Plasma Laboratory

Geochemistry @ University of Maryland

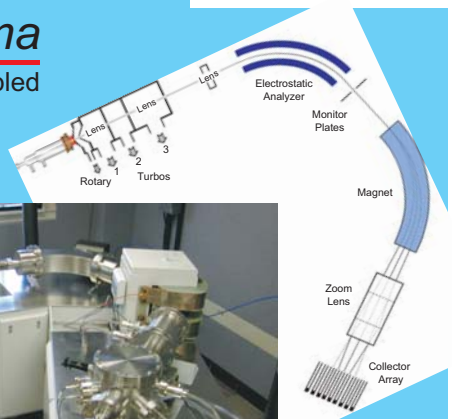
Elemental & isotopic analyses of solids & liquids

(www.geol.umd.edu/plasma-lab)

Multi-collector ICP-MS

Nu Plasma

Inductively Coupled Plasma - Mass Spectrometer

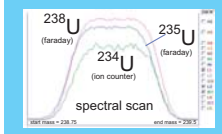


12-faraday collectors

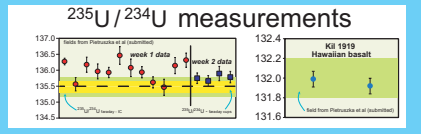
High precision isotope analyses:

applications:
- -cosmochemistry
- -environmental chemistry
- -geochemistry
- -geochronolgy

$^{7}Li/^{6}Li$	± 1‰ [all given @ ±2σ]
$^{98}Ru/^{101}Ru$	± 0.16 ‰
$^{99}Ru/^{101}Ru$	± 0.1 ‰
$^{198}Pt/^{195}Pt$	± 0.1 ‰
$^{230}Th/^{232}Th$	± 2‰
$^{234,235}U/^{238}U$	± 2‰



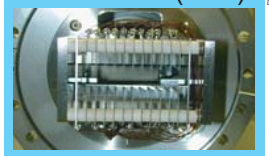
$^{235}U/^{234}U$ measurements



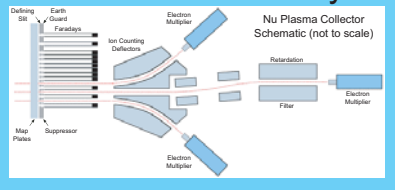
Innovative Collector Assembly:

- 12 faraday cups in a fixed assembly
- 17% mass dispersion (e.g., simultaneous ^{6}Li - ^{7}Li)
- zoom optics to separate out masses
- multi-multiplier for simultaneous ion counting

Zoom Lens ("L1")



Collector Assembly



Laser Ablation Systems

2 Deep UV lasers: excimer & Nd:YAG

- DUV wavelength couples effectively with most materials
- for in situ analyses of solids & liquids
- for use in: cosmochemistry, environmental chemistry, geochemistry and geochronolgy

ArF excimer laser system

λ = 193 nm E = 6.43 eV

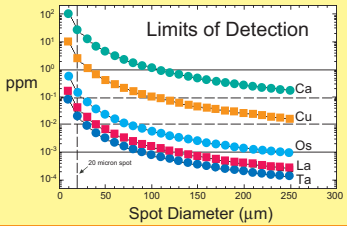
$\lambda = c\,\nu^{-1}$, $E = h\,\nu = h\,c\,/\,\lambda$

spot sizes 4 to 400 µm

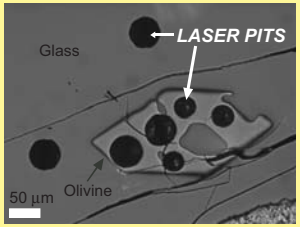
thickness of ablated layer (50-100 nm) depending on beam's energy density

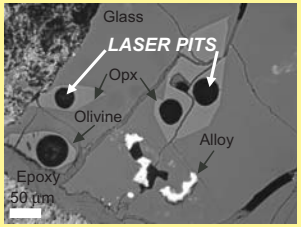
Solid state Nd:YAG laser
5th harmonic of Nd:YAG
λ = 213 nm, E = 5.83 eV

select spot sizes from 5 to 160 microns



Element detection limits are a function of spot size, mass of the isotope, and the element's 1st ionization potential (ip). Ca, La, and Ta have similar 1st ip, while Os and Ta have similar masses.



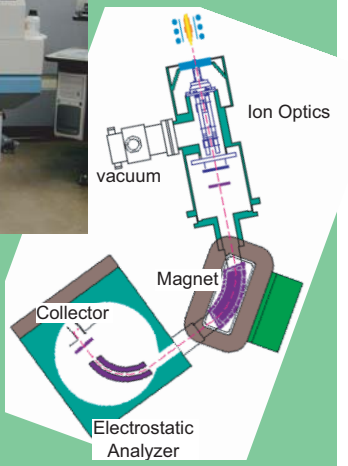


Laser Spots in Experimental Charges

Sattari, Brenan, Horn & McDonough - Economic Geology 2002, 97:385-398

Single-collector ICP-MS

Element 2

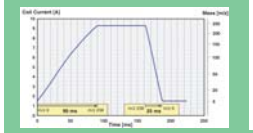


Inductively Coupled Plasma - Mass Spectrometer with a single electron multiplier detector

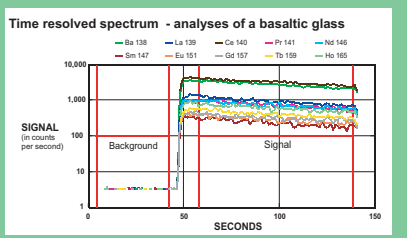
Rapid scanning & high sensitivity:

- abundance determinations for most elements, excepting noble gases, from Li to U
- solution analyses of waters, sludges, airborne particulates, dissolved rocks and metals, etc.
- *in situ* laser ablation analyses of solids or liquids (including fluid inclusions)
- low detection limits: e.g., U in solution has a detection limit of <1 ppq (i.e., $1*10^{-15}$g/g)
- high resolving power to avoid interfering iosbars

Fast scanning magnet - needed for time resolved analyses



***In situ* analyses via laser ablation**



The instruments in this facility have been jointly funded by the University of Maryland and the National Science Foundation

Plasma Lab Publications (2002 – 2006)

Kevin T. Wheeler, David Walker, Yingwei Fei, William G. Minarik, William F. McDonough (2006) Experimental partitioning of uranium between liquid iron sulfide and liquid silicate: Implications for radioactivity in the Earth's core. *Geochimica et Cosmochimica Acta* **70**, 1537–1547.

Fang-Zhen Teng, William F. McDonough, Roberta L. Rudnick, Richard J. Walker (2006) Diffusion-driven extreme lithium isotopic fractionation in country rocks of the Tin Mountain pegmatite. *Earth and Planetary Science Letters* **243**, 701-710.

Pietruszka A. J., Walker R. J. and Candela P. A. (2006) Determination of mass dependent molybdenum isotopic variations by MC-ICP-MS: an evaluation of matrix effects. *Chemical Geology* **225**, 121-136.

Brenan J. M., McDonough W. F., and Ash R. (2005) An experimental study of the solubility and partitioning of iridium, osmium and gold between olivine and silicate melt. *Earth and Planetary Science Letters* **237**, 855-872.

Gangopadhyay A., Sproule R. A., Walker R. J. and Lesher M. (2005) Re-Os systematics of komatiites and komatiitic basalts at Dundonald Beach, Ontario, Canada: Evidence for a complex alteration history and implications of a late-Archean chondritic mantle source. *Geochimica et Cosmochimica Acta* **69**, 5087-5098.

Hall, J.M., Chan, L.-H., McDonough, W.F. and Turekian, K.K. (2005) Determination of the lithium isotopic composition of planktic foraminifera and its application as a paleo-seawater proxy *Marine Geology*, **217**, 255–265.

Keshav S., Corgne A., Gudfinnsson G. H., Bizimis M., McDonough W. F., and Fei Y. W. (2005) Kimberlite petrogenesis: Insights from clinopyroxene-melt partitioning experiments at 6 GPa in the CaO-MgO-Al2O3-SiO2-CO2 system. *Geochimica et Cosmochimica Acta* **69**, 2829-2845.

Walker R. J., Brandon A. D., Bird J. M., Piccoli P. M., McDonough W. F., and Ash R. D. (2005) 187Os-186Os systematics of Os-Ir-Ru alloy grains from southwestern Oregon. *Earth and Planetary Science Letters* **230**, 211-226.

Gelinas A., Kring D. A., Zurcher L., Urrutia-Fucugauchi J., O. Morton and Walker R. J. (2004) Osmium isotope constraints on the proportion of bolide component in Chicxulub impact melt rocks. *Meteoritics Planet. Sci.* **39**, 1003-1008.

McDainel D. K., Walker R. J., Hemming S. R., Horan M. F., Becker H. and R. I. Grauch (2004) Sources of osmium to the modern oceans: New evidence from the 190Pt-186Os system. *Geochimica et Cosmochimica* Acta **68**, 1243-1252

Teng F. Z., McDonough W. F., Rudnick R. L., Dalpe C., Tomascak P. B., Chappell B. W., and Gao S. (2004) Lithium isotopic composition and concentration of the upper continental crust. *Geochimica et Cosmochimica Acta* **68**, 4167-4178.

Rudnick R. L., Tomascak P. B., Njo H. B., Gardner L. R. (2004) Extreme lithium isotopic fractionation during continental weathering revealed in saprolites from South Carolina. *Chemical Geology* 212, 45-57.

Wiebe R. A., Manon M. R., Hawkins D. P., and McDonough W. F. (2004) Late-stage mafic injection and thermal rejuvenation of the Vinalhaven granite, coastal Maine. *Journal of Petrology* **45**, 2133-2153.

Brenan J. M., McDonough W. F., and Dalpe C. (2003) Experimental constraints on the partitioning of rhenium and some platinum-group elements between olivine and silicate melt. *Earth and Planetary Science Letters* **212**, 135-150.

Zack T., Tomascak P. B., Rudnick R. L., Dalpe C., and McDonough W. F. (2003) Extremely light Li in orogenic eclogites: The role of isotope fractionation during dehydration in subducted oceanic crust. *Earth and Planetary Science Letters* **208**, 279-290.

Becker, H., Dalpe, C. and Walker, R.J. (2002) High-precision Ru isotopic measurements by multicollector ICP-MS. *Analyst*. **127**, 775-780.