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Grain size of loess and paleosol samples: what are we measuring?

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Particle size falling into a particularly narrow range is among the most important properties of windblown mineral dust deposits. Therefore, various aspects of aeolian sedimentation and post-depositional alterations can be reconstructed only from precise grain size data. Present study is aimed at (1) reviewing grain size data obtained from different measurements, (2) discussing the major reasons for disagreements between data obtained by frequently applied particle sizing techniques, and (3) assesses the importance of particle shape in particle sizing.
Grain size data of terrestrial aeolian dust deposits (loess and paleosoil) were determined by laser scattering instruments (Fritsch Analysette 22 Microtec Plus, Horiba Partica La-950 v2 and Malvern Mastersizer 3000 with a Hydro Lv unit), while particles size and shape distributions were acquired by Malvern Morphologi G3-ID.
Laser scattering results reveal that the optical parameter settings of the measurements have significant effects on the grain size distributions, especially for the fine-grained fractions (<5 μm). Significant differences between the Mie and Fraunhofer approaches were found for the finest grain size fractions, while only slight discrepancies were observed for the medium to coarse silt fractions. It should be noted that the different instruments provided different grain size distributions even with the exactly same optical settings.
Image analysis-based grain size data indicated underestimation of clay and fine silt fractions compared to laser measurements. The measured circle-equivalent diameter of image analysis is calculated from the acquired two-dimensional image of the particle. It is assumed that the instantaneous pulse of compressed air disperse the sedimentary particles onto the glass slide with a consistent orientation with their largest area facing to the camera. However, this is only one outcome of infinite possible projections of a three-dimensional object and it cannot be regarded as a representative one. The third (height) dimension of the particles remains unknown, so the volume-based weightings are fairly dubious in the case of platy particles.

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