Pb isotope systematics in volcanic river system: Constraints about weathering processes

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We present a series of lead isotopes in soils and sediments developed on volcanic rocks forming a small watershed flowing through the Massif Central (France). The Massif Central volcanic province is a widespread area of Tertiary to Recent continental alkaline volcanism comprising alkali basalts and basanites. The Allanche watershed has an area of 160 km2, a maximum altitude in the watershed of 1400 m (a.s.l.) and the relief between the extreme sampling points of 340 m The river is 29 km long from headwaters to the outlet and from its origin in the Cézallier area to its mouth in the Allagnon river (a tributary of the Allier river), the Allanche river flows through the volcanic terrains of the lava plateau (11 to 2.5 Ma).

Main bedrocks are basanites (nepheline or leucitic basalts), with SiO2 around 41-45%, low Na2O + K2O (<5%), and with modal or normative nepheline or leucite and a ground mass of clinopyroxene and plagioclase. Surrounding rocks are feldspatic basalts with SiO2 close to 46-49%, low Na2O + K2O (<5%). The main phase in these basalts is plagioclase with normative nepheline, hyperstene and olivine. Crustal contamination (e.g. by granite, gneiss or metasedimentary granulite, as stated by Downes, 1987, doi: 10.1144/GSL.SP.1987.030.01.25) has occurred in the differentiated magmas of both series, as witnessed by lead isotopic variations in conjunction with Rb/La ratios and lead contents.

Using Pb isotope ratios, major and trace elements (from Négrel and Deschamps, 1996, Aquatic Geochemistry, 2, 1-27) we therefore compare sediments and soils evolution over the Allanche river watershed. K and Ca are considered as mobile reference elements and illustrate the weathering state of soils and sediments relative to parent rocks through a large decrease in K and Ca content when compared to Si; the sediments being less depleted than soils. Lead, with regards to Si shows three behaviour with depleted Si content- same lead content that bedrock, depleted Si content- less lead content and depleted Si content – high lead content that bedrock. The comparison of 1000Pb/K versus Si/K ratio evidenced the evolution line from weathering processes and the lead enrichment from atmospheric deposition as a major contributor to explain the deviation of several points from this line.

Lead isotopes decrease from bedrock to sediments-soils without any clear relationship when compared to lead contents. The use of Pb-isotopic compositions showed that most of the lead budget in sediments and soils result from bedrock weathering with an influence of gasoline additive-lead derived inputs and a lack of lead input from agricultural activities.