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プレートの定常沈み込みに伴う島弧の変形とその特徴
Characteristics of island arc deformation due to steady plate subduction

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Steady plate subduction elastically brings about permanent lithospheric deformation in island arcs, though this effect has been neglected in most studies based on dislocation theory. We investigate the characteristics of the permanent lithospheric deformation using a kinematic model, in which steady slip motion is given along a plate interface in the elastic lithosphere overlying the viscoelastic asthenosphere under gravity. As a rule of thumb, long-term lithospheric deformation can be understood as a bending of an elastic plate floating on non-viscous fluid, because the asthenosphere behaves like water in a long term. The steady slip below the lithosphere-asthenosphere boundary does not contribute to long-term lithospheric deformation. Hence, the key parameters that control the lithospheric deformation are only the thickness of the lithosphere and the geometry of the plate interface. Slip on a plate interface generally causes substantial vertical displacement, and the gravity always tries to retrieve the original gravitational equilibrium. For a curved plate interface gravity causes upward bending of the island arc lithosphere, while for a planar plate interface gravity causes downward bending. Larger curvature and thicker lithosphere generally causes larger deformation. When the curvature changes along the plate interface, internal deformation is also involved intrinsically, which modifies the deformation field due to gravity. Because the plate interface generally has some curvature, at least near the trench, upward bending of the island arc lithosphere, which involves uplift of island arc and subsidence around the trench, is always realized. On the other hand, the deformation field of the island arc lithosphere sensitively depends on lithospheric thickness and plate interface geometry. These characteristics obtained by the numerical simulation are well consistent with observed topography and free-air gravity anomalies in subduction zones, where a pair of topography and gravity anomaly, high in the arc and low around the trench, exists without exceptions all over the world, while there are large variety in the amplitude and horizontal scale.

キーワード: 島弧, 地殻変動, 粘弾性, 重力異常
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