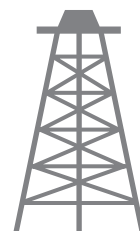




Pacific Petroleum Geology



NEWSLETTER

Pacific Section • American Association of Petroleum Geologists

January & February 2015



2015 Pacific Section Convention. Oxnard, CA.



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COVER PHOTO: Morning fog near Prisoner's Harbor on Santa Cruz Island, Channel Islands National Park. Santa Cruz Island will be one of six field trips offered at the upcoming PS-AAPG Convention this May in Oxnard.

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January 1, 2015 – Happy New Year!!

John T. Williams, Pacific Section AAPG President's Letter

Geologists, the decks are being reshuffled. Spouses, Don't Be Left Out!!

Surfs' up! Catch the Energy Wave and meet me at the beach for the 2015 Pacific Section AAPG Convention at Mandalay Beach Hotel & Resort. Don't let the Oil Wars stop you from treating your family to the best Four Star vacation destination in California. I am calling on all Petroleum Geologists: please bring your significant other and the entire family to the Convention (May 3-5, 2015).

Spouses: don't be left behind by your goofy geologist mate! Oxnard is unquestionably the greatest locality around. Don't get "wiped out" hearing that old parting statement, "Oh honey, I'm just going over hill to catch a couple technical talks at the Convention, no big deal." Remember, the Mandalay Beach Hotel & Resort is your VACATION destination. It is a must for your whole family to recharge with friends and colleagues.

Spouses, **Rise Up and Demand, "we are going to Mandalay Beach."** I am checking the registration list for your name, and I will personally come to your house to pick you all up and make sure you don't let a temporary oil glut spoil your PSAAPG blowout! No exceptions!



WOW, the Oil War is now raging! In just the past few months, orchestrated global overproduction has created a market glut. The glut has driven prices down below \$50 from over \$100/barrel. American Petroleum Geologists have done a great job finding oil. Now, we are temporally vulnerable because of too much good work. In just 8 years, USA has gone from a mantra of 'Peak Oil' – that claimed oil is finished -- to an oil war that will force a slow down, impacting the whole economy.

As the deck is re-shuffled, the slowdown will generate new opportunities. For some, this is the ideal moment for visualizing their next discovery. It might be your chance to inventory leads and prospects to be ready for the upturn. For others, it is a chance to refocus on getting organized and re-igniting neglected projects after many months of hectic activity. Some companies cannot prudently justify holding leases, thus creating openings for new players! Unfortunately, some small and medium sized California oil companies missed opportunities during the great oil boom of the past few years. These missed opportunities were primarily the result of political and permitting problems created by SB4, among many other frustrating Californian obstacles. The most recent Munger Rig count (see Figure on next page) tells the story of the past few weeks; the rig count dropped from 77 rigs to 48 rigs and counting. There has never been a decline in oil prices that did not lead to a corresponding decline in oil field activity – but this downturn seems different, more contrived, not a 'fundamental transformational change.' This downturn is real but for how long? I sense that it will be short and spike back up before the end of 2015. This Oil War will not last long!

(Continued on next page)



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The PSAAPG 2015 Convention at Mandalay Beach is a mandatory requirement for your professional practice; don't miss your chance as the deck is now being re-shuffled! If your practice is wildcatter, deal maker, play maker, oil finder, prospect generator, manager, executive, YP, service provider, land man, consultant, professor, student, DOGGR, environmental, water resources, or State-Federal-County regulator, I expect to meet you at Mandalay Beach.

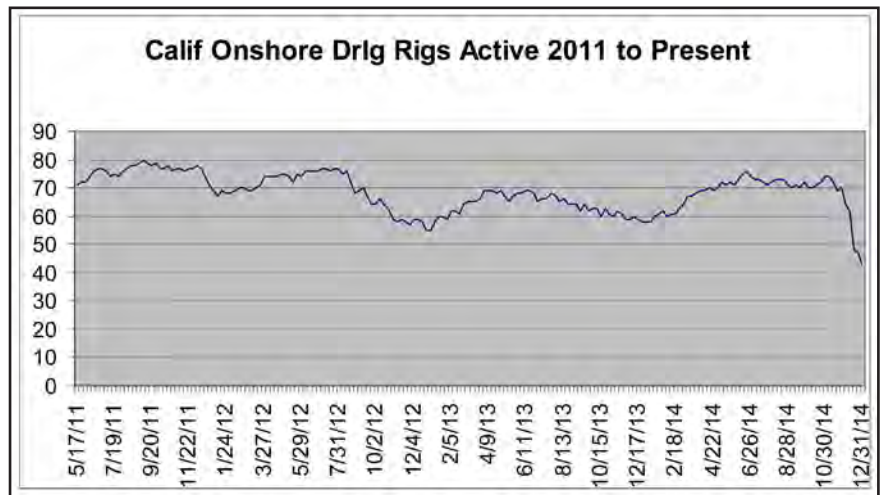
Happy New Year,
PSAAPG President 2014-2015
John T. Williams

P.S. I'd like to mention that we have been working toward a new award, The Distinguished Young Professional Award. This award is given to practicing petroleum geologists who are under 35 years of age or who have been employed as a petroleum geologist for less than 10 years. The Honoree has volunteered and demonstrated excellence, enthusiastic participation, organization creativity, leadership and passion for the geological sciences.

Questions for the Curious: (find answers on page 22)

1- Who among our PSAAPG ranks almost single handedly discovered the incandescent, narrow focus, 'Flashlight Method' using a MINI MAGLITE AAA for self-diagnosing cataracts? The answer can be found in the November & December 2014 Pacific Petroleum Geology Newsletter.

2- Where is the Mandalay Palace?



Munger Rig Count for California

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Robert Stewart Williams

December 31, 1926 - October 20, 2014

Robert Stewart Williams passed away October 20, 2014 peacefully at home, surrounded by his loved ones. Robert was born on New Year's Eve 1926 in Chicago Illinois to Paul and Ethra Doan Williams. One of four children he attended Arlington Heights Township High School. After graduating in 1944 he and his twin brother Bill enlisted in the Navy. Together they trained as aviation radiomen and gunners in aircraft carriers and joined an Air Group in 1946.

He was honorably discharged in 1946 and remained in the reserves while attending Beloit College in Wisconsin. He enjoyed many activities including football, wrestling and track. He graduated in 1950 with a Bachelor of Science degree in Geology and maintained many lifelong friendships from his college days and loved returning for class reunions and to see his SAE fraternity brothers.

While on break from graduate school from Northwestern University in 1951 he accepted a job on a seismic crew with Cities Service Oil and Gas in New Mexico. It was the start of a fulfilling career as a petroleum geologist. His work took him all over the world -- Dhofar (Oman), Senegal, Columbia, Indonesia, Argentina, Peru, Myanmar and many other places. He could always entertain with many stories from his adventurous life.

In 1983 Bob settled in Bakersfield and after retiring from Occidental Petroleum in 1988 he had more time to enjoy some of his other interests. He played golf at Buena Vista, always walking and carrying his clubs and was a member of a bowling league for over 30 years. During winter you could find him downhill skiing at Shirley Meadows. He loved fly-fishing and was a member of the Kern River Fly Fishing Club since moving to Bakersfield. Nothing gave him more pleasure than fishing Lake Success, the Kern, or in Oregon and Alaska with his two sons. He played tennis with the Siemon Park Tennis Group and enjoyed going to coffee at AMF Westchester Lanes with friends. He stayed active in his profession by attending meetings of the San Joaquin Geological Society, American Association of Petroleum Geologists and many others.

In November of 2013 the brothers were fortunate enough to take part in the WWII Honor Flight to Washington D.C. and travel together as they had 69 years ago when they began their military service. He was proud of becoming a member of First Presbyterian Church where he attended services for almost 30 years. Bob possessed a great joy for life and lived in the present. There was always an open chair at the table for the friends his children brought home or anyone else who stopped by; you never left hungry. He was a wonderful brother, father, uncle, grandfather and friend and will be greatly missed by the many people whose lives he touched.

He was preceded in death by his parents; Paul and Ethra, his sister Dorothy and brother Dale. He is survived by his twin brother William Williams (Karina) of Lakeway, TX, sister-in-law Elizabeth Williams of NJ, brother-in-law Thomas Orihel of PA; sons Terence (Jennifer) of Fairbanks, AK, Richard (Koreen) of La Grande, OR and their mother Emmy Williams of Santa Maria, CA; grandsons Elijah and William and many cousins, nieces and nephews.



- From flag – Byron Ayme, Bob Williams, Mike Walsh, Ted Tilbury - SJGS Golf Tournament 2011 – Bob has played/supported every SJGS golf tournament

Leon Jerrell Earnest

December 31, 1931 - November 6, 2014

Leon Jerrell Earnest 82, of Pahrump, Nevada was called to Heaven on the afternoon of November 6, 2014.

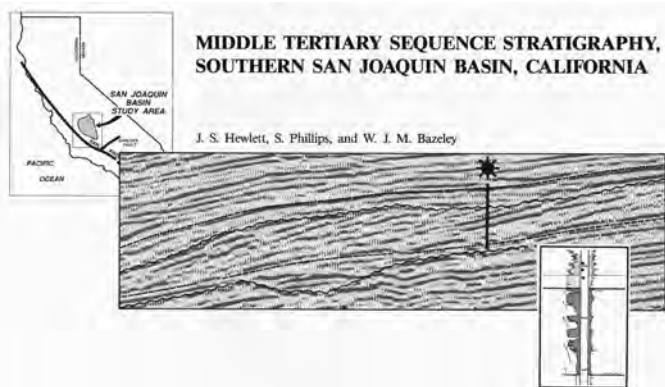
Born December 31, 1931 in Okemah, Oklahoma to John and Myrtle Earnest, he lived most of his life in Bakersfield, California. Leon served in the 45th division during the Korean War from 1951 – 1952 where he obtained a rank of Sergeant. Upon returning home to Okemah in October of 1954, he met the love of his life, Rita. The young lovebirds exchanged vows on December 20, 1954. They were looking forward to celebrating 60 wonderful years together this December. Leon was a true family man. He was extremely proud of his three children; Kim Earnest of Bakersfield, Kevin Earnest and wife Cheryl of Bakersfield, and Kenneth Earnest and wife Staci of The Woodlands Texas. Time spent with family made for his fondest memories. He will be greatly missed by his six grandchildren; Kristi Wallace, Kati Wonderly, Deron Earnest, Michael Earnest, Kyle Earnest, and Konner Earnest, as well as his grandsons-in-law, Jeremy Wallace and Darren Wonderly. His four great grandchildren Kimber, Josh, Gavin, and Luke were an endless source of entertainment for him and he was their best playmate. They all loved their Pa.

Leon was on a constant quest to learn something new. This led to him graduating from Oklahoma State University in 1957 with a degree in Geology. He loved following his OSU Cowboys in basketball and football. He was a regular of supporter the OSU Alumni Fund. Geology was the perfect career for Leon as loved all things oil, and enjoyed a successful career with Getty Oil and Bechtel Petroleum. Upon retirement in 1996, Leon and Rita traveled the country for seven years and visited all of the lower 48 states. They finally decided to make their new home in Pahrump, Nevada. Here they made many new friends and acquired their furry, four legged children, Abby and Zoey. Leon spent his days watching the stock market, playing solitaire, helping Rita cut fabric for quilts and engaging in witty banter with her. He always looked forward to family and friends dropping in for a visit.

Leon was the second of three children. He is preceded in death by his sister Joyce Woodruff and survived by his brother Johnnie Earnest of Costa Mesa, California. (Bakersfield Californian)

Leon was an exceptional teacher and mentor. Whenever we showed him our “completed” maps and cross-sections (hand correlated on a drafted base map) we knew he would find the ONE mismatched tie between the maps and sections. Leon encouraged us to expand our geologic and industry knowledge and strongly supported our involvement in AAPG, Pacific Section AAPG and the San Joaquin Geologic Society. Leon continued to mentor his geologists until his untimely passing following heart surgery in Las Vegas. We will miss him. (Kay Pitts)

PSAAPG Has A New Publication – MP 51



“This publication follows from a technical project in the ARCO sequence stratigraphy group in Plano, Texas. This study was published as an internal company research report in 1989 in the early days of sequence stratigraphy. Twenty-five years later, the authors chose to not alter the original text and figures except to satisfy a few publication requirements – we hope the studies contribute to understanding the future exploration potential of the southern San Joaquin basin.”

Originally published in-house in 1989 by ARCO: Hewlett, J. S., Phillips, S., & Bazeley, W. J. M.

This is an 11" X 24" spiral-bound book with B/W and color figures, 73 p. (1st edited version)

To purchase this publication you may go to the PSAAPG webpage (www.psaapg.org) and download the publication ordering form or you may contact Larry Knauer (PS-AAPG Publications Chair) at larryknauer@chevron.com. Cost is \$85 + S&H.

John N. Evers

April 22, 1928 – December 23, 2014

John Evers was born on April 22, 1928 in North Sacramento. He was the son of Hans Evers and Jessie Hooker. He is survived by his wife of 64 years, Sharon, and children John Jr. (Deborah), James and Susan (Donald). 5 grandchildren and 14 great-grandchildren.

John enlisted in the Navy in 1944 and served in the Pacific zone as helmsman on an LST, circling the Philippines, until his discharge. After going to college in Sacramento for a year, he transferred to Cal Poly San Luis Obispo where he met his future wife Sharon. John worked for the State of California as an under-engineering aide until he was offered a job with Shell Oil Company in Sacramento as a draftsman. Shell sent him to Elma and Seattle Washington, Los Angeles and then he returned to Sacramento with Western Gulf.



When he was caught in the layoffs in 1958, he started his own business, Evers' Oil and Gas Exchange. This was the first business to obtain well information from the active gas drilling companies and offer it for sale to companies interested in drilling in certain areas. It was good for the industry, since it was easy for interested companies to obtain information without having to go to the drillers in person.

He was one of the founding members of the Sacramento Petroleum Association (SPA). It started when a group of guys (principally landmen and scouts) got together during the late 1950's/early 60's and transformed the Northern California Petroleum Round Table into SPA. The group is still going strong to this day.

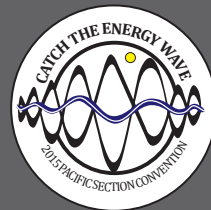
After 50 years John closed the business and retired. Through the years John and Sharon were active in the industry at conventions and other related events. John loved the oil and Gas industry and enjoyed working with all those interested in any part of it.

John created a reputation of honesty and integrity in all his business and personal dealings. His word was his bond.

He will be missed.

REMINDER!

Pacific Section Convention



Abstracts due 31 January 2015 (p.20)
Exhibitor booths and sponsorship opportunities (p.21)

Dear friends and colleagues,

Happy New Year! May 2015 bring you and your family's lots of success and happiness!

2015 is bound to be an exciting time in our community. With oil prices approaching \$50 / barrel, our Young Professionals are getting a feel for what many of our seasoned experts have experienced many times in the past. Students are also feeling the low oil prices. Jobs are scarce and graduates have to be creative in approaching their introduction to the oil patch. Experienced oil finders likely feel apprehensive for possible worst case scenarios while still feeling secure in the fact that they have weathered such storms in the past. Of course, each storm brings its own challenges, but action, innovation and collaboration are always our tools and they always do their job.



I recently had the opportunity to attend an AAPG DPA meeting in Tulsa. The meeting was filled with oil veterans and industry leaders and as much as half the discussions revolved around the importance of professional societies; specifically the AAPG. I was amazed to hear some of the stories from folks that had experienced downturns in the past. The one common theme I heard in all my conversations was how important it is to have a strong professional network and someone to consider a mentor.

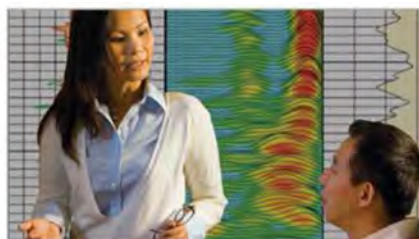
Networking is the foundation of experience from which our geological knowledge is nurtured. Through our society meetings and network, we have a great opportunity to grow and learn. I specifically urge the students to sharpen your skills, make sure your resume stands out and follow up on any networking conversations.

In the back pages of this newsletter, we provide a list of up and coming talks and meetings. They are packed with great talks and opportunities to share experiences. And, don't forget, those seeking an ideal venue to network, the big event of the year will be the Pacific Section Convention in Oxnard from 2 – 6 May 2015.

P.S. Our dear friend, Greg Hummel, passed away on December 31, 2014. The Hummel Family would like to thank everyone for their prayers, love and support as they journeyed through a very difficult time while Greg battled the monster of all diseases, ALS.

Greg always said, "No Regrets, No Fears, No Worries, No Tears", so a "Celebration of Life" has been planned for Sunday, February 8, 2015 4pm-7pm at The Diamond Bar Center. 1600 S. Grand Ave, Diamond Bar, CA. 91765. We will include Greg's memorial column in the next issue of PPG.

Sincerely,
Vaughn



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Historic Development of Fracturing and Hydraulic Fracturing

Part I – Explosives and Guns (1821-1940)

Introduction

This article is Part I in a series of three to four historical write-ups covering the development of fracturing and hydraulic fracturing (well completion and stimulation techniques). Part I covers what I refer to as the period of “**Explosives and Guns.**” This article will describe some of the chronology and achievements of our early attempts at well stimulations (roughly 1820 – 1940). Part II will be featured in the next issue of PPG. It will focus on the birth of the petroleum engineer and the crazy sixties.

The idea to write this series came from the fact that hydraulic fracturing has become a highly visible and controversial topic recently. This is evidenced by multitudes of news articles, regulatory workshops, local public hearings, documentaries, and films such as *Gasland*, *FrackNation* and *Promised Land*. With all the media attention, one is led to believe that hydraulic fracturing is a novel technology, only recently becoming utilized in oil fields. The truth of course is that down-hole stimulation can be traced back as far back as the early 1800’s.

The story begins in 1821, with the drilling of wells for the extraction of gas from shale in Fredonia, NY. These wells pre-date the famous 1859 Drake well drilled on the northern bank of Oil Creek in Titusville, PA. Early gas operations were small-scale and had a limited market, primarily fueling streetlight illumination. Natural gas would not play a significant role in America’s energy portfolio for another century and a half. This re-birth of natural gas as a significant commodity would be as a result of innovative horizontal drilling and multi-phase high volume hydraulic fracturing.

A general overview of the historical development of hydraulic fracturing is provided in two noteworthy books: 1) *The Frackers: The Outrageous Inside Story of the New Billionaire Wildcatters* (Zuckerman, 2013); and 2) *The Boom: How Fracking Ignited the American Energy Revolution and Changed the World* (Gold, 2014). A summary of significant technological advancements and events described in these books is presented in Table-1.

Table 1
Chronology of Significant Technological Developments
and Events Leading up to Modern-Day Well Stimulation Techniques

Date	Event
1821	Natural gas is first extracted from shale in Fredonia, NY.
1859	Edwin Drake drills the first commercially successful oil well on the northern bank of Oil Creek in Titusville, PA, in August 1859.
1866	Edwards Roberts develops a petroleum torpedo for fracturing rock, an idea that came to him during the Battle of Fredericksburg.
1911	Stanolind Oil, based in Tulsa, OK, is formed from the breakup of the John D. Rockefeller’s Standard Oil trust by the Supreme Court.
1932	Dow Chemical engineers mix 500 gallons of acid with arsenic to prevent corrosion of steel pipes and increase production.
1934	H. John Eastman pioneers rapid drilling of slant boreholes together with George Failing who had recently patented a portable drilling truck.
1946	Riley “Floyd” Farris and Bob Fast, with Stanolind Oil in Tulsa OK, used a liquid to fracture limestone (“ <i>hydrafrac treatment</i> ”) in the Klepper #1 well in the Hugoton natural gas field in southwestern Kansas. They used a napalm-thickened gasoline in November 1946 and they also experimented with high-explosive rocket fuel with ill-fated results.
1998	Riley “Floyd” Farris files a fracking patent in May 1948.
1948	The first paper by Fast’s colleagues publishes Stanolind’s findings in the Transactions of the American Institute of Mining Engineers. Initially presented in October 1948, and then published in January 1949.

(Continued on next page)

Date	Event
1956	M. King Hubbert publishes paper on “Peak Oil”. Companies beginning to use more water with fewer additives as a frack fluid.
1959	Interest in peaceful uses of nuclear power, and the US Atomic Energy Commission created Project Plow share to evaluate nuclear fracking.
1967	Project Gasbuggy implemented by Plowshare scientists nuclear fracking. A 29-kiloton bomb was detonated in a gas well outside Farmington, New Mexico.
1970s	Federal cost controls caused a natural gas shortage in the 1970’s. Domestic gas production on the decline; Morgantown Energy Research Center (MERC) initiates the Eastern Gas Shales Project and Gas Research Institute.
1973	Project Wagon Wheel in Wyoming ceased before it got implemented which ended the use of nuclear energy to frack wells.
1994-1975	The test-well drilled for Project Wagon Wheel was employed by El Paso Natural Gas to conduct tests of “Massive Hydraulic Fracturing” (MHF). MHF is a method where water is pumped into a well until the pressure of the water causes the rocks to fracture. EPNG concluded the MHF technique employed was not commercially feasible.
1976	Two Morgantown Energy Research Center (MERC) patents filed for early technique of directional drilling in shale.
1977	Unconventional Gas Research Program (UGR) established at Morgantown, WV. Department of Energy (DOE) successfully demonstrates massive hydraulic fracturing (MHF) in shale.
1980	Congress creates Section 29 production tax credit for unconventional gas which lasts until 2002.
1986	First successful multi-fracture horizontal well drilled by joint DOE-private venture in Wayne County, WV.
Late 1980s	Horizontal drilling technology achieves commercial viability.
1991	GRI subsidizes Mitchell Energy’s first successful horizontal well in the Texas Barnett shale.
1998	Mitchell Energy achieve commercial shale gas extraction.
1998	Nick Steinberger, at Mitchell Energy, uses slick water fracking in the well S. H. Griffin in the Barnett Shale north of Fort Worth, TX, on June 1, 1998.
2000s	Natural gas generation grows faster than any other energy source; shale gas boom pushes prices to record lows.
2012	For one month in spring, more natural gas was burned and used to generate electricity in the United States than by the burning of coal, for the first time ever.

The early days: The Battle of Fredericksburg and the Roberts Petroleum Torpedo Company

Following the drilling of the first commercially successful oil well in 1859 (Drake well), pressure to create and develop new technologies was constant (Adomites, 2011). Colonel Edward A. L. Roberts, and his brother, Walter, arrived in Titusville, PA in 1864. Taking advantage of explosives technology from the Civil War, their mission was to stimulate recovery from shallow oil wells by “shooting” wells using black powder (Figure 1). Their first attempt was in 1866 on *The Ladies’ Well*, located on Watson’s Flat, about a half mile north of Drake’s famous discovery. The two men had six torpedoes filled with black powder that were tamped with water and detonated at a depth of 463 feet. Rumor has it that Roberts developed the water-tamping idea from watching bombs land in the Rappahannock River at the Battle of Fredericksburg in Virginia. However, Roberts was nowhere near Fredericksburg during the actual battle (Adomites, 2011). The use of water-tampering helped keep the explosive activity down in the well where it would do the most good. In late 1866, they would achieve great success with their torpedoes on a dry hole, *the Woodin Well*. After shooting the well, it began producing eighty barrels of oil per day.

Shortly after their success, the Roberts Torpedo Company was formed and they acquired the rights to use a new explosive, nitroglycerin, developed by the Swiss chemist Alfred Nobel (Figures 2 and 3). The company billed between \$100 and \$200 per charge, plus a royalty of 1/15th of production on stimulated wells. Roberts Torpedo Company was successful in obtaining a patent in 1866 that protected this technology. Now owning the technique, Roberts spent hundreds of thousands of dollars in lawsuits against those who used his torpedoes to re-open wells. At one time there were as many as 2,000 active cases involving his patent being heard in the courts. In the following years, Roberts Torpedo Company claimed to have spent a quarter of a million dollars in litigation fees.

(Continued on next page)

Although Roberts was not the first to test explosives in new oil wells throughout Western Pennsylvania, he was successful and had the foresight to patent his idea. George Van Vliet of Pleasantville, Venango County, claimed to have been shooting wells for more than 30 years (Babcock, 1919). Van Vliet had shot his first well in 1864, two years prior to the arrival of the Roberts brother's. A legal arrangement allowed Van Vliet to work certain fields around Pithole, Shamburg, and Petroleum Centre, unbothered by Roberts.

Shooting, as described in the 1865 Articles of Association, By-Laws and Prospectus of The Roberts Petroleum Torpedo Company, is: *"The invention consist of a torpedo, cylindrical in form, and of a size suitable for the introduction into the bore of an oil well of the usual diameter, To it is attached a simple and ingenious contrivances for effecting its explosion by percussion,,infallibly accomplished at any depth of submission"* (Adomites, 2011). The process involved transporting the nitroglycerin in specially designed protective packaging on "nitro wagons" to the well site. The number of four-foot shells was determined based on depth and geologic conditions at the bottom of the bore hole. Each shell was first filled with water, and then the heavier nitroglycerin was added, sinking to the bottom of the shell, and causing water to displace over the shell's top rim. This technique reduced the chance that nitroglycerin would be splashed during pouring. A trigger unit, referred to as a "squib," was loaded together with the nitroglycerin, and a percussion cap rested on top of the shell. The unit would then be lowered into the well. The well was then filled with water (at least 50 feet above the top of the shell), and an eight-pound cast iron unit called a "go-devil" was dropped in the well while the "shooter" galloped away *"going like the devil."* Lewis (1934), also noted: *"A unit quantity of solid or liquid nitroglycerin on explosion produces more than 7,000 times its own volume at normal temperature...but, at the moment of explosion, temperature is raised to more than 6,000 degrees Fahrenheit. It evolves at a rate of 23,600 feet per second."* That's 16,090 miles per hour.

Shooting continued to evolve and would later be used in both oil and gas wells. It is interesting to note that the direct corporate descendants of the original Roberts Petroleum Torpedo Company, the Otto Cupler Company, are still shooting wells near Titusville today.

Well Casing Perforators

With the onslaught to drill new wells and reinvigorate old wells, a variety of perforating technologies were developed. Cement well casing was developed in 1919 by Erle P. Halliburton's New Method Oil Well Cementing Company in Duncan, OK. The purpose of the casing was to isolate wellbore zones and guard against collapse. Drilling induced wellbore damage was also understood by the 1920's, and perforation techniques aimed to bypass the damaged area. The U.S. Patent Office records many technologies designed to solve the problem of safely perforating well casing. In 1902, one invention (Patent No. 702,128) relied upon a scissors-like expanding mechanism to drive and then retract "perforating levers" through the casing (Figure 4).

By the 1930's, "bullet" devices using projectiles, most commonly, steel bullets, were the most popular. In 1939, a downhole projectile firing device was designed by Ira J. McCullough of Los Angeles (Figure 5). McCullough received two patents for his multiple bullet-shot casing perforator and mechanical firing system, and reported: *"It is the object of my invention to provide a device for perforating a well after the casing has been installed in the well in which there is plurality of projectiles, each of which is adapted to be propelled by the burning of a separate charge of powder,...The charges of powder are simultaneously ignited in order that all of the projectiles will be shot or projected from the apparatus at substantially the same time and with ample force and velocity to penetrate a plurality of casings and intervening walls of cement."* McCullough's device (patent no. 2155322) also included a "disconnectable means" that, once the charges are lowered into the borehole, can render the device inoperative as "a safeguard against accidental or inadvertent operation." Thus, perforating guns were born.

The First Perforating Guns

In 1930, two oilfield tool salesmen, Bill Lane and Walt Wells, envisioned a tool which would shoot steel bullets through casing and into the adjacent formation, but without splitting the casing or breaking the cement-to-formation bond. Their efforts would lead to the creation of a multiple-shot perforator which fired bullets individually by electrical detonation of the powder charges. By late 1935, the company Lane-Wells was becoming the leading provider of well-perforation technology.

(Continued on next page)

An August 1938, Popular Science Monthly article describes a “*machine gun*” technology used for “*the deepest hole man has ever made in the crust of the earth*” – a 15,000-foot well in Wasco, California (Figure 6). The article notes: “*Apparently the well had just missed an oil pool, blocked off from it by a formation impervious to oil.*”

The “*underground machine gun*,” was not really a machine gun, but a torpedo-shaped cylinder of steel, studded with recessed knobs along its outer shell, which was lowered down the well with a cable. Each knob formed the barrel of a pistol. Once at the desired depth, an operator at the surface closed an electric switch. Slugs of solid steel punctured the well casing and ripped through the surrounding sand “*As if released from a bullet riddled tank, oil gushed through the holes and up the pipe...*” Several multiple gun barrel type devices would be developed to enhance development and control well production issues such as sanding and well control issues. The solutions to some of the problems associated with early perforating guns would come from the battle field. Primarily, focused charge technology and the Bazooka would not only perforate, but stimulate the formation too.

Modern day perforators basically fall into two types: over-balanced and under-balanced perforating. In overbalanced perforating, the weight of the well-bore column is greater than the reservoir pressure, thus, ensuring the well does not flow immediately after perforation. However, over-balanced perforating can often damage the formation. Under-balanced perforating aims to alleviate well bore damage but not introducing damaging fluids into the wellbore. Today’s perforating guns include casing guns, expendable guns, retrievable guns, and high shot density guns. Modern types of perforators are presented in Table 2.

Table 2
Modern Day Types of Perforators

Type of Perforator	Description	Benefit
Casing gun	An assembly that creates holes in a casing string. Typically 3-5 inches in diameter and carries up to 6 perforating charges per foot.	Allows perforation through production casing using larger diameter gun assembly.
Expendable gun	An assembly that disintegrates upon firing, creating finer debris.	It is relatively light and simple in design with phased expendable guns.
Retrievable gun	An assembly that is retrievable from the wellbore after firing.	Generates minimal debris, with minimum distortion of the gun body to help ensure easy retrieval. Usually used where wellbore restrictions allow only limited access, as in through-tubing applications.
High shot density gun	An assembly with more than four shots per foot.	Improves the phasing, or distribution of perforations, around the wellbore, and enables improved distribution of the perforations around the circumference of the casing or liner.

Bazooka Technology

The tank was a new and terrible weapon developed during World War I. By the 1930’s, advancements in German armor had military planners in England and France developing counter weapons. A Swiss Army veteran and chemical engineer, Henry Mohaupt, worked on this problem and brought his research to America, where the U.S. Army’s Ordnance Department put him in charge of its secret program to develop an anti-tank weapon. It was Mohaupt’s idea to use a conically hollowed-out explosive charge to direct and focus the detonation’s energy. This idea led to the invention of the grenade used in the Army’s 60-millimeter, M1A1 Rocket Launcher, otherwise known as a bazooka (Figure 7). Realizing the potential industrial use of this military technology, Mohaupt was recruited by the Well Explosive Company, located in Fort Worth, TX. His patent submission, dated September 24, 1951, for a “*Shaped Charge Assembly and Gun*” brought bazooka technology to the oilfield (Figures 8a and 8b; US Patent Office No. 2,947,250, 1960).

(Continued on next page)

Since any drilling process creates some damage to the formation adjacent to the borehole, bypassing this damage is key when perforating. Mohaupt explained in his patent application that “*This invention relates to improvements in means for perforating casing in wells and for perforating and fracturing earth formations around well bores...*” Focused explosive energy was found to easily cut through casing and strata. In later years, such companies as Welex Jet Services (formerly Well Explosives Company), DuPont and others continued to explore and develop this technology.

Summary

The concept of fracturing rock adjacent to a well bore can be traced back to the mid-1860’s with the development of the petroleum torpedo. Following World War I we see the use of well casing perforators and perforating guns. The heyday in the use of explosives and guns to enhance productivity of oil and gas wells ended in the late 1930’s, but expanding technologies and developments in downhole explosives still continue to this day.

Later, chemistry became increasingly important in the early 1930’s with the development of acidizing treatments under pressure. Hydraulic fracturing has its domestic roots in the late 1940’s, and by the 1950’s, it was also being developed in the Soviet Union. Modern developments in fluids, proppants, pumping equipment, and fracture-treatment design, have all contributed to the dramatic increase in the number of producing fields nationwide.

Through technological innovations, it is now estimated that about 30 percent of all U.S. recoverable oil and natural gas reserves are accessible via hydraulic fracturing.

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E.A.L. Roberts. Torpedo
No 59936. Patented Nov. 20 1866

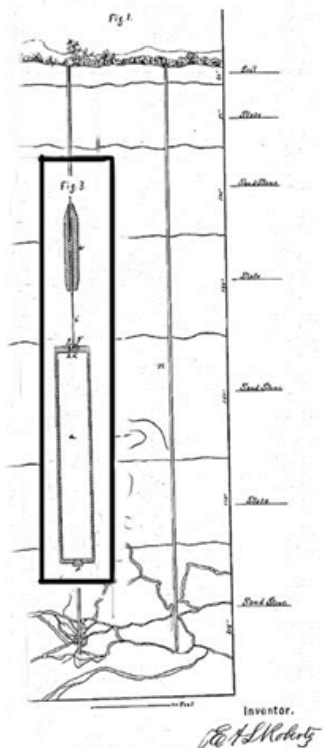


Figure 1. Schematic of E.A.L. Roberts Torpedo, Patent No. 59936, November 20, 1866. The cylindrical torpedo would be filled with gunpowder and later nitroglycerin, and lowered into the well and ignited by dropping a weight referred to as a “go devil” along the suspension wire onto a percussion cap. (<http://aoghs.org/oilfield-technologies/shooters-well-fracking-history>)

(Continued on next page)



Figure 2 Stock certification for the Roberts Petroleum Torpedo Company. Established in 1885, numerous patents provided Roberts a monopoly on torpedoes in the early years of the oil industry. (<http://aoghs.org/oilfield-technologies/shooters-well-fracking-history>)

Figure 3. A torpedo shell being filled with nitroglycerine and was known as "shooting the well." Illegal shooting led to the term "moonlighting." (<http://aoghs.org/oilfield-technologies/shooters-well-fracking-history>)

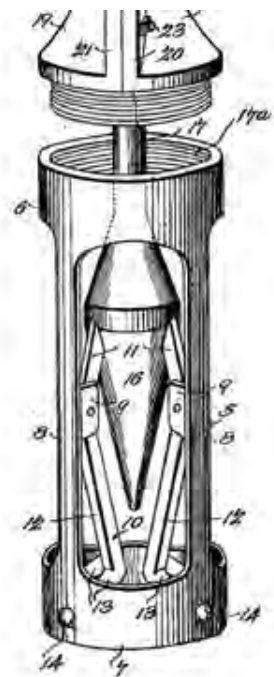
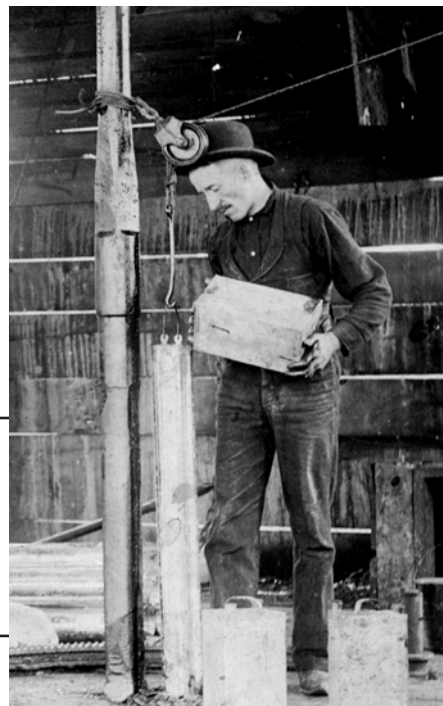
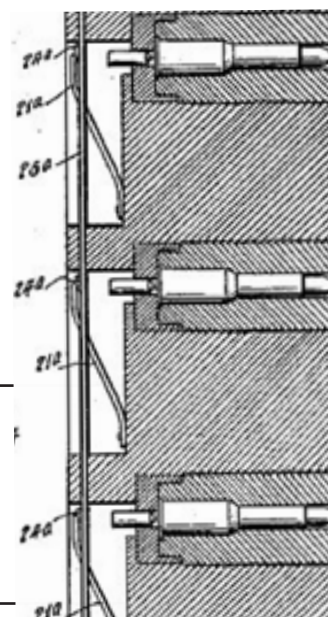


Figure 4. A 1902 invention used a scissors-like expanding mechanism to drive and then retract "perforating levers" through the casing. (<http://aoghs.org/oilfield-technologies/downhole-bazooka>)

Figure 5. The 1930s brought various downhole "guns" that shot steel-jacketed bullets through casing and about a foot into the producing formation. (<http://aoghs.org/oilfield-technologies/downhole-bazooka>)



(Continued on next page)



Figure 6. Although not a "machine gun" as noted in this August 1938 Popular Science Monthly article, vital production technologies provide explosive energy to cut through casing and strata – and produce petroleum. (August 1938 Popular Science Monthly)



Figure 7. Improved perforating technology evolves from the rocket grenade used in the Army's M1A1 "bazooka."
<http://aoghs.org/oilfield-technologies/downhole-bazooka/>

(Continued on next page)

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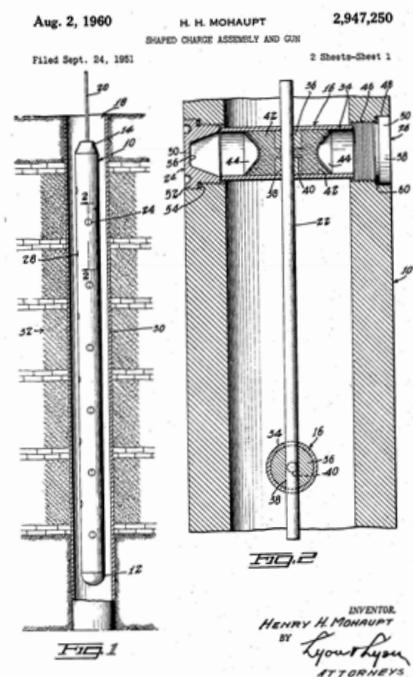


Figure 8a. US Patent Office No. 2,947,250, 1960

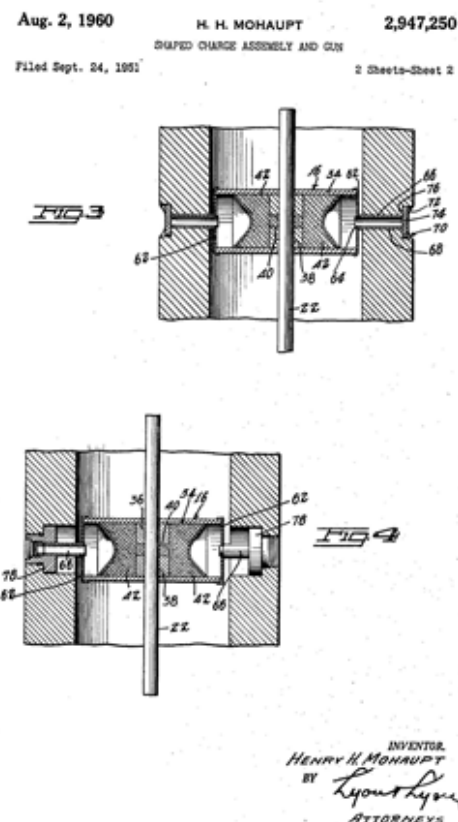
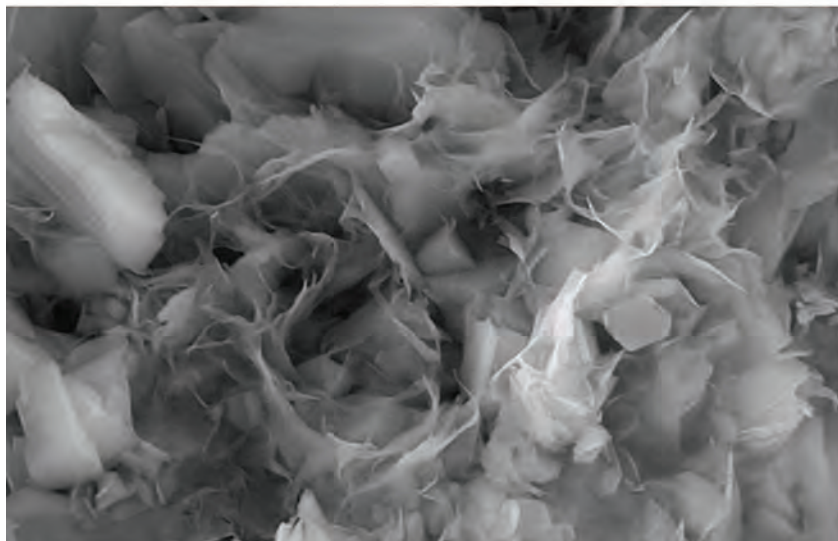


Figure 8b. Henry Mohaupt's revolutionary idea was to use a conically hollowed-out explosive charge to direct and focus the detonation's energy. (<http://aoghs.org/oilfield-technologies/downhole-bazooka>) (US Patent Office No. 2,947,250, 1960)

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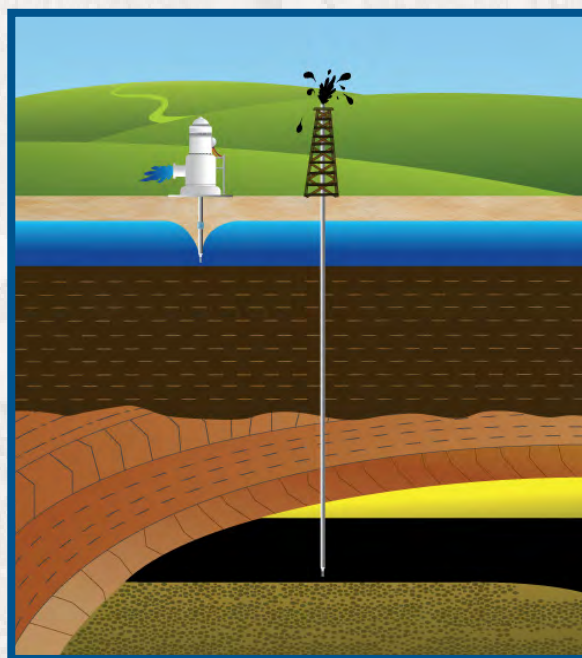


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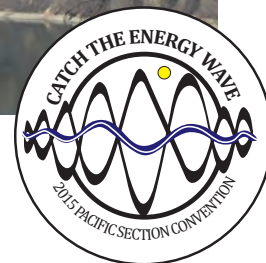
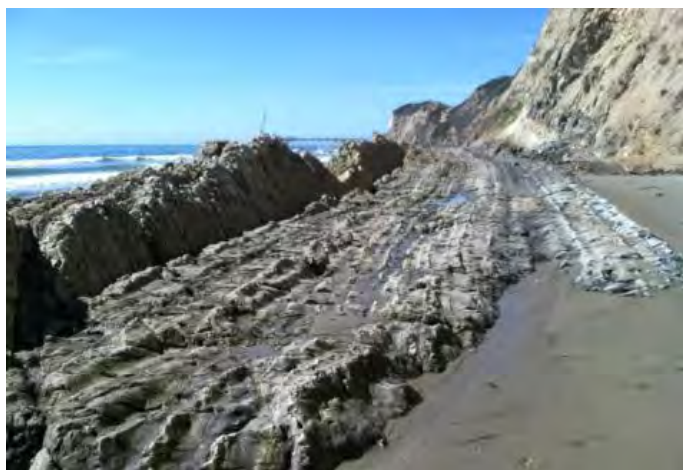
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Hosted by the Coast Geological Society. Email Jon Schwalbach at psaapg2015@gmail.com for questions about the technical program.

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Exhibitor Booths are now available for the 2015 Pacific Section Convention. The event will be held at the Mandalay Beach Hotel & Resort in Oxnard, California from May 3-5, 2015.

Exhibits provide you and your company or organization a great venue for interacting with petroleum and geoscience professionals, students, and educators from across the western states.

Over 500 people are expected to attend and ample opportunity to visit your booth will be afforded during the Icebreaker on Sunday May 3rd and each day of the convention. Socializing opportunities in the Exhibit Hall will bring people together for collegial information exchange as they view new products and services, talk with sales reps, and network with colleagues in the business of geology.

Exhibitors will be recognized through logo and name placements in the Convention Announcement, Convention Program, PSAAPG Newsletter and Website, and Convention Site Banners.

The Exhibit Hall is an integral part of the Pacific Section Convention, and is always well-subscribed and well-attended. Be a part of the gathering in May 2015 by displaying your products or services.

Please contact Exhibit Chair Eric Kroh at ekroh@slb.com for information or with questions.

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Please contact me for sponsorship information or with questions:

Mike Nelson, Sponsorship Chair, 805-890-2922, mnelson@dcorllc.com

Alaska Geological Society Membership Renewal:

Dear AGS Member,

In May, 2015 the Alaska Geological Society will cease to print and mail out the monthly newsletter and all future newsletters will go out as electronic (pdf) files attached to e-mails. The AGS Board of Director's decision to distribute newsletters in solely an electronic format was reached because the preparation and mail-out of printed newsletters is one of the largest costs borne by the Society and is not offset by revenues from dues, thus eroding the reserve scholarship funds. At present our membership roster lists 263 past and present members, most receiving printed newsletters, with 97 active members (dues paid through November 2015).

To continue to receive the AGS newsletters after May 2015, you will need: 1) to be an active member (annual dues paid up); and 2) to provide the Society with a functional e-mail address. Membership renewals or submissions of updated e-mail addresses can be done through the AGS web page at <http://www.alaskageology.org/membershipSUBMIT.htm> or by e-mail to membership@alaskageology.org, respectively. If you want to find out your membership status please contact the AGS at membership@alaskageology.org and we will be happy to reply with a check of our records. The AGS membership dues cycle starts on November 1st of each year.

ANSWERS TO PRESIDENT'S MESSAGE QUESTIONS, page 5:

1- Harold E. Sugden, CA P.G.#1954

2- Burma or now known as Myanmar

The Mandalay Palace (located in Mandalay, Myanmar, is the last royal palace of the last Burmese monarchy. The palace was constructed, between 1857 and 1859 as part of King Mindon's founding of the new royal capital city of Mandalay. The plan of Mandalay Palace largely follows the traditional Burmese palace design, inside a walled fort surrounded by a moat. The palace itself is at the centre of the citadel and faces east. All buildings of the palace are of one story in height. The number of spires above a building indicated the importance of the area below.

Tenure-Track Faculty Position in Sedimentary Geology / Earth System Science, California State Polytechnic University, Pomona

The Geological Sciences Department invites applications for an Assistant Professor tenure-track appointment beginning September 2015. Applicants must hold a PhD in Geology or a related field by August 2015. The ideal candidate will have teaching and research interests that link shallow lithosphere sedimentary processes with specialized fields such as Sedimentology, Stratigraphy, Earth History, Global Environmental Change, Critical Zone Science, Energy Resources, Basin Analysis, Marine Geology. We seek a versatile faculty member to teach Sedimentary Geology and Earth Time and Life, and contribute to instruction of courses such as Blue Planet, Petroleum Geology, Oceanography, Meteorology, Coastal Processes, Geotectonics, GIS Applications and our popular Field Modules that utilize modern digital mapping tools and instrumentation. The successful candidate is expected to ensure that our curriculum in their specialty area remains current, engage students in research and supervise MS and Senior theses. He/she should have experience with field studies and data collection using modern instrumentation. Preferred qualifications include demonstrated success with external funding, established ties to research institutions, petroleum industry or government agencies and interest in developing intradepartmental and cross-campus collaborations. Applicants must submit a signed application form (see <http://academic.csupomona.edu/faculty/docs/application.pdf>), letter of interest, CV, statement of teaching and research interests, and contact information for five professional references. A campus interview, three formal reference letters and official confirmation of degree transcripts are required of all finalists. Initial screening begins January 7, 2015. Mail application materials to Search Committee Chair, Geological Sciences Department, California State Polytechnic University, Pomona, CA 91768. Cal Poly Pomona is an affirmative action, equal opportunity employer. Full Position Description: <http://geology.csupomona.edu/employment.htm>.

Alaska Geological Society

Alaska Geological Society luncheon meetings are held at the BP Energy Center in Anchorage, Alaska. The meetings are typically scheduled on the 3rd Thursday of each month 11:30 AM – 1:00 PM

January 15th, 2015, 11:30-1:00 pm

Speaker: Jamey Jones, USGS Alaska Science Center

"Late Cretaceous through Oligocene magmatic and tectonic evolution of the western Alaska Range"

Coast Geological Society

January 20th, 2015

Speaker: Jim Norris

"Death Valley Raceway Rocks"

February 17th, 2015

Speaker: Kate Scharer

"Prehistoric Occurrence and Effects of Large Earthquakes - San Andreas Fault"

L.A. Basin Geological Society

January 22nd, 2015

Speakers: Dr. Donald Paul, Executive Director of the USC Energy Institute, and William M. Keck, Chair of Energy Resources at USC.

Due to LABGS co-hosting the Oil, Gas, and Groundwater Symposium on February 18 and 19, 2015, there will not be a regularly scheduled meeting in February

Northern California Geological Society

January 28th, 2014, 7:00pm

Speaker: Dr. Lisa White, UCMP

"Understanding Global Change From Deep Time To The Anthropocene"

February 25th, 2014, 7:00pm

Speaker: Dr. Bradley Erskine, Kleinfelder, PG, CEG, CHG, Principal Geologist

"Building a Dam out of Naturally Occurring Asbestos: Challenges and Solutions at the Calaveras Dam Replacement Project, Sunol, CA"

Northwest Energy Association

January 15th, 2015

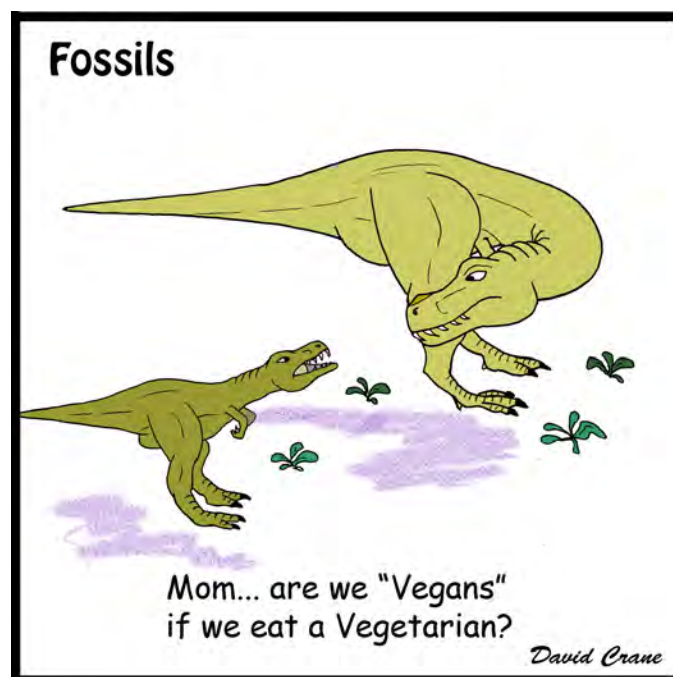
Speaker: Kevin Banister, VP of Business Development, Principle Power, Inc.

"Overview of Principle Power's plans on building a 30 MW floating wind farm fifteen miles off Coos Bay - the first off-shore wind project on the West Coast"

February 19th, 2015

Speaker: Clay Riding, Director of Natural Gas Resources, Puget Sound Energy

"Gas Storage at Jackson Prairie - Its Significance in Today's Market"



Sacramento Petroleum Association

Roland Bain's 50th year anniversary of presenting "Review of Drilling Activities and Highlights in the Sacramento Valley". We are working on making it a special occasion. The meeting will be at the Club Pheasant (W. Sacramento) at noon – February 18th...anyone is welcome!

San Joaquin Geological Society

January 13th, 2015

Speaker: Dr. Junhua Guo

"Evolving clay mineral assemblages in the Nankai Trough, Kumano Basin, and Shikoku Basin, offshore Japan: A summary of results from the NanTroSEIZE project"

February 10th, 2015

Speaker: Dr. Mike Clark

"Vertical Methods in Field Geology"



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Luncheon meetings are held monthly September through May, usually on the third Thursday of the month, at the BP Energy Center (1014 Energy Court) from 11:30 a.m. to 1:00 p.m. The hot lunch cost is \$20 for members with reservations; \$22 for non-members with reservations; and \$25 without reservations. The box lunch cost is \$13 for members with reservations, \$15 for non-members with reservations, and \$18 without reservations. For reservations, call the AGS reservation voice mail at 907-258-9059 or contact David Hite at hiteconsult@acsalaska.net by noon on Monday before the meeting.

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Dinner meetings are held monthly September through May, on the third Tuesday of the month, at Poinsettia Pavilion, 3451 Foothill Road in Ventura. Social hour starts at 6:00 p.m., dinner is served at 7:00 p.m., and the talk starts at 8:00 p.m. The cost of dinner with reservations is \$20 (members), \$25 (non-members), or \$10 (students and K-12 teachers). For reservations, please email Bonnie Walters (secretary@coastgeologicalsociety.org), and should be made by 4:00 p.m. on the Friday before the meeting.

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Los Angeles Basin Geological Society
www.labgs.org

Contact: Jean Kulla
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Luncheon meetings are held monthly September and October; and January through June, usually on the fourth Thursday of the month, at The Grand at Willow Street Conference Centre (4101 E. Willow Street) in Long Beach. Lunch is served at 11:30 a.m., and the talk starts at 12:15 p.m. The cost is \$25 (with reservations), \$30 (without reservations), \$20 for retired members, and \$5 for students. Reservations can be made online at www.labgs.org or by contacting Graham Wilson at 562-326-5278 or GWilson@SHPI.net. Reservations must be made prior to Tuesday before the meeting.

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Contact: Barb Matz
Barbara.Matz@CBIFederalServices.com



Evening meetings are held monthly September through May, usually on the last Wednesday of the month, at the Masonic Center (9 Altarinda Road) in Orinda. Social hour starts at 6:30 p.m., and the talk starts at 7:00 p.m. (no dinner). For reservations, contact Dan Day at danday94@pacbell.net before the meeting. Cost is \$5 per regular member; \$1 per student member; and \$1 per K-12 teachers.

(Continued on next page)

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President-elect:	vacant	vacant
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Secretary	Dan Day	danday94@pacbell.net
Treasurer	Phil Reed	philecreed@yahoo.com
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Field Trip Coordinator	Tridib Guha	tridibguha@yahoo.com
Past President	Phil Reed	philecreed@yahoo.com
Scholarships	Phil Garbutt	plgarbutt@comcast.net

Northwest Energy Association

www.nwenergy.us

P. O. Box 6679

Portland, OR 97228-6679

*Contact:**Jim Jackson or John Armentrout*

Luncheon meetings are held monthly September through May, on the third Thursday of the month, at the Multnomah Athletic Club (1849 SW. Salmon Street) in Portland, Oregon. Meeting time is at 11:45 AM to 1:00 PM (speaker about 12:15 PM). The cost is \$25 for members and \$30 for non-members. For information or reservations email NWEnergyAssociation@gmail.com, or our Postal Box: Northwest Energy Association, P.O. Box 6679, Portland, Oregon 97228-6679.

President	John Armentrout	jarmenrock@gmail.com
Vice-President	Bill Rodgers	wlrodgers@stoel.com
Past President	Jim Jackson	jackson.js@comcast.net
Treasurer	Barb Portwood	bbportwood@gmail.com
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Sacramento Petroleum Association

P. O. Box 1844

Folsom, CA 95763-1844

*Contact: David Hartley**530.304.4277*

Luncheon meetings held monthly January through November, on the third Wednesday of the month. Location: Club Pheasant Restaurant in West Sacramento. The meetings starts at noon. The cost is \$16 - \$20. For information or reservations, contact Pam Ceccarelli.

President:	Jerry Reedy	JWR5532@aol.com
Vice-President:	David Hartley	drilmax1@aol.com
Secretary	Derek Jones	djones@gasbiz.com
Editor/Treasurer	Pam Ceccarelli	pc626@comcast.net

San Joaquin Geological Society

www.sanjoaquingeologicalsociety.org

P. O. Box 1056

Bakersfield, CA 93302

*Contact: Laura Bazeley**lbazeley@wziinc.com*

We have dinner meetings on the second Tuesday of the month at the American Legion Hall at 2020 "H Street" in Bakersfield. There is an icebreaker at 6:00 p.m., dinner at 7:00 p.m., and a talk at 8:00 p.m. Dinner is \$25 for members with reservations and \$30.00 for nonmembers and members without reservations. Students may attend for free.

President:	Anne Draucker	AnneDraucker@chevron.com
Past President:	Laura Bazeley	lbazeley@wziinc.com
President-Elect:	Ariel Auffant	aauffant@chevron.com
Vice-President:	Greg Gordon	gsgordon@aeraenergy.com
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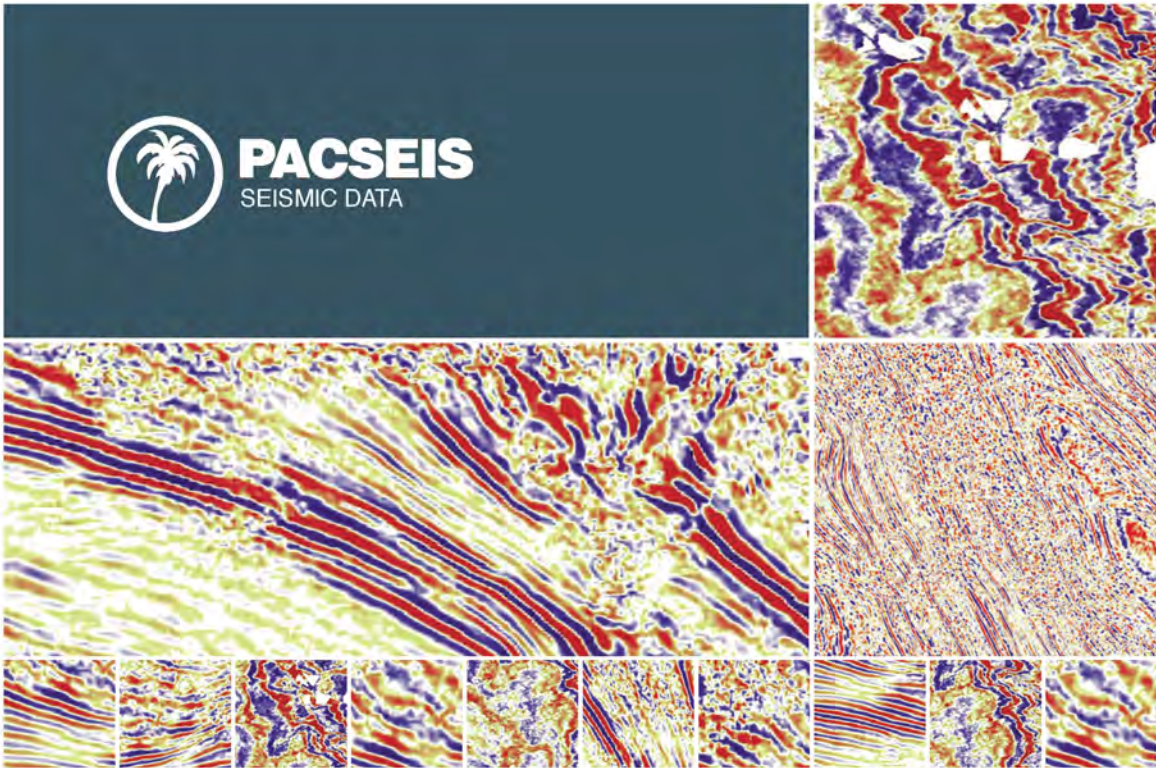
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