Geophysical Research Abstracts
Vol. 12, EGU2010-6479, 2010
EGU General Assembly 2010

Vertical movement of passive margins: interactions between surface transfer, flexural isostasy and 3D thermal subsidence

Delphine Rouby (1,2), Francois Deschamps (1,2), Jean Braun (1,2), Olivier Dauteuil (1,2)

(1) Geosciences Rennes, UMR6118 CNRS/INSU, Rennes, France (delphine.rouby@univ-rennes1.fr), (2) Universite de Rennes 1, Rennes, France

Passive margins preserve the terrigeneous sediment resulting from its erosion, and as such, record the dynamics of its relief variation. The thermal evolution of the stretched lithosphere, surface processes (erosion/sedimentation) and flexural isostatic compensation induce vertical movements of the passive margin that can also be altered by the superposition of vertical movement induced by flow in the mantle or tectonically driven deformation. Our objective is to quantify the expression of these different types of vertical movements in the stratigraphic architecture of passive margins basins. The novel aspect of our approach is to integrate the evolution of both domains in erosion and in sedimentation, in a 3D framework involving state of the art numerical modeling tools of the thermo-mechanical evolution of the lithophere and advanced concepts in sequence stratigraphy.

Flex3D provides us with a useful tool to determine the influence of surface transfer processes on the temporal and spatial evolution of post rift vertical movements of a passive margin in a framework including the flexural isostasy and the 3D thermal evolution of the margin. To discuss this point, we simulated the evolution of a cylindrical passive margin. For sake of simplicity, we assumed (i) an equal stretching distribution for the lithosphere and the crust (=); (ii) that the crust density is homogeneous along the margin, i.e. the oceanic crust portion in the model is approximated by a crust with a continental crust density c and a standard 7 km thickness. We performed 4 sets of simulations: (i) one set without surface processes; (ii) one set with surface processes but no distinction between marine and continental domains; (iii) two sets with surface processes and distinction between marine and continental domains with either low values or high values.

These simulations illustrate how significant the impact surface processes on the flexural response of the lithosphere is and, as a consequence, on spatial and temporal distribution of vertical displacements. Indeed, for simulation using the reference geometry, erosion is necessary to produce uplift: surface transfer induces the an uplifting coastal relief associated with a fast and narrow maximum of subsidence at the stretched/ ”oceanic” crust transition. This coastal relief is actually very rapidly eroded (during the first 10 Myr of simulation). In the following evolution, the coastal relief remains absent despite some uplift in the corresponding domain suggesting that it is controllef by the balance between the flexural response and erosion/sedimentation. Also, the relaxation of the initial thermal anomaly progressively increases the stretched lithosphere thickness resulting in: the decrease in vertical motion and denudation/sedimentation rates as well as the increase in the wavelength of the flexural response of the lithosphere i.e. in the wavelength of the deformation (subsidence/uplift spatial distribution).

The differentiation between “continental” and “marine” surface processes produces a more complex flexural response that is to say spatial and temporal distribution of vertical displacement: some areas potentially evolving from subsidence to uplift as the wavelength of the deformation changes. For low Kdc/Kdm values, the early subsidence pattern forms a “coastal” basin in addition to the main basin. This area then evolves into an uplifting domain eroding away the sediments preserved in that basin and transferring them into the main basin. For very low values of Kdc/Kdm, this basin is not entirely eroded after 140Myr of simulation.