Long-term Aspects of Uranium Mining Remediation

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Abstract. After completion of the remediation of the legacy of uranium mining and milling for most of these objects and sites a continued monitoring will be necessary and some of these objects may require maintenance.

The main remediation objects in Saxony are waste rock piles, tailings ponds/deposits and underground mines. The monitoring and maintenance needs of the individual objects differ substantially and consequently the regulatory requirements (both type and extent of monitoring) placed on the individual objects will vary following an object-/site specific approach. Among the most sensitive monitoring parameters are the qualities of seepage and ground water. Another essential parameter is the monitoring of performance and maintenance of functionality of the covers placed on the waste rock piles and tailings to control radon exhalation and contaminated seepage. Unfortunately, there is no reliable database available for the long-term performance of the remediation measures and there has been no effort yet to develop such a database. To obtain a reliable estimate of the period of time needed for the active post remedial care, it is recommended to carry out studies on natural analogues. At present, the Saxon regulatory authorities demand a monitoring and maintenance period of 25 (radiation protection) rsp. 30 years (conventional waste regulations).

Provided the remedial measures taken prove to perform well, the monitoring effort will decrease with time. Considering the fact that the remediation measures implemented were designed for a 200 to 1000 years long stabile performance it is

expected that little maintenance will be needed. However, singular cases of disruption, such as damages of cover cannot be excluded.

A most relevant issue in this respect is the funding of the long-term post remedial tasks. The owner responsible for the uranium sites and objects that were in legal possession of Wismut on June 30, 1990 is and will remain the Federal Government of Germany. For the former Wismut sites, which are legally owned by other parties, the responsibility for funding of long term monitoring and maintenance is in the hands of the actual owners.

Introduction

Long-term stewardship is the only surety for a safe and healthy environment around uranium mining residues. Effective public institutions, the long-term preservation of knowledge and the provision of funds provide the main basis for a successful long-term stewardship. The lack of one of these issues may cause a failure of the stewardship and consequently also of the safety of the environment.

An international consensus regarding the necessity of long-term stewardship can be deduced from IAEA Report (2005) and similar publications.

In the following text the main objectives regarding long-term stewardship are discussed and the current status of the discussion in Saxony is presented.

Sites and Objects

Uranium mining in Saxony took place from 1945 to 1990 by the SAG/SDAG Wismut.

Exploration for uranium ore was performed more or less in the whole area of the former GDR. Nevertheless, the main focus was located in the south. Mineable deposits were found in Saxony and Thuringia. In Saxony three major sites were mined:

- Aue (Ore mountains) hydrothermal vein deposit
- Königstein creataceous sandstone deposit (uranium fixed at organic compounds)
- Gittersee Permian coal deposits (uranium enriched coal seams)

The ore was milled in Crossen, where one of the worlds biggest uranium tailings site

- Helmsdorf/Dänkritz

was constructed (ca. 50 ha, i.e. ca. 125 acre; ca. 50 million m³).

Beside these sites uranium was mined and milled also at some smaller sites in the ore mountain area in the first two decades (until 1962). Wismut produced in total 251 000 t of ore.

The residues from conventional underground mining are

- waste rock piles,
- tailings ponds,
- open mine shafts and drifts and
- contaminated mine water.

From in – situ – leach mining

- acidic solutions (sulphuric acid; pH 1.5 – 3)

remained in the pores and fissures of the host rock and in the mine shafts and drifts.

Additionally

- soil and building material

contaminations existed at former mining and milling areas.

Remediation measures

Waste rock

Waste rock piles commonly are shaped in a way to provide for surface water drainage from the tops and stability of the slope areas. Subsequently they are covered with one meter of soil. The soil properties are optimized resp. low permeability for precipitation and radon emission (Leitfaden Uranbergbausanierung 2000; Forschungsinstitut für Bergbaufolgelandschaften e.V. and G.U.B 1987; Freistaat Sachsen 1997).

Tailings

For tailings ponds a similar procedure is needed. After pumping and treating the pond water from the surface, an intermediate cover to stabilize the surface for further steps is applied.

Following this, the slopes and surface area are shaped and covered (Palme and Wittig 2003; Palme 2003a, 2003b). The minimum cover thickness is 1.5 m.

Underground mines

The stabilization of open mine shafts and drifts is subject matter of the mining authorities only.

The flooding water on he other hand has to be treated in a way to guarantee low emissions of radionuclides and heavy metals (Merkel 2002; Meyer et al. 2002). Experiences from old mines show that after a maximum of two decades following the flooding of the mine natural attenuation processes will bring the water quality to original background values.

Steps

The chronological procedure from the end of uranium mining to the long-term phase is shown in a simplified way in Fig. 1.

After remediation of the objects described above a warrantee phase of 5 years is following. During this phase the remediation measures are undergoing a practical test. The monitoring program of the remediation phase may be reduced. The plant cover is developing which has to stabilize the cover geotechnically.

In the eventually following long-term phase the base monitoring program is replacing the monitoring of the remediation phase. Maintenance, i.e. repair activities, may be needed and must be institutionally fixed and technically installed.

Remediation is the step where the highest effort and costs are needed, while the warranty phase and the long term phase are comparably inexpensive.

In the last few years many comments on the length of time needed for the long term phase were made. They showed that society cannot come away from the responsibility for the uranium mining legacy. To take this responsibility does not necessarily mean high burden.

Funding

A basic legal fact is the responsibility of the owner for the funding of long-term measures.

In the case of the Wismut legacy the federal government has to provide the financial means. It has been discussed also to entrust the State of Saxony with the ownership and consequently with the funding and with the responsibility for long term stewardship. In such a case the former owner has to provide the new owner with the respective financial means.

If ownership changes responsibility for the funding of long term measures is also changing.

The new owner has to take care for all issues associated with long term stewardship.

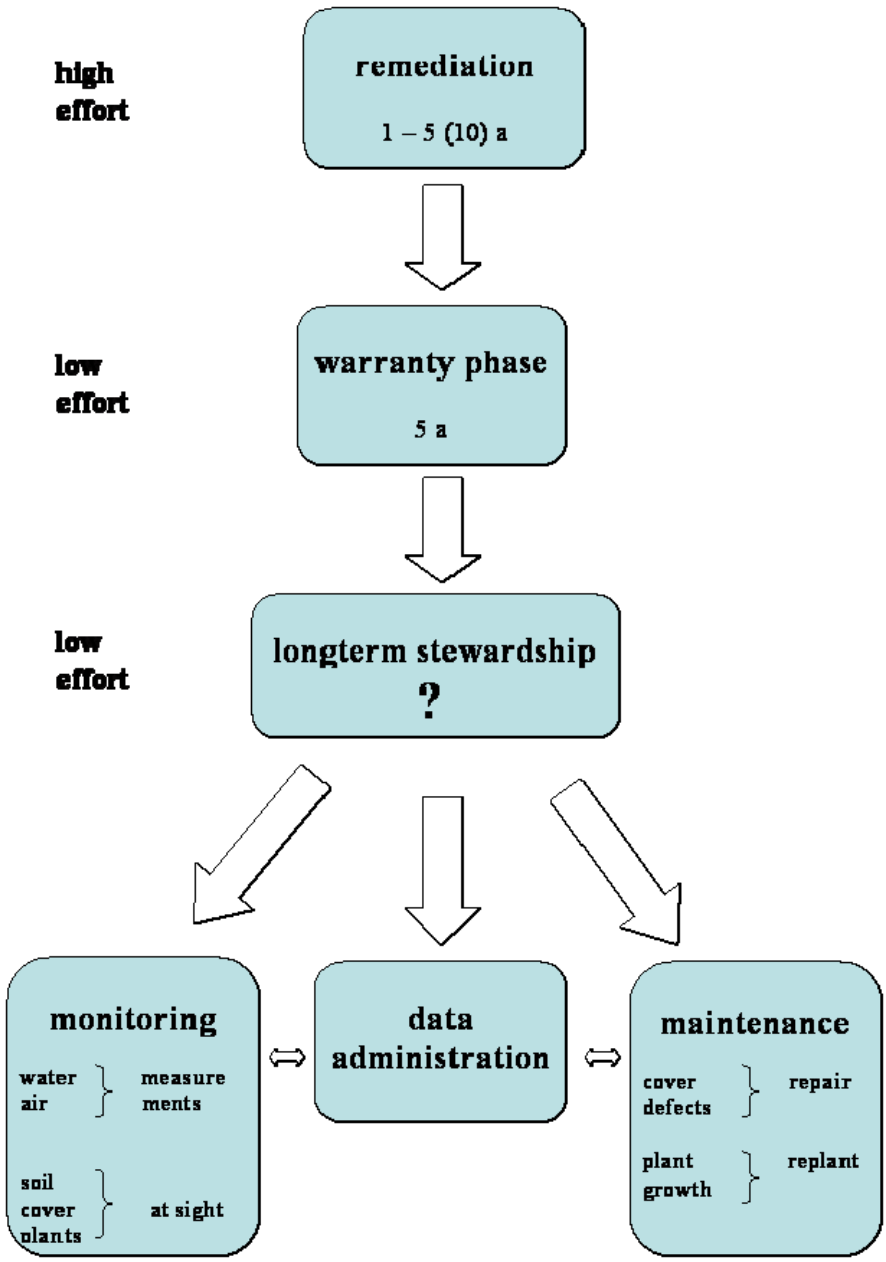

Fig. 1. Chronological procedure from the end of uranium mining to the long-term phase.

The planning of the dimensions of the financial means needed for long term measures has to take into consideration possible future interest rates. Conservative calculations should base on not more than one percent. This is the result of considerations on the development of the interest rates between the year 1950 and the year 2000 in the USA.

Knowledge

To ensure that information is kept over generations two main factors have to be taken into account:

- Willingness of the communities to take over responsibility for information transfer.
  The main issue is to make information about the restricted use of the objects long term stable. The communities are those concerned by the restricted use of objects situated on the community area. They are making decisions on the future use of their municipal land. To feel responsible for the remediated objects is prerequisite for the functioning of their long-term stability. For this reason permanent contact and exchange with the communities from the beginning of remediation is needed. The discussions already during the remediation process are a helpful base for the acceptance of the remediated objects. The objects must become harmonically and aesthetic fitting components of the natural scenery. On such a base the communities will take care and make wise use of their objects and make sure money for remediation measures is well spent.

Fig. 2. Surface water runoff facility at waste rock pile 366 in Schlema.

- Optimized information/data management
  Generally two types of data have to be managed: Object data (properties of objects) and monitoring data (field and lab measurements, visual inspection results). Monitoring data are representing the "living" part of the data store while the object data are representing the "dead" part. Monitoring data are the base of all future technical decisions about e.g. ongoing water treatment, need of cover repair, need of monitoring frequencies or change of use restrictions.
  The data bank systems for the monitoring data should contain tools to evaluate the data (developments, statistics etc.) and to represent the state of the information (graphs, outlines etc.). There should be tools to connect the monitoring data with the object data and to export informations for the public to fulfil the conditions of the environmental information law. The German Environmental Information Law of February 2005 was made on the base of the European Directive on Public Access to Environmental Information (2003/4/EC).

In Saxony the data bank KANARAS (cataster for natural radioactivity in Saxony) is in construction. It is consisting of

- Wismut data bank (Wismut sites, produced by Wismut ltd)
- A.LAS.KA (radiological data of old sites, federal)
- FbU (radiological and geographical data of old sites, federal prod.)
- DURAS (radiological analyses of saxon state lab UBG)

There are no experiences at all on the long-term safety of digital data. On the other hand the longevity of paper written information was prooved in many cases. Under these circumstances there is still a need to keep as much paper documents as possible.

Additionally there will be a need for long-term conservation of some important object informations in the Saxonian state archive. The legal and material conditions for this step are not yet compiled.

Institutional Control

Institutional control in the long-term stewardship phase will – as in the remediation phase - be an issue for different state authorities.

But the framework for these authorities will be different. While during remediation an active constructive development of the best resp. optimized measures was needed, in the long-term phase the institutions play a relatively passive observative role.

For radiation protection institutions Radon behavior is the radiologically most important factor. Therefor they will - as well as ground- and surface water authorities - be interested in the visual control of the covers and the monitoring data for the water path. The quality development of seepage water will be an issue for many decades. As long as active water treatment will be needed, good technical performance of the treatment plants has to be guaranteed and it has to be taken

care that the residues of the treatment are minimized and deposed in a radiologically safe way.

Secondarily radiation protection authrities will controll plant growth by vision. This item will be the main issue for the forestry authorities.

Cover and slope stability will be monitored under the responsibility of the mining authority. Anyway also the water and radiation protection authorities have the duty to take care for the protective function of the covers. From the radiation protection point of view an opening in the cover may work as a chimney for radon and is defintely a case for immidiate repair activities.

Further on all institution for public concerns must be provided after remediation with updated maps of the remediation areas. They have to take care that restrictions for use are kept when the communities are planning new projects.

Maintenance

All remediation measures are planned and performed in a way to minimize future activities.

Nevertheless it may be the case that mending of covers or other subjects is needed. E.g. after storms uprooting of trees may happen and covers of waste rock piles or tailings ponds may be perforated or – in the worst case - completely destroyed.

Surface water runoff facilities like the one shown in the Fig. 2., may be other important subjects of maintenance especially in the first years of long-term stewardship. Experience has already shown, that leavefall in autumn may fill the facilities. As a consequence mixtures of leaves and earth may create blockades for the runoff (Ohlendorf 2004).

Consequences and work to be done

The Saxon state agency of environment and geology as the responsible licensing authority has developed a task schedule for all open questions regarding long-term stewardship. It contains the following issues:

- Financial arrangements of the federal government
- Longterm responsibility for the stewardship /Change of ownership
- Long-term stewardship measures
- Documentation and data management
- Authorities – controlling
- Communities – Bearer of information and project planners

For the tasks which are in the responsibility of the State of Saxony a time schedule was made.

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