Elucidation of the internal evolution and rotation effect of the Earth based on high sensitive observations of earth strain

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There is a fluid core in the Earth consisting of about half radius of the whole Earth and it can rotate around the axis different from that of the mantle. It is thought from theoretical estimation that the motion of the fluid core is related with the figure of the core-mantle boundary (CMB), density distribution, temperature distribution, a magnetic field, viscosity, but the details are still unclear. It is an effective way for this study to observe the free core nutation (FCN) which is a rotational motion of the whole earth caused by the motion of the fluid core. Because its period is very close to that of diurnal tides, they are amplified by resonance. Their amplitude must be terribly big if their periods coincide.

The Z-term which is a great discovery by Hisashi Kimura is a good example showing the motion of the Earth's axis caused by the fluid core. The Very Long Baseline Interferometer (VLBI) has observed the CMB as a motion of the rotational axis of the Earth relative to the inertial space and discovered that the CMB is a little oblate. However, there is few geodetic observations succeeded in detection of FCN as surface deformation because of its small amplitude. We expect to know the density structure of the core, electromagnetic coupling at CMB other than the figure of CMB if we observe the effect of FCN on the ground.

The tidal components having periods close to that of FCN are ϕ_1 and ϕ_1, and they are not amplified very much because the periods are still apart at present. However, if the Earth changes its rotation speed, the relation between the periods of the tidal components and FCN will change, because the former is related to only the rotation speed but the latter depends on both the rotation speed and the figure of MB. Therefore, there might have been a time when both periods coincided. Based on a model of the Earth’s rotation history, we estimated the yearly variation of the relation between the periods of tidal components and the FCN. We suppose that only the rotation speed changes and the orbits of the sun and the Moon do not change. The dynamic flattening of the core is supposed to be in proportion to the square of the angular velocity of FCN. The history of the rotation speed in the geologic time is based on the result of Ooe and Abe (2002) which went back to 1,200 million years ago.

Figure shows the result of calculations from present to 1.4 billion years ago. The vertical axis indicates length-of-day (LOD) in the unit of the mean solar day at present and the difference between the periods of tidal components and FCN is shown. We find that the period of N_1 coincided with that of ϕ_1 at approximately 280 million years ago, and that ϕ_1 coincided with it at 1.25 billion years ago. There must have been catastrophic at those times. The model of the history of the Earth rotation used here does not include the effects of such as the continental drift and ups and downs of glaciers, which might have big influence on the Earth rotation. However, we can say that the periods of tides could be the same as that of FCN in the past even in the simple model.

It was recently revealed that the change of the rotation speed with the period of several million years had some relation with the change of the strength of the magnetic field of the Earth (Miyakoshi, Hamano, 2013). The simulation shows that the speed change of approximately 2% in the Earth rotation causes

change of approximately 20-30% in the strength of magnetic fields. Physical mechanism governing the fluid core may become more clear if we can observe the effect of FCN on the deformation of the Earth, and it will contribute to the prediction of the future environment related to slowdown of the rotation speed and disappearance of the magnetic field.

We are planning to measure deformation of the Earth in high sensitivity with the optical fiber interferometer of long baseline.

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