Gore® Amplified Geochemical Imaging℠ -

The advanced tool for derisking HC exploration

FINDING PETROLEUM, Feb 15, 2011

Presented by

Dirk Hellwig, W.L. Gore & Associates

Today´s Menu

- Innovation Runs through everything we do, Gore Enterprise & Surveys
- Amplified Geochemical Imaging
  - Earth´s Fractionation Process
  - AGI – How it works
  - The advanced tool
- Case studies
- Track Record & Wrap-up

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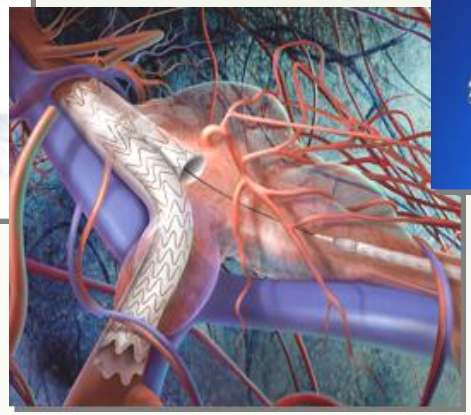
Innovation Runs Through Everything We Do


Fabrics

Medical Products



Electronic Products


Industrial Products

- Established in 1958, Privately held
- ~ $2.5 billion annual sales
- 9,000+ associates
- Recognized as a “Best Company to Work For”
- 50 offices worldwide
- Dedication to R&D

www.gore.com/surveys

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Gore Survey Products Group, Global resources & locations

GORE™ Surveys

FOR OIL AND GAS EXPLORATION

Location	Resources
Elkton, MD, USA	Manufacturing, Lab, Interp., Sales, Leadership
Munich, Germany	Interp., Sales, Sales Admin.

GORE Amplified Geochemical Imaging service is:

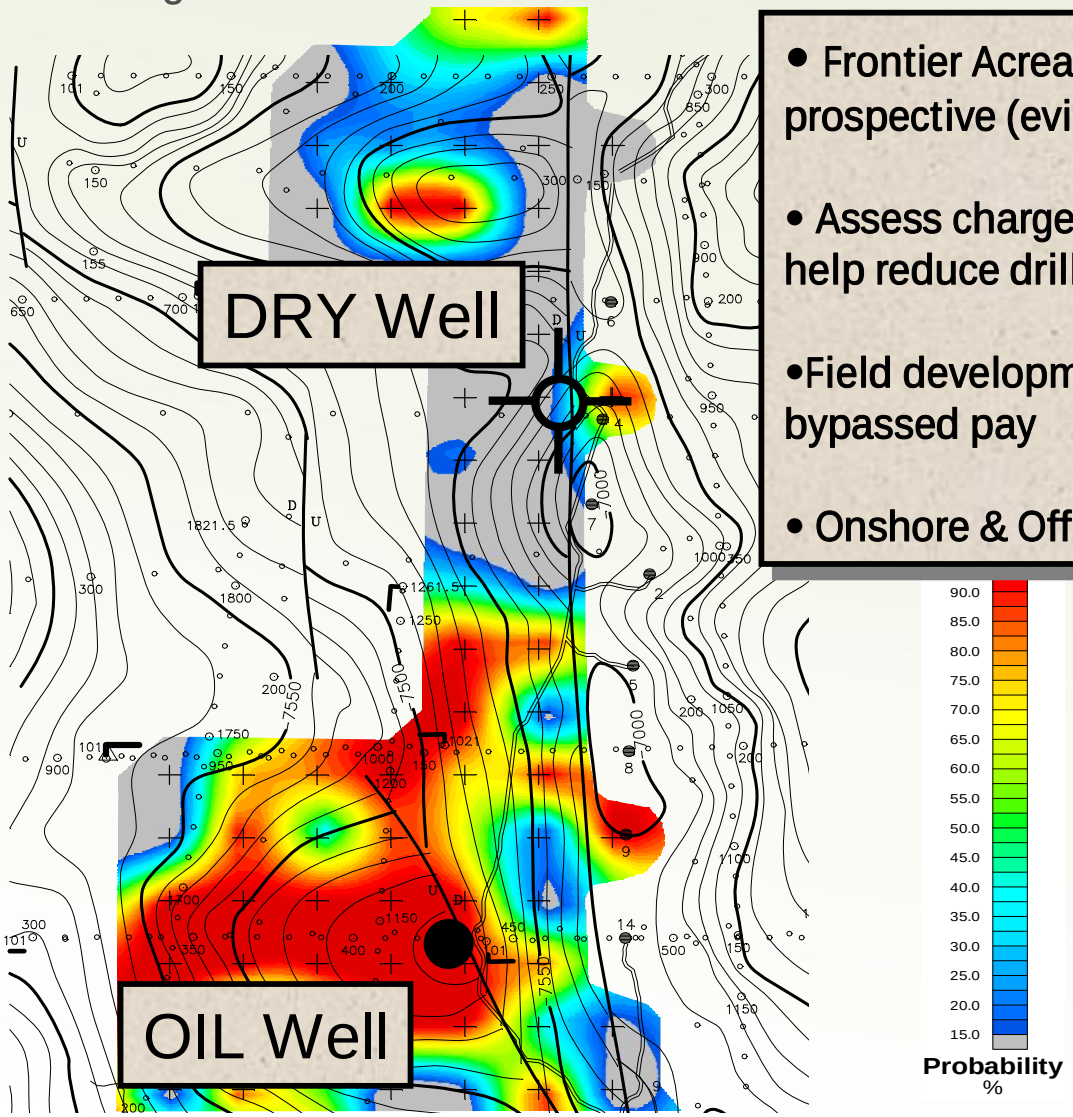
- a surface based
- passive
- geochemical method
- Direct Hydrocarbon Indicator

It measures and maps
- HC compounds from the soil gas in the sub part per billion range

It uses
- Gore´s unique and highly sensitive passive diffusion module
- advanced mathematical and statistical techniques to identify and analyze the microseepage signal

It creates
- a comprehensive geochemical dataset that can be interpreted with various techniques (incl. AGI modelling)

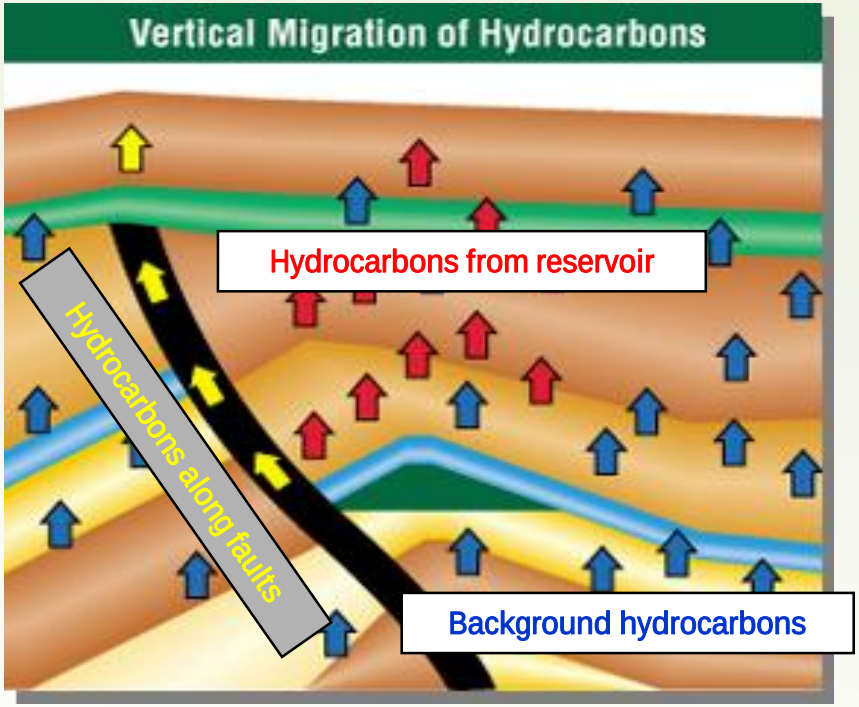
Benefit of AGI to your Exploration Program



- Frontier Acreage – is my concession prospective (evidence of a petroleum system)?
- Assess charge potential in defined leads to help reduce drilling risks
- Field development to find field extents and/or bypassed pay
- Onshore & Offshore Capability

The Earth´s Fractionation Process

Vertical Migration



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

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The Earth´s Fractionation Process

Vertical Migration - Microseepage

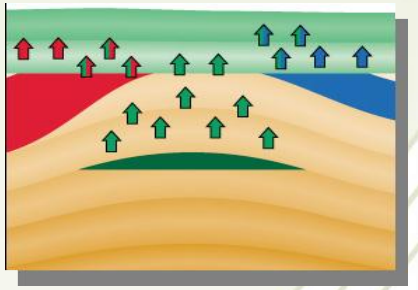
Four possible mechanisms:

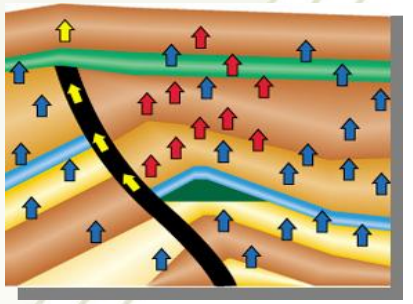
1) Diffusion - gradient movement of dissolved gases
2) Aqueous transport - movement in ascending water
3) Continuous gas phase flow

Favoured mechanism:

4) Microbuoyancy - transport in buoyant microbubbles
   - Direct surface projection of reservoirs
   - Migration in the absence of faults
   - Rapid changes in surface anomalies as production starts

"Vertical Migration Mechanisms"





Klusman, R.W., and M.A. Saeed, 1996, Comparison of light hydrocarbon microseepage mechanisms, *in* D. Schumacher and M.A. Abrams, eds., Hydrocarbon migration and its near-surface expression: AAPG Memoir 66, pp. 157-168.

Brown, A., 2000, Evaluation of possible gas microseepage mechanisms, AAPG Bulletin, pp. 1775-1789.

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The Earth´s Fractionation Process

Hydrocarbon Seepage – Response Speed

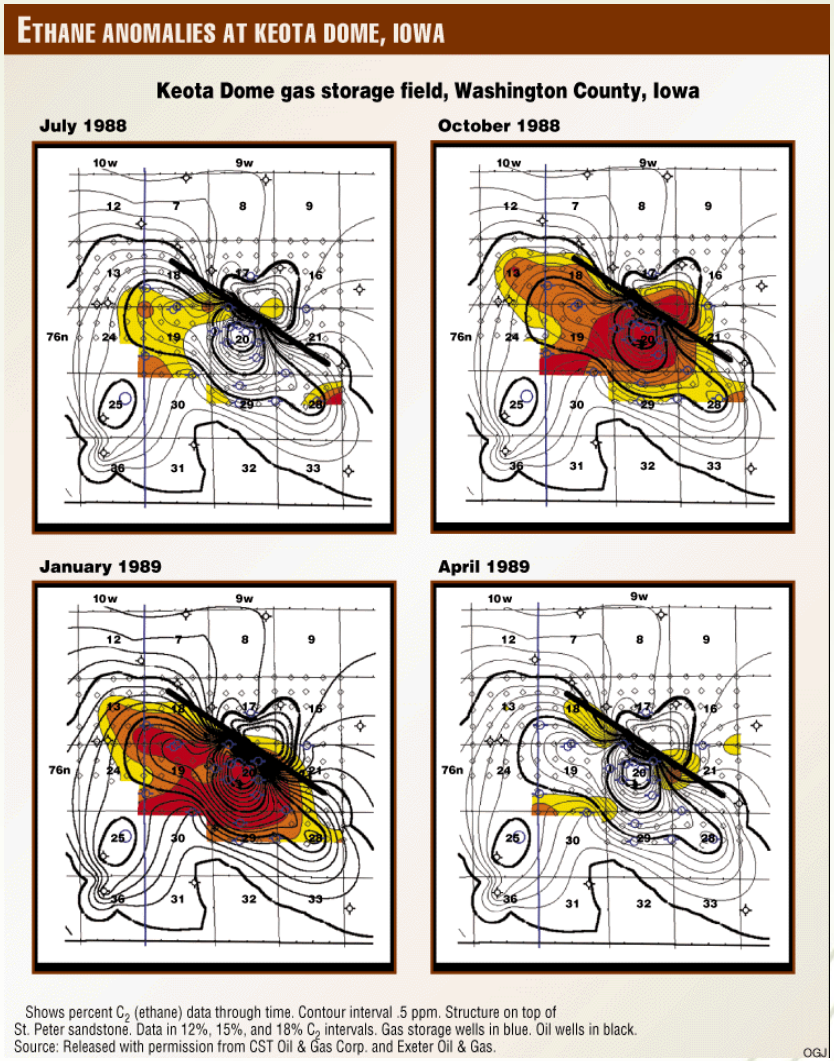
Keota Dome Iowa – 700 m

CST Oil & Gas

Exeter Oil & Gas

Before Charge - July

During
Draw down - January



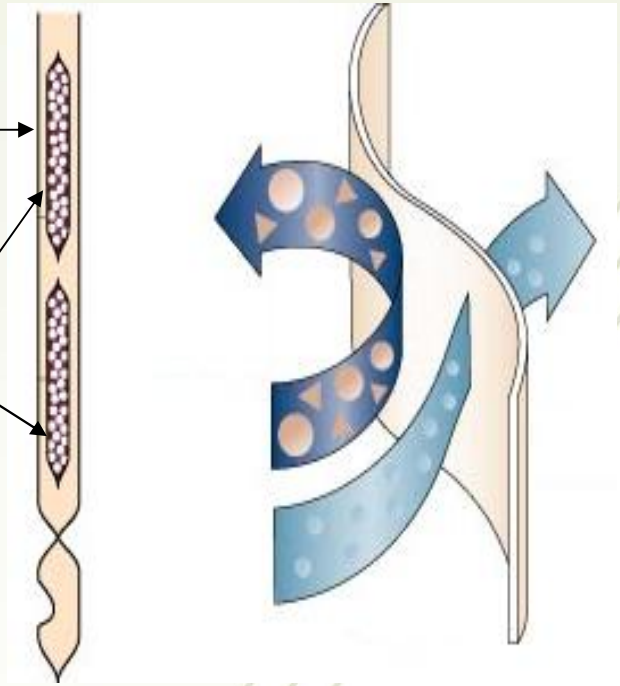
After Charge - October

After
Draw down - April

Amplified Geochemical Imaging - How it works

Gore Sampler (Module)

- 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



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Amplified Geochemical Imaging - How it works

Module installation & retrieval

Onshore

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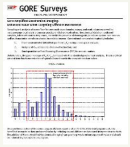
Amplified Geochemical Imaging - How it works

Offshore Application

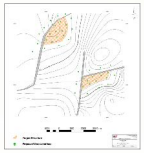
- **Slick sampling** and analysis to validate petroleum systems



- **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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Amplified Geochemical Imaging - How it works

Offshore Application

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

Place insertion rod in module

GORE™ Surveys

FOR OIL AND GAS EXPLORATION

GORE™ Surveys Offshore Slick Sampling & Analysis Service

Slick sampling to validate and characterize your offshore petroleum system

GORE™ Slick Sampler has been validated by customers and industry consortiums

- Easiest to use: Simply cast a "slick lure" onto your slick and reel for 2 minutes
- Most sensitive for very thin slicks
- Widest compound range: From C_1 to C_{25}

Gore is the only provider of the Amplified Geochemical Imaging[SM] technology for petroleum reservoirs onshore and offshore

GORE™ SLICK SAMPLING KIT

Rugged hard waterproof case includes everything you need:

- 20 ready-to-use samplers
- folding fishing rod
- weighted bobbers
- fishing line and hardware
- gloves
- instructions, video
- sample documentation for moist environments

Equip each of your offshore working boats with a Slick Sampling Kit.

ASTRIUM

AN EADS COMPANY

Global Seeps

Near-real-time slick mapping & analysis

The use of spaceborne SAR systems for mapping seepage slicks is well established technology.

Over the past two decades, Infoterra Ltd has interpreted over 11,000 satellite scenes over the majority of the Worlds offshore basins.

Such information is used widely in the hydrocarbon industry to identify new fields and risk manage exploration activities.

Geochemical sampling of seepage slicks can add another level of information to this data, helping to add confidence & allowing a greater understanding of the nature of the seep.

Faster data processing and delivery of data & slick interpretation, allows information fed directly to survey teams to guide them to current slick locations, increasing the chances of a successful slick survey whilst decreasing the high cost of keeping vessels at sea. This technique is of particular benefit in frontier exploration areas where the presence of a mature oil source rock is a risk.

Infoterra have been able to provide repeat observations of target areas for a number of such surveys, supplying updates of seepage slick locations within 24 hours of image acquisition.

One such project was completed on behalf of an Encana led consortium of clients across West Greenland in 2008, with sampling work undertaken by GORE™.

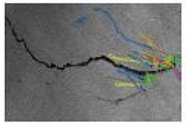
- Tasked image collections covering the entire survey area of approx. 20,000km^2 every 3 days. Slick locations fed directly to the survey vessel.
- Detailed mapsheets, vectors & imagery in a GIS environment were available to the onshore team between 12 & 36 hours of image acquisition.
- Combined with historical archive dataset of likely seepage locations and feeds of weather information, the chances of successful slick sampling were maximised and decisions regarding the survey vessels locations & movements could be made with up-to-date information.

Data Specification

Global Seeps data comprises a series of deliverables in GIS digital format for every study area.

- Scene interpretation results - scene outlines, metocean interpretation details, ship traffic and rig/platform information.
- Slick interpretation results - slick source points, slick vectors, probable slick type and confidence levels.
- Digital geo-coded calibrated data for the full scene at 100m resolution.
- Slick subset images at 25m resolution.

Seepage slick detected on SAR scene & sampled within hours of image collection



Multi-temporal interpretation from SAR imagery showing repeat seepage

Slick located during rapid SAR survey, Offshore West Greenland 2008

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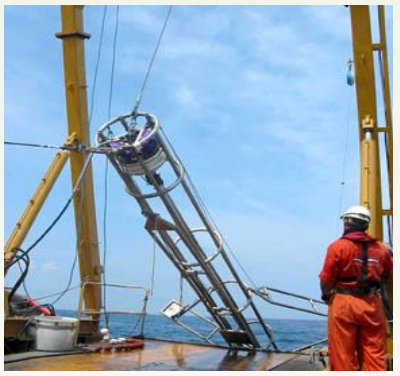
Amplified Geochemical Imaging - How it works

Offshore Application

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

Collection of shallow seabed cores

Gravity coring / vibrocoring
Penetrating 3 - 5 meters



Grid sampling over defined prospects

Multiple data points

Modeling of charged fields, when possible

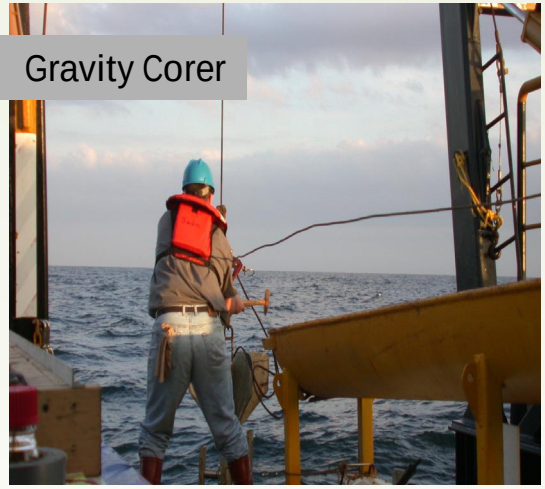
Applicable anywhere a core sample can be taken

Amplified Geochemical Imaging - How it works

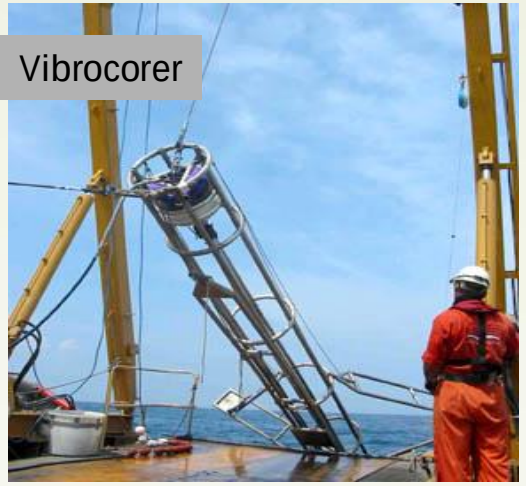
Offshore Application

Boat

Gravity Corer

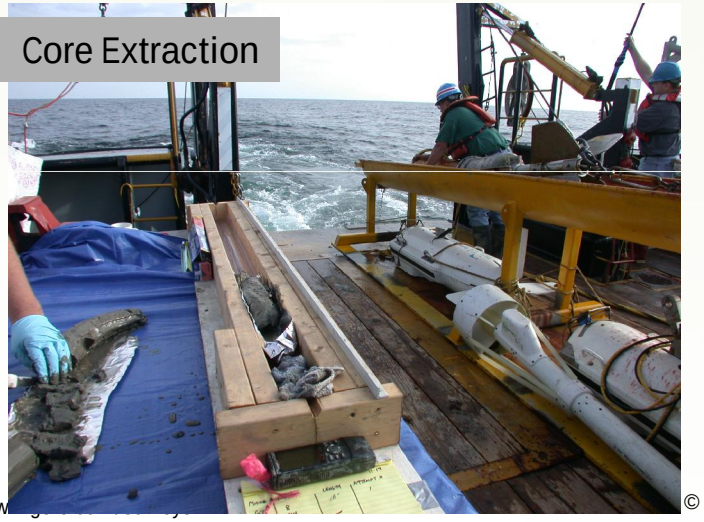


Vibrocorer



Tools of trade

Core Extraction



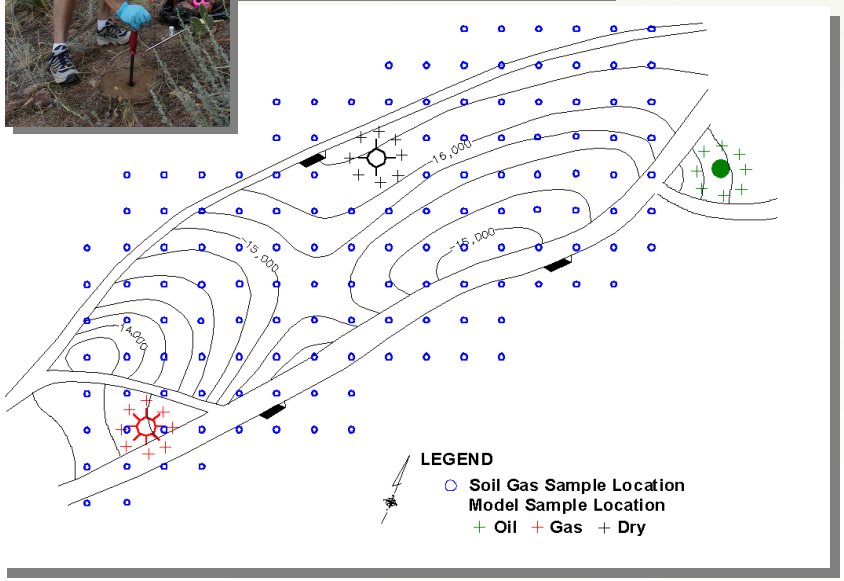
Sub-cropping

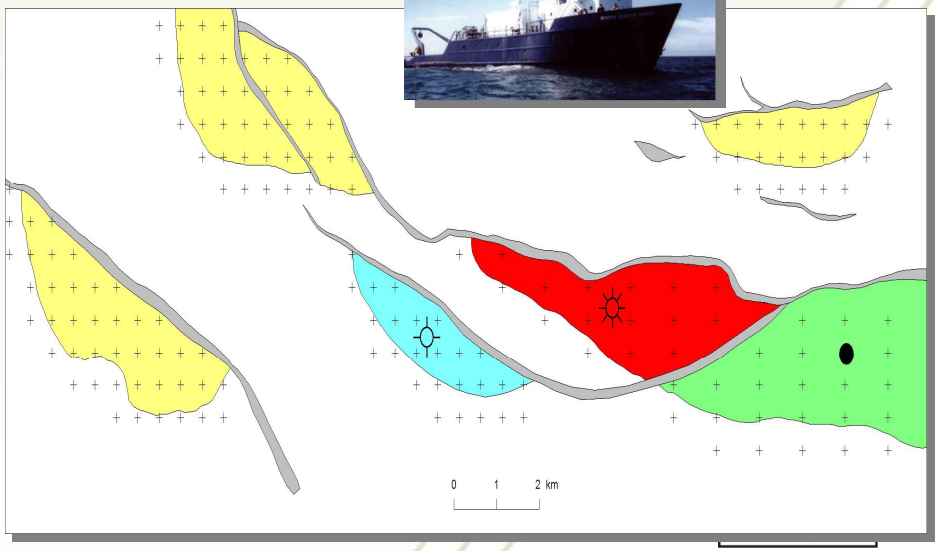
Sample Jar + Module

Amplified Geochemical Imaging - How it works

Regular to
Irregular grid

Sample distance
200 m to 1.5 km





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Amplified Geochemical Imaging - How it works

TD/GC/MS Module Analysis

- Yields sensitive, compound specific results
- Analytical compound standards
- 87+ compounds – C_2 through C_{20}
    - Aliphatics
    - Aromatics
    - Oxygenated compounds

Amplified Geochemical Imaging - How it works

Target Analytical List for GORE™ Survey for Exploration

Typical Petroleum Constituents
Carbon number in ( )

Normal Alkane: 17	Iso-alkane: 11	Cyclic Alkane: 15	Aromatic and PAH: 17
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 and Alteration Compounds
Included in this method to provide a comprehensive inventory of the geochemical system in the surface soil zone

Alkene: 10	Alteration/Byproduct: 3	Biogenic: 4	NSO: 5
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 (ng)
1-Octene (8)			Dimethylsulfide (ng)
1-Nonene (9)			Dimethyldisulfide (ng)
1-Decene (10)			
1-Undecene (11)			

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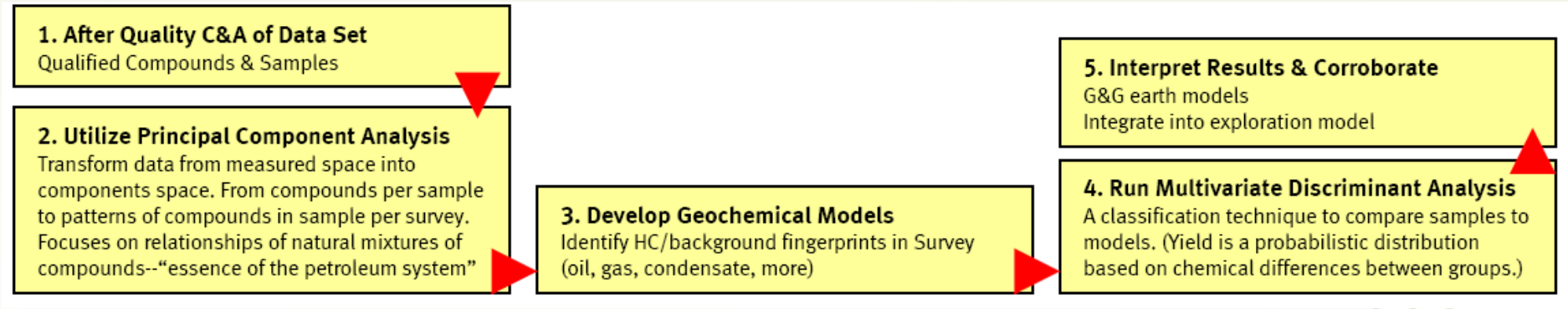
Amplified Geochemical Imaging - How it works

Data Interpretation

› conditions the data to enhance signal/noise and uses multivariate statistical techniques to distinguish differences in hydrocarbon signatures



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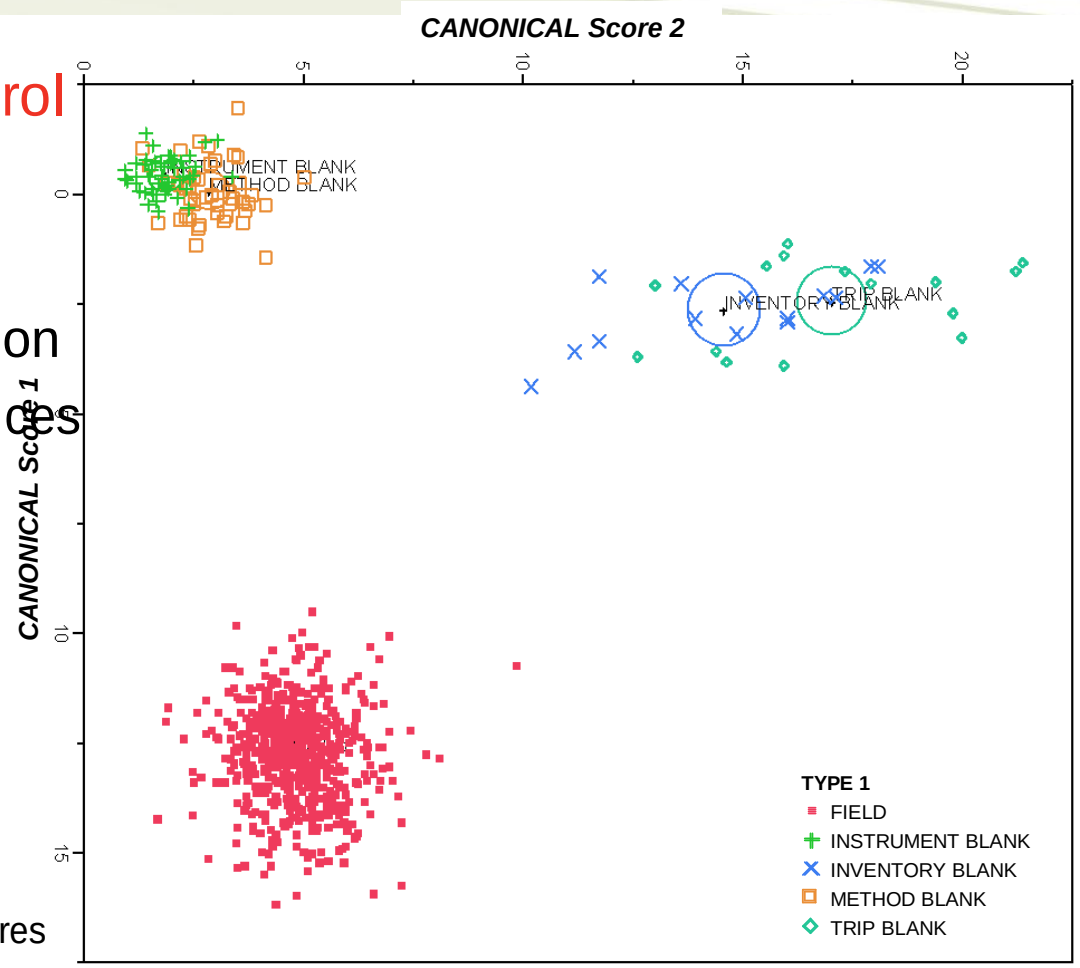
Amplified Geochemical Imaging - How it works

Quality Assurance /Quality Control

- Analytical QA/QC blanks
- Calibration & tuning standards
- Industry standard instrumentation
- Clean facility standards & practices
- Good Laboratory Practices
- ISO guidelines



Groups	
TYPE 1	**Count**
FIELD	659
INSTRUMENT BLANK	51
INVENTORY BLANK	14
METHOD BLANK	47
TRIP BLANK	15

Canonical Variate Scores

Field Data Distinguished from QA Information

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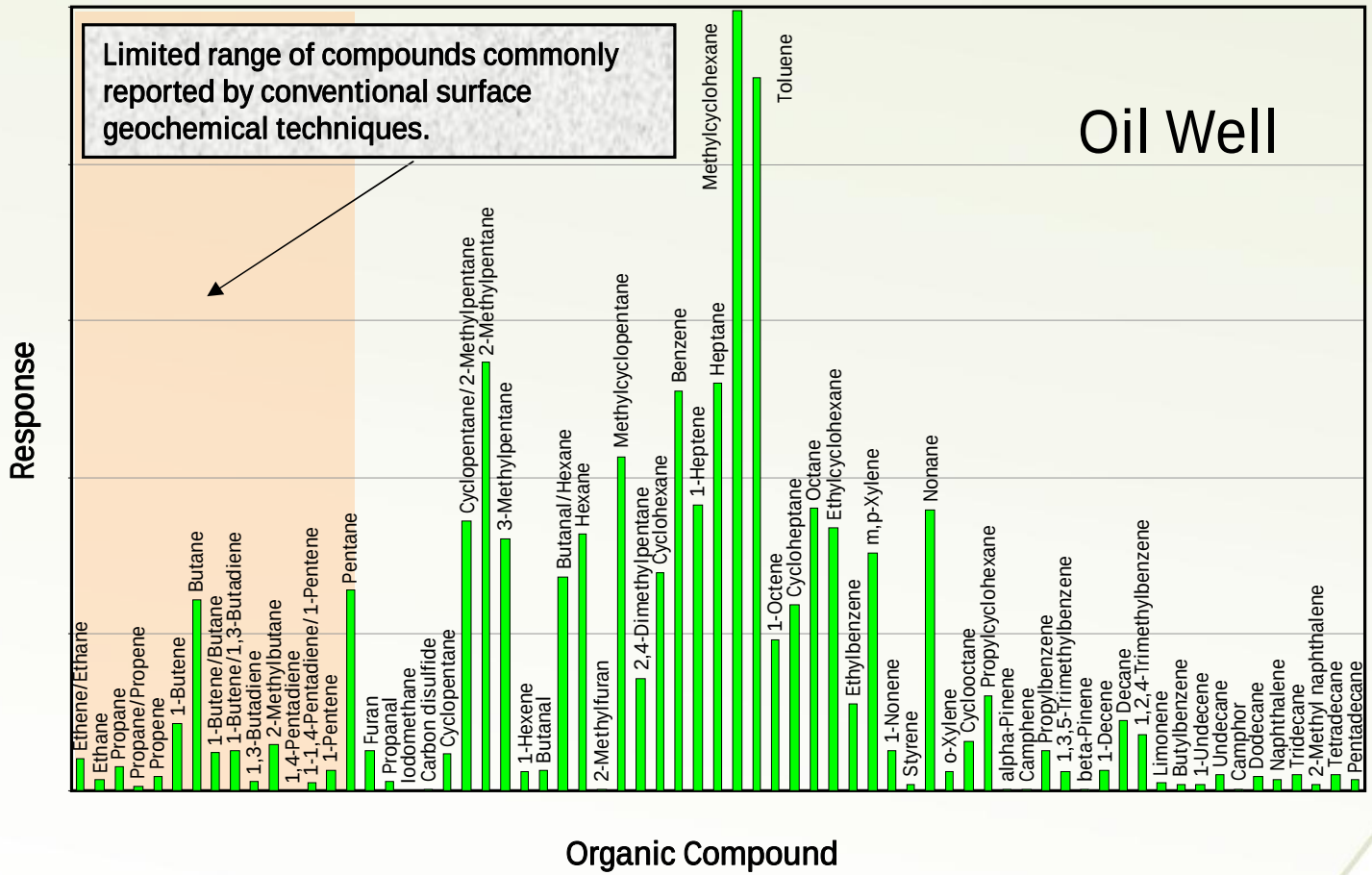
Amplified Geochemical Imaging – The advanced tool

Geochemical Data Differentiation



"Oil Well Signature"

- *300 bopd*
- *41 API*

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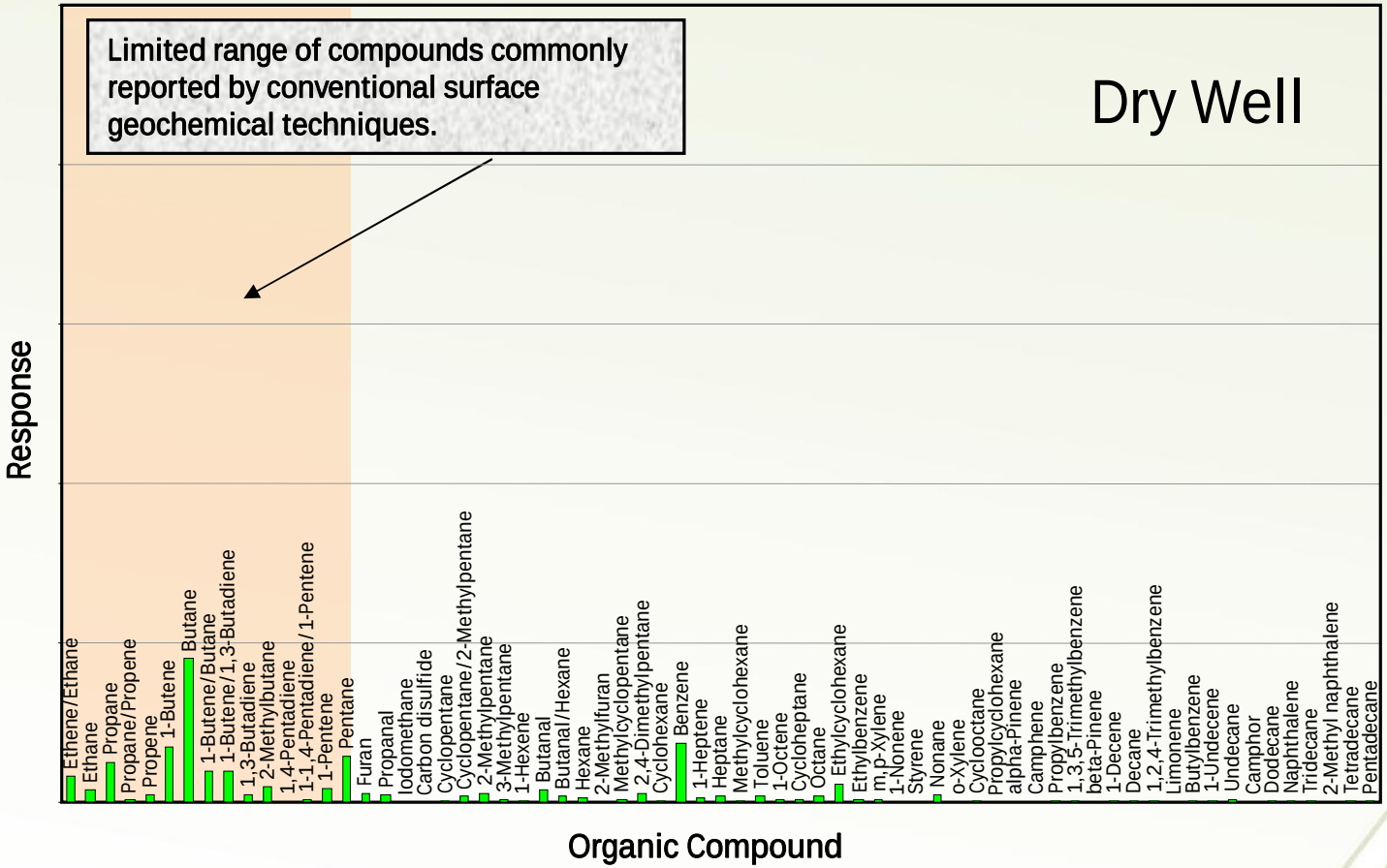
Amplified Geochemical Imaging – The advanced tool

Geochemical Data Differentiation



"Dry Well Signature"

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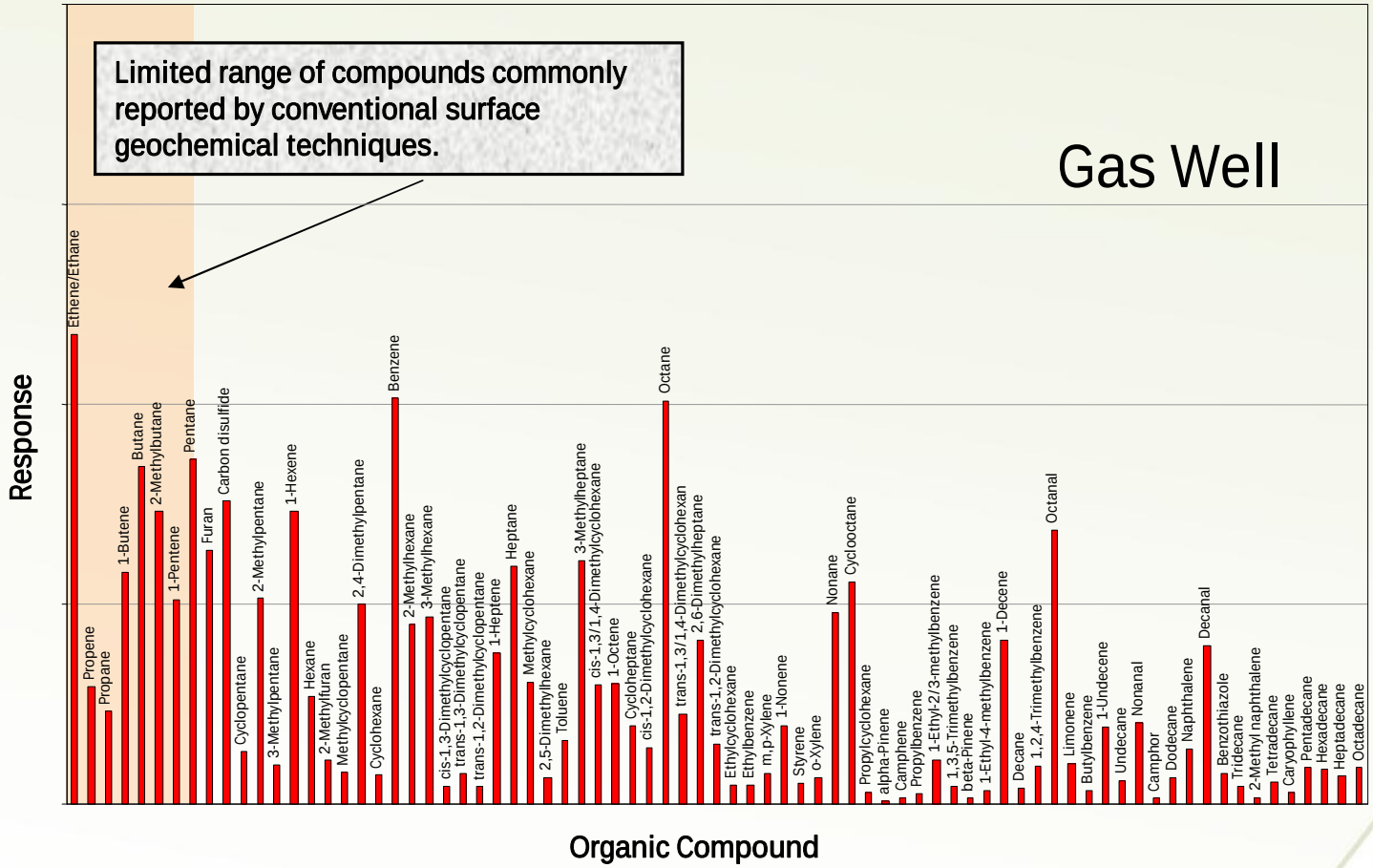
Amplified Geochemical Imaging –The advanced tool

Geochemical Data Differentiation



"Gas Well Signature"

- ***99% Methane***

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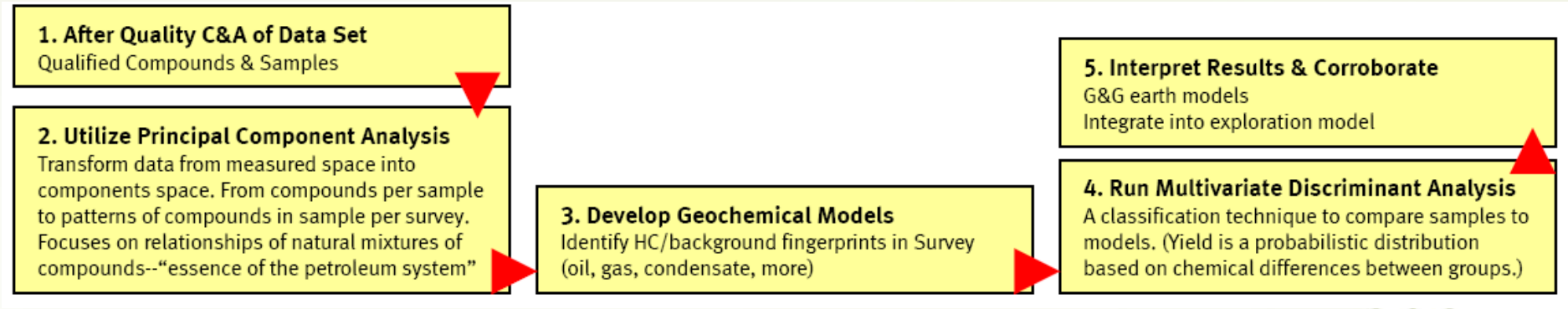
Amplified Geochemical Imaging - How it works

Data Interpretation

› conditions the data to enhance signal/noise and uses multivariate statistical techniques to distinguish differences in hydrocarbon signatures



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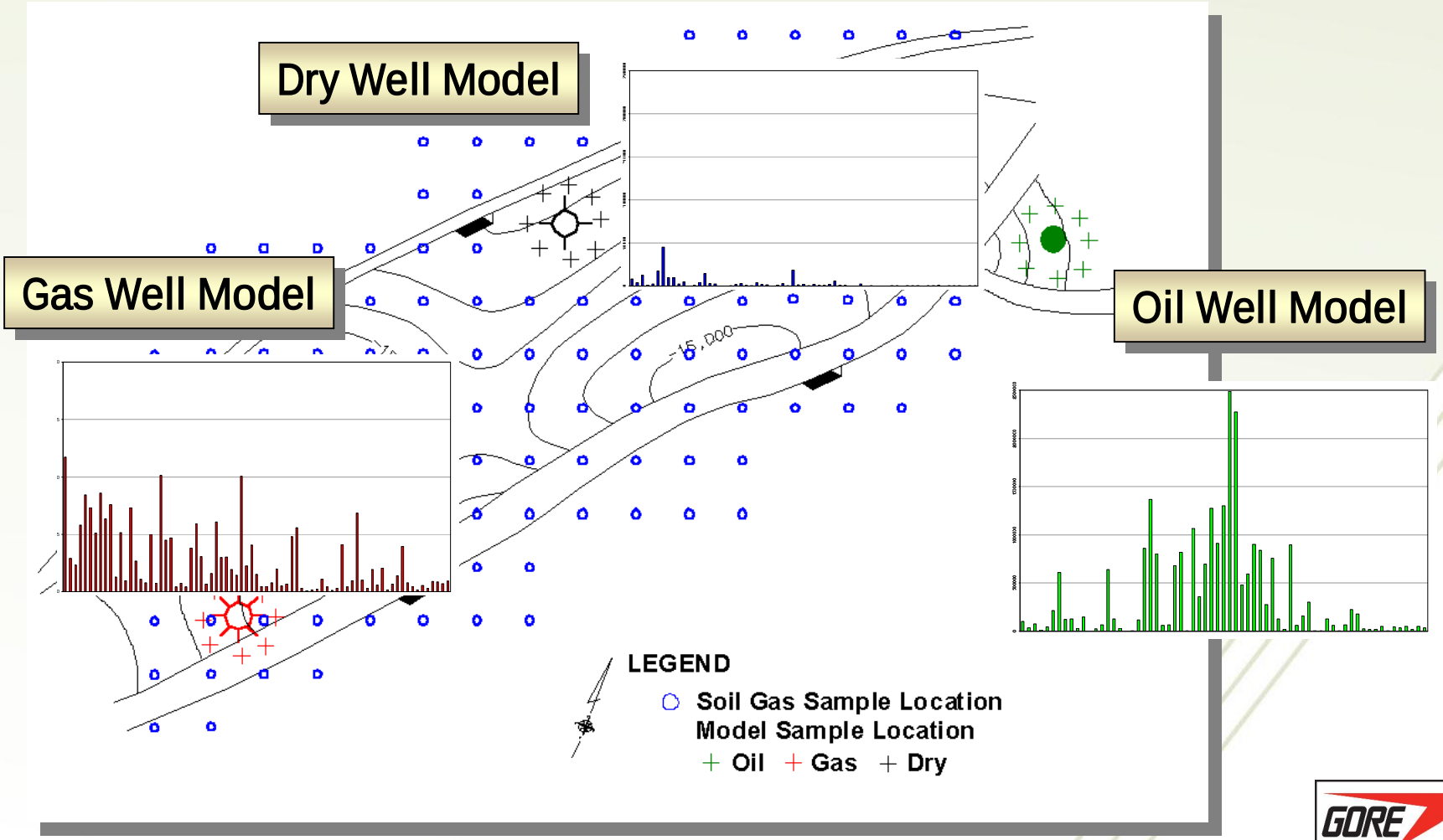
Amplified Geochemical Imaging – The advanced tool

Geochemical Model Development



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Amplified Geochemical Imaging – The advanced tool

Geochemical Model Development

Cluster Analysis

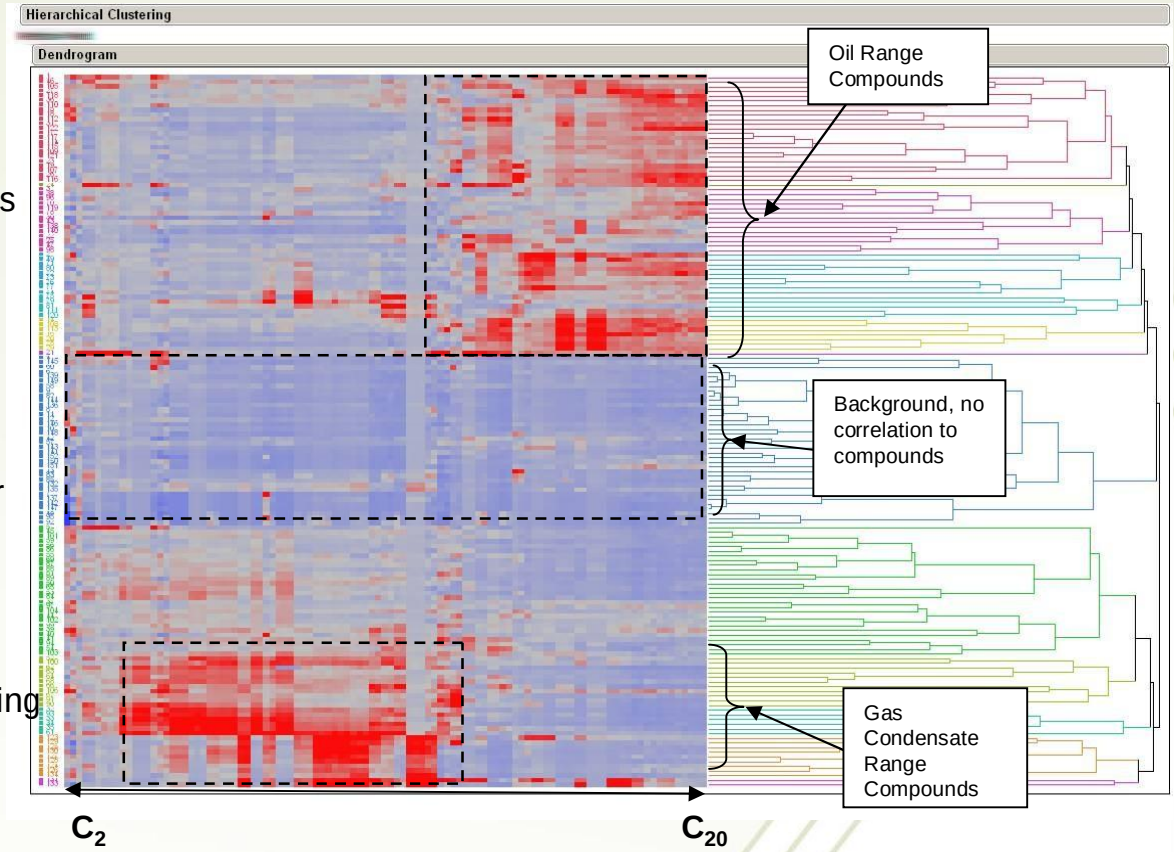
Identify geochemical similarities in data patterns
- Soil gas data grouped by clusters

Assumptions/Requirements
- Identify & remove noisy variables

- Cluster structure isolates "petroliferous" vs "background" character

- Sufficient cluster membership to sample signal variance

- Clusters have subsurface geochemical meaning



Example shown: Gas/Condensate Well and Dry well models; No oil discoveries in this area, HCA performed on Compounds post S/N, HCA clearly detects an oil signature in the data

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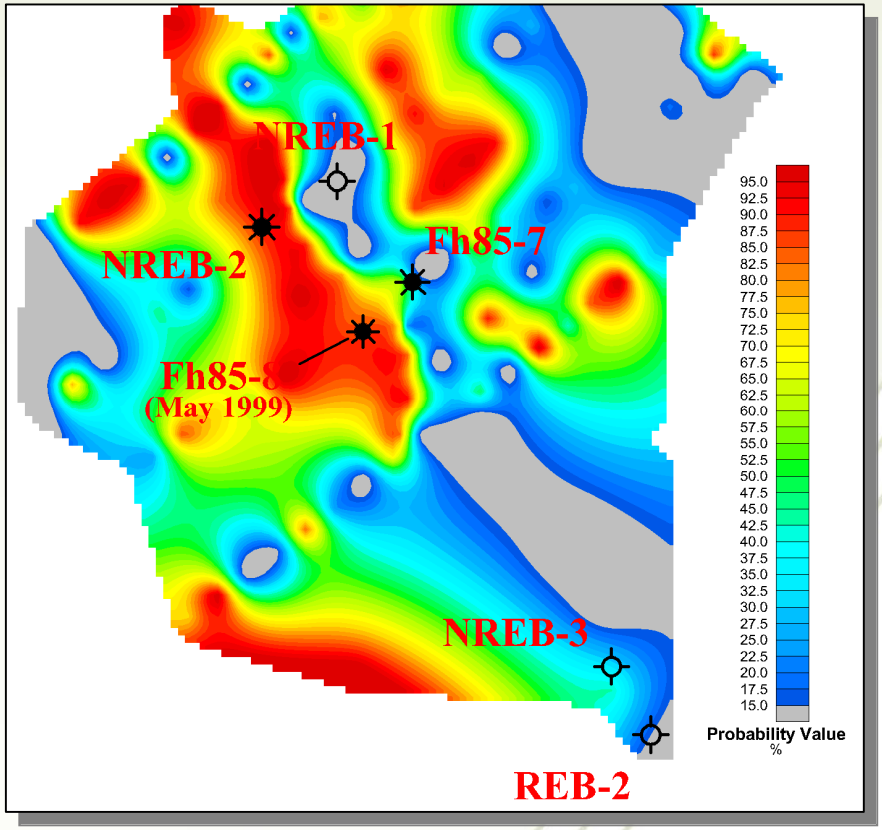
Amplified Geochemical Imaging – The advanced tool

Interpretation & Integration

Final Report:

- Objectives, design, & field work
- QA/QC summary
- Geochemical modeling
- Results
- Summary & conclusions
- Color contour probability maps
- Supporting appendices
- Available electronically



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Amplified Geochemical Imaging

Case histories Onshore

Development – Egypt

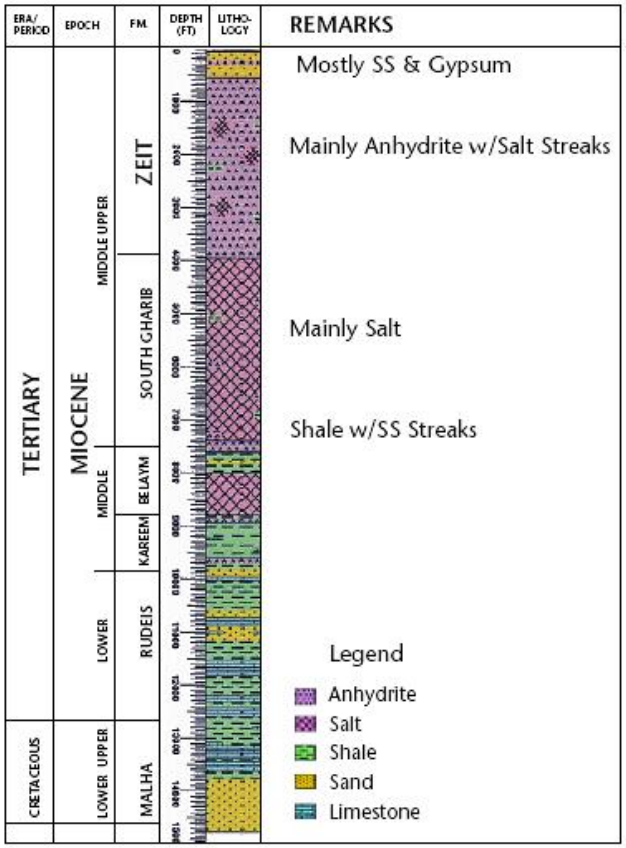

Figure 1: Stratigraphic column of the West Gebel El Zeit field shows massive salt.

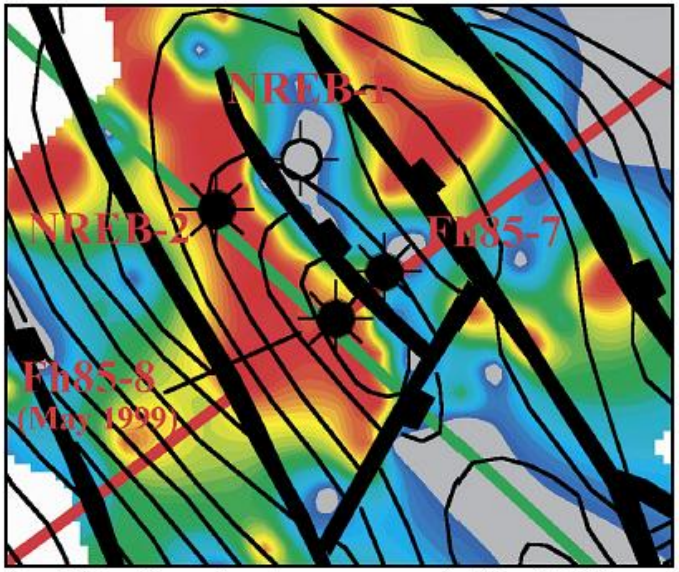

Figure 2: Top of Kareem formation structure merged with the GORE™ Survey oil-like hydrocarbon probability map, showing new well FH85-8, initial potential 800 b/d.

Survey Summary

- Egypt – Development
- Producing oil field
- Detect microseepage through massive salt
- 150 GORE™ Modules installed
- Sample spacing - 250 to 250 m regular grid along seismic lines

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Amplified Geochemical Imaging

Case histories Onshore

Multi-layer Gas Exploration – Texas

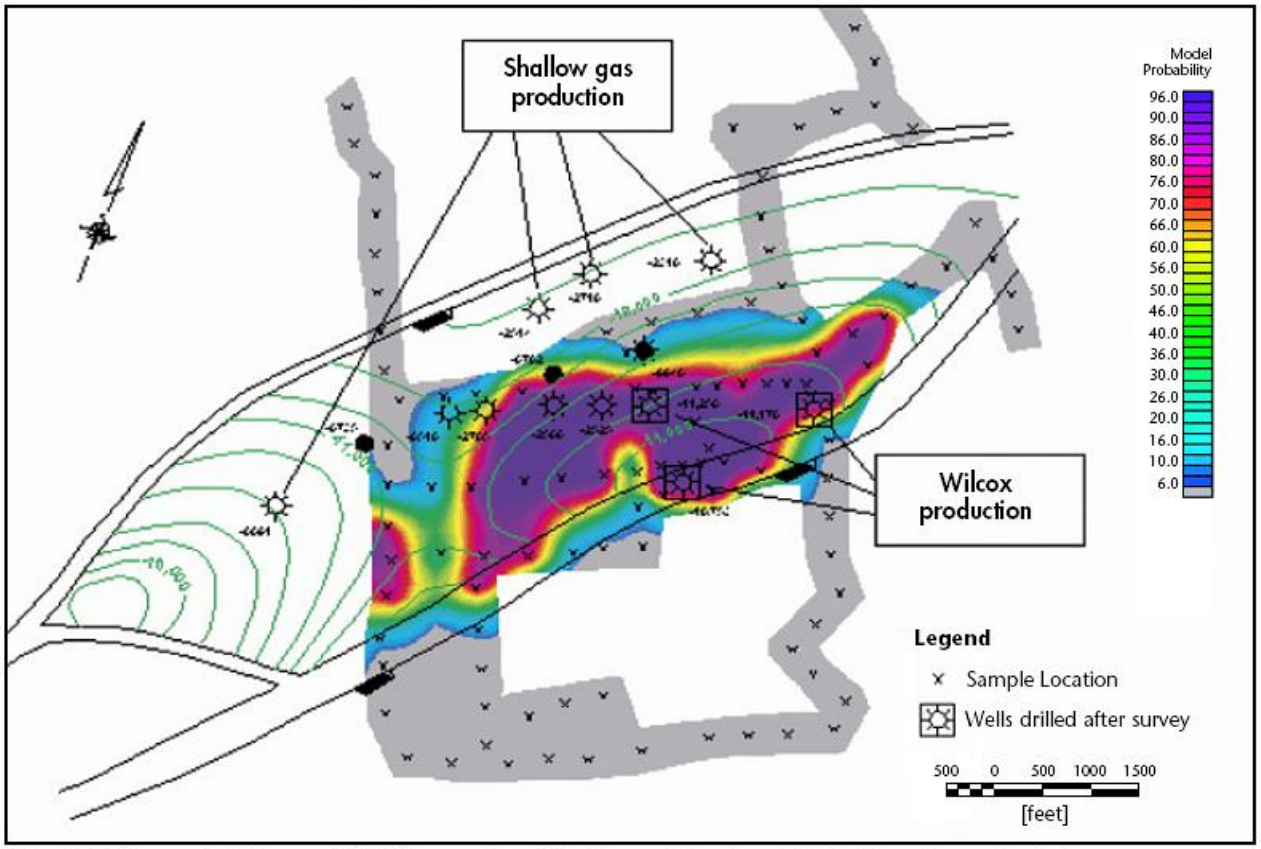

Figure 1: Surface geochemical anomaly for Wilcox gas, Texas USA. Three wells have been drilled on the positive geochemical anomaly identified by the survey, all of which have encountered natural Wilcox gas.

Survey Summary

- Texas, USA, multi-layer prospect
- Natural deep Wilcox gas, overlying shallow production
- 150 sample collectors installed
- Sample spacing – 150 to 250 m irregular grid
- Three economic natural gas wells drilled in positive geochemical anomaly

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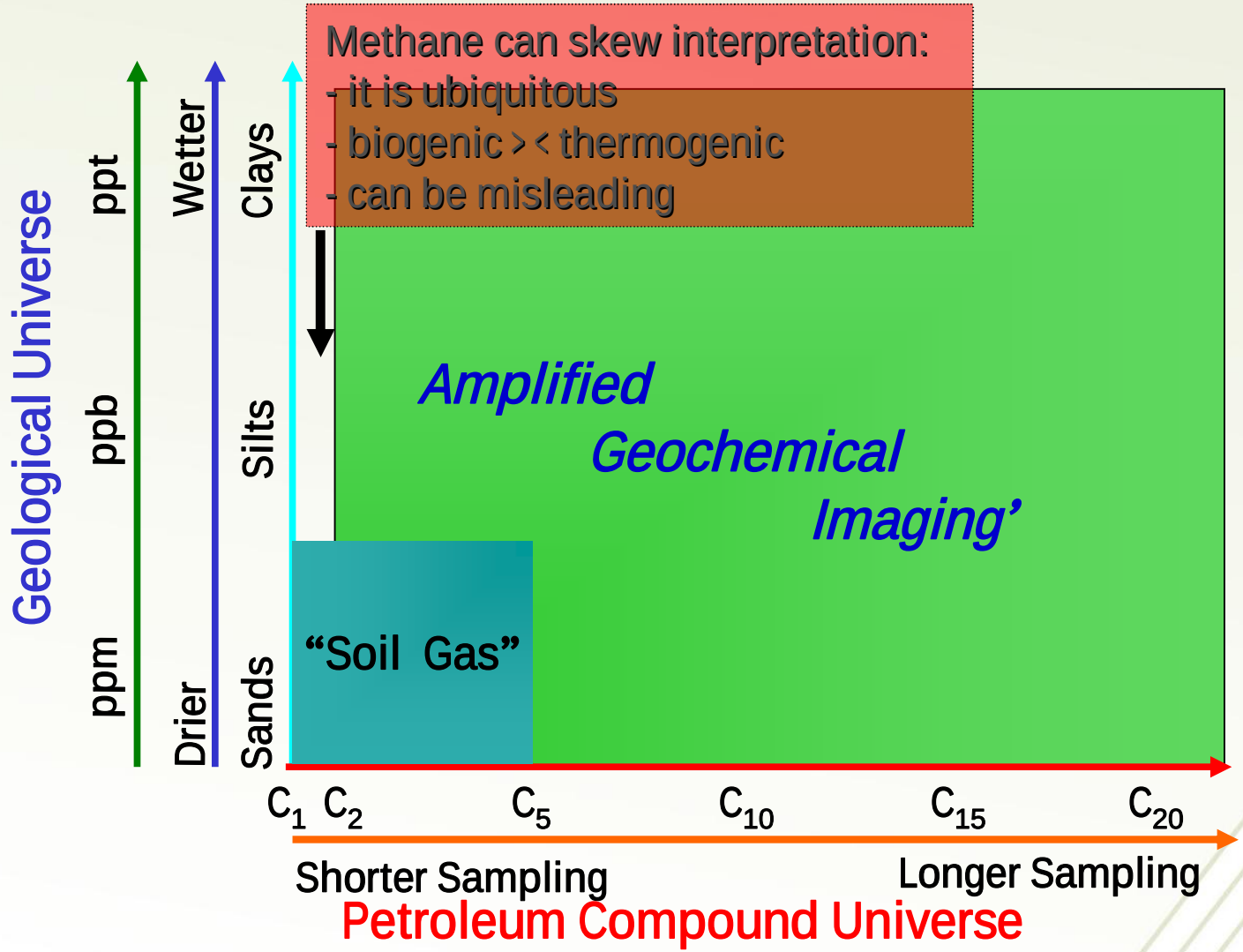
Amplified Geochemical Imaging – The advanced tool



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Amplified Geochemical Imaging – The advanced tool

Track Record

- More than 600 surveys in O & G EXP

- Gore Surveys for Exploration has been used effectively in over 130 basins / 56 countries worldwide
  - >Through sediment, volcanic cover & thick-evaporite sequences
  - >Structural, stratigraphic, combination & salt traps

- Including all continents, terrains and climate (e.g. desert, jungle, plains, tundra, offshore)

- for more than 150 companies

- with a success rate of + 90%

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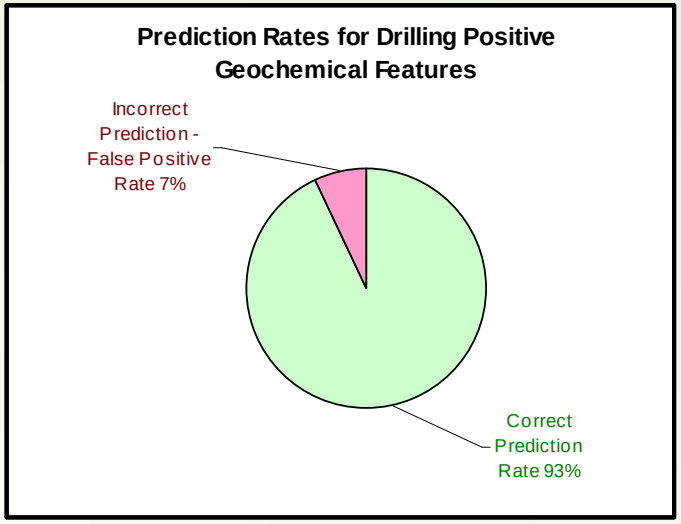
Thank you for your Time and Interest

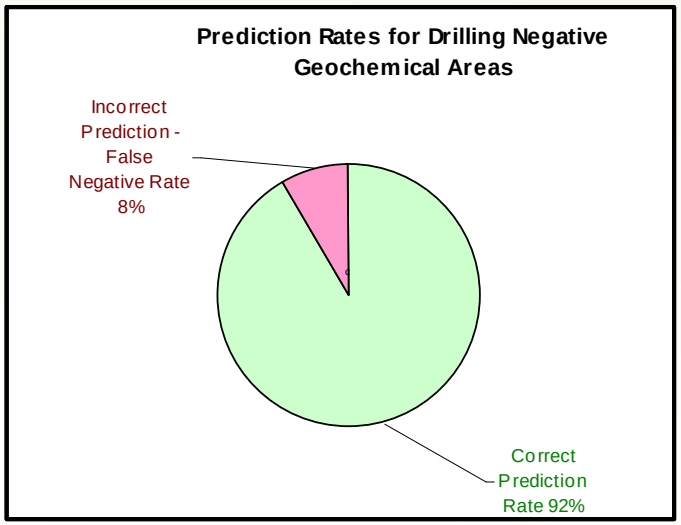
GORE® Surveys

FOR OIL AND GAS EXPLORATION

Creative Technologies Worldwide

Success Rates





- ✓ Known no. wells drilled on our results – 179 [worldwide]
- ✓ Oil & Gas Discovery Well Prediction
  → 93%
- ✓ Dry Well Prediction
  → 92%
- ✓ Correct Predictions Total
  → 93%

GORE
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