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Effects of Gravity on Delta Morphology and Stratigraphy

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Deltas are important landforms in planetary research and exploration because they indicate past fluvial activity, contain a sedimentary-record amenable to study, and have the potential to store past signs of life. As exploration missions are searching for (ancient) biomarkers, deltas are targets of interest. Therefore, it is important to understand the differences between deltas on Earth and Mars, so we can adjust our expectations of the past conditions and stratigraphy that we derive from the visible morphology. Furthermore, enhanced understanding of the effects of gravity can improve our estimations about past flow conditions and the duration of fluvial activity in certain areas. This eventually leads to a better understanding of the fluvial history of Mars and improved selection of target locations with the highest probability of preserved biosignatures.

To research the effect of gravity on deltas, we use a 2D hydro-morphodynamic numerical model that simulates the flow of water, transport and deposition of sediment, and the evolution of topography. We use the software Delft3D, developed by Deltares research institute (the Netherlands). This software is typically used for river and coastal systems on Earth, but we adapted the software by identifying all explicit and implicit dependencies on gravity, so it can also be used for deltas on Mars. The model set-up consists of a straight channel flowing into a sloping basin. The inflow channel is 200 m wide and the water depth is 3 to 10 m, depending on the model scenario. This results in discharges of about 1000 to 2500 m^3/s. We impose two different grain sizes, namely a coarse fraction, transported as bedload, and a fine fraction, transported in suspension.

Our preliminary results show that gravity affects fine sediments stronger than coarse sediments, because of the difference in transport mode. For example, reduced gravity significantly slows down suspended sediment settling, while bedload transport is affected less. We expect that this will result in a different delta stratigraphy. This process is in addition to the effect that gravity has on water and sediment fluxes; lower gravity results in a smaller water discharge, while sediment transport is enhanced, with all else held equal. With our modelling efforts, we aim to further investigate the morphological results of these effects.