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Source to Sink systems: Quantification of mass transfer from mountain ranges to active sedimentary basins in the Danube basin system

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The Danube River Basin - Black Sea area represents an unique natural laboratory for studying the interplay between lithosphere and surface processes, source-sink relationships, and the impact of global change. The densely populated Danube River Basin is threatened by landslides, flooding and earthquakes. Human activities contribute to these risks at local, regional and transnational scales. Water, air and soil pollution cause serious deterioration of the Black Sea sink environment. This natural laboratory represents also a major area for integrated geo-resources management, in particular for the hydrocarbon resources. Process-oriented studies improve understanding and thus form the base for developing defence strategies and an integrated management of geo-resources.

Mountain building processes lead to exhumation of orogenic cores during gradual shortening by nappe stacking. As a result, large oceanic basins and associated passive continental margins become fragmented and reduced in size during active subduction, collision and resulting uplift. Such processes often lead to the isolation of sub-basins. The parameters controlling the connectivity amongst late orogenic semi-isolated basins, and with open marine environments, respectively, are complex. They are influenced, for example, by interplay between uplift and subsidence creating accommodation space and building sediment source areas, inherited tectonic pathways across mountain chains or climate and sea-level variations. One important element in the quantification of sedimentary fluxes in the source areas is the link between the scale of orogenic exhumation and associated erosion and the testing of these processes in recent, active settings. Specific patterns of sediment storage types in alpine environments can be interpreted as a result of geomorphologic processes operating on various spatio-temporal scales. Influencing sediment yield and sediment budget in alpine cascading systems, highly variable residence times of stored sediments, different buffering capacities in alpine catchments or the variability of geomorphologic processes in terms of frequency and magnitude are major problems to be tackled in this context.

Orogenic processes active during the Oligocene-Miocene in the Danube basin realm have generated an isolated/endemic evolution of rather large areas, such as the various Paratethys sub-basins, separated by the late-stage orogenic evolution of the Alps/Carpathians. Starting from the Alpine source areas, these types of basins are characterised by multiple potential gateways which functioned in various spatial and temporal domains during the gradual basin fill and migration of the depocenters towards the present-day active sink area, the Black Sea. Large sea-level variations in this main controlling realm generate rather limited local base-level variations in the restricted basins situated near the Carpathians. Such low amplitude connectivity events with short duration such as the ones observed here are seen to be controlled mainly by features such as: evolution of local sea-levels, basin overspill, uplift and fluvial incision of the connecting gateways, drainage capture or (tectonic) migration of drainage divides, gradual filling patterns and transition towards continental environments. These can be demonstrated in particular for the source areas and the gateways active during the late stages evolution of the Carpathians – Black Sea system.