

YBRA UPLIFT

Annual Newsletter of the Yellowstone-Bighorn Research Association

Issue 12

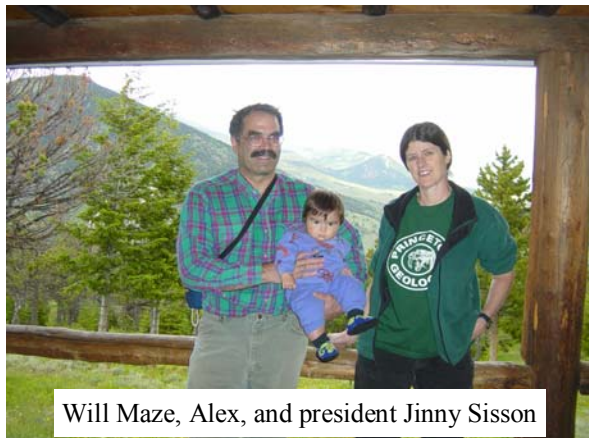
Spring 2006



SIU geology field camp students underground looking for the J-M reef. photo by Eric Ferre, SIU, 2005



Jinny and Russ presenting Janette with award



Will Maze, Alex, and president Jinny Sisson



New Jersey State Museum field crew survey prospecting outcrop in Elk Basin, Park County, Wyoming



Identify for extra credit. Answer on page 11





From the President:

This has been a quiet year in Houston with many small achievements as I watch my young son become a toddler. In many ways, that is the same for YBRA this past year. There have not been any major happenings, just some minor changes to the routine. Most of the happenings have centered on the two main issues the camp has faced for many years, the bridge and the water supply. For example, we had to determine whether or not YBRA is a public water supply. Since camp usage is low, we do not have to follow the public water supply guidelines. However, Russ follows them anyway but avoids paperwork and inspections. The continuing long term dry spell means we still have to address the issue of drilling a well in the near future. The other main issue is the bridge. We had hoped to bid on a bridge that was being abandoned by Carbon County. However, the bridge committee thought it was too old and too long and could not be adapted for our use. So unless another suitable secondhand bridge is found, we will have to install a new bridge. The final issue being addressed is whether or not to install a receiver system so the camp can support wireless computer service. This will be a boon to teaching but a financial burden as most of the year it will not be used. Also, with the advent of the GeoScope project, we hope to have a seismic station installed to monitor local earthquakes as well as worldwide seismicity.

Camp usage fluctuates, with some groups experiencing increases and others decreases. Southern Illinois had their largest group in years last summer, whereas this coming year, Penn State does not have enough students to warrant the trip out to Montana.

Significant YBRA People

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Betsy Campen (Betsycampen@bresnan.net)

Last year, a group of biologists from Prescott College in Arizona were first time users as well as the first group to use the facility. We are trying to get additional groups to use the facility, as without a steady use throughout the summer, it becomes difficult to finance the camp.

We are hoping that this issue of the "YBRA Uplift" will reach many who have visited or attended a field camp at YBRA. We hope that you had a great time and will consider becoming a member to support the mission of YBRA. As always, please feel free to stop by if you are in the Red Lodge area. Jeanette Reinhart enjoys seeing visitors. Or plan to attend the workweek in August and help us keep everything in working order.

Jinny Sisson

YBRA CAMP MANAGER'S REPORT

The summer of 2005 brought two important events relative to maintenance and improvements at the YBRA Camp: a well-attended WORK WEEK and replacement of the porch on Fanshawe Lodge.

Franklin and Marshall Alumni WORK WEEK volunteers organized by Marv Kauffman turned out in substantial numbers and never stopped working between August 29th and September 2nd! In addition to those necessary tasks including painting, staining and oiling, screen repair, tidying up around cabins, trimming overhanging limbs, etc., the specialized skills represented allowed for electrical and flooring improvements to be made to the bathroom of F and M Cabin, replacement of damaged siding on Wadsworth Study Hall, and moss removal on the roofs of several cabins. Our sincere thanks to the volunteers, members and staff that made this effort a great success!!

In spite of inclement weather immediately after Camp closed, Jack Owen and his crew were able to complete the dismantling and rebuilding of the porch on Fanshawe Lodge. This major project included replacing the vertical supports and the full-length log sills under the deck; replacing the deck, deck flooring and the seriously deteriorated front and end stairs- all while preserving the porch roof, supports and railings. Camp now has a stable and level porch again following years of hard use of the old porch built by Roy Wadsworth in the mid-1930's and replaced in 1938 after a windstorm removed 20 feet of the porch roof.



Marv Kauffman on the restored porch at the Fanshawe Lodge

An unforeseen consequence of the construction is a deck surface slightly higher than the original. Additional funds above the project cost of \$15,000. will be necessary to add a higher rail around the porch and modify porch stair railings. These safety modifications need to be completed before Camp opens this summer.

We would like to express our gratitude to our members who contribute to these capital projects! Replacement of our aging infrastructure requires skills our regular staff and volunteers sometimes can't provide. Then these financial contributions become critical to our non-profit organization. The summer of 2006 gives us the opportunity to continue repairs to Foose Cabin begun during WORK WEEK last year, present some estimates to Council at the Annual Meeting for improvements to Howell Gulch Road and continue efforts to replace the bridge across Rock Creek.

The success of WORK WEEK 2005 continues to underscore the importance of this event to the upkeep of Camp. The week of August 14-18 has been set aside for this purpose. As always, room and meals are provided at no cost to all participants, and we provide time for play! For more information, please contact me or Jeanette Reinhart at Camp at (406) 446-1333.

Russ Dutcher dutchrus@siu.edu (406) 446-2607

Peg Fanshawe

Born in Erie, Pa., on Jan. 15, 1913, as Margaret Luise Wright. Peggy was a rugged and bright individual who traveled from Erie, to La Jolla, Calif., to attend boarding school. Subsequently, she graduated from Smith College and continued to be a very curious and dedicated student for the rest of her life. Due to her deep appreciation of the out-of-doors, her gardens sparkled with uniqueness as she exhibited her love and appreciation of art and the joys of nature. She played a fantastic game of tennis, was an excellent equestrian and a successful entrepreneur in the world of investments. Traveling near and far stimulated her passionate quest to learn about and enjoy other cultures and their unusual cuisine.

Peggy was preceded in death by her longtime love and husband, Jack (John) Fanshawe. She is survived by her three children, Cynthia McKean of Saugatuck, Mich., Katie Rosenberg of Palo Alto, Calif., and Paul Fanshawe of Georgetown Colo.; seven grandchildren and four great-grandchildren. Peggy died peacefully in Billings, on March 11, 2006. A private family service will be held in the fall.

Summer Camp Schedule

June

U Penn Geology field camp, June 6-July 11 (out of camp from ?? to ??)
U Penn Graduate Environmental Sciences course, June 13-27
Southern Illinois University Geology field camp, June 24-July 13

July

U Penn Geology field camp, July 11-August 15 (out of camp from ?? to ??)
New Jersey State Museum field camp, July 16-28
Southern Illinois University Geology field camp, July 28-31
Cincinnati Museum Center, Dig for Dinosaurs, July 24-30 July 31-

August

Cincinnati Museum Center, Dig for Dinosaurs, July 31-August 6
Franklin and Marshall Alumni camp August 6-13
YBRA Work Week, August ??
YBRA Open House, August ??
Red Lodge Women's Conference, August 28

JOHN MAXWELL

John C. Maxwell, educator, geologist, and scholar, died on January 23, 2006. He embraced life with enthusiasm and lightened it with his sense of humor, much appreciated by his students during long summer traverses in Italy and California. He was born in Xenia, Ohio on December 28, 1914 to Addie Crawford and William Maxwell, and was predeceased by his older brother Bob and his sister Jane. He is survived by his wife of 66 years, Marian Maxwell, and their daughter, Marilyn Bradford. Their older daughter July died of leukemia in 1977.

After high school he was awarded a four-year scholarship to DePauw University, where he graduated in 1936 with a degree in Geology. From there he went to the University of Minnesota, once again on a scholarship, and graduated with a master's degree in 1937. After the University of Minnesota he took a job with Sun Oil Company in Beaumont, Texas, where he met and married Marian Buchanan. The academic world was his real interest, and in 1940 they drove to Princeton University, he on scholarship, and she hoping to find a job.

He was always appreciative of the scholarships he received, and in 2001 he started an endowment at The University of Texas to establish an undergraduate scholarship in the Department of Geological Sciences.

After two years of graduate work at Princeton, he enlisted in the Navy and was stationed at 90 Church Street, New York City. His Naval Intelligence group was headed by Commander Harry Hess, his thesis advisor at Princeton. Later he was stationed at the South Pacific Headquarters in New Caledonia. When he was released from the Navy in October, 1945, the family left immediately for Princeton for him to complete his thesis, and to get his PhD degree.

His teaching career began at that time and lasted at Princeton until 1970, when he accepted the William Stamps Farish Chair in Geology at The University of Texas. His effectiveness as a teacher is best described by one of his former graduate students, now a professor himself: "John Maxwell was revered by his students, who found him to be an enthusiastic lecturer, a supportive advisor and one who never tried to push his ideas onto his students. His cheerful, infectious humor and his hearty laugh brightened many a classroom and defused many awkward situations."

He served as President of the American Geological Institute, 1971; President of the Geological Society of America, 1973; Chairman, Earth Sciences Division, National Research Council, 1970 to 1972 and again 1981 to 1985; Chairman, Advisory Panel, Earth Sciences Division, National Science Foundation 1975 to 1976; Consultant to Advisory Committee on Reactor Safety of the Nuclear Regulatory Commission 1976 to 1984; Vice-chairman of Board of International Geological Correlations Program, UNESCO 1979 to 1984; Member, scientific panel advisory committee to the Gas Research Institute on the Siljan Deep Hole, Sweden. He was a Fulbright Research Scholar in Italy in 1952 and a Guggenheim Scholar in Italy 1961 to 1962. Living in Italy was a life-expanding experience for him and his family, as all benefited from living in a different culture.

His geologic work centered on ophiolite complexes, particularly those exposed in Tuscany and Liguria, Italy. He was the first American geologist to accept the existence of an ophiolite sequence ranging from peridotite at the base to volcanic rocks at the top. His pioneering insight led indirectly to the widespread acceptance of this sequence on the part of American geologists, and to the recognition a few years later of ophiolites as fragments of oceanic crust and mantle formed at mid-oceanic spreading centers. In 1964 he co-led with Italian colleagues an American Geological Institute, Summer Field Institute to the northern Apennines of Italy. This trip introduced a whole generation of young American structural geologists to the geology of northern Italy, in particular the melanges containing diverse rocks in a sheared matrix of shale or serpentine.

In the late 1960's he began a mapping project in northern California where such melanges are widespread. Over the next decade or so, he and his students mapped a complete transect of the Franciscan rocks of the northern California Coast Ranges. This work still stands as the most detailed systematic mapping of an entire transect across the northern Coast Ranges of California.

Memorial services will be at the Unitarian-Universalist Church, 4700 Grover Avenue at 2:00 p.m., Saturday, January 28. Rather than flowers, the family requests that those wishing to make memorial contributions send them dedicated to John C. Maxwell, either to GSA Foundation, 3300 Penrose Place, Boulder, CO 80301, or to the Memorial Endowment Fund of the Unitarian-Universalist Church.



Mass Extinction - Trilobites

Dr. Marv Kauffman, Dr. Rob Thomas, Univ. Montana-Western

What are Trilobites?

One of the earliest forms of life to develop a carapace or shell was the trilobite. This is an extinct form of life that resembled the modern horseshoe crab. It had three lobes (hence its name) - one central and two lateral lobes. In addition it had three main body parts - a head (or cephalon), a middle body (or thorax) and a tail (or pygidium). In the Cambrian rocks around the flanks of the Beartooth Mountains are to be found thousands of pieces of trilobites.

Because the carapace was shed as the trilobite grew larger, there can be many fragments of such carapaces left by a single individual during its lifetime. Additionally, the carapaces are made of material like human fingernails, so they fall apart when the animal dies, leaving many disarticulated heads and tails. Such accumulations of fragments are nonetheless useful for identifying and classifying trilobites.



Asaphiscus wheeleri
The Paleontological Research
Institution

Environments of Deposition

Most trilobites lived in relatively shallow marine waters. The Beartooth region was near the shoreline of the extensive Cambrian seas. The location of Red Lodge Mountain occurs in similar location with respect to this Cambrian sea.

Some trilobites are known to have foraged along the shallow sea bottoms for food, taking in the muds with the enclosed microscopic organisms. Others swam above the bottom and filter fed on small swimming and floating organisms. Still others appeared to rise in a "hopping motion" above the sea floor into the shallower zones. They all needed relatively clear and shallow water. When conditions changed, trilobites had to migrate to more agreeable environments or else they would perish. When conditions were right, trilobites flourished in the Paleozoic seas.



Agnostus interstrictus
The Paleontological Research Institution

Cambrian Flourishing and Extinctions

Trilobites were the dominant life forms during the Cambrian Period. Starting with a few families, trilobites diversified and multiplied for millions of years, only to undergo drastic reductions in numbers over relatively short time intervals. They flourished when conditions were right and died out suddenly when conditions changed. This change may have been either a fairly sudden deepening of the ocean waters or, conversely, an equally rapid shallowing. In either case, the trilobites were no longer living under ideal conditions and many entire families died out. This occurred at least five times during the Cambrian Period. Only one or a few families made it through these devastating episodes of changing environments. Each of these instances of mass extinction was followed by another episode of blossoming out into many lineages of trilobite families, only to be wiped out by another mass extinction.

Dinosaur Extinction at K/T Boundary

There are many tales of the great extinction of the dinosaurs at the end of the Cretaceous Period, prior to the start of the Tertiary Period (known as the K/T boundary). This certainly was a mass extinction of tremendous proportions. Had the dinosaurs not died out, there is no telling what the sequence of life development might have been. The small mammals living during the latter stages of the reign of the dinosaurs, may not have developed into the dominant life forms of the Tertiary Period. Who knows what might have been the fate of humans under such a scenario?!

HELEN WEAVER

March 21, 1902-Dec 24, 2005

An old friend of the YBRA, Helen Weaver, passed away on December 24, 2005. She was one of the, if not THE last member of the Red Lodge generation who knew many of its early students and founders. In 1934, on the last day of school before summer vacation, the Weaver family, Al, Helen, and son John, plus a few other workers went as far as they could by Jeep into Sunlight Basin. Then with fourteen head of horses loaded with enough supplies to last until fall, they rode for three days into steep rocky terrain to the head of Galena Creek. All summer long, Helen cooked and washed clothes for the four to eight men working the mine. It was hard and dangerous work, but those were the good old days, she would say as Sunlight continued to be a focus of their dreams and memories. Near the end of Allan's life, both would still go up to Sunlight Basin and work the claims with John and grandsons Clark and Scott.

During those years they met and befriended Will Parsons, working on his Ph.D. thesis in Sunlight. Will was the first of many YBRAers that the Weavers took under their wing. Some of those most closely associated included Don Wise, Noel Potter, Marv Kauffman, and Dusty Ritter but whole generations of students and faculty would stop at the Weaver's cabin for information, hospitality and friendship. The Weavers commonly went in the field with the geologists using the Blue Elephant, Al's armoured jeep that usually had both doors flopping in the wind like elephant's ears. Al also worked in the mines and was a good friend of Roy Wadsworth, builder of the main lodge and many of the early structures of the camp. In later years, Al and Helen would come by the camp each summer to tell tales of old Red Lodge, of cattle drives still coming though, of mines and miners, of early attempts to get the Beartooth Highway established, and of stage coaches still plying the Meteetse Trail. Parts of Al's tales were probably true but Helen never forced him to distinguish them from the alternatives.

Helen Meyer was born in Billings, Montana in 1902. She was one of six daughters of German parents who met in Butte. In 1906, the family moved to Joliet where her father operated the Eagles Nest Saloon. With inheritance from his parents John Meyer built a hotel next to the saloon on the Meyer block, the site of the present Joliet City Hall. As a girl Helen used to sing to the Joliet coal miners in the saloon. She graduated in 1920 from Joliet High School and went on to attend college in Dillon for two years to become a teacher. Her first teaching position was near Boyd but she also taught at Billings Bench, Grass Creek and Thermopolis, Wyoming, Washoe and Red Lodge. In 1957 she obtained an additional degree in education from Eastern Montana College.

While teaching in Billings, she was on a train with a girl friend who introduced her to Allan Weaver who was on his way to the Milwaukee School of Engineering. He had some Shrine business in Billings that week and that weekend took her to the Shriner's Ball before going on to Milwaukee. They corresponded until a home wedding followed in 1923 with a move to Red Lodge where their son, John, was born in 1928

Following Al's death, Helen remained in Red Lodge helping cheer up the "old folks" before she too entered the retirement home. With advancing years she moved to Ohio to be with John, his wife Zelma, and their two sons, Clark and Scott. After John's passing she remained with the family and was cheered by occasional phone calls from some of her YBRA friends from the past. As a centenarian Helen still had that beaming smile that kept her going those many years.

Her passing marks the end of a colorful era that linked the early YBRA to Red Lodge and its wild frontier, cattle town and mining days, the last reminders of which were enjoyed by many a YBRAer at the Swinging Doors Saloon. She, Al, and the generation that they represented are remembered most fondly and are sorely missed.

Clark and Scott are planning to have a memorial gathering in Red Lodge in early summer 2006. Cards and correspondence may be sent to Clark Weaver, 4316 Van Buren St. University Park, MD 20782 or emailed to scottl2@fastmail.fm In the summer of 2004 our family returned to camp again to celebrate the marriage of our daughter, Amanda. We walked to the Point once again and looked out across the meadow of wildflowers to the distant plains, knowing that the memories of this visit would be a new chapter in a book that is still being written. Clark and Scott are planning to have a memorial gathering in Red Lodge in early summer 2006. Cards and correspondence may be sent to Clark Weaver, 4316 Van Buren St. University Park, MD 20782 or emailed to scottl2@fastmail.fm.

NEW JERSEY PALEONTOLOGISTS AT YBRA: GLENN JEPSEN'S LEGACY

David C. Parris, New Jersey State Museum
Barbara Smith Grandstaff, University of Pennsylvania

Glenn Lowell Jepsen was a truly memorable person. Those who remember him, mostly Princetonians, will recall an incredible intellect for paleontology, a Victorian professorial demeanor, and an unquenchable appetite for field work. At least that's the way we remember him. Recruited from West River South Dakota, where he was born and raised, he went to Princeton University in New Jersey to study paleontology and lived there the rest of his life. He never really left South Dakota either, we hasten to add, and he also developed an overwhelming love of the Bighorn Basin of Wyoming and Montana. After various expeditions that formed the basis of his doctoral dissertation, he spent essentially every summer there, formed lifelong friendships with the people who lived there, and ultimately asked that his ashes be scattered on Polecat Bench in Wyoming. Several generations of geology students who learned field methods at the Yellowstone-Bighorn Research Association (YBRA) would remember him as their guide to an intensive one-day introduction to vertebrate paleontology.



“Jep”, as he was known to practically everyone, was a great raconteur. Among his most frequent stories were anecdotes about Dr. J. C. F. Siegfriedt, the unabashed promoter of everything in Carbon County, Montana. Jep’s primary paleontological interest was mammals of the Paleocene Epoch, and a major site for them had been found in Bearcreek, Montana in the Eagle Mine. Buoyed by the rumor that human ancestors were represented among the Bearcreek fossils, Siegfriedt touted Carbon County as some sort of cradle of humanity itself. Jepsen and fellow Princetonian Erling Dorf often joked about Siegfriedt, while conceding that he had an important role in the history of YBRA. While W. Taylor Thom and other Princetonians were instrumental in the founding and sustaining of YBRA, the critical role of Carbon County residents also was undeniable.

In a sense, Jepsen’s long career in the Fort Union faunas of the Bighorn Basin confirmed the idea of a cradle of evolution. He often remarked that the tectonic activity that created the Basin had likely isolated the gene pools of mammals living there during that epoch, and that the Bighorn Basin mammalian sequences probably represented true ancestral lineages. Among the early mammals that Jepsen studied are the multituberculates. While superficially rodent-like, these strange early mammals had molar tooth surfaces lined with many cusps, as the scientific term for the group implies. After many millions of years of success, they ultimately became completely extinct. The Princeton collections, now primarily in repository at Yale University, are remarkable documents of the evolution of early mammals at a very important phase of geologic history. Pivotal fossil faunas that Jepsen’s field collectors discovered and described include the Cedar Point,

Princeton, and Rock Bench Quarries, and an outstanding collection from just after the great extinction episode, the Cretaceous/Tertiary boundary. He named this last quarry Mantua after a railroad siding community in Park County, Wyoming. Because Jepsen's interests mostly began with the Paleocene, the Mantua Local Fauna effectively marked the critical boundary of his investigations as well. During most of his later years Jepsen hoped to find another fauna at the Cretaceous/Tertiary boundary, the same age as the Mantua Local Fauna.

The paleontologists who continue to build upon Jepsen's legacy include Philip Gingerich and Kenneth Rose, both of whom trained with him in the Bighorn Basin. The Winston Churchill family of Powell, Wyoming, who hosted Jepsen's field crews for many years, continues to host reunion gatherings of his successors each summer. Many of these competent scholars were continuing Jepsen's work, so we decided instead to stay on the Eastern Seaboard and work in the coastal plain of New Jersey, where much of the American tradition in paleontology began.

The next three decades of intensive work brought many new discoveries in the discipline of vertebrate paleontology, particularly in studies of the Cretaceous System. The rocks and fossils that date from about 120 million until about 60 million years ago further revealed an American continent subdivided by an epicontinental seaway. Our work was primarily successful in documenting general faunal studies in the Eastern Subcontinent, including its first identifiable Cretaceous mammal fossils in the Ellisdale Site of New Jersey and the Elizabethtown Site in North Carolina, and the remarkable faunal assemblage from the Inversand Company Site that crosses the Cretaceous/Tertiary boundary in a New Jersey township named---Mantua.

So we figuratively looked back across the Cretaceous Seaway for comparative study sites in the Western Interior, and once again thought of the Bighorn Basin. Once you have worked there, it seems that it influences your career forever. Although the Western Interior seems like an odd place to seek comparisons with the Eastern Seaboard, during the Cretaceous Period the environments of these two regions were remarkably similar. The epicontinental seaway that extended from the Gulf Coast to the Arctic had marine faunas, notably ammonites and mosasaurs, that show remarkable similarity between the Great Plains and the New Jersey Coastal Plain. The Judith River Formation of the Montana Group represents a marginal marine environment in a stage of the Late Cretaceous that is the same as New Jersey's Ellisdale Site, but in the Western Subcontinent. After assisting Princeton University with plans for renovation and revision of its Museum of Natural History, we were also convinced that comparative studies in the Bighorn Basin should be undertaken. We would not be working so much in Jepsen's beloved Paleocene rocks and faunas, but in the earlier and less studied ones of Cretaceous age that preceded them.

Our expeditions, begun in 2000, have been modest efforts of several weeks each year. With permits from the Bureau of Land Management (U. S. Department of the Interior) and with the permission of a number of private landowners, we have discovered and collected fossil faunas from various sites in the Bighorn Basin. Perhaps best known for dinosaurs, the Cretaceous rocks actually yield impressive numbers of fish, amphibian, reptile, bird, and mammal fossils, enabling the studies of whole faunas that we have been seeking for comparison to the ones from the Eastern Subcontinent. Exemplary among these sites is the Shield Wolf Quarry in Carbon County, Montana, which has yielded multituberculate mammals, the very same archaic fur-bearers that interested Glenn Jepsen so much.

The Yellowstone-Bighorn Research Association has been our base of operations as we have returned to this classic area of investigations. Princetonian legacies are deeply embedded at YBRA, and the New Jersey State Museum is honored to be part of such a great tradition.

Stillwater Complex: A resource in many ways

Dr. Jinny Sisson

During the first year of the “Red Lodge Project” run by Princeton University (1930), Ed Sampson, faculty, and Joe Peoples, a graduate student, visited the Stillwater layered complex. They were struck by the fact that it resembled the Bushveld complex that Sampson had recently seen during an International Geological Congress field trip. This important observation was one reason they decided to look for a permanent location for the YBRA facility in the Red Lodge area. Thus, began a long association of YBRA field camps with the Stillwater complex. It continues to be a teaching resource for almost every geological group that stays at YBRA as well as an important resource for palladium and platinum.

The first exploration of the Stillwater complex began in the 1883 with Jack Nye looking for sulfides (mostly copper and nickel ores) in the Basal Series. This was followed by exploration and mining for chromite in the Ultramafic Series. Despite the discovery by Joe Peoples and Art Howland of platinum group minerals (PGMs) during their work in the early 1930's, it was not until the 1960's and 1970's that important discoveries were made. Specifically, the J-M Reef, the host for palladium and platinum, was discovered by Johns Manville Corporation (“Manville”) geologists in 1973. In 1979, a Manville subsidiary entered into a partnership agreement with Chevron U.S.A. Inc. to develop PGMs discovered in the J-M Reef. They formed the Stillwater Mining Company and commenced underground mining in 1986. Recent exploration as well as research has changed the ore deposition model. Now, most agree that the ore was deposited as a result of secondary hydrothermal activity during cooling of the complex. Thus, the ore deposit is not confined to one stratigraphic layer as previously thought but changes along strike depending on the fluid influx.

Now, the Stillwater Mining Company is one of the world's leading producers of PGMs and the only significant producer of palladium in the Western Hemisphere. Currently, price for palladium is about \$360 per ounce. Over the years that I have taken field camp groups to the Stillwater complex, their estimate of the life span of the mine has fluctuated x to y years depending on the price as well as current estimate of the size and continuity of the J-M reef. Palladium is a precious metal; mining from this location produces a high-grade ore containing a palladium:platinum ratio of just over 3:1. After mining, the ore is refined near Columbus, Montana, to a purity of 60% PGMs, then shipped to Johnson Matthey in New Jersey for final refining. Palladium is a lustrous silver-white metal used as a catalyst, in electrical contacts, and in alloys.

The reason why a visit to the Stillwater complex is important for geology students is that it is a world-class example of a layered mafic/ultramafic complex. Some think these are relict magma chambers that fed large igneous complexes or other volcanic edifices. They are unusual as they have a dramatic layered stratigraphy defined by sudden changes in mineralogy across the entire complex. These features record many igneous processes that typically are discussed only hypothetically in the classroom as they are rarely seen in outcrop. In addition, this is the first visit to an active mine for many students. Also, the environmental impact of hard rock mining can be seen up close.

A typical visit to the Stillwater complex starts at the headquarters of the Stillwater Mining Company with an introduction to the area by one of the mine geologists. Then depending on the group size, there is either an above ground or underground tour of the J-M reef, the ore horizon. After this, there is a road trip to see the world-class outcrops of the layered mafic-ultramafic complex. The road above the mine goes through almost the entire sequence from the ultramafic basal units through the mafic units up to the Mouat granodiorite, which crosscuts the Stillwater complex. The complex is now steeply dipping due to Laramide thrusting. So, to begin a tour, you have to drive to the end of the road up in the Mountain View mine area. This is the site of the chromite mine active between WWII and ~1960. Here bands of

Chromite occur within layers of harzburgite (olivine-pyroxene rock) and dunite (olivine-rich rock). Below, the old mine is the contact between the ultramafic and mafic unit. This nicely demonstrates part of Bowen's reaction series for students who have only heard about this in introductory geology or petrology. The coarse-grained nature of these rocks makes it very easy to identify the minerals and textures that most students struggle with in mineralogy and petrology classes. In addition, these outcrops offer many other interesting petrologic features such as oikocrysts and sedimentary-like structures. The daylong trip usually ends near the famous "inch scale" layering outcrop which continues to perplex students and petrologists with abrupt changes in mineralogy over a short distance. If you are interested in seeing some of these world-class outcrops, please note that access to some of these outcrops is by permission of the landowners. We thank Ennis McGarrity, chief geologist of Stillwater Mining for hosting many field camp groups and allowing us access to the spectacular outcrops.

Following is a short list of references to some publications that give much more on the petrologic and economic geology of the Stillwater Complex. A geologic map and stratigraphic section for the Stillwater complex is on the back cover of the newsletter.

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Boudreau, A.E. (1999) Fluid fluxing of cumulates: The J-M reef and associated rocks of the Stillwater Complex, Montana. *Journal of Petrology* v. 40, pp. 755-772.

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Helz, R.T., 1995, The Stillwater Complex, Montana: a subvolcanic magma chamber? *American Mineralogist*, v. 80, p. 1343-1346.

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McCallum, I.S., et al., 1980, Investigations of the Stillwater Complex Part I. Stratigraphy and structure of the banded zone. *American Journal of Science*, v. 280-A, p. 59-87.

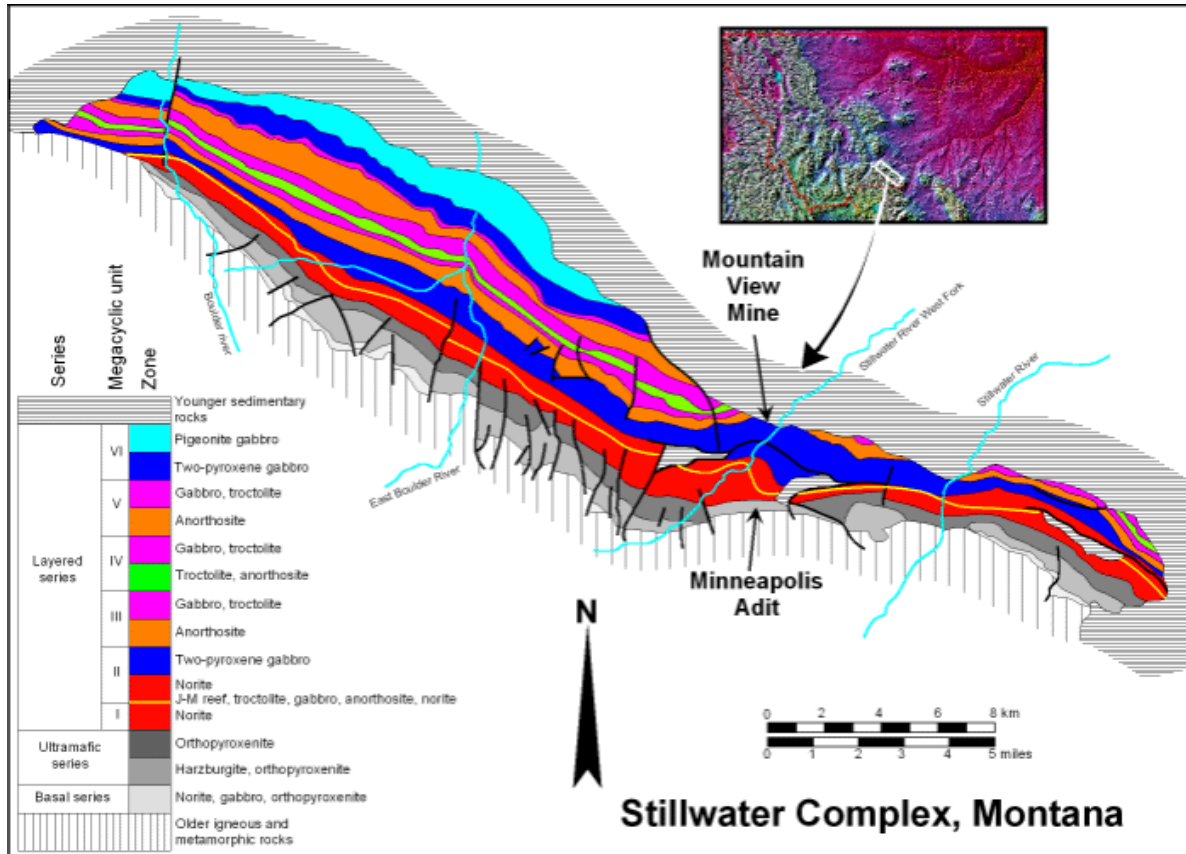
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The captions should read: SIU geology field camp students underground looking for the J-M reef. photo by Eric Ferre, SIU, 2005

and "Geologic map and stratigraphic section for the Stillwater complex. After McCallum et al."

Extra credit answer: Ankylosaur. (David C. Parris, New Jersey State Museum
Barbara Smith Grandstaff, University of Pennsylvania)



Geologic map and stratigraphic section for the Stillwater complex. After McCallum et al., 1980

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ATTN: Proxy Enclosed