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Radon Concentration by SSNTD in South-East Sicily buildings

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Abstract

Radon levels in buildings vary widely from area to area also depending on local geology. Thus, it is important to assess the radon prone area of a geographic region on the basis of geological data and to search for any possible correlation between the local geology and the indoor radon concentrations.We report about indoor radon measurements in Ragusa, a municipality of the SE Sicily, placed in the Hyblean Plateau (northern region of the African Plate), carried out in collaboration with schools. The survey was performed using Solid State Nuclear Track Detectors (SSNTD), CR-39 type, and a well-established methodology for chemical etching and reading, developed at the Radioactivity Laboratory of the Department of Physics - University of Catania.

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1. Introduction

Inhalation of Radon and its progeny is one of the principal sources of radiation exposure of the population (UNSCEAR, 2000). High radon exposure can have effects on the public health, Radon, in fact, is considered as the second cause of lung cancer after smocking (NAS, 1999). So it is very important to plan Radon monitoring survey. In many countries all around the world mapping of radon risk area or radon-prone area are in progress in accordance to the International Committee on Radiological Protection Recommendations (ICRP, 1993). Since 2005 in the framework of a scientific dissemination INFN (National Institute for Nuclear Physics) project, while high school students are informed on natural radioactivity and its health effects, indoor radon activity mapping in dwellings and schools is performed in the eastern Sicily. During the project the involved students firstly receive explanation about

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radon and on nuclear particles detection techniques; they also assemble themselves radon detectors and place them in the classrooms at school and at home (Catalano et al., 2012). In this way it is possible to monitor vast areas.

We report about the results of a Radon survey carried out in Ragusa municipality from October 2012 till October 2013.

Ragusa is located in the central Hyblean Plateau in the south-east of Sicily (Fig. 1.). The Hyblean Plateau is part of the northern margin of the African plate and has remained a relatively undeformed foreland during the Neogene collisional process affecting the African-European convergent belt; it consists of circa 6000 m of carbonates and marls with intercalations of volcanic horizons, which have occurred at several episodes (Patacca et al., 1979; Bianchi et al., 1989; Ragg et al., 1999). The rock successions in which Ragusa lies are Oligo-Miocene carbonates.

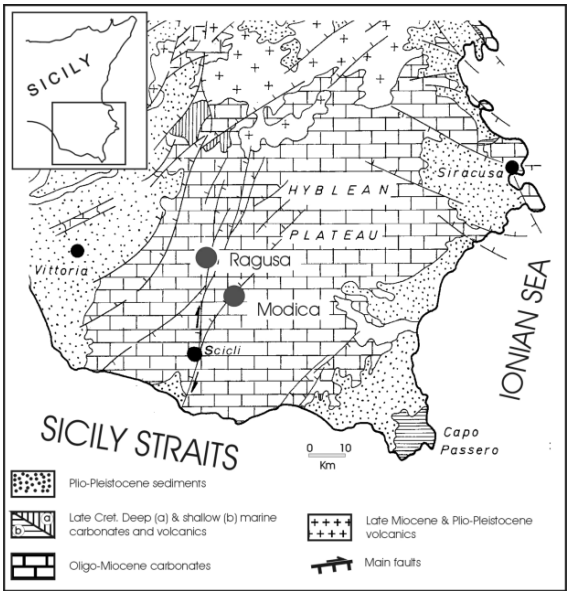

Fig. 1. Radon survey area.

2. Indoor Radon measurements

Indoor radon measurements were performed using SSNTD Cr-39 Type. Measurements were carried out from October 2012 till October 2013 in fifty different buildings. Two sets of detector were exposed, the first one from October 2012 till May 2013, the second one from May 2013 till October 2013. In particular, in thirty-five buildings detectors were placed in the same sites in the two measurement sets to evaluate seasonal influences and to obtain radon concentration values as mean over one year as indicated by the European and national radon regulation.

After the exposure, the CR-39 dosimeters were chemically etched using a 6.25 M NaOH solution at 98°C for 1 hour. The detector reading was carried out by means a semiautomatic system composed of an optical microscope equipped with a CCD camera connected to a PC. A video acquisition software allowed to capture and store the images (Field Of View or FOV) from the microscope. The stored images were analyzed by means of ImageJ 1.29x (Image Processing and Analysis in Java) freeware software, in which an opportune routine was edited (Immé et al., 2013).

The obtained results are shown in Fig. 2.

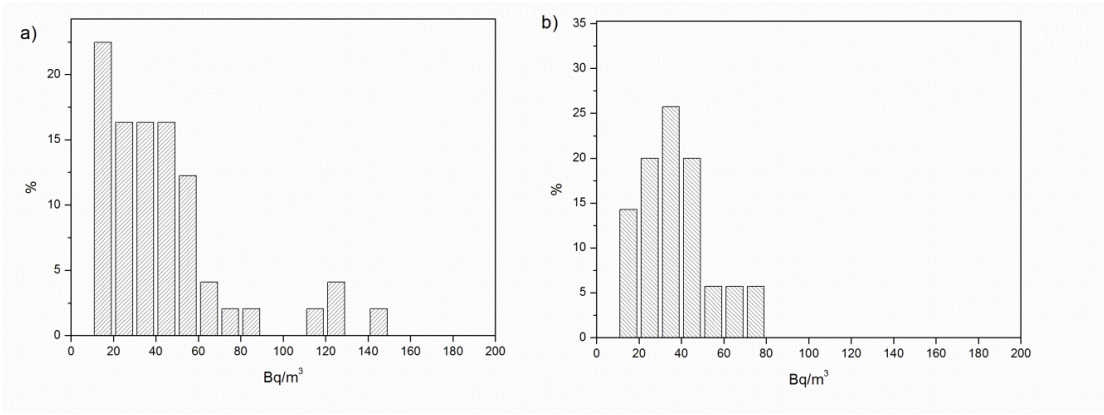

Fig. 2. (a) Indoor Radon concentration in 50 dwellings (October 2012- May 2013); (b) Indoor Radon concentration in 35 dwellings (May 2013- October 2013)

All the data are lower than the National law limits (200 Bq/m^3). In table 1 the detail of the obtained values is reported.

Table 1. Indoor Radon concentrations – statistical analysis on monitored sites

Exposition period	Min [Bq/m^3]	Max [Bq/m^3]	Avg [Bq/m^3]	S.D. [Bq/m^3]	Median [Bq/m^3]
October 2012-May 2013	12,71	168.63	43,51	30,59	35,6
May 2013- October 2013	14,11	156,88	41,06	26,39	36,3

No relevant differences were found between summer and winter radon concentration values. In Fig. 3. the data are reported for the two periods recorded in the same buildings.

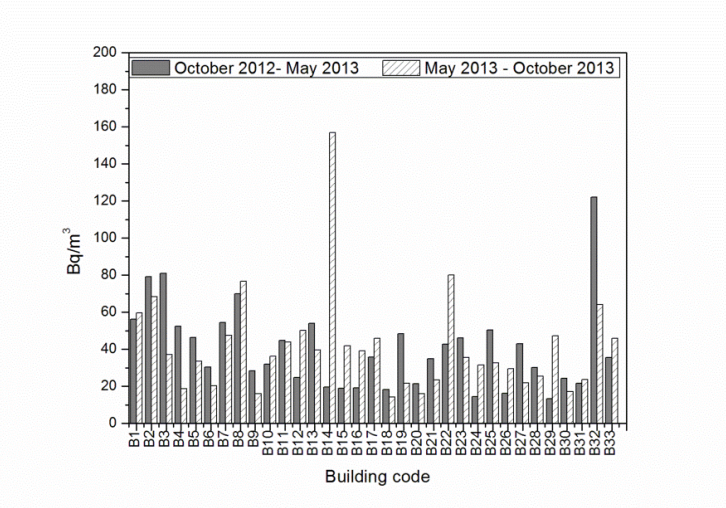

Fig. 3. Comparison between Radon concentration recorded in the two survey periods in the same thirty-five buildings

Only few buildings shown a high seasonal variability possibly due to the inhabitant's lifestyle. The previous data were, also, analyzed with respect to the building materials. The results are shown in Table 2, where the mean radon value is reported according to the different materials and the highest and lowest values.

Table 2. Radon concentration according to building materials

Building Material	Mean [Bq/m^3]	Max [Bq/m^3]	Min [Bq/m^3]
Concrete	18	18	18
Cement	38	79	20
Block of limestone	79	122	38
Bricks	18	20	16
Bricks and cement	42	120	18
Stone	50	150	18

The obtained results have shown that there is an high variability in indoor radon concentration for each material.

3. Conclusion

A survey of radon concentration in Ragusa, a city placed in the south-east of Sicily was carried out in the period October 2012 – October 2013. The radon concentration was measured using solid state nuclear tracks detectors. The results of the present work have shown medium indoor radon concentrations with values around the previously estimated mean value of 35 Bq/m^3 for the Sicily (Bochicchio et al. 1999) but lower respect to the Italian average of 70 Bq/m^3 and much lower respect to our previous survey in the same area (Catalano et al., 2012). The differences are imputable to the larger detector distribution density inside a limited area. These results suggest that for a better indoor radon mapping it is necessary to optimize the detector distribution according to the geomorphology of the area.

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