Hydroisotop

Energy technological use of deep geothermal groundwater reservoirs

WATER

GEOTHERMAL ENERGY

TRACERTESTS

POLLUTANTS

FILTER TECHNIQUES

FOOD

RENEWABLE RESOURCES

ISOTOPES

GASES

SOLIDS

ANALYSIS

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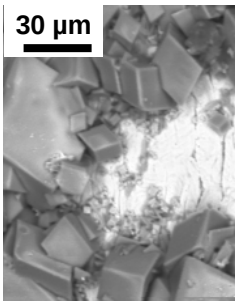
accreditated accoriding to DIN EN ISO/IEC 17025:2005

Isotopy & Chemistry in Environmental Hydrology & Food



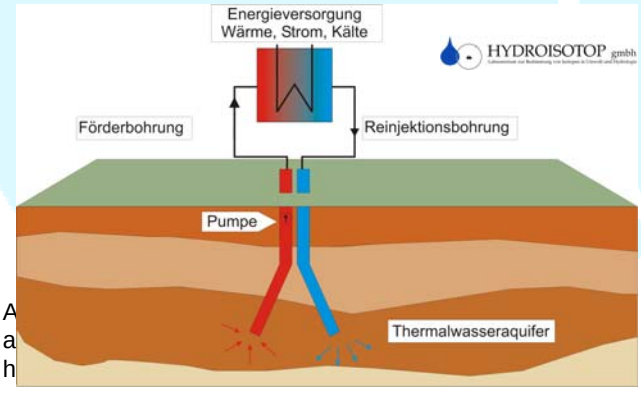
DEEP GEOTHERMAL ENERGY

Use of a natural ressource

99 % of our planet is hotter than 1.000 °C and only 0,1 % is colder than 100 °C. Temperatures in the inner core of the earth are estimated to be 5000 – 7000 °C. This heat source radiates permanently to the exterior leading to a heat flow that reaches the relatively thin crust of the earth. In central Europe this heat flow results in a temperature gradient of 3 °C per 100 m in near surface layers. By use of special technologies this geothermal energy can be utilized effectively for the production of energy and heat. Not only high enthalpy zones (> 200 °C) such as in Island and in Tuscan Larderello can be used, but also low enthalpy zones and geothermal reservoirs close to the surface. In Germany the usage of geothermal energy from hydrothermal deposits is mainly possible in the Southern German molasse basin, the Northern German Basin and the Upper Rhine Valley. The big advantage of this renewable energy production is a continual, climate friendly supply that is providing base load power and is independent from environmental conditions and raw materials.

Functionality of hydrogeothermal energy

Thermal water is usually obtained from aquifers in a depth of 1.000 m to 5.000 by use of a pump that is inserted into a production well. After passing a heat exchanger the now cooled water is grouted back into the layer of which it was extracted. This procedure secures that the utilized water gets reheated in the underground.



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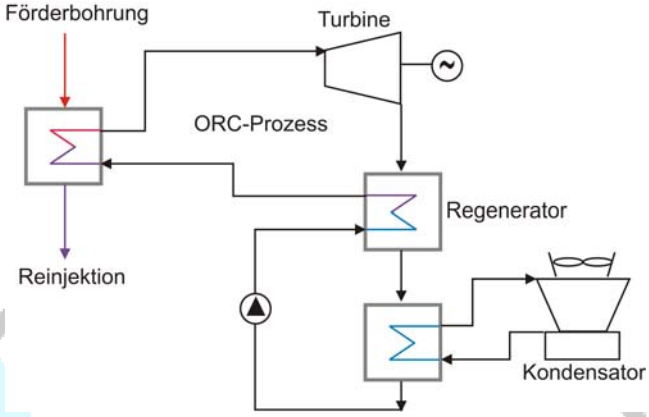
Main purpose of projects using deep geothermal energy is the heat supply of small towns and urban districts. By the utilization of all known resources of hydrogeothermal energy in Germany around a third of the total heat demand could be covered. With the appropriate production rate (> 50 L/s) and water temperature (> 100 °C) hydrogeothermal energy also bears the potential for energy generation. Media with low boiling point are heated up in a separate cycle by use of heat exchangers and are then used for steam production. Organic media are used for energy generation in facilities with Organic-Rankine-Cycle (ORC). Alternatively a mixture of two substances ammonia and water are used.



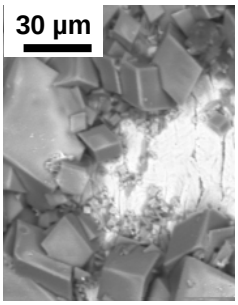
A HYDROISOTOP gmbh ORC

Next to hydrothermal systems with yielding and water-bearing reservoirs petrothermal systems (Enhanced Geothermal System) are of minor importance. Furthermore borehole heat exchangers with a closed, circulating watercycle are installed.

Multiple use

Successfully developed geothermal deep waters don't only supply energy and heat, but they also have many more uses. The following possible uses contribute to a decrease of CO_2 emissions and to a increase of the economic efficiency of your project:

- Heating and cooling with long-distance heating
- Drying, e.g. wood chips or agriculture
- Greenhouses
- Balneology and wellness
- Aquacultures
- Generation of mineral waters and medicinal waters
- Waters with natural carbon dioxide



WATER PARAMETERS

Hydrochemistry, gases, isotopy

Apart from knowing physical parameters (pressure, temperature, production rate) the foundation of a successful long-term operation of a geothermal power plant is the exact characterization of the reservoir and its thermal water. These informations about groundwater chemistry are essential for geothermal development. Therefore we offer analytical methods as well as counselling for a better understanding of the thermal water system and for the characterization of the reservoir.

Depending on the rock of the reservoir the hydrochemical composition of the water changes. The analysis of cation and anion composition provides important information about the geothermal system. The analysis of dissolved gases, e.g. carbon dioxide, hydrogen sulphide, nitrogen or methane reveals a characteristic signature for geothermal facilities and indicates corrosion potential and possible precipitation. Isotope hydrological methods on the basis of oxygen-18 and deuterium allow further characterizations of the conditions under which waters were formed. In addition age determination or water-rock-gas-interaction can be derived using isotopic analysis.
Because of the variable contents of minerals and gases in hot water the decrease in temperature and pressure during the energetic use of thermal waters can lead to serious precipitations and corrosion. Furthermore the lime-carbonic acid-equilibrium is to be mentioned, which is observed especially during the delivery of thermal waters from lime aquifers. The high content of dissolved CO_2 can, in case of changes in pressure, temperature and pH-value, lead to extreme precipitation of calcium carbonate according to following reaction equation:

$$2\ HCO_3^- + Ca^{2+} \rightleftharpoons CaCO_3 + H_2O + CO_2$$

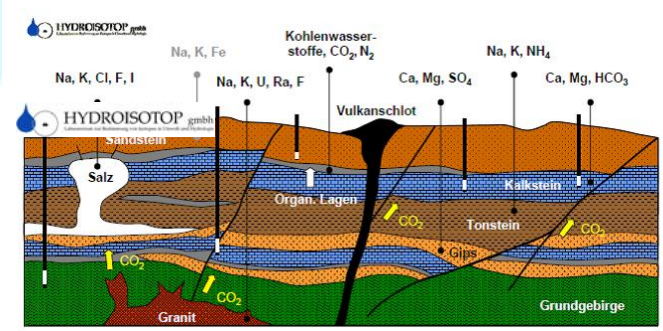
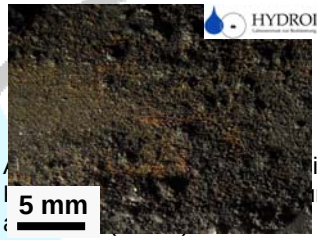


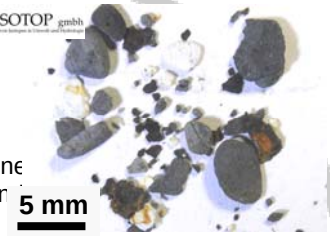
Abbildung: Profilskizze verschiedener Tiefengrundwässer in unterschiedlichen Gesteinsschichten

SOLIDS

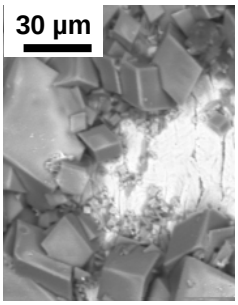
Filter residues, precipitations, corrosion

The petrological, mineralogical and geochemical characterization of rocks forming the reservoir, filter residues, precipitations and corrosion products contains information about potential uses as well as possible operating problems and material stresses during the utilization of geothermal waters. Solids are analyzed and characterized using microanalytical methods. Next to shape and colour especially the size of particals is of importance. Carried along rock fragments of the reservoir may lead, apart from precipations from the thermal waters, to operational disruption. Even minor changes in pressure and temperature conditions in pipes and heat exchangers can induce unexpected precipitations, for example of carbonates, which can result in up to cm-thick coverings. This can be prevented through procedurally changes or removed through acidification of the facility.





Dissolved anions of chlorine and sulphur in water have a relevant contribution to the wearing off of materials through corrosion. The formed chlorides and sulphides create a coating on materials, whereas different kinds of corrosion like pitting, formation of hollows or plane errosion may evolve. The best protection for structural elements is a material selection which is aligned to the chemistry of the thermal waters. How badly materials are affected by the thermal waters and the intensity of mass loss per time unit through corrosion can be determined through experiments using corrosion coupons, so that destructive research methods don‘t have to be tested on components of the facility.



Service range

Comprehension of thermal waters

Through the experience from working in numerous geothermal projects and in water analysis Hydroisotop GmbH offers a wide range of services leading to a better comprehension of the thermal water system, the facility and the reservoir. The interpretation of physical-chemical, gas-physical and isotope-hydrological analyses of thermal waters and associated gases provides information about:

- Hydrochemical composition
- Stable isotopes, isotope-hydrologiical characterizations
- Dadioactivity and age composition
- Determination of origin and formation conditions
- Gas compostion and content of inert gases
- Water-rock-gas-interaction
- Cross-Formation-Flow
- Flow regime
- Reservoir size and usability
- Possible system changes
- Reciprocal influences
- Corrosion potential
- Precipitations, formation of coverings, scalings
- Biofilms, biological activity
- damage prevention

Monitoring

Supervision in the field of geothermal energy for many years makes Hydroisotop GmbH a valuable partner in planning, execution, evaluation and interpretation of pumping tests and samplings of thermal waters. Furthermore we offer the following services:

- Supervision and prevention of precipitation
- Corrosion-chemical monitoring
- Analysis of corrosion products
- Material design based on waterchemistry
- Validation of cleaning processes and cleaning solutions
- Longterm- and technical operation surveillance

Consulting

Apart from analysis and monitoring Hydroisotop GmbH offers competent consulting from planning phase to facility operation. Our consultancy services for deep geothermal energy are:

- Development of feasibility studies
- Modelling of thermodynamic euqilibriums based on geochemical data
- Evaluation of geology and hydrology
- Planning, coordination and analysis of surface geophysics
- Preparation and execution of tendering and procurement procedures
- Creation and submitting of licence applications according to WHG, BayWG, BBergG, etc.
- Concepts for geothermal multiple use and alternative use of unproductive boreholes
- Analysis of reservoirs for the operations risk assessment
- Material design according to waterchemistry
- Quality assurance and risk evaluation
- Technical solutions and damage prevention
- Conceptions for remediation measurements and operation improvement
- Avoidance of corrosion and precipitation through he use of inhibitors
- Preperation and filtration
- Planning, supervision and execution of research projects

Outlook

Indepth examination and research of deep geothermal energy is necessary to ensure a longterm and efficient utilization. Hydroisotop GmbH is part of research projects on European level which deal among other things with corrosion, precipitation as well as longterm preservation and accessibility of reservoirs.


Rogner Bad Blumau (Architekt: Friedensreich Hundertwasser)