

Common backfill in the Parisian area: Inventory of metallic (Cu, Pb and Sb) mineralogy phases

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Abstract:

In the middle of the 20th century, backfilled of the Parisian area was systematically done on 2 to 5 m minimum thickness and used as basement for buildings because of their fair geotechnical qualities and mainly to avoid major flood events. For risk assessment purposes, sampling and analyses are performed for every re-urbanization procedure. Materials used for backfill revealed very high sulphate content, and depending on the location, Cu, Pb, Sb and Sn concentrations hundred times higher than for the Parisian natural geochemical background. Macroscopical observations showed for instance black colours with traces of slags or ashes. No relationship between geographical locations and/or past activities on site could be established as the Parisian area has never hosted important metallurgic activities.

This study had to answer several questions: what are the Cu, Pb and Sb -bearing mineral phases where do come from sulphates, why metals are apparently never leached and mainly, where do come from those millions of cubic yard of material with such metallic and sulphates properties, which type of industrials activities could have produced such materials?

Five samples from four different locations have been selected. Stability of metals or metalloids host phases has been tested under batch conditions for every sample, coupled with ICP-AES (Induced Coupled Plasma - Atomic Absorption Spectrometry) and X-ray diffraction (DRX) analyses, Electron Probe Micro-analyses (EPMA), optical and Scanning Electron microscopical (SEM) observations on raw or remaining solid phases. Bulk chemical analyses show metallic concentration ranges from several ppm up to several percents, with high variations between the samples as shown in the following table.

<i>mg/kg</i>	Cu	Ni	Pb	Sb	Sn	Sr	Zn	Zr	Cd
Sample 1	20000	60	2132	48	1635	122	1883	285	5
Sample 2	606	60	305	4	289	594	378	121	1
Sample 3	162	32	304	17	152	259	270	141	1
Sample 4	5453	891	394	8	209	489	3163	125	2
Sample 5	715	83	2164	54	227	306	1043	156	2

Microscopical observations have shown that metallic phases are alloys or native metallic phases with silicates and oxides. Supergene alteration products are also commonly observed around metals and metalloids-bearing phases as secondary transformation. Bulk XRD patterns showed gypsum, calcite, quartz, muscovite or feldspars constituting the primary mineralogy of the geological formations in the Parisian basin. Typical materials issued from industrial processes such as graphite and coke have also been identified. Among the identified metals or metalloids bearing phases, micro-scale chemical analyses (EPMA) reported that Sb (e.g., up to 5,3 wt.% Sb₂O₃ in sample 3) is preferentially trapped by Fe/Pb-oxides and that alloys of Pb-Sn are common, showing high heterogeneities within one phase (e.g., for sample 1: 3,3 < Pb < 23,8 elt.% and 25,2 < Sn < 40,4 elt.%).

From FeO-MnO phases stability graph, it can be deduced that all primary phases are characteristic of reductive conditions and high temperatures (>1400 °C) formation. From the variety of alloys with Cu, Pb and Sn, it seems that small mechanical or foundry / smelters shops could have produced such wastes.

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