

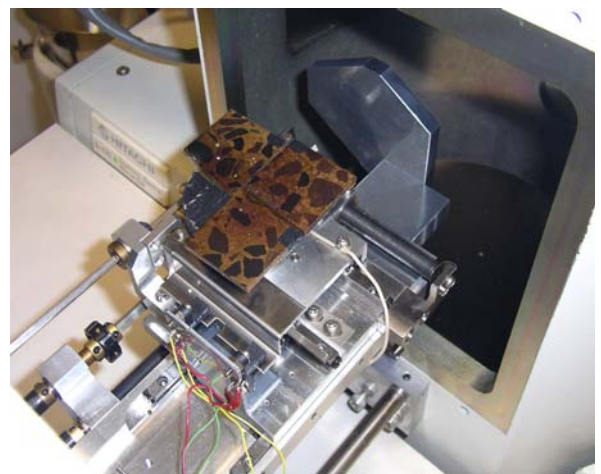


Geomaterials

In-House Scanning Electron Microscopy and X-Ray Microanalysis

Introduction

The Sandberg Geomaterials Department has its own in-house Hitachi Scanning Electron Microscope (SEM) fitted with a state of the art Oxford Instruments INCA energy dispersive X-Ray microanalysis system and liquid nitrogen-cooled thin-window Pentafet X-ray detector capable of light element detection. The equipment is supervised by staff with over 20 years experience in SEM and associated petrographic/analytical techniques.



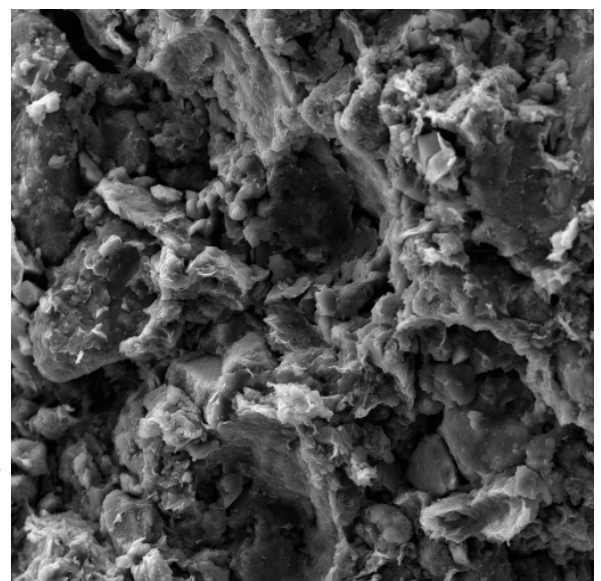
Capabilities

One of the advantages of the SEM is the ability to examine samples at much higher magnifications than by conventional light microscopy.

Magnifications in excess of $\times 100000$ are possible and the maximum resolution achievable in routine examination would be in the order of $0.1\mu\text{m}$ (0.0001mm).

Such high magnifications are essential for the characterisation of soil microstructure, cement hydrate morphology and many other applications.

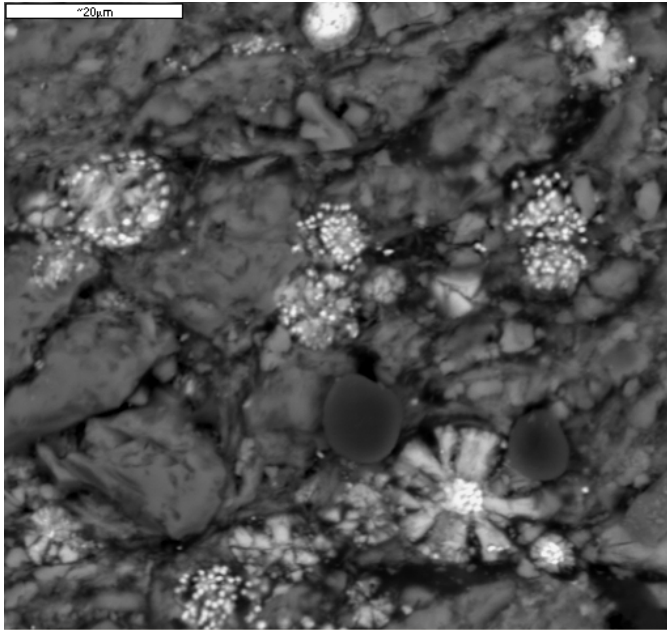
Secondary electron image of silty argillaceous sediment from the Middle East showing soil microstructure [specimen gold-coated for maximum resolution]



70µm

To discuss your needs please contact
Mr Mike Eden, Partner
Geomaterial Research Services, part of Sandberg LLP

GMRS02



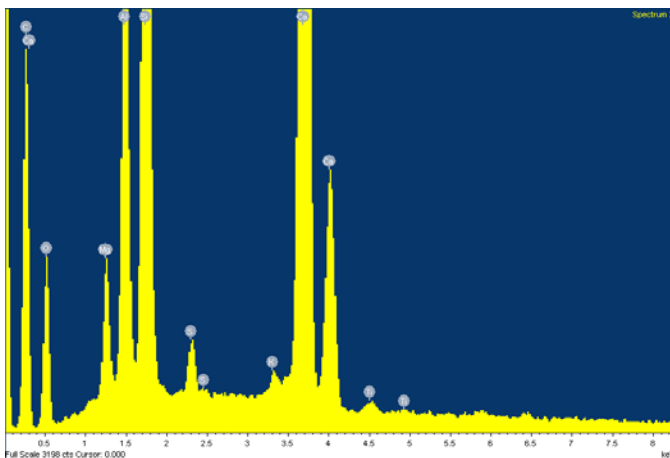
Backscattered electron image of silty mudstone with altered framboidal pyrite (white) and alteration products with less iron (darker relative to unaltered pyrite). This type of imaging is routinely used in the evaluation of polished surfaces and is essential for the examination of concrete.

The SEM is fitted with a backscattered electron detector that can be used to provide images of samples that show variation in chemical composition.

Materials containing elements with a high atomic mass, such as iron, appear brighter in backscattered electron images than materials containing elements with predominantly low atomic masses, such as magnesium or carbon.

The Sandberg SEM has an unusually large specimen chamber and is capable of examining irregular-shaped specimens up to a maximum sample size of 15x80x80mm for non-porous material.

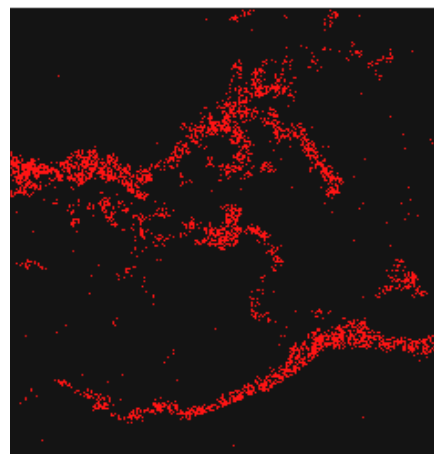
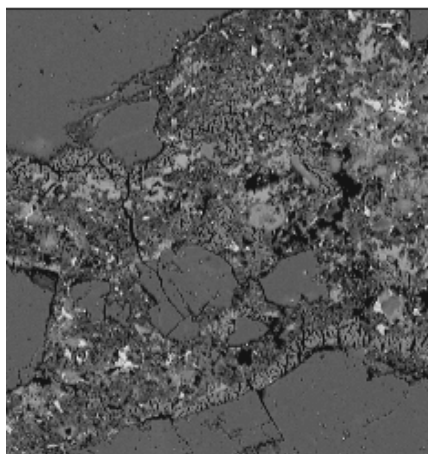
Chemical analysis / X-ray Microanalysis



Typical X-ray spectrum from a GGBS particle in concrete. Spot chemical analysis measuring about 0.01mm in diameter.

The Oxford Instruments INCA analysis system allows for the simultaneous analysis of multiple elements and can provide a cost-effective solution to establishing general information about the chemical composition.

A typical analysis would commence with the identification of the elements present which are then analyzed simultaneously and expressed as either elements or oxides.



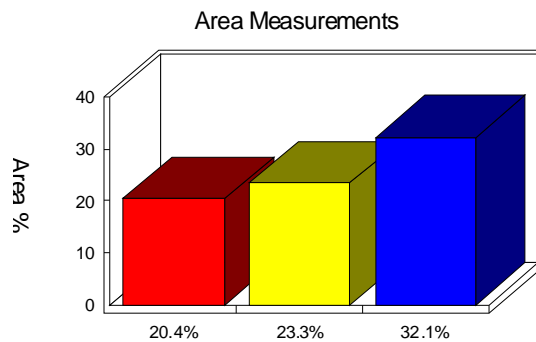
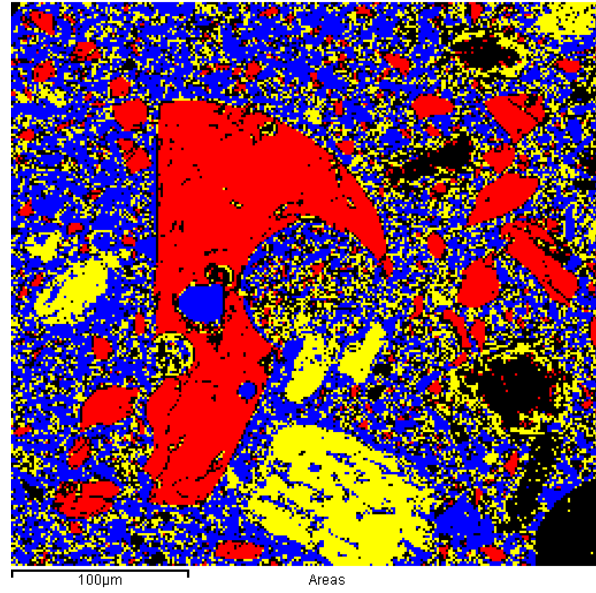
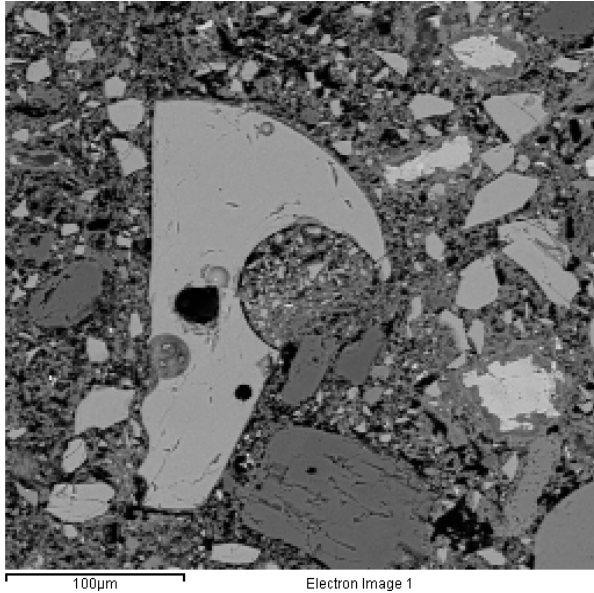
Sample of concrete from structure with internal sulphate attack.

Back scattered image of a polished concrete sample with sulphur distribution shown in accompanying X-ray map red).

Image Analysis

The SEM has the ability to carry out image analysis based either on contrast / brightness or on chemical composition.

Backscattered electron image of concrete containing GGBS with accompanying analysis showing GGBS selectively highlighted in red. Area measurements of each colour block are given in the bar graph.



Summary

The Sandberg SEM / EDX facility has a vast array of applications. The facilities are routinely used for the analysis of:

- Concrete
- Mortar
- Grout
- Cement
- Plaster
- Historic construction materials
- Building stone
- Rock
- Soil
- Aggregate
- Glass and metals