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ENVIRONMENTAL RESTORATION PLANS AND ACTIVITIES IN FRANCE: 1995-1996 PROGRESS REPORT

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Abstract

In 50 years, more than 200 mining sites and 11 processing plants have contributed to French uranium production. At present only two mines are still in production. The others have already been restored or are in the final phase of restoration.

This report gives a retrospective account of developments and statutory actions currently in progress, with examples of sites at various stages of restoration. The importance of research and development studies as well as efforts being put in to communicate with all the parties concerned in these restoration projects are specially emphasized.

1. REVIEW OF SITES IN FRANCE

The prospecting carried out since 1946 indicated major uranium bearing districts in France. Uranium resources are related to certain types of granite from hercynian massifs (Massif Armoricain and Massif Central) and grounds of the Permian or lower Tertiary resulting from erosion of the massifs.

Thus uranium ores mined in France were located in granitic and metamorphic areas (Vendée, Massif Central, Limousin) or sedimentary areas (Lodève, Coutras).

TABLE I. URANIUM SITES IN FRANCE

Rocks	District	Year of discovery	Geographical location
Granitic	Vendée	1951	Near Cholet
or	Limousin	1948	Near Limoges
Metamorphic	Forez	1947	Near Roanne
Sedimentary	Lodève	1957	Near Montpellier
	Coutras	1974	Near Bordeaux

A total of 53 million tonnes of ore has been mined, containing nearly 87,000 tonnes of uranium; 81,000 tonnes of uranium was produced in the form of concentrates (1995 figures).

TABLE II. URANIUM ORE EXTRACTION (10^6 t) IN FRANCE

Mining sites	Vendée	Limousin	Forez	Lodève
Mined out ore	13.3	24.8	2.6	4.4

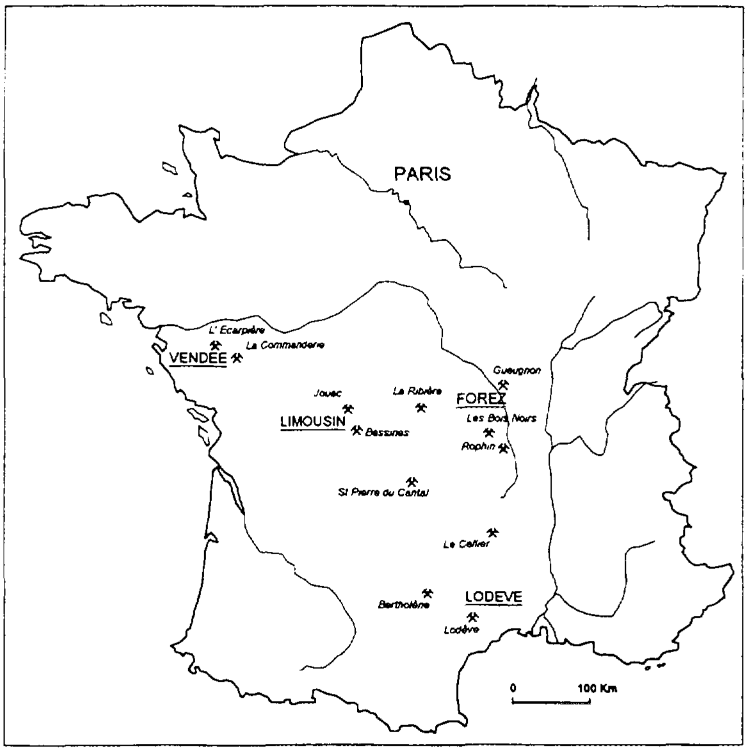

FIG. 1. Location of mining areas in France

Over the years uranium mining in France by COGEMA and its subsidiaries has lead to:

- more than 200 mining sites, three fourth of them being of area one hectare or more. Whether open pit or underground mining, the associated waste dumps have to be dealt with;
- 11 industrial sites with mill or heap leaching operations;
- 22 storage sites with residues from ore processing.

Total areas for the industrial sites and the associated impoundments range from three to more than a hundred hectares.

Due to the very low grade of uranium ore treated in France (average 0.15%U or 0.23%U if low grade ore is excluded) more than 98% by weight goes to waste and as such large tonnages have to be dealt with. By the end of 1995, a total of nearly 50 million tonnes has accumulated.

Dismantling of a mill leads to several thousand tonnes of slightly contaminated concrete debris and scrap. The most contaminated equipment are those used for chemical attack of the ore and resin extraction of uranium. The estimated radioactivity is less than one percent of the activity treated during the life time of the mill and the calculated radioactivity of the impoundment takes this into account.

Types of storages are either piles of heap leached ores or impoundments of mill tailings. Impoundments are limited by dikes or by open pit.

The present status of remediation is as follows:

- production completed; remediation completed: Gueugnon, Les Bois Noirs, Le Cellier;
- production completed; remediation in progress: L'Ecarpière, Bessines, Saint Pierre du Cantal, Bertholène;
- production in progress; remediation projected, or in progress by stages: Jouac, Lodève.

TABLE III. TONNAGE OF RESIDUES (10^6 t) OF THE MAIN STORAGE SITES IN FRANCE

Site	Forez	Vendée (Ecarpière)	Limousin (Bessines and Jouac)	Lodève	Cellier
Dumps of poor ore	none	none	none	0.8	none
Static leaching residues	none	4	8.6	none	4.5
Dynamic leaching residues	1.3	7.6	15.0	4.0	1.1

2. REGULATORY ASPECTS

Uranium mining activities in France are controlled under the general jurisdictional framework of extraction industry, with special provisions relevant to the radioactivity of the handled materials.

The Mining Code is the central point of the mining regulation; it refers to other Acts and Rules coming from the general regulation in France. The most important of these are:

- Act No 76-629 relating to the Protection of the Nature,
- Act No 76-663 relating to the Registered Facilities for Environmental Protection,
- Act No 83-630 relating to the Democratisation of the Public Inquiries and to the Environmental Protection.

These Acts are completed with regulations on Water, Air, Wastes, Noise and Landscape Protection.

2.1. The Mining Code

The objectives of the Mining Code are:

- to promote the development of natural resources by improving the extraction conditions,
- to enhance the state control over the natural resources management, and
- to reinforce the administrative supervision to achieve a better interaction of the extractive industry with the environment.

The Mining Code defines the relation between the owner of the surface, the mine operator and the State which owns ground resources of uranium.

It sets up two basic principles:

- remediation is mandatory, and
- the mine operator remains always responsible for the damages caused by the mining activity even after mine closure, except where the liability of a third party is proven.

It defines in detail:

- the task of the regulatory bodies involved in mining: occupational and public safety, environmental protection ;
- the process of licensing in mine and mill projects: before the beginning of exploration or production activities, the mine operator must ask for an administrative authorisation ; the process includes an environmental impact statement and a public inquiry. The license establishes constraints relating to the protection of the environment ;
- the process for the mine closure: before the mine closes, the operator must make a declaration to the administration; the file explains the measures to be taken to lessen or to mitigate the residual impacts of the activities. The administrative authority gives approval in the same way as before starting the operations.

A leading part of the mining code deals with occupational and public safety and thus implements the principles for protection against ionising radiations; dose limits are set to 5 mSv per year (according to ICRP 26 recommendations), calculated in addition to the natural background, using a theoretical exposure scenario for a critical group.

2.2. Registered Facilities for Environmental Protection Regulation

General French regulation stipulates operators of some potentially hazardous facilities to be licensed. The detailed list of such facilities is frequently updated. Some of them operate mines, maintenance shops, crushing plants or tailings ponds.

The file for licensing contains an environmental impact statement and risk analysis with a description of possible contingencies and consequences and organizational set up to deal with emergency situations. The licensing process includes administrative and public inquiries. The license fixes prescriptions for the operations, particularly concerning environmental releases and waste management, site monitoring and organizational structure. Financial guarantee provisions included to cover the costs of site monitoring, corrective measures in case of pollution and site reclamation are clearly stated.

An administrative process is also required to close this kind of facilities; the licensing file and process are similar as for a mine closure and the administrative approval stipulates conditions of site remediation and monitoring.

2.3. Changes occurring over the period 1995 - 1996

The period 1995-96 was mainly notable in the field of environmental protection, for the promulgation of the Act No. 95-101 of February 2, 1995, regarding the reinforcement of environmental protection.

This Act introduces, into French law, general principles on environmental law that are largely inspired by international law. These are the principles of precaution, preventive action, participation and polluter-payer.

The principle of precaution is the principle according to which lack of certainty with regard to current scientific and technical knowledge must not delay the adoption of effective and appropriate measures aimed at preventing risk of serious and irreversible damage to the environment, at an economically acceptable cost.

The principle of preventive action and the correction of detrimental effects on the environment at source as a matter of priority, involves the utilization of the best techniques available at an economically acceptable cost.

The principle of participation gives every citizen the right of access to information regarding the environment.

The polluter-payer principle makes the polluter responsible for the expenses incurred on preventive measures, reduction of pollution and pollution control.

This Act also reinforces the right of Associations to take action in the field of environment by giving them the opportunity of instituting proceedings in cases of pollution.

The period of 1995-96 also saw the publication of two enforcement decrees completing the statutory provisions concerning mines and installations classified for protection of the environment.

Two of the new provisions to be noted are:

- The prefectural order authorising the opening of mining works to stipulate the conditions under which analyses, measurements and the results of tests shall be brought to the knowledge of the public. These provisions will, naturally, be applied in the field of monitoring of the environment of closed-down mining sites as well.
- The methods of establishing the financial guarantees required to cover the costs of site monitoring, corrective measures in the event of pollution and restoration on the closure of classified installations to be defined precisely.

2.4. Future development

The main development for the coming years will concern the incorporation of the EURATOM 96/29 directive of May 13, 1996 defining the basic standards regarding the protection of the health of the population and workers against the hazards of ionising radiation into the French Law.

This European directive takes into account the recommendations of ICRP 60 and defines the dose limit to be complied with for members of the public at 1 mSv per year instead of the current level of 5 mSv per year.

The effective dose is calculated on the basis of a realistic exposure scenario, whereas the scenario currently used can be qualified as very conservative.

3. ENVIRONMENTAL RESTORATION ACTIVITIES IN 1995-96

It would take too long to review all the sites concerned and looking at the most significant ones, the sites could be grouped into three categories: sites in service, sites no longer worked and currently in the process of restoration, and restored sites under monitoring. This leads to a logical chain of remediation tasks.

3.1. Sites in service

3.1.1. Lodève

The Hérault Mining Division is located in the immediate vicinity of the town of Lodève in the south of France. Activities started in 1975 with the development of the underground mine followed by open pit operation in 1978. As of the end 1995, the plant produced approximately 12,300 tonnes of uranium as concentrates. Mill tailings were stored in two disused open mines located side by side and known as "Failles Centrales" (Central Faults) and "Failles Sud" (South Faults) with a total area of 60 hectares including a tailings area of 30 hectares.

The restoration of the open pits was undertaken as and when they were closed, the main measures generally consisting of partial backfilling of excavations and landscaping of waste rock dumps which were remodelled and replanted.

Three sites with an approximate area of 10 hectares each were restored in this way.

Filling of the excavation of the "Central Faults" was completed in 1987 and covering tests on about one-third of its area were conducted as from that date. These tests contributed a wealth of information for the restoration of these storage sites.

The stopping of production at Lodève is scheduled for mid 1997. In recent years a major development is seen in the preparation for site restoration in the following fields:

- Studies concerning tailings storage facilities: geotechnical stability of the of tailing containments, geomechanical stability (erosion resistance) and geochemical stability of coverings, and geochemical changes in the tailings.
- Studies concerning the underground mine: the main study concerns the site hydrogeology which should allow the phenomena resulting from the rising of water levels during mine flooding to be predicted and the consequences to be forecast. This study required drawing up a complete inventory of the water inflows into the underground mine and to characterise them.
- Works: a second test covering about one third of "the Central Faults" pond was conducted to measure the radiological effectiveness of a 1 m thick layer of non compacted waste rock. Radon exhalation measurements were made directly over the tailings and after covering, and compared with measurements made over the waste rock dump. This test showed that the radon exhalation was only due to the waste rock.

3.1.2. Jouac (Limousin)

The Jouac mining company (Société des Mines de Jouac), a French subsidiary of Cogema, has been working the Bernardan deposit in the Limousin region in the north-western part of the Massif Central since 1978.

Extraction, which began with an open pit, is currently being continued as an underground mine with a plant to process the ore. From the beginning and up until the end of 1995, it produced approximately 6,200 tonnes of uranium in concentrates. The mill tailings are stored in cells separated by containment dikes with a maximum thickness of 15 metres. Two cells are in service and two others have already been filled and are in the process of being restored. The total area of this storage installation is 34 ha and the stored quantity is 1.3 million tonnes.

This storage facility restoration work forms part of the normal working cycle of the mine which is expected to operate for a few more years.

Action is under way which will, when the time comes, have the effect of anticipating and facilitating the closing of this mining complex. The following points should be noted, in particular:

- the drawing up of a study of all the waste generated on the site and the implementation of specific measures to reduce detrimental effects on the environment by means of, in particular, sorting out and recycling ;
- the hydrological and hydrogeological study of surface and underground water flows in the site's future configuration ;
- the radiological monitoring of the two restored storage cells.

3.2. Sites currently being restored

3.2.1. L'Ecarpière (Vendée)

The mining complex of L'Ecarpière is located in the west of France, 30 km south-east from the town of Nantes. Its surface is 240 hectares. It comprises:

- an underground mine and three open pits from which a total of 4,100 tonnes of uranium was extracted between 1953 and 1991,
- an ore processing complex fed by the L'Ecarpière mine and, also, by other mines in the Vendée Mining Division. A production of 14,800 tonnes of uranium was achieved, most of it (13,500 tU) by an ore processing plant, which was complemented (1,500 tU) by a heap leaching installation which operated from 1967.
- a settling pond for ore dynamic mill tailings. The peripheral containment dike was built up gradually, using the coarsest part of the tailings. The final state of the dike is: height varying from 15 m to 50 m, length 3 km, maximum tailings thickness 40 m.

Restoration of the L'Ecarpière site began in 1992 and had reached the following stage at the end of 1994:

- Open pits: restoration completed. This consisted of backfilling two excavations with waste rock materials, resloping and flooding the third one, resloping and recontouring the waste rock dumps and replanting the sites.
- Mine installations and processing plant: dismantling was completed and debris was stored on mill tailings.
- Tailings pond: work was in progress. This consisted of covering the residues to minimize the radiological impact to as low as reasonably achievable (and less than 5 mSv), to get a good control on the run off of rain water, and in replanting vegetation to limit erosion and ensure landscaping.

The main characteristics of the site are summarised in Table IV.

TABLE IV. CHARACTERISTICS OF THE L'ECARPIÈRE SITE BEFORE RESTORATION

	Area (ha)	Tonnage (10^6t)
Open pit	115	
Underground mining installations	12	
Heap leaching facilities	16	
Heap leaching dump	9	4
Mill	6	
Mill tailings pond	73	7.6
Waste water collecting zone	9	

The years 1995 and 1996 were essentially dedicated to the following tasks on the storage of tailings:

- The mill structure was demolished.
- Dismantling debris of the mine installations and the plant was covered at the same time as the tailings.
- The multi-layer cover for the storage facility was installed. This consisted of 1 to 8 metres of static leaching tailings, approximately 30 cm of compacted altered gabbros (by-products of a quarry near the site) and 10 to 15 cm of top soil. In all, 3.5 million cubic metres of material were moved.
- Two chambers were constructed on the tailings storage facility to receive the sludge produced by water treatment.
- The whole water drainage network is in place.
- Sowing of the site for vegetation has been completed.

All the work was carried out in compliance with the restoration project approved by the administration in November 1995. In appreciation of the quality of work performed, Ph. Crochon, the engineer in charge of the restoration of sites in Vendée, was awarded the "Environment" prize by the French Association for the advance of sciences (Association Française pour l'Avancement des Sciences) in 1995.

3.2.2. Bessines (Limousin)

The Bessines complex is located in the Limousin region, in the western part of the Massif Central. After the start up in 1958, the processing plant produced a little more than

27,000 tonnes of uranium in concentrates by the middle of 1993. Most parts of this was supplied by the five leading mines (50 extraction sites) in the Crouzille mining division. There are two types of mill tailings:

- heap leaching tailings on the Bessines site,
- plant mill tailings. These were, at first, tipped into a pond created by means of a dike ("Lavaugrasse") then in a disused open pit ("Brugeaud") located on the same site and finally, in two disused open pits situated a few kilometres from the plant ("Montmassacrot" and "Bellezane").

TABLE V. CHARACTERISTICS OF THE BESSINES INDUSTRIAL SITE

	Area (ha)	Tonnage (10^6 t)
Heap leaching	25	8.6
Mill	20	
Lavaugrasse pond	35	5.7
Brugeaud pond	20	5.8

Restoration work on the Bessines site was begun as soon as the plant was shut down and is conceived similar to that followed for the L'Ecarpière site:

- The static leaching tailings are used to cover the Brugeaud pond. A first cover formed in this way is approximately 2 m thick. A platform is created to receive scrap iron and other scrap from the dismantling of the processing plant. The whole facility is to be covered over with heap leaching wastes and waste rock from the former open pit. The total thickness of the cover is projected to vary from 2 to 10 m.
- The tailings and the Lavaugrasse pond dike is covered with heap leaching wastes and at least 2 m of waste rock from the disused open pit, with the exception of 2 hectares area developed as a storage chamber for the sludge produced by the water treatment plant.
- The dumps of the former open pit are recontoured.
- A selective water collecting network is constructed.
- The whole site is replanted with vegetation.

It is planned to move 2.5 million cubic metres in the course of all this work.

In 1993 and 1994, the work mainly consisted of dismantling the plant and the heap leaching installations and in covering the Brugeaud pond and the dike of the Lavaugrasse pond. The Lavaugrasse pond was, in fact, used as an industrial water reservoir and could only be emptied after the closure of the plant.

The covering work of the ponds continued in 1995 and 1996. They are now in the process of being completed and less than 500,000 cubic metres are still to be moved. Good progress has also been made in finishing work and one part of the site has already been replanted. The plant has been completely dismantled and the debris and scrap iron has been stored in the Brugeaud pond and is waiting to be covered.

All this work, carried out in compliance with the restoration project approved by the administration in December 1995, involved moving of large quantities of materials. The quantities moved per year are summarised in Table VI.

TABLE VI. QUANTITIES OF MATERIAL PLACED ON PONDS (10^3 m^3)

	1993	1994	1995	1996 (prev.)	Total
Brugeaud pond	20	310	340	70	740
Lavaugrasse pond	0	335	565	540	1,440
Total	20	645	905	610	2,180

3.3. Restored sites under monitoring

3.3.1. Les Bois Noirs (Forez)

The mining complex of Les Bois Noirs is located in the Massif Central region of France. It was worked from 1955 to 1980 and produced 6,400 tonnes of uranium in concentrates. The complex included an open pit, an underground mine mainly worked by cut and fill, an ore processing plant and a settling pond formed by means of a dike.

The site restoration was undertaken as follows:

- In the first stage just after the closure of the mine, restoration consisted in securing of the mine working structures, dismantling surface installations that were no longer of use, ensuring landscaping of the site and installing a water treatment system.
- The second stage implemented in 1985, consisted of reinforcing the safety of mill tailing storage facilities which were completely submerged by dredging the sandy banks, and improving the safety of the dike by redimensioning the high water drainage system.

Monitoring of the site concerns two points: the stability of the dike containing the tailings and the radiological impact. It shows that:

- the dike is stable,
- the site has no significant impact on the food chain,
- the quality of the water seeping through the dike has quickly improved since the complex closed except the period during which the sandy banks were dredged (see Table VII),
- the quality of water from the underground mine has also improved (see Table VIII),
- the total added exposure above the natural background level is in the region of 1 mSv per year, compared to the limit of 5 mSv (ICRP 26) permissible.

Studies are currently in progress with a view to decreasing the site monitoring and maintenance requirements and, in particular, those of the dike and associated hydraulic structures.

TABLE VII. SEEPAGE WATER QUALITY EVOLUTION

	Standard	1981	1983	1985	1987	1989	1991	1993	1995
Ra ($Bq.l^{-1}$)	0.37	0.02	0.04	0.05	0.02	0.03	0.04	0.05	0.03
U ($mg.l^{-1}$)	1.8	0.42	0.21	0.23	0.13	0.15	0.14	0.11	0.11
SO_4 ($mg.l^{-1}$)	250	324	160	820	207	154	130	110	110
pH		6.7	6.6	6.6	6.4	6.4	6.4	6.4	

TABLE VIII. MINE WATER QUALITY EVOLUTION

	Standard	1981	1983	1985	1987	1989	1991	1993	1995
Ra ($Bq.l^{-1}$)	0.37		0.96	0.82	0.58	1.00	0.98	0.67	0.50
U ($mg.l^{-1}$)	1.8		0.64	0.27	0.20	0.19	0.15	0.13	0.18
pH		7.1	7.6	8.3	7.6	7.5	7.5	7.4	

3.3.2. Le Cellier (Lozère)

The mining complex of Le Cellier is located in the south-eastern part of the Massif Central. It was worked from 1956 to 1990, producing 2,750 tonnes of uranium in concentrates, from ore extracted from the underground mine and from the open pit. The ores were processed either by heap leaching or by dynamic leaching in a plant which operated from 1977 to 1990. The dynamic mill tailings were first stored with the heap leaching tailings and, then, in the open pit as from 1986.

The restoration of the site, undertaken in 1990 and 1991, consisted in:

- Securing the underground mine: sealing of openings, backfilling of some stopes,
- covering the heap leaching tailings and the dynamic mill tailings storage facility,
- reducing the gradient of slopes and replanting to ensure landscaping of the site.

More than two million tonnes of material were moved over a total area of 66 hectares.

These measures were completed with the construction of a water treatment plant of capacity 50 $m^3.h^{-1}$ and setting up of an environmental monitoring network to keep check on the quality of both air and water.

Tables IX and X specify the average annual values of the potential alpha activity of radon 222 and its daughters and of external radiation field, respectively, measured on the site in its immediate surroundings and in the reference natural environment. These values remain lower than the reference values which are 286 $nJ.m^{-3}$ and 570 $nG.h^{-1}$ respectively.

TABLE IX. POTENTIAL ALPHA ACTIVITY DUE TO RADON 222 ($nJ.m^{-3}$)

	1990	1991	1992	1993	1995
Le Cellier site	33	32	36	32	28
Immediate surroundings	77	35	37	34	34
Natural environment	40	36	36	31	26

TABLE X. EXTERNAL RADIATION FIELD ($nG.h^{-1}$)

	1991	1992	1993	1994	1995
Le Cellier site	360	270	270	250	240
Immediate surroundings	240	210	210	230	230
Natural surroundings	200	155	140	124	125

The monitoring of seepage water through various storage facilities shows, in all cases, a favourable trend towards a return to the natural balance. This trend varies, however, according to the storage facilities, thus reflecting the differences in the ores and in the processing they were subjected to, as for example:

- The uranium concentrations in water from the dynamic mill tailings storage facility are lower than the statutory value of 1.8 $mg.l^{-1}$ and radium showed a major decrease from five times the statutory value of 0.37 $Bq.l^{-1}$ in 1991 to only twice that value in 1995.
- For storage facilities containing ores processed by heap leaching, the radium concentrations noted in 1995 were between two and three times lower than in 1991 and uranium concentrations were five times lower.

This shows soundness of the principle of selective collection of water instituted during restoration. This allowed the water treatment system to be completed by a sodium hydroxide neutralising station reserved for water from the site requiring only simple pH adjustment before being discharged into the natural environment.

Finally, the total added exposure above the natural level is lower or in the region of 1 $mSv.year^{-1}$, compared with the limit of 5 mSv (ICRP 26).

TABLE XI. TOTAL ADDED EXPOSURE ($mSv.year^{-1}$)

	1991	1992	1993	1994	1995
Village of Le Cellier	1.1	0.6	0.6	0.65	0.55

4. RESEARCH AND DEVELOPMENT

The conceptualization of restoration of each site means, being able to predict and monitor the natural phenomena which may lead to pollution and to prevent and correct their consequences.

That is why Cogema, in close collaboration with various research organisations, is conducting an active research and development programme in three directions: characterisation of source terms, methods of transfer of contaminants, and efficiency of containment barriers.

4.1. Characterisation of source terms

This study was carried out in three phases:

- acquisition of data on the source terms to be managed,
- interpretation of data so that the operations at the storage sites can be understood,
- application of the results to predict the evolution of the tailings impoundments.

4.2. Transfer of contaminants

This line of research consists of studying the processes of dissolution of minerals by various solvents impregnating the tailings storage facilities and recrystallization phenomena.

4.3. Containment barriers

This line of research covers three types of containment:

- Natural encasing of storages: hydrogeology and hydrogeochemistry are essential aspects in these studies.
- Multi-layer covering of storages: on the basis of the mineralogical study of the materials used and full-scale tests, an attempt is made to qualify the coverings in terms of geotechnical stability, resistance to erosion and deterioration, and geochemical stability. The part played by vegetation is also taken into account.
- Water treatment: this barrier which is often indispensable just after mine closure bears heavily on the cost of restoration. It is therefore necessary to seek optimization of classical techniques. There is also a need to stabilise the sludge produced. The combination of these two lines of study is achieved through research into passive treatment processes.

5. COMMUNICATION

Site monitoring and environment protection measures as well as communication go on beyond the end of mining activities.

In conformity with Cogema's communication strategy, people living in the vicinity of mining sites are leading targets for communication specific to mining site environment. Personnel of the firm responsible for execution of the works at site are of course first informed. Cogema addresses an adapted communication to other agencies, like administrative and political authorities, press and associations.

Aim of communication is to show and to explain what Cogema does to protect environment, in order to make everyone able to form their own opinion. This is a means to ensure that remediation will be seriously performed. Communication must therefore be pedagogic and based on transparency.

Cogema ensures communication by the following means:

- mails to people living in the vicinity of the sites,
- "open" days and visits to installations and works,
- sessions of statutory commissions generally comprising representatives of administration, local political authorities and environment protection associations.

The results of site monitoring are regularly published: this is a good way of being transparent. The quality of this monitoring is, thus, essential. Every abnormality is explained and everyone can ask his own questions. This is important to win the confidence of those concerned. Constancy, coherency and long lasting are key factors of success.

6. CONCLUSION

The restoration of mining sites is the last operation carried out in the working of a mine. It may be the last but it is not, however, the least as it has long-term implications for the future.

In recent years, Cogema has successfully achieved the restoration of several major complexes, such as Bessines and L'Ecarpière. Thanks to the knowhow and experience acquired in carrying out this work, the relevant research and development studies and the corresponding communication, it can look forward to future closures with confidence.