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Gravity effects on sediment sorting: limitations of models developed on Earth for Mars

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Most studies on surface processes on planetary bodies assume that the use of empirical models developed for Earth is possible if the mathematical equations include all the relevant factors, such as gravity, viscosity and the density of water and sediment. However, most models for sediment transport on Earth are at least semi-empirical, using coefficients to link observed sediment movement to controlling factors such as flow velocity, slope and channel dimensions. However, using roughness and drag coefficients, as well as parameters describing incipient motion of particles, observed on Earth on another planet, violates, strictly speaking, the boundary conditions set for their application by fluid dynamics because the coefficienst describe a flow condition, not a particle property. Reduced gravity affects the flow around a settling partcile or over the bed of a watercourse, therefore data and models from Earth do not apply to another planet. Comparing observations from reduced gravity experiments and model results obtained on Earth confirm the significance of this error, e.g. by underestimating settling velocities of sandy particles by 10 to 50% for Mars when using models from Earth. In this study, the relevance of this error is examined by simulating the sorting of sediment deposited from water flowing on Mars. The results indicate that sorting on Mars is less pronounced than models calibrated on Earth suggest. This has implications for the selection of landing sites and, more importantly, the identification of strata potentially bearing traces of past life during rover missions on Mars.