ANTIPODAL TERRAINS CREATED BY THE RHEASILVIA IMPACT ON ASTEROID 4 VESTA

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Introduction: The Rheasilvia impact on asteroid 4 Vesta was large enough to have disrupted the terrain at the impact antipode in a manner similar to that which produced the hilly and lineated terrains opposite the Caloris basin on Mercury [1]. We utilize the iSALE shock physics hydrocodes [2-4] to simulate the impact event that formed the Rheasilvia basin and determine the amount of deformation expected at the impact antipode. In many of our models the amount of antipodal deformation is larger that the simulation resolution (400 m), and we are able to directly resolve displacements. When the amount of deformation is smaller than the simulation resolution, we rely on peak surface velocity to quantify the amount of deformation expected at the antipode. We test the dependence of antipodal deformation on three parameters: the porosity and sound speed of Vesta's mantle, and the strength of Vesta's iron core.

Results: Porosity plays a critical role in reducing the amount of impact energy that reaches the antipode. As the impact shockwave moves through the mantle, pore space is crushed out and energy is sapped from the wave. In simulations with 0% porosity, the impact antipode is significantly disrupted, to the point that a topographic feature several kilometers in height is formed. The introduction of mantle porosity quickly dampens this deformation. At 5% porosity (the expected value based on Dawn observations) no uplift can be resolved [5].

The strength of Vesta's iron core determines well the impact shockwave is transmitted through to the antipode. When a weak core is used, the core itself deforms considerably, and peak surface velocities at the antipode are small. When a strong core is used, stresses are more easily transmitted, core deformation is diminished, and velocities at the antipode are considerably higher.

As the impact shockwave passes through Vesta, the core acts like a convex lens, focusing stresses to the antipode. The amount of focusing that occurs is dependent on the sound speed difference between the core and the mantle. Raising or lowering the sound speed of the mantle changes the breadth and magnitude of surface velocities near the antipode.

Comparison to Observations: The antipodal point of the Rheasilvia impact lies on the edge of a morphologically fresh 63 kilometer diameter impact crater [6]. Any topographic uplift produced by the Rheasilvia impact would have been largely erased by the formation of the younger crater. The most convincing evidence that deformation did occur at the antipode comes from crater densities. At large crater sizes (D>9 km), densities resemble those of the ancient Vestan terrains that predate the Rheasilvia basin. At small crater sizes (D<3 km), densities resemble those of the Rheasilvia ejecta blanket. This suggests that the Rheasilvia impact induced enough deformation at its antipode to significantly degrade or erase craters several kilometers in diameter.

References: [1] Bowling T. J. et al. (2013) *JGR Planets, accepted*. [2] Wünnemann K. et al. (2006) *Icarus, 180,* 514. [3] Amsden A. et al. (1980) *Los Alamos National Laboratory Report, LA-8095*. [4] Ivanov B. A. et al. (1997) *International Journal of Impact Engineering, 20*, 411. [5] Jaumann R. et al. (2012) *Science, 336,* 687. [6] Blewett, D. T. et al. (2013) *JGR Planets*, *submitted*.

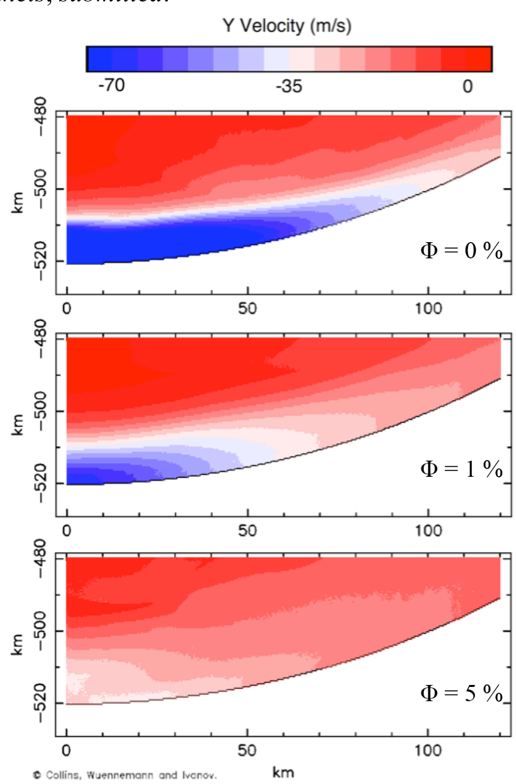

Figure 1: Peak surface velocity at the Rheasilvian antipode following the arrival of the impact shock wave, for mantle porosities of 0%, 1%, and 5%. The impact occurs at the origin.