



## Results of the simultaneous measurements of radon around the Black Sea for seismological applications



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### A B S T R A C T

Results of measurements of radon around of the Black Sea are shown. Radon stations in zones of active faults were placed. Simultaneous hourly measurements of soil radon in 2005 were carried out in the Sivrice Fault Zone that is a segment of East Anatolian Fault System, in the town of Tbilisi (Georgia) and in the South Russia. In 2008 simultaneously hourly measurements of soil radon were carried out in the Western Caucasus (Russia) and in the Mytilene Island (Greece). In 2013 radon in underground waters simultaneously in midday was measuring in Crete (Greece), in the Pamukkale geothermal region (Southwest Turkey) and in the Western Caucasus. Measurements of radon concentration in the points located around of the Black Sea have shown identical regularities in changes of the data. Influence of meteorological, tidal and solar factors on changes of water radon concentrations and soil radon concentrations was observed in all researches points. But this influence was insignificant. Seismological application of observed results also was considered. Various mathematical methods of definition of anomaly in the radon data during earthquakes were considered. During researches in the Black Sea region basically earthquakes with M from 2.0 up to 5.0 and in a depth about 10 km were occurred. For these earthquakes method of daily subtraction of the data of the next and previous day was used. This method has allowed solving a problem with a choice of average value. Probability up to 0.69 (number of earthquakes with radon anomalies/total number of earthquakes) of detection of radon anomalies before earthquakes was achieved applying this method. Changes of radon maps before regional earthquakes were also observed. The frequency analysis of variations of the radon data on the basis of the Wavelet analysis was carried out. Occurrence of the short periods (about 2 days) was observed during regional earthquakes.

### 1. Introduction

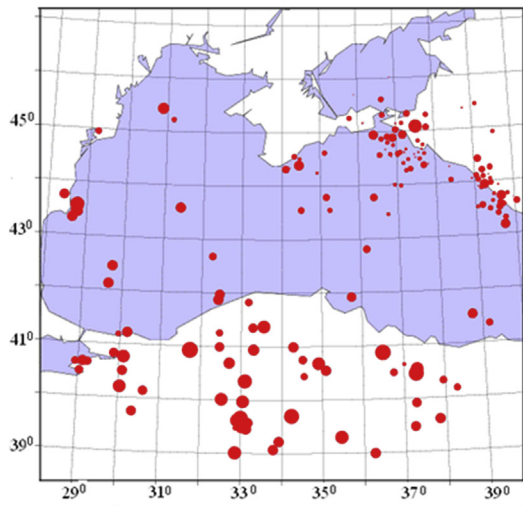
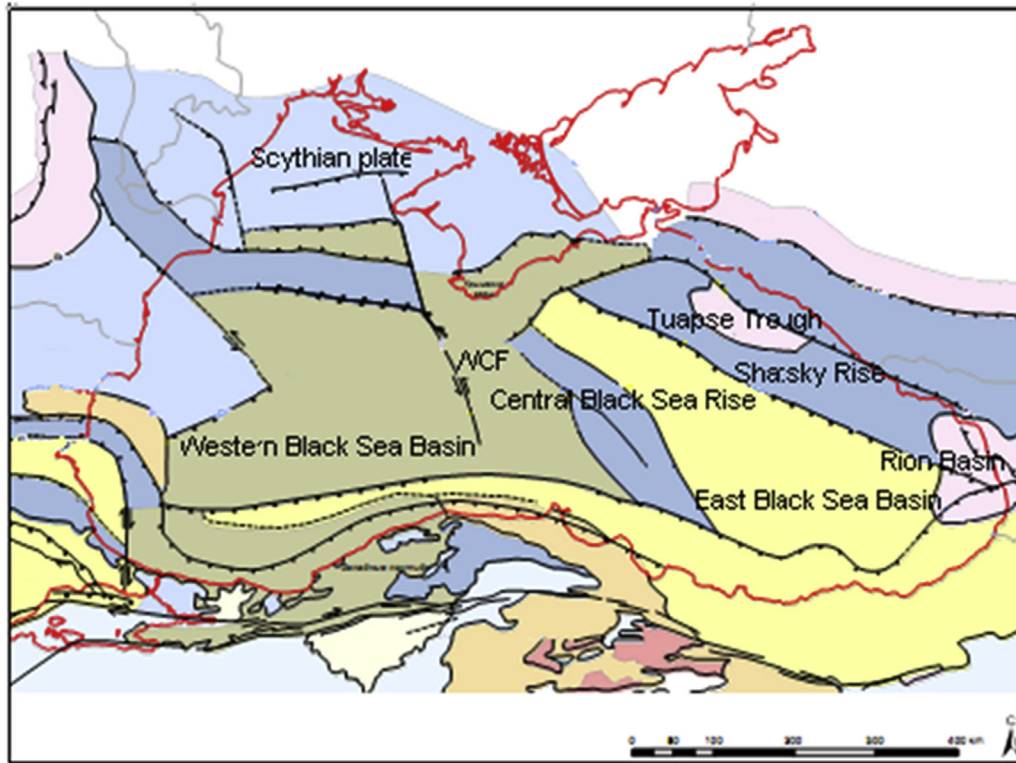
Geophysical studies in the Black Sea region are important due to the presence of various geological structures and tectonic features. Tectonic map of Black Sea region is shown in Fig. 1a (the map from Krasnodar Regional Geological Funds was received). This region is the seismically active zone. Earthquakes that have occurred there from 2005 to 2016 are shown in Fig. 1b (this map was based on the seismic catalog of the Central Experimental Expedition (CEE) of the Geophysical Service of

the Russian Academy of Sciences (GS RAS)).

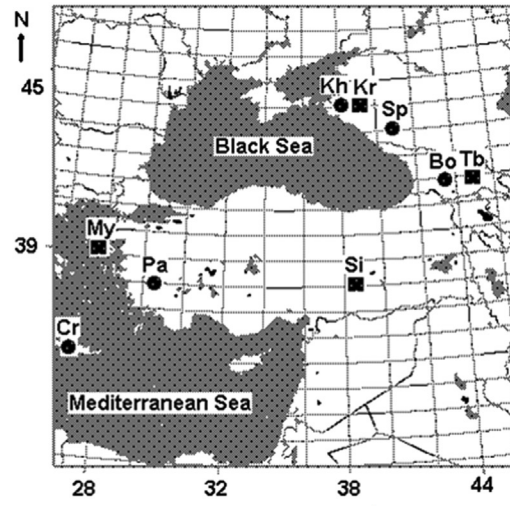
One feature of the Black Sea is the extraordinarily extensive presence of gas emissions from rocks in waters of the Black Sea (Esipovich, 2003). Gas emissions have been observed from the coast of Turkey up to the coast of Georgia in the east and up to the Bulgarian shelf in the west. Gas streams of methane in seawater are connected with mud volcanoes of the Kerch-Taman province and with faults. Therefore, measurements of underground gas concentrations are very important for tectonic and seismological studies. In previous seismological studies performed in

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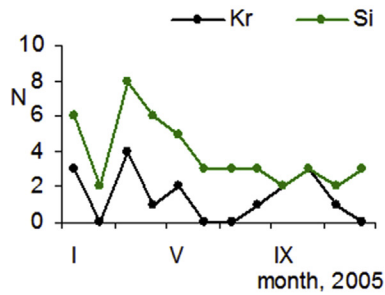


a)

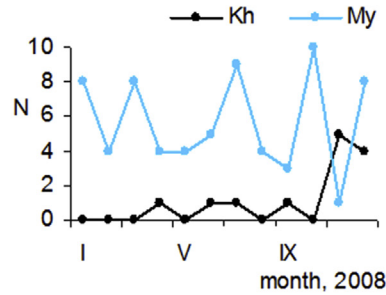


b)

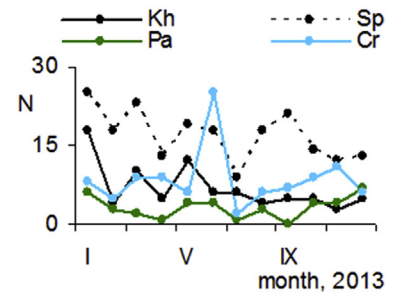
c)



d)



e)



f)

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