Implications of the Moon-forming impact for late stage terrestrial accretion

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The “canonical” Moon-forming impact by a Mars-sized body produces a planet-disk system whose angular momentum is comparable to that in the current Earth and Moon, together with an iron-poor Moon (Canup & Asphaug 2001; Canup 2004). However in canonical impacts, the disk is formed primarily from impactor derived material, and is thus expected to have an initial composition distinct from that of the Earth’s mantle. This is at odds with multiple close compositional relationships between the Moon and the Earth’s mantle, although post-impact equilibration offers a potential solution (Pahlevan & Stevenson 2007). Cuk & Stewart (2012) argue that the Earth-Moon system angular momentum could have been decreased by a factor of two or more through capture of the Moon into the evection resonance, which allows for much higher angular momentum Moon-forming impacts. Two impact scenarios – involving either the high-velocity impact of a sub-Mars object into a protoearth that is rotating at nearly the fission rate before the Moon-forming collision, or the low-velocity impact of a half-Earth sized impactor -- can produce a disk with a comparable silicate composition to that of the planet’s mantle (Cuk & Stewart 2012; Canup 2012). Such models have different implications for the nature of Earth’s late stage accretion.