Silica, Al and Pb in atmospheric PM10 and in human lungs in Upper Silesia,Poland

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Upper Silesia (US) is the most densely populated (>1600 people/km^2) and the most polluted region of Poland. Annual average of PM10 concentration is still higher then national standars set by the regulators at 40 μg/m^3. That situation poses a high risk to human health as evidenced by the medical data. In this study silica, aluminium and lead were determined in atmospheric PM10 and in human lung tissues. Silica occurs as quartz and amorphous phase, whereas aluminium is in clay minerals, feldspars, amorphous alumino-silicates etc. Lead occurs in the form of galena, lead chloride and lead oxide. All of those mineral particles are abundant in respirable fraction of PM10 and in ultrafine particles.

Fifteen samples of PM10 and 34 samples of lung tissues from autopsy donors from US (13 female and 21 male) were analysed. Silica was determinated by colorimetry, and aluminium and lead were determined using inductively coupled plasma-atomic emission spectrometry (ICP-AES).

The concentration of silica in PM10 is the range of 1,00 – 34,98 wt. % (the average is 12,11±5,19 wt. %). In human lung tissues the average concentration of silica is 3,03±0,84 wt. % (the minimum value is 0,37 wt. % and the max. 5,65 wt. %). The concentration of aluminium in PM10 ranges from 0,58 wt.% to 2,78 wt. %. The average concentration of Al of 1,69±0,42 wt. % is distinctly higher than the average of Al in human lungs (0,197±0,08 wt. %). The lead content in PM10 ranges from 45 ppm to 1473 ppm, with the average 296±92 ppm. In human lungs the content of lead is 13±3 ppm, (min. 2 ppm, max. 47 ppm).

The presence of abundant Si, Pb, and Al in ultrafine particles is particularly worrisome as it is known, that particles with a diameter less than 0.5 μm immediately infiltrate into blood circulation system similarly to gases [1]. 100% of Pb hosted by ultraparticles is absorbed by lung tissues [2].

References

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SEQUENTIAL DISSIPATION OF A POORLY-VENTILATED WATER MASS UPON THE LAST GLACIAL TERMINATION

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It is believed that no single mechanism can account for the full amplitude of past CO_2 variability. But although multiple synergistic processes may be involved, intensified isolation of deep-water masses from the atmosphere has emerged as a central mechanism for low glacial CO_2. This could have resulted from increased oceanic density stratification, increased sea ice cover, or a decrease wind-driven vertical mixing. Recent evidence is consistent with the existence of a poorly ventilated, carbon-rich water mass in a large portion of the glacial Pacific and Southern Oceans. However, the mechanisms by which this water mass dissipated upon glacial terminations remains a subject of debate.

Here, we present a compilation of sedimentary redox-sensitive trace metal records from the subarctic Pacific and the Southern Ocean to reconstruct changes in deep ocean oxygenation – and, by inference, respired carbon storage - across the last glacial termination.

Our results suggest that the abyssal Pacific and Southern oceans were depleted in oxygen during the last glacial maximum, though they were not anoxic. The large and abrupt increase in sedimentary opal accumulation observed in the Southern Ocean at approx. 18 kyr is accompanied by a decrease in authigenic uranium concentrations suggesting better oxygenation at the depth of the core site. Enhanced mixing within the Southern Ocean, driven by stronger winds and/or changes in the density profile of the water column, would have invigorated circulation at depth, The increase in the rate of nutrient supply to the surface would have enhanced the strength of the Southern Ocean High Nutrient Low Chlorophyll (HNLC) region, and increased the leakage of nutrients into intermediate and mode waters of the southern hemisphere. Simultaneously, the decrease in nutrient-poor NADW to the deep sea, caused by the freshwater forcing associated with Heinrich Event 1, allowed nutrient-rich AABW to dominate the deep ocean. Both of these mechanisms would have increased global preformed nutrient concentrations, previously shown to contribute to higher atmospheric pCO_2, and could have explained the large-scale transfer of carbon from the deep ocean to the atmosphere between 18 and 15 ka. In the subarctic Pacific, the arrival of well-oxygenated abyssal waters appears to have taken place at the onset of the Bolling/Allerod, 14.7 ka, accompanying the reinvigoration of North Atlantic Deep Water, which increased the overall rate of deep ocean ventilation, even as it contributed to an overall decrease in the preformed nutrient load of the global ocean. The fact that atmospheric pCO_2 stopped increasing at this time is consistent with this interpretation. Our results suggest that this stepwise reinvigoration of deep water circulation, resulting from the buffeting of ocean density structure by large inputs of freshwater, was responsible for driving carbon out of the abyssal ocean during the melting of the large continental ice sheets.