# Phase equilibria in the aqueous subsystems of Li-Rb-Cs-$SO_4$-$H_2O$

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There are more than 700 salt lakes with an area larger than 1 $km^2$ in the Qinghai-Tibet Plateau. High concentrations of rare alkali metal ions (Li, Rb, and Cs) have been found in these salt lakes, in particular the salt lake in Qaidam Basin. Most of the salt lakes in the Qaidam Basin are of the sulfate-type. In sulfate type brine, lithium, rubidium, and cesium are easily formed into solid solution and double salt because of their similar ion radius, information on the aqueous solution composed of Li-Rb-Cs-$SO_4$ equilibria is of a particular importance for the purification of chemical produces, trace element geochemistry and element cycles.

Accordingly, the phase equilibria of three subsystems of $Li^+$, $Rb^+$, $Cs^+$ // $SO_4^{2-}$ - $H_2O$ at 298 K have been done by using isothermal dissolution method and Schreinemakers wet residues method. The stable phase diagrams of these three ternary system at 298 K belong to complex type with solid solution or double salt formed. In the systems Li-Rb(Cs)-$SO_4$-$H_2O$, there are three invariant points, four isothermal dissolution curves, and four crystallization zones corresponding to two single salts ($Rb_2SO_4$/$Cs_2SO_4$, $Li_2SO_4 \cdot H_2O$) and two double salts ($Li_2SO_4 \cdot Rb_2SO_4$ and $3Li_2SO_4 \cdot Rb_2SO_4 \cdot 2H_2O$) or ($3Li_2SO_4 \cdot Cs_2SO_4 \cdot 2H_2O$ and $Li_2SO_4 \cdot Cs_2SO_4$). In the systems Rb-Cs-$SO_4$-$H_2O$, there are two invariant points, three isothermal dissolution curves, and three crystallization zones corresponding to two single salts ($Rb_2SO_4$ and $Cs_2SO_4$) and one solid solution [$(Rb, Cs)_2SO_4$]. The double salt and solid solution has the largest crystallization field almost occupies the entire phase region.

**Acknowledgements**

The authors acknowledge the support of National Natural Science Foundation of China (U1607121, 41473059) and Science and Technology Innovation Talent Program of Sichuan Province (19CXRC0043).