

External Advisor

Finn B. Michelsen

Geoscientist

External Affiliate Consultant and Strategic Alliant member of GeoStatic Ltd

Mr. Michelsen is an accomplished geoscientist with multi-disciplinary, integrated expertise in applied geophysics, geology, instruments engineering and design capabilities. His career is supported by academic studies in geology and geophysics, and 30 years of professional work experience in applied geophysical and geologic survey services, project management, and business development, in the oil and gas (land and marine exploration), applied engineering geophysics, and environmental industries worldwide. He has diverse experience and knowledge with product technologies and instruments development, data acquisition and processing methods for geophysical exploration projects in both land and marine environments, and overall project and field operations management. Land and marine applied geophysical and geologic consulting experience includes:

Land

- Surface and Borehole 2D/3D Seismic Methods
- Borehole Wireline Logging
- EM & Magnetic Methods
- 2D/3D Electrical Resistivity Imaging
- Microgravity Surveying
- Ground Penetrating Radar
- Geophysical Data Processing/Modeling

Marine

- 2D/3D High Resolution Seismic Methods
- Single/Multi-Beam Bathymetry
- Sidescan Sonar Surveys
- Sub-bottom Profiling
- Marine Magnetometer
- Offshore Borehole Geophysics
- Marine Geophysical Data Processing

Industry Experience Includes

- Oil and Gas Exploration Industry
- General Engineering and Environmental Industries
- Minerals and Mine Exploration Industries
- Geosciences Industries for Marine and Land Geohazard Investigations

Summary of Professional and Business Operations Experience

- Business Planning, Development, Marketing & Sales
- Special Projects Planning and Operations Management
- Geophysical/Geologic Survey Data Processing, Data Analysis & Modeling, Reports Writing
- Research & Development Planning and Geophysics Technology Development

Mr. Michelsen is currently President (Owner) and Chief Geophysicist with GeoSurvey Systems Inc, responsible for planning and managing geophysical-geologic operations and consulting services, geophysical data processing, and instruments integration technology development, and business development. His most recent land and marine geophysical applications and project activities include:

Geophysics Specialization and Applications Experience

- 2D and 3D P and S wave marine and land seismic planning, survey design, data acquisition, and advanced data processing-modeling methods for oil & gas exploration, minerals exploration, and

geo-engineering projects (includes: unconventional oil & gas reservoir characterization, 3D seismic applied to gas storage reservoir development, near-surface geology mapping & characterization, strategic minerals exploration).

- 2D/3D high resolution seismic tomography imaging
- High-resolution 2D and 3D marine geohazards seismic projects
- 2D and 3D Electrical Resistivity Imaging (Site Characterization, Karst Geology, Archaeological Investigations, Environmental Studies)
- Borehole Seismic Methods (P-S Wave Crosshole, PS Downhole, SASW, MASW)
- Ground Penetrating Radar (Archaeology, Geology Characterization, Utility Detection)
- EM and Magnetic methods (Archaeology, UXO, UST, Site Characterization)
- Gravity and Microgravity methods

Geology Specialization

- Oil & Gas Reservoir Analysis & Structures Mapping
- Geologic Mapping & Modeling for Groundwater Studies
- Geologic Modeling for Geothermal Projects
- Combined Geologic & Geophysical Data Interpretation for Foundation Studies
- Land and Marine Geohazards Studies (*Volcanos, Slope Failure, Sinkholes, Analysis of Shallow Water Gas-Overpressure Systems and Pore-Pressure Gradient*)
- Investigation of Reservoir Geology for CO₂ Sequestration and Gas Storage
- Geologic/Reservoir Structure and Seismic Stratigraphic Mapping for Minerals and Hydrocarbon Exploration

During his career Mr. Michelsen has been involved in a wide range of projects worldwide, supporting petroleum and minerals exploration projects, land and marine geohazards and geo-engineering projects, geologic modeling, geotechnical and civil engineering projects, environmental & archaeological site investigations, and unexploded ordnance (UXO) investigations, using a variety of advanced geophysical survey and data processing methods. Career experience includes 15 years with major oil and gas seismic exploration contractors as Sr. Project Geophysicist and Projects Manager, providing worldwide land and marine 2D/3D project operations management and applications technology support, geophysical-geologic data interpretation.

Applied geophysical and geologic research and development activities is represented by 10 years of experience associated with seismic instruments manufacturer and technology develop companies, where projects emphasized applied surface and borehole 2D/3D seismic, seismic and acoustic sensor and energy source systems design and applications development, 2D/3D electrical resistivity imaging (ERI), and other integrated applied geophysical survey and data processing methods to land and marine geo-engineering and environmental site characterization problems.

Worldwide geophysics and geologic consulting experience includes domestic USA and Canada, and international projects in more than 20 countries worldwide. International experience includes Europe (Norway, Denmark, United Kingdom, France, Italy, Greece), African Continent (Egypt, Qatar, Nigeria, Equatorial Guinea, Yemen, Morocco, Angola), South and Central America (Mexico, Guatemala, Venezuela, Ecuador, Brazil, Trinidad), the Far East, Australia, Japan, India, Antarctica.

Summary of Company Employment, Affiliations, and Development

GeoSurvey Systems Inc (3/2013 – Present)

Positions: President/Owner and Chief Geophysicist

Terrasond (2/2012 – 3/2013)

Position: Geophysics Group General Manager & Director of Applied Geophysics / term contract

AMEC E & I (3/2011 – 12/2011)

Position: Sr. Geophysicist / term contract

GeoSurvey Systems Inc (1998 – 2011)

Positions: President/Owner and Chief Geophysicist

AOA Geophysics Inc (2005 – 2009)

Position Held: Vice President & Director of Applied Geophysics / term contract

Shaw E & I (2003 – 2005)

Positions Held: GeoSurvey Systems Consulting/Sr. Geophysicist

Oyo Corporation/Oyo Geosciences (1991 – 1997)

*Positions Held: Sr. Geophysicist/Instruments Technology & Business Development Specialist
President of Oyo Geosciences*

Innovative Transducers Inc (1990 – 1991)

Position Held: Co-founder and Owner

Terra Marine Engineering (1989 – 1991)

Position Held: Seismic Telemetry Systems and Applications Specialist/Marketing & Business Dev.

Western Geophysical Inc (1980 – 1989)

Position Held: Sr. Project Geophysicist/Data Acquisition & Processing

Sample of Geophysical Survey Projects

- International Gas Consulting/Monroe Gas Storage, LLC – Planning and operations management of 10 sq mi high resolution 3D seismic survey in the State of Mississippi to delineate shallow structure and stratigraphic attributes of the Carter Sand target gas injection formation (Aug – Dec 2012).
- International Gas Consulting/Cadeville Gas Storage, LLC – Planning and operations management of a 8.5 sq mi high resolution 3D seismic survey in Monroe County, Louisiana. Purpose of the seismic survey was to delineate structure and stratigraphic attributes of James Sand target gas injection formation. 3D seismic processing utilized seismic interferometry methods to isolate sand formation closure zones, and higher porosity zones (April – June 2012).
- Karoon Brazil – 3D data processing and analysis of high resolution seismic data over four planned drilling and exploration sites to map and delineate seafloor “pock mark” crater features, gas chimneys, shallow over-pressured formations, and faults.
- Dupont Mexico – Acquisition and processing of 2D high resolution seismic data to delineate and characterize deep Jurassic sand formation, which is being considered for deep well injection of contaminant waste. Project is a continuation of work conducted in 2008 (2011 – 2012).
- Georgia Pacific Gypsum – Conducted multi-geophysical surveys using seismic tomography, 2D resistivity imaging, electromagnetic (EM31), and ground penetrating radar, on North Texas Gypsum Mine Site. Purpose of the geophysical surveys was to determine best methods for locating subsurface solution caverns, and to develop suitable geophysical survey methods for delineation of minable gypsum deposits (2011)
- CF Industries – Performed and managed multi-electrode 2D resistivity imaging surveys to map subsurface phosphate deposits as part of a strategic mine operations and development program (2011).
- BCI Engineers & Scientists – Land geohazards project using 2D and 3D electrical resistivity tomography to delineate karst solution zones over limestone mine and tunnel complex (2010).

- BCI Engineers & Scientists – Clay exploration and mining project using 2D electrical resistivity tomography method to delineate locations of paleo-karst clay deposits (2010).
- Geo Estratos Mexico – Shallow oil and gas 2D seismic exploration project in Tampico, Mexico using Accelerated Impact Source and portable seismic system. Project was designed to aid with delineation of shallow fracture zones for PEMEX exploration drilling project (2010).
- TDI-Brooks International – Multi-site marine geohazard surveys (six 3km x 3km sites) using multibeam bathymetry, side scan sonar, marine magnetometer, subbottom profiling, and high resolution mini-steamer 2D seismic survey methods for seafloor site clearance. Seismic data is used to delineate submarine stratigraphy, gas traps, faults, over-pressured zones, to 2,000 meters below seafloor (2010).
- State of Pennsylvania DCNR – CO₂ Sequestration project for the State of Pennsylvania using high resolution 2D seismic method for reconnaissance and delineation of shallow “containment zone” structure within the Marcellus Shale. Study will continue in 2010 through 2015 with application of multi-component 3C survey to obtain full waveform reservoir characterization data (2010).
- Progress Energy/EPCR – Karst investigation project using 2D seismic, Electrical Resistivity Imaging (ERI), and other geophysical methods to delineate subsurface solution cavities and fissure zones (2009).
- Dupont Mexico – CO₂ Sequestration project using 2D seismic survey method to delineate deep marine carbonate formations and interbedding of shale fracture zones to depth of 3000 meters (2009).
- ATMOS Power & Energy (Feasibility Test) – Salt Structure Gas Storage Project to test the application of 2D and 3D high resolution seismic imaging to delineate possible fault and collapse structures along salt dome cap zones at depths ranging from 2,000 ft to 6,000 ft.
- Florida USA (Zachry Engineering & Construction) – Use of electrical resistivity imaging (ERI) and P-wave seismic tomography to map subsurface Karst caverns and void structures at the Crystal River, Florida nuclear power plant facility; May 2007.
- Texas USA (CDM Corp) – Resistivity profiling survey to delineate subsurface Karst structure (caverns, voids, fracture zones), and define bedrock profile over land development site; March 2008.
- Texas USA (ACI) – Karst investigation project using high definition resistivity profiling to identify and map subsurface voids and caverns over land development site. Data was combined with geotechnical information to plan and design subsurface remediation and excavation operations, and to locate potential structural land geohazards.
- Qatar (URS Dames & Moore) – Borehole P and S wave crosshole seismic imaging and downhole seismic testing projects at the Ras Laffan Shell Gas to Liquid Plant for determination of site soil and rock modulus properties (2007 – 2008).
- Saudi Arabia (URS Dames & Moore) – Conducted 2D seismic tomography, 2D resistivity imaging, and borehole geophysical surveys for investigation of Karst geology at site in Jeddah, Saudi Arabia. Client required identification of subsurface solution caverns and other Karst geohazards as part of a large construction site foundation study (2007).
- Nigeria (Chevron) – Shallow (1000 meters) marine geohazard site survey using 2D multi-line high-resolution seismic method, side-scan sonar, marine magnetometer, multi-beam bathymetry, and acoustic methods to delineate fault structure, hazardous gas traps, seafloor morphology and obstructions, for exploration well site and drilling operation clearance.
- Georgia USA (Southern Company Services) – 2D and 3D resistivity imaging project to delineate and map subsurface caverns, voids, and Karst structure at proposed power plant facility. Data used to plan geotechnical drilling program, subsurface grouting, and foundation engineering design.
- Texas USA (TxDOT) – Ground Penetrating Radar survey for archaeological investigation to locate grave 1863 Civil War grave sites.
- Texas USA (Collier Consulting) – Performed P and S wave downhole seismic velocity study at Wind Farm Site to determine foundation integrity and soil Modulus for location of wind generators.
- Nigeria (Chevron) - Shallow (900 meters) geohazards site survey using the 2D multi-channel streamer high-resolution seismic method, in addition to side-scan sonar, marine magnetometer, multi-beam bathymetry, and acoustic chirp methods to delineate fault structure, hazardous gas traps, seafloor morphology and obstructions, for exploration well site and drilling operation clearance.
- Arkansas USA (Collier Consulting) – 2D Electrical Resistivity Imaging survey to delineate flow of subsurface liquid contaminant along top of perched aquifer. Data was used to model hydro-geologic structure for prediction of contaminant fluid flow into local water resources reservoir.

- India (Integrity Geosciences) – Consulting for development of comprehensive 2D seismic tomography and deep resistivity profiling survey programs for deep tunnel alignment project in Kashmir Lower Himalayan region. The Northern Indian Railway (Konkan) experienced severe tunneling collapse and water intrusion, requiring specialized geophysical and geologic mapping to develop accurate geologic model of deep shear zone along fault lines.
- India (Reliance Energy) – Team project to combine high resolution deep water bathymetry mapping of seafloor gas seep structures, and 3D seismic data interpretation of gas chimney correlations.
- Texas USA (Collier Consulting, Bechtel, E TTL) – 2D seismic tomography imaging survey, resistivity profiling, and PS downhole seismic testing at five proposed and active power plant sites to delineate geologic structure, stratigraphy, archaeological site clearance, low velocity shear zones, for plant expansion and construction planning.
- Texas USA (PSI Inc) – 2D seismic tomography, resistivity profiling, and borehole logging, to delineate shallow secondary “slump” fault system, and general soil and rock stratigraphic structure across proposed elevated highway construction site.
- Peru – Archaeological site investigation using GPR and magnetic methods at the archaeological site of Machu Picchu, Peru to map buried ancient foundations, and to locate buried artifacts. The ground penetrating radar survey was also used to evaluate the nature and characteristics of the shallow surficial sediments and uppermost bedrock at a buried citadel.
- Florida USA (Florida Department of Transportation) – A comprehensive resistivity profiling survey was performed along a planned elevated highway construction site to locate and map deep sinkholes. Previous geotechnical investigations could not determine the presence of sinkholes in limestone bedrock along the planned highway route, and collapse of support footings had already been experienced. The method successfully located zones with sinkhole structures.
- Alabama USA (Southern Company Services) – A continuous electrical resistivity survey was performed across the Rattle Snake Dam to investigate dam leak zones, and to delineate the internal dam structural integrity. The geophysical survey located several water saturation zones that were confirmed as dam leaks. Following the raising of reservoir water levels, a second resistivity profile survey was performed to delineate increased water flow through leak zones.
- Equatorial Guinea (Marathon, Bechtel, Golder Associates) – Performed combined high-resolution seismic tomography, 2D resistivity profiling, PS wave downhole seismic testing surveys to augment geotechnical data at an LNG development site (jungle environment). The site required pre-excavation and construction site characterization to map subsurface geologic structure and stratigraphy, potential slope failure zones, and for locating buried channels, voids, and other anomalies that represent geohazards to LNG tanks and facility structures. The PS wave downhole seismic testing was performed to obtain P and S-wave velocity data for determination of near surface soil modulus properties, and to identify weak soil shear zones. Geotechnical and geophysical data were integrated to develop an accurate site geologic, hydro-geologic, and soil properties models.
- Japan (Kyushu Municipality) – An extensive ground penetrating radar survey was performed to map an ancient 6th century Kofun buried tomb. Special depth-slice processing was used to identify tomb structure and to locate any buried artifacts.
- Texas USA (Collier Consulting, E TTL, TxDOT) – Conducted a multi-line seismic tomography survey to map deep sinkhole and solution cavity structures beneath, and around roadway collapse zone. Results indicated a collapse zone along a subsurface channel, and shallow fault zones that formed within a graben geologic structure.
- Fairbanks Alaska Volcano’s Project – Worked with University of Fairbanks Alaska Volcano Projects Team to develop and install geologic and geophysical monitoring instruments in St. Augustine Volcano crater. Project was designed to measure seismicity using seismic sensor arrays, volcano crater deformation, and gas chemistry.
- Oyo Corporation Volcano Monitoring - Japan sits at the juncture of three major tectonic plates, Pacific, Euroasian and Philippine. The Hakone volcano is above a triple juncture point. Monitoring the surface expansion of this structure is crucial to understanding the subsurface plate dynamics and the risks to local people from volcanic eruption, earthquake and tsunami events. The Hot Springs Research Institute of Kanagawa Prefecture constantly monitors this volcano with respect to the surrounding ground using a combination of EDM, GPS and Tilt meter technology. These constantly measure slant ranges corrected by accurate meteorological measurements to a

number of prisms located throughout the caldera. All measurements are data based to provide a time line data set of the ground surface expansion.

Commercial Geophysical Methods and Technology Development Work

- **RESEARCH AND APPLICATION**

Use of P and S Wave Seismic Tomography Imaging and Borehole Data to Derive Continuous 2-Dimensional Dynamic Shear Modulus Sections, *AOA Geophysics, 2005-2007*

- **RESEARCH AND APPLICATION**

Use of Mixed Electrode Arrays for Continuous High Resolution Electrical Resistivity Tomography for Complex Geologic Site Characterization, *AOA Geophysics, 2005-2007*

- **RESEARCH AND APPLICATION**

Application of Multi-Point Mixed Frequencies for SUE and archaeological investigations using ground penetrating radar, *GeoSurvey Systems, 2003-2005*

- **ENGINEERING GEOPHYSICS DEVELOPMENT**

Ultra High Frequency Acoustic Surveying Methods for Foundation Investigations to Map Subsidence and Voids, *GeoSurvey Systems, 2003-2005*

- **GEOPHYSICS SEISMIC ENERGY SOURCE TECHNOLOGY & APPLICATIONS DEVELOPMENT**

Design and development of accelerated impact seismic energy source for application to high-resolution 2D and 3D seismic surveys. *GeoSurvey Systems, 1998-2005*

- **GEOPHYSICS TECHNOLOGY DEVELOPMENT**

Development of ultra-slimline high pressure/high temperature 3-component borehole seismic system for downhole and vertical seismic profiling. *GeoSurvey Systems, 1997/1998*

- **GEOPHYSICS TECHNOLOGY DEVELOPMENT**

Development and design of 3-component high temperature/pressure borehole receiver system for deep hydro-fracture seismic monitoring applications, *Oyo Geosciences/Union Pacific Resources Project, 1996 - 1997.*

- **GEOPHYSICS TECHNOLOGY DEVELOPMENT**

Development and design of ultra-high performance hydrophone receiver array system using PVDF film technology for oil and gas exploration, acoustic monitoring, and borehole seismic applications, *Innovative Transducers R&D Project 1994 - 1996.*

Professional Research and Technology Development

- **DEVELOPMENT AND APPLICATION OF MIXED ARRAYS FOR 2D AND 3D ELECTRICAL RESISTIVITY IMAGING.**

GSS and AOA Geophysics – Karst geologic site characterization projects, 2004-2007

- **COMBINED HIGH RESOLUTION SEISMIC REFRACTION TOMOGRAPHY AND RESISTIVITY IMAGING**
GSS and AOA Geophysics – Karst geologic site characterization projects to develop integrated geophysical methods for delineation of land engineering geohazards, 2004-2007
- **COMBINED GEOPHYSICAL-GEOLOGIC SURVEY METHODS FOR ARCHAEOLOGICAL INVESTIGATIONS**
GeoSurvey Systems – Use of GPR, electromagnetic, magnetic, and resistivity imaging for archaeological investigations, 2002-2004
- **ENVIRONMENTAL PROTECTION AGENCY (EPA);GUIDELINES FOR SURFACE GEOPHYSICS APPLICATIONS TO GEO-ENGINEERING PROJECTS.**
EPA Publication – Technical Reviewer, March 1997
- **APPLICATION OF MULTI-CHANNEL SEISMIC STREAMERS FOR HIGH RESOLUTION SUB-BOTTOM PROFILING TO DELINEATE SUBMARINE GEOLOGY.**
USGS – Chesapeake Bay Sub-Bottom Characterization Project, 1994
- **SEISMIC BOREHOLE INSTRUMENTS TEST AT THE DOEHANFORD FACILITY.**
DOE Publication, 1994
- **HIGH RESOLUTION SEISMIC IMAGING AT THE DOEHANFORD FACILITY USING HIGH FREQUENCY VIBROSEIS FOR MAPPING OF GEO-VOLCANIC FORMATIONS.**
DOE Publication, Poster Presentation at SAGEEP Conference, 1994
- **APPLICATION OF SUSPENSION P-SVELOCITY LOGGING METHOD (TECHNICAL REVIEWER).**
ISSMFE Technical Report for Geophysical Characterization of Sites, 1993
- **HIGH RESOLUTION IMAGING AND GEOLOGIC MAPPING OF SATURATED SEDIMENTS – ACASE FOR SHEAR WAVE REFLECTION.**
Symposium on the Application to Engineering and Environmental Problems, 1993

Professional Affiliations History

- Society of Exploration Geophysics (member since 1982)
- SAGEEP/EEGS: *Contributing Co-founder of Engineering and Environmental Geophysics Society. Served as Corporate Committee Chairman, 1993 - 1995.*
- SAGEEP Paper Presentation: *Integrated Geophysical Methods for LNG Site Characterization in a Jungle Environment Applied Engineering and Environmental Geophysics Conference, 2004*
- American Society of Civil Engineers (ASCE) Member.
ASCE Paper Presentations: *Application of Geophysical Methods to Engineering Problems*
- Geology Society of America (GSA).

