The Precambrian Research Center was established in 2007 to satisfy an urgent, long-term need within the private and public sectors of the geological community for geoscientists skilled in geological mapping and the study of Precambrian geology. The Center’s goals are to train geoscientists in modern methods of geological mapping and map making in glaciated Precambrian terranes of the Canadian Shield. As shown in our logo, the Canadian Shield makes up almost half of the North American continent. Such terrains of low-lying ancient rocks form the cores of all continents and are extremely important to global society because they host a large percentage of the world’s mineral resources.

The Precambrian Research Center is managed as a collaborative effort between two geosciences institutions at the University of Minnesota Duluth—the Natural Resources Research Institute and the Department of Geological Sciences. Training in field methods particularly suited to Precambrian terranes is provided through a variety of programs including the Precambrian Summer Field Camp, professional workshops, graduate student advising, and various mapping and Precambrian geology courses offered at UMD. Instructors for these programs include a consortium of experienced Precambrian field geologists from the University, as well as from the Minnesota Geological Survey, other academic and governmental institutions, and private industry.

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Letter from the PRC Directors

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Field camp was another great success and rewarding experience. We are all in agreement that this was, as a whole, the best class of students we’ve had in camp over the past five years. We are pleased and surprised to report that our 2012 field camp is already full! We have accepted 24 students from 18 different schools. Guess the word is getting around.

One of the new things that we will be adding to the upcoming camp is a strong emphasis on field safety. Marsha Patelke, PRC manager, will assume the role of safety coordinator for the camp. Although we have always emphasized safety during the camp, it has been in a rather ad hoc way. We decided after an unfortunate canoe incident on Lake Superior last summer (no injuries, see the field camp write-up for details), that we needed to formally integrate safety into every aspect of the camp. Using the ExxonMobil field safety leadership model, we will develop safety plans for each mapping activity and especially for our capstone projects, which commonly involve mapping in wilderness areas.

Speaking of capstone projects for next summer, we are excited about a new opportunity provided by a major forest fire, the Pagami Creek fire, which affected over 100,000 acres in the Boundary Waters Canoe Area last September. This act of nature has provided us with an outstanding opportunity to map in areas of extensive, freshly exposed outcrop, and will enable mapping at a detail not previously possible. We are planning at least two, and possibly three, capstone mapping projects in the burn area next year. If you have never mapped a burn in a boreal forest, you haven’t lived as a Precambrian mapper. Rather than scrambling through god-awful undergrowth and deadfall, a recent burn is like walking through a park – a very black park in which bone-white outcrop devoid of moss and lichen stand out like macadamia nuts in a chocolate cookie. The area affected is completely within a poorly-mapped area of the Duluth Complex, so Jim and Dean are particularly excited.

The PRC expanded our outreach programs this year in two significant and rewarding ways. The first was to take the lead in planning the 14th Annual Minnesota Minerals Education Workshop. The MMWE is a three-day workshop held annually for K-12 earth and science educators that offers short courses and field trips focused on the geology and mineral resources of Minnesota. The workshops have been held in various locations throughout Minnesota since its inception in 1997. PRC staff have been involved in the workshops in the past (particularly the 2008 meeting in Ely), but this past year took on the leadership and planning role for this very popular workshop. The 2011 MMWE was held in June in Eveleth, MN with field trips focused on the geology and resources of the Mesabi Iron Range. A total of 76 teachers from across Minnesota attended and over 30 people volunteered their time as instructors, field trip leaders, and meeting assistants. The PRC is taking the lead again in planning next summer’s MMWE which will be held at Winona State University in southeastern Minnesota.

Another educational outreach initiative for the PRC this year was our encouragement and sponsorship of UMD geology students to start a Society of Economic Geologists student chapter. With a membership roster of 25 students, UMD was awarded a student chapter in May, 2011. PRC directors George Hudak and Jim Miller, as well as PRC Board Member Ron Morton, are serving as faculty advisors to the new chapter. Students have been meeting regularly and had planned several activities for their first year, including a spring break trip to visit mines in New Mexico and Arizona.

An unofficial PRC activity that nevertheless kept Jim and George busy most of last year was serving on the field trip committee for the 2011 national Geological Society of America meeting in Minneapolis. Our task was to solicit, encourage, remind, and advise potential leaders on trip planning, and then to encourage, remind, and review their guidebook contributions. A total of 40 trips were offered and 23 actually ran. As a consequence of this time commitment for the October meeting, we decided to not run a PRC professional workshop in 2011. However, we are gearing up for our fifth professional workshop scheduled for next fall on the topic of frac sand mining in Minnesota and Wisconsin.

A new initiative that we will offer this coming May is the first PRC professional field camp. With encouragement from our Board of Advisors and our many company supporters for such a camp, we plan to routinely offer a 7-10 day field camp each spring that is intended for professional geologists who need more advanced training in field mapping. The course will teach mapping and field observational skills that are specific to a particular type of Precambrian terrane, with an emphasis on collecting field data that would aid in evaluating the mineral potential of that terrane. Our first camp, which will be led by PRC directors Peterson and Hudak, will be held in the Ely-Soudan area of northern Minnesota next May and will focus on mapping in Achenrite greenstone belts that are prospective for lode gold deposits.

A great success this past year has been the record number of membership contributions to the PRC from corporate and individual sponsors. Total contributions for 2011 were $99,000, which is almost $9,000 more than we raised in 2007, our first year. And already in 2012, we have received over $25,000. This support has come from the sustained contributions of our longtime corporate members like Anglo American, Cliffs Natural Resources, Duluth Metals, Golder Associates, Newmont, Prospectors and Developers Association of Canada, and Teck American, and individuals like Tom Gardner, Al MacTavish, and Chris White. We also welcome our first-time supporters – Antofagasta PLC, Barr Engineering, Kennecott Exploration, Twin Metals Minnesota, Dave Groves, and Paul Lindberg.

Thanks to this fantastic show of support, the PRC has been able to increase the number of graduate research assistantships given out from one in preceding years, to three in the 2011-12 academic year.

Finally, on a more somber note, the PRC lost an avid supporter and true friend with the passing of Richard Patelke in September. Rich, a UMD graduate (MS'86) and most recently chief geologist for PolyMet mining, was an early and ardent supporter of the PRC. When we were first seeking moral as well as financial support for the PRC back in 2006, Rich wrote an impassioned letter about the need for a field school like we were proposing.

“Minnesota has all the components in place to be a major minerals producer: permiscive geology, reasonable environmental permitting rules, infrastructure, and a capable workforce; but currently the state lacks the critical mass in skilled entrepreneurs/field geologists to bring companies into the area. Exploration is a high risk and expensive process - for us as a geologic community to move forward we must offer companies the human resources on the ground that they need. The ‘Precambrian Research Center’ seems like the best first step in the growth of a revived Minnesota minerals industry.”

Thanks to Rich’s efforts on several fronts, that growth is quickly taking shape. To honor Rich’s legacy and his support of the PRC, Marsha Patelke, his wife and best friend, established a scholarship fund to support UMD students wishing to enroll in the Precambrian field camp. We greatly appreciate Marsha’s benevolence and we are honored to be able to remind students each year about the passion and expertise that Rich applied to field studies of Minnesota’s geology.

Thanks to everyone who has believed in our mission of training students and professionals in field studies of Precambrian geology this past year. We raise a glass of cheer for a prosperous and productive 2012.
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Dean Peterson
Jim Miller

Precambrian Research Center 2011 Annual Report

George Hudak

Precambrian Research Center 2011 Annual Report

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Thanks to everyone who has believed in our mission of training students and professionals in field studies of Precambrian geology this past year. We raise a glass of cheer for a prosperous and productive 2012.
The fifth Precambrian Research Center Field Camp took place July 10 - August 19, 2011. Once again, 22 students representing 16 different colleges from across the United States, participated in the camp. The 2011 field camp faculty included the PRC Directors Jim Miller, George Hudak, and Dean Peterson, as well as Mark Asp (Minnesota Geological Survey), Phil Larson (Duluth Metals), Nigel Watrous (UMD Department of Geological Sciences), Martha Panichi (NRRI-UMD), and Mark Severson (NRRI-UMD). Amy Radakovich and Ben Brooker (both alumni) of the 2010 PRC Field Camp were excellent teaching assistants for the course.

As in the past, we taught fundamental mapping skills that comprise the curriculum at most field camps, but continued to focus the bulk of our training on specialized training in skills that are needed to efficiently and effectively map in glaciated Precambrian shield terrains. Exercises involving diamond drill core logging, surficial (glacial) mapping, mineral prospecting techniques, magnetic and gravity geophysical surveying and interpretation, metamorphic grade recognition, identification and interpretation of polyphase deformational structures and fabrics, and recognition of economic mineralization and associated alteration remained essential and unique components of our program. Unfortunately, we were unable to conduct a underground mapping project of the Soudan Underground Mine State Park as in past years, due to a shaft fire earlier in the year. Field camp projects (described below with maps on the back cover of this annual report) enabled students to rapidly (less than 2 weeks!) transform their field observations and interpretations into high quality, published geological maps and professional presentations that utilized a variety of software tools including ArcMap, Microsoft Excel, Microsoft Word, Microsoft PowerPoint, Adobe Illustrator, Adobe Photoshop, AutoCAD and Surfer.

Eight mapping projects involving a wide variety of geologic units, including metasedimentary, metavolcanic, and intrusive rocks were completed during the first four weeks of camp. Minor changes once again took place in the curriculum based on student feedback. The significant changes was the wonderful opportunity presented by the Minnesota Department of Natural Resources to conduct complete and detailed mapping of Soudan Mine State Park for our greenstone mapping project during the fourth week of camp. This mapping built on capstone projects conducted in 2010 at Soudan Mine State Park and the adjacent, new Lake Vermilion State Park. The Precambrian Research Center is currently in the process of compiling a new, detailed (1:5,000 scale) geological map of Soudan Underground Mine State Park and Lake Vermilion State Park that the Minnesota DNR intends to make available for state park visitors and park planners for years to come.

During the fifth week of camp, students and faculty once again dispersed across northeastern Minnesota to conduct their capstone mapping projects in previously unmapped or poorly mapped areas. Four capstone mapping projects were completed, including:

- Reconnaissance shoreline mapping of Archean geology of the central Boundary Waters Canoe Area Wilderness. Under the direction of Mark Asp, this mapping project was the most ambitious capstone mapping effort to date, involving mapping parts of four 7.5-minute quadrangles along a 44-mile traverse through 22 lakes and even more portages.
- Detailed mapping of Mesoproterozoic layered mafic-ultramafic rocks associated with the Brule Lake-Hovland gabbro complex in the Sawbill Lake area.
- Under the direction of Jim Miller, this capstone extended, and built upon earlier capstone studies completed by FC students in 2007, 2009, and 2010. This series of capstone mapping projects will be integrated with new mapping by Ben Brooker (FC student in 2010, FC teaching assistant in 2011) as part of his MS thesis at UMD.
- Regional mapping of previously unreported, high grade metamorphic rocks of the Quetico Subprovince along the Vermilion River. This capstone project, under the direction of Dean Peterson, included shoreline mapping and geophysical traverses through a sequence of granitoids, associated gneisses and schists, and mafic intrusions and dikes that host historic gold prospects. The students were able to decipher large-scale structural elements that were previously unknown in this area.
- Detailed mapping of the eastern half of Lake Vermilion State Park. Under the direction of George Hudak, this capstone project completed the mapping of Lake Vermilion State Park initiated during the 2010 PRC capstone efforts, and has resulted in significantly more detailed geological information than previously available in this part of the Vermilion District.

During the final week of camp, students digitally compiled their field data, developed geologic map interpretations, and produced summary PowerPoint presentations. On the last day of camp, the five new capstone maps were unveiled to the PRC faculty, minerals industry professionals, and other invited guests. The five new capstone maps are illustrated on the back cover of this annual report. These maps, as well as the students’ final PowerPoint presentations on the maps, can be downloaded from the PRC website: www.dsm.umn.edu/prc/fieldcamp/Capstone%20Projects.

Of the 22 students who completed the 2011 PRC Field Camp, all but one went back to complete their undergraduate geology degrees at their respective colleges and universities. Currently, several are applying for graduate studies in the geological sciences, and two 2011 field camp alumni are employed in the minerals industry. Several of our 2011 field camp alumni have applied to UMD to initiate their graduate studies in economic geology in fall, 2012.

As in the past, the PRC faculty were truly impressed by the efforts, skills, and work ethic of the 2011 field camp students. As indicated by their comments (page 7), most student feel that the camp has given them the confidence and special skills that will allow them to be successful and make big contributions to the geosciences.

In planning for the 2012 PRC Field Camp, we developed an "Early Application Option" so that students could be informed of their acceptance into the program at an earlier date than in the past. This enabled students to better plan for their upcoming summer programs, and will allow them to be successful and make big contributions to the geosciences. It was again impressive with 18 different schools being represented. Based on the impressive academic records of these applicants, we anticipate that the "Early Application Option" will continue to be a popular choice for incoming PRC field campers. Once again, we are very grateful to the 22 students who have contributed to the success of the 2011 PRC Field Camp.

The diversity of the group is again impressive with 18 different schools being represented. Based on the impressive academic records of these applicants, we anticipate that the "Early Application Option" will continue to be a popular choice for incoming PRC field campers. Once again, we are very grateful to the 22 students who have contributed to the success of the 2011 PRC Field Camp.
Precambrian Field Camp

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Eight mapping projects involving a wide variety of igneous, metamorphic, and intrusive rocks were completed during the first four weeks of camp. Minor changes once again took place in the curriculum based on student feedback. The two major changes were the wonderful opportunity presented by the Minnesota DNR to map a greenstone complex in northeastern Minnesota to conduct their capstone mapping projects in previously unmapped or poorly mapped areas.

Four capstone mapping projects were completed, including:

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In planning for the 2012 PRC Field Camp, we developed an “Early Application Option” so that students could be informed of their acceptance into the program at an earlier date than in the past. This enabled students to better plan for their upcoming summer that may have committed to other field camps. By the January 24 early application deadline, 25 students had applied for the 24 available slots – the earliest we have filled up to date. The diversity of the group is again impressive with 18 different schools represented. Based on the impressive academic records of these applicants, we anticipate an even more robust class next summer.

Students

2011 Field Camp Staff

Principal Instructors:

George Hudak
Natural Resources Research Institute
Univ of Minnesota Duluth
Expertise: Volcanology, Economic Geology, Geologic Mapping

Jim Miller
Dept. of Geological Sciences
Univ of Minnesota Duluth
Expertise: Structural Geology, Geologic Mapping

Dean Peterson
Duluth Metals Ltd.
Expertise: Economic Geology, Geologic Mapping

Associate Instructors:

Mark Jirsa
Minnesota Geological Survey
Univ of Minnesota Duluth
Expertise: Mapping, Structural Geology

Phil Larson
Duluth Metals, Ltd.
Expertise: Economic Geology, Geologic Mapping

Mark Severson
Natural Resources Research Institute
Univ of Minnesota Duluth
Expertise: Geochemistry/Geotagging

Nigel Watrous
Department of Geological Sciences
Univ of Minnesota Duluth
Expertise: Economic Geology, Geologic Mapping, Core Logging

Teaching Assistant:

Amy Radakovich
Univ of Minnesota Duluth
MS Candidate, 2011 FC alum

Ben Brooker
Univ of Minnesota Duluth
MS Candidate, 2010 FC alum

2011 Field Camp Faculty

Precambrian Research Center 2011 Annual Report

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with each assignment in a different environment."

"Shield was the greatest part and it was executed very well."

"Becoming familiar with the geology of the Precambrian was invaluable. The professors were very involved and organized and also to not be afraid to ask questions."

"Confidence and detailed observation are key. Being thorough and organized and also to not be afraid to ask questions."
Field Camp Student Comments

“My confidence is far greater with geology than I ever expected it could be in six weeks”

At the end of the field camp, students were asked to anonymously evaluate their experience by answering a series of questions. Here are some of their comments.

How did this camp meet your initial expectations?

“I was really nervous at first thinking that I would be completely lost, until I realized that the staff was so good about helping and explaining stuff.”

“The camp definitely focused on Precambrian rocks, which is what I expected, but so much more enjoyable than I could have hoped for.”

“I knew that I would learn a lot but I didn’t know just how much the time in the field would help improve myself as a geologist.”

“This camp met and exceeded my expectations. Knowledge that I gained, skills acquired, and good times had were more than I could have dreamed.”

“It was kind of a shock to be in the field right away, but I learned a lot straight away. The professors were very involved and organized and also to not be afraid to ask questions.”

“Absolutely. Having industry people at the capstone presentation was an excellent idea and extremely helpful.”

“This camp greatly improved my field observation skills and documentation.”

How do you think this camp will help you with your career goals?

“My field skills have never been anywhere near what they are now and with the connections given to me from the final capstone presentation, my career will be successful.”

“It will help me network to get a future job and start my career. Also, I now have the confidence and ability to map an area and show that I’m capable.”

“Hopefully a lot. I think the skills that this camp teaches are unlike any other nation-wide.”

“What I expected it could be in six weeks”

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What are your enduring understandings from this experience?

“How to map and how maps are put together. I’ll never look at a map again and not appreciate the work put into it.”

“Confidence and detailed observation are key. Being thorough and organized and also to not be afraid to ask questions.”

“Maps are personal interpretations of factual data. There is no right or wrong.”

“How happy I am that I chose geology as a major and furthermore, that I went to a great school with a great field camp with an emphasis on economic geology.”

“I have learned to be a professional geologist!”

A primary objective of the Precambrian Research Center is to provide financial and advisory support to graduate and undergraduate students conducting field-based research on the Precambrian geology, primarily in the Lake Superior region. This support comes in the form of graduate research assistantships, which are limited to UMD graduate students in their second year of study, and research grants, which are available to undergraduate or graduate students from any school. The extent to which the PRC can provide such support depends on the annual level of corporate and individual or membership contributions. With a record level of contributions in 2011, we were able increase our support of students for the 2011-12 academic year to about $30,000 (see pg. 18).

Graduate Research Assistantships

Whereas only one graduate research assistantship (GRA) has been awarded annually in previous years, this year two and one-half GRAs were awarded for the 2011-12 academic year. Two full year GRAs were awarded to Ben Brooker and Matt Chaffee and a GRA for the Spring 2012 semester was awarded to Chris Goscina. All three graduate students are expected to complete their MS theses by the summer of 2012.

Ben Brooker, who is a 2010 PRC field camp alum and served as a field camp teaching assistant in 2011, is conducting his field-based MS thesis on a previously unnamed and poorly mapped layered mafic intrusion comprising the eastern Duluth Complex. Mapping of this intrusion has been the subject of capstone Grant Grant since 2007 under the supervision of Jim Miller. The main objective of Ben’s thesis is to integrate prior mapping with new mapping that he conducted in the summer of 2010 to create a geologic map of what he is calling the Sawbill Lake intrusion. Follow-up petrography and mineral chemical analyses of samples collected during the mapping will be used to document the igneous stratigraphy and evaluate the petrogenesis of the Sawbill Lake intrusion. Support for Ben’s thesis comes from a U.S. Geological Survey and a PRC research grant. Dr. Jim Miller serves as Ben’s thesis advisor.

Matt Chaffee has received his GRA as part of a Student Sponsorship Grant awarded to the Precambrian Research Center by Magma Metals Ltd of Perth, Australia (see pg. 12). Matt’s MS thesis seeks to evaluate the petrogenetic relationship between a Ni-Cu-PGE sulfide mineralized ultramafic intrusion (the Current Lake Intrusion) and a marginal, strongly altered, inclusion-rich, heterogeneous mafic to intermediate intrusive rock (termed the hybrid unit). These ultramafic and hybrid units are encountered in drill core from Magma Metal’s Thunder Bay North property in NW Ontario. Magma Metals contributed a total $37,000 toward salary and research support of Matt’s thesis and employed him during the summer of 2011. Dr. Jim Miller serves as Matt’s thesis advisor.

Student Research Assistantships & Grants

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Chris Goscina is conducting fieldwork, microstructure kinematic analysis, and quartz petrographic fabric analyses to evaluate the sense of shear along major shear zones in the Archean Vermillion District. This kind of structural analysis has yet to be applied to this area and will prove useful in determining if shear sense is parallel, or perpendicular, or at some angle to lineation. Chris conducted several weeks of field work in the summer of 2011. Chris’ thesis project is also being supported by a research grant. Dr. Vicki Hansen serves as Chris’ thesis advisor.

Update on previous PRC GRA recipients

Chris White (PRC GRA 2007-08, MS 2009) has been working for Cardero Iron Ore since 2009 as project geologist for exploration of the Titac and Longnose Tri-Fe deposits of the Duluth Complex.

Tom Johnson (PRC GRA 2008-09, MS 2009) has been working for Marine Tech, a marine engineering and services company based in Duluth.

Dan Foley (PRC GRA 2010-11, MS, 2011) has been working for Kennecott Eagle Corp. (Rio Tinto subsidiary) out of Marquette, Michigan since fall 2011.

Student Research Grants

The Precambrian Research Center awarded about $5,000 in research grants to five students in 2010 to support their graduate research on a variety of field-based Precambrian geology topics. The students, their colleges, the award amounts, the use of the grant, and the topic of their research is listed below.

Earnest Thalhammer, Univ. of WI-Milwaukee, MS Candidate Award: $1000 for field expenses and thin sections. Research Topic: Analyzing ductile shear zone network geometries in the Grassy Portage Sill, Rainy Lake region, northwestern Ontario, Canada.

Jon Dyes, University of Minnesota Duluth, PhD Candidate Award: $1200 for field expenses and thin sections. Research Topic: Age and structural and kinematic analysis of multiple Archean shear zones, Superior Province Northeastern Minnesota.

Amy Radakovich, University of Minnesota Duluth, MS Candidate Award: $1000 for mineral chemical analyses. Research Topic: Crystallographic preferred orientations and structural and kinematic analysis of multiple Archean shear zones, Superior Province Northeastern Minnesota.

Ben Brooker, University of Minnesota Duluth, MS Candidate Award: $1000 for field expenses and thin sections. Research Topic: Geology and petrology of the Sawbill Lake Intrusion, Brule Lake and Cherokee Lake 7.5' Quadrangles, Northeastern Minnesota.

Amy Radakovich, University of Minnesota Duluth, MS Candidate Award: $1000 for mineral chemical analyses. Research Topic: Age and structural and kinematic analysis of multiple Archean shear zones, Superior Province Northeastern Minnesota.

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Another important function of the PRC is to conduct outreach activities intended to educate the general public and K-12 educators about Lake Superior area geology and mineral resources. The PRC served as the lead organizer for the 14th Annual Minnesota Minerals Education Workshop (MMEW) held June 21-23, 2011 at the Mesabi Range Community and Technical College in Eveleth, Minnesota. A total of 76 participants, composed largely of K-12 earth science teachers from throughout Minnesota, attended the three-day workshop. The first day was devoted to participants attending four of 17 short course offerings on a variety of geologic and mineral resource topics. The courses were taught by volunteers from local academic institutions, K-12 schools, state agencies, and mining and geo-engineering companies. The second and third days of the workshop were devoted to field trips in the central Mesabi Range. Included in the field trips were visits to PolyMet Cu-Ni mining facilities (tailings basin, crushing and mill facilities, and core logging shed), the former LTV taconite mine, and mineral occurrences in the NorthMet deposit of the Duluth Complex. Eleven UMD geology students participated in the trip, which was led by Jim Miller and George Hudak. The group was joined by 12 economic geology students and their instructor (Dr. Geoff Pignota) from the University of Wisconsin-Eau Claire and by 24 engineering geology students and their instructor (Dr. Carlos Caranaza-Torres) from UMD.

With the encouragement and advisement by PRC directors, students in the Department of Geological Sciences at UMD applied to the Society of Economic Geologists to start an SEG student chapter last spring. Approval for a student chapter was awarded on May 31st. Four students volunteered for executive positions and twenty-five students, a mix of undergraduates and graduates, signed up to be members. George Hudak, who is an SEG fellow, serves as Academic Sponsor; Harry Noyes (Encampment Resources and UMD graduate), who is the current SEG Treasurer, serves as Industry Sponsor; and Jim Miller serves as Faculty Advisor.

Activities sponsored by the UMD-SEG student chapter during the fall semester included:

- Sept. 11 – Host of a pizza lunch during an American Geosciences Institute webinar on “Canadian Exploration-High Demands for the Future Workforce”
- Oct. 6 – Noon-hour lecture to students on “China and the Growing Demand for Minerals Resources” by Dr. Chusi Li of Indiana University. Dr. Li was a 2011 SEG traveling lecturer who also gave a department seminar entitled: “Formation of magmatic sulfide deposits in magma conduits: Examples from Jinchuan, NorthSak and Voisey’s Bay”
- Oct. 29-30 – SEG-PRC-sponsored field trip on the geology and mineral deposits of northeastern Minnesota. Eleven UMD geology students participated in the trip, which was led by Jim Miller and George Hudak. The group was joined by 12 economic geology students and their instructor (Dr. Geoff Pignota) from the University of Wisconsin-Eau Claire and by 24 engineering geology students and their instructor (Dr. Carlos Caranaza-Torres) from UMD.

The PRC directors and staff were deeply involved in the planning, organizing and production of field trips associated with the 2011 National Geological Society of America meeting to be held in Minneapolis, October 9-12, 2011. Jim Miller and George Hudak served as chair and co-chair, respectively, of the field trip committee. Along with two other co-chairs and a GSA Field Trip coordinator, the committee met regularly to develop a slate of 43 field trips and to edit guidebook contributions. In the end, 20 trips filled sufficiently to be run, including several led by PRC-affiliated staff. GSA published a 544-page guidebook that includes field trip descriptions for 25 trips.

In addition, Jim Miller took the lead in organizing two half-day topical sessions on the “Geology and Mineral Deposits of the Midcontinent Rift.” The sessions included 22 oral and two poster presentations. The Society of Economic Geologists has agreed to publish contributions on the subject in a special issue of Economic Geology. Presentations by PRC-affiliated students and professionals included:

- GOLDBERG, Brian D. 1st, and MILLER, James D. 1st – Emplacement and crystallization history of the Tamarack intrusion, Minnesota.
- PETERSON, Dean M. 1st – Disseminated Cu-Ni-PGE deposits in the South Kawishiwi intrusion of the Duluth Complex: End result of intense crystallization of sulfide-bearing magmas.
- HEGGIE, Geoff, MACTAVISH, Allan, JOHNSON, Justin, MA, Leon, and CHAFFEE, Matt 2nd, 3rd – Thunder Bay North Pt-Pd-Cu deposit.
- GALÍ, Benedek 1st, 2nd, MOLNÁR, Ferenc, MOGESSIE, Aberra, and PETERSON, Dean M. 1st – Segregation of magmatic fluids during crystallization of the Cu-Ni-PGE-mineralized South Kawishiwi intrusion of the Duluth Complex, Minnesota, USA.
- CERVIN, Daniel D. 1st – Characterization of precious metal mineral occurrences in the NorthMet deposit of the Partridge River Intrusion, Duluth Complex, Minnesota.
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- MILLER, James D. Jr., GOLDER, Brian D., FOLEY, Daniel J.; HEGGIE, Geoff, and HOLLINGS, Peter – Parent magma characteristics of early Midcontinent Rift ultramafic intrusions
- PETERSON, Dean M. – Disseminated Cu-Ni-PGE deposits in the South Kawishiwi intrusion of the Duluth Complex: End result of magma evolution and crystallization of sulfide-bearing volcanic lobe.
- HEGGIE, Geoff, MACAVISH, Allan, JOHNSTON, Justin, MA, Leon, and CHAPFEE, Matt – Thunder Bay North Pt-Pd-Au deposit.
- GÁL, Benedek; MOLNÁR, Ferenc, MOGESSIE, Aberra, and PETERSON, Dean M. – Segregation of magmatic fluids during crystalization of the Cu-Ni-PGE-mineralized South Kawishiwi intrusion of the Duluth Complex, Minnesota, USA.
- CERVIN, Daniel D. – Characterization of precious metal mineral occurrences in the NorthMet deposit of the Partridge River Intrusion, Duluth Complex, Minnesota.
Other Activities (cont.)

2011 INSTITUTE ON LAKE SUPERIOR GEOLOGY MEETING

Poster presentations by PRC-affiliated participants included:
- Jakob Wartman1, 2, Ron Morton, George Hudak3, and Cory Hercun – Physical volcanology and hydrothermal alteration of the Rainy River Gold Project, Northwestern Ontario
- Britanny Saylor, Jonathan Stencil, Michael DeVlazzio4, and Prajukti Bhattacharyya – Whole rock geochemical analyses of sheared granitic rocks from Mountain, Wisconsin
- Terrence J. Boerboom5 and John C. Green – Bedrock geologic maps of the Grand Marais and Kadunce Creek River Quadrangles, North Shore of Minnesota
- *Cabin Ross1,4, George Hudak1, Ron Morton, Tom Quigley, and Bob Mahin – Preliminary stratigraphy and physical volcanology associated with the Paleoproterozoic Back Forty VMS deposit, Menominne County, Michigan
- George Hudak1, Stephen Monson Geerts, Larry Zanko, April Severson, Allison Severson, and Bryan Bandli – The Minnesota Taconite Workers Health Study: Environmental study of airborne particulates - 2011 update

As has been the tradition since 2008, PRC field camp capstone maps (see back page) are presented as a poster presentations at ILSG. Poster presentations from the 2010 field camp included:
- Eric Carlson, Corey Holton, Kyle, Kubitsa, Lucy Mulvey, Eric Scheurer, and Terry Boerboom – Mesoproterozoic bedrock in the Kadunce River Quadrangle, NE Minnesota—Precambrian Research Center Capstone
- Ryan Birkmeier, Tyler Boles, Brittneee Brannan, Ryan Doucette, Aubrey Lee, and Mark Jirsa – Geologic mapping of Neoproterozoic rocks near Opishnemuke northen Lake, by students of the Precambrian Research Center’s 2010 field camp
- Ben Brooker, Max Hadley, Levi Markwood, Jeff Olson, Alex Tomilinson, and Jim Miller – 2010 Precambrian Field Camp Mapping in the Jack Lake Area, Cook County, Northeastern Minnesota
- Amy Radakovik, Charlie Parent, Molly Partridge, Andrew Ritts, Rita Pierce, and George Hudak – Reconnaissance Bedrock Geological map of the northern part of Sudab Underground Mine State Park and the northwestern part of Lake Vermillion State Park, St. Louis County, Minnesota
- Alli Vallowe, Ernie Thalhamer, Damon Rhoades, and Dean Peterson – Surface and subsurface geologic maps of the Soudan Underground Mine State Park, St. Louis County, Northeastern Minnesota

2011 GEOLOGICAL ASSOCIATION OF CANADA – MINERALOGICAL ASSOCIATION OF CANADA MEETING (GAC-MAC)

Two PRC alumni, Cabin Ross and Jakob Wartman, presented posters on their Master’s thesis research at the annual GAC-MAC meeting held in Ottawa, Ontario in May, 2011. Once again, Cabin Ross was awarded one of several best student paper awards at the meeting.
- Jakob Wartman1,2, Ron Morton, George Hudak3, and Cory Hercun – Physical volcanology and hydrothermal alteration of the Rainy River Gold Project, Northwestern Ontario
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* Recipients of Best Student Paper Awards
### 2011 INSTITUTE ON LAKE SUPERIOR GEOLOGY MEETING

PRC-affiliated students, faculty, and staff were well represented at the 57th Annual Institute on Lake Superior Geology (ILSG) held May 18–21, 2011 in Ashland, Wisconsin. PRC director, Jim Miller, led a pre-meeting field trip on the “Igneous Stratigraphy of the Layered Series at Duluth - Type Intrusion of the Duluth Complex.” PRC field camp instructor, Terry Boerboom of the Minnesota Geological Survey led a post-meeting trip entitled: “The Archean/Paleoproterozoic Unconformity near Denham, Minnesota.”

Oral presentations by PRC-affiliated participants included:
- Phil Larson, John Swenson, and Marsha Patelke – The Biwabik Iron Formation: geochemical and textural evidence for deposition of iron-formation in a Paleoproterozoic epeiric sea
- Stephanie Theriault, Jim Miller, Mike Berndt, and Ed Ripley – The mineralogy, spatial distribution, and isotopic geochemistry of sulfide minerals in the Biwabik Iron Formation
- Michael Totenhagen, Penny Morton, and Phil Larson – Characterization of gangeous minerals in lower cherty ores of the Biwabik Iron Formation at United Taconite LLC
- Dan Cervin, Penny Morton, Jim Miller, and Richard Patelke – Characterization of precious metal occurrences in the NorthMet deposit of the Partridge River Intrusion, Duluth Complex, Minnesota, USA
- Dan Foley2,3,4 and Jim Miller – Petrology and Cu-Ni-PGE mineralization of the Bosive Igneous Complex, Baraga County, Northern Michigan
- Erik R. Tharalson and Thomas Monecke – Geology and mineralization of the Serpentine Cu-Ni deposit, Duluth Complex Minnesota
- Brian Goldner and Jim Miller – Petrology of the Ni-Cu-PGE-mineralized Tamarack Intrusion, Aitkin and Carlton Counties, Minnesota
- Dean Peterson, Phil Larson, Gabriel Sweet, and Jack Gibbons – The Mineral Exploration Trifecta

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- Ryan Birkmeier, Tyler Boley, Brittnée Brannan, Ryan Doucette, Aubrey Lee, and Mark Jirsä – Geoologic mapping of Neoproterozoic rocks near Ogishkemuncie Lake, by students of the Precambrian Research Center’s 2010 field camp
- Ben Brooker, Max Hadley, Levi Markwood, Jeff Olson, Alex Tomlinson, and Jim Miller – 2010 Precambrian Field Camp Mapping in the Jack Lake Area, Cook County, Northeastern Minnesota
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At its inception, the Precambrian Research Center established a Board of Advisors whose role is to offer advice and counsel to the PRC directors on PRC programs. The Board serves as a vehicle for communication and interaction between the PRC, academia, geological surveys, and the mineral industry. In addition to being ambassadors in the larger geological community, the board provides fresh and objective viewpoints on strategy, curriculum, funding opportunities, collaborative educational opportunities, and research programs.

Since 2009, the PRC Board of Advisors has held its annual meeting during the Prospectors and Developers Association of Canada (PDAC) convention held each March in Toronto. After the 2011 meeting, three advisors retired from the board: Greg Stott of the Ontario Geological Survey, Dave Groves of Newmont Mining, and Prof. Bruce Marsh of Johns Hopkins University. We greatly appreciate the guidance and advice each has provide to the PRC since its inception. We are glad to know that we can continue to seek their counsel and expertise as needed in the future.

The PRC is happy to welcome three new advisors this year to fill the vacant positions.

Professor Paul Spry will assume the Academic Position vacated by Bruce Marsh. Paul's research interests are in economic geology, mineralogy and petrology and include the geochemistry of metallic and non-metallic deposits. He is particularly interested in the petrological, mineralogical, structural, geochronological, stable isotope and fluid inclusion characteristics of epithermal and mesothermal gold deposits, as well as the effects of metamorphism on volcanogenic massive sulfide deposits.

Mark Smyk will assume the Canadian Survey Position vacated by Greg Stott upon his retirement. Mark has worked for the Ontario Geological Survey, MNDM in Thunder Bay since 1987. He currently serves as Northwest Regional Manager for the Resident Geologist Program. He is a recipient of the Samuel Goldich Medal presented by the Institute on Lake Superior Geology for his contributions to the understanding of the geology of the Lake Superior region, most recently in collaborative research on the Midcontinent Rift.

Mike Nemitz will fill the Industry Position vacated by Dave Groves. Like Dave, Mike works for Newmont Mining, a long-standing corporate sponsor of the PRC, and is a UMD graduate (BS ‘01). He currently manages Newmont’s exploration activities in New Zealand. In previous roles, Mike managed exploration projects in Alaska, Yukon, and Nevada with lesser roles associated with projects in Wyoming, California, and Mexico.

Current PRC Board Members
- Donald Fosnacht, Director, Center for Applied Research and Development
- Ron Morton, Head, Department of Geological Sciences
- Harvey Thorleifson, Director, Minnesota Geological Survey
- Mark Smyk, NW Resident Geologist, Ontario Geological Survey
- Harold Gibson, Professor, Director-Minerals Exploration Research Centre, Laurentian University
- Mark Hannington, Professor, Goldcorp Chair in Economic Geology, University of Ottawa
- Paul Spry, Professor of Economic Geology, Iowa State University
- James Franklin, Franklin Geosciences
- Jon Scoates, formerly Chief Geologist, Manitoba Geological Survey
- Dave Peck, President, Peck Geosciences & Exploration Corporation
- Mike Nemitz, Senior Exploration Geologist, Newmont Mining Corporation
- Vern Baker, President, Duluth Metals Ltd.
- Ron Graber, General Manager– Resource Technology, Cliffs Natural Resources

Former Members: PRC Board of Advisors
- Anthony (Tony) Naldrett - Emeritus Professor of Geology, University of Toronto (2006-2010)
- Odin Christensen - Former Chief Geologist, Newmont Mining Corporation (2006-2010)
- Alan Bailes - Senior Geologist (retired), Manitoba Geological Survey (2006-2010)
- Alar Soever - President and Director, Wallbridge Mining Company Ltd. (2006-2010)
- Dave Groves - Former Chief Geologist, Newmont Mining Corporation (2009-2011)
- Bruce Marsh - Professor of Igneous Petrology, Johns Hopkins University (2006-2011)
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Beginning in 2011, the Precambrian Research Center actively began to solicit exploration and mining companies for direct support of Master’s-level graduate student research at UMD. Although arrangements of company support of academic research on projects of mutual interest have been a common means of funding graduate studies for many years, this program looks to codify and simplify that support through an informal contract and a one-time payment to the PRC. The contract, which lays out the objectives of the project, a timetable, confidentiality stipulations, and the level of company support, is negotiated between the company, the PRC directors, the student, and the student’s academic advisor.

Companies are encouraged to contribute the total amount of agreed-upon support to the PRC, who then is responsible for distribution of that support to the student and vendors. The company receives financial and progress reports on a quarterly basis during the duration of the contract. Companies who support UMD students in this way are given special recognition as an “Industry Sponsor of Student Research” (see www.d.umn.edu/prc/IndustrySponsors)

Possible components of support include:

Graduate Research Assistantship - includes support for 1/2-time salary, fringe benefits, and tuition waiver during the academic year (Sept.-May). For Master’s students, Assistantships are usually awarded during the second year of studies. For the 2011-12 academic year, the cost for an Assistantship at UMD was approximately $28,000.

Analytical expenses - companies cover the costs of analytical services and data acquisition, such as thin section preparation, lithogeochemistry, isotope chemistry, assay analyses, mineral chemistry, radiometric dating, paleomagnetic analyses, etc.

Field expenses - travel, room and board associated with field studies.

In-kind Support - companies agree to share data, material (e.g., core), and services that pertain to the research project.

Employment - companies agree to employ the student for part of the duration of the contract. Ideally, this would occur during the summer between the student's 1st and 2nd year.

In January 2011, Magma Metals Ltd. of Thunder Bay, Ontario, (headquartered in Perth, Australia) was the first company to enter into such a contract arrangement with the PRC. Their contribution of $37,300 provided UMD Master’s candidate Matt Chaffee with graduate research assistantship for the 2011-12 academic year and funding for petrographic, analytical, and travel expenses. Magma Metals also provided Matt with in-kind support (company drill core logs and assay data) and employed him during the summer of 2011. See www.d.umn.edu/prc/prcfundedstudents for a description of Matt’s Master’s project.

Companies interested in arranging similar sponsorships for UMD students are encouraged to contact any of the PRC directors.
Beginning in 2011, the Precambrian Research Center actively began to solicit exploration and mining companies for direct support of Master’s-level graduate student research at UMD. Although arrangements of company support of academic research on projects of mutual interest have been a common means of funding graduate studies for many years, this program looks to codify and simplify that support through an informal contract and a one-time payment to the PRC. The contract, which lays out the objectives of the project, a timetable, confidentiality stipulations, and the level of company support, is negotiated between the company, the PRC directors, the student, and the student’s academic advisor.

Companies are encouraged to contribute the total amount of agreed-upon support to the PRC, who then is responsible for distribution of that support to the student and vendors. The company receives financial and progress reports on a quarterly basis during the duration of the contract. Companies who support UMD students in this way are given special recognition as an “Industry Sponsor of Student Research” (see www.d.umn.edu/prc/IndustrySponsors).

Possible components of support include:

- **Graduate Research Assistantship** - includes support for 1/2-time salary, fringe benefits, and tuition waiver during the academic year (Sept.-May). For Master’s students, Assistantships are usually awarded during the second year of studies. For the 2011-12 academic year, the cost for an Assistantship at UMD was approximately $28,000.

- **Analytical expenses** - companies cover the costs of analytical services and data acquisition, such as thin section preparation, lithogeochemistry, isotope chemistry, assay analyses, mineral chemistry, radiometric dating, paleomagnetic analyses, etc.

- **Field expenses** - travel, room and board associated with field studies.

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Now in our sixth year, the Precambrian Research Center is pleased to report that our geology summer field camp and our professional workshops – our core programs – have grown to become both popular and successful. In fact, we are now getting correspondence from students all over the country inquiring about our field camp program, and have recently been asked on numerous occasions what our upcoming professional workshop plans are by geologists from universities, government, and industry alike. It’s apparent that the PRC has become a “go to” organization for training associated with field studies of Precambrian rocks and the mineral deposits they contain. We take our responsibility to provide this training as job one, and it keeps all of the PRC directors, staff, and associated faculty striving to develop effective, informative, and timely programs about a wide variety of topics associated with Precambrian rocks and mineral deposits.

Along with skills training, mentoring to students will continue to be a major function of the PRC. Jim Miller and George Hudak will continue to be co-advisors for UMD’s recently certified student chapter of the Society of Economic Geologists, which is one of only 11 SEG student chapters in the United States. Also, Dr. George Hudak will continue participating in the Mentoring Program conducted by the SEG. Such mentoring is part of our commitment and our pleasure in providing training and opportunities for the next generation of Precambrian geologists.

Our public outreach programs will continue into 2012 and beyond. In June, the PRC will once again organize the Minnesota Minerals Education Workshop (MMEW), a three-day workshop designed for K-12 earth science educators that offers short courses and an overview of the geology and mineral resources of Minnesota. This year’s 15th Annual MMEW will take place at Winona State University, in southeastern Minnesota, and is anticipated to attract our primary audience – secondary education teachers and secondary school educators from throughout the state. The PRC is also committed to organizing the 2013 MMEW, which will likely be held at UMD. As well, PRC Directors Jim Miller and George Hudak will continue to serve their terms as Vice Chair of Operations and Director, respectively, for the Minnesota Center for Minerals Resource Education, a program which promotes awareness of the positive contribution that mineral resources have made to Minnesota’s ways of life, and provides support for the development and implementation of mineral resources curricula in Minnesota’s schools.

Discussions over the past several years with our Board of Advisors have led to the planning of the PRC’s first professional field camp this coming May. This week-long camp will involve field training for up to 20 participants and is specifically geared to mapping Neoarchean gold deposits. The camp will focus on mapping lithologies and structures in Minnesota’s Vermilion District, which is closely associated with the tectonic juxtaposition of the Wawa-Abitibi and Copper-Nickel provinces of the Archean Superior Province. We are currently developing plans for a professional field camp in 2013 as well – this camp will likely involve mapping mafic layered intrusions associated with Cu-Ni-PGE mineralization. Initial reactions regarding the development of a professional field camp from our Board of Advisors has been very positive, and we expect this to be a very popular program among the minerals exploration industry. As with our professional workshops, we will reserve slots in these camps for our PRC members.

After a one-year hiatus due to the PRC faculty’s close involvement with the 2011 Geological Society of America meeting in Minneapolis, the PRC is once again planning to conduct a professional workshop during Fall, 2012. In October, the PRC and the Twin Cities Section of the Society for Mining, Metallurgy, and Exploration (SME) will collaborate on a workshop on Frac Sand Mining in Minnesota and Wisconsin. Cambrian formations (of Precambrian quartz) in the Upper Mississippi Valley hosts some of the best sources of natural quartz propganant used for hydraulic fracing and horizontal drilling in the booming domestic oil and gas exploration industry. The increasing demand for this material is causing a rapid expansion of current mines and a land rush for new frac sand mines in southeastern Minnesota and southwestern Wisconsin. Growing public concern over this new “mineral rush” makes an informational workshop on this subject a timely and important topic to address. Current plans are for the workshop to include 1) a one-day short course of invited lectures on various topics related to silica sand occurrences, uses, mining techniques, environmental issues, and transportation, and 2) a two-day field excursion to view mining, processing and transportation facilities dealing with silica sand, as well geological points of interest. We expect to formally open registration for this workshop in mid-April at the time of the regional SME meeting held annually in Duluth.

Last year, the PRC began development of a specialized, company-specific field training program, and we are planning to implement our first offering of this training program during late spring or early summer of 2012. Such training programs can involve a wide variety of topics, ranging from providing logging training, to methods for mapping specific types of rocks, alteration zones, and/or ore deposits. We also continue to investigate developing a program involving short-term contract mapping provided by PRC faculty, staff, and PRC-trained students. Over the past year, PRC faculty have acquired various types of licensure that will enable this plan to become a reality.

A vital gauge of, and key to, the success of the PRC is the financial support we receive from mineral resource-related companies and individuals through their membership donations and support of student research. As we have reported here, our 2011 donations have totaled over $140,000 and committed donations for 2012 are already over $25,000. We are extremely grateful and humbled by this show of support for our students and our program. We will continue to work hard to be worthy of that sustained support and to seek out new supporters.

With healthy exploration and mining industries, and with world demand for mineral resources continuing to increase, we anticipate another successful year for the PRC. The demand for well-trained geologists with knowledge of Precambrian rocks, and efficient and effective ways of mapping and interpreting them drives the need for, and illustrates the importance of, our training and educational programs. With the development of the new professional field camp, with the opportunity to once again develop, organize and conduct a fall professional workshop, and with continued efforts at increasing our membership, we hope to continue to expand our important role in training the next generation of Precambrian geoscientists.

The year 2012 is shaping up to be another exciting year for the PRC. We look forward to reporting to you next year on the PRC’s progress in 2012.
Looking Ahead to 2012

Now in our sixth year, the Precambrian Research Center is pleased to report that our geology summer field camp and our professional workshops – our core programs – have grown to become both popular and successful. In fact, we are now getting correspondence from students all over the country inquiring about our field camp program, and have recently been asked on numerous occasions what our upcoming professional workshop plans are by geologists from universities, government, and industry alike. It’s apparent that the PRC has become a “go-to” organization for training associated with field studies of Precambrian rocks and the mineral deposits they contain. We take our responsibility to provide this training very seriously, and it keeps all of the PRC directors, staff, and associated faculty striving to develop effective, informative, and timely programs about a wide variety of topics associated with Precambrian rocks and mineral deposits.

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