



## IDENTIFICATION AND ASSESSMENT OF THE IMPACT OF PLASTIC WASTE ON SEDIMENTS

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### 1. Introduction

Plastic is a generic term for polymeric materials that may or may not contain other elements for modification of their performance or cost reduction [1]. Characteristics such as flexibility, durability, low degradation rate, moisture resistance, low cost, ease of manufacturing, low weight, and consequently, low transportation cost, make them widely used in a myriad of products, ranging from packaging to spacecraft [2]. Among the main additives used in plastic manufacturing are plasticizers, thermal stabilizers, lubricants, antioxidants, pigments, flavorings, and biocides. Dyes and pigments give color to the polymer and can have organic or inorganic origins. Inorganic dyes are generally salts or metallic oxides and contain elements such as Pb, Cr, Fe, Mo, Ti, among others. Inorganic compounds are also used as flame retardants, employed in flammable polymers in their pure form, with the most commonly used compounds being Br and Sb.

The widespread applications of plastics result in their accumulation and persistence in the environment when they are discarded, due to their resistance to degradation. Currently, microplastics, originating from additives used in everyday materials or the degradation of larger plastic objects, constitute the most abundant form of solid waste pollution on the planet [[3], [4], [5], [6]]. So-called biodegradable plastics have pro-oxidant additives such as stearates and Fe, Co, Ce, Ni, or Mn carboxylate [7]. The accumulation of diverse microplastics is also a concern due to their contaminant pollutant nature, interacting with metal ions, especially of heavy metals. Microplastics alter the migration and transformation of metal ions with a consequent impact on their environmental presence, thus necessitating an investigation into the mechanisms and characteristics of the interaction between these ions and microplastics for an accurate assessment of their ecological impact [8].

Given this perspective, the aim of this study is to characterize some metal content in plastic pellets of different polymers to assess their contribution to the dispersion of these elements in the environment.

### 2. Methodology

Neutron Activation Analysis (NAA) is widely employed in the characterization of different geological, biological, archaeological, and environmental matrices, among others [[9], [10], [11] [12], [13]], using

the comparative method (which compares the sample's activity with the standard's activity after irradiation). It is one of the most suitable methods for determining various chemical elements present in plastic matrices due to its multi-elemental nature for a wide range of concentrations and the absence of the sample dissolution step.

## 2.1 Preparation of standards

Standards were prepared by pipetting standard solutions onto Whatman filter paper strips. After drying, the strips were folded and placed in demineralized and transparent polyethylene envelopes, which were wrapped in paper for short irradiation (20 s). This set of standards was placed in plastic containers, along with the samples and irradiated under a thermal neutron flux of  $2 \times 10^{12} \text{ n cm}^{-2} \text{ s}^{-1}$ .

Short-duration irradiations of 20 seconds were performed to determine elements such as Na, Mg, Mn, Ti, K and V. After appropriate decay times the activity of the samples and standards were determined using a high-purity Germanium detector (model GC1930) coupled with the Digital Spectrum Analyzer DAS 1000, both from Canberra. The Genie 2000 program, version 3.1 from Canberra, was used for acquiring the gamma spectrum and its processing. The identification of radioisotopes was done by their gamma ray energy. For calculating concentrations obtained by the comparative method [14], an Excel spreadsheet was used.

## 3. Results and Discussion

The presence of the metals Mg, V, Ti, Mn, Na, and K was investigated in virgin polymers. The analyzed polymers were low-density polyethylene (LDPE), thermoplastic polyurethane (TPU), poly(butylene adipate-co-terephthalate) (PBC), polystyrene (PS), polystyrene (UPS), polypropylene (PP), and polyamide 6 (PA6) from different suppliers. The results are shown in Table 1.

Table I: Concentration of chemical elements in polymer samples.

Samples	Elements		
	Ti ( $\text{mg kg}^{-1}$ )	Mn ( $\text{mg kg}^{-1}$ )	Na ( $\text{mg kg}^{-1}$ )
PBC1	$1,18 \cdot 10^2 \pm 3,36 \cdot 10^1$	$1,19 \cdot 10^{-1} \pm 1,88 \cdot 10^{-2}$	$1,81 \cdot 10^0 \pm 6,09 \cdot 10^{-1}$
PBC2	$1,23 \cdot 10^2 \pm 3,56 \cdot 10^1$	$1,35 \cdot 10^{-1} \pm 2,41 \cdot 10^{-2}$	$2,66 \cdot 10^0 \pm 1,08 \cdot 10^0$
PR61	–	$1,61 \cdot 10^{-1} \pm 2,07 \cdot 10^{-2}$	$2,35 \cdot 10^0 \pm 5,44 \cdot 10^{-1}$
PR62	–	$8,63 \cdot 10^{-2} \pm 2,72 \cdot 10^{-2}$	$3,41 \cdot 10^0 \pm 2,35 \cdot 10^0$
PPP1	–	–	$2,86 \cdot 10^3 \pm 6,33 \cdot 10^2$
PPP2	–	–	$2,90 \cdot 10^3 \pm 6,42 \cdot 10^2$
PT1	–	$2,35 \cdot 10^{-2} \pm 8,61 \cdot 10^{-3}$	$6,85 \cdot 10^{-1} \pm 3,14 \cdot 10^{-1}$

When analyzing the polymer samples, all found metals had low concentrations. Titanium (Ti) was the element found in higher concentrations but just in the PBC polymer. Manganese (Mn) was found in PBC, PR6, and PT, while Sodium (Na) was found in samples of PBC, PR6, PPP, and PT. The chemical elements Mg, V, and K were not found in any of the analyzed samples. The presence of such elements in plastic pellets may be related to the use of inorganic additives or organic compounds containing

inorganic elements. This should be the case of Ti in PBC and Mn in PBC, PR6, and PT [15], [16]].

#### 4. Conclusions

The presence of metals Ti, Mn, and Na in the analyzed pellets indicates that these elements are present in the plastic raw material. Once converted into products and subsequently discarded, they will carry these elements with them, contributing to their dispersion into the environment.

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