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Shape of quartz grains as an indicator of duration of transport in sedimentary environments and inheritance of shape – efficacy of automatic image analysis

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Recognition of quartz-sand grain shape, particularly its roundness and sphericity, is essential in reconstruction of sedimentary settings, transport conditions, duration of transport and post-sedimentary weathering. It is assumed that in currents environments (e.g. aeolian, fluvial) the increasing transport duration is reflected in progressively higher degree of roundness and sphericity of quartz grains. Furthermore, during transport, grains are gradually reduced to similar size and similar roundness; this leads to the accumulation of sediments with similar grain size distributions in differing environments. However, the question still remains: to what extent is the shape of a grain is the result of processes in given environment (e.g. aeolian or fluvial) and how much of its shape is inherited from other environments. The description of shape is subjective and reduction to a mathematical formula is time-consuming and in many cases impossible to apply (e.g. in field studies). One of the solutions is the automatic analysis of particle shape using the Morphologi G3SE. This study aimed to verify the efficacy of automatic image analysis (AIPS) in discerning quartz sand grain shape and associated sedimentary settings. Quartz grains (0.8-1.0 mm) from three sedimentary environments: angular, fresh grains (G_{NU}) and aeolian (G_{RM}) and fluvial grains (G_{EL}) and with similar degree of roundness (well and very well rounded) were analyzed in terms of four shape-description parameters: Circularity High Sensitive (Circularity HS); Convexity; Solidity; Aspect Ratio. Next, principal component analysis (PCA) and discriminant analysis were applied to the obtained AIPS data. The parameter that best distinguishes the shape of G_{NU}, $G_{RM,}$ and G_{EL} grains is Circularity HS, associated with the degree of roundness, whereas Aspect Ratio was useful for analysing the degree of grain sphericity. The G_{RM} and G_{EL} grains with a high degree of roundness and either low or high sphericity should be characteristic for a long-term reworking by aeolian and fluvial processes. The presence of grains with low sphericity and high roundness in the environments where saltation transport prevails indicates that their shape has been inherited. Such grains require special attention to the Aspect Ratio values. Detailed analysis of grain features - such as sphericity and roundness enables accurate interpretation of transport environments in terms of transport duration and sediment maturity.