ED41B-1167 0830h POSTER

Student Dust Counter I : Science Objectives

C. Mitchell[1] (Colin.Mitchell@lasp.colorado.edu); C. Bryant[1] (Chelsey.Bryant@lasp.colorado.edu); N. Bunch[1] (Nicholas.Bunch@lasp.colorado.edu); T. Chanthawanich[1] (Tim.Chanthaw@lasp.colorado.edu); M. Colgan[1] (Matt.Colgan@lasp.colorado.ed); A. Fernandez[1] (Anselm.Fernandez@lasp.colorado.edu); B. Grogan[1] (Beth.grogan@lasp.colorado.edu); G. Holland[1] (Gene.Holland@lasp.colorado.edu); C. Krauss[1] (Corinne.Krauss@lasp.colorado.edu); E. Krauss[1] (Ervin.Krauss@lasp.colorado.edu); O. Krauss[1] (Otto.Krauss@lasp.colorado.edu); M. Neeland[1] (Michael.Neeland@lasp.colorado.edu); M. Horanyi[1] (303 492 6903; horanyi@colorado.edu)

[1]LASP, University of Colorado, Boulder, CO 80309, United States

The New Horizons mission to Pluto and the Kuiper Belt is scheduled for launch in January 2006. As part of the Education and Public Outreach activity of the mission, undergraduate and graduate students at the Laboratory for Atmospheric and Space Physics, University of Colorado, are building a space experiment: the Student Dust Counter (SDC). This talk will summarize the scientific goals of this experiment. An accompanying poster describes the technical details of SDC. The primary goal of SDC is to map the dust distribution in the Solar System from 1 to 50 AU. It will greatly enhance our knowledge of dust production and transport in the outer Solar System by providing more sensitive observations than earlier experiments past Saturn, and the first in situ dust observations beyond 18 AU.

ED41B-1168 0830h POSTER

Student Dust Counter II: Building the Instrument

C. Krauss[1] (Corinne.Krauss@lasp.colorado.edu); C. Bryant[1] (Chelsey.Bryant@lasp.colorado.edu); N. Bunch[1] (Nicholas.Bunch@lasp.colorado.edu); T. Chanthawanich[1] (Tim.Chanthaw@lasp.colorado.edu); M. Colgan[1] (Matt.Colgan@lasp.colorado.edu); A. Fernandez[1] (Anselm.Fernandez@lasp.colorado.edu); B. Grogan[1] (Beth.Grogan@lasp.colorado.edu); G. Holland[1] (Gene.Holland@lasp.colorado.edu); E. Krauss[1] (Ervin.Krauss@lasp.colorado.edu); O. Krauss[1] (Colin.Mitchell@lasp.colorado.edu); C. Mitchell[1] (Colin.Mitchell@lasp.colorado.edu); M. Neeland[1] (Michael.Neelnd@lasp.colorado.edu); M. Horanyi[1] (Mihaly.Horanyi@lasp.colorado.edu)

[1]LASP, University of Colorado, Boulder, CO 80309, United States

The New Horizons mission to Pluto and the Kuiper Belt is scheduled for launch in January 2006. As part of the Education and Public Outreach activity of the mission, undergraduate and graduate students at the Laboratory for Atmospheric and Space Physics, University of Colorado, are building a space experiment: the Student Dust Counter (SDC). This talk will summarize the technical details of this experiment. An accompanying poster describes the science goals of SDC. SDC has a high degree of heritage from dust detectors of this type built by the University of Chicago for several missions, including Vega 1 and 2 to comet P/Halley, Cassini and Stardust. Dust detection is based on signals generated by impacts into a thin polyvinylidene-fluoride (PVDF) film.

ED41B-1169 0830h POSTER

Creating A Virtual Fault Database Using Ontologies

Gideon Juve[1] (213.821.6340; juve@usc.edu); Hunter Francoeur[1] (francoeu@usc.edu); Lindsay Gordon[1] (llgordon@usc.edu); Shalini Jhatakia[1] (jhatakia@usc.edu); Nitin Sharma[1] (kingnitin@rediffmail.com); Phil Maechling[1] (maechlin@usc.edu); Thomas Jordan[1] (tjordan@usc.edu)

[1]Southern California Earthquake Center, 3651 Trousdale Parkway SCI 169, Los Angeles, CA 90089, United States

SCEC's Fault Information System (FIS) consists of several databases including SCEC's Fault Activity Database (FAD) and SCEC's Community Fault Model database (CFM). The purpose of the FIS is to provide an interface for obtaining fault data contained in multiple, distributed databases using a single point of access. Constructing such an interface requires the existence of a mapping that links terms used in the databases to their semantic meaning. In this way, terms appearing in different databases, but representing the same data, can be treated as equals from the point of view of the query interface. In this project we explore a system which uses ontologies to provide the necessary database semantics. The system uses two ontologies: one to represent semantics in the domain of fault geology and one to represent relational databases. Using these ontologies a mapping can be created that links entities in the fault database ontologies to their equivalent semantic meanings in the fault domain ontology. An interface can then be constructed using the ontologies to mediate between FIS users and the databases contained within the FIS.

ED41B-1170 0830h POSTER

Using Java 3D for Magnetospheric Visualization

Dale Betterton[1]

Isidoros Doxas[2] ((303) 492 7988; doxas@colorado.edu)

[1]Center for Integrated Plasma Department of Computer Science, University of Colorado, Boulder, CO 80309

[2]Center for Integrated Plasma Studies, University of Colorado, Boulder, CO 80309

The paper will discuss the design characteristics of CALCHAS, a 3D visualization package that integrates models and data and is used in data assimilation schemes in Space Weather forecasting. The package is written in Java 3D, and has a modular design, so that different models and datasets, both real-time and historical, can be seamlessly compared using a variety of goodness-of-fit measures. The package is used both in research and education at the undergraduate as well as secondary level. It was developed in Spring 2003 on a Research Experience for Undergraduates (REU) supplement for NSF grant # 1R01HD-44276.01, "Scaling up Reading Tutors".

ED41B-1171 0830h POSTER

Undergraduate Research - Analyzing Data Sets: Global Positioning System (GPS) and Modeling the 1994 Northridge Earthquake

G. Simila[1] (gsimila@csun.edu)

C. Shubin[2] (carol.shubin@csun.edu)

W. Horn[2] (werner.horn@csun.edu)

[1]Department of Geological Sciences, CSUN 18111 Nordhoff St., Northridge, CA 91330

[2]Department of Mathematics, CSUN 18111 Nordhoff St., Northridge, CA 91330

Our undergraduate research program (2000-2003), funded by NASA, consisted of four short courses on the analysis of selected data sets from GPS, solar physics, orbital mechanics, and proteomics. During the program, approximately 80 students were recruited from science, math, engineering, and technology disciplines. This short course introduced students to GPS and earthquake data analysis with additional presentations by scientists from JPL. Additional lectures involved discussions of the wave equation, Fourier analysis, statistical techniques, and computer applications of Excel and Matlab. Each student modeled the observed GPS displacements produced by the 1994 Northridge earthquake and presented an oral report. An additional component of the program involved students as research assistants engaged in a variety of projects at CSUN and JPL. Each short course continued the following semester with weekly research lectures.

ED41B-1172 0830h POSTER

Earth in Space: A CD-ROM Version for Pre-College Teachers

Phillip Pedigo (832-771-6598; stdpcp11@unxmail.shsu.edu)

Sam Houston State University, 1235 Josey St. #183, Huntsville, TX 77340, United States

Earth in Space, a magazine about the Earth and space sciences for pre-college science teachers, was published by AGU between 1987 and 2001 (9 issues each year). The goal of *Earth in Space* was to make research at the frontiers of the geosciences accessible to teachers and students and engage them in thinking about scientific careers. Each issue contained two or three recent research articles, rewritten for a high school level audience from the original version published in peer-reviewed AGU journals, which were supplemented with short news items and biographic information about the authors. As part of a 2003 summer internship with AGU, sponsored by the AGU Committee on Education and Human Resources (CEHR) and the American Institute of Physics, this collection of *Earth in Space* magazines was converted into an easily accessible electronic resource for K-12 teachers and students. Every issue was scanned into a PDF file. The entire collection of articles was cataloged in a database indexed to key topic terms (e.g., volcanoes, global climate change, space weather). A front-page was designed in order to facilitate rapid access to articles concerning specific topics within the Earth and space sciences of particular interest to high school students. A compact CD-ROM version of this resource will be distributed to science teachers at future meetings of the National Science Teachers Association and will be made available through AGU's Outreach and Research Support program.

ED41B-1173 0830h POSTER

Multi-kilohertz Microlaser Altimeter(MMLA)Real-time Scan Footprint Mapping Software

Jim Sanovia (605-394-2461; "Jimmy Sanovia" <thesanoves@hotmail.com>)

South Dakota School of Mines and Technology, Department of Geological Engineering 501 East St. Joseph Street, Rapid City, SD 57701, United States

It is expected that this near Real-time Scan Footprint Mapping Software (R-T Scan) display will alert us to any missed areas that we can re-fly to obtain more complete coverage. The value-added custom software is the Visual Basic Data conversion package. This software captures the GPS NEMA string(s) from the 2nd serial port, reads the attitude data form (the shared file of "most recent" attitude data), and performs a geometric projection of 10 (user adjustable) hypothetical laser scan angles to ground based latitude and longitude coordinates. The Lat/Long data are then converted back into the NEMA string format used by Street Atlas. The Multi-kilohertz Micro Laser Altimeter (MMLA) acquires high spatial resolution digital topographic databases and can observe geographical terrains such as hydrological runoff, measure ice sheet thickness, and the changes in lakes and reservoirs. The MMLA is ideal for making topographical (digital) maps of forest settings and cities. (NASA/GSFC 920.3) In order to maximize flight time efficiency and to avoid the potential disastrous situation of missing a target of prime importance, we have developed the MMLA R-T Scan.

ED41C MCC: Level 2 Thursday 0830h

Teaching Petrology in the 21st Century I Posters *(joint with V)*

Presiding: **C A Manduca,** Science Education Resource Center, Carleton College**; C Davidson,** Carleton College**; D Mogk,** Montana State University

ED41C-1174 0830h POSTER

The Barrovian Metapelitic Rocks In Northern Idaho: An Outstanding Suite For Teaching Undergraduate Metamorphic Petrology

Timothy W. Grover[1] (802-468-1289; grovert@castleton.edu)

Helen Marie Lang[2] (304-293-5603; lang@geo.wvu.edu)

[1]Castleton State College, Dept. of Natural Sciences, Castleton, VT 05735, United States

[2]West Virginia University, Dept. of Geology and Geography, Morgantown, WV 26506, United States

The Barrovian metapelitic rocks in the St. Joe-Clearwater region in northern Idaho provide an outstanding suite for the study of many aspects of regional metamorphism in an undergraduate petrology class. Metamorphosed Belt Supergroup and associate rocks, located along the northwest border zone of the Idaho batholith, record the effects of three phases of recrystallization. The first phase of metamorphism (M1) is recognized by the presence of (M2) muscovite pseudomorphs after staurolite. The second phase of metamorphism, M2, was Barrovian and ranges in grade from biotite zone through K-feldspar + sillimanite zone. M2 porphyroblasts are commonly quite large and easily recognizable in hand sample as well as petrographically. Four and five AFM phase assemblages present in these

rocks can be used to discuss the effects of extra components or variable fluid compositions on stable mineral assemblages. The presence of epidote-bearing plutonic rocks, emplaced during M2 metamorphism, provides additional data on the tectonometamorphic evolution of the region. In the central part of the area are unusually Al- and Mg-rich metapelitic rocks associated with several anorthosite bodies. These rocks contain kyanite, andalusite, and sillimanite in a single thin section but the polymorphs are not in textural equilibrium. These rocks also contain cordierite coronas around kyanite and andalusite. The inversion of kyanite to andalusite and the late growth of cordierite occurred during M3 metamorphism. M3 recrystallization was generated by a phase of rapid, nearly isothermal decompression. The texturally late, lower pressure overgrowths of cordierite are explained to undergraduates through the use of petrogenetic grids. Published mineral analyses for rocks in this area are available, as are limited geochronologic data. Ongoing research on the structural evolution of the region provides a context for the integration of tectonics and petrology.

ED41C-1175 0830h POSTER

The Dutchess County, New York, Barrovian Sequence as a Teaching Tool for Metamorphic Petrology

Donna L Whitney[1] (612-626-7582; dwhitney@umn.edu)

William H Peck[2] (315-228-6798; wpeck@mail.colgate.edu)

[1]University of Minnesota, Dept. of Geology and Geophysics, Minneapolis, MN 55455, United States

[2]Colgate University, Department of Geology, Hamilton, NY 13346, United States

Sequences of regionally metamorphosed shales or mudstones (Barrovian sequences) are a classic teaching tool for demonstrating the effect of temperature and lithostatic pressure on mineral assemblages during progressive metamorphism. One of the most complete Barrovian sequences in the world is in Dutchess County, NY, in which the Paleozoic Taconic event of the Appalachian orogeny buried and heated a Cambro-Ordovician continental margin. In the western part of the sequence, near Poughkeepsie, NY, rocks have a faint metamorphic fabric but preserve many characteristics of the sedimentary protoliths: bedding, sedimentary structures, and detrital minerals. Over a map distance of 40 km, the metamorphic index minerals chlorite, biotite, garnet, staurolite, kyanite, sillimanite (fibrolite), and K-feldspar progressively appear in metapelitic rocks. Outcrop is abundant enough that changes within metamorphic zones can also be observed; for example, the staurolite zone can be tracked from the incipient growth of staurolite from chloritoid to the upper staurolite zone in which chloritoid was no longer stable. The effect of bulk composition can also be observed within the metamorphic zones; e.g., the appearance of chloritoid vs. biotite in different bulk compositions of the garnet zone. Although a database of mineral compositions, metamorphic reactions, P-T conditions, oxygen isotope values, and some geochronology results from metamorphic minerals exists, more work needs to be done integrating structural geology with metamorphic assemblages, and interesting questions remain about the assemblages in mafic and carbonate rocks interleaved with the pelitic rocks. These features make the Dutchess County sequence an excellent site for teaching fundamental concepts of metamorphic petrology.

ED41C-1176 0830h POSTER

Teaching contact metamorphism, isograds, and mixed-volatile reactions: A suite-based approach

William H. Peck (wpeck@mail.colgate.edu)

Department of Geology, Colgate University, Hamilton, NY 13346, United States

An important goal of teaching Introductory Petrology is to demonstrate how different kinds of approaches are integrated in studying petrologic problems. Depending on the goals of the study data used can be from the field, hand-sample, microscope, electron beam instrument, or mass spectrometer. A suite of samples with a known geographical and geological context can help students in drawing connections between different petrologic approaches, as the geologic story' of the samples becomes a unifying theme. For teaching a unit on calc-silicates I use a suite of siliceous dolomite samples collected from the Ubehebe contact aureole (Death Valley, NV) as well as published data (Roselle et al., 1997; 1999) in a linked series of laboratory exercises and problem sets. The geology of the contact aureole is introduced in a three-hour laboratory exercise, where students identify the appearance of tremolite, forsterite, and periclase/brucite and the disappearance of quartz as the intrusion is approached. A concurrent problem set uses simplified mineral assemblage maps from the aureole. In the problem set students delineate isograds and determine the balanced metamorphic reactions by which the metamorphic minerals formed. Lecture material during this unit focuses on the physical properties of fluids in the crust and the mineralogical evidence for fluid-flow (with an emphasis on mixed-volatile reactions and T-XCO_2 diagrams). A concrete field example helps focus student attention on the interrelation of disparate approaches by which petrologic problems addressed. The Ubehebe suite then becomes a unifying theme throughout the course: the specimens or regional geology are used in subsequent laboratories and lectures when introducing concepts such as grain nucleation and growth, reaction overstepping, and replacement textures. A virtual field trip of the Alta aureole, UT (using field photographs, maps, and photomicrographs) concludes the unit. The geology of the Alta aureole is similar to that of Ubehebe, and the virtual field trip acts as a review that emphases the general usefulness of the approaches discussed.

ED41C-1177 0830h POSTER

The Alta Stock, Utah: An Exemplar Rock Suite for Learning Metamorphic Concepts

Cameron Davidson[1] (cdavidso@carleton.edu)

Bereket Haileab[1] (bhaileab@carleton.edu)

[1]Carleton College, Dept. of Geology One North College St, Northfield, MN 55057, United States

Using rock suites in a discovery-based setting is a terrific way to learn important petrologic processes and concepts such as the role of fluids during metamorphism, phase equilibrium, and metastability to name just a few. A particularly effective rock suite we use in our petrology course is from the contact aureole of the Tertiary Alta stock in Utah. The intrusion of the Alta stock into Paleozoic dolostone containing chert nodules produced a well-defined contact metamorphic aureole that includes talc-, tremolite-, forsterite-, and periclase-in field isograds (Cook and Bowman, 2000). Students work in free-form groups with collaboration between groups to define the mineral assemblages using hand samples and thin sections from throughout the areole and then work out what they think are the important petrologic processes that worked together to form what they see. The main goals of the exercise include: 1) learning to identify mineral assemblages common to metamorphosed siliceous dolostones; 2) learning to infer metamorphic reactions from progressive changes in mineral assemblages; 3) being able to identify balanced metamorphic reactions responsible for isograds mapped in the field; 4) begin to develop an understanding of how bulk composition and fluid composition controls mineral assemblages; and 5) learning how to infer the temperature and fluid composition evolution of the Alta stock aureole based on published T-X(CO_2)diagrams. This suite is particularly effective because all the important minerals the students observe in thin section can be defined by the easy to plot and understand CaO-MgO-SiO_2 system. This offers the opportunity to introduce (or reinforce) the concept of plotting minerals in composition space, using the phase rule to define the variance of your system, using tie lines to define stable mineral assemblages, and the flipping of tie lines to produce univariant reactions. In addition, the students work out the topology of these reactions in P-T space by plotting the resulting Shreinemaker's bundles and (hopefully) drawing on their developing geologic intuition on which phases should fall on the high temperature side of the univariant reaction line. Other important processes that can be addressed by this suite include the role of fluids during metamorphism, nucleation and growth of metamorphic minerals, metastability (e.g. there are beautiful reaction rims of brucite around periclase), and the influence of bulk composition on stable mineral assemblages (e.g. wollastonite is present in some rocks). Reference: Cook, S.J., and Bowman, J.R. (2000) Mineralogical evidence for fluid-rock interaction accompanying prograde contact metamorphism of siliceous dolomites: Alta Stock Aureole, Utah, USA. Journal of Petrology, 41, 739-757.

ED41C-1178 0830h POSTER

Refining a Proposal to Build Data-Rich Rock Suites for Learning Petrology

Karl R Wirth[1] (651-696-6449; wirth@macalester.edu)

Cameron Davidson[2] (507-646-7144; cdavidso@carleton.edu)

John W Creasy[3] (207-786-6153; jcreasy@bates.edu)

[1]Geology Department, Macalester College, 1600 Grand Ave, St. Paul, MN 55105, United States

[2]Geology, Carleton College, One North College Street, Northfield, MN 55057, United States

[3]Departement of Geology, Bates College,, Lewiston, ME 04240, United States

One of the outcomes from the 2003 Teaching Petrology workshop held in Bozeman, MT was a call for the development of a series of data-rich rocks suites that could be used to help students learn fundamental petrologic processes and concepts such as partial melting, magmatic differentiation, and phase equilibria. These suites would include detailed field, structural, geochemical, and geochronologic data that could be used in short lecture demonstrations, laboratory exercises, multi-week activities or semester-long projects. The motivation behind the development of these suites is the growing understanding in the education community that hands-on, problem-based learning activities that allow students to build their own knowledge are more effective than most traditional lecture formats. In discovery-based environments students learn to pose questions, work with data, manage ambiguity, and synthesize diverse observations. Many existing rocks suites used in petrology courses consist of rocks that were not necessarily selected to facilitate learning of important petrologic processes, or to develop higher order skills in a discovery-based setting. Our proposal is to develop a collection of genetically related rocks that can be used to discover fundamental petrologic concepts through guided data collection, interpretation, and synthesis by students and faculty. The use of suites in this manner helps develop a “community of learners” atmosphere in a course, where the outcome is perhaps not well defined and could change from year to year depending on the interests of the students and faculty involved. In addition, we hope these suites will be developed and used by several institutions, thus modeling the process of modern research by promoting sharing of equipment, data, ideas, and expertise perhaps through the use of a dedicated web site for each suite. This abstract solicits interest in and feedback from the community on the development of a series of data-rich rock suites and curricula for learning petrology.

ED41C-1179 0830h POSTER

Improving Student Understanding of Magmatic Differentiation Using an M&M Magma Chamber

Karl R Wirth (651-696-6449; wirth@macalester.edu)

Geology Department, Macalester College, 1600 Grand Ave., St. Paul, MN 55105, United States

Many students, especially those in introductory geology courses, have difficulty developing a deep understanding of the processes of magmatic differentiation. In particular, students often struggle to understand Bowen's reaction series and fractional crystallization. The process of fractional crystallization by gravity settling can be illustrated using a model magma chamber consisting of M&M's. In this model, each major cation (e.g., Si, Ti, Al, Fe, Mg, Ca, Na, K) is represented by a different color M&M; other kinds of differently colored or shaped pieces could also be used. Appropriate numbers of each color M&M are combined to approximate the cation proportions of a basaltic magma. Students then fractionate the magma by moving M&M's to the bottom of the magma chamber forming a series of cumulus layers; the M&M's are removed in the stoichiometric proportions of cations in the crystallizing minerals (e.g., olivine, pyroxene, feldspars, quartz, magnetite, ilmenite). Students observe the changing cation composition (proportions of colors of M&M's) in the cumulus layers and in the magma chamber and graph the results using spreadsheet software. More advanced students (e.g., petrology course) can classify the cumulates and resulting liquid after each crystallization step, and they can compare the model system with natural magmatic systems (e.g., absence of important fractionating phases, volatiles). Students who have completed this exercise generally indicate a positive experience and demonstrate increased understanding of Bowen's reaction series and fractionation processes. They also exhibit greater familiarity with mineral stoichiometry, classification, solid-solution in minerals, element behavior (e.g., incompatibility), and chemical variation diagrams. Other models (e.g., paths of equilibrium and fractional crystallization on phase diagrams) can also be used to illustrate differentiation processes in upper level courses (e.g., mineralogy and petrology).

ED41C-1180 0830h POSTER

The Poster: A Petrologic Exercise For The Resource-Challenged

Tim P Flood (920-403-1356; tim.flood@snc.edu)

St. Norbert College, 100 Grant Street, DePere, WI 54115, United States

The scientific poster is a common format for transmitting information and can be used as a petrologic exercise that may be particularly beneficial for those programs with limited resources. For example, the Saint Norbert College geology program was founded in 1987 and a traditional geology major established in 1994. We have high quality petrographic microscopes and excellent on-campus computing resources but otherwise lack common facilities such as a rock preparation room and instrumentation for obtaining research quality geochemical data such as XRF or SEM. The petrology poster exercise is designed to mimic the formative stages of a research project from fieldwork through

geochemical analysis. A background literature search on a regional rock assemblage, usually suggested by the instructor, is conducted by the students. A specific petrologic aspect, such as the troctolitic portion of the Duluth Complex, is selected for investigation. Fieldwork consists of detailed outcrop and handsample descriptions, with approximately ten samples collected for thin section analysis. Geochemical data is culled from the literature by the instructor and computer modeled by the students using standard petrologic modeling programs such as IGPET. Having characterized the rock in detail, the students make interpretations of their data and more importantly, formulate research questions for future investigation. The final poster summarizes a student's work and is presented to their peers for critique. The goal of this semester-long exercise is to provide a near-professional research experience to the students for limited costs (i.e. site field trip and professional preparation of the thin sections). Additional benefits include: in-depth instruction related to writing an abstract, enhanced computer graphic skills related to poster construction, and a final product that makes an excellent springboard to a senior thesis.

ED41C-1181 0830h POSTER

Taos Plateau Volcanic Project: A Vehicle for Integration of Concepts in Igneous Petrology

Darrell Henry[1] (225-578-2693; dhenry@geol.lsu.edu)

Barb Dutrow[1] (dutrow@geol.lsu.edu)

[1]Louisiana State Univ., Dept. Geology & Geophysics, Baton Rouge, LA 70808-4101, United States

Integrating concepts of igneous petrology is generally a challenge, but can be effective in the context of a project based on actual field, geochemical and geochronological data. The final lab project in the igneous portion of petrology involves a series of volcanic and associated rock samples that were collected from the Taos Plateau Volcanic Field, New Mexico, USA. Samples were collected over an area of several tens of km^2 throughout the Plateau and represent a spatially and temporally correlated rock suite related to continental rifting. Rift-related magmatism encompasses much of the diversity of terrestrial magma types. Compositions of mafic magmas range from tholeiite to some of the most silica-undersaturated magmas found on the continents. Large effusive eruptions from fissures are typical of some rifts, whereas others may be dominated by central vent cones or even silicic caldera complexes. The injection of mantle-derived magma in extending crust may have a profound effect on the rheology of the crust and, therefore, the style of deformation associated with extension. Most of these aspects of rift volcanism and a wide range of mafic to silicic magma compositions are represented in the Rio Grande rift and the volcanic rocks of the Taos Plateau. In addition, much published data exists for whole rock and trace element geochemistry as well as geochronology. Rock samples and associated information are presented so that the student must integrate multiple lines of evidence, petrographic, petrologic, geochemical and geochronological data in a geospatial framework, to establish a geologic history of the region. The student must also draw on skills learned in mineralogy and structural geology furthering core geoscience education. Subsequent to the petrology course, the students visit the Taos Plateau Volcanic Field during their required field camp, thus reinforcing the linkage between the classroom setting and geologic reality.

ED41C-1182 0830h POSTER

Using Spreadsheets and Internally Consistent Databases to Explore Thermodynamics

Somnath Dasgupta[1] (sdg@cal3.vsnl.net.in)

Sumit Chakraborty[2] (+49-234-322 4395; Sumit.Chakraborty@ruhr-uni-bochum.de)

[1]Department of Geological Sciences, Jadavpur University, Kolkata 700032, India

[2]Institut fuer Geologie, Mineralogie und Geophysik, Ruhr-Universitaet Bochum, Bochum 44801, Germany

Much common wisdom has been handed down to generations of petrology students in words - a non-exhaustive list may include (a) do not mix data from two different thermodynamic databases, (b) use of different heat capacity functions or extrapolation beyond the P-T range of fit can have disastrous results, (c) consideration of errors in thermodynamic calculations is crucial, (d) consideration of non-ideality, interaction parameters etc. are important in some cases, but not in others. Actual calculations to demonstrate these effects were either too laborious, tedious, time consuming or involved elaborate computer programming beyond the reaches of the average undergraduate. We have produced "Live" thermodynamic tables in the form of Excel^{TM} spreadsheets based on standard internally consistent thermodynamic databases (e.g. Berman, Holland and Powell) that allow quick, easy and most importantly, transparent manipulation of thermodynamic data to calculate mineral stabilities and to explore the role of different parameters. We have intentionally avoided the use of advanced tools such as macros, and have set up columns of data that are easy to relate to thermodynamic relationships to enhance transparency. The approach consists of the following basic steps: (i) use a simple supporting spreadsheet to enter mineral compositions (in formula units) to obtain a balanced reaction by matrix inversion. (ii) enter the stoichiometry of this reaction in a designated space and a P and T to get the delta G of the reaction (iii) vary P and or T to locate equilibrium through a change of sign of delta G. These results can be collected to explore practically any problem of chemical equilibrium and mineral stability. Some of our favorites include (a) hierarchical addition of complexity to equilibrium calculations - start with a simple end member reaction ignoring heat capacity and volume derivatives, add the effects of these, followed by addition of compositional effects in the form of ideal solutions, add non-ideality next and finally, explore the role of varying parameters in simple models of non-ideality. (b) Arbitrarily change (i.e. simulate error) or mix data from different sources to see the consequences directly. More traditional exercises such as exploration of slopes of reaction in P-T space are trivial, and other thermodynamic tidbits such as "bigger the mineral formula, greater its thermodynamic weight" become apparent to undergraduates early on through such direct handling of data. The overall outcome is a far more quantitative appreciation of mineral stabilities and thermodynamic variables without actually doing any Math!

ED41C-1183 0830h POSTER

Using Observations to Interpret Magma Processes in the Sierra Nevada: An Undergraduate Petrology Laboratory Exercise

Jennifer M Wenner (920-424-7003; wenner@uwosh.edu)

University of Wisconsin Oshkosh, Geology Department 800 Algoma Blvd, Oshkosh, WI 54901, United States

Undergraduate igneous and metamorphic petrology is often one of the few courses in which students use field, thin section, hand sample and geochemical observations to interpret a suite of related rocks. Many students may not have encountered the idea of separating observation from interpretation prior to petrology; yet being able to distinguish these is an important skill for any budding petrologist to learn. Labs that require students to integrate abstract concepts from the lecture portion of the course to present a coherent story based on observations are essential to producing students that are well versed in petrology. A capstone-type lab allows students use many of their recently acquired skills to solve real problems in petrology. These integrated labs can take a number of forms from a short lab looking at a few related thin sections, to a multi-week lab with specified tasks, to a semester-long project culminating in a paper or a presentation. For the past few years, I have used a suite of rocks from the Sierra Nevada batholith to give petrology students a capstone experience for the igneous portion of the course. Students are given thin sections with hand samples, a map and a table of geochemical analyses and asked to record hand-sample and thin section observations with the idea that these will be used to understand processes that were active during batholith generation. Because students are given geochemical analyses, they are also expected to experiment with the use of graphs (e.g., Harker and spider diagrams) to better understand tables of geochemical analyses. The students use observations about rocks and geochemistry to build a coherent story around these rocks; the final product is a short paper in which they use petrographic observations and geochemical diagrams to back up their interpretations. Although the lab presented is specifically designed around a set of thin sections housed at the University of Wisconsin Oshkosh for an upper level course, the lab is highly adaptable. I present some options for adapting this lab to any set of thin sections and hand samples with associated geochemical analyses. This lab can also be tailored to a variety of skill levels - from 2nd year introductory petrology to a graduate course.

ED41C-1184 0830h POSTER

Student Experiments for Investigations of Physical Controls on Viscosity and the Implications for Volcanic Hazards

Benjamin R Edwards[1] (717-254-8934; edwardsb@dickinson.edu)

Rachel Teasdale[2] (Teasdale@asu.edu)

James Myers[3] (magma@uwyo.edu)

[1]Department of Geology, Dickinson College, Carlisle, PA 17013, United States

[2]Department of Earth Sciences, University of Bristol, Bristol BS8 1RJ, United Kingdom

[3]Department of Geology and Geophysics, University of Wyoming, Laramie, WY 82071, United States

Interactive laboratory investigations and demonstrations using analog materials can be used to introduce students to the rheologic properties of magmas and lavas. Using such an approach, students investigate the physical, compositional, and thermodynamic controls on viscosity through observations, experimental investigations, calculations, and computer simulations. During lab exercises, which are typically preceded by a reading assignment and brief introduction, students use analog materials (e.g. corn syrup) to experiment with parameters controlling viscosity. They prepare a set of syrup solutions at 3 (or more) temperatures, another set of syrup solutions with varying proportions of particles (e.g. sand), and a final set of syrup solutions mixed with water. A fourth experiment, which produces somewhat more complex results, can be prepared by using a hand mixer to make syrup with varying proportions of bubbles. Students make qualitative observations of the relative force required to blow bubbles into the syrup solutions with a straw as an analog for comparing the effects of viscosity on the formation and bursting behavior of gas bubbles in magma. During class, students observe syrup "lava flows" flowing on a slope. Measured flow characteristics are used to calculate viscosities for each "lava" using a dynamic visual equation (DVE) of the Jeffries equation. The DVE, which was created in Flash MX, allows students to explore interactively and visually how changing various parameters in the Jeffries equation affects fluid viscosity. Before each experiment, a critical set of questions lead students to make predictions and hone their observational skills. The questions also help students generate graphs and sketches and write brief reports to synthesize their observations. Additional activities incorporating volcanic hazards associated with low versus high viscosity flows and highly viscous explosive eruptions bring students back to very real applications of the principles investigated. In some cases, classroom activities have led students to independent research. One such project used analog flow materials to illustrate the effect of the shape and abundance of crystals on lava flow morphology. Students report having a clearer understanding of the viscous properties of lavas and magma, allowing more advanced discussions of volcanologic and petrologic principles such as conduit flow dynamics, crystallization of magmas, and volcanic hazards.

ED41C-1185 0830h POSTER

Employing Fluid Inclusions as an Application of Phase Diagrams and an Introduction to Geothermobarometry

John R Farver[1] (419-372-7203; jfarver@bgnet.bgsu.edu)

Charles M Onasch[1]

[1]Bowling Green State University, Department of Geology, Bowling Green, OH 43403-0218, United States

One of the ongoing challenges in petrology course development is designing meaningful student learning activities that promote understanding of phase diagrams and their application to relevant geologic processes. In addition, an important component of a modern petrology course is to provide a foundation in the methods employed to establish temperature and pressure conditions during geologic events. We have developed a laboratory exercise wherein students analyze fluid inclusions (water + NaCl) in natural samples of quartz or fluorite. Using a USGS-type fluid inclusion stage, the students observe the heating and cooling behavior of the fluid inclusions and measure the temperatures of homogenization, last ice melting, and the eutectic. In this fashion, students can attach a physical meaning to the phase diagram of water + NaCl that they determined in a previous laboratory exercise (after Brady, 1992, JGE, v.40, p.116-118). Each student collects a set of data that they then combine with the data of their colleagues to produce histograms that they must interpret. The second component of the exercise is to fix the trapping temperature and pressure of the fluid inclusions. Using the data they collect, students calculate the isochore and plot it on a P-T diagram. They also plot the lithostatic and hydrostatic pressure gradients for a given geothermal gradient on the P-T diagram. At this point, additional information on the geologic/tectonic setting of the sample can be provided so that students can consider the overall P-T history of the sample/region. We typically use samples containing both primary and secondary inclusions to illustrate the utility of fluid inclusions to fix P-T conditions during mineral growth as well as later tectonic events. This leads to a general discussion of geothermometric/barometric systems and the requisite assumptions and limitations of the different techniques currently employed. In addition to providing students with a hands-on opportunity to develop a more meaningful understanding of phase diagrams and their application to geologic processes, this exercise provides numerous potential extension activities. In particular, discussions of the important role of fluids in the crust and applications of the phase diagram to economic vein deposits have proved very rewarding.

ED41C-1186 0830h POSTER

Weathering of Igneous, Metamorphic, and Sedimentary Rocks in a Semi-arid Climate - An Engineering Application of Petrology

Wendy J. Harrison[1] (303-273-3821; wharriso@Mines.edu)

Richard F. Wendlandt[1] (303-273-3809; rwendlan@Mines.edu)

[1]Department of Geology and Geological Engineering, Colorado School of Mines, 1500 Illinois Street, Golden, CO 80401, United States

Over the last 10 years, analytical methods have been introduced to students in CSM's undergraduate geological engineering program through a multi-year and multi-course approach. Beginning with principles and simple applications of XRD and SEM in sophomore Mineralogy and building on these skills in subsequent junior and senior year courses, geological engineers acquire proficiency in analytical methods. Essential workplace skills are thus acquired without adding an extra course in the undergraduate program. The following exercise is completed by juniors in an integrated Ig.-Met.-Sed. petrology course. The identification of clay mineral assemblages in soils provides a unique opportunity to demonstrate how basic principles of petrology and geochemistry are applied to engineering design criteria in construction site preparation. Specifically, the problem investigates the conditions leading to the formation of smectite in soils and the resulting construction risk due to soil expansion. Students examine soils developed on igneous, metamorphic, and sedimentary rocks near Denver, Colorado. The field locations are areas of suburban growth and several have expansive soil problems. The 2-week exercise includes sample collection, description, and preparation, determining clay mineralogy by XRD, and measurement of Atterberg Plasticity Indices. Teaching materials may be found at: http://serc.carleton.edu/NAGTWorkshops/petrology03/. This exercise accomplishes three objectives: First, skills in XRD analysis are developed by introducing students to concepts of particle size separation, particle orientation, and sequential analysis steps which are standard practices in clay characterization. Second, lecture material on the geochemistry of weathering of different rock types is reinforced. Students interpret the origin of clay mineral assemblages developed in soils derived from Precambrian gneisses, lower Paleozoic feldspathic sandstones, upper Paleozoic marine shales, and Tertiary basalts and volcaniclastics. Third, the role of petrologic characterization in site engineering is demonstrated. Students use Atterberg Limits measurements in conjunction with soil mineralogy to assess swelling potential and to design soil treatment needs for each building site.

URL: http://serc.carleton.edu/NAGTWorkshops/petrology03/teaching_materials.html

ED41C-1187 0830h POSTER

A Web Resource for Lab Activities Using SEM, EDX and Light Microscopy

Anne Argast[1] (260-481-6252; Argast@ipfw.edu)

Clarence F. Tennis[1] (260-481-6294; Tennisc@ipfw.edu)

[1]Geosciences Dept. Indiana-Purdue University Fort Wayne, 2101 E. Coliseum Blvd., Fort Wayne, IN 46805-1499, United States

A resource that facilitates undergraduate activities centered on the development of perthitic textures is available at http://www.geosci.ipfw.edu/sem/semedx.html. The web site provides a coherent set of data and images from a perthite and an anorthoclase sample. Backscatter and secondary electron images, plane- and cross-polarized light images, energy dispersive X-ray (EDX) data from 13 points on the perthite and 31 points on the anorthoclase (including spectra and results files with data expressed as wt. and atomic percents) and X-ray diffraction (XRD) data are available. Care has been taken to match the areas examined by light and electron methods, allowing students to directly compare the data available from each technique. Brief descriptions of the various methods are provided. The available information can be the basis for many different exercises. Those without easy access to mircoprobes or EDX spectrometers will find the spectra useful for discussions of microchemical techniques. Different phases can be identified in the light and SEM images. The chemical results can be used to calculate formulas. (In addition to the feldspar, the anorthoclase phenocryst contains olivine, clinopyroxene, ulvospinel, apatite and glass.) Feldspar compositions can be plotted to illustrate compositional differences in perthite and anorthoclase. Glass compositions from the interior and margins of the anorthoclase phenocrysts can be compared. Numerous other possibilities, of varying levels of complexity, exist. The perthite (from Perth, Ontario) and the anorthoclase (from Mt. Erebus, Antarctica) were purchased from Wards Natural Science. There are many students with little or no access to data derived from EDX, SEM, XRD and similar techniques. It is our responsibility to find ways to make this information more universally available to all students.

ED41D MCC: Level 2 Thursday 0830h

Teacher Professional Development Programs Promoting Authentic Scientific Research in the Classroom I Posters

Presiding: **S K Croft,** National Optical Astronomy Observatory**; C E Walker,** National Optical Astronomy Observatory

ED41D-1188 0830h POSTER

Astronomy Village: Multimedia and Authentic Research in the Classroom

Steven K Croft[1] (520-318-8495; scroft@noao.edu)

Stephen M Pompea[1] (520-318-8285; spompea@noao.edu)

[1]National Optical Astronomy Observatory, 950 N. Cherry Ave, Tucson, AZ 85719, United States

Two recent trends in American science education are: the use of technology in the classroom, and the development of inquiry-based science curricula that model authentic scientific research in the classroom. Two products have been developed in recent years at the Center for Educational Technology to test the ability of multimedia to put effective research models into the classroom: Astronomy Village: Investigating the Universe (AV-IU), and Astronomy Village: Investigating the Solar System (AV-ISS). AVIU is designed for high school students and deals with topics mostly in stellar and galactic astronomy, while AVISS is designed for middle school students and deals with topics in astrobiology and planetary geology. The objective of both products is to engage students in scientific inquiry by having them acquire, explore, and analyze real scientific data and images drawn from real scientific problems. By doing "hands-on" activities both on and off-line, the students would gain an understanding of scientific concepts and how science works. The challenge is to guide students through an investigation using a stand-alone multimedia CD-ROM. The central device for guidance in both products is the "Research Path Diagram," a visual representation and interactive model of the scientific process. In the earlier AV-IU, the "path" was linear and each investigation was independent. In the later AV-ISS, the path is circular and investigations are linked, so that students can see how research activities are in a sense cyclical and build on one another. While even the AV-ISS version is still not a truly accurate representation of the sometimes tortuous path trod by the research scientist, both models provide a good framework for approximating real research in a multimedia environment. NOAO is operated by the Association of Universities for Research in Astronomy (AURA), Inc. under cooperative agreement with the National Science Foundation.

ED41D-1189 0830h POSTER

DASL–Data and Activities for Solar Learning

Frank Hill[1] (fhill@noao.edu)

Michael V Gearen[3] (mikeg@puhahou.edu)

Carl J Henney[1] (chenney@noao.edu)

Harrison P Jones[2] (hjones@noao.edu)

Travis Stagg[4] (tstagg@northstar.k12.ak.us)

[1]National Solar Observatory, PO Box 26732, Tucson, AZ 85726-6732, United States

[2]NASA/GSFC, PO Box 26732, Tucson, AZ 85726

[3]Punahou School Punahou School Punahou School, 1601 Punahou Street, Honolulu, HI 96822, United States

[4]West Valley High School, 3800 Geist Rd., Fairbanks, AK 99709, United States

Data and Activities for Solar Learning (DASL) provides a classroom learning environment based on a twenty-five year record of solar magnetograms from the National Solar Observatory (NSO) at Kitt Peak, AZ. The data, together with image processing software for Macs or PCs, can be used to learn basic facts about the Sun and astronomy at the middle school level. At the high school level, students can study properties of the Sun's magnetic cycle with classroom excercises emphasizing data and error analysis and can participate in a new scientific study, Research in Active Solar Longitudes (RASL), in collaboration with classrooms throughout the country and scientists at NSO and NASA. We will demonstrate a compact disc with the data and software, and a web site for uploading the RASL results.

URL: http://eo.nso.edu/dasl/

ED41D-1190 0830h POSTER

Workshop on Teaching Astronomy Space Science at High School and Middle School Level

Rosalyn A Pertzborn[1] ((608) 265-4160; RoseP@ssec.wisc.edu)

Sanjay S Limaye[1] ((608) 262-9541; SanjayL@ssec.wisc.edu)

[1]Office of Space Science Education, University of Wisconsin-Madison, 1225 West Dayton Street, Madison, WI 53706, United States

For the last two years we have conducted a workshop mostly supported by a NASA IDEAS grant on providing professional development for teachers teaching Astronomy/Space Science at high school and middle school level. In some cases this effort has also supported efforts at schools in creating new courses in Space Science. The effort has included a one week summer workshop with as many as six follow up one-day meetings in the school year. The summer workshops have included presentations by experts in current space science research themes and also tours of professional and amateur observatories in and around Wisconsin. The format also allows for some time for teachers to share ideas, curricula among themselves and to present and share "best practices". As in many other instances, the different needs of individual schools, students and teachers prevents a single approach to content and course implementation in schools. Therefore our efforts have focused in serving the needs of individual teachers as much as feasible with limited resources. We gratefully acknowledge the support received from NASA/IDEAS program as well as the Wisconsin Idea program funded by the University of Wisconsin-Madison.

URL: http://tellus.ssec.wisc.edu/outreach

ED41D-1191 0830h POSTER

Teacher Intern Experiences during a Graduate Level Summer School

Esther L Zirbel (617-358-3245; zirbel@bu.edu)

Boston University, Center for Space Physics 725 Commonwealth Ave, Boston, MA 02215, United States

This paper summarises the learning experiences of a teacher intern who attended the two week graduate level summer school given by the Center for Space Weather Modeling (CISM); and who subsequently spend another two weeks desiging laboratory exercises that were based on the material presented at the summer school. Two of these laboratories that are based on professional research will be reviewed and the effect these laboratories had on the teacher's coworkers and the teacher's own students will be evaluated and described.

ED41D-1192 0830h POSTER

High Leverage NASA Education & Public Outreach Teacher Professional Development Programs

Bryan J. Mendez[1] (510-643-2178; bmendez@ssl.berkeley.edu)

Laura M. Peticolas[1] (510-643-6295; laura@ssl.berkeley.edu)

Greg Schultz[1] (510-643-0012; schultz@ssl.berkeley.edu)

Nahide Craig[1] (510-643-7273; ncraig@ssl.berkeley.edu)

[1]UC Berkeley, 7 Gauss Way Space Sciences Laboratory, Berkeley, CA 94720-7450, United States

E
D