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silvia@geofisica.unam.mx
Universidad Nacional Autónoma de México
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Indoor radon measurements in six Latin American countries

A. Canoba[1], F. O. López[1], M. I. Arnaud[1], A. A. Oliveira[1], R. S. Neman[2], J. C. Hadler[2], P. J. Iunes[2], S. R. Paulo[2], A. M. Osorio[3], R. Aparecido[3], C. Rodríguez[3], V. Moreno[4], R. Vasquez[4], G. Espinosa[5], J. I. Golzarri[5], T. Martínez[6], M. Navarrete[6], I. Cabrera[6], N. Segovia[7], P. Peña[7], E. Taméz[7], P. Pereyra [8], M. E. López-Herrera[8] and L. Sajo-Bohus[9]

[1] *Autoridad Reguladora Nuclear. Buenos Aires, Argentina.*
[2] *Instituto de Física, UNICAMP, Campinas, Sao Pablo, Brazil.*
[3] *Universidad Estadual Paulista, Sao Pablo, Brazil.*
[4] *Comisión Ecuatoriana de Energía Atómica, Quito, Ecuador.*
[5] *Instituto de Física, UNAM., México, D.F., México.*
[6] *Facultad de Química, UNAM., México, D.F., México.*
[7] *ININ, México, D.F., México.*
[8] *Pontificia Universidad Católica de Perú, Lima, Perú.*
[9] *Universidad Simón Bolivar, Caracas, Venezuela.*

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RESUMEN

De acuerdo con las guías internacionales vigentes respecto a problemas de contaminación radiológica ambiental, es necesario evaluar y conocer los niveles de radón intramuros, especialmente debido a que el radón y sus hijos son el principal causante de la dosis de radiación natural que recibe el ser humano. Algunos países han establecido instituciones y programas nacionales encargadas del estudio del radón y su interrelación con el cáncer pulmonar y la salud pública.

En este trabajo se presentan mediciones de radón intramuros en algunos países latinoamericanos, siendo los participantes Argentina, Brasil, Ecuador, México, Perú y Venezuela. Se usaron diferentes tecnologías y métodos para este esfuerzo común, presentando los niveles de radón intramuros en lugares específicos de cada uno de los países participantes.

Finalmente, este trabajo fue hecho con el ánimo de integrar las instituciones latinoamericanas avocadas a las mediciones de radón intramuros.

PALABRAS CLAVE: Radón intramuros, detección de radón, países de Latinoamerica.

ABSTRACT

Most of the natural radiation dose to man comes from radon gas and its progeny. Several countries have established national institutions and national programs in charge of the study of radon and its connection with lung cancer risk and public health. In this paper an indoor radon measurements in Latin American countries is presented. The participants in this work were from Argentina, Brazil, Ecuador, Mexico, Peru and Venezuela. Many different techniques are used in this common effort, and the indoor radon levels in specific locations in each of the participant countries are presented.

KEYWORDS: Indoor radon, radon detection, Latin American countries.

INTRODUCTION

Residential exposure to radon has been considered an important environmental risk factor for lung cancer.

Since 1986, US EPA has recommended that all dwellings below the third floor be tested for the presence of indoor radon and be mitigated in homes with levels exceeding 148 Bq/m^3, to reduce indoor radon.

Until now, in some Latin American countries such regulations do not exist, but it is the responsibility of the governments to investigate and ascertain the indoor radon levels in the respective countries in order to identify the population radiological risks, such as lung cancer. This has been the motivation to perform the present work, gathering the information on indoor radon levels in the Latin American countries.

Moreover, indoor radon levels in working areas are considered in the legal regulations for environmental contaminants, for the benefit of the working people and public health (IAEA, 1998; US-EPA, 1992).

Many efforts have been made to choose a laboratory set-up for radon monitoring which could be conveniently and rapidly adopted by all the regional laboratories and transfer these radon monitoring units to any laboratory in developing countries in a co-operative research program. These sentences were expressed by L Tommasino, G. Furlan, H.A. Khan and M. Monnin in the late of 80´s. (Tomassino *et al.*, 1989). But, still in the year 2000, Latin American countries have the same problem, and we are looking for cooperation projects basically within the cited region, USA and European countries, to create regional laboratories for radon measurements and public health studies.

This work was compiled from the participation of the laboratories shown in Table 1.

LOCATIONS AND INDOOR RADON LEVELS REPORTED

Table 2 shows the locations where indoor radon was measured and indoor radon levels reported (Espinosa and Gammage, 1997; Espinosa and Gammage, 1998; Espinosa and Gammage, 1999; Espinosa *et al.*, 1999; Franco-Marina *et al.*, 2001; Martínez *et al.*, 1998; Sajo-Bohus *et al.*, 1999; Segovia and Cejudo, 1984; Segovia *et al.*, 1993; Segovia *et al.*, 1995; Segovia *et al.*, 1997).

As we can see, presently there are measurements of indoor radon levels in an important number of cities throughout Argentina and Mexico, and also in some highly populated cities and some capital cities of other participating countries. The geographical distribution of measurements is shown in Figure 1.

DATA ANALYSIS AND RESULTS

From the information of Table 2 we evaluate the maximum, minimum and average values contained in Table 3. Figure 2 is a graph showing the distribution average values, most of which are below 100 Bq/m^3 and all of them are below the limit of 148 Bq/m^3.

CONCLUSIONS

The obtained results may be used in future public health studies, including the eventual establishment of patterns for indoor radon distribution in Latin American countries, incorporating these patterns to the existing studies in countries of North America, Europe, Asia and Oceania.

The work could be an implementation of a Latin American Environmental Radiation Network (LAERNET).

This work was done under the coordination of Dr. G. Espinosa (IFUNAM-Mexico). All the data and results are responsibility of each research group.

Table 1

List of Participant Institutions

Ref. No.	Country	Institution Name	Institution Clasification	Objective
1	ARGENTINA	Autoridad Reguladora Nuclear	National Lab.	Services
2	BRAZIL	Instituto de Física, UNICAMP	University	Research
3	BRAZIL	Universidad Estadual Paulista	University	Research
4	ECUADOR	Comisión Ecuatoriana de Energía Atómica	National Lab.	Reserach
5	MEXICO	Instituto de Física, UNAM	University	Research
6	MEXICO	Facultad de Química, UNAM	University	Research
7	MEXICO	Instituto Nacional de Investigaciones Nucleares	National Lab.	Research
8	PERU	Pontificia Universidad Católica de Perú	University	Research
9	VENEZUELA	Universidad Simón Bolívar	University	Research

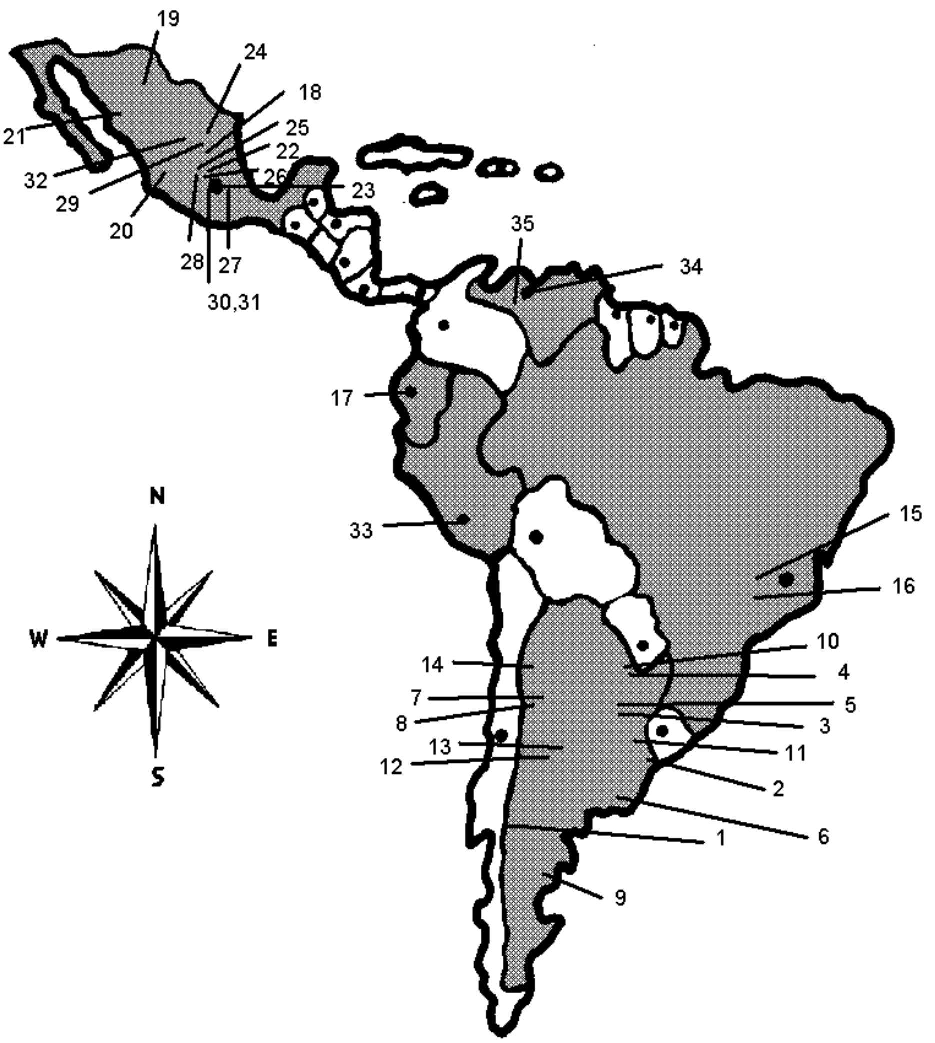

Fig. 1. Geographical distribution of countries, in gray and cities measured; the site location codes are given in Table 2.

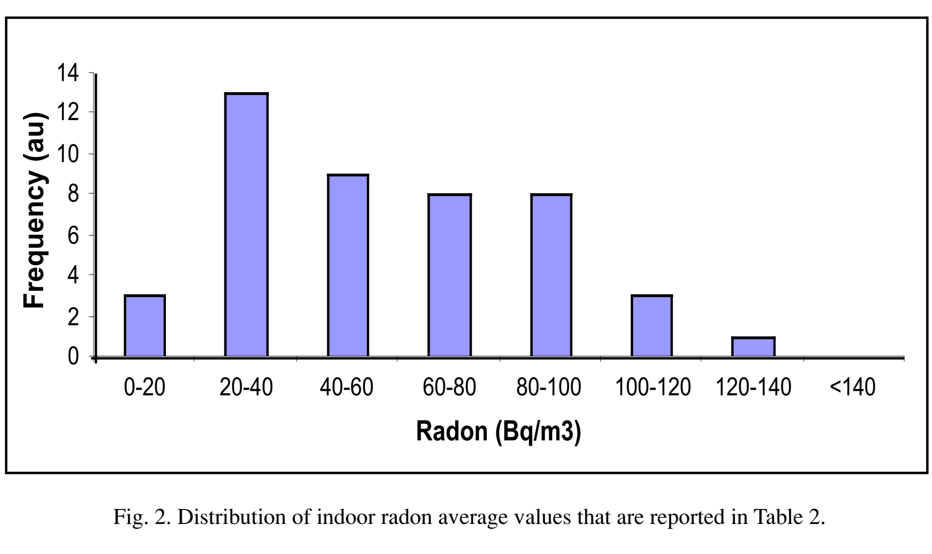

Fig. 2. Distribution of indoor radon average values that are reported in Table 2.

Table 2

Radon levels measurements in the different locations in Latin American countries.

No.	Country	Code	Site	Number of Dwellings	Indoor Radon Level (Bq/m^3)		
					Max	Min	Mean
1	ARGENTINA	1	Bariloche	18	59.0	28.2	36.0
1	ARGENTINA	2	Buenos Aires	354	235.0	6.0	26.0
1	ARGENTINA	3	Córdoba	154	198.0	5.0	23.3
1	ARGENTINA	4	Corrientes	109	286.0	4.0	48.0
1	ARGENTINA	5	Cosquín	70	211.0	5.0	48.2
1	ARGENTINA	6	Gral Alvear	106	145.5	5.0	45.0
1	ARGENTINA	7	Malargue	239	250.0	9.0	38.9
1	ARGENTINA	8	Mendoza	139	256.0	4.4	49.6
1	ARGENTINA	9	Prov. De Chubut	70	74.5	6.0	33.0
1	ARGENTINA	10	Resistencia	35	131.5	12.6	49.0
1	ARGENTINA	11	Rosario	61	220.0	18.0	31.0
1	ARGENTINA	12	San Luis	204	84.3	10.0	30.7
1	ARGENTINA	13	San Rafael	413	116.0	7.0	30.8
1	ARGENTINA	14	Santiago de Estero	62	81.9	5.0	28.0
2	BRAZIL	15	Campinas-SP (summer)	70	254.5	16.7	77.6
2	BRAZIL	15	Campinas-SP (winter)	70	310.0	26.3	86.3
3	BRAZIL	16	Sao Paulo State, Presidente Prudente City.	180	262.7	7.03	79.92
4	ECUADOR	17	Quito (DC Zone)	14	157.40	49.41	87.1
4	ECUADOR	17	Quito (CP Zone)	17	160.39	20.39	77.6
4	ECUADOR	17	Quito (CV Zone)	14	225.66	36.38	117.8
4	ECUADOR	17	Quito (LG Zone)	16	207.66	37.43	94.7
5	MEXICO	18	Aguascalientes, Ags.	180	130	39	61
5	MEXICO	19	Chihuahua, Chih.	250	273	42	135
5	MEXICO	20	Guadalajara, Jal.	250	190	37	117
5	MEXICO	21	Hermosillo, Son	250	157	27	91
5	MEXICO	22	León, Gto.	250	130	20	67
5	MEXICO	23	Mexico City	400	217	15	84
5	MEXICO	24	Monterrey, NL.	250	280	45	97
5	MEXICO	25	Morelia, Mich.	250	165	15	45
5	MEXICO	26	Pachuca, Hgo.	200	187	20	120
5	MEXICO	27	Puebla, Pue.	250	101	49	72
5	MEXICO	28	Querétaro, Qro.	180	163	15	61
5	MEXICO	29	San Luis Potosí, SLP.	180	148	15	49
6	MEXICO	23	Metropolitan Zone	*	300	55	90
6	MEXICO	23	Metropolitan Zone, (winter)	*	276	43	86
7	MEXICO	30	Metepec, Lerma	320	40.7	7.1	17.8
7	MEXICO	23	Mexico City	500	103.7	15	14.3
7	MEXICO	23	Mexico City	500	296	15	33.5
7	MEXICO	27	Puebla	100	59.5	48.4	54.0
7	MEXICO	31	Toluca	200	44.7	15	17.9
7	MEXICO	32	Zacatecas	120	86.0	14.0	46.2
8	PERU	33	Lima (CAPU-PUCP)	84	42.66	18.57	30.62
8	PERU	33	Lima (Library, PUCP)	84	50.20	25.70	33.97
9	VENEZUELA	34	Caracas	75	-	-	35
9	VENEZUELA	35	Estado Barinas	68	346	15	70

* No information

Table 3

Maximum, minimum and average indoor radon levels

Ref . No.	Country	Indoor Radon Level (Bq/m^3)		
		Max	Min	Mean
1	ARGENTINA	286.0	15	36.96
2	BRAZIL	310.0	16.7	81.95
3	BRAZIL	262.7	15	79.92
4	ECUADOR	225.66	20.39	94.30
5	MEXICO	280	15	83.25
6	MEXICO	300	43	88.00
7	MEXICO	103.7	15	30.62
8	PERU	50.20	18.57	32.29
9	VENEZUELA	346	15	52.50

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[1] Autoridad Reguladora Nuclear, Av. Libertadores 8250. Buenos Aires, Argentina
[2] Instituto de Física, UNICAMP, 13083-970, Campinas, Sao Pablo, Brazil
[3] Universidad Estadual Paulista, Sao Pablo, Brazil
[4] Comisión Ecuatoriana de Energía Atómica, P.O. Box 17-01-2517, Quito, Ecuador
[5] Instituto de Física, UNAM. Apdo. Postal 20-364. 01000, México, D.F., México
[6] Facultad de Química, UNAM, Edificio D, Cd. Universitaria, México, D.F., México
[7] ININ, Apdo. Postal 18-1027, 11801 México, D.F., México
[8] Pontificia Universidad Católica de Perú. Apdo. Postal 1761, Lima 100, Perú
[9] Universidad Simón Bolivar, P.O. Box 89000, Caracas, Venezuela
Correspondig author: Guillermo Espinosa; phone (52)652 25051; Fax: (52) 563 51254.
Email: espinosa@fisica.unam.mx