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Granulometric profiling of aeolian dust deposits by automated image analysis

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Determination of granulometric parameters is of growing interest in the Earth sciences. Particle size data of sedimentary deposits provide insights into the physicochemical environment of transport, accumulation and post-depositional alterations of sedimentary particles, and are important proxies applied in paleoclimatic reconstructions. It is especially true for aeolian dust deposits with a fairly narrow grain size range as a consequence of the extremely selective nature of wind sediment transport. Therefore, various aspects of aeolian sedimentation (wind strength, distance to source(s), possible secondary source regions and modes of sedimentation and transport) can be reconstructed only from precise grain size data. As terrestrial wind-blown deposits are among the most important archives of past environmental changes, proper explanation of the proxy data is a mandatory issue.

Automated imaging provides a unique technique to gather direct information on granulometric characteristics of sedimentary particles. Granulometric data obtained from automatic image analysis of Malvern Morphologi G3-ID is a rarely applied new technique for particle size and shape analyses in sedimentary geology. Size and shape data of several hundred thousand (or even million) individual particles were automatically recorded in this study from 15 loess and paleosoil samples from the captured high-resolution images. Several size (e.g. circle-equivalent diameter, major axis, length, width, area) and shape parameters (e.g. elongation, circularity, convexity) were calculated by the instrument software. At the same time, the mean light intensity after transmission through each particle is automatically collected by the system as a proxy of optical properties of the material. Intensity values are dependent on chemical composition and/or thickness of the particles.

The results of the automated imaging were compared to particle size data determined by three different laser diffraction instruments (Malvern Mastersizer 3000 with a Hydro LV unit; Fritsch Analysette 22 Microtec Plus and Horiba Partica LA-950 v2) and SEM micrographs. To date, there has been very few data published on automated image analyses of size and shape parameters of sedimentary deposits, accordingly many uncertainties exist about the relationship among the results of the different applied methods.

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