

# Characterization of seasonal sea-salt particles in Antarctica by the combined use of low-Z particle electron probe X-ray microanalysis and Raman microspectrometry



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## Introduction

Antarctica, having minimal influence from trade-winds, is isolated from cross-continental anthropogenic aerosol sources. Hence, it is one of the few pristine sites ideal for studying natural sea salt aerosols (SSAs) processes (Maskey et al., 2011). The different phases of natural SSAs significantly affect earth's radiative balance by scattering light and acting as cloud droplet or ice-nuclei (Ault et al., 2013). So far most investigations are based on artificially generated SSAs. This study aims to present a systematic examination of the interdependence of hygroscopic properties and the chemical heterogeneity of natural SSAs collected in the Antarctic.

Aerosol samples were collected at a Korean scientific research station in the Antarctic: the King Sejong station (62°22'S, 58°78'W). Sea salt particles were collected on Al foils (Aldrich, 99.8% purity) using a three stage cascade impactor (PM<sub>10</sub> Impactor, Dekati Inc.) in different seasons. The impactor has aerodynamic cut-offs of 10, 2.5, and 1 μm for stages 1, 2, and 3, respectively, at a 10 L min<sup>-1</sup> sampling flow. The chemical compositions, mixing states, and spatial distribution of chemical species within individual particles are obtained by the combined use of low-Z particle energy-dispersive X-ray microanalysis and Raman microspectrometry.

## Material and Methods

### 1. Sampling :

#### • Sampling methods

- 3-stage Dekati PM<sub>10</sub> impactor
- Aerodynamic cut-offs : 10, 2.5, 1 μm
- Substrate : Al foil (Sigma-Aldrich, 99.8% purity)
- Sampling flow : 10 L min<sup>-1</sup>

#### • Sampling site

- The King Sejong station (62°22'S, 58°78'W)

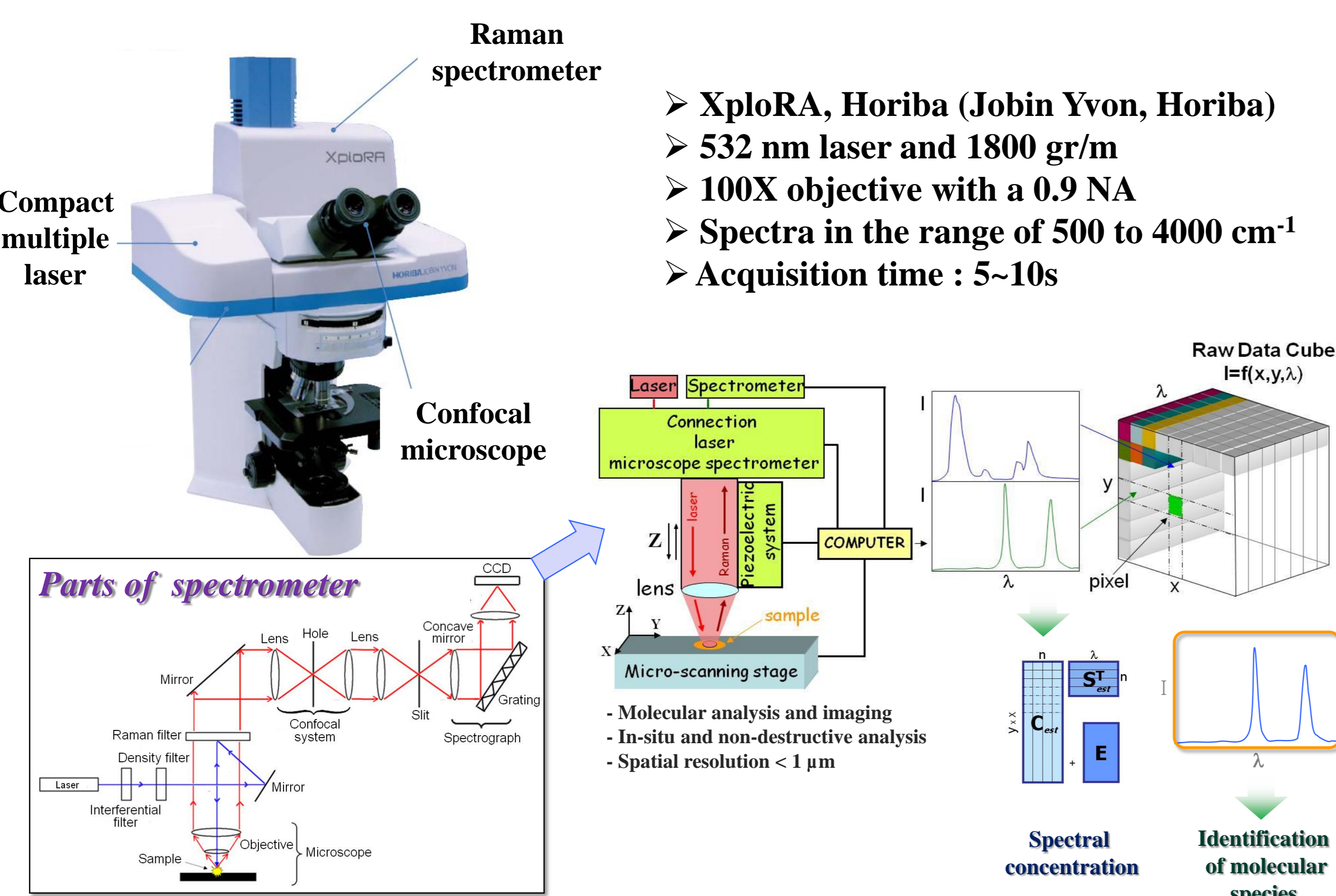
#### • Samples

Season	Year	Month	Date	Stage	Sea Temp. (°C)	Chl-a (μg/L)	Temp. (°C)
Summer	2011	12	9	2	0.6	123.0	1.1
Winter	2012	7	23	2	-1.6	6.3	0.4



### 2. Measurement and Analysis :

#### • Micro-Raman spectrometry for single particle analysis



#### • Particle morphology and X-ray mapping measurement using SEM/EDX

#### ❖ SEM-EDX (Scanning Electron Microscopy–Energy Dispersive X-ray Spectrometry)

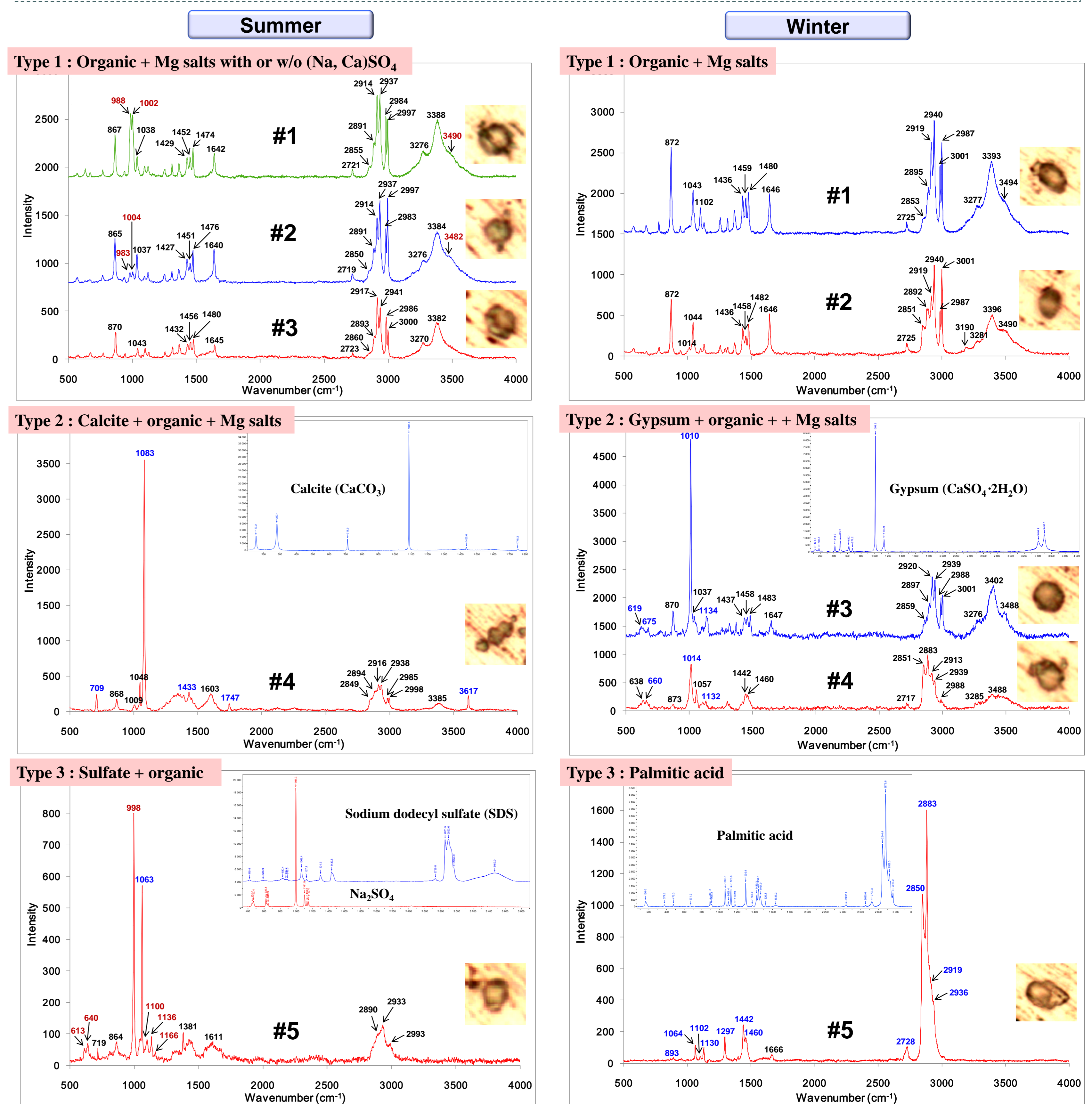
- Individual Particle Analysis:
  - shape and size: secondary / backscattered electron images
  - chemical composition: X-ray spectrum
- ❖ Ultra-thin window EDX for low-Z elements detection (C, N, O, F)
- ❖ Metallic collecting substrates for minimizing charging effects (Ag or Al)

- Jeol JSM-6390 SEM
- Oxford Link SATW ultrathin window EDX detector
- The detector resolution : 133 eV for Mn Kα X-rays
- 10 kV accelerating voltage
- 0.5 nA beam current
- Oxford INCA Energy software : X-ray spectra and elemental maps

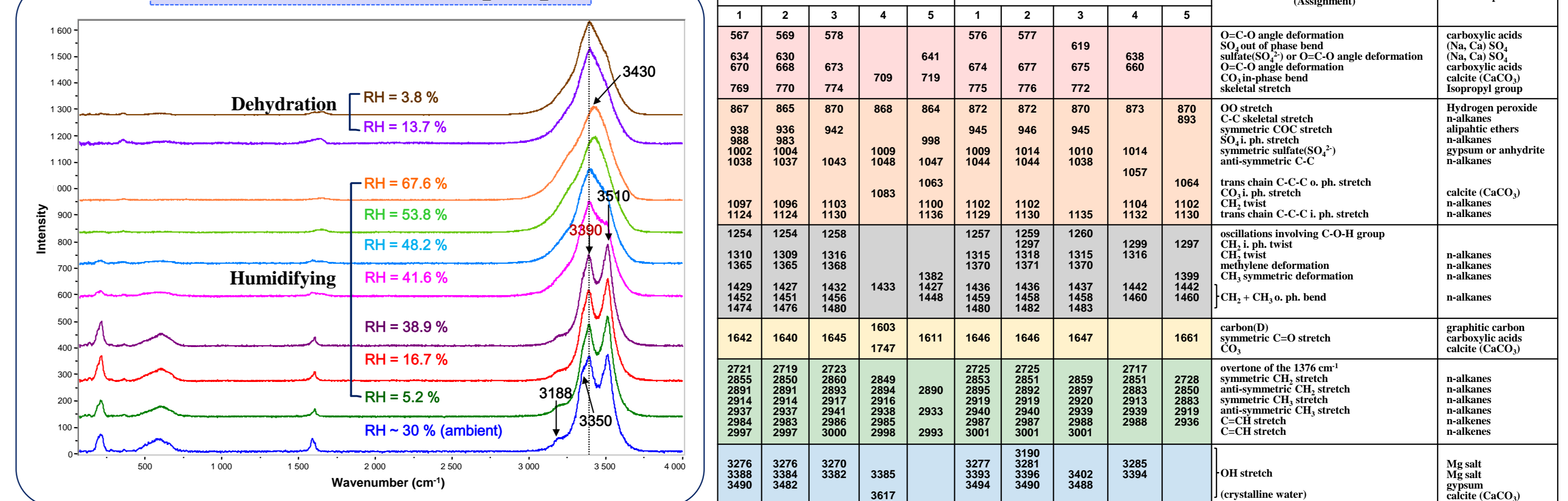


## Results

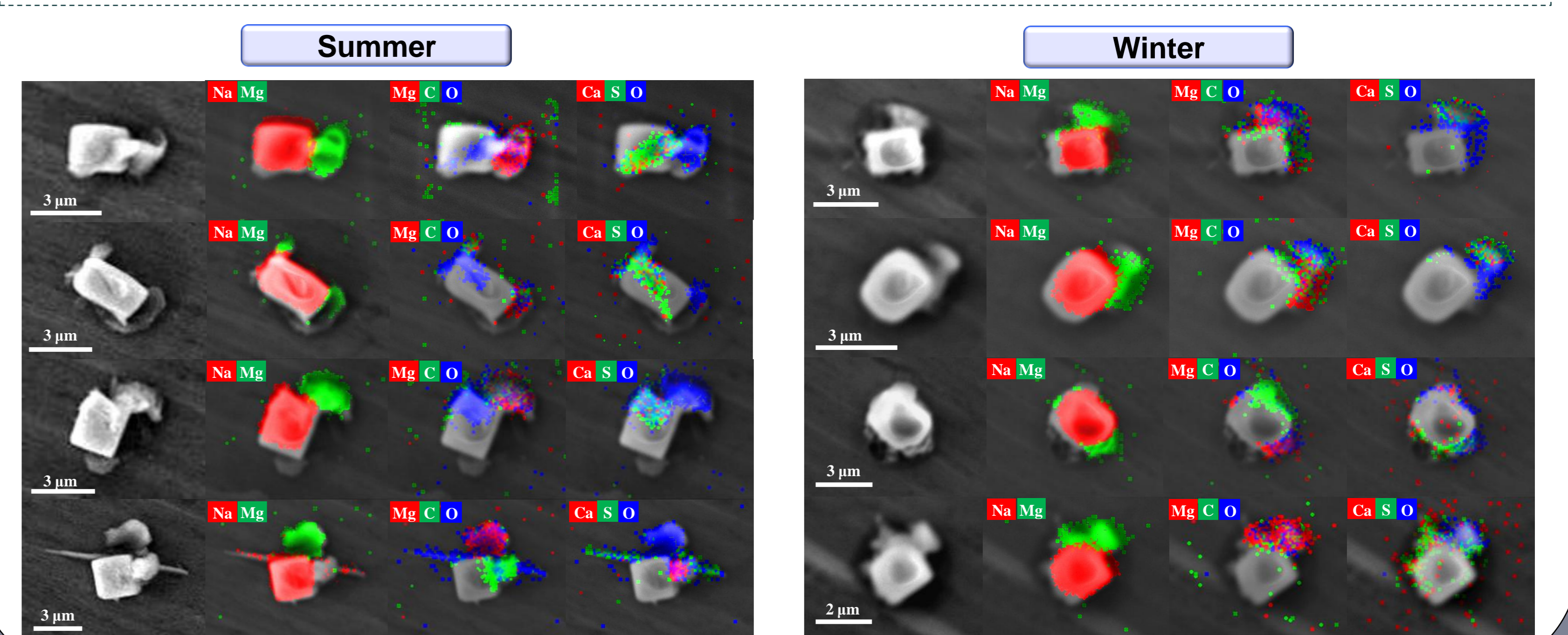
### Typical Raman spectra of SSAs in Antarctica



### Results of standard MgCl<sub>2</sub>·6H<sub>2</sub>O



### Typical element X-ray maps of SSAs in Antarctica



## Discussion

Most of the sea salt particles have NaCl showing cubic structures in core and Mg<sup>2+</sup> and organic species in boundaries. Raman signatures indicate presence of many organic species apparently from phytoplankton activity. The association of sulfate species with NaCl are more abundant in the summer than in the winter SSAs.

### References

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