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Natural Evaporation of Dangxiongcuo Salt Lake Spring Brine in Tibet, China

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1 Introduction

Dangxiongcuo salt lake (Fig. 1), which is located in the southwest of Tibet, China, is rich in valuable mineral elements like lithium, potassium, boron, rubidium, caesium and others. Such special salt lake with its typical carbonate-type brine is extremely rare and precious, and has good industrial exploitation prospect. Therefore, it is very necessary to study on the brine evaporation and the salt minerals crystallization in different seasons which have the practical significance for the resource extraction from the salt lake brine.

In this paper, the natural evaporation experiment of Dangxiongcuo salt lake spring brine has been done on the lakeside. The concentration and enrichment behaviors of each element have been analyzed in detail. The precipitation regularity of salt minerals and their phase chemistry properties have also been researched as well.

2 Experiment Results and Discussion

The experiment results can be seen from Table 1 and Table 2. It was indicated that the sodium chloride remained the saturated state and crystallized out as the form of Halite continuously along with the process of the spring brine evaporation. The typical cold-phase mineral salts such as Mirabilite and Natron could be precipitated in advance due to the lower temperature in spring. Sylvite precipitated relatively earlier than Borax with larger amount, and the Lithium crystallized out at last in the form of Zabuyelite.

Since there is not applicative phase diagram of complex water-salt system, the brine system of Dangxiongcuo salt lake could be simplified as a quinary system. And based on the metastable diagram of quinary system Na^+, K^+ / CO_3^{2-}, SO_4^{2-}, Cl^--H_2O (25℃), the crystallization path of salt minerals could been seen from Figure 2. And the precipitation sequence in spring is Halite (NaCl), Mirabilite ($Na_2SO_4·10H_2O$), Natron ($Na_2CO_3·10H_2O$), Trona ($Na_2CO_3·NaHCO_3·H_2O$), Sylvite (KCl), Borax ($Na_2B_4O_7·10H_2O$) and Zabuyelite (Li_2CO_3).

Fig. 1. Photo of Dangxiongcuo salt lake in Tibet, China

The early stage of the evaporation process was the enrichment stage of potassium and boron. After that, they began to precipitate as the form of sylvite and borax separately. When the concentration rate of brine was about 26%, the content of sylvite in solid phase reached the highest peak of 15.3%, with the borax accounting for 8.86%. Lithium also experienced a longer period of

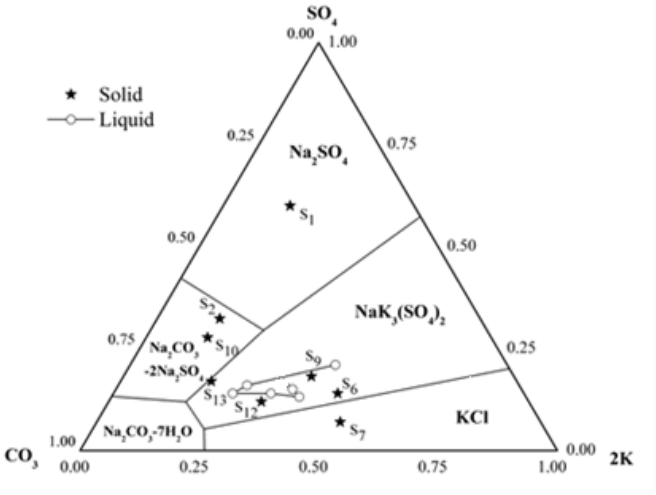

Fig. 2. Natural evaporation and crystallization path of Dangxiongcuo salt lake brine in spring based on metastable phase diagram of quinary water-salt system Na^+, K^+ / Cl^-, SO_4^{2-}, CO_3^{2-}-H_2O (25℃)

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Table 1 Experimental data of natural evaporation of salt lake brine in spring

Concentration rate of brine (%)	Solid sample No.	Salinity (%)	Li^+ (g/L)	K^+ (g/L)	$B_4O_7^{2-}$ (g/L)
100	—	26.4	0.809	18.98	6.02
73.94	SX-1	31.2	1.042	22.83	8.15
57.87	SX-2	31.8	1.264	30.70	8.93
53.57	SX-3	32.1	1.568	36.82	9.70
47.26	SX-4	32.6	2.006	45.23	11.25
40.51	SX-5	33.1	3.150	44.85	13.97
34.14	SX-6	33.8	4.836	46.47	18.24
26.15	SX-7	33.8	2.908	50.82	8.15
23.29	SX-8	34.1	0.809	18.98	6.02
17.35	SX-9	35.1	0.892	23.93	7.37
11.67	SX-10	34.4	1.264	30.70	8.93
8.49	SX-11	34.9	1.442	32.28	8.93
5.75	SX-12	37.5	1.568	36.82	9.70
1.88	SX-13	33.1	1.528	42.35	9.70

Table 2 Constituents of salts in solid phase precipitated.

Sample No.	Major constituents of salts	Rest constituents of salts
SX-1	Halite, Mirabilite	Natron, Sylvite, Borax, Zabuyelite
SX-2	Halite, Natron, Mirabilite	Sylvite, Borax, Zabuyelite
SX-3	Halite, Natron	Borax, Mirabilite, Sylvite, Trona, Zabuyelite
SX-4	Halite, Natron	Borax, Mirabilite, Sylvite, Zabuyelite
SX-5	Halite	Natron, Sylvite, Mirabilite, Borax, Zabuyelite
SX-6	Halite	Natron, Sylvite, Mirabilite, Borax, Zabuyelite
SX-7	Halite, Natron, Sylvite	Mirabilite, Borax, Trona, Zabuyelite
SX-8	Natron, Halite, Sylvite	Mirabilite, Borax, Zabuyelite, Trona
SX-9	Halite, Natron, Mirabilite, Sylvite	Borax, Zabuyelite, Trona
SX-10	Natron, Mirabilite, Halite	Borax, Sylvite, Zabuyelite
SX-11	Halite, Natron	Sylvite, Mirabilite, Borax, Zabuyelite
SX-12	Halite, Sylvite, Natron	Mirabilite, Borax, Zabuyelite, Trona
SX-13	Natron, Halite, Mirabilite	Sylvite, Borax, Zabuyelite

concentration process, and the content of lithium in liquid phase rose from 0.81 g/L to 4.84 g/L. During that time, only a small amount of Zabuyelite was entrained within the solid mixed salts. After reaching saturation, it started to crystallize out largely and the content in solid phase could be up to 2.85%. The brine rich in Lithium could be obtained through the low-temperature evaporation in spring, and the mother liquor at the later evaporation stage could also be used to extract the sylvite and borax.

The research results can provide the reference data and technology basis for the large-scale comprehensive exploitation and utilization of the salt mineral resources from the carbonate-type brine such as Dangxiongcuo salt lake.

Key words: Dangxiongcuo salt lake, carbonate-type spring brine, natural evaporation, crystallization path, precipitation regularity of salt minerals

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