The seven Western Atlas companies have combined technical resources to offer oil firms an integrated approach to explore and produce hydrocarbons cost-effectively.

Photographic collections mark milestones in our lives, show us where we have been, and suggest future direction. This collection provides a pictorial glimpse of Western Geophysical highlights, showing with pride some of the people and work that comprise a decade of discovery.

Downhole Seismic Services specializes in borehole seismic services, the common denominator between surface-seismic surveys conducted by Western Geophysical, well logging performed by Atlas Wireline Services, and core analyses from Core Laboratories.

After being in the doldrums for so long, it is refreshing to see some optimism in the oil industry these days. So far, this feeling of euphoria—"the worst is over"—has not translated into much actual activity. However, the price of oil is holding, companies are talking about work as evidenced by the increased number of bid requests, and sales of our spec data have perked up a bit over the past three months. Today’s reality is that competition continues to be cut-throat and prices for our services are still at a very low level, so it is no time to relax and feel we are over the hump. Unfortunately, the underpinnings for the so-called recovery in the oil services sector will remain rather shaky because so much hinges on the activities of OPEC.

On balance, however, we remain cautiously optimistic about the rest of 1987. The picture as of this moment is still a little opaque for 1988. We feel confident that our massive investment in research and technology, which continued relatively constant throughout the recession, will bear fruit for us in the near future.

You will note that several articles in this issue are dedicated to describing the expansion and realignment of the scope of our services dating from the formation of WESTERN ATLAS INTERNATIONAL, INC. on May 1, 1987. The purpose is to familiarize you with the various new companies, groups, and individuals which now fly the WESTERN ATLAS banner. We hope in so doing to impress you with the strength and breadth of our new company so that you can share with us our confidence for a bright and prosperous future.

President's Page

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Larner chosen president-elect of SEG for 1987-88.

Dr. Ken Larner, Western Geophysical vice president, Research and Development, has received one of the most prestigious honors in the geophysical industry. Ken was recently elected to the office of president-elect for the Tulsa based International Society of Exploration Geophysicists (SEG) for 1987-88. Following a year as president-elect, he will assume the office of president of SEG for 1988-89. The SEG is the world’s largest association of exploration geophysicists, with nearly 18,000 members in approximately 100 countries.

Ken joined Western as a senior research geophysicist in 1970 and was manager of research and development from 1974 to 1979 when he was promoted to vice president. Always active in the geophysical industry, he has co-authored many award-winning papers.

Tom Hix is appointed corporate controller of Western Atlas.

Tom B. Hix has been named an officer and corporate controller of Western Atlas International, Inc. In his new position, he will be the chief accounting officer for Western Atlas.

Tom joined Western Geophysical in 1971 as an accountant and has served in many financial capacities, including supervisor of fixed assets, general accounting supervisor, London office accounting supervisor, controller, and since 1984, vice president, Finance and Administration for Western. He is a graduate of Rice University with a B.S. in economics.

Tom and his wife, Jeannette, have a 16-year-old son, Jason, and a 13-year-old daughter, Angela.

Larner looks forward to two years of learning and personal growth, involving interaction with the SEG staff and the large number of volunteers who are at the core of SEG’s many accomplishments.

Litton scholarship awarded to Maurice Lotman.

Maurice Lotman, Jr., son of the late Maurice Lotman of Aero Service, was awarded a Litton Industries’ Merit Scholarship in April. Maurice plans to attend Wesleyan University in Middleton, Connecticut but has not yet selected a major. A talented musician, Maurice plays four and trumpet and his interests vary, ranging from acting in school plays to computer work and travel.

Each year, Litton sponsors scholarships for up to 10 students with awards ranging from $1,000 to $2,500 per year. The process begins with the Preliminary Scholarship Qualifying Test (PSAT/NMSAT) and ends one and one-half years later with the announcement of the winners.

Two Western Atlas companies contribute to energy exhibit.

Western Geophysical and LRS recently played an active part in an oil industry exhibit set up at the Center of Science and Industry in C-grounds, Ohio. The museum’s new exhibit, “Energy from Petroleum”, which opened May 13, features displays on oil exploration, oil formation, properties of oil, oil production and refining, and applications. Students can learn a few of the “ins and outs” involved in the petroleum business.

Western and LRS donated a geophone, oscilloscope, and explanatory materials for the development of a display about the seismic industry. Students could experiment by stamping their feet on the floor and seeing the resulting “echoes” picked up by the geophone on the oscilloscope. Story boards explained oil and gas formation, seismic reflection, land and marine surveys, and data processing.

Organizing materials from Western and handling correspondence to the Center was Marketing Services Manager Rhonda Boone. Technical Writer Pramod Thakarain wrote copy for accompanying story boards. Director of Electrical Engineering Ted Cruise and LRS Engineer James Sackett provided the display that was designed by LRS Vice President Bill McNeel. Western was the only geophysical company contacted for contribution to the exhibit. “Energy from Petroleum” is a permanent exhibit at the Center of Science and Industry.
Larner chosen president-elect of SEG for 1987-88.

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As president-elect, Ken will serve on the SEG Executive Committee for one year, primarily as secretary to the president, but with liaison responsibilities for several SEG committees. As president, he will chair the Executive Committee, which selects the SEG's world-wide activities and decides how the SEG will apply its resources to serve the needs of its members and affiliated societies.

Ken says he looks forward to two years of learning and personal growth, involving interaction with the SEG staff and the large number of volunteers who are at the core of SEG's many accomplishments.

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Western Atlas contributed new logo, Western and LRS contributed storyboards and other printed pieces. (See back cover for color version of logo.)

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The National Merit Scholarship Committee selects the recipients based on test scores, academic records, personal leadership, and extracurricular activities. The committee also determines the scholarship amounts based on the winners' financial needs and the cost of the selected universities.

Western Atlas International adopts new logo.

Western Atlas management has approved a logo design submitted by the Corporate Communications department, and the mark is currently being incorporated into ads and other printed pieces. (See back cover for color version of logo.)

The modern, stylized presentation of an integrated “W” and “A” will provide a distinctive, clean graphic identity for many years to come. The Corporate Communications department is developing a graphic guideline manual which should be distributed to all Western Atlas divisions later this year. Artwork for business cards, letterhead, and mailing pieces was selectively distributed in August.

Corporate Communications Designer Michael Jungnickel created the new Western Atlas logo.

Students visiting the new COSI exhibit, "Energy from Petroleum", view sound waves on an oscilloscope while reading about exploration. Western and LRS contributed materials for the interactive display in the oil exploration segment of the exhibit.
NEWS BRIEFS

WPC conventioneers tour Western and LRS facilities.
Delegates to the World Petroleum Congress (WPC), which was held in Houston in April, toured Western and LRS facilities as part of the "Technical Tours" offered by the WPC.

The Congress is held once every four years and has been held in only one other U.S. city (New York City in 1950) since its beginning in 1953. Members of the delegation included representatives of the oil industry from all over the world.

The full-day tour consisted of visits to Western's headquarters and LRS' Alvin manufacturing plant. Items of interest included a videotape of seismic operations, the handling and processing of seismic tapes, a tour of computer facilities, and a demonstration of the CRYSTAL Interpretation System. After a barbecue lunch in Alvin, delegates learned of LRS' system of manufacturing vibrator trucks, marine cable, and electronics. Conducting tours for Western were Juan Vallbonrat, manager, Computer Science, and Fred Merritt, manager, Training and Documentation. Handling the afternoon segment for LRS was President Jim Porter.

Computer Science department hosts CAPS course.
Western Geophysical's Computer Science department presented a course on CAPS (Computer Aided Plotting System) in the Houston office in May. The week-long course was organized by Programming Supervisor Jeff Ramsey and Senior Programmer Kip Haugen. Kip was also an instructor along with Geophysical Analyst Tom Emmine.

The course, a mixture of classroom lectures and hands-on work sessions, was offered to all Western Geophysical processing centers and to clients that subscribe to Western's seismic software package. The course objective was to train the participants in the use of CAPS, with special emphasis on the recent CAPS enhancements distributed in February.

Data processors from HDC-I and HDC-II, as well as Envoy, the London Data Center, were in attendance. Representatives from seven software client centers in Houston, California, Canada, Mexico, and Italy also participated.

Litton recognizes Chuck Diggins for creative excellence.
Charles F. (Chuck) Diggins of Western Geophysical's Denver Digital Center was selected to receive one of seven 1987 Litton Advanced Technology Achievement Awards, a yearly recognition of employees who made very significant technological contributions to the company. Chuck was the only employee in the Litton Resources Group who was so honored.

Chuck has developed computer algorithms for Western Geophysical to automate the process of interpreting and correcting seismic data to avoid refraction statics. These statics are the effect of a misalignment of signals reflected from the earth's subsurface geology. Compensating for the misalignment has been labor-intensive and relied on trial-and-error methods. With Chuck's new extended generalised reciprocal method, data processing time is greatly reduced.

Chuck joined Western Geophysical's Research Department in Houston in 1978. He transferred to the Denver office in 1980 and in 1984 was named technical coordinator with responsibility for Western's statics software development worldwide. He earned B.A. degrees in anthropology and Spanish from Pennsylvania State University and an M.S. degree in marine geophysics from the University of Delaware. He and his wife, Glenda, live with their three children in Englewood, Colorado.

Presenting Chuck Diggins (second from right) the 1987 Litton Advanced Technology Award are, from left to right, Litton Vice President and Chief Scientist Charles S. Bridge, Litton President Orion L. Huch, and Litton Staff Vice President and Director, Patents & Licensing, Walter R. Thief (far right).
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MULTIPULSE® Source makes waves for Western.

Vibrators were introduced as an energy source for land seismic surveying more than three decades ago. Today, vibrators are used in approximately 45% of the land surveys conducted throughout the world. Western Geophysical has now extended the high productivity and advantages of vibrators to marine surveys with the introduction of the MULTI­PULSE Source.

Several types of analog marine vibrators have been introduced in the past, but they are not currently used today. The MULTI­PULSE Source is the industry's first marine vibrator that incorporates digital electronics and innovative hydraulic technology. The source offers the benefit of high productivity for multisource, multistreamer surveys and is suitable for areas where diver safety or environmental concerns might prevent the use of airguns.

Advanced Engineering

The MULTI­PULSE Source has been designed and manufactured by Hydroacoustics, Inc. to Western Geophysical's specifications. Each source module has an electric motor that drives two hydraulic pumps. In turn, each pump drives two radiators, which move in opposite directions.

The output of a module is governed through a digital hydraulic valve to generate a sweep signal. The signal can be adjusted to meet specific geophysical objectives. For example, the 4-octave bandwidth can be tuned down to 5 Hz to obtain low-frequency penetration for deep targets and up to 120 Hz for resolving shallow prospects.

Efficient Acoustic Output

The MULTI­PULSE Source uses a non-symmetrical waveform that generates more acoustic power than a sinusoidal waveform with the same cavitation limitations. A single two-dowel consisting of two source modules produces a far-field, continuous signal with a free-field sound pressure level (SPL) of approximately 0.8 bar-m. After correlation, four modules or eight sources have a half-peak amplitude of approximately 100 bar-m (12.5 - 100 Hz band with 6 dB/octave slope).

High Productivity

When operated in a continuous mode, the MULTI­PULSE Source enables data acquisition without a listening interval. As a result, full-fold coverage can be recorded with a 5-km streamer at 25-m shot spacing. Four full-fold coverage lines can also be achieved for dual-source, dual-streamer surveys by generating orthogonal codes for each source into each streamer.

Minimal Interference

Because of the correlation process, the MULTI­PULSE sweep signal is resistant to many types of interfering noise. The source can be used effectively in active offshore areas, such as the U.S. Gulf Coast, where surveying sometimes must be conducted on a time-sharing basis to prevent acoustic interference from adjacent crews.

The acoustic pressure levels from the MULTI­PULSE Source itself are low, making it an ideal substitute for impulsive sources in environmentally sensitive areas. Diving operations can also be conducted in the vicinity of the source.

Proven Performance

In May, 1987, four MULTI­PULSE units were installed aboard the Western Inlet with full rigup. A rigorous series of field tests were conducted over a span of two weeks, and 200 miles of production data were acquired under the direction of the Western Research and Hydroacoustics staff.

Participants in the sea trials included Mark Houston, manager of the Western Research Applied Marine Technology Department; Dallas Martin, project engineer; and Jim Huntrods, technician. MULTI­PULSE mechanics aboard the vessel were Larry Howard, Murray Koating, Robert Tant, Mark Danielson, Al Hathorn, and Dale Little.

"We've demonstrated the MULTI­PULSE Source as a viable seismic exploration tool through which we can tailor the source spectrum to handle specific client problems," Houston said. The MULTI­PULSE Source will be used for several upcoming seismic projects in the Gulf of Mexico. Surveys are also being planned with the new source in the North Sea.

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Western Atlas International has achieved a similar integration of geoscientific services to streamline the search for "energy. Each of the seven Western Atlas companies offers expertise in certain aspects of oil and gas exploration, field development, and production services. By linking the technical resources of the individual companies, Western Atlas is able to offer oil companies an integrated approach to evaluate cost-effectively the hydrocarbon potential of sedimentary basins, locate economical pay zones, and squeeze the maximum recovery out of each reservoir.

The companies of Western Atlas International include Western Geophysical, Atlas Wireline Services, Core Laboratories, Aero Service, LRS, Downhole Seismic Services, and J.S. Nolen & Associates.

To gain an insight into the integrated approach, it will be useful to start at the beginning of an oil and gas development project and see how geoscientific services are used to make economic and engineering decisions at each stage.

**Exploration Services**

The first task in oil and gas exploration of new areas is to look for sedimentary basins where oil is normally found. Several Western Atlas companies are contracted at this stage to gather information that will help the geoscientists in narrowing the exploration focus.

Surface geology is mapped and analyzed by Core Lab's Geological Sciences department. At the same time, the Aero Service staff is involved in identifying structural makeup from high-resolution images acquired via satellite and airborne instruments. Aero Service also conducts aeromagnetic and gravity surveys for mapping the thickness of the sedimentary rocks. The integration of the remote sensing, aeromagnetic, and surface geological information forms the basis for selecting a site for more intensive exploration.

**Formation** beneath the most promising area of the basin are mapped through seismic surveys conducted by Western Geophysical. The computer-processed seismic data are interpreted by the Western staff to select potential traps where oil and gas may have accumulated. Western offers an extensive library of seismic data for prospects throughout the world.

The most attractive traps mapped from seismic data may not, however, be economically attractive if the right geological conditions did not exist for forces of nature to generate, and preserve, oil and gas from prehistoric organic matter buried underground. Core Lab answers this question by conducting biostratigraphic studies. Geologic age of the rocks and the degrees of maturity of the source-rock intervals are calculated to select traps that most likely contain hydrocarbons.

At this stage, Western Geophysical conducts a detailed 2-D seismic survey in order to map the subsurface in and around the selected trap. Depth contour
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At this stage, Western Geophysical conducts a detailed 2-D seismic survey in order to map the subsurface and around the selected trap. Depth contour
maps, derived from the seismic data, are used to pick the wildcard drilling site and target depth.

During wildcard drilling, Atlas Wireline offers a broad range of services to provide borehole information concerning resistivity, porosity, lithology, and most importantly, depth.

Field Development Services
Once a discovery well is drilled, several Western Atlas companies are contracted to map the reservoir and to develop a cost-effective plan to drill step-out wells to produce the oil that might exist in different locations and at different depths in the reservoir.

Western Geophysical acquires densely spaced seismic data to produce 3-D data volumes to map the reservoir. Accuracy of the 3-D description is achieved by matching the seismic data with vertical seismic profiles (VSP) obtained in the borehole by Downhole Seismic Services (DSS).

Key information about rock properties, such as porosity and permeability, is obtained through wireline logs run by Atlas Wireline Services. The log information is correlated with precise physical measurements of rock and fluid properties by Core Lab. The rock properties measured in the well are extended throughout the reservoir with the aid of seismic data from Western Geophysical and DSS. Thus the combined expertise of the Western Atlas companies is useful in selecting the best sites for step-out wells and production facilities.

Production Services
In order to squeeze maximum production from the basin at the lowest cost, extensive engineering studies are conducted to predict reservoir performance over the life of the oil and gas production cycle. A reservoir model is first created by Core Lab’s Engineering & Consulting group. Inputs to the model consist of rock properties derived from well logs and core analysis, and production characteristics derived from well tests. Computer simulation of the reservoir performance is then carried out by using software developed by J.S. Nolen & Associates.

Oil and gas production commences by perforating the selected pay zones. The perforations are created by firing projectiles that penetrate through the casing and cement into the adjacent formation. Atlas Wireline Services offers several types of perforating schemes that are designed to minimize formation damage and maximize production. Once a well is producing, casing evaluation and production logging services from Atlas Wireline and Core Lab stories assist Core Lab’s petroleum engineering staff in monitoring well conditions.

On the average, only about one-third of the oil in a field can be brought to the surface by reservoir pressures and mechanical pumping. Analysis of well performance with software from J.S. Nolen can provide an early indication of the need for stimulating production through secondary and tertiary recovery techniques. Typically, fluids are pumped into the reservoir to force the oil and gas to migrate toward the producing wells. Common injection fluids include water, steam, nitrogen, carbon dioxide, and polymers.

Core Lab performs feasibility studies, recovery scheme design, pilot testing, and full-scale field implementation. Tests conducted in the laboratory provide information concerning injectivity behavior, chemical-rock interaction, and oil recovery efficiency. When hydraulic fracturing is required, Downhole Seismic Services can perform frac monitoring services to delineate the fracture geometry. Atlas Wireline Services provides full support through the logging of injection and production wells.

The field data acquired by Western Atlas companies during the exploration and development phases are particularly useful in enhanced-oil recovery projects. For instance, Core Lab engineers can conduct time-lapse studies to evaluate changes in the reservoir by performing a base survey during the exploration phase and then repeating the surveys, with identical data acquisition parameters, to monitor recovery operations.

Conclusion
We’ve examined, in general, how the seven Western Atlas companies are involved in providing high-technology services for the petroleum industry—from interpreting images acquired by satellites high above the earth to analyzing core samples from deep within the well. By placing the full spectrum of geoscientific services under a common horizon, Western Atlas International has unlocked a new combination for efficient energy exploration and production—now well into the twenty-first century.

(See color announcement ad insert in this magazine.)
maps, derived from the seismic data, are used to pick the wildcat drilling site and target depth.

During wildcat drilling, Atlas Wireline offers a broad range of services to provide borehole information concerning resistivity, porosity, lithology, and most importantly, depth.

Field Development Services
Once a discovery well is drilled, several Western Atlas companies are contracted to map the reservoir and to develop a cost-effective plan to drill step-out wells to produce the oil that might exist in different locations and at different depths in the reservoir.

Western Geophysical acquires densely spaced seismic data to produce 3-D data volumes to map the reservoir. Accuracy of the 3-D description is achieved by matching the seismic data with vertical seismic profiles (VSP) obtained in the borehole by Downhole Seismic Services (DSS).

Key information about rock properties, such as porosity and permeability, is obtained through wireline logs run by Atlas Wireline Services. The log information is correlated with precise physical measurements of rock and fluid properties by Core Lab. The rock properties measured in the well are extended throughout the reservoir with the aid of seismic data from Western Geophysical and DSS. Then the combined expertise of the Western Atlas companies is useful in selecting the best sites for step-out wells and production facilities.

Production Services
In order to squeeze maximum production from the basin at the lowest cost, extensive engineering studies are conducted to predict reservoir performance over the life of the oil and gas production cycle. A reservoir model is first created by Core Lab's Engineering & Consulting group. Inputs to the model consist of rock properties derived from well logs and core analysis, and production characteristics derived from well tests. Computer simulation of the reservoir performance is then carried out by using software developed by J.S. Nolen Associates.

Oil and gas production continues by perforating the selected pay zones. The perforations are created by firing perforating tiles that penetrate through the casing and cement into the adjacent formation. Atlas Wireline Services offers several types of perforating schemes that are designed to minimizeformation damage and maximize production. Once a well is producing, casing evaluation and production logging services from Atlas Wireline and Core Lab stories assist Core Lab's petroleum engineering staff in monitoring well conditions.

On the average, only about one-third of the oil in a field can be brought to the surface by reservoir pressures and mechanical pumping. Analysis of well performance with software from J.S. Nolen can provide an early indication of the need for stimulating production through secondary and tertiary recovery techniques. Typically, fluids are pumped into the reservoir to force the oil and gas to migrate toward the producing wells. Common injection fluids include water, steam, nitrogen, carbon dioxide, and polymers.

Core Lab performs feasibility studies, recovery scheme design, pilot testing, and full-scale field implementation. Tests conducted in the laboratory provide information concerning injectivity behavior, chemical-rock interaction, and oil recovery efficiency. When hydraulic fracturing is required, Downhole Seismic Services can perform frac monitoring services to delineate the fracture geometry. Atlas Wireline Services provides field support through the logging of injection and producing wells.

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| Schedule for Western Atlas International Ad Campaign |
|---------------------------------|------------------|------------------|------------------|
| September – December 1987       |                   |                   |                   |
| General                        |                   |                   |                   |
| Oil & Gas Journal              | September 21     | September 28     | October 12       |
| World Oil                      | September        |                   |                   |
| Geophysical                    | September        | September        | September        |
| Oilweek (Canada)               | September        |                   | November         |
| Oilweek (UK)                   | September        |                   | November         |
| Asian Oil & Gas                | October          |                   | November         |
| Petroleum International        | November/December|                   |                   |
| Geophysical                    |                   |                   |                   |
| Leading Edge                   | September        | October           | November         |
| Geophysics                     | September        | October           | November         |
| First Break                    | September        | October           | November         |
| Geophysical                    |                   |                   |                   |
| AAPG Explorer                  | September        | October           | November         |
| Petroleum Engineering 3D      | September        | November          | December         |
From blazing mid-eastern deserts to the paralyzing cold of the Arctic, Western Geophysical crews have met their challenge worldwide, regardless of environmental conditions. Their endeavors and success are commended in this pictorial tribute to Western seismic exploration. Photographer Michael Fluit has graphically captured the skill, quality, and ingenuity characteristic of Western crews, past and present.
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DSS offers the industry's first software package for interactive VSP processing and interpretation.

**Downhole Seismic Services links Western Atlas technologies**

Western Atlas International, Inc. has brought together a full spectrum of high-technology geoscientific services. In order to provide our clients with the benefits of these multidisciplinary resources, we need tools to link surface-seismic surveys conducted by Western Geophysical with well logging performed by Atlas Wireline Services and core analysis from Core Laboratories.

The common denominator between these technologies is acoustic or seismic wave velocity. The required link is provided by making measurements at an intermediate scale between the broad coverage of surface seismics and the micro-scale of logs and core data. This is the specialty of another member of Western Atlas International, Downhole Seismic Services (DSS).

DSS conducts borehole seismic surveys by lowering a geophone into a well. The resulting vertical seismic profiles (VSPs) provide an exact velocity-to-depth relationship at the wellbore as well as an intermediate-scale image with superior resolution. The VSPs allow us to extrapolate core and log-derived data over the extent of a surface-seismic survey.

With the formation of Western Atlas International, DSS has been established as one of the seven Western Atlas companies by consolidating the resources of Western Geophysical and Atlas Wireline Services. At present, DSS operates 21 land and offshore field units made up of 17 ex-Atlas units and four units from Downhole Seismic Service, formerly a division of Western Geophysical. In addition, the borehole seismic processing and interpretation services previously
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Developing Long Sight at the Well Site

FRAC MONITORING SERVICES

Subsurface formations in many areas of the world have long, thin cracks called fractures. These fractures can serve as conduits for the migration of hydrocarbons. One way of improving oil and gas recovery is by injecting water or some other fluid into the reservoir to expand the fractures. The recovery is greater if the hydraulic pressure is applied in the direction of the fractures. It is important therefore to monitor the location and the extent of the fractures throughout the planning and execution phases of recovery operations.

Downhole Seismic Services has developed a frac monitoring service that is using borehole seismic methods to delineate the fractures as never before possible. Fracture-seismic data from DSS can be used to delineate fractures reliably up to several hundred feet away from the well.

DSS conducts the frac monitoring service by placing a triaxial geophone detector just below a perforated zone. A mini frac test is then carried out by injecting a chemical gel into the well. During the hydraulic frac operation, and for some time thereafter, the geophone response is recorded for processing and interpretation.

The relative direction of the formation fracture is sensed through a technique called axis rotation. The minimum frac length is estimated on the basis of known formation velocities and the measured compressional (P-wave) and shear (S-wave) arrival time ratios.

DSS currently operates 21 land and offshore field units in 15 countries around the world.

DSS processing package is the only interactive software of its kind available in the industry," Akka said.

Pete Aronstam, most recently affiliated with Western Geophysical of Canada, Ltd., is working on an aggressive program to market the full range of applications from borehole to surface seismic correlation and calibration, detailed structural and stratigraphic mapping, salt-proximity analysis, prediction ahead of the bit, and three-component fracture and reservoir analysis. (See box.) Peter is also involved in coordinating and directing the development of new downhole tools and future service capabilities in cross-hole tomography, a special technique for imaging a reservoir by placing energy sources and acoustic sensors in adjacent wells.

In addition to integrating technical and operations resources of Western Geophysical and Atlas Wireline, DSS has capitalized on the capabilities of the other Western Atlas companies. For instance, DSS uses proprietary triaxial geophones and downhole tools manufactured by LRS and interactive processing software developed by Western Research London and the Western Geoscience group in Calgary.

A prototype downhole seismic source, which DSS plans to field test before the end of the year, is being developed by a team of scientists and engineers at Core Research, a division of Core Lab.

The synergy arising from the linking of technical resources across the world and across many scientific disciplines offers enormous potential for rapidly advancing the state of the art in borehole seismics as well as all the other geoscientific services provided by Western Atlas International.
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Provided by Western and Atlas have now been combined and are available through DSS.

"DSS combines the unique strengths of Western Geophysical and Atlas Wireline Services," says Raymond Garcia, the newly appointed general manager of DSS. "Atlas Wireline has the field data acquisition resources and Western Geophysical is recognized in the industry as the leader in borehole seismic data processing." Raymond had previously served as the manager of the Atlas Seismic Logging division.

The new management team working with Raymond consists of Doug Gibson, manager, Global Operations; Akkas Manzur, manager, Global Data Processing; and Peter Arnostam, manager, Global Marketing/Research & Development. Assisting Doug in managing the day-to-day operations of field units throughout the world will be Paul Henson and Bill Ayres. Paul is responsible for the crews in the Western hemisphere and Bill for the Eastern hemisphere. DSS land and offshore units are currently operating in the United States, Canada, England, Scotland, Norway, Holland, Germany, Italy, Venezuela, Argentina, and India. Operations may be expanded before the end of the year into five additional countries, according to Doug.

DSS offers interactive data processing and interpretation services at Houston and London facilities. Akkas, who had previously directed the borehole data processing services in Houston, is now busy setting up similar service capabilities in Calgary, Denver, and Caracas. All the centers will use Western's CRYSTAL Workstations for interactive processing and interpretation, upgraded with Atlas logging and calibration software. "Our

VSP processing package is the only interactive software of its kind available in the industry," Akkas said.

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PARTY PICKINGS

311 Party 311 - Michigan

By Tom Thornton

As spring rolled into central Michigan, Party 311 was operating in and around the numerous asparagus fields and fruit orchards famous to that part of the country. Michigan, which is currently one of the busiest areas for seismic activity, is known for its beautiful scenery with lakes, forests, clear streams, and gently rolling hills. Michigan offers an endless array of activities for the yearround recreationist.

Due to the dense forests and widely scattered farms and orchards found in this area, Party 311 uses mine-hole psharans for its energy source. Little back-pack drills are used to drill the holes where small explosives are loaded and then detonated. All work, including the layout of the geophones and cables, is carried out with portable equipment, and existing roads and trails are used where possible.

Party Manager Jim White, along with Assistant Party Manager Tom Thornton, has been heading the operation since its start in late February. After a brief stint in the Houston processing center, Jim is happy to be back in operations and grateful to have the opportunity to start up a new area for Western. He and his wife, Rebecca, recently added a new member to their family when daughter Rachael was born in Houston in February. Tom has been drawing on his various experiences as 717 party manager. He has set residency in Pentwater, one of the more quaint fishing harbors on Lake Michigan. Permit agent Kim Peddle and David Bean negotiate with the local land owners, making every effort not to disrupt the asparagus harvest.

Heading up the 240-channel master-slew recording systems is chief observers Jerry Fullkerson and Ardik Trevino. Previous experience in mine-hole work has given them the edge in helping kick off production, while training the local labor force in geophysical operations.

The survey crew of Tim Granlie, Steve Colburn, and Mona Granlie have found the many different topographical features in Michigan to be most difficult to survey. Extra time usually is required in "bushing" the line.

Keeping an accurate account of all the explosives used in the field is Powderman Larry "Bear" Hakes. Bear's former experience with handling powder is valuable in our effort to maintain a safe operation.

Safety is a strong concern of Crew 311. We are striving to uphold our priorities of safety, quality, and production, in that order. With portable operations, especially with all of the local field help that we currently employ, accidents seem to occur more often. We hope that by stressing a good safety program, we may eliminate some of the more common injuries.

As we continue working in western Michigan, we wish all Westerners a safe and productive atmosphere for the upcoming year.

In the foreground (left to right) Safety Supervisor Gene Stremel, Shooter Ken Dang, and Assistant Party Manager Tom Thornton supervise mine-hole loading in the deep woods of Manistee National Forest.

In the background (left to right) Safety Supervisor Gene Stremel, Shooter Ken Dang, and Assistant Party Manager Tom Thornton supervise mine-hole loading in the deep woods of Manistee National Forest.

Managing the drills for Party 311 are Powderman Larry Hakes (left) and Driller Doug Hill.

Maintaining the drills for Party 311 are Powderman Larry Hakes (left) and Driller Doug Hill.

From left to right, Driller Duane Khan, Mechanic Francisco Merlano, and Mechanic Scott McDonald spend much of their time in the camp workshop.

Surveyor William Duane works late at night doing surveys on the HP-85.

Mechanic Steve Hammond smiles after a job well done.

Driller Tom Curry (left) drills another uphole in the As Jud area.

Vibrator Technician John Sheldon takes a break from the scorching sun.

Party Manager Joanne White reports Crew 311's daily activity to the client.

Observer Arline Trevino quality checks a shot record.

Resident Manager Ron R. Coomer, who just celebrated his 25th anniversary with Western, is busy working with his computer in the Son's office.

Driller Joe Curry (left) drills another uphole in the As Jud area.

Pictured at desk is Party 770's main camp site.

PARTY PICKINGS

770 Party 770 - North Yemen

By Tom Thornton

Profile
PARTY PICKINGS

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770 Party 770 — North Yemen

Photographer. Ian Curry

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Pictured at dusk in Party 770's main camp site.
President of IRS since 1977, Jim Porter (right) greets a WPC delegate touring IRS facilities in April.

Working in data entry for 13 years, Linda Harter is lead operator, also acting as assistant to the department supervisor. The data-entry department keys in data relating to LSPC and finance.

Senior Programmer Kip Haugen works on Computer Aided Plotting System (CAPS) program details for a recent course designed by the Computer Science department.

 Billing Clerk Earl White has handled billing for Atlas Wireline (formerly Dresser Atlas) for 10 years, including billing for both offshore and some land areas.

Geophysical Technician Cathy Moffat works on marine gravity and magnetic data for Aero Service but is pictured here working on a special mapping assignment for a Saudi Arabian project.

Head Vibrator Mechanic Juan Aguirre checks out repair on a vib radio for Party 704. (Photo by Butch Allen)

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Spic Data Office Manager Patricia Greeson, working on Western’s new SLIC™ System, spends much of her time showing data to clients.

Draftsman John Savoie drafts, puts films together, and makes corrections on seismic sections.

Geophysical Technician Doug Weber checks the set up for a new line he’s working on in Group 28, LSPC.

Manuel Garcia, who has been with Western for 17 years, is vibrator mechanic for Crew 704 in South Texas. (Photo by Butch Allen)
BEHIND THE LINES

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BEHIND THE LINES

INFORMATION STATION

YES! I would like to receive additional copies of the following Western Geophysical, Aero Service, and Downhole Seismic Services brochures and technical papers. I have indicated my preferences and desired quantities in the spaces provided.

WESTERN GEOPHYSICAL BROCHURES

Marine Acquisition:
- Coordinated Two Vessel Surveying
- Transition-Zone Surveying (DIGISEIS®-200)
- Marine Seismic Exploration folder with inserts:
  - R/V Western Polaris
  - R/V Western Aetherian
  - R/V Arctic Star
  - R/V Western Horizon
  - R/V Western Anchorage
  - Dual Streamer Surveying
- 3-D Marine Seismic Data Acquisition folder with inserts:
  - Pre-survey Planning
  - Source Array Design
  - Real-Time Q.C.

Land Acquisition:
- 3-D Land Seismic Data Acquisition folder with inserts:
  - Pre-survey Planning
  - Positioning Surveys
  - Recording Systems
  - Field Auxiliary Computer Effort
- Data Processing:
  - MISER®
    - Wave Equation Migration: Two Approaches
    - Minimum Entropy Deconvolution (MED)
    - Horizon Velocity Analysis (HTA)
    - Depth Migration
    - Attenuation of Long Period Multiples
    - A Geologic Section from Seismic Data (SHADCON™)
    - Wave Equation Based Multiple Suppression
    - Migration in 3-D
    - Wave-Theoretical Depth Migration
    - Tree Interpretation

General:
- 3-D Seismic Data Processing folder with inserts:
  - Pre-survey Planning
  - Velocity Analysis
  - Trace Positioning and Binning
  - Display
  - 3-D DMO and NMO Stack
  - Trace Interpretation, Migration

Interpretation:
- CRYSTAL® Interpretation System
- Integrated Interpretation Services
- 3-D Seismic Interpretation

- Seismic Software Package folder with inserts:
  - Supported Hardware
  - Software Package Offerings
  - Interactive Graphics Capabilities
  - Modeling Capabilities
  - Entry-level 4300 Configuration
  - VELAN® Velocity Analysis
  - EXPEDITOR™ Interactive Workstation
  - Seismic Data Displays
  - Inverse Q-Filtering
  - Imaging Complex Structure
  - SLIM® (Seismic Lithologic Modeling)
  - Imaging Steep Structure: Dip-Moveout Processing
  - 3-D Dip-Moveout
  - DMO and Steep-Dip Migration
  - Poststack Signal Enhancement
  - Wave-Theoretical Layer Replacement
  - Marine Statics
  - Reflection Statics
  - Amplitude-versus-Offset Analysis
  - Migration Velocity Analysis
  - 3-D Data Processing folder with inserts:
    - Pre-survey Planning
    - Velocity Analysis
    - Trace Positioning and Binning
    - Display
    - 3-D DMO and NMO Stack
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SEND THIS FORM TO:
MARKETING SERVICES DEPARTMENT
Western Atlas International
PO. Box 2469
Houston, Texas 77252

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  - R/V Western Aleutian
  - R/V Western Horizon
  - R/V Western Anchorage
- Dual-Streamer Surveying
- 3-D Marine Seismic Data Acquisition folder with inserts:
  - Pressure Planning
  - Source Array Design
  - Real Time Q.C.

Land Acquisition:
- 3-D Land Seismic Data Acquisition folder with inserts:
  - Pressure Planning
  - Positioning Surveys
  - Recording System
  - Field Ancillary Computer Effort

Data Processing:
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  - Minimum Entropy Deconvolution (MED)
  - Horizon Velocity Analysis (HVA)
  - Depth Migration
  - Averaging of Long Period Multiples
  - A Geologic Section from Seismic Data (SHADOW™)
  - Wave Equation-based Multiple Suppression
  - Migration in 3-D
  - Wave-Theoretical Depth Migration
  - Trace Interpolation

Interpretation:
- CRYSTAL® Interpretation System
- Integrated Interpretation Services
- 3-D Seismic Interpretation

General:
- 3-D Seismic Survey Benefits
- This New Combination Will Help You Unlock More Hydrocarbons
- Reservoir Description from Seismic Lithologic Parameter Estimation
- Reservoir Description from Seismic Lithologic Modeling

SEND THIS FORM TO:
MARKETING SERVICES DEPARTMENT
Western Atlas International
P.O. Box 2469
Houston, Texas 77222

Name __________________________
Title __________________________
Company _______________________
Address _________________________

DI G I S E IS™ is a registered trademark of Terra Marine Engineering, Inc.

No. 13-11-96

Head Vibrator Operator Euben Molina works for Crew 704 outside the City Cafe in Pensacola, Florida. (Photo by Butch Allen)

Aero Service Accountant Bonnie Stos HA SH CON™ at work in the accounting system. (Photo by Butch Allen)

Jeff Newton, geophysical technician for Party 717 outside of Pensacola, Florida. (Photo by Butch Allen)

As manager of interpretation/special processing, John Sherwood (right) is responsible for supervisory, organizational, and marketing functions. Here he explains a CRYSTAL® demonstration to some Western visitors.

Pictured inside the recording truck is Party 704 Observer Calvin Martwick. (Photo by Butch Allen)
NAMES IN THE NEWS

DOWNHOLE SEISMIC SERVICES / VSP BROCHURES

Surveying:
- Geodetic Surveying
- MACROMETER* Interferometric Surveying System
- MACROMETER II Surveys: The Dual Band Advantage
- MACROMETER II Interferometric GPS Surveying System
- SAR Synthetic Aperture Radar
- SAR System® Imagery (Synthetic Aperture Radar Non-Exclusive Proprietary Imagery)
- SAR System Imagery (Alaska Non-Exclusive Proprietary Imagery)
- Digital Spectrometry

AERO SERVICE BROCHURES

Database:
- Digital Databases and Mapping
- Industrial Mapping and Digital Database Management Services
- Utility Mapping and Digital Database Management Services

Geophysical:
- Gamma-Ray Spectrometry
- Geophysical Data Acquisition, Processing, and Interpretation Services
- Geophysical Digitizing and Plotting Services
- High-Sensitivity Aeronautical Surveys
- High-Sensitivity Measured Vertical Gradient
- Integrator® Interpretation Services
- Marine Gravity and Magnetics
- Sedimentary Anomalies from High Resolution Aeronanetics
- SedMag® Process

Photogrammetry:
- Photogrammetry

Remote Sensing:
- Geoimages® (Digital Processing of Multispectral Imagery)
- Thematic Mapper (Digital Image Processing)

NAMES IN THE NEWS

From 1969 to 1977 Bill was assistant supervisor in the London Digital Center. He then returned to Canada and became supervisor of Spec Data. Bill and his wife Lila met in the 1960's while he was working in Ecuador. They have two children: William, 15, and Steve, 12.

Wilbur Riley began with Western of America as a drill helper in October of 1951 at Hobok, Colorado. In November, 1967, he started work with Western of Canada.

Some interesting job experiences for Wilbur have included drilling all types of formations with air, water, air/water combinations, terri-poles, and a sonic rig along the coastline of the Beaufort Sea. Wilbur has worked in 14 states for Western, including Alaska, and three provinces of Canada.

Wilbur has moved approximately 60 times. His oldest son, Bruce, was in 32 schools before coming to Calgary to start ninth grade. Wilbur and his wife, Alice, have five children: Bruce, 34; Debra, 32; Tim, 30; David, 24; and Diane, 22.

Alice Riley has worked for Western Canada's Accounts Receivable department for the last nine years. Wilbur now works in the Shipping/Receiving department. - Rena Novak

LEN DUNN (left) and Bill Ross on Bill's 35-year anniversary.

Leonard Dunn (left) congratulates Wilbur Riley on his 35th anniversary with Western.

ANNIVERSARIES

35 Years

Eleven employees of Western of Canada attended a luncheon held recently at the Marborough Inn in Calgary to honor both William F. (Bill) Ross and Wilbur W. Riley on their 35th anniversaries with Western.

Bill began nine years of foreign travel as a marine party chief, working in the Arabian Gulf, New Guinea, Indonesia, Liberia, Ghana, Senegal, Ethiopia, Australia, England, Ireland, Norway, Denmark, Italy, and Portugal. He also worked in land areas such as Louisiana, Spanish Sahara, Libya, Egypt, Pakistan, Saudi Arabia, and South America.

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ANNIVERSARIES

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NAMES IN THE NEWS

DOWNSHOLE SEISMIC SERVICES/VSP BROCHURES

- Interactive VSP Processing and Interpretation folder with inserts:
- Zero-Offset VSP Processing
- Offset VSP
- Salt-Proximity Surveys
- Website Seismic Exploration folder with inserts:
- Acquisition Equipment
- Wellsite Seismic Surveys
- Energy Sources
- Wireline Services
- Simultaneous Multifoilset VSP Acquisition

AERO SERVICE BROCHURES

Database:
- Digital Databases and Mapping
- Industrial Mapping and Digital Database Management Services
- Utility Mapping and Digital Database Management Services

Geophysical:
- Gamma-Ray Spectrometry
- Geophysical Data Acquisition, Processing, and Interpretation Services
- Geophysical Digitizing and Plotting Services
- High-Sensitivity Aeronautical Surveys
- High-Sensitivity Measured Vertical Gradient
- Integrated Interpretation Services
- Marine Gravity and Magnetics
- Sedimentary Anomalies from High Resolution Aeronomagnetics
- SedMagSM Process

Photogrammetry:
- Photogrammetry

Remote Sensing:
- GeoImages® (Digital Processing of Multispectral Imagery)
- Thematic Mapper (Digital Image Processing)

Surveying:
- Geodetic Surveying
- MACMETER® Interferometric Surveying System
- MACMETER II Surveys: The Dual Band Advantage
- MACMETER II Interferometric GPS Surveying System
- SAR Synthetic Aperture Radar
- SAR System® Imagery (Synthetic Aperture Radar Non-Exclusive Proprietary Imagery)
- SAR System Imagery (Alaska Non-Exclusive Proprietary Imagery)
- Digital Spectrometry

WESTERN GEOPHYSICAL TECHNICAL PAPERS

- Coherent Noise in Marine Seismic Data
- A Comprehensive Method for Evaluating the Design of Airguns and Airgun Arrays
- Data Enhancement from a 500-Channel Swimmer
- Depth Migration of Imaged Time Sections
- Desired Seismic Characteristics of an Airgun Source
- Effectiveness of Wide Marine Seismic Source Arrays
- Efficient 3-D Migration in Two Steps
- Far-Field Signatures by Wavefield Extrapolation
- Imaging Beneath Complex Structure: A Case History
- Migration of Seismic Data from Inhomogeneous Media
- Predictive Deconvolution and the Zero-Phase Source
- Prestack Layer Replacement
- A Relationship Between Dynamic Range and Word Length in Digital Systems
- Simultaneous Estimation of Residual Statics and Cospread Corrections
- Experimental Investigation of Interference from Other Seismic Crews
- Airgun Source Instabilities
- Cawaged Migrations: A Way of Improving the Accuracy of Presto-Difference Migration
- Migration Velocity Analysis by Wave-Field Extrapolation
- Model-based Wavelet Processing
- Techniques Applied to Obtain Very High Resolution 3-D Seismic Imaging at an Abbawaara Tar Sands Thermal Pilot

ANNIVERSARIES

35 Years

Sixteen employees of Western of Canada attended a luncheon held recently at the Marlborough Inn in Calgary to honor both William F. (Bill) Ross and Wilbur W. Riley on their 35th anniversaries with Western.

Born and raised in Winnipeg, Manitoba, Bill Ross earned a B.S. in geology from the University of Manitoba and joined Western in Canada immediately after graduation in May, 1952.

In 1960, Bill began nine years of foreign travel as a marine party chief, working in the Arabian Gulf, New Guinea, Indonesia, Liberia, Ghana, Senegal, Ethiopia, Australia, Spain, Morocco, Ireland, Norway, Denmark, Italy, and Portugal. He also worked in land areas such as Louisiana, Spanish Sahara, Libya, Egypt, Pakistan, Saudi Arabia, and South America.

From 1969 to 1977 Bill was assistant supervisor in the London Digital Center. He then returned to Canada and became supervisor of Spec Data. Bill and his wife Liliana met in the 1960's while he was working in Ecuador. They have two children: William, 15, and Steve, 12.

Wilbur Riley began with Western of America as a drill helper in October of 1951 at Hesky, Colorado. In November, 1967, he started work with Western of Canada.

Some interesting job experiences for Wilbur have included drilling all types of formations with air, water, air/water combinations, terrapulse, and a sonic rig along the coastline of the Beaufort Sea. Wilbur has worked in 14 states for Western, including Alaska, and three provinces of Canada.

Wilbur has moved approximately 60 times. His oldest son, Bruce, was in 32 schools before coming to Calgary to start ninth grade. Wilbur and his wife, Alice, have five children: Bruce, 34; Debra, 32; Tim, 30; David, 24; and Diane, 22.

Alice Riley has worked for Western in Calgary's Accounts Receivable department for the last nine years. Wilbur now works in the Shipping/Receiving department.

Leo Dunn (left) and Bill Ross on Bill's 35-year anniversary.

Leo Dunn (left) congratulates Wilbur Riley on his 35th anniversary with Western.
In Memoriam

■ Dean Wayne Robe, a 24-year-old mechanic on Party 770 in the Yemen Arab Republic, was killed last June when he opened a briefcase that had been booby-trapped and left on the side of the road.

Dean hired on with Western on Oct. 3, 1983 after graduating from technical school in Iowa. His first assignment was on Crew 768. He moved to Party 333 in the U.A.E., then to 758 in Tanzania, and finally to Yemen.

On each crew, and on every assignment, Dean excelled. His contribution was not only to the job objectives, but also to crew life and morale. He was a crew member liked and respected by all. He will be greatly missed.

— Marilyn Wrigley

■ John Hollander, gravity supervisor, celebrated his 35-year anniversary with Western Geophysical in July.

John began his career on July 9, 1952. He rapidly moved to positions such as helper, assistant shooter, permit agent, computer draftsman, surveyor, party manager, gravity operator, and supervisor.

Between 1952 and 1969, John spent most of his time travelling around the world as either party manager, surveyor, or marine gravity operator. Areas he has worked in include the United States, Venezuela, Jamaica, the Philippines, Alaska, Canada, Cuba, Iran, the Persian Gulf, Argentina, Bahrain, Hong Kong, Egypt, Thailand, India, Singapore, London, and Liberia.

In 1969, John permanently relocated to Houston as field gravity supervisor.

Celebrating 15 years of service with Western is Data Processing Area Manager W. J. (Joe) Chatoor (right). Vice President Joe Saltamachia presented Joe with a pin at a celebration dinner at Montpelian Restaurant in London.

— Sally Humphreys

Manager Lee Siems (center) is congratulated on 20 years of service with Western by Senior Vice President Damir Skerl (left) and Director of Electrical Engineering Ted Cruise.

Vice President Joe G. Saltamachia (right) congratulates Manager, Marine Technology Ugo Picciani on 30 years of service with Western. — Sally Humphreys

London Security Guard George Jordan (left) receives a retirement gift and congratulations from Office and Safety Manager M. G. (Gerry) Reynolds. George had been with Western seven years after joining us from Unilever when London Operations acquired the building. — Sally Humphreys
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Celebrating 15 years of service with Western is Data Processing Area Manager W. J. (Joe) Chatnor (right). Vice President Joe Saltamachia presented Joe with a pin at a celebration dinner at Montpelier Restaurant in London.

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Manager Lee Siemens (center) is congratulated on 20 years of service with Western by Senior Vice President Damir Skerl (left) and Director of Electrical Engineering Ted Cruise.

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