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Cobalt in the Atmosphere (October 2006)

This short article aims to bring together information on Cobalt in the atmosphere.

What are the sources for Cobalt in the Air?

As Cobalt is a non-volatile material, it is rarely found in the atmosphere alone. Typically it is found in the air attached to anthropogenic pollutant particles, with a fraction of the cobalt found in natural dust. There are a number of anthropogenic sources for such particles, and natural sources of dust include the weathering of local geology, volcanic eruptions, forest fires and seawater spray. Coarse particles with diameters greater than $2\mu\text{m}$ may be deposited within 10km of the point of emission, whilst smaller particles may travel further. The mass median diameter of atmospheric cobalt has been found to be $2.6\mu\text{m}$ (Milford and Davidson, 1985)

The main sources of atmospheric pollution for cobalt are industrial plants such as incinerators and chemical plants. In many countries, there is a limit on the amount of cobalt which such plants can release. Smaller sources for cobalt entering the atmosphere are exhaust fumes, the burning of fossil fuels (Vouk and Piver, 1983) and agriculture.

How much Cobalt is in the Atmosphere?

Friberg et al (1986) reported average natural background levels of cobalt in the atmosphere at around $1.0 \times 10^{-9} \text{mg/m}^3$ and stated that the atmospheric concentrations of cobalt in remote areas is very low (less than $1.0 \times 10^{-10} \text{mg/m}^3$ in the Antarctic) while in urban areas the ambient air concentration is usually higher (in the order of $1.0 \times 10^{-6} \text{mg/m}^3$ and exceeding $1.0 \times 10^{-5} \text{mg/m}^3$ in heavily industrialised cities). Seiler et al. (1988) reported the cobalt concentrations in ambient air in several places in North and South America and in the United Kingdom and found that the levels were in the range 7.0×10^{-8} to $5.0 \times 10^{-6} \text{mg/m}^3$. Over the open ocean, cobalt concentrations ranged from 0.0004 to 0.08 ng/m^3 (Chester et al. 1991)

Khan et al (2003) investigating dustfall in Peshawar (Pakistan) found levels of cobalt at around $68\mu\text{g}$ per g of dustfall. In the paper these levels were ascribed to industrial uses such as the manufacture of alloys and its use as a catalyst in industry, although no direct evidence was given for this relationship.

Where does the Cobalt end up?

The length of time that cobalt stays in the atmosphere depends upon factors such as meteorological conditions, particle size, density and form. When the dust settles out of the atmosphere it can either land on soil, where it will eventually add to the soil concentration of cobalt, or into water, both of which are discussed in other documents available on this website.

Rainwater washes out any soluble cobalt species which are in the atmosphere. Studies have identified mean cobalt concentrations in rainwater to be between $0.3\mu\text{g/l}$ in rural areas and $1.7\mu\text{g/l}$ in highly industrial areas (Arimoto, 1985; Hansson et al, 1988). Recent data from the Swedish Environmental

Research Institute (ECOLAS, pers comm) indicate that cobalt levels in precipitation over rural areas were below 0.039 µg/l between 2001 and 2003. Equally low values were seen in the Netherlands for 1999 and 2000 with the annual concentration of cobalt in rainwater being 0.001µmol/l, translating to a mean annual cobalt wet deposition rate of 4.1µg/m² in the Netherlands for 1999 and 2000. In comparison a wet deposition level of 12µg/m² was found in Massachusetts Bay as part of a total (wet and dry) of 47µg/m² between September 1992 and September 1993 (Golomb *et al.* 1997).

Studies in the UK have shown that between 33 and 44% of the cobalt occurred as stable organic complexes (Nimmo and Fones, 1997), meaning it was not bio-available to soil dwelling or aquatic organisms. Total Cobalt deposition flux at a site in the Rhone delta in southern France in 1988-1989 was 0.42±0.23kg/km² year with 0.15 kg//km² year in the form of wet deposition (Guieu *et al.* 1991)

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