforward way to obtain high ejection velocities but in this case the vestoids would mainly be from the projectile rather than from Vesta [4]. If the projectile were a differentiated body, it seems unlikely that such a large fraction of the fragments would be from the crust and thus have basaltic spectra. An alternative is that all fragments were coated by the dust generated during the impact event, and that this dust is mainly from Vesta. This layer is expected to persist several Ma, depending on thickness, which in turn depends on the efficiency of dust accretion by the vestoids. Such a recent dusty event might be expected to show up in the IRAS studies of asteroidal dust bands. In fact, the most prominent band, the 10° dust band, was inferred to have a semimajor axis of 2.44 AU, similar to that of the Vesta family, and an inclination of ≈8.4° [5], slightly higher than the family mean (≈7°). Detailed modeling experiments show that the inclination of this IRAS dust band cannot be explained by the hypothesized Vesta event nor by the steady-state grinding among Eos family members, the explanation proposed earlier [5]. It appears possible, however, to explain this band with a mixture of dust from a recent event at Vesta and the steady-state production by the Eos family.

Schultz and Gault [6] noted that, on Earth, an impact angle Ø<5° results in "a nearly intact ricochet of the projectile", whereas 5≤Ø≤15° leads to disruption into 5-10 large fragments retaining about 50% of the original impact velocity. About 5% of random impacts occur in this range of angles. Wasson [4] assumed the size-frequency relationship of Dohnanyi [7] to estimate the amount of dust expected in the collisional event, and found that a collection efficiency of l% for the dust (10 μm to 1 cm) produced a mean dust depth of ≈1 cm on the kilometer-size fragments produced in the hypothesized collision.

The vestoids are, on average, redder than Vesta; if they formed in the same event, they appear to be weathering faster. This is opposite to the trend expected if these asteroids consisted fully of basaltic (or diogenitic) materials. In such a case Vesta, which can retain a deep regolith, would weather more rapidly than the vestoids, which inefficiently retain regolith because of their low escape velocities. According to our model, the degradation of the vestoid spectra occurs because excavated nonbasaltic intrinsic materials slowly cover up (or mix with) the thin layer of basaltic dust. Observations of Gaspra and Ida suggest that 10% dilution with fresh material would occur within about 10 Ma.

We attempted to model the IRAS 10° dust with dust initially having the same orbital parameters as the vestoids and found that diffusion of this dust band to higher inclinations did not occur. Thus, this simple model cannot explain the so-called 10º band, the most prominent of the IRAS dust bands. The early idea was that this band was due to steady-state grinding by collisions of the Eos family members. However, simulations of the band by Dermott and Nicholson (5) revealed a 8.4º inclination, appreciably lower than that of Eos, 10.2°; they also inferred a semimajor axis (2.44 AU) much smaller than that of Eos, but because of the high uncertainty, this did not provide a major constraint. We are now examining mixes of Vesta and Eos dust to find a proportion that will match the IRAS observations.

References: [1] Binzel R. P., and Xu S. (1993). *Science* **260**, 186. [2] Chapman C. R et al. (1995). *Nature* **374**, 783. [3] Pieters C. and Binzel R. P. (1994) *Lunar Planet Sci.* **25**, 1083. [4] Wasson J. T. (1996) *Icarus*, submitted. [5] Dermott S. F., and Nicholson P. D. (1989). *Highl. Astron.* **8**, 259. [6] Schultz P. H. and Gault D. E. (1990) *Geol. Soc. Spec. Paper* **247**, 239. [7] Dohnanyi J. S. (1969) *J. Geophys, Res.* **74**, 2531.