UNDERSTANDING DIVERSE SHOCK AND BRECCIATION HISTORIES OF BASALTIC AND OTHER METEORITES
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Introduction: Two major types of meteoritic basalts, eucrites and angrites, have remarkably different textures. Eucrites are mostly breccias, commonly shocked and metamorphosed. By contrast, the 8 angrites are unbrecciated, unshocked and largely unmetamorphosed [1]. Ordinary chondrites and aubrites, like eucrites, are commonly brecciated, shocked, and metamorphosed, whereas acapulcoite, lodranite, brachinite and CO3 chondrite breccias and shocked samples are rare. What caused this textural dichotomy?

Parent bodies of large meteorite groups: Many large meteorite groups are linked to families in the inner asteroid belt that formed < 2 Ga (e.g., the CM, L, and HED meteorites are connected by a collisional cascade to the Baptistina, Flora, and Vesta families [2, 3]). These families are not only dynamically favored to produce meteorites but they also possess an enormous reservoir of fragments, such that collisions on family members tend to produce many more meteoroids than smaller asteroid groups residing in the same region of space.

Dating shock and breccia formation: The surface area of family asteroids >3 km across can be 100× greater than that of the original body implying that impact processing is more efficient on small bodies. However, several features suggest that some breccias/shocked rocks formed on large bodies [4-7]. Given that asteroidal regolith breccias are consolidated at much greater depths than lunar regolith breccias [8], and that family-forming events cause mixing between material near the parent body’s exterior and fragments from the interior, many shocked/brecciated rocks in a meteorite group should be a combination of old/new material. Accordingly, these rocks are telling us about (i) life on the parent body, (ii) deformation and mixing during the family-forming event, and (iii) subsequent impacts on the meteorite-precursor bodies.

Discussion: There are few angrites so the lack of breccias could be a fluke (i.e., perhaps their precursor just happened to be coherent). But it could also mean that they do not come from a traditional family-forming event. We propose that the angrite parent body was Ceres-sized or larger [cf. 10, 11] and experienced a “hit-and-run” collision with a protoplanet [12]. A ~10 km body produced by this event was then dynamically embedded in the main belt 4.5 Ga [13]. We argue that the small size of the precursor limited the amount of shocked/brecciated rocks it could retain, so that its disruption mainly produced coherent rocks.