ABANDONED CHRYSOTILE ASBESTOS MINES IN SERBIA: AN ENVIRONMENTAL MINERALOGICAL STUDY

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Asbestos is an industrial term for a group of silicate minerals, and as such, asbestos is a component of the natural environment. In addition, mankind has been using asbestos minerals for a few thousand years as industrial raw materials. Since the end of the 19th century, it has been inserted in large quantities into our built environment. As the health risks associated with the inhalation of asbestos fibres became evident in the second half of the 20th century, all asbestos types (chrysotile and five amphiboles) were classified as carcinogenic. Most developed countries have banned the use of asbestos and continue to remove them from the built environment.

Recently, natural asbestos outcrops draw increasing attention due to the potential health risks associated with them. The risk is primarily manifested in that fibres may become airborne and inhalable. Large-surface and disturbed outcrops, such as abandoned and non-rehabilitated asbestos mines, have the highest air contamination risk. Two such mines have been selected for study: Korlaće and Stragari in Serbia. Both mines produced the least dangerous chrysotile asbestos by open-cast mining. Asbestos extraction was performed near the mines, and the processed serpentinite debris was deposited in huge piles (waste dumps) in the mining area, still having a few percents residual asbestos content.

In Korlaće, classic cross-fibre chrysotile was mined, while in Stragari the leather asbestos variety was mined and in subordinate amount, dark green splintery antigorite is present, too. We sampled the asbestos types, the waste material and the air (MCE filters were used for phase contrast microscopy (PCM) and gold filters for comparative SEM+EDX studies).

At Korlaće, on the waste dumps, 0.4 fibre/dm^3 concentration (PCM; Hungarian background permissible limit: 1 fibre/dm^3) was measured during dry, windy weather. Dust formation was found to be insignificant. Potential air contamination may arise if the spoil material is disturbed (by move or re-use). This process is being tested by lab experiments. On the comparative gold filter sample, gypsum particles in the asbestos size range were detected, and a bunch of blue asbestos (riebeckite) was found, too, probably originating from corrugated asbestos cement roofing. According to our results, the host rock contains all the three serpentine varieties, namely chrysotile, antigorite and lizardite, and constant iron content is typical of them (0.05–0.1 *a.p.f.u.*).

The former processing plant is located in the mine area, and towards the end of its operation, it was not cleaned regularly, so that the finest-grain dust accumulated in vast quantities inside the plant buildings. This dust is composed of serpentinite fragments and a few percents of asbestos fibres, "indoor" air sampling (MCE filter, phase contrast microscopy) yielded 14 fibre/dm^3 concentration (above the Hungarian asbestos removal efficiency limit, 10 fibre/dm^3). When dismantling the building, this dust needs to be collected first, in order to avoid large-scale asbestos fibre release into the air. Fibre release from unprocessed serpentinite blocks is not probable in large quantities, as the outcrop of fresh chrysotile veins is negligible in the mine yard.

In Stragari, the mine yards are dominantly covered with serpentinite debris, while the fine-grained processed waste material is deposited in huge piles, closer to the village, along the way. The ground waste material is still used by local potters as temper in jars and bricks. The processing plants are now largely dismantled and do not contain fine-grained serpentinite dust any more. The factory where asbestos paper and asbestos plate were once manufactured, was last used for the production of recycled paper, therefore its surroundings are clear of asbestos, too. Approximately 1 km to the north-east of the mine, a reservoir basin of 400 m diameter hosts the production sludge of asbestos paper and plate production. In the past 30 years, since not in use, soil formation has started on the surface, and the area is partly covered with trees and shrubs. According to the mine manager, plans are already outlined for the utilisation of the waste material for silica gel production.

Fibres of the Stragari leather asbestos cling strongly together, therefore have a low potential to become airborne, even in the case of the processed material. The green, macroscopically splintery antigorite weathers to asbestos-sized fibres, too, therefore may present additional health risk. PCM of air samples (sampling in dry, windy weather) yielded low airborne fibre concentrations: 0.3–1 fibre/dm^3 at the waste piles and 0.5 fibre/dm^3 in the mine yard. At this site, the application of TEM for air filter analysis is suggested, for the proper discrimination between antigorite and chrysotile fibres, both having some iron content (0.06–0.09 *a.p.f.u.*).