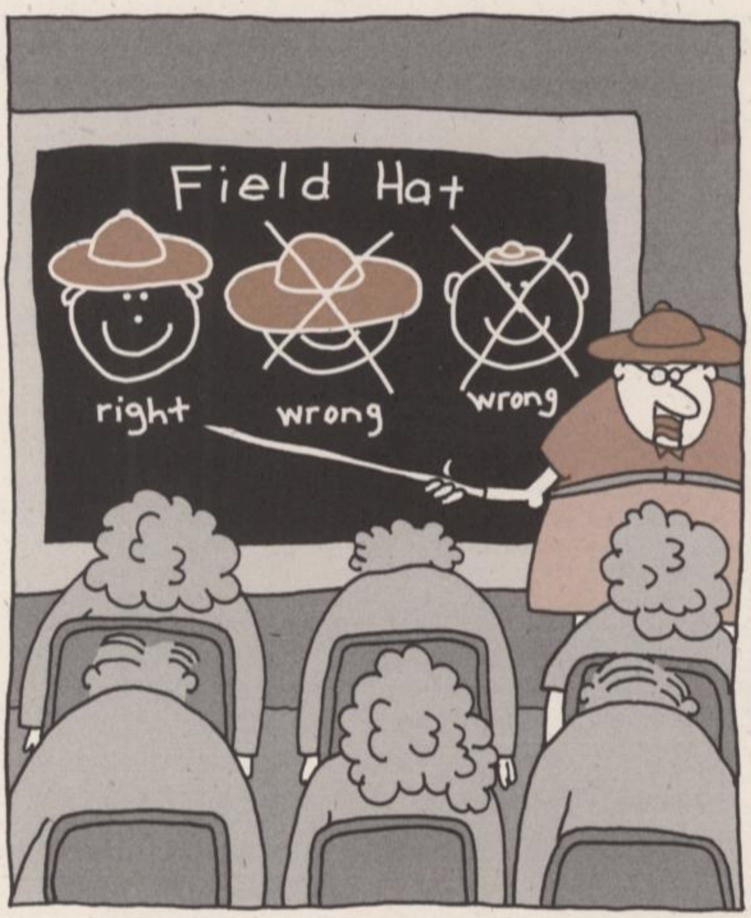
Number 20
1998

LITE geology

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

New Mexico Bureau
of
Mines and Mineral
Resources
a division of New Mexico Tech



Useful geologic information.

This Issue

Earth Briefs

Celebrate the first annual Earth Science Week!

The week of October 11-17, 1998 has been designated as the first annual Earth Science Week. The American Geological Institute, which is sponsoring Earth Science Week as part of its 50th anniversary celebration, invites you to join the celebration. You can visit their web site at ***http://www.earthsciweek.org.*** to get details, ideas, and materials for planning Earth science activities and events in your community (see back cover).

Why Celebrate Earth Science Week? This event has enormous potential for increasing public awareness and understanding of the importance of the earth sciences in our lives. The celebration, which will be held annually during the second full week of October, will give geoscientists and organizations repeated opportunities:

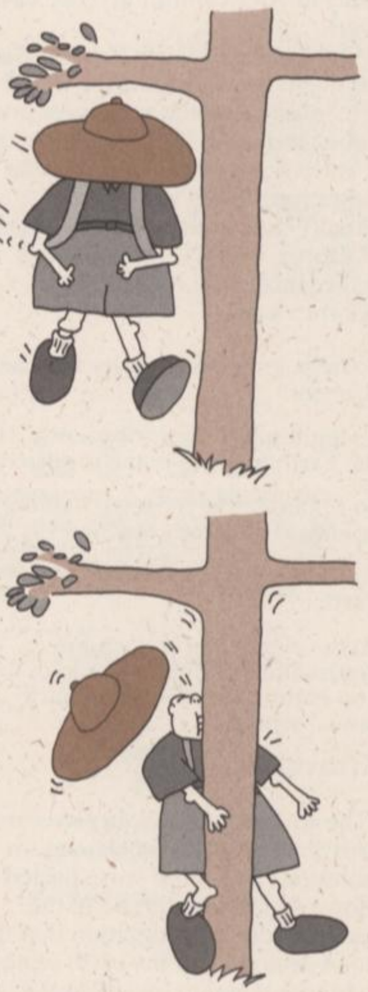
- To help students discover the Earth sciences.
- To highlight the contributions that the Earth sciences make to society.
- To publicize the message that Earth science is all around us.
- To encourage stewardship of the Earth.
- To develop a mechanism for geoscientists to share their knowledge and enthusiasm about the Earth and how it works.
- To have fun!!!

The governors of 25 states have issued Earth Science Week proclamations and resolutions and more are expected to follow. A common thread in the proclamations is recognition that the role of geology and the earth sciences are fundamental to society and to our quality of life. An understanding of geology and the earth sciences can

help citizens make wise decisions for land management, is crucial to addressing environmental and ecological issues, and provides the basis for preparing for and mitigating natural hazards.

Check out the Earth Science Week website for information on volunteer opportunities, governor's procalamations, and events that are planned. Don't wait to celebrate. Get involved now!

Source
Modified from a press release by American Geological Institute, July 14, 1998.



Natural accumulations of carbon dioxide in the New Mexico region-

Where are they, how do they occur, and what are the uses for CO_2?

Ron Broadhead
Sr. Petroleum Geologist
NMBM&MR

Introduction

Carbon dioxide (CO_2) gas occurs naturally in three major underground rock reservoirs in New Mexico and southern Colorado (fig 1). The CO_2 gas is produced commercially from wells drilled into these reservoirs. The primary use of the produced CO_2 is for enhanced recovery of oil in oil fields of southeast New Mexico and southwest Texas. Other uses of CO_2 include refrigeration (dry ice), carbonation of soft drinks, and as a medium in fire extinguishers. In 1995, the CO_2 produced from the Bravo Dome field of northeast New Mexico had a value of \$43.5 million and generated \$1.8 million in tax revenues and royalties for the state. Approximately 100 people are employed in CO_2 production and

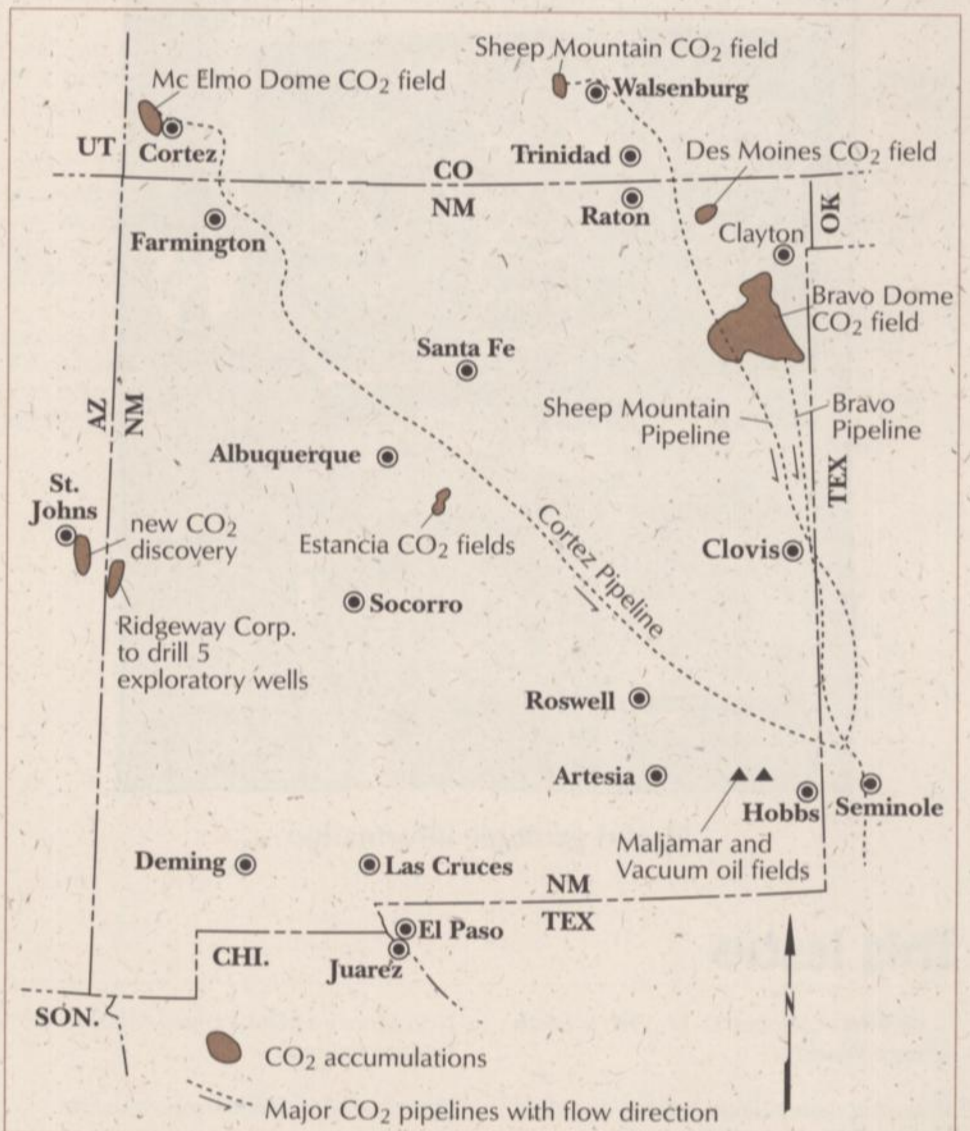


Figure 1—Location of CO_2 fields, pipelines, and CO_2 enhanced oil recovery projects in NewMexico.

Table 1—Summary of carbon dioxide accumulations in New Mexico and southern Colorado.

Field Location (county, state)	**Depth to production (ft.)**	**Date discovered**	**Reserves trillion ft3**	**Comments**
Bravo Dome Union & Harding, NM	1900 - 3000	1916	16+	Used primarily for enhanced oil recovery
Sheep Mountain Huerfano, CO	4500 - 5500	1971	2.5	Used for enhanced oil recovery
McElmo Dome Montezuma, CO	7900	1944	17	Used for enhanced oil recovery
Des Moines Union, NM	2000 - 2600	1935	unknown	Field abandoned in 1966. CO_2 was converted to dry ice and liquid.
Estancia Torrance, NM	1200 - 2000	1928	unknown	Two small fields, abandoned in 1942. CO_2 was converted to dry ice and liquid.

processing operations in New Mexico.

Carbon dioxide–natural accumulations

There are three known major accumulations of carbon dioxide (CO_2) gas in rocks in New Mexico and southern Colorado. These accumulations are the Bravo Dome field of northeastern New Mexico, the Sheep Mountain field of southeastern Colorado, and the McElmo Dome field of southwestern Colorado (Fig. 1; Table 1). In addition, there are two known lesser occurrences of CO_2 gas at the Des Moines field in northeastern New Mexico and the Estancia fields of central New Mexico (Fig. 1; Table 1). The past three years have seen the discovery of an accumulation of CO_2 near St. Johns in eastern Arizona.

The CO_2 gas in these areas occurs naturally as underground accumulations in porous sedimentary rocks. The Bravo Dome field is the principal known CO_2 accumulation in New Mexico. Let us look at this accumulation in some detail in order to gain an understanding of how CO_2 occurs underground.

The Bravo Dome field was originally known as the Bueyeros field. It was discovered in 1916 by a well that was drilled in search of oil, the American Production Corp. No. 1 Bueyeros well. While the well was being drilled, CO_2 gas was encountered in the Tubb sandstone of Permian age (Fig. 2) at a depth of 2,000 ft. The CO_2 gas flowed out of the sandstone and into the well at a rate of 25 million ft^3 (MMCF) per day. The well was plugged and the gas flow was shut off because there was no commercial market for the CO_2 at the time (Anderson, 1959).

Carbon dioxide in the Bravo Dome area remained unproduced and undeveloped until 1931 when a second well was drilled, the Southern Dry Ice Company No. 1 Kerlin well. That well was drilled specifically for the CO_2, which it encountered at a depth of 940 ft in the Santa Rosa Sandstone of Triassic age (Fig. 2). Nineteen additional wells were drilled in the Bueyeros area in the 1930s. Those wells produced CO_2 from both the Santa Rosa and Tubb sandstones. At the well head, the gas was collected into a pipeline system and sent to a nearby processing plant where it was compressed into dry ice and bottled as liquid CO_2. In the days before modern refrigeration, the dry ice was used as a refrigerant for perishable foods. One of the uses of the liquid CO_2 was for the carbonation of soft drinks.

Production of CO_2 from these 19 wells was modest but steady through the end of the 1970s and ranged from 500 million ft^3 (MMCF) per year to 1 billion ft^3 (BCF) per year (Fig. 3). In the mid-1980s a new use for CO_2 arose—enhanced recovery of oil from the oil fields of southeast New Mexico and southwest Texas. This new use for the CO_2 quickly outstripped all previous demands for this product. The major known occurrences were quickly explored and developed by the drilling of additional wells. Production rose steeply as the wells were drilled. In the Bravo Dome field, more than 270 additional wells were drilled and production quickly rose to more than 120 BCF per year (Fig. 3). CO_2 gas produced from the wells at Bravo Dome, McElmo Dome, and Sheep Mountain is compressed into a liquid and fed into pipelines that transport the liquid CO_2 to oil fields in southeast New Mexico, southwest Texas, and western Oklahoma (Fig. 1).

More than 99% of the CO_2 at Bravo Dome is produced from the Tubb sandstone (Fig. 2). This gas occurs under pressure within the pore spaces of

Stratigraphy		Rock Types	Thickness (ft)	CO_2 Production
Cretaceous		shales, sandstones	0–400	
Jurassic		shales, limestone	0–600	
Triassic	Chinle	shales, sandstones	500–1000	
Triassic	Santa Rosa	sandstones	200–300	minor
Permian	San Andres	limestones, anhydrites	0–400	
Permian	Glorieta	sandstones		
Permian	Clearfork	sandstones, limestones, shales, anhydrites		
Permian	Cimarron	anhydrites	10–150	
Permian	Tubb	sandstone	100–400	major
Permian	Abo	sandstones, shales, conglomerates	0–4500	
Precambrian		granites, metamorphic rocks		

Figure 2—Stratigraphic column of the Bravo Dome of northeast New Mexico indicating thickness of rock units and rock units that CO_2 is produced from.

the porous and permeable Tubb sandstone. When a well is drilled into the Tubb, the gas expands and moves into the wellbore from which it is produced. The gas is said to be **trapped** within the Tubb by **seals** of impermeable, fine-grained rock through which the gas cannot move. The Cimarron Anhydrite is one of the seals; it is an impermeable rock that overlies the Tubb. It prevents the CO_2 gas from leaking upward and escaping. The Tubb also dips to the southeast (Fig. 4). The CO_2 would leak updip to the northwest but for a fortuitous circumstance. The sandstone that forms the Tubb changes gradually into fine-grained impermeable shale in that direction; this shale effectively keeps the gas confined to the sandy part of the Tubb.

The gas produced from Bravo Dome is 98 to 99% CO_2. Other constituents include nitrogen (N_2), and trace amounts of the noble gases (helium, He; neon, Ne; argon, Ar; krypton, Kr; and xenon, Xe). The CO_2 is thought to have originated deep within the mantle of the Earth. Evidence for this postulated origin comes from regional geological studies as well as isotopic analyses of the gases (Staudacher, 1987; Broadhead, 1993a). The CO_2 may have leaked upward through major deep-seated fault systems and into the reservoirs where it is trapped.

Staudacher (1987) reviewed published studies of isotopic analyses of gases from the Bravo Dome field. In particular, he looked at isotopes of Xe, Ne, Ar, and C. The C isotopes, of course, occur as carbon within the CO_2. The Xe, Ne, and Ar occur separately as described above. Staudacher compared the isotopic composition of the Bravo Dome gases with the isotopic composition of gases trapped within mid-ocean ridge basalts. The mid-ocean ridge basalts are present along centers of sea-floor spreading at the bottom of the world's oceans and are thought to be derived from eruption of magmas sourced in the upper mantle. The isotopes from the Bravo Dome gases are very similar to the isotopes from the mid-ocean ridge basalts but are distinctly different from isotopes in the continental crust (see Fig. 5 for an example).

CO_2 in enhanced oil recovery

As mentioned above, the main use for CO_2 produced from the Bravo Dome, McElmo Dome, and Sheep Mountain fields is in the enhanced recovery of oil from old oil fields, that is, from oil fields that have been producing for many years. In newly discovered oil fields, the natural pressures within the reservoir rock are sufficiently high to force oil out of the pore spaces of the reservoir rock and into the borehole of the oil well. This is called *primary production*. The higher the pressure within the reservoir rock, the higher the production rate of the oil. As the oil is produced over time, the pressure level within the reservoir rock gradually falls until oil can no longer be produced quickly enough to pay for the operation of the well. Depending on the geologic and

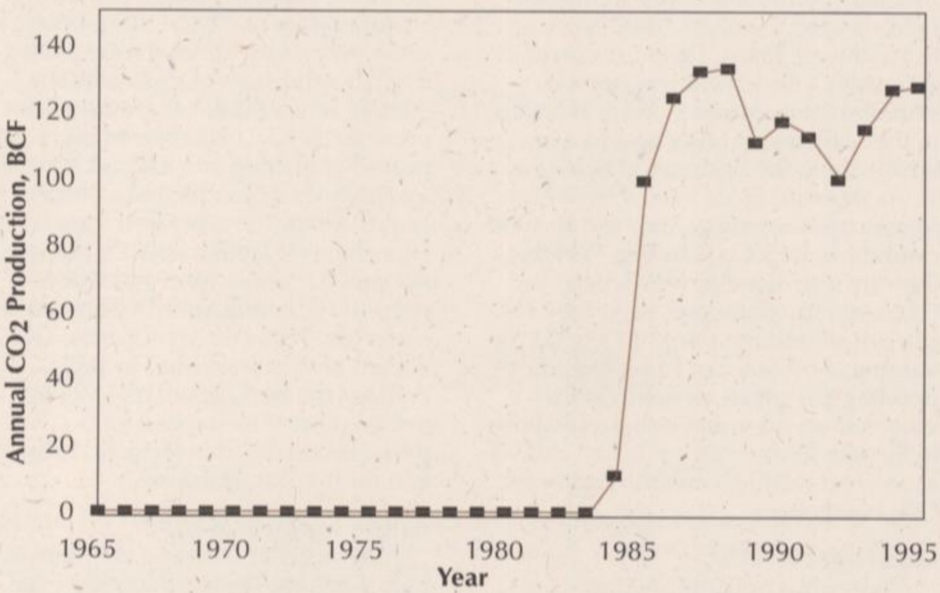


Figure 3—Historical production of CO_2 in New Mexico from 1965 until the present. All of this production is obtained from the Bravo Dome field.

engineering characteristics of the reservoir rock, as much as 50 to 70% of the oil in the reservoir can be left behind after primary recovery. Although enhanced recovery by CO_2 flooding can not recover all of the oil that is left behind, it can recover substantial amounts of it under the right circumstances.

In order to restore pressure within the reservoir rock and increase production, some fluid must be injected into the reservoir rock to compensate for the oil that has been withdrawn through production. If production is to be economic, the injected fluid must cost much less than the oil that is produced (Taber, 1993). Usually water is injected first, but CO_2 may be injected later after oil production associated with water injection declines.

The CO_2 is injected into the reservoir rock though specially drilled *injection wells* (Fig. 6). At first, the CO_2 acts to physically displace oil from parts of the

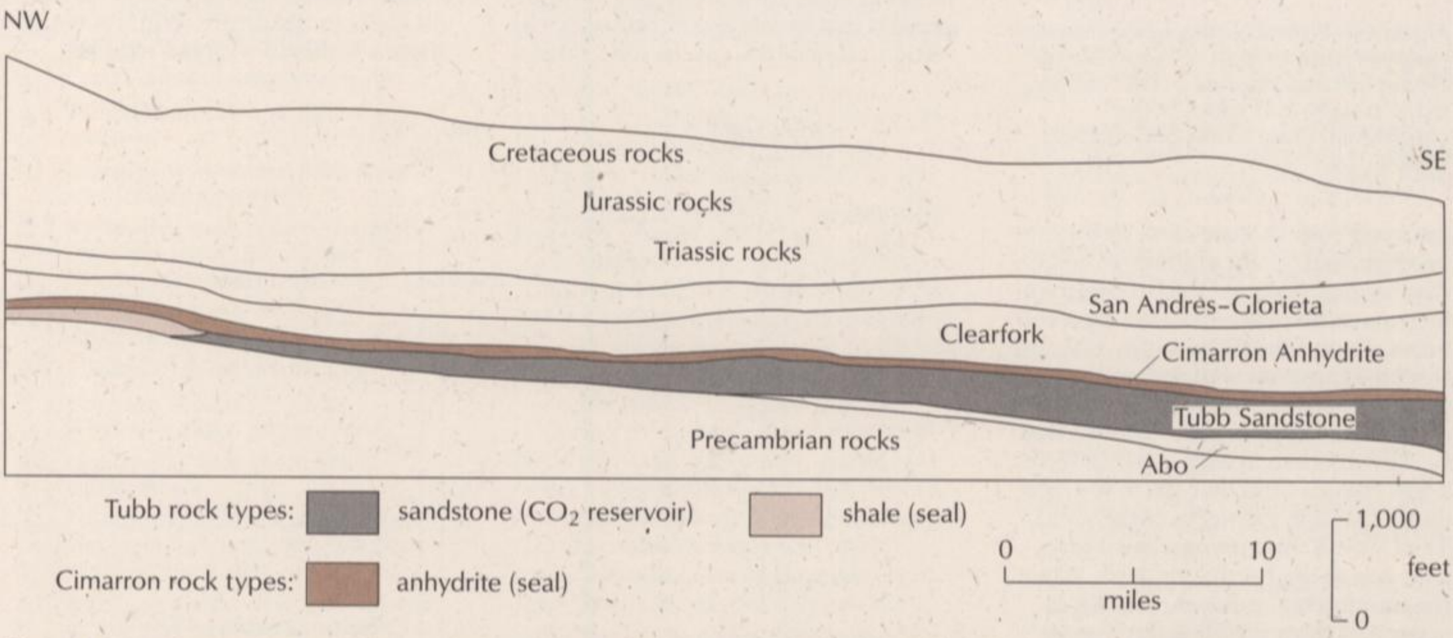


Figure 4—Northwest-southeast cross section through rocks of the Bravo Dome CO_2 field showing distribution of the sandstone reservoir within the Tubb Sandstone and anhydrite and shale seals within the Tubb Sandstone and Cimarron Anhydrite.

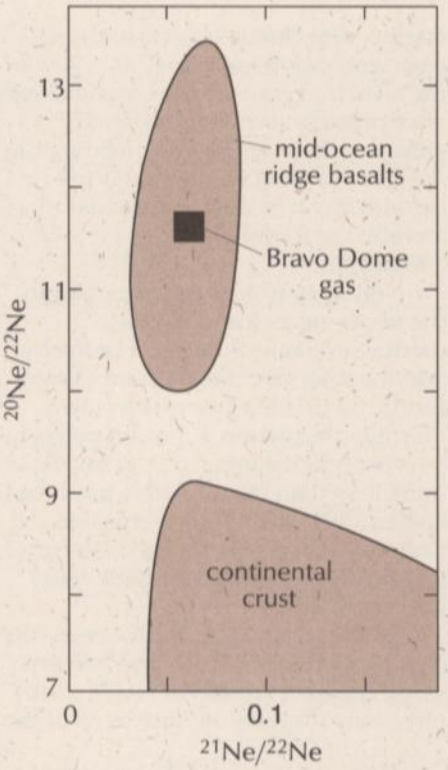


Figure 5—Plot of Ne isotopes, showing isotopic composition of Ne in Bravo Dome gas and regions of mid-ocean ridge basalts and rocks in the continental crust. After Staudacher (1987).

reservoir rock that are close to the injection well. As the volume of the CO_2 that has been injected into the reservoir increases, the pressure in the reservoir increases and the CO_2 moves outward from the injection well. When the pressure becomes sufficiently high, the oil and the CO_2 become miscible, that is, they dissolve in each other to form a less viscous fluid that can move more easily through the pores of the rock. The CO_2-oil mixture moves under pressure to the producing well. When the mixture is produced, the CO_2 is separated from the oil and reinjected back into the reservoir. An example of the effect of CO_2 injection on oil recovery is shown in Fig. 7.

At present, most CO_2 produced from the Bravo Dome, McElmo Dome, and Sheep Mountain fields is used in enhanced oil recovery in southwest Texas. There are currently only three CO_2 injection projects in southeast New Mexico, one of which is in the Maljamar oil field and two of which are in the Vacuum oil field (Fig. 1). As more oil fields in southeast New Mexico become mature, they will become candidates for CO_2 flooding. Whether they are ever flooded will depend on: (1) economic conditions, especially the price of oil and the price of CO_2; (2) the volume of oil that can be produced by flooding any given oil field; (3) the economic situation and technical abilities of the operators of the oil fields; and (4) access to a readily available supply of CO_2 (see below).

Other uses of CO_2

There are a number of other commercial uses of CO_2 (Table 2). Three physical properties of CO_2 make it a useful commodity. (1) It is very cold when converted from a gas into either liquid or solid form through a complex process that involves compression and refrigeration of the gas. In solid form it is known as *dry ice*, which sublimes at a temperature of -78.5° C. (Sublimation is the process by which a solid passes from its solid state to a gas without melting into a liquid; at atmospheric pressure, solid CO_2 sublimes into a gas instead of melting into a liquid.) (2) Dry ice sublimes slowly so that a block of it can last several days before it completely vaporizes. (3) Unlike air, CO_2 gas does not contain free oxygen and will not support the combustion of flammable materials. These three properties make it ideal for the uses listed in Table 2. Perhaps the best known uses are for carbonation of beverages, for refrigeration when in the solid form, and for fire extinguishers.

Future supplies of CO_2

Presently known and developed CO_2 fields appear to be adequate for maintaining the present CO_2 floods in southeast New Mexico and southwest Texas. However, additional CO_2 supplies may be needed to initiate enhanced recovery operations in other oil fields in the future. While some of these additional supplies may be

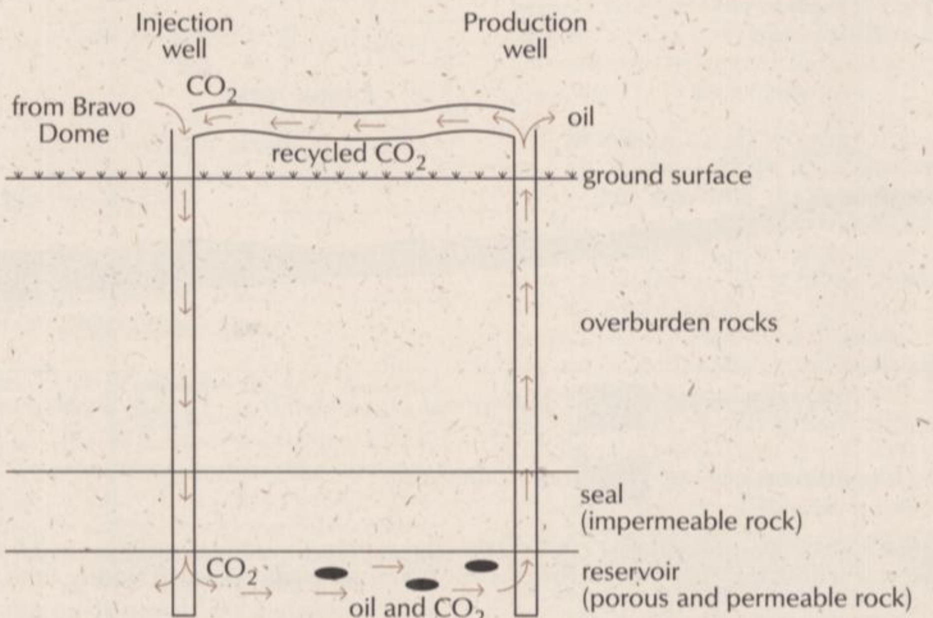


Figure 6—Diagram showing injection of CO_2 into an oil reservoir and enhanced production of oil from that reservoir.

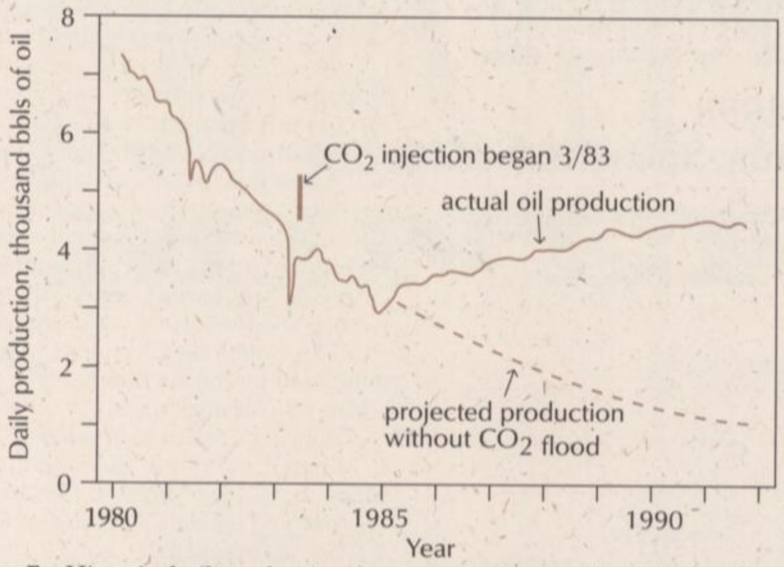


Figure 7—Historical oil production from the Seminole oil field in southwest Texas, showing how CO_2 injection has increased oil production in this old, mature field. From Taber (1993) after Hadlow (1992).

Table 2— Some uses of CO_2 (courtesy of Augustus Hayoz, Ross Carbonics Company, Mosquero, NM)

1. Enhanced oil recovery
2. Refrigeration with dry ice
3. Carbonation of beverages
4. Shredding of old tires (freezing process)
5. Stripping of insulation from scrap wire (freezing process)
6. Removal of corn kernels from the cob during food processing (freezing process)
7. Removal of hair from hogs in slaughterhouses
8. Cooling of metal cutting tools
9. Stripping of paints (freezing process)
10. Noncombustible gas in fire extinguishers
11. Noncombustible atmosphere that can be introduced into grain silos to prevent grain dust explosions
12. Inert, noncombustible atmosphere for welding combustible materials
13. Nontoxic aerosol propellant
14. Branding of livestock
15. Stimulation of plant growth in greenhouses
16. Excellent solvent when in the supercritical state

obtained by additional drilling in the known fields, new undiscovered CO_2 fields may have to be explored for (and found!). One place to look would be in the known CO_2 areas of northeast New Mexico and southern Colorado. However, in the last three years, exploratory drilling by Ridgeway Oil Corp. has discovered previously unknown accumulations of CO_2 near St. Johns in eastern Arizona (Fig. 1). The full extent and size of these accumulations is not completely known. Ridgeway Oil Corp. has recently drilled several exploratory wells in west-central New Mexico in the search for additional reserves of this useful gas.

In the future, CO_2 also may be collected from waste gases from coal-fired electrical generating plants and other industrial facilities. This would not only provide additional sources of CO_2 for enhanced oil recovery but would also help control emissions of greenhouse gases and help alleviate concerns about global warming. At present, however, the cost to recover CO_2 from these sources is estimated to range from $1.00 to $2.50 per thousand ft^3 of CO_2 (Taber, 1990). This is expensive compared to the present cost of $0.30 to $0.35 per thousand ft^3 to obtain CO_2 from the Bravo Dome field. Unless more cost-effective methods of extracting CO_2 from waste gases can be found, this source is unlikely to be tapped in the immediate future.

Economic impact on New Mexico

The CO_2 gas produced from the Bravo Dome field has a major economic impact on the state of New Mexico. During 1995, 132 BCF of CO_2 gas valued at $43.5 million were produced from the Bravo Dome field (New Mexico Energy and Minerals Department, 1996). this generated $1.8 million in tax and royalty revenues for the state (New Mexico Energy and Minerals Department, 1996). The CO_2 production and processing facilities at Bravo Dome employ approximately 100 people in the northeastern part of the state.

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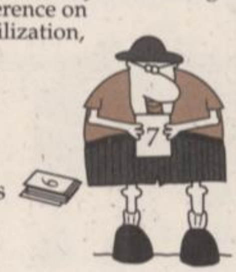

19th Annual New Mexico
MINERAL SYMPOSIUM

November 7 & 8, 1998
Macey Center, NM Tech Campus, Socorro, NM

(Sponsored by: New Mexico Bureau of Mines & Mineral Resources, Albuquerque Gem and Mineral Club, Los Alamos Geological Society, New Mexico Geological Society, Chaparral Rockhounds)

REGISTRATION FORM

Name____

Address______________________________________

Phone____

Registration: ☐ General $22 ☐ Senior $16.50 ☐ Student $13

Banquet: ☐ Adult $16 no.______

☐ Children $6 (2-12 yrs.) no.______

Total: $________

website announcement: ***http://www.nmt.edu/mainpage/calendar/mineral.htm***

The purpose of the symposium is to bring together professionals and amateurs interested in mineralogy. Colorful presentations highlight mineral occurrences in the Four Corners States and other areas. Informal tailgating and discussions among mineralogists, geologists, and hobbyists should benefit all. A banquet on Saturday night and auction to benefit the symposium are part of the festivities. A silent auction on Sunday (free admission), sponsored by the Albuquerque Gem & Mineral Club, provides a lively and unique way to add to mineral collections. Money generated by the auction benefits the club's scholarship funds.

This year's featured speaker is Terry E. Huizing, curator at the Cincinnati Museum Center–Museum of Natural History and consulting editor of *Rocks & Minerals* magazine.

For more information contact:
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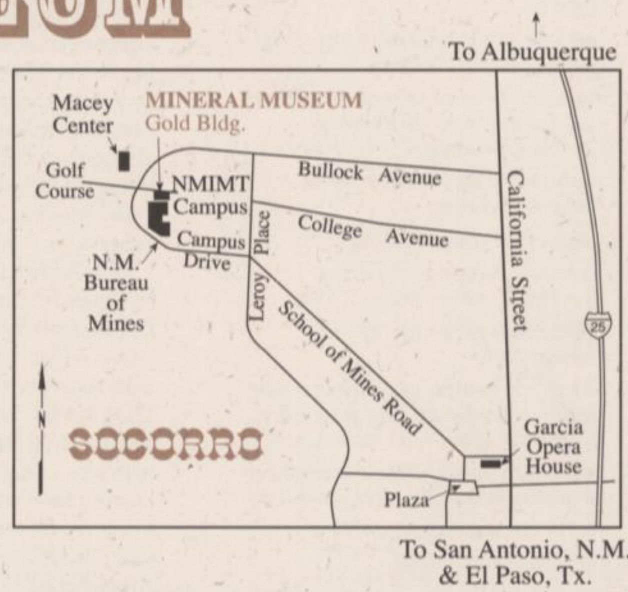
MINERAL MUSEUM

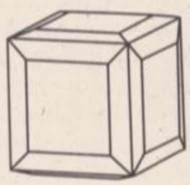
HOURS OF OPERATION:
8 a.m.-5 p.m. Monday through Friday (closed for lunch)
10 a.m.-3 p.m. Saturday and Sunday
Closed Official NMT Holidays

TOUR INFORMATION:
To make an appointment for school or group tours of the museum, contact: Lynn Heizler (Ed. Outreach Assistant) 505-835-5166
lheizler@gis.nmt.edu

To schedule visits after hours or access the collection for research, contact: Dr. Virgil Lueth (Mineralogist/Economic Geologist)
505-835-5140
vwlueth@nmt.edu



New Mexico's Most WANTED MINERALS



Copper tetrahexahedron a common crystal form

NATIVE COPPER "CHILI"
The NMBM&MR Museum Mascot

COPPER
(spinel twin)

DESCRIPTION: Copper (L. *cuprum*, from the island of Cyprus—where copper is still mined from massive sulfide deposits) normally a dull red metal that can take on a bright metalic luster. Metallic streak with shiny luster. No cleavage. Hackly fracture. Highly ductile and malleable. Mohs hardness of 2.5-3. Specific gravity of 8.8-8.9. Crystallizes into a face-centered cubic lattice. Crystals are rare but when present, twinning is common, often into spear-shaped forms (spinel twins).

WANTED FOR: Man has mined copper since ancient times, perhaps for more than 5000 years. It is one of the most important metals used by people, hence it is grouped with zinc and lead as one of the "base metals." Used heavily in the electrical industry. Alloyed with tin and zinc to make bronze and zinc to make brass. Most U.S. coinage is copper alloy.

HIDEOUT: Native copper is usually found just below the zone of weathering of copper deposits (most copper is refined from sulfide minerals). Most copper is now mined from large pits called porphyry copper deposits. These deposits are of low grade (0.25% Cu) and large tonnage. Copper also occurs in veins. Red sandstone deposits that contain copper are also mined in Africa. Deposits called massive sulfides, formed by submarine vents (black smokers) also contain large amounts of copper as sulfides. Large deposits of native copper were mined from basalts in upper Michigan.

LAST SEEN AT LARGE: In porphyry copper deposts at the Chino and Tyrone mines in Grant Co., NM. In red bed copper deposits at Scholle (near Mountainair), Nacimiento (near Cuba), Pastura (near Santa Rosa), and High Rolls (near Cloudcroft). Also found in some veins deposits around the state and in the massive sulfide deposit at Pecos.

ALIASES: Copper is so distinctive it has no aliases. However, it is often associated with azurite, malachite, and cuprite.

New Video Highlights Geoscience Careers

Careers for Geoscientists is a new video created by the American Geological Institute to inspire college and high school students to pursue careers in the earth sciences. The 40-minute video introduces the wide scope of careers in the geosciences, encompassing the atmosphere, the oceans, and the solid Earth. It was created for freshmen or sophomores in college and for high school juniors and seniors. This video is a valuable resource for students who have an interest in the earth sciences but need a description of real-life jobs to determine what focus they should take in their studies.

The video features geoscientists who are involved in exploration, discovery, and stewardship of the Earth. Interviews with 11 geoscientists with diverse occupations and backgrounds reveal information about the variety of careers in the geosciences. The "day in the life" approach and the description of the geoscientists' current projects provides a practical understanding of each career. The geoscientists profiled in the video discuss the opportunities for travel, the use of technology, and the chance to work outdoors—all facets of the geosciences that appeal to students.

Careers for Geoscientists features different earth scientists and the connections between them. Christopher Henry, a research geologist in Nevada, discusses the opportunity for teamwork in his career. "No one geologist can address every problem—can resolve every issue. [Teamwork among geoscientists] ties into a more complete understanding of the whole geology." The other geoscientists interviewed include a physical oceanographer, a geomorphologist, a geochemist, a meteorologist, a stratigrapher, an environmental geologist, and a geophysicist as well as petroleum and exploration geologists.

AGI produced the video with support from the Alfred P. Sloan Foundation. AGI is in a partnership with the Sloan Foundations Career Cornerstone Series, a collaborative effort among 11 engineering, mathematical, and physical science societies to produce outreach materials about careers. The series includes 9 CD-ROMS, videos, and web sites that describe career paths in these sciences. Information on the foundation as well as ordering information for the complete set is available at ***http://www.careercornerstone.org.***

The video's release coincides with preparations for the first annual Earth Science Week, October 11-17, 1998. Information about Earth Science Week is available on the World Wide Web at ***http://www.earthsciweek.org.*** *Careers for Geoscientists*, along with other career-oriented materials, will become part of a Speaker's Kit designed for geoscientists interested in speaking to students about careers during Earth Science Week or year-round.

Other AGI careers publications available are the 18" x 24" Geoscience Careers poster and the careers brochure. Both have colorful graphic designs and descriptions of 27 types of geoscience careers. Check out AGI's Careers in the Geosciences website at ***http://www.agiweb.org/career/*** for complete information about AGI's careers materials, or contact Julie Jackson at AGI by e-mail: ***jjackson@agiweb.org*** (see mailing address below).

The regular price for the video is $14.95, including shipping. The video will be available to academic geoscience departments at no cost until Nov. 1, 1998. To order your copy, contact Robert Tiffey at AGI.

The American Geological Institute, founded in 1948, is a not-for-profit federation of 32 professional organizations in the earth sciences representing more than 100,000 geologists, geophysicists, andother earth and environmental scientists.

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"Women Who Walk Through Time"

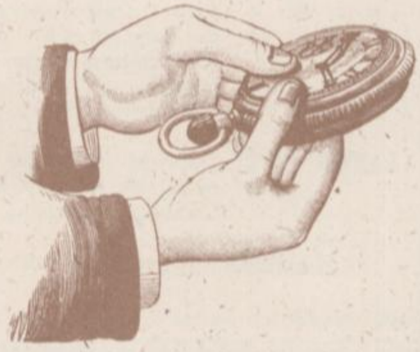
Walk through a billion years of geologic time with three Earth scientists in this 30-minute educational video. Spectacular footage highlights the beauties and mysteries of our dynamic Earth. The video is designed for young people 10-18 years old, but is appropriate for all classroom ages. Learn what Earth science is about and why Earth scientists love what they do.

This project has been sponsored by the National Science Foundation and is designed to educate young people about the Earth sciences and its exciting careers and opportunities. This project also includes a special web page at ***http://www.mines.utah.edu/geo/video*** that has fun activities and resources aimed at young audiences.

"Women Who Walk Through Time" was produced at the University of Utah and has won a 1998 Telly Award in the category of high school education. The Telly Awards, founded in 1980, is designed to showcase and give recognition to outstanding non-network and cable commercials, and film and video productions. Over the past two decades the Telly Awards has become a well- known, respected national competition. More than 10,000 entries were received for this year's awards.

To order a copy of this video, specify the title "Women Who Walk Through Time" and send check or money order for $5.00 to cover postage and handling to:

Video West Productions
1065 W. North Temple
Salt Lake City, UT 84116–3303



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:

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

or in New Mexico, contact:

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

Information on earthquakes in New Mexico is available by contacting:

Program Manager
New Mexico Earthquake Preparedness Program
Department of Public Safety
P.O. Box 1628
Santa Fe, NM 87504
(505) 476–9617

***Subscriptions*:**
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 of New Mexico, we now charge **$4.00 per year for out-of-state readers**, which covers the cost of mailing. If you are a paid subscriber, you will find a number after your name on the mailing label. This number represents the last *Lite Geology* issue in your subscription. When the issue number is the same as that on your mailing label, it's time to renew your subscription. If you have questions, please call Debbie Goering at (505) 835–5490.

State of New Mexico **EXECUTIVE OFFICE**, Santa Fe, New Mexico

Proclamation

WHEREAS, GEOLOGY AND OTHER EARTH SCIENCES ARE FUNDAMENTAL TO THE SAFETY, HEALTH, AND WELFARE OF NEW MEXICANS AND OUR ECONOMY; AND

WHEREAS, THE EARTH SCIENCES ARE INTEGRAL TO FINDING, DEVELOPING, AND CONSERVING MINERAL, ENERGY, AND WATER RESOURCES NECESSARY FOR OUR STATE'S CONTINUED PROSPERITY; AND

WHEREAS, THE EARTH SCIENCES PROVIDE THE BASIS FOR PREPARING FOR THE MITIGATION OF NATURAL HAZARDS WE ARE EXPOSED TO HERE IN THE "LAND OF ENCHANTMENT;" AND

WHEREAS, THE EARTH SCIENCES ARE CRUCIAL TO ENVIRONMENTAL AND ECOLOGICAL ISSUES RANGING FROM WATER AND AIR QUALITY TO WASTE DISPOSAL; AND

WHEREAS GEOLOGICAL FACTORS OF RESOURCES, HAZARDS, AND THE ENVIRONMENT ARE VITAL TO LAND MANAGEMENT AND LAND USE DECISIONS IN OUR GREAT STATE; AND

WHEREAS, THE EARTH SCIENCES CONTRIBUTE CRITICAL PIECES TO OUR UNDERSTANDING, APPRECIATION, AND RESPECT OF NATURE;

NOW, THEREFORE I, GARY E. JOHNSON, GOVERNOR OF THE STATE OF NEW MEXICO, DO HEREBY PROCLAIM THE 11TH THROUGH THE 17TH OF OCTOBER, 1998 AS

"EARTH SCIENCES WEEK"

THROUGHOUT THE STATE OF NEW MEXICO.

DONE AT THE EXECUTIVE OFFICE THIS 17TH DAY OF SEPTEMBER, 1998
WITNESS MY HAND AND THE GREAT SEAL OF THE STATE OF NEW MEXICO.

STEPHANIE GONZALES
SECRETARY OF STATE
(SIGNED)

GARY E. JOHNSON
GOVERNOR
(SIGNED)

Lite Geology
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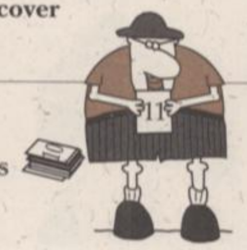

ALBUQUERQUE TEACHERS ARE INVITED!

New Mexico Bureau of Mines and Mineral Resources and New Mexico Tech

open house

Saturday, October 17
10 a.m.-4 p.m.

This event is to celebrate the first annual Earth Science Week (October 11-17) and to introduce you to the staff and resources available in our Albuquerque offices.

Please come by and see our hands-on demonstrations of a working seismometer, ground-water flow model, and more. Browse through our teacher resource center and pick up earth science teaching materials and curricula. We will have refreshments and door prizes.

Our Albuquerque office is located at 2808 Central SE (on the corner of Vassar and Central, across from UNM; one block west of Girard) Please RSVP by phone to 255-8005; or send e-mail to ***rcase@admin.nmt.edu***.

Lite Geology is published 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 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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