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The Mazarrón Pb–(Ag)–Zn mining district (SE Spain) as a source of heavy metal contamination in a semiarid realm: Geochemical data from mine wastes, soils, and stream sediments

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ABSTRACT

The Mazarrón epithermal ore deposits (SE Spain) formed in Miocene time in relation to the emplacement of dacitic–rhyodacitic domes. The Pb–(Ag)–Zn ore deposits are of the high sulphidation vein and stockwork type. There are two main mining sites: San Cristóbal–Perules (adjacent to the town of Mazarrón) and Pedreras Viejas. The area is located in the southern realm of a Miocene marine basin surrounded by mountains in its western, eastern and southern flanks. A main seasonal river (Rambla de las Moreras) crosses the basin from North to South and is strongly affected by contaminated sediments from the San Cristóbal–Perules mining site. The mine tailings are extremely rich in Pb (mean = 12,400 μg g^{-1}) and Zn (mean = 6100 μg g^{-1}), whereas As concentrations are also very high (mean = 650 μg g^{-1}). Our geochemical survey also covered anthropic soils, stream sediments and the so-called *almagres* deposits (red alum calcines). All these environmental matrices have also very high concentrations of Pb, Zn, As, and Cd compared to our local or world baseline concentrations. The calcines are rich in As (mean = 450 μg g^{-1}), and the main environmental concern relates to the wrong use of these materials as agricultural soils at discrete sites in the district. Besides, the anthropic soils of the district are very rich in Pb (mean = 2550 μg g^{-1}) and Zn (mean = 1870 μg g^{-1}). On the other hand, the seasonal river Rambla de las Moreras receives contaminated sediments from the San Cristóbal–Perules old mining site and mine wastes, which results in high concentrations of As (mean = 120 μg g^{-1}), Pb (mean = 2700 μg g^{-1}) and Zn (mean = 1090 μg g^{-1}) in the sediments. These high concentrations of dangerous contaminants in an area close to a town of 35,000 inhabitants and adjacent to significant agricultural activity may pose a risk to human health.

1. Introduction

The Mazarrón Pb–(Ag)–Zn mining district (now abandoned) is located close to the town of Mazarrón, only 4 km away from the Mediterranean coast in SE Spain (Fig. 1A, B). The mining area shares many geologic and environmental features with other districts from SE Spain such as La Unión (Robles-Arenas et al., 2006; Navarro et al., 2008) or Rodalquilar (Oyarzun et al., 2008) however, the magnitude of the environmental disturbances is much stronger. This is not surprising for an area that has been mined, although intermittently, since Roman time (200 BC to 300 AD) (Manteca Martínez et al., 2005). The district was first mined for lead in Roman time, later for the alum (aluminium sulphate: alunite) during the 15th–16th Centuries, then for the alum wastes (calcines; 1774–1953), and finally for lead, silver and zinc during the 19th–20th Centuries (until the early 1960s) (Rodríguez and Hidalgo, 1997; Manteca Martínez et al., 2005; Martínez Alcalde, 2005). The latter corresponds to the peak period of mineral extraction. For example, 3 Mt of ore at 10% Pb and 150 g t^{-1} Ag were extracted between 1920 and 1941, whereas a decline is observed for the period 1951–1962, when only 1 Mt of ore at 3% Pb, 5% Zn and 115 g t^{-1} Ag was extracted. Despite the extent of environmental disturbances little or nothing has been done to mitigate the risk in the Mazarrón area, where most of the 35,000 inhabitants live adjacent to large abandoned mining sites and agricultural activities. Besides, water resources are exposed to contamination from waste materials. We here present a comprehensive environmental study of the Mazarrón district including geological, geochemical, mineralogical, physiographic and climatic data (Fig. 1A, B).

2. Climatic, physiographic and geologic setting

2.1. Climate and physiography

The area is characterized by a typical Mediterranean climate, with rain deprived summers and moderation of temperatures by the

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