TP C6

The Andean Lithosphere: from static density modeling to dynamical models

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Introduction

The present density structure of the Central Andes is rather well known from 3D− forward modeling, which is constrained by mainly seismic information. However, rheology and/or kinematics of the Andean crust and lithosphere is still rather unknown. Therefore finite element modeling has been conducted to figure out by what extent the uplift of the Andes was triggered by compression or how big is the underplated volume to produce the observed topography. Constraining data were obtained from calculus of rigidity and petrological models.

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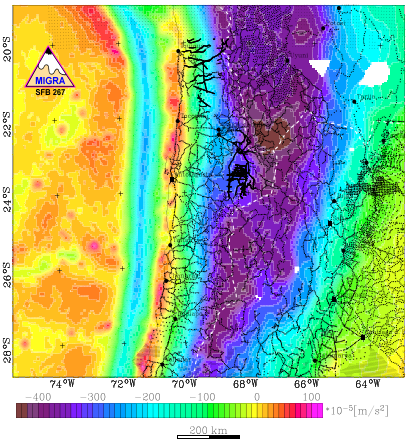
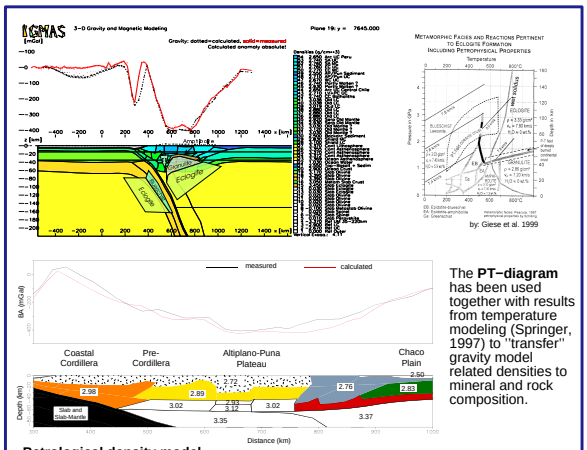


Bouguer and Free air anomaly

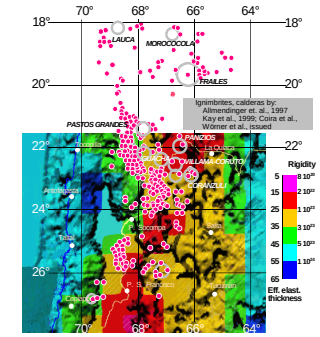
The observed minimum of some −450 x 10^{-5} m/s^{-2} in the central area corresponds to a 65 − 70 km thick crust. Positive anomalies are caused by local mass distribution of the former Jurassic arc and the shallow position of dense Nazca Plate. Free air anomalies offshore are caused mainly by the topography of the oceanic plate.



The **PT−diagram** has been used together with results from temperature modeling (Springer, 1997) to ''transfer'' gravity model related densities to mineral and rock composition.

Petrological density model

Most recently Franz and Lucassen showed, that lithospheric densities can be calculated from the petrological composition. They adopted these densities to the geometry of Kirchner's density model (Kirchner, 1997) and showed, that the modeled gravity is able to match the observed one.



Compilation of rigidity, magmatic rocks (12 - 3 Ma), and major ignimbrite centers in the Central Andes

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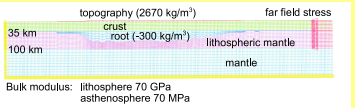
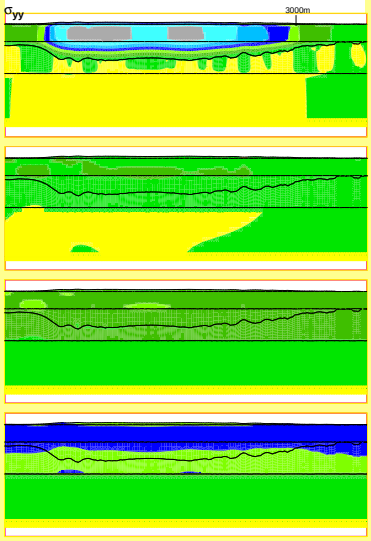
Rigidity

Values for lithospheric rigidities (or effective elastic thicknesses) were modeled by the aid of the density models and topography and provide general information on crustal/lithospheric behavior to some physical extend. Remarkably are low values of rigidity in the area of the recent volcanic arc. Rigidity values will help to define initial parameters for calculus of finite elements (FE) methods.

Static FE−Modelling

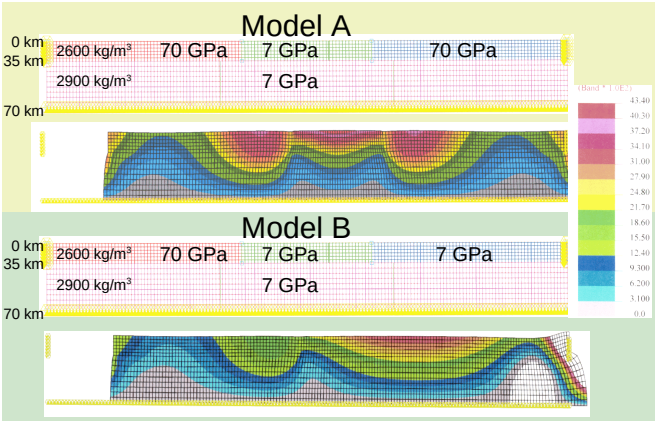


The static model was constructed along 21°S.The crustal root of the Airy model was calculated on base of the digital elevation grid (1 km x 1 km).



In the **static FE−model** we will investigate the amount of far field stress acting on a simplified model. To do so, we have to compare vertical stress with horizontal stresses. If horizontal stress is larger than vertical stress, we obtain a compressional regime, otherwise we have extension. In the future we will include also density inhomogeneities in the model process.

In our **dynamic FE−model** we can show that even for very simple models different surface structures can be obtained which will help to understand the nature of mountain uplift in principle. The models shown here are extremely simplified concerning topography, constraints of composition and rheology. However, clear indications for different deformation styles may be obtained − comparable to those observed in real world. In future also erosional and sedimentation processes will be included in the modelling process.



Model (A) can "explain" the present situation in the Central Andes along the northern traverse: modeling results in a very "week" zone in the area of the volcanic arc. In the central part of the model it was built a plateau (the Altiplano?) − it is surrounded by mountain chains. Refinement of structures and parameters will concentrate on the questions how sensitive are modifications of model properties and to what extend we are able to explain "real" topography.

Model (B) results can "explain", how to build a back arc basin like the Neuquen basin at the southern traverse. Modeling results in a small and relatively low W to E mountain uplift and a second long wavelength uplift.

Comparision of the two models gives hints to general differences in the style of mountain building.