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GEO ENeRGY

REPP-CO2 – Czech-Norwegian research project to prepare a CO_2 storage pilot in the Czech Republic

REPP-CO2 is a Czech-Norwegian research project focusing primarily on the development of the CO_2 geological storage technology in the Czech Republic through its validation by means of a pilot project in geological settings similar to possible future commercial storage sites.

The project builds on a long-term partnership between the Czech Geological Survey and the International Research Institute of Stavanger. These institutes form the core of the project consortium. This comprises five more Czech institutions, mostly research-oriented, with complementary competences. In total, more than 100 researchers and technicians from 7 institutions are participating in the REPP-CO2 project.

The main project objectives include:

• Assessing the selected geological structure (a depleted and recently abandoned oilfield) as a possible geological storage site for a research CO_2 storage pilot project, utilising the methodology according to the Czech national law No 85/2012 Coll. (equivalent to the EU CCS Directive) on the storage of carbon dioxide in natural geological structures;

• Strengthening the Czech-Norwegian cooperation in the area of CO_2 geological storage and related research and development that was initiated from our previous TOGEOS research collaborative effort. TOGEOS project investigated the feasibility of storing CO_2 in deep saline aquifers in the Czech Republic;

• Testing the methodology, procedures and criteria for the description and assessment of a planned CO_2 storage complex as specified by the law No 85/2012 Coll. on the storage of carbon dioxide in natural geological structures under real (field) conditions of a concrete storage site preparation;

• Integrating existing geological, geophysical, well and reservoir knowledge into developing an upgraded geological (static) model of the storage site;

• Conducting laboratory measurements and modelling to investigate rock/fluids interactions in terms of geochemical evaluations and geomechanical behaviour of both the storage formation and overlaying cap rock;

• Utilizing the new static model to develop a dynamic full-field simulation model that integrates geomechanical and geochemical knowledge (data) that will be used to history match the past field performance using available production data and subsequently apply it to conduct numerical simulation studies of CO_2 injection into the given formation;

• Performing a risk analysis of the storage site, including assessment of conflicts of interest, proposal of risk mitigation measures and compilation of storage site monitoring plan;

• Developing a monitoring program to monitor the post-CO_2 injection storage site behaviour to predict any potential unwanted CO_2 leakage out of the geological storage formation;

• Modelling any unwanted potential CO_2 leakage to overburden strata either through an existing abandoned wellbore or through the cap rock, and assessing any risks of leaked CO_2 contaminating potable water resources or reaching the atmosphere;

• Re-assessing the potential of the Czech Republic Carpathian rock formations from the point of view of CO_2 geological storage.

The core part of the project focuses on the first preparatory phase of the research pilot project on CO_2 geological storage. This consists of obtaining the necessary data (geological, geophysical, well log), constructing a three-dimensional geological model of the storage complex, subsequently conducting dynamic modelling of the storage complex behaviour during the site's operational (CO_2 injection) phase and post-injection one, executing a risk analysis, and compiling a monitoring plan. In future stages of the pilot project development, these outcomes will be used after any necessary replenishment as a basis for a future Storage Site Permit Application.

Further project activities focus on methodological research in important aspects of CO_2 geological storage, professional capacity building at Czech project partner institutions, and knowledge dissemination activities.

The LBr-1 site, chosen for the prepared storage pilot, is a depleted hydrocarbon field situated in the Vienna Basin, in the south-eastern part of the Czech Republic. The research geological target for CO_2 storage is the Miocene (Badenian and Sarmatian) oil- and gas-bearing sandstone sediments that were exploited for oil and gas production in the 1960s – 1970s, as well as the adjacent saline aquifer. The reservoir is laterally bound by impermeable faults, while on the top it is sealed by a well-defined, thick and impermeable clayey caprock.

The REPP-CO2 project is supported by a grant from Norway.

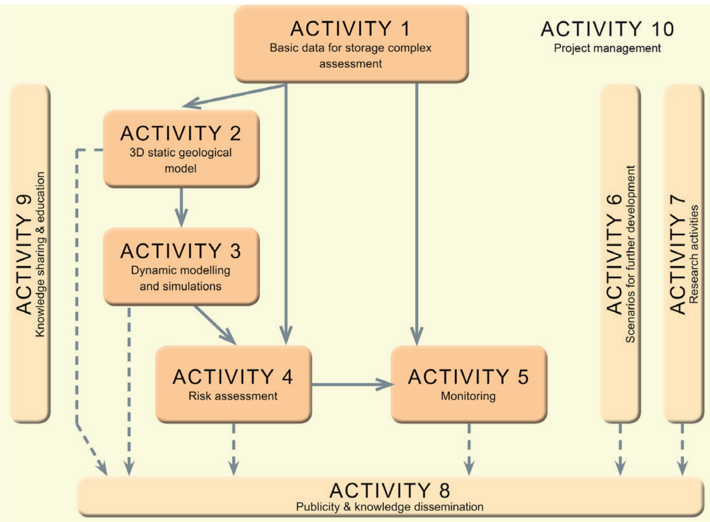

Fig.1 Schematic diagram illustrating the REPP-CO2 project activities

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The Newsletter content

Natural gas hydrate: a potential future energy resource

Increased natural gas prices and advancement of technology have triggered production of natural gas from unconventional natural gas reservoirs such as natural gas hydrate (NGH), shale gas, tight gas, and coal-bed methane reserves. Although it is known that there is a huge potential of natural gas resources in NGH reservoirs, currently there is no available commercial gas production. NGH reservoirs are considered as a potential future energy resource because it is widely available in permafrost zones and deep sea sediments. One m^3 of NGH can release about 160 to 180 m^3 of natural gas at standard conditions. Resource estimations were carried out by considering (1) how much methane originates in the natural environment; (2) how thick the Gas Hydrate Stability Zone (GHSZ) is and how does methane reach this zone; (3) how the natural sediments in the GHSZ are saturated with methane. According to the studies between 1973 and 1984, around 106 trillion cubic meters (TCM) of NGH resource was estimated. However, in these studies, it was assumed that all potential hydrate zones were fully saturated with CH4 and hydrate formation limiting factors were not considered. According to recent studies that consider the limiting factors for hydrate formation obtained during the field trials, NGH resource amount is estimated around 3000 TCM. The magnitude of this resource makes hydrate reservoirs a substantial future energy resource.

Although NGH reservoirs are considered as a potential energy for future, currently there is no commercial gas production. The conventional gas and oil production techniques cannot be directly applied to NGH reservoirs because NGH is in solid form at reservoir conditions. Before discussing production methods in NGH reservoirs, it is important to understand the reservoir types of NGH. Depending on the reservoir type of NGH, different production scenarios can be developed. NGH reservoirs are mainly divided into three classes. Class 1 hydrate consists of stable hydrate layer and an underlying free gas zone. Class 2 is composed of stable hydrate layer and an underlying free water zone. Class 3 hydrate only consists of stable hydrate layer bounded by impermeable shale zones. Although there is another Class 4 hydrates, they are only distributed in oceanic floor with low hydrate saturation and there is no geologic strata around Class 4 hydrates. Hence, they are not considered as target NGH reservoirs.

Depressurisation, thermal stimulation, chemical inhibition injection and their combinations are commonly proposed gas production methods from NGH reservoirs. Depressurisation is thought to be the most economically viable because there is no extra heat introduced into the system. However, the depressurisation method, has several disadvantages, such as low gas production rates, high amounts of water production, the risk of hydrate reformation due to fast depressurisation, and possible reservoir subsidence. Secondly, thermal stimulation involves injecting a heat source into the hydrate stability zone to raise its temperature and decompose NGH. Although thermal stimulation is an effective way to decompose hydrate very fast, it may not be efficient because of heat loss to formations which do not contain hydrate and also it is very expensive. As a third NGH production method, chemical inhibitors such as salts, alcohols and glycols could be used to shift the pressure-temperature equilibrium conditions leading to dissociation of the gas hydrate. This method is also likely to be expensive due to the cost of the chemicals. Recently CO_2 injection into NGH reservoirs is becoming an area of great interest in terms of gas production from NGH and CO_2 sequestration. However, the low replacement rate and low CH4 recovery illustrate that the studies are still in their infancy, and too much work need to be done in the future.

Although there are many proposed gas production methods from NGH reservoirs, there is no long-term production data or field experience. The longest gas production from NGH was in Messoyakha hydrate gas field (permafrost) in Western Siberia, Russia. For decades, experimental studies have been conducted to analyse the production mechanism for NGH. In the light of those studies, field pilot projects for gas production from NGH reservoirs were held in Mallik field (Canada), Alaska North Slope (U.S.A.), Nankai field (Japan), etc. In the Mallik field in 2002, depressurisation, hot water injection and their combinations were tested at field scale. In 2012, the Ignik Sikumi gas field trial, CO_2 (23%) + N_2 (77%) gas mixture were injected into the NGH reservoir and the replacement mechanism was observed in the field. With CH_4 production, 70% of the injected N_2 was recovered, while only 40% of the CO_2 was produced. Although CH_4 was produced and the replacement mechanism was observed in Ignik Sikum field, this was only short field test. A long production period is needed to decide on the efficiency of this production method. In 2013, the first offshore production test globally was performed at the Nankai Trough (Japan) – a six day depressurisation test. Moreover, it is planned to produce gas from the NGH reservoir in this field by the depressurization method for at least two years. This long–term production will give an idea about the gas production flow rate, the amount of water production, the effect of depressurisation on formation stability, and the temperature change in the formation.

Çağlar SINAYUÇ
and
Şükrü MEREY

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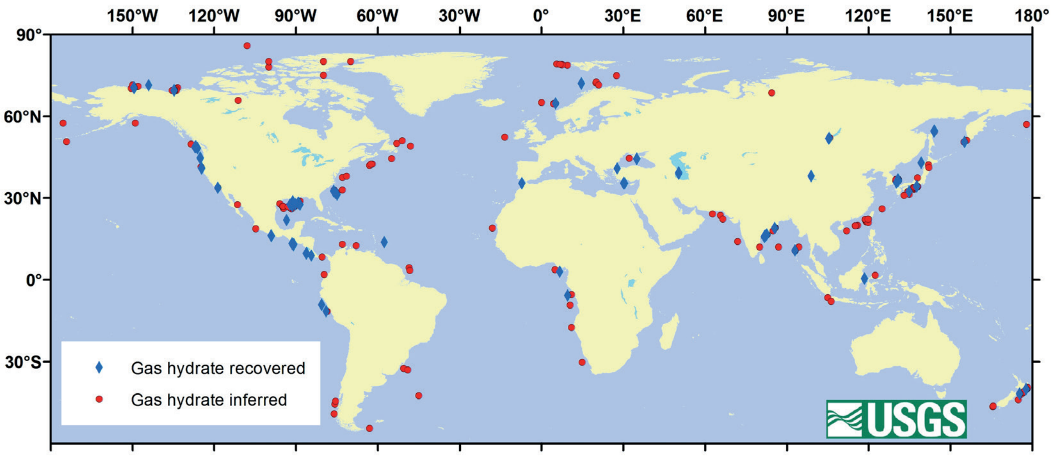

Fig. 2 Map of locations where gas hydrate has been recovered (blue diamonds) and inferred (red circles) (US Geological Survey)

Technology options for coupled underground coal gasification and CO_2 capture and storage

TOPS is an international research collaboration funded by the European Union's Seventh Framework Programme for 2013-2016. The main objective of the project is to develop a generic UCG–CCS site characterisation workflow, and the accompanying technologies. The research addresses field based technology such as cavity progression and geomechanics, potential groundwater contamination and subsidence impacts, process engineering solutions together with the experimental research carried out, which utilises a newly constructed high pressure gasification reactor investigating several prospective options of UCG technology implementations.

Combining underground coal gasification (UCG) with CO_2 capture and storage (CCS) is considered as a potential option to mitigate against the climate change impacts of CO_2 emissions. It has been suggested that UCG may create an opportunity for CO_2 storage in the post-gasification structures due to their high permeability and injectivity; the potential for secondary coal adsorption storage, autoclosure through swelling of the coal; use of existing wells could significantly reduce storage costs by 40-60%; and access to site within highly secure settings. On the other hand, it is recognised that the problems associated with the use of these structures may outweigh the potential benefits; the cavity itself is likely to be disturbed and may be difficult to characterise before CO_2 storage is initiated. CO_2 may interact with other coal gasification products generating potential environmental impacts. Most importantly, the storage potential could be orders of magnitude smaller than the capacity required to store the CO_2 produced during the UCG process. Furthermore, the potential CO_2 storage capacity will only be available after the gasification operation in the field, making the simultaneous UCG-CCS rather difficult in many geological settings. Therefore, the project also investigates potential alternatives to post-gasification storage in situ.

The project benefits from a number of field UCG pilots and receive field data to use in modelling, as well as calibrating and validating the models developed. These pilots include:

- Wieczorek mine UCG pilot, Poland (in situ coal gasification project at 400 m depth)
- Coal mine Velenje UCG pilot, Slovenia (feasibility study in coal seam at 30 m depth)
- YiHe Scoping UCG Plant in Inner Mongolia, China (test and monitor the UCG process at around 450 m depth)

The mapping of coal and coalbed methane (CBM) resources in the European area has gained significant interest in recent years and, in 2011, the EuCoRes project proposed a common classification and terminology for coal and CBM as well as a harmonised GIS database model integrating different data sources. The EuCoRes GIS database is made available to the TOPS project and towards its UCG and CO_2 storage capacity assessment work. In addition, a number of projects funded by the European Commission, such as Joule II, GESTCO, GeoCapacity, and CO2STOP have evaluated the CO_2 storage potential of saline aquifers, depleted hydrocarbon reservoirs and coal seams over several decades. The deep saline aquifers in CO2STOP database is currently being utilised by the TOPS project for evaluating the combined UCG–CCS potential in Europe.

Niels E. Poulsen
GEUS

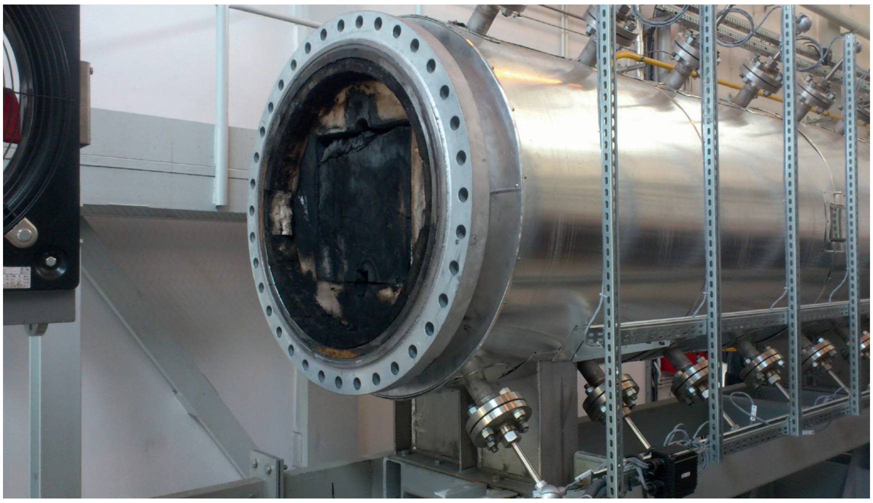

Fig.3 High pressure gasification reactor, Clean Coal Technology Centre, Główny Instytut Górnictwa, (Central Mining Institute), Poland

Partners

Imperial College London, United Kingdom (Coordinator)
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GFZ Potsdam, Germany
Delft University of Technology, the Netherlands
University of Glasgow, United Kingdom
Coal Mine Velenje, Slovenia
Geological Survey of Denmark and Greenland, Denmark
Katowicki Holding Weglowy S.A, Poland
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ENeRG – European Network for Research in Geo-Energy

ENeRG – European Network for Research in Geo-Energy is an informal contact network open to all European organisations with a primary mission and objective to conduct basic and applied research and technological activities related to the exploration and production of energy sources derived from the Earth's crust.
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GEO ENeRGY country profile - Moldova

IGS of ASM - the Institute of Geology and Seismology of the Academy of Sciences of Moldova. It is main research institution in fields of geology and geophysics in the Republic of Moldova. The history of the Institute dates back to 1949, when Department of Geology was created at Moldavian Branch of the former USSR Academy of Sciences. It was set up to encourage investigations of geological structure of territory and its mineral resources. Later in 1958 the Department was developed into Institute of Geology and Mineral Resources. In 1967 it was transformed into Institute of Geophysics and Geology by comprising of Institute and seismic station. From 2006 it is known like Institute of Geology and Seismology of the Academy of Sciences of Moldova.

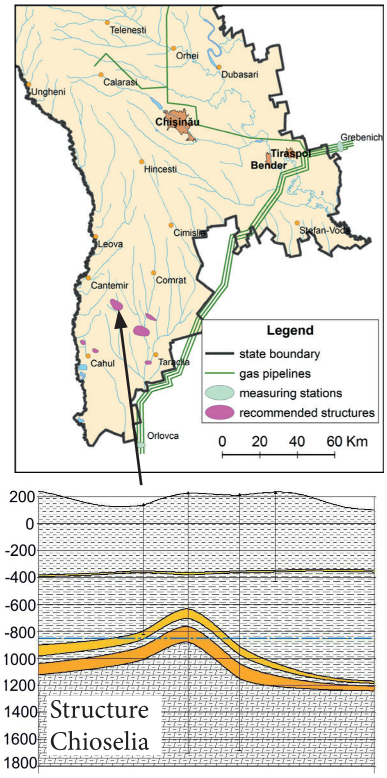

Fig. 4 The most perspective structure for gas storage in Republic of Moldova

Main research directions at IGS are:

- Seismic regime study of the Carpathian-Balkan region, seismic macro-zoning of the territory of the Republic of Moldova and micro-zoning of urban areas, seismotectonics and geodynamics.
- Study of regional geology, lithology and stratigraphy of geological formations, tectonics and neotectonics and sustainable use of minerals resources;
- Hydrodynamics and investigation of regimes of ground water in the Republic of Moldova, the ground water reserves and quality, hydrologic prognosis and riverbed processes of small rivers;
- Study of the geoecological processes at the territory of the Republic of Moldova, geochemical monitoring, modelling of environmental pollution, methods for pollution localisation and reduction.

Other institutions

Agency for Geology and Mineral Resources is a legal authority for mining and manages geological archives. Institute of Power Engineering of ASM is focused on study of Energy efficiency and renewable energy sources.

Main activities in the field of geo-energy

In last year's as the main results in a field of Geoenergy, "The feasibility study of geological and geophysical conditions in southern part of the Republic of Moldova, including mapping of potential geological structures, which can be used for construction of underground gas storages in the region" can be mentioned. As results of this study six geological structures, which may have prospects for construction of the underground gas storages were discovered. These structures need additional study to confirm or reject their prospects. The most perspective at this moment Chioselia structure is shown at the Fig 4.

At a next stage of exploration of this prospective geological structure the following objectives should be included: improvement of geological structure by additional geophysical and geological exploration; additional study of physical parameters of reservoir rocks with estimation of their quality, and other required studies.

Other direction of the possible use of this structure can be CO_2 geological storage (CGS), but this need an additional CGS study with significant investigations.

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