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# Solubility and Supersaturation of Lithium Carbonate in Zabuye Salt Lake Brine, Tibet

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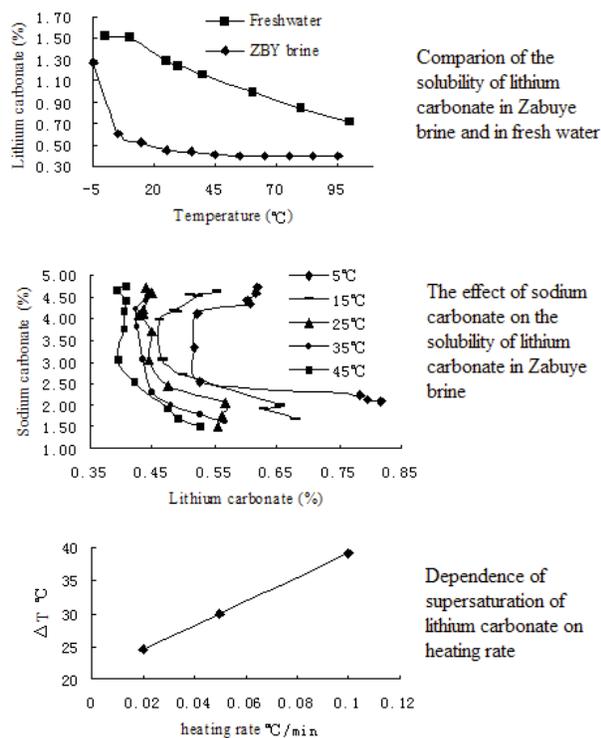
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The highest abundance of lithium has been found in brine of salt lakes in China, such as Zabuye Salt Lake in Tibet and Dongtaijinaier and Xitaijinaier salt lake in Qinghai. Lithium has been produced from such brines since 1959. The alkaline Zabuye Salt Lake is hydrochemically unique, containing a comparatively complex and special mineral assemblage rich in Li, B, K, and sodium carbonate. The amount of the mineral zabuyelite ( $\text{Li}_2\text{CO}_3$ ) is particularly large. The solar pond technology was developed based on the evidence that the solubility of  $\text{Li}_2\text{CO}_3$  decreased with increasing temperature, as documented by Zheng Mianping between 1995 and 2002. The first industrial scale production line for  $\text{Li}_2\text{CO}_3$  was founded in Zabuye Salt Lake in 2004. However, detailed solubility data for  $\text{Li}_2\text{CO}_3$  in the presence of other salts in Zabuye Salt Lake brine have not been reported. Solubility data for pure  $\text{Li}_2\text{CO}_3$  in fresh water cannot be used for the accurate prediction of zabuyelite production. Therefore, the solubility of  $\text{Li}_2\text{CO}_3$  in Zabuye brine has to be determined. Because lithium production in solar ponds was not in chemical equilibrium because of the increasing temperature of the solar pond, the degree of supersaturation of  $\text{Li}_2\text{CO}_3$  in the brine is very important in estimating the production rate and quality of the product. We have investigated the solubility of  $\text{Li}_2\text{CO}_3$  and its degree of supersaturation in Zabuye brine. Solubility was studied using the isothermal method. The effect of sodium carbonate on  $\text{Li}_2\text{CO}_3$  solubility was also studied. Based on the crystallization theory, salt supersaturation in solution depends on many factors such as the mixing intensity, cooling (or heating) rate, and the presence of solid surfaces. We studied lithium carbonate supersaturation at different heating rates because the solubility of lithium carbonate is decreased with increasing temperature. Lithium carbonate has limited solubility and its concentration change in solution is difficult to measure in supersaturation experiments. Therefore, supersaturation of lithium carbonate was expressed by a temperature difference calculated from (a) the directly measured temperature of the solution in the experiments. The lithium concentration is considered to be saturated at this temperature. (b), the temperature calculated based on the measured concentration of lithium carbonate in the solution. There is a saturation temperature which corresponds to the

measured concentration of lithium carbonate, and this temperature is used to express the degree of supersaturation of the solution. The difference between these two temperatures can then be used to express the level of solution supersaturation. The solubility of  $\text{Li}_2\text{CO}_3$  in Zabuye brine was found to be quite different from that in fresh water, and to be strongly affected by the  $\text{Na}_2\text{CO}_3$  concentration as shown in Figure 1. The solubility of the salt was expressed by weight percent, defined as the amount of salt in the solution divided by the total weight of the solution. At low temperature,  $\text{Na}_2\text{CO}_3$  has a complex effect on the solubility of  $\text{Li}_2\text{CO}_3$ . At low  $\text{Na}_2\text{CO}_3$  concentration the solubility of  $\text{Li}_2\text{CO}_3$  decreases with increasing  $\text{Na}_2\text{CO}_3$ . However, when the  $\text{Na}_2\text{CO}_3$  concentration is high, the solubility of  $\text{Li}_2\text{CO}_3$  is increased with increasing  $\text{Na}_2\text{CO}_3$ . At high temperature, the solubility of  $\text{Li}_2\text{CO}_3$  decreased with increasing  $\text{Na}_2\text{CO}_3$  concentration. With increasing heating rate, the supersaturation level was increased (Figure 1).



**Figure 1**—Solubility of  $\text{Li}_2\text{CO}_3$  in Zabuye brine and the dependence of  $\text{Li}_2\text{CO}_3$  supersaturation on heating rates.