CORRELATION OF NATURAL AND ARTIFICIAL RADIONUCLIDES IN SOILS WITH PEDOLOGICAL, CLIMATOLOGICAL AND GEOGRAPHIC PARAMETERS

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Various types of soil samples were collected in the southern part of Brazil, with depth intervals of 5 cm, down to 50 cm, using a specially designed sampler. Pedological analysis of these soils were performed. Nuclear activities of $^{137}$Cs (expressed in Bq m$^{-2}$) and radioactive natural element ($^{226}$Ra, $^{228}$Ra and $^{40}$K) concentrations were determined by low background gamma-ray spectrometry. $^{137}$Cs concentrations were correlated with radioactive natural element concentrations and pedological, climatological and geographic parameters related to the soil samples collected.

The concentrations of natural radioactive elements such as $^{226}$Ra, $^{228}$Ra and $^{40}$K and man-made $^{137}$Cs were determined in soil samples and the results are expressed as Bq m$^{-2}$. $^{137}$Cs is a man-made radionuclide and was deposited in soil as fallout produced by atmospheric nuclear tests and accidents. Gamma-ray spectrometry was used to determine nuclear activities. Samples of soils, provided by the International Atomic Energy Agency (IAEA), were used to calibrate the detector.

SCHUCH et al. have studied $^{137}$Cs behavior in soil samples collected in 1991 in Paraná State, Brazil. These samples were compared with others collected in the same locations in March 1977, and November-December 1983. In all samples for which pedological analysis were performed, concentrations of $^{137}$Cs, $^{226}$Ra, $^{228}$Ra and $^{40}$K were measured. This study has shown the latitudinal dependence of $^{137}$Cs fallout, as well as the impossibility to measure $^{137}$Cs contribution from the Chernobyl accident among $^{137}$Cs concentrations measured, due to the intense leaching within these soils from high rainfall regions. It was also shown that, on the contrary of what

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happens with $^{137}$Cs, natural radioactive elements were practically not affected by the effects of leaching, confirming the fact that they are strongly fixed to soil matrix or included in insoluble mineral of the bedrock.

The main purpose of this work was to determine possible correlations between $^{137}$Cs concentrations, natural radionuclide concentrations ($^{226}$Ra, $^{228}$Ra and $^{40}$K), and pedological (Ph, clay and organic carbon, exchangeable bases Ca$^{++}$, Mg$^{++}$, K$^{+}$ and Na$^{+}$, cation exchange capacity and percentage of base saturation), climatological (mean annual rainfall and temperature) and geographic (altitude, latitude and longitude) parameters. $^{137}$Cs distributions within the soil profiles were also analyzed.

**Experimental**

In June 1991, in Rio Grande do Sul State, 7 profiles of soils were collected down to 50 cm, with depth intervals of 5 cm, using a carbon steel sampler (area of 20 cm x 10 cm and depth of 5 cm) specially designed for this purpose, as shown in Table 1.

Samples were collected, prepared, and the concentrations of radioactive elements measured, following the methodology described in SCHUCH et al. Pedological analysis was performed by the Soil Department of the Rural Sciences Center of the Federal University of Santa Maria. Table 2 presents the mean values of 10 samples obtained for each soil profile for the concentrations of radionuclides and for the pedological parameters of all soil from Rio Grande do Sul State. Climatological and geographic parameters of all soil samples are given in Table 1.

**Results and Discussion**

The coefficients of linear correlations for $^{137}$Cs concentrations per unit and the rest of the parameters shown in Tables 1 and 2 are presented in Table 3.

From Table 3, we can conclude that there is a certain linear correlation between the concentrations per unit area of $^{137}$Cs and the concentrations of K, C, Ca$^{++}$, Mg$^{++}$ and CEC (cation exchange capacity). This result seems to show that the fixation of Ca$^{++}$ and Mg$^{++}$ by clays prevents a larger absorption of $^{137}$Cs by the clays, even though the $^{137}$Cs has a greater affinity for the clays. The result obtained for the CEC is explained in the same way. The larger the CEC, the easier the way $^{137}$Cs, eventually adsorbed by the clays, will be substituted by extractable bases.

The soils taken for that work were chosen in locations of similar mean annual rainfall, to eliminate this possible influence in the correlations made with pedological parameters. However,