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Ice core based Pb pollution from gasoline in South America in the context of a 2000 year metallurgical history

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Lead (Pb) is highly neurotoxic and, in contrast to many other heavy metals including cobalt, copper, and zinc, it has no beneficial effects to humans even at low concentrations. The introduction of leaded gasoline in the 1920s initiated a period of unabated growth in the global emissions of Pb. Prior to the onset of leaded gasoline phase-out in the 1970s, atmospheric Pb levels increased dramatically. Long-term histories of Pb pollution in Eastern and Western Europe, Asia, and North America suggest that emissions from leaded gasoline within the Northern Hemisphere are dominant compared to that from metallurgy and coal combustion during the second half of the 20th century. However, there is no equivalent data for Southern America. Although exploitation of the extensive polymetallic deposits of the Andean Altiplano in South America since pre-colonial times has caused substantial emissions of neurotoxic Pb into the atmosphere, its historical significance compared to recent Pb pollution from leaded gasoline is not yet resolved.

Here we present the first comprehensive, high-resolution two millennia Pb emission history for South America, based on ice core records of Pb concentrations, Pb enrichment factors (EFs), and Pb isotope ratios from Illimani glacier in Bolivia. Complementary to local air pollution recorded in lake sediments, ice cores from mid latitude glaciers provide information about more extended source areas. Illimani is the highest mountain of the eastern Bolivian Andes and is located at the northeastern margin of the Bolivian Altiplano. The ice core Pb deposition history revealed enhanced Pb EFs due to metallurgical processing for silver production during periods of the Tiwanaku/Wari culture (AD 450-950), the Inca empires (AD 1450-1532), colonial times (AD 1532-1900), and tin production at the beginning of the 20th century. After the 1960s 208Pb/207Pb ratios decreased significantly, whereas Pb EFs increased by a factor of three compared to the emission level from metal production, which we attribute to gasoline related Pb emissions. Our results show that anthropogenic Pb pollution levels from road traffic in South America exceed those of any historical metallurgy in the last two millennia, even in regions with exceptional high local metallurgical activity.