

Transport and Retardation Processes in Fractured Rocks: Concepts, Theory and Practice

Held : 15th – 24th October, Meiringen, Switzerland
General background and objectives

The course will consist of modules including classroom sessions, workshops, case studies, field trips and practical application (hands-on experience) at the Grimsel Test Site (GTS). The course structure will allow interaction with the tutors and enough time will be reserved for ad hoc discussions on specific topics in the afternoon of each day.

To set the stage, a first series of lectures will cover the basic concepts and theories of underground rock facilities (URFs). Beside general aspects of working underground the roles and benefits of URFs in the different stages of a national radioactive waste disposal programme will be at the centre of the presentations. For logistical reasons, some of these lectures will be held during the ongoing practical exercises, which will take place underground, at the GTS.

The focus of the practical modules will be the development of an in depth understanding of radionuclide transport and retardation processes through deep geological formations (clays and fractured rocks). Although the practical training will be performed at the GTS, the course will not only address (Grimsel) granite specific aspects, but other URFs and other geological environments. The discussion of examples from other locations (and host rocks) will provide a comprehensive understanding of the benefits and limitations of tracer testing and radionuclide migration projects within the frame of typical repository implementation phases.

Course Outline

Lectures and discussions

- Types of URF and their place at different stages of a national repository development programme
- Repository site characterization requirements and their relationship with URFs
- Strategies for developing URF programmes within national programmes
- Working in clay environments

- using the data from Mt Terri URL for repository feasibility studies
- the Hades URL: experience gained over the last 20 years

- Working in hard rocks

- geosphere retardation processes overview and discussion of migration and retardation projects performed at the GTS
- transport in fractured rocks - geological and hydraulic properties of water conducting features, including methodologies for characterization of water conducting features
- Ongoing and planned projects at the GTS utilizing radionuclides

- Theory and practice of in-situ tracer testing: basics of hydrotesting, data needs, equipment requirements
- Case studies on retardation experiments - setting the objectives, planning the in-situ work, implementation and interpretation

Complementary laboratory programmes

- Working with radionuclides in-situ: introduction to applied radioprotection
- Field work at the GTS with tracers
- Raw data handling and analysis
- Modelling exercises are part of the course, using data from previous experiments and the data generated during the course tracer test exercise.

Course Organiser

The course is organised by the ITC-School in collaboration with, and supported by, the IAEA (International Atomic Energy Agency) within its network on Training and Demonstration of Waste Disposal Technologies in Underground Research Facilities (<http://www-tc.iaea.org/tcweb/default.asp>).

The local host organisation is Nagra (National Cooperative for the Disposal of Radioactive Waste (www.nagra.ch). Participants from IAEA Technical Co-operation Project

The IAEA will finalise arrangements for the INT 9.173 Technical Co-operation Project "Training in Radioactive Waste Disposal Technologies in Underground Research Facilities", of which this course is a part. A draft prospectus will be circulated by IAEA to target countries in the scheme which explains the application procedure and the support arrangements. Participants from the countries within the IAEA training scheme (Argentina, Armenia, Brazil, Bulgaria, Chile, the Peoples Republic of China, Croatia, the Czech Republic, India, Lithuania, Kazakstan, Mexico, Pakistan, Philippines, Republic of Korea, Romania, Republic of South Africa, Romania, Russian Federation, Slovakia, Slovenia, Ukraine) should contact responsible officers at the Agency as below.

Mr. Mykola Kurylchyk Department of Technical Co-operation, ext. 26368 e-mail M.Kurylchyk@iaea.org

Malcolm Gray, Technical Officer, Department of Nuclear Energy, Division of Waste Management and the Fuel Cycle, IAEA for details: Tel. ++ 43 1 2600 21535; e-mail: M.N.Gray@iaea.org
Course Programme

Monday 15th October

0830 - 0930

Introduction and Welcomes

Participants introduce themselves

0930 - 1030

The concept of geological disposal and geological environments for deep disposal

1030 – 1100

Coffee/tea

1100 - 1230

Radionuclide migration processes in the geosphere (sorption, precipitation, matrix diffusion, colloids etc) and the link between R_d and K_d

1230 - 1400

Lunch

1400 - 1500

Treatment of radionuclide migration in PA: what are the data requirements

1500 – 1530

Coffee/tea

1530 - 1630

Gathering data for radionuclide migration use in PA from field site characterisation

Tuesday 16th October

0900 - 1015

Historical overview of large-scale in situ radionuclide tracer testing experiments (surface and URL based) and their findings

1015 - 1045

Coffee/tea

1045 - 1200

Supporting laboratory experiments – how do the data and techniques support field experiments and what are the limitations?

1200 - 1400

Lunch and transfer to Grimsel Test Site (GTS)

1400 - 1430

Introduction to the GTS

1430 - 1530

GTS tour and visit to ongoing experiments

1530 – 1700

Introduction to the practical exercises (planning, radioprotection issues, drilling, mapping, follow-on hydro testing)

1700 – 1745

Visit the Crystal Cave and return to Meiringen

Wednesday 17th October

0830 - 1000

Water-conductive features in fractured rocks: characterisation, abstraction of information for PA

1000 - 1030

Coffee/tea

1030 - 1130

Modelling in situ radionuclide tracer tests a look at how the approach has evolved

1130 - 1230

Upscaling in situ tracer tests to the repository – integration of lab, in situ & natural analogue data: example of the HPF experiment

1230

Lunch and FREE AFTERNOON

Thursday 18th October

0830

Depart for GTS

0900 - 1130

Case Study: Setting the Objectives

Planning and design of in situ work implementation and interpretation

1130 - 1230

Radioprotection aspects of tracer tests in URLs

1200 - 1330

Lunch

1330 - 1700

Introduction to hydraulic testing

Do, or observe, a simple hydraulic test

First estimation of hydraulic characteristics based on field interpretation tools

1700

Depart for Meiringen

Friday 19th October

0830

Depart for GTS

0830 - 1230

Modelling exercise on the planned tracer test

Design of tracer test and experimental set-up

1230 - 1330

Lunch

1330 - 1600

Tracer Test Exercise

1600 - 1700

Case Study: Colloid Retardation Analysis

From the CRR experiment to today's CFM project

1700

Depart for Meiringen

Free WEEKEND J

Monday 22nd October

0830

Depart for GTS

0900 - 1230

Tracer Test Exercise

First interpretation, comparison of model and results and lessons learned

1230 - 1330

Lunch

1330 - 1700

Second Tracer Test Exercise

Setting the objectives

Design of the experiment and modelling

1700

Depart for Meiringen

Tuesday 23rd October

0830

Depart for GTS

0900 - 1230

Second Tracer Test Exercise

Using either another tracer (sorbing/non-sorbing) or other flow fields

1230 - 1330

Lunch

1330 - 1600

Comparison of results of 1st and 2nd tracer tests and interpretation of retardation results

1600 - 1700

Case Study: The LTD experiment with focus on the choice of radionuclides

1700

Depart for Meiringen

Wednesday 24th October

0830 - 1200

Presentation of Group Results

1200 - 1330

Lunch

1330 - 1415

The regulator's view of in situ radionuclide tracer tests – how and why did HSK license Nagra to begin these tests over 20 years ago?

1415 - 1500

Have data from in situ test been used successfully to support the needs of PA discussed early in the week?

1500 - 1530

Coffee/tea

1530 - 1630

Closing discussion and course wrap-up

1630

Close