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Cadmium and mercury in topsoils of Babagorogor watershed, western Iran: Distribution, relationship with soil characteristics and multivariate analysis of contamination sources

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ABSTRACT

The main objectives of this study were to identify spatial variability and main sources of cadmium and mercury in rural soils of Babagorgor watershed. A total of 87 composite soil samples were collected in an area of about 1352 km^2. The average concentrations of the analyzed elements in topsoil were 3.289 mg Cd/kg and 0.632 mg Hg/kg. To identify the sources of heavy metals, we used: (a) the relationship between the heavy metal content in soils and the origin of the parent material; (b) the comparison of heavy metal in soils among different land uses; and (c) the heavy metal distribution in the study area. The results indicated that land use had no significant effect on Cd and Hg concentrations, and that the concentrations of Cd and Hg were primarily controlled by the parent materials of soils. High Cd concentrations in soils can be explained by occurrence of the magmatic rocks in the area. Mercury concentrations were associated with areas characterized geomorphologically as alluvial deposits at the lowest altitudes within the region. In fact, high adsorption of Hg with silt fraction allowed for its migration towards the drainage network.

1. Introduction

Geogenic heavy metal contents in soils are dependent initially on the geological sources (Burak et al., 2010). However, important discrepancies in heavy metal contents between the soils and the underlying bedrocks in the same area are possible due to the geochemical processes acting on heavy metal distribution within the landscape (Burak et al., 2010). Metal distribution in the landscape should be analyzed based on the geomorphology, and hydrology (Miller, 1997) that control the mobility of metals in solution (Kabata-Pendias and Pendias, 2005) and on factors that can act as geochemical barriers controlling the mobility of metals (Perel'man, 1986).

Heavy metal enrichment/contamination of the soil has attracted a great deal of attention worldwide due to their non-biodegradable nature and long biological half-lives for elimination from the body (Li et al., 2004; Raghunath et al., 1999).

Warnings of health risks from Cd pollution were issued initially in the 1970s (Nordberg et al., 1997). Cadmium is water soluble and can be transferred efficiently from soil to plants, which may affect human health if there is excessive intake from a contaminated food source (Satarug et al., 2003).

According to Zagury et al. (2006), Hg is a nonessential element and concerned as a potential neurotoxin. Since Hg is a bioaccumulatable pollutant with a high potential for wildlife and human exposure (Bahnick et al., 1994) there is concern relative to its biogeochemical cycling and deposition in terrestrial and aquatic ecosystems (Rolfhus and Fitzgerald, 1995).

Mercury emissions from natural sources occur through processes such as volcanic eruptions, weathering of rocks, and undersea vents which release Hg into water bodies, soils, and the atmosphere (Rhoton and Bennett, 2009), however, anthropogenic emissions, such as mining, chemical industry, coal combustion, municipal solid waste incineration (Biester et al., 2002; Jiang et al., 2006), electronic, paper and pharmaceutical industries (Rodrigues et al., 2006; Tack et al., 2005), are major sources of Hg in the environment. Soil, which acts as both source and sink of Hg, is an important reservoir in its biogeochemical cycling (Gillis and Miller, 2000), and Hg levels in soil are a significant environmental issue. The distribution of Hg in soils is dependent on geologic parent material, profile depth, particle size distributions, and organic C concentrations (Rhoton and Bennett, 2009).

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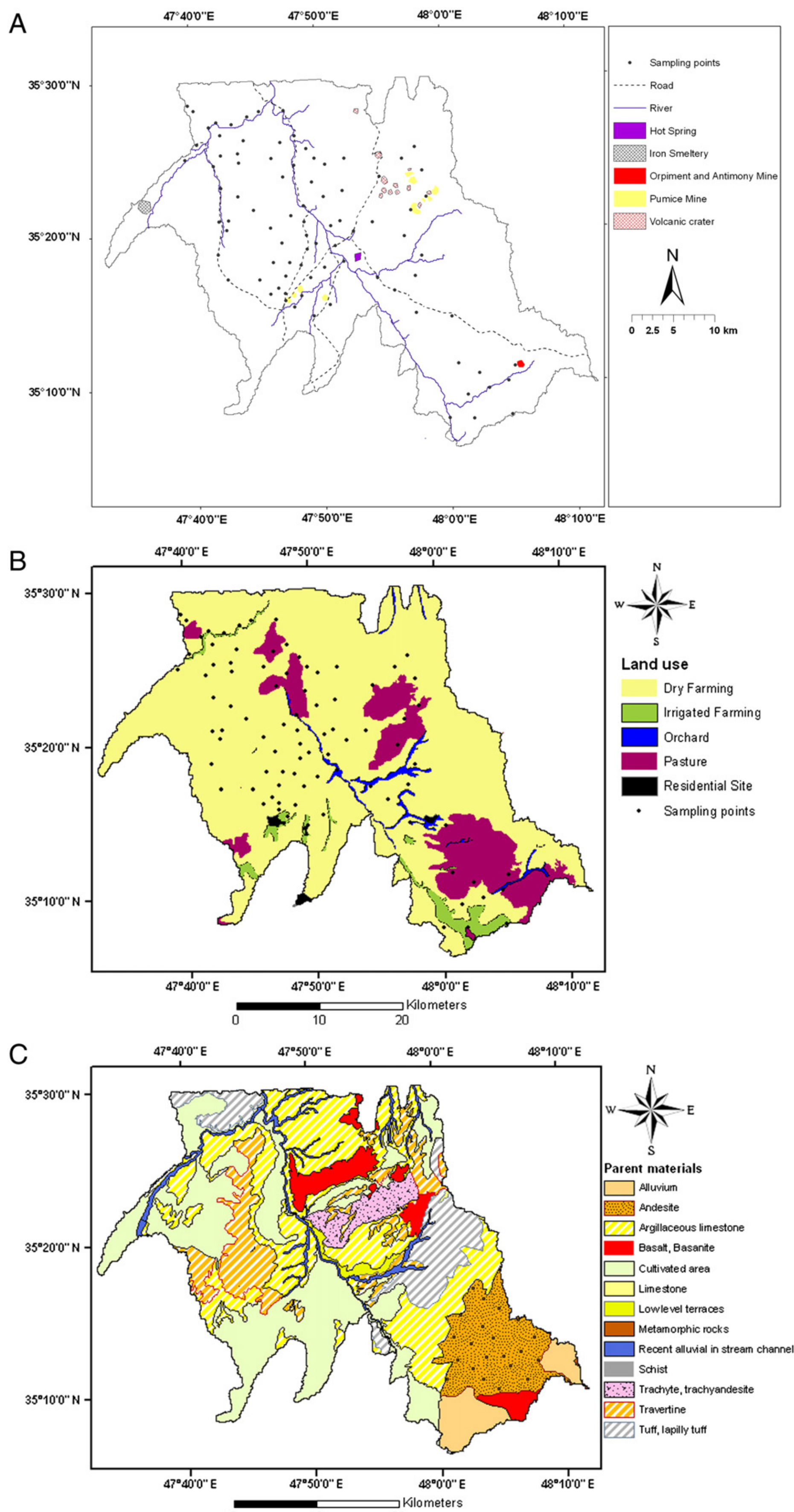

Fig. 1. (A) Location (B) land use and (C) simplified geology maps of the study area.