NATURAL AND ARTIFICIAL LEVELS OF RADIOACTIVITY IN SOIL OF CAMPANIA REGION

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The ground radioactivity is generally ascribed to: i) the natural radiation present in soil and, ii) the artificial radionuclides originated by nuclear weapons tests, accidental releases from nuclear power and industrial plants. The redistribution of natural radioactivity related to agricultural management and the use of fertilizers presenting a high concentration of radioelements (ref.1) must be also considered. The aim of the present work was to investigate the various components of the ground radioactivity in Campania, a region of Italy, including the recent Chernobyl fall out.

Campania (13,600 Km^2) is a south Italy region lying between the Appennines and the Tirreno sea. It consists principally of three areas: the calcareus area of the Appennines, a flat country by the sea containing three volcanic groups (Roccamonfina, Campi Flegrei and Vesuvio) and some alluvial soils, and finally the Cilento high land, rich in karst-formations. Samples of soil (0-5 cm) collected from 19 sites around the region (FIG. 1), in the period May 20, June 5, 1986, were analyzed for gamma-ray activity by using a 20% efficiency and 2,1 KeV resolution (at 1.33 MeV) Ge(Li) detector and a multi channel analyzer. The spectra were analyzed off-line by the automatic code CERNUC (ref.2).

Three major natural gamma radiation sources were identified: ^{40}K, the Uranium and the Thorium decay series. The most intense members of the radioactive families are shown in table I. ^{40}K accounted for more than 50% of the total activity. The sites nearest to the volcanic areas (1,2,3,14 and 15) presented a higher level of radioactivity. In rows 20 and 21 the results of the measurements performed on samples of two fertilizers, mineral superphosphate and potassic sulphate, are reported. The first fertilizer contained a very high concentration of the Uranium family members and some of the elements of the Actinium serie, not detected in the soil samples; the second one presented a ^{40}K activity of 23 kBq/Kg. Nevertheless the use of both fertilizers has

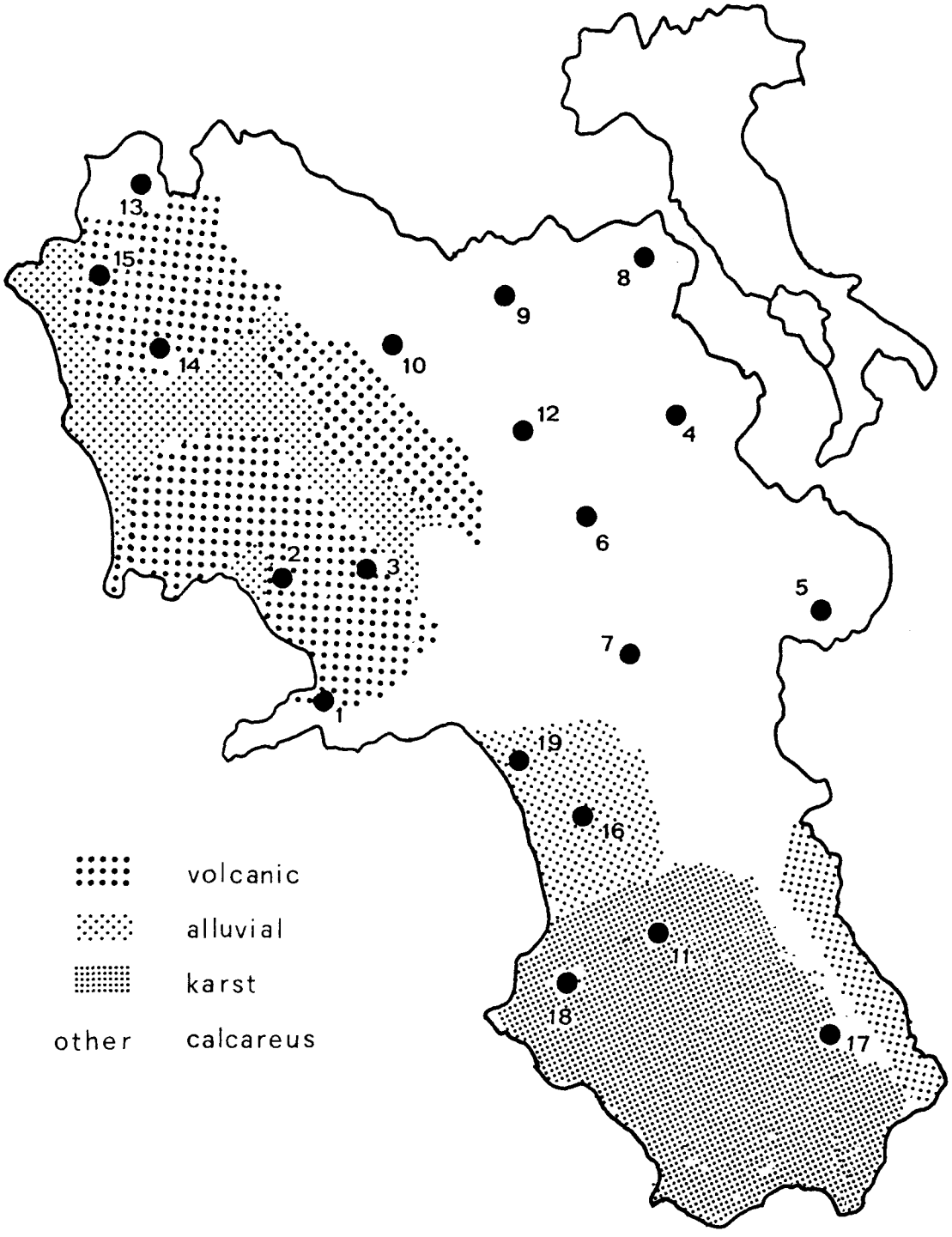

FIG.1 - Campania region and sampling locations

no influence on the soil radioisotopic concentration. In fact, no difference was found between cultivated and uncultivated soils. Therefore local variations of the radionuclide concentrations are to be attributed to geological and geochemical differences.

The measured high values of the Cesium radioisotopes are to be attributed to the Chernobyl accident. Measured radionuclides (ref 3) with short half lives are not reported here since they do not present any long term consequence. The observed dispersion of the values is probably due to the very irregular orographic profile of the Campania region, the local meteorological conditions during the fall out period and the different physical and chemical properties of the soils. The actual mean concentration of ^{137}Cs was found to be 107 Bq/Kg. The average ratio $^{137}Cs/^{134}Cs$ was greater than the estimated ratio (equal to 2) for the activity released from the reactor. This indicates that some amount of ^{137}Cs was already present in the soil, produced by previous atmospheric nuclear tests. As the half life of the ^{134}Cs is 750 d, the presence of this isotope is only due to the Chernobyl release. Assuming $^{137}Cs/^{134}Cs$ = 2 at May 1, 1986 we obtained that 94 Bq/Kg were a consequence of the Chernobyl accident, while the remaining 13 Bq/Kg were pre-existent. Taking into account the depth and the average density of the soil samples (1.387 g/cm^3), we assessed the total ^{137}Cs fall out to be 89 TBq (6.5 KBq/m^2). The uncertainty due to the differences among sample densities and sampling procedures was evaluated around 30%. It is of some interest to calculate the amount of this element in the environment immediately after the experiments of the sixties. An indirect estimation of this concentration may be derived by analysing the content in matrices which have a high efficiency for retention of ^{137}Cs. It is well known that the lichens have this peculiarity (ref.4). For this reason, samples of lichens (Stereocoulon Vesuvianum) were collected at the Vesuvio (altitude 370,490,580,780,960 m) in three different times (October 28 and December 5, 1986 and October 5,1987). Their ^{137}Cs mean contents were 2016±203,1868±240 and 1776±166 Bq/Kg, respectively. As done for the soil samples, we calculated the contribution of the fall out before the May 86 (403 Bq/Kg). Performing a linear least square fit of the logarithm of the ^{137}Cs values versus time, we obtained an effective half life of the isotope in the lichens of 6.1±0.9 y, corresponding to a biological half life of 7.6±1.2 y. Using the measured effective half-life, the ^{137}Cs level in 1970 can be extrapolated obtaining a value of 2600 Bq/Kg.

The ground doses related to the mean concentration of ^{137}Cs and the mean activity of natural radionuclides contained in a layer of 5 cm of top soil were 0.12 mSv and 2.38 mSv, respectively. Although in these estimations we took into account only one of the possible pathways of the dose to the man, the comparison is helpful

for a better understanding of the real impact of the Chernobyl accident.

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Table I. Radioisotope concentrations (Bq/Kg) at different sites in the Campania region.

#	^{137}Cs	^{134}Cs	^{226}Ra	^{214}Pb	^{214}Bi	^{228}Ac	^{212}Pb	^{212}Bi	^{235}U	^{211}Pb	^{40}K
1	111	40	503	346	294	144	141	118	-	-	2590
2	156	64	488	394	347	148	179	245	-	-	3135
3	234	106	629	588	484	118	84	114	-	-	2801
4	227	110	128	75	78	73	54	93	-	-	1622
5	126	68	61	45	54	68	65	69	-	-	1340
6	69	30	269	202	188	142	159	115	-	-	2498
7	168	76	128	167	159	153	141	95	-	-	2279
8	61	20	54	35	36	51	43	37	-	-	992
9	123	54	144	48	47	78	93	62	-	-	1650
10	53	14	52	51	51	91	88	57	-	-	1289
11	44	19	91	73	41	88	74	41	-	-	1084
12	179	88	273	115	85	145	174	158	-	-	2384
13	51	23	211	74	59	174	164	105	-	-	2198
14	160	78	381	151	116	231	240	150	-	-	2888
15	17	3	211	153	151	206	141	145	-	-	2335
16	168	78	332	106	104	159	100	171	-	-	2042
17	39	9	142	79	76	89	84	60	-	-	1304
18	23	7	81	39	46	38	28	15	-	-	1014
19	33	10	307	161	167	152	134	115	-	-	2291
20 *	-	-	1628	1017	925	14	18	8	102	150	-
21 *	-	-	-	4	7	5	4	5	-	-	23051

*) Fertilizers

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