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BSc 1991, University of Calgary
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“Understanding the evolution of the Universe: Earth Systems”

Interpretation of the Isotopic Archives in Extra Terrestrial Materials

Dr. Wieser is investigating how meteorite parent bodies formed by examining the isotopic composition of elements in the molybdenum mass region. Meteorites are great archives of the history of the Solar System. Within the mineral matrix are subtle clues that can tell us how long it took for the planets to form and under what conditions. The isotope composition of molybdenum in meteorites is the key to unlock the secrets of the origins and evolution of our Solar System. Molybdenum has seven stable isotopes formed by a variety of nuclear processes. The seven stable isotopes of molybdenum span a mass range from 92 to 100 atomic mass units. These nuclides were formed by a combination of rapid and slow neutron capture and proton capture nucleosynthesis as well as the decay of short-lived radioactive parents. Isotope fractionation can be caused by changes in the redox environment as well as condensation of high-temperature magmatic fluids. Dr. Wieser uses these data to better understand the fractional crystallization of elements during the formation of the parent bodies. Isotope abundance anomalies are investigated to elucidate the sources of nucleosynthetic material to the early Solar System and establish the timing and duration of planetary formation. In addition, distinct isotope signatures and elemental concentrations are used to identify the genetic origins of meteorites.

The investigation of the isotopic composition of molybdenum is realized using thermal ionization and inductively coupled plasma mass spectrometry. So-called “double-spiking” analytical techniques permit high accuracy and high precision data to be collected from sub micro-gram quantities of material. The often low concentrations of molybdenum in rare and precious materials requires the processing of samples under strict clean room conditions to minimize the amount of contaminants introduced.

Dr. Wieser is working with colleagues in Geochemistry and industry to trace the source of pollutants in ground water by measuring the boron isotope composition of atmospheric and water sources in pristine and impacted environments. The boron isotope composition of shallow ground water in Alberta is often significantly different compared to formation waters or water coming from industrial activities. There is great potential to exploit this difference in natural isotope composition to elucidate the source of water to a particular region.

Wieser's laboratory employs a ThermoFisher Scientific Triton thermal ionization mass spectrometer and a Neptune inductively coupled plasma mass spectrometer to make highly accurate and precise isotope abundance measurements of trace metals. The instrumentation is supported by a clean room for the preparation of materials in an environment designed to minimize contamination of the rare and precious samples.

Dr. Wieser is actively involved with the Commission on Isotopic Abundances and Atomic Weights, a commission under the auspices of the International Union of Pure and Applied Chemistry. This Commission publishes the Table of Standard Atomic Weights and Table of the Isotopic Composition of the Elements based on evaluations of the scientific literature.

Group Members

Adam Mayer – Graduate Student

Chris Petten – Research Assistant

Teaching Interests

Modern and Nuclear Physics

Experimental Methods in Physics

Articles in Refereed publications:

Wieser, M.E. and De Laeter, J.R. (2009) Molybdenum isotope mass fractionation in iron meteorites, *International Journal of Mass Spectrometry*, 286, 98-103.

Wieser, M.E. and Berglund, M. (2009) Atomic weights of the elements 2007. *Pure and Applied Chemistry*, 81, 2131-2156 doi:10.1351/PAC-REP-09-08-03.

Wieser, M.E., De Laeter, J.R., Varner, M.D. (2007) Isotope fractionation studies of molybdenum. *International Journal of Mass Spectrometry*, 265, 40-48.

Wieser M.E. Atomic weights of the elements, 2005. (2007) *Journal of Physical and Chemical Reference Data*. 36, 485-496.

Hannah, J. L., Stein, H.J., Wieser, M.E., De Laeter, J.R., Varner, M.D. (2007) Mo isotopic variations in molybdenite: Vapor transport and Rayleigh fractionation of Mo. *Geology*. In Press.

Wieser, M. E. and De Laeter, J. R. (2007) The absolute isotopic composition of molybdenum and the solar abundances of the p-process nuclides ⁹², ⁹⁴Mo. *Physical Review C*. In Press.

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Wieser, M. E. and Schwieters, J. B (2005) Development of Multiple Collection Mass

- Spectrometry for Isotope Ratio Measurements. *International Journal of Mass Spectrometry*, 242, 97-115.
- Serra, F., Guillou, C. G., Reniero, F., Ballarin, L., Cantagallo, M. I., Wieser, M., Iyer, S. S., Héberger, K., and Vanhaecke, F. (2005) Determination of the geographical origin of green coffee by principal component analysis of carbon, nitrogen and boron stable isotope ratios. *Rapid Communications in Mass Spectrometry*, 19, 2111-2115.
- Wieser, M. E., Buhl, D., Bouman, C., and Schwieters, J. (2004) High precision calcium isotope ratio measurements using a magnetic sector multiple collector inductively coupled plasma mass spectrometer. *Journal of Analytical Atomic Spectrometry*, 19, 844-851.
- Wieser, M. E. and De Laeter, J. R. (2004) Spontaneous fission yields for ²³⁸U in molybdenum measured in Archean zircons. *Journal of Radioanalytical and Nuclear Chemistry*, 261, 95-100.
- Wieser, M. E. and De Laeter, J. R. (2003) A preliminary study of isotope fractionation in molybdenites. *International Journal of Mass Spectrometry*, 225, 177-183.
- Wieser, M. E. and De Laeter, J. R. (2001) Evidence of the double beta decay of zirconium-96 measured in 1.8 x 10⁹ year-old zircons. *Physical Review C (Nuclear Physics)*, 64.
- Wieser, M. E., Iyer, S. S., Krouse, H. R., and Cantagallo, M. I. (2001) Variations in the boron isotope composition of *Coffea arabica* beans, *Applied Geochemistry*, 16, 317-322.
- Williams, L. B., Wieser, M. E., Fennell, J., Hutcheon, I., Hervig, R. L. (2001) Application of boron isotopes to the understanding of fluid-rock interactions in a hydrothermally stimulated oil reservoir in the Alberta Basin, Canada. *Geofluids*, 1, 229-240.
- Williams, L. B., Hervig, R. L., Wieser, M. E., and Hutcheon, I. (2001) The influence of organic matter on the boron isotope geochemistry of the gulf coast sedimentary basin, USA. *Chemical Geology*, 174, 445-461.
- Wieser, M. E. and De Laeter, J. R. (2000) Molybdenum concentrations measured in eleven USGS geochemical reference materials by Isotope Dilution Thermal Ionization Mass Spectrometry. *Geostandards Newsletter*, 24, 275-279.
- Wieser, M. E. and De Laeter, J. R. (2000) Thermal Ionization of Molybdenum Isotopes. *International Journal of Mass Spectrometry*, 197, 253-261.
- Wieser, M. E. and De Laeter, J. R. (2000) Stable Isotope Dilution Analyses of Molybdenum in Meteorites. *Fresenius Journal of Analytical Chemistry*, 368, 303-306.
- Wieser, M. E. and Brand, W. A. (1999) A Laser Extraction/Combustion Technique for *in situ* $\delta^{13}\text{C}$ Analysis of Organic and Inorganic Materials. *Rapid Communications in Mass Spectrometry*, 13, 1218-1225.

Articles in Non-Refereed Contributions:

Wieser, M.E. and De Laeter, J.R. (2008) ^{97}Mo isotope abundance enrichments in selected iron meteorites. Poster given at the 18th V. M. Goldschmidt Conference, Vancouver, Canada.

Coplen, T.C., Holden, N.E., and Wieser, M.E. (2008) What is the standard atomic weight of an element? Poster given at the 18th V. M. Goldschmidt Conference, Vancouver, Canada.

Neuheimer, E.M., Wieser, M.E., and De Laeter, J.R. (2008) Molybdenum concentrations in chondrites, stony and iron meteorites. Poster given at the 18th V. M. Goldschmidt Conference, Vancouver, Canada.

Wieser, M. and De Laeter, J.R. (2007) Molybdenum Isotope Anomalies in Iron Meteorites. Talk given at the International Symposium on Calibrations of Isotope Abundance Ratios and Atomic Weights, and their Applications, Pisa, Italy.

Varner, M. D., Wieser, M. E., De Laeter, J. R. (2006) Isotopic anomalies of molybdenum in iron meteorites. Poster presented at the 16th V. M. Goldschmidt Conference, Melbourne, Australia.

Hannah, J. L., Stein, H. J., Wieser, M. E., De Laeter, J. R., Varner, M. E. (2006) Mo isotopic variations in molybdenite: vapor transport and Rayleigh fractionation of Mo. Talk given at the 16th V. M. Goldschmidt Conference, Melbourne, Australia.

De Laeter, J. R., Wieser, M., Stein, H., Hannah, J. (2005) Application of molybdenum isotope fractionation measurements in ore deposit studies. Talk given at the 6th International Symposium on Applied Isotope Geochemistry, Prague.

Buhl, D., Wieser, M. (2005) Possibility and Pitfalls for calcium isotope abundance measurements by MC-ICP-MS. Talk given at the International Symposium on Calibrations of Isotope Abundance Ratios and Atomic Weights, and their Applications, Beijing, China.

Wieser, M. E., Berglund, M., De Bièvre, P. (2005) The determination of atomic weights by new analytical techniques. Poster presented at the 15th Goldschmidt Conference held in Moscow, Idaho, USA.

Varner, M., Wieser, M. E., De Laeter, J. R. (2005) Molybdenum isotope abundance variations in selected iron meteorites. Talk given at the 2005 CAP Congress, Vancouver, BC.

Crowley, Q., Wieser M. E., Schwieters, J. (2004) Single zircon U-Pb dating by Multiple Ion Counting on the Finnigan TRITON TI-MS. Invited talk given at the NSF-sponsored workshop: Reinvigorating TIMS, Boulder, Colorado.

Buhl, D., Wieser, M. E., Bouman, C., and Schwieters, J. (2004) High Precision Calcium Isotope Abundance Variations Measured by the High Resolution Finnigan Neptune. Oral presentation at the 14th V. M. Goldschmidt Conference, Copenhagen, Denmark.

Schwieters, J. B., Bouman, C., Tuttas, D., and Wieser, M. E. (2004) A new tool for in situ

- isotopic analysis of small samples: Multiple ion Counting –ICPMS and –TIMS. Oral presentation at the 14th V. M. Goldschmidt Conference Copenhagen, Denmark.
- Bouman, C., Vroon, P. Z., Van der Wagt, B., Wieser, M. E., and Schwieters, J. B. (2004) Sr isotope analysis by Multiple Ion Counting (MIC-ICPMS). Poster presentation at the the 14th V. M. Goldschmidt Conference Copenhagen, Denmark.
- Wieser, M. E., De Laeter, J. R., Stein, H., Tuttas, D., and Schwieters, J. B. (2004) Molybdenum isotope abundance variations measured in molybdenites by double-spiking thermal ionization mass spectrometry. Poster presentation at the 14th V. M. Goldschmidt Conference Copenhagen, Denmark.
- Wieser, M. E., Buhl, D., Bouman, C. and Schwieters, J. (2004) High Precision Ca Isotope Measurements with the High Resolution Finnigan Neptune MC-ICP-MS. Poster presentation at the 2004 European Geophysical Union General Assembly, Nice, France.
- Wieser, M. E., Buhl, D. Schwieters, J., and Bouman, C. (2003) High Precision Ca Isotope Measurements with High Resolution MC-ICP-MS Oral presentation at the IVth International Conference on High Resolution Sector Field ICPMS, Venice.
- Wieser, M. E., Tuttas, D., Bouman, C., Schwieters, J. B. (2003) Performance characteristics of a new multi-ion counting system for a TIMS multicollectors: Nd and U. Oral presentation at the 13th V. M. Goldschmidt Conference, Kurashiki, Japan.
- Schwieters, J. B., Bouman, C., Tuttas, D., and Wieser, M. E. (2003) Sensitivity study of the Thermo Finnigan Neptune MC-ICPMS using different inlet systems. Poster at the 13th V. M. Goldschmidt Conference, Kurashiki, Japan.
- Bouman, C., Cocherie, A., Robert, M., Schwieters, J. B., and Wieser, M. E. (2003) In situ U-Pb zircon dating using laser ablation multi ion counting ICPMS (LA-MIC-ICPMS). Oral presentation at the 13th V. M. Goldschmidt Conference, Kurashiki, Japan.
- Wieser, M. E. and De Laeter, J. R. (2003) Molybdenum Isotope Abundance Variations Revealed by Double Spike Isotope Ratio Mass Spectrometry. Oral presentation at the Fifth International Applied Isotope Geochemistry Conference, Heron Island, Australia.
- Wieser, M. E. and De Laeter, J. R. (2000) Evidence for the double beta decay of ⁹⁶Zr measured from billion year-old zircons. Oral and poster presentations, GeoCanada 2000, the Millenium Geosciences Summit, Calgary, Canada.
- Wieser, M. E., Iyer, S. S., Serra, F. and Krouse H. R. (2000) The application of boron and carbon stable isotope abundance studies for quality assurance and understanding the biogeochemistry of coffee. Poster 31st Geological Congress, Rio de Janeiro, Brazil.
- Wieser, M. E. (1999) New Directions in Thermal Ionization Mass Spectrometry at the University of Calgary. Oral presentation, Stable Isotope Laboratory Seminar Series.
- Wieser, M. E. (1999) Double Beta Decay: The subatomic needle in the granite haystack. Oral presentation, Department of Physics and Astronomy (UofC) Seminar.
- Wieser, M. E. (1999) Is there substance to neutrinos? Fusion: the newsletter of the

Department of Applied Physics, Curtin University of Technology, Perth, Western Australia, No. 22, June 1999.

Wieser, M., Brand, W. A., Schlüter, H-J. (1999) Laser Ablation IRM-GCMS for *in-situ* $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ Analysis. Poster, Annual Meeting of the Stable Isotope Mass Spectrometry Users Group, Exeter, England.

Wieser, M., Brand, W. A., Pesch, R., Oeßelmann, J. (1998) Laserablation als on-line IRMS zur ortsauflösenden ^{13}C -Bestimmung, Oral presentation, 21st Meeting of the Arbeitsgemeinschaft Stabile Isotope, Düsseldorf, Germany.

Mayer, B., Krouse, H. R., Trummer, M., Wieser, M. E., and Norman, A. L. (1998) Potential and Limitations of Sulfur Isotope Measurements on Organic Materials by CF-IRMS. Oral presentation, 5th Canadian Continuous Flow Isotope Ratio Mass Spectrometry Workshop, Ottawa, Ontario.

Krouse, H. R., Wieser, M., Norman, A. L., Alewell, C., and Mitchell, M. (1997) Continuous Flow Combustion Isotope Ratio Mass Spectrometry (CF-C-IRMS) of Sulfur: Applications in Hydrology. Oral presentation, Annual Meeting of the Geological Society of America, Salt Lake City, Utah, USA.

Berg, K., Wieser, M., Amerl, P., and Matlock P. (1997) An Inexpensive Multi-Task PC Interface for Controlling Isotope Ratio Mass Spectrometers and Preparation Equipment, and Data Processing. Poster, 2nd International Symposium of Applied Isotope Geochemistry, Lake Louise, Alberta, Canada.

Wieser, M. and Buhl, D. (1997) Trace Sulfur Measurements by AsS^+ -TIMS. Oral presentation, 2nd International Symposium of Applied Isotope Geochemistry, Lake Louise, Alberta, Canada.

Wieser, M. (1997) The Boron Isotope Composition of Coffee Beans. Poster, 2nd International Symposium of Applied Isotope Geochemistry, Lake Louise, Alberta, Canada.

Williams, L. B., Wieser, M., Hervig, R. L., and Hutcheon, I. E. (1997) Isotopic Investigation of the Role of Organic Matter in the Sedimentary Cycle of Boron. Oral presentation, 2nd International Symposium of Applied Isotope Geochemistry, Lake Louise, Alberta, Canada.

Krouse, H. R. and Wieser, M. (1997) Isotope Composition of Different Sulfur Functional Groups in Oil and Bitumen. Poster, 2nd International Symposium of Applied Isotope Geochemistry, Lake Louise, Alberta, Canada.

Wieser, M. and Krouse, H.R. (1997) Boron Isotope Abundance Measurements in Natural Systems. Invited speaker to BIOGEOMON, 3rd International Symposium on Ecosystem Behavior, Villanova, PA, USA. Journal of Conference Abstracts, Vol. 2, No. 2.

Krouse, H. R., Norman, A. L., Wieser, M. (1997) Isotope Analysis of Microgram Quantities of Sulfur. Oral presentation, BIOGEOMON, 3rd International Symposium on Ecosystem Behavior, Villanova, PA, USA. Journal of Conference Abstracts, Vol. 2, No. 2.

Wieser, M. and Krouse, H. R. (1996) Designing Flexibility into Your Continuous Flow Isotope Ratio Mass Spectrometer. Oral presentation, 3rd Canadian Continuous Flow Isotope Ratio Mass Spectrometry Workshop, Saskatoon, Saskatchewan, Canada.

Wieser, M., Krouse H. R., Iyer, S., Abercrombie, H., Davidson, R. (1993) Boron Concentration and Isotope Abundance Measurements. Comparison of Negative Thermal Ionization Mass Spectrometry and ICP-MS Techniques. Oral presentation, 1st International Symposium of Applied Isotope Geochemistry, Geiranger, Norway. ISBN 82-7017-130-1.

Norman, A. L., Wieser, M., Krouse, H. R., Gieseemann, A. (1993) Isotope Abundance Measurements of Microgram Quantities of Sulphur. Oral presentation, 1st International Symposium of Applied Isotope Geochemistry, Geiranger, Norway. ISBN 82-7017-130-1.

Wieser M. and Krouse, H. R. (1993) Environmental Applications of Negative Thermal Ionization Mass Spectrometry (NTIMS). Oral presentation, Scientific Meeting of the Canadian Geophysical Union, Banff, Alberta, Canada.

Wieser, M. and Krouse, H. R. (1992) Isotope Dependence of Sulphate Diffusion in Water. Poster, Canadian Association of Physicists Congress, Windsor, Ontario, Canada.

Wieser, M. and Krouse, H. R. (1992) Isotope Fractionation During Diffusion of Ions in Aqueous Solutions. Oral presentation, International Isotope Workshop, Lublin, Poland.

Book Chapters:

Wieser, M. E. and Brand, W. A. (1999) Isotope Ratio Studies using Mass Spectrometry. In: Encyclopedia of Spectroscopy and Spectrometry. J. C. Lindon, G. E. Tranter, and J. L. Holmes, (eds.), Academic Press. ISBN 0-12-226680-5.