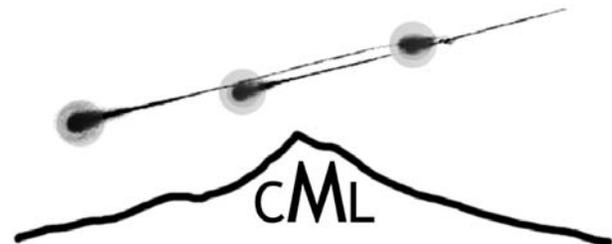


# Cascadia Meteorite Laboratory

Sixth Newsletter, August 2012

<http://meteorites.pdx.edu>



Cascadia Meteorite Laboratory

## ***Mission Statement***

The mission of our laboratory is to conduct meteorite research to help understand our place in the universe, and to share this knowledge with the wider community. Meteorites provide vital clues about the origin of the Earth and other planets, our solar system, and the molecules that serve as precursors to life. Meteorite research contributes to the larger field of planetary science which can help society evaluate how to utilize extraterrestrial resources, how to protect our planet from the devastating effects of a major cosmic impact, and how planetary climate change might occur. Our lab maintains and increases a carefully curated collection of meteorites which can be used for research and education. Through mentoring, classes, and outreach programs, laboratory personnel help inspire and educate students of all ages, teachers and the general public, and help to prepare a new generation of scientists.

## **Welcome to our sixth newsletter!**

The Cascadia Meteorite Laboratory's (CML's) continuous personnel are Dr. Alex Ruzicka (director), Dr. Melinda Hutson (curator and Alex's wife), and Mr. Dick Pugh (outreach specialist). In addition, we have an ever changing roster of graduate and undergraduate students working on research projects in the lab. For 2012, this group includes graduate students Kristy Hauver, T. J. Schepker, and Kat Armstrong, and undergraduate students Niina Jamsja (who graduated mid-year), Ryan Brown, and Karla Farley (who started spring term). A complete list of past and present students can be found at <http://web.pdx.edu/~ruzickaa/students.htm>.

As usual, the 2011-2012 academic year was an incredibly busy one. So much happened that it is impossible to cover it all in this newsletter, and so here at the start let us thank all of you who have helped to support our lab over the past year.

### **Big News Items:**

1) Congratulations to Alex Ruzicka who received tenure and was promoted to Associate Professor at the end of the 2011-2012 academic year.

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2) Congratulations to two of our graduate students, Kristy Hauver and T. J. Schepker, who were married on the beach at Ft. Stevens State Park in Oregon on August 5, 2012.

3) CML is happy to announce that Alex Ruzicka received a NASA PME grant for \$132,000 to purchase an electron backscatter detector (EBSD). This detector will be added to the scanning electron microscope (SEM) at the Center for Electron Microscopy and Nanofabrication (CEMN) at Portland State University (PSU).

Having EBSD capability vastly enlarges the range of topics that can be studied by CML researchers. Initially, we will be using this detector as part of a currently grant funded research project, to bridge the gap between optical and transmission electron microscope (TEM) studies of shock deformation in ordinary chondrites.



*T. J. Schepker and Kristy Hauver, with Kristy's 6 year old son Phenex, who acted as ring bearer.*

## Research at CML

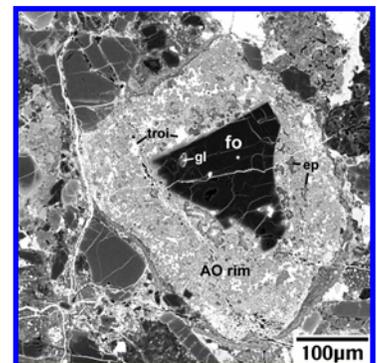
### LET'S STICK TOGETHER

Earlier this year, Alex, Melinda, and collaborator Christine Floss of Washington University (St. Louis, Missouri) were writing and revising two research papers about aggregational objects in carbonaceous and ordinary chondrites. This was the culmination of work performed for a now-expired NASA research grant. The two papers are:

Ruzicka A., C. Floss and M. Hutson (2012) Amoeboid olivine aggregates (AOAs) in the Efremovka, Leoville and Vigarano (CV3) chondrites: A record of condensate evolution in the solar nebula. *Geochim. Cosmochim. Acta* 79, 79-105.

Ruzicka A., C. Floss and M. Hutson (2012) Agglomeratic olivine (AO) objects in ordinary chondrites: Accretion and melting of dust to form ferroan chondrules. *Geochim. Cosmochim. Acta* 76, 103-124.

Writing a paper is an act of synthesis, and leads to ideas and discoveries not noticed at the time of data collections. While working on these papers, Alex and Melinda got the opportunity to attend a workshop on the formation of the first solids in the solar system, which was held in Kauai in November 2011. Some of the ideas associated with this paper were put forth in an abstract for the workshop. Afterwards, Alex was asked to submit a paper for a special issue of *Meteoritics and Planetary Science*. The manuscript, which connects chondrule formation to aggregational objects, is now in press and will be published later this year.

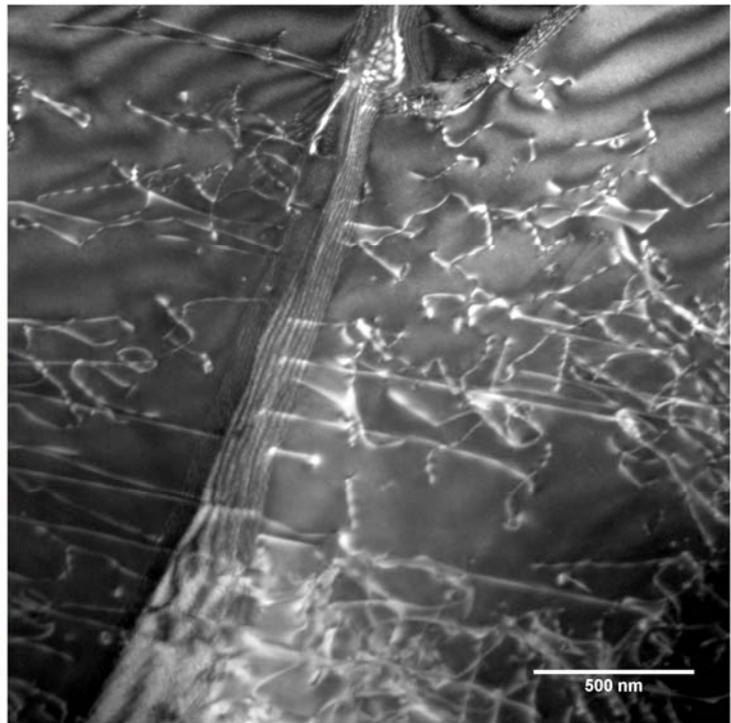
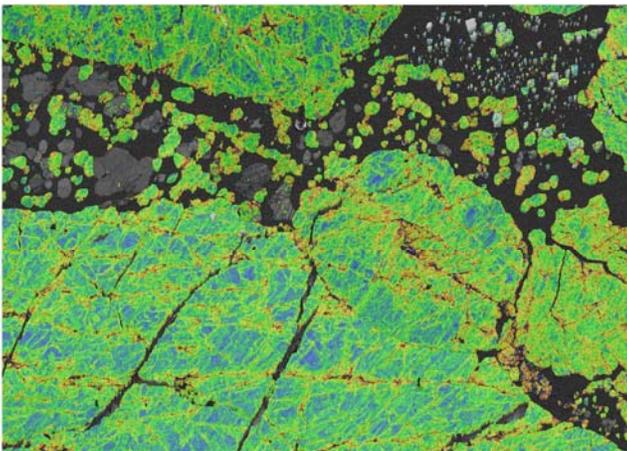
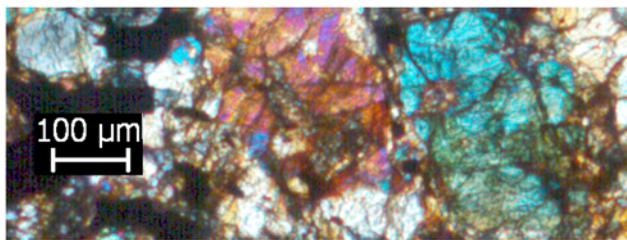


*Backscattered Electron (BSE) image of an agglomeratic olivine rim surrounding an angular forsterite grain.*

WE'RE SHOCKED

In 2010, Alex received a NASA grant to fund a three-year project examining the shock histories of chondrites. As originally written, the study would compare data obtained with an optical light microscope with that of a transmission electron microscope (TEM) and x-ray microtomography ( $\mu$ CT) analysis. Co-investigators on the grant include Rick Hugo of PSU's Department of Geology, who is an expert electron microscopist, and is obtaining all of the TEM data, and Jon Friedrich at Fordham University in New York, who is obtaining the  $\mu$ CT data. Three abstracts containing preliminary data and results have been published in the last two years. Data acquisition is still underway, and Alex expects to start writing a larger manuscript later this year.

As we studied shock effects in multiple meteorites, we realized that we lacked information at an intermediate scale between optical microscopy and TEM. The pictures below of the Morrow County (L6) chondrite should give some idea of the problem. The image in the upper left is a cross-polarized photomicrograph of shock-deformed olivine grains in the Morrow County (L6) meteorite. The variation in color of each grain indicates the amount of shock deformation. The scale bar in the image is 100 microns, comparable to the olivine grain size. On the right is a TEM micrograph, which shows numerous dislocations (bright features) in an olivine grain. The scale is 500 nm, showing that only a tiny region of a single grain is being examined, leading to a question of how representative are the observed data to the whole grain (and whole meteorite). Typically, one gets only compositional data with an SEM. But with an EBSD detector, we can also see deformation at a scale that bridges the optical and TEM data. An EBSD image of Morrow County is shown to the bottom left. Local misorientation within olivine grains is given by color, with blue representing low misorientation, and green, yellow, and red showing successively higher misorientation. The black scale bar is 100 microns.



The solution to the problem was to go back to NASA and ask for funding for an EBSD detector for the SEM. This will provide information about shock effects at a scale intermediate to the optical and TEM scales. The EBSD detector has been ordered and should be installed in the next few months.

## SERENDIPITY

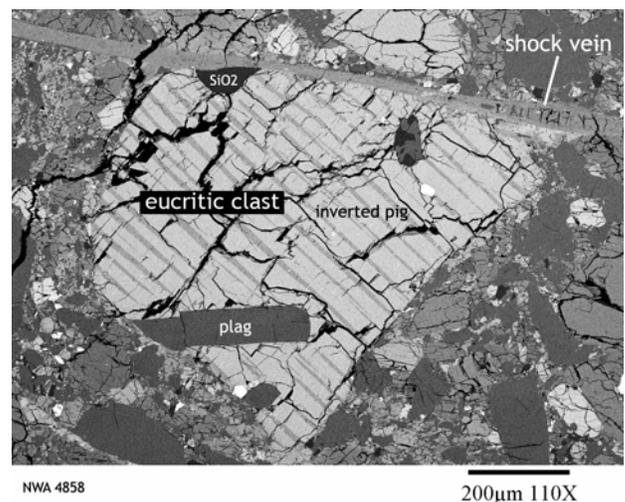
As side projects CML personnel classify between six to twelve meteorites per year, funded by public donations to the lab. Many of these meteorites contain interesting features that lead to small research projects, including those for undergraduate and graduate students.

In 2008, Melinda and Alex worked with Alan Hildebrand of the University of Calgary, Canada to classify the newly fallen Buzzard Coulee (H4) chondrite. The meteorite contains igneously-textured inclusions (rock fragments that formed originally by crystallizing from a nonchondritic melt). Alex had seen similar inclusion in other meteorites, and follow-up research led to a journal article, which has been peer-reviewed and is in the process of revision. This has also given Alex an idea for future research, and he submitted a grant proposal to NASA last spring. We won't find out before December whether the grant was funded. Funded or not, graduate student Kat Armstrong will be working on this project for her degree.



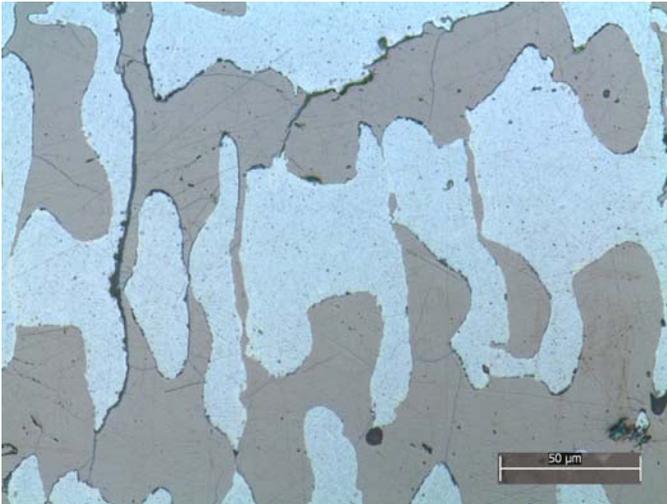
Kat Armstrong is finishing up her first year at Portland State University. During the year, she obtained optical and electron microscope data for the classification of two new carbonaceous chondrites, NWA 7290 (CO3) and NWA 7210 (CM2). Then she switched gears to begin working on the origin of igneous inclusions in ordinary chondrites. In addition to classes, classification of meteorites, and TA work, Kat has spent time reading background material on igneous inclusions and writing a proposal for a highly competitive student grant for funding. (Unfortunately, her proposal was not funded.)

T.J. Schepker has been working on a project involving achondrites believed to come from the third largest asteroid. For this, T.J. has been involved in classifying several new HED (howardite – eucrite – diogenite) meteorites for CML over the last three years. Major and trace element data has been obtained for this project, using the electron microprobe (EMP) and laser-ablation inductively coupled-plasma mass-spectrometer (LA-ICP-MS) at Oregon State University. Besides getting married, T.J. has been processing and analyzing data. He is planning on finishing his Master's degree this coming year.

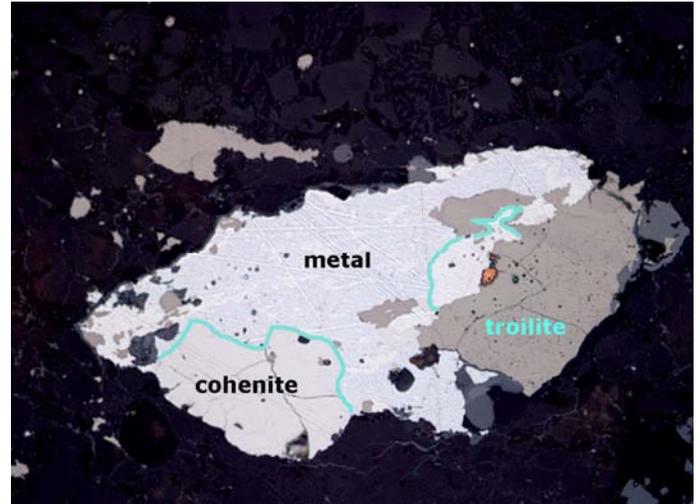


*BSE image (taken with the SEM) of a eucritic clast in NWA 4858, one of the samples studied by T.J.. Gray levels correspond to average atomic number of material/mineral.*

Kristy Hauver's graduate research project resulted from the classification of the NWA 5964 (L3-6 melt breccia) chondrite. Part of this work was funded by an internal grant from PSU. This meteorite contained a shock melt with complicated intergrowths of metal and troilite. Kristy found cohenite (an iron-nickel carbide) in metal-sulfide assemblages in the unmelted portion, and presented a poster and abstract at the 2011 Lunar and Planetary Science conference. Since then, she has collected and analyzed additional data and was married. She plans on graduating later this year.



*Above: Reflected light photomicrograph showing metal (intergrown kamacite and taenite – white color) dendrites surrounded by troilite (FeS – brown color) in shock melted region in NWA 5964. 50 micron scale bar shown in lower right of image.*



*Above: Reflected light photomicrograph of metal-sulfide region in the unmelted chondritic portion of NWA 5964. Phases present are an intergrowth of kamacite and taenite (metal), cohenite (Fe<sub>3</sub>C), and troilite (FeS). A small orange grain of metallic copper can be seen at the boundary between troilite and cohenite. Same scale as left image.*

Kristy's project has grown since she began working on it. It is clear that additional research needs to be done before a paper is submitted for publication. Fortunately, a visiting professor from Wisconsin (see section on Visitors to the lab below) took an interest in this project and is currently using equipment and funding from her institution to obtain more data.

Niina Jamsja graduated with her Bachelor's degree during this past academic year. She began her undergraduate career at CML by classifying an unusual LL chondrite melt breccia (NWA 4859). Her work led to a journal paper in 2010 and a series of awards (see previous newsletters). After finishing this paper, Niina switched to classification of two R chondrites (NWA 6491 and NWA 6492). She published two abstracts on this work in 2011. We will all miss her.

One prerequisite of obtaining NASA funding is that you have to demonstrate you are capable of doing the work you describe in your proposal. Niina's work on R chondrites suggested a follow-up project. In order to get the data necessary to write a grant proposal, Alex has lined up collaboration with researchers (Jamie Gilmour and student) at the University of Manchester, England, for isotopic studies. Preliminary data has been obtained on NWA 6491 and is being analyzed.

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The first classification ever done by CML personnel was that of the Buck Mountain Wash (H3-6) chondrite by Melinda. This was one of hundreds of stones to come from the Franconia area in Arizona. Melinda went on to classify a dozen Franconia-area stones, and of course, the more one looks, the more there is to see. A journal article on Buck Mountain Wash was published in 2007. Another manuscript was submitted for publication this spring, and has just come back for revisions after the peer-review process. The last two Franconia-area meteorites we looked at (Buck Mountains 004 and Buck Mountains 005) were classified this past year. Buck Mountains 005 contains an interesting silicate vein (see image below) which has become the research project for undergraduate Ryan Brown.

Ryan started working on his project last summer. He was taking the microprobe (EMP) class and obtained some of the mineral-chemical data that was used to classify Buck Mountains 005. It should be noted that when a student takes the microprobe class or the SEM class, they get to use the instrument (EMP or SEM) to do a small class project. CML students have obtained data at no cost to CML by taking these classes and having the class project overlap the research they are doing for CML. Ryan followed up during the year by taking the class on scanning electron microscopy (SEM). He has worked this summer with Melinda and Alex to obtain and process more SEM data.



CML would like to welcome undergraduate student Karla Farley. Karla joined the lab this past spring. She took the “Exploring Mars” course with Melinda and “Meteorites” with Alex during Winter term 2012. She has just begun optical microscopy on two unclassified meteorites which appear to be mesosiderites.



#### SERENDIPITY IS NICE, BUT EXPENSIVE

All of the projects listed above are “unfunded”. All came about because we were classifying a sample, observed something interesting, and decided to obtain data to figure out what was going on. Judging from the many comments we receive from people wanting a stone classified, there is a misperception in the minds of many people as to how our lab operates. We are a small university research group. The faculty are paid to teach classes. As a tenured faculty, Alex is also supposed to mentor students and obtain grant funding for research projects and outreach programs (which helps to pay Dick for his work—see Outreach below). Graduate students receive a small amount of funding to work as teaching assistants. Portland State University has provided space—but no direct funding—for the lab.

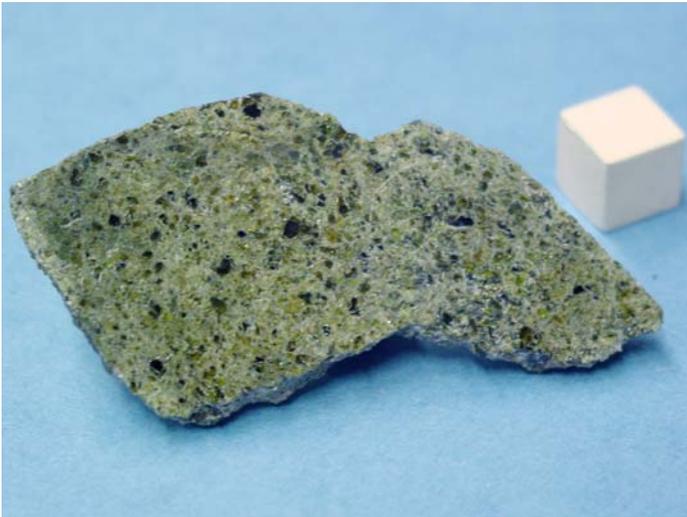
Classification is funded by public donations. So are the “serendipity” projects. The faculty and students are not paid any salary for doing this work. It is impossible to get grant funding from NASA or the NSF for classification, because classification is not considered “research”. (Neither, by the way, is any aspect of meteorite curation). CML uses donation funds to purchase lab supplies, pay for thin section preparation, and to pay user fees for the microprobe and electron microscopes.

#### THANKS FOR THE DONATIONS AND SUPPORT

All of us here at CML would like to thank everyone who has supported our lab. There are too many of you to name, but you know who you are. During the past academic year, you donated \$7450 to the Erwin F. Lange Endowment. Those funds cannot be spent, but are added to the principal of the endowment. This fund pays out a small amount of interest each year. It is the hope of the fund’s founder (Dick Pugh) that the Lange Endowment will eventually grow large enough that the interest can fund a paid curatorial position. Additionally, you donated \$5591 to the CML operating account. We spent \$4862 on supplies, travel, and instrument usage. This included \$973 for thin section preparation.

As we were finishing this newsletter, we learned that an anonymous donor was giving the lab \$10,000, our largest single donation. Most of these funds are earmarked for student research.

During this past academic year the CML collection increased by 43 meteorites. Ten of those were purchased for research using CML funds, while 33 samples were donated to the lab. These have included wonderful samples, such as HEDs, ureilites, carbonaceous chondrites, some weird and wonderful ordinary chondrites, and more. Ten of the samples originally came from the American Meteorite Laboratory, and came to CML with their original AML labels. Again, many thanks to everyone.



*NWA 6693, an ungrouped achondrite, donated by Edwin Thompson. White cube is 1 cm<sup>3</sup>.*



*NWA 6695, a howardite, donated by Edwin Thompson. 1 cm<sup>3</sup> cube at upper right.*

### **Outreach at CML**

Dick Pugh is our outreach specialist. He receives half a dozen or more phone calls each week from people who think they have a meteorite. Dick spent the past year driving around the Pacific Northwest giving lectures, letting people handle a teaching collection of meteorites, and looking at all of the rocks that people brought in. He was drafted at the last minute to replace another instructor and teach G201 this summer. Dick has spoken before a diverse group of people this year. In addition to the schools, libraries, and town meeting halls that he visits every year, Dick spent three days at the Northwest Federation of Mineralogical Societies' Annual Gem and Mineral show in Kennewick, Washington. Dick attended summer camp with deaf students at Camp Taloali in Stayton, Oregon (see images below), and he spent "Meteorite Day" at the Rice NW Museum of Rocks and Minerals in Hillsboro, Oregon.



*Dick (in plaid shirt) lecturing via a sign-language interpreter (in red on right) to kids at Camp Taloali.*



*Kids at Camp Taloali get to handle a collection of stony, iron, and stony-iron meteorites.*



*Top: Dick lectures at the Rice Museum. Bottom: a Kansas chondrite (left) brought in by Paquita Rupp (right).*

One of the people who came to listen to Dick at the Rice Museum was Paquita Rupp. In the late 1890s, her grandfather recovered a “bushel basket” of meteorites on his farm in Ness County, Kansas. He’d distributed them to family members. Ms. Rupp wanted to confirm that her stones were actually meteorites (they are). It turns out that a lot of chondrites have been recovered from the area. It was initially assumed that all were the same meteorite, but it is now known that there are at least three different chondrites from the area. Ms. Rupp visited CML during the summer and allowed us to take slices from two of her stones. As soon as they were cut, it was apparent that they are two different meteorites. A potential future student project?

For the last nine years, CML has been fortunate to have obtained NASA grants to fund much of Dick’s outreach activities. We were told this year that this particular program element is no longer available. LEO (Libraries of Eastern Oregon) has also provided some funding (thank you). We hope to fund future outreach efforts in part with public donations.

Since the last newsletter, “Meteorites on the Road” has given 38 lectures in Oregon and Washington. There were 1680 adults and 1633 K-12 students attending these talks. Dick drove 5981 miles and looked at 447 rocks. Only 41 of these were meteorite, and none were new. Dick saw numerous samples of Canyon Diablo, Campo del Cielo, Sikhote-Alin, and northwest African stones.

### **Visitors to CML**

We’ve had a number of visitors stop and tour the lab over the past academic year. Paquita Rupp and her husband stopped by the lab (see Outreach above) and donated samples of two Kansas stones. Fred and Debbie Olsen (Mineral & Fossil Supply, Denver, Colorado) stopped by to look at the lab and leave eight samples (thanks Fred and Debbie). Local collectors and long-time lab supporters Tim Gutschow and Tim Stout showed up on the same day to donate material. Tim Stout’s unclassified stone is turning out to be a challenge to classify (thanks, Tim). Another collector/supporter Greg Carr stopped by several times to donate shock-melted samples (thanks, Greg).

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Professor Lauren Likkel from the Department of Physics and Astronomy at the University of Wisconsin/Eau Claire spent one week this summer here at CML, as part of her sabbatical. In the image on the right, she is in our lab, using an optical microscope to choose thin sections for further study in Wisconsin. She will be using the University of Wisconsin's SEM to obtain data which expands the scope of the research project started by graduate student Kristy Hauver.



## Everything Else

Alex and Melinda went traveling this past year (both together and apart). In November 2011, we both went to Kauai to participate in a workshop on the formation of the first solids in the solar system. Melinda received \$1000 in travel funds from Portland Community College towards this workshop. The CML Endowment provided a small amount of funding to help Alex attend.

Ruzicka A. and Hutson M. (2011) Agglomeratic olivine (AO) objects: Melting of dust to create Type II chondrules. *Workshop on Formation of the First Solids of the Solar System*, Abstract #9020.

In November 2012, most of the lab got together for a CML Thanksgiving (photos on next page). We ate turkey, talked meteorites, and had football playing in the background.

In March 2012, Alex presented preliminary data at the annual Lunar and Planetary Science Conference in Houston, Texas.

Ruzicka, A., M. Hutson, C. Floss and A. Hildebrand (2012) Large, silica-rich igneous-textured inclusions in the Buzzard Coulee (H4) chondrite. *43<sup>rd</sup> Lunar Planet. Sci. Conf.*, Abstract #1630.

Friedrich J.M., A. Ruzicka, D. S. Ebel, J. Thostenson, R. A. Rudolph, M. L. Rivers, R. J. Macke and D. T. Britt (2012) Three Dimensional Petrography of Kernouvé: A Story of Vein Formation, Compaction, and Metamorphism. *43<sup>rd</sup> Lunar Planet. Sci. Conf.*, Abstract #1197.

In May 2012, Melinda attended the third International Conference on Early Mars at Lake Tahoe, Nevada (with a field trip to Mono Lake). This trip was funded entirely by a faculty enhancement grant from Portland State University, as it connected with two different classes that Melinda teaches at PSU.

While Melinda was in Nevada, student Ryan Brown stood in for her, attended the annual banquet of the Columbia-Willamette chapter of Sigma Xi, and picked up the Sigma Xi Supporter of Research Award for 2012, which was given to Melinda for her work in promoting research at CML.

In August 2012, just before completion of this newsletter, NASA paid for Alex to go to Boulder, Colorado to serve on a NASA grant review panel. Alex spent four days working with other panelists to go through the grant proposals submitted to NASA, and make recommendations about the funding worthiness of each proposal.



*Above: Thanksgiving 2011 at T.J. Schepker's apartment. Everyone gathered for a group photo. From left to right: Kristy, a friend with glasses, T.J. (in front), Phenex (Kristy's son) next to T.J., Ryan (in back with tie), Alex (in the middle), Maggie (long-time lab supporter – in back), Niina (in front in black), Dick (in back), Christopher + Melinda + Catherine (squished together in the cushions). Bottom left – Niina, Kristy, T.J., and Ryan cooking in the kitchen. Bottom right – the CML children – Catherine and Christopher (with cup) were 4 ½ at the time. They are Alex's and Melinda's children. Phenex (on the right) was 5 ½ at the time and is Kristy's (and now also T.J's.) son.*

Yes, I/we want to support meteorite research and curation at Portland State University with a pledge or payment of:

- \$50       \$100       \$250       \$ 500       \$1,000       Other \_\_\_\_\_

Name: \_\_\_\_\_ Phone \_\_\_\_\_ Email: \_\_\_\_\_

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Please designate your gift to the fund of your choice:

- Cascadia Meteorite Laboratory 2315162       E.F. Lange Endowment 2315104

My preferred method of payment is:       Check enclosed payable to the PSU Foundation

- Charge my     Visa       MasterCard       Discover       American Express

Name on Card: \_\_\_\_\_ Card Number: \_\_\_\_\_ Expiration Date: \_\_\_\_\_

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

- I would like to pledge my gift over time. Please charge my credit card or bill me:     Monthly     Quarterly     Annually

- I would like information about including PSU in my estate plans.

**Thank you for your generosity!**

Mail to: Cascadia Meteorite Laboratory, Dept. of Geology (GEOL), Portland State University, P.O. Box 751, Portland OR 97207-0751

Cascadia Meteorite Laboratory  
Department of Geology  
17 Cramer Hall, 1721 SW Broadway  
Portland OR 97207-0751

RETURN SERVICE REQUESTED



*"Halle..d—n..lujah!"*

DICK PUGH, UPON  
HEARING THE NEWS THAT  
ALEX HAD RECEIVED  
TENURE

For more information about the Cascadia Meteorite Laboratory  
visit <http://meteorites.pdx.edu>

## CML's sixth newsletter

Inside you'll be finding out what we've been doing over the last year. We'd also like to take this opportunity to thank all of you for your interest in and support of the Cascadia Meteorite Laboratory. We wouldn't be here without you.