

Relationship between geometric parameters and compositional data: A new approach to karst bauxites exploration



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ABSTRACT

Southern Italy karst bauxites occur in Apulia and Campania regions. In Apulia there are the autochthonous concentrations of Spinazzola (Murge) and San Giovanni Rotondo (Gargano), as well as the allochthonous Salento-type deposits. Typical Campania bauxites are those of the Matese Mts and in the Caserta area. During Cretaceous, both Apulia and Campania experienced sub-aerial carbonate exposures, which promoted bauxite accumulation. Southern Italy bauxite deposits share the same ooidic texture consisting of sub-circular aggregates dispersed in a fine-grained matrix. The ooids are mainly formed by a large core of Al-hematite surrounded by alternating layers of boehmite and Al-hematite reflecting dry and wet climate periods. The ooids of the allochthonous Salento-type bauxite consist of a large boehmite core surrounded by a thinner rim of Al-hematite.

Image analysis, performed on these karst bauxites provided geometric data such as ooids circularity and aspect ratio, number of ooids and fractal dimension *D*. In the Southern Italy bauxite deposits significant correlations exist between the results of image analysis and compositional data. In the allochthonous Salento-type bauxites significant correlations between geometric features (number of ooids and aspect ratio) and some critical elements (Sc, Ni and REE) have been observed. In the autochthonous Apulian bauxites a significant correlation between Ni and circularity has been observed instead.

The arrangement and the growth of the ooids can be described with a molecular diffusion pattern, and their growth can be described in terms of fractal geometry. The values of fractal dimension are different between Apulia and Campania bauxite deposits, this suggesting that during long-lasting sub-aerial events, the diffusion-limited cluster aggregation process may prevail over the simpler diffusion-limited one, which is responsible for ooids formation during time-limited exposure events.

Image analysis and its integration with other analytical techniques provide interesting information about the genesis of bauxite deposits, and can therefore represent an innovative and useful tool for the exploration of bauxite ores.

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1. Introduction

Karst bauxites are residual ores of supergene origin, mainly composed of Al- and Fe-oxy-hydroxides (Bárdossy et al., 1977; Bárdossy, 1982; Bárdossy and Aleva, 1990). These deposits form in tropical to sub-tropical climates (Bárdossy, 1982) and in most cases testify local or regional unconformities correlated with sub-aerial carbonate exposure. Bauxites are important from the economic point of view because they are the main resource of aluminum, and furthermore they may contain several critical elements, including rare earth elements. Rare earth elements have been analyzed in a great number of recent and less recent works for their geological, economic and environmental importance

(Abedini and Calagari, 2013a, 2013b, 2013c, 2014, 2015; Chetty and Gutzmer, 2012; Davranche et al., 2005; Herrington, 2013; Leybourne and Johannesson, 2008; Karadağ et al., 2009; Petrosino et al., 2013; Sadeghi et al., 2013, 2015; Vidal et al., 2013; Wang et al., 2010). These deposits can also provide useful paleogeographic and paleoclimatic informations which, for what concerns Southern Italy can be found in: Bárdossy, 1982; Bárdossy et al., 1977; Boni et al., 2012; D'Argenio et al., 1973; Mindszenty et al., 1995; Mondillo et al., 2011; Mongelli, 1997, 2002; Mongelli and Acquafredda, 1999; Mongelli et al., 2014, 2015. For the above reasons, the study of bauxite deposits is currently a subject of growing interest.

Southern Italy karst bauxites have not an economic relevance; however, they can be considered as analogues of economic bauxite deposits in other parts of the world. The bauxites of Southern Italy, mostly formed during Late Cretaceous carbonate exposure events, occur mainly in the Apulia and Campania regions (Fig.1) (Table 1). Other bauxite

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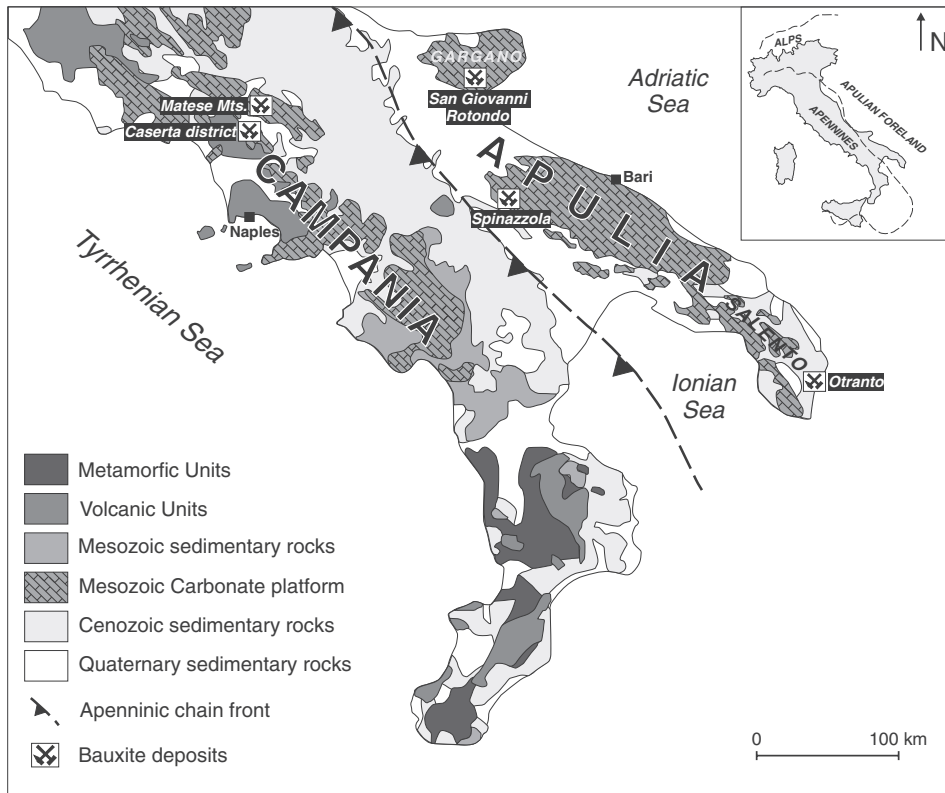


Fig. 1. Geolithological map of the Southern Apennines. The sampling sites are shown. Modified from Bonardi et al. (2009).

occurrences are located in the Abruzzi (Bárdossy et al., 1977), but they will not be discussed in this paper.

In the Apulian Carbonate platform bauxite deposits occur on the Gargano peninsula, in the Murge area and in the Salento peninsula

(Bárdossy et al., 1977; Mindszenty et al., 1995), while in Campania region, they are located in the Matese Mountains and in the Caserta district (Bárdossy et al., 1977, Bárdossy, 1982; D'Argenio et al., 1973). The typical texture of karst bauxites is defined “oolitic”, because they are

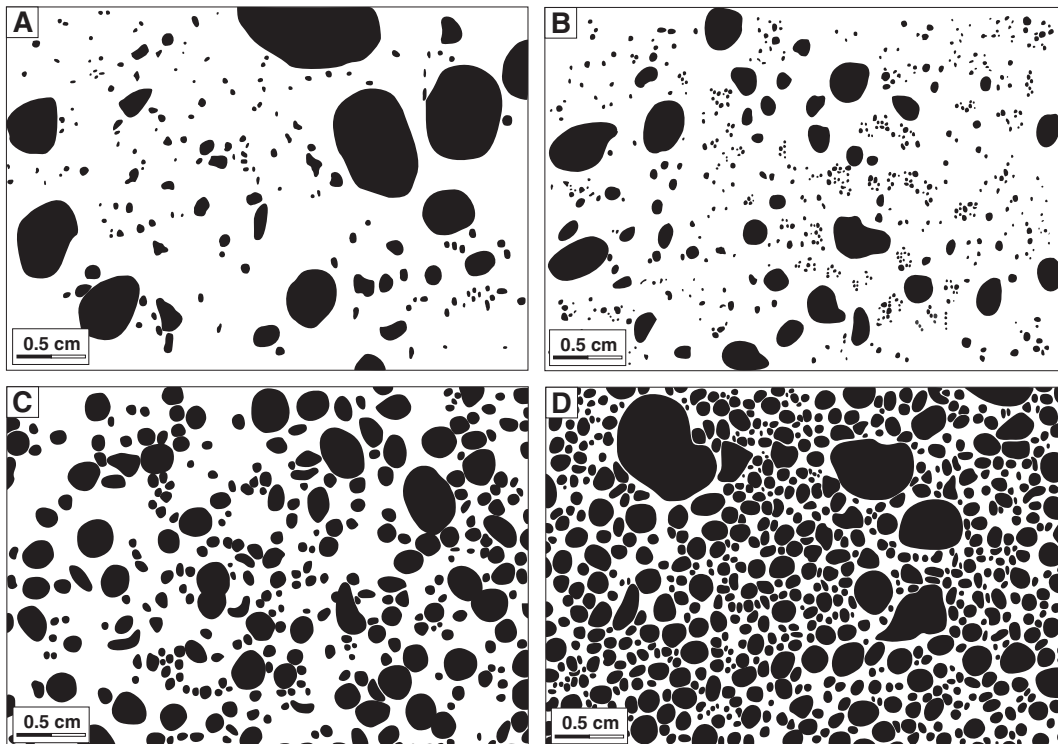


Fig. 2. Binary images samples of the bauxite deposits considered for image analysis. (a) Salento; (b) Murge; (c) Gargano; (d) Campania.

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