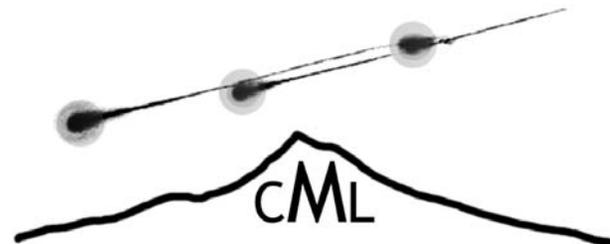


Cascadia Meteorite Laboratory

Seventh Newsletter, July 2013 (prepared by M. Hutson)

<http://meteorites.pdx.edu>, e-mail: cmlpsu@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.

We're celebrating our 11th year!

Have you ever forgotten an important anniversary? Well, we did. We were planning on celebrating the tenth anniversary of the founding of the Cascadia Meteorite Laboratory (CML), when we realized that the anniversary was last year. Oops. Please join us in celebrating our belated tenth anniversary this year.

Looking Backwards:

Eleven years ago, Portland State University's Geology Department owned one meteorite: a very nice 35 lb. Odessa iron (shown on the next page) that had been purchased by Erwin F. Lange in 1968. Alex Ruzicka had moved to Oregon in the summer of 2000, and had spent one year teaching as an adjunct faculty at Portland Community College. Following that, he was hired as an adjunct faculty at Portland State University, spending his time teaching undergraduate classes such as Freshman Inquiry, while trying to get his first research grant. Alex got that first grant in 2003, along with two others (one of the reasons we got our dates mixed up). Dick Pugh retired in 1999 from 31 years of teaching at Cleveland High School, and was giving occasional talks about meteorites at public venues. In 2002, Melinda Hutson was teaching at Portland Community College, and had done no research since finishing graduate school.

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Dick Pugh had been a meteorite enthusiast ever since he was a student at Portland State University in the late 1960s. Alex, Dick, Melinda and local meteorite dealer Edwin Thompson would get together from time to time for lunch or dinner, and talk about meteorites. Inevitably, either Dick or Edwin would say that they dreamed of one day having a meteorite lab in Oregon. During one of those meals in early 2002, Melinda replied “well, why don’t we?” and the Cascadia Meteorite Laboratory (CML) was born.

To inaugurate the lab, Edwin Thompson generously donated 34 unclassified meteorites from northwest Africa. These meteorites were given internal lab numbers (CML 0001 to CML 0034). To date, only one of those 34 stones has been classified. NWA 4003 was classified as part of a project involving undergraduate student Karen Carroll. The sample is a moderately shocked (S3) H5 ordinary chondrite with very little weathering (W1). Notably, the thin section contained an unusually large number of intergrowths of the minerals chromite and plagioclase feldspar.

The remaining 33 meteorites from this inaugural batch are still awaiting the time and funding for classification. They are a “wrapped gift” waiting to be opened. The Odessa iron meteorite didn’t get transferred from the Geology Department to the Cascadia Meteorite Laboratory until about one year later, which is why it is sample number 0117.



Above: CML 0117 is a 35 lb Odessa (Texas) iron meteorite (IAB) purchased by Erwin F. Lange in 1968. A U.S. penny is shown for scale.



Above: CML 0001 (357 grams) was classified as an H5 chondrite, and is officially named NWA 4003. The numbers on the ruler are in centimeters.

CML has grown over the last 11 years with help from all of our friends and supporters. Edwin Thompson gave our lab's first annual fundraiser at his house in 2004. Dick started the E.F. Lange Endowment in 2005, in honor of his former university advisor. This fund is designed so that the principal cannot be spent—it just grows gradually over time; only the interest on this account can be used to fund lab activities. A second fund, the CML Fund was started in 2010, and acts more like a checking account. This is the primary fund that we use to pay for thin section preparation, equipment usage fees, and travel. In addition to financial support, we've received donations of meteorites from dozens of people, and are now in the 0750s in terms of internal lab sample numbers.

Update on the Past Year

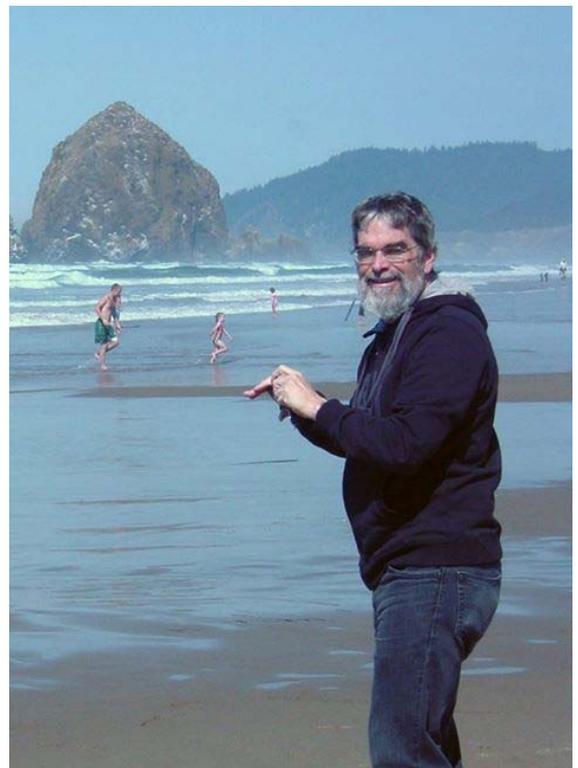
CML PERSONNEL DURING 2012-2013

Faculty and Staff	Graduate Students	Undergraduate Students
Alex Ruzicka	Katherine Armstrong	Ryan Brown
Melinda Hutson	Kristy Schepker	Karla Farley
Dick Pugh	T.J. Schepker	

AUTUMN, WHEN LEAVES FALL, THE RAIN BEGINS, AND FUNDING ARRIVES

In Portland, Autumn is the time of year when nature begins the process of slowing down for the winter. The trees turn color and the rains begin. For those of us in the lab, autumn is a time when our lives accelerate, rather than slow down.

We start each autumn with our annual fundraiser, which is when we usually receive most of our financial donations. The fall 2012 fundraiser was unusual in many ways. For the first time, we had a guest speaker, Brother Guy Consolmagno from the Vatican, who lectured on the history of the Vatican meteorite collection. We had a large turnout, but received very little funds during the actual event (approximately \$1500, which just about equaled the costs of putting on the fundraiser). Atypically, we received a large number of donations just before and after the fundraiser. In the end, we received a record amount of money during a one month period around the fundraiser. Four anonymous donors combined contributed approximately \$17,000, with over half of that going to the E.F. Lange account. One of those donors went on to donate approximately \$7600 later in the year to cover Dick Pugh's salary for education/public outreach (see that discussion below). Those of us at the lab would like to express our gratitude to everyone who donated to the lab this past year.



Brother Guy Consolmagno at Cannon Beach, Oregon. Alex and Melinda drove him out to the Coast for a quick tourist trip the day after the CML fundraiser. As you can see from the photo, the weather was perfect.

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SHOCKING RESEARCH

Alex, Rick Hugo (Portland State University) and Jon Friedrich (Fordham University in New York) continued to collect data as part of a NASA funded grant project on shock effects in ordinary chondrites. The PSU part of the project slowed to a crawl as the new Electron Backscatter Diffraction (EBSD) detector was installed and tested, discovered to be damaged, replaced, re-installed and re-tested. The new equipment also required upgrades in software, so everyone has had a steep learning curve to climb to be able to use the Scanning Electron Microscope (SEM). In the meantime, the three-dimensional images obtained by micro-tomography have proven to be interesting, leading to an abstract and a paper submitted for publication.

Friedrich J.M., A. Ruzicka, M.L. Rivers, D.S. Ebel, J.O. Thostenson and R.A. Rudolph (2013) Metal veins in the Kernouve (H6 S1) chondrite: Evidence for pre- or syn-metamorphic shear deformation. In Press, *Geochimica et Cosmochimica Acta*.

Friedrich J.M., A. Ruzicka, D.S. Ebel., J.O. Thostenson, R.A. Rudolph and M.L. Rivers (2012) Early microstructures of asteroidal building blocks from 3D petrography: A compaction and porosity perspective. Asteroids, Comets, Meteors (ACM) 2012, Abstract #6205.

R CHONDRITE SURPRISE

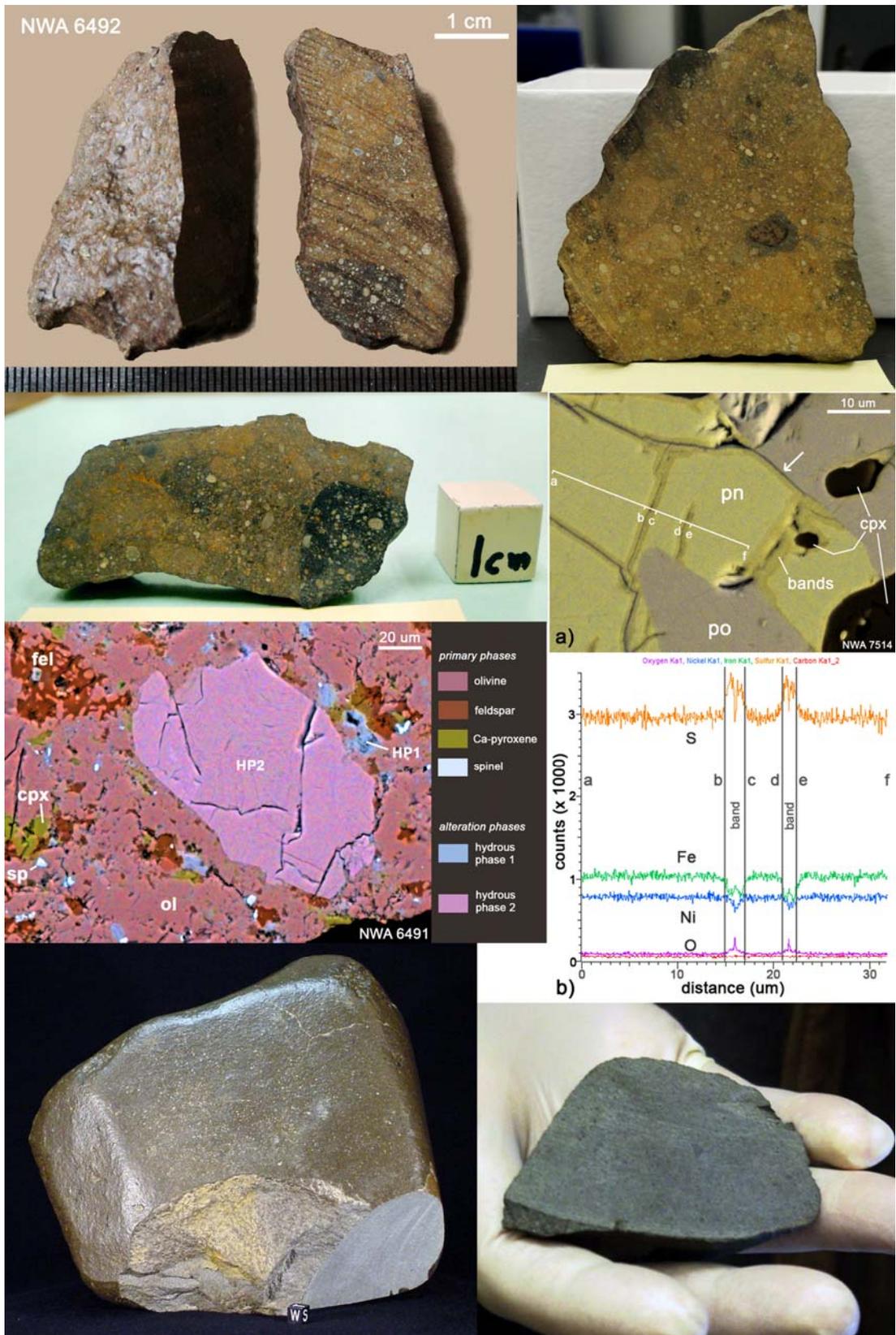
Anyone looking at an older book on meteorites will notice that three broad categories of chondrites are listed: ordinary, carbonaceous, and enstatite. In the mid-1990s, a series of papers defined a new group of chondrites that were heavily oxidized and contained relatively few chondrules. This new group was called the R chondrites (which stands for Rumuruti-like). They contain hydrous alteration products, and it is not clear whether this is all terrestrial weathering, or if some alteration took place in an asteroid (the R chondrite parent body). Almost all of the R chondrites are reddish colored and most are very obvious breccias. So when Tim Stout brought in a fairly featureless gray/slightly greenish-gray stone lacking metal, we had no reason to expect it to be an R chondrite. But it is, and it is the largest and least weathered R chondrite that we know of. We classified it, and it has joined other R chondrites previously classified by CML personnel in a pilot study (funded by public donations) that we hope will lead to grant funding in the future. Tim also donated a framed poster of the thin sectioned imaged in cross-polarized light for the lab. Two abstracts on these samples were presented at the 2013 Lunar and Planetary Science Conference in Houston:

Ruzicka A., M. Hutson, N. Jamsja and T. Stout (2013) Anhydrous and hydrous R chondrites: Evidence from NWA 6491, 6492 and the newly discovered NWA 7514. *44th Lunar Planet. Sci. Conf.*, Abstract #1168.

Claydon J.L., A. Ruzicka, S. A. Crowther, M. Y. P. Lee, A. Bischoff, H. Busemann and J. D Gilmour (2013). First I-Xe ages of Rumuruti chondrites and the thermal history of their parent body. *44th Lunar Planet. Sci. Conf.*, Abstract #2211.

YUCCA CONTINUES

As described in last year's newsletter, the first ever classification done by CML personnel, was a stone called Buck Mountain Wash from an area in western Arizona. This area has been referred to as the Franconia area (for the first meteorite found in the area). During Fall term, Melinda and Alex revised a manuscript on meteorites from the area, and this paper has now been published.



R chondrites: Top 2 images on left are of NWA 6942. The topmost image shows the exterior and a cut face. A better image of that face is below, showing the variety of clasts in this breccia. Top right is NWA 6941, another typical reddish R chondrite with black and orange clasts. Center left: Colorized BSE image of hydrous phases in NWA 6491. Center right: Colorized BSE image, with elemental line scans showing alteration of pentlandite (pn – an iron-nickel sulfide) along cracks. Other phases shown are pyrrhotite (po) and clinopyroxene (cpx). Bottom left: The very large fresh R chondrite NWA 7514 (see the tiny black one centimeter cube at the bottom of the image right for scale). Bottom right: A cut slice of NWA 7514 showing how different it appears from a typical R chondrite.

Hutson, M., A. Ruzicka, T. Jull, J. Smaller and R. Brown (2013) Stones from Mohave County, Arizona: Multiple falls in the "Franconia strewn field". *Meteorit. Planet. Sci.* **48**, 365-389.

As the paper was going to press, the Nomenclature Committee of the Meteoritical Society designated the area as the Yucca Dense Collection Area (Yucca DCA). In late Fall, Alex was contacted by Jérôme Gattacceca of CEREGE (Centre Européen de Recherche et d'Enseignement des Géosciences de l'Environnement) in France about working together on a magnetic susceptibility study of Yucca area stones. So, in early March 2013, Melinda flew to Arizona, and she and Jérôme visited Lake Havasu City to make measurements on two large collections of Yucca stones owned by Jerry Baird and Denny Asher. Samples from ten stones (in most cases whole stones) were donated to CML so that microscopy and chemical analyses could be made to correlate stones with the susceptibility measurements. We would like to thank Jerry and Denny for being gracious hosts and donating samples. The CML portion of this study is funded entirely by public donations.



Upper left image: From left to right are Jerry Baird, Jerome Gattacceca, Melinda Hutson, and Denny Asher. The other three images provide various views of the two rows of tables upon which the Yucca area meteorites were organized.

A SHOCK MELT DIKE AND RYAN

One of the Yucca area stones that we had previously classified is Buck Mountains 005, an L6 chondrite containing a shock melt dike. Alex and Melinda have been working with undergraduate student Ryan Brown to figure out how this unusual feature formed. Denny Asher donated the original sample. A second sample, from Larry Sloan, was scanned using micro-tomography to look at the structure in 3D. Three abstracts have resulted, one given as a poster at the Lunar and Planetary Science conference in March 2013, one as an oral presentation at the upcoming Meteoritical Society meeting, and a third, which will be a poster presentation this coming Winter at the American Geophysical Union meeting.

Brown R., A. Ruzicka, J. Friedrich, M. Hutson and M. Rivers (2013) A shock melt dike in 3D: Shear and melt migration in the Buck Mountains 005 L6 chondrite. *Meteorit. Planet. Sci.*, Abstract #5078.

Hutson M., A. Ruzicka, and R. Brown (2013) A pyroxene-enriched shock melt dike in the Buck Mountains 005 (L6) chondrite. *44th Lunar Planet. Sci. Conf.*, Abstract #1186.

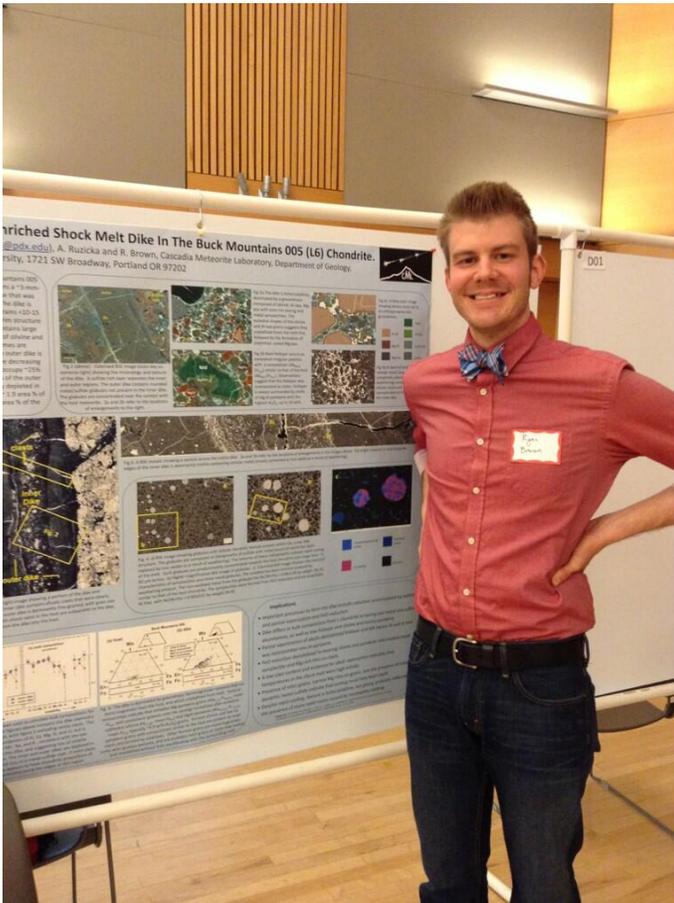
Brown R., A. M. Ruzicka, M. Hutson, J. M. Friedrich, and M. L. Rivers (2013) Micro-tomography and electron microscopy of a shock dike in the Buck Mountains 005 L6 chondrite. *AGU Abstract*.



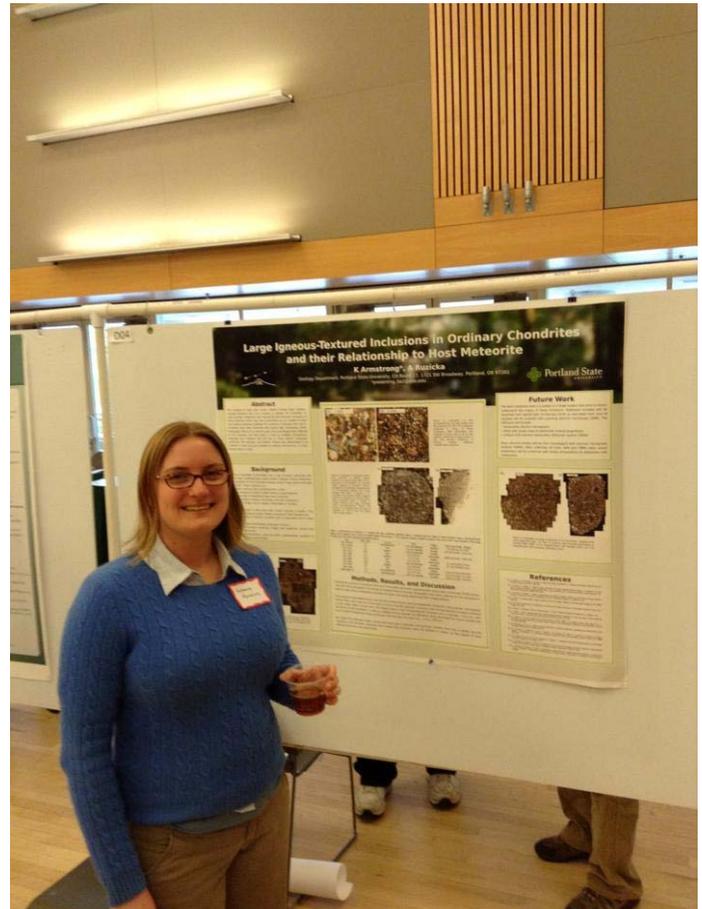
Left: A single stone from the Yucca dense collection area. The shock dike is a straight dark smudge facing the viewer on a cut face. Right: An optical thin section view of the complex shock dike in Buck Mountains 005. This is the first such complex dike described in detail from a chondrite.

This has been an exciting, but moderately expensive project. Ryan managed to collect some data on the electron microprobe (EMP), and some scanning electron (SEM) data, as part of taking two instrument classes at PSU. But we have spent close to \$2000 worth of public donations on this project to date, and still have some loose ends that need a bit more EMP and SEM data. Ryan, Alex, and Melinda will be working together on a manuscript for publication during the early part of the next academic year.

Ryan has worked hard on the shock dike project. He has had an especially good Spring term. In February, he learned he had been chosen to receive a McNair fellowship, which give students a small stipend for research in a STEM (science, technology, engineering, math) field. Ryan took our poster to the Lunar and Planetary Science conference in Houston in March, where he was chosen as one of the conference's official tweeters. In April, Ryan presented the poster at two student venues: the Sigma Xi poster session, and the AEG (Association of Engineering Geologists) poster session. Ryan impressed the judges with his ability to explain the research behind the poster, and won the Sigma Xi award for best undergraduate presentation, and the AEG best graphics award.



Ryan Brown in front of the LPSC poster on Buck Mountains 005 at the Sigma Xi poster session. He won best undergraduate presentation.



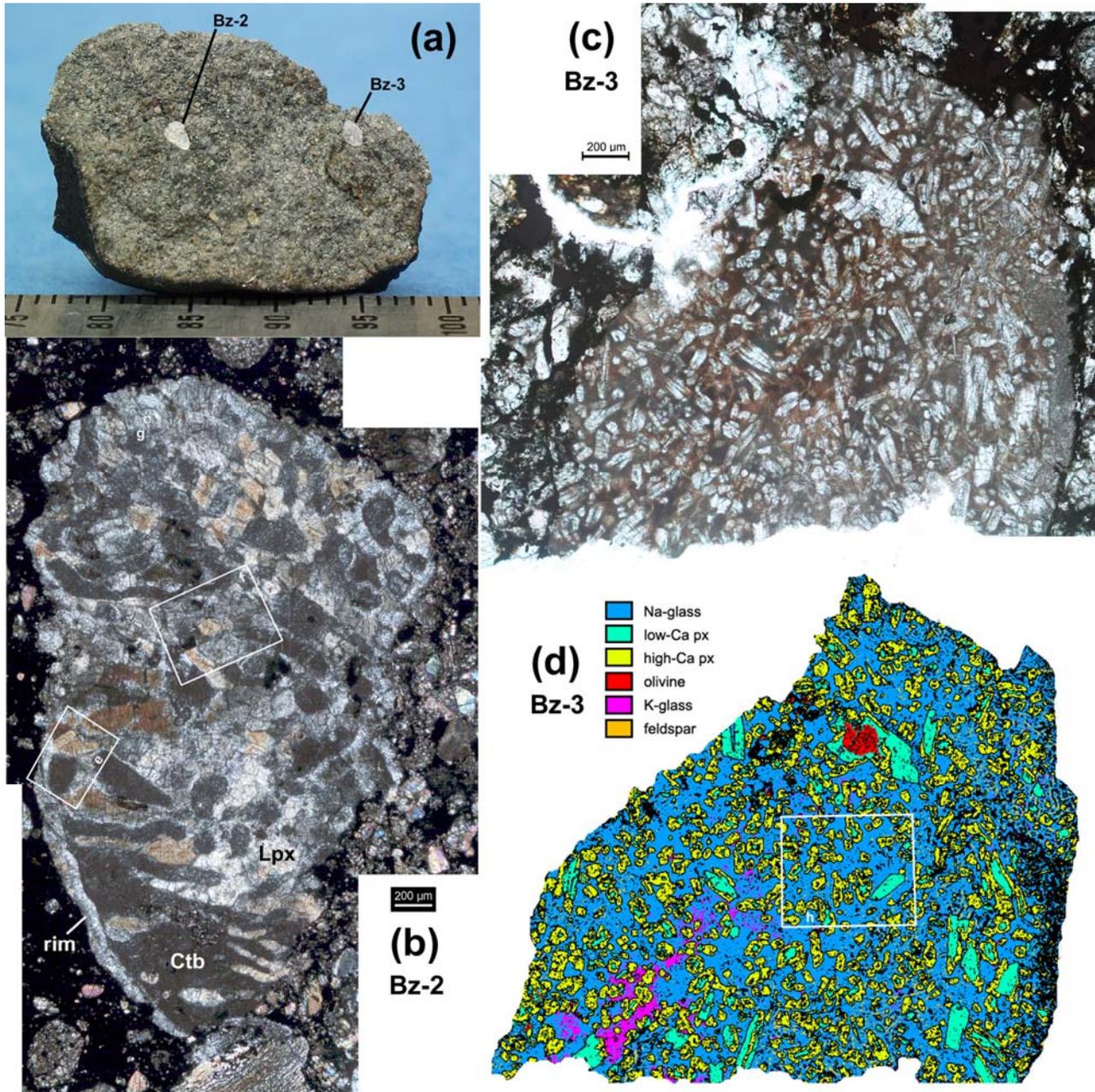
Katherine (Kat) Armstrong at the Sigma Xi poster session presenting her poster on Large Igneous Textured Inclusions in Ordinary Chondrites.

CHONDRITE INCLUSIONS AND KAT

Last year's news letter described the beginnings of the project on inclusions in chondrites, otherwise known as LITEs (large igneous-textured enclaves—a term coined by former undergraduate student Niina Jamsja (now graduated) and Alex in their 2010 paper on NWA 4859). As with many of our “serendipity” projects, Niina’s project grew out of classification of a chondrite with unusual features. Almost at the same time, in 2008 Melinda and Alex classified the newly fallen Buzzard Coulee (H4)

chondrite. Buzzard Coulee contains two very obvious, but different igneous-textured inclusions, referred to as “white” and “tan” inclusions. Follow-up analysis of these inclusions led to another journal article.

Ruzicka A., M. Hutson, C. Floss and A. Hildebrand (2012) Large silica-rich igneous-textured inclusions in the Buzzard Coulee chondrite: Condensates, differentiates, or impact melts? *Meteorit. Planet. Sci.* **47**, 1809-1829.



Above: Images from the paper on Buzzard Coulee inclusions. a) A sample of the meteorite showing white (Bz-2) and tan (Bz-3) inclusions; b) a white inclusion viewed with cross-polarized light under the microscope—the inclusion is composed of pyroxene (Lpx) and cristobalite (Ctb); c) a tan inclusion viewed with transmitted light under the microscope; d) a phase map generated with the SEM showing that the tan inclusion is composed primarily of pyroxene crystals set in a brown-colored glass.

Writing papers on both NWA 4859 and Buzzard Coulee reminded Alex that he had seen similar inclusions in other meteorites. When graduate student Kat Armstrong arrived, Alex started her on a pilot study of LITEs in unclassified chondrites in the CML collection. In order to use these samples, they all had to be classified. Kat has spent much of the year classifying samples and describing the various types of igneous lithologies observed in the CML samples. She will be presenting her initial results this summer at the 2013 Meteoritical Society Meeting in Edmonton. We are happy to report that Kat is the recipient of a student travel award from the Planetary Studies Foundation, which allows her to attend the meeting.

Armstrong K. and A. Ruzicka (2013) Survey of large, igneous-textured inclusions in O-chondrites. *Meteorit. Planet. Sci.*, Abstract #5278.

All of the work described above was funded by public donations, but provided enough data for Alex to apply for grant funding for a project on the topic. Alex was notified at the end of Fall term that his grant proposal entitled “The origin of large igneous-textured inclusions in ordinary chondrites” was funded by NASA’s Cosmochemistry program for \$315,000 over a three year period starting the beginning of 2013. Kat is now receiving funding from the grant for the remainder of her research project. This includes travel funds, which allowed Kat to visit the American Museum of Natural History in New York (AMNH) to select additional samples from their collection for this study. She was so enthusiastic, that she got AMNH curator Denton Ebel excited about the project, and he has become involved in the project.



Above: Images of NWA 7871 (CML 0178), classified by Kat and Alex. Left: the main mass, which is still in the possession of owner Edwin Thompson; Center: slices removed from the main mass—the circled piece was chosen for thin section preparation; Right: thin section of CML 0178, showing the large inclusion (lower left) surrounded by normal chondrite host (the scale bar is 1 mm).

As with Ryan, Kat is having a busy, adventurous year. She went to Sudbury in October to map shatter cones as part of a field project. She presented a student poster at the Sigma Xi poster session in April. She got to venture inside the backrooms in the American Museum of Natural History to look at meteorite samples for the LITE study. She’ll be heading for Edmonton to present a poster at the Meteoritical Society Meeting in August. Then, she’s getting married to Joe Fitzgerald on September 1. So we’re all looking forward to another wedding. Congratulations Kat (and Joe).

DICK REACHES OUT

For the past ten years, Alex has been able to obtain Education/Public Outreach (E/PO) grants from NASA to help fund Dick Pugh's outreach efforts. E/PO grants are supplemental awards which are attached to a research grant. Alex's current E/PO grant will end this coming Spring. Once Alex heard that he had received a Cosmochemistry grant for the LITEs project, he expected to apply for another E/PO grant. But, that program is no longer available through NASA, the direct result of the sequester.

This left us all wondering what was going to happen to Dick's outreach program. Fortunately, an anonymous donor stepped in to supply funding solely earmarked for Dick's E/PO activities. We would like to thank this person again for their generosity.

During 2012-2013, Dick Pugh continued to drive around the Pacific Northwest giving lectures and hands-on demonstrations. He visited schools, libraries, and an interesting assortment of other venues including "Science in the Pub" sponsored by OMSI, and Meteorite Day at the Rice NW Museum of Rocks and Minerals in Hillsboro. Dick put 1875 miles on his truck to give 24 lectures over the past academic year. He spoke to 1259 students and 815 adults. People brought 271 samples for Dick to examine. Of those, 9 were real meteorites, but these were already classified ones, such as Canyon Diablo.



Dick and part of his "teaching collection" of meteorites at Astronomy Day (June 30, 2013) at the Oregon Museum of Science and Industry (OMSI). Photo by Ryan Brown, who was there to assist Dick.

THE SKY IS FALLING AND EVERYTHING ELSE

As all meteorite enthusiasts know, meteors and meteorites were a global sensation this past year. On February 15, 2013, the sky literally fell in the form of a large meteor over Siberia. The meteoroid broke up into hundreds of small pieces. Local media contacted CML, and Dick spent almost a full day at a television station. Edwin Thompson and Dick Pugh donated three pieces of the Chelyabinsk meteorite to CML.



Above: The three pieces of the Chelyabinsk meteorite donated to CML, ranging from very glassy to a veined, light-colored chondrite fragment with partial fusion crust.

In addition to the projects highlighted earlier in this newsletter, there are dozens of other projects at various stages of completion, some involving students (Karla, Kristy, T.J.), some not. Some involve research scientists at other institutions. All of these are being funded by public donations. We also have three additional publications that are not discussed above.

Ruzicka A. (2013) Silicate-bearing iron meteorites and their implications for the evolution of asteroidal parent bodies. *Chemie der Erde*, recently submitted invited review paper.

Ruzicka A. (2012) Chondrule formation by repeated evaporative melting and condensation in collisional debris clouds around planetesimals. *Meteorit. Planet. Sci.* **47**, 2218-2236.

Likkel L., A.M. Ruzicka, M. Hutson, K. Schepker, and T.R. Yeager (2013) Cohenite in chondrites: Further support for a shock-heating origin. *Meteorit. Planet. Sci.*, Abstract #5145.



Alex did some traveling at NASA's expense, including a visit to Johnson Space Center (JSC) in February to review a sample disk used for education/outreach. While at JSC, Alex got a brief tour of the Antarctic meteorite collection. This helped Alex choose some Antarctic samples for the LITE study described above, which are being prepared at JSC as this newsletter is being written.

Left: Alex, all suited up, holding a diogenite found in Antarctica, at the Johnson Space Center.

During the early part of the summer, the lab finally had two of our long-standing "wants" fulfilled. We obtained a used flammable liquids cabinet at no cost. Additionally, the Department of Geology received one-time funds from PSU for equipment for the department. One of the pieces of equipment purchased was a badly-needed sample cabinet for CML.

Looking Ahead

We have accomplished a lot over the last decade (plus one year). But, we are feeling some growing pains. We have had unclassified meteorites come into the lab faster than we can process them, with a current backlog of over 200 unclassified meteorites. Almost half of these need thin sections prepared (which will cost around \$4500). Some of these samples are going to provide surprises that lead to research projects, and potentially to grant funding. But, none of these are scheduled to be examined any time soon. Why? The main reason is that we are understaffed.

Our #1 need is for a full-time curator for the lab. Melinda has been volunteering her time as the lab's curator, but spends most of her time teaching classes. PSU does not have funding for a curatorial position—it will have to come from the E.F. Lange Endowment or some other source. Please consider leaving a generous donation to our Endowment in your will.

NICKELS AND DIMES ADD UP

Although large donations are greatly appreciated and very helpful, it has been the accumulation of small donations that have been our primary source for funding small research projects. Much of what we do is supported not by NASA grants but by philanthropy. If you value the Cascadia Meteorite Laboratory, please send in a donation. Thank you for your support, past, present, and future.



Above: An original photo of the Willamette meteorite, taken in 1903, was discovered among the papers of Erwin F. Lange, and donated to CML by his daughter Carol Lange. The person on the left is Ellis Hughes, discoverer of the meteorite. The other two men are loggers who helped Hughes create the log sledge and load and move the meteorite.

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: _____

Address: _____

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

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Department of Geology
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Portland OR 97207-0751

RETURN SERVICE REQUESTED



*Kitty Killgore,
Melinda Hutson, and
Marvin Killgore,
touring the lab on a
hot day in July 2013.*

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

CML's seventh newsletter

Inside you'll find 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.