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Instituto de Salud Pública Ministerio de Salud Gobierno de Chile

OCCUPATIONAL EXPOSURE TO RADON IN WORKPLACES IN UNDERGROUND MINING OPERATIONS

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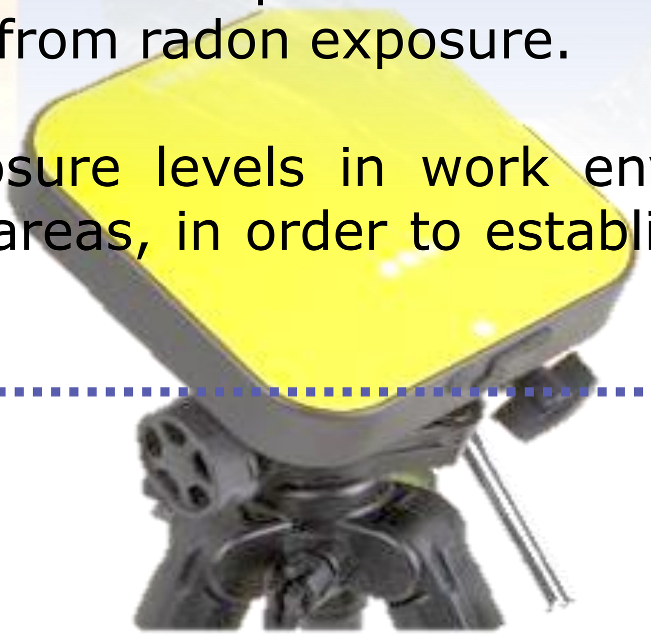
Introduction:
Internationally, methodologies and criteria have been established to know the possible problem that radon could constitute at workplace. Chile is a country where mining is one of the main economic activities, some are done in underground way, however few radon workplace assessment of radon have been made, less with occupational health criteria, so there is no with a baseline that reflects the magnitude of risk in the workplace. On the other hand, currently there is not specific regulation that establishes exposure limits or criteria under which to address the presence of radon at workplace. Adding issue problem is the situation that many of these activities occur at high geographical altitudes, since, in the country, many of these activities occur between 2000 and 5000 meters above sea level.

Objectives:
- Perform radon measurements in workplaces in the mining sector, in order to have evidence that allows a preliminary assessment of the magnitude of the risk from radon exposure.
- Have results of radon exposure levels in work environments, which define the need to extend the measurements to other economic sectors and work areas, in order to establish appropriate health policies and criteria for managing the risk, appropriate to national conditions.



Methods:

Sample size and type.
Measurements have been made in two underground mines located in central and northern Chile, both with the particularity of being at a considerable geographical altitude.

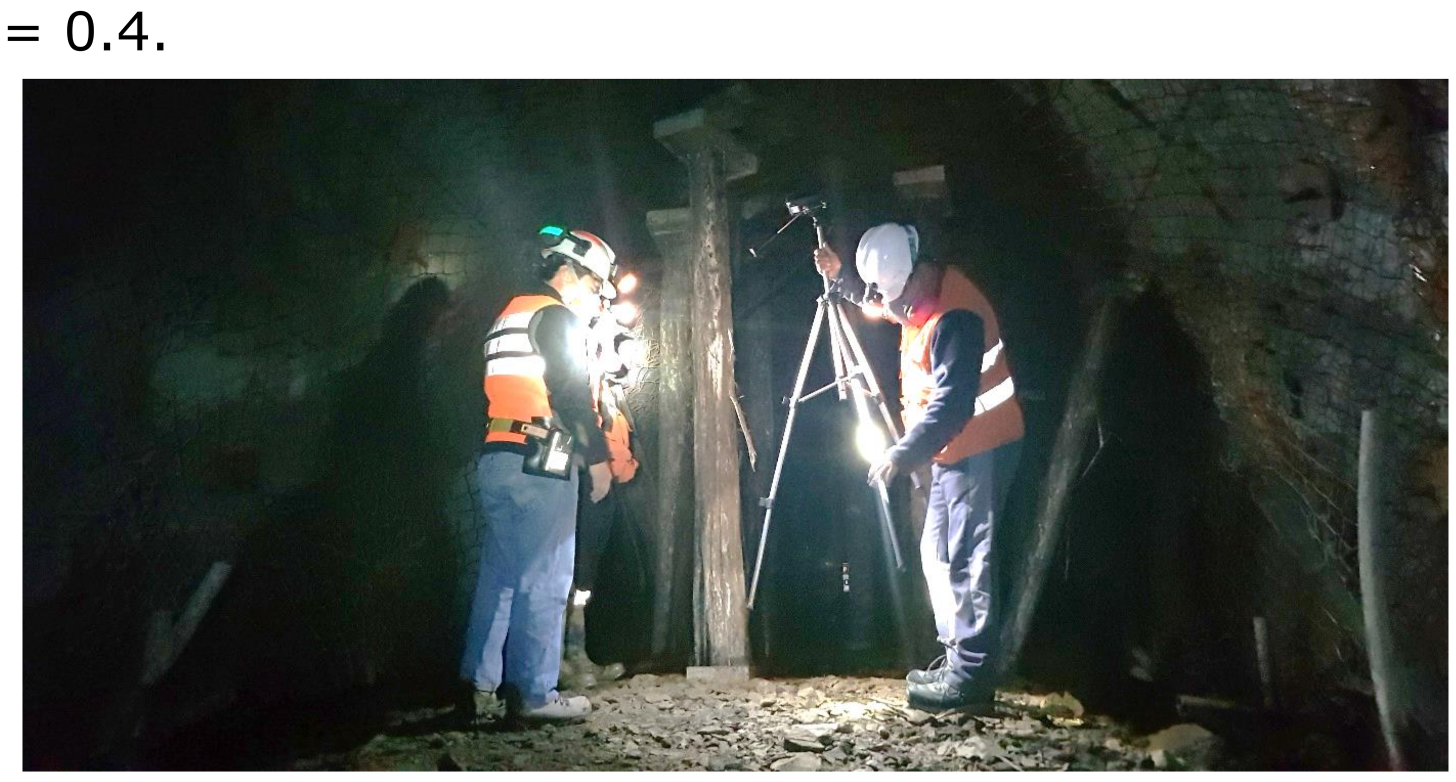
An **Airthings Corentium Pro** detector was used, which was located at respiratory level of workers with sampling periods of one hour, obtaining a mean concentration value within one hour.

Workplace variables.
Temperature, relative humidity and barometric pressure were measured. In addition, data related to ventilation (type and flow) of the areas to be evaluated will be recorded.

Also exposure time and schedules, geographic altitude, type and use of respiratory protection, type of fortification or other sealing of walls and water leaks, the type of activity, also including places where food is consumed.

Concentration and dose criteria. 1000 Bq/m^3 and 10 mSv.

Dose calculations derived from radon concentrations and its decay products.
Radon concentration, Working level (WL), Working Level Month (WLM), Equilibrium Equivalent Concentration (EEC), Concentración equivalente de equilibrio (EEC), Equilibrium factor (F) = 0.4.



Results:

Table 1: Mining operations assessed.

Mine site	Geographical altitude (MASL)	Measurements	Measurement distribution
A	Between 3000 and 4000	50	Transport level. Subsidence level. Production level and crushing plants. Grinding.
B	Between 2000 and 3000	48	Production level. Dump. Foundry.

Table 2: Main results.

Mine Site	Measurement site	Concentration Average (Bq/m^3)	WL	WLM	Dose (mSv/year)
A	Subsidence level Sector 1	63,60	0,01	0,11	0,56
A	Subsidence level Sector 2	980,80	0,14	0,40	1,98
A	Transport level	19,50	>0,0001	>0,0001	>0,01
A	Crushing plant	253,00	0,05	0,07	0,35
A	Grinding plant	50,00	0,01	0,01	0,07
B	Production level Sector 1	27,00	<0,0001	<0,0001	<0,01
B	Production level Sector 2	9,00	<0,0001	<0,0001	<0,01
B	Office workshops – ventilation	182,00	0,02	0,23	1,13
B	Office workshops + ventilation	85,00	0,01	0,11	0,56

Discussion:
Concentrations at Mining Site A fluctuate between 9 and 1304 Bq/m^3 of radon, while at Site B concentrations between 9 and 163 Bq/m^3. Annual effective dose values in Site A range from 0.07 mSv to 1.98 mSv per year, while for Site B they range between <0.01 mSv to 1.13 mSv per year.

All values were obtained with normal ventilation conditions and in the warmer season. Presumably, in the colder season with technical difficulties imposed by the low temperatures that occur at these geographical heights. Likewise, due to rain or snowfall, the greater presence of water percolated through the mining substrate could be a factor that can increase the concentration of radon gas in the air. An exception to the above, are the last two readings of Site B, in which there was the opportunity to take measurements under conditions with normal ventilation and without by scheduled maintenance activity, producing increase in radon concentration.

Conclusions:
There are presence of radon gas at workplace in underground mining operations. The dose levels founded are less of levels that imply the implementation of mitigation measures. However levels are significant compared with levels are usually found for practices authorized in country, therefore, it is convenient to continue assessments for more robust information regarding the real magnitude of the problem previously to promote a treatment of this type of exposures is approached from a policy or regulatory.

Can be observed that factors such as ventilation are fundamental, exists in large underground mining are already present for the control of other pollutants such dust, silica, combustion gases, among others, also other factors such us ambient temperatures, geographical altitude and the natural presence of water could be important.