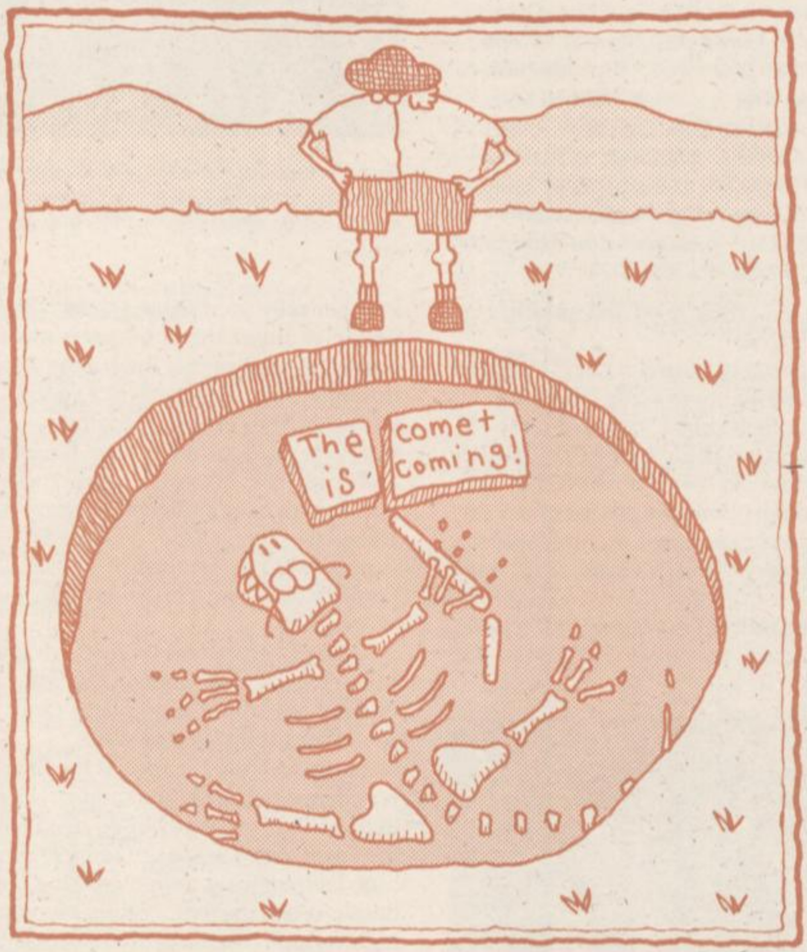
Winter 1993

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)



Earth Briefs

Receding Floodwaters Expose Fossils

The devastating flooding in the summer of 1993 caused widespread destruction in the Midwest. However, receding floodwaters revealed some remarkable surprises that are more than 300 million years old at the Coralville and Saylorville dams in Iowa. During the peak of the flooding, the Iowa River flowed for the first time over the Coralville Dam spillway. A campground and some roads below the spillway were washed away, along with a 15–foot-thick layer of ice-age sediments that left Devonian bedrock exposed. The limestone bedrock reveals hundreds of fossils from the Devonian era, which is also known as the "age of fishes." According to the Army Corps of Engineers, 250,000 visitors have viewed the impressive showing of brachiopods, crinoids, and corals at this site.

The Des Moines River flowed over the Saylorville Dam spillway, cutting a 70–foot-deep path—loosely referred to as "Saylorville Canyon" by local geologists—below the dam that sliced into a wide variety of Quaternary and Pennsylvanian sediments. Exposed fossils include plants, as well as brachiopods and crinoids.

Fossil enthusiasts in New Mexico can view an exposure of dinosaur tracks in the dam spillway of Clayton Lake State Park near Seneca. This area was once on the western shore of a vast, ancient sea. At least eight different dinosaurs left their tracks in the muddy shoreline; the tracks were then covered up for millions of years. During construction of the dam in 1955, all but the last three inches of overlying sediments were removed. Finally, in the early 1980s, the tracks were exposed when water was allowed over the spillway. The footprints are most easily visible in the oblique light that appears in the morning and late afternoon.

Sources – Iowa Dept. of Natural Resources, Geological Survey Bureau, 109 Trowbridge Hall, Iowa City, IA 52242; Clayton Lake State Park, P.O. Box 20, Seneca, NM 88437. –editor

This Issue:

Have you ever wondered...

. . . why New Mexico is so Rich in Oil and Gas?

Ronald F. Broadhead
Senior Head Petroleum Geologist, NMBM&MR

Introduction

New Mexico has been a major oil and natural gas producing state since oil and natural gas were first discovered in the state during the early 1920s. In 1992, New Mexico ranked fourth among states in gas production and seventh in oil production. Production of crude oil in 1992 was 70.8 million bbls (barrels; 1 bbl = 42 U.S. gallons) worth $1.3 billion. Production of natural gas in 1992 was 1.2 trillion ft^3 worth $2.0 billion. More than 99% of this oil and natural gas is produced from the Permian Basin of southeast New Mexico and the San Juan Basin of northwest New Mexico. In 1992, New Mexico received $335 million from state oil and gas production taxes and from oil and gas royalties on state trust lands. In addition, New Mexico received $111 million as its share of revenues from production on federal lands within the state.

The Permian Basin covers a large part of southeast New Mexico and west Texas (Fig. 1). It was formed during the Permian Period as a gigantic depression covered by an ancient sea; this depression was ultimately infilled by sedimentary rock. The New Mexico part of the Basin accounted for 93% of the oil and 39% of the gas produced in New Mexico during 1992. The New Mexico and Texas parts of the basin together produced 429 million bbls oil, 16.5% of total U.S. production of 2.6 billion bbls (includes Alaskan and offshore production). This prolific region also produced 1.7 trillion ft^3 natural gas during 1992, 9.3% of total U.S. production of 18.3 trillion ft^3. The Permian Basin currently is the most active oil exploration area in the onshore U.S.

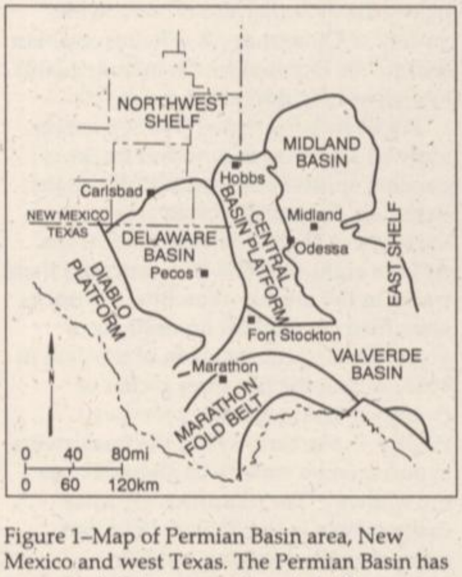


Figure 1–Map of Permian Basin area, New Mexico and west Texas. The Permian Basin has several subdivisions: northwest shelf, Delaware Basin, central basin platform, Midland Basin, and east shelf.

What is the origin of oil and natural gas accumulations?

Discussion of oil and natural gas in the Permian Basin raises many questions regarding their origin. Where did the oil and natural gas come from? How do they occur? How did they get where they are? Four geologic elements are necessary to form oil and natural gas accumulations: **reservoir rocks, source rocks, seals,** and **traps**.

Oil and natural gas occur within **pore spaces** in reservoir rocks (Fig. 2), and not in large underground pools or lakes (a common, but wrongly held belief). These pore spaces are small holes, voids, or passageways that may contain water, oil or natural gas. In order to be a reservoir, a rock must contain a sufficient percentage of pore space (**porosity**) to contain economically producible volumes of oil or gas. In addition, the pore spaces must be interconnected so that fluids may flow through them (they must have good **permeability**). The most common reservoir rocks are sandstone, limestone, and dolostone. However, these rocks do not always have sufficient porosity to be reservoirs (Fig. 3). Good reservoirs generally have porosities of 10-20%. Porosity of the very best reservoirs may exceed 30%.

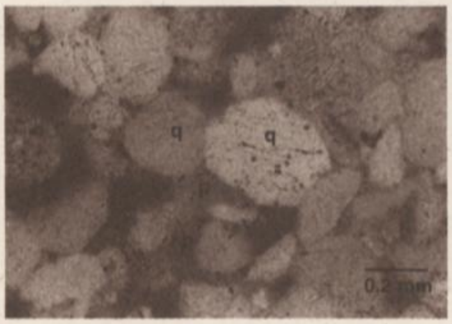


Figure 2–Photo of thin slice of a reservoir sandstone, showing quartz sand grains (q) and open pore spaces, or voids (p).

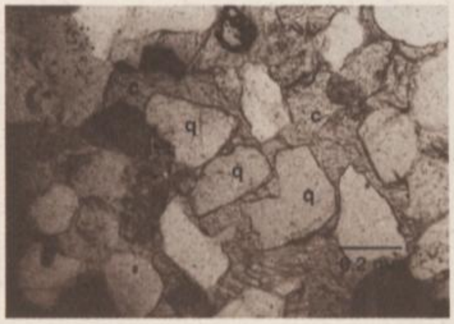


Figure 3–Photo of thin slice of non-reservoir sandstone, showing quartz sand grains (q) and natural calcite cement (c) that fills in pore spaces.

Oil and natural gas originate in source rocks. Source rocks contain the finely divided remains of dead plants (and sometimes animals) that were incorporated into the rock at the time it was deposited. After the source rock is deposited, it becomes buried deep within the Earth and is subjected to increasingly high temperatures with increasing burial depth. When the temperature becomes high enough (generally more than 65°C, or 150°F), the molecules in the organic material undergo chemical reactions and hydrocarbons are generated. If the organic material in the source rock mainly is derived from woody land plants, most of the hydrocarbon molecules that are formed will contain only one carbon atom (methane, Fig. 4a) and natural gas

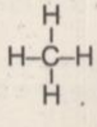


Figure 4a–Methane, the simplest hydrocarbon and principal component of natural gas.

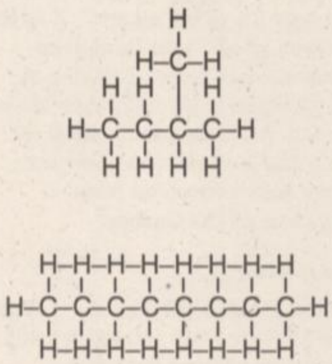


Figure 4b–Long-chained hydrocarbons that are typical components of oil.

will be generated. If the organic matter is mainly derived from aquatic organisms (principally marine algae), the resulting hydrocarbons will be composed of long chains of carbon atoms (Fig. 4b) and oil will be generated. However, if the oil generated is buried yet more deeply, it will be subjected to increasingly higher temperatures; above 100–150°C (212–300°F), the oil molecules undergo chemical reactions that break down their long hydrocarbon chains into methane, and natural gas is formed. So, natural gas may be generated directly from the remains of woody land plants or it may form from oil that is heated to the point where long-chained hydrocarbon molecules become unstable and break down into the smaller molecules of natural gas. Most source rocks are dark-gray to black shales or black microcrystalline limestones. Source rocks generally contain more than 0.5% organic material by weight, and good source rocks often contain more than 2% organic material. In contrast, the porous sandstones, limestones, and dolostones that form reservoir rocks rarely contain enough organic material to generate sufficient hydrocarbons to become source rocks.

After generation, the oil and/or gas move from the source rock into the reservoir rock. Once in the porous and permeable reservoirs, the oil and gas are relatively free to move. Most reservoir rocks are buried to depths ranging from 1,000 ft to 20,000 ft, or more. The pore spaces of most reservoirs are filled with ground water, which is usually saline. Saline ground water has a density greater than 1 g/cm^3 (the density of fresh water). Because oil and natural gas are less dense than the saline ground water (density_{oil} = 0.82–0.93 g/cm^3; density_{gas} = 0.12 g/cm^3), they rise upward through the water-saturated pore spaces until they meet a barrier of impermeable rock (a seal) such as a bed of shale or a bed of salt. The oil and gas then move (migrate) along the top of the reservoir until further movement is blocked by physical arrangement of the reservoir rock and one or more seals.

This arrangement of reservoir and seal(s) is said to constitute a trap. There are two main types of traps, structural and stratigraphic (Fig. 5a, b). Structural traps are formed when a layer or bed of reservoir rock and an overlying seal are deformed by folding or faulting. Usually, this deformation occurred tens or hundreds of millions of years after deposition of the rock. In the case of a fold trap (Fig. 5a), the oil and/or gas will rise to the highest part of the fold. If both oil and gas are present, the gas will form a layer (within the pore space of the rock) that rests above a layer of oil because natural gas is less dense than oil. The layer of oil will, in turn, rest above the water zone. Stratigraphic traps (Fig. 5b) are formed when the reservoir rock is deposited as a discontinuous layer or bed. Seals are deposited beside and on top of the reservoir. A common example of this results from a sandy river channel that snakes its way across a muddy flood plain. If the river changes course or if a channel is abandoned, the muddy sediments of the floodplain will be deposited over the sandy channel sediments; the result is a lenticular or ribbon-like sandstone encased in a shale seal (Fig. 6). If the surrounding shales are source rocks, oil and/or gas generated will migrate from the shales into the reservoir and will be trapped.

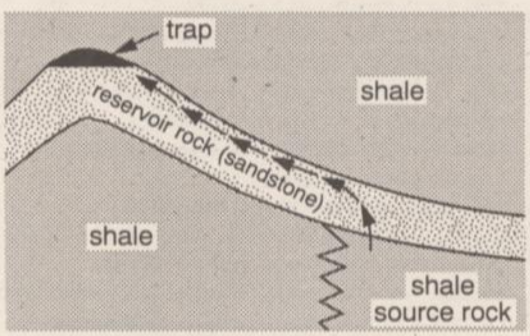


Figure 5a–A structural trap showing source rocks and migration of oil (source ⟶ trap).

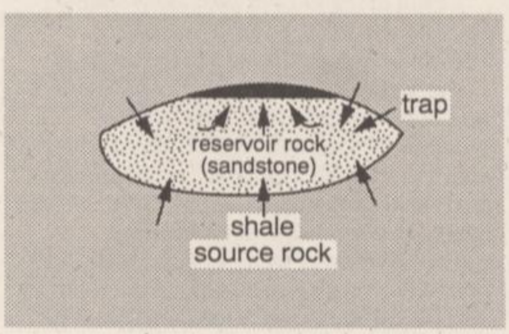


Figure 5b–A stratigraphic trap showing source rocks and migration of oil (source ⟶ trap).

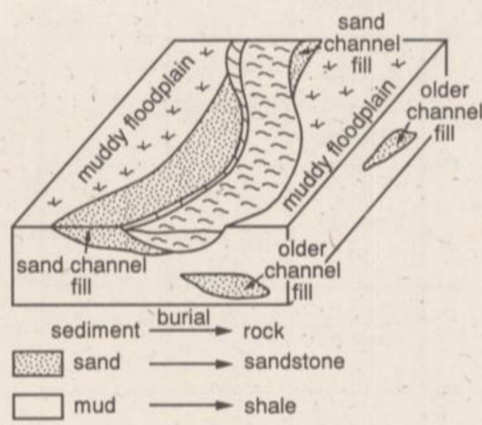


Figure 6–Block diagram of river channel showing areas of sand (sandstone) and mud (shale) deposition.

Oil and gas–underneath the surface

Oil and natural gas in the Permian

Age, million years (base)	Geologic Period	Cumulative Production oil (million bbls)	Cumulative Production gas (billion ft³)
0–1.6	Quaternary		
65	Tertiary		
146	Cretaceous		
416	Jurassic		
245	Triassic		
290	Permian	2,834	11,201
323	Pennsylvanian	419	6,237
363	Mississippian	2	18
409	Devonian	438	440
439	Silurian		
510	Ordovician	114	237
570	Cambrian		
	Precambrian		

Figure 7–Stratigraphic column showing Geologic Periods, chronologic dates, and cumulative volume of oil and gas produced from strata of each geologic period in the New Mexico part of the Permian Basin.

Basin are located in traps buried beneath the land surface. Depth to traps ranges from less than 2,000 ft in Chaves and eastern Lea Counties to more than 15,000 ft in Eddy and western Lea Counties. Sedimentary rocks in the Permian Basin range in age from Cambrian through Tertiary (Fig. 7). Triassic, Cretaceous, and Tertiary sedimentary rocks are thin (0–1,000 ft thick) and have mostly been eroded from southeast New Mexico. Igneous and metamorphic rocks of Precambrian age underlie Cambrian rocks and form the floor of the basin.

Economically viable accumulations of oil and gas are found in sandstones, limestones, and dolostones that range in age from Ordovician through Permian. These rocks were deposited in a variety of environments from ancient rivers to beach sands to oceanic reefs to sandstones laid down by deep currents hundreds or perhaps thousands of feet beneath the surface of the sea. During Permian times (245–286 million years ago), the Permian Basin was formed as a gigantic depression that covered a large part of southeast New Mexico and west Texas (Fig. 1). This depression was filled by an ancient sea. A variety of sandstones, limestones, dolostones, shales, and salts were deposited, covered by other sediments, and ultimately buried to depths exceeding 20,000 ft. Many of the sandstones, limestones, and dolostones became reservoir rocks. This primeval sea teemed with life. As organisms died, they sank to the sea floor and were buried in the sediments. Many of the muddy sediments became shale source rocks.

Depth of the ancient seas was variable. The deepest parts, possibly more than 1,000 ft deep, were located to the south in a deep basin, known in New Mexico as the Delaware Basin; the Texas part is called the Midland Basin. An uplifted area, the Central basin platform, separates the two deep basinal areas and was covered by shallow waters. Shallow marine shelf areas were present north and east of the deep basins. Traps in the shelf areas to the north (northwest shelf on Fig. 1) and on the Central basin platform have produced 97% of the oil and 99% of the gas extracted from the New Mexico part of the basin. The deep Delaware Basin has produced only 3% of the oil and 1% of the gas. However, production from deep basin reservoirs has been increasing as previously unknown oil and gas fields are discovered. A more detailed history of production and a discussion of oil and gas reserves will be covered in an upcoming issue of *Lite Geology*.

Suggested reading:

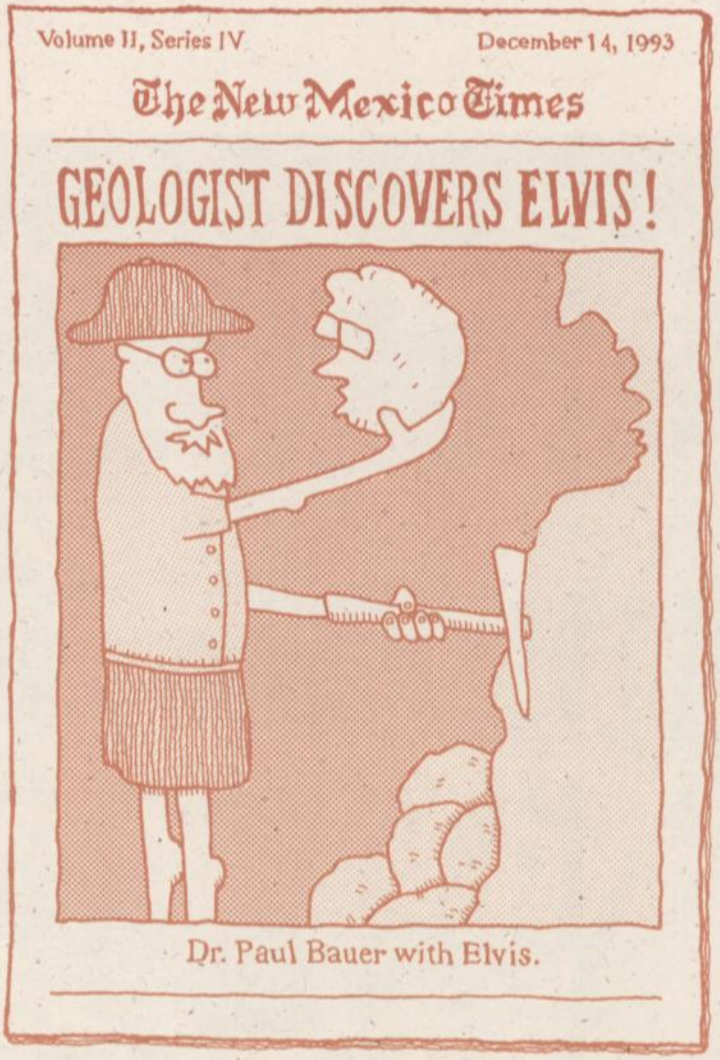
Christiansen, P. W., 1989, The story of oil in New Mexico: New Mexico Bureau of Mines and Mineral Resources, Scenic Trips to the Geologic Past no. 14, 112 pp., $5.00 + $1.50 postage and handling. History of the oil industry and oil production in New Mexico, laced with colorful anecdotes.

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.

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 the potential undiscovered oil and natural 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, postage included. Technical description and discussion of 861 major 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.



a geologist—

- studies the physical nature, structure, and history of the Earth;
- conducts research into the formation and dissolution of rock layers;
- analyzes fossil and mineral content of layers and endeavors to fix historical sequence of development by relating characteristics to known geologic influences;
- studies dynamic processes that bring about changes in the Earth's crust—great internal pressure and heat; volcanic eruptions; earthquakes; and air, water, and glacial erosion;
- studies seismic, gravitational, electrical, thermal, and magnetic phenomena to determine structure and composition of the Earth's surface;
- employs theoretical knowledge and research data to locate mineral, oil, and gas deposits, and determines the probable area, slope, and accessibility of ore deposits;
- prepares reports, maps, and diagrams of regions explored.

Source: Mineral Information Institute (MII) listing of state geologists, which is available by contacting MII at 475 17th St., Suite 510, Denver, CO 80202–4015; (303) 297–3226. Editor's note: If you recently received one of the new listings with some portions of addresses deleted, please contact the MII and request a corrected version.

Window Shopping from the Car

Jacques Renault
Senior Scientist, NMBM&MR

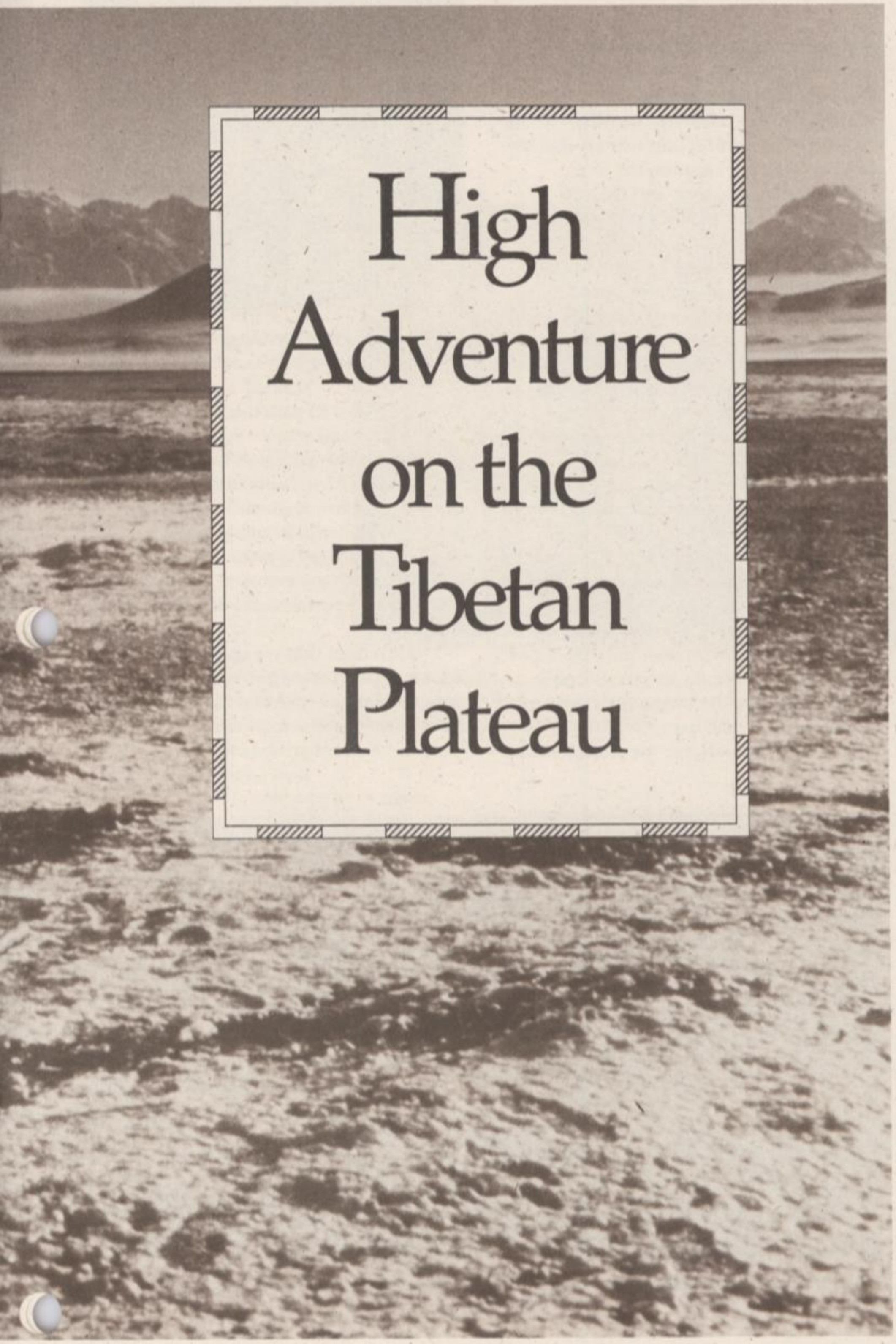
We're going window shopping from the car
You can come just as you are
We won't be stopping close around
We'll do our window shopping out of town

I'll be the driver, you can be the scout
At every roadcut, you'll cry out
Slow down a little, there you are!
We're going window shopping from the car

Wow! Look at that! A folded faulted fold!
I'll slow down a bit as I've been told
So we can marvel from afar
We're doing window shopping from the car

The hours go so quickly by this way
As we arrive you have to say
How fine it is to travel far
And do our window shopping from the car

Jacques Renault is a senior scientist for the New Mexico Bureau of Mines and Mineral Resources, and specializes in mineralogy and geochemistry. Dr. Renault has been with the Bureau since 1964. He started writing poetry for the amusement of himself and his family long before that.



High Adventure on the Tibetan Plateau

Scientists Study Uplift Rates from Continental Collision

Nelia Dunbar
Analytical Geochemist, NMBM&MR

Research takes geologists to some unusual places, but few as exotic and remote as the Tibetan Plateau (Fig. 1). This plateau is an area of the Earth's crust that has startling and uniformly high elevation, averaging 5000 meters (16,500 ft) over a land mass roughly one half the size of the United States. Uplift of the Tibetan Plateau is known to have been caused by the **tectonic** (due to movement of different parts of the Earth's crust) **collision** of the Indian crustal plate with the Asian crustal plate, a collision that also caused the very high Himalayan Mountains, of which Mt. Everest is the highest peak. However, the timing of **uplift** of the Tibetan Plateau relative to the plate collision is not well known, and different types of geological evidence have given contradictory results. The Tibetan Plateau is the only place in the world where geologically recent uplift is combined with dry climate, resultant barren landscape, and pristine rocks that allow many types of detailed studies of uplift rates. Better understanding of this process in Tibet will help geologists understand the process of crustal uplift in other parts of the world that are geologically more difficult to study, such as the Colorado Plateau area of northwestern New Mexico.

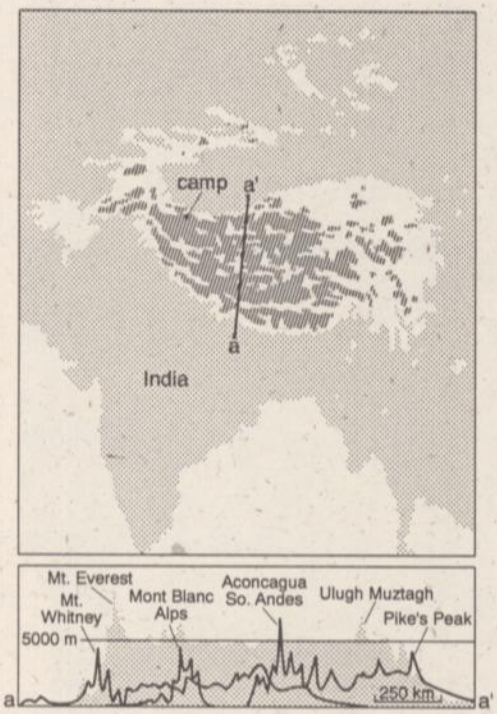


Fig. 1– Map of the Tibetan Plateau, emphasizing the high overall elevation, showing the Indian subcontinent, field site location and elevation cross section (a-a′) across Tibet as compared with cross sections across parts of North and South America (after Molnar, P. 1989, The Geological Evolution of the Tibetan Plateau, Am. Sci., 77, 350-360).

When Dr. Fred Phillips, Dr. William McIntosh and I (all of New Mexico Institute of Mining and Technology) embarked on an expedition to the Tibetan Plateau to collect samples for a new and innovative method of determining uplift rates, little did we suspect the kind of adventure that awaited us. We spent three weeks in one of the remotest parts of the world, walking miles every day with a band of 50 donkeys carrying our camp on their backs, encountering wild yaks, antelope and wolves, and sampling rocks from tiny volcanoes along the shores of cobalt blue lakes with white salty beaches.

Our journey began in Beijing, China, where we met our six Chinese colleagues, and traveled by air and over land to a small village, Pulu, in the foothills of the Kunlun Mountains in western China, which form the northern boundary of the Tibetan Plateau. In Pulu, we met our 10 **Uighar** (wee-gur) guides, the local inhabitants of the area, and their 50 donkeys. From there, we proceeded on foot up the Pulu Gorge (Fig. 2), a very deep and steep-walled valley that leads over the Kunlun Mountains onto the Tibetan Plateau. We only travelled during the morning and early afternoon because the level of the glacially-fed river that flowed in the bottom of the gorge would rise sharply in mid-afternoon, filling the narrow floor of the gorge, and covering our trail with icy, rushing water. This dramatic and sudden increase in water level was caused by warm daytime temperatures that resulted in a greater amount of glacial melting and runoff in the surrounding mountains, which increased the supply of water to the stream. We limited our ascent rate to between 600 and 700 m per day (2000–2300 ft), to allow our bodies to acclimatize to the unusually high elevations at which we were travelling. After 4 days of walking, we reached the 5100 m (16,800 ft) pass into the uninhabited and remote Aksu Basin where our field work was carried out (Fig. 3). The Aksu Basin is ringed by high peaks and is not drained by any rivers. Hence, any precipitation that falls in the basin accumulates in one of three lakes (Fig. 4), which are extremely salty due to continual evaporation of water in the dry climate.

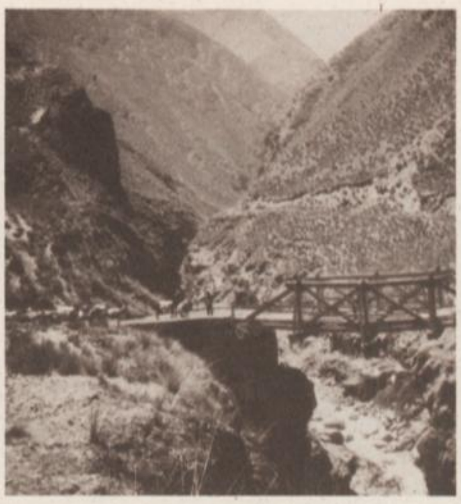


Fig. 2–View up the Pulu Gorge into the Kunlun Mountains.

The ten days that we spent camped in the Aksu basin were devoted to sampling young volcanic rocks that may yield some clues to the uplift rate of the Tibetan Plateau. A number of small volcanic

Fig. 3–North margin of Aksu Basin, emphasizing its flat-floored nature and surrounding mountain ranges.

centers (Figs. 5 and 6), consisting of 100–300 m (300–1000 ft) -high cinder cones and associated lava flows were present in several different areas of Aksu basin. The upper surfaces of the lava flows are characterized by a hawaiian-style pahoehoe (ropy) structure that formed as the flow erupted. Samples of the pahoehoe surface from a number of lava flows, as well as the dense interior of flows were taken and returned to New Mexico for a variety of analyses (Fig. 7).

Two types of analyses are necessary in the investigation of our Tibetan samples in order to define uplift rates. The first involves determination of the **true age** of eruption of the volcanic rock by measuring the abundance of **isotopes** of the element argon that is produced by natural radioactive decay of the element potassium within the rock (an isotope is an atom with same number of **protons**, but different number of **neutrons**, and thus different **atomic weight**, as another atom of the same element). The amount of the argon isotope that is present in the rock is proportional to the rock's age, and will be precisely measured by Dr. McIntosh at the New Mexico Geochronological Research Laboratory, a cooperative project of Los Alamos National Laboratory, New Mexico Bureau of Mines and Mineral Resources and New Mexico Tech. The second part of the analytical approach involves a method called **chlorine-36 dating**, which was largely developed by Dr. Fred Phillips (see Lite Geology, Spring, 1993). The isotope chlorine-36 in a rock is produced mainly by natural cosmic-ray bombardment. Thus, the amount of chlorine-36 in the outer surface of a rock is proportional to the age of the rock, but also is strongly dependent on the rock's elevation, because the Earth's atmosphere acts as a filter to cosmic radiation. For instance, you would be exposed to many more cosmic rays on top of Mount Everest than at sea level. We should be able to determine the elevation history of the rock since it was formed by:

1) measuring the chlorine-36 content of the pahoehoe surfaces of the Tibetan volcanic rocks that were exposed to cosmic radiation since they were erupted;

2) knowing the true age of the rock by measurement of the argon isotopes; and

3) knowing how elevation affects the abundance of cosmic rays.

For example, if a lava flow on the Tibetan Plateau was erupted at a low elevation and was subsequently uplifted to its current high elevation, we would expect to find a lot less chlorine-36 in the rock than if it had been at high elevation since the time of eruption. So, a combination of low-tech field work in a remote area, and high-tech analyses in our New Mexico laboratories may yield important clues to tectonic processes within the Earth's crust.

The implications of determining uplift rates of the Tibetan Plateau are far-reaching. As mentioned earlier, studying rocks that were uplifted in geologically recent time can help us understand older uplifts, such as are present in some areas of New Mexico. Furthermore, large

Fig. 4–Lake Ashik-kohl, one of the three main saline lakes in the Aksu Basin. The arcuate patterns on the beach are evidence of old lake levels higher than those today. Beaches are white with encrusted salt.

Fig. 5–Cinder cone and flow in the Aksu Basin

Fig. 6–Cinder cone and flow in the Aksu Basin

Fig. 7–Sampling a young lava flow.

uplifted areas of the Earth's crust can have an impact on global climate. An uplifted area of the crust results in local cooler temperatures that can cause greater local snowpack and changes in global atmospheric circulation. Chemical weathering of minerals that erode rapidly from high, cold altitude to warmer lower elevations can reduce CO_2 levels in the atmosphere, which can have the effect of moderating natural "greenhouse effect" (proposed global warming caused by CO_2 buildup in Earth's atmosphere). Characterizing the uplift rate of the Tibetan Plateau, where timing of climatic variation is relatively well-understood, will help show the effect of crustal uplift on climate and will help decipher past records of uplift and climatic variation, such as those in the Rocky Mountains and Sierra Nevada Ranges of the western United States.

This research project is funded by the National Science Foundation, the National Geographic Society, and New Mexico Tech.

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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
(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:

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

Upcoming Geological and Scientific Events

April 24–26, 1994
The New Mexico Conference on the Environment will be held at the Albuquerque Convention Center in Albuquerque, NM. The theme of the conference will be *Environmental Economics—Prevention Versus Cleanup.* For more information, contact:
New Mexico Environment Dept.
1190 St. Francis Drive
P.O. Box 26110
Santa Fe, NM 87502
(505) 827–2850

May 4–6, 1994
The Southwest Section of the National Association of Geology Teachers and the *Geological Society of America* will hold a joint symposium at the 1994 GSA Rocky Mountain Sectional Meeting, at the Tamarron Resort in Durango, Colorado. For more information, you may contact Steve Semken at (505) 368–4225.

Teachers Resources:

The K-12 Environmental Education Initiatives Handbook offers helpful hints and strategies for environmental education initiatives, case studies, and resources. For information, contact:
Abby Ruskey, Coordinator
K-12 Env. Ed. Initiatives Project
College of Natural Resources
Univ. of Wisconsin-Stevens Point
Stevens Point, WI 54481
(715) 346–4179.

"Sharing Science With Children—A Survival Guide for Scientists and Engineers" and ***"Sharing Science—Linking Students with Scientists and Engineers—A Survival Guide for Teachers"*** are two booklets available for $1.50 each from:
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continental breakfast plates collide: geologist gets a clue...

In this issue we show how scientists from New Mexico study rocks in a remote part of the world to find clues about the history of rocks closer to home. We also give our readers an overview of how the oil and gas reserves in New Mexico were formed millions of years ago. Both of these stories illustrate how our lives today are affected by geologic processes that happened long ago. If your concept of a geologic era is "how long I wait before each new issue of *Lite Geology* arrives," or if your definition of a fossil is "any person, place, or thing that is more than 40 years old," stay tuned to *Lite Geology* as we begin to tackle geologic time. But please be patient, geologic processes sometimes take a while!

Lite Geology **staff**

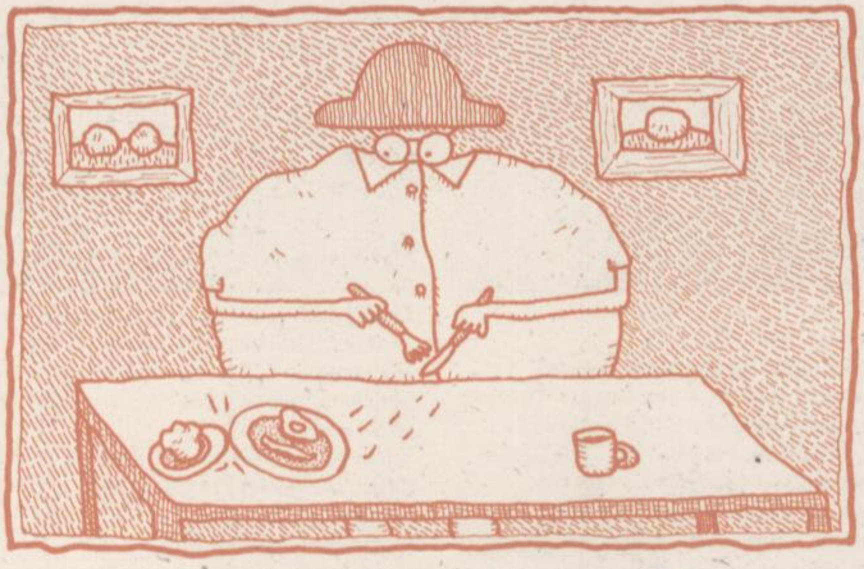

PLATE TECTONICS

LITE geology

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