Previous Measurements of Radioactive Emissions from Fires

Several scientific publications [Ref. 1-4] show that the largest radioactive emissions from fires are the naturally-occurring decay products of radon: Pb-210, Bi-210 and Po-210.

Typical atmospheric concentrations of Po-210 and Pb-210 are about 1 fCi/m^3 and 10 fCi/m^3, respectively [Ref. 5]. Pb-210 is produced by the decay of radon gas; Bi-210 and Po-210 are produced by the decay of Pb-210. Radon decay products in the atmosphere are newly produced and so contain more Pb-210 than Po-210. After the Pb-210 settles on the ground and on plant surfaces, the Po-210 activity grows until its activity is equal to that of the Pb-210. The residence time of natural radionuclides in forests has been measured [Ref. 6] and modeled [Ref. 7]. Pb-210 remains on trees for more than a year, which allows time to reach equilibrium.

During a fire, the accumulated decay products become volatile so the atmospheric concentrations increase, typically to about 30 fCi/m^3 and in some cases to more than 300 fCi/m^3 [Ref. 1,2]. Because they are in equilibrium, the emissions of Po-210 and Pb-210 are about equal.

Plants generally contain about 1 pCi of Po-210 per gram of dry plant matter [Ref. 1]. During a forest fire, about 30 Mg of fuel is consumed per hectare of forest [Ref. 8], releasing about 30 micro-Ci of Po-210 in about a million cubic meters of air. Depending on the intensity of the fire, these numbers can vary by about a factor of ten in either direction. Smaller amounts are emitted from smoldering fires, <300 degrees C, whereas more is emitted from flaming fires, >600 degrees C [Ref. 2].

Close to African fires, Po-210 concentrations of more than 1 pCi/m^3 have been observed [Ref. 2]. Several thousand miles away, a concentration of 10 fCi/m^3 was observed in the plumes of African fires during an atmospheric-sampling flight over the Pacific Ocean [Ref. 4].

Plants also contain about 2 pCi/g of two other naturally occurring radionuclides: potassium-40 (K-40) and carbon-14 (C-14). However, C-14 is almost all emitted in the form of CO2, which does not accumulate on filters, and most of the K-40 remains in the ash [Ref. 8]. Furthermore, the low-energy beta from C-14 is difficult to detect and K-40 is masked by background radiation. In contrast, the unique alphas from Po-210 can be measured even in small concentrations.

Several other radioactive materials have been observed in forests and plants at lower concentrations (~ 0.1 pCi/g) namely: Be-7 [Ref. 6], Sr-90 [Ref.9], Cs-137 [Ref.9], and uranium [Ref. 9,10]. In studies of emissions from peat and coal [Ref. 11-13], Be, U, Sr, Cs, and K are reported to be less volatile than Po and Pb. In volcanic emissions, Po is the most volatile followed by Bi, Pb, and K [Ref. 14]. Thus, Po, Bi, and Pb are favored.

In summary, in the emissions from a forest fire we expect the Los Alamos AIRNET system to detect significant amounts of Po-210, Bi-210, Pb-210, and smaller amounts of Be-7. C-14, K-40, Sr-90, Cs-137 will probably not be detected. Natural uranium will probably not increase above the usual concentrations.

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