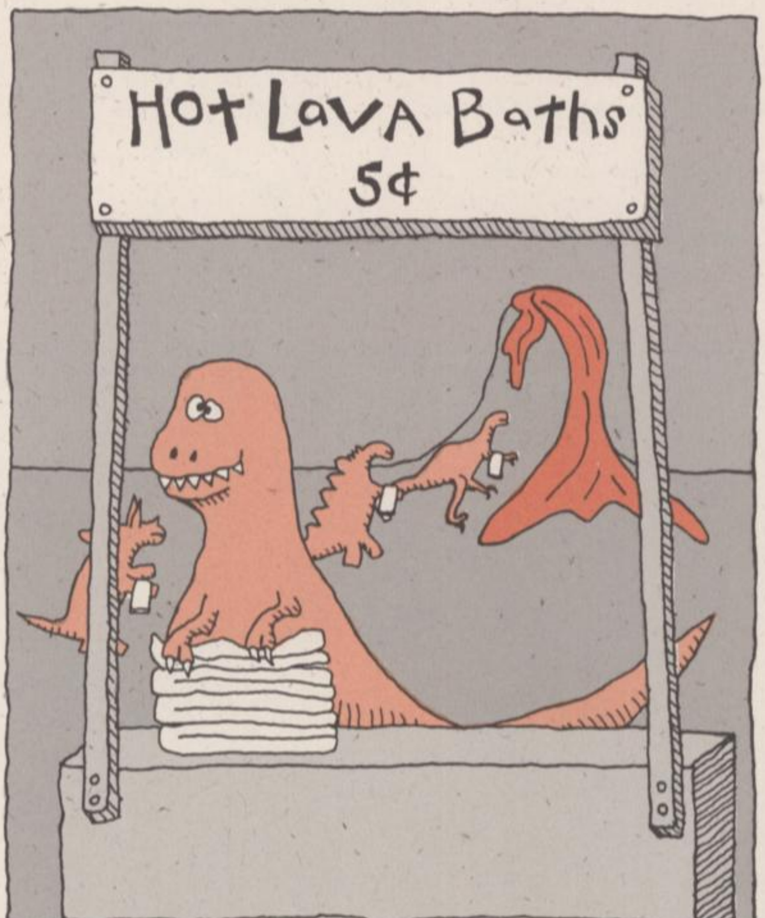
Summer 1996

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)



It may have been the dinosaurs love of long relaxing soaks that was their final undoing.

This Issue:

Earth Briefs

Popocatépetl Volcano: past eruptions—future dangers?

Nelia Dunbar
Geochemist, NMBM&MR

Popocatépetl (pōpō-kah-tah-petal), whose name means "steaming mountain" in the Nahuatl language, is a 5,464-meter-high (18,031 feet) active volcano located 60 km southeast of Mexico City. The volcano has had many episodes of activity in the past 5,000 years, and came to life again on December 21, 1994 with a series of small explosive eruptions. The volcano has remained active after this initial event, producing periodic explosive bursts, and emitting large quantities of gas (up to 15,000 tons of sulfur dioxide ((SO_2) per day). Nearby towns have been showered with volcanic ash and 75,000 people living on the eastern flank of the volcano were evacuated from their homes following the December event.

Mexican geologists feel that there is reason to worry about the current Popocatépetl activity because of patterns of eruptive behavior that the volcano has shown in the past (Siebe and others, 1996). Using detailed geological mapping and carbon-14 dating of organic material in deposits from past eruptions, they have been able to determine that Popocatépetl has experienced frequent small eruptions punctuated by a small number of major events. Based on the timing of the last two large eruptions, they think that the time span, or **recurrence interval,** between large eruptions is between 1,000 and 1,500 years. These major eruptions consisted of ash falls, hot ash flows, and dangerous volcanic mudflows called "lahars." Archeological evidence suggests that thriving civilizations and cities were destroyed by these large eruptions in the past.

The geologists warn that Popocatépetl could be due for another major eruption before the twenty-second century. They also suggest that the high gas emissions observed during the recent eruptive activity are cause for concern because the amount of gas emitted from a volcano can be related to the amount of new magma that is moving into the volcanic chamber. Geologists in Mexico have prepared detailed hazard maps of the volcano, and are developing plans for evacuation of the million people within the danger zone for a large eruption.

For up-to-date information, pictures and maps of Popocatépetl, and other active volcanoes, look on the World Wide Web! Here are some places to start:

The Global Volcanism Network
gopher://nmnhgoph.si.edu/11/.gvp/

Michigan Tech University Volcano Homepage
http://www.geo.mtu.edu/volcanoes/

Also, try GeoLinks, available through the *New Mexico Bureau of Mines and Mineral Resources Homepage*
http://geoinfo.nmt.edu/

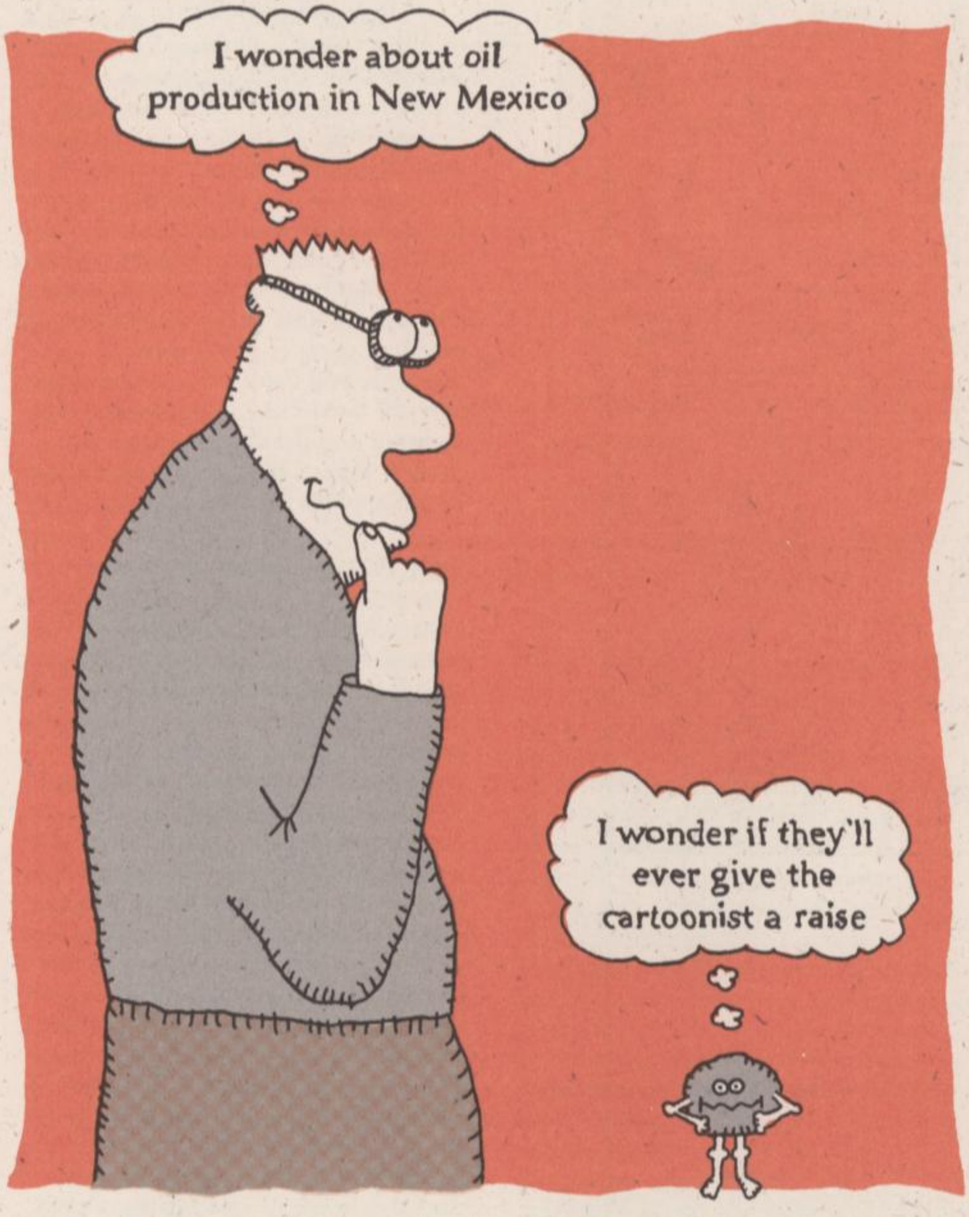
Source:

Siebe, C., Abrams, M., Macias, J. L., Obenholzner, J., 1996: Repeated volcanic disasters at Popocatépetl, central Mexico: Past key to the future? Geology, 24, pp. 399–402.

Popocatépetl near Mexico City. Photo by C. Chapin, NMBM&MR.

Have you ever wondered...

About Oil Production in New Mexico?



Ron Broadhead
Senior Petroleum Geologist, NMBM&MR

Introduction

In the Winter 1993 issue of *Lite Geology*, we discussed how oil and natural gas are formed and why these hydrocarbons accumulate where they do. In this issue, we'll discuss the history of oil production in New Mexico and look into our crystal ball to see what the future may hold. We will do the same for natural gas in an upcoming issue.

Oil was first discovered in New Mexico in 1922 when the Midwest Refining Company drilled a well and discovered the Hogback field in San Juan County of northwest New Mexico (Fig. 1). Two years later, Tom Flynn, Van Welch, and Martin Yates drilled the discovery well for the first commercial oil field in southeast New Mexico, the Artesia field (Fig. 1). From inauspicious beginnings in what were then isolated areas of the state, the oil industry has grown to be one of the foremost industries in New Mexico. As of 1994, a total of 4.7 billion bbls (barrels; 1 bbl = 42 U.S. gallons) worth an estimated $36 billion had been produced. In 1994, production in the state was more than 63 million bbls. Approximately 93% of the oil production in the state comes from the Permian Basin of southeast New Mexico; the remaining 7% is obtained from the San Juan Basin of northwest New Mexico.

With the appearance of the motorcar as the preferred mode of transportation for many Americans, the demand for the crude oil that powered these machines rapidly increased. Oil production and exploration companies were up to the task of meeting the demand and New Mexico soon became a principal oil-producing state (Fig. 2), with annual production rising from a few hundred thousand bbls per year to approximately 40 million bbls per year by World War II. The post-war industrial boom created further demand for oil in the nation and production peaked at almost 130 million bbls per year in 1969. A steep decline in New Mexico oil production began in the 1970s. The decline in production leveled off in the late 1970s. Thereafter, production actually increased briefly during two short periods, one in the early 1980s and one in the early 1990s. This article examines the reasons for the halt in the production decline and the two short periods of increased production; it also discusses the future of oil production in the state.

Early 1980s production increase

The increase in production in the early 1980s is directly related to the oil embargoes of the 1970s that were placed upon our nation's imports of

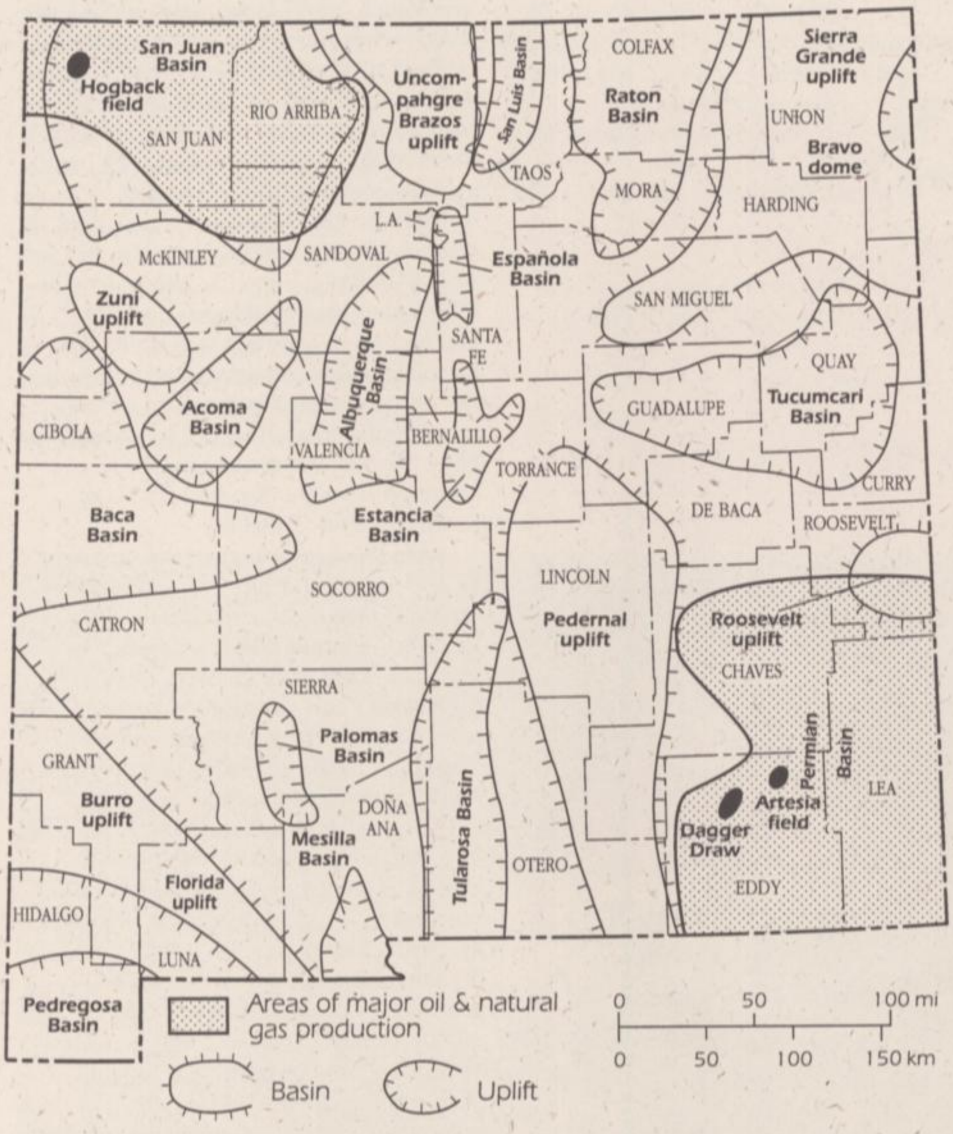


Figure 1—Location of major basins and oil-producing areas in New Mexico.

crude oil by several oil-producing Middle Eastern countries. Those countries refused to sell oil to the United States during most of the 1970s. Because the U.S. was a major importer of oil and a large percentage of the imports was obtained from these countries, domestic oil shortages resulted when domestic production and other international sources could not make up for the shortfall in supply. As a result, the well-remembered gas lines were formed by motorists who sought the then-scarce commodity. More importantly, the price of oil rose from less than \$5/bbl to more than \$30/bbl in response to the large demand and the limited supply.

One result of the higher prices was that drilling rates in the United States increased dramatically in an attempt to meet demand. The higher prices meant that many marginal oil accumulations could now be produced economically and greater risks could be tolerated in exploratory drilling. Drilling in New Mexico increased from less than 1,000 new wells drilled in 1970 to an all-time record of 2,218 wells completed in the state in 1981. The higher prices continued into the early 1980s, as did elevated rates of drilling. The increased rates of drilling resulted in many discoveries of new oil fields throughout the southeast and northwest parts of the state (as well as many other parts of the United States) and also resulted in the development of marginal parts of previously discovered oil fields. As a result of this new oil, the decline in production was reversed and production increased from 71 million bbls per year in 1982 to 79 million bbls per year in 1984.

Early 1990s production increase

Drilling tapered off in the early 1980s with the lifting of the oil embargoes and subsequent decrease in oil prices. Production again began to decline (Fig. 2). However, the decline in production was again reversed and production increased during 1991 and 1992. This time, the increase in production was not caused by an increase in statewide drilling rates. Oil prices were higher for a short time as a result of the invasion of Kuwait by Iraq in 1990 and subsequent shocks to the international oil markets. However, these higher prices were too brief to increase drilling significantly. Rather, the increase in production resulted from re-development of the Dagger Draw oil field.

The Dagger Draw field (Fig. 1) is a classic example of an underdeveloped oil field. Production at Dagger Draw is obtained from carbonate rocks of Late Pennsylvanian age. Originally discovered in 1973, Dagger Draw saw minimal production with only 19 wells drilled by 1987 and with annual production rates less than 500,000 bbls oil from the entire field. Annual production rates were less than 250,000 bbls during most years. In 1989, the operators of the field attempted absolutely no guarantees of success. The geological and geophysical work necessary for exploration is expensive and time-consuming. Hundreds of thousands or even millions of dollars can be spent identifying a drilling prospect that has a far-from-certain probability of success. Nevertheless, new field exploration is necessary for a sound future for petroleum production and will ultimately form the basis for oil production a generation or more from now.

Many new fields probably will be found within the presently productive areas of southeast and northwest New Mexico, but there also may be unknown oil fields awaiting discovery beneath the unproductive frontier areas of the state. Remember, at one time all producing areas were petroleum frontiers with no established production. Before Mssrs. Flynn, Welch, and Yates discovered oil near Artesia, the great producing areas of southeast New Mexico were frontiers that had been written off by many experienced explorationists as having no potential for production.

Other means of increasing production involve **enhanced recovery** techniques. Enhanced recovery is a term for processes that can be used to increase production from oil fields whose primary production has decreased to marginally economic or subeconomic levels. There are many types of enhanced recovery that have been used with success in oil fields throughout the world and an explanation of these is quite involved. They will be the topic of an upcoming article in *Lite Geology*.

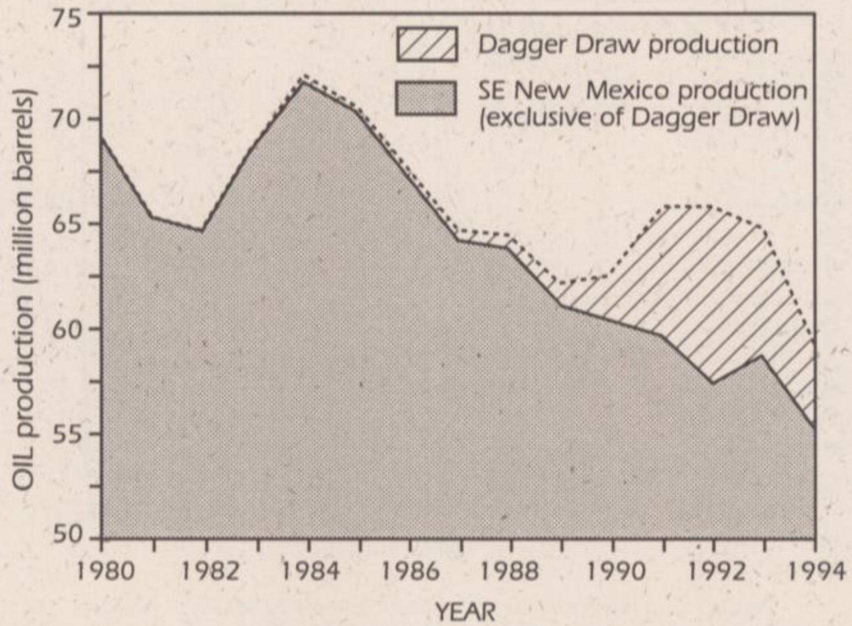


Figure 3—Annual oil production in southeast New Mexico from 1980 through 1994 and annual oil production from Dagger Draw field. See Fig. 1 for location of Dagger Draw field.

References:

Hatfield, C. B., 1995, Will an oil shortage return soon?: Geotimes, v. 40, no. 11, p. 4.

Teitelbaum, R. S., 1995, Your last big play in oil: Fortune, October 30, 1995, pp. 88–104.

Suggested reading:

Berger, B. D., and Anderson, K. E., 1992, Modern petroleum: a basic primer of the industry, 3rd ed.: PennWell Books, Tulsa, OK, 255 pp. *Comprehensive overview of the oil and natural gas industry, written in layman's language. Also available in a Spanish language version.*

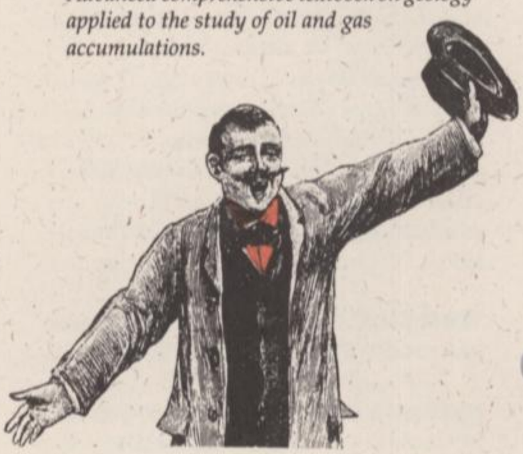
Broadhead, R. F., 1996, Oil and gas activities in New Mexico in 1995: New Mexico Geology, v. 17, no. 4. *General discussion of significant, recent developments in oil and natural gas drilling and production in New Mexico. $1.50 for single issue or $6.00 for annual subscription from New Mexico Bureau of Mines and Mineral Resources.*

Christiansen, P. W., 1989, The story of oil in New Mexico: New Mexico Bureau of Mines and Mineral Resources, Scenic Trips to the Geologic Past, no. 14, 112 pp. *$5.00 + $1.50 postage and handling. History of the oil industry and oil production in New Mexico, laced with colorful anecdotes.*

Grant, P. R., Jr., and Foster, R. W., 1989, Future petroleum provinces in New Mexico, discovering new reserves: New Mexico Bureau of Mines and Mineral Resources, 94 pp. *Large atlas format, $30.00 + $4.00 postage and handling. Technical discussion of potential undiscovered oil and gas in New Mexico.*

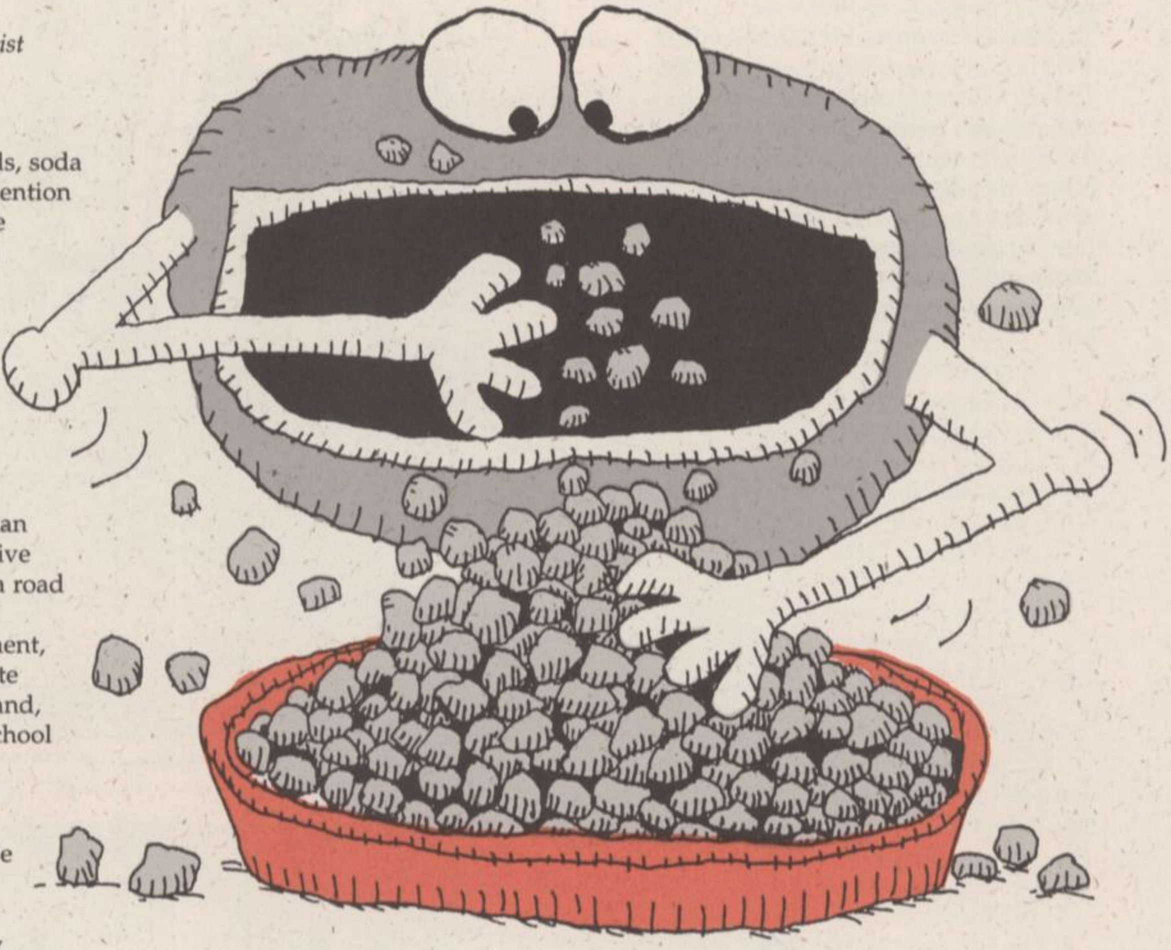
New Mexico Bureau of Mines and Mineral Resources, 1993, Atlas of major Rocky Mountain gas reservoirs, 208 pp. *Large atlas format; 10 oversize sheets, 3 floppy disks. $99.75, shipping included. Technical discussion of 861 major oil-and gas-producing fields in New Mexico, Colorado, Utah, and Wyoming.*

North, F. K., 1985, Petroleum geology: Allen & Unwin, Inc., Winchester, MA, 607 pp. *Advanced comprehensive textbook on geology applied to the study of oil and gas accumulations.*



How Much Do We Consume?

George S. Austin
Senior Industrial Minerals Geologist
NMBM&MR



Each year every American consumes flour and other foods, soda pop, shoes, and gasoline, to mention only a few items. We consume these items by various means: we *eat* the flour in bread, *drink* soda pop, *wear* out shoes, and *burn* gasoline. Each of us also consumes, or uses, large amounts of earth materials—although they are consumed in different ways than food or clothing. When we drive on the highway, we are using a road that was constructed of either concrete or bituminous pavement, both of which contain aggregate composed of crushed stone, sand, and gravel. When we are at school or the office, we are using a building that was constructed of earth materials, mostly of aggregate and cement. As these roads and structures deteriorate, they must be maintained, which means they will be refitted or replaced after a finite length of time. New ones also must be built to keep up with the increasing population.

How much earth materials are used in the United States every year? According the U.S. Department of the Interior, the total weight of nonfuel minerals produced in this country in 1994 was more than 2.7 billion tons! This is a tremendous amount, but can we understand how large an amount 2.7 billion tons really is? Let's figure out how many pounds or tons of nonfuel minerals each person uses in one year.

On the Internet, the U.S. Bureau of the Census reports that the United States population in 1994 was estimated to be 260,651,000 (U.S. Bureau of the Census, 1996). If we divide the 2.7 billion tons (actually 2,713,799,694 tons) by 260,651,000, our answer is 10.41 tons. That is more than 10 tons of earth material that every man, woman, and child uses per year! If we break down that number into metals and nonmetals, we get 2% metals and 98% nonmetals (Fig. 1). We can break down the nonmetals further:

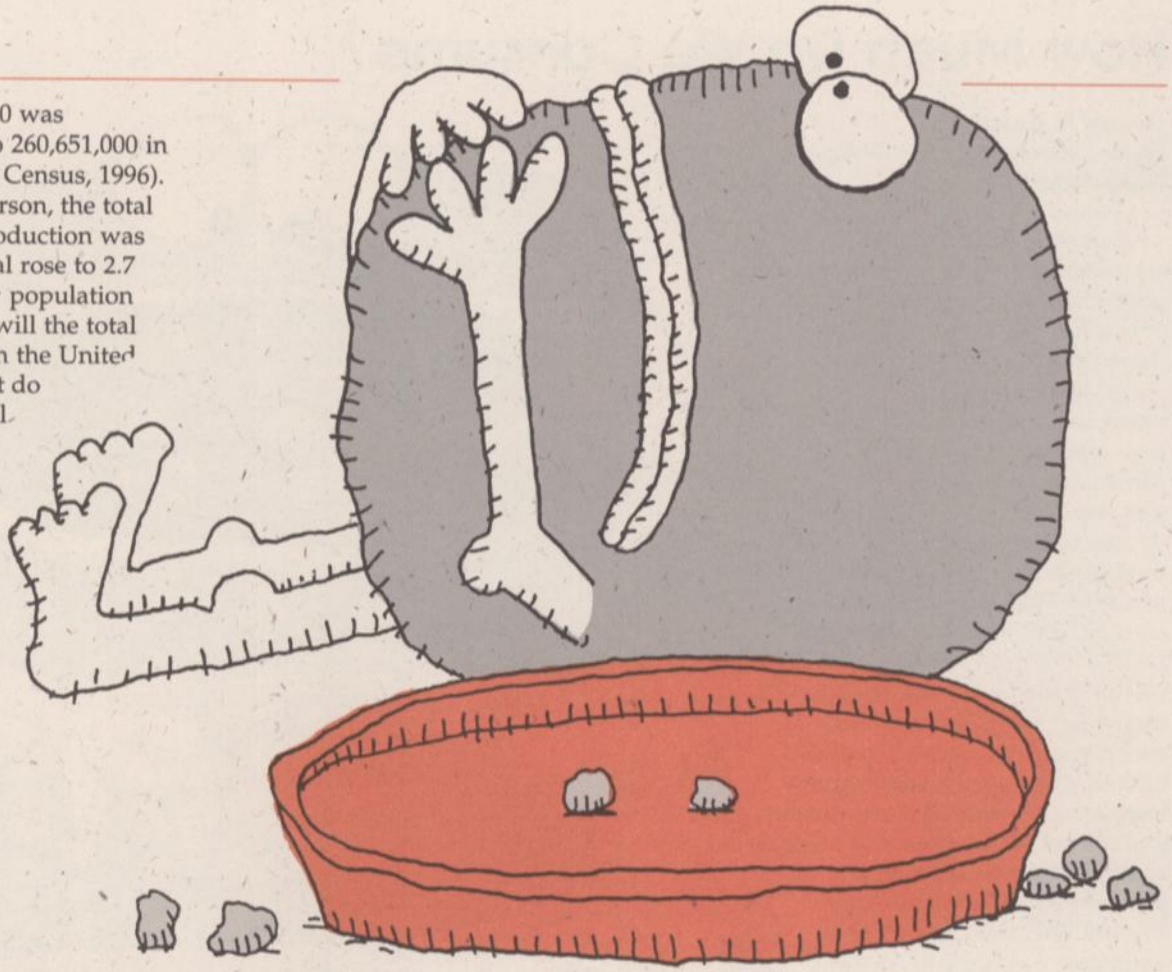
	lbs
Crushed stone	**10,400**
Sand and gravel	**7,764**
Cement	**629**
Clays	**356**
Phosphate rock	**348**
Salt	**333**
Lime	**148**
Gypsum	**145**
Other nonmetal minerals	**187**
All metals	**510**
TOTAL	**20,820 lbs (or 10.41 tons)**

The *all metals* category includes the ones with which we are so familiar—iron, copper, and aluminum.

The commodity totals listed above are only for earth materials produced in the United States. If we consider imported goods, our consumption of earth materials is even larger! Some aggregate used in the United States is from Canada and Mexico, but we probably export to them nearly the same amount. However, we are totally reliant on foreign sources for some minerals—such as bauxite as a source of aluminum.

Fortunately, our individual share of mineral production is decreasing somewhat. Similar calculations for back in 1980 by Bates and Jackson (1982) indicated that the average citizen consumed about 11 tons of earth materials each year. Still, the United

States population in 1980 was 227,726,000 compared to 260,651,000 in 1994 (U.S. Bureau of the Census, 1996). In 1980 at 11 tons per person, the total U.S. nonfuel mineral production was 2.5 billion tons. The total rose to 2.7 billion tons because our population continues to rise. What will the total mineral production be in the United States in 10 years? What do you think your *share* will be?



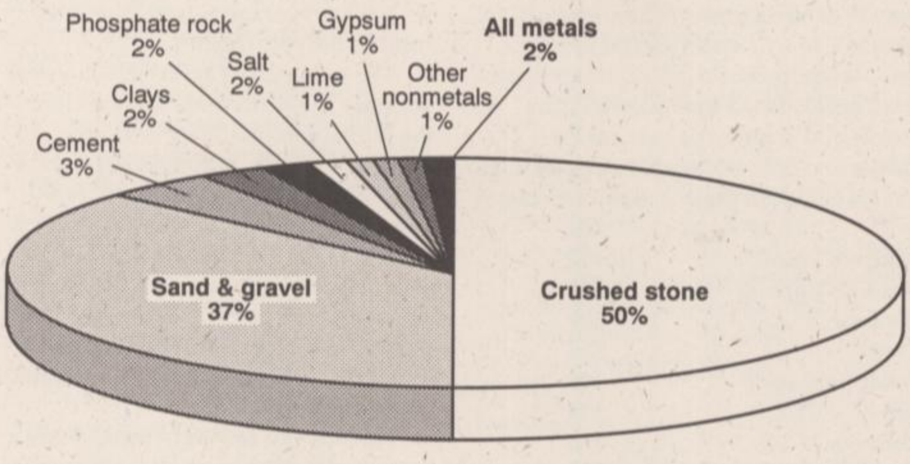


Figure 1—Total U.S. mineral production in tonnage in 1994 by percent (U.S. Department of the Interior, 1996).

References

Bates, R. L., and Jackson, J. A., 1982, Our modern stone world: William Kauffman, Inc., Los Altos, California, 135 pp.

U.S. Department of the Interior, 1996, Mineral industry surveys, Statistical summary: U.S. Department of the Interior, Bureau of Mines, 22 pp., available via Mines Faxback (accessed June 6, 1996).

U.S. Bureau of the Census, Current population reports, P25-311, P25-802, P25-1045, and P25-1126 online, U.S. Department of Commerce, available <http://www.census.gov/ftp/pub/statab/freq/95s0002.txt> (accessed June 6, 1996).

Program Update

New Mexico Princeton Earth Physics Project (PEPP)

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Michelle Hall-Wallace, *University of Arizona*
Mitch Withers, *New Mexico Tech*
Dave Love, *New Mexico Bureau of Mines and Mineral Resources*
Bob Redden, *New Mexico Earthquake Preparedness Program, Department of Public Safety*

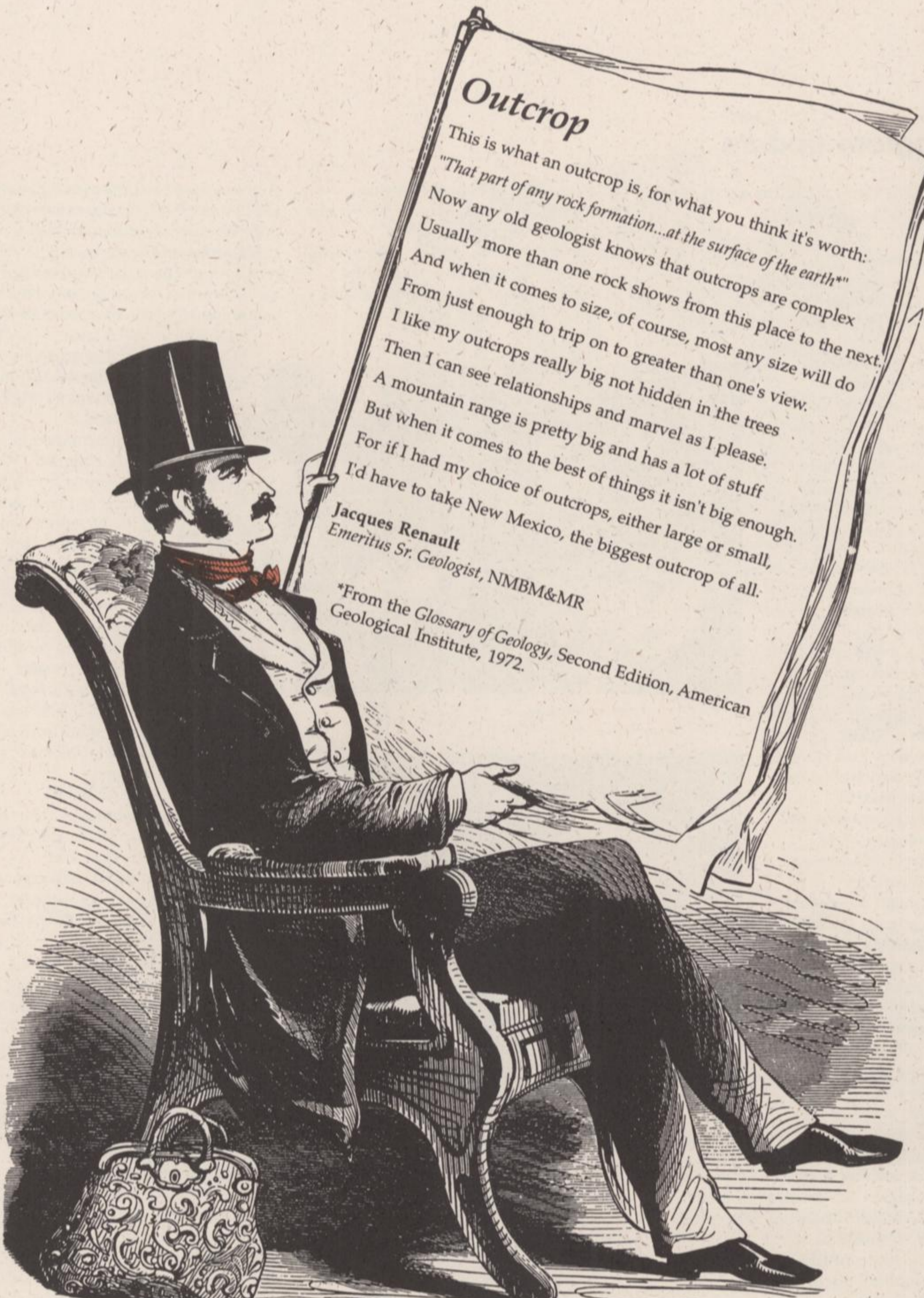
The New Mexico PEPP (Princeton Earth Physics Program) workshop was held during the week of July 7–12 at New Mexico Tech in Socorro. The goals of PEPP are 1) to enhance both earthquake and general Earth Science education in New Mexico secondary schools and 2) to deploy high-quality seismometers and recording equipment at selected high schools throughout the state. This will facilitate educational and research partnerships between the professional seismological community and the public schools. New Mexico is one of ten states participating in the program, which is funded by NSF and is coordinated by Princeton University in association with the Incorporated Research Institutions for Seismology (IRIS) consortium.

The July workshop hosted 20 participating teachers (7 women and 13 men), with the majority of teachers representing schools with large Hispanic and/or Native American enrollments. Approximately 50% of our teachers were predominantly involved in teaching Earth Science, with the remaining participants roughly divided between Physics and General Science. Participants represented 3 community colleges, 11 high schools, 2 community schools, and 3 middle schools widely distributed throughout the state.

PEPP instructors provided wide-ranging classroom lectures on the basic concepts of seismology, supplemented by hands-on classroom activities. A high point of the workshop was the half-day field trip to the USGS Albuquerque Seismological Laboratory (ASL) where ASL scientists Bob Hutt, Bob Woodward, and associates explained world-wide seismic monitoring. The scientists provided a demonstration featuring one of the prototype high-school seismometers.

The latest indications from Princeton are that the design and testing of the seismic instrumentation is nearly complete. We will be able to begin placing as many as 15 of the PC-controlled instruments in New Mexico beginning in January of 1997. PEPP coordinators are also investigating the possibility of funding a follow-up tri-state workshop during the summer of 1997 for participants from New Mexico, Colorado, and Arizona.

Additional information about the workshop, the PEPP program, and a map of participants' school locations is available via the Web on the NMPEPP homepage (http://griffy.nmt.edu/Geop/nmpepp.html). Teachers who may be interested in collaborating with some of the participating schools should contact NMPEPP coordinator Rick Aster of the New Mexico Tech Earth & Environmental Science Department (aster@nmt.edu). This novel and highly-interdisciplinary program also hopes to secure funding for future associated educational and research activities from the private sector during 1997.



Outcrop

This is what an outcrop is, for what you think it's worth:
"That part of any rock formation...at the surface of the earth"*
Now any old geologist knows that outcrops are complex
Usually more than one rock shows from this place to the next.
And when it comes to size, of course, most any size will do
From just enough to trip on to greater than one's view.
I like my outcrops really big not hidden in the trees
Then I can see relationships and marvel as I please.
A mountain range is pretty big and has a lot of stuff
But when it comes to the best of things it isn't big enough.
For if I had my choice of outcrops, either large or small,
I'd have to take New Mexico, the biggest outcrop of all.

Jacques Renault
Emeritus Sr. Geologist, NMBM&MR

*From the *Glossary of Geology*, Second Edition, American Geological Institute, 1972.

Sources for Earth Science Information

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:

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) 476–9681

upcoming events...

November 21–23, 1996
New Mexico Science Teachers Association (NMSTA) State Science Convention will be held at the La Posada Hotel in Albuquerque. The themes this year are Laboratory Safety and the new Science Standards. For more information about the convention, or to join NMSTA contact:

NMSTA
2430 Juan Tabo NE
Suite 142
Albuquerque, NM 87112

New Mexico Tech provides teacher in-service professional development opportunities

New Mexico Tech invites teachers to participate in a very flexible teacher in-service program that is tailored to meet the needs of participants. Teachers can request in-service sessions to be held either on the campus of New Mexico Tech, in the field, or at the requestor's school. In past programs, teachers have spent a day working with Tech faculty, or taking a paleontological field trip to Chaco Canyon, or visiting various research facilities on or around campus. Tech research facilities available to in-service teachers include the Waldo underground mine, Energetic Materials Research and Testing Center (EMRTC; explosives research), Langmuir Laboratory (lightning research), and Petroleum Recovery Research Center (PRRC). The Very Large Array (VLA) radio astronomy facility also can host in-service teachers. To find out more about these professional development opportunities through New Mexico Tech, contact the Tech Admission office in Albuquerque at (505) 266–9606 or in Socorro at 1 (800) 428–TECH.

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Lite Geology began as a small Earth-science publication designed and scaled for New Mexico. Our subscription list now includes a large number of out-of-state readers. In order to keep up with the demand for this publication from outside New Mexico, we will charge **$4.00 per year for out-of-state readers**, which covers the cost of printing and mailing. The subscription year begins with the Fall issue, and ends with the Summer 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.** If you have questions, please call Theresa Lopez at (505) 835-5420.

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Lite Geology

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Purpose: to build Earth Science awareness by presenting educators and the public with contemporary geologic topics, issues, and events. Use *Lite Geology* as a source for ideas in the classroom or for public education. Reproduction is encouraged with proper recognition of the source.

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