AN ORIGINAL METHOD TO MEASURE THE NATURAL RADIOACTIVITY IN THE OUTDOOR ENVIRONMENT BY MEANS OF A MOBILE LABORATORY.

M.C. ROBE, V. LABED, P. RICHON,
A. BENEITO, D. HARISTOY, S. DEMONGEOT.

Institut de Protection et de Sûreté Nucléaire, Département de Préventionet d'Etude des Accidents,

Service d'Etudes et de Recherche en Aérocontamination et en Confinement

91191 Gif-Sur-Yvette Cedex, France

ABSTRACT

The Nuclear Protection and Safety Institute has developed a special tool, a mobile laboratory, to perform measurement of natural radioactivity (gamma radiation and radon activity in the air) in the outdoor environment. With this mobile laboratory, it is possible to study the temporal and the spatial variations of the natural radioactivity. For that, measurements are made either by stopping the mobile laboratory at one point, or while the vehicle is moving. This last configuration allows to obtain cartographies of gamma radiation and radon level, that can be correlated with the geological characteristics of the site under study. This methodology can be applied to study the impact of radium-rich by-products storage site in the outdoor environment. It can provide very rapidly information useful for the site operator, the local authorities and the population.

Measurements made in France with this mobile laboratory show significant various areas as a function of the geological parameters. For example, the gamma dose rate is comprised between 60 and 300 $nGy.h^{-1}$ and the radon activity between 5 and 100 $Bq.m^{-3}$ and even higher.

INTRODUCTION

In the open air, the activity of radon gas depend locally on the exhalation rate and on the conditions of atmospheric diffusion. We can observe temporal and spatial variation in the range of a few $Bq.m^{-3}$ to several hundred $Bq.m^{-3}$ (1-2).
In fact, depending on the thermal structure of the atmosphere, with the presence or absence of temperature inversion, and on others meteorological parameters, the observed concentrations vary at a given site by a factor from 10 to 100.
Radon concentration also depends on the geological and pedological characteristics of the studied site (for example granitic or sedimentary area and parameters of the soil such as porosity, humidity, permeability, ...).So, we observe spatial changes in radon concentration due to the type of soils and not to the variation of meteorological parameters.

DESCRIPTION OF THE MOBILE LABORATORY

To perform measurement of natural radioactivity (gamma radiation and radon activity in the air) our Institute has developed a mobile laboratory. The vehicle is a diesel powered, cross-country four-wheel drive. The inside is fitted out with racks. These are equipped with silentblocs, selected according to the weight of the instruments, to eliminate low frequencies emitted by the vehicle engine or present in road noise. The measuring equipment is modular to accommodate the various tasks the mobile laboratory may be assigned.

It is equipped with the following:

- an electrical power generation system which provides 24 hours of measurement autonomy,
- a navigation system,
- a data acquisition and processing unit,
- ionisation chambers, for continuous measurement of the gamma dose rate, at approximately 2 m off the ground, and of the radon activity concentration. The air samples are taken at approximately 1.5 m off the ground.

The mobile laboratory is used to measure the temporal and/or spatial evolution of a pollutant on times scales ranging from a few minutes to several hours, and distance scales ranging from a hundred metres to tens of kilometres. Several measurement procedures have thus been developed.

Measurements are made as follow:

- at fixed stations, at several points of the site, over periods of several hours to several days and under various conditions of atmospheric diffusion. This reveals variations according to time of the day which are related, for example, to temperature changes at night;

- along various points of paths determined according to the site's characteristics (i.e. road infrastructure, housing, orography, etc.) and according to weather conditions under various conditions of atmospheric diffusion. This reveals spatial variations;

- at semi-fixed stations : the mobile laboratory is immobilised for 4 to 5 minutes at a point of known co-ordinates (x, y and z) then moved by a few hundred metres (in accordance with the orography) to carry out new measurements.

RESULTS

Figure 1 shows the results of cartographies made in east of France. These itineraries cross trough a granitic area (top of the map) and a sedimentary area (bottom of the map). Accordingly we find more radon in the north than in the south. The same phenomena is observed for the gamma dose rate. During the night the radon activity reached 200 $Bq.m^{-3}$ in the north for some points. For a same point of measurements, we observe that the radon concentration is increased by a factor of 2 between night and day.

This methodology can be applied:

- within the framework of studies on radon in buildings, to identify the radon-prone areas. Thus, some mitigation technics can be applied to reduce radon at home;.
- to study the impact of radium-rich by-products storage site in the outdoor environment. It can provide very rapidly information useful for the site operator, the local authorities and the population (3);
- to study the radiological regional background.

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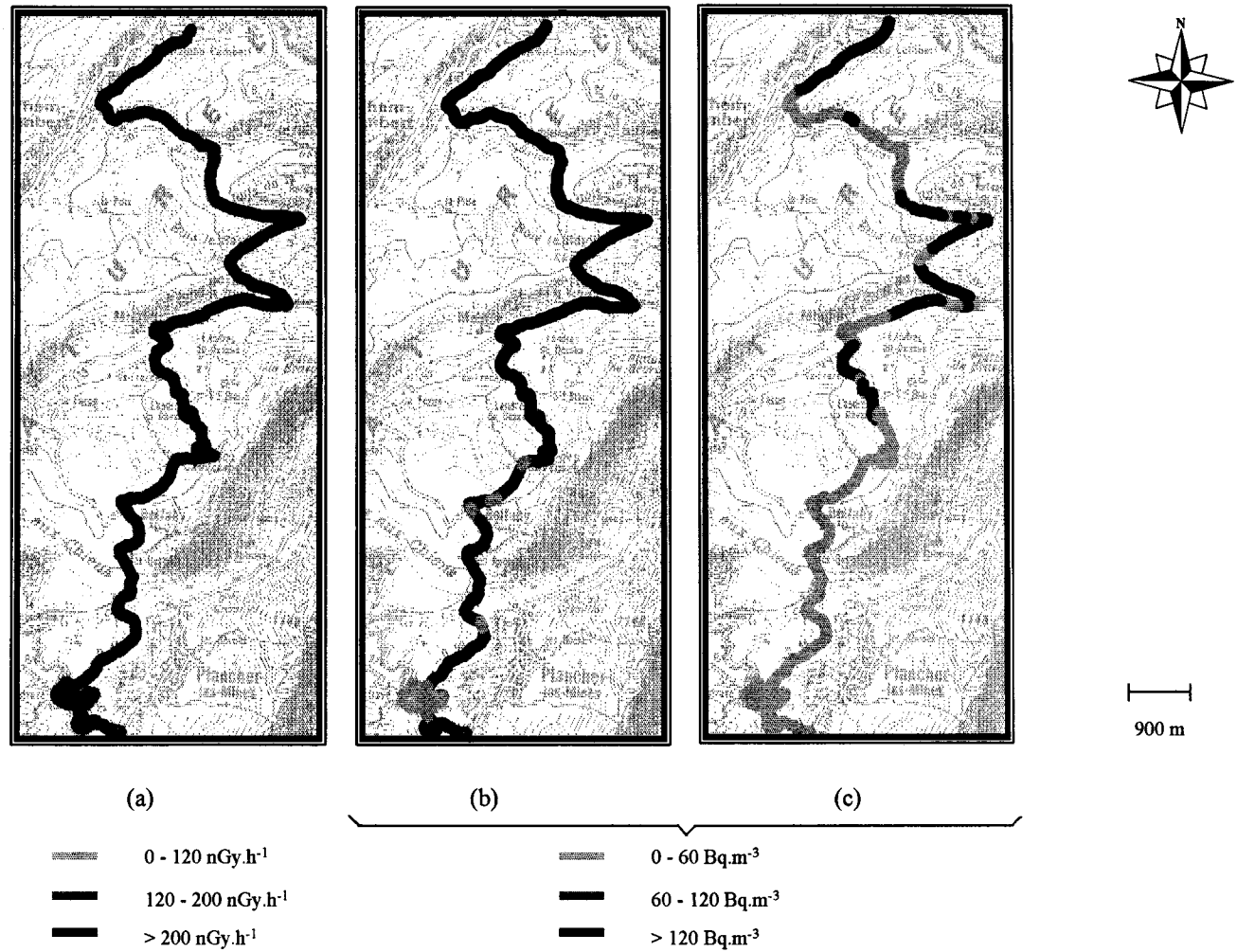

Figure 1: Cartographies of: (a) gamma dose rate, (b) radon concentration during the night, (c) radon concentration during the day