

Alpine water resources

Geo-hydrochemical and geo-biological processes in the spring catchment of the Rhine and Inn rivers

Field trip to the Swiss Alps for Participants of the Geosciences Program
at the Eberhard-Karls-University, Tübingen, and guests
Wednesday September 5 to Friday September 7, 2007

Key topics

alpine water cycle, subsurface microbiology, low-nutrient life strategies, cold-adapted microorganisms, chemolithotrophy, hydrosphere-lithosphere interactions, mineral dissolution, surface reactivities, geochemical cycles, Fe, Mn, S, P chemistry, polar and alpine microbial habitats, alpine geology, Trias evaporites, Dolomite, Gypsum, Bündnerschiefer, „Lower Engadin Window“

Guides

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Objectives

Hydrology: The terrestrial hydrological cycle, which begins in the central European mountains distributes water by 4 major river systems across much of the continent. Millions of people in Europe depend on water, which originates in the Alps for drinking water, power generation, transport, industrial purposes and recreation.

Hydrochemistry: On the field trip we will illustrate the quality of the water when it arrives as rain or snow in the Alps, we will investigate how it gets stored and transported and how its chemical composition changes while it percolates through different rock formations (Rauwacke, Gypsum, Bündnerschiefer)). These topics will be illustrated at different locations in the upper catchment of the Rhine and Inn rivers (Rothenbrunnen, Alvaneu, Scuol-Tarasp). We will focus on the chemical composition of a variety of spring waters and follow how this can create a diversity of ecosystems for microorganisms (Alvaneu).

Geomicrobiology: Often the solutes present in spring water not only represent the water soluble mineral components of the rocks, they also carry a signature of microbiological processes which take place in the subsurface. The presence of certain reduced chemicals can be due to the activity of anaerobic chemoorganotrophic bacteria and archaea in the deep subsurface. Aerobic chemolithotrophs at the spring mouth can make a living by oxidizing them.

Bio-geo-chemical cycles: During the excursion we will see surface phenomena which relate to underground and surface geochemical cycles of iron, manganese, sulfur and phosphorus (Alvaneu, Jöri, Gonzen). Often ferrous iron and sulfide oxidizing bacteria develop in masses at the anoxic-oxic transition zone. We will study the conditions, which must prevail to select specifically for the kind of bacteria, which are present in these aquatic habitats.

High altitude research: In the Jöri catchment the Microbial Ecology Group of the University of Zürich, in collaboration with other institutions, is studying how microorganisms respond and adapt physiologically to the complex interactions between chemical, geological and atmospheric determinants in the lakes, in snow and on ice. The studies are aimed at understanding evolutionary processes and the microbial diversity in cold-extreme environments.

Locations

(might change depending on weather and time)
Mineral springs (Rothenbrunnen, Rhäzüns, Scuol Tarasp Vulpera) former iron mine Gonzen (Sargans) - High alpine Jöri lakes (Davos / Klosters) – Gypsum containing dolomitic outcrop (Alp Weissenstein, Albula) - Carbonate-lake Palpuogna (Preda / Bergün) - Sulfur and iron springs (Alvaneu).

Contents

Gonzen, Sargans: Here we will have an opportunity to see the inside of an „iron mountain“. Microbiologists will concentrate on the large number of chemolithotrophic bacteria, which are able to make use of the energy released during the oxidation of ferrous (Fe-II) to ferric (Fe-III) iron. Since only one electron gets transferred during this oxidation and since only small amounts of energy get released, a lot of Fe-II needs to be oxidized to support growth. Large volumes of biological „rust“ around bacterial sheaths can be seen at the surface of a water filled former mine shaft.

Mineral springs, Rothenbrunnen and Rhäzüns: For centuries highly mineralized spring waters were used for healing purposes; today they are mostly bottled and marketed as mineral enriched drinking water.

Sulfur and iron springs, Alvaneu: The „rust“ in the outflow of the iron spring consists of badly soluble iron(III)-oxides and iron(III)-hydroxides which dominate the habitats of ferrous iron oxidizing bacteria. Bacteria which catalyze the ferrous iron oxidation (e.g. *Gallionella ferruginea*) protect themselves from being completely encapsulated with „rust“ by forming an extracellular sheath from which the cells can „escape“ as soon as exchanges of metabolites by diffusion becomes limiting.

Carbonate-enriched Lac da Palpuogna, Preda: This and other lakes, which are located just below the dolomitic outcrop reflect the consequences of elevated carbonate concentrations on algal growth and primary productivity.

Gypsum containing dolomitic outcrop, Alp Weissenstein: At Igls Plans (2044 m asl) a gypsum containing dolomitic outcrop offers a window into what is buried in the subsurface on most other locations. Endolithic phototrophs find habitats in near surface rock layers.

High alpine Jöri lakes, Davos / Klosters: The University of Zürich maintains a High Mountain Research Station at Jöri Lake XIII, upper Vereina valley/GR. Research topics are „Microbial life strategies under harsh environmental conditions“ and „Geochemical nutrient scavenging in nutrient-poor high mountain environments“. High mountain lakes and glacial ice are ideal for the study of adaptations of organisms to a variety of environmental extremes: water temperatures are often near freezing, darkness under snow and ice lasts for many months, UV radiation is strong during the summer months and nutrients are scarce. One wonders how life has adapted to these challenges over time and yet is constantly amazed at the strategies microbes have developed to cope with these extreme conditions.

Thermal mineral springs, Scoul Tarasp Vulpera: At the mouth of the spring the underground waters contain the solutes which were dissolved from the rock minerals. Spring waters are therefore the mirror image of the underground geology and the contact time.

Evening Discussion Preparation for next day's field trip include aspects to (depending on interest):

- Alpine (and polar) microbial ecosystems
- Chemical and microbially mediated subsurface mineral weathering
- Geochemical cycling of nutrients in cryosphere ecosystems
- The role of the iron cycle for nutrient accumulation
- Geochemical nutrient scavenging in oligotrophic high-mountain lakes
- Self-trophication – a phenomenon of specialized low nutrient environments
- Microbial adaptation to extreme environments: psychrophilic lifestyles
- Microbial mats & biofilms in nutrient poor flowing and stagnant mountain waters
- Chemolithotrophic microbiota in mineral springs
- Adaptation to low temperatures, intensive solar radiation and long periods of darkness
- Regulation of community diversity by changing habitat conditions

Program

September 5 (Wednesday)

- 10.30 Meet at Sargans Gonzen mine (take exit Sargans and follow signs to Bergwerk Gonzen)
- 11.00 Gonzen, former iron mine. Short movie about the geology of Gonzen iron mountain and the former mining operations.
Train ride from the Visitors' Center to the central hall of the mine and walk through some of the former mine tunnels. Mass development of aerobic chemolithotrophic ferro-iron oxidizing bacteria. Collecting ferrous iron oxidizing bacteria from iron mats and microscopy at the site.
- 13.30 Return to the Visitor's Center. Summary of field trip topics.
- 14.30 Rothenbrunnen, iron spring, de-ironing of water to make bottled mineral water
- 15.30 Alvaneu (Iron and sulfur spring rich in microbes. Use of sulfidic water for health)
- 16.00 Carbonate-rich Lake Palpuogna Albulapass road
- 16.30 Alp Weissenstein, dolomitic outcrop, endolithic microbial habitats
- 18.30 Arrival at Davos
- 19.00 Dinner and overnight stay at „Time Out“, Davos Platz (Tel. +41-81- 415 36 72)
- 20.00 Presentations and discussions about topics of the next day

September 6 (Thursday)

- 07.00 Breakfast at „Time Out“. (You may leave your luggage in the room)
- 07.30 Depart from Davos
- 08.15 Wägerhus, begin climb to Jöri lakes
- 11.00 Arrival at Research station lake XIII: geochemical Fe-, Mn-, P-cycles
- 12.30 Lakes I: highly turbid lake, biofilms
- 13.30 Lake II: iron rich swamp
- 14.30 Lake XIV: Glacial sedimentation field, fractionation of erosion particles
- 15.30 Glacial lakes XVI – XXII
- 16.30 Cryoconite holes on Jöri glacier, depends on snow cover
- 17.30 Winterlücke, begin descent
- 18.30 Depart Wägerhus
- 19.00 Arrival Davos. Dinner and overnight stay at „Time Out“, Davos Platz (Tel. +41-81- 415 36 72)
- 20.00 Presentations and discussions about topics of the next day

September 7 (Friday)

- 07.00 Breakfast at „Time Out“. (We will take all luggage with us)
- 07.30 Depart from Davos
- 08.30 Thermal and mineral springs at Scuol-Tarasp-Vulpera
- 13.00 Load cars onto train in Sargans to Klosters (€ 17)
- 13.20 Depart Sargans, arrival in Klosters Selfranga 13.40
- 14.00 Begin travel home

Clothing	<p>Sturdy walking shoes are a must since we will traverse rough mountainous terrain and glacial ice. Backpack for provisions and samples. The weather can change abruptly in the mountains. Please be equipped with rain gear and have extra dry cloths with you. At the mine you will be equipped with a hard hat and a lamp. Please wear warm clothes, since it is still rather cool inside the mine.</p> <p>Take collecting vials for bacteria with you and a camera with a flash light if you intend to take pictures of iron mats inside the mine.</p> <p>The excursion can take place regardless of the weather forecast if you are equipped accordingly. But we might decide on the day to change the program in case the weather should demand it.</p>
Fitness	<p>We will walk on well marked mountain paths. The highest point that we will reach is 2800 m asl, the maximum altitude difference will be 600m but the walks will not be strenuous.</p>
Travel	<p>By private cars and mini-buses (large buses are not possible on the narrow mountain roads). Gasoline is available along the route.</p>
Route	<p>Day 1: Tübingen – Ulm – Memmingen – Bregenz – Vaduz – Sargans – Rothenbrunnen – Alvaneu – Albula Pass – Davos. Day 2: Davos - Flüela Pass – Davos. Day 3: Davos - Scoul Tarasp Vulpera - Sargliains – Klosters – Landquart – Tübingen</p>
Costs	<p>€ 90 for the full 3-days (2 nights) field trip per person. Included are entrance fee to the mine and transportation with the mine train, lodging at the base camp in Davos (room and board (half pension, occupancy 4 persons per room, no sleeping bags required). The costs for transportation by private cars are not included. Backpack lunches are the participants responsibility. The housing costs and the fees for the mine visit have to be paid in advance at the time the reservations are made. The expenses will be collected during the trip. € 120 if you prefer a private room at Davos.</p>
Insurance	<p>is the responsibility of the participant. The tour guides cannot be held liable for damages or lost items. Please do not leave the group in the mountains or in the mine since you might get lost or get yourself into danger.</p>
Signing up	<p>There are 25 places available. Please sign up before July 31. For the housing and the mine and at the „Time Out“ in Davos we have to make reservations far in advance. Once you have signed up and you are prevented from participating, please let us know as soon as possible. Fees already paid can only be paid back to you if they are reimbursed by the institutions.</p>
Information	<p>Kurt Hanselmann, Institute for Plant Biology / Microbial Ecology Group, University of Zürich Zollikerstrasse 107, 8008 Zürich. Tel. 044/ 6348284. hanselma@botinst.uzh.ch</p>

We are looking forward to having as many students and guests as possible on this excursion to the beautiful Jöri Lakes and the mineral springs in the Canton of Graubünden. If the weather allows, we will have opportunities to enjoy the beautiful landscapes with great views of the Alps. Don't forget your camera!

Field trip for participants of the Tübinger Geo-Sciences program,
and guests

September, 5 -7, 2007

I would like to participate at the field trip, on

Alpine water resources

Last Name

First Name

Affiliation

E-mail address

Please mark if you would like a private room for the 2 nights at Davos YES NO

Please make sure that your accident insurance policy covers mountain rescue operations by helicopter (REGA in Switzerland, www.rega.ch, tel. ++41 (0)844 834 844 or similar)