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STUDIES OF DEBRIS PARTICLES FROM THE FOURTH AND FIFTH CHINESE NUCLEAR TESTS

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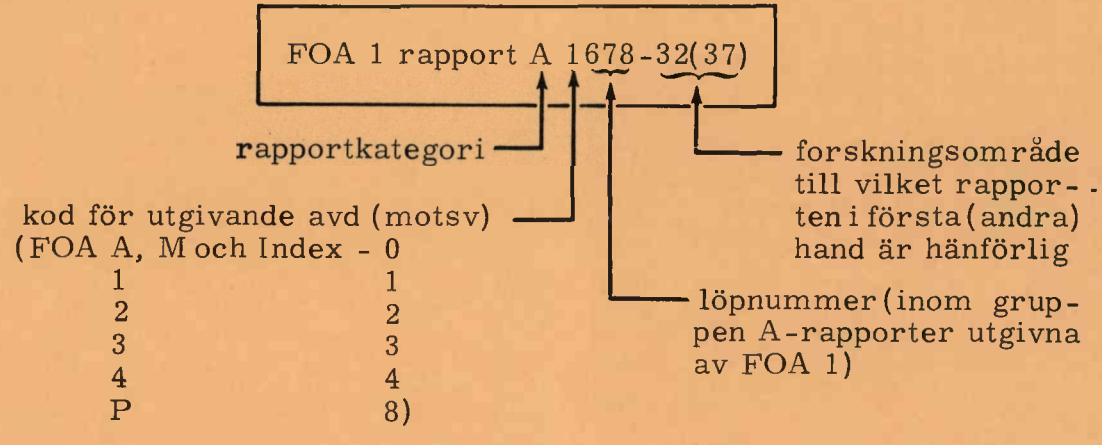

Försvarets forskningsanstalt
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by J Sisefsky

Antal blad 8

Abstract

Nuclear debris particles from the fourth and fifth Chinese tests in 1966 collected in air samples have been examined by reversal-autoradiography and microscopy. The particles from China IV are yellow and resemble those from China II. The particles from China V are mostly colourless - orange - black, unusually large and with very low specific activities. There are also a small fraction of red particles with higher specific activities. China V particles show strong chemical resistance.

Sammanfattning

Partiklar från Kinas fjärde och femte kärnexplosioner under 1966, samlade i luftprov, har undersökts med reversal-autoradiografi och mikroskopi. Partiklarna från Kina IV är gula och liknar dem från Kina II. De från Kina V är mestadels färglösa - orange - svarta, ovanligt stora och med mycket låga specifika aktiviteter. Därjämte förekommer sparsamt röda partiklar med högre specifik aktivitet. Kina V partiklarna visar stor motståndskraft mot kemisk påverkan.

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During 1966 China conducted three nuclear tests. Studies of the particle properties in the first one (being China's third test) have been published previously (1). In this paper examinations of debris particles from the two later 1966 tests are reported. The particles were collected and examined according to our usual routine, which includes sampling of ground air, and air 1 km above and 1 km below the tropopause, γ-spectrometry (2), β-counting and reversal-autoradiographic technique (3,4).

China's fourth nuclear test was performed 27.10.1966. 13 days later the first activity from the test was collected in Sweden. The particles resembled those from China's second test (May 1965) (5). They were mostly yellow or yellowish sometimes with a brownish tint, transparent and without optical activity. The specific activity is also about the same as in China II and thus slightly less than those from China's third test (1) (see fig 1).

China's fifth nuclear test was performed 28.12.1966. 8 days later, the debris was observed in Sweden. The samples which were collected then and during the following month were very weak. The particles were found to be quite different from those observed from earlier Chinese and USSR tests. The particle spectra were shifted against larger sizes, in both high altitude and ground air samples. In ground air, sizes larger than 6 µm were quite common and particles up to 11 µm were found (i.e. two times as large as was observed in earlier Chinese samples) (5,6). The fact that larger particles than usual reached Sweden, could perhaps indicate that the particles are lighter than usual.

The specific activity, on the other hand, is extremely low, about the same as from the first Chinese test, which was a ground level test with a great incorporation of inactive ground material in the fire-ball (6). The correlation between size and activity is however larger (see fig 2). Most of the particles are perfect spheres, with no signs of wrinkles or similar surface irregularities. Sometimes smaller particles are attached to the surface, from a few ones to as many as to cover the surface completely. The covering particles

range in size from barely visible ($\sim$ 0.2 μm) to $\sim$ 0.5 μm. However, the sizes of the particles, covering the same host particle, are rather uniform. The covering particles are often not spherical but more irregular, sometimes resembling rice-grains. The colours of the particles range from completely colourless and transparent over yellow - orange - brown to nearly black. The covering particles have sometimes colours, different from the host particle. There is a slight tendency that darker particles have higher specific activities than the other in contrast to particles from USSR tests in 1958-1964 which more or less show the opposite tendency (e.g. 7,8).

Together with these particles (type 1) there is a small fraction of particles of quite another type (type 2). They are "cherry" red, transparent, and not so perfectly spherical as type 1. Their specific activity is about a factor of 80 higher. The largest type 2 particle found was 2 μm (fig 3).

In order to test the resistance of the particles to chemical attack, pieces of ground-air filters were immersed for a day in various solvents. Then, they were dried and autoradiographed together with an untreated filterpiece for comparison. It was found that neither water, 3 mol HCl, 4 mol NaOH, nor aqua regia caused any visual change in the autoradiograms; thus the particles do not readily dissolve in these solvents (cf. 9). After filtering and evaporating the solvents and testing the residues for β-activity, it was, however, found that at least aqua regia had a slight dissolving action. When a glass-fiber filter was treated with HF it dissolved completely, and when the solution was filtered the filter did not show any hot spots when autoradiographed; thus the particles are soluble in HF as expected. The chemical properties and the indications of low density may suggest that the particles consist mainly of SiO_2 (cf. 10,11). The low specific activity indicates a near-ground explosion, with a great incorporation of ground material in the fire-ball.

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CHINA IV

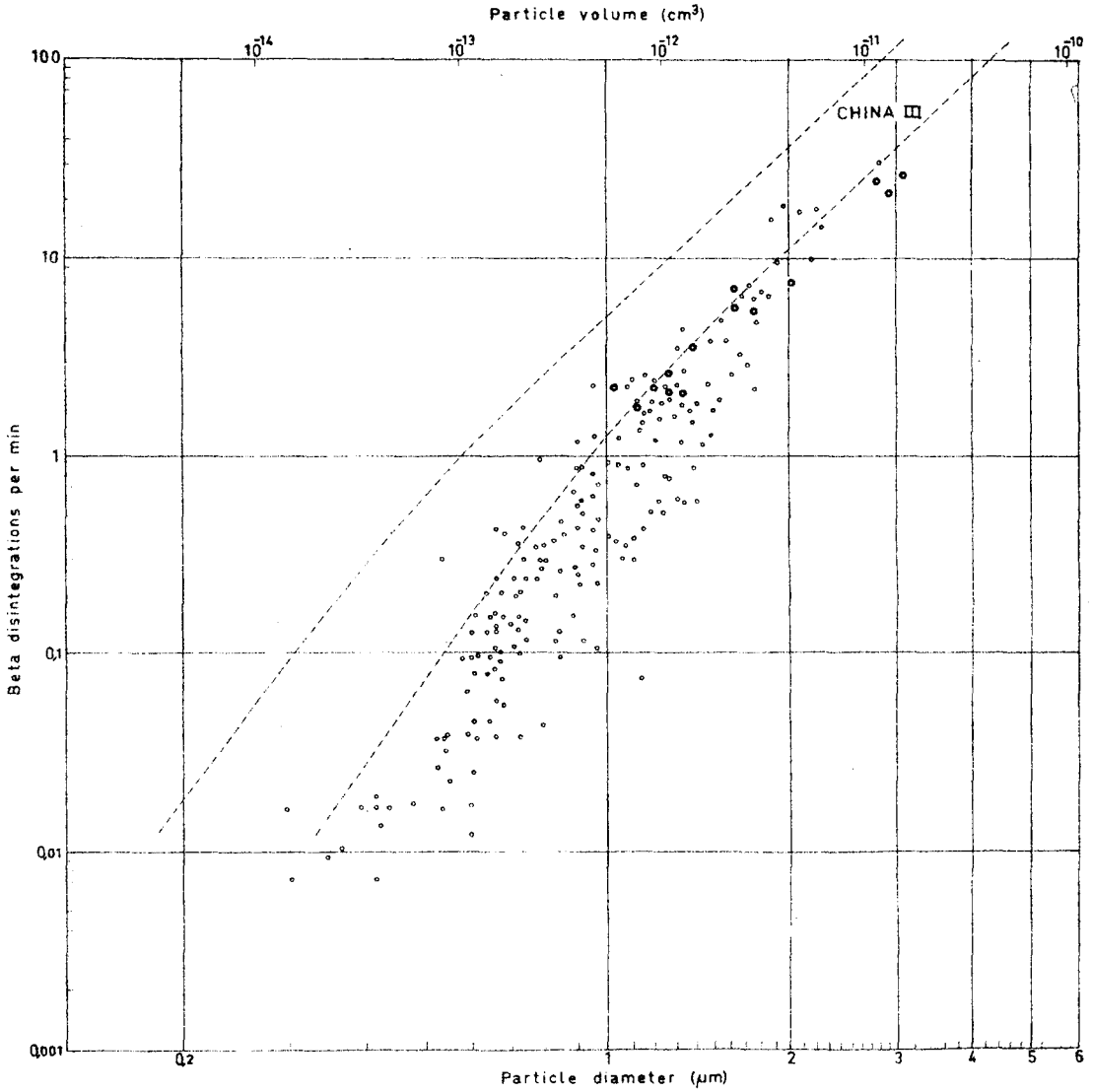


Fig. 1.

β-activity at 100 days after explosion versus diameter for particles from the fourth Chinese nuclear test. The double circles indicate particles which were directly measured in a β-counter. The other activities were determined indirectly from the spot sizes on the autoradiograms (4). A corresponding plot for the third Chinese test is shown schematically as dashed lines enclosing 90 % of the recordings in the "point cloud".

CHINA V type 1

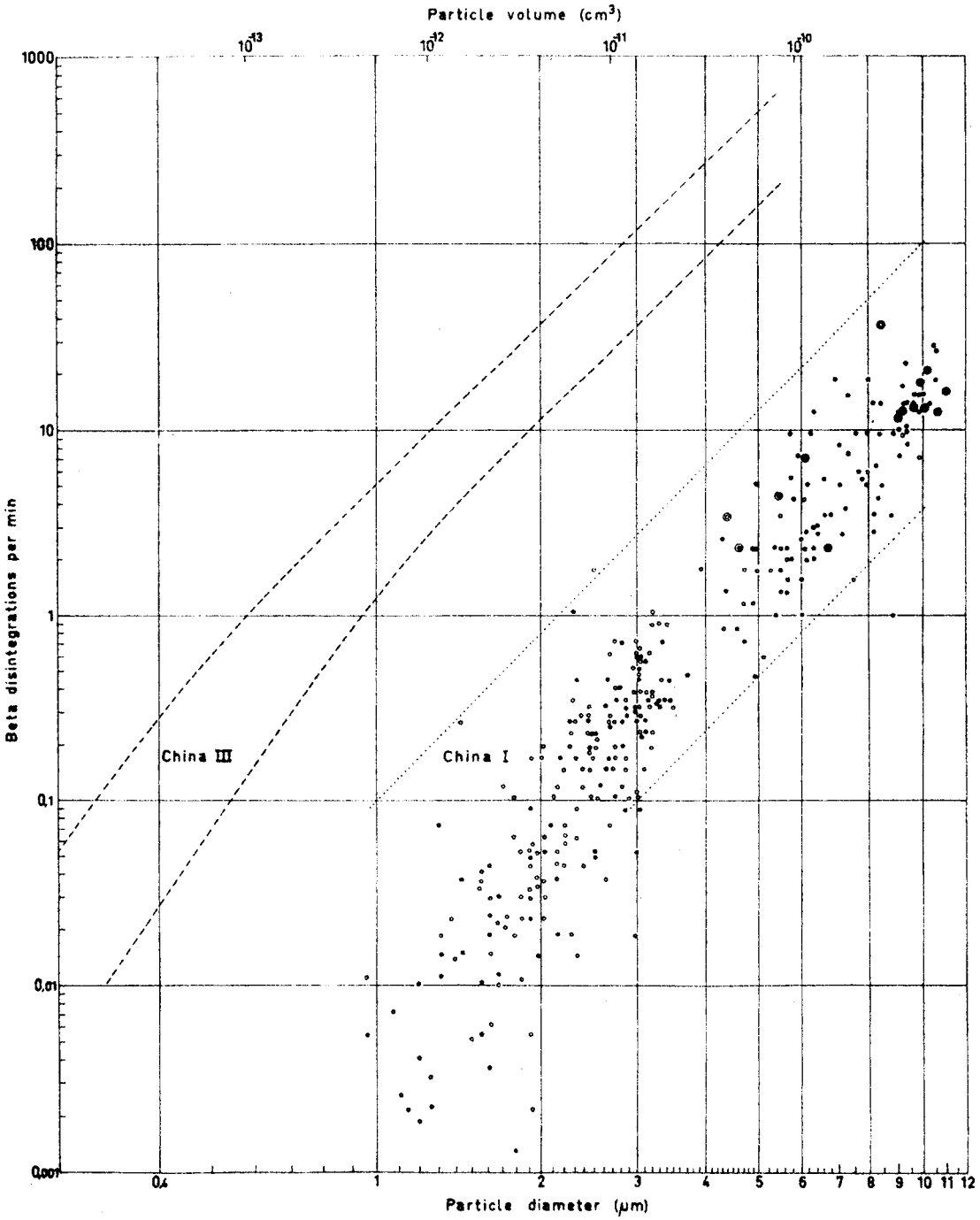


Fig. 2.

β-activity at 100 days after explosion versus diameter for type 1 particles (see text) from the fifth Chinese nuclear test. Filled circles indicate darkly coloured particles, unfilled circles lightly coloured ones. Corresponding plots for China's first and third tests are shown schematically for comparison. Otherwise, see legend to fig. 1.

CHINA V type 2

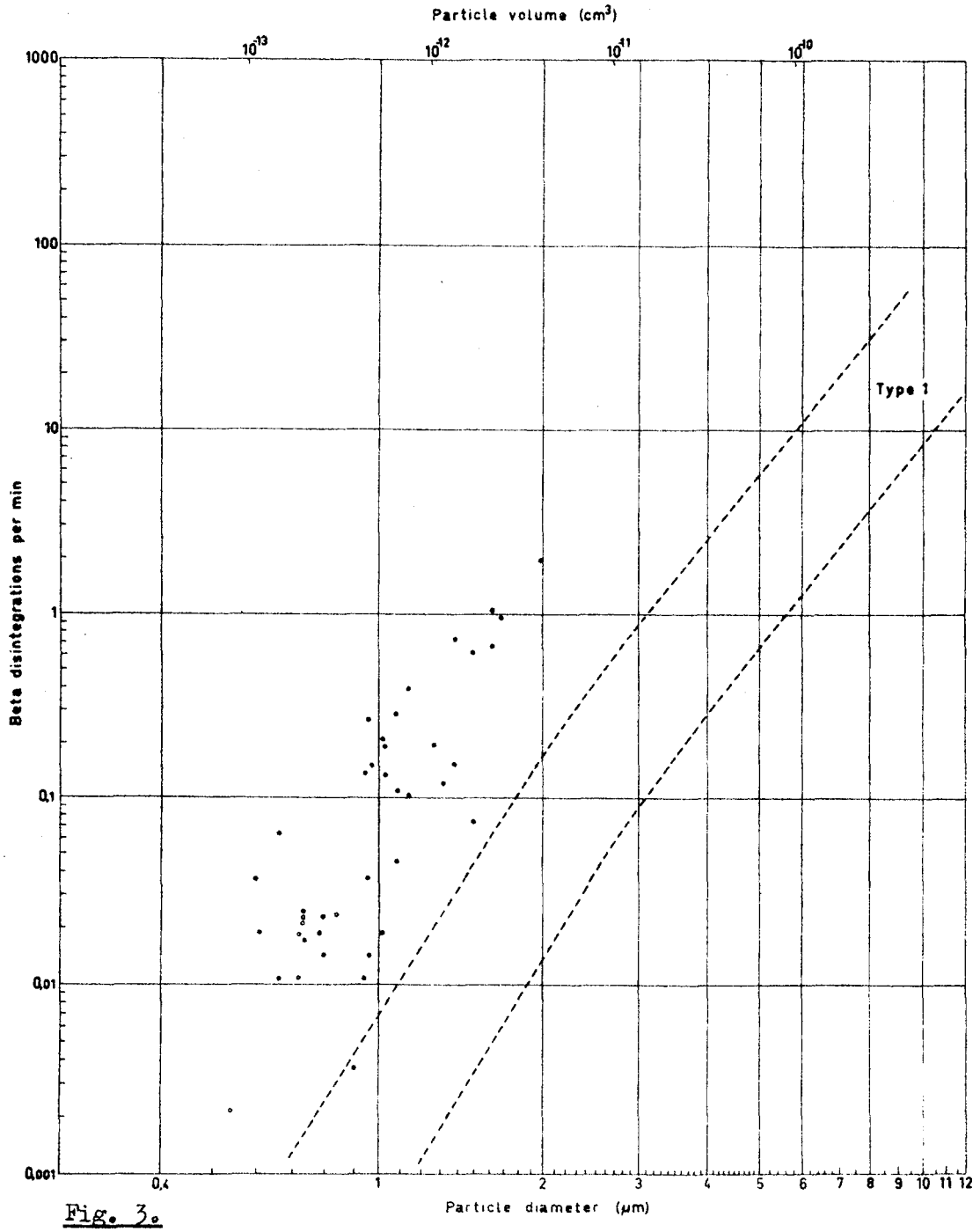
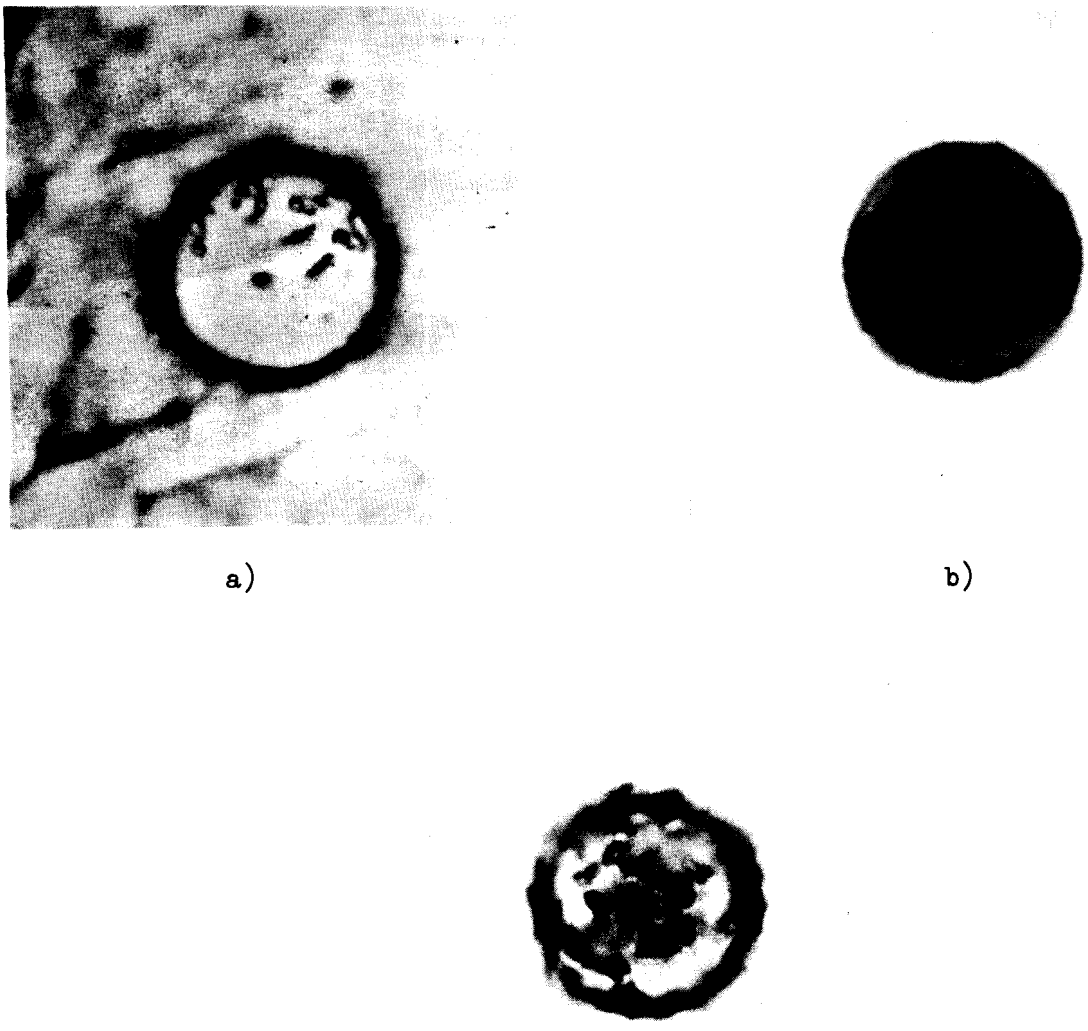


Fig. 3.

β-activity at 100 days after explosion versus diameter for type 2 particles (see text) from the fifth Chinese nuclear test. Filled circles indicate particles, where a "cherry" red colour was observed. A corresponding plot for type 1 particles (see fig. 2) is shown schematically for comparison. Otherwise, see legend to fig. 1.



a) b)

c)

Fig. 4.

Type 1 particles from China V.

a) 9.8 μm, faintly yellow with small yellow particles on the surface

b) 10.5 μm orange-brown

c) 9.6 μm orange-yellow with small orange particles in chain-like arrangement on the surface