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Self-burning coal mining residues – an environmental issue or a source of raw materials?

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The self-burning of coal mining residues disposed at environmental conditions have been described in the literature as a phenomenon occurring worldwide. These coal related fires are of significant concern because of the risks to environment and human health due to the emission of harmful gases and particulate matter to atmosphere. Another concern is the degradation of soils and waters in surrounding areas owing to the mobilization and leaching of hazardous elements. The self-burning of coal mining waste deposits may be a very persistent phenomena over decades. The carbon content (combustible fraction) and chemical composition of coal waste materials (and some physical properties) are the most relevant factors that influence intensity and duration of the self-burning process. The comprehensive characterisation of coal waste deposit materials provide information on the self-burning process and above all useful insights about the propensity to ignition and burning and their environmental impacts. The characterization of coal waste materials can contribute to assess their reuse as a secondary source of critical raw materials and carbon based materials.

The recycling of these materials, from both burning and non-burning coal waste deposits, is in good agreement with recommendations from European Union (EU) pointing out the need for developing sustainable recovery of mining and industrial wastes to mitigate environmental impacts. The EU identifies 26 critical raw materials including inorganic trace elements and natural graphite as a critical raw materials with extremely high level of external dependence, and strongly recommends the development of measures to increase recycling of by-products and residues. In this framework, research has been dedicated to burning or already burned coal mining waste deposits in Portugal and Spain. Non-burning coal mining waste deposits from the same mining areas have also been investigated. These coal waste deposits, resulted from the discharging of coarse mine refuse from mining exploration. They are very heterogeneous and present variable amounts of coal that is the combustible fraction. The comprehensive characterization of mining waste materials as well as the identification of products formed during combustion reveals the potential environmental impact, principally due to the concentration of volatile organic compounds emitted to atmosphere. The combustion process also causes changes in trace

elements' mode of occurrence with some becoming more easily mobilised for surrounding soils and water systems by percolation or deposition of solid atmospheric particles. On the other hand, the mining waste burned materials reveal an enrichment of some trace elements, including critical raw material; and, the production of graphitic structures, including graphene. Therefore the coal wastes mining deposits are an environmental issue, they can be seen as an alternative secondary source of critical raw materials and carbon based materials.