GEOGRAPHY AND GEOLOGY

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ABSTRACTS

Coal Mine Subsidence Problems in Indiana. RICHARD L. POWELL, Department of Geosciences, Purdue University, West Lafayette, Indiana 47907.—— The ultimate effect of abandoned underground coal mines in southwestern Indiana is progressive upward collapse and brecciation of the roof rock from the mine workings to the earth's surface. Such subsidence has caused differential settling and consequent fracturing of some buildings, houses, and other structures in several urban areas, and surface features such as "sinkholes" and trenches make some undeveloped real estate unsuitable for construction. Subsidence beneath highways has temporarily disrupted major transportation, water and utility lines.

The type of roof materials and overburden above the mined coal bed, the thickness of the overburden, the thickness of the mined seam, the size of the mined area, the types of roof support used during mining, and the time interval since abandonment determine the magnitude and extent of land subsidence.

Previous mine subsidence is most easily detected on conventional air photography, topographic maps or field investigation. Areas susceptible to future mine subsidence may be determined only by plotting the extent of underground mines from maps commonly on file in the individual County Recorder's offices or the Indiana Bureau of Mines. Nearly all of the available mine maps have been plotted on a county base preliminary coal map series published by the Indiana Geological Survey. However, not all mine maps are complete nor accurate.

Impact of Coal Mine-Waste Runoff on a Small Stream. PHILLIP M. CASEROTTI, Department of Geology, Indiana University, Bloomington, Indiana 47401, and GREGG MARLAND, Department of Geography-Geology, Indiana State University, Terre Haute, Indiana 47809.—— West Little Sugar Creek drains an area of Vigo County, Indiana, which includes a major coal mine waste pile. Data show that the impact of the mine waste on the physico-chemical character of the stream is essentially unchanged 10 years after cessation of mining and is likely to continue indefinitely unless positive corrective measures are taken. Seepage from the pyrite-rich waste has been observed to contain as much as 200,000 parts per million dissolved sulfate and 56,000 ppm dissolved iron. Iron is precipitated as ferric hydroxides and dissolved oxygen and the pH recovers fairly rapidly with downstream distance and dilution. The adverse effects are more pronounced at low flow. By

the time the stream joins the Wabash River, some 11 kilometers from the waste pile, pH and dissolved oxygen have recovered to near normal values but the stream and stream sediments contain abundant ferric hydroxides.

Fossil Fuels and the Energy Crisis in Indiana. CHARLES E. WIER, Indiana Geological Survey, Bloomington, Indiana 47401.——The energy crisis will affect Indiana in much the same manner as it does the remainder of the United States. The State is now almost entirely dependent on the three fossil fuels: oil, natural gas, and coal. Although all three fuels are produced in the State, we import more than we produce. In 1972 we produced 24.5 million tons of coal, 6.2 million barrels of crude oil, and 640 million cubic feet of gas. We consumed nearly twice as much coal, 30 times as much oil, and 1000 times as much natural gas as we produced.

Known recoverable coal reserves will last about 300 years if production increases no faster than a few per cent per year. Petroleum produced at a slightly decreasing rate will last less than 10 years, and natural gas, assuming some effort to increase production, will last, perhaps, 20 years.

Reserves of coal occur in southwestern Indiana and the amount is fairly well documented. Additional exploration is not likely to increase reserves by more than 20 per cent. On the other hand, there are untested potential reservoirs that may contain significant new reserves of crude oil and natural gas in deeper rocks.

If Indiana tried to be self-sustaining in energy production, the fossil fuels would be consumed within two decades.

The Mineralogy and Geochemistry of Mercury Ore from the Senator Mine, Nevada, in the Light of Experimental Studies. NABIL Z. BOCTOR and GUNNAR KULLERUD, Department of Geosciences, Purdue University, West Lafayette, Indiana 47907.——At the Senator Mine, Nevada, a rather rare type of mercury mineralization is found. Cinnabar and metacinnabar occur together in barite veins transecting a granitic country rock. The mercury minerals are found mainly in the interstices of highly silicified fragmented barite as well as in quartz or chalcedony veinlets transecting the barite. The ore minerals are mainly metacinnabar and cinnabar which are associated with minor amounts of pyrite. Cinnabar occurs both as a primary mineral and as an inversion product of metacinnabar. Microprobe analysis shows that metacinnabar contains up to 4 weight per cent zinc and 2.5 weight per cent iron in solid solution. Metacinnabar in mercury ores associated with granitic intrusions is remarkably enriched in zinc compared to mercury ores of the serpentinite type where the concentration of zinc is < 0.01 weight per cent. Using the data of Barnes and Kullerud (1961) on the stability of sulfur containing aqueous species as function of f_{O_2}, f_{S_2}, and pH, we can tentatively delineate the limits of the chemical environment during ore formation. The deposition of barite at the early stage of the mineralization indicates a high activity of the $SO_4^{=}$ species relative to the reduced sulfur species. The deposition of the sulfides at a later stage indicates a reduction of the sulfate by crossing the phase boundary between $SO_4^=$ and the reduced sulfur species to within or beyond the field in which barite is insoluble. The presence of pyrite and the absence of pyrrhotite in the ore stipulates a value of f_{S_2} greater than that which permits coexistence of the two minerals.

Formation of Silicious Stones: Agate. WILLIAM W. DAVIS, 4124 N. Pennsylvania Street, Indianapolis, Indiana 46205.——A procedure is described for examination of lap-polished sections of agates, jaspers, massive quartz crystals, and other silicious stones. Color and "topo" photographs provide a basis for examining structural detail on which an hypothesis is proposed for the conditions and sequence of events during formation and alterations of the stone.

Successive layers of silica, whether macrocrystalline quartz, chalcedony, or common opal (all of which may alternate repeatedly) are clearly distinguished. Influences of conditions such as the direction of gravity, quantity of solution, its composition and pH, and the temperature are discernible. The common elements and the variations in conditions and resulting structures in agates from around the world are illustrated photographically.

Masonry Materials in Historic Indiana Structures. JOHN B. PATTON, Indiana Geological Survey, Bloomington, Indiana 47401.——For authentic restoration or for acceptable renovation or alteration of historic structures, the exposed masonry materials must be identified, and the same or similar materials must be found.

Of the common masonry construction materials—stone, brick, mortar, and tile—only stone is used in its natural state. This may make the original sources easier to identify, but it poses difficulties when that source is no longer usable. The varieties of Indiana dimension stone extensively utilized have come from the stratigraphic units named Salem, Laurel, Mansfield, Liston Creek, and Ste. Genevieve. Much stone has been imported, but more for interiors or trim than as major exterior materials.

For many early structures, brick was burned at the construction site, and genuine duplication is nearly impossible. Even the commercially made brick of the pre-1890 period has no modern counterpart.

Early mortars can be readily imitated but rarely duplicated, as different constituents are used to attain similar appearance. Much of the tile used in historic buildings was obtained from outside the state. Few of the early varieties are obtainable now.

Techniques for identifying ceramic materials and mortar are not well developed, but microscopic examination and x-ray diffraction offer promising leads. Many early materials that would not meet modern specifications have splendid performance records.

What God and Man Have Wrought. TIM GOGNAT and STANLEY S. SHIMER, Science Teaching Center, Indiana State University, Terre Haute, Indiana

47809.——A blend of 2x2 slides and folk-rock music can be used in earth science classes to stimulate interest, raise questions and sensitize students to their environment. This teaching approach has been used to introduce units on astronomy, rocks and minerals, volcanoes, forms of erosion, mountain forms, fossils and meteorology. As a result of this innovative teaching strategy, college, high school, and middle school students have been inspired to explore further into earth science problems.

Preliminary Study of Interrelationships of Resistivity and Velocity in Indiana Lithologies. A. J. RUDMAN, M. E. BIGGS, R. F. BLAKELY and J. F. WHALEY, Indiana Geological Survey, Bloomington, Indiana 47401.——Present knowledge of vertical seismic velocities in Indiana is based almost solely on acoustical transit times recorded on continuous velocity logs. Comparatively few wells have been logged for velocity, despite the importance of such data in seismic reflection prospecting for petroleum. Numerous wells in the state have been logged by electrical methods and the resistivity logs from these wells bear a close resemblance to the few available velocity logs. Using an empirically derived scale function which relates apparent resistivity and acoustical transit time, pseudo velocity logs that closely match real velocity logs have been generated from resistivity logs. Although the method shows promise for interpolating velocity information in local areas, the validity of a scale function over large geographic areas remains to be tested.

Should Indiana Be Prepared for a Shock? GERALD J. SHEA, Department of Life Sciences, Indiana State University, Terre Haute, Indiana 47809.——Although Indiana is considered to be located in a non-destructive earthquake area, a total of 14 tremors have occurred in the past 100 years. Also, over 160 years ago a major earthquake affected our State, causing major damage, the full extent of which we can only guess. Should such an event occur again, is Indiana prepared for the shock?

By using differential analysis an interpretation of the strong motion seismograms, which were made by instruments located in Terre Haute, yield the following results: What moved 2 inches in 1968 probably moved 5 inches in the earth tremor of 1909 and as much as 13 inches in the earthquake of 1811. This deduction is interesting when you consider its relation to the trends in modern construction.

Multiple Tills at Wabash, Indiana. WILLIAM J. WAYNE, Department of Geology, University of Nebraska, Lincoln 68508.——Large till exposures are rare in northern Indiana, but a gravel pit at the south edge of Wabash has displayed as many as five separate till beds with intervening gravels and sands continuously for more than 25 years. The soft, clayey uppermost till of the Lagro Formation represents the most recent advance of Erie Lobe ice; it overlies a gravelly sand outwash. Three very compact sandy silty gray tills, each distinctive in color and composition, underlie this sandy outwash and are underlain by a thick gravel unit that coarsens upward. A boulder pavement caps the middle till, which is stonier than the tills that sandwich it. Beneath the coarse gravel at the north end of the pit is a silty till that is reddish brown (5YR 5/4 to 7.5YR 5/4). No buried weathering profiles were observed on any of the tills or gravels. The triple till unit undoubtedly is the Trafalgar Formation (Wisconsinan). No records of a reddish brown till exist for northeastern Indiana, although a till of somewhat similar color in Warren County may be part of the Jessup Formation. It would seem reasonable at this time, then, to include this unusual till in the Jessup Formation and to regard it as Illinoian in age.

Fracture Analysis of the Kentland, Indiana, Disturbance. HEATHER COLLINS, Department of Earth Sciences, Washington University, St. Louis, Missouri, and L. A. BROWN, Department of Geosciences, Purdue University, West Lafayette, Indiana 47907.——A survey of joints in the McCray quarry exposing the Kentland cryptoexplosion structure in Northern Indiana revealed a systematic pattern. An equal-area plot of joint poles indicated three major joint sets. Two of these sets were nearly at right angles to the fold axis and the third, nearly parallel to the fold axis. An equal area net of poles of bedding planes showed the fold axis to be plunging 58° N 16 W. A paired diagonal joint set to the fold axis was not readily discernible. Joint spacings recorded at the quarry fall within the range of 0.5 to 3.0 feet with a peak spacing concentration occurring at 1.0 feet. Bedding planes generally are spaced less than 5 feet apart.

A comparison between the Kentland disturbance and other similar type structures, presence of coesite in trace amounts in the St. Peter Sandstone, high pressures developed by normal geological processes and by explosives used in the quarrying operation lead us to question the popular meteorite-impact origin for the disturbance. Until more information is available, the Kentland disturbance will have to remain classified as a cryptoexplosion structure.