Status of uranium mining in France and remediation issues

AIEA RLS Workshop - Grand Junction (Colorado, US)
August 21-24, 2012

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Overview of uranium mining in France

~230 mine sites

Exploitation period: 1945 -1995

- 76 000 tons of U
- 52 000 000 tons of ore
- 166 000 000 tons of waste rock

17 uranium mill tailings repositories

- Mill tailings: 31 000 000 tons
- Heap leaching residues: 18 000 000 tons

Remediation period: 1995 - 2001+

Areva responsible for almost all the mining sites

(15 orphan sites)
Overview of uranium mining in France

Sedimentary bedrocks

Granitic bedrocks
Overview of uranium mining in France

- Mining work techniques

**Underground tunnels (UT)**

**Open pits (OP)**

Mine

La MO de Bruguerolles en 1962

AIEA RLS Workshop - Grand Junction - August 22, 2012 - IRSN technical issues
Overview of uranium mining in France

- **Impact management**
  - Management of the water outflow at the outlet
  - Environmental monitoring to control potential leaks (diffuse fluxes)

![Diagram of uranium mining in France](image)

- OP backfilled with tailings
- Collection, treatment if necessary
- Outflow
- Galerie 1
- Galerie 2
- UM
Overview of uranium mining in France

Rehabilitation of the site nearly finished

Sites and disposals post-mining disposition

- regulatory surveillance/monitoring
- chemical treatments of some collected mine water depending on their U and Ra content
- easement (# 40 sites of which the tailings repositories)
TECHNICAL ASPECTS CONCERNING THE REMEDIATION (REHABILITATION) OF THE SITES AND DISPOSALS
Objectives

➢ To assure a perennial (durable) stability in terms of security

   Geotechnical stability of the works (waste rock piles, disposals, dams,..)

   Leaching processes limitation

➢ To reduce as much as possible residual impacts

   Reduce gamma dose rate and radon dispersion

   Limitation of leaching processes

   Guarantee an efficient collection of the mine waters

   Guarantee a good management of the materials (avoid incongruous re-use)

➢ To limit the surface of lands to be burden with use restriction (easement)

➢ Achieve the landscaping and encourage the site reconversion
Technical aspects concerning remediation/rehabilitation

- Remediation actions carried out

- Former pitheads
- Underground tunnels (UT)
- Open pits (OP)
- Milling plants (SIMO)
- Heap leaching areas
- Water treatment plants
- Tailings disposals
- Waste rock piles
Technical aspects concerning remediation/rehabilitation

- Former pitheads

Le carreau de la mine de Bauzot, à gauche, la tour de conc. d'extraction PIC du puits de Bauzot. (photo CEA)
Technical aspects concerning remediation/rehabilitation

- **Former pitheads**
  - Mine shafts dismantling
  - Landscaping
  - Buildings (offices) transferred to local firms
Technical aspects concerning remediation/rehabilitation

- Underground mining works

Technical aspects concerning remediation/rehabilitation

- Underground mining works
  - Flooding
  - Tunnels and declines partially backfilled
Open pit mines

Vue du parement de la MCO du Bernardan en fin d’exploitation.

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Tir de mines à la MCO du Bernardan.

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Technical aspects concerning remediation/rehabilitation

- Open pit mines
  - Backfilled
  - Flooded

Potential use of the water pond as a *fishing* area (no kill)
*eg Puy de l’Age site*
Open pit mines

- Tailings disposal

OP filling

OP + dam

digue
Technical aspects concerning remediation/rehabilitation

- Milling plants

1993, vue aérienne de l’usine.

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* Société Industrielle des Minerais de l’Ouest
Technical aspects concerning remediation/rehabilitation

- Milling plants

- Le Bouchet
- L’Ecarpière
- Le Bernardan
- SIB
- Saint Pierre
- Gueugnon
- Bois Noirs Limouzat
- Le Cellier
- Site du Bosc
Technical aspects concerning remediation/rehabilitation

- **Milling plants**
  - Dismantling
  - Landscaping

Area generally in the vicinity of a tailings disposal (no specific use)
Technical aspects concerning remediation/rehabilitation

- Heap leaching residues areas
Technical aspects concerning remediation/rehabilitation

- Heap leaching residues areas

Area potentially accessible to the public (e.g. Saint Pierre site)
Chemical treatment ($\text{BaCl}_2$, flocculant) + settling ponds

- Water treatment plant
  - Still in operation (14 in France)
  - Milling plants discharges/effluents
  - Mine waters
Water treatment plant

- Dismantling (sludge disposed of with the tailings)
- Ponds let as is (development of local vegetation)
- Possible re-use of the ponds (e.g., for disposal)

- Milling plants discharges/effluents
- Mine waters
Overview of uranium mining in France

- 4 types of tailings disposals

- Backfilled OP
- Depression + ring dam
- Thalweg + dam
- Vegetation disposal cover structure

- 11 (over 17) enclosed with dams
- Facilities classified for the Protection of Environment Regulation (ICPE - cf Environmental code)
- Control exerted by the local Authority (DREAL), on behalf of the Environment Ministry (MEDDE), assisted by ASN for radioprotection matters
Technical aspects concerning remediation/rehabilitation

- Tailings disposal

Rearrangement of the site is planned
- to remove the water cover
- to reduce the height of the dam (presently under the « large dam » regulation)
Basic authorization to use to site for field research

Technical aspects concerning remediation/rehabilitation

- SEUIL + DIVERS
  - 100 KEUR
  - 3 sections: 715 m

- TRANSIT ON FILLINGS
  - 2 sections: 740 m

- Option: keeping the canal be dug on the right bank

- Option: Fast flow section

- Upstream natural Besbre river

- Downstream natural Besbre river
Drainage sections
Waste disposal
Couche de finition Revegetalting
Reforesting
Tailings disposal

- Property of the operator (Areva)
- Under specific regulation
- Surveillance and long term management necessary
- No public use allowed
- No use likely to damage the cover allowed

Potential use of disposal area as a solar array area (photovoltaic panels)
*eg L’Ecarpière site (project agreed)*
Closed to the waste rock excavation works

La mine à ciel ouvert de Grands-Champs, vue vers le Nord en 1990.
Technical aspects concerning remediation/rehabilitation

- Waste rock piles

Motocross tracks observed on some piles

Landscaping

- Water fluxes at the bottom of the pile likely to contaminate downstream streams
Issues related to remediated sites/disposal

- The understanding of the hydrological functioning of the mining reservoir and in a wider extent of the remediated sites (including tailings disposals) and the outflow management

- The water treatment (optimisation, passive treatments, ...) and the radiological imprints of waterpond sediments downstream the former uranium mine sites

- The water discharge regulatory limits (eg not restrictive enough with regard to U)

- The diffuse fluxes (non collected water) as for example the fluxes at the bottom of waste rock piles in the vicinity of stream

- The perenity of the systems implemented on tailings disposal (cover, dams, ...)

- The long term evolution of the whole system (water quality, tailings features, physical alteration of the cover, dams, piles, ...)

- The monitoring system (present and over the long term)

- The impact assessment (present and over the long term) on human and environment (ecosystems)

- The characterisation of exposure to radon from the former mine (natural radon excluded)
Main issues arising from the present and future situations

- The Saint-Pierre case-study: Development of sensitive uses of the land
Technical aspects concerning remediation/rehabilitation

Specific issue: the past re-use of waste rock in the public domain

Waste rock transferred to local population without any constraint for many years (for the sake of good neighborhood relationship)

Potential consequences
- Increase of the gamma exposure locally
- Materials could be ingested in particular situations (ex: playground)
- Radon accumulation when used as foundation materials for dwellings or public places

Existing situations where waste rock were removed
- Waste rock as sawmill foundation materials
- Waste rock used to backfill a playground
Circular dated July 22, 2009, signed jointly by ASN and the Ministry of the Environment, to pursue the management of the former uranium mines.

Point 3. “Manage the waste rock transferred to the public domain: destination and impact assessment if necessary.”

Actions carried out by Areva to inventory the areas concerned by the re-use of waste rock (U > 300 ppm):

- Measurements by radiological air detection
  - Investigative superficies: (1000 + 2000) km²
  - Flying over altitude: 40 m
  - Speed: 100 km/h
  - Grid cell: 15 m

On-going actions:
- In situ control of the exposure levels
- Management of the inconsistent situations, in agreement with the authorities
Memory of the sites and waste rock re-used areas

Mimausa program
Memory and Impact of the uranium mines: Synthesis and et Archives

Inventory of the sites
Interactive website map
Feedback on the sites/disposals/waste rock re-used areas remediation

- To have an appropriate regulation that takes into account the feedback from observed situations and associated issues
- To keep the memory of the site location, mining works, data records....
- Technical issues:
  - Identify the exhaustive stokes linked to the site
  - Think about remediation actions including long term issues
  - Present issues
  - Future issues
- Stakeholder involvement
- Improve technical interactions between the operator(s) and the regulatory body