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Correlation of Arsenic and Fluoride in the groundwater for human consumption in a semiarid region of Mexico

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Abstract

The measurement of the values of arsenic and fluoride becomes critical in the characterization of groundwater quality. Although there are anthropogenic sources, most large-scale pollution in groundwater have been documented of geological origin, the arsenic to the reaction of oxidation in sulfide minerals in metasedimentary rocks and the F⁻ value is proportional to the degree of water-rock interaction with fluorite (CaF₂), the concentration values are proportional to residence times in aquifers and generally are associated with regional flow systems. The objective of this research was to determine the current correlation of arsenic and fluoride with emphasis in the extraction points used for human consumption, due to the water-rock interaction in a semiarid region in México.

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1. Introduction

The presence of total inorganic arsenic (As) and fluoride (F⁻) in groundwater is frequently observed worldwide. A high As concentration in water for human consumption usually causes health problems. Besides this problem, the use of these waters for irrigation purposes could cause problems on crop production and the food chain [1]. Although there

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are anthropogenic sources, most large-scale pollution in groundwater has been documented of geological origin. The As is associated the reaction of oxidation of sulfide minerals in metasedimentary rocks, where those rocks have a greater variability in arsenic, with averages and ranges somewhat higher than those of igneous and metamorphic rocks, mainly shale, with mean values of 28 ppm in alluvial quaternary basins which causes a condition of occurrence of high concentrations in large areas [2]. Adverse effects on human health of high F⁻ concentrations have been revised by different researchers [3-5]; one of the most noticeable effects is the occurrence of yellow spots in the teeth of people who drink this water for prolonged periods of time. The F⁻ concentration values, generally associated with regional flow systems, are proportional to the degree of water-rock interaction with fluorite (CaF₂) and the residence times in aquifers [6], where the metamorphic rocks could have a fluorine concentration from 100 ppm (regional metamorphism) up to more than 5000 ppm (contact metamorphism) and the original minerals are enriched with fluorine by metasomatic processes [7]. Other source of F⁻ can be the soil contamination as a consequence of the use of fertilizers and phosphate pesticides reaching the groundwater [8]. In this context, the objective of this research was to determine the correlation between arsenic (As) and fluoride (F⁻) with emphasis in the extraction points used for human consumption, due to the water-rock interaction within aquifers of a semiarid region in México.

1.1 Description of the Study Area (SA)

The SA is located in the Sierra Madre Occidental volcanic terrain, which is within the southern part of a regional graben structure that gives origin to the Calera endorreic basin, characterized by ephemeral streams that are dry most of the year. The Zacatecas Formation (maximum elevation 2,700 m.a.s.l.) and the Chilitos Formation bound a flat area (2010 m.a.s.l.) in south-central part and other flat area (2100 m.a.s.l.) in the north; the soils are from 10 cm up to depths of 50 cm. In general, the SA is considered arid, the average annual temperature is estimated between 18 and 20 °C, with precipitation ranging from 400-450 mm, there are important surface runoffs, with small intermittent streams; runoff is toward the center of the study area to continue at north, with a few reservoirs of surface water with reduced capacity but of great importance for the area [9]. This zone encompasses two important cities of the Zacatecas state, where the main economic and social activities are established (Figure 1).

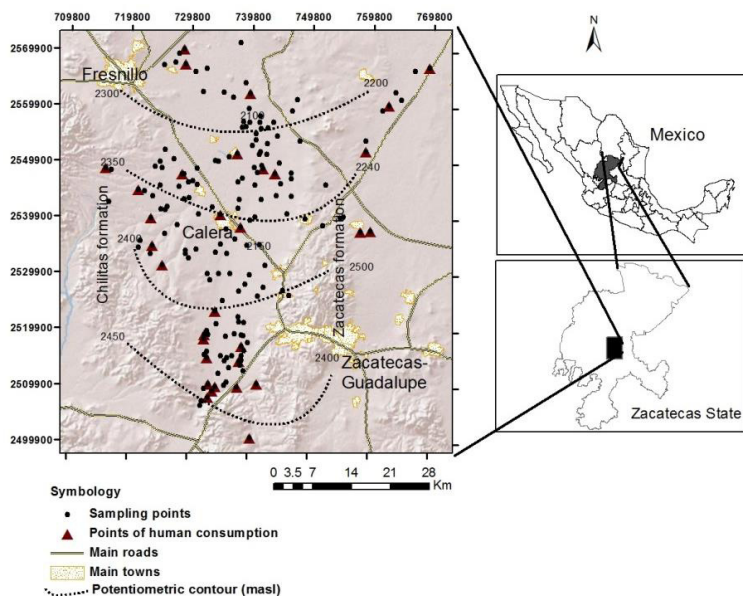


Fig. 1. Location of sampling points

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