

Research Advances

Resource Potentials of Soda and Boron in the Lower Permian Fengcheng Formation of the Mahu Sag in Northwestern Junggar Basin, China



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Objective

Sodium carbonate and sedimentary boron concentration are commonly relevant to alkaline evaporitic environments. Sodium carbonate minerals are important industrial raw materials for “soda ash (Na_2CO_3)”, which can be obtained by thermal decomposition of various sodium carbonate minerals. Modern alkaline saline lakes are mainly located in arid and warm environments, e.g., the Magadi Lake in East Africa, which contained large amounts of sodium carbonate for industrial demands (McNulty, 2012). Meanwhile, ancient sodium carbonate deposits are also important resources, such as the trona deposits in the Eocene Green River Formation in America (Dyni et al., 1995), and in Paleogene Hetaoyuan Formation in Biyang Depression in China (known as Anpeng Trona Deposits). The drilling holes across the bedded sodium carbonate showed that the Lower Permian Fengcheng Formation in the Mahu Sag contains tremendous “soda resources” (Fig. 1a). Additionally, boron is also extremely concentrated in these strata, which may be the first case of deposits both rich in soda resource and “boron resource” in China. This work is based on core section studies to illustrate prospects of soda resource and “boron resource” in the Fengcheng Formation.

Methods

The results presented in this work are based on X-Ray Diffraction (XRD), complimented with core section and thin section analyses, logging curve analyses, correlations between wells. Based on above analyses, the minerals were identified and their occurrences have been characterized, and the distributions, volumes, and their economical values of sodium carbonate and boron-rich rocks have been evaluated.

Results

(1) Soda resource. Sodium carbonate occurred as pure beds coupled with dark-colored fine-grained

lithological units repeatedly. The carbonate minerals identified in the light-colored sodium carbonate beds include wegscheiderite, trona, nahcolite, pentasodium trihydrogentetracarbonate. Wegscheiderite and trona are dominant sodium carbonate minerals in bedded sodium carbonates (Figs. 1b–c). Compared with that in the Green River Formation, there is few Ca, Mg carbonate minerals, calcites, dolomites occurred in both light-colored sodium carbonates units and dark-colored fine-grained lithological units. And, the contents of halite and sulfates are very low, and at least, there is no bedded halite and sulfate occurred in the studied core sections. If the sodium carbonate is recovered in form of alkaline brines by the solution mining method, the proportion of sodium carbonate is relatively high because of low contents of other dissolving salt minerals.

(2) Boron resource. Boron-bearing mineral, reedmergnerite, occurred as massive aggregates (Fig. 1d), nodules (Fig. 1d), scattered crystals (Fig. 1e), layers (Fig. 1f), etc. Reedmergnerite is a major rock-forming mineral in this evaporitic sequence. Boron concentration in the Fengcheng Formation is a typical volcano-sedimentary boron mine type, which has a similar sedimentary and tectonic background to those in west Turkey and occurred in an alkaline saline lake with intense volcano eruptions. Boron deposits in west Turkey and other sedimentary boron mines worldwide are dominated by borates (Helvacı, 2005), while that in the Fengcheng Formation is dominated by borosilicates. Although reedmergnerite has been reported in some other alkaline basins, their contents may not meet industrial interests. Boron concentration in the Fengcheng Formation may be considered as the first case of boron mine in the form of reedmergnerite.

Base on correlations between wells, it can be inferred that sodium carbonate and reedmergnerite successions have huge sedimentary thicknesses and large volumes, and possess considerable prospects of soda resource and boron resource. The only disadvantage for industrial production is their notable burial depth.

Conclusions

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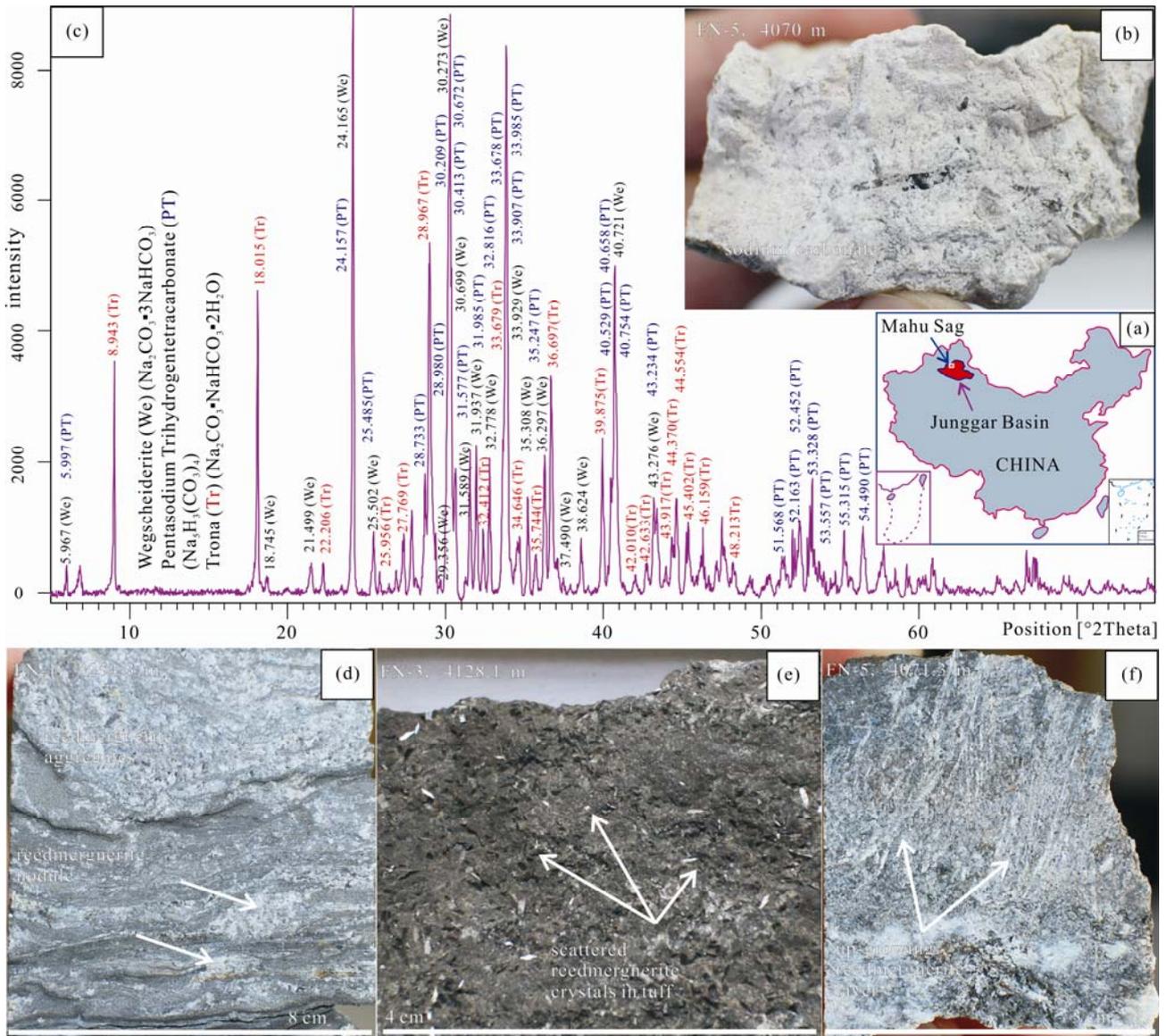


Fig. 1. Location of study site and occurrences of sodium carbonate and reedmergnerite in the Fengcheng Formation.

(a) Mahu Sag is located in the northwestern Junggar Basin in China; (b) A representative sodium carbonate sample from well FN-5, 4070 m; (c) XRD analyses of the sample in b; (d) Reedmergnerite occurred as massive aggregates and nodules, well FN-1, 4254.3 m; (e) Scattered reedmergnerite crystals in tuff matrix, well FN-3, 4128.1 m; (f) Layered up-growing reedmergnerite in saline lake center, well FN-5, 4071.3 m.

The Fengcheng Formation in the Mahu Sag contains huge volumes of bedded sodium carbonates and borosilicate mineral, reedmergnerite, which provides industrial raw materials for producing soda ash and industrial boron. This may be the first report of volcano-sedimentary sequence both rich in soda resource and sedimentary boron resource in China, and is the oldest soda resource discovered in China so far.

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