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LIBS-mapping of geomaterials: generation of element and mineral distribution maps for a well-characterised chromitite layer

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LIBS-mapping of geomaterials may provide a fast method for generation of element- and mineral distribution maps. This poster shows preliminary LIBS-mapping and classification results for a well-characterised rock sample with a chromitite layer, consisting of relatively large and clearly defined minerals (Merensky Reef, Bushveld Complex, SA). The results are validated with respect to EDXRF-microscope measurements.

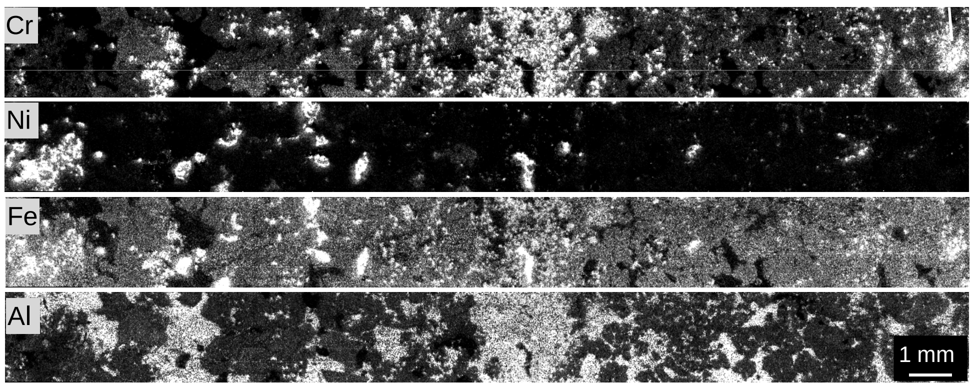

Figure 1a: LIBS-mapping: element distribution maps for Cr, Ni, Fe, and Al.

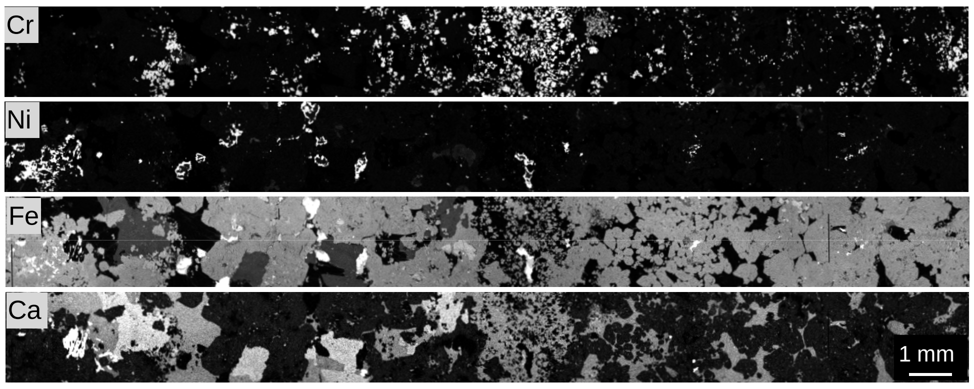

Figure 1b: EDXRF-mapping: element distribution maps for Cr, Ni, Fe, and Ca (source: [2])

Supervised classification: The multispectral image data analysis system MultiSpec (v. 3.1) was used to classify the element distribution maps based on mineralogy. Known mineral particles were selected as reference classes (see Fig. 2). Best results were obtained with the ECHO Fischer linear discriminant analysis method (Fig. 3, 4).

►Element distribution maps based on LIBS and EDXRF are basically similar. The LIBS–maps, however, appear more diffuse compared to the EDXRF-maps, because of signal averaging due to a larger sampled volume.

►Supervised classification works very well for LIBS- and ITRAX-measurements in case the mineral phases are relatively large and clearly defined. A smaller spot size is required to reliably classify the finer-grained chromitite layer.

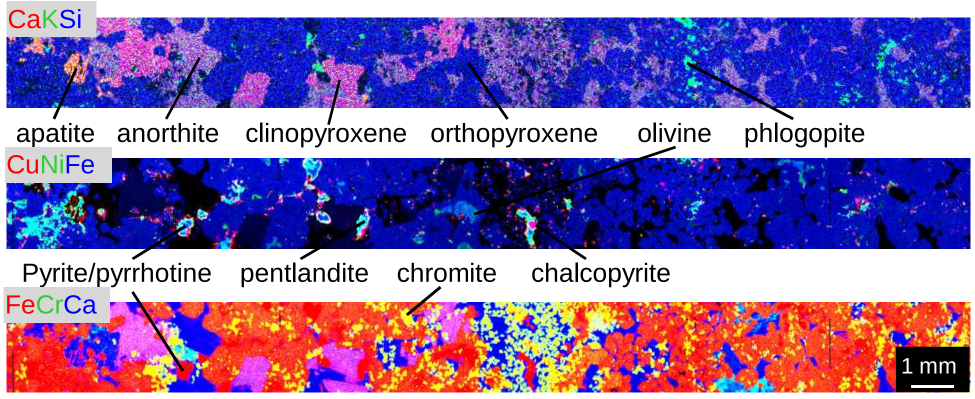

Figure 2: EDXRF-microscope analysis results showing combined element distribution maps for CaKSi, CuNiFe, and FeCrCa. Reference minerals used for classification are indicated (source: [2]).

LIBS-mapping: With the LIBS-core scanner as described in [1], a sample area of 227 x 21 mm was mapped, using a distance of 0.2 mm within laser shots. Characteristic atom lines for Al, Ca, K, Mg, Na, Si, Fe, Mn, S, Cr, Cu, and Ni were selected. Integral values over the selected peaks were automatically calculated using the software "Sophi" (Version 1.0.8, LTB Berlin, Germany). Measurements represent the near-surface chemistry (≤ 200 µm depth) of the polished rock sample (Fig. 1a).

Energy Dispersive X-Ray Fluorescence (EDXRF) mapping [2]: The distance between individual measurements was 0.2 mm, the beam size was 0.1 mm. Measurements represent the surface chemistry of the polished rock sample (Fig. 1b).

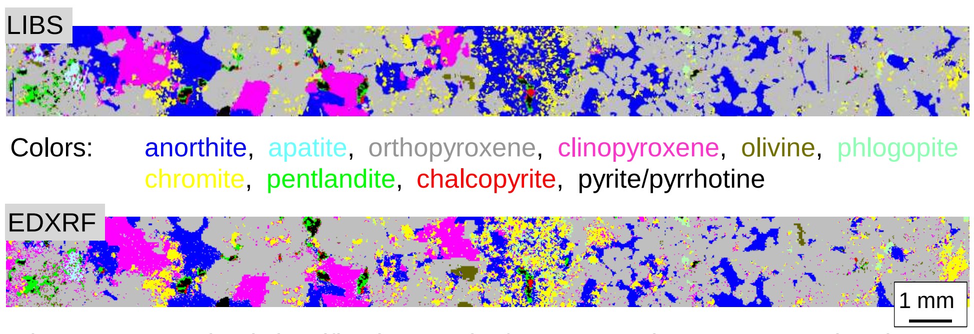

Figure 3: Supervised classification results for LIBS- and EDXRF- mapping data.

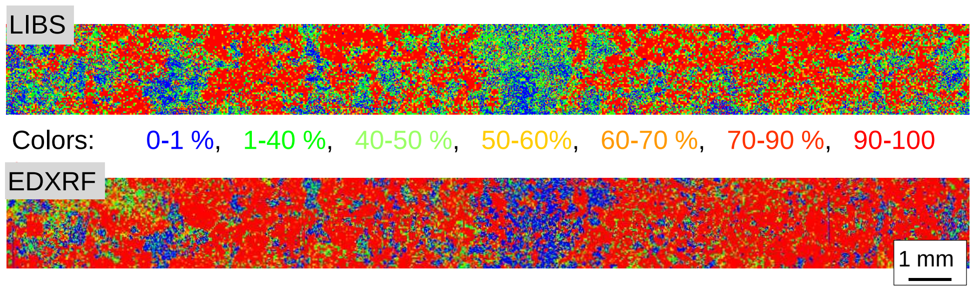

Figure 4: Probability maps for the classification results shown in Fig. 3.

[1] K. Kuhn, J.A. Meima, D. Rammlmair, G. Martinewski, *EMSLIBS* (2011).
[2] D. Rammlmair, M. Wilke, K. Rickers, R.A. Schwarzer, A. Moller, and A.Wittenberg, In: B. Beckhoff et al. (ed.) Handbook of practical x-ray fluorescence analysis. Springer, Heidelberg, 640 – 687 (2006).