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Shallow circulation groundwater - the main type of water containing hazardous radon concentration

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Radon dissolves in water very good. As an effect this gas is present in surface and groundwater, which are used in households. The range of Rn-222 concentration in water is very wide, it changes from below 1 Bq/dm^3 up to several hundreds of thousands Bq/dm^3. Inhabitants may be exposed to an important additional dose from ionizing radiation if they use in household radon water (concentration of Rn-222 between 100 and 999.9(9) Bq/dm^3), high-radon water (1000 – 9999.9(9) Bq/dm^3) or extreme-radon water (10 000 Bq/dm^3 and more). Value of the dose depends on the amount of radon released from water during cooking, washing, taking bath or shower, and it not depends on the amount of radon dissolved in drinked water or water used for making a meal. Radon released from water to the air in a house may be inhaled by inhabitants and increase the risk of lung cancer.

Knowing the risk, international organizations, i.e. WHO, publish the recommendations concerning admissible levels of radon concentration in water in the intake (before supplying households). In a few countries these recommendations became a law (i.e. USA, England, Finland, Sweden, Russia, Czech Rep., Slowak Rep.). Law regulations force to measuring concentrations of radon dissolved in water in all the intakes of water supplying hauseholds. Knowing radon behaviour in the environment it is possible to select certain types of water, which may contain the highest radon concentration. As a result one may select these intakes of water, which should be particularly controled with regard to possible hazardous radon cencentration.

Radon concentration in surface water depends on partial pressure of this gas over the water table – in the atmosphere. Partial pressure of radon in the atmosphere is very low, so the radon concentration in surface water is usually low and as a rule it is not higher than several, rarely several tens of Bq/dm^3. In the spring, where the groundwater flows out on the surface, and groundwater become a surface water forming a stream, radon very quickly escapes to the atmosphere. This is the main reason, that even in regions, where the bottoms of streams and rivers are formed by the rocks containing high amounts of radium (and uranium), surface waters very quickly lose radon escaping to the atmosphere. Concluding, surface waters cannot be the source of hazardous radon concentration. One may expect completely different situation in the case of groundwater. When the groundwater is exploited without any contact with the atmosphere, it contains higher concentration of Rn-222, than surface water in the same neighbourhood with regard to geological structure. Concentration of radon dissolved in groundwater depends first of all on the emanation coefficient of the reservoir rock. This coefficient may be calculated taking into account a few parameters, like cancentration of parent Ra-226 isotope in the reservoir rocks, effective porosity of the rock and the density of the grain framework of the rock. The way of radium atoms disposition in crystals or mineral grains of rock with reference to the pores and cracks filled with groundwater is also an important parameter. Calculations made by the author for more than 100 intakes of groundwater proove, that the highest values of emanation coefficient are characteristic for the rocks in the weathering zone – on the depths between surface level and 30 – 50 m below surface level. Groundwater exploited from the rocks of this zone contains the highest concentration of Rn-222. On the greater depths even high Ra-226 content in the reservoir rock does not affect to the Rn-222 concentration in groundwater flowing through this rock. Summing up, potentially the great radon concentration may contain groundwater of shallow circulation (up to $\sim$50 m b.s.l.), flowing through weathered resrvoir rock with high content of parent Ra-226 isotope.