

## Uranium mining and extraction industries: Environmental impacts and mitigation techniques

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In the nuclear fuel cycle, the initial stages or processes; mining and milling of uranium ores produce huge volumes of residual materials are created contaminated with certain levels of radioactivity. Other stages of the nuclear fuel cycle produce different quantities of radioactive waste vary in volume and activity level according to the type of the process and the adopted strategy of the nuclear fuel cycle. In this context, the present paper is concerning with the safety aspects of nuclear fuel cycle facilities with emphasis to uranium mining and extraction processes. Uranium resources and mining capabilities in Egypt have been reviewed and discussed in the light of the governments of Egypt planning and R&D efforts from the beginning of the 1980s, to implement a nuclear power program for electric power generation. The environmental radiological impacts, siting issues and potential health hazards of uranium mining and extraction processes have been reviewed, discussed and evaluated. The paper outlines and discusses different aspects of the environmental hazards of uranium ores waste rocks as well as mill tailings produced during uranium extraction processes. Within the framework of an intensive program for nuclear safety and radiation control in Egypt, airborne radioactivity measurements and radiological dose assessment were conducted in some phosphate and uranium mines. In Abu-Tartur mine, is one of the biggest underground phosphate mines in Egypt. Airborne radioactivity, radon ( $^{222}\text{Rn}$ ) and its short-lived decay products (progenies) and thoron ( $^{220}\text{Rn}$ ), were measured in selected locations along the mine. The environmental gamma and workers dose equivalent rate were measured inside and outside the mine using thermo-luminescence dosimeters. The results indicated that, the annual effective dose due to airborne radioactivity occupational exposure for mine workers, are exceeding the maximum recommended level by ICRP-60 inside the mine tunnels. Useful recommendations are suggested to control the occupational exposures, and various techniques adopted worldwide either to confine or to mitigate these hazards are reviewed, discussed and evaluated.

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