

## Radiocarbon determination on carbonaceous particles

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*Abstract – Atmospheric carbonaceous particles include biogenic and fossil fuel based components. Radiocarbon is a versatile tool to determine the contribution of each source to elemental carbon (soot or black carbon) and to organic carbon, the two components of carbonaceous particles. Moreover, radiocarbon determination on organic carbon from particulate matter stored in archives such as glacier ice may be used for nuclear dating purpose.*

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Atmospheric aerosol particles include roughly 50% (by mass) of carbonaceous particles. These particles are composed of elemental carbon (EC) – often named black carbon or soot – and of organic carbon (OC). In the context of current discussions on human impact on the atmosphere a quantitative determination of fossil fuel sources and of biogenic sources to these components is needed. One tool to assess this value is a radiocarbon determination, since this radionuclide is extinct in fossil fuel based carbon while it has a well known activity concentration level in carbon from ambient biogenic sources. In order to perform such measurements from atmospheric aerosol samples usually only small amounts of carbon is available, far below the mg-level, which is usually needed for an accelerator mass spectrometric measurements.

A technique was developed that enables a determination of radiocarbon at a mini-tandem accelerator using a novel gas injection system. With such a technique reliable measurements can be performed on a routine basis down to about 10 µg of carbon.

In several field campaigns performed at urban and remote sites in Switzerland aerosol samples were collected with high-volume samplers and processes in order to measure their radiocarbon activity concentrations in the EC and OC fractions. These data are being used by Swiss authorities to control political commitments made in the Kyoto protocol.

Typical values for e.g. the winter period 2006 in Zürich were about 35% fossil and 65% biogenic origin, pointing to a surprisingly large contribution of biogenic sources to these particles (domestic wood fires). The reason is probably the sub-optimal temperature condition during wood burning.

Another application of this technique is nuclear dating of ice. European glaciers contain roughly 50 to 100 µg carbonaceous particles per kilogram of ice. This means that from several 100g of ice a radiocarbon determination of OC becomes feasible. Since in ancient time no fossil fuel sources

disturbed the atmospheric signal, the radiocarbon determination can directly be used for dating purposes.

Several ice cores retrieved from glaciers of the European Alps (Colle Gnifetti, Monte Rosa, Swiss/Italian border), the Andes (Illimani, Bolivia) and from Siberia (Belukha, Altai) were dated using this method in combination with other well established methods such as <sup>210</sup>Pb, T (nuclear weapons peak), stratigraphic layers from well known volcanic eruptions or Saharan dust transport and seasonally varying chemical signals such as ammonia.

It could e.g. be shown, that the oldest ice found close to bedrock at Colle Gnifetti reaches back to the last glacial period (see Figure).

The presentation will briefly summarize the technical developments successfully performed to achieve high quality measurements of aerosol samples in the sub-milligram range, some applications as outlined above as well as ongoing research to couple, in future, on-line HPLC separations to accelerator mass spectrometry.

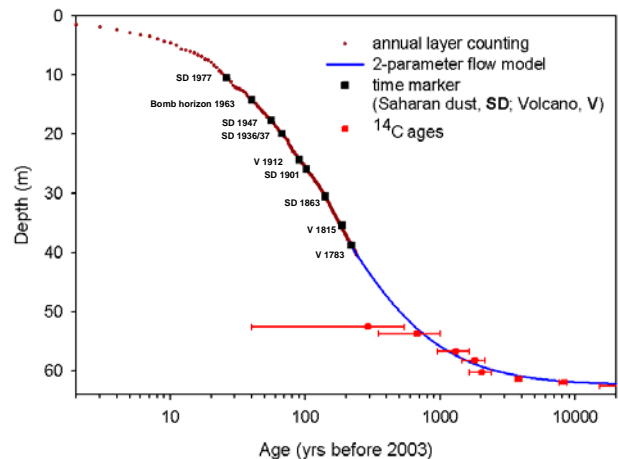


Figure: Depth age relationship for an ice core drilled at Colle Gnifetti, Swiss Alps (4450 m asl). The lowermost part was dated with radiocarbon contained in the OC fraction of carbonaceous particles.