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Non-destructive geochemical analysis and element mapping using bench-top μ-XRF: applications and uses for geoscience problems

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X-Ray Fluorescence (XRF) has long been used to provide valuable geochemical analysis of bulk rock samples in geological studies. However, it is a destructive technique, requiring samples to be homogenised by grinding to a fine powder and formed into a compacted pellet, or fused glass disk and the resulting sample has to be completely flat for reliable analysis. Until recently, non-destructive, high spatial resolution μ- XRF analysis was possible only at specialised Synchrotron radiation facilities, where high excitation beam energies are possible and specialised X-ray focussing optical systems are available. Recently, a number of bench-top μ-XRF systems have become available, allowing easy, rapid and non-destructive geochemical analysis of various materials.

We present a number of examples of how the new bench-top M4 Tornado μ-XRF system, developed by Bruker Nano, can be used to provide valuable geochemical information on geological samples. Both quantitative and qualitative (in the form of X-Ray area-maps) data can be quickly and easily acquired for a wide range of elements (as light as Na, using a vacuum), with minimal sample preparation, using an X-Ray spot size as low as 25 μm.

Large specimens up to 30 cm and 5 kg in weight can be analysed due to the large sample chamber, allowing non-destructive characterisation of rare or valuable materials. This technique is particularly useful in characterising heterogeneous samples, such as drill cores, sedimentary and pyroclastic rocks containing a variety of clasts, lavas sourced from mixed and mingled magmas, mineralised samples and fossils.

An obvious application is the ability to produce element maps or line-scans of minerals, allowing zoning of major and trace elements to be identified and thus informing on crystallisation histories.

An application of particular interest to 40Ar/39Ar geochronologists is the ability to screen and assess the purity of mineral separates, or to characterise polished slabs for subsequent in-situ 40Ar/39Ar laser probe analysis; in the past such samples may have been characterised using SEM, but recent work [1] suggests that charging of a sample during electron-beam excitation can cause redistribution of K, thus disturb the 40Ar/39Ar system.

Finally, we assess data accuracy and precision by presenting quantitative analyses of a number of standards.

[1] Flude et al., The effect of SEM imaging on the Ar/Ar system in feldspars, V51C-2215 Poster, AGU Fall Meeting 2010