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Highlights of Saturn's Icy Satellites after the Cassini mission

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The Cassini Mission turned the icy moons of the Saturnian system into stunning worlds, with active geologic processes, surfaces evoking a violent past, and habitable oceans hidden below. The first close flyby of Phoebe prior to Saturn Orbit Insertion revealed a heavily cratered world with low-temperature condensates indicating a possible origin in the Kuiper Belt (Clark, R. et al. 2005, Nature 435, 66; Johnson, T. and J. Lunine, ibid., 69.). The next surprise was the discovery of a hot spot and extensive fault system at the South Pole of Enceladus, with jets of water spewing forth from a subsurface ocean (Spencer, J. et al. 2006, Science 311, 1401; Porco C. et al., ibid. 1393; Dougherty, M. et al., ibid 1406). These jets comprised a vast plume that fed Saturn's E-ring. Close flybys of Hyperion and the small inner moons of Saturn revealed a violent past, and with densities much less than 1 gm/cc, it is likely these moons are reaccreted rubble piles. The small inner moons appear to be currently accreting particles from the rings: some have interesting accretion features around their equators and subsequent slumping.

Iapetus, which harbored one of the longtime mysteries of the Solar System with its extreme albedo dichotomy, is seen to have patches of low albedo material originating from the Phoebe ring and now nested in discrete areas on its surface. Complex hydrocarbons, the building blocks of life, were identified in this material (Cruikshank, D. et al. 2014, Icarus 233, 306). Hyperion may be coated with the same material (Dalton, B. et al. 2012, Icarus 220, 252).

At least three "ecologies" alter the moons: the Phoebe ring, the E-ring, and the accretion of ring material containing a red chromophore that colors the ring moons (Filacchione, G. et al. 2012, Icarus 220, 1064), especially the embedded ones Pan and Daphnis. Superimposed are alterations to their surfaces by magnetospheric plasma and dust, although this process is not as intense as it is for the Jovian moons.

Many questions still remain: what is the longevity and variability of the activity on Enceladus? Has there been activity on Dione, as a wide range of clues suggest? What is the nature of red chromophore that colors the main ring system of Saturn and many of its moons? What is the age of the rings – and the moons embedded within? What are the minor constituents of the moons' surfaces? Has ammonia hydrate been detected? What are the mysterious red streaks on Tethys and the blue pearls on Rhea, both of which appear to be painted onto their surfaces? What is the origin of the unique equatorial ridge on Iapetus? Is it evidence for a remnant ring? Finally, why does the history of the Jovian and Saturnian moons diverge so much, with the former having physical characteristics that are determined by their position with respect to Jupiter, and the latter being formed by stochastic events?