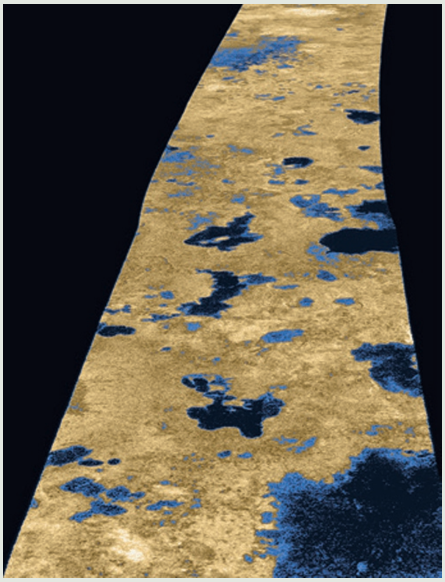
PLANETARY SCIENCE

Titan dissolved

Saturn's moon Titan is the only planetary body in the Solar System other than Earth that is known to have lakes — and its polar regions are pockmarked with hundreds of them. With steep-sided rims, rounded shapes and shallow depths, these lake depressions are distinctive features of Titan's high-latitude surface, but their origin remains an active debate. Thomas Cornet and colleagues suggest that Titan's polar terrains have been nibbled at by episodic dissolution processes, analogous to karstic dissolution on Earth (*J. Geophys. Res.* http://doi.org/4jm; 2015).

Karstic landscapes on Earth are the product of the dissolution of carbonate and evaporite minerals by the percolation of groundwater and rainfall through cracks in the rocks. Such landscapes are characterized by sink-holes and caves in humid climates. Under more arid conditions, dissolution leads to evaporitic landforms such as playa lakes, where the evaporation of ephemeral standing water leaves behind salt deposits across a dry lake-bed.

On polar Titan, however, there are probably no carbonates, salts, or liquid water. Instead, spectral data collected by the Cassini spacecraft are consistent with the presence of various hydrocarbon and nitrile organic compounds. Titan's hydrological cycle is probably dominated by methane that can condense as rain and fill topographic surface depressions in its liquid form. Many of the organic compounds thought to make up Titan's surface are soluble in liquid methane under Titan's surface conditions, suggesting that the karst-like lakes on Titan could be due to processes analogous to those that form terrestrial karstic landscapes.



NASA/JPL-CALTECH/USGS

Thomas Cornet and colleagues computed the denudation rates of Titan's surface through the dissolution of solid organics in liquid hydrocarbons using a thermodynamics–climatic theoretical model. They find that dissolution processes are likely to occur on Titan's hydrocarbon-rich surface, but at least 30 times more slowly than on Earth: on Titan, rain falls only during the summer — and the Titan year is as long as 30 years on Earth. Exactly how much dissolution occurs over a Titan year, however, depends on two factors that are not very well constrained: the composition of Titan's surface and precipitation patterns.

Nevertheless, depressions with depths of 100 metres could have formed by dissolution in a few tens of millions of years at polar latitudes, assuming present climatic conditions. This timescale is consistent with the numerous observed lakes as well as the age of Titan's surface, which shows few craters and is thus probably less than a billion years old.

Bright terrain seen in Cassini radar images around lakes and inside empty depressions would be analogous to terrestrial evaporites deposited in playa lakes in this scenario.

TAMARA GOLDIN

CARBON CYCLE

Hoard of fjord carbon

Fjords account for less than 0.1% of the surface of Earth's oceans. A global assessment finds that organic carbon is buried in fjords five times faster than other marine systems, accounting for 11% of global marine organic carbon burial.

Richard Keil

Marine geologists have long appreciated that fjords — steep-sided marine inlets carved by glaciers — are effective traps for sediments transported from the land surface (Fig. 1). Rapid erosion of coastal mountain ranges and shoals at the ocean's edge combines, resulting in high sediment loads and entrainment within the coastal system. Geochemists, however, have not paid as much attention to the role of fjords in the global carbon cycle, perhaps because fjords account for <0.1% of the marine surface area. It has been assumed that even if sediment accumulation in fjords is faster than the ocean average, the net effect on global organic carbon burial must be small. Smith and colleagues[1] flip this assumption on its head and show that fjords bury a hefty 18 Mt of organic carbon per year, despite their miniscule areal extent.

Organic carbon burial in marine sediments is typically a slow process involving the accumulation of sinking organic and mineral particles. Prior to being permanently buried, organic carbon mixed with the sinking particles undergoes extensive degradation by benthic macrofauna and microorganisms. The majority of the organic matter is remineralized back to inorganic carbon and nutrients, and only a small organic component escapes oxidation before being buried beneath the zone of active