Geophysical Research Abstracts
Vol. 13, EGU2011-8959, 2011
EGU General Assembly 2011

Modelling the relation between grain-size distribution and geochemical composition: application to a marine record of mixed fluvial-eolian provenance (Late Quaternary, offshore Northern Senegal)

Menno Rudolf Bloemsma (1), Gert Jan Weltje (1), Jan Berend Stuut (2), and Matthias Zabel (3)

(1) Delft University of Technology, Faculty of Civil Engineering and Geosciences, Department of Geotechnology, Stevinweg 1, NL-2628CN Delft, The Netherlands, (2) Netherlands Institute of Sea Research (NIOZ), Department of Marine Geology, Landsdiep 4, NL-1797SZ 't Horntje (Texel), The Netherlands, (3) MARUM - Center for Marine Environmental Sciences, University of Bremen, Leobener Strasse, D-28359 Bremen, Germany

In its most general form, compositional and textural variation of sediments reflects the interplay of provenance and selective dispersal. The former may be expressed in terms of mixing of detritus from multiple sediment sources, whereas the latter is a complex function of size, shape, and density-selective generation, erosion, transport, and deposition of the sediments shed by each of these sources. Previous research has shown that log-ratios of petrographic component abundances may be approximated by linear functions across a wide range of grain sizes, and the same is likely to be applicable to the chemical component abundances. Similarly, it has been shown that grain-size records may be conveniently decomposed into mixtures of end-member grain-size distributions using the end-member unmixing algorithm EMMA. In this study we combine these two concepts in order to decompose bulk geochemical records of heterogenous sediments in terms of provenance and grain-size-related variation. We illustrate our approach by means of a Quaternary core obtained at the continental slope off Northern Senegal. The cored sediments have been interpreted as mixtures of eolian and fluvial deposits which record glacial-interglacial climate changes. The statistical model approximates the record as a series of linear combinations of end members with a fixed grain-size distribution and a unique compositional fingerprint describing compositional change with grain size. In order to set up this model, several preprocessing steps were necessary. The core was sampled at cm-resolution and the grain-size distribution of each sample was measured with a laser-particle sizer. The grain-size record was subsequently decomposed into mixtures of theoretical end-member grain-size distributions using EMMA. Samples for chemical analysis of narrow size ranges were selected so as to represent a wide range of predicted mixing coefficients. A bulk chemical record was obtained by measuring the core with an XRF core scanner at cm-resolution, followed by log-ratio calibration using conventional XRF analyses of selected calibration samples. By iterative linear unmixing of the chemical compositions of the different size ranges and the bulk chemical record, linear functions of composition versus grain size were estimated for the different end members. The best-fit geochemical provenance model turned out to be fully consistent with previously published interpretations of grain-size end members occurring in the study area. Modelling showed that the “initial guess” of size-composition functions derived from chemical analysis of isolated size fractions was far from perfect. This could be due to the fact that the isolated size fractions did not have a within-class uniform composition and grain-size distribution, and showed between-class overlaps. Further research into the most appropriate optimization technique, sampling of “pure” end member sediments, and more precise methods to physically isolate narrow size fractions for chemical analysis are likely to lead to significant improvements of the proposed approach to analyzing the relation between grain size and geochemical composition. This improved method, in turn, may shed more light on the general applicability of log-ratio linear fingerprints for the purpose of characterizing signals in clastic-sediment cores.