Geophysical Research Abstracts
Vol. 15, EGU2013-10609, 2013
EGU General Assembly 2013

Testing the sub-ice lake model for chaotic terrains on Mars: a numerical simulation

Manuel Roda, Rob Govers, and Tanja Zegers
Universiteit Utrecht, Faculty of Geoscieces, Budapestlaan 4, 3584 CD Utrecht, The Netherlands. (m.roda@uu.nl)

The identification of Hesperian chaotic terrains as the source of the outflow channels has led to a general scenario where water is rapidly discharged from the subsurface resulting in catastrophic outflows. However, the process leading to chaotic terrain formation and collection and discharge of catastrophic volumes of water has remained controversial. Geological and hydrological analysis of Aram Chaos suggests that a single, rapid and catastrophic event is sufficient to carve the outflow channel of Aram Chaos and the resulting Aram Chaos morphology imply large amount of subsidence (up to 1.5 km). These observations are in agreement with the sub-Ice lake hypothesis of catastrophic collapse of sediments induced as a consequence of melting of a buried ice sheet [1].

We use time-dependent numerical models to test different aspects of the hypothesis. The simulation starts from the complete freezing of an intra-crater lake. Subsequent ice melting and eventual destabilization is driven by planetary heat loss in combination with sediment blanketing and loading. The simulation ends when the complete sediments filling of the crater occurs.

The results show that initial freezing occurs very rapidly, 360-1300 kyr, depending on the planetary heat flux (10-25 mW/m^2). Subsequent melting of the buried ice is slow and depends on the heat flux and sedimentation rate. For the lowest heat flux (10 mW/m^2) no melting occurs. The ice melting rate decreases linearly with increasing sedimentation rate, from 150 m/Myr for the fastest (0.1 mm/yr) sedimentation to 1.5 m/Myr for the slowest (0.001 mm/yr)

The mechanical system remains stable until the complete filling of the crater, except in the case of slowest sedimentation (0.001 mm/yr) and 25 mW/m^2 heat flow. Here, a complete top-bottom fracturing of the overburden starts at the transition between the wall and the floor of the crater, when the molten ice layer reaches a thickness of 1.5-1.6 km. The thickness of water generated beneath the sediments before the mechanical destabilization is in full agreement with the amount of subsidence achieved in the Aram Chaos after the water expulsion.

This simulation suggests that, for an heat flow higher than 10 mW/m^2, the sub-ice lake model can be a reliable mechanism to explain the chaotic terrains formation.

References:

[1] Zegers, T.E., Oosthoek, J.H., Rossi, A.P., Blom, J.K., Schumacher, S., 2010. Melt and collapse of buried water ice: An alternative hypothesis for the formation of chaotic terrains on Mars. Earth and Planetary Science Letters. 297, 496 - 504.