

Announcements

Call for papers:

Meeting: Scientific Visualization: Special SEG Research Workshop following the 60th Annual Meeting

Date: September 28, 1990

Location: San Francisco

Sponsored by: SEG Research Committee

Technical sessions: Poster papers and video presentations (to augment invited lectures) showing examples of geophysical visualization: demonstrations and hands-on review of developments in fields as varied as data gloves, entertainment, geologic modeling, holography, medical imaging, molecular modeling, space exploration, and virtual reality.

Abstract deadline: July 31

Additional information: Send brief abstract to H. Roice Nelson Jr, Landmark Graphics Corp, 333 Cypress Run, Houston, TX 77094; phone (713) 579-4794; fax (713) 579-4814, Email: rnelson@lgc.com; or to Kay Dautenhahn Wyatt; Phillips Petroleum, 560 Plaza Office Bldg, Bartlesville, OK 77004; phone (918) 661-9710; fax (918) 661-5250.

Meeting: 23rd Annual Offshore Technology Conference

Date: May 6-9, 1991

Location: Houston Astrodomain

Technical sessions: Emphasis on technology and applications rather than "pure" science; papers dealing with reservoir development are particularly appreciated.

Abstract deadline: September 14, 1990

Abstract format: Send for abstract forms to SEG Representative to OTC Technical Program Committee Linda Zimmerman, Exxon Production Research, Box 2189, Houston, TX 77252-2189.

Meeting: 35th International Geophysical Symposium

Date: October 1-6, 1990

Location: Grand Hotel, Drujba Resort, Varna, Bulgaria (on the Black Sea)

Theme: Applied geophysics on the eve of the 21st century

Sponsored by: Bulgarian Geophysical Society and societies, institutions, and companies from Cuba, Czechoslovakia,

German Democratic Republic, Hungary, Poland, and USSR

Technical sessions: Regional geophysics, methods for geophysical surveys, and prospecting of oil, gas, industrial minerals, and geothermal waters.

Abstract deadline: Papers submitted by August 10 will be given only in English.

Abstract format: Send to SEG Representative/Technical Program Chairman A.K. Mostafa Sarwar, Director of Geophysical Laboratory, University of New Orleans, LA 70148.

Additional information: For registration form, write Bulgarian Geophysical Society, Enterprise for Geophysical Exploration and Geological Mapping, 23 Hr Kabaktchiev Blvd, Sofia 1505, Bulgaria 35 IGS; phone 44-33-09; Telex 022338.

Meeting: 8th Conference/exhibition of the Australian SEG and Geological Society of Australia Exploration Symposium

Date: February 17-21, 1991

Location: Darling Harbour Convention Centre, Sydney, Australia

Theme: Exploration in a changing environment

Technical sessions: Petroleum exploration (advances in seismic acquisition, processing, interpretation and stratigraphy, reservoir and model evaluation, case histories, nonseismic methods); Mineral exploration (advances in geophysical equipment and analysis techniques, case histories); Geotechnical and groundwater studies; Regional and crustal studies; Financial and business controls of exploration; and Earth science education. Workshops offered before and after the conference.

Additional information: Conference Secretariat, 1991 ASEG/GSA Conference, Box 925, Crows Nest, NSW 2065, Australia; phone +612 439-6185; fax +612 436-3730.

Meeting: 3rd Biennial SEG/EAEG 1990 Joint Research Workshop

Date: July 15-18

Location: Queens' College, Cambridge University, England

Theme: Estimation and practical use of seismic velocities

Technical sessions: Estimation of velocities (P & S)—methods and limitations from surface seismic, borehole geophysics, and rock modeling at seismic frequencies; and Applications using velocities—stacking and imaging, depth conversion (structural), and interpretation (fluid and lithology, reservoir description, cross-hole). Oral and poster papers and audience/panel discussions included; attendance limited.

Additional information: Chairman of Organizing Committee Andrew Lucas, BP Exploration, Britannic House, Moore Lane, London EC2Y 9BU England.

Meeting: SEG Research Committee 1990 Summer Research Workshop

Date: August 5-8

Location: Hyatt Regency Tech Center, Denver

Theme: Permeability, fluid pressure, and pressure seals in the crust

Technical sessions: Laboratory measurement of microscopic permeability, Measurement of macroscopic permeability in situ, Detection of overpressured regions using remote sensing techniques, Fluid pressure versus depth curves, Occurrence of pressure seals and mechanics and kinetics of seal formation, and Effects of fluids on mechanical properties of crustal rocks. Includes invited reviews, contributed poster presentations, and open discussions led by session chairmen.

Additional information: Workshop Chairman Brian Evans, MIT, Room 54-720, Cambridge, MA 02139; phone (617) 253-2856; fax (617) 253-6208.

Meeting: SEG/China Society of Petroleum Geophysicists Joint Meeting

Date: August 24-29, 1990

Location: Chengdu, China

Theme: Exploration for petroleum in carbonates

Additional information: Commemorative activities celebrating initial contacts of SEG with Chinese geophysicists are planned. Contact Technical Program Chairman Thomas Davis, Colorado School of Mines, Golden, CO 80401; phone (303) 273-3938.

have the problem with misalignments of multiples due to incomplete knowledge of the geometries of multiple generating interfaces.

Wiggins described the wave equation based multiple prediction method and gave successful examples of its use with actual data.

Alf Klavness was invited to explain his use of multiples in developing the image of the reservoir beds during horizontal drilling.

Seismic tomography

Organizers: Wafik B. Beydoun, ARCO
C.H. Cheng, MIT
Joseph G. Gallagher, Phillips Petroleum
T.W. Lo, Texaco*

Seismic crosshole tomography is emerging as an important tool in production geophysics. Although recent results from several sources have demonstrated some of the capabilities of crosshole data to describe or monitor reserves, the technique is still in its early stages of applications. The workshop objectives were: to take stock of recent developments and practical uses of crosshole tomography; and to outline research directions which may enhance reservoir seismic characterization. Technological constraints, cost-effective acquisition in a producing field environment, data preprocessing and imaging techniques were some of the issues that were addressed.

The format consisted of eight 15-minute presentations, followed by discussions in which both organizers and speakers participated as panel members. The presentations and speakers were:

The effect of downhole source signature on crosswell seismic data by Gallagher; *Well effects and crosshole seismic data* by Benoit Paternoster (Elf); *Toward a complete inversion—the Gypsy project* by Walter Turpening (BP Exploration); *Current issues in acoustic tomography* by Anthony Vassiliou (Mobil R&D); *Characterization of a steamed oil reservoir using crosswell seismology* by Bjorn Paulsson (Chevron); *Seismic crosshole tomography with variational constraints* by Jim Berryman (Lawrence Livermore Laboratory); *Traveltime tomography in anisotropic media* by Gerhard Pratt (University of Toronto); and *Traveltime tomography and holography—a complementary combination* by Lo.

It was the general consensus that current technology allows only traveltime tomography to be performed routinely. Amplitude information is possible, but it takes special planning and care in conducting the experiments. Under certain conditions, a wave equation based method, which will calculate the head waves and modes, may be preferable over a purely ray-based method. Effects of anisotropy must also be considered.

For any tomographic reconstruction methods that require amplitude information, borehole coupling is an important issue. The radiation pattern from the source into the formation must be known, as well as the recoupling of the wavefield into the borehole. Conversions from body waves to guided waves and vice versa along the borehole or at distinct subhorizontal interfaces, such as fractures and bedding planes, are a big problem and need to be addressed.

Field examples presented at the workshop showed the potential of crosshole seismic tomography. In one case, a possible high permeability steam channel was discovered during steam flooding. In another case, complex structures and fault blocks were uncovered between wells. These complex structures were not imaged by traditional surface reflection techniques.

Some of the reported advances in traveltime tomography consist of the following: replacing ray-based techniques by robust and more efficient wave-based techniques; developing a new stable optimization technique based on Fermat's principle; and incorporating anisotropy effects.

We are just starting to comprehend some of the complex

relationships between all possible waves propagating in the crosshole geometry. Interactions of borehole-induced waves in the two wells (i.e., tube waves and leaky modes) with body waves, guided waves, and head waves are being observed in synthetic or field data. Understanding these relationships gives us the opportunity to extend migration-type imaging techniques (i.e., VSP-CDPs, diffraction tomography, holography, migration-inversion, etc.) to include additional waves. This should enhance the quality and spatial resolution of interwell seismic images.

It is clear that seismic tomography has a potentially very significant role in reservoir delineation, and development/monitoring programs. What we have seen are the first results of this research effort, similar to the first wave-equation-based constant velocity 150 migration in reflection seismology. In general, we are optimistic about truly detail imaging of the subsurface using seismic tomography.

The bottom line of the workshop is that crosshole first arrival traveltime tomography is currently the most popular methodology for imaging a reservoir region. Attempts to link tomograms with reservoir petrophysical information are being addressed. Handling amplitudes or waveform data is still a research area requiring additional effort in downhole source/receiver technology, survey planning, data acquisition, preprocessing, imaging, and interpretation.

Scientific visualization

Organizers: H. Roice Nelson, Landmark Graphics
Tracy J. Stark, Exxon
Kay Dauenhahn Wyatt, Phillips Petroleum
Geoff Dorn, ARCO
Richard A. Ottolini, Stanford University
Wulf Massell, HARC
Paul E. Sovelius, Visual Science Corporation
John L. Shanks, Amoco

This all-day workshop was unique in that it included a comprehensive display of computer equipment and visualization applications. The presentations and demonstrations came from applications both inside and outside of the exploration industry.

The workshop also featured, concurrent with the formal presentations, three break-out rooms which had demonstrations of some of the latest visualization techniques discussed below.

Formal presentations were given by eight invited speakers after an introduction by Nelson, chairman of the organizing committee. He expressed the enthusiasm that the committee members felt about this topic and how important it is to our business. He also gave the audience a sense of history and introduced the linkage between the technology that we were about to see and business needs of the petroleum exploration community.

The keynote address by Georges Grinstein, of the University of Lowell, captivated the audience and put the basics of data visualization on a scientific basis. Grinstein pointed out that we are becoming inundated in data which we need to be able to analyze and absorb lest they are wasted. His team worked on presenting multidimensional data in a way which can be quickly analyzed by the viewer. Especially revolutionary was the use of sound to help analyze and scan large data sets. Much of the work at the Institute for Visualization and Perception Research at the University of Lowell involves cognitive research and gets at the core of the visualization problem. He also demonstrated some fascinating results and discussed the directions which his projects will most likely take in the future.

The medical profession has data visualization problems which are in many ways similar to those in petroleum exploration. Dan Wessel, of the Boron-Neutron Capture Therapy research program at the Idaho National Energy Laboratory, showed that a 3-D data volume of a person's head could be obtained from magnetic

resonance imaging (MRI) or computer assisted tomography (CAT scan) data. The radiation oncologist interprets planar slices from the volume of data, picking control points to define the outline of a tumor. As the physician picks the control points, a curve is defined around the tumor on each slice. Continuing this process gradually defines a three-dimensional surface around the tumor. By using the three-dimensional structures, the clinician can maximize the tumor cell kill and minimize the damage to healthy tissue. Wessol extended the subject of his talk by showing how the oncologist could view the MRI and CAT scans, as both slices and 3-D volumes, and interactively pick boundaries in the images and define data volume areas. This entire procedure is analogous to the process of interpreting 3-D seismic and well data, defining the structure and stratigraphy of a field, and planning drilling and development based on reservoir modeling using the interpretation as input.

Harlen Baker, a researcher in computer vision and visualization at SRI International, presented additional examples of application of 3-D visualization in medicine, paleontology, and motion analysis. MRI or CAT scan data can be studied by slicing this volume and extracting geometric surfaces, much like a geophysicist interprets 3-D seismic data on lines, crosslines, and time slices. Using more advanced tools, the surgeon can make an "incision" in the image of the skin and muscle tissue, and peel it away from the skull revealing the bony structures. He may cut away part of the bone to examine the structures of the brain. Such intuitive tools may lead to more precise surgical planning for delicate operations. In exploration, we have used motion to display time slices from seismic sections. These researchers are extending such concepts to include volumetric data in motion, and relative motion of various data sets.

The exploration business already has experience with using special data visualization techniques for analyzing space satellite collected data. Robert Brovey, of Exxon, discussed the state of that technology. There are a number of data collection systems in place and the United States and others are moving forward with plans for new systems. To date, these data have been used successfully to derive geologic information. The data have also been helpful in planning logistic support for exploration activities in areas which are otherwise poorly mapped, and for which information on local conditions is difficult to obtain.

George Zachery of VPL Research discussed his company's pioneering work on "Virtual Reality", a topic which has received considerable coverage in computer industry publications. VPL has developed a "data glove" that registers finger and hand gestures to control a scene presented to the viewer by a head mounted display. The viewer is thereby given real-time dynamic control over the spatial relationship between the person and the computer-generated "scene" (or database). Experience has shown that a realistic degree of artificial presence can be achieved. Architects can now use these tools of artificial reality to "walk through" a plan to examine lighting, access, and scenes within a proposed building. NASA Ames Research Center is experimenting with a form that links the head-mounted display to cameras and the glove to robotic arms. Zachery's presentation gave attendees a hands-on look at this technology. They were allowed to put on the helmet viewer and data glove and move around visually in a computer-generated 3-D scene. The program allowed a certain amount of interaction with the scene, including the ability to pick up various "objects" and move them.

Karl-Heinz Winkler of the National Center for Supercomputer Applications and Richard Phillips from Los Alamos National Laboratory gave papers on visualization projects requiring more than one machine. For example, in computational fluid dynamics or atmosphere modeling, extremely large amounts of computer computation time may be used to generate an image. Yet the image must be displayed on a 3-D graphics device not resident on the primary computation machine. These two authors discussed the work that Los Alamos is doing in developing a very extensive network to handle their distributed visualization needs. Very often, the network is the weakest link in this type of endeavor and Los Alamos appears to employ the very latest in state-of-the-art net-

works necessary to solve the problem.

- Visualization theater. Two of the university posters treated techniques to display geophysical data. The video presentations covered a wide range of data visualization problems, including the display of numerically modeled physical systems such as storm systems and fluid flow. The general topic of volume visualization was also presented. A poster, *Frame rate image processing*, by Doug Rickman of Wilmer Eye Institute presented a system being developed by NASA for the visually impaired.

- Geoscience visualization. This break-out room contained 16 demonstrations devoted to geology and geophysics, providing convincing evidence that:

- Visualization, construction, and modification of 3-D geologic models can be achieved much more easily with the aid of real-time 3-D graphics to manipulate the 3-D images. The animation of 3-D objects achieves a breakthrough in helping the human to perceive that third dimension.

- Volume visualization of 3-D seismic data, discretized 3-D geologic models, etc., is proving to be a very useful aid in viewing and understanding large 3-D data volumes.

- Borehole televiewer data displayed in a 3-D form is more readily understood than the conventional 2-D displays. This is achieved by 3-D display of traveltime or amplitudes on a borehole and allowing the interpreter to rotate, zoom in or out, and even travel into the borehole column.

- Frontier visualization. This room featured some results from very new visualization projects. These projects were not directly related to petroleum exploration, but showed new ways to look at data which may well lead to revolutionary applications in our industry.

This workshop definitely required more time and resources than the normal session. However, the response of the audience was so strongly positive that we should consider a similar format for some future topic.

Engineering geophysics— site characterization

*Organizers: Ganpat S. Lodha, AECL Research
Robert F. Ballard, US Army Corps of Engineers
Phillip R. Romig, Colorado School of Mines
Gary Olhoeft, US Geological Survey
Scott E. Hulse, Lockheed Engineering
Richard A. Gibb, Geological Survey of Canada*

This workshop was built around invited talks by 10 researchers. Applications of a variety of geophysical techniques (involving electrical, seismic, and magnetic methods) used to characterize a shallow subsurface (i.e., depth less than 500 m) were the major theme. Most talks focused on demonstrating state-of-the-art technology used in site characterization studies concerned with the disposal of toxic, low- and high-level hazardous waste.

Three talks focused on shallow site characterization within the upper 50 m of the subsurface for the study of soil contamination caused by toxic waste disposal. Six speakers discussed national programs in four countries (Canada, US, Germany, and Sweden) for hazardous waste disposal at subsurface depths of 100-500 m. The other paper, on borehole logging, covered characterization problems for both applications. The titles and speakers were:

Geophysical techniques for characterizing plutonic rocks for nuclear waste disposal by Lodha

Geophysical methods applied to the characterization of a test site in the Stripa Mine (an OECD/NEA International Project) Sweden by O. Olsson (ABEM)