

**Client:** Pilbara Minerals Ltd  
**Job number:** 18\_2053  
**Sample ID:** 18\_2053\_01  
**Client ID:** **Fines and coarse**  
**Date:** 08/03/2019  
**Analysis:** Fibre characterisation by scanning electron microscopy (SEM) with elemental analysis by energy dispersive spectroscopy (EDS) following AS 4964

### Sample preparation

The sample was supplied to Microanalysis Australia as a bulk sample.

A sub-sample was taken, weighed, dry sieved at 150 µm and the mass of each size fraction recorded. A portion of the undersize material was placed on top of a double sided carbon tab before being carbon coated. Non-conducting samples require coating prior to SEM analysis to prevent charging whilst being analysed by the electron beam.

### Analysis

The sample was analysed using a Carl Zeiss EVO50 scanning electron microscope (SEM) fitted with an Oxford INCA energy dispersive spectrometer (EDS). The sample was scanned at low magnification to identify any possible fibre clusters before the magnification was increased to 2000x magnification for closer examination.

EDS is a semi-quantitative technique (at best) on well prepared, optically flat samples. Factors such as sample unevenness may adversely bias elemental concentration interpretation. EDS has a spatial resolution of ~5 µm meaning spectra from particles less than this size may contain elemental concentrations biased by their surroundings.

All images were acquired using backscatter electrons. Image brightness is proportional to average atomic number – the brighter the pixel, the higher the atomic number of the element.

### Summary

Following AS 4964, asbestos is defined as:

- Many particles with aspect ratios (i.e. length to width ratios) ranging from 20:1 to 100:1 or higher for particles >5 micrometers in length. Bundles of fibres may have lower aspect ratios.
- Sets of fibre bundles generally less than 0.5, but always less than 1.0 micrometres in width, unless in thick bundles.
- In addition to the mandatory fibrillar crystal growth, one or more, and preferably three of the following aspects:
  - Parallel fibres occurring in bundles.
  - Fibre bundles displaying splayed ends.
  - Matted masses of individual fibres.
  - Fibres showing characteristic curvature.
- Respirable asbestos fibres are defined as:
  - Asbestos fibres less than 3 micrometres in width, and greater than 5 micrometres in length, and with a length to width ratio greater than 3 to 1.

A total of **100** images/fields were examined. Each field was approximately 70 µm by 55 µm - a total area of  $3.85 \times 10^{-3}$  mm<sup>2</sup>.

**Less than 3 observed countable fibres had an elemental composition and morphology indicative of asbestos mineral fibre, according to the definition in AS 4964.**

Depending upon sample condition, composition and fibre type, the detection limit of AS 4964 has been found to lie generally in the range of 1 in 1,000 (0.1 wt %) to 1 in 10,000 (0.01 wt %) parts by weight, equivalent to 1 to 0.1 g/kg.

For this report, a limit of reporting of 0.01 wt % has been assumed, as stated in AS 4964.

A selection of images/fields and associated elemental spectra are reported below. The fields are not representative of the area analysed. The images/fields were reported due to their higher fibre count.

Fibre #	Image/Field #	Diameter (µm)	Length (µm)	Aspect ratio	Major Elements	Minor Elements	Morphology	Assigned mineralogy
1	2/1	0.8	25.0	31 :1	O, Si	Al	Parallel sides	Aluminosilicate
2	3/1	0.4	11.3	28 :1	O, Si	Al, K, Fe, Mg	Parallel sides	Aluminosilicate
3	5/1	1.1	9.2	8 :1	O, Si	Al	Parallel sides	Aluminosilicate
4	6/1	1.3	7.8	6 :1	O, Si	Al, K, Fe, Mg	Parallel sides	Aluminosilicate
5	8/1	1.3	9.8	8 :1	O, Si	Al, Ca	Parallel sides	Aluminosilicate
6	10/2	1.7	10.6	6 :1	O, Si	Al	Non-parallel sides	Aluminosilicate
7	11-Jan	1.3	15.1	12 :1	O, Si	Al	Parallel sides	Aluminosilicate

It should be noted that the higher resolution of the SEM may increase the number of fibres observed when compared with optical microscopy. Positive identification of asbestos fibres by SEM EDS uses elemental information that is not available by optical methods.

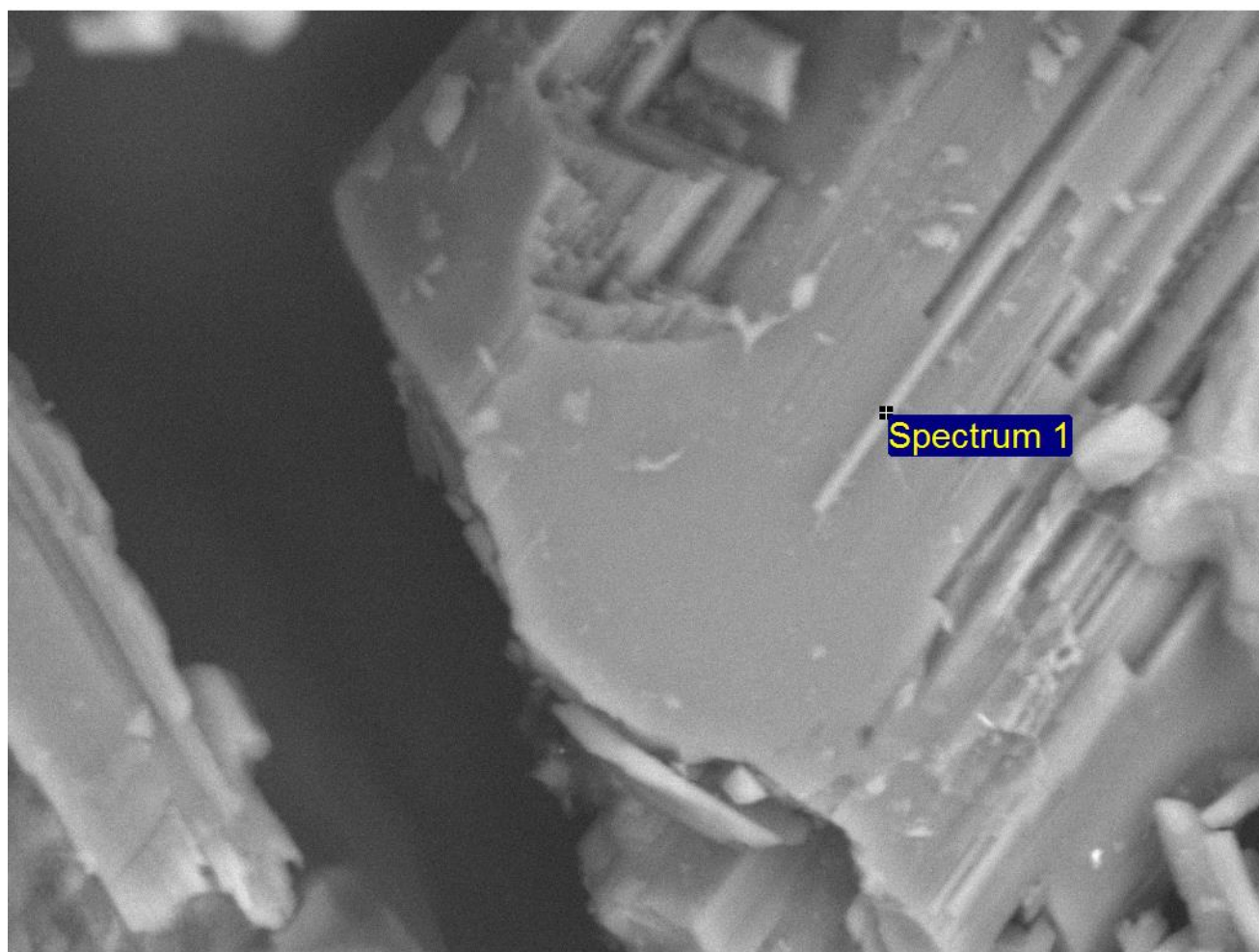
**Analyst:** [REDACTED] B.Sc. (Applied Chemistry)

**Reported:** [REDACTED] .Sc.(Applied Chemistry)

**Approved:** [REDACTED] B.Sc.(Nanotechnology)

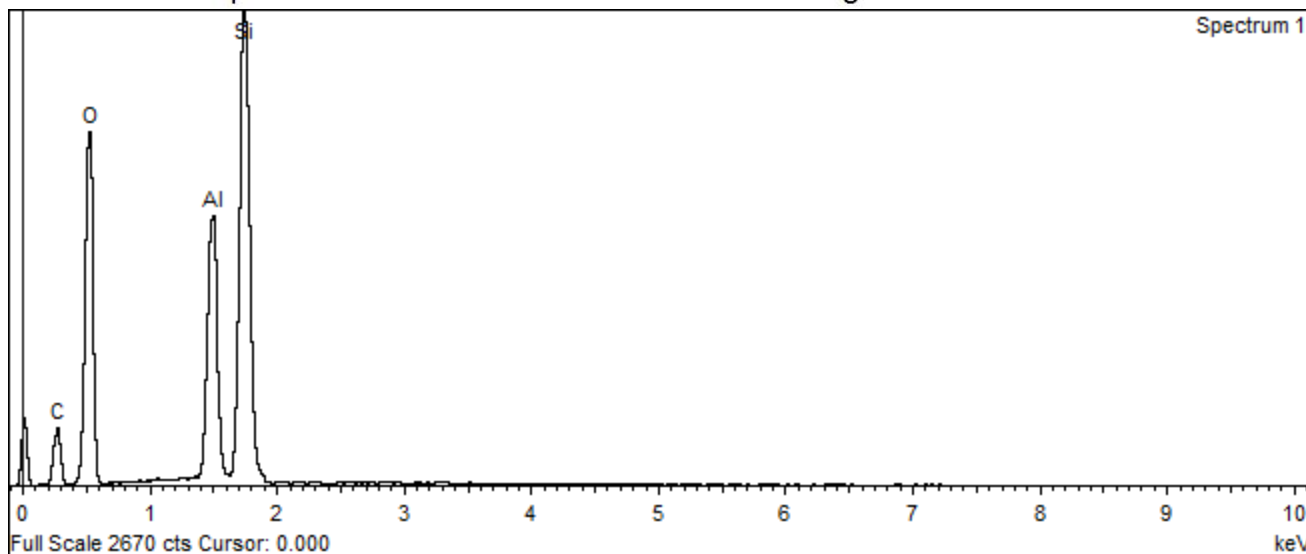
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Type: Default  
ID: Fines and Coarse

Project: 18\_2053  
Owner: sem  
Site: Site of Interest 2



20µm

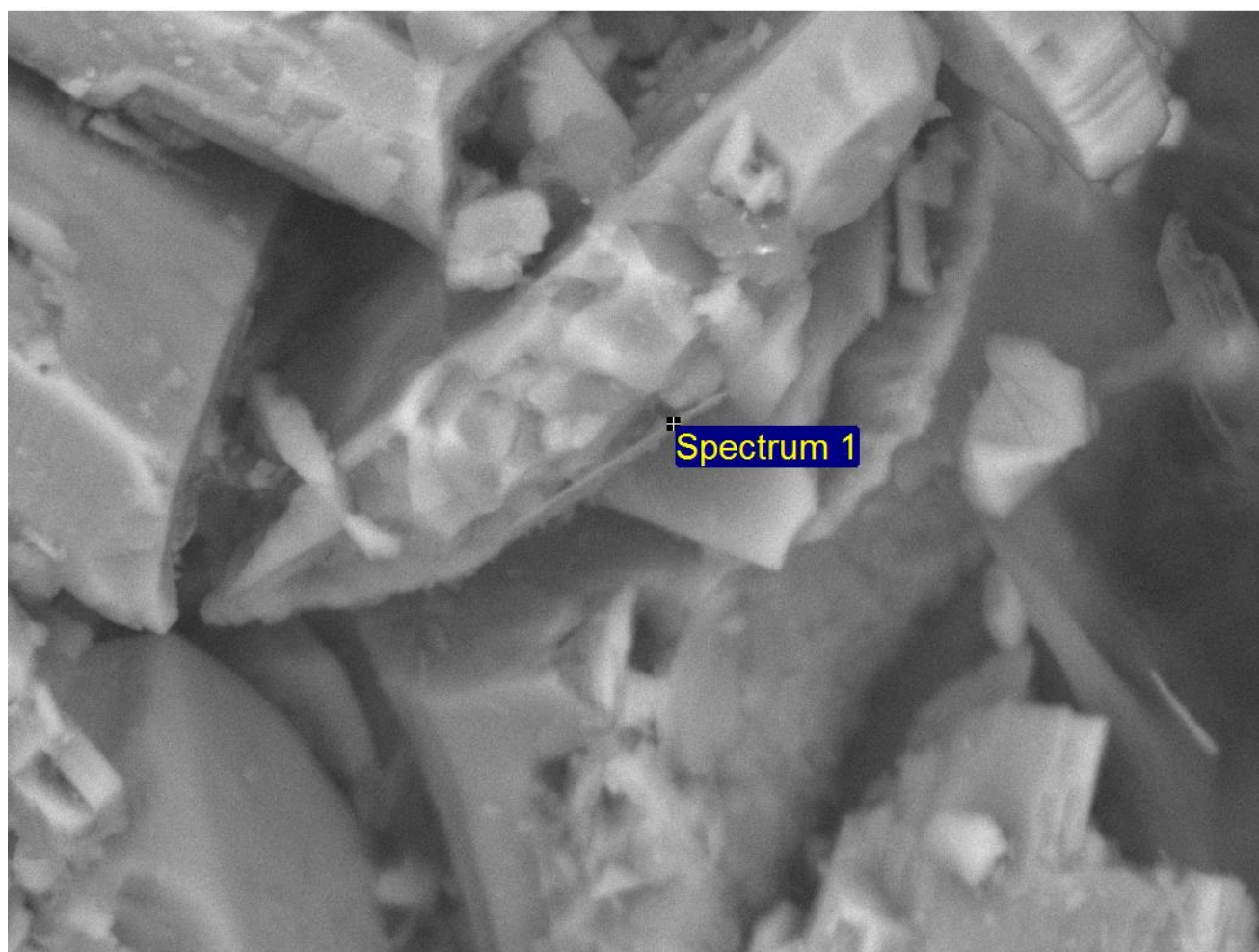
Electron Image 1



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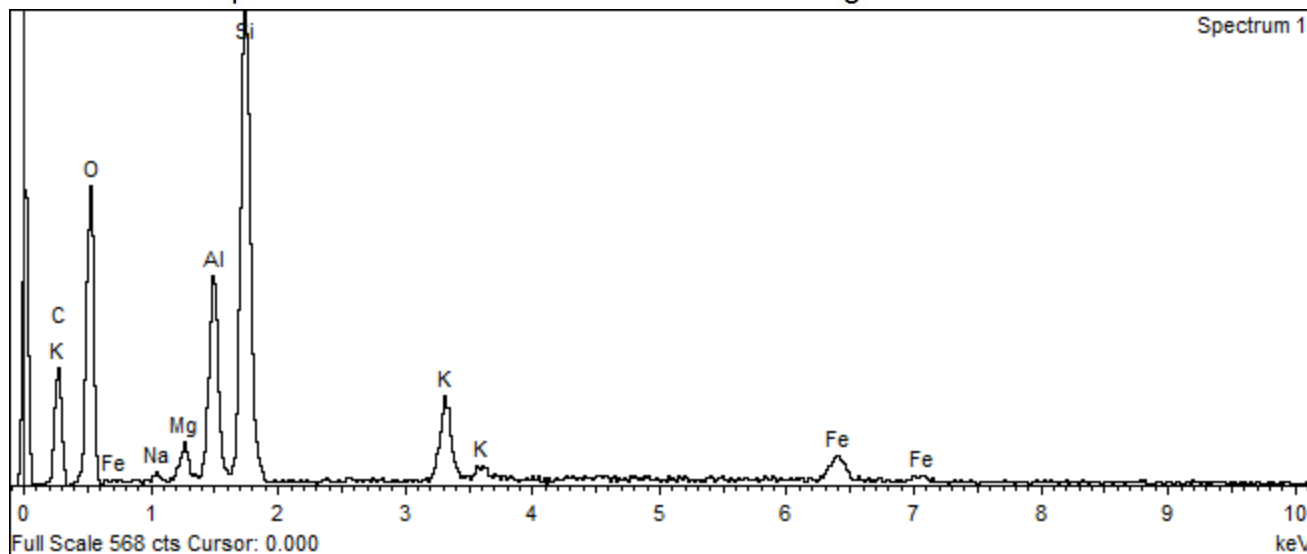
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ID: Fines and Coarse

Project: 18\_2053  
Owner: sem  
Site: Site of Interest 3



20µm

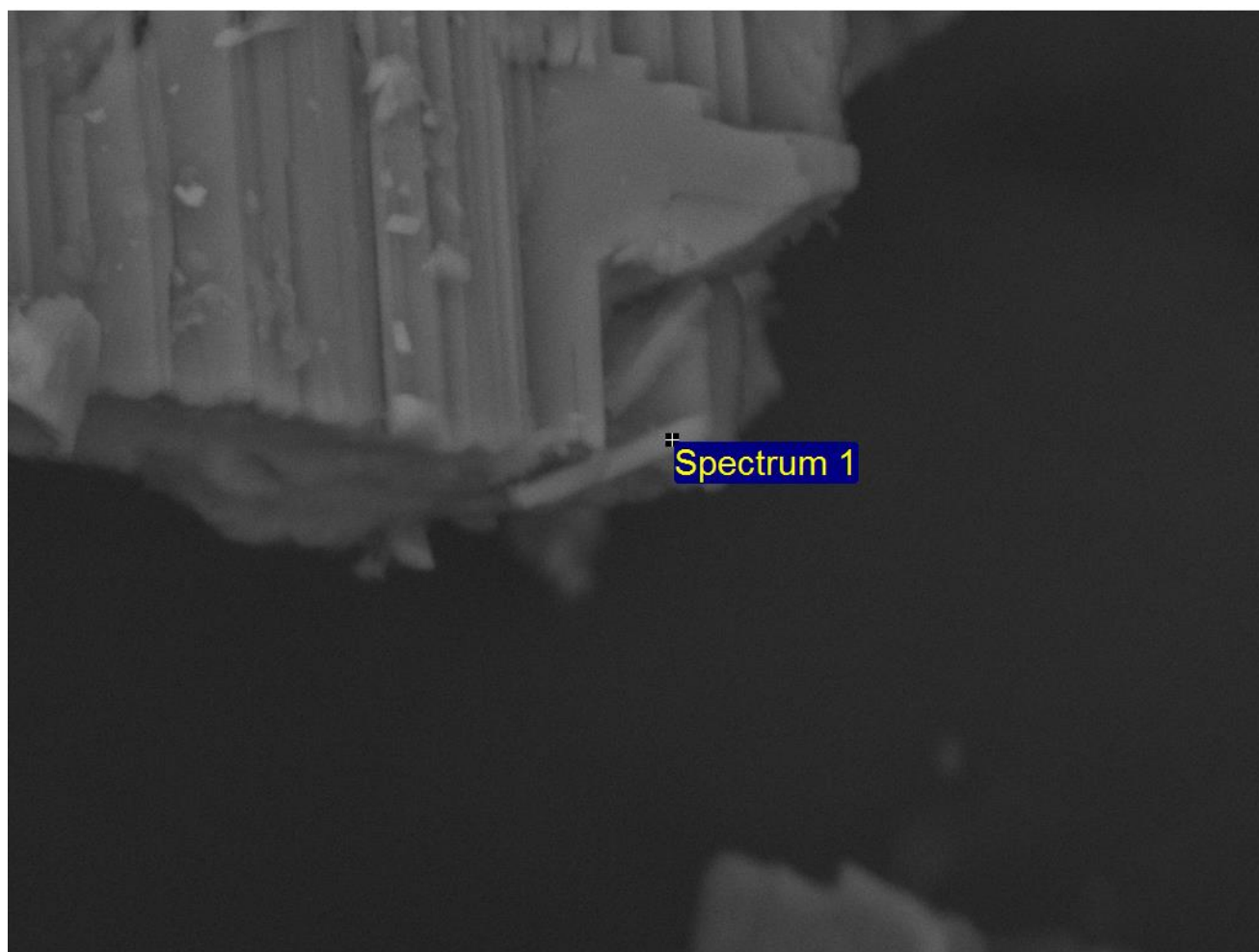
Electron Image 1



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australia

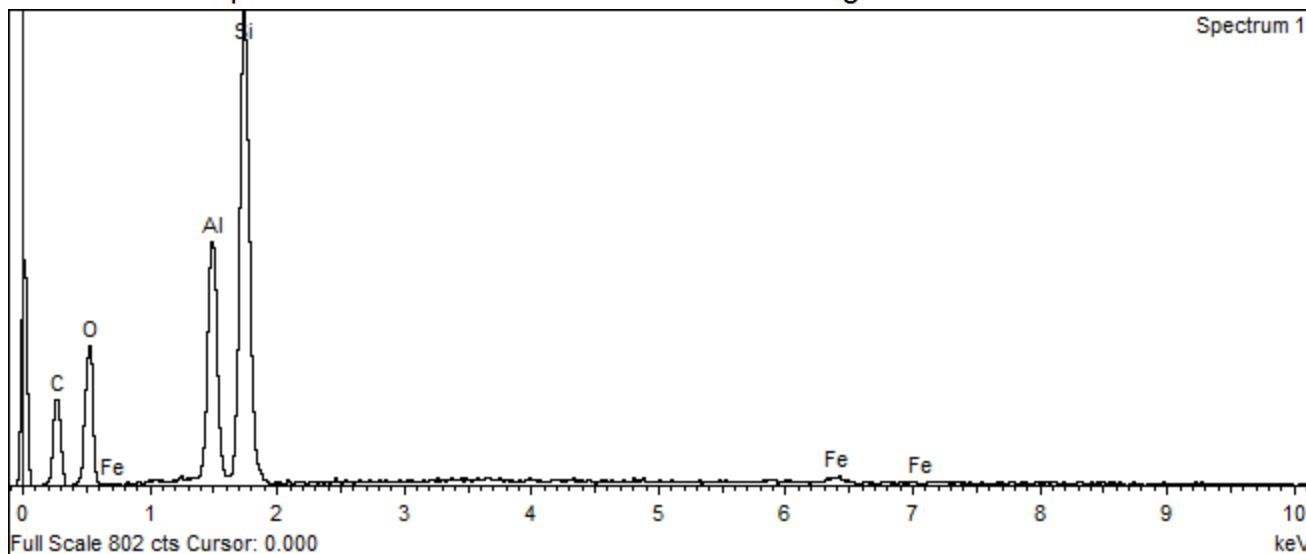
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Project: 18\_2053  
Owner: sem  
Site: Site of Interest 5



20µm

Electron Image 1



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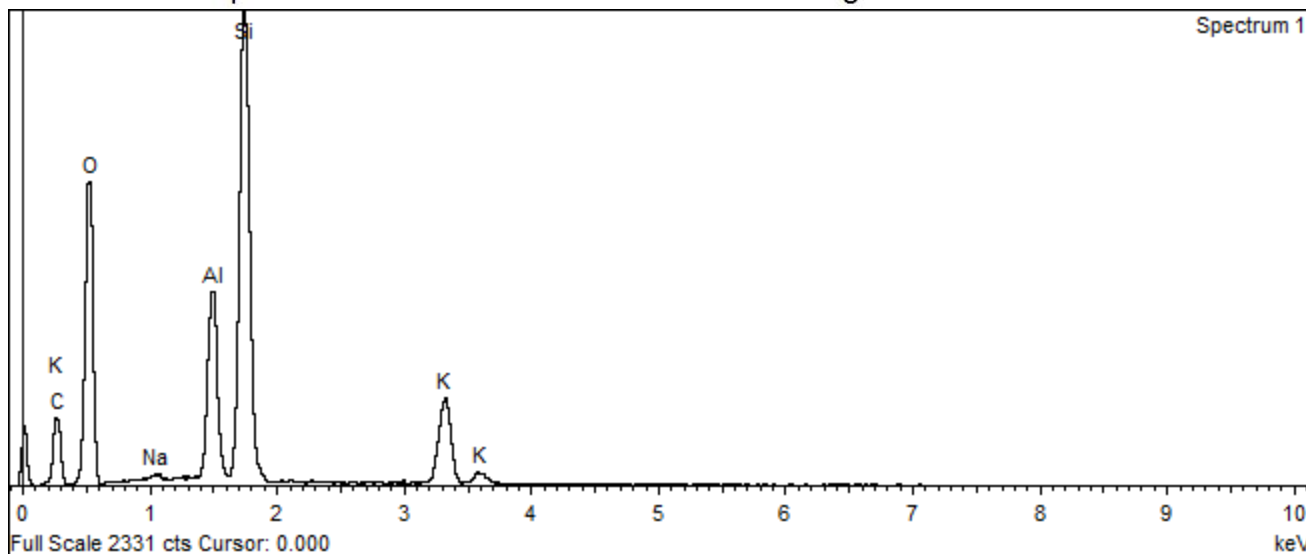
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20µm

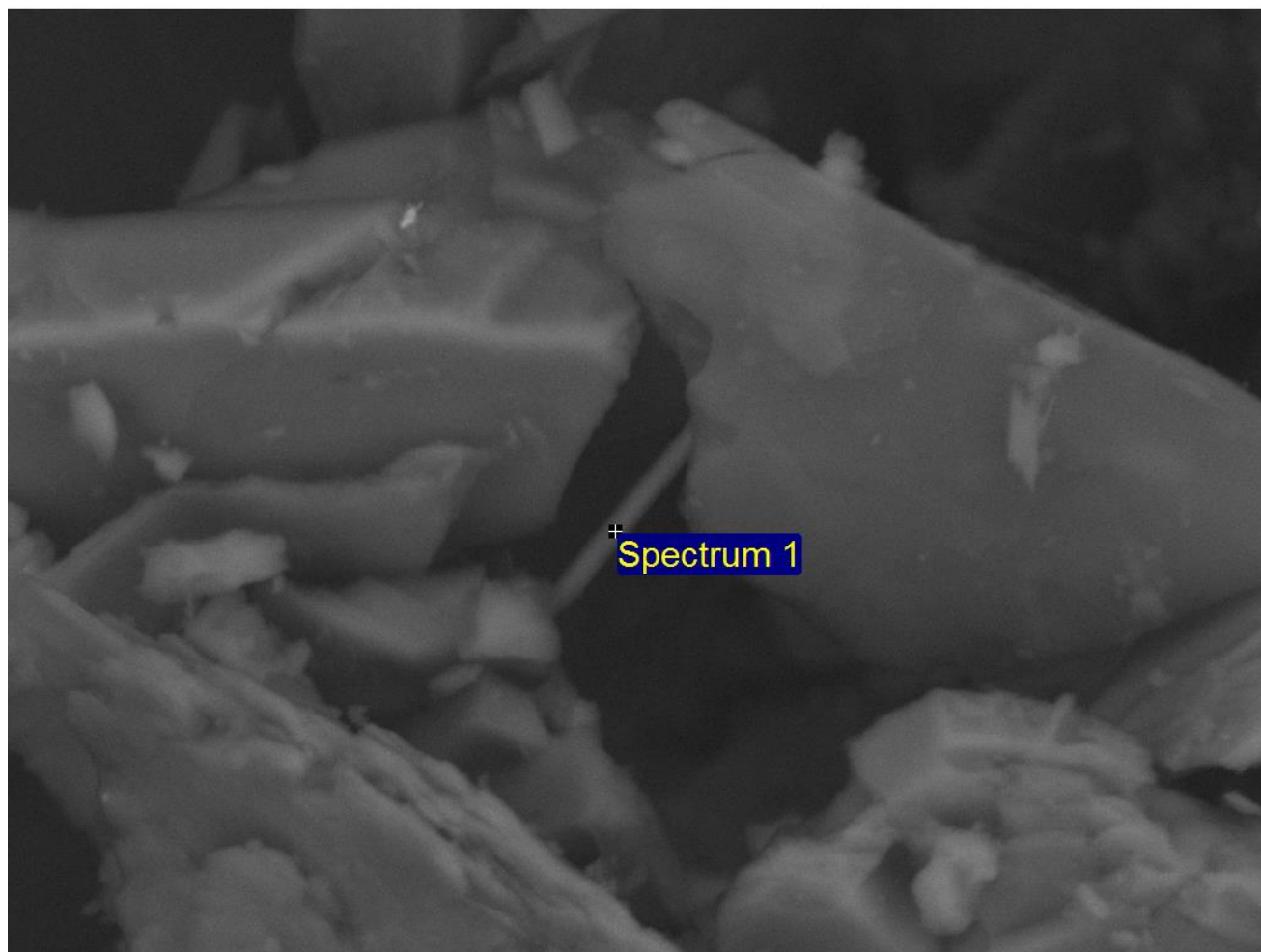
Electron Image 1



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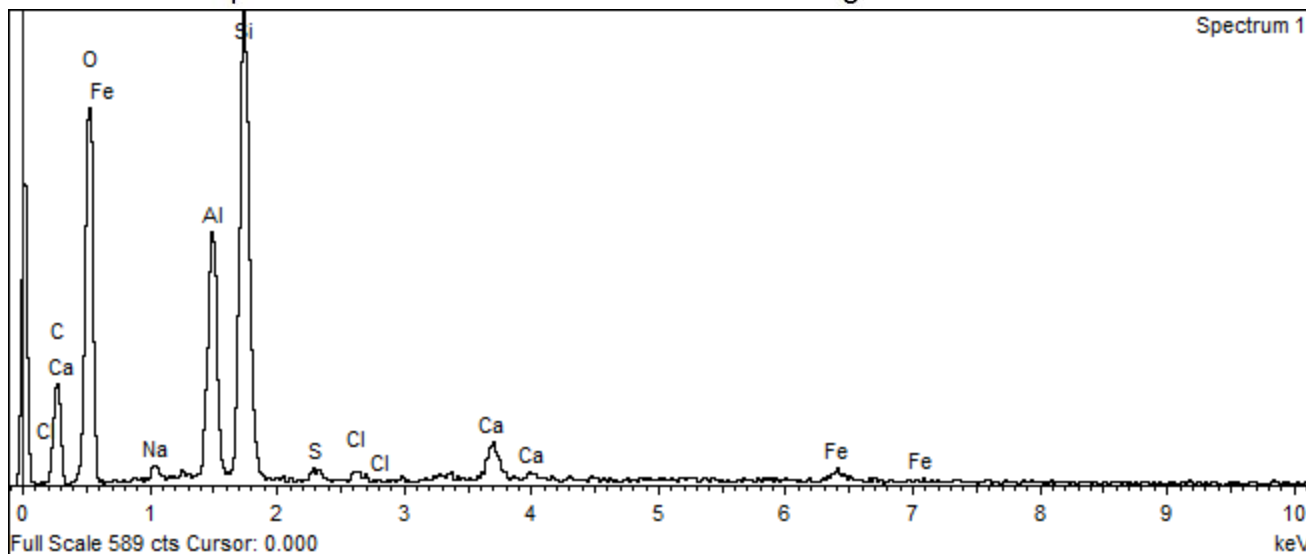
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Site: Site of Interest 8



20µm

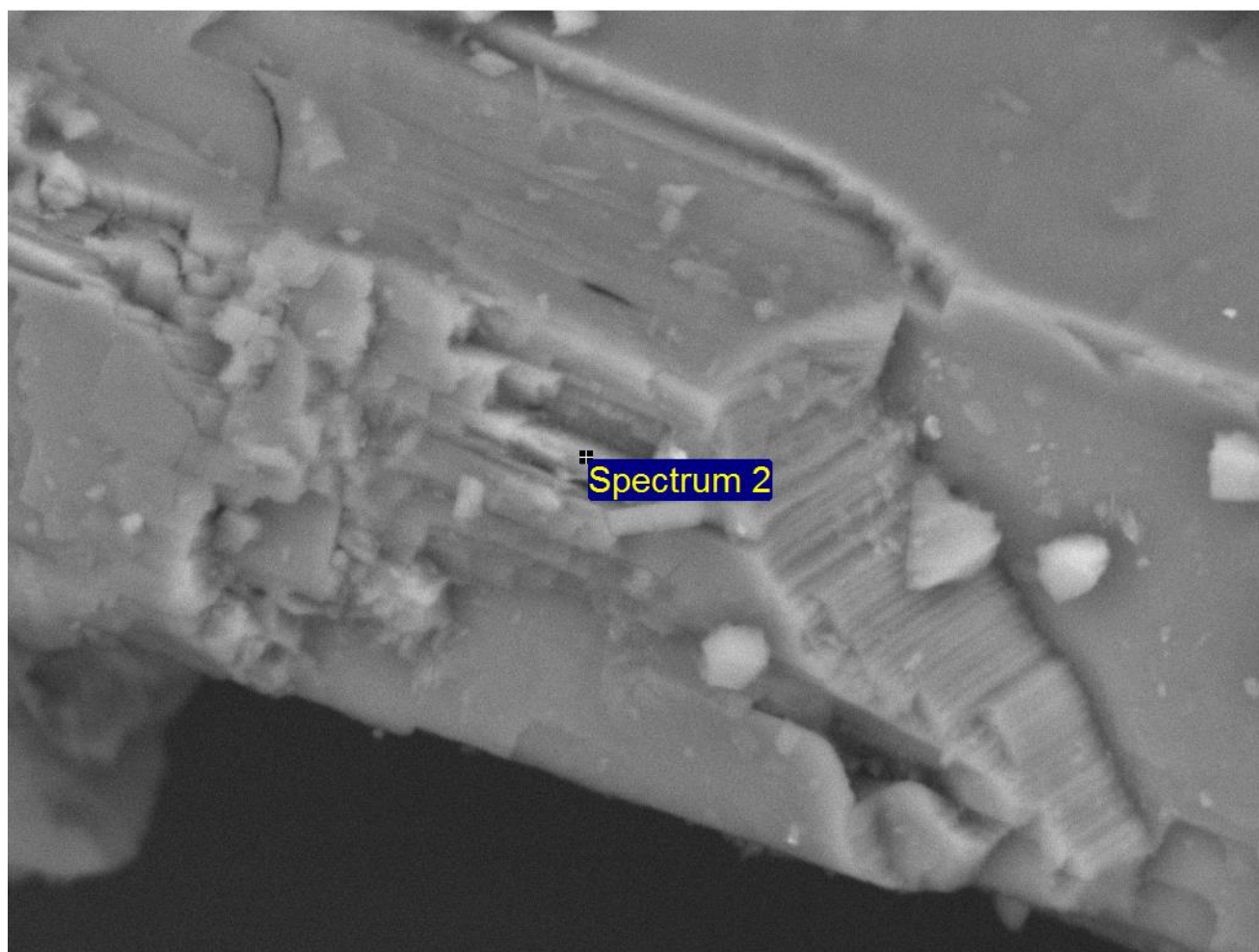
Electron Image 1



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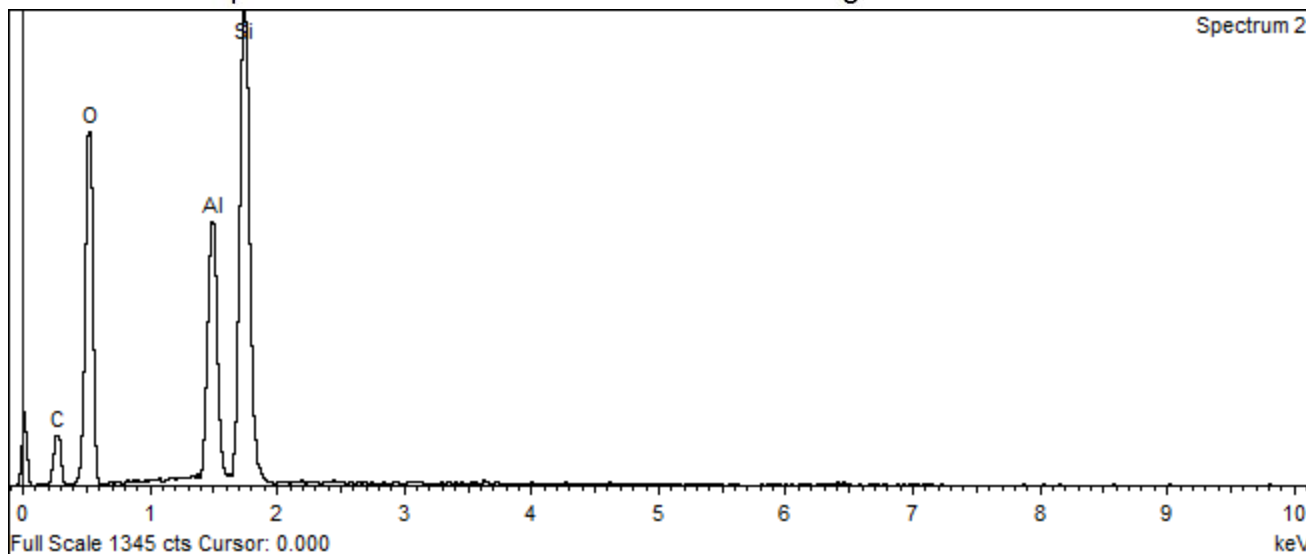
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ID: Fines and Coarse

Project: 18\_2053  
Owner: sem  
Site: Site of Interest 10



20µm

Electron Image 1

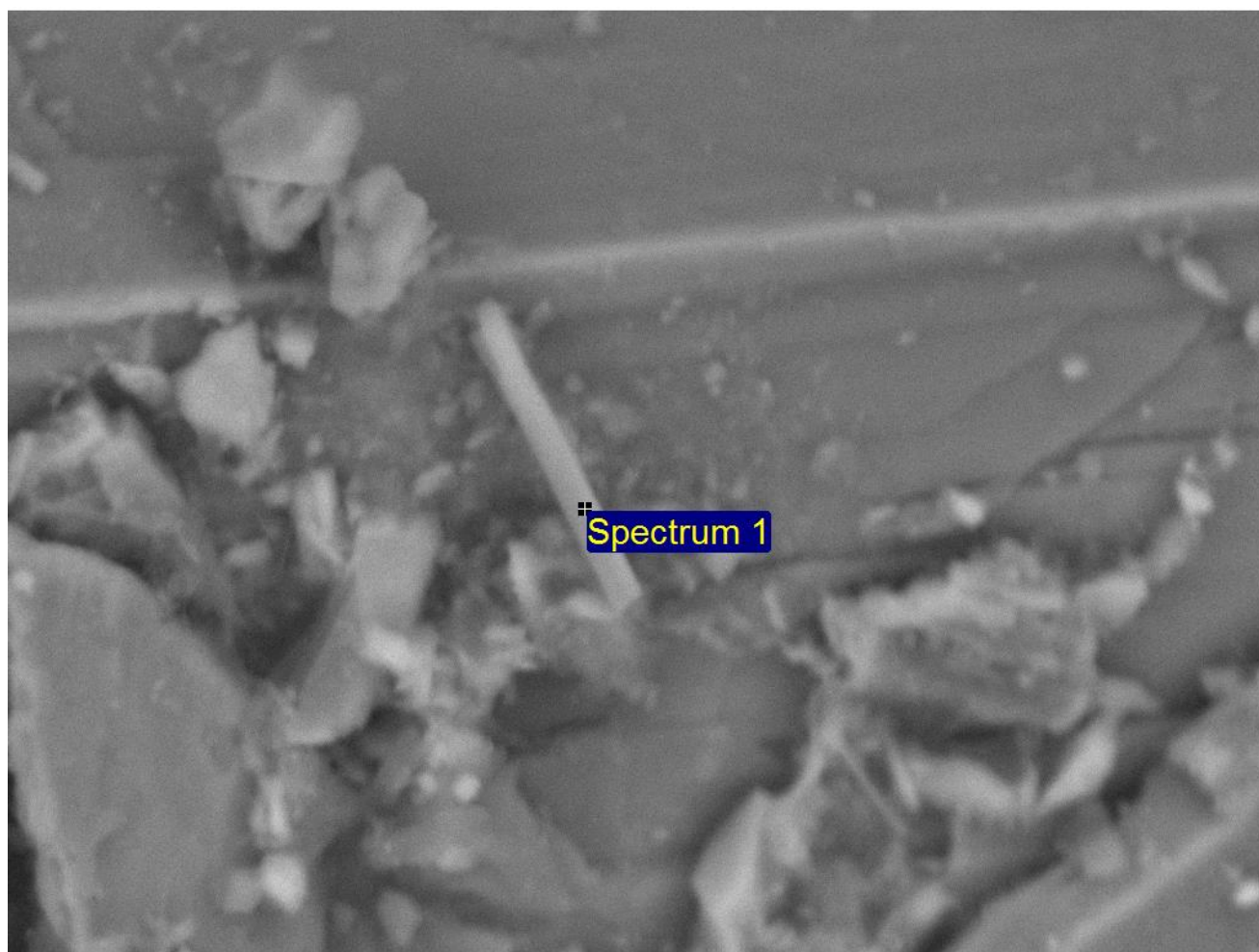


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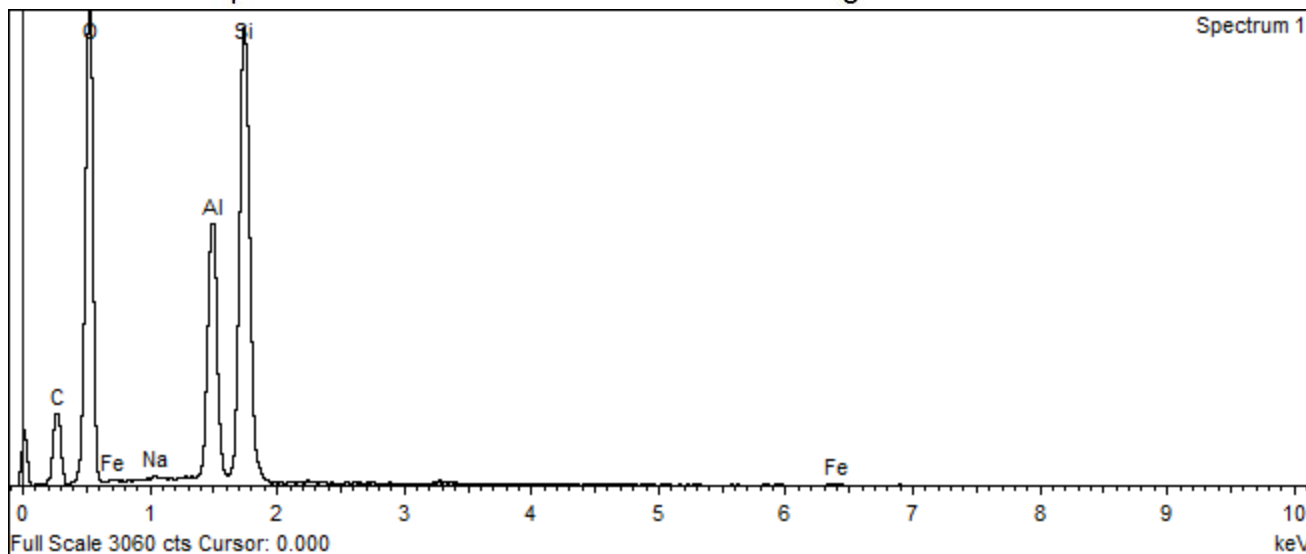
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Project: 18\_2053  
Owner: sem  
Site: Site of Interest 11



20µm

Electron Image 1



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