



Geomorphological significance of Ontario Lacus on Titan: Integrated interpretation of Cassini VIMS, ISS and RADAR data and comparison with the Etosha Pan (Namibia)

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Ontario Lacus is the largest lake of the whole southern hemisphere of Titan, Saturn's major moon. It has been imaged twice by each of the Cassini imaging systems (Imaging Science Subsystem (ISS) in 2004 and 2005, Visual and Infrared Mapping Spectrometer (VIMS) in 2007 and 2009 and RADAR in 2009 and 2010). We compile a geomorphological map and derive a "hydrogeological" interpretation of Ontario Lacus, based on a joint analysis of ISS, VIMS and RADAR SAR datasets, along with the T49 altimetric profile acquired in December 2008. The morphologies observed on Ontario Lacus are compared to landforms of a semi-arid terrestrial analog, which resembles Titan's lakes: the Etosha Pan, located in the Owambo Basin (Namibia). The Etosha Pan is a flat-floored depression formed by dissolution, under semi-arid conditions, of a surface evaporitic layer (calcretes) controlled by groundwater vertical motions. We infer that Ontario Lacus is an extremely flat and shallow depression lying in an alluvial plain surrounded by small mountain ranges under climatic conditions similar to those of terrestrial semi-arid regions. Channels are seen in the southern part of Ontario Lacus in VIMS and RADAR data, acquired at a 2-years time interval. Their constancy in location with time implies that the southern portion of the depression is probably not fully covered by a liquid layer at the time of the observations, and that they most probably run on the floor of the depression. A shallow layer of surface liquids, corresponding to the darkest portions of the RADAR images, would thus cover about 53% of the surface area of the depression, of which almost 70% is located in its northern part. These liquid-covered parts of the depression, where liquid ethane was previously identified, are interpreted as topographic lows where the "alkanofer" raises above the depression floor. The rest of the depression, and mostly its southern part, is interpreted as a flat and smooth exposed floor, likely composed of a thick and liquid-saturated coating of photon-absorbing materials in the infrared. This hypothesis could explain its dark appearance both in the infrared and radar data and the persistence of channels seen on the depression floor over the time. Shorelines are observed on the border of Ontario Lacus suggesting past high-stand levels of the alkanofer table. The analogy with the Etosha Pan suggests that Ontario Lacus' depression developed at the expense of a soluble layer covering the region. Dissolution of this layer would be controlled by vertical motions of the alkanofer table over the time. During flooding events, liquid hydrocarbons covering the depression floor would dissolve the surface layer, increasing progressively the diameter of the depression on geological timescales. During drought episodes, liquid hydrocarbons of the underground alkanofer would evaporate, leading to crystallization of "evaporites" in the pores and at the surface of the substratum, and to the formation of the regional soluble layer. The presence of specific landforms (lunette dunes or evaporites) is compatible with such evaporitic regional settings. Alternatively, but not exclusively, the surface soluble layer might have formed by accumulation on the ground of soluble compounds formed in the atmosphere.

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