Characteristics of Salt Deposits in the Dry Salt Lake and the Formation of Potash Beds

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ABSTRACT

When a saline basin evolves into a stage of potash deposition, a vast expanse of salar coexists with some residual brine lakes. Such a special geologic and geographic setting is known as a "dry salt lake." Salt deposits in that basin are quite different from "playa." The potash deposit in Chaidam Basin of China is cited as a typical example of a modern dry salt lake.

The difference between the water levels of the residual brine lakes and the intercrystal brine within the salar, and their hydrogeological relationships, have decided the characteristics of salt deposits in the stage of dry salt lakes. The residual brine lake formed at the lowest water level is the main "potash basin." The potassium compounds are enriched in the brine lake by the processes of selective solution and vertical and horizontal differentiation of salts in the intercrystal brine within the salar. The bedded potash deposits are usually formed in the flat lake beach along the bordering regions of salar and lake. The mechanism of formation of the potash beds is similar to modern coastal sabkha, but the salts are supplied from the intercrystalline brines in the salar.

The residual brine lakes, in the dry salt lake stage, are not simply formed within a structural depression; they are the comprehensive geological phenomena of structural depression, depositional compensation and, especially, the surface and underground drainage system of the lake basins.

INTRODUCTION

The dry salt lake, as a geomorphic landscape, was known for a long time. In dry salt lakes there are not only abundant salt deposits, such as halite, mirabilite, soda, borax, etc., but also lots of interstitial brine which contains useful elements such as K, Li, Rb, Cs, Br, I, etc. This is why the dry salt lakes are considered as important mineral resources of great economic significance.

China has numerous large modern salt lakes in many provinces, such as Qinghai, Xizang (Tibet), Kansu, Ningsia, and Inner Mongolia. The exploitation and utilization of salt lakes in China can be traced from the earliest times. Recently, the research work of salt lake resources has been carried out. In several dry salt lakes the large potash beds can be directly observed. Among them the Charhan dry salt lake, located in the Chaidam Basin, is the largest one. A progress of formation of economic potash deposits (carnallite and sylvite) is precipitating even today. It will no doubt be a good natural laboratory to study the genetic mechanisms of potash deposits and so it is of great importance in theory, too.

K. J. Hsü (1972) proposed the origin of saline giants, e.g., the Late Miocene desiccation of the Mediterranean. In China extensive desiccational signs have also been discovered in ancient potash deposits as well as the modern dry salt lakes. Based on the data obtained at Charhan we present some basic features of the dry salt lakes and the conditions of formation of modern potash deposits in such environment.

FEATURES OF THE DRY SALT LAKES

There are different terms in the literature for dry salt lake, such as playa, playa lake, continental sabkha, salar, salina or salt pan. The meaning of this word varies with different contexts. Usually such dry lakes will soon get covered with sands and finally become blind lakes. However, the local brine lakes can also coexist side by side with the wide salt beaches for a long time. This landscape of long term coexistence between brine lakes and salt beaches is called a "dry salt lake," which forms in arid regions. The salt beaches are the desiccated remnants of brine lakes in which all of the surface brine has become interstitial brine.

There are three stages in the evolution of dry salt lakes. In the *early stage*, part of deposited salt beds formed from the brines is exposed. When the rainy seasons come, all of

deposited salt beds become inundated by the flooding brines.

In the *middle stage* of development wide salt beaches coexist with brine lakes. Sometimes the lake brines flood only over the lower salt beaches.

In the *final stage* there is only a bit of residual brine in the lake and it is almost completely dried up.

The data obtained in these Chinese studies proved that the geomorphic and hydrologic conditions of dry salt lakes are more complicated than those which M. G. Valyashko, academician of the USSR, had reported in his studies (1962). Charhan dry salt lake is one of the best examples.

THE SURVEY OF CHARHAN DRY SALT LAKE AND ITS POTASH BEDS

Charhan dry salt lake is located in the center of Chaidam Basin and it covers an area of 5,800 square kilometers. A branch range of the Chillian Mountains stands on the north border of the lake region. On the south edge there are the famous Kunlun Mountains. The wide flat salt beaches with their surrounding nine brine lakes are located between those two mountain systems.

The brine lakes are supplied with surface flows from the interior rivers or from underground water. Between the old salt beds and overlying sands and muds in which precipitated on the floors of brine lakes, there is an irregular erosion surface. This was formed when the surrounding supplied water dissolved away part of old salt beds and then formed the brine lakes.

Old salt beds with thicknesses of several tens of meters are also observed within the salt beaches. They mainly consisted of halite and minor amounts of silt or clayey silt. There are seven horizons of potash deposits in halite formations. The upper ones are the main potash-bearing formations. The potash deposits occur as two types: the bedded and the disseminated deposits.

The bedded potash deposits occur with interbedding halites. The ore beds are in the form of lenses with a thickness of 7–11 meters. The main mineral is carnallite and the next one is sylvite.

The new potash beds are located on the shore between salt beaches and the brine lakes. Their minerals are carnallite, too.

The disseminated deposits occur in the upper halite formation in the form of filled porosity. They are disseminated in almost all of the upper salt formation.

Since the late 1950s the potash salts have been precipitating. They are the modern potash deposits.

The origin of all of the potash deposits—old and new—is apparently the same process. The brine lake coexisting with the wide salt beaches, the cross-supplements and cross-mixing of lake brine and the interstitial brine are the necessary conditions to form the continental potash beds. For example, there is a special type of "pearl salts" which occur in both the old salt beds, the new salt beaches and the modern potash deposits. They develop as the key bed and form in a similar sedimentary environment.

The study of the modern dry salt lakes may help us to find the new economical potash deposits. So it may be very important.

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