

# **The meteorite-asteroid connection: critical gaps and opportunities**

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Virtually all meteorites regardless of class or chemical composition can be characterized by a common set of chemical and physical traits, including isotope variations (both primordial and cosmic-ray induced), some evidence of shock such as microcrack porosity, and some sort of space weathering. Arguably the same must be true of the unsampled asteroidal material as well.

All meteorites come from an collisional environment that progressed from lithifying accretional collisions, to more energetic impacts that fragmented asteroids without destroying them, to catastrophic impacts followed by reaccretion of the fragments into rubble piles, and finally resulting in the impact events that launched meteoritic material into orbits that ultimately intersected the Earth. These same events should lead to characteristic traits in the asteroids themselves, including significant fracturing and macroporosity, the darkening of asteroidal surfaces, and the sorting of materials within an asteroid on the basis of particle size and density.

Spacecraft experiments can contribute to our understanding of these issues in a number of ways. Ultimately, one would like to see experiments that could measure the nature and extent of void spaces in asteroids, and measurements on the surfaces of asteroids to characterize their compositions and physical natures (for example, the presence and size of chondrules or nanophase iron) precisely enough to compare the surface material against the material in our meteorite collections. In addition, sample-return missions will be necessary to measure the shock and isotopic histories of the materials on their surfaces. Unfortunately, all such missions will be difficult, and expensive to mount.

However, a significant amount of information about an asteroid can be determined even by simple flyby missions. Knowing the density and spin rate of an asteroid, combined with an accurate shape of the body (determined by detailed imaging over a range of aspects), can give important information about the degree, if not the nature, of its total content of void spaces. Such measurements can also put limits on the nature of the lithostatic stresses within an asteroid, and put quantitative limits on the internal strength of the asteroid. Even where the density cannot be measured, accurate spin/shape information can put useful limits on an asteroid's density, void spaces, and stress state.