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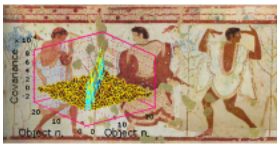

Geochemistry and Mineralogy of Clays From the Algarve Basin, Portugal: Contribution of Multivariate Analysis to Paleoenvironmental Studies

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Abstract

Multivariate techniques were selected to study simultaneously the geochemistry and mineralogy of the main clay deposits from the Algarve Basin (South Portugal). This approach revealed useful in distinguishing Triassic and Cretaceous clays by establishing geochemical fingerprints and enabling a more direct and easy palaeoenvironmental interpretation of the data, due to the information given by the mineralogy.

Introduction

During the Mesozoic the subsidence of the Algarve Basin (South Portugal) was controlled by extensional tectonics associated with the break up of Pangea and development of the westernmost Neo-Tethys. The sedimentary environments evolved from continental (in Triassic) to open marine, with facies variations triggered by various regression/transgression episodes. The main clay deposits of the basin come from siliciclastic continental units of Lower Cretaceous (Barremian and Berriasian) and from a unit composed by shales, dolomites and evaporites of the Upper Triassic/Hettangian. Considering both clays formed under different palaeoenvironmental conditions, the aim of this work is to explore a multivariate solution for mineralogical and geochemical data together, in order to put in evidence those differences and the variables that have greater contribution to their diffrentiation. The inclusion of the mineralogy in the multivariate analysis facilitates the palaeoenvironmental interpretation of the geochemical differences, like the illite/kaolinite ratio related with aridity/humidity changes during the weathering of source rocks.

Materials & Methods

Several clays from the Algarve Basin have been investigated (Trindade, 2007). For this study we selected 24 samples from Cretaceous units and 23 samples from the Triassic unit referred above.

The X-ray diffraction study of clay and non-clay minerals was carried out on both bulk rock and below 2 μm fraction. Clay-size fraction was obtained after decarbonation (with acid acetic buffer solution), sand separation by wet sieving and sedimentation, according to Stoke's law. Oriented slides were then prepared and treated: ethylene-glycol solvation, heating to 550 °C, Mg-saturation, Mg-glycolation, HCl-glycolated and HCl-550 ºC. Clay mineralogy was study in oriented preparations, while bulk mineralogy was determined in random powders. We used a Philips X' Pert Pro diffractometer with a PW 3050/6× goniometer, CuKα radiation and operating at 45 kV/40 mA. Semiquantification of minerals was obtained measuring the main reflection peak areas and then weighted by empirically estimated factors, according to Schultz (1964) and Biscaye (1965).

Major elements were determined by X-ray fluorescence (XRF), using a Philips PW 1410/00 spectrometer and CrKα radiation. Na_2O and K_2O contents were determined by flame photometry, using a Corning 400 spectrometer. Minor and trace elements were obtained by instrumental neutron activation analysis (INAA) at the Portuguese Research Reactor.

Results

Principal Component Analysis (PCA), after Sc normalization of the geochemical data, which enables to avoid enrichment/dilution effects, is shown in Figure 1, where the first two factorials supply more than 50% of the information. As supplementary variables is represented the mineralogical data.

Triassic clays have high content of mobile elements (Cs, K_2O, Rb and P_2O_5), MnO, Fe_2O_3T and MgO. The last two are related with carbonates, which can be present in highly variable amounts. The most relevant mineralogical aspect is the high illite/kaolinite ratio and the presence of hematite. So, mobile elements, illite and hematite are good discriminators of this unit, indicating oxygenated environment and arid climate, where physical weathering of the source was the main process for clay production.

Cretaceous clays define a homogenous group along factor 2 in the opposite direction. The main contributions are the presence of goethite, quartz, TiO_2 and low illite/kaolinite ratios. The terrigenous character of these clays is shown by high content of quartz and the less oxygenated conditions by the presence of goethite. The association goethite + kaolinite + illite reflect a siderolithic facies related with erosion and transport of laterites under tropical climates, during a regressive episode.

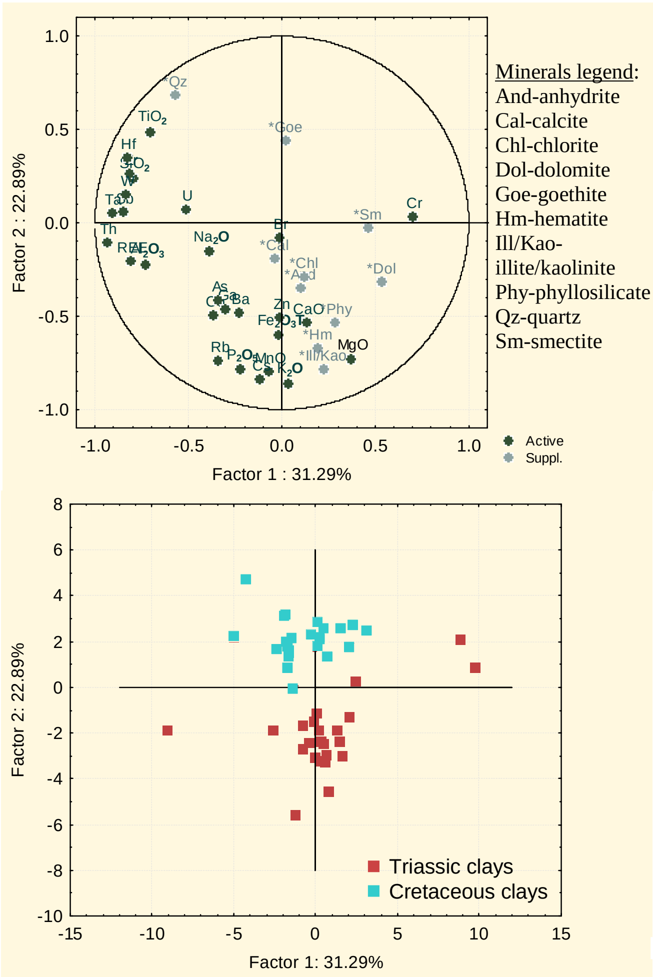

Fig. 1; PCA of variables and samples for Cretaceous and Triassic clays from the Algarve Basin.

Conclusions

The illustrated example shows how multivariate analysis is helpful when much data of different nature are present and, specifically, it can be very useful in the palaeoenvironmental interpretation of the data. Besides PCA other multivariate techniques were explored, like K-means clustering and tree-clustering, which gave suitable results concerning the separation of the Cretaceous and Triassic clays on the basis of a simultaneous approach of geochemical and mineralogical data.

References

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