Geochemical de-risking in Arctic Regions: Identifying Hydrocarbon Phase Before Drilling

Finding Petroleum: Exploring the Arctic
11th October 2011

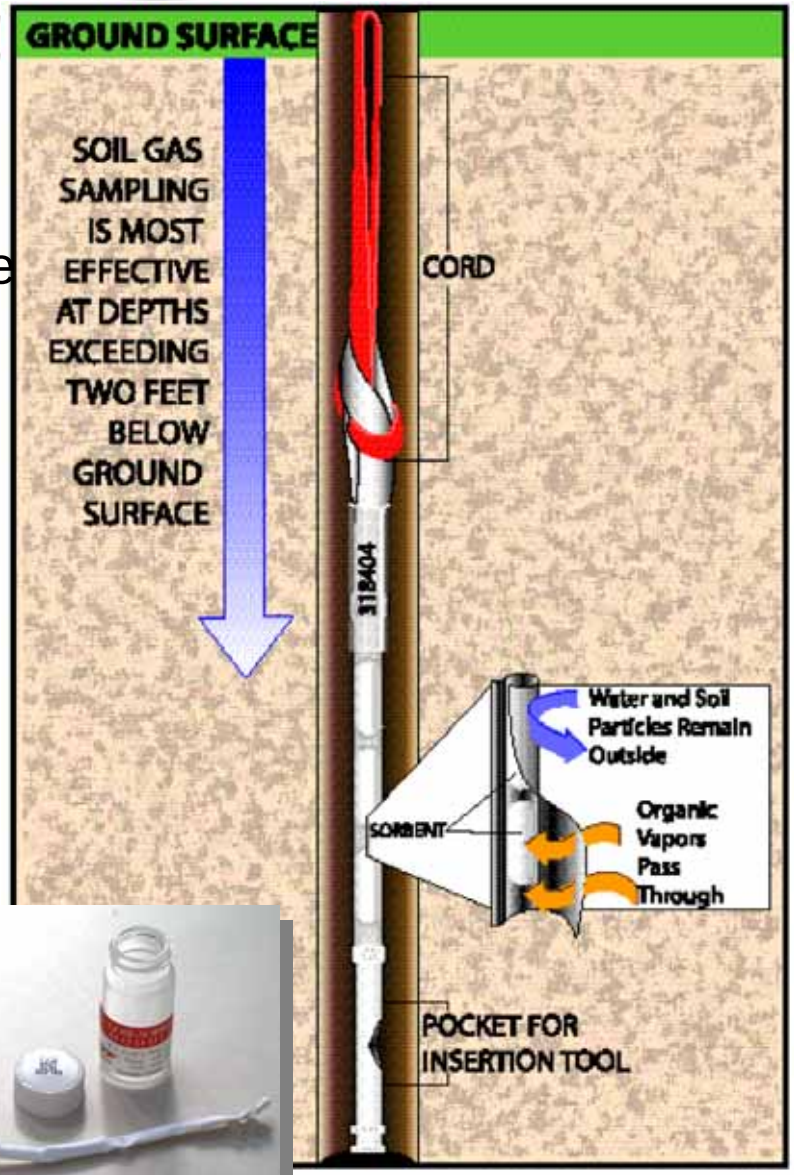
GORE® Surveys

How do you know if a structure is charged before Drilling?

- If it is charged, is it charged with gas or oil?
- Amplified Geochemical Imaging℠ technology can define Hydrocarbon Phase in Structures
- Two examples from arctic regions in West Siberia and Northwest Territories

GORE® 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



GORE® Surveys - Collection

Module Installation & Retrieval

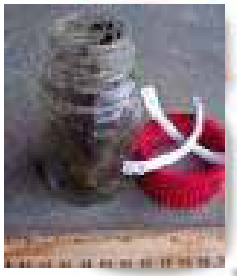

Create installation hole


Place insertion rod in module


Insert module into hole & cover


Secure module, mark field location, record GPS data and field notes


Sub-sample core


Secure sample & Gore modules in sealed jar

Onshore
&
Offshore

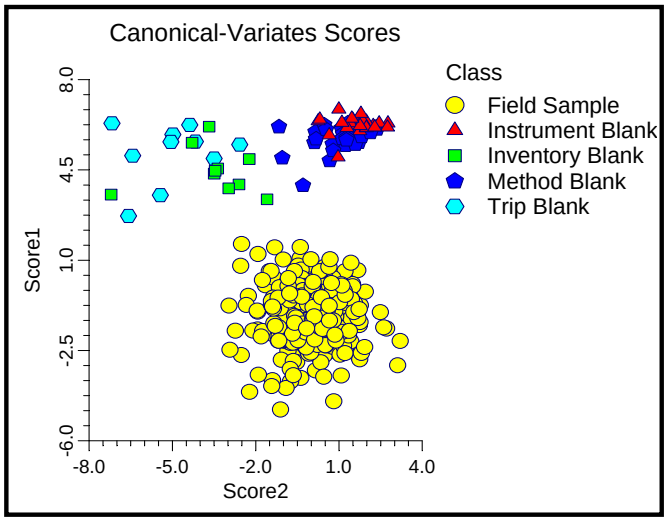
AMPLIFIED GEOCHEMICAL IMAGING℠

Winter Sample Installation & Retrieval

GORE® Surveys mosule Analysis

Lab & QA/QC

- TD/GC/MS analysis in controlled laboratory
- Rich mass data set
- [85 compounds, C_2 thru C_{20}]



- Analytical QA/QC blanks
- Calibration & tuning standards
- Industry standard instrumentation
- Clean facility standards & practices
- 40% samples analyzed are QA/QC Samples
- ISO guidelines

GORE® Surveys - Analysis

Analytical Compound List by Compound Class: C2 – C20

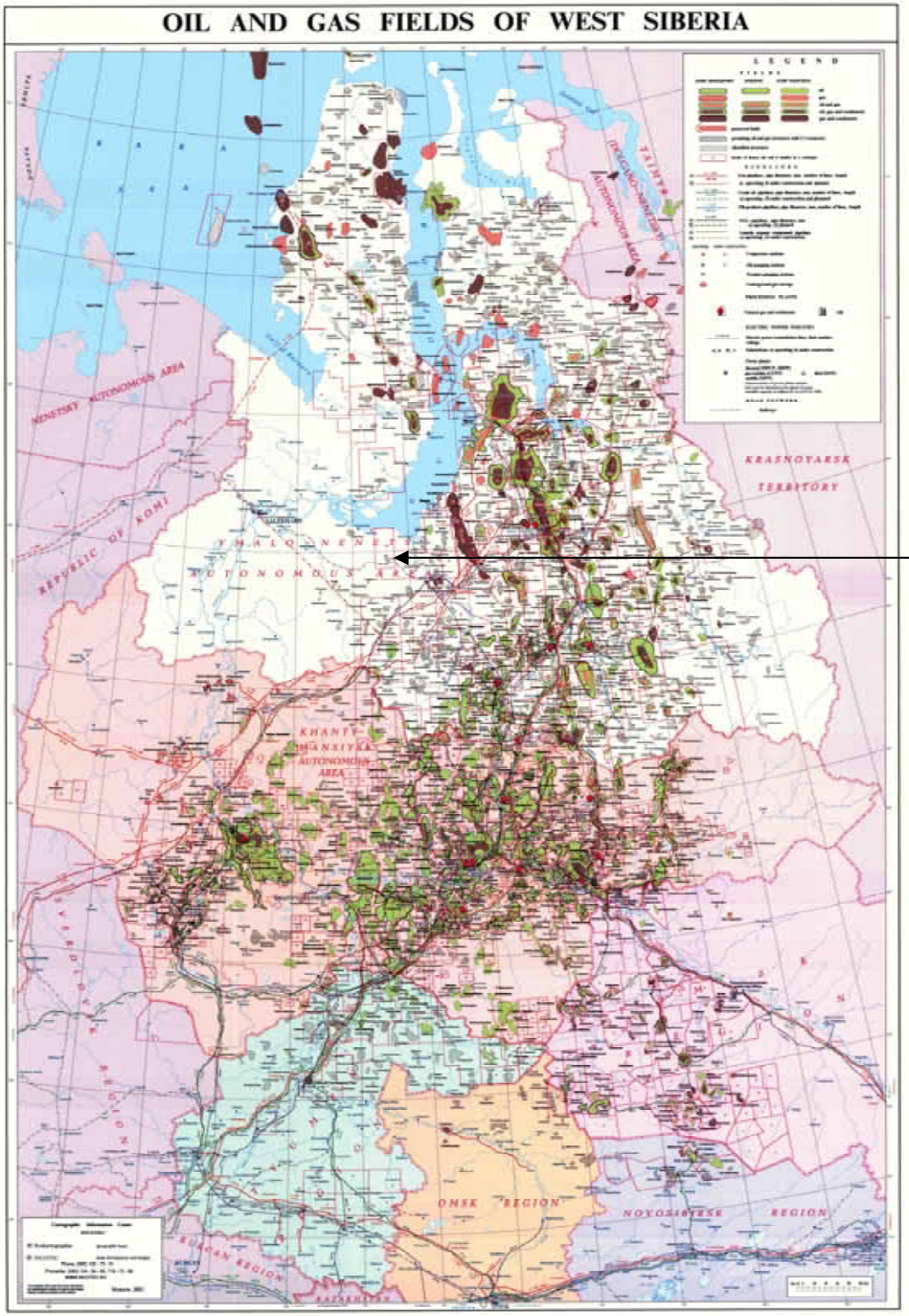
Typical Petroleum Constituents Hydrocarbon number in ( )			
Normal Alkanes	**Iso-alkanes**	**Cyclic Alkanes**	**Aromatics and PAH***
Ethane (2) Propane (3) Butane (4) Pentane (5) Hexane (6) Heptane (7) Octane (8) Nonane (9) Decane (10) Undecane (11) Dodecane (12) Tridecane (13) Tetradecane (14) Pentadecane (15) Hexadecane (16) Heptadecane (17) Octadecane (18)	2-Methylbutane (5) 2-Methylpentane (6) 3-Methylpentane (6) 2,4-Dimethylpentane (7) 2-Methylhexane (7) 3-Methylhexane (7) 2,5-Dimethylhexane (8) 3-Methylheptane (8) 2,6-Dimethylheptane (9) Pristane (19) Phytane (20)	Cyclopentane (5) Methylcyclopentane (6) Cyclohexane (6) cis-1,3-Dimethylcyclopentane (7) trans-1,3-Dimethylcyclopentane (7) trans-1,2-Dimethylcyclopentane (7) Methylcyclohexane (7) Cycloheptane (7) cis-1,3/1,4-Dimethylcyclohexane (8) cis-1,2-Dimethylcyclohexane (8) trans-1,3/1,4-Dimethylcyclohexane (8) trans-1,2-Dimethylcyclohexane (8) Ethylcyclohexane (8) Cyclooctane (8) Propylcyclohexane (9)	Benzene (6) Toluene (7) Ethylbenzene (8) m,p-Xylenes (8) o-Xylene (8) Propylbenzene (9) 1-Ethyl-2/3-methylbenzene (9) 1,3,5-Trimethylbenzene (9) 1-Ethyl-4-methylbenzene (9) 1,2,4-Trimethylbenzene (9) Indane (9) Indene (9) Butylbenzene (10) 1,2,4,5-Tetramethylbenzene (10) Naphthalene (10) 2-Methylnaphthalene (11) Acenaphthylene (12)
Byproduct / Alteration and Other Compounds			
Alkenes	**Aldehydes**	**Biogenic**	**NSO* and Other Compounds**
Ethene (2) Propene (3) 1-Butene (4) 1-Pentene (5) 1-Hexene (6) 1-Heptene (7) 1-Octene (8) 1-Nonene (9) 1-Decene (10) 1-Undecene (11)	Octanal (8) Nonanal (9) Decanal (10)	alpha-Pinene beta-Pinene Camphor Caryophyllene	Furan 2-Methylfuran Carbon Disulfide Benzofuran Benzothiazole Carbonyl Sulfide Dimethylsulfide Dimethyldisulfide

Example from West Siberia

Geologic Setting

- Location - Yarudey Uplift
- Shuginskaya Anticline
- Target - Lower-middle Jurassic formation
- Depth – 2,500 to 3,000 meters

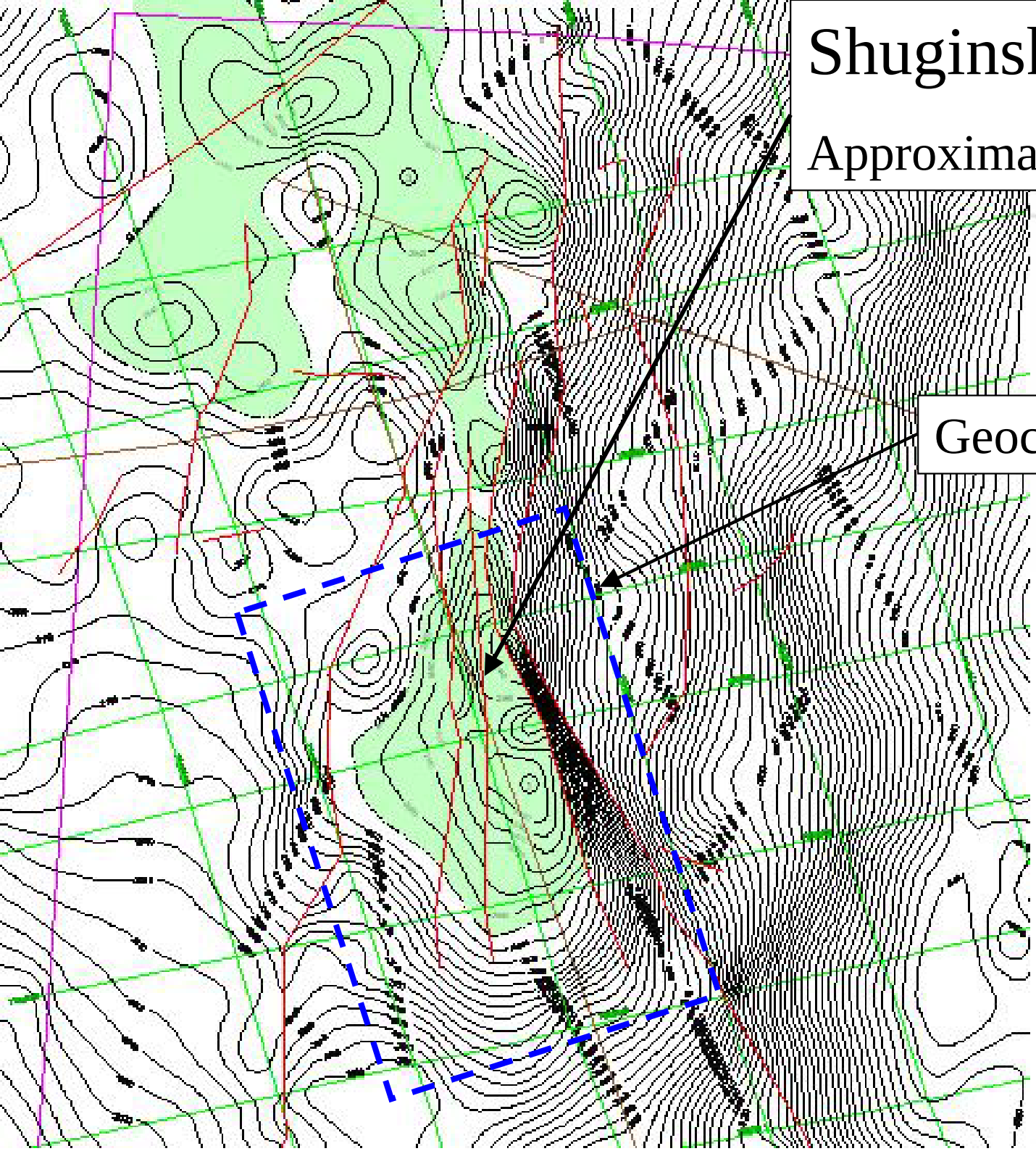
OPERATION LOCATION



Shuginskaya Survey Area

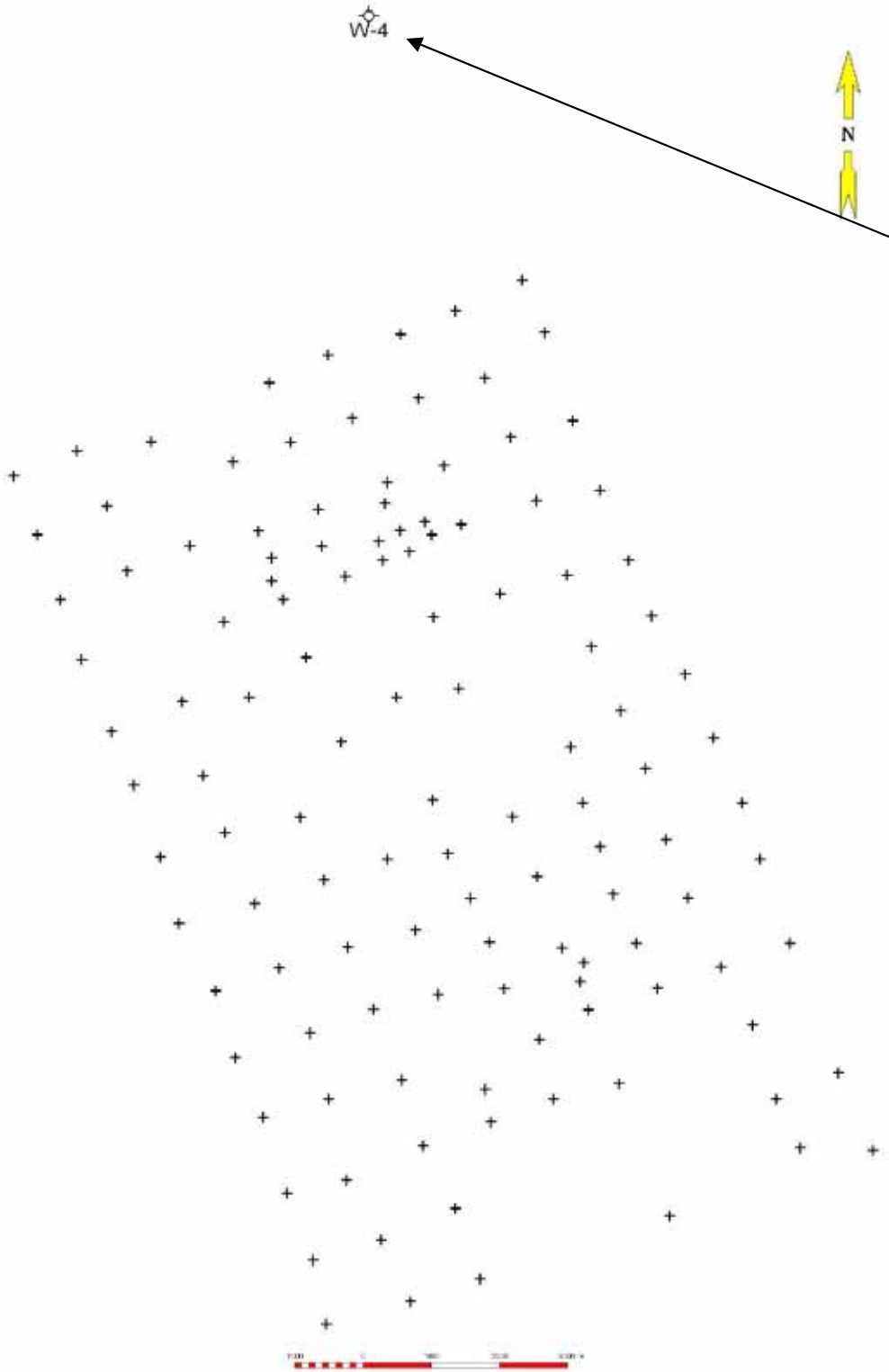
Shuginskaya Structure 14

Approximate areal extent 60 km^2



Survey Design

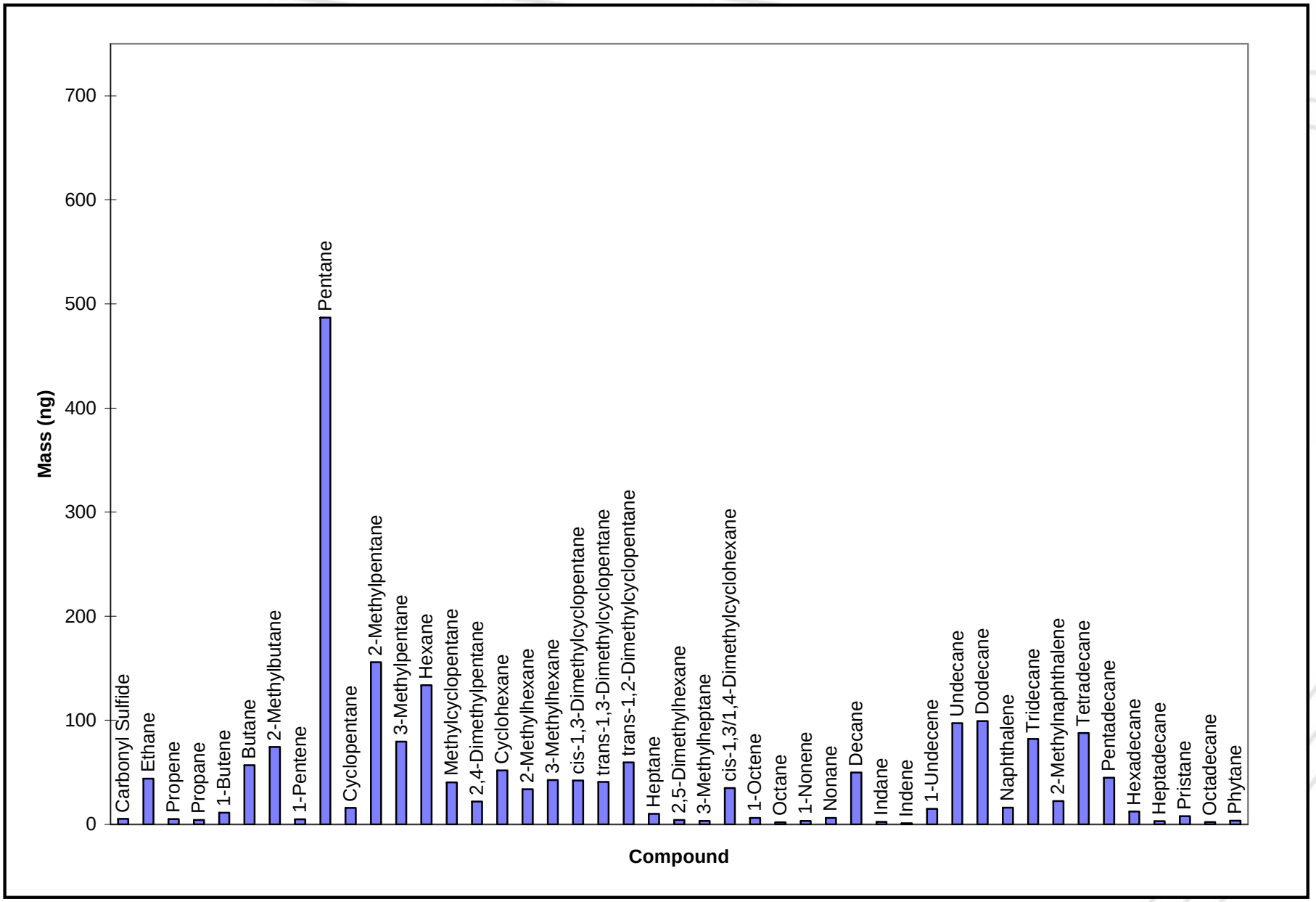
1 kilometer Spacing



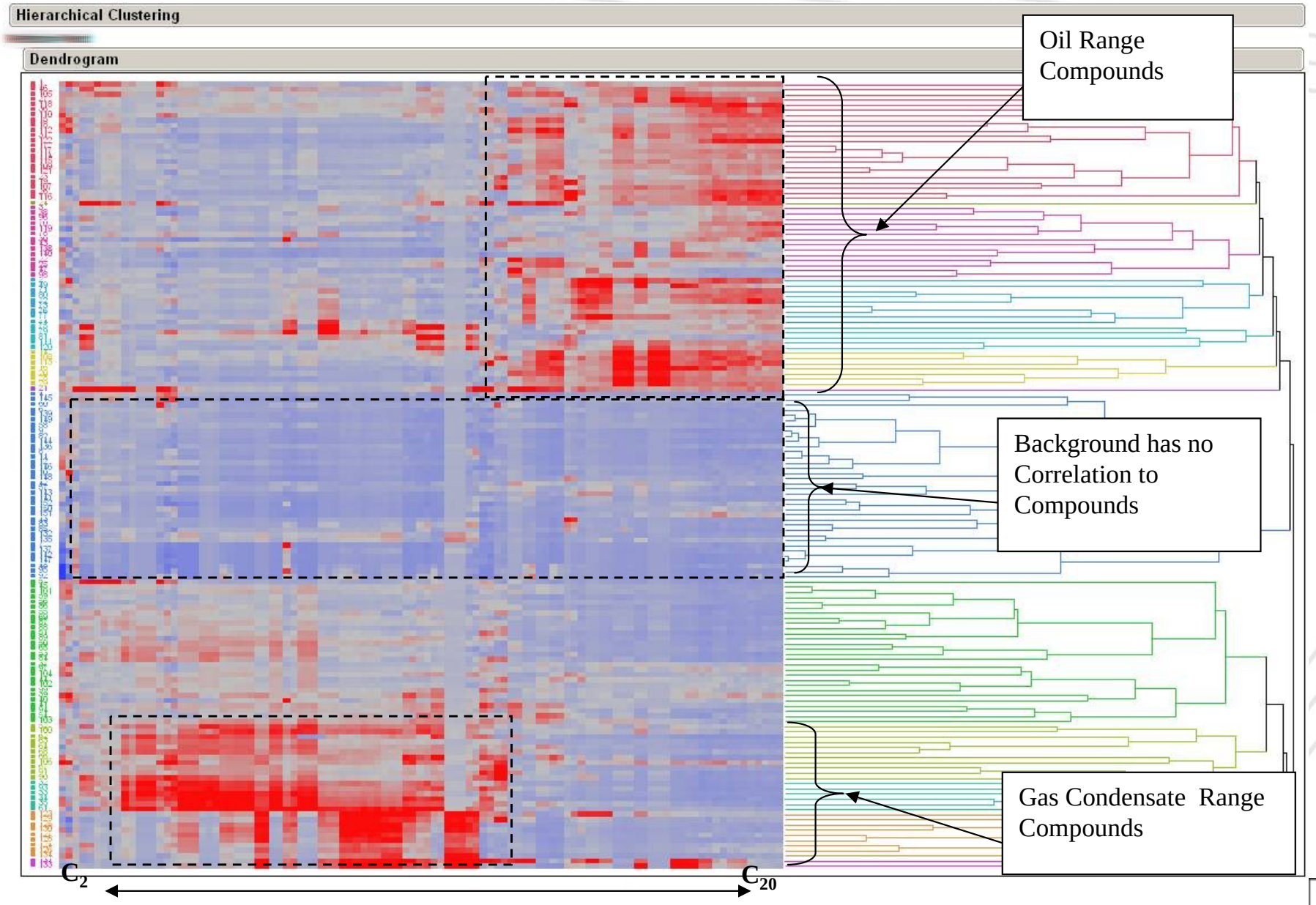
Background Model

Gas Condensate Model Located 30 Kilometers South of Survey Area

Gas Condensate Well Signature



Hierarchical Cluster Analysis



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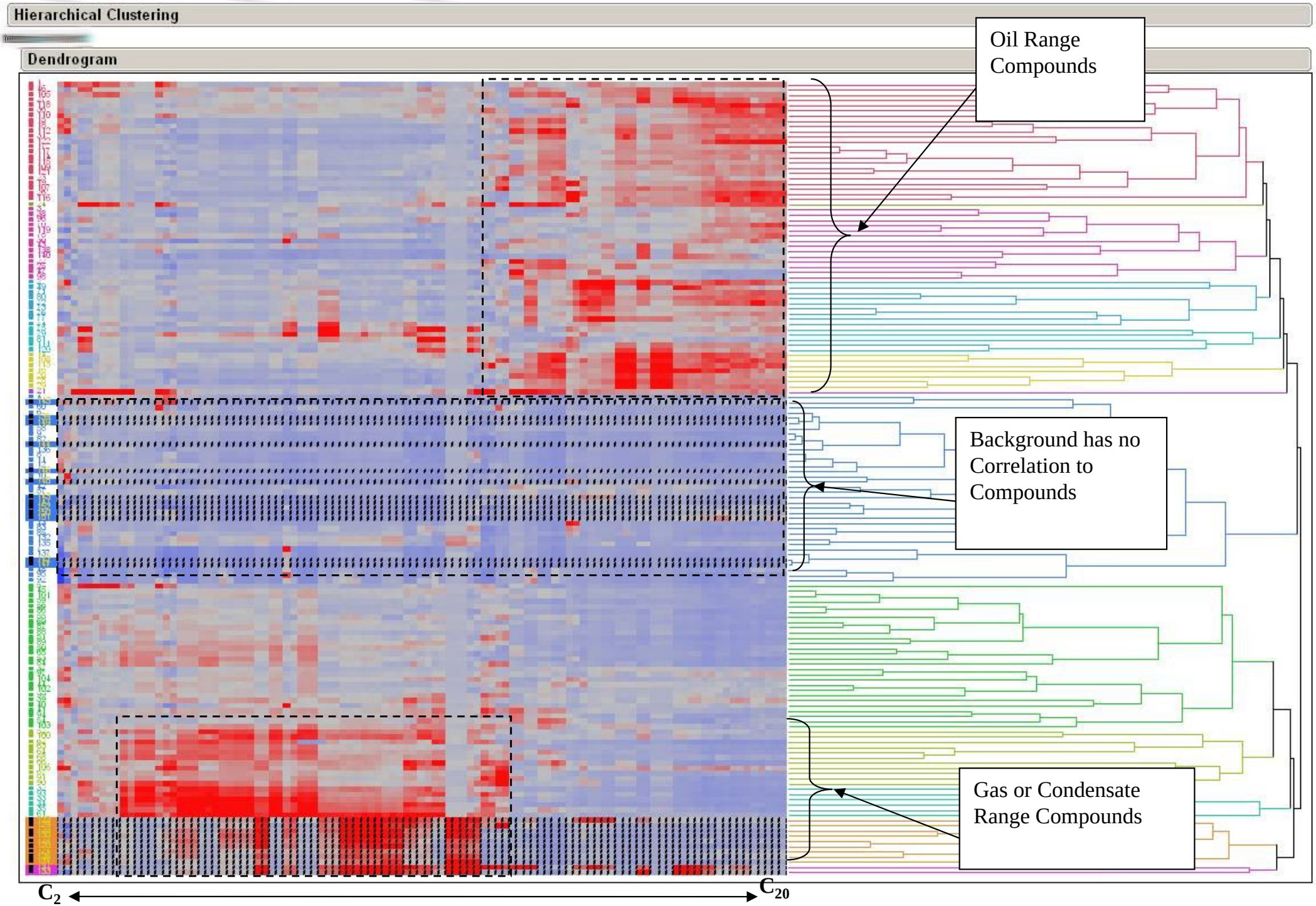
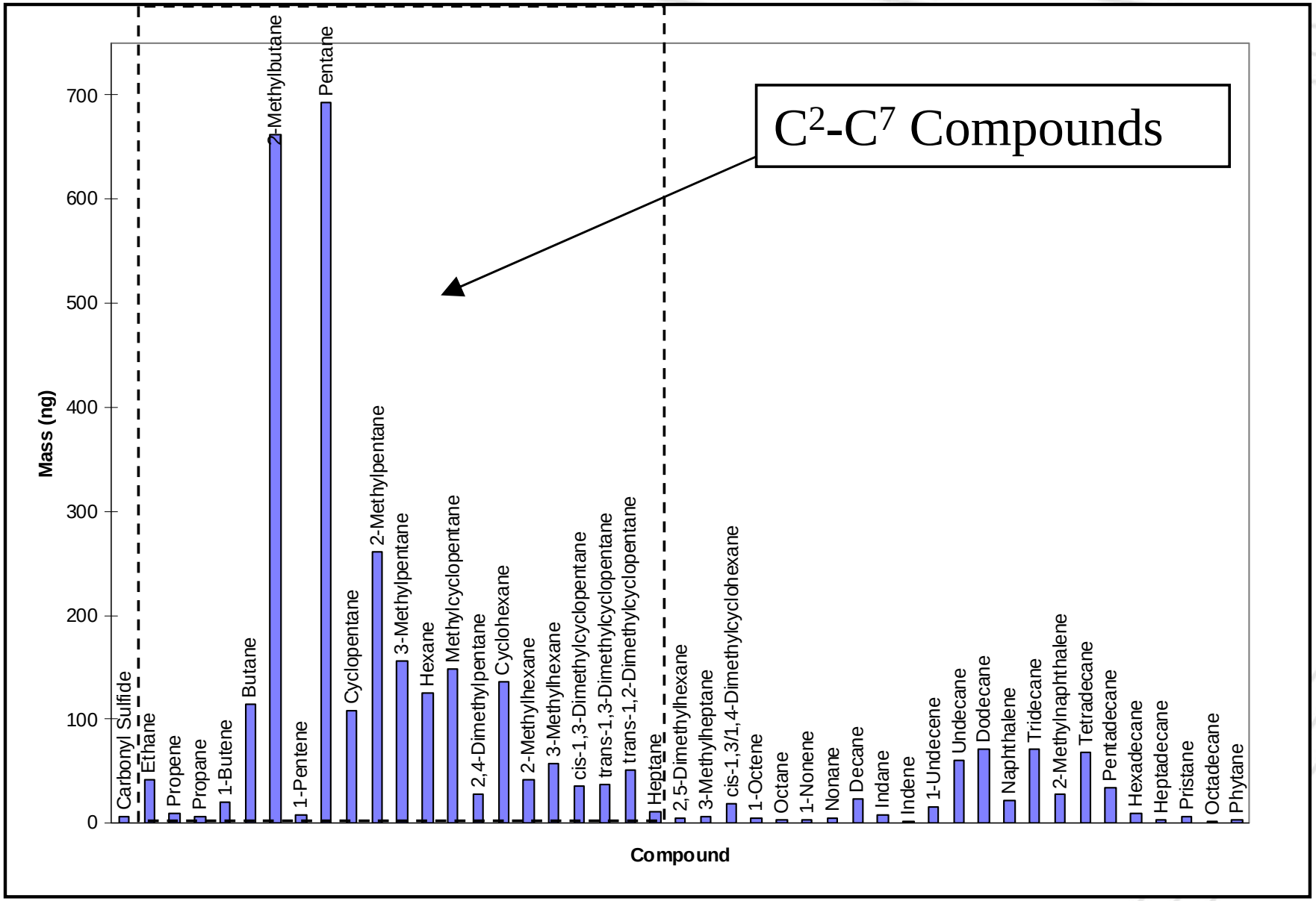
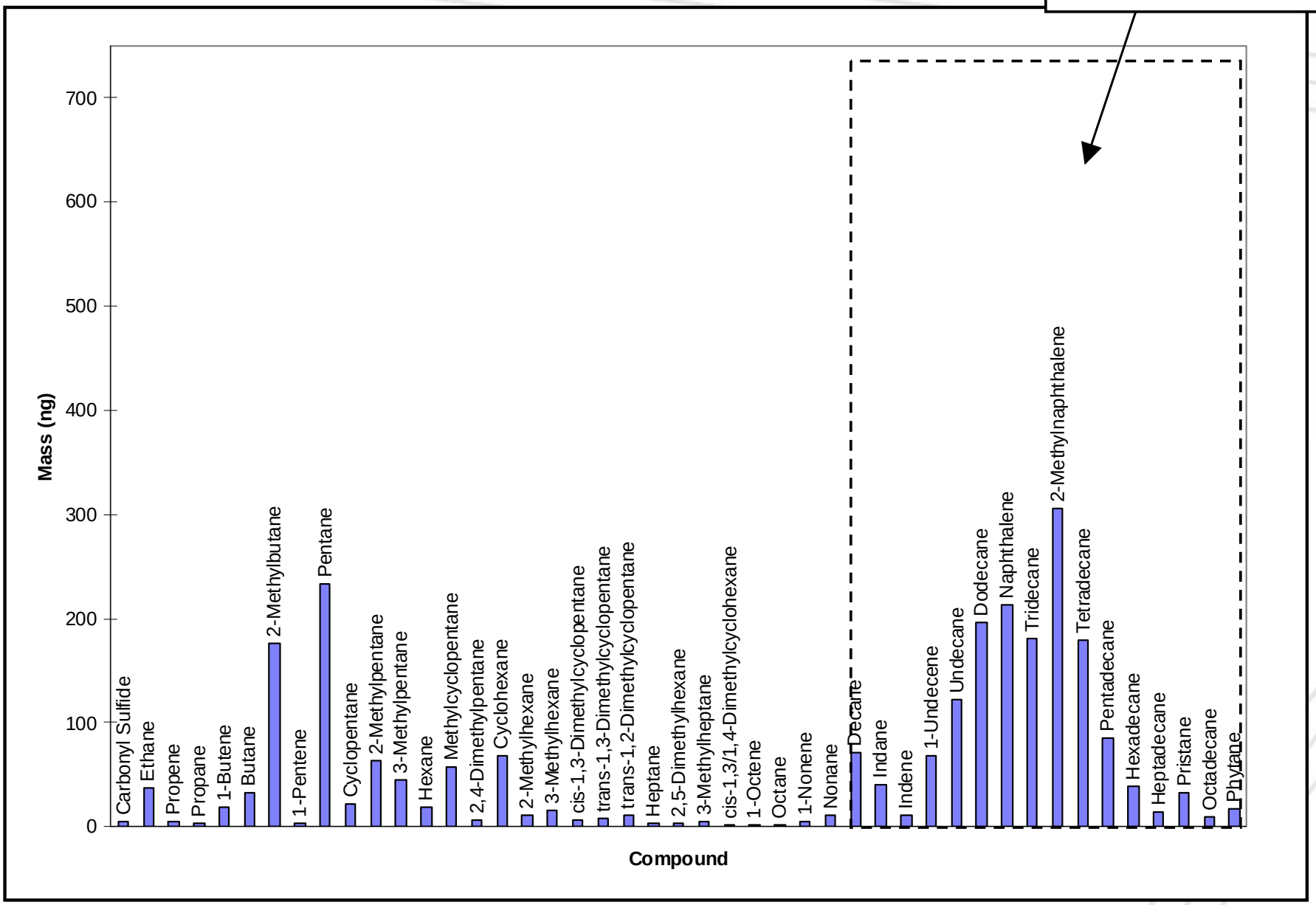


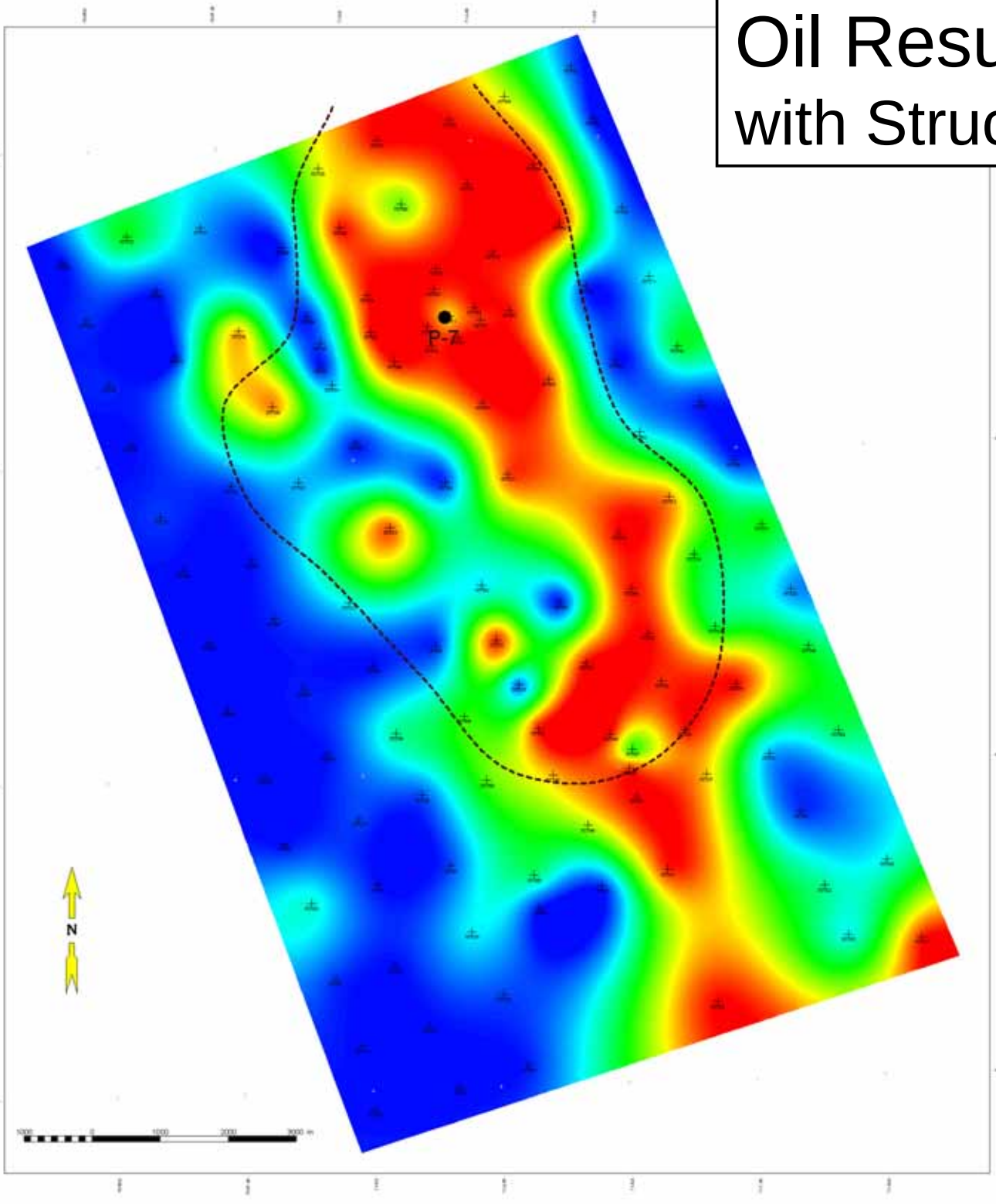
Gas Condensate Signature from HCA



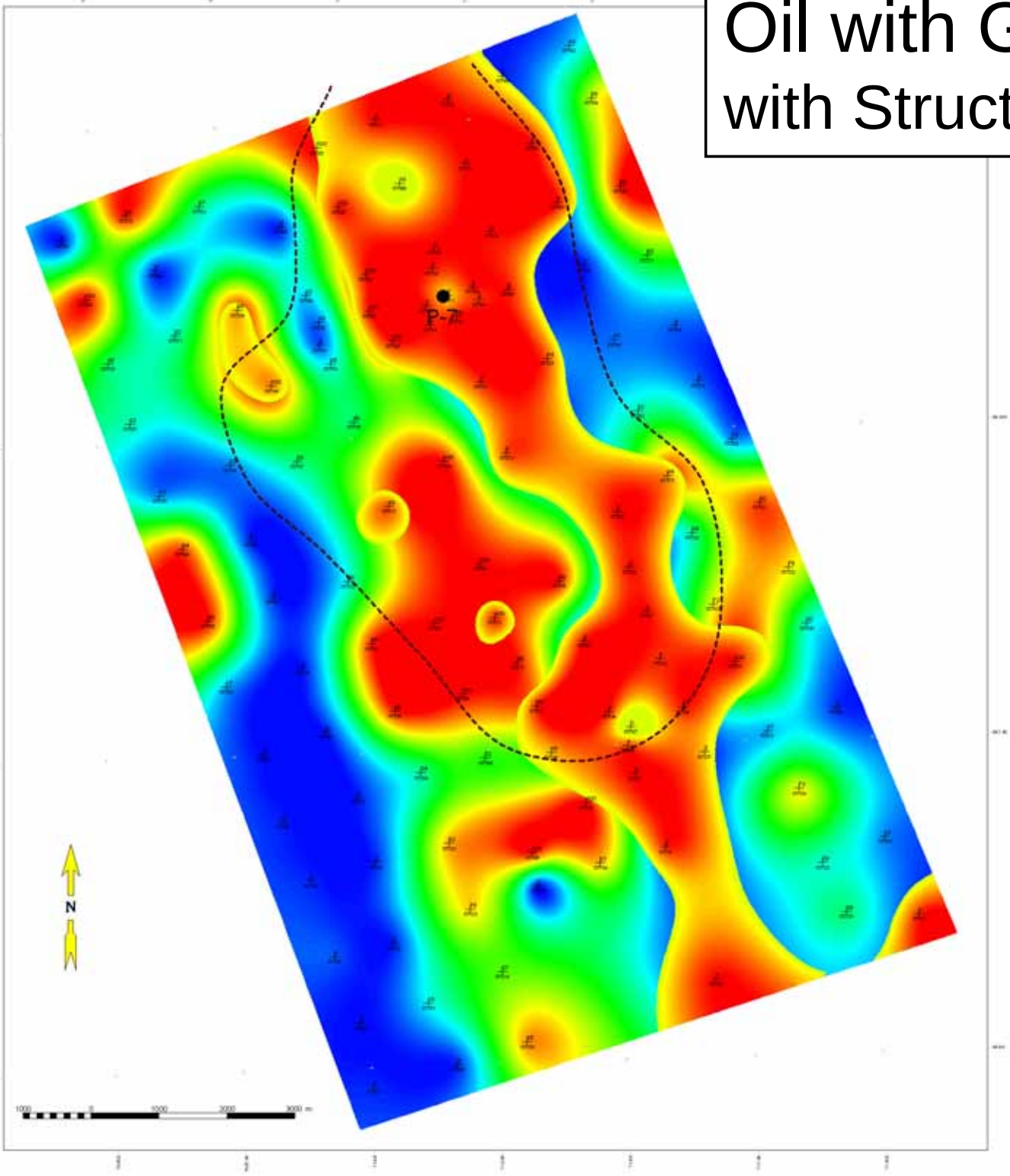
Oil Signature from HCA



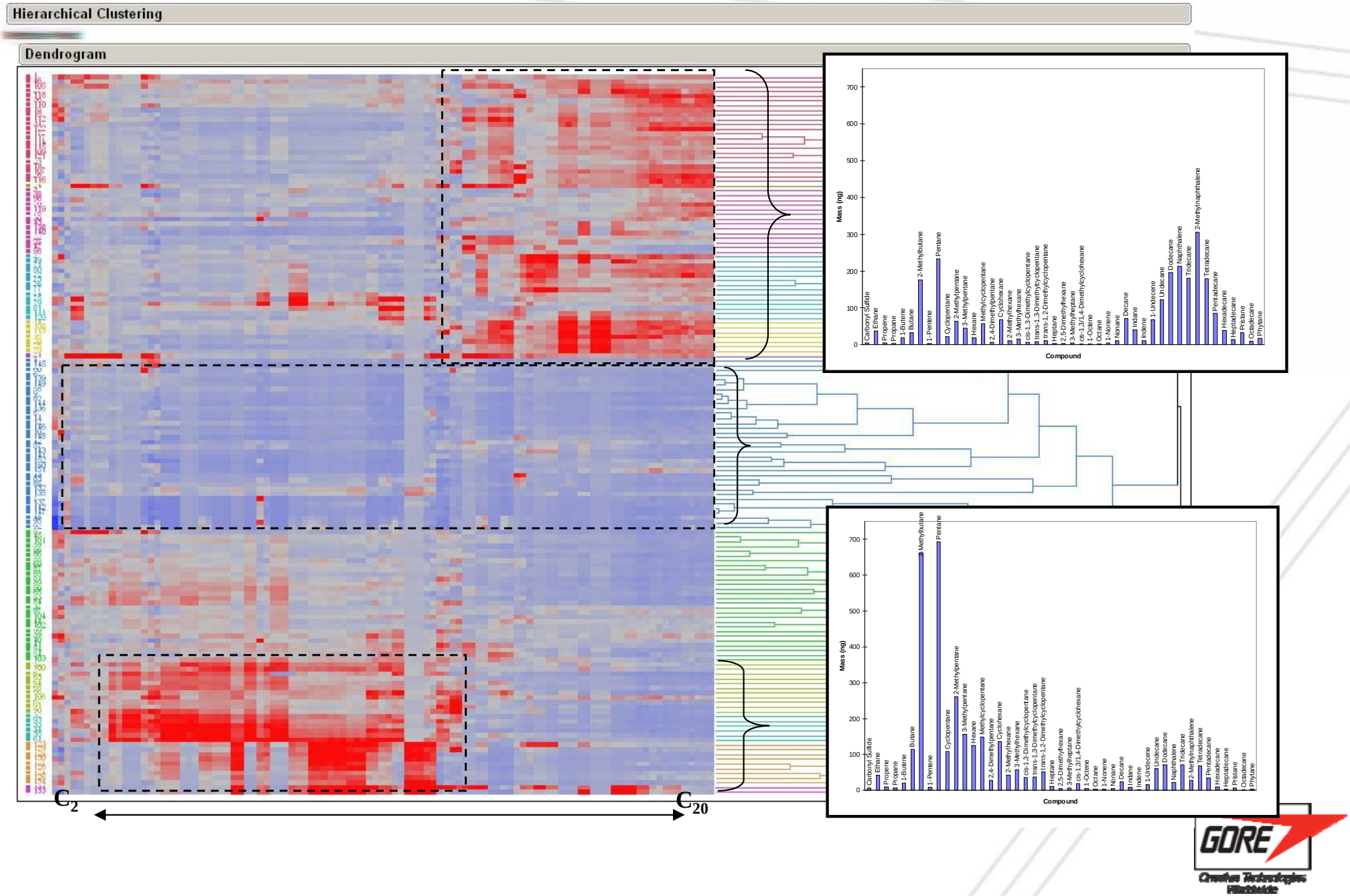
Oil Result
with Structure 14 outline



Oil with Gas Results
with Structure 14 outline



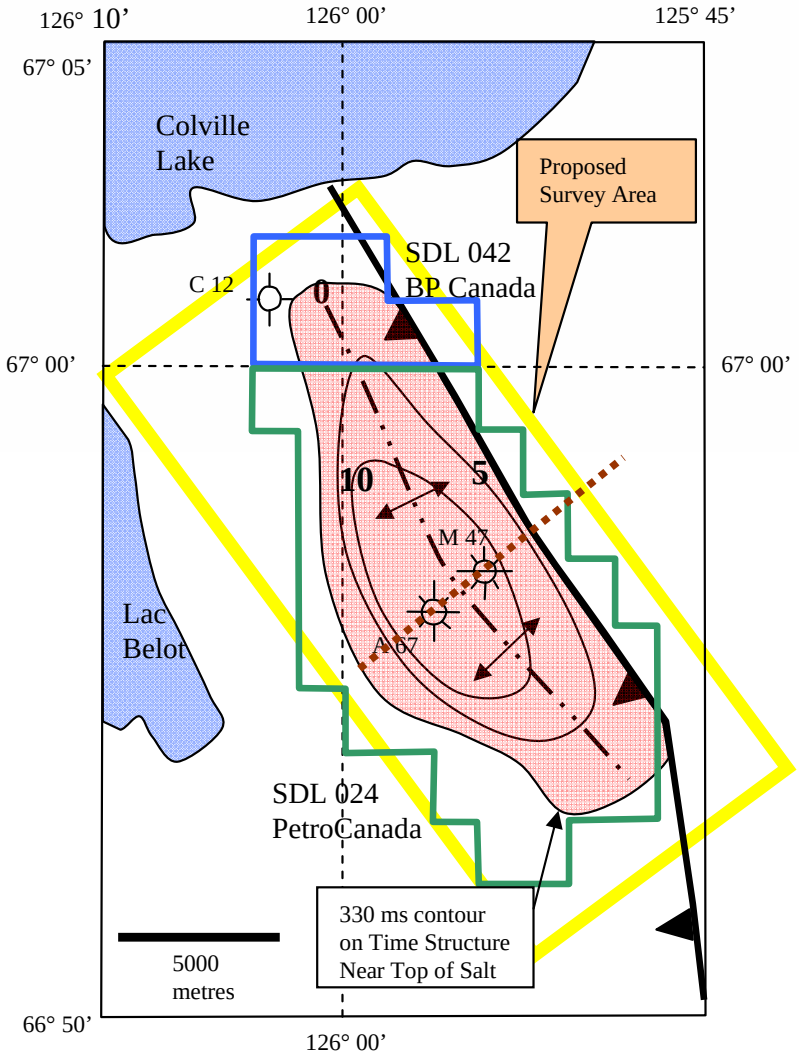
Hierarchical Cluster Analysis



Example from Northwest Territories, Canada

Geologic Setting

- Location – Colville Hills
- Tweed Lake Anticline
- Target – Cambrian Mount Clark Sandstone overlain by 400 meter thick Saline River evaporate sequence
- Depth – 1,500 meters



Cambrian Mount Clark Net Pay (metres)
NWT Open Report 2004-006; E.P. Janicki

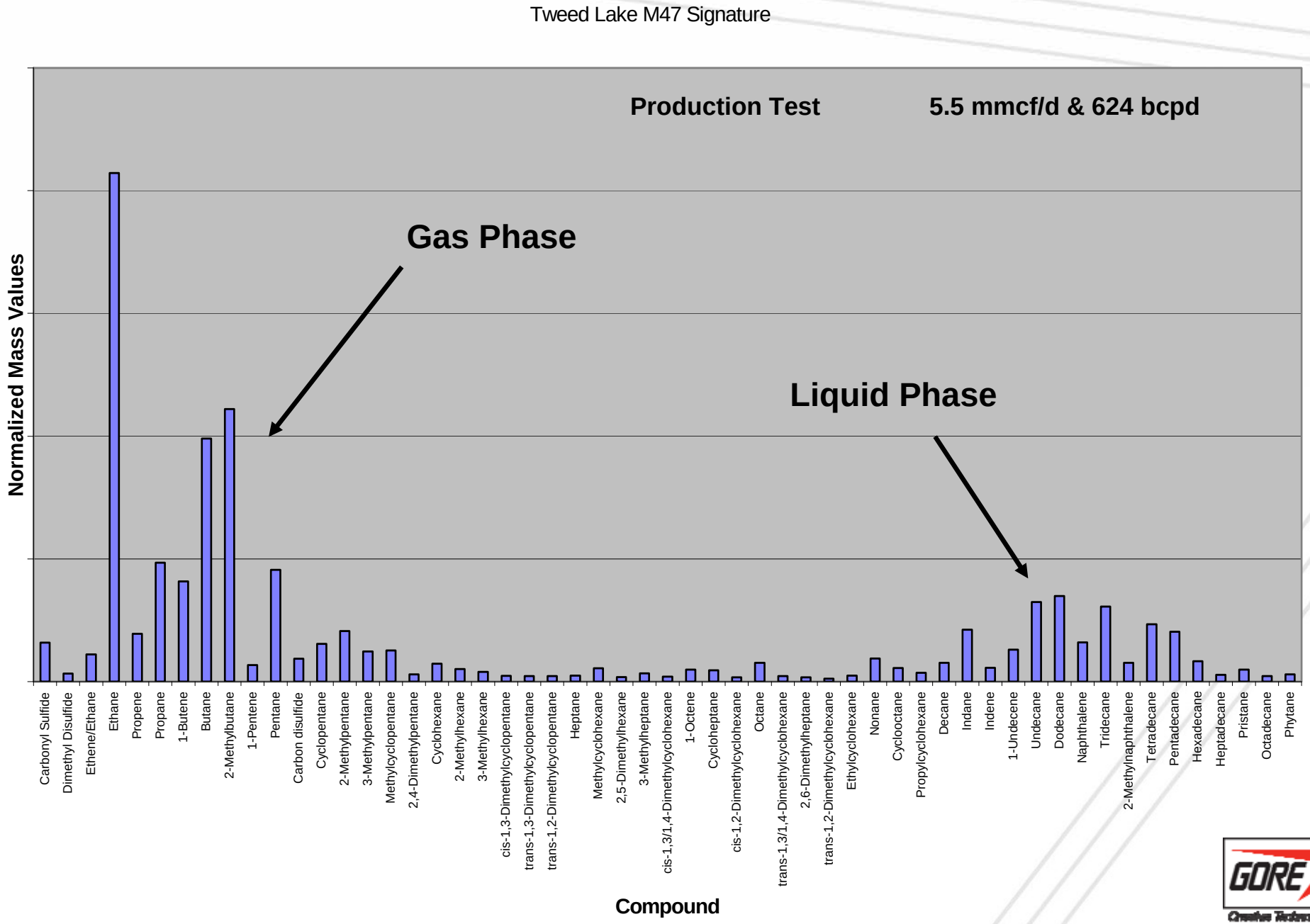
Tweed Lake

Northwest Territories, Canada

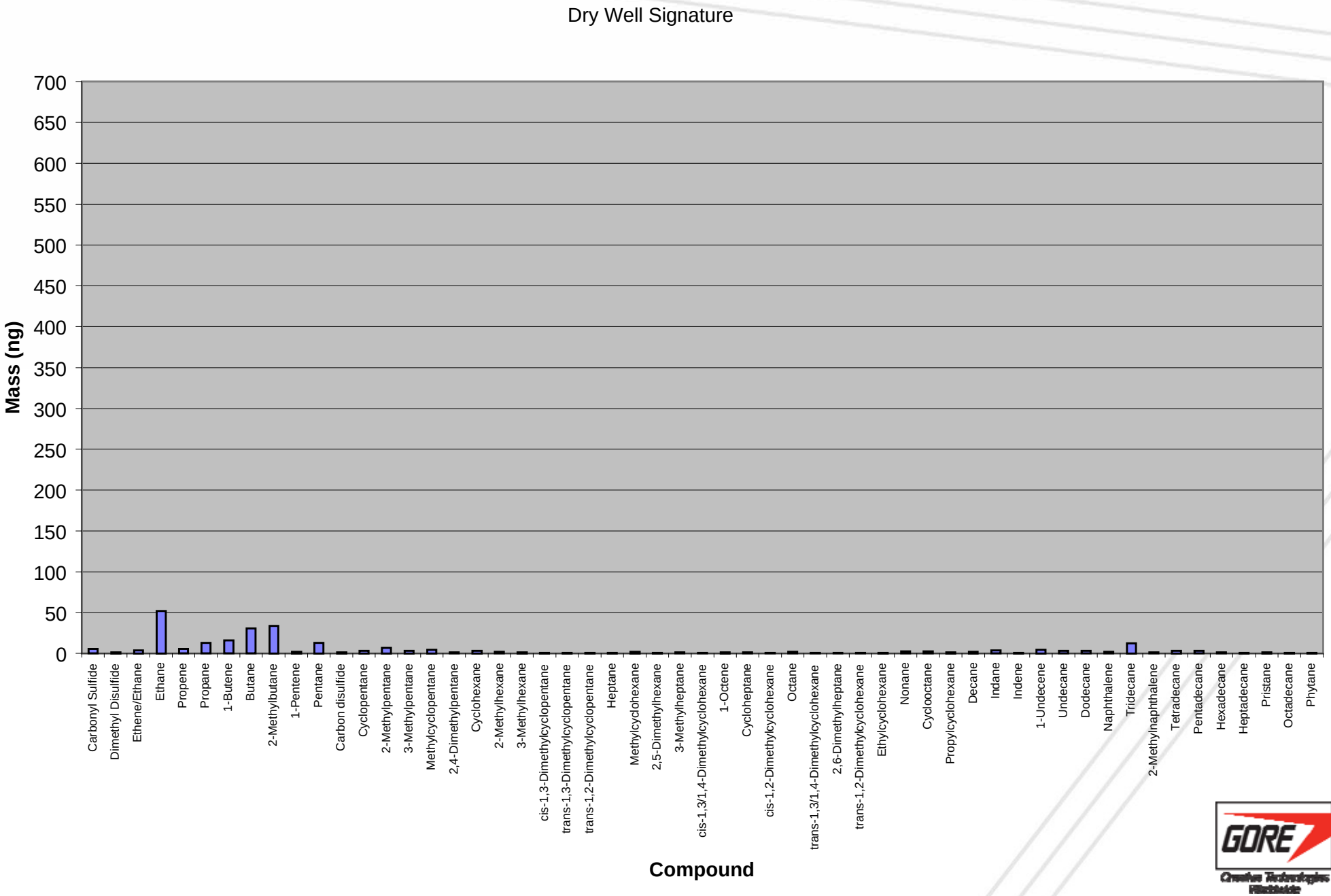
March, 2005

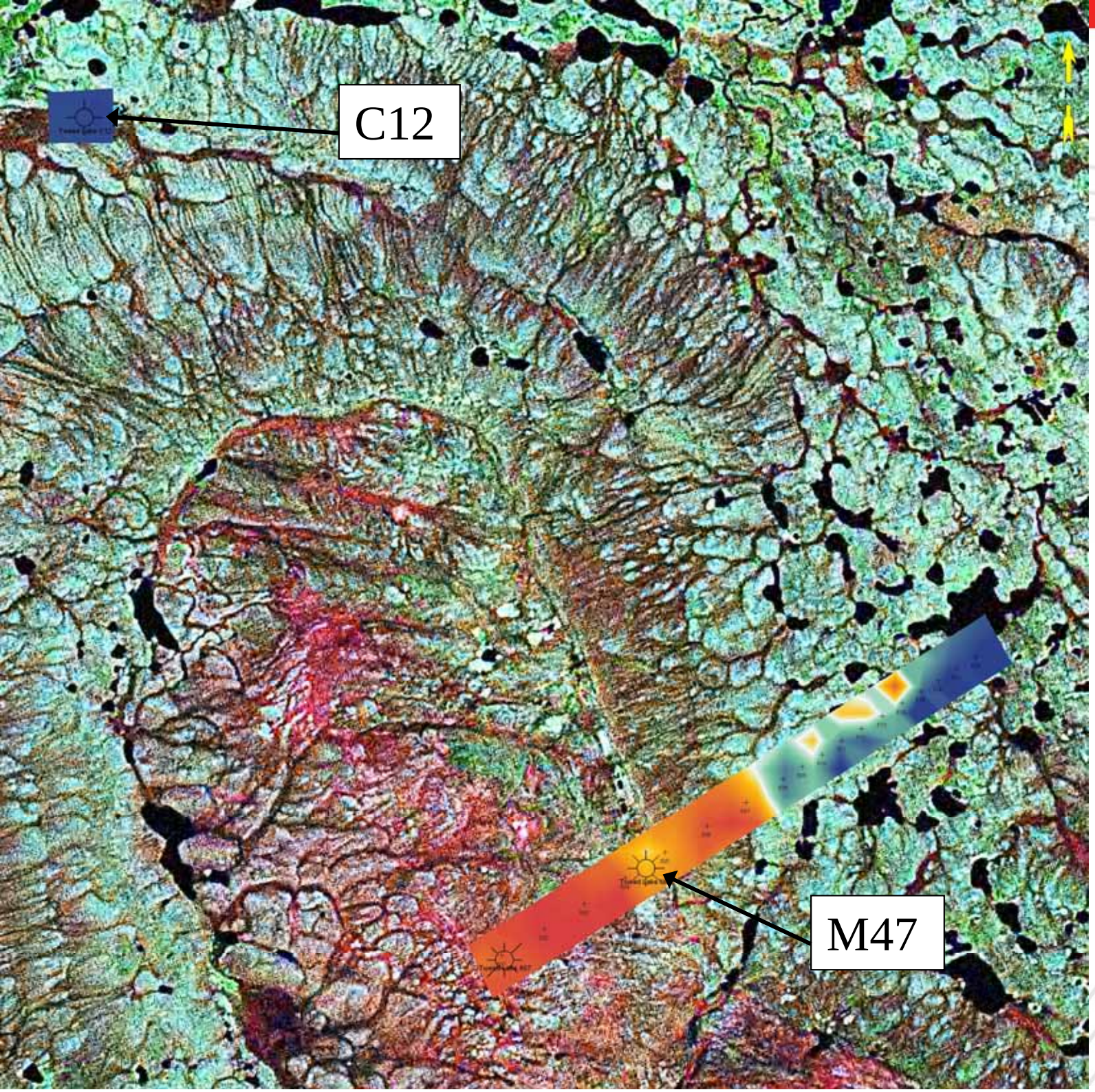
Marketable Reserves		**500 BCF**
Survey Outline		
Area:		**394 Km^2**
Size:	**Grid**	**595 Modules**
	Model (3 Wells)	**45 Modules**
	TOTAL	**640 Modules**
Grid:		**500 / 500 meters**

Tweed Lake M47 Gas/Condensate Well



Dry Well Signature

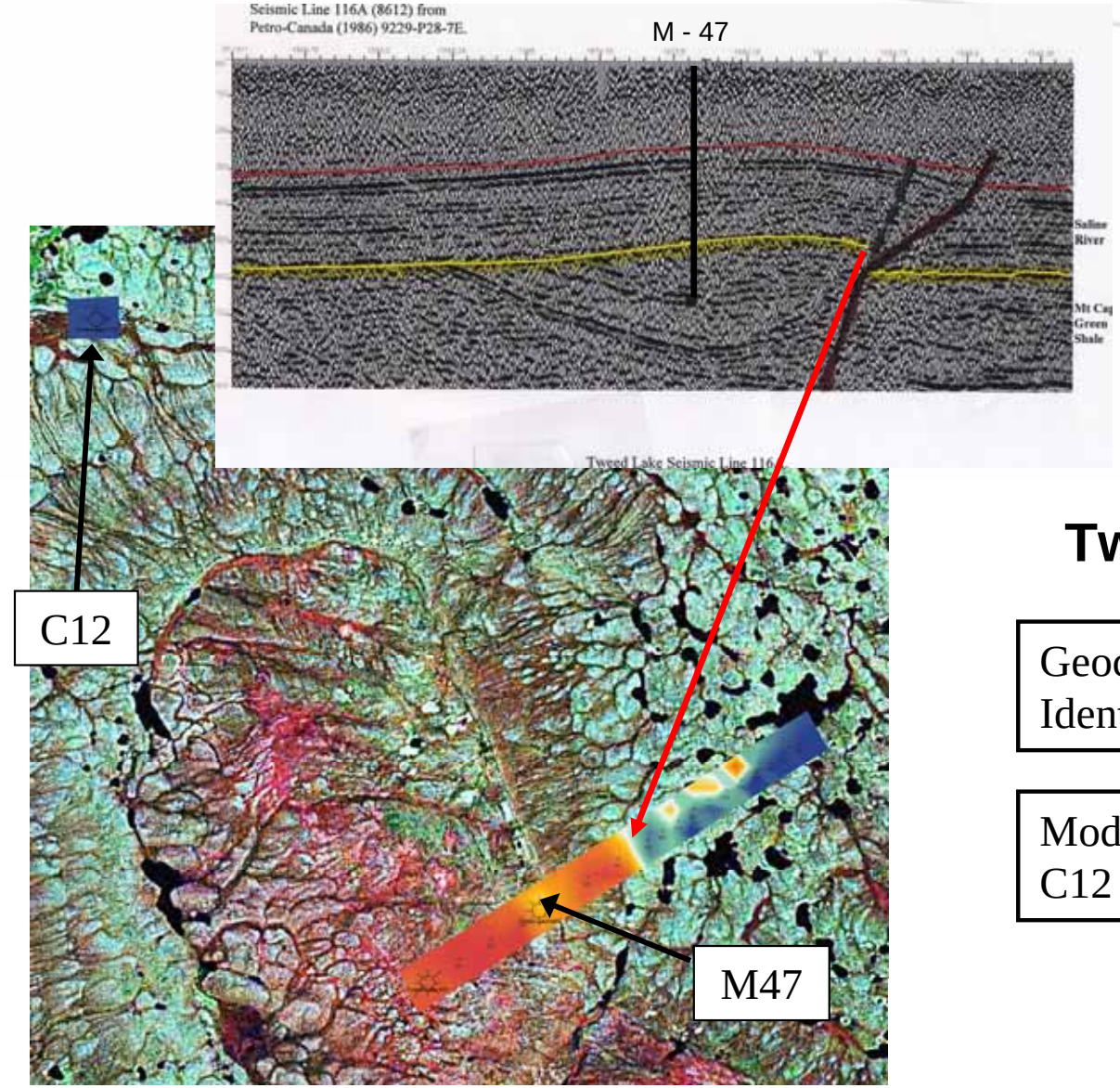




Tweed Lake Result

Geochemical Feature Identified at Tweed Lake

Model of M47 (gas) versus C12 Dry Well

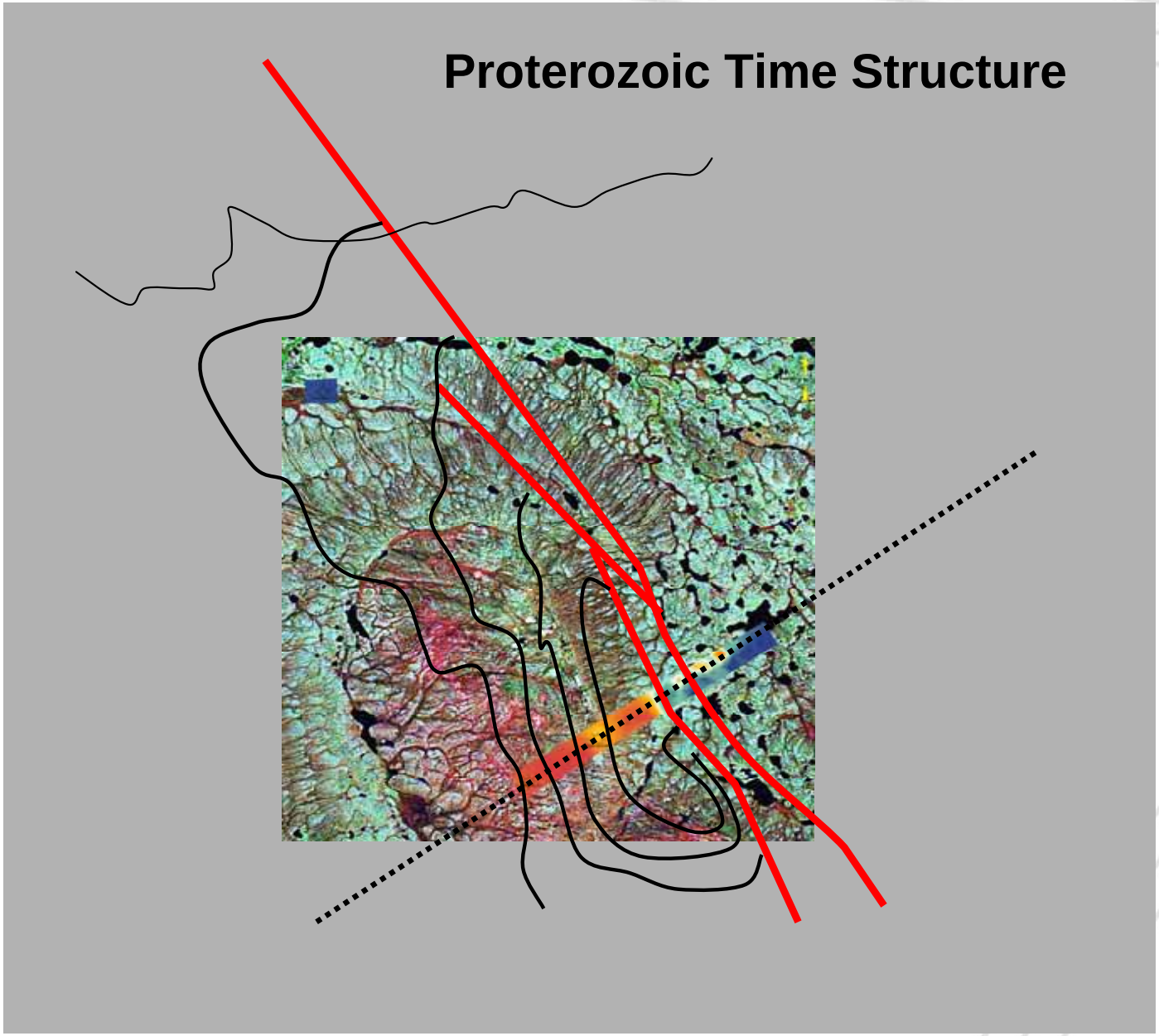


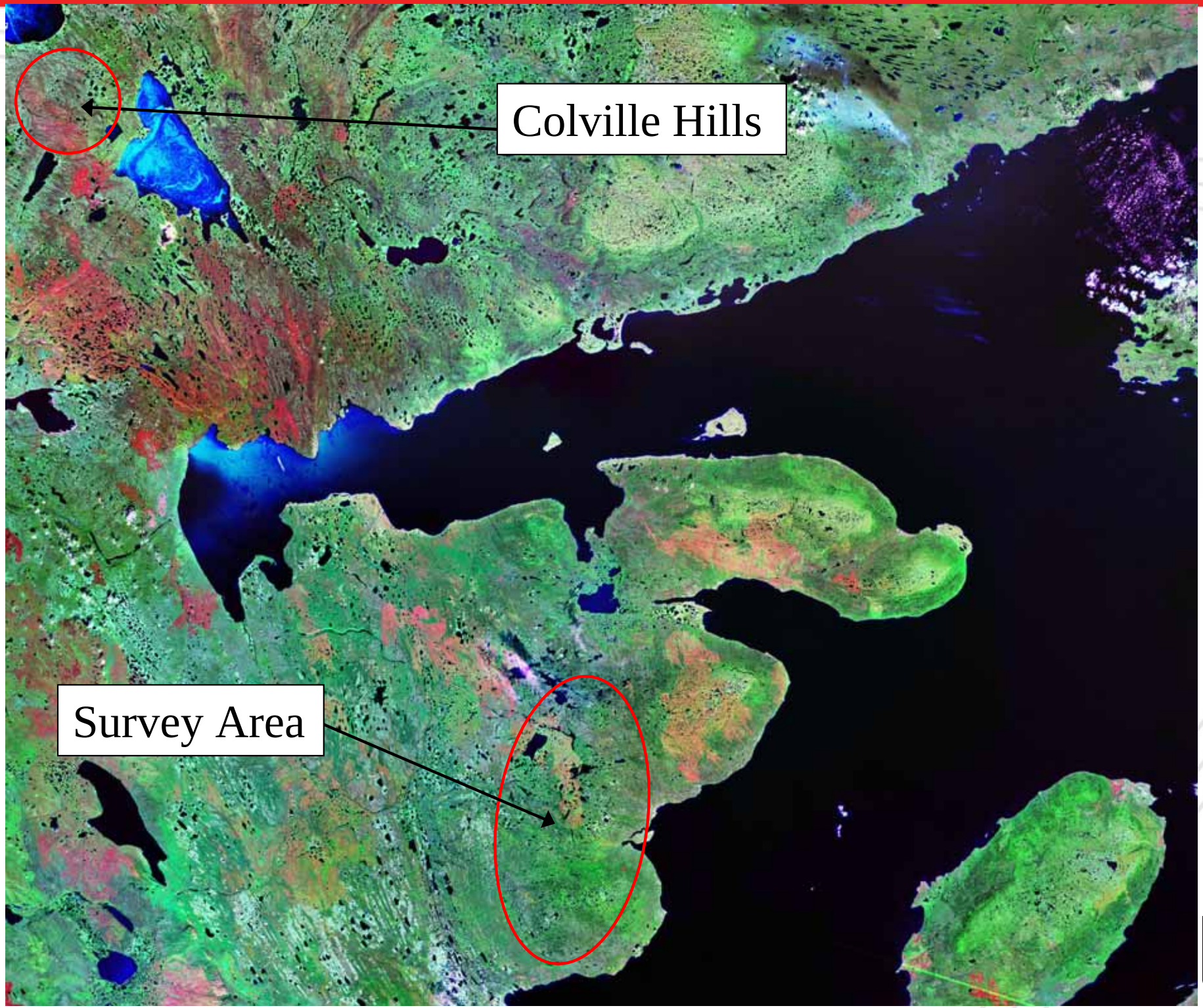
Tweed Lake - 2007

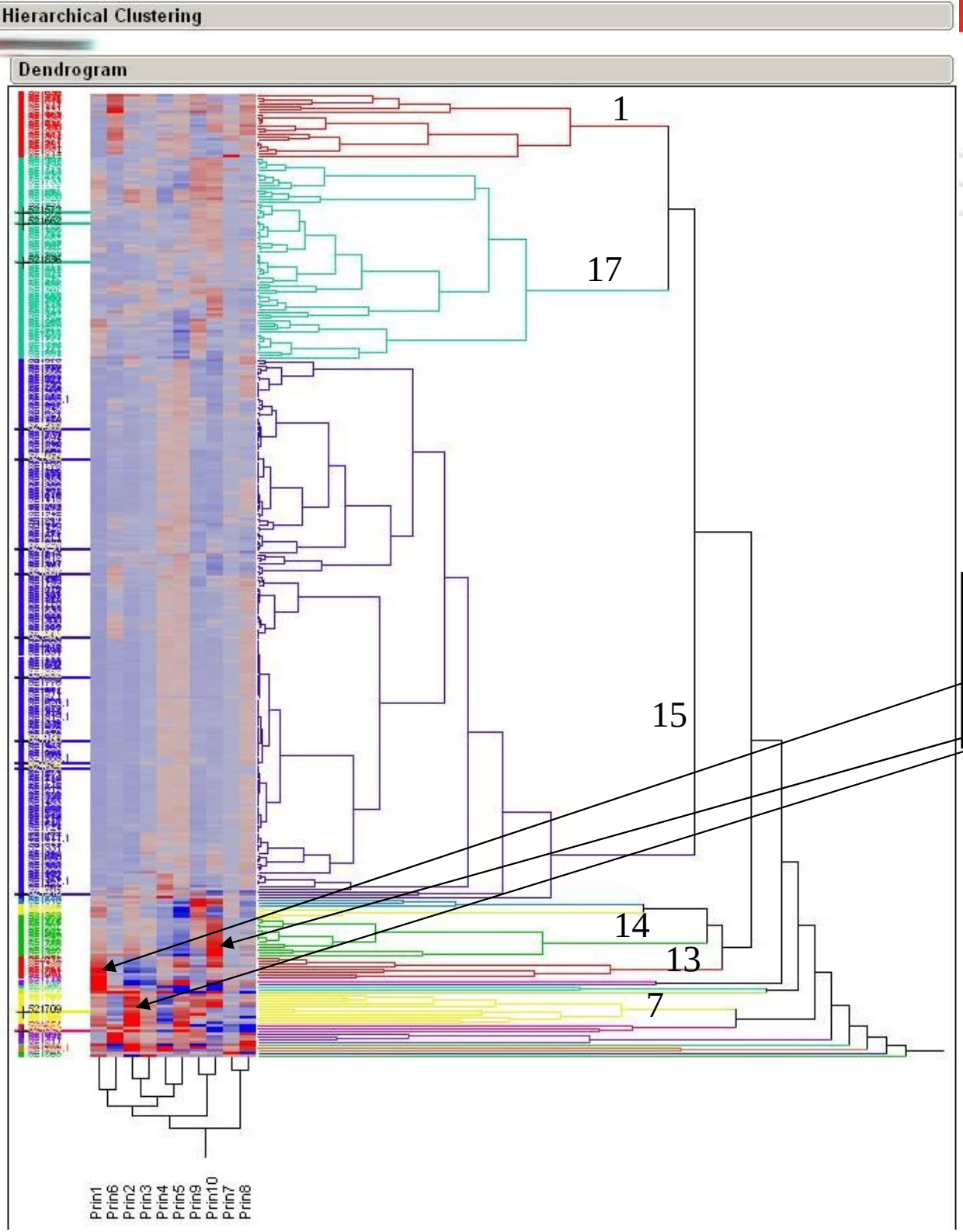
Geochemical Feature Identified at Tweed Lake

Model of M47 (gas) versus C12 Dry Well

Tweed Lake, Northwest Territories Canada




Colville Hills
Survey Area

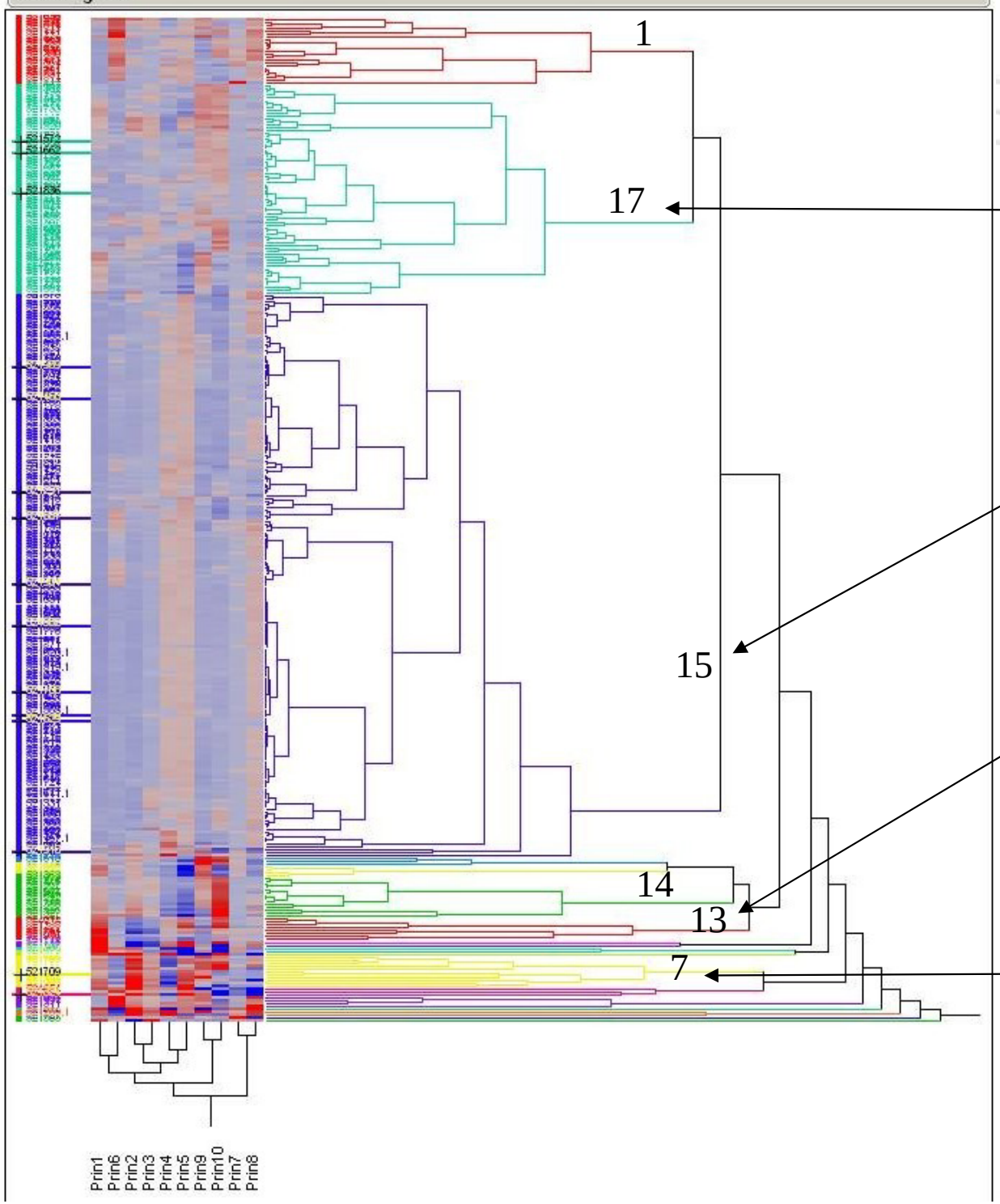


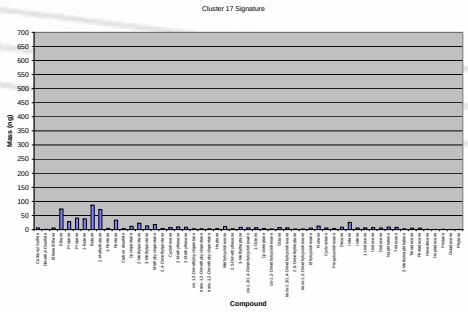
Hierarchical Cluster

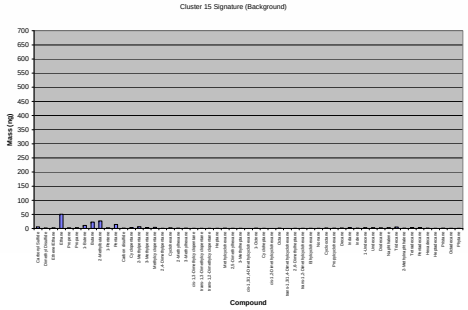
Clusters 15 and 17 Appear Unremarkable (Background)

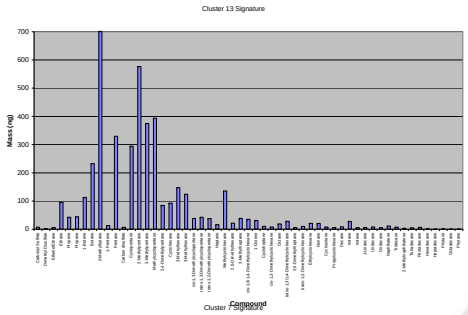
Principle Components Correlated to Clusters

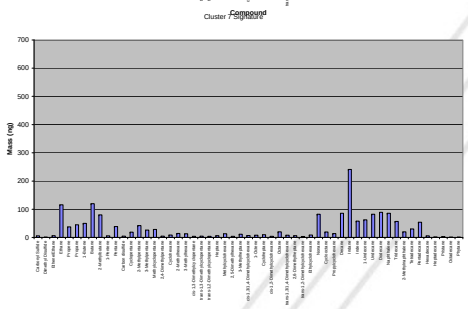
Hierarchical Cluster











Conclusions

- These examples show that a surface geochemical technology can determine whether a structure is charged with hydrocarbons before drilling
- Hydrocarbon phase can be identified prior to drilling thereby lowering your risk in areas where only an oil discovery would be desirable or economical