Geophysical constraints on the accretion, early thermal evolution, and bombardment history of the Moon and Mars

Jeffrey C. Andrews-Hanna
Department of Geophysics and Center for Space Resources
Colorado School of Mines
Golden, CO

Although the first 500 Myr of planetary evolution is largely absent from the geological records of the terrestrial planets, geophysical data provides important constraints on planetary accretion and differentiation. GRAIL gravity data reveals evidence for extensive intrusive activity driven by the early expansion of the Moon. This observation suggests that the Moon possessed a shallow magma ocean underlain by a cooler interior, providing a constraint on lunar accretion from an impact-generated disk. For Mars, the tectonic record cannot discriminate between hot and cold start models. The late stages of planetary accretion should have been characterized by declining fluxes of impacts, with the potential for giant impacts to leave lasting signatures. Giant impact basins have been proposed to explain the northern lowlands of Mars and the Procellarum region of the Moon. Analysis of gravity and topography data supports the existence of the hemisphere-scale Borealis basin on Mars. In contrast, GRAIL gravity data finds no evidence for the Procellarum basin, and instead reveals a set of ancient tectonic-magmatic structures of endogenic origin. The formation and subsequent evolution of the planets are a continuum of processes, with the earliest geophysical records providing useful constraints on planetary accretion and differentiation.