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LITE geology

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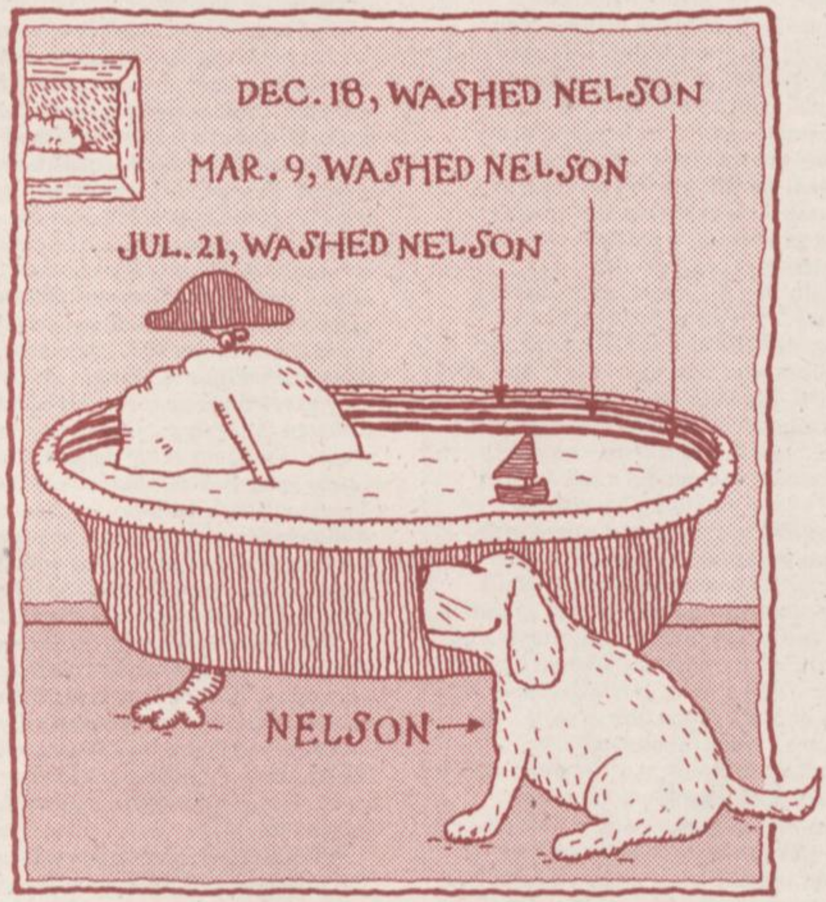
contemporary geological topics, issues and events

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



TUB-RING DATING

This Issue:

Earth Briefs

Old Trees on El Malpais Reveal Climate History Back to 180 B. C.

El Malpais National Monument in west-central New Mexico contains many lava beds ranging in age from three thousand years to more than a million years old. These lava beds are the unlikely home for some of the oldest trees in the Rocky Mountains, along with other rare and unique plants and animals that have adapted to the unusual, unfriendly conditions there. Henri Grissino-Mayer, a researcher at the University of Arizona Laboratory of Tree Ring Research, was called in by El Malpais personnel to study the climate history of the area and discovered some "incredibly old living specimens" including a 1,276-year-old Douglas-fir. Normally these trees only grow at a higher altitude in this part of the Southwest, and usually mature at about 150-200 years of age. Although these trees "shouldn't be here," they provide a valuable window into the past for **paleoecologists** like Henri. The lava also has preserved very old pieces of dead trees for study that would have decayed in a normal forest environment.

Henri reconstructed the climate history of the area by examining cross sections of trees and dating them, a technique called **dendrochronology**. A tree adds one ring to its cross section during each year's growing season. Wide rings indicate a season of optimum growth conditions, such as high rainfall, while rings narrower than normal indicate moderate to severe drought years. In addition, scars on the tree rings resulting from fires or human activity can be dated to the year when they occurred, allowing scientists to reconstruct histories of forest fires and past Native American settlement and migration patterns.

Henri has examined living trees and also dead standing and down wood. He has been able to piece together the entire chronology of the area dating back nearly 2,200 years using overlapping tree-ring patterns from different trees. One piece of wood Henri found lying on the lava had tree-ring patterns that matched some *younger* living tree samples and also had patterns that matched his *oldest* dead and down tree samples. This "middle aged" piece of wood was the missing link that tied together the El Malpais **tree-ring chronology** now dating back to 180 B. C. According to Henri, the tree chronology of the El Malpais is the third oldest in Arizona and New Mexico, and is by far the strongest chronology anywhere in the region. Henri said "These trees should be taken care of, they are very rare."

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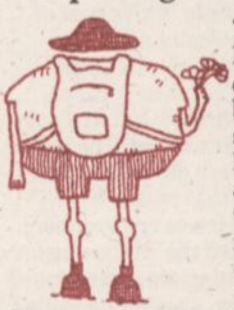
Prospecting with Poppies



The California Poppy (*Eschscholzia californica*) blooms brilliantly in the spring, and is known to grow in abundance where the ground is mineralized with copper. This is dramatically illustrated near the San Manuel mine located in an area north of Tucson, Arizona, where copper-mineralized ground supports a profuse crop of California poppies; however, the stand of poppies abruptly terminates at a major fault line where the mineralized ground is adjacent to non-mineralized ground. Prospectors can use the California poppy not only as a copper indicator, but also to provide clues about the presence of gold, silver, and other metals often associated with copper.

Lapidary Journal, November 1992, Facets, p. 10.

Have you ever wondered...

How Big is Avogadro's Number?

William C. Haneberg
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Lite Geology editor Susan Welch remembers a college professor who told her that an **Avogadro's number** of oranges is equal to the volume of the Earth. Is this true? I could just tell you the answer—after all, I am a professional scientist with a Ph.D. and lots of impressive certificates hanging in my office—but that would be too easy. Instead, we will use this problem to illustrate how scientists and engineers make assumptions, perform calculations, and arrive at conclusions.

Who was Avogadro, and what is so special about his number? Amedeo Avogadro was an Italian chemist and physicist who was born in 1776 and died in 1856. The number for which he is remembered is 6.02×10^{23} (602 followed by 21 zeroes), and it is *the number of atoms or molecules in a* **mole** *of a substance*. A mole of any substance has a **mass** (measured in grams) equivalent to its **atomic** or **molecular mass**. For example, a mole of salt contains 6.02×10^{23} NaCl molecules. The **atomic mass** of sodium is 23.0 and atomic mass of chlorine is 35.4, therefore 1 mole of NaCl would have a mass of 58.4 grams. If one dissolves one mole of NaCl in one liter of water, the result is a 1 **molar solution**. It is important to realize that the mass must be measured in grams, not kilograms, micrograms, slugs, or any other unit.

By Avogadro's time, the concept that matter is made up of molecules and that moelcules are, in turn, made up of atoms was generally accepted. But the number of atoms in a molecule wasn't known. Based on the work of earlier researchers, Avogadro postulated that all gases under similar temperature and pressure contain the same number of molecules. Avogadro further postulated that a molecular weight of any element or compound will contain the same number of atoms or molecules. Other scientists were later able to experimentally determine this number (Faraday using electrolysis and Perin using diffusion) which became known as Avogadro's number. The number has great significance because it allowed the study of individual molecules for the first time.

To decide whether an Avogadro's number of oranges is equivalent in volume to that of the Earth, we need to know two things: the volume of the Earth and the volume of a typical orange. Notice that I am being careful not to say that we are trying to decide how many oranges one could fit inside of the Earth, or if an Avogadro's number of oranges would form a pile as big as the Earth. Why? The primary reason is that if someone could really pile up that many oranges, all but a few oranges near the top of the pile would be squashed by the weight of the pile. This is a much more difficult problem to solve, because we would need to know how the volume of an orange changes as it is subjected to higher and higher pressures. This is the same reason why we will not worry how the oranges are packed. If we were to make a small pile of oranges, it would be easy to see that there is empty space between the oranges. Depending on how closely the oranges are packed, the empty space will be somewhere between 26% and 48%. If we were to pile up an Avogadro's number of oranges, however, the weight of the pile would squash the oranges and eliminate any empty space except near the very top of the pile.

To follow this example at home or in a classroom, you will need a working knowledge of exponents and the use of scientific notation to represent very large and very small numbers. The calculations are simple enough that you can probably carry them out using just a pencil and paper.

The Earth's **polar diameter** (D_p = 12,714 km) is slightly smaller than its **equatorial diameter** (D_e = 12,756 km), so its shape is that of a flattened sphere (Fig. 1).

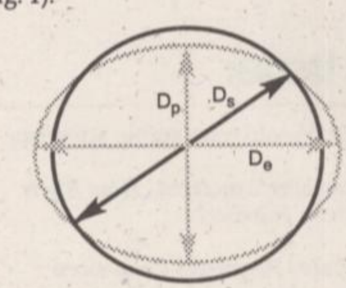

Figure 1–Cross-sectional view of a flattened spheroid with equatorial diameter D_e and polar diameter D_p along with a sphere having an equivalent diameter, D_s.

There are formulae from which one can calculate the volume of flattened spheres, but to make our calculations easier we will assume that the Earth is a perfect sphere with an equivalent diameter of D_e = 12,742 km (Press and Siever, 1982). We will also assume that the surface of the Earth is perfectly smooth, even though we know that the Earth is covered by valleys, mountains, and other topographic features. Is this assumption justified? The tallest mountain on Earth, Mt. Everest, is about 8840 m tall, which is only about 0.07% of the earth's diameter. The errors introduced due to our neglect of mountains will also tend to be offset by errors introduced by our neglect of large canyons and ocean basins. Therefore, assuming that the Earth is a perfectly smooth sphere will not have much of an effect on our answer. Now that we know the Earth's diameter, we can calculate its volume using the formula

$$V = (1/6)\,\pi D^3$$

where π is a numerical constant equal to approximately 3.14. The answer is 1.1×10^{21} cubic meters. Next, we need to calculate the volume of an orange. One problem that immediately comes to mind is that oranges come in many different sizes, so we will guess that an average orange has a diameter of about 8 cm. (Calculating the effects of different sized oranges is one of the exercises below). Using the same formula for the volume of a sphere, we calculate that the volume of a typical orange is about 270 cubic centimeters or 2.7×10^{-4} cubic meters. Although it is a little awkward to deal with quantities such as 10^{-4} cubic meters, we must be careful to make sure that the volume of the Earth and the volume of the orange are expressed in the same units! To find out how many of our hypothetical oranges are equal in volume to the volume of the earth, divide the volume of the earth by the volume of an orange to find an answer of 4.1×10^{24}. This is almost 7 times the size of Avogadro's number. We can explore this problem further by asking what size sphere would be required in order for an Avogadro's number of them to equal the volume of the Earth. This problem is a little more difficult, but we can still solve it without too much trouble. If we need Avogadro's number of spheres to equal the earth's volume, then the volume of each sphere must be the volume of the Earth divided by Avogadro's number, or

$$\frac{1.1 \times 10^{21} \text{ cubic meters}}{6.02 \times 10^{23} \text{ oranges}}$$

$$= 1.8 \times 10^{-3} \text{ cubic meters per orange}$$

Take the value of 1.8×10^{-3} cubic meters per sphere and use it for V in the volume equation, and then solve for D. The result is a diameter of about 15 cm, which seems closer to the diameter of a cantaloupe than that of an orange.

Do scientists and engineers spend much time worrying about how many oranges they can fit into the Earth? Not really. They do, however, spend time trying to estimate how steep a slope can be made before a landslide will occur, how much weight a bridge can safely carry, how powerful an engine must be to keep an airplane in flight, and many other practical problems. Each of these involves many calculations and assumptions similar to those that we were forced to make in order to reduce a seemingly complicated problem into one that can be solved.

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Exercises

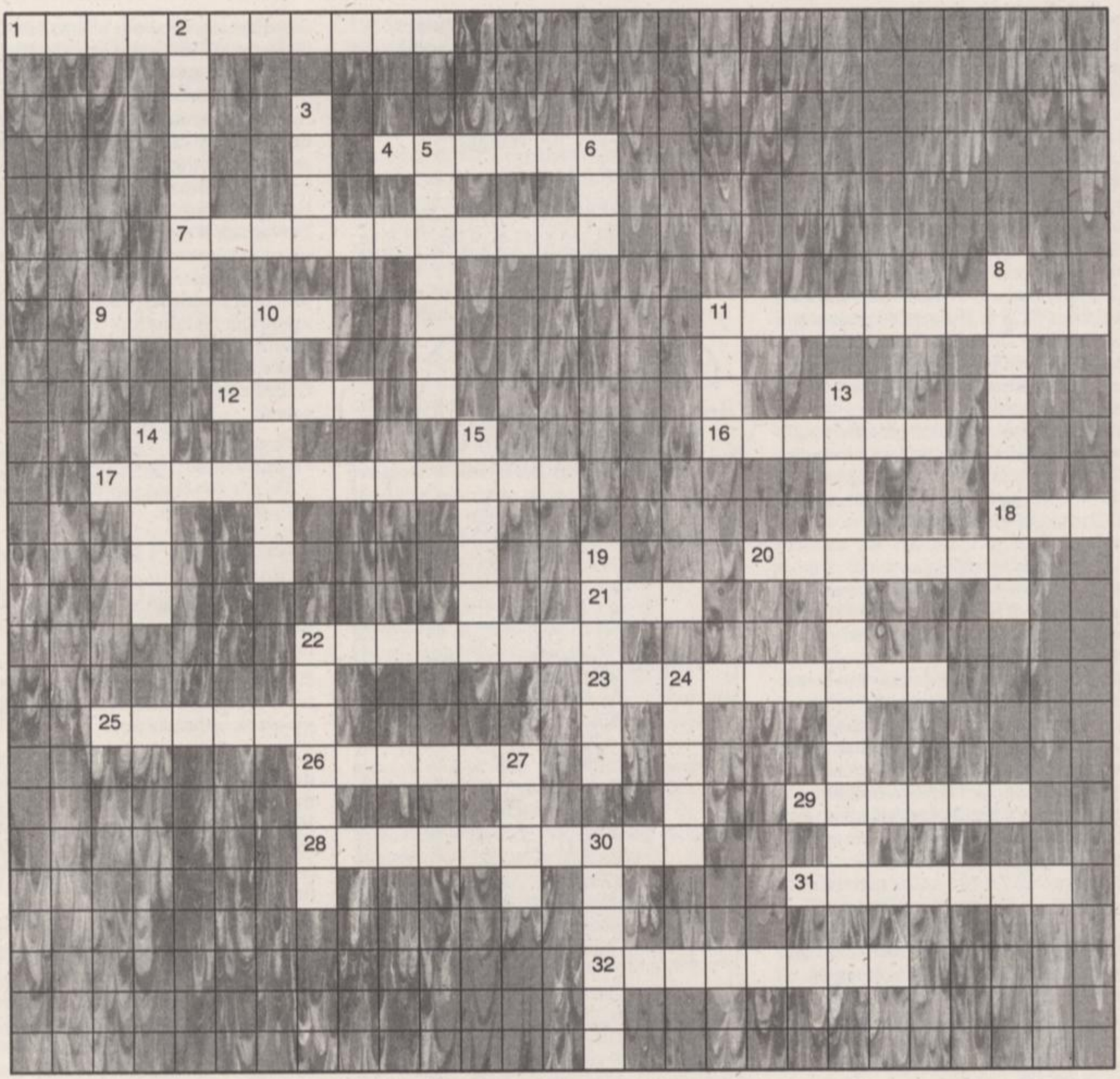
1. What is the difference between weight and mass? Explain why an astronaut will have identical mass but different weights on the Earth and on the Moon.

2. What would Avogadro's number be if we were to use kilograms rather than grams as units of mass?

3. Using a periodic table of the elements, determine the mass of 1 mole of each of the following compounds: H_2O (water), CH_4 (methane, a major constituent of natural gas), $C_{12}H_{22}O_{11}$ (sucrose, or common table sugar), FeS_2 (pyrite, or fool's gold).

4. Make a list of all the assumptions used to calculate how many oranges would be equal in volume to the Earth.

5. Find ten or twelve different sized oranges and calculate the diameter of each orange using the formula $D = C/\pi$, where D is the diameter of each orange, C is the circumference, and $\pi = 3.14$. What are the smallest, largest, and average values of orange diameters in your experiment? How many of the smallest oranges would be equal in volume to the volume of the Earth? How many of the largest oranges? Would you say that the calculated number of oranges is sensitive to the size of the oranges (that is, does your answer change much if the size of the orange changes)?



Natural resources of various types are abundant in New Mexico. How familiar are you with some of the more important mineral resources in our state? Use the attached word list to help improve your resources vocabulary.

New Mexico Resources Crossword Puzzle

by William X. Chavez, Jr.
Associate Professor of Geological Engineering
New Mexico Tech

ACROSS

1 The physical, biological, and chemical world that surrounds us.

4 Water that moves along the surface and does not seep into the ground during precipitation or snowmelt.

7 The process involving restoration of the land surface to a productive state following surface mining; required by the Surface Mine and Reclamation Act of 1977.

9 Defined as the "ability to do work;" Materials such as petroleum, coal, and uranium, abundant in New Mexico, are potential sources.

11 The physical and chemical decomposition of rocks and soil due to agents such as wind, rain, and snow.

12 The end product of the physical and chemical breakdown of rock; resulting in horizons of organic material as well as rock components.

16 A rock made up of potassium salts; used for fertilizer as a source of potassium. Mined in the Carlsbad area from underground mines, in rocks approximately 230 million years old!

17 A term for the study of ancient life.

18 A common term for petroleum.

20 Transportation of weathered materials; results in removal of rock and soils from the site of original deposition. Especially important with respect to loss of productive soils in the eastern part of New Mexico.

21 A mineral, rock, or soil material that may be mined for profit, using existing technologies and under current economic conditions.

22 Naturally occurring, inorganic crystalline substances having a definite chemical composition or range of compositions and physical characteristics.

23 A type of mine in which narrow, elongate areas are excavated in order to mine a material (usually coal). Reclamation of mined land can be undertaken relatively soon after mining. Used in northwest New Mexico to extract coal.

25 Used to make concrete; composed of complex alumino-silicates and is made from such diverse components as limestone, shale, and coal ash.

26 An inert gas, this substance is extracted from wells in northeast New Mexico.

28 Generally a gaseous phase recovered from petroleum extraction, this gas may provide part of the pressure to recover liquid hydrocarbons from oil wells.

29 Extraction of water or mineral commodities from the Earth.

31 A glassy volcanic rock containing 2—5% water. Mined in important quantities in the Tres Piedras and Socorro areas of New Mexico. Used in filters, insulation, and lightweight materials.

32 An important reason why mineral resources are required by society; to maintain our ________ of living.

DOWN

2 A naturally occurring material or land that may be utilized for the benefit of society. Examples: timber, ore, and National Parks.

3 A rock formed from organic material, generally derived from woody plants; may contain inorganic matter, (clay, silt, and sulfur compounds). Mined as an energy source, especially in northern New Mexico.

5 Formerly mined in the Grants–Gallup–Crownpoint areas, this metallic commodity was once an important economic resource for New Mexico. This metal provides for about 20% of the energy requirements of the U.S.

6 The deposition of sediment in a delta-shaped accumulation at the base of a mountain by water, usually during flood-type runoff, results in the formation of an alluvial ___.

8 Rock made up of calcium carbonate, with lesser quantities of other carbonates, clays, and perhaps fossil materials; important in the manufacture of cement.

10 Term for the study of the Earth.

11 An acronym for the proposed storage site for low-level radioactive wastes near Carlsbad, New Mexico.

13 A gaseous substance extracted from wells in northeastern New Mexico. Important component of soda pop!

14 An extremely important resource used by all people in all societies; nonetheless, is being mined from some areas without significant recycling by people.

15 The red metal; mined in very significant amounts in New Mexico, especially in the Silver City area.

19 Evidence of former life, usually limited to pre-historic life.

22 The main component of natural gas; derived from petroleum wells or from degassing coal beds; important resource in NW and SE New Mexico.

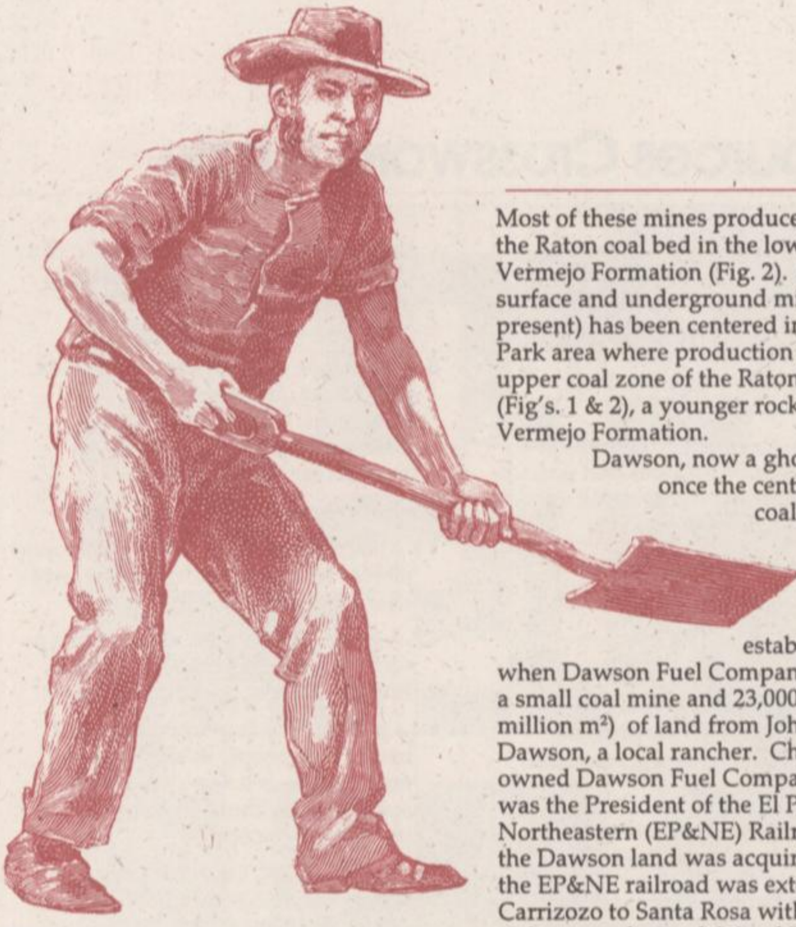
24 Granite, limestone, perlite, and gneiss are examples of _____.

27 The result of the shallow eruption of magma into water-bearing ground; responsible for the formation of volcanic craters west of Las Cruces.

30 A calcium sulfate mineral mined in New Mexico; used in wallboard and as a soil conditioner. Important mineral in the construction industry.

WORD LIST

coal • oil • paleontology • gypsum • maar • rocks • helium • limestone • cement • soil • energy • geology • ore • reclamation • minerals • methane • standard • potash • weathering • mining • environment • resource • WIPP • water • runoff • copper • erosion • uranium • fossil • perlite • fan • carbon dioxide • strip mine • natural gas



Dawson,
a Town Dependent on Coal

Gretchen K. Hoffman
Coal Geologist, NMBM&MR

The Raton coal field, in northeastern New Mexico, is the second largest coal area in the state, with coal seams in the Vermejo and Raton Formations (Figs. 1 & 2). These coal seams are low in sulfur (0.5-1.0 %) and have high heat values (10,000 to 14,000 **Btu/lb**), which has made them **economic** for more than one hundred years. Coal was discovered in this area as early as the 1820's, and the first phase of coal mining began in the late 1880's and continued until 1966. The majority of these early underground mines were located on the eastern edge of the Raton field where mine entries were easily driven into the coal seams exposed in the sides of numerous canyons (Hoffman, 1990). Dawson, Koehler, Van Houten, Gardiner, and Blossburg were some of the larger coal-mining districts in the early part of this century (Fig. 1).

Most of these mines produced coal from the Raton coal bed in the lowermost Vermejo Formation (Fig. 2). Recent surface and underground mining (1966 to present) has been centered in the Vermejo Park area where production is from the upper coal zone of the Raton Formation (Fig's. 1 & 2), a younger rock unit than the Vermejo Formation.

Dawson, now a ghost town, was once the center of a major coal-producing district in the Raton field. The town was established in 1900 when Dawson Fuel Company purchased a small coal mine and 23,000 acres (93.1 million m^2) of land from John Barkley Dawson, a local rancher. Charles B. Eddy owned Dawson Fuel Company and also was the President of the El Paso and Northeastern (EP&NE) Railroad. Once the Dawson land was acquired by Eddy, the EP&NE railroad was extended from Carrizozo to Santa Rosa with trackage rights over the Rock Island Line to Tucumcari. A spur, called the Dawson Railway, was then built from Tucumcari northwest to Dawson, connecting the Dawson coal mines with the main rail lines to El Paso and to the East (Myrick, 1970).

The Stag Canyon Fuel Company, a subsidiary of Phelps Dodge, bought the Dawson coal property and the railroad in 1905 to provide coal and **coke** to their Arizona copper smelters. Several improvements were made to the mine property and to the town at this time. A new **tipple** and power plant were constructed and 446 **underflue coke ovens** were built to supplement the 124 existing **beehive coke ovens** (Fig. 3). In 1906, a 32-bed hospital was built, and plans were made for a theater and community center, which were completed in 1907 for $40,000. By 1909, the population of Dawson was 4000, with 1163 of the adult population employed in the mines, **washery**, and coke ovens. Phelps Dodge had built one school in Dawson, and another was built by the county. These schools were in session for 10 months during the year, an uncommon occurrence in New Mexico at this time (U.S. Mine Inspectors Report, 1909). In 1914, a new three-story brick mercantile was built by Phelps Dodge that had the facilities of a grocery, hardware, furniture, clothing and drug store in one location (*Phelps Dodge Today*, 1984; Fig. 4).

In 1906 Stag Canyon began introducing safety improvements in the mine such as **electric-shot firing** to decrease the chance of coal-dust

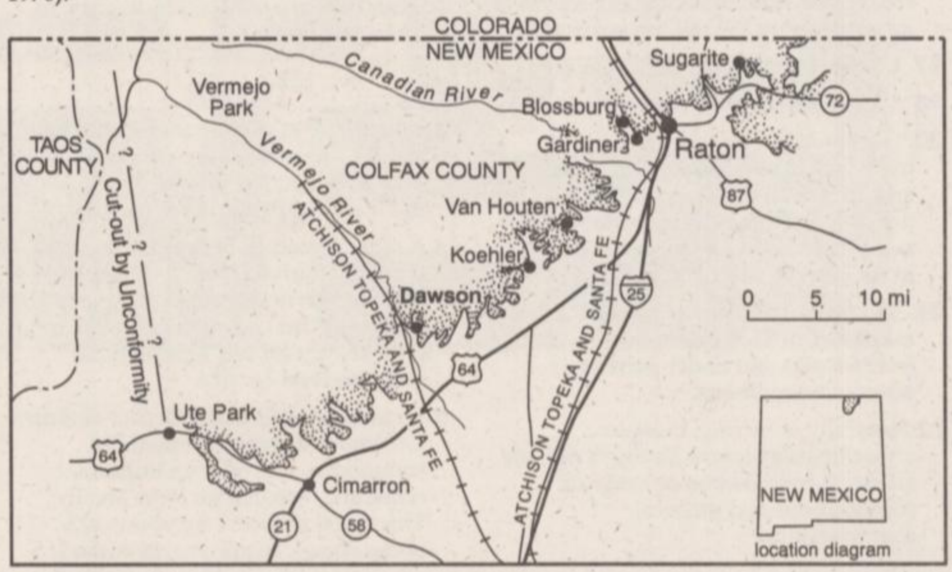


Figure 1—Raton Mesa region in New Mexico. Modified from Jurich and Adams (1984). Stipple pattern = extent of coal-bearing units. Reprinted from Hoffman, 1990, with permission from New Mexico Geological Society.

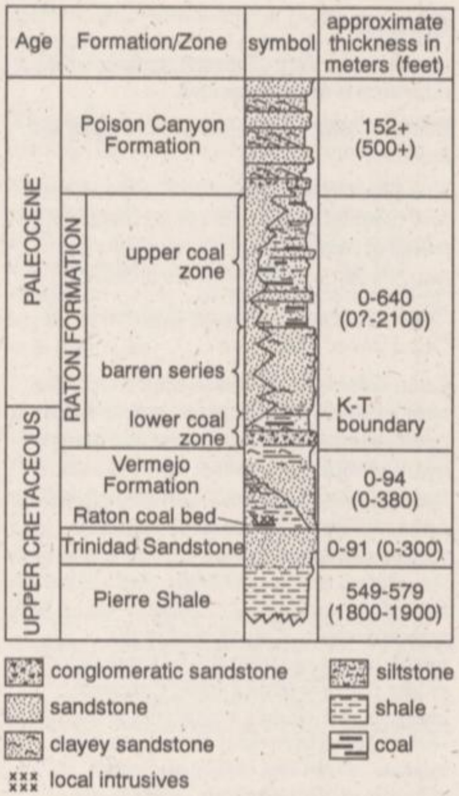


Figure 2–General **stratigraphic column** for Raton coal field (see glossary). Modified from Pillmore and Flores (1987). Reprinted from Hoffman, 1990, with permission from New Mexico Geological Society.

explosions. Stag Canyon made many changes in the Dawson mines to improve their safety, making them some of the safest mines in the U.S. at the time. The problem of coal-dust explosions was a constant source of concern in the Dawson mines and contributed to three mine disasters. The first accident occurred in 1913 in the No. 2 mine when coal dust ignited after an unsupervised shot by a miner, which was strictly against company rules. Except for 29 men, an entire shift (292 men) lost their lives in this disaster. This was the fourth worst mine accident, in terms of lives lost, in U.S. mining history and first in property damage (Price and Scholer, 1983). To lower the coal dust, the coal in the rail cars was sprayed with water; steam boilers and moisture radiators were installed to increase the temperature in the mines and increase the moisture in the air, respectively. To eliminate unsupervised shots, the job of placing explosives in blast holes and connecting blasting wires became specialized and was no longer done by the miners. First aid training became a requirement for certain employees in each of the Dawson mines.

In 1920 another coal dust explosion killed thirteen men. The third tragedy in the Dawson mines occurred in 1923 when an electric arc from a power line, caused by the derailment of coal cars, ignited coal dust, killing 120 men. After this explosion Phelps Dodge installed battery operated locomotives and sprayed a mixture of crushed limestone and water called "adobe" onto the walls of the mine entries and **return air courses** within the mine to further decrease the coal dust in these areas.

From 1899-1950, a maximum of eight mines in the Dawson area produced 33 million tons of coal, approximately half of the total production from the Raton field during this time. In the early 1900's coal and coke were supplied to the copper smelters in Arizona, steel mills in Colorado and Pennsylvania, and railroads in the area (Hoffman, 1990). The depressed copper industry in 1915 and the eventual conversion to oil at the smelters forced the closure of the coke ovens by 1926. From 1926, most of the coal production at Dawson went to supply the railroads. Production continued to decrease through the depression, and by 1933 the No. 6 mine was the only mine in operation. This mine continued to produce coal until April 28, 1950. The closure was due to high labor costs, a depressed coal market, the conversion to diesel fuel by the railroads, and the great distance from the **active mine face** to the tipple (4 mi; 6.45 km). The longevity of the Dawson coal mines is attributed to the increased mechanization by the company during better economic periods. When the mine closed all the equipment and structures (400 homes, stores, opera house, hospital, and schools) were sold, moved, or dismantled to lower taxes on the land (*Phelps Dodge Today*, 1984). Today all that remains of the town of Dawson is a few time-worn coke ovens, the power plant stack, one or two houses, and the graveyard. The Dawson property is still owned by Phelps Dodge Corporation and is leased for cattle grazing (Fig. 5).

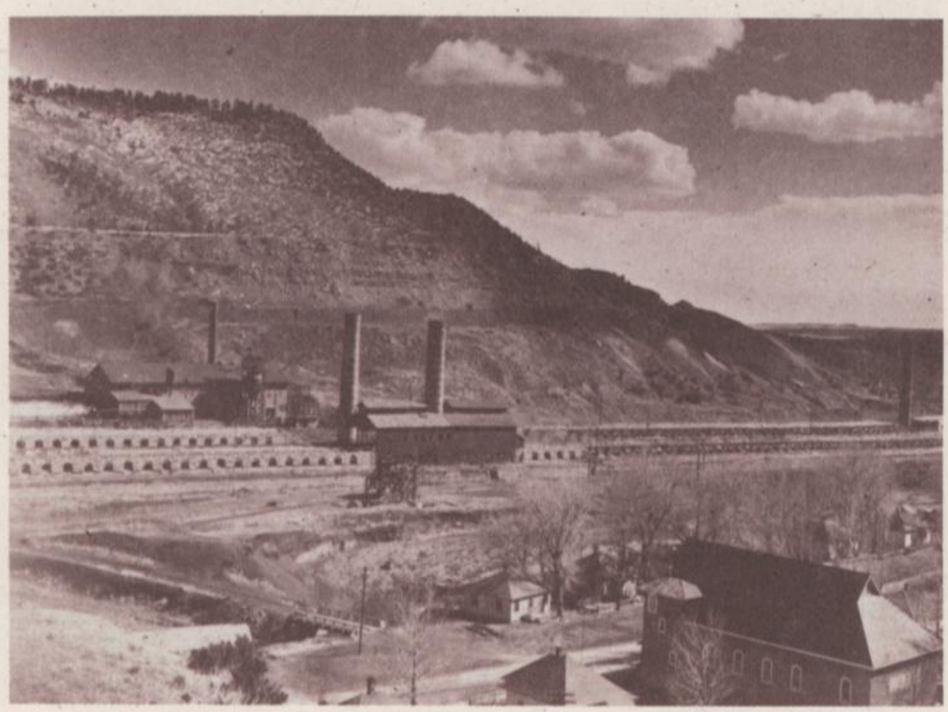


Figure 3—View, looking east, of the power house, town boiler plant, old coke ovens, and Catholic church at Dawson. Photo courtesy of Phelps Dodge Corporation.

Figure 4—View of the lower end of town, looking west, showing the Phelps Dodge Mercantile, warehouse, and hotel. Dawson Ranch Headquarters is in center background; No. 7 camp is in right background. Photo, dated November 11, 1920, by courtesy of Mr. Roy M. Bauer.

Figure 5—Coke ovens, in disrepair, are some of the only remains of the once-booming coal producing and coking operations at Dawson. The State Mining Inspector in 1909, J. E. Sheridan, described the coke ovens at Dawson (Sheridan, 1909) "There are 570 coke-ovens in operation: 124 beehive ovens, 13 ft. in diameter, and 446 English under-flue ovens, 11 ft. in diameter. Each oven is charged with 6 tons of slack, burns 48 hours, and produces 52 per cent. in weight of coke.

"The under-flue ovens are an innovation along economical lines,...These ovens are in batteries of from 54 to 58 ovens each, and arranged in a double row,...The flaming gases from the coke-oven, passing downward into horizontal flues beneath the oven, serve to coke the slack from the bottom as it is being coked on top, passing thence through an opening in the rear to a main horizontal flue between the two strings of ovens to the boiler-houses, where the heat is used for steam-purposes." Photo by G. Hoffman.

Glossary

Active mine face–*The rock surface in the mine that is being excavated.*

Beehive coke oven–*Coke ovens shaped like beehives.*

Btu–*(British thermal unit)–The quantity of heat required to raise the temperature of 1 pound of water 1 degree Fahrenheit at, or near, its point of max. density of 39.1 °F.*

Coal–*see crossword puzzle description for "no. 3 down" (this issue).*

Coke–*Coal is heated in the absence of air or with a large deficiency of air and the lighter constituents are volatilized and the heavier hydrocarbons crack, which liberates the hydrogen, leaving a residue of amorphous carbon. This carbonaceous residue that contains some ash and some of the sulfur of the original coal is called coke. Not all coal is suitable for making coke—it must have a high carbon content. Coke is used in the production of pig iron, the first step in production of iron and steel. Coke and limestone are used in a reduction process to remove the oxygen from the ore, leaving a mixture of iron and carbon and small amounts of other elements. Coke is the reducing element and the source of heat in this process* (Steam, 1975).

Economic coal–*Coal that can be sold for a profit to produce energy or produce coke for metallurgical purposes.*

Electric-shot firing–*igniting the explosives (shots) within the mine to loosen the coal by electric means when all the men are out of the mine instead of lighting the fuses by hand. One person is in charge of firing shots and takes many precautions to ensure no one is in the mine at the time a shot is fired.*

K-T boundary–*The K–T boundary separates rock of the Cretaceous and Tertiary ages. The Paleocene is the earliest epoch of the Tertiary period. In the Raton Basin, the K-T boundary has been placed at or near the top of the lower coal zone in the Raton Formation (Pillmore and Flores, 1987).*

Low-sulfur coal–*Coal containing less than 1% sulfur.*

Paleocene–*The age of rock units deposited in the lower Tertiary. The Raton Formation (minus the lower coal zone) and Poison Canyon Formation were deposited 66.4 to 57.8 million years ago (Colpitts, et al., 1990).*

Return air courses–*Part of the mine's ventilation system that exhausts the used air from the mine out to the surface.*

Tipple–*Structure where cars loaded with coal are emptied, generally by being tipped over.*

Stratigraphic (or geologic) column–*A chronological arrangement of rock units in a columnar form with the oldest at the bottom and youngest at the top (Fig. 2); this is a composite diagram showing the rock units in the order in which they were deposited in an area over time.*

Underflue coke oven–*Coke ovens that cause the volatilized gases from the burning of the coal to pass beneath the oven to coke the coal from the bottom as well as the top (see Fig. 5).*

Upper Cretaceous–*In the Raton Basin, the upper Cretaeous is represented by rock units deposited from 97.5 to 66.4 million years ago (Colpitts, et al., 1990).*

Washery–*(or washing plant)–where coal is brought from the tipple by conveyor belts to be sized by a series of screens, crushed if needed, and run through a series of jigs to separate out any non-coal material (rock). Because the coal is lighter than shale or sandstone, which may have been partings in the coal seam, the coal stays on top of the jigs, that contain water, and the heavier material sinks. The final product is a 'cleaner' coal sometimes called '**slack**' (Sheridan, 1909).*

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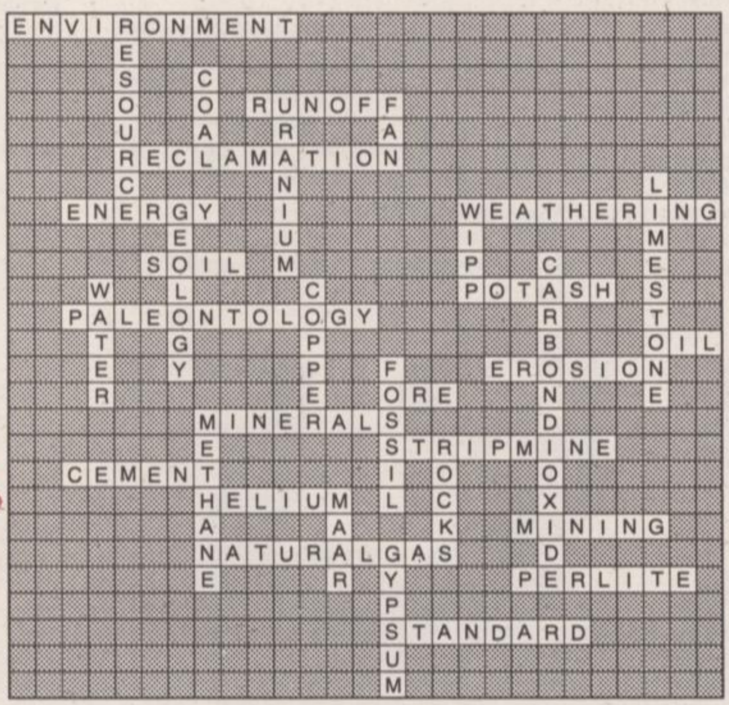

New Mexico Resources Crossword Puzzle answers

high LITES

EARTH SCIENCE UPDATE

Upcoming Geological and Scientific Events

April 24–26, 1994
New Mexico Conference on the Environment will be held at the Albuquerque Convention Center. For information, contact the Conference Coordinator, New Mexico Environment Department, 1190 St. Francis Drive, P.O. Box 26110, Santa Fe, NM 87502; or call (505) 827–2850.

next year...

September 28–October 1, 1994
The *45th Annual Fall Field Conference of the New Mexico Geological Society* will tour the scenic Mogollon Slope (northern Catron County) in west-central New Mexico. For information contact Richard Chamberlin (505) 835–5310 (NMBM&MR, Socorro), or Jim Ratte' (303) 236–5618 (USGS, ret., Denver).

NMBM&MR publications profile...

Bulletin 141—Quality assessment of strippable coals in northwestern New Mexico: Fruitland, Menefee, and Crevasse Canyon Formation coals in San Juan Basin, and Moreno Hill Formation coals in Salt Lake field, by G. K. Hoffman, F. W. Campbell, and E. C. Beaumont, 1993, 84 pp; price $12.00 plus $2.50 shipping.

During three years of drilling and sampling in the San Juan Basin, 524 coal core samples were collected from 149 drilling sites on approximately 2 mi centers in the Fruitland, Menefee, Crevasse Canyon, and Moreno Hills formations. Significant aspects of chemistry, quality, coal rank, thickness trends, stratigraphic-depositional features, and petrographic composition are presented in this report. To order Bulletin 141, send your request along with $14.50 (includes shipping) to Publications, New Mexico Bureau of Mines and Mineral Resources, Socorro, NM 87801. Please mention *Lite Geology* when ordering.

Teachers Resources:

Resource Directory—*Archeology and the Public* contains sources for archeology teaching kits, teacher workshops/school outreach programs, classroom activities, video and slide programs, newsletters, travelling exhibits, and kids publications. For a copy of this directory, contact Lonnie Vicklund, Education Committee, New Mexico Archaeological Council, P.O. Box 1023, Albuquerque, NM 87103.

what is...

helictite? A curved, twiglike cave deposit, usually of calcite, that grows at its free end by deposition from water emerging there from a nearly microscopic central canal.

moonmilk? Soft, white plastic calcareous deposit that occurs on the walls of limestone caves. Moonmilk may consist of aragonite and other carbonate minerals.

bacon-rind drapery? A thin sheet of travertine that is translucent, and is formed when drops of water flow down an inclined cave ceiling, leaving behind a wavey trail of calcite.

Reference-

Bates, R. L., and Jackson, J. A. (editors), 1980, Glossary of geology: American Geological Institute, Alexandria, VA, 2nd edition, 749 pp.

Earthlinks for Educators

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
(303) 236–0747

For answers to questions on economic mineral deposits and the extractive mineral industry, contact:

Mine Registration & Geol. Serv. Bur.
Bill Hatchell
Mining and Minerals Division
2040 South Pacheco
Santa Fe, NM 87505
(505) 827–5970

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:

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

For information about state environmental programs in New Mexico, contact:

John Geddie, Administrative Asst.
Public Information
New Mexico Environment Dept.
P.O. Box 26110
Santa Fe, NM 87502
(505) 827–2850

The Environmental Protection Agency provides a free information hotline for radon. Call:

1-(800) SOS–RADON.

Information on earth science projects, programs, reports, products and their sources is available from:

Earth Science Information Center (ESIC). Call 1–(800)–USA–MAPS.

on the air...

Earth and Sky is a three-year-funded National Science Foundation project begun in 1991 to present to radio listeners explanations about the universe. The series explores established ideas as well as new discoveries in Earth science, astronomy, and environmental science. *Earth and Sky* features sky events to watch for, provides insight into the processes of science, and answers listener questions. Deborah Byrd is the creator and writer of *Earth and Sky;* she co-hosts and co-produces the popular radio series with Joel Block. The radio show can be carried for free by radio stations. Information about how to get *Earth and Sky* on the air in your area will be provided by Margo at Byrd and Block Communications, P.O. Box 2203, Austin, TX 78768, phone (512) 477–4441. To submit a listener question, write or call (512) 480–8773 and have your question ready to read (your call will be recorded).

Earth & Sky is currently carried on the following New Mexico radio stations:

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Alamogordo	KPSA	92.7 FM	Air times vary
Albuquerque	KANW	89.1 FM	M-F 4:10
Albuquerque	KKJY	100.3 FM	M-F 7:40 am
Albuquerque	KMBA	1050 AM	M-F 3:40 pm
Clovis	KTQM	99.9 FM	M-F 6:00 am, 6:00 pm
Dulce	KCIE	90.5 FM	M-F 9:00 am, 4:00 pm, 7:30 pm
Farmington	KSJE	90.9 FM	M-F 9:05 am
Gallup	KGLP	91.7 FM	M-F 8:00 am
Las Cruces	KASK	103.1 FM	M-F 6:15 am, 12:15 pm, 4:15 pm
Santa Fe	KIOT	102.3 FM	M-F 8:25 pm
Santa Rosa	KSSR	1340 AM	M-F 8:00 am, 1:00 pm
Taos	KTAO	101.5 FM	M-F 2:00 pm, 8:00 pm

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we've got rocks on our minds...

We're always thinking about ways to keep our readers excited about rocks. Rocks hold hidden stories about the Earth from a long time ago. Rocks can heat our homes; we build our dwellings from rocks. Most of the items we use every day come from rocks. If we don't grow it...we get it from rocks. Watch for upcoming issues of *Lite Geology* to learn more about rocks: how the rocks in Tibet help us understand rocks in New Mexico; why rocks tremble and shake; what minerals are present in rocks; and why we *need* rocks. Until next issue, set your watch by geologic time, and take a rock to lunch.

Lite Geology **Staff**

P.S. In case you don't know where we are in geologic time, we'll tell you in a future issue.

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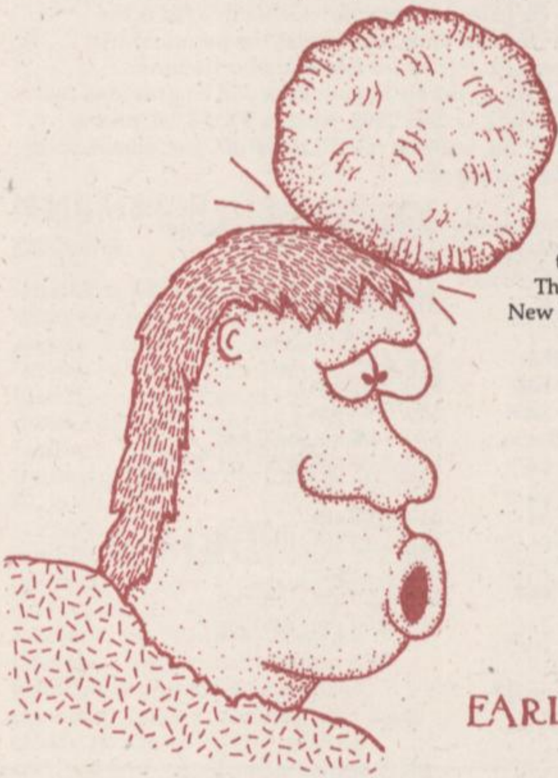

EARLY VOLLEYBALL

LITE geology

is published quarterly by **New Mexico Bureau of Mines and Mineral Resources** *(Dr. Charles E. Chapin, Director and State Geologist)*, a division of **New Mexico Tech** *(Dr. Daniel H. Lopez, President).*

Purpose: to help build earth science awareness by presenting educators and the public with contemporary geological 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 source.

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