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氷衛星表層地形における応力の起源
Origins of stresses in the lithosphere of icy satellites

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Surface geological features on the Moon, terrestrial planets and icy satellites reflect past interior activity which effects surface stress.

Most geologic features on icy satellites suggest a possibility that the surface have fractured and extended due to tensional stress. In case of large icy satellites such as Europa and Ganymede, it also well-recognized that the surface stresses were directly generated from the past interior activity. On these surfaces, elastic lithosphere is divided from asthenosphere due to the large viscosity contrast between the base of icy shell and the surface. Therefore we assume that surface features have been formed by the stress of elastic lithosphere that directly affected by the current and past interior activity.

We will discuss origins of stresses of elastic lithosphere of icy satellites. On surfaces of Europa and Ganymede, we can see many extensional features, stripes, bands and ridges, which have been interpreted as a sign of past interior activity, especially global volume expansion (Greenberg *et al*., 1998). In previous studies, various origins of such extensional features have been suggested.

In case of Europa, stress associated with icy convection (McKinnon (1998)) and tidal deformation (Greenberg *et al.*, 1998) discussed but the resultant of amplitude of surface stress is too small to create the observed extensional features. Therefore we thus focus on global expansion as important source of surface feature. The growth of the surface Ice-I layer is proposed for the expansion quantitatively (Kimura et al., 2007). Hillier and Squyres (1991) discussed thermal stress on small satellites of Saturn and Uranus including contribution of the phase transition of water ice, and they suggested that thermal stress is another source of surface features. Although they included an effect of temperature change due to phase transition, they neglected a contribution of volume change due to the phase transition and thermal history. Kimura *et al*. (2007) discussed surface stress on surface of Europa, and they considered stress due to temperature change and volume change of phase transition. Furthermore they also simulated interior thermal history coupling with stress calculation. Surface stress due to temperature change associated with the temperature evolution in the lithosphere and the stress raised by the excess pressure in the asthenosphere are coupled. Therefore this method is consistent with the physical process of phase transition.

In the case of Ganymede though the amount of the expansion seems significant the origin is still enigmatic. Therefore in this report we try to formulate a kind of Stefan problem which takes into account of the self-consistent adaptation of pressure build-up by phase change of Ganymede. We consider the heat transfer in the lithosphere by temperature-dependent rheology in the scheme of MLT(Kimura *et al*., 2009) and the elastic lithosphere which accumulate stress is estimated by estimated the thermal history of Ganymede.

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