Ore-forming fluid system of bauxite in WZD area of northern Guizhou province, China

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Ore-forming fluid system of bauxite in WZD area of northern Guizhou province, China

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Abstract. The ore-forming fluid system of bauxite in Wuchuan-Zheng'an-Daozhen (short for WZD)Area of northern Guizhou Province was studied from the perspective of deposit formation mechanism. It was discovered that ore-forming fluids were mainly effective for transporting and leaching during the formation of bauxite. The means of transport mainly included colloidal transport, suspended transport and gravity flow transport. In the course of their leaching, fluids had a range of chemical reactions, as a result of which elements such as silicon and iron migrated downwards. In this process, properties of fluids changed as well.

1. Introduction

The WZD bauxite in northern Guizhou Province of China is situated in the Northern Guizhou Province-Southern Chongqing ore-forming belt, which is important for bauxite in China. There have been many studies on bauxite of WZD Area, where abundant outcomes have been achieved (Wu et al., 2008; Jin et al., 2009; Lei et al., 2013; Du et al., 2013, 2014; Huang et al., 2013; Zhang et al., 2013; Zhang et al., 2013). In spite of numerous related studies, very little research has been performed to explore the ore-forming fluid system for bauxite formation. The ore-forming fluid system dependent upon which the bauxite form in the WZD area is relatively complicated. This paper briefly analyzed the ore-forming fluid system of bauxite in the WZD area by investigating features of their ore-bearing rock series.

2. Geological setting

Bauxite of the WZD area in northern Guizhou Province, located in Wuchuan, Zheng,an and Daozhen counties in the north of Guizhou Province, are adjacent to Chongqing with convenient water and land transport as integral parts of bauxite belts between middle Guizhou Province and southern Chongqing(Du et al., 2007). In terms of regional tectonics, these bauxite are situated on Jura-type folds of northern Guizhou Province in the south of the Yangtze craton (Liu, 1993). According to chronological order of their exposure, the strata may be classified into cambrian, ordovician, silurian, carbonaceous, permian and jurassic strata within the investigated area. Inside this area, the tectonic line is distributed along NNE. The cambrian strata are mainly distributed in the anticlinal core, while the triassic and jurassic stratum are mainly in the synclinal core. Permian Liangshan formations on ore-bearing strata and overlying strata, the carboniferous Huanglong Formation or the silurian

Hanjiadian Formation on underlying strata show parallel unconformity. The spatial distribution of bauxite is controlled by 8 major synclines, including Daozhen, Datang, Luchi-Liyuan, Taoyuan, Anchang, Huanxi, Xinmo and Zhangjiayuan (Fig .1).

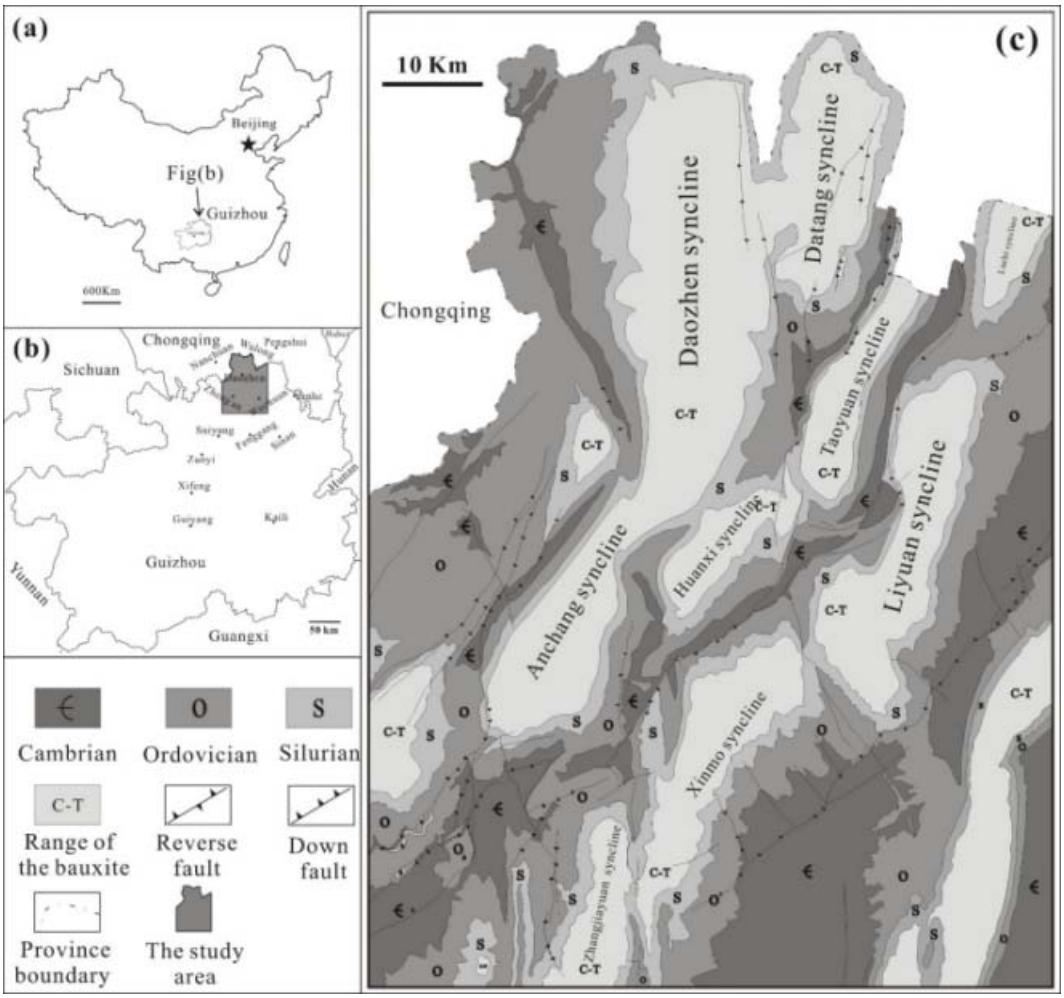

Fig. 1(a)Locality map of Guizhou,(b)The map showing the location of the study area,(c)Geology map of the WZD area in northern Guizhou (modified from:Wang et al., 2013； Cui et al., 2013)

3. Features of ore-bearing rock series of the bauxite in WZD area

Bauxite of the WZD area is sedimentary bauxite (Du et al., 2013) They are stratiform-like, forming a sharp contrast with funneled bauxite in Zunyi. For bauxite of the WZD Area, their ore-bearing rock series show evident ternary structures, which is generally in line with the bauxite of Zunyi. However, the ternary structures of bauxite are more apparent in the WZD Area. Under the Liangshan Formation, there are grey bauxite with lower grade. Under the gray bauxite, there are light gray clastic, oolitic and compact bauxite, with bauxite without tenor of ores in between. On the lower parts, there exist compact or ferruginous bauxite or iron ore deposits. ZK3402 generally represents structures of ore-bearing rock series in bauxite of the WZD area.

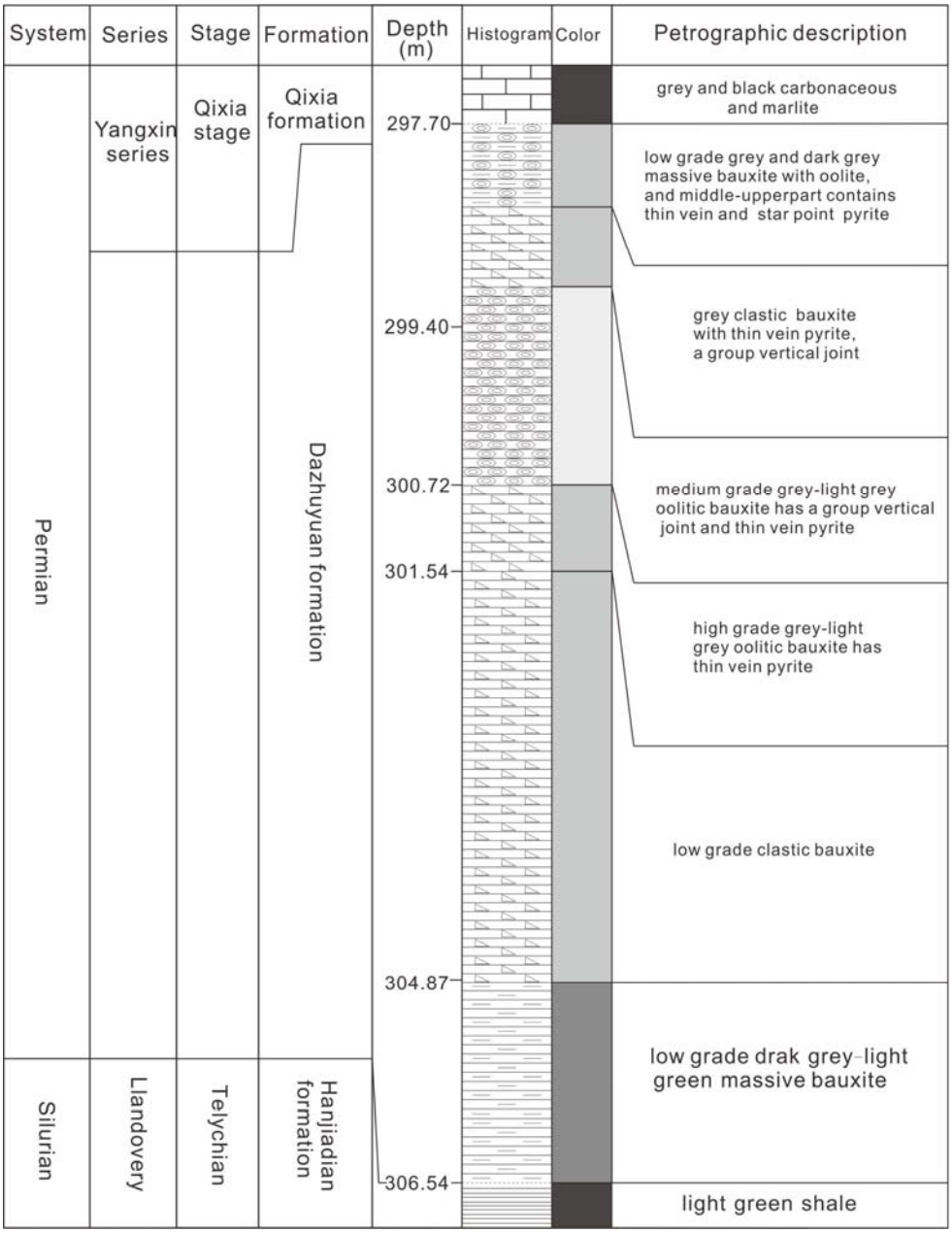

Fig.2 bore hole columnar section of ZK3402

4. Roles of fluid transport during metallogensis of bauxite

The fluids play following roles during metallogenesis of bauxite in the WZD area: 1) colloidal transport, 2) suspended transport through intermittent flow, 3) gravity flow transport. However, no evident evidence proved other roles of fluid transport. Roles of colloidal transport and coacervation were also quite striking in bauxite of the WZD Area. Some metallogenic substances are transported in the form of colloids. Although colloidal structures are common among bauxite (Fig. 3), there are so many metallogenic substances that they can't be simply moved by colloidal transport, which is not the major means of transport. Metallogenic substances, which are mostly muddy, may be transported distantly through suspension, and in bauxite of the WZD area, they are mainly transported in this way to basins (Du et al., 2013; Cui et al., 2013, 2014) via intermittent flow. Apart from regular transport

through intermittent runoff, structures like erratics of bauxite suggest that gravity flow transport would exist during metallogenesis (Cui, 2013).

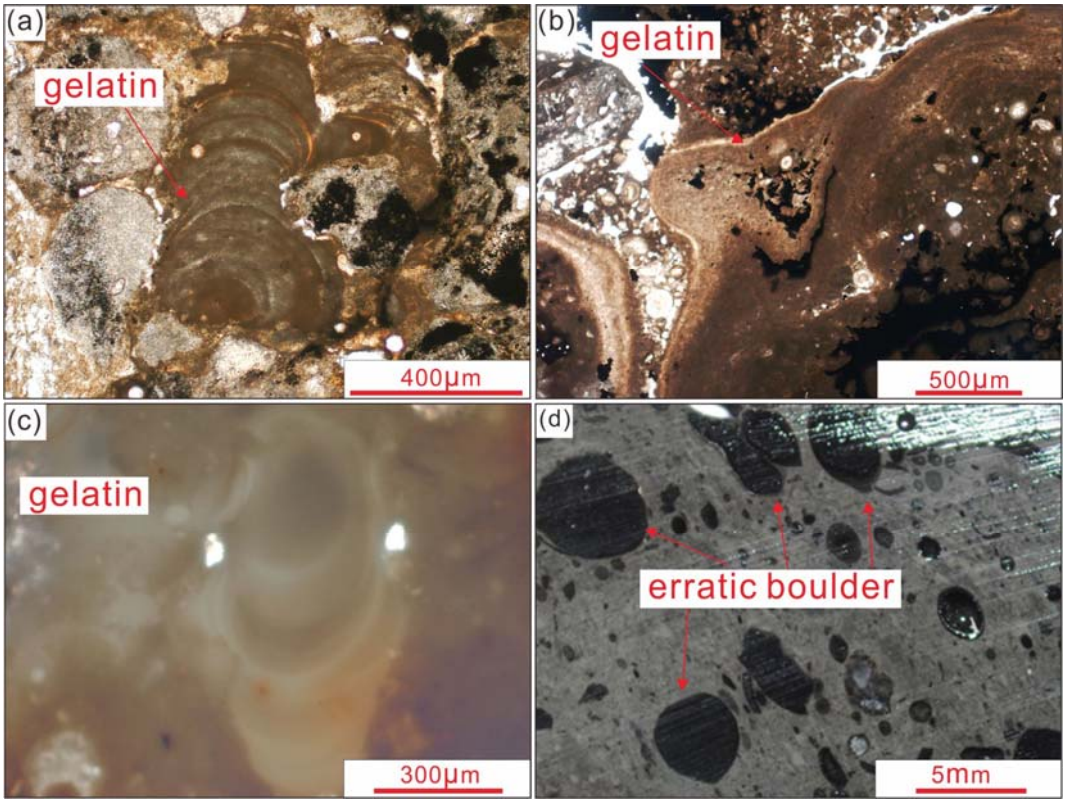

Fig.3 Colloidal action in WZD bauxite (Modified from Du et al., 2015, Cui, 2013)

5. Roles of fluid leaching during metallogensis of bauxite

5.1. Roles of precipitation leaching

Vertical changes to color, particle size, structures, major elements and rare elements suggested that the bauxite were leached several times during their forming process (Yu et al., 2013; Wang et al., 2013; Cui et al., 2014). As an important source of fluids for leaching bauxite in the WZD Area, atmospheric precipitation is not only useful for direct vertical leaching, but also forms intermittent flow on the earth's surface around basins and flows downwards to low-lying areas. Since original sediments are relatively loose, they will infiltrate downwards during the flow of surface runoff and leach the flow regions. Unlike karst bauxite, karst depressions are not major parts of leaching in the WZD area. In general, industrial bauxite deposits are heavily leached in the WZD Area, which has certain impacts upon the whole area. However, bauxite deposits can form among bauxite of Zunyi area as long as the leaching impacts the karst depressions. In other words, the leaching efficiency of karst bauxite in Zunyi area is higher than that in the WZD Area, which is in line with most scholars' view that lower karst depressions of sedimentation basins are helpful for the formation of bauxite (Lei et al., 2013; Weng et al., 2013; Du et al., 2013).

5.2. Roles of Seawater

In the WZD area, bauxite form under semi-closed bay environment, under which the sea levels change frequently in metallogenic regions (Du et al., 2013; Lei et al., 2013; Cui et al., 2013), or some unfavorable elements like iron and silicon are taken away, in order that these elements won't be enriched at the bottom. With the rise of sea levels, there would be some sundries which lead to lower

grade of upper bauxite among ore-bearing rock series. However, frequent changes to sea levels are generally helpful for the formation of bauxite. By analyzing features of ore-bearing rock series, it was found that sea level changes would be more frequent in the WZD Area than those in Zunyi area.

6. Discussion

Ore-forming fluids are essential for the formation of bauxite in the WZD Area. First of all, metallogenic substances are transported by fluids from surrounding areas to basins, which is fundamental for the formation of bauxite. Secondly, water flow resulting from atmospheric precipitation or transport is helpful for leaching and promotes the formation of bauxite. Thirdly, a range of chemical reactions happens in the process of vertical leaching from the top to the bottom of the section. In these reactions, the oxygen carried by ore-forming fluids is constantly consumed, and the fluids thus become acid. Meanwhile, sundries such as iron and silicon migrate downwards. At last, industrial bauxite deposits form on upper parts. Leaching not only contributes to migration of elements such as iron and silicon, but also stable rare earth elements. Research has suggested that lots of rare earth elements of bauxite in the WZD area are apparently migrated and enriched in the vertical direction (Wang et al., 2013).

Compared with Zunyi area, ore-forming fluids are also helpful for gravity flow deposition in the WZD Area, where these fluids play their roles in leaching in multiple stages and much more frequently. In the course of vertical leaching, bauxite are generally the same between the WZD Area and Zunyi area, but only show some differences in strength. Metallogenesis of bauxite in the WZD area is dependent upon large-scope intensive and frequent fluid transports and leaching. Since there are well-developed karst depressions in the lower parts of bauxite in Zunyi, ores may form within small local areas. Therefore, the requirements for fluids in Zunyi area are not as rigorous as those for the WZD area.

7. Conclusion

After our research, we have reached following conclusions: 1) Fluid system is mainly effective for transport and leaching during the formation of bauxite in the WZD area; 2) Metallogenic substances are mostly moved through colloidal transport, suspended transport and gravity flow transport; 3) Fluids impact the formation of bauxite in the WZD area more intensively and frequently compared with bauxite of Zunyi area.

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