

Mining Activities and Arsenic in a Baja California Sur Watershed

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Abstract.— Mining is one of the most important sources of income for the Baja California Sur state. This state is the second most important area for mineral (gold, silver, copper) and non-mineral (salt) mining activities in the Mexican Republic. In the San Antonio-El Triunfo region, mineral-mining activities flourished during the 19th century. Tons of debris containing a high quantity of arsenic were deposited on the soil as a by-product of these activities. In 1998, local inhabitants reported their suspicion of the contamination of the region's wells. For this reason, we developed this study, which establishes the sampling of underground water in the region. Our results indicate that all the underground water sampled in the region's wells exceeded official safe limits (0.05 mg/l).

Introduction

Under normal conditions, most potentially toxic metals are fixed in geological formations. However, human activities such as mining can change this condition. Mining activities can result in the accumulation of toxic metals in large quantities and in soluble forms. This kind of pollution usually reaches higher trophic levels through bioaccumulation. If this pollution reaches human populations, it can cause health disorders and diseases (Jímenez 1994). We studied the arsenic concentration in the wells of two Baja California Sur towns located in a mining district.

Materials and Methods

A field study was developed in the mining district of San Antonio-El Triunfo, located in the southern part of the Baja California Sur State (23°48' to 23°49', NL; 110°06' to 110°03', WL) (figure 1). We sampled all the wells that

provide water to the towns of San Antonio and El Triunfo from June to August 1997. For each well we sampled, we recorded its position using a GPS (Mark X), and its altitude above sea level. All sampling equipment was submerged for 24 hours in nitric acid to avoid any possible contamination. Wells were sampled using a Vandor bottle and a plastic cord. Each sample was then transferred to plastic containers. Well-water parameters recorded were pH and temperature. Water samples were filtered by a pump (Vac Model) and 47 mm filters in the laboratory. Samples were then fixed with pH 2, nitric acid, and arsenic, and were quantified using the standard procedure (Chapman and Paret 1991). Arsenic quantities were compared by ANOVA followed by the Tukey-Kramer test (Sokal and Rohlf, 1969) to find statistical differences among the samples.

Results and Discussion

Table 1 shows the results of the arsenic concentrations found in the samples analyzed. All the samples contained arsenic levels above the safety limits established by the World Health Organization. However, arsenic in the wells of San Antonio were statistically higher than those of El Triunfo ($F_{(2,24)} = 17.51; p < 0.001$). Our results indicated that there are significantly high amounts of arsenic in the groundwater tested, which is used by the inhabitants of both towns. For this reason, we propose to prohibit the use of these wells and study the effects they have had on the health of the inhabitants of the region.

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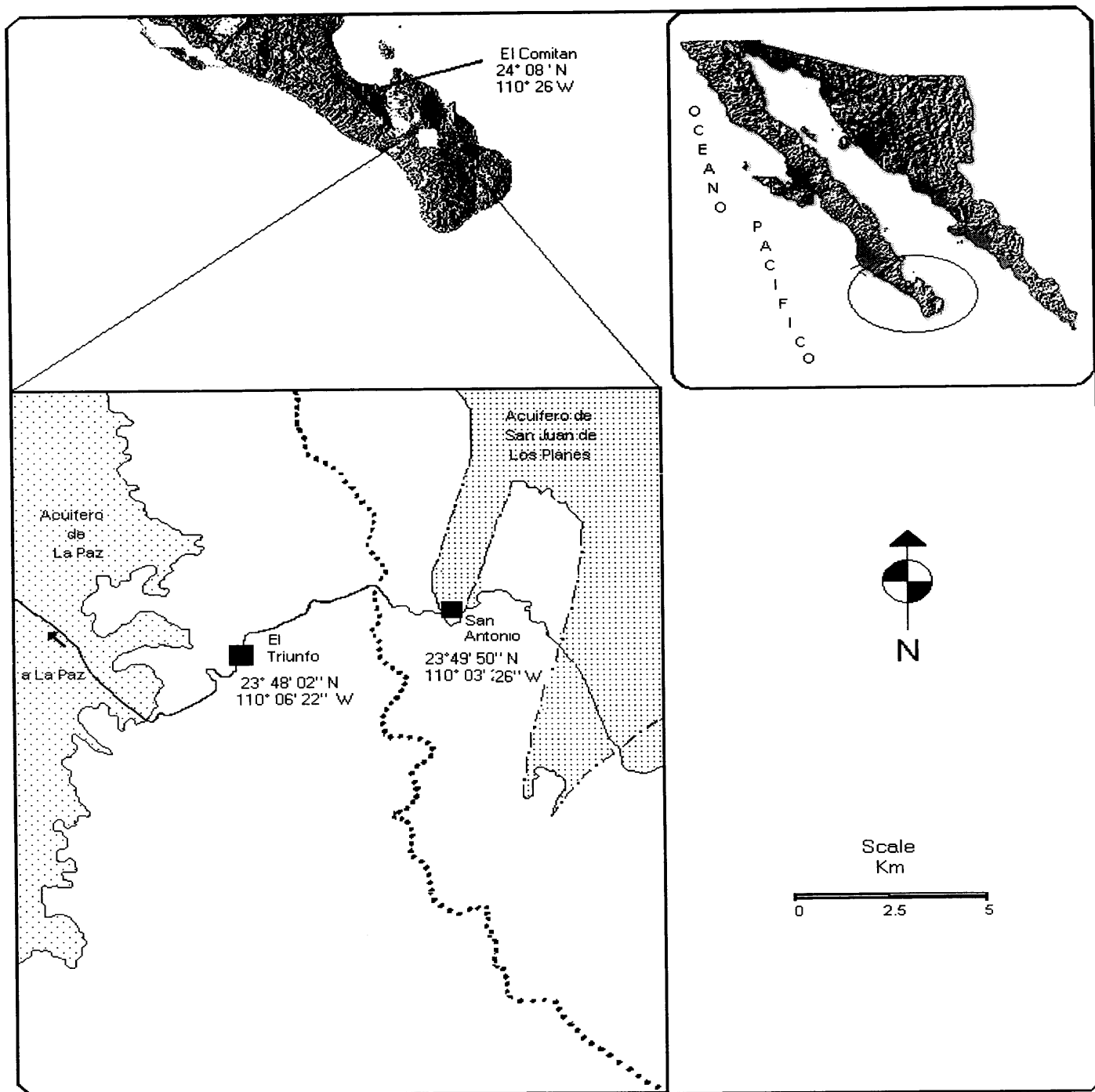


Figure 1. Mining district of San Antonio-EI Triunfo, located in the southern part of the Baja California Sur state.

Table 1. Arsenic concentrations found in the underground water sampled.

Samples	Location	Well	Ubication	Conc. As (Mg/l)
San Antonio				
1 a la 3	Los San Juanes	1	23°47'47 N 110°03'20 W	0.0871
4 a la 6	1 Km North Planta Los San Juanes	2	23°47'14 N 110°03'20 W	0.0903
7 a la 9	1.9 Km North Los San Juanes	3	23°47'11 N 110°03'27W	0.1904
10 a la 12	1.95 Km North of Los SanJuanes	4	23°47'11N 110°03'20W	0.1754
13 a la 15	2.85 Km North of Los San Juanes	5	23°48'50 N 110°03'10W	0.1676
16 a la 18	2.95 Km North of Los San Juanes	6	23°48'51 N 110°03'10W	0.2440
El Triunfo				
19 a la 21	900m SE under stream Los Encinos	7	23°48'02 N 110°06'22 W	0.0942
22 a la 24	850 m SE under stream Los Encinos	8	23°48'03 N 110°06'22W	0.0430
El Comitan				
25 a la 27	COM	9	24°08'10 N 110°26'30 W	**

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