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State of stress in lunar farside basins: Analysis of boundary elements method

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The global gravity data of the Moon was obtained first by SELENE launched in 2007. Based on new dataset, Namiki et al. (2009) classified major impact basin on the Moon into three type (primary mascon basin, Type I basin, and Type II basin). Type II basin are located in a center of farside and on limb, and are characterized by local compensation at the center of the basin and positive masses anomalies beneath center of the basin. Generally, viscous relaxation is faster for longer wavelength topography than for shorter one. For Type II basins that show depth to diameter ratio of about 0.1, an entire topography of the basin is unlikely to be relaxed. Thus viscous relaxation only at the center of the basin is not plausible. Alternatively, Namiki et al. (200 9) suggest that the depression could occur in center of the basin by development of fault system. Freed et al. (2001) calculated numerical models of topographic deformation of the lunar basin. They applied a viscoelastic finite element method (FEM) under an assumption of axial symmetry. They analyzed the state of stress in and around the nearside basin where mare basalt are exposed (mascon basin). They consider topography of basin and mare-fill, a lithospheric thickness, curvature of the Moon, and premare stress states. Unlike Freed et al. (2001), we adopt an elastic boundary element method (BEM), and analyze stress field in and around the farside basin (both Type I and Type II basin). BEM is used to take into consideration a brittle deformation. When fractures and fault planes are formed, we include the new fault into the calculation by making a new boundary with appropriate boundary conditions. Then we can continue calculating stress field. For such calculation, we adopt axisymmetric elastic model in cylindrical polar coordinate by including the body force. We assume that the lithosphere is floating over an asthenosphere. The boundary conditions are set as follows; the outer boundary which is sufficiently distant from the center of basin is fixed. Top boundary is a free surface. At the bottom boundary, hydrostatic pressure is given depending on vertical deflection. An impact excavation cavity is expressed by additional upward buoyancy at the top boundary. In this calculation, the effective load is mantle uplift at crust-mantle boundary beneath the Type II basin. We assume a crustal density of 2800 kg/$m^3$and a mantle and mare basalt densities of 3360 kg/m^3. In addition, the elastic strength of lunar lithosphere is assumed to be uniform. Young's modulus is 10^{11}Pa and Poisson's ratio is 0.25. The gravitational attraction at the lunar surface is 1.62 m/s^2. The magnitude of mantle uplift is estimated by Ishihara et al. (2009). The lunar curvature is taken into account by spherical figure of the top surface.