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Subduction Erosion Processes and their Quantification along the Andean Subduction Zone

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Although subduction erosion is shaping at least half of the world's convergent margins, its rates, variability, and modes are only poorly understood. Based upon a compilation of published and newly derived estimates of subduction erosion along the Andean margin we discuss possible loci and modes of subduction erosion. We evaluate different approaches to estimate subduction erosion. Rates of subduction erosion computed from the offshore subsidence record and geometry of the margin turned out to be robust and thus also reveal information on regional variability of the efficiency of subduction erosion. Due to the episodicity of the migration of the volcanic arc front, however, estimating subduction erosion from migration rates may be erroneous on the shorter (neotectonic) time scale. Information about the processes underlying subduction erosion is coming from both, natural observations and scaled physical experiments. Hydrofracturing at the base of the overlying forearc crust is identified to be a process explaining basal subduction erosion. Subduction erosion off northern Chile is faster than that off Peru, and further, subduction erosion along the Central Andean margin also is faster than magmatic addition, thus making this subduction zone a site of net destruction of continental crust. From the geological record, we demonstrate that the south Chilean subduction zone, which is in the accretive mode since the Pliocene, has experienced subduction erosion since at least the middle Miocene at rates similar to the north. The change in mode is related to doubling of the sediment flux into the trench after onset of Southern Hemisphere glaciation at c. 6 Ma. Hence, we identify sediment flux as the key variable controlling long-term material transfer while ridge collision drives subduction erosion to excess rates over the background value.