URANIUM MINING AND MILLING SITES IN ARGENTINA: ENVIRONMENTAL RADIOLOGICAL MONITORING (1981-1994)

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ABSTRACT

Environmental radiological monitoring in the vicinity of Argentinean uranium mining and milling plants is performed on a routine basis, in order to assess the possibility of a significant environmental contamination due to uranium mill wastes or by mill tailings for the plants still operating or by those plants where the exploitation was concluded.

Dissolved ^{226}Ra and natural uranium concentrations in surface water are measured in samples taken at selected points upstream and downstream from rivers, in the area of influence of the mills.

In the present paper the environmental radiological monitoring program results obtained for the 1981-1994 period are shown, and from the analysis of these data it can be concluded that no remarkable exposure occurs for the population living in the vicinity of the analysed areas due to the uranium mining and milling plants operation or their wastes.

INTRODUCTION

In figure 1 are shown the uranium mining and milling areas included in the environmental radiological monitoring program, their geographical location and the type of exploitation. The uranium industry began its development in Argentina in the '50 and, at present time only San Rafael and Los Colorados plants are still operating.

As a results of plant operation, two types of wastes are obtained, acid liquid wastes that are neutralised before being piped into large evaporation ponds and ore tailings, solid wastes that result after the acid-leach process.

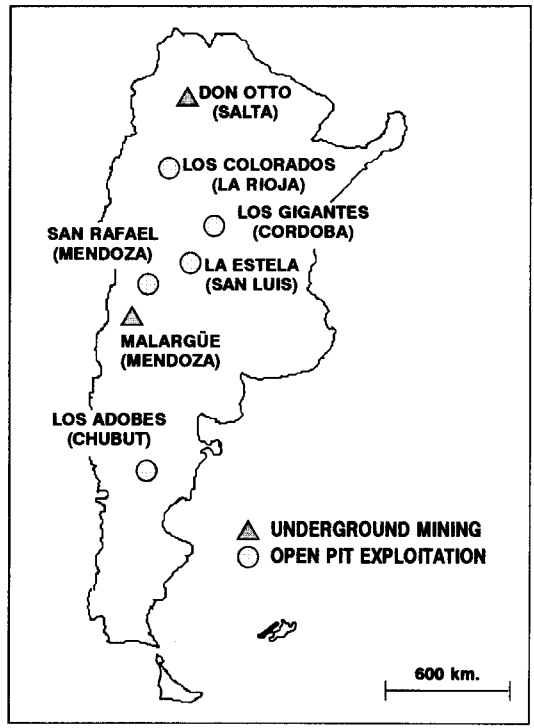

Figure 1: Uranium mining and milling areas included in the environmental radiological monitoring program.

MATERIALS AND METHODS

Surface water samples are taken from river locations upstream and downstream from uranium mills, according to a special monitoring plan set up for each facility (1), in order to allow the estimation of an eventual water contamination.

Dissolved ^{226}Ra in surface water samples were analysed by the classical radon emanation Rushing technique with Lucas cells (2). From 1988 till 1993, gross alpha counting using ZnS (Ag) as a detector was performed on water samples. Only those samples exceeding 70 mBq/L of gross alpha activity were selected for ^{226}Ra analysis. Nowadays, the ^{226}Ra concentration is measured by the ^{222}Rn emanation technique in sealed vials with toluene scintillation cocktail (3). The method consists in a ^{226}Ra co-precipitation with $BaSO_4$ and an alkaline EDTA dissolution before the liquid scintillation counting .

Natural uranium concentration is determined by a direct fluorometric measurement or after a co-precipitation with $CaHPO_4$ as a carrier, in order to enhance the detection limit.

^{222}Rn emanation rate from ore tailings is determined by adsorption on activated charcoal and a gamma measurement of the ^{214}Bi (609 Kev) in equilibrium.

RESULTS AND CONCLUSIONS

Figures 2 and 3 show the range of values of ^{226}Ra activities and the maximum natural uranium concentrations measured in surface water samples taken from the Diamante river and the El Tigre stream, from sampling points located in the surrounding of the San Rafael plant, from 1981 to 1994.

The average ^{226}Ra concentration was 4mBq/L either for samples taken from points < 10 km upstream or those samples taken < 50 km downstream, from the San Rafael mining and milling plant, with a range of values of 0.7-19 mBq/L and 0.7-13 mBq/L, respectively.

For the same period of time considered, the average natural uranium concentration measured was 0.02 mg/L, with a range of values of 0.0009-0.1 mg/L either in samples taken above or below the plant discharge point.

The application of the statistical test of Wilcoxon (4) demonstrated that no significant differences in the ^{226}Ra and natural uranium concentrations were found between the surface water samples from river locations above and below the milling plant of San Rafael, as well as for the rest of mining and milling areas of Argentina, where the environmental radiological monitoring program was performed.

Figure 4 and 5 show the corresponding ranges of ^{226}Ra concentrations and the maximum natural uranium concentrations, obtained for all the uranium sites, for the last year assessed. An important variability was observed in the concentrations of the radionuclides of interest, due to geographical and seasonal causes, but all the results obtained were below the derived limits for drinking water, that taking into account the biokinetic model (5) and dose conversion factors (6) were estimated as 180 mBq/L for ^{226}Ra and 0.12 mg/L for natural uranium.

^{222}Rn emanation rates were measured at San Rafael (1992) and Malargüe (1993) ore tailing sites, and the range of values obtained were 9-11 $Bq/m^2.s$ and 10-17 $Bq/m^2.s$, respectively. The contribution of ^{222}Rn at the natural background concentration, due to the ore tailings, is not significant at a few hundred meters from the emanation points.

Taking into account all the measurements of the environmental radiological monitoring program for the last 14 years, it may be concluded that no remarkable exposure occurs for the population living in the vicinity of the uranium mining and milling sites in Argentina due to their operation or their wastes.

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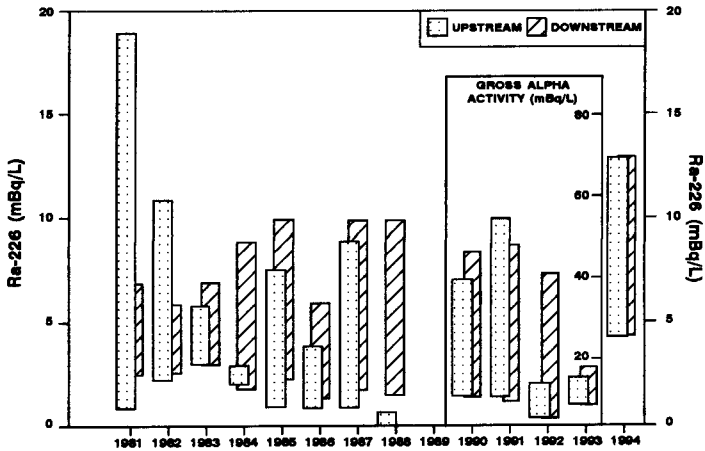

Figure 2: Range of ^{226}Ra concentrations and gross alpha activities measured in surface waters, < 10 km upstream and < 50 km downstream from the San Rafael plant (Mendoza), 1981-1994.

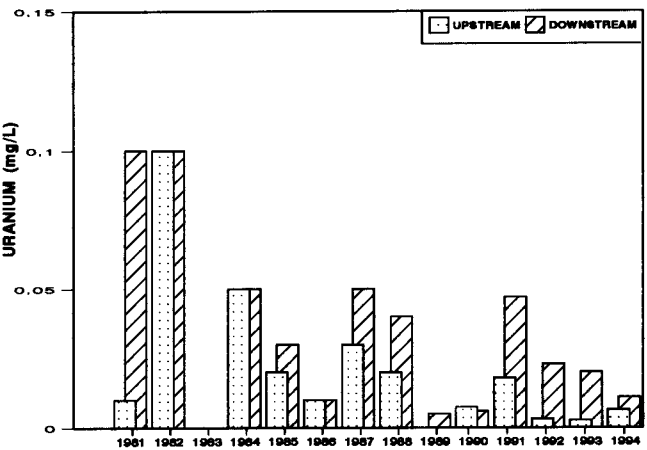

Figure 3: Maximum natural uranium concentrations measured in surface waters, < 10 km upstream and < 50 km downstream from the San Rafael plant (Mendoza), 1981-1994.

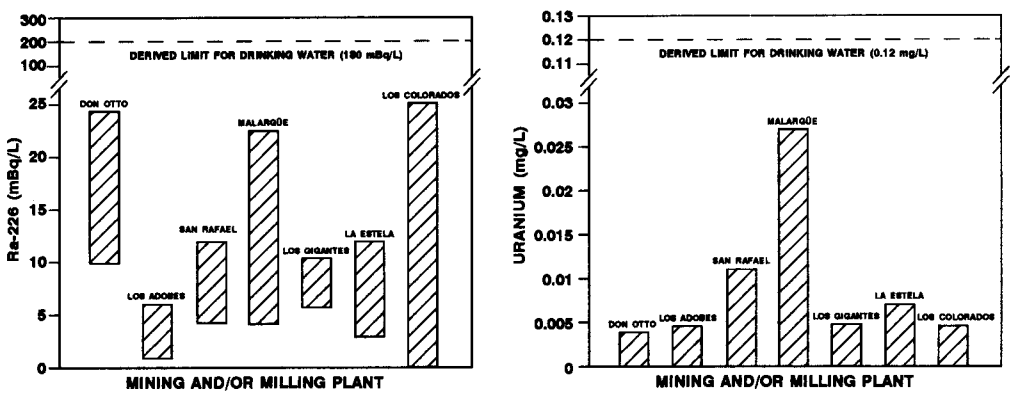

Figure 4 and 5 : Range of ^{226}Ra concentrations and maximum natural uranium concentrations measured downstream, < 50 km from the plants, for the last year assessed.