THE CONCENTRATION OF RADON IN A TOWN WHERE RADIUM-ACTIVATED PAINTS WERE USED

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INTRODUCTION

In a particular town in the Swiss Jura, important for its watch industry, probably 20 workshops existed between 1920 and 1963, where dials and faces were painted with radium-activated paints. Some workshops produced even their own paints.

After removal of the radium and complete decontamination of such workshops, which prestens its own problems, one sometimes still finds a high radon concentration in the cellar of such a workshop. Similar high values are sometimes found also in adjacent houses. In that particular town, however, a larger area was concerned.

MEASUREMENTS

In cooperation with the Bundesamt für Gesundheitswesen and the local authorities we decided to place radon dosimeters for several months in the suspected area and in some other quarters, where we did not expect radon. We placed 3 dosimeters in 95 houses, one in the cellar, one in the living room and one in a bed room. 59 dosimeters were placed in shafts associated with the tubes of the drinking water distribution (shafts). 29 dosimeters were put in the shafts giving access to the sewage (sewerage). All dosimeters were of the type SF from Terradex.

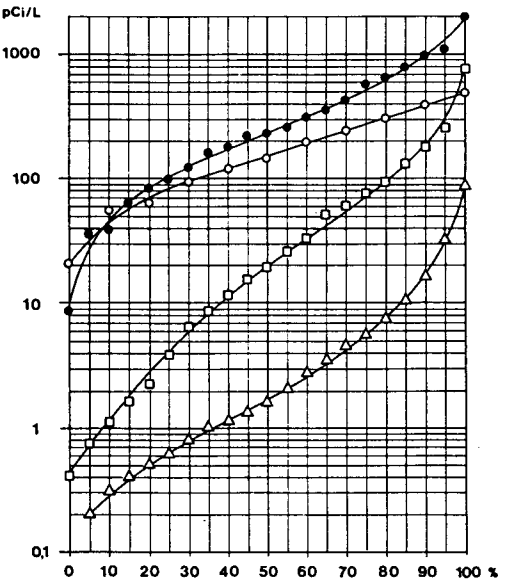
RESULTS

Table 1 shows the mean and extreme values of these measurements. Fig. 1 presents the cumulative distribution of the measurements. For the latter representation we combined the values from living rooms and bed rooms into one value, adding them after weighting with a factor of 3/4 and 1/4 respectively. These weighting factors result from the assumptions of the UNSCEAR-Report 1982 about the breathing volumes in these rooms: Living room 5.5 h x 1200 L/h and 5,5 h x 750 L/h, bed room 8 h x 450 L/h. The assumptions for the calculation

		radon (pCi/L)	
place	n	mean	range
shafts	59	360	8,7 - 2000
sewerage	29	190	20 - 500
cellars	94	60	0,4 - 730
living rooms	95	7,5	0 - 100
bed rooms	95	4,0	0 - 24

Table 1: Mean and range of the radon concentration

Fig. 1:
Distribution of the Rn-concentration in
- ● shafts
- o sewerage
- ◘ cellars
- ▲ living- and bed rooms (weighted 0,75 and 0,25 and added). This value tims 0,1 yields the annual dose in rem.



of the annual effective equivalent dose are a daughter/radon equilibrium of 0.5 (1 pCi/L = 0.005 WL = 1.04 E-10 J/L) and a dose factor of 200 rem/J (as currently used by UNSCEAR, OECD and NEA for indoor radon). For radon at this particular equilibrium we abtain 2.08 E-08 rem/pCi. Multiplication by an annual breathing volume (indoors) of 5.23E06 L yields 0.109 rem/(pCi/L). 0.1 rem/(pCi/L) may be an adequate precision for the calculation of the annual dose from a weighted radon concentration.

From table 1 we combine a weighted mean of 6.6 pCi/L, yielding a mean dose of 0.66 rem per year. From Fig. 1 we see, that a minority of houses with relatively large doses (up to 8.4 rem) contribute to this high mean. If we assume that a person spends some time in the cellar (e.g. half an hour per day, breathing rate 1200 L/h) one would have to add the radon concentration in the cellar multiplied by a weighting factor of 0.04. This would add a dose of 0.24 rem in the mean and 2.9 rem in the extreme case.

Fig. 2 shows the local distribution of the measurements in this town. We have indicated the values measured in the cellars, as the radon appears to leak into the dwellings through the cellars.

Fig. 3 shows the local distribution of the measurements from the shafts associated with the tubes of the drinking water. There is no evidence that the drinking water itself has something to do with the radon in this town. The radon in the shafts is rather a very good indicator for the radon in the soil. The measurements of the shafts, as far as available (Fig. 3), correspond reasonably well to the measurements in the cellars (Fig. 2).

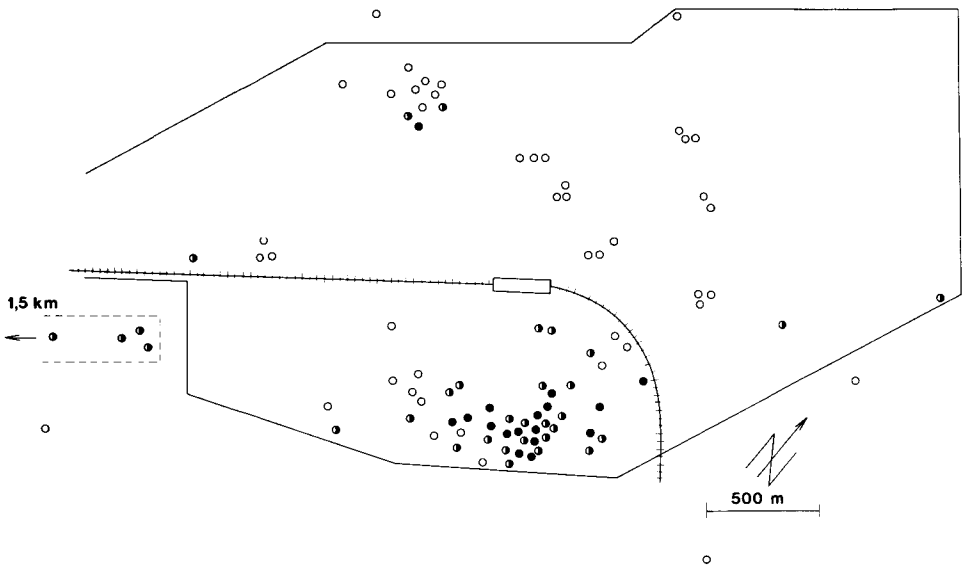


Fig. 2: Rn-Concentration in cellars
○ 0-20 pCi/L ◐ 20-100 pCi/L ● 100-780 pCi/L

Fig. 3: Rn-Concentration in shafts
○ 0-200 pCi/L ◐ 200-600 pCi/L ● 600-2000 pCi/L

DISCUSSION

The town is located on limestone, which contains very little uranium. Therefore we would not expect much radon. This was confirmed earlier by a study carried out by the Eidgenössisches Institut für Reaktorforschung. The mean from 25 houses elsewhere in the Jura was 2.5 pCi/L in the cellars and 1.4 pCi/L in the living rooms.

On the other hand, the radon seems to emanate from the soil. The highest values are found in the shafts (Fig. 1). These shafts with a volume of about 8 m^3 are hardly ventilated. The measurements in the shafts seem to be the best indicator for the radon in the soil. The radon in the cellars, also strongly correlated to the concentration in neighbouring shafts, shows lower values and a larger scatter due to a larger and veriable ventilation.

The measurements in the sewerage were carried out in order to find out whether deposits of radium in the sewerage could be the source of radon. However this hypothesis must be discarded for two reasons. First the sewerage shows lower concentrations of radon than the shafts (and the soil). We cannot expect the radon to move in the opposite direction of this gradient of concentration. Second the sewage was conducted into local pits until 20 years ago. Radium previously poured into the sink must still stay in these pits. In one case such a pit contaminated with radium was recently found. A workshop where radium was used was connected to this pit as well as other houses where high levels of radon were found. It is planned to ventilate this pit and to see whether the radon in these houses decreases.

There is much suspicion that in some cases of very high radon concentration unknown deposits or pits with radium waste are likely to be the cause. On the other hand, some geological anomalies may also be important. The limestone is very much fissured and contains molasse in certain areas. If this particules geological situation would be another cause for some elevated values of radon, it would explain why some rather high concentrations of radon were also found in houses chosen as a reference, because they were in quarters of recent construction or far away from earlier activities involving radium (as far as we know). This point awaits further clarifaction.

The owners of those houses, where an annual dose above 3 rem is calculated, are invited to study counter measures on a volontary basis in a first round. Depending on the experience gained from these cases, measures may be proposed later also for less urgent cases.