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GAMMA RADIATION AT GROUND LEVEL IN SWEDEN IN 1975 - 1977

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Measurement of the gamma radiation 2 1/2 m above the ground, carried out continuously since 1960 (6), has been continued during 1975 - 1977 at 24 places in Sweden (Fig 1). From the beginning of 1967 the calculation of the exposure has only been made from the records from the 5 stations underlined in Fig 1. The records from the remaining stations are filed, without analysis, after they have been checked to ensure that the instruments are operating correctly.

The instruments, consisting of high pressure ionization chambers, were designed and described by Sievert (2, 3). The net of gamma stations is intended for the rapid detection of large quantities of fallout. The standard deviation of an exposure reading (incl. natural exposure) has been estimated to be ± 5 %. The smallest detectable increase due to fresh fallout is approximately 20 %, because of the natural variations (1, 5).

In 1973, a modification programme was started to modernize the instruments and this was completed in 1976. Previously the instruments were powered by dry batteries which had to be replaced twice a year in order to maintain statisfactory operation. The electrometer units are extremely sensitive and each battery change involved a risk that the electrometer would cease to function properly. An additional factor was the rapidly increasing costs for the batteries and for transporting them to the measuring stations. The modernized instruments are powered by the mains but they contain nickel-cadmium batteries which can keep them in operation for a week if the mains supply fails. The 220 volt mains supply is reduced by a transformer and rectified to provide 12 volt d.c. The nickel-cadmium batteries are trickle-charged continuously and the 12 volt supply is converted by stabilizing circuits to the various voltages required for the operation of the instruments. A converter circuit supplies 90 volts to the ionization chamber from the 12 volt system and the 12 volt stand-by batteries can therefore supply this circuit. The introduction of stabilized power supplies has been found to have several advantages. There have been fewer interruptions in operation and fewer calibrations have been necessary. A further result of the redesign is that it has lead to simpler evaluation of the readings.

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The measuring circuit is so designed that a given preset exposure, for example 5 μR, generates one impulse which is recorded in the form of a mark on a paper disk. In the earlier version a microammeter was used to make the record. In the new version this microammeter has been replaced by a comparator and well-insulated reed relay. In comparison with the previous version the switching action - both making and breaking - is more distinct and more rapid. In the evaluation of the results the earlier version indicated a somewhat lower exposure rate (< 1 μR/h) for some of the detectors. An investigation showed that the microammeter in that version had an appreciable inertia and that this inertia varied between different microammeters.

Tables 1, 2 and 3 show the monthly averages in μR/h for the 5 stations. Figs 2 and 3 show the variation of the exposure in μR/h from 1960 for three of the stations. The broken lines indicate the level found during the summer months of 1960 and 1961 before the large nuclear weapon tests of 1961 and 1962. The dot-dash lines indicate the contribution from the cosmic radiation. To illustrate the absorption of the snow cover the monthly averages of the snow cover have been indicated at the bottom of each diagram. The data regarding the snow cover are taken from data issued by the Swedish Meteorological and Hydrological Institute.

After a peak of about 24 mR/y in 1963 (17 mR/y the actual value including absorption in the snow), the average additional exposure due to fallout decreased to about 10 mR/y (the actual value 7 mR/y) and since 1965 there have been no significant variations in the annual exposure due to fallout. The contribution from fallout to the irradiation level above the ground depends mostly on cesium-137 from the atmospheric nuclear explosions in 1961 and 1962 with some contribution from fresh fallout originating from later nuclear explosions.

References:

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7. Swedjemark, G.A., Håkansson, B.H. and Kjelle, P.E.: Gamma radiation at ground level in Sweden.
Primary data report.
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Table 1: γ-radiation at ground level, including cosmic radiation, during 1975.

Monthly averages in μR/h

Station	A2	B6	C3	D2	D6
Place	Kiruna	Idre	Erken	Torslanda	Smygehamn
Altitude	505 m	450 m	15 m	8 m	5 m
Latitude	68°	62°	60°	58°	55°
Placed 2 1/2 m above	gravel	grass	rock	grass	grass
Jan 1975	9.2		11.8	11.1	8.6
Feb	8.6		11.5	10.9	8.4
March	8.3		11.9	11.2	8.7
April	3.1		11.6	11.2	8.6
May	11.5	a)	11.9	11.5	8.6
June	12.8		12.1	11.6	8.6
July	13.3		12.4	11.6	8.7
Aug	13.1	10.4	12.4	11.1	8.6
Sep	13.4	10.6	12.2	11.3	8.7
Oct	12.7	10.4	12.2	11.3	8.6
Nov	11.7	10.1	11.6	11.5	8.9
Dec	11.1	9.4	11.9	11.2	8.3

a) Instrument out of order.
Replacement instrument in operation from August 1st, 200 m from previous site.

Table 2: γ-radiation at ground level, including cosmic radiation, during 1976.

Monthly averages in μR/h

Station	A2	B6	C3	D2	D6
Place	Kiruna	Idre	Erken	Torslanda	Smygehamn
Altitude	505 m	450 m	15 m	8 m	5 m
Latitude	68^{o}	62^{o}	60^{o}	58^{o}	55^{o}
Placed 2 1/2 m above	gravel	grass	rock	grass	grass
Jan 1976	9.8	9.0	11.3	11.0	8.4
Feb	9.1	8.5	10.3	10.8	8.3
March	8.5	8.4	10.8	11.0	8.3
April	8.4	9.3	11.9	11.0	8.4
May	11.3 a)	10.4	12.2	11.2	8.4
June	11.7	10.6	12.3	11.3	8.4
July	11.8	10.7	12.6	11.7	8.5
Aug	11.8	10.7	12.4	11.8	8.5
Sep	11.8	10.8	12.4	11.8	8.5
Oct	11.1	10.4	12.3	11.7	8.9
Nov	10.4	9.8	12.1	11.5	8.7
Dec	9.1	9.0	11.4	11.0	8.7

a) Rebuilt devices.

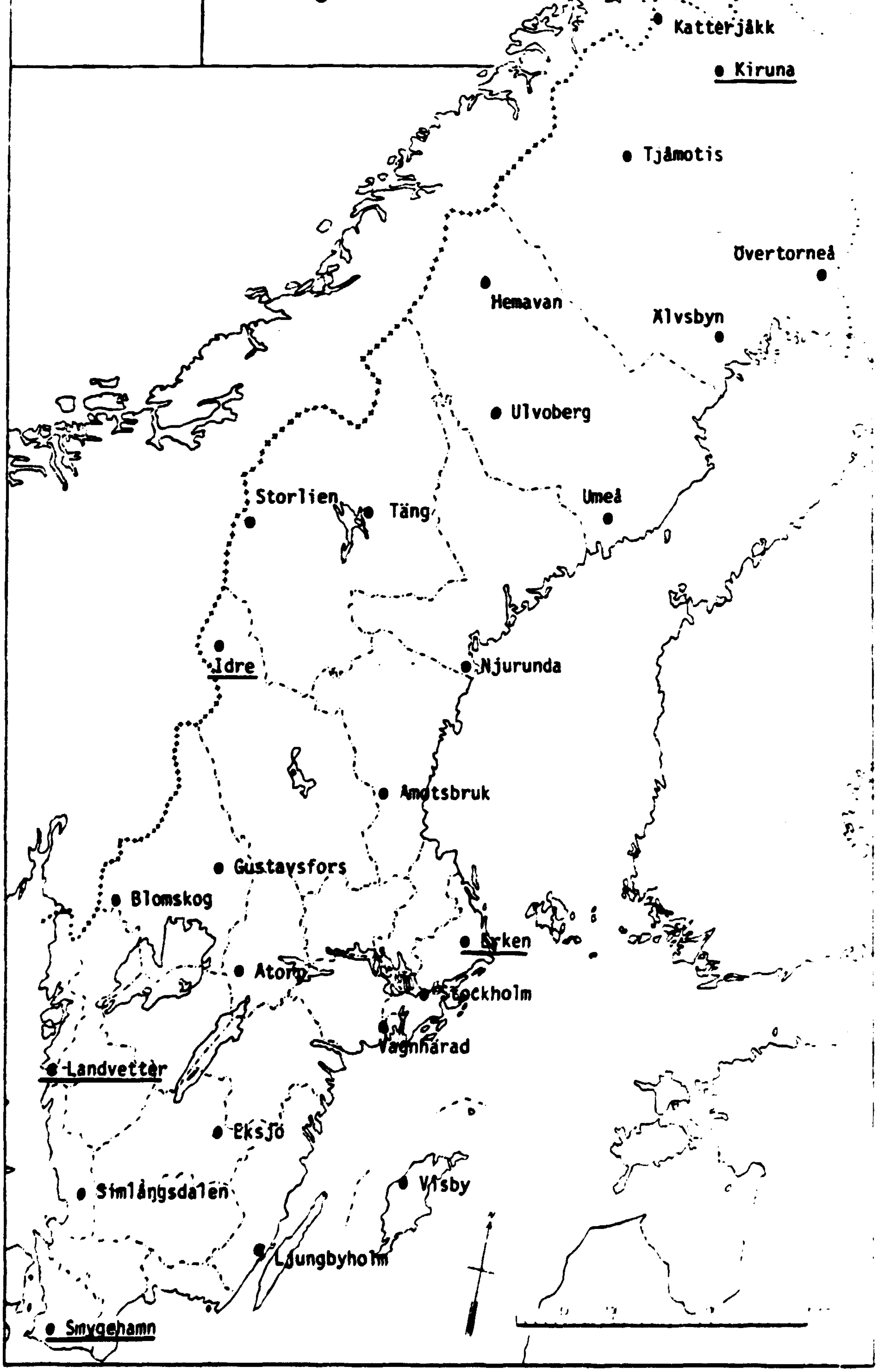
Table 3: γ-radiation at ground level, including cosmic radiation, during 1977.

Monthly averages in μR/h

Station	A2	B6	C3	D2	D6
Place	Kiruna	Idre	Erken	Torslanda	Smygehamn
Altitude	505 m	450 m	15 m	8 m	5 m
Latitude	68°	62°	60°	58°	55°
Placed 2 1/2 m above	gravel	grass	rock	grass	grass
Jan 1977	8.8	8.4	9.3	9.3	8.6
Feb	8.2	8.3	8.9	8.8	8.6
March	8.0	8.1	9.5	10.3	8.5
April	6.7	8.3	11.7	11.2	8.6
May	7.4	10.1	12.0	11.3	8.5
June	11.3	10.8	12.4	11.3	8.7
July	11.6	10.9	12.0	11.6	8.6
Aug	11.6	10.9	12.1	11.6	8.5
Sep	11.8	10.9	12.1	11.2	8.5
Oct	10.8	10.9	12.0	10.6 a)	8.6
Nov	10.6	11.1	12.1	10.7	8.7
Dec	9.8	9.9	11.7	10.3	8.6

a) D2 was moved and placed 2 1/2 m above grass at Landvetter, a new site 20 km east of Torslanda with an altitude of 155 m and a latitude of 58°.

Fig. 1


Katterjåkk
Kiruna
Tjåmotis
Övertorneå
Hemavan
Älvsbyn
Ulvoberg
Storlien
Täng
Umeå
Idre
Njurunda
Amotsbruk
Gustavsfors
Blomskog
Erken
Atorp
Stockholm
Vagnhärad
Landvetter
Eksjö
Simlångsdalen
Visby
Ljungbyholm
Smygehamn

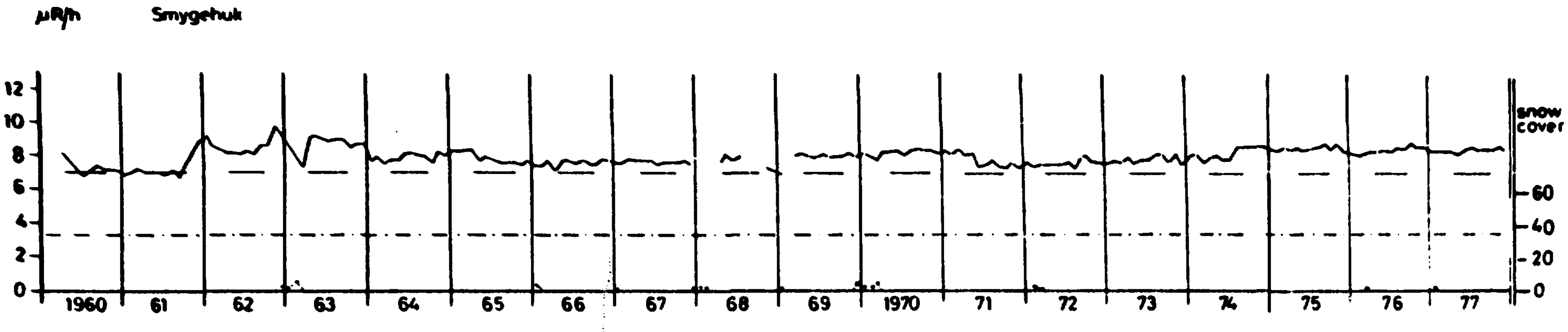


FIG. 2 External exposure rates at 2 1/2 meters above ground and monthly averages of the snow cover.

——— Total external exposure.

—·—·—· Average exposure from cosmic rays.

— — — Exposure level summer 1960 and 1961.

·········· Snow cover (the scale to the right).

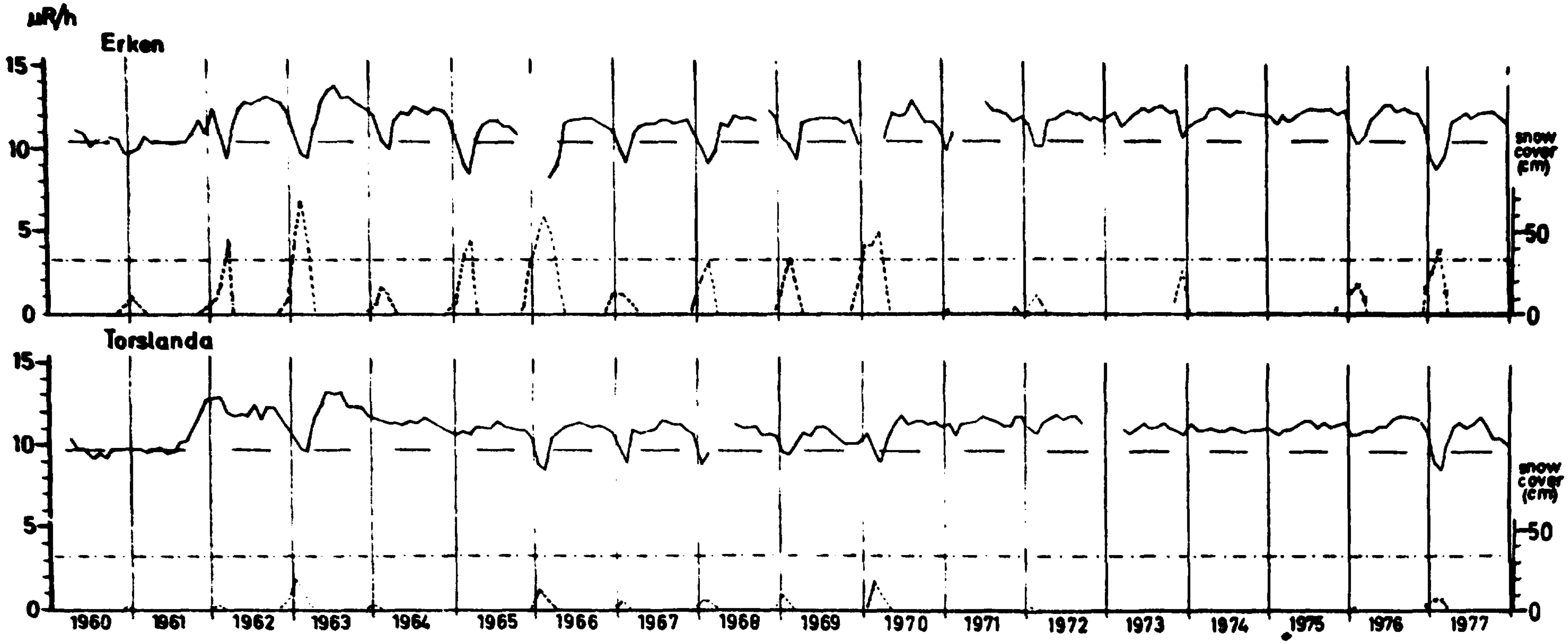


FIG. 3 External exposure rates at 2 1/2 meters above ground and monthly averages of the snow cover. (See explanation under Fig. 2).

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