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Rn-222 air concentrations in Chihuahua State (Mexico) dwellings and in the U.S./Mexico border

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Abstract

Using charcoal detectors and electrets, radon concentrations were measured at 12 different locations in Mexico, homes in particular, throughout Chihuahua State. While these measurements were short-term, long-term measurements were also conducted around Chihuahua and Aldama cities using LR-115 II type detectors. In addition, LR-115 II type detectors were deployed for comparative purposes between Ciudad Juarez (Mexico) and El Paso (Texas). Significant average radon values were obtained in Aldama and Parral at 225 and 173 Becquerel per cubic meter (Bq m^{-3}), respectively. Over 30% of the homes sampled in Aldama, Cuauhtemoc, Parral and Chihuahua had radon concentrations greater than 148 Bq m^{-3}.

Keywords: Indoor radon; Short-term radon sampling; Long-term radon sampling; Charcoal detector; Electrets; Chihuahua; U.S./Mexico border

1. Introduction

^{222}Rn is a product of the ^{238}U disintegration chain. Uranium is a common element found in all type of soils, rocks and water. Radon is produced in subsoil as a result of the transformation of uranium and is hence carried from the soil to air. Radon daughters are both solid and radioactive. The last element resulting from such disintegrations is lead, an element that remains very stable. Radon daughter atoms adhere to dust particles, which are eventually inhaled by the surrounding population. Once breathed into the human body, radon and its by-products disintegrate in the respiratory tract, producing devastating effects in the lungs from ionizing radiation. Once deposited in lungs, these by-products can cause hazardous effects due to the effective dose produced by internal exposure to ionizing radiation. For example, the effects of the radioactive disintegration of radon and its daughters increase the risk of cancer.

The consequences of radon inhalation have been primarily observed in those working in mines, an industry where people are exposed to higher concentrations of radon than any other profession [1]. In fact, the inhalation of radon is the second leading cause of lung cancer in the United States [2], and probably worldwide. It is considered that radon is responsible for approximately 50% of the effective annual dose from natural sources [3].

In recent years, a plethora of work has been conducted in order to determine the correlation between radon concentrations in the air and lung cancer. Detailed studies

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conducted by the United States and United Nation organizations have proposed different action levels in order to control this problem. The action level value of chronic radon exposure for the United States [4] is 148 Becquerel per cubic meter (Bq m^{-3}), equal to 4 pCi/L in other units. However, the recommended action level by the IAEA [5] in situations of chronic radon exposures within homes ranges from 200 to 600 Bq m^{-3} of ^{222}Rn in air.

Studies related to radon concentration and radon emanated in different stages throughout Mexico have been published mainly by physicists from the Instituto Nacional de Investigaciones Nucleares [6,7] and the Instituto de Fisica de la UNAM [8,9], the Facultad de Quimica de la UNAM [10], and by the Centro Regional de Estudios Nucleares de la Universidad Autonoma de Zacatecas [7]. These studies have shown concentrations within houses to be below the values required by EPA, 148 Bq m^{-3}.

1.1. Radon in Chihuahua

In Chihuahua, the annual mortality rate for lung cancer from 1995 to 2000 was approximately twice the national figure [11]. This in itself justifies the need for a detailed study of radon concentrations in homes. Radon is related to the presence of uranium in the subsoil and approximately 50 uranium deposits are located in Chihuahua State, mainly in the mountains of Villa Ahumada, Chihuahua, Aldama,

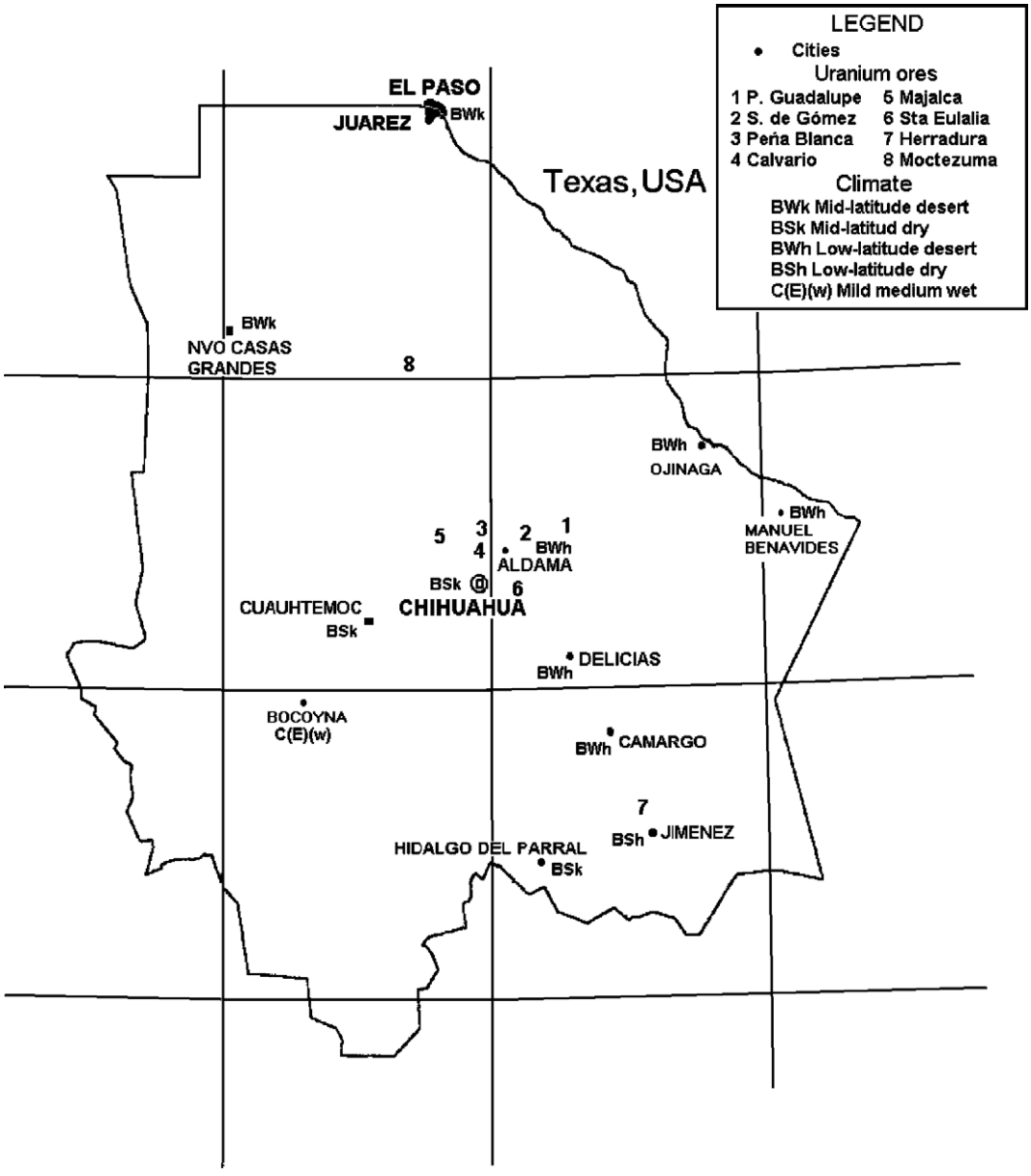

Fig. 1. Map of the location and climate of municipalities studied in the State of Chihuahua. Uranium ore deposits are also shown.