The Earth's global deformation of non-plate-tectonic origin

Ryoko Ogawa[1]; Kosuke Heki[1]

[1] Div.Earth Planet. Sci., Hokkaido Univ.

Retreat of ice sheets causes slow crustal movements to achieve isostatic adjustment. Such post-glacial rebound (PGR) enables us to constrain the mantle viscosity profile. In addition to its well known near field deformation, PGR gives rise to global deformation characterized by low degree zonal harmonics. It also changes the Earth's principal axis of inertia, resulting in the slow movement of the Earth's mean pole (true polar wander, TPW). TPW changes the centrifugal potential and causes another kind of slow deformation of the Earth.

Vertical displacements due to the PGR (the longest wavelength component) and TPW have the pattern similar to the degree two spherical harmonics, i.e. P_20 and P_21, respectively (horizontal velocities are proportional to their spatial gradients). Mitrovica et al. (2001) calculated such velocity field based on a realistic Earth model and suggested that the relative velocities of PGR/TPW origin often exceed 1 mm/yr. This is well above the current uncertainties of Global Positioning System (GPS) station velocities.

We assumed that the velocities are composed of P_20 (PGR) and P_21 (TPW) terms as well as plate motions, and tried to detect these two components from the 3-D velocity data of worldwide continuous GPS sites. The estimation results suggested the existence of the P_20 components. There the obtained ratio of the Shida number l_2 to the Love number h_2 was somewhat larger than those in tidal deformation, which possibly reflects the flow in the upper mantle. On the other hand, we failed to obtain clear P_21 signals, due possibly to, (1) non-uniform distribution of GPS points, and/or (2) the existence of velocity components not considered in our model.