Case Study

One Minute Separations in Ice Core Samples Using Capillary Ion Chromatography

Ice Core Analysis

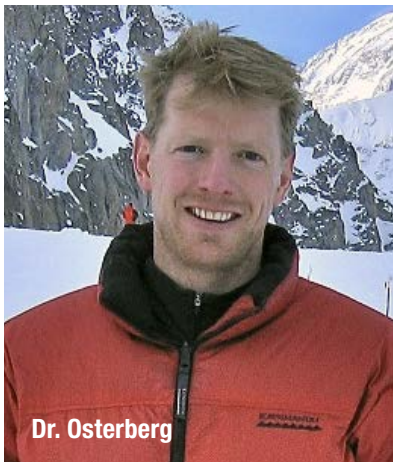
Challenges

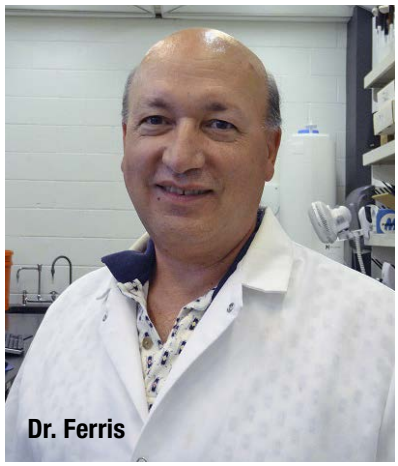
The chemistry of ice core samples provides insight into understanding the history of both climate change and atmospheric pollution. A key challenge for labs performing ice core analysis is minimizing the sample size of these precious ice core samples.

Solution

Capillary Reagent-Free™ Ion Chromatography (IC) simplifies ice core analysis by:

- Requiring smaller injection volumes
- Improving sensitivity
- Providing time savings with automated eluent generation


Dr. Osterberg


Dr. Ferris

Dr. Erich Osterberg: ***"Capillary IC takes ice melting technology to a whole new level. Smaller volume injections require less ice which leaves more for other analyses. Sensitivity is also a major improvement when using the Dionex Capillary ICS-5000 system. Limits of detection have gone down by an order of magnitude."***

Dartmouth Ice Core Lab

Dr. Erich C. Osterberg is an Assistant Professor at the Dartmouth College Department of Earth Sciences in Hanover, NH. He is also head of the Dartmouth Ice Core Lab which is managed by Dr. David Ferris. The lab's primary research objective is to understand the history of climate change and atmospheric pollution by analyzing the chemistry of ice core samples. Research activities evolve based on emerging global concerns. For example, the Asia Pacific region is currently concerned with lead and mercury contamination in ice cores. Globally, analyses of organic pollutants are increasingly important as well.

The chemistry of ice cores can be preserved in samples that are hundreds of thousands of years old. These ice cores (up to 3,000 meters long) are collected from mountain glaciers and ice sheets found in Alaska, Greenland and Antarctica to help predict future responses to continued global warming.

Tracing Sample Impurities using IC

The ice cores are collected using mechanical drills and stored in various freezer facilities. A continuous ice core melter system with discrete sampling facilitates major ion (low µg/L), trace element (low ng/L), and stable water isotope analyses progressively along the length of the ice core. However, the concentrations of major ions provide the essential data stream required from each ice core to develop a time scale and to understand past climate change. The majority of sample impurities can be traced to certain cations (sodium, potassium, magnesium and calcium) and anions (chloride, nitrate, sulfate) which are measured using ion chromatography (IC).

Thermo SCIENTIFIC

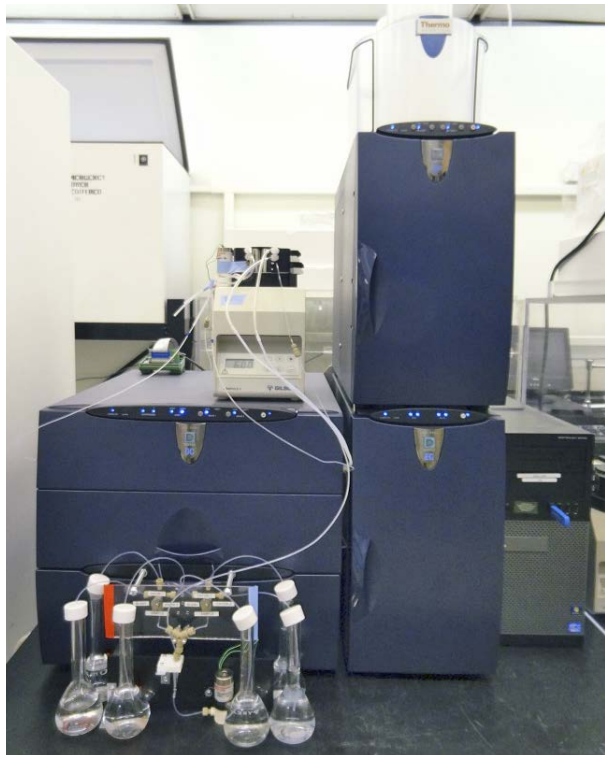
Dr. Ferris has been performing ion analysis of ice core samples for over 14 years using Thermo Scientific™ Dionex™ IC systems. An ongoing challenge with ice core analysis is effectively minimizing the sample size of these precious ice core samples as well as limiting any contamination. Formerly at South Dakota State University, his lab would inject 0.25 mL samples sequentially every minute using four paired cation and anion analytical IC systems. This method was highly effective but required the use of relatively large amounts of ice core sample which are generally limited and difficult to collect.

Dr. David Ferris: ***"Ion chromatography is key to ice core chemistry analysis. Among the ions we analyze, sulfate is a very important measurement for determining annual layers and volcanic eruption history and is best quantified using IC."***

Smaller Volume Injections using Capillary IC

At Dartmouth College, the lab is running approximately 400 ice core samples daily and separately for cation and anion analysis. Dr. Ferris purchased the Thermo Scientific™ Dionex™ ICS-5000 Reagent-Free™ Capillary HPIC™ system for the lab.

Capillary IC systems can offer significant benefits in trace analysis where sample volumes might be limited. Smaller injection volumes can provide trace level determinations since injection volumes and flow rates are scaled down by a factor of 100 when using capillary columns. The lab performs 5 µL injections every minute on a single Dionex ICS-5000 Capillary IC system. Consequently, significantly less ice is required for analysis which is a huge advantage when working with precious ice core samples. Furthermore, sensitivity has improved with limits of detection dropping by an order of magnitude.



Dionex ICS-5000 system

Time and Labor Savings using RFIC

At South Dakota State University, Dr. Ferris recalls spending a day per week on manual eluent preparation. It was problematic to continually adjust eluent strength. The Dionex ICS-5000 Capillary system is also a "reagent-free" ion chromatography (RFIC) system which automatically creates the required eluents by only using deionized water.

Dr. Ferris: ***"Having to make and adjust eluent for eight ICs consumed 1 day per week. Using RFIC systems, this time is used for analysis. The RFIC system also makes developing and fine tuning a method much easier and faster."***

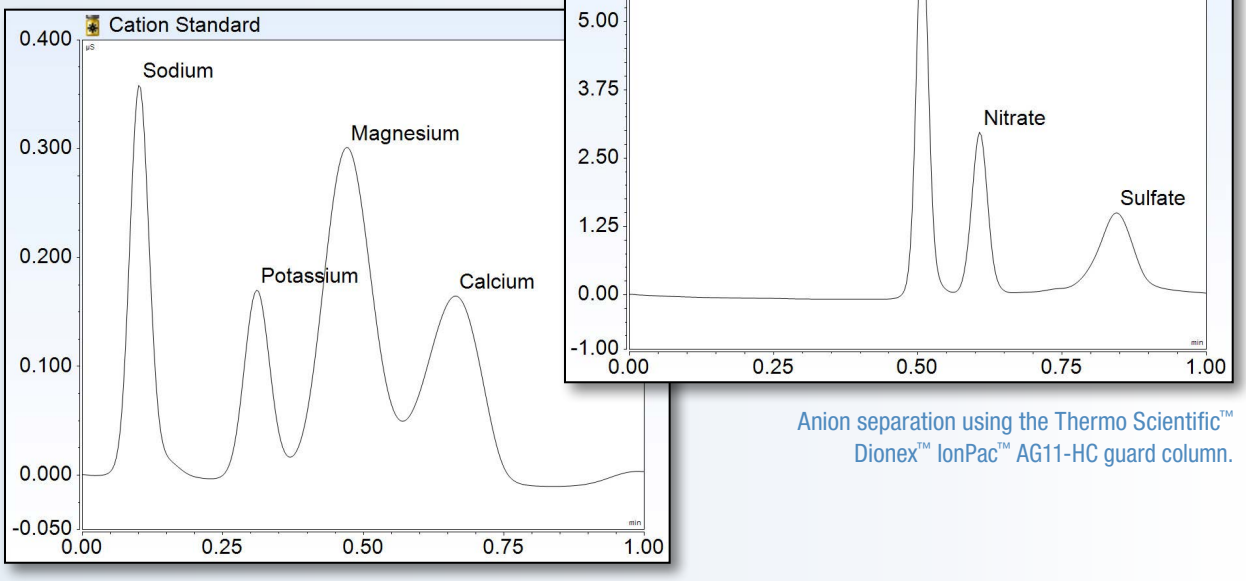
Easy-to-Navigate Dionex Chromeleon CDS Software System

Dr. Ferris is also a long time user of the Thermo Scientific™ Dionex™ Chromeleon™ Chromatography Data System (CDS) software, recently upgrading to version 7.1. Dr. Ferris is able to quickly customize control panels through an easy to navigate interface on Chromeleon 7.1 CDS.

Dr. Ferris: ***"Our service engineer explained the differences between using the preceding version and Chromeleon 7.1 CDS. Once I learned Chromeleon 7.1 CDS, I quickly noticed how much easier it was to move around panels and make changes."***

Overall, the lab finds capillary RFIC to be beneficial in terms of smaller injection volumes, improved sensitivity and time savings with automated eluent generation for ice core sample analysis. Chromeleon 7.1 CDS enables the lab to quickly analyze results with an intuitive user interface. As a result, Dr. Ferris and Dr. Osterberg find working with Thermo Fisher Scientific to be a very positive experience.

One Minute Anion and Cation Separations



Anion separation using the Thermo Scientific™ Dionex™ IonPac™ AG11-HC guard column.

Cation separation using the Dionex IonPac CS12A column.

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