Trace elements bioaccessibility in fine and ultrafine particles from the industrial area of Dunkirk (France) during the NANO-INDUS project

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Keywords: Fine particles, Trace elements, bioaccessibility, lung fluid.
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Inhalable atmospheric particles (< 10 µm) may contain high concentrations of trace elements (TE) that could induce adverse cardiovascular and respiratory effects (Donaldson *et al.,* 2002). Fine and ultrafine particles (smaller than 2.5 and 0.1 µm, respectively) are suspected to be more harmful, because of their small size and high specific surface, allowing them to penetrate deeply in our respiratory tract and even pass through the cellular membrane. After penetrating in our body, particulate TE can be partially or completely dissolved upon contact with the lung fluids (Costa and Dreher, 1997). Particle size, shape, chemical composition and potentially toxic bioaccessible content are the main characteristics to consider in the PM-induced biological impacts (Oberdörster *et al.,* 2005). Trace metal pulmonary bioaccessibility assessment requires the use of extraction solutions mimicking the physiological fluids (Caboche *et al.*, 2011). The purpose of this study was to assess TE bioaccessibility in different size fractions of PM, collected according to emission sources using a synthetic lung fluid (Gamble solution, pH = 7,4 et ≈ 37 °C). Coarse, fine and ultrafine PM were collected in the vicinity of metallurgical plants (at 500 and 2000 m from the chimneys) and in traffic influenced urban area nearby, using cascade impactors (DEKATI - 3 and 13 stages). Bioaccessible fractions and total concentrations of a large set of elements, selected according to their potential toxicity and their property of source markers (Al, As, Ba, Cd, Co, Cr, Cu, Fe, K, La, Mg, Mn, Mo, Ni, Pb, Rb, Sb, Sr, Ti , V and Zn), were analyzed by ICP-AES and ICP-MS.

Overall, total concentrations in PM_{10} increased with the industries proximity, implying the large contribution of industrial sources in PM_{10} TE concentrations. Pulmonary bioaccessibility results show that metal solubility would depend on the source types. Indeed, the solubility in the Gamble solution for Mn, Pb, Rb and Zn (associated to the metallurgical emissions) in PM_{10} were higher in the vicinity of industrial plants than in urban area where, inversely, traffic related elements (Cu and Sb) showed higher dissolution percentages. For elements associated to industrial emissions, bioaccessibility in PM_{10} decreased with the distance from the sources that could be linked (1) to the change of elemental speciation during PM transport or (2) the increasing contribution of others/more refractory sources. In the industrial and "urban-traffic" areas, the bioaccessibility increased toward smaller PM, particularly for anthropogenic elements like Cd, Co, Mn, Ni, Pb, Rb, Sb and Zn.

These results indicate that the bioaccessibility may vary according to the type and distance from the sources, in addition to the size of PM and the chemical form of TE. Our current works move at the moment to a better estimate of these two parameters within industrial plumes.

This work was part of a program from the "Institut de Recherche en ENvironnement Industriel" (IRENI) and was financially supported by the French Environment and Energy Management Agency (ADEME), the Nord-Pas-de-Calais Regional Council, the French Ministry of Higher Education and Research, the European Regional Development Fund (ERDF) and Ecole des Mines de Douai.

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