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Mass loading of mercury in the Monte Amiata mining district, Southern Tuscany (Italy)

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In mining districts, quantification of metal loadings to streams is particularly important, because it offers the unique opportunity to evaluate the real entity of mine drainage, to identify sources of contamination, thus helping taking decisions about remediation of impacted areas. Among metals, mercury (Hg) is of particular concern in natural environments, because it strongly bioaccumulates in the foodweb and converts to methyl-Hg. The aim of this study is to quantify the mass load of Hg transported by the Paglia River, which drains the wide Hg district of Monte Amiata (Southern Tuscany, Italy), which is the 4^{th} largest Hg producing district worldwide. A recent study showed that mine activity severely affected the downstream ecosystem of Paglia River, which flows down to Tiber River, the main river of Central Italy. Mass loadings were determined for both dissolved and particulate Hg. As accurate measurements of water discharge are required to determine metal mass loads, discharge measurements were obtained by coupling traditional techniques (flow meters) and tracer dilution techniques by injection of a specific tracer (NaCl). Conductivity curves were reconstructed in the field by means of a couple of electrical conductivity meters for each sampling sites. Specific calibration constants for each sampling site and conductivity meter were obtained in laboratory. Equations based on the mass balance principle were then applied to compute the stream discharge, expressed as an average of the values obtained by the two salt curves. Mass loadings of Hg were determined at four sites with increasing distance from the main Hg mine in the area (Abbadia S. Salvatore mine, ASSM, in operation until the late 1970s).

Quantification of Hg loadings along Paglia River has shown that a significant amount of Hg is transported by surface water as a result of runoff from ASSM. Maximum Hg loads (34 g/day) were observed for the site located just downstream to the main Hg mine of the area, which supplies 100% of the total Hg budget to the basin. Progressively lower Hg loads were reported for the sites located at greater distances from the Hg mine, suggesting deposition of Hg (total and particulate forms) along the river course. Particulate matter Hg loads represent the largest part of total Hg flux, ranging from 67 up to 99% of the total, suggesting that Hg was transported mainly as Hg attached to suspended particles. Conversely, the highest quantities of dissolved Hg were found at the farthest site from ASSM (about 35 km), suggesting chemical conversion of Hg from particulate Hg to the more mobile dissolved Hg.

This research shows that a significant amount of Hg was transported by the Paglia River, mainly as the result of past mining activity developed in the Monte Amiata district, dominantly from the ASSM. These results may be useful for planning watershed remediation in this area. Moreover, the presence of dissolved Hg species in the Paglia River should be monitored by local agencies for environmental protection as they could promote active formation of methyl-Hg.