



46th Forum on the Geology of Industrial Minerals

Program with Abstracts and Field Trip Guide

**Middletown, Pennsylvania, USA
May 22-25, 2010**

**Hosted by:
Pennsylvania Department of Conservation
and Natural Resources
Bureau of Topographic and Geologic Survey**



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☒ Sound practices

NOTES

The 46th Annual Industrial Minerals Forum

Sponsored by the
Pennsylvania Department of Conservation and Natural Resources
Bureau of Topographic and Geologic Survey

May 23 – May 25, 2010
Pennsylvania Geological Survey
3240 Schoolhouse Road
Middletown, PA 17057-3534

PROGRAM

Sunday, May 23, 2010

7:00-8:00	Registration
8:00–5:00	Field Trip #1 – Quarry and Gettysburg Geology; Gettysburg Battlefield
8:00–5:00	Spouse Field Trip #1 – Gettysburg Mall; Gettysburg Battlefield

Monday, May 24, 2010

7:00-8:00	Registration and Breakfast (open to all)
9:30-4:30	Spouse Field Trip #2 – Hershey Gardens, Hershey Museum and Chocolate Labs (lunch in Hershey on your own)
8:00-12:00	Technical Session 1: Pennsylvania Overview
8:00-8:15	Welcome - Jay B. Parrish
8:15-8:45	Geologic History of Pennsylvania - Donald M. Hoskins
8:45-9:10	Current Status of the Pennsylvania Industrial Mineral Industry - G. Robert Ganis and John H. Barnes
9:10-9:35	Sand and (Mostly) Gravel in NW PA - Gary M. Fleege
9:35-10:00	Geology of the Ridgeley Member of the Old Port Formation, an Important Sand Resource in Central PA - Thomas A. McElroy

10:00-10:20 **Break - Posters:**

10:20-10:45 **Geologic and Mining History of
Serpentinities in Pennsylvania and
Maryland** - Stephen Shank

10:45-11:10 **Raw Material Reserve Estimates and
Quarry Optimization Using Geophysical
Surveys** - Jeffrey Leberfinger, William
Seaton, and Beth Williams

11:10-11:35 **Brick Firing – Have You Got a Pore
Connection?** - Kip Jeffrey

11:35-12:00 **Effects of Halokinesis on the Economic
Viability of Potash-Bearing Salt
Deposits** - Mark D. Cocker and Greta J.
Orris

12:00-1:00 **Lunch**

1:00-5:00 Technical Session 2: Regulatory Issues

1:10-1:35 **21st Century Noncoal Regulatory Issues**
- Sharon Hill

1:35-2:00 **Noncoal Mining in Pennsylvania—
Better Living Through Reclamation** -
Michael W. Smith and Thomas Callaghan

2:00-2:25 **Plans for an Earth Science Interpretive Center at
Valley Quarries, Inc.'s Gettysburg Quarry** -
Brian W. Kauffman

2:25-2:40 **Break - Posters**

2:40-3:15 **Surface Mining and Sinkhole Distribution in the
Karst Terrain of Pennsylvania**
- William E. Kochanov

3:15-3:40 **The Role of Groundwater Modeling in
Quarry Permitting** - James O.
Rumbaugh

3:40-4:30 Posters (authors present) and Core Library

**PAMAP Lidar Elevation Data: Geologic and
Mine-Related Applications** - Helen L. Delano

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The Historic and Economic Geology of South Mountain Phosphate Minerals - Michael Stefanik

The Importance of Freight Rates for Bentonite from the Northern Great Plains - D. H. Vice and Ganesh Bal

Tuesday, May 25, 2010

7:00-8:00	Breakfast and Business Meeting (Committee only)
9:00-5:00	Spouse Field Trip #3 – The Governor's Mansion and Gardens, State Museum (private tour), and the Capital Building (lunch on your own)
8:00-12:00	Technical Session 3: Energy and Other
8:00-8:25	Marcellus Shale Gas—Energy Savior or Industry Hype? - John A. Harper
8:25-8:50	Energy Bills Getting You Down? Maybe Coalbed Methane Can Help - Antonette K. Markowski
8:50-9:15	Geologic Carbon Sequestration Opportunities in Pennsylvania - Kristin R. Carter
9:15-9:40	Application of Reflected Light Microscopy to the Study of Industrial Minerals - Richard D. Hagni
9:40-10:00	Break
10:10-10:25	The Geology of Catoctin Metarhyolite, Adams County, Pennsylvania - Bob C. Smith II
10:25-10:50	Intra-site Artifact Patterning and Settlement Patterns at the Snaggy Ridge, South Mountain Metarhyolite Quarries - Kurt Carr
10:50-11:15	Opportunities for Aggregate Suppliers in the Roofing Industry - Daniel N. Leavell
11:15-11:40	The Diamond Mining Industry – Taking Stock of the Changes - Kip Jeffrey

12:00-5:00 Field Trip #2 – **Magnesita Refractories Company Quarry**

5:00-5:30 Closing Remarks

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ABSTRACTS
OF THE
FORTY-SIXTH ANNUAL
INDUSTRIAL MINERALS FORUM

May 23—May 25, 2010
Pennsylvania Geological Survey
3240 Schoolhouse Road
Middletown, PA 17057-3534

CARR, KURT W., The State Museum of Pennsylvania, 300 North Street,
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**Intra-site Artifact Patterning and Settlement Patterns at the Snaggy
Ridge, South Mountain Metarhyolite Quarries**

Metarhyolite from the South Mountain region of Pennsylvania and Maryland has been used by Native Americans since Paleoindian times and studied by archaeologists since the 1890's. Although, the metarhyolite formation covers several hundred square miles, there are abrupt changes in quality and quarry sites are spread unevenly throughout the region. This presentation will describe our investigations of the Snaggy Ridge/Carbaugh Run region of these "quarries". This report includes the results of mapping different types of sites associated with this outcrop, experimental knapping of the metarhyolite and the initial results of one of the few, controlled test excavations conducted at a prehistoric metarhyolite quarry pit in the Middle Atlantic region. It would appear that material lying on the surface was not suitable for use by Native flint knappers and mining excavations were the only alternative. The diagnostic projectile points recovered from this excavation and radiocarbon dates have implications concerning the use of these Native American mining operations.

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LIST OF ATTENDEES

Producing a fairly unique product from a geologically complex deposit and dealing with out of balance extraction ratios for a number of years have led us to develop a philosophy of “Getting the Squeal out of the Pig”. What this translates to is – getting full utilization of the deposit and property. This requires close control over the deposit to insure that no high-purity reserves are wasted and finding markets for all materials encountered in the quarry (clay, marble, limestone).

This even includes improved utilization of the buffer property around the quarry to generate higher income (Christmas tree plantation - \$\$71,000 income in 2001).

CARTER, KRISTIN R., Pennsylvania Geological Survey, 400 Waterfront Drive, Pittsburgh, PA 15222-4745

Geologic Carbon Sequestration Opportunities in Pennsylvania

There is a consensus that increasing atmospheric concentrations of greenhouse gases (GHGs), particularly carbon dioxide (CO₂), are affecting the Earth’s climate worldwide. Leading climate scientists recommend dramatic reductions in global GHG emissions by 2050 in order to stabilize atmospheric GHG concentrations at levels of 450 to 550 parts per million. One approach to reducing these emissions is through geologic sequestration of CO₂. This process involves capturing CO₂ at its source, compressing and cooling it to a liquid, transporting it to a sequestration site, and injecting it into deep subsurface geologic formations where, theoretically, it will remain trapped for thousands of years or more.

The Commonwealth of Pennsylvania became involved with climate change issues when the Pennsylvania Geologic Survey joined the Midwest Regional Carbon Sequestration Partnership (MRCSP), one of seven regional partnerships established by the U.S. Department of Energy to develop robust, cost-effective options for mitigating anthropogenic CO₂ emissions. As part of this effort, the Survey has been researching potential sequestration targets in Pennsylvania and the greater Appalachian Basin since 2003. Results of the work so far have spawned additional research and drawn the attention of the Survey’s parent agency, the Department of Conservation and Natural Resources (DCNR). DCNR’s leadership and on-going commitment to carbon reduction and sequestration in the Commonwealth further resulted in reports from the Carbon Management Advisory Group (CMAG), published in 2008, and from additional technical assessments, published on May 1 and November 1, 2009.

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Effects of Halokinesis on the Economic Viability of Potash-Bearing Salt Deposits.

Stratabound potash-bearing salt deposits are preserved in basins where the salt deposits are not subject to surface or groundwater dissolution. Preservation is related mainly to depth of burial and integrity of overlying aquicludes. In many if not most basins, depth of burial is generally on the order of 1 to 10 plus kilometers but can be deeper. Aquicludes may include shale, well-cemented, impermeable sandstone and carbonate units, and to a certain extent, salt. Under favorable conditions, conventional mining techniques may economically extract the potash-bearing salts to a depth of about 1,200 meters. Solution mining is technically possible to depths of up to 3,000 meters, although present solution mining is from shallower depths. Conditions favorable to mining at deeper levels include potash grade, thickness and continuity of the potash-bearing salt, presence of aquicludes, and structural integrity of enclosing strata.

Halokinesis, which involves the structural deformation and movement of salt to higher structural levels in sedimentary basins, may result in movement of deeply buried potash-bearing salt to much shallower depths on the order of 100's to a thousand meters. Most of the early potash deposits in the Zechstein Basin in Germany were discovered and developed during the late 1800's and early 1900's, and were hosted by shallow-level halokinetic structures referred to as diapirs. Much of the potash-bearing portions of the Zechstein Basin remain buried at depths greater than 3,000 meters and are presently uneconomic.

Internal bedding in a salt diapir may or may not have been subjected to extreme structural deformation depending on the emplacement history of the diapir, competency of overlying rocks, and internal composition of the diapir. Potash-bearing layers within a complexly folded diapir may exhibit thinning and thickening as well as extremely convoluted structures referred to as enterolithic folds. Selective, labor intensive, and high cost mining techniques are required to extract potash in these types of structures.

Potash-bearing salt deposits near the surface are susceptible to dissolution by meteoric water or by ground water in aquifers penetrated by the halokinetic structures. Dissolution of potash-bearing salts and other salts may thin or completely remove the salts and leave behind a caprock consisting of residual, relatively insoluble materials such as gypsum, clay, and carbonate rock plus other rock types entrained during the upward movement of the salt through overlying basin fill. The presence of aquifers surrounding a halokinetic structure as well as faults associated with upward movement of the salt makes mining operations highly susceptible to catastrophic flooding of the mine workings and, in some cases, complete loss of the mine. Descending brines, perhaps resulting from dissolution of higher level salts, may alter the mineralogy and grade of lower potash-bearing salts. Most of the

quality the shot or portion of the shot may be run for. Some shots are sampled after they are blasted down to make a final determination on their use.

Additionally samples of the crushed and sized kiln feed are taken as the material is being binned, and again as the dolomite exits the bins and is fed to the rotary kilns.

Magnesita has two long straight rotary kilns on site for the manufacture of a refractory dolomite grain and dead-burned dolomite. Both kilns are approximately 91 meters in length. The NO. 1 kiln (1952) is three meters in diameter. The No. 2 kiln (1959) is 3.5 meters in diameter.

Due to a combination of both chemical and physical characteristics of the raw dolomite, these kilns can produce a high-density (3.24 minimum) refractory grain in a single-pass through a rotary kiln. This does require extremely high temperatures in excess of 2000°C, and slow kiln speed (time/temperature).

Refractory grain is transferred to the sizing plant where all of the different size fractions required for the various refractory products are produced. The products from this plant can be delivered to the Specialties Plant, the refractory brick plant, or the EC Plant.

At the Specialties Plant the grain will be combined with a variety of additives and binders to produce gunning mixes, ramming mixes, mortars and various other non-shaped refractory products.

The EC Plant produces a range of accessory products for the Steel industry, mainly for continuous casting applications and furnace bottoms.

Most of the refractory grain is transferred to the brick plant.

Here the grain is mixed with binders, additives and other refractory materials, and then pressed into a "green brick" shape.

After pressing, bricks are placed on either a kiln car, if they are to be ceramically

bonded in a tunnel kiln, or on racks if they are resin bonded and require tempering in an oven. Due to the nature of dolomite refractories, special packaging is employed.

Magnesita ships its refractory products world wide. Currently about one-third of the brick plant production is exported.

Most of the products from all of the plants are used in both the steel and cement/lime industries.

Materials Company. Vulcan is the largest producer of aggregate in the United States, has an excellent reputation in regard to environmental compliance and community relations. Vulcan installed an aggregate plant adjacent to the Magnesita quarry. Dolomite not meeting the strict chemical specifications for Magnesita products, and other “waste” rock will be diverted to the Vulcan plant.

Vulcan partnered with a local asphalt producer. This producer erected a reconditioned plant on the property. This plant helps guarantee a market for Vulcan.

The quarry is operated utilizing four main pieces of mobile equipment. Quarry loading is completed with a Cat 990 loader. Hauling is completed utilizing both a 60 ton and 70 ton Komatsu haul truck.

A Cat 330 excavator is used with either a bucket for face scaling, trenching, stripping etc., or is equipped with a hydraulic hammer for breaking oversize blocks and toe removal.

Vulcan operates in the quarry utilizing a Cat 988 loader and two or three Cat 773B haul trucks, depending on the haul distance.

The primary crusher employed is a Universal double impeller impactor. This crusher was installed used in 1959. It currently generates a -6.35 mm product. The location of the primary crusher is beginning to adversely impact quarry development.

All fines from both primary and secondary crushing will be utilized to manufacture agricultural lime and mineral fillers. Approximately 465,000 tons of kiln feed will be transferred to the rotary kiln department.

Due to the selective mining that is required and in order to insure that only the proper quality of dolomite is produced, and intensive quality control program is utilized. Those that have been involved in securing I.S.O. certification will know the importance that is placed on quality checks, documentation and traceability.

At the Magnesita quarry these checks begin with the close spaced diamond core drilling, and progress to blast hole sampling. All blast holes are sampled, with samples collected every three meters. Quarry shots typically consist of five to eleven holes in a single row. Burden is 4.9 meters, and the hole spacing can vary from 4.6 to 5.2 meters depending on dolomite quality.

The chemical analysis of the blast hole cuttings is used to develop a quarry usage report from each shot in the pit. This color-coded report indicates what

primary potash salt in marine evaporite basins consists of carnallite, that has a K_2O content of 16.9% and is highly soluble. Dissolution of carnallite by brines may result in precipitation of less soluble, but higher grade potash salts such as sylvite (63.2 % K_2O) and (or) kainite (19.3 % K_2O) and (or) langbeinite (22.7 % K_2O). Carnallite is commonly preserved at deeper levels unaffected by brines. In the Zechstein Basin, early mining extracted the higher grade, altered potash salts (sylvite, kainite and langbeinite) that were present at shallower levels. As higher grade ores were exhausted, mining continued into the deeper, lower grade carnallite-dominant salt.

Both the higher grade of the altered potash salts and elevation of the potash salts to near-surface levels may contribute to the economic success of potash mining operations in halokinetic structures. On the other hand, dissolution at near surface levels and structural deformation of potash salts may detract from the economic viability of potash mining operations.

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PAMAP Lidar Elevation Data: Geologic and Mine-Related Applications

The PAMAP program has nearly completed collection and processing of statewide high-resolution Lidar elevation data, as part of Pennsylvania's portion of The National Map. Although the PAMAP data is collected and provided to serve a wide variety of users and applications, it has great promise as a tool for mapping geology. Use of the high-resolution elevation data greatly enhances digital depictions of the land surface, and the enhanced ability to visualize surfaces and to "see through" vegetation offers particular opportunities for mapping bedrock and surficial geologic features.

In some areas, lidar data allows delineation and measurement of attitudes of individual beds in outcrops, identification of jointing patterns, and drainage features that may be subtle or hidden by vegetation. Pennsylvania Geological Survey geologists have identified mined and reclaimed areas, mine adits, drainage from underground mines, landslides, karst features, and glacial features.

The data can also serve as a base layer in various software for engineering applications such as slope analyses, volume calculations, and flood analysis. Its use is also enhanced by the availability of orthophotos acquired at similar times and resolutions.

Standard products derived from the classified Lidar data are 3.2-foot gridded Digital Elevation Models (DEMs) and 2-foot contours. Lidar data for approximately one-third of Pennsylvania were gathered in each of 2006, 2007, and 2008. Processing some of the data has been delayed by funding issues, but all is now on track for completion in 2010. All of the PAMAP data is freely available to the public, either by download from the PASDA website or for cost of duplicating from the Pennsylvania State Data Center.

More information on the PAMAP program, including the Lidar elevation data is at www.dcnr.state.pa.us/topogeo/pamap.

The Ledger appears to have been deposited directly on the shelf margin. Along this break in shelf occurs a patchwork of algal reefs. Behind the reefs were ooid shoals, similar to what is currently found in the Bahamas. These reworked ooid shoals eventually became the source of most of the high-purity dolomite.

Recent overburden stripping has uncovered two of these well preserved undolomitized algal reef complexes (refer to Carol de Wet's abstract "Depositional Environments in the Cambrian Ledger Dolomite Formation, Magnesita Refractories, York, PA." for more detail on these reef complexes). Slow weathering under the protective soil mantle has allowed unparalleled preservation of the sedimentological structures. The pinnacled nature of the limestone allows three-dimensional views of the features. This area has been under active study by a local university.

The Magnesita quarry is located in the center of a 485 hectare property. Two hundred thirty of these hectares are under an active surface mining permit.

The quarry was started in 1950. The pit itself covers over 50 hectares. It is about 1200 meters long by 425 meters wide, and is currently 73 meters deep. Five benches have been developed. Each bench is approximately 14 meters high. All benches are currently active. A sixth bench is under development.

As previously mentioned the deposit mined by Magnesita is structurally complex and can exhibit rapid facies changes. This requires close-spaced diamond core drilling (22.86 meter square grid) for proper reserve determination and production planning. Original drilling on the property was only completed to a depth of 30 meters (2 levels). Lower levels must be drilled after the upper levels are removed by quarrying.

Quarrying begins with careful stripping of the top soil and clay overburden. Topsoil is stored in berms around the perimeter of the quarry to be used later for reclamation. A contractor removes much of the clay overburden. This clay is screened by the contractor and sold to a local landfill. Magnesita receives a royalty for each ton sold.

Three grades of dolomite are produced from the quarry. The highest grade dolomite, brick stone, is used to manufacture the refractory grain. The middle grade dolomite is used to produce a dead-burned dolomite, and the lowest grade dolomite is used to produce agricultural lime, mineral fillers, or aggregate.

In order to help insure a balance between the extraction ratio of the different grades of dolomite, and what is present in the deposit, and in an effort to effect the timely removal of waste rock, LWB entered into a relationship with Vulcan

Field Trip #2
Tuesday May 25th, 2010

MAGNESITA REFRACTORIES COMPANY

Dave Hopkins
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The Magnesita plant and quarry are located approximately 11 km west of the city of York in Southeastern Pennsylvania. The operation is well situated in regard to the larger cities of the northeastern United States, and is only 80 km from the port of Baltimore.

The quarry is located along the north edge of the Conestoga Valley, a northeast-southwest trending structure that is predominately underlain by Cambrian to Ordovician Carbonates with some clastic rocks.

The formation being mined is the Ledger Dolomite. The Ledger has been informally divided into three members. The unit of the greatest economic importance is the Lower Dolomite Member, which directly overlies the Upper Member of the Kinzers formation.

This Lower Dolomite Member is typically massive, gray to light gray, medium to coarsely crystalline, oölitic to mottled dolomite.

Structurally, the quarry is located in the "West York Block". The West York Block is a thrust sheet that is bounded to the south by the Gnatstown Fault and bounded unconformably to the north by the border of the redbeds of the Triassic New Oxford formation.

The New Oxford formation can lap over the Paleozoic Carbonates, or be in fault contact with them. This contact is exposed in the northwest corner of the quarry. Paleokarst associated with the proximity of the Triassic is also prevalent in some areas.

The area has been subjected to several periods of deformation and the deposit is heavily faulted. In the quarry area the formation generally trends east-west and dips 20° to 30° to the south.

Recent work with trilobite fauna indicates a Lower Middle Cambrian age for the Ledger Dolomite. Previously the Ledger was assigned to the Lower Cambrian based only on its stratigraphic position.

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Sand and (Mostly) Gravel in NW PA

Sand and gravel resources in NW PA are mainly the result of multiple continental glaciations. Several geologic criteria determine the characteristics of the deposit and the quality of the sand and gravel.

A critical criterion is the origin of the deposit. Generally, there are two types of sand and gravel deposits associated with glaciation- ice-contact and outwash. Ice-contact sediments are found within and immediately adjacent to the glaciated area in the form of eskers, kames, deltas, and kame terraces. Outwash is usually found beyond the glacial borders confined to stream valleys (valley trains).

Both types of deposits can provide good quality aggregate, but ice-contact sediments often have a greater range in grain size. As a result, it may reduce the quantity of useable material and require special processing to remove the finer-grained material.

The quality of deposits of either origin varies, largely dependent on the extent of weathering of the deposit. In general, deposits from earlier glaciations have been exposed to weathering agents for a longer period of time than more recent deposits. They have a thicker weathered zone, which must be removed to access the higher quality sediment.

Sediments from different glaciations also have a different composition. Sediments from earlier glaciations have a larger proportion of locally-derived sedimentary material. More recent deposits have more far-traveled crystalline (igneous and metamorphic) clasts. Gray siltstones and crystalline clasts have the lowest amount of loss during freeze-thaw tests.

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Current Status of the Pennsylvania Industrial Mineral Industry

Pennsylvania produces a wide range of industrial mineral products from a diverse assortment of rocks which is a reflection of its complex geology. In 2006, there were approximately 1,300 active mines and quarries producing non-fuel industrial minerals according to the state's Department of Environmental Protection. The U. S. Geological Survey estimate for the value of non-fuel mineral production in that year was \$1.71 billion. The primary minerals produced in Pennsylvania include construction aggregates (crushed stone and sand and gravel), cement, lime, specialty carbonates (fillers, refractories, fluxes, glass constituents, ag-lime, etc), dimension stone (slate, flagstone, and cut rock), brick and heavy clay products, and roofing granules. Collectively, these products are found in rocks that range from Proterozoic to Pleistocene found in the Piedmont, Reading Prong, Mesozoic Basin, Valley and Ridge and Plateaus physiographic provinces. Piedmont and Reading Prong rocks mined for mineral products include granite gneisses, marbles, serpentinites, amphibolites, quartzites, and slates. Paleozoic sedimentary rocks from the Ridge and Valley province provide a wide variety of carbonates, sandstones, and shale resources. The Mesozoic basin has production of argillites, diabase, hornfels, and shale. The Plateaus produce sandstone, "bluestone," shale, underclays (by-product of coal mining), and is the location for glacial sand and gravel.

structure was built initially in 1773 by the original owner, one Patrick Vance of Donegal, Ireland. A nationally recognized native trout fishery, the Falling Spring Creek, flows through the property as well.

- Geology: Gettysburg Formation, hornfels and Diabase: SRL “H”, 12,000-30,000 psi
- # Employees: 25 (incl. BT plt.)
- Plant Capacities: Primary- 1000 tons/hr.
- Secondary- 700 tons/hr
- Tertiary, dry- 500 tons/hr
- Wash Plant- 200 tons/hr
- Blacktop Plant- 325-400 tons/hr
- Plant Superintendent: Bruce Gillin Asst. Supt.: Roy McGlaughlin
- BT Plant Operator: John Jacoby BT Site Mgr./QC : Jim Bulger
- Quarry Dispatch: Wendy Crouse, Gary Crabbs
- Adams Co. & MD Area Mgr.: Darryl “Smitty” Smith

Valley Quarries Overview

Valley Quarries, Inc. has been an integral part of South Central PA for over 50 years. The company's history began in 1952 with the vision of three men, S. Howard Brown, Richard L. Davis, and Paul E. White. The trio, most notably Paul White, who became synonymous with the company, purchased Chambersburg Stone and Shippensburg Stone from Paul and Frank Walker on March 1, 1952.

Mr. White took charge of the quarry, and D. Lyman Howard became the superintendent. Under the direction of White and Howard, Valley Quarries, Inc. grew into a major contributor to the local economy.

In 1959, the company continued to expand. Four concrete plants - Chambersburg, Shippensburg, Waynesboro, and Greencastle - were purchased. Between 1967 and 1972, Mt. Cydonia Sand was purchased. Also during the period, Valley Transit Mix and Mt. Cydonia Sand were made divisions of Valley Quarries, Inc. and continued to operate under their names. In 1976, Valley Quarries became a wholly owned subsidiary corporation of the New Enterprise Stone and Lime Co. More acquisitions followed, the Adams Co operations and a blacktop paving division, building Valley Quarries, Inc. into the major employer that it is today.

The corporate headquarters, located just East of Chambersburg on Quarry Road between Rt. 30 and the Falling Spring Road, is a beautifully sited, pre-revolutionary war limestone farmhouse. Now fully renovated, the

HAGNI, RICHARD D., Department of Geological Sciences and Engineering, Missouri University of Science and Technology, Rolla, MO 65401-0410

Application of Reflected Light Microscopy to the Study of Industrial Minerals,

Reflected light microscopy has been routinely applied to the study of metallic ore minerals, but its use in the study of most industrial minerals has been largely overlooked and neglected. The purpose of this communication is to emphasize the value of the application of reflected light in the study of industrial minerals and to provide some identification characteristics for selected industrial minerals. The most useful property for the identification of industrial minerals under reflected light is their reflectance (R). Although the reflectance values for most industrial minerals are not given in standard reference volumes, they can be calculated from their index of refraction values. Alternatively, one can determine the approximate reflectance for an industrial mineral using the graph provided below. The graph has been constructed using Beer's equation and has neglected the effects of absorption. Neglecting the absorption factor for the determination of reflectance is justified because absorption is an insignificant factor for most industrial minerals. The reflectance values for the industrial minerals are significantly lower than for most ore minerals, however, the difference between specific industrial minerals usually is sufficient to distinguish between those minerals under reflected light study.

The reflectance values for some of the typical industrial minerals are: fluorite (R = 3.1), sylvite (3.8), feldspar (4.2), gypsum (4.2-4.3), quartz (4.5), beryl (4.6-5.3), talc (4.5-5.2), muscovite (4.6-5.5), biotite (4.5-5.8), pyrophyllite (4.5-5.3), apatite (5.6-5.8), wollastonite (5.7), barite (5.8), calcite (3.9-6.1), dolomite (4.0-7.0), kyanite (6.9-7.0), and periclase (7.2). Other industrial minerals have somewhat higher reflectance values: olivine (forsterite 6.1-6.2; fayalite 9.5-9.6), garnet (7.2-9.6), monazite (8.0-8.6), bastnaesite (7.0-8.3), uranothorianite (9.5-9.7), and sphene (9.7-11.0). Some minerals that are sometimes classified in the industrial mineral group have reflectance values that overlap the darkest of the ore minerals, such as baddeleyite (13-14) and anatase (19.2-19.5).

Additional properties that aid in the identification of some industrial minerals in reflected light include crystal form, bireflectance and anisotropism, hardness, internal reflections, and mineral associations. The shapes of crystals are helpful in recognizing quartz (prismatic and 6-sided basal section), calcite and especially dolomite (rhombohedrons), apatite (short prisms and 6-sided basal sections), pyroxene (prisms), and bastnaesite (elongate prisms). The bireflectance and strong anisotropism shown by calcite and dolomite distinguish those carbonate minerals from quartz and feldspar. The strong white internal reflections of anatase, and brown internal reflections of monazite are characteristic of those minerals. The replacement of ilmenite crystals by anatase is a common association for those two minerals, and serves as a typical

example of mineral associations.

The microscopic study of Portland cement has routinely utilized the reflected light microscope to determine the abundances of the constituent synthetic phases and their textural characteristics. The easy preparation of polished sections for reflected light microscopy, the relatively rapid oxidation of the sections, the ease of application of etching and staining techniques, and the rapid phase identifications has led to the selection of reflected light over transmitted light techniques for most microscopic studies of Portland cement. The reflectance values for the main four cement phases are: alite (tricalcium silicate) (5.8-7.0), belite (dicalcium silicate) (7.0), tricalcium aluminate (7.0), and ferrite ($\text{Ca}_4\text{Fe}_3\text{O}_{10}$ to $\text{Ca}_4\text{FeAl}_3\text{O}_{10}$) (10.8-12.3). The reaction of these phases to etches and stains also produce characteristic properties for their recognition in polished sections.

Coal petrographers have long used reflected light microscopy to identify and characterize coal macerals that vary in reflectance from about 0.5 to 3. Quantified results from coal reflected microscopy can provide valuable information regarding the cokability of a given coal and significantly increase its value if it can be used as a coking coal. Polished sections can be prepared from coal specimens much more easily than thin sections of coal that must be one-third the thickness of thin sections for normal rock petrography.

In conclusion, reflected light microscopy is a valuable tool that should not be overlooked in the study of industrial minerals. Polished sections prepared for reflected light microscopy can be further utilized for examinations with the electron microbeam techniques of SEM and EPMA to determine the chemical compositions of the constituent industrial mineral phases.

Graph based upon Beer's equation:

$$\text{Reflectance (in air)} = \frac{(\text{index of refraction of mineral} - 1)^2}{(\text{index of refraction of mineral} + 1)^2}$$

is maintained on the upper production level. A new permit application is currently under review which will add about 6 additional acres to the quarry area.

Primary Crusher- The 42-65 Allis Chalmers in-pit primary crusher was installed here in 1999. The "igloo concept" was a first for Valley and NESL and so far has worked out quite well in addition to saving significant construction time and dollars. The crusher is powered by twin 200 HP electric motors. The rock is reduced from run-of-shot size to about 7" and smaller before being sent to a 150-ton surge bin and 48 inch conveyors up and out of the pit to the primary surge-pile. A Caterpillar 992-D front-end loader along with 773 CAT trucks convey stone to the primary. A Komatsu hydraulic excavator with breaker is stationed at the dump point to handle any oversize or stubborn rock.

Secondary/Finishing Plants

The secondary and dry tertiary plants were built in 1999 at the same time as the 42-65 primary. The current wash plant, now less its' old jaw and gyratory crushers is all that remains of the former processing equipment installed by Genstar and Valley and operated up through the recent construction. Primary crushed rock stockpiled on the large surge-pile at the western quarry rim is fed via three Syntron feeders and conveyor onto a twin shaft, two deck, 7X20 TelSmith scalping screen. Crusher run may go on the ground as product or to the secondary surge. Likewise, 3" to 4" clean rock may be pulled out here as product or sent to the secondary crusher. All oversize material is conveyed to the 84 inch Allis Chalmers secondary crusher. After the 84, stone is put onto the large secondary surge-pile where it is available to both the dry and wet plants. The dry finishing plant consists of a 60 inch AC fine cone and AVE-80 TelSmith/CEMCO VSI in closed circuit with a twin shaft 8X24 triple deck TelSmith Vibro-King screen. The VSI can also be used in a fourth stage regrind circuit. Also employed are the dual Buell air classifiers for removing fines from the manufactured sand.

Blacktop Plant

The Astec, continuous mix "Turbo-400" or Double Barrel blacktop plant is now about 8 years old. Two of the three 200-ton silos/scales/drag and office/lab were built when blacktop operations first commenced at VQ Gettysburg in 1996. The third silo along with three 20,000 gal. vertical asphalt tanks, control tower, and various site improvements came along with the 400.

Fast Facts

- Gettysburg Quarry Acres: 152, 113 permitted, Pit- 35 acres, 10 additional permit pending

Field Trip #1
Sunday, May 23, 2010

A BRIEF HISTORY OF THE GETTYSBURG QUARRY OPERATION

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- During the Battle of Gettysburg, the land now being quarried was a farm owned by the *Isaac Diehl* family and it served as an encampment area for reserve troops. The stone farmhouse, which stood until 1957, was used as a field hospital.
- In 1926, *John S. Teeter* acquired the property and began to quarry the “trap rock”. Teeter installed stationary crushers and supplied the local demand for crushed stone of 300 to 400 tons per day.
- In 1959, *Harry T. Cambell Son’s Corporation* purchased the quarry from John S. Teeter & Sons, Inc. During the next ten years only the owners and names changed, *Grove* and *Flintcote* being the most remembered.
- *Genstar Stone Products Company* bought the operation in 1969. Genstar upgraded much of the plant equipment, brought in front end loaders to replace the Northwest shovels, and increased production capacity to 1200 to 1400 tons per day.
- *Valley Quarries, Inc.* took over the Gettysburg and Fairfield quarries from Genstar in 1983. Various plant and equipment modifications and improvements would occur over the next 20 years with the most recent being a total primary through finishing plant project and 992 loader in 1999, and in 2004, an 84 inch Allis-Chalmers secondary. With a steadily growing local market aided by the addition of an on-site blacktop plant in 1997, Stone production has increased from around 300,000 tons per year in the mid 1980’s to around 900,000 tons currently.

Quarry and Primary Crusher

Geology- Stone reserves at the Gettysburg Quarry lie within the Triassic Gettysburg Basin and consist of a dense metamorphosed shale sometimes referred to as hornfels or argillite. Also visible in its exposure on the upper portion of the Northwest face is the massive diabase which overlies the hornfels and thickens as it dips sharply to the north. While quarry faces are still advancing to the west, north and east, the bulk of the reserves are at depth and the pit is permitted to extend from the current rim elevation of +340 ft. MSL to an ultimate depth of -390 ft. A variance to operate a 100-ft. highwall

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Marcellus Shale Gas – Energy Savior or Industry Hype?

The first well dug specifically for natural gas production in North America was completed in organic-rich shales in Fredonia, NY in 1821. In the 1900s, oil and gas drillers found that just about every well drilled into the organic-rich Marcellus Formation had a flow of gas. These gas flows occurred in “pockets”, so the flows could not be sustained, and drillers soon began to ignore them. Since 2005, however, the Marcellus has become very popular with both the oil and gas industry and the news media. A combination of higher prices, improved technology, and substantial gas production from shales in other parts of the US has raised interest in the Marcellus, which lies beneath much of Pennsylvania, to a fever pitch. Some companies are paying substantial fees to lease acreage and offering what amounts to huge royalties to mineral-rights owners in Pennsylvania. This activity has been exciting the press, landowners, and state and municipal authorities, who look upon the Marcellus as a major economic boon for Pennsylvania. Resource estimates from numerous sources suggest the Marcellus contains enough gas to sustain America's needs for decades. An examination of the state’s limited production data makes these estimates suspect, however, and the cost in environmental degradation (water usage and waste water) could offset much of the gain. Will the Marcellus really save America in our time of growing energy shortages and concerns about global warming, or is it just oil-and-gas-industry hot air?

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21st Century Noncoal Regulatory Issues

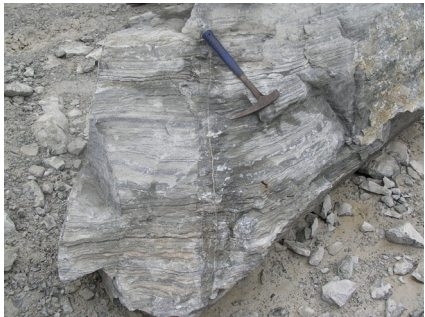
Regulatory updates follow a process that can be measured in geologic time. While the noncoal regulations in Pennsylvania have not seen a major update since 1984, case law and real-life situations have changed the way regulators and the public think about how a permit gets issued (or not) and how operations should proceed. The public is now better informed and better able to organize a coalition for or against environmental actions. Noncoal operations should be aware of a shift in attention by the public and regulators to concerns about land use, water withdrawals, special protection areas, and hydrologic balance. These issues are driving changes to permit review processes, operation and reclamation plans and responses to citizen complaints. The old adage “This is the way we’ve always done it”, will not continue unchallenged forever.

FORTY-SIXTH ANNUAL INDUSTRIAL MINERALS FORUM

DESCRIPTIONS OF FIELD TRIPS

Sunday, May 23 and Tuesday, May 25, 2010

SCENES OF THE GEOLOGY OF THE GETTYSBURG AREA



JEFFREY, KIP, Department of Geology, University of Leicester, University Road, Leicester, UK LE1 7RH

Brick Firing – Have You Got a Pore Connection?

Brick making involves the industrial low-pressure metamorphism of clay and non-clay mineral mixtures to form largely non-equilibrium mineral assemblages that are required to be durable in use as a construction material. Manufacture must therefore involve the engineering of a material that has the correct mineralogy, physical properties and microstructure for the required performance.

Time-temperature transformation studies pioneered by Prof. Ansel Dunham at the University of Leicester in the 1990's revealed the different mineralogical composition of bricks fired under different conditions and its relationship to some of the bricks essential physical properties. This has led to the introduction of faster, more energy-efficient firing profiles in a number of brick plants in UK & Europe. The full potential of this approach however is complicated by the bulk of the brick.

During brick firing heat must be transferred by conduction and gas transfer into the core of the brick, with the simultaneous migration of water, carbon, nitrogen and sulphur-based gases outwards to the brick surface. This is achieved by the pore network developed initially by the raw materials and then by their breakdown and reaction products during firing. The maintenance of pore connectivity between brick core and surface during this mineralogical evolution is essential for satisfactory firing.

Examination of pore development during the firing process has revealed a number of critical controls on how a fully densified durable fired brick develops. With this knowledge, modification of the forming process, or incorporation of void forming fillers, can be introduced to facilitate further improvements in energy efficiency and speed of firing.

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The Diamond Mining Industry – Taking Stock of the Changes

Diamonds are big business. Natural diamond production is around 169 million carats / yr equating to US\$13 billion / yr. Diamond jewellery sales are US\$ 72 billion / yr and the industry employs directly or indirectly around 10 million people worldwide.

For over a century the diamond industry was dominated by a single company - De Beers. Through the Central Selling Organisation (CSO), they marketed over 80% of the world's gem diamonds. The company owned most of the larger mines and bought mine rough from other major players to ensure a 'single-channel' marketing model.

The supply-demand balance was maintained by the CSO through stocks and by controlling production from De Beers own mining operations. This kept diamond prices stable, allowed long term investments and development in the producing countries in Africa. Other diamond producers also benefited from the stable prices but without the need to regulate supply. Some criticized this approach as price maintenance, artificially inflating diamond prices and in the nineties the company was subject to a number of anti-trust actions in the US & elsewhere.

The world of diamonds has however changed and new leadership in De Beers has radically revised the business model. The company now markets around 40% of world rough supply through the Diamond Trading Company (DTC), making it still a major player but no longer effectively *the* market. This came about partly from financial studies which demonstrated that large scale stocks, effectively massive working capital, more than offset the benefits of stabilised markets. Legal constraints to accessing the US market, the conflict diamond issue and growing power exercised by the governments of producing countries all pointed to the need for change.

As a result the use of stocks to stabilise the market has gone, the company has divested a number of mines including the famous Cullinan Mine, and introduced new arrangements for relations with 'sightholders'. The company has focussed on larger mines in Botswana (e.g. Jwaneng) and South Africa to supply diamonds at a relatively low cost per carat. High quality diamond production from the Namibian beach deposits is also reducing. Against the backdrop of a predicted medium to long term shortfall of diamond supply against demand De Beers have invested heavily in three new mines in Canada, and South Africa. The company itself restructured and re-invested with the 'centre of gravity' moving gradually from London to southern Africa. This was effectively predicated on a growth market with a shortage of supply, all of which changed with the recent financial and economic crisis. During parts of 2008-9 sales decreased by 80% finishing the year at about 50% of pre-crisis levels - double the decline seen in the major world car markets. The free-market has now reached the diamond industry - retrenchments in

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The Importance of Freight Rates for Bentonite from the Northern Great Plains

The senior author did a quick study of bentonite reserves in the major producing districts, including the Western Black Hills, Northern Black Hills, Central Wyoming, the North-Central Montana district, and the Big Horn Basin to settle an internal dispute over available bentonite reserves and whether freight rates would need to be changed. The conclusion of these studies was that sufficient reserves were available to last for at least 20 years and so Burlington Northern established a lower freight rate, and a bentonite company eventually moved to the Highline district. This paper provides a concrete example of the sensitivity of bentonite and other low-value, bulk, industrial minerals to freight rates and to the general rule of thumb that there is an order of magnitude between transportation costs for trucks, trains and boats (e.g., 50 miles by truck are similar in cost to 500 miles by train and 5000 miles by boat). Thus, bentonite mined in the northern Great Plains was competitive for making taconite pellets in the iron producing regions of Minnesota, Wisconsin, and the upper peninsula of Michigan, but was not competitive in the iron producing regions of eastern Canada.

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The Historic and Economic Geology of South Mountain Phosphate Minerals

Botryoidal nodules of wavellite occur on the foot of the northern slope of South Mountain in the vicinity of Mount Holly Springs, Pa, between a faulted contact of the Antietam Quartzite and the Tomstown Dolomite. Typically for phosphate rock to be considered economically feasible, it is obtained from large concentrations of phosphorite and apatite. Very rarely is it mined from secondary mineralizations such as wavellite, which occur in limited quantities. The unique geology of the area allowed for the formation of these nodules in such a pure form and sufficient quantity that this became the only commercially mined source of wavellite in the world. Wavellite was actively mined from the Northern flank of South Mountain in the early 1900's in the midst of a paradigm shift in the use of phosphate rock and the technology used to refine it. A better understanding of what led to the formation of wavellite and other secondary phosphate minerals in this area will enable geologists to identify similar areas for commercial mining and potentially refine existing processes, which artificially concentrates low grade phosphate ore based on the natural conditions found at South Mountain.

southern Africa, mine closures, the worlds largest sorting facility suffering shut-downs. This is not a monopolistic company immune from the market.

The response of the company has been to 'shorten the pipeline' moving effectively towards a 'just-in-time' approach. It is seeking to deliver diamonds through an 'intention to offer' process that requires it to predict mine output and produce targeted parcels of stones that its 'sightholders' want and are expecting. It must also balance supply against overall future market demand. To do this the mines must predict not only how many carats of diamonds are in each tonne of kimberlite mined but also the number of individual stones, their size distribution, their quality, colour, shape, and value. This is a tough ask.

As with other major mining companies De Beers has aimed to develop large, low cost, long life mines. Mine production will always lag market conditions so the mines responses to market fluctuation must be amplified. Producer countries also want more of the action so the new DTC building in Botswana is now the world centre of diamond sorting and producer governments are determined that downstream diamond industries will locate in-country. The market is getting intensely competitive and costs are increasing as Africa becomes a more expensive place to operate. Rough diamonds are now cut in China & India rather than New York and Antwerp.

So while 'a diamond is forever' – the industry has been through major change and will never be quite the same again.

KAUFMAN, BRIAN W. Kaufman Engineering, Inc., Oliphant, PA 18447,

Plans for an Earth Science Interpretive Center at Valley Quarries, Inc.'s Gettysburg Quarry

The Valley Quarries, Inc. Gettysburg facility has begun feasibility and planning analysis for an Earth Science Interpretive Center. The Center would consist of a museum/classroom setting within a remodeled farmhouse for small groups such as high school earth science classes or geology clubs, although it would also be open to the public as well. The grounds would also include an active quarry overview and entry to an upper bench for hands on access to geologic features.

The Gettysburg Quarry, located near the battlefield, is an ideal location for an Earth Science Interpretive Center. The quarry mines Triassic age Gettysburg Formation hornfels below the Gettysburg diabase pluton, exposed on the upper lifts. The quarry is a noted mineral collecting locality (featured in several published articles) for zeolites and "mini Cornwall-like" orebodies.

The story of "Geology and the Gettysburg Campaign" would also be featured (a topic of Survey publications and recent GSA fieldtrips) along with the economic geology of the deposit with information on the value of industrial minerals to society.

The talk will be informal and interactive. The team will discuss their approach to this most challenging assignment. A scaled 3-D model of the plan will be displayed along with a power-point presentation detailing the project.

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Noncoal Mining in Pennsylvania – Better Living Through Reclamation

The predominant public perception of industrial minerals mining operations is that they are not particularly good neighbors. The most frequent complaint is that they never reclaim anything. This negative perception often creates great difficulty in permitting new or expanded operations, especially in many of the more populated areas of the state. Indeed there is usually much more opposition to industrial mineral mining operations than to coal mining operations. Our experience has been, however, that operations that make a concerted effort to reclaim their mining area as concurrently as possible, create an appealing site entrance, and reduce any visual impacts of their operation have a much better relationship with the surrounding community. This, in turn, makes it much easier to gain acceptance of new mining proposals. Additionally, reclamation plans that maximize concurrent reclamation facilitate compliance with Pennsylvania's Noncoal Surface Mining Conservation and Reclamation Act and help to minimize reclamation bond costs. This presentation will review several notable examples where good reclamation has made life better for the industrial mineral miner.

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The Geology of Catoctin Metarhyolite, Adams County, Pennsylvania

Catoctin Metarhyolite from Adams County, Pennsylvania and, to a lesser extent, adjacent Frederick County, Maryland, was used to make stone tools in pre-historic times. The Catoctin Metarhyolite occurs in metavolcanic core the South Mountain anticlinorium, near the northern terminus of the Blue Ridge physiographic province. Metarhyolite found on the surface does not appear to have been suitable for tools, so pits were dug. Pit distribution at first appears to be random, but on closer examination, it appears that pit clusters were generally sited in enclaves where the otherwise pervasive Alleghanian-age cleavage is poorly developed. Other factors that appear to have been favored for tool production include very fine-grained matrix, readily developed conchoidal fracture, and a lower abundance of feldspar phenocrysts than typical.

The TiO₂ content of Catoctin Metarhyolite from Pennsylvania ranges from 0.1 to 0.4 weight % as determined by a commercial lithium metaborate/tetraborate fusion ICP (Inductively Coupled Plasma) analyses. However, only those metarhyolites containing 0.275 +/- 0.003 and 0.196 +/- 0.003 % TiO₂ are known to have been utilized. These limited chemical ranges as well as distinctive textures appear to permit finished products found > 150 km from the pits to be matched to perhaps as close as 100m of their source.

The Catoctin Metarhyolite and associated Catoctin Metabasalt are bimodal rift volcanics that developed at approximately 570 million years, the second stage of crustal thinning, associated with the opening of the Iapetus Ocean. The basalts are probably mantle-derived and the metarhyolites represent the remelted base of the continental crust. As rifting and crustal thinning progressed, eventually there was insufficient continental crust to yield rhyolite so that composition of volcanism ceased. However, the basalts continued to evolve from rifting to drifting, i.e., towards those having a more oceanic affinity.

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Surface Mining and Sinkhole Distribution in the Karst Terrain of Pennsylvania

Portions of south-central Pennsylvania are underlain by thick sequences of deformed Cambro-Ordovician carbonate bedrock. Certain carbonate units, such as the Cambrian Ledger Formation and the Ordovician Epler Formation, share characteristics in that they are more susceptible to sinkhole development than other carbonate units. They also share roles as targets for mining, providing source material for a variety of uses including construction aggregate, cement, and mineral additives.

As part of the mining process, groundwater levels are lowered by pumping as the mining operation deepens. The lowering of the water table can increase the formation of sinkholes. This increase in sinkhole formation continues until the depressed water table achieves a state of relative equilibrium where groundwater levels are more or less static over a period of time.

Sinkholes are more abundant within the cone of depression, being most common in areas closer to the cone maximum, decreasing within the medial cone and rising again towards the cone minimum. During a temporary period of equilibrium, established during a prolonged and constant pumping rate, the level of sinkhole activity generally drops overall.

Despite this drop, the vadose zone, overlying the cone of depression, remains in a state of flux. Short-term changes in surface water hydrology can increase sinkhole formation over a relatively short period of time, particularly during and immediately following precipitation extremes.

Recognition of karst terrain is an important consideration in the long-term planning for the extraction of limestone and dolostone. It is important to establish the zone of influence by the quarrying operation based on accurate hydrogeologic data and a well-defined long-term monitoring network.

The development of contingency plans in the initial stages of permit development would help to define responsibilities of the quarry with regard to sinkhole occurrences within and outside the zone of influence.

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Opportunities for Aggregate Suppliers in the Roofing Industry

The roofing industry offers many opportunities for industrial rock and mineral suppliers to develop high-value, year-round markets for their products. This market opportunity is not widely known in the aggregates industry, and few of the manufacturers of roofing materials have a good idea of the alternate materials available close to their plants. Materials routinely produced for aggregate may be graded in relatively narrow size-ranges, and offered as components for use in a wide variety of composite roofing types. Asphalt shingles are a truly composite material, with asphalt representing an important, but minor component. By weight, shingles are more than 80 % rock and mineral, and shingle manufacturers provide a broad target market for industrial mineral producers.

At the heart of the shingle is a fiber mat, most commonly made of non-woven fiberglass, although some shingles are still made with a paper mat. The mat is saturated with mineral-filled asphalt coating, applied to both the top and bottom surfaces of the mat. While the asphalt-saturated mat is still very hot, granular rock materials are placed first on the topside of the sheet, and later on the backside of the sheet. The granular materials consist of rock granules coated with colored ceramic (prime granules), rock or slag granules with a similar gradation (headlap granules), and finer silt-sized granules deposited on the backside (backdust).

Huge potential opportunities exist for supply of all four of these graded rock materials, as there are dozens of roofing plants in the US and Canada, each requiring significant year-round supply. The greatest opportunity by weight is in supply of fine-grind mineral filler. Individual plants require a minimum of 100,000 tons of filler per year. Granules, both prime and headlap, are also used in high volume by each plant, and represent the greatest expense of manufacturing shingles, particularly the ceramic-coated prime granules. Backdust material supply is a smaller opportunity, but can be a lucrative use for mineral fines from aggregate production.

Breaking into the supply chain for asphalt shingle manufacturing can be difficult, as the industry is conservative and change can be temporarily interrupt a high speed manufacturing process, adding to short term costs. However the opportunity for both the supplier and the manufacturer is great. Industrial rock and mineral suppliers should assess the potential market in their area, and consider whether these narrow-specification products can be made with minimal capital additions to their plant.

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Geologic and Mining History of Serpentinities in Pennsylvania and Maryland

The long and varied geologic history of the serpentinites in southeastern Pennsylvania and Maryland has resulted in a wide range of mineral and stone resources. Fractional crystallization of a basaltic magma resulted in chromite ore and ultramafic dunite and peridotite cumulates. Later low-grade metamorphism altered the ultramafic rocks to serpentinite. Emplacement in and reaction with quartz-rich metasediments, intrusion of pegmatites, hydrothermal alteration, and weathering produced additional mineral deposits including talc, asbestos, magnetite, feldspar, corundum, and magnesite.

Mining and quarrying span the time period from the pre-Columbian era to the present. Indians quarried and carved soapstone for use as cooking vessels and ornaments. Chromite was discovered in 1810 and under the guidance of Isaac Tyson, Pennsylvania and Maryland became the largest producers of chromite in the world until the mid-19th century. Sporadic, minor production continued until World War I. The chromite was used by the chemical industry in the production of pigments (chrome yellow) and in dyes. The serpentinite region was also the major source of magnesite for magnesia and Epsom salt in the early 19th century. Talc and soapstone were used for refractory linings, ceramics, washtubs and as filler for paint.

In addition to mineral production, the serpentinites has been quarried for aggregate, building and decorative stone. Building stone was widely used in the Philadelphia area in the 19th century, but declined in use, in part, because it did not weather well. Decorative 'green marble' from Cardiff, Md. was quarried until the early 1970s. Today serpentinite is quarried for use as crushed stone.

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The Role of Groundwater Modeling in Quarry Permitting

Under existing regulations (§ 77.403b), Pennsylvania Department of Environmental Protection (PA DEP) has the authority to require the use of groundwater models for noncoal mine permit applications and modifications of existing permits (including changed to NPDES permits). Groundwater models are most often required whenever a noncoal project has significant potential for dewatering to affect water supplies, streams or wetlands, unless equivalent data is available by other means.

Groundwater models are computer simulations of the groundwater system in the vicinity of the quarry. The goal of the modeling is to create a reasonable representation of aquifer conditions so that impacts from mine pumping can be predicted. Groundwater models require the collection of a wide variety of data, not only in the immediate vicinity of the mine, but also at distances of several miles from the mine. This is especially true of permeable units, such as limestone and dolomite in karst terrains. Several examples of groundwater models constructed and calibrated for Pennsylvania quarries are presented to illustrate the steps required to build a credible model, data requirements of the model, and information that should be submitted to PA DEP in support of a permit application.

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Raw Material Reserve Estimates and Quarry Optimization Using Geophysical Surveys

Advances in surface geophysical technology over the last 15 years have allowed geologists and geophysicists to accurately estimate raw material reserves, quantify overburden removal efforts, and optimize quarry planning for industrial mineral operations. Geophysical technology provides 2- and 3-dimensional measurements of subsurface parameters, such as earth resistivity and surface wave/shear wave velocity, that can be directly correlated to soil and overburden thickness, bedrock type, bedrock quantity and quality, the presence of subsurface discontinuities such as faults or fractured areas, groundwater saturated zones and other important parameters that are useful in quarry planning and delineation.

Geophysical field methods are generally non-invasive and environmentally friendly and can usually be completed relatively quickly with only a limited amount of field logistical support. Geophysical data may be correlated with surface bedrock outcrops, borehole information, borehole logs and other “ground truth” data to substantiate subsurface estimates. The use of geophysical data can substantially reduce quarry exploration and development costs that have traditionally been associated with large scale borehole or core drilling programs. Examples of geophysical surveys used for raw material reserve estimates, overburden quantification and quarry delineation are presented from a variety of industrial mineral extraction operations ranging from unconsolidated sand and gravel deposits to hard rock quarries.

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Energy Bills Getting You Down? Maybe Coalbed Methane Can Help.

Interest in the economic value and development of natural gas from coalbeds in Pennsylvania grew during the late 1980s, resulting in a dramatic increase in production a decade later. Major growth in coalbed methane (CBM) as an unconventional source of natural gas continued from 1999 to 2008 during a time of higher gas prices and more favorable national economic conditions. Since then, CBM exploration and development continues at a slower pace, owing to the global recession and growing interest in the Middle Devonian Marcellus shale, another unconventional source of natural gas.

Commercial quantities of CBM are presently being produced in the southern and southwestern portions of the Main Bituminous field from seven counties. According to the Pennsylvania Department of Environmental Protection (PA DEP), there are approximately 800 active CBM wells in the state as of January 2009. The total reported CBM production in 2008 was 11.6 billion cubic feet (Bcf), the highest reported annual production to date (1 Bcf methane could heat 14,494 households for one year).

Various resource estimates are as follows: 1) A 1983 Geomega study revealed 2,654 Bcf for Pennsylvania anthracite and bituminous; 2) A 1988 Gas Research Institute report placed total gas-in-place estimates for Pennsylvania and West Virginia at 51 trillion cubic feet (Tcf); and 3) A 1996 U.S. Geological Survey Oil and Gas Resource Assessment totaled technically recoverable CBM for the Northern Appalachian coal basin (Pennsylvania, Ohio, Maryland, and northern West Virginia) at 11.5 Tcf. CBM, an energy source that rivals conventional natural gas in composition and heating value, continues to be a valuable part of the domestic energy mix throughout the United States.

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Geology of the Ridgeley Member of the Old Port Formation, an Important Sand Resource in Central PA

The Ridgeley Member of the Old Port Formation is one of the principal gas producers in Pennsylvania and is one of the finest glass sands in the world.

Gas is produced from the member where is several thousand feet below the surface in the Appalachian Plateaus physiographic province. It is quarried for glass and industrial uses where structure has brought it up to the surface in the Ridge and Valley physiographic section of the Appalachian Mountains. Since 2003, McElroy has mapped the Ridgeley Member in the Valley and Ridge section in Huntingdon, Mifflin and Juniata Counties. This paper largely describes the member where he mapped it.

The Ridgeley Member is variable in thickness and composition. Variability is, in places, over short distances. Thickness ranges from 350 feet in Bedford County, thinning in a northeast direction to zero and recurring further to the east in thicknesses up to 50 feet. Where it is economically important, it is a pure, white quartz sandstone. In other areas, it is a bluish quartz sandstone locally metamorphosed into a quartzite, or a calcareous sandstone which sometimes grades into an arenaceous limestone. It contains conglomeratic beds over much of its outcrop. The change in lithology causes a change in resistance to erosion.