Sedimentary Geology 325 (2015) 168–176

Contents lists available at ScienceDirect

Sedimentary Geology

journal homepage: www.elsevier.com/locate/sedgeo

Genesis of autochthonous and allochthonous Apulian karst bauxites (Southern Italy): Climate constraints

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ARTICLE INFO

Article history:
Received 30 March 2015
Received in revised form 3 June 2015
Accepted 4 June 2015
Available online 19 June 2015

Editor: J. Knight

Keywords:
Cretaceous bauxites
Climate
Image analysis
Mineralogy
Apulia

ABSTRACT

The Apulian Carbonate Platform (ACP) in southern Italy has experienced several episodes of subaerial exposure, which were in some cases associated with the formation of karst bauxite deposits. The ACP contains both autochthonous canyon-like bauxite and allochthonous Salento-type bauxite, with the latter having been derived from a weathered and eroded pristine bauxite deposit. The remnants of this pristine bauxite are preserved as transported pebbles embedded in a clayey matrix.

The autochthonous bauxite and the pebbles of the allochthonous bauxite have the same texture of sub-spheroidal components (ooids) dispersed in a fine-grained matrix. The fractal dimension of ooids from both deposits is very similar and corresponds to the growth of "aggregates" under a diffusion-controlled process.

The ooids of the autochthonous bauxite have a different composition to those in the pebbles of the allochthonous bauxite, because they formed under different climatic conditions. During the Turonian, autochthonous bauxite ooids formed in alternating wet tropical conditions (promoting Al-hematite formation) and drier conditions (favouring boehmite stability). In the allochthonous pebbles, ooids formed mainly in a dry climate, promoting the formation of large boehmite cores. The ooids/matrix ratio and the geometrical features of the ooids reflect these climate differences.

The differences in composition and age (post-Turonian) of the Salento-type bauxite bedrock suggest that the pristine bauxite that produced the Salento-type pebbles was different in composition to and younger in age than the Canyon-like bauxite. The latter probably formed during a middle Campanian emersion event (evidenced by large karstic cavities), which is correlated with the subaerial exposure of karst recorded on the Adriatic island of Brač.

1. Introduction

Karst bauxites are residual rocks that occur on carbonate rocks and form in tropical to subtropical climates (Bárdossy, 1982). In many cases, as in the circum-Mediterranean realm, bauxites mark local or regional unconformities associated with subaerially exposed carbonates. These deposits are important for geodynamic assessments (Mindszenty et al., 1995), provenance studies (Boni et. al., 2012) and palaeogeographic reconstructions (Mongelli et al., 2014).

Bauxite ores are commonly enriched in many economically important elements.

It is thus not surprising that the wide and recent literature on bauxite deposits has focused on the genetic mechanisms promoting the formation of this type of sedimentary rock (e.g., Mongelli, 2002; Laskou and Economou-Eliopoulos, 2007; Mameli et al., 2007; Zarasvandi et al., 2008; Hoefs, 2009; Karadağ et al., 2009; Wang et al., 2010; Boni et al., 2013; Hanilçi, 2013; Zarasvandi et al., 2013; Abedini and Calagari, 2014; Mongelli et al., 2014; Peh and Kovačević Galović, 2014; Yu et al., 2014).

Southern Italy contains several, well-known karst bauxite deposits of Cretaceous age (Table 1). The deposits within the Apulian Carbonate Platform are both autochthonous and allochthonous (information e.g., Mindszenty, 1995). Karst bauxites are often composed of iron-rich, rounded particles dispersed in a clayey matrix, forming a typical oolitic texture (e.g., Bárdossy, 1982). Previous studies (Mongelli, 1997; Mongelli and Acquafredda, 1999; Mongelli, 2002), focussing on the autochthonous Apulian karst bauxites, stated that ooids are formed in situ through a pedogenic process involving chemical fractionation and their composition was largely controlled by climate. No data on genesis and composition of ooids from allochthonous Apulian karst bauxites were available as yet. Expanding our knowledge of the features and genesis of the Apulian karst bauxites can contribute to better constraints on the evolution of the Tethyan realm in the late Cretaceous. In addition, although these deposits no longer have any economic value, they can also provide a model that may be a valuable exploration tool for similar deposits elsewhere in the world.

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http://dx.doi.org/10.1016/j.sedgeo.2015.06.005

Table 1
Principal geological features of the central and southern Italy bauxites. Med. = Mediterranean type bauxite; Sal. = Salento-type bauxite; auto. = autochthonous deposit; allo. = allochthonous deposit.

Region of Italy	Typical outcropping site	Age of deposition	Type	Maximum thickness	Texture	Degree of bedrock carsification	References
ABRUZZO	Orsello Mt.	Cenomanian	Med., auto.	10 m	massive, oolitic	weak to medium	Bárdossy, 1982
CAMPANIA	Matese Mts.	Albian/late Turonian-Senonian	Med., auto.	5 m	pisolitic, oolitic	weak	Carannante et al., 1987
	Caserta district	Albian-Aptian/Cenomanian	Med., auto.	10 m	massive, oolitic	weak	Crescenti and Vighi, 1970
SARDINIA	Nurra district	Aptian/Albian	Med., auto./allo.	5 m	massive, oolitic	medium	Mameli et al., 2007
APULIA	Gargano	Cenomanian/Turonian	Med., auto.	15 m	massive	medium	Bárdossy, 1982
	Murge	Cenomanian/late Turonian	Med., auto.	25 m	oolitic, massive	strong	Bárdossy, 1982
	Salento	Campanian	Sal., allo.	5 m	oolitic	medium	Bárdossy, 1982

In this study, a multidisciplinary approach, including image analysis, texture observations and mineralogical, chemical and microchemical determinations was performed on karst bauxites from two Apulian deposits. These deposits are of different types according to the Bárdossy (1982)) classification scheme. The studied deposits were an autochthonous canyon-like deposit (a Mediterranean-type deposit) in the Murge area, and an allochthonous Salento-type deposit at Otranto on the southernmost Salento Peninsula, southern Italy.

2. Geological setting and bauxite occurrence

The Apulia region extends for 350 km in southeast Italy between the Adriatic Sea and the Ionian Sea (Fig. 1). It is part of the northern Africa Plate (also known as the African Promontory; Argand, 1924), which belongs to the complex structural framework of the Central Mediterranean. In this region, the African and Eurasian plates have been converging since the late Cretaceous (Dewey et al., 1989).

The Apulia region represents an extensive foreland domain (usually called the "Apulian foreland" or "southern Apennine foreland"; Spalluto, 2012, and references therein) of both the Apenninic and Dinaric orogens. It is weakly deformed and affected by Apenninic (NW–SE-trending) and anti-Apenninic (NE–SW-trending) faults that divide the region into three main structural blocks including the Murge area and the Salento Peninsula (Fig. 1), which have different landscapes and uplift rates (Funiciello et al., 1991).

From the Triassic to early Cretaceous, the Apulian foreland was a passive continental margin. The formation and evolution of the Apulian Carbonate Platform (ACP) occurred during this time (Ricchetti et al., 1992). The ACP is interposed between basement formed of continental crust and thin carbonate and terrigenous successions of Neogene and Quaternary age (Ciaranfi et al., 1992; Ricchetti et al., 1992). The ACP consists of an autochthonous platform succession that is composed mainly of carbonate sediments recording the development of metre-scale, shallowing-upward aggradational cycles. Carbonate deposition was frequently punctuated by ephemeral subaerial exposure (as indicated by palaeosols and palaeokarst) resulting from interactions of platform subsidence, long-term sea level change, and superimposed higher-order eustatic oscillations with the actual rate of carbonate production (Mindszenty et al., 1995).

On the basis of seismic sections and borehole data, Mindszenty et al. (1995) recognized several regional chronostratigraphic unconformities in the ACP. Of these, the Turonian unconformity resulted from subaerial exposure and was associated with formation of industrial-grade bauxite.

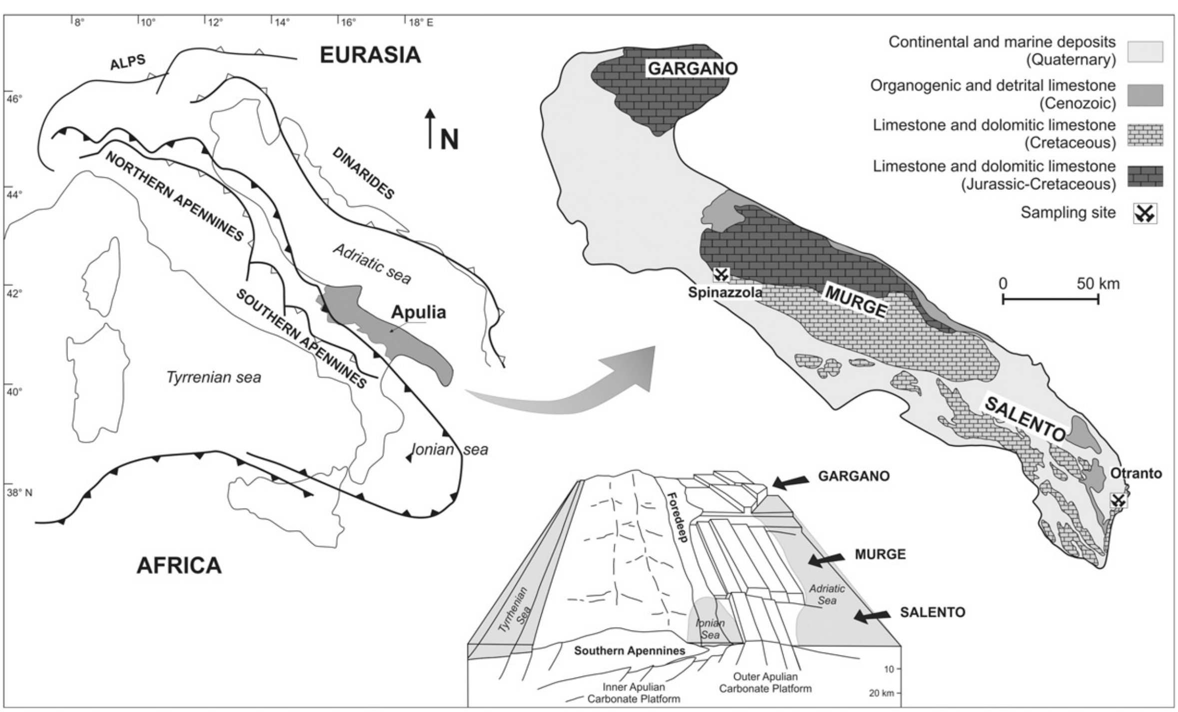

Fig. 1. Outline map of the western Mediterranean realm showing main tectonic lineaments (left). Lines with filled triangles are active thrust; lines with unfilled triangles are old thrust (after Dewey et al., 1989). Geological sketch map of the Apulia region (right). Spinazzola and Otranto sampling sites are also shown. Simplified block diagram of southern Apennine foreland (bottom) displaying the three main structural blocks (Gargano, Murge, Salento) of the Apulian Carbonate Platform (modified after Funiciello et al., 1991).