

# **PS Geochemical Exploration Case Study of Fifteen Frontier Indonesian Deepwater Basins\***

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## **Abstract**

TDI-Brooks, under contract with TGS-NOPEC, conducted an extensive Surface Geochemical Exploration (SGE) survey in 15 deepwater areas offshore Indonesia in 2007/2008. Core sites were selected based on multibeam bathymetry/backscatter anomalies and combined with 2-D seismic data. More than 1,200 piston cores were acquired during the study, each positioned with an USBL navigation system to within 25 m of its pre-selected seabed target.

Sediment extracts were qualified for the presence of oil and gas seeps using standard geochemical screening for aromatic and saturate hydrocarbons. An unusually high percentage (13% of samples) of oil seeps detected attests to the potential of the region as well as to the quality of the targets selected. In addition, sediment samples canned for interstitial gas measurements indicate that 46% of the cores contained evidence of thermogenic gas.

Qualified samples were further analyzed for biological markers and stable carbon isotopic compositions of selected gases. These more detailed analyses were used to match hydrocarbons in the sediment extract with a specific maturity or age of oil or source rock. For example, the study produced solid evidence for mature lacustrine source rocks of Miocene age in seeps from more than one basin, distinct from another set indicating a paralic/deltaic/coaly source rock of the same age. Other sets of extract biomarkers indicated seep oils derived from a Mesozoic (Jurassic?) carbonate-rich source with a maturity level well within the oil window.

There is also dramatic evidence for a unique mature source in this region. There is also compelling evidence of a common source of gas from one basin to another in the samples analyzed as part of the overall program. These seep samples portend the discovery of reservoired gas of unique composition, source, and maturity, and may have significant ramifications for future exploration in Eastern Indonesia. When

viewed as a whole, the geochemical data can be used to constrain the presence, distribution, extent, and even maturity of the known hydrocarbon systems in Indonesia. The large number of oil and gas shows in a project of this scale is unprecedented.

### **Reference**

Peters, K.E., T.H. Fraser, W. Amris, B. Rustanto, and E. Hermanto, 1999, Geochemistry of Crude Oils from Eastern Indonesia: AAPG Bulletin, v. 83/12, p. 1927-1943.

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## Study Sequence

- Core targets from multibeam, bathymetry & backscatter
- Piston coring on targets w/USBL navigation
- Basic screening analysis of all core samples
- Detailed biomarker analysis of selected samples
- Geochemical interpretation

## Screening Geochemistry Objective

Intent: To study regional & site-specific distribution of seepage to prove up charge, and to help define areas of active oil generation & migration.

Expectation: Oil seepage is typically proved up in 4-8% of cores. Thermogenic gas seepage is typically proved up in 15-30% of cores.

## Biomarker Measurements Objective

Intent: To compare biomarker data to regional oils for ages & maturities.

Expectation: Oil-seep biomarkers typically provide information on oil families in about half of the macroseeps of a program.

## Geochemistry of Crude Oils from Eastern Indonesia

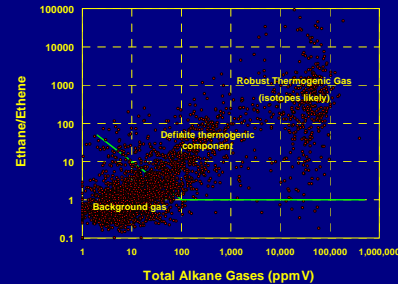
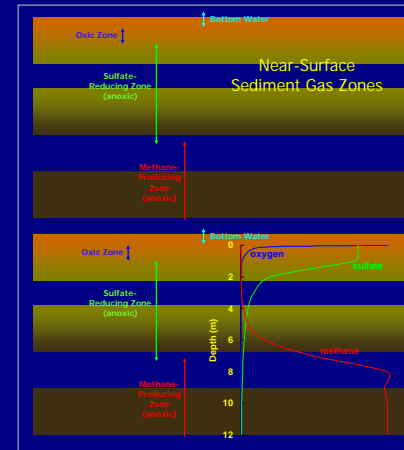
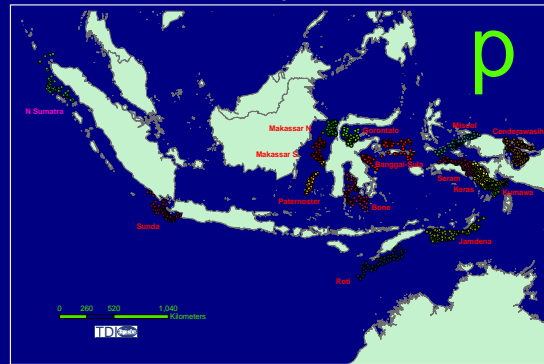
AAPG Bulletin, December 1999

\*Twenty oils mainly from Irian Jaya and Sulawesi originated from Tertiary marine marlstone source rocks that contained type II/III kerogen deposited under suboxic conditions, probably the upper Miocene Klasafet Formation. These low-sulfur oils show high oleanane, C<sub>25</sub> 24-nordiacholestane, and pristane/phytane ratios, and <sup>13</sup>C-rich carbon isotope compositions.

\*Five oils from Seram originated from Triassic-Jurassic marine carbonate source rock that contained type II kerogen deposited under anoxic conditions. These high-sulfur oils lack oleanane and generally show low C<sub>25</sub> 24-nordiacholestane and pristane/phytane ratios.

\*Low-sulfur shallow oil from Miocene Kais reservoirs in the Wiragar field in Irian Jaya lacks oleanane, is highly mature, and has undergone extensive migration fractionation. This oil probably originated from syntri- to post-tri Lower-Middle Jurassic Kombelangan Formation clay-rich shales that contained mixed type II/III kerogen deposited under oxic conditions.

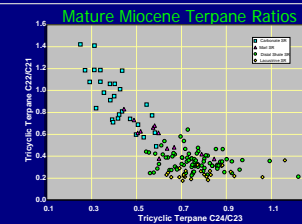
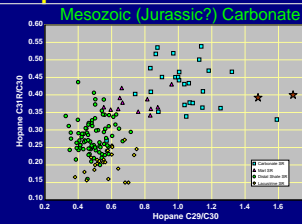
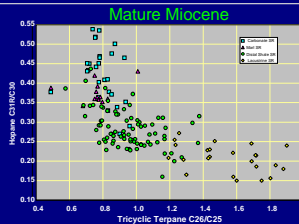
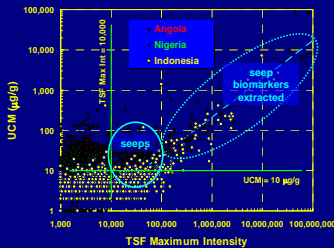
## 1,238 Cores Acquired in 15 Basins



## Geochemistry Sample Set (1 Core)

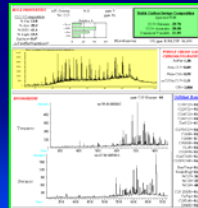


## Oil Seeps

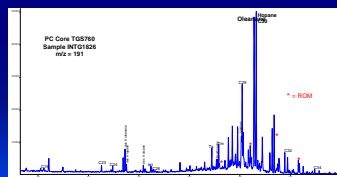


## Biological Markers in Macroseep Samples

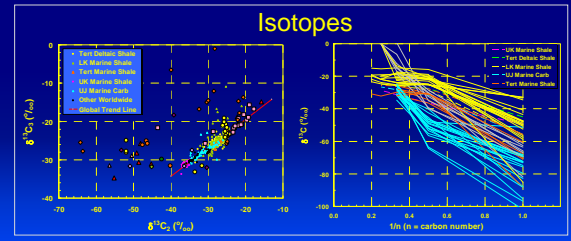
- Separate saturate & aromatic fractions
- Measure  $\delta^{13}C$  of aliphatic & aromatic fractions
- Determine Terpene & Sterane ratios
- Compare to Regional Oils
- Assign Maturity/Age



## Miocene Paralic/deltaic/coaly-sourced Seep



## Isotopes



## Observations & Conclusions

- Proved up charge
  - 1,238 cores acquired
  - 138 oil seeps confirmed (11% of cores)
  - 523 thermogenic gas seeps (42% of cores)
- Defined source & maturity
  - 434 carbon isotopic ratio sets distinguished gas origins
  - 20 biological marker sets distinguished multiple source rocks
- Remarkable program success
  - oil and gas is actively seeping in these basins (world-class)
  - seep targets successfully identified with multibeam bathy/backscatter
  - cores successfully positioned on targets with USBL core-rig navigation
  - worldwide geochemical database of oils, gases, and seeps was critical

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