

Analyse micro-historique
du laboratoire souterrain
« Mont-Terri Project » :
une appréciation du rôle
du canton du Jura



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Micro-historical analysis of the underground laboratory “Mont-Terri Project”: an assessment of the role of the Canton of Jura

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Abstract

A historical outline of the international laboratory “Mont-Terri Project” and the role of the Monitoring and Surveillance Committee (Commission de suivi) is provided by its long-time president, the geologist and social scientist Marcos Buser. It demonstrates the relevance of a questioning and learning process when dealing with such issues in the nuclear waste sector. This not only postulates the development of a new culture in dealing with knowledge and society but also requires an adaptation of the underlying structures and behavioral patterns. Accordingly, the Mont-Terri Project is an example of a learning culture with structural differentiation intended to meet the high societal expectations and demands for high-quality work, transparent control and monitoring of a research project by an authority.

I A highly successful project

1995 - 2020. The Mont Terri Project (MTP) for geological research celebrates its 25th anniversary. It is a unique research project – not only on a national, but also on an international level. Its evolution is equally unique as nobody would have imagined the great success of this research platform at the outset. Many scientists, authorities and politicians were involved; the decisive contribution to this success, however, was made by the project manager, swisstopo, more precisely by its laboratory director from 2006 to 2020, Dr Paul Bossart, and his team of scientists and technicians. Evidently, it was the initial vision of Dr Marc Thury of the National Cooperative for the Disposal of Radioactive Waste (Nagra) that made the project possible. None the less, a management structure was needed to coordinate the rapidly booming scientific research of a growing number of project partners. The success was only made possible with this contribution and the enthusiasm of the institutions involved. This development points out what people and institutions can achieve when they are able and willing to agree on a joint project. Of course, there were also difficult phases, debates and critical situations, but at the end of the day, this only strengthened the project. The singular history of the scientific achievements of the MTP remains to be written, notwithstanding the many scientific reports and syntheses on the experiments available (Bossart & Thury 2008, Bossart et al. 2017). It is, however, certain that this project has delivered particularly relevant contributions to the research on clay rocks for high-level radioactive waste disposal. Moreover, its extension to geothermal energy and CO₂ storage issues enriches this research as a large-scale interdisciplinary and multi-partner project.

Other actors involved in this project were the Canton of Jura with its government and institutions. Their role was not very visible to the outside world, but they, too, shaped the structural setting of the project as well as the specific operational safety issues. This article traces the important elements of this contribution for remembrance. It is a personal view of the then and long-time chairman of the so-called “Commission de suivi” – the cantonal Monitoring and Surveillance Committee.

2 The general context of the Mont-Terri Project (MTP)

Originally, the Mont-Terri Project, MPT was at the crossroads of three national and international megaprojects: firstly the construction of the Swiss national road network and, more specifically, the highway from Biel to the French border in Eastern Jura (called “Transjurane”); secondly as part of the research for the Swiss project for nuclear waste management in the Opalinus Clay rocks crossed in the Mont-Terri and Mont-Russelin motorway tunnels; and finally, as a research platform for various national agencies of European and other overseas industrialised countries responsible for radioactive waste management. The Transjurane

motorway project thus offered unique framework conditions for the execution of a geological research project by means of the geological outcrops inside the Mont-Terri tunnel and, therefore, by its easy access.

The interest in clay rocks for deep underground disposal of radioactive waste dates back to the 1950s (Theis 1955, EKRA 2000). However, it would need several more decades for this concept to be actually included in the short list of potential host rocks. In the 1980s, clay rocks became more and more “popular” with the agencies and authorities responsible for the disposal of nuclear waste. Thus, the Nuclear Energy Agency (NEA) of the Organisation for Economic Cooperation and Development (OECD) created a working group called the “Clay Club”, charged with studying the properties of clay rocks in the context of the concept of deep geological repository of radioactive waste (Horseman et al. 1996). Concerning Switzerland, the National Cooperative for the Disposal of Radioactive Waste (Nagra) and the Swiss Federal Nuclear Safety Inspectorate (formerly HSK, now ENSI) are represented in the Clay Club.

During the 1980s, university professors, external experts – and even some Nagra scientists – drew the attention of the Swiss regulatory authorities to the need to extend the research program for radioactive waste disposal sites to sedimentary rocks. Finally, in the course of 1985, the Federal Inspectorate HSK demanded specific studies of clay formations in the Molasse Basin and the Jura, and in particular of the so-called “Opalinus” clays, named after an ammonite characteristic of this geological stage called “Lower Lias”, 174 million years old. Nagra started this program in 1985 and published a first interim report two years later. In the meantime, the National Hydrogeological and Geological Service made initial investigations of the Mont-Terri and Mont-Russelin tunnels and informed Nagra. The interest grew and the contacts were extended in 1989. The first experiments in the niches of the safety gallery were discussed and even proposed by Swiss universities and offices (EPFL, Bureau Norbert SA, etc.). But it was not until 1994 that the project effectively took off. It was precisely the members of the “Clay Club” who took up the idea of developing a joint research project in the security gallery. In fact, this was the start of the laboratory project, which does and will particularly benefit from its international scale: a multidisciplinary field research laboratory, serving as an international platform for research, exchange and discussion.

3 The Mont Terri laboratory (LMP) in the national context

The fact that the laboratory LMP was to be built on Swiss territory is closely linked to the reorientation of the Swiss deep geological repository program. In the mid-1980s, as part of the “Guarantee 1985” project presented by Nagra and initially focused on the search for a repository site in the crystalline rocks of Northern Switzerland, the Swiss Federal Council decided that from now on sedimentary rocks should also be considered as host rocks for the disposal of high-level radioactive waste. As already mentioned, this was the beginning of research into the sedimentary cover of the crystalline basement, which resulted in a first interim report by Nagra on sediments (Nagra 1988). In the 10 years to follow, the interest in Opalinus clays as host rocks increased (Nagra reports of 1991, 1994, 1996), whereas the former strategies of exploring the deep crystalline basement under the Swiss Midlands and the Jura were gradually abandoned.

In parallel with this fundamental change concerning the host rock for high-level waste repositories, the program for low- and intermediate-level waste had also experienced difficulties. In Wellenberg (Canton Nidwalden), the Wellenberg Nuclear Waste Management Cooperative (GNW) was not really making progress with its project. The Department of the Environment, Transport, Energy and Communications (DETEC) became increasingly aware that a re-evaluation of the concepts for the disposal of radioactive waste in Switzerland was inevitable. In 1999, Federal Councillor Leuenberger appointed a commission to study “radioactive waste management concepts”, called EKRA. The findings of this commission (EKRA 2000, 2002) were largely incorporated into the new Nuclear Energy Act (NEL), which finally came into force in 2003. However, the rejection of the GNW project at Wellenberg by popular vote in autumn 2002 was a severe setback in the search for a repository in Switzerland. The federal government was obliged to launch a new site-selection procedure which took place between 2005 and 2008 (SFOE 2008). Parallel to this development, a growing controversy about the future of nuclear energy was underway since the year 2000. This controversy

temporarily ended with the Fukushima accident on 11 March 2011 and the decision not to renew the existing nuclear power plants.

The adjustments of the national program and the national and international developments in the field of nuclear energy had a direct impact on the management of the MTP. The project management by representatives of the nuclear industry, supported by the competent federal authorities, particularly DETEC, had caused problems of acceptance. In this context, it must be taken into account that the structures of the nuclear waste disposal programs and the governance of these programs followed the provisions established at the time of the introduction of nuclear energy in Switzerland in the 1950s. These structures had been determined with the putting into operation of the four nuclear power plants with five reactors by the electricity companies owned by Swiss cantons. Since then, the nuclear industry has been managing the plants and responsible for the conditioning and storage of the waste. Following the serious accident at the Lucens reactor (canton of Vaud) and the necessary decontamination and remediation work, the responsible electricity companies together with the Confederation as minority partner decided to create a cooperative dedicated to the interim storage of waste and to the search for storage possibilities for low- and medium-level waste from Swiss nuclear power plants, as well as from the medical, industrial and research sectors (Flüeler 2002). This was the birth of Nagra, which thus took the lead in specific programs to find sites for final disposal of the waste. Finally, the federal authorities were responsible for the legal and political decisions necessary in this program (KARA 1976, Flüeler 2002, Buser 2019). Following this logic, financing was also clearly in the hands of the electricity industry under the “polluter pays” principle. This division of labour had an influence on the development and events of the Mont-Terri Project concerning the Swiss position. As a result, and because of these structural conditions as well as the experience gained in the management of the second Swiss research laboratory at Grimsel (Canton of Bern) in the crystalline rocks of the Alps, Nagra has long claimed the management of the research laboratory. Over time, however, it had to accept that the MTP would have to be managed in a fundamentally different way since issues of research acceptance in the field of deep geological disposal were and are of great importance to the general public. But let us return to the development of the events related to the LMP.

The Canton of Jura, as the owner of the site, played a crucial role in the decisions and development that led to this change in perception. Clearly, the debates and conflicts surrounding the decision-making processes have strongly shaped the history of the MTP. This was undoubtedly the most important point of conflict that arose in the early years after 2000 between the canton, the federal authorities, and the Swiss MTP partners. The canton, relying on the cantonal mining regulations, therefore insisted on the establishment of project management structures independent of the interests of the nuclear industry. This dispute between the institutions involved has had a profound effect on the history of the LMP. It should be noted, however, that the need for scientific and political independence of research at Mont Terri was finally accepted by all Swiss actors.

4 The evolution of the project and the role of the Canton of Jura (Table 1)

The MTP was not intended to start as a long-term research project. Initially, scientific experiments were launched in the safety gallery, primarily to better understand the geo-mechanical behaviour of rocks in underground vaults, and then as additional experiments by a consortium of project developers in the field of nuclear waste disposal. The transformation of the project from an experimental field limited by individual interests into an internationally renowned research laboratory with an increasingly broad research orientation is not only remarkable but also shows how random such transformations may be. For many years, no one expected this development. The success of the project is largely due to the enthusiasm of the institutions and individuals involved over the years. Despite many difficulties the project has faced over a number of years, this enthusiasm of the founding generation of the project has been an essential element of its success. Of course, the competence and good management of the project as well as the strict control of the Canton have also strongly contributed to the development of the project. But it is difficult to imagine that the project would have been so successful without the “fire” of the commitment of the people and institutions involved. This

brief retrospective does not pretend to trace the evolution of the research and the scientific results of the project, which are the responsibility of swisstopo and the other partners; it rather complements them and describes the role of the Canton of Jura as owner of the laboratory and supervisory body.

4.1. The beginning of the project: 1989 - 1995

In fact, at the very beginning, no long-term research project was planned in the safety gallery of the Mont-Terri motorway tunnel. The construction of the Mont-Terri and Mont-Russelin tunnels led to a test program in the exploratory gallery under the direction of EPFL, the Swiss Federal Institute of Technology in Lausanne. A geological survey of the underground outcrops was necessary anyway. It was in this context that the National Hydrological and Geological Service (SHGN) entered the scene. This service, originally attached to the Federal Office for the Environment (SFOE), was associated over the years with various federal departments and administrations. The world of geologists being small, it was therefore not surprising that Nagra was aware of it. In the process, colleagues in other nuclear waste disposal programs around the world also learned about it.

In any case, as early as 1989, experiments in the safety gallery were being discussed between companies, interested administrative bodies and Nagra (SHGN 18.01.1989). A first outline of an experimental program was discussed shortly afterwards (27.01.1989). During the winter, the search for funds for the survey of the underground galleries was started and the licences by the Service des Ponts et Chaussées du Canton du Jura were granted (RCJU 13.02.1992).

However, it was not until 1994 that the search for partners was to be developed (SHGN 23.11.1994). Marc Thury, chief geologist at Nagra, submitted a request to the SHGN, which supported it (Mont-Terri Project 14.09.1994). On October 26, 1994, a more complete research project was presented at a meeting with the competent authorities of the Canton, the Service des Ponts et Chaussées (SHGN 23.11.1994). The project in fact foresaw a phase of scientific experiments between 1995 and 1998, with the possibility of extension. The SHGN was envisaged as responsible to the Canton, which demonstrated that the Federal delegates were aware of the political sensitivity of the issue. In addition, the Geotechnisches Institut Bern became involved in 1996, and Paul Bossart became the project leader until his promotion to director 10 years later.

However, from the outset, the Jura Government had made it clear that the approval of the project applied only to research. The storage or disposal of radioactive waste was excluded from the outset, an issue that subsequently became the subject of numerous interventions and information activities on the side of the Canton. On February 13, 1994, three days after environmental protection organizations (Greenpeace, ProNatura) had submitted a petition with 5,000 signatures calling for a halt to the storage of special chemical waste in the nearby Fours à Chaux underground quarry on the access road to the motorway tunnel, the Jura minister responsible, Pierre Kohler, authorised the hydrogeological test program submitted on November 23, 1994. However, the message was unequivocal: the Canton approved the research project but ensured the independence of the management. Following licensing, the Jura Roads and Bridges Department (Service des Ponts et Chaussées) sent a list of the general conditions to be respected in the framework of the project to the National Hydrogeological and Geological Department on March 31, 1995.

The search for partners, which Nagra was pursuing intensely, was successful: five organisations or research institutes in the field of nuclear waste management signed up. The Mont Terri Consortium was thus created. Marc Thury took over the management of the consortium: He was officially delegated to the SHGN, although he also worked at Nagra's headquarters in Wettingen. In the following two years three new European partners joined the project. The project grew. In September 1997, the Canton of Jura bought back the plots of land of the former lime factory (Groupe de travail 2013), which allowed the Mont-Terri Consortium to conclude a long-term lease for the buildings.

4.2 A first major expansion of the project: 1995 - spring 2000

The main features of a longer-term project, however, were linked to the partners' decision to plan new experiments. For this they needed space and planned a first extension by way of an elongated horseshoe-shaped gallery. This extension was built in the course of 1997 and 1998, creating the necessary space for the continuation of the scientific work and giving the project new impulse (PMT n. d.). The ambitious research program started after the inauguration of the new gallery in September of the same year. After the construction of the gallery and the implementation of the extensive research program the actual consolidation of the project continued. Several new European and overseas partners (Japan) joined the consortium (PMT n. d.). In 2001 the project reached the number of ten partners. In addition, the Canton underlined its support in 1999 by extending the decision on the use of the safety tunnel (Government RCJU 22.06.1999).

However, the successful growth of the project also meant that its management became more and more demanding. As is often the case in a growing project, tensions within the consortium arose. The context of these tensions was not communicated. But the outcome raised questions: Marc Thury, founder and leader of the project for almost six years, withdrew from the project in the spring of 2000 (PMT n.d.). The succession was difficult. Nagra finally proposed one of their scientists, Markus Hugi, as director, and declared itself ready to take over the general management costs. The partners agreed with this proposal. Thus, Markus Hugi was promoted to head of the project and officially assumed his duties at the beginning of the new phase (PMT 24.08.2000). Nagra had thus effectively taken over the leadership of the research project on July 1, 2000. But it had failed to inform the Canton, as well as the federal services, which ended up posing a fundamental problem for the elected representatives of the Jura.

4.3 A break is emerging: summer and autumn of 2000

In fact, Pierre Kohler, the minister responsible for the Canton's Department of Equipment and Environment (DEE), had indirectly learned of the appointment of the new director. The political situation of the Canton in terms of environmental policy was already heavily burdened by the presence of two conventionally toxic waste storage sites, on the one hand in the Fours à Chaux galleries (DMS St-Ursanne, Groupe de travail 2013a) and at the Bonfol industrial waste dump (Ribeaud 2014) on the other. The risk of a new drift of a large waste project on cantonal territory was not accepted by the Jura politicians. Kohler informed the Government, which insisted on the independent management of the project. On September 20, 2000, Kohler informed the SHGN of his surprise at not having been informed of the change of management and the resumption of the project management by Nagra. Several letters followed, including an exchange of letters with the Federal Minister for the Environment Moritz Leuenberger in October 2000. The positions were defined. The Canton was not prepared to accept Nagra managing the project and demanded that the project be taken over by a Federal body.

It was at this stage in the development of the MTP that the historical difficulties of nuclear waste disposal in Switzerland popped up again. For decades the national structures in the nuclear field had followed the primacy that Otto Zipfel, the then delegate for nuclear energy, had already stipulated in 1957: The concrete programs were the responsibility of the nuclear industry, with the power plants essentially in the possession of the Swiss cantons or municipalities. The Federal Government saw no reason to be more involved than necessary in this management. This division of tasks was adopted and pursued by all politicians and administrations of the Confederation. Although the Atomic Energy Act of 1959 was amended by the Federal Decree of October 1978, there was no change in the organisation of responsibilities.

However, the EKRA commission (2002) had pointed out the need to reflect on management structures and models as well as on the financing of the radioactive waste disposal program in Switzerland. In the end, however, Parliament only adopted provisions to strengthen independent research in the new Nuclear Energy Act of 2003 (NEL, Art. 86). A reorganisation of the structures beyond a narrow interpretation of the polluter-pays principle was neither in the focus nor in the interest of the federal administration. As a result, fundamentally different concepts were expressed in the organisation of the research laboratory. These diverging ideas shaped the discussions for the years to come – they were fundamentally different

organisational models with respect to the responsibilities of the various stakeholders. This led to major communication problems and even conflicts among the actors involved.

The federal authorities, in particular the Swiss Federal Office of Energy, supported the historically defined division of responsibilities, which meant that Nagra was considered a legitimate institution for the management of the research project at Mont Terri. It is interesting to note that the federal authorities did neither take into consideration the governance problems in this model nor the difficulties of acceptance of the project by the Jura region. Experience with the two landfill projects mentioned above – particularly in relation to the Greenpeace site occupations in 1994, 1995 and 2000 – had made the cantonal government aware of these issues of public acceptance. The Jura, as a canton fundamentally opposed to nuclear energy, wanted to avoid further political actions of this nature. As already mentioned, this constellation had led to prolonged conflicts between the main actors which became apparent as early as the autumn of 2000 and which fundamentally changed the development of the project.

4.4 Conflicts and a new organisation: 2000 - 2001

What followed in the years to come was a difficult confrontation between these two positions. The Canton demanded a project independent of the interests of the nuclear industry. But DETEC hesitated. In his letter of 10 October 2000, the Federal Minister of Energy referred to the patronage of the SHGN. However, the Canton's considerations went much further: It was not patronage that was desired but scientific independence of the project and – following this logic – a management of the PMT independent of Nagra's interests. On November 7, 2000, the day before the key meeting of November 8 concerning the structure to be given to the research project, Minister Kohler, as a sign of good will, authorised the so-called "Raise boring" experiment in a large diameter borehole which urgently required cantonal authorisation. At the same time he stated that the other experiments would be subject to a separate application which would be processed according to the results of the meeting.

The meeting of November 8, 2000, brought together the Department of the Environment and Equipment and its experts on the one hand, and representatives of the National Geological and Hydrological Service (SGHN) and representatives of the MTP on the other. Kohler imposed the rules of the game: Either the Confederation took over the management of the project or the Jura Government stopped it. "Take it or leave it", said the Jura minister during the meeting. The SHGN decided to go ahead with the project. Two days later, it communicated its decision to take over the management of the project to the DEE, while specifying that an agreement would have to be drawn up between the Canton and the Confederation and a "contract with the research consortium" for the execution of the experiments (SGHN 10.11.2000). Federal Minister Leuenberger (DETEC) confirmed this approval in his letter of December 1, 2000, and announced the need to draw up an agreement for the management of the laboratory between the Canton of Jura and the new organisation at the head of the project, the Federal Office for Water and Geology (OFEG). The SGHN was attached to this new office in 2001. Thus begins a long chapter on the definition and concrete distribution of the responsibilities of the actors involved.

For its part the Jura Government had taken steps to establish a structure and had appointed a temporary working group by decree on December 19, 2000, to supervise and monitor the MTP. The Commission de suivi – as it would later be called – was thus established. It joined the various departments of the Jura state as well as external experts, and in particular the Service des Ponts et Chaussées, which assumed the official supervision of the project on behalf of the Canton (Fig. 1).

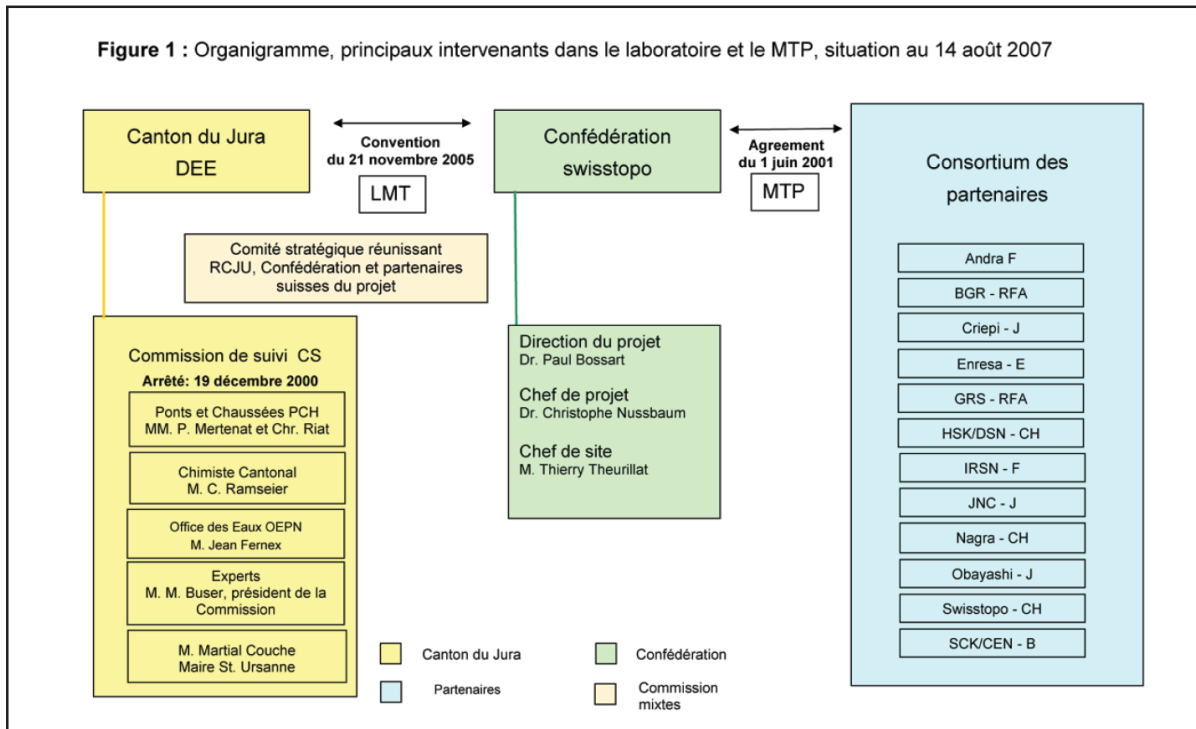


Fig. 1: Organisational chart, main participants in the laboratory and the MTP, situation as of August 14, 2007.

The chair was given to the geologist Marcos Buser, who had been already working on other major projects for the Canton of Jura. Pascal Mertenat, engineer at the Service des Ponts et Chaussées, became his main support in this project and would succeed him as President of the Commission in 2013/2014. The list of tasks was ambitious for a commission of this size: to follow a complex and growing research program, to control the safety conditions in an escape tunnel of a motorway tunnel, and to support the management of strategies and an independent information policy.

The Commission de suivi, CS thus became the major respondent of the project on the side of the Canton. At the beginning of 2001, SGHN was officially informed of the creation of the CS (DEE 12.01.2001). This is how the commission approached the functions assigned to it. It is interesting to recall the tasks entrusted to the commission in view of the subsequent decisions: among other things, they include “notification of authorisations for new phases of the experimental program”, “monitoring and control of the experimental program”, “supervision of the communication policy of the scientific project” and “negotiations with the competent federal authorities or institutions involved in the project”. Other functions assigned are in the area of administrative tasks. All these tasks had to be specified and then implemented, pushing the Commission to the limits of its capacity, given its modest resources. In the end, it was only possible to accomplish these many and varied tasks through exceptionally good internal cooperation and sometimes unconventional methods. For example, the CS would sometimes show up unannounced at the laboratory and point out safety deficiencies on the spot, even though the majority of its members – including its chairman – had forgotten to put on the mandatory protective helmets that day. A little anecdote that was the subject of many jokes. But let us get back to the story.

On February 6, 2001, the CS met for the first time and focused on the new agreement to be implemented (CS 6.2.2001). During the next few months, drafts of the Convention were prepared and exchanged between the SGHN and the CS. The final convention would regulate the rights and obligations of the signatory parties. Transparency was key in this new agreement.

At the same time, SGHN (OFEG) and the partners drew up a contract between partners (agreement) which regulated the rights and responsibilities between the parties. On May 23, 2001 the Convention was signed by the Jura Government and the OFEG. On July 1, 2001, the Federal Office for Water and Geology (FOWG)

took over the project and appointed the head of the National Hydrological and Geological Service, the geologist Peter Heitzmann, as director. The Canton of Jura was satisfied – it had obtained the necessary guarantees for independent management of the laboratory. But new difficulties would soon arise.

4.5 The conflict brews and breaks out: 2002 – 2005

Despite this success, the situation was not really relaxed. There were problems with the management of the project by the National Geological Survey. The Canton had wanted a more determined commitment by the Confederation. In addition, the situation was aggravated by the fact that the project manager had fallen ill. He was replaced at the beginning of 2003 by Marc Thury, who was invited to take over the management for a second time. However, the disagreements between the project and the Canton continued under his leadership. The roles of the different actors had not been sufficiently clarified. The Canton and its then minister, Laurent Schaffter, were under pressure. The minister asked the CS to look for solutions. To this end, the Commission contacted certain partners of the MTP, representatives of Swiss institutions and independent external scientists. As a result of these consultations, the Commission developed possible management models and submitted them to the minister and the Cantonal Government (Fig. 2). Subsequently, the government clearly expressed its support for the existing structure.

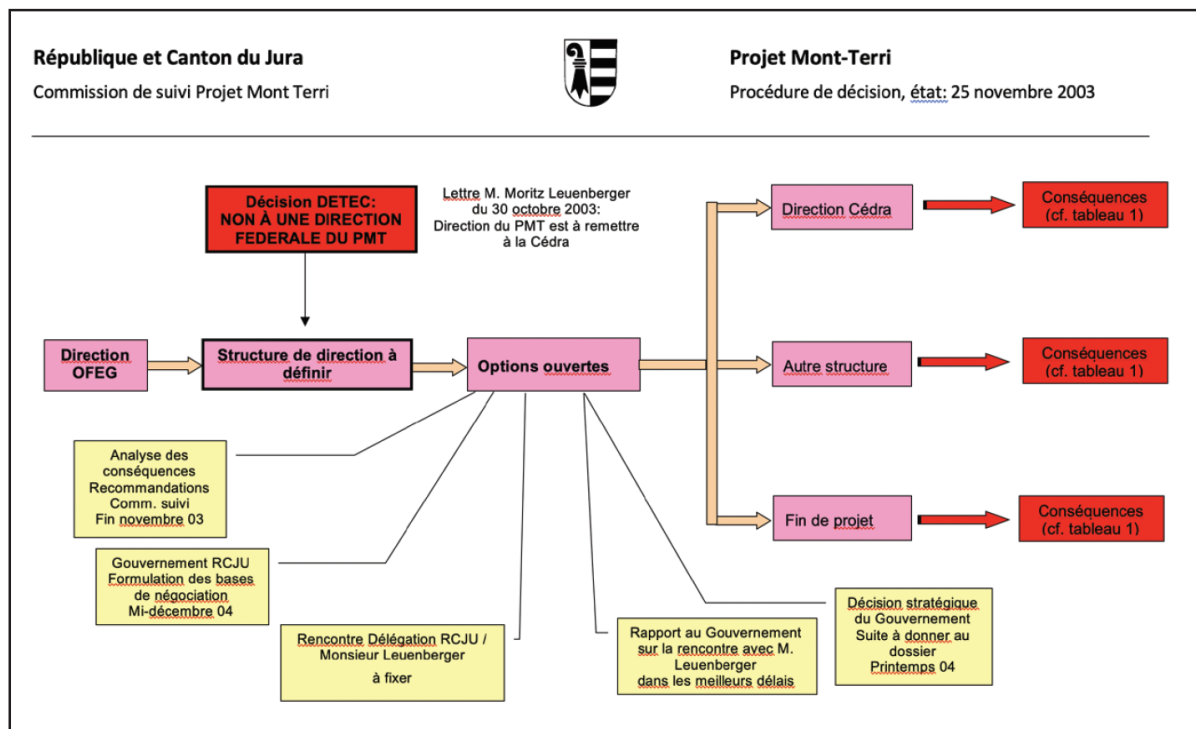


Fig. 2: Open options for the reorganisation of the structures studied and submitted to the government. The takeover of the project by Nagra was rejected by the Jura Government, which still wanted a federal institution to head the project.

For their part, the Federal Government and Nagra considered a new project structure. The polluter-pays principle was once again brought to the fore. This led to the project being managed by the waste producers themselves. This solution was unacceptable to the Jura Government. From 2003 onwards, conflicts between the actors made it increasingly difficult to reach agreement between the parties. The day-to-day work had become difficult. Exchanges of letters followed. The federal minister even expressed his wish that the management of the laboratory be taken over by Nagra. The pressure was mounting. It was a power game in

which the various players were trapped. Faced with this situation, Thury addressed a memorandum to one of Nagra's executive directors on April 5, 2004. He commented on the need to reform the MTP, suggesting that it would be more realistic to aim for "a program to promote acceptance that would allow Nagra to take over the project in the near future" (Marc Thury, 05.04.2004).

The Cantonal Government again refused in April 2004 (Gouvernement RCJU 27.04.2004). It implied that it would re-evaluate the granting of the operating permits for the laboratory in case of withdrawal by the Confederation. Faced with this situation, the Confederation finally gave in, without committing itself further to the project. Finally, the Federal and Jura Governments agreed to a meeting. This was held on 9 September 2004 in Bern. Several issues were discussed, in particular those relating to the restoration and backfilling of the Fours à Chaux galleries, which had been blocked for years, and the Mont-Terri laboratory. The Confederation had to take note of the fact that the Canton was not ready to give in. The question of Nagra's management of the laboratory was thus definitively out of the question. This episode marked the beginning of a new phase in the search for a solution to replace the OFEG. DETEC was no longer interested in becoming involved in the MTP. The OFEG was dissolved for reasons unrelated to the MTP. In addition, the National Hydrological and Geological Survey had to be transferred again. It was attached to swisstopo in the Federal Department of Defence, Civil Protection and Sport (DDPS). From spring 2005 onwards, a new agreement was negotiated, which will occupy the Monitoring Commission in a prominent way. A new director was appointed: Paul Bossart, who has led the development of the MTP with great success until January 2006. With the definitive takeover of the project by swisstopo, peace was at last restored to the project. The Jura government finally imposed itself. This was probably the turning point for the institutionalisation of the MTP structures and for the relations within the project.

4.6 Interim assessment of the structures

In retrospect and from the point of view of cantonal interests, three elements should be noted in the development of the project structures. First, the eminently important role of the political-economic model of the Swiss economy must once again be emphasised. The liberal attitude of the Swiss society model is expressed in the primacy of the economy over other public interests. It is therefore not surprising that environmental protection in Switzerland, and in particular the long-term consequences of economic action, is not the subject of reflection on the sustainable organisation of public interests. This applies particularly, but not exclusively, to the use of nuclear technology. On the other hand, the chemical industry also faces a similar challenge, although there are significant differences in the way potential environmental impacts are handled.

This framework condition must be considered as one of the fundamental problems resulting from the use of nuclear energy. It has become particularly evident in the area of nuclear waste disposal. Management models have been subordinated to economic interests. The state has determined the framework conditions but has not taken on (or has not wanted to take on) the tasks of monitoring and controlling the processes. Under these conditions, the possibilities of intervention or even correction were limited. In the end, this model has weakened the interests of the public sector, which is the last safety net in case of crashes or budget overruns of mega-projects running out of control.

The second factor that arises directly from this form of organisation is related to the dependencies and asymmetries that result from it. The use of available financial resources is the simplest way to demonstrate this. The structures are based on the principle of "who pays commands". If resources are allocated unilaterally – as is the case with the Swiss organisational model and the strict application of the polluter-pays principle – it is the causer who manages a process entirely on his own terms. He therefore also controls the research. Scientific interests beyond the narrow circle of its interests have little opportunity to develop. In this way, development opportunities shift very unilaterally to the resource holder. This weakens the monitoring authorities, amplifies the asymmetries in terms of competence and know-how, and leads to a weakening of the control function. This is an essential reason why the CS has always tried, within its limited budget, to

ensure a minimal supervisory function for the current research programs and thus to ensure its knowledge of the scientific development of the project.

Finally, it is precisely the problems of asymmetry and ultimately of governance arising from such an organisation that become evident. Until its expansion into new research fields (CCS, geothermal energy), the MTP was characterised by the participation of institutional bodies for radioactive waste management as well as regulatory authorities or their research institutes in the nuclear field. The project management established during one phase of the project by the Swiss cooperative of nuclear energy producers posed two additional problems: on the one hand, an organisation defending the interests of the waste producers thus managed a research platform in which its own supervisory authorities were also involved. On the other hand, the cooperation of waste management agencies and regulatory authorities in joint experiments within the framework of the same research project thus posed a fundamental problem for the governance of the process and the credibility of its results. Public and scientific acceptance of such a process are hard to win.

Beyond political considerations, these questions were at the heart of the CS logic of action. As a control and supervisory body, such a commission had to be able to intervene in the processes when a project went astray in terms of structure or governance. Strong control and supervision ultimately strengthened the fundamental aspects of the MTP, even if the operator and certain partners did not always appreciate the actions of the Canton.

4.7 Tasks, successes and failures of the monitoring commission CS

In the following, the most important activities of the Commission are briefly described.

On the one hand, the activities of the CS were already laid down in the government decree, and on the other hand, they have developed selectively over time. Two areas of activity have been particularly demanding for the CS: the monitoring of research in the laboratory through the examination of annual research programs, and the safety requirements. Let us not forget: Until 2000, the Canton of Jura was responsible for the Jura part of the A16 freeway. As of January 1, 2008, the freeways were transferred to the Confederation. This automatically resulted in new ownership conditions: The Canton was only responsible for the laboratory, while the Federal Roads Office (FEDRO) became the owner of the tunnel. This change in ownership meant that the agreement between the Canton and the Confederation had to be modified and new agreements became necessary. FEDRO became more involved in the CS and was given the seat of vice-presidency of the Commission. In this way, the cantonal and federal supervision of the project was combined. The following is a brief summary of the Commission's activities.

4.7.1 Safety concerning laboratory, access, work and risk

In the early phases of operation, the operators and the Canton placed only limited emphasis on safety measures in the laboratory and in the safety tunnel. This situation changed fundamentally on September 11, 2003. On that day, part of the vault of the 2004 tunnel under construction collapsed within a few hours. The stability of the massif had been overestimated. This led not only to a clear expansion of stabilisation measures (anchors, shotcrete, etc.) on the galleries but also to systematic measurements of the convergence movements of the galleries. From then on, the canton required an annual monitoring report, the so-called “report on the conservation of the structures”, which now presented convergence measurements and assessments as well as the resulting safety and maintenance measures by the operator in the autumn of each year. When the laboratory was extended in 2008 (Gallery 08) pore water flows appeared, suggesting a direct reaction of the rock to the drilling carried out with tunnel boring machines. These phenomena were repeated during the construction of the new gallery from 2018. This is a very important observation, as the construction of a deep geological repository will require alternating construction and storage phases.

A second very important effect of large drilling operations was the production of dust. Here, too, the CS has always intervened in a targeted manner. In 2008, major discussions took place between the operator and the Canton regarding dust detection in the safety gallery. Analysis of the dust by X-ray diffractometry showed

that the dust consisted mainly of fine particles of Opalinus clay. This result led the laboratory operator not only to take over the cleaning operations in the safety gallery but also to employ effective filter systems during the drilling operations from then onwards.

The most important effect of the CS's supervision was related to the planning of measures to be taken in the event of a serious accident. The Canton required a number of safety measures that were implemented progressively from 2006: a survival cell in case of an underground fire, risk analyses of various serious accident scenarios, implementation of protective measures (fire detectors, extinguishing and alarm measures, evacuation measures, drills, pressurisation of the safety gallery from 2010 onwards, etc.). The development of this safety culture took many years and is still ongoing. A "safety concept" report is updated every year, thus enabling the continuation of the efforts and the modernisation of the protective measures for the users of the laboratory.

The last field of CS activity was the radon measurements inside the laboratory (and the former lime kiln galleries) by the former Jura cantonal chemist and the strict monitoring of the various experiments with radioactive tracers or probes with high radioactive sources in boreholes. Supervision was strengthened within the Commission by involving the former president of the Federal Commission for Radiation Protection.

Although swisstopo resisted more effective safety measures for many years due to a lack of financial resources, the Canton maintained its position. Yet friction has long persisted. In September 2011, an incident occurred at the north gate of the survival space, without the CS – and thus the Canton – being immediately informed. Minister Philippe Receveur threatened to close the laboratory if the processes required by the Canton were not applied. Following this latest dispute between the operator and the Canton, swisstopo secured the necessary funds for the safe operation of the underground laboratory. This episode marked the end of the conflictual relations. From now on, both parties have cooperated in a mutually profitable manner. The laboratory manager and the partners are now pleased with the high level of safety of the galleries. This success has shown the decisive role of firm, economically and politically independent control authorities.

4.7.2 Research and experiments

A second axis of great importance for the Commission was the follow-up of scientific experiments. From the moment it took office, the CS has closely followed the research. Not only did it monitor the progress of the annual projects which are the basis for the annual approvals but it also examined in particular those experiments that involved (operational) risks or were of great importance for public acceptance. It should not be forgotten that the ongoing Swiss Sectoral Plan for deep geological repositories also focuses on the research carried out by the Swiss partners, especially Nagra, at Mont Terri. In addition, the cantonal experts perform other important functions in the field of Swiss programs for radioactive waste management or radiation protection. From the outset, therefore, the Commission has placed research and the promotion of research at the heart of its activities, with mixed success. Some initiatives were successful, such as the proposals in 2000 to have a group of researchers from the Geological Institute of ETH Zurich (Prof. J. McKenzie) study the questions of microbiology and gas production. Nagra has taken up this idea and coordinates this research with other partners. The proposal made by the Commission in 2003 within the framework of the "long-term research program" to launch a project for systematic information campaigns was also successful. Starting in 2008, swisstopo, Nagra and the supervisory authority, the Swiss Federal Nuclear Safety Inspectorate ENSI, planned and implemented the "Visitors' Centre", which provides information on the laboratory's research and on the sectoral plan for deep geological repositories to interested organisations, scientists, politicians and the general public.

Other research ideas have been taken up only partially, if at all. In 2003, four former members of the EKRA Commission (Buser, Hufschmied, Keusen, Wildi) proposed experiments with the so-called "pilot" repository and monitoring concept, but these did not generate the necessary interest for implementation. Similarly, experiments on the storage of radioactive materials (Laboratory A), which are extremely delicate for reasons of public acceptance but absolutely necessary for the proof of safety, could never be discussed. A final failure was the idea put forward by the CS to develop a systematic research plan (in the sense of the Earth Science

Technical Plans for Mined Repositories [DOE 1979]). This idea seems to be beyond the strategic and financial scope of the research project.

However, as already mentioned, the Commission has followed the research developments as well as possible. In addition to diffusion experiments with radiotracers, these are mainly experiments with gases (in particular hydrogen or supercritical CO₂). In these cases, the commission required risk analyses, each of which was performed by an external specialist. Other experiments were examined in depth. This applies mainly to the two experiments EB and FE, which have already yielded significant results concerning the corrosion of the steel packages or the thermal, hydraulic and mechanical effects of the heat from the steel packages on the emplacement filling bentonite as well as on the gallery walls.

4.7.3 Other Activities

Process control played a major role in the supervision of the project. It was not only the approval of the annually submitted research projects that proved to be important. Regular participation in steering meetings and technical meetings as well as personal reports were also helpful. Also the information programs played an important role for the Canton. Of course, they have been the focus of the laboratory operators' interests, without being neglected by the Canton.

The Commission's activities over the years have included regular information to the responsible minister and the government, strategy development, negotiations, meeting preparations, coordination between the Canton's services within the framework of the MTP, monitoring and control of the facilities, development of ideas for the training of young people and for scientific monitoring [think tank], etc. Over the years, the Commission has also visited nuclear facilities such as Zwiilag in Würenlingen, the Soulaines-Dhuys storage facility and the Bure laboratory in France, organised the reception of Opalinus marl from the laboratory extensions and its interim storage in the Fours à Chaux caverns, and participated in information days and conferences.

5 Final remarks: The Mont Terri project, the role of the Canton and the monitoring authority in the light of recent international development

The involvement of the Canton of Jura in the Mont-Terri Project, MTP is part of the almost simultaneous projects for the remediation and backfilling of the former lime kiln galleries of Fours à Chaux and the remediation of the Bonfol landfill for industrial waste. Without the experience of these two projects, the commitment of the Canton could not be properly assessed. On the one hand, there is the requirement, formulated from the outset, to prohibit storage or disposal of radioactive waste in the laboratory. On the other hand, the need for close monitoring of the project by a Commission de suivi, CS with the necessary competencies is the result. In this sense, it took years to establish and implement an operating model for the laboratory that ultimately corresponded to the interests of the Canton and the Confederation. The fact that the interests of the nuclear industry were able to be put on the back shelf and that the laboratory was finally run by a department of the federal administration can be considered a great success for the Canton. Especially since even Nagra supports the current organisational structure, with the project being managed by a state agency. But that is not all: This organisational model has created an essential basis for a research platform that is more independent of industrial interests. In this respect, the chosen annual licensing model has strongly contributed to the success of the project; it requires continuous monitoring of the project and a thorough review of program proposals by the Canton, but at the same time ensures a close exchange between the operator and the authorities.

The fact that the international partners supported this model can also be considered a special success. The model finally chosen has allowed the project to further open up and to consider new areas of research. This would not have been possible in a laboratory run by the nuclear industry. The experience at Mont Terri shows, by way of example, that close supervision and strict control by a state supervisory authority can only

strengthen a project. The Canton's strategic foresight and the establishment of a clear operational framework played a major role in this development. The fact that the partners in the research project also accept the exemplary nature of the security requirements shows how important it is to establish such framework conditions.

If we examine this organisational model in the light of the current international development, it becomes clear how visionary this approach to independent – and therefore credible – leadership of such a project was at the outset. In recent years in particular, radioactive waste management has been increasingly viewed from the perspective of organisational challenges. A particularly interesting development can be observed in Germany. After decades of failure, the various parties involved have reached a more or less accepted agreement on the launch of a research program for deep geological repositories for radioactive waste. On May 5, 2017, the so-called Site Selection Act (Stand AG) came into force. It regulates the search for repository sites, defines the appropriate structures for this search process and contains, among other things, two specific basic regulations. On the one hand, it defines the search process as “a participatory, scientific, transparent, self-questioning and learning process”, which is to result in the siting of a long-term safe repository for the storage period of one million years. The wording is remarkable, because the “participatory” element requires the cooperation of society and the public, the “science-based” approach implies strong and open scientific research programs and processes, and transparency means not only making the impact visible, but also revealing conflicts and criticism. Above all, the “process of self-questioning and learning” aims at what a culture of error and safety seeks to achieve. A culture that nuclear energy has been boasting for decades and which, as in aviation, should allow for learning from mistakes. Because: to learn from one's mistakes, one must of course be able to talk about them openly and sincerely. This is the core of any learning process. On the other hand, the siting law uses a simple model with state organisational structures: a project promoter (Federal Company for Disposal BGE), a supervisory authority (Federal Office for the Safety of Nuclear Waste Disposal BASE) and a national supervisory committee independent of special interests (Nationales Begleitgremium), which is to mediate any interests in the social debate and to guarantee the necessary transparency and acceptance of the process. Thus, these two fundamental principles of organisation and operation are reflected in the objectives and structure of such a program.

If the Mont-Terri Project is looked at from this angle, we see that it has been based on these same two essential principles for almost two decades. The first agreement signed by the contracting parties in 2001 – the 2001 Convention – was based on these very words. It determined and ensured that a strong structure independent of vested interests would be established and that a solid monitoring structure would accompany the project and the research program in the service of the public. The outcome today is encouraging and can in fact be seen as an example of how – despite all the difficulties and disputes – the credibility of such a program can be built on a respectful, critical and open interaction between the three stakeholders of the deep geological repository project: the manager, the monitor and the public.

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Abbreviations

CS Commission de suivi

CSS Carbon dioxide capture and storage

DDPS Federal Department of Defence, Civil Protection and Sport

DEE Department of Equipment and Environment (Department of Environment)

DETEC Department of Environment, Transport, Energy and Communication

DSN Main Nuclear Facilities Security Division

EKRA Commission on "Radioactive Waste Management Concepts"

ETH Federal Institutes of Technology

GNW Wellenberg Nuclear Waste Management Cooperative

IFSN Federal Nuclear Safety Inspectorate

LENu new nuclear energy law

MTP Mont-Terri Project

Nagra National Cooperative Society for the Disposal of Radioactive Waste

OFEG Federal Office for Water and Geology

OFEN Federal Office of Energy

OFEFP Swiss Agency for the Environment, Forests and Landscape (now the Swiss Federal Office for the Environment SFOE)

OFROU Federal Roads Office

PCH Roads and Bridges Department (Infrastructure Department)

SHGN National Hydrological and Geological Service