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Researchers use GIS to evaluate environmental threat of closed landfills

A geographic information system (GIS) was recently used by University of Nebraska-Lincoln researchers to evaluate environmental risks posed by the more than 200 unlicensed solid-waste landfills in Nebraska.

Unable to meet new state and federal regulations, most of the unlicensed dump sites will close by 1995. Even so, many of the sites may pose a ongoing threat to groundwater quality. The computerized GIS for landfill evaluation was used to identify potential trouble spots, said Mark S. Kuzila, head soil scientist with the UNL Conservation and Survey Division (CSD).

The GIS could also be used to locate safe sites for the large regional landfills that will likely be built to replace the unlicensed dump sites, Kuzila said.

Kuzila and Craig Erikson, a UNL master's student in geography working with the CSD Center for Advanced Land Management Information Technologies (CALMIT), recently demonstrated the system at the MidAmerica GIS Symposium, held May 4-7 in Overland Park, Kan. GIS is a computer-based technology to capture, store, analyze and display spatial information about the earth.

For the demonstration, three study areas were selected to represent a combination of environmental factors typical in different areas of the state. Each study area was nine square miles surrounding existing landfills near O'Neill, Elk Creek and Imperial.

Information on soils, slope, depth to groundwater, net recharge and the nature of the unsaturated zone was entered into the GIS for each area. Vulnerability to contamination depends on each factor. For example, an area with permeable soils and shallow depth to groundwater is more prone to contamination than one with less permeable soils

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Niobrara Formation tapped for first gas production

For the first time, natural gas is being produced from the Niobrara Formation in Nebraska. This formation underlies the western four-fifths of the state.

Snyder Oil Corp. of Fort Worth, Texas, is producing 900,000 cubic feet of natural gas a day from six wells in northeastern Cheyenne County from the Niobrara--yellow, lead-gray and orange chalky limestones at depths of about 3,400 feet.

Previous attempts to extract gas from the formation were either shut-in--temporarily closed because small amounts were being produced--or abandoned, according to a report by Raymond R. Burchett, a University of Nebraska-Lincoln geologist with the Conservation and Survey Division. The report appeared in the May 11 issue of the *Oil and Gas Journal.*

Burchett said there is good potential for expansion of natural gas production from the Niobrara in southwestern Nebraska and in the southern Panhandle.

Most of the natural gas now produced in the state comes from older Cretaceous-age rocks. Snyder officials have said they are interested in the Niobrara because of government tax breaks for developing hard-to-mine formations.

Geologists uncover agate origins, revamp theory of formation

Without a doubt the most-often asked question of Roger K. Pabian, paleontological and gem expert, is, "How do agates form?"

And, until recently, Pabian, a University of Nebraska-Lincoln research geologist with the Conservation and Survey Division, could answer with only mild conviction. This situation led him, along with Andrejs Zarins, a Nebraska Department of Environmental Quality geologist, to conduct a systematic study of agate formation.

The geologists conducted the study on their own time, researching the stratigraphic context and environment of deposition of the stones. They found that agates are primarily the products of silica diagenesis, Pabian said. Diagenesis is a change in or recombination of old rock, minerals or fossils into a new product. He said the main source of silica for all agates is probably volcanic ash.

Pabian and Zarins presented their findings at the annual meeting of the north-central section of the Geological Society of America held in Iowa City, Iowa, in late April.

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The bimonthly newsletter of the Conservation and Survey Division

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In their report, the geologists state that agates can form in four geologic settings: in volcanic ash-flow tuffs--rocks formed by consolidation of volcanic debris--in certain basalts overlain by volcanic ash-flow tuffs, in continental sedimentary rocks, common in western Nebraska, and in ancient marine limestones, which are common throughout the Midwest.

Previous agate research has focused primarily on the formation of colored bands found within individual stones, Pabian said. Such research, he said, takes the agates out of their stratigraphic, tectonic and geochemical context.

"We started looking at what all the stones had in common instead of at the individual differences," Pabian said.

Putting the stones back into geological context, the geologists studied the layers of deposition in which agates are found around the world. In essence, they studied the stones much like fossils are studied.

The geologists note four environments of agate formation. First, basalt, a black igneous rock that contains no free silica, escaped from deep in the earth's crust and spread across the surface through fissures--cracks--usually found along spreading continental margins. Volcanoes then formed along the fissures, and subsequent eruptions covered the basalts with a silica-rich rock called a welded ash-flow tuff--an ash-flow tuff that has been hardened by heat and pressure.

Alkaline or saline lakes later formed on the tuffs. They freed silica from the volcanic ash in the form of gels. The silica gels moved downward in the rocks and first formed a kind of agate called a "thunder egg" in the tuffs. Some silica continued moving downward and eventually filled gas vesicles--cavities or bubbles--in the underlying basalts, there forming an amygdaloidal (related to an agate pebble) agate. Minerals forming in the lakes began the crystallization of the silica to form the banded agate, they said.

Volcanic eruptions also sent volcanic ash high into the atmosphere and carried it hundreds, even thousands, of miles from the source. Some ash eventually fell on the land surface. There, silica in the ash broke down over time and combined with other minerals, eventually forming agates.

Much the same thing happened to ash that fell on ancient seas and settled on the ocean floor. It was previously thought that the source of silica in marine limestone was primarily organic, perhaps derived from the skeleton-like remains of sponges. However, Pabian and Zarins believe that the main source was volcanic ash.

Four-state coal field may produce methane, new industry

The coal field that underlies three southeastern Nebraska counties has the potential to produce methane gas and, possibly, create a new industry for the state.

Raymond R. Burchett, geologist with the University of Nebraska-Lincoln Conservation and Survey Division (CSD), said there is probably enough coal in the basin to produce some methane but that the quantity involved is unknown at present.

CSD has, therefore, joined with the U.S. Geological Survey (USGS) and the Kansas, Iowa and Missouri geological surveys in asking Congress for $8 million to conduct a 4-year study into the methane-producing potential of coal in the Forest City Basin.

The Forest City Basin is a 5,000-square-mile coal field that underlies parts of Iowa, Missouri, Kansas and Nebraska. The largest part of the field is in Kansas and Missouri, but the formation containing these coal beds is thickest in Nebraska's Otoe, Nemaha and Richardson counties, Burchett said. The largest part of the coal under Nebraska is in Richardson County.

In Nebraska, the formation is made up of nine separate coal beds that extend across 815 square miles, he said. The thickness of each bed, which lie at an estimated depth of 1,000 to 1,500 feet, is uncertain because no core samples have ever been taken. But, he said, if each bed were a foot thick, there could be as much as 8.5 billion tons of coal underlying the three counties.

That amount, small in comparison to most major mines

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Resource News is a bimonthly publication of the Conservation and Survey Division, 113 Nebraska Hall. Institute of Agriculture and Natural Resources, University of Nebraska–Lincoln, 68588-0517. It is distributed free to all interested in earth science in the state. To receive it, write to the address above. In addition, the Resource News audience will receive Resource Notes, the annual report of the division. **The Conservation and Survey Division is the agency designated by statute to investigate and interpret the geologically related natural resources of the state, to make available to the public results of these investigations and assist in the development and conservation of these resources.** The Conservation and Survey Division provides information and educational programs to all people without regard to race, color, national origin, sex or handicap. Background of nameplate on page one depicts the layered rock column from the Geologic Bedrock Map of Nebraska. Layers shown are (from the bottom) Precambrian, Cambrian, Ordovician, Silurian and Devonian rocks.

Wind-blown deposits noted in Mid-continent Rift core

A core sample of rock deposited more than 1 billion years ago has yielded new information about an ancient environment preserved under modern-day Nebraska, according to a University of Nebraska-Lincoln research geologist.

Marvin P. Carlson, with the UNL Conservation and Survey Division (CSD), said that some sediments within the core sample, drilled along the Midcontinent Rift about 6 miles north of Nehawka in Cass County, have characteristics of wind-blown (eolian) deposition. Eolian deposition has never before been noted in the Midcontinent Rift System, he said.

Carlson presented his findings at the annual meeting of the north-central section of the Geological Society of America, held in late April in Iowa City, Iowa. James B. Swinehart, a CSD research geologist, and Samuel B. Treves, a geologist with the UNL geology department, also worked on the core study.

The Midcontinent Rift, formed about 1.1 billion years ago during the Precambrian Era--5 billion to 600 million years ago--stretches from eastern Kansas through southeastern Nebraska, northwestern Iowa, central Minnesota and into Lake Superior. The rift was a major plate boundary during the Precambrian that formed when the North American continent began to break apart. Pieces of the continent had drifted together many millions of years before.

It was active for awhile, then failed. Carlson said that when the rift formed, a rift valley formed as well. When rains came, water washed into the valley, depositing sediment and large cobbles as it came. Since the rivers in the rift valley were only filled with water after storms, the stream-deposited (fluvial) sediment would dry and shift in the wind, forming the ripples identified as eolian deposits in the core sample, he said.

Deposits throughout the rest of the Midcontinent Rift System have always been identified as fluvial, Carlson said. Perhaps because the environments of deposition were different or because eolian deposits are hard to see in outcrops, they haven't been identified earlier, he said.

The core sample study was part of a larger study by Carlson to characterize the Midcontinent Rift System in Nebraska. When completed, a drill-hole database, map of the rift and detailed description of the core will be produced. The core was drilled in 1924 by an oil company, but interest in the rift has picked up in the last 5-7 years because of interest in possible natural gas and mineral deposits. Precambrian rocks are present from 1,567 feet deep to the bottom of the core at 1,828 feet.

Carlson said it's important to study and map the ancient rift system because original rift faults tend to reactivate and major earthquakes sometimes occur along ancient plate boundaries. Metallic minerals such as iron and copper are also found in Precambrian-age deposits.

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and greater depth to water. The factors were numerically ranked and calculations made to determine environmental sensitivity.

On the final map, areas with high vulnerability are depicted in hot colors like red and yellow, and those with low vulnerability are depicted in blue and violet.

The demonstration GIS indicates that the potential for contamination is highest at O'Neill, where groundwater is fairly shallow and soils are sandy, and lowest at Imperial, where groundwater is fairly deep, Kuzila said. The contamination potential of the Elk Creek site is between the two.

Earlier this year, the U.S. Environmental Protection Agency issued a set of regulations requiring, among other things, chemical-leak monitoring at all landfills. Installation of special liners to prevent seepage will be mandatory at new sites.

Most unlicensed landfills in Nebraska are operated by and for small communities that can't afford to upgrade to the new requirements, which will be phased in from 1993 to 1996. Those landfills will be closed. Larger regional landfills are proposed as a replacement. However, some are concerned that those too will place an economic burden on rural communities through high transportation, equipment and maintenance costs.

The MidAmerica GIS Symposium is designed to address all interests of GIS users and potential users. James Merchant, associate director of CALMIT, serves as co-chair of the MidAmerica GIS Consortium, which hosted the symposium.

This year's second annual meeting was attended by about 550 people. The attendance was primarily made up of government, utility, business and university employees.

Topics addressed included GIS applications for natural resources management and environmental protection; transportation and utilities; land records and tax mapping; fire, police and medical emergency services; management of cultural resources; and business and commercial use.

Tentative plans exist for a third symposium, to be held in 1994. Contact Merchant at (402) 472-7531 for more information.

Methane *continued from page 2*

in Wyoming, would most likely produce good quantities of methane, Burchett said.

Two Missouri congressmen asked the interior subcommittee of the House Appropriations Committee to provide $1.6 million next year for the first year of the study. CSD and the Missouri Geological Survey applied for the grant, in cooperation with the USGS and the geological surveys of Kansas and Iowa. If the appropriation is approved, CSD will use its portion to drill two cores in southeastern Nebraska, Burchett said.

Methane is a clean-burning gas used for heating, cooking, electricity generation and in manufacturing. It is extracted from coal in a chemical process called coal gasification.

New publications on Nebraska geology, geography and water

Available from U.S. Geological Survey

--David City Quadrangle, 1:100,000-scale topographic map, surveyed from 1981-1985.
--Norfolk Quadrange, 1:100,000-scale topographic map, surveyed from 1984-1985.
--Stanton Quadrangle, 1:100,000-scale topographic map, surveyed from 1981-1985.
Contact the Nebraska district office of the USGS to order at 100 Centennial Mall, Lincoln, Neb. 68508 (402) 437-5082

Coming up: CSD annual report to be published this fall

This issue brings to a close the first volume of *Resource News. Resource Notes*, the annual report of the University of Nebraska-Lincoln Conservation and Survey Division (CSD), will be published this fall and will take the place of the September/October issue of *Resource News*. Volume two of *Resource News* will start in November.

The forthcoming issue of *Resource Notes* will include articles about:

--a GIS land-cover database for the coterminous United States developed by Center for Advanced Land Management Information Technologies (CALMIT) researchers;
--a well-head protection study conducted for the city of Lincoln;
--remote sensing of Sand Hills lakes to study groundwater flow and quality;
--the annual Nebraska mineral resources inventory;
--movement of atrazine under the Lincoln well field;
--a study into irrigation-well sampling; and
--a study in western Nebraska exploring how irrigation canals affect groundwater flow and levels.

Resource News and *Resource Notes* are distributed free of charge. If interested in receiving the newsletter-news magazine package, or if you would like a CSD publications catalog, write to CSD: 113 Nebraska Hall; UNL; Lincoln, Nebraska; 68588-0517 or call (402) 472-7523.

Coming up: National, state and regional meetings and workshops

--Urban and Regional Information System Association (URISA) annual conference, July 12-16, Washington, D.C.
--CALMIT Workshops: GIS and Remote Sensing for Water Resources, September 14-18; Advanced Techniques in GIS, September 21-25, Lincoln; contact Chris Keithley for more information (402) 472-2565.
--Association of Engineering Geologists annual meeting, Oct. 2-9, Long Beach, Calif.
--Geological Society of America annual meeting, Oct. 26-29, Cincinnati.

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