



Influence of redox conditions on the chemical partitioning of heavy metals in soils and sediments (Champagne vineyard, France)

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Fertilizers and pesticides have been commonly added in vineyards to compensate nutrient deficiencies of soils, to facilitate vine growing and to fight against vine diseases. In the Champagne vineyard (northeastern France), these inputs which meant at enhancing the quality of calcareous soils have noticeably been reduced for a few years. But the previous intensive use of these anthropogenic products during several decades led to heavy metal accumulation in wine producing soils. Extensive erosion processes in the Champagne vineyard lead metals accumulated in soils to be transferred spatially by runoff and to constitute a non-punctual pollution source for streams in the catchment area. Numerous detention ponds have been constructed downstream in order to collect runoff waters and eroded material from vineyard during rainy events and to keep contaminants away from nearby rivers.

Though total heavy metal content is useful to evaluate the soil and sediment contamination, it gives insufficient information on the potential mobility of trace metals. The environmental effects are directly related to the chemical forms under which metals exist in soils and sediments (i.e. their chemical partitioning). Sequential extraction procedures are commonly used to evaluate the potential mobility of heavy metals. We

selected the three-step sequential extraction scheme recommended by the BCR (Bureau Commun de Référence, now Standard, Measurement and Testing Programme) of the European Communities for this study. The BCR procedure divides metals into four fractions : acid soluble fraction (exchangeable and carbonate-bound), reducible fraction (iron and manganese oxide-bound), oxidizable fraction (organic matter and sulphide-bound) and residual fraction (crystal lattices of primary and secondary minerals). The first three forms are potentially mobile and can be released by changes of pH or redox conditions. The last form can be considered as immobile.

Two wine-producing soils and sediments of two stormwater ponds were selected in order to emphasize the influence of redox conditions on the chemical partitioning of heavy metals from anthropogenic source. Three patterns were highlighted : (1) The oxic wine-producing topsoils exhibited high trace metal concentrations obviously of anthropogenic source and trace metal partitioning was largely governed by the reducible phase (65-86 %, 45-66 %, 32-48 % and 23-48 % of total Pb, Zn, Cd and Cu, respectively) and by organic matter to a lesser extent (26-55 % of total Cu and 22-28 % of total Cr). (2) The low content of trace metals essentially fitted into the residual fraction in bottom calcareous wine-producing soils. (3) Anoxic conditions prevailed in fairly contaminated pond sediments where the oxidizable fraction greatly ensured trace metal retention (63, 58, 33, 26 and 21 % of total Pb, Cu, Cr, Zn and Cd, respectively). The chemical association of anthropogenic metals with relatively stable phases (iron hydrous oxides in soils and organic matter/sulphides in sediments) made metal mobility limited and groundwater contamination unlikely. Environmental risks would concern oxidation of dredged muds during land disposal or sewage.