^{226}Ra- AND ^{222}Rn-CONTENT OF DRINKING WATER

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^{226}Ra- and ^{222}Rn-concentrations were measured in drinking water in parts of the Federal Republic of Germany. 254 samples were analysed for ^{226}Ra, 57 for ^{222}Rn. The average contents were found to be $4,4 \times 10^{-3}$ Bq/l (0.2 pCi/l) for ^{226}Ra and 7,4 Bq/l (0.2 nCi/l) for ^{222}Rn with maximum values of 0.11 Bq/l (3 pCi/l) and 43 Bq/l (1.2 nCi/l), respectively. For both radionuclides there was a log-normal distribution of concentrations. Statistical analysis revealed no correlation between ^{226}Ra and ^{222}Rn, both for processed drinking and raw water. It is shown that there is a significant influence of the processing method on the final content of radioactivity. The average yearly doses to the critical organs are estimated to be about 0.003 mSv/a for ^{226}Ra (bone lining) and about 70 µSv/a for ^{222}Rn (stomach).

INTRODUCTION

Radium and its daughter products constitute an important part of natural environmental radiation exposure. Since ingestion forms a major pathway - apart from inhalation for Radon - for internal irradiation, the measurement of radioactivity in drinking water is relevant to assess the contribution of these environmental radiation hazards. Although a considerable body of information is already available it is generally felt that more data are desirable (1). We started therefore a survey of ^{226}Ra- and ^{222}Rn-concentrations in a part of central Germany to obtain also a better insight into the distribution of the measured parameters.

MATERIAL AND METHODS

Scope:

Random samples of drinking water (257 for ^{226}Ra and 57 for ^{226}Ra and ^{222}Rn) were taken in Hessia, a state of the Federal Republic of Germany during 1977 - 1979. In some instances the waterpath was followed from the well to

the final consumer.

Measurement

^{226}Ra and initially ^{222}Rn were measured using Lucas szintillation chambers as already described (2). Later ^{222}Rn was determined by means of liquid szintillation in a Beckman LS 8000 according to Pritchard and Gesell (3).

RESULTS

Figure 1 shows the sum distributions of the measured values on a probit scale with a logarithmic abscissa. The approximately straight line indicates a log-normal distribution. The mean values are 0.2 pCi/l for ^{226}Ra and 0.2 nCi/l for ^{222}Rn. In 50 samples both nuclides had been measured. Statistical analysis of these data showed no correlation, the correlation coefficient was 0.12 ($p < 0.9$). Since it is known that water processing strongly influences the radionuclide distribution (see below) the same analysis was carried out with unprocessed well water (22 samples). The correlation coefficient was 0.28, which is again too small to accept a statistical correlation.

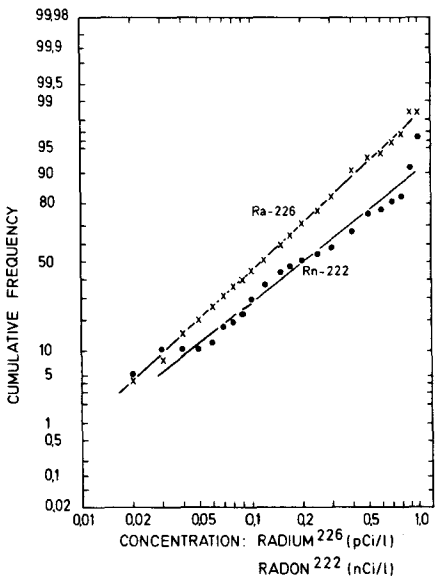

Figure 1.
Sum distribution of ^{226}Ra- and ^{222}Rn-concentrations

In some places it was possible to follow the radionuclide content from the well to the final consumer. Two examples are shown in figure 2A and 2B: In the first one the processing consisted of an aeration stage with subsequent fast filtration through a bed containing oxydizing sub-

stances to precipitate Fe- and Mn-contamination.

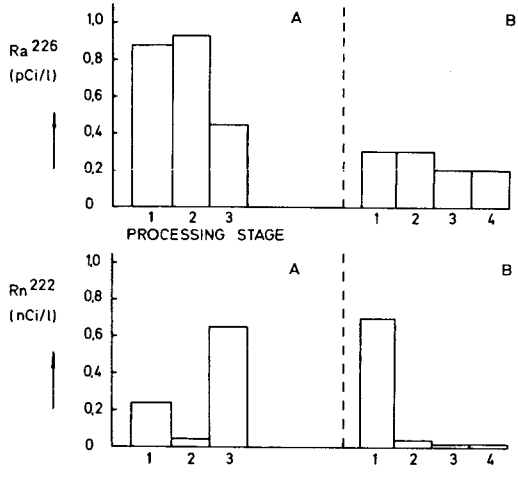

Figure 2. Influence of water processing on radionuclide content: A: Processing using rapid filtration with oxydizing substances; B: slow filtration; stages: 1. Well water; 2: after aeration; 3: after filtration; upper panel: ^{226}Ra; lower panel: ^{222}Rn

It is seen that the ^{226}Ra-content drops to about 50% during filtration, presumably due to Ra-binding in the filter bed. ^{222}Rn is lost drastically by aeration, but its concentration rises to rather high levels after filtration. We suggest that this is caused by Ra-accumulation in the filter bed. If a slow filtration process is used (figure 2) the decrease in ^{226}Ra is smaller and there is no increase in ^{222}Rn after the last stage. It is clear from this comparison that the processing method influences the final concentrations in drinking water.

DISCUSSION

We have measured the ^{226}Ra- and ^{222}Rn-content in drinking water in a part of Germany. The average values found agree reasonably with those reported for other areas (4). If we assume a daily consumption of 1.2 l drinking water the mean dietary intake is 0.14 pCi/l. According to UNSCEAR 77 (1) this would lead to a bone activity of 0.9 pCi/kg^{-1}. From this we estimate a yearly dose equivalent of about 15 µ Sv/a (1.5 mrem/a). For ^{222}Rn only unboiled drinking water has to be taken into account (about 0.15 l/d) which exerts its action mainly on the stomach. The mean somatically significant dose equivalent to this

organ is then estimated to be 70 μ Sv/a (7 mrem/a) (5). Our results demonstrate that the yearly dose-rate expected from ^{226}Ra and ^{222}Rn intake via drinking water is low compared to other radiation sources.

Acknowledgement

This study was supported by a grant from the German Federal Ministry of Internal Affairs ("Bundesministerium des Innern")

REFERENCES

1. Sources and effects of ionizing radiation, 1977 report (1977): United Nations, New York

2. Scheibel, H.G., Porstendörfer, J. and Wicke, A.(1979): Nucl. Instr. Meth. 165, 345

3. Pritchard, H.M. and Gesell, T.F. (1977): Health Physics 33, 577

4. Aurand, K., Gans, I. and Rühle, H. (1974) in: Die natürliche Strahlenexposition des Menschen (eds. K. Aurand, H. Bücker, O. Hug, W. Jacobi, A. Kaul, H. Muth, W. Pohlit, W. Stahlhofen), Georg Thieme Verlag, Stuttgart, p. 29

5. Aurand, K., Gans, I., Wollenhaupt, H., personal communication