4.63.P01

High-resolution reconstruction of air pollution

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Our history is preserved in all kinds of archives. During the last decades, most climate and environmental parameters (e.g. temperature and air quality) are recorded instrumentally. For climate data, we can even rely on written records from the past 200 years. Natural archives (e.g. peat bogs, ice cores and lakes) give us the possibility to extend these records.

Monitoring of Dutch air quality, for example, started not earlier than 1987. In order to reconstruct the air quality, before 1987, we sampled two small lakes near Utrecht. The lake cores were ^{137}Cs dated by using the Pharos core scanner. Based on the ^{137}Cs data it was concluded that the sedimentation rate was fairly constant during the last 60 years (0,8 cm/year for lake Vechten and 1,5 cm/year for Fort bij Vechten). In figure 1 the atmospheric Pb deposition from 1987 to 2002, measured in the lake sediments, is plotted against the air Pb content, measured in the same period in air samples (RIVM data).

Figure 1

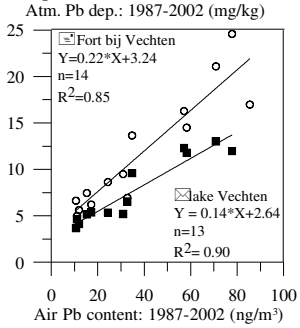
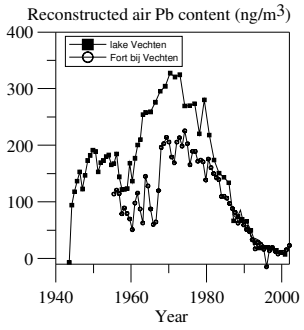


Figure 2



In Figure 1 a good correlation exists between the atmospheric Pb deposition and the air Pb content. Based on this correlation, it was possible to reconstruct the air Pb content before 1987, which is visualised in figure 2. From figure 2 it is clear that the air Pb content increased from 1940 towards the 1970's, followed by a sharp decrease. The increase in the Pb content is caused by an increased usage of leaded gasoline from 1923 onwards. This is confirmed by Pb-isotopic measurements. Not until 1970 legislative measures were taken to curtail Pb in gasoline. After that a strong decline in the air Pb content is observed. In addition, the results in figure 2 show that the air Pb content was higher near lake Vechten than near Fort bij Vechten. This is caused by the position of both lakes. Lake Vechten is located only 50 meters from a highway, while Fort bij Vechten is located more than 500 meters from the same highway.

Our study shows the value of natural archives. The reconstruction of environmental pollution does not only give insight in the history of air pollution, but it also shows the effect of the legislative measures.

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Sulphate in speleothems records atmospheric sulphate variability

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Stable isotope and trace element variability in annually laminated stalagmites are powerful tools to reconstruct past climate changes. From the same archives, information about atmospheric aerosol history can be also obtained by applying to layered stalagmites X-ray microfluorescence (micro XRF) maps coupled with X-ray absorption near edge structure spectroscopy (XANES) to obtain spectra and maps of sulphate concentration trends and distribution. The sulphur molecular environment characterization in two layered Alpine speleothems has been feasible through the high brilliance X-ray synchrotron radiation source at the European Synchrotron Radiation Facility (ESRF) by tuning the energy of the incident X-ray photons from 2.45 to 2.55 KeV across the absorption K-edge, with an energy resolution of 0.25eV. The sulphur spectra showed clear, intense peaks at the energy of highly oxidized sulphur in sulphates at 2.282 keV. In one Modern, annually laminated stalagmite, two parallel scans show steadily increasing S concentration trends from the year 1850 AD. This trend was also observed in the Greenland ice cores and related to increasing anthropogenic sulphate emissions in the Northern Hemisphere. A second, Mid-Holocene specimen, which formed in a pre-anthropogenic emission period, is characterized by a sequence of brown, 10 μm-thick layers dated from 5060 to 5140 ± 140 years BP by MC-ICP-MS U/Th method. The XAF S-sulphate maps of the specimen show that these layers are sulphate rich. The XANES spectra also show sulphate enrichment at the layers with respect to the general composition of the other parts of the stalagmite. The higher S-concentration in laterally continuous layers probably mark events when more sulphate was available to be transferred from the surface to the cave. Volcanic sulphate aerosol emissions were detected in the ice cores at the same age span. Thus, we believe that the brownl layers in the stalagmite correspond to volcanic-related sulphate aerosol emissions. Synchrotron XANES and XAF sulphate mapping in stalagmites thus, provide a powerful tool to extract a record of both natural and anthropogenic sulphate aerosol emissions from archives formed in continental, mid-latitude and low altitude regions.