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Early History of Titan

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We revisit models for the early history of Titan. Our models are formed a few My after the production of calcium-aluminum inclusions (CAIs), consistent with the dates required by our thermophysical-dynamical modeling of Saturn's medium-sized satellites. Depending on the time of formation with respect to CAIs, the accretion timescale, and the available accretional energy, models of Titan's interior after accretion are partially to fully differentiated. At one extreme, the model Titan accretes incorporating a minimal amount of heat. This results in a relatively cold core that, over the long term, heats up and overturns, consistent with previous models of Titan. At the other extreme, a lot of heat is accreted. For this model of Titan complete differentiation quickly occurs, there is no core overturn, and conditions soon develop for silicate serpentinization and hydrothermal activity to occur. We identify the periods during which conditions are suitable for hydrothermal geochemistry leading to the production of molecular nitrogen from ammonia decomposition and methane from the Fischer-Tropfsch reaction. Key issues involve the storage of the reactants and products inside Titan, and mechanisms by which they are released to the surface.

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