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Pt-based anticancer drugs: adsorption studies onto isolated phases and natural soils

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The development of emerging key technologies begets an increasing use of some elements that were rarely used and therefore poorly investigated. Platinum, for instance, belongs to the family of the Technology Critical Elements (TCEs) which are elements that have both a high economic importance and a high supply risk. For the last 40 years, Pt has been widely used in different industries, including the pharmaceutical industry for its anti-cancer properties. After excretion by the human body, these compounds reach the urban wastewaters and the wastewater treatment plants (WWTP) where there are only partially removed. Thus, they get in contact with different environmental compartments: WWTP effluents can be used for field crops or greenhouse irrigation whereas sewage sludges can be directly applied onto soils as a fertilizer. Very little is known about their environmental consequences and the complex processes involved in their fate in soils which can be a threat to both the environmental and human health, hence the need of their study.

We present here the adsorption behavior of carboplatin and oxaliplatin (2 of the 3 most widely used Pt-based anticancer drugs) in five natural soils with different properties. Adsorption onto isolated phases such as goethite, organic matter, kaolinite and montmorillonite will be also presented. The Pt-based compounds adsorption behaviors were studied as a function of various parameters such as contact time, pH and concentration which gave us macroscopic information. Besides, molecular information using X-Ray Absorption Spectroscopy (XAS) were obtained and combined to the macroscopic data to get a better understanding of the adsorption process.

The results highlight that with such compounds, adsorption kinetics is of very high importance since the adsorption equilibrium time ranges from 48 hours (e.g. oxaliplatin on goethite) to more than two months (carboplatin on soils). Surprisingly, carboplatin displays a lower affinity towards the studied solid phases than oxaliplatin, evidencing that sterical hindrance is not the limiting phenomenon.