

Titan's internal structure and evolution

Gravity measurements indicate that Titan's normalized moment of inertia is 0.33-0.34, larger than expected for a fully differentiated body. There is circumstantial evidence for a subsurface ocean, from Huygens electromagnetic observations, Titan's spin state, and Titan's non-hydrostatic shape. Detection of gravity variations due to tides may confirm the presence of an ocean. If Titan's shape is due to shell thickness variations, this indicates the shell is not convecting, probably because of a cold, ammonia-rich ocean beneath. Long-term shell convection is also inconsistent with Titan's surprisingly high eccentricity.

Titan's moment of inertia suggests either hydrated silicates or an ice-rock mixture in its deep interior, both of which imply relatively cold temperatures. On the other hand, the (approximately) hydrostatic gravity means that temperatures must have been warm enough to permit long-term relaxation of the interior. Low internal temperatures require accretion primarily from relatively small objects, and depletion of radiogenic elements (e.g. by leaching). Moderate (5-10%) outgassing of the silicate interior is indicated by the presence of ^{40}Ar in the atmosphere. The required reservoir of CH_4 probably resides in the near-surface, perhaps in clathrates. Communication between the atmosphere, ocean and interior likely resulted in feedbacks and a complex history.