

Mont Terri Project

Underground Rock Laboratory
Laboratoire souterrain

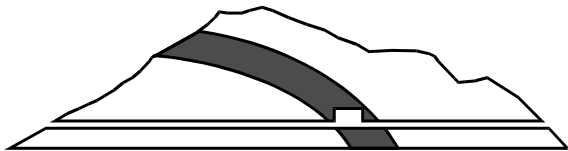
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History of the Mont Terri project

In 1989, during the excavation of the special gallery for the Mont Terri motorway tunnel, the National Hydrological and Geological Survey and NAGRA (National Cooperative for the Disposal of Radioactive Waste) carried out detailed geological and hydrological studies. They found that the Opalinus Clay is practically impermeable along the entire stretch – the tunnel walls did not display any damp spots or areas of water penetration. They also found that Opalinus Clay is much more stable than expected, which meant that the tunnel wall could be stabilised with sprayed concrete and the originally planned, 30-cm-thick concrete lining would no longer be required. Opalinus Clay appeared, therefore, to be a potentially highly suitable host rock for the deep geological storage of radioactive waste. These findings were subsequently discussed by an international OECD/NEA workgroup called the Clay Club, and were of great interest to a variety of foreign organisations that were also considering clay formations as potential host rock for deep geological repositories. However, comprehensive studies in clay formations were still required in order to address the many questions that remained unanswered.

In autumn 1994, Marc Thury, Chief Geologist at NAGRA, announced his decision to set up an international research project in the Mont Terri exploratory tunnel. His vision was to develop a project in which interested organisations could participate as partners and subsequently carry out experiments in accordance with their own requirements and wishes, with or without other partners. The idea was to organise the project democratically so that all involved partners could incorporate their own ideas and interests. To ensure that the project would be accepted by the local population, it should be placed under the patronage or leadership of a federal body and the studies and findings should be reported in a fully transparent manner. Thury then drew up a written proposal (“Initial Mont Terri Document,” dated 14 September 1994), which he submitted to Charles Emmenegger, Director of the National Hydrological and Geological Survey. Emmenegger subsequently decided to support the project and submitted an application to the Canton of Jura for permission to construct niches, drill boreholes, and carry out measurements in the above-mentioned exploratory tunnel. In February 1995, Minister Pierre Kohler and Cantonal Engineer André Voutat decided to back the proposed project and approved the application.

In spring 1995, a proposal encompassing 13 experiments was prepared by Paul Bossart from the Geotechnical Institute in Bern together with scientists from NAGRA and the National Hydrological and Geological Survey. This proposal was subsequently submitted to the member organisations of the Clay Club and met with a very positive interest. A variety of institutions indicated that they would be interested in participating, and three of them immediately confirmed their participation. Thus the Mont Terri Project was launched with the involvement of five partner organisations: National Hydrological and Geological Survey, NAGRA, ANDRA (National Radioactive



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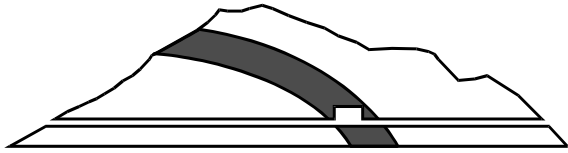
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Waste Agency), PNC (Power Reactor and Nuclear Fuel Development Corporation) and the Belgian nuclear research centre, SCK•CEN (Studiecentrum voor Kernenergie, Centre d'étude de l'énergie nucléaire). Together these organisations drew up an agreement of cooperation and detailed programme of activities that were discussed with and approved by the relevant authorities of the Canton of Jura.

Fieldwork commenced in January 1996 with the construction of 8 niches (exploration galleries in the Mont Terri tunnel) and the drilling of 18 boreholes, in which 13 experiments were initiated. In the spring, the agreement of cooperation was signed by the five partners, who elected Marc Thury as President of the Mont Terri Project and Paul Bossart as Project Manager. In accordance with the cooperation agreement, the Project was to be implemented by a consortium comprising the five partners under the patronage of the National Hydrological and Geological Survey, which was responsible for submitting applications to the authorities of the Canton of Jura. All partners were responsible for the programme with the same rights and obligations. This democratic organisational structure was the first of its kind in the world. All other existing rock laboratories are each managed by a single body that invites other organisations to participate in specific experiments. The democratic structure adopted in the Mont Terri Project has stood the test of time and is still in place today. The Project is managed by a steering committee comprising representatives from the partners, together with the Project Manager and the President. The Project itself consists of individual experiments that are carried out and financed by the partners involved in each experiment. For each of these experiments an annual research programme is prepared that has to be approved by the Canton of Jura, the former owner of the motorway tunnel.

In spring 1997, the partners drew up plans for a number of new experiments. These called for construction of a new gallery with several lateral niches. The Swiss National Hydrological and Geological Survey submitted these plans to the government of the Canton of Jura for approval. These plans were approved 64 days later. The new gallery was constructed during the winter of 1997/98 and spring 1998, and was inaugurated in September that year. This paved the way for a comprehensive programme of experiments.

The project continued to expand, and attracted additional organisations as partners: in 1997, the Federal Institute for Geosciences and Natural Resources (BGR) and ENRESA (Empresa Nacional de Residuos Radiactivos S.A.); in 1998, IRSN (Institut de radioprotection et de sûreté nucléaire [formerly IPSN]); in 1999, OBAYASHI; and in 2000, GRS (Gesellschaft für Anlagen- und Reaktorsicherheit / Global Research for Safety). At the beginning of 1998, Marc Thury joined the National Hydrological and Geological Survey and managed the project as a representative of the Swiss Federal Government. This move was greatly appreciated by the Canton of Jura, because it meant that the Project was less likely to be obstructed by militant opponents of nuclear energy. Thanks to the existing mutual trust and the transparency of the project, relations between the authorities of the Canton of Jura and National



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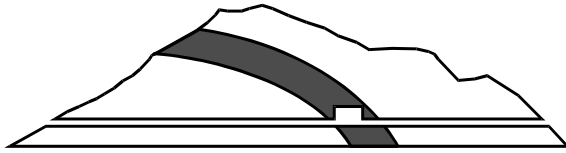
Hydrological and Geological Survey were excellent. In summer 2000, the founder of the project, Marc Thury, stepped down and Markus Hugi from NAGRA was elected as new President. In autumn 2000 the authorities of the canton of Jura called, however, for the operation of the Mont Terri project to be placed back in the hands of the Federal Government. This led to the preparation of an agreement between the Federal Office for Water and Geology (FOWG), into which the National Hydrological and Geological Survey was integrated at the beginning of 2001, and the Canton of Jura. This “2001 Agreement” governed cooperation between the various partners and also specified that the Federal Government, represented by the FOWG, be responsible for the operation of the Project and for nominating a Director to replace the President who had been elected by the Mont Terri partners. In summer 2001, Peter Heitzmann, head of the Geology Division of the FOWG, was appointed Director of Mont Terri to replace Markus Hugi. The canton of Jura also established a Supervisory Committee (Commission de suivi). The international cooperation agreement (“2001 Agreement”) was then amended accordingly. In summer 2002, a new partner joined the project: CRIEPI (Central Research Institute of the Electric Power Industry). Peter Heitzmann continued as Director for a further two-and-a-half years, then handed back the reins back to Marc Thury at the beginning of 2003.

In autumn 2002, the partners decided to develop a new long-term research programme, and in May 2003 they agreed on a programme with more than 30 new experiments, as well as on the construction of a new gallery with additional niches for these experiments. In the summer, the Federal Nuclear Safety Inspectorate (ENSI, formerly HSK) joined the Project as its twelfth partner. Construction work on the niches and a new gallery (Gallery 04) was initiated in autumn 2003 with the launch of several major experiments.

At the beginning of 2003, NAGRA approached the newly elected government official, Minister Laurent Schaffter, who was now responsible for the Mont Terri Project, and proposed that NAGRA should take over as its operator. Several senior federal officials also backed this proposal, and Federal Councillor Moritz Leuenberger also supported it by sending two letters to the cantonal government relating to this issue. However, the cantonal government insisted that the operation of the project must remain in the hands of the Federal Government, because it was still anxious to avoid any actions on the part of opponents of nuclear energy.

In summer 2005, Marc Thury handed over the position of Director to Paul Bossart, who had been in charge of the Project since 1996.

At the end of 2005, the “2005 Agreement” was signed, superseding the “2001 Agreement.” This new agreement between the Canton of Jura and the Mont Terri project was drawn up by the FOWG together with NAGRA, ENSI (at that time, HSK) and the Supervisory Committee. This created the legal basis for the continuation of the Project, and meant that the differences between the Cantonal and Federal Governments and NAGRA had now been amicably resolved.



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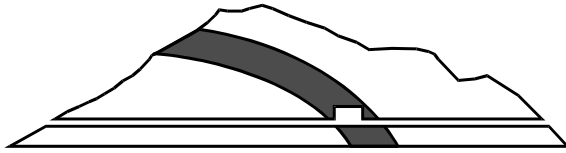
In January 2006, swisstopo (Federal Office of Topography) took over the operation of the Mont Terri Project from the FOWG, which had been disbanded as of the end of 2005, and assumed the contractual obligations specified in the “2001 Agreement” and the “2005 Agreement.” This meant that swisstopo was now the official operator of the rock laboratory and was able to assure long-term availability of the facility to all partners for carrying out experiments.

In May 2006, the Mont Terri Project celebrated its 10th anniversary. During a scientific conference in St-Ursanne, researchers from the 12 partners and the participating universities and research organisations reported on the various experiments and their highly valuable results and findings. On the next day a festive event was organised in the Fabrique de Chaux (Chalk Factory), followed by a visit to the rock laboratory. During the following two days, the rock laboratory opened its doors to the public so that interested citizens could gain an insight into the completed and planned research activities.

In summer 2008, the Canadian Nuclear Waste Management Organisation (NWMO) joined the Project as a partner, and US oil company Chevron followed suit in summer 2009. This meant that 14 major research partners were now involved in the Mont Terri Project.

In 2008, the biggest expansion of the rock laboratory to date was initiated to pave the way for new experiments. The objective was to create sufficient space for researchers in the laboratory to be able to carry out these new, large-scale experiments under the best possible conditions. Gallery 08 was excavated to create around 300 metres of tunnels and niches. While the excavation work was in progress, various experiments were carried out, including two major mine-by tests. The Swiss partners ENSI (formerly HSK), swisstopo and NAGRA, together with ANDRA (France), BGR and GRS (Germany) and CRIEPI (Japan) provided the necessary funding. The rock laboratory now had a total tunnel length of around 500 metres, and could justifiably be regarded as a major international research facility situated in Opalinus Clay. Up until summer 2010, the involved partners had invested around CHF 50 million, approximately one-third of which was contributed by the Swiss partners. In 2000, the EU began to support selected experiments with around CHF 10 million. Approximately twenty percent of these investments remained in the Canton of Jura, mainly in the hands of suppliers in the construction industry.

In November 2008, within the scope of the Swiss sectoral planning procedure for deep geological repositories, NAGRA proposed six potential sites for deep geological repositories for low-level and high-level radioactive waste. The proposed sites were in the Cantons of Zurich, Schaffhausen, Aargau, Solothurn and Obwalden. No sites were proposed in the Canton of Jura, and this greatly increased the degree of acceptance among the local population for the Mont Terri research project.



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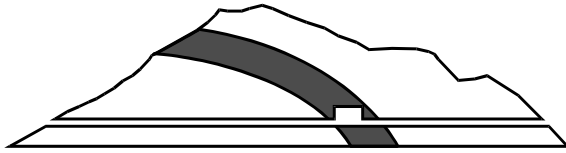
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In the past few years, interest in visiting the Mont Terri rock laboratory has increased sharply. While in 2000 the number of visitors was around 200, from 2005 onwards it constantly increased, rising by a factor of 10 to around 2,000 in 2009. Demand is particularly high from the proposed site regions in Switzerland. In order to respond to this increased demand, the Swiss partners ENSI, swisstopo and NAGRA set up a visitors centre with the aim of providing up to 5,000 visitors a year with information about the Mont Terri research laboratory and the results of the site selection procedure for deep geological repositories for radioactive waste in Switzerland. A preliminary project submitted by swisstopo for the construction of a pavilion, a bypass, and a model repository was approved by the government of the Canton of Jura in autumn 2009, and the application for the required building permit was submitted in February 2010. The canton of Jura issued the building permit in May of that year. Construction work on the visitors centre was initiated on August 23, 2010 with the laying of the foundations for the new bypass in front of the Chalk Factory in St-Ursanne. Work was delayed due to a contaminated site (an earlier oil spill in the feed to the Chalk Factory), but this was quickly cleaned up. The construction of the visitors centre itself was initiated at the beginning of 2011, but in April the Canton of Jura ordered work to stop: the work had encroached on the red zone on the natural hazards map. Simulations carried out by safety experts revealed that there was a potential risk of rockfalls and landslides. A number of crisis meetings were held, and in the end, the cantonal authorities and the operator agreed on the construction of an earthen wall above the construction site. The wall was to hold back any falling rocks or boulders, and permission was granted for work to be carried out on Saturdays in order to make up for lost time. It was therefore possible to complete the construction work on schedule, and on 5 September 2011 Federal Councillor Ueli Maurer was able to officially open the visitors centre in a ceremony attended by around 100 guests from Switzerland and abroad. He was the first Federal Councillor to enter the rock laboratory, but would certainly not be the only one: from now on, visitor numbers began to continually increase.

In 2011, the “Full-Scale Emplacement” experiment was initiated: this involved a heat test on a scale of 1:1 with a duration of at least 15 years. The aim of this experiment is to simulate processes that would take place following deposit of high-level radioactive waste. No radioactive waste is actually being used in this experiment, however, the heat produced that could be produced by radioactive waste is simulated by special heating units. A 50-metre-long gallery was constructed for this experiment, and in 2014 the heating units were installed and the gallery was then backfilled with bentonite granulate. The heating units were then switched on at the beginning of 2015. This experiment will be continued for at least 10 more years.

In 2012, the operator decided to open the laboratory for other energy-related experiments. Thus it is not only experiments associated with the deep geological storage of radioactive waste in Opalinus Clay that are being carried out here, but also CCS (carbon capture and storage/sequestration) and geothermal experiments. For CCS, clay formations act as protective and sealing layers that prevent gases from escaping into the biosphere from lower-lying aquifers. In the Opalinus Clay Formation, various weak points are being examined, for example, to determine how



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gas can escape into the atmosphere via fault zones or old boreholes. A broad variety of experiments have been initiated to test the sealing properties of the claystone.

In summer 2013, the US Department of Energy (DOE), Lawrence Berkeley National Laboratory, joined the project, and in 2015 the Belgian Nuclear Safety Authority, FANC (a body similar to Switzerland's Federal Nuclear Safety Inspectorate, ENSI) signed up as a further project partner. This meant that 16 high-level research partners were now involved in the Mont Terri Project. As of the end of 2015, 93 of the 138 experiments had been concluded, evaluated and documented, and 45 were still in progress.

In 2016, the Mont Terri Project celebrated its 20th anniversary. At the Technical Meeting that was held in the old Jesuit Church in Porrentruy on February 10 and 11, scientists from the 16 partners and from the participating universities and research institutions, were able to reflect on the activities of the past 20 years and ask themselves what they have learned and accomplished, and what they still need to discover.

Then on May 19, 100 invited guests celebrated the 20th anniversary together with Federal Councillor Guy Parmelin and were taken on a guided tour of the rock laboratory. During the following weekend, the rock laboratory opened its doors to the public so that interested citizens could gain an insight into the completed and planned research activities.

Already in 2015 it became apparent that there was an acute shortage of space for carrying out new experiments. The Mont Terri project partners gave the go-ahead for an expansion of the laboratory so that it would be possible to clarify research questions that are still open in the next few years. The Mont Terri team (swisstopo) prepared the preliminary project, which was approved by the Canton of Jura at the end of 2015. The definitive construction project was submitted to the Canton for approval in October 2016, after the question of financing had been clarified and the regulations concerning the award of contracts had been finalised. The expansion is scheduled to be completed in the course of 2018.