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MEASUREMENT OF PM10 AND PM2.5 PARTICLE CONCENTRATION IN ALDAMA, CHIHUAHUA, MEXICO

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Abstract: The city of Aldama is the head of the municipality that bears the same name and is located 30 km NNE of the capital of the State of Chihuahua. In this region is the Peña Blanca uranium deposit, one of the most important in the country, which was exploited from 1970 to 1980 and its processing plant was located in the vicinity of the city. It is of interest to study the behavior of PM10 and PM2.5 particle concentrations in the air, to determine the levels to which the city's population is being exposed. Air quality monitoring was carried out for a year, taking into account the climatic seasons and placing a High Volume sampler in the Municipal Presidency, which is located in the center of the urban area. The concentration of PM10 and PM2.5 particles in the air was determined following the methodology of NOM-035-SEMARNAT-1993 and they were compared with the permissible limits established in NOM-025-SSA1-2014. It was found that the concentrations of particulate matter in the air do not exceed the maximum daily acute exposure limit value or the annual average of the NOM. Exposure to air pollution must be prevented; since in PM10 and PM2.5 particles there is the possibility that they contain radionuclides due to mining operations and the geological characteristics of the area. The geological, climatic and geographical conditions of the populations must begin to be taken into account in order to be considered in the air quality monitoring systems in the country.
Keywords: PM10, PM2.5, air quality, monitoring, uranium.

INTRODUCTION

The development and flourishing of urban areas in Mexico have been accompanied by the increase in environmental problems, due to the increase in population, industrial activity, the vehicle fleet and the supply of services. These activities cause a large amount of substances to be emitted into the air and modify its natural composition. Large amounts of pollutants are emitted into the atmosphere on a daily basis.

The need for government authorities and society to obtain reliable information on the concentration of pollutants in the air, their sources and their effects on the health of the population is fundamental in decision-making for the protection of public health and the environment. ecosystems.

To measure and evaluate the impact of air pollution on the population and on natural resources, it is essential to have adequate systems, networks and programs for measuring air quality. The establishment of Air Quality Monitoring Systems (SMCA) has allowed the environmental authorities of most of the large cities in the world to successfully face the urban problem of atmospheric pollution. The SMCA have become a tool that allows knowing, with acceptable levels of reliability, the quality of the air with respect to specific pollutants and formulating, based on the data obtained, control strategies and timely and adequate measures for an effective environmental management (INECC, 2019).

In Mexico, the Ministry of the Environment and Natural Resources (SEMARNAT) through the National Institute of Ecology and Climate Change (INECC) is responsible for preparing the National Report on Air Quality through the National Information System on Air Quality. (SINAICA), which is a series of computer programs that allow the collection, transmission and publication of air quality information that is generated in the monitoring stations located in the various states that have the adequate infrastructure for this type of measurement. The information comes from Air Quality Monitoring Systems (SMCA), which are managed by different government, state and municipal orders. (SINAICA, 2020).

Figure 1 shows the cities and metropolitan areas of Mexico that have air quality monitoring regarding suspended particles (PM10 and PM2.5) and Ozone (O3); In the case of the State of Chihuahua, there are SMCAs in Ciudad Juárez, in Ojinaga and in the capital (SINAICA, 2018).

In Mexico, the Official Mexican Standard NOM-156-SEMARNAT-2012 (DOF, 2012), specifies the minimum conditions that must be observed for the establishment and operation of SMCA, indicating that such conditions apply throughout the national territory and are enforceable mandatory for local governments, as appropriate, in those areas or population centers that have any of the following conditions:

- Metropolitan areas;
- Human settlements with more than five hundred thousand inhabitants;
- Human settlements with emissions greater than twenty thousand tons per year of primary criteria pollutants into the atmosphere;
- Conurbations; Y,
- Industrial activity that, due to its characteristics, requires the establishment of air quality monitoring stations and/or air pollutant sampling stations.

The City of Aldama, to the best of our knowledge, does not meet any of these criteria and therefore does not have an SMCA; but due to its proximity to the capital of the State of Chihuahua, it is of interest to determine its air quality because in the 2018 air quality monitoring in Chihuahua, non-compliance with the two regulated limits for PM10 was recorded, when concentrations of 189 μg/m3, as an average of 24 hours and 55 μg/m3, as an annual average, which are equivalent to 2.5 and 1.4 times the respective normative limit. At the level of the entire city, 49 days were recorded with concentrations above the 24-hour regulated limit. Concentrations of PM2.5 were recorded in the city that exceeded the 24-hour limit, however, this situation was not reflected in non-compliance with the NOM because the quarterly data sufficiency criterion established by the NOM itself was not met. to carry out the evaluation of its compliance (SINAICA, 2018).

The world population is constantly exposed to radiation through natural and anthropogenic sources, which involve the use of radiation and radioactive substances that cause additional exposure to that of natural origin, such as mining, the production of energy Through the combustion of coal, medicine, environmental contamination due to radioactive waste resulting from nuclear weapons tests and large-scale nuclear accidents, they continue to be a global source of human exposure (UNSCEAR, 2008).

That is why it is of interest to study the behavior of radionuclide concentrations in the air and on the ground surface in order to determine the current levels of radioactivity (Rosner and Winkler, 2001).

As the city of Aldama is located in one of the most important regions of the country in terms of uranium deposits; as well as its proximity to the border with the United States of America where nuclear tests were carried out in the mid-20th century; coupled with the radioactive remnant of the Chernobyl accident in the mid-1980s; without forgetting that during the 70's and 80's there was a mining operation and concentration of uranium in the municipality of Aldama; It is extremely important to implement radionuclide monitoring systems in the environment and the application of dispersion modeling systems to contribute to the study of air quality in the region.

WORK AREA

The city of Aldama is located 30 km NNE of the capital of the state of Chihuahua, with

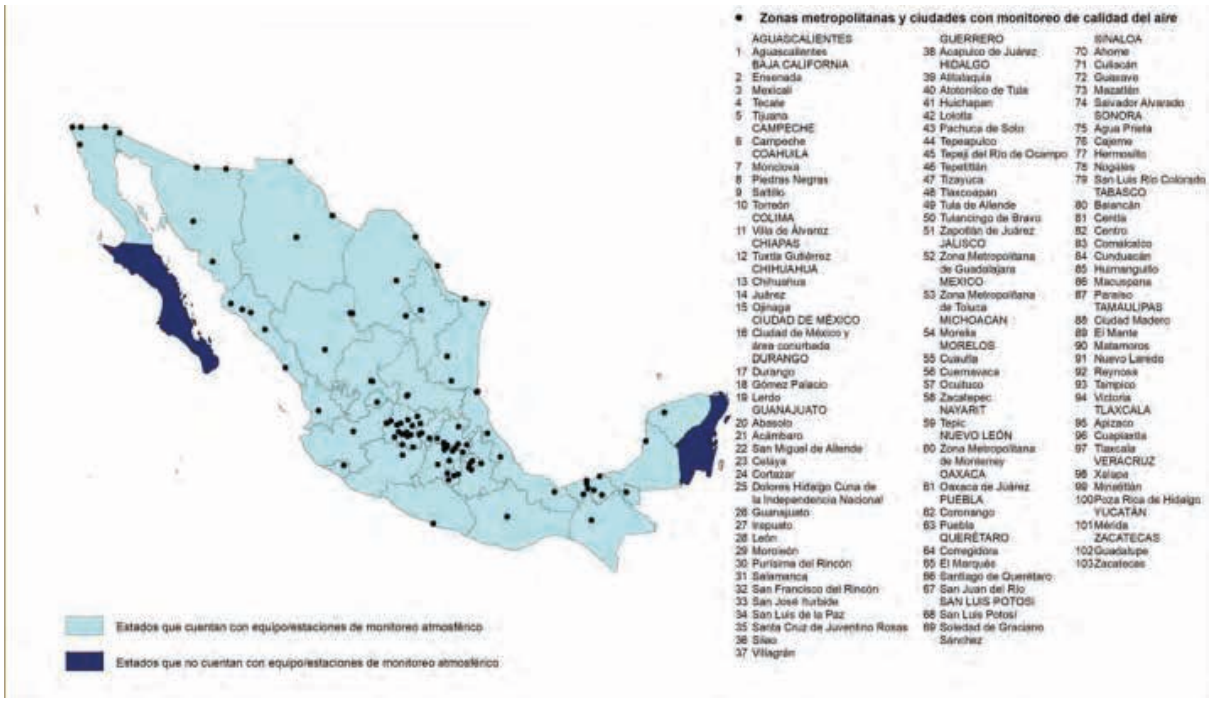

Figure 1. Cities and metropolitan areas of Mexico with air quality monitoring.

Source: National Air Quality Report 2018, SINAICA,https://sinaica.inecc.gob.mx/archivo/informes/Informe2018.pdf

Figure 2. Former facilities of the URAMEX plant.

Source: Google Earth.

coordinates of 28º 50' 19" N latitude and 105º 54' 40" W longitude and an altitude of 1,270 meters above sea level. With a maximum average temperature of 44ºC and a minimum of 14ºC. The average annual rainfall in the municipality is 305.2 millimeters, with a relative humidity of 45% and an average of 49 rainy days. The prevailing winds come from the west. The population has 18,642 inhabitants (INEGI, 2010 Census).

Aldama is located in one of the most important regions of the country in terms of uranium deposits; Between 1969 and 1971, the National Nuclear Energy Commission and the Mining Development Commission jointly operated a uranium and molybdenum concentrate production plant located near the city (SGM, 2017). Figure 2 shows the old facilities of the processing plant located in the southern part of the city.

The exploration of radioactive minerals in Mexico began in 1955, being in charge of the federal public body called the National Nuclear Energy Commission (CNEN) until 1972. Later, in 1979, it was divided into the National Institute of Nuclear Research (ININ) and the National Commission for Nuclear Safety and Safeguards and Mexican Uranium (URAMEX), created to develop the mining stage of the nuclear cycle (exploration, exploitation and processing of radioactive minerals) (Perea, 1979).

The uranium deposits located in the Sierra de Peña Blanca, municipality of Aldama, Chihuahua, are 85 km north of the city of Chihuahua, as can be seen in Figure 3.

ANALYTICAL AND MATERIAL METHODS

On the roof of the Municipal Presidency building located in the center of the urban area of the city of Aldama, a high-volume Graseby-Andersen/GMW Model 1200 sampler with PM10 cascade particle head and grid impactor was installed. it is designed to use a standard 8" x 10" filter (placed on the last stage) and 5 5.625" x 5.375" filters (placed on each of the impactor stages); with operational expenditure between 1.1 and 2.2 m3/s with the objective of being able to measure the concentrations of PM10 and PM2.5 particles in the air from December 2017 to September 2018. Being a total of 16 PM10 samples and 16 PM2 samples. 5 throughout the period in which the monitoring was carried out.

PM10 and PM2.5 particle monitoring was carried out in the months of December, March, June and September. In each month, 4 measurements were made every 6 days, which is how the United States Environmental Protection Agency (EPA) recommends it. It was decided to carry out the measurements in these months to consider the different climatic conditions throughout the year and to be able to determine if these influence the concentration of particulate matter in the air.

The filters that were used were fiberglass of the WHATMAN brand and were weighed in a Sartorious brand electronic balance, model BP 211D, Serial Number 71104196, with a maximum capacity of 210 grams and resolution of 0.1 milligrams and conditioned for 24 hours in a controlled environment at a temperature of 25°C and a humidity of 50% before and after the collection of particles. Following the guidelines established in the Official Mexican Standard NOM-035-ECOL-1993 (SE, 1993), which specifies that the difference in weight of the filters before and after collection corresponds to the concentration of PM10 and PM2.5 in air. The concentrations of particles collected on the measured filters were determined in µg/m3.

The concentration of PM10 and PM2.5 particles in the filters were compared with the maximum concentration value allowed in the Official Mexican Standard NOM-025-SSA1-2014 to determine the exposure of the

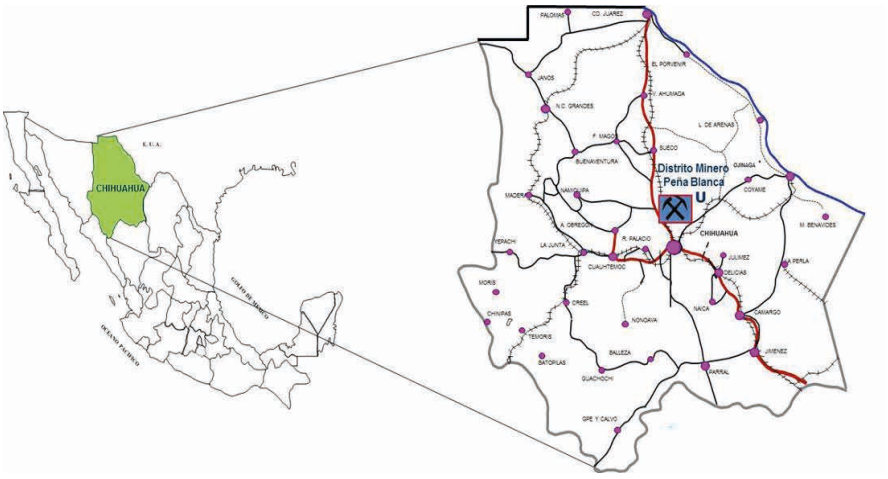

Figure 3. Location of the mining district of Peña Blanca in the State of Chihuahua.

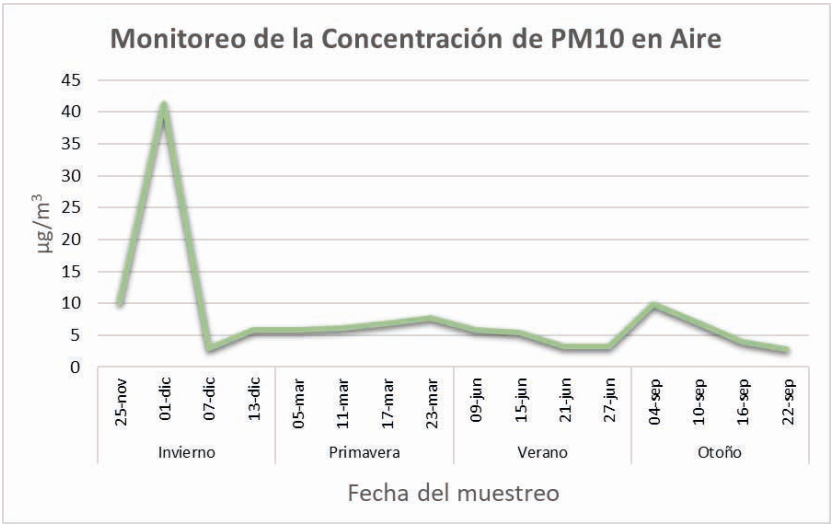

Figure 4. PM10 concentration in air in 24 hours of measurement throughout the year of monitoring.

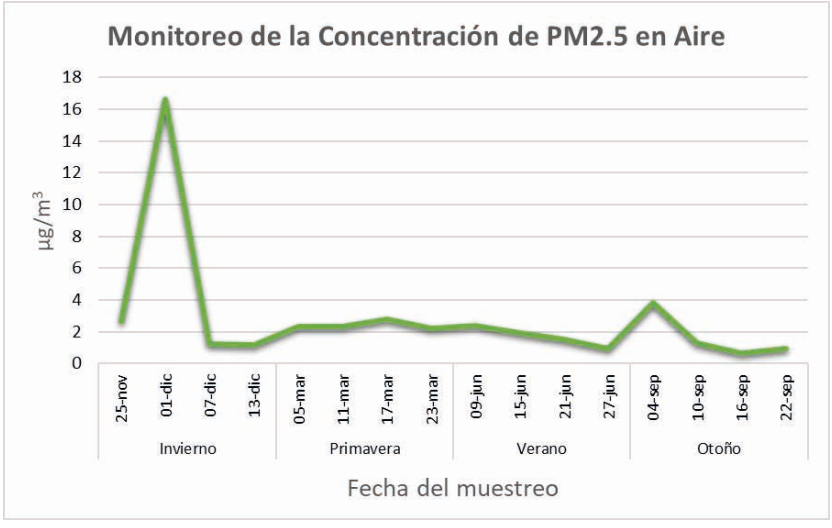

Figure 5. PM2.5 concentration in air in 24 hours of measurement throughout the monitoring year.

population. Said standard specifies that for PM10 the 24-hour limit is 75 μg/m3, as an average of 24 hours, and the annual limit is 40 μg/m3, as an annual average. The 24-hour limit for PM2.5 is 45 μg/m3, as a 24-hour average, and the annual limit is 12 μg/m3, as an annual average. (SE, 2014).

RESULTS

Figure 4 shows the results obtained from the measurements of PM10 particles in air. Where it is observed that the highest concentration was measured on December 1, 2017, reaching a value of 41.3 μg/m3 and on September 22, 2018, the lowest concentration was obtained with 2.8 μg/m3. In addition, it was found that the annual average value was 8.0 μg/m3. None of the measurements exceeded the 24-hour average limit, nor the maximum average annual limit allowed by the NOM-025-SSA1-2014 standard.

Figure 5 shows the results obtained from the monitoring of PM2.5 particles. Where it was found that the highest concentration value measured was on December 1, 2017 with 16.6 μg/m3 and on September 16, 2018 the lowest concentration was measured with 2.8 μg/m3. In addition, it was determined that the annual average value was 2.8 μg/m3. Neither in any of the samplings was the 24-hour average limit exceeded, nor the maximum average annual limit allowed by the NOM.

DISCUSSION AND CONCLUSIONS

Of the 16 measurements of both PM10 and PM2.5 particles carried out on the roof of the building of the Municipal Presidency of the city, none exceeded the 24-hour limit value stipulated by the NOM. In the measurement of December 1, 2017, the average annual limit for PM10 of 40 μg/m3 was exceeded; as well as for PM2.5 of 12 μg/m3. Although it was only one day during the measurement year, it is of interest to continue monitoring that the 24-hour particle concentration value does not increase to prevent the annual average from exceeding the average annual value. It is also necessary to determine if this increase in the concentration of particles is related to the variation of climatic conditions in the area during the year; Therefore, it is recommended to do this analysis. In addition, it is necessary to determine the composition of said particles; especially if they are composed of radioactive elements, due to the proximity of the city of Aldama to the uranium deposits, since they can cause not only respiratory diseases to the population of the city.

This work is important because it represents an initial step to detect that not only metropolitan areas or human settlements with more than five hundred thousand inhabitants must be considered in the air quality monitoring systems in the country. If not, we must begin to take into account the geological, climatic and geographical conditions of the populations.

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