Automated Mineral Particle Analysis as a Tool in Paleoenvironmental and Paleoclimatic Studies

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ABSTRACT

Automated SEM-EDS mineral analysis provides a powerful analytical technique for determining the size, shape, and abundance of minerals or particles from ion-milled or polished rock surfaces. Using the FEI QEMSCAN® system we apply these methods to paleoenvironmental and paleoclimatic applications on marine sediments. Kaolinite/illite ratios have been adopted previously as a proxy for paleoclimate, with high values of the ratio indicating a warm wet climate. A problem with this approach is over-printing by authigenic kaolinite leading to higher kaolinite content then primarily delivered to the basin, and therefore misleading kaolinite/illite ratios. Using the QEMSCAN® system we have distinguished detrital from authigenic kaolinite on the basis of particle size, with particles <4 11m assumed to be detrital. From these data it is possible to calculate the proportion of detrital kaolinite in a sample and ratio it to the proportion of illite, similarly determined. Another paleoenvironmental indicator often applied in mudrocks is the pyrite framboid size distribution, which has been used as an indicator of redox conditions during time of deposition. Pyrite framboids in sediments formed under euxinic conditions are on average smaller and less variable in size than those of sediments underlying dysoxic or oxic water columns. The widely applied method requires a manual counting and measuring of pyrite grain size with the SEM, possibly resulting in a user-biased statistical outcome of the results. The automated mineralogy approach allows the scanning of selected areas and automated determination of individual pyrite grain sizes and its variation. Examples of this approach are presented from Early Jurassic organic-rich mudrock sequences in NW Europe and elsewhere.