Deposition of atmospheric selenium to the northern Greenland ice sheet during the 1900-1970 AD

이강현[1], 한영철[1], 문장일[1], 전성준[1,2], 허순도[1], 홍성민[2]

[1] KOPRI, [2]Inha univ.

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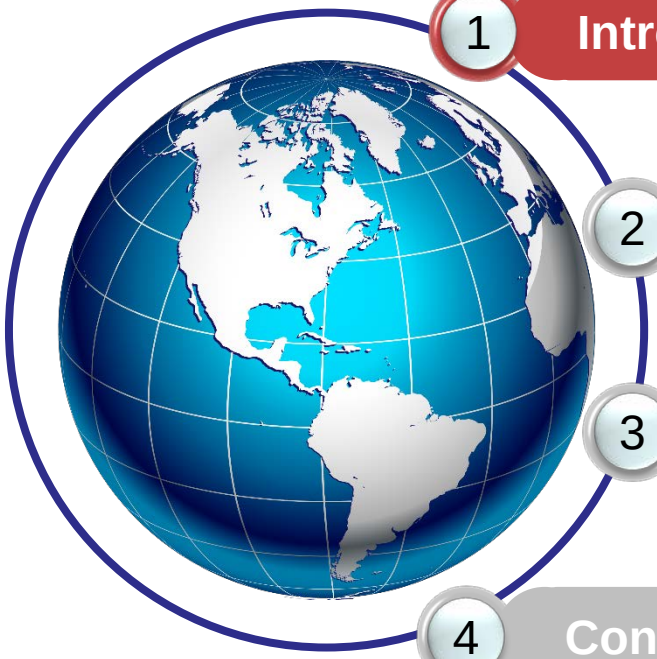

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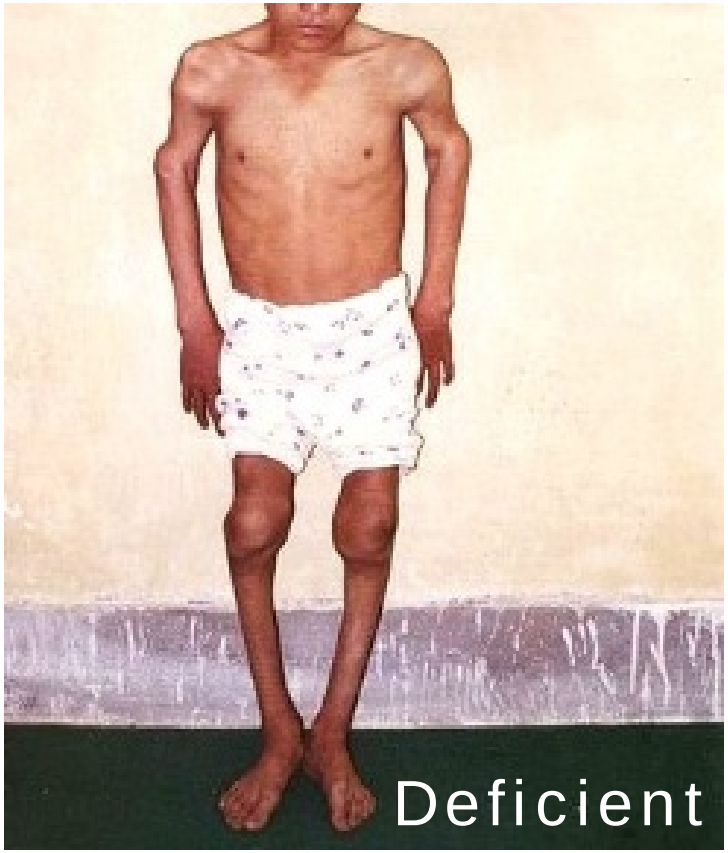
Essential for health

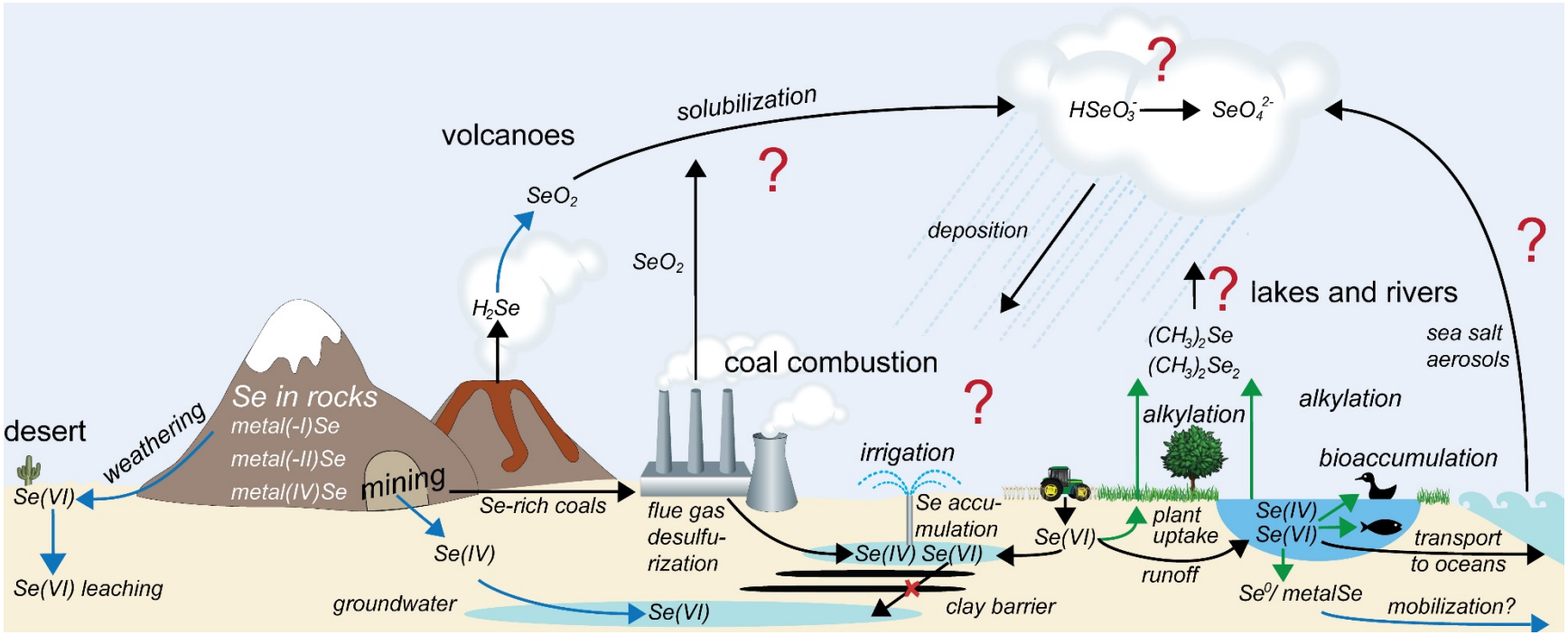


<http://www.mineravita.com/en/selenium-disease.html>

vs.

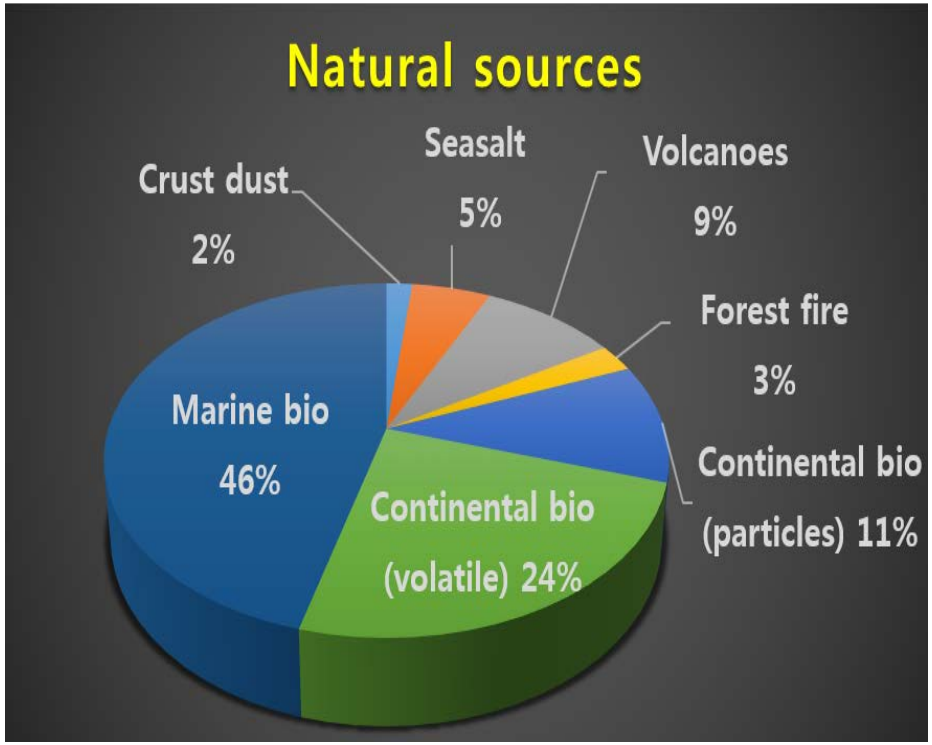
<http://www.vth.colostate.edu/poisonous_plants/>

Biogeochemical cycle

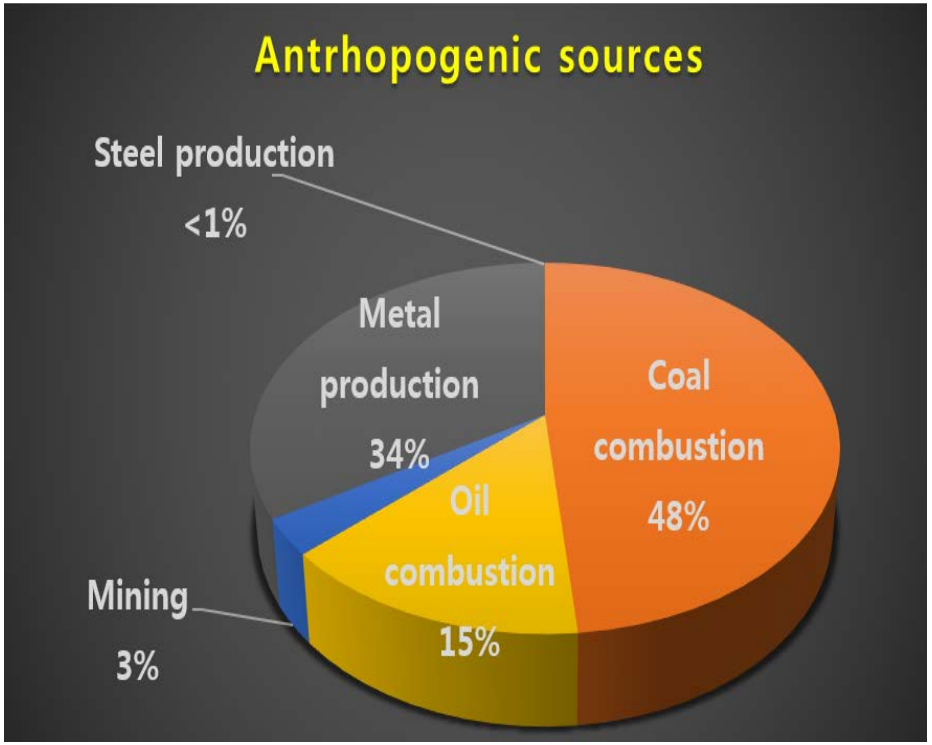


<http://www.ieg.ethz.ch/research/research-interests.html>

Sources for atmospheric Se



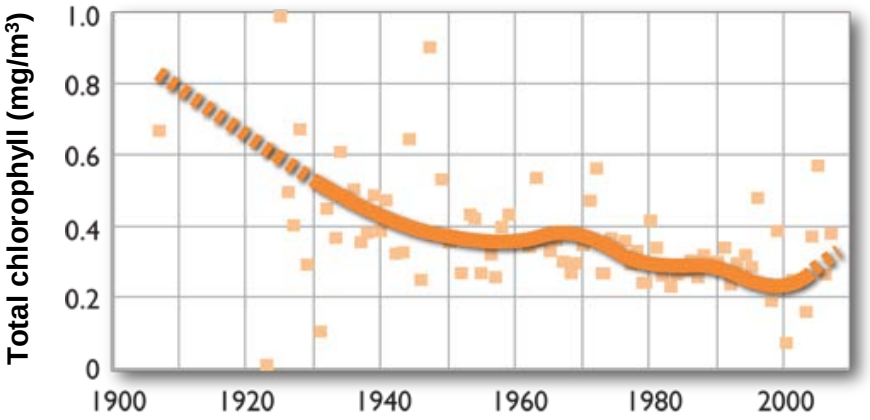
<Nriagu and Pacyna, 1989>



<Nriagu, 1988>

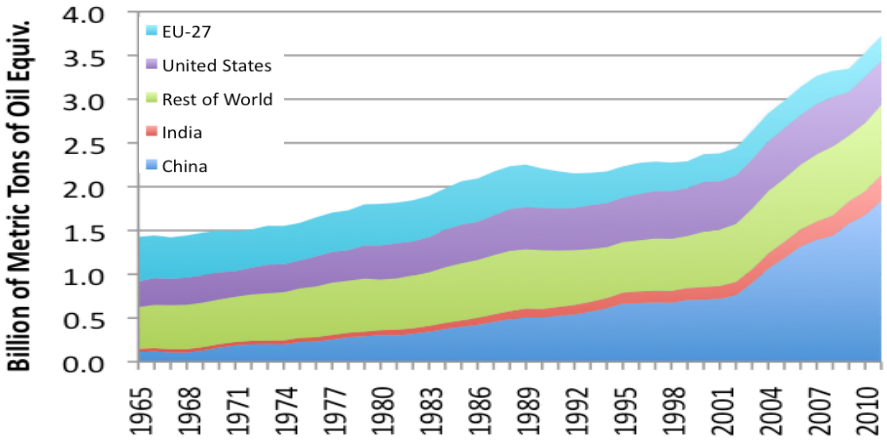
Purpose of the study

<Primary production in North Pacific>



<Boyce et al., 2010>

<World coal consumption>



<BP's 2012 Statistical Review of World Energy>

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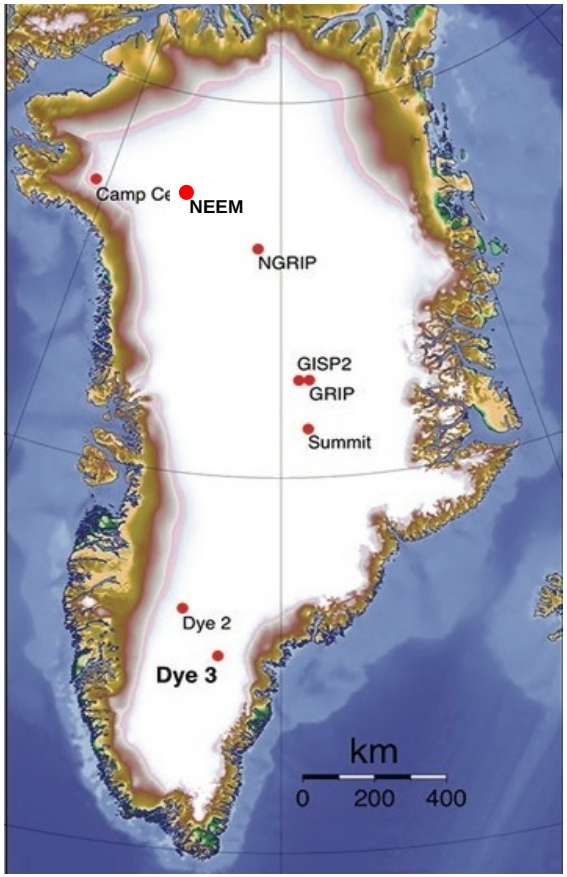
NEEM deep ice core project



International ice core research project	
Site	77.45°N, 51.06°W
Camp	2007~2011
Length	2542 m
Age	108000 yr B2K at 2203.3 m

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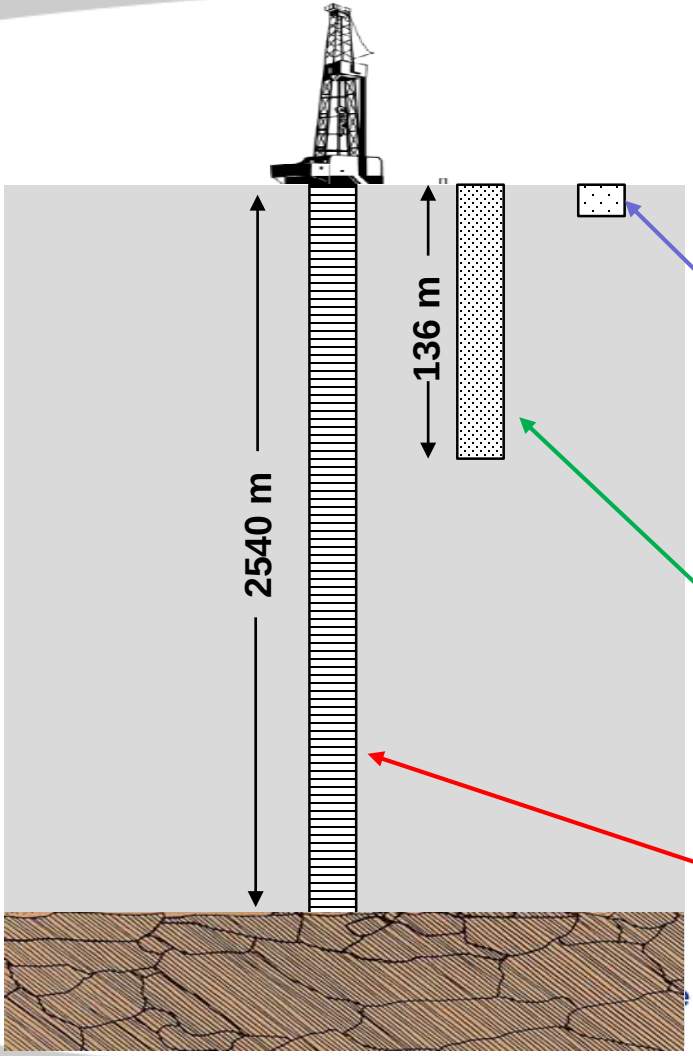
Samples in KOPRI

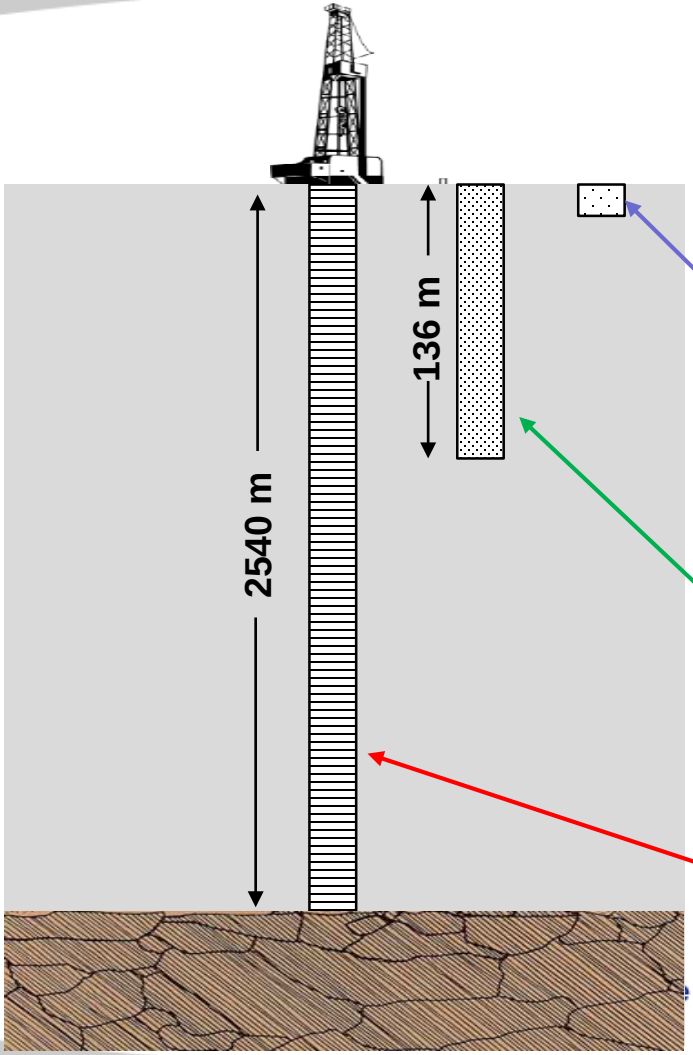


❖ **Snow pit** (2009)
- 0~3.2 m (2003~2009 AD)
- present condition of atmospheric environment

❖ **Firn core** (2009)
- 2~87.8 m (~194 years BP)
- natural vs. anthropogenic influences on atmospheric environment for last 200 years

❖ **Deep ice core** (2007-2011)
- 98~2200 m (350~108000 years BP)
- climate change impact

Samples in KOPRI



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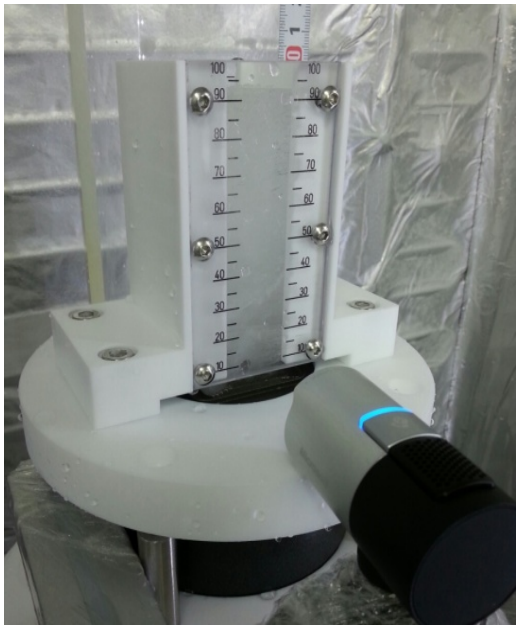
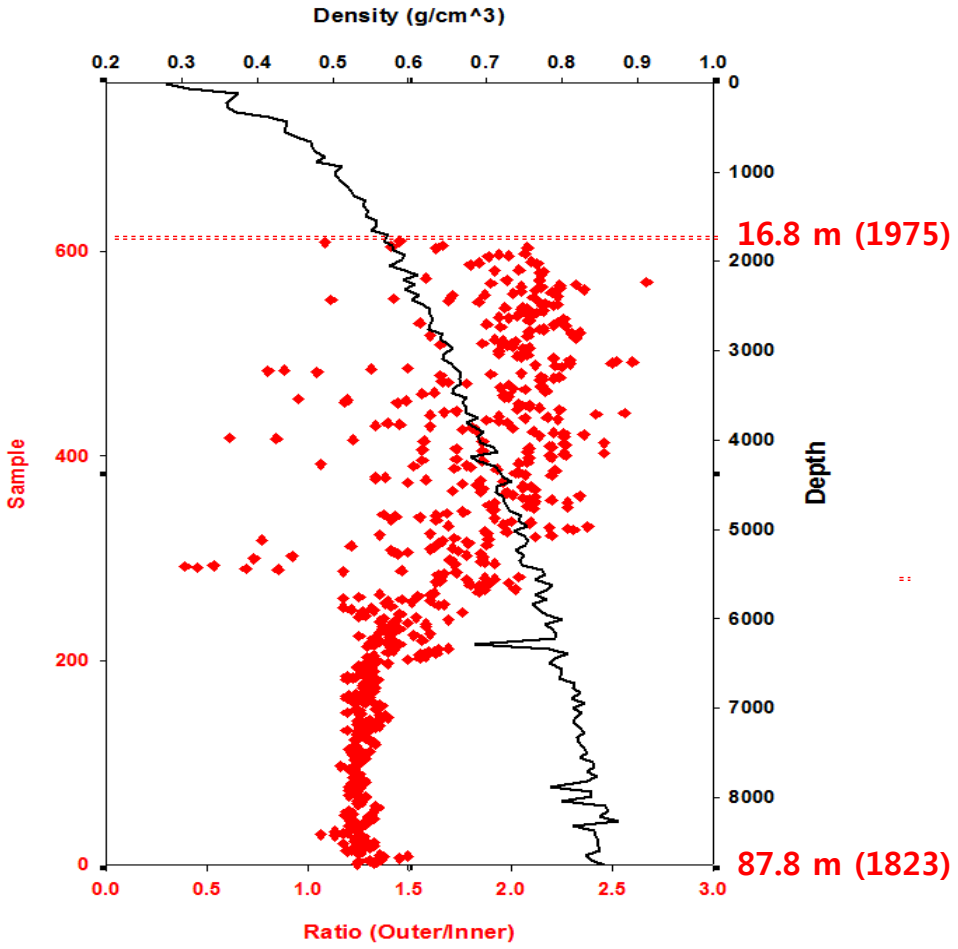
Melting process



- 586 samples (16.8~87.8 m)
- Length: 8~18 cm
- Duration : 0.1~0.8 year



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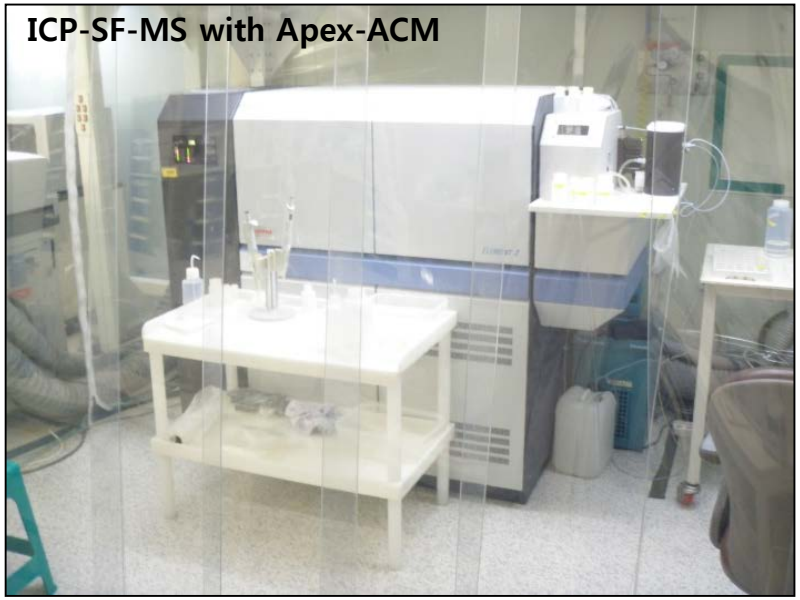
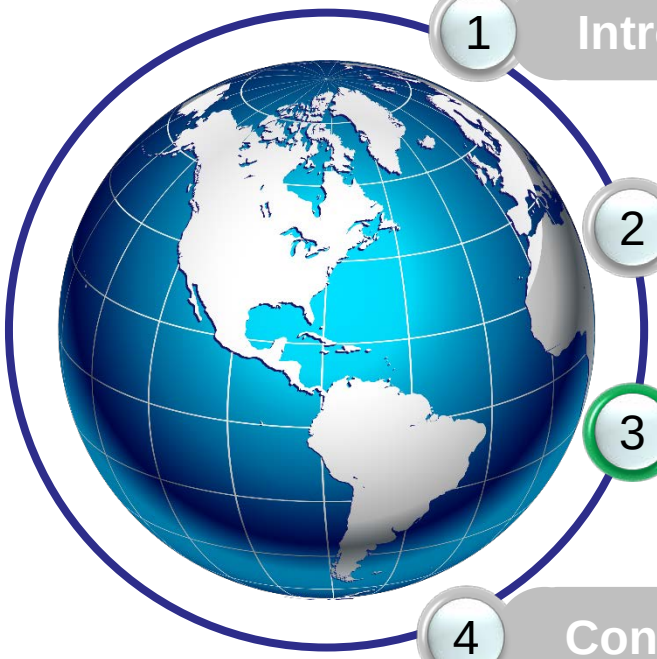
Data acquisition



- 322 samples from NEEM ice core
  - 1823 ~ 1975 AD (1902~1975 for Se)
- 38 samples from Euro ice core
  - 1773~1965 AD
- 22 samples from GRIP ice core
  - 500~9000 yr BP

	Measured	Certified	Accuracy (%)
Al	132.3 ± 6.0	138.3	95.6
As	58.2 ± 1.7	59.0	98.7
Ba	547.4 ± 4.4	531.0	103.1
Bi	13.5 ± 0.2	13.8	97.9
Cd	6.7 ± 0.1	6.4	104.9
Co	29.4 ± 1.2	26.4	111.5
Cr	19.7 ± 1.2	19.9	98.8
Cu	21.4 ± 1.8	22.2	96.2
Mn	37.1 ± 1.9	38.0	97.7
Mo	119.4 ± 0.9	118.5	100.7
Ni	56.6 ± 4.7	60.9	92.9
Pb	20.7 ± 6.6	19.2	107.9
Rb	14.8 ± 0.2	13.8	107.3
Sb	57.7 ± 0.6	56.9	101.4
Se	**11.7 ± 1.0**	**11.7**	**100.4**
Sr	340.6 ± 3.2	315.2	108.1
Tl	7.4 ± 0.1	7.3	102.0
V	34.0 ± 3.2	36.9	92.1
Zn	73.7 ± 5.1	76.5	96.3



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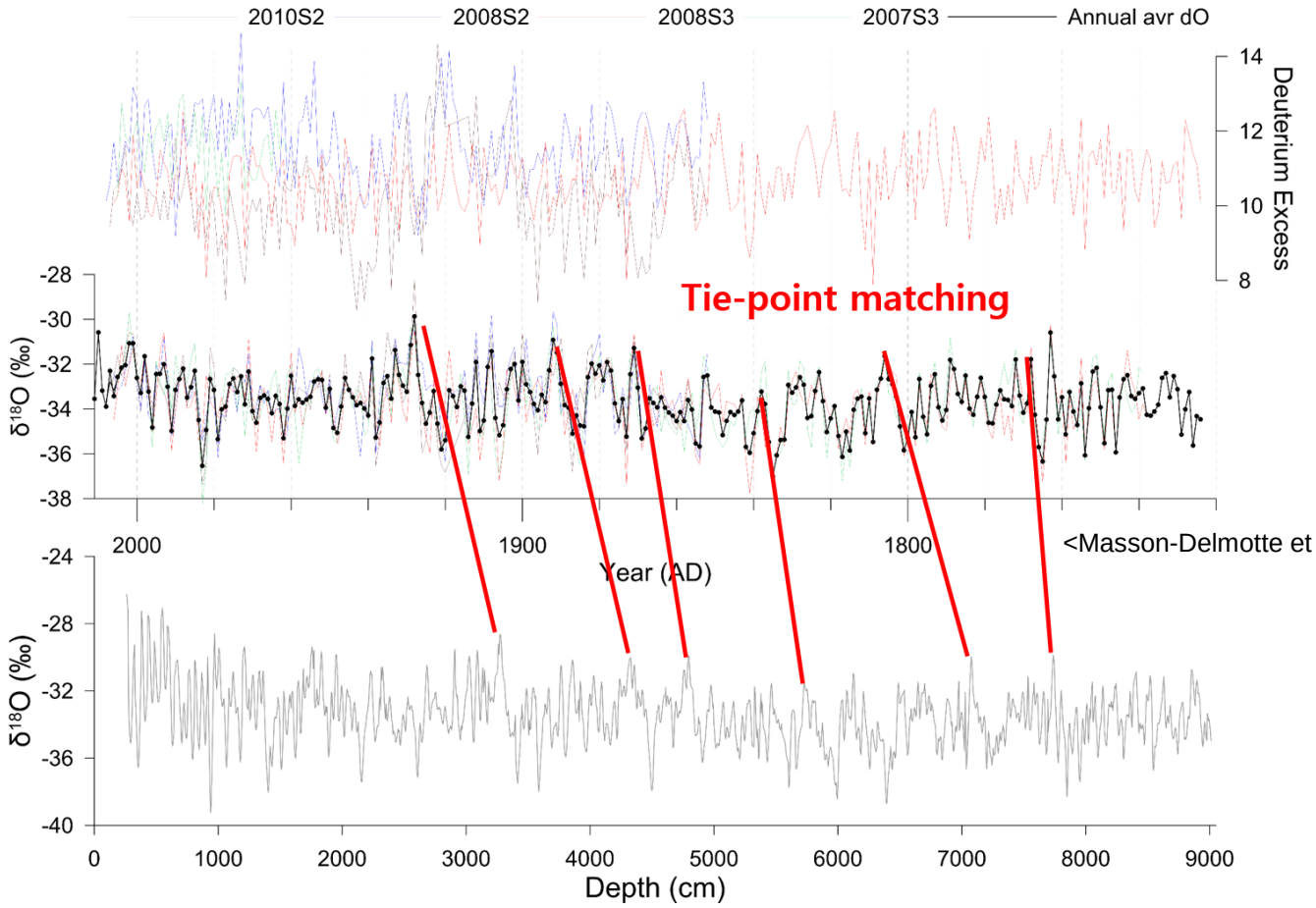
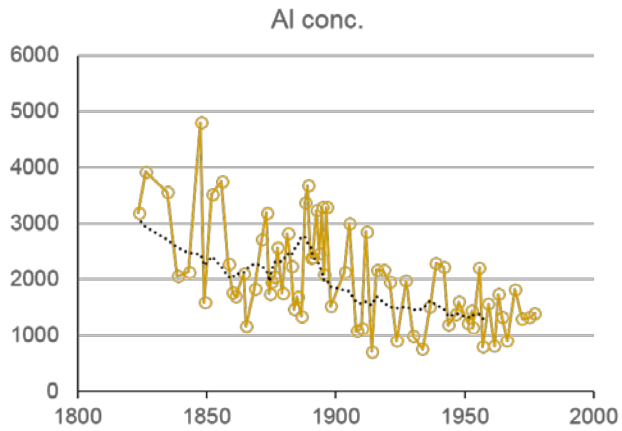
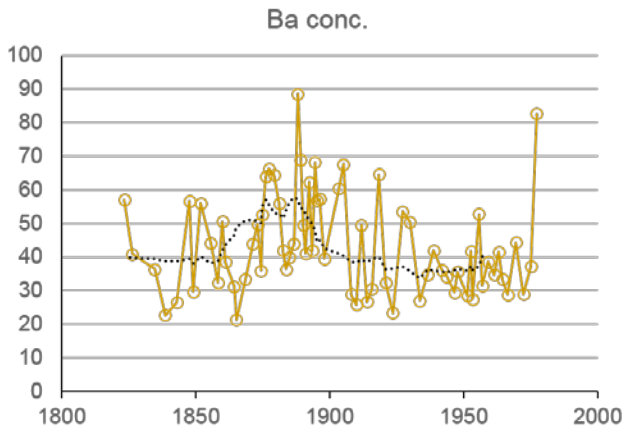
Age dating

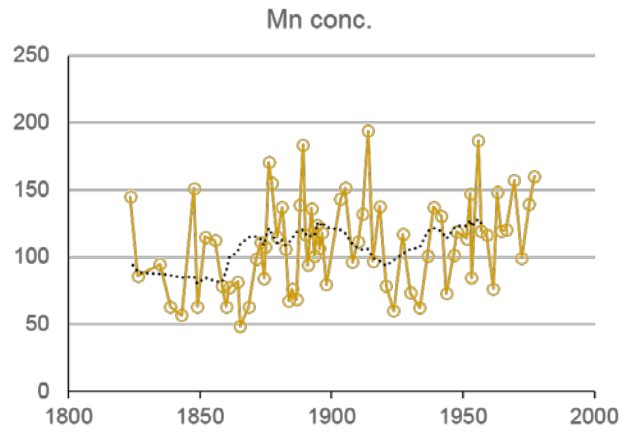


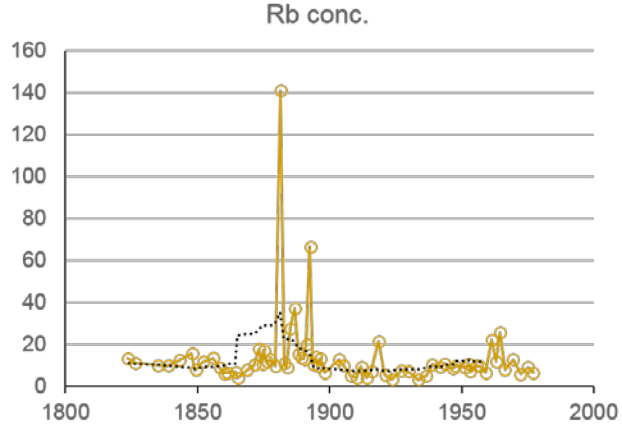
<Masson-Delmotte et al., 2015>

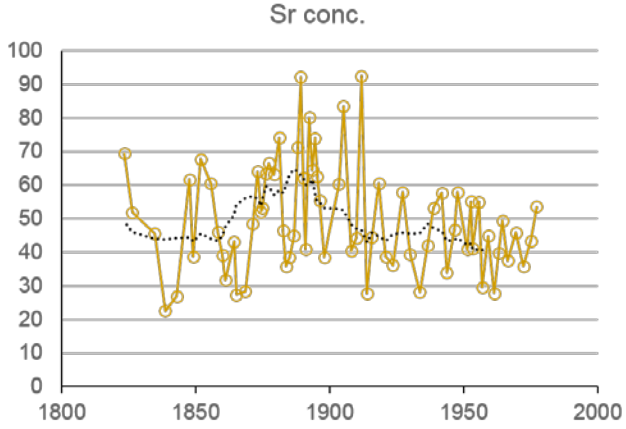
Dust origin trace elements

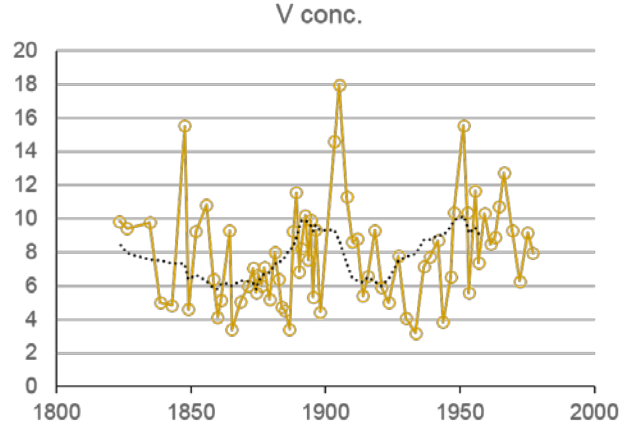












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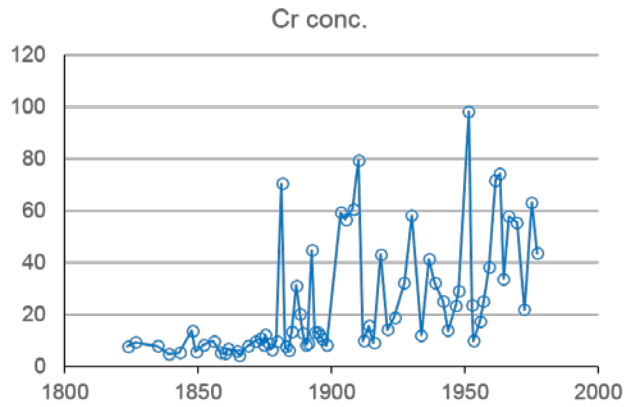
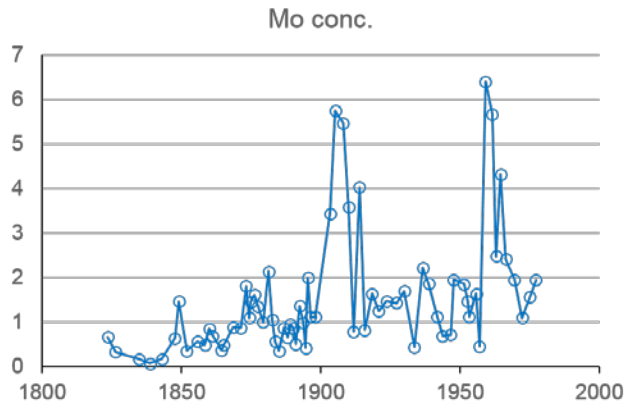
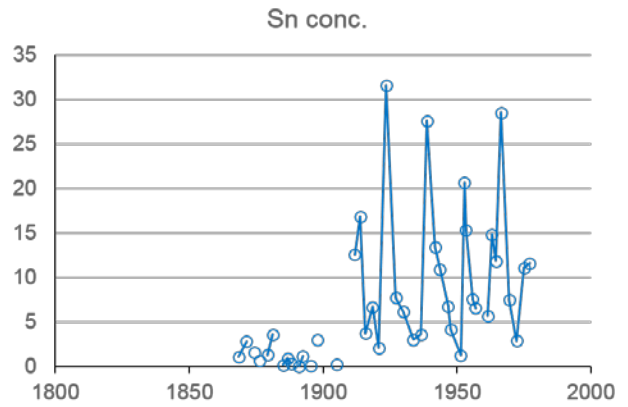
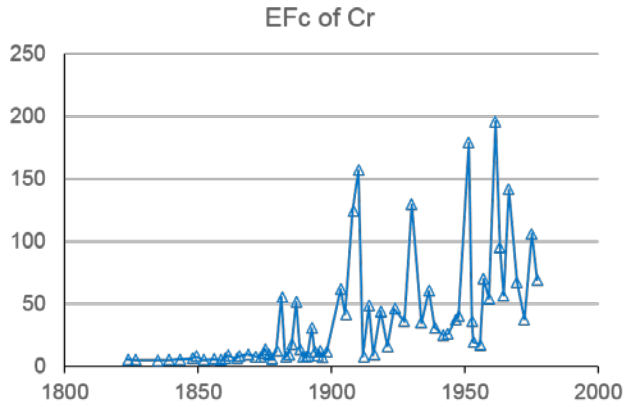
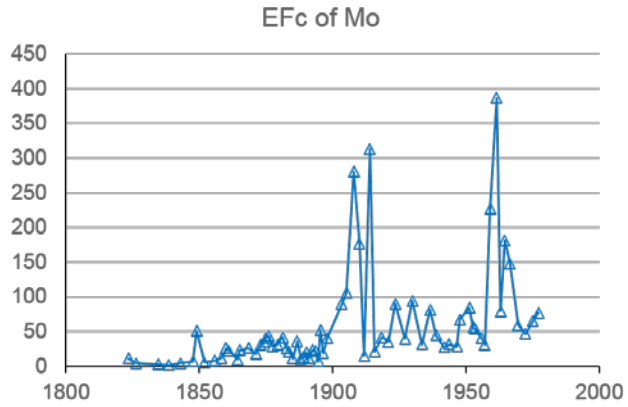
Anthropogenic (Coal) trace elements

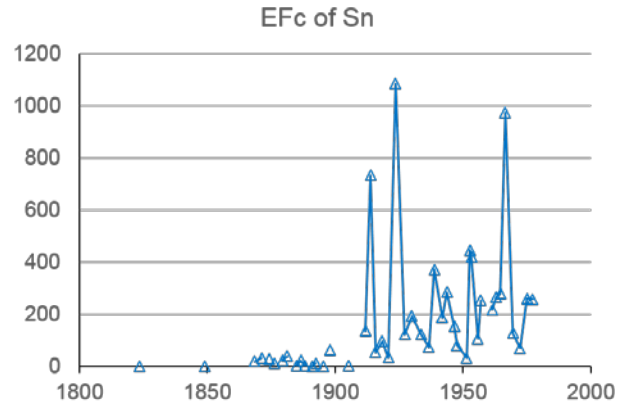












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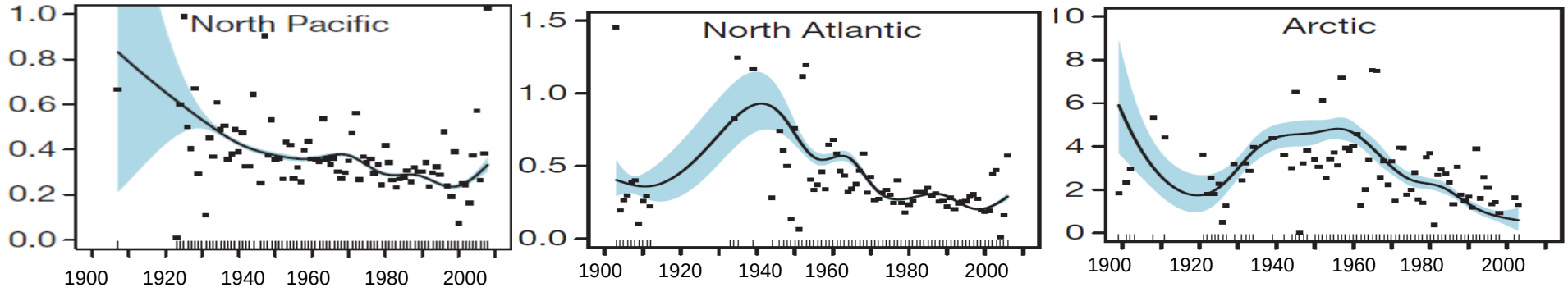
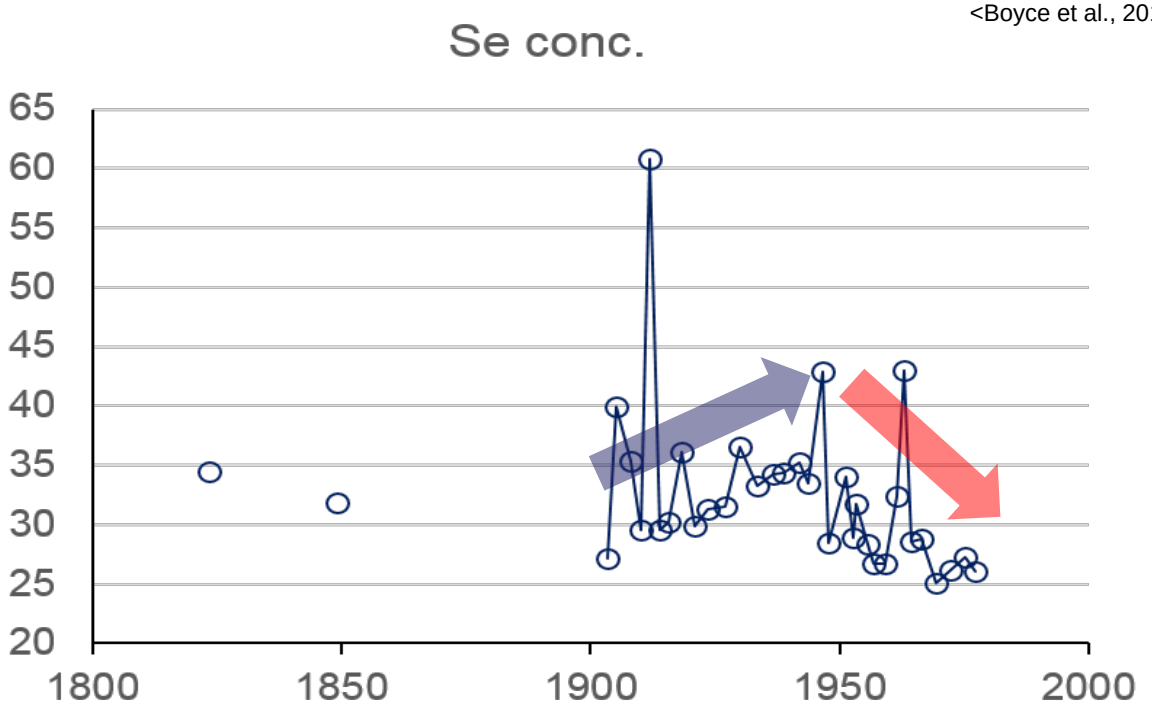
Se record of NEEM ice core



<Boyce et al., 2010, Nature, Vol. 466, 591-596>



Air mass trajectories

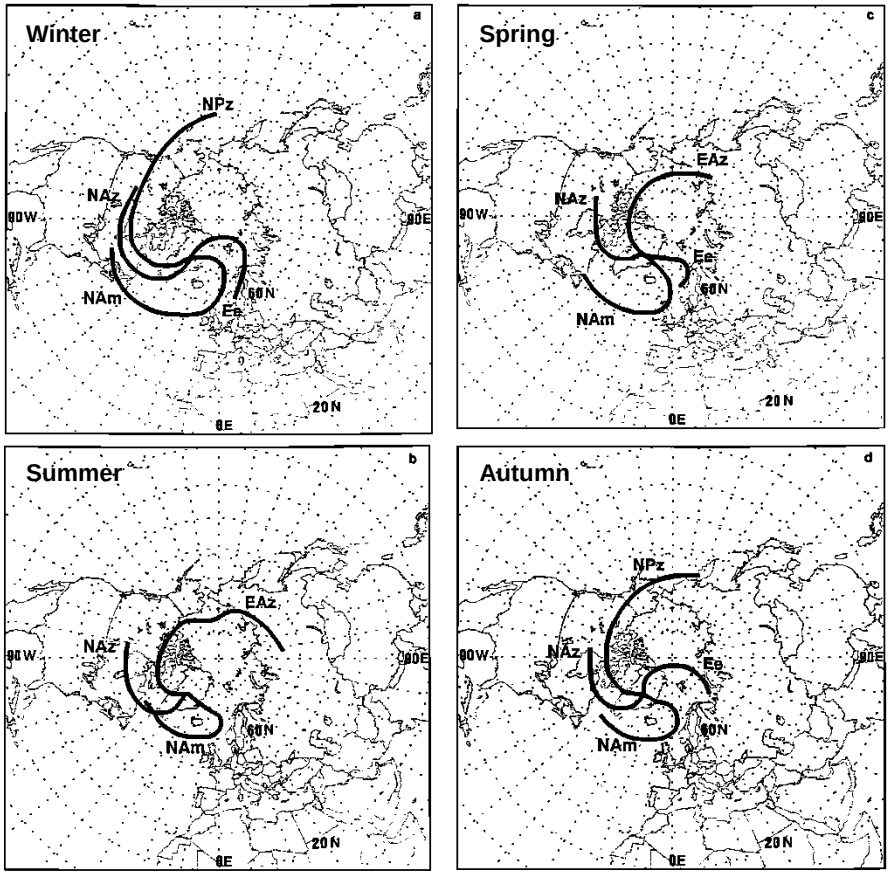


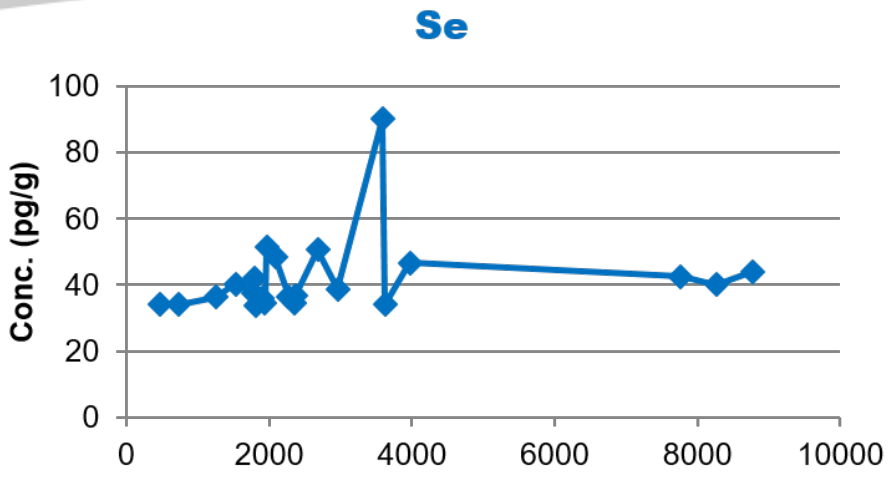
Table 3. Summary of Source Regions and Transport Routes for 10-day, 700-hPa Back Trajectories to Summit, Greenland

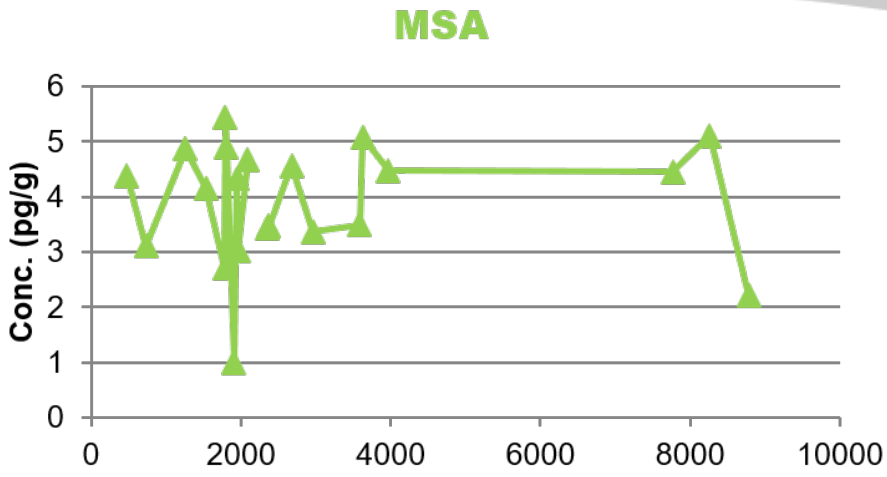
Season	North America[a] Zonal (NAz)	North America[b] Meridional (NAm)	North Pacific Zonal (NPz)	Europe Easterly (Ee)	East Asia Zonal (EAz)
Winter	70%	2%	19%	7%	–
Spring	85%	3%	–	--	8%
Summer	85%	3%	–	6%	6%
Autumn	74%	4%	17%	5%	–

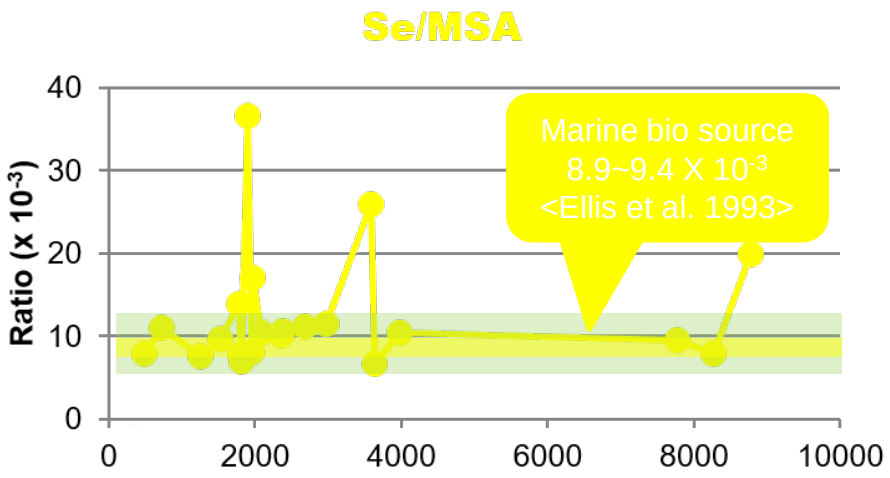
a Principally westerly transport.
b Arriving at Summit from the east.

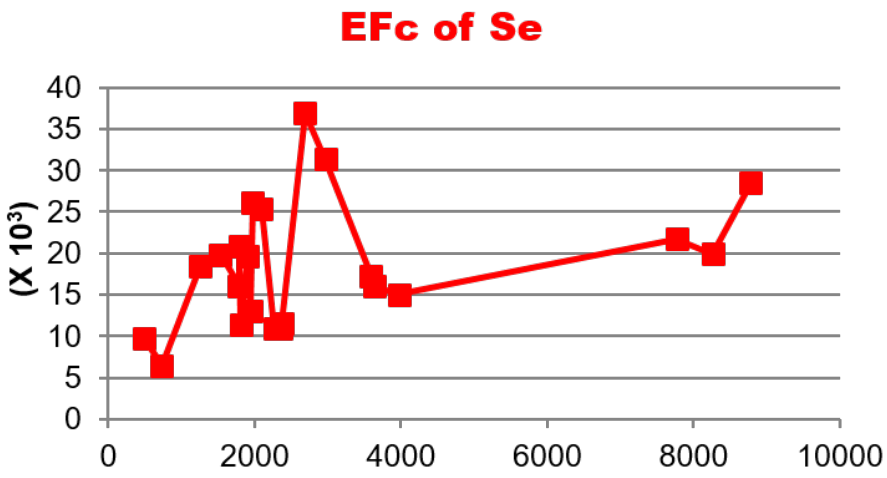
<Kahl et al., 1997>

GRIP ice core records



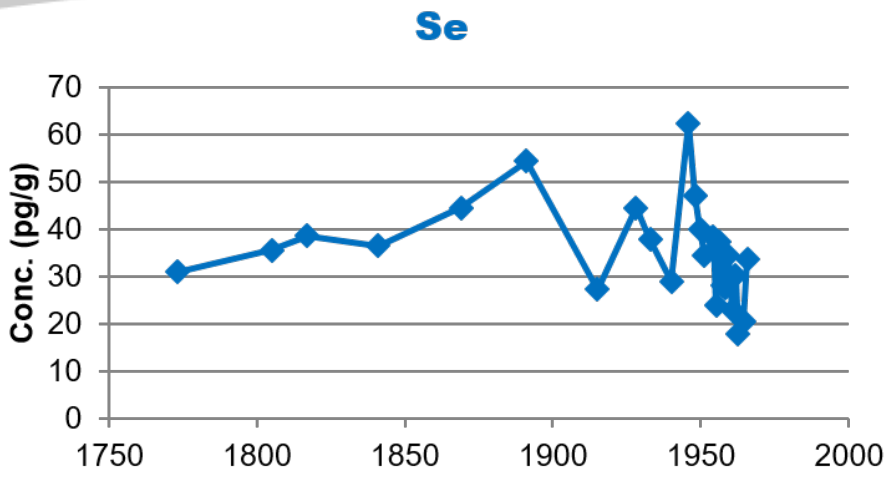


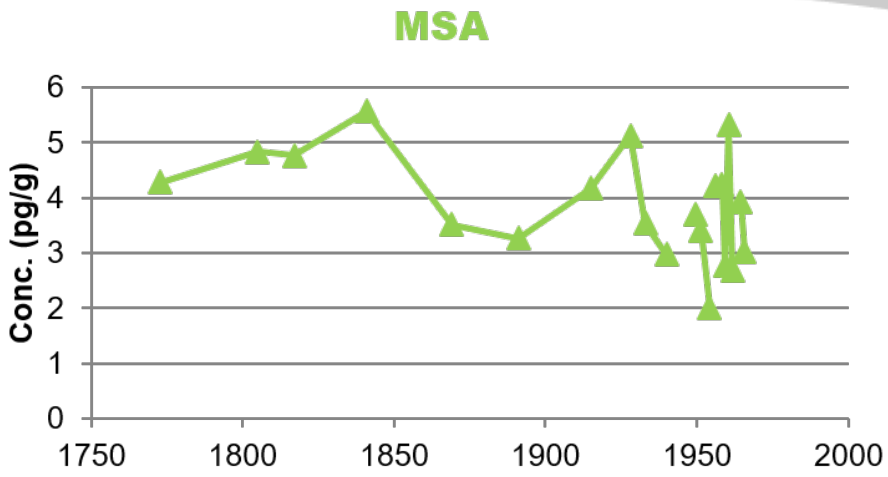


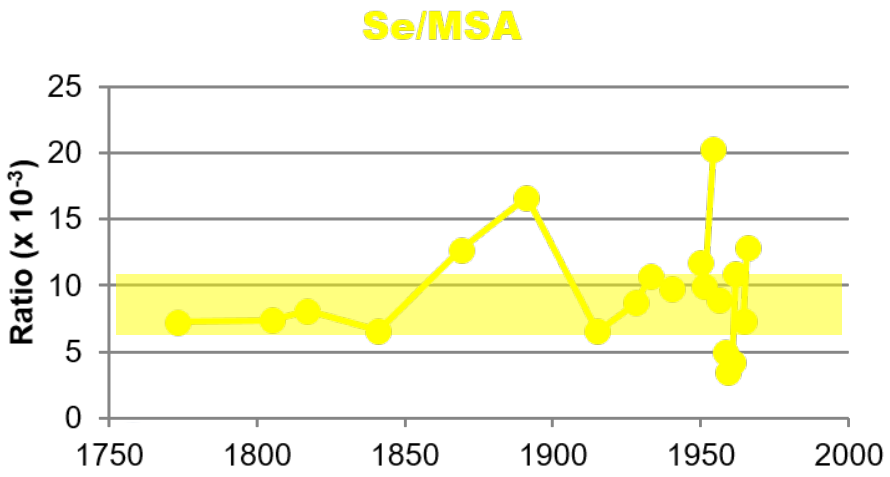


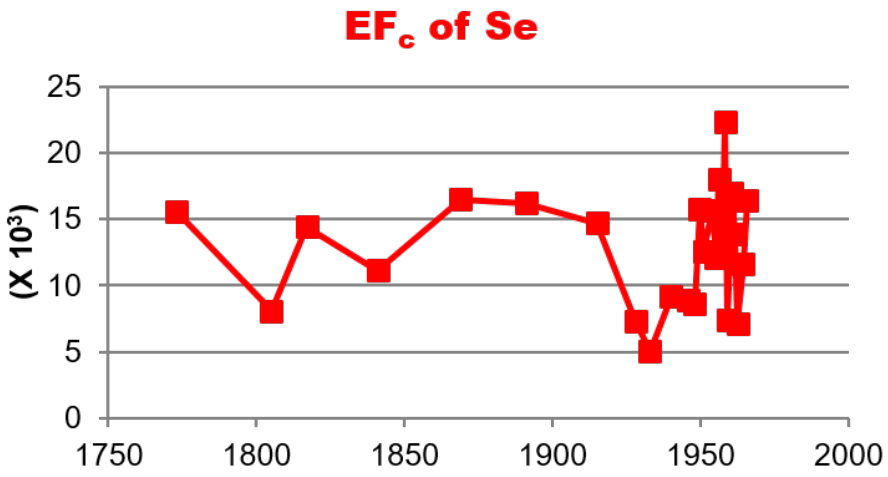
Year (B2K)

Euro ice core records









Year (AD)

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Conclusion

- Se records of Greenland ice core were similar to north Atlantic chlorophyll change
- Se/MSA ratios during 1900~1970s were mostly fit in the range of those for 500~9000 years BP when no significant anthropogenic influence
- High EF_c values of Se (>5,000) represent little influence of crust dust
- The atmospheric Se input during 1900~1970s seemed to be mainly controlled by natural emission from marine biogenic source

Further studies

- Decontamination of most shallow samples
  - Surface ~ 16.8 m
- Completion of high resolution Se record in NEEM ice core
  - Responses of biosphere to the climate event such as AO and NAO
- Se isotope ratios research
  - Fractionation by oxidation/reduction
  - Estimation of fluxes between various reservoirs

Thanks for your attention