Material Composition and Microstructure of a Sedimentary Clay-Type Lithium Resource by Mineral Liberation Analyser

Zhi Liu[a], Wudan Xiao[b], Ting Song[c], Zhizhen Zhang[d], Guiming Shi[*]

School of Chemical Biology and Environment, Yuxi Normal University, Yuxi, 653100, China

[a]2022145112@yxnu.edu.cn, [b]2022145129@yxnu.edu.cn, [c]2022145122@yxnu.edu.cn, [d]2022145138@yxnu.edu.cn, *sgm_008@yxnu.edu.cn

Abstract. There is a low grade lithium in a sedimentary clay-type lithium resource in central Yunnan, which has certain utilization value. In this paper, mineral liberation analyser was used to conduct process mineralogy research on the mineral, and the results show that the main minerals are kaolinite, illite, magnetite, limonite, etc. Due to the current new energy policy in China, a large amount of lithium is urgently needed. Although the grade of Li is also low, which can be considered for recovery in the future. When the fineness is 100% -0.074 mm, the dissociation degrees of all minerals are not high, especially the dissociation degrees of magnetite, limonite and chlorite are not more than 50%, and the dissociation, binary symbiosis and ternary inclusion of all minerals are complicated. Subsequently, lithium ions in the solution can be obtained by leaching under acidic conditions, which can be used to produce lithium carbonate or lithium hydroxide.

Keywords: Sedimentary clay-type lithium; MLA; Illite; Kaolinite; Montmorillonite.

1 Introduction

Sedimentary clay-type lithium resources (which contain lithium in clay deposits) are a new type of lithium resources with potential development significance [1,2], but the development of this type of lithium resources is still in the preliminary stage. According to the different origin, it is divided into volcanic clay lithium ore, carbonate clay lithium ore and Jadar lithium ore, etc. Zhu Li et al. [3] classified the main lithium extraction methods for clay lithium ore at home and abroad, discussed the characteristics of each method, and prospected the technical methods with potential development and utilization from the perspectives of cost, impurity separation and environmental protection. Mineral Liberation Analyser (MLA), as an advanced automatic quantitative analysis and test system for process mineralogy parameters, can quickly and accurately identify minerals and collect related information on the basis of scanning electron

H. Bilgin et al. (eds.), *Proceedings of the 2024 6th International Conference on Civil Engineering, Environment Resources and Energy Materials (CCESEM 2024)*, Advances in Engineering Research 253,
https://doi.org/10.2991/978-94-6463-606-2_19

microscopy, energy spectrum and image processing technology and can afford the required process mineralogy data [4,5]. Although the application of MLA to the analysis of various minerals are constantly appearing in the literature [6-10], the MLA analysis of sedimentary clay-type lithium resources are relatively rare.

This paper described the process mineralogy of a sedimentary clay-type lithium resource with MLA. The process mineralogy data can provide a reference for the development and utilization of this type of resource and are deserving research.

2 Ore Material Composition

The instrument used in this study contained MLA650, Shanghai Baihe Instrument Technology Co., LTD., and ICP (Avio 220 Max), PerkinElmer, USA, the same as below.

2.1 Mineral Composition

A sedimentary clay-type lithium resource mineral mainly included kaolinite, illite, magnetite, limonite, etc. The results of mineral composition analysis are shown in Table 1.

As can be seen from Table 1, the main minerals are mainly clay minerals, a small amount of limonite and magnetite.

2.2 Chemical Composition

The results of ore chemical multi-element analysis are shown in Table 2.

Table 1. Results of mineral composition analysis /%

Minerals	Kaolinite	Illite	Magnetite	Limonite	Chlorite
Contents	51.77	15.97	7.13	10.35	8.41
Minerals	Rutile	Phosphorus pentoxide	Augite	Pyrite	Barite
Contents	0.03	0.01	0.01	0.01	0.01
Minerals	Gibbsite	Quartz	Titanium-containing aluminosilicate	Periclase	Others
Contents	4.65	0.05	0.04	0.01	1.54

Table 2. Multi-element analysis results in ore /%

Elements	O	Al	Si	Fe	K	N	Cl
Contents	41.26	19.48	15.56	14.06	3.31	1.68	1.41
Elements	Ti	Mg	P	Na	Ce	Li	-
Contents	0.78	0.55	0.43	0.03	0.01	0.07	-

2.3 Phase Analysis of Major Metal Elements

According to MLA analysis, the main metal elements in this sample are Al, Fe and Ti, as shown in Table 3-5.

Table 3. The proportion of phase containing Al element /%

Phase	Kaolinite	Illite	Gibbsite	Chlorite
Proportion	68.62	18.06	7.26	3.67
Phase	Limonite	Titanium-containing aluminosilicate	Others	-
Proportion	2.32	0.03	0.02	-

Table 4. The proportion of phase containing Fe element %

Phase	Magnetite	Illite	Gibbsite	Limonite
Proportion	35.86	21.27	20.20	11.24
Phase	Kaolinite	Chlorite	Ilmenite	Pyrite
Proportion	5.78	2.84	0.02	0.02

Table 5. The proportion of phase containing Ti element %

Phase	Kaolinite	Rutile	Titanium-containing aluminosilicate	Illite
Proportion	91.51	2.34	1.63	1.42
Phase	Gibbsite	Chlorite	Limonite	Ilmenite
Proportion	1.07	1.04	0.52	0.36

It can be seen from Table 2-5 that the ore has a Fe grade of only 14.06%, Ti grade of 0.78% and Al grade of 19.48%, all of which have not reached the usable grade. Although Li grade is also low, but it can be utilized in the follow-up because the current new energy policy urgently needs a large amount of lithium in domestic.

3 Microstructure of Major Minerals

3.1 Magnetite

Magnetite is distributed in irregular clumpy aggregates with dense structure and surrounded by clay minerals, as shown in Figure 1. However, flocculent magnetite forms a spongy deferrous structure with chlorite, and magnetite distributed in a cotton-like manner that metasomatized with chlorite, as shown in Figure 2.

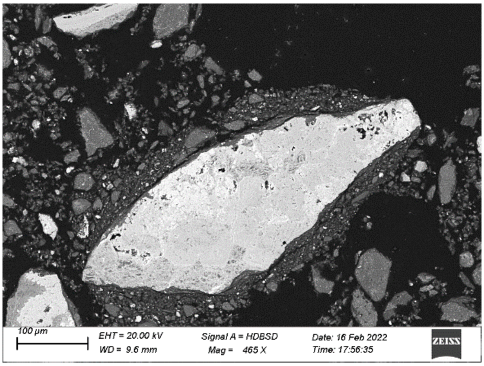

Fig. 1. Magnetite particles with dense structure

3.2 Limonite

Limonite is mainly distributed in banded (Figure. 3), amorphous (Figure. 4), and granular (Figure. 5) forms related to kaolinite. It is existed in the inner part of kaolinite or in a monomer dissociated state.

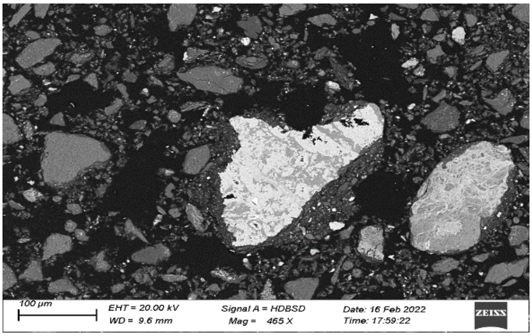

Fig. 2. Floc magnetite and chlorite form spongy meteorite structure

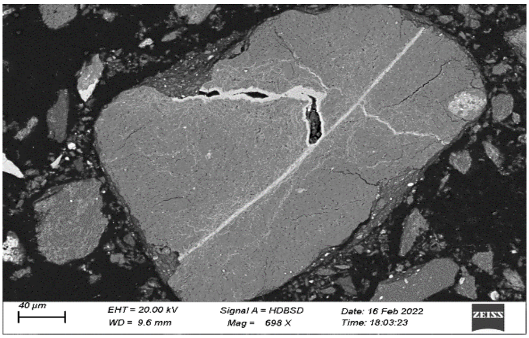

Fig. 3. Needle-like limonite embedded in large-grained kaolinite

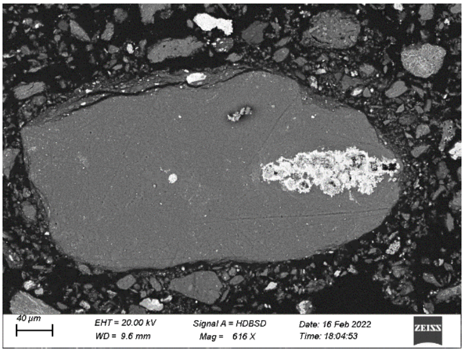

Fig. 4. Amorphous limonite encased in kaolinite

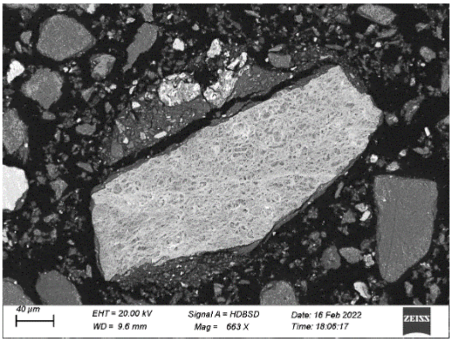

Fig. 5. Monomer dissociative limonite

3.3 Kaolinite, Chlorite and Gibbsite

Kaolinite is the gangue mineral with the largest content in this mineral. Gibbsite is enclosed or symbiosis in kaolinite, and chlorite is dispersed in the kaolinite as a network shape (Figure.6, Figure.7, Figure.8).

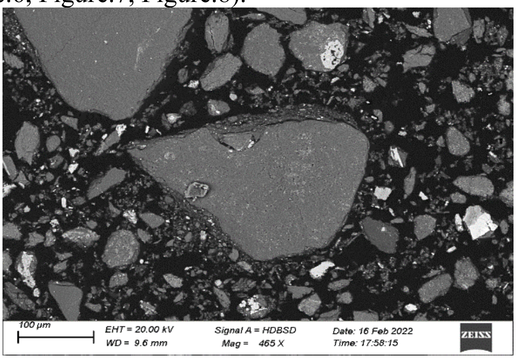

Fig. 6. Gibbsite encased in kaolinite

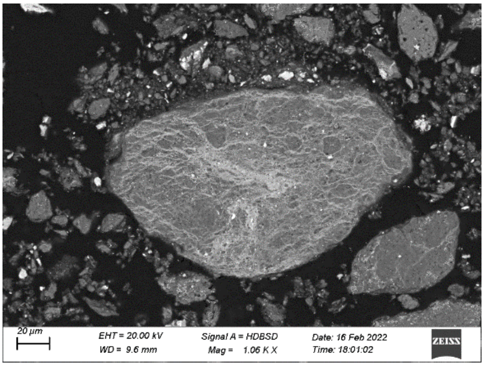

Fig. 7. Reticulated chlorite dispersed in kaolinite

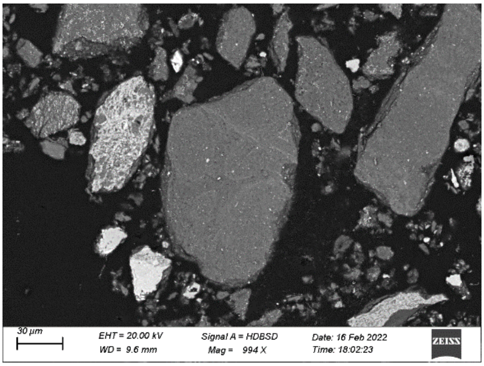

Fig. 8. Paragenesia of gibbsite and kaolinite

4 Conclusions

(1) A sedimentary clay-type lithium resource mineral mainly includes kaolinite, illite, magnetite, limonite, etc. The ore grade is only 14.06% Fe, 0.78% Ti and 19.48% Al, all of which have not reached the usable grade. Although Li grade is also low, but it can be utilized in the follow-up because the current new energy policy urgently needs a large amount of lithium in domestic.

(2) When the fineness is -0.074mm of 100%, the liberation degree of each mineral is not high, especially the liberation degree of magnetite, limonite, and chlorite is less than 50%. The liberation, binary symbiosis and ternary inclusion of each mineral are all quite complicated. Illite and chlorite are more easily broken than magnetite and kaolinite, and their particles are smaller.

(3)Lithium ions in the solution can be obtained by leaching under acidic conditions, which can be used to produce lithium carbonate or lithium hydroxide. Because lithium is embedded in the montmorillonite structure, in order to improve the leaching efficiency of lithium, the sample may need to be roasted at high temperatures, so that the mineral structure becomes more loose to facilitate leaching.

Acknowledgments

We gratefully acknowledge financial assistance from National Natural Science Foundation (No: 51964044), Yunnan Local Colleges Applied Basic Research Projects (No: 2018FH001-051), Yunnan University Students Innovation and Entrepreneurship Training Program (No: 2023A019).

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