

**DETERMINATION OF TRACE ELEMENTS IN METEORITES USING INDUCTIVELY COUPLED MASS SPECTROMETRY** A.H. Spitz and Joaquin Ruiz. Department of Geosciences; University of Arizona; Tucson, AZ 85721.

We have used inductively coupled plasma mass spectrometry (ICP-MS) to determine the rare earth and other elements in the chondritic meteorites, Allende and Leedey and the ureilite North Haig. We have also employed this technique to analyse for Cu, Zn, Ga, Se, Rb, Sr, Y, Mo, Cs, Ba, Hf, W, Re, Ir and Pb in the ureilites ALHA 78019, ALHA 78262, EET 87511, LEW 85328, LEW 85440, META 78008, PCA 82506, Y790981, Hajmah, Kenna and North Haig. Use of a dissolution technique employing boric acid ( $H_3BO_3$ ) rather than perchloric acid ( $HClO_4$ ) provides a far superior dissolution of the sample and leads, therefore, to a consistently high level of data reproducibility.

### PROCEDURE

200 mg samples were dissolved in multi-step process using  $HF/HNO_3$  to dissolve the silicate structure and  $H_3BO_3$  to dissolve insoluble fluorides formed during the bomb digestion. Bulk samples were then brought up in 2N HCl to analyse on the ICP-MS. Because we wish to develop the technique to analyse meteorites with extremely low concentrations of the rare earth elements (REE), we ran other samples through cation-exchange columns to separate out the REE for analysis. Multiple counts were made of each sample during a run and multiple runs were made for each sample to determine reproducibility.

### RESULTS

The REE were determined in both the bulk and column-separated samples of Allende, Leedey and North Haig. The results are within ten percent of average literature values of the chondrites. The column-separated concentrations are lower than the bulk values usually by no more than five percent. The main group ureilites as well as these three meteorites were analysed for Cu, Zn, Ga, Se, Rb, Sr, Y, Mo, Cs, Ba, Hf, W, Re, Ir and Pb with successful concentration determinations of most elements.

### DISCUSSION

We chose Allende because it is a well-studied CV chondrite which would provide ample comparison for our concentration determinations. The concentrations of REE are about two times CI chondrite. Leedey is an L6 chondrite with REE concentrations slightly above CI chondrite values and scarce literature data. (1) The concentrations determined using ICP-MS display excellent agreement with the literature and unpublished results using neutron activation analysis (NAA). (2) Standard deviations of multiple analyses of the samples within one run are usually under one percent and never more than four percent.

The ureilite North Haig is a polymict breccia. REE concentrations for the brecciated ureilites can range around chondritic values. This makes North Haig readily accessible to REE analysis using the ICP-MS technique. The REE values obtained for North Haig are similar to those of other ureilite breccias. (3) Because the REE concentrations of the main group of ureilites are several orders of magnitude lower, these meteorites remain below the detection limit of the ICP-

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MS using these dissolution and column-separation procedures. Nevertheless, the signals of the elements were significantly improved using the procedure and with larger sample sizes and/or less dilution, the concentrations could be determined.

There are thirty-eight ureilites. Although many of these have been analysed for the major and minor elements, relatively few data have been published on the trace elements. The elements analysed in this work increase the database for the ureilites. These data are being studied for element patterns and correlations with respect to petrogenic and weathering behaviors.

The technique most often used to determine trace element concentration in meteorites is NAA. The drawbacks of this technique are long analysis times, complex interelement interferences and high costs. In comparison, ICP-MS is a relatively simple technique. It uses an Ar inductively coupled plasma as an ion source for a quadrupole mass spectrometer. Samples are prepared following standard dissolution techniques. Using the ICP-MS at the University of Arizona with data reduction software developed by the manufacturer, we obtained results in short analysis time and without elemental interferences. Our typical experiment from the time of initial sample preparation to final data reduction takes approximately ten to eleven days (seven days of this is high temperature/high pressure bomb dissolution). Although NAA still remains the preferred technique for very small (<10 mg) or very low concentration (<40 ppb) samples, ICP-MS is a powerful new technique for other samples: the sample preparation is simpler; the standard preparation is simpler; no radioactive wastes are created; greater reproducibility and precision are possible; the speed with which data can be collected and reduced is greater; and the expense is comparable to or less than NAA.

#### REFERENCES

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