Minimizing Offshore Exploration Risks by Evaluating the Charge of Subsea Structures*

Rick Schrynemeeckers[1]

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General Statement

For each prospective area, a map is delivered of probable hydrocarbon charge based on direct measurement of C_2-C_{20} hydrocarbons emanating from the reservoir. Technology permits analysis of microseepage, which is considered to be the result of a nearly vertical pathway; this means that microseepage essentially overlies source/reservoir. Short summaries show good results in offshore settings—in the deepwater Gulf of Mexico and South China Sea. In the latter, predictions were 100% accurate.

Reference

Samuels, B.M., and H. Dembicki, 2007, Improved identification and characterization of deepwater thermogenic hydrocarbon macro-seepage using high-resolution AUV geophysical data: AAPG 2007 Annual Meeting Abstracts, p. 122-123.

North America GTW

Deepwater Reservoirs: Multi-Disciplinary Exploration and Development

24 January 2012

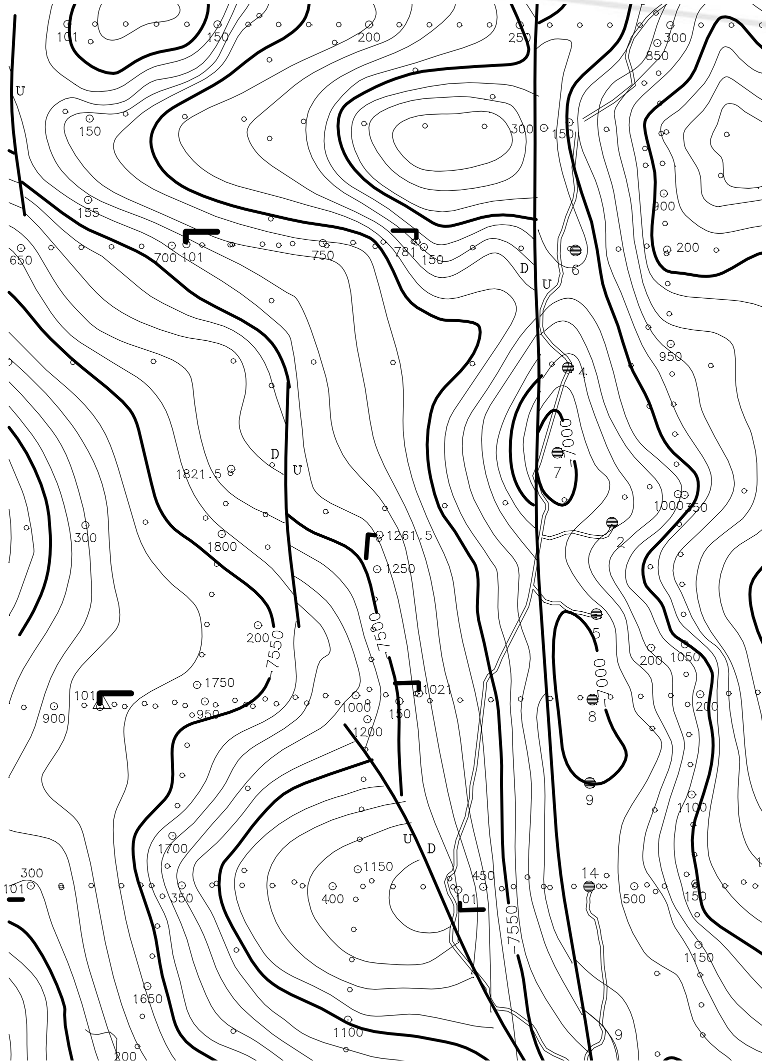
Houston, Texas | Norris Conference Center CITYCENTRE

Minimizing Offshore Exploration Risks by Evaluating the Charge of Subsea Structures

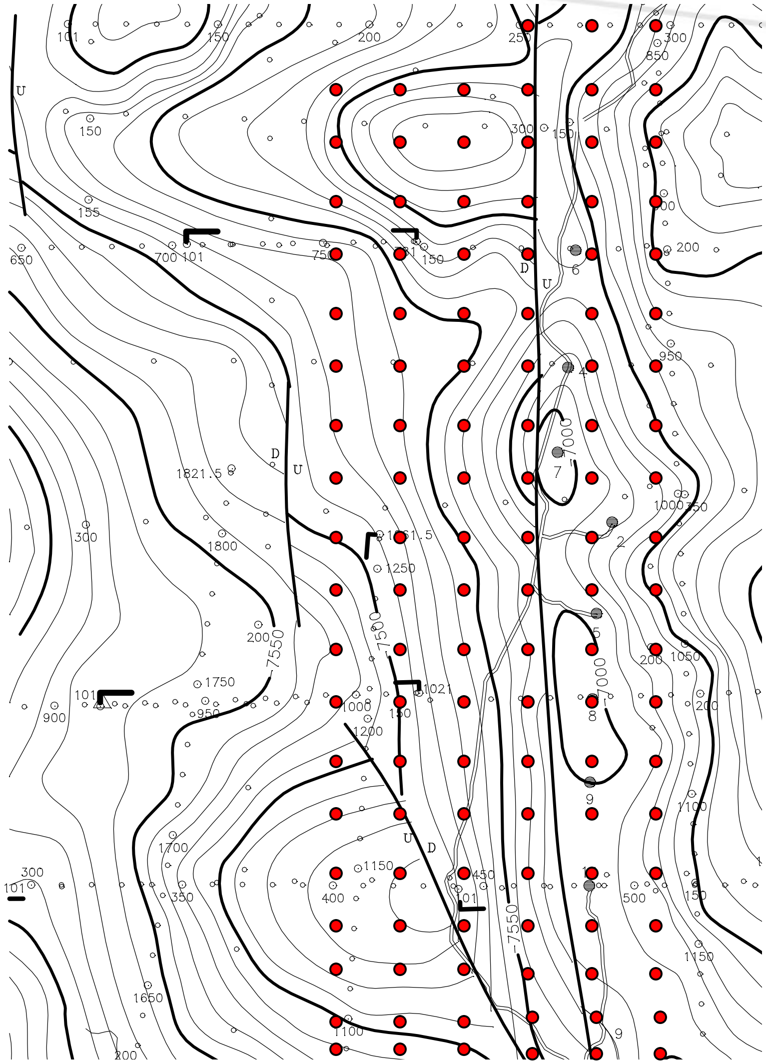
by Rick Schrynemeeckers

W.L. Gore & Associates, Inc.

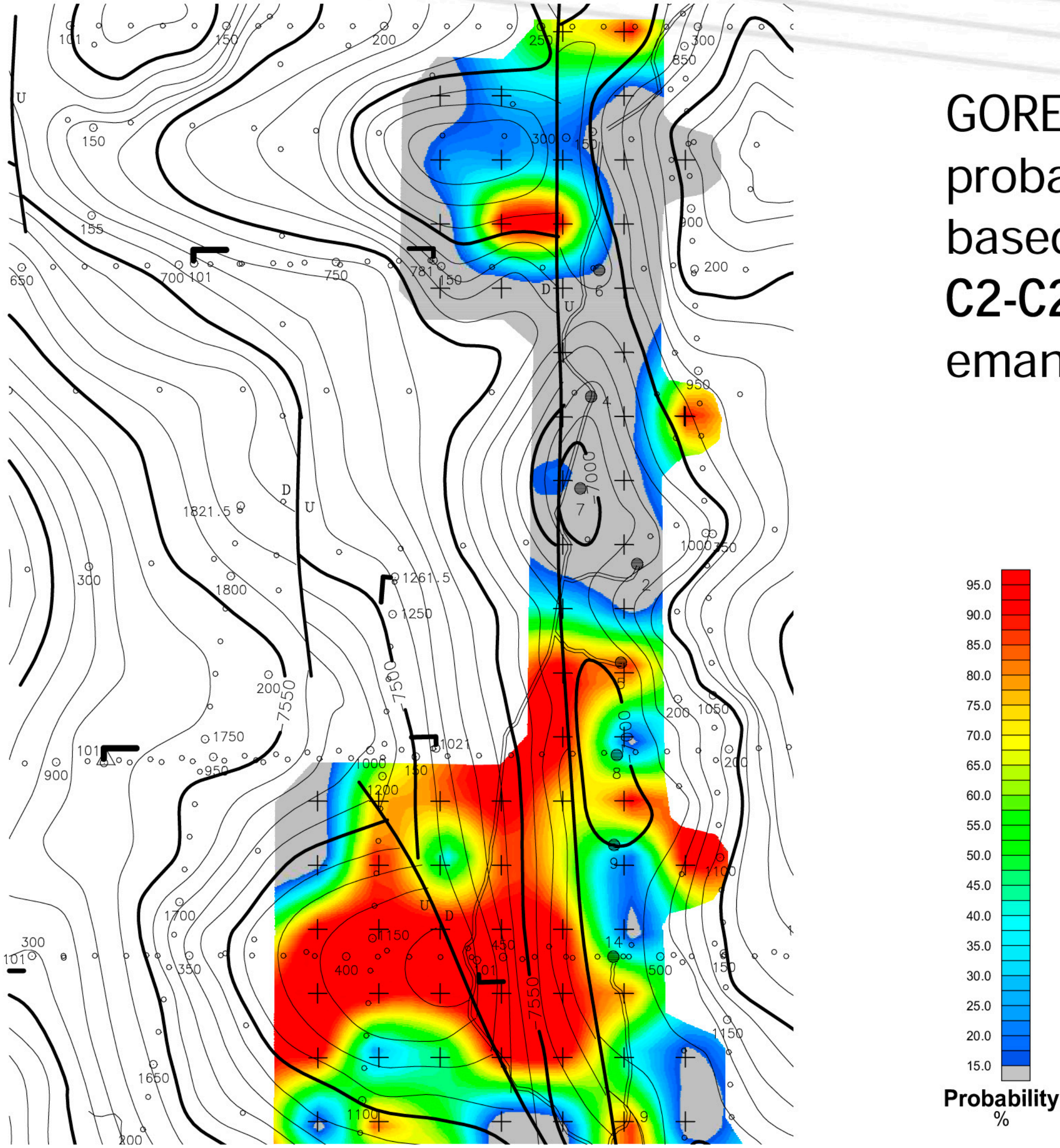
Where Do We Start



What Do We Do



What Do We Deliver

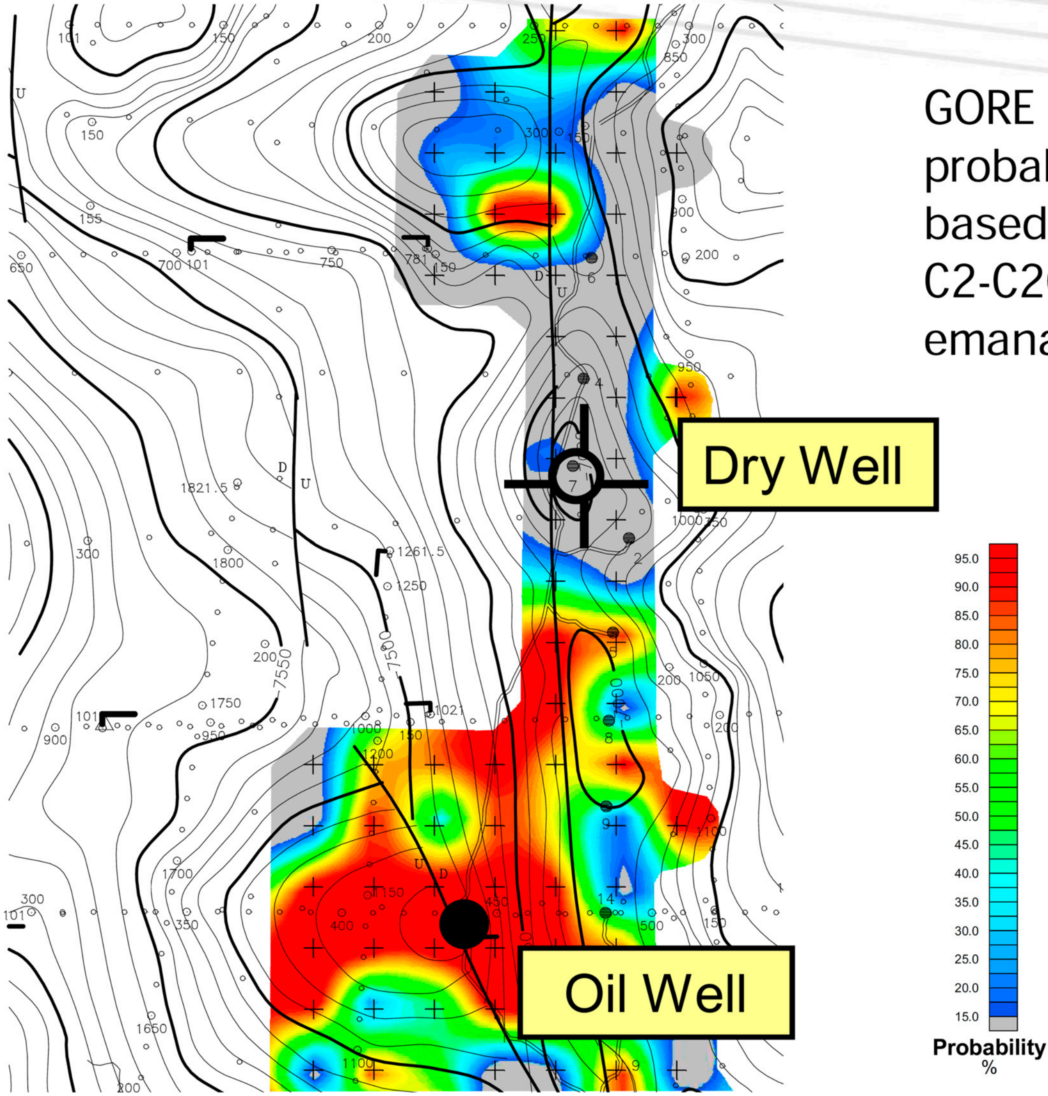


GORE delivers a map of probable hydrocarbon charge based on direct measurement of **C2-C20 hydrocarbons** emanating from the reservoir

High oil probability

Low oil probability

How is it Applied



GORE delivers a map of probable hydrocarbon charge based on direct measurement of C2-C20 hydrocarbons emanating from the reservoir

High oil probability

Low oil probability

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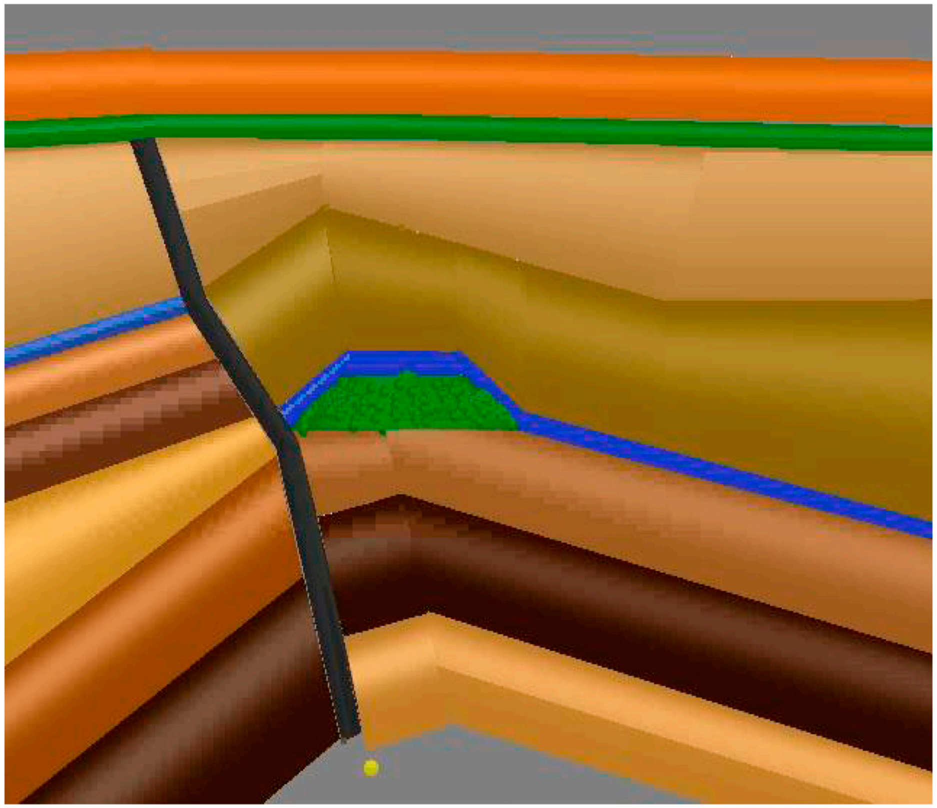
Vertical Migration - The Earth´s Fractionation Process

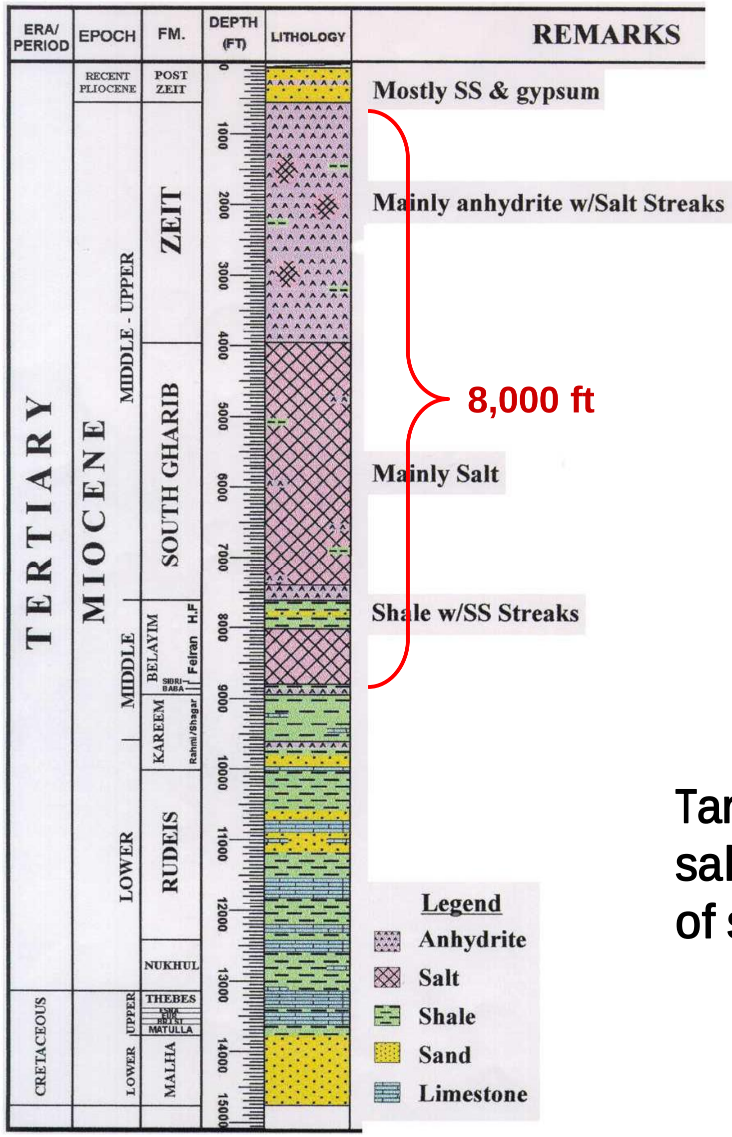


Macroseepage:
- Detectable in visible amounts
- Pathway follows discontinuities
- Offset from source/reservoir

VS

Microseepage:
- Detectable in analytical amounts
- Pathway is nearly vertical
- Overlie source/reservoir

The Perfect Seal - Salt



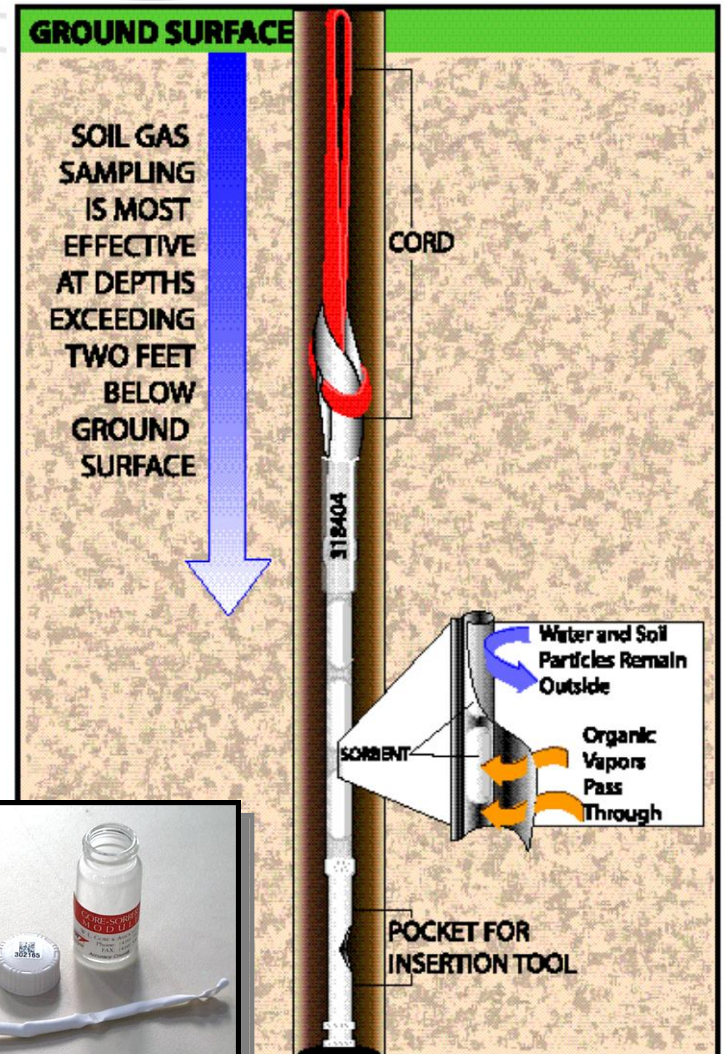
Egypt, onshore

Targets are overlain by 8000 ft of evaporitic salt and anhydrite sequences with interbeds of shale

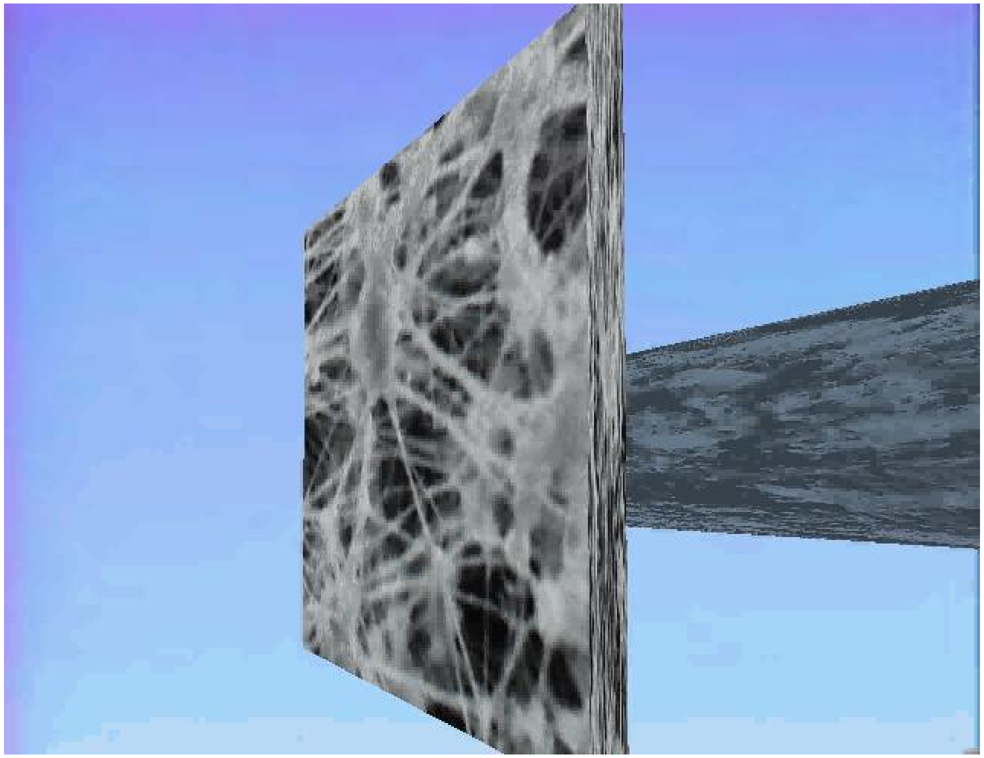
GORE™ Module

Based on Patented ePTFE Technology

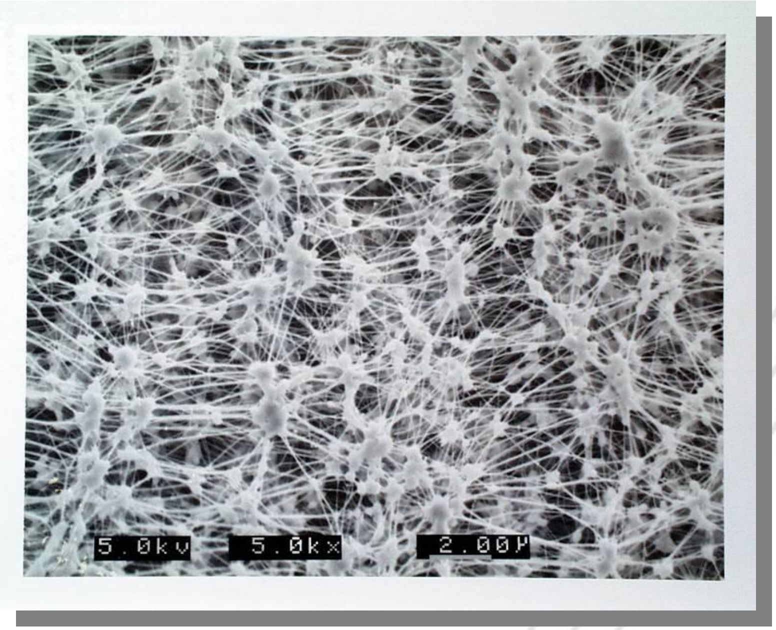
- Patented, passive, sorbent-based
  - Chemically-inert, waterproof, vapor permeable
  - Direct detection of organic compounds
  - Sample integrity protected
- Engineered sorbents
  - Consistent sampling medium
  - Minimal water vapor uptake
- Time-integrated sampling
  - Minimize near-surface variability
  - Maximize sensitivity (up to C20)
  - Avoids variables inherent in instantaneous sampling
- Duplicate samples



GORE™ Surveys - Collection



C_2-C_{20} molecules are ~5-10A
Membrane pores are ~1000A
Water drops are >5000A



ePTFE - 50,000 x magnification

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Thermal Desorption GC/MS Analysis

- Yields sensitive, compound specific results
- Analytical compound standards
- Approximately 87 compounds
    - C2 through C20
    - Aliphatics
    - Aromatics
    - Oxygenated compounds

Analytical Compound List by Compound Class: C2 – C20

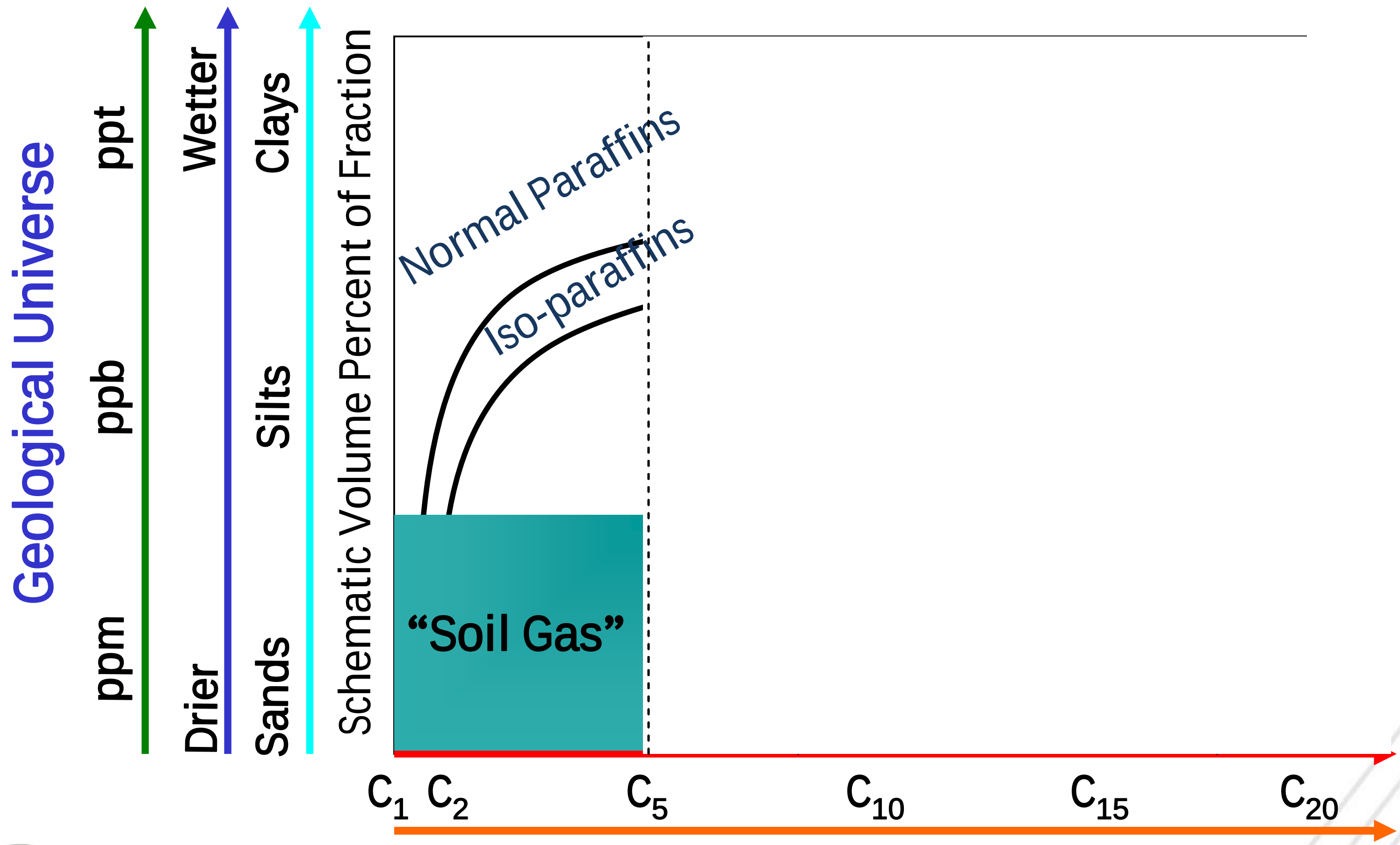
Typical Petroleum Constituents
Hydrocarbon number in ( )

Normal Alkanes	Iso-alkanes	Cyclic Alkanes	Aromatics and PAH*
Ethane (2)	2-Methylbutane (5)	Cyclopentane (5)	Benzene (6)
Propane (3)	2-Methylpentane (6)	Methylcyclopentane (6)	Toluene (7)
Butane (4)	3-Methylpentane (6)	Cyclohexane (6)	Ethylbenzene (8)
Pentane (5)	2,4-Dimethylpentane (7)	cis-1,3-Dimethylcyclopentane (7)	m,p-Xylenes (8)
Hexane (6)	2-Methylhexane (7)	trans-1,3-Dimethylcyclopentane (7)	o-Xylene (8)
Heptane (7)	3-Methylhexane (7)	trans-1,2-Dimethylcyclopentane (7)	Propylbenzene (9)
Octane (8)	2,5-Dimethylhexane (8)	Methylcyclohexane (7)	1-Ethyl-2/3-methylbenzene (9)
Nonane (9)	3-Methylheptane (8)	Cycloheptane (7)	1,3,5-Trimethylbenzene (9)
Decane (10)	2,6-Dimethylheptane (9)	cis-1,3/1,4-Dimethylcyclohexane (8)	1-Ethyl-4-methylbenzene (9)
Undecane (11)	Pristane (19)	cis-1,2-Dimethylcyclohexane (8)	1,2,4-Trimethylbenzene (9)
Dodecane (12)	Phytane (20)	trans-1,3/1,4-Dimethylcyclohexane (8)	Indane (9)
Tridecane (13)		trans-1,2-Dimethylcyclohexane (8)	Indene (9)
Tetradecane (14)		Ethylcyclohexane (8)	Butylbenzene (10)
Pentadecane (15)		Cyclooctane (8)	1,2,4,5-Tetramethylbenzene (10)
Hexadecane (16)		Propylcyclohexane (9)	Naphthalene (10)
Heptadecane (17)			2-Methylnaphthalene (11)
Octadecane (18)			Acenaphthylene (12)

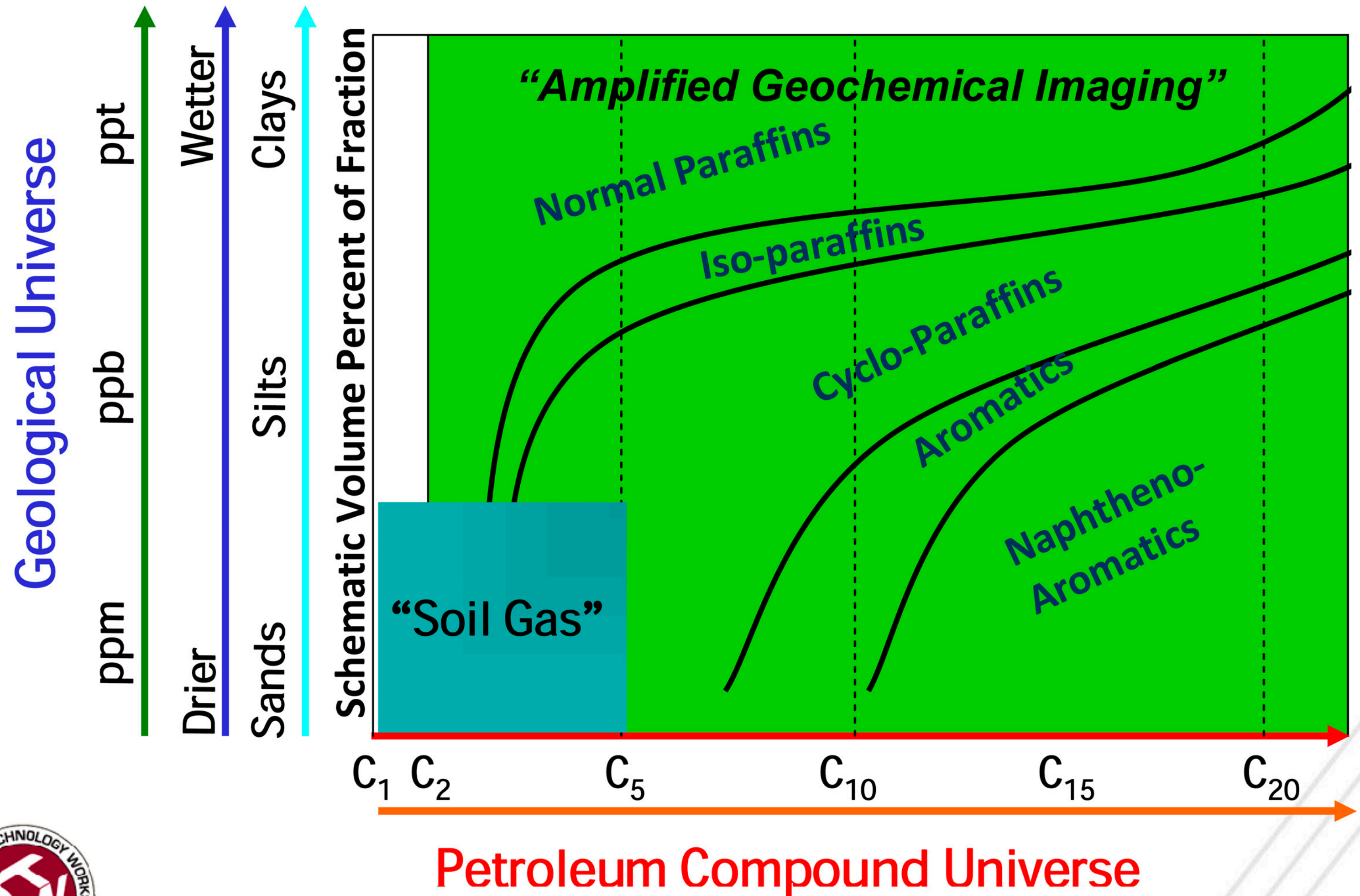
Byproduct / Alteration and Other Compounds

Alkenes	Aldehydes	Biogenic	NSO* and Other Compounds
Ethene (2)	Octanal (8)	alpha-Pinene	Furan
Propene (3)	Nonanal (9)	beta-Pinene	2-Methylfuran
1-Butene (4)	Decanal (10)	Camphor	Carbon Disulfide
1-Pentene (5)		Caryophyllene	Benzofuran
1-Hexene (6)			Benzothiazole
1-Heptene (7)			Carbonyl Sulfide
1-Octene (8)			Dimethylsulfide
1-Nonene (9)			Dimethyldisulfide
1-Decene (10)			
1-Undecene (11)			

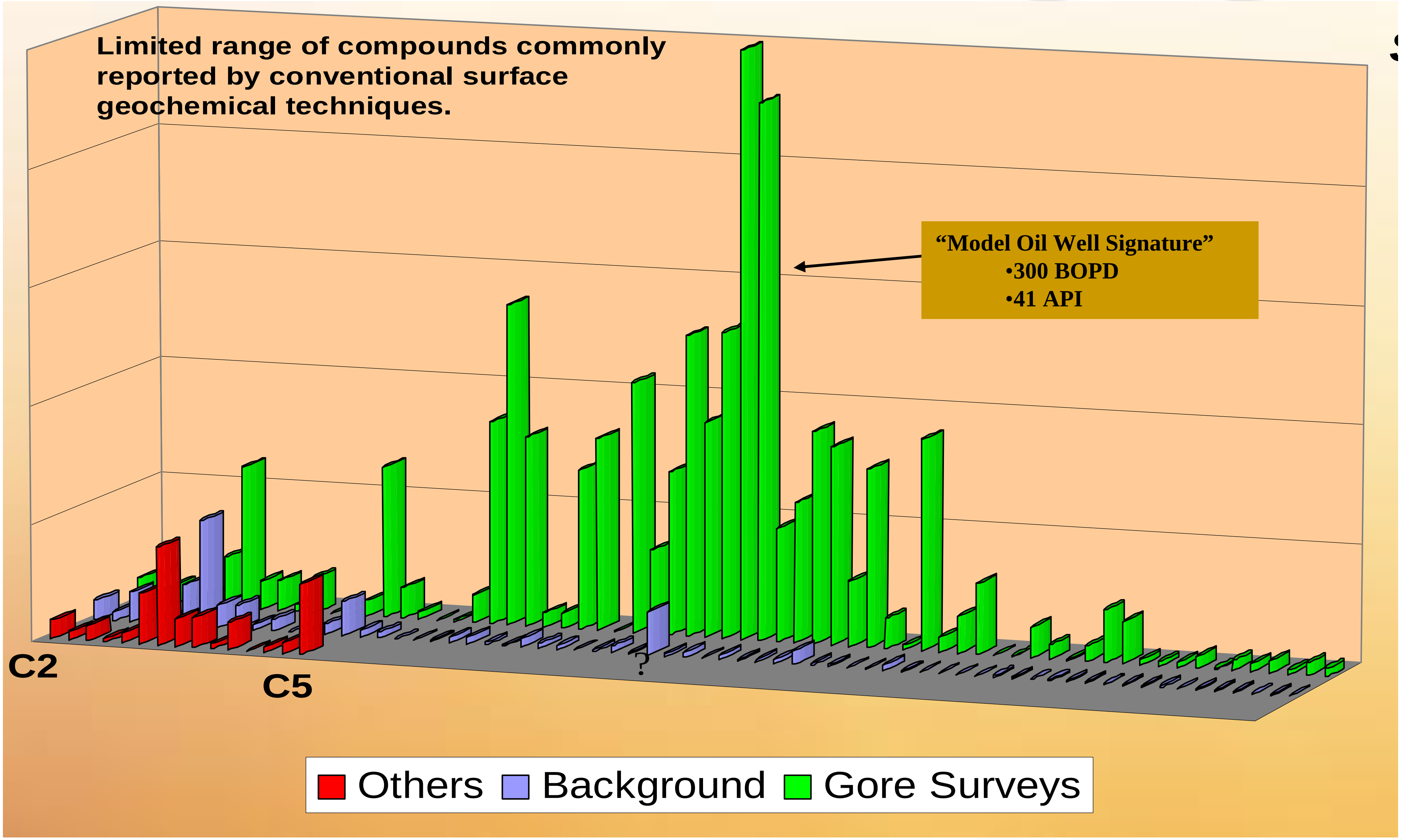
Superior to conventional surface geochemical techniques



Superior to conventional surface geochemical techniques

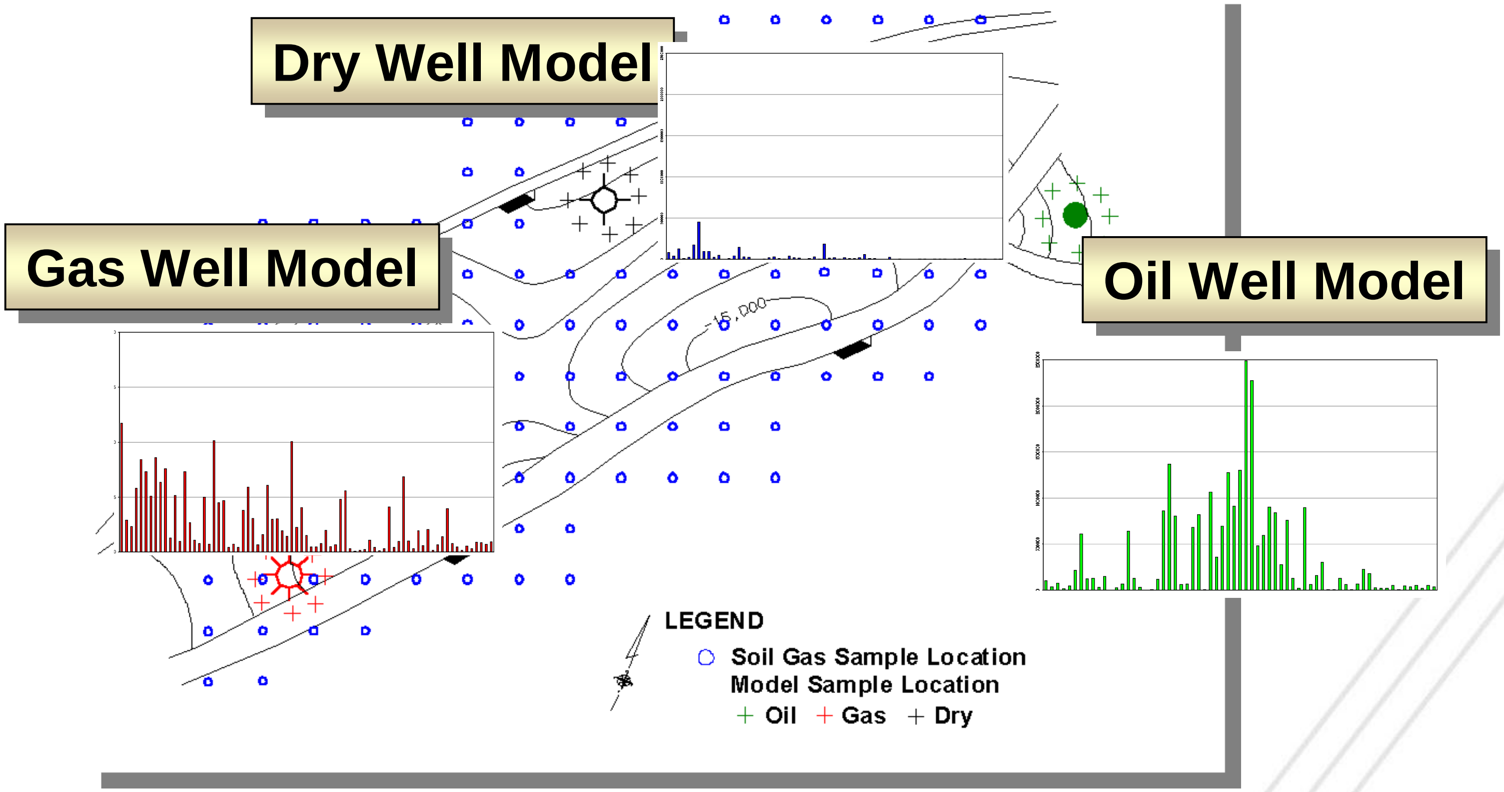


Geochemical Data Differentiation



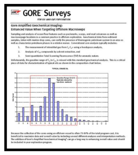
GORE™ Surveys for Offshore Exploration

Model development



Offshore Applications

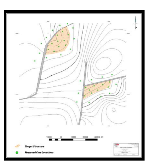
- **Slick sampling** and analysis to validate petroleum systems



- **Macroseep** & seabed feature targeting to validate petroleum system

- **Transition zone** (0-40 meters) mapping of direct hydrocarbons for prospect ranking

- **Shallow (40 m) to Deep water (3000 m)** coring & mapping of direct hydrocarbons for prospect ranking



- **Site Survey Sampling.** Collecting seabed samples while geotech/env site surveying

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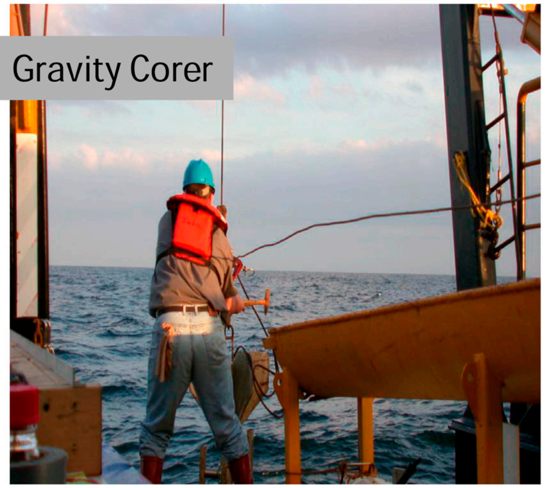
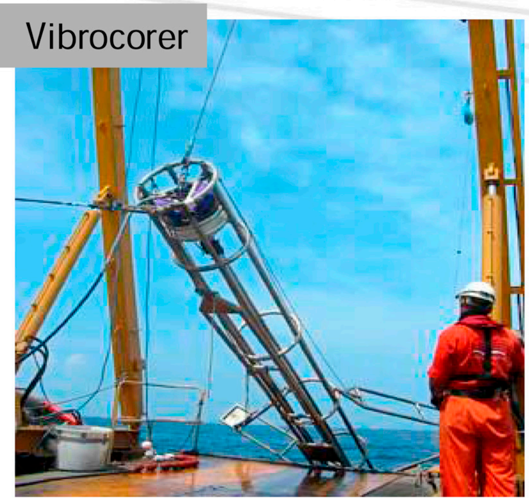
Offshore Application

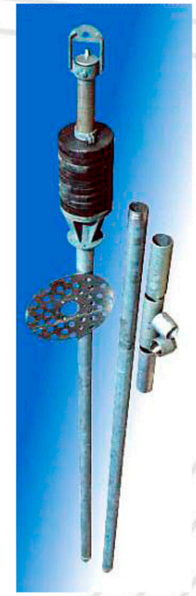
Boat

Gravity Corer



Vibrocorer





Core Extraction

Subcropping

Sample Jar + Module

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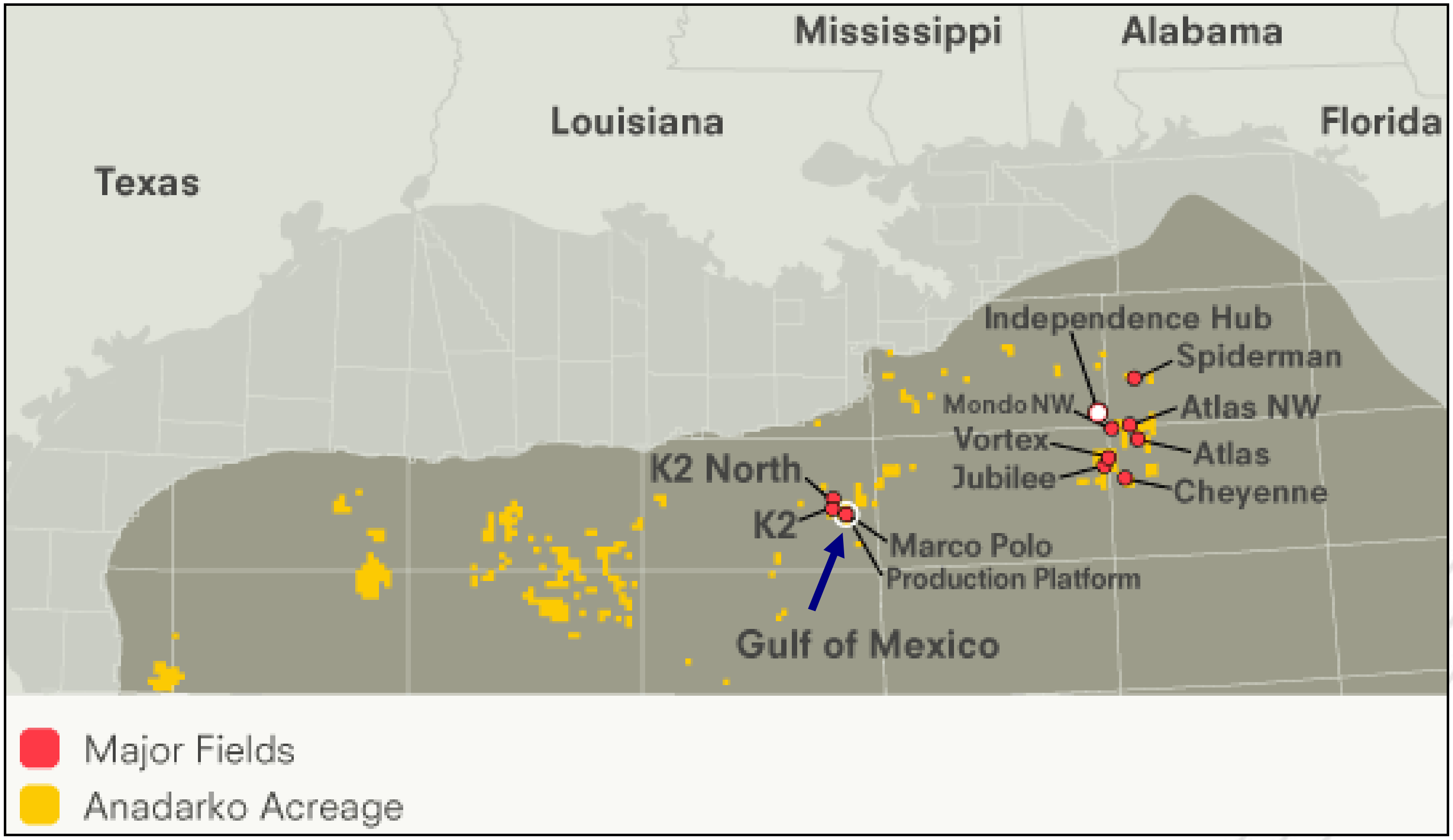
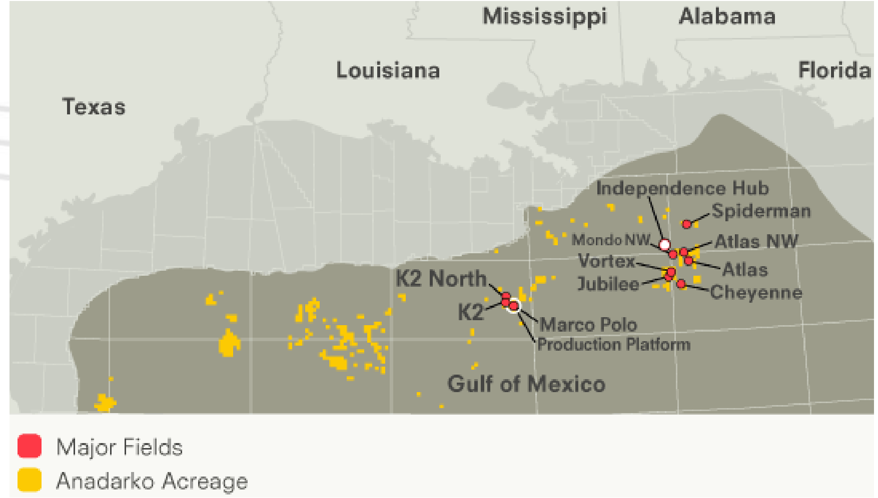
Case Study 1 - Macroseepage

Gulf of Mexico offshore study by the Energy & Geoscience Institute (EGI)

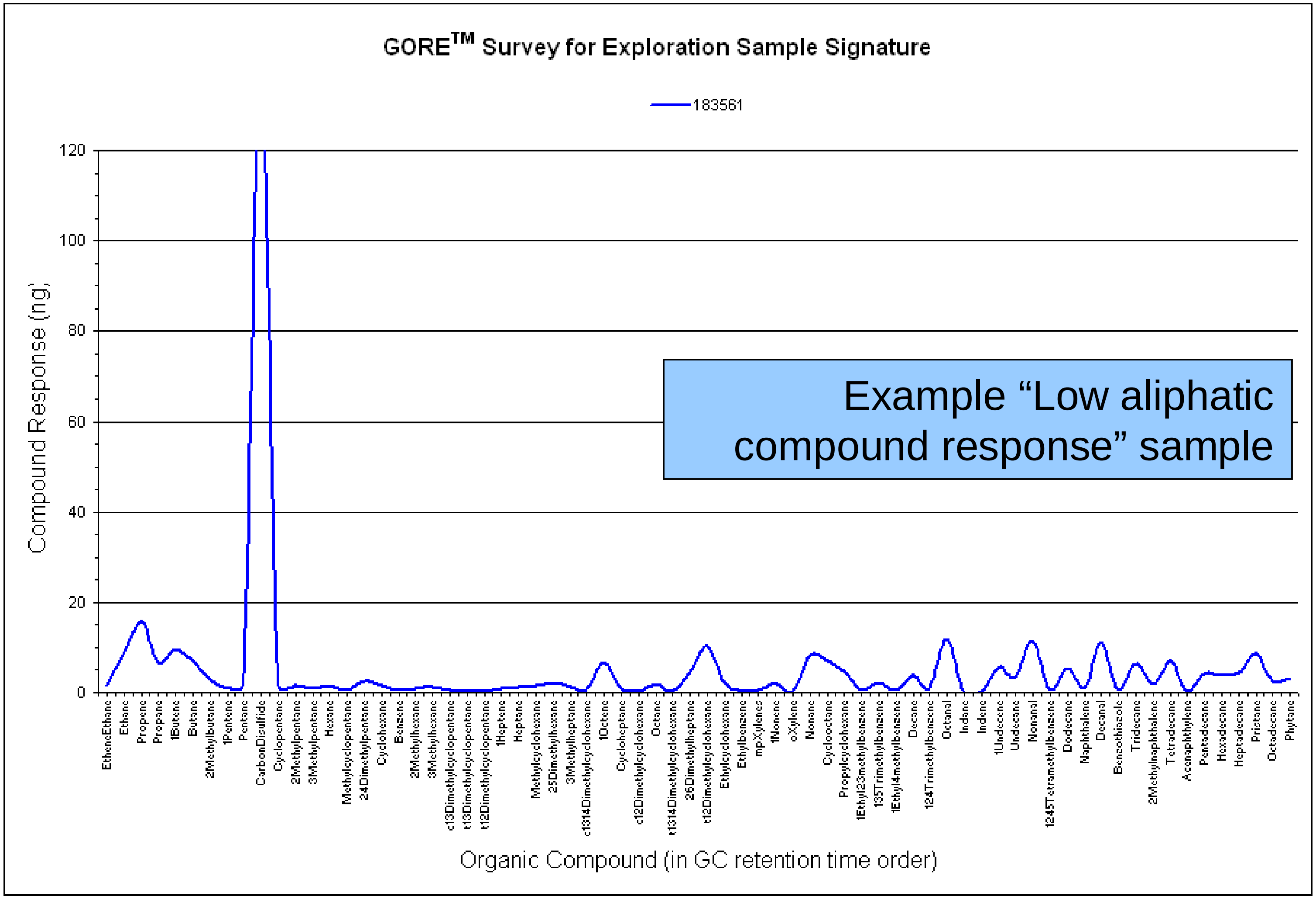


Survey Operations

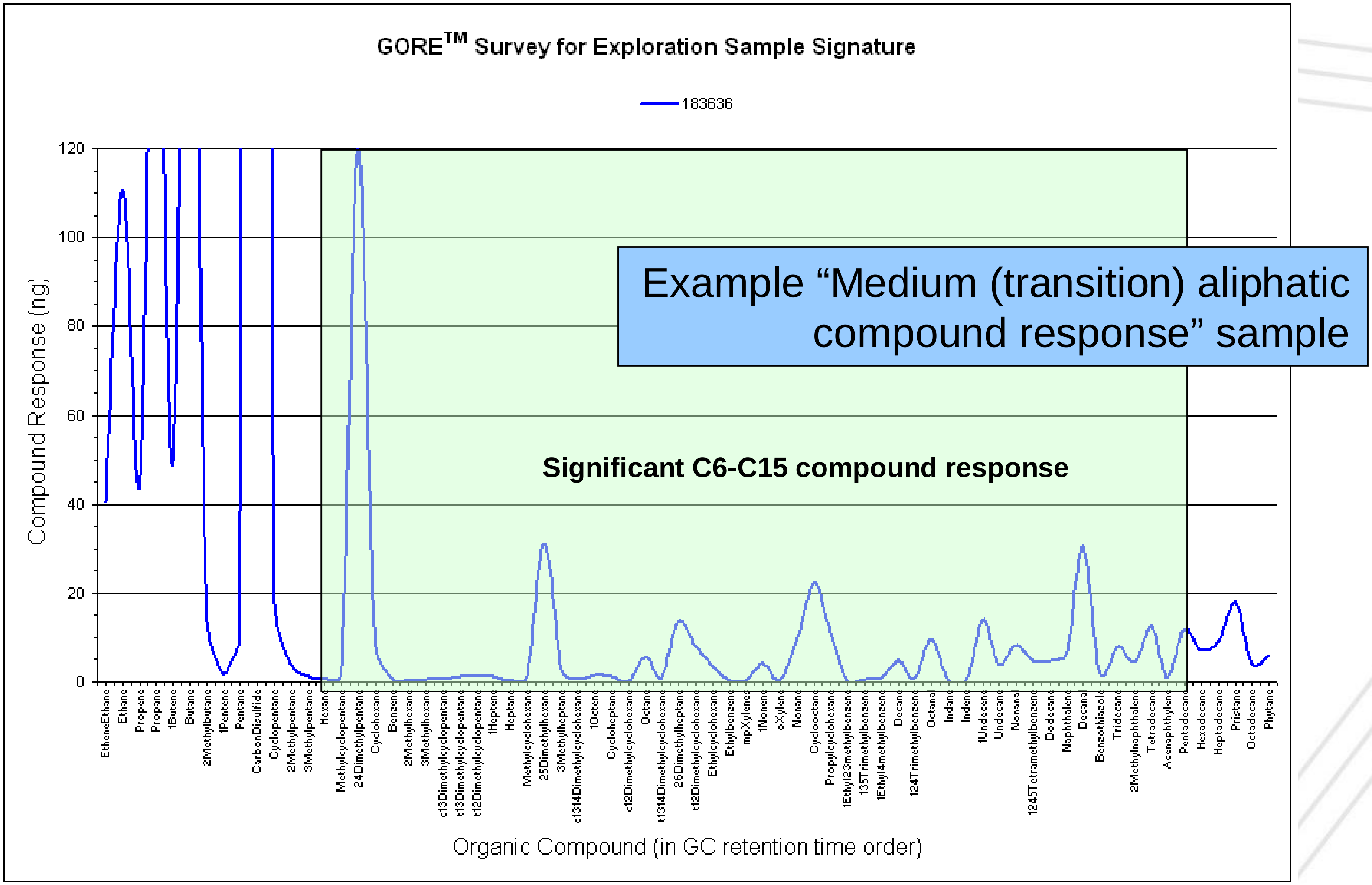
- Cruise duration 5 – 7 days
- GORE contracted Peregrine Ventures to conduct core subcrop sampling
- Core samples obtained near Marco Polo Field (Green Canyon Block 608)
- 93 geochemical samples total

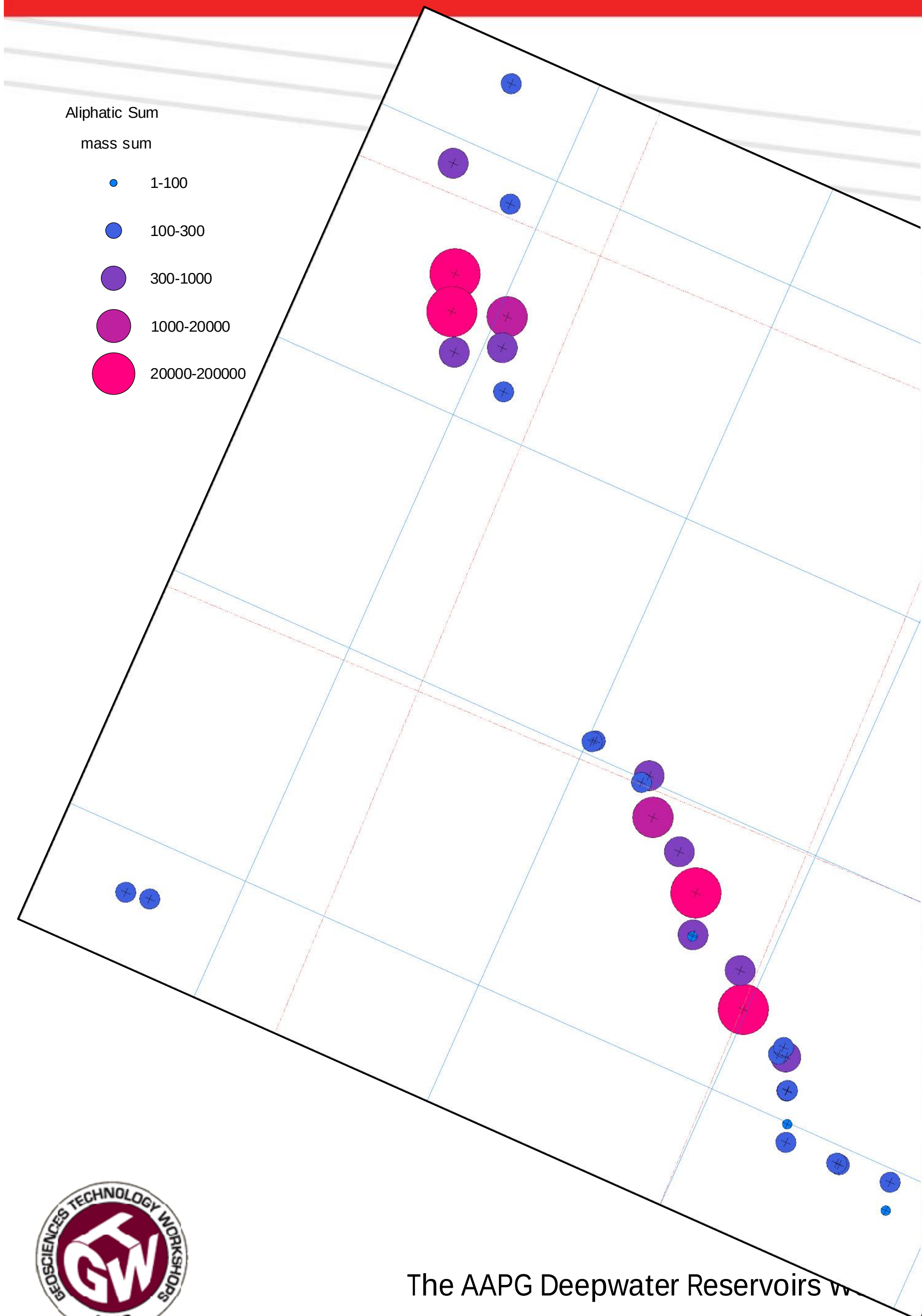


Hydrocarbon Response



Hydrocarbon Response





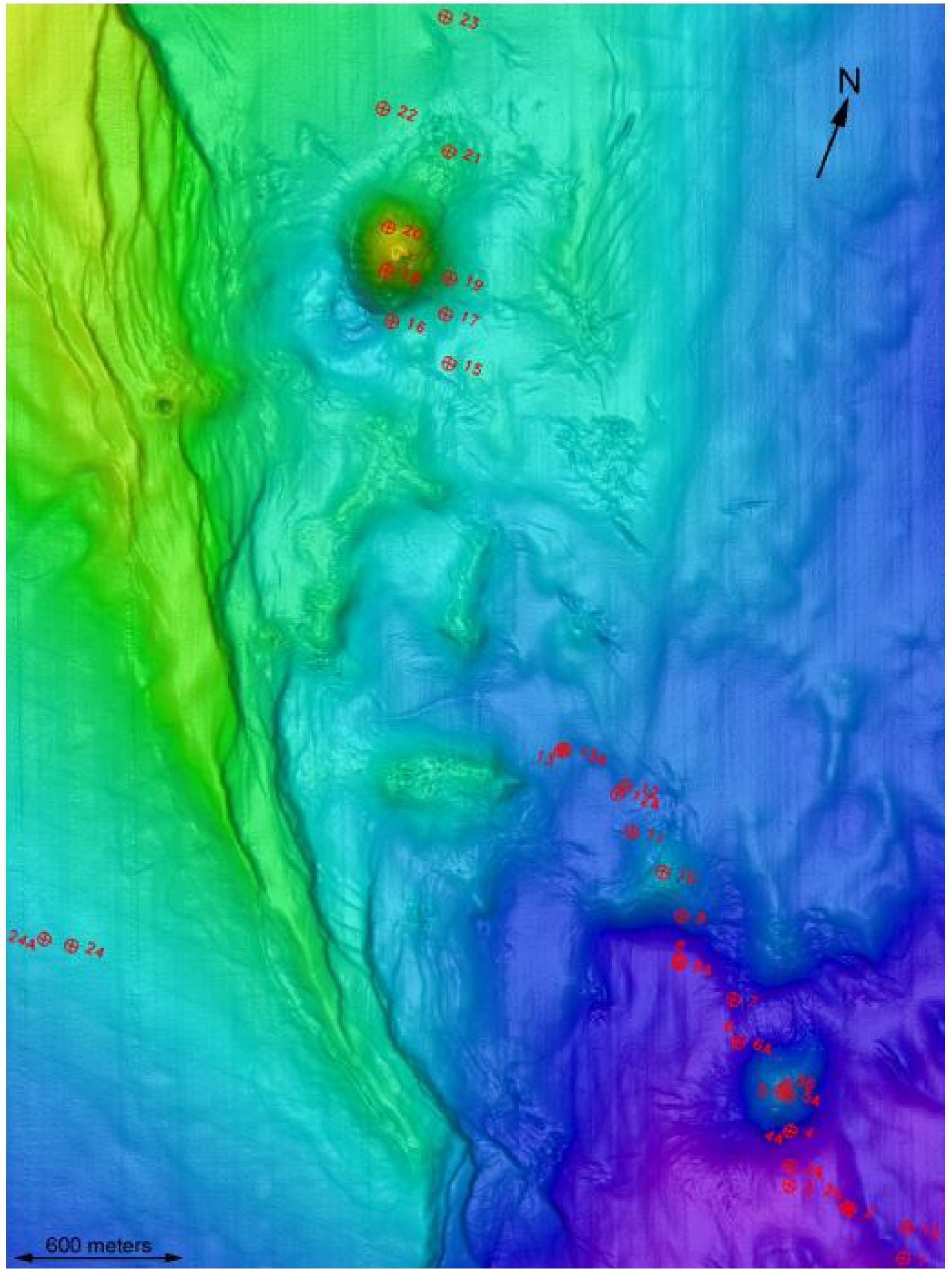
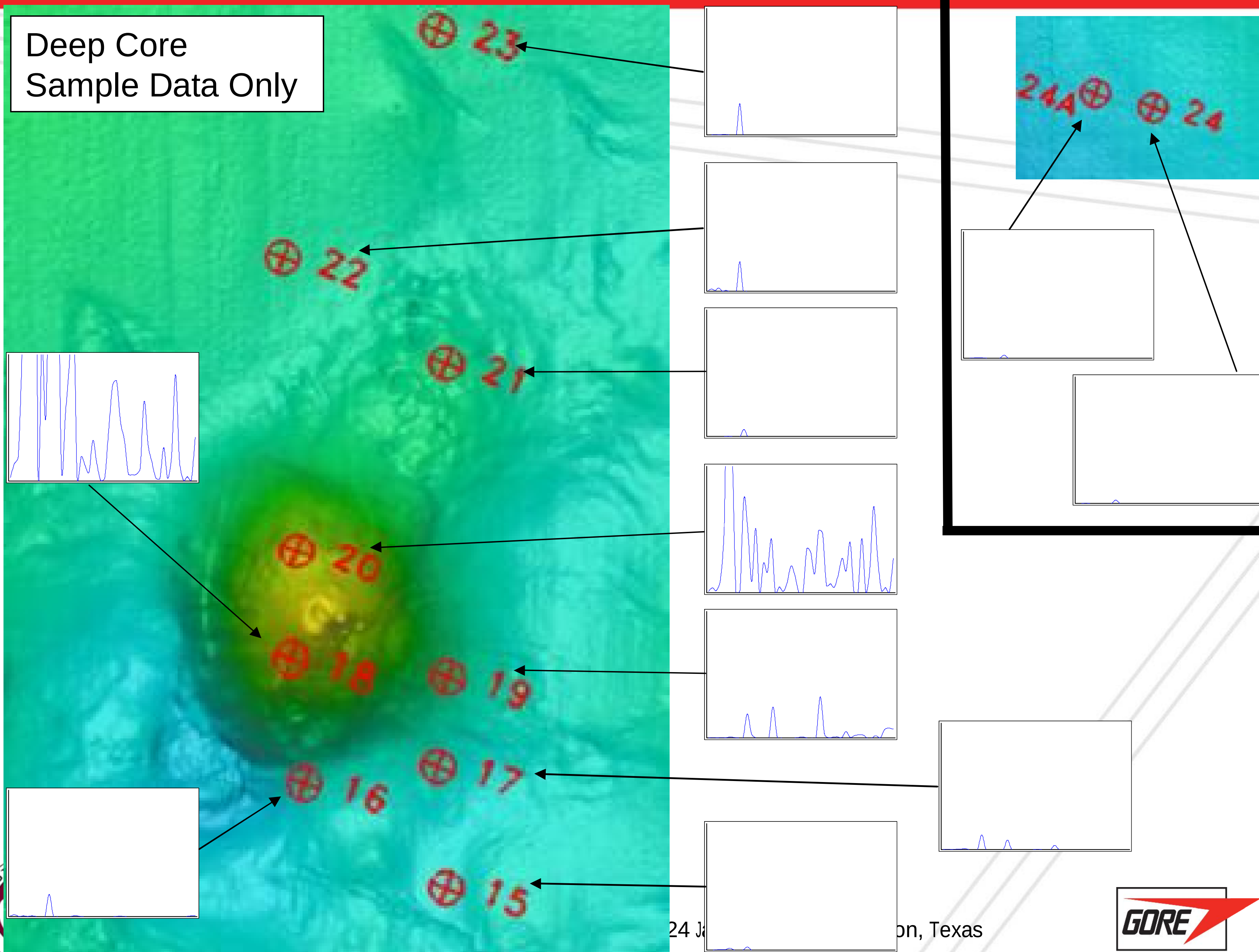


Figure 8: DTM plan view map of the high resolution multibeam bathymetry showing the sea surface locations from which the piston coring device was deployed for each core gathered. Dembicki and Samuels (2007)



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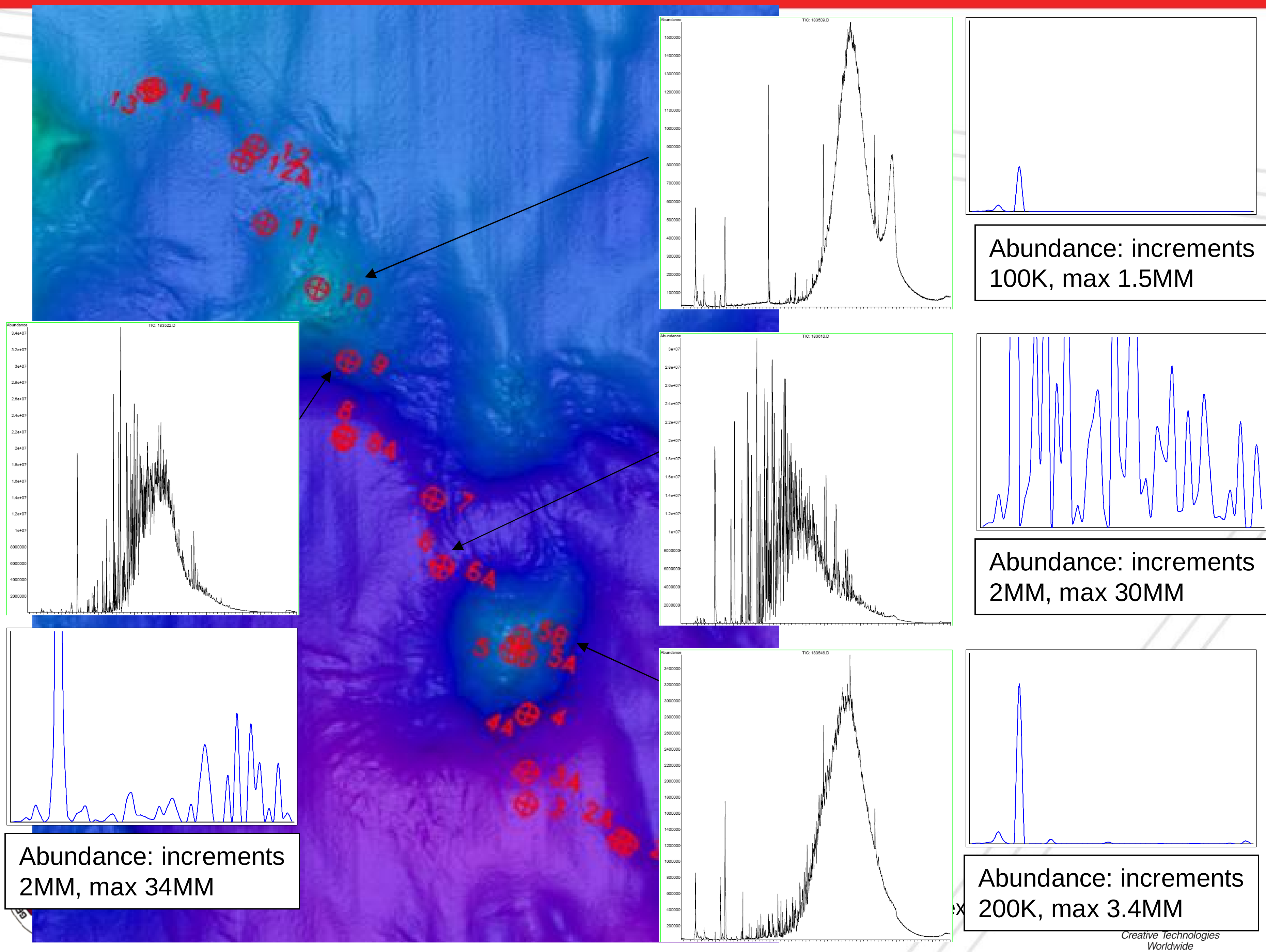
Abundance: increments 100K, max 1.5MM
Abundance: increments 2MM, max 30MM
Abundance: increments 2MM, max 34MM
Abundance: increments 200K, max 3.4MM
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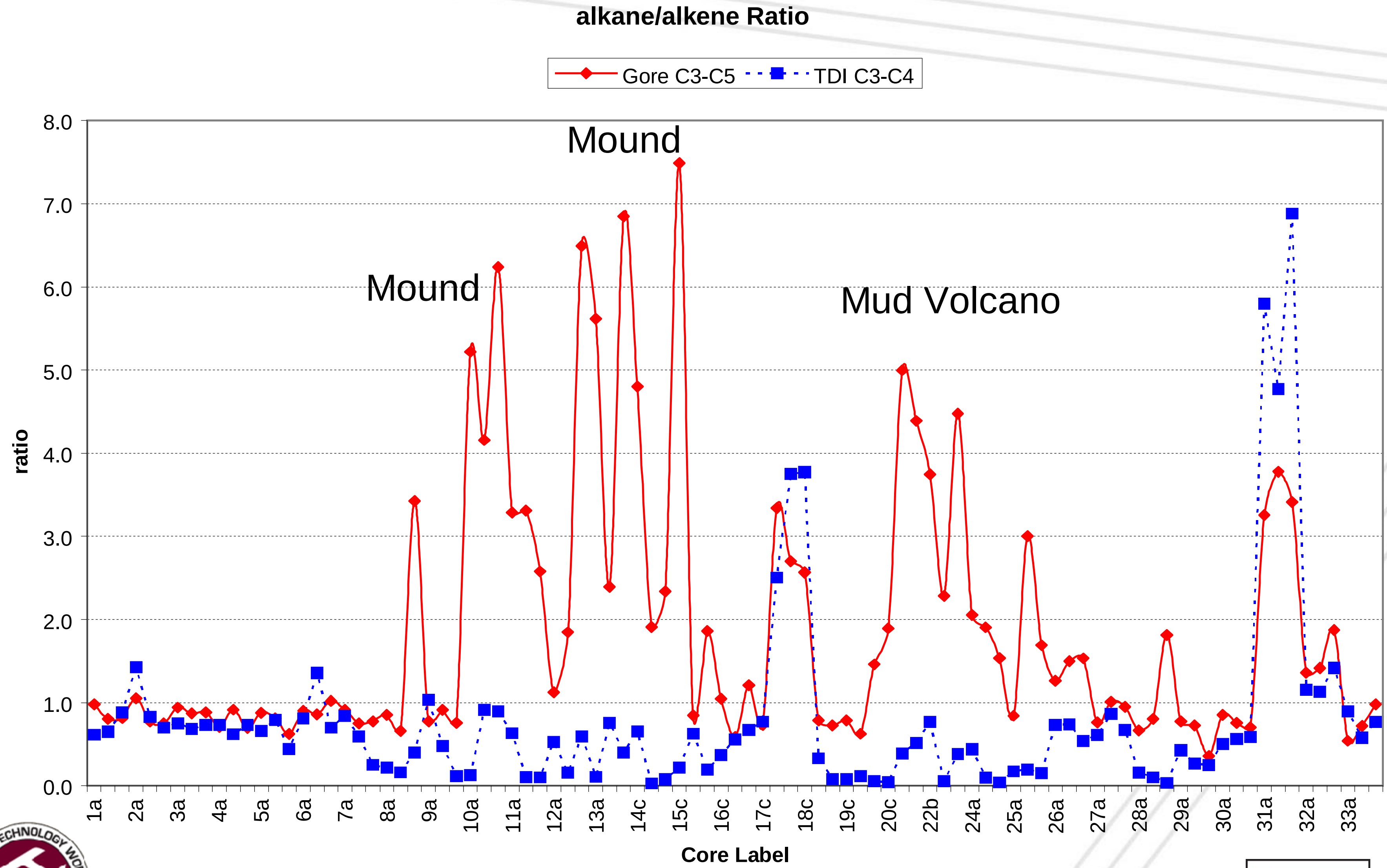
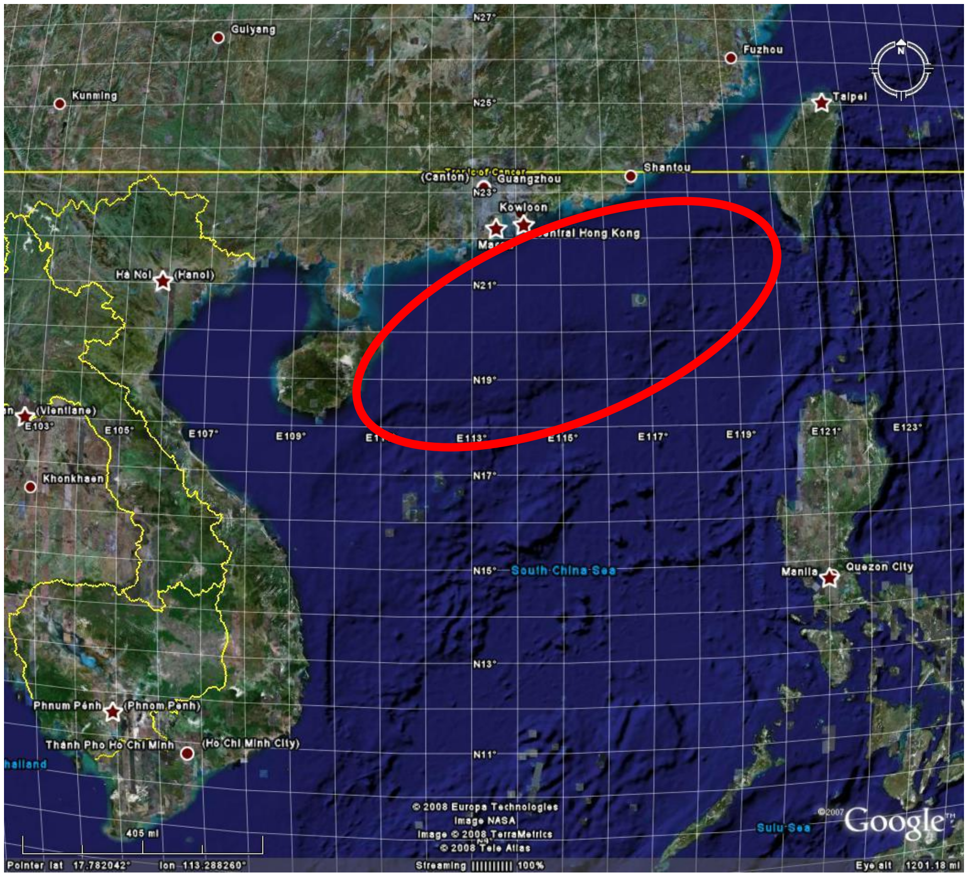
Hydrocarbon Response



Area of Operation – South China Sea

Microseepage

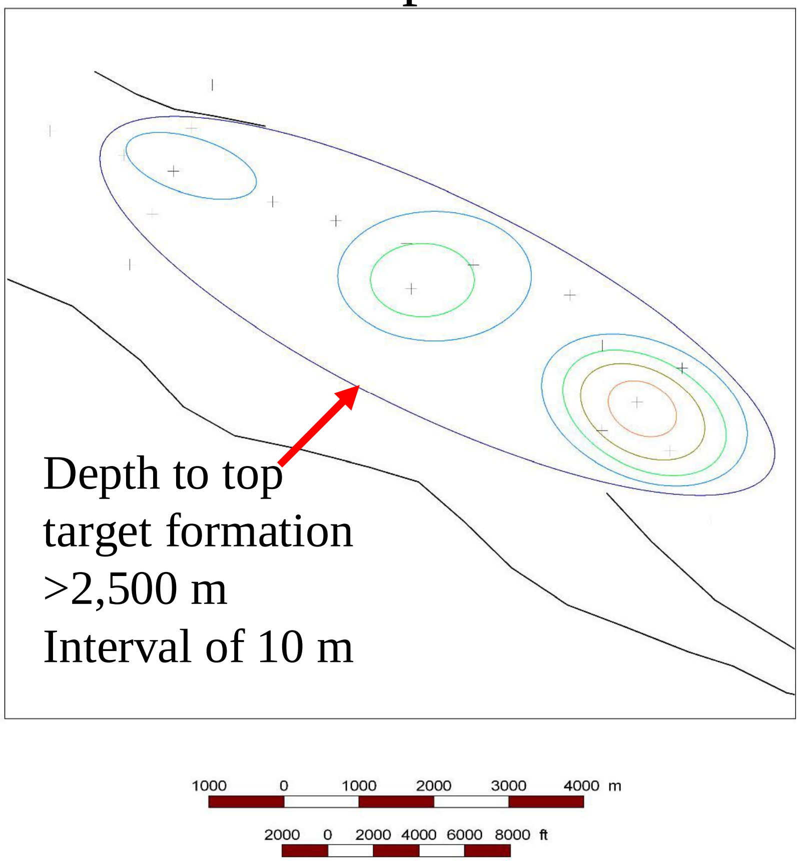


Geochemical Survey Area

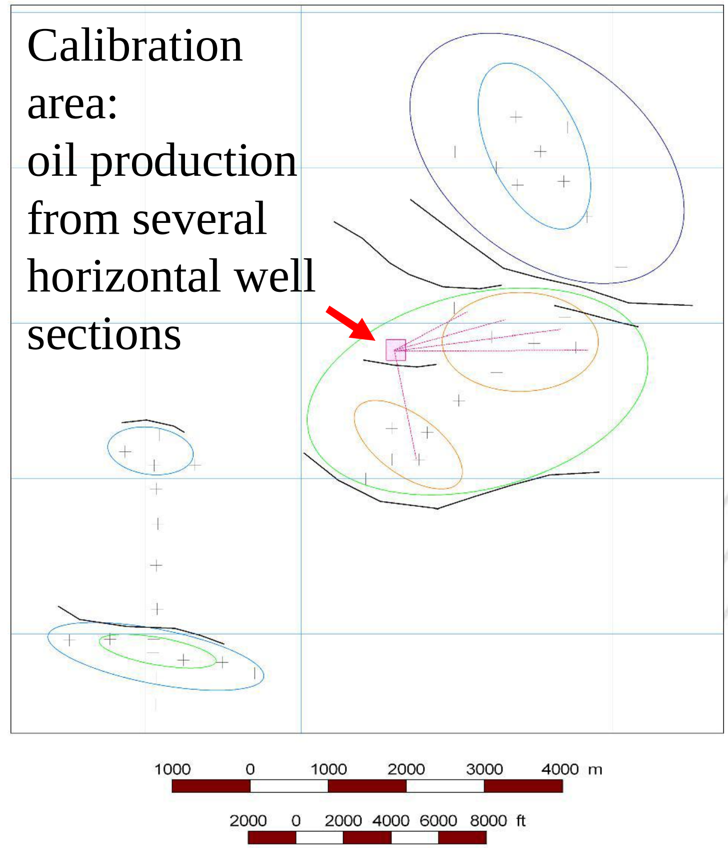
- Water Depth: <500 m
- Sediment: clay, poorly sorted sands and gravels
- (difficult core penetration)
- Vessel: survey vessel contracted in China
- Coring equipment: vibrocorer
- Cruise duration: 2 weeks

Geochemical Survey Design

Western Prospects



Eastern Prospects



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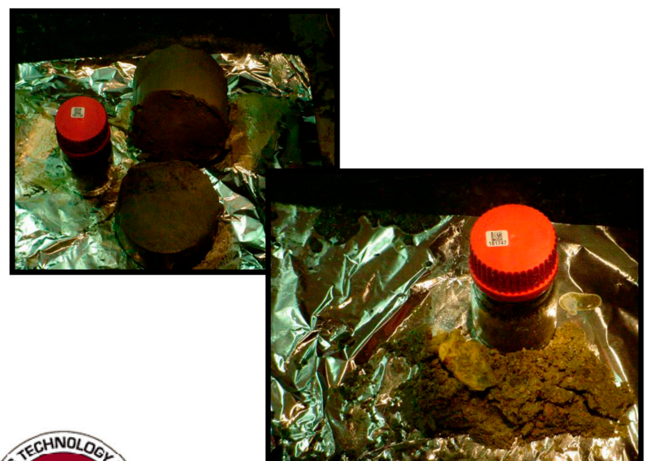
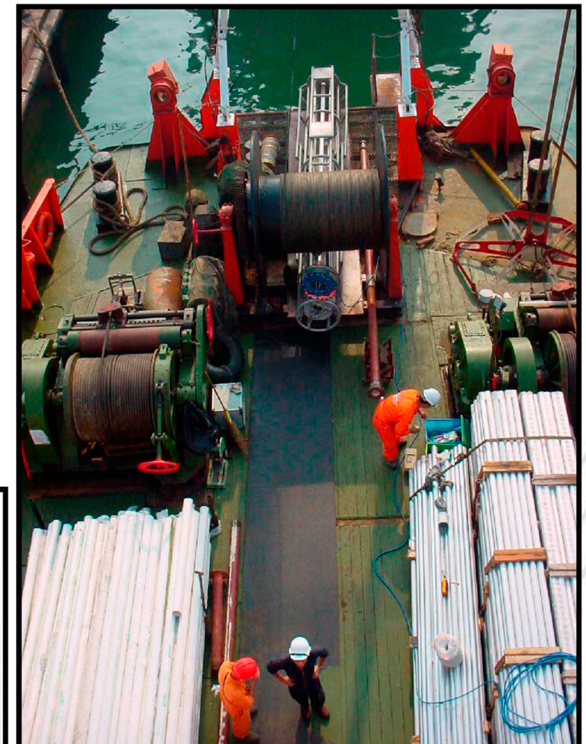
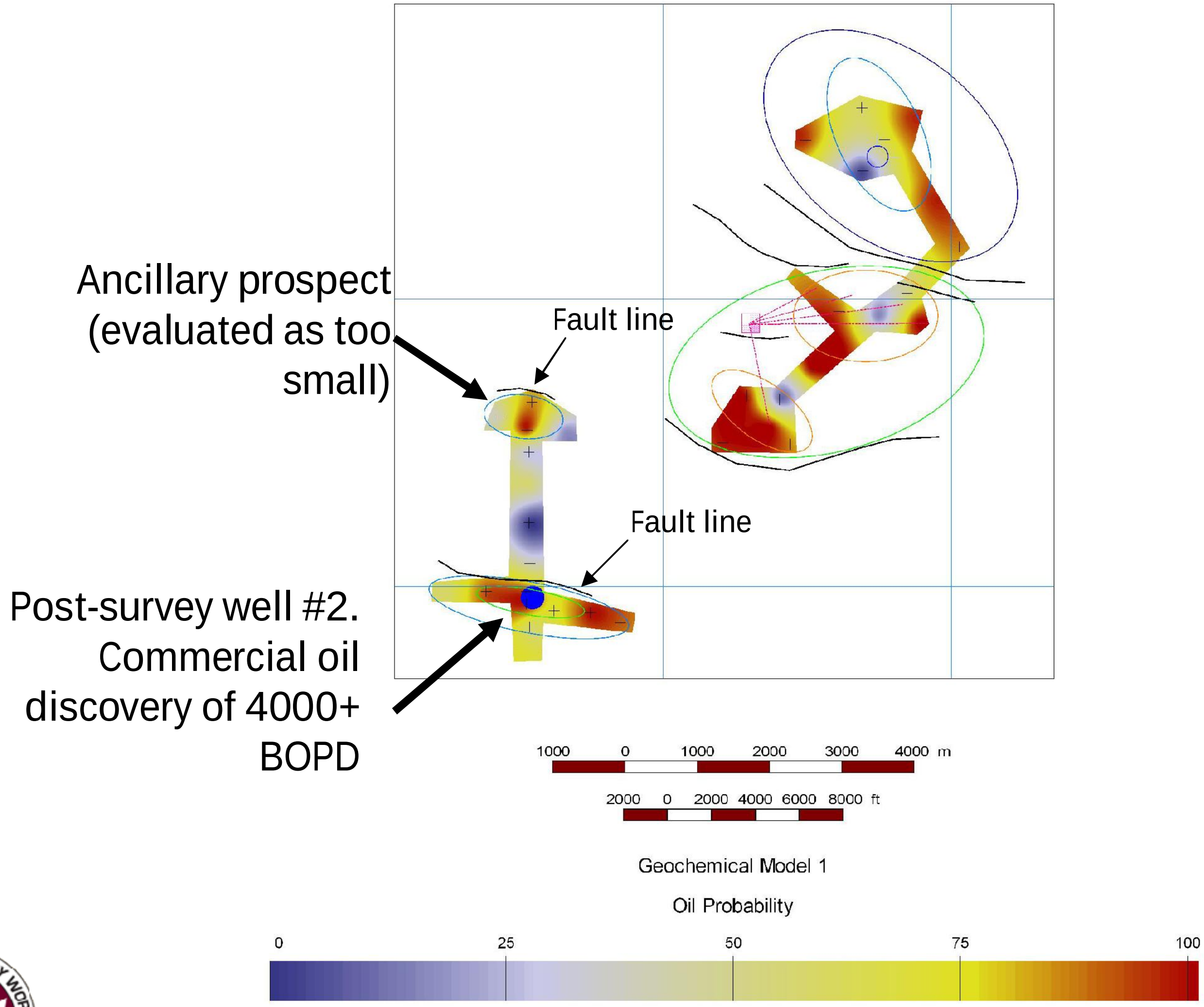
Field Operations

- 75+ survey core samples over prospects
- 75 calibration core samples from oil production and dry hole areas
  - 45 cores from over-producing reservoirs
  - Used to develop models and to study reservoir areas
- Marine vessel contracted from Shanghai, supervisory staff from USA

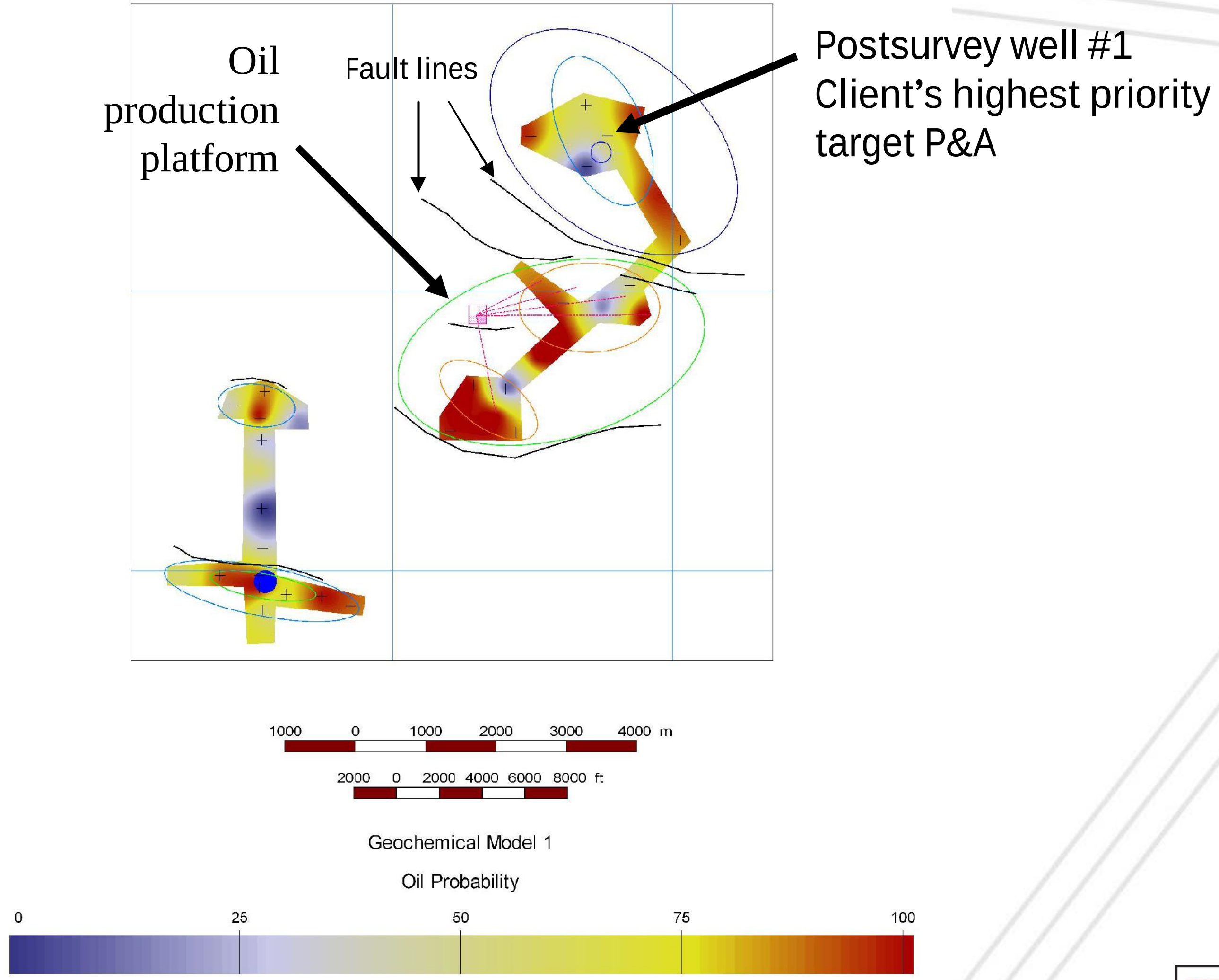




Interpretation of Eastern Prospects



Interpretation of Eastern Prospects



Interpretation of Eastern Prospects

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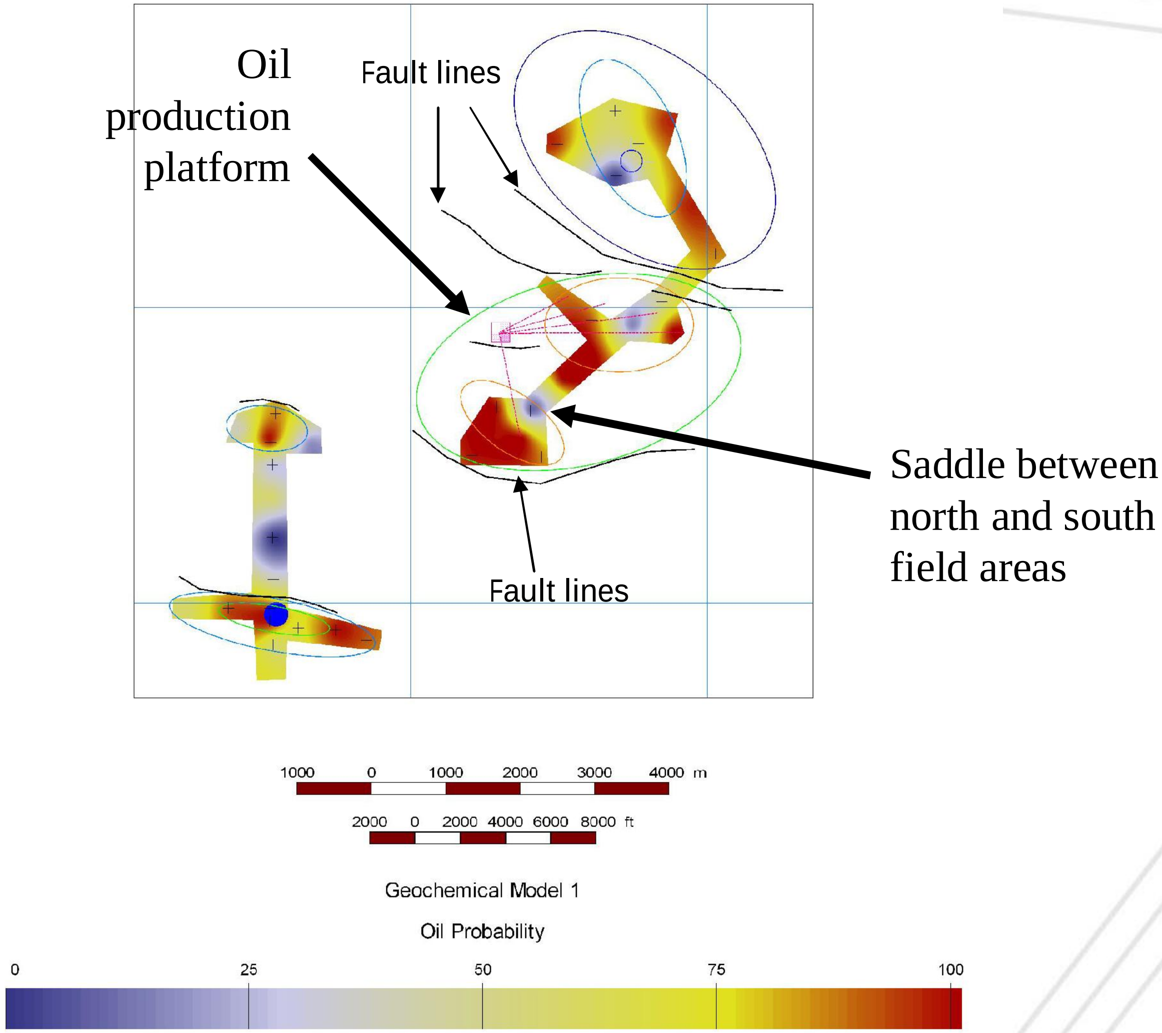
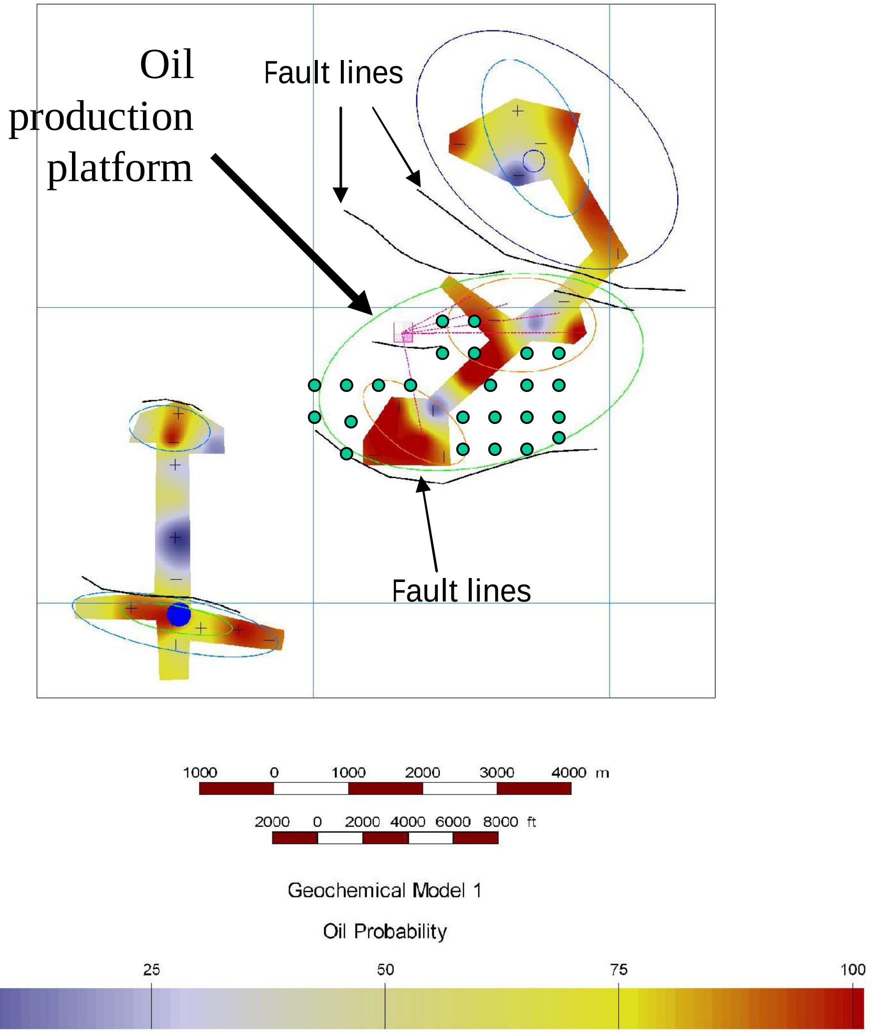


Interpretation of Eastern Prospects



Survey Results

- Three prospects recommended for further attention as very positive prospects
- Three prospects recommended as ill-defined prospects with less potential
- Three prospects were recommended as nonprospective

Three wells were drilled post-survey.

Predictions 100% accurate

Frequently Asked Questions

- Can you tell at what depth a reservoir is situated?
- Can your data determine if a positive anomaly is economic?
- What happens when you have stacked zones?
- How deep can you see?
- Are there situations where your technology doesn't work?

Thank you!