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Clastic Sediment Dispersal in Rifted Margins, an Example From the Swiss Alps

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Detrital zircon (DZ) and detrital rutile (DR) U-Pb ages and mineral trace element data from Permian to Cretaceous Alpine sedimentary strata allow for the reconstruction of sediment provenance within Alpine basins and their evolution during Tethyan rifting. Permian and Triassic pre-rift sedimentary strata are characterized by local derived detritus. Permian DZ U-Pb signatures are more localized and dominated by Cambro-Ordovician and Late Proterozoic zircons. In contrast, Triassic sandstones show a first prominent and pervasive occurrence of Variscan-aged zircons with two main age peaks at 290-300 Ma and 330 Ma, while the abundance of Cambrian and Proterozoic zircons is strongly reduced. From a population of ca. 1000 zircons (<5% discordance) from Permo-Triassic strata of the European margin, no zircon exhibit ages between 1200 and 1700Ma. In the Helvetic domain, the lower Liassic sandstones mark the first appearance of detrital zircons with ages between 1200-1700 Ma and a more generalized dominance of the 330 Ma peak over the 290-300 Ma peak. Throughout the Lower Jurassic (early syn-rift), the abundance of 1200-1700 Ma detrital zircons increases with time. This trend marks the transition from sediment supply dominated by local sources toward sediment supply dominated by far-field sources, probably due to the importance of longitudinal currents, depositional system integrations, and the progressive submersion of local sources. This trend is confirmed by detrital rutile thermometry and geochronology as Permo-Triassic sediments are dominated by Paleozoic rutile with Zr-in-rutile temperatures between 600 and 750°C, while Jurassic sandstones mark the appearance of abundant rutile recording temperatures above 750°C with U-Pb ages ranging from late Proterozoic to earliest Permian in age. The Middle Jurassic (main Alpine Tethyan rifting phase) marks a major shift in provenance and the abrupt renewal of local sources. Along the northern Alpine margin, detrital zircons with ages U-Pb between 1200 and 1700 Ma are drastically reduced to complete eliminated. In the distal Helvetic margin realm, the 290-300 Ma DZ peak becomes dominant, although locally this Variscan peak is drastically reduced (or eliminated) and replaced by a post Variscan 260-280 Ma DZ peak. In the distal Helvetic margin, detrital rutile recording temperatures above 700°C are drastically reduced and the input of rutile from mafic sources as well as a Permo-Triassic population is observed. This trend marks the compartmentalization of the European margin in sub-basins, the emergence and rapid unroofing of local sources and the progressive reduction and eventual disconnection from far-field sources. However, eventually this period leads to the creation of new sediment dispersal pathways tapping into very far-field sources, as deduced from the Cretaceous DR record.
In particular, Aptian to Cenomanian ("Gault") sedimentary strata in the Helvetic, North Penninic, and Briançonnais domains show remarkable similarities, incl. the reappearance of abundant Mid-Proterozoic zircons and the appearance, for the first time in the system, of Paleoproterozoic (1.8-2 Ga) rutiles. This trend marks the general subsidence of the rifted margin and the instauration of strong longitudinal currents. The appearance of abundant Paleoproterozoic rutile in central Europe, whose basement has been formed and repeatedly metamorphosed during the late Proterozoic and the Paleozoic, suggests a source located to the east of the Tornquist-Teisseyre zone, in the basement of the East European platform and a direct connection through E-W currents between the Outer Carpathians and the Central Alps.