

Patterns of rare earth and other trace elements in Paleogene and Miocene clayey sediments from the Mondego platform (Central Portugal)

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ABSTRACT

In the present study the origin of clay deposits occurring in an inland platform, in central Portugal, was investigated by their mineralogical and chemical composition. The clay deposits, exploited for ceramic industry are composed of silt-clay facies, the Monteiro Member and the Arroça Member, which are assigned to the Coja Formation (Paleogene) and the Campelo Formation (Miocene), respectively. These clayey facies show almost compositional homogeneity, especially concerning texture. The mineralogical composition of the Monteiro Member displays slightly higher content in smectite and interstratified clay minerals, which is supported by the chemical composition of samples analyzed. Both members present similar REE patterns, displaying an intense weathering record and little variation in the source area composition. Minor element geochemistry suggests low content in heavy minerals and transition metals. REE patterns and ratios of geochemical parameters support the dominant metasedimentary provenance, with a granite source contribution and also mature recycled sediments of continental origin. The study results' suggest that the clays of these two members have the same source in terms of lithology and recycled sediments from the Hesperian massif. During the deposition of the Arroça Member, a major remobilization of the Monteiro Member is suggested, explaining the geochemical similarity of both facies.

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1. Introduction

The sediments' chemical composition result from a combination of factors such as: the composition of the source area, intensity of alteration, calibration and sediment diagenesis, which will determine its final characteristics (Piper, 1974; McLennan, 1989). This paper focuses on the geochemical characterization of silt-clay facies that constitute important clay resources for construction ceramics and integrate deposits occurring in inland basins, west of Coimbra, in the designated Mondego platform. These facies mostly belong to two formations, assigned respectively to the Paleogene and Neogene: Coja and Campelo formations (Cunha, 1992), which have been studied before, from a stratigraphic and sedimentological approach (Carvalho, 1960; Soares et al., 1983; Cunha, 1992, 1999). More recently these formations' silt-clay facies were assessed regarding the relationship between the composition and

most relevant ceramic properties (Lisboa, 2009; Lisboa et al., 2013) as both facies provide the main supply of clays for ceramics in the Mondego planation.

The composition and particularly the presence of lithic clasts suggest a metasedimentary and granitic provenance; the latter especially concerning the Coja formation (Reis et al., 1991), but so far geochemical techniques have not been applied to the provenance assessment or the tectonic setting of these sediments. Other studies within the study area broaching mineralogy and geochemistry of Cretaceous sediments were carried out by Prudêncio et al. (1988, 1989).

This study complements the preliminary geochemical study performed on the major elements (Lisboa, 2009) of the silt-clay facies, towards a better knowledge on the provenance, tectonic setting and weathering in the source area, using trace elements and REE, on which studies regarding these sediments are not known. As these facies present similar compositional characteristics, particularly from a textural point of view, hindering its distinction, the geochemical characteristics of both facies are examined in an attempt to reveal relationships or, on the opposite, distinctive geochemical signatures if any, among the sediments. Given that

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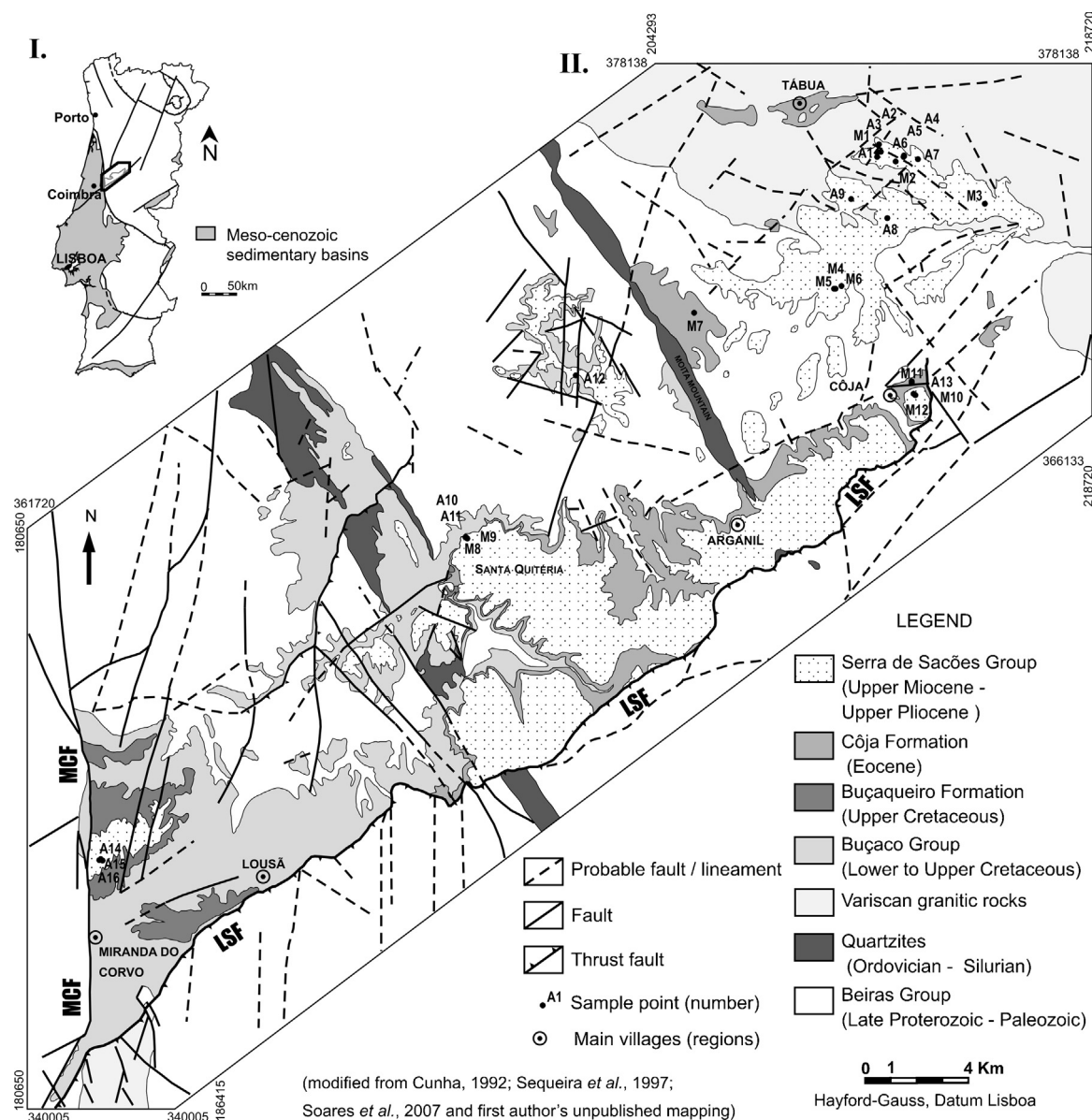


Fig. 1. Geological setting of the study area in the Mondego planation showing: (I) Meso-Cenozoic terrains and study area location (rectangle) in Portugal, (II) sample locations (LSF: Lousã-Seia fault; MCF: Miranda do Corvo fault). Modified from Cunha (1992); Sequeira et al. (1997); Soares et al. (2007) and first author's unpublished mapping.

both facies constitute the exploited raw material for ceramics, the knowledge of their genetic inter-relationships is essential to create raw material stocks with controlled mean quality (constant quality) and also to discriminate clay fillings derived from different sources.

2. Study area and geological setting

The study area is located in the central zone of Portugal (Fig. 1I), east of Coimbra and west of the Portuguese central mountain range, corresponding to a large polygenic planation surface (Mondego planation) that encompasses Precambrian and Palaeozoic age metasediments (Beiras Group) and Variscan granitoids. Continental fluvial and alluvial deposits (Cretaceous and Cenozoic age) were partly preserved in tectonically depressed areas, which are confined by two major faults: Miranda do Corvo and Lousã-Seia faults (Fig. 1II). The Cretaceous age deposits include feldspathic sands rich in kaolinite composing the Buçaco group (Albian to Upper Campanian), which is unconformably overlain by the Buçaqueiro Formation (Campanian to Paleogene) (Cunha, 1999, 2000). The

Cenozoic sediments are siliciclastic and comprise the Coja Formation and the Serra de Sacões Group (Soares et al., 1983; Cunha, 1992, 1999; Pais et al., 2012), which unconformably overlie either the Cretaceous sediments or the Hercynian basement.

The Coja Formation (Middle Eocene to Lower Chattian?) comprises two members separated by a disconformity:

- The Casalinho de Cima Member, which consists of tabular beds of massive coarse arkoses.
- The Monteiro Member (MM) occupies an upper stratigraphic position and includes gravels, arkoses and clays, which were sampled and are object of this study.

The Serra de Sacões Group is ascribed to the Upper Tortonian to Gelasian (Cunha, 1999), or even to the earliest Pleistocene. This mainly conglomeratic succession, which covers most of the study area, is interpreted as alluvial fan sedimentation along tectonic scarps and includes three formations—the Campelo, Telhada and Santa Quitéria formations.

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