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Physical weathering limits on fluvial erosion and surface armouring rates for hillslopes on the 10-1000 year timescale and controls of river transport processes

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Hillslopes are the source material for sediments transported by rivers so that understanding the detachment rates and grading of eroded hillslope materials is important for investigating the potential balance between detachment- and transport-limited river systems. Using (1) a model simulating the armouring of hillslopes as a result of fluvial erosion and the breakdown of these armours by weathering and (2) experimental data for the salt weathering of a schistose mine spoil we explore potential limits on the erosion rate driven by armouring and/or weathering. The modelling results show that the observed erosion rate on the 100-1000 year timescale is a result of feedbacks between the size selectivity of the particle entrainment mechanism (which creates the surface armour) and the creation of fine transportable material from the coarse armour by weathering. The erosion rate and the particle size distribution of the eroded sediments are also dramatically different depending on whether the weathering process is spalling or splitting. The laboratory experiments show that particle splitting, not spalling, is the dominant weathering mechanism. We will show results from fitting particle fragmentation models to the laboratory data to support this assertion. On this basis it will be asserted that over the 100-1000 year timescale undisturbed hillslopes are simultaneously weathering- and transport-limited. On the other hand at short timescales the feedback between size selection and weathering is weak so that slopes are transport-limited. Thus erosion from undisturbed hillslopes will be weathering-transport-limited while disturbance (e.g. by ploughing, etc) should result

in the dominant process switching to pure transport-limitation. We will argue that this conclusion is universal. We will explore the consequences of this for interpretation of erosion and paleo-climate process using geomorphology, and the implications of this for the use of “agricultural” erosion models for long-term process-based geomorphic studies (which in turn will provide a description of the sediment stored in the floodplain).