Geochemical Exploration Strategies for Myanmar and Other Geologically Complex Areas: Opportunities for Surface Geochemical and Non-Seismic Hydrocarbon Detection Methods*

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Abstract

The petroleum potential of geologically complex areas - such as highly faulted and folded terranes - is often poorly known due to technical challenges affecting seismic acquisition and imaging. When these areas occur in jungles and highlands, the logistical challenges only add to the difficulty of evaluating the petroleum potential of such regions. For such areas, surface geochemical and non-seismic hydrocarbon detection methods provide an opportunity to reliably detect and map the elevated hydrocarbon concentrations and hydrocarbon-induced changes commonly associated with undiscovered oil and gas accumulations. It has long been established that (1) all petroleum basins exhibit some type of near- surface hydrocarbon leakage, and more importantly (2) that the majority of petroleum accumulations have a surface geochemical expression. Hydrocarbon seepage can be active or passive, and it can be visible (macro-seepage) or only detectable analytically (microseepage). The surface and near-surface expressions of hydrocarbon migration and seepage can take many forms ranging from elevated hydrocarbon concentrations in soils and shallow sediments, to complex mineralogical, microbial, and geophysical changes. While such hydrocarbon microseepage does not require significant faulting and fracturing, the common presence of faults and fractures in structurally complex and tectonically active terranes provides additional migration pathways for hydrocarbon seepage and microseepage.

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GEOCHEMICAL EXPLORATION STRATEGIES FOR MYANMAR AND OTHER GEOLOGICALLY COMPLEX AREAS:

OPPORTUNITIES FOR SURFACE GEOCHEMICAL AND NON-SEISMIC HYDROCARBON DETECTION SURVEYS

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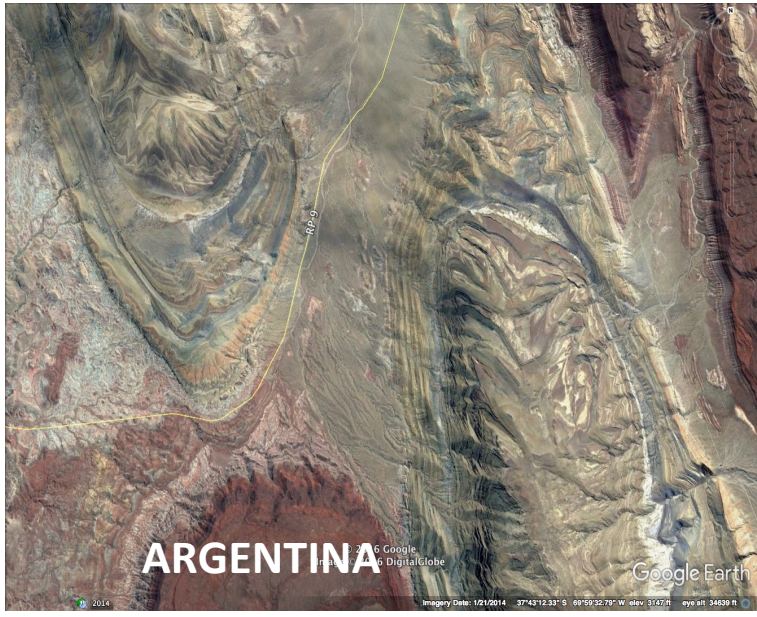
OUTLINE

- Characteristics of Geologically Complex Areas
- Why Hydrocarbon Detection Surveys
- Survey Methods for Geologically Complex Areas
- Survey Objectives and Design Considerations
- Selected Exploration Examples
- Conclusions

Geologically Complex Areas

ADVANTAGES – **MORE LEAKAGE POINTS; OUTCROPS; MATURE SOURCE ROCKS, ACCUMULATIONS, SEEPS**

LIMITATIONS – **MORE LEAKAGE POINTS, MORE "ANOMALIES"; INTERPRETATION CHALLENGES, LOGISTICAL CHALLENGES; SURFACE EXPRESSIONS OF FAULTS YIELDS BIGGEST ANOMALIES**



WHY HYDROCARBON DETECTION SURVEYS ?

Most productive basins leak

Most accumulations leak

Discriminate between oil versus gas

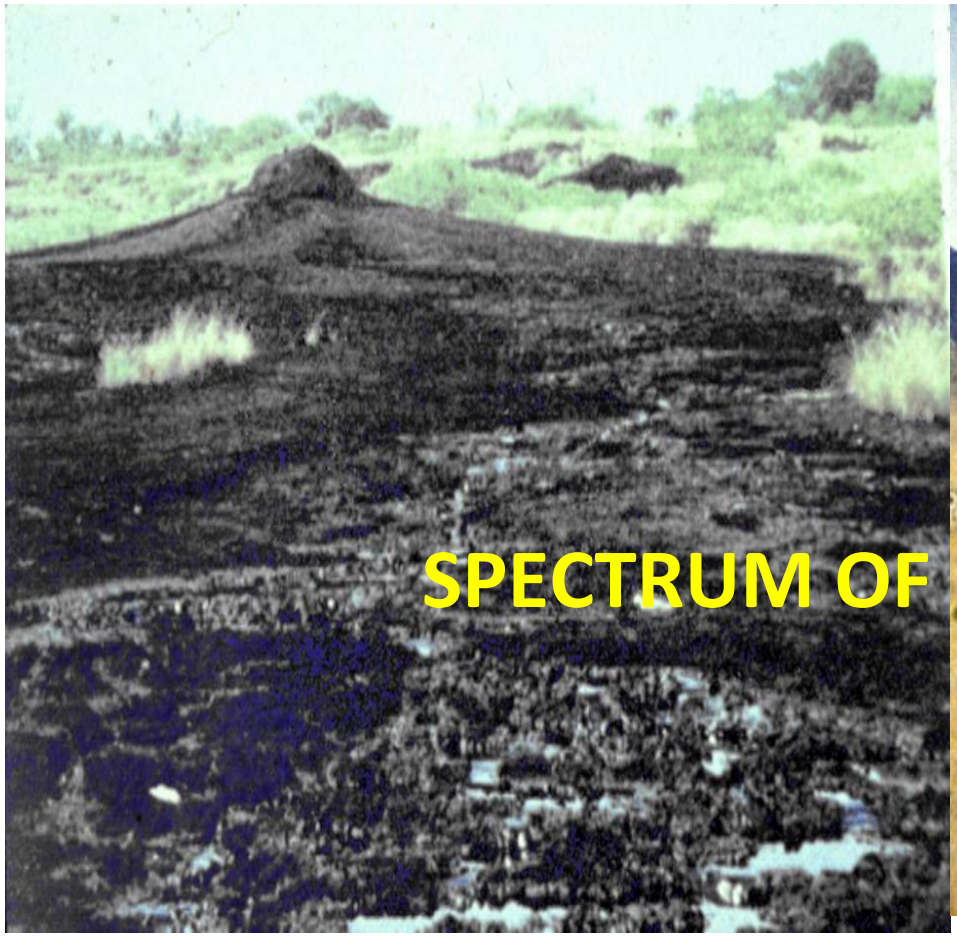
Leakage is predominantly vertical

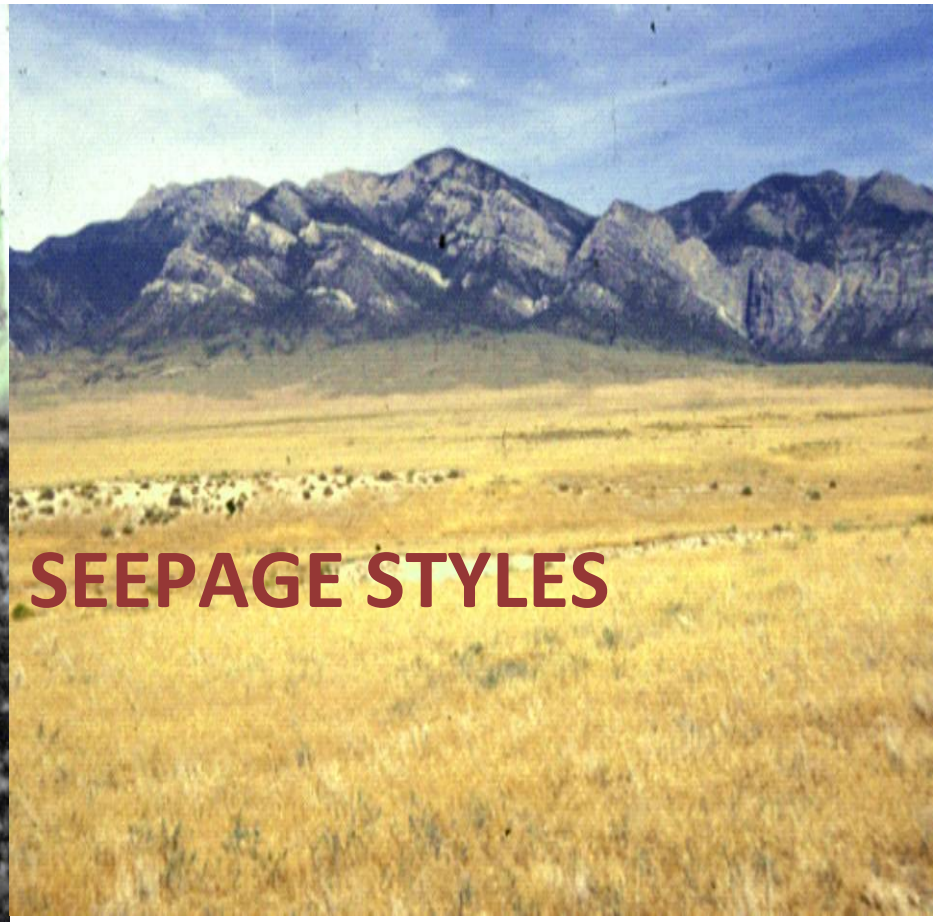
Direct indicator of hydrocarbons

Identify and map hc-induced alteration

Minimal environmental impact

Prospects with hydrocarbon anomaly are 4 to 6 times more likely to yield discovery





SPECTRUM OF SEEPAGE STYLES

MACROSEEPAGE -- visible oil and gas seeps; located at faults fractures, and outcrops; tectonically active basins

MICROSEEPAGE – not visible but detectible; occurs above mature source rocks and over accumulations

Microseepage Characteristics

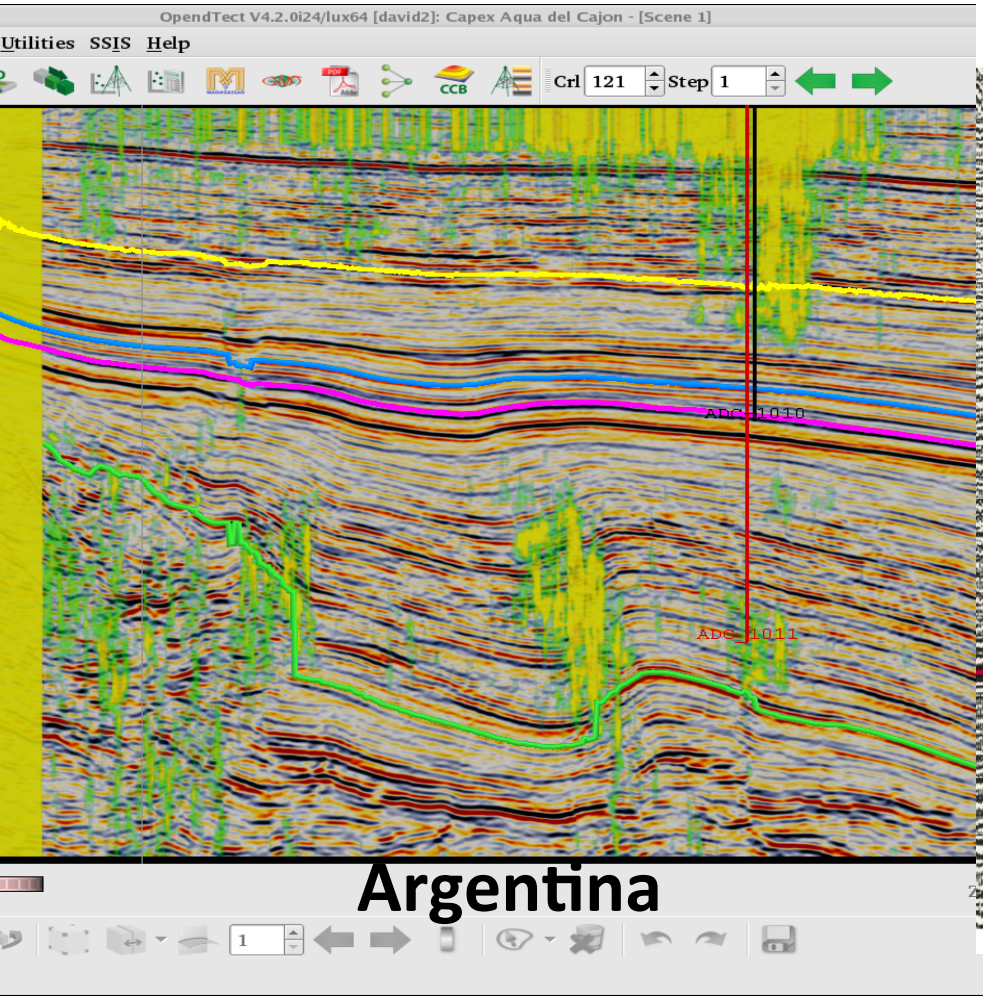
Detailed geochemical surveys and research documents that hydrocarbon microseepage from oil and gas accumulations is

Common and Widespread

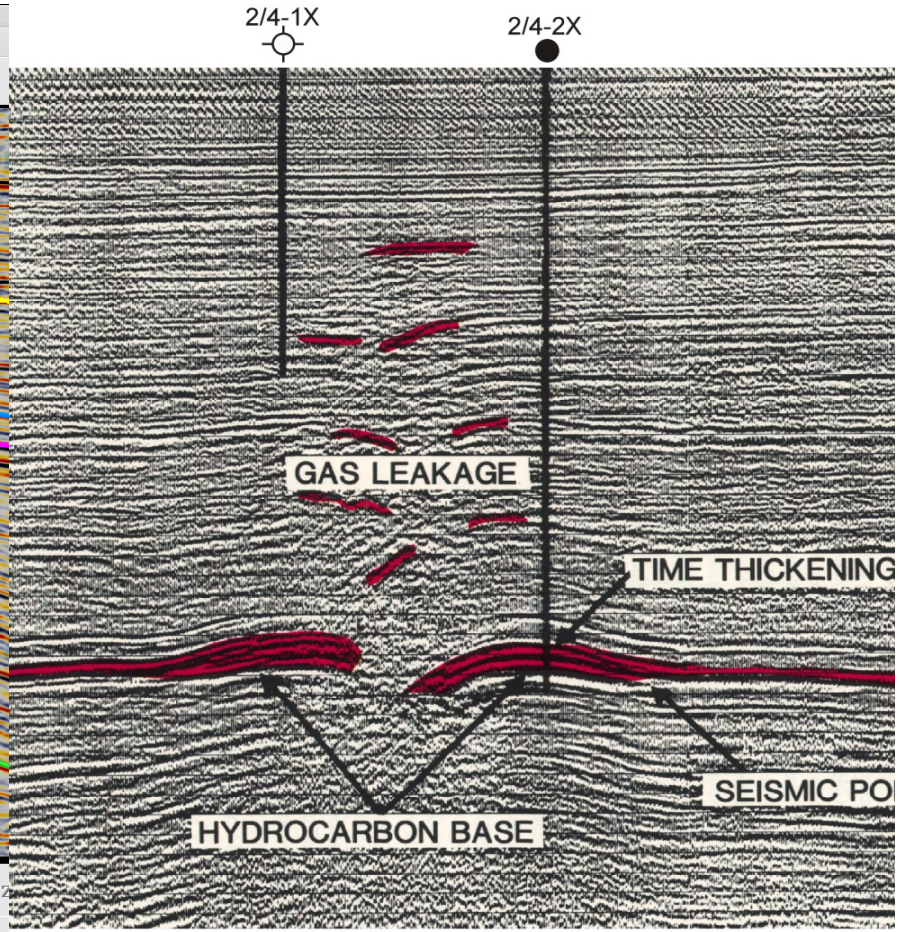
Predominantly Vertical

Dynamic (1-3+ m/d)

Hydrocarbon Microseepage is Predominantly Vertical



Argentina



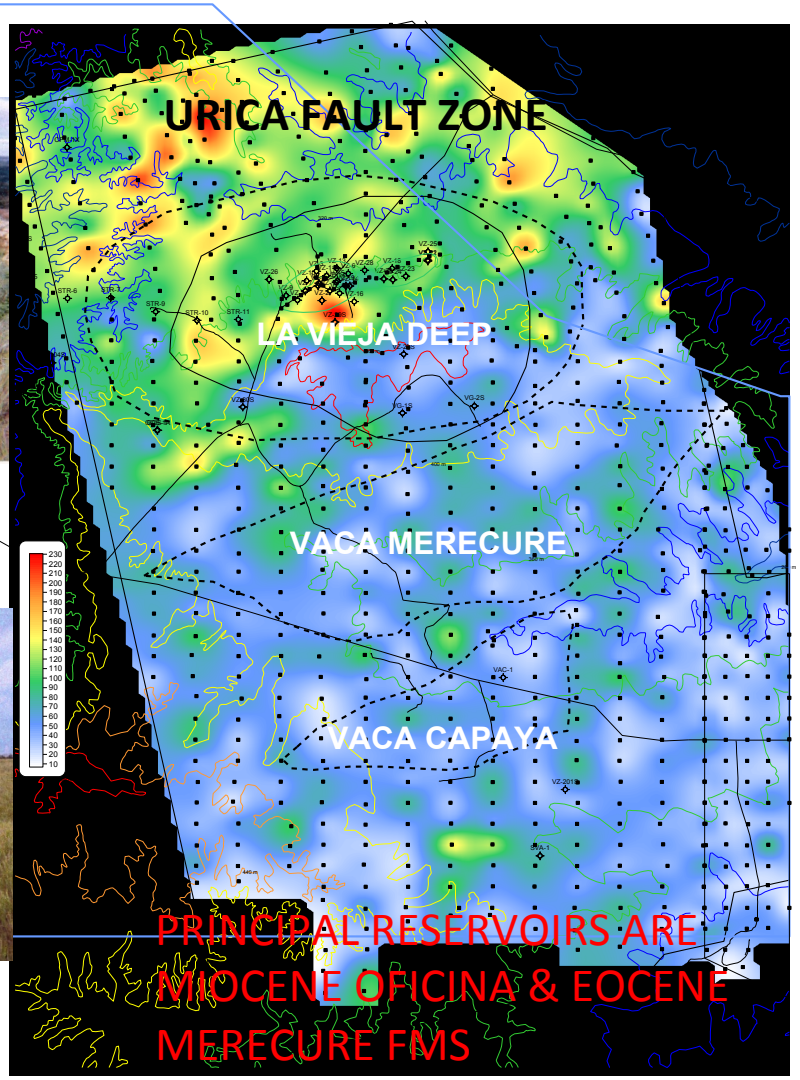
North Sea

(from Van d

Leakage is 1000 liters/hour; approx. 1 TCF/MY

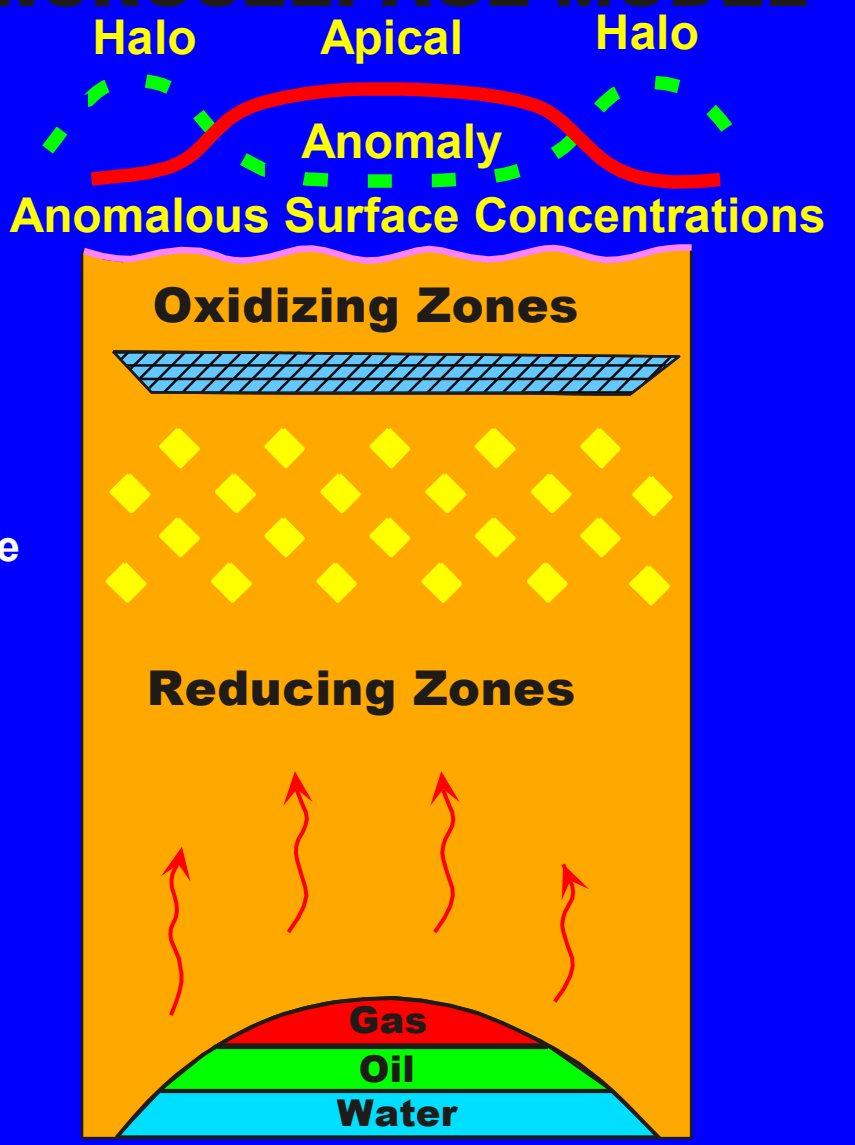
Eastern Venezuela Basin

QLC Block, Prospect Evaluation



575 SQ KM
1600 SAMPLES
SOIL GAS, MICROBIAL

MICROSEEPAGE MODEL



GEOCHEMICAL

Carbonate Precipitation

Pyrite Precipitation
also sulphur, pyrrhotite
greigite, uranium, etc.

Bacterial Degradation
of Hydrocarbons

Light Hydrocarbons
Seep Upward from
Trap Creating a
Reducing Zone

GEOPHYSICAL

High Resistivity
Anomaly

High Polarization
Anomaly

Magnetic
Anomaly

Low Resistivity
Anomaly

Seismic Velocity
Anomaly

Schumacher, 1996

HYDROCARBON DETECTION METHODS

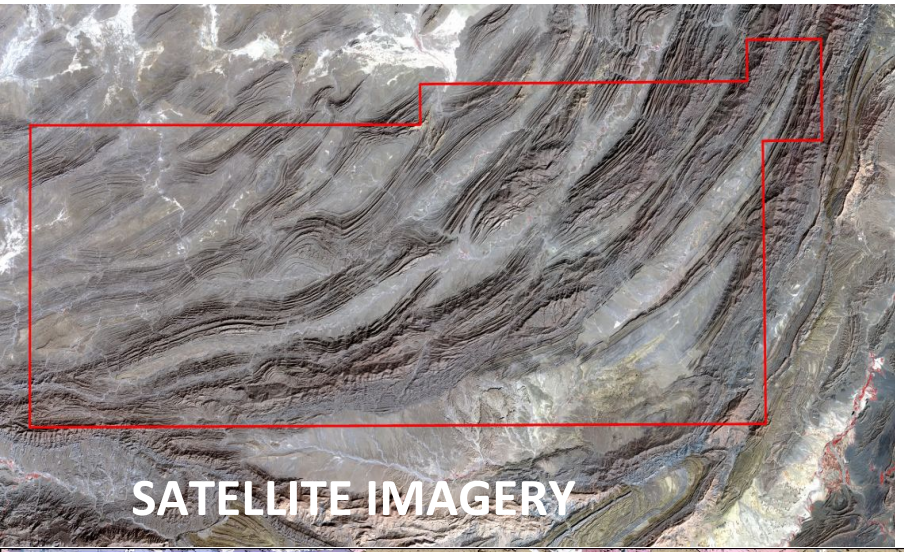
- **REMOTE SENSING, SATELLITE IMAGERY**
  - detects hydrocarbon-induced alteration, oil slicks
  - unique spectral signatures of seeps and minerals
- **AEROMAGNETICS, MICROMAGNETICS**
  - detects hydrocarbon-induced mineralization between reservoir and surface
- **SOIL GAS, FLUORESCENCE, C15+ HCs**
  - hydrocarbon concentration and composition
- **MICROBIOLOGICAL**
  - measures presence of HC-oxidizing bacteria
- **PASSIVE ELECTROMAGNETICS, TELLURICS**
  - determines depth to hydrocarbon-bearing zones

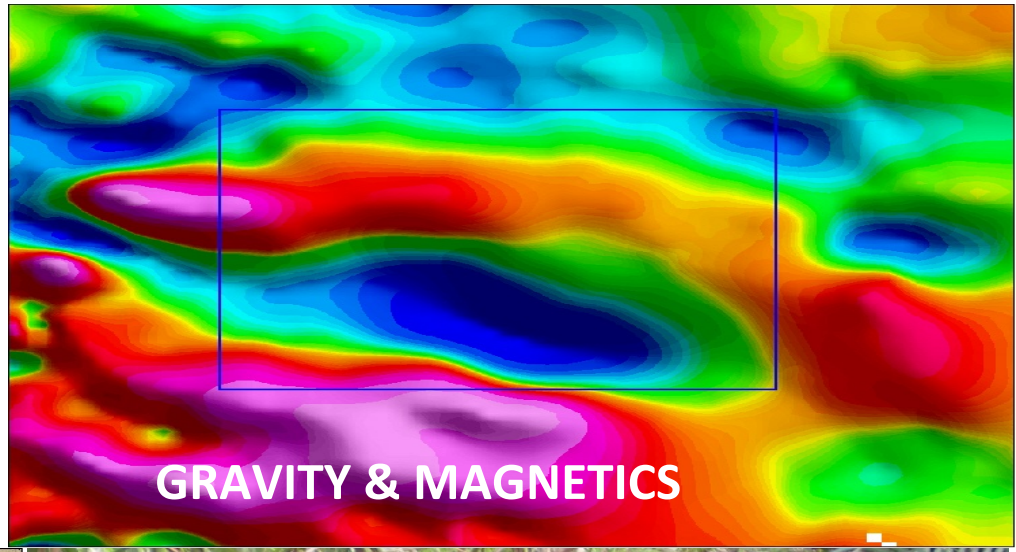
Survey Design Considerations

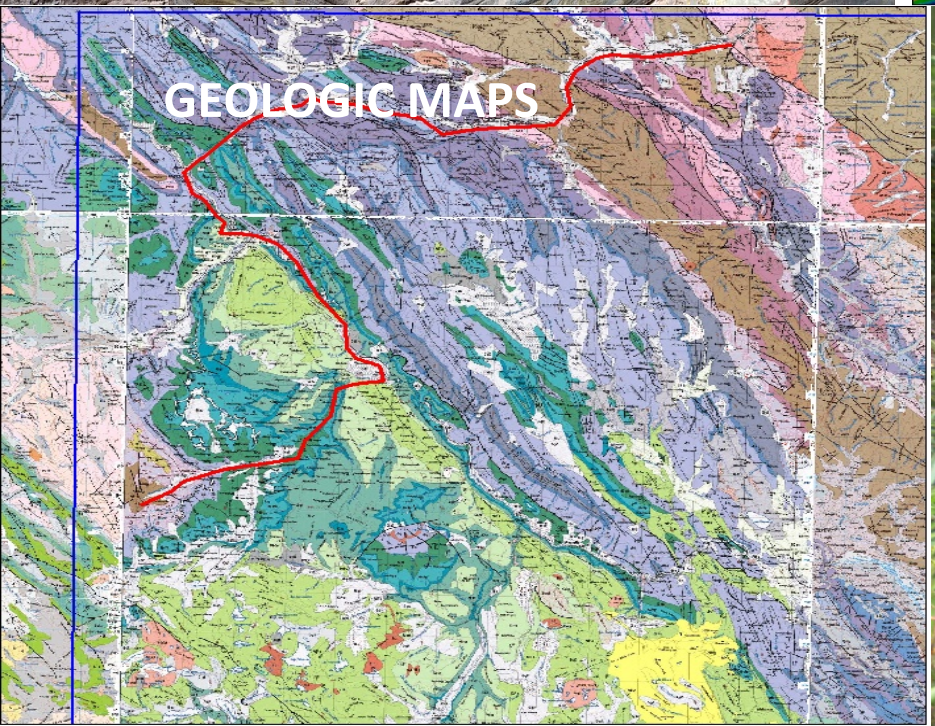
Survey Objectives

- Target Size, Shape
- Geologic Setting
- Topography, Vegetation
- Logistical Considerations
- Data Integration
- Ability to Sample Along & Between Seismic Lines
- Geologic Analogs for Calibration
- Permitting
- Environmental Issues
- Prior Experience

PLANNING THE SURVEY







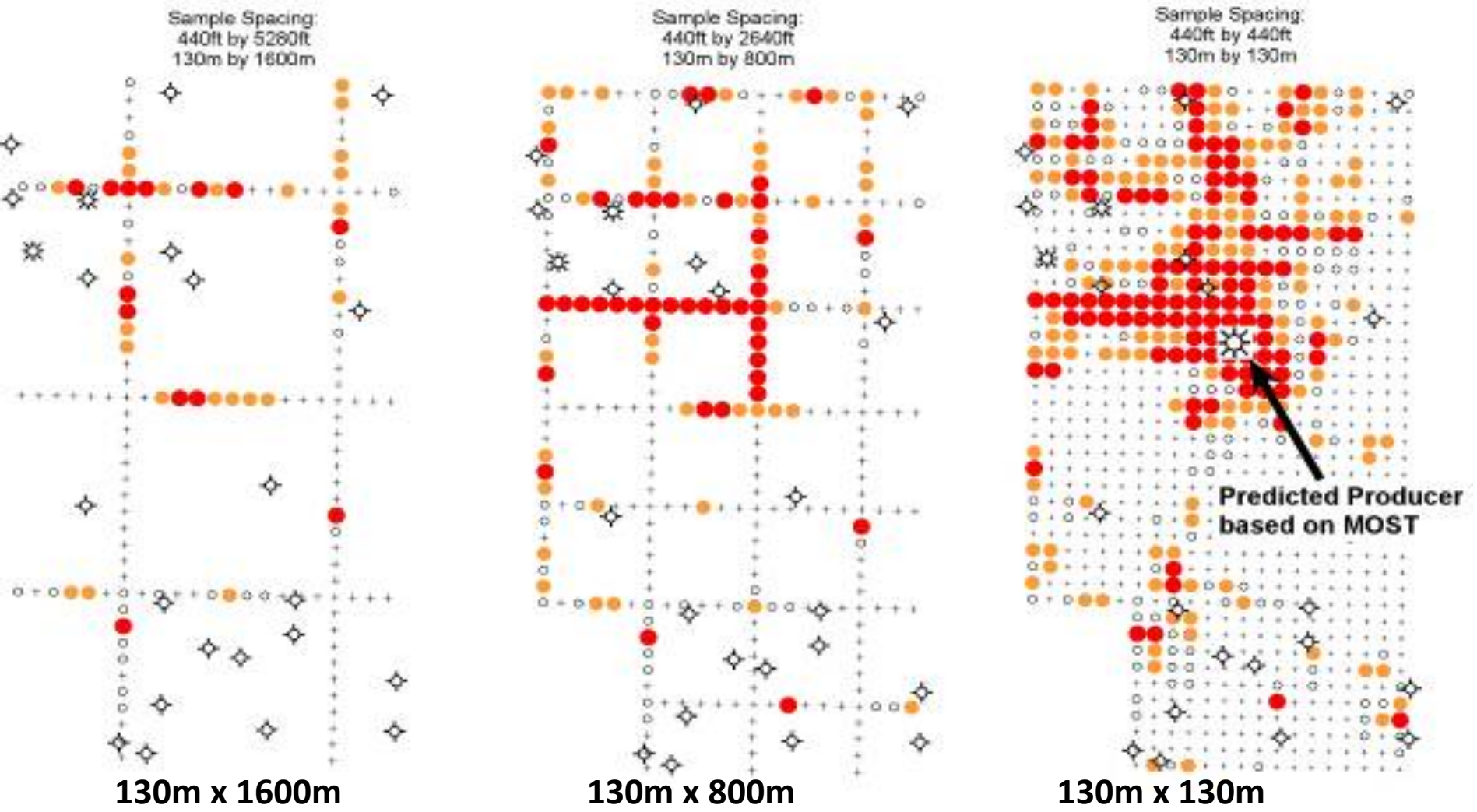
WHAT AND WHERE TO SAMPLE

- Oil and Gas Seeps, if present
- Along & Across Faults and Fracture Zones
- Gravity Lows (Basin Depocenter?)
- Structural Highs
- Exploration Leads, Prospects
- Possible Seep-Induced Soil/Sediment Alteration
- Along Regional Seismic Lines, if available
- Geologic Analogs (both productive and dry)
- Regional Survey Lines or Grids, depending on terrain and logistical considerations

Geo-Microbial Technologies, Inc.
Ochelata, Oklahoma USA

Sampling Strategy - Survey Design

The value of sample grids over line surveys is illustrated in this example from Oklahoma.



Note: Abandoned / depleted oil field in south part of survey area demonstrates Microbial Reservoir Characterization (MRC) principle of pressure withdrawal and microseepage shutdown

SURVEY OBJECTIVES

RECONNAISSANCE

400m – 1000m

LEADS & PROSPECTS

100m – 250m

FIELD DEVELOPMENT

50m – 150m

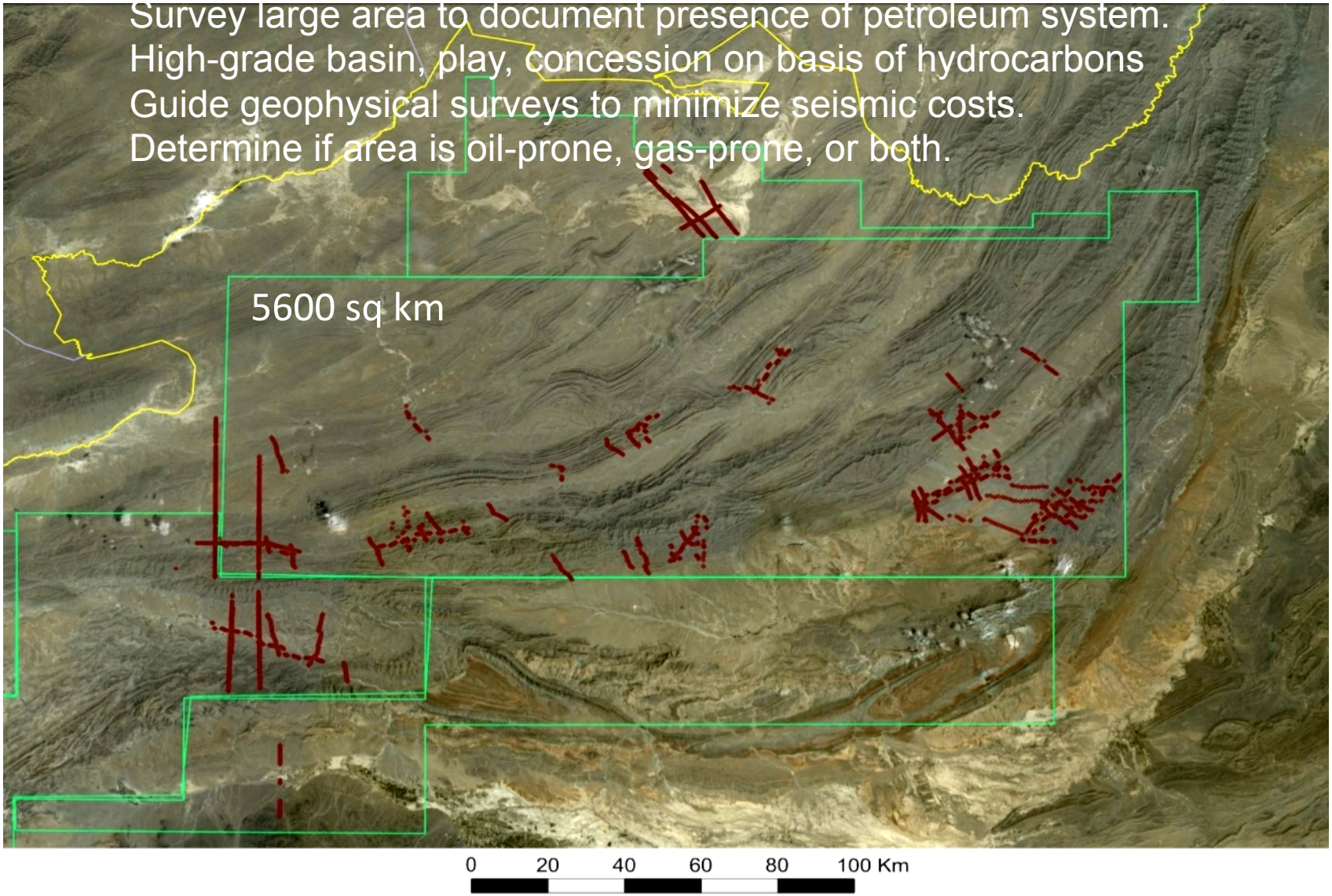
PRODUCTION MONITORING

REPEAT SURVEYS OVER LIFE OF FIELD

SELECTED EXPLORATION EXAMPLES

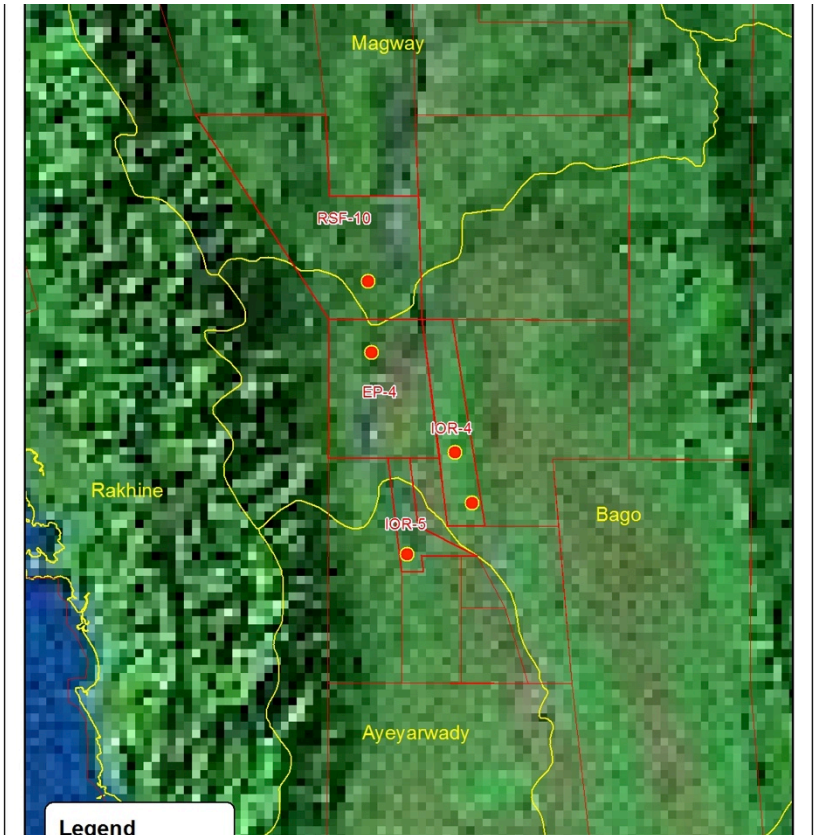
Pakistan
Myanmar
Peru
Kalimantan
Taiwan
Australia
Yemen

PAKISTAN, PISHIN BASIN, RECONNAISSANCE



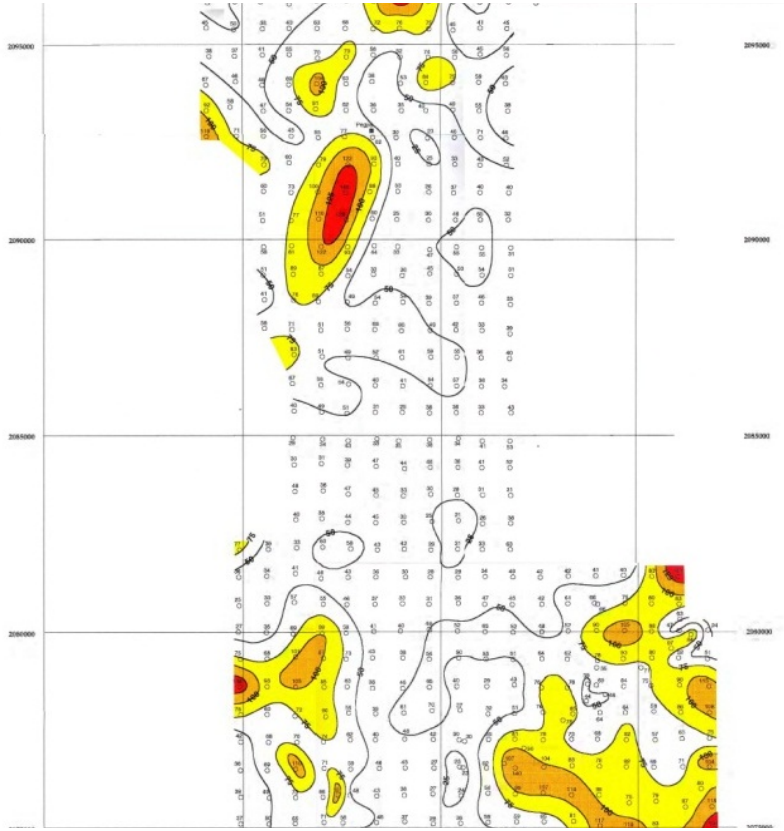
Myanmar
Reconnaissance Geochem Surveys

Current Block Designations
Showing sites of 1995 JNOC surveys



1995 JNOC Surveys, PSC B2

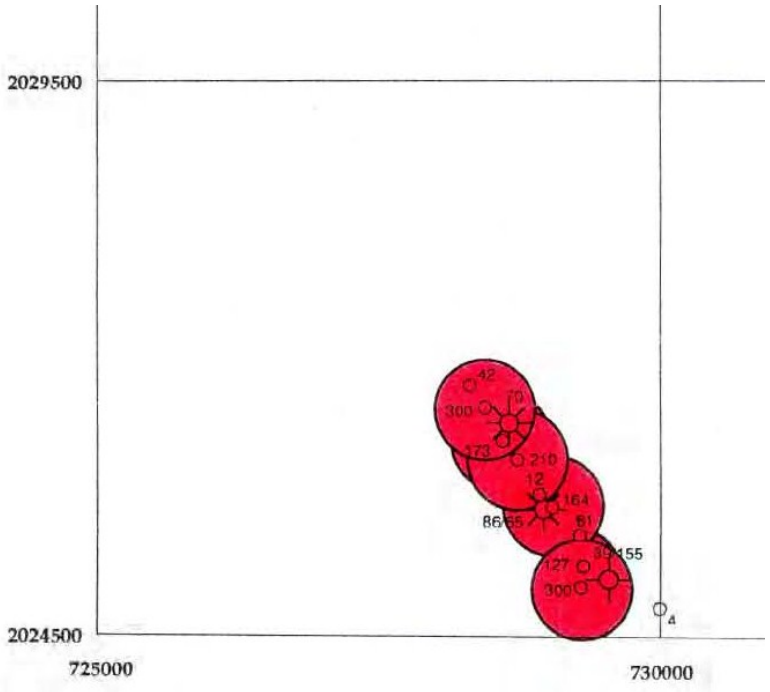
Reconnaissance Prospect Evaluation



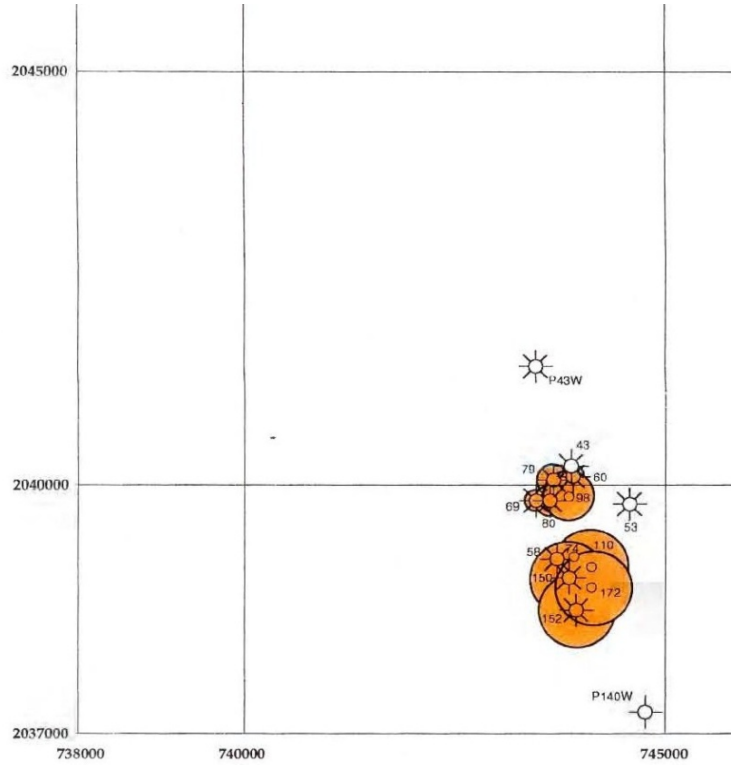
MYANMAR

1995 JNOC Recon Geochem Survey

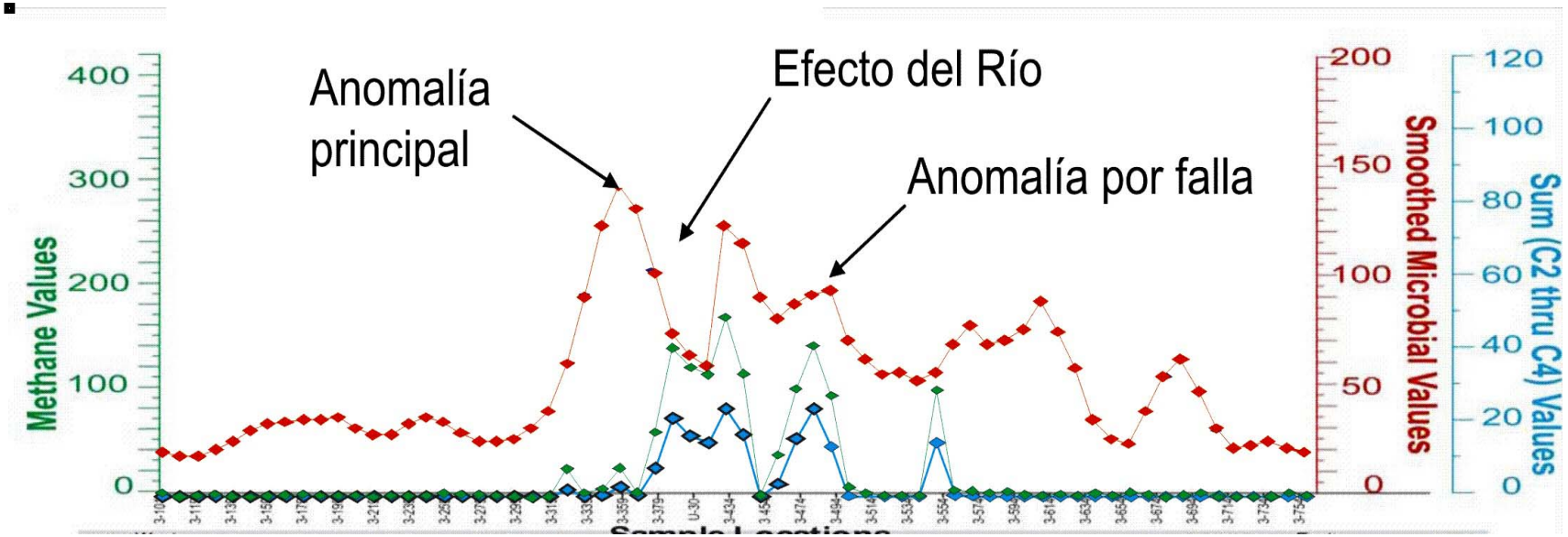
Calibration Soil Gas Survey (Acid Extraction) Over Known Producing Fields, Blocks IOR 4 and IOR 5

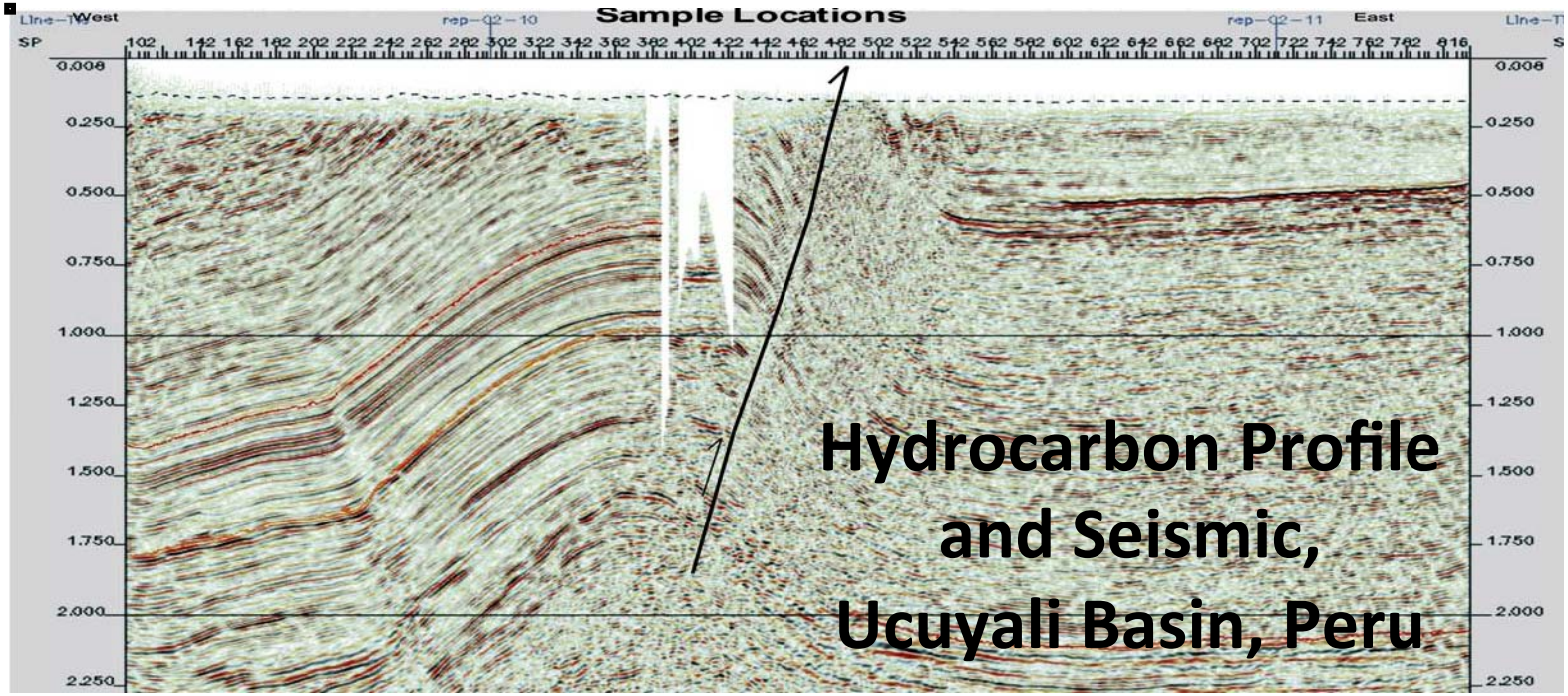


HTANTABIN FIELD



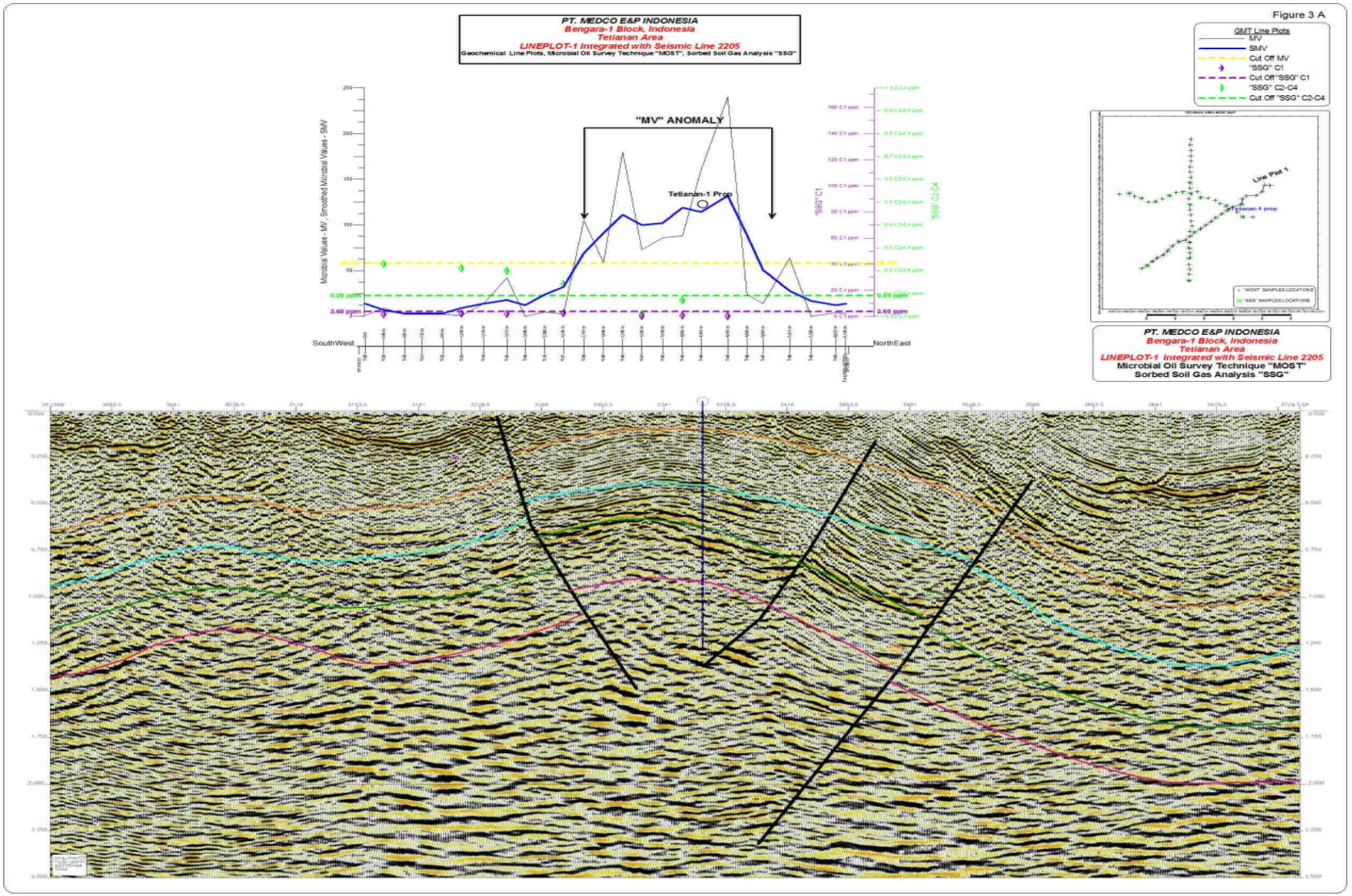
PYAY FIELD


Anomalía principal
Efecto del Río
Anomalía por falla
Methane Values
Smoothed Microbial Values
Sum (C2 thru C4) Values
Sample Locations


Hydrocarbon Profile and Seismic, Ucuyali Basin, Peru

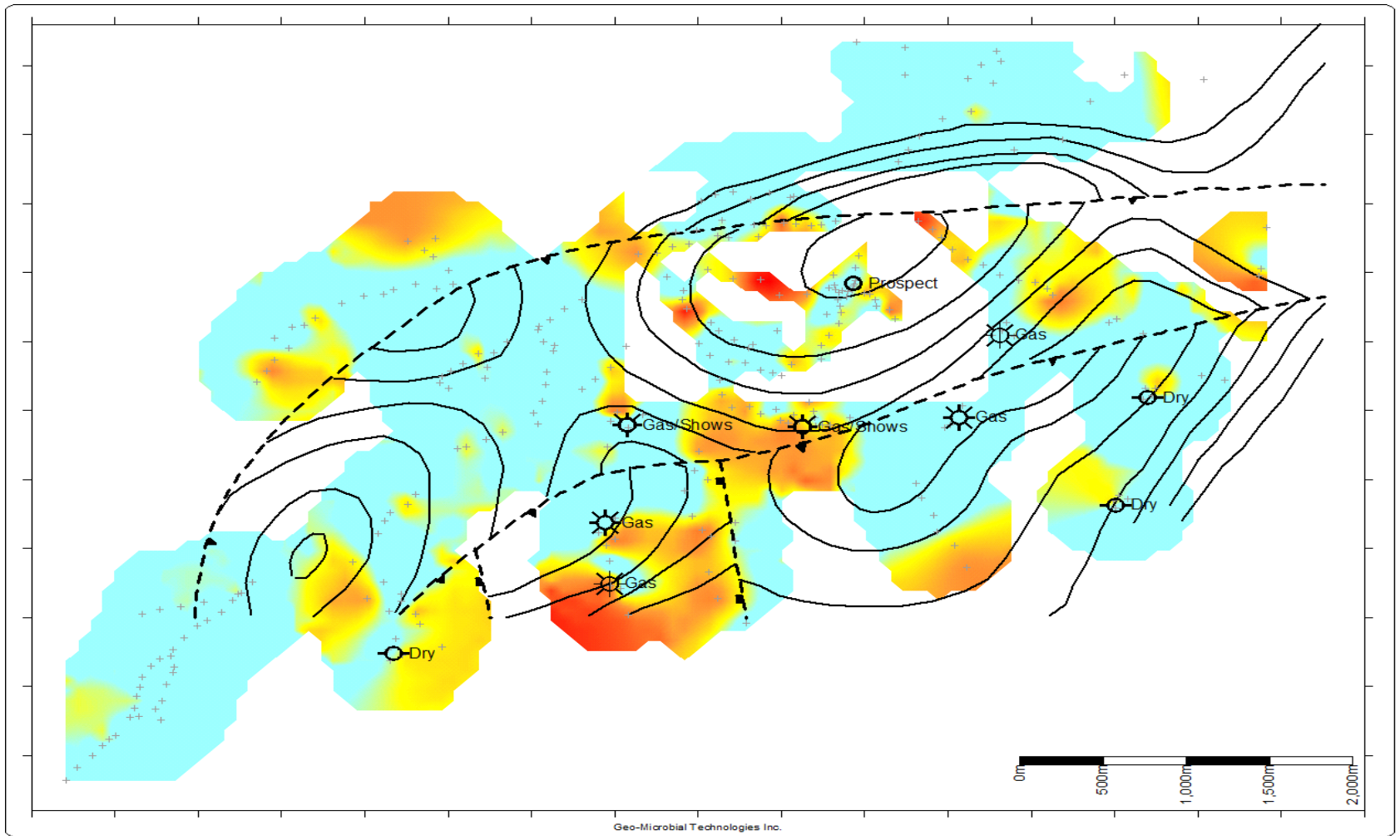
BENGARA BLOCK, KALIMANTAN

Tetianan Prospect , Seismic and Microbial

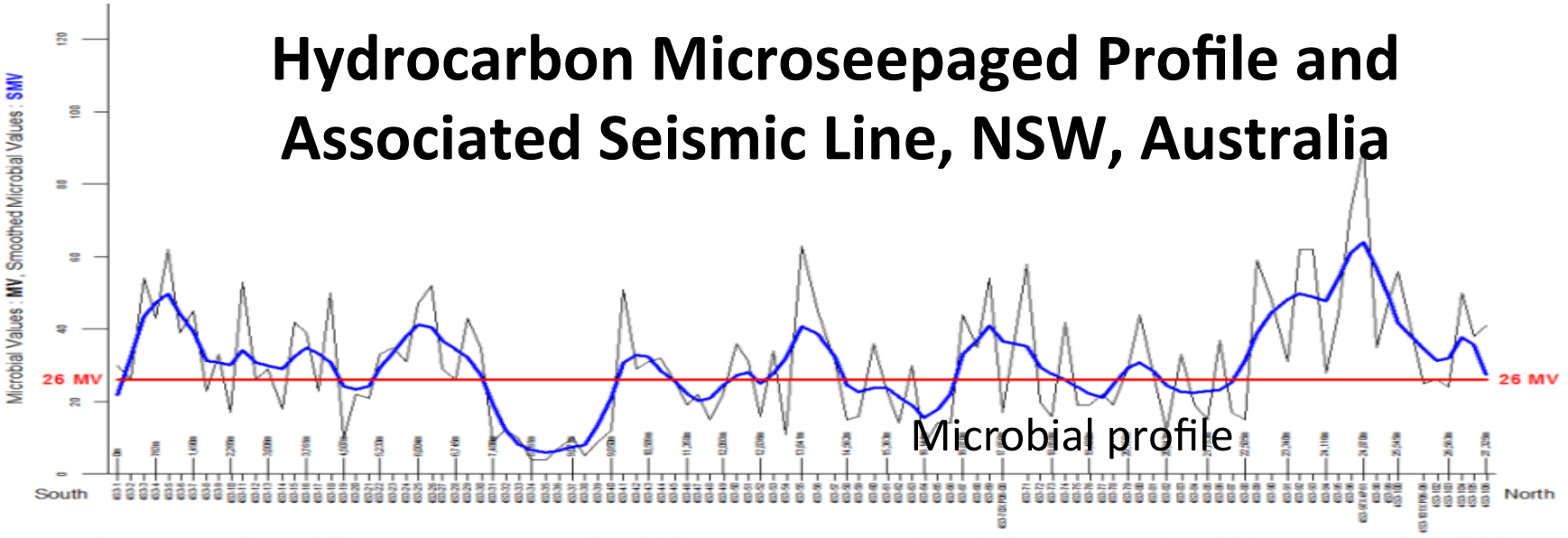


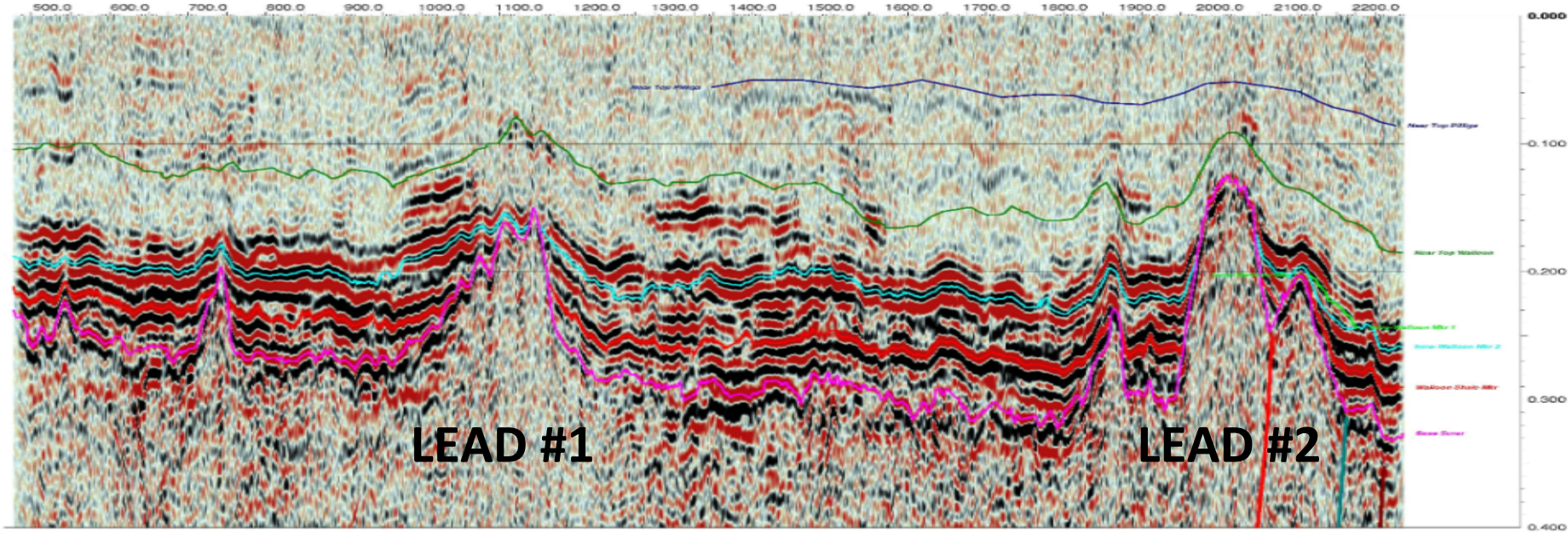
TAIWAN

A microseepage map of the survey in which the areas of maximum microseepage are shown in red, orange and yellow colors



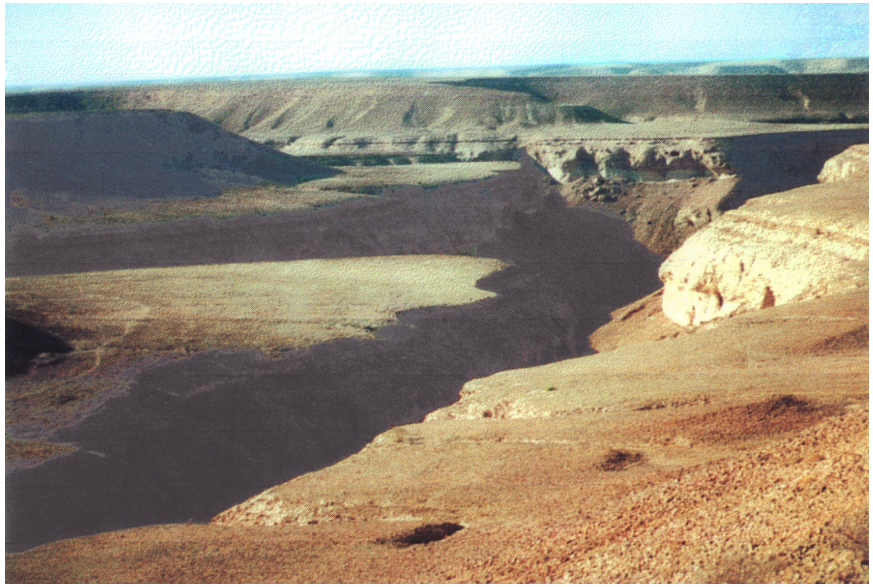
Hydrocarbon Microseepaged Profile and Associated Seismic Line, NSW, Australia

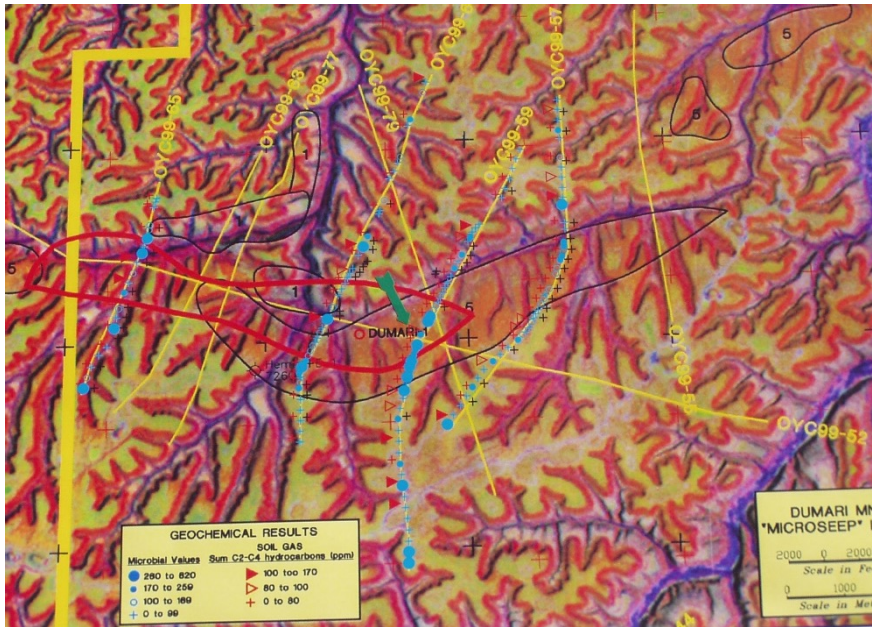


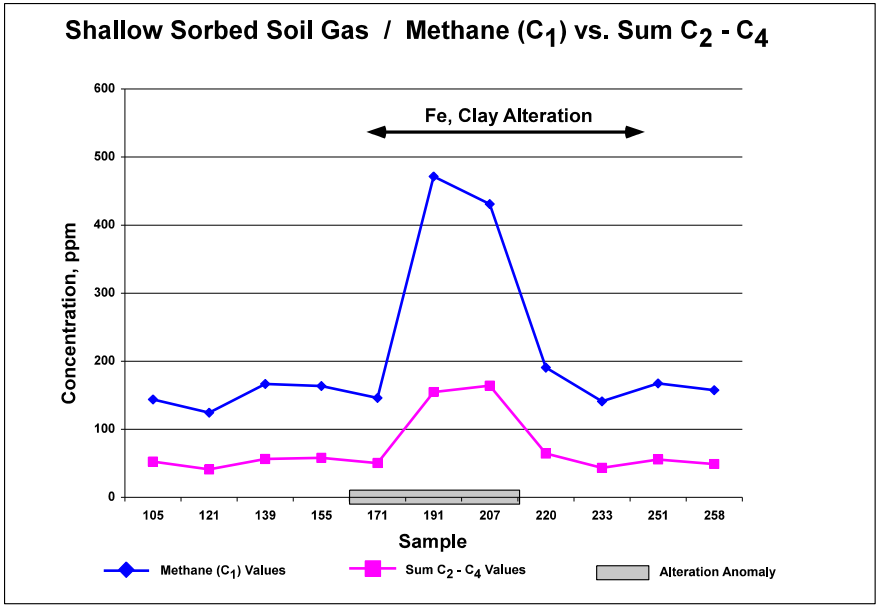


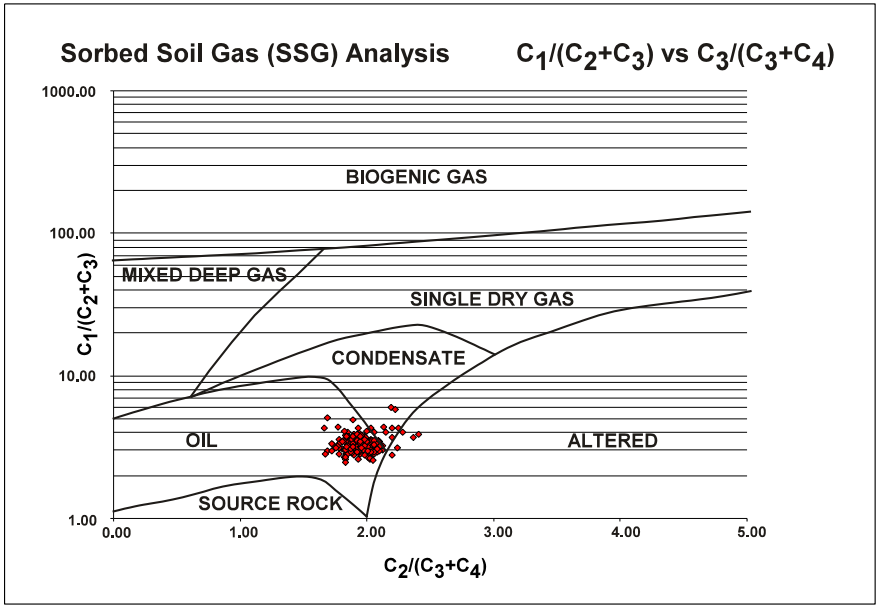
Yemen, Masila Basin

Remote Sensing and Surface Geochemistry









SUMMARY

Variety of remote sensing, geochemical, and non-seismic hydrocarbon detection methods are available

Document presence and characteristics of petroleum system(s), or hydrocarbon charge to specific target

High-grade basin or concession based on its hydrocarbon potential

Identify priority targets or areas for more detailed evaluation (i.e., seismic surveys, etc.)

Geologically complex areas have more hydrocarbon leakage points and are more challenging to interpret

THANK YOU FOR YOUR ATTENTION !

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