

A one-day field trip on **June 21**, 2009, before the Goldschmidt Conference in Davos, Geobiology in the mineral springs of the Lower Engadine Window / GR / Switzerland for alumni of the international Agouron-USC GeoBiology Courses

your guide



EXTREMOPHILE GEO-MICROBIOLOGY

Low temperature geochemistry and microbial ecology in the mineral springs of the „Lower Engadine Window“, GR

Contents

Subsurface geo-hydro-microbiology, Trias evaporites, Bündner shales, mineral dissolution, deep subsurface chemical interactions and biological processes, CO₂ outgassing and „carbonate ice“ precipitation, surface reactivities of sedimentary rock minerals, dynamics of spring habitats, ecological „cold spots“

The Lower Engadine Window (LEW) is a large tectonic opening into penninic sediments that originated in a former oceanic basin. The slightly metamorphic pelagic sediment layers are visible as large Bündner shale outcrops in the area of Scuol-Tarasp-Vulpera-Ftan. South of the Inn river the deformed Bündner shales are overlaid by gneiss and serpentinite and by dolomitic sedimentary rocks, which form a permeable karst aquifer.

The highly mineralized waters that emerge from these aquifers in numerous low temperature springs are oversaturated with regard to calcium carbonate. They contain high concentrations of hydrogen-carbonate and dissolved CO₂ as well as variable concentrations of sulfate, calcium, magnesium and a number of other dissolved anions and cations. Some contain dissolved ferrous iron, others sulfide, both of which can promote microbial growth and mineral precipitation at the mouth of the springs.

During the field trip we will study the geological and geochemical settings and corresponding microbial life strategies in a number of cold mineral water springs.



Clüs: Travertine terracettes

„Geysir“ carbonate precipitates

Fuschna, „carbonate ice“

Objectives

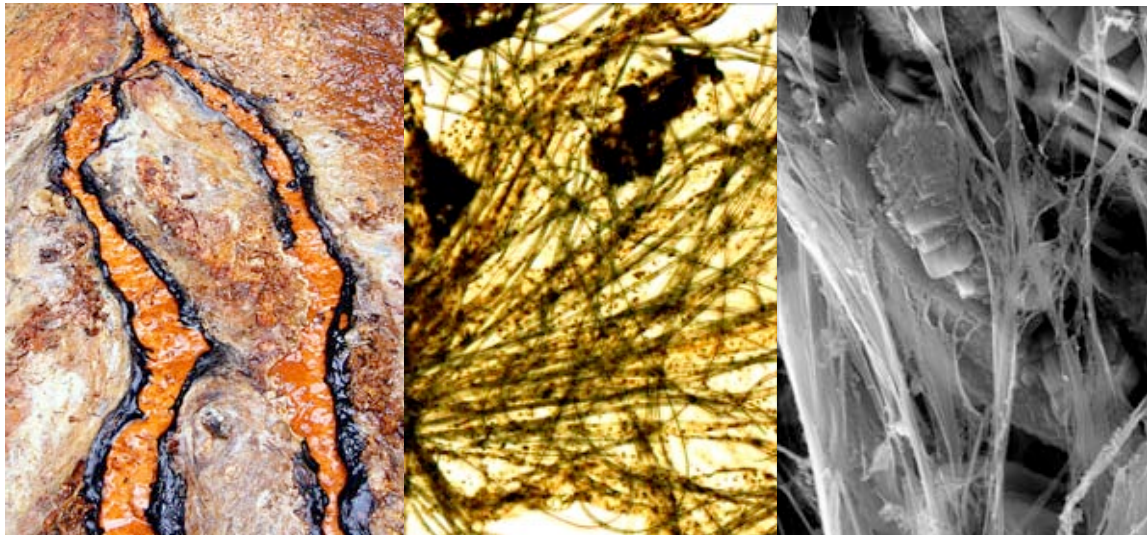
Geo-microbiology: Often the solutes present in spring water not only represent the water soluble mineral components of the rocks, they also carry a signature of microbiological activities which have taken place in the subsurface. The presence of certain reduced chemicals can be due to the activity of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

Bio-geo-chemical cycles: We will study surface phenomena which relate to underground and surface geochemical cycles of iron, sulfur and carbon. Often ferrous iron and sulfide oxidizing as well as oxigenic phototrophic bacteria develop in masses at the transition zones. We will examine the conditions that must prevail to select specifically for the kind of microorganisms present in these aquatic habitats.

Research sites (visits might change depending on weather and time)

Mineral springs, Scoul-Tarasp-Vulpera-Ftan: 1. Tarasp: Sulfidic spring, 2. Bonifiacius: Carbonate spring, 3. Fuschna: Iron spring, 4. Carola, Luzius, Emerita, Sfondraz: Alpine mineral water tourism, Clozza: CO₂ outgassing and travertine formation.

Spring water composition reflects the mirror image of the underground geology and is dependent on the contact time between water and the bedrock. At the mouth of the springs the waters contain the dissolved solutes from the rock minerals. Dangerously large amounts of gaseous CO₂ are formed in enclosed areas underground. When the carbonic acid / bicarbonate saturated aqueous solution reaches the surface the dissolved H₂CO₃ equilibrates with the CO₂ of the atmosphere. This can lead to the formation of carbonate ice and small travertine terracettes.



Fuschna: Cyanobacterial biofilms surrounding iron precipitates and forming dense EPS networks

Discussion topics (depending on interest):

- Geology of the Lower Engadine Window
- How mineral waters are formed
- How mineral water composition can be altered by microbes
- What is the composition of the chemolithotrophic microbiota in mineral springs?
- How subsurface mineral weathering is mediated by chemical and microbial processes
- How “carbonate ice” and travertine are formed at cold water mineral springs

Field trip program

June 20 (Saturday) 5pm – 6 pm

Preparation: Lecture on field trip topics and sites

Location: lecture room of the Swiss Alpine Gymnasium, Guggerbachstrasse, Davos-Platz

June 21 (Sunday)

07.55 Assemble at Davos-Dorf, Railroad Station RhB

08.04 Depart from Davos-Dorf, Railroad Station RhB to Scuol-Tarasp-Vulpera via Klosters. Have a drinking cup with you. We will taste different mineral waters along the way.

09.47 Arrival at Tarasp Fontana

10.15 Sulfur Spring

11.00 Bonifazius: Travertine formation at spring outflow into the Inn river

12.00 Fuschna, cyanobacterial mats, CO₂ outgassing and carbonate ice formation

13.00 Backpack Lunch

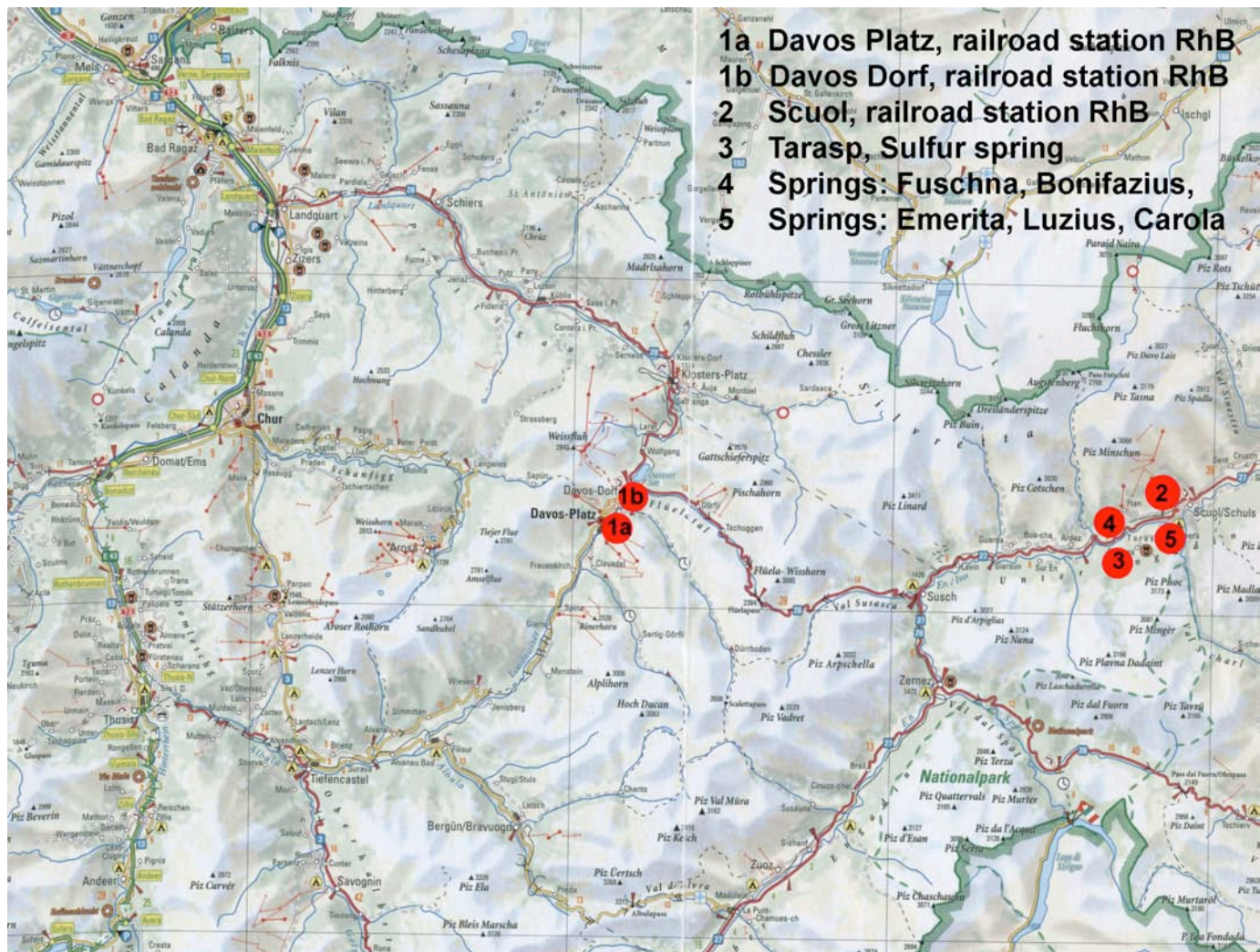
14.00 Carola, Luzius, Emerita, „Geysir“, Sfondraz, high mineralization, CO₂ formation and escape.

15.30 Clozza drinking fountain, formation of travertine terracets at Clüs

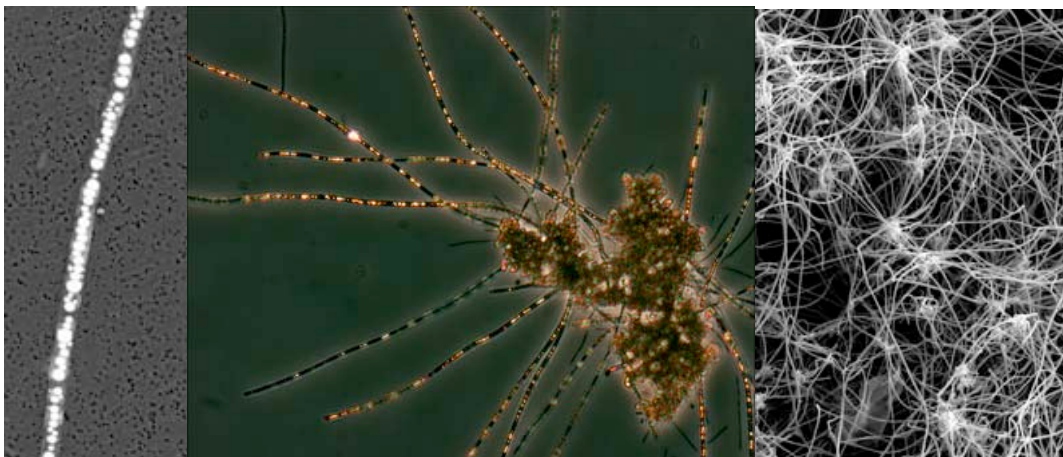
17.42 Depart from Scuol station RhB to Klosters, Davos

18.55 Arrival Davos-Platz, End of field trip

Locations



- Clothing** The excursion will take place regardless of the weather forecast. We might decide on the spot to change the program if the conditions demand it. The weather can change abruptly in the mountains; please be equipped with a hat and rain gear as well as sun glasses and UV protective lotion.
Sturdy, waterproof walking shoes are a must since we will traverse rough mountainous terrain and possibly snow. A small backpack will be necessary for provisions, drinks, lunch and sample collection.
If the weather allows, we will have opportunities to enjoy the beautiful landscapes with great views of the Alps. Don't forget your camera!
- Fitness** We will be in the field for about 8 hours, walking on well marked paths and stopping frequently. The walks will not be strenuous. The highest elevation that we will reach is about 1800 m.
- Travel** We will travel as a group by public transportation (train, bus) from Davos and return to Davos in the evening. This requires that you are aware of the schedule and do not miss connections. As a group we will have to take the reserved railroad cars and buses.
Special train-bus tickets: If you plan to travel further before or after the conference you might consider buying a Swiss travel pass, valid for 3, 4 or more days of travel by public transportation to anywhere within Switzerland. Such a ticket would cover your travel from the airport to Davos and back, the transportation on pre- and post-conference field trip days and any other traveling by train or bus within Switzerland for the chosen number of days within 4 weeks. There are additional discount tickets if you always travel with a second person. Some of the special tickets are only available at Swiss border stations, e.g. at the airport. Please look up details at <http://www.swisstravelsystem.ch/en/content/offer/tickets/swiss-card/>
- Costs** are included in the 8-day package offered to GeoBio alumni. 80 € for all other Goldschmidt conference participants. Backpack lunches are the participants' responsibility and must be purchased in Davos the day before the trip; there are no stores or restaurants along the way.
- Credits** For attending the conference and participating at the two field trips you may request a certificate for 2 ECTS points (equivalent to about 1 US academic credit hour).
- Insurance** is the responsibility of the participant. The tour guides cannot be held liable for damages or lost items. You may not leave the group on the walks since you might get lost or get yourself into danger. Please make sure that your accident insurance is valid outside your country of origin.
- Signing up** There are 25 places reserved for GeoBio alumni. Please sign up before January 30 for the GeoBio alumni package (June 10 for field trip only). Once you have signed up and if you are prevented from participating, please let us know as soon as possible, so we can offer your place to a person on the waiting list.
- Information** Kurt Hanselmann, swiss | i-research & training, kurt.hanselmann@hispeed.ch



Thiothrix sp. filaments with hod fast and intracellular sulfur globules from Alvaneu sulfur fountain