

GEO ENeRGY

Transenergy: transboundary geothermal energy resources of Slovenia, Austria, Hungary and Slovakia

The project „TRANSENERGY – Transboundary Geothermal Energy Resources of Slovenia, Austria, Hungary and Slovakia” is implemented through the Central European Program and co-financed by ERDF. Its aim is to provide a user friendly, web-based decision supporting tool which transfers expert know-how of sustainable utilization of geothermal resources in the western part of the Pannonian basin.

TRANSENERGY addresses the key problem of using geothermal energy resources shared by different countries. The main carrying medium of geothermal energy is thermal groundwater. Regional flow paths are strongly linked to geological structures that do not stop at state borders. Therefore only a transboundary approach and the establishment of a joint, multinational management system may handle the assessment of geothermal potentials and give guidelines for a balanced fluid/heat production to avoid possible negative impacts (depletion, or overexploitation) in the neighboring countries.

Targeted stakeholders are primarily authorities, present and future users and investors, who will get a regional evaluation of geothermal resources in the project area. Assessment will be done by various geological, hydrogeological and geothermal models at a regional scale and on five selected cross-border pilot areas with different geothermal settings, where existing utilization problems have been identified.

MAIN OUTPUTS:

- multilingual interactive geothermal web-portal containing databases linked to thematic maps, cross sections and models
- geological, hydrogeological and geothermal models for the regional and pilot areas
- scenario models showing estimates on the potential and vulnerability of the cross-border geothermal systems for different extractions of thermal water/heat
- database of current geothermal energy users and production parameters, visualized on transboundary utilization maps
- database of authorities dealing with management and licensing of transboundary geothermal reservoirs
- summary of actual legal and funding framework at the participating countries
- strategy paper evaluating existing exploitation, future possibilities and recommendations for a sustainable and efficient geothermal energy production at the project area

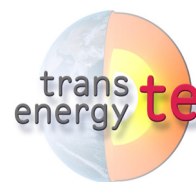
The results of the TRANSENERGY project achieved so far are associated with the overview of utilization of thermal groundwater in the project area, including a database of authorities dealing with



geothermal energy utilization, a database of current users and utilization parameters from 172 users which are visualized on 12 utilization maps and a summary report discussing the various utilization aspects, waste water treatment, monitoring practices, exploited geothermal aquifers and their further potentials. A great variety of geological, hydrogeological and geothermal data to be used for modeling have been collected and uploaded into a harmonized, multilingual database, containing data from more than 2500 boreholes from the 4 countries. Additional investigations (hydrogeochemical analyses, temperature logging, petrophysical measurements) were carried out from areas with poor data coverage and these will also be incorporated into the final expert database, a part of

which will be available to the public in 2012. Geological, hydrogeological and geothermal modelling is ongoing on a supra-regional scale covering the entire project area. The geological model shows the spatial distribution of the most important hydrostratigraphic units, while maps of temperature distribution at various depths characterize the thermal field. This serves a basis for more detailed modelling to be carried out on selected cross-border pilot areas in 2012 and 2013.

Results can be downloaded from the project website (<http://transenergy.eu.geologie.ac.at/>), which provides further information and PR material about ongoing activities.



Annamária Nádor
(project leader)
Hungarian Geological
and Geophysical
Institute

nador.annamaria@
mfgi.hu



Fig.1 Transenergy project area. Within the investigated region (red line) the project focuses on some representative pilot-areas along the borders (thermal karst of Komarno-Stuovo area (HU-SK), Pannonian Central Depression of the Danube basin (A-SK-HU), Lutzmannsburg – Zsira area (A-HU), Vienna basin (SK-A) and Bad Radkersburg – Hodoš area (A-SLO-HU))

Ex-situ and in-situ mineral carbonation: alternative technology to mitigate climate change

Fixation of CO₂ in the form of inorganic carbonates, also known as "mineral carbonation" was proposed in the USA by Seifritz in 1990 and developed by Lackner in 1995-2003. The thought behind it is to accelerate the natural weathering processes up to an industrially acceptable level. Initially, only natural Ca- and Mg-rich minerals (serpentine, olivine, wollastonite, talc) were considered as CO₂ binders, while several alkali wastes, like steel slag and ashes from power plants were considered later. The main parameters of dry and aqueous CO₂-binding by natural minerals and process routes were worked out in 1995-2005. At the present time United States Geological Survey (USGS) is working in two areas of mineral carbonation: CO₂ mineral carbonation using ultramafic rocks (peridotite, dunite, serpentinite and picrite) and accelerated weathering of limestone (AWL) (http://crustal.usgs.gov/projects/CO2_sequestration/carbonation.html).

Carbonation of alkaline minerals mimics the natural weathering of rock and involves the permanent storage of CO₂ as the thermodynamically stable form of calcium and magnesium carbonates. Unlike other CO₂ sequestration routes, it provides a leakage-free long-term sequestration option, without a need for post-storage monitoring once CO₂ has been fixed. Mineral carbonation of CO₂ is an exothermic reaction, theoretically allowing a decreased energy penalty for CO₂ capture.

In-situ CO₂ storage involves reacting CO₂ with alkaline minerals to form carbonates. This is possible in mafic (deep flood basalt formations and basaltic lava flows) and ultramafic rocks rich in mineral olivine (peridotites). The concept of CO₂ storage in basalts was proposed by McGrail in 2003 and then developed using laboratory and numerical simulations, resulting in two ongoing pilot projects in USA and Iceland. The porosity of ultramafic rocks is usually much lower compared to sedimentary reservoirs, therefore artificial permeability enhancement through hydraulic fracturing is likely required to support injection of significant amounts of CO₂. However, brecciated interflow zones in basalts can have good porosity (5-15%) and permeability sufficient for commercial-scale CO₂ injection. Flood basalts also happen to be located in many onshore and ocean regions where conventional saline aquifer storage options are limited (e.g. India).

The Wallula Basalt Sequestration Pilot Project (Big Sky Partnership; DOE, USA) plans to inject up to 1000 tons of CO₂ into the Columbia River flood basalts at a depth of approximately 900 m (Fig. 2). The injection well at the site has an exposed injection zone containing non-potable brackish water, sealed and covered by extremely low permeability cap rocks. The Wallula storage site was studied by seismic surveys in 2007 and the borehole was drilled in 2009 to a total depth 1253 m. Washington State approved the world's first supercritical CO₂ injection permit for a flood basalt test in March 2011. Injection planning is presently in-progress (<http://www.bigskyco2.org/research/geology/basaltproject>). Conservative estimates

for CO₂ storage in the Miocene Columbia River Basalt Group is 10-50 Gt CO₂, while total capacity of US Basalt Formations is 240 Gt, compared to 2600 Gt in USA Saline aquifers as reported by Dahowski et al. in 2005.

A field scale injection of CO₂ into basalts in Hellisheidi, Iceland, was started in late January 2012 in the frame of the international CarbFix project, a combined industrial and academic research program. 175 tonnes of pure CO₂ were injected at the CarbFix injection site in Hellisheidi, SW-Iceland, over a period of approximately 5 weeks, from late January to early March. A mixture of water and steam is harnessed from 2000 m deep wells at Hellisheidi geothermal power plant. CO₂ from the plant is dissolved in water at elevated pressure and then injected through wells down to 400-800 m, just outside the boundary of the geothermal system. The liquid should react with calcium from the basalt and form calcite. This process

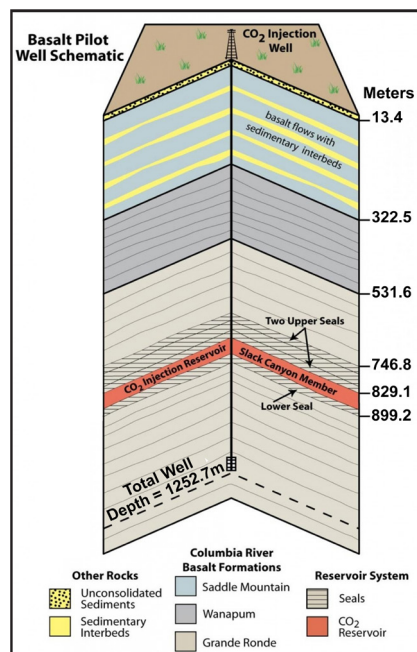


Fig. 2 Stratigraphy surrounding the CO₂ injection borehole at the Wallula Basalt Pilot site. Source: Battelle Pacific Northwest Division, Richland, Washington, USA

occurs naturally and the mineral calcite is stable for thousands of years in geothermal systems. Assuming an average of 10% porosity of basalts at Hellisheidi pilot storage site, the storage capacity is estimated as 12 Mt CO₂, which is sufficient for 200 years production for the nearest geothermal Power Plant which emits 60000 t CO₂ per year (<http://www.or.is/English/Projects/CarbFix/AbouttheProject>). In situ mineral carbonation projects will need monitoring programs to avoid possible leakage through fractures, faults or abandoned boreholes and metal leaching from the rocks.

The first ex-situ mineral carbonation pilot project combining CO₂ with serpentinite was announced in 2010 in Newcastle, Australia. The two-phase process will react serpentinite and CO₂ to make magnesium carbonate,

which could be used for products such as building materials, bricks, pavers, cement and agricultural additives. There is enough serpentinite in New South Wales to capture carbon dioxide in this way for thousands of years if the technology proves to be feasible on a large scale. The pilot demonstration plant is planned to be built at an experimental site in Newcastle and to provide bulk sample carbonate material to interested product developers by 2012. If the Newcastle trial proves successful a demonstration scale plant is scheduled to become operational by 2016 and an industrial full-scale plant could be available at about 2020 (<http://www.sustainabilitymatters.net.au/articles/41409-Mineral-carbonation-project-for-NSW>).

Ex-situ mineral carbonation using waste materials is also currently studied. This technique can use coal and oil-shale ash and waste water, stainless steel slag from the steel industry, as well as waste products from the cement industry, municipal solid-waste incineration ashes, paper-produced industry ash and medical solid-waste incinerator ash. These options are usually available near the CO₂ emission source, and allow the stabilization and neutralization of hazardous/toxic waste material, with the economic benefit of by-products with high commercial value. The main disadvantages of ex-situ mineral carbonation technology is that the amount of CO₂ which can react with the waste material is not very large. Maximum of 5% of the produced CO₂ amount for coal ash up to 10-12% for Estonian oil shale ash based on fresh ash and waste water (up to 90% of CO₂ is possible to avoid using near deposited old alkaline ash as sorbent). For ex-situ mineral carbonation by geological minerals, large mining works are required, because to fix a tonne of CO₂ requires 1.6-3.7 tonnes of rock. The scale could be the same as the existing mining works in the world and the price for one tonne of CO₂ abandoned could be higher than for Carbon Capture and Storage (CCS). At present, the European Commission has not published any call for projects targeted on mineral carbonation and did not include it in CCS or any other directive. A regulatory framework for wide implementation of mineral carbonation technology is absent worldwide, while mining laws and available regulations for underground CO₂ injection and storage can be applied for in-situ projects. Mineral carbonation technology is considered to be now in research and developing, as well as early pilot phase.



TALLINN UNIVERSITY OF TECHNOLOGY

Alla Shogenova, Rein Kuusik
(Tallinn University of Technology) &

B. Peter McGrail
(Pacific Northwest National Laboratory,
Richland, Washington, USA)
Pete.McGrail@pnl.gov

