Origin of Basaltic Asteroids in the Main Asteroid Belt

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Asteroid (4) Vesta, located in the inner asteroid belt, is the only known large asteroid currently showing a basaltic crust, implying that it underwent mineralogical differentiation. It is associated to a large dynamical family that was formed by an impact excavating a crater on Vesta's surface. Since 2000, many small basaltic asteroids have been discovered that are not members of the Vesta family, raising the question of whether they are fragments from Vesta or from other differentiated bodies. We simulated the orbital evolution of 6600 test bodies with initial orbits within the Vesta family over 2 Gy, aiming to reproduce the dynamics of fragments ejected from Vesta's surface over the Vesta family age. Our model included gravitational perturbations of all planets except Mercury and the Yarkovsky effect. The results show that a large fraction of the original Vesta family members may evolve out of the family borders. We compared the distribution of our model fragments to that of the known basaltic asteroids outside the Vesta family to find that: (i) Most basaltic asteroids with $a < 2.3$ AU are likely fugitives from the Vesta family that have evolved to their current orbits over the past 2 Gy through various identified dynamical pathways. (ii) Many basaltic asteroids with $2.3 < a < 2.5$ AU show lower inclinations than the Vesta family and were not reproduced in our simulations with sufficient efficiency. (iii) Some basaltic asteroids beyond 2.5 AU may have reached their present orbits by crossing the 3/1 Jovian mean motion resonance or by following other identified pathways. We propose that those populations that are partially explained by our model might include fragments from differentiated bodies other than Vesta; or they were liberated from Vesta's surface during the epoch of planetary migration 3.8 Gy ago.