

What's Shaking in Bedrock? The Paradox Valley Deep-Well Injection Program

by Jon Ake, Ken Mahrer, Lisa Block and Dan O'Connell,
Seismotectonics and Geophysics Group, U.S. Bureau of Reclamation,
Denver, CO 80225

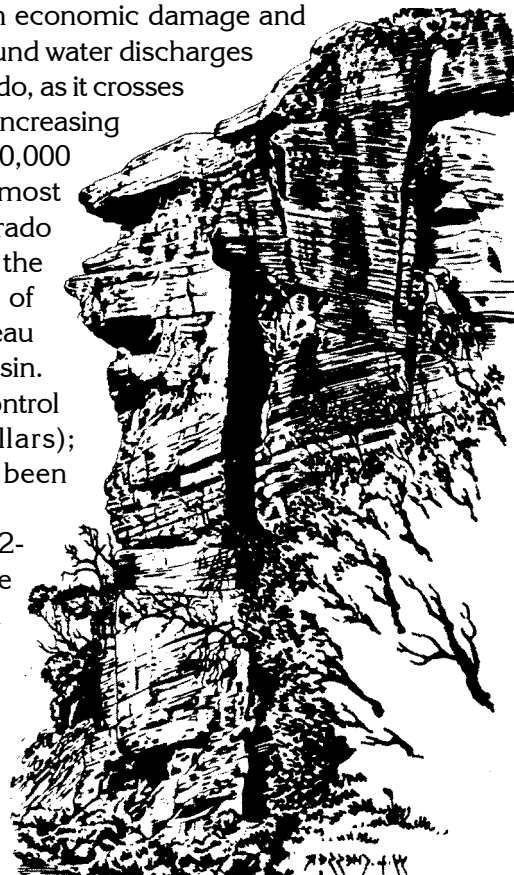
Introduction

"The Problem in Paradox"

The Colorado River provides water for nearly 23 million people and irrigation for about 1.6 million ha in the southwestern United States. However, excess salinity in the lower Colorado River results in economic damage and difficult political issues. Saline-saturated ground water discharges into the Dolores River, a tributary of the Colorado, as it crosses the Paradox Valley in southwestern Colorado increasing the dissolved-solids load by approximately 200,000 tons per year. Because this is one of the most significant point sources of salt into the Colorado River system, it prompted construction of the Paradox Valley Unit (PVI), one of a number of salinity control projects developed by the Bureau of Reclamation within the Colorado River basin. The estimated economic benefit of salinity control is \$340/ton of salt removed (1994 dollars); approximately 650,000 tons of salt have been removed by the PVI since 1991.

At present, PVI consists of 13 shallow (12-21 m depth) brine extraction wells along the Dolores River, a surface treatment facility, a deep (TD 4.9 km) injection well and a local seismic monitoring network. Prior to injection the brine is cut with 30% fresh water to prohibit in situ calcium sulfate precipitation and treated with a corrosion inhibitor. The

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Welcome to New Members...

James A. Bucci

Jim is a project geologist with EOG Resources Inc. in Denver. He holds both a BS and an MS in Geology from the University of South Carolina. Jim is a member of AAPG.

Charles W. Campbell

Charles is a recently retired team leader/geologist with Texaco. He holds a BS in Geoscience from Purdue University. Charles is a member of AAPG and AEG.

Paul C. Differding

Paul is with Landmark Graphics in Englewood. He holds a BS in Geology from Southern Illinois University. Paul is a member of SEG.

Walter S. Fees, III

Walter is the son in Walter S. Fees Jr. and Son Oil & Gas in Grand Junction, Colorado.

Walter's father passed away recently, and he wishes to continue membership in RMAG in memory of his father. He holds a BS in Geology from Mesa College and is a member of AAPG.

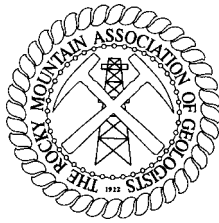
Ben R. Funderburk

Ben is with Forest Oil in Denver. He holds a BS in Geoscience from Arizona State University, and is a member of AAPG and SEG.

Patricia B. Kaygi

Patricia is a senior geologist at Harding ESE in Golden. She holds a BS in Geology from Florida State University and an MS in Geology from Virginia Tech. Patricia is a member of AAPG.

(Continued on page 3) ►



The Rocky Mountain Association of Geologists

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The Rocky Mountain Association of Geologists is a nonprofit organization whose purposes are to promote interest in geology and allied sciences and their practical application, to foster scientific research and to encourage fellowship and cooperation among its members. *The Outcrop* is a monthly publication of the RMAG.

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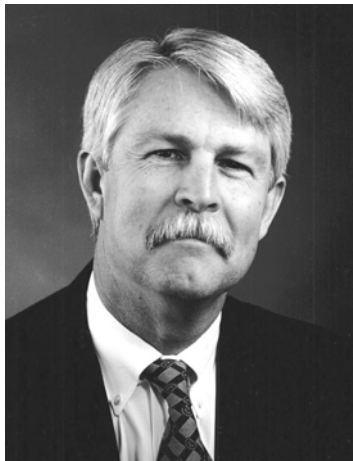
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President's Column

by John Robinson
(robinson_jw@msn.com)

Have Gas – Will Sell

I recently had the good fortune to participate in the reorganization and sale of my company. As you might expect, this is a classic good news, bad news story. The best part of the transaction was the opportunity to work with a team of professionals who were focused and motivated to grow the company and complete the sale. The unfortunate part was the ultimate dismantling of a very successful team.

Our team was composed of a traditional multidisciplinary group, including experts in geoscience, production/operations, reservoir engineering, land/lease records, legal, corporate planning/finance, environmental/regulatory, and accounting/tax. The process of the sale was sequential through our team – each specialty had a role and a turn in the progression. The following discussion is a simplified chronology of the team responsibilities for the sale.

The geoscience/land/engineering group was first to make contact and provided enough technical data to demonstrate sufficient value to continue the discussions. Maps, cross-sections, digital data, ownership interests were exchanged and reviewed. Reserves were verified and forecast. At some point, the drilling/production/operation costs were layered into the analysis. With a green light to proceed, a letter of intent bound the parties to proceed to a Purchase and Sale Agreement (PSA). Senior management, legal and corporate planning personnel were now charged with "knocking out" a PSA that was acceptable to both parties. Environmental due diligence was next on the list, to assure the assets were "clean" and free of further obligation. After closing (great rejoicing on both sides of the table), the accounting group sorted out the business of paying bills and transferring files. Of course, the transaction won't be complete until tax returns are filed and inspected by the IRS. This was an outstanding team effort and each member of the team had an important part to contribute to the sale.

I'm a team guy, always have been. I enjoyed my association with this team and will miss the constructive interaction. We accomplished many goals in our short tenure. We had good days and bad days, but we always kept our eyes on the prize. ◀

Welcome to New Members...

(Continued from page 2) ▼

Laurence O. Luebke

Larry is retired from Amoco. He holds BS and MS degrees in Geology from the University of Nebraska. Larry is a member of AAPG.

Christian F. Murer

Ted is with Amalgamated Explorations Inc. in Denver. He holds a Geological Engineering degree from the Colorado School of Mines.

Peter H. Northrop

Peter is a geophysicist with Interactive Earth Sciences Corporation. He holds a BA in Geology from the University of New Hampshire and an MS in Computer Science from the University of Denver. Peter is a member of AAPG, DGS and SEG.

Chuck Sawyer

Chuck is the Manager of Business Development at Western Gas Resources Inc. in Denver. He holds a BS in Geology from Western Washington University and an MS in Geology from the University of Oklahoma. Chuck is a member of AAPG.

Douglas D. Sharp

Doug is a petrophysical engineer with EOG Resources Inc. in Denver. He holds a BS in Petroleum Engineering from the Missouri School of Mines. Doug is a member of AAPG, SPE and SPWLA.

(Continued on page 8) ►

Friday Luncheon Program

March 1 – “The Coalbed Methane Potential in the Upper Cretaceous to Early Tertiary Laramie and Denver Formations, Denver Basin, Colorado.”
Speaker Jurassic Elko Orogeny – A Major Tectonic Event in Nevada-Utah.” Speaker will be Charles Thorman.

March 15 – “The Middle Jurassic Elko Orogeny – A Major Tectonic Event in Nevada-Utah.” Speaker will be Charles H. Thorman.

April 5 – “Sequence Stratigraphy of the Dakota Sandstone, Eastern San Juan Basin, New Mexico, and Its Relationship to Reservoir Compartmentalization.” Speaker will be Peter J. Varney.

April 19 – “Overview of Geology and Operations, Grand Valley, Parachute, and Rulison Fields, Piceance Basin, Colorado. Speaker will be Steve Cumella. ◀

Planning to Attend?

People gather about 11:30 a.m. and sit to lunch about 11:55 a.m. The speaker's presentation begins about 12:25 p.m. Reservations are taken on a recording line, 303-623-5396, until 10:30 a.m. on the Wednesday before the luncheon. Cancellations are taken until 11:00 a.m. also on that day by calling 303-573-8621. The cost of the luncheon is \$23.00.

No reservations are necessary to attend the talk only. The cost of this is \$3.00 at the door. Luncheons are held in the Pinnacle Room of the Denver Petroleum Club on the 37th floor in the Anaconda Tower, 555 17th Street, downtown Denver. Call the recording line for exact time and location.

Your attendance is welcomed and encouraged. Bring a guest or new member!



Friday Luncheon Abstracts

The Coalbed Methane Potential in the Upper Cretaceous to Early Tertiary Laramie and Denver Formations, Denver Basin, Colorado

Laura L. Wray,
Colorado Geological Survey, Denver, CO, Laura.Wray@state.co.us
Friday, March 1

Coals in the Late Cretaceous Laramie Formation and early Tertiary Denver Formation hold some intrigue for coalbed methane potential by virtue of their measured heating values, shallow depths, areas of reasonable thickness and continuity, and the documented occurrences of gas accumulations and explosions in coal mines.

Over the past 140 years, more than 300 historic mines were developed in the Denver Basin. The vast majority of them were underground mines in the Laramie Formation coals from which approximately 130 million tons of subbituminous coal was mined. Now that newly developed completion technologies are allowing commercial methane production from shallow, low rank coals, even the Denver Formation lignitic coals, mined in the past in small quantities, may be prospective.

The great diversity in coalbed methane plays proves that there are various reservoir characteristics critical to successful methane production from low rank coals. Preliminary analyses of coal data collected by mining companies, combined with data collected from gas, oil, and water wells drilled in the Denver Basin, strongly suggest that further research and testing is required to demonstrate the economic feasibility of a coalbed methane play in the basin. In order to assess the preliminary potential of these coals, the Colorado Geological Survey has compiled a Geographic Information System (GIS) coalbed methane database that captures the data contained in numerous hardcopy publications released over the past twenty years. The GIS ArcView™ format allows easy manipulation of important data such as isopach and structure maps, log cross sections, desorption and heating value data, locations of historic mines, coal analyses from those mines, and calculated gas content values.

Original gas in place and recoverable reserves for Denver Basin coals were estimated using analogies from the low-rank Fort Union Formation coals that produce methane in the Powder River Basin. The respective values for both formations are 2.4 trillion cubic feet (TCF) and 2.2 TCF which closely approximate the resource estimate of 2.0 TCF made by the

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Friday Luncheon Abstracts

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Gas Research Institute (now the Gas Technology Institute) several years ago. Two-thirds of this resource exists within the Laramie Formation.

In addition to evaluating the resource potential, careful consideration must be paid to the shallow aquifers that surround and include these coals and into which thousands of water wells have been drilled. Before coalbed methane production becomes a reality, further research is imperative to establish whether the coals and aquifers are hydraulically connected and what statutory authorities must be established to handle the issues of produced water from coal beds. Clearly, regulatory and environmental factors will play vital roles in determining the producing potential for a coalbed methane play in the Denver Basin.

The Middle Jurassic Elko Orogeny — A Major Tectonic Event in Nevada-Utah

Charles H. Thorman
U.S. Geological Survey, Emeritus, March 15

The Elko orogeny is a widespread Middle Jurassic event that extended from central Nevada to central Utah and involved miogeoclinal and eugeoclinal rocks. The region has undergone a continuum of eastward-progressive deformational pulses from the middle Paleozoic to early Tertiary. Each successive orogenic event resulted in the superposition of structures and has made it difficult to impossible to determine the age of many of them because of their similarity in style, unless crosscutting relationships exist. These deformational events include the Antler (late Devonian-middle Mississippian), Humboldt (late Pennsylvanian), Sonoma (late Permian-early Triassic), Elko, and Sevier (middle Early Cretaceous-early Tertiary) orogenies. The Elko appears to have occupied the same area as the Sevier in Nevada,

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Trader's Corner

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In Memoriam

Walter S. Fees, Jr.

Walter S. Fees Jr passed away on May 30, 2001. He was born on September 17, 1917 in Fredonia, Kansas. He graduated from the University of Kansas in 1942 with a BS in Geology. Mr. Fees served in the Air Force during World War II. After being honorably discharged as a Captain and receiving the Bronze star, he returned home to Kansas and began his career in the oil and gas business by working on a cable tool rig for his father. During his career he worked for Continental Oil Company in Casper, Wyoming, as a partner in Fees Drilling Company and helped organize Fees-Krey Inc. In 1977 he started his own company for the purposes of exploring, developing and producing oil and gas wells in Utah, Wyoming, Montana, Nebraska and Kansas. In 1986 he sold the operating part of his business to National Fuels Corporation and became an exploration company. In 1998 Mr. Fees started up Walter S. Fees Jr. & Son Oil and Gas LLC, an oil and gas exploration and development company which currently has operations in Colorado, Montana, Utah and Wyoming.

Walter S. Fees was a charter member of Independent Petroleum Association of the Mountain States and Vice President of the association in 1975. He was a fifty-three year member of AAPG. A lifetime member of Wyoming Geological Association, Rocky Mountain Association of Geologists, The Elks and a member of both the Denver and

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Friday Luncheon Abstracts

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but did not extend as far to the east as the Sevier. Many structures in eastern Nevada-western Utah attributed to the Sevier are more likely Elko in age.

A Middle Jurassic Elko foredeep in western Utah along the leading eastern edge of the orogenic belt is inferred from Middle Jurassic strata that thicken westward and abruptly terminate at the edge of the Colorado Plateau. The depocenter of the westward expanding sedimentary sequence was in western Utah, and possibly easternmost Nevada, but was uplifted and eroded during the Sevier orogeny. The existence of a Middle Jurassic Elko foredeep subsequently uplifted and eroded during the Sevier orogeny is compatible with the orogenic belt to the west and explains the missing westward thickening wedge.

Miogeoclinal and eugeoclinal rocks ranging in age from Proterozoic to early Middle Jurassic were deformed during the Elko orogeny. Late- to post-tectonic late Middle Jurassic plutons (155 to 165 Ma) cut structures and regionally metamorphosed rocks throughout the region. Major features include eastward-directed older-over-younger thrust faults and bedding parallel 'thrust' faults. Another important type of structure includes E- to ESE-trending strike-slip or tear faults. Some strike-slip faults are deep-penetrating structures, whereas others are restricted to allochthonous thrust sheets as tears and/or lateral ramps. The orientation of the larger strike-slip faults appears to have been inherited from Precambrian basement and strongly influenced Sevier and Basin-and-Range faulting and emplacement of plutons of all ages. Large-scale crustal shortening of Middle Jurassic age has yet to be demonstrated, though many Elko structures indicate crustal shortening occurred. In addition, extensional faulting has been documented in numerous ranges, a style of deformation atypical of the Sevier.

The role of the Elko orogeny in the formation and accumulation of hydrocarbons in eastern Nevada and western Utah is not well understood at the present time. Burial depths, and subsequent maturation, of Paleozoic and early Mesozoic strata prior to and during the Elko for the majority of the region undoubtedly differed little, if any, from that calculated for Sevier time. No major mineral deposits of Elko age are documented in eastern Nevada-western Utah. Mineralization related to the plutons formed predominately small to moderate polymetallic base-metal deposits with subordinate gold. It is of major importance, however, to note that Elko-age mineralization was strongly controlled by the E- to ESE-trending faults and related structures. This being the case, migration of hydrocarbons at the Elko was most certainly influenced by these same structures. Thus, Mesozoic migration of hydrocarbons controlled by structures most likely began, at a minimum, in Middle Jurassic time. The superposition of Sevier deformation ~30-50 Ma later probably disrupted traps resulting in the loss of the trapped hydrocarbons or their migration to other sites.

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Friday Luncheon Abstracts

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Sequence Stratigraphy of the Dakota Sandstone, Eastern San Juan Basin, New Mexico, and Its Relationship to Reservoir Compartmentalization

Peter J. Varney, PhD

The Metropolitan State College of Denver

Denver, Colorado, April 5

Dakota outcrops in the eastern San Juan Basin, New Mexico, show that the interval contains three depositional sequences within an overall third-order transgressive systems tract. Sequence 1 lies on the regional K2 unconformity above the Early Cretaceous Burro Canyon Formation and extends upward to Dakota Surface 2 (S2), a combination lowstand surface of erosion/transgressive surface of erosion that was subaerially exposed. Sequence 2 extends from S2 upward to Surface 3 (S3), a regressive surface of erosion that extends throughout the study area and perhaps much further. The interval between S2 and S3 comprises a transgressive systems tract in which there are two or more shorefaces that prograded basinward during fourth-order relative sea level fluctuations. Sequence 3 extends from S3 upward to the top of the Dakota interval. It contains fourth-order lowstand, transgressive and possible highstand systems tracts (HST).

Dakota parasequence characteristics are continuous over great distances along paleostrike, allowing outcrop gamma ray profiles to tie to, and permit

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U.S./Canada Petroleum Business: A New Networking Pipeline

The Petroleum Society of the Canadian Institute of Mining (CIM) has created a Denver Section and is seeking new members representing the diverse range of professions in the petroleum industry. Membership will provide educational, mentoring, and networking opportunities and facilitate a 'pipeline' for the flow of information, transfer of technology and expansion of links in the oil & gas industry between the U.S. and Canada. Members enjoy additional benefits that flow from the affiliation with a large, professional society. For more information on the Petroleum Society, visit the national website at www.petsoc.org. For questions on the Denver Section, contact Philip O. Johnson at deajohnsoninc@attbi.com. ◀

In Memoriam

(Continued from page 6) ▼

Grand Junction Petroleum and Mining Club. Walter S. Fees Jr. was a true wildcatter and gentleman.

Earl West

Earl West was known by friends and associates as a man of remarkable talent, intellect, curiosity and integrity. He was a voracious reader and pursued perfection in all undertakings. Born in Mountain View on August 23, 1923, he was raised in Saratoga and Wheatland. After graduating from the University of Wyoming he moved to Casper where he spent the rest of his life.

He served in the US Army's 14th Armored Division from 1943-46 earning the good conduct and Victory Medals for service in the European Theater during World War II.

He worked for Continental Oil Co. as a geologist and then became an independent geologist and oil and gas producer. He was a pioneer in explorint for petroleum in the Powder River Basin.

He was a member of the WGA, WPA, RMPGA, AAPG, Casper Petroleum Club, Kiwanis Club of Casper, Cowboy Joe Club, University of Wyoming Alumni Association, Ducks Unlimited and Central Wyoming Retriever Club.

Earl died on November 1, 2001. ◀

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(Continued from page 2) ▼

Matthew E. Thomas

Matthew lives in Denver. He holds a BS in Geology from the University of Colorado.

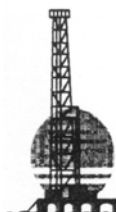
Stephen E. Trudell

Steve is the principal at Trudell Geophysical Consulting. He holds a BA in Geology from the University of Connecticut, and is a member of SEG.

...Welcome Back to Returning Members

Soli S. Shapurju

Soli is a geological consultant in Denver and holds a BS in Geology from the University of Idaho. ◀



O & G INFORMATION
FOR DAKOTAS & MONTANA

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Friday Luncheon Abstracts

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calibration of, well logs in the South Lindrith Field, 44 miles to the southwest. Subsurface well log cross sections show that the sequence framework established on outcrop applies to the subsurface.

Within the Sequence 3 HST, northwest to southeast trending shoreface deposits prograded northeastward. Syndepositional faults, detected through very close-spaced contour mapping, helped determine their orientation. One of these shoreface deposits produces gas from abundant porosity in a fault bounded, stratigraphic reservoir compartment. It helps confirm the importance of structurally enhanced reservoir compartmentalization in the Rocky Mountain area.

Overview of Geology and Operations, Grand Valley, Parachute, and Rulison Fields, Piceance Basin, Colorado

Steve Cumella, Barrett/Williams

April 19

Grand Valley, Parachute, and Rulison fields are part of a basin-centered gas accumulation that has formed in the deep part of the basin in an area of active gas generation. Production from these fields, which is from the Williams Fork Formation of the Mesaverde Group, is currently over 170 MMCFPD. The Williams Fork in these fields is comprised of approximately 3,000-3,500 ft of nonmarine strata, the lower 1,700-2,400 ft of which are gas saturated. The sandstone reservoirs within the gas-saturated interval are predominantly point-bar sandstones that are laterally discontinuous with estimated average widths of approximately 750 ft. The lower 500-900 ft of the Williams Fork is coal bearing and has been named the Cameo Coal Member. The matrix permeability of the sandstones is very low (microdarcy range), but natural fracturing is can greatly enhance reservoir permeability. Massive hydraulic stimulation is required to make commercial wells. Wells are typically completed in 4 to 6 stages with average gross intervals of about 300 ft. Net pay averages about 350 ft per well. Estimated ultimate recoveries average 1-2 BCF per well. Over 13,000 acres are currently being developed at 20-acre density, with relatively little evidence of depletion. A pilot is currently being undertaken to determine the viability of 10-acre density. ◀



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Tensleep water flow is from SE to NW. The oil accumulations therefore have tilted oil-water contacts in the direction of flow into the basin. Sometimes the crestal well or near crestal wells will test water. All of Viking’s prospects in our Hinge Play should have an oil-water contact tilting northwesterly into the basin as do the following four producing nearby oil fields:

	Murphy Dome	NW Lake Creek	Lake Creek	Black Mtn
Producing Zone	Tensleep	Tensleep	Phosphoria	Tensleep
Cum. Oil Production bbls. As of 12/31/98	39MM	10MM		18.5MM
Tilt Factor	6.5	7.3	6.5 – 9	9
Vertical Oil Column, Feet	948	323	726	833
Actual Slope of Oil- Water-Contact, ft / mile	253	96	213	231

Six parallel NW-SE structural trends exist between six NW-SE trending thrust faults spaced about two miles apart. IBEX Resources (Houston) purchased one of these trends (13,970 acres) and plans to drill 5 or 6 wells along this trend. Similar size fields and similar tilted oil-water contacts are expected in each trend.

Viking will sell one or more similar trends to interested parties. The Tensleep prospects range in depth from 3,800’ to 9,700’. Tensleep oil reserves range from an estimated 3.6 to 54 MMBO per prospect and total 450 MMBO for the 25 prospects.

These prospects were generated using 70 miles of multiple fold and 222 miles of single fold seismic, with our detailed Hydrodynamic study, complete Landsat coverage, aerial photos with dips and strikes verified in the field, eletctro-tellurics, radiometrics, and gas sniffing.

The acreage is reasonably priced at \$33.00/acre – 50% down upon signing contract. Terms on the balance. The acreage block in each trend is about the same size.

For more details, please log on to www.vikingexploration.com or call Chuck Einarsen at 303-932-7734.

In the Pipeline

March 1

GeoLand Ski Day.

March 10-13

AAPG Annual Convention, Houston, TX.

May 11

"On-The-Rocks" Field Trip: Dinosaur Trackway — A Mountain Bike Adventure Along the Purgatoire River. Leaders: Joanna Wright, CU Denver, and Matt Morgan, Colorado Geological Survey.

June 18

RMAG Coalbed Methane Symposium at the Marriott in downtown Denver.

September 8-11

Rocky Mountain Section AAPG Meeting, Laramie, WY.

November 11

DAPL/RMAG/DGS Denver Prospect Fair & TechnoFest 2002.

Email: butch@amigo.net,
web: www.rmag.org/fair. ◀

Strong Rockies NAPE 2002 Presence

by Jane Estes-Jackson

The annual North American Prospect Expo (NAPE), sponsored by the American Association of Petroleum Landmen and the Independent Petroleum Association of America, was held at the George R. Brown Convention Center in Houston on January 30 and 31. This year marked the 10th anniversary of the expo, which bills itself as "the largest oil and gas exploration and production event in the world." Since its inception in 1993, attendance at NAPE has grown annually, and this year was no exception. Over 8000 people pre-registered for a glimpse at over 600 exhibitors. The majority of the attendees were from Texas, and the prospects shown were heavily weighted towards the Gulf Coast. However, the Rockies were well represented by such companies as Anschutz, Beartooth Oil & Gas, Energy Investments, Flying J, Gary Nydegger & Associates, Julander Energy, Kestrel Energy, Lario Oil & Gas, Petrogulf, Pioneer Oil & Gas, Pyr Energy, Thomasson Partner Associates, Tom Brown Inc., True Oil Co., Westport Oil & Gas, and Wold Oil Properties, with prospects in the Green River, Powder River, Paradox, Wind River, Bighorn, Sand Wash, Piceance, Raton, Uinta, and DJ basins, as well as the Overthrust Belt and Nevada. Other Denver companies represented but not showing Rockies prospects were AEC, Cabot, Calpine, EOG, Forest, J.M. Huber, Kerr-McGee, Key Production, Pan Canadian, Phillips, Westech, Whiting, and Yates.

Coalbed methane plays continued to generate much interest. In addition there were prospects from the Permian Basin, Midcontinent, Williston Basin, Alaska, and California, as well as a significant number of international prospects, primarily from Australia. Exhibitors also included vendors such as Baker Atlas, Halliburton, IHS Energy Group, Schlumberger, and Veritas, as well as numerous banks, mezzanine financiers, and venture capitalists. Even with current oil and gas prices, the mood among attendees was generally upbeat. This expo provides a unique forum for networking among members of various disciplines from all areas of the country. For more information about NAPE, go to the AAPL web page at www.napeonline.com. ◀

Spring 2002 Lecture Series – Van Tuyl Lectures

March 6	David Hyndman	Dept. of Geologic Sciences Michigan State Univ.	NGWA Darcy Lecture
March 21	*Geoffrey Dorn	University of Colorado	The Role of Visualization In Resource Exploration & Development
March 28	Open		
April 4	Open		
April 11	Dr. Paul Santini	Colorado School of Mines	TBA: Engineering Geology Topic
April 18	Open		

Lectures conducted in Berthoud Hall, Room 108. Refreshments served at 4:00 p.m., lecture begins at 4:30 p.m.

*Held in Metals Hall, Green Center, CSM Campus. ◀

RMAG Membership Application Form

Last Name _____ First _____ Middle _____ Nickname _____ Spouse _____

Company Name _____ Position / Title _____

Company Address _____ City _____ State _____ Zip _____ ()
Company Phone Number _____

Home Address _____ City _____ State _____ Zip _____ ()
Home Phone Number _____

E-Mail Address _____ ()
Fax Number _____

Preferred Mailing Address: Company Home

SCHOOL	YEAR	DEGREE	MAJOR
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_____	_____	_____	_____

Professional Affiliations: AAPG AIPG SEPM SEG Other

Membership Category: Member Associate Student Re-Instatement

Membership Qualifications

MEMBER: Any person holding a degree in geology, geophysics, geochemistry, paleontology, petroleum engineering, or other allied earth sciences may apply for membership. Members shall be elected by vote of the Board of Directors. The Board of Directors may, by majority vote, make exception to accept for full membership a qualified geological scientist who does not meet the above requirements.

HONORARY MEMBER: Honorary Members shall be elected from time to time by unanimous vote of the Board of Directors from those persons who have made outstanding contributions to geology or the Association.

STUDENT MEMBER: Any person actively engaged in the pursuit of a degree in geology, geophysics, geochemistry, paleontology, petroleum engineering, or other allied earth sciences at a college of acceptable academic standards may apply for student membership. Student members are not allowed to receive a ballot and vote for the Board of Directors.

ASSOCIATE MEMBER: Any person who is not qualified for full or student membership and who is a graduate of a college of acceptable academic standards, with a minimum of twelve (12) months of geologically related experience may apply for election as an associate member. Applicants shall be approved for membership by majority vote of the Board of Directors. The Board may waive degree requirement if, in its judgement, an applicant has adequate professional experience. Associate members are not allowed to receive a ballot and vote for the Board of Directors.

MEMBER DUES AMOUNTS

ACTIVE & ASSOCIATE:	\$37.00 Full Year (Dec-Nov)	\$18.50 Half Year (June-Nov)
STUDENT:	\$20.50 Full Year (Dec-Nov)	\$10.25 Half Year (June-Nov)
RE-INSTATEMENT:	\$39.00 (There is a \$2.00 penalty for lapse in membership dues.)	

OBTAIN SIGNATURE of two Active (No Student or Associate) Members as Sponsors. PRINT sponsors' last names after signatures. STUDENTS may be sponsored by their Earth Science Professors. RMAG operates on a fiscal year: December 1 - November 30.

1 _____
2 _____

Send application and Check to: RMAG, 820 16th Street, Suite 505, Denver, CO 80202 (303) 573-8621

Membership Approved By: _____ Date: _____

Type of Membership Granted: _____

What's Shaking in Bedrock? The Paradox Valley Deep-Well Injection Program

(Continued from page 1) ▼

injection horizon is the Mississippian-age Leadville Limestone at a depth of ~4.3 km. The surface facilities (which operate 24 hrs per day) are capable of injecting 1325 liters/min at a sustained pressure of 34 MPa. Since operations began in 1991, the PVU has injected approximately 3 billion liters of fluid.

Geology

The town of Bedrock is located within the Paradox Valley ~120 km south of Grand Junction, CO (Figure 1). The valley is a collapsed diapiric salt anticline that trends approximately N55°W; is ~38 km long, 5-7 km wide; and is underlain by up to 6 km of interbedded salts and shales of the Pennsylvanian Paradox Formation. The Dolores River crosses Paradox Valley (normal to strike and across the anticline, hence the Paradox) after flowing through deeply incised canyons. Gently dipping late Jurassic and Triassic sedimentary rocks form spectacular mesas and canyon walls at the surface. The target Leadville Limestone is a locally vuggy, fractured dolomitic

limestone with an effective porosity less than ~6%. However, widespread fracturing significantly increases the local permeability. Petroleum industry investigations and PVU design studies identified a series of Laramide-age faults (the Wray Mesa fault system) trending sub-parallel to the strike of the Paradox Valley. The injection well was sited to optimize fluid migration along these pre-existing fractures.

Testing at PVU began in 1991. Seven injection tests, with durations ranging from a few weeks to months, were conducted between July 1991 and March 1995. During these tests injection rate and chemistry of the injectate were varied. Continuous injection began in July 1996. Pressure and injection rate are measured at the surface; no downhole measurements are available during injection.

Paradox Valley Seismic Network

The potential to induce earthquakes by high-pressure, deep-well injection was conclusively established at the

(Continued on page 13) ►



Figure 1. The historic Bedrock General Store

What's Shaking in Bedrock? The Paradox Valley Deep-Well Injection Program

(Continued from page 12) ▼

Rocky Mountain Arsenal near Denver, CO, in the 1960's. Recognizing this potential, the Paradox Valley Seismic Network (PVSN) was installed in 1984. The network presently operates 15 stations loosely arranged in two concentric rings about the injection well; the outer ring has a diameter of about 80 km. All sites have extremely low levels of cultural noise (evident to anyone visiting Bedrock and the Paradox Valley), which allows detection and location of very small earthquakes. The seismic monitoring program: (1) records, evaluates and locates seismic events in the region surrounding the Paradox Valley, with a specific focus on the immediate vicinity of the injection well; (2) determines focal mechanisms of the events when feasible; and (3) identifies and evaluates relationships between seismicity, geology, subsurface brine location, and injection parameters.

In almost six years of monitoring prior to the first injection test in 1991, PVSN recorded and located only six earthquakes within the ~19,000 km² region monitored by the array. None of these events were within 5 km of the injection well. During the first week of the initial injection test in 1991, more than a dozen earthquakes were detected and located within ~1 km of the well. Between July 1991 and March 2001, PVSN has recorded and located more than 3,700 events within 10 km of the injection well. About a dozen events were large enough to be felt (magnitude (M) ~2.5 or greater). The largest event, a M 4.3 event, occurred on May 27, 2000. Based on the microearthquake locations, we infer that fluid-pressure perturbations have migrated at least 8 km from the injection well. A strong association between injection and seismicity has been observed throughout the course of the project. In mid-1999, a M 3.7 earthquake caused PVI operations to include a 20-day injection

shutdown every six months. Prior to the May 27th M 4.3 earthquake, PVI injected fluid at ~1290 liters/min with a nominal surface pressure of 33.1 MPa. Following the May 27th event, well operations were suspended for 28 days. To reduce the potential for more large events we resumed pumping on June 23rd at a reduced rate of ~870 liters/min. The 20-day shutdown periods and lower injection rate have substantially reduced the rate of earthquake production as shown in Figure 2.

Results

To enhance our understanding of injectate and connate fluid flow, we have focused on improving earthquake location procedures. We performed a three-dimensional analysis of ~650 events and obtained a new three-dimensional P-wave velocity model. The model reproduces the major geological features including the low-velocity region of the Paradox salt anticline and high-velocity region of the laccolith beneath the LaSalle Mountains to the north.

(Continued on page 14) ►

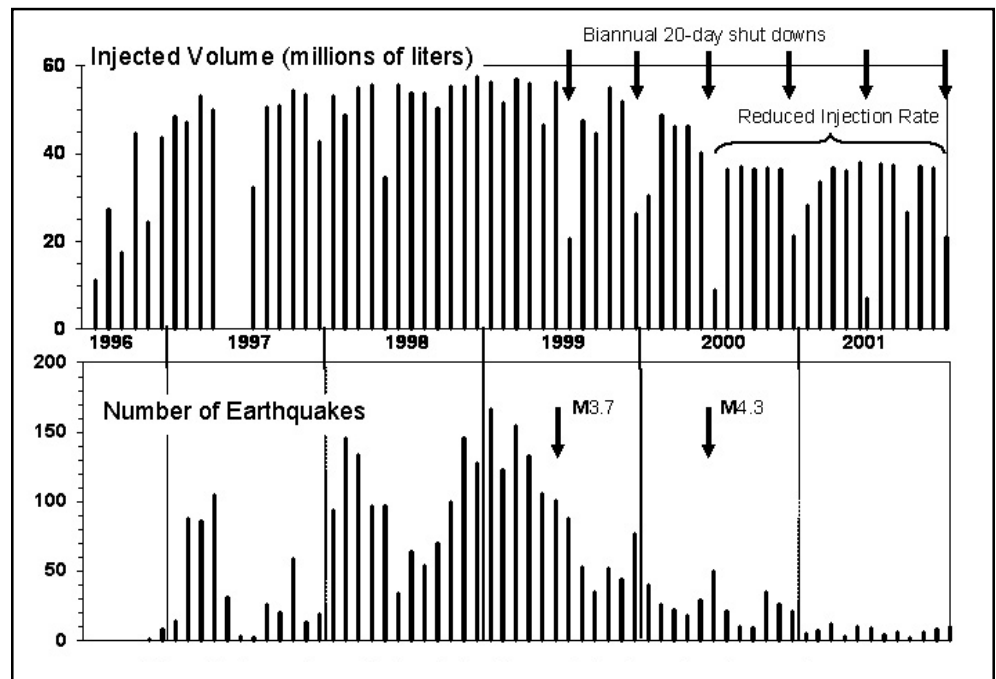


Figure 2. Comparison of induced seismicity and injection volume by month

What's Shaking in Bedrock? The Paradox Valley Deep-Well Injection Program

(Continued from page 13) ▼

Using this velocity model and seismic wave travel-time differences we improved the locations of ~3500 events. We found that the earthquakes were confined to a relatively narrow depth range with most dipping gently to the northeast following the inferred depth interval of the Leadville Formation (see Figure 3). The grouping of events approximately 0.5 km to the southwest of the injection well agrees with the inferred location and trend of one of the faults of the Wray Mesa fault system. A second distinct group of events ~2.5 km southwest of the well is interpreted to be a previously unidentified element of the same system. The deepest events near the well occur below the Leadville within the crystalline Precambrian rocks.

Using 346 events, we calculated seismic focal mechanisms; the results suggest mainly strike-slip motion with two dominant fault plane orientations. The direction of minimum stress (T-axis) is consistently northeast and sub-horizontal for all events. Analysis of pressure data from well completion showed relatively high deviatoric stresses ($s_1 - s_3$). These observations suggest the maximum and intermediate principal stresses are nearly equal at the injection depth and considerably larger than the minimum

principal stress. Fractures observed in oriented core samples recovered during drilling agree with the strike of the observed focal planes. The event locations define lineaments having strikes consistent with the fault planes suggested by the focal mechanisms. The lack of microearthquake fault planes with orientations parallel to the major throughgoing faults of the Wray Mesa system suggests these N55°W striking planes may be conduits for fluid transport but do not have sufficient shear stress to produce earthquakes. They are favorably oriented for dilation (normal to the northeast-directed minimum principal stress) within the inferred stress field.

By understanding the relationship between small earthquakes and injection parameters (in particular injection rate) we have been able to modify operations at PVU to minimize the likelihood of future larger, damaging earthquakes. We are pleased to report the classic Bedrock general store is undamaged.

These studies were possible through the continued support of Andy Nicholas, Project Manager of the Paradox Valley Unit. Mike Sullivan contributed Figure 3, Donna and Larry Anderson provided helpful review comments and the great picture of the Bedrock store. ◀

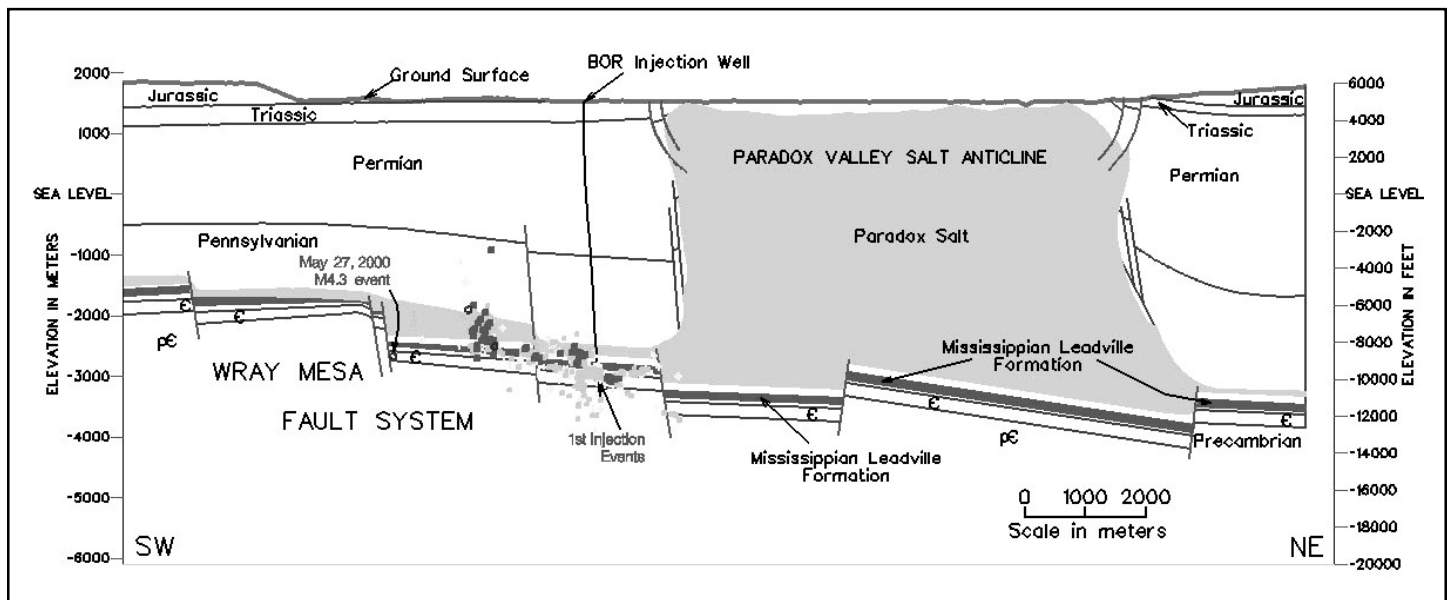


Figure 3. Northeast-southwest section through Bureau of Reclamation injection well and Paradox Valley. Section is normal to strike of valley. Only events within ±1.5 km of section plane are plotted.

Legislative Committee

Larry Anna, Chairman, lanna@usgs.gov

Late last year the city of Parker, Colorado's Water and Sanitation District (PWSD) held a conference to inform geologists, hydrologists, planners, elected officials, and the media about PWSD's short and long range planning strategies to deliver water to the area. Why? I think it was because PWSD wanted to brag about how they found the goose that laid a golden egg. For years PWSD struggled to get public and insider approval to develop water storage and delivery systems. Finally, they figured out that they had to get the public on their side if they were to have the success they wanted. So they hired a local media and public relations firm (the goose) to determine public concerns, develop a strategic plan (the egg) that was practical and appealed to everyone, and then help implement the plan. As a result, PWSD is in the final stages of permitting the Reuter-Hess reservoir as well as developing water well fields to supplement supplies. Although everyone area's problems are unique, PWSD's approach could be used as a template to solving problems, as well as a long-term strategy.

The debate in Congress over reauthorizing the Comprehensive Environmental Response, Liability, and Compensation Act (CERCLA) of 1980 has been transformed in the last few years. CERCLA, more commonly known as Superfund, is the primary federal program for cleanup of hazardous waste. Many in Congress feel that CERCLA needs to undergo a comprehensive reform that reflects new priorities to clean up lesser contaminated areas, or brownfields. Separate legislation for brownfields has emerged in the past few sessions. Brownfield sites would not be subject to the lengthy Superfund listing and clean-up process that proponents say prevent condemned areas from being remediated in a timely manner. Attempts to focus on brownfields legislation in past Congresses have been defeated by those who want brownfields to remain a part of the comprehensive Superfund reform bill. The 107th Congress appears to have passed this hurdle and will likely pass a stand-alone brownfields bill. (Taken, in part, from AGI's website <http://www.agiweb.org/gap/gaphome.html>). ◀

Federal Lands Analysis, Natural Gas Assessment, Southern Wyoming and Northwestern Colorado

We reported on this project last year, and it appears that most, if not all, of the project maps are available to the public. The Department of Energy's Greater Green River Basin study is part of a larger planned project to analyze natural gas resources under federal lands in the Rocky Mountain Region. This basin was chosen as the first to be studied because it contains the largest amount



of estimated technically recoverable natural gas resource in the region. The study has produced several products that are likely to be of value to landowners and natural gas producers operating in the Basin. The website: http://fossil.energy.gov/oil_gas/reports/fla/ has a list of maps and downloading instructions. If anyone knows what's next on the agenda for this study, let me know. ◀

RMAG/DGS Golf Tournament News

Yes, even though it is still the cold and flu season, it is time to start thinking about summer fun: field work, painting the house, trips to Disneyland with the family...and GOLF.

First, the big news...although not 100% finalized as of this writing, we are pleased to announce that we plan for this year's tournament to be held on Tuesday, July 9th, at a new venue, the 27-hole Omni Interlocken Resort Golf Club in Broomfield. This spectacular championship layout is home to the John Elway Celebrity Classic Golf Tournament, and should provide us with plenty of room for all who want to participate.

Of course, an event like this doesn't come together without a bit of teamwork and effort, so the golf tournament committee needs to staff up with folks from both the RMAG and the DGS. If you are interested in helping out with the planning of this event please contact Jeff Ware at 303-595-8030 or jeff@lario.net. NOTE: This is the perfect opportunity for all of you who complained about something at last year's tourney.

Our first committee meeting will be held at Marlowe's, 16th and Glenarm, at 4:30 pm on Thursday, March 21. Beer is NOT provided, but is certainly available. ◀

WANTED


Rocky Mountain Drilling Prospects.
Would prefer 50% to 100% WI and operations,
but would consider others.
Contact Jeff Herman at Petro-Hunt, L.L.C.
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jherman@petrohunt.comeology
from SUNY at Buffalo.



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Center Manager

Veritas GeoServices

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2002 RMAG/DGS Directory

This is an even numbered year, so the biennial effort to publish a joint RMAG and DGS directory is already underway. The 2002 Directory will include more information than ever before.

The 1998 directory included for the first time the FAX numbers and e-Mail addresses of those members who had reported these to the RMAG office. This year we plan to add Company FAX numbers and e-mail addresses, where they differ from those listed for the member's home. The percentage of our members who have listed e-mail addresses with the RMAG continues to grow.

In the 2000 Directory, we included in the RMAG Companies section those academic and government organizations employing RMAG members. This was appreciated by our members, especially the 6.3% of our members who are so employed.

RMAG had intended that a file of members' photographs in digital format be accumulated, starting two years ago, so that eventually a photo directory could be published. This did not happen, largely because no one willing to take charge of the project could be found. Until someone is found with the dedication of someone like Jack Rathbone, who was RMAG's Official Photographer for many years, no photo directory will be forthcoming. (Any volunteers, for 2004?)

In the meantime, be on the lookout for the first RMAG/DGS directory of the third millennium. The 2002 Directory will be available for sale to members in late June. Ordering information will appear in the April *Outcrop*. The Directory will be prepared from information in RMAG's membership database. All revisions and additions to individual data files must be in the RMAG and DGS offices by April 30, 2002, for inclusion in the directory.

As has been the case in past years, the Directory will carry full-page advertisements on the outside back cover, and on the insides of both covers. Ads of various sizes, including business cards, will be interspersed with the listings. Details of advertising rates and copy formats will be found elsewhere in this issue of *The Outcrop*. Camera-ready copy for all advertising material must be in the RMAG office, and paid for, by May 20, 2002.

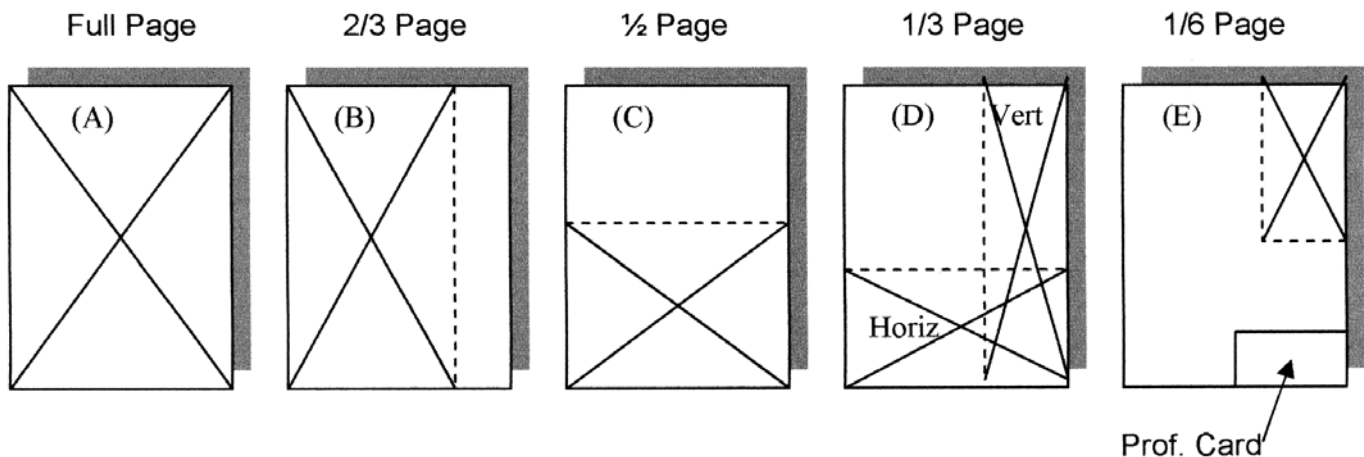
The RMAG/DGS Directory, with its handy spiral binder, is a necessity for members and others in the geoscience professions. Of the approximately 2000 RMAG members who will be listed in the 2002 Directory, about 15% will be new members since the last directory, and well over 50% of the remaining entries will have new contact information. According to DGS President Margi Oldani, similar statistics apply to the DGS membership. ◀



2002 RMAG/DGS JOINT DIRECTORY ADVERTISING RATES

ADVERTISEMENT SIZES -

	<u>Width</u>	<u>Height</u>	<u>Price</u>
Outside Back Cover	7-1/2"	9-1/4"	\$1,750
Inside Front & Back Covers	7-1/2"	9-1/4"	\$ 950
Full Page.....	7-1/4"	9-1/4"	\$ 745
2/3 Page.....	4-7/8"	9-1/4"	\$ 495
1/2 Page.....	7-1/2"	4-7/8"	\$ 385
1/3 Page - Vertical.....	2-3/8"	9-1/4"	\$ 250
1/3 Page - Horizontal.....	4-7/8"	4-7/8"	\$ 250
1/6 Page.....	2-3/8"	4-7/8"	\$ 135
Professional Card	2-1/4"	1-1/4"	\$ 50



PROFESSIONAL CARDS will be reduced to under 1/2 page width, no vertical cards.

HELPFUL HINTS – Color art will be accepted ONLY if it can be printed in black and white. Simple line art and photographs provide helpful illustration. A border is recommended for advertisements of 1/2 page (C) or less.

Advertisements must be received at the RMAG Office, in final form, by **May 20, 2002**. For **Order Forms** or additional information, please call the RMAG office (303-573-8621), Karen Christopherson (chinookgeo@aol.com), or Hal Kellogg (303-237-5613 or halkellogg@attbi.com).

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41%

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*Finding Report on the Study of Well Log Data Management, Phillip C. Crouse and Associates, 1998.



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Upcoming Workshops offered by PTTC



TECHNOLOGY | CONNECTIONS
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Subsurface Fluid Pressures and Their Relation To Oil & Gas Generation, Migration, and Accumulation

April 14, 2002, \$95 (\$15 student) Includes lunch

8:30 am – 5:00 pm, Fort Lewis College, Student Union, Durango, CO

Instructor: Fred F. Meissner, Colorado School of Mines and Geological Consultant

This one-day workshop will present the properties of rock matrices and multi-phase fluid interaction, with special emphasis on Rocky Mountain Basins. Fluid pressure quantification and its relationship to rock failure (faults and fractured reservoirs) will be discussed. Other topics will include abnormal pressure, sealed and unsealed pressure compartments, groundwater systems, and migration and accumulation of oil and gas under hydrostatic and hydrodynamic conditions. This information is very pertinent to the San Juan and Paradox Basins, and the Colorado Plateau; virtually all of the oil and gas accumulations are affected by these mechanisms (not commonly considered by engineers, geologists, and geophysicists.) Co-sponsored by Four Corners Geological Society and Fort Lewis College.

Optimized Horizontal Well Technology—Part B

April 23, 2002, \$150 (or \$140 if you bring workbook distributed at Part A) Includes lunch

8:30 am – 5:00 pm, Denver Athletic Club, Denver, CO

Instructor: Bob Knoll, Maurer Engineering, Calgary, Alberta

This is a follow-up and continuation of the workshop presented in September 2001—highly acclaimed! For those who missed the September workshop, that material will be briefly summarized. For those who attended Part A, additional details on horizontal well design and application will be presented—new material, not previously covered. Special emphasis: marginal settings and misconceptions held by operators with respect to applicability, cost, technical risk and challenges inherent in applying the technology. Take the opportunity to learn about horizontal well technology from one of the world's leading experts on the subject.

Low-Cost Geologic and Seismic Software: RockWare Programs

May 21 & 22, 2002, \$40 each day or \$75 both days

8:30 am – 5 pm, Colorado School of Mines, Berthoud Hall Room 222, Golden, CO

Instructors: Jim Reed, RockWare and David Abbott, Mountain Man Geophysics

This two-day series of hands-on computer software training will feature RockWorks2002 and RockWare Visual Seismic. These two programs provide the oil and gas professional with both geologic mapping and seismic interpretation capability for a package price under \$1,800.

Day 1 (May 21, 2002): RockWorks2002. This class will provide an introduction to this low-cost (under \$1,000) Windows software program; create maps, cross sections and fence diagrams (including deviated boreholes), solid stratigraphic models, volumetrics, and sophisticated graphics using integrated geological data management tools. Participants will receive demo software for further evaluation.

Day 2 (May 22, 2002): RockWare Visual Seismic is a new, low-cost (under \$1,000) PC software package that provides the functionality of UNIX-based visualization packages. Participants will receive a first hand view of how to use visualization techniques for 2D and 3D seismic interpretation as well as integrated reservoir characterization/modeling. A real life project area will be used to demonstrate how the software provides an effective tool for day-to-day prospect generation. Participants will receive demo software for further evaluation.

For more information, contact Sandra Mark, 303.273.3107, smark.95@alum.mines.edu

Register on-line at: www.pttcrockies.org

or copy this page, check off the courses (below) that you wish to register for, and fill out the form:

- | | |
|--|--|
| <input type="checkbox"/> Subsurface Fluid Pressures (Apr 14) \$95 (\$15 student) | <input type="checkbox"/> Horizontal Drilling Part B (Apr 23) will bring book from Part A \$140 |
| <input type="checkbox"/> Horizontal Drilling Part B (Apr 23) book provided \$150 | <input type="checkbox"/> RockWare Visual Seismic, Day 2 (May 22) \$40 (or \$75 for both RockWare days) |
| <input type="checkbox"/> RockWorks2002, Day 1 (May 21) \$40 (or \$75 for both RockWare days) | |

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Mail or FAX to: Sandra Mark, PTTC/Geology Dept., Colorado School of Mines, Golden, CO, 80401, FAX: 303.273.3859

Open House for BP Center for Visualization, University of Colorado, April 12th

The University of Colorado has established a new interdisciplinary center, the BP Center for Visualization, dedicated to immersive visualization research. This Center was created from a \$10.6 million donation from BP and a \$1 million donation from Landmark Graphics. The BP donation included the hardware, software and intellectual property developed and used by the Visualization Technology Group at ARCO. The BP Center for Visualization has a four-fold mission of research, development, commercialization and education. The initial focus of applications R&D will be oil and gas industry

and other geoscience applications, aerospace engineering sciences, medical visualization and human perception, and human/machine interaction in immersive environments.

Beginning at 1:00 p.m. on April 12 (Friday), the Center will hold an open house with tours and demos for interested members of RMAG. The Center is located in the SW corner of the Nuclear Physics Building at 3400 Marine St., in Boulder. Directions and a map are available on the Center's web site: <http://www.Colorado.EDU/Research/bpVisCenter>. ◀

June 19, 2002

Third RMAG Coalbed Methane Symposium

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Video Impact Awards



Linda Flis received the 2001 Video Impact Award in the Professional Documentary category from Denver Community Television for the video program "Rocky Mountain Anthology: Raton Basin." This program is 23.5 minutes long and is the first in a series documenting the oil and gas patch in the Rockies. It features the geology, history, and people of the area around Trinidad, Colorado, and a frac job on an Evergreen Resources coalbed methane well. It appeared on several community television stations in Colorado during October, 2001, in order to observe Earth Science Week.

The program was produced in part with a matching grant from the RMAG Foundation, along with sponsorship from the Denver Earth Resources Library and several of its members, the RMS-AAPG Foundation, Trinidad Las Animas County Film Commission, Trinidad Las Animas Economic Development Inc, and Evergreen Resources. Copies of the program

were distributed to community access cable channels in Aspen, Longmont, Rifle, Denver, and Trinidad, Colorado, using another grant from the RMAG Foundation.

In Denver the number of potential viewers is about 200,000, with a few thousand more in each of the other communities.

The First Annual Video Impact Awards of Denver (VIA-Denver) were presented in December of 2001. The

main judging criteria was positive impact in the community as a result of using Denver Community Television (DCTV) to promote an idea, issue, culture, noncommercial service or community event. All award-winning programs will be automatically entered in the 26th annual Hometown USA Video Festival, which is a national event to be held this summer. This is the largest Public Access video festival competition in the United States. ◀



Some of the 2001 Video Impact Award winners are, from left to right, Taylor Grant (as Happy), winner of the Youth category; Otto Trujillo, winner in the Nonprofessional Documentary category; and RMAG's Linda Flis, winner in the Professional Documentary category.

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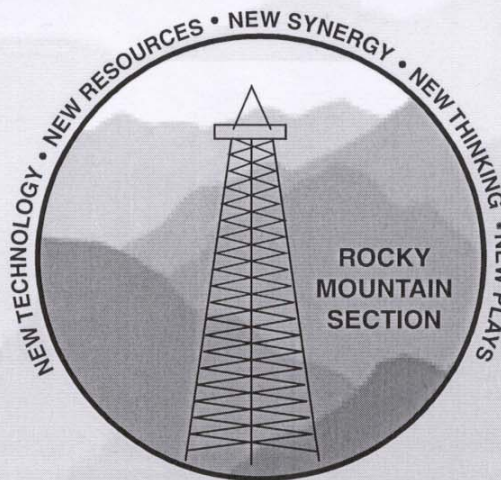
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CALL FOR ABSTRACTS DEADLINE MARCH 22, 2002!

THE ROCKY MOUNTAINS, the backbone of North America, provide an abundance of fossil fuels, minerals, spectacular scenery, world-class outcrops, and complex geology. There is no better time to be "on the rocks" here than in September when temperatures are pleasant, skies are brilliantly blue, and the aspens are turning to gold. We invite you to Laramie, Wyoming, to celebrate scientific achievements and share innovation at the annual meeting of the Rocky Mountain Section of the American Association of Petroleum Geologists. You can take advantage of our dynamic geologic setting and its locally preserved western history, unparalleled exposures of siliciclastic depositional systems, classic structures of the Wyoming Foreland, and world-famous dinosaur digs at Como Bluffs.

The theme for this meeting is **The Resource-Full Rockies**, focusing on the ideas, analyses and strategies that make new plays a reality. Laramie once provided a gateway to frontier exploration and settlement of the western U.S.; likewise, this meeting will provide a gateway to future exploration and development in the West. From Archean tectonism to quaternary glaciation, from Paleozoic reservoirs to Cenozoic source rocks ... the geologic record has been



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Send your abstract today and join us for a meeting in "The Resource-Full Rockies"!

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Phone 307-766-4858 • Fax 307-766-2737
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Technical Program Chairman

Edmund R. "Gus" Gustason, Consulting Geologist
Phone 720-299-2972 • E-mail GusGustason@aol.com

Hosted by the Department of Geology and Geophysics and the Institute for Energy Research (IER) at the University of Wyoming, the Wyoming Geological Survey, the Wyoming Geological Association, and the Rocky Mountain Section of SEPM

preserved and dramatically exposed in this region.

The technical program will promote cross-disciplinary collaboration and will be geographically organized by geologic basin or province. For a list of session topics, see www.aapg.org/meetings/rms02.

There will also be a special forum

For more information go to www.aapg.org/meetings/rms02

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Who Is This Member?

G. Allan Nelson correctly identified Bob Zinke as our February Mystery Member. Do you know who this month's Mystery Member is?



Who is this member?

This picture of one of our current members will challenge you. Do you know this member?

The RMAG member with the first correct answer to arrive at the RMAG office (in case of a tie, the earliest postmark) will win \$15 RMAG "bucks", which can be used toward the purchase of any RMAG book, symposium, or Friday lunch.

NO PHONE CALLS PLEASE!

The fine print: Please, one prize per member per calendar year. Members of the RMAG Board and Publications Committee as well as the staff of the RMAG office are ineligible. ◀

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March 6	David Hyndman	Dept. of Geologic Sciences Michigan State Univ.	NGWA Darcy Lecture
March 21	*Geoffrey Dorn	University of Colorado	The Role of Visualization In Resource Exploration & Development
March 28	Open		

GEO-CALENDAR

March 2002

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
					1 <i>GeoLand Ski Day</i> RMAG Luncheon Speaker: Charles Thorman	2
3	4	5	6	7	8	9
10	11	12	13 ● New Moon	14	15 RMAG Luncheon Speaker: Charles Thorman	16
17 <i>St. Patrick's Day</i>	18	19	20 First Day of Spring	21	22	23
24 Palm Sunday	25	26	27	28 Passover ○ Full Moon	29 Good Friday	30
31 Easter						