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During a two week stay of Gabriele Cambiotti (Univ. Milano) at GFZ Potsdam, from February 28 to March 13, 2010, the problem of material compressibility in viscoelastic earth models was analysed in cooperation with Volker Klemann (GFZ) with the aim of solving the Longman (1963) paradox. The problem of material compressibility was identified as one aspect in improving models of glacial-isostatic adjustment in the topic of COST action ES0701.

We examined carefully the isostatic compensation process due to surface loading of compressible self-gravitating viscoelastic earth models. According to Cambiotti & Sabadini (2010), the relaxation spectra of such Earth models show different features depending on the type of radial stratification: compressional (adiabatic) or compositional (non-adiabatic). Whereas earth models with compressional stratifications contain the usual relaxation modes assigned to buoyancy and viscoelastic relaxation, compositional stratifications show an additional set of relaxation modes, the C modes, which is denumerably infinite and whose relaxation times diverge to infinity. This difference results in substantially different behaviour at very large time scales.

The usual buoyancy and transient viscoelastic relaxation is expressed by the main normal modes. They proceed on shorter time scales than the C modes and describe the reconfiguration to an equilibrium state for compressional stratifications, where the particle positions differ from their initially hydrostatic ones. For compositional stratifications, this perturbed state deviates from gravitational equilibrium and provokes a buoyancy process which is ascribed to the set of C modes. If the compositional stratification is unstable, the C-modes describe the gravitational overturning which results, due to the adopted first order perturbation theory, in diverging radial, tangential and gravitational perturbations. If the compositional stratification is stable, the C-modes describe a residual buoyancy that restores the particles to their initial hydrostatic positions, nullifying the radial and tangential perturbations. The isostatic compensation of the surface load is then achieved by the formation of an incrementally thin boundary layer at the earth's surface whereas a divergent long period tangential flux of material allows the radial perturbations to vanish except at the surface. If an elastic lithosphere is apparent, this long period tangential flux occurs just below the bottom of the lithosphere. These findings solve the Longman (1963) paradox for the viscoelastic mantle at large time scales. Previously, this paradox was only studied for the Earth's fluid core and the free oscillations of the Earth (Pekeris & Accad 1972; Dennis 1999).

A further aspect of concern was the core-mantle boundary condition at Legendre-degree one in order to investigate the geocenter motion by means of the finite element code (Martinec 2001) when considering the core density profile of the PREM (Dziewonski & Anderson 1981). The quantitative impact of the PREM core compared to the incompressible homogeneous one is under investigation.