

GHGT-9

CO₂GeoNet, the unique role of the European scientific body on CO₂ geological storage

Isabelle Czernichowski-Lauriol^{a,b,*}, Rob Arts^{a,c}, Dominique Durand^{a,d}, Sevket Durucan^{a,e}, Peter Johannessen^{a,f}, Franz May^{a,g}, Marie-Laure Olivier^{a,h}, Sergio Persoglia^{a,i}, Nick Riley^{a,j}, Mehran Sohrabi^{a,k}, Sigmund Stokka^{a,l}, Samuela Vercelli^{a,m}, Olga Vizika-Kavvadias^{a,n}

^aCO₂GeoNet Network of Excellence, 3 av. C. Guillemin, BP 36009, 45060 Orleans Cedex 2, France

^bBRGM, Bureau de Recherches Géologiques et Minières, 3 av. C. Guillemin, BP 36009, 45060 Orleans Cedex 2, France

^cTNO, Netherlands Organisation for Applied Scientific Research, P.O. Box 80015, 3508 TA Utrecht, The Netherlands

^dNIVA, Norwegian Institute for Water Research, BP 2026, Nordnes N-5817 Bergen, Norway

^eImperial College London, Department of Earth Science and Engineering, London SW7 2BP, UK

^fGEUS, Geological Survey of Denmark and Greenland, Øster Voldgade 10, DK-1350 Copenhagen K, Denmark

^gBGR, Federal Institute for Geosciences and Natural Resources, Alfred-Bentz-Haus, Stilleweg 2, D-30655 Hannover, Germany

^hSINTEF Petroleum Research, Strindveien 4, 7465 Trondheim, Norway

ⁱOGS, National Institute of Oceanography and Experimental Geophysics, Borgo Grotta Gigante, 42/C, 34010 Sgonico (TS), Italy

^jBGS, British Geological Survey, Kingsley Dunham Centre, Keyworth Nottingham NG12 5GG, UK

^kHWU, Heriot-Watt University, Institute of Petroleum Engineering, Riccarton, EH14 4AS Edinburgh, UK

^lIRIS, International Research Institute of Stavanger, Prof. Olav Hanssensvei 15, N-4021 Stavanger, Norway

^mURS, Sapienza University of Rome, piazzale A.Moro 5, 00185 Roma, Italy

ⁿIFP, 1 & 4 avenue de Bois Préau, 92852, Rueil-Malmaison, France

Abstract

CO₂GeoNet is a Network of Excellence on the geological storage of CO₂, initiated by the EC's 6th research framework programme in 2004 and integrating Europe's key research institutes to create a scientific reference body dedicated to the development of CO₂ geological storage as a viable option for mitigating climate change. It has gained international recognition through bodies such as CSLF and IEA-GHG. It emerges as the world's largest integrated scientific community on this theme. In 2008, the network has been transformed into a legally registered Association, thus reinforcing its identity as a durable entity engaged for the safe and reliable deployment of CO₂ geological storage. CO₂GeoNet's activities encompass joint research, training, scientific advice, and information and communication on CO₂ geological storage.

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Keywords: CO₂GeoNet; Network of Excellence; Association; CO₂ geological storage; research; training; scientific advice; information and communication

* Corresponding author. Tel.: +33 2 38 64 46 55; fax: +33 2 38 64 37 19.

E-mail address: i.czernichowski@brgm.fr.

1. Introduction

CO₂GeoNet is a Network of Excellence initiated by the EC's 6th Framework Programme in 2004 in order to draw together Europe's key Research Institutes on CO₂ storage and create a durable scientific reference body dedicated specifically and entirely to geological storage as a whole (Contract SES6-CT-2004-502816, "Network of Excellence on CO₂ geological storage - CO₂GeoNet April 2004 - March 2009"). CO₂GeoNet has gained international recognition through bodies such as the Carbon Sequestration Leadership Forum (CSLF) and the Greenhouse Gas Programme of the International Energy Agency (IEA-GHG). It emerges as the world's largest integrated scientific community on this theme. CO₂GeoNet aims to provide the necessary scientific knowledge to make the widespread use of CO₂ storage technology in geological formations a reality, backed up by pledges of security and efficiency, thus ensuring a substantial contribution to limiting global warming and ocean acidification whilst posing no risks to local populations and ecosystems.

In 2008, the network has been transformed into a non-profit legally registered Association under the French law of 1901, adept to provide impartial scientific advice and expertise to the European Commission, European public authorities, and industry and community stakeholders during the successive phases of CCS deployment. This milestone marks a major step in achieving durability of the CO₂GeoNet Network of Excellence beyond the end of the five-year EC contract, thus reinforcing its identity as *the* European scientific authority on CO₂ geological storage.

CO₂GeoNet's activities encompass joint research, training, scientific advice, and information and communication on CO₂ geological storage. They address site selection and characterization, modelling and monitoring CO₂ fate and site behaviour, risk assessment—including possible local impacts on humans and ecosystems, and safety protocols. The network also tackles the issue of public acceptance of CO₂ storage, looking for the best approaches to communicate with the general public and organizing dialogue sessions with the different stakeholders based on clear and unbiased scientific data. CO₂GeoNet's forte is to harness a multidisciplinary team of eminent specialists that masters all facets of the geological storage of CO₂.

The geological storage of CO₂ is a complex field of research in which many different disciplines interact: geology, geophysics, geochemistry, geomechanics, hydrology, microbiology, ecology, reservoir engineering, and oceanography (for storage under the seabed). Various components of a storage site have to be considered: reservoir, cap rock, overburden, groundwater, soils, surface, vegetation, wells. Different phases too: planning period (~5 years), injection period (~40 years), closure period (~5 years) and post-closure period (~1000 years). All the required expertise is found amongst the CO₂GeoNet scientists. In addition, CO₂GeoNet has adopted an innovative science psycho-social approach for science communication and dissemination on CO₂ geological storage, thanks to the expertise of a clinical psychologist specialized in image and communication.

In this paper, the latest developments of the Network are presented, including an overview of the recent and planned activities related to research, training, information and communication, and scientific advice on technical, regulatory and policy issues. The aim is to further foster European and international collaboration to contribute to worldwide capacity building and answer concerns of policy makers, regulators and the public, in order to build confidence on CO₂ storage and help gain societal acceptance of this new technology.

2. Research

Over 150 CO₂GeoNet researchers from thirteen institutes in seven European countries continue to work hand-in-hand to constantly improve knowledge on the geological storage of CO₂, to perfect tools and to develop new methods. They are involved in eight high-priority research domains:

- the geological modelling of storage sites that allows a three-dimensional representation of the subsurface to be obtained together with its various characteristics at different spatial scales, taking into account natural heterogeneities;

- the development of predictive modelling tools to simulate the future evolution of CO₂ and the behaviour of the storage site at different time scales, ranging from when the gas is being injected (about 40 years) to after the site has been shut down (on the order of several millennia);
- laboratory and field experiments, in order to acquire the necessary basic data and to test tools and methods;
- the development of geophysical and geochemical methods to monitor storage sites, together with monitoring strategies that combine different methods;
- the development of risk-assessment methodologies and action plans, should abnormal behaviour be detected;
- studies on ecosystem response to elevated natural CO₂ fluxes in order to identify indicator organisms and establish exemplary flux-impact relationships
- coupling CO₂ storage with enhanced retrieval of hydrocarbons, thereby conferring an additional economic advantage;
- the development of criteria for dissemination and communication of research on CO₂ geological storage.

Research addresses every level of the issue: the reservoir, the cap rock, potential passageways for CO₂ migration from the reservoir up to the ground surface, and potential impacts on Man and local ecosystems in the event of leakage or anomalous behaviour.

The CO₂GeoNet's researchers have drawn their experience from their involvement in the pioneer CO₂ storage sites (Sleipner in the Norwegian North Sea, Weyburn in Canada, In Salah in Algeria and K12B in the Netherlands), but also from their study of natural analogues, either natural accumulations of CO₂ in the subsurface or natural releases of CO₂ into the atmosphere (primarily volcanic in origin), that occur in many places throughout the world and can date back thousands or millions of years. CO₂GeoNet is presently conducting research on 12 natural field laboratories in marine or terrestrial settings, where CO₂ migration along natural pathways (faults and fractures) can be studied, monitoring tools can be tested, and local environmental impacts can be measured. These 12 natural field labs, located in four countries (Italy, France, Germany, Norway) will usefully complement the 10-12 large-scale CCS demonstration projects of the EU Flagship Programme. The reasoning behind such a large number of demonstration projects and natural field laboratories is to test different combinations of geological, environmental, geographical and social settings.



Figure 1: Field surveys at Latera natural field laboratory, Italy

These natural field laboratories are research infrastructures unique to CO₂GeoNet. The Network also possesses other high-level infrastructures that could be highly beneficial to many researchers across Europe and the world:

- A large set of geophysical, geochemical, microbiological and remote sensing monitoring facilities that has been tested and cross-calibrated in our marine and terrestrial natural field laboratories and could be used on other sites.

- A set of experimental and modelling facilities to investigate CO₂-fluid-rock interactions for a wide range of subsurface temperature and pressure conditions. These facilities enable assessment of the phase behaviour of gas mixtures, the flow properties, the chemical reactivity of CO₂ with the reservoir rocks and cap rocks, and rock mechanics, for various samples taken from current or planned CO₂ storage sites.

An overview of CO₂GeoNet research activities was previously presented at GHGT-8 by Czernichowski-Lauriol et al. [1]. Various research results have also been published at GHGT-9 [2, 3, 4] and peer-reviewed journals.

3. Training and capacity building

Training activities are proceeding through a number of important and productive avenues, including the training of undergraduate, Masters, and PhD university students (via courses, specialized programmes, and theses focused on geological CO₂ storage), staff exchange for at least several weeks, the organization and implementation of workshops, short courses and summer schools. Training activities aim at sharing and spreading the multidisciplinary expertise in the field of CO₂ geological storage, both for own staff and external stakeholders, such as research scientists, professionals, decision-makers, and even school children.

Students are co-supervised by at least two CO₂GeoNet partners and are encouraged to jointly work with CO₂GeoNet researchers, either in the field or at Partners' institutes. Currently there are eleven PhD students, three of which are directly funded by the Network, and the remaining eight funded by institutional and external funds. Numerous undergraduate and masters level students have also been involved in the CO₂GeoNet joint research activities. One example is a field school organized in October 2007 at the natural analogue site at Latera, Italy. A small number of selected students gained practical field experience by working for one week as seismic and geo-electrical crew members, and learned about CO₂ geological storage and the geophysical and geochemical methods used in its monitoring.

A portfolio of CO₂GeoNet training courses is currently being developed. Presently, CO₂GeoNet is co-organizing two continuing professional development courses that are on offer each year:

- A one-day training course entitled “Introduction to the technology of CO₂ capture and geological storage”, which aims to teach the basics of this emerging technology, the main options for capture, transport and storage of CO₂, an overview of the present status of research and industrial pilots worldwide, and the technical, economic, legal, political, and social conditions for applying this technology.
- A specialized four-day training course on "Modelling chemical reactivity during CO₂ geological storage". The course aims to raise awareness concerning the impacts of geochemical processes on CO₂ storage behaviour, teach the basic knowledge of geochemical modelling and certain standard modelling codes, present different methodologies and highlight the modelling limitations and uncertainties, as well as the current R&D challenges.

CO₂GeoNet is co-organizing the IEA GHG annual summer schools, for which it also provides lecturers. CO₂GeoNet will also organize a European Science Foundation (ESF) Research Conference “CO₂ Geological Storage: Latest Progress”, to be held on Obergurgl in Austria on 22-27 November 2009. CO₂GeoNet was awarded this role after its successful application to the ESF Research Conference call in 2007. The ESF Research Conferences Scheme provides the opportunity for leading scientists and young researchers to meet for discussions on the most recent developments in their fields of research.

4. Information and communication

CO₂GeoNet has positioned itself externally as an important player in the exchange of ideas on the whole geological storage issue. Recent examples worth highlighting are indicated below.

In September 2008, CO₂GeoNet published a new brochure entitled "What does CO₂ geological storage really mean?" [5]. The aim is to deliver clear scientific information to a broad audience and, in parallel, to encourage dialogue about the geological storage of CO₂. The brochure tackles six frequently asked questions:

1. Where and how much CO₂ can we store underground?
2. How can we transport and inject large quantities of CO₂?
3. What happens to the CO₂ once in the storage reservoir?
4. Could CO₂ leak from the reservoir and, if so, what might be the consequences?
5. How can we monitor the storage site at depth and at the surface?
6. What safety criteria need to be imposed and respected?

This brochure is a follow-up of CO₂GeoNet's first Training and Dialogue workshop held in Paris on 3rd October 2007. The wide audience included stakeholders, industrialists, engineers and scientists, policymakers, journalists, NGOs, sociologists, teachers, and students. In total, 170 people from 21 different countries attended, during which they had the opportunity to share their views and gain a more complete understanding of CO₂ geological storage.

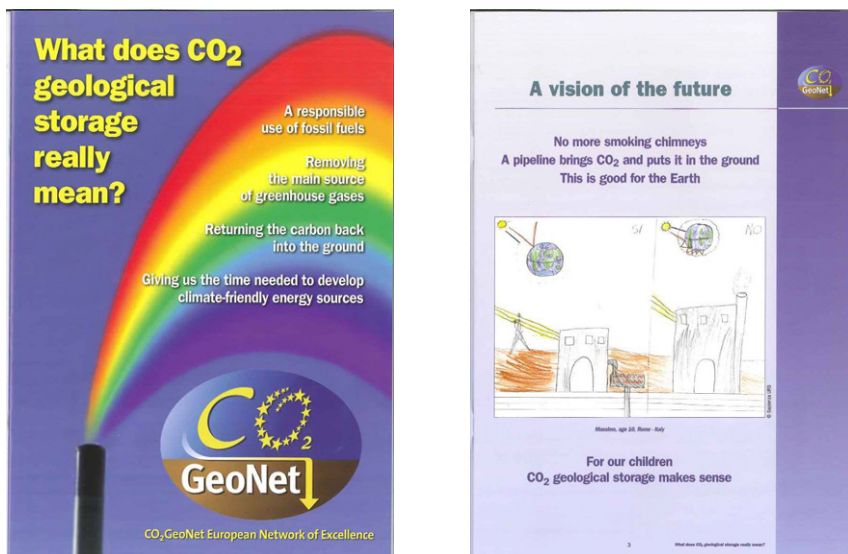


Figure 2: Cover and first pages of the new CO₂GeoNet brochure (Sept. 2008)



Figure 3: CO₂GeoNet Training & Dialogue Workshop on CO₂ geological storage, Paris, 3rd October 2007

On 11-12 September 2008 in Bucharest, CO₂GeoNet co-organized the 1st CCS workshop in Romania, entitled “Promoting CO₂ capture and storage in Romania”. This workshop brought together key players, including policy makers, industry representatives, financing bodies, municipalities, consulting and engineering companies, research bodies. Its main goal was to evaluate and discuss the state-of-the-art as well as the prospects of development and implementation of CCS concepts and technologies.

On 18-22 July 2008 in Barcelona, the EuroScience Open Forum (ESOF), which is the biggest European event for science exchange and communication, hosted CO₂GeoNet who led an outreach activity on CO₂ geological storage. The forum was attended by more than 4,700 participants, including scientists, journalists, and policy makers. The outreach activities were also open to the general public, offering interactive activities, debates, art performances on science topics. CO₂GeoNet researchers had the opportunity to disseminate scientific information on CO₂ underground storage, explaining and answering participants' questions on the many aspects of this technology, many of whom had never heard of CCS before. Thanks to the collaboration with the European Technology Platform for Zero Emission Fossil Fuel Power Plants (ETP – ZEP) and IEA GHG, a number of informative documents on CCS were made available to the public. Rock samples and specific posters were used to illustrate the concept of CO₂ geological storage. Dialogue sessions were held with groups of interested attendees who welcomed the opportunity to listen to the researchers' explanations to a wide variety of questions.



Figure 4: CO₂GeoNet at EuroScience Open Forum (ESOF), Barcelona, 18-22 July 2008

5. Scientific advice

CO₂GeoNet draws upon a multidisciplinary pool of experts from its individual members, and is thus able to provide scientific advice not only on technical issues, but also on regulatory, policy and public acceptance issues. A significant number of CO₂GeoNet experienced scientists are members of eminent national, European and international committees, such as:

- ETP-ZEP: Task Forces on Technology, Demonstration and implementation, Policy and regulation, Public communication
- CSLF Technical Committee and Task Forces

- IEA-GHG Executive committee and research networks
- Working group on Cleaner power generation from fossil fuels of the United Nations Economic Commission for Europe (UNECE)
- Work groups on CCS for the London and OSPAR conventions for the prevention of marine pollution
- CO2NET, the European Carbon Dioxide Knowledge Transfer Network

CO₂GeoNet researchers have played a significant role in advising the European Commission, the European Parliament, national authorities and European stakeholders on the European Directive on the geological storage of CO₂, which was proposed by the EC on January 2008.

6. International collaboration

International collaboration with industrialized countries, as well as with emerging economies, is crucial for enabling the development and deployment of CCS technologies worldwide and on time. CO₂GeoNet will use its formal links through the CSLF and the IEA GHG to establish synergies on international collaboration activities concerning storage, in particular and more widely CCS research and demonstration projects.

7. Next CO₂GeoNet Open Forum and future developments

Since 2006, CO₂GeoNet has organized an annual Open Forum on CO₂ storage in Venice in the spring. European stakeholders, including those from industry, non-governmental organizations, and government officials, have benefitted from these events, learning of the work that the Network is conducting and having the opportunity to voice their opinions regarding needs and future research. Special features in 2008 were the launch of the CO₂GeoNet Association and discussion on the proposed EC Directive on the geological storage of CO₂.

The 2009 CO₂GeoNet Open Forum, the final one under the FP6 EC contract, will be held on 18-20 March 2009 in Venice. It promises to be a major international event open to a wide audience (policymakers, public authorities, industrial stakeholders, regulatory bodies, NGOs, engineers and scientists, etc.). It will offer the unique opportunity to gain an up-to date overview of the 5 years of activities in the Network, and to discuss further developments and collaboration opportunities under the framework of the CO₂GeoNet Association.

8. Conclusion

Created thanks to the support of the European Commission, the CO₂GeoNet Network of Excellence has succeeded in positioning itself as *the* European scientific authority on CO₂ geological storage. It has now acquired a legal status as a non-profit scientific Association under the French law. As an independent and multidisciplinary scientific body, CO₂GeoNet has the key role of building trust on CO₂ geological storage and supporting wide scale CCS implementation.

Storage indeed deserves special attention as it is the most critical, important and spatially anchored part of the CCS chain. It is, of course, vitally important that CO₂ capture from fossil-fuel burning plants is addressed by R&D, especially in the aim of reducing costs and upscaling capture technology so that it can be applied to a variety of very large point sources. However, even more vital is the security of CO₂ storage, since the ultimate aim of CO₂ capture is to isolate it from the atmosphere and store it permanently in terms of at least human timescales. The lifetime of industrial facilities is several decades, during which time capture technology will improve. The geological storage of CO₂, however, relies fundamentally on the effectiveness of the chosen storage site and the underlying geology. Moreover, the storage site has to perform safely and efficiently for thousands of years. This is the reason why storage is of utmost concern to policy makers, regulators and the public. Indeed, an authoritative scientific body able to provide sound scientific information, shared by a large and multidisciplinary community of European scientists, is essential to support deployment of, and to build trust on, CO₂ storage. This is all the more so because scientists are the most trustworthy source of information according to Eurobarometer 2006 poll on environmental issues.

In order to strengthen its role at European and international level, CO₂GeoNet considers expanding its membership with strategic public research organizations from other European countries and engaging further collaborations with various types of stakeholders worldwide, for any activities dealing with research, training, scientific advice, information and communication on CO₂ geological storage.

9. Acknowledgements

The funding of the European Union under the Sixth Framework Research Programme is gratefully acknowledged. Networks of Excellence were new instruments of EC's FP6 to help overcome the fragmentation of the European research landscape with the objective to strengthen European excellence in key areas. The 5-year EC support was essential to create a legally registered Association and positioning the CO₂GeoNet Network of Excellence as *the* European scientific authority on CO₂ geological storage.

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