Improving Success of Surface Geochemical Surveys: 7 Pitfalls to Avoid*

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Search and Discovery Article #80504 (2016)**
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Editor's note: Please refer to closely related articles, Search and Discovery Article #80503 (2016) and Article #80505 (2016).

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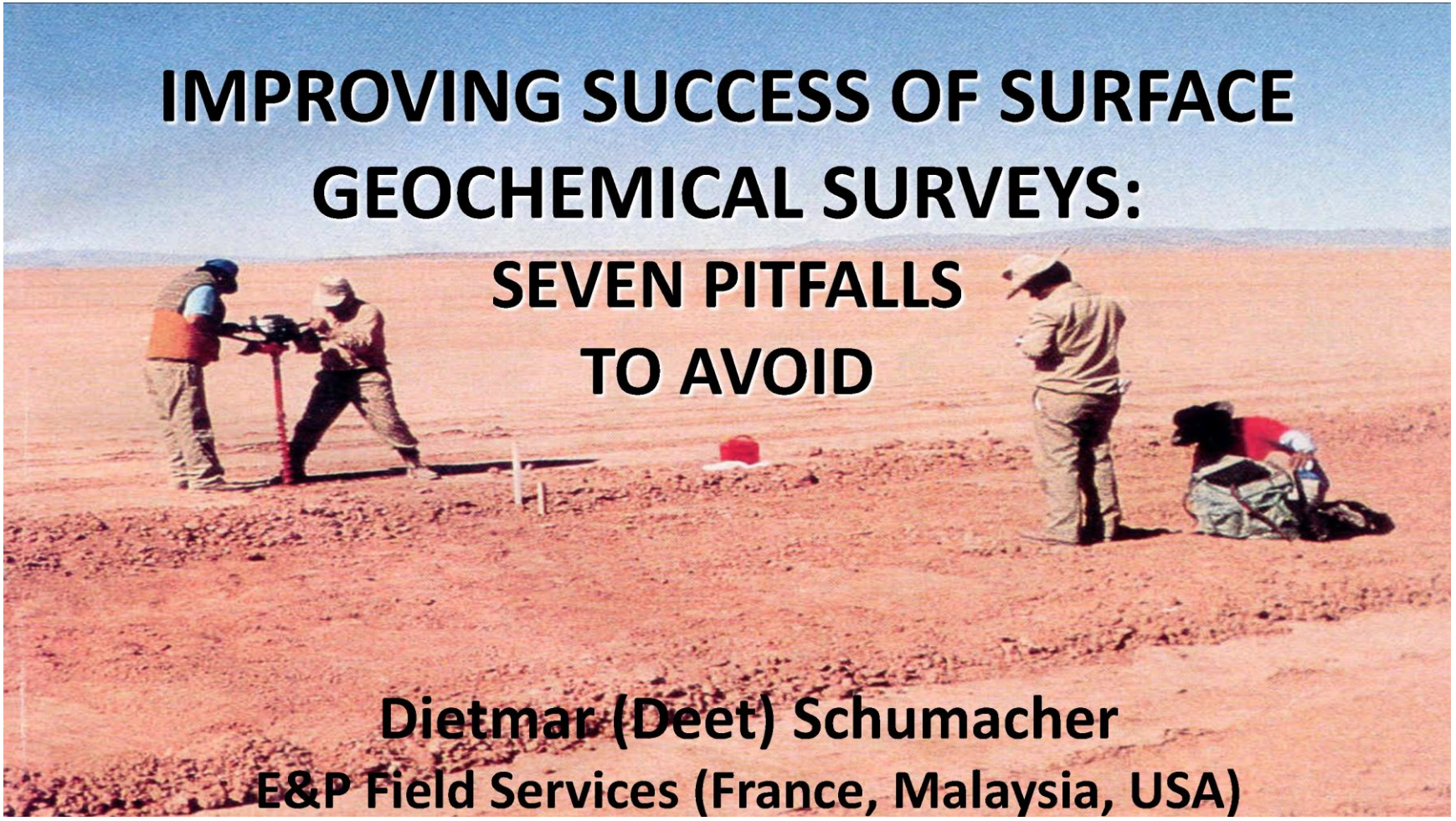
Abstract

The phenomenon of hydrocarbon microseepage has been well documented and forms the basis for numerous direct and indirect hydrocarbon detection methods. Over the years, these hydrocarbon exploration surveys have resulted in significant successes and some equally significant apparent failures or disappointments. How can we improve the probability of success of these geochemical and non-seismic hydrocarbon detection surveys? A review of several hundred geochemical surveys identifies seven major pitfalls that contribute to survey failure or interpretation ambiguity. These surveys were conducted in geologically and environmentally diverse settings, and used a variety of survey designs and analytical methods. The seven pitfalls to avoid are the following:

1. Survey objectives poorly defined.
2. Improper survey design.
3. Too few samples.
4. Poor data quality.
5. Interpretation errors.
6. Absence of good analogs.
7. Data integration poor or incomplete.

For a successful surface geochemical survey one must select the right analytical methods, use proper survey design, calibrate with a good geologic analog or recent discovery, and fully integrate surface and subsurface data. The discovery of a surface

geochemical anomaly does not guarantee discovery of commercially significant volumes of hydrocarbons. However, it has been well documented that prospects associated with such hydrocarbon anomalies are 4 to 6 times more likely to result in commercial discoveries than similar prospects lacking such microseepage anomalies.



Presenter's notes: Team on left is collecting soil sample from one meter depth to be analyzed for acid-extracted soil gas; team on right is collecting soil sample from 20cm depth --to be analyzed for presence of hydrocarbon-utilizing microbes (specifically for butane-utilizers). If it is important to identify presence of liquid hydrocarbons, the shallow soil sample can also be analyzed for aromatic hydrocarbons using a fluorescence method.

OUTLINE

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OUTLINE

- Why Hydrocarbon Detection Surveys
- Common Pitfalls to Avoid
- Survey Objectives and Survey Design
- Interpretation Failures
- Data Integration
- Summary

Why Hydrocarbon Detection Surveys ?

Most accumulations leak

Discriminate between oil versus gas

Leakage is predominantly vertical

Identify and map hc-induced alteration

Direct indicator of hydrocarbons

Minimal environmental impact

Prospects with an associated hydrocarbon anomaly are 4-6 times more likely to result in a commercial discovery than prospects without such an anomaly

Pitfalls to Avoid

1. Objectives poorly defined
2. Improper survey design
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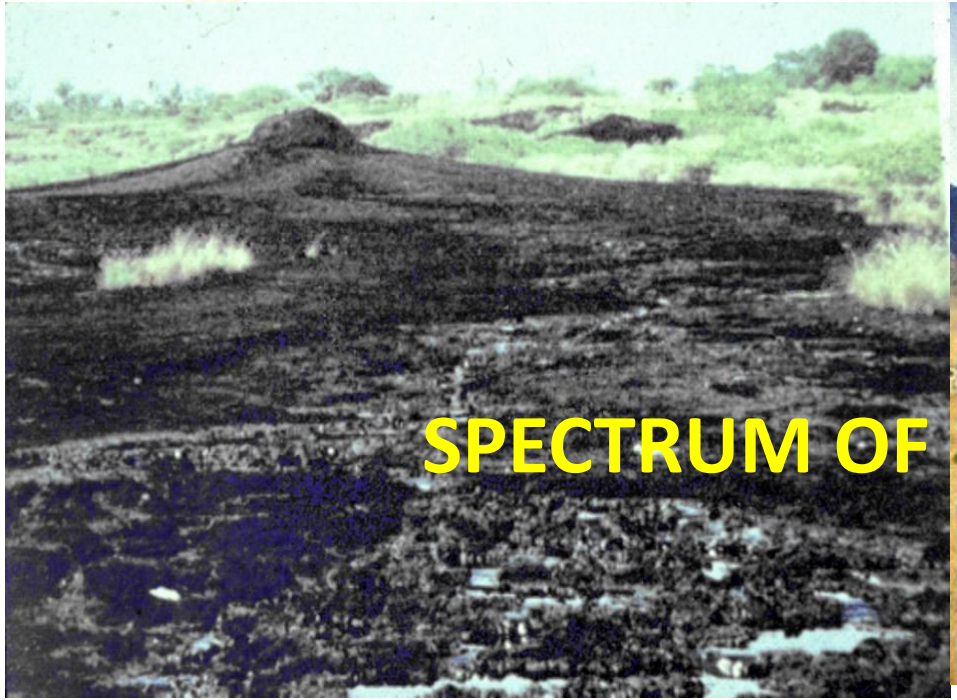

SPECTRUM OF SEEPAGE STYLES

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

Geochemical Methods

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DIRECT DETECTION

Soil Gas
Interstitial, Headspace
Acid Extracted Soil Gas
Aromatics/Fluorescence
Heavy Hydrocarbons, C10+
"Sniffers" and Lasers
Remote Sensing of Slicks

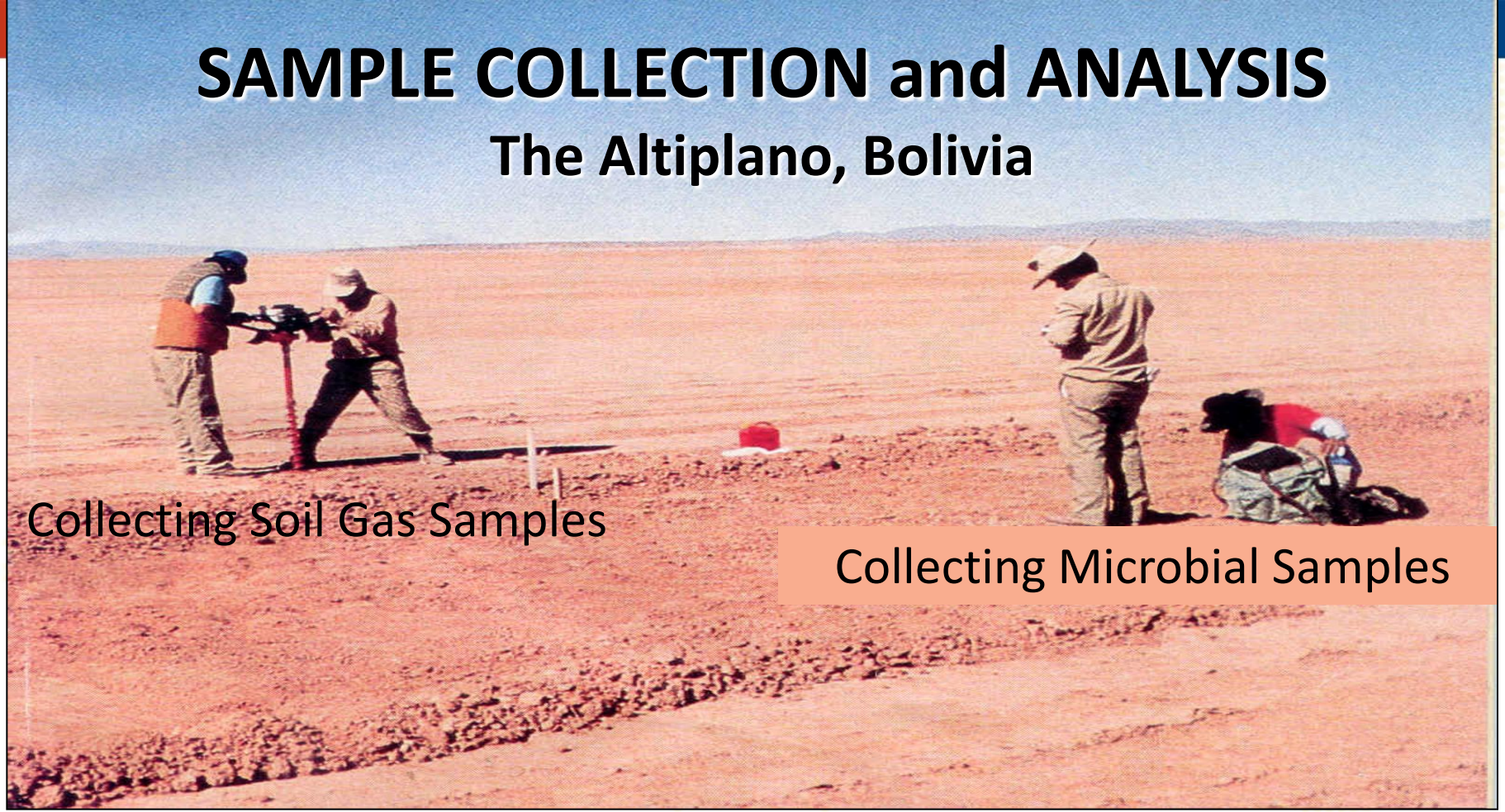
INDIRECT DETECTION

Microbial
Radiometrics
Helium, Radon
Iodine
Trace Elements
Remote Sensing
Electrical
Magnetic
Electromagnetic

Presenter's notes: List of the main surface geochemical exploration methods; highlighted methods are the ones E&P Field Services uses for majority of its surveys. Other analytical methods are available if needed or warranted (i.e., chromatography, biomarkers, carbon isotopic analysis, etc.), as well as passive EM measurements to determine depth to hydrocarbon-bearing zones down to 5000m depth at 5-10m resolution.

SAMPLE COLLECTION and ANALYSIS

The Altiplano, Bolivia



Collecting Soil Gas Samples

Collecting Microbial Samples

USE 2 OR MORE INDEPENDENT BUT COMPLEMENTARY ANALYTICAL METHODS

Survey Design Considerations

Survey Objectives

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

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SURVEY OBJECTIVES

Reconnaissance: Document the presence of a working petroleum system; identify areas for more detailed geochem, seismic, etc.

High-Grade Leads, Prospects … based on likely **Hydrocarbon Charge**

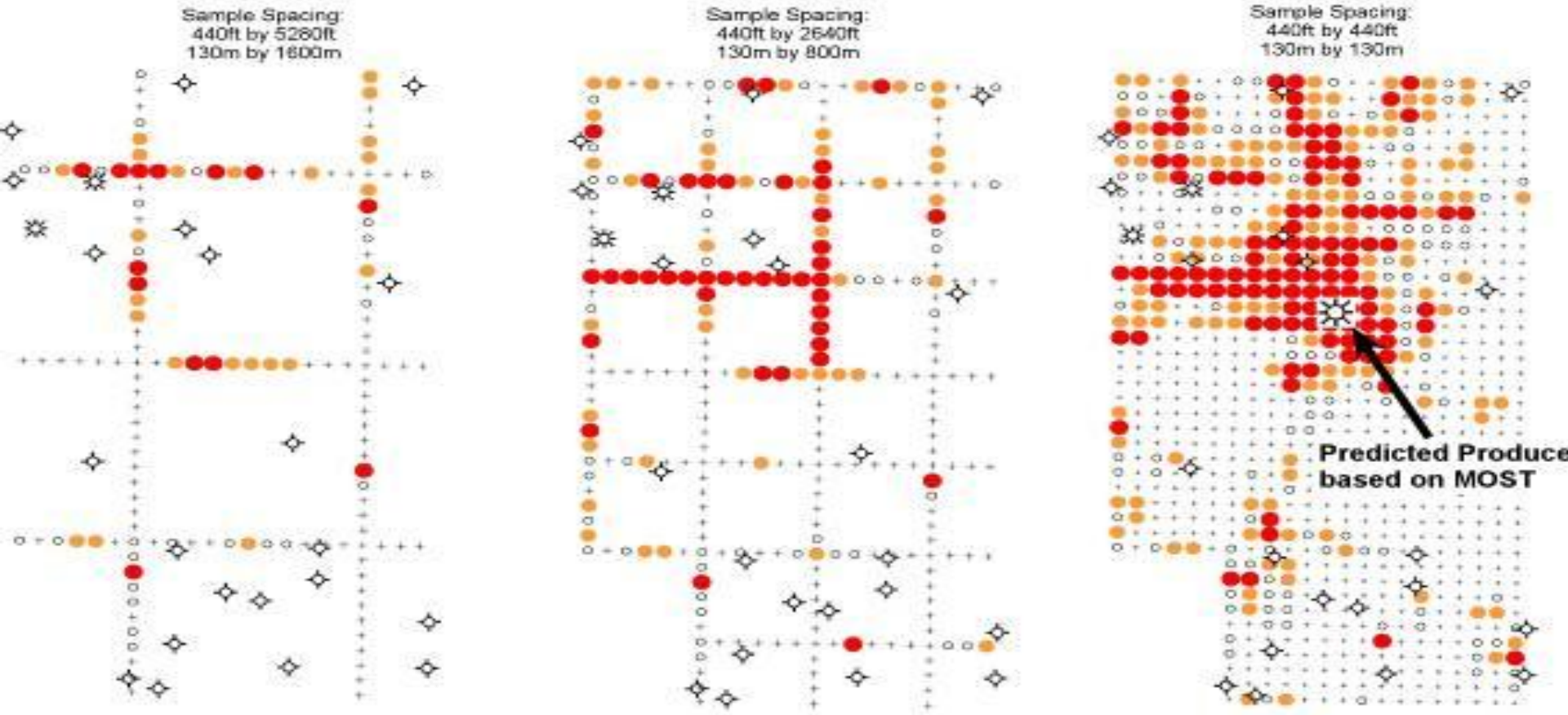
Field Development, Production: Identify by-passed pay, discriminate between charged and uncharged compartments

Near-Field Exploration: Identify new exploration opportunities

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.



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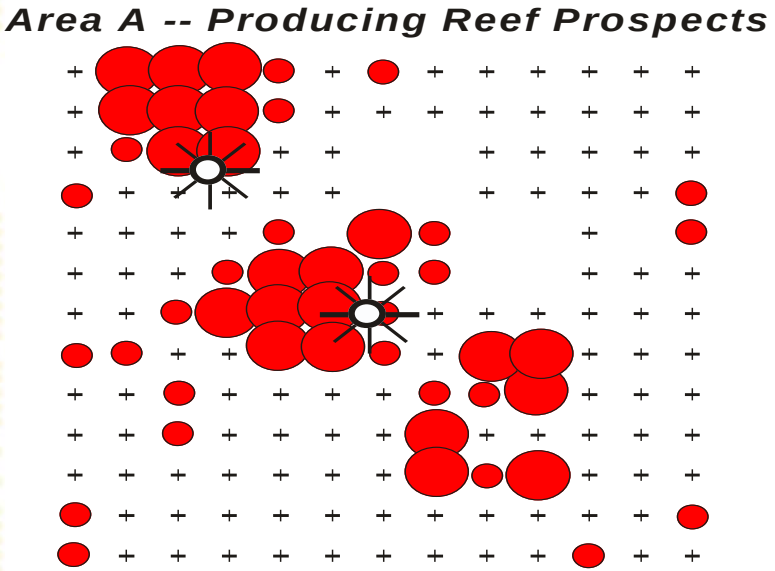
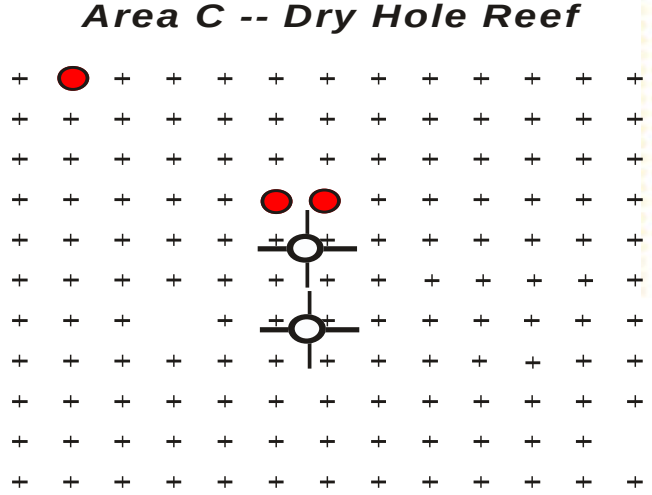
PITFALLS #2, 3

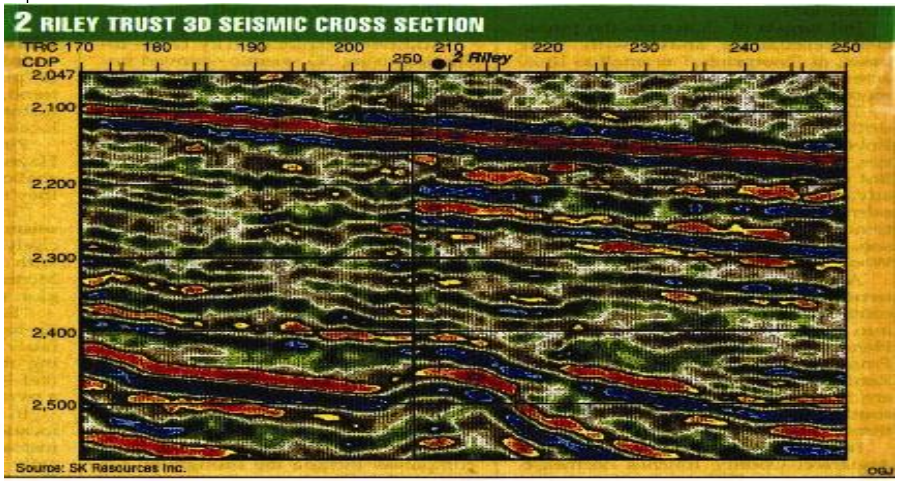
Undersampling and/or the use of improper sampling techniques is the leading cause of ambiguity which leads to interpretation failures in geochemical surveys.

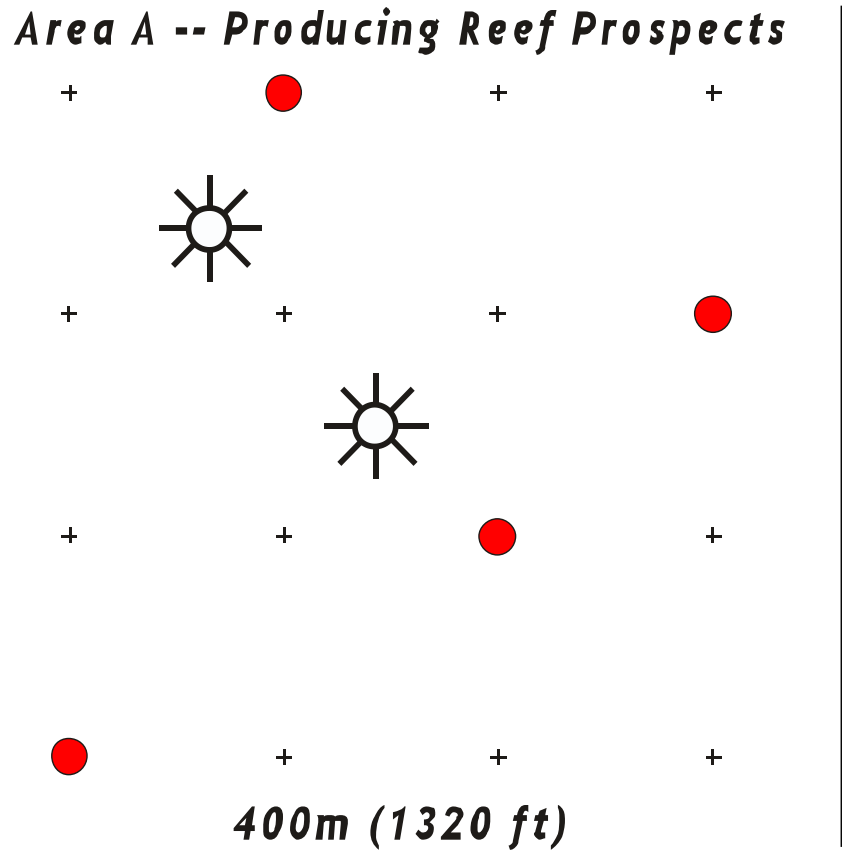


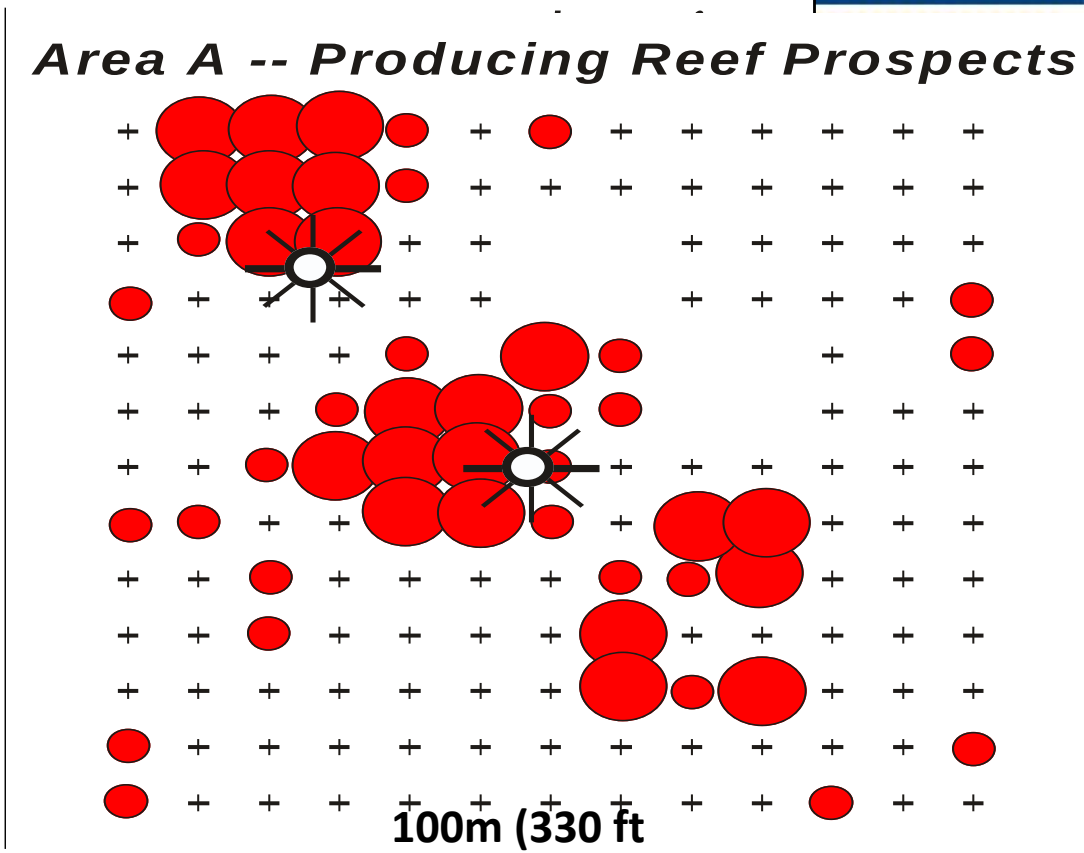


East Texas Jurassic Cotton Valley Pinnacle Reefs

Reefs are 300m wide
and 4500-5000 m deep







Sample Pattern and Spacing MUST Consider Target Shape and Size

(400m versus 100m = 16 samples versus 160 !)

The Value of Geologic Analogs

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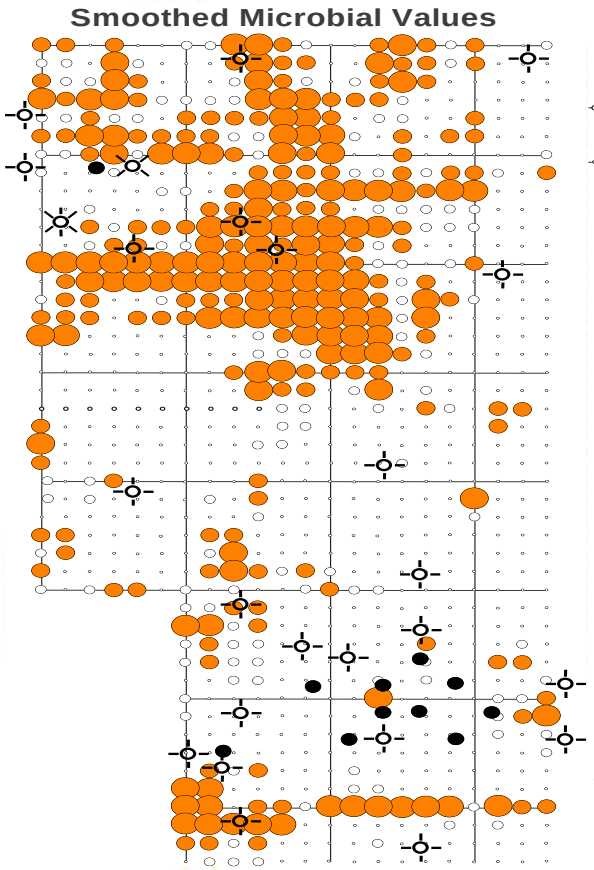
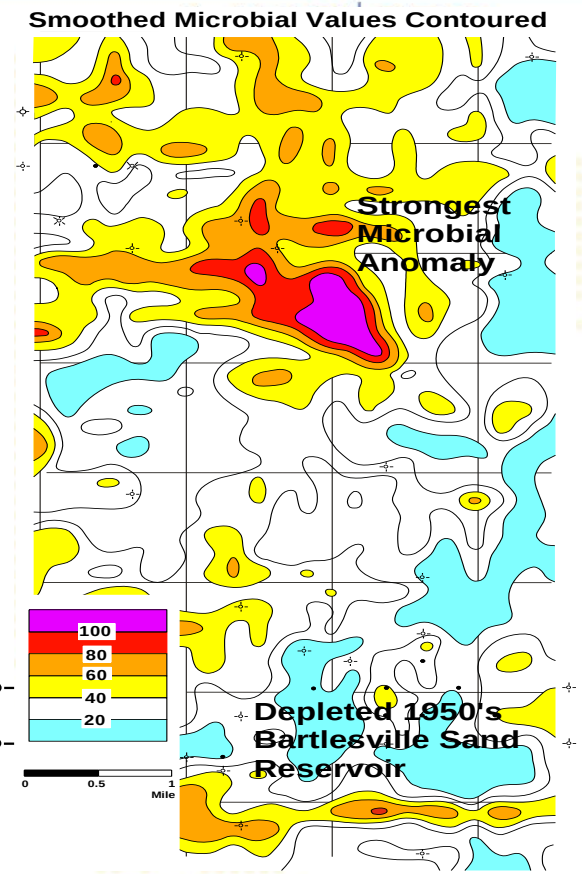
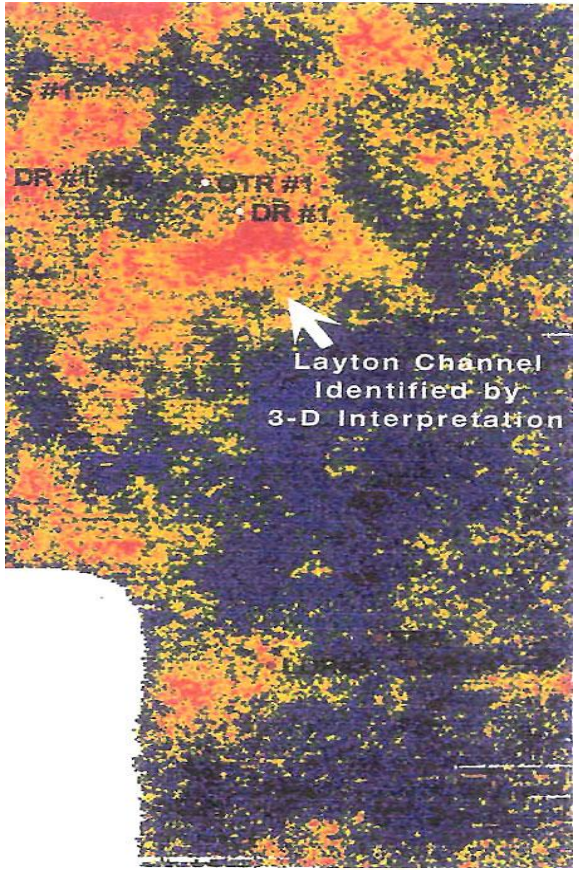
Geological and geochemical analogs are valuable. What constitutes a significant geochemical anomaly? Are your survey results meaningful? Are you using the best sampling and analytical methods for the area of exploration interest, and for your objectives?

These questions can sometimes be answered by acquiring surface geochemical data from over a geologic analog or a recent discovery. Producing fields may not be good analogs unless they have only been on production a short time (the disappearance of geochemical anomalies over old fields has been well documented). Dry holes can be good analogs if they penetrate the section(s) of interest.



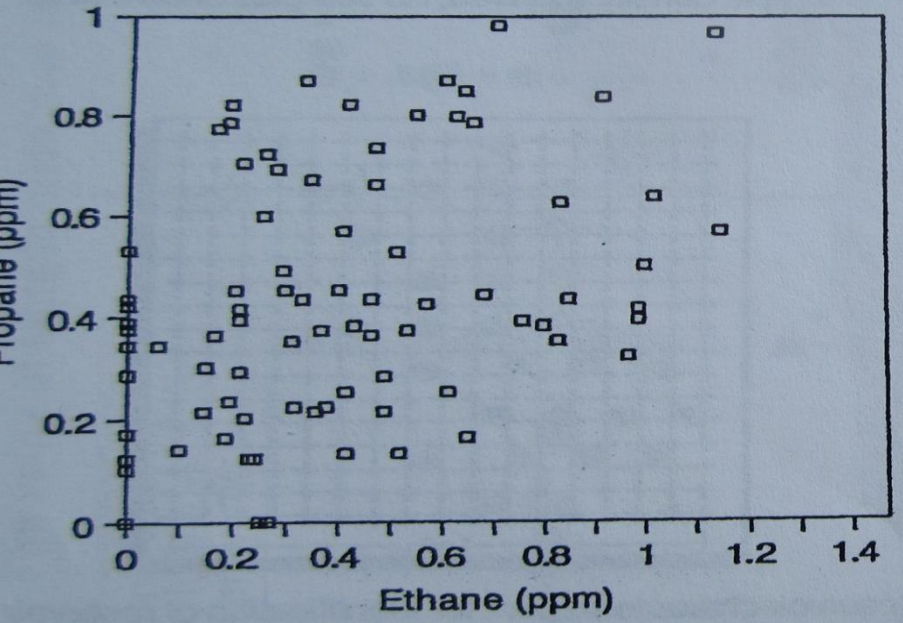




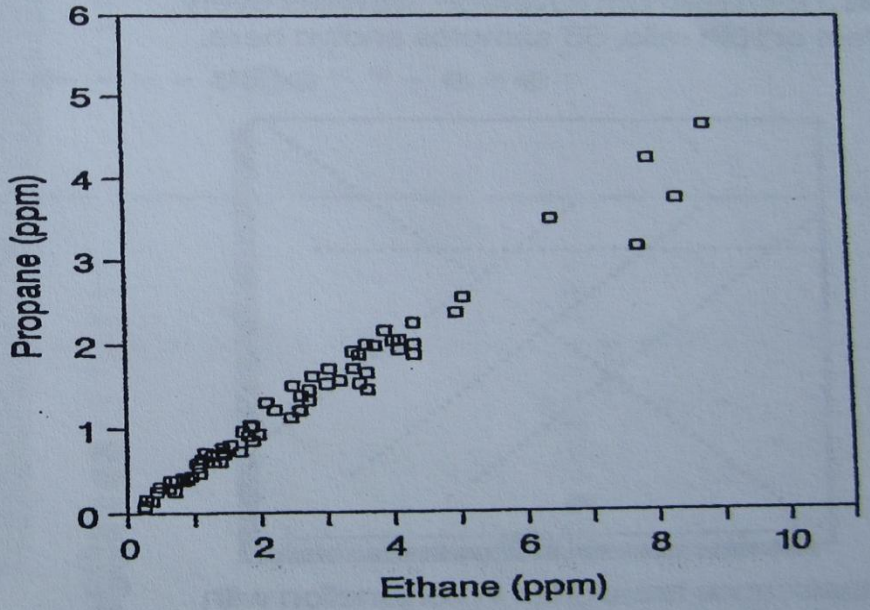
Carboniferous Channel Sands, Oklahoma – Geochem and 3D Seismic

PITFALL #4

DATA QUALITY



Cleveland Co., Oklahoma

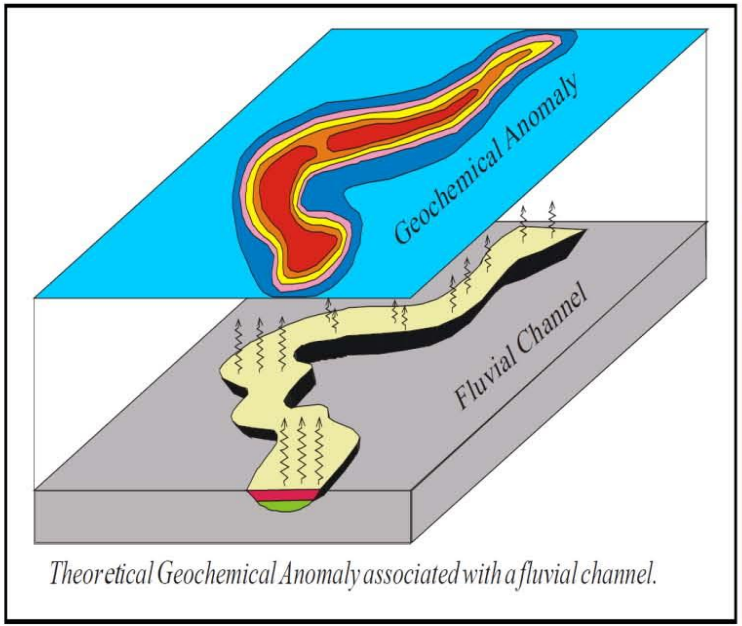


Menard Co., Texas

Microseepage is Predominantly Vertical

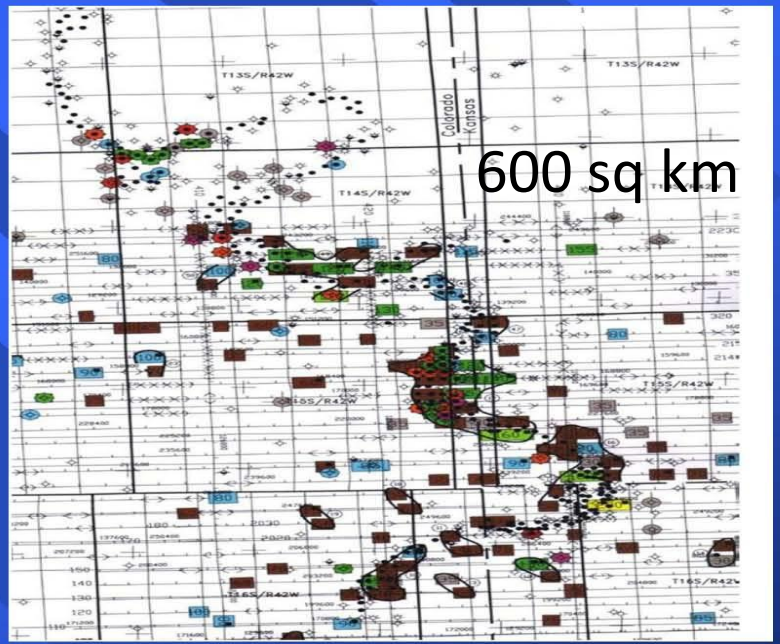
Extent of Surface Anomaly Approximates Shape and Areal Extent of Reservoir at Depth

San Jorge Basin

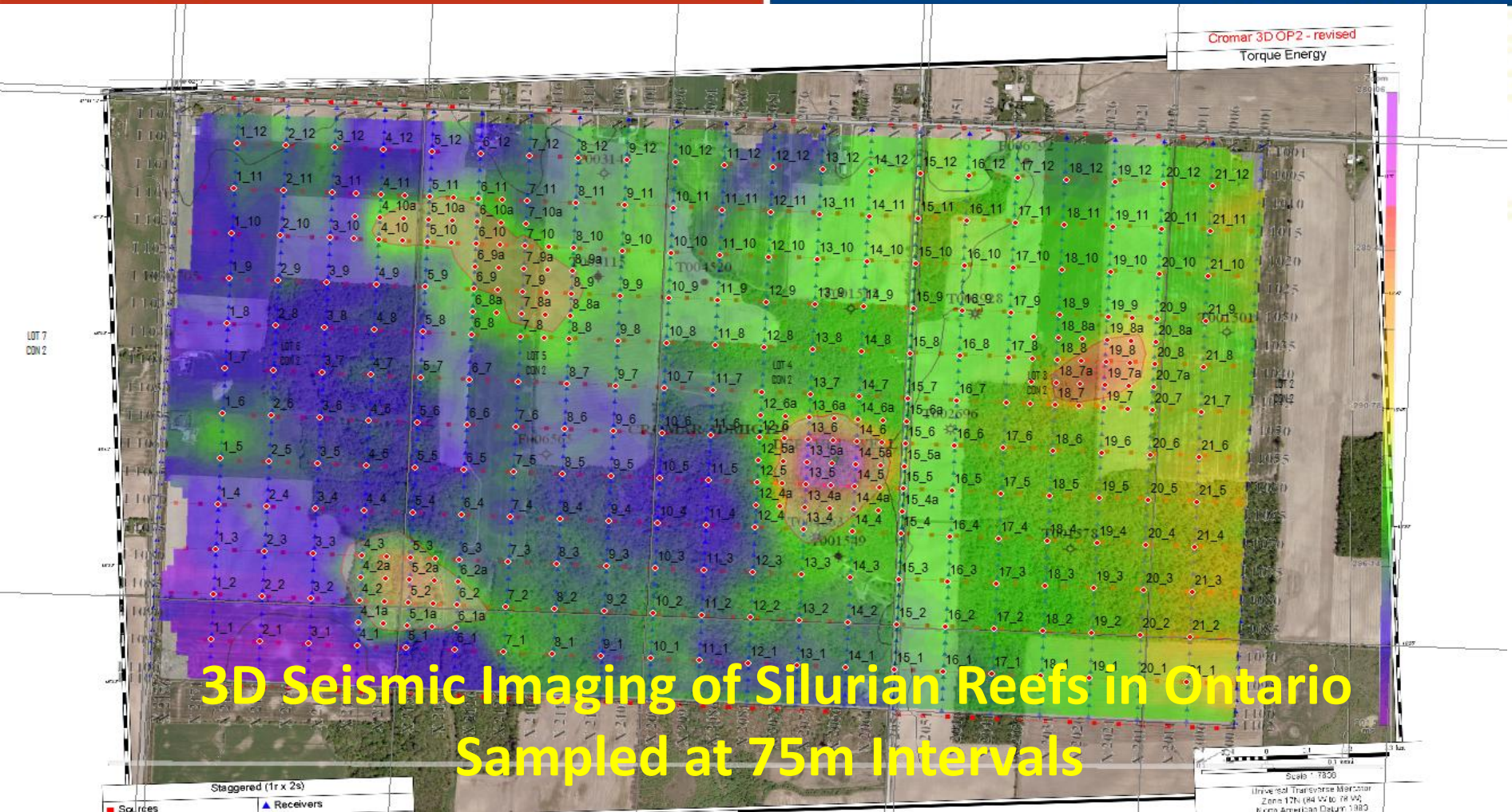


Theoretical Geochemical Anomaly associated with a fluvial channel.

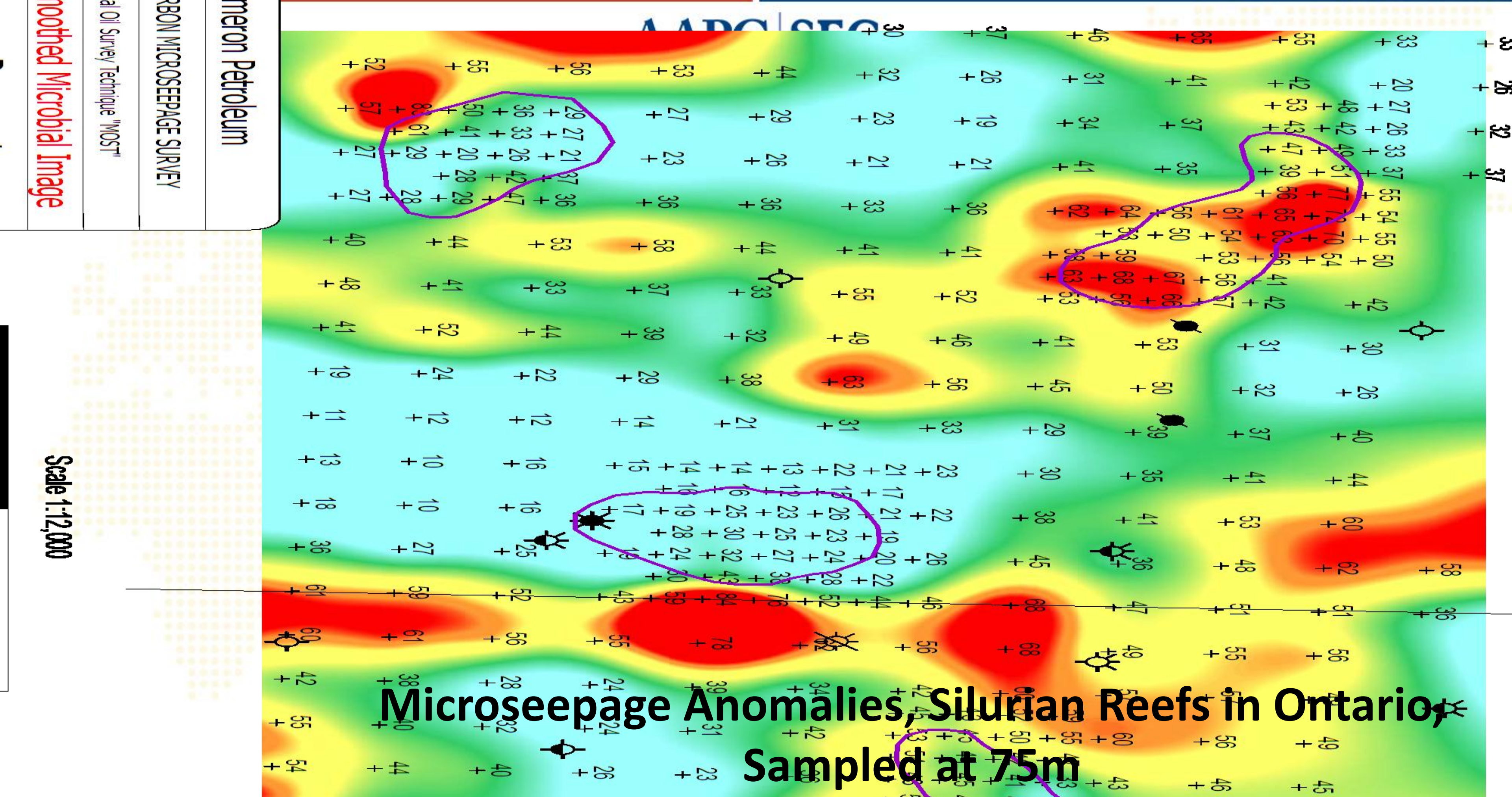
Morrow Channel, CO-KS



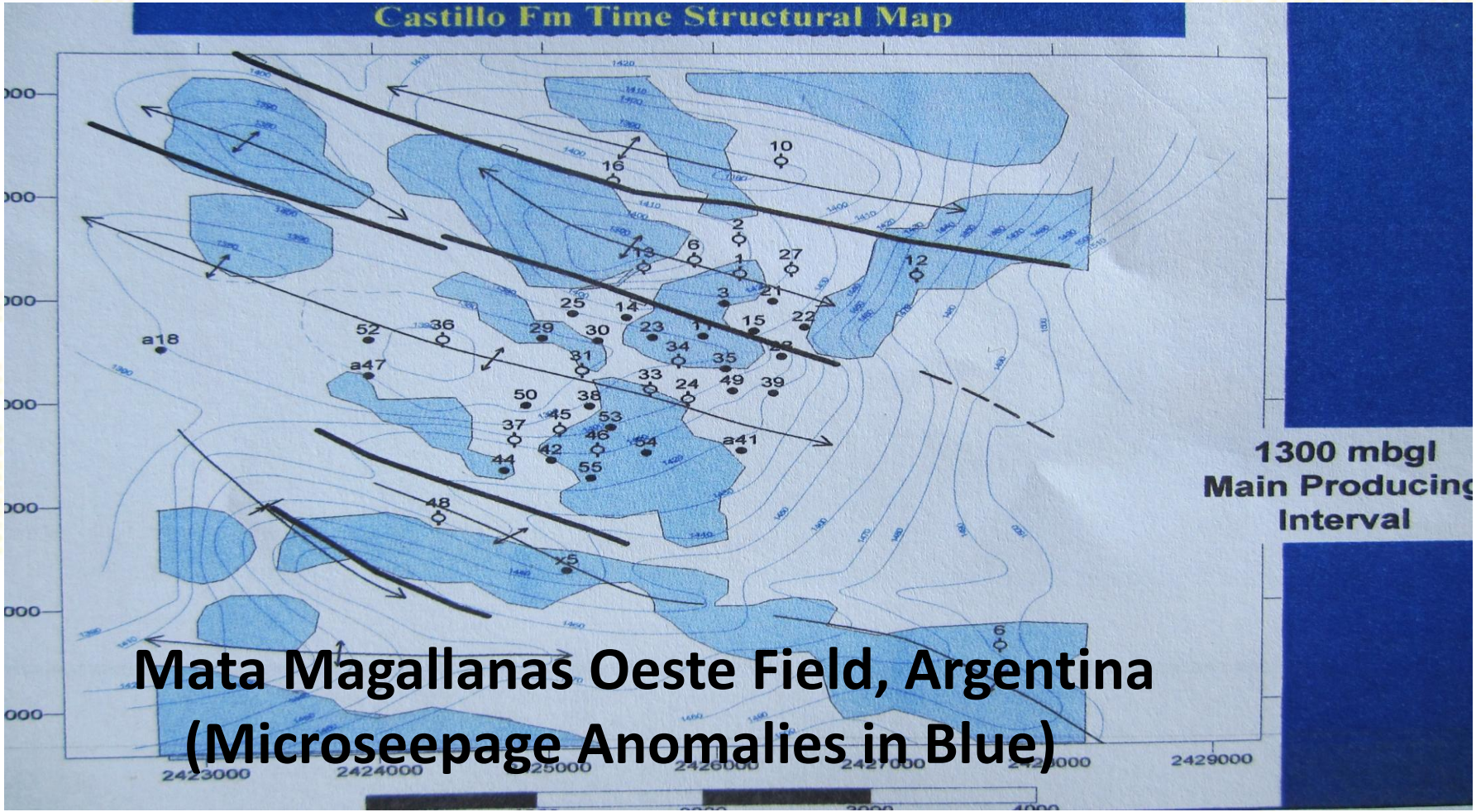
PITFALLS #5, 7 – INTERPRETATION ERRORS, DATA INTEGRATION



3D Seismic Imaging of Silurian Reefs in Ontario Sampled at 75m Intervals



Microseepage Anomalies, Silurian Reefs in Ontario, Sampled at 75m



Mata Magallanas Oeste Field, Argentina (Microseepage Anomalies in Blue)

Interpretation requires integration of surface and subsurface data

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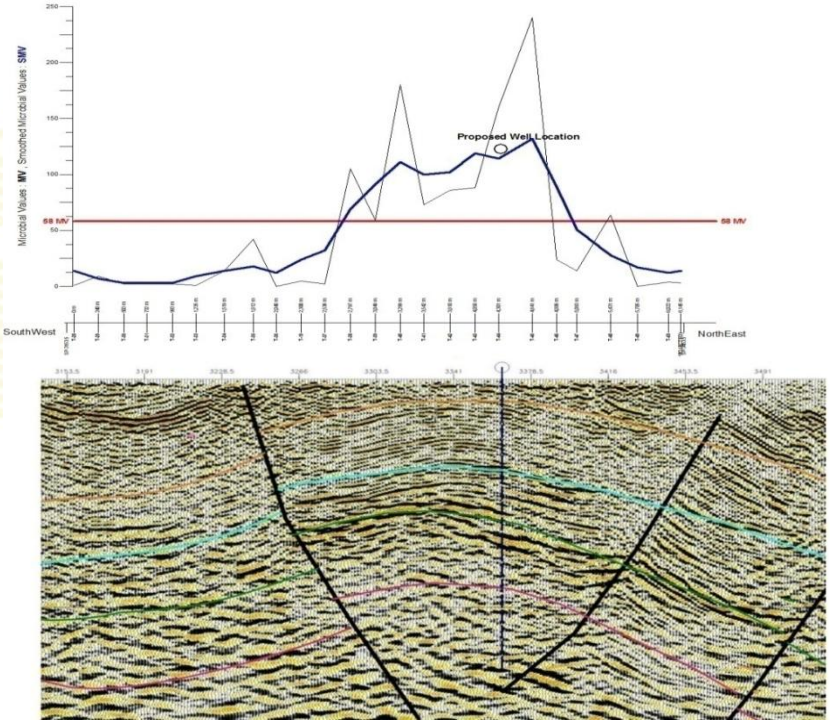
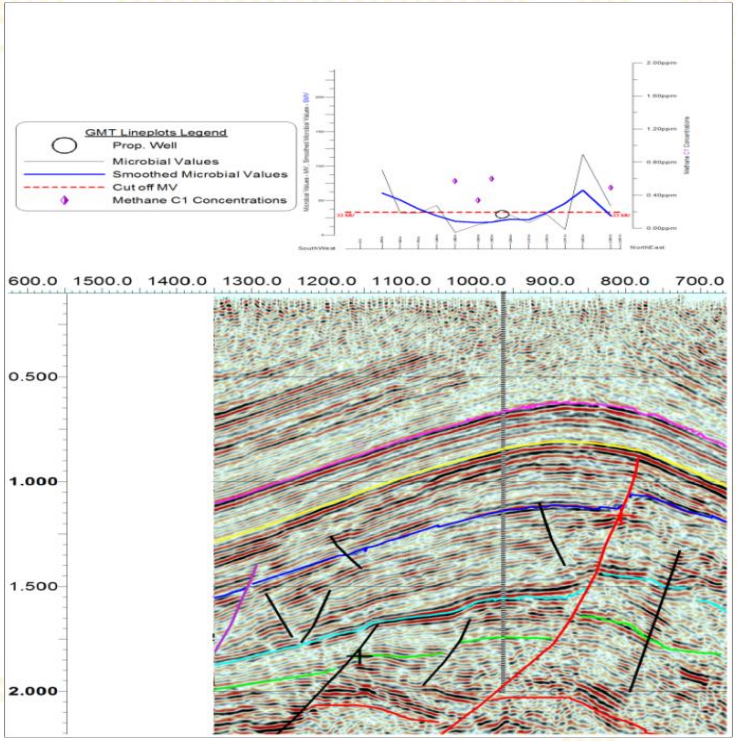
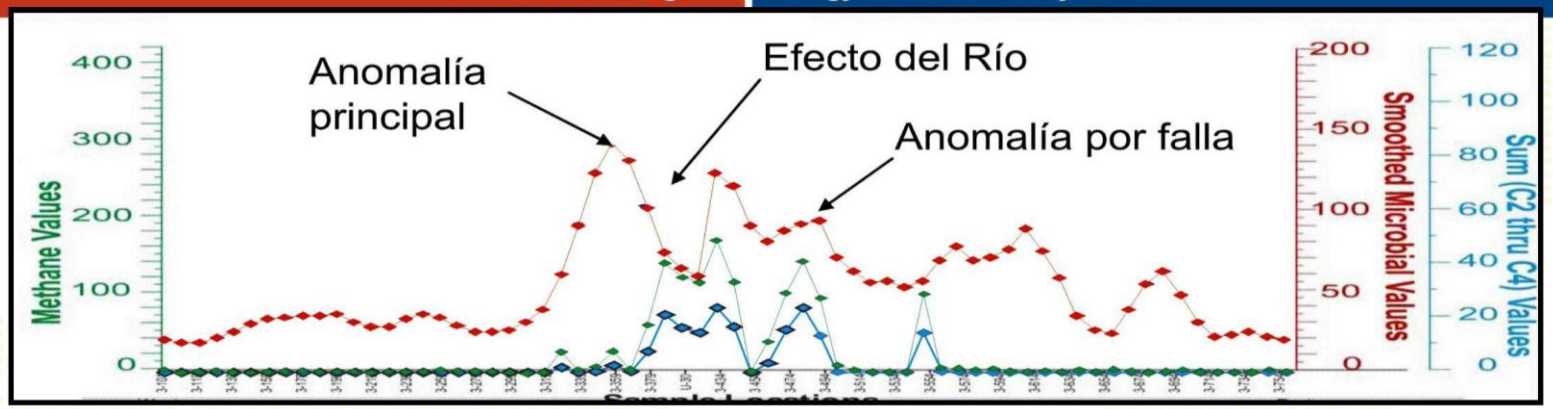
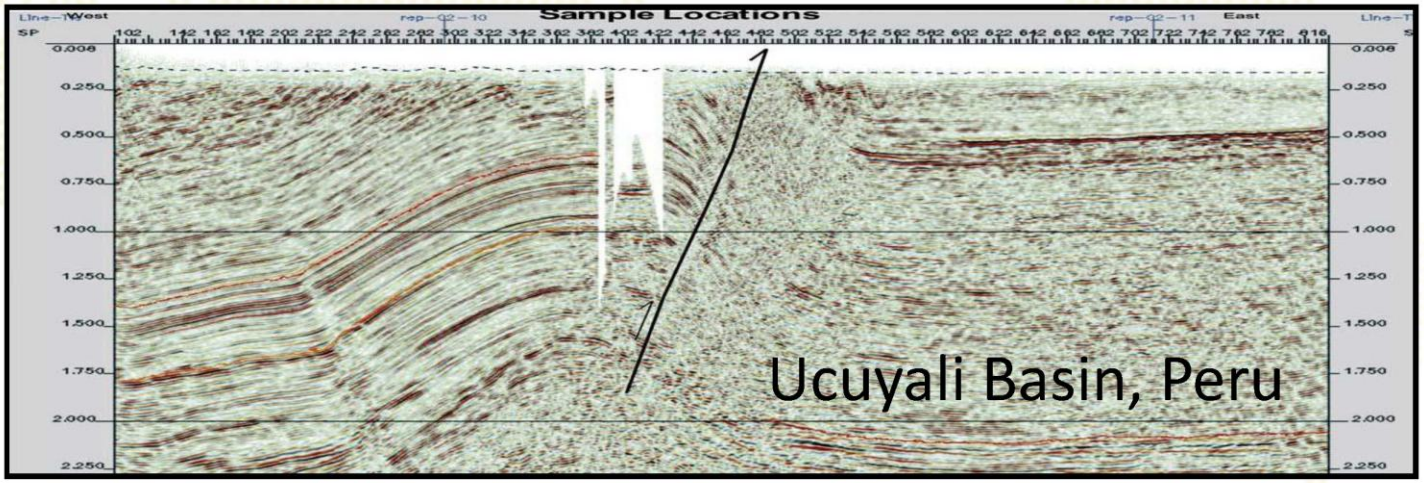
Understanding geology is key to using seeps and microseeps in exploration









Presenter's note: Profile of microbial values, in particular, shows the main anomaly, the effect of the river, and the anomaly due to the fault.

Pitfalls to Avoid

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Thank you !
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