Andean Orogeny and Plate Generation

Uwe Walzer, Roland Hendel, Markus Müller,
Christoph Köstler, and Jonas Kley
Institut für Geowissenschaften, Friedrich-Schiller-Universität Jena

We present the basic conception of a new fluid-dynamic and geodynamic project on the Andean orogeny. We start with a kinematic analysis of the entire orogeny and test different numerical options to explain these systematized observations by a physical model. Therefore we consider partly kinematic, partly dynamic regional models as well as purely dynamic models. Because of stochastic effects which are unavoidable in purely fluid-mechanical mechanisms of this kind and which influence the specific form of the Andes and because of the, to a large extend, unknown initial conditions, the partly kinematic, partly dynamic models have their right to exist. A purely dynamic model would be, of course, much more satisfactory. Therefore we want to approach nearer to the purely dynamic models prescribing a less number of parameters and dropping some artificial constraints. We have a concept to embed a regional model into a global spherical-shell model to determine the boundary conditions of the regional model as a function of time. So we avoid the artificially simplified boundary conditions of some published models of the Andean mechanism. On the other hand, the regional model has to retroact upon the global surrounding model. So, we have an iteration concept. For the two mentioned reasons there are, analogously to the two kinds of regional models, also two kinds of spherical-shell convection models, namely circulation models and forward models. As a first step, we present a spherical-shell model of mantle convection with thermal evolution and generation of continents and, as a complement, the depleted-mantle reservoir. Our presented numerical result is that plate tectonics occurs only if at least the lithosphere deviates from pure viscous rheology and if there is a low-viscosity layer beneath of it. We suppose especially a viscoplastic yield stress for the lithosphere and an asthenosphere which is determined, e. g., by the intersection points of water abundance and water solubility curves .The number of plates, at a certain fixed time of evolution, depends on Rayleigh number and, to a minor degree, on yield stress. We discuss our new efforts to improve the basic code Terra. The numerical regional Andean model has to be embedded into a global circulation model. Therefore we need an improved Terra for the latter one.