



Natural Resources  
Canada

Ressources naturelles  
Canada



## Geological Survey of Canada Scientific Presentation 75

# Characterization of smelter dust from the mineral fraction of humus

R.D. Knight and P.J. Henderson

2017



# Presented at: 6<sup>th</sup> International Symposium on Environmental Geochemistry

**Date presented: September 2003**

© Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources, 2017

For information regarding reproduction rights, contact Natural Resources Canada at  
[nrcan.copyrightdroitdauteur.nrcan@canada.ca](mailto:nrcan.copyrightdroitdauteur.nrcan@canada.ca).

**Permanent link:** <https://doi.org/10.4095/306043>

This publication is available for free download through GEOSCAN (<http://geoscan.nrcan.gc.ca/>).

## **Recommended citation**

Knight, R.D. and Henderson P.J., 2017. Characterization of smelter dust from the mineral fraction of humus; Geological Survey of Canada, Scientific Presentation 75, 1 .pptx file. <https://doi.org/10.4095/306043>

*Publications in this series have not been edited; they are released as submitted by the author.*

# *Characterization of Smelter Dust from the Mineral Fraction of Humus*

R.D. Knight and P.J. Henderson



# Setting the Stage

## Metals in the Environment Point Source Project

To determine:

- **Extent of metal loading**
- **Characteristics of emitted metals**
- **Processes and factors controlling metal distribution**
- **Criteria for differentiating geogenic and anthropogenic metal loading**
- **Mass balance of emissions to metal concentrations**



# Setting the Stage

## Part II

### **Metals in the Environment - GSC**

**Lake Sediments**

**Dendrochemical**

**Snow**

**Peat**

**Humus and soil**

**Smelter Dust**

### **Metals in the Environment - RN**

**Sources / Processes  
/ Impacts**

**Cascade Impactors – St. Mary's  
Atmospheric Studies –  
Meteorological Service of  
Canada**

**Stack chemistry  
Slag chemistry**

# Factors affecting the distribution of metal in soil

- **Wind**
- **Soil Type**
- **Humus** (thickness/type)
- **pH**
- **Geology** (bedrock & surficial)

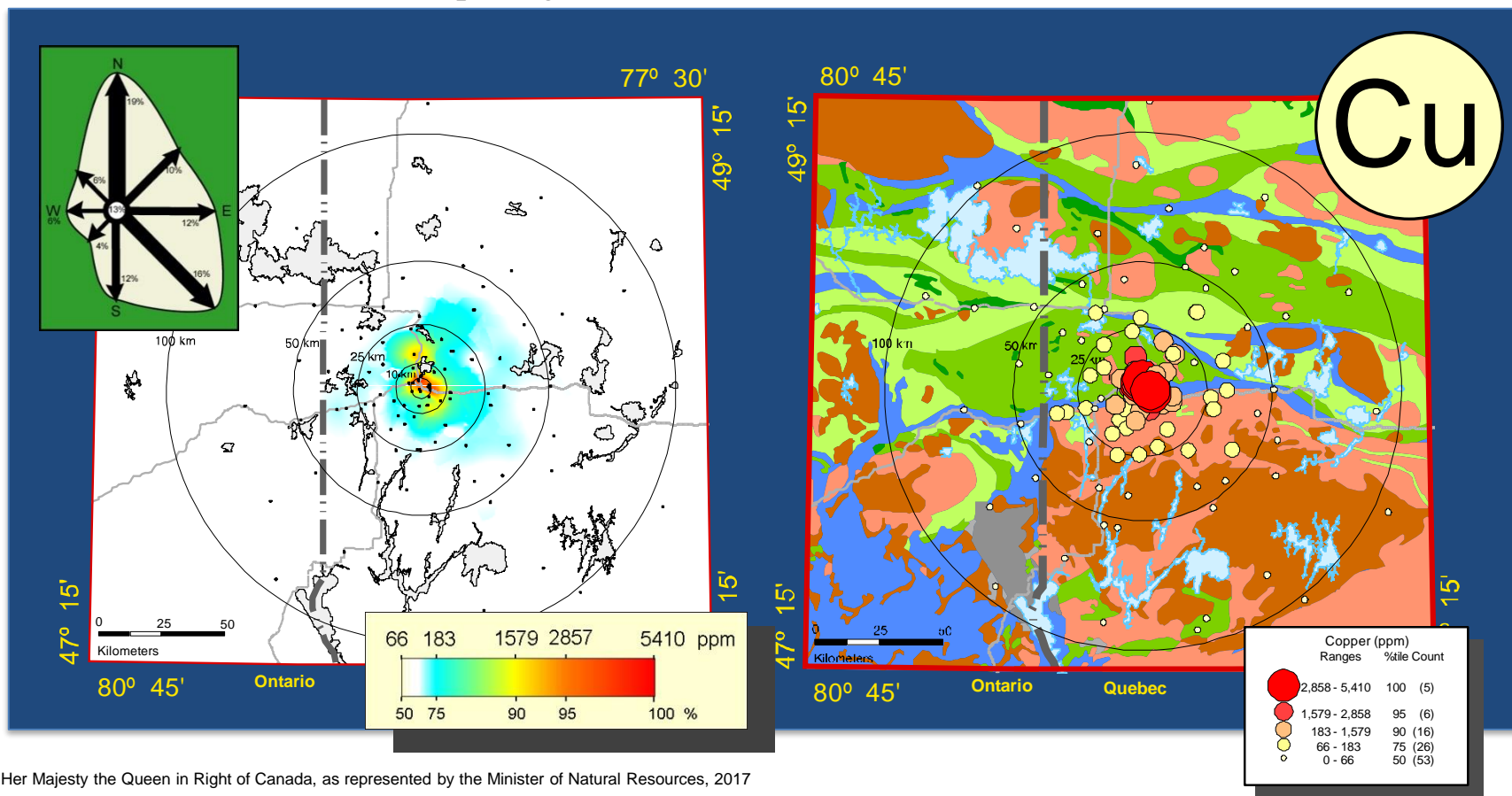


# Extent of Metal Loading

## Humus

<2mm

ICP-AES Aqua regia



© Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources, 2017

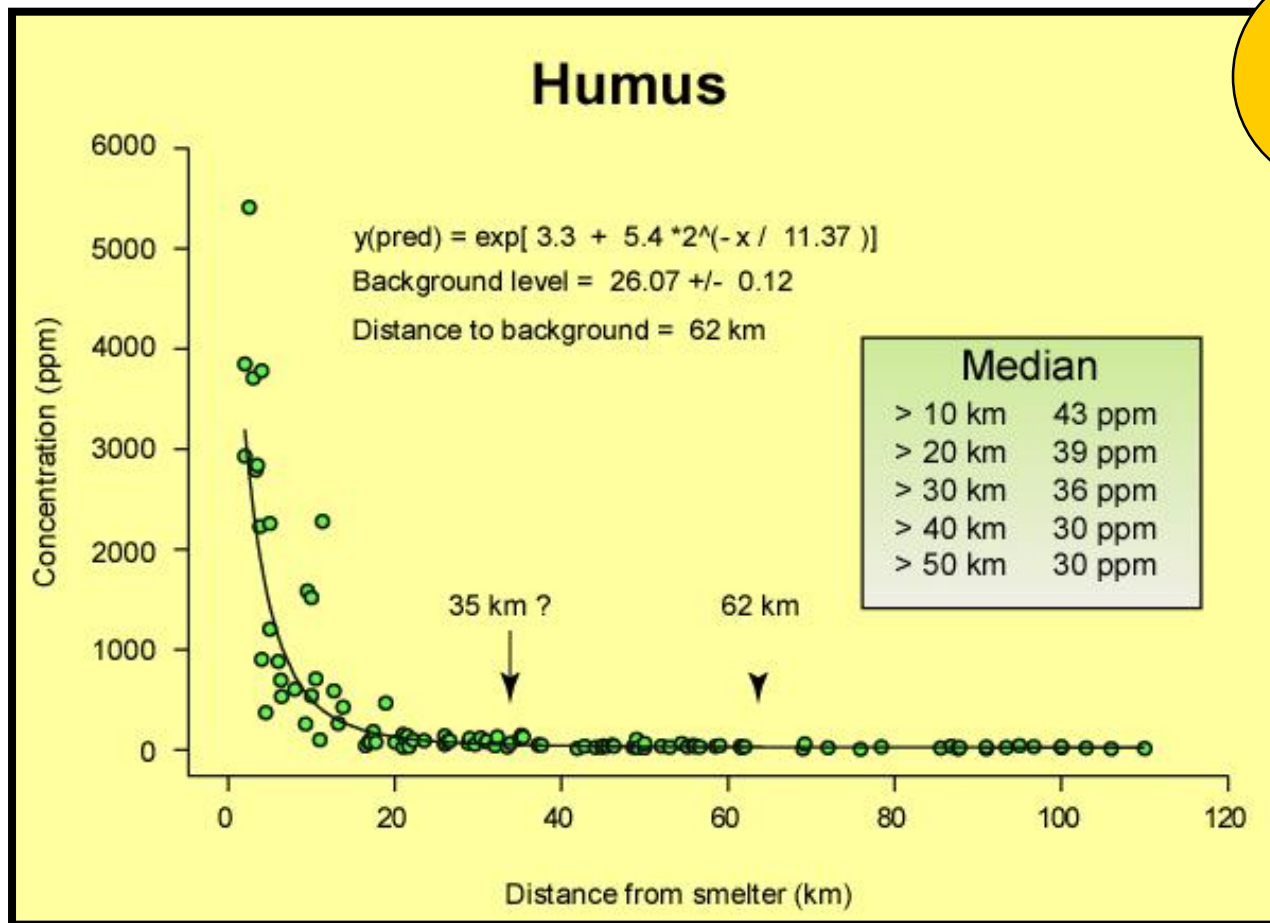


Natural Resources  
Canada

Ressources naturelles  
Canada

Canada

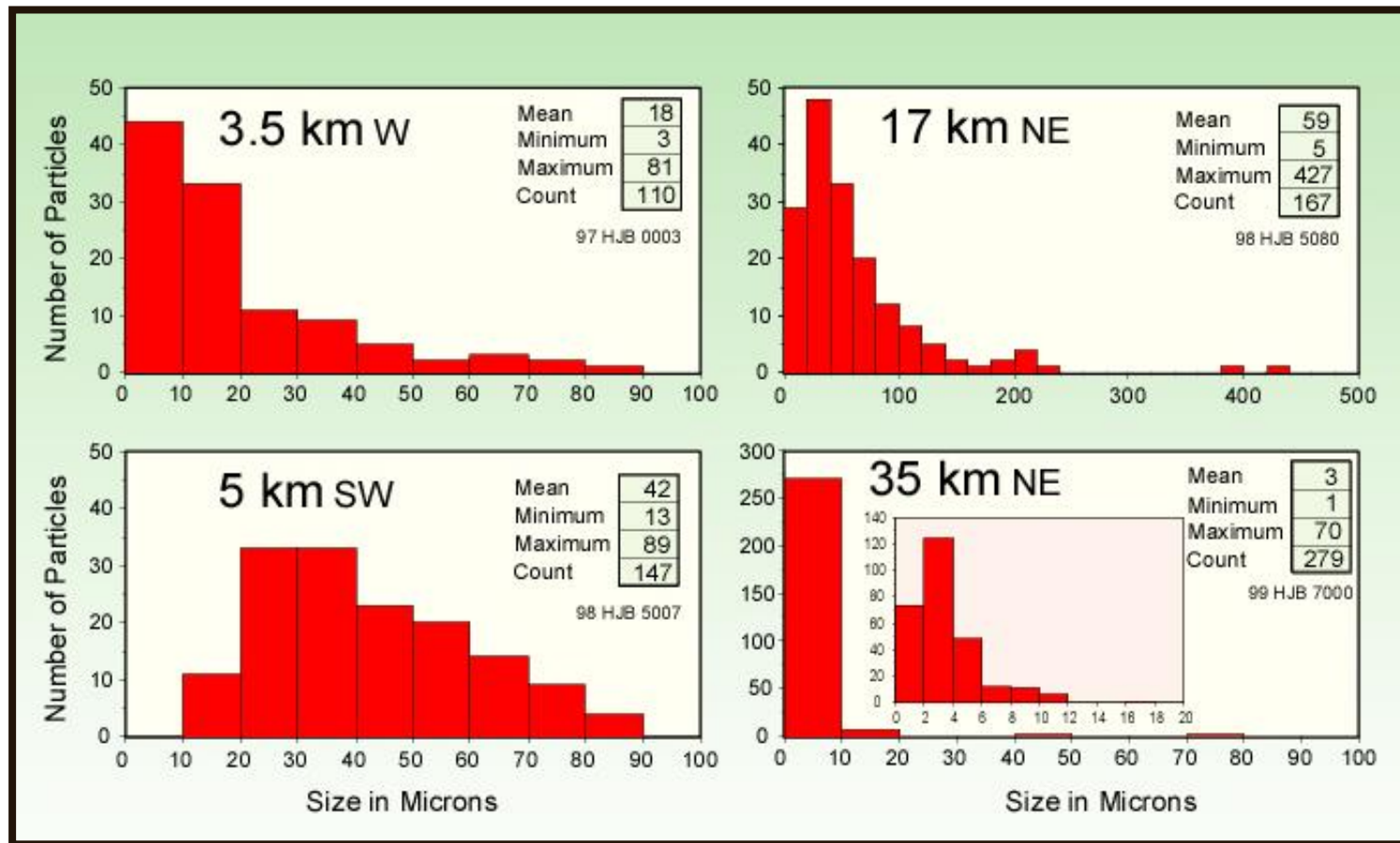
# Extent of Metal Loading





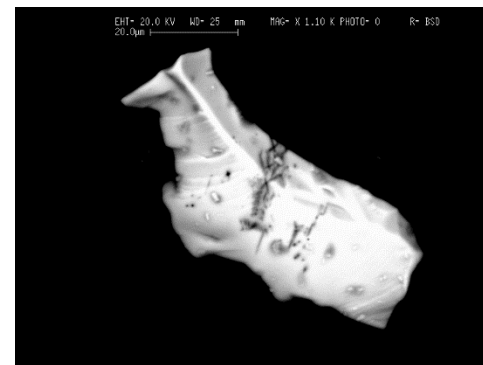
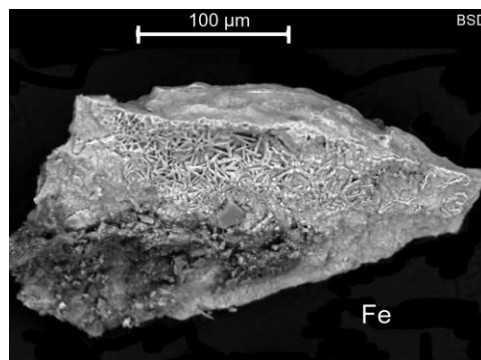
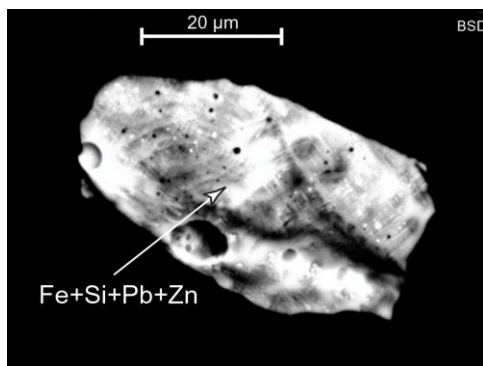
# Characteristics of Emitted Particles

## Size and abundance with distance

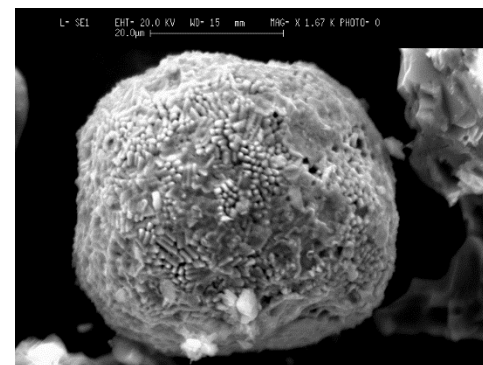
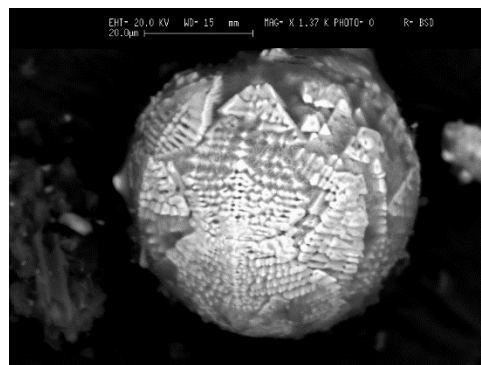


# Characterization of Particles in Humus

## Angular morphology

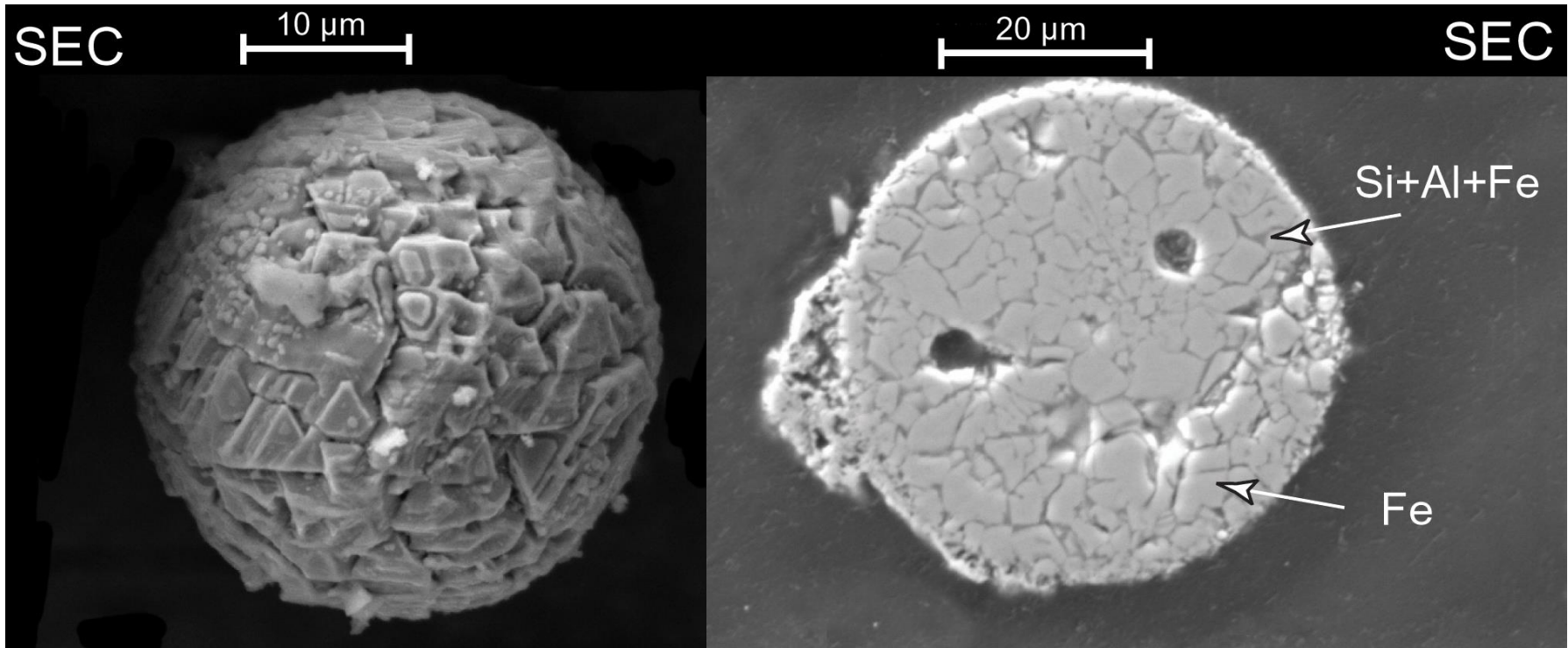


## Spherical morphology



© Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources, 2017

# Class 1: Plated



**Fe and Fe+Si**

**-agglomeration and partial fusing of flux**

**-complete melting and slow re-crystallization**

© Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources, 2017

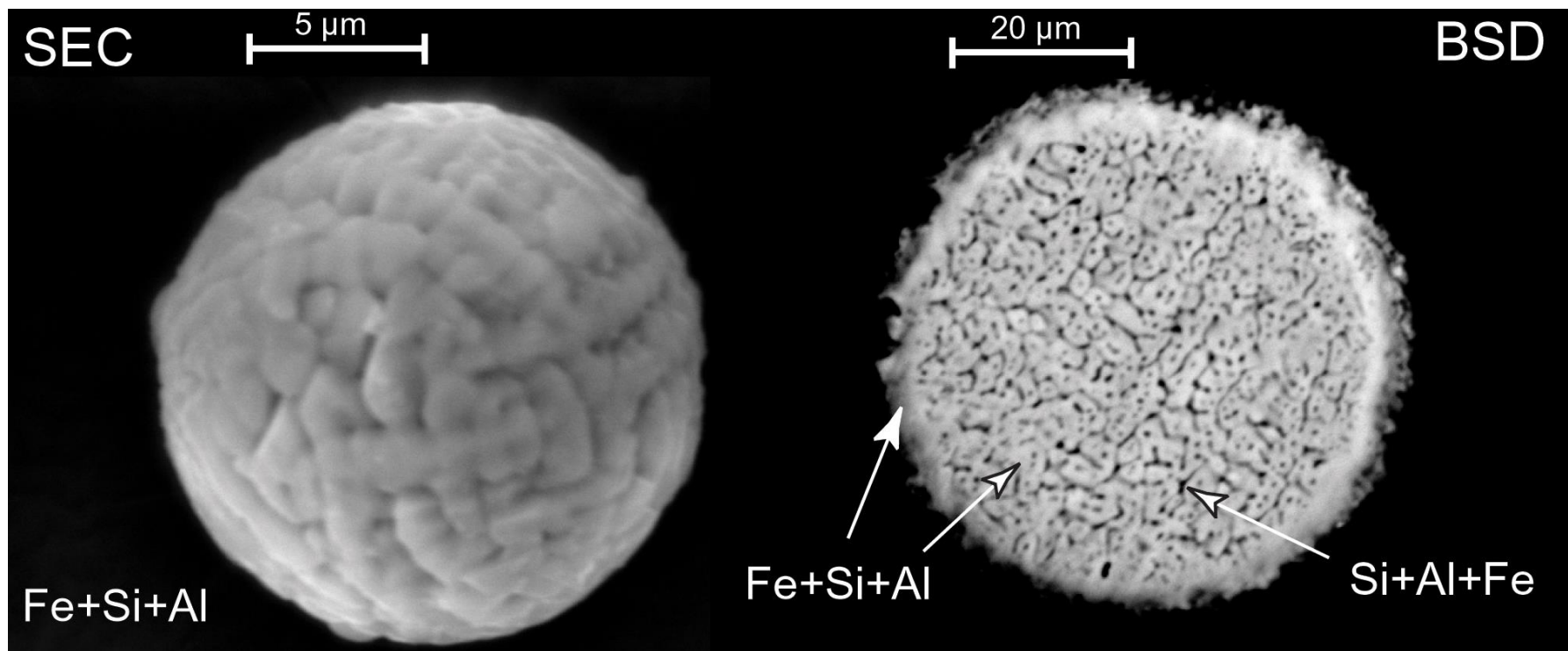


Natural Resources  
Canada

Ressources naturelles  
Canada

Canada

## Class 2: Tubular



**Fe and Fe+Si+Al**

**greater amount of agglomeration and partial fusing than Class 1**

**complete melting and faster re-crystallization than Class 1**

© Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources, 2017

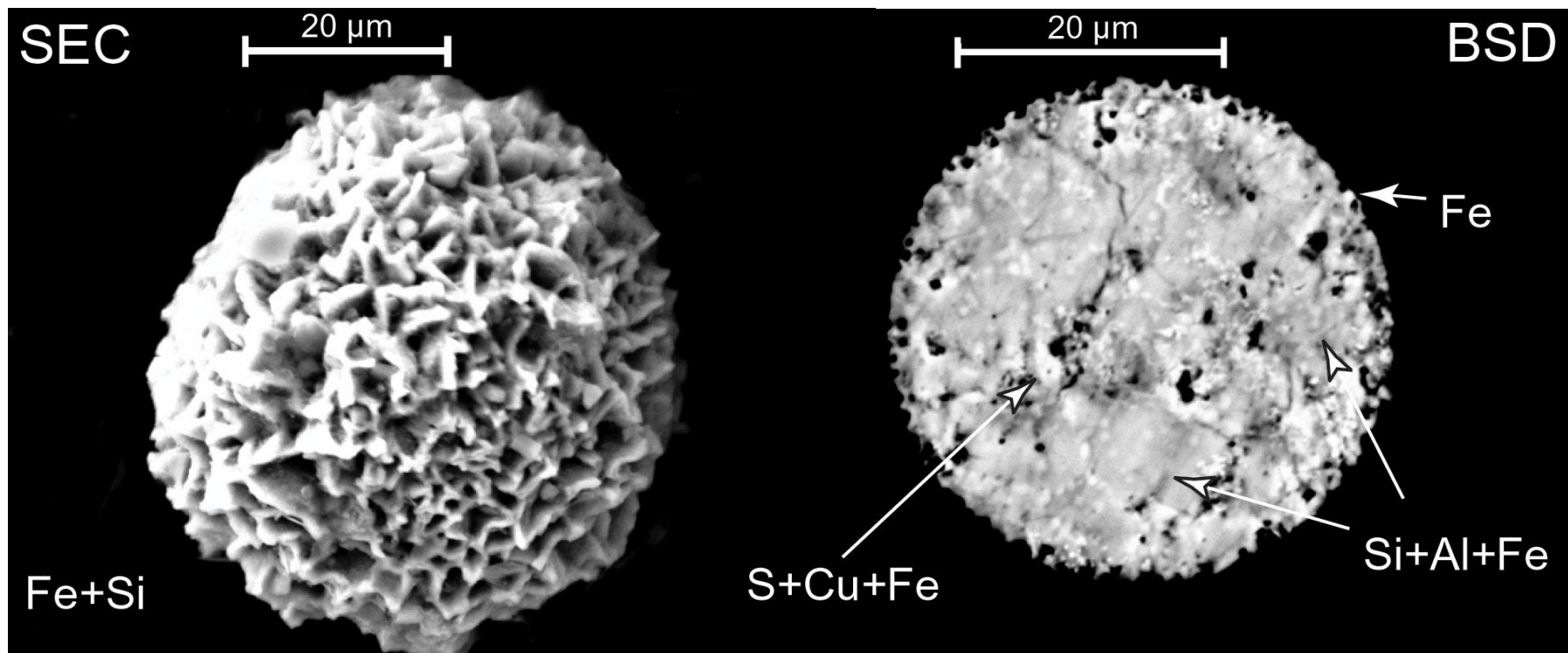


Natural Resources  
Canada

Ressources naturelles  
Canada

Canada

# Class 3: Etched



**Fe, S+Cu+Fe**  
**matrix of Si+Al+Fe**

- molds of chalcopyrite
- poorly differentiated phases

© Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources, 2017



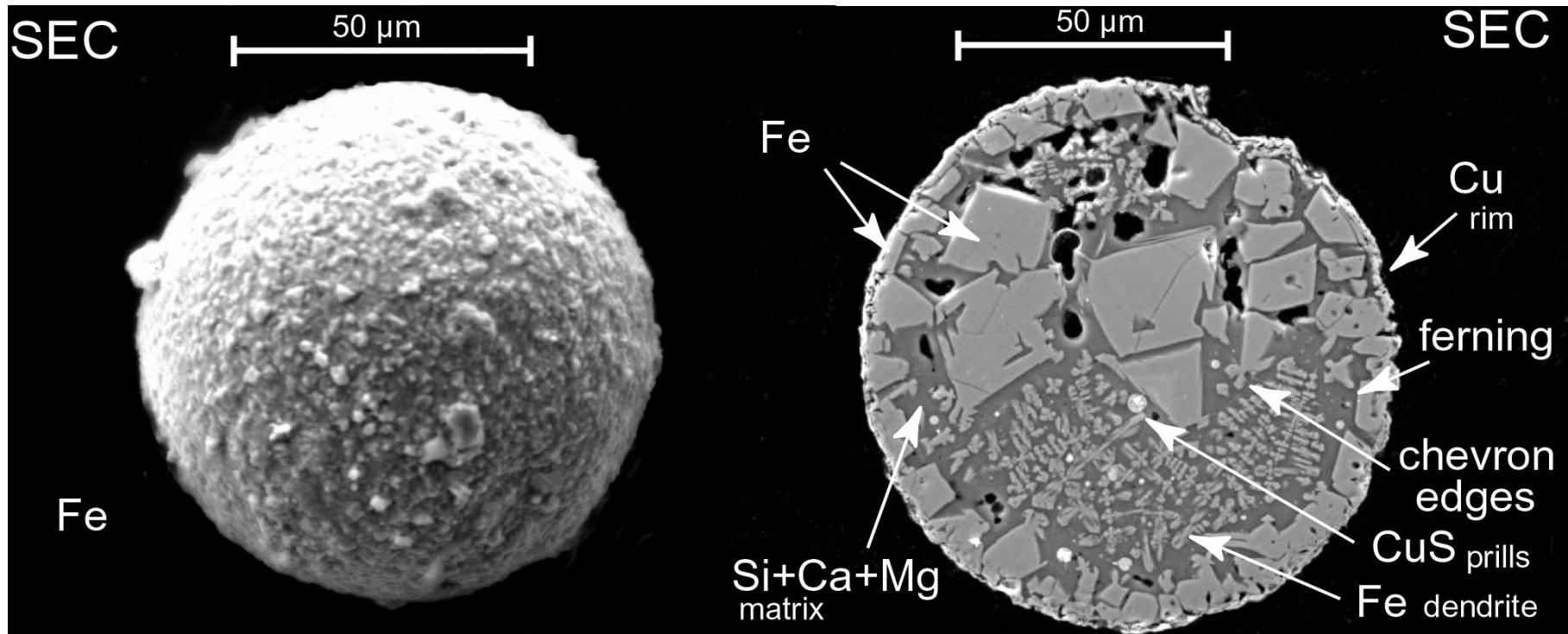
Natural Resources  
Canada

Ressources naturelles  
Canada

Canada



# Class 4: Granular to Smooth



**Fe**

**matrix Si+Al+Mg**

- multiple stages of formation

- molten droplets and un-melted mineral dust

© Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources, 2017

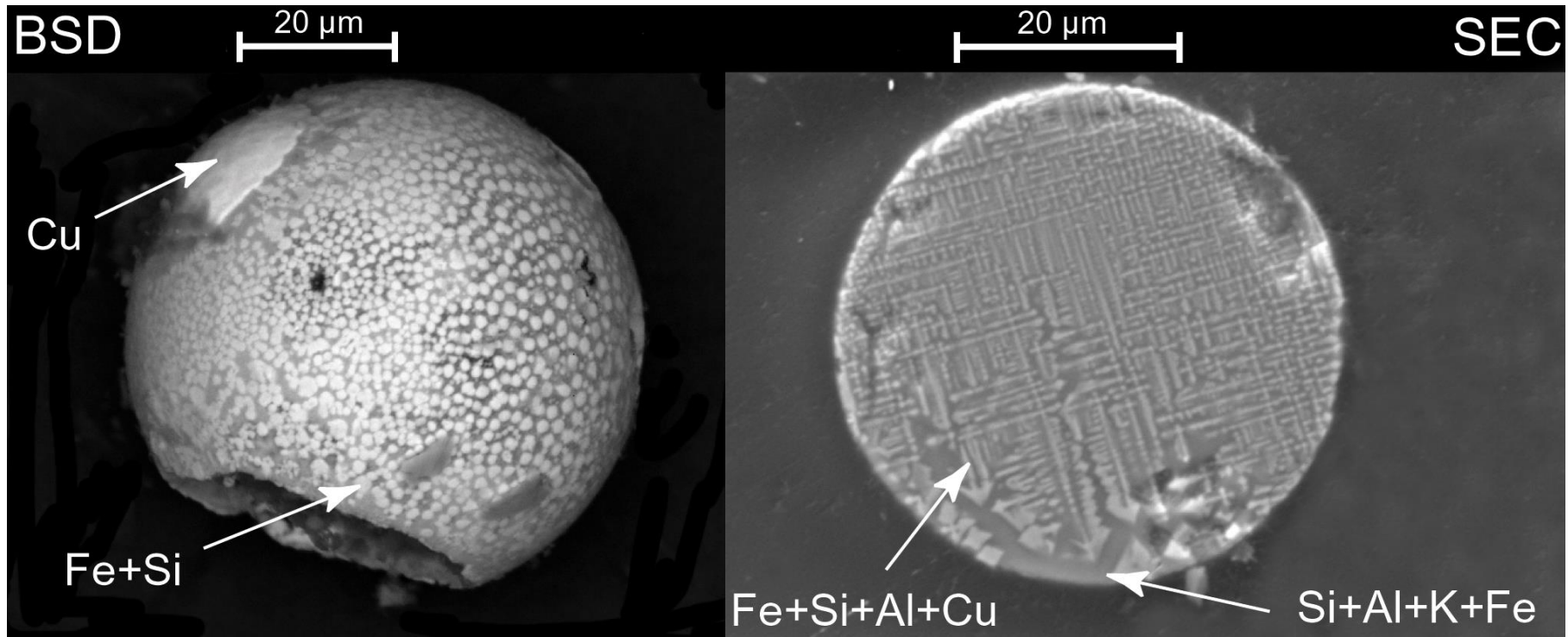


Natural Resources  
Canada

Ressources naturelles  
Canada

Canada

# Class 4: Granular to Smooth



**crystalline Fe**

- dendritic to trellis quench textures

**matrix Si+Al+Mg**

- note the outer cap of Cu on the left image

© Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources, 2017

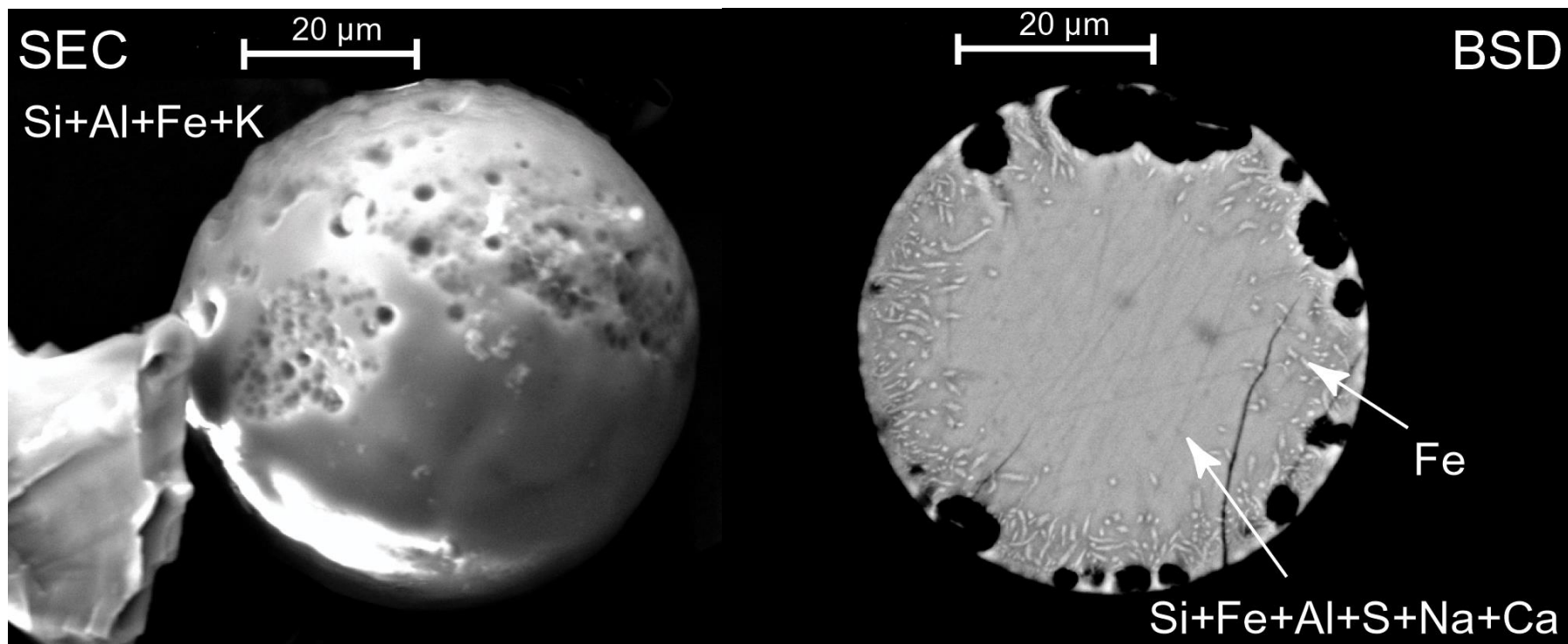


Natural Resources  
Canada

Ressources naturelles  
Canada

Canada

# Class 5: Lunar



**Si+Al+Na with  
minor Fe**

- almost complete release of metals
- last remnants of Fe near dust edge

© Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources, 2017

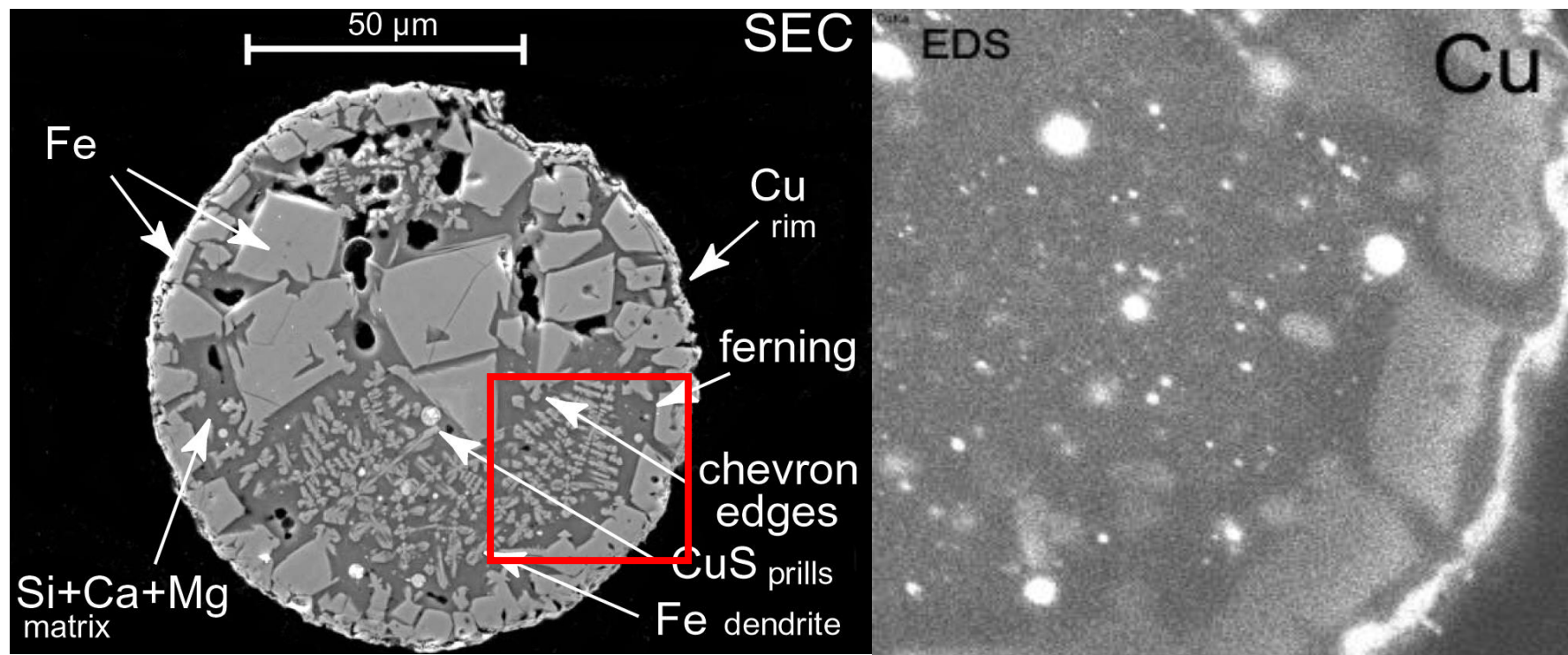


Natural Resources  
Canada

Ressources naturelles  
Canada

Canada

# Class 4: Granular to Smooth



**Fe**

- multiple stages of formation

**matrix Si+Al+Mg**

- molten droplets and un-melted mineral dust

© Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources, 2017



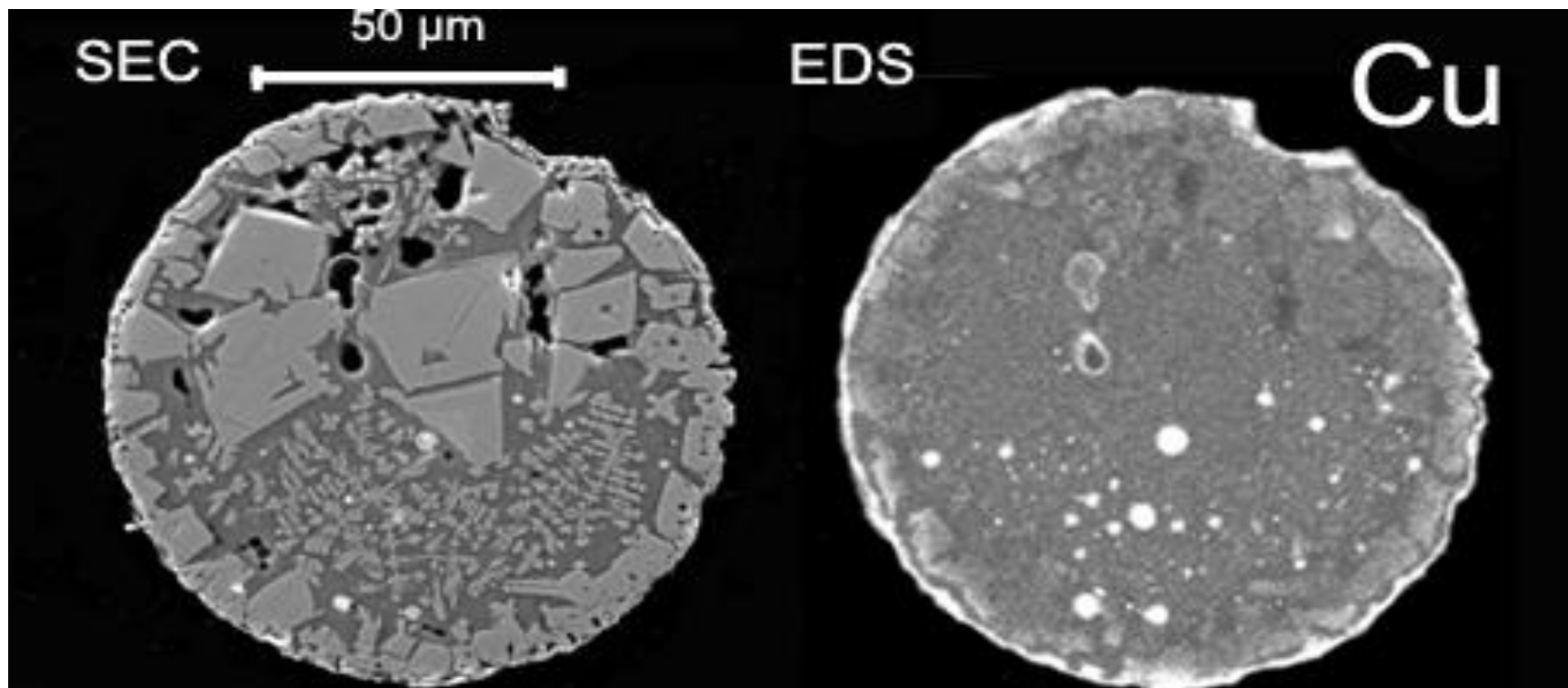
Natural Resources  
Canada

Ressources naturelles  
Canada

Canada



# Cu content by EDS image analyses



**Class 4: Granular to Smooth**

**Cu = 6% of area**

**Fe, matrix Si+Al+Mg**

© Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources, 2017



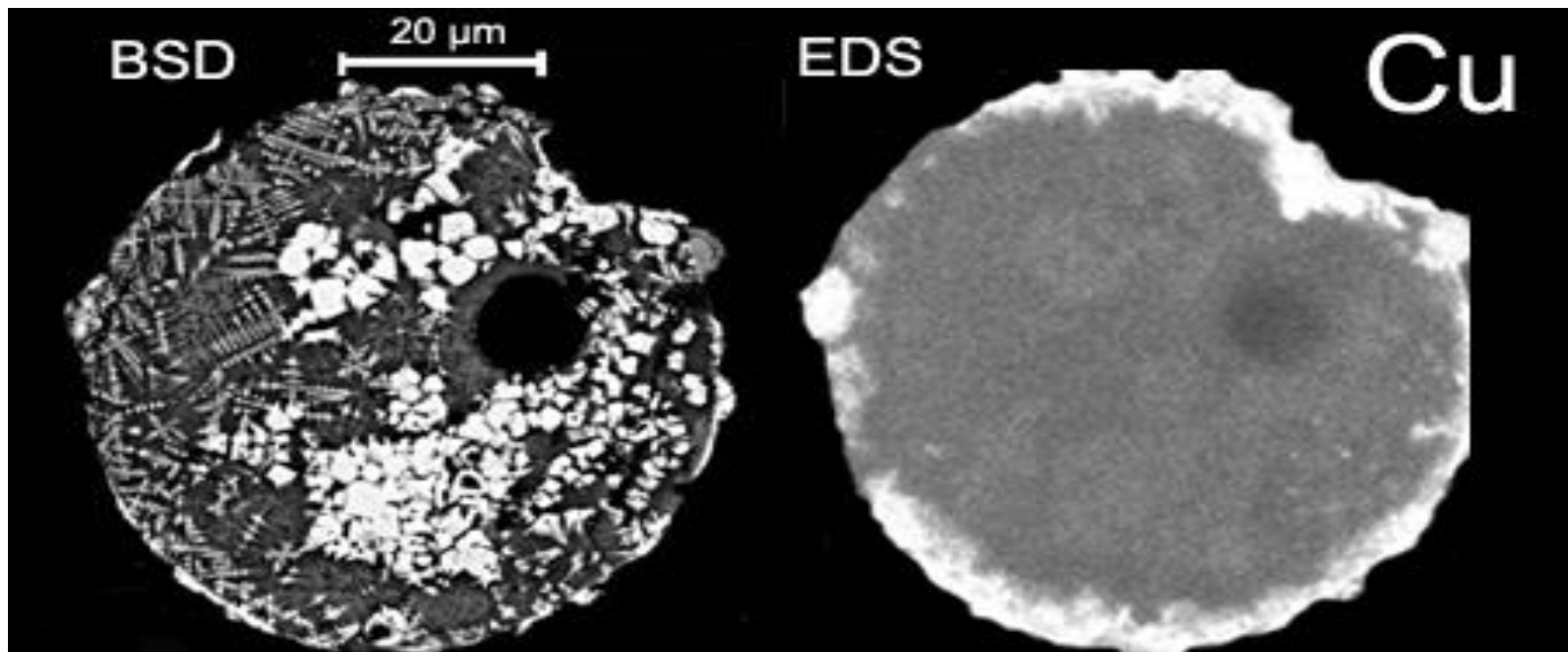
Natural Resources  
Canada

Ressources naturelles  
Canada

Canada



# Cu content by EDS image analyses



**Class 4: Granular to Smooth**  
**Fe, matrix Si+Al+Mg**

**Cu = 17% of area**

© Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources, 2017

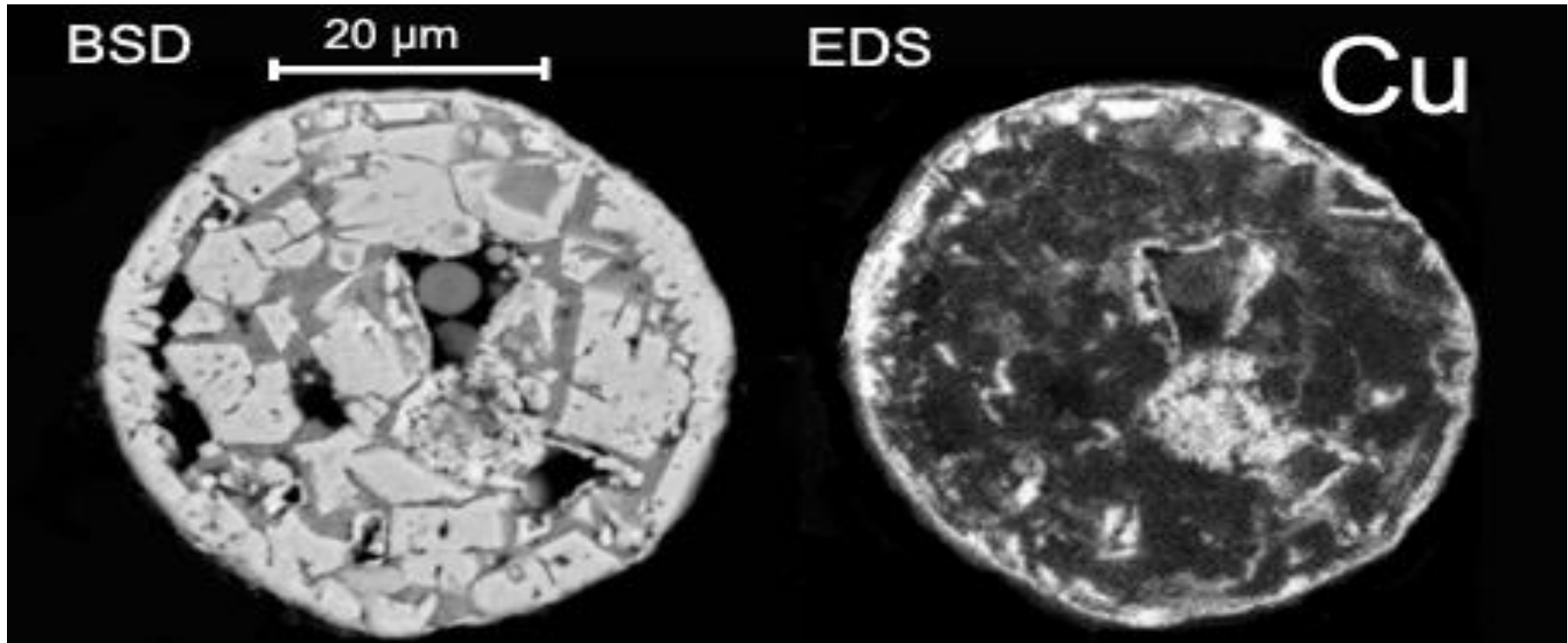


Natural Resources  
Canada

Ressources naturelles  
Canada

Canada

# Cu content by EDS image analyses



**Class 4: Granular to Smooth**  
**Fe, matrix Si+Al+Mg**

**Cu = 19% of area**

© Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources, 2017



Natural Resources  
Canada

Ressources naturelles  
Canada

Canada

# Does the Cu add up

**How many particles are there?**

**How many contain Cu?**

**How many Cu bearing particles are there per gram?**

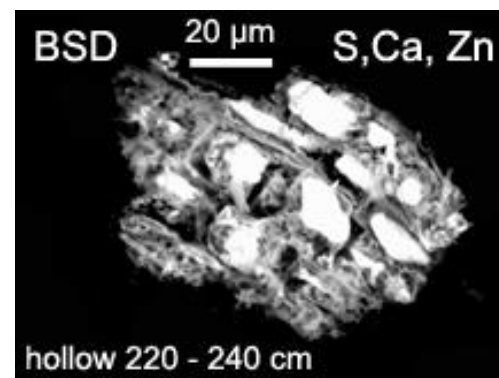
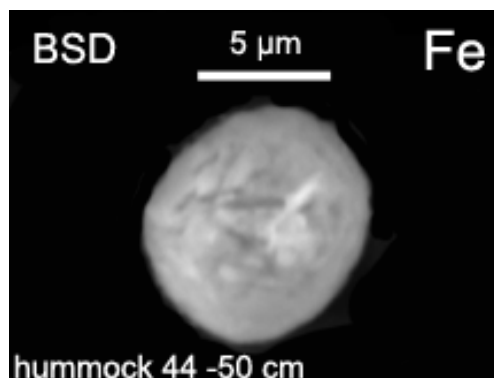
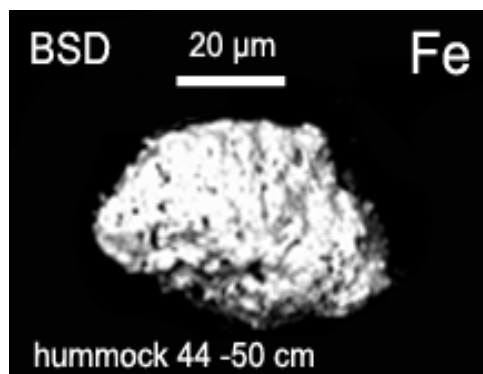
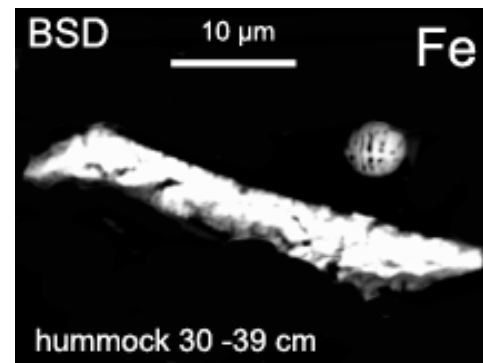
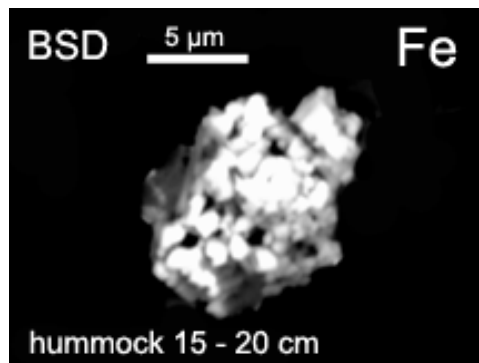
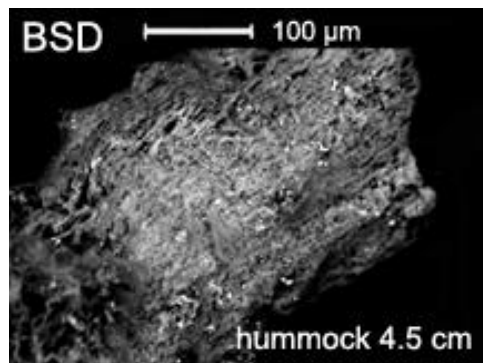
**How much Cu is in a Cu-bearing particle?**

**What is the weight of Cu in one particle?**

**How much Cu comes from Cu-bearing particles?**

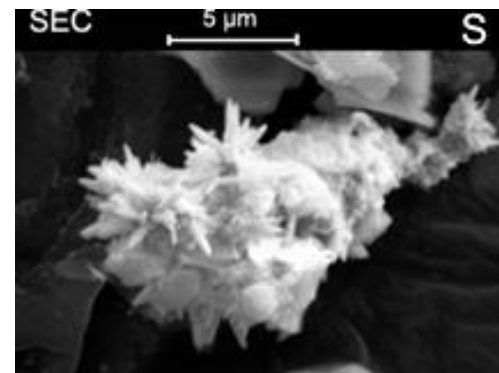
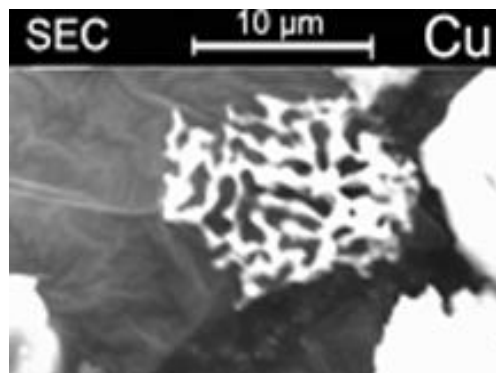
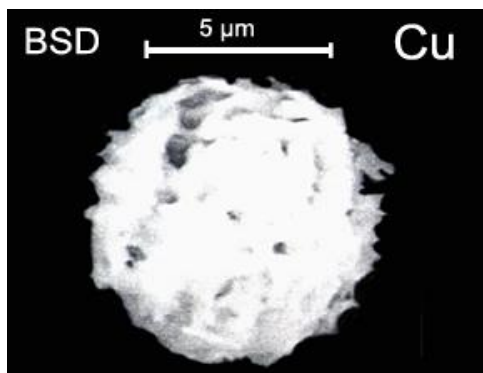
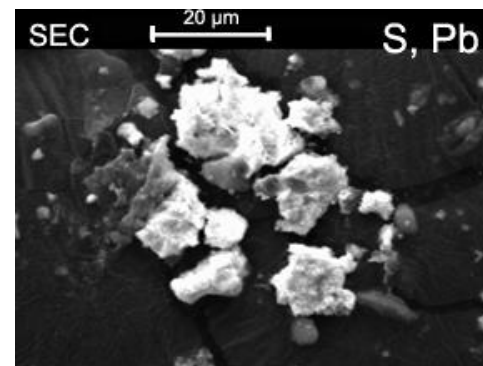
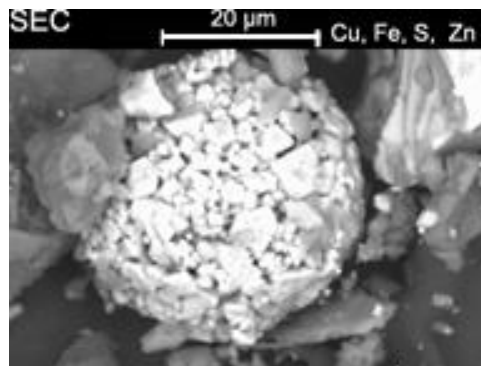
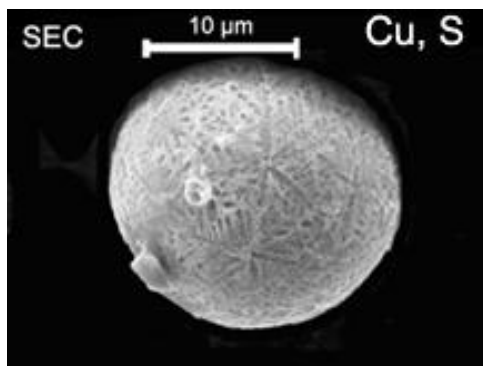
**~ 1 ppm**

# Particles in Peat



**From: Inez Kettles  
GSC Bulletin 584**

# Particles in Snow



**From: Kliza, Telmer, Bonham-Carter, Hall,  
GSC Open File 3869, Sept. 2000**

© Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources, 2017



Natural Resources  
Canada

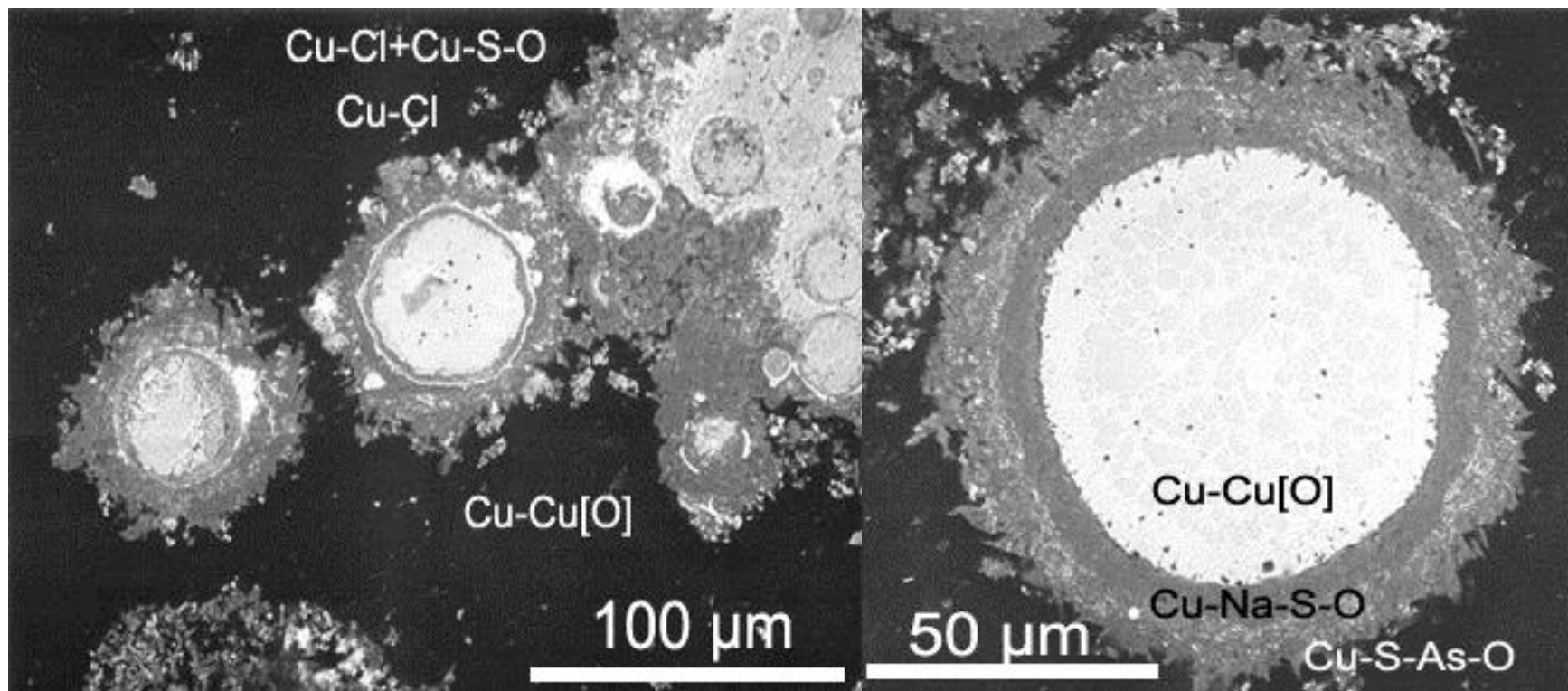
Ressources naturelles  
Canada

Canada



# Particles from the Stack and Plume

Speciation and chemical characterization: Jim Skeaff. Dogan Paktunc,  
Jim McGeer



Kröhnkite  $\text{Na}_2\text{SO}_4 \cdot \text{CuSO}_4 \cdot 2\text{H}_2\text{O}$  37%  
 $\text{As}_2\text{O}_3$  12%  $\text{Na}_2\text{SO}_4$  9%  $\text{ZnSO}_4$  7%

Anglesite  $\text{PbSO}_4$  20%  
 = 85%

© Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources, 2017



Natural Resources  
Canada

Ressources naturelles  
Canada

Canada

# Yearly Summary

## **Year 1 – Reconnaissance**

Limited data collection and processing (transects – Rouyn and Trail)

## **Year 2 – Data Collection**

Primary data collection and sample analyses

## **Year 3 – Data Analyses**

Completed data analyses and compilation; initial plotting

## **Year 4 – Compilation and Interpretation**

Re-analyses based on poor QA/QC results for selective leaches;  
development of access database; preparation of open file;  
LINKAGES with other point-source data sets. Publications, in  
house and journals

## **Year 5 – Publications and Presentations**

GSC Open file; GSC Bulletin linking point source sub-projects;  
Joint and individual Journal papers; Conference special sessions.

*Thank you for your attention*

*R.D. Knight and P.J. Henderson*



© Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources, 2017



Natural Resources  
Canada

Ressources naturelles  
Canada

Canada