Target Group

The course is aimed at scientists, engineers and technicians dealing with crystallization and precipitation processes.

Schedule:

The course consists of four to five days of 10 lectures and 5 exercises, 90 minutes in length. On demand, special subjects can be included.

Required knowledge

Basic knowledge in Physical Chemistry and/or Chemical Engineering.

Previous participation in the course "Graphical representation and quantitative analysis of salt – solution – equilibriums" is advised.

Contact:

Dr.rer.nat.habil. G. Ziegenbalg
Chemical and Geochemical Consultancy
Balthasar-Rößler-Str. 36
09599 Freiberg
Germany

e-mail: gerald.ziegenbalg@ibz-freiberg.de
www.ibz-freiberg.de

fax: +49-3731-698 365

Training Course

The solid –liquid equilibriums of the quinary system of oceanic salts

- An introduction to the fundamentals of the system, its graphical representation and the quantitative description of the equilibriums –

Dr.rer.nat.habil. G. Ziegenbalg
Chemical and Geochemical Consultancy
Balthasar-Rößler-Str . 36
09599 Freiberg, Germany

Aims

The equilibriums in the quinary system Na^+, K^+, Mg^{2+}/Cl^-, SO_4^{2-}// H_2O and the subsystems have immense economic and scientific relevance. They are the basis both for potash and salt production. The formation of salt deposits can be explained only when the stable and metastable phase equilibriums are understood. Although the system has already been investigated for more than 100 years, the solid-liquid equilibriums of the so called quinary system of oceanic salts are still the subject of much research. The quinary system consists of six binary, nine ternary and five quaternary subsystems. There are hundreds of publications summarizing, solubility of these substances, and in many cases it is difficult to assess the given data. The phase equilibriums are often very complex and understand them requires the graphical representation of stable and metastable crystallization fields. This is one main subject of the course as well as the presentation of the phase relations in the quinary system.

Based on his experience in teaching salt chemistry at university level for many years, the lecturer Dr. G. Ziegenbalg gives an overview on fundamental and applied aspects of the quinary system. Starting with the subsystems, all relevant minerals and equilibriums will be reviewed. Not only are the phase equilibriums discussed, but also properties of selected double salts. Possibilities of their production are summarized. In special seminars the construction and usage of phase diagrams will be trained both for qualitative and quantitative calculations.

Program

1. Fundamentals
1.1 Thermodynamics
1.2 Stable / metastable equilibriums
1.3 The phase rule
1.4 Concentration units

2. Historical development of the graphical representation of salt water systems

3. Binary systems
3.1 Possibilities of graphical representation
3.2 The system NaCl-H_2O
3.3 The system KCl-H_2O
3.4 The system Na_2SO_4-H_2O
3.5 The system $MgSO_4$-H_2O
3.6 The system K_2SO_4-H_2O
3.7 The system $MgCl_2$-H_2O
3.8 Quantitative calculations

4. Ternary systems
4.1 Possibilities of graphical representation
4.2 The system NaCl-KCl-H_2O
4.3 The system NaCl-$MgCl_2$-H_2O
4.4 The system KCl-$MgCl_2$-H_2O
4.5 The system NaCl-Na_2SO_4-H_2O
4.6 The system $MgCl_2$-$MgSO_4$-H_2O
4.7 The system K_2SO_4-KCl-H_2O
4.8 The system Na_2SO_4-K_2SO_4-H_2O
4.9 The system Na_2SO_4-$MgSO_4$-H_2O
4.10 The system K_2SO_4-$MgSO_4$-H_2O
4.11 Quantitative calculations

5. Quaternary systems
5.1 Systems with one common ion
5.1.1 Possibilities of graphical representation
5.1.2 The system NaCl-KCl-$MgCl_2$-H_2O
5.1.3 The system Na_2SO_4-K_2SO_4-$MgSO_4$-H_2O
5.2. Reciprocal salt pairs
5.2.1 Possibilities of graphical representation
5.2.2 The system 2 NaCl/K_2SO_4-H_2O
5.2.3 The system 2 NaCl/$MgSO_4$-H_2O
5.2.4 The system 2 KCl/$MgSO_4$-H_2O

6. The quinary system
6.1 Possibilities of graphical representation
6.2 The isotherms at 25 °C, 50 °C, 75 °C, 90 °C
6.3 Polythermal representation

7. Outlook