

Sedimentary features of the bauxite-bearing rock series in Central Guizhou

Bauxite resources are abundant in Central Guizhou. Through systematically analyzing the sedimentary records of bauxite-bearing rock series, this paper reveals the paleogeography environment of this region, and explores the ore-control significance of favourable zone. The research shows that the ore-bearing rock series of bauxite in Central Guizhou is the continental deposition based on karst landform. Surrounding the paleo-land, the diluvial fan-diluvial uvala sedimentary system is developed in the eastern Xiuwen region and the diluvial fan-diluvial-control fan delta-diluvial-control lake sedimentary system is developed in the western Qingzhen region. Diluvial-fan channel sediments and diluvial-control-fan delta front sediments are the most favourable facies belt for bauxite occurrence. Moreover, serious dissolution areas in the diluvial uvala can also become the favourable aggregation sites for bauxite by rapid accumulation effect.

Keywords: Bauxite-bearing rock series; continental deposition; paleogeography environment; Central Guizhou; carboniferous.

1. Introduction

Guizhou has a large scale of bauxite resources and minerals with excellent ore quality, and is the key output province of bauxite resources in China. In this province, the Central Guizhou area is located in the bauxite belt of Central Guizhou-South Chongqing carboniferous system, mainly distributed in Guizhou Xiuwen-Qingzhen-Guiyang area (Fig.1), belonging to the typical karst sedimentary bauxite deposit distribution area.

In recent years, many institutions and scholars have done a lot of exploration and research works in Central Guizhou. However, there is still a considerable controversy about the sedimentary filling process of bauxite and its controlling factors. Mo et al. (1991) believed that the bauxite was formed in the Early Carboniferous lagoon environment, and the latter was surrounded by the barrier island along Zhijin-Pingba-

Guiyang (Chen et al., 2010). The research on ore-bearing rock series in bauxite conducted by Gao (1996) indicated that the bauxite was the product of alluvial and diluvial proximal accumulation, and the latter had the characteristics of poor mechanical separation and rapid accumulation (Yang et al., 2009). The above problems not only restricted the understanding of Early Carboniferous sedimentary pattern, but also seriously hinder the exploration and development of bauxite in the region.

Based on the existing geological data and previous research results in Central Guizhou, this study aims at analyzing the sedimentary characteristics of ore-bearing rock series in bauxite, determine the source of ore-forming materials, restore paleo-geographical environment and discuss the ore-controlling significance of favourable facies belt, so as to provide a reference for further ore-prospecting work in this area.

2. Regional geological setting

In Central Guizhou from Late Ordovician to Early Carboniferous, tectonic stress resulted in multiple intermittent crustal uplift, and thus the Lower Paleozoic strata were exposed to surface and subjected to long-term intense physical and chemical weathering, eventually forming laterite-type paleo-weathering crust. In the meantime, the Early Carboniferous differential uplift induced a series of karst topography (Gao, 1992) in this region, and the latter is an important place for the transport and deposition of aluminum silicate minerals in weathered crust.

According to previous comprehensive research and exploration achievements (Gao, 1996; Yang et al., 2009; Liu et al., 2016), the ore-bearing rock series of bauxite is located in the Lower Carboniferous Jiujialu formation (C1jj). The strata shows discontinuity and disconformity on the paleo-karst erosion surface of Cambrian Loushanguan Group. In the paleo-karst depression, the strata have a large thickness with quasi-laminar occurrence. However, the paleo-karst hilly areas are thinned or pinched out. The ore-bearing rock series of bauxite is generally 5-20 m thick as an assemblage of deep grey-purple clay, bauxite and carbonaceous shale. The upper part is dominated by magenta-gray black clay, micrite and crystalline dolomite. The central part is the main occurrence

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Fig.1 The geographical location map of Central Guizhou

place for bauxite, dominated by magenta-gray white conglomeratic, muddy or colloid bauxite and clay rock. The lower part is composed of grayish-purple iron clay and clay rock (Fig.2).

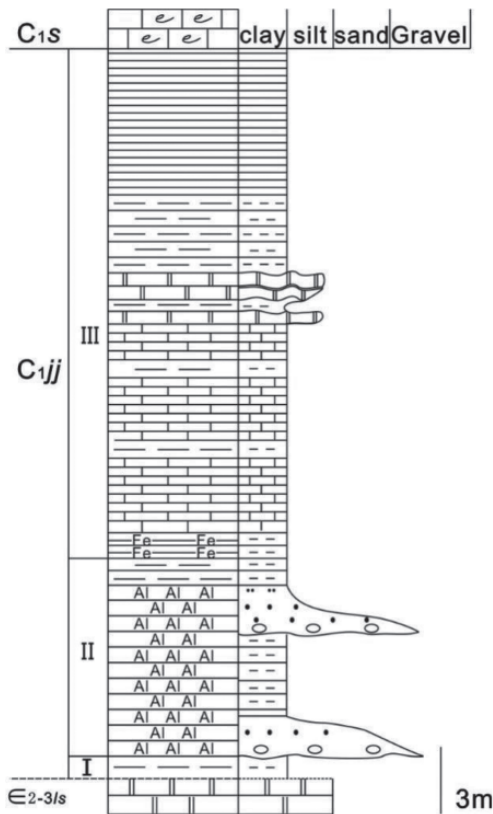


Fig.2 Lithologic column of Xiuwen section in Guiyang

3. Sedimentary characteristics

The Early Carboniferous region is located near the Equator, where the climatic conditions are suitable for the development of weathering crust (Mo et al., 1991). Due to the influence of surrounding paleo-land, the formed dissolution basins and sags receive the parent rocks transporting and gathering around, leading to the obviously increased sedimentary

range. According to the sedimentary structure and sequence of regional profile, ore-bearing rock series is developed in this region, including diluvial fan, fan delta and diluvial-control lake, and each facies belt has typical sedimentary characteristics.

3.1 DILUVIAL FAN

Diluvial fan is a common piedmont sedimentary type. Especially in the areas under strongly weathering conditions, piedmont diluvial fans are coupled and superimposed each other, often forming the diluvial fan

group surrounding paleo-land, where the medium-large bauxite deposits often occur. There are three types of sedimentary assemblage in the diluvial fan, including debris flow sediment, channel sediment and overflow sediment.

(1) Fan debris flow sediment

The debris flow sediment has poor stratification and lateral instability, mainly composed of fine-coarse gravel and sandy bauxite, of which the clastic content is generally greater than 50%. Floating debris is formed based on matrix support, not by separation. Some flat conglomeratic bauxite shows a directional alignment at the bottom, upwards showing gravel-structure bauxite and argillaceous bauxite in sequence. In vertical direction, debris flow sediments constitute multiple cyclothem of alternated fine and coarse grains with mutual scouring contact, reflecting the multiphase debris flow events (Fig.3).

(2) Stream channel sediment

Channel sediment is the most important sedimentary and metallogenic site in the ore-bearing rock series of bauxite, mainly distributed in the central fan area, and composed of conglomeratic bauxite obtained through poor mechanical separation, and the clastic content is generally greater than 60%. This kind of sediment is formed by dominant matrix

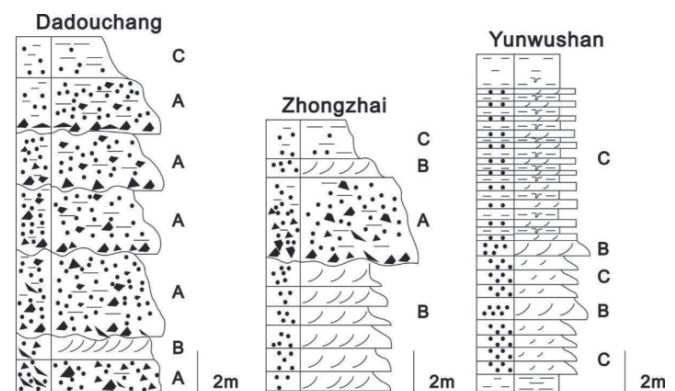


Fig.3 Vertical sequence of the diluvial fan sedimentary characteristics
A. Fan debris flow; B. Stream channel; C. Overflow

support and auxiliary particle support, where large cross bedding and parallel bedding are developed. Although the single-channel sand body thickness is generally only 0.3-0.6 m, multi-channel sediment is superimposed with overflow sediment or debris flow sediment in vertical direction. The typical scouring-filling structure is developed at the riverbed, but the retained gravel layer is less developed, showing distinct characteristics of flood control (Fig.3).

(3) *Overflow sediment*

According to the development position, overflow sediment can be divided into fan overflow and inter-fan overflow. The former has an unstable thickness, dominated by thin-layer silt or inequigranular bauxite interbed, and a structure with a low maturity, small cross bedding, horizontal bedding and trace fossils. Overflow sediment and channel sediment occur alternately (Fig.3). The latter is the product of flood overflow fan body, containing most of particles with muddy and silty sand structure and a few with conglomeratic structures as well as the matrix support of blocky structure.

3.2 DILUVIAL UVALA

Mainly developed in the eastern Xiwen region, diluvial uvala is located in the low-energy area where the diluvial fan unloads materials to the center of karst depression. Due to the obvious effect of base karst difference in diluvial uvala, the sediment in this facies belt shows strong sedimentary heterogeneity (Fig.4). Typical diluvial uvala mainly consists of fine-grained clastics with small cross-bedding, intercalated river or overflow sediment unit (Fig.4), transiting upwards the argillaceous bauxite or clay rock with horizontal lamina, where a large number of trace fossils occur. In the vertical direction, normal graded structure is formed by the multiple alternations of underwater accretion sequence combination and swamp sequence.

Due to the effect of the flood, flood fan or debris flow sediment units are often developed in diluvial uvala (Fig.4). The latter shows the higher gravel proportion and lower structure maturity with scouring contact to normal sediment.

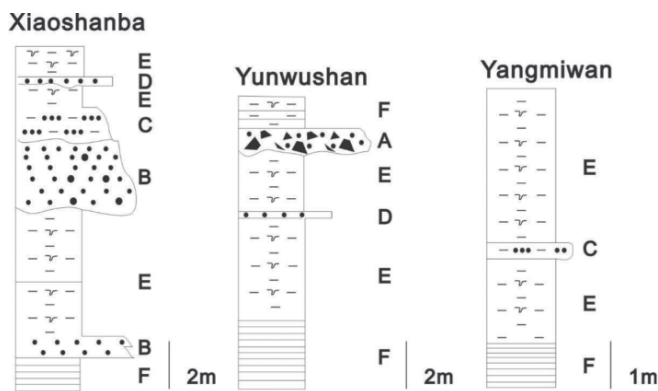


Fig.4 Vertical sequence of the diluvial uvala sedimentary characteristics

A. Fan debris flow; B. Stream channel; C. Stream flood; D. Flood fan; E. Swamp; F. Lake

3.3 DILUVIAL-CONTROL FAN DELTA

Diluvial-control fan delta is located in the transition region between diluvial-control fan and diluvial-control lake environment, where the provenance is mainly supplied by diluvial fan and debris flow with a wide distribution area, a stable thickness and the occurrence of large or ultra-large bauxite deposit. In this region, the complete fan-delta sedimentary sequence is composed of prodelta, delta front and delta plain sediment, forming a reverse graded structure in the vertical direction. Among them, delta plain is dominated by swamp sediment, while the sheet sand body formed by distributary channel has a less proportion with lenticular distribution. In the delta front, sheet sand body has a stable thickness, mainly formed by the superimposition of multi-stage underwater gravity-flow sediments (Fig.5).

(1) *Fluvial delta plain sediment*

The channel sand body generally shows a normal graded structure in the vertical direction (Fig.5). The lower part is composed of gravel-structure bauxite, where parallel bedding is often developed. The upper part consists of sandy clayey bauxite and argillaceous bauxite or clay rock, where a small number of trace fossils and plant fossils are found.

(2) *Delta front sediment*

It is composed of quasi-lamellar sheet sand body with poor clastic separation, with the characteristics of quick slump accumulation and the overall reverse graded structure in the vertical direction. A single sedimentary formation usually consists of incomplete underwater gravity-flow sediment. The lower part is comprised by conglomeratic bauxite with massive or graded bedding, of which the structure and composition have low maturity. The upper part is made up of the

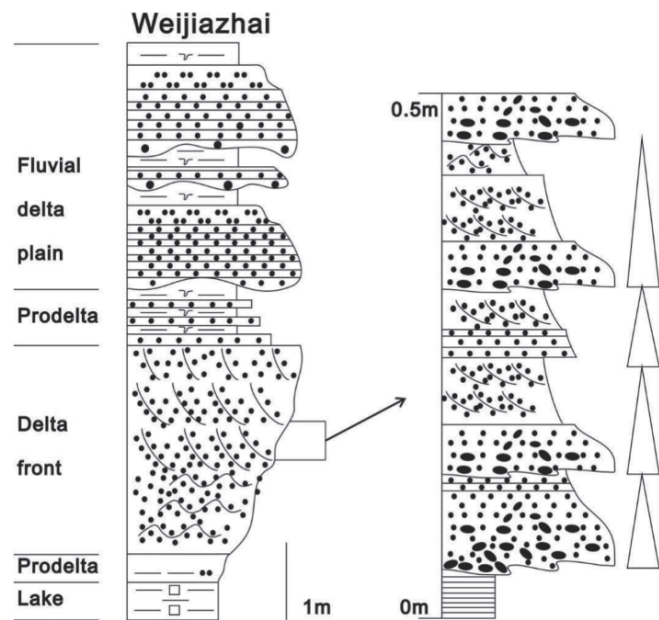


Fig.5 Vertical sequence of diluvial-control fan delta sedimentary characteristics

conglomeratic bauxite with the development of parallel bedding and the bauxite or clay rock with apparent horizontal bedding respectively, but generally the complete sequence is relatively rare (Fig.5).

(3) Prodelta sediment

In the prodelta environment, bauxite has a considerable proportion, dominated by thin-layer argillaceous and colloid structure with high organic matter content, interlayered by several thin layers of silty bauxite formed by underwater gravity flow transportation, where horizontal laminate or wavy bedding are commonly developed.

3.4 DILUVIAL-CONTROL LAKE

Diluvial-control lake is mainly distributed in Qingzhen region of the western region, formed by the abrupt water supply during the flood period, but evolves to swamp in the flood interval due to lake water seepage. Therefore, the sediments are mainly composed of thin-layer clay stone with a small amount of colloid bauxite. This environment has long been under the condition of weak reduction, so there are generally pyrite nodules or clumps of various scales in the sediments (Fig.5).

4. Sedimentary facies and metallogenic environment

From a research on the aluminized rock series through B/Ga conducted by Zhang et al. (1982), it is considered that the high B/Ga may indicate the marine lagoon environment. However, modern inland salt lake sediment measurement proves that many modern continental sediments are also rich in B (Sun et al., 1992), so it is very arbitrary to take the salinity index of geochemical data as the mark for marine and terrestrial facies. According to the research on the sediment records of ore-bearing rock series in bauxite, it is shown that controlled by paleogeomorphology in the sedimentation period, water mass is gradually deepening from NE to SW (Gao, 1992), showing the offshore continental environment as a whole, and the obvious zonation of sedimentary facies. In the zone near the northern paleo-land, provenance supply is abundant with the development of sediments dominated by conglomeratic bauxite, belonging to typical diluvial fan and diluvial-control fan delta sediment, which transits southwards the diluvial-control lake and diluvial-control depression environment mainly featured with argillaceous or colloid bauxite.

This region is roughly divided by the central Yangjiazhuang area, and the diluvial fan-diluvial uvala sedimentary system is

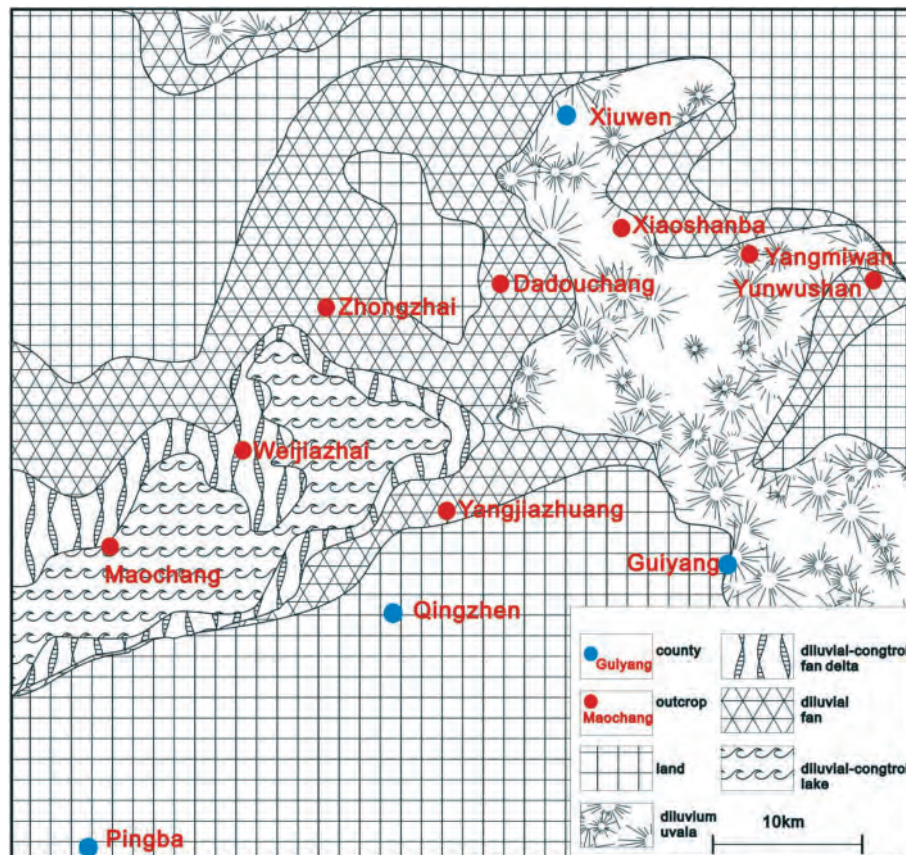


Fig.6 The paleogeographical sketch of bauxite sediment stage during the early carboniferous in Central of Guizhou

formed in the eastern Xiuwen region. Bauxite is mainly distributed in the diluvial fan facies belt with abundant provenance supply and the feature of rapid accumulation (Fig.6). The base of diluvial uvala is an area experiencing strong dissolution, which can be filled by bauxitic sediment with a large thickness, belonging to the favourable sedimentary facies belt for bauxite.

The western Qingzhen region is confined by the north and south paleo-lands (Fig.6), where the sedimentary system is mainly composed of diluvial fan, diluvial-control fan delta and diluvial-control lake, and the diluvial-fan channel and diluvial-fan delta front are the favourable sedimentary places for weathering crust material under the diluvial action. The latter is distributed stably in the fan-delta sheet sand-body bauxite as the most important part for bauxite occurrence. The argillaceous and colloid bauxites are mainly developed in the diluvial-control lake environment.

5. Conclusions

1. The ore-bearing rock series of bauxite is mainly distributed in the geomorphological area with strong dissolution, and the sedimentary filling sequence study shows typical continental sedimentary characteristics. The paleo-land and basement provide the mineral source for the final formation of bauxite. The diluvial fan, diluvial-control fan

Continuation on page 286