A multi-isotope approach (Pb, S, N, O and Sr) to estimate the impact of long distance air pollution on sensitive karst groundwater resources

M. Kralik, F. Humer[1], J. Grath[1], J. Nurmi-Legat[1], A. Hanus-Illnar[1], S. Halas[2], N. & M. Jelenc[3]

1 Umweltbundesamt Austria (Federal Environment Agency Austria), Spittelauer Lände 5, A-1090 Vienna, Austria; (martin.kralik@umweltbundesamt.at)
2 Mass Spectrometry Laboratory, Marie-Curie-Sklodowska Univ., PL-20-031 Lublin, Poland
3 Geochronology Lab., Inst. of Geological Sci., Univ. of Vienna, Althanstr. 14, A-1090 Vienna, Austria

The impact of air pollution is a substantial European and global problem which has been observed even in the most remote areas of our planet. Not only surface water, but also groundwater resources are partly endangered by dry and wet deposition from the air. Karst and other sensitive aquifers contribute up to 90 % to the total drinking water supply in some European regions.

However, karst groundwaters are more vulnerable to contamination than other aquifers due to short transfer times from recharge to source. Therefore, the main objective of this paper is to show possibilities to quantify the impact of air pollution on sensitive water resources (e.g. karst), to develop an innovative surveillance tool based on isotopes and meteorological considerations.

Comparison of lead isotope measurements in precipitation, spring waters, soil profiles and dolomite bedrock in a relatively pristine and remote area at the front-range of the Northern Calcareous Alps in Austria with literature data (Novak et al. 2003) indicate that radiogenic Australian gasoline-lead still dominates with 60–80% the composition of the trace lead in the spring waters. In addition to the lead leached from the dolomite bedrock a third source contributes about 5–10%. This second long distance Pb-contribution may originate from coal burning and/or Ag-Pb-ore smelting in Central Europe in the past (Kralik et al. 2006).

The monthly precipitation (May and September 2005) samples show ^{18}O-rich sulphate ions, whereas the soil sulphates change in the direction to lower ^{18}O- and higher ^{34}S values with depth. The spring waters and the bedrock dolomites show relatively low d ^{34}S values (4–9 ‰). Assuming the precipitation samples and the dolomite bed rocks are end-members the contribution of atmospheric sulphate can estimated to be 20 % in the spring waters and between 10 to 45 % in the soil samples.

The $^{87}Sr/^{86}Sr$-isotope results in the precipitation (0.7092) support at least a more radiogenic, far transported source in addition to a possible recycling of local dolomite and

limestone (0.7080-0.7083) dust. Spring waters show similar ratios between 0.7083-0.7084 confirming Sr-isotopes are good indicators for groundwater contact with specific host rocks.

Kralik, M.; Humer, F.; Grath, J.; Numi-Legat, J.; Hanus-Illnar; A.; Halas; S. and Jelenc, M. (2006): Impact of long distance air pollution on sensitive karst groundwater resources estimated by means of Pb-, S-, O- and Sr-isotopes. En: Duran, J.J., Andreo, B. y Carrasco, F. (eds.). Karst, cambio climático y aguas subterráneas. Publicaciones del Instituto Geológico y Minero de España. Serie: Hydrogeología y Aguas Subterráneas N.º 18. 311-317, Madrid

Novak, M.; Emmanuel, S.; Vile, M. A.; Yigal, E.; Veron, A.; Paces, T.; Kelmann, W.; Vanecek, M.; Stepanova, M.; Brizova, E. & Hovorka, J. (2003): Origin of Lead in Eight Central European Peat Bogs Determined from Isotope Ratios, Strength, and Operation Times of Regional Pollution Sources. Environmental Sci. & Technology, 37, 437-445.