

BASELINE CONCENTRATIONS OF TRACE ELEMENTS IN SURFACE SOILS OF THE TORRELLES AND SANT CLIMENT MUNICIPAL DISTRICTS (CATALONIA, SPAIN)

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Abstract. An investigation was conducted to study the baseline levels of Ba, Cd, Cu, Cr, Ni, Pb, Sr, V and Zn (aqua regia-extractable) based on 51 representative soils of the Torrelles and Sant Climent Municipal Districts (Catalonia, Spain). The baseline concentrations of those elements were (mg kg^{-1}): Ba 73.9–617.9, Cr 9.2–120.2, Cu 4.0–111.6, Ni 6.1–118.6, Pb 5.6–217.5, Sr 19.6–128.8, V 12.1–101.2, and Zn 16.8–326.8, respectively.

Forty-nine samples were reported as having less than the 0.67 mg kg^{-1} detection limit for cadmium and were therefore not useful for baseline determination; however, these results suggest that the baseline average is probably below 0.67 mg kg^{-1} .

Upper baseline values for most of the elements corresponded with those reported in the literature, except for Pb and Zn, which were two to four times greater.

Soil properties, including clay fraction, OC, CEC and pH_w were related to metal concentration using correlation and factorial analysis. R-mode factor analysis separates the soil analysis data into three factors. These factors explain 67.3% of the total variance, suggesting that metal concentration was controlled by soil composition.

Keywords: baseline concentrations, Catalonia, soil contamination, Spain, trace elements

1. Introduction

The increase in anthropogenic trace elements in soils may be an important factor in the development of urban and agricultural areas. These trace elements may adversely affect the soil environment, agricultural production or crop quality, and groundwater quality. To evaluate natural concentration variations of trace elements and to assess trace metal contamination in soils, it is necessary to survey trace metal background values. These are needed to provide regulators for a scientific database in order to address the how clean is clean issues and to establish reasonable clean up criteria.

Natural background concentrations in soils from Belgium (De Temmerman *et al.*, 1984), China (Chen *et al.*, 1991), Germany (Bachman *et al.*, 1995),

India (Kuhad *et al.*, 1989), Italy (Bini *et al.*, 1988), Poland (Andersen *et al.*, 1994), Switzerland (Landry and Célardin, 1988), The Netherlands (Denneman and Robbersen, 1992), United Kingdom (Thornton, 1982), United States of America (Holmgren *et al.*, 1993; Bradford *et al.*, 1996; Ma *et al.*, 1997) and Western Europe (Angelone and Bini, 1992) have been investigated. These national scale projects lay a solid foundation for understanding natural concentrations levels of trace elements in soils and assessing soil contamination.

Background values of trace elements in soils have also been determined for more local scales (e.g., state, province, municipal district, etc.) (Andersen *et al.*, 1994; Rovinsky *et al.*, 1995; Esser, 1996). Twenty years ago, Barcelona University began to study the background values in Catalonia, Spain (Bech, 2000; Bech *et al.*, 1992, 1998; Bech and Tobías, 1995; Tobías *et al.*, 1997a,b).

Geochemical background concentrations should represent natural concentrations in soils, which ideally exclude human influence. Geochemical baseline concentrations, in contrast, represent an expected range of element concentrations around a mean in a normal sample medium and are not always true background concentrations and are defined as 95% of the expected range of background concentrations. Due to the long distance aerial transport of trace pollutants, it has become difficult to estimate the true geochemical background levels of trace elements in soils, the baseline values have been recognized as the only means to establish reliable worldwide elemental concentrations in natural materials (Gough *et al.*, 1988; Kabata-Pendias and Pendias, 1992; Tack *et al.*, 1997).

Baseline concentration levels of trace elements have been obtained for the soils of Brazil (Campos *et al.*, 2003), Flanders (Tack *et al.*, 1997), Great Britain (McGrath, 1986), Poland (Dudka and Market, 1992), USA (Shacklette and Boerngen, 1984; Gough *et al.*, 1988; Chen *et al.*, 1999).

The objective of this study was to establish baseline concentrations of Ba, Cd, Cr, Cu, Ni, Pb, Sr, V and Zn (aqua regia-extractable) in surface soil horizons of the Torrelles and Sant Climent Municipal Districts (Catalonia, NE Spain) and investigate the relationship among elements and between soil properties and the concentrations of those elements.

2. Materials and Methods

2.1. SITE DESCRIPTION

The studied area is located to the SW of Barcelona (Catalonia, NE Spain) and includes the municipal districts of Torrelles de Llobregat and Sant Climent de Llobregat with a total area of 24.38 km² (see Figure 1).

Geologically, the study area occurs within a contact zone between the north eastern foothills of the Garraf massif and the southern plain of the Llobregat river valley. The materials correspond to the Paleozoic basement of the coastal