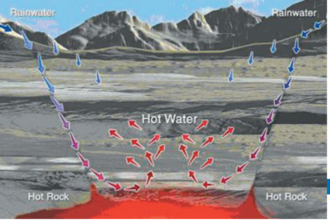
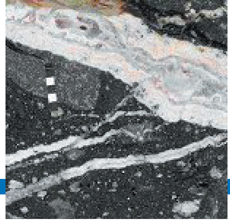
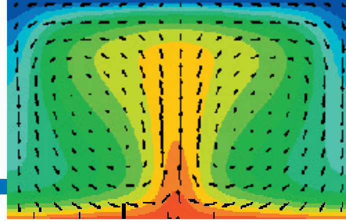


Hydrothermal Systems

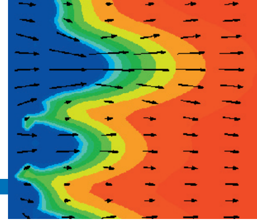


Rock Deformation and Geodynamics

Fluid Flow



Heat Transfer



Reactive Transport

Date:
27 - 29 August 2007

The participant will receive a certificate of attendance of RWTH Aachen University.

Course location:
Guest House (Gästehaus) of RWTH Aachen University
Melatener Str. 31
52074 Aachen

Fee:
900 €; course notes, access to computer, lunch, coffee break are included.
Reduced fee for students on presentation of a valid student ID: 450 €.
Maximum number of participants: 30
Minimum number of participants: 10

Registration:
Please register register online at www.rwth-academy.com/geophysics.html or by mail, fax, or email in writing at
RWTH International Academy, Aachen University
Ms. Friederike Wolter, M.A.
Kármánstr. 17-19
52062 Aachen
Germany
Phone: +49 (0)241 80-993 67
Fax: +49 (0)241 80-925 25
Email: geophysics@rwth-academy.com

A preliminary registration is possible by telephone which must be followed by a written registration no later than 4 August 2007. A cancellation of the registration until four weeks before the beginning of the course is possible at no cost. A cancellation of the registration until two weeks before the beginning of the course will be accepted with a cancellation fee of 50% of the regular course fee (e.g. 450,00 €). A suitable person may be proposed as substitute.

For hotel reservations please contact:
aachen incoming service
Postfach 10 22 51
52022 Aachen
Phone +49 (0)241 1 80 29 -50 or -51
Fax: +49 (0)241 1 80 29 30
Email: incoming@aachen-tourist.de

Target audience:
Geophysicists, geologists, geochemists and hydrogeologists from industry, universities and governmental institutions interested in processes and simulation techniques of hydrogeological, geothermal and reactive transport applications. Postgraduate students specialising in one of the mentioned fields. All users of the program package SHEMAT / Processing SHEMAT.

Course content:
The focus of this course is on coupled numerical simulation of fluid flow, heat transfer, multi species transport and chemical reactions and how these processes relate to rock deformation and geodynamics. We will give an outline of the physical and chemical foundations and will discuss in detail the philosophy of how to conceptualise, set up and carry out numerical modelling projects. This is a hands-on course with an emphasis on using the program SHEMAT.

Course structure:
The course is aimed to enable the participants to develop a process understanding of reactive transport in hydrothermal systems and to make responsible decisions based on results of numerical simulations.

Instructors:
Dr. Michael Kühn is a Research Scientist at the Institute of Applied Geophysics in the Faculty of Georesources and Material Sciences at RWTH Aachen University. He is also adjunct lecturer for "Reactive flow in groundwater" at the Technical University of Hamburg-Harburg.

Dr. Klaus Gessner is Senior Lecturer and leads the Earth Systems Modelling Group, a research and teaching initiative of the Predictive Mineral Discovery Cooperative Research Centre (pmd*CRC), located at the Centre for Exploration Targeting at the University of Western Australia, and CSIRO Exploration and Mining.

Dr. Christoph Clauser is Professor for Applied Geophysics in the Faculty of Georesources and Materials Engineering at RWTH Aachen University. He is the original author of SHEMAT which since 1988 has undergone continuous development within a number of projects involving various members of his research group.

Information about the Institute of Applied Geophysics:
www.geophysik.rwth-aachen.de

RWTH AACHEN UNIVERSITY

Update Seminar

Process Modelling of Hydrothermal Systems
using SHEMAT / Processing SHEMAT
27 - 29 August 2007
Aachen, Germany

Hydrothermal Systems

Rock Deformation and Geodynamics

Fluid Flow

Heat Transfer

Reactive Transport

RWTH AACHEN UNIVERSITY INTERNATIONAL ACADEMY

APPLIED GEOPHYSICS

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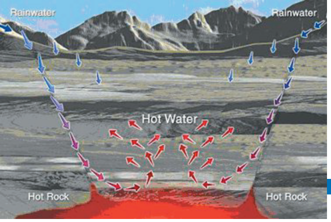
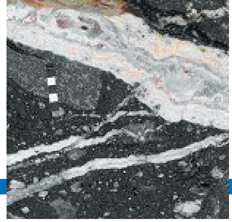
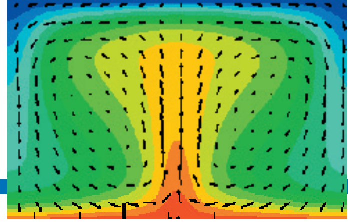
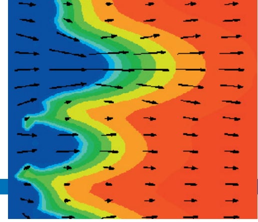


Hydrothermal Systems


Rock Deformation and Geodynamics


Fluid Flow


Heat Transfer


Reactive Transport

Process Modelling of Hydrothermal Systems using SHEMAT / Processing SHEMAT

Hydrothermal systems are the engines that fuel geothermal fields and are of great significance for the generation of the world's hydrocarbon and mineral resources. Adequate and reliable supplies of affordable energy, obtained in environmentally sustainable ways, are essential to economic prosperity, environmental quality, and political stability around the world.

The challenge for geological exploration is to find cost-effective ways of locating high quality geothermal and mineral resources. Numerical simulation of reactive transport is an emerging exploration tool, which can provide a more quantitative exploration effort.

The focus of the course 'Process Modelling of Hydrothermal Systems' is on coupled numerical simulations of fluid flow, heat transfer, multi species transport and chemical reactions and how these processes relate to rock deformation and geodynamics. The physical and chemical foundations as well as the philosophy of how to conceptualise, set up and carry out numerical modelling projects are discussed and demonstrated. 'Process Modelling of Hydrothermal Systems' is a hands-on course, designed for industry practitioners, university researchers, and students interested in the simulation of fluid flow and reactive transport in hydrogeology, geothermal energy and economic geology.

'Process Modelling of Hydrothermal Systems' will provide an overview of existing simulation techniques with an emphasis on coupled simulations using the program package SHEMAT / Processing SHEMAT. SHEMAT (Simulator for HEat and MAss Transport) is an easy-to-use, general purpose reactive transport simulation code for a wide variety of thermal and hydrogeological problems in two and three dimensions. Specifically, SHEMAT solves coupled problems involving fluid flow, heat transfer, species transport, and chemical water-rock interaction in fluid-saturated porous media. It can handle a wide range of time scales. Therefore, it is useful to address both technical and geological processes. In particular, it offers special and attractive features for modelling steady-state and transient processes in hydrogeothermal systems.

Geothermal systems: Commercial extraction of heat from active hydrothermal systems has been growing steadily over the past few decades.

Hydrothermal ore deposits: Extraction of minerals from fossil hydrothermal systems continues to have large economic significance and provides a practical impetus for research on these systems. Most economically significant ore deposits exist because of the advective transport of solutes and heat by flowing groundwater. Mobilization, transport, and deposition of chemical species are all linked to fluid flow.

Five questions and five processes

The application of reactive flow modelling provides a means to lower risk, costs and time during reservoir management, remediation or exploration targeting. In order to deal with the complexity of natural systems, simplified models are employed to illustrate the principal and regulatory factors controlling a chemical system. Following the aphorism of Albert Einstein: "Everything should be made as simple as possible, but not simpler", models need not to be completely realistic to be useful, but need to meet a successful balance between realism and practicality. Properly constructed, a model is neither so simplified to be unrealistic nor too detailed so that it cannot be readily evaluated and applied to the problem of interest. The results of a model have to be at least partially observable or experimentally verifiable.

Reactive transport modelling is extremely useful in understanding the spatial and temporal distributions of solute concentrations and mineral assemblages in the environment. The main target of reactive flow modelling is the simulation on a real time scale with real spatial coordinates, but generally this goal is only partially achievable. The limitations of reactive transport simulation are embedded in the conceptualized set of equations used to best approximate the real situations. But models provide a tool for critical analysis. They are a means to organize our thinking, test ideas and indicate which are the sensitive parameters. They direct further studies and help to design new experiments and to critically test hypotheses. Particularly surprising model outputs often provide new insights otherwise inaccessible.

Studies of hydrothermal systems should begin by considering the following five questions (this approach has been successfully applied in research projects of the pmd*CRC):

(1) What is the architecture of the system?
(2) What is its geodynamic history?
(3) What processes are driving fluid flow on the scale of the system?
(4) What is the nature of the fluids in the hydrothermal system?
(5) What are the mechanisms of alteration?

Qualitative answers to these questions lead the way to conceptual models, which in turn provide a framework for quantitative, numerical models. Answering these questions as good as possible will help to conceptualise the scientific problem.

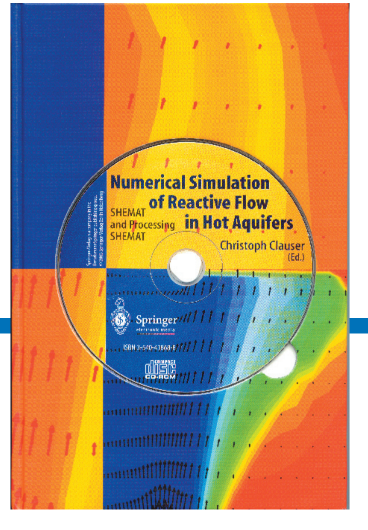
Key steps in conceptualising the models are:

(1) simplifying assumptions must be made;
(2) appropriate boundary conditions and initial conditions must be identified;
(3) the range of applicability and limits of prediction of the models need to be understood.

Models for coupled simulation of reactive transport processes consist of five physical and chemical processes to be solved numerically:

(1) mechanical deformation;
(2) fluid flow;
(3) heat transfer;
(4) multi species transport and
(5) chemical reactions.

The course is structured into 6 lectures accompanied by 5 practical exercises. First a general overview will be given on modelling hydrothermal systems for mineral exploration, geothermal energy production and CO_2 sequestration. Then basic physical processes involved in hydrothermal systems - heat transfer, fluid flow driving processes, deformation and reactive transport - will be reviewed. Practical exercises will introduce the application of the software package SHEMAT / Processing SHEMAT to solve relevant problems with regard to hydrothermal systems. The final part of the course will address the use of coupled reactive transport models for hypotheses testing.



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