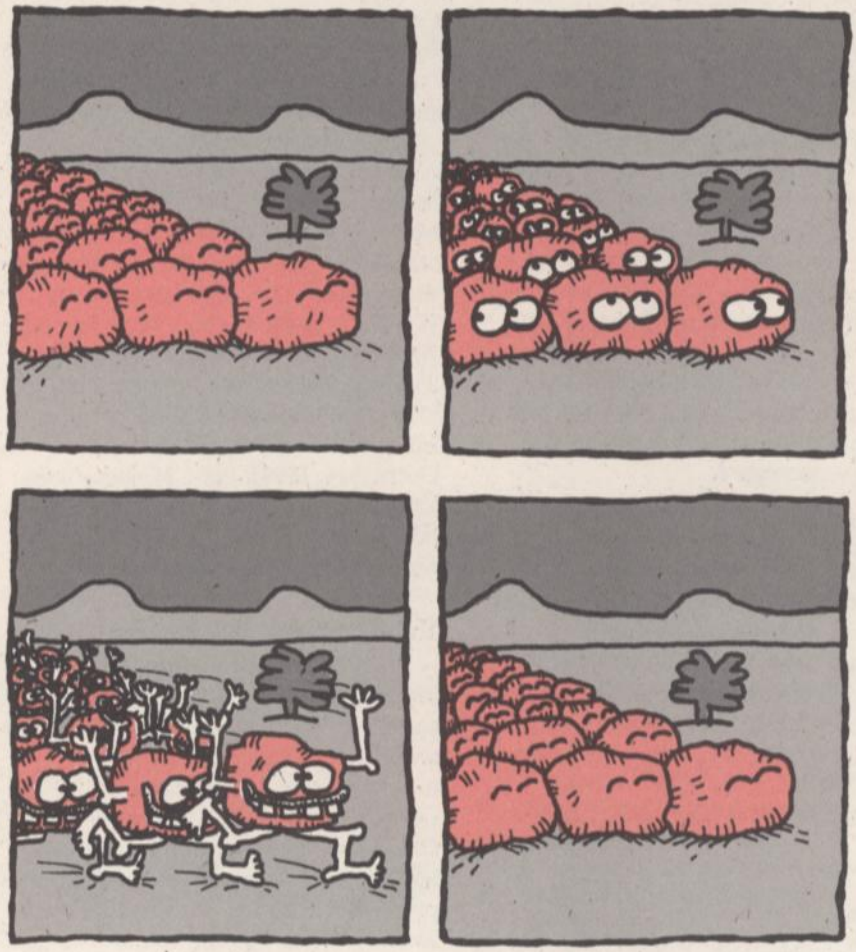
Spring 1995

LITE geology

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

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



How rock glaciers move.

This Issue:

Earth Briefs

Geologist Makes Heads and Talus of Rock Glaciers

In mountainous parts of New Mexico and Arizona, relics of near-glacial conditions—**rock glaciers**—have been described by John Blagbrough (Blagbrough, 1984; 1994), a geologist from Albuquerque who began studying them in the 1960s using aerial photos and reconnaissance flights. An active rock glacier is a slowly moving mass of poorly sorted boulders and smaller rocks, which is cemented by **interstitial ice** (ice that forms *between* rocks and *within* cracks in the rocks). When the ice melts away, the rock glaciers become inactive. This is the case with the rock glaciers in New Mexico, which are no longer moving and are free of ice.

The rock masses originated on steep slopes where **diurnal** (daily) freeze-thaw cycles (during part of the year) broke up cliffs and large rocks, leaving a sloping pile of loose material called a **talus cone or talus sheet**. At the base of the talus, where temperatures hover near freezing, interstitial ice caused the mass of rocks to creep in a manner similar to that of true glaciers, which are large, continuous sheets of ice. **Tongue-shaped** rock glaciers are elongated, with a greater length than width. These occur at the head of a valley or **cirque** (a deep glacial cut at the head of a valley). **Lobate** rock glaciers are as wide as (or wider than) they are long, and occur at the base of talus along valley walls (Blagbrough, 1984).

Rock glaciers were formed in alpine areas (mountainous regions lying between timberline and snowline) in south-central and west-central New Mexico and east-central Arizona. The New Mexico and Arizona sites where rock glaciers are evident are the Capitan, Carrizo, Gallinas, Magdalena,

San Mateo, Mogollon, and Escudilla Mountains. The rock glaciers are believed to be of late **Wisconsin** age (30,000–10,000 years before present), which was the most recent glacial stage of the Pleistocene Epoch.

Understanding the conditions under which rock glaciers form and move gives paleoclimatologists a tool for piecing together the climatic history of an area. These rock glaciers formed in late Wisconsin climate, which had **permafrost** conditions (mean annual temperatures at freezing or below) that favored interstitial ice development, and temperatures that were low enough to maintain the ice and allow for creep. In south-central New Mexico, mean annual temperatures were at about 0°C (32° F) at the lower limit of rock glaciers.

Modern conditions of 0°C occur about 1,000m (3,280 ft) higher in elevation than rock glaciers in south-central New Mexico. The modern temperatures at the lower elevation limit of rock glaciers are 7.2 to 7.9°C, showing that temperatures were 7 to 8°C lower in late Wisconsin time.

To the west, elevations of the lower limits of rock glaciers are higher than in south-central New Mexico. This rise may be due to increased snow cover in the western mountains, because snow insulates the ground and inhibits rock-glaciers' development (Blagbrough, 1994).

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–story by D. Love and S. Welch

Have You Ever Wondered...

... About Coal Mining?

Gretchen Hoffman
Senior Coal Geologist, NMBM&MR

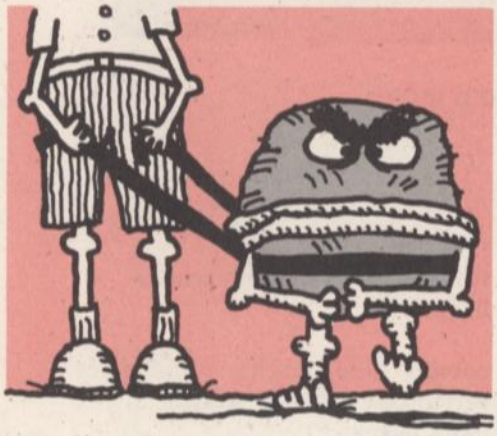
Introduction

In the Winter 1994 issue of *Lite Geology* we learned about coal formation, its **ranking** system (**lignite, subbituminous, bituminous**, and **anthracite**), and coal quality designations (in terms of heating values and sulfur content).

Although coal-bearing rocks cover one-fifth of New Mexico, most people in our state have little direct contact with coal. Coal is the third largest source of revenues in the state from mineral and energy production, and it is an important source of energy for most New Mexicans. The following explores coal production, modern mining techniques, and uses for coal. **Boldface terms** are defined in the glossary on page 6.

Coal Production

The United States produces approximately one billion tons of coal per year, and the coal industry employs more than 100,000 workers (Energy Information Administration, December 1994; 1993 figures). At the present rate of production, the United States has more than 250 years of **recoverable reserves** (264.6 billion tons).



Harnessing coal's energy.

Most of this country's annual production comes from eastern coal fields, but western coal production has increased significantly during the past 30 years. Western mines are primarily surface operations that are more efficient than underground mining, generally reducing the cost of western coal. The average mine price of coal from the Western region is $11.14/ton compared to $20.03/ton and $27.64/ton from the Interior and Appalachian regions (Energy Information Administration, December, 1994). Production costs and the demand for low–sulfur coal to meet environmental standards have significantly increased the consumption of western coals. Wyoming with its thick beds (average 70 ft thick) of low-sulfur coal is the leading coal-producing state (210 million tons per year; Energy Information Administration, December, 1994). New Mexico ranks 12th in the nation, producing 28.3 million tons of coal in 1993, a record high for the state (Hatton, 1994).

Production by Rank

In 1993, 61% of the total United States production was bituminous coal, 29% subbituminous, 9.5% lignite, and 0.5% anthracite (Energy Information Administration, December, 1994). Texas and North Dakota are the leading producers of lignite in the United States, where it is primarily used to generate electricity. North Dakota has the nation's largest coal gasification plant, Great Plains Synfuel, which converts lignite into gas and creates several by-products such as ammonia, sulfur, and liquid nitrogen (Energy Information Administration, January 1994). Wyoming is the leading producer of subbituminous coal (207.9 billion tons, 1993) followed by Montana (35.6 million tons, 1993). More than half of New Mexico's production is from subbituminous coal (16.9 million tons, 1993).

Most of the nation's bituminous coal production comes from the

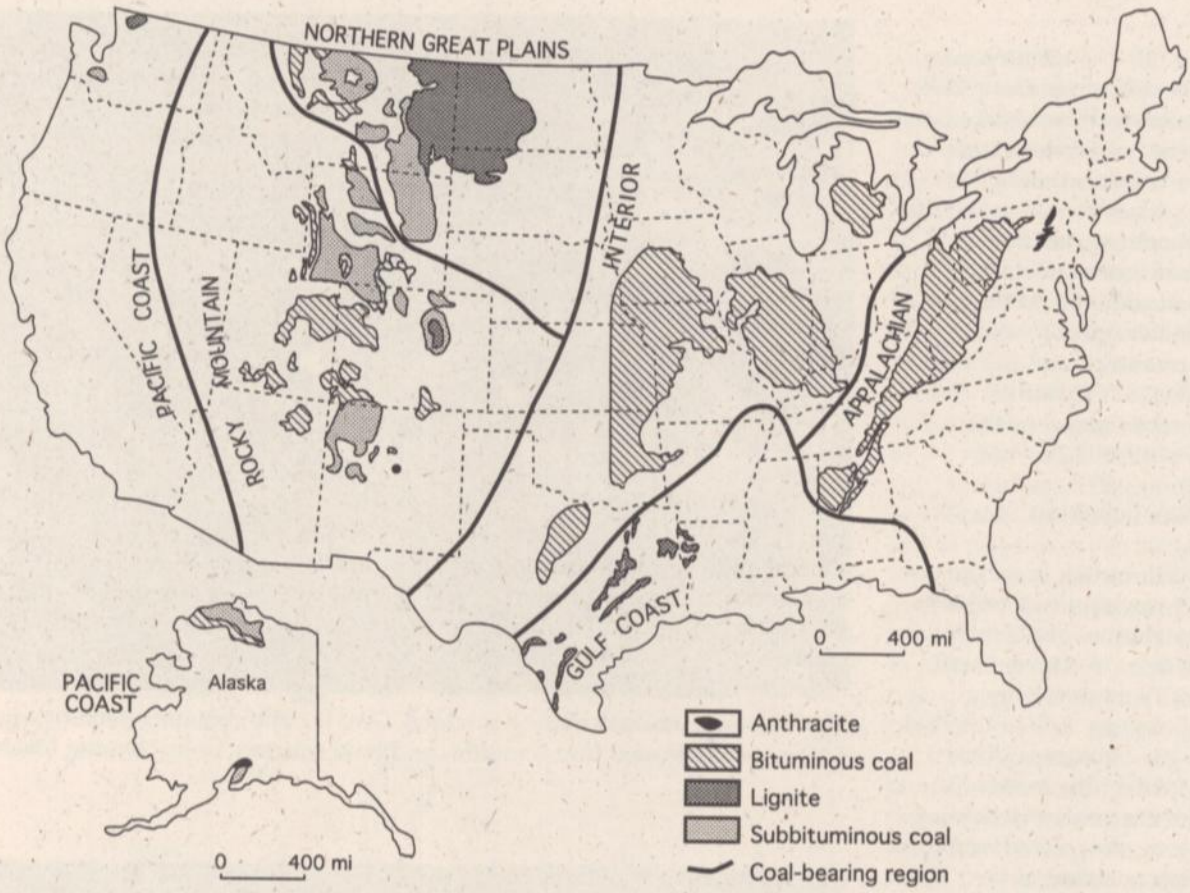


Figure 1—Coal-bearing areas of the United States. Modified from Energy Information Administration, December, 1994.

Appalachian coal fields (Fig. 1). Kentucky and West Virginia are the largest producing states within this region, 156.3 and 130.5 million tons in 1993, respectively. Approximately one tenth of the nation's bituminous coal production is from the Rocky Mountain region, and most of this output is from Utah (21.8 million tons, 1993). Less than half of New Mexico's yearly coal production is bituminous coal (11.3 million tons, 1993). Present production of anthracite (about 4,000 tons) in the United States comes from the Appalachian region for home heating fuel and for **coke** production.

Mining Coal

In the past, most coal mining was underground and very labor intensive. Although surface mining with large mechanized equipment began as early as the 1920s, surface production did not overtake underground output until the 1970s. Today, 60% of coal produced in the United States is from surface operations. The remaining production is from underground mines, primarily in the eastern coal fields. Utah is unusual among western coal-producing states because all 15 of the operating coal mines are underground (Energy Information Administration, December, 1994). There are 13 underground mines in Colorado and New Mexico had one underground operation in the Raton field as recently as March of 1995. Until the 1960s, all coal mined in New Mexico came from underground mines.

Underground mining

Present underground operations in the United States are highly mechanized and must comply with the Federal Coal Mine Health and Safety Act. Ventilation, control of coal dust, and roof stability are major concerns that are monitored. For all underground mining the average coal recovery rate is about 56%. There are three methods of mining coal underground: 1) **room and pillar** with **continuous mining**, or 2) room-and-pillar with **conventional mining** , or 3) **longwall mining**.

In the room and pillar method using continuous mining, the mining machine breaks the coal from the **mine face** and transports the coal to a shuttle car that loads it onto a conveyor belt, which moves the coal to

the surface (Fig. 2). The continuous mining machine advances about 20 ft into the coal seam and then backs out so the roof can be bolted to provide stability. This is repeated along the mine face, but pillars of coal, generally 40 to 80 ft on a side, are left between the paths of the continuous mining machine for roof stability. At the end of a mine's production phase, some pillars may be removed and the roof allowed to collapse. Of all the underground mines active in the United States in 1993, 56% used continuous mining (Energy Information Administration, March, 1995).

Conventional mining is also a room-and-pillar method but involves the use of explosives to break the coal from the mine face. In conventional mining, the coal is undercut by a machine and holes are drilled into the coal to pack with explosives. After blasting the coal bed, the broken coal is loaded into shuttle cars for delivery to the conveyor and transported to the surface. The roof is bolted in the excavated area and the process is repeated (Energy Information Administration, March 1995). Pillars are left between the excavated rooms to maintain stability of the mine roof. Conventional mining includes only 11% of underground production in the United States.

Longwall mining uses a cutting machine operating along a 400– to 800–ft-long face of the coal seam. As the machine cuts into the coal using a revolving cylinder with bits, the coal falls onto a conveyor belt that carries the coal to the surface (Fig. 3). Attached to the longwall machine are steel roof supports that advance as the machine moves forward, allowing the roof behind the supports to fall. The longwall method has a higher recovery rate than room and pillar method, but is used in fewer mining applications because of the need for greater roof stability and seam consistency. The Cimarron underground mine (Fig. 4) near Raton used the longwall method.

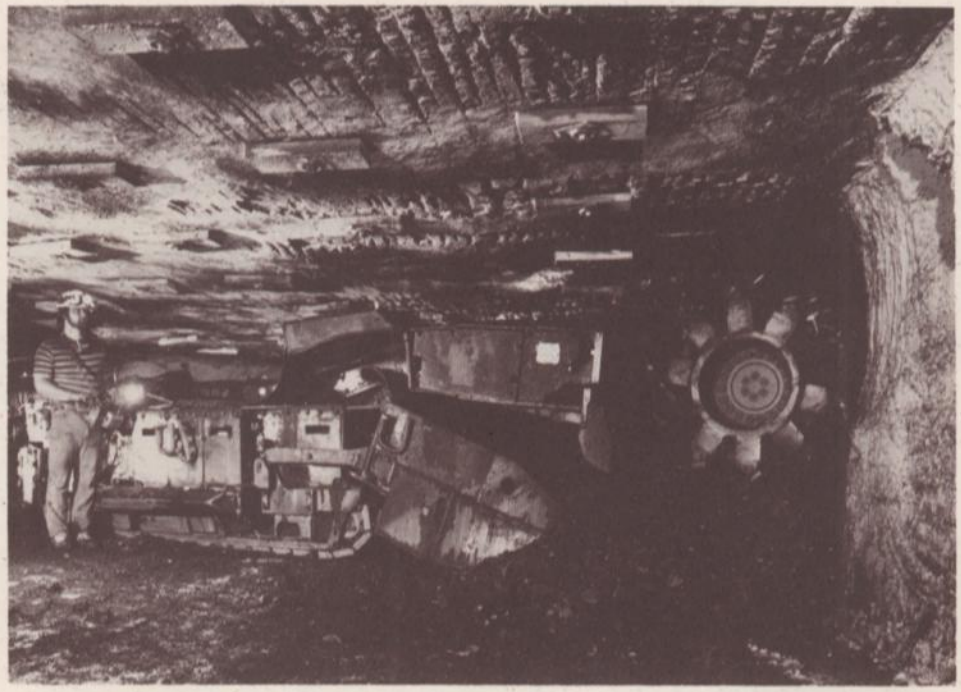


Figure 2—Continuous mining machine. Coal is cut by rotating cylinder and automatically loaded into a shuttle car. Photo courtesy of Joy Mining Machinery.

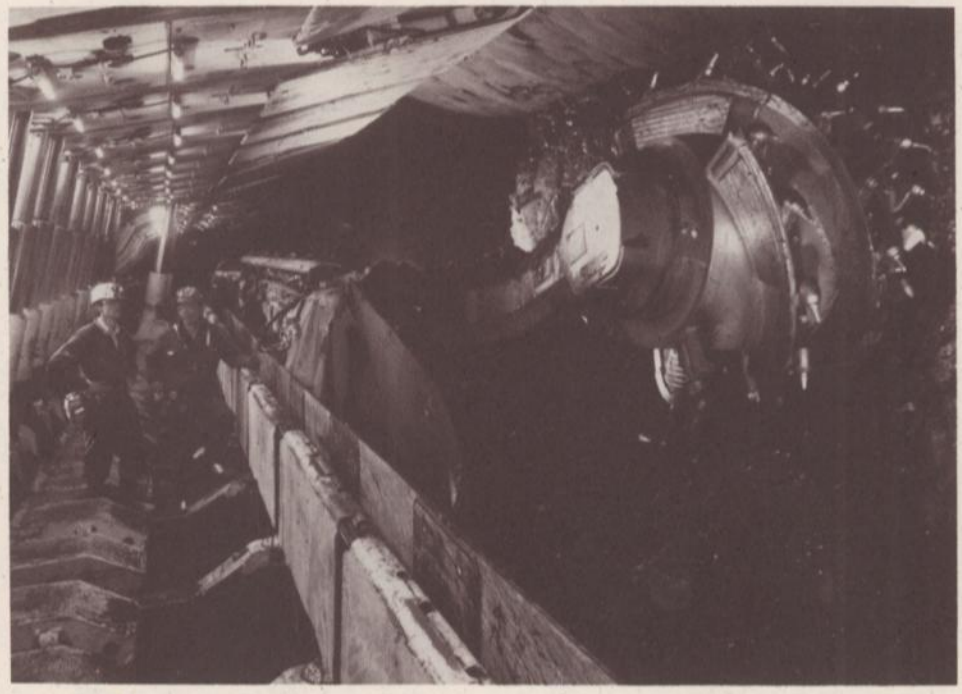


Figure 3—Longwall mining machine. A revolving cylinder with tungsten bits shears off coal by moving back and forth across the coal face. Water is sprayed to keep coal dust down. Movable supports on left side of photo hold up roof in the working area. Photo courtesy of Joy Mining Machinery.

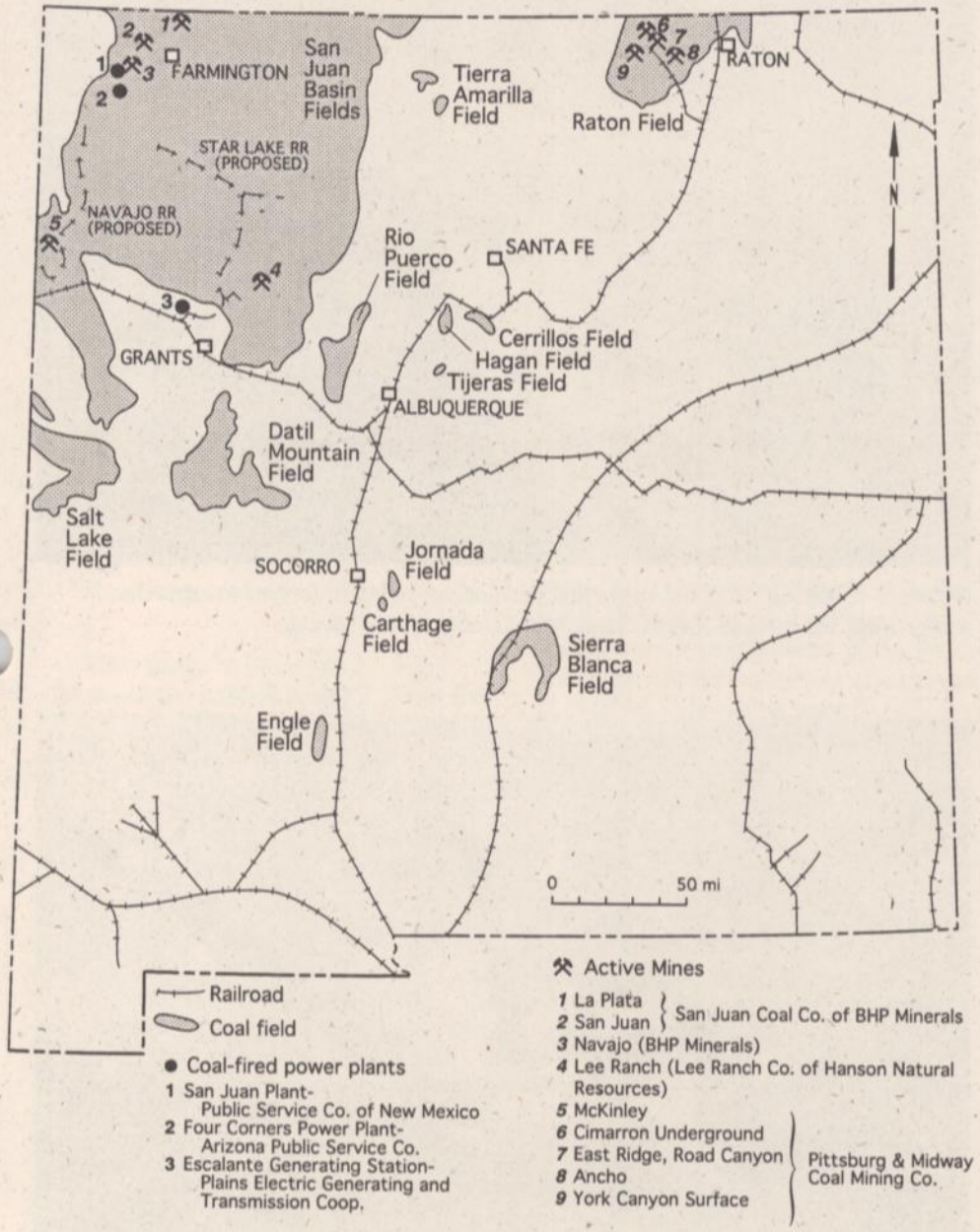


Figure 4—Map of coal-fired power plants, coal mines, and major coal fields in New Mexico. From New Mexico Energy, Minerals and Natural Resources Department, 1994.

Surface mining

Surface mining employs a combination of draglines or shovels, front-end loaders, and trucks. Four of the five surface mines in northwest New Mexico are dragline operations (Fig. 4). Smaller operations or complex mining situations use front-end loaders and trucks. The La Plata Mine (Fig. 4) near the Colorado–New Mexico border uses trucks and front–end loaders for removal of **overburden** and coal because of the high angle dip of the coal beds. The East Ridge and Ancho surface mines near Raton (Fig. 4) will also use front-end loaders and trucks because of the rugged topography of the area.

Besides the health and safety regulations, surface mines today have to follow strict environmental regulations during the development, production, and reclamation phases as set by the Surface Mining Reclamation and Control Act (SMRCA) of 1977. Federal and State surface mining agencies regularly inspect mines to make sure the mines comply with these regulations.

Mining begins by removing and storing the topsoil for use in the reclamation process. Overburden is drilled at regular distance intervals and the drill holes are loaded with explosives to break up the overburden for easier removal (Fig. 5). Draglines or shovels (55–86 yd^3 bucket) remove the overburden exposing the coal (Fig. 6). Smaller (15–30 yd^3 bucket) shovels or front-end loaders scoop up the coal and load it into dump trucks for transport to the preparation plant. Overburden goes into the spoil pile to fill the pit during the reclamation process.

Reclamation begins after removing the economic coal from an area in the mine. Regrading and contouring to natural slopes is done before replacing the topsoil. Planting of native vegetation and trees is part of the reclamation process to make the land as productive as it was before mining.

Monitoring the reclaimed areas to ensure vegetation growth and slope stability is the final step in the reclamation process. After the final seeding and mulching, regulations require monitoring reclaimed lands for five or ten years depending on the annual precipitation (Bill Sanderford, NM Energy, Minerals, and Natural Resources Department, personal comm., 1994). Most of the mines in New Mexico have a ten-year monitoring process.

Before SMRCA, many coal mines were abandoned with little or no reclamation. To fund reclamation of these old mines, the federal government collects $0.35 for every ton produced from surface mines and $0.15 for every ton mined from underground coal mines. Funding of State projects for remediation of abandoned mines comes from this tax. Most of the coal mines considered hazardous in New Mexico have been remediated through the Abandoned Mine Lands program.

Coal Consumption

Electrical generation

During our grandparents' and great-grandparents' time, burning coal was a common way of heating homes and directly supplying energy for transportation and industry. Today, coal still supplies many of our energy needs through electrical generation and industrial uses. Coal became an economic fuel for creating electricity in the mid-1970s when the Arab oil embargo drove up the cost of petroleum products. For the past thirty years, coal and nuclear power have provided increasingly larger shares of the fuel used for electrical generation. In 1993, 57% of the electricity generated in the United States was from coal-fired power plants (Energy Information Administration, July, 1994). Electrical generation used more than 87% of all the coal consumed in the United States (Fig. 7).

Figure 5—Drill rig used for shot blast (explosive) holes to loosen overburden in foreground. At the Lee Ranch mine, near Grants, New Mexico.

Figure 6—Dragline removing overburden at Lee Ranch mine, near Grants, New Mexico. This dragline has an 86 cubic yard bucket and the boom is 320 ft long. The entire dragline weighs 9 million lbs (Carter, 1994).

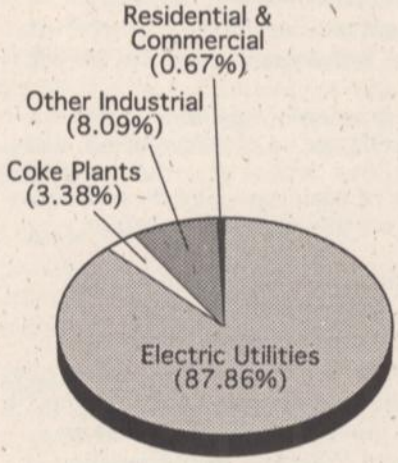


Figure 7—United States coal consumption by end-use in 1993. From Energy Information Administration, December, 1994.

Coal usage in New Mexico has followed the national trends. From the 1890s to the 1950s, New Mexico coal was used for home heating, powering railroads, and supplying coke to the steel and copper industries in the Southwest. With the arrival of diesel engines and use of petroleum products as a fuel source, coal consumption dropped to record lows in the 1940s and 1950s.

Beginning in the late 1950s, the demand for electricity in the Southwest and California steadily increased because of population growth. The low cost of coal and expected shortages of natural gas for heating prompted the need for large surface mines and coal-fired power plants. New Mexico coal production went from 0.25 million tons in 1954 to 9.41 million tons in 1974 (New Mexico State Mine Inspector, 1954, 1974) with opening of three large surface mines, the Navajo, McKinley, and San Juan (Fig. 3).

In 1993, coal-fired powerplants generated 90% of the electricity in New Mexico. The major generating stations are the Four Corners (2269 megawatts) and the San Juan (1717 megawatts), both west of Farmington, and the Escalante (233 megawatts) northwest of Grants (Fig. 4). These plants use about two-thirds of the coal produced in the state (New Mexico Energy, Minerals and Natural Resources Department, 1994). Much of the electricity generated in New Mexico goes to Arizona, California, and Texas. Most of the remaining coal produced in New Mexico is shipped by train to power plants in Arizona and, as of 1993, Wisconsin for electrical generation. Of the total energy consumed in New Mexico, 37% comes from coal, 33% from petroleum products, and 29% from natural gas (New Mexico Energy Minerals and Natural Resources Department, 1994).

Industry and other uses

Industry and coke plants consume about 11% of the coal produced in the United States (Fig. 6). Coal supplies energy for making cement, glass, paper and metal. Today only a small amount of New Mexico coal is used by industry, at a paper mill in Arizona. Coke is used in the production of iron and steel, and most of this coal comes from the eastern United States. Coal is also used as a **chemical feedstock** to make dyes, insecticides, fertilizers, explosives, synthetic fibers, ammonia, food preservatives, medicines, and other products. Residential and commercial uses consume less than 1% of the coal used in this country.

Exports

The United States exports 74.5 million tons of coal (Energy Information Administration, December, 1994) primarily from the Appalachian region. Japan, Canada, and Italy were the largest buyers of U.S. coal in 1993. Other European countries, Brazil, and China also import coal from the United States. The amount of coal exported is dependent on the economic climate of other nations. During the past few years, total coal exports have dropped because of the slow economic growth overseas.

Coal will continue to play a major role in the generation of electricity. The Clean Air Act regulations will play a part in determining whether new power stations will be coal-fired and will increase the market for low–sulfur Western coal. This will be an important factor in potential new markets for New Mexico coal.

Acknowledgments

The author wishes to thank Kay Hatton of NMEMNRD, Tom Clifford and Jim O'Neil of NM Taxation and Revenue, and Don Moseley of BHP Minerals for providing valuable information for this project. Thanks also to Frank Kottlowski and Charles Chapin for their helpful suggestions and to Kathy Glesener and Jan Thomas for illustrations.

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Glossary of coal terms

Gretchen Hoffman
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Agglomerate—Collected into a ball or mass; agglomeration.

Anthracite—A rank class of coals defined as having more than 86 percent *fixed carbon* and less than 14 percent *volatile matter* on a *dry, mineral-matter-free basis*. This rank is divided into semianthracite, anthracite, and meta–anthracite groups on the basis of increasing fixed carbon and decreasing volatile matter.

Ash—The inorganic residue remaining after complete incineration of coal.

Bituminous coal—A rank class of coals defined by the ASTM (see rank) as having less than 86 percent *fixed carbon*, and more than 14 percent *volatile matter* and more than 10,500 *Btu*/lb on a *moist, mineral-matter-free basis*. An overlap of bituminous and subbituminous heat values from 10,500 to 11,500 Btu/lb is dependent on whether an *agglomerate* button with swelling characteristics is formed during volatile matter analyses. There are several divisions of bituminous coal. High–volatile C, B, and A are divided by increasing heat value. Medium and low-volatile bituminous coals are classified on the basis of increasing fixed carbon and decreasing volatile matter.

Btu—Btu is British thermal unit. The Btu is the amount of heat needed to raise the temperature of 1 pound of water by 1 degree Fahrenheit.

Chemical feedstock—Raw material supplied to a machine or processing plant.

Coke—Material derived from heating *bituminous coal* in the absence of air and driving off the volatile constituents, so that the fixed carbon and ash are fused together.

Conservation tax—Tax (0.18%) on sales value less Federal, State, and Indian royalties. Revenues from this tax go into the state's general fund.

Continuous mining—A form of room-and-pillar mining in which a continuous mining machine extracts and removes coal from the working face in one operation; no blasting is required.

Conventional mining—The oldest form of room-and-pillar mining which involves cutting the coalbed so that it breaks easily when blasted with explosives or high-pressure air, and then removing the broken coal.

Dry, mineral-matter-free-basis—A calculated, analytical value of a coal sample expressed as if total moisture and mineral matter had been removed.

Fixed carbon—The solid residue, other than *ash*, remaining after the *volatile matter* has been liberated from coal during combustion.

Lignite—Lowest rank of coal, with low heat values between 6,300 and 8,300 *Btu*/lb, *on a moist, mineral-matter-free basis*.

Longwall mining—An underground mining method that can be used at greater depths than room-and-pillar methods. A cutting machine is pulled back and forth across a panel of coal 400 to 800 feet wide, and the broken coal is moved by conveyor belt to the surface. The roof is held up by moveable supports that are advanced as the coal bed is cut away. The roof in the mined-out area is allowed to fall as the mining advances.

Mine face—Surface in mine where excavation is being done.

Moist, mineral-matter-free basis—A calculated number based on basic analytical data—*Btu*/lb, *ash* and sulfur—to determine a number representative of the value if mineral–matter had been removed and the natural moisture in the coal retained. Used in determining the *rank* of coal.

Overburden—Material of any nature, consolidated or unconsolidated, that overlies a deposit of useful materials, ores, or coal, especially those deposits that are mined from the surface.

Rank—The classification of coals according to their degree of metamorphism or coalification (maturation) in the natural series from lignite to anthracite. Rank is defined in the United States by the American Society of Testing and Materials (ASTM) classification based on *agglomeration* characteristics, heat values, *fixed carbon*, and *volatile matter* content.

Recoverable reserves—Oil, gas, coal, and other minerals that can be economically recovered after allowing for environmental, legal, and technological controls.

Resources excise tax—Tax (0.75%) on sales value of coal, less sales or royalties paid to State and Federal governments. Revenues from this tax go into the state's general fund. Two-thirds of the general fund helps support public schools and education.

Room-and-pillar mining—The most common method of underground mining in which the mine roof is supported mainly by coal pillars left at regular intervals. Rooms are places where the coal is mined; pillars are areas of coal left between the rooms. Room-and-pillar mining is done either by conventional or continuous mining.

Severance tax—Tax on number of tons sold, consumed, or transported out of state. Revenues from this tax go into the State's severance tax bonding fund, for buildings, and other state bonds. Severance tax on coal is $1.17/ton for surface-mined and $1.13/ton on underground-mined tonnages.

Subbituminous coal—A *rank* class of coals having a heat value content of more than 8,300 *Btu*/lb and less than 11,500 *Btu*/lb on a moist, mineral-matter-free basis. This class of coal is divided by increasing heat value into subbituminous C, B, and A coal groups.

Volatile matter—In coal, those products, exclusive of moisture, given off as gas and vapor, determined analytically by prescribed methods.

Glossary Sources:

American Society of Testing Materials (ASTM), 1990, Standard classification of coals by rank *in* Annual Book of ASTM Standards—Gaseous fuels; coal and coke: ASTM, Philadelphia, PA, sec. 5, v. 05.05, pp. 193–196.

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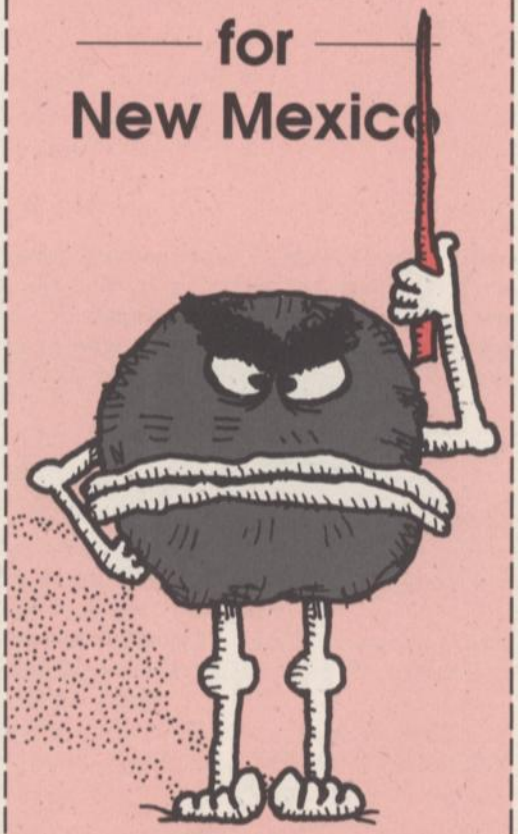
Coal Facts for New Mexico



• One fifth of New Mexico is underlain by coal. Most of the state's coal is located in San Juan, Colfax, McKinley, and Catron Counties.

• New Mexico ranked 12th in the nation in coal production in 1993.

• New Mexico's coal production reached an all-time record high in 1993 of 28.3 standard tons of clean coal, which was up 15.3% from the previous year.

• The **yearly payroll** for coal mining employees in New Mexico for 1993 was **$99.4 million**.

• Revenues from coal mining collected by New Mexico for 1993 were:

—**$34.7 million** (from **severance**, **resources excise**, and **conservation taxes**)

—**$18.8 million** (from gross receipts taxes)

—**$3.4 million** (from State land royalties and rentals)

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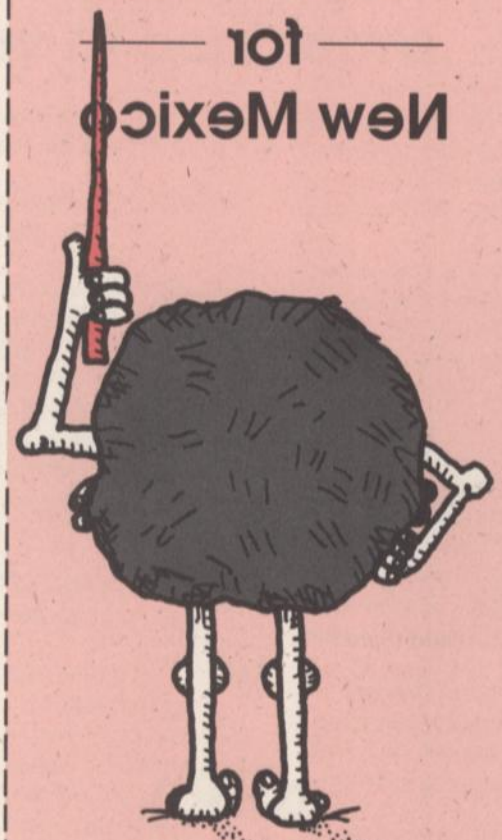
Coal Facts for New Mexico



—**$8.4 million** (New Mexico's federal royalty share)

•The active coal mines in New Mexico are:

- York Canyon Surface
- Ancho
- East Ridge
- Road Canyon
- Cimarron
- McKinley
- Navajo
- San Juan
- La Plata
- Lee Ranch

Source

New Mexico Mineral Industries—
Data 1994: Mining and Minerals Division of the New Mexico Energy, Minerals, and Natural Resources Department, 2040 South Pacheco, Santa Fe, NM 87505.

Published in the Spring 1995 issue of *Lite Geology*: New Mexico Bureau of Mines and Mineral Resources, Socorro, NM 87801

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Publication sources:

Earth in Space is an AGU publication created to keep science teachers and students abreast of the changing world of geophysical research. Each issue contains articles by leading research scientists as well as brief reports of new findings. The articles demonstrate research applications of scientific principles and analyses, and use examples that are interesting to teachers and students. *Earth in Space* is published monthly from September through May and is a good way to increase science literacy by introducing current geophysical information into the classroom. *Earth in Space* costs $12.00 per year (nine issues). For ordering information, call the American Geophysical Union (AGU) at 1-800–966–2481.

On the Rocks is an Earth science teacher's guide that contains 52 activities for students in grades 1–8. The activities are divided into seven categories: Rocks and Minerals; Earth Works; Water Works; Fossil Explorations; Maps, Maps, and More Maps; Science Basics; and Geology, Society, and the Environment. ***On the Rocks*** is published by SEPM (Society for Sedimentary Geology), P.O. Box 4756, Tulsa, OK 74159–0756. The price is $9.75 plus $1.90 for shipping.

What everyone should know about coal is a 15-page booklet that is available, along with other coal education materials, for teachers who write to the American Coal Foundation. Please specify grade level, and send your request to American Coal Foundation, 1130 Seventeenth St., NW, Suite 220, Washington, DC 20036.

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EARTH SCIENCE UPDATE

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:

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

or in New Mexico, contact:

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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

a reminder...

BHP Minerals will sponsor a teachers' workshop on minerals education on August 10, 1995 at San Juan College in Farmington. Learn hands-on activities, tour San Juan coal mine, and come home with lots of classroom materials, including a rock kit. **Registration dedline is July 1**. Contact Teri Conrad at BHP Minerals, 300 West Arrington, Suite 200, Farmington, NM 87401; or call Teri at (505) 327–6587.

art about water...

This summer, under the ***Watermarks*** program, four teams of environmental artisits will come to New Mexico to communicate about humanity's relationship to water. This program is sponsored by the Center for Contemporary Arts (CCA) in Santa Fe. Scheduled exhibits are:

- Dominique Mazeaud (Santa Fe) and Ichi Ikeda (Japan): June 9–July 18
- Wittenborn and Biegert (Germany): July 29–August 20
- Mel Chin: (call for dates)
- Helen Meyer and Newton Harrison: Sept. 22–Nov. 4

Anyone interested may call Liz Rymland at (505) 982–1338, ext. 840.

***Lite Geology* evolves:**

Lite Geology began as a small Earth-science publication designed and scaled for New Mexico. Our subscription list has grown tremendously during the past two 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*. **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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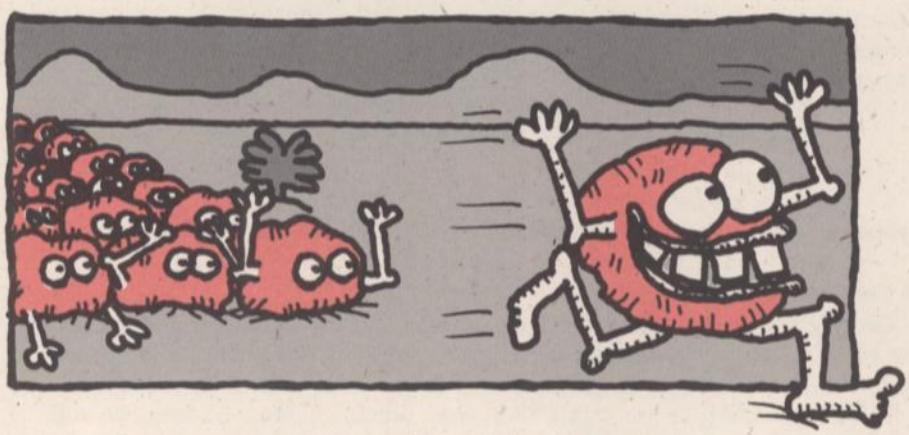
**Beginning with the Fall 1994 issue, out-of-state subscribers will be charged $4.00 per year to cover printing and mailing costs.

coming soon to a school near you...

Earthquake safety training and curricula for grade levels K–6 (*Tremor Troop*) and 7–12 (*Seismic Sleuths*) will be available soon for New Mexico teachers. *Tremor Troop* was developed by the National Science Teachers Association (NSTA); *Seismic Sleuths* was developed by the American Geophysical Union (AGU). Both programs are sponsored by the Federal Emergency Management Agency (FEMA), and will be delivered in our state by the New Mexico Earthquake Preparedness Program (NMEPP) and the New Mexico Bureau of Mines and Mineral Resources (NMBM&MR). Teachers who are interested in receiving the training and teaching materials may contact either Bob Redden, Program Manager for NMEPP in Santa Fe at (505) 827–9254, or Susie Welch, Geologic Extension Service, NMBM&MR in Socorro, at (505) 835–5112.



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