Endogenic activity of medium size icy satellites of Saturn and eccentricities of their orbits

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Global volcanic and tectonic activity observed on medium size icy satellites (MIS) of giant planets are probably a result of solid-state convection. Tidal deformations and decay of radioactive elements are the main sources of heat in these bodies. The tidal deformations depend on the eccentricity of the satellite's orbit. The recent progress in 3D numerical modeling of solid-state convection driven by radiogenic and tidal heating makes possible to develop a parameterized theory of convection. Using the parameterized theory we determine the intensity of convection as a function of a satellite's properties and the eccentricity of its orbit. The theory is used for 6 MIS of Saturn. Two of them (Tethys and Dione) are presently geologically dead but they were active in the past. We find that endogenic activity on Tethys and Dione were possible if eccentricities of their orbits exceed some critical values e_{cr} that is in the range of (0.0018÷0.0021) for Tethys or (0.0022÷0.0035) for Dione. The value of e_{cr} depends on material parameters of the satellite's interior. It is also found that eccentricity of never active Rhea could not exceed 0.07. The eccentricity of Enceladus was probably close to the present value for long time. The method cannot be used to estimate past eccentricities of Mimas and Iapetus.

Keywords: medium-sized satellites, thermal evolution, tectonics, orbit, eccentricity.