

## Nuclide identification of alpha-emitters by autoradiography in specimen of atomic victims at Nagasaki

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### Abstract

The explosion of a plutonium Atomic bomb over Nagasaki city in Japan took place at 1102h on August 9, 1945. Radiation dose of A-bomb survivor is practically estimated from external radiation. The alpha particles can be disregarded since they travel only a short distance through air. Plutonium remaining in the soil at Nagasaki after 24yr has been determined in 1971. In the patients subjected to the Atomic bomb there was no evidence of the introduction of radioactive material. We have already studied the preserved body cells of seven A-bombed victims in 1945, and became the first one to prove that plutonium is continuing to emit radiations after more than 60 years since the A-bomb attack. In this study, the nuclide identification of alpha-emitters in environmental samples and calibration standards has been attempted by the measurement of the alpha track length using autoradiography. Alpha track length in Nagasaki soil; Ground surface soil collected in 1979 from the Nishiyama area in Nagasaki City, <sup>210</sup>Po, <sup>241</sup>Am and <sup>243</sup>Am fitted the relation curve between energy and track length of alpha-particles in the photo emulsion. Moreover, the alpha track length in Nagasaki soil was consisted with that in paraffin-embedded specimen of A-bomb cases. Therefore, the nuclide of alpha-emitters in specimen of atomic victims at Nagasaki was identified with <sup>239,240</sup>Pu by autoradiography.

### Introduction

The explosion of a plutonium Atomic bomb over Nagasaki city in Japan took place at 1102h on August 9, 1945. Radiation dose of A-bomb survivor is practically estimated from external radiation (the Dosimetry System 2002:DS02)<sup>1</sup>. Alpha particles emitted from plutonium, consisting of two protons and two neutrons, are a densely ionizing type of radiation with low capacity to penetrate living tissue. The alpha particles can be disregarded since they travel only a short distance through air. Plutonium remaining in the soil at Nagasaki after 24yr has been determined in 1971<sup>2</sup>. In the patients subjected to the Atomic bomb there was no evidence of the introduction of radioactive material. A much more palpable danger would exist from the ingestion or inhalation of radioactive material.

We have already studied the preserved body cells of seven A-bombed victims in 1945, and became the first one to prove that plutonium is continuing to emit radiations after more than 60 years since the A-bomb attack.

Alpha particles emitted from the paraffin-embedded specimen, such as lung, liver, bone etc. were detected by a classical method of autoradiography. The frequency distribution of alpha-particle track

lengths of the A-bomb cases was consistent with the pattern of alpha-particles emitted from <sup>239,240</sup>Pu, and different from that of non-A-bomb cases. The calculated radioactivity of A-bomb cases was higher than that of non-A-bomb cases and relevant for factors of shielding and death time (unpublished data).

In this study, the nuclide identification of alpha-emitters in environmental samples and calibration standards has been attempted by the measurement of the alpha track length using autoradiography.

### Material methods

Particle forms in the tissue specimen were detected using the classical method of alpha-particle track autoradiography<sup>4</sup>, and nuclear emulsion method for environmental samples and calibration standards. Alpha tracks were observed in Nagasaki soil; Ground surface soil collected in 1979 from the Nishiyama area in Nagasaki City<sup>3</sup>, <sup>210</sup>Po, <sup>241</sup>Am and <sup>243</sup>Am (Table 1). Four um-thick sections of tissue were mounted on glass slides, and the unstained sections were dipped in liquid photographic emulsion. The emulsion was developed with developer. After development, the slides were stained with H&E. Particle were measured lengths using a standard optical microscope at 1000x magnification. At least two individuals shared in counting the particles in each case.

### Results

Alpha track length in Nagasaki soil; Ground surface soil collected in 1979 from the Nishiyama area in Nagasaki City<sup>3</sup>, <sup>210</sup>Po, <sup>241</sup>Am and <sup>243</sup>Am fitted the relation curve between energy and track length of alpha-particles in the photo emulsion<sup>5</sup> (Figure 1 and Figure 2). The alpha track length in Nagasaki soil was consisted with that in paraffin-embedded specimen of A-bomb cases (data not shown).

### Discussion

We have already demonstrated that the evidence of internal deposition of alpha-emitters in the specimen of Nagasaki A-bomb cases which had been within approximately 1 km from the hypocenter and died from acute A-bomb disease. Alpha-emitters had been introduced to the human body after the A-bomb explosion. The probability distribution pattern of alpha track length observed in A-bomb cases was apparently consistent with those characteristic of <sup>239,240</sup>Pu, but not those of the controls.

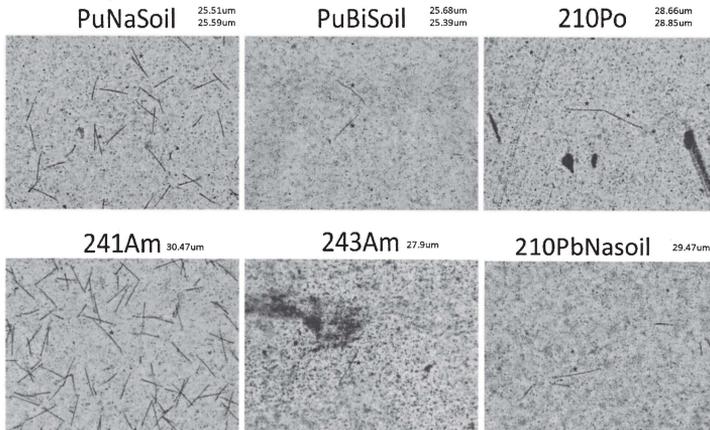
In this study, Alpha track length in Nagasaki soil from the Nishiyama area, <sup>210</sup>Po, <sup>241</sup>Am and <sup>243</sup>Am fitted the relation curve between energy and track length of alpha-particles in the photo emulsion.

## Table 1. Sample

		E(keV)
1	PuNaSoil a-LEPS 82.5.4	5156.59
2	PuBiSoil a-LEPS82.5.13	5156.59
3	210Po82.1.15	5304.33
4	241Am82.1.15	5485.56
5	243Am82.1.15	5275.3
6	210PbNasoil11.4.12	5304.33

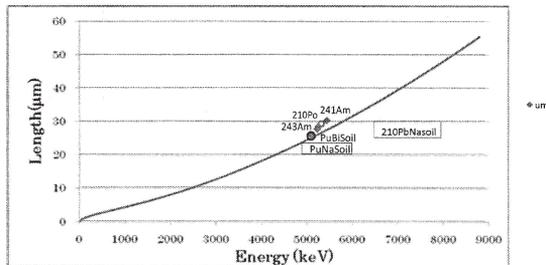
Moreover, the alpha track length in Nagasaki soil was consisted with that in paraffin-embedded specimen of A-bomb cases. Therefore, the nuclide of alpha-emitters in specimen of atomic victims at Nagasaki was identified with  $^{239,240}\text{Pu}$  by autoradiography, which was clearly distinguished from  $^{210}\text{Po}$ ,  $^{241}\text{Am}$  and  $^{243}\text{Am}$ .

### Figure 1. Autoradiographs



### Figure 2. Calculated track length

Emulsion is composed of dry emulsion, water and gelatin. Content of gelatin is not unknown and the content was adjusted so that the calculated track length of Po-212  $\alpha$ , 8.785 MeV (highest energy  $\alpha$  emitted from Thorotrast) coincided with observed length 55  $\mu\text{m}$ .



Elemental composition of dry emulsion, water content was referred from Norris and Woodruff (1955) Annu. Rev. Nucl. Sci. 297-326, that of gelatin from ICRU (1964).

## References

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