Geophysical Research Abstracts
Vol. 13, EGU2011-13935-1, 2011
EGU General Assembly 2011

Teleconnections in orogenic belts?

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Teleconnections are conventionally invoked to describe far-field links between parts of the global climate system. However, the increasing wealth of time-series of exhumation, deformation and deposition within mountain belts starts to indicate that the underlying principles may be also applicable in a geodynamic framework. Thereby, teleconnections between mountain belts and their forelands are considered as an emergent phenomenon, resulting from (i) the load dependence of tectonic faulting (Mandl 1988), which in turn is dependent upon surface processes that themselves are linked to the global climate system and from (ii) the finite flexural rigidity of lithospheric plates (Beaumont 1981). It shall be emphasised that each individual entity of such a process chain follows local rules only. We thus differentiate between far field connections, e.g. lithospheric folding and geodynamic teleconnections. The latter involve that a signal is transmitted between at least two Earth systems, e.g. atmosphere and tectonosphere, whereas the former would only reside within the tectonosphere.

These considerations are illustrated using timeseries from two-dimensional sandbox simulations involving surface erosion finally implemented with flexure calculations of foreland basins. Based on our results we highlight that the four components of an orogenic system, i.e. pro-foreland basin, pro-wedge, retro-wedge, and retro-foreland basin are mechanically coupled via the load dependence of tectonic faulting and the finite flexural rigidity of lithospheric plates We further demonstrate that the impact of pro-wedge erosion is most pronounced within the pro-wedge but also modifies the shape and size of the retro-wedge, which in turn changes the geometry and propagation velocity of the retro-foreland basin and vice versa. This suggests that one out of the four components of an orogenic system cannot be fully understood without recognition of the other three components. Thus, spatial separation between processes or observations does not necessarily imply their physical independence. This conceptual model is applied in a case study to the Pyrenean orogenic wedge and its Ebro and Aquitaine foreland basins. Our analysis suggests that the Pyrenean pro- and retro-wedges are mechanically coupled and that this coupling manifests itself in the migration of depocentres in both foreland basins. Finally implications for the formation of Mississippi Valley Type deposits are explored.