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How different statistical analyses of grain size data can be used for facies determination and palaeoenvironmental reconstructions – an example from the Black Sea coast of Georgia

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Granulometric analyses enable precise and significant statements about sediment transport processes and depositional environments. Bivariate statistics of graphical parameters (mean, sorting, skewness, kurtosis) of grain-size distributions, open the opportunity of grain-size analysis in context of sediment transport patterns, to differentiate between several depositional environments. While such approaches may be limited to unimodal grain-size distributions, the statistical method of the end-member modelling algorithm (EMMA) was created to solve the explicit mixing problem of multimodal grain-size distributions. EMMA enables the extraction of robust end-members from the original dataset. A comparison of extracted end-members with recent surface sample's grain-size distributions allows assumptions for transport processes and depositional environments.
Bivariate statistics of graphical grain-size parameters and EMMA were performed on a 9 m long sediment record, taken from a beach ridge sequence at the coastal area of western Georgia. Whereas biplots of calculated parameters give valid information of modern environments, this method fails for the reconstruction of palaeoenvironments. However, by applying EMMA it is possible to extract four robust end-members and combine them with grain-size distributions of modern surface samples. Results gained from EMMA, indicate a threefold of the sediment core (Unit 1, 2 and 3 - from bottom to the top).
End-members (EM) 1 and 2 show multimodal grain-size distributions, quite similar to the distributions of modern low-energy fluvial deposits. Such comparable distributions do not indicate exactly the same transport system of present and past, but give a hint on the energy level and the flow velocity of the transport medium. Whereas EM 1 and 2 represent most of the relative EM amount from Unit 2, EM 3 and 4 dominate Unit 1 and 3. They are represented by unimodal distributions, only differing by the position of their peak, which is slightly coarser for EM 4. The relative EM amount in Unit 1 indicates a coarsening upward sequence, possibly related to an increase of the energy level. The coarser EM 4 nearly fully dominates the uppermost Unit 3 and can be explained by modern distributions of littoral and coastal dune samples. Such results indicate a change within the examined sediment record from sublittoral (Unit 1) to supralittoral (Unit 3), interrupted by a low-energy environment (Unit 2).
The gained information will be used for further statistical analysis on grain-size data, combined with geochemical and sedimentological data from a transect of several sediment cores, to reconstruct the environmental change of the study area close to the Rioni delta, Black Sea coast of Georgia.