Interreg Alpine Space

EUROPEAN UNION
EUROPEAN REGIONAL
DEVELOPMENT FUND

Geological Survey of Austria

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contact@greta-alpinespace.eu

ARBEITS TAGUNG 2017

Greta Near-surface Geothermal Resources in the Territory of the Alpine space

Potential assessment for the use of near surface geothermal energy in the Alpine region within the GRETA project

Doris Rupprecht, Stefan Hoyer and Magdalena Bottig
Geological Survey of Austria, corresponding autor: doris.rupprecht@geologie.ac.at

The project GRETA aims to foster Near-Surface Geothermal Energy (NSGE) in the territory of the Alpine Space. Main goals are to assess potentials of NSGE, exchange knowledge and best practices on a transnational basis and to integrate NSGE into policy instruments. Besides these overall objectives, every of the participating countries (Austria, France, Germany, Italy, Slovenia, Switzerland) is carrying out detailed analysis in their case study area.

For Austria, this focus region is represented by the two communities Leogang and Saalbach-Hinterglemm where settlements are located in altitudes of about 800 – 1.000 m. In these communities, as well as in large parts of the Alpine space region in Austria, winter sports tourism is an important economic factor. The demand for heating and domestic hot water in this region of about 6.000 inhabitants rises significantly in the winter months due to around 2 million guest nights per year. This is the reason why the focus was set on the potential of NSGE use for touristic infrastructure like alpine huts or hotels. The detailed analysis of aquifers and of current NSGE installations as well as ground temperature studies will represent the base for the potential assessment of the region.

The use of NSGE in Alpine regions in Austria

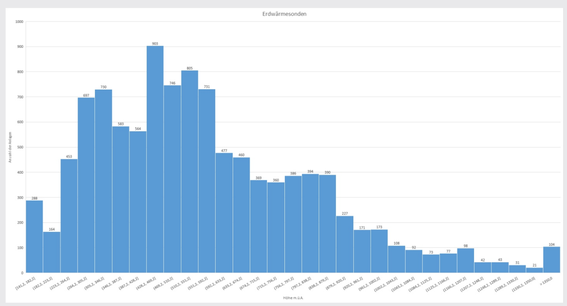


Figure 1: Height distribution of borehole heat exchangers in AUT.

Figure 2: Good practice: Hotel Crystal, Tyrol at 1905m. Use of 100% renewable energies. Solar panels combined with 76 x 120 m borehole heat exchangers.

Introduction

Temperature plays a significant role in high-altitude regions where ground temperatures may stay very low the whole year and the question arises, to which point the NSGE use is still efficient. The objective of detailed investigation is, to which extent the elevation, the gradient and the orientation of the hillside influence the geothermal usability of the shallow underground. Using a software developed by the University of Soil Sciences in Vienna a ground temperature map will be compiled. The calculation is based on climatic data considering parameters like soil composition, solar irradiation and snow cover. For model validation, measurement stations are necessary but were missing in the case study area. That is why, in autumn 2016, monitoring stations were realized in the municipality of Leogang - two stations in the valley at about 800 m, two further up the mountain at 1250 m (south slope) and 1400 m (north slope).

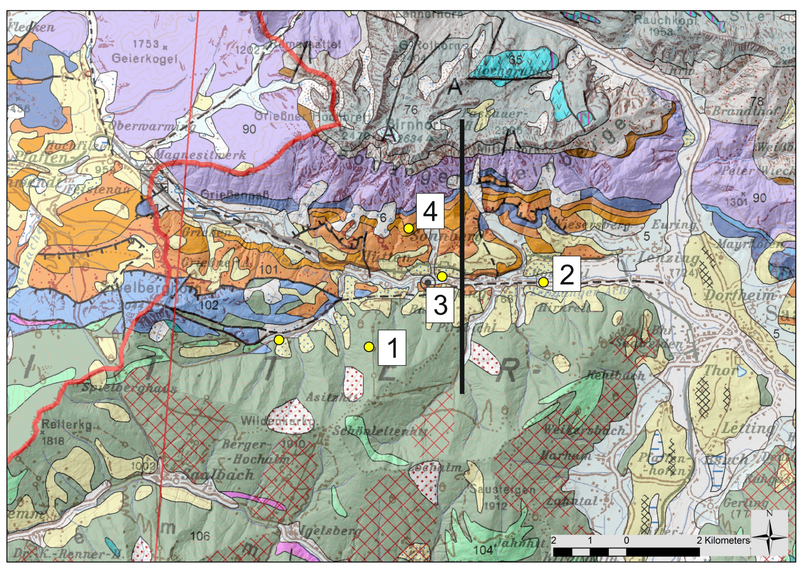


Figure 3: Geological map 1:200.000 of the Leogang valley, Austria.

The E-W striking Leogang valley is located in the province of Salzburg and represents the geological boundary between the Greywacke Zone with its sand-, silt- and claystones in the south and the Northern Calcareous Alps with their sandstones, conglomerates and carbonates to the north (see figure 3 & 4).

The valley is filled with Quaternary sediments and bears multiple aquifers (figure 5) used for thermal- and drinking water supply. They reach thicknesses of up to 20 m and hydraulic conductivity values of up to 2x10e-3 m/s with annual temperature values of about 8 °C. Up to date, only scattered groundwater heatpumps (GWHP) are installed in the valley (see figure 5).

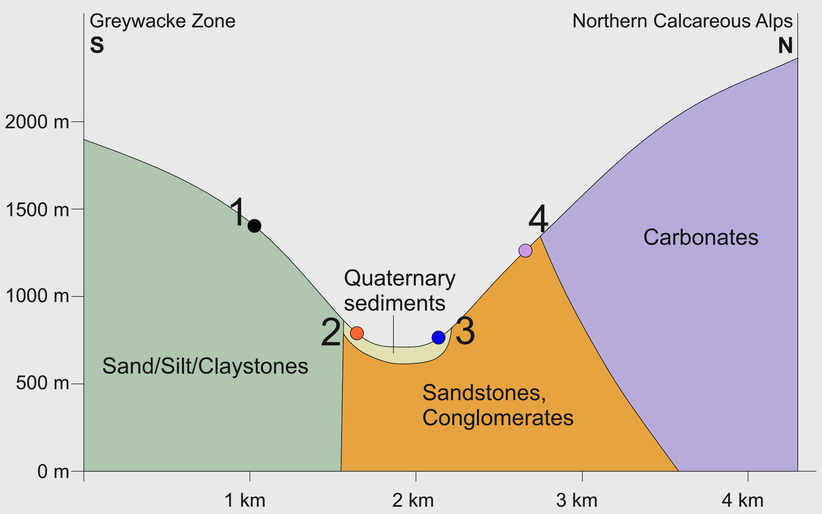


Figure 4: Schematic cross-section of the Leogang valley indicating the locations of the temperature measurement stations accomplished in November 2016.

Aquifer characterization

The characterization of the defined aquifers in the valley of Leogang and the valley of Saalbach-Hinterglemm have shown that large parts of these valleys are suitable for the thermal use via groundwater heatpumps. Ten suitable aquifer bodies characterized by fine- to coarse grained Quaternary gravels were identified.

They show thicknesses between 10 and 20 m with hydraulic heads of maximum 20 m. Their hydraulic conductivity values range between 0,0001 to 0,0025 m/s. Red dots in figure 5 indicate the locations of GWHP installations, from where mean annual aquifer temperatures of about 8 °C are derived.

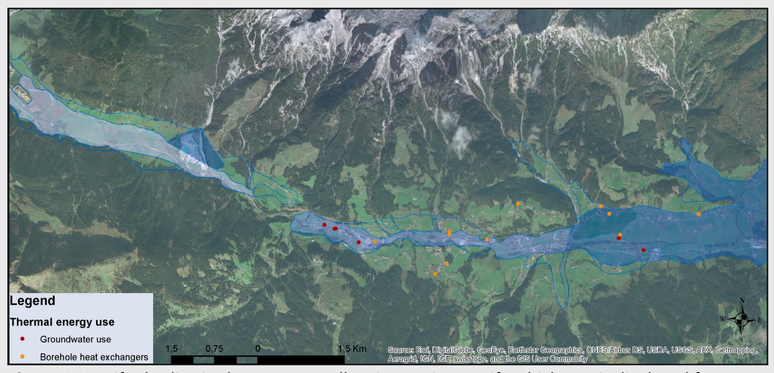


Figure 5: Aquifer bodies in the Leogang valley; increasing aquifer thickness is displayed from light to darker blue; orange dots are BHE´s, red dots GWHP´s.

Drilling , construction and first results of the T- measurement stations

The measurement chains consist of single digital thermometers (Ds18b20) measuring the underground temperature. They are attached to a data cable in depths of 10 cm, 20 cm, 50 cm, 1 m, 1.5 m and 3 m below surface. The data loggers are based on an Arduino Micro controller and were, after programming, connected to the measurement chains. Power is supplied by lead accumulators and a solar panel. Data is collected every two hours and stored on an SD card. The drillings were carried out using an electric hammer. Dependent on underground properties, the drillings reached depths of 1 to 3 m. Samples were taken from the drilling cores in order to perform soil analyses. The remaining material, mixed with bentonite pellets, was used to backfill the drillings .

Figure 6: Left to right: Drilling and construction of the T-measurement station 1 (Bergbahn), drilling and construction of the T-measurement station in Neuhäusl (station 2) Top: Measurement chain

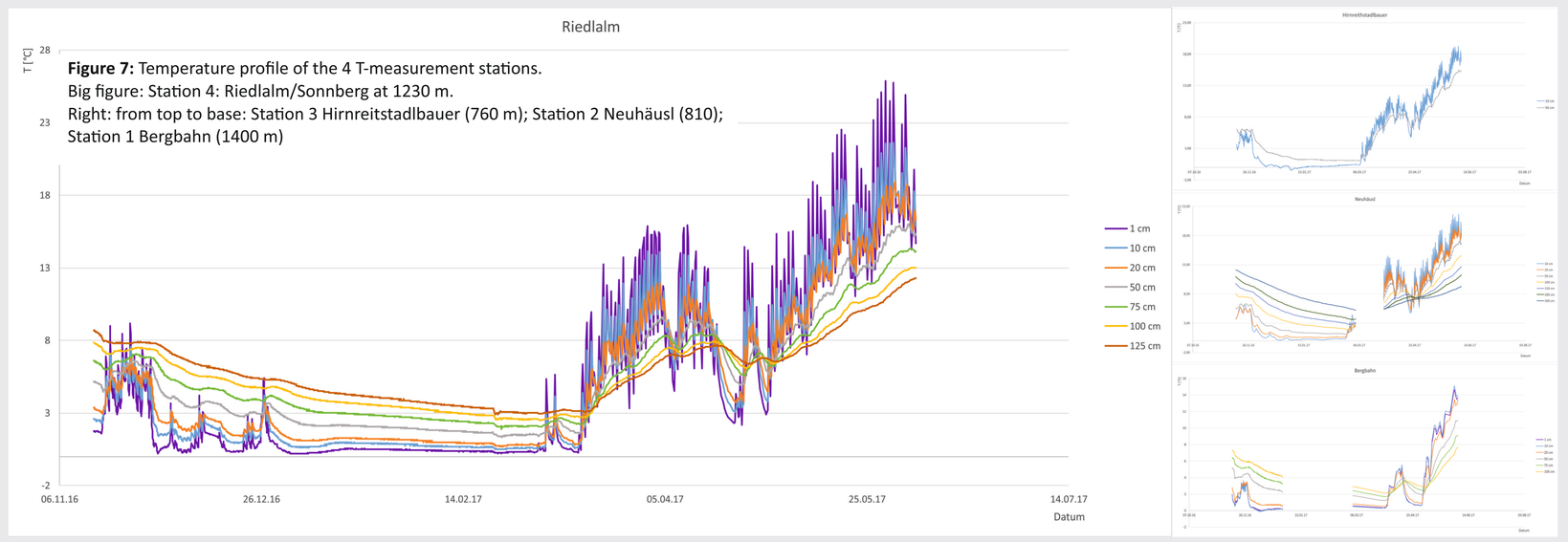
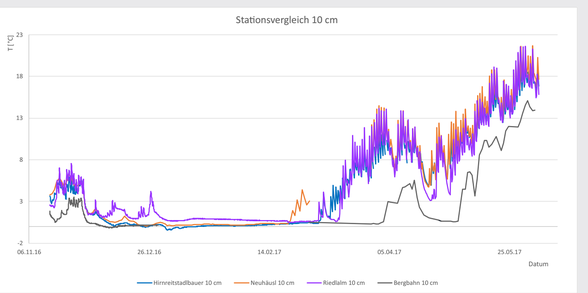


Figure 7: Temperature profile of the 4 T-measurement stations.
Big figure: Station 4: Riedlalm/Sonnberg at 1230 m.
Right: from top to base: Station 3 Hirnreitstadlbauer (760 m); Station 2 Neuhäusl (810); Station 1 Bergbahn (1400 m)

Ground temperature measurements for BHE potential assessment

Almost over the winter measurement period - not the sensors in the valley show the highest temperatures but the sensors located in the mountains at an altitude of 1250 m (station 4, heading south). This can be seen in all measurement depths. Also „soil input" temperatures remain higher in station 4 during winter than in the valley. Due to an early snow cover in November, the soil temperature stays above zero at all locations. The earliest, thickest and longest lasting snow cover is at the north facing station 1. Here, the temperature drop is the least significant (only about 3 °C, March). Large temperature differences (7 - 12 °C) were measured in March between the snow covered and snow free stations.



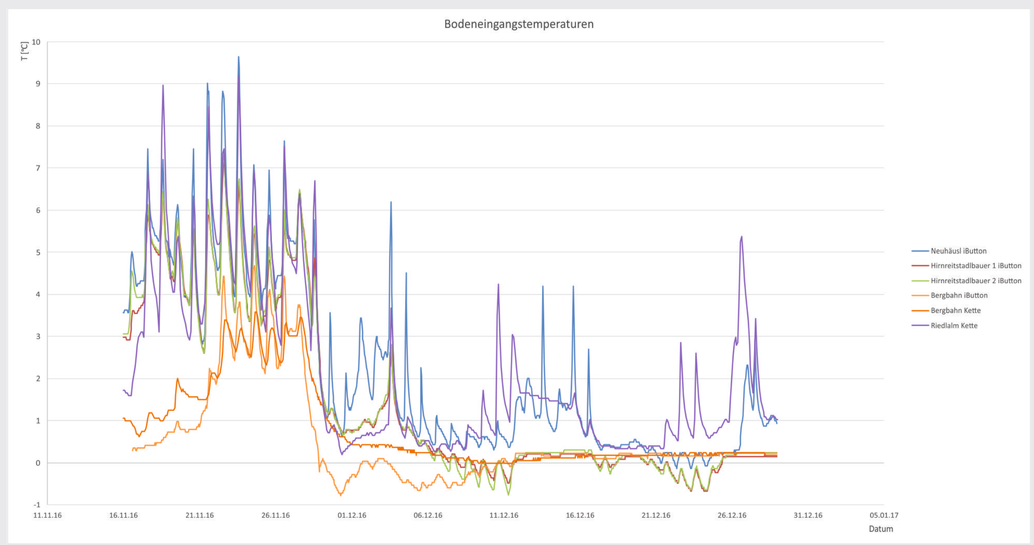


Figure 8: Top: Soil temperatures in 1 cm depth; Right: Comparision of the different stations at depth of 10 cm, 50 cm and 100 cm.

This project is co-financed by the European Union through the Interreg Alpine Space programme

Project duration
16/12/2015 - 15/12/2018

Funding
Total eligible costs: 2.962.952,30 € ERDF grant: 2.308.232,96 €

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