A case study of the complete characterisation of geological materials with the latest generation of SEM + EDS + EBSD: from initial investigations to automated mineralogy

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The scanning electron microscope (SEM) is a commonly used tool in the Earth sciences offering a great deal of flexibility to perform a comprehensive array of high level analytical tasks. Here we consider an SEM based multi-technique workflow for geological materials starting with considerations of initial investigations, both in terms of chemistry and crystallography, and proceeding to a fully automated analysis for particulated or modal samples which includes calculation of all the mineralogical parameters required for mineral liberation analysis. Of great importance in this setup is the fact that exactly the same instrument and hardware is used both for the initial manual steps of investigation and the automated mineralogy - flexibility is maintained.

We will discuss the latest generation of hardware which is available to the user for these analyses. High sensitivity, large area Energy Dispersive X-ray Spectrometry (EDS) detectors (Oxford Instruments Ultim) allow very high count rates to be accessed meaning that a very large number of highly resolved x-ray counts can be used in each spectrum; this permits a higher level of statistical certainty and so a better quality of result than can be achieved with other setups. This approach is as applicable to the initial investigation stage as it is to automated analysis. We discuss the processing of these spectral data both in terms of quantification and in terms of a level of automated interpretation which uses rapidly collected element maps to make a fast assessment of the chemistries in the sample. We also discuss the use of Electron Backscatter Diffraction (EBSD) in this workflow which is equally valuable in both industrial and academic settings. EBSD analyses the crystal structure of samples and as such is particularly well suited to geological analyses. Phases can be identified by their crystal structure and in cases where crystal structures are the same but chemistry is different, EDS data can be used to differentiate. Furthermore, grain textures and strain can be analysed giving a further source of information which is not typically available in other setups. CMOS technology is utilised in the latest generation of EBSD detector (Oxford Instruments Symmetry) and the advantages of this approach - specifically greater sensitivity at the highest speeds will be detailed.

Both particulated and solid samples will be considered in this case study covering the range of uses from the calculation of bulk mineralogy to the determination of specific parameters for the optimisation of mineral processing plants.