BGP – BEYOND GEOPHYSICAL PROSPECTING

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中国石油集团东方地球物理勘探有限责任公司
BGP Inc., China National Petroleum Corporation

精诚伙伴，找油先锋
Loyal Partner, Energy Pioneer

Catalogue

CNPC
BGP

An Address from Chairman of BGP

As a globally trusted integrated geophysical service provider, BGP has served more than 300 energy companies during the last several decades with a remarkable footprint in over 70 countries, enabling BGP to become one of the leading geophysical contractors in the world today. In retrospect, it would be impossible for BGP to achieve such outstanding success without the steadfast trust and support of its clients, business partners and friends. To all of them, I would like to express my deepest appreciation.

As we all know, the energy industry has been subject to unavoidable changes in the markets in recent times, however global situations are forever changing and it can now be seen that the energy industry is becoming stronger after a turbulent few years and also it is changing with the need for transition from hydrocarbons to greener renewable energies. BGP, as a major geophysical services company, is actively preparing to meet such challenges by continuing to improve its strategies, developing innovative solutions, reducing operational costs

and attracting elite geoscience-talent. Also extending into non-hydrocarbon geophysical activities and assisting energy companies with their development of CCUS, geothermal and wind farm placements amongst others.

BGP has vigorously stressed that both technological and business innovations are vital to its success as demonstrated by the roll out of a series of core and proprietary technology packages that include the GeoEast® and KLSeis® software systems, rugged and reliable seismic instruments including the eSeis land node , the oSeis Ocean Bottom node and the shallow water DP hybrid vessel. Also included are the customizable land source products to accommodate variations in terrain, environment and imaging requirements including the high-precision broadband vibrator EV56, the shear-wave vibrator BV310S and other vibrator series along with high-productivity vibroseis techniques, the digitial-seis system and uDAS VSP techniques, etc. The application of these cutting-edge products enables BGP to design more efficiently

when executing the most complex seismic programs while lowering costs, improving data quality and considerably increasing client satisfaction.

One of BGP's core values is that the "Clients Come First" . BGP champions the idea of win-win cooperation, endeavoring to obtain all present resources, reducing client risk and helping clients discover additional hydrocarbon reservoirs at the lowest possible cost with the best service quality, while also extending its reach into helping energy companies develop their green energy portfolios.

BGP supports the philosophy of an open and inclusive culture by respecting every client and partner while greatly respecting differing cultures, religions and customs around the world. BGP is committed to its socially responsible activities and projects through its support of charitable causes and construction of roads, schools and hospitals, amongst others, which are essential in facilitating economic development of the countries in which BGP operates.
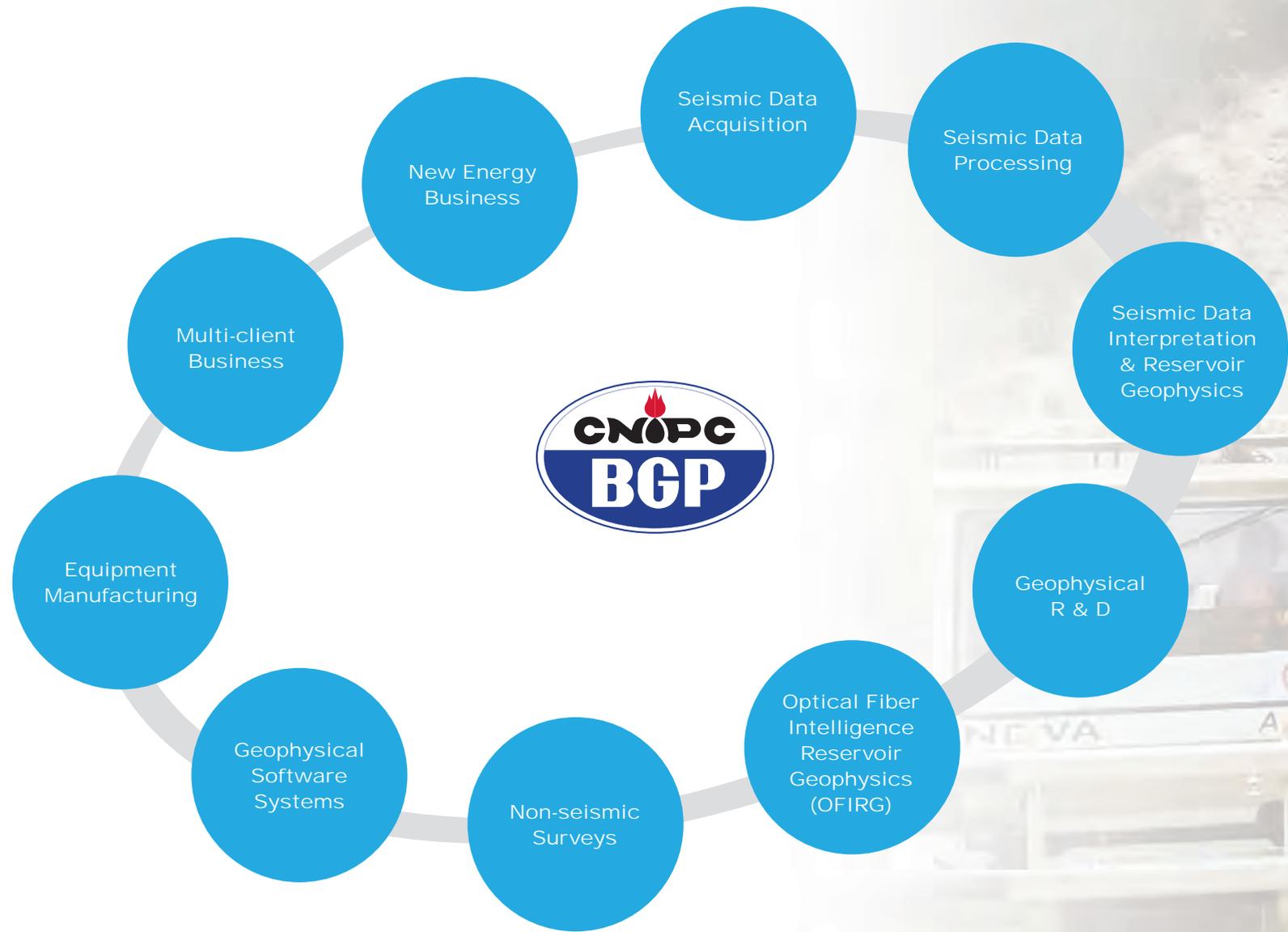
BGP will continue its dedication to geophysical innovation by accelerating the integration of programs and practices of seismic with non-seismic, onshore with offshore, in addition to the current integration of geophysics with AI technology. BGP believes these developments will create more value for its clients allowing them to continue in the improving energy markets and also with the necessary transition to renewable energies.

"Innovation is seeing what everybody has seen and thinking what nobody has thought." BGP continues to innovate in order to benefit the success of all its clients and partners.

Thank you!

Zhang Shaohua
Chairman of BGP

Seismic Data Acquisition

Seismic Data Processing

New Energy Business

Multi-client Business

Seismic Data Interpretation & Reservoir Geophysics

Equipment Manufacturing

Geophysical R & D

Geophysical Software Systems

Non-seismic Surveys

Optical Fiber Intelligence Reservoir Geophysics (OFIRG)

Business Introduction

BGP is one of the world's completely integrated geophysical companies, delivering a full spectrum of geophysical products and services while its state-of-the-art R&D facility is staffed with outstanding personnel that are unrivalled in the industry.

In 2002, BGP was formally established as a liability-limited company after its merger with six other geophysical divisions operating within different parts of China. BGP's headquarters are located in Zhuozhou City, Hebei province, P.R.China.

Currently BGP owns and operates a fleet of 156 land seismic crews, 6 OBC and OBN crews, 3 streamer vessels , 11 VSP crews, 22 non-seismic crews, as well as 16 seismic data processing and interpretation centres distributed around the world.

BGP has been actively engaged in seismic activities since 1951 in China with the opening of its international operations in 1990's. In all, BGP has proven to be a very good quality and reliable services provider for more than 300 energy companies around the world including almost all the major national and international energy companies.

Onshore Seismic Acquisition

Underpinned by the remarkable experiences accrued in the past 70 years along with the ownership of the most advanced technologies, BGP has the resources and confidence to successfully undertake seismic data acquisition projects under all terrain conditions, such as mountains, deserts, loess lands, gravel plains, swamps, jungles, and urban areas.

Additionally, BGP operates and maintains 65 onshore seismic crews outside China as well as 54 branches and offices spanning across the Middle East, Africa, Central Asia, Southeast Asia and the Americas.

PP	SS

PP	SS

Structure map of PP wave

Structure map of SS wave
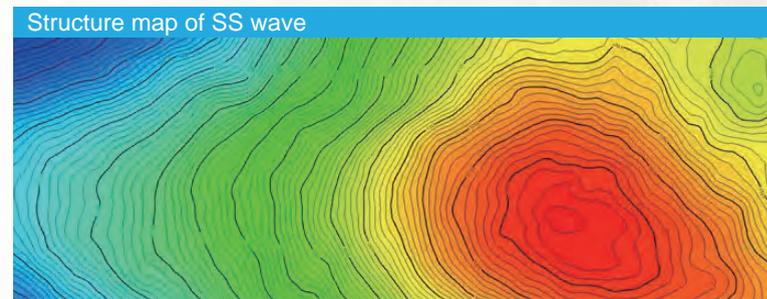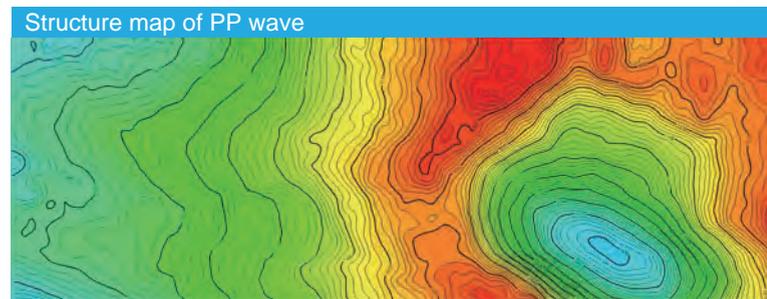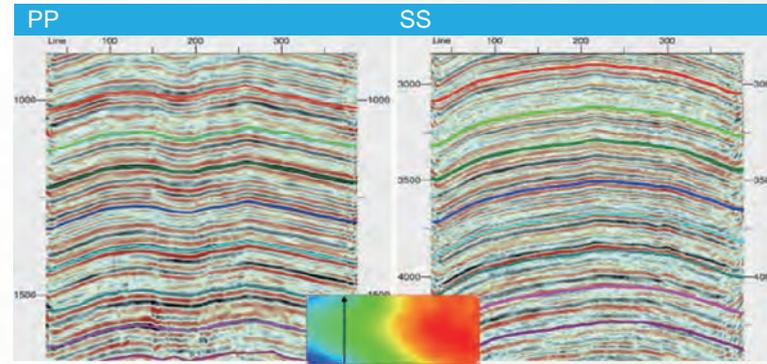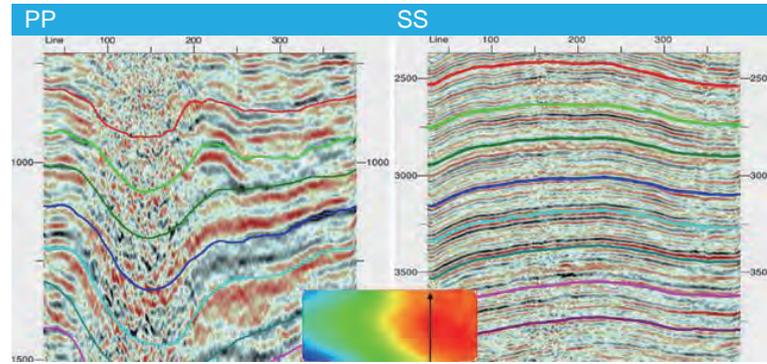
Full Wave Field

BGP has been performing land full wave field seismic acquisition in terms of nine-component data with the high precision vibrator EV56 (1.5-160Hz) and the specially designed shear wave vibrator (BV330S).

Full High Productivity

- Compressive sensing acquisition
- High channel-count acquisition
- Simultaneous acquisition
- Smart crew operation & QC

Compressive Sensing Design
Operation Optimizing Design

Seismic Acquisition Design

High Channel-count Receiving

Quantum/eSeis Nodal system (100K+)
G3i HD+SL11 Single Digital Sensor (230K+)

Full High Productivity

Simultaneous Shooting

Vibesis: ISS, UHP, FSSS, DSA
Dynamite: Autonomous shooting

Data Processing

De-blending
CS Data Re-structure

Smart Crew Operation & QC

DSS system, HyperQ, HyperSource
KL-RtQC, KL-SeisPro, KL-NodeQC

Offshore Seismic Acquisition

BGP provides the highest quality 2D, 3D and 4D seismic services globally using OBC / OBN and streamers

• OBN / streamer / TZ seismic solutions

• Seismic seamless design from land to marine

• Seismic source design and optimization

• Quality control and processing for large volume seismic data

• Comprehensive navigation and positioning techniques

• Offshore seismic equipment design and manufacturing

Automated NOAR deployment/retrieval system

• Fully automatic rope attach & de-attach system

• Deployment under tension

• Higher speed deployment (up to 4knots)

• Higher positioning accuracy

• Up to 500m water depth

• Containerized

BGP Innovator

• DP shallow water vessel

• Hybrid node handling and multi-source vessel

• Minimum draft of 2.5 meters

• Clean ship design notation complying with BV, USCG, EC/MED, IMO and OMD

• Equipped with10T-level QC processing, USBL, ADCP, USV and Ku-BAND VSAT system onboard

Seismic Data Processing

BGP offers a range of signal processing and imaging solutions, through its global processing centers. From acquisition through to final subsurface image, our integrated approach utilizes well logs, geological information and multi-physics into our imaging workflows and achieve geophysical objectives from large-scale exploration to reservoir focused imaging challenges.

Seismic data processing techniques and solutions

• Advanced statics solution (3D Tomo, DWI and SWI)
• Deblending (OBC/OBN, streamer and land data acquisition)
• Multiple attenuation (GSRME, EPSI, extended SRME ,ISS-IME)
• Velocity model building (FWI, Hybrid Tomo, Q Tomo)
• Complex structure imaging (RTM, LSM, Q-Migration)
• Marine seismic data processing (OBN, OBC and streamer)
• WAZ and broadband seismic data processing
• Time-lapse seismic data processing
• Multi-component seismic data processing
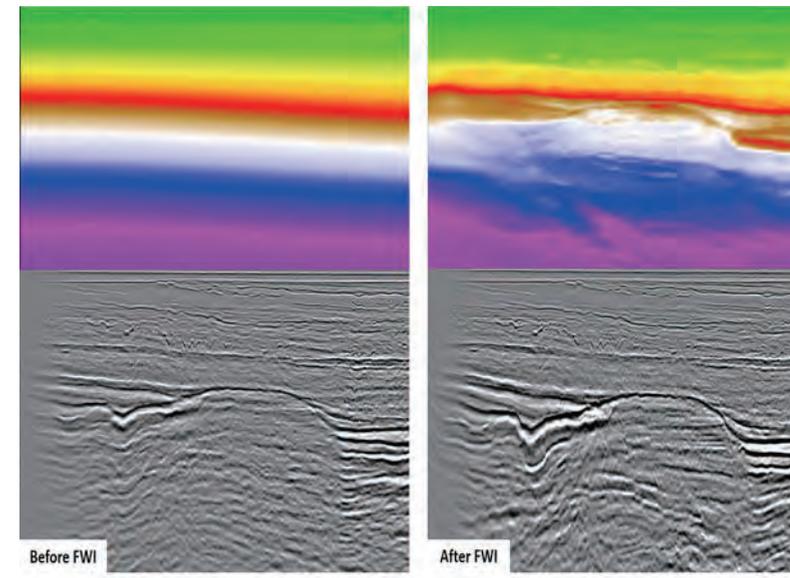• Shear wave seismic data processing
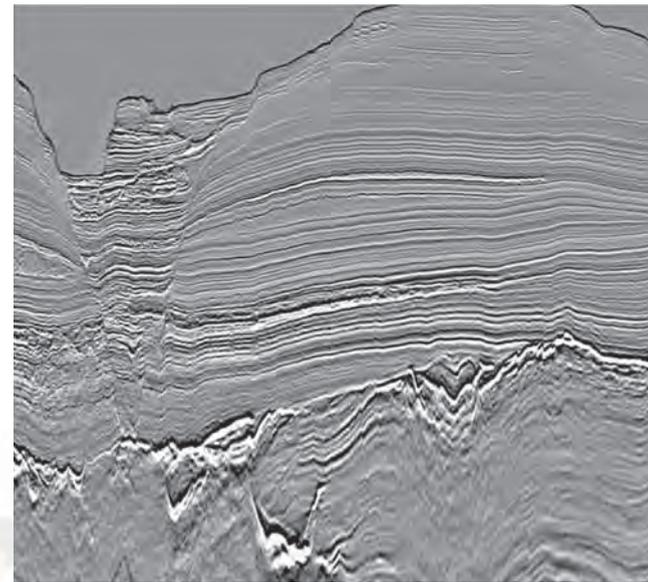
PSTM section from BGP broadband
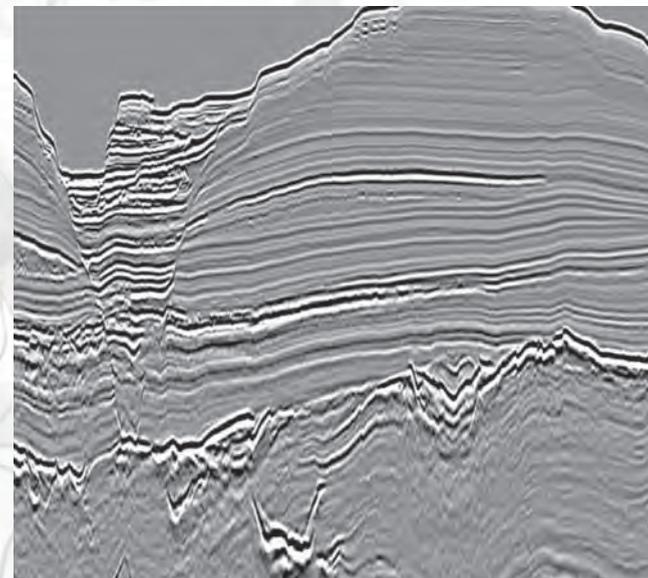
PSTM section from conventional processing
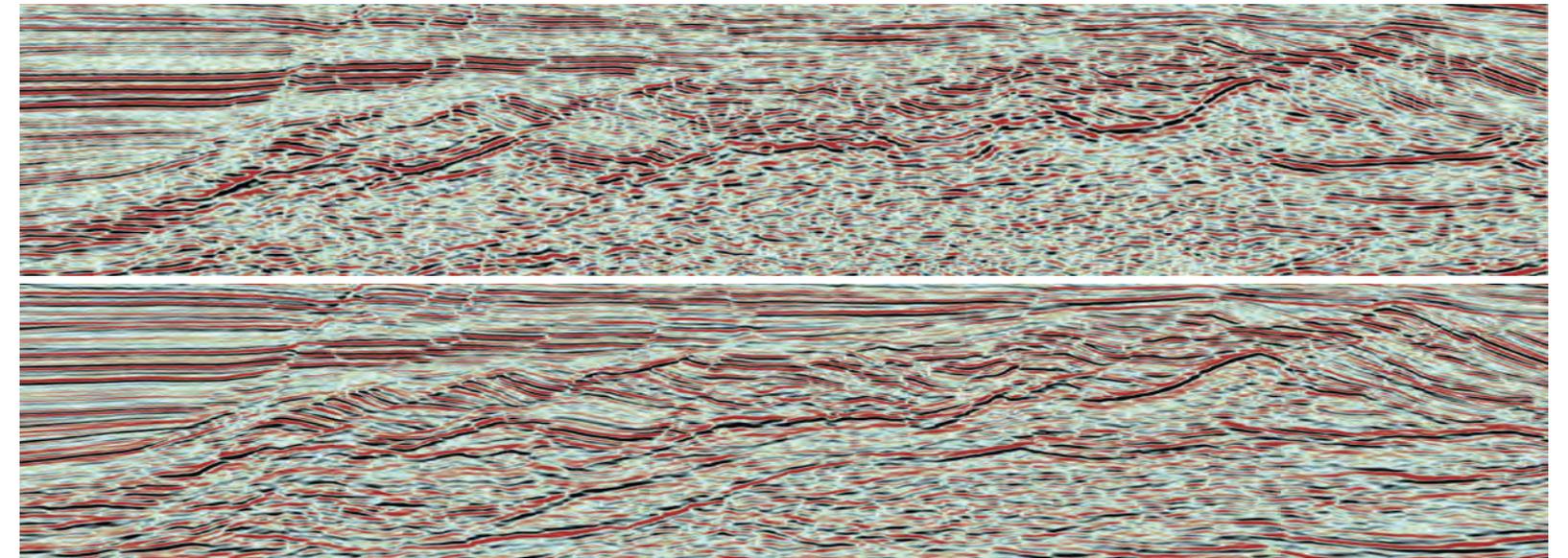
Legacy acquisition PSTM (top) vs New WBH acquisition PSDM (bottom)
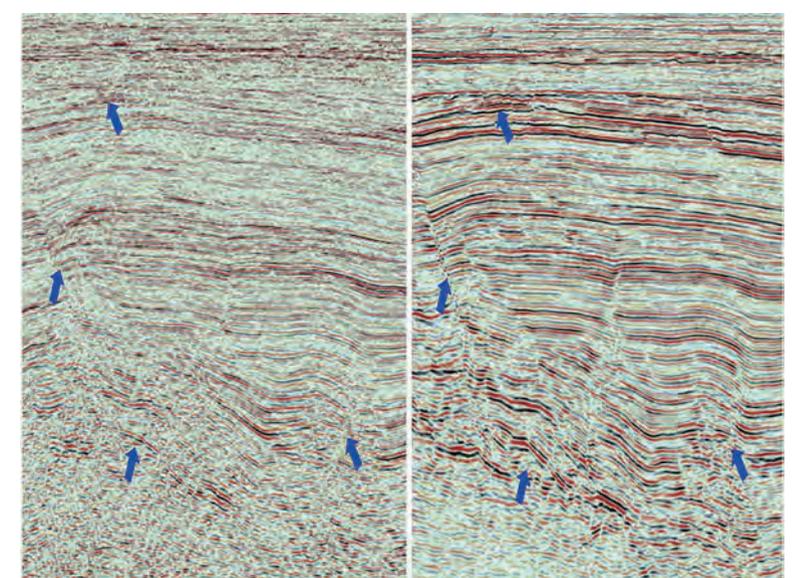

Before FWI

After FWI

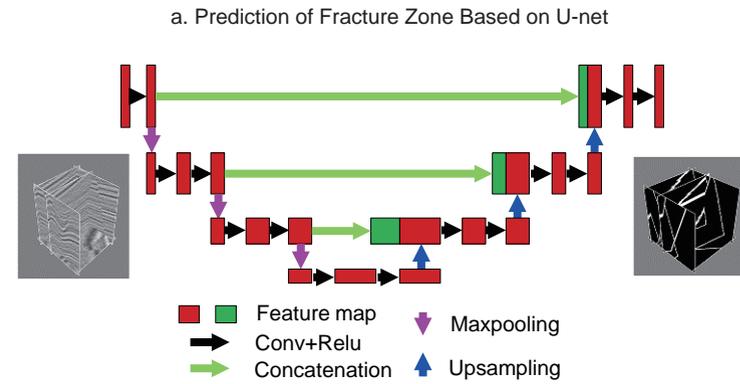Initial velocity with OBN PSDM section   FWI velocity and OBN PSDM section   Legacy streamer 3D PSTM section   New OBN 3D PSTM section
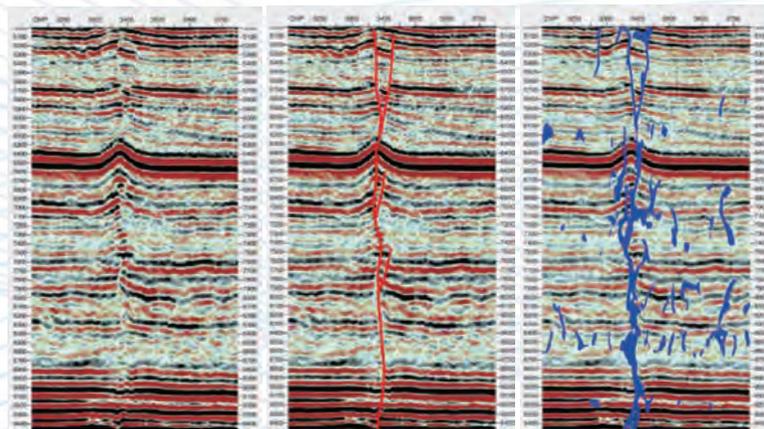
Seismic Data Interpretation & Reservoir Geophysics

Having dedicated itself to professional G&G studies for decades in a wide variety of basins and reservoirs in China and around world, BGP has developed an integration analysis system with many advanced techniques which are applicable to all kinds of reservoirs.

Whether characterization and monitoring are at the well, field, or basin scale, our specialists can use proprietary workflows to derive the maximum value from the seismic data obtained and provide real-time support and quick turnaround time based on our global presence.

a. Prediction of Fracture Zone Based on U-net

- ■ ■ Feature map
- → Conv+Relu
- → Concatenation
- ↓ Maxpooling
- ↑ Upsampling

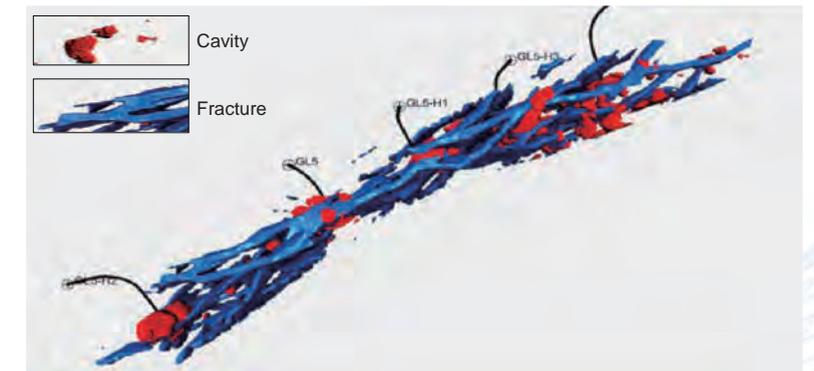b. Comparison of interpretation effect profiles

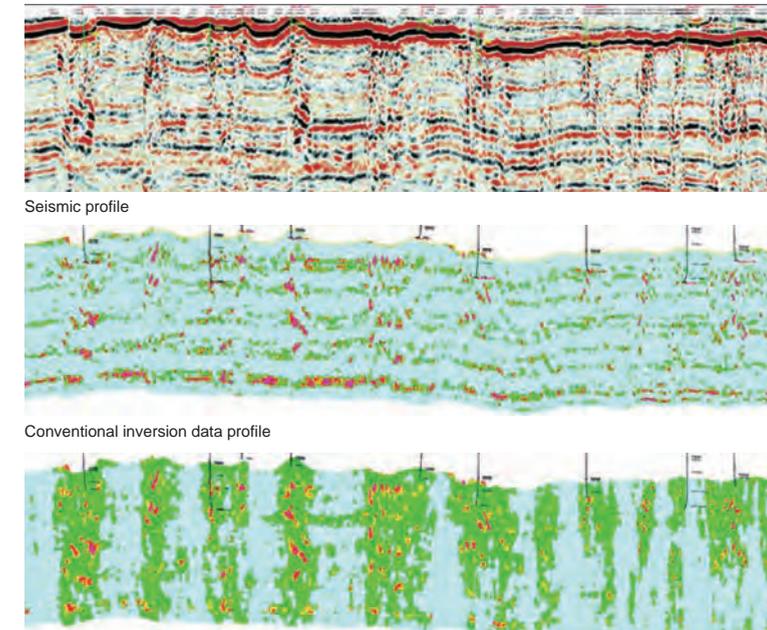## Data Interpretation Techniques and Solutions

- Multi-attributes analysis
- Thrust structure interpretation
- 5D interpretation & fracture detection
- PP-PS joint inversion
- AVO & pre-stack inversion
- 4D data seismic inversion
- AI interpretation
- Sweet spot prediction

Seismic profile

Conventional inversion data profile

"Double isochronous" phased inversion data profile

Comparison of different inversion data profiles

3D carving visualization diagram of fault controlled reservoir in FI19 fault zone
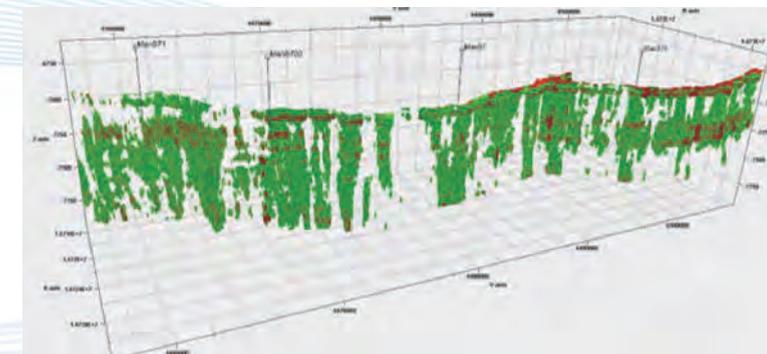
Reservoir Geophysics Techniques and Solutions

- Real time seismic guided drilling (SDG)
- Lithological / stratigraphic prospect identification
- Static modeling & reservoir simulation
- Petrophysical evaluation
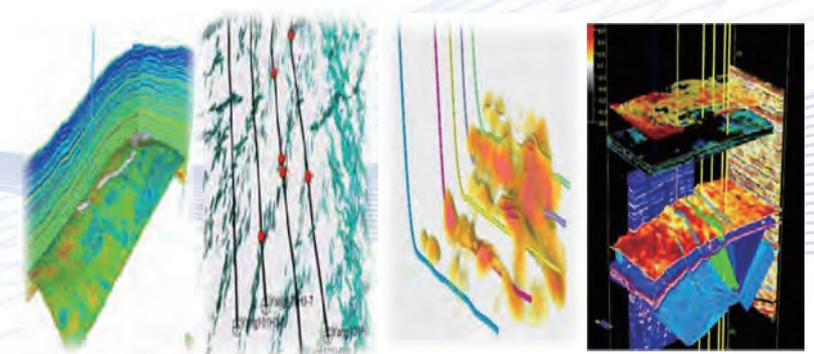- Pore pressure prediction (PPP)

Cavity

Fracture

3D carving visualization diagram of a fault controlled fractured-vuggy unit

Reservoir Geophysics

Geophysical R & D

We understand that it is the geo-talent that makes it possible for BGP to maintain a sustainable development. BGP has long-term strategies in the development of new technologies to improve the acquisition and processing quality of seismic data.

BGP has always attached great importance to technology advances. Our recent geophysical R & D is focused on OBN and broadband data processing, FWI, Q migration, multi-component PSDM, VTI/TTI velocity model building, 5D seismic interpretation, seismic-guided drilling and software Ecosystems.
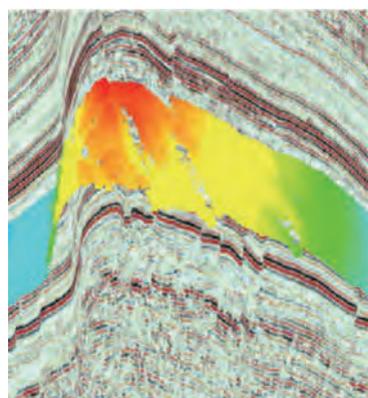
In the oil & gas exploration field, artificial intelligence (AI) techniques have been paid increasingly more attention. BGP attaches great importance to the research and development of AI techniques and recently, many intelligent technologies have been developed, such as intelligent velocity spectrum interpretation, first-arrival pickup, random noise attenuation, fault identification, horizon interpretation, logging interpretation, geological body identification, etc.
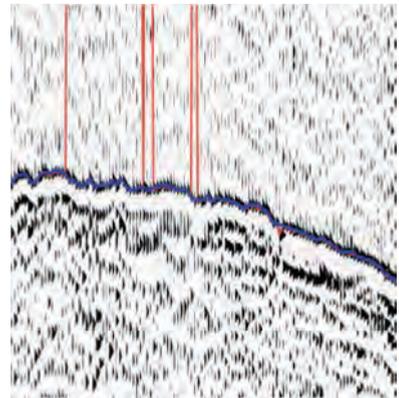
Traditional auto pick　　　　　　　AI pick　　　　　Deep learning horizon interpretation　　　Deep learning-based
　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　in 3D scene　　　　　　　　　fault interpretation
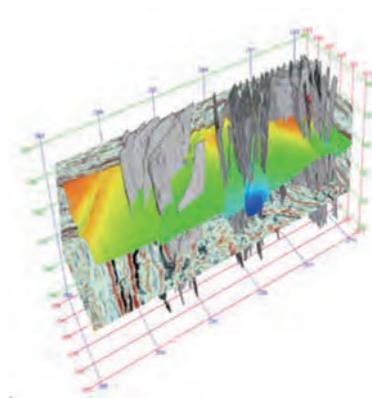
AI techniques

5D Seismic Interpretation

VTI/TTI Velocity Model Building

Seismic-guided Drilling

Multi-component PSDM

R&D

OBN Processing

FWI

Software Ecosystem

Q Migration

Broadband Processing

# Optical Fiber Intelligence Reservoir Geophysics (OFIRG)

BGP provides Optical fiber intelligence reservoir geophysics services, including Zero-offset VSP, Offset VSP, Walkaway VSP, Time-lapse VSP, 3D-VSP, Integrated VSP and Surface Seismic, SWD (Seismic While Drilling), Micro-seismic monitoring (Adjacent well and same well), Liquid production profile monitoring, and Wellbore integrity monitoring, as well as DAS (Distributed Acoustic Sensing) observation using BGP's ultra-sensitive "uDAS" system. We also have strong capabilities to process and interpret the data collected from the above mentioned services.

DAS

DTS

Walkaway-VSP

3D-VSP

Zero-offset-VSP

Micro-Seismic monitoring

Reservoir

Wellbore integrity monitoring

Micro-Seismic monitoring
in the same well(DAS)

Liquid production profile monitoring
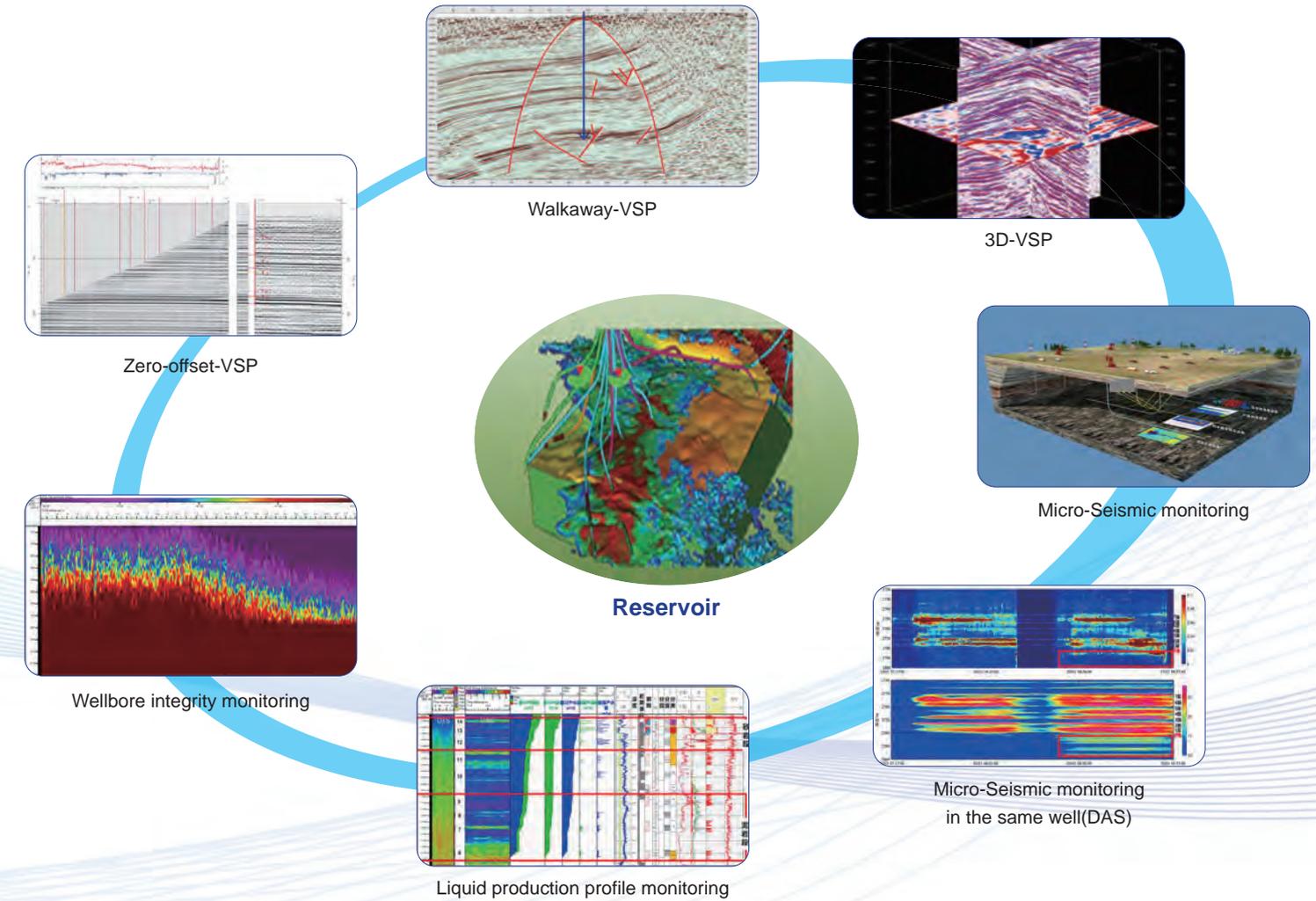
Non-seismic Surveys

Business Scope

• Oil and gas exploration and production enhancement

• Reservoir monitoring and oil & gas field development

• Mineral exploration

• Geothermal and groundwater prospecting

• Unconventional resource exploration

• Engineering survey

• Topographic & Topobathymetric Survey

Products

BGP's Non-seismic Department designs and manufactures its own geophysical instrumentation and software, such as:

• Land EM acquisition instrument

• Marine EM acquisition system

• GMECS: Onsite QC and Data Processing

• GeoGME: Data processing and integrated interpretation based on GeoEast® platform

Key Techniques

• Time-Frequency ElectroMagnetic (TFEM®)

• Borehole-Surface ElectroMagnetic (BSEM)

• 3D Gravity, Magnetic & Electromagnetic (3D GME®)

• Gravity, magnetic, electromagnetic and seismic integrated exploration

Conventional Techniques

• Land / Marine / Airborne gravity and magnetic

• Light Detection And Ranging (LiDAR)

• Ocean bottom node electromagnetic (OBNEM)

• Audio Magnetotelluric (AMT)

• Magnetotelluric (MT)

• Continuous EM profiling (CEMP)

• Controlled Source Audio Magnetotelluric (CSAMT)

• Transit Electromagnetic (TEM)

• Long Offset Transit Electromagnetic (LOTEM)

• Ground Penetrating Radar (GPR)

• Electrical Resistivity Topography (ERT)

• Geochemical

• Microbiology

KLSeis II

BGP is strongly committed to geophysical method research and software development and integrates all leading technologies to produce its new powerful seismic data acquisition software system.

As a leading seismic acquisition software system, KLSeis II ® provides the users with full data acquisition services. It is characterized with openness, high performance and cross platform, comprising 5 main categories of applications, namely Design, Modeling, Data QC, Vibroseis and Statics.
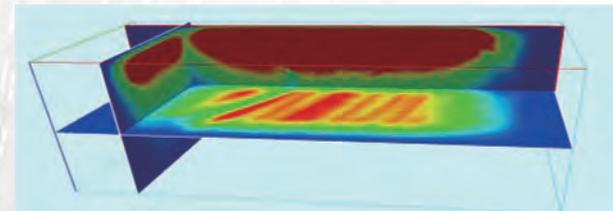
• Optimal geometry design in complex terrains for high-resolution oil & gas exploration
• Real-time equipment QC and monitoring to ensure data quality
• Near-surface solution improving PSTM & PSDM imaging
• Complex geological model building and forward modeling & illumination
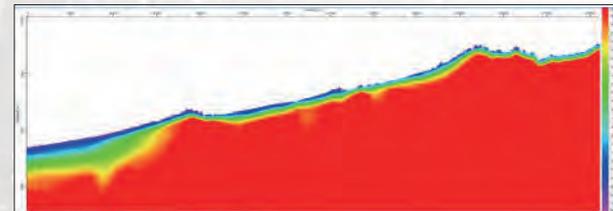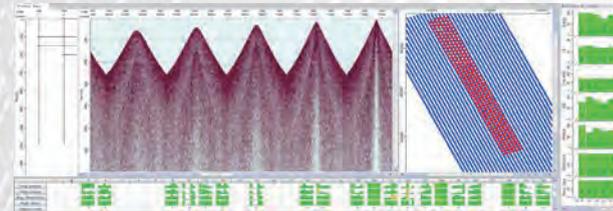• Hybrid & UHP are fully supported
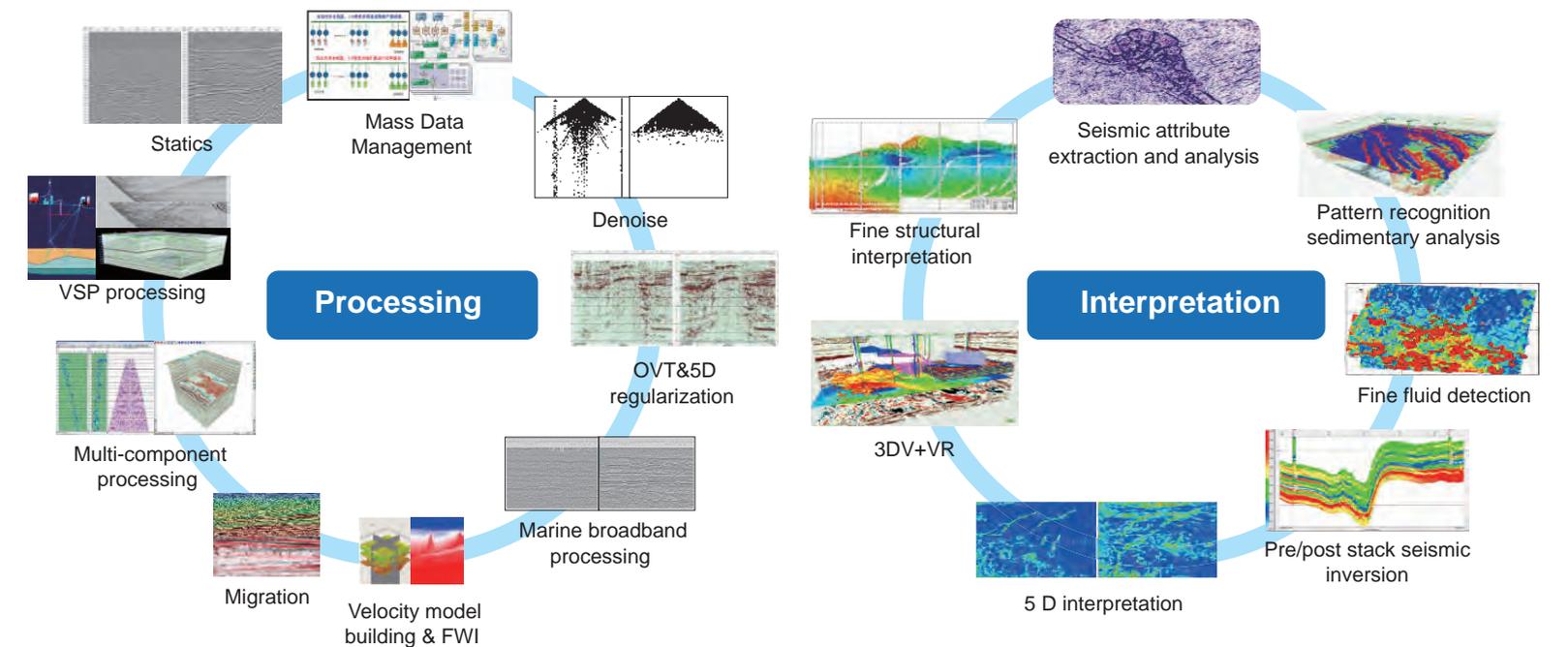

Design
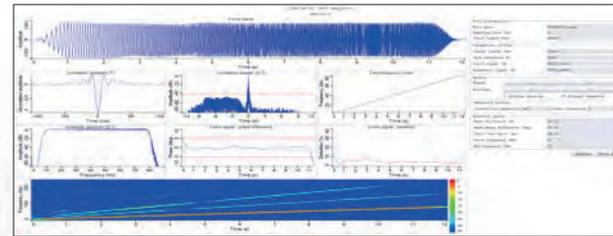
Vibroseis

Modeling

Statics

Data QC

Geo East

GeoEast®, an integrated seismic data processing and interpretation system, can be tailored for both on-site and in-house processing and / or interpretation.

• A unified platform for seismic processing and interpretation
• Solutions to data from complex surface conditions and geological targets
• Full approaches to velocity model building and seismic imaging
• Up-to-date techniques in multi-component & VSP processing

• Efficient seismic interpretation
• Cutting-edge attribute analyses
• Featured hydrocarbon detection
• Distinctive geo-body characterization

Processing

Statics
Mass Data Management
Denoise
VSP processing
OVT&5D regularization
Multi-component processing
Marine broadband processing
Migration
Velocity model building & FWI

Interpretation

Seismic attribute extraction and analysis
Pattern recognition sedimentary analysis
Fine structural interpretation
Fine fluid detection
3DV+VR
Pre/post stack seismic inversion
5 D interpretation

Equipment Manufacturing

BGP pays great attention to the R & D of geophysical equipment based on its copyrighted and state-of-the-art technologies, which enables its seismic crews to undertake any tasks in a wide variety of surface conditions in the world. The expertise and experiences of our specialists make it possible for BGP to continuously optimize seismic equipment solutions for its clients.

The main products include:
- Data recording system
- Vibrators
- Seismic Geophones
- Seismic Vessels

GPR

eSeis

BV330S

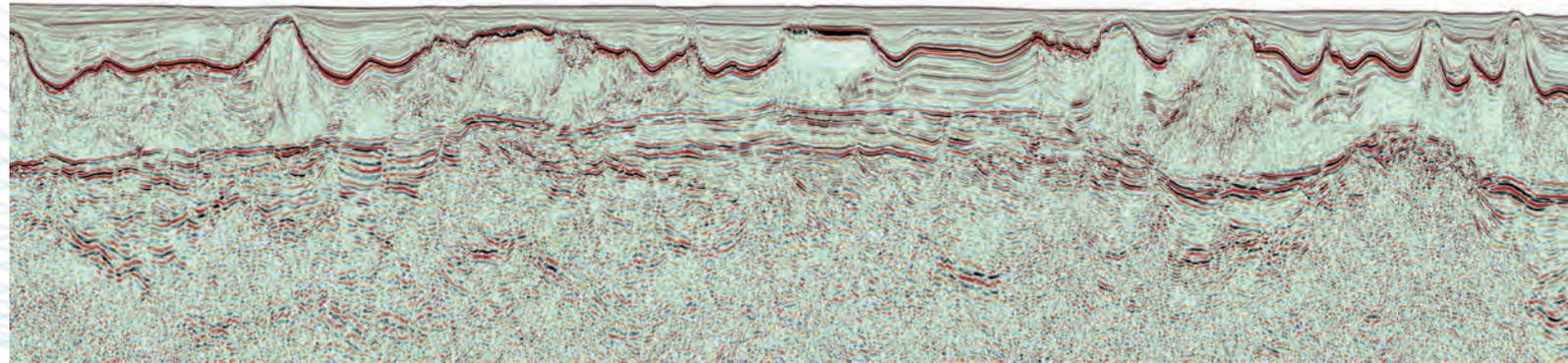BGP Innovator

EV56

uDAS

SD7M

Multi-client Business

Investment in Multi-client data equips our clients with new opportunities in frontier, emerging and mature basins worldwide.
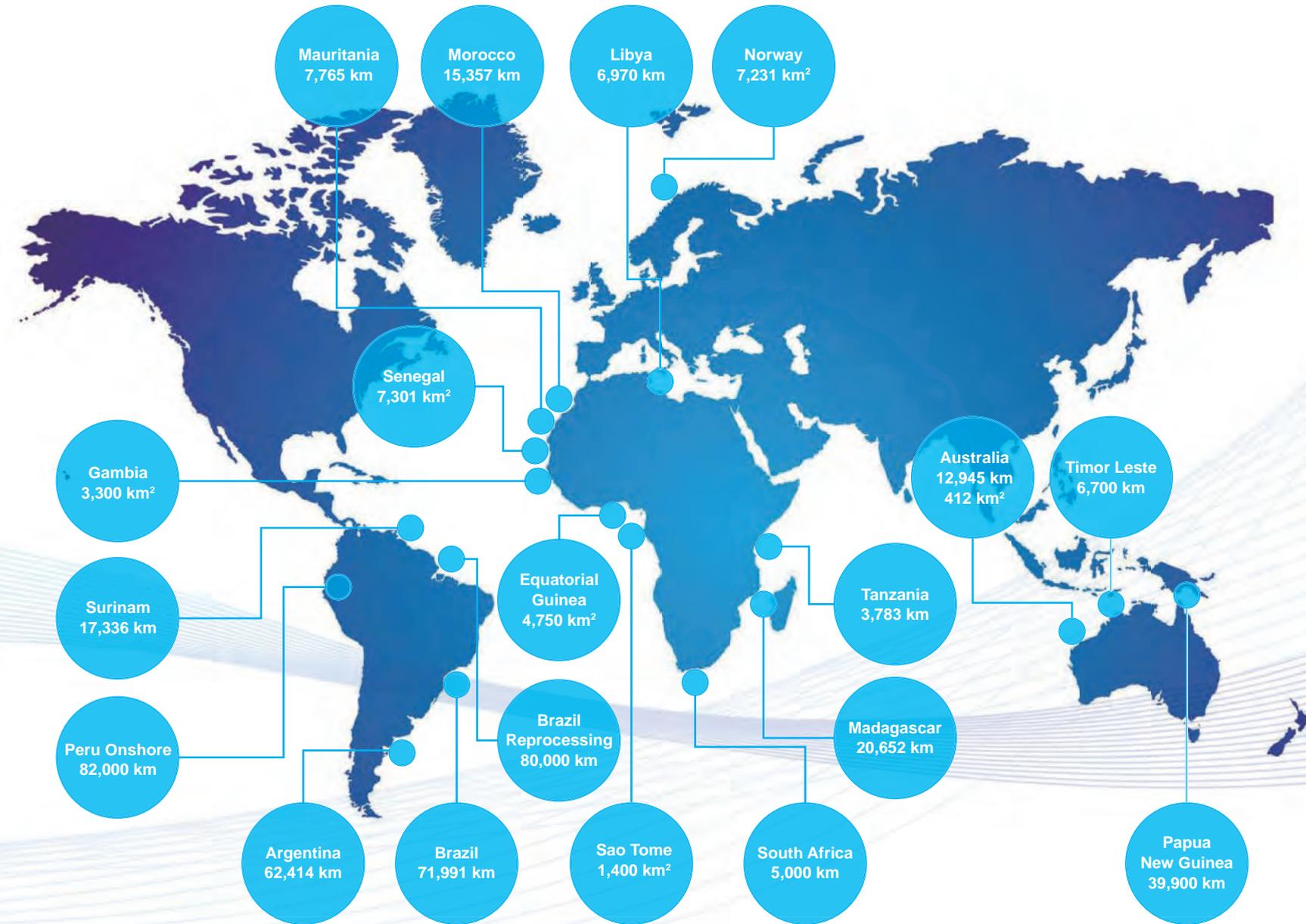
BGP utilizes state of the art technology and equipment on its Multi-Client projects ensuring the highest quality multi-client geophysical and geological data & services available to be provided to the energy industry. Our many customers include host governments, NOCs, Super-Majors & Major Oil Companies.

BGP offers fully integrated Multi-Client services which allow our pre-commit clients to be involved in survey design, acquisition, processing and interpretation. For host governments we can support in marketing and preparation for license rounds.

BGP's extensive multi-client library includes seismic, magnetic, gravity and interpretation products with Approximately 45,000 Km^2 of 3D data and over 500,000 km of 2D data from Europe, South America, Africa, Oceania and Middle East.
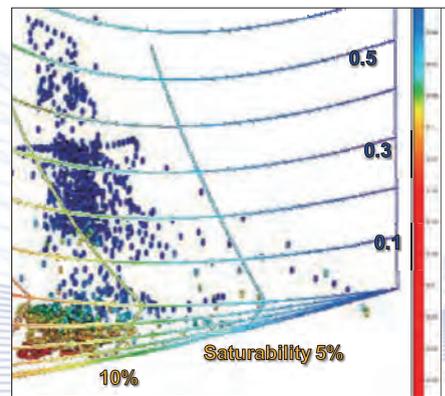

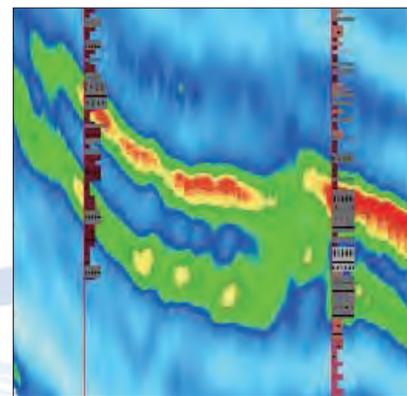Representative PSTM section in Brazil Santos Campos basin, in association with TGS

Mauritania
7,765 km

Morocco
15,357 km

Libya
6,970 km

Norway
7,231 km^2

Senegal
7,301 km^2

Gambia
3,300 km^2

Surinam
17,336 km

Peru Onshore
82,000 km

Equatorial Guinea
4,750 km^2

Brazil Reprocessing
80,000 km

Australia
12,945 km
412 km^2

Timor Leste
6,700 km

Tanzania
3,783 km

Madagascar
20,652 km

Argentina
62,414 km

Brazil
71,991 km

Sao Tome
1,400 km^2

South Africa
5,000 km

Papua New Guinea
39,900 km

New Energy Business

## Evaluation technology for CO2 potential storage capability

• High resolution and high-fidelity seismic imaging technology

• Seismic and geological characterization of geological bodies in brackish water

• Comprehensive evaluation techniques for reservoirs

• Evaluation technology for storage potential

• Monitoring technology for the CO2 storage process

Geothermal exploration and evaluation technologies

• Geophysical technology used for geothermal exploration

• Geothermal resource evaluation technology on basis of GME

• Evaluation technology for geothermal preferential targets

• Geological characterization technology for deep geothermal resources

• Geothermal temperature prediction technology

• Comprehensive assessment technology for geothermal resources

• Geothermal well location design technology

• Fracturing monitoring technology for tight high-temperature reservoirs
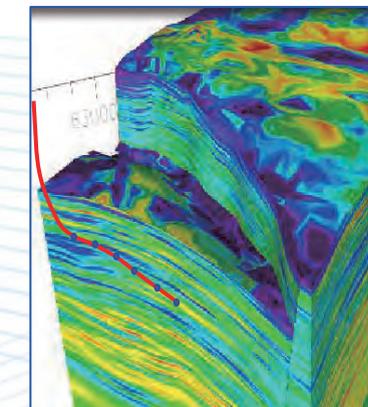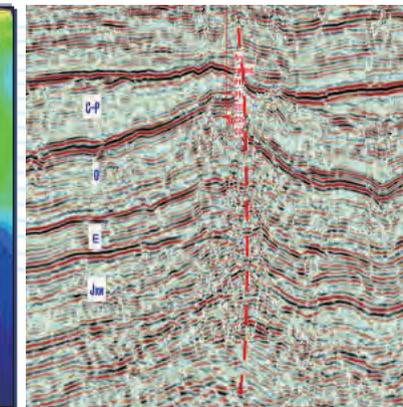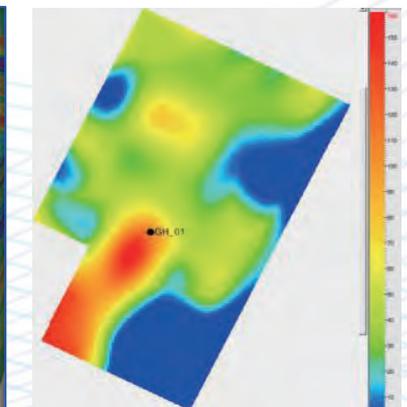
Physical characterization of brackish rock

Seismic reversion of brackish water
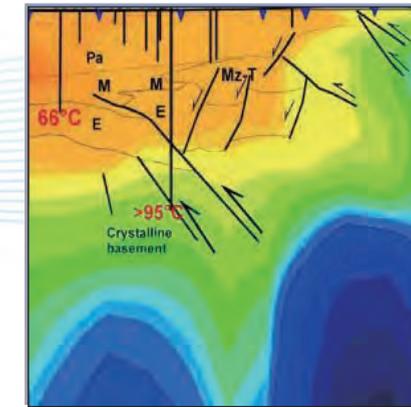
Seismic survey for geothermal exploration

Visual well design based on depth model

Geothermal temperature map

HSSE Management

Rigorous and consistent implementation of its HSSE Management System (HSSE MS), is one of the top priorities for BGP to ensure the health, safety, security and environment of our operations globally. BGP management will provide a healthy and safe workplace where all stake holders, workers, representatives of the client and third parties involved will protect the operation and workplace from accidents, injuries, and work-caused illness.

BGP's HSSE Management System has been established since the early 1990s based upon relevant industry standards and guidelines from IOGP, IAGC, OSHA etc. The HSSE MS is reviewed and updated periodically to incorporate the best practices of the seismic industry, while adapting to the ever evolving needs of field operations to meet the requirements of contracts, local government or authorities as well as communities affected.

To implement the HSSE MS within our operation requires us to develop and execute a specific project HSSE plan based upon all HSSE MS elements and contract clauses. This practice has enabled BGP to complete hundreds of seismic projects safely and successfully for numerous clients located all around the world.

BGP has realized the benefits of its excellent HSSE performance as demonstrated through its business growth and success over the decades. Furthermore, continued relentless effort by all BGP employees whose dedication to pursue greater HSSE performance, which in turn will generate long-term business growth and prosperity for BGP, its clients, partners and all stakeholders, together with communities wherever we operate.

17 years safe operation without LTI

Peace & Harmony

HSSE training

DDC training

BGP Worldwide Operations

International Activities

- ■ 54 branches and offices
- ■ 16 processing and interpretation centers
- Streamer vessel
- OBC crew
- OBN crew