



## **Legacy pollution from historical mining vs modern day input - Pervasive impact of mining and land use over 1000 years in Sweden**

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In the public consciousness Sweden is often viewed as a largely natural landscape. However, many parts of the landscape have undergone substantial changes. In the historically and culturally important Bergslagen region in central Sweden, which has played an important role in the economic development of Sweden since the medieval period, agriculture and mining have transformed the landscape over the past 1000 years. Mining was often small-scale but generally widespread throughout the landscape; for example, in the Norberg mining district-which covers 1000 km<sup>2</sup> and is the oldest of Sweden's 23 mining districts, there were >1030 mine pits, 115 smelters and 40 forges. Pollution (e.g. Hg and Pb) from pre-industrial times caused by mining activities such as ore exploitation and processing, when there were few if any environmental controls, could be substantial. As mining also entailed widespread land use that included forest disturbance and agriculture the small-scale but generally widespread mining activities thus amounted to a geographically large-scale impact on the landscape. In this project we have studied the sediment record from five lakes and two peat bogs in the Norberg iron-mining district, and compared these to a modern pollution event (i.e. a sludge dam barrier rupture) within the same area. One of these sediment records is annually laminated, giving us a precise chronology of environmental changes. Our analyses included mercury and multi-element analyses using XRF, which provides data on lithogenic elements (e.g. Ca, K, Mg, Na, Rb, Sr, Zr), ferrous metals (Fe, Mn) and trace elements (e.g. As, Cu, Pb, Ti, U, Zn) as well as analyses of pollen and total-carbon/nitrogen. The earliest evidence of human impact in the area is c. AD 950, with diffuse signs of forest grazing and a small source of locally derived Pb. From 1250 evidence for an increasing scale of forest clearance (loss of pine, increased charcoal particles) and cultivation (rye) and mining begin, and by 1300 – along with the establishment of a blast furnace – the alteration of the landscape was comprehensive. About AD 1500 the concentrations of many metals increased by 2–10-fold (Zn 2x; Cu 3–5x; As 5x; Hg 10x). Despite declines in mining and metallurgy since 1800 and complete cessation of activities since the mid-20th century, metal concentrations in most cases have remained consistently elevated over the past 500 years, occasionally even overshadowing any modern pollution signal. This reflects the long human-environment interaction and that legacy pollution have lasting impacts on the contemporary environment even long after activities have ceased.