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Visco-Elastic Geodynamic Modeling of the Tibet Plateau

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The main body of the Tibet Plateau is in Airy isostasy. This usually implies that, like a block of ice floating on water, the crust is stronger than the upper mantle. On the other hand, it is suggested by rock experiments and a number of observations, that the lower crust of the Tibet Plateau is ductile and weaker than both the upper crust and the upper mantle beneath the Moho. There is a paradox: which is stronger - the lower crust or the upper mantle? We find more evidence to support the idea of a ductile lower crust. We use a genetic algorithm – Finite Element stress inversion, i.e., trying to find at what kind of boundary actions and basal shear the calculated stress can best fit with respect to the observed stress from earthquake mechanisms. We find that the upper crust beneath north-eastern Tibet is subjected to a north-eastwards basal drag, and that the upper crust beneath south-eastern Tibet is subjected to a south-eastwards basal drag. This implies a ductile flow of the lower crust, and that the flow of the lower crust drags the upper crust. Post-seismic deformation, based on GPS observations, also favours a ductile lower crust. GPS observations also indicate that some parts of the surface of the Tibet Plateau are in expansion. A north-south compression can produce east-west extension, but cannot produce the surface area expansion that is observed; additional E-W extensional forces are needed to explain this. The basal pull may provide the kind of forces required. However, why is the main body of the Tibet Plateau in Airy isostacy? Our calculations indicate that if the ductile lower crust is enclosed by strong crust or mantle and cannot flow freely, under long wave length load, the entire lithosphere including the upper and lower crust and lithospheric mantle, together support the load and reach isostacy. The paradox is therefore solved. Based upon such a rheological structure, we made a three dimensional Finite Element model of the deformation of the Tibetan Plateau, which interprets the clockwise rotation of the Plateau around its eastern tectonic syntax.