BOLETÍN OFICIAL DEL ESTADO

Núm. 279 Jueves 18 de noviembre de 2010 Sec. I. Pág. 96395

I. DISPOSICIONES GENERALES

MINISTERIO DE LA PRESIDENCIA

17709 *Real Decreto 1439/2010, de 5 de noviembre, por el que se modifica el Reglamento sobre protección sanitaria contra radiaciones ionizantes, aprobado por Real Decreto 783/2001, de 6 de julio.*

El Reglamento sobre protección sanitaria contra radiaciones ionizantes vigente fue aprobado por el Real Decreto 783/2001, de 6 de julio. Mediante este Reglamento, junto

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III. OTRAS DISPOSICIONES

CONSEJO DE SEGURIDAD NUCLEAR

1238 *Instrucción IS-33, de 21 de diciembre de 2011, del Consejo de Seguridad Nuclear, sobre criterios radiológicos para la protección frente a la exposición a la radiación natural.*

El artículo 2.a) de la Ley 15/1980, de 22 de abril, de creación del Consejo de Seguridad Nuclear, atribuye a este ente público la facultad de «elaborar y aprobar las Instrucciones, Circulares y Guías de carácter técnico relativas a las instalaciones nucleares y radiactivas y a las actividades relacionadas con la seguridad nuclear y la protección radiológica».

El Reglamento de Protección Sanitaria contra Radiaciones Ionizantes (RPSRI), aprobado por Real Decreto 783/2001, de 6 de julio, establece, en los artículos 62 y 63 del título VII, disposiciones relativas las fuentes naturales de radiación.

El artículo 62 establece que los titulares de las actividades laborales, no reguladas en el artículo 2.1, en las que existan fuentes naturales de radiación, deberán declarar estas actividades ante los órganos competentes en materia de industria de las comunidades autónomas en cuyo territorio se realizan estas actividades laborales y realizar los estudios necesarios a fin de determinar si existe un incremento significativo de la exposición de los trabajadores o de los miembros del público que no pueda considerarse despreciable desde el punto de vista de la protección radiológica.

El Consejo de Seguridad Nuclear, a la vista de los resultados de los estudios realizados al amparo del artículo 62, identificará aquellas actividades laborales que deban ser objeto de especial atención y estar sujetas a control. En consecuencia definirá aquellas actividades laborales que deban poseer dispositivos adecuados de vigilancia de las exposiciones y, cuando sea necesario establecerá la aplicación de acciones correctoras destinadas a reducir las exposiciones o de medidas de protección radiológica de acuerdo, total o parcialmente, con otros títulos del Reglamento (II, III, IV, V y VI).

El Reglamento no especifica los criterios radiológicos que harían necesaria la aplicación de medidas correctoras o de protección y, por ello, se considera necesario establecerlos de forma que sirvan de referencia para las autoridades competentes y para los titulares de las actividades laborales afectadas.

De acuerdo con lo anteriormente expuesto, y en virtud de la habilitación legal prevista en el artículo 2, apartado a), de la Ley 15/1980, de 22 de abril, de creación del Consejo de Seguridad Nuclear, previa consulta a los sectores afectados, tras los informes técnicos oportunos, este Consejo, en su reunión del día 21 de diciembre de 2011, ha acordado lo siguiente:

Primero. *Objeto y ámbito de aplicación.*

El objeto de la presente Instrucción es establecer criterios radiológicos sobre los siguientes aspectos relacionados con la exposición a la radiación natural en lugares de trabajo:

– Valores de dosis efectiva a los trabajadores cuya superación requeriría la adopción de medidas correctoras o dispositivos de vigilancia.
– Concentraciones de radón en lugares de trabajo cuya superación requeriría la adopción de medidas correctoras o dispositivos de vigilancia.
– Aplicación total o parcial de los títulos del RPSRI citados en el título VII, en los casos en los que los resultados de los estudios demuestren que se han superado los niveles de dosis efectiva establecidos o las concentraciones de radón.

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La Instrucción establece también los datos a incluir en la declaración de actividades que deben hacer los titulares de las actividades laborales en las que existan fuentes naturales de radiación y en qué casos estos titulares deben remitir a los órganos competentes en materia de industria de las comunidades autónomas los estudios que requiere el título VII del Reglamento de Protección Sanitaria contra Radiaciones Ionizantes (RPSRI).

La Instrucción es aplicable a los titulares de las actividades laborales en las que existan fuentes naturales de radiación, que están dentro del ámbito de aplicación del artículo 62 del RPSRI, que, sin carácter exhaustivo, son las que se listan en el anexo.

Segundo. *Definiciones.*

Las definiciones de los términos y conceptos utilizados en la presente Instrucción se corresponden con las contenidas en las siguientes disposiciones:

Ley 25/1964, de 29 de abril, sobre Energía Nuclear.
Ley 15/1980, de 22 de abril, de creación del Consejo de Seguridad Nuclear.
Real Decreto 1836/1999, de 3 de diciembre, por el que se aprueba el Reglamento sobre Instalaciones Nucleares y Radiactivas.
Real Decreto 783/2001, de 6 de julio, por el que se aprueba el Reglamento sobre Protección Sanitaria contra Radiaciones Ionizantes.

Tercero. *Valores de dosis efectiva a los trabajadores cuya superación requeriría la adopción de medidas correctoras o dispositivos de vigilancia.*

1. Los criterios radiológicos, en términos de dosis efectiva a los trabajadores debida a su actividad laboral, que tienen por objeto servir como umbral de referencia para las actuaciones indicadas en el artículo 63 del RPSRI, deben ser los siguientes:

– < 1mSv/a: no es necesario control.
– 1-6 mSv/a: se debe aplicar un nivel bajo de control.
– >6- mSv/a: se debe aplicar un nivel alto de control.

2. Se consideran medidas de control aquellas destinadas a reducir las exposiciones, ya sean de tipo técnico o administrativo.
3. Estos criterios son de aplicación a los trabajadores cuyas actividades laborales suponen el almacenamiento o la manipulación de materiales, o de residuos, que normalmente no se consideran radiactivos, pero que contienen radionucleidos naturales.
4. Para la estimación de las dosis efectivas se deben tener en cuenta todas las vías de exposición (sustrayendo la contribución del fondo natural), exceptuando la debida al radón, que únicamente se tendrá en cuenta en los casos indicados en el punto 2 del artículo quinto, «Aplicación de los principios de protección radiológica operacional», de esta Instrucción.
5. En el artículo quinto de esta Instrucción se establecen los controles aplicables, en términos de medidas de protección radiológica, para los rangos de dosis efectiva indicados en este artículo.
6. Los límites del artículo 9 del RPSRI son aplicables a los trabajadores expuestos a radiación natural.
7. Los titulares de actividades laborales con exposiciones a radiación natural deben aplicar el principio de optimización.

Cuarto. *Concentraciones de radón en lugares de trabajo cuya superación requeriría la adopción de medidas correctoras o dispositivos de vigilancia.*

1. El nivel para la protección de los trabajadores frente a la exposición al Rn-222 en sus puestos de trabajo debe ser de 600 Bq/m^3 de concentración media anual de Rn-222, durante la jornada laboral. Este se considera un nivel de referencia, por debajo del cual

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IS 33 Instruction: Spanish Nuclear Safety Council

II

(Non-legislative acts)

DIRECTIVES

COUNCIL DIRECTIVE 2013/59/EURATOM

of 5 December 2013

laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom

THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty establishing the European Atomic Energy Community, and in particular Articles 31 and 32 thereof,

Having regard to the proposal from the European Commission, drawn up after having obtained the opinion of a group of persons appointed by the Scientific and Technical Committee from among scientific experts in the Member States, and after having consulted the European Economic and Social

(3) Directive 96/29/Euratom establishes the basic safety standards. The provisions of that Directive apply to normal and emergency situations and have been supplemented by more specific legislation.

(4) Council Directive 97/43/Euratom [3], Council Directive 89/618/Euratom [4], Council Directive 90/641/Euratom [5] and Council Directive 2003/122/Euratom [6] cover different specific aspects complementary to Directive 96/29/Euratom.

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ANNEX XVI

(Articles 53 and 103)

List of items to be considered in the national action plan to manage long-term risks from radon exposures

ANNEX XVIII

List of items to be considered in preparing the national action plan to address long-term risks from radon exposures as referred to in Articles 54, 74 and 103

(1) Strategy for conducting surveys of indoor radon concentrations or soil gas concentrations for the purpose of estimating the distribution of indoor radon concentrations, for the management of measurement data and for the establishment of other relevant parameters (such as soil and rock types, permeability and radium-226 content of rock or soil).

(2) Approach, data and criteria used for the delineation of areas or for the definition of other parameters that can be used as specific indicators of situations with potentially high exposure to radon.

(3) Identification of types of workplaces and buildings with public access, such as schools, underground workplaces, and those in certain areas, where measurements are required, on the basis of a risk assessment, considering for instance occupancy hours.

(4) The basis for the establishment of reference levels for dwellings and workplaces. If applicable, the basis for the establishment of different reference levels for different uses of buildings (dwellings, buildings with public access, workplaces) as well as for existing and for new buildings.

(5) Assignment of responsibilities (governmental and non-governmental), coordination mechanisms and available resources for implementation of the action plan.

(6) Strategy for reducing radon exposure in dwellings and for giving priority to addressing the situations identified under point 2.

(7) Strategies for facilitating post construction remedial action.

(8) Strategy, including methods and tools, for preventing radon ingress in new buildings, including identification of building materials with significant radon exhalation.

(9) Schedules for reviews of the action plan.

(10) Strategy for communication to increase public awareness and inform local decision makers, employers and employees of the risks of radon, including in relation to smoking.

(11) Guidance on methods and tools for measurements and remedial measures. Criteria for the accreditation of measurement and remediation services shall also be considered.

(12) Where appropriate, provision of financial support for radon surveys and for remedial measures, in particular for private dwellings with very high radon concentrations.

(13) Long-term goals in terms of reducing lung cancer risk attributable to radon exposure (for smokers and non-smokers).

(14) Where appropriate, consideration of other related issues and corresponding programmes such as programmes on energy saving and indoor air quality.

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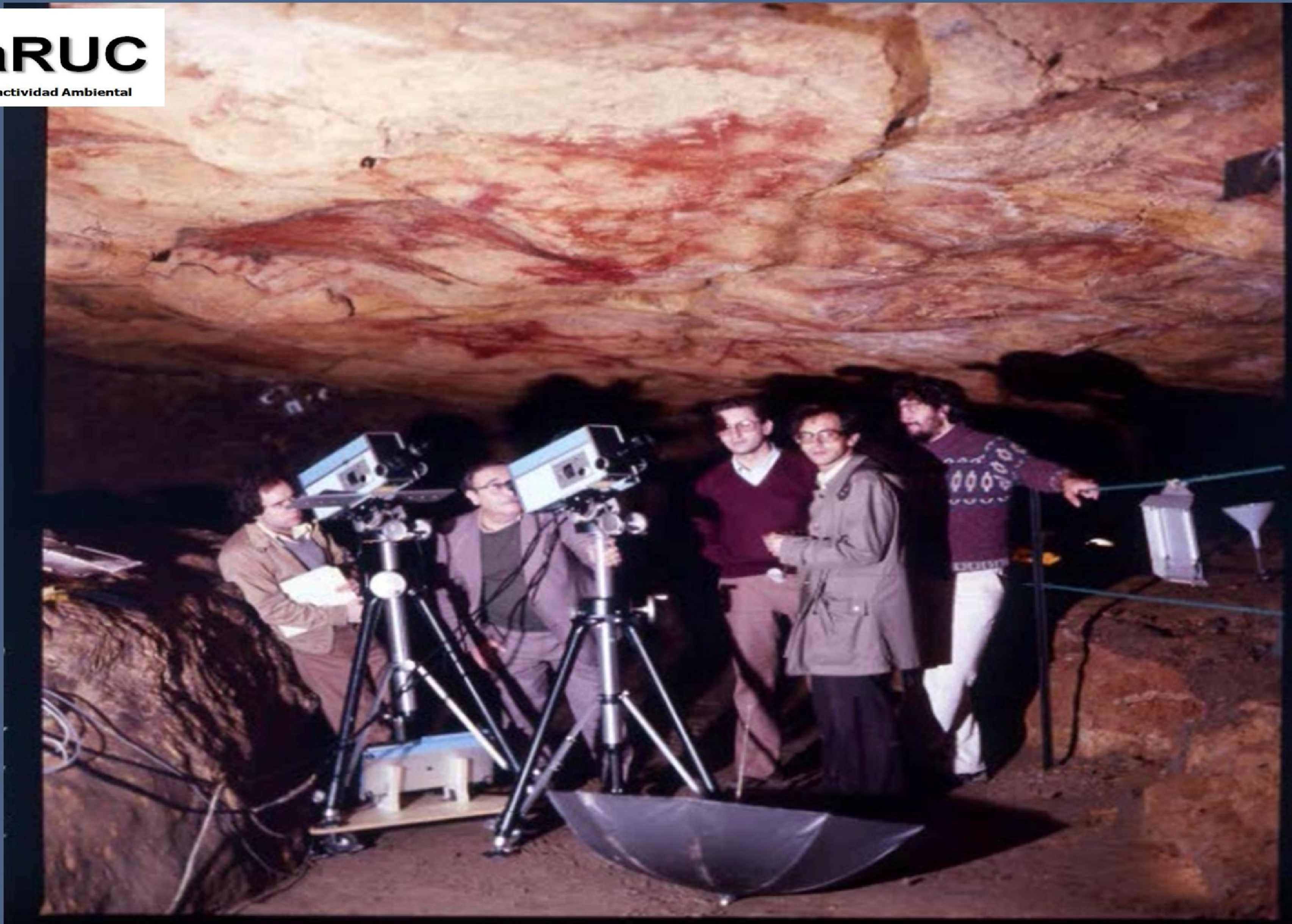

Reprinted from Nature, Vol. 321, No. 6070, pp. 586-588, 5 June 1986

Natural ventilation of the Paintings Room in the Altamira cave

P. L. Fernández*, I. Gutierrez†, L. S. Quindós†, J. Soto† & E. Villar*

* Fundamental Physics Department, Science Faculty, and †Medical Physics Department, Medicine Faculty, University of Santander, 39005 Santander, Spain

The Altamira cave (Santillana del Mar, Santander, Spain) is famous for the ceiling of one of its chambers, the Paintings Room, which is decorated with palaeolithic paintings. However, the massive influx of visitors resulted in deterioration of these rupestrian paintings and the cave was closed in 1977 to determine both the causes and the maximum number of visitors that could visit the cave without putting the paintings at risk[1–3]. The natural ventilation of the Paintings Room is one of the most important factors in formulating the maximum occupational index for visitors to the cave. The emission of carbon dioxide and water vapour by visitors inside the chamber is directly proportional to the number of visitors and the time spent in the room. By ventilating the room, these components should be removed from the air within a short period of time, thus returning the chamber to the prevailing conditions before visitors were allowed in. We report here variations in the ^{222}Rn concentration in the air of the Paintings Room which we use as a quantitative index of the natural ventilation existing in this chamber. We carried out parallel studies of the temperature at different points in the cave and the evolution of the carbon dioxide concentration in the air of the Paintings Room, and hence established the maximum number of people per hour that should be allowed to visit this chamber.

Radon-222 is a noble gas of the radioactive series of ^{238}U, an element that occurs in rocks in the Earth's crust with a concentration between 2 and 5 p.p.m. (parts per 10^6). Because of its gaseous nature and its greater concentration within the Earth, radon escapes through the interstices of the soil to the atmosphere, with an exhalation rate of ~ 1 atom $c^{-2}\ s^{-1}$. When this exhalation occurs in places with little ventilation, the radon concentration of the air may be high.

The ^{222}Rn concentration of the air of the Altamira cave was measured by scintillation cells with a capacity of 500 cm^3, in which a vacuum had been created down to a pressure of 50 torr. These scintillation cells were made of transparent plastic and their internal walls were covered with a film of SZn(Ag). The emission of α radiation by the radon ($t_{1/2} = 3.8$ days) contained in the air filling the cell leads to this radiation falling onto the film of SZn(Ag), where it produces fluorescence. The light thus emitted can be detected using a photomultiplier tube and the pulses produced can be recorded.

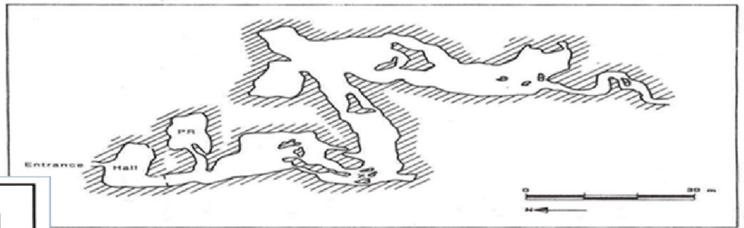

Fig. 1 Map of Altamira cave. PR, Paintings Room.

Because two of the short-lived radon daughters, ^{218}Po and ^{214}Po, are also α emitters, their contribution to the total counting supplied by an air sample increases with time until a radioactive equilibrium is reached between the radon and the two daughters. This equilibrium is reached 3 h after the sample is taken only if, initially, radon gas was present in the air sample. Therefore, to calculate the radon concentration, we carried out a 10-min counting 3 h after the collection of the air sample assuming that there was a radioactive equilibrium between the radon and its daughters. The number of counts obtained from the scintillation cell when empty was subtracted from each measurement resulting from fluorescence of the SZn(Ag).

The ^{222}Rn concentration was measured in two chambers within the cave: the Hall chamber, located at the entrance to the cave; and the Paintings Room (see Fig. 1). Measurements were made three times per week over a period of 1 yr between February 1983 and January 1984. From these results, we calculated the monthly average radon concentrations (Table 1).

To calculate the natural ventilation in the Paintings Room from the radon concentrations, we used the simplified model proposed by Wilkening[4], which is based on the fact that the temporal variation in the radon concentration (C) in the air of this chamber can be expressed as the sum of the production caused by radon exhalation from the rock surfaces, the radioactive decay and the radon loses resulting from the natural ventilation:

$$\frac{dC}{dt} = E\frac{S}{V} - \lambda C - \frac{Q}{V}(C - C_h) \qquad (1)$$

where E is the radon exhalation rate, S and V the surface and volume of the Paintings Room, respectively, Q the ventilation rate in this chamber, λ the radon decay constant and C_h the radon concentration in the Hall chamber.

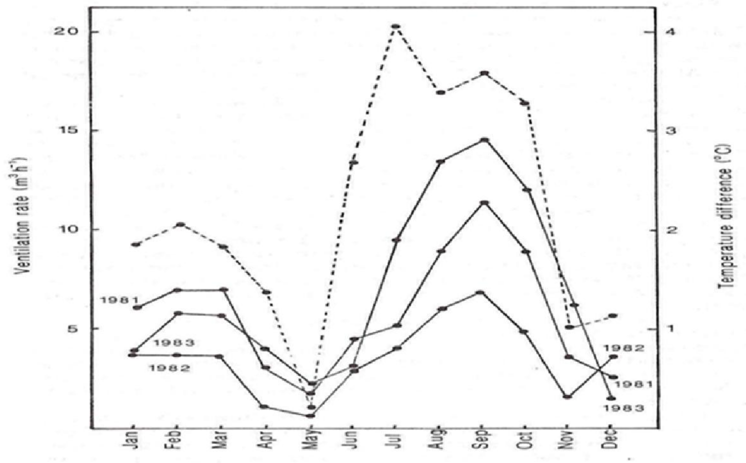

Fig. 2 Variations in the ventilation rate (dashed line) and the temperature differences (solid lines) between the Paintings Room and the Hall chamber.

Evolution of the Radon Concentration in Altamira Cave

Luis S. QUINDOS, Pedro L. FERNANDEZ, Jesus SOTO, Eugenio VILLAR
Department of Physics, University of Santander, Cantabria, Spain

and

Toshikatsu MIKI
Technical College, Yamaguchi University, Ube, 755 Japan

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Volume 13, December 29, 1988

Akiyoshi-dai, Japan

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UKAS QUALITY MANAGEMENT

Health Protection Agency

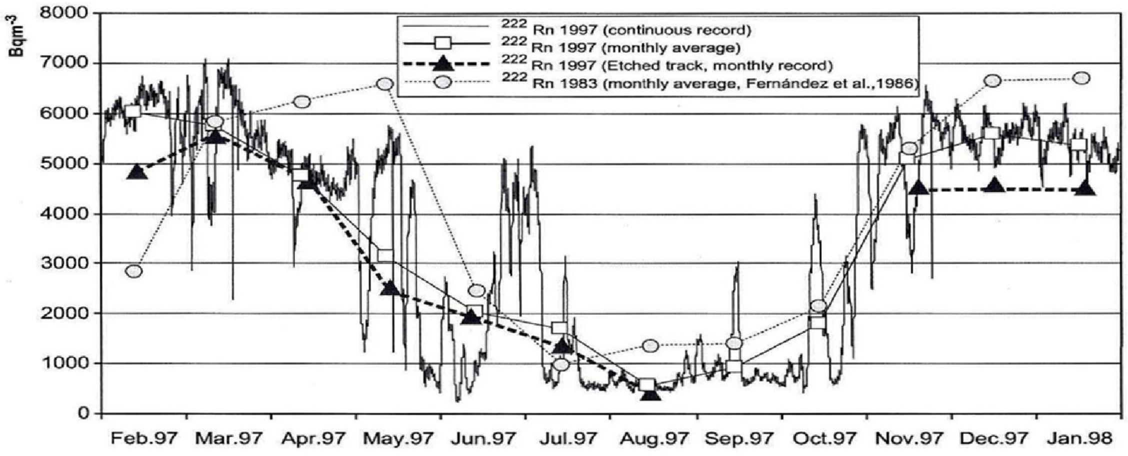
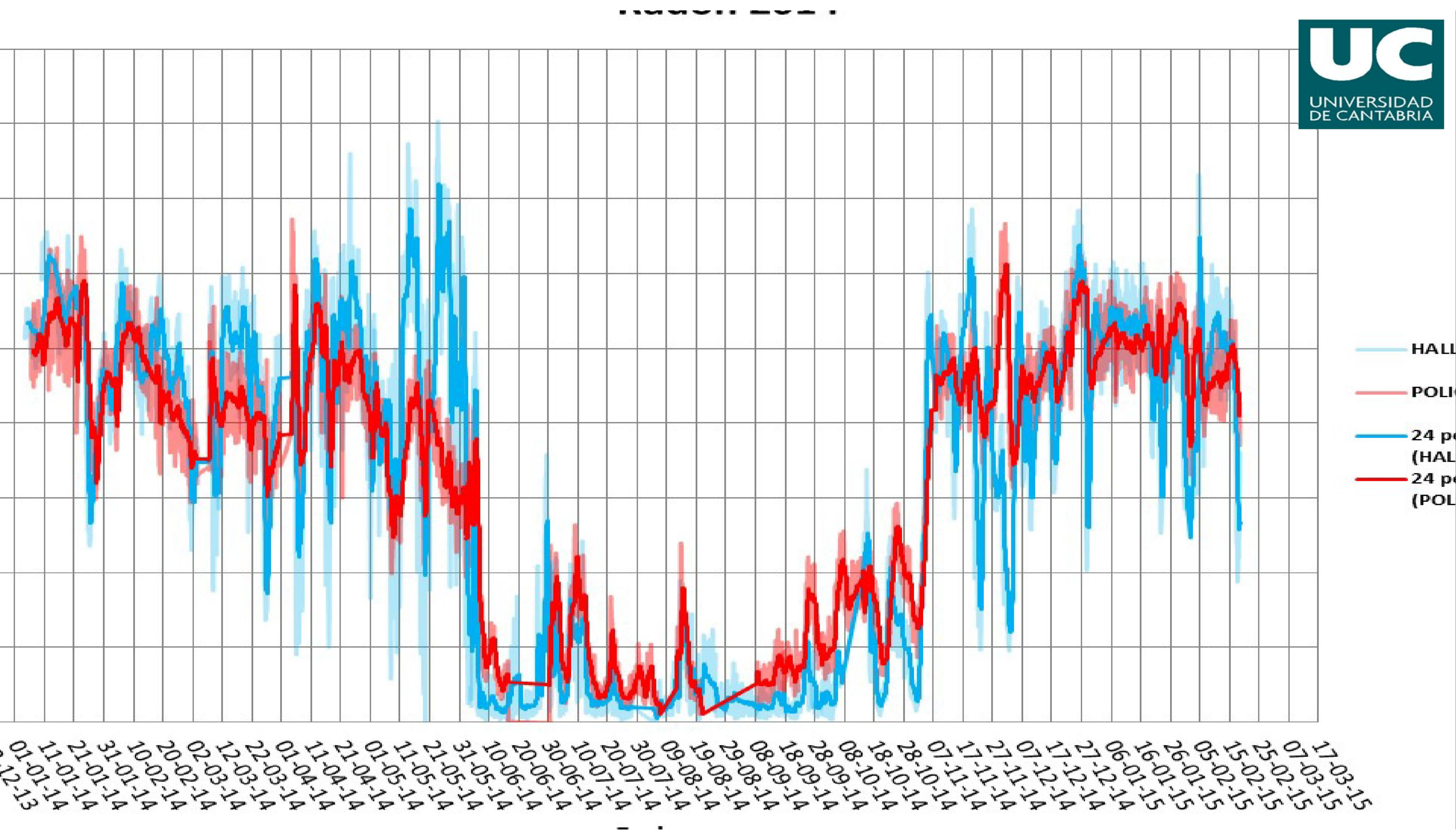


Fig. 2. ^{222}Rn concentration in Altamira Cave from February 1997 to January 1998 (continuous monitoring and monthly average) and comparison with radon concentration measured in 1983 by Fernández et al. (1986).


01-01-14
11-01-14
21-01-14
31-01-14
10-02-14
20-02-14
02-03-14
12-03-14
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01-04-14
11-04-14
21-04-14
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07-12-14
17-12-14
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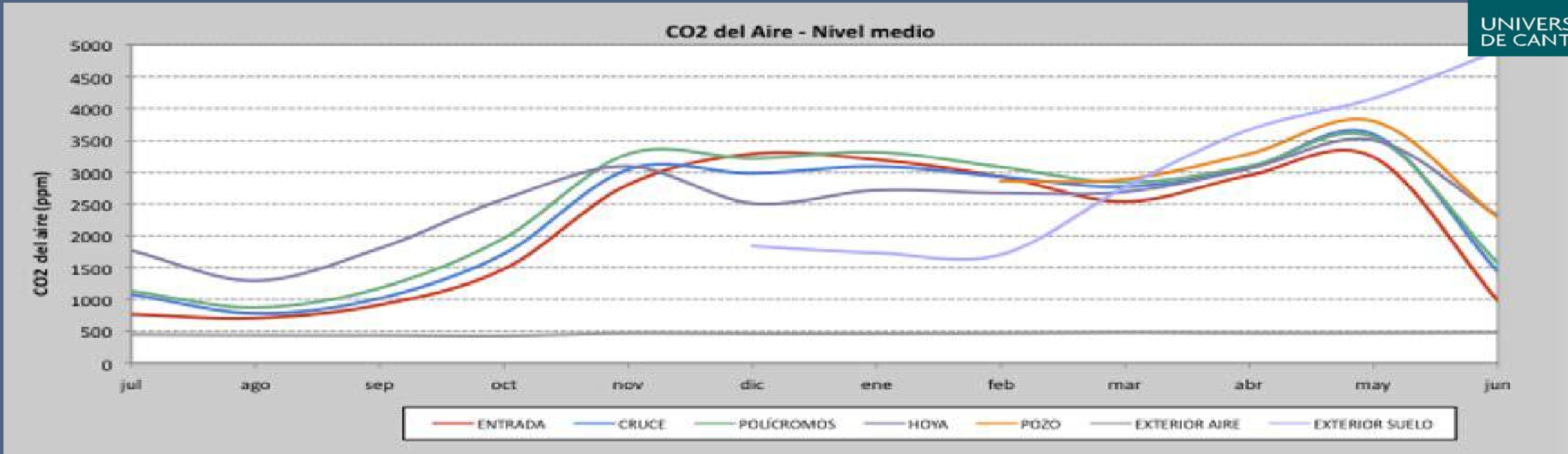
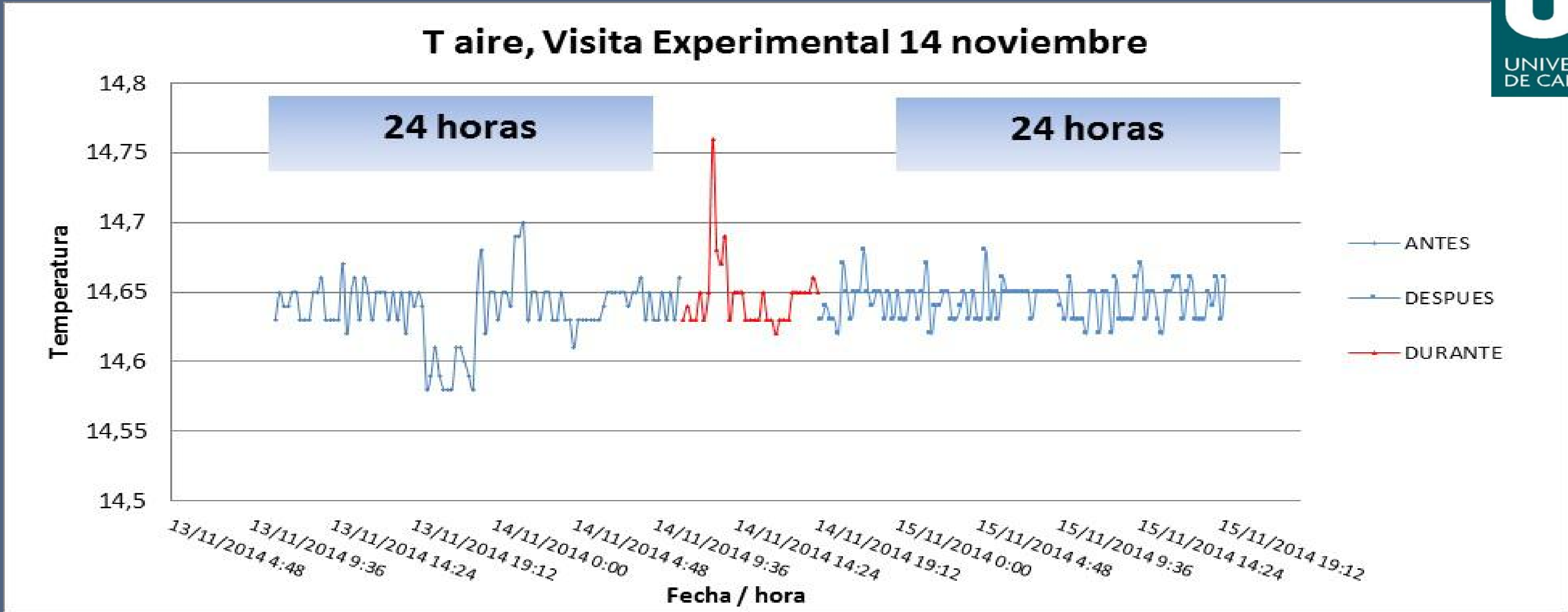
07-03-15
17-03-15



CO2 del Aire - Nivel medio
CO2 del aire (ppm)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
jul
ago
sep
oct
nov
dic
ene
feb
mar
abr
may
jun
ENTRADA
CRUCE
POLÍCROMOS
HOYA
POZO
EXTERIOR AIRE
EXTERIOR SUELO



T aire, Visita Experimental 14 noviembre
24 horas
24 horas
Temperatura
14,8
14,75
14,7
14,65
14,6
14,55
14,5
13/11/2014 4:48
13/11/2014 9:36
13/11/2014 14:24
13/11/2014 19:12
14/11/2014 0:00
14/11/2014 4:48
14/11/2014 9:36
14/11/2014 14:24
14/11/2014 19:12
15/11/2014 0:00
15/11/2014 4:48
15/11/2014 9:36
15/11/2014 14:24
15/11/2014 19:12
Fecha / hora
ANTES
DESPUES
DURANTE


CO2, Visita Experimental 14 noviembre
24 horas
24 horas
CO2 (ppm)
3100
3050
3000
2950
2900
2850
2800
2750
2700
13/11/2014 4:48
13/11/2014 9:36
13/11/2014 14:24
13/11/2014 19:12
14/11/2014 0:00
14/11/2014 4:48
14/11/2014 9:36
14/11/2014 14:24
14/11/2014 19:12
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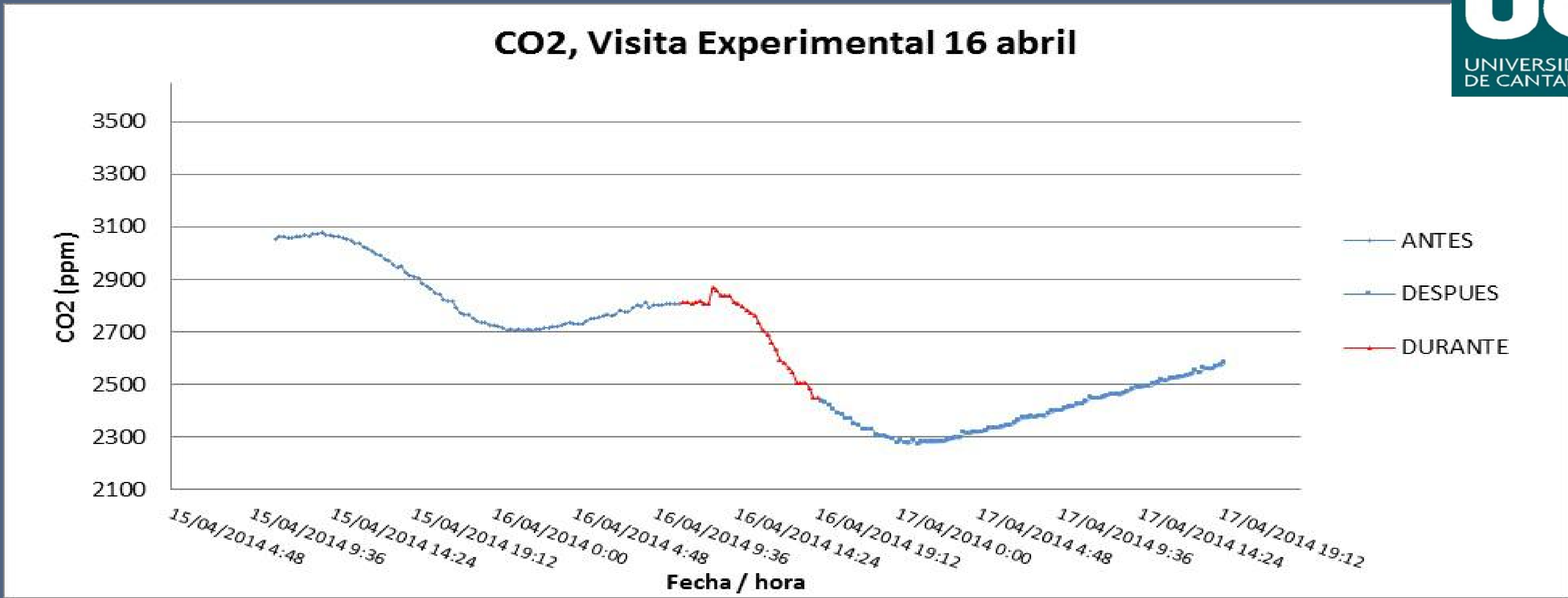

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Health Physics Vol. 46, No. 2 (February), pp. 445–447, 1984
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Radiation Exposure Levels in Altamira Cave

(*Received* 7 *October* 1982; *accepted* 2 *April* 1983)

Introduction

RADON is unique among the nuclides in the naturally occurring radioactive series because of its inert gas character. Radon-222 atoms are formed at or near the surface of mineral grains in rocks and soils as the result of the decay of the parent ^{226}Ra atoms. Once formed, the radon atoms are free to diffuse through the interstices between mineral or soil particles where they become a minor constituent of the soil gas.

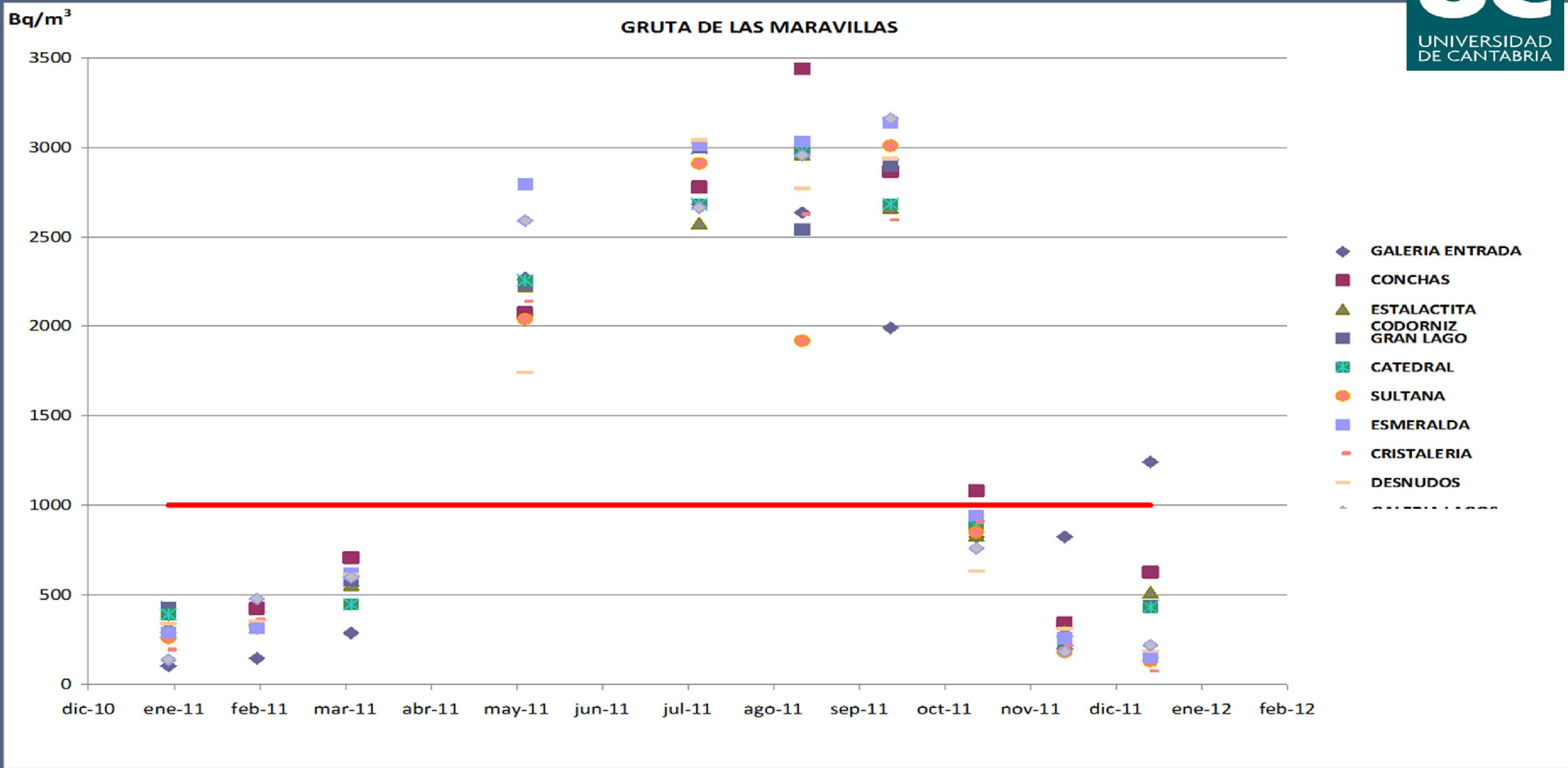
The concentration of ^{222}Rn in soil capillaries several meters below the earth's surface exceeds that of ordinary outdoor air by a factor of a thousand. Hence, a steady flux of ^{222}Rn atoms from soil to air at the earth-air interfaces and depends on the concentration of the parent ^{226}Ra in the soil and rocks; on the "emanating power" which is the fraction of atoms which escape the mineral grains within or on which they are formed; the porosity of the soil; the degree of water saturation and other meteorological influences.

Radon–222 has been used previously as a tracer in studies of the origin and trajectory of air masses (Ka74) to determine vertical matter diffusion coefficients (Hs80), and as an indicator of the vertical stability of the lower atmosphere (Gu80). More recently, measurements have been used in uranium mines, caves and houses to evaluate the exposure levels for persons under different ventilation conditions (St80; Ab80; Wi76).

In this paper, measurements of ^{222}Rn concentrations are listed in Altamira Cave, with special emphasis on the evaluation of radiation exposure levels. Altamira Cave is located in the village of Santillana del Mar, 30 km from the city of Santander, Spain.

Discovered in 1878, the cave's prehistoric Painting Room attracted more than 1,000 visitors daily between 1970 and 1976. However, because the quality of the pigments began to degenerate, the cave was closed to the public in May 1976.

Since 1980, our group has studied the cave's characteristics, in its "natural conditions" without visitors to discover the origin of the pigment degradation and to look for possible solutions.



Bq/m³
GRUTA DE LAS MARAVILLAS
3500
3000
2500
2000
1500
1000
500
0
dic-10
ene-11
feb-11
mar-11
abr-11
may-11
jun-11
jul-11
ago-11
sep-11
oct-11
nov-11
dic-11
ene-12
feb-12
GALERIA ENTRADA
CONCHAS
ESTALACTITA
CODORNIZ GRAN LAGO
CATEDRAL
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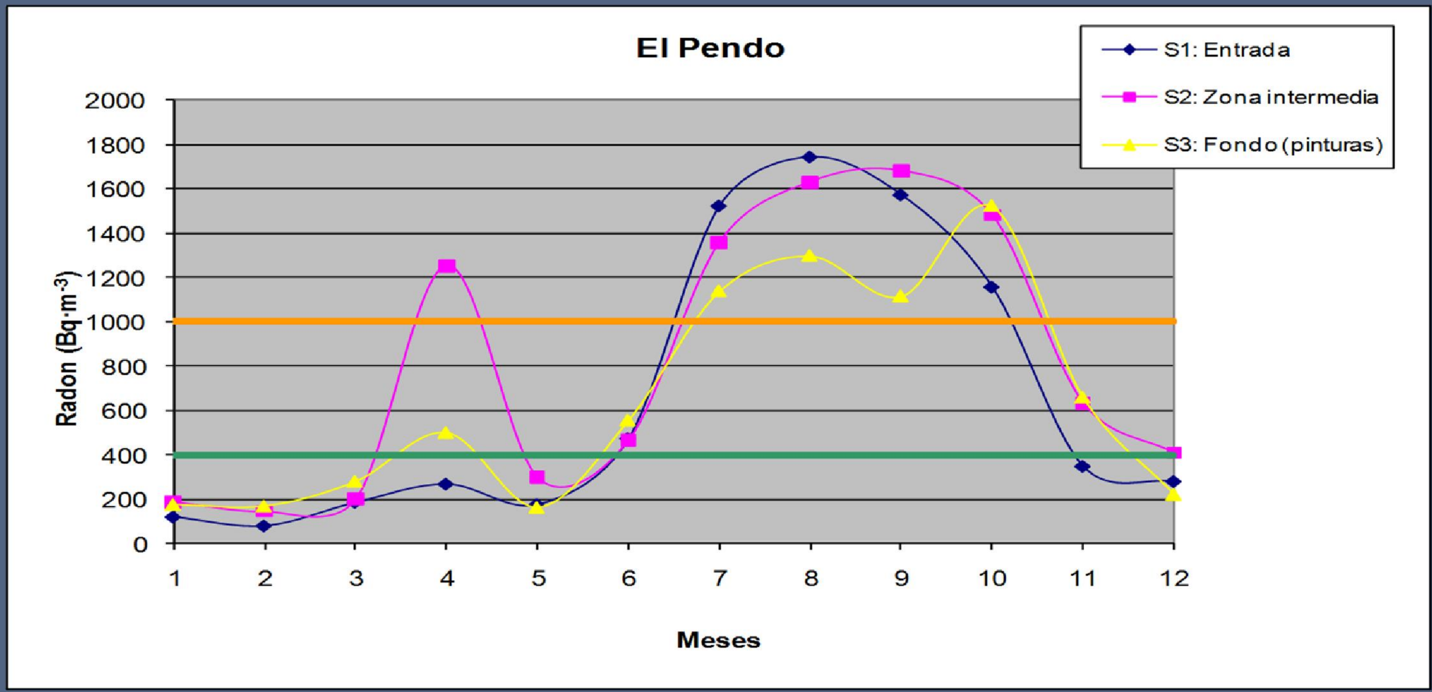
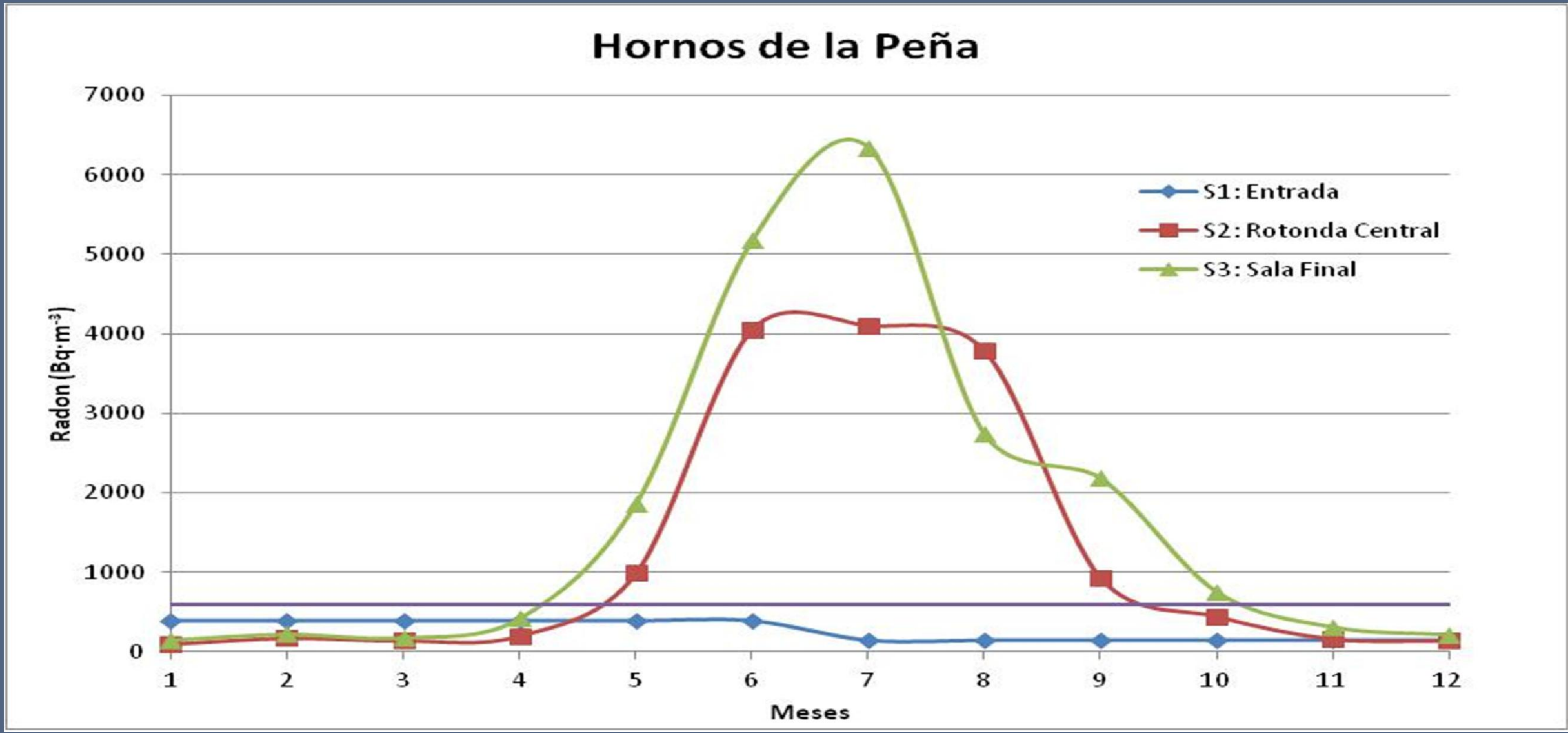
DESNUDOS

Variación mensual de la concentración de radón en varios sectores de la cueva de El Pendo





Hornos de la Peña
7000
6000
5000
4000
3000
2000
1000
0
Radon (Bq·m⁻³)
1
2
3
4
5
6
7
8
9
10
11
12
Meses
S1: Entrada
S2: Rotonda Central
S3: Sala Final

ALGUNOS DATOS IMPORTANTES

"ICRP 126 Radiological protection against radon exposure, 2014"

600 Bq/m^3 ------------------------- 10 mSv/año

T=7000 h   F=0.4

4 mSv/WLM (ICRP 115, 2010)

300 Bq/m^3 ----------------ICRP126------------------------10 mSv/año

ALGUNOS DATOS IMPORTANTES

$$F = WL * 3700 / (Bq/m^3)$$

$$WLM = WL * t(h) / 170$$

Si F= 0.5 y 5 mSv/WLM

10.000 Bq/m^3 ---------- 0.04 mSv/h -------------25 h ------------ 1 mSv

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High ^{222}Rn levels in a show cave (Castañar de Ibor, Spain): Proposal and application of management measures to minimize the effects on guides and visitors

J. Lario[a,*], S. Sánchez-Moral[b], S. Cuezva[b], M. Taborda[b], V. Soler[c]

[a]*Facultad de Ciencias, Universidad Nacional de Educación a Distancia (UNED), c/Senda del Rey, 9, 28040 Madrid, Spain*
[b]*Dep. Geología, Museo Nacional de Ciencias Naturales (CSIC), c/José Gutierrez Abascal, 2 28006 Madrid, Spain*
[c]*Instituto de Productos Naturales y Agrobiología, CSIC, Avda. Astrofísico Fco, Sánchez, La Laguna, Tenerife, Spain*

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Abstract

Castañar de Ibor (Caceres, Spain) is a low energy cave showing very high micro-environmental stability throughout the annual cycle and minimum rates of energy exchange with the atmosphere. The radon (^{222}Rn) levels monitored inside Castañar cave reached 50,462 Bq m^{-3} in April 2005 and had an annual average of 32,246 Bq m^{-3}. Annual variations in Rn concentration seem mainly related to differences in internal and external temperature. The highest values of ^{222}Rn concentration occur during winter and early spring when air-cave temperature surpasses the external air temperature, evidencing very low air exchange rate. These values are the highest recorded in any Spanish cave, either natural or show, and are much higher than the average in most caves around the world. The calculation of the effective dose received by guides during 2004 showed values higher than the maximum effective dose recommended by authorities. Two management measurements were applied to reduce these doses: reduction of the time of visit to a maximum of 60 min, and opening the cave door 1 hour before the entrance of the guides and visitors. These management measures were effective, as they led to a decrease of 10–12% in ^{222}Rn in the cave atmosphere during visits and prevented the guides from being exposed to higher than recommended doses of radiation.

1. Introduction

Radon monitoring at highly radioactive locations such as underground mines or caves is important to assess the radiological hazards to on-site workers and occasional visitors. Previous research has investigated radon concentrations in underground environments and studied health implications for users (Duffy et al., 1996; Hakl et al., 1997; Dueñas et al., 1999; Gillmore et al., 2000, 2001, 2002; Sperrin et al., 2000; Solomon, 2001; Lario et al., 2005). Radon levels in karstic systems depend on a complex interrelation of several factors, both external and internal (Kies et al., 1997): outside–inside temperature differences, wind velocity, atmospheric pressure variations, humidity, karstic geomorphology, porosity and radium content of the sediments and rocks. The complex dynamics of radon in natural underground atmospheres makes

*Corresponding author. Tel.: +34913987879.
E-mail address: javier.lario@ccia.uned.es (J. Lario).

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ALGUNOS DATOS IMPORTANTES

Si F= 0.5 y 5 mSv/WLM

500 Bq/m^3 ---------- 0.002 mSv/h -------------280 h ------------ 0.56 mSv

(2 meses) - 35 h semanales

ARTIFICAL vs NATURAL

AÑO 2009

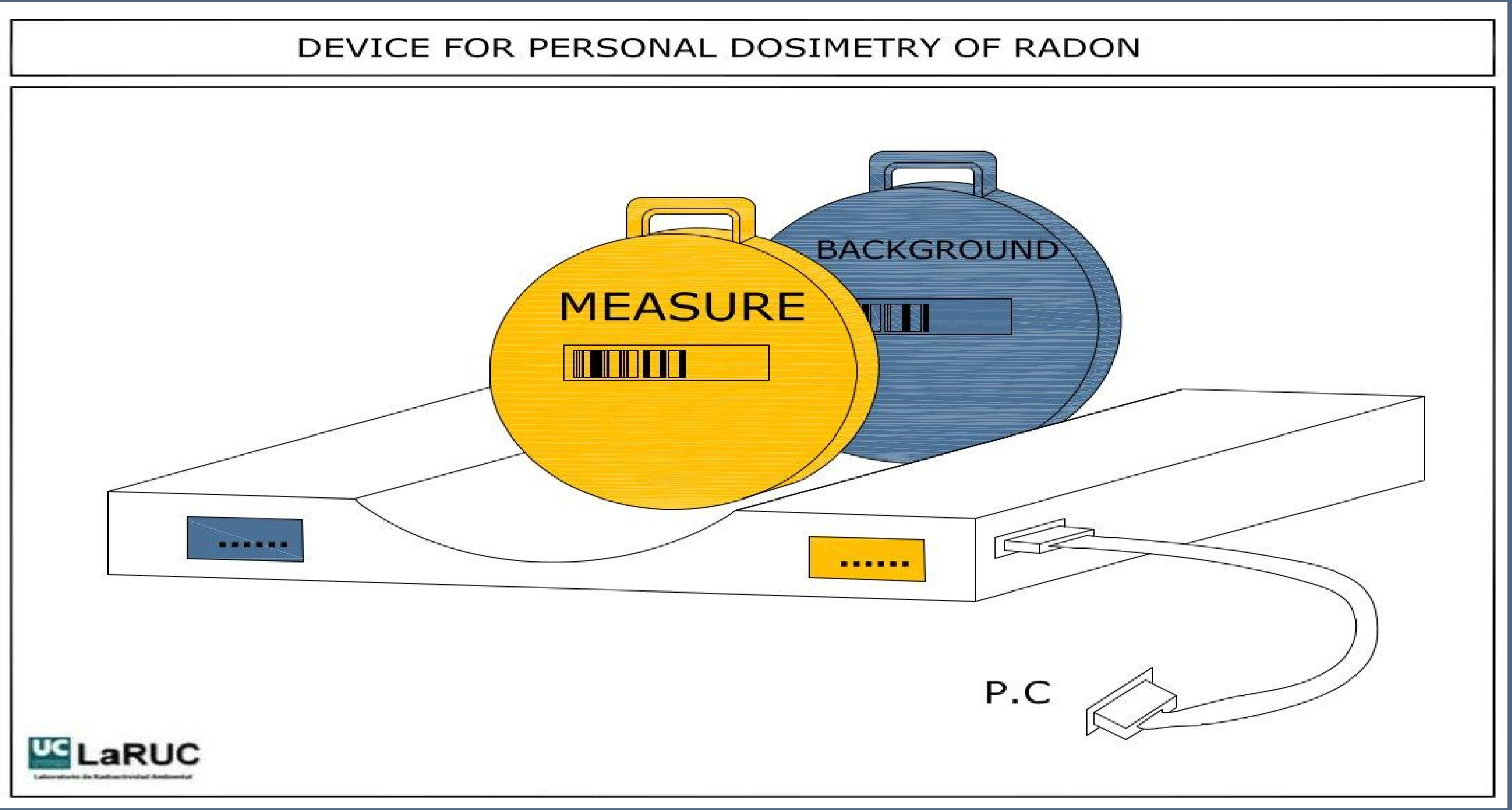
Nº DE TRABAJADORES	Fondo	< 5 mSv	> 5 mSv < 20 mSv	> 20 mSv < 50 mSv	> 50mSv
89004 105150 (2013)	52325	35362	1255	53	9

Radon: 300 Bq/m^3; 1700 h; F=0.4 $\longleftrightarrow$ **10 mSv/año**

Fuente: Consejo de Seguridad Nuclear

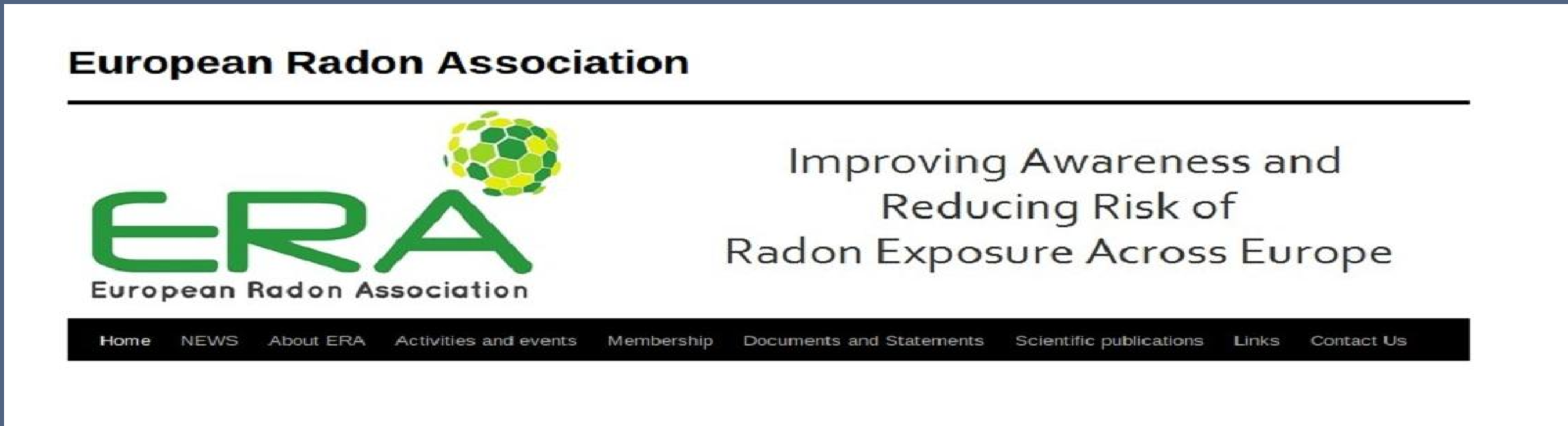
SOLUTION

Proyecto Europeo-Landauer



El laboratorio LaRUC ha sido uno de los impulsores de la creación de la asociación europea ERA (European Radon Association). 3 de los componentes del LaRUC son en la actualidad miembros del comité ejecutivo de dicha asociación

www.radoneurope.org



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