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Gravity inversion constrained by seismic velocities: two long-range whole crustal-mantle profiles for the Southern California

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We produce a detailed 2-D density transects for the crust and mantle across the ocean-continent transition zone for Southern California. Both lines start in the Pacific ocean, then cross the Borderland, then one line follows along LARSE-1 line, and the other along LARSE-2 line crossing Los Angeles basin, Santa Monica and San Gabriel Mountains, and finish in the Mojave Desert. A two-dimensional, linear gravity inversion technique was used. This technique approximates two crust-mantle sections as a set of blocks that are based on published seismic-geological models. Each block can have a range of densities, constrained where possible by borehole measurements, seismic velocities and petrologic arguments. To further constrain the models, it was assumed that the lithosphere is close to isostatic equilibrium at both ends of the profiles, in the deep ocean and east of the Mojave Desert. Furthermore we calculate the lithostatic pressure field for the whole cross sections to rule out geophysically insignificant solutions.

In the linear equation r=a+bV which approximates the mantle density (r) - velocity (V) relationship, different coefficients for b were tested. Lower coefficients ($b < 0.2$) correspond to an almost purely thermally-driven mantle, while higher coefficients ($b > 0.3$) imply that other effects such as composition and/or metamorphic changes play an important role in mantle processes. In fact, these other factors can be considered responsible for creating a high-velocity and high-density mantle body beneath the Transverse Ranges of southern California.

Gravity modeling gives a non-unique inversion solution. Two alternative models with coefficients b=0.1 and b=0.5 for the mantle velocity-density relationship (both fitting the observed gravity field) are demonstrated. Analysis of the isostatic imbalance and the average density of the consolidated crust in our models did not allow us to clearly distinguish a preferred model. It was revealed, however, that the greater the coefficient in the mantle density - velocity relation is, the less dense the crust in the Mojave block and the higher the density in the Catalina schist block should be. Coefficients of b= 0.4 - 0.5 require a very low average crustal density of ˜2.73 g/ccm in crustal Mojave block By comparison, the average density of a stable platform is typically around 2.85 g/ccm. Models with a coefficient of b= 0 - 0.2 were characterized by an average crustal density of ˜2.78 g/ccm, and density in the lower crust of ˜2.85 g/ccm. Models with high b-coefficients (0.4-0.5) were characterized by a high degree of isostatic imbalance. Solutions with b˜(0.3-0.4) were considered close to optimal, but arguments were not strong enough to exclude other models. Thus, uncertainty in the gravity interpretation did not allow us to deduce the role of temperature and chemistry in uppermost southern California mantle geodynamics.