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Do grain size patterns from Oligo-Miocene Swiss Molasse sequences reflect shifts in sediment flux through time?

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The formation of large-scale coarsening- and thickening-upward sedimentary sequences is commonly related to mountain belt evolution, where tectonic, lithological or climatic controlled changes (e.g. Whittaker et al., 2010; D'Arcy et al., 2017) have a major influence on the large-scale architecture of the adjacent foreland basin. Furthermore, as proposed by Lane (1955), trends in stratal patterns are also controlled by variations in hydrological conditions such as sediment and water discharge. These changes affect the dynamics of alluvial systems, which are commonly preserved by grain size and stacking patterns. A relation between grain size trends and sediment flux has been in the focus of previous research (e.g. Schlunegger and Castelltort, 2016) yet with a limited dataset only. Here, we extend this approach and investigate whether there exists a direct correlation between grain size patterns and shifts in sediment flux through time at the scale of an entire basin.

The Swiss Molasse basin, our study area, includes three major depositional systems situated in eastern, central and western Switzerland. These systems have been active during Oligocene- to Miocene-times between 31 and 13 Ma (Schlunegger et al., 1997; Kempf et al., 1999). We collected grain size data from several km-thick conglomerate sequences along 16 individual sections using state-of-the-art techniques and compared grain size patterns with published data of sediment flux to the Molasse basin (Kuhlemann et al., 2001).

Preliminary results reveal that from 31 to 21 Ma, both, the median grain size (D_{50}) and the D_{84} percentiles show an increase from 4.4±0.8cm to 4.8±0.1cm (D_{50}, +10%), and from 8.0±1.4cm to 9.5±1.2cm (D_{84}, +20%). Simultaneously, sediment flux to the entire Molasse basin increased from c. 6'000 km^3/Myr at 31 Ma to c. 23'000 km^3/Myr at 21 Ma recording almost a fourfold increase (Kuhlemann et al., 2001). A substantial flux reduction at 20 Ma to c. 17'000 km^3/Myr was followed by strong fluctuations, reaching c. 15'000 km^3/Myr at 13 Ma. However, compared to the peak at 21 Ma, this corresponds to a 30% decrease in sediment discharge. In contrast, during the same time interval, the grain size data record a 20% increase in D_{50} from 3.7±0.5cm to 4.5±0.4cm and a 40% increase in D_{84} from 6.2±1.0cm to 8.7±1.0cm, respectively.

The preliminary results thus show that grain size patterns are positively correlated to shifts in

sediment flux during Oligocene-times (31 to 21 Ma), but weak to no correlations between sediment flux and grain size trends were observed during Miocene-times (20 to 13 Ma). We interpret this data as showing that surface erosion and topographic development occurred in pace with the geological driving forces such as ongoing continent-continent collision during Oligocene-times. In contrast, we tentatively suggest that the landscape entered a transient stage after 20 Ma when large-scale tectonic exhumation started to interfere with the fluvial processes in the Alpine hinterland, thereby shifting the Alpine topography in a transient state.

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