THE EVOLUTION OF GIANT IMPACT EJECTA AND THE AGE OF THE MOON

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The Moon formed in a giant impact (GI) between a very large protoplanet and the proto-Earth. The GI was probably the youngest largest collision to take place in the terrestrial planet region. A mystery, however, is precisely when the GI took place; estimates range from ~10 My to >200 My after CAI formation. Here we examine a novel method to calculate the GI's timing and effects. Hydrocode simulations of the GI show that, on average, ~5% of an Earth-mass escapes the Earth-Moon system. Before being collisionally and dynamically eliminated, however, considerable GI ejecta will be driven onto asteroid belt-crossing orbits by planetary perturbations and resonances. This allows some GI fragments to slam into primordial main belt asteroids at velocities > 10 km/s. Using methods defined in Marchi, Bottke et al. (2013; Nature Geo.), we find these ejecta likely produced a suite of ancient Ar-Ar shock degassing ages in asteroidal meteorites. Modeling this process, we find the GI took place 100 ± 30 My after CAI formation. Impacting GI ejecta may explain other events near this time (e.g., the ages of the most ancient lunar and martian zircons). We speculate that remnants of the primordial Earth and Moon-forming impactor might still be found as ancient meteorite clasts.