IN SITU REMEDIATION OF GROUND AND GROUNDWATER USING ZEROVALENT IRON NANO PARTICLES: PRELIMINARY EVALUATION

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ABSTRACT

The GEOPLANO/LNEC consortium tested an emerging in situ methodology of soil and groundwater remediation using zero-valent iron nanoparticles (nZVI), in a brownfield site located south of Lisbon. The area where the pilot tests were conducted has an industrial background with a strong presence of heavy metals, sulfates and nitrates. The implementation of the in situ testing was preceded by the physical and chemical characterization of soils, groundwater and lixiviates produced by contaminated soils. The effect of different nZVI dosing was tested at laboratory. The in situ tests were executed with three different concentrations of nZVI solutions. After the nZVI injection, a program for monitoring the groundwater quality and the concentrations of contaminants was implemented.

1 - INTRODUTION

In the context of the urgent need for low cost solutions that enable the in situ recovery of contaminated soil and aquifer systems and the emergence of remediation technologies using nanomaterials in the United States, the GEOPLANO/LNEC consortium decided to check the applicability of in situ remediation of soils and groundwater using zero-valent iron nanoparticles (nZVI).

2 - LOCATION AND SITE CONDITIONS

The pilot tests were conducted inside an important brownfield site (an industrial complex that worked for more than a half-century, producing fertilizers and sulfuric acid), located in southern Lisbon, in the left bank of the Tagus river (Figure 1), in the town of Barreiro.

Figure 1 – Site location.

The grounds of the testing area belong to the Pliocene detrital formations - PSM "Formação de Santa Marta". From the base to the top this Formation includes very thick and discontinuous conglomerate, followed by fine to coarse arkosic sand, of fluvial genesis. Kaolinite and illite predominate in the clay fraction. The tidal effect influences the water table in the local, which is positioned approximately from 4.5 to 5.0 m deep. The hydraulic diffusivity of the aquifer, considering a horizontal leakage factor of 432 m^2, is 18 344m^2/h. This value is compatible with a semi-confined aquifer system.

3 - SOIL CONTAMINATION

The implementation of in situ testing was preceded by the physical and chemical characterization of soils, groundwater and lixiviates produced by contaminated soils. The site has a strong presence of heavy metals (Zn, Cu, Pb, As, Ni, Sn, Co and Ba), sulphates and nitrates (Figure 3).

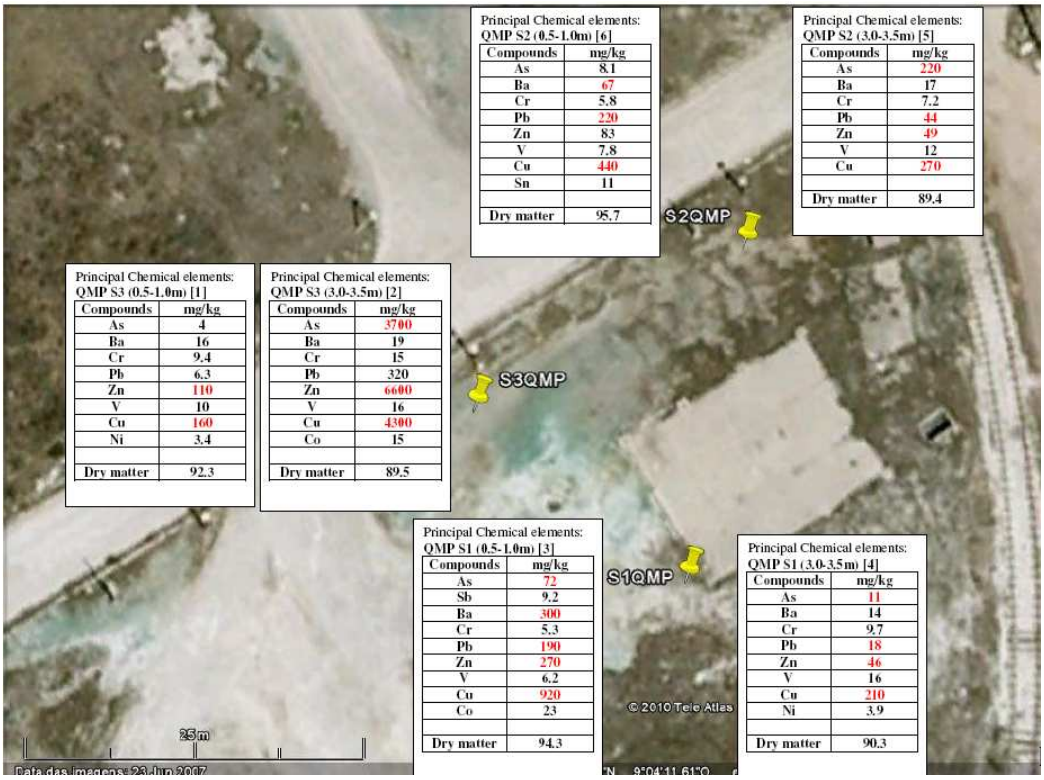

Figure 3 – Soil sampling location.

4 - TEST PILOT SITE

The test site was divided in four zones (Figure 4), with distinct dimensions and purposes, where four different concentrations of nZVI solution have been injected. After the nZVI injection, a program for monitoring the groundwater quality and the contaminants concentrations was implemented. The results are presented in Figures 5 and 6.

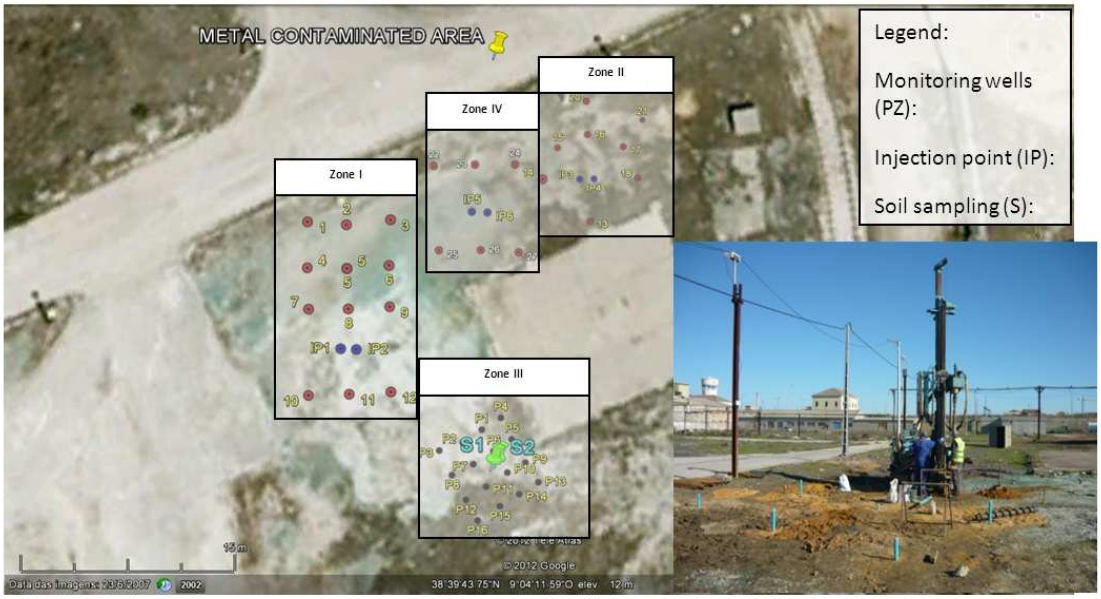

Figure 4 – Test zones location (I, II, III and IV).

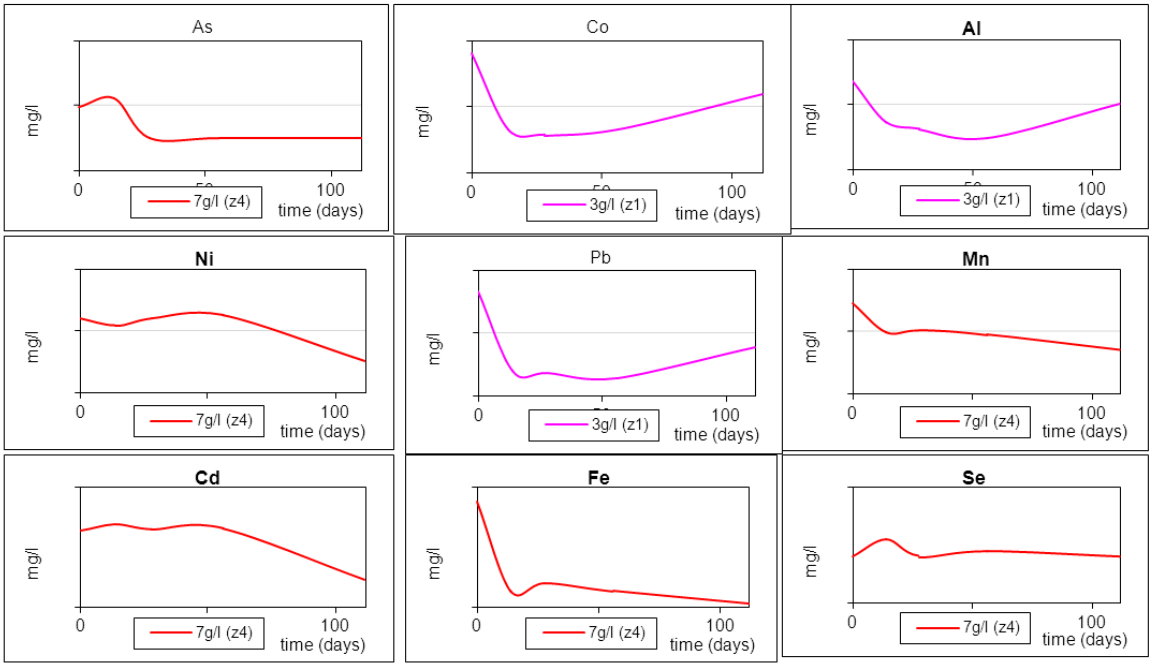

Figure 5 – Summary results on water samples, collected before and after nZVI injection in zone I, II and IV.

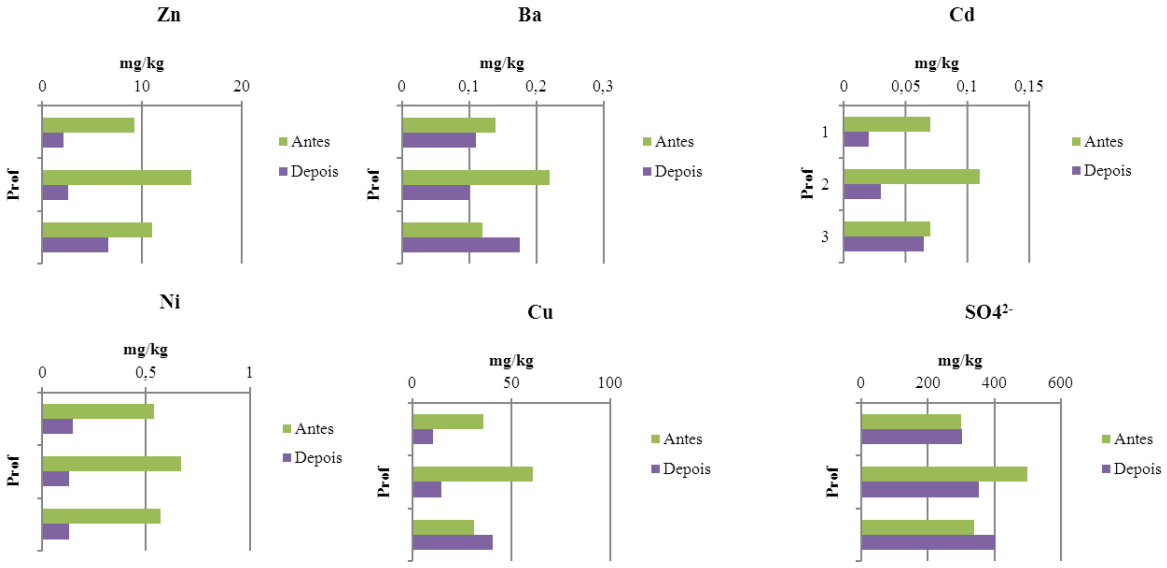

Figure 6 – Results on soil samples leachates, collected before and after nZVI injection at zone III.

5 - RESULTS

In Zones I, II and IV the nZVI injection effects on the contaminants concentration in the saturated zone have been observed. Zone III was considered to evaluate the nZVI behavior in a non-saturated environment, assuming a hypothetical stabilization effect on the horizon above the water table and thus the reduction of the effect of leaching by surface water.

The results of leaching tests made over collected samples before and after nZVI injection at Zone III show significant differences in metals concentrations.

The efficiency and the speed are two of the relevant aspects that have been retained from this investigation procedure.

The studies conducted to date are encouraging. It is however recognized that there are unknown aspects, such as transport mechanisms of nanoparticles in the environment, its persistence, the interaction with organisms and eventual parallel effects on biological systems.

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