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Quantification of the radon distribution in various geographical areas of West Georgia

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Abstract

Authors have studied radon distribution in various geographic areas of West Georgia. According to these data, there are more than 100 water sources with anomalously high content of Rn. In anomalous areas the concentration reaches: in soil - 28 KBq/m^3 and in water – 33 Bq/L. It should be marked that significant part of anomalies are located in the densely populated areas, resort zones, agricultural regions and other human activity areas.

1. Introduction

According STCU project N 3992 "Assessment of radon-hazard potential, residential exposure, lung cancer and COPD in West Georgia" during 2007-2008 authors carried our field work in order to quantify the radon distribution and reveal uranium/radium deposits and ascertain geological factors influencing indoor radon concentrations in various geographical areas of West Georgia.

2. Method

When undertaking the gas survey of Rn the particular attention was paid to the multiple active zones of faults and areas with elevated geochemical background of Uranium and other Hydro-chemical parameters etc. Mobile group conducted the researches by Radon measuring equipment PPA-01M-03 and other devices. During mapping Rn content in any type of water source (boreholes, wells and springs) and in the soil aeration zone in the several regions (Samtredia, Kutaisi, Tskaltubo, Khoni and Vani) was measured. All observation sites were fixed by GPS measurements. The goal was to map anomalous zones on West Georgia territory.

3. Data analysis

On the basis of these data the map of Rn content in water and soil were compiled using GIS technique (Figs.1-2). The points show the sites of measurements.

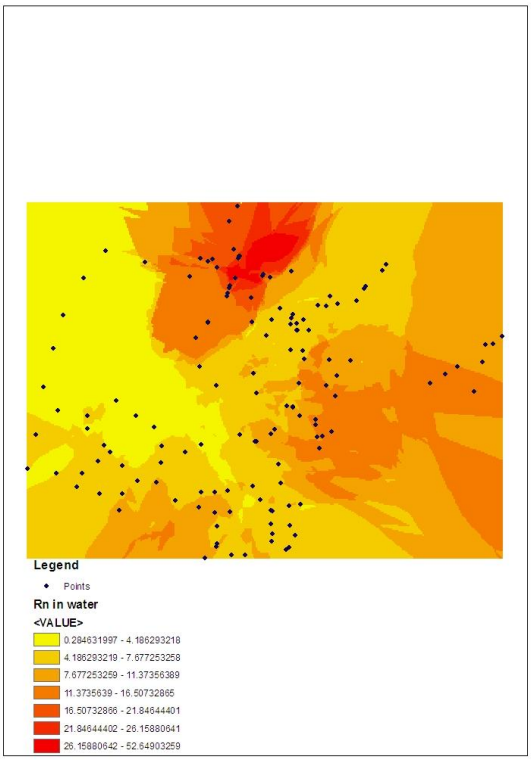

Fig. 1

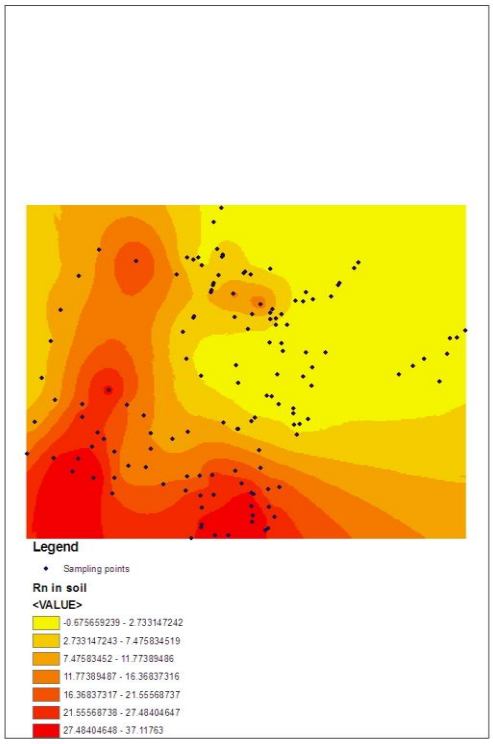

Fig.2

Areas of anomalously high Rn exhalation both in water and in soil were revealed in Tskhaltubo, Kuttaisi, Vani and Bagdadi regions. In order to understand the nature of these anomalies it is necessary to analyze all factors that influence intensity of Rn degassing and heighten the risk of its accumulation.

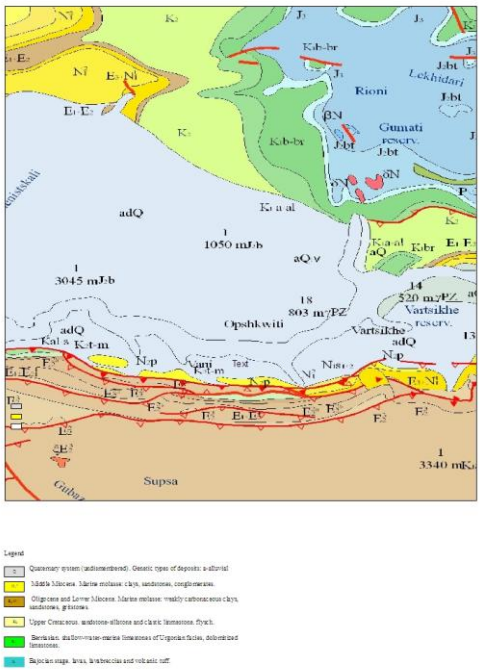

Fig. 3

These factors are: geological structure of the region, presence of tectonic faults, presence of radioactive elements in the rocks, hydrogeological and geomorphological structures of the region, soil characteristics etc (Fig. 3).

The Northern and Central parts of the tested area from the geological point of view belong to the Kutaisi sub-zone of the Georgian plate and its Southern part – to the Adjara-Trialeti folded system. The North-East part of the first zone (villages Rioni and Gurna) is composed mostly of Jurassic volcanic rocks, which contain fissure groundwater of low mineralization (hydrocarbonate and calcium type). From the morphological point of view here we have glacial-erosion terrain that is characteristic for this mountainous area. In this area to the north of Kutaisi we found a band of elevated radon content in the soil (22-26 KBq/m^3), which should be related to the presence of dikes of the crystalline rocks and systems of faults, developed on this territory. At the same time the content of radon in the water is low, which can be explained by influence of near surface groundwater circulation in this band.

To the South there outcrops of lower Cretaceous rocks, which contain fissure and fissure-karsts type of pressurized ground water (regions of Tskaltubo and Kutaisi); the characteristic example is the low-radioactivity thermal waters of Tskaltubo resort. Here the springs have large debit (200-220 L/s). The recharge of the aquifer takes place in the northern elevated areas; then the aquifer plunge under the Quarternary layers and its discharge takes place at the contact area of Georgian plate and Adjara-Trialeti folded system, where a lot of transversal faults are found. This is also confirmed by the existence in this zone of low-radioactivity thermal waters at the resorts Sulori, Amaghleba and Vani. Geomorphologically the area is of karsts-terrain type.

Earlier many radioactivity anomalies (U and Th content from 0.01 to 0.35%) were associated with crystalline dikes containing radioactive elements in the vicinity of villages Kursebi and Rioni, river Tskaltsitela etc. In this zone is fixed the highest content of radon in soil (in soil – 22- 58 KBq/m^3) and the highest content of radon in water (16-52 Bq/L). High content of Rn in the soil should be associated with the openness of the karsts systems for gas migration and its good permeability in conditions of dry mountainous terrain. As to the high Rn content in the water, it is connected with rising of thermal underground water and its free discharge on the surface. This is confirmed by the fact that the high Rn content is not observed to the south of this zone (Rokhi, Vartsikhe, Ofshkviti), where the territory is covered by quarternary sediments. In the same area the probes taken from the deep wells reveal high content of Rn, which is explained by tapping by boreholes of deep limestone aquifers. Farther to the South Cretaceous formations are covered by Quarternary sandy-pebble layers; their thickness varies from 120 m in the East to 400 m in the West. Here both shallow groundwater and pressurized aquifers are observed. In this area the accumulative-erosional terrain with terraces is developed.

The above discussion was related to the eastern part of this territory. As to the western part, here the increased content of Rn is fixed in the soil (14-22 KBq/m^3), but Rn is practically absent in the water, in contrast to the situation in the eastern part of the area. This should be connected with specific geological and terrain conditions: though the Quarternary deposits are thick, the underlying basement limestone rocks contain the system of faults. This fault system through the "hydrogeological windows" allows gases to reach the day surface and accumulate in the soil.

In the extreme south part of test area, i.e. in the Adjara-Trialeti folded system (regions of Vani and Bagdadi), in the volcanic and sediment rocks of Middle Eocen we observe karstic-fissure and fissure pressurized groundwaters of low radioactivity. The terrain here is of erosion- peneplain type.

Similar to Tskaltubo region here also are observed high values of Rn content in the soil (22-58 KBq/m^3); this can be explained by high gas permeability of rocks and geomorphology of the area. As to the Rn content in water, it is a bit less (16-22 Bq/L) than in Tskhaltubo region and cover much less area due to the fact that here mostly the shallow groundwaters are observed; these waters are characterized by shallow circulation system and they are not discharged on the surface (situation is alike to that in the North, where groundwater is presented in volcanic rocks of Jurassic age.

4. Results

The elevated exhalation of Rn is the result of draining of Lower Cretaceous and Middle Eocen aquifers by rising springs and boreholes.

We can conclude that the data obtained point to the general sub-horizontal zonality of parameters, which is conditioned by peculiarities of geological structure.

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Количественная оценка распределения радона в отдельных районах Западной Грузии

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Резюме

Проведена количественная оценка распределения радона в отдельных районах Западной Грузии. В соответствие с полученными данными более 100 проб воды имеют высокое содержание радона. В аномальных зонах содержание радона в почве более 28 КБк/м^3, а в воде – 33 Бк/л. Следует отметить, что значительная часть аномальных зон располагается в плотно населенных местностях, агрокультурных районах и других местах с активной деятельностью человека.

რადონის გავცელების რაოდენობითი შეფასება დასავლეთ საქართველოს ცალკეულ რაიონებში

ავთანდილ გ. ამირანაშვილი, თამაზ ლ. ჭელიძე, გიორგი ი. მელიქაძე, იგორ იუ. თრეკოვი, მარიამ შ. თოდაძე

რეზიუმე

ჩატარებულია რადონის განაწილების რაოდენობრივი შეფასება დასავლეთ საქართველოს ცალკეულ რაიონებში. მიღებული მონაცემები მოწმობს, რომ 100-ზე მეტი წყლის სინჯში აღინიშნება რადონის მაღალი შემცველობა. ანომალურ ზონებში რადონის შემცველობა ნიადაგში აღწევს 28 კილობეკერელს/მ^3, ხოლო წყალში – 33 კილობეკერელ ს/მ^3. უნდა აღიიშნოს, რომ ანომალური ზონების მნიშვნელოვანი ნაწილი განლაგებულია მჭიდროდ დასახლებულ არეებში, სასოფლო მეურნეობის რაიონებში და ადამიანის აქტიურობის სხვა ადგილებში