Elevated Radon Concentration At The Entrance Of An Unused Old Coalmine Near An Urban Area, Western Crete, Greece

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1. INTRODUCTION

A wide scale radon survey has been carried out in Greece for the measurement of radon concentration inside dwellings (Nikolopoulos et al., 2002). In these studies several areas of elevated radon concentration as well as two 'radon prone' areas were identified and depicted on a map (Fig 1).

Although a possible explanation for the origin of radon for the 'radon prone' area at Arnaia Chalkidikis has been given, as due to its lying above a granitic rock, no explanation has been proposed for the second prone area near Vrisses Apokoronou, in Western Crete (Louizi et al., 2005).

This work aims to investigate possible geological causes for the elevated concentration of radon in the area of Vrisses Apokoronou, by radon measurements in the field. This will allow us to consider the relationship between the elevated radon levels in Vrysses Apokoronou , as measured indoors (Nikolopoulos et al 2002) , with the levels as measured in the field in the present study. To approach the problem a geological outline of the area is necessary.

Fig.1. Map showing the radon surveyed areas in Greece (after Nikolopoulos et al 2002).

2. OBJECTIVES

This work aims to investigate possible geological causes for the elevated concentration of radon in the area of Vrisses Apokoronou, by radon measurements in the field. This will allow us to consider the relationship between the elevated radon levels in Vrysses Apokoronou , as measured indoors (Nikolopoulos et al. 2002) , with the levels as measured in the field in the present study. To approach the problem a geological outline of the area is necessary.

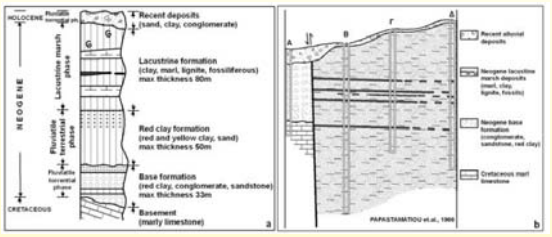

Fig 2: Stratigraphic column of Vrysses area; (b): Geological section of boreholes in Vrysses area (after Karageorgiou et al 2010)

3. GEOLOGICAL OUTLINE

The sediments of the study area belongs to Tortonian/Messinian sequence consists of blue or purple amorphous clays, but locally these clays are laminated. Within these clays strongly indurated, graded and ungraded, sandstones, calcarenites and organic limestones occur at various stratigraphic levels. At several localities sand or gravel layers, without any clear graded bedding, occur within the blue and purple amorphous clays at various stratigraphic levels. These layers deposited in a fluvio- lacustrine - brackish - shallow marine environment and host four lignite beds (Fig. 2) (Papastamatiou et al 1966, Karageorgiou et al 2010). In the beginning of the Messinian 'Salinity Crisis' the lignite deposits likely represent the syntectonic deposition occurring at the isolated margin basin due to a progressively growing carbonate ramp.

4. MEASUREMENTS IN THE FIELD

Two types of field measurements were made. Firstly total radioactivity in air was monitored, by using a pancake-type Geiger counter, model RM-80 of Aware Electronics, incorporating a 1" mica window, sensitive to alpha, beta and gamma radiation. This allowed the rapid surveillance of an area for the existence of radon and its daughters. Secondly, dedicated radon concentration measurements were performed, in air, by using a continuous radon monitor, model 1028, of Sun Nuclear Corporation, incorporating a solid state diode detector.

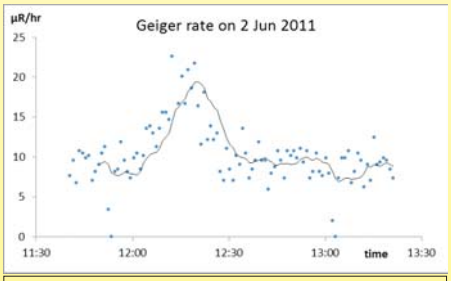

Fig 3: Radioactivity in air, 2m from the mouth of the gallery, now collapsed, leading to the abandoned mine. A mica-window Geiger is used, handheld. Firstly approaching to the mouth, then stopping near it and finally retreating from the place. The solid line joins the 10- point (10 mins) moving averages.

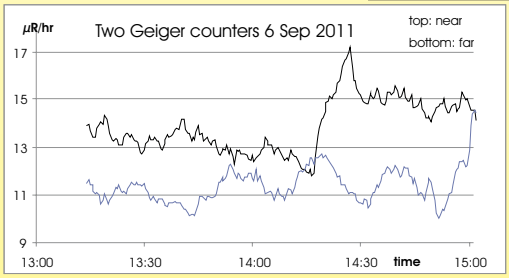

Fig. 4: Radioactivity, in air, monitored by two Geiger counters, positioned at two points, one near (2m) and the second far (10m) from the mouth gallery of the abandoned mine. The solid line joins the 20- point (10 mins) moving averages

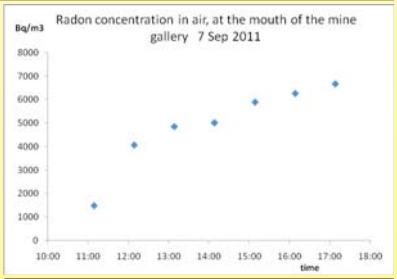

Figure 5. Radon concentration, in air, monitored by a continuous radon monitor, positioned 1 m within the mouth of the gallery of the abandoned mine.

5. RESULTS

Following the geological inspection of the area, the vicinity of an old unused lignite mine was selected for the measurements, where elevated Geiger rates were detected, as shown in Figure3.

The measured radioactivity in air was found to be higher than normal background levels by a factor of 2-3. The elevated radioactivity was confirmed by a second series of measurements, using two Geiger counters, monitoring simultaneously the radioactivity at two different distances from the mine entrance (Fig 4). The data show elevated counts and also that, under the same atmospheric conditions, the radioactivity in air is higher nearer the mine entrance.

The elevated radioactivity detected by geiger counters was finally confirmed by measuring, specifically, the radon concentration in air. The continous radon monitor was suspended 1m within the mouth of the mine gallery. These measurements are shown in Fig. 5. The data presented in this work identify for the first time a source of radon in the area capable of producing radon concentrations three orders of magnitude above typical radon concentrations in air.

6. CONCLUSIONS

There are no volcanic or granitic rocks in the study area that could explain the origin of the elevated radon concentration observed. Also no large faults occur in the area. The only relevant geological feature in the area is the existence of four lignite beds at a relatively small depth. These lignite deposits were formed before the Messinian salinity crisis in a period of increased erosion and weathering processes due to climatic conditions. It is known that a high uranium concentration exists in peat and lignite mines (Read et al 1993). In the area of Vrysses Apokoronou, the lignite was mined from a depth of approximately 30 m. Since 1960s mining has stopped and today the mine gallery has collapsed and only its mouth exists as a relic. The very high radon concentrations that were measured in air in the present research are likely to originate from the lignite beds of the clastic sediments in the area.

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