「97 年度台日技術合作計畫項下—東亞地區空氣污染跨境傳輸之監測技術與資料分析」成效檢討報告

97 年 12 月

行政院環境保護署

目錄

一、 摘要

由於我國位處東亞空氣污染物傳輸路徑，容易受到工業污染或沙塵影響。本署近年來加強與鄰近國家(如日本與韓國等)進行監測技術交流、資料交換或聯合觀測等，以瞭解污染物長程傳輸盛行季節、途徑及影響範圍等，整體評估對我國環境之影響。

藉由此次邀請日本專家學者來台指導，介紹大氣汞監測技術與相關研究成果，以提供我國空氣污染物跨境傳輸監測技術參考。本次邀請日本滋賀縣立大學永淵修教授 9 月 30 日至 10 月 4 日來我國指導，安排行程(如附件 1)說明如下：

9 月 30 日：中午 12 時自日本飛抵我國桃園國際機場，下午 2 時與中央大學大氣物理研究所許桂榮副研究員拜會本署(如附件 2)，永淵教授進行 20 分鐘簡報，報告內容包括相關研究成果，並商談雙方進行資料交換或聯合觀測。

10 月 1 日：上午參觀中央大學「大氣微量毒化物分析實驗室」，下午於中央大學進行專題演講(附件 3)，演講主題分別為「東亞地區空氣污染跨境傳輸之監測成果」及「大氣汞監測技術(被動式採樣)介紹」，簡報內容詳附件 4。

10 月 2 日、3 日：參訪本署鹿林山背景監測站(附件 5)，並介紹此測站建置與功能及監測儀器，並說明此測站之優越性與重要性，藉此

彰顯台灣對全球環境研究與保護的投入與努力，並且商談台日雙方進行資料交換及聯合觀測。

10 月 4 日；接送永淵教授至桃園國際機場，搭乘華航班機返回日本。

二、 有害空氣污染物

台灣位處於亞洲大陸東南隅，由地理與氣候條件看，大範圍氣象環流容易將上游亞洲之污染物(例如酸性污染物、亞洲沙塵暴及生質燃燒等)輸送到臺灣的上空，影響空氣品質與環境生態，亦可能影響人民健康。其中亞洲沙塵暴和生質燃燒更是近幾年相當熱門的研究議題，其瞬間可排放出大量的空氣污染物，對於區域環境的衝擊甚劇(Wild and Akimoto, 2001; Ramanathan et al., 2001; Akimoto, 2003)，且在經由長程傳輸過程中，各污染物之組成特性也引起國內外學者的注意。

各式空氣污染物中除了一般污染物如硫氧化物、氮氧化物、懸浮微粒、臭氧與揮發性有機物外，還包含「有害空氣污染物（Hazardous Air Pollutants, HAPs）」或「毒性空氣污染物（Toxic Air Pollutants）」，在台灣對於此類污染物之定義尚不明確，而在美國則是指已知或可能具致癌性或是能導致嚴重人體健康與環境負面影響的空氣污染物。在美國目前共有 188 種（類）污染物被列為是 HAPs，其種類包羅萬象，包含有機物與無機物，金屬與非金屬，而 Spicer et al. (2002)則將其區

分為含氮碳氫化合物（49 種）、含氧碳氫化合物（39 種）、鹵化碳氫化合物（27 種）、無機物（23 種）、芳香族化合物（18 種）、殺蟲劑（15 種）、鹵化芳香族化合物（8 種）、鄰苯二甲酸鹽（4 種）、碳氫化合物（3 種）、硫酸鹽（2 種）等十大類。

亞洲排放之大氣污染物中亦潛藏有「有害空氣污染物」，如汞（mercury, Hg）與戴奧辛（dioxins）。戴奧辛是 HAPs 之一，Li et al. (2007)指出中國沿海省分(如廣東及浙江省)大氣戴奧辛濃度明顯偏高，其中電子廢棄物處理廠鄰近地區大氣中戴奧辛濃度甚至高達 51,200 fg-TEQ m-3，遠超過日本環境省之管制標準(600 fg-TEQ m-3)。

汞(mercury, Hg)是一個全球性污染物，美國及歐盟都將之列為持久性及生物累積性的毒性污染物(Persistent and Bioaccumulative Toxic Pollutants, PBTs)，大氣是汞散佈與傳輸的主要介質，大氣中的汞可分成三大類：氣態元素汞(gaseous elemental mercury, GEM)、活性氣態汞(relative gaseous mercury, RGM)及顆粒態汞(particulate mercury, PHg)，後兩者很快會經由乾、濕沉降移除，所以氣態元素汞是大氣汞的主要物種，且在大氣之滯留時間(residence time)介於 6 個月至 2 年之間，因此可藉由大氣之長程輸送而到全球各角落，造成環境污染並危害人體健康。

大氣汞的來源包含自然界釋放與人為排放，主要的人為排放原有

燃煤、廢棄焚化、非鐵金屬冶煉、鐵礦冶煉、水泥製造、鹼氯工廠、冶金、水銀製造等。近年來國際間大氣汞的研究蓬勃發展，其中東亞地區更是受到重視，原因是近年來東亞經濟與工業活動快速成長，包括煤與石油等能源消耗量大幅增加，但相關污染防治措施尚待加強，導致大氣污染物排放增加。以大氣汞而言，據估計在 2000 年亞洲人為大氣汞排放量佔全球人為總排放量(2190 公噸)的 54%，而中國就佔全球人為總排放量的 28%，排放量高居世界第一位(Pacyna et al.,2006)，此外，近年的研究顯示生質燃燒(如森林火災或木材燃燒等)也會釋放汞至大氣中，而中國與東南亞地區都有顯著的生質燃燒活動。因此，位居下風處的台灣空氣與環境品質以及生態都可能受影響。在 ACE-Asia 的研究進行期間即在中國、日本與韓國周遭量測到高濃度大氣汞(Friedli et al., 2004)，在日本琉球 Hedo Station 亦可偵測到高於背景值的大氣汞濃度(Jaffe et al., 2005)，甚至連遠在美國西岸奧勒岡州的 Mt. Bachelor Observatory 都可偵測到東亞大氣汞的影響(Jaffe et al., 2005; Weiss-Penzias et al., 2006)。

三、 東亞地區空氣污染物傳輸之監測技術與資料分析專題演講簡報摘要重點

(一)分析東亞地區長程大氣污染物傳輸情形

1、 在日本 Kyushu mountain 地區進行監測的情形

2、 大氣污染物隨水汽凝結成霜後的成分分析

3、 由水汽凝結後的樣品空氣組成物質量分析

4、 東亞地區長程污染物的傳輸情形

(二)空氣污染物對環境森林造成之影響

1、 針對日本南方屋久島白松樹(Yakushima White Pine, Pinus amaniana)受污染造成衰退情形的分析

2、 空氣污染物中酸性物質沉澱之分析與影響

3、 傳輸污染物特徵及對環境及生態上的影響

(三)傳輸污染物化學成份對地面逕流酸化之影響

1、 在日本 Yakushima Island 地區進行監測的情形

2、 樣本化學成分特徵與分析

3、 污染物化學成份對 Yakushima Island 地區造成之影響

(四)透過湖水成分採樣歷史紀錄分析傳輸污染物對環境之影響

1、 檢驗出湖水中主要污染成份來自能源燃燒排放物(燃煤或是石油燃燒所排放)

2、 根據分析資料，追溯污染物來源為東亞地區、中國大陸，自進入21世紀以來，污染物傳輸的情形更趨嚴重

3、 長程傳輸污染物研究可看出時間分布及污染性質的特徵，長期連續觀測將更有助於了解傳輸污染行為的影響

四、 效益

本次邀請日本滋賀縣立大學環境科學部環境生態學科永淵修教授來台，協助我國進行東亞地區空氣污染跨境傳輸之監測技術與資料分析技術指導，其獲致效益說明如下：

(一) 永淵修教授自 2007 年起即在日本富士山頂（海拔 3778 公尺）與屋久島（海拔 1930 公尺）進行大氣汞採樣分析，探討東亞大氣汞排放經長程傳輸對日本之影響，相關資料有助於我國分析研究長程污染物對空氣品質之影響。

(二) 永淵修教授研究項目與我國環保署進行中的「空氣中有害物質長程傳輸監測先期評估」專案計畫研究內容密切相關，教授於日本監測之實際操作經驗將有助相關業務之執行。

(三) 此次來訪除了解日本同步進行之長程傳輸污染物監測的經驗及成果，將有助於未來國際合作業務，進行資料交換或聯合觀測，以綜合評估東亞有害物質長程傳輸對下游區域環境之影響與衝擊。

「97 年度台日技術合作計畫項下—東亞地區空氣污染跨境傳輸之監測技術與資料分析」成效檢討報告

附件 1

教授來台行程

附件 1 日本滋賀縣立大學永淵修教授來台行程

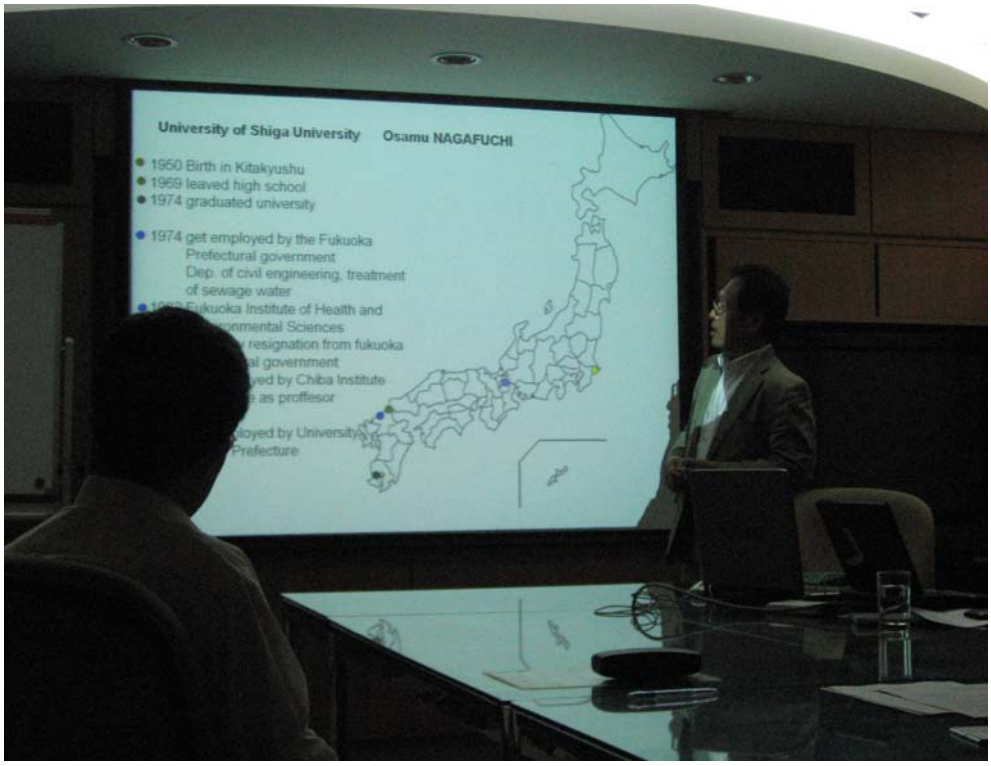
日期	時間	行程
9 月 30 日	10：00~12：00	日本(名古屋機場)出發至台灣
	14：00~17：00	拜會環境保護署
10 月 1 日	10：00~12：00	中央大學大氣汞實驗室 參訪與交流
	14：00~15：00	演講題目： 東亞地區空氣污染物跨境傳輸 之監測與成果
	15：00~15：20	休息
	15：20~16：20	演講題目： 大氣汞監測技術 (被動式採樣)介紹
	16：20~17：00	綜合討論
10 月 2 日	10：00	出發前往鹿林山
10 月 3 日	09：30~17：00	參訪鹿林山背景測站與交流
10 月 4 日	16：20~19：30	台灣出發返回日本(福岡機場)

「97 年度台日技術合作計畫項下—東亞地區空氣污染跨境傳輸之監測技術與資料分析」成效檢討報告

附件 2

永淵修教授拜會環保署並進行簡報

永淵修教授拜會環保署並進行簡報



「97 年度台日技術合作計畫項下—東亞地區空氣污染跨境傳輸之監測技術與資料分析」成效檢討報告

附件 3

專題演講照片


Today' s Theme: Study on Atmospheric Environment issue
Major subjects are flowing five themes:
3) Acidification of stream water
4) Analysis of environmental pollution history using lake sediments

「97 年度台日技術合作計畫項下—東亞地區空氣污染跨境傳輸之監測技術與資料分析」成效檢討報告

附件 4

專題演講簡報內容

Graduate School of Environmental Science
Department of Ecosystem Studies
University of Shiga Prefecture

Osamu NAGAFUCHI

Mt. Kuromidake, Yakushima Island

Mt. Halla, Cheju Island,Korea

Today' s Theme: Study on Atmospheric Environment issue

Major subjects are flowing five themes;

1) Analysis of long-range transported atmospheric pollutants in East Asia

3) Acidification of stream water

4) Analysis of environmental pollution history using lake sediments

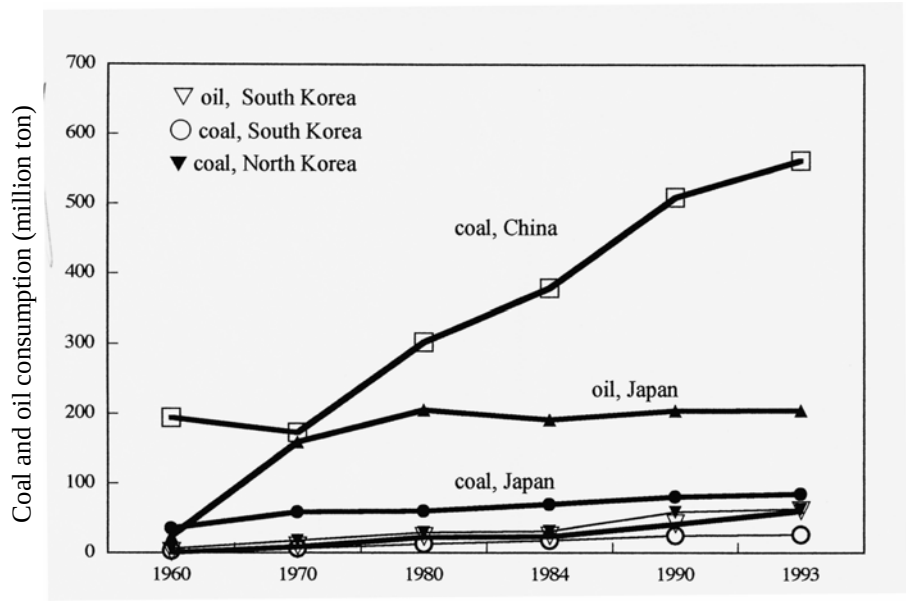
5) Atmospheric pollution and pollution history of Mercury associated with gold mining, Central Kalimantan, Indonesia

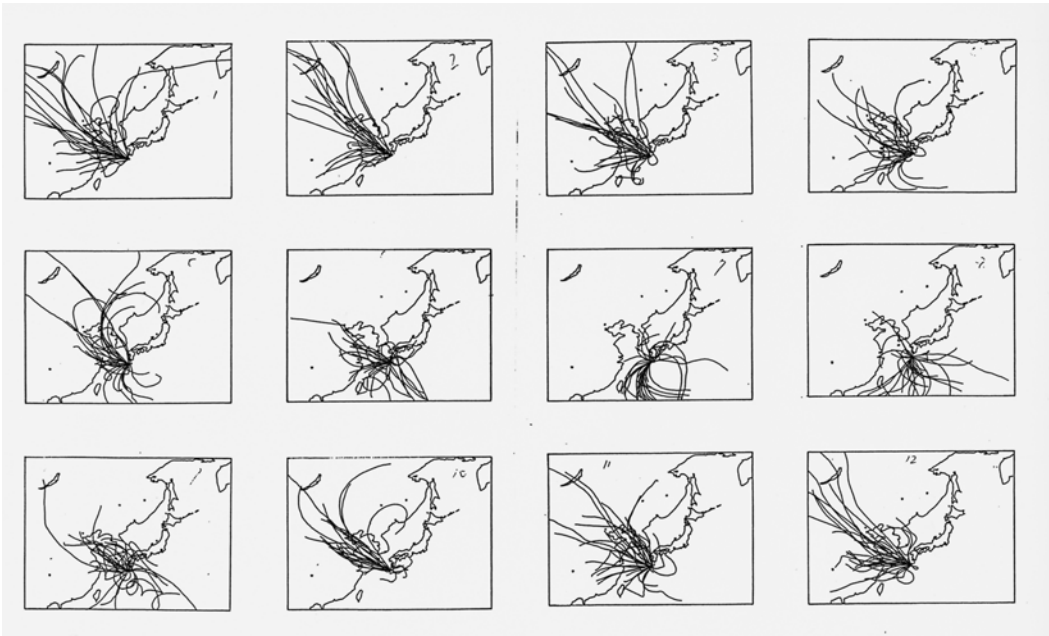
Analysis long-range transported atmospheric pollutants in East Asia

By
Osamu NAGAFUCHI

1. The characteristics of Kyushu mountain area
2. The characteristics of rime-ice
3. The characteristics of air mass when rime-ice form
4. Analysis long-range transportation of air pollutants

Background

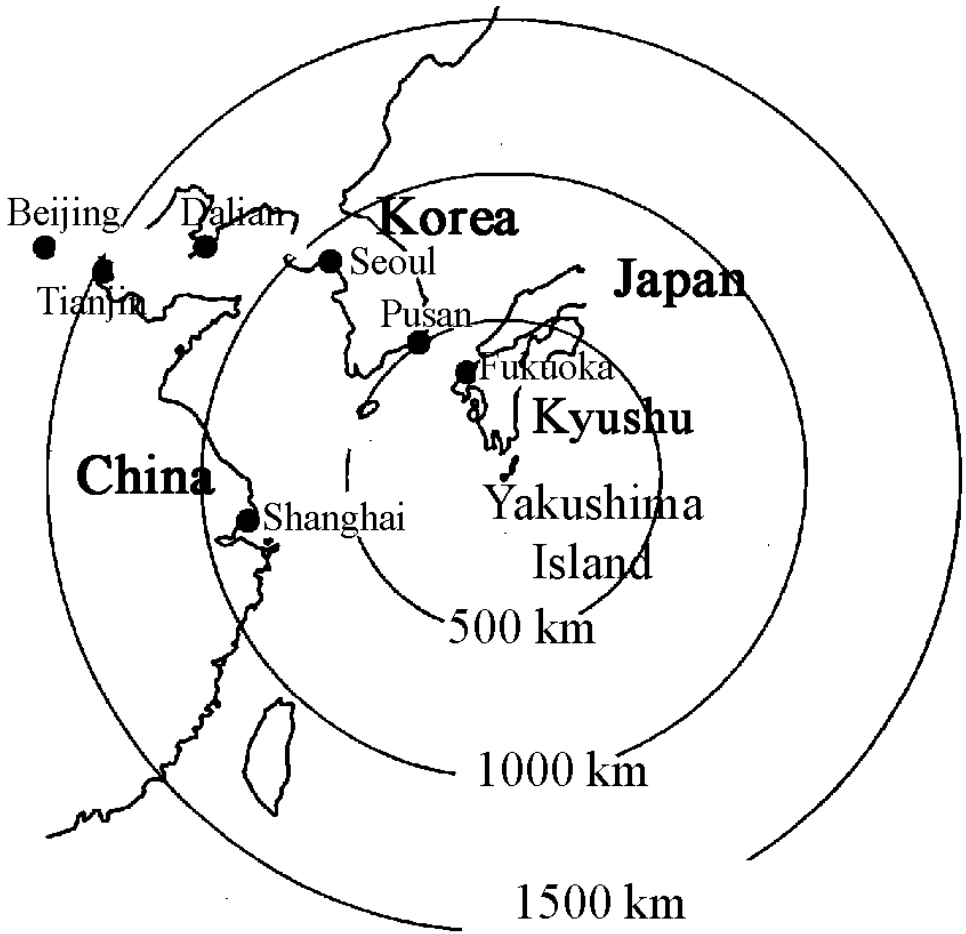




Air trajectory of Mt. Miyanouradake on 1997

Why is the Yakushia Island

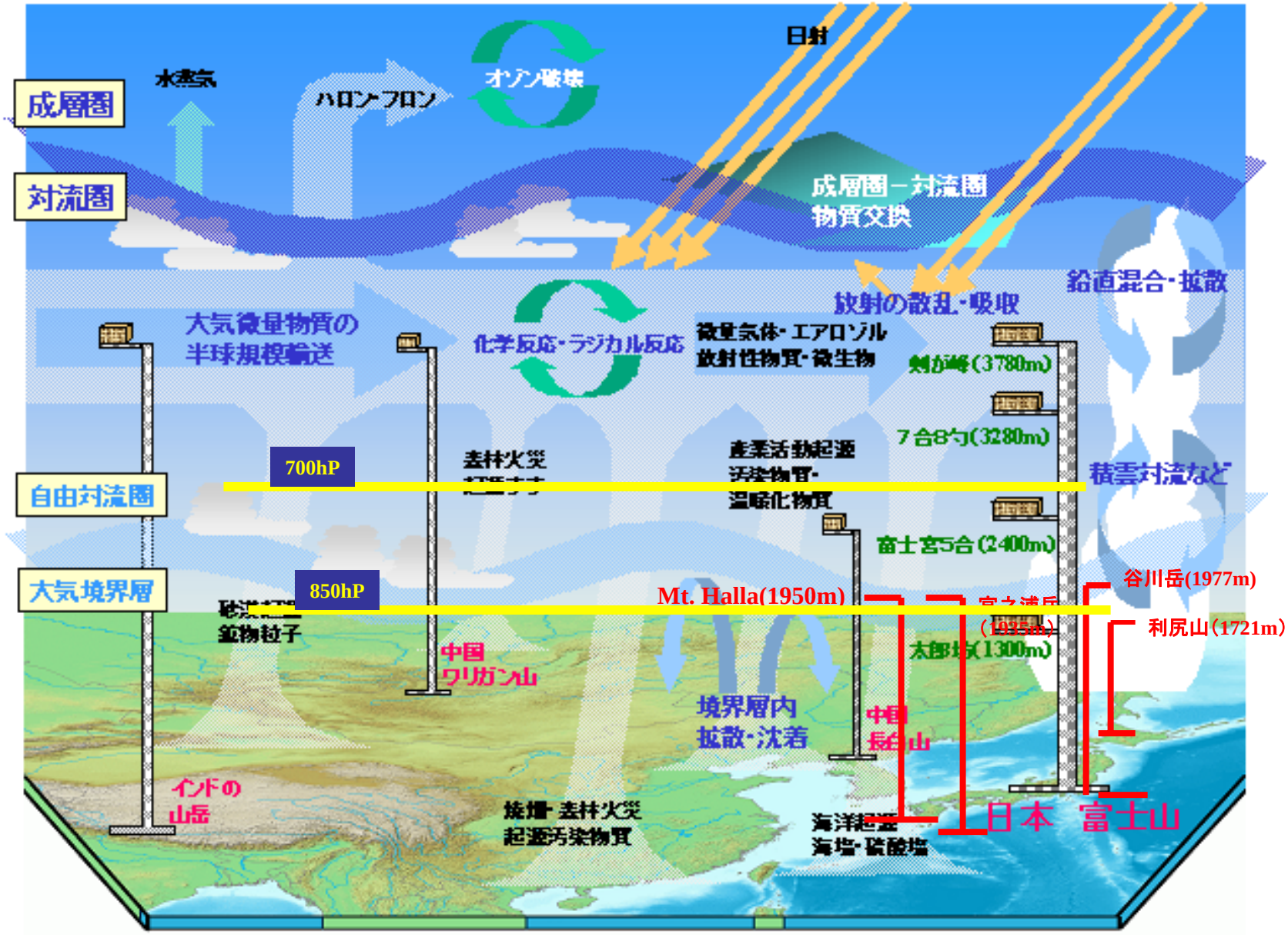
Distance from Yakushima Island to origin of air pollutants



Objective

To estimate the source of long range transported air pollutants in the East Asian region, we demonstrate analytical data of soluble and insoluble components in environmental samples collected in mountain area

研究の背景と目的


成層圏
対流圏
水蒸気
ハロン・フロン
オゾン破壊
日射
成層圏－対流圏
物質交換
鉛直混合・拡散
放射の散乱・吸収
大気微量物質の
半球規模輸送
化学反応・ラジカル反応
微量気体・エアロゾル
放射性物質・微生物
剣が峰(3780m)
7合8勺(3280m)
富士宮5合(2400m)
太郎坊(1300m)
700hP
850hP
自由対流圏
大気境界層
産業活動起源
汚染物質・
温暖化物質
積雲対流など
Mt. Halla(1950m)
谷川岳(1977m)
利尻山(1721m)
中国
ワリガン山
境界層内
拡散・沈着
中国
長白山
インドの
山岳
海洋起源
海塩・硫酸塩
日本 富士山

調査地点

: 富士山，ハラ山，宮之浦岳，谷川岳
　大山，利尻山，市房山

: 福岡，ハバロフスク，大連，天津

方法（本日のお話の中心）

: 電子顕微鏡を用いたエアロゾルの
　形態分析

: 他の方法はアクセントで


RUSSIA
KAZAKHSTAN
MONGOLIA
KYRGYZ
Tarim Basin
Kunlun mts.
Tibet Plat.
Himalaya mts.
NEPAL
BHUTAN
INDIA
BANGLADESH
MYANMAR (BURMA)
LAOS
VIETNAM
CHINA
N.KOREA
S.KOREA
JAPAN
Sea of Okhotsk
Sea of Japan
Yellow Sea
East China Sea
South China Sea
Philippine Sea
PACIFIC OCEAN
Bay of Bengal
TAIWAN
PHILIPPINES
East Asia
1:25,000,000
Conic Equidistant Projection

Located in Yakusima Isl, Japan on East Asia

材料：樹氷，雪，粉じん

Rime-ice is the one of the environmental sample

Mt. Miyanouradake

1931m

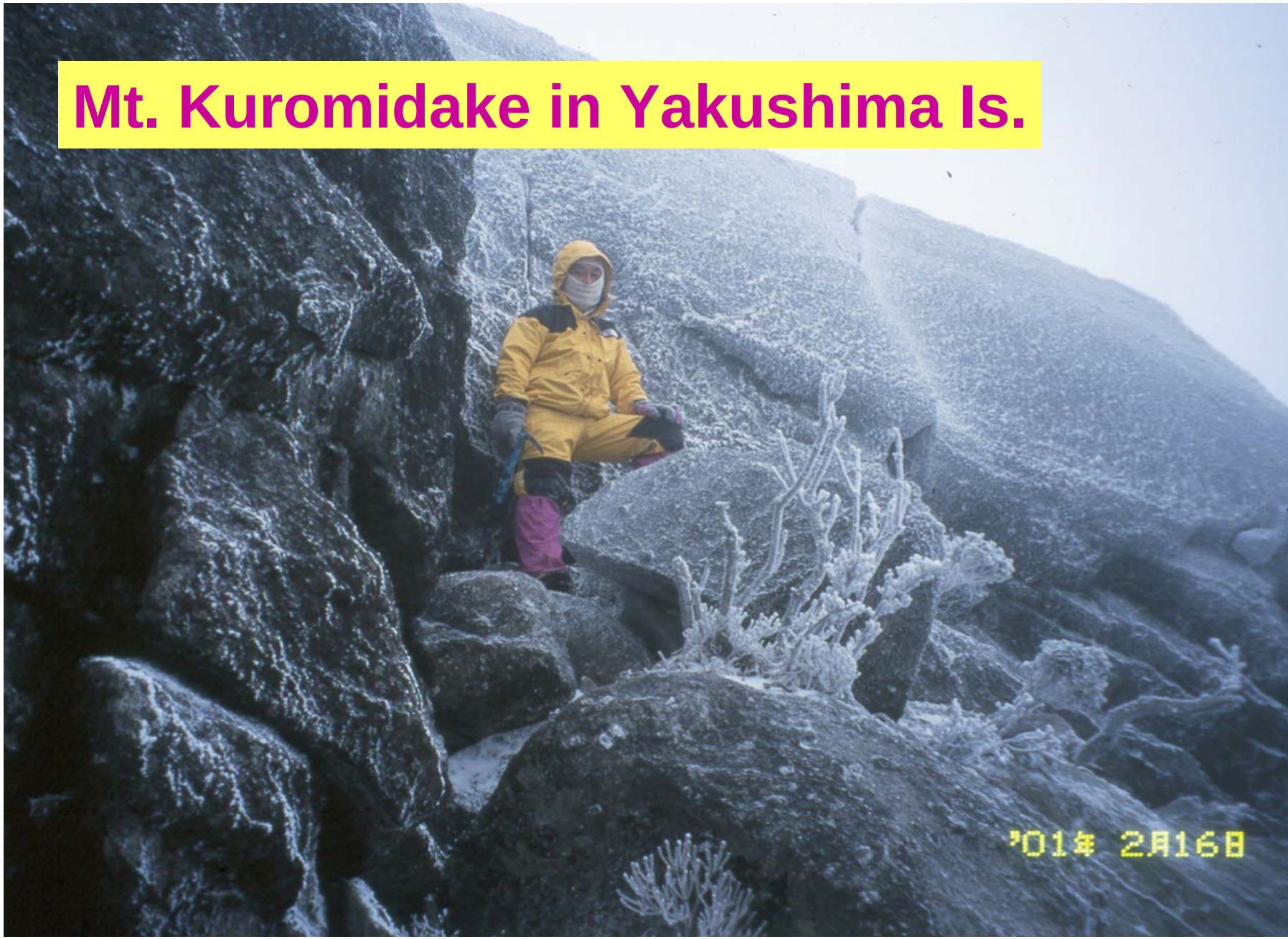
Rime-ice at 1600m

Rime-ice at summit

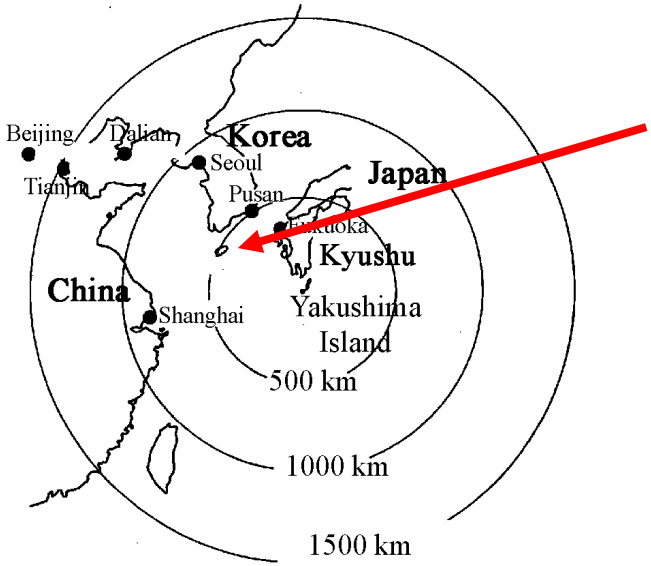
Rime-ice at 1300m

Weather measurement devise

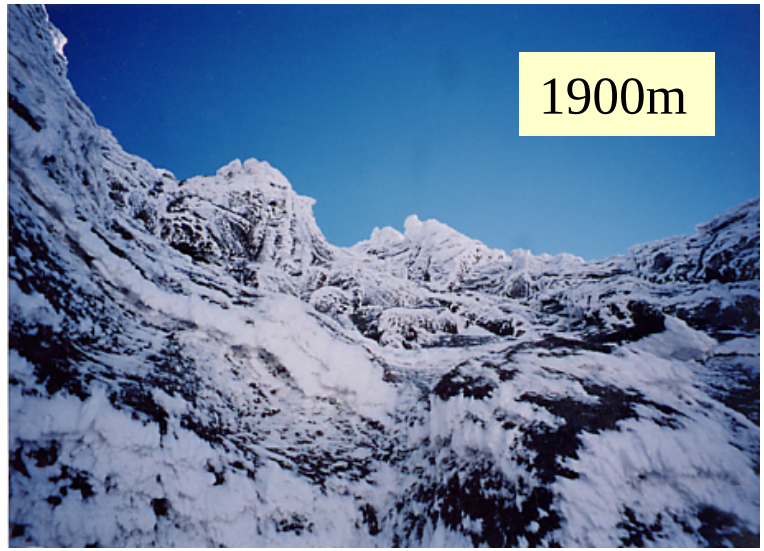
Sampling site


Mt. Kuromidake in Yakushima Is.
'01年 2月16日

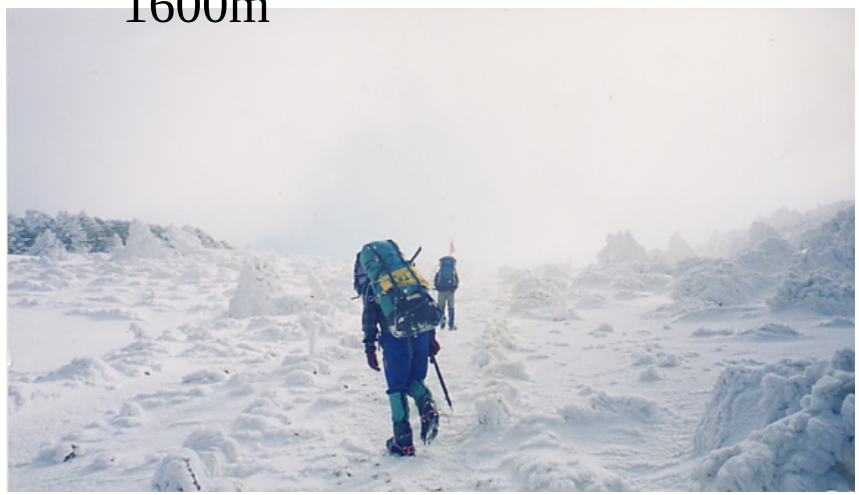
Cheju Is., Korea



Mt. Halla

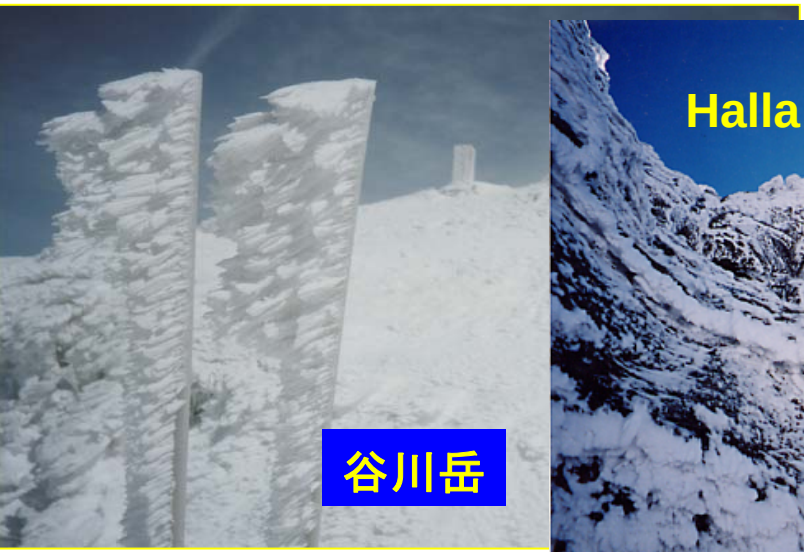


1600m




屋久島


利尻岳


谷川岳


Halla 山

Why is it a Rime-ice

Rime-ice occures on structures which are exposed to a cloud of supercooled dropl

The droplets impact on the structures and freeze causing the characteristic white Rime-ice deposit.

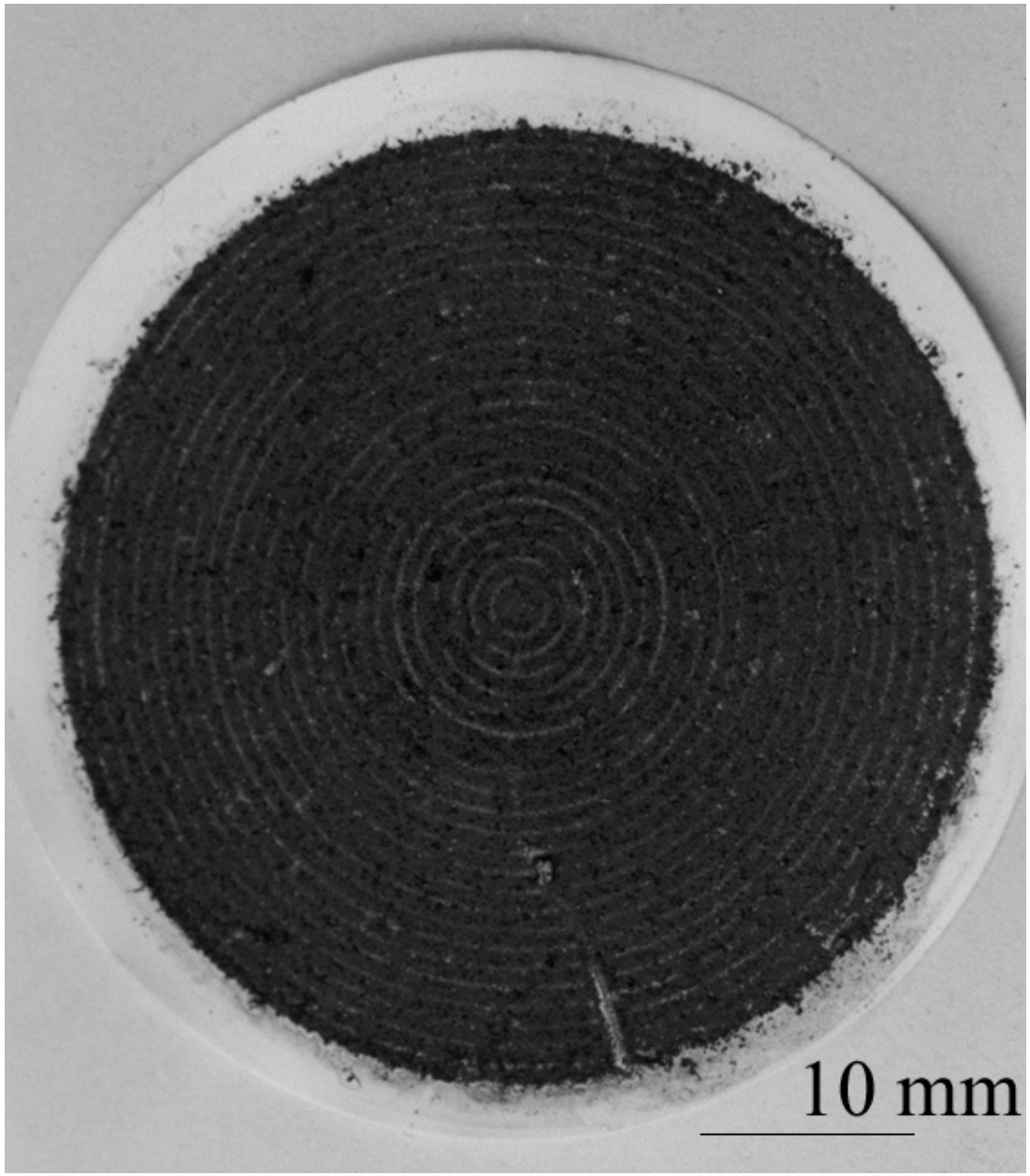
Rime-ice deposits are common on high elevation trees and mountain top structures

Therefore, it is conceivable at the elevation rather than that of snowfall at same site and same time

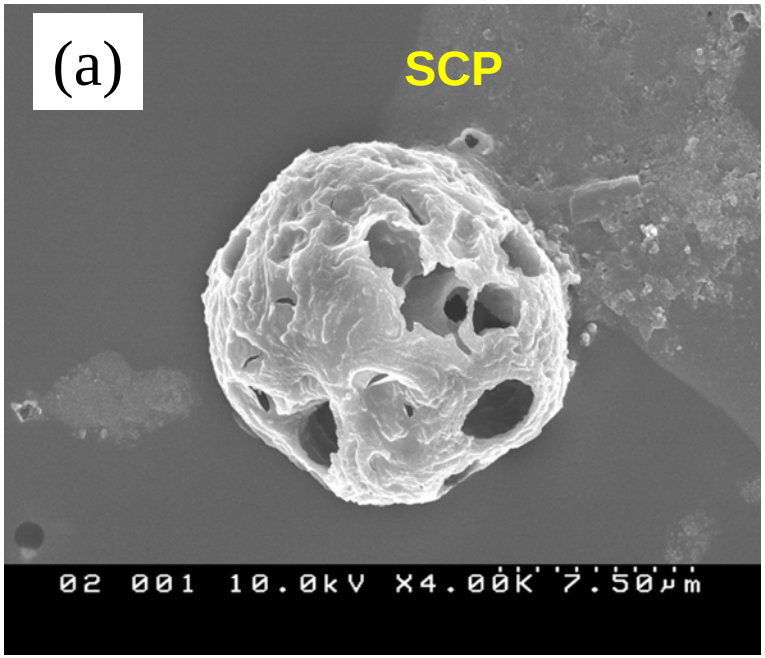
In addition, Rime-ice in the Kyushu mountainous region repeatedly forms and then falls off.

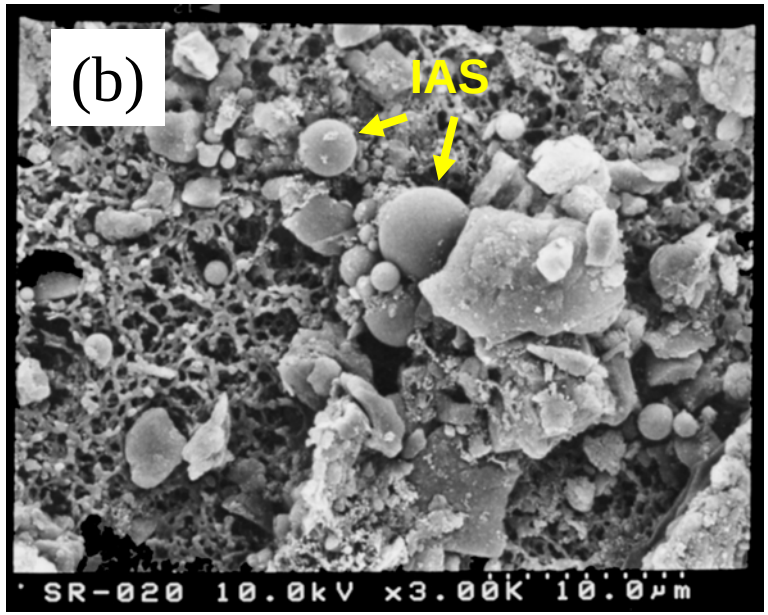
Namely, the rime-ice occurs under the influence of cold masss and it separate from structures when the cold masses leave.

Consequently, it may be possible to identify the special air mass that affects to the component of rime-ice at Kyushu mountainous regions.

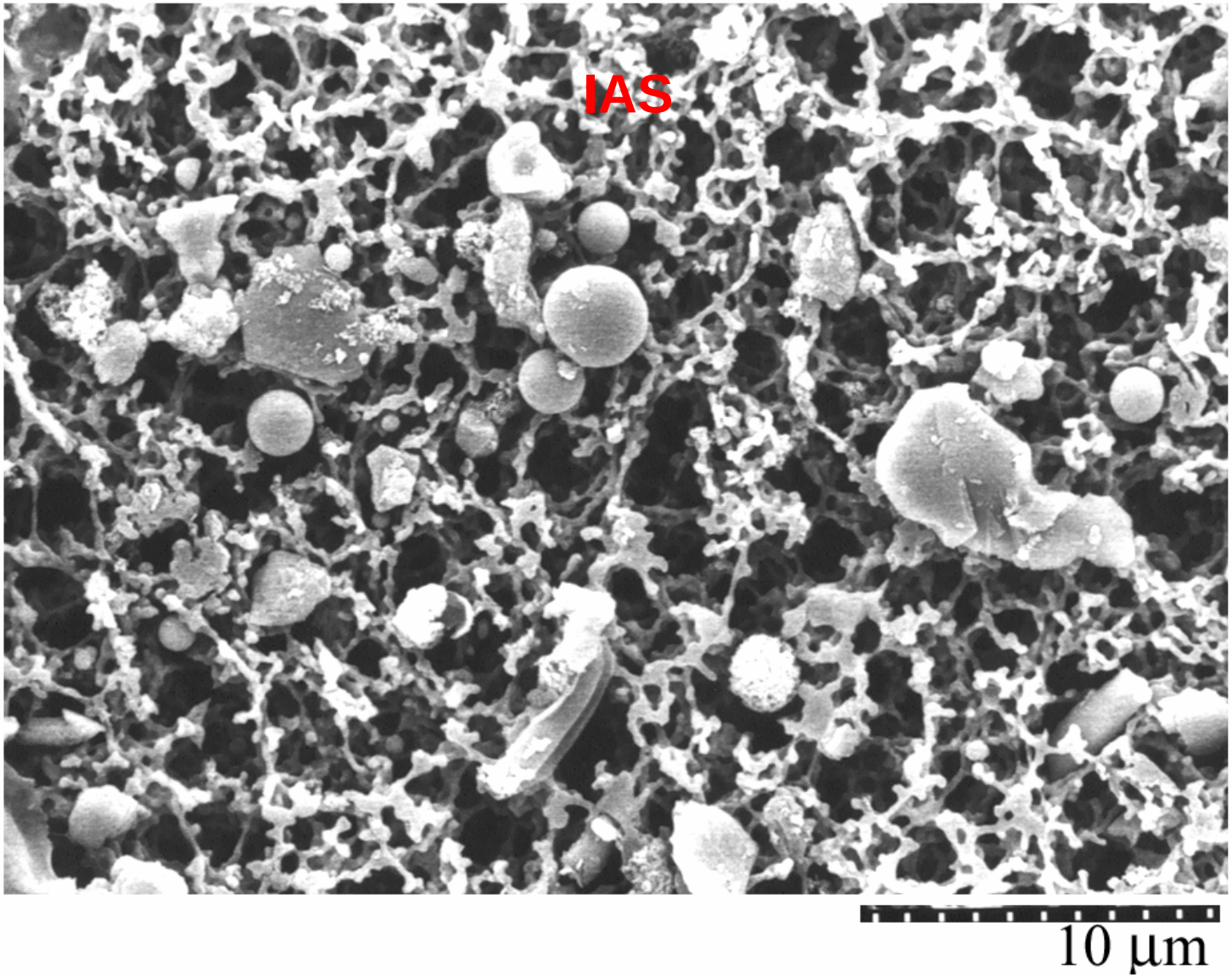


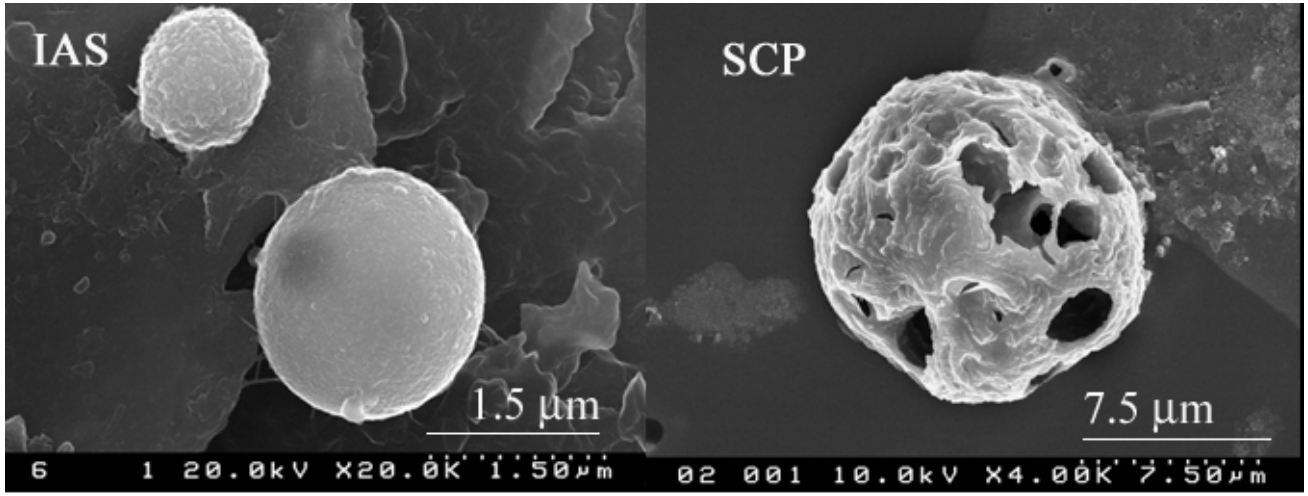
The residue that filtrate 200ml of the rime ice solution

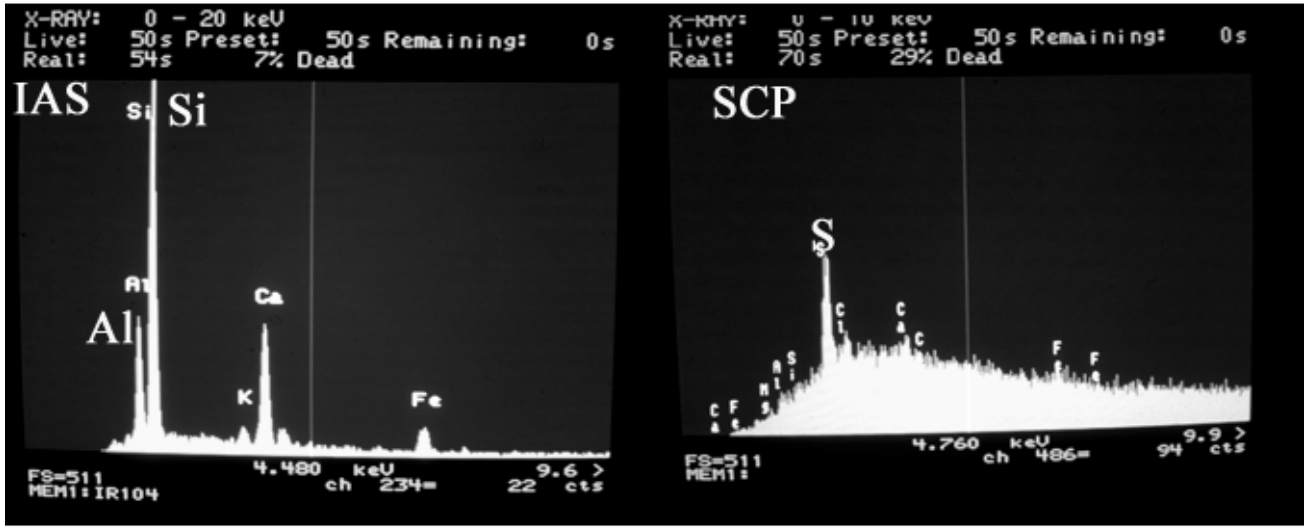




SEM photographs of the residue of rime ice solution

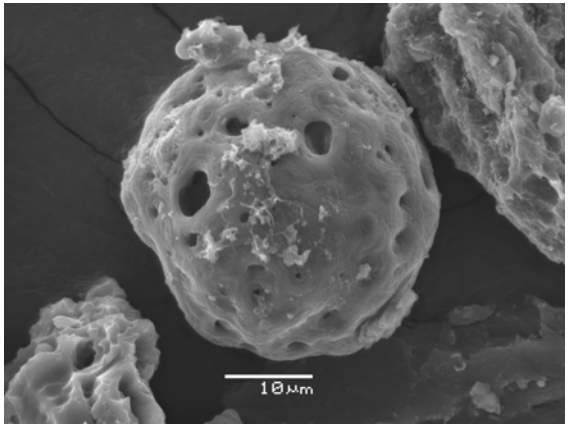

IAS
10 µm

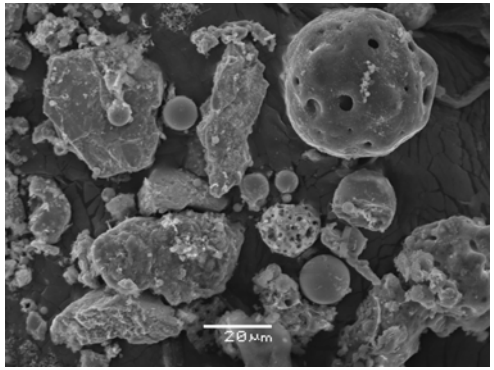

IAS
1.5 µm
6 1 20.0kV X20.0K 1.50µm
SCP
7.5 µm
02 001 10.0kV X4.00K 7.50µm

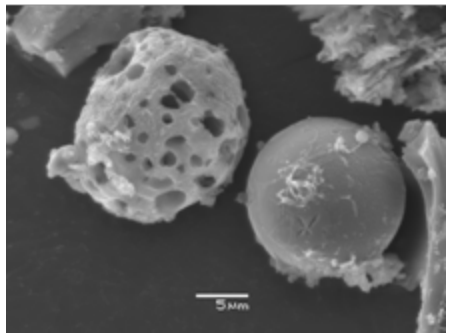

X-RAY: 0 - 20 keV
Live: 50s Preset: 50s Remaining: 0s
Real: 54s 7% Dead
IAS
Si
Si
Al
Al
Ca
K
Fe
FS=511
MEM1:IR104
4.480 keV
ch 234=
9.6 >
22 cts
X-RAY: 0 - 10 keV
Live: 50s Preset: 50s Remaining: 0s
Real: 70s 29% Dead
SCP
S
S
Cl
Ca
FS=511
MEM1:
4.760 keV
ch 486=
9.9 >
94 cts

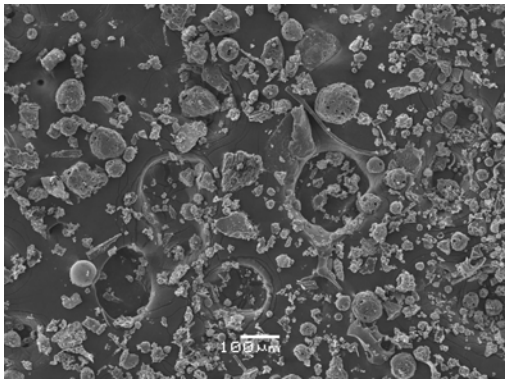
発生源の粉じんの形態分析：

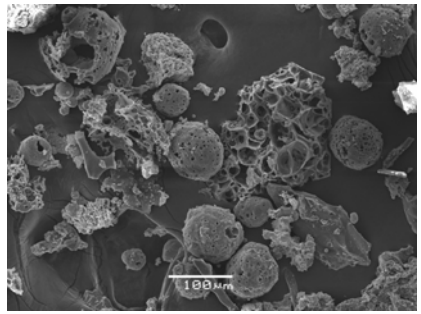
大連の積雪中エアロゾル
ハバロフスクの積雪中エアロゾル
天津の大気中エアロゾル



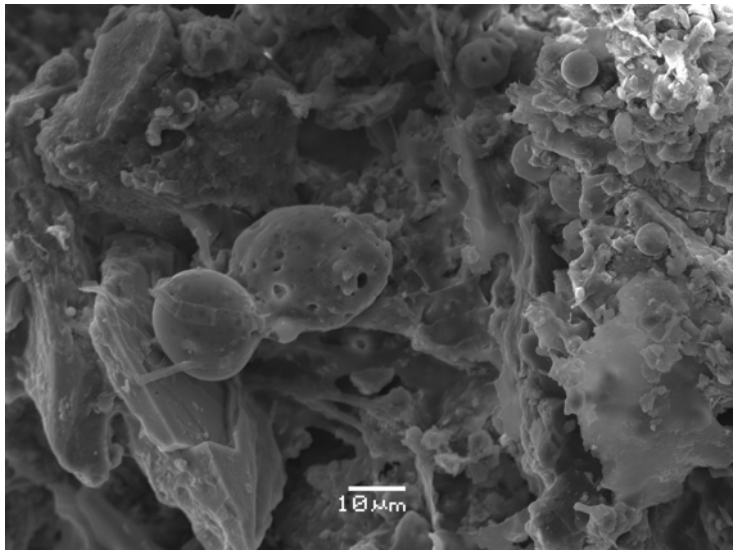


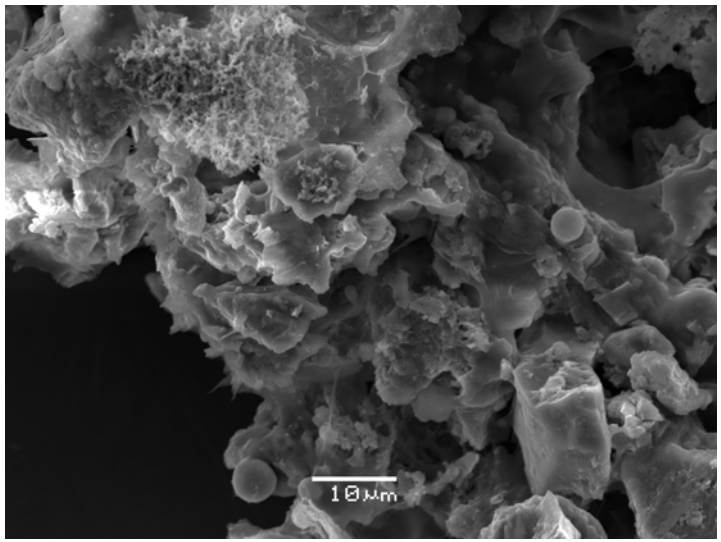




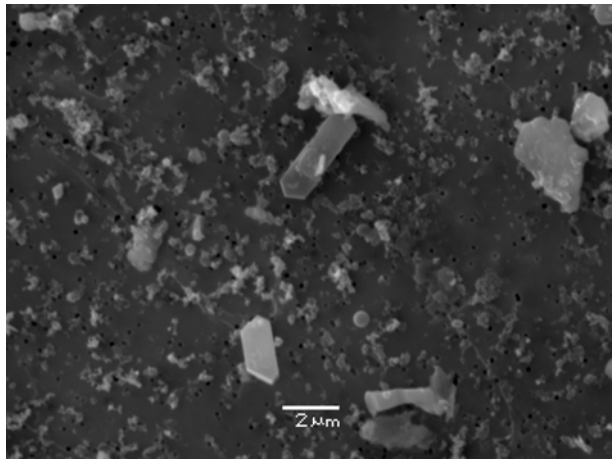


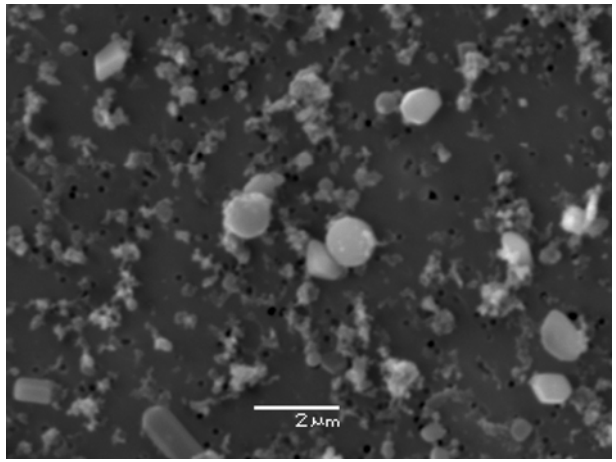
大連の雪



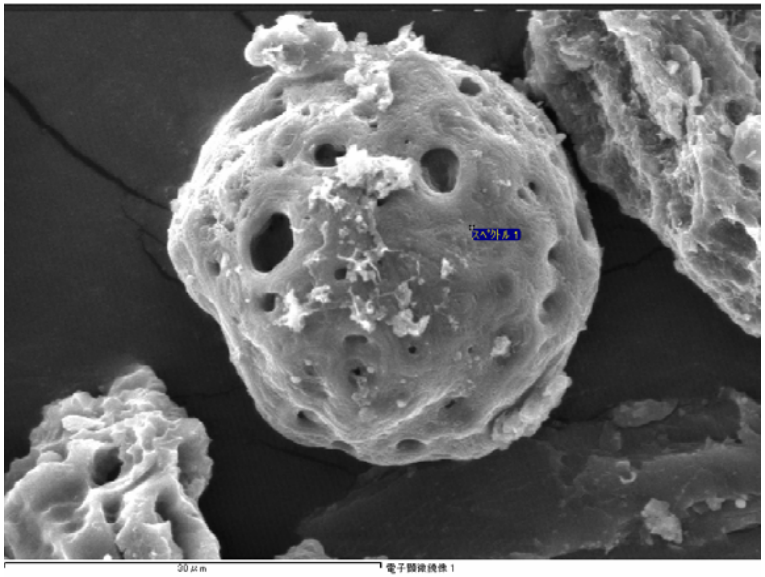


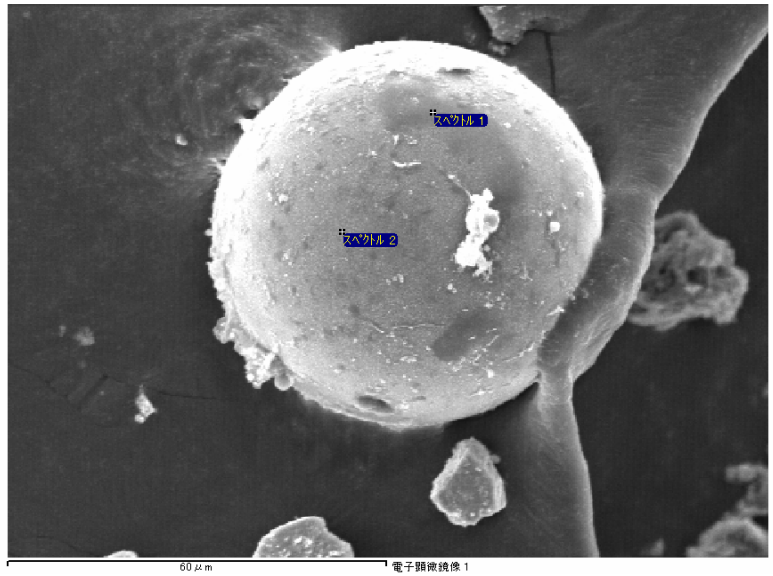
ハバ

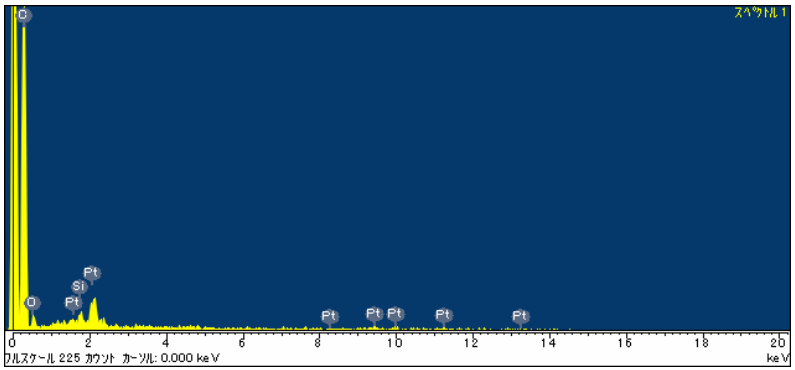


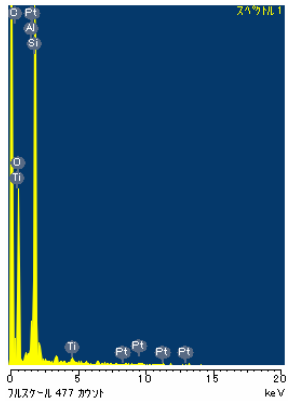


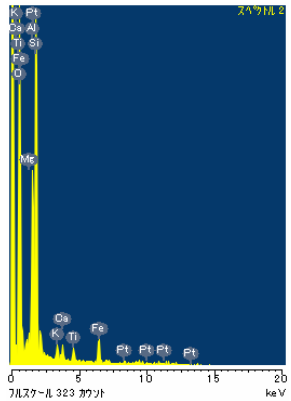
天津　大気粉じん


スペクトル 1
30 µm
電子顕微鏡像 1

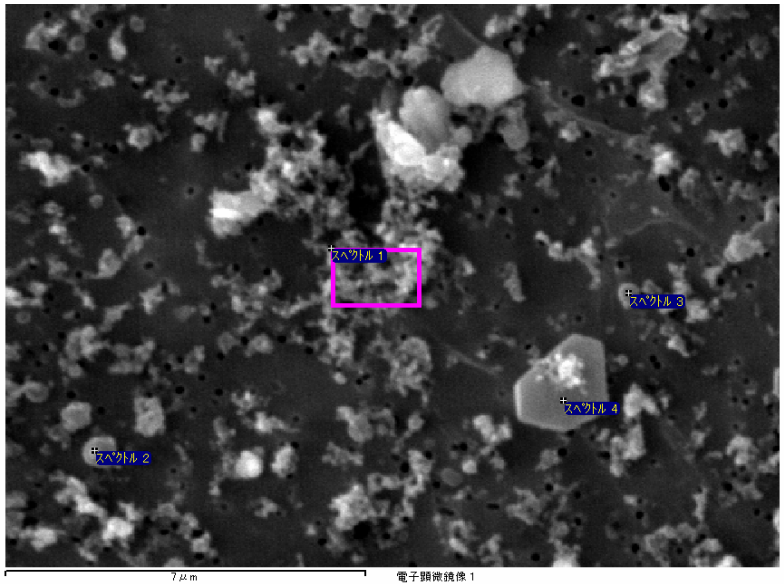

スペクトル 1
スペクトル 2
60 µm
電子顕微鏡像 1

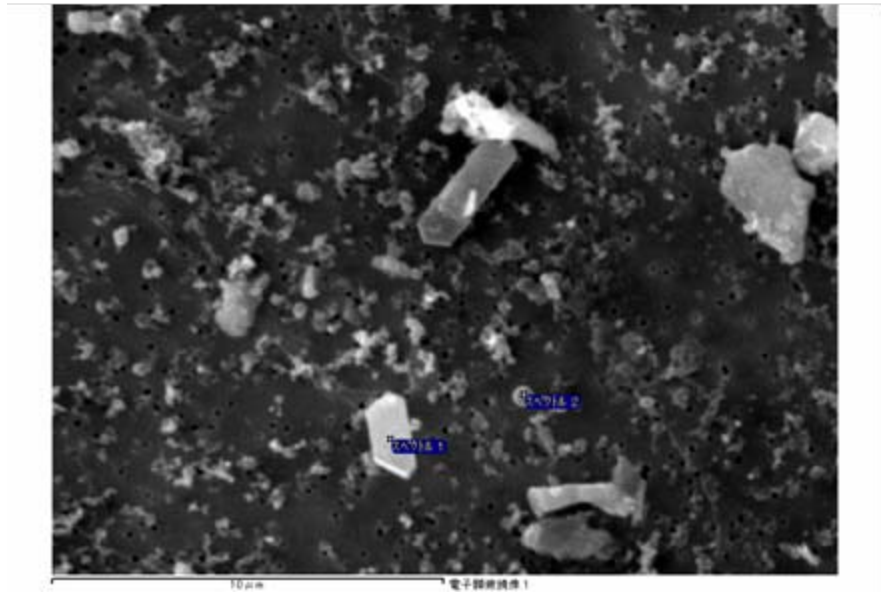

スペクトル 1
C
O
Pt
Si
Pt
Pt Pt Pt Pt
0 2 4 6 8 10 12 14 16 18 20
keV
フルスケール 225 カウント カーソル: 0.000 keV

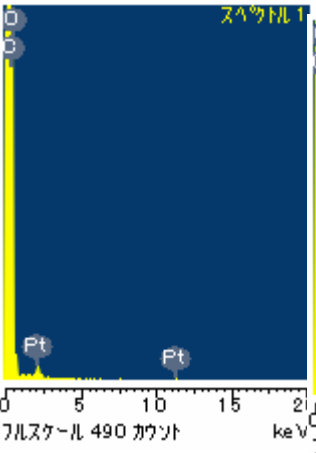

スペクトル 1
O Pt
Al
Si
O
Ti
Ti
Pt Pt Pt Pt
0 5 10 15 20
keV
フルスケール 477 カウント

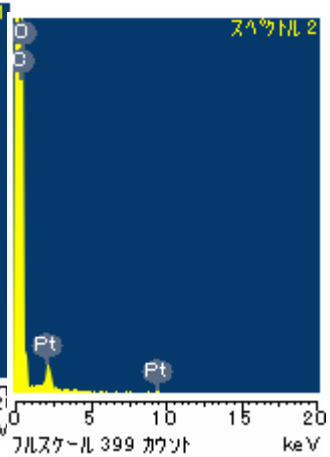

スペクトル 2
K Pt
Ca Al
Ti Si
Fe
O
Mg
Ca
K
Ti
Fe
Pt Pt Pt Pt
0 5 10 15 20
keV
フルスケール 323 カウント

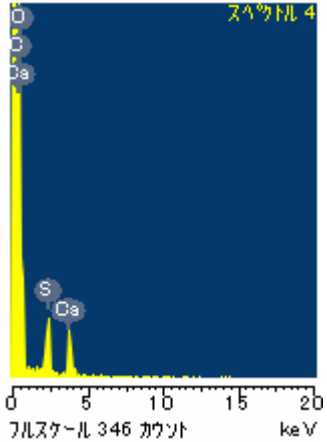
大連の雪

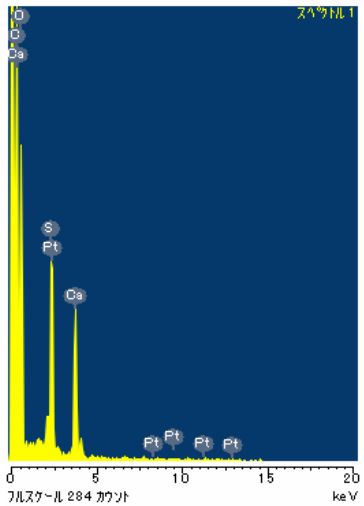

スペクトル 1
スペクトル 2
スペクトル 3
スペクトル 4
7 μm
電子顕微鏡像 1

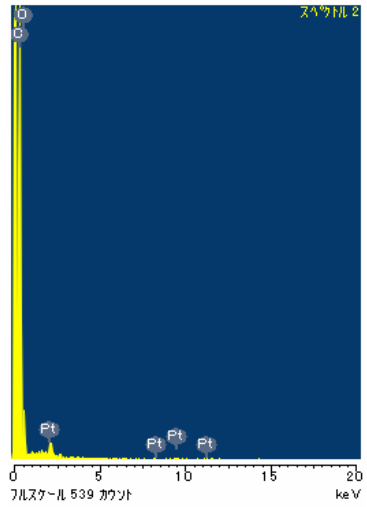



スペクトル 1
O
C
Pt
Pt
0 5 10 15 20
フルスケール 490 カウント
keV


スペクトル 2
O
C
Pt
Pt
0 5 10 15 20
フルスケール 399 カウント
keV


スペクトル 4
O
C
Ca
S
Ca
0 5 10 15 20
フルスケール 346 カウント
keV

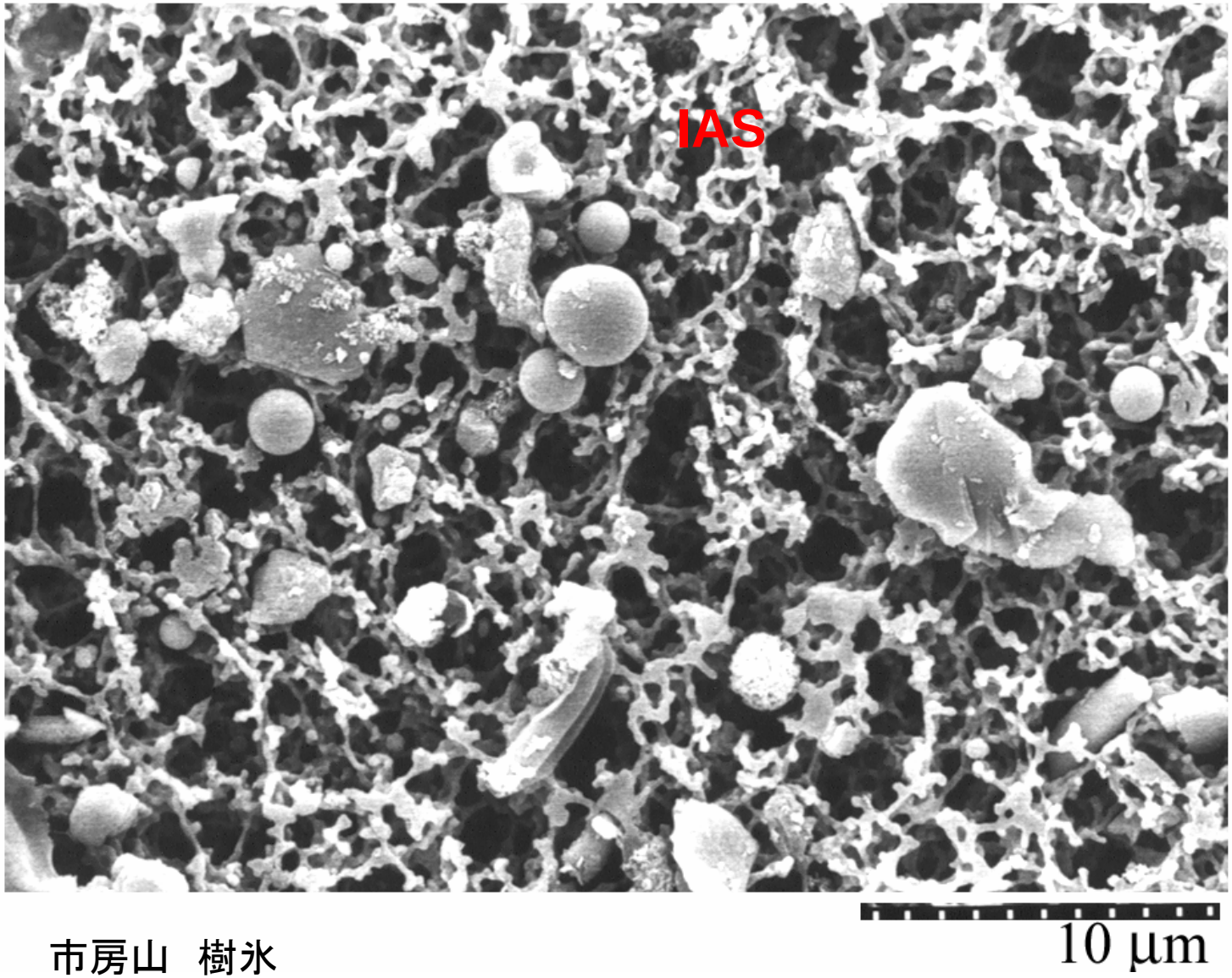

スペクトル 1
O
C
Ca
S
Pt
Ca
Pt
Pt
Pt
Pt
0 5 10 15 20
フルスケール 284 カウント
keV


スペクトル 2
O
C
Pt
Pt
Pt
Pt
0 5 10 15 20
フルスケール 539 カウント
keV

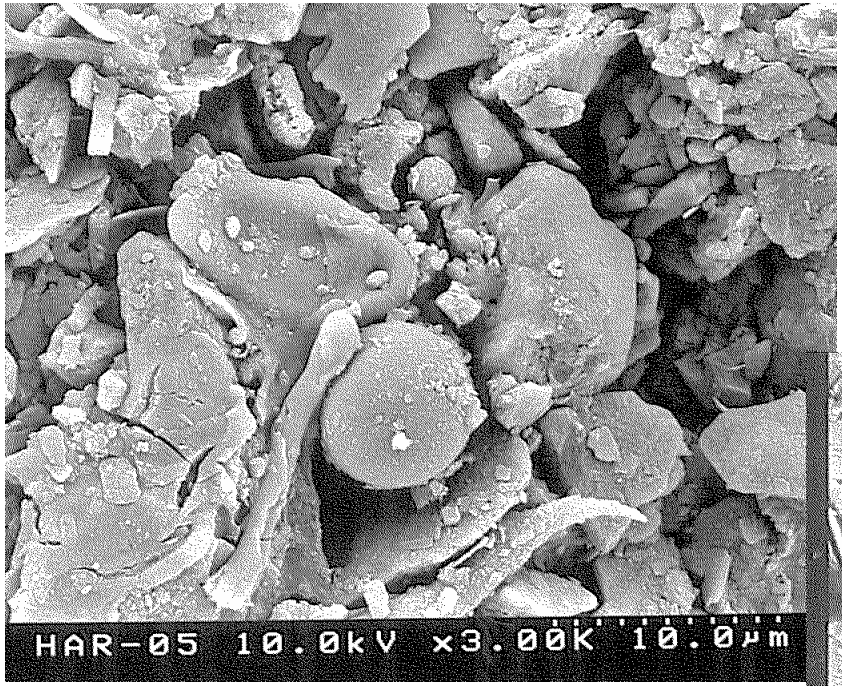
天津　大気中粉じん　5月

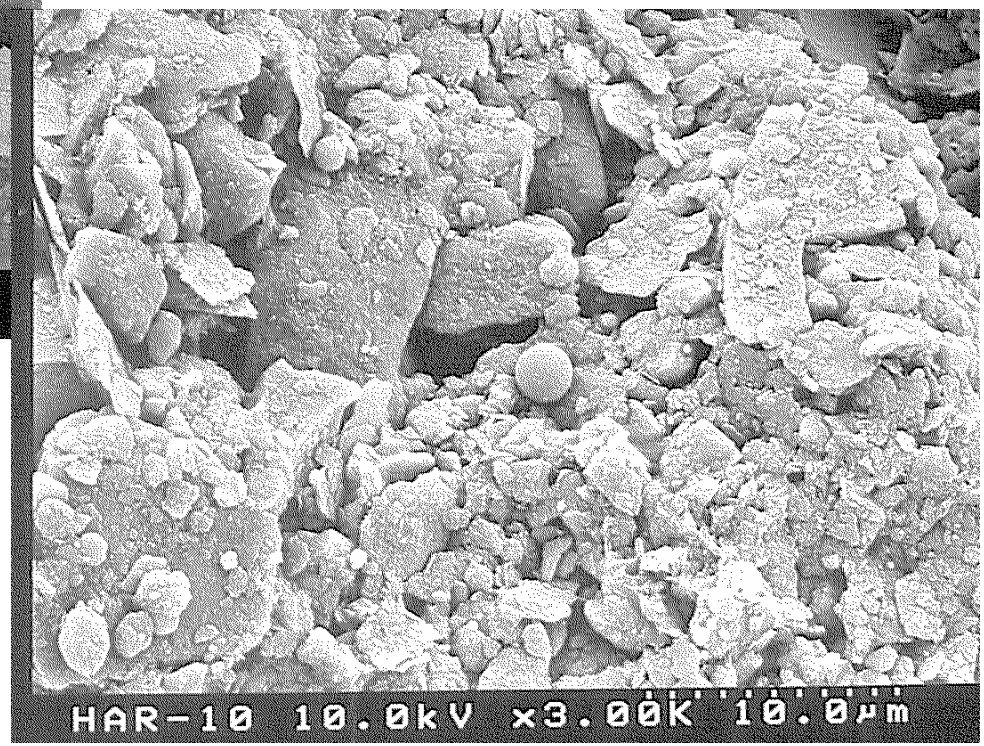
移流先のエアロゾル:

ハラ山樹氷中
宮之浦岳樹氷中
市房山樹氷中
大山樹氷中
谷川岳樹氷中
黄砂粒子(大宰府市)
富士山大気中粒子
屋久島大気中粒子

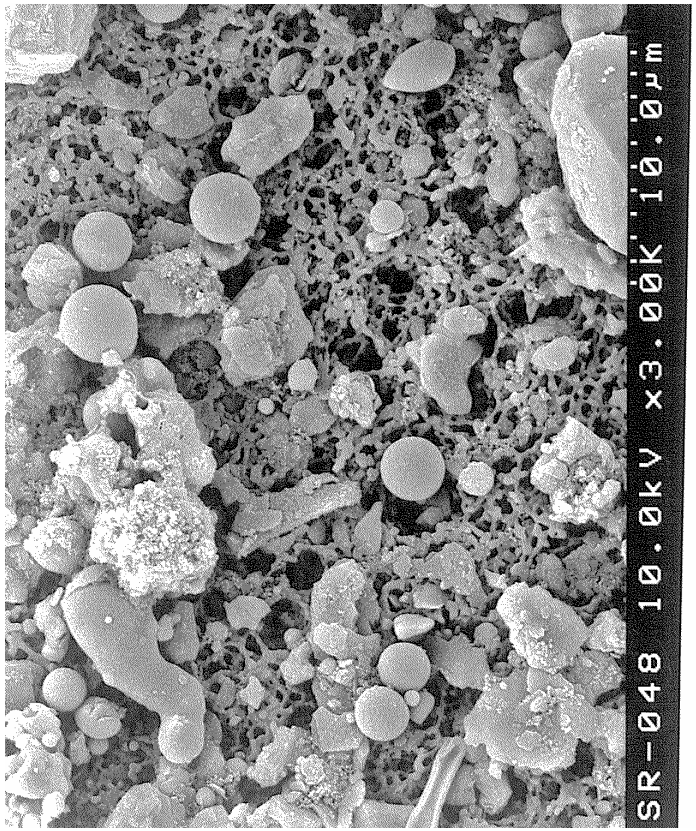


市房山　樹氷

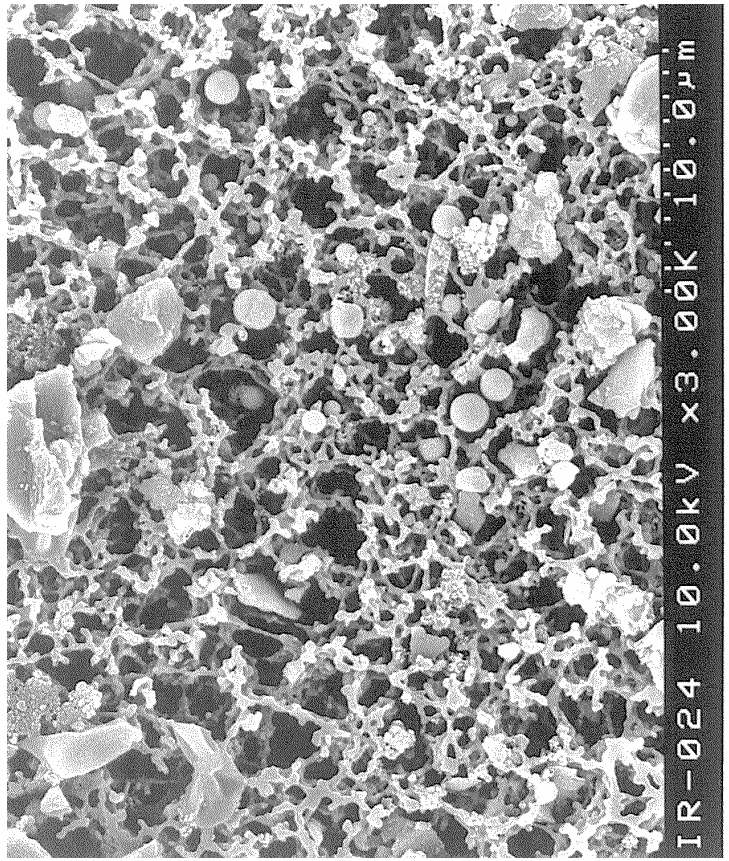




黄砂時の樹氷中エアロゾル
ハラ山

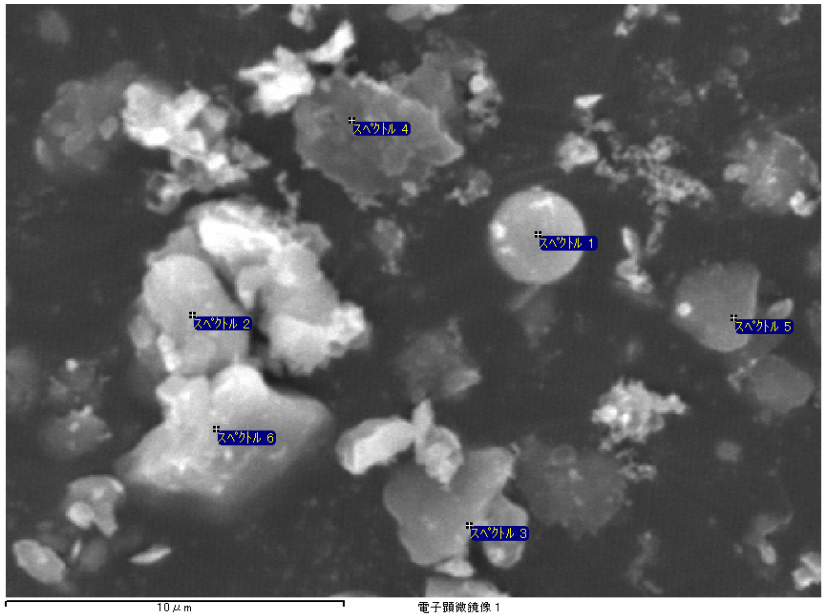


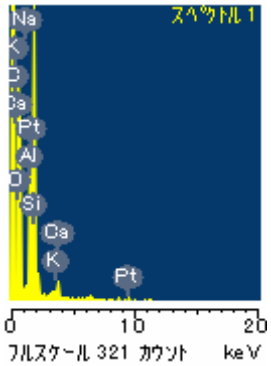
ハラ山　樹氷

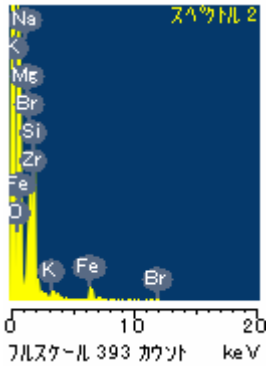


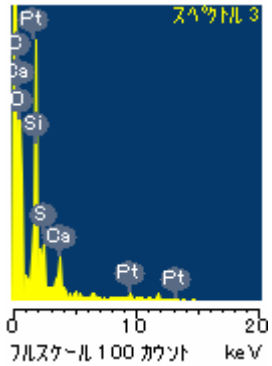
市房山　樹氷

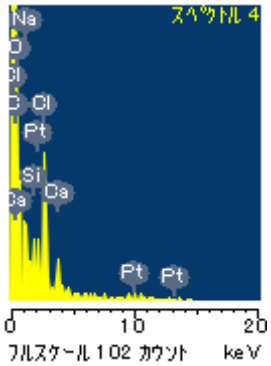
黄砂（大宰府）

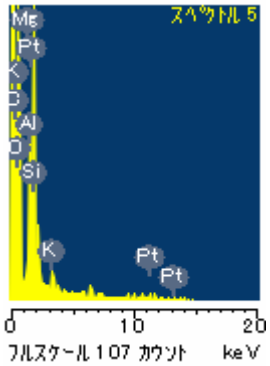

スペクトル 4
スペクトル 1
スペクトル 2
スペクトル 5
スペクトル 6
スペクトル 3
10 μm
電子顕微鏡像 1

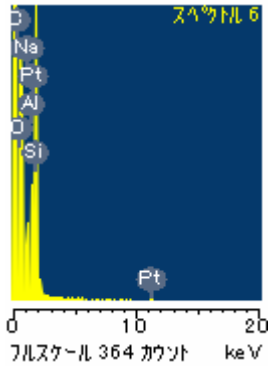

スペクトル 1
Na
K
O
Ca
Pt
Al
O
Si
Ca
K
Pt
0
10
20
フルスケール 321 カウント
keV


スペクトル 2
Na
K
Mg
Br
Si
Zr
Fe
O
K
Fe
Br
0
10
20
フルスケール 393 カウント
keV

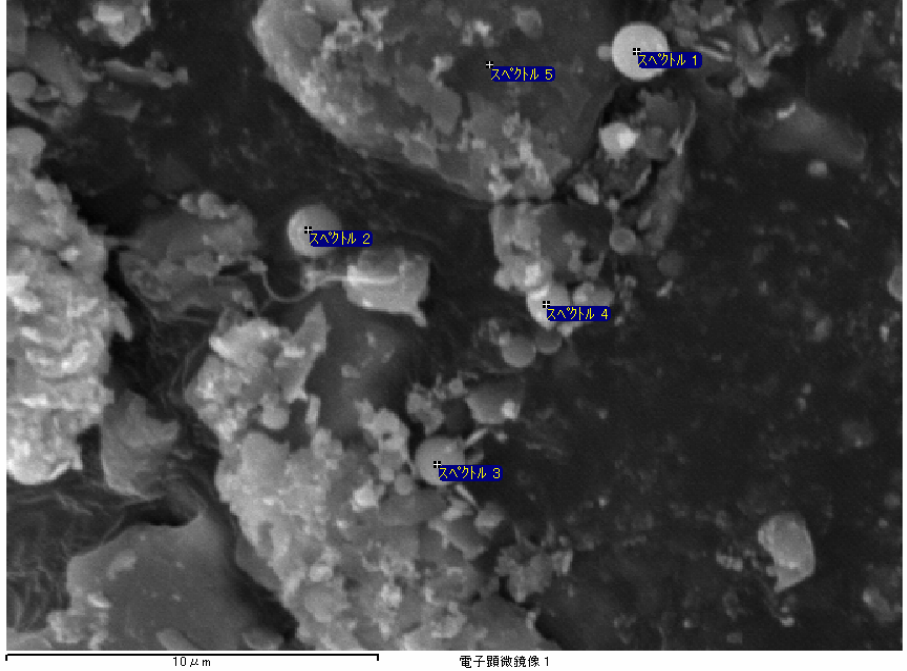

スペクトル 3
Pt
O
Ca
O
Si
S
Ca
Pt
Pt
0
10
20
フルスケール 100 カウント
keV

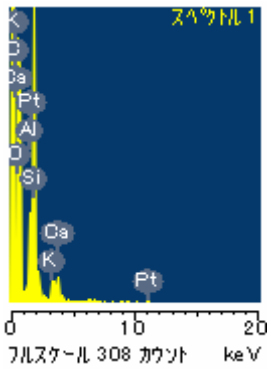

スペクトル 4
Na
O
Cl
O
Cl
Pt
Si
Ca
Ca
Pt
Pt
0
10
20
フルスケール 102 カウント
keV

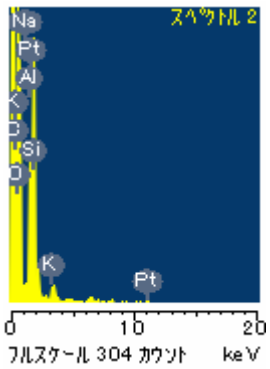

スペクトル 5
Mg
Pt
K
O
Al
O
Si
K
Pt
Pt
0
10
20
フルスケール 107 カウント
keV

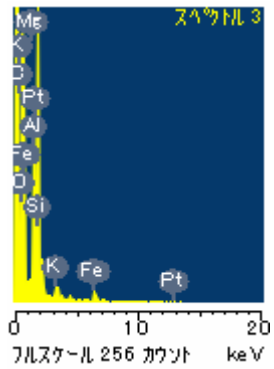

スペクトル 6
O
Na
Pt
Al
O
Si
Pt
0
10
20
フルスケール 364 カウント
keV

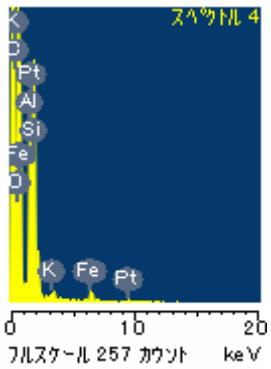
宮之浦岳
山頂　樹氷

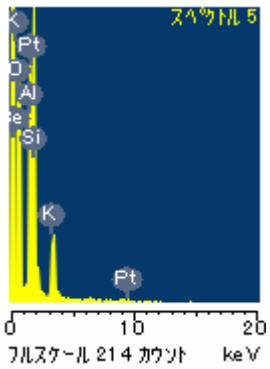

スペクトル 5
スペクトル 1
スペクトル 2
スペクトル 4
スペクトル 3
10 μm
電子顕微鏡像 1


スペクトル 1
Pt
Al
Si
Ca
K
0
10
20
フルスケール 308 カウント
keV

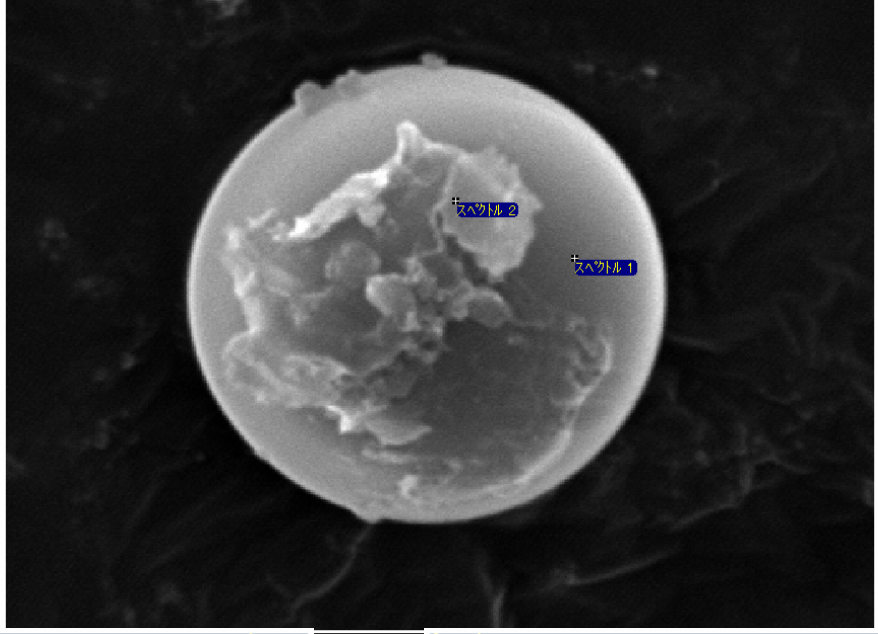

スペクトル 2
Na
Pt
Al
Si
K
0
10
20
フルスケール 304 カウント
keV

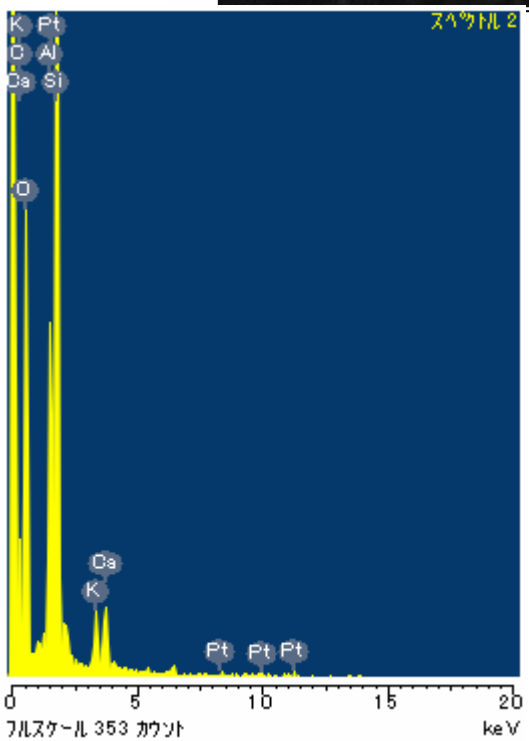

スペクトル 3
Mg
Pt
Al
Fe
Si
K
0
10
20
フルスケール 256 カウント
keV

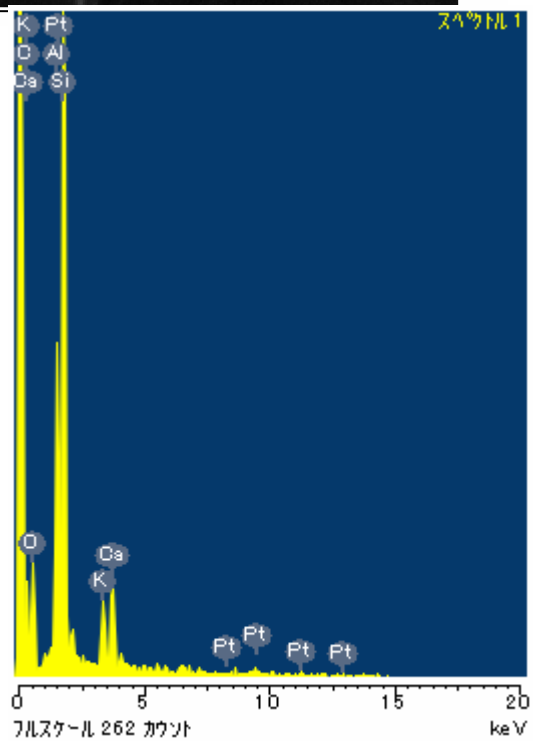

スペクトル 4
Pt
Al
Si
Fe
K
0
10
20
フルスケール 257 カウント
keV

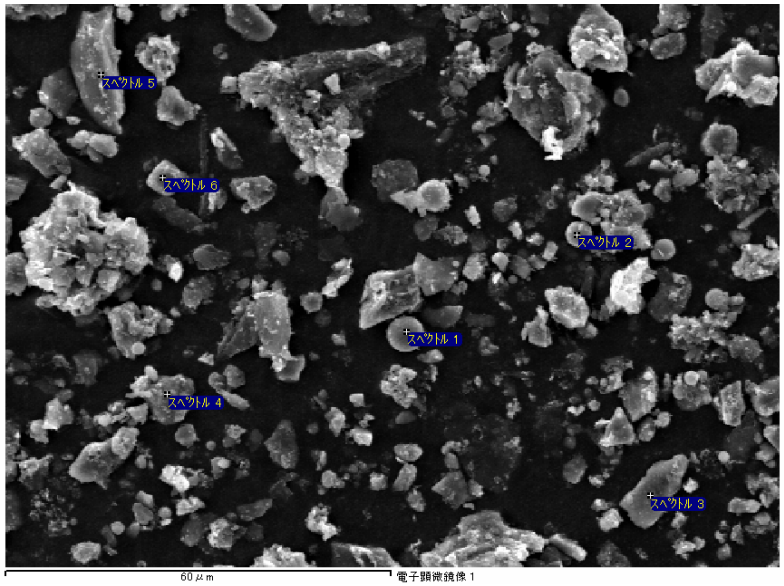

スペクトル 5
Pt
Al
Si
K
0
10
20
フルスケール 214 カウント
keV

谷川岳
樹氷


スペクトル 2
スペクトル 1

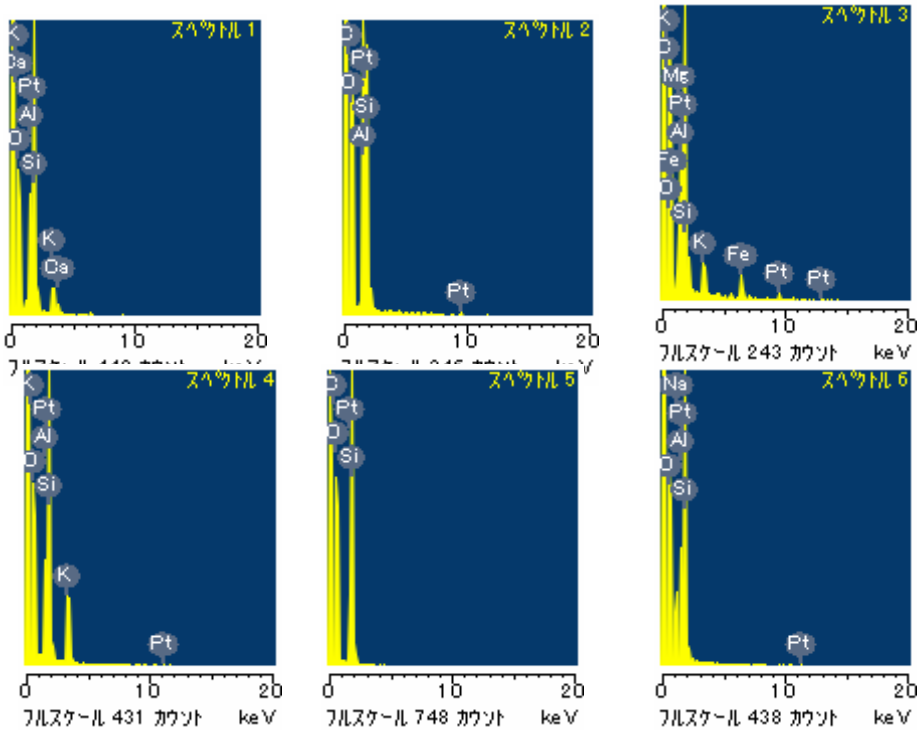

スペクトル 2
K
Pt
C
Al
Ca
Si
O
Ca
K
Pt
Pt
Pt
0
5
10
15
20
フルスケール 353 カウント
keV

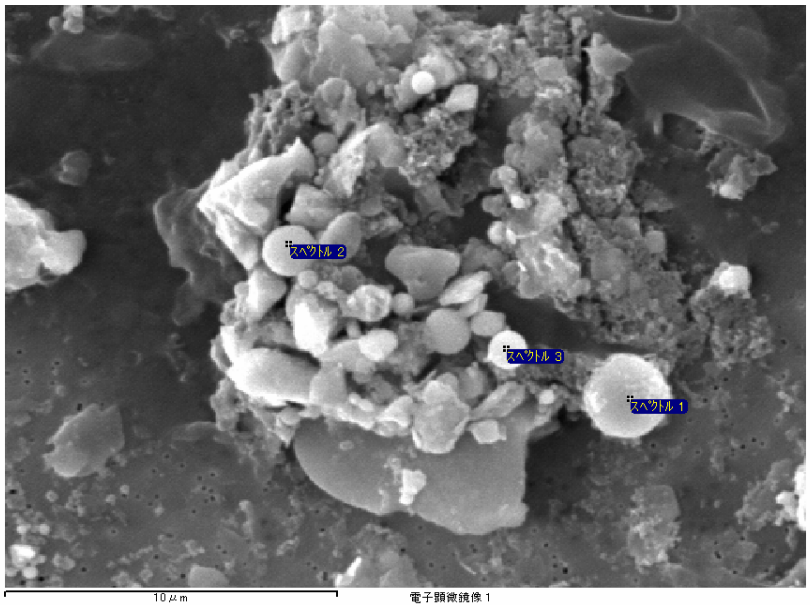

スペクトル 1
K
Pt
C
Al
Ca
Si
O
Ca
K
Pt
Pt
Pt
Pt
0
5
10
15
20
フルスケール 262 カウント
keV


スペクトル 5
スペクトル 6
スペクトル 2
スペクトル 1
スペクトル 4
スペクトル 3
60 μm
電子顕微鏡像 1

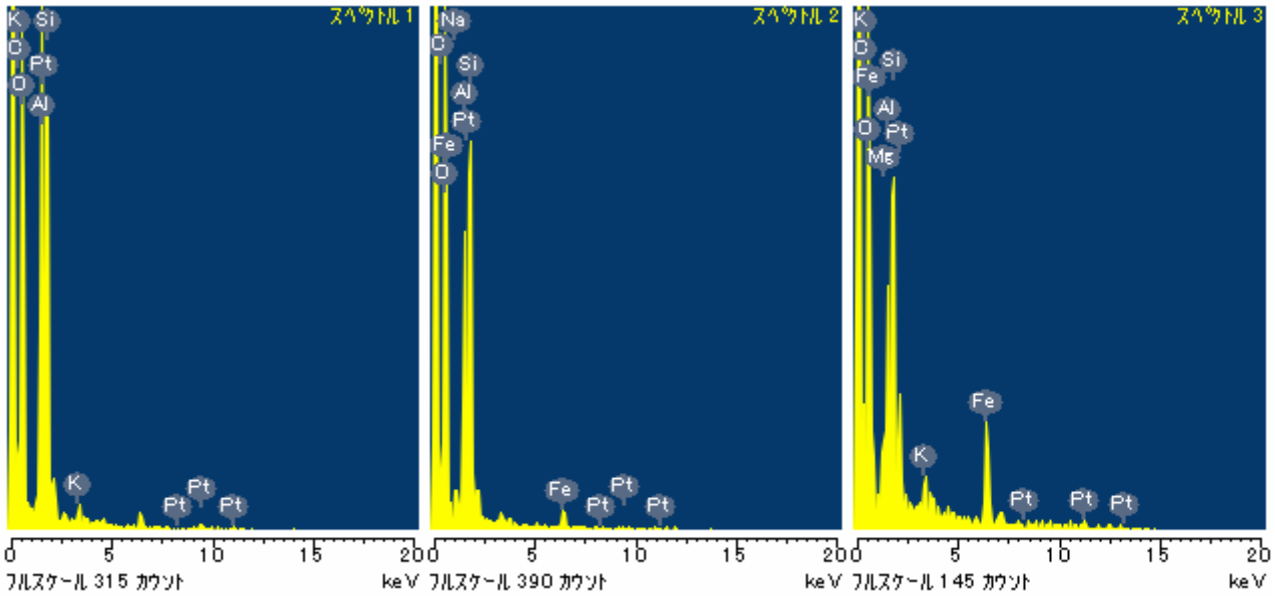
谷川岳

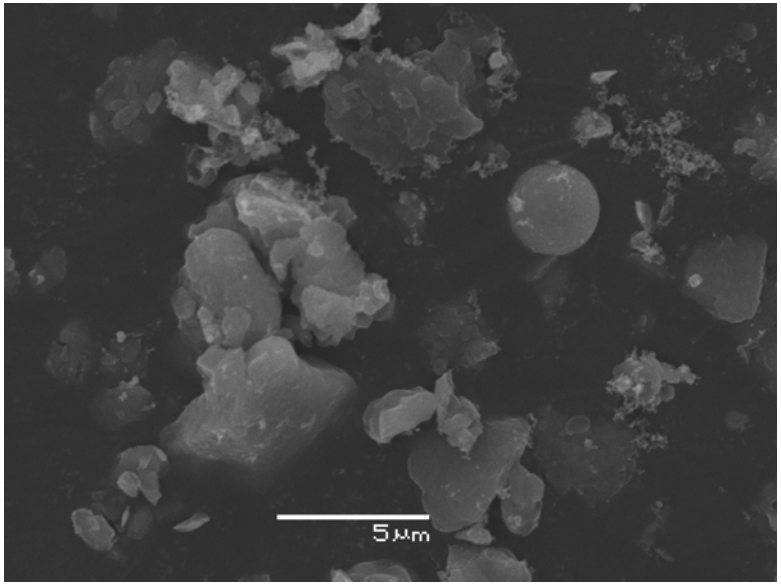
樹氷

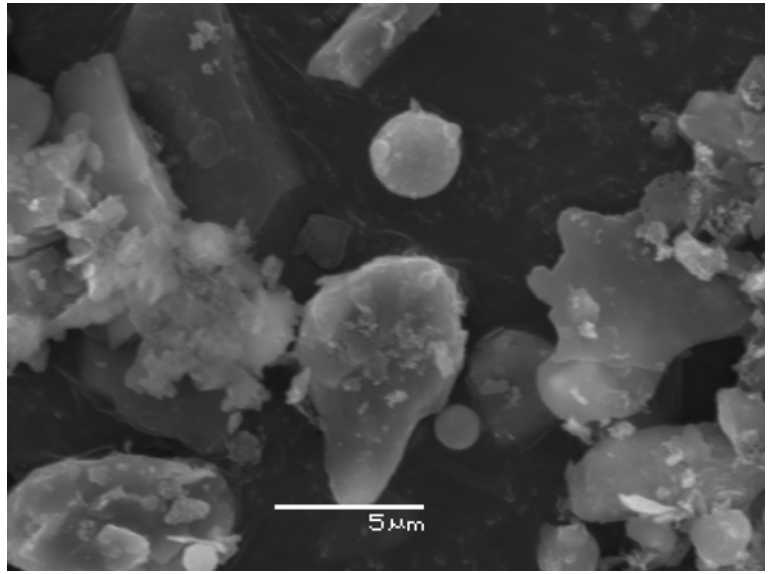

スペクトル 1
K
Ca
Pt
Al
O
Si
スペクトル 2
O
Pt
Si
Al
Pt
スペクトル 3
Mg
Pt
Al
Fe
O
Si
K
Fe
Pt
Pt
フルスケール 243 カウント
keV
スペクトル 4
K
Pt
Al
O
Si
Pt
フルスケール 431 カウント
keV
スペクトル 5
O
Pt
Si
フルスケール 748 カウント
keV
スペクトル 6
Na
Pt
Al
O
Si
Pt
フルスケール 438 カウント
keV

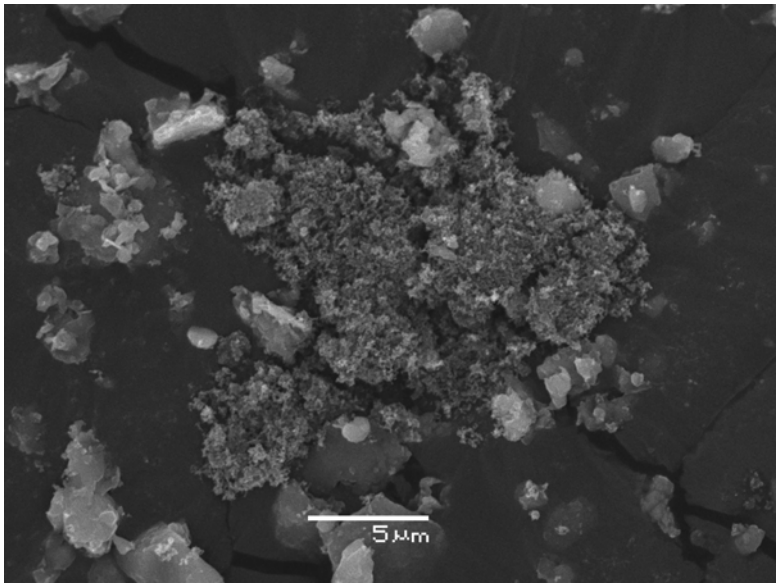


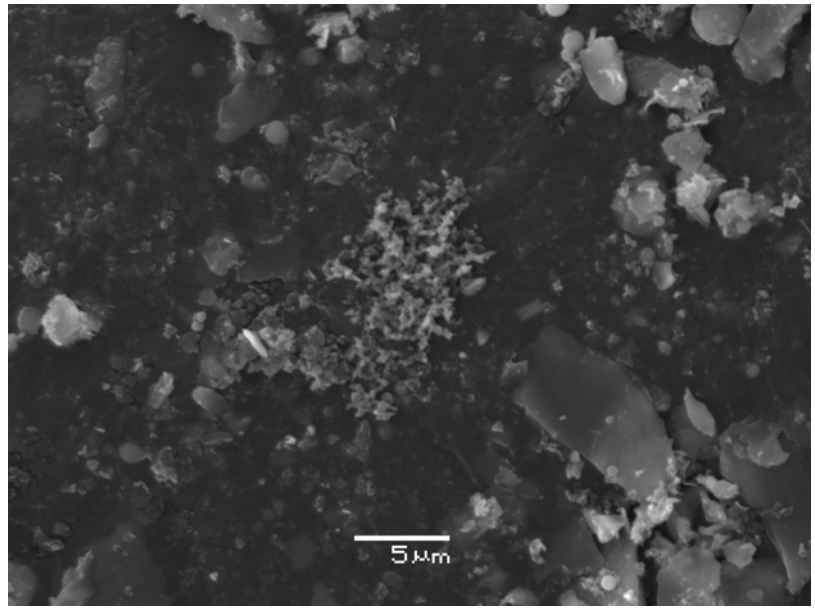
宮之浦岳
樹氷
1998/02





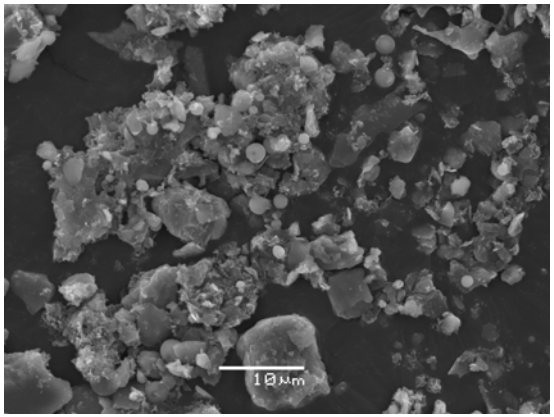


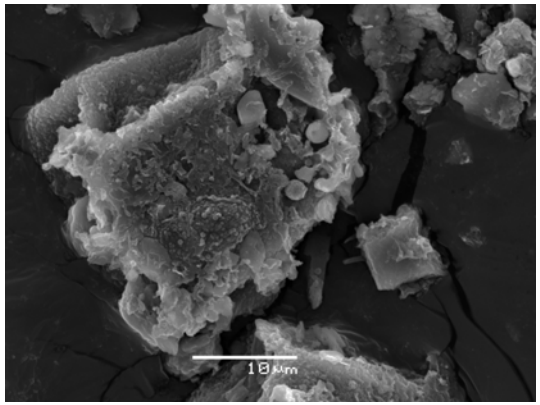


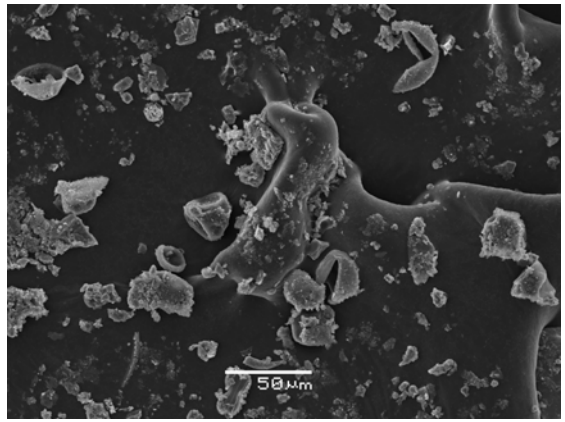


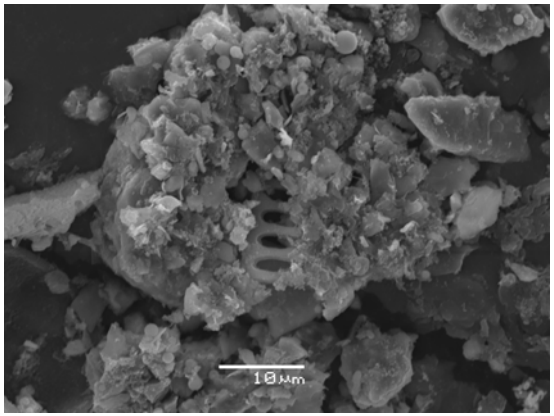
黄砂飛来時

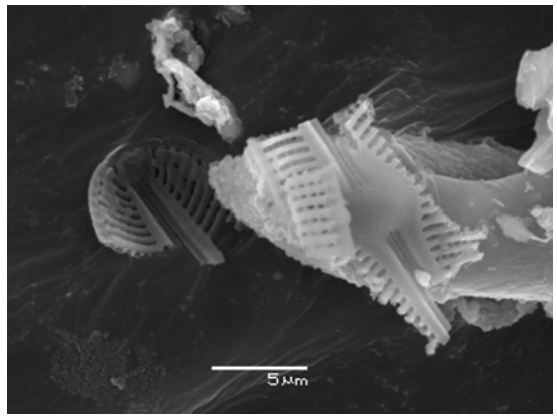
宮之浦岳　樹氷





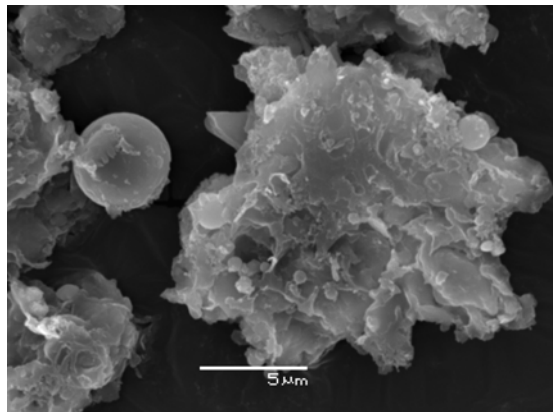


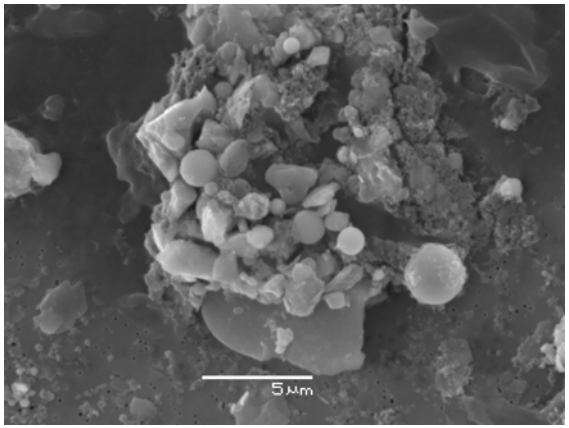




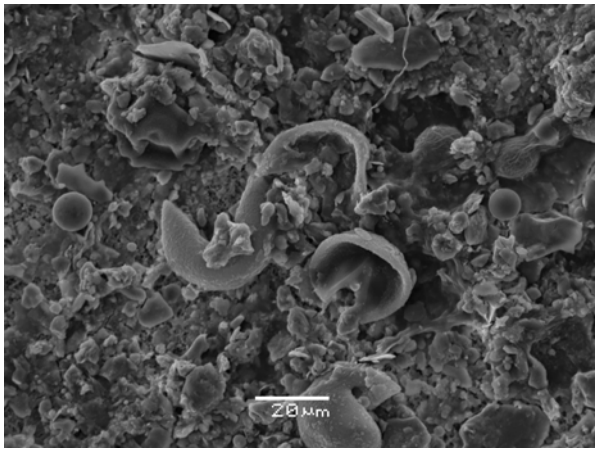
谷川岳　3月

谷川岳　2月

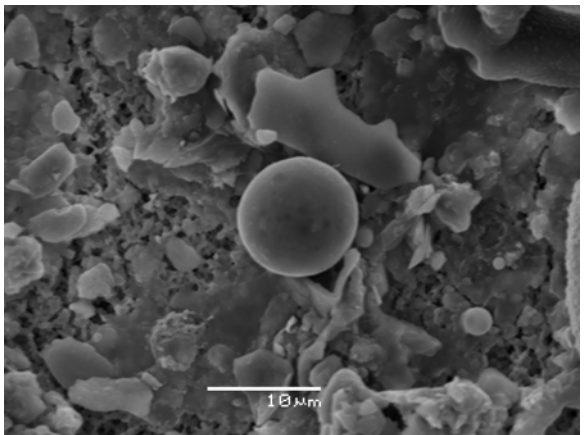




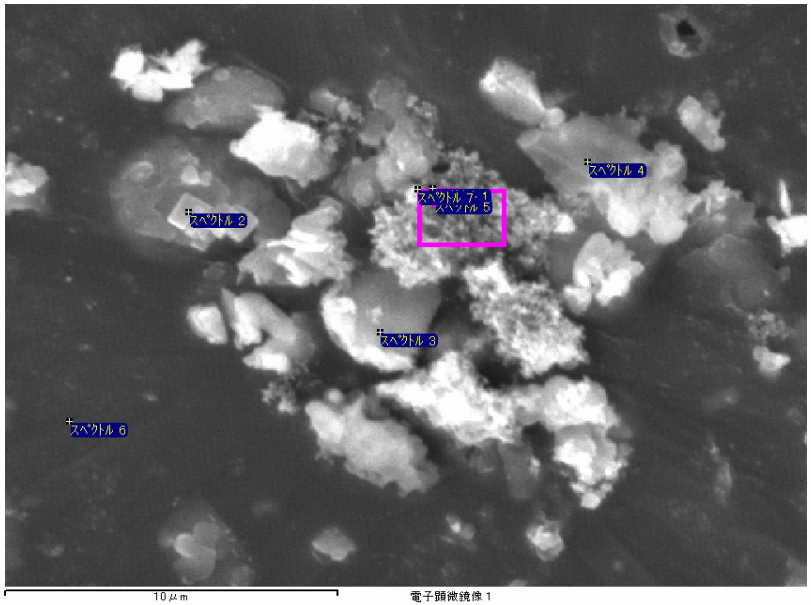
宮之浦岳

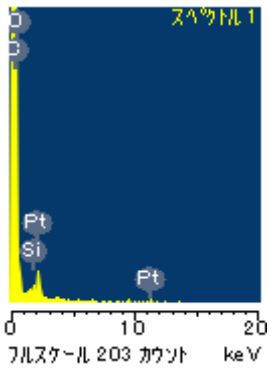


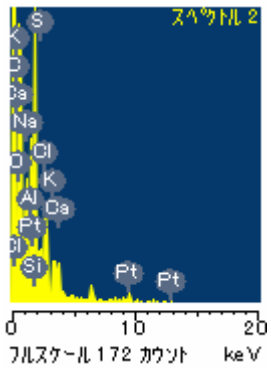
大山
3月

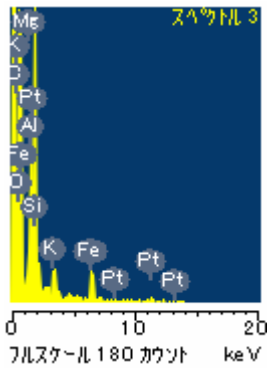


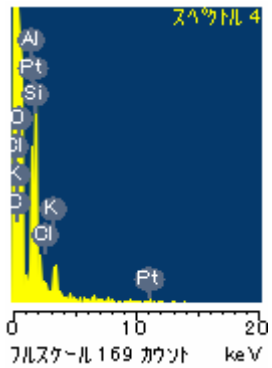
大山3月

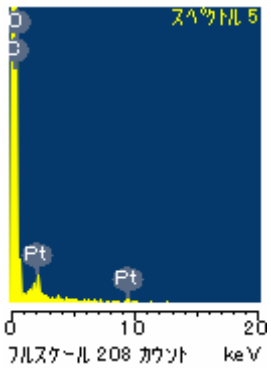

スペクトル 4
スペクトル 7-1
スペクトル 5
スペクトル 2
スペクトル 3
スペクトル 6
10 μm
電子顕微鏡像 1

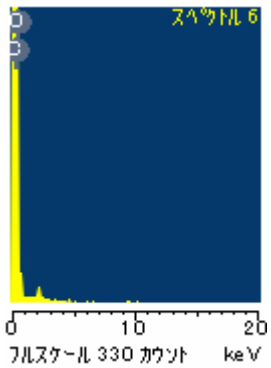

スペクトル 1
O
C
Pt
Si
Pt
0
10
20
フルスケール 203 カウント
keV

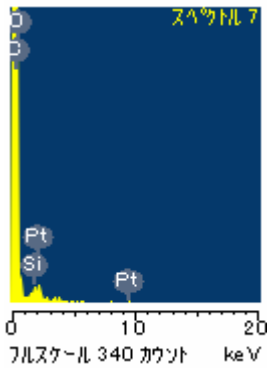

スペクトル 2
S
K
C
Ca
Na
O
Cl
K
Al
Ca
Pt
Cl
Si
Pt
Pt
0
10
20
フルスケール 172 カウント
keV

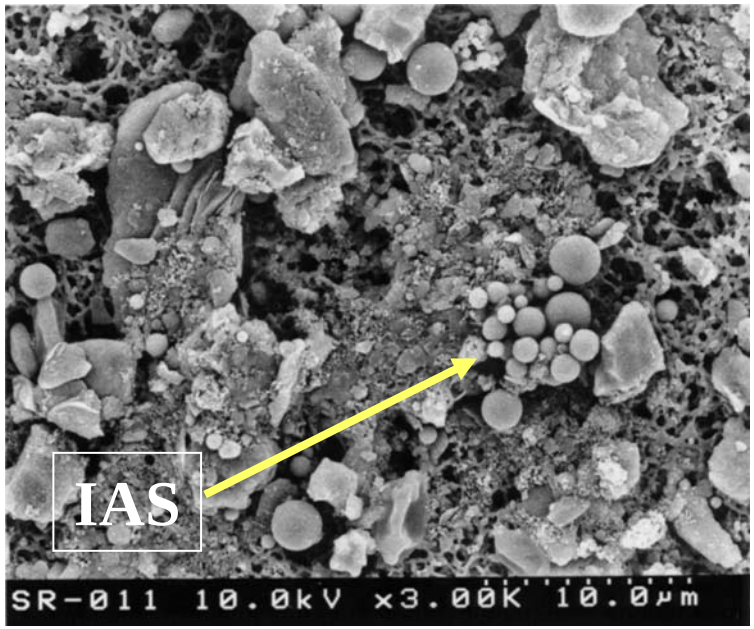

スペクトル 3
Mg
K
O
Pt
Al
Fe
O
Si
K
Fe
Pt
Pt
Pt
0
10
20
フルスケール 180 カウント
keV


スペクトル 4
Al
Pt
Si
O
Cl
K
C
K
Cl
Pt
0
10
20
フルスケール 169 カウント
keV

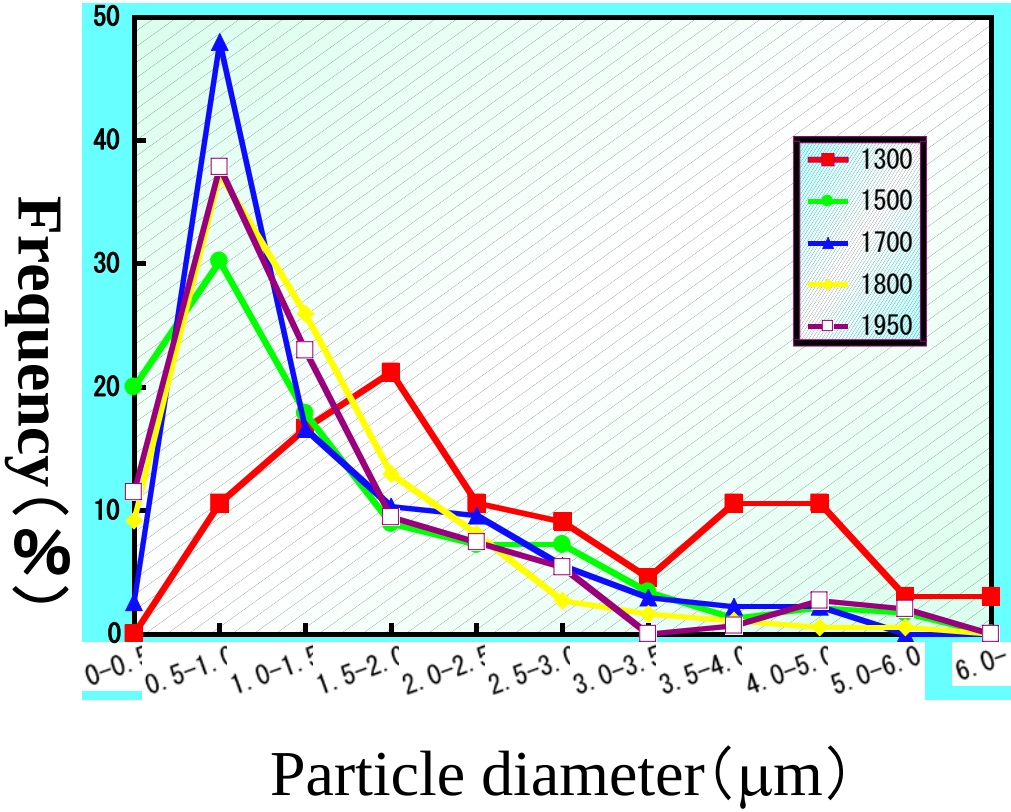

スペクトル 5
O
C
Pt
Pt
0
10
20
フルスケール 208 カウント
keV


スペクトル 6
O
C
0
10
20
フルスケール 330 カウント
keV


スペクトル 7
O
C
Pt
Si
Pt
0
10
20
フルスケール 340 カウント
keV



IAS: inorganic ash sphere



Particle diameter（μm）

The IAS of 500 particles in each altitude was measured at randam using SEM.

1300m　various size exist

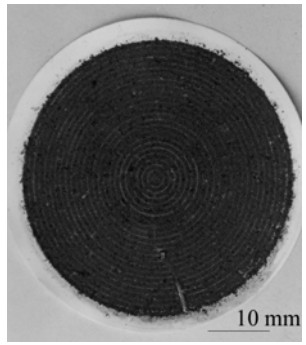
Other altitude　converge at 1.0μm

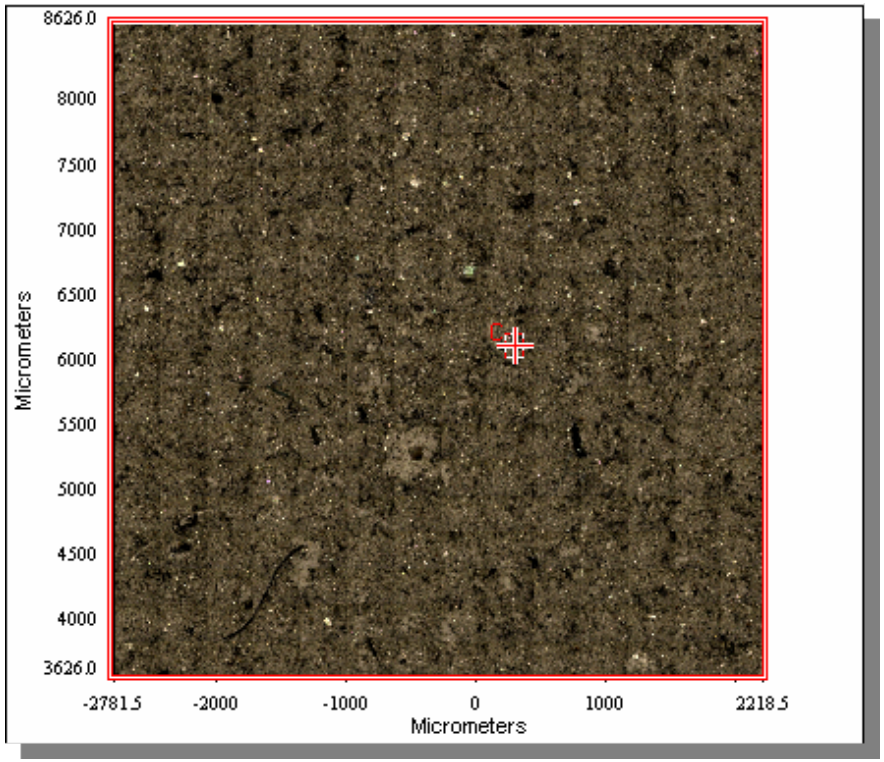
Quantitative evaluation　the number of sheets of photograph

　1500m　1950m

The number of particles of IAS was the maximum in 1500m

The visible image and measurement condition of surface of filter

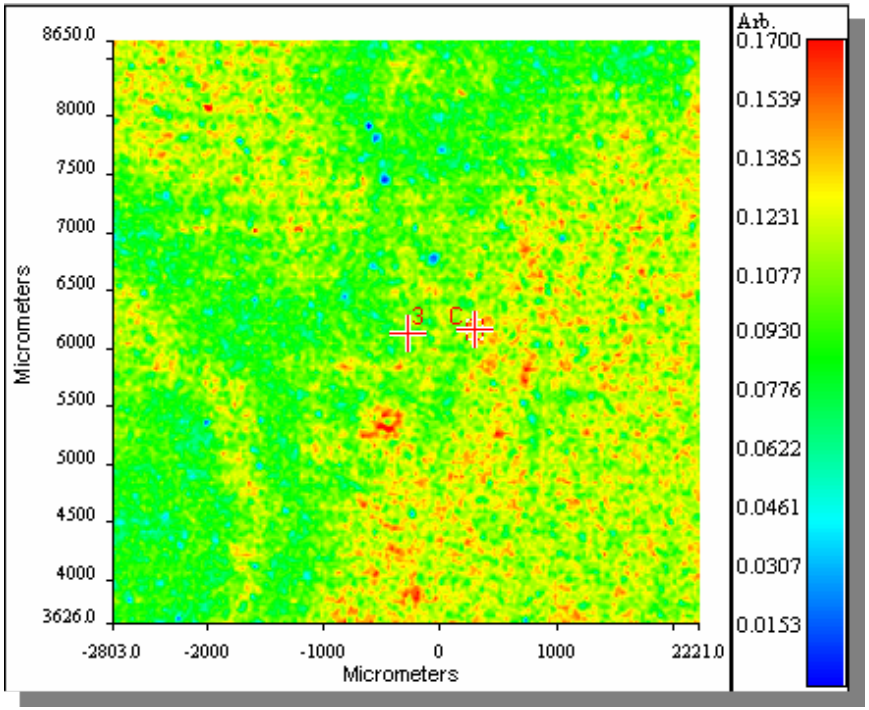




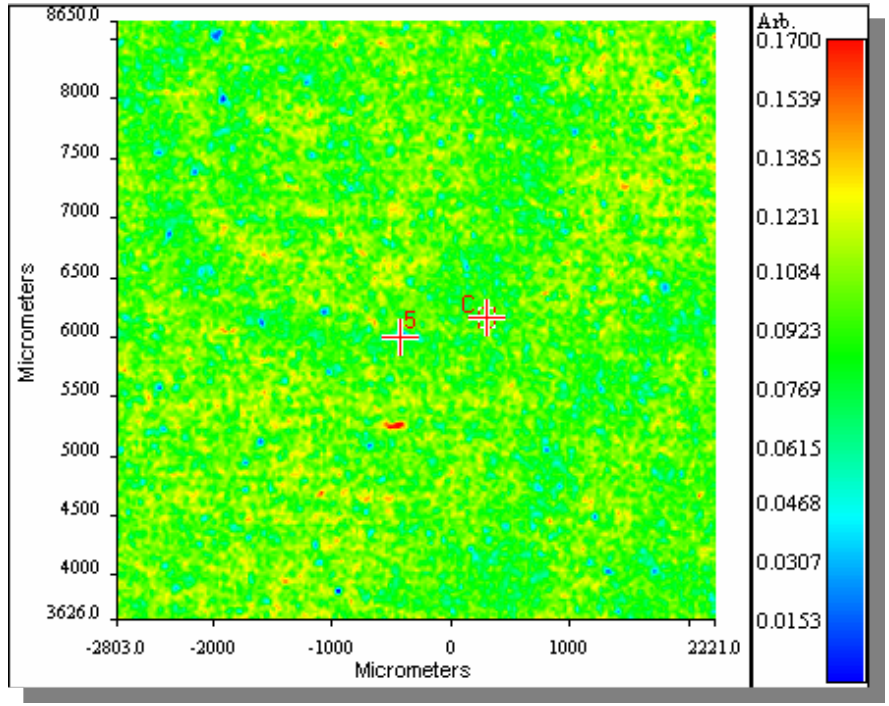
Imaging inside red frame

- :
- :
- :
- :
- : μ × μ
- :
- : 分

Chem image (2920cm^{-1})

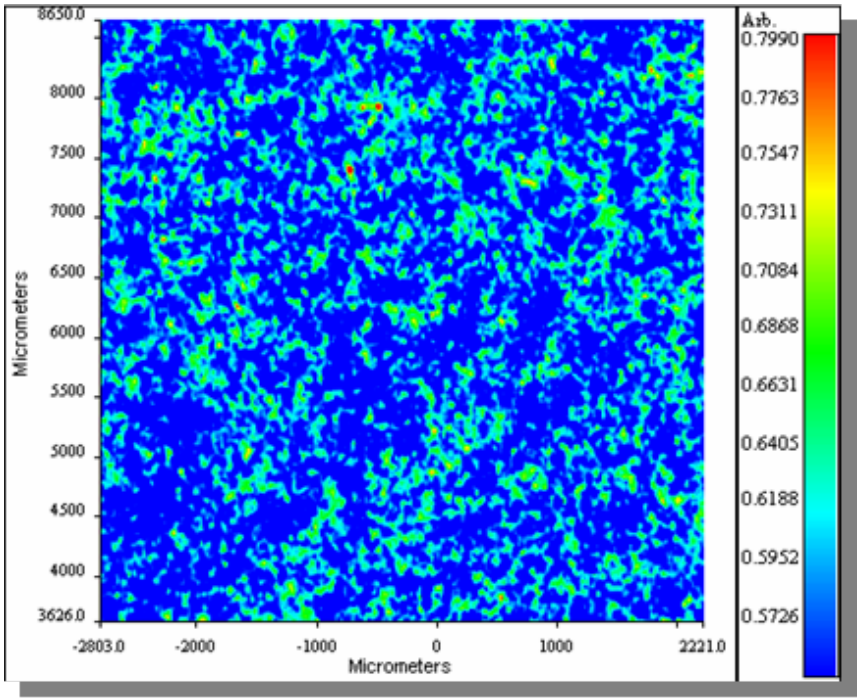


1600m(a.s.l)

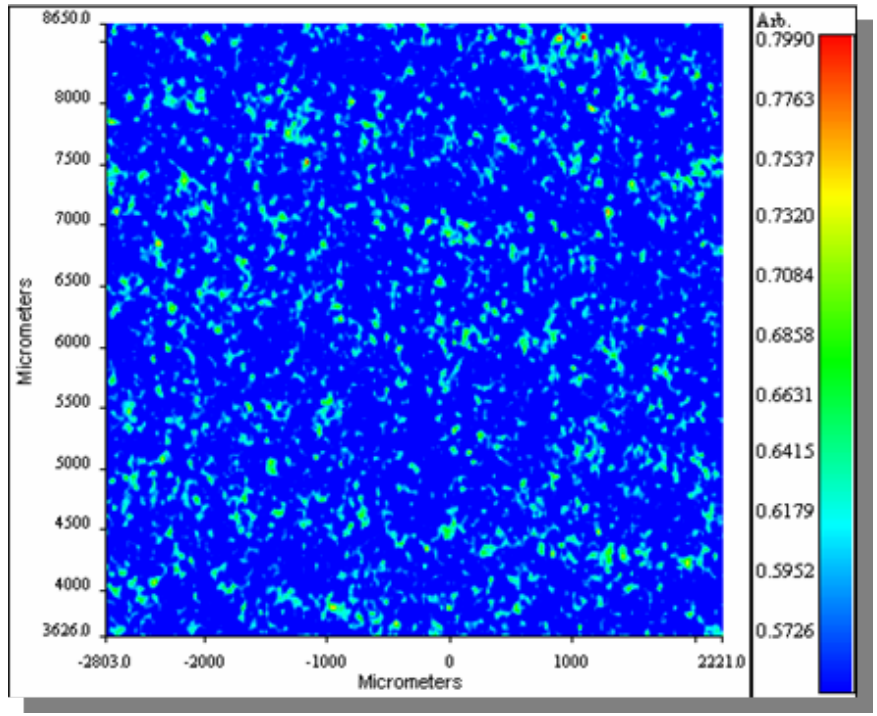


The top of Mt. Miyanouradake

Distribution of SiO_2

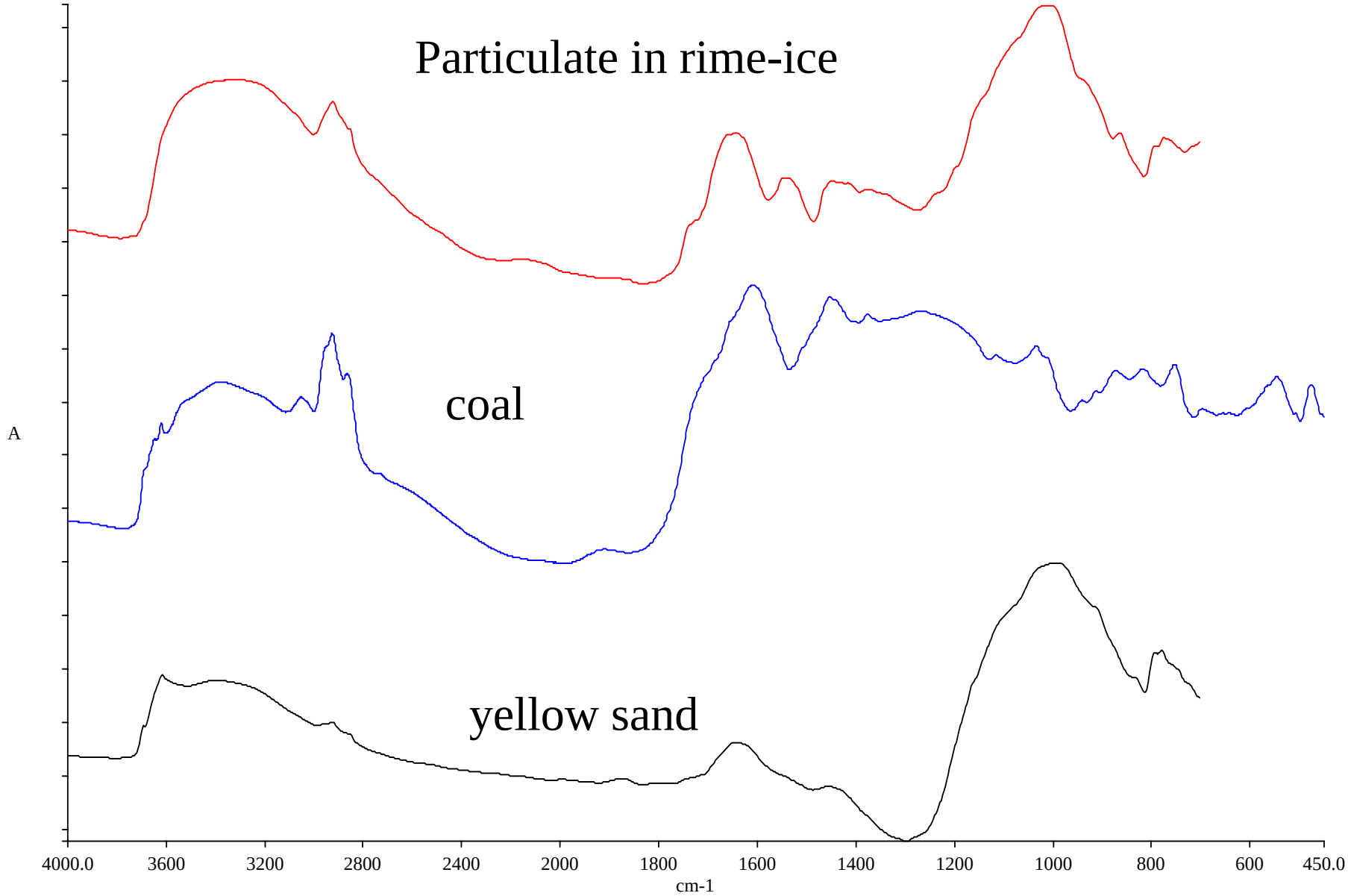


1600m (a.s.l.)

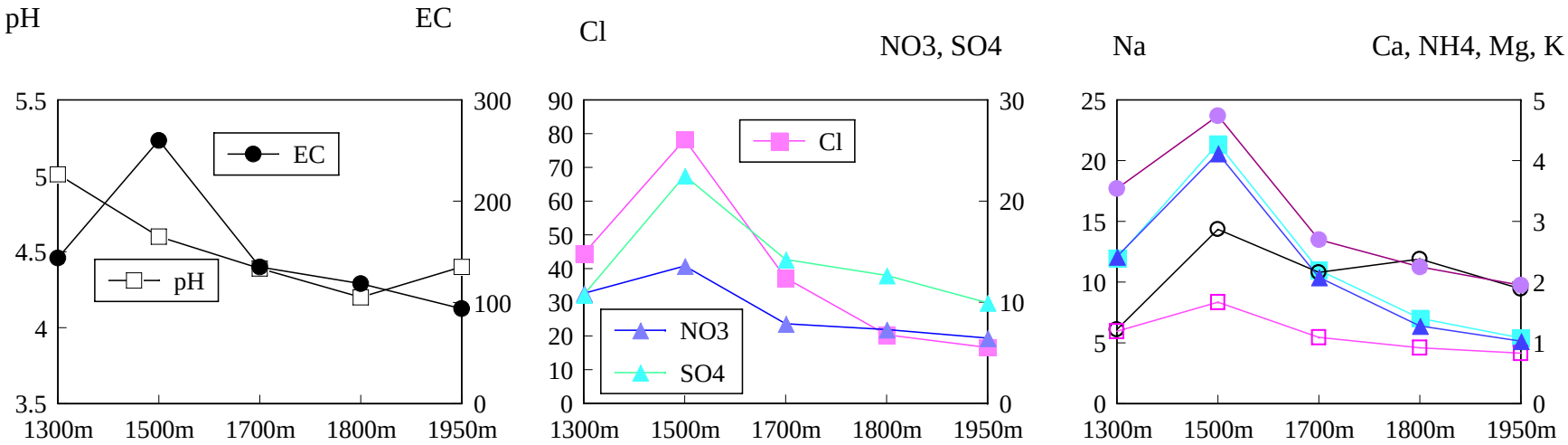


the top of mountain

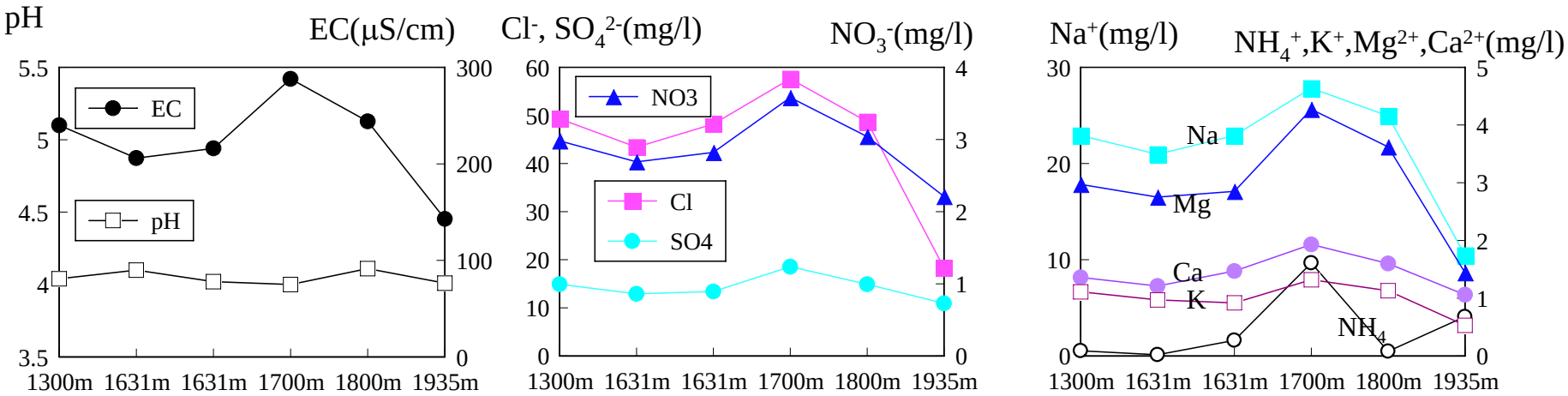
1931m


Particulate in rime-ice
coal
yellow sand
A
4000.0
3600
3200
2800
2400
2000
1800
1600
1400
1200
1000
800
600
450.0
cm-1

Change in ion concentration in rime-ice according to altitude（Mt. Halla）



The maximum value was observed to 1500m as for EC and ion components. However, the pH is a decrease tendency from 1300m to 1800m.



Yakushima Is.

The change in the pH by the altitude is small. However, the maximum value of index was observed to 1700m as for EC and the ion Components. Moreover, the minimum value was a top of mountain. Especially, a decrease of the ion that originates in the sea salt particle in the top of a mountain is remarkable.

Distance Index=$(\Sigma(X_{ji}-X_{ki})^2)^{1/2}$

X=the relative ratio (%) of each anion and cation constituent versus the total anion and total cation.

i=each anion and cation constituent,

j, k=a numerral corresponding to No. in Table 2

The similar degree of ion component in rime ice using Distance Index at Mt. Halla

	島-1300m	島-1500m	島-1700m	島-1800m	島-1950m
島-1300m		**5.04**	**8.22**	**18.2**	**18.0**
島-1500m	**4.08**		**6.47**	**17.6**	**17.9**
島-1700m	**8.26**	**6.42**		**11.2**	**11.6**
島-1800m	**21.2**	**20.3**	**13.9**		**2.54**
島-1950m	**20.7**	**20.1**	**13.8**	**1.42**	
upper half:cation, lower half: anion					

$$\text{Distance Index}=(\Sigma(X_{ji}-X_{ki})^2)^{1/2}$$

☆ **anion**

There is a drastic change between 1700m and 1800m.
1800m and 1950m are similar.
D.I. changes gradually from 1300m to 1700m in each altitude

★ **cation**

The tendency was similar to the anion.

Similar degree of ion component in rime ice using Distance Index At Miyanouradake

	Y-1300m	Y-1641m	Y-1641m	Y-1700m	Y-1800m	Y-1931m
Y-1300m		0.65	1.19	7.07	2.46	13.6
Y-1641m	0.32		1.74	7.45	2.24	14.2
Y-1641m	1.69	1.39		6.74	3.24	12.9
Y-1700m	1.35	1.66	3.04		6.43	9.98
Y-1800m	0.32	0.61	2.00	1.05		14.2
Y-1931m	17.7	18.0	19.4	16.3	17.4	

upper: cation; lower: anion

- **The characteristics of anion**
  There is not the similarity between the summit and other altitude
- **The characteristics of cation**
  The tendency is similar to the anion

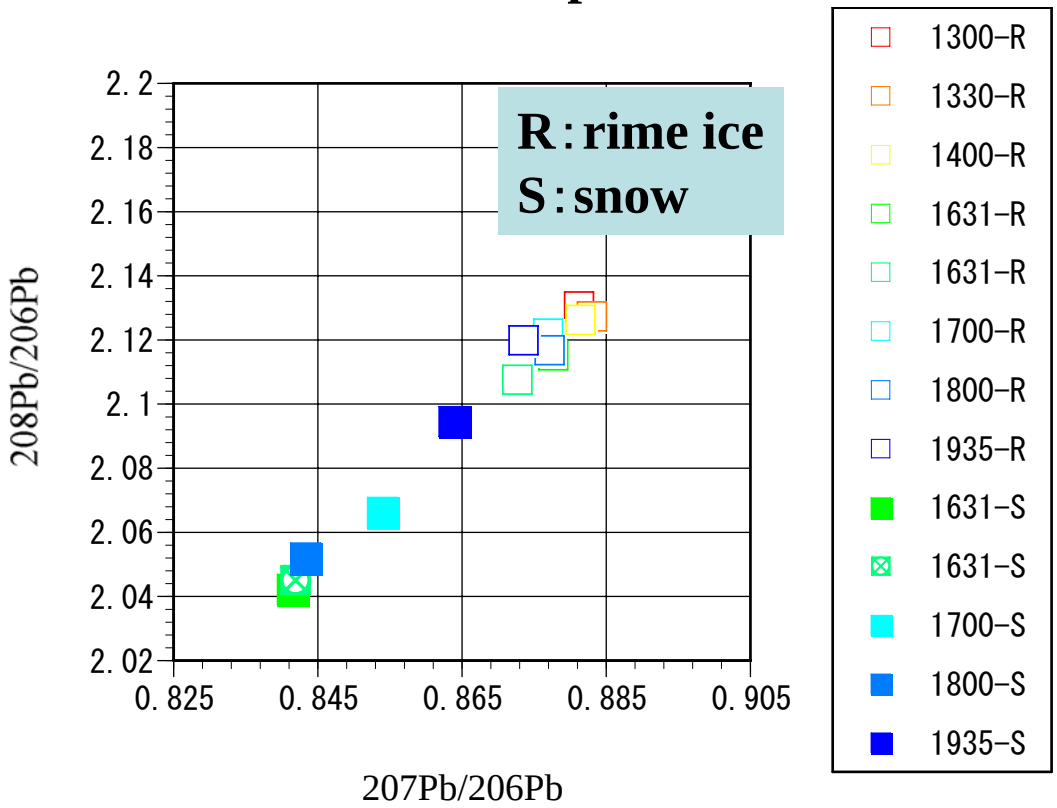
Lead stable isotope ratio in each altitude

月日	度 雪 樹氷	207Pb/206Pb	208Pb/206Pb
1999/1/13	1300-R	0.88123	2.13044
1999/1/13	1330-R	0.88301	2.12734
1999/1/13	1400-R	0.88143	2.12625
1999/1/13	1631-R	0.87765	2.11519
1999/1/14	1631-R	0.87268	2.10761
1999/1/14	1700-R	0.87695	2.12197
1999/1/14	1800-R	0.87715	2.11678
1999/1/14	1935-R	0.87352	2.11987
1999/1/13	1631-S	0.84145	2.04224
1999/1/14	1631-S	0.84194	2.04500
1999/1/14	1700-S	0.85395	2.06624
1999/1/14	1800-S	0.84332	2.05202
1999/1/14	1935-S	0.86388	2.09456

.2.15-19, .2.10-11

Yakushima Is.

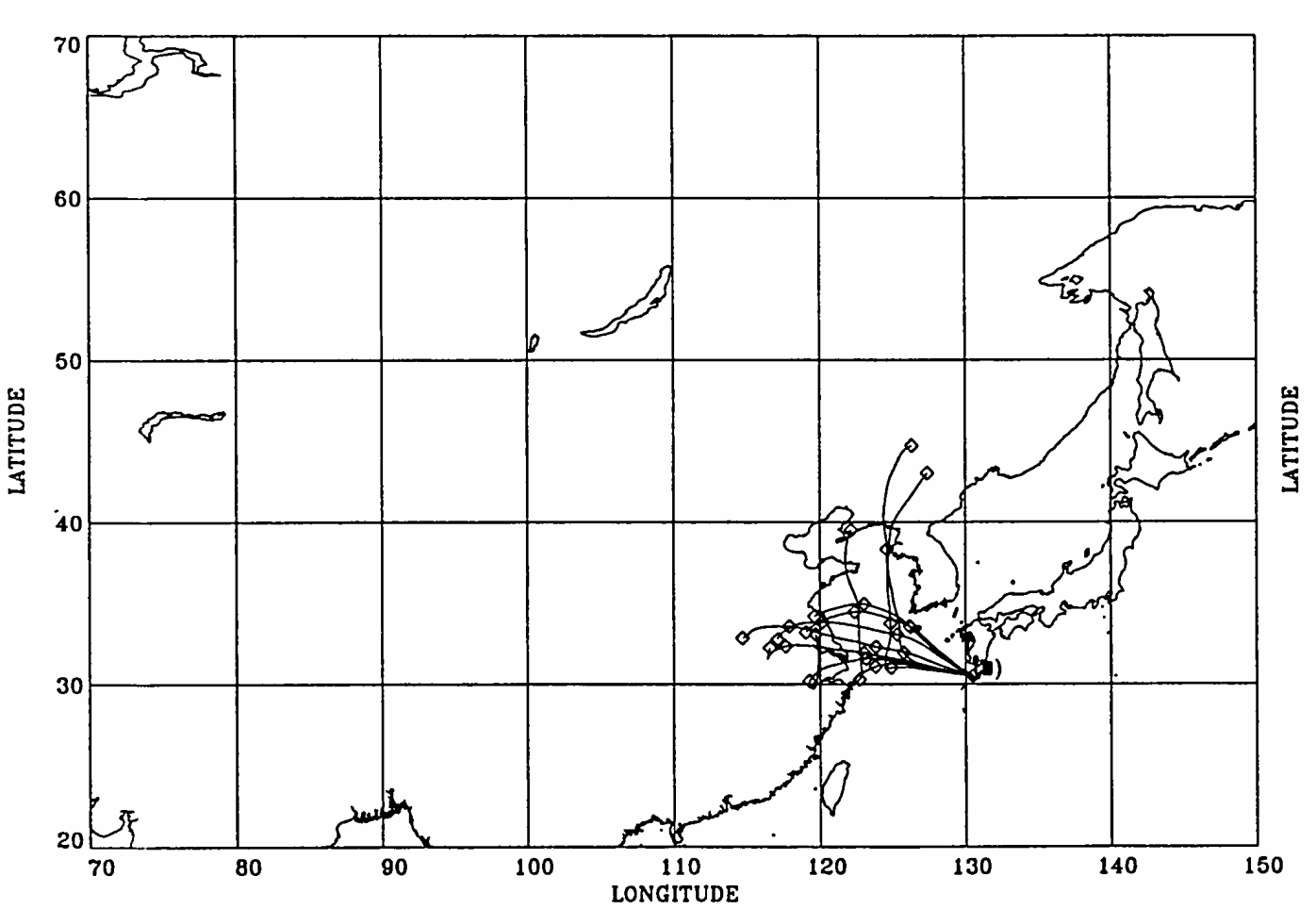
The origin of the contaminant is presumed from Lead stable isotope ratio



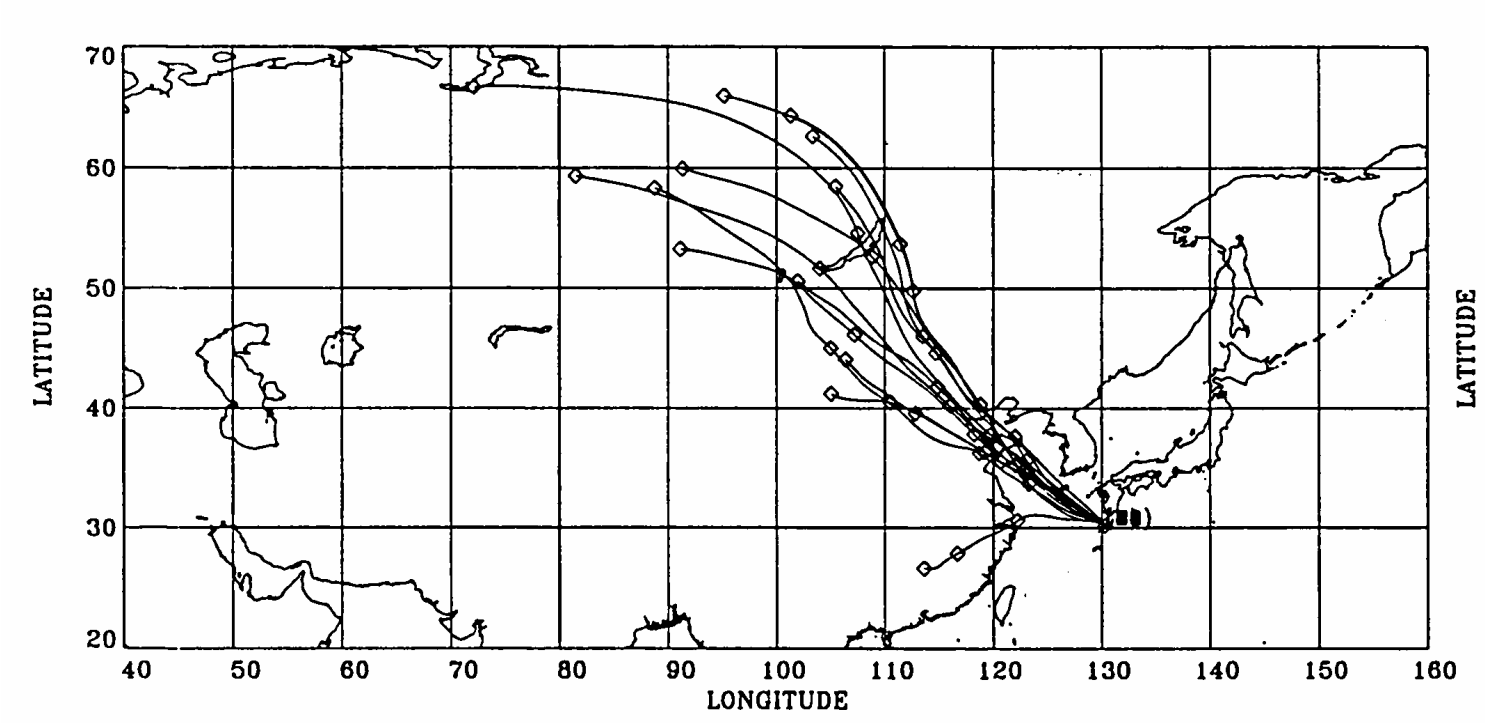
The origin is different in the snowfall and the rime-ice

樹氷は中国大　の分　域　た
1300m～1400mと1400m　では
分　域が
積雪は　が国の分　域　山頂は樹氷

Back trajectory

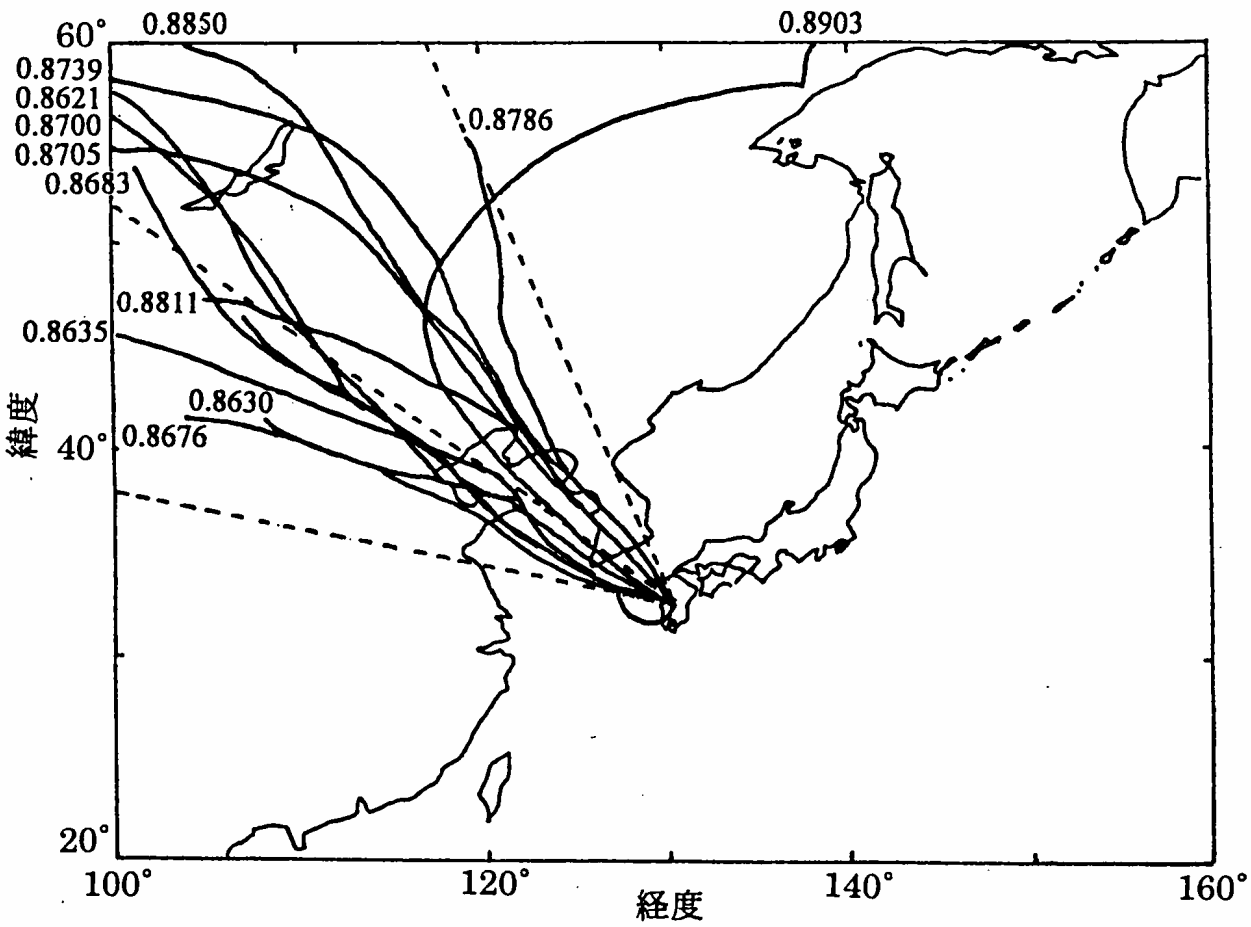


Jan. 1997 at Yakushima Is.



Feb. 1997 at Yakushima Is.

ECMWF（European Centre for Medium –range Weather Forecasts）


60°
0.8850
0.8903
0.8739
0.8621
0.8700
0.8705
0.8683
0.8786
0.8811
0.8635
0.8630
0.8676
緯度
40°
20°
100°
120°
140°
160°
経度

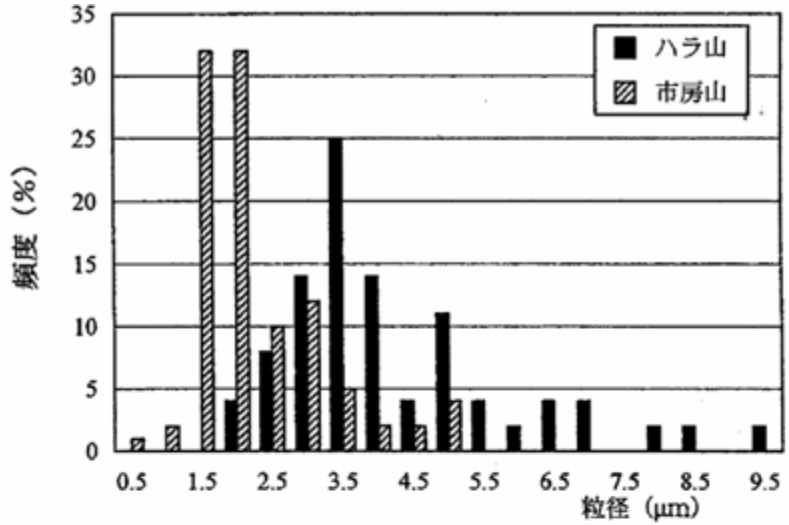


図 4.8　ハラ山と市房山で採取した樹氷中の IAS の粒径頻度分布

（1995 年 3 月 7 日～ 8 日にそれぞれ，調査した.）

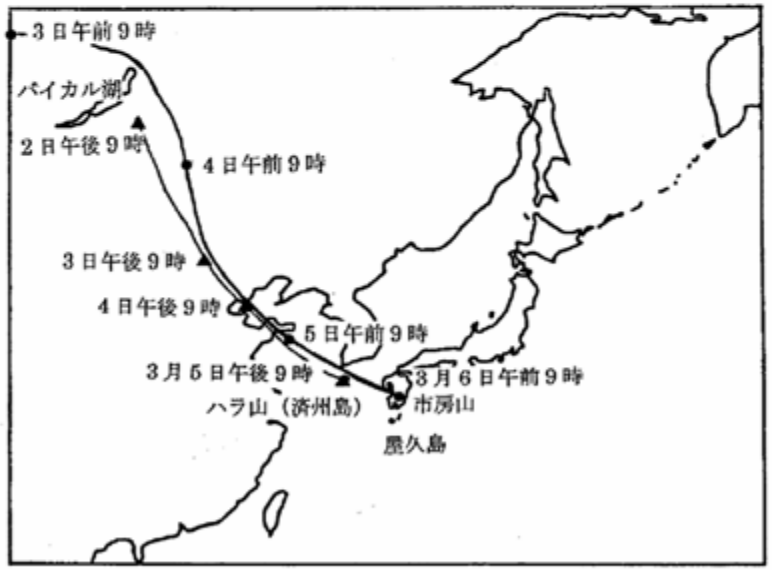


図 4.9　ハラ山と市房山から計算した各流跡線

樹氷の採取は 1995 年 3 月 7 日～ 8 日であるが気象条件と採取場所の情況から樹氷の付着はそれぞれ 3 月 5 日と 6 日とし，樹氷付着時から計算した.

Long-range transported air pollutants was clarified?

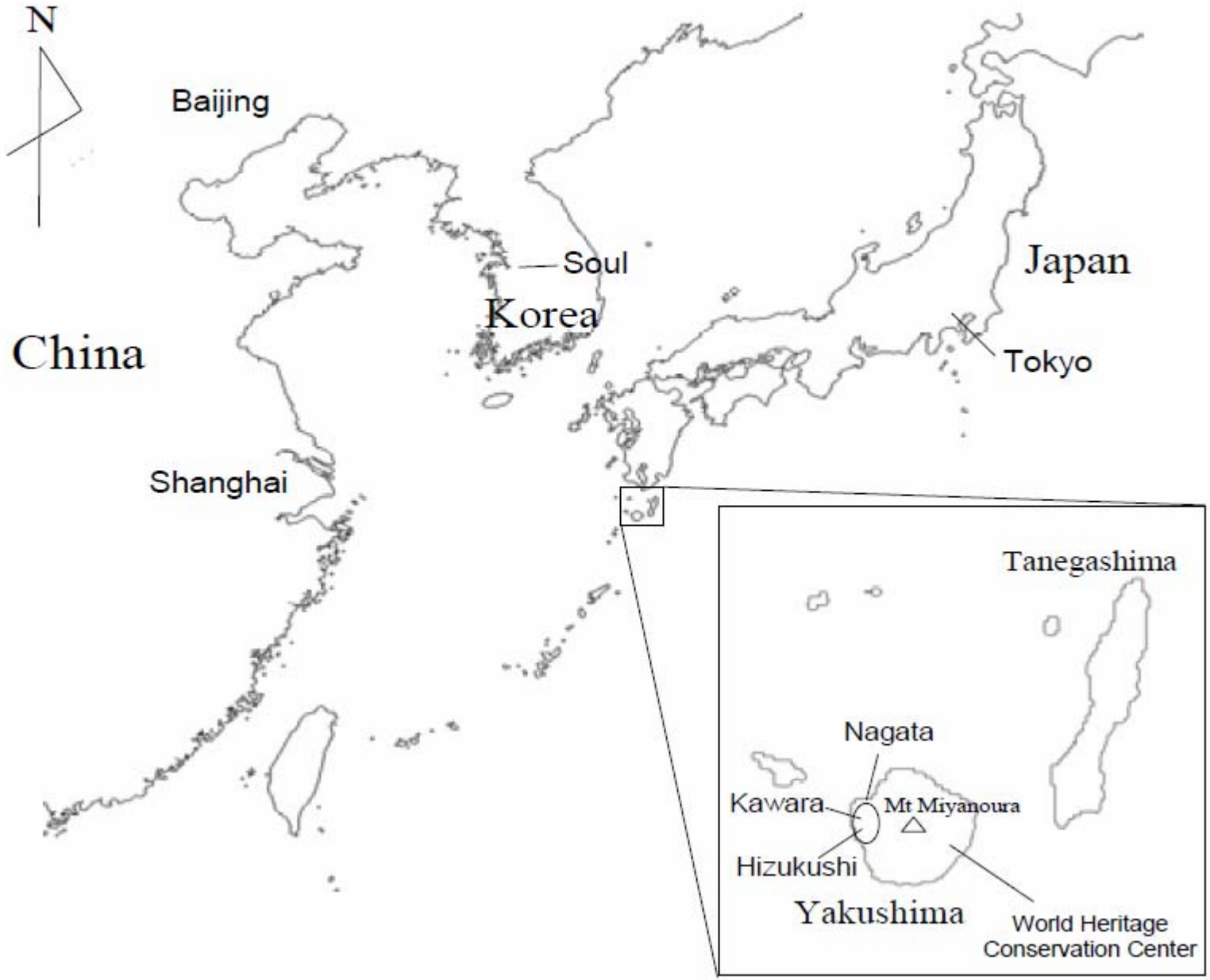
Base on scientific data

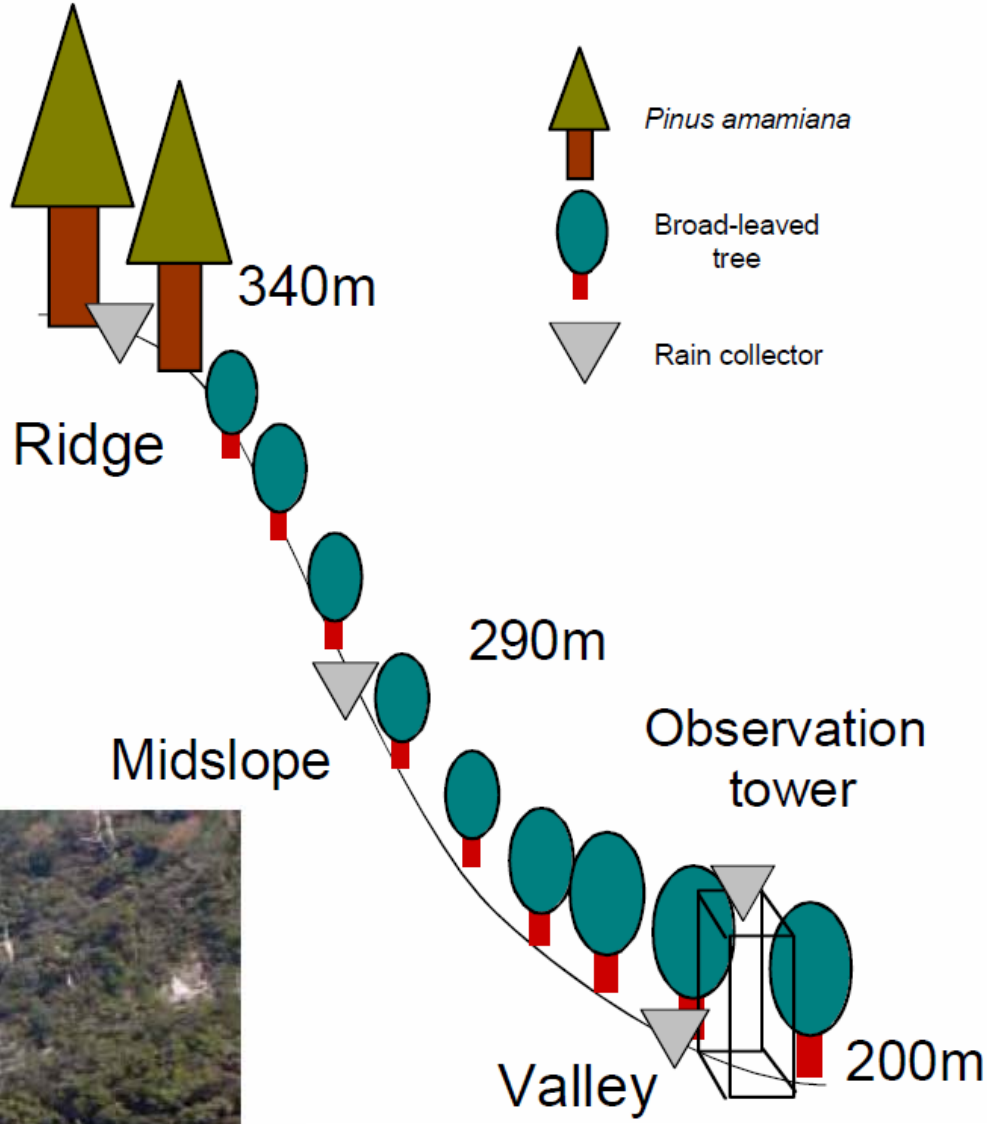
Then, its influence
on natural environment

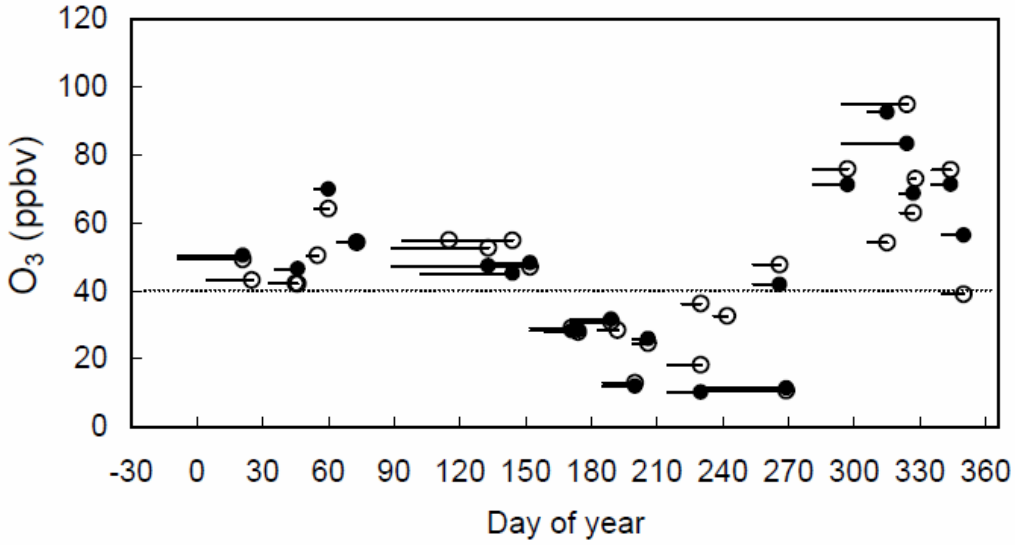
Effect on air pollutants causing forest decline

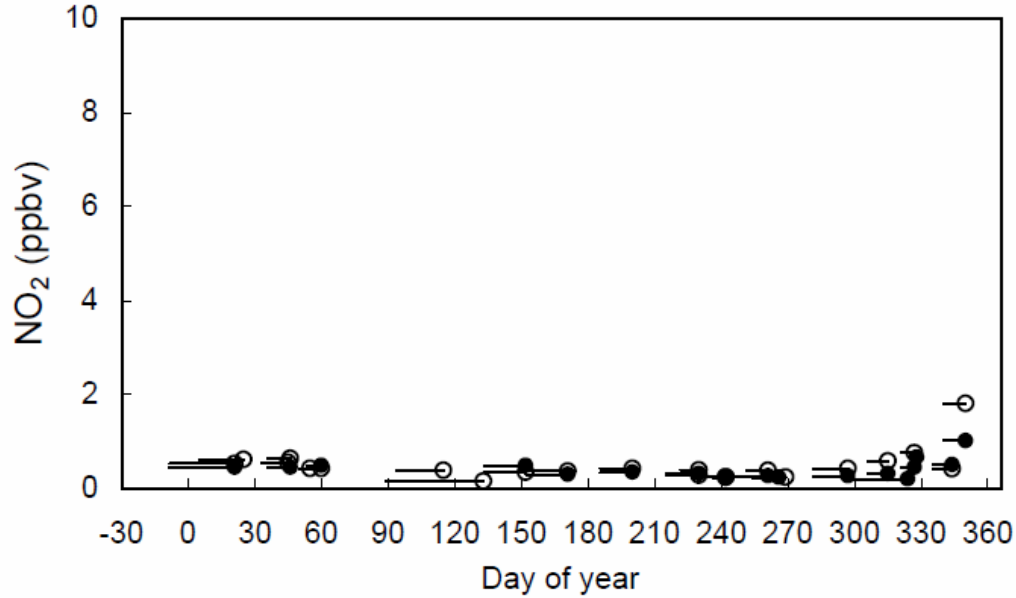
by
Osamu NAGAFUCHI

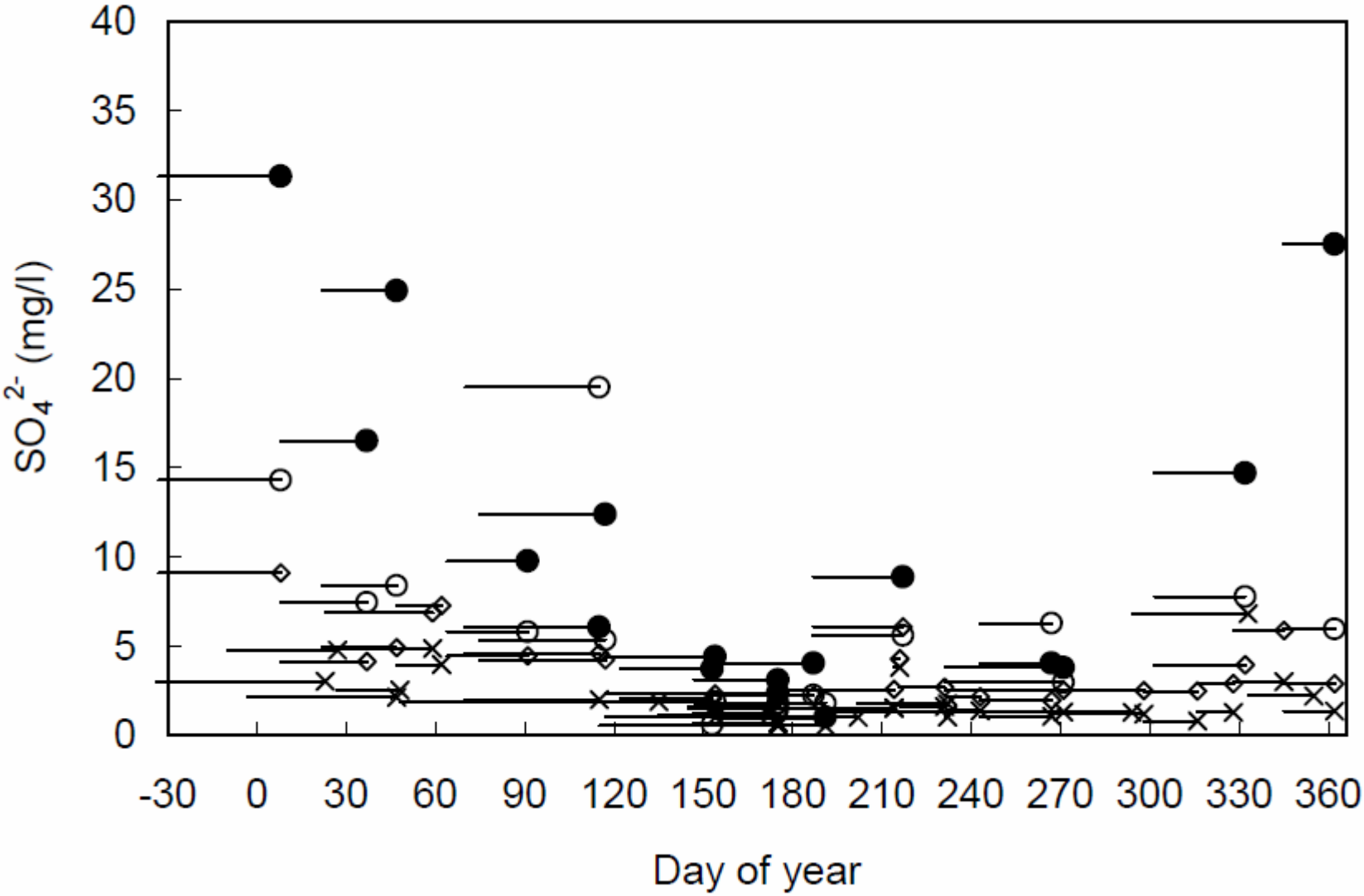
1) The significant decline of *Pinus amamiana*
2) The characteristics of the acid deposition
3) The characteristics of the physiological effects

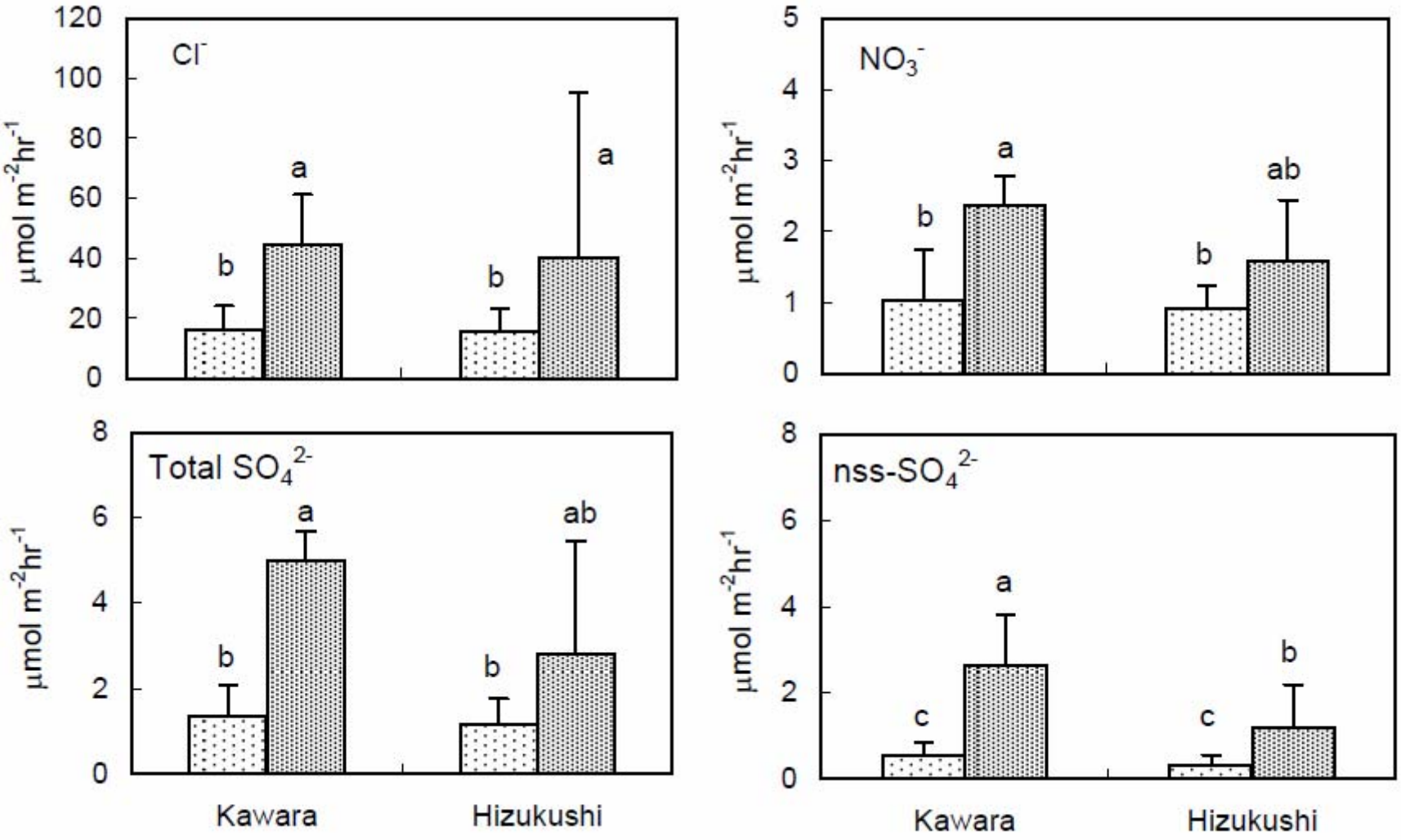

N
Baijing
Soul
Korea
Japan
China
Tokyo
Shanghai
Tanegashima
Nagata
Kawara
Mt Miyanoura
Hizukushi
Yakushima
World Heritage
Conservation Center

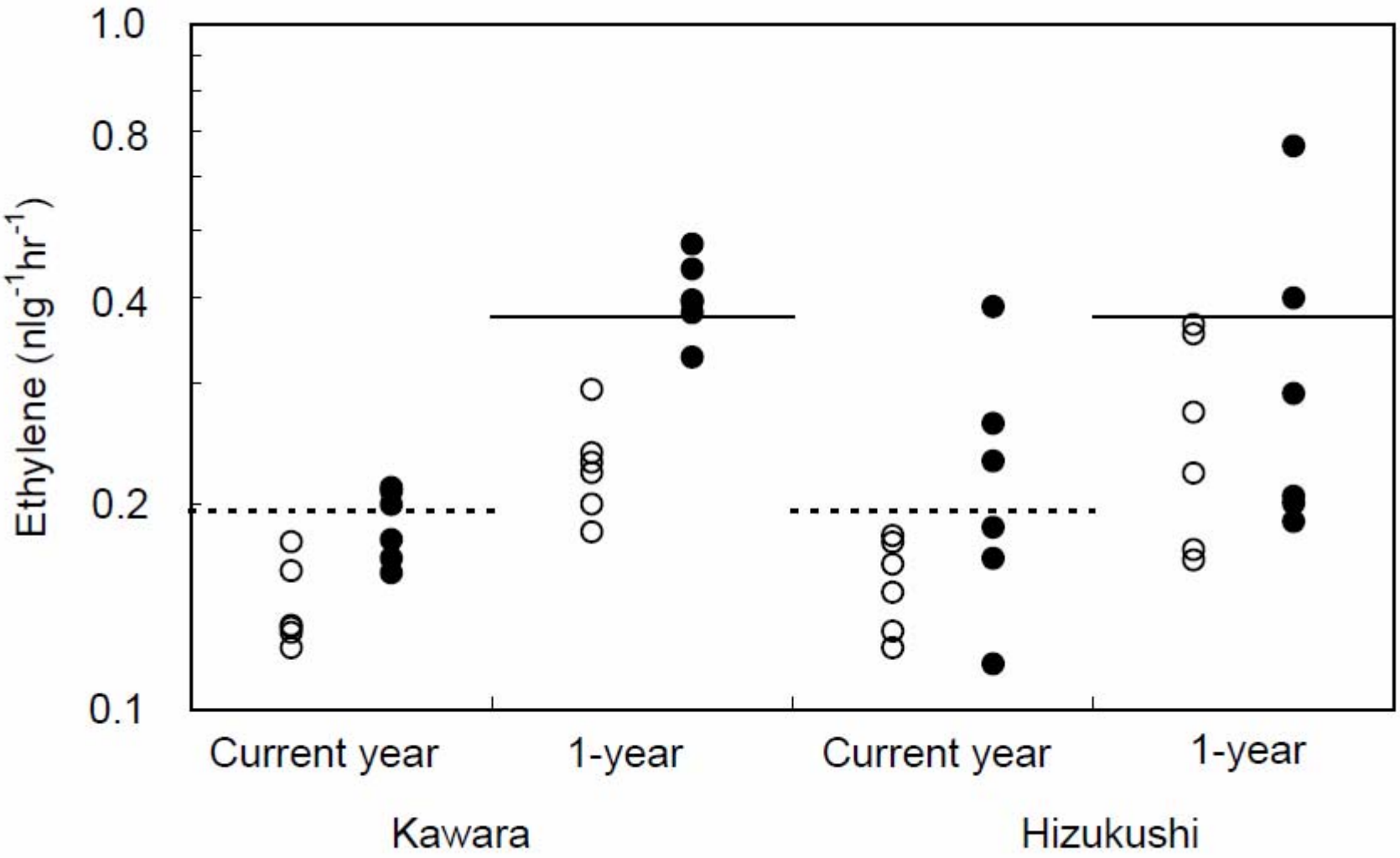

Pinus amamiana
Broad-leaved tree
Rain collector
340m
Ridge
290m
Midslope
Observation tower
200m
Valley

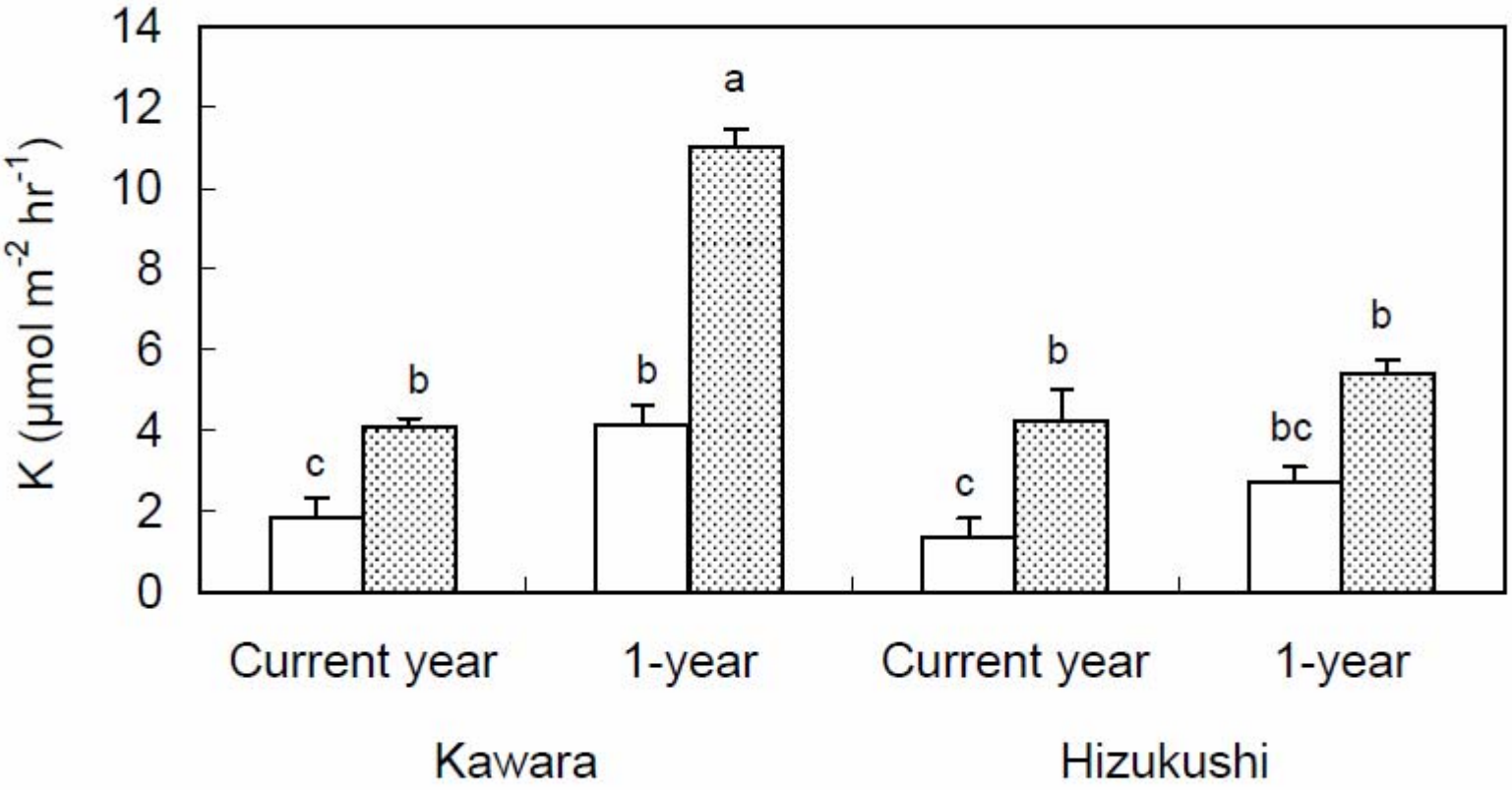

120
100
80
60
40
20
0
O_3 (ppbv)
-30 0 30 60 90 120 150 180 210 240 270 300 330 360
Day of year

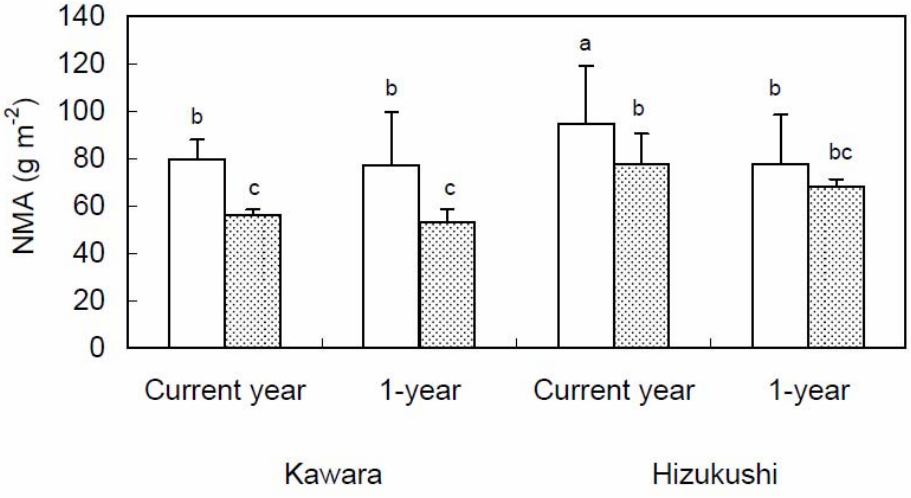

10
8
6
4
2
0
NO_2 (ppbv)
-30 0 30 60 90 120 150 180 210 240 270 300 330 360
Day of year

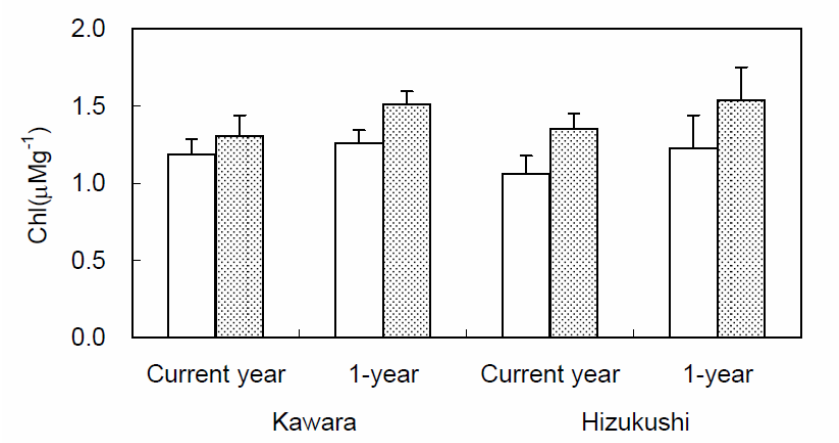

40
35
30
25
20
15
10
5
0
SO_4^{2-} (mg/l)
-30
0
30
60
90
120
150
180
210
240
270
300
330
360
Day of year

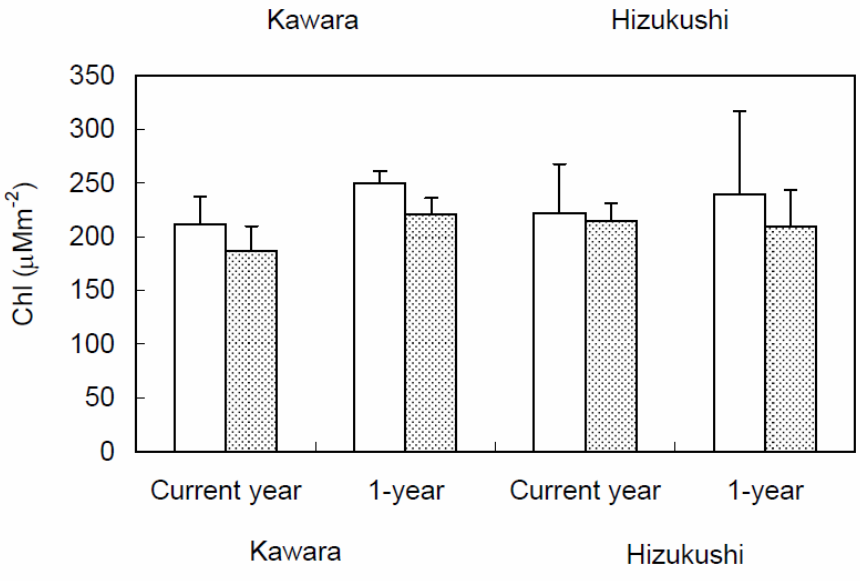

Cl-
120
100
80
60
40
20
0
μmol m-2hr-1
b
a
b
a
NO3-
5
4
3
2
1
0
μmol m-2hr-1
b
a
b
ab
Total SO4 2-
8
6
4
2
0
μmol m-2hr-1
b
a
b
ab
nss-SO4 2-
8
6
4
2
0
μmol m-2hr-1
c
a
c
b
Kawara
Hizukushi
Kawara
Hizukushi

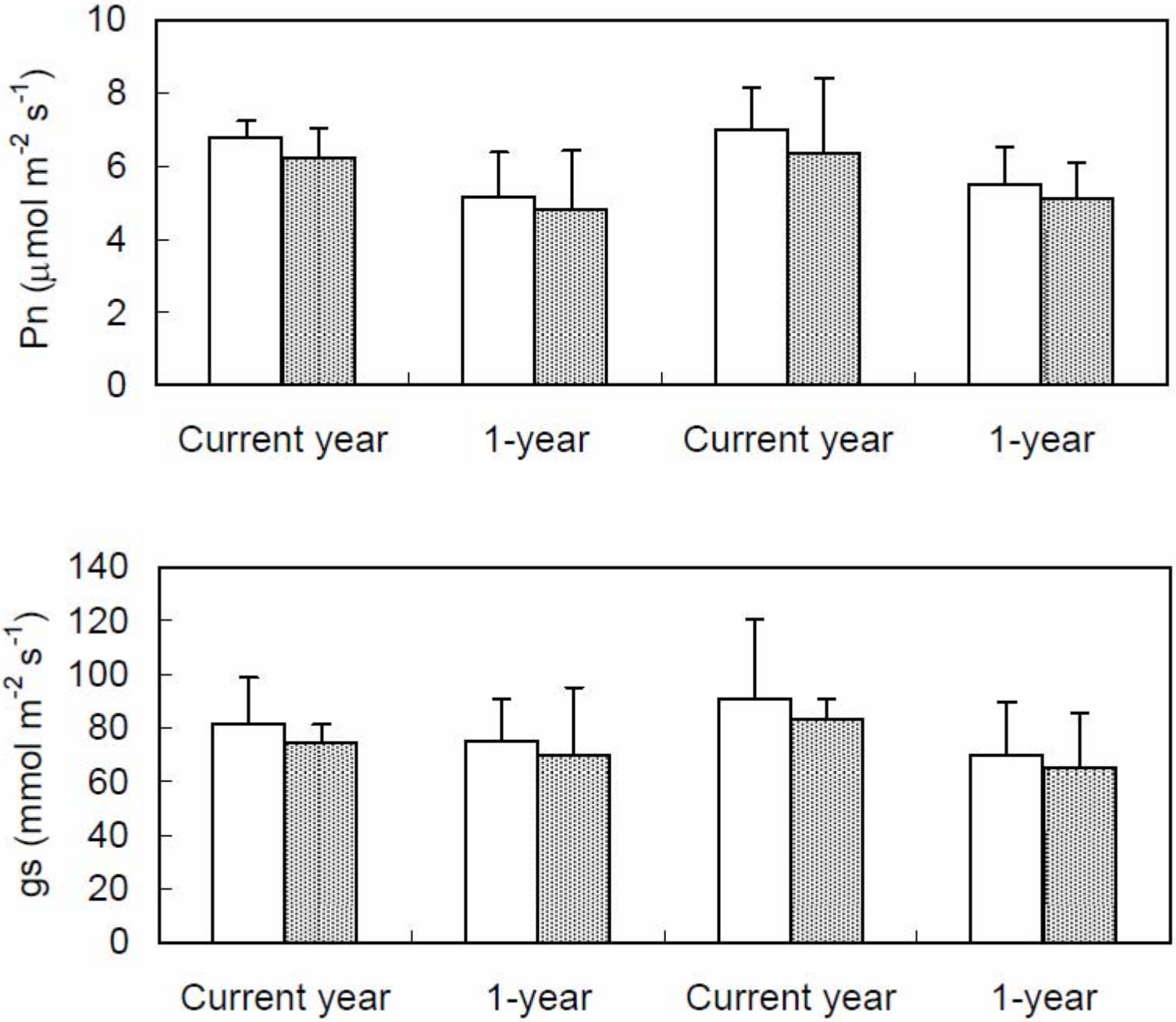

1.0
0.8
0.4
0.2
0.1
Ethylene (nlg-1hr-1)
Current year
1-year
Current year
1-year
Kawara
Hizukushi


K (μmol m-2 hr-1)
14
12
10
8
6
4
2
0
c
b
b
a
c
b
bc
b
Current year
1-year
Current year
1-year
Kawara
Hizukushi


NMA (g m-2)
140
120
100
80
60
40
20
0
b
c
b
c
a
b
b
bc
Current year
1-year
Current year
1-year
Kawara
Hizukushi


Chl(μMg-1)
2.0
1.5
1.0
0.5
0.0
Current year
1-year
Current year
1-year
Kawara
Hizukushi


Kawara
Hizukushi
Chl (μMm-2)
350
300
250
200
150
100
50
0
Current year
1-year
Current year
1-year
Kawara
Hizukushi


Pn (μmol m-2 s-1)
10
8
6
4
2
0
Current year
1-year
Current year
1-year
gs (mmol m-2 s-1)
140
120
100
80
60
40
20
0
Current year
1-year
Current year
1-year

Conclusion

The soil of Yakushima Island is depleted in base cations and nutrient-poor granite bedrock and the larger amount of acid rain quickly eluviates mineral nutrients from the soil. However as shown by Kennedy et al. (2002), the most of base cations for plant nutrition in Yakushima Island were estimated to derive from sea salt (Nakano et al. 2001b) and the forest trees feed nearly exclusively on cations of atmospheric origin. In addition, Satake et al. (1998) showed that the major source of N compounds entering the ecosystem is atmospheric deposition. Therefore, adhering and concentrated nitrogen compounds and nutrient salts are originally very important resource for plant growth in Yakushima Island. Although sea salt particles cause leaf surface deterioration, additional input of nss-SO_4^{2-} acidifies the needle surface and accelerates leaf surface deterioration and leaching from needles. Our study showed that *P. amamiana* is the most sensitive tree species to the increase of nss-SO_4^{2-} flux because of its growth characteristics.

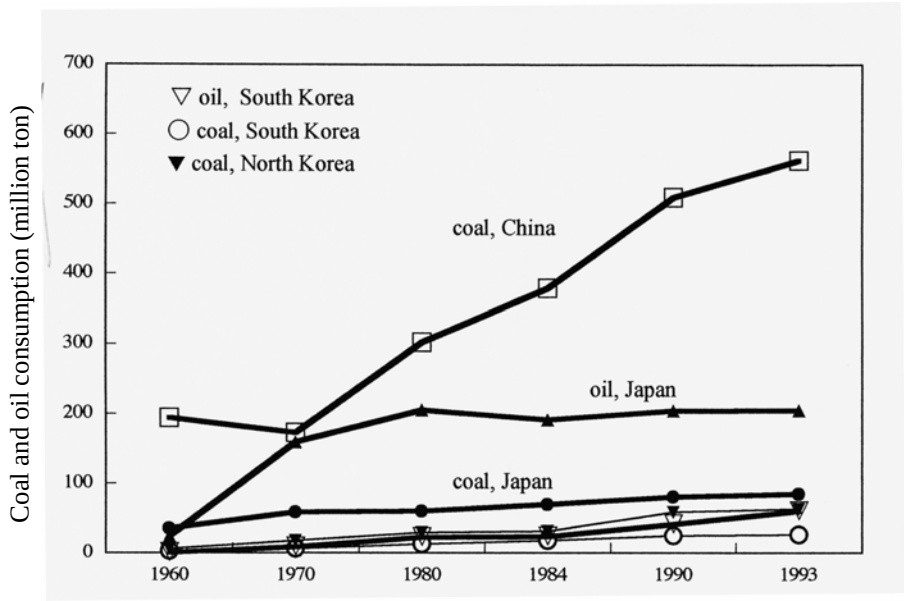
The concentration of atmospheric O_3 was also maintained high in Yakushima Island. O_3 may have some important stress factor of *P. amamiana*, but it is hard to judge the degree of importance in the decline process under present condition. Some comparative field experiments, such as open top field chambers receiving charcoal-filtered air, may be effective.

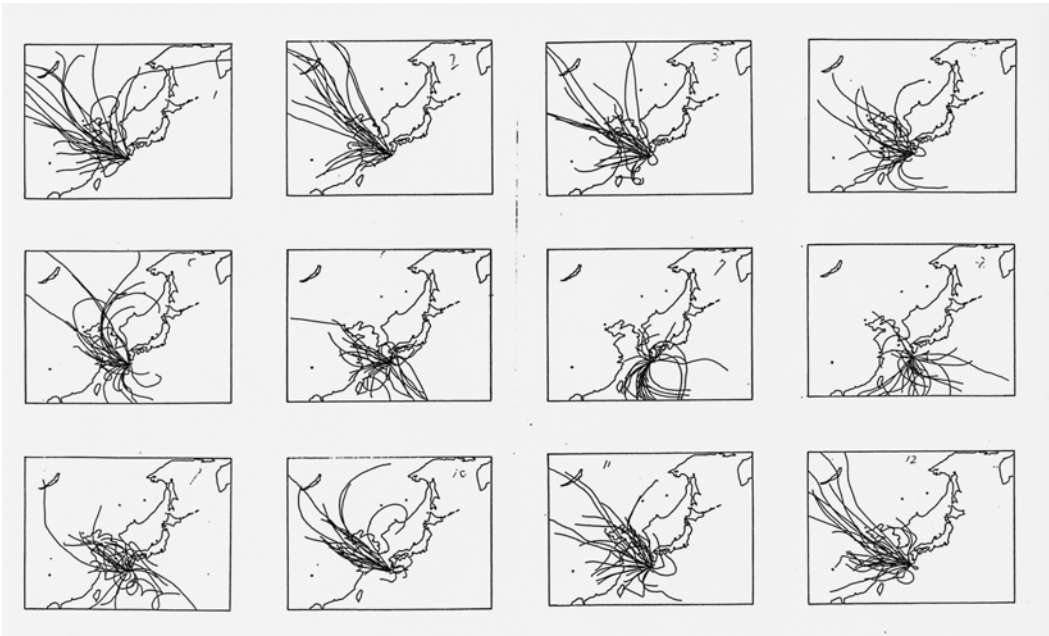
Acidification of stream water due to chemical weathering

by
Osamu NAGAFUCHI

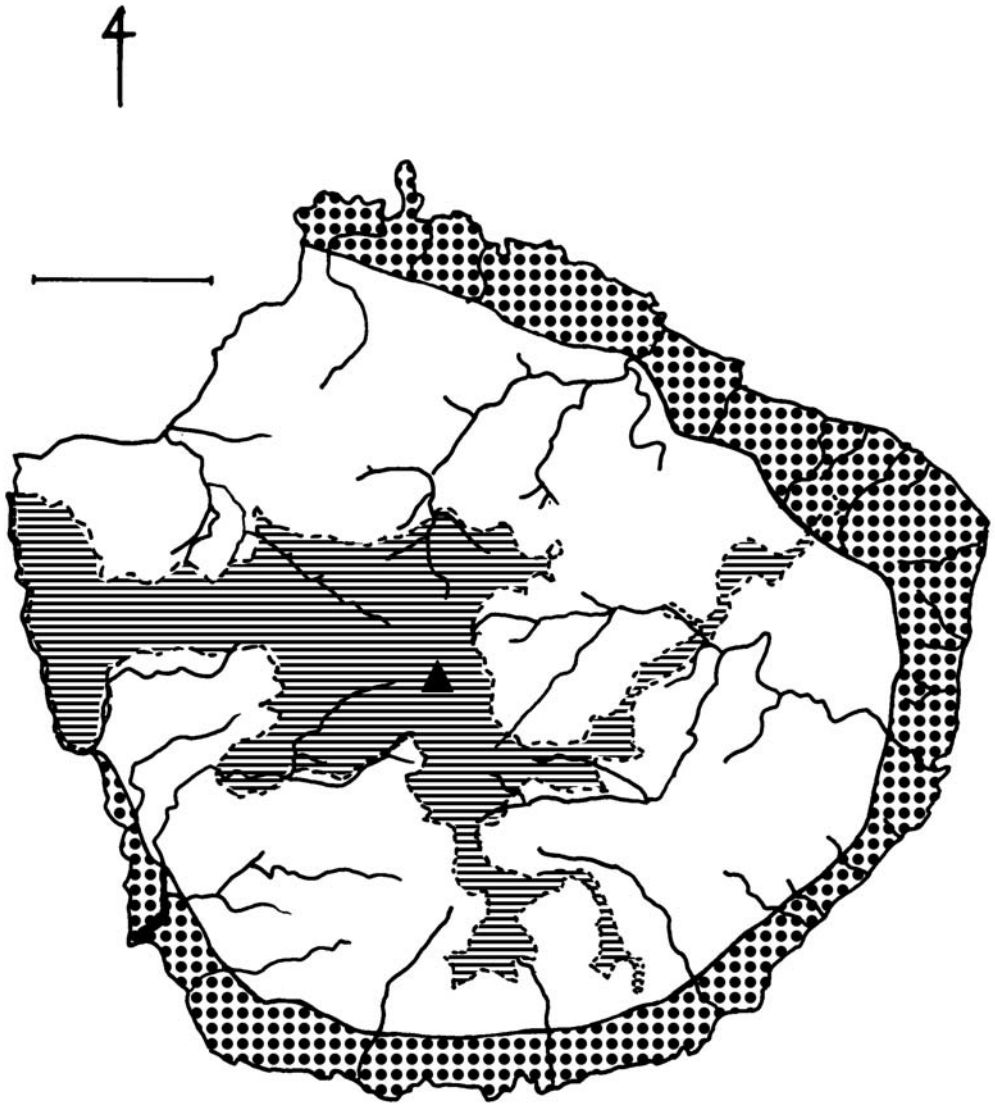
1. The characteristics of Yakushima Island
2. The characteristics of water chemistry
3. Chemical weathering in Yakushima Island

Background





Air trajectory of Mt. Miyanouradake on 1997



: granite rock
: sedimentary rock
: the World Natural Heritage area
▲ : the highest summit Mt. Miyanoura (1935 m)

Fig. 1. Location map of Yakushima Is.

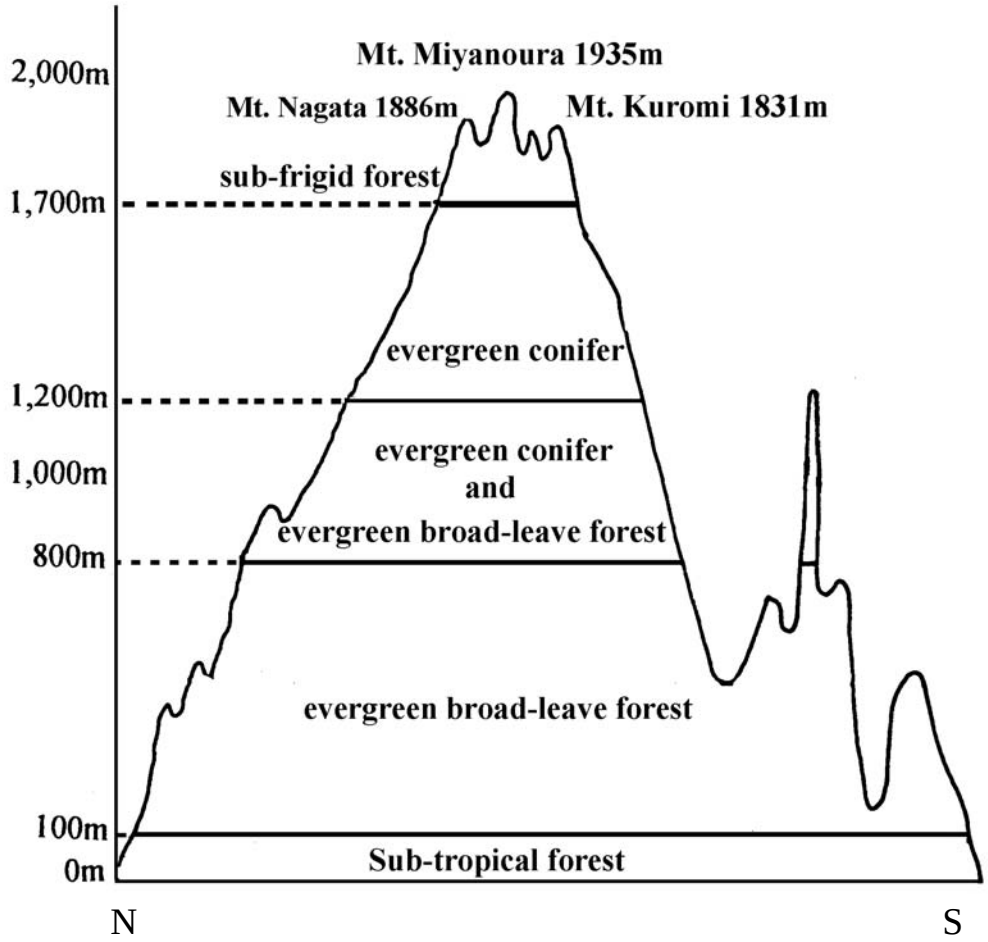


Fig. 3. Schematic diagram of the N-S vertical sectional view and the distribution of forest vegetation in Yakushima Is.

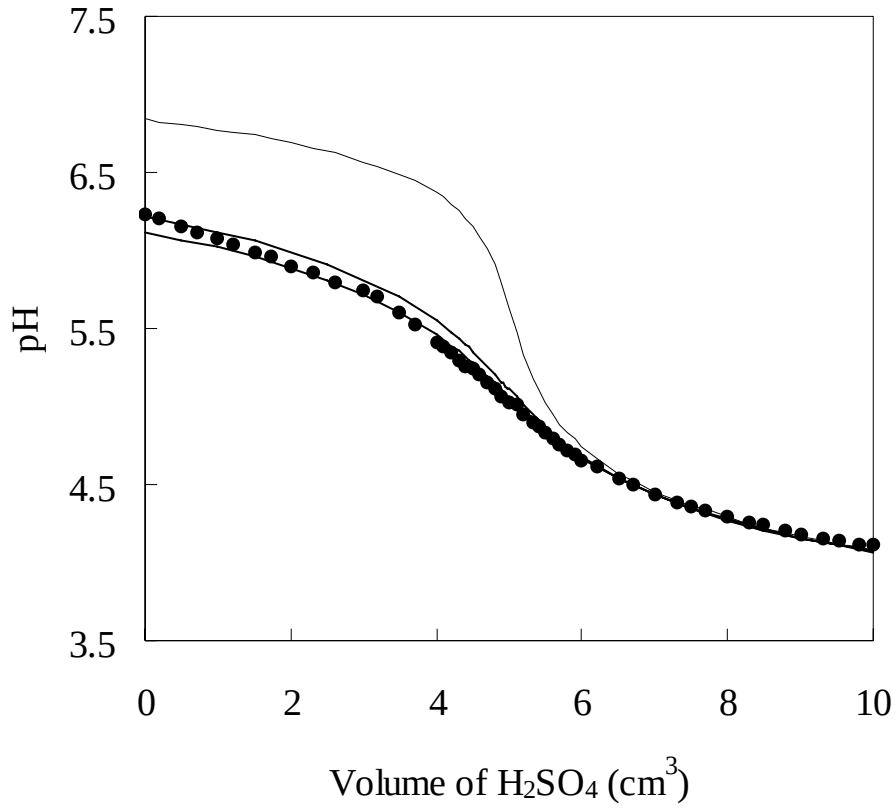
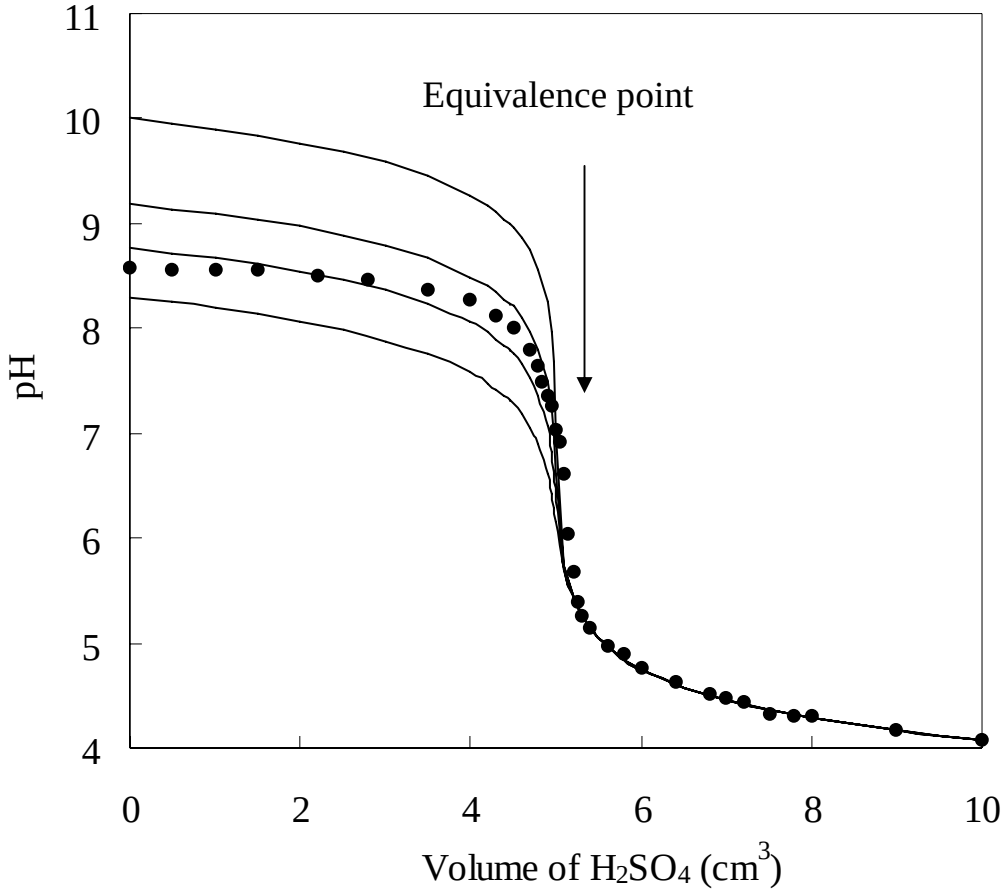


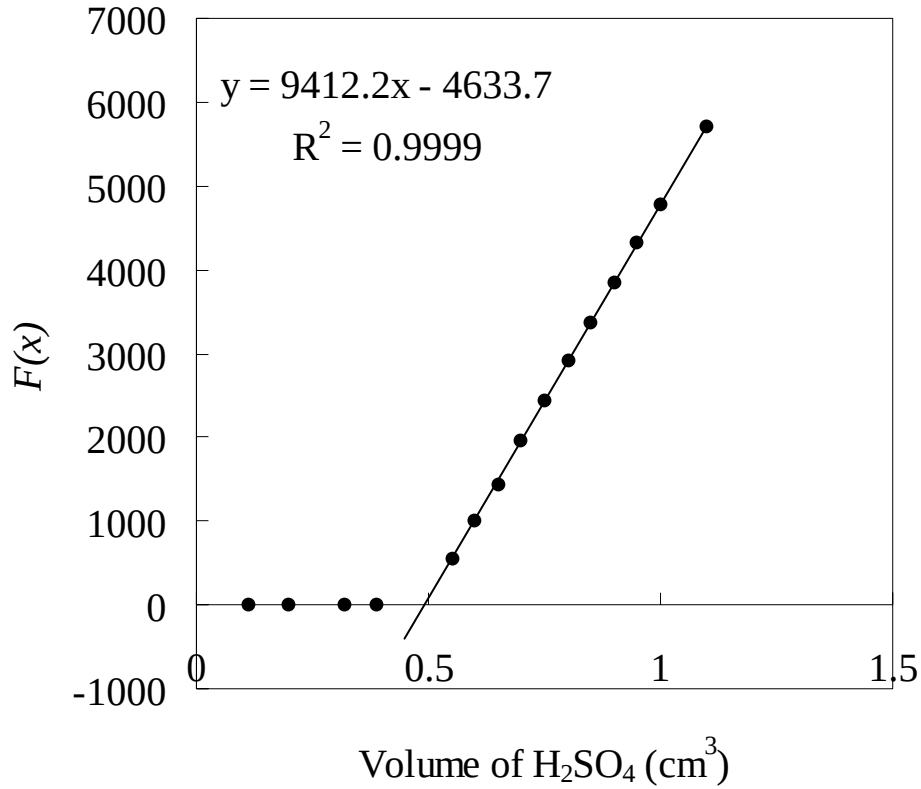
Fig. 8	Titration curve of HCO_3^- with H_2SO_4 under constant P_{CO_2} condition (I = 0.1 mol dm^{-3}, NaCl)
	HCO_3^- : 1.00×10^{-4} mol dm^{-3}, 50 cm^3
	H_2SO_4 : 5.00×10^{-4} mol dm^{-3}



Titration curve of HCO3- with H2SO4 under N2 atmosphere (*I* = 0.1 mol dm-3, NaCl)

HCO3- : 1.00 × 10-4 mol dm-3, 50 cm3

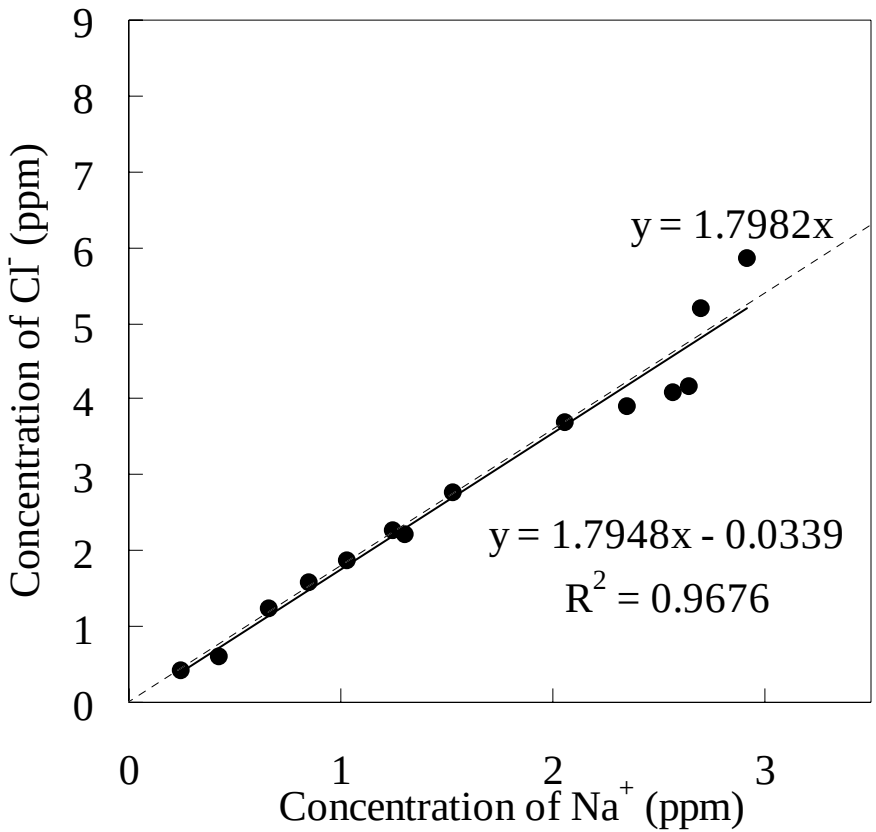
H2SO4 : 5.00 × 10-4 mol dm-3

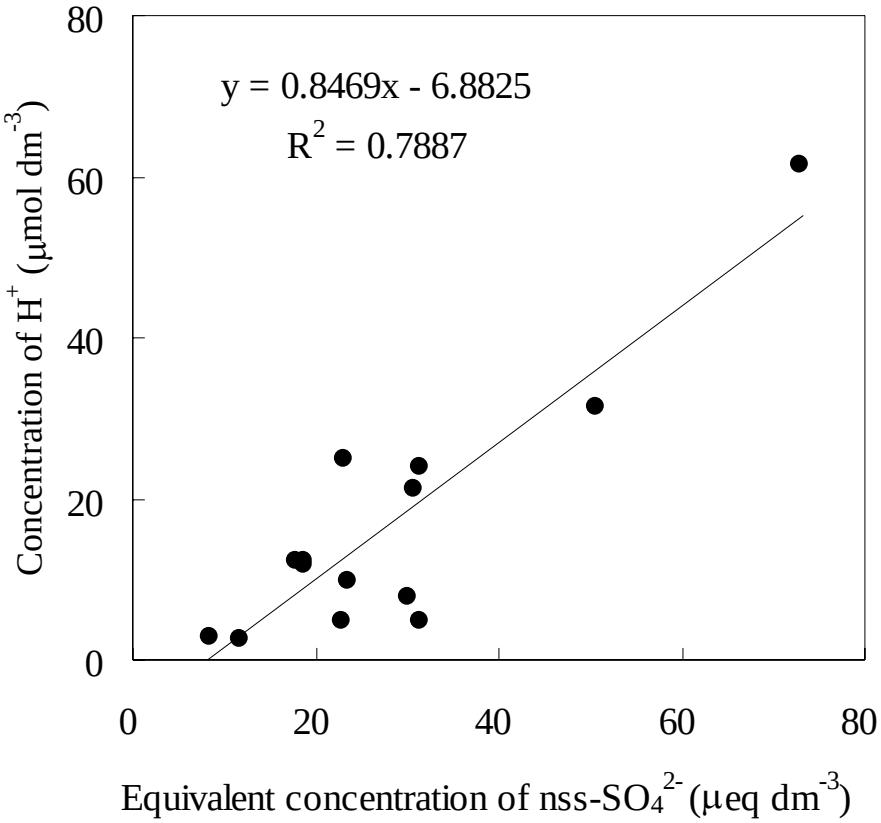


Gran plot of HCO3- with H2SO4 under N2 atmosphere (*I* = 0.1 mol dm-3, NaCl)

HCO3- : 1.00 × 10-5 mol dm-3, 50 cm3

H2SO4 : 5.00 × 10-4 mol dm-3


9
8
7
6
5
4
3
2
1
0
0
1
2
3
Concentration of Cl- (ppm)
Concentration of Na+ (ppm)
y = 1.7982x
y = 1.7948x - 0.0339
R2 = 0.9676



Correlation of between the concentration
of hydrogen ion and the equivalent concentration
of nss-SO42- in precipitation.

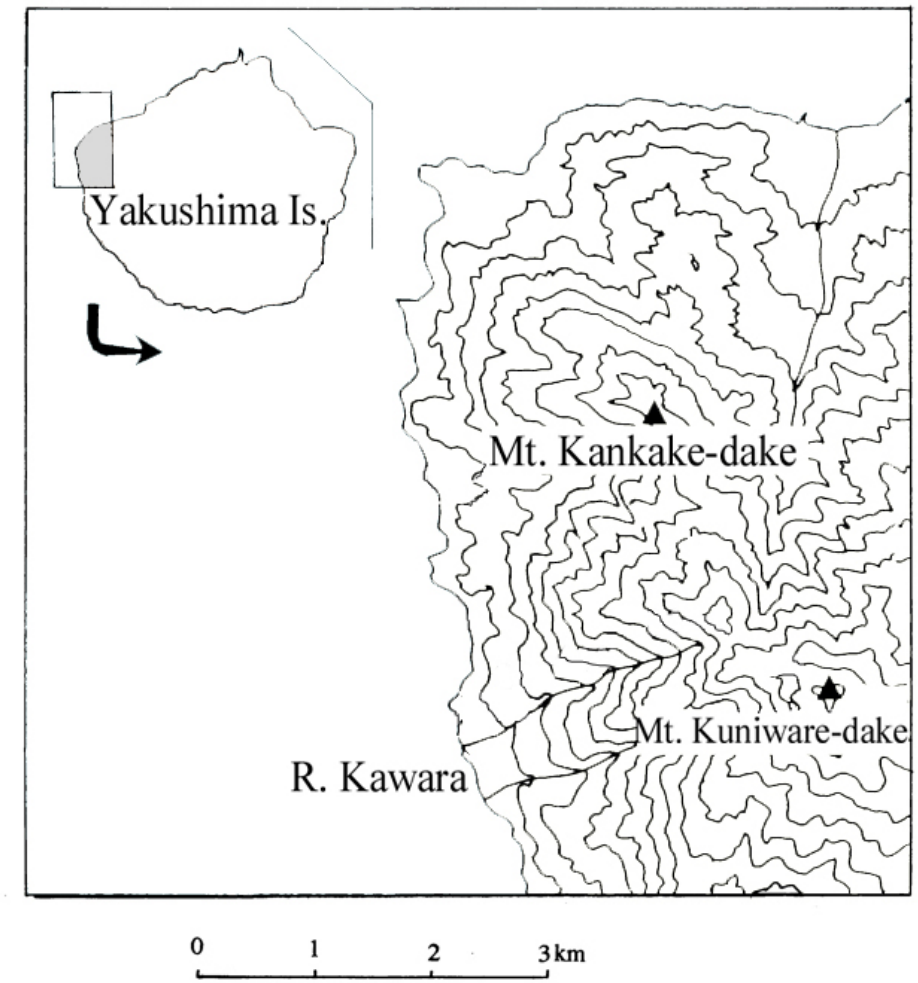


Fig. 5. Location map of the western part of Yakushima Is.
● : Collection sites of surface water samples of R. Kawara
○ : Collection sites of surface water samples of R. Hanyama

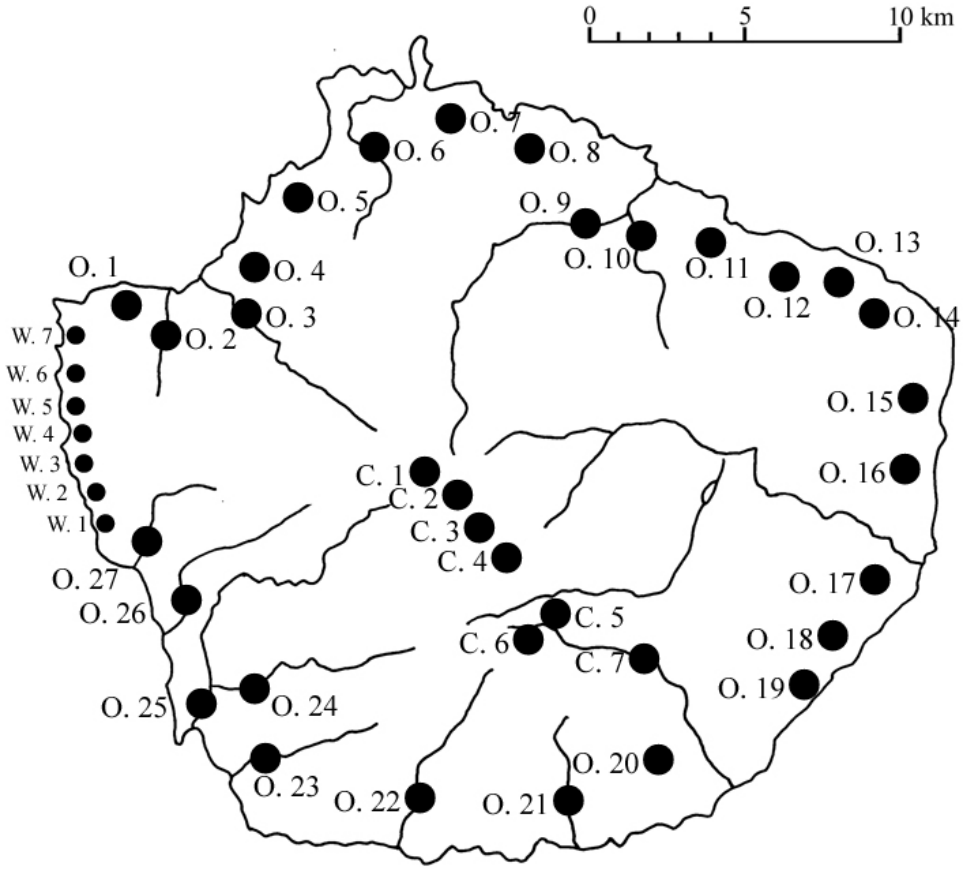


Fig. 6. Location of river and stream water sampling points in Yakushima Is.

W : in the western area (Hanyama and Kawara River)

C : in the central mountainous area

O : in the other area

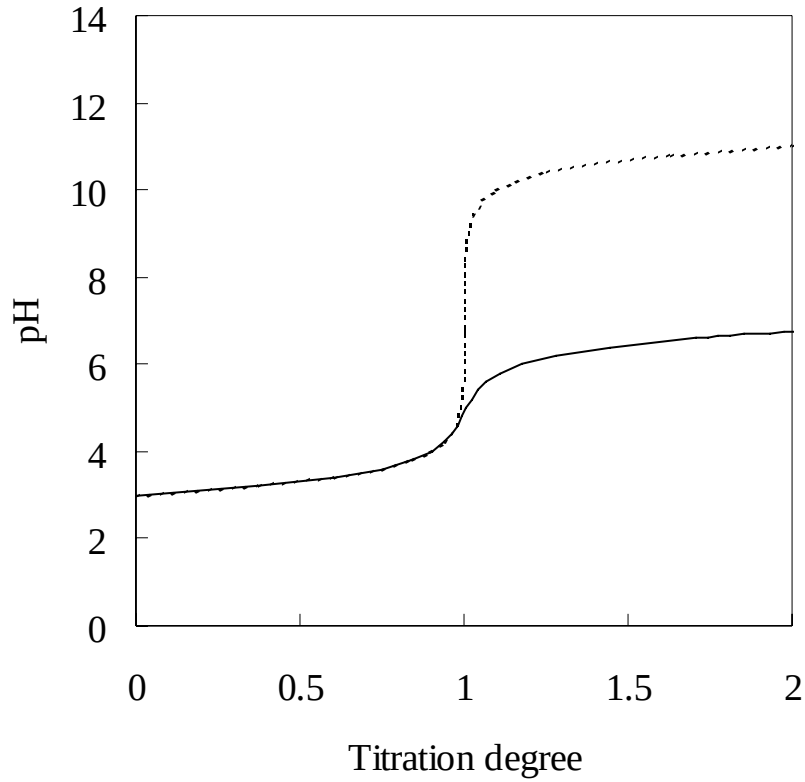
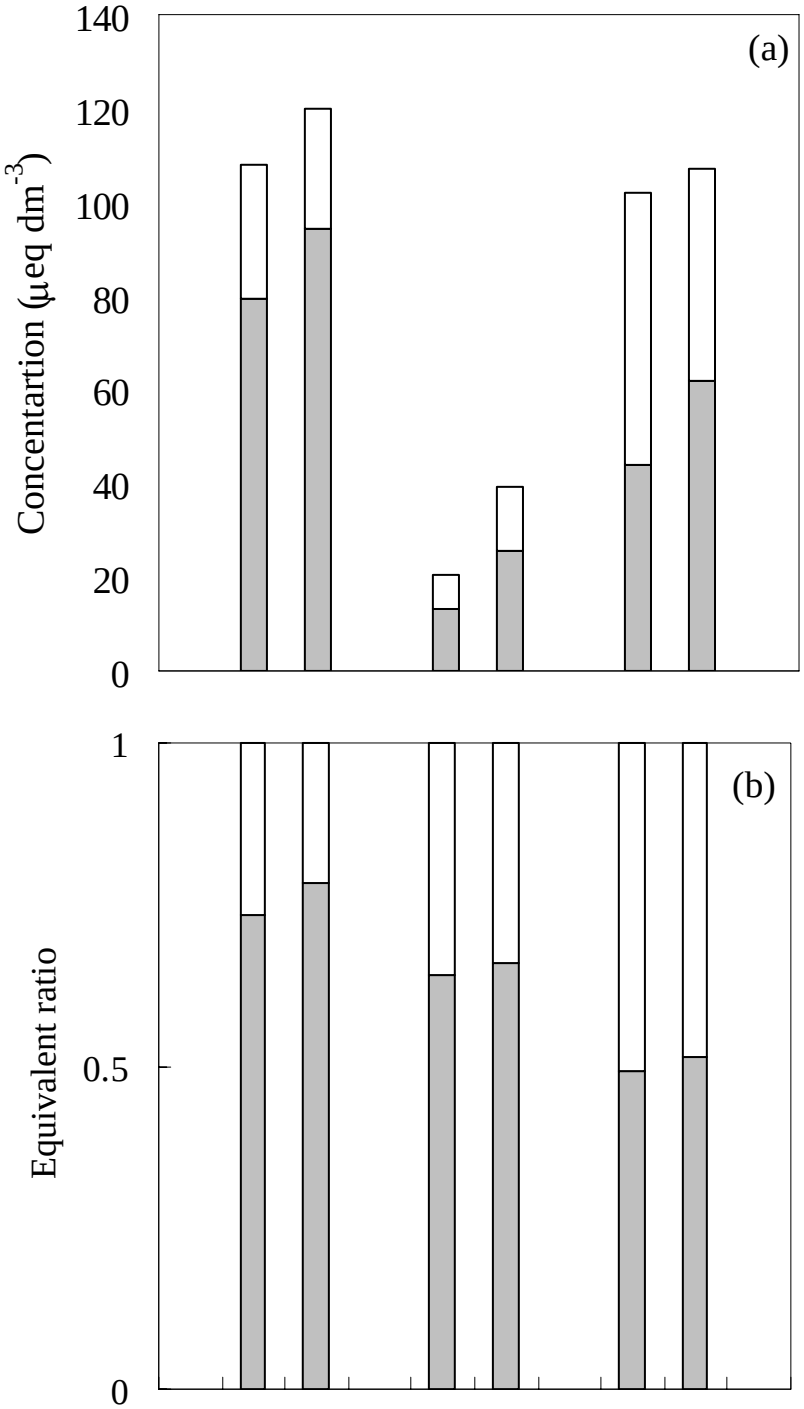


Fig. 16 Acid - base titration curves showing the role of dissolved CO2 in the neutralization of hydrogen ions.


(a)
Concentartion (μeq dm-3)
140
120
100
80
60
40
20
0
(b)
Equivalent ratio
1
0.5
0

Conclusion

The typical analytical method of alkalinity such as JIS method could not be applied to the determination of low alkalinity in the surface water in Yakushima Is. The theoretical curves drawn under various partial pressure of CO2 clarified the reason why the presence ofCO2 in solution keeps pH lower and changes the pH values at the equivalence point. This problem during the titration was improved when the titration was carried out under N2 atmosphere. Furthermore, the Gran method was much suitable for the alkalinity determination even at a few mmol dm-3 levels, because this method takes only 20 minutes to complete the titration, and could determine alkalinity in accurate and precise.

The activity diagram showed that chemical weathering was advancing only towards the generation of kaolinite from primary minerals because of the short residence time of water in this area. The concentration of SiO2 was excessive against that of HCO3- and it was suggested that there is other sources of hydrogen ions.

There was a clear correlation between the total equivalent concentration of nss-SO42- and HCO3- and that of SiO2 all over the island. In Yakushima Is., the chemical weathering is affected by nss-SO42- more than by dissolved CO2. Particularly in the western area, this phenomenon appears remarkably. In the western area, the amount of H+, provided from the acid substances and consumed by the chemical weathering, occupied 70～80% of the conjugate base of hydrogen ion donor and the remaining only 20～30% was supplied by dissolved CO2. Even in the other areas, the fraction was 50 %. In winter season, the concentrations of dissolved components were increased together with that of nss-SO42- transported in long distance from Eastern Asia, and the acid buffer capacity was decreased. The further increase in the acid deposits may cause surface waters in the Yakushima western area to be acidified.

In this study, it was clarified that the buffer capacity of surface stream waters has almost been depleted in Yakushima Is. For the quantitative prediction of the acidification, it is necessary to compile much more information on the annual mass balance, chemistry and discharge of the precipitation and surface water in a confined catchment area.

Analysis of environmental pollution history using lake sediments

by
Osamu NAGAFUCHI

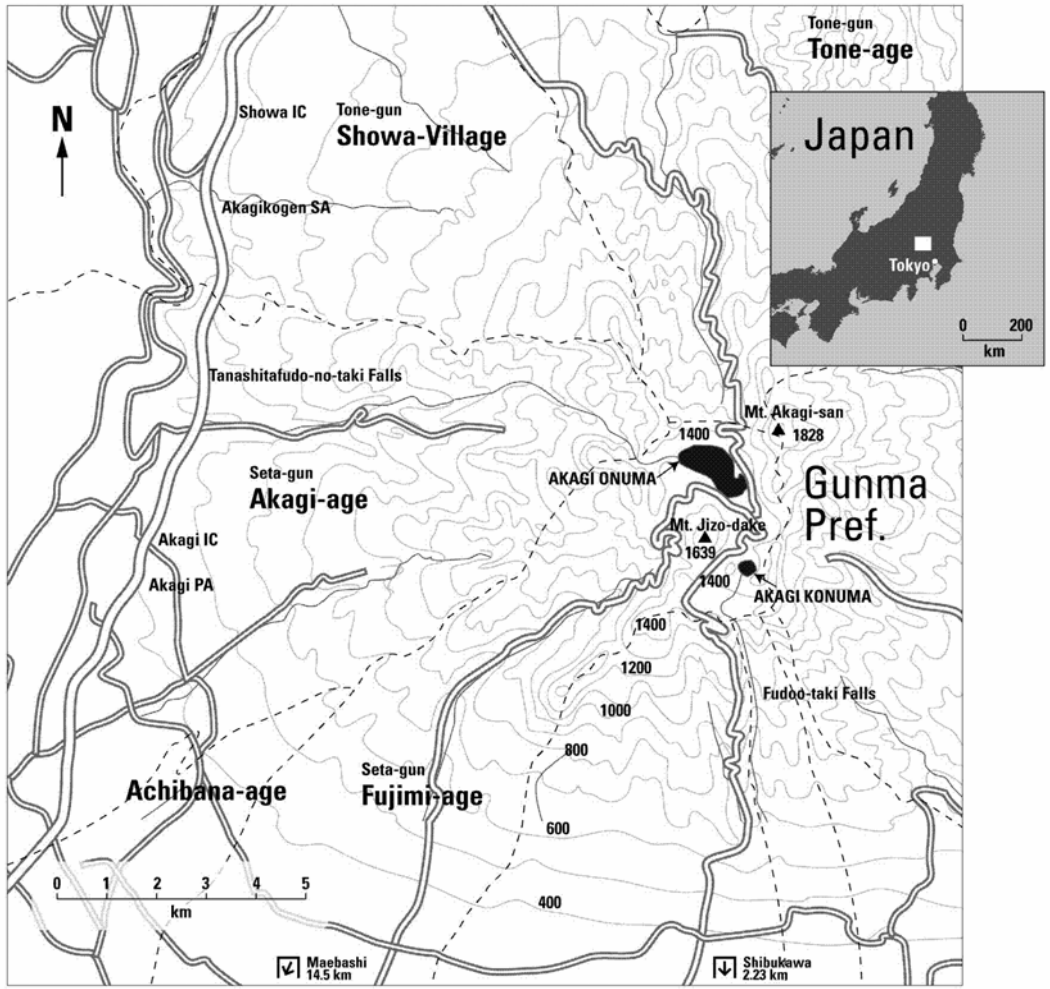
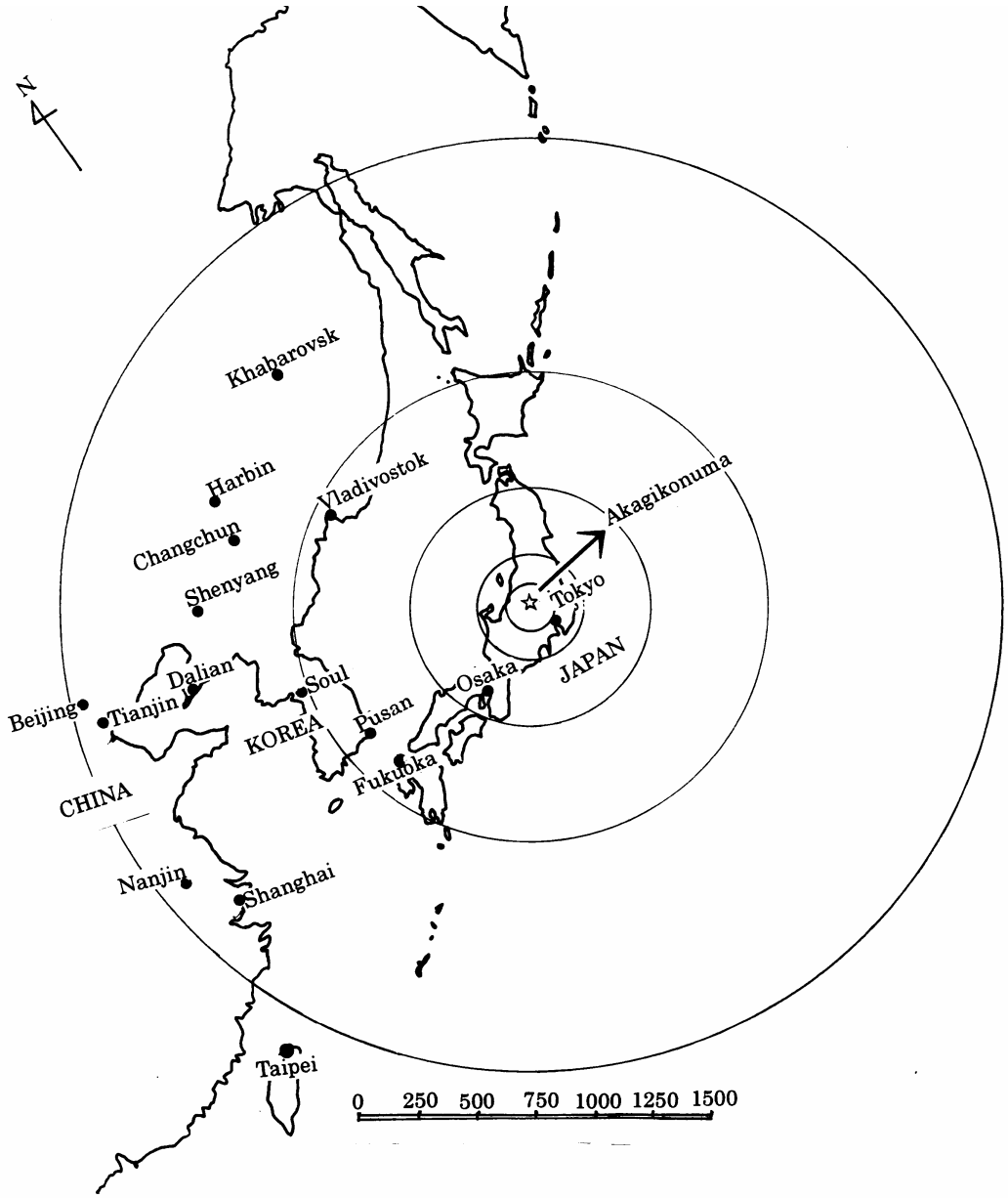
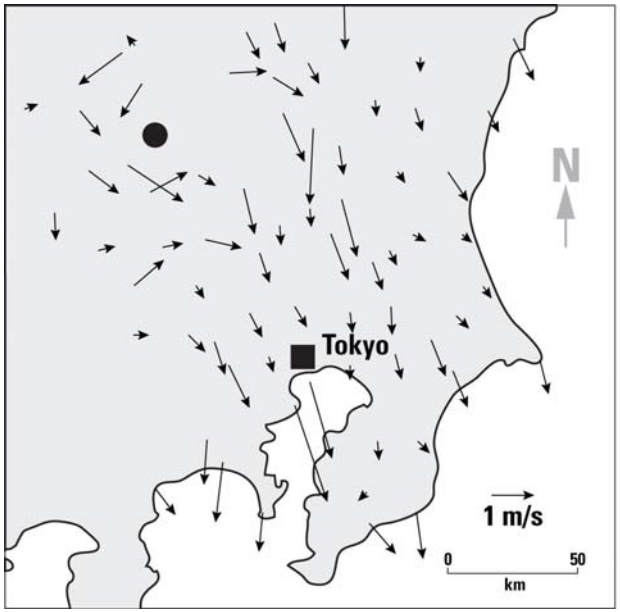


Figure 1. Location map of Lake Akagi-konuma and inset, map of Japan showing enlarged area. Contour interval is 100 m.



調査地点および汚染源への距離

a)



b)

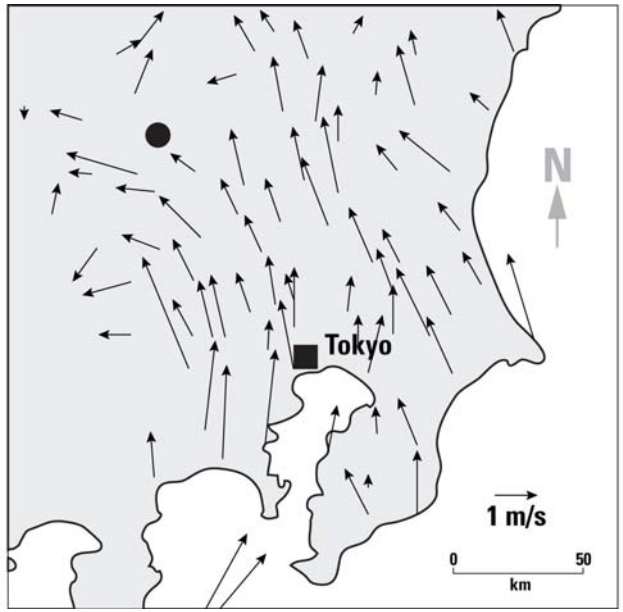


Figure 2. Wind direction data for the Kanto region of Japan showing air mass movement (a) taking pollutants away from Lake Akagi-konuma during the night and (b) taking pollutants from Tokyo towards Lake Akagi-konuma during the day. Data are from the Automated Meteorological Data Acquisition System (AMEDAS) of the Meteorological Agency of Japan using the 131 sites in the Kanto area. Data are 2003 – 2005 means for (a) 0300 – 0400 and for (b) 1500 – 1600 (local time). The position of Lake Akagi-konuma is marked ●.

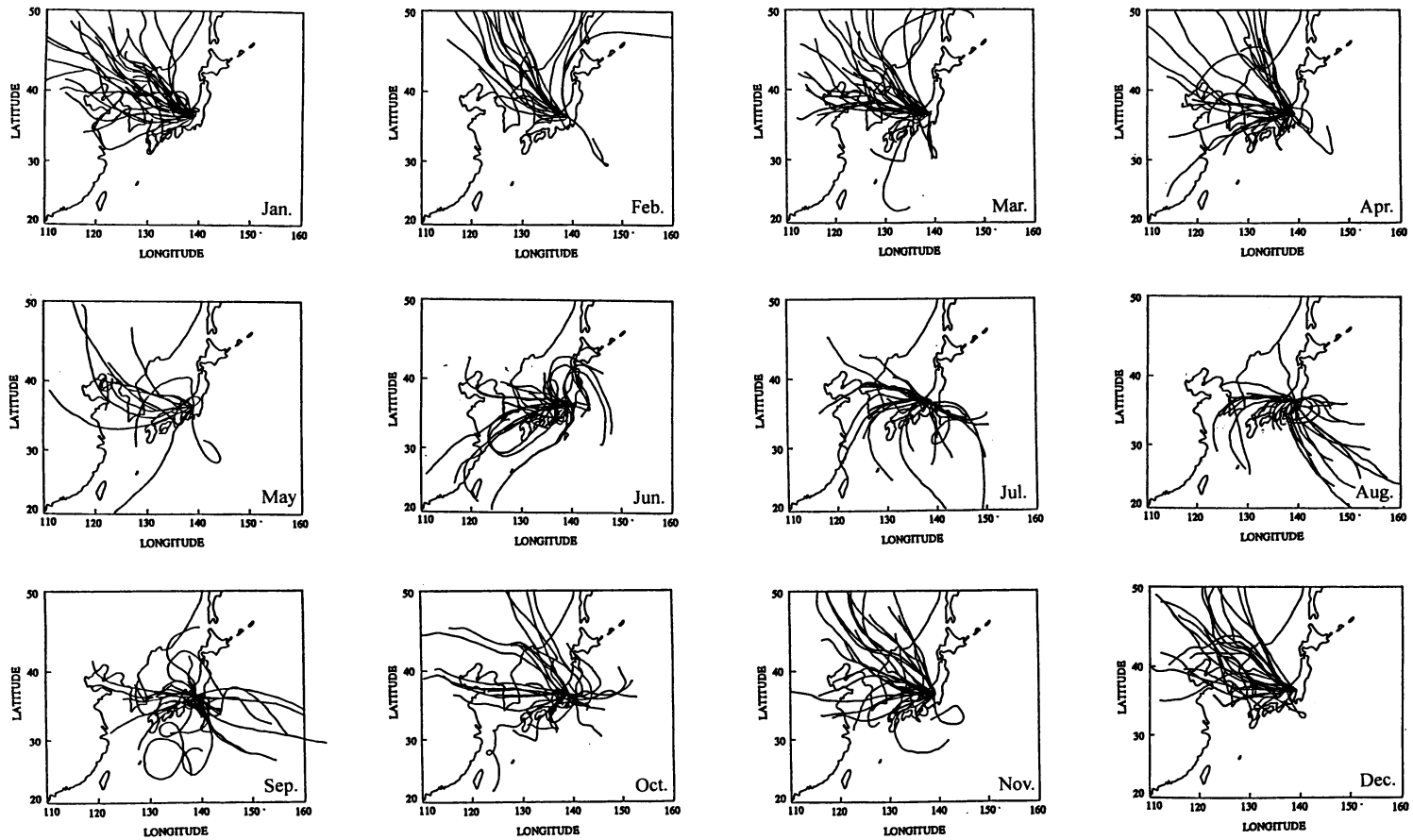


Figure 3. Three-day isobaric back-trajectories ending at the elevation of Lake Akagi-konuma at 0000 and 1200 UT (0900 and 2100 LT) for each day of 1994. Each panel shows a month of data.

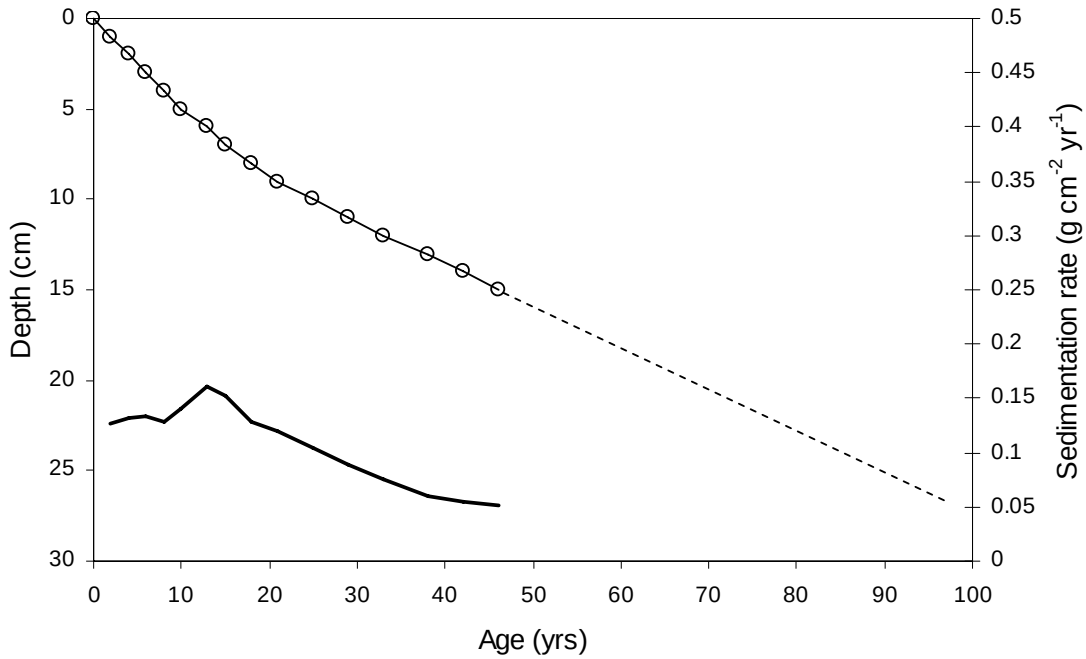


Figure 4. Depth-age curve (○) based on the 210Pb chronology corrected using the 137Cs peak at 1963. Dotted line represents the extrapolation of the depth-age curve using the basal rate of the dateable section. The resulting chronology is used to apply dates throughout the rest of the paper. Also shown (solid line) is the sedimentation rate profile.

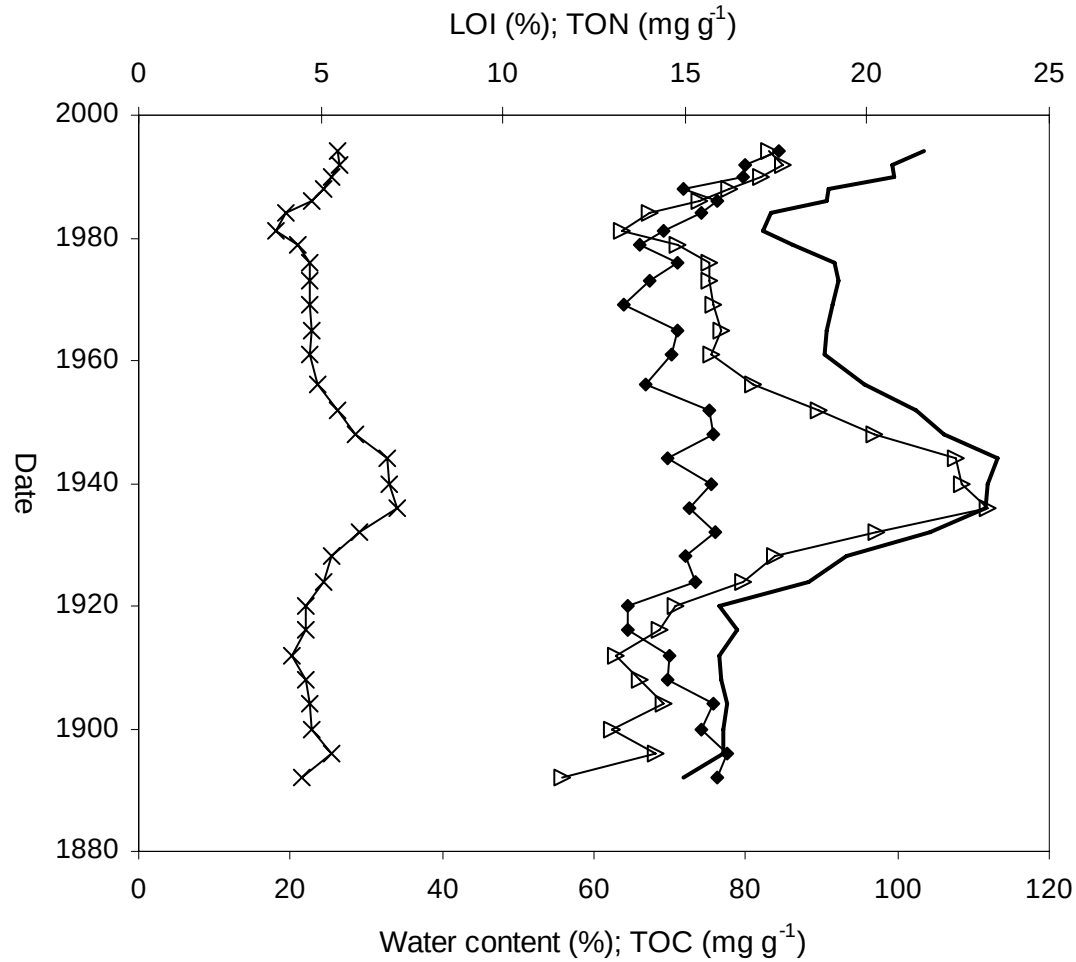
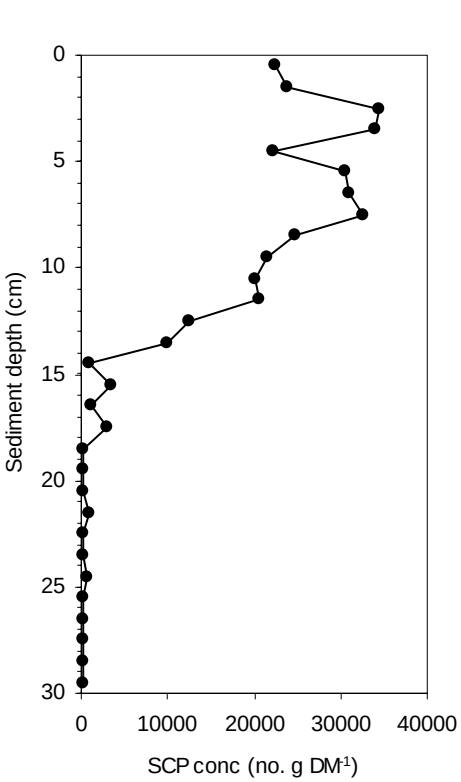
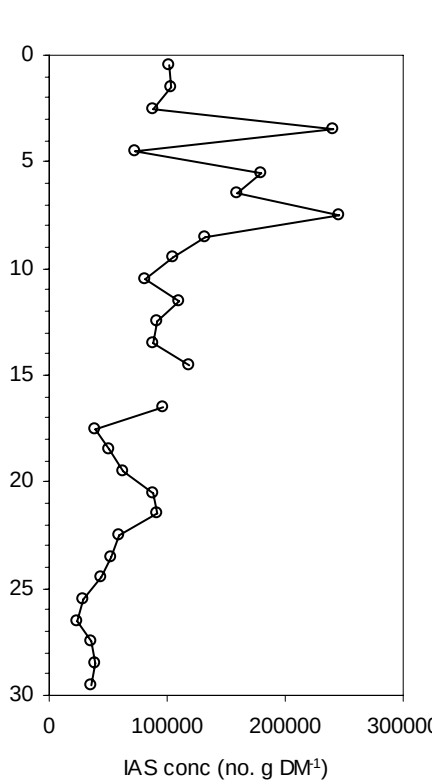
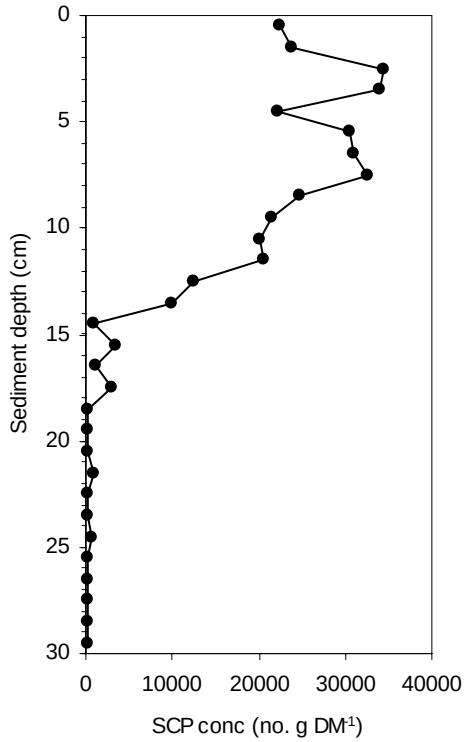
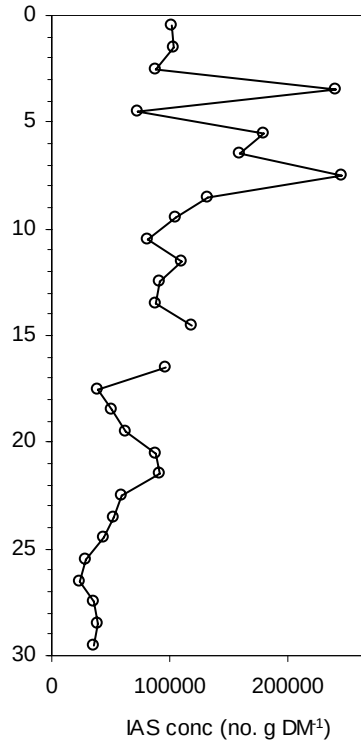


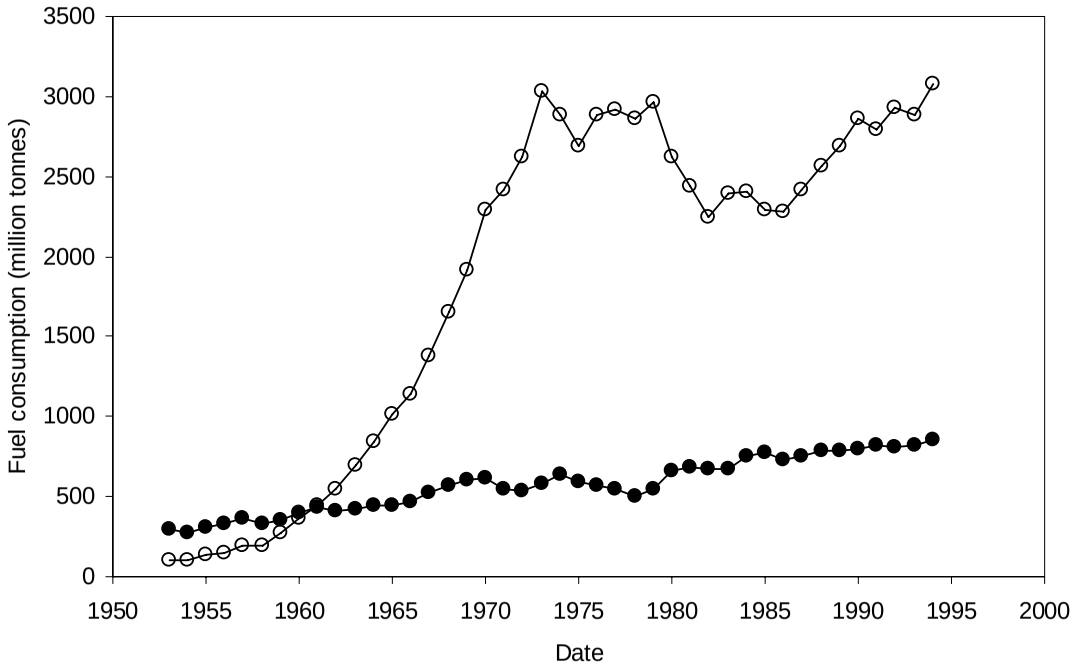
Figure 5. Lithostratigraphic data for the Lake Akagi-konuma core. Profiles for loss-on-ignition (550 ºC) (solid line); percentage water content (◆); total organic carbon (TOC) (△) and total organic nitrogen (×) (TON) are shown on a chronological axis

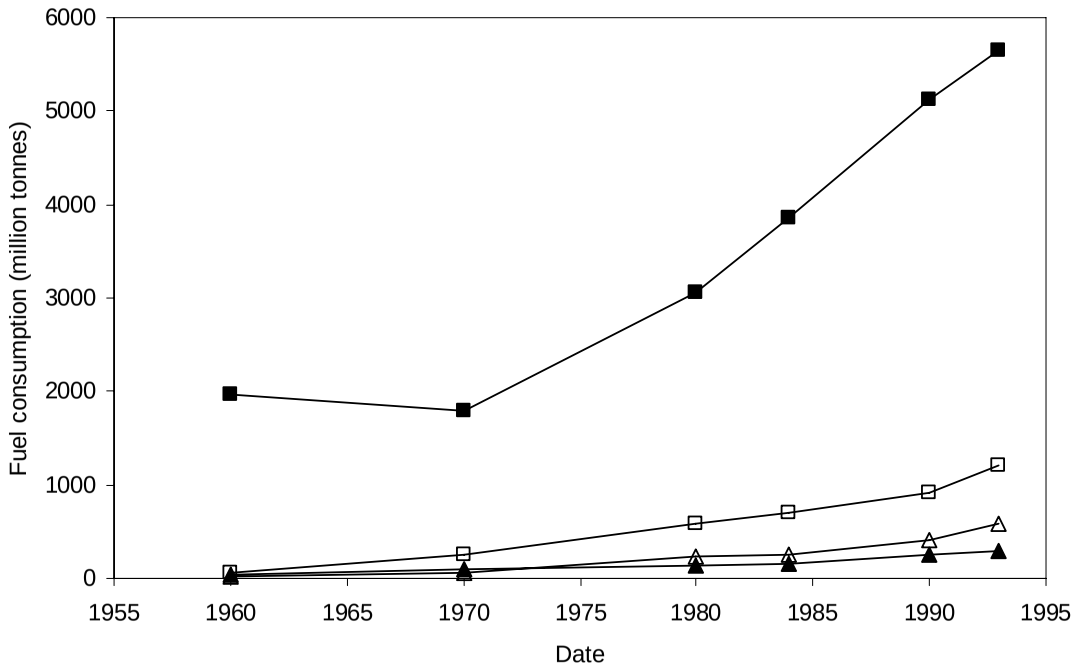

Sediment depth (cm)
0
5
10
15
20
25
30
0
10000
20000
30000
40000
SCP conc (no. g DM-1)


0
5
10
15
20
25
30
0
100000
200000
300000
IAS conc (no. g DM-1)


Sediment depth (cm)
0
5
10
15
20
25
30
0
10000
20000
30000
40000
SCP conc (no. g DM-1)


0
5
10
15
20
25
30
0
100000
200000
IAS conc (no. g DM-1)


3500
3000
2500
2000
1500
1000
500
0
Fuel consumption (million tonnes)
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
Date


6000
5000
4000
3000
2000
1000
0
Fuel consumption (million tonnes)
1955
1960
1965
1970
1975
1980
1985
1990
1995
Date

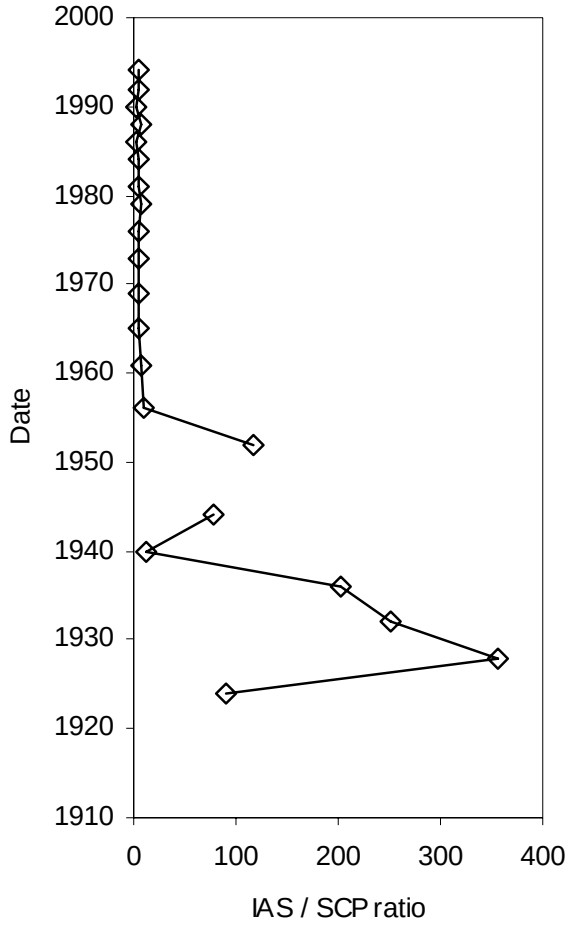
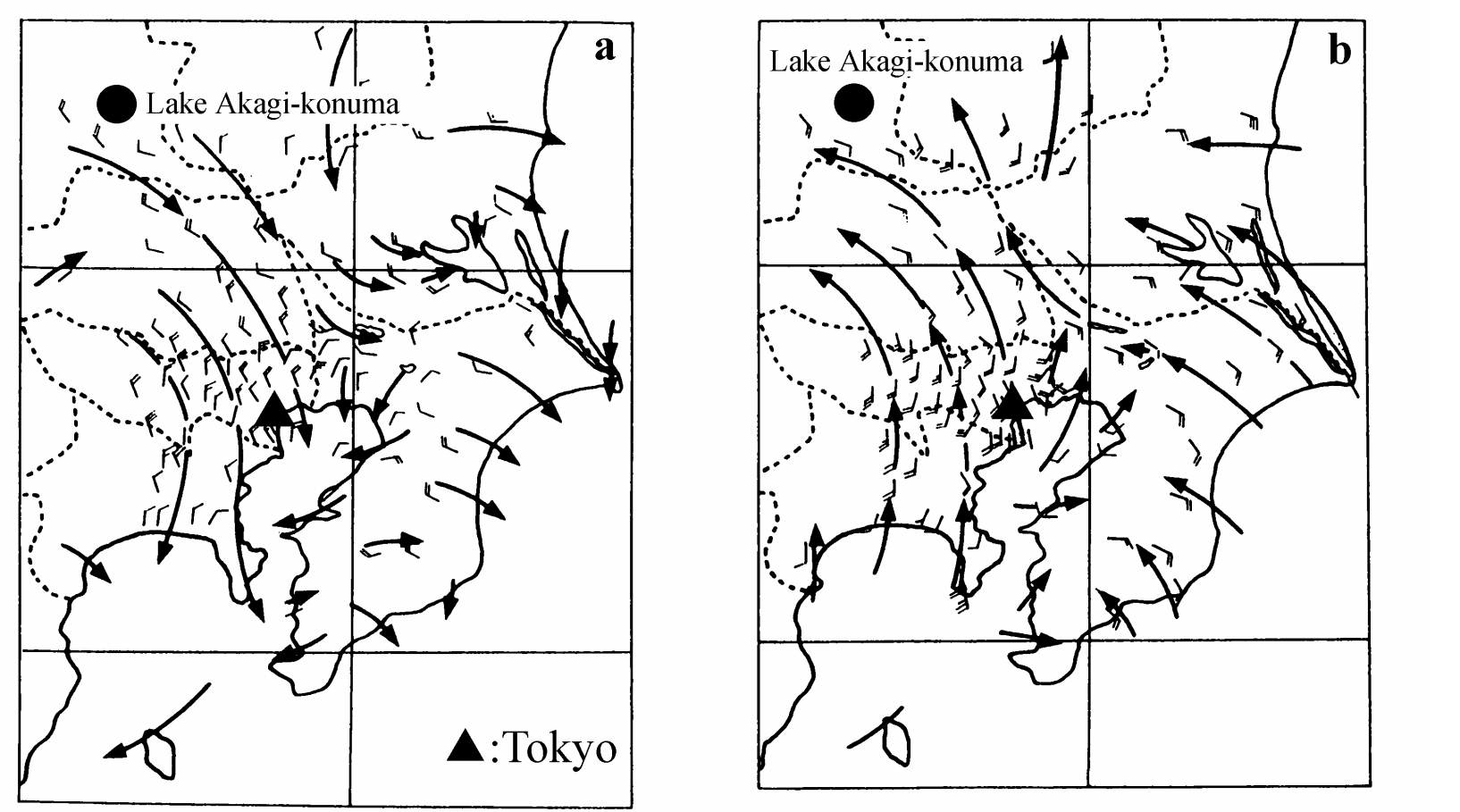


Figure 8. Ratio of IAS:SCP fluxes for the Lake Akagi-konuma sediment core for the period where both particles are detectable.

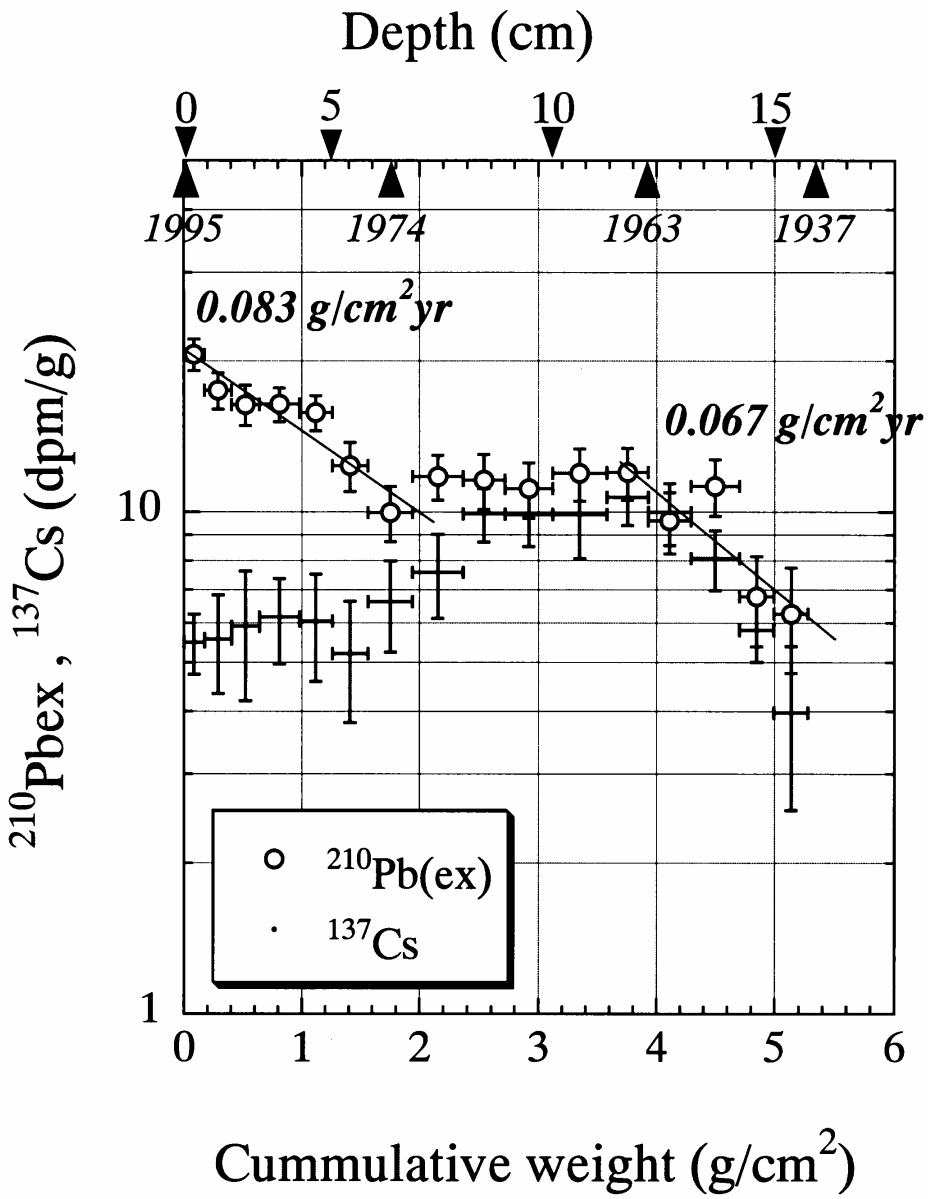
Conclusion

The SCP record of Lake Akagi-konuma indicates predominantly the influence of emissions from Japanese combustion sources (originally coal and now oil). The record of IASs, however, indicate the additional influence of more distant East Asian sources, especially from China. There is, therefore, concern over the scale of the impact on Japanese mountain areas from these long-distance sources as a result of the continued and predicted increase in Chinese coal consumption into the 21st century. SCPs themselves may not be damaging environmentally but may act as indicators of other associated industrial pollutants (sulphur, trace metals, persistent organics) which can be.

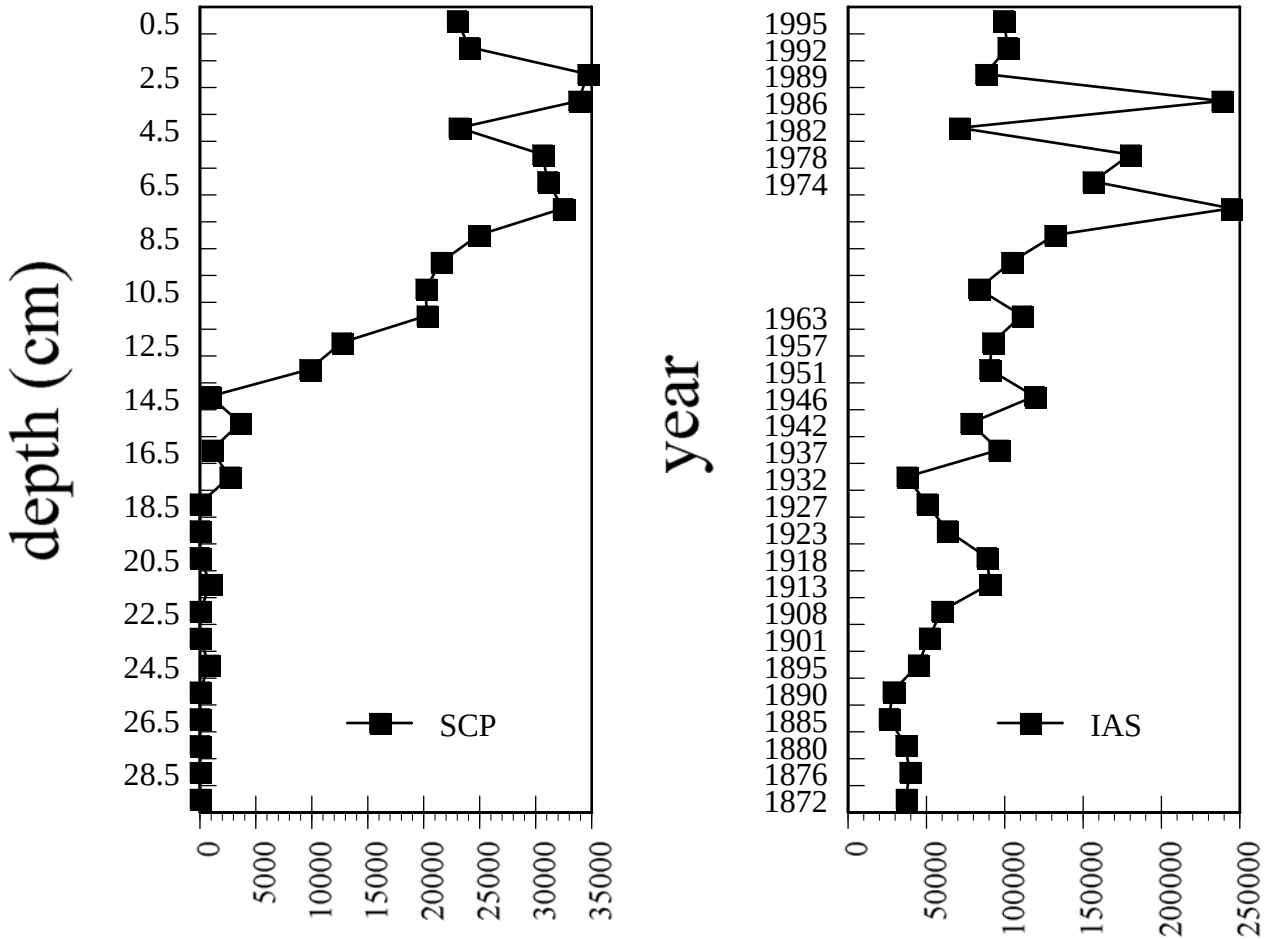
The scale of contamination recorded by Lake Akagi-konuma sediments are moderate in European terms and high with respect to lakes in the western USA, but a better comparison would be with other Japanese mountain lakes. There is is a need to undertake further research to confirm the temporal signal reported here, ascertain the spatial distribution of these contaminants across Japan and, particularly with a view to determining the ongoing impact from increasing East Asian sources, monitor the effects of depositing pollutants to these remote sites.



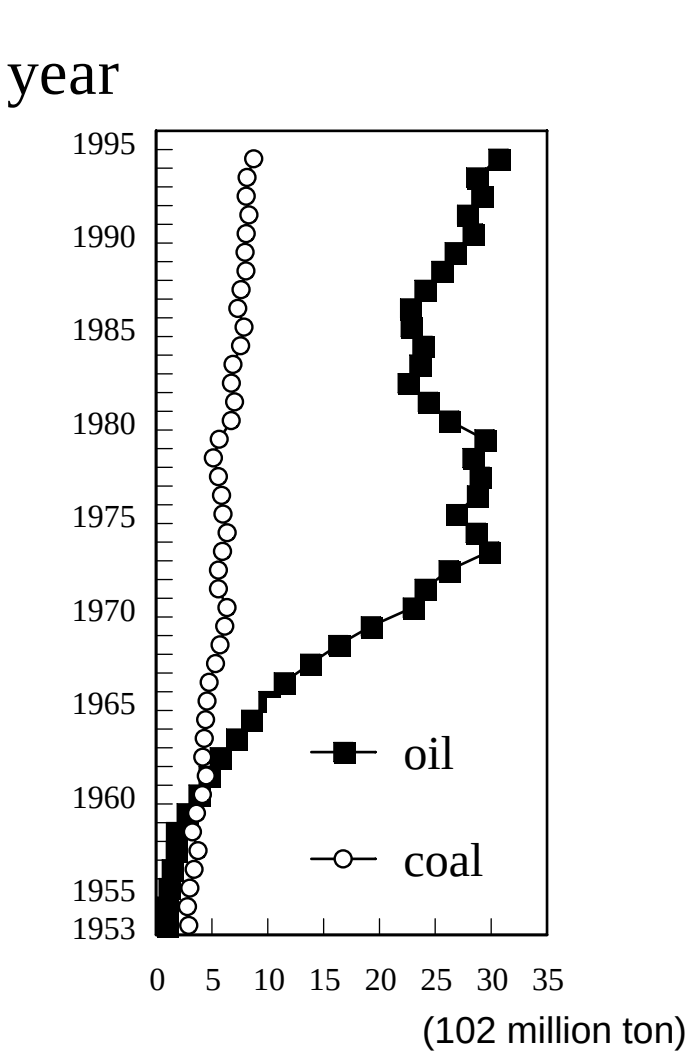
関東地域の地域風　夜間(a)　昼間(b)


Depth (cm)
0
5
10
15
1995
1974
1963
1937
0.083 g/cm²yr
0.067 g/cm²yr
210Pbex , 137Cs (dpm/g)
10
1
0
1
2
3
4
5
6
210Pb(ex)
137Cs
Cummulative weight (g/cm²)

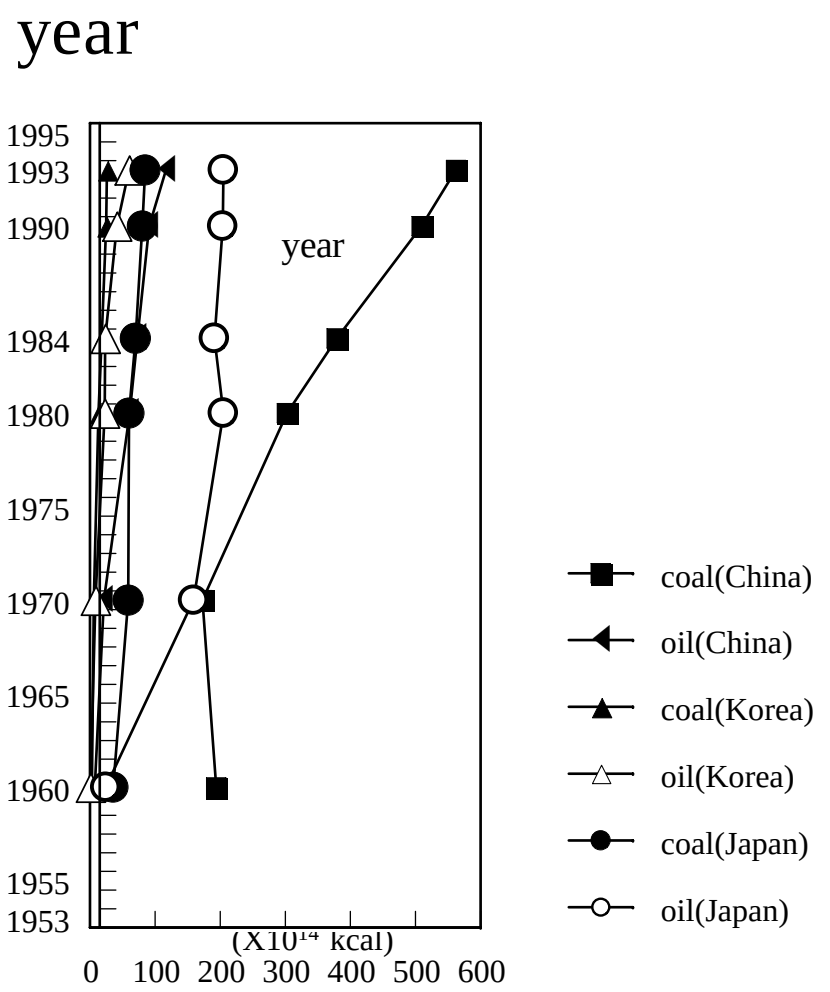
赤城小沼の堆積速度



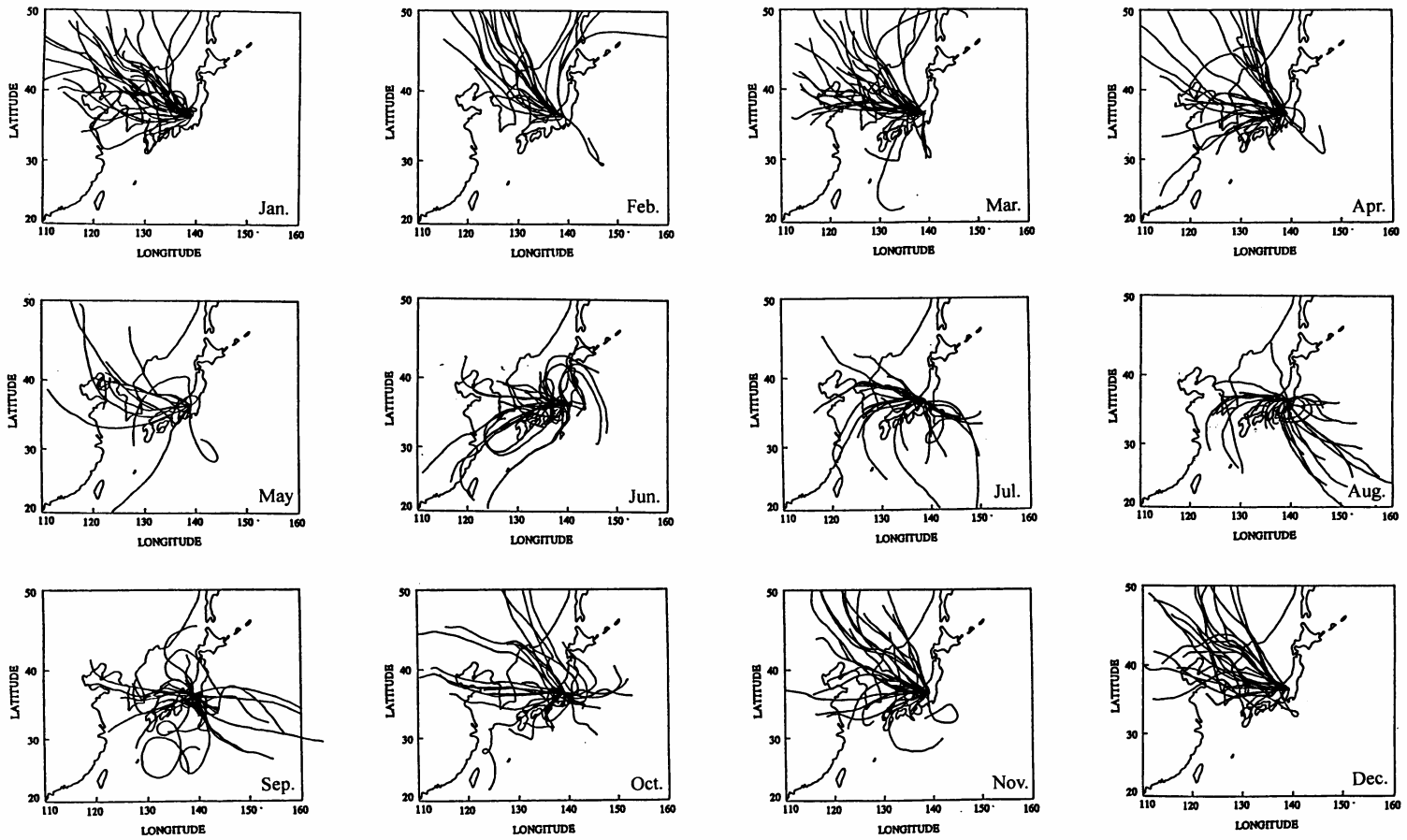
SCPおよびIASの鉛直プロファイル



わが国の石炭および石油の消費量の変遷



東アジア諸国の化石燃料の消費量変遷



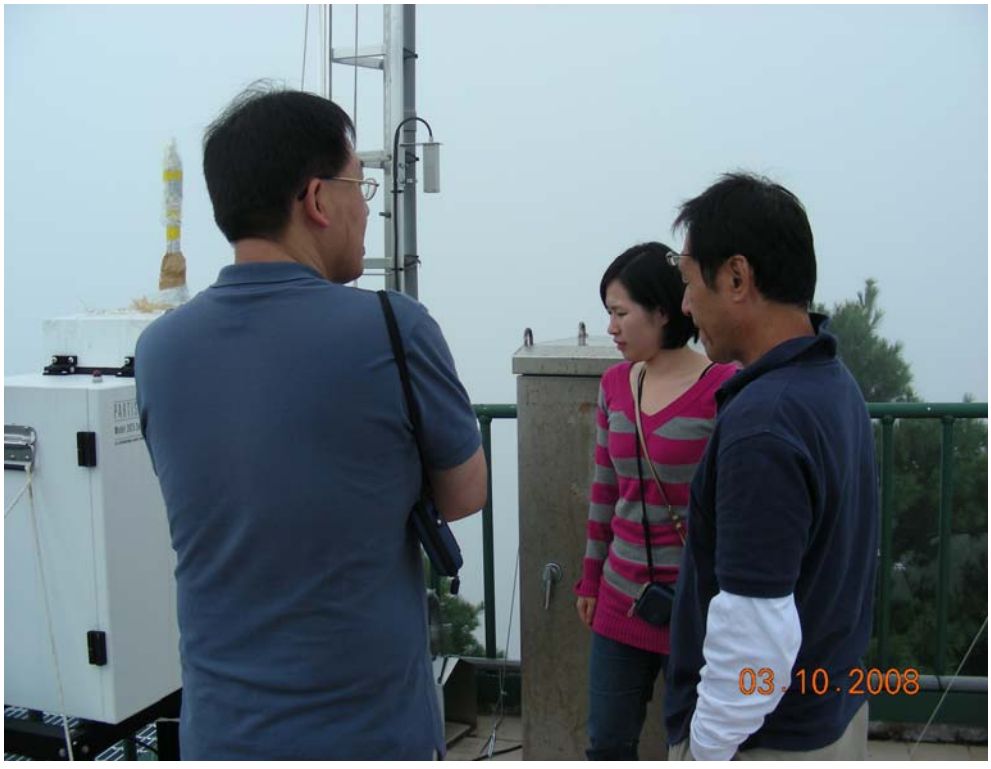
赤城小沼から計算した流跡線(1994)

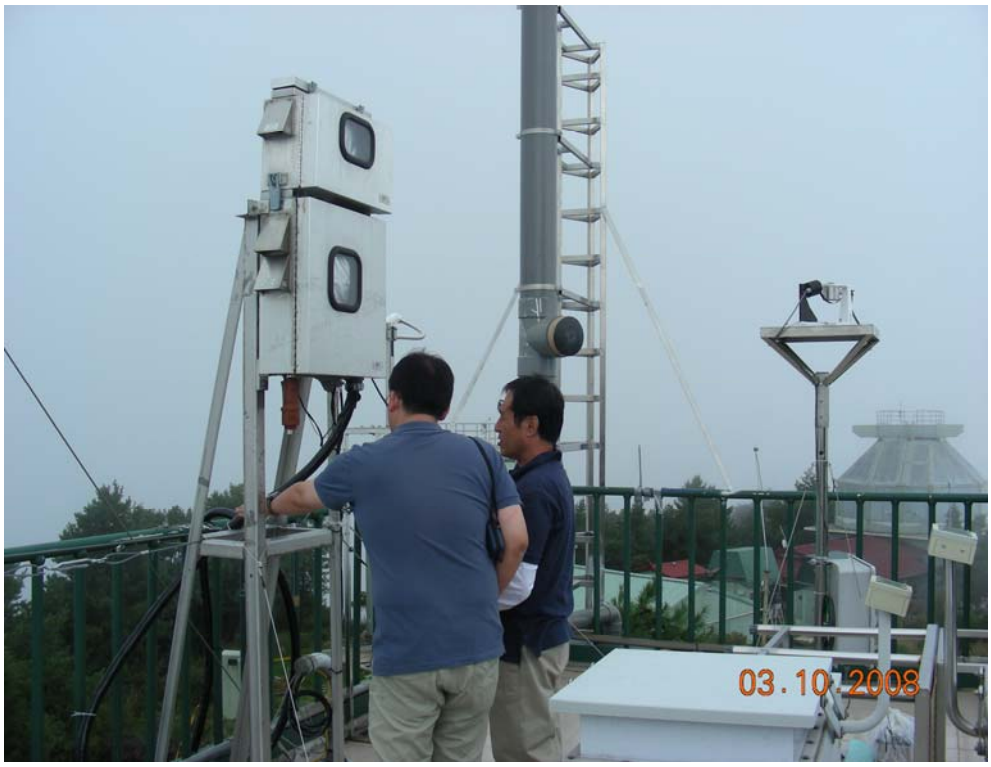
「97 年度台日技術合作計畫項下—東亞地區空氣污染跨境傳輸之監測技術與資料分析」成效檢討報告

附件 5

參訪環保署鹿林山背景監測站


行政院環境保護署
鹿林山空氣品質背景測站
03.10.2008


03.10.2008


03.10.2008


03.10.2008