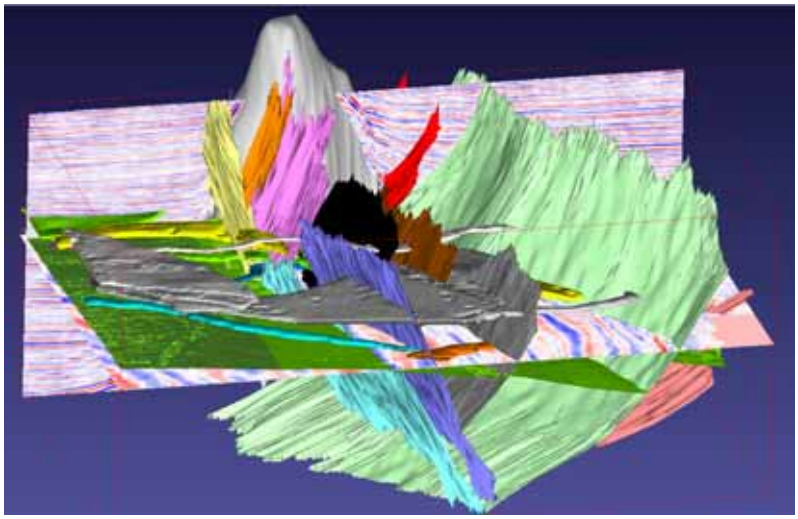
Society of Exploration Geophysicists (SEG), San Antonio 2007



TerraSpark's Computer Aided Stratigraphic Interpretation – CASI[1]

Forum presentations revealed that unconventional will mean serious geophysical activity over tight sands/shale gas plays. **Chesapeake** is showing the way with a $160 million investment in 3D seismic surveys on unconventional plays throughout the US. Both **Paradigm** and the University of Colorado spin-out **TerraSpark** are offering new approaches to seismic interpretation by transforming a present day seismic image back to its depositional setting. The idea is that this allows easier interpretation of sedimentary bodies that can then be re-transformed back to their present day state. A more conventional, but nonetheless spectacular development is the appearance of a seismic 'probe' in **Petrel**. Seismic modeling has also seen some interesting developments with the acquisition of GeoSmith's Shapes 3D topology engine by **Landmark**. Demand for seismic processing is 'going through the roof', driven especially by the high end 3D wave equation market and esoteric acquisition techniques such as wide azimuth. The problem set that this presents – spanning storage, multi core CPUs, networking was the subject of several **high performance computing** presentations. The open source **JavaSeis** environment, with its 'in situ' storage model has received support from ConocoPhillips and Landmark. A presentation by **Total** suggests that the graphics processing unit (GPU) is likely to have a considerable impact on HPC. The **NVIDIA Tesla** boxes, quite ubiquitous at the show, herald what has been described as a 'tipping point' in GPU-based number crunching. HPC involves an interplay between hardware and software – particularly in the field of parallel processing across complex arrangements of clusters and disk storage. This has resulted in bundled offerings such as **Fraunhofer**'s PreStackPro and high performance filesystem and Paradigm's GeoDepth bundle on Panasys storage. **Dynamic Graphics**' CoViz has been re-vamped to include real time data feeds so the platform now offers a credible overview of a multiplicity of data sources (including production) and third party applications.

Highlights

[1] *Image courtesy TerraSpark – www.terraspark.com.*

Contents

TW0714_1 SEG Forum – geophysics and unconventional reserves

0714_1.1 Sverre Strandenes, PGS

Strandenes[2]

Oils' R&D is a mere one tenth that of Microsoft or GM. Schlumberger is to spend more on R&D this year than ExxonMobil. One example of geophysics in unconventional resources is the use of multi transient electromagnetics (EM) in reserve mapping of tar sands and in monitoring steam assisted gravity drainage. Permanent monitoring with seabed fiber seismics has applications in all reservoir monitoring and CO2 sequestration. PGS is working to integrate EM acquisition with seabed seismics. Multi transient EM is applicable to tar sands and heavy oil deposits to map reserves and monitor SAGD. Permanent monitoring with seabed fiber seismics has applications in reservoir monitoring and CO2 sequestration. PGS is working to integrate EM acquisition with seabed seismics. Industry should make more aggressive take-up of new technology.

0714_1.2 Jean-Marie Masset, Total

Masset

Unconventional resources are required to plug the gap between conventional supply and growing demand in 10 to 15 years time. Masset offered a very broad definition of 'unconventional' including high pressure high temperature (HP/HT) reservoirs, sour gas and deep water. In the latter category, Total's Block 17 in Angola shows geophysics 'at its best,' allowing for fluid content changes to be tracked with 4D tome lapse seismics. Future challenges for geophysics will include smaller size, non turbidite reservoirs, subsalt imaging. Heavy and extra heavy SAGD oil exploitation in Athabasca and Venezuela can provide 40% recovery (cf. 10% for cold process). Seismics can be used to monitor of steam chamber evolution with live seismic 'movies'. The process produces 'a lot of CO2' – offering potential for a sequestration 'industry' in Athabasca. Turning to high pressure, high temperature reservoirs, Masset cited Total's experience with the 5200m, 1100 bar, Elgin Franklin North Sea development, the largest HP/HT in the world. Here, as in other sub salt plays, wide azimuth seismic acquisition, innovative processing and high performance computing are being used to investigate what happens at burial depths of around 10,000 m. Such conditions exist in the undrilled central part of the Franklin field where drilling is confronted by casing rupture from compaction. Well engineering is problematical and 'typical of what the future holds.'

[2] *This and other Forum images courtesy SEG.*

0714_1.3 Larry Lunardi, Chesapeake

Lunardi

Chesapeake has interests in all the unconventional exploration plays in the US. These include granite wash, fractured reservoirs and shale gas plays. Chesapeake uses 3D seismic for all of these plays and is now the prime 3D onshore seismic data acquirer in US. In all some 250-300 wells will be drilled. Most all unconventional US plays relate to the Wichita thrust which provided the heat to produce gas in the Barnett Shale through to the Appalachians. One spectacular application has been an extensive 3D seismic survey targeting the Barnett Shale in the Dallas Fort Worth area. Seismics was acquired on the DFW airport taxiway system (by Dawson). The airport gets a 25% royalty. Barnett Shale exploration is complex with karsts and faults obstructing the search for the ideal 'fracturable' sweet spot. At $233/net acre for 3D, seismic costs are considered reasonable compared with leasing and drilling. Chesapeake is now drilling 250-300 horizontal wells under the airport with five rigs. The first gas sales are due next week.

The Fayetteville shale play, Arkansas, involves 12 rigs and three large seismic surveys totaling 450 squares at $115k license fee. Microseismics is used to monitor frac jobs to identify faults near a well which adversely affect production. Microseismics is 'interesting and evolving technology.'

The Woodford play in SE Oklahoma is economically challenged with disappointing reserves. The shales are complex and the sweet spots thin – typically a 50 foot thick target in a 4,000 ft lateral. Chesapeake has 50 squares of new 3D in progress – it is 'hard to stay ahead of the drilling program.'

Lunardi noted the variability of shale plays, 'they don't all work.' Fractures are a 'kiss of death' in the Barnett which is more of a 'fracturable' shale play. Fayetteville is more of a natural fracture play. But the good news is that 'we sometimes get lucky and get a conventional target – even where the shale play doesn't work.' Chesapeake has acquired or is in the process of acquiring 3104 squares in 2007/2008 and will have invested $160 million in 3D seismic.

0714_1.4 Ray Boswell, US DoE – Gas hydrates

Boswell

Ray Boswell (US Department of Energy) traced the interest in gas hydrates back to 1984 when the Glomar Challenger recovered a 1 meter core offshore Guatemala. Gas hydrates may contain half of all the world's captured organic carbon. Arctic sandstones are estimated to hold hundreds of kTCF reserves but the numbers for low permeability marine reservoirs are much higher. BP Alaska has mapped a seismic hydrate zone - direct detection is possible in some circumstances. The Mount Elbert stratigraphic test (February 2007) confirmed a 50 ft thick interval with 70% gas hydrate saturation. Mount Elbert is a cost effective laboratory for government – but the really big reserves are in the marine environment. Here, geophysics has given some paradoxical results. Initially it was believed that the 'bottom simulating reflection' (BSR) observable on many deepwater seismic lines was a direct gas hydrate indicator. It turns out that this is not the case. In fact the science today is confusing and some doubt has been cast on the existence of significant

reserves. In general seismic data is neither acquired nor processed for the shallow section. Rock physics models are poor. A federal program on rock physics modeling, seismic reprocessing and 4C OBS acquisition is being conducted by the DoE's National Energy Technology Lab in the Gulf of Mexico.

0714_1.5 Q&A

What are top opportunities for geophysics and what are the impediments. Do we need better algorithms or better computers?

Boswell – GH is a huge 'potential opportunity' even though I do not advocate it as a 'resource.' There is a lot there, but it is unclear if it is exploitable.

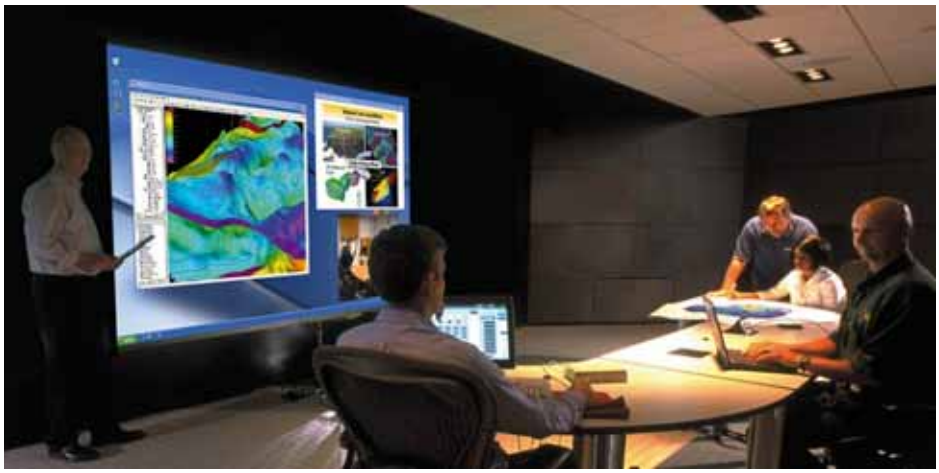
Masset – Improved imaging will let us drill deeper targets.

Lunardi – There is potential in mature area plays that didn't work because of vertical drilling. Horizontal drilling and modern frac techniques have potential in granite wash and very arkosic, proximal deposits, with up to 10 fold production increases observed. 3D can be very useful in mapping extent. The main impediment is access – especially in the Rockies. We are working on cable-less acquisition – but there remain issues with government/state agencies that 'stand in way of profits.'

TW0714_2 Appro – HPC session

Appro reported the sale of several of its clusters to the Lawrence Livermore National Lab – the 'Tri-Laboratory Linux Capacity Cluster' (TLCC07). The 'next generation' Appro Xtreme-X HPC clusters are based on Quad-Core AMD Opteron processors and InfiniBand 20 Gb/s fabric.

TW0714_3 Barco Galaxy NH12 screen and LC-5621 flat panel monitor

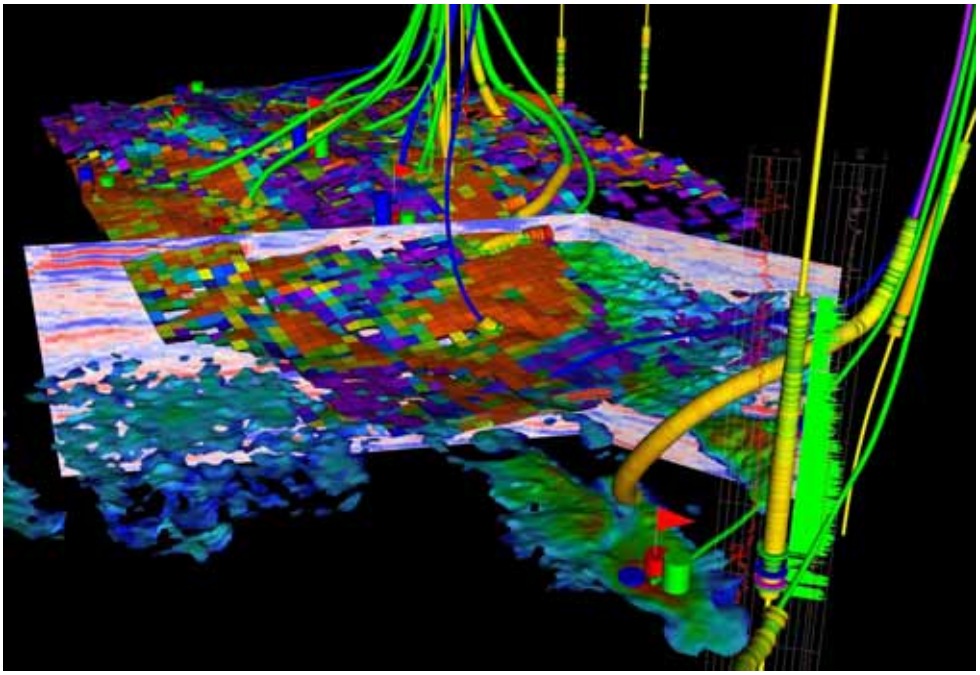


Barco NH-12 screen.[3]

Barco's Galaxy NH-12 screen offers 3D viewing at 1080p HD. The DLP projection system supports mouse and keyboard and multi-windowed hybrid displays of mono and stereo sources. Multiple NH-12 projectors can be linked to create a seamless, large-size image. The Barco LC-5621 QHD flat panel ultra high-definition, 56" display offers 8 megapixels resolution for real time operations centers or the boardroom. More from www.barco.com.

[3] *Image courtesy Barco.*

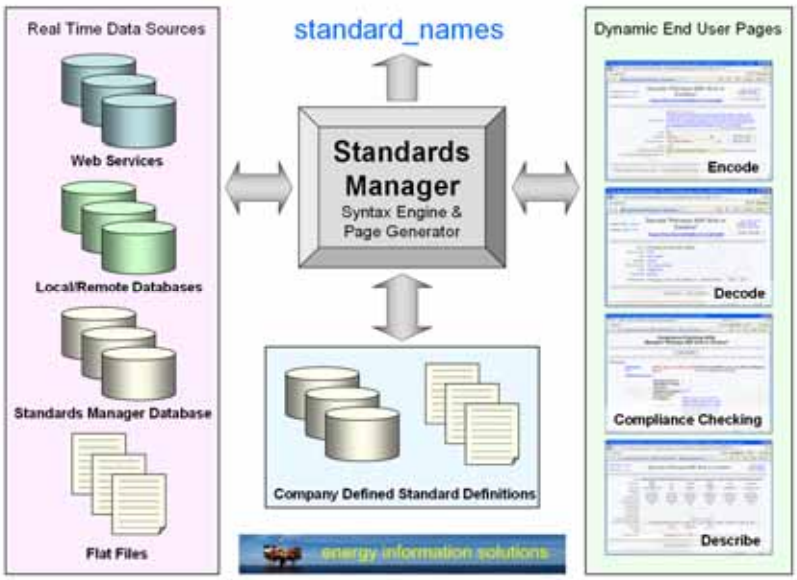
TW0714_4 Dynamic Graphics – real time data in Coviz 2.0



Dynamic Graphics' CoViz 2.0.[4]

Dynamic Graphics (DG) has livened up its CoViz product, adding a 4D time lapse display function. This was developed for Occidental's reservoir surveillance and can show, for instance, producers and injectors as a movie with changing well status—alongside of simulator results. DG reports 160 CoViz users within BP. The tool offers an impressive 'big picture' view for a 'high level' understanding. More from www.dgi.com.

TW0714_5 Energy Information Solutions Standards Manager



Standards Manager[5]

Energy Information Solutions' Standards Manager provides enterprise standard nomenclature checking and compliance for the major upstream interpretation packages. Users fill in a few terms and generate names according to a selected nomenclature. Names can be cut and pasted into the interpretation system. One Petrel user ties data files to interpretations via header metadata. Santos is a user. More from www.standardsmanagement.com.

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[4] *Image Courtesy Dynamic Graphics.*

[5] *Image courtesy Energy Information Solutions.*

TW0714_6 Ergonomic interpretation systems, avoiding RSI – Doug Bishea, ExxonMobil

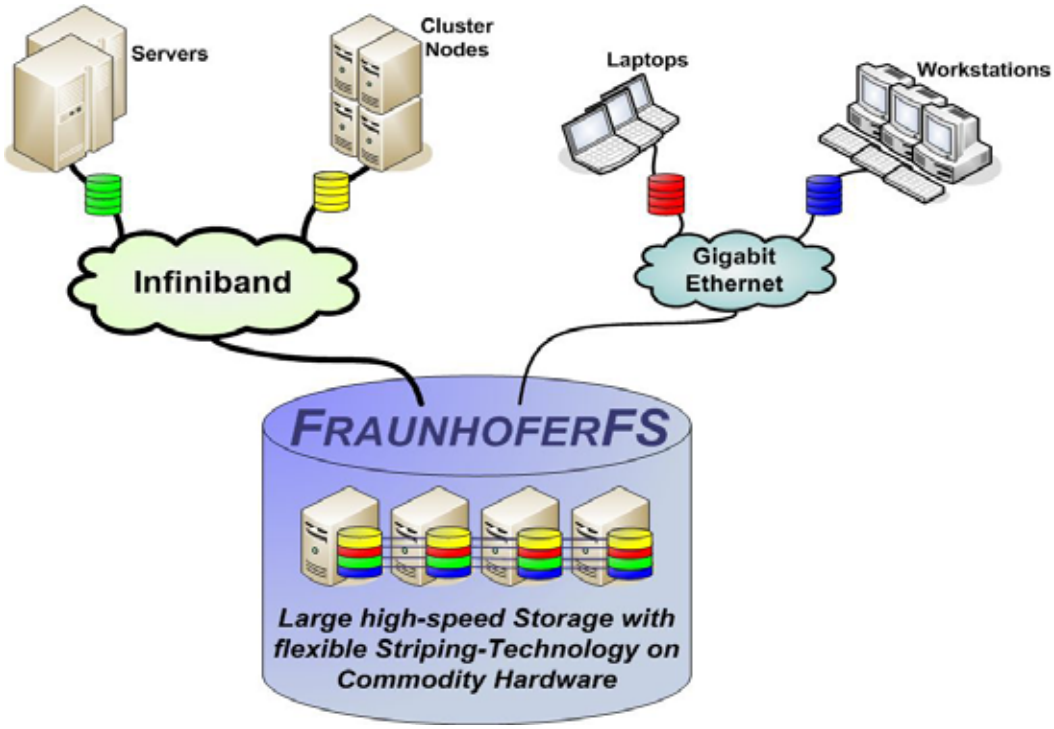
Repetitive strain injury – suffered by many users of the computer mouse involves damage to tendons, nerves and muscles. The problem is serious and growing. 'We have people in pain.' According to statistics from the US Bureau of Labor, RSI was responsible for $33bn. in lost productivity in the US in 2005. Susceptibility to RSI is hard to predict. There is much individual variability and hardware, software and users' hobbies can be factors. People may do things at home that make it worse. There is not so much age correlation – even young people get RSI.

ExxonMobil is addressing RSI by applying HSE concepts and engineering controls to reduce what is a 'safety risk'. Engineering controls involve removing or enclosing a hazard. This can be done by engineering an application to take advantage of automation – by scripting, autotracking, and ensuring that a minimal amount of user input is required – a.k.a. 'user centric design.' Administrative control (checklists for 'safe operation') is harder to achieve and needs management involvement. Reducing time at the workstation has been successful – but this needs cooperation. Users should not go home to play World of Warcraft for 6 hours! The third way is to issue protective equipment such as new mouse/trackball/pen tablet, diversifying input and output. Larger screens are appreciated. An 'ergonomic' approach is being tested with 'rest break' software and attention to workstation setup and intervention when symptoms arise. RSI friendly software is relevant to geophysics, along with better pointing device support on the Linux PC. 3D models are particularly problematic.

ExxonMobil has a joint venture with Schlumberger Information Solutions underway on an 'ergonomic fitness forum' to identify potentially harmful software. This is testing both ExxonMobil and third party tools. In the long term a solution may be the 'telepathic' interface – the Neural Impulse Actuator OCZ technology 2007 (from gaming).

The principles of mitigating RSI include reduced mouse usage – keyboards are better. Reduce or eliminate unnecessary work such as clicking or typing. Offer (and use) keyboard shortcuts, widgets (button, input box). Pay attention to tab order, focus and arrow keys. (e.g. In Microsoft Office, Alt P brings up properties[6].) Note that in Google, search already has focus. Streamline common tasks with a workflow editor and offer support for undo redo, prevent 'disastrous' choices, implement auto complete. Much of this is coming from gaming industry. More research is needed. Bishea suggests a possible RSI community of practice in the oil and gas industry.

TW0714_7 Fraunhofer Parallel Filesystem



Fraunhofer Parallel Filesystem[7]

[6] *Chez nous it is ALT-F, I!*

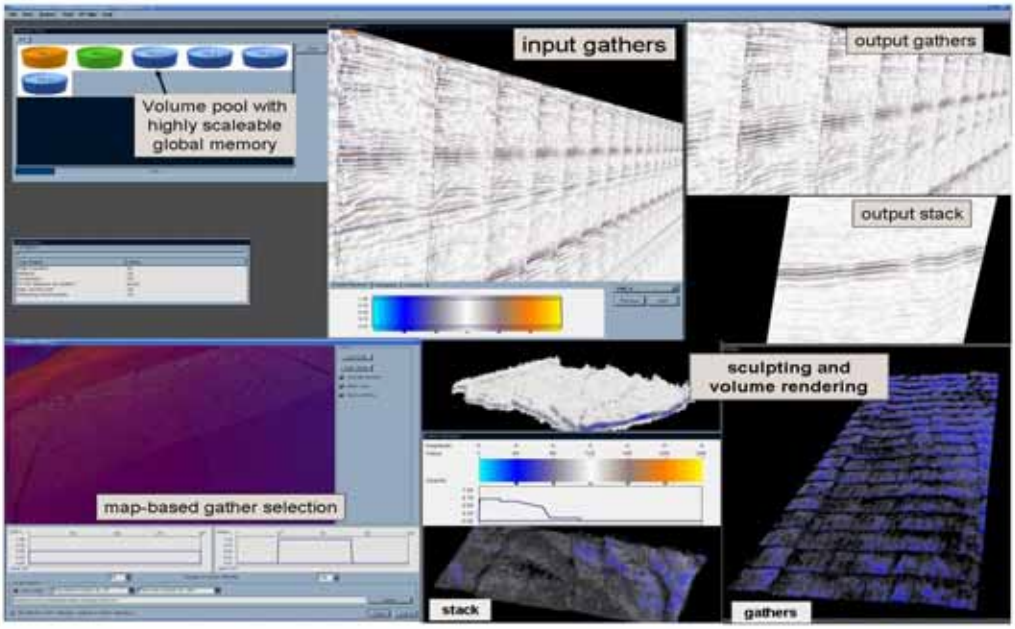
[7] *Image courtesy Fraunhofer.*

Fraunhofer's new parallel file system targets smaller companies that want to get more out of their storage systems and large installations focused on getting high bandwidth to a single node and 'unlimited scalability.' Features include POSIX compliance, no kernel patches, distributed metadata, a scalable multithreaded architecture and support for Gigabit Ethernet and Infiniband. Tests on a system with dual Opteron nodes, the Areca Controller and 10 SATAII disks running in RAID6 with a single data rate Infiniband interconnect gave the following results.

Clients	Servers	Memory per server	Write	Read
8	1	24 GB	182 MB/s	224 MB/s
8	2	24 GB	351 MB/s	290 MB/s
8	4	24 GB	704 MB/s	537 MB/s
8	8	24 GB	1445 MB/s	977 MB/s

More from www.fhgfs.com.

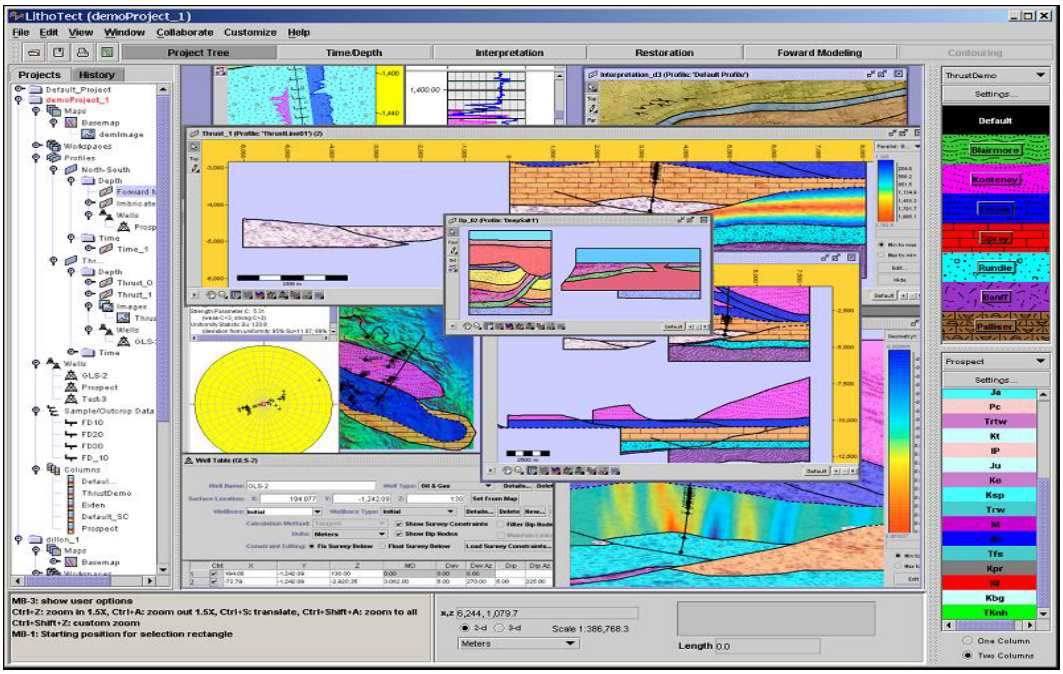
TW0714_8 Fraunhofer/EnVision PreStack Pro



Fraunhofer PreStack Pro

Pre-Stack Pro is a new, high-performance computing (HPC) application for visualization, processing, and quantitative analysis of very large pre-stack seismic data sets. PSPRO provides fast access to volumes of CDP gathers from any 3D seismic survey, with code that scales seamlessly on commodity cluster hardware and multi-core CPUs. Scalability has been achieved by fully exploiting parallelism at all levels, from the I/O system, CPU and operating system, to each individual algorithm in the application. PSPRO has been developed through a joint venture between the Fraunhofer and the Norwegian EnVision consultancy, with StatoilHydro as Industry Partner. A commercial version will be available in late 2008. More from www.pv4d.com and www.envision.no.

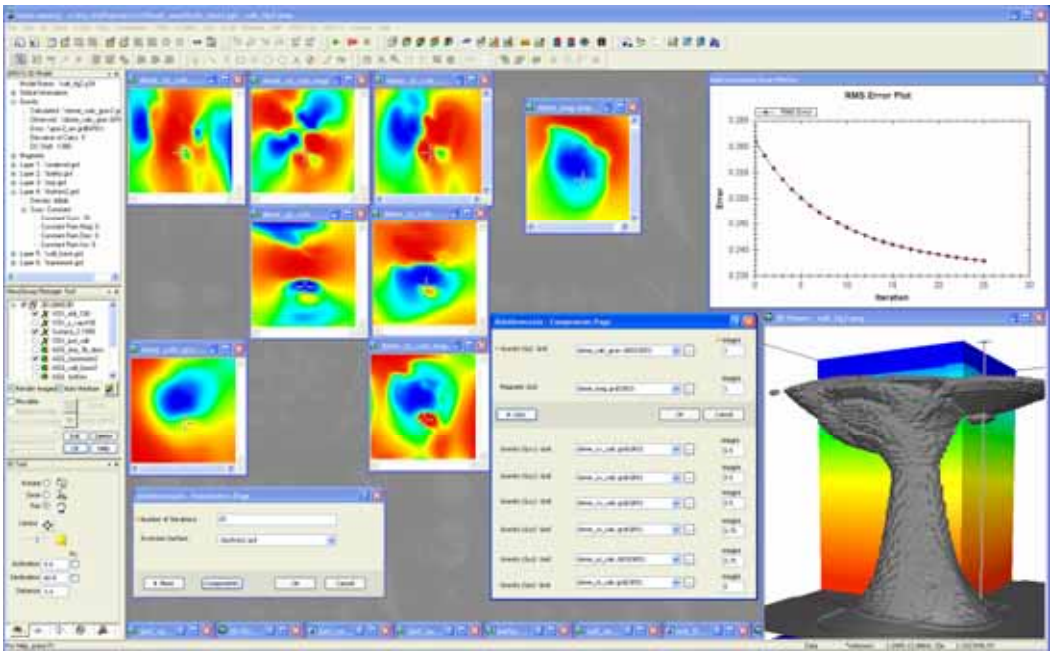
TW0714_9 Geo-Logic – LithoTect



Geo-Logic's LithoTect

LithoTect is a geological map, well, seismic, cross section, and 3D interpretation and data management toolset. The package supports structural and stratigraphic interpretation with restoration and forward modeling techniques, which remove folding and faulting, include decompaction and isostacy, and operate on both interpretations and seismic data. Non-English language versions are available. LithoTect users include over 40 of the world's largest integrated hydrocarbon exploration and production companies, more than 35 university research groups, and many single-person consultants. More from www.geologicsystems.com.

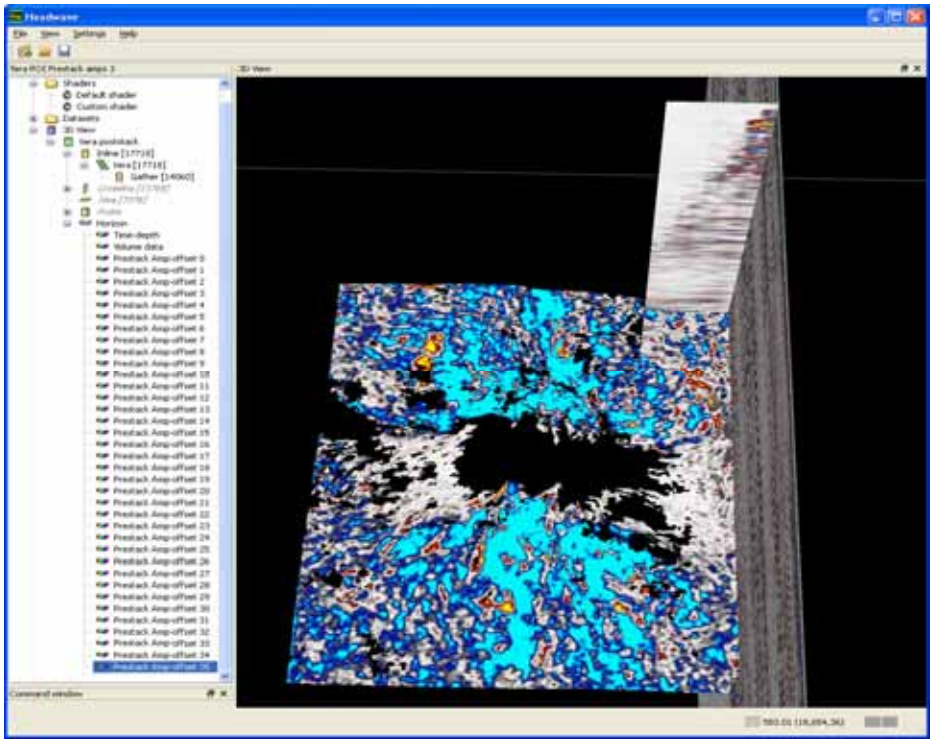
TW0714_10 Geosoft – full tensor gravity gradient inversion in GMSYS-3D



FTG Joint Inversion in GMSYS-3D

Geosoft announced the release of Full Tensor Gravity Gradient inversion in version 6.4.2 of GMSYS-3D gravity and magnetic modeling. The inversion algorithm has been licensed from ConocoPhillips. Any combination of gravity gradient, magnetics and normal gravity can constrain the inversion. A data mis-fit is displayed at each step so that users can monitor the progress of the inversion and stop it at any time.

TW0714_11 Headwave – pre-stack interpretation



Headwave display of individual prestack traces[8]

Headwave offers a variety of prestack interpretation tools that use NVIDIA's Tesla GPU-based compute engine. Here, a prestack attribute has been mapped to a stacked horizon. The interpreter can scroll through stacked traces and view the individual prestack traces in stack. Headwave expects to be showing 'quite a mature product' at the EAGE next year and is working with SU/Amoco codes to add some processing to the mix. More from www.headwave.com.

TW0714_12 HPC 'not designed for geophysics' – Phil Neri, Paradigm

Computer processor speed greatly exceeds memory access and seek times are increasing in the new huge memory systems. Multiple levels of cache (on die, in memory, disk, network and in storage) complicate optimization. Software houses (like Paradigm) only deal with the last couple of cache levels. Visualization used to be synonymous with data in RAM (VoxelGeo/Magic Earth/Geoprobe), an issue that Paradigm has addressed with disk cache. A related issue is the fact that commercial clusters are designed for transactions not HPC. HPC is a second class citizen! Seismic processing applications like wide azimuth and tomography need to 'see' all data and the distributed computing paradigm is not so good in this context. Neri sees a breakthrough in Panasas' parallel storage and multiple Gigabit Ethernet connectivity. A 20 fold improvement was observed on one migration algorithm. This was achieved by de-tweaking prior 'optimizations' and running the application on a virtual machine with parallel storage.

0714_12.1 Q&A

How do you restore after an outage?

With RAID VI or even RAID on each hard drive?

What about space requirements?

The latest systems are getting smaller. BP will run out of power before we run out of space.

TW0714_13 HPC in BP – Keith Gray

BP is using HPC to create new ideas and solve problems like deepwater imaging. Innovative techniques like wide azimuth towed streamer acquisition and seismic nodes on the seabed were 'proved' in the computer before field tests. These have now been industrialized with, for example, PGS' Crystal wide azimuth towed streamer (WATS) survey covering 400 OCS blocks and resulting in 200 terabytes of field data. BP's own HPC setup now boasts Intel quad core Xeons totaling 15,000 CPUs and a 125 terflop bandwidth. Storage is currently 500 going to 750 terabytes of Panasas disk and 2 petabytes of SGI CXFX 'and we still can't keep

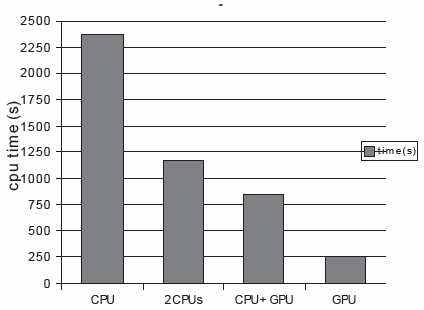
[8] *Image courtesy Headwave.*

up'. BP has been testing Cluster File System's Lustre file systems—which 'looks promising.' Looking to the future there is a pressing need to build bigger file systems that assure data integrity. 'We can't afford to lose data that took weeks to compute.'

TW0714_14 HPC Session[9]

0714_14.1 HPC in Total – Henri Calandra

HPC is about 'looking for the efficient match between data, algorithms and platform.' Depth imaging evolution is closely related to HPC progress which in turn revolves around CPU count, interconnect speed, memory bandwidth and programming models. New technology will impact depth imaging algorithms as the following graphic of hardware and speed of parallel computation for various CPU/GPU architectures indicates.



CPU times and architectures.[10]

Optimizing HPC involves addressing load balancing, kernel optimization, data distribution, and communications. HPC needs to take advantage of hardware specifics and the intrinsic parallelism of the algorithm. Load balancing involves optimizing data management and compute distribution. Depth imaging algorithms will benefit from the new hardware platforms. By introducing several levels of parallelism we can push the limits of scalability and assure load balancing across novel hardware architectures.

0714_14.2 Targeting the bright spot with HPC – Henri Houllevigue, Total

Houllevigue traced the impact of HPC as an enabler in geophysical R&D – from 4 azimuth (Nkwane Elf Gabon, 1995) through dual azimuth (Bullwinkle Shell GOM, 1998) to 3D wide azimuth seismic (Mad Dog BP 2004). The success of these high end techniques relies on a blend of code, acquisition and HPC. Today's HPC challenges include 3D wide-azimuth, 3D finite difference acoustic and visco-elastic modeling, one-way shot profile migration, reverse time migration and full waveform inversion. Interaction between the seismic depth domain and the geological/reservoir model adds another challenge. Houllevigue expects that reverse time migration (RTM) will be ready for prime time by 2010. The extent of the challenge can be gauged from the fact that RTM processing of a 300 sq. km. survey, even at a modest bandwidth of 3-55 Hz would takes 2 years on a 20 teraflop machine. One recent RTM imaging job took Total 6 months. Houllevigue introduces the concept of imaging 'efficiency,' a blend of depth imaging tools and competencies spanning PSDM algorithms (depth imaging group), model building (asset teams), interpretation and, HPC (IT).

0714_14.3 Hybrid hardware, PERCS software, an HPC 'call to action' – Earl Dodd, IBM

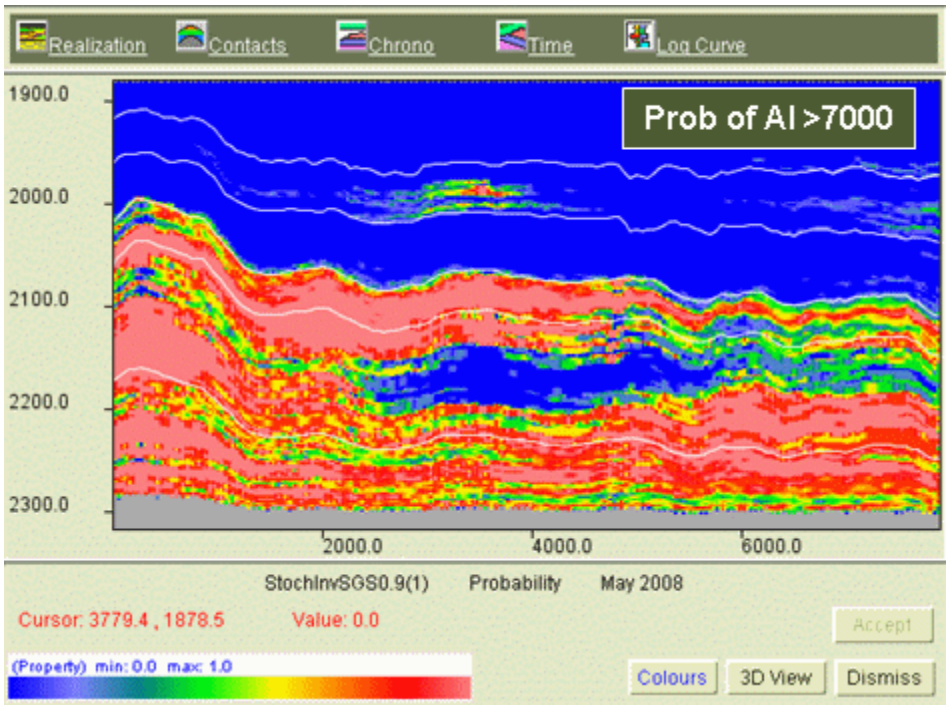
Dodd set the scene with some projections of HPC bandwidth requirements. The Mission-Oriented Seismic Research Program (M-OSRP) at the University of Houston (www.mosrp.uh.edu) is working on seismic codes that require 45 x 10e15 FLOPS. This compares with the Intelligent Oilfield at 1.7 x 10e21 FLOPS and, most surprisingly, modeling inventory planning and deployment of 10,000 spare parts at 2.4 x 10e15 FLOPS! For Dodd, the software 'ecosystem,' including application workflows and people are both the problem and the solution to achieving 'petascale' computing. On the horizon are complex hardware architectures - with GPU/Cell BE/DP/Quasar Power6/7 and Blue Gene Q. IBM expects massive compute 'scale-up' with systems 100-1000 times bigger than those installed today. There is also a need for storage and visualization to scale with compute power. Power issues are being addressed by 'non homogenous' multiprocessor architectures such as the Cell BE. Memory issues will be solved with 'streaming DMA architecture' and a 3-level memory model with main, local and register memory. On the software

[9] *We were unable to stay on in San Antonio for the HPC event on Friday. We thank the presenters who were able to supply their slides for this short review.*

[10] *Image courtesy Total.*

(development) side the productive easy-to-use reliable computer system (PERCS) programming model offers tools and compilers tuned to HPC. Dodd sees disruptive forces in system design at work and issues a call to action in the face of complex infrastructures that will impact system utility and 'salience.' Note too that 'hybrid systems' are on the fastest raw performance track – beating even GPUs.

TW0714_15 Ikon Science – RokDoc-3D4D



Stochastic inversion in RokDoc 3D4D[11].

Ikon's RokDoc 3D4D includes a stochastic inversion module that targets asset teams and those involved in real time measurement while drilling operations. Multiple parameters can be tested and viewed as stratigraphic slices, fences and volumes. Stochastic realizations are stored as seismic volumes. More from www.ikonscience.com.

TW0714_16 Intel HPC roadmap

Intel's HPC director Paresh Pattani's presentation described how Intel was 'tuning' its multi core products to the seismic HPC market. Multi core is important to get over the 'thermal wall' that Intel is currently facing. Over clocking is confronted by a square law of increased power consumption. It is better to decrease frequency and add extra cores. Unfortunately this is not without consequences for the software developer. Intel's 7x00 series offers a return to large shared memory architectures with up to 256 GB addressable – designed for large Oracle databases. In the HPC space the 5x00 series is 'good for seismic,' while the 3x00 series is better for reservoir modeling. Intel now offers a full suite of compilers and has acquired parallel/threading technologies and an MPI debugger. Cluster solutions are certified to run out of the box. Seismic benchmarks on 8 processor platforms will be 7 times faster than the single processor solutions of two years ago. Reservoir simulation does not scale so well with multi core architecture. 8 processors give only 3 times speed up over a single processor. 'Bandwidth per core is where it's at.'

Q&A

More cores, faster cores are great but there is concern about the ability of memory bandwidth to keep up.

That's true – but there are OEM[12] solutions. We have faster CPUs than a Cray but balance is where it's at. This is why Intel is no longer a microprocessor company but is rather a computing platform company. We will be seeing the same issues with GPU-based computers next.

TW0714_17 JavaSeis – Chuck Mosher, ConocoPhillips

Speaking on the Landmark booth to a good audience, Chuck Mosher (ConocoPhillips) traced the history of

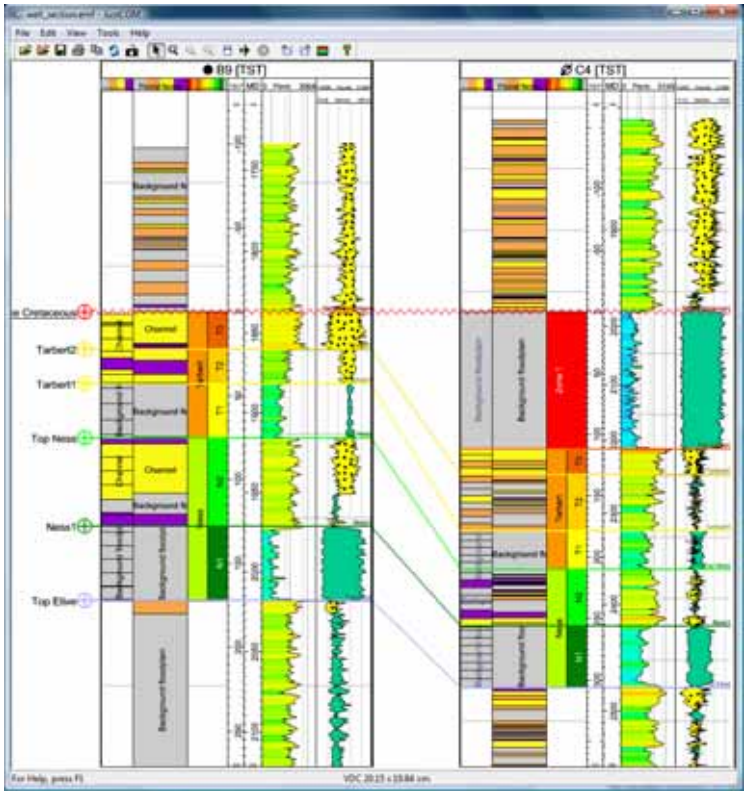
[11] *Image courtesy Ikon Science.*

[12] *Original equipment manufacturer – like Appro.*

the JavaSeis project[13]. ConocoPhillips, Arco and Chevron all contributed intellectual property to the project which is now in the public domain. The main value proposition of JavaSeis is its support for parallel input/output (I/O) and the 'parallel distributed array' concept.

Typical seismic processing is done on a trace, or on an 'ensemble' of traces, at a time. 3D 'process-lets' produce small but cascading quality improvements. Unfortunately these are hard to implement and manage on clusters, which is where JavaSeis comes in. JS treats seismics as n-dimensional array of sample, trace, frame, volume... Array elements are associated with (mapped to) 'logical' names like 'trace,' 'shotpoint,' etc. Complex objects like marine 4D data can be built from 2D arrays of time, channel and sail line. JavaSeis' 'filing cabinet' metaphor allows for massively parallel I/O and introduces 'true' multi dimensional arrays à la Fortran into Java. Code is written for serial processes or for a single processor and JavaSeis manages parallelization behind the scenes. Unlike many conventional approaches, data is processed 'in situ' and not moved around – resulting in the 'fastest sort in the world.'

TW0714_18 Justcroft – JustCGM for Windows (and Petrel)



JustCGM for Windows[14].

Justcroft's JustCGM for Windows offers visualization, conversion and plotting of computer graphics metafile (CGM) image files. Justcroft and Schlumberger have teamed to offer this solution for converting Petrel generated EMFs to CGM. The functionality is available in Petrel's Process Manager allowing for processing in batch mode. The tool is also endorsed by Talisman. More from www.justcroft.com.

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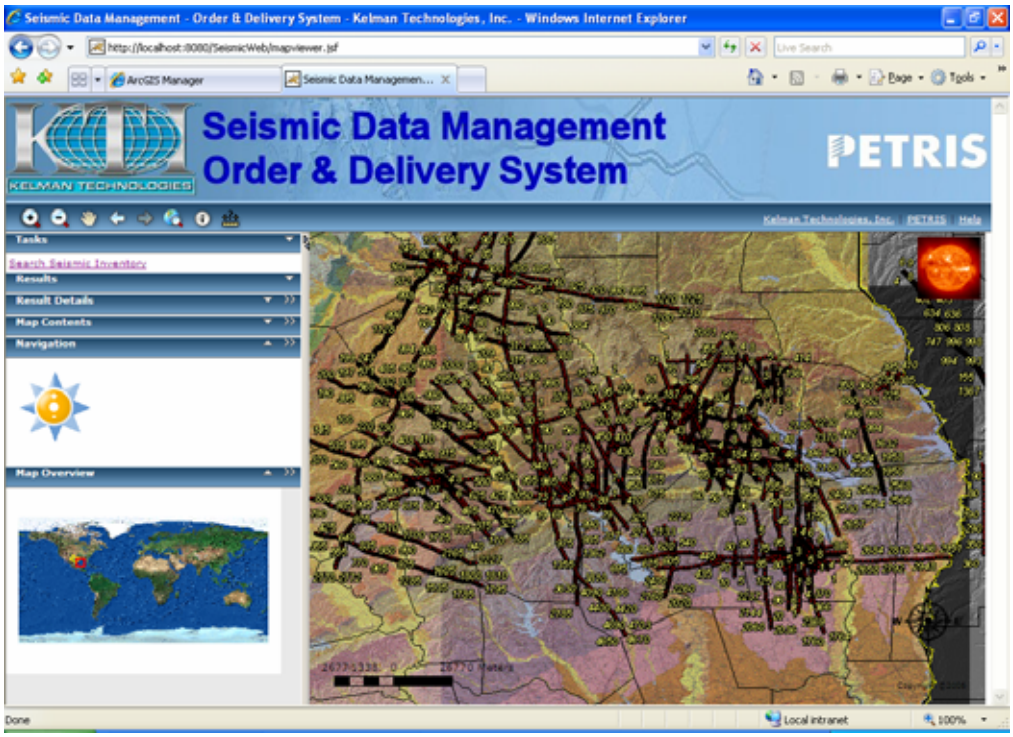
[13] *javaseis.sourceforge.net and www.javaseis.org.*

[14] *Image courtesy Justcroft.*

TW0714_19 Kelman's seismic data management system



Kelman's new seismic data management system.[15]

Kelman's new seismic data management, order and delivery system was custom built from Petris WindsEnterprise. The interface shows digital terrain, geology and a classic ESRI interface for map control and search. The system is used internally for database QC. Data can be ordered and loaded into a workstation project.

TW0714_20 Landmark – integration of JavaSeis in ProMax[16]

JavaSeis is the default storage format for Landmark's SeisSpace seismic processing environment. JavaSeis is also the native I/O subsystem for the new parallel processing option in SeisSpace. Significant performance improvements are reported for sorting and FXY deconvolution which was previously constrained by hardware limitations. It is now possible to work with an 'ensemble,' a prestack data subset, and perform true 3D operations with 3D algorithms. A new 3D visualization toolkit has been built for processing (as opposed to previous use of interpretation visualization tools). JavaSeis provides efficient support for sparse datasets. JavaSeis' efficiency stems from its use of in situ data. A sort is performed by manipulating header information. Sorted traces are read from disk locations without rearranging bulk data. JavaSeis' file storage was originally written in Fortran to fix NFS deficiencies. It includes code to handle failing clusters and poor cluster latency – all of which is hidden from the programmer.

TW0714_21 Landmark acquires Geosmith

Landmark has acquired the Geosmith's Shapes modeling engine. This has already been deployed in GeoGraphix' SmartSection and will be embedded in the R5000 release of EZModel. The modeling toolset provides framework-based interpretation for basin modeling through to simulation. A 'sealed' framework is updated in real time. EZModel can be fired up from inside Geoprobe where faults and horizon can be repicked and the framework updated on the fly. The framework can be sealed with a couple of clicks. All this happens inside Geoprobe, without going out to the modeling application. Model results can be constantly checked with seismic data.

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[15] *Image courtesy Kelman.*

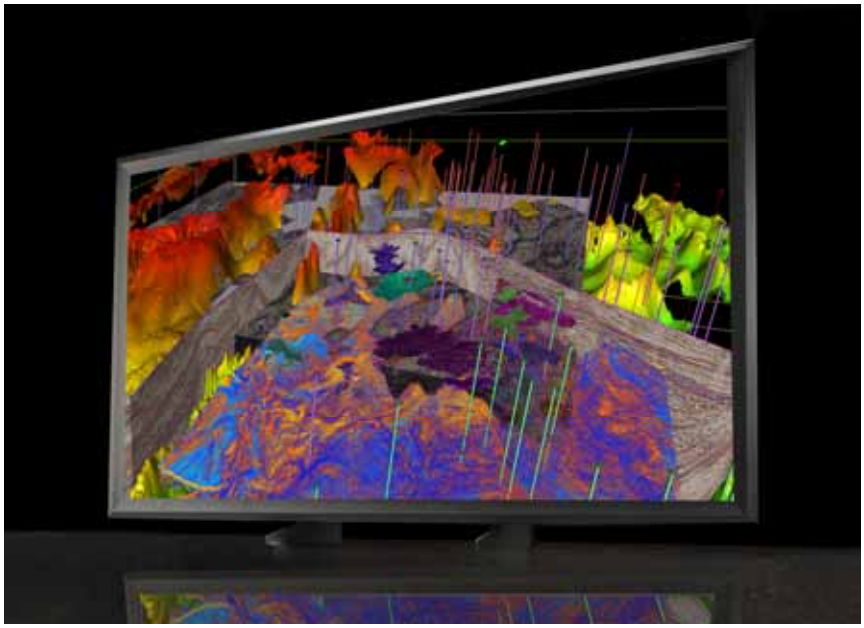
[16] *This demo made with Impress and OpenOffice - http://www.openoffice.org/product/impress.html. .*

TW0714_22 Landmark offers Storwize data compression

Storewize STN-6000 hardware compression[17].

Landmark is to offer compressed seismic data storage through a 'preferred provider' deal with San Jose, CA-based Storwize Inc. (Storwize changed its name from Storwiz earlier this year.) The Storwize STN 6000 device sits between the user and disk storage and offers a claimed lossless compression of a factor of about four for a database and around twofold compression for seismic data. Storwize's marketing now places less emphasis on high compression ratios—the company's real intellectual property lies in the bit level access. This means that the compressed representation of a database for instance can actually be queried. A background compressor is also supplied for large volume legacy data. A 'revert box' software package decompresses data on the disk in the event of a failure of the STN device for 'worst case disaster recovery.' Storwize states that SEG Y data shows '55%' compression, in other words, a 100TB of data is compressed to 45TB with 'no impact' on performance. The box is a 30 minute 'plug and play' install with no change to existing infrastructure. Landmark, as 'preferred provider' of the STN 6000 to the E&P industry, offers global delivery and installation of the product, as well as deployment and integration services. Storwize works with most network attached storage including EMC and NetApp. Storwize claims 120 appliances have been shipped worldwide.

TW0714_23 Landmark's instant team room display



Instant Team Room

Landmark is offering a huge 56", 8 megapixel screen. An 'Instant Team Room' bundle comprising the screen and a Verari E&P 7600 visualization system comes in at under $100,000. The screen is driven by the NVIDIA Quadro Plex. More from www.lgc.com.

[17] *Image courtesy Storwize.*

TW0714_24 Maxeler MAX-1 FPGA-based seismic processing

Maxeler Technologies, working with the Stanford Center for Earth and Environmental Sciences (CEES) is claiming a 48 fold speed up on a shot profile migration on its MAX-1 FPGA card with a single Xilinx Virtex-4 FPGA. The speed-up compares with a single AMD Opteron node. More from www.maxeler.com.

TW0714_25 Microsoft and Schlumberger collaboration, Ed Draper, Microsoft

Schlumberger Information Solutions SIS and Microsoft have been collaborating since 2000 on .NET which, according to Draper, is Microsoft's infrastructure for connected systems. With .NET there will be 'no more tailor made, point solutions for particular situations.' Standards, such as http, TCP/IP, RPC and SOAP 'are essential.' Collaboration is based on Windows SharePoint (WSP) Service and new .NET-based tools in Microsoft Office. SIS has leveraged .NET technology in its Ocean API including the Windows Forms GUI, Windows Workflow Foundation, the BITS file transfer (as used in Windows Update and in the Ocean update service), XPS file format and MS coding guidelines. SIS has adopted Windows as 'the sole platform for the desktop'. Schlumberger's is said to be the largest single product code base on Windows (according to the Microsoft team. A Vista64bit edition of Windows will be released in Q1 2008. There is a SQL Server 2005 option for the Seabed database. Eclipse Parallel edition runs on Windows Compute Cluster Server. In the near future, SQL Server 2008 (Longhorn) will release with spatial data types, round earth geodetics and flat earth OGIS simple feature and spatial indexes for both.

TW0714_26 NVIDIA deskside supercomputer

NVIDIA ubiquitous

NVIDIA's Quadro and Tesla boxes were everywhere at the show. The Quadro Plex boxes offer hardware accelerated graphics. The Tesla D870 is NVIDIA's GPU-based computing engine in a box – a.k.a. the 'deskside supercomputer,' powered by two 128-processor core GPUs. PCI x16 board and rackmount versions are also available. More from www.nvidia.com/tesla.

TW0714_27 Panasas – ActiveStore cluster for seismic processing

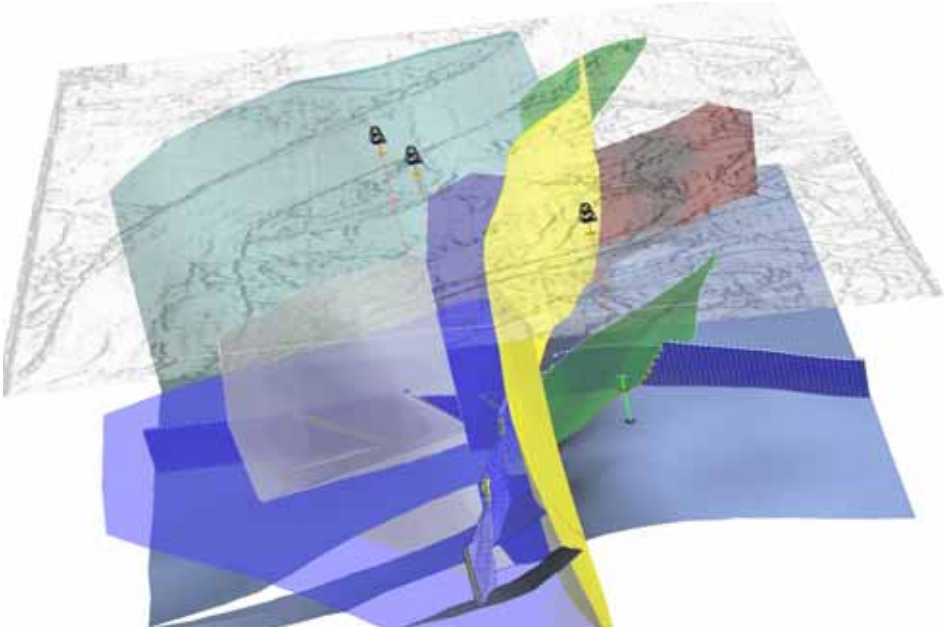
Panasas' first, and still largest, customer is the Los Alamos Natonal Lab with over 2PB of storage. Intel is a customer and uses a 12,000 processor cluster to build its new chips. Panasas has released an ActiveStore cluster tuned for use with Paradigm's Geodepth[18] seismic processing system. Significant performance advantage is claimed over NFS filesystem-based storage. Panasas is working with Paradigm, Landmark and Fluent CD/Adapco to parallelize code, 'not just for clusters but also for I/O.' Panasas' enhanced data path to all parallel storage system vendors is moving to 10GB Ethernet 'across the board'. The 'big thing' this fall is parallel NFS. More from www.panasas.com.

[18] *http://www.panasas.com/docs/ParadigmGeoDepth_SolnBrief_FINAL.pdf*.

TW0714_28 Paradigm – SKUA

Gibson in green shirt.

At the SEG, Paradigm personnel were sporting very green shirts in a visual rebranding exercise, emphasizing its status as a third upstream software pole, alongside Halliburton's red and Schlumberger's blue. The positioning was backed up by the roll-out of a brand new seismic interpretation tool, 'Skua,' for 'subsurface knowledge unified approach.'



Paradigm's SKUA interpretation system.[19]

Skua (previously called 'Ingrid') traces its origins back to work done by Jean-Laurent Mallet's team at the École Nationale Supérieure de Géologie in Nancy, France, the team behind the previous GoCad geomodeler[20]. Paradigm's 'Skua,' the 'Seismic Knowledge Unified Architecture' is the result of three years of further Ingrid development. Skua takes seismic data in the conventional time or depth domain and transforms it into a 'paleo-chronologic' coordinate system. An unstructured tetrahedral mesh that can be deformed and un-deformed places each cell at its depositional location. Working with a palaeo-geographically 'correct' mesh, geobodies, reservoir properties and other attributes can be studied in their depositional state. Skua is claimed to facilitate model building and to circumvent the limitations of pillar grids and 2 ½D 'extrusion' representations. Skua is expected to help geostatistical reservoir studies by providing 'more realistic in-situ realizations of syn-depositional effects.' Deformation can be tracked with time in a 'film' of sedimentology and tectonics. The technology relates to the 'Wheeler' chrono-stratigraphic diagram as used in Exxon's sequence stratigraphy. Paradigm also claims that Skua is essentially scale independent – and that it can equally be used for basin and reservoir scale studies.

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[19] *Image courtesy Paradigm.*

[20] *See also the GeoChron project paper at http://aapg.confex.com/aapg/paris2005/techprogram/A98764.htm*

TW0714_29 Petrosys and Petrel integration

Petrel does 3D and Petrosys adds high-end 2D mapping from a large number of data sources and formats. Petrosys and SIS share common customers who want to make presentation quality maps using Petrel grids, surfaces and well data for posting. Structural data in Petrosys can be shared with Petrel models and Petrel data can be gridded in Petrosys. Schlumberger's Ocean API was used to create 'rich connections' not just point to point. The Petrosys map/viewer is now integrated with the Petrel menu. A demo using the Gulfaks dataset showed Shape files and well data from the NPD, data from SeisWorks etc. Petrosys' EPSG-based coordinate reference system management can redraw to another projection on the fly. More from www.petrosys.com.au.

TW0714_30 Planar Systems' SD2020 stereo monitor

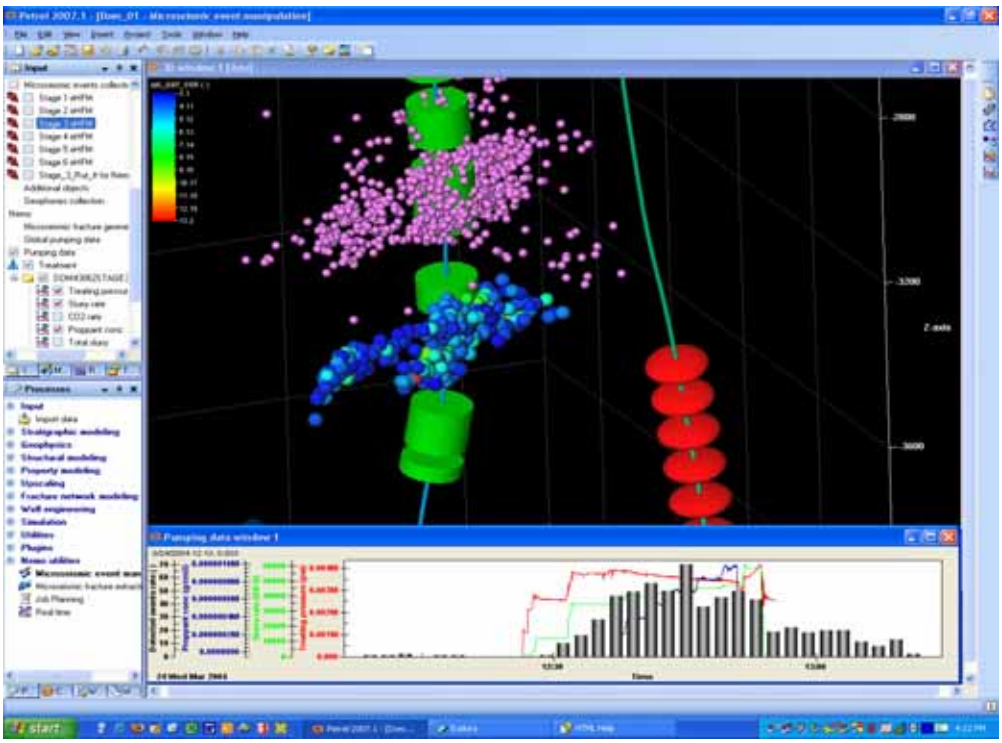
Planar Systems' SD2020 20" stereoscopic monitor.

Planar Systems showed two high-end stereoscopic 3D monitors at the SEG conference. The SD2020 stereo monitor has a 20" display with 1600x1200 stereo resolution while the SD2320W had 23" wide-format displays with 1920x1200 resolution. More from www.planar3d.com.

TW0714_31 Schlumberger – Petrel's new 'probe,' plug-ins, data management

Schlumberger Information Solutions (SIS) and third party software developers are 'adding value' to the Petrel interpretation flagship, leveraging the 'Ocean' development framework. Tightest integration with Petrel is achieved by 're-factoring' an application (rewriting the code) to take full advantage of Petrel's .PET database file. Companies with niche applications can embed their intellectual property (IP) into Petrel and have the resulting composite certified by Infosys.

An example of a ground-up re-write was the appearance of **spectacular voxel-based 'probe'** interpretation technology inside Petrel. This leverages graphics processing units (GPU) for rendering and geobody interpretation. An offshore West African crevasse splay play was shown, with 'tuning' of probe amplitudes to optimize discrimination of reservoir sands from shales. A 'WYSIWIG' geobody picking tool gives a rough outline to the sand body in a semi automated process which did a reasonable job of following the channel. This was instantly 'cellularized' and color coded with seismic-derived attributes.



Microseismic application in Petrel.[21]

A Schlumberger-developed **microseismic** monitoring application has been integrated by embedding new data objects into Petrel. This showed a real time monitoring of a Barnett Shale frac job with a dual display of fracs 'popping' with a second window showing engineering data on pumping and slurry rates and proppant concentration as a function of time.

Third parties like Ikon Science, Petrosys and Geovariances have joined the Petrel developers' club. Ikon's 'RokDoc' seismic modeling can be kicked off from within Petrel, a wavelet extracted from the data and then used to build rock physics models. A full version of RokDoc is available from within Petrel and picking is mirrored in both applications' windows. Geovariances' Isatis geostatistical package can now share data with Petrel and Petrosys has added presentation quality mapping for Petrel—leveraging the Ocean API's 'rich connections' between Petrel and other data stores.

Petrel's data management is improving. Coordinate reference management is possible – although this is done in ProSource rather than in Petrel. Multiple Petrel projects can be viewed and managed in ProSource. Today Petrel project metadata and results can be stored in Seabed thanks to the information management extensions. One Houston-based client manages its data in the UK remotely with PS. SIS is offering IM specialists advice on consolidation and migration of Petrel 2005 projects, publishing a spatial inventory prior to P 2007 migration. In a future release, there will be an option to store Petrel bulk data in Seabed. Petrel will keep its current project based file system however, with data replicated between Petrel and Seabed.

TW0714_32 SEG Advanced Modeling Project (SEAM)

The SEG has created the SEG Advanced Modeling project (SEAM) Corporation to develop synthetic data sets for algorithm testing. Members have currently chipped in over $1 million to the SEAM fund. Members include PGS, BHP Billiton, Total, CGG, Shell, Halliburton, Exxon and WesternGeco. After an initial period, results of the modeling will be made available to the SEG membership at a nominal cost.

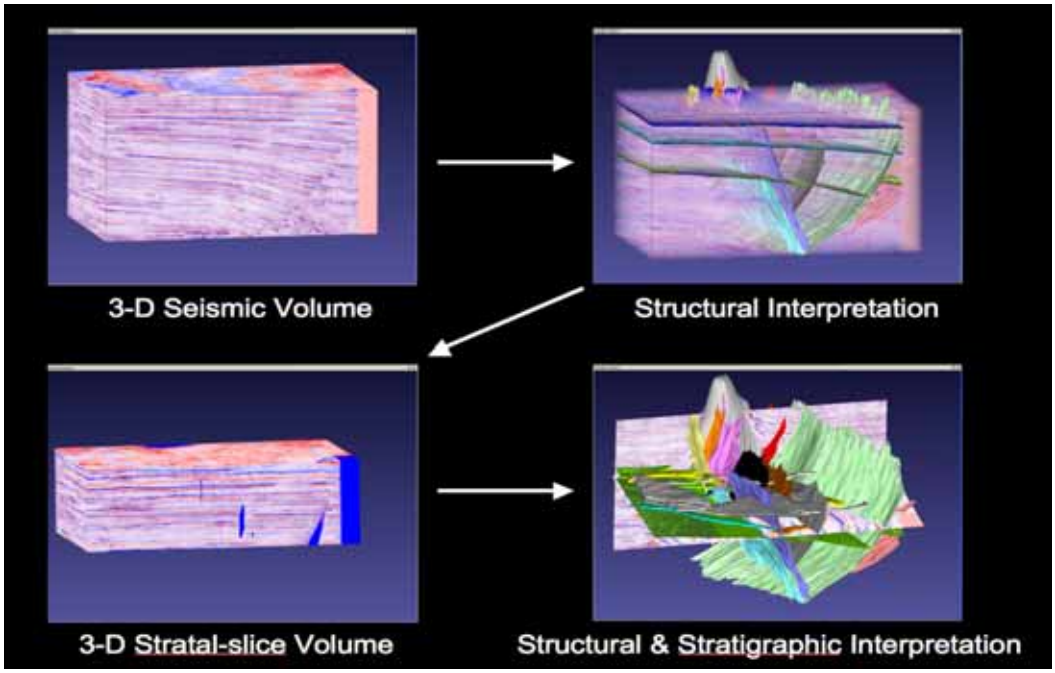
[21] *Image courtesy Schlumberger Information Solutions.*

TW0714_33 Spatial Energy – image data hosting

Spatial Energy – high resolution imagery to order[22].

Spatial Energy's Energy Partner Program (EPP) is an annual imagery subscription program that provides simplified, cost effective (30-50% savings) access to satellite imagery. Spatial integrates archives of geospatial data such as satellite imagery, aerial photography, topographic maps, and digital elevation models (DEMs) into a single online database. Spatial will also host client's image data from a centralized, secure site. More from www.spatialenergy.com.

TW0714_34 TerraSpark – computer aided stratigraphic interpretation



TerraSpark's Computer Aided Stratigraphic Interpretation workflow[23].

According to TerraSpark GeoSciences' CEO Geoff Dorn, 'We don't compete with VoxelGeo or GeoProbe, we just make them better.' TerraSpark's Stratal Slice technology transforms acquired seismic volumes into a 'depositional environment' volume in which palinspastic reconstruction is used to visualize channels and sedimentology that do not appear on a times slice. A mathematical transform, the CASI calculator, moves voxels back and forth from the seismic structural and depositional domains. Automated fault extraction, 'surface wrapping' (geobody extraction) combine in what TerraSpark calls Computer Aided Stratigraphic

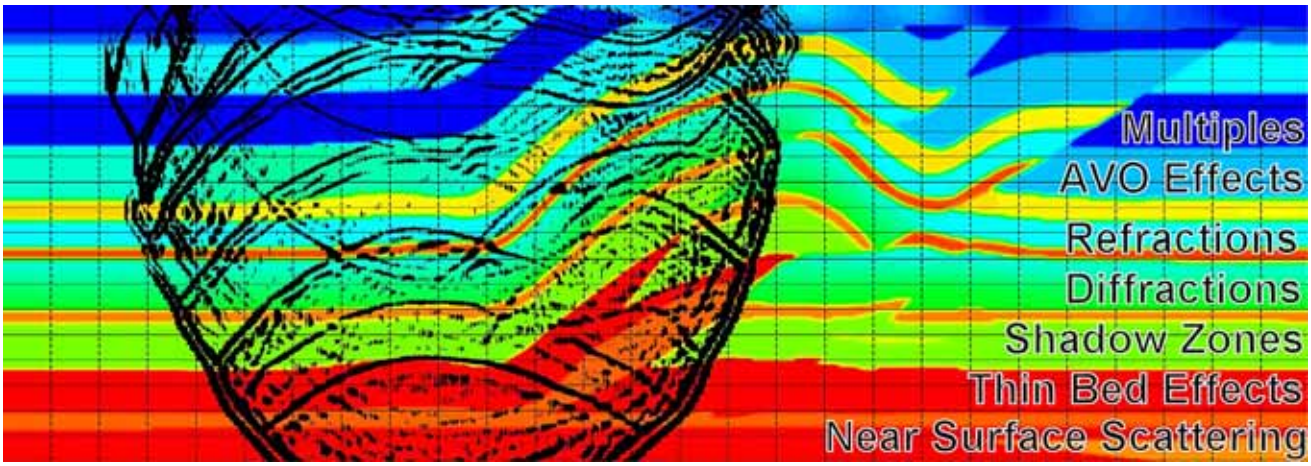
[22] *Image courtesy Spatial Energy.*

[23] *Image courtesy TerraSpark.*

Interpretation—CASI. Geobodies and other objects can be turned on or off in the display. CASI and the stratal slice developed under the Geoscience Interpretation Visualization Consortium[24] (GIVC).

TerraSpark has teamed with Transform Software to market its interactive drilling planner and with JOA to develop a Jewel Suite plug-in of its automated fault extraction technology. More from www.terraspark.com.

TW0714_35 TierraGeo 3D finite difference modeling



Tierra Geophysical's 3D seismic modeling[25].

Tierra Geophysical offers 3D seismic modeling of geology and artifacts for comparison with acquired data. Tierra's 3D finite difference modeling is the same approach as will be used for the SEG's advanced modeling project (SEAM). Tierra comments that finite difference modeling 'no longer needs a consortium,' and is available for individual companies. The likelihood is that SEAM will be able to increase the model's resolution to create a more realistic, high frequency, dataset. Tierra gives a strong endorsement to Dynamic Graphics' EarthVision for model preparation. More from www.tierrageo.com.

TW0714_36 The Data Room – Technology Watch subscription information

This report has been produced as part of The Data Room's Technology Watch reporting service. For more on this subscription-based service please visit the Technology Watch home page or email tw@oilit.com.

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Technology Watch

[24] *http://www.terraspark.com/GIVC.consort.*

[25] *Image courtesy Tierra Geophysical.*