Observation of ^{110m}Ag in Chernobyl fallout

SIR—The initial radiometric flurry of interest in fission products with relatively short half lives following the Chernobyl reactor accident has been replaced with concern about the entry of fission products with longer half-lives into the food chain.

The movement and slaughter of lambs in Wales, Cumbria and Scotland has recently been prohibited due to the identification of lamb meat containing abnormally high levels of ^{134}Cs ($T_{1/2}$=2 yr) and ^{137}Cs ($T_{1/2}$=30 yr).

The radiometric laboratory of the Department of Physics at the University of Liverpool, which houses several low-level γ-ray counting systems, has been employed to carry out measurments on various dairy and meat products originating from North Wales. The low-level counting systems consist of high-efficiency, hyperpure germanium detectors with Compton suppression shields enclosed in lead castles to reduce background radiation. All systems are efficiency calibrated so that radionuclide concentrations can be determined.

A recent study of beef and lamb products in this laboratory revealed the presence of the radionuclide ^{110m}Ag ($T_{1/2}$=250 days) in both beef and lamb liver but not in other meats from the same animals. This radionuclide is readily identified by the presence of a γ-ray line of 658 keV alongside the characteristic 662 keV line of ^{137}Cs, although several other γ-rays including those at 447, 620, 707, 764, 885 and 937 keV provide an unambiguous identification of ^{110m}Ag.

A relevant portion of the γ-ray spectrum shown in Fig. 1 indicates the excellence of the detection system with its low background contribution and the clear resolution of the 658 and 662 keV lines.

Although the levels of ^{110m}Ag are small in both the beef and lamb liver, this radionuclide has not been observed in any other samples measured in this laboratory including air filters, rainwater and milk measured on 5–9 May 1986, nor in other meats and from ecological studies since.

In the beef liver we observed 23 ± 1 Bq kg^{-1} of ^{110m}Ag, 19 ± 1Bq kg^{-1}of ^{134}Cs and 21 ± 1 Bq kg^{-1} of ^{137}Cs. In lamb liver we observed 74 ± 1 Bq kg^{-1} of ^{110m}Ag, 30 ±1 Bq kg^{-1} of ^{134}Cs and 48 ± 1 Bq kg^{-1} of ^{137}Cs.

The radionuclide ^{110m}Ag is unlikely to arise as a fission product of ^{235}U. A=110 is near the minimum of the saddle point in the asymmetric mass distribution arising from the fission of ^{235}U by thermal neutrons. Also, a neutron-rich mass chain of A=110 produced in fission would terminate after successive β-decays at the stable nucleus ^{110}Pd before ^{110m}Ag could be reached.

A more plausible explanation is that the ^{110m}Ag is generated via the ^{110}Cd (n,p) ^{110}Ag reaction. Cadmium has been widely used in nuclear reactors as a neutron absorber for control purposes, however, following the Chernobyl reactor accident, cadmium may well have been used to try to control self-sustaining fission after the core meltdown.

As liver acts as a filter for large particles in the blood it is perhaps surprising that ^{110m}Ag has not previously been observed in dust from air filters although the fallout on Merseyside was slight compared to other parts of the country.

Further study of the lungs, liver and kidneys of animals reared in the areas of heavy fallout may provide yet more information concerning the Chernobyl accident.

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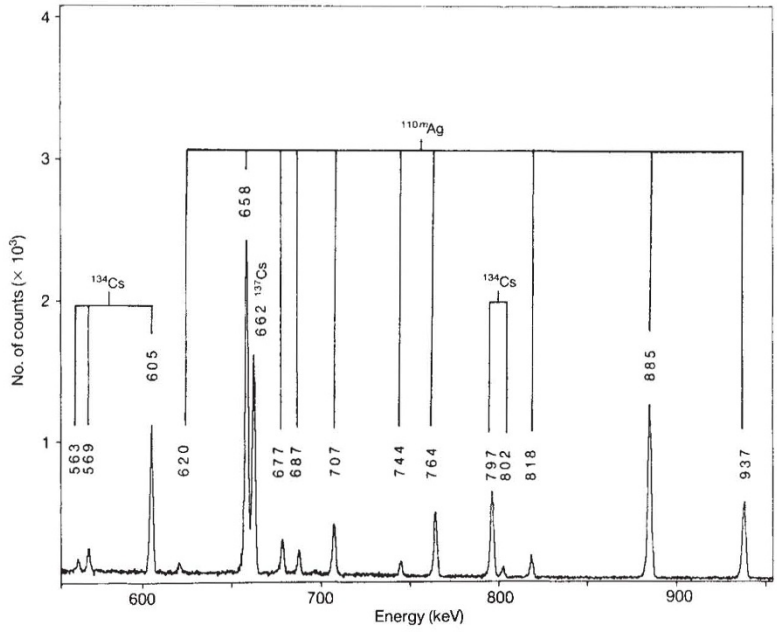

Fig. 1 A partial γ-ray spectrum arising from a sample of liver from a Welsh lamb. The count time was 57,700s. The lines are labelled by their energies in keV and by the originating radionuclides ^{110m}Ag, ^{134}Cs and ^{137}Cs.

Characteristics of Chernobyl radioactivity in Tennessee

SIR—Fission product radioactivity from the Chernobyl reactor accident was first detected in air samples at Oak Ridge, Tennesee on 10 May 1986. The aerodynamic sizes of the aerosol-associated fission products were evaluated in four measurements made during the period 7 May to 13 June, using Sierra high-volume cascade impactors and low-background intrinsic germanium coaxial and well detectors. Additional air and precipitation samples were also obtained over this period. The Chernobyl activity was mostly sub-micrometre in size, and the particle size increased significantly over the measurement period. Only a small fraction of the aerosol ^{131}I was soluble in $CHCl_3$. Both ^{134,137}Cs and ^{103}Ru were less soluble than natural radioactivity, indicating some association with aerosols produced by the accident.

Two distinct phases in airborne radioactivity were evident in our measurements. The first phase lasted from 10 to 17 May and was characterized by a ^{137}Cs/^{103}Ru activity ratio of ~1.5, resembling the airborne fission products and deposition reported in Finland on the 28–29 April[1]. The second phase began on 18 May, when precipitation from a convective storm yielded much higher ^{103}Ru and ^{140}Ba activities, relative to ^{137}Cs, than previously found in air or precipitation. This resulted in ^{137}Cs/^{103}Ru ratios of <0.8, similar to that calculated from British data[2]. Subsequent air and precipitation samples showed that this lower ^{137}Cs/^{103}Ru ratio persisted until 13 June. Table 1 summarizes these data.

The change in ^{137}Cs/^{103}Ru ratio on 18 May is interpreted as reflecting separate releases from the reactor which were meteorologically and/or temporally isolated. Two separate maxima in radioactivity were reported in Sweden, one on 28 April and one in the first week of May[3]. The highest measured air concentration of ^{103}Ru, 3.7 mBq m^{-3}, occurred in the 20–23 May sample. By 3 June, ^{103}Ru had declined to 0.1 mBq m^{-3}. We have also measured the amount of aerosol ^{131}I and its chemical