0.025 cm/y, respectively, maximum erosion level of ~9 km of uplifted crust is reached at 45 Ma after the onset of collision (at postcollisional stage). The material will be transported from a depth of 20 km to a depth of about 5 km while the rocks that were initially located at a depth of 3.5 km will experience a rather complicated *PT*-evolution. At the postcollisional stage (after 20 Ma of shortening) the compressional regime is changed by extension with very low velocities.

Local effect may result from the frictional heating along the slip zone during the overthrusting. The frictional heat production is proportional to the product of the shear stress across the slip plane, the velocity of obduction and coefficient of friction. The additional heating can rise the temperature by 50—150 °C at 10—20 Ma in the vicinity of slip zone in the case of horizontal shortening rate of up to 4 cm/y and thrust sheet thickness up to 20 km [Brewer, 1981]. This local and moderate additional heating (in comparison with crust thickening effect) is much less in the case of slower thickening.

The following set of parameters is critical to initiate crustal melting and granite formation: initial temperature distribution with heat flow density value higher than 60 mW/m^2, relatively high radiogenic heat production, slow crustal thickening (0.5—1 cm/y for 10—20 Ma) and slow exhumation. The results of the modeling confirm other model estimates [England, Thompson, 1984; Gerdes et al., 2000].

The research is supported by the Russian Foundation for the Basic Research (09—05—01032).

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Seismic structure of the upper mantle and problems of geodynamics

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During the last decades of the XX century severall long-range seismic profiles were carried out by Russian institutions in oceans and in the continents. The longest profiles are the Angola-Brazil geotraverse in the Southern Atlantic with the investigation depth of 100 km [Pavlenkova et al., 1993] and a system of profiles with large chemical and Peaceful Nuclear Explosions (PNE) in the Northern Eurasia with the wave penetrating depth of 700 km [Fuchs, 1997; Pavlenkova G., Pavlenkova N., 2006]. The studies show that the revealed structural peculiarities of the oceanic and continental upper mantle are difficult to describe in a simple lithosphere-asthenosphere system.

The Angola-Brazil geotraverse shows that the oceanic basin lithosphere is of 60—70 km thickness and it is underlined by the low velocity layer (the asthenosphere). However beneath the mid-oceanic ridge instead of the asthenosphere uplift, two local low velocity zones (asthenolites) are revealed at depth of 20 and 50 km. The seismic velocities between these zones are too high (up to 8.5 km/s) for such high heat flow area, they may be explained only by the anisotropy effects.

In the cratonic regions of the Northern Eurasia the thermal lithosphere was proposed from the heat flow data at depth of 200—250 km. The seismic data have not revealed any decrease of the velocities at these depths. On the contrary the low velocity layers are often observed inside the lithosphere at depth of 80—100 km. Two basic boundaries were traced over the study area: N boundary at the low velocity layer bottom, and L boundary at a depth of 180—240 km. All the boundaries are not simple discontinuities, they are thin layering zones with the alternation of high and low velocities in inner layers.

The *N* and *L* boundaries divide the upper mantle in three layers of different plasticity. It follows from regular change of the upper mantle horizontal heterogeneity. The most heterogeneity is observed in the uppermost mantle: the velocities change from the average 8.0—8.1 km/s beneath the high heat flow areas (the West Siberian Plate) to 8.3—8.4 km/s in some blocks of the Siberian Craton and of the Urals. At the depth of 100—120 km the local high velocity blocks disappear and low velocity layers are often observed. These structural features propose that the depth of 100—120 km is a bottom of a brittle part of the lithosphere. Another visible change of the matter plasticity is observed at depths of 200—250 km where the mantle structural pattern is changed too: the velocities decrease beneath the *L* boundary uplifts, which makes the isostatic equilibrium of the upper mantle. At these depths the *Q*-factor is also decreased [Egorkin, Kun, 1978].

The other large explosion experiments and the world seismological studies show that these boundaries may have a global significance. The geophysical and geological data reveals some additional characteristics of these complicate mantle boundaries. They are the higher electrical conductivity zone favoring the existence of fluids at a depth interval of 100—150 km. The most part of the xenoliths comes from the depths around 100, 150 and 200 km and the xenoliths from the Siberian Craton kimberlites taken from the depths of these seismic boundaries have indications of film melting [Solov'eva et al., 1989]. In different tectonic regions, inside the continents and in the continental margins, the most earthquakes are located at depths of around 100 and 200 km.

The correlation the xcenolits origin depth and the earthquake clusters with the regional mantle boundaries could no be an accidental correlation and it shows that the depths of the regional boundaries are critical depths where some regular transformations of the matter are happened.

One possible explanation of these upper mantle properties involves the deep fluids. The concentration of fluids at certain *PT*-levels changes mechanical properties of the matter, they initiate partial melting and metasomatism of the mantle material which results in the velocity changes. The practically infinite energy sources for earth-quakes are the explosive chain reaction of the decomposition, triggered by decompression within the fault zone [Gilat, Vol, 2005]. The matter flow along these weak zones results in origin of the seismic boundaries with the velocity anisotropy.

The determined upper mantle weak zones can have a great effect on all dynamic processes. Together with deep faults they form a channel system for the mantle fluids and matter transportation. The weak zones play an important role in the horizontal displacement of the lithosphere blocks and in formation of tectonic structures. During tectonic activation the weak layers can be transformed in the asthenolites by partial melting and provoke the plume tectonics.

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Scaling and Performance Analysis of Underworld: Towards the One Billion Particle Target

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We investigate the scaling performance of Underworld, a geodynamic modeling framework, on high performance computing resources. These results inform the configuration and allocation of resources committed to study the complex geodynamic processes in and around subduction zones. We use a 3D thermal convection model that includes a temperature and stress dependent rheology as a proxy for the computational difficulty of the eventual subduction problems. This proxy model is designed with significant variation in viscosity, in conjunction with the non-linear temperature and stress dependent rheology this results in a computational problem that is significantly more challenging than the similar isoviscous convection problem.

”Using an allocation of 30000 service units on Texas Advanced Computing Center (TACC) cluster, Ranger, we ran a suite of models that exercised Underwold by solving problems with element subdomain sizes of 16×16×8 and 16×16×16 per core. For each of subdomain size we ran the models at several global resolutions, from what we call "tiny" models (32×32×32) to what we refer to as "huge" (192×192×192). The global resolutions selected require CPU core allocations from 100’s to 1000’s.

Underworld supports both a basic FEM solution method and Particle In a Cell (PIC). We solve the thermal convection problem using both methods to verify the equivalence of solutions. At the highest resolutions using the PIC method the number of particles approaches 1.5 million. We continue to explore this model with an eye towards systems populated by up to 1 billion particles.

Timing results are measured as the walltime per model timestep. A common steady-state model is first calculated over several thousand timesteps. This steady-state model is then restarted at the appropriate resolution whence the performance data is gathered.

Stress modeling in the Central Asia crust, importance of gravity stresses

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The Southern and Central Asia is a tectonically complex region which characterized by the great collision between the Asian and Indian plates. Its tectonic evolution is strongly related to the active