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Stig Ledin
Swedish University of Agricultural Sciences, Sweden

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Establishing vegetation on mine waste areas in northern Sweden

Stig Ledin

Swedish University of Agricultural Sciences, Box 7014, SE-75007 Uppsala, Sweden

E-mail: Stig.Ledin@mv.slu.se

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The studies concern vegetation establishment in mine tailings from the Aitik copper mine at Gällivare in Northern Sweden ($67^{\circ} 0' 06''$ N; $20^{\circ} 0' 3''$ E). The studies were carried out between the years 1996 and 2006. The tailings consist of the rest remaining after enrichment of metals from the crushed and milled copper ore. The material has been dispersed in water and pumped to the pond during somewhat more than 30 years. The deposit covers an area of about 1400 hectares and is enclosed by the slopes of a valley and by constructed dams. The tailings have the texture of fine sand and are prone to wind erosion when getting dry. Thus, there is a need to cover the surface when the tailings are no longer pumped into the pond. Since the area is so large, covering the tailings with soil from the surroundings is out of question. Covering the whole area with water is possible, because the climate is humid, but there is a risk of dam-break. Thus, to cover the deposit with vegetation probably is the most sensible action for erosion control.

The overall aim of the studies has been to find out how the establishing of vegetation should be performed, and to elucidate what consequences the measures taken at establishment will have for land use and the environment. The specific aims have been to get new knowledge on how trees, bushes, small bushes, herbs, grasses, lichens and mosses, naturally occurring in the Aitik area will develop in pure tailings and in tailings amended with organic material and alternatively mineral plant nutrients. Also a few plants from other environments were tried. Other specific aims were to find out which soil amendment that has the best positive and sustainable effect on development of plants, and to clarify the change over time in the amended tailings. The main environmental questions included how nitrogen and heavy metals behave at the plant establishment stage and later, and to state the risk of pollution of those elements. There were a number of field, greenhouse—and laboratory trials performed to reach the goals.

Grass and clover species are recommended as initial vegetation. Many species from the surrounding area were self seeded in the trials, indicating that the tailings deposit will be easily colonized by species naturally occurring in the area.

In several trials the pH decreased, due to the oxidation of pyrite occurring in the tailings. This resulted in a low survival of the plants. However, the mining company has decided to alter the metal enrichment procedure, in order to remove as much pyrite as possible. It was also shown that only the additions of organic material to the tailings lead to a successful plant establishment. Digested sewage sludge was found to be suitable, and also potentially available in the large amounts needed. It was clear from the results that there is a risk of nitrogen pollution during the first growing season from the mineralized organic material. To prevent this, it is recommended that drainage water from the tailings pond should be taken care of during the first years. However, in the long run the nitrogen pollution from the vegetated pond probably is smaller than from the surrounding natural land, due to a smaller total amount of carbon and nitrogen.

There is a risk that the plants may take up high amounts of metals from the tailings, which might make the plants toxic to grazing reindeers and moose, but only if pH decreases to values below 5.