Mechanism of Iodine Enrichment in Phosphorite of Late Sinian, SW China

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1 Introduction

Yangtze platform Doushantuian is the first large-scale phosphorous forming peak period of China, and the sedimentary phosphorite is widely distributed in south China, at same time, this area have phosphorous deposits with abundant iodine element. Especially, the phosphorite occurred in the Doushantu formation in the Late Ediacaran in Central Guizhou features the highest iodine, with the content achieving 76 mg kg\(^{-1}\) (Zhou 1984; Zhang et al., 2003). In 20\(^{th}\) century many countries extract the iodine from the phosphorite, however, the process flow was complicated the production cost was too high and the industrialized production was not realized (Zhang et al., 2011; Reich et al., 2013). In 2007, Wengfu (Group) Co., Ltd. extracted the iodine from the processing of the phosphorite successfully. The proved phosphate ore reserve of the whole Guizhou Province is 2.7 billion tons. There is a large reserve of associated iodine resource, for instance, the Yingping ore block of Wengfu phosphate ore has associated iodine reserve of almost 7,000 t (Zhang et al., 2011). However, the previous researches all focus on the mineral processing technology, only few of them related to the enriching reasons and rules, occurrence states and control factors of the iodine in the phosphorite, which becomes as a point of departure and priority to this research work.

2 Sample Collection

Doushantuian Weng’an - Fuquan area located in the shallow continental shelf environment where Wengzhao uplift gently inclined to the north and east. In the research area, Doushantu formation and underlying Nantuo formation refer to pseudo-conformable contact, and the local section shows obvious angle unconformable contact, with conformable contact with the Dengying formation of the overlying formation. Collect a piece of Anfa profile of Xinqiao ore block and a piece of No. 1 surface profile of Xiaoba ore block in the research area.

3 Results and Discussion

Restricted by the Yangtze platform, the Doushantu formation of Late Ediacaran was distributed in the Central Guizhou Province (Zhou, 1984; Zhang et al., 2003). The iodine element in the phosphorite formed in this period was relatively high, and its enrichment regularity and mechanism are to be analyzed and researched deeply. This article mainly discusses the iodine enrichment regularity from the relationship of iodine between phosphorus, biology and element composition in the profile.

Iodine contents are different in the various lithological sections and various types of phosphorite, the iodine content in the phosphorite consisting of light gray granular and grain sandy and other clastic structures is relatively high; followed by the strip and thin-layer gel texture phosphorite; the iodine content of the phosphorite consisting of black and gray-black carbonaceous and sandy and other compacted structures is the lowest; while content of iodine in the overlying siliceous rock and Dengying formation dolomite is low. The analysis diagram indicates the correlation between iodine and major elements on Xiaoba profile, it shows good positive correlation with phosphorus, calcium and sodium, while shows obvious negative correlation with aluminum, iron, potassium and silicon, while shows no obvious correlation with manganese. The algae statistics and iodine distribution of the two profiles show certain correlation. Specifically, at the lower phosphorus ore bed and the lower part of the upper phosphorus ore bed formed by rapid accumulation under the anaerobic condition, which phosphorite lack oxidation condition have few algae or no
such possibilities. From the analysis of correlation between these two in the research area, the algae feature actively correlation with iodine, and the correlation coefficient is 0.80, showing an obvious positive correlation, and this also implies that the phosphorite formed by biological function and biochemical function refers to iodine-enriched ores.

The iodine mainly occurs in the apatite of the phosphorite, and occupies more than 98% of the total iodine of the phosphorite; the iodine content of gangue mineral in the phosphorite is only 1-2 mg kg\(^{-1}\), and is still less than 2% of the total iodine of the phosphorite.

For the iodine contents in the apatite of different structural types, Sun (1993) utilized a microanalysis quantitative method in determining the iodine contents in different mineral types in the 1990s, and found that the iodine content of the carbonated-fluor apatite with microcrystalline structure is relatively low, and even close to zero; while the iodine content in the berry globose apatite with gel texture or cryptocrystalline texture is relatively high, and the content achieves hundreds of to thousands of mg kg\(^{-1}\) in some regions.

4 Conclusions

The iodine is only distributed in the phosphorite, the iodine contents in the gray and gray-white clastic phosphorite are the highest. Besides, iodine contents in the gel texture phosphorite, strip phosphorite and the carbonaceous compacted blocky phosphorite is the lowest.

The iodine was concentrated in the apatite and shows obvious positive correlation with P\(_2\)O\(_5\) and CaO, major components of the apatite and phosphorite, and displays negative correlation with Fe\(_2\)O\(_3\), Al\(_2\)O\(_3\), K\(_2\)O and SiO\(_2\).

The sedimentary environment is the key control factor for the iodine content in the phosphorite. The iodine content in the compacted phosphorite formed by chemical deposition function in the neritic basin facies is relatively low; besides, in the neritic platform facies, the stratigraphic reef and the shoal are the iodine-enriched facies belts of the phosphorite, and the phosphorite with gravel, aggregate and granular structures occurred in these facies belts is the main iodine-enriched ore type.

The iodine shows obvious positive correlation with the algae in the phosphorite, and in the algae-poor or without algae phosphorite formed under the anaerobic condition, the iodine content is very low, however, the phosphorite with the algal limestone structure formed by the biological and biochemical functions is rich in iodine result from there is a large number of algae concentrates and aggregates the iodine.

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References


