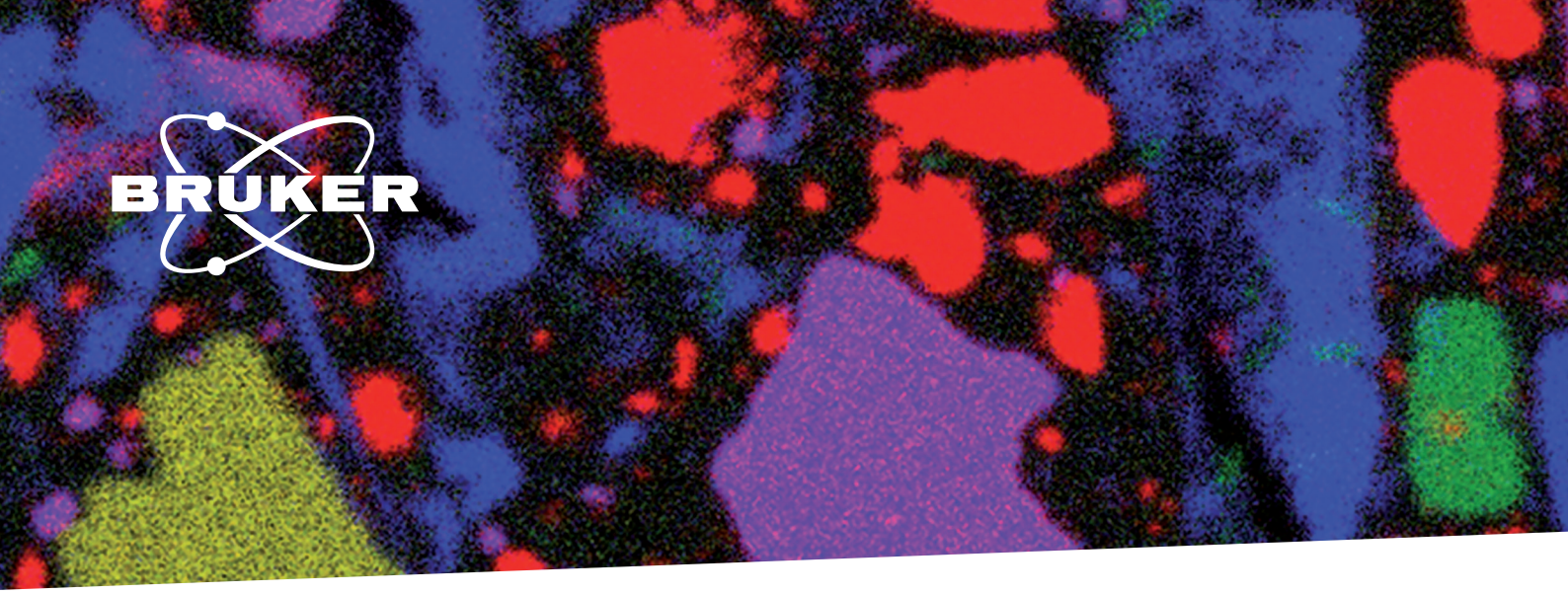


EDS

Fast identification of mineral phases: High-speed mapping with the XFlash® silicon drift detector (SDD)

Application Note # EDS-02

Introduction

The determination of different mineral phases through backscattered electron (BSE) detectors is a common task in mineralogy. This approach however has limitations. If minerals with different composition but similar average atomic number are viewed with a BSE detector there is very little if no material contrast to be observed. This shortfall can be overcome through use of X-ray elemental maps. The innovative XFlash® 4010 SDD allows extremely high input and output count rates, hence elemental maps can be performed in about one tenth of the time required by conventional Si(Li) detectors.

In this report, various mineral phases of different composition were rapidly identified through elemental maps and subsequently more closely defined through qualitative spectrum analysis.

Methods used

A Bruker QUANTAX system equipped with a liquid nitrogen free XFlash® 4010 detector (energy resolution 124 eV for MnKα at 100,000 cps) was used for mapping acquisition and evaluation. Acquisition conditions were:

- Accelerating voltage: 20 kV
- Beam current: 80 nA
- Detector to sample distance: 56 mm
- Acquisition time: 300 s
- Input count rate: 220,000 cps
- Output count rate: 150,000 cps
- Mapping resolution: 600 x 450 pixels

Additionally, spectra were acquired with an input count rate of 5 – 9 kcps and an acquisition time of 120 seconds.

Results

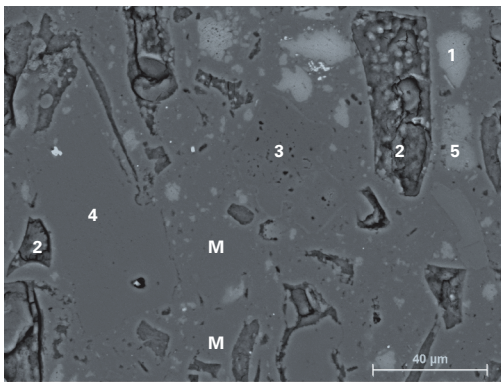
The BSE micrograph (Figure 1) shows a polished sample with mineral phases, which are embedded in a SiO_2 matrix (labeled "M" in Figure 1). Two major mineral phases and the matrix can be easily discriminated by their BSE contrast. The elemental maps (Figure 2) clearly show that the first phase ("1" in Figure 1)

corresponds to the presence of calcium and phase 2 contains magnesium. Additionally, they reveal the presence of three mineral phases that are difficult to detect in the BSE micrograph: Phase 3 contains calcium and magnesium; the mixing of both colors results in a violet color in the composite map (Figure 3.). Phase 4 contains a significant amount of sodium and phase 5 potassium.

To specify the identified mineral phases, the acquired spectra of these phases (Figure 4) were evaluated. Phase 1 is calcium carbonate, phase 2 clay-altered silicate melt, phase 3 calcium-magnesium-carbonate, phase 4 a sodium feldspar and phase 5 a potassium feldspar.

Conclusions

Results show that EDS maps have an advantage over BSE images: latter fail to distinguish some mineral phases due to their similar average atomic number contrast. The maps permit to discriminate the minerals quartz [SiO_2], dolomite [$(Ca,Mg)CO_3$] and sodium feldspar [$NaAlSi_3O_8$] as well as calcite [$CaCO_3$] and potassium feldspar [$KAlSi_3O_8$] – and so display a wealth of data that electron images simply cannot provide.



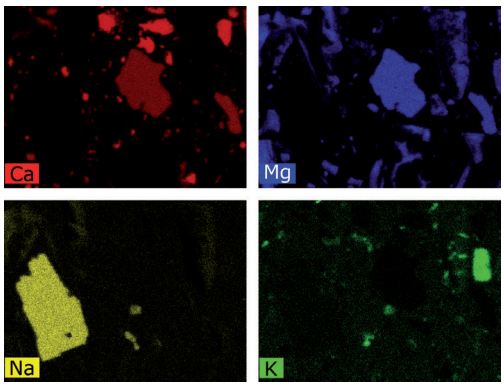
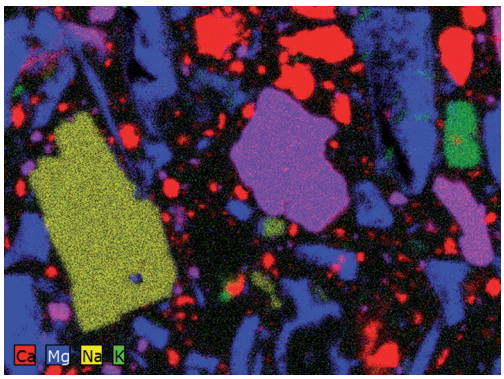


Figure 1 – left
BSE image of the polished mineral section analyzed. The matrix and phases (visible and determined through the mapping) are labeled in yellow. Refer to the text for details.

Figure 2 – right
Maps of specific elements, calcium (Ca) is shown in red, magnesium (Mg) in blue, sodium (Na) in yellow, potassium (K) in green.



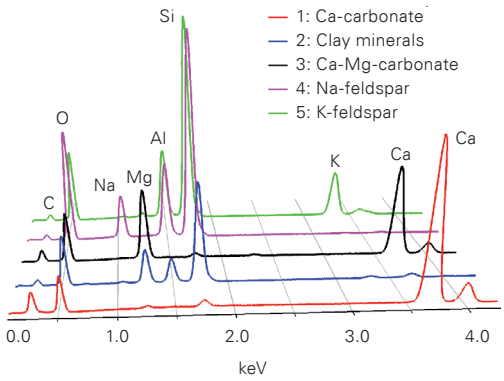


Figure 3 – left
Composite element map of calcium (red), magnesium (blue), sodium (yellow) and potassium (green).

Figure 4 – right
Spectra overlay of all phases determined qualitatively in the mapping.

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All configurations and specifications are subject to change without notice.
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