Crustal movement considering ductile lower crust based on a multi-layer Maxwell body

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The crustal movement is caused by convective flow of mantle material, and the viscosity structure of the Earth's mantle, therefore, plays an important role on a pattern of the crustal movement. In this study, we simulate a response of the multi-layer Maxwell body to an internal load related to the mantle upwelling, and discuss the time dependent and the spatial pattern of the response. Especially, we examine models considering ductile lower crust. In such models, mantle upwelling in the upper mantel causes the crustal movement characterized by the coupling between the lower crust and uppermost mantle. In the model with the lower crustal viscosity of 10^19, for example, the Earth's surface uplifts by a normal upward force till about 100kyr after loading. Then, lower crust behaves as viscous material and is eroded by the flow caused by the coupling. This mode, referred to as MC mode, was indicated by Nakada (1994) and is characterized by the surface subsidence and the uplift of the Moho discontinuity. We think this mechanism may explain a large scale deformation. In actual earth, however, the space generated by the subsidence is filled by the sediment and the Moho flexures downwards in the large scale deposition area. Then, we incorporate three factors into the model; deposition and erosion, horizontal compressional force, and time dependent internal load. In these three factors, the horizontal force of about 100MPa hardly contributes to the deformation. We assume following process by considering remained two factors. In the initial stage, the Earth's surface uplift is caused by the normal upward force associated with internal load. Then, the Earth's surface subsides and the Moho uplifts by the coupling between the lower crust and uppermost mantle. The sedimentation succeeds through this process. As the mantle upwelling weakens, a drag by the coupling becomes weak and the Moho moves to downward. We must incorporate a mechanism which makes the flexure of the Moho to be downward into the model. Amount of the subsidence by the drag is open and the Earth's surface also uplifts. More quantitative comparison with actual geological data is necessary for whether this assumed process is appropriate or not. Although a tectonic scenario discussed above is based on the assumptions that the lithospheric lid does not exist and the lower crust is ductile, we may be able to examine the detailed viscosity structure through the quantitatively discussion, especially for the viscosity of the lower crust and the upper mantle.