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Bedrock landscape erodibility as a function of stress

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Playing Jenga, building a house of cards or tearing down a brick wall you know that the pieces that support most loads have higher friction and are more difficult to remove. But you also know that pieces that can easier be removed within the tower, house or wall, are structurally of little importance. Does the same hold true for the erodibility of rocks? Which factors control bedrock erodibility in landscape evolution? Proposed factors are typically lithology, climate and tectonics. As near surface, low stress magnitudes cause a structural strengthening and evoking a negative feedback on erosion, we propose that stress fields/state also pose a control on the erodibility of bedrock.

We use analogue experiments on fast eroding Strelec locked sand (SLS) to assess the relationship between loading and erosion. SLS is a natural sandstone that consist of quartz sand grains locked into each other without any cement. We observe erosion via sediment yield at constant confining loads from 25N to 100N. The erosional driving force are rain impacts. Their magnitude is kept constant and applied over defined time intervals. We aim to quantify the effect of stress on erodibility and to deduce an analytical relationship between erosion and loading based on frictional mechanics.

This stress control affects not only the overall shape but also how each sand grain is held in its position. This in turn affects the shape and the shape controls where some grains are less easy to be removed. With these experiments we want to highlight how and at what scale, from interacting sand grains to an arching shape, stresses govern the removal of material. We find a stress control relationship on the scale of the experiment and material properties. We can propose an erodibility function based on friction mechanics. Due to the functional relationship, this could also be a control of landscape evolution.