

The 47th Forum on the Geology of Industrial Minerals



Program with Abstracts and Field Trips

**May 15–17, 2011
I Hotel and Conference Center
Champaign, Illinois**

**Hosted by the
Illinois State Geological Survey
Zakaria Lasemi and Donald G. Mikulic**

Open File Series 2011-2



**ILLINOIS STATE
GEOLOGICAL SURVEY**
PRAIRIE RESEARCH INSTITUTE



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Front cover: Thornton quarry. Photograph by Joel M. Dexter.

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CONTENTS

Annual Meetings of the Forum	ii
Schedule of Events	1
Sunday, May 15, 2011	1
Monday, May 16, 2011	1
Tuesday, May 17, 2011	3
Poster Titles	4
Abstracts	6
Technical Sessions	6
Posters	30
Spouse/Guest Program	40
Field Trips	41
References	43
Author Index	44

Annual Meetings of the Forum on the Geology of Industrial Minerals

1 st	1965	Columbus, Ohio
2 nd	1966	Bloomington, Indiana
3 rd	1967	Lawrence, Kansas
4 th	1968	Austin, Texas
5 th	1969	Harrisburg, Pennsylvania
6 th	1970	Ann Arbor, Michigan
7 th	1971	Tampa, Florida
8 th	1972	Iowa City, Iowa
9 th	1973	Paducah, Kentucky
10 th	1974	Columbus, Ohio
11 th	1975	Kalispell, Montana
12 th	1976	Atlanta, Georgia
13 th	1977	Norman, Oklahoma
14 th	1978	Albany, New York
15 th	1979	Golden, Colorado
16 th	1980	St. Louis, Missouri
17 th	1981	Albuquerque, New Mexico
18 th	1982	Bloomington, Indiana
19 th	1983	Toronto, Ontario, Canada
20 th	1984	Baltimore, Maryland
21 st	1985	Tucson, Arizona
22 nd	1986	Little Rock, Arkansas
23 rd	1987	North Aurora, Illinois
24 th	1988	Greenville, South Carolina
25 th	1989	Portland, Oregon
26 th	1990	Charlottesville, Virginia
27 th	1991	Banff, Alberta, Canada
28 th	1992	Martinsburg, West Virginia
29 th	1993	Long Beach, California
30 th	1994	Frederickton, New Brunswick/ Halifax, Nova Scotia, Canada
31 st	1995	El Paso, Texas
32 nd	1996	Laramie, Wyoming
33 rd	1997	Québec, Canada
34 th	1998	Norman, Oklahoma
35 th	1999	Park City, Utah
36 th	2000	Bath, England
37 th	2001	Victoria, British Columbia
38 th	2002	St. Louis, Missouri
39 th	2003	Reno, Nevada
40 th	2004	Bloomington, Indiana
41 st	2005	Istanbul, Turkey
42 nd	2006	Asheville, North Carolina
43 rd	2007	Boulder, Colorado
44 th	2008	Oklahoma City, Oklahoma
45 th	2009	Delaware, Ohio
46 th	2010	Middletown, Pennsylvania
47 th	2011	Champaign, Illinois

SCHEDULE OF EVENTS

SUNDAY, MAY 15, 2011

5:00 PM–8:00 PM

Registration, reception, and poster setup at the I Hotel Conference Center

MONDAY, May 16, 2011

Technical Sessions

8:20 AM–8:50 AM

State Geological Surveys— Science That Works: *E. Donald McKay III, State Geologist and Director, Illinois State Geological Survey, Prairie Research Institute, University of Illinois, Champaign, Illinois*

8:50 AM–9:10 AM

Carbon Sequestration Potential of the Cambrian and Ordovician Strata in the Illinois Basin: *Hannes E. Leetaru and Robert J. Finley, Illinois State Geological Survey, Prairie Research Institute, University of Illinois, Champaign, Illinois*

9:10 AM–9:30 AM

Geologic Mapping of the Ordovician St. Peter Sandstone and Platteville and Galena Groups, Ogle County, Illinois: *Mary J. Seid, Illinois State Geological Survey, Prairie Research Institute, University of Illinois, Champaign, Illinois*

9:30 AM–9:50 AM

Measuring and Describing Outcrops That You Can't Actually Touch: *Christopher J. Stohr, Donald Keefer, Andrew Stumpf, Barbara Stiff, and Donald G. Mikulic, Illinois State Geological Survey, Prairie Research Institute, University of Illinois, Champaign, Illinois*

9:50 AM–10:30 AM

BREAK

10:30 AM–10:50 AM

Geology and Fluorescent Minerals at the Omya White Knob Quarry, Lucerne Valley, California: *Howard J. Brown, Omya California, a Division of Omya Inc., Lucerne Valley, California*

10:50 AM–11:10 AM

Exploration for Carbonatite-Hosted Nb-Ta Deposits Using Biogeochemical Methods, Blue River Area, British Columbia, Canada: *Robert Fajber, University of Victoria, George Simandl, Victoria Geological Survey, and Colin Dunn, Consultant Geologist, British Columbia, Canada*

11:10 AM–11:30 AM

“If Your Name’s Not Down—You’re Not Coming in” or How I Learned to Stop Worrying and Love Critical Minerals: *John Cowley, Mineral & Resource Planning, Dorset, United Kingdom*

11:30 AM–11:50 AM

Origin of Tripoli Deposits in Southern Illinois and Implications for Exploration: *C. Pius Weibel, Illinois State Geological Survey, Prairie Research Institute, University of Illinois, Champaign, Illinois*

11:50 AM–1:30 PM

LUNCH

(on your own; Houlihan’s is onsite; many restaurants nearby on Neil St.)

1:30 PM–1:50 PM

Underground Extraction of Aggregate: *John Cowley, Mineral & Resource Planning Associates, Dorset, United Kingdom*

1:50 PM–2:10 PM

An Overview of Mining and Mineral Specimens from the Conco Mine: North Aurora, Kane County, Illinois: *Jared Freiburg, Illinois State Geological Survey, Prairie Research Institute, University of Illinois, Champaign, Illinois*

2:10 PM–2:30 PM

Possible Causes for Significant Variations in Chemical and Mineralogical Compositions between the Major Ore Districts in the Mississippi Valley: Tri-State Zinc District, Southeast Missouri Lead District, and Southern Illinois-Kentucky Fluorite District: *Richard D. Hagni, Missouri University of Science and Technology, Rolla, Missouri*

2:30 PM–2:50 PM

Rare Earth Mineral Concentrations within Fluorite in the Illinois-Kentucky Fluorite District and Igneous Intrusives at Hicks Dome Cryptoexplosive Complex, Southeastern Illinois and Northwestern Kentucky (USA): *F. Brett Denny, Illinois State Geological Survey, Prairie Research Institute, University of Illinois, Champaign, Illinois, Renald N. Guillemette, Texas A&M University, and Liliana Lefticariu, Southern Illinois University, Carbondale, Illinois*

2:50 PM–3:30 PM

BREAK

3:30 PM–3:50 PM

What Do I Do with This Hole Now—Reusing Mined Areas: *Nelson R. Shaffer, Indiana Geological Survey, Bloomington, Indiana*

3:50 PM –4:10 PM

Community Education and Outreach from the Aggregate Mining Industry in Illinois: *Becky Kazmierski, CTL Group, Skokie, Illinois, and Shawn McKinney, Illinois Association of Aggregate Producers, Springfield, Illinois*

4:10 PM –4:30 PM

Geology and the Aggregate Industry: No Plan for the Future: *Donald G. Mikulic, Illinois State Geological Survey, Prairie Research Institute, University of Illinois, Champaign, Illinois, and Joanne Kluessendorf, Weis Earth Science Museum, Menasha, Wisconsin*

4:30 PM–4:50 PM

Characterization of Warping Marble in New Orleans’s Cemeteries: *Joseph T. Hannibal, Cleveland Museum of Natural History, Cleveland, Ohio*

MONDAY EVENING DINNER

Open to all registered participants

I Hotel and Conference Center, 1900 South First Street, Champaign, Illinois

6:30 PM Cash Bar and Social

7:00 PM Dinner

8:00 PM Presentation

Past and Future Stone Resources for the Chicago Metropolitan Area: *Donald G. Mikulic, Illinois State Geological Survey, Prairie Research Institute, University of Illinois, Champaign, Illinois*

TUESDAY, MAY 17, 2011

7:45 AM–8:30 AM

Steering Committee Meeting and Breakfast

Technical Sessions

8:30 AM–8:50 AM

The Production of Contaminated Drywall Compared to American-Made Drywall as Determined by Materials Characterization: *Ann M. Hagni, Ann Hagni Consulting, LLC, Rolla, Missouri*

8:50 AM–9:10 AM

Chemical and Mineralogical Characteristics of Flue Gas Desulfurization By-products and Swine Manure Mixtures after Controlled Leaching Experiments: *Shane Butler, William R. Roy, and Zakaria Lasemi, Illinois State Geological Survey, Prairie Research Institute, University of Illinois, Champaign, Illinois*

9:10 AM–9:30 AM

Studies of the Oldest Industrial Mineral Use Create New, Low-Cost Methods for Today’s Industry: *Sarah Wisseman, Illinois State Archaeological Survey, Prairie Research Institute, Champaign, Illinois, Shane Butler and Randall Hughes, Illinois State Geological Survey, Prairie Research Institute, Champaign, Illinois, and Thomas Emerson, Illinois State Archaeological Survey, Prairie Research Institute, University of Illinois, Champaign, Illinois*

9:30 AM –10:00 AM

BREAK

10:00 AM –10:20 AM

Aggregate Fines—Problem or Opportunity: *Nelson R. Shaffer, Indiana Geological Survey, Bloomington, Indiana*

10:20 AM –10:40 AM

High-Calcium Limestone Resources in Illinois: *Zakaria Lasemi, Illinois State Geological Survey, Prairie Research Institute, University of Illinois, Champaign, Illinois*

10:40 AM –11:00 AM

Obtaining Special Use Permits for Mineral Sources and Development Encroachments on Current and Potential Future Mineral Extraction Sites:
Mark J. Krumenacher, GZA GeoEnvironmental, Inc., Waukesha, Wisconsin.

11:00 AM –11:20 AM

Supply-Demand Issues for Minerals in “Green” Energy: *Jim Burnell, Colorado Geological Survey, Denver, Colorado*

11:20 AM–12:00 AM

Forum Business Meeting

12:00 Noon

CATERED LUNCH

12:00 Noon–5:00 PM

Field Trip: This trip is limited to those registered for the Forum meeting and will examine the geology of crushed stone in central Illinois. The trip will include a visit to a quarry near Tuscola, Illinois, where Middle Devonian and Silurian limestone and dolomite are being currently mined. The trip will conclude at a Pennsylvanian limestone quarry in east-central Illinois.

POSTERS

Available for viewing throughout the meeting

Derivative Mapping for Potential Industrial Mineral Resources in Ohio: *Mark Wolfe and Mike Angle, Ohio Department of Natural Resources, Division of Geological Survey, Columbus, Ohio*

An Updated Inventory of Illinois Mineral Producers and Maps of Extraction Sites:
Xiaodong Miao, Zakaria Lasemi, and Donald G. Mikulic, Illinois State Geological Survey, Prairie Research Institute, University of Illinois, Champaign, Illinois, and Michael Falter, Office of Mines and Minerals, Illinois Department of Natural Resources, Springfield, Illinois

Sand and Gravel Resources of McHenry County, Illinois: A New Look: Xiaodong Miao, Jason F. Thomason, Steven E. Brown, and Christopher J. Stohr, *Illinois State Geological Survey, Prairie Research Institute, University of Illinois, Champaign, Illinois*

Progress of the Arkansas Mineral Commodity Database (AMCD) and End-User Utilization through GIS Technology: J. Michael Howard and Nathan Taylor, *Arkansas Geological Survey, Little Rock, Arkansas*

Methods of Analyzing Clay and Non-Clay Minerals Using X-ray Diffraction: Shatosha Maddix, Stefan Raduha, and Shane Butler, *Illinois State Geological Survey, Prairie Research Institute, University of Illinois, Champaign, Illinois*

Utilization of Westminster Terrane Carbonates for Cement Production, New Windsor and Union Bridge, Maryland: Elizabeth Graybill, *Ohio University Department of Geological Sciences, Athens, Ohio*

An Overview of the Illinois Industrial Minerals: Zakaria Lasemi, Donald G. Mikulic, and Xiaodong Miao, *Illinois State Geological Survey, Prairie Research Institute, University of Illinois, Champaign, Illinois*

Spatial and Temporal Analysis of Salt Ponds Using ASTER Images: Lake Acigöl (Denizli), Southwest Anatolia, Turkey: M. Budakoglu, M. Karaman, D. Avcı Uca, M. Kumral, and S.B. Karabel, *Istanbul Technical University, Istanbul, Turkey*

Geological and Geochemical Characteristics of Küre Kastamonu Copper Deposits: M. Kumral, M. Budakoglu, M. Karaman, S.B. Karabel, D. Yıldırım Kıran, and E. Ciftci, *Istanbul Technical University, Istanbul, Turkey*

Geochemical Investigation and Economic Properties of Chromite Occurrences around Köyceğiz Lake, Muğla, Southwest Turkey: M. Kumral, M. Budakoglu, M. Karaman, S.B. Karabel, D. Maral Temel, S. Uzaşci, and E. Ciftci

ABSTRACTS

Monday May 16, 2011 Technical Sessions

8:20 AM–8:50 AM

State Geological Surveys—Science That Works

*E. Donald McKay III, State Geologist and Director
Illinois State Geological Survey, Prairie Research Institute, University of Illinois,
Champaign, Illinois*

State geological surveys are institutions of geoscience research and service located in virtually every state in the nation. Although they operate under somewhat different administrative and funding models, all surveys share common mission elements and goals with respect to providing current, relevant, state-based geologic understanding to their stakeholders in order to help insert scientific facts into societal decision making. Most are the primary repositories for and some of the largest generators of new geologic information for their states.

Collectively, state geological surveys expend nearly \$250 million annually, making them a considerable force in the geoscience research agenda of the nation. The Illinois State Geological Survey is one of the larger surveys and is an example of the breadth of survey operations, methods, funding, and projects.

We will examine several projects and partnerships between state geological surveys and industries, government agencies, and non-governmental organizations that facilitate relevant timely research and are yielding valuable new data for their states as well as for issues of national importance.

8:50 AM–9:10 AM

**Carbon Sequestration Potential of the Cambrian and Ordovician Strata
in the Illinois Basin**

Hannes E. Leetaru and Robert J. Finley

*Illinois State Geological Survey, Prairie Research Institute, University of Illinois,
Champaign, Illinois*

The Cambrian-Ordovician strata of the Illinois and Michigan Basins encompass most of the states of Illinois, Indiana, Kentucky, and Michigan and, for some areas, may be the only available target for geological sequestration of CO₂. The three most significant sequestration reservoirs are the Cambrian Mt. Simon Sandstone, Cambrian carbonate intervals in the Knox Group, and the Ordovician St. Peter Sandstone.

These formations were evaluated using wireline logs, core data, pressure data, and seismic data from the U.S. Department of Energy-funded Illinois Basin–Decatur Project being conducted by the Midwest Geological Sequestration Consortium (MGSC) in Macon County, Illinois. All three reservoirs have significant potential. The Knox reservoir is composed of interconnected solution cavities that make CO₂ plume prediction difficult. The St. Peter is a potential reservoir but, at 52 m (170 feet) thick, has less storage capacity than the Mt. Simon. The Mt. Simon is over 487 m (1,600 feet thick) at Decatur and has porosities ranging up to 30% and permeabilities of over 1 Darcy.

By fall 2011 the MGSC should be injecting 1,000 tonnes per day of CO₂ into the basal Mt. Simon at 2,133 m (7,000 feet) for a three-year period to test the sequestration potential of this formation. At least two other Illinois carbon capture and sequestration projects with planned injection rates of over up to 3,000 tonnes per day are also in development and should begin injection into the Mt. Simon in the next couple of years.

9:10 AM–9:30 AM

Geologic Mapping of the Ordovician St. Peter Sandstone and Platteville and Galena Groups, Ogle County, Illinois

Mary J. Seid

Illinois State Geological Survey, Prairie Research Institute, University of Illinois, Champaign, Illinois

The Ordovician St. Peter Sandstone, Platteville Dolomite, and Galena Dolomite are important industrial materials in northern Illinois. Detailed geologic mapping of these units in Ogle County, Illinois, is currently being performed by the Illinois State Geological Survey.

The Grand Detour and Mount Morris 7.5-minute Quadrangle maps will be available online in September 2011. New scientific findings have made us rethink the tectonic history of central Ogle County and may have implications for the extent and deformation style of the Sandwich Fault Zone. Previous mapping of the Oregon 7.5-minute Quadrangle (2010) and current mapping have encouraged collaborations with the Illinois State Archaeological Survey, the Illinois Department of Transportation, and industrial material companies in the region.

Currently there are three construction sand and gravel pits, nine stone quarries, and one silica sand operation in Ogle County. According to the U.S. Geological Survey, in 2008, the latest year for which data are available, about 1,154,000 tons of crushed stone and 146,000 tons of construction sand and gravel were produced in Ogle County. The value of crushed stone and sand and gravel produced in 2008 was \$8.5 million and \$777,000, respectively. Ogle County has a significant amount of crushed stone reserves, and its proximity to the Chicago metropolitan area makes this county an attractive target for construction aggregate exploration. Furthermore, because of increased demand for frac sand in the petroleum industry, the St. Peter Sandstone has become a major source of silica sand used for fracking to increase oil and gas production. The current geologic mapping underway in Ogle County will delineate additional reserves of industrial minerals that may exist in the county.

9:30 AM–9:50 AM

Measuring and Describing Outcrops That You Can't Actually Touch

*Christopher J. Stohr, Donald Keefer, Andrew Stumpf, Barbara Stiff, and Donald G. Mikulic
Illinois State Geological Survey, Prairie Research Institute, University of Illinois,
Champaign, Illinois*

Outcrops are valuable sources of geologic information, but they are commonly inaccessible or short-lived, such as exposures at mines and quarries. Even when accessible, the expense, safety, and logistical limitations can prevent detailed description and surveying for georeferencing, which reduces the value of the information collected at these sites. New remote-imaging and measurement technologies remove these obstacles.

Three technologies, laser transit, terrestrial LiDAR, and close-range photogrammetry, can be used to obtain 3-D georeferenced measurements of geologic features in outcrops and exposures. Laser transit surveying requires more time onsite because lithologies and features are described in the field as part of the surveying process, but less follow-up processing is required. Terrestrial LiDAR scanner imagery produces a georeferenced point cloud over which conventional color photography is draped. Outcrop stereophotography is processed by photogrammetric software to make a 3-D stereomodel and a georeferenced orthorectified photograph.

Measurements of joints, fractures, and bedding surfaces made from point clouds or stereomodels can be used to compute dip, strike, length, and inclination, which are important for mapping lithologic changes and performing slope stability analyses. Additional measurements such as thickness, area, and ground elevations tied to real-world coordinates can be combined with descriptive information, such as materials and sedimentary structures, to improve stratigraphic correlations in 3-D geologic mapping. These techniques also allow inference of material properties where physical samples cannot be obtained for examination.

Image processing techniques, customarily employed for aerial and satellite imagery, can be used to improve georeferenced outcrop photography for interpretation and analyses. In addition, statistical processing can augment conventional, digital, visible-light photography by enhancing differences in lithology, contacts, moisture, and sedimentary structure. Georeferenced imagery can preserve outcrops and sections for virtual field visits and additional examination.

In the future, remote sensing of outcrops, including nonvisible wavelengths, may be used to reliably characterize changes in texture, moisture, and mineral occurrence as well as distribution in sedimentary structures, to help set sampling/testing priorities and provide more complete, georeferenced descriptions of the exposed materials.

10:30 AM–10:50 AM

Geology and Fluorescent Minerals at the Omya White Knob Quarry, Lucerne Valley, California

Howard J. Brown

Omya California, A Division of Omya Inc., P.O. Box 825, Lucerne Valley, California 92356

Omya, a leading global producer of ground calcium carbonate, produces white calcium carbonate from the White Knob quarry in Lucerne Valley, California. The quarry is located on the north slope of the San Bernardino Mountains in the Mojave Desert area of southern California. The quarry is developed in multiply folded, deformed, and metamorphosed Paleozoic miogeoclinal carbonate rocks that have been intruded by a variety of Mesozoic age plutonic rocks. The formation being mined is the Bullion Member of the Monte Cristo Limestone of Mississippian age that has been metamorphosed to amphibolite grade to form very coarse-grained, high-purity white calcite marble ore. At the quarry the steeply dipping rocks are exposed over a vertical interval of over 1,000 feet. Mining is by standard open pit drill and blast, load and haul methods. Ore is processed at the plant into fine-grind calcium carbonate utilized in hundreds of common consumer products.

Although mining started in 1988 at White Knob, it was not until 2004 that fluorescent minerals were recognized. Fluorescent minerals occur in waste rock and not within the high-purity calcium carbonate ore. Fluorescent minerals at the quarry respond to short wave ultraviolet light. Fluorescent minerals have several modes of occurrence at the quarry. Most occur within the Arrowhead Member of the Mississippian Monte Cristo Limestone, originally an impure cherty limestone that has been metamorphosed to wollastonite calc-silicate marble. Several pink-colored Mn-bearing minerals occur, including manganiferous calcite, rhodochrosite, piedmontite, spessartine garnet, and Mn vesuvianite. Small amounts of Mn within the rock allow fluorescence to occur. Several fluorescent minerals occur in the Arrowhead, including orange-fluorescing calcite, bright yellow wollastonite, lime green hyalite and aragonite, blue diopside, white dolomite and unknown minerals that fluoresce violet, azure blue, sky blue, and shades of green. Another common fluorescent mineral occurrence is magenta-fluorescing feldspar, which occurs in granite dikes and veins. When the dikes cut the fluorescent Arrowhead Member, spectacular multicolor specimens are present. Other common fluorescent occurrences include highly phosphorescent travertine and caliche. Least common are skarn mineral occurrences including calc-silicates and metallic minerals such as disseminated powellite (a molybdenum mineral), which fluoresces as bright white “snowflakes”. Another well-known fluorescent mineral location in the general area is the Desert View Mine. The presence of activator impurities in the host rock, including Mn, U, Zn, and Fe, are likely responsible for the fluorescence at both the Desert View Mine and the White Knob quarry.

10:50 AM–11:10 AM

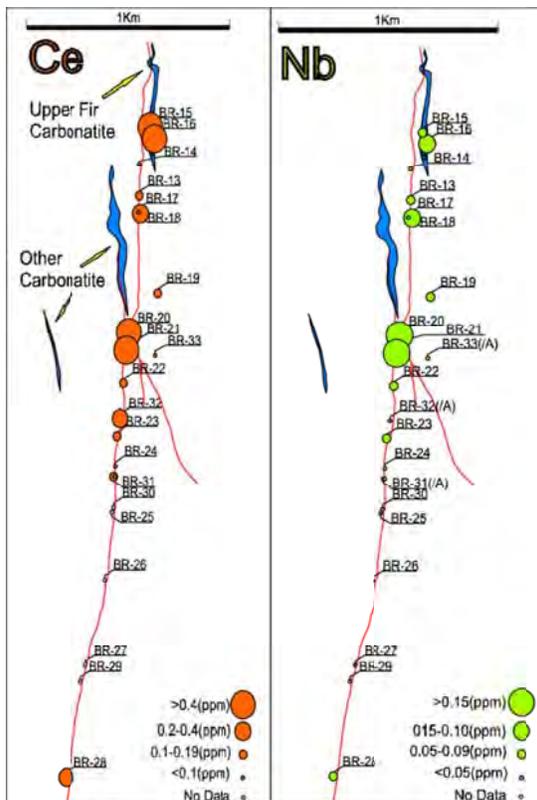
Exploration for Carbonatite-Hosted Nb-Ta Deposits Using Biogeochemical Methods, Blue River Area, British Columbia, Canada

Robert Fajber¹, George Simandl², and Colin Dunn³

¹University of Victoria, ²Victoria Geological Survey, and ³Consulting Geologist, British Columbia, Canada

This survey over the Upper Fir carbonatite shows that coniferous trees are suitable sampling media in direct exploration for carbonatites and related rare earth elements (REE), Ta, Nb, phosphate, and in indirect exploration for vermiculite and fluorspar. Twenty-four samples of twigs with needles both from Subalpine Fir (Fir) and White Spruce (Spruce) trees were collected over the Upper Fir carbonatite as well as over surrounding amphibolites and paragneisses. Twigs and needles were analyzed separately. Twigs were milled using a Wiley mill before the resulting pulps were digested in HNO₃, then in aqua regia, and analyzed using ICP-MS/ICP-ES methods. Needles were ashed and then digested in aqua regia and analyzed using the same methods.

Light REE, Y, Zr, and P anomalies in both twigs and needles have good spatial correlation with carbonatite-related REE and apatite mineralization. Concentrations of heavy REE are near or below the detection limit. The highest concentrations of REE are located directly over the carbonatite deposit (see figure). Chondrite-normalized plots of the vegetation samples show distinct negative Eu anomalies. Tantalum is found in detectable concentrations only in twig samples spatially related to carbonatite deposits. Detectable concentrations range from 0.001 to 0.003 ppm Ta (dry weights normalized). Niobium was detected in most of the samples.



Concentrations were highest on or near known carbonatite occurrences. Concentrations range from 0.02 to 0.24 ppm Nb in Spruce twigs, 0.005 to 0.071 ppm Nb in Spruce needles (dry weight normalized), and 0.012 to 0.030 ppm Nb in Fir needles (dry weight normalized). Spruce twig data show strong positive correlations between Fe, REE, and Zr as well as between Nb, Fe, Ti, Ce, and Nd. Fir twigs were not analyzed due to insufficient sample size after milling. Spruce needle data show strong positive correlations among P, Mg, and Ti, moderate positive correlations between P and Ca, and strong positive correlation among Nb, REE, Zr, and Fe. Too few Fir needle samples were obtained for formal statistical analysis; however, there appears to be a strong positive relationship between Fe and REE, Fe and Ti, and also P and Zr. More research is required, but these results suggest these methods could be used for carbonatite-related exploration in other parts of the world.

11:10 AM–11:30 AM

**“If Your Name’s Not Down—You’re Not Coming in”
or How I Learned to Stop Worrying and Love Critical Minerals**

John Cowley

Mineral & Planning Associates, Ltd., 23 Bayfram Way, Blandford Forum, Dorset, United Kingdom DT11 74Z

It is almost impossible to open a serious newspaper without seeing an article referring to the use of and shortage of critical minerals, especially rare earth elements (REE). The impact of the Chinese “monopoly” of supply, the apparent critical or scarce nature (or otherwise) of the minerals, their significance in new materials, their necessity in new “green” energy, even the strange tongue twisting names of some (particularly some of the REE), has made these minerals “sexy”, so that even politicians are taking note.

Committees of the great and the good are considering what this means and how we can resolve the apparent problem by statements of government policy backed up by government action. Questions are being asked, such as what critical minerals are, what is meant when we talk about critical minerals, how critical these minerals are (and of course what alternatives exist and how we can resolve the problem by recycling), and how government can, or should, act.

Unfortunately, this is not yet a coordinated approach in the UK, and the relationships between availability and use and the scale and extent of the issue is rather muddled. A partly misleading issue is the proclivity of committees or research bodies to draw up a list of what is or isn’t critical according to their assumptions or knowledge (or lack of knowledge) about the use and availability of a mineral. Currently in the UK we have (i) a list and a review compiled by Europe, (ii) two different studies and lists compiled by one government department, (iii) a policy document under production by another government department, (iv) a joint policy review by another two government departments, (v) a further approach on research proposed by the relevant academic research council, and (vi) a policy review by a committee of the House of Commons.

The unfortunate thing is that while matters as to the availability of REE etc. are being debated earnestly by committees and research groups, other economically critical minerals in the UK and Europe are suffering because of current disinterest. The UK is about to lose the fluorspar industry, and high-grade kaolin production is under threat. The question is whether we can translate the narrow concern about “critical minerals”, which is dominated by concerns about REE, into a more useful concern about the supply issues for many minerals important to our economy.

11:30 AM–11:50 AM

Origin of Tripoli Deposits in Southern Illinois and Implications for Exploration

C. Pius Weibel

*Illinois State Geological Survey, Prairie Research Institute, University of Illinois,
Champaign, Illinois*

Tripoli (microcrystalline chert) has been mined for more than a century in the southern Illinois region. Tripoli deposits reportedly occur almost entirely in the Lower Devonian Clear Creek Chert. Traditional exploration for tripoli deposits has been by sampling and drilling of exposed and near-surface weathered siliceous rocks. In ISGS Circular 555, Berg and Masters (1994) proposed that hydrothermal fluids heated by deep-seated plutonic intrusions were partially responsible for the formation of tripoli deposits—and by inference the implication was that deeper exploration methods should be applied.

A review of the key reasons of Berg and Masters for the inclusion of a hydrothermal component indicates that exploration based on this new hypothesis should not be undertaken without strong consideration of the traditional hypothesis that tripoli deposits formed by a long period of weathering of siliceous rocks. Berg and Masters cited the coincidence of prominent magnetic anomalies with tripoli mining district locations. The highest concentration of mines and prospects, however, do not correlate well with either magnetic or gravity anomalies and indicate the absence of a relationship between a presumed hydrothermal source (iron-rich intrusive mass) and tripoli occurrences. Berg and Masters' claim that a discordant leaching surface is not supportive of the near surface weathering hypothesis is flawed conceptually and by poorly defined surfaces. A fluid inclusion analysis indicating quartz precipitation at temperatures ranges near 200°C is in conflict with temperature data based on hydrogen and oxygen isotopic ratios. In addition, there is very little mineralogical data to support the occurrence of hydrothermal deposits.

Characteristics that support the hypothesis that tripoli was formed by a weathering process include (1) the presence of unweathered to weathered transitions in the region, (2) the absence of carbonate material at the surface and in near surface strata in which tripoli formed, (3) the physical appearance of tripoli deposits combined with the absence of carbonate material is typical of the products of a weathering environment, (4) a sandstone overlying the Clear Creek Chert contains fossil molds—suggestive of a near-surface weathering environment, (5) weathering and leaching of carbonate beds resulted in contortion and intrusion of residual clay beds within the Clear Creek Chert, and (6) the irregular areal distribution of the tripoli deposits appears to be typical of an erosional remnant of an older deeply weathered horizon.

To summarize, there is ample evidence that the tripoli deposits are largely the product of a long period of weathering. Evidence for a hydrothermal component is weak, but this possible component should not be completely ruled out without further study.

1:30 PM–1:50 PM

Underground Extraction of Aggregate

John Cowley

Mineral & Planning Associates, Ltd., 23 Bayfram Way, Blandford Forum, Dorset, United Kingdom DT11 74Z

Underground extraction of aggregate seems to offer substantial advantages in sustainable development terms. Conceptually it dramatically minimizes surface impacts on landscape, habitat, and adjacent land uses and increases the resource base by turning non-resources, due to depth of overburden or limiting surface land uses, into resources. Spurred on by those conceptual advantages, a number of countries (including the UK) have over the last 40 years considered underground extraction as a simple and neat solution to the pressing need for aggregate in the future, although it is always in the future. However, while underground extraction of aggregate is a feature of the U.S. Midwest, it is apparently absent elsewhere in the world.

In 1976, a UK government-sponsored committee charged with trying to resolve the aggregate shortfall, particularly in the South East of England around London, saw underground extraction as a possible solution. Ever since then the prospect of underground extraction in the South East has been seen by some as an ideal and smart solution to resolve the aggregate supply problem. The only perceived problem was the extra cost, but this was seen to be resolved by the use of the mine void and the surface for commercial uses. Little consideration has been given to other significant, if not “show-stopping” factors.

Unfortunately, suitable mineral resources cannot be manipulated or moved to where we want them to be, nor is an underground void always ideal for commercial after uses. An in-depth analysis of the barriers to underground extraction in England has identified a number of factors as effectively removing the prospect for underground extraction in the South East of England, but not elsewhere. This paper will describe the problem and the opportunity.

1:50 PM–2:10 PM

An Overview of Mining and Mineral Specimens from the Conco Mine: North Aurora, Kane County, Illinois

Jared Freiburg

Illinois State Geological Survey, Prairie Research Institute, Champaign, Illinois

As urban sprawl continues around the City of Chicago, the demand for aggregate has steadily risen. Limited land availability and surface permitting for quarrying operations have led to the increase of underground limestone and dolomite mines and the contemplation of current quarry operations to go underground. Since 1991, the Conco Mine in North Aurora has been mining limestone and dolomite underground. Previously owned by Conco-Western and now owned by Lafarge North America, Conco continues to prove that underground aggregate mining around a large metropolis is economical and successful.

One exciting consequence of underground mining has been the discovery of massive solution cavities lined with large specimen quality minerals such as calcite, pyrite, and marcasite. The scientific importance of these minerals has been recognized, and the mining company has allowed the author to extract specimens for scientific research. Research has been ongoing to interpret the diagenetic fluids responsible for carbonate diagenesis of the limestone host rock and precipitation of world class mineral specimens.



Photograph by Jeff Scovil

2:10 PM–2:30 PM

Possible Causes for Significant Variations in Chemical and Mineralogical Compositions between the Major Ore Districts in the Mississippi Valley: Tri-State Zinc District, Southeast Missouri Lead District, and Southern Illinois-Kentucky Fluorite District

Richard D. Hagni

Missouri University of Science and Technology, Rolla, Missouri

Ore deposits of the major ore districts in the Mississippi Valley proper, Tri-State, southeast (SE) Missouri, and southern Illinois, share similar geological character and contain most of the same minerals, but the abundance of certain minerals is significantly different. The purpose of this communication is to emphasize those differences and speculate on possible causes.

The Tri-State and SE Missouri districts both contain galena and sphalerite as their main economic minerals, but Tri-State is especially dominated by zinc, whereas SE Missouri is markedly dominated by lead. The ore fluids in the Tri-State District appear to have been generated within and traversed through mainly zinc-containing sedimentary rocks and had little or no interaction with Precambrian rocks. Although the ore fluids in the SE Missouri district were generated within and traversed through zinc-bearing sedimentary rocks, they also had significant interaction with lead-bearing feldspar in Precambrian igneous basement rocks and with feldspar in overlying sedimentary Lamotte sandstone that was derived partly from the Precambrian basement rocks.

Tri-State contains very abundant quartz, mostly as jasperoid, in contrast to the SE Missouri ores that contain only minor local jasperoid. The much greater silica content of the Tri-State ore fluids may be due to leaching of silica during their traverse of the very cherty Mississippian limestones.

The SE Missouri District contains much chalcopyrite, and copper is sufficiently abundant to be recovered at most mines in the Viburnum Trend. Cobalt and nickel also are relatively abundant, mostly as siegenite, and locally cobalt is sufficiently abundant to be recovered as a separate concentrate. The abundant Cu, Co, and Ni in the Viburnum Trend could be due the ore fluids leaching of those elements from copper-bearing iron deposits in the Precambrian basement.

Although fluorite is especially abundant in the southern Illinois-Kentucky district, it is totally absent from the Tri-State and SE Missouri districts. Hicks Dome in the southern Illinois district contains deep fluorite ores that may be of carbonatite origin. As speculated by Reynolds et al. (1997), MVT basin-derived lead-zinc-bearing ore fluids may have received significant fluorine contributions from mixing with fluorite-bearing carbonatite-derived fluids.

To summarize, it is speculated that the causes for significant variations in mineralogy between the three major MVT districts in the Mississippi Valley is the result of (1) metals present at the sites of ore fluid generation, (2) metals present in rocks and ore deposits traversed by the ore fluids en route to the sites of deposition, and (3) intermixing of the ore fluids with other fluids during transport.

2:30 PM–2:50 PM

Rare Earth Mineral Concentrations within Fluorite in the Illinois-Kentucky Fluorite District and Igneous Intrusives at Hicks Dome Cryptoexplosive Complex, Southeastern Illinois and Northwestern Kentucky (USA)

F. Brett Denny¹, Renald N. Guillemette², and Liliana Leticariu³

¹Illinois State Geological Survey, Prairie Research Institute, University of Illinois, Champaign, Illinois, ²Texas A&M University, ³Southern Illinois University, Carbondale, Illinois

The rare earth elements (REE) are composed of the lanthanide series of 15 elements with atomic numbers (57) through (71), scandium (21), and yttrium (39). Due to their geochemical behavior, REE rarely form their own minerals and more often are found incorporated within the structure of other minerals. There is a growing concern over the economical availability of REE because of their diverse and expanding array of technological applications and limited supply. This paper presents the results of a mineralogic and geochemical study of fluorite ore, ultramafic rock, and igneous breccia from the Illinois-Kentucky Fluorite District (USA).

Igneous rocks and fluorite ore were analyzed through whole rock, trace element geochemistry, and electron microscopy to determine the relative abundance of REE. Geochemical analysis (ICP-AES and ICP-MS) of outcrop (whole rock) samples from the Sparks Hill Diatreme (Hardin County, Illinois) detected elevated concentrations of cerium group or light rare earth elements: La (293 ppm), Ce (467 ppm), Pr (45.5 ppm), and Nd (143 ppm). Results of electron microprobe analyses indicate that the source of REE anomalies in the Sparks Hill Diatreme is a REE fluorocarbonate mineral. Electron microscopy detected several tabular fluorocarbonate grains that are less than 20 μm in size and associated with an unidentified Al-Sr phosphate. The fluorocarbonate was identified as synchysite $[\text{Ca}(\text{Ce}, \text{La}, \text{Nd}, \text{Y})(\text{CO}_3)_2\text{F}]$ and was found in both the well-rounded clasts and the matrix within the diatreme/breccia. Synchysite is similar to other rare earth fluorocarbonates such as parisite $[\text{Ca}(\text{Ce}, \text{La}, \text{Nd})(\text{CO}_3)_2\text{F}]$, bastnasite $[(\text{Ce}, \text{La}, \text{Y})\text{CO}_3\text{F}]$, and rontgenite $[\text{Ca}(\text{Ce}, \text{La})(\text{CO}_3)_2\text{F}]$. These fluorocarbonate minerals can occur together as intergrowths and thus are difficult to classify. The identification of a rare earth fluorocarbonate mineral within the igneous diatreme/breccia at Sparks Hill can have significant economic implications relating to the concentration of REE within the Illinois-Kentucky Fluorite District. Future studies will focus on the fluorite, igneous breccia, and the rare earth fluorocarbonate through additional geochemical and electron microprobe analyses.

3:30 PM–3:50 PM

What Do I Do with This Hole Now—Reusing Mined Areas

Nelson R. Shaffer

Indiana Geological Survey, Bloomington, Indiana 47405

Mining makes holes. In the past, after mining ceased, the pits, underground works, processing wastes, and surface facilities were generally abandoned with little thought of reuse. New public sensibilities, government regulations, interests in sustainability, and economic conditions make it desirable, if not actually necessary, to consider reusing mined lands. Planning for economic reuses before operations commence leads to greater incomes, better outcomes, and increased public acceptance of mining. A number of reuses are currently in place in Indiana and elsewhere, and many novel, new, and varied additional opportunities may be implemented in the future.

More than 500,000 abandoned mine sites are estimated to exist in the United States. Most of these are small, and although some have been reclaimed by design or through natural processes, many mines are left in less than optimal conditions. In Indiana, more than 516,000 acres have been affected by past mining, and several hundred active mines are currently operating, even in this small state. Because transport costs of industrial minerals are so important, many aggregate operations are close to cities. Such sites can be modified into very well-placed and attractive building sites. Conventional reuses are already common, especially for agriculture or redevelopment as office parks, industrial sites, subdivisions, parks, and even art parks. Less conventional reuses should also be considered. Storage sites, sources of low temperature geothermal waters, reservoirs for process waters, energy production or storage sites, water control structures, sports or civic venues, and tourist destinations are also possible reuses for mined sites. Examples of such reuses, such as the Eden Project, which converted an old clay mine into a showplace, exist mainly in Europe, but opportunities could be exploited in the Midwest. Long-range thinking and creative reuse projects will help mining industries by continuing or extending the useful lives of sites, providing income, contributing to community health, gaining environmental improvements, generating increased recreation or cultural venues, enhancing the education of the public, and showing sustainable land uses.

3:50 PM –4:10 PM

Community Education and Outreach from the Aggregate Mining Industry in Illinois

Becky Kazmierski¹ and Shawn McKinney²

¹CTL Group, Skokie, Illinois, and ²Illinois Association of Aggregate Producers, Springfield, Illinois

As members of a uniquely important industry, one often misunderstood by the public, mining companies and equipment manufacturers are coming to understand and embrace their responsibility to engage the public on behalf of the mining industry. The Illinois Association of Aggregate Producers and its Public Information and Education Committee are committed to helping members educate the general public about the aggregate industry and its importance in our everyday lives.

During this presentation you will learn how committee members representing mining companies, equipment manufacturers, consulting firms, state agencies, and educational institutions accomplish this goal by sponsoring or participating in many educational events around the state. The Committee also develops and makes available numerous educational materials relating to earth science, geology, mine reclamation, and the many uses for products made from minerals, crushed stone, sand and gravel. By doing so, members think they are enhancing the image and public perception of mining in Illinois and helping its citizens to better appreciate the raw material resources found within this state.

4:10 PM –4:30 PM

Geology and the Aggregate Industry: No Plan for the Future

Donald G. Mikulic¹ and Joanne Kluessendorf²

¹Illinois State Geological Survey, Prairie Research Institute, University of Illinois, Champaign, Illinois, and ²Weis Earth Science Museum, Menasha, Wisconsin

Geology is a critical, but often overlooked, aspect of successful aggregate production. No modern operation can stay in business or remain profitable without a comprehensive site-specific understanding of geology. The enormous growth in the stone industry during the twentieth century has demonstrated that many locations thought to have “unlimited” resources could be depleted rapidly with changes in demand, rock quality, and room for expansion. As a considerable financial investment is now required to open new sites and even to continue operations at existing locations, the need for accurate geological information is more important than ever before.

Two significant issues must be considered to meet future needs for geologic information by the aggregate industry. First is the proper use of the company geologist. In the past, many companies mistakenly relied on engineers to make geological decisions. Although many larger companies began to employ a geologist in recent decades, their talents often are not utilized effectively, as they spend much time on projects unrelated to geology. They seldom have the opportunity to do a basic comprehensive study, supported by drilling programs and testing, of company sites. As a result, their expertise comes into play only when a problem occurs, rather than predicting where issues might arise beforehand. Companies need to provide the time and opportunity for geologists to develop comprehensive geologic knowledge of their operations as well as a good understanding of local geology, independent of engineering programs. Doing so will help minimize production problems and provide the background needed to locate new sites for expansion.

The second issue relates to training geologists for this type of work in the future. In the past there weren't specific university programs that trained students to work as aggregate geologists, either for an individual producer or as an industry consultant. Most geologists employed in the industry were able to use what they learned in basic geology courses, but, without a program to follow, it is unlikely they took all of the course work needed for this field. The same is true for many geologists employed as consultants. The situation has now become critical, as most universities and colleges no longer offer even many of the basic courses, let alone aggregate-specific training. It would be possible to develop an aggregate program at any school by offering basic instruction in such subjects as mineralogy, petrology, geophysics, stratigraphy, sedimentology, structural geology, geohydrology, environmental geology and glacial geology, as well as pertinent regional geology. A graduate of this program would be a valuable asset to any aggregate producer.

4:30 PM–4:50 PM

Characterization of Warping Marble in New Orleans’s Cemeteries

Joseph T. Hannibal

Cleveland Museum of Natural History, Cleveland, Ohio

Thin (~2 to 2.5-cm-thick) tablets (slabs/plaques) of fine-grained marble have been widely used as vertical covers for the entrances to tombs constructed of brick and concrete in New Orleans cemeteries. These marble tablets are commonly warped. In 1996, Erhard Winkler published a note on this deformation, concentrating on the deformation of marble tablets in the city’s Metairie and Greenwood cemeteries, located near the 17th Street Canal. Similar deformation is also found at St. Louis Cemetery No. 1, located just outside the French Quarter and the oldest remaining cemetery in New Orleans, and Lafayette Cemetery No.1, located in New Orleans’s Garden District. Winkler identified convex (outward) and concave (inward) bowing, some of it asymmetric, but some tablets are also bowed into an additional, S-shaped form. Bowing in New Orleans cemeteries is so distinct that it can be seen in photos in general publications on New Orleans cemeteries.

The tablets used as covers in the New Orleans cemeteries are roughly similar in thickness to that of bowed marble used for exterior cladding of large buildings (3.2-cm thick in the case of the Amoco Building in Chicago) and for bowed tablets inside of the Cuyahoga County Soldiers and Sailors Monument (2.5-cm thick) in Cleveland, Ohio.

Marble on the exterior of the former Oil and Gas Building in New Orleans and the exterior cladding of several buildings in Houston, Texas (which is also located in a hot, humid, environment), are also bowed.

Winkler proposed that outward bowing in the cemeteries was due to the effect of sun and high humidity, whereas inward bowing was due to extremely high moisture behind the panels. It is not clear, however, that this is the case, but heat and moisture certainly play a key role in the deformation seen in the cemeteries.

8:00 PM

Past and Future Stone Resources for the Chicago Metropolitan Area

Donald G. Mikulic, Illinois State Geological Survey, Prairie Research Institute, University of Illinois, Champaign, Illinois

The Chicago region has long been one of the largest producers and consumers of stone resources in the United States. Throughout the nineteenth century, locally quarried Silurian dolomite was used to produce lime, crushed stone, and building stone. “Athens Marble,” quarried near Lemont and Joliet, was one of the most valued building stones in the Midwest, and numerous large structures in the area were constructed from it. Even though local Silurian rocks supplied most of the area’s needs for stone materials, many of these products were shipped across the region. Lime, primarily from Silurian rocks in Wisconsin, was imported into Chicago and, as more decorative building stone came onto the market in the late 1800s, limestone from Indiana and midwestern granite and sandstone were used commonly in showcase structures. To a large extent, this successful stone import/export was due to Chicago’s role as a national transportation center, first with early shipping on Lake Michigan, followed by the opening of the Illinois and Michigan Canal (1848), the beginnings of an extensive railroad network (1850s), and the opening of the Sanitary and Ship Canal (1900).

Lime and building stone became less important in the Chicago market in the late 1800s. Although many building stone quarries closed at this time, new uses generated an even greater demand for stone. Specifically, demand for crushed stone expanded dramatically, as Portland cement revolutionized the construction industry. Crushed stone, used primarily for macadam roads, experienced slow but steady growth from the 1850s onward. After 1900, its use as aggregate in concrete created an enormous new demand. Silurian rocks of the Chicago area were especially well suited to produce this material. This thriving market changed little until the end of the twentieth century, when surface resources at many local quarries were depleted.

As urban expansion covered undeveloped quarry sites, underground mining became economically feasible in the region. These new operations target deeply buried Ordovician dolomite, which is rather uniform across the area. These sites differ only in amount and composition of overburden. In order to avoid new land purchase and zoning issues, companies prefer siting these new mines at depleted quarries and gravel pits. Surprisingly, underground mining has not focused on near-surface Silurian rocks, even though they comprise extensive reserves.

Eventually, shipping on the Great Lakes, which brought the first stone to Chicago, may return as a future source of stone.

TUESDAY, MAY 17, 2011
Technical Sessions

8:30 AM–8:50 AM

The Production of Contaminated Drywall Compared to American-Made Drywall as Determined by Materials Characterization

Ann M. Hagni

Ann Hagni Consulting, LLC, Rolla, Missouri

One of the largest building materials problems ever experienced in the United States has been drywall reacting in houses, primarily located in the southeastern states. It is estimated that more than 60,000 homes, which were either built or remodeled during 2004–2007, have been affected by defective drywall imported from China during a construction boom after nine hurricanes hit Florida and the Gulf Coast states during 2004–2005, including Hurricane Katrina in 2005. The Consumer Product Safety Commission has spent millions of dollars studying Chinese-made versus American-made drywall determining a sulfur reaction causing copper erosion. This presentation will emphasize a materials characterization study by the author distinguishing between drywalls and the differences in production of American-made drywall versus contaminated drywall.

8:50 AM–9:10 AM

Chemical and Mineralogical Characteristics of Flue Gas Desulfurization By-products and Swine Manure Mixtures after Controlled Leaching Experiments

Shane Butler, William R. Roy, and Zakaria Lasemi

Illinois State Geological Survey, Prairie Research Institute, University of Illinois, Champaign, Illinois

The volume of flue gas desulfurization (FGD) by-products is expected to increase because of continued stringent federal and state regulations requiring significant reductions in sulfur oxide and other pollutants, such as mercury. Simultaneously, the agricultural profile of Illinois is changing to meet the demand for more ethanol. Changes in fertilization methods and crop rotation, coupled with environmental requirements to upgrade to clean burning coal systems, could link the agricultural and power generation markets in the state of Illinois in the form of utilizing FGD by-products as a fertilizer additive. Previous studies have shown that treating manure with coal combustion by-products (CCBs) such as FGD can provide beneficial results in stabilizing manure phosphorus and increasing yields. Many studies have, however, not focused on the mineralogical and chemical composition of FGD by-products when mixed with manure and the possible environmental impact from the leaching of potential groundwater contaminants.

The main objective of this project was to characterize and compare samples from three separate coal plants in Illinois in order to investigate the mineralogical and chemical composition of different ratios of FGD by-products to swine manure. The mineralogical properties of FGD samples were determined with x-ray diffraction methods. Chemical composition was determined by inductively coupled plasma spectroscopy-mass spectroscopy and whole-rock x-ray fluorescence after the FGD-manure mixtures were subjected to a Standard Test Method for Shake Extraction of Solid Waste with Water. When the samples were exposed to water, bassanite was converted to gypsum. Chemical analysis demonstrated that the ratio of FGD by-product to manure can determine the concentrations of soil nutrients, such as phosphate or calcium, which would have a direct impact on crop variables such as root growth, crop yield, crop health, or growth rates. The concentrations of Al, Cd, Co, Cr, Mo, Ni, Pb, Sb, and Zn in the 18-hour and 26-day laboratory extracts were at or less than analytical detection limits. Arsenic was not detected in any of the extracts. Selenium was present, but in trace amounts near analytical detection limits. The FGD samples contained mercury at levels that were less than that required by the U.S. Environmental Protection Agency for classification as a Low Mercury Waste for land-disposal restrictions. The reaction pH values of the sample mixtures suggested that potential groundwater contaminants would be relatively insoluble. When considering the chemical and mineral characteristics of the FGD-manure mixtures, however, it is still difficult to accurately predict environmental interactions in an open system, which necessitates additional work before FGD-manure mixes can be applied in commercial agricultural practices.

9:10 AM–9:30 AM

**Studies of the Oldest Industrial Mineral Use Create New
Low-Cost Methods for Today’s Industry**

Sarah Wisseman¹, Shane Butler², Randall Hughes², and Thomas Emerson¹

*¹Illinois State Archaeological Survey and ²Illinois State Geological Survey, Prairie Research
Institute, University of Illinois, Champaign, Illinois*

A small number of destructive analyses (XRD and ICP) showed that most of the source quarries for pipestone artifacts 200 to 5,000 years B.P. can be distinguished by their major mineral suites, principally clay minerals, micas, and carbonates. Nondestructive methods were needed to extend these laboratory determinations to the large number of priceless Native American pipestone artifacts kept at museums and owned by collectors. The PIMA^{SP-TM} (portable infrared mineral analyzer) produces near-infrared reflectance spectra in a minute or less for minerals with hydroxyl or carbonate bonds. During a consulting job at a gold mine, Hughes observed the utility of the PIMA, and as soon as possible, PIMAs were obtained for the ISAS and ISGS programs. The instruments are completely portable and nondestructive, and the best data are obtained with no sample preparation other than drying in air. We added a Hunter[®] color meter to further distinguish source quarries and color-correct images. A National Science Foundation proposal would fund a Bruker[®] portable X-ray fluorescence instrument to our “tool kit.” The Bruker will provide major element data that can serve as a proxy for a lack of PIMA spectra from burned and very dark artifacts, and the Bruker will detect any previously undetected minor or trace-element signatures of the source quarries.

10:00 AM –10:20 AM

Aggregate Fines—Problem or Opportunity

Nelson R. Shaffer

Indiana Geological Survey, Bloomington, Indiana

The crushing of stone inevitably produces unwanted fine-grained (<75 µm) materials (fines). Fines are also separated from more desirable, coarser sands and gravels during screening of unconsolidated deposits and are collected in suppressing dust during screening or cutting operations. In Indiana, the cutting and shaping of dimension stone also generates large amounts of fines. Most are washed into settling ponds for drying and disposal (often as quarry backfill). Environmental concerns about escape of stored fines also exist. Finding economic uses of aggregate and dimension stone fines could reduce such concerns and generate additional revenue for stone operations.

Some fine-grained (<75 µm) materials are used for agricultural lime, pH control, and engineering applications, but quarries usually have large stacks of unused fines that potentially can be used if they have proper chemistry, physical characteristics, and advantageous properties such as brightness, oil absorption, surface area, electrical properties, or meet even more esoteric specifications.

Many specialized, relatively small markets could accept fines having the correct properties. Producers have begun to deliberately produce fines. Four plants in Indiana purposely produce very fine limestone fillers, and a new operation opened in 2010. Determining special properties such as grindability and reactivity (with SO₂) of Indiana limestones helped to start a new and growing market for flue gas desulfurization scrubber stone in the state. Fine heavy minerals (some of which contain strategic metals) that are screened from sands of glacial origins may also become an important by-product of aggregate production. Increased knowledge about stones having other positive, special properties should open additional markets for fines.

10:20 AM –10:40 AM

High-Calcium Limestone Resources in Illinois

Zakaria Lasemi

*Illinois State Geological Survey, Prairie Research Institute, University of Illinois,
Champaign, Illinois*

Stringent pollution control requirements have accelerated installation of limestone-based flue gas desulfurization (FGD) systems in coal-fired power plants. This trend toward increasing numbers of FGD units is expected to continue into the future. Because of the importance of high-calcium limestone as a scrubbing agent, it is essential that issues associated with the transport, availability, and suitability of high-calcium limestone resources for use in FGD power plants be addressed. Nearby sources of suitable limestone raw material must be found to feed existing and new scrubber installations and to aid in the selection of proper resources for desulfurization systems in the future.

Illinois has abundant limestone and dolomite resources. However, high-calcium limestone is not readily available throughout the state. The suitability of limestone for FGD applications also varies, and the most suitable limestone resources also are not widely available. Through grants from the Illinois Clean Coal Institute, the ISGS has been conducting a statewide study dealing with the inventory and characterization of limestone and dolomite resources. This work has resulted in a database and maps showing the quality and quantity of limestone and dolomite resources near existing and planned Illinois utility sites that will potentially use this material to remove sulfur dioxide from their stack gases. Limestone containing more than 95% CaCO_3 commonly occurs in the pre-Pennsylvanian rocks in the western and southern parts of Illinois along the Mississippi and Ohio Rivers. Existing quarries currently extract these materials from the Mississippian units, but the potential for high-calcium limestone mining also exists in rock units from the Ordovician and Devonian systems in the southern part of the state. Limited amounts of Pennsylvanian-age limestone are present in the central part of the state and are mined at a few locations. These limestones are variable in purity but, in some cases, may contain between 90 and 95% CaCO_3 . Dolomite predominates in northern Illinois, especially the Chicago area, where much of the material is used as construction aggregate.

Calculated reactivity data for high-calcium limestones showed that they should be the most reactive sorbents for FGD systems. However, sulfur reactivities vary among the tested limestones and appear to be more dependent on the proportions of typical limestone constituents (fossil fragments, microcrystalline calcite matrix, sparry calcite cement, non-skeletal grains, etc.) as well as physical properties such as absorption than on limestone purity alone. Dolomites are generally not suitable as scrubbing agents in FGD systems due to the much lower reactivity of dolomite. This presentation will highlight the distribution and properties of existing and potential high-calcium limestone resources in Illinois.

10:40 AM –11:00 AM

**Obtaining Special Use Permits for Mineral Sources and Development
Encroachments on Current and Potential Future Mineral Extraction Sites:**

Mark J. Krumenacher

GZA GeoEnvironmental, Inc., Waukesha, Wisconsin

There has been a quiet revolution in land-use control through the development of local zoning ordinances that place the future of mining in the hands of the residents and locally elected municipal, township, and county representatives. Mining is a unique industry that has in recent decades transitioned from a private business operating behind tall fences to one of the most heavily regulated industrial businesses with increased public exposure and public control over the permit to operate. Mining permits are now written largely by the public specifically to incorporate input from residents, community groups, NGOs, and other stakeholders. This is an added burden on the mining entity due to the effort to educate all stakeholders and has greatly increased the cost of permitting and, in some cases, operation. Due to the (1) historical private nature of mining, (2) mining's relatively negative reputation, (3) the general lack of public education on the mining processes, and (4) the role that mining plays in everyday life, obtaining a special or conditional use permit for mining requires engaging a multitude of stakeholders, most importantly the local community as well as obtaining a commitment by the mining entity to the public interest in health, safety, environment, and sustainable business practices.

The strategies that have developed to obtain permits have evolved along with the local zoning ordinances; the residential development of land around urban areas; pressure brought on by the public's growing affluence, education, and easy access to information; and overall emphasis placed on groundwater protection, rural lands, and sustainability. As with the realization that the days of easy oil are over, the days of easy mineral resources are also past. Ironically, as the population increases and communities expand, the need for convenient aggregate and mineral resources increases. Existing mining operations are encroached upon and resources are made unavailable for future use by the expanding new developments. The land-use management plans and local ordinances recently developed to control land use too often ignore the importance of mining and the source of all raw materials needed to develop the land that the planning and ordinances control.

11:00 AM –11:20 AM

Supply-Demand Issues for Minerals in “Green” Energy

Jim Burnell

Colorado Geological Survey, Denver, Colorado

Public awareness of the potential for energy generation from “alternative” sources requires discussion of the mineral commodities needed for these technologies. The infrastructure requires mined materials, including imported strategic and critical minerals. Silica, copper, gallium, indium, selenium, cadmium, and tellurium are required for the dominant photovoltaic technologies. Silver and aluminum are necessary for “concentrating solar power” technology. Lithium, vanadium, manganese, and rare earth elements are key components of power storage, hybrid vehicle, and fuel cell applications. All these materials must be mined. At present, the U.S. is woefully dependent on import sources for most of these materials and demand is already squeezing prices. Domestic sources must be found and developed if energy independence is to be achieved using alternative sources.

Posters

Derivative Mapping for Potential Industrial Mineral Resources in Ohio

Mark Wolfe and Mike Angle

Ohio Department of Natural Resources, Division of Geological Survey

2045 Morse Road, Building C-2, Columbus, Ohio 43229

The Ohio Department of Natural Resources, Division of Geological Survey (also known as the Ohio Geological Survey), has an ongoing program of creating a surficial geology map for a 30 × 60-minute quadrangle each year. The main components of these maps are polygons containing three-dimensional “stacks” that summarize the gross lithologic material and thickness for the entire package of glacial/Holocene materials and identify the appropriate bedrock lithology at the base of the stack. Common lithologies include glacial till, ice-contact deposits, silty-clayey lacustrine deposits, sand and gravel deposits, organic deposits, and type of bedrock. Thicknesses are measured in feet and reported in factors of 10. For example, a mapped polygon labeled *T5/SG3/T2/LS* would indicate a sequence containing approximately 50 feet of till overlying 30 feet of sand and gravel that overlies 20 feet of till above limestone bedrock. The maps are color-coded according to the uppermost surficial material.

Through 2010, the Ohio Geological Survey has mapped 19 of the 34 complete or partial 30 × 60-minute quadrangles that span Ohio, including a large portion of glaciated Ohio. Map uses include regional resource analyses of potential crushed stone and sand and gravel. A potential crushed stone resources map for the Marion, Ohio, 30 × 60-minute quadrangle was produced in 2007 using both visual and digital techniques. In 2008, the Ohio Geological Survey created the first in a series of derivative maps based upon the surficial geology in the Mansfield, Ohio, 30 × 60-minute quadrangle. Database queries verified polygons with sand and gravel unit thicknesses that exceeded those of overlying or interbedded finer-grained materials by a ratio of at least 4:1. The resulting map is then color coded based upon this ratio and also the total thickness of the sand and gravel units. In 2010, GIS techniques were used to produce a map of the potential for mineable bedrock in the Findlay 30 × 60-minute quadrangle, a revised Mansfield sand and gravel resource map, and a revised Marion 30 × 60-minute quadrangle for potential of mineable bedrock. A series of three smaller inset maps provide locations of sand and gravel or crushed stone mining operations, drift thickness, and the Quaternary or bedrock geology for the quadrangle. The Ohio Geological Survey will continue potential industrial mineral resources derivative mapping during 2011 in the previously completed Canton 30 × 60-minute quadrangle. The future integration of digital geologic mapping with mineral industry databases containing historical production, mined geologic units, geochemistry, and physical properties is a vital component in assessing future industrial mineral resources in Ohio.

An Updated Inventory of Illinois Mineral Producers and Maps of Extraction Sites

Xiaodong Miao¹, Zakaria Lasemi¹, Donald G. Mikulic¹, and Michael Falter²

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Champaign, Illinois, ²Office of Mines and Minerals, Illinois Department of Natural Resources,
Springfield, Illinois*

A new survey of mineral resource producers has been undertaken to more accurately determine the character of the industry and location of its operations in Illinois. This study lists the companies (other than coal, oil and gas producers) involved in mining, processing, and manufacturing mineral products in the state while new maps show the locations of non-fuel mineral resource extraction sites. Information about the listed operations has been gathered from Illinois Office of Mines and Minerals (Illinois Department of Natural Resources), Mine Safety and Health Administration (Department of Labor), Illinois Department of Transportation, Illinois Association of Aggregate Producers, and the staff of the Illinois State Geological Survey.

In addition to updating the lists and locations of these operations, some of the importance of markets and resource availability is indicated by these maps. For example, most aggregate production is located in northeastern Illinois near the Chicago metropolitan area, which is the state's largest market for these materials. In this area, most of the state's sand and gravel resources, both quantity and quality, are related to continental glacier deposits.

The production of crushed stone resources is also concentrated in northeastern Illinois because of the large Chicago market, which takes advantage of the local availability of Silurian and Ordovician-age dolomites, which produce high-quality aggregate. New listings of underground mine sites in this area indicate the increasing importance of locating new aggregate sources in this rapidly growing region.

Providing a new listing of all mineral resource producers will aid a wide variety of groups, including the aggregate industry, landowners, and land-use planning agencies in meeting future needs for these resources.

Sand and Gravel Resources of McHenry County, Illinois: A New Look

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McHenry County, in northeastern Illinois, contains extensive deposits of sand and gravel, which were deposited mostly by glacial meltwater streams of the recent geological past. The geological origins and landforms associated with these sand and gravel deposits were classified, and their occurrences have been described, by Anderson and Block (1962) and Curry et al. (1997). However, the thickness and depth of burial of these deposits, two of the important factors for the aggregate industry, are not well documented. Fortunately, in the last two decades, surficial mapping and 3-D mapping by the ISGS and state universities at a variety of scales have provided important new data on the potential sand and gravel resources of the county. McHenry County is one of the most intensively drilled counties in the state. At numerous drilling sites in this county, stratigraphic information has been recorded in great detail. Also, texture information has been extracted from soil data to get full spatial coverage on the industrial mineral resources.

In this mapping project, the potential sand and gravel resources can be evaluated in two ways. First, the numerous stratigraphic drilling sites within the county are shown and labeled with four numbers related to the sand and/or gravel layers at the site. The labels, from top to bottom, indicate total thickness of sand and gravel, number of layers, maximum thickness, and depth of burial of the single thickest sand and gravel layer, respectively. In addition to the stratigraphic drilling data from ISGS, we reclassify the McHenry County map of NRCS Soil Survey Geographic (SSURGO) Database: the surficial map units are a representation of the lowermost soil texture data. These units have been symbolized based on grain size and relevance to geologic parent material. For example, “warm” colors such as red, tan, and yellow represent relatively coarse-grained materials such as gravel, sand and gravel, and sand, respectively. Units symbolized with “cool” colors such as blue and green represent relatively fine-grained materials such as clay and clay loam, respectively.

This representation of soil texture data coupled with detailed stratigraphic drilling data shows a more detailed distribution of possible aggregate-grade sand and gravel deposits than previous studies. The methodology used in our study can be applied to other counties in Illinois and elsewhere.

As the Chicago metropolitan area population continues to grow, a better understanding of the distribution of sand and gravel deposits in McHenry County and nearby counties will be increasingly important for land use, environmental planning, and groundwater resource decisions. In addition, this type of map can certainly help constituents in the sand and gravel industry with implications for aggregate quality, transportation, and economic feasibility.

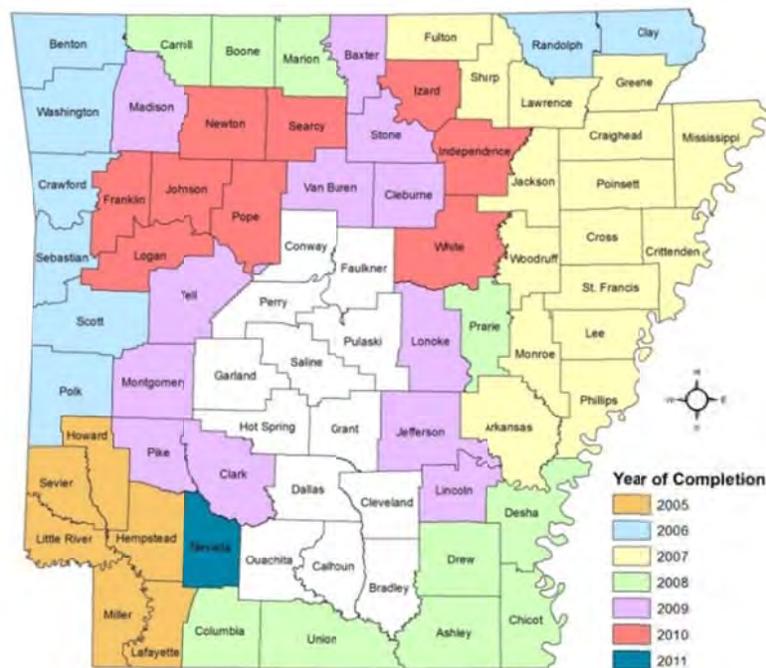
Progress of the Arkansas Mineral Commodity Database (AMCD) and End-User Utilization through GIS Technology

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Begun in 2001, the AMCD has been built in an MS Excel spreadsheet and, as of January 2011, contains 7,648 entries. Figure 1 displays the field progress of checking counties since 2005. Site examination is done by both normal field visits and by using Google Earth imagery. Of 75 counties in Arkansas, 62 have been completed. An end date for the project is projected to be the summer of 2013, based on current field activities. This data set excludes oil and natural gas.

As of 2010, the data from the original AMCD has been reformatted and incorporated into an agency-wide MS SQL Server 2008 database. This database format was chosen to take advantage of spatial data for mapping software applications, such as ArcGIS 10. Currently, VB.NET programming language is being utilized to create in-house search forms to be published later on the Arkansas Geological Survey Web site.

Figure 1



Methods of Analyzing Clay and Non-Clay Minerals Using X-ray Diffraction

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The X-ray diffraction (XRD) and clay mineralogy laboratory in the Bedrock Geology and Industrial Minerals Section of the Illinois State Geological Survey has the capacity to provide qualitative and semi-quantitative mineral characterization of whole rock and soil samples. The laboratory offers three types of analysis: bulk powder analysis, <2- μm clay mineral analysis, <16- μm clay mineral analysis.

Bulk powder analysis of whole rock samples is suitable for quick mineral identification. Samples undergo various size-reduction processes to meet a ~10- μm particle size fraction. Once in powdered form, the sample is packed into a sample tray and analyzed by XRD. The XRD analysis provides semi-quantitative and/or qualitative data for a suite of minerals. Identification of minerals is based on the location and intensity of peaks on the 2θ scale.

The <2- μm clay mineral analysis method is used mainly for identification of clay minerals from Quaternary-age deposits, but can also be used on shales and soils. Samples are immersed in deionized water and disaggregated. The samples are individually stirred in an electronic mixer to isolate the clays in suspension. The particles settle, and the salts that remain in solution are poured off. The samples are stirred again and allowed to settle until only the <2- μm particles are in suspension. Using an eye dropper, the <2- μm clays are placed onto a glass slide, which is then dried, glycolated, and scanned by XRD. This method provides semi-quantitative clay mineral analysis, comparing only the amount of clay minerals in the sample relative to each other.

The <16- μm clay analysis method is used for identification and relative comparison of clays within sandstone samples. In this method, the sample is disaggregated and then rinsed with bleach to remove oil (if in an oil-bearing-unit). The sample is immersed in acetic acid to dissolve carbonates. The sample is stirred to bring the clays into suspension for removal. The clays are centrifuged and smeared onto a glass slide. Finally, to properly identify clay minerals, the sample is glycolated, scanned by XRD, heated to 350°C for 1 hour, and rescanned by XRD. This procedure provides two sets of data. The first set provides semi-quantitative clay mineral analysis that compares the amount of clay minerals relative to each other. The second set provides semi-quantitative mineral percentages of the expandable clays in the sample.

Samples prepared by each of the three methods are scanned with a Scintag[®] XDS2000 X-ray diffractometer using $\text{CuK}\alpha$ radiation at 40 kV and 30 mA. The majority of the scans are performed using a continuous scan mode from 2 to 34° 2θ with a 0.05 step size at 2 degrees per min. The collected data are then analyzed using Jade 9+[®] software. Semi-quantitative mineral percentages for both clay and non-clay minerals are determined using methods pioneered at the ISGS by Herb Glass and others. To conclude the process, the results are assembled into easy-to-read spreadsheets, and the XRD trace for each sample is put into the form of a .jpg image for our clients.

Utilization of Westminster Terrane Carbonates for Cement Production, New Windsor and Union Bridge, Maryland

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Two limestone quarries located in north-central Maryland present an opportunity for a comprehensive study of the carbonate sequence(s?) in the Westminster Terrane of the Appalachian Piedmont province. These Neoproterozoic (?) carbonates are associated with Catocin-affinity (?) meta-basalts and are very poorly understood, both tectonically and depositionally. Lehigh Cement Company, LLC, mines limestone for the production of portland cement at the Union Bridge quarry while the New Windsor quarry is currently not in operation. Production from these deposits has been ongoing for decades; however, much about these carbonates is unknown.

A major issue in producing cement from this area is the presence of detrimental dolomite. The ore bodies of the Union Bridge and potential New Windsor quarries contain acceptably low magnesium limestones interbedded with unacceptable dolostone and dolomitic limestone. The dolomite replacement occurs in varying degrees, from thoroughly dolomitized dolostone beds to partially dolomitized limestone beds. Understanding the distribution of magnesium in the ore body is critically important to cement manufacturing. Examination of the stratigraphy, petrography, and geochemistry of these rocks has the potential to hypothesize the model of magnesium replacement responsible for dolomitization, which may allow for prediction of the occurrence of dolostone.

Preliminary results indicate that high-grade limestones show banded or mylonitic textures, and that there is stratigraphic control to the interbedded dolomitic intervals. Petrographic analysis reveals that the phyllites are of pyroclastic origin. The two quarries contain fundamentally different stratigraphy, indicating that the carbonates may be different sequences, potentially bounded by a mapped fault. Lead-zinc deposits have been found within the carbonates of the New Windsor quarry, which will be studied from an economic and geologic perspective.

Analysis of quarry exposures and thousands of feet of rock core will provide comprehensive, high-resolution stratigraphy. Studying the igneous and metamorphic associations is crucial to dolomitization models and may also lead to reinterpretation of overall tectonic and paleogeographic models of the Westminster Terrane.

An Overview of the Illinois Industrial Minerals

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Industrial minerals continue to be one of the Illinois' major mineral resource commodities, accounting for \$1.22 billion in 2007. According to the 2007 U. S. Geological Survey mineral industry profile, Illinois ranked twentieth among the 50 states in total value of nonfuel mineral production. By value, crushed stone was the state's leading industrial mineral, accounting for about 48% (\$586 million) of the total, followed by portland cement, 25% (\$305 million); construction sand and gravel, about 14% (\$170 million); industrial sand, about 7% (\$85 million); and lime, fuller's earth, tripoli, and other nonfuel minerals, in decreasing order, for most of the remaining 6% (\$73 million).

Since 1970, Illinois has been consistently among the top five leading states in production of crushed stone. Illinois also has continuously been a major producer of construction sand and gravel. In 2007, Illinois remained first among the 49 mineral-producing states in the production of industrial sand, tripoli, dolomite, and recycled cement concrete and sixth in crushed stone. Of the industrial minerals mined or manufactured in Illinois, those that have the highest value include crushed stone, cement, construction sand and gravel, and industrial sand. Crushed stone, construction sand and gravel, and portland cement combined continued to account for more than 85% of the value of Illinois' nonfuel industrial minerals mined or manufactured.

Sand and gravel deposits are widely distributed throughout the state, but they are most abundant and of highest quality in northeastern Illinois. They are primarily extracted from glacial deposits in the central and northeastern parts of the state. Production of sand and gravel, however, has not increased significantly since the late 1960s. This is probably related to the better quality and larger reserves of crushed stone aggregate and the difficulty in securing permits for new sand and gravel operations due to public opposition. Dolomite, mined from the Silurian and Ordovician carbonates in northern Illinois, especially in the Chicago area, accounts for most of the stone produced in the state. Northeastern Illinois is one of the largest aggregate producing and consuming regions in the country and will likely remain so, long into the future. In the western and southern parts of the state, limestones of the Mississippian System are extracted for construction aggregate, cement manufacture, and other related purposes. Limited amounts of Pennsylvanian-age limestone occur in the central part of the state and are quarried where they are present near the surface.

In partial response to the opposition to new stone quarries and sand and gravel pits, companies continue to evaluate or pursue development of underground mines, especially in northeastern Illinois. Illinois has been ranked third in the amount of crushed stone produced from underground mining operations.

Spatial and Temporal Analysis of Salt Ponds Using ASTER Images: Lake Acıgöl (Denizli), Southwest Anatolia, Turkey

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The Lake Acıgöl drainage basin covers about 1,200 km². The extremely saline Lake Acıgöl and its industrial salt ponds are located in the center of this closed basin. Solar salt production from Lake Acıgöl began in the middle of the twentieth century. Currently, private companies are producing different types of salt in the region either with natural or industrial methods. As conductivity increases, all major ions also increase, but there is a shift in cation dominance from Na⁺ to Mg²⁺ to Ca²⁺ and in anion dominance from SO₄²⁻ to Cl⁻. The natural solar process uses the artificial salt evaporation ponds as a basin where the mineral is dissolved at temperatures around 40°C. The sodium sulfate is separated from the concentrated hot solution by fractional crystallization during the night when temperature is low. Large amounts of sodium sulfate have been produced by this method. The sodium sulfate salt products are used as a raw material for textile, glass, and paper sectors. A remote sensing study is applied to determine the temporal change in spatial extension of the artificial ponds, which are mostly situated along the northern shore of the lake. The natural salt production areas were delineated for the last 10 years, and the temporal change in areal extent of artificial ponds surrounding the lake coast boundary was analyzed using multi-temporal ASTER images. As a first step, both of the images were filtered with a 9*9 high pass filter to highlight the lineaments. Then, the increase in areal sizes of the ponds was determined after extracting the pond regions by manual digitizing operation. Finally, the areal extent of the salt ponds was determined for the years of 2001 and 2010. Results indicate that the water mining activities spatially expanded almost 100% between 2001 and 2010.

Geological and Geochemical Characteristics of Küre Kastamonu Copper Deposits

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The study area was in Küre in the Kastamonu Province of the Karadeniz region. In the research area, magmatic, metamorphic, and sedimentary units are seen together. The oldest unit in the area consists of the Lower Triassic-age ophiolite sequence. The Triassic-Lower Jurassic-age Akgöl Formation overlies the ophiolite sequence. The Triassic-age Küre Lava Member is conformably reversed on the Akgöl Formation. The Upper Jurassic-Lower Cretaceous-age Inalti Formation unconformably overlies the Kgöl Formation. The youngest unit in the area is Lower Cretaceous-age Ulus Formation, which conformably overlies the Inalti Formation. Thin-section petrography revealed pyroxene, plagioclase, quartz, serpentinite, muscovite, biotite, and calcite minerals and a few fossil remains in the limestones.

A geologic map for the Küre region's 20-km² area has been prepared at a 1:25,000 scale, and a cross section was constructed in the mapped area to show structural features of the region. Additionally, a stratigraphic cross section was constructed in order to be able to understand the general stacking pattern of the rock units in the region. Measurements were made on the region's folds and small-scale faults. The presence of small-scale faults suggests that there may be larger-scale folds and faults in the region. From the observations and examinations within the surveying area, Aşıköy, Toykondu, and Bakibaba massive sulfide deposits appear to be related to ophiolitic volcanic rocks. Küre region's deposits have been formed within pillow structured basalts and Cyprus type deposits.

The region's weald vegetation cover and inadequacy of the samples made it difficult to conduct the intended research. For this reason, it was not possible to understand the geology of the region in the strict sense. Mineralization took place on the northwest of Küre Borough. Additional examination of the region in more detail is recommended. Many small faults were present in the study area, but they could not be mapped. Serpentinization is commonly observed along these fault zones. Samples do not show a significant amount of heavy metals or Ag. Küre copper deposits are important in terms of Cu and Zn but not in terms of the other metallic minerals.

Geochemical Investigation and Economic Properties of Chromite Occurrences around Köyceğiz Lake, Muğla, Southwest Turkey

M. Kumral, M. Budakoglu, M. Karaman, S.B. Karabel, D. Maral Temel, S. Uzaşci, and E. Ciftci

The study area consists of two different localities in Muğla. These localities are in the northwest and southeast part of Köyceğiz Lake, covering a 40-km² area (20 km² each). Geological units include Allochthonous Jurassic limestone at the base, the Upper Cretaceous interval complex, with a thrust fault above the Jurassic limestone, followed by the Cretaceous peridotite nappe over interval complex with thrust fault, and Quaternary alluvial deposit at the top. In the eastern part of the Allochthonous Jurassic limestone, 15-m-high cliffs were seen at the fault contact with the alluvial unit. Alluvial and peridotite units have a sharp contact with the normal fault, with no metamorphism at the contact, which indicates the peridotite was cool when it was emplaced along the Alpine Orogenic Belt. The high degree of tectonism is the proof of emplacement of units with nappes. The mineralogy and chemistry of chromites are synchronous with the host rock. Peridotite nappe is composed of harzburgite, dunite, and mafic dykes that crosscut them. Chromites are in harzburgites that enveloped by dunites. This case resembles mafic intrusion to a lherzolite body that adds silica to the basic environment via melting clinopyroxenes. Residual melt composition and volume after chromite accumulation resulted in thick dunite formation that enveloped chromites seen in the field. Chromites in the study area are podiform type and have nodular, disseminated, and massive texture. Peridotite nappe is the top segment of ophiolite suite. Massif is an incomplete ophiolite suite because only tectonites are observed. According to geochemical analyses, SiO₂ ranges from 7.32–38.1%; Fe₂O, 8.2–10.6 %; Al₂O₃, 2.21 – 15.6%; CaO, 0.03–1.63%; MgO, 14.55–38%; and Cr₂O₃, 2.5–16.95%.

SPOUSE/GUEST PROGRAM

May 16, 2011

A day-trip for spouses and guests includes visiting the Abraham Lincoln Presidential Library and Museum, a state-of-the-art facility located in Illinois' capitol city of Springfield and home to the world's largest collection of Lincoln-related material. A 90-minute bus ride will take you to the library and museum complex, which features "high-tech exhibits, interactive displays, and multimedia programs." The visit will also include a reproduction of the 1861 White House, holographic and special effects theaters, an opportunity to witness the 1860 Presidential Election in twenty-first century style, and an opportunity to see the pen used to sign the Emancipation Proclamation. The current State Capitol Building in Springfield was built with Silurian rocks from the Joliet, Illinois, area. The Old State Capitol Building in Springfield was built using sandstones from the Springfield, Illinois, area.

Itinerary

8:00 AM	Load van at I Hotel
8:15 AM	Depart for Springfield
10:00 AM	Arrive at Lincoln Museum and Library
12:00 AM	BOXED LUNCH
1:45 PM	Load van at Museum
2:00 PM	Depart for Lincoln's Tomb
2:15 PM	Arrive at Lincoln's Tomb (silence is required while touring tomb)
3:15 PM	Load van
3:30 PM	Depart for Champaign
5:00 PM	Arrive at I Hotel
6:30 PM	Cash bar and Social
7:00 PM	Dinner
8:00 PM	Presentation

FIELD TRIPS

Meeting Field Trip, May 17, 2011 Local Quarries

This trip is limited to those registered for the Forum meeting and will examine the geology of crushed stone in central Illinois. The trip will include a visit to a quarry near Tuscola, Illinois, where Middle Devonian and Silurian limestone and dolomite are being currently mined. The trip will conclude at a Pennsylvanian limestone quarry in east-central Illinois.

Pre-Meeting Field Trip, May 13–15, 2011 Cement Plant, Limestone Quarries, Tripoli Mine, Fluorspar, and Garden of Gods

The pre-meeting trip departs from the I Hotel in Champaign, Illinois, and picks up additional participants in Mt. Vernon, Illinois, at the Illinois Oil and Gas Association office. Participants should arrange their own room reservations at the Cheekwood Inn, Ullin, Illinois (618-845-3700) for the evening of May 13 and at the Super 8 (618-253-8081) or Economy Inn and Suites (618-253-7651) in Harrisburg, Illinois, for the evening of May 14.

This 3-day field trip will include a stop at the Holcim (US) cement plant and quarry in Ste. Genevieve, Missouri. This plant, one of the largest cement manufacturing facilities in the world, is also among the most environmentally efficient and safest. It is the largest single-kiln line, cement-producing facility in the world and has the capacity to produce 4 million metric tons of high-quality cement annually. The plant will ship up to 75% of its product to terminals by barge, among the most environmentally efficient means of transportation. Many of the raw materials (coal, gypsum, fly ash) used to make cement at this plant will be shipped by river. The company also has in place an ongoing reclamation plan that will restore the land that has been mined, ensuring that no more than 200 acres of land is actively mined at any one time.

Other stops include visits to quarries in southern Illinois to examine operations extracting high-calcium limestone and construction aggregates from the Mississippian carbonates. Additional stops include a visit to a microcrystalline silica (tripoli) pit and another Mississippian limestone quarry where fluorite is extracted along with construction aggregates. If time permits, we also will stop by the Griffith Farm in Elizabethtown to look at and/or purchase fluorite specimens. The Griffiths are three generations of miners that are currently mining fluorite in Hardin County.

On the last day of the trip, Sunday, May 15, we will drive across the Hicks Dome crypto-explosive structure and view the spectacular scenic view at the Garden of the Gods. The trip will end at Podolsky Oil Company in Fairfield, Illinois, where we will have the opportunity to examine a large collection of minerals from Illinois and many other locations worldwide. We will then proceed to Champaign-Urbana, arriving mid to late afternoon.

Post-Meeting Field Trip, May 18, 2011
Silurian Reef and Chicago's Stone Industry

The trip will depart from and return to the I Hotel in Champaign, Illinois. Participants should arrange their own room reservations, if needed.

This one-day field trip is planned to examine the geology of Chicago's stone industry. This trip will focus on how the geology of the region controlled the industry's historical development and led to what today is one of the largest production centers and markets of aggregate resources in the United States.

The stops will include remnants of the famous nineteenth century Athens building stone business, which began shipping construction material on the Illinois and Michigan Canal in the late 1840s. Additional stops will highlight the modern aggregate industry and will include one of the largest quarries in the country exhibiting spectacular examples of a Silurian reef.

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AUTHOR INDEX

Angle, Mike, 30
Brown, Howard J., 10
Brown, Steven E., 32
Budakoglu, M., 37, 38, 39
Burnell, Jim, 29
Butler, Shane, 24, 25, 34
Ciftci, E., 38, 39
Cowley, John, 14
Denny, F. Brett, 17
Dunn, Colin, 11
Emerson, Thomas, 25
Fajber, Robert, 11
Falter, Michael, 31
Finley, Robert J., 7
Freiburg, Jared, 15
Graybill, Elizabeth, 35
Guillemette, Renald N., 17
Hagni, Ann M., 23
Hagni, Richard D., 16
Hannibal, Joseph T., 21
Howard, J. Michael, 33
Hughes, Randall, 25
Karabel, S.B., 37, 38, 39
Karaman, M., 37, 38, 39
Kazmierski, Becky, 19
Keefer, Donald, 9
Kiran, D. Yildirim, 38
Kluessendorf, Joanne, 20
Krumenacher, Mark J., 28
Kumral, M., 37, 38, 39
Lasemi, Zakaria, 24, 27, 31, 36
Leetaru, Hannes E., 7
Lefticariu, Liliana, 17
Maddix, Shatosha, 34
McKay, E. Donald III, 6
McKinney, Shawn, 19
Miao, Xiaodong, 31, 32, 36
Mikulic, Donald G., 9, 20, 22, 31, 36
Raduha, Stefan, 34
Roy, William R., 24
Seid, Mary J., 8
Shaffer, Nelson R., 18, 26
Simandl, George, 11
Stiff, Barbara, 9
Stohr, Christopher J., 9, 32
Stumpf, Andrew, 9
Taylor, Nathan, 33
Temel, D. Maral, 39
Thomason, Jason F., 32
Uca, D. Avci, 37
Uzaşci, S., 39
Weibel, C. Pius, 13
Wissemann, Sarah, 25
Wolfe, Mark, 30

