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IDENTIFICATION OF SEDIMENTATION EPISODES CAUSED BY CATASTROPHIC FLOODS BASED ON MINERALOGICAL ANALYSIS OF HOLOCENE DEPOSITS IN TWO ESTUARIES IN SOUTHERN PORTUGAL: BOINA AND ARADE-ODELOUCA

Abstract: Mineralogical analysis of the sandy fractions from the sediment cores recovered from two boreholes located near the confluence of two rivers, draining different rock types revealed striking compositional differences within the separated density fractions. The characteristics of light fraction, composed mainly of quartz and feldspars, shows a clear relation to the source rocks. The incidental variation in the chemical composition of feldspars indicates a sporadic change of the sediment source and it is probably a signal of the catastrophic floods. Surprisingly, the localization of two boreholes imparts no influence on the composition of the heavy fractions.

Keywords: Holocene, sediments, catastrophic flood, mineralogy

The Boina-Arade estuary is located at the cofluence of (1) the Boina River and (2) the river system of Odelouca and Arade. Both branches erode rocks of different lithology. The first one drains nepheline syenites of the Monchique Massif and the surrounding Carboniferous slates and greywackes, and finally the Lower Jurassic volcano-sedimentary complex at the river confluence. The second one mainly drains the Paleozoic slates interbedded by greywackes and the Lower Jurassic volcano-sedimentary complex (Fig. 1). The E-W elongated massif of Monchique presents marginal and nuclear zones which are asymmetrically distributed around the outcrop of the main magmatic body which is in 95% nepheline syenite. Older studies subdivided the massive in two major units: pulaskitic (Foia block) and foiaitic (Picota block). The syenites of the Foia block have a lower content of nepheline than Picota. 4.5% of the area of the intrusion is formed by rock previously classified as sub-

Fig. 1. Aerial view of the confluence of the Boina river (P5) and Arade-Odelouca (P2)

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volcanic breccias. The breccias which resemble the non assimilated remnant of roof stopping process occur in several places within the massive and present conspicuous compositional inhomogeneities. The basic rocks occupy about 0.5% of the outcrop and occur on the southern slopes of the mount of the Foia. The lamprophyres are confined in the area NNE of Caldas of Monchique and they had resulted of multiple intrusions of lamprophyric magma. Since the mid XIX century the alkaline massif of Monchique attracted the interests of the investigators due to its structural and petrologic peculiarities. The first published work by Blum (1861, in Rock 1978) aimed the general aspects of tectonics, petrography and geomorphology and originated the now classic petrographic study. According to Rock (1978) it is probable that the alkaline massif of Monchique would have formed as a result of magma pulses from shallow sub-volcanic reservoir. Until now, the geochemical knowledge about the massif was based on rather limited number of analyses both mineralogical and chemical. In general terms, the published studies on Monchique emphasized its differentiated alkaline character, potentially favorable to the accumulation of incompatible elements. However it was never studied with an explicit aim on the mineral potential in terms of chemical elements applicable in high-tech industries. A preliminary work having in sight an elemental geochemical cartography as well as the definition of economic potentialities was published by Simão et al. (1999).

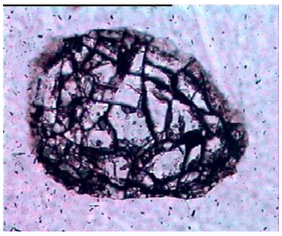

Fig. 2. Oval quartz-grain with deep cracks

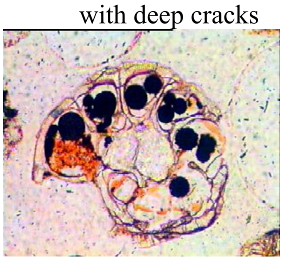

Fig. 3. Foraminifer's test partially filled with framboidal pyrite

Studies embraced 6 samples of sandy fraction 0.125 mm from the P2 borehole and 7 samples from the borehole P5, which cover the depths 3.8 - 18 m and 0.8 - 15 m, respectively. The boreholes are in a distance of a few kilometers from each other. The mineral compositions of deposits from P2 and P5 are different. The contribution of heavy fraction, separated by using bromoform, is about 2 times higher in P5 than in P2. In the light fraction, prevail quartz and K-feldspar with less plagioclase and subordinate muscovite detected by XRD. Ovally shaped aggregate grains built up of clay minerals, mainly kaolinite and chlorite, and shell fragments occur occasionally. Both types of feldspars, K-feldspar and plagioclase occur in samples from P5 borehole, while in the samples from P2 only plagioclase is present. The composition of plagioclase itself also differs, being more sodic in P5 (oligoclase-andesine) than in P2 (labradorite). These differences in mineral composition likely reflect the change of the source of the sediment supply. If so, then the occurrence of two kinds of feldspar in P2 sample from the depth 16.25 m might be a signal of a catastrophic flood event which led to the erosion over a wider area in the catchment of Odelouca river.

The quartz grains from P2 borehole are more rounded than those from P5. It points out to their longer transport. They show cracks, which could either be the feature inherited from the source material or could be a transport related characteristics (Fig. 2).

In the heavy fraction the main constituent are grains of Fe-oxides and hydroxides, which are products of weathering and erosion of the rocks of the volcano-sedimentary complex. Framboidal pyrite mainly occurs as the foraminifer's test infillings (Fig. 3), and is diagnostic for input of marine and/or brackish material. Other heavy minerals: pyroxenes and amphiboles, sphene and biotite originate from the Monchique Massif, while andalusite and epidote - from the slates-grauwackes complex. The share of Monchique Massif-derived minerals is higher in P5.

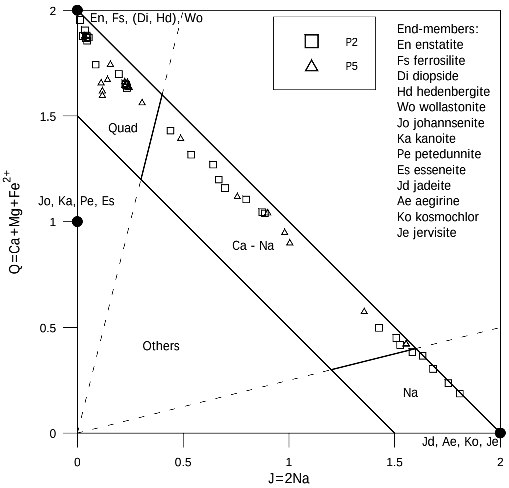

Fig. 4. The analysed pyroxenes on the preliminary classification of pyroxenes into 4 groups: Ca-Mg-Fe (Quad), Ca-Na, Na and other pyroxenes

Pyroxenes show the biggest variability in chemical composition. Under transmission light microscope, three groups of pyroxenes can be distinguished: the colourless ones – diopsides, the darker ones, pleochroic in brown – augites and the most rarely occurring green ones – Na-pyroxenes. Unequivocal identification of pyroxenes provides electron microprobe analysis. Accordingly, the most abundant population of pyroxenes belongs to the so-called "Quad" category, less populated are Ca-Na pyroxenes (Figs. 4, 5). Na-pyroxenes together with Ca-Na pyroxenes abundant in Na form the distinct group (Fig. 6).

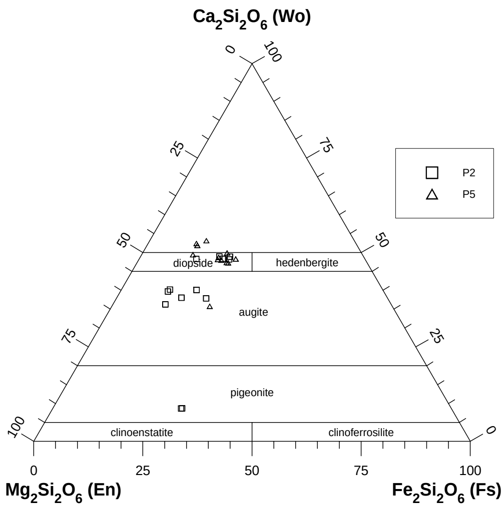

Fig. 5. Ca-Mg-Fe pyroxenes on classification triangle

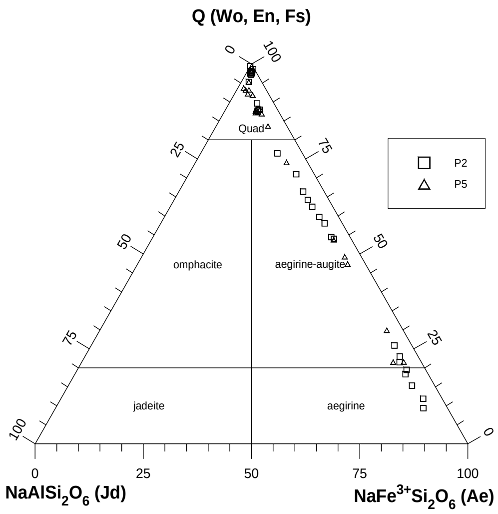

Fig. 6. Na and Ca-Na pyroxenes on classification triangle

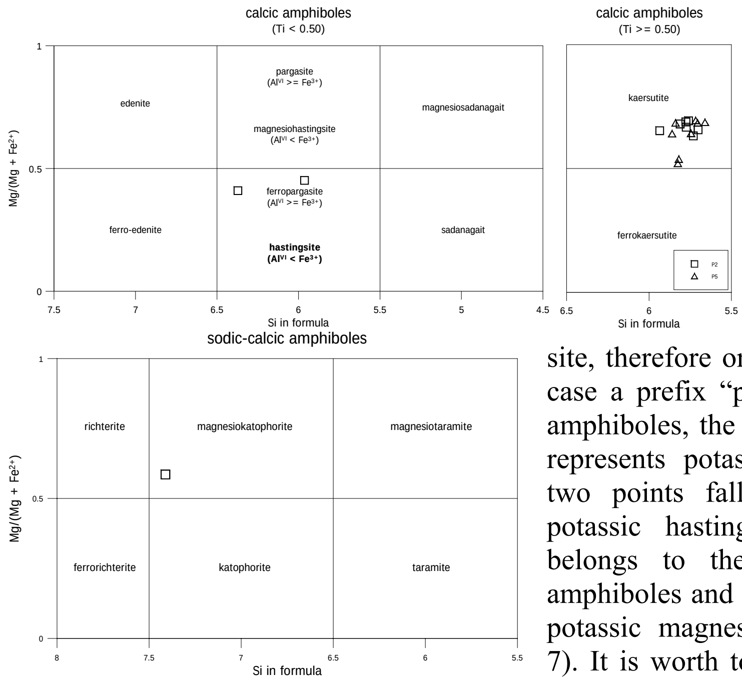

Fig. 7. Calcic and sodic-calcic amphiboles on classification diagrams

Occurring in lesser amounts than pyroxenes, amphiboles belong to two groups: Ca- and Na-Ca-amphiboles. All amphibole samples contain more than 0.5 K in the "A"-site, therefore one should use in this case a prefix "potassic". In the Ca-amphiboles, the majority of analyses represents potassic kaersutites, and two points fall into the field of potassic hastingsites. One sample belongs to the group of Na-Ca amphiboles and falls into the field of potassic magnesiokatophorites (Fig. 7). It is worth to note that the latter sample was encountered in the P2 sediments, though such amphiboles are typical of alkaline magmatic complexes such as Monchique Massif. Similarly, alkaline pyroxenes, also probably derived from Monchique, were found in both drilling cores. Niobium-rich rutiles (1-3.5 wt% Nb_2O_5), apart from the stoichiometric ones, were identified in sediments from both localities. Rutiles with elevated Nb-contents are characteristic of alkaline magmatic rocks, and they likely originated from the Monchique Massif.

CONCLUSIONS

The composition of the light and heavy fractions of the estuarine sediments in two studied boreholes is differentially biased by the diagenetic and synsedimentary processes. In the light fraction, the morphological characteristics of quartz and the chemical composition of feldspars reflect the nature of the source rocks. The changes in feldspar composition indicates, most probably, catastrophic flood event. The compositional spectrum of the heavy mineral fraction did not vary and reflected the mixed influence of diagenetic processes and erosion of the Monchique Massif rocks.

REFERENCES

ROCK N., M., S., 1978: Petrology and Petrogenesis of the Monchique Alkaline Complex, Southern Portugal. Jour. Petrology 19, part. 2: 171-214.

SIMÃO J., BRAVO M., S., RIBEIRO M., L., 1999: Distribuição de terras raras e outros elementos incompatíveis no Maciço de Monchique - nota preliminar. Ciências da Terra (UNL) 13, Lisboa, 71-75.