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Trace elements availability in desert sediments affected by acidic phosphogypsum slurry pollution

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On June 2017, estimated 250,000 m^3 of concentrated acids and phosphogypsum slurry drained from an industrial pond of a phosphate industry, into Ashalim ephemeral stream, at the southern Judean desert, Israel, leaving behind dead animals and plants, as well as acidic cisterns and polluted soil. The acidic effluents contained a mixture of flourosilicic, phosphoric and sulfuric acids and high levels of salts and heavy metals.

The Ashalim stream incises a range of geological structures and formations. The western part of the stream drains the Rotem plateau composed of quartz sands, while its central part cuts through a carbonate bedrock. The present work focuses on the upper Ashalim stream, characterized by sandy alluvial riverbed with lime, chalk and flint aggregates derived from the surrounding bedrocks. The contamination event can be identified through several new morphological features in the field, including white phosphogypsum deposits, consolidated crusts and whitish sands. Field and laboratory investigations were carried out on these morphologies in order to identify the prominent contaminants, their spatial distribution, geochemical availability and potential mobility. Here we chose to address the availability of trace metals to the soil solution using repeated leaching cycles by double distilled water (DDW), with a 1:1 soil to DDW ratio.

The main contaminants in the stream are F^-, SO_4^{2-}, PO_4^{3-}, and Na^+ along with heavy metals, particularly Cd, Cu, Mo, Al, Fe, Zn and ^{226}Ra. In addition, despite the carbonate environment, few flash floods and local rain events, 4 years past the contamination, the pH of the sediments is still slightly lower with respect to the surrounding and nearby control sites. The polluted soils contained higher levels of metals as compared to the reference site even after repeated leaching, though the absolute levels were not very high. Yet, this results in significant cumulative metal availability to the soil solution.

The findings signify major change in the chemical characteristics of the habitat; increased soil salinity and elevated levels of fluoride, nutrients and metals. These findings explain and support the findings from the ecological monitoring program that point to metal bioaccumulation, along with high biological crusts and vegetation stress.