

**STABILITY OF CLATHRATE HYDRATES AT LOW LATITUDE ON MARS.** E. Gloesener<sup>1,2</sup>, Ö. Karatekin<sup>2</sup> and V. Dehant<sup>1,2</sup>, <sup>1</sup>Earth and Life Institute, UCLouvain, Place de l'Université 1, 1348 Louvain-la-Neuve, Belgium (elodie.gloesener@uclouvain.be), <sup>2</sup>Royal Observatory of Belgium, Avenue Circulaire 3, 1180 Uccle, Belgium.

**Introduction:** The multiple detections of methane in the martian atmosphere have raised numerous questions about its potential sources. Many of the proposed generation mechanisms for CH<sub>4</sub> would take place hundreds of meters to several kilometers deep in the crust of Mars, while subsurface reservoirs such as clathrate hydrates could release methane from shallower depths.

Under appropriate low temperature and high pressure conditions, water can solidify in the presence of gases to form clathrate hydrates. Thermodynamic conditions prevailing on Mars favour clathrate formation from near subsurface to deep down in the cryosphere (<15 m up to 24 km deep; [1]) and kinetics experiments [2] showed that their dissociation, initiated by a change in temperature, pressure or composition of the reservoir, is a feasible mechanism for near-surface methane release. Stability models show that methane clathrates are stable from several tens of meters deep in equatorial regions [3-4]. However, local slopes considerably alter surface and subsurface temperatures and can therefore affect clathrate distribution in the soil.

In this work, the stability depth of methane clathrate hydrates in the martian subsurface is investigated considering sloped surfaces at low latitude and especially in regions where methane has been locally reported.

**Methods:** We follow an approach similar to [5] where the dissociation pressure of a multiple guest clathrate is calculated from the dissociation pressures of simple guest clathrates as:

$$P_{mix}^{diss} = \left( \sum_G \frac{x_G}{P_G^{diss}} \right)^{-1}$$

where  $x_G$  is the molar fraction of species  $G$  in the initial gas phase. The dissociation pressure of a simple clathrate of guest species  $G$  follows an Arrhenius law [6]:

$$\log(P_G^{diss}) = A + \frac{B}{T}$$

where  $P_G^{diss}$  is expressed in Pa and  $T$  is the temperature in K. The constants  $A$  and  $B$  fit to experimental equilibrium data.

A one-dimensional diffusion equation for subsurface temperature with depth dependent thermal conductivity, density and specific heat is solved with a semi-implicit Crank-Nicolson scheme on a grid with variable spacing. The heat balance on the sloped surface is implemented similarly to [7].

**Results:** The stability field of methane clathrate in the martian soil is shifted upwards with tilted surfaces oriented towards the pole as these slopes experience

colder surface temperature. The shallowest stability zone at  $-4.6^\circ\text{N}$  and  $30^\circ\text{N}$  has been found to occur with a slope angle of  $70^\circ$  and  $60^\circ$  respectively. At  $30^\circ\text{N}$ , CH<sub>4</sub> clathrate could be stable as close as 10 m to the surface. Moreover, at very low latitude, some equator-facing slopes can also bring the clathrate stability zone closer to the surface. At Gale crater latitude, this is the case for slope angles  $\geq 30^\circ$ . In equatorial regions, the destabilization of methane clathrates by surface processes could thus be easier on crater walls, especially as sloped surfaces are more prone to landslides.

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