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Microfluidic device for continuous-flow analysis of organics in oldest ice

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The Beyond EPICA Oldest Ice (BEOI) project will drill an ice core dating back to 1.5 million-years (1.5 Myr) ago. This ice core is of particular interest to the scientific community as it will be the only one covering the climate history of the Mid Pleistocene Transition, when glacial-interglacial cycles changed from a 40 Kyr to 100 Kyr cyclicity, and for which causes are not well understood currently. Obtaining useful climatic information beyond 800 Kyr represents an analytical challenge due to the fact that the deepest section of the ice core is very compact and the amount of sample available is very low.

Current analytical methods for the determination of organics in ice are characterized by a large number of steps that requires large amounts of sample for a single analysis. This results in the loss of the high time resolution desired from ice cores which is particularly problematic for deeper (i.e. older) records where the ice is more compact.

This work aims at combining the growing field of microfluidics with improvements to conventional mass spectrometry to allow for continuous analysis of organics in ice cores, melted in continuous on a melting-head. In fact, microfluidic is a powerful technology in which, only a small amount of liquid (10^{-9}-10^{-18} liters) is manipulated and controlled with an extremely high precision. The method invokes a three-step process: (1) the melted ice core sample is sent to a nebulizer to produce aerosol, then (2) the aerosol is dried to remove water content and concentrate the sample, and (3) the aerosol is sent to a mass spectrometer for continuous analysis through a modified electrospray ionization (ESI) probe.

This novel system, once operational, can be applied to a range of ice cores but is especially useful for older ice cores given the stratification of deeper segments. It will allow the research community to measure organic compounds with a high time resolution, even in the oldest of ice, to retrieve paleoclimatic information that would otherwise be lost using traditional methods.