AN EARTH-CROSSING SOURCE BODY FOR THE BASALTIC ACHONDRITES: VESTA'S SON OR VESTA'S NEPHEW? Jeffrey F. Bell (Hawaii Institute of Geophysics, University of Hawaii, 2525 Correa Road, Honolulu HI 96822)

INTRODUCTION: The discovery of a basaltic crust on the large asteroid Vesta in 1970 (1) had a profound impact on our understanding of asteroids and meteotites, by demonstrating that at least some very small planetesimals had undergone complete geochemical differentiation. The extent of this very early volcanic episode, the source of the heat which caused it, and the suitability of Vesta as a parent body of the basaltic meterorites are still topics of debate. Several other asteroids have been identified over the years as other possible source bodies for the basaltic meterorites. Most recently, 5-color visible photometry of the small Earth-crossing asteroid 1983 RD has suggested that it is a member of taxonomic type V, which previously contained only Vesta (2). A favorable apparition of this object (since numbered 3551) in late 1986 offered the possibility of testing this proposal.

MEASUREMENTS: 0.8-2.5μm reflection spectra of asteroid 3551 were obtained on 23 October 1986 with the 3-meter NASA Infrared Telescope at Mauna Kea, Hawaii. The InSb detector system "RC2" was used with circular variable filters. Due to the low predicted brightness of this object (m_B=15.4) and the short observing time available due to its southerly position (-40°), we obtained photometry in only 26 channels of the 52-color system. Approximatly 30% of the data obtained was found to be distorted by a defect in the instrumentation and was discarded. The solar-like star 16 Cyg B was used for extinction corrections.

RESULTS: The average spectrum obtained is shown in Figure 1. Althougth somewhat noisy, the deep pyroxene absorption bands clearly indicate a basaltic composition. In fact, out of over 130 asteroids observed in this wavelength range to date, only 4 Vesta and 3551 1983 RD possess this distinctive spectral signature. Within the error bars, the spectrum of 3551 is identical to that of Vesta. Unfortunatly, it is not possible to distinguish between eucrite-like and diogenite-like mineralogies for 3551, since the strength of the weak 1.2-μm plagioclase band cannot be measured. This would be particularly interesting since Vesta exhibits eucritic and dioginitic compositions on opposite hemispheres (3). A review of other proposed basaltic asteroids in light of this new data indicates that there is only one other viable candidate, 1915 Quetzalcoatl. The spectral data for this object are conflicting, with 24-color data showing a deep Vesta-like pyroxene band (4), but 8-color photometry indicating a normal S-type spectrum (5). There are no other V-class objects down to the limit of the Arizona 8-color survey (about 20km diameter in the inner main belt) (6). This class seems to consist only of Vesta and a few sub-kilometer fragments.

DISCUSSION: In the past the transport of meteorites from Vesta to Earth has posed some problems, since Vesta is not close to one of the dynamical resonances which currently are thought to be important in the transport process. The existence of at least one basaltic fragment on an Earth-crossing orbit at first glance eases this problem. However, there are a variety of questions raised by this discovery: Is 3551 actually a fragment excavated from the crust of Vesta, or could it have come from another parent body which no longer shows the V-class spectral signature on its surface? Vesta exhibits at least one large dunite-like area, which is interpreted as a large impact crater which penetrated the eucrite/diogenite crust into an olivine-rich mantle (3). 3551 (and 1915 as well) could have been thrown out by this event. The fact that all non-SNC basaltic achondrites seem to come from one parent body argues that the current population of <1km basaltic objects in the inner solar system is entirely derived in geologically recent times from Vesta. On the other hand, the inner asteroid belt contains many other objects whose current surfaces appear to represent the deep interiors of differentiated parent bodies. Small basaltic crust fragments could have been shed in the distant past by asteroids who currently are classified as R (peridotite), A (dunite), S (pallasite/lodranite/iron), or even M (iron). Have all these earlier generations of crustal fragments entirely perished? Or is one particular Vesta fragment in a magic orbit dominating the current flux? This latter hypothesis appears unlikely. The eucrite/howardite/diogenite meteorites represent a vast range of formation environments from deep magma chambers to surface flows to lithified regolith, and record a wide variety of geochemical histories. It seems unlikely that a single 1-km chunk carved out of a lunar or terrestrial basalt deposit would encompass the variety seen in the basaltic achondrites.

CONCLUSIONS: While the goddess Vesta had no offspring, the asteroid Vesta almost certainly does. Distinguishing them from more distant relatives would provide valuable insight into the early history of the inner asteroid belt, which has apparently been highly distorted by repeated collisions in most other classes of asteroids. The arguments outlined above suggest but do not prove that 3551 and all other small V-type asteroids which may be found in the future are ejecta fragments from geologically recent impacts on Vesta. It appears unlikely that remote observations will ever fully resolve this question; but they can at least locate the asteroids whose direct examinations would do so.

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