

Laser Ablation ICP-MS

BGS's leading role in the development of a new technique

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Inductively coupled plasma mass spectrometry (ICP-MS) is a powerful tool for measuring a wide range of elements at low concentrations; it can also provide isotopic information. ICP-MS instruments are found in laboratories involved in fields as diverse as the nuclear industry, medicine, agriculture, petrochemicals and food safety. Normally, a sample is presented to the instrument as a liquid, so geological materials need to be ground to a fine powder and dissolved in a mixture of acids before analysis. Not only is this time-consuming but all spatial information is lost.

Laser ablation (LA) is an attractive alternative means of introducing samples to an ICP mass spectrometer, especially when information on the spatial distribution of elements in a sample is required. A laser beam is focused on the sample through a specially adapted microscope and removes minute amounts of material from the sample surface, which are then swept by a stream of gas into the ICP-MS instrument for analysis. In contrast to other microbeam techniques used to analyse solids directly, laser ablation ICP-MS requires little or no sample preparation and provides good multi-element sensitivity across the periodic table.

Geochemists have exacting requirements in microanalysis, so it is no accident that the BGS has been at the forefront of developments in this field for over a decade. In the late 1980s, the ultimate aim was to determine the chemical composition of single fluid inclusions. This meant the laser had to be capable of drilling craters less than 10 microns in diameter in transparent materials such as quartz. At

that time there was no commercial system with this capability, so the BGS commissioned Birkbeck College, University of London to build one to its specification.

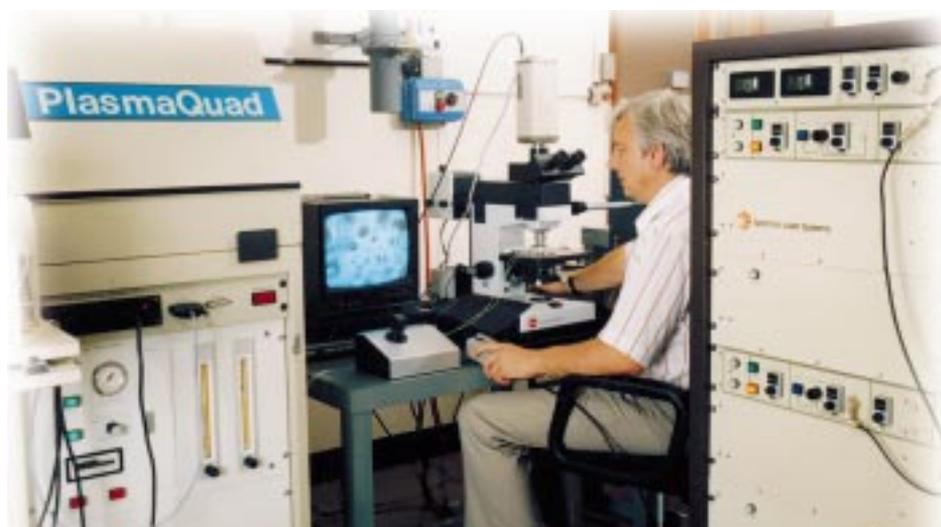
While most early work on LA-ICP-MS was carried out with Nd:YAG lasers operating at wavelengths of 1064 nm in the infra-red region, pioneering research at the BGS and the Memorial University of Newfoundland independently demonstrated that superior performance is obtained using a laser operating in the ultra violet at wavelengths of 266 nm. A key feature of the BGS Laser Ablation Microprobe (LAMP) is its high performance petrological microscope. Even today it is debatable whether any commercial system has the optical versatility required for the most complex geological samples.

These world-class facilities have attracted four EU-funded post-doctoral fellows and a stream of UK and overseas researchers. Joint research has included the distribution of trace elements in coal, the analysis of fluid inclusions, calculating partition coefficients of trace elements in minerals, the composition of fracture cements and the analysis of particles on air filters.

Applications of LA-ICP-MS are not confined to the earth sciences. BGS scientists have used the technique to study milk teeth from children living in the UK and Uganda to see if their different diets are reflected in the composition of their teeth. Environmental markers come in all shapes and sizes. Organisms such as coral and mussels have a skeleton, shell or similar hard structure which grows on a seasonal or even daily basis and incorporates elements from the animals' food and from the water in which they live. Laser ablation ICP-MS enables us to examine the chemical signatures in these growth bands, which can also be dated and thus act as a record of contaminant levels in the local environment.

The BGS organises and hosts regular international workshops on LA-ICP-MS in conjunction with instrument manufacturers.

In 1996 and 1998 the BGS was asked to present research projects involving LA-ICP-MS at the annual Exhibition and Soirée of the Royal Society. The theme of the first was the analysis of fluid inclusions and the second displayed the use of aquatic biomarkers to monitor environmental change.



Dr Tom Shepherd operating the laser ablation ICP-MS instrument in the BGS laboratory at Keyworth.