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'The Myths, Facts & Value of Surface Geochemistry'

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Petroleum Exploration's Challenge



Interpreting the Unseen.

We as humans are equipped with a very limited set of sensors. Yet we want to explore into earth's interior. For this purpose mankind has developed various methods that enhance our understanding for the deep.

- Surface Geology
- Aerial photos
- Geologic maps
- Subsurface Analysis
- Gravity
- Magnetics
- Seismic reflection
- Wells
- Geochemistry



Decision Points:

Charged?

Oil or Gas?

Compartmentalization?

For additional information

we need

additional technologies



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Early 20th Century surface geochemical techniques Direct measurement of ethane & methane in soil Flux (amount of leakage) measurements C1 and C2

Key technological milestones - next 50 years

Active soil gas sampling (vacuum pumping) Methane & limited range of light hydrocarbons Acid extraction on soils Flux & concentration measurements coupled with compound ratio mapping Bacteria-based technologies **C1 to C6**

Recent technology milestones - last 20 years

GC/MS technological advances - Computing Adsorbent-based passive (time integration) in situ soil gas sampling Sensitive to a wider range of volatile organic compounds High-resolution compound specific analyses

C2 to C20





The biggest myths regarding surface geochemical technologies (perhaps "misconception" is a better word):

- 1. It is a standalone tool.
- 2. It always yields perfect results.
- 3. If one survey does not work, ALL surface geochemical technologies are crap
- 4. It works or "I do not believe".

No, it is not and was never intended to be.

No it does not, no method does.

Sounds unfair to me

It is about science not personal believe.

The science part is what I am going to show you now.



Evaluate frontier basins

Focus geophysical budgets

Prioritize prospects & leads

Help define stratigraphic accumulations

Reservoir management tool

On- & off-shore















Vertical migration of hydrocarbons



Macroseepage:

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

Microseepage:

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



VS.

Favoured mechanism:

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.







Hydrocarbon Seepage – Response Speed

Keota Dome Iowa - 700 ft deep - Gas storage facility

Pumping time max 120 days

Before Charge – July

Distance from reservoir to surface 700 ft

Calculation of speed: 700 ft in 120 days

Microseepage speed of approx. 2 m per day

During Draw down -January

ETHANE ANOMALIES AT KEOTA DOME, IOWA



After Charge -October



9w

Shows percent C2 (ethane) data through time. Contour interval .5 ppm. Structure on top of St. Peter sandstone. Data in 12%, 15%, and 18% C2 intervals. Gas storage wells in blue. Oil wells in black. Source: Released with permission from CST Oil & Gas Corp. and Exeter Oil & Gas.



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Mechanism of Microseepage - Concept





Sampling Device

- 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 (C2 up to C20)
- Duplicate samples









- Regular to irregular grid
- Sample distance 200 m to 1.5 km
- Time to stay in ground 3 weeks
- Calibration with available wells
- Onshore and offshore









Tools & Processes - In the 'Field'





Automated Thermaldesorption

Gas Chromatograph

Mass Spectrometer

Yields sensitive, compound specific results

Compounds from C_2 through C_{20}





Geochemical Data Differentiation







Integration with G&G













- Are there hydrocarbons present?
- Where are the hydrocarbons?
- What kind of hydrocarbons are present?
- AFTER INTEGRATION WITH OTHER G&G:
- Are structures charged?





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Thank you for your time and interest!

For questions please contact AGI ③

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