Comparing Small Main Belt Binary Asteroids of the Inner and Intermediate Zones using Doublet Craters on Vesta and Ceres

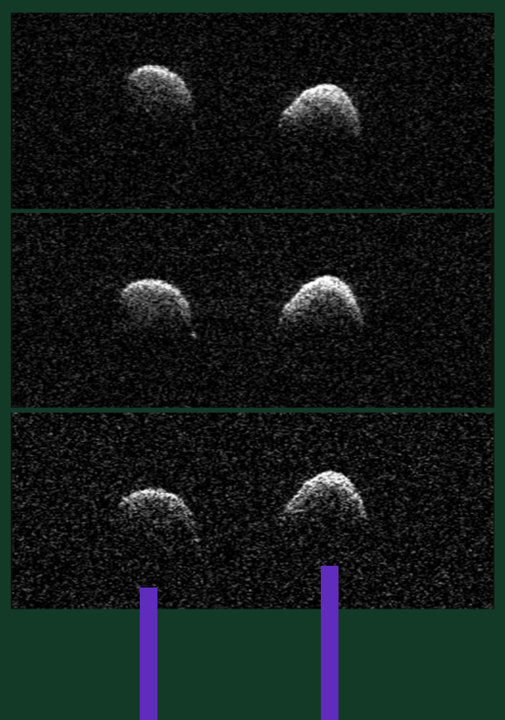
paul.wren@asu.edu

Paul F. Wren[1] and Ronald A. Fevig[2]

[1]School of Earth and Space Exploration, Arizona State University, Tempe, AZ [2]Department of Space Studies, University of North Dakota, Grand Forks, ND

BINARY ASTEROIDS

Figure 1: Binary Asteroid 2017 YE5
Image: Arecibo/GBO/NSF/NASA/JPL-Caltech



- Systems of two asteroids in orbit around each other [16]
- Figure 1 shows bistatic radar imagery of binary asteroid 2017 YE5
- 152 Binary Asteroids in the Main Belt [13], but we've likely missed the smaller binaries

QUESTION: How to detect small Main Belt binary asteroids?

ANSWER: By looking at doublet impact craters on the larger bodies in the Main Belt [14,15].

DOUBLET CRATERS

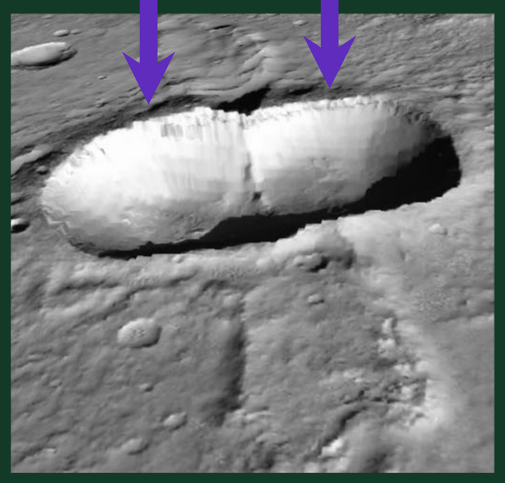


Figure 2: Doublet crater on Mars.
Image credit: NASA/JPL-Caltech/MSSS

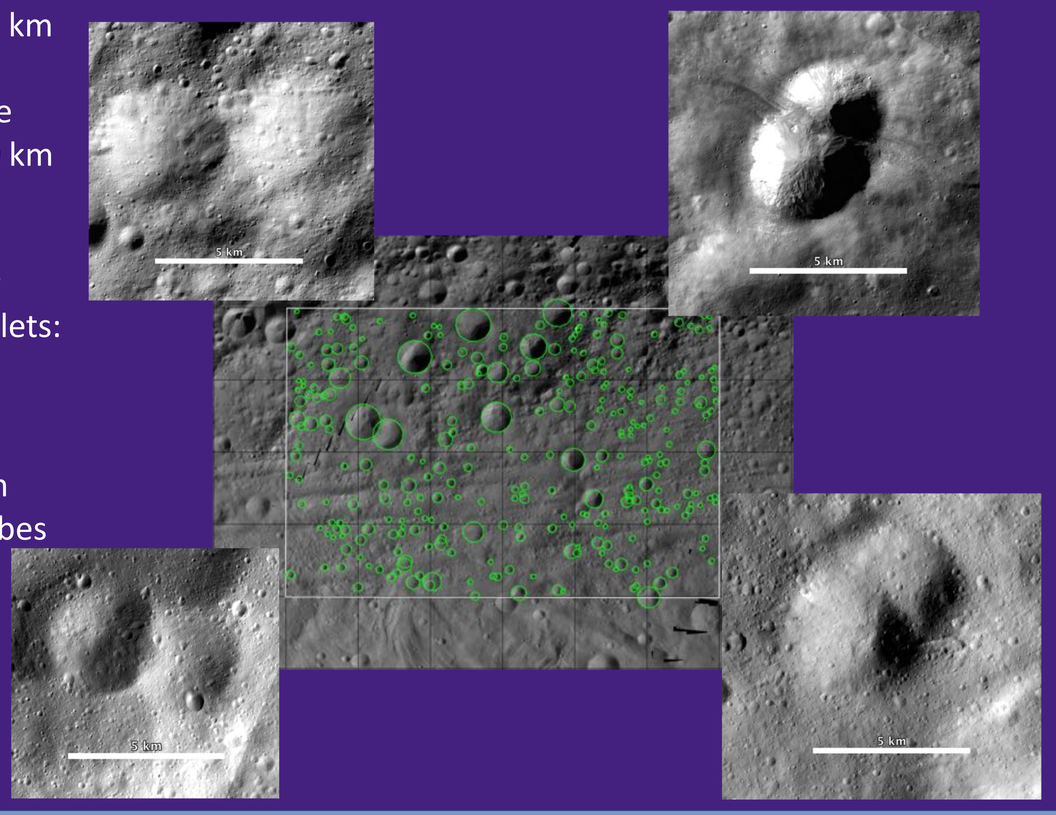
- A pair of craters created by the same impact event [1]
- Observed on Earth, the Moon, Mercury, Venus, Mars, and Ceres [2,3,4,5,6,7,8,14]
- Once attributed to a single impactor broken up by either atmospheric disruption [9] or tidal forces [1,10], further studies showed these were insufficient [11,12]
- Well-separated binary asteroids are the source of doublet craters [12]

WHAT WE DID: Surveyed 55,218 km^2 area on Vesta

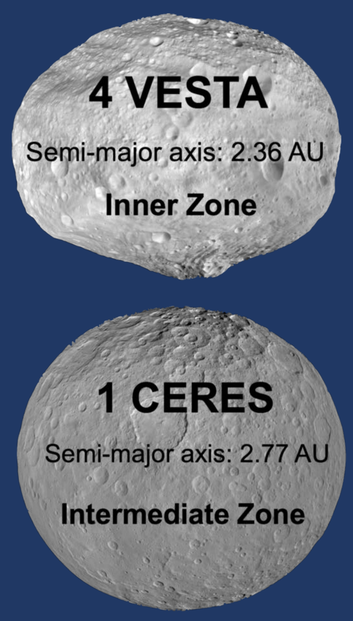
- Located 289 craters ≥ 3 km
- Identified 2087 possible pairs separated by < 20 km
- Inspected pairs for evidence supporting or rejecting them as doublets:

FOR:
✓ Similar erosion
✓ Presence of a septum
✓ Presence of ejecta lobes

AGAINST:
👎 Superposition
👎 Differing depth



WHAT WE FOUND: Twice as many Doublets on Vesta



	Mean Impactor Diameter	*Doublet Craters*
4 VESTA, Inner Zone	253m	1.4%
1 CERES, Intermediate Zone	247m	0.7%

- 4 doublets identified out of 285 impact events on Vesta (1.4%)
- Similar Ceres study [15] showed only 0.7% of impacts as doublets
- Doublet impactors are essentially the same size in both zones [15]
- We can infer 9.3% of asteroids in the Inner Zone are binary systems (only 15% of binaries create a visible doublet [2,8])

REMAINING QUESTIONS:

- What might be causing this difference?
- What parts do the ages of the target surfaces play?

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