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PRESENCE OF ^{57}Co IN THE ATMOSPHERE*+

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We have established the presence of the radioisotope ^{57}Co in the atmosphere. It has been done by collecting a few thousand liter of rain water, adding Co carrier to it, and passing it through an ion exchange column to retain the cations. The technique is similar to the one we used to determine ^{22}Na in the atmosphere and it has been described already[1].

The cations with the Co were eluted from the column and the Co precipitated with H_2S in basic solution. The Co was dissolved, then scavenging was done with sulphides of Cu, Sb, Te, Se, Bi and Pb; with sulphate of Ba; and with hydroxides of Fe and La. The Co

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was extracted from thiocyanate solution with a mixture of amyl alcohol and ethyl ether, returned to H_2O phase, precipitated in solution of HCl with 1-Nitroso-2-Naphtol, and ignited to the oxide. The procedure described is specific for Co, and the chemical yield ranged from 15 to 60%.

The Co was counted in a well crystal scintillation spectrometer Model 516, built by Baird-Atomic, Inc., Cambridge, Mass., which we calibrated for energy measurements and for efficiency. The spectrum obtained showed one peak with an energy of 125± 5 Kev corresponding to the tabulated gamma rays of ^{57}Co of 123 Kev and 137 Kev. We observed, of course, one peak only due to the poor resolution of the spectrometer. The counting efficiency at the photoelectric peak was 65%.

We carried out three experiments and the results are shown in TABLE I. The average activity of ^{57}Co for these three experiments is 0.020 dpm/liter.

TABLE I

Date 1957	Amount of rain water in liters	Absolute specific activity in dpm/liter
June	8500	0.016
September	3500	0.011
October	3000	0.040

One does not expect that ^{57}Co will be formed with appreciable yield in nuclear tests, whether they derive their energy from fusion or from fission. To see that, we will write the reactions that can produce ^{57}Co in decreasing order of likelihood. They are $^{57}Fe(p,n)^{57}Co$; $^{56}Fe(p,\gamma)^{57}Co$; $^{56}Fe(d,n)^{57}Co$; $^{58}Fe(p,2n)^{57}Co$; $^{58}Ni(n,2n)^{57}Ni$; $^{59}Co(n,3n)^{57}Co$; etc.

Examining these reactions, one arrives at the conclusion that nuclear tests having mostly fission could not account for the ^{57}Co observed, since all the reactions indicated produced by neutrons require thresholds of 12 Mev or greater, and one can calculate that this is not compatible with the amount of the fission product ^{137}Cs in rain water which is 1.2 dpm/liter[2].

The two first reactions written are the most likely to produce ^{57}Co in a test having mostly fusion. They should be hindered by the potential barrier. The only thermonuclear reaction giving protons with energy greater than the barrier in Fe is the reaction $^{3}He(d,\alpha)p$; but in a device where this reaction takes place, the reaction $d(d,^{3}He)n$ will be more prominent and give a large number of neutrons. In any case, in a fusion nuclear test where protons with a few Mev are produced, it is likely that more neutrons will be produced, and since there might be iron in the device, we decided to look for the radioisotopes formed in iron by neutron capture, namely ^{55}Fe and ^{59}Fe. One expects that (n,γ) will be more probable than (p,n) and (p,γ) in iron in a nuclear test.

A sample of 3000 liters of rain water was processed, and the iron purified with a chemical yield of 50%. The sample was counted with a Geiger counter and no detectable activity was found, giving an upper limit of 1 cpm. We corrected this upper limit for absorption, self-absorption, back-scattering, geometry, efficiency and yield and it gives an upper limit for ^{55}Fe of 0.010 dpm/liter. The corresponding upper limit for ^{59}Fe is 0.003 dpm/liter. Both upper limits are lower than the activity of ^{57}Co.

In conclusion, the presence of ^{57}Co in the atmosphere has been proven. The present evidence from theoretical considerations and from the absence of radioisotopes of iron seems to indicate that it is not likely to come from a nuclear test, although this point is not definite yet. The systematic observation of ^{57}Co in rain water and the radioisotopes in its neighborhood during three of four years will help to decide its origin.

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1. L. Marquez, N.L. Costa and I.G. Almeida: Nuovo Cimento (to be published).

2. L. Marquez, N.L. Costa and I.G. Almeida: An. Acad. Bras. Ciências (to be (published).