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Effects of particle optical properties on grain size measurements of aeolian dust deposits

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Particle size data are holding crucial information on the sedimentary environment at the time the aeolian dust deposits were accumulated. Various aspects of aeolian sedimentation (wind strength, distance to source(s), possible secondary source regions and modes of sedimentation and transport) can be reconstructed from proper grain size distribution data. Laser diffraction methods provide much more accurate and reliable information on the major granulometric properties of wind-blown sediments compared to the sieve and pipette methods.
The Fraunhofer and Mie scattering theories are generally used for laser diffraction grain size measurements. () The two different approaches need different 'background' information on the medium measured. During measurements following the Fraunhofer theory, the basic assumption is that parcticles are relatively large (over 25-30 μm) and opaque. The Mie theory could offer more accurate data on smaller fractions (clay and fine silt), assuming that a proper, a'priori knowledge on refraction and absorption indices exists, which is rarely the case for polymineral samples. This study is aimed at determining the effects of different optical parameters on grain size distributions (e.g. clay-content, median, mode).
Multiple samples collected from Hungarian red clay and loess-paleosol records have been analysed using a Malvern Mastersizer 3000 laser diffraction particle sizer (with a Hydro LV unit). Additional grain size measurements have been made on a Fritsch Analysette 22 Microtec and a Horiba Partica La-950 v2 instrument to investigate possible effects of the used laser sources with different wavelengths. XRF and XRD measurements have also been undertaken to gain insight into the geochemical/mineralogical compositions of the samples studied. Major findings include that measurements using the Mie theory provide more accurate data on the grain size distribution of aeolian dust deposits, when we use a proper optical setting. Significant differences between the Mie and Fraunhofer approaches have been found for the finest grain size fractions, while only slight discrepancies were observed for the medium to coarse silt fractions. Since the two approaches gave similar results for the medium to coarse silt fractions that are the most abundant in loess, the use of the different approaches has no appreciable effect on the mode of the distributions. (Actually, the Fraunhofer theory can be regarded as an approximate expression of the Mie scattering theory). In conclusion, the two different applied theories and also the optical settings of Mie theory have had significant effects on the finer tail of the aeolian grain size distributions.
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