NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

JANUARY MEETING ANNOUNCEMENT

DATE: **Wednesday, January 31, 2001**

LOCATION: **Orinda Masonic Center, 9 Altarinda Rd., Orinda**

TIME: **6:30 p.m. Social; 7:00 p.m. talk (no dinner)**
Cost is $5.00 per person

RESERVATIONS: Leave your name and phone number at 925-294-7530 anytime before the meeting.

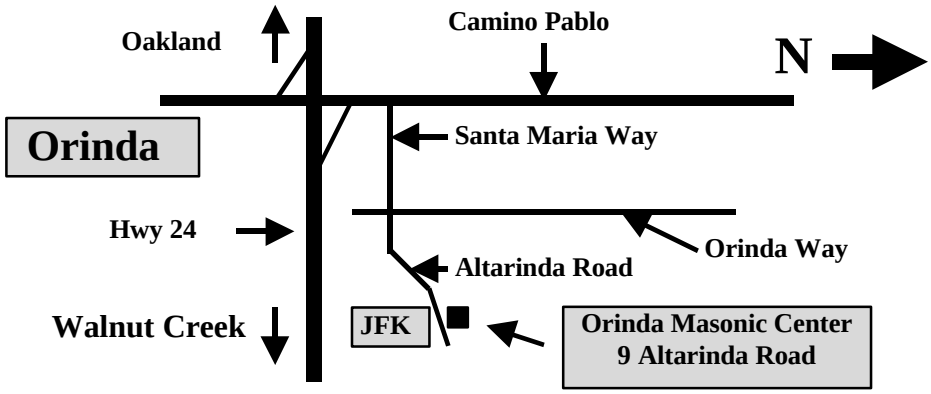
SPEAKER: Keith L. Knudsen, California Division of Mines & Geology, San Francisco

New Quaternary Geologic and Liquefaction Susceptibility Mapping of the Nine-County San Francisco Bay Region and CDMG's Seismic Hazard Mapping Program

Mr. Knudsen will be discussing two projects in which he is involved. The first topic will be recently published Quaternary geology mapping and derivative liquefaction susceptibility mapping of the San Francisco Bay Region. This project is a collaborative effort by Keith Knudsen, Janet Sowers, Rob Witter, Carl Wentworth, Ed Helley, Rob Nicholson, Heather Wright, and Katherine Brown, which has been released as U.S. Geological Survey Open File Report 00-444 (available at ***http://geopubs.wr.usgs.gov/open-file/of00-444/***). The new Quaternary maps provide a modern and regionally consistent treatment with 44 different geologic map units that range from historically placed artificial fill over Bay Mud (afbm) to Pleistocene marine terrace deposits (Qmt). Author affiliations are as follows: William Lettis & Associates, Inc. (WLA), the U.S. Geological Survey (USGS), and the California Division of Mines and Geology (CDMG).

The second topic for discussion will be the State of California's Seismic Hazards Mapping Act and CDMG's related work in the Bay Area. CDMG's geologists develop maps that delineate seismic hazard zones and identify areas prone to liquefaction and earthquake-induced landsliding. These maps are adopted by local jurisdictions and are used to trigger site-specific investigations and reports that discuss the level of hazard(s) and formulate mitigation measures. As of early January 2001, the Seismic Hazard Mapping Program has released maps of the City and County of San Francisco, and the cities of Oakland and Piedmont. Present efforts in northern California are focused on the Santa Clara Valley area.

(continued on back page of newsletter)



Keith L. Knudsen is a Senior Engineering Geologist with the California Division of Mines and Geology, Seismic Hazards Mapping Program in San Francisco. He has served in that capacity for a little over a year. Prior to joining CDMG, Mr. Knudsen was with William Lettis & Associates, Inc., where he worked with other WLA and USGS geologists to produce the recently released Quaternary geology and liquefaction susceptibility maps of the Bay Area (USGS OFR 00-444). His professional interests include most natural processes that shape (or shake) the earth's surface.

New NCGS Members

Please give a warm welcome to the following new NCGS members:

Allen Bailey **Chris Higgins** **Bill Perkins**

We hope to see these new faces at upcoming NCGS functions!

Northern California Geological Society
c/o Judy Hayes
453 Scotts Mill Rd.
Danville, CA. 94526-4234

Would you like to receive the NCGS newsletter by e-mail? If you are not already doing so, and would like to, please contact **Dan Day** at ***dday@nrmc.com*** to sign up for this service.

NCGS 2001-2002 Calendar

Wednesday, January 31, 2001
Keith Knudsen, California Division of Mines and Geology (CDMG)
New Quaternary Geologic and Liquefaction Susceptibility Mapping of the Nine-County San Francisco Bay Region and CDMG's Seismic Hazard Mapping Program
Orinda Masonic Center

Wednesday, February 21, 2001 / AAPG Distinguished Lectures
John Warme, Colorado School of Mines, Golden, CO.
Active Margin Sequences and Submarine Canyon Facies Models
Chevron Overseas Petroleum, Inc. (Noon hour; exact time TBA)
AND
Anatomy of an Anomaly: The Catastrophic Devonian Alamo Impact Breccia, Nevada
Lafayette Veterans Memorial Building (Evening; exact time TBA)
Tentative Joint Meeting with BAGS.

Saturday, March 3, 2001
Caldecott Tunnel Field Trip (Please check future newsletters for details)
9:30 am at site TBA / Leader: ***Grant Wilcox,*** Branch Chief, CalTrans Geologists, Oakland, CA.
A trip including a movie on the tunnel construction, a trek through tunnel air ducts, and a synopsis of the tunnel engineering geology

Thursday, March 22, 2001 / AAPG Distinguished Lecture
Andrew Pulham, University of Colorado, Boulder, CO.
Reservoir Performance and Reservoir Quality in a Sequence Stratigraphic Framework: Case Studies from Siliciclastic Reservoirs in the Americas and Europe
COPI; Room 1036; 11:00 am to 2:00 pm (exact time TBA)

Wednesday, April 25, 2001
Laurel Collins, San Francisco Estuarine Institute
Tentative topic: **Wildcat Canyon: Watershed and Sedimentation Interactions**
Orinda Masonic Center

Wednesday, May 30, 2001
Dave Mustart, San Francisco State University
Tentative title: **Hydrothermal Pipes in Six Granitic Plutons in California: Evidence for Evolution and Migration of a Magmatic Volatile Phase**
Orinda Masonic Center

Wednesday, June 27, 2001
Bruce Jaffe, USGS Menlo Park
Tentative Title: **Mercury Contaminated Hydraulic Mining Debris in North San Francisco Bay: A Legacy of the Gold Rush**
Orinda Masonic Center

Wednesday, September 26, 2001
Richard Sedlock, San Jose State University
Tentative title: **Blueschists and Ophiolites in Baja: Coast Range Geology, But With Outcrops**
Orinda Masonic Center

Wednesday, October 24, 2001
David Lawler, Far West Geoscience Foundation, Berkeley (Tentative)
Title: **Hydraulic Gold Mining's Historical Legacy - Mercury Contamination Issues: Sierra Nevada and Klamath Mountain Regions, California**
Orinda Masonic Center

Wednesday November 28, 2001
David Des Marais, NASA Ames Reseach, Menlo Park
Title: **The Biogeochemical Carbon Cycle and the Coevolution of Early Earth and Biosphere**
Orinda Masonic Center

Wednesday January 30, 2002
Roger Ashley, USGS Menlo Park
Title: **Lode Gold Deposits of the Sierra Nevada and Their Environmental Impacts**
Orinda Masonic Center

AAPG Distinguished Lecture "*Doubleheader*"

Sponsored by Chevron Overseas Petroleum, Inc. and NCGS

Wednesday, February 21, 2001

Presentations by Dr. John E. Warme, Colorado School of Mines, Golden, Colorado

Noon Lecture at Chevron Park, San Ramon, CA. (time and room location TBA)

Active Margin Sequences and Submarine Canyon Facies Models

Superb Lower and Middle Eocene forearc facies in northern San Diego County, California, exhibit three stratigraphic sequences that show shoreline and shallow marine facies (Delmar/Torrey Sequence) unconformably overlain by submarine canyon deposits (Ardath and Scripps Sequences). Delmar/Torrey facies include fan-delta, lagoon, barrier beach, and marine shelf environments backed by alluvial fan complexes. This sequence contains suites of sedimentary structures, fossils, and trace fossils characteristic of the now-familiar proximal facies models. In contrast, the large scale of submarine canyons and their sedimentary fills has inhibited development of applied models for them. The study area provides rare, continuous exposures that can be applied to subsurface exploration and development. They show that the Delmar/Torrey Sequence is separated from the overlying Ardath submarine canyon facies by a major sequence boundary and facies shift. This unconformity represents the floor and margins of the fossil "Eocene Torrey Submarine Canyon." The submarine canyon facies model includes a basal massive sandstone overlain by cross-cutting marine channels with unpredictable heterolithic fill that includes active-channel conglomerates, diverse sandstones and siltstones, and abandoned-channel mudstones, collectively termed "variegated fill." A second sequence-bounding unconformity caps these channels, overlain by the conglomeratic Scripps Sequence. Surprisingly, age dating of the lower canyon boundary and the canyon fill strongly suggests that their development was driven primarily by eustacy, even though the regional setting was a tectonically-active forearc.

Evening Lecture at the Lafayette Veterans Memorial Building, Lafayette, CA. (time/cost TBA)

Anatomy of an Anomaly: The Catastrophic Devonian Alamo Impact Breccia, Nevada

Facies models, stratification sequences, sequence stratigraphy, and seismic stratigraphy provide tools for rock analysts to interpret sedimentary basin structures. Without such experience and insight, important anomalous occurrences are misinterpreted or completely overlooked. This theme is illustrated using three catastrophic carbonate mass flows; two are explainable based on associated structural features, but the third, the Alamo Breccia, requires another level of investigation. The Late Devonian Alamo Breccia is a sedimentary megabreccia found in 15 different mountain ranges in Nevada. It occurs anomalously within shallow water carbonate platform facies of the Upper Devonian Guilmette Formation. Before thrust dismemberment it covered a north-south distance of 200 km. and an area of several thousand square km. across the carbonate platform. The Breccia is 130 meters thick at its center and feathers out on its periphery. Iridium concentrations, shocked quartz, ejecta spherules, displaced fossils, a chaotic ejecta bed, and up to 500-meter long displaced blocks overlain by five tsunami-deposited graded beds confirm that the Breccia formed from meteorite or comet impact. The Alamo Event was large enough to rearrange the Devonian platform paleogeography, but not sufficient to cause direct extinctions. Known asteroid and comet fluxes with Earth-crossing orbits suggest there are other similar deposits in the stratigraphic record that serve as reservoirs, seals, and seismic markers as well as extinction horizons. The Alamo Breccia is a model for such deposits.

John E. Warme, has been Professor of Geology and Geological Engineering at the Colorado School of Mines since 1979. He received his Ph.D. in Geology from UCLA in 1966 and was a professor at Rice University from 1967 to 1979, where he held the W. Maurice Ewing Chair in Oceanography (1976-1979). Dr. Warme was a Fulbright Scholar at the University of Aberdeen, Scotland in 1966-67, and is a former President of SEPM (1983-84) and an honorary member of that organization. His professional interests include stratigraphy, basin analysis, and paleoecology. He has done field work and subsurface studies in California, Nevada, the Rocky Mountains, Latin America, Europe, and North Africa, and has led or co-led AAPG Field Seminars in California, the Grand Canyon, and Morocco. He is member of the AAPG, AAAS (Fellow), AGU, GSA (Fellow), SEPM, the International Association of Sedimentologists, the Rocky Mountain Association of Geologists, the Moroccan Association of Petroleum Geologists, the Colorado Scientific Society, and Sigma Xi. In 2000 Dr. Warme received the Augustana College (Illinois) Alumni Association Outstanding Achievement Award.

NASA Ames Planetary Scientist Discusses Evidence for the Evolution of Life on Mars at NCGS Family Night

The NCGS closed its year 2000 monthly meeting program with an informative Family Night presentation on the search for life on Mars. Planetary scientist **Christopher P. McKay** of NASA Ames Research Center's Space Science Division captivated the audience with his talk ***Landscape Geomorphology and the Search for Water on Mars: Implications for the Development of Life.*** Chris took his listeners on a tour of Mars that not only described key geomorphological evidence for the presence of water there, but also introduced them to innovative research conducted at remote terrestrial locations that show how life could have independently evolved and perhaps survived on the Red Planet.

Chris began with a brief description of Mars and its physiographical characteristics. It is the fourth planet in the solar system located an average distance of about 140 million miles from the sun (1.5 times as far as the earth). It has a diameter of 4200 miles (about half the earth's), a minimum surface temperature of -200°F (polar regions in winter), a maximum surface temperature of 80°F (equatorial regions in summer), and a global average temperature of -67°F. The Martian atmosphere is 95.3% CO_2, 2.7% N_2, 1.6% Ar, and 0.13% O_2 with traces of water vapor, neon, krypton, and xenon. The days are slightly over 24 hours long and the Martian year lasts 687 Earth days (1.9 Earth years). Its surface area is the same as the Earth's land area, but its topography is much more extreme, with its highest point, the enormous volcano Olympus Mons, rising 24 km. (~15 miles) above the surrounding terrane. By comparison, the island of Hawaii, which represents the greatest local relief difference on Earth, looms only 5.7 miles above its base on the Pacific Ocean floor. The Martian surface is marked by huge volcanoes, canyons several times the width and depth of the Grand Canyon, large expanses of sand dunes, orange-yellow skies with clouds, and extensive valley regions reminiscent of river tributaries here on Earth. Its surface displays apparent seasonal shrinking and growth of white polar caps and darker color shifts in its equatorial regions suggestive of annual climatic variations similar to those on Earth. These phenomena have intrigued astronomers for decades and have fueled the search for evidence of life on Mars.

With this background information, Chris proceeded to explain the proposed climatic conditions on Mars. Since the Red Planet has an atmospheric pressure of only 7 to 10 millibars (roughly 1/100th that of earth), water, a key ingredient for the evolution of life forms as we know them, would behave there as carbon dioxide does on Earth---it would sublimate (fluctuate between the solid and gas phases without forming a liquid, like frost and water vapor do in cold climates). The current climatic conditions on Mars, therefore, are not conducive to biological life as we know it. What, then, is the compelling reason for the continued search for life on this planet? A key reason is the inconclusive evidence from biological studies conducted in the mid 1970's by the Viking Landers that life does not exist on Mars. These results, along with topographic features suggesting erosional landforms and biological studies in extremely harsh terrestrial environments, have kept scientists' hopes alive.

The current Martian atmosphere is comparable to what scientists believe the earth's atmosphere was like before life appeared 3.5 to 3.8 billion years ago. Algae-bearing stromatolites appear in the fossil record 3.5 b.y. ago and mark the beginning of biological cycles that eventually evolved into photosynthetic organisms that eventually changed the earth's atmosphere from a carbon dioxide-dominated system to its current nitrogen-oxygen mixture. The latter was driven in part by the removal of carbon dioxide through the hydrologic cycle as bicarbonate anion in seawater, and subsequent precipitation as carbonate limestone. The same process would have occurred on Mars in the presence of liquid water. The catch is that Mars had no mechanism for renewing CO_2 in the atmosphere. The Earth, being a larger planet (10 times the mass of Mars), was able to sustain the volcanic activity that injects CO_2 into the atmosphere via plate tectonics, a process fueled by heat generated from radioactive decay in the core and mantle. This unique process and the associated buffering of CO_2 levels in the atmosphere by biological and hydrological cycles provide the conditions for life to evolve on earth. Mars was simply too small to develop any sustainable volcanism to replenish carbon dioxide in its atmosphere, which was eventually removed by explosive meteorite impact activity, solar wind bombardment of the upper atmosphere, and presumably by conversion to carbonate in the presence of liquid water. The Red Planet ultimately cooled, volcanic activity all but ceased, surface temperatures dropped, and liquid water vanished from its surface.

However, the possible existence of life, or at least the fossil evidence of life, has kept exobiologists' hopes alive. That there are undeniable geomorphological features that closely resemble terrestrial fluvial and lacustrine systems on Mars has inspired these researchers to explore the most hostile environments on earth for clues to the survival of life forms in these harsh, Mars-like climates. So being a dedicated scientist, Chris traveled to the Antarctic dry valleys where the annual average temperature is -4ºF and precipitation is extremely sparse to study algal mats flourishing on the bottom of ice-covered lakes. The lakes are about 100 feet deep and have a fairly constant 5-meter thick ice cover which insulates the water beneath it that is fed by glacial runoff when the temperatures periodically rise above freezing in the summer. The latent heat of freezing keeps the lakes from freezing solid, and the ice cover is thin enough to permit enough light to reach the bottom to sustain algal photosynthetic activity. Similar conditions could have existed on Mars when water was still liquid.

The next question, then, is if life were frozen into ice, how long could it survive? Answers were found in 3.5 million-year-old permafrost layers in Arctic Siberia. Here the average annual temperature is 15ºF, and dormant microorganisms were found in this frozen ground. However, the survival of these dormant organisms can be shortened by exposure to the ionizing effects of naturally occurring radionuclides of uranium, thorium, and potassium. Kinetic arguments can exponentially extend biological dormancy at lower temperatures (-95ºF), but it is unlikely that 3 billion-year-old microbes would be genetically intact and revivable today. However, even partial DNA coding would be scientifically invaluable to evolutionary biologists.

Assuming there is a reasonable chance of finding fossilized life on Mars, where should one begin the search? The most likely sites will have chronological, geographical, and geomorphological constraints placed on them. Martian chronology, unlike terrestrial and lunar chronology, does not enjoy the benefit of radioactive or absolute dating technology. Its relative chronology is based on cratering density referenced to lunar absolute chronology and cratering events. The three major time periods in Martian history, beginning with its formation 4.6 billion years ago, are the Noachian (earliest) which represents a stage of intense planetary bombardment ending ~3.5 b.y. ago; a period of reduced cratering called Hesperian time, from 3.5 to 1.8 b.y. ago; and the youngest, called Amazonian, which began 1.8 b.y. ago. The most likely prospects for the evolution of life would be in the Noachian, which parallels the earliest appearance of life on Earth. And depending on when climatic conditions became prohibitive, there is significant possibility that life, had it evolved on Mars, would have survived into Hesperian time. Most experts feel conditions were too harsh by the Amazonian to permit the evolution of biological life forms. There is a chance that pre-existing life could have survived in sheltered environments to the present day, but so far no direct evidence of such favorable conditions has been documented.

Chris favors searching for Martian life in sedimentary rocks, preferably in lacustrine or fluvial settings similar to those he encountered in the dry Antarctic valley lakes. An extremely promising site is the Gusev Crater, a 150-km. wide Noachian impact feature located in the equatorial or "tropical" latitudes. The crater lies at the outlet of one of the largest valley networks on the planet, Ma'adim Vallis. This apparent fluvial system forms what appears to be a large delta where it enters the crater. Various geological features reflect a depositional history that lasted 2 billion years! This site would be a good place to search for the elusive carbonate sediments, or transient fluvial networks feeding frozen lakes like those in Antarctica, that could possibly contain dormant or fossilized Martian life forms. Researcher's hopes are also bolstered by the discovery of possible microbacterial life preserved in a Martian meteorite (ALH 84001,0). The upcoming Mars Odyssey probe scheduled for 2001 will be armed with a gamma-ray detector that will be used to detect hydrogen several meters below the barren Martian surface. So stay tuned!

The NCGS sincerely thanks planetary scientist Chris McKay and his associates at NASA Ames Research Center for making this fascinating presentation possible. Chris provided the audience with an entertaining, and often amusing glimpse of the on-going search for life on the most Earth-like planet in our Solar System. An excellent series of short articles on NASA's study of the Red Planet can be found at the Center for Martian Exploration website http://cmex.arc.nasa.gov.

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Second Visualization Demonstration at Chevron Park Showcases State-of-the-Art GIS and 3-D Projection Systems

In a repeat performance of the April 1, 2000, 3-D Virtual Reality Demonstration at Chevron Overseas Petroleum, Inc.'s San Ramon, CA. campus, Bob Kieckhefer, Tod Rubin, and technician Rose Hsiao treated their audience to an impressive display of visualization technology. The December 2, 2000, demonstration showcased not only the seismic reconstruction of the subsurface Absheron Prospect in the Caspian Sea, but also demonstrated Chevron's impressive GIS (geographic information system) with actual data from COPI's Nigerian project.

The center is located in the San Ramon Chevron Park complex. It is less than 2 years old and uses a highly configurable 2-pipe SGI Onyx 2-IR graphics supercomputer with connections to two viewing rooms—the larger 35 seat room with a curved 9 by 28 foot screen for group presentations and a smaller room with a 3 by 10 foot screen for work sessions. This system has 4 CPUs (microprocessors) with 4 gigabytes of RAM and 288 gigabytes of hard disk capacity. The driving force behind the development of 3-D viewing facilities throughout Chevron is the need to process massive quantities of 3-D seismic data, reduction in manpower to evaluate the data, the shortened time frame for completing major projects, and the need for more accurate results. The comfortably furnished larger viewing facility is used for group conferences and multimedia productions. COPI prefers to purchase most of its 3-D visualization software and uses it for velocity modeling, subsurface structural reconstructions, reservoir characterization, scale-up simulation, and well planning. This viewing room cost about $300,000; the three RGB projectors and screen cost $250,000; and the SGI supercomputer had a price tag of about $400,000. When the $20,000 to $100,000 licensing costs for each of the four software packages is added to this figure, one realizes the investment that COPI has in this technology. Other visualization facilities, besides ones in Sumatra, Norway, and Nigeria are under consideration. The next step in visualization technology will involve voice

control software, alternate input device capabilities, software feedback to prevent the operator from overlooking vital information, and the ability for remote site collaboration.

The technical portion of the program began with a GIS demonstration by Remote Sensing and GIS Team Leader Tod Rubin. Tod showcased COPI's Nigerian GIS dataset which essentially uses a point-and-click method to access an enormous database of construction, habitation, physiographical, and environmental information. This system uses former spy satellite radar imaging technology developed by Lockheed Martin to capture surface details to a resolution of 4 meters in the color mode, and to an incredible 1 meter maximum resolution in black-and-white. The system uses ARCVIEW software linked to an Oracle database for the GIS management. The satellite images can be enlarged to see surface structures and a dropdown menu can be searched for the desired site information. The database is used to store vital environmental, cultural, population, and engineering infrastructure information along with data for planning production facilities and remediation strategies in the event of an oil spill or gas leak. This kind of searchable database is an invaluable tool for maintaining good relationships with the local population and the Nigerian government. The program also fosters goodwill and cooperation between Nigerian officials and COPI by encouraging them to provide information for the GIS database.

Bob Kieckhefer followed Tod with an impressive 3-D seismic subsurface reconstruction of COPI's Absheron Prospect in the Caspian Sea. This information was also presented at the April 1, 2000, 3-D demonstration. Drilling of the anticlinal structure is currently underway and the target zone should be reached very soon. COPI's involvement with potential hydrocarbon plays in the Caspian Basin is the continuation of over 100 years of exploration and production activity in this region. The Absheron Prospect is a 40km by 10km site off the Absheron peninsula on the southwest coast of the Caspian Sea occupied by the former Soviet republic of Azerbaijan. The major port of Baku was the oil capital of the world at the turn of the century, prior to the discovery of massive oil deposits on the Arabian Peninsula. Like many oil-rich regions, the Caspian Sea lies in a politically tense sector surrounded by several Islamic republics, several being under the sphere of influence of Russia. The primary bone of contention in the region is the placement of vital pipelines to transport the oil out of this landlocked sea to distribution ports. COPI, through its 1993 partnership with the CIS nation Kazakhstan, formed Tengizchevroil (TCO), a 40-year venture to develop petroleum resources on the northeast shore of the Caspian Sea. Chevron is also the largest oil company member of the Caspian Pipeline Consortium, which plans to establish a 900-mile pipeline around the northern shore of the Caspian to the Black Sea port of Novorussiysk. But bitter ethnic conflicts abound in this region, particularly in the Caucasus Mountains, which threatens the establishment of safe pipeline routes across the lowlands between the Black and Caspian seas. The existing pipeline from Baku to Novorussiysk lies dangerously close to Chechnya, where Russia is currently battling Islamic rebels. COPI's partners in the Absheron Prospect are TotalFinaElf and SOCAR, an Azerbaijani oil company.

Geologically, the Caspian Sea lies in the center of a complex collision zone between the Arabian and Eurasian Plates, with some influence from the African Plate. The compressive forces uplifted the Caucasus Mountains and are forcing the Anatolian Block (Turkey) westward between the North and East Anatolian Fault systems. The horizons of interest off the Absheron peninsula are Tethyan back-arc basin sediments shed off the uplifting Caucasus range. The prospect lies near the deepest part of the Caspian Sea in 200 to 700 meters of water. The target zone is in the lower Pliocene nonmarine sands and shales of the Balkhany and Fasila Formations under the Sabunchy seal at depths of 5000 meters. Oil and gas finds have been made northeast and west of the Absheron plot, which itself is estimated to contain either 1.5 billion barrels of oil or 20 trillion cubic feet of gas.

Bob proceeded to describe the data acquisition and interpretive stages of the project. The 3-D dataset was collected using a boat towing three alternately firing streamers behind it. The data from this survey was presented for interpretation in January, 1999. The information was registered in an 18.25 meter by 12.5-meter bin array and took four specialists, including Bob, two Azerbaijanis, and a French scientist four months to complete. The corrected seismic data from this work was projected onto the visualization screen in a continuous vertical scan with increasing depth beginning at the Caspian Sea bottom. The patterns were colored in red for soft seismic reflector layers and black for high velocity (denser) layers. A similar west-to-east cross sectional scan was made to illustrate the structures captured by the seismic survey. The vertical axis was in reflection time, which is not a true depth indicator. The time-lapse scan revealed structures which included a gentle anticlinal structure (the hydrocarbon trap), crestal graben structures, thrust faulting, a submarine landslide, an eastward-flowing paleo stream channel system, and a large mud volcano on the eastern end of the prospect. Chaotic zones at depths of 900 to 1200 meters were interpreted as possible gas hydrate (methane clathrate)-rich horizons stabilized by 40 to 50ºF temperatures in the sediments.

Using proprietary COPI software, the seismic data was assembled into a 3-dimensional block diagram of the prospect showing major fault planes and specific horizons selected to emphasize the geological structure at depth. This module was viewed by the audience with special glasses that gave the image a 3-D appearance. Using this remarkable technology, exploration geologists can carefully select the placement of exploration wells and thus optimize

their chances for success. Bob noted that the Caspian Sea sediments were laid down very rapidly, creating overpressured shales which have generated 70 to 100 mud volcanoes like the one discovered on the Absheron block. The drilling rig must stay about 3 km. from this structure to ensure safe anchoring for the vessel. The seismic data also allowed the identification of the apparent shallow methane hydrate zone that will require casing the well to 1500 meters. The drilling will be conducted by a semi-submersible Soviet-era ship refurbished at a cost of $250 million by British Petroleum. Due to the water depth and various unique structural hazards, this will be the most challenging well that Chevron has ever drilled. It is scheduled to reach the target horizon sometime in December 2000.

Bob Kieckhefer, Tod Rubin, and Rose Hsiao of COPI and Chevron Information Technology Company deserve our thanks for hosting another fascinating 3-D visualization demonstration. The NCGS is indebted to COPI for allowing its members to experience this state-of-the-art visualization technology. Chevron has also financed the AAPG Distinguished Lecture program with a generous annual contribution to the NCGS.

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AAPG 2000-2001 President Addresses Risk Management at December 8th Talk

The NCGS was very fortunate to have AAPG 2000-2001 President and oil industry legend Marlan Downey address its members at a lecture hosted by Chevron Overseas Petroleum Inc. on December 8, 2000. The topic was *Predicting the Future*, something that virtually all corporations and individuals attempt to do on a relatively frequent basis.

Mr. Downey has long served the petroleum industry as a former President of Pecten International and ARCO International, and as Bartell Professor on the faculty at the University of Oklahoma. His presentation was both entertaining and thought provoking, for it ventured into a realm encountered by all petroleum-producing enterprises: *risk management*. It is vital to all corporations, as well as to the individual. Driven by the basic needs of providing food and shelter for mankind, or sometimes by man's penchant for accumulating personal wealth, it is still more an art than a science---or is it?

Why is man always trying to predict the future? Quite simply put, we want to maximize the returns on our investments. By the proper choice of long term investments, one is assured of future financial prosperity. So who predicts the future correctly? Anyone can sometimes be successful at this, but NO ONE can do it consistently. To illustrate this point, Marlan displayed a slide depicting the predicted and actual United States GDP (Gross Domestic Product) in dollars for the past several decades. The graph represented the results of repetitive 1-year predictions of the following year's GDP by some of our country's brightest economic minds. The predictions, well, were extremely poor and rarely even close to the actual values. Other examples of predicted oil usage and oil production costs were equally disappointing.

Well then, what is the problem? Are we listening to the wrong people? Is our science of forecasting WRONG? In a single word, the answer is YES because there is no accurate science for predicting the future! We have many non-scientific techniques for determining the future: astrology, augury, divination, geomancy, necromancy, and oneiro-criticism to name a few. But our only scientific approach to ascertaining the future is based on models. However, models are only as good as the data we put into them. A respected colleague of Mr. Downey's, Andrew Hurst at the University of Aberdeen, made a study of input data for models. His conclusions were: ~15% of the time we are not aware that our input data is flawed or inaccurate; ~15% of the time we know that we do not have accurate data, so we make estimates; ~15% of the time we feel sure that our data is correct, but it really isn't; and only ~60% our data is considered to be correct and actually is. Not a very reassuring level of confidence!

The point to these examples and critiques is that *the future almost assuredly will never be exactly as we plan or hope for it to be.* The key, therefore, to protecting oneself from the uncertainty of the future is to maintain *options* and *flexibility* in our personal and corporate business plans. This will minimize our risk and allow us to adjust our plans as undesirable situations arise.

Several interesting suggestions Mr. Downey made for minimizing risk when attempting to predict the future are: 1) future events can be predicted rigorously ONLY if they represent the expected outcome of physical (scientific) laws; 2) future events can be predicted with a comfortable level of statistical confidence if they represent a MODEST extrapolation of consistent and accurate historical evidence; 3) the farther we extrapolate into the future, the less reliable our historical data becomes; 4) as more parameters influence an event, the less predictable it becomes; 5) the more precision we expect in the outcome, the less certain our forecast becomes; and 6) the prediction of singular events is very uncertain. A final parting comment he made was: *the first step towards wisdom is recognizing ignorance.*

The NCGS greatly appreciates President Marlan Downey's willingness to travel to the West Coast to address the AAPG's local affiliates. It is rare that a speaker of his caliber and popularity is able to address our members, and we sincerely thank him for doing so. The NCGS would like to extend its gratitude to Chevron Overseas Petroleum, Inc. for generously allowing Mr. Downey to use their Chevron Park, San Ramon, lecture facilities.