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Identifying and overcoming the constraints that prevent the full implementation of decommissioning and remediation programs in uranium mining sites

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ABSTRACT

Environmental remediation of radioactive contamination is about achieving appropriate reduction of exposures to ionizing radiation. This goal can be achieved by means of isolation or removal of the contamination source(s) or by breaking the exposure pathways. Ideally, environmental remediation is part of the planning phase of any industrial operation with the potential to cause environmental contamination. This concept is even more important in mining operations due to the significant impacts produced. This approach has not been considered in several operations developed in the past. Therefore many legacy sites face the challenge to implement appropriate remediation plans. One of the first barriers to remediation works is the lack of financial resources as environmental issues used to be taken in the past as marginal costs and were not included in the overall budget of the company. This paper analyses the situation of the former uranium production site of Poços de Caldas in Brazil. It is demonstrated that in addition to the lack of resources, other barriers such as the lack of information on site characteristics, appropriate regulatory framework, funding mechanisms, stakeholder involvement, policy and strategy, technical experience and mechanism for the appropriation of adequate technical expertise will play key roles in preventing the implementation of remediation programs. All these barriers are discussed and some solutions are suggested. It is expected that lessons learned from the Poços de Caldas legacy site may stimulate advancement of more sustainable options in the development of future uranium production centers.

1. Introduction

Uranium mining and milling operations have been performed since the 1940’s. These activities decreased due to the low prices of uranium in the international market, however it is expected that the sector will experience reasonable expansion in the coming years due to what is being called the “Nuclear Renaissance” (IAEA, 2009a).

Many of these older operations caused severe environmental impacts (Waggitt, 2008) in part due to a lack of appropriate regulations, but also because environmental aspects used to be taken as externalities in the overall operations.

A dramatic example of environmental impacts caused by uranium processing is the Fergana valley where intensive mining and milling operations has taken place from 1942 to 1998. There, dozens of open pit uranium mines had operated in borders areas of Kyrgyzstan, Tajikistan and Uzbekistan (Torgoev et al., 2008).

Another example of environmental impacts due to uranium processing involves the operations of the Soviet-German mining company SDGA Wismut in the former East-German lands of Saxony and Thuringia. These operations took place in the period between 1945 and 1990. At the time of production cessation, in the early 1990’s the inventory of contaminated areas and objects included five large underground mines; an open pit mine of 100 Mm^3; 311 Mm^3 of waste-rock dumps 160 Mm^3 of tailings and two big processing plants. These operations produced more than 216,500 tons and placed SDGA Wismut as third in the rank of the largest uranium producers (Hagen et al., 2005). The company’s operations were uncompetitive and with the reunification that took place in 1990 uranium production stopped and remediation work began. At the end of 2002, after ten years of remediation work most environmental impacts have been reduced to an acceptable level (IAEA, 2009a). However, remediation work is not yet completed at all sites; the Koenigstein mine is not completely flooded and some sites still wait for remediation (Jenk et al., 2009; Merkel, 2001). Although the remediation program has been based on the best practices, it seems that long-term stability of slopes and barrier concepts remain a challenge to be faced (Merkel, 2001). The overall

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cost of remediation was estimated to exceed 6.0 billion Euros (IAEA, 2009a).

The Zirovski Vrh uranium mine located in the northwest of Slovenia is another example of elevated remediation costs. After six years of operation, production was stopped in 1990 (Kontiae, 1999). After the termination of mining activities the installation was left without sufficient maintenance. In 2002, after creating a legislative support, the government of Slovenia started the implementation of remediation programs previously designed. These programs included demolition of milling facilities, closure of underground mine and the stabilization and covering of the mill tailings (Logar and Pozun, 2005). The total remediation costs associated with this mine site amounted to 86.3 M Euros (Paul et al., 2008).

In the USA the Department of Energy established the Uranium Mill Tailings Remedial Action Program (UMTRAP) in 1979 to clean up 22 uranium mill tailings sites and the associated properties contaminated by tailings debris. The overall efforts were aimed at preventing public exposure to radiation (USDOE, 1992). Initially conceived to cost $150–200 million in 1978, the UMTRA program had cost approximately $2 billion dollars by the year 2000. Ground water remediation (phase 2) is currently continuing at several sites and these costs are not included in the previous value (Robinson, 2004).

In Australia the Rum Jungle uranium-copper project was the first project to produce uranium in commercial basis. The site is located at the south of Darwin (Northern Territory) and was operated from 1954 to 1971. The poor solid and liquid waste management practices during the project operation led to significant environmental impacts due to the long-term generation of acid drainage (Mudd and Patterson, 2008). A large remediation project was undertaken in the 1980's followed by a decade-long environmental monitoring. The total cost of remediation program was estimated in 13.5 M Euros (Waggitt and Zapantis, 2000). Despite significant effort made, Rum Jungle still remains a problematic site (Mudd and Patterson, 2010; Taylor et al., 2003).

Uranium mining activities played also an important role in the region of Limousin/France for many years. The decline of these activities in the 1980's led to the progressive shutdown of the region's mines requiring considerable technical and administrative effort to remediate the sites in accordance with environmental protection and human safety objectives (Gay et al., 2007).

As it could be seen from above, some countries were able to cope with the technical and financial costs of remediation contaminated sites by uranium operations. On the other hand, some countries – as those in central Asia - will need strong support (technical and financial) to achieve meaningful results.

In order to expedite the cleanup of the remaining uranium mining legacies worldwide, some barriers need to be overcome. It is clear that solutions and strategies will need to be conceived and implemented in a case-by-case basis. However, it is useful to be aware of individual experiences as similarities can be found and lessons can be learned.

The more important barrier to be overcome is of course the lack of resources (financial and human). This paper, however, will demonstrate that some other constraints need to be carefully addressed as they can play a very critical role in delaying or even refraining the implementation of remediation works even when money is available. The former uranium mining and milling site of Poços de Caldas in Brazil will be used as a study case.

2. The uranium mining and milling site of Poços de Caldas

In Brazil, the activities related to the exploration, production and processing of uranium ores are developed by the state-owned company Brazilian Nuclear Industries (INB). The prevailing uranium production policy in Brazil is set to supply the domestic demand, presently represented by two PWR-type reactors.

The Poços de Caldas mining site was the first deposit to be exploited in the country. Extensive geological, geomorphologic, hydrogeological and radiological information of that area has been published (Chapman et al., 1992; Holmes et al., 1992; Nordstrom et al., 1992; Waber et al., 1991). This deposit is located at the Poços de Caldas plateau, in the southern region of Brazil (21°45′S and 46° 35′W). It consists of a Volcanic Caldera roughly circular, about 33 km diameter and 800 km^2 in area (Fig. 1). The geological evolution of the Caldera associated to intense metassomatic processes and a strong

Fig. 1. - Location of the study area (Poços de Caldas Volcanic Caldera - Landsat Satellite Image).