Heat Sources and Hydrothermal Systems at the Internal Ocean Floors in Small Ocean Planets

Jun Kimura[1]; Steve Vance[2]; Jelte Harnmeijer[2]; Hauke Hussmann[3]; J. Michael Brown[2]

[1] ERI, Univ. of Tokyo; [2] Department of Earth and Space Sciences
, Univ. of Washington; [3] Institut fuer Planetologie, Westf. Wilhelms-Universitaet Muenster

http://www.eri.u-tokyo.ac.jp/junkim/

We examine the hydrothermal activity in extraterrestrial oceans on icy moon and TNOs, and evaluate the depth of hydrothermal system based on a model for cooling induced thermal cracking. Where fluid-rock interactions propagate slowly into a deep brittle layer, thermal energy from serpentinization may be the primary cause of hydrothermal activity in small ocean planets. We also show that the time-varying hydrostatic head of a tidally forced ice shell may drive hydrothermal fluid flow through the seafloor, which can generate significant heat through viscous interaction with porous material. Considering all presently known potential ocean planets (a number of icy satellites, Pluto and other Trans-Neptunian Objects) we find depths of circulation are more than an order of magnitude greater than in Earth assuming identical material properties and cooling rates. In Europa, Enceladus, Rhea, Titania, Oberon, and Triton, tidal flexing may drive hydrothermal circulation and, in Europa, may generate heat on the same order as present-day radiogenic heating.