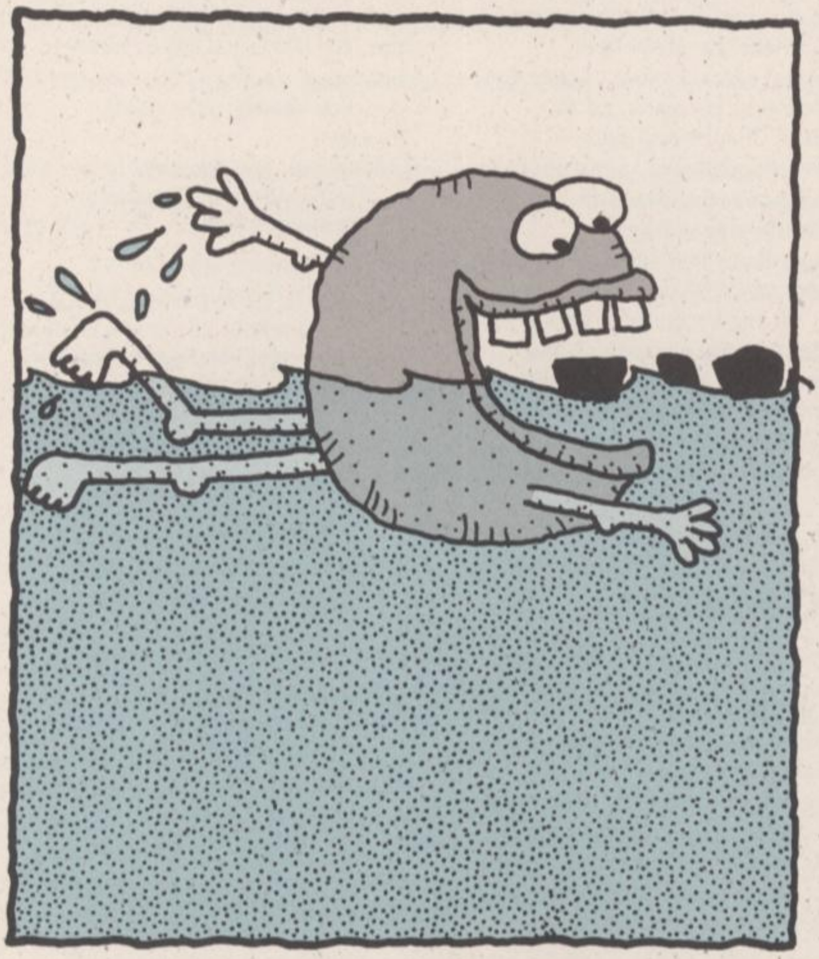
LITE geology

A quarterly publication for educators and the public–
contemporary geological topics, issues and events

Summer 1995

New Mexico Bureau
of
Mines and Mineral
Resources
(NMBM&MR)



Microbe cleans up water pollution.

This Issue:

Earth Briefs

What's Bugging the Environment?

Environmental pollutants such as pesticides, solvents, petroleum products, and other toxic substances can accumulate in the soil and water, threatening the health of plants, animals, and people. For years, scientists have recognized the important role that microorganisms play in **biodegrading**, or breaking down, these substances. A cleanup method called **bioremediation** uses living organisms (primarily microorganisms) to degrade environmental pollutants or to prevent pollution through waste treatment. This technology has applications in cleaning contaminated sites as well as preventing further contamination by managing pollutants as they are generated.

In many situations, the **indigenous** organisms (those that occur naturally at the pollution site) can biodegrade contaminants without influence from humans. But some compounds are resistant to biodegradation, presenting challenges for environmental scientists who must design methods to enhance the biodegradation process. Important research is underway to identify microorganisms that attack more efficiently an increased number of compounds, and are capable of doing so under a broad range of conditions. Especially in demand are organisms that can tolerate extremes in temperature and **pH** (acidic or basic environments) and the presence of organic solvents.

In some cases, scientists are able to genetically engineer new microbial strains with unique abilities to biodegrade. Scientists engineered a strain of *Pseudomonas fluorescens HK44* with genes for naphthalene degradation and also genes for **bioluminescence** (firefly-like light emitted by an organism). The gene for bioluminescence is a **reporter** gene that causes an easily monitored effect when certain microbial activities occur. In the case of *Pseudomonas fluorescens HK44*, when naphthalene and other hydrocarbon pollutants are degraded, light is emitted. Here, bioluminescence is an **indicator** for monitoring and controlling the progress of biodegradation.

Although microbes can be introduced onto a contaminated site, most of the successful applications of bioremediation have been where the environment is modified to stimulate the naturally occurring organisms. Cleanup of the *Exxon Valdez* oil spill was one of the largest bioremediation projects in the United States. After the oil tanker spilled 11 million gal of crude oil into Prince William Sound in March of 1989, about 11,000 workers spent the summer attempting to clean 1,000 miles of shoreline. High-pressure water was used to wash the rocks, which cost Exxon more than $1 million per day, but which left subsurface oil to recontaminate the shoreline.

During a second stage of cleanup, bioremediation consisted of the application of nitrogen and phosphorus fertilizers to the shoreline. This treatment stimulated the hydrocarbon-degrading microorganisms that were abundant in the waters of Prince William Sound. As a result, oil contamination impacted the shoreline for only a couple of years, compared to the possible decade that might have occurred if left untreated. Although the actual cost of bioremediation was only $1 million, the field demonstration (monitoring studies) added $10 million to the bill.

Bioremediation accelerated the biodegradation of oil, but did not completely remove all contamination. Most of the residual oil is bound up in water-insoluble asphalt-like materials that are not expected to impact biological systems but are expected to degrade slowly over time.

Source

Atlas, R. M., 1995, Bioremediation: American Chemical Society, Chemical and Engineering News, v. 73, no. 14, pp. 32-42.

Sayler, G. S., July 30, 1995, personal communication, (Center for Environmental Technology, University of Tenessee, Knoxville).

—story by S. Welch

Have you ever wondered...

... About the History of Earthquakes in New Mexico?

Dr. Allan Sanford
Senior Research Geophysicist, New Mexico Tech Seismological Observatory

In previous issues of *Lite Geology*, we have explored the questions of why earthquakes occur (Aster, 1994a), and how they are measured (Aster, 1994b). Now let's look at the *history* of seismic activity in New Mexico.

Before 1962, there were too few seismic instruments in place in New Mexico to locate earthquakes. However, accounts from people who felt and reported earthquake structural damage to buildings are valuable in piecing together the seismic history of our state. These historical records are the basis for seismic data in New Mexico prior to 1962.

Earthquake intensity scale

Location and strengths of earthquakes determined without instruments are based on **intensity** values. These are established from 1) reactions and observations of people during a shock and 2) the degree of damage to structures. The most commonly used intensity scale, **Modified Mercalli of 1931**, has twelve levels of intensity (indicated by Roman numerals I–XII) that range from barely felt to total destruction (Table 1).

In addition to the strength of the earthquake, intensity depends on distance from the epicenter and on ground conditions at the point of observation. Given many intensity observations, the **point of maximum intensity** and the **area of perceptibility** can be established. Both of these quantities, particularly the area of perceptibility, can be roughly related to the earthquake **magnitude**. (Aster, 1994b).

A major difficulty in determining the strength and location of earthquakes from intensity observations is that the method depends on population density. In sparsely settled areas, shocks may go completely unreported or reported at low intensity values that do not indicate the true strength of the earthquakes. Much of New Mexico is sparsely settled now, and it was sparser in the historic past. Even in areas where the population was relatively high, such as some sections of the Rio Grande valley, the point of maximum intensity or area of perceptibility may not have been defined adequately to determine the true strength of some earthquakes.

Reliability of early reports of earthquakes

The reliability of the early reports of earthquakes must be considered. Some of the intensity values for strong

Modified Mercalli Intensity Scale of 1931 (abridged)

I—Not felt except by a very few under especially favorable circumstances.

II—Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.

III—Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motorcars may rock slightly.

IV—During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, and doors disturbed; walls make creaking sound. Standing motorcars rocked noticeably.

V—Felt by nearly everyone; many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned.

VI—Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.

VII—Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures.

VIII—Damage slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons in motorcars disturbed.

IX—Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse.

X—Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.

XI— Few, if any masonry structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.

XII—Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into the air.

Table 1—Earthquake intensity values according to the Modified Mercalli Intensity Scale of 1931, abridged.

earthquakes in New Mexico prior to 1962 are based on reports from local residents tens of years after the shocks. Newspaper accounts of earthquakes also have been used to estimate earthquake intensity. In most cases this method has proved to be a fairly reliable procedure. However, in at least two instances the effects of earthquakes in the Rio Grande valley at Socorro were exaggerated in stories appearing in newspapers in Albuquerque and El Paso (see insert on page 7).

Despite their imperfect nature, noninstrumental data are invaluable because they are available for a period of time roughly three times longer than that for which instrumental data are available. Moderate to strong earthquakes are rare events in New Mexico; hence, the longer the available earthquake history, the more reliable the estimates of seismicity in the state.

Historical accounts of quakes in New Mexico

Although settlement by the Spanish began in the early seventeenth century, little is known of seismic activity in New Mexico prior to its becoming part of the United States in 1848. No doubt reports of earthquakes exist in Spanish and Mexican archives, but this information is difficult to extract and to our knowledge no such attempt has been made.

The earliest report of earthquakes after U.S. occupation is the description by a U.S. army surgeon of a swarm of shocks in the Rio Grande rift at Socorro. The swarm, which contained 22 felt shocks, began on December 11, 1849, and lasted until February 8, 1850. No shock in this swarm was reportedly felt at distances greater than 25 km (15 miles) from Socorro; maximum intensities, therefore, were probably less than V (Modified Mercalli). Similar sequences of shocks located away from population centers along the Rio Grande valley or elsewhere in the state easily could have gone unreported before the start of instrumental studies.

Influence of population density

For the period 1849–1963, Dr. Stuart Northrop (Northrop, 1976) cites evidence, primarily from old newspaper files, for more than 600 felt earthquakes in New Mexico. Approximately 95 percent of these shocks occurred along a 150 km (90 mile) section of the Rio Grande rift from Albuquerque to Socorro. The majority occurred in the 75 km (50 miles) from Belen to Socorro. The concentration of reported activity in the Belen–Socorro area cannot be attributed to population density because the population in the area from Belen to Albuquerque historically has exceeded the population from Belen to Socorro.

However, when considering the *entire state*, Northrop's data are influenced by the distribution of population. Historically, population density has been higher in the Albuquerque-to-Socorro section of the Rio Grande valley than in most other sections of the state. To reduce bias arising from the distribution of population, only shocks with maximum reported intensities (Modified Mercalli) of V or greater are shown in Figure 1. Locations of events in Figure 1 were adjusted arbitrarily to avoid overlapping of symbols. With few exceptions, shocks of this time period can be placed only at the nearest population center. The earliest earthquake on the map occurred April 28, 1868 near Socorro; the latest on July 3, 1961, also near Socorro.

Of the 58 earthquake epicenters plotted in Figure 1, 39 are well within the Rio Grande rift boundaries proposed by Dr. Charles Chapin (1971). This historical activity correlates well with the distribution of population in New Mexico, which was and is heavily concentrated along the Rio Grande. Therefore, bias toward population centers probably exists in this pre-1962 earthquake data, particularly for events with maximum intensities of V, which constitute about 60 percent of the epicenters in Figure 1.

Localities of earthquakes with intensities greater than VII

The concentration of earthquakes with maximum intensities of VII or VIII along the Rio Grande valley from 1868 through 1961 is real because events of this strength would have been observed in all but the most isolated areas of the state. Included in this group are three earthquakes near Socorro (34.0°N and 107.0°W) that were the strongest earthquakes in New Mexico since 1868. The three events, felt over areas on the order of 200,000 to 250,000 km^2, were part of a swarm that commenced in early July 1906 and continued into January 1907. Although the evidence is not conclusive, the distribution and strength of intensity values for the three strong shocks in the swarm suggest, beneath the Socorro Mountain, a relatively young north-south uplifted block in the central part of the main rift graben. The December 1935 swarm that was centered near Belen (34.6°N, 106.80°W) in the Albuquerque Basin also seems to have originated near the axis of the central rift graben at that location. At Los Lunas, 18 km north of Belen, the shocks of the 1935 swarm were felt much more weakly than at Belen. This was an unlikely observation if the epicenters were on the rift margins, which are located approximately 30 km to the east and west of the two communities. Recent instrumental studies in the same region show considerable seismic activity within the main rift **graben** but little associated with its well-defined boundary faults.

Besides the Socorro and Belen swarms, the best-documented earthquakes for the pre–1962 period were (1) a single shock near the axis of the Rio Grande rift at 35.45°N and 106.1°W, and (2) a swarm centered in

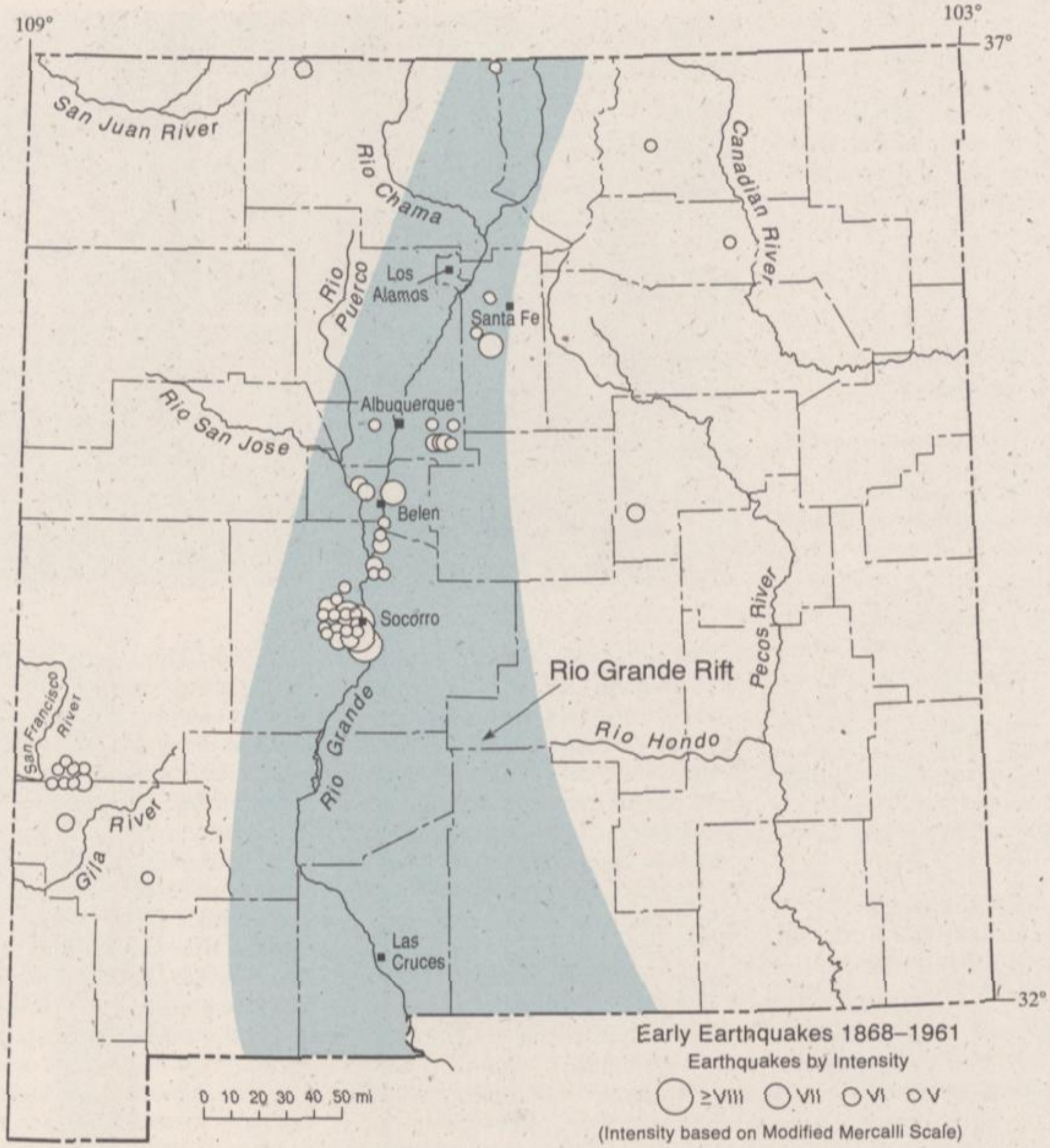


Figure 1—Earthquake activity in New Mexico prior to 1962. Plotted are the approximate epicenters for earthquakes with maximum intensities (Modified Mercalli, see Table 1) of V or greater. The intensity based epicenters come primarily from Coffman and von Hake (1973) and Sanford and others (1981). Locations of some events have been adjusted slightly to avoid superposition of symbols. The approximate position of the Rio Grande rift proposed by Chapin (1971) is shaded.

the southwestern corner of the state at 33.20°N and 108.70°W. The Rio Grande rift event, known as the Cerrillos earthquake, occurred on May 28, 1918 and had a maximum Modified Mercalli intensity of VII to VIII. The swarm in southwestern New Mexico occurred from September 1938 through early June 1939 and contained six shocks of maximum intensity V or VI.

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Aster, R. C., 1994b, Have you ever wondered how earthquakes are measured?: New Mexico Bureau of Mines and Mineral Resources, Lite Geology, Summer 1994, pp. 4–6.

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Coffman, J. L., and von Hake, C. A., 1973, Earthquake history of the United States: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Publication 41-1, revised ed. (through 1970), pp. 59–88.

Northrop, S. A., 1976, New Mexico's earthquake history, 1849–1975: New Mexico Geological Society, Special Publication 6, pp. 77–87.

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Soviet/American rift studies...

Geophysicists from the Soviet Union (Dr. Yuri Zorin, left) and the United States (Dr. Kenneth Olsen, right) demonstrate at the bridge over the Rio Grande how the Earth's crust was stretched to form the The Grande rift. A team of scientists from the two countries toured the Rio Grande rift of the western United States and the Baikal rift of Siberia in 1988 to compare their structures and volcanic rocks. Both rifts consist of a chain of sedimentary basins formed by subsidence of large fault blocks as the Earth's crust was stretched during movement of the continental plates upon which they reside. The rifts are bordered by high mountains (like the Sangre de Cristo Mountains) that formed as fault blocks bordering the basins rose concurrently and shed sediments into the basins.

Volcanism, earthquakes, and high heat flow from the Earth's interior are other common characteristics of continental rifts. The Rio Grande rift extends from near the Wyoming–Colorado border to the Big Bend area of Texas. The Albuquerque and San Luis Basins are two of the largest and deepest sedimentary basins of the Rio Grande rift. Estimates of east-west stretching of the Earth's crust across the Albuquerque Basin range from 17–28%. As the Albuquerque Basin subsided, sedimentary deposits accumulated to depths as great as 15,000 feet and the bordering Sandia Mountains rose to elevations of 5000 feet or more above the surface of the basin.

—photo and description by Charles Chapin, NMBM&MR Director and State Geologist

the way it wasn't...

In 1904, a reporter for the El Paso *Herald* wrote an exaggerated description of a swarm of earthquakes near Socorro. In reality, no significant damage occurred and the article sparked this reply in the Socorro *Chieftain*:

The El Paso *Herald* of March 16 contains a column article on the recent earthquakes in the vicinity of Socorro. The article is remarkable. In fact, it is a masterpiece; for without the sensible and true avouch of one's own eyes it would be beyond belief that there could be crowded into so small a space so much airy and fantastic nonsense resulting apparently from a too liberal indulgence in the fluid extract of either Texas corn or Arizona cactus.

For example, the *Herald* writer says that one of the recent earthquakes in this vicinity "lasted three minutes" that "pedestrians were caused to reel on their feet," that the walls of adobe houses have "become cracked and rendered almost unsafe as places of abode," that the spring which supplies the city with water "has commenced to boil since the trouble has been going on" and is "now a seething cauldron," and that there are those who say that Socorro because of past wickedness "is getting a touch of the experience that was administered to Sodom and Gomorra."

Let us see. Within the last six weeks Socorro has suffered perhaps 15 earthquake shocks not one of which lasted 20 seconds. As a result not a single wall is one-half as badly cracked as the brain pan of the *Herald* writer must be. During this earthquake period a few pedestrians have been seen to "reel on their feet," but a little investigation by the proper authorities has revealed the fact that such pedestrians were Texas Democrats and that the reeling was habitual. The waters of the Socorro spring still come from the mountain at the same temperature as for years past. If the *Herald* man will drink of them for a short time and abstain from his usual beverages, it is quite possible that he will be able to suppress the fantastic working of his own imagination. Socorro was once a wicked city. There is no doubt of that. However, judging from the fact that newspaper men are among the most moral citizens of any community, the performance of the *Herald* writer is ample proof [that] Socorro in its wickedest days was an Elysium as compared with that present in El Paso, the moral cesspool of two great republics.

—(Socorro *Chieftain*, March 19, 1904).

Trust Land for New Mexico Classrooms

One of New Mexico's most precious birthrights is its 13 million acres of land. This land is held in trust for 22 beneficiary institutions, including the public schools, state universities, hospitals, and medical facilities. Revenues raised from the use of trust land resources fund the beneficiary institutions, greatly offsetting the burden that would otherwise be borne by the taxpayers.

The responsibility for managing the trust lands is vested in the New Mexico State Land Office. The Land Office is headquartered in Santa Fe; field offices are located in Carlsbad, Farmington, Grants, Hobbs, Las Cruces, Moriarty, Portales, Roy, Roswell, Socorro, and Silver City.

The Land Office is headed by the Commissioner of Public Lands, who is Ray Powell. An elected state official, the Land Commissioner acts as a trustee and chief fiduciary officer of the trust. The commissioner is required to manage the trust's assets to maximize income to the beneficiaries. At the same time, the assets must be protected from waste and dissipation in order to ensure that future generations of New Mexicans will be able to enjoy this trust land legacy.

The State Land Office offers New Mexico's public school teachers the opportunity to adopt a parcel of trust land through an Education Easement. These tracts of trust land are meant to be used as outdoor classrooms where students can do hands-on projects in land restoration, range management, soil analysis, reforestation, wildlife preservation, and nature observation.

The purpose of this program is to encourage teachers to take students out of the classroom and onto the land where they can begin to develop a sense of ownership and caring for our state lands and an understanding of the relationships between the natural and built environment.

How to adopt land for your school

Teachers wishing to use a tract of state trust land need to request an application. Please include a brief description of the projects planned for the tract. There is no cost associated with the application or easement.

When the application has been processed, the local Land Use Specialist will contact the school and together they will locate an appropriate parcel of land. Tracts ranging from one to ten acres will be granted to individual schools. Teachers within each school will share the same tract, but will be able to select individual parcels within the tract for use by specific teachers.

Suggested activities

Land Office staff can help teachers develop guidelines appropriate to their area of the state and tract of land. They can conduct teacher training and work with students in the following disciplines:

- **Archaeology**
  Classroom presentations in New Mexico's history and prehistory; field schools in site documentation, mapping, and survey. Field trips can be scheduled to cultural sites throughout the state.

- **Geology**
  Rock and fossil identification and classification, compass reading and mapping. Field trips for the purpose of investigation, discovery, and nature observation.

- **Range analysis**
  Identification of native and non-native plant and grass species. Setting up transects for range analysis and presenting techniques for range and soil conservation.

- **Reforestation**
  Identification of native and drought resistant trees. Instruction in the planting and maintenance of trees, and managing plantings to increase wildlife habitat.

- **Watershed rehabilitation**
  Assessing natural and man-made erosion and teaching low impact erosion control techniques, such as building rock and brush check dams, swales, and shallow ditches that follow land contours, and reseeding techniques.

State Science Competencies

Environmental education activities on state trust land can help satisfy the required State Department of Education competency in "Environmental Issues" and the study of natural systems. If there are any questions concerning these competencies, please call the Science Consultant at the Department of Education in Santa Fe, (505) 827-6579.

To apply for an Environmental Education Easement, contact:

New Mexico State Land Office
310 Old Santa Fe Trail
P.O. Box 1148
Santa Fe, NM 87504–1148

(505) 827–5760 phone
(505) 827–5766 fax

Source:
Environmental Education Easement pamphlet, New Mexico State Land Office, Santa Fe, New Mexico.

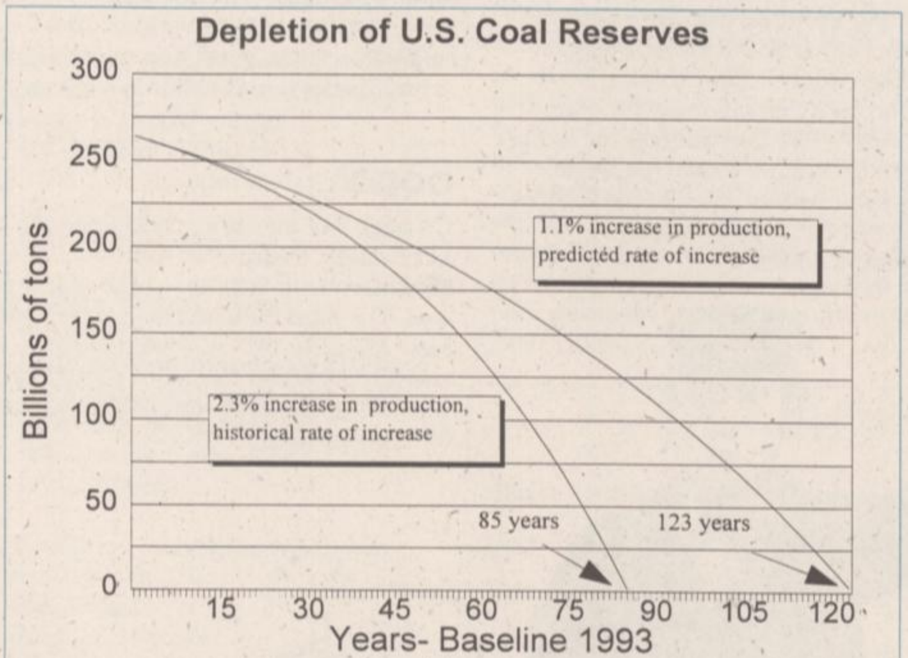
How Long Will U.S. Coal Reserves Last?

Gretchen Hoffman
Senior Coal Geologist, NMBM&MR

A reader commented on a statement in the article "Have you ever wondered about coal?" that appeared in the Spring 1995 issue of *Lite Geology*. The statement was "At the present rate of production, the United States has more than 250 years of recoverable reserves." This estimate is based on a constant annual production rate of one million tons and 264.6 billion tons recoverable reserves. The reader felt this projection was much too optimistic so we looked at the *Annual Energy Outlook 1995*, published by the Energy Information Administration (EIA). The EIA predicts an **annual increase of 1.1%** for United States coal production in the next 20 years. Historically the rate of increased production for the **past 20 years is 2.3%**. The predicted increase is lower because of the smaller projected increase in coal demand for electrical generation (EIA, Energy Outlook 1995, p. 51).

If we begin with one million tons of annual production and use both rates of increase, 1.1% and 2.3%, we get two sets of projected yearly production figures. By subtracting both sets of production figures from the recoverable reserves (264.6 billion tons) starting in 1993, we can find out how long they will last. The U.S. coal supply will last 123 years or 85 years (Fig. 1), using the predicted and historical rates of increase in production from EIA.

Several factors influence coal production and how quickly our reserves will be depleted. Environmental regulations will decide how much of the present reserves will be mined through restrictions on the quality of the coal that can be burned. New technology may increase the percentage of coal that can be extracted during mining. New technology also may make coal that is uneconomic now, either because it is too deep or too thin, economic in the future, increasing the recoverable reserves. Other types of fuel, such as natural gas, may replace part of coal's share in generating electricity, which will decrease the rate of production. It is difficult to predict how quickly our nation's coal resource will be depleted, because there are so many economic, environmental, and technological factors to consider. Because of environmental concerns, many clean coal technologies are being implemented. The goal of these technologies is to reduce pollutants, in particular greenhouse gas (carbon dioxide) emission, and increase the conversion efficiency from coal to electricity. When these technologies are feasible and affordable, they will definitely impact the rate of production. For these reasons the use of predicted rates of increased production determined in 1995 may not be applicable in 20 years.



Production rates are from Energy Information Administration, Annual Energy Outlook 1995, p. 51.

late shaking news event...

Village of Polvadera buzzing over swarms

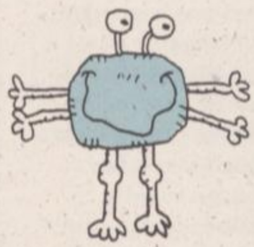
Residents in the village of Polvadera, New Mexico, located ten miles north of Socorro, recently experienced a series, or swarm, of small but perceptible earthquakes. The swarm began on Monday, August 28, 1995 and has continued for two weeks. The five earthquakes measured between 2.0 and 2.7 on the Richter scale and were monitored by a network of nine stations operated by New Mexico Tech's Seismological Observatory. Although a magnitude 2 generally is the *smallest* quake felt by humans, Polvadera residents perceived these as strong tremors because they occurred so close to the surface, at a depth of only one or two miles.

Lite Geology's own cartoonist, **Jan Thomas**, lives in Polvadera with her husband Peter Mozley and son Willie. Jan reported that her house shook, and there was a noise like a sonic boom, which startled Willie. Dr. Allan Sanford, professor of geophysics and senior geophysicist at New Mexico Tech, suggests that the seismic energy in the ground is probably being converted to sound waves in the atmosphere, causing the loud noise associated with the Polvadera quakes. Other residents of the village reportedly vacated their homes when they felt the ground vibrations.

Dr. Sanford said that there appears to be no cause for alarm over this swarm, although it interests scientists. The strongest swarm in Socorro that we know of occurred in 1906, and included three magnitude 6 quakes, which are capable of causing serious damage. The Socorro area is prone to earthquake swarms because there is a thin, extensive body of magma about 12 miles below the surface, which from time to time inflates and stretches the Earth's crust, causing earthquakes.

New Mexico residents interested in learning about earthquake safety can contact either Bob Redden, Program Manager for the New Mexico Earthquake Preparedness Program (505) 827–9254 (see address on facing page); or Susan J. Welch, Geologic Extension Service, NMBM&MR, at (505) 835–5112; or by e-mail susie@gis.nmt.edu.

Publication sources:



Rocks from space—This guide to meteorites, asteroids, and comets is written for rockhounds, astronomy buffs, and the inquiring layperson. *Rocks from space* tells the story of cosmic debris, including the science, the superstition, and tales of people who collect them. The 464–page paperback book costs $20.00 plus shipping, and is available from Mountain Press, 1301 S. Third West, P.O. Box 2399, Missoula, MT 59806; their toll-free phone number is **1–(800) 234–5308**. The Mountain Press catalog contains various titles on Earth science, gems and minerals, natural history, and children's topics.

oops...

On page 9 of the Spring 1995 issue of *Lite Geology*, we featured a cut-out bookmark with facts about New Mexico coal. The third bulletted item states that New Mexico's 1993 coal production was 28.3 standard tons. This should be 28.3 *million* standard tons. We apologize for any confusion.

Sources for Earth Science Information

Teachers can receive free materials including curricula, student handouts, and reference materials for school resource media centers by contacting:

U.S. Bureau of Mines
Guy Johnson, Staff Engineer
Building 20
Denver Federal Center
Denver, CO 80225–0086

A free teacher's packet including a poster, lesson plans, activities, and a list of mineral resource information can be obtained by calling or writing to:

Mineral Information Institute
Jackie Evanger
475 17th Street; Suite 510
Denver, CO 80202
(303) 297–3226

Information on Earth Science programs, projects, reports, products and their sources is available from:

US Geological Survey
Earth Science Information Center
(USGS ESIC)
Call 1–(800) USA–MAPS

or in New Mexico, contact:

Amy Budge
Earth Science Information Center
Earth Data Analysis Center
University of New Mexico
Albuquerque, NM 87131
(505) 277–3622

Information on earthquakes in New Mexico is available by contacting:

Bob Redden
Program Manager
New Mexico Earthquake Preparedness Program
Department of Public Safety
P.O. Box 1628
Santa Fe, NM 87504
(505) 827–9254

note: Please mention *Lite Geology* as the referral source when contacting these agencies. Thanks!—ed.

upcoming events

September 27–30, 1995
New Mexico Geological Society 46th Annual Field Conference will be held in Santa Fe, New Mexico this year. Conference Headquarters will be the High Mesa Inn. For registration information, please contact:

Maureen Wilks
NMGS Registration Chair
NM Bureau of Mines
Socorro, NM 87801
(505) 835–5420
Fax (505) 835–6333

October 13–14, 1995
New Mexico Science Teachers Association Fall Conference (NMSTA) will be held jointly with the New Mexico Council of Teachers of Mathematics (NMCTM). The conference will be based in Ruidoso at the Convention Center. For registration information, contact Carla Burns in Ruidoso at (505) 257–4205.

1995–1996 subscriptions for Lite Geology:

Lite Geology began as a small Earth-science publication designed and scaled for New Mexico. Our subscription list has grown tremendously during the past three years, and now includes a large number of out-of-state readers. In order to keep up with the demand for this publication from outside of New Mexico, we will charge **$4.00 per year for out-of-state readers**, which covers the cost of printing and mailing *Lite Geology*. The subscription year begins with the Fall 1995 issue, and ends with the Summer 1996 issue to correspond with the academic year. **If you reside outside of New Mexico and wish to keep your subscription active, please return this form with a check for $4.00.** We thank all of our readers for their enthusiastic support, and hope that all of you will continue to subscribe. If you have questions about your subscription, please call Theresa Lopez at (505) 835-5420. Thanks! —ed.

Lite Geology

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**Beginning with the Fall 1994 issue, out-of-state subscribers will be charged $4.00 per year to cover printing and mailing costs.

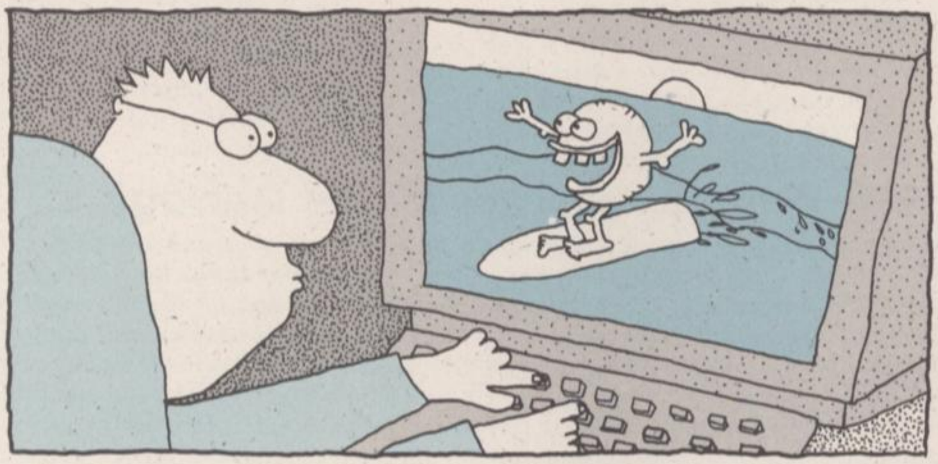
what's on-line?

The New Mexico Bureau of Mines and Mineral Resources announces a new World Wide Web home page. If you are able to access the Web, we invite you to visit us at:

http://geoinfo.nmt.edu/

At the geoinfo site you will find our *Guide to Services and Annual Report*, Publications price list, staff directory, highlights of *Lite Geology* cartoons, color photos of minerals and geologic scenes in New Mexico, along with teacher resources and other features. Our Geolinks page will connect you to many different sites offering geologic information. If you visit our web page and have comments or questions, you can leave a message by using our e-mail mailbox. See you on the Web!

Susan Welch
Geologic Extension Service
susie@gis.nmt.edu



Surfing the net

LITE geology

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