Geophysical Research Abstracts,
Vol. 11, EGU2009-1425, 2009
EGU General Assembly 2009
© Author(s) 2008

Simulation of tectonic erosion of accreted sediments at the Torlesse Accretionary Wedge, New Zealand

H. Deckert (1) and U. Ring (2)

(1) Institut für Geowissenschaften, Universität Mainz, Becherweg 21, 55099 Mainz, Germany. Now at: Institute for Geothermal Resource Management, University of Applied Sciences Bingen, Germany. , (2) Department of Geological Sciences, University of Canterbury, PB 4800, Christchurch 8140, New Zealand

Accretionary wedges are major sites of continental growth at subduction zones. Their growth and dynamic evolution is still a matter of debate, especially how sediments are accreted during progressive deformation and how tectonic erosion influences its stability with respect to the critical taper theory. At the frontal part of the Torlesse Accretionary wedge in New Zealand, the so-called Esk-Head melange separates the Rakaia Terrane from the underlying Pahau Terrane. A main feature of the Esk-Head melange is a major stratigraphic gap: Sedimentation in the Rakaia Terrane lasted until the Late Triassic (c.205 Ma) and deposition of the rocks of the Pahau Terrane occurred from c.165 to c.120 Ma. It is interesting to note that high-pressure metamorphism and exhumation in the Otago Schist in the internides of the Torlesse wedge also occurred at that time. In order to study the processes during sediment accretion of tectonic wedges and to test whether tectonic erosion might be responsible for the hiatus at the Esk-Head Melange, Discrete-Element (DE) simulations of wedge deformation were performed.

For the simulations a synthetic DE-material reflecting properties of sediments in an accretionary wedge were produced numerically. This material can be described with a Mohr-Coulomb fracture behaviour within the upper crust. DE-simulations allow in contrast to analogue sandbox modelling the change of material properties during progressive deformation. Thus, a strain rate dependent criterion was implemented within the models to reproduce the effect of fault zone weakening along major active faults in the simulations. If relative displacement along an active shear zone exceeds a pre-defined value, the synthetic DE-material is replaced by a weaker material with lower friction. As a result deformation is strongly localised along discrete shear zones as it is observed in accretionary wedges.

With the performed experiments it was possible to simulate the deformation behaviour of accretionary wedges. During the simulations foreland vergent duplex structures formed at the front of the growing wedge. This caused lengthening of the wedge and promoted a compressive horizontal stress across the wedge. In later stages out-of sequence thrusting commenced establishing a mid-level detachment within the already accreted sediments. Interestingly, the models show a simultaneous formation of the mid-level detachment and progressive foreland propagation of the deformation front with new frontal duplex thrusts. As a result of the out-of sequence thrusts frontal parts of the wedge are partly tectonically eroded and subsequently underplated at the base of the wedge. This leads to a thickening of the wedge that is in part compensated by normal faulting in the higher levels of its fore-arc high region.

The outcomes of the DE-simulations can explain how tectonic erosion (out-of-sequence thrusting) might be responsible for the hiatus at the Esk-Head Melange. In the models, out-of-sequence thrusting commenced after frontal accretion lengthened the wedge causing subcritical tapering. Tectonic erosion caused underplating of previously frontally accreted material. Underplating in turn promoted normal faulting and thus exhumation. The concurrency of underplating-related high pressure metamorphism and the depositional hiatus probably excludes that a lack of incoming sediments on top of the oceanic plate was responsible for the hiatus.