Rare earth elements and other trace elements in Greenland aerosols

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Introduction

Aerosols in ice-core and snowpit samples provide information on past atmospheric conditions and change in aerosol sources. Environmental pollution is can be measured by investigating trace elements in Arctic (Richard et al., 2012; Svensson et al., 2000). Specifically, rare earth elements (REEs) reflect the characteristics of the original site of provenance. REE is a useful tool for estimating source regions (Kang et al., 2007; Soyol-Erden et al., 2011).

Materials and Methods

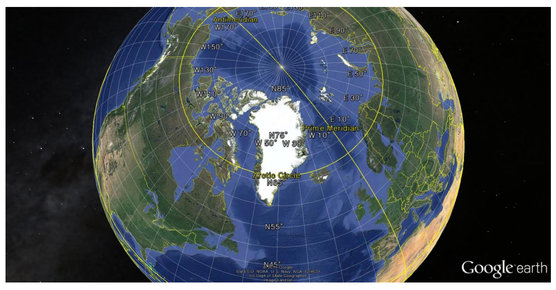

Fig. 1. Site of Greenland.

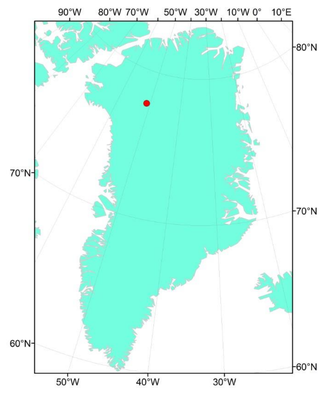

Fig. 2. Site of NEEM (North Greenland Eemian Ice Drilling).

Sample site

The sampling was conducted on June 2009 at a site located 2461 m (77°26'81'' N, 51°56'78'' W, NEEM) (Fig. 2). Total samples are 70, which were collected a 3.2 m depth snowpit.

All samples were kept frozen (-20℃) and transported to the Korea Polar Research Institute (KOPRI).

Experiment

At KOPRI, samples were melted in acid cleaned LDPE bottle.

Particles were counted by coulter-counter.

Cation and anion concentrations were measured by ion chromatography for seasonal features.

Stable water isotopes ($\delta^{18}O$ and δD) were measured by wavelength scanned cavity ring-down spectroscopy. Ratio of $\delta^{18}O$ and δD is changed with temperature variation, precipitation and origin of vapor. (Davies et al.,2010).

Trace elements and REEs were measured by inductively coupled plasma sector field mass spectrometry in a clean booth (class: 10) (Soyol-Erden et al., 2011).

Acknowledgement

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Results

Summers and winters are calculated by result of $\delta^{18}O$ and δD concentrations. Samples present five winters and six summers during 2003 to 2008(Fig. 3). Number of particles and sulfate concentrations shows correlation without seasonal feature (Fig. 4).

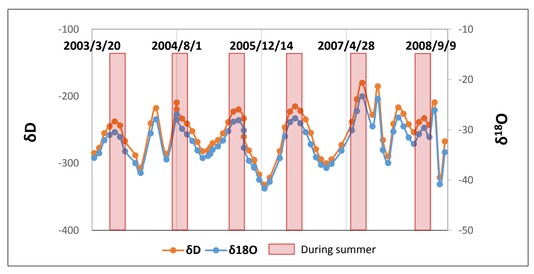

Fig. 3. seasonal variation from $\delta^{18}O$ and δD concentrations.

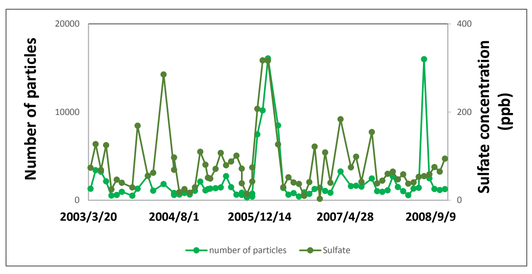

Fig. 4. Number of particles (1.06-6.0 μm particles number/ 1 mL) and sulfate concentration.

All REE data was normalized by Post-Archean Australian Shale (PAAS) for interpreting a REE pattern. There is middle-REE (MREE) enrichment pattern in whole observation period (2003-2008) (Fig. 5).

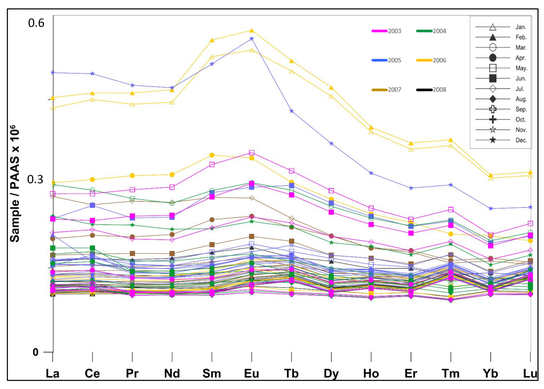

Fig. 5. REE pattern during 2003 to 2008 at NEEM snow pit.

Table. 1. SLRS-5 certified concentrations, measured values expressed as recovery rate and reproducibility expressed as % RSD.

	Heimburger et al., 2012			This study		
Element	n	SLRS-5 concentration	% RSD	n	SLRS-5 concentration	% RSD
La	6	196 ± 11	0.4	12	215±12	5.4
Ce	6	236 ± 16	1.3	12	266 ± 15	5.6
Pr	6	46.9 ± 2.5	1.2	12	53 ± 5.2	9.7
Nd	6	185 ± 20	2.0	12	205 ± 14	6.8
Sm	6	32.4 ± 3.3	2.2	12	35.9 ± 3.5	9.7
Eu	6	5.6 ± 1.4	2.3	12	6.1 ± 0.5	7.8
Gd	6	24.9 ± 3.0	2.8	12	29.5 ± 2.2	7.2
Tb	6	3.2 ± 0.6	2.5	9	3.3 ± 0.3	9.9
Dy	6	18.2 ± 2.5	0.8	12	19 ± 1.2	6.2
Ho	6	3.6 ± 0.5	2.3	9	3.5 ± 0.4	11.3
Er	6	10.5 ± 1.0	2.5	12	11.0 ± 0.8	7.6
Tm	6	1.3 ± 0.3	2.4	9	1.4 ± 0.2	15.9
Yb	6	9.3 ± 0.7	3.2	9	9.9 ± 1.0	14.0
Lu	6	1.5 ± 0.2	2.3	9	1.5 ± 0.1	10.1

Discussions

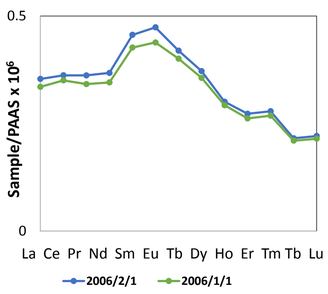

Fig. 6. Unique REE patterns in 2006.

There is unique REE pattern in January and February, 2006. It shows different dust source.

Alaskan volcanic dust can reach and deposit in Greenland (Peter and Siwan, 2012). Augustine volcano was occurred in 2006, Alaska (Alaska Volcano Obsevatiatory)

There is one suggested idea that specific REE pattern based on particle and sulfate data is estimated proxy of volcanic activity (Fig.4 and Fig. 6) .

Most of Mo is released from coal combustion. Pb and Zn are mainly from producer of non-ferous metal production (Nriagu and Pacyna., 2001).

Trace metal enrichment factor (EF) normally using to evaluate changing trace metal input in local area. EF calculation is using local soil elemental compositions and reference element compositions. Local area trace metal EF is calculated by normalized to ratio of the upper continental crust (Hong et al., 2009).

Normalized Pb and Zn concentrations have slightly decreased from 2003 to 2008. However, Mo concentration has gradually increased (Fig. 7).

Trace metals that are originated from fossil fuel combustion and smelting in Asia has effect on Greenland snowpit (McConnell and Edwards., 2008).

Although Pb and Zn concentrations are reduced, fossil fuel pollution increased during 2003 to 2008 in NEEM site, Greenland.

It is estimated that fossil fuel pollution was increased during 2003 to 2008 in Asia.

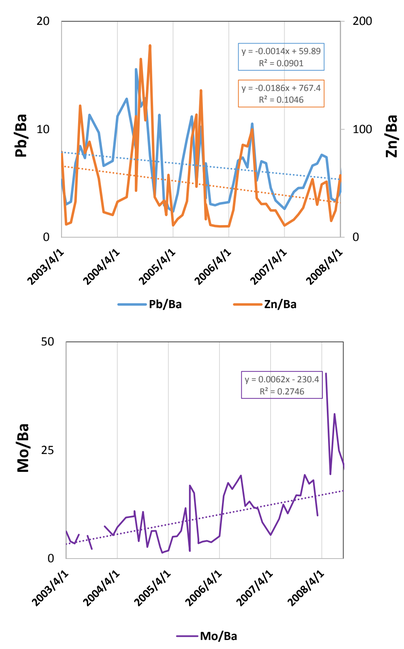

Fig. 7. Upper: Pb and Zn concentration which is normalized by Ba concentration.
Lower: Mo concentration which is normalized by Ba concentration.

In this research, variation on trace elements measurement can be indicate to find features of trace elements and REE sources in NEEM, Greenland.

Further work

Find the feature of MREE enrichment pattern on REE.