Estimation of the ocean tide on the early Earth based on the all ocean model

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The ocean tide is one of the important factors affecting the Earth's surface environment and the evolution of the Earth-Moon system. According to the Giant impact hypothesis, the Moon was formed at a distance of about three Earth's radius (R_E) 4.6 billion years ago. In this case, the tidal force in the ocean of the early Earth would be more than ten to thousand times as strong as the present. However previous studies pointed out that severe attenuation of tidal waves might work due to mechanical response of seawater motion to result in relatively calm state (e.g. Abe et al., 1997). In the present study, we have analyzed tidal response of the ocean on the early Earth assuming the simple model in which the constant-depth ocean covers all the surface of the rigid Earth (called the all ocean model). The ocean depth is treated as a parameter of 1300, 2600 and 5200 m, since the present volume of the seawater gives ~2600 m depth for the all ocean model. The tidal force is assumed to be caused by the Moon's gravitational force since the Earth-Moon distance should be smaller at the early time than at present. Assuming reasonable values of the friction and the Earth's rotation period, we have analyzed the tidal response of mode Y_n^m (n, m ≤3) in the all ocean model, where Y_n^m is the spherical harmonics of degree n and order m. We will discuss possible resonance and estimate height of the tidal wave.

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