The Third Annual Geoscience Graduate Symposium
May 7-8, 2009

Department of Geology and Geophysics, UW-Madison

Weeks Hall, 1215 W. Dayton Street, Madison, WI, 53706

Talks on Thursday May 7, 2009 in room 140

Talks on Friday May 8, 2009 in room 140

4:30-6:00 **Poster Session in the Geology Library room 440**

David M. Mickelson

About Dave

I retired in 2005 from the Department of Geology and Geophysics at UW–Madison. For over 30 years as a professor, I taught, among other things, glacial geology, geomorphology, and geology of the National Parks.

My interests are in modern glacial processes, glacial deposits and landscapes in the Midwest, and coastal processes along the Great Lakes. My students and I have worked on the genesis of glacial deposits in Argentina, Tibet, Scandinavia, New England, Utah, Alaska, and Wisconsin. We have also researched shoreline erosion and slope stability problems along the shorelines of Lake Michigan and Lake Superior.

talk

Glacial landscapes of Wisconsin

David M. Mickelson, Professor Emeritus

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

Wisconsin has experienced glaciation several times during the last two million years. Little is known about the chronology or even number of early glacial events because the last glaciation removed most evidence of older ice advances. In the areas where these older deposits are at the surface, soil development can be used to determine their relative age, but there are no absolute dates. About 30,000 cal BP glaciers advanced into Wisconsin and by 28,000 cal BP covered about two thirds of the state. This most recent glacial event is called the Wisconsin glaciation. Climatic conditions varied considerably over this time. Ice advanced onto permafrost and the outer zone of the glacier was frozen to its bed. By about 17,000 cal BP permafrost was disappearing in southern Wisconsin and by 14,000 cal BP it was disappearing in east central Wisconsin. By about 10,000 cal years ago ice had retreated out of Wisconsin. It appears that a frozen bed zone near the front of the glacier and a wet bed behind led to the formation of thousands of drumlins and hundreds of tunnel channels. By about 17,000 cal BP it appears that the Green Bay lobe warmed sufficiently at the ice margin to allow eskers to form and to allow more rapid fluctuations of the ice margin. End moraines were formed not only at the position of maximum advance, but at numerous positions of ice margin stability during retreat.

It is fitting that over 40 years ago Congress established the Ice Age National Scientific Reserve and somewhat later the Ice Age National Scenic Trail, both of which highlight and protect glacial features. There is also a very active Ice Age Trail Alliance, a group of volunteers who hike and work on the trail. I am now working with two co-authors to write a book on the geology of the Trail and Reserve. In addition to describing the formation of various glacial processes and features, I will highlight opportunities for Ice Age Trail hikes and other activities as well.

poster

Macrostratigraphy of New Zealand: Patterns in Sedimentation Cretaceous to Cenozoic

Neal Auchter, Shanan E. Peters

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

Spatiotemporal patterns in sedimentation are the result of several different geologic processes that combine to determine the balance between sediment supply and the formation and destruction of sediment accommodation space. On million-year timescales, eustatic sea level change and tectonic uplift and subsidence are expected to be dominant drivers of patterns of sedimentation, but it is not always clear which is more important. Here we use macrostratigraphy to analyze the Cretaceous through the Cenozoic sedimentation in the tectonically active region of New Zealand. Sedimentation during this time period displays significant fluctuations that reflect expansions and contractions in the area of sedimentation. In addition, the relative frequency of carbonate and terrigenous clastic packages changes dramatically over time. Relatively low and stable levels of carbonate deposition occur during Cretaceous –- Eocene and Miocene-Pliocene, with a significant increase in carbonate package initiation in the early Oligocene and truncation during the late Oligocene. Significant elevations in carbonate package initiation and truncation are coupled with a dramatically elevated total number of carbonate packages during the late Eocene and Oligocene. The quantity and distribution of clastic packages is higher and fluctuates more than carbonate packages over the same time period. Rates of clastic gap-bound package initiation and truncation vary throughout the Cenozoic and are increasingly correlative with changes in carbonate deposition in the mid to late Cenozoic (Eocene – Pleistocene). Correlation analyses between these macrostratigraphic patterns in New Zealand and published eustatic sea level estimates suggest an important role for eustasy, but one that is strongly mediated by tectonic boundary conditions.

poster

Along-strike variations in the Mesozoic western Idaho shear zone, Owyhee Mountains, Idaho

Bryn A. Benford[1], James C. Crowley[2], Mark D. Schmitz[2], Clyde J. Northrup[2], Basil Tikoff[1]

[1]Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706
[2]Department of Geosciences, Boise State University, Boise, ID 83725

The Owyhee Mountains, south of the western Snake River Plain, contain exposures of granitic rocks correlate to the western margin of the Idaho batholith. A well-developed and consistently oriented (020) foliation exists in the north-central region. U-Pb analyses of zircon grains yield a range of ages, from 160 Ma to 50 Ma. Strontium analyses indicate initial $^{87}Sr/^{86}Sr$ exhibits a sharp west-to-east transition from 0.704574 to 0.707892 over a distance of ~30 kilometers. We interpret that the north-central section of the Owyhee Mountains contains the southward continuation of the western Idaho shear zone based on following similarity in characteristics: The orientation of foliation and lineation, the age of the deformed plutons, the occurrence of a sharp Sr isotopic boundary, and the presence of a syn-tectonic tonalite sill.

This southern continuation ("Owyhee segment") of the western Idaho shear zone has three major differences from McCall segment of the shear zone): 1) Significantly less well-developed solid-state fabrics; 2) A trend of 020 rather than north-south; and 3) A wider transition zone in initial strontium ratios from 0.704 to 0.708.

We propose a simple tectonic model to explain these differences, assuming a 20° along-strike difference in the initial orientation of the western margin of the Idaho batholith, a rigid-body collision, and transpressional kinematics. For the Owyhee segment, the model predicts an oblique convergence angle of 26º-39º, 40-69 km of convergent movement, and 80-85 km of dextral transcurrent movement. For the McCall segment, the model predicts an oblique convergence angle of 46º-59º, 65-94 km of convergent movement, and 56-62 km of transcurrent movement, and an overall larger finite strain.

talk

Constrictional strain and sheath folding in the deep crust, Mt. Hay, central Australia

Chloë Bonamici, Basil Tikoff, Laurel B. Goodwin

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

Mt. Hay, located in the Arunta Inlier tectonic province of central Australia, provides a unique window into strain distribution in the deep orogenic crust. The mountain is compositionally dominated by interlayered gabbroic and charnockitic granulites, which were intruded into the shallow crust as a mafic and silicic layered intrusion (MASLI) but were subsequently buried, deformed, and metamorphosed at >30 km depth during Paleoproterozoic orogenesis.

Lithologic, structural, and fabric-type mapping demonstrate that Mt. Hay is a 10-km-scale sheath fold. Primary intrusive layering of the MASLI and screens of metasedimentary rocks, which are common near the mountain front, define a compositional layering that encircles the mountain. The tectonic fabric defined by elongate grains and grain aggregates is superimposed on compositional layering. A moderately NE-plunging lineation is pervasively developed across Mt. Hay. Foliation is axial planar to folds at all scales and is itself gently folded about a NE-plunging axis. We suggest that large-scale sheath folding, pervasive lineation development, and gentle refolding occurred during a single progressive deformational event.

Comparison of Mt. Hay strain data with data from other naturally occurring and experimentally produced sheath folds reveals good agreement with the strain types and strain distribution patterns observed for sheath folds formed in constrictional strain. Strain markers (cm-scale felsic segregations within gabbroic granulite) were measured at 25 sites across the mountain and show that L-type fabric development is uniform across Mt. Hay but that S-type fabric development decreases predictably inward toward the hingeline of the sheath fold. The development of a strong S-type fabric component spatially correlates with areas of interlayered metasediments, and we speculate that compositional layering that juxtaposes lithologies of distinctly different mechanical competency may exert a first-order control on the distribution of strain within sheath folds and within the deep crust rather than serving as a mechanically passive marker as previously suggested.

talk

Geochemical and Sedimentological Constraints on the Aerial Extent of the Greenland Ice Sheet during the Last Interglacial

Lisa Colville[1], Anders E. Carlson[1], Brian L. Beard[1], Joe S. Stoner[2], Claude Hillaire-Marcel[3]

[1]Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706
[2]College of Ocean & Atmospheric Sciences, Oregon State University, Corvallis, OR 97331
[3]GEOTOP, Université du Québec à Montréal, CP 8888 Québec, Canada

The greatest uncertainty for future sea level rise is the contribution from the Greenland Ice Sheet (GIS) due to limited understanding of GIS sensitivity to a warming climate. We present new geochemical (Nd isotopes) and sedimentological data (% silt) from sediment core MD99-2227 (58°12.64'N, 48°22.38'W, 3460 m of water depth) located on the Eirik Drift that illustrate the GIS response to warming during the last two deglaciations. These new data provide constraints on the aerial extent of the southern GIS during the last (TI, 21-7 ka) and penultimate (TII, 135-118 ka) deglaciations and subsequent interglacials. The % silt record suggests a significantly longer period of terrestrial sediment input during TII than TI (18 kyr vs. 5 kyr) in agreement with prior Ti, Fe and magnetic records. During TII, the radiogenic isotope records indicate that the earlier part of this sediment input (137-128 ka) has an e_{Nd} signature consistent with input of sediment with a significant Archean province (e_{Nd} ~- 20) that is likely derived from the southern Greenland Archean block (~64 °N), whereas sediment from 127-118 ka have e_{Nd} values of ~-15. The Nd isotope signature of sediment from 125- 117 ka are consistent with enhanced sediment supply from Proterozoic or younger affinity sources. This period of terrestrial sediment flux corresponds with the maximum sea level of the Last Interglacial (LI) suggesting that the greatest GIS retreat occurred between 127-118 ka. If this younger sediment was derived from the Proterozoic Central Nagssugtoqidian Orogenic Belt (~67.5 °N), then the sediment data would be consistent with ice sheet models that suggest a 3.9-4.8 m sea level contribution from the GIS to the ~ +6 m LI maximum sea level. A sustained freshwater flux from Greenland may have reduced the surface density of the Labrador Sea, explaining the lack of Labrador Sea Water formation during this interglacial. Further Nd-isotope analyses combined with Sr and Pb isotope analyses of the silt fraction of suspended load sediment from Greenland streams will provide new end-member data that will aid in deciphering the provenance of the sediment

poster

Modeling Flow and Arsenic Contamination in an Aquifer Storage and Recovery System, Green Bay, WI

Meghan Dickoff, Jean M. Bahr

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

Aquifer Storage and Recovery (ASR) was investigated early in this decade as an option to enhance municipal water supply capacity in Green Bay, WI. The project was ultimately determined to be unfeasible due to high levels of arsenic in the recovered water. Prior to 1957, Green Bay used water from the local Cambrian-Ordivician aquifer, but heavy use created such a large cone of depression that the municipal supply source was switched to Lake Michigan water. During the ASR testing period an old municipal well, open to approximately 550 ft of the aquifer system, including an upper aquifer, a lower aquifer, and a middle unit assumed to be confining, was used as the ASR injection and recovery well. Packers installed in a nearby monitoring well allowed for sampling from three intervals, roughly coinciding with these units. Arsenic concentration histories in these three intervals indicate that the middle unit is the source of most of the arsenic. Previous studies have investigated the presence of preferential flow paths in the units making up this middle interval, and breakthrough curves for specific conductivity indicate that in Green Bay this interval is horizontally highly conductive, allowing for the mobilization and transport of significant quantities of arsenic. This study incorporates this revised conceptual model into computer models for the local flow system and the mobilization and transport of arsenic.

poster

Three-Dimensional Geometry of Growth Faults Determined from Flume Experiments

Bridget C. Diem[1], Basil Tikoff[1], Christopher Paola[2]

[1]Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706
[2]Department of Geology & Geophysics, University of Minnesota-Minneapolis, MN 55455

Growth faults are common in many sedimentary environments, particularly on passive margins. A series of growth faults were analyzed that formed in a large experimental flume ("Jurassic tank") located in Saint Anthony Falls Hydraulic lab at the University of Minnesota. The growth faults are normal faults, with offset determined from the stratigraphy preserved in the flume. The growth faults step basinward in time and have a concave-up shape in cross-section. There are two sets of growth faults in the model, the earliest of which occurs during a rise in water level. The second sets occur during equilibrium conditions (no drop in the basin floor or rise in water level). We focused on the youngest (highest) of these growth faults systems, because of their simple geometry and clear view of depositional history.

Two-dimensional cross sections were taken approximately every 2.5 cm, which allow us to recreate the three-dimensional geometry of these growth fault systems. The three-dimensional visualization was done using Geoprobe volume interpretation software, which exhibits two geometric relations not observed in cross-section. First, the upper set of faults, as well as the lower set, does not share a common basal slip plane. Instead, spoon-shaped faults are stacked and show regular spacing between successive faults. Second, the growth faults are long and continuous, although local smaller faults splay off of dominant faults. The splaying faults show an asymmetry with respect to the main channel of sediment input: faults splay basinward away from the sediment channel. Two other features were found by examining the cross-sectional images as well as the three-dimensional interpretations. First, multiple faults were active at the same time as the faults stepped basinward. As one fault is ending, offset has already begun on the next down-basin fault. Second, a main fault in the upper set of growth faults documents a clear transition of sediment transport down slope that is seen moving along strike and away from the sediment input. Transport by sediment flow is found near the sediment input, which transitions into a clear growth fault with distance away from the sediment input. The results of theses experiments are then compared to geological and geophysical observations of growth faults

poster

Pinpointing Provenance using Radiogenic Isotopes: Provenance of Deepwater Sandstone and Conglomerate from the Gualala Basin, CA

Amalia C. Doebbert, Alan R. Carroll, Clark M. Johnson

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

Deepwater sandstone and interbedded conglomerate from the late Cretaceous – Eocene Gualala Basin of northern California have a shared provenance history that is connected to the regional tectonic evolution and erosion from the Mesozoic Sierran arc. Based on U/Pb ages and isotopic data, several discrete populations have been recognized in conglomerate clasts and linked with possible sediment sources. These same populations are also present in U/Pb age spectra from associated sandstones. However, sandstones include additional age populations that are not represented by conglomerate clasts. Furthermore, sandstone populations with ages that match those known for conglomerate clasts could represent sediments from different sources.

Femtosecond LA-MC-ICP-MS Pb isotope analyses of detrital K-feldspars can provide a new means of comparison between sandstone and conglomerate populations. They will also allow new constraints on the origin of sandstone populations that cannot be tentatively linked to conglomerate clasts. The use of a femtosecond laser allows rapid analyses of single grains, with significantly higher precision than is more commonly obtained from nanosecond lasers, allowing the same kind of multiproxy approach in sandstones that has previously been applied in conglomerates.

talk

Quantifying the effect of a weak phase on the rheology of naturally deformed polyphase rocks, Mt. Isa Inlier, Australia

Evan J. Earnest-Heckler, Basil Tikoff, Laurel B. Goodwin

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

An outcrop of 15-20 cm thick metamorphosed turbidite deposits located in the Mt. Isa Inlier, Queensland, Australia, provides us with a unique opportunity to study the rheology of naturally deformed polyphase rocks. These Bouma sequences are cross-cut by a series of granitic composition veins which display increasing angular shear strain as they cross from a load-bearing, quartzofeldspathic framework at the base of each sequence, where the veins have a high initial angle to bedding, into mica-rich domains towards the top of each sequence, where the veins have rotated into near-parallelism with bedding. Our hypothesis is that these veins are acting as passive strain markers during non-coaxial deformation, recording increasing angular shear strain with increasing mica content, reflecting strain partitioning into mechanically weaker phases. The spatial association of increasing mica percentage and increasing strain allows us to quantify the effect of a week phase, in this case mica, on rock strength. Indeed, our results show that as mica percentage increases and becomes more interconnected, strain is increasingly partitioned into mica rich shear planes parallel to bedding. Additionally, the outcrop provides insight into modes of foliation development. Where mica grains are isolated in a quartzofeldspathic framework (8-12% mica), strain is accommodated by both semi-brittle deformation and bedding parallel transgranular cataclasis of mica-adjacent quartz and feldspar grains, the latter caused by stress concentrations at the tips of isolated mica grains. As mica percentage increases to 15-25%, the micas become interconnected parallel to the transgranular fracture networks mentioned above. Further increase in mica content results in through going, bedding parallel shear planes and foliation development, which upon high strain (γ>4) develop into distinct S-C' foliations. Continued work will focus on quantifying these relationships with respect to mica%, mica connectivity, deformation mechanisms, vorticity and strain.

talk and poster

Calcic Labradorite from the Dust Devil Mine, Oregon

Gabriela Farfan[1], Huifang Xu[2,3]

[1]Madison West High School, Madison, WI 53726
[2]Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706
[3]Department of Materials Science and Engineering, University of Wisconsin-Madison, WI, 53706

Oregon sunstone is a unique, gem-quality calcic labradorite that can exhibit intense colors and a shimmering effect called “schiller.” Some of the colored stones also exhibit a rare pleochroism effect that is visible under normal transmitted and reflected lights. We investigated the schiller-causing metallic Cu inclusions with SEM and detected traces of zinc which formed a bronze-like alloy in some inclusions. We also found Fe-bearing enstatite inclusions that had not been described before. To explain the pleochroism effect, we came up with a three dimensional, nano-scale model based on the sizes, shapes and orientations of the metallic Cu inclusions as revealed by examination at the micron scale. Future and ongoing TEM studies are required to confirm orientations and shapes of the Cu nano-precipitates.

Additionally, the fractured nature of the phenocrysts lead us to believe that they underwent a type of thermal shock that broke most of the crystals except for the colored stones. The pleochroic color and thermal shock resistance properties of the Oregon sunstone could have applications to materials in the future. This research directly affects the gemstone industry and may eventually be applied to the nano and materials sciences.

poster

Macro- and micro-evolutionary response of bivalves to sea level change

Erin E. Fenlon, Dana H. Geary, Shanan E. Peters

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

The main goal of this research is to investigate bivalve response to sea level change on a macro- and microevolutionary scale. The frequency, magnitude and rate of sea level change clearly impact the environmental stability of marine habitats. Changes in sea level are certainly a controlling environmental force on macroinvertebrates, influencing their geographic range, potential for isolation, and species longevity, in addition to reflecting and influencing climatic and sedimentation regimes. However an insufficient number of case studies exist to allow for generalizations of the impact of sea level fluctuations on ecosystems. We hypothesize, using sea level change as a proxy for environmental stability, that bivalve response to sea level change will differ based the rate, magnitude, and frequency of sea level fluctuations. On a macroevolutionary scale we predict that biotic response (measured as origination and extinction rates) will be greatest when the rate and magnitude of sea level change are high and/or the elapsed time between sea level events is relatively long. On a microevolutionary scale we hypothesize that the dominant evolutionary pattern during periods of frequent sea level fluctuation will be punctuated equilibrium, whereas gradualism will be relatively more common during quieter periods. In addition, since sea level has been dominated by glacioeustatic controls over the last 100 my there may be a correlation between biotic response and climate regime. These hypotheses build off the ideas of previous researchers on environmental stability and biotic response.

talk

Macroevolution of the Planktonic Foraminifera

Andrew J. Fraass, D. Clay Kelly, Shanan E. Peters

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

The Planktonic Foraminifera are an excellent microfossil group for evolutionary study, yet most macroevolutionary studies have treated the Mesozoic or Cenozoic parts of this history separately, rather than taking a more holistic approach. Recent publication of several new atlases with standardized taxonomies provide an opportunity for a new analysis of planktonic foraminiferal diversity trends for 615 species, 126 genera, and 20 families for the entire Late Jurassic to Recent history of the group. The overall shapes of the species-, genus- and family-level diversity curves are similar and do not appear to be strongly affected by temporally asymmetric preservation or sampling biases (e.g., “Pull of the Recent”). Diversity at all taxonomic levels exhibits peaks of similar magnitude in the Cretaceous, Eocene, and Recent that are separated by diversity minima that vary in their severity and underlying diversity dynamics. The largest diversity decline occurs in response to a transient pulse of extinction in the upper third of the last biozone of the Cretaceous. This extinction-driven event divides planktonic foraminifera into distinct sets of “evolutionary faunas.” Recovery from this well-known extinction pulse is rapid, with pre-extinction diversity levels attained by the Lutetian. The second largest decrease in diversity occurs at the E/O boundary. In contrast to the K/Pg, this longer-duration decline in diversity is driven by a sustained decrease in rates of origination with little corresponding increase in rates of extinction. Diversity does not fully recover from the Oligocene diversity minimum until the Late Miocene. These results highlight (1) the ability of genera to accurately proxy species-level macroevolutionary patterns, (2) the importance of identifying underlying origination and extinction components of observed changes in biodiversity, and (3) the importance of the greenhouse-icehouse transition in the evolution of the planktonic foraminifera.

poster

Experimental Study of the Roles of Mechanical and Hydrologic Properties in the Initiation of Natural Hydraulic Fractures

Melodie French[1], Laurel B. Goodwin[1], David F. Boutt[2], Hassan Lilydahl[2]

[1]Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706
[2]Department of Geosciences, University of Massachusetts Amherst, Amherst, MA 01003

Natural hydraulic fractures (NHFs) are inferred to form where pore fluid pressure exceeds the least compressive stress; i.e., where the hydraulic fracture criterion is met. Although it has been shown that mechanical heterogeneities serve as nuclei for NHFs, the relative roles of mechanical anisotropy and hydrologic properties in initiating NHFs in porous granular media have not been fully explored. We designed an experimental protocol that produces a pore fluid pressure high enough to exceed the hydraulic fracture criterion, allowing us to initiate NHFs in the laboratory. An initial test with a low diffusivity sandstone produced NHFs parallel to bedding laminae that were optimally oriented for failure.

To evaluate the relative importance of mechanical heterogeneities such as bedding versus hydraulic properties, we are currently investigating variably cemented St. Peter sandstone. This quartz arenite exhibits a wide range of primary structures, from well developed bedding laminae to locally massive sandstone. Bulk permeability varies from $k=10^{-12}$ m^2 to $k=10^{-15}$ m2 and porosity varies from 5% to 28% in this suite of samples. Variations in a single sample are smaller, with permeability varying no more than an order of magnitude within a single core. Air minipermeameter and tracer tests document this variability at the cm scale. Experiments will be performed with the least compressive stress and the pore pressure gradient both perpendicular and parallel to sub-cm scale bedding. The results of these tests will be compared to those of structurally homogeneous samples and samples with heterogeneities.

In preparation for these tests, we have used poroelastic finite element models of our experimental procedure to develop a better understanding of how geologic heterogeneity affects elastic displacement, pore fluid pressure, and fluid pressure gradients.

poster

Extrapolation of monomineralic rock properties into a two-phase system: When does the second phase matter?

JoAnn R. Gage, Laurel B. Goodwin, Basil Tikoff

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

The rheology of rocks is often approximated by extrapolating steady state laboratory flow laws for monomineralic systems to strain rates and temperatures observed in the lithosphere. In naturally deformed polymineralic rocks, however, the material properties of each mineral collectively determine the rheology of the composite aggregate. Thus, the extrapolation of laboratory data for monomineralic systems to naturally deformed polymineralic systems is insufficient. Microstructural analysis of a naturally deformed two-phase rock (quartz and muscovite) shows that the amount of mica affects quartz deformation and thus impacts rock rheology. The Cambrian Harkless quartzite in the White-Inyo Mountains of eastern California contains interlayered quartzite and pelitic schist on the meter to millimeter scale. The proportion of mica in the quartzite varies from zero to 100%. Emplacement of the 85 Ma Papoose Flat pluton deformed this bimineralic system in the Harkless quartzite. On the outcrop scale, the variation in thickness and pinch and swell of the dominantly pelitic schist and quartzite layers shows competency contrast between the mineral phases. On the thin section scale, in pure quartz domains quartz grains are large, display undulose extinction, and are more equant than in mica-rich domains. Also, quartz grain boundaries are not pinned by mica grains; rather small mica grains are included in quartz. In mica-rich domains, quartz grain size is significantly smaller and quartz grains are elongate and rectangular with grain boundaries pinned by mica grains and aggregates. Approximately 15% mica appears to be the threshold composition, over which the mica begins the pin quartz grain boundaries and influence rock behavior. The contrast in quartz microstructures suggests that the amount of mica controls quartz deformation mechanisms and influences the strength and rheology of the rock.

poster

Adsorption Of L-Aspartate On γ-Alumina Surfaces

Anthony Giuffre, Nita Sahai

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

The general aims of the project are to determine the adsorption affinity, speciation and structure of amino acids on oxide mineral surfaces at conditions representative of natural geochemical environments and body fluids. Using a UV-Vis spectrophometric assay of the ninhydrin-asparate complex, we determined the adsorption of L-aspartate (L-Asp), a negatively-charged amino acid, on the surface of g-Al_2O_3 which has an isoelectric point of ~ 8. The adsorption experiment was performed over a wide range of pH values (4 to 9) and L-Asp concentrations (0 to 10 mM). At pH 4, the adsorption isotherm reaches a plateau at 0.8 $mmol.m^{-2}$. Combined with an estimated site density of 1 $site.nm^{-2}$, this corresponds to one L-Asp molecule for every two surface aluminol (>AlOH) sites. Based on analogous isotherms and ATR-FTIR spectroscopy for L-Asp and glutamate (L-Glu) adsorption on hydrous ferric oxide (HFO, $Fe(OH)_3$) and titanium dioxide (TiO_2), we infer bridging bidentate geometry for L-Asp on the g-Al_2O_3 surface. Future work includes determination of the pH dependence of adsorption at lower L-Asp concentrations along with ATR-FTIR structural characterization.

poster

Reservoir Contribution to groundwater flowpaths in the Nariarlé watershed of Burkina Faso

Drew B. Gower, Jean M. Bahr

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

A study of interactions between seasonal irrigation reservoirs and groundwater within the Nariarlé basin in Central Burkina Faso was undertaken in order to assess potential for groundwater contamination from agricultural activities. Seepage rates at three reservoirs of varying size were measured at the beginning of the dry season from October 2007 to December 2007 in order to determine the direction and magnitude of aquifer/reservoir exchange. The elevation of the regional water table was monitored over a similar period using measurements from large-diameter wells. Samples of reservoir, well and borehole water were taken from points in ten clusters throughout the basin. These samples were then analyzed for geochemical and isotopic signatures. Well logs and pumping test results of water supply boreholes were used to characterize the aquifer dimensions and hydraulic parameters at points in and around the basin. This information was combined with a GIS topographic profile to determine basin boundaries as well as potential recharge and discharge zones.

Seepage meter measurements show that reservoirs generally act as zones of focused infiltration, with seepage losses to groundwater preferentially occurring in areas with remain dry for parts of the year. Isotopic analyses show that water taken from both wells and boreholes downstream of reservoirs is enriched in heavier isotopes while samples taken at points upgradient of reservoirs have the same signature as rainwater. These results indicate that hillslope reservoirs act as zones of focused recharge and thus could affect downgradient groundwater quality. A numerical model of groundwater flow, calibrated using observed water levels and transmissivity estimates, provides further constraints on the magnitude of reservoir/groundwater exchange.

talk

TEM investigation of micro- and nano-precipitates in Oregon sunstones: genesis of and mechanisms for color and pleochroism in gem-quality feldspars

Tina R. Hill[1], Gabriela Farfan[2], Hiromi Konishi[1], Huifang Xu[1,3]

[1]Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706
[2]Madison West High School, Madison, WI 53726
[3]Department of Materials Science and Engineering, University of Wisconsin-Madison, WI 53706

We investigate native copper and previously undetected pyroxene to determine whether precipitation or epitaxial co-precipitation dominates exsolution as part of an unusual coloration process for gem-quality feldspar phenocrysts. High resolution transmission electron microscopy (HRTEM) is used to quantify crystallographic orientation of minerals in the host feldspar lattice. Previous silicate glasses show ~30 nm spherical particles responsible for red color in coppy ruby glass; this study proposes that ~50 nm thick copper platelets parallel to feldspar lattice plane (010) with a preferred pyroxene orientation of a-axis are mechanisms for red and green transparent color and atypical pleochroism in rare igneous phenocrysts of labradorite from Lake County, Oregon olivine basalts. Macroscopic copper schiller inclusions appear to be oriented on feldspar crystal planes (010) and (001). Properties of particles are known to alter at the nanoscale copper and pyroxene are evaluated for contributions to gemmy color generation in the labradorite lattice. Materials scientists have produced nanomaterials in the lab and examined their properties in simple minerals and systems for many years; geologists in recent decades have only begun to examine the properties of minerals at the nanoscale and the enormous effect they may have on rock formation. Here, an atypical mineral form of a ubiquitous mineral is chosen to study these effects. These labradorite phenocrysts have emerged from small, thin basalt flows indicating a singular event in an arc setting. The pyroxenes associated with copper nanocrystals have been shown to be high-Al using electron dispersive spectroscopy. The labradorite phenocrysts exhibit only a small amount of twinning and little chemical zonation for feldspar in a basalt. The feldspars and high-Al pyroxenes may hold clues for geologic formation of phenocrysts in arc settings.

talk

Direct Water Splitting Through Vibrating Piezoelectric Micro-Fibers in Water

Kuang-Sheng Hong[1,2], Huifang Xu[1,2], Xiaochun Li[2,3]

[1]Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706
[2]Department of Materials Science and Engineering, University of Wisconsin-Madison, WI, 53706
[3]Department of Mechanical Engineering, University of Wisconsin-Madison, WI 53706

We have proposed a novel mechanism, the *Piezoelectrochemical Effect,* for the direct conversion of mechanical energy to chemical energy. This phenomenon is further applied for generating hydrogen and oxygen via direct-water decomposition by means of as-synthesized piezoelectric ZnO micro-fibers and $BaTiO_3$ micro-dendrites. The fibers and dendrites are vibrated with ultrasonic waves leading to the development of strain-induced electric charges on the surface. Strained piezoelectric fibers (dendrites) in water with sufficient electric potential triggered the redox reaction of water as a result of hydrogen and oxygen gas production. ZnO fibers with ultrasonic vibrations showed a stoichiometric ratio of H_2: O_2 (2:1) initial gas production from pure water. This study provides a simple and cost-effective technology for direct water splitting forming hydrogen fuels by scavenging the waste energy such as noise from the environment. The new discovery may have potential implications in solving challenging energy and environmental issues we are facing today and in future.

poster

The Potential of Terrestrial Volcanic Glass as an Energy Source for Microbial Life on Mars

Andrew Honma, Eric E. Roden

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

Volcanic glass weathering has largely been studied from the chemical and physical point of view. Recently, the effects that microbial communities have on this process have been explored, with the bulk of this research focused on describing alteration textures that are believed to be associated with those communities in deep-ocean or subsurface volcanic glass. Much less work has been done in regards to terrestrial volcanic glass alteration, with the bulk of that work focused on the roles that phototrophs may have in the process.

Our interests are in the potential use of volcanic glass as an energy source for microbial life, with a focus on terrestrial environments analogous to past and present locations on Mars. One such example environment would be one that contained sub-surface impact ejecta blankets, as the blankets not only contain volcanic glass, but can also serve as conduits for liquid water. Other potential environments include glacial volcanic eruptions and eruptions into past lakes and oceans. Due to the high UV flux and high ionizing radiation of the surface environment, we are primarily interested in chemotrophs, as photosynthesis is an unlikely metabolic pathway to be found on Mars.

Our initial, ongoing work involves growing a known iron oxidizing chemotrophic culture on ground up basaltic glass from Kilauea. This will lay the groundwork for isolating and growing cultures more specific to the Martian environments of interest. A better understanding of the processes involved could potentially allow us to better design methods for detecting life in the present, or evidence of it in the past, on the Red Planet.

talk

Recurrence of Enigmatic Nannofossil Assemblages in the South Atlantic During the Early Oligocene

Katharine J. Horst, D. Clay Kelly

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

Significant global changes occurred during the Eocene/Oligocene transition (~33.7 Ma) as Earth's climate state shifted from a 'greenhouse' to an 'icehouse'. Prominent changes included the development of Antarctic ice sheets, heightened meridional temperature gradients and a reorganization of ocean circulation. These changes resulted in increased provincialism amongst the calcareous nannoplankton. This restructuring of plankton biogeographies is best exemplified by the recurrence of prominent *Braarudosphaera* blooms in subtropical South Atlantic during the Early Oligocene. To better understand the paleoceanographic conditions that fostered these unusual blooms, an Early Oligocene section recovered from atop the Walvis Ridge in the southeastern Atlantic (ODP Site 1263A) was used in this study. Cursory examination of over 1,000 smear slides spanning the entire Early Oligocene section revealed four prominent *Braarudosphaera* layers, all within planktic foram Zone P21a. A parallel series of stable isotope ($\delta^{13}C$, $\delta^{18}O$) records was generated through the core containing these *Braarudosphaera* layers using three depth-stratified species of foraminifera (surface, thermocline, benthic) to detect changes in water column stratification. All four layers coincide with decreases in the $\delta^{13}C$ record of the thermocline species, a pattern of isotopic change signaling increased upwelling. Baseline $\delta^{13}C$ and $\delta^{18}O$ values in the surface-dwelling species converge and diverge, respectively, with those of the thermocline species at ~28.8 Ma, consistent with increased surface-ocean mixing and decreased sea surface salinities. These changes occurring at 28.8 Ma are coincident with changes in the composition of planktic foraminiferal assemblages. Most notable is a decline in the abundance of *Paragloborotalia opima*, which indicates that this biostratigraphic datum is diachronous, and should be used with caution as an indicator in the South Atlantic.

talk

Crystal Orientation Effects on Bias of $\delta^{18}O$ in Magnetite by SIMS

Jason M. Huberty[1], Noriko T. Kita[1], Philipp R. Heck[2], Reinhard Kozdon[1], John H. Fournelle[1], Mike J. Spicuzza[1], Huifang Xu[1,3], John W. Valley[1]

[1]Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706
[2]The Department of the Geophysical Sciences, The University of Chicago, Chicago, IL 60637
[3]Department of Materials Science and Engineering, University of Wisconsin-Madison, WI, 53706

High precision in-situ analyses by Secondary Ion Mass Spectrometry (SIMS) reveals analytical bias of oxygen isotopes in magnetite due to crystallographic orientation effects. Multiple magnetite samples were analyzed conventionally (2 mg, BrF_5) and found to be homogeneous in $\delta^{18}O$, but showed variability of 4 to 5‰ during analysis by a Cameca IMS-1280 ion microprobe (10 μm spot ~ 2ng). Magnetite standard #5830 has a $\delta^{18}O$ of 3.96 ± 0.2‰ (2SD) VSMOW by laser fluorination. $\delta^{18}O$ values by SIMS are within bracketed 2SD errors (0.4‰) within individual grains but vary by 4 to 5‰ between grains. Crystal orientation effects in magnetite by SIMS were suggested previously and attributed to ion channeling along <110> (Lyon *et al.,* 1997, Int. J. Mass Spec. Ion Proc.).

We used Electron Back Scatter Diffraction (EBSD) to determine the crystallographic orientation of randomly oriented magnetite grains. We plotted the orientation of the Cs^+ beam for each grain on a stereonet centered on [111]. Raw $\delta^{18}O$ values measured by SIMS were assigned to each beam orientation and the resulting equal area projection was contoured for measured $\delta^{18}O$. The results show that the highest (least fractionated) $\delta^{18}O$ values are obtained with the Cs^+ beam parallel to <*hk*0>, corresponding to open directions in the lattice along which the Cs^+ ions are channeled. The total range of analytical bias becomes smaller by reduction of sputtering energy (20kV vs.10kV) or by analyzing at shallow depths (1 μm vs. 0.1μm).

SIMS precision for $\delta^{18}O$ in silicate minerals has improved from ±2‰ twenty years ago to ±0.3‰ 2SD today while at the same time analyses of magnetite have remained at ±2‰. The correlation between $\delta^{18}O$ in magnetite by SIMS and crystal orientation may provide the basis for accurate correction in conjunction with EBSD and may significantly improve SIMS magnetite data allowing in-situ quartz-magnetite thermometry among other potential applications. No other mineral has been shown to demonstrate orientation effects.

poster

Investigation of groundwater nutrient contribution to Dunes Lake, Door County, Wisconsin

Scott K. Johnson, Mary P. Anderson

Department of Geology and Geophysics, University of Wisconsin-Madison
WI 53706

Dunes Lake, an 80-acre lake/wetland complex in Door County, WI, which drains into Lake Michigan, is situated in thin (<30 ft) glacial deposits overlying fractured Niagara Dolomite. Eutrophication (increase in nutrients) is suspected owing to observed changes in plant and animal communities in the lake. Dunes Lake provides habitat for migratory birds, spawning area for fish from Lake Michigan, and may be a habitat for the endangered Hines Emerald Dragonfly. Field observations and preliminary groundwater flow modeling suggest that Dunes Lake is primarily groundwater fed. Measurements by the Door County Soil and Water Conservation Department in springs around the lake show 1 to 11 mg/L nitrate, and 12 to 60 g/L phosphate concentrations. Land use in the watershed is primarily agricultural, but there are two small municipal wastewater treatment ponds in the upper portion of the watershed.

The objective of the current study is to quantify the groundwater component of the lake's water and nutrient budgets. Observation wells will be installed around the lake, inflow and outflow streams will be gaged to measure surface water flows, and land use within the watershed will be analyzed. In addition, human enteric viruses will be used as a tracer to evaluate the connection between the wastewater treatment ponds and Dunes Lake. A groundwater flow model using the code MODFLOW2000 will be calibrated to water level and stream flow measurements. Boundary conditions for the model will be taken from a regional analytic element (GFLOW) model (Bradbury et al. 2008). The model will be used to estimate water and nutrient budgets and delineate the zone of groundwater contribution to the lake. The results from the study will be used to help design an effective Lake Management Plan.

talk

Fold Thrust Belt Kinematics from 3D Seismic Imaging along the NanTroSEIZE Transect, Nankai Accretionary Prism, Japan

Joe Kington[1], Harold J. Tobin[1], Gregory F. Moore[2]

[1]Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706
[2]Department of Geology and Geophysics, University of Hawai'i, Honolulu, Hawai'i 96822

The accretionary prism of the Nankai Trough, Japan provides an excellent location to study the kinematics of a fold and thrust belt developed primarily in low permeability units. Recently acquired 3D reflection seismic data covering a 12 x 56 km area from the Kumano basin seaward to the deformation front reveals three structural domains within the frontal accretionary prism. The farthest seaward domain of the prism consists closely-spaced, apparently in-sequence thrust sheets forming a steep critical taper angle. The primary decollement beneath these thrusts ramps upsection above a topographic high within the oceanic basement. The farthest landward domain within the study area consists of the hanging wall of an apparently out of sequence megasplay thrust fault that dips landward to the top of the oceanic crust. The central structural domain within the prism consists of thrust sheets formed above a decollement approximately 2 km above the top of the oceanic crust, above the decollement associated with the more seaward thrusts. These thrusts are more widely spaced than those nearer the deformation front and are blanketed with syn and post kinematic sediments. Synkinematic sediments indicate that thrusts in the most seaward and most landward structural domains within the prism are the most active, though some reactivation of structures in the middle domain has occurred. Additionally, gas hydrate bottom simulating reflectors (BSRs) in the lowermost portions of the prism are present as discrete bands striking parallel to thrusts. These BSRs occur primarily along the most active thrusts, and are only present as small patches within the central structural domain of the prism. As these are expected to be the result of fluid migration along faults and permeable structures, they provide insight into the hydrologic controls on thrusting within the accretionary prism.

poster

Plowing through the Paleozoic: Trilobite Ichnofossils as Stratigraphic Indices

Mary Ruth Kotelnicki, Dana H. Geary

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

The presence of *Cruziana* and *Rusophycus* in rock sequences that lack body fossils has proven to be an effective stratigraphic marker for the paleocontinent Gondwana. The Gondwanan "*Cruziana* stratigraphy" provides an ichnostratigraphic paradigm that can be tested on the Laurentian paleocontinent. We examine *Cruziana* and *Rusophycus* ichnospecies from Laurentia and discuss their application to a Laurentian and to a global "*Cruziana* stratigraphy." Distinction between different species of *Cruziana* and *Rusophycus* is based on unique appendage impressions and scratch patterns. Comparative analysis of North American *Cruziana* and *Rusophycus* ichnospecies indicates that stratigraphic correlation is possible on the Laurentian paleocontinent. However, Laurentia has a trilobite ichnofossil fauna distinct from that of Gondwana, suggesting that a global "*Cruziana* stratigraphy" is not possible.

Cruziana and *Rusophycus* ichnofossils also provide information about the ventral morphological features of their trace-maker. Such features include impressions of biramous limbs, coxae, and cephalic doublure, as well as drag marks from genal and pleural spines. The study of these ichnofossils lends itself to improving the understanding of trilobite limb evolution. Except for the extremely rare occurrences of soft-part preservation, there is little evidence available to study trilobite limbs. The breadth of appendage diversity seen in many arthropod lineages was never attained by trilobites. It has been suggested that this lack of variation may be the product of a common substrate relationship shared among all trilobites; alternatively, it may be the effect of having a constrained basal-arthropod prototype. Systematic examination of the temporal patterns of limb markings on *Cruziana* and *Rusophycus* can help explain the basis for their homogenous limb morphology.

talk

Distributed Temperature Sensing as a Hydrostratigraphic Characterization Tool for Aquifer Storage Recovery (ASR)

Andrew T. Leaf, Jean M. Bahr

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

Aquifer Storage and Recovery (ASR) is the use of aquifers for the temporary storage of surface water, via injection and withdrawl through wells. The use of ASR has increased substantially over the last decade, and will likely continue to increase as climate change and population growth create additional water management challenges. However, adverse geochemical reactions resulting from the subsurface storage of surfacewater can complicate ASR implementation. Detailed characterization and monitoring of ASR sites can help address this challenge. Temperature is a potentially useful tracer for injected water, but conventional measurement technologies are limited by their discrete nature. Distributed Temperature Sensing (DTS) is a new technology that allows for the economical and nearly continuous measurement of temperature in time and space.

ASR cycle testing has been performed at the Oak Creek, WI ASR pilot site since 1999. During a cycle, treated Lake Michigan water is injected into the Cambrian-Ordovician Sandstone Aquifer in early spring (low daily demand), and recovered during summer (high daily demand).

Following eight injection/recovery cycles, DTS measurements were collected in June 2008, in a monitoring well located 180 feet from the ASR well. Ambient measurements revealed perturbations in the geothermal gradient corresponding to hydrostratigraphically significant lithologies. During a week of continuous pumping in the ASR well, temperature changes were observed over some intervals. Coupled groundwater flow/heat transport modeling is being used to reconstruct a “thermal history” of this site, and investigate the potential processes causing these temperature anomalies

talk

Terrestrial analog of martian jarosites, using Rb-Sr as a possible geochronometer

James M. Ludois, Brian L. Beard, Clark M. Johnson, Eric E. Roden

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

K-rich sulfates precipitated from highly acidic solutions are commonly found in oxidizing environments, i.e., Iron Mountain, California. This study aims to characterize the Rb-Sr geochemistry of K-rich sulfates from multiple environments as an analog to the jarosite recently discovered at the Meridiani locality on Mars. Mineral samples studied range in composition from end member to mixed compositions of jarosite, $KFe_3(SO_4)_2(OH)_6$ and alunite $NaFe_3(SO_4)_2(OH)_6$. By characterizing the Rb-Sr systematics of jarosite, specifically the Rb/Sr ratio, the utility of the Rb-Sr system as a possible geochronometer on Mars can be investigated. Model ages of jarosite precipitation on Mars could be obtained in-situ, based on the possible reservoirs of Rb-Sr on Mars. Samples were obtained from Gumma Iron Mine, Japan, Gilbert, Nevada, and the Rio Grande Rift in southern New Mexico. The Rb/Sr ratio of analyzed samples ranges from .03 to about 6, as the concentration of Rb and Sr is highly variable between samples. These ratios are likely dependent on the environment of formation, but further investigation is needed to determine what is controlling the Rb-Sr chemistry of these sulfate minerals.

poster

Influence of Wetland Hydrodynamics on Subsurface Microbial Redox Transformations of Nitrate and Iron

Cassidy Miller, Jean M. Bahr, Eric E. Roden, Evgenya S. Shelobolina

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

The objective of this project is to constrain the mechanisms of nitrate loss and coupled cycling of iron within a riparian wetland aquifer. Although several recent studies have addressed the influence of hydrologic dynamics on subsurface denitrification, the impacts of competing microbial metabolic pathways and redox interactions are not well understood in relation to hydrological dynamics. In particular, interaction between N and Fe redox cycles represents a potentially important but poorly constrained driver of aquifer N dynamics.

A network of multilevel samplers and piezometers has been installed in the wetland, with two transects perpendicular to the creek and a single multilevel near County Highway Q. From this network, a variety of geochemical parameters (temperature, conductivity, dissolved O_2, dissolved organic carbon, Fe^{2+}, Fe^{3+}, NO_3^-, SO_4^{2-}, and Cl^-) were determined on a monthly basis, and one set of samples were taken in September 2009 for microbial analysis to determine the abundance of culturable organotrophic NO_3^--reducing, organotrophic Fe(III)-oxide reducing, and Fe^{2+}-oxidizing NO_3^--reducing microorganisms in the groundwater. The combined geochemical and microbial analyses indicate active nitrate reduction and the occurrence of an active iron redox cycle in at least two of the wells installed.

poster

Numerical Modeling of Crustal Deformation in the South Iceland Seismic Zone

Anousa Mukhopadhyay, Kurt L. Feigl

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

Considerable evidence indicates that one earthquake can trigger another by stress transfer. The textbook example is a pair of magnitude 6 earthquakes that shook the Superstition Hills, California in 1987. First, the left-lateral Elmore Ranch fault ruptured. Some 12 hours later, the right-lateral Superstition Hills fault ruptured in a second earthquake. The distance between the first (source) epicenter and second (receiver) epicenter is about 10 km. Similar sequences of large ($M \geq 6$) earthquakes occurred in 1784, 1896, 2000, 2008 in the South Iceland Seismic Zone (SISZ). One goal of our research is to explain the separation in both time and in space between such triggered earthquakes. As a first step toward this goal, we are focusing in particular on the 2000 SISZ sequence. In our modeling, we consider several levels of sophistication. The simplest model assumes that the coseismic rupture can be described as dislocation embedded in an elastic half-space with only two coefficients, Poisson's ratio and a rigidity (shear modulus) to describe the rheology. In the second level of sophistication, a poroelastic rheology can be approximated by changing the Poisson's ratio to approximate drained and undrained conditions, again in a halfspace. In the third level of sophistication, we plan to consider a general poroelastic medium with four coefficients. In this poster, we describe the first two levels of modeling sophistication in an inverse problem. The data are geodetic measurements of crustal deformation performed by GPS surveys and interferometric analysis of synthetic aperture radar images (InSAR). Using a simulated annealing algorithm, we estimate the source parameters of the two M 6.6 earthquakes that occurred on 17 and 21 June 2000. The results from this study will allow us to proceed to the third level of sophistication, that will necessarily involve the use of the finite element method. The end goal will be to test hypotheses about how earthquakes trigger one another.

poster

SAFOD Target Earthquake Detection via Waveform Cross Correlation

Rachel A. Murphy[1], Clifford H. Thurber[1], Charlotte A. Rowe[2]

[1]Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706
[2]Geophysics Group EES-11, Los Alamos National Laboratory, Los Alamos, NM 87545

Although the SAFOD project was not able to carry out the planned drilling into the rupture patch of a magnitude ~2 earthquake, it is still critical to understand the relationship between deformational features observed in SAFOD cores and borehole logs and the seismically active fault strands surrounding the borehole. In order to increase completeness of the observations of the target-area events, we applied a correlation-based scanning detection algorithm to temporary array data from the PASO deployments to find earthquakes that had not been identified previously. The scanning code is a modification of the cross-correlation phase repicking algorithm of Aster and Rowe (2000) and Rowe et al. (2002) that incorporates adaptive, cross-coherency filtering. Application of the cross-coherency weighting allows for analysis of a greater portion of the spectrum than would be achieved with standard bandpass filtering methods, while enhancing the coherent portion of the signals being compared. The scanner compares a user-defined master waveform to triggered or continuous waveform data, tracking the maximum cross-correlation coefficient and associated correlation lag for each windowed time segment to identify repeating or near-repeating waveform segments. Our preliminary application of this method to triggered waveform segments from 2000-2002 has led to the identification of several events in the target region that are not present in existing catalogs. We will present our analysis of these events and additional events detected in continuous waveform data streams during time periods in 2004 and 2005 when a seismic instrument was deployed in the SAFOD borehole. We also apply the cross-correlation detector to search for deep off-fault thrust events that occurred close to SAFOD, which may provide important constraints on the local state of stress.

poster

Geochemical Constraints of Laurentide Ice Sheet Freshwater Discharge to the NW Atlantic during the Last Deglaciation

Elizabeth A. Obbink[1], Anders E. Carlson[1], Gary P. Klinkhammer[2]

[1]Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706
[2]Department of Geosciences, Oregon State University, Corvalis, OR 97331

During the last deglaciation, the eastward routing freshwater from retreat of the Laurentide Ice Sheet along with periods of enhanced meltwater discharge presumably caused reductions in Atlantic meridional overturning (AMOC) strength. The timing of freshwater discharge is relatively well constrained during Heinrich Event 1 (H1) (~17.5-16 ka) and the Younger Dryas cold event (~12.9-11.5 ka); however, the history of LIS discharge to the North Atlantic between these two events remains poorly constrained. Here we present new deglacial (~17 to 13 ka) records of sea surface temperature (SST) (planktonic Mg/Ca) and sea surface salinity (SSS) (planktonic SST-ice volume-corrected $\delta^{18}O$ of seawater ($\delta^{18}O_{sw}$) and $\delta^{13}C$) from the Laurentian Fan. The SST record shows similarities to other North Atlantic temperature records with warming following Heinrich Event 1 (H1) and at the onset of the Bølling, with several SST oscillations superimposed on gradual cooling through the Allerød. The SSS dependent $\delta^{18}O_{sw}$ record decreases at ~16.5-16 (H1), 14.2-14.0 and 13.6-13.4 ka, with similar decreases observed in the $\delta^{13}C$ record. These decreases indicate the arrival of water depleted in ^{18}O and ^{13}C, presumably of terrestrial origin, suggesting increased terrestrially derived freshwater discharge from northeastern North America. The timing of inferred increases in terrestrial freshwater discharge at ~14.1 and 13.5 ka are concurrent with the Older Dryas cold event and a cold oscillation during the earlier part of the Allerød, southward shifts in the Intertropical Convergence Zone and reductions in Southeast Asian Monsoon intensity, as well as two increases in atmospheric $D\delta^{14}C$. This suggests that these relatively brief freshwater discharge events reduced AMOC strength with attendant affects on climate.

poster

High-resolution Paleoclimate Records From Soreq Cave Speleothems: Sub-annual Resolution by Ion Microprobe

Ian J. Orland[1], Miryam Bar-Matthews[2], NorikoT. Kita[1], Avner Ayalon[2], John W. Valley[1]

[1]Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706
[2]Geological Survey of Israel, 30 Malchei Israel Street, Jerusalem, 95501, Israel

Speleothems provide an important record of continental paleoclimate over the last 500 ka. Isotopic data from calcite-dominated cave formations have been used as proxies to identify changes in annual rainfall, monsoon strength, telecommunication of Northern Hemisphere climate aberrations, changes in vegetation cover, and other region-specific paleoclimate time-series over both short and long timescales.

This study focuses on speleothems from the semi-arid Eastern Mediterranean region (Soreq Cave, Israel) where prior research shows that conventional drill-sampling analysis of calcite $\delta^{18}O$ permits a temporal resolution of ~10-50 years in speleothem paleoclimate records. The WiscSIMS lab at the University of Wisconsin-Madison has developed analytical techniques that yield a precision of ~0.3‰ (2 s.d.) in $\delta^{18}O$ from 10 mm-diameter spots, which corresponds to sub-annual-resolution measurements of stable isotopes in a speleothem. Coupled with imaging of annual growth bands by confocal laser fluorescent microscope (CLFM) in a 2200-year-old speleothem from Soreq Cave, Orland et al. (2009, QR) reports seasonal climate patterns and their variability through time.

As reported by Bar-Matthews et al. (2003, GCA), Soreq cave speleothems record over 185 ka of regional climate history. Soreq stalactite sample 2N grew from ~24-1.0 ka and preserves a time-series of oxygen isotope data across multiple rapid global climate change events, including the onset/termination of the Younger Dryas, the last glacial termination, abnormal variability near 8.2 ka, as well as multiple abrupt regional events. Ion microprobe analysis of $\delta^{18}O$ from >700 spots (most at sub-annual resolution) across a radial traverse of sample 2N also identifies apparent changes in the seasonal character of the record during and after the last glacial period at ~20 ka. CLFM imaging across the sample reveals changes in growth-banding characteristics that may give further insight into the varying character of seasonal climate in the region since ~20 ka. Further U-series dating by laser-ablation ICP-MS and oxygen isotope analysis by ion microprobe will enhance our understanding of the timing and magnitude of climatic events in the Eastern Mediterranean and their relation to globally-observed changes.

poster

Evidence for Dilational Processes Accompanying Earthquakes at The Geysers Geothermal Field, California

Summer J. Ohlendorf[1], Douglas Dreger[2]

[1]Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706
[2]Department of Earth and Planetary Science, University of California, Berkeley, CA 94720

Volcanic and geothermal systems are often characterized by high seismicity rates due to the movements of fluids through the subsurface. The seismic moment tensor is a useful tool for investigating the source mechanisms of the largest of these earthquakes. This study performs full moment tensor inversion for six shallow events with magnitudes between 3.5 and 4.5 occurring within the last four years at The Geysers Geothermal Field, California. Previously, regional catalogs have included only deviatoric solutions for Geysers events, which are calculated assuming that the source mechanism consists of only double-couple (DC) and compensated linear vector dipole (CLVD) components (no volume change occurs at the source). Most tectonic earthquakes are fit well by almost entirely DC mechanisms. More complex faulting can result in non-double-couple (CLVD and isotropic) components in the moment tensor solutions. All six of the events studied reveal significant isotropic/volumetric components in the best-fitting solutions, indicating anomalous seismic radiation patterns. One likely explanation for these patterns is failure involving both shear and tensile faulting as hydrothermal fluids are injected into a region. Thus, fluid migration may directly trigger these moderate events. The consistently high isotropic component of the mechanisms suggests that full moment tensors should be found for future events at The Geysers in order to accurately characterize the processes involved in producing the region's seismicity.

poster

Getting Started in Academic Careers: *On the Cutting Edge* Resources for Graduate Students, Postdoctoral Fellows, and Early Career Faculty

Carol J. Ormand[1], R. Heather Macdonald[2], Cathryn A. Manduca[3]

[1]Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706
[2]Department of Geology, The College of William & Mary, Williamsburg, VA 23187
[3]Science Education Resource Center, Carleton College, Northfield, MN 55057

On the Cutting Edge is a professional development program for the geosciences. Two sections of the *Cutting Edge* website focus on navigating the transitions from graduate school to post-doc and faculty positions:

Preparing for an Academic Career in the Geosciences
http://serc.carleton.edu/NAGTWorkshops/careerprep/index.html

The Job Search features pages on beginning your search, assembling your application materials, interviewing, negotiating, dual career couples, international scholars, and additional considerations. Moving Your Research Forward features pages on moving beyond your dissertation, getting published, and postdoctoral fellowships. Preparing to Teach features pages on getting teaching experience, designing your courses, daily class planning, and documenting your teaching

Early Career Geoscience Faculty: Teaching, Research, and Managing Your Career
http://serc.carleton.edu/NAGTWorkshops/earlycareer/index.html

Finding Your Balance features case studies of academic geoscientists (describing how they achieve balance in their lives), a worksheet to help you clarify your personal and professional priorities, resources on task & time management, and a page on balancing career and family. Efficient, Effective Teaching features resources on course design, teaching efficiently, building your tenure case for teaching, learning styles, expanding your teaching toolkit, teaching large classes, teaching research seminars, and assessing student learning. Developing a Research Program features resources on planning your research program, funding your research, collaborating with students, setting up your lab, making time for research, and publishing your work. Getting Tenure features resources to help new faculty chart their progress toward tenure and plan strategically.

poster

Mineral inclusions in zircons: A tool for provenance analysis of sedimentary rocks

Dayanidi M. Ortiz, John W. Valley

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

Mineral inclusions have been analyzed in zircons from 85 rocks from a wide range of known host rocks, and from sands where zircons are detrital and parent rocks are unknown. These analyses were done in order to compare with the Jack Hills zircons from Western Australia for which the parent magma is unknown. Zircon samples are from a range of known parent rocks including: eight granitoids from Sierra Nevada Batholith; four rhyolites from Yellowstone; six rhyolites from Superior Province; four anorthosites from the Adirondack mountains; two kimberlites from South Africa; two gabbros from Australia; several trondhjemites and gabbros from modern Mid Oceanic Ridges and a gabbro and a peridotite from Scotland. Detrital zircons from three other samples of unknown sources including Florida beach sands and the St. Peter sandstone were analyzed. In addition, detrital zircons were analyzed from the Jack Hills metamorphosed conglomerate from which the oldest zircons on Earth were dated; four samples of all of which have oxygen isotope, geochronological and REE analyses. Zircons from the Jack Hills granitoids have also been analyzed. From 3,696 zircon grains analyzed, the composition of ~15,000 inclusions has been analyzed by Scanning Electron Microscope imaging using Backscatter Electron and Energy Dispersive X-Ray Spectroscopy. Data collected suggests that the Jack Hills zircons are similar to continental rock zircons. This demonstrates that the mineral paragenesis of inclusions in zircons, corresponds to that of the parent igneous rock. These histograms form fingerprints that are characteristic of the host rock type of the zircons. This is a valuable tool for provenance studies of sedimentary rocks.

poster

Formation and evaluation of anoxygenic BIF genesis: linking microbiology, mineralogy and iron isotopes

Elizabeth M. Percak-Dennett, Eric E. Roden

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

Banded Iron Formations (BIFs) are composed of alternating layers of iron oxides and chert with shale. In addition to being an economically important source of iron, BIFs serve as a geologic enigma, with their exact formation mechanisms and origins remaining elusive. This project seeks to explore an anoxygenic environment as a possible early-earth scenario for the deposition of BIFs using iron oxidizing and iron reducing organisms, while monitoring iron isotopes, mineralogical composition of bacterial outputs, and microbial community dynamics. Environmental mud-flat samples were obtained from Sausalito, CA and used as innoculum for enrichment cultures specific for anoxygenic phototropic iron-oxidizing cultures, as well as a “robust consortia” of dissimilatory iron reducing (DIR) and fermentative organisms. Once these communities have been isolated, they will serve as model organisms to explore the possibility of reduced iron being oxidized in an anoxygenic setting, and the end products from this oxidization serving as carbon sources and electron acceptors for a robust community of DIR organisms. These experiments will test the hypothesis that BIFs were created through anoxygenic microbial iron oxidation coupled to microbial iron reduction, allowing for alternating iron-rich and iron-poor layers. Additionally, pure culture experiments using *Desulfurmonas acetoxidans* and varying input of organic carbon will be used in a simulated Archean marine environment, in an attempt to explore mineral end products of dissimilatory iron reduction while examining changes in mineralogy and iron isotopes during the DIR process. This project has implications for furthering knowledge of early microbial communities on earth, as well as providing a mechanism for the anoxygenic formation of BIFs within the Archean and Proterozoic rock record.

talk

Pulses of rapid garnet growth observed from microsampling and Sm/Nd geochronology in a single zoned garnet

Anthony D. Pollington,[1] Ethan F. Baxter[2]

[1]Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706
[2]Department of Earth Sciences, Boston University, Boston, MA 02115

Chemically zoned garnets have the potential to provide geoscientists one of the most useful records of the changing conditions within the tectonically evolving crust where metamorphic mineral growth occurs. Yet full exploitation of this continuous multi-million year record of tectonic processes requires high resolution geochronologic measurements. An improved method for microsampling narrow growth zones of garnet porphyroblasts based on chemical composition has been developed and implemented on a single large (6 cm) garnet from a shear zone in the Stillup Tal, within the Tauern Window of the Austrian Alps. Despite evidence for fluid flow and major-element metasomatism in the shear zone [1], a late-Hercynian age whole rock isochron indicates that the Sm-Nd system was not disturbed by these water-rich fluids during the Alpine Orogeny. This method coupled with updated partial dissolution protocols to remove Nd-rich mineral inclusions leads to small but pure garnet samples (each yielding 2-12 ng Nd) which can be dated at a very high precision using Sm-Nd isochrons. Here, we present precise garnet-matrix isochron ages from 12 distinct concentric growth zones within this garnet. Age uncertainties for these 12 garnet zones range from ±0.43 to ±0.67 Ma (2s). The radial pattern of ages is consistent with an average constant volumetric growth rate of 10.28 +0.76/-0.66 cm^3/Myr over a total growth span of 7.55±0.52 million years. However, at a finer level of detail afforded by the spatial and temporal resolution of the dataset, the data reveal two brief distinct pulses of accelerated growth (at least 5 times faster than the background rate) which correlate with prominent chemical excursions in the zoned garnet, indicating significant shifts in pressure, temperature, bulk composition and/or the introduction of catalyzing fluids during these pulses. These data provide evidence that tectonometamorphic processes leading to garnet growth within this shear zone (i.e. exhumation, fluid flow, heating) were pulse-like in nature, rather than steady, during the waning stages of the Alpine orogeny 28-20 million years ago.

[1] Selverstone *et al.* (1991) *J. Met. Geol.* 9, 419-431.

poster

Self-organization and quantitative properties of polygonal fracture networks, Tuolumne Intrusive Suite, CA

Paul R. Riley, Basil Tikoff

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

Qualitatively, polygonal fracture patterns are highly recognizable, but due to irregularity of fracture spacing and orientation within the patterns, are difficult to quantify and model. We documented ~50 polygonal fracture networks in the Tuolumne Intrusive Suite, Sierra Nevada Batholith to investigate fracture network organization. Measurements (size, orientation, length) of fractures and fracture-bound polygons were taken in nearly isotropic granitic rocks, away from zones of fabric development. Each fracture network is constrained to an exfoliation sheet; the free surfaces of the exfoliation sheet form the bounding surfaces for the polygonal fracture network. Data indicate that the size of fracture-bound polygons logarithmically scales with exfoliation sheet thickness. The size-frequency distribution (normalized) of the networks' polygons has a positively skewed distribution, indicating preferential formation of polygons larger than the average. Fracture-bound polygons are not isotropic; a shape preferred orientation exists for all networks that is independent of scale, layer thickness, and dip. Rather, the degree of anisotropy correlates with the degree of exfoliation sheet curvature.

These fracture networks likely formed due to freeze-thaw cycles. Each fracture network exhibits a distinct pattern, but our data indicate that quantitative similarities exist between networks. We propose that the observed patterns are a product of interactions between fractures, not extrinsic conditions, and that relatively simple equations and geometric relations govern the system. Any proposed formation model does not necessarily need to reproduce the exact fracture pattern, but must adhere to the observed quantitative properties of the natural networks. Using the observed quantitative properties as controls (e.g., polygon size distributions, degree of polygon anisotropy, etc.), we propose a self-organization fracture model based on the Plug and Werner (2001) sorted-circle model to describe fracture network development.

talk

Septal spacing variation among Paleozoic nautiloids

George X. Rothdrake, Dana H. Geary

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

The shell of a nautiloid cephalopod has two components: the phragmocone, which is divided into chambers by septa, and the living chamber, which is open at the aperture and houses most of the animal's body. The septa are added sequentially during the animal's life, and so furnish a convenient record of the phragmocone's growth.

In the Recent nautilus, the shell grows in a roughly logarithmic spiral, but septal spacing sometimes departs from isometric growth, especially as it approaches maturity. This pattern of terminal septal crowding is more conspicuous in some Mesozoic coiled nautiloids, as well as some Paleozoic orthocones (cone-shaped cephalopods). Orthoconic nautiloids, in the broad sense, provide models simpler in geometry but distinct in pattern from coiled cephalopods.

The goal of this study is to examine how septal spacing differs, within the ontogeny of an individual, among individuals within a species, and among widely different taxa. The data come from linear measurements of nautiloid shells residing in the collections of several museums.

Some orthocones exhibit isometric growth, while others depart significantly of isometry. For instance, some orthocerids and pseudorthocerids grow isometrically throughout ontogeny. By contrast, the Ordovician actinocerid genus *Actinoceras* grows in two phases, showing first increasing and later decreasing septal spacing. The crowding of the last few septa coincides with a constriction of the aperture, which may contest the hypothesis that septal approximation adjusts for an allometric expansion of the living chamber.

talk

Rb-Sr White Mica Ages of HP/UHP Ophiolite Metasediments, Zermatt-Saas Ophiolite, Switzerland

Eva Szilvagyi, Clark M. Johnson, Brian L. Beard

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

Rb-Sr “white mica”-whole rock-carbonate-clinozoisite internal ischrons and careful petrographic analysis of high-pressure Alpine metasedimentary rocks of the Zermatt-Saas ophiolite complex of the western alps are used to investigate timing of peak metamorphism and exhumation at various locations in the northern portion of this oceanic crustal fragment. Samples are calcareous micaschists with phengite/paragonite-quartz-garnet-calcite/dolomite-clinozoisite-apatite compositions and strong deformation fabrics mostly apparent in micas. The Zermatt-Saas ophiolite was most likely subducted independently of its overlying nappes but then coupled to them during exhumation. Even within this particular unit, diachronous subduction rates have been proposed, and Sm-Nd and Lu-Hf garnet ages from previous studies show a range of ages for peak garnet growth. This study reports preliminary mica-whole rock Rb-Sr isochron ages that are similar but statistically distinguishable at 39.85 Ma, 37.70 Ma, 40.03 Ma, 39.75 Ma, 39.80 Ma in each of 6 localities within about 10 km of each other near Zermatt. Similarity between these and prograde garnet Sm-Nd ages indicate micas dated probably grew extensively during peak metamorphism, rather than during a prolonged retrograde reaction. Phengite barometry using Si substitution in coexisting white micas is used to determine pressure conditions. Together with other isotope systems on various high-pressure minerals, these Rb-Sr ages on micas will help constrain subduction and exhumation rates and bracket timing of peak metamorphism of the Zermatt-Saas ophiolite.

poster

Aftershock distribution relative to main shock slip and trench parallel gravity anomalies

Alex Teel[1], Clifford H. Thurber[1], Guoqing Lin[2]

[1]Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706
[2]Division of Marine Geology and Geophysics, Rosensteil School of Marine and Atmospheric Science, University of Miami, Miami, FL 33149

A recent study by Llenos and McGuire (2007) uses second moments to create rupture models for 15 great subduction zone earthquakes and compares the centroid and rupture extent results relative to trench parallel gravity anomalies (TPGA). They find that for 75 percent of the events studied, TPGA increases between earthquake centroid and the edges of rupture, indicating structural control on rupture arrest. As an independent test of this relationship, we are using a modified Joint Hypocenter Determination code to relocate aftershocks of the events studied by Llenos and McGuire (2007). Available arrival time data have proven adequate to robustly relocate 8 of the 15 aftershock sequences. Our preliminary results show good agreement between the aftershock distributions and the Llenos and McGuire (2007) rupture extent and directivity results for 5 events. We do not observe a clear-cut relationship between TPGA features and the aftershock zone, however. We will explore the use of waveform cross-correlation to provide additional and more accurate arrival time picks for first arrivals and depth phases in order to extend our analysis to the remaining sequences.

talk

Polygonal Faulting in 3D Seismic Data of the Halten Terrace, Norwegian Sea

Andrew Trzaskus, Alan R. Carroll, Harold J. Tobin

Department of Geology and Geophysics, University of Wisconsin-Madison
WI 53706

The advent of three-dimensional seismic surveying has allowed for the identification of small scale normal fault networks of non-tectonic origin in the subsurface. The faults have oblique strike directions and traces of less than 1 km; such features have been termed polygonal faults. Polygonal faults form networks of cells that are hundreds of meters across and occur in dominantly clay-rich layers bound above and below by undisturbed units. Numerous explanations for the formation of these fault patterns have been proposed, including lateral or compactional stress due to gravity and mineralogical transitions.

A polygonal fault network has been identified in a 3D seismic volume of the Heidrun Field in the Halten Terrace of offshore Norway. The faults occur in the smectite-rich Lower to Middle Eocene Brygge Formation. The Brygge Formation is time equivalent to units in the North Sea that contain polygonal faults, suggesting a regional component to the formation of the faults in this area. Despite the increasing identification of polygonal faults in data volumes worldwide, large scale three-dimensional interpretations of the fault planes and associated fault maps have not been produced. It is the aim of this study to produce such an interpretation in the Heidrun dataset, showing the complex structure of the faults and their relationships at intersections.

poster

Preliminary Northwest Atlantic planktonic foraminiferal Mg/Ca-temperatures during the last and penultimate deglaciations

Kelsey Winsor[1], Anders E. Carlson[1], Gary P. Klinkhammer[2], Elizabeth A. Obbink[1], Lisa Colville[1], Shaun A. Marcott[3], Reinhard Kozdon[1]

[1]Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706
[2]College of Oceanic and Atmospheric Sciences, Oregon State University, Corvalis, OR 97331
[3]Department of Geosciences, Oregon State University, Corvalis, OR 97331

During warming climate, the amplitude of sea surface temperature (SST) change in high latitude regions is greater than in lower latitudes. However, deglacial sea surface temperature (SST) records are relatively sparse in the subpolar and polar regions of the North Atlantic and are predominately focused in the eastern portion of the basin. Here, we present preliminary planktonic *Neogloboquadrina pachyderma* sinistral Mg/Ca sea sub-surface temperature records for the last and penultimate deglacial periods from the Eirik Drift, south of Greenland. Foraminiferal Mg/Ca was determined using a flow-through time-resolved analysis, which reduces uncertainty due to postdepositional alteration and recrystallization and residual clay. Preliminary data suggests that SST response to radiative forcing during the two deglaciations (last and penultimate) was of similar amplitude though with different timing. Last deglacial SSTs from the northwest North Atlantic will be compared to the timing and retreat of the southern Greenland Ice Sheet.

talk

Reduction of Phyllosilicates and Fe(III) Oxides in Different Size Fractions of Subsurface Sediment

Tao Wu, Eric E. Roden

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

Recent studies indicate that Fe-bearing phyllosilicates (along with iron oxides) can be important electron acceptors for dissimilatory iron reducing bacteria in soils and sediments. The goal of our research is to compare and quantify experimentally the kinetics of microbial Fe-bearing phyllosilicate versus iron oxide reduction in natural sediments. The research of microbial reduction in different size fractions of FRC Area 2 sediment gave a important interpretation to our research. Clay (<2 mm), silt (2-50 mm) and sand (>50 mm) size fractions of FRC Area 2 sediment were collected by sedimentation and used for microbial Fe(III) reduction experiments. Preliminary results show that the extent of microbial reduction had no or very little relationship with the specific surface area of the different size fractions, but had a positive correlation with the percentage of total Fe in phyllosilicates. This phenomenon could indicate an important role of phyllosilicates and of the association of phyllosilicates with Fe(III) oxides in microbial Fe(III) reduction. More research remains to be done on this topic. Mössbauer spectroscopy will be used to identify and quantify the proportion of both Fe-phyllosilicates and Fe oxides in natural sediments during microbial reduction experiments, which are the essential data to help understand the relative importance of Fe(III)-bearing phyllosilicates vs. Fe(III) oxides as substrates for DIR.

talk

Lysis of Pseudomonas *aeruginosa* at Oxide Surfaces in the Absence/Presence of Extracellular Polymeric Substances: A Survival Mechanism for Microorganisms at Unfavourable Mineral Surfaces?

Jie Xu, Nita Sahai

Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706

Mineral-bacteria interactions are ubiquitous in the aqueous geochemical environment and are critical for the solubility and transport of nutrients and elements. Mineral surfaces, however, are not all favourable toward bacteria [1,2]. Our hypotheses are (1) certain mineral surfaces can cause cell lysis of bacteria and (2) the existence of extracellular polymeric substances (EPS) can shield cells from the adverse effect of the minerals.

We examined the lytic effect of four oxides (amorphous silica, anatase, hematite, and g-alumina) toward two isogenic strains of Pseudomonas *aeruginosa*, of which the wild-type is a normal EPS-producer and the mutant is devoid of major EPS components. Oxide minerals were chosen because (1) they are prevalent in aqueous geochemical settings, (2) they stand for end members of most rocks and (3) they are of relatively low solubility. Bacterial cells were incubated in oxide suspensions, and the lytic effect of each oxide was determined by comparing the cell viability of mineral-cell mixtures with that of blank controls. The role of EPS was isolated by comparing the results of wild-type and mutant systems. Preliminary results show that the presence of four oxides reduces the cell viability by 30-50%, and the lytic effect increases as amorphous silica < anatase < hematite < γ-alumina. A similar trend was found by Epi-fluorescence microscopy images. However, the role of EPS in protecting cells against the adverse effect of the minerals is not obvious. The reacted culture was also examined for soluble species by Ion-Coupled Plasma –Atomic Emission Spectroscopy (ICP-AES).

talk

Investigation of sulfide-catalyzed nucleation and growth of high-magnesian calcite and disordered dolomite, a precursor to sedimentary dolomite

Fangfu Zhang[1], Huifang Xu[1,2], Hiromi Konishi[1], and Eric E. Roden[1]

[1]Department of Geology and Geophysics, University of Wisconsin-Madison, WI 53706
[2]Department of Materials Science and Engineering, University of Wisconsin-Madison, WI, 53706

The "Dolomite ($CaMg(CO)_3$) Problem" has been a subject of scientific debate for decades. The "Dolomite Problem" is composed of the fact that: (i) dolomite is rare in Holocene and modern sediments, yet abundant in older rocks; and (ii) dolomite has never been successfully grown inorganically in laboratory experiments in modern sea water at near surface conditions; although dolomite can form in wide range of geological environments at low temperatures according to results from field and thermodynamic studies. Some dolomite formations are associated with sediments where sulfate-reduction is active. We studied the effect of sulfides on Mg-Ca carbonate precipitation. Our results show that high-Mg calcite and disordered dolomite with more than 40 mole% $MgCO_3$ can precipitate from aqueous sulfide-bearing solutions. We propose that the soft Lewis base of aqueous HS^- would interact with H^+ in the water dipoles that bind to Mg^{2+} ions on a calcite surface, which weakens the chemical bonds between the water dipoles binding to Mg^{2+} ions, lowers the kinetic energy barrier of dehydration of Mg^{2+}-water complex, and therefore enhances Mg^{2+} incorporation into calcite. This new study will contribute to the understanding of dolomite formation mechanism.

Contact the authors

Anderson, Mary P.	andy@geology.wisc.edu
Auchter, Neal	auchter@wisc.edu
Ayalon, Avner	ayalon@gsi.gov.il
Bahr, Jean M.	jmbahr@geology.wisc.edu
Bar-Matthews, Miryam	matthews@gsi.gov.il
Baxter, Ethan F.	efb@bu.edu
Beard, Brian L.	beardb@geology.wisc.edu
Benford, Bryn A.	bryn@geology.wisc.edu
Bonamici, Chloë	bonamici@geology.wisc.edu
Boutt, David F.	dboutt@geo.umass.edu
Carlson, Anders E.	acarlson@geology.wisc.edu
Carroll, Alan R.	carroll@geology.wisc.edu
Colville, Lisa	colville@geology.wisc.edu
Crowley, James C.	jimcrowley@boisestate.edu
Dickoff, Meghan	mdickoff@geology.wisc.edu
Diem, Bridget C.	diem@wisc.edu
Doebbert, Amalia C.	doebbera@geology.wisc.edu
Dreger, Douglas	dreger@seismo.berkeley.edu
Earnest-Heckler, Evan J.	earnestheckl@wisc.edu
Farfan, Gabriela	gabriela.farfan@yahoo.com
Feigl, Kurt F.	feigl@geology.wisc.edu
Fenlon, Erin E.	efenlon@geology.wisc.edu
Fournelle, John H.	johnf@geology.wisc.edu
Fraass, Andrew J.	ajfraass@geology.wisc.edu
French, Melodie	melodie@geology.wisc.edu
Gage, JoAnn R.	jgage@geology.wisc.edu
Geary, Dana H.	dana@geology.wisc.edu
Giuffre, Anthony	giuffre@wisc.edu
Goodwin, Laurel B.	laurel@geology.wisc.edu
Gower, Drew B.	dgower@geology.wisc.edu
Heck, Philipp R.	prheck@geosci.uchicago.edu
Hill, Tina R.	tinahill@geology.wisc.edu
Hillaire-Marcel, Claude	hillaire-marcel.claude@uqam.ca
Hong, Kuang-Sheng	khong2@wisc.edu
Honma, Andrew	ahonma@geology.wisc.edu
Horst, Katharine J.	kjhorst@geology.wisc.edu
Huberty, Jason M.	jason@geology.wisc.edu
Johnson, Clark M.	clarkj@geology.wisc.edu
Johnson, Scott K.	skjohnson1@wisc.edu
Kington, Joe	jkington@geology.wisc.edu
Kelly, D. Clay	ckelly@geology.wisc.edu
Kita, Noriko T.	noriko@geology.wisc.edu
Klinkhammer, Gary P.	gklinkhammer@coas.oregonstate.edu

Konishi, Hiromi	hkonishi@wisc.edu
Kotelnicki, Mary Ruth	maryruth@geology.wisc.edu
Kozdon, Reinhard	kozdon@geology.wisc.edu
Leaf, Andrew T.	aleaf@geology.wisc.edu
Li, Xiaochun	xcli@engr.wisc.edu
Lin, Guoqing	glin@rsmas.miami.edu
Ludois, James B.	jludois@wisc.edu
Macdonald, R. Heather	rhmacd@wm.edu
Manduca, Cathryn	cmanduca@carleton.edu
Marcott, Shaun A.	marcotts@onid.orst.edu
Mickelson, David M.	davem@geology.wisc.edu
Miller, Cassidy	cmiller@geology.wisc.edu
Moore, Gregory F.	gmoore@hawaii.edu
Mukhopadhyay, Anousa	chini@geology.wisc.edu
Murphy, Rachel A.	rmurphy@geology.wisc.edu
Northrup, Clyde J.	cjnorth@boisestate.edu
Obbink, Elizabeth A.	eobbink@geology.wisc.edu
Ohlendorf, Summer J.	summer@geology.wisc.edu
Orland, Ian	orland@geology.wisc.edu
Ormand, Carol J.	cormand@geology.wisc.edu
Ortiz, Dayanidi M.	dortiz2@wisc.edu
Paola, Christopher	cpaola@umn.edu
Percak-Dennett, Elizabeth M.	lizpd@geology.wisc.edu
Pollington, Anthony D.	apolling@geology.wisc.edu
Peters, Shanan E.	peters@geology.wisc.edu
Riley, Paul R.	priley@geology.wisc.edu
Roden, Eric E.	eroden@geology.wisc.edu
Rothdrake, George X.	gxrothdr@wisc.edu
Rowe, Charlotte A.	char@lanl.gov
Shelobolina, Evgenya S.	zhenya@geology.wisc.edu
Sahai, Nita	sahai@geology.wisc.edu
Schmitz, Mark D.	markschmitz@boisestate.edu
Spicuzza, Mike J.	spicuzza@geology.wisc.edu
Stoner, Joe S.	jstoner@coas.oregonstate.edu
Szilvagyi, Eva	evaszil@geology.wisc.edu
Teel, Alex	alex@geology.wisc.edu
Thurber, Clifford H.	thurber@geology.wisc.edu
Tikoff, Basil	basil@geology.wisc.edu
Tobin, Harold J.	htobin@geology.wisc.edu
Trzaskus, Andrew	trzaskus@geology.wisc.edu
Valley, John W.	valley@geology.wisc.edu
Winsor, Kelsey	winsor@geology.wisc.edu
Wu, Tao	wutao@geology.wisc.edu
Xu, Huifang	hfxu@geology.wisc.edu
Xu, Jie	xujie@geology.wisc.edu
Zhang, Fangfu	fzhang@geology.wisc.edu

The Geoscience Graduate Symposium is a department-wide event focusing on current graduate students' research. The symposium is a two-day event organized by the graduate students and features:

- A keynote speaker
- Graduate student posters and oral presentations
- Networking with faculty, post-doctoral research scientists, graduate and undergraduate students and colleagues

The UW-Madison Geoscience Graduate Symposium was started in 2007 for the graduate students of the department as a way to showcase and discuss their current research in an open forum.

For more information, please contact the 2009 Graduate Symposium at jason@geology.wisc.edu. Program by Jason Huberty.

A pdf of this document can be found at:
www.geology.wisc.edu/news_events/recent.html

Acknowledgments

The members of the 2009 UW-Madison Geoscience Graduate Symposium Committee are Jason Huberty, Liz Percak-Dennett, Alex Teel and Dave Lovelace.

We would like to acknowledge all of the contributors who made this year's symposium such a success. We received 44 abstracts with a total of 86 authors from 14 universities.

We would like to thank the faculty advisor to the committee, Professor Eric E. Roden for his guidance and assistance. In addition, we would like to thank Mary Diman for her assistance with editing and formatting.

Our thanks also extend to the faculty and staff members who contributed their time and expertise to the logistics for the symposium.