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Lead isotopes and trace metal ratios of aerosols as tracers of Pb pollution sources in Kanpur, India

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The anthropogenic flux of Pb in the Earth's surface is almost an order of magnitude higher than its corresponding natural flux [1]. Identifying the sources and pathways of anthropogenic Pb in environment is important because Pb toxicity is known to have adverse effects on human health. Pb pollution sources for America, Europe, and China are well documented. However, sources of atmospheric Pb are unknown in India, particularly after leaded gasoline was phased out in 2000. India has a developing economy with a rapidly emerging automobile and high temperature industry, and anthropogenic Pb emission is expected to rise in the next decade. In this study, we report on the Pb- isotope compositions and trace metal ratios of airborne particulates collected in Kanpur, an industrial city in northern India. The Pb concentration in the airborne particulate matter varies between 14-216 ng/m^3, while the other heavy metals vary by factor of 10 or less, e.g. Cd=0.3-3 ng/m^3, As=0.4-3.5 ng/m^3, Zn=36-161 ng/m^3, and Cu=3-22 ng/m^3. The ^{206}Pb/^{207}Pb, ^{208}Pb/^{206}Pb, and ^{208}Pb/^{207}Pb vary between 1.112 - 1.129, 2.123-2.141, and 2.409-2.424 respectively, and are highly correlated with each other (R_2>0.9). Pb isotopes and trace metal data reveals that coal combustion is the major source of anthropogenic Pb in the atmosphere, with limited contribution from mining and smelting processes. We further conclude that combination of Pb isotope ratios and V/Pb ratios are powerful tracers for Pb source apportionment studies, which is otherwise difficult to differentiate based only on Pb systematics

[1] Sen and Peucker-Ehrenbrink (2012), Environ. Sci. Technol.(46), 8601-8609