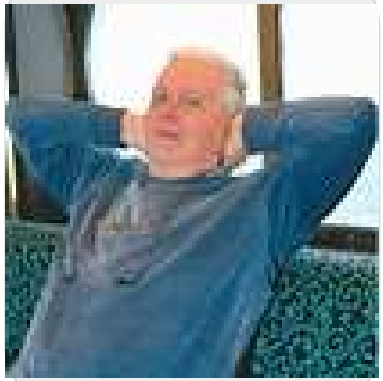

From counting-rate profile to ^{137}Cs profile

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Co-authors:

15th INTERNATIONAL SYMPOSIUM ON RADIATION PHYSICS (ISRP-15)
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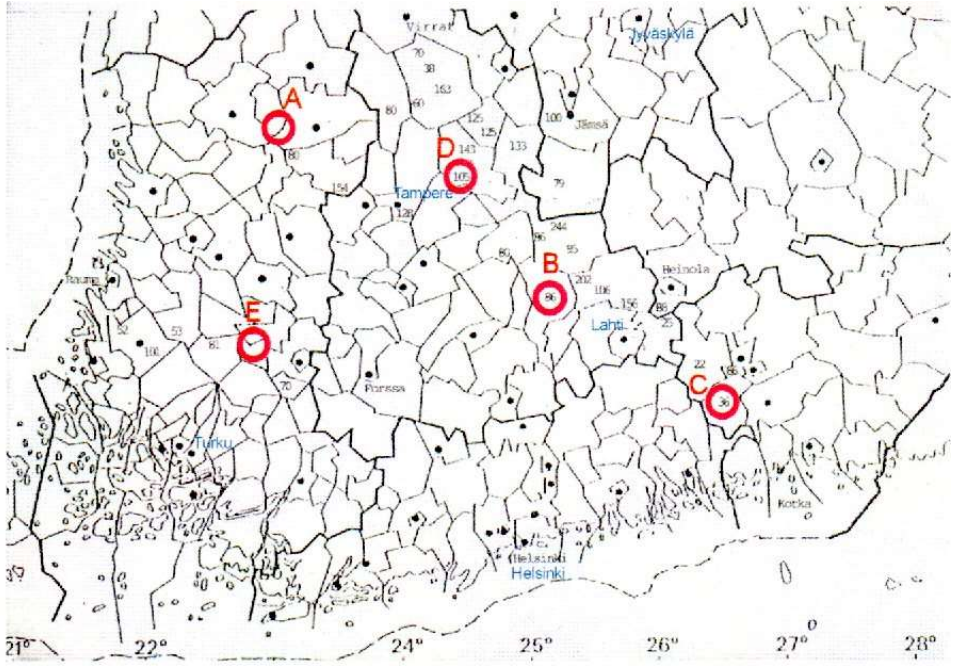
1.Introduction

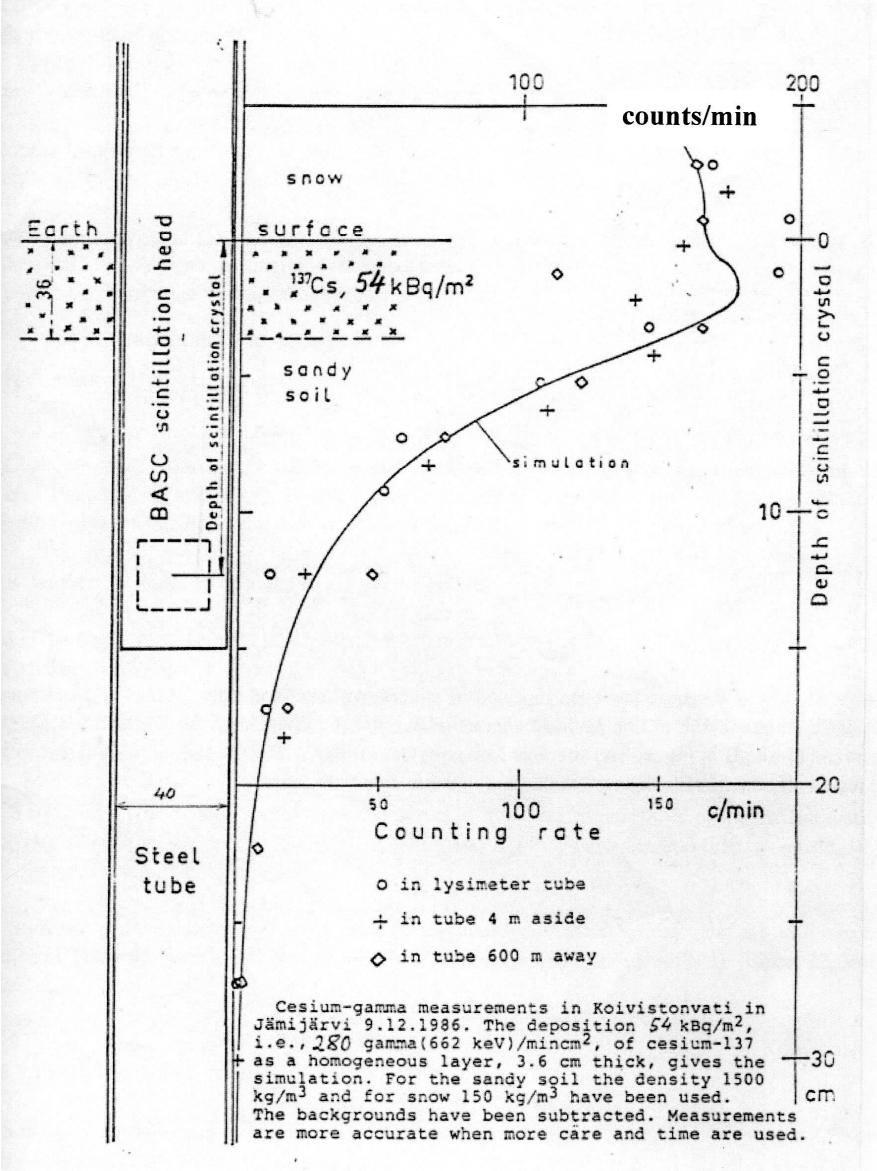
April-May in 1986 from Chernobyl near Kiova came radiation fall-out in Europe. Cesium isotopes 137 and 134 were a significant part of the fall-out. In soil they stay close to the surface. Some vertical tubes were in soil before the fall-out. Using scintillation detectors in tubes the counting rate profiles caused by soil gamma emitters were measured. This presentation describes the determination of ^{137}Cs profiles from the measured counting rate profiles.

9.12.1986 measurement in Koivistonvati

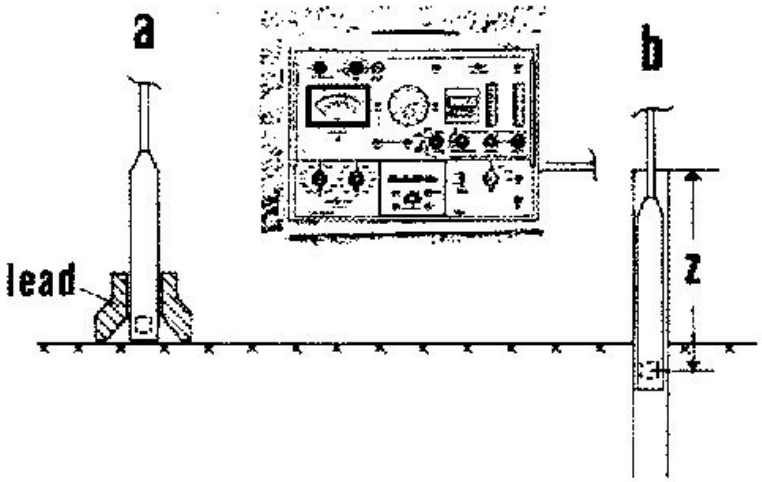
The points in the figure (at right) are from 3 tubes nea-by each others. The constant density of the cesium zone was determined with an inversion calculation, The constant density of sandy medium was assumed.

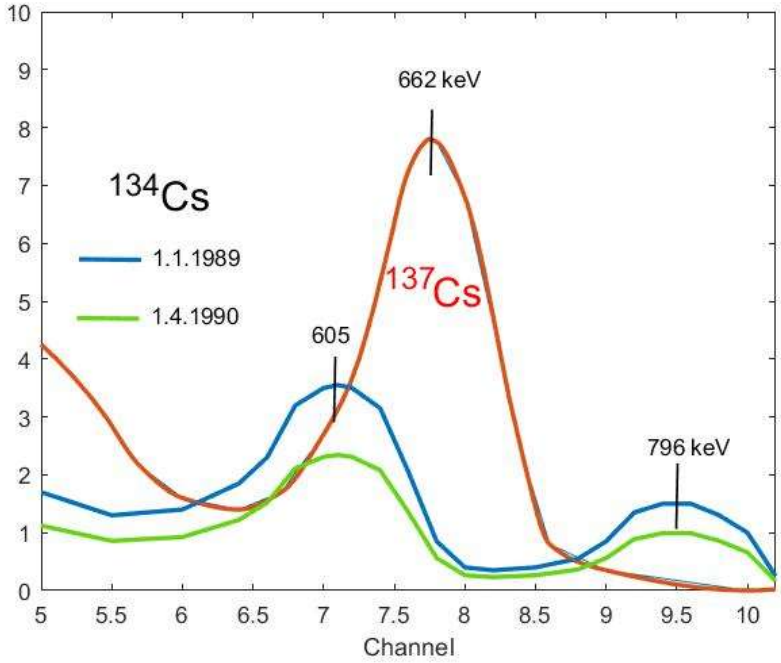


Southern Finland, A Koivistonvati, B Tullinkangas



My measurements:





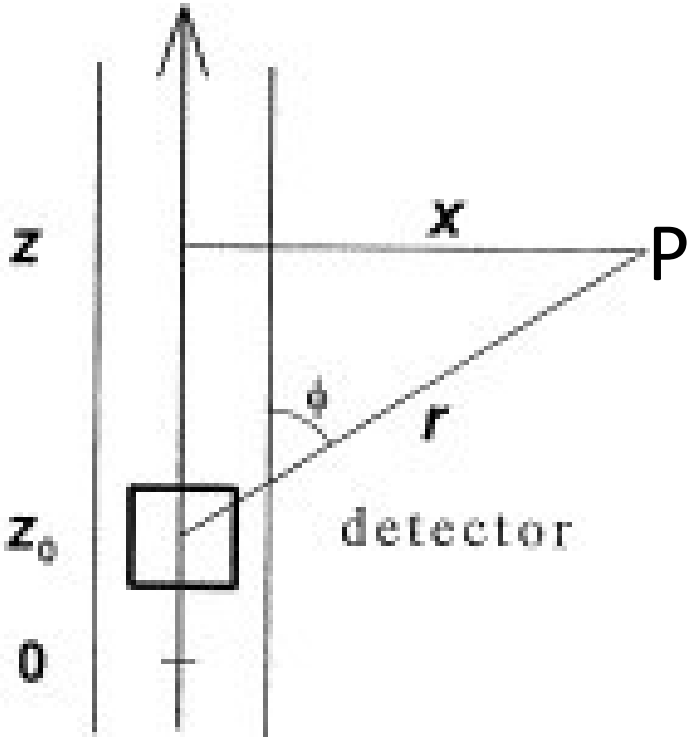
Single channel analyser I used. For to determine just ^{137}Cs the lower boundary of the counting window must be relatively high, so that 605 keV photons of ^{134}Cs do not confuse, and the upper boundary should not be too high.

In the point P in the volume element dV there is the radioactivity *qdV*, where *q* is the radioactive atom density.
In the detector qdV causes the counts

$$dC(z_0) = D(r)\, exp\left[-\int_{\frac{x_0}{sin\,\varphi}}^{r} \mu\rho\,(z')dr'\right] q(z)dV$$

where $2x_0$ is the diameter of tube. *D* is the detector function.

When integrating over x and z we find



$$C(z_0) = \int_{-\infty}^{\infty} q(z) \int_{x_0}^{\infty} D(r)\, exp\left[-\int_{x_0/sin\,\varphi}^{r} \mu\rho\,(z')dr'\right] x d\,x/2\,r^2\,dz$$

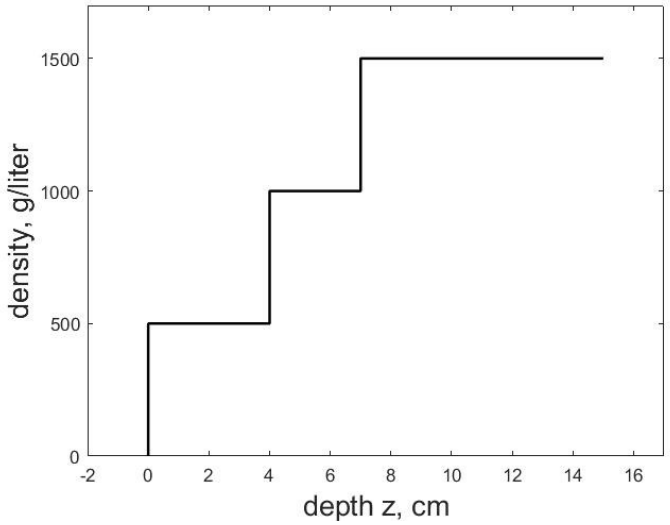
for the counting rate *C*.

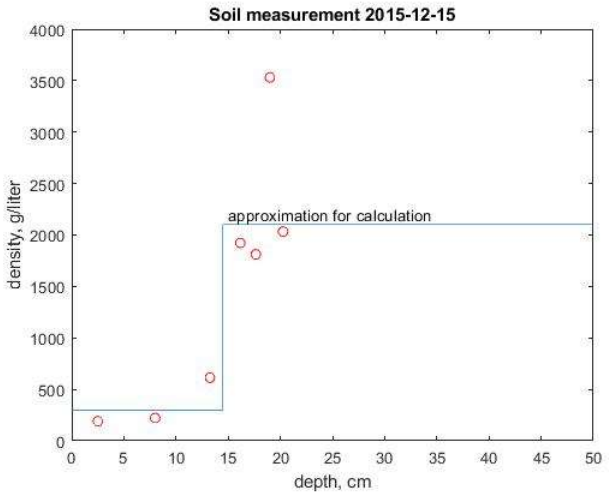
In the equation above *C* is the measured counting rate profile and the *q(z)* is the unknown. This function is determined with an inversion calculation.

Repeatable measurements I have made in Tullinkangas (B in the map) . See the Fig. 2 in the last dia from:
Kasi, S.S.H., 2001. Cesium deposition in soil and its effects. Radiation Physics and Chemistry **61**, pp. 673–675. (8th ISRP).

There in Fig. 2 is the series of four countingrate profiles in the Tullinkangas tube. In the Summer 1987 measurement there (that separately in Fig. 4) I had not a measured density distribution. At right the density distribution I used.

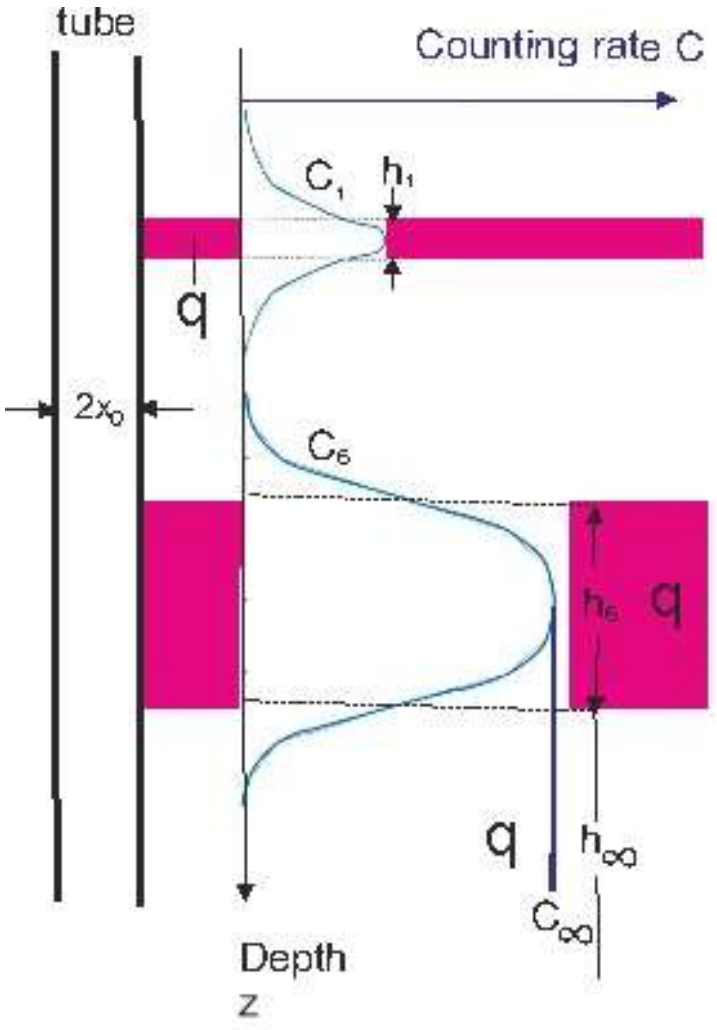
In 2015 I measured the density distribution 1 meter from the measurement tube.





The same method (as here) has in the world been used in the borehole measurements of natural radioactivity (radioactive potassium, uranium, thorium).

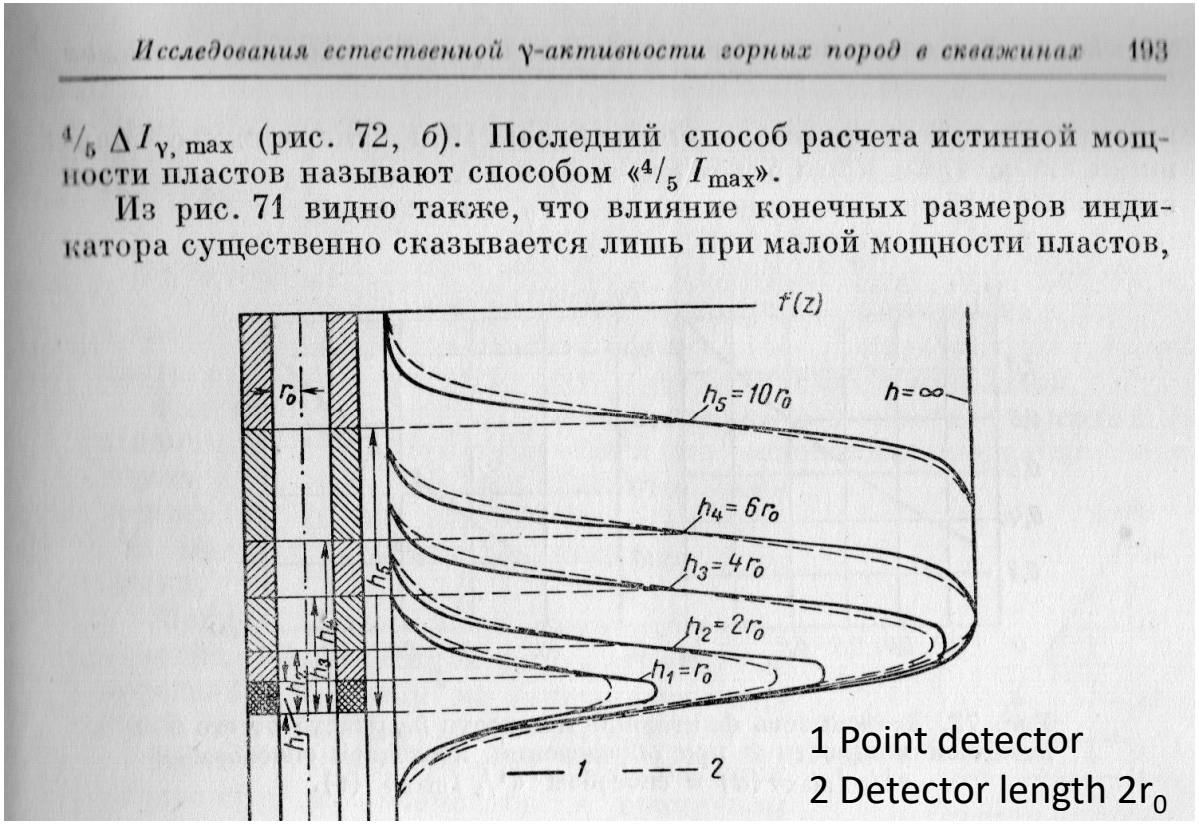
The figure at right I drew according to the presentation of Larionov (1963). The density of radioactive elements *q* was constant. The selected zones has the width: $h_1 = x_o$, $h_6 = 6x_o$ and infinite. $2x_o$ was the hole width. In the calculation the so-called “linear” attenuation coefficient $\lambda = \mu\rho = 0.1\ cm^{-1}$. ρ is the



density and μ is the mass attenuation coefficient of gamma photons in matter. At right

a part of the Russian book: Larionov V. V. Yadernaya geologiya i geofizika, International Kindle Paperwhite, Eng

See too: Killeen, P. G., 1982. Gamma-ray logging and interpretation, in:



Fitch, A.A. (Ed.), Developments in Geophysical Exploration Methos-3, Applied Science Publishers Ltd, London and New York, pp. 95-150.

Conflict of Interest Disclosure Statement

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- The author declares that he has no conflict of interest.
- This examination from 1986 has had no suppert.

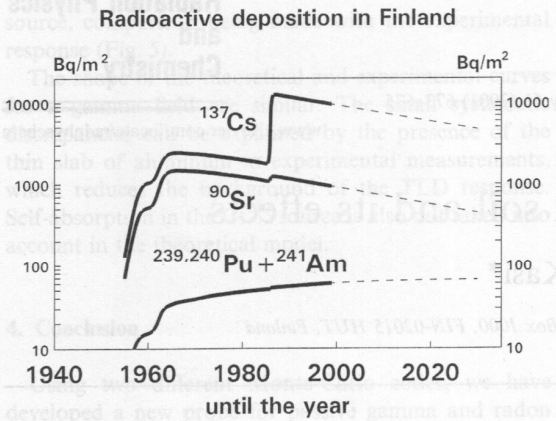

Fig. 1. Deposit of radioactive long-lived elements from atom bombs and accidents.

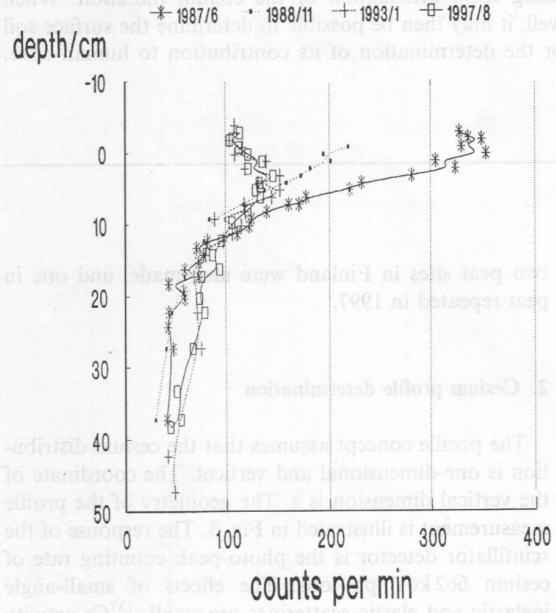

Fig. 2. Evidence of cesium profile stabilization in a mineral soil.

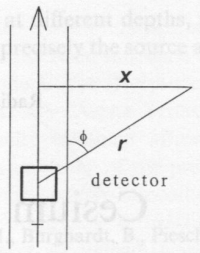

Fig. 3. Geometry for a relatively small photopeak detector in a vertical tube or hole.

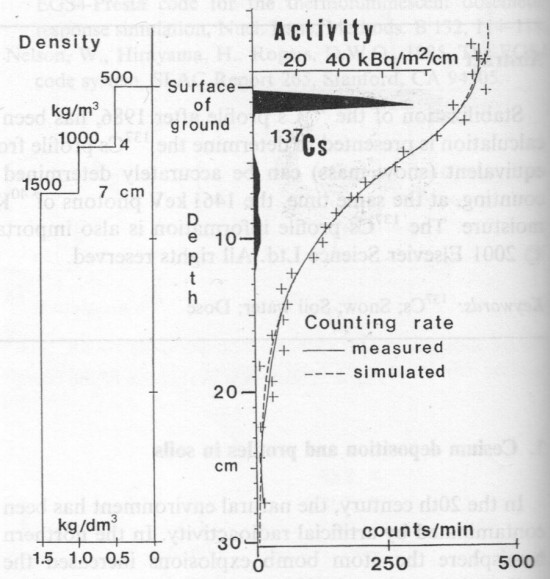

Fig. 4. The ^{137}Cs profile determined from the year 1987 counting rate profile of Fig. 2.

found in practice to be almost insignificant. The purpose is, however, to apply more adequate density profiles.

3. Snow water equivalent by using deposited cesium

Cesium photons are attenuated by soil and also