A Modified Method of Microbial Analysis for Oil Exploration and its Application on Five Basins of Southern and Western Argentina*

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Abstract

This communication presents the results of a modified version of the MPOG method for bacterial detection, applied to surface geochemical exploration for oil deposits. The modified MPOG method was applied in five sedimentary basins of the Argentina Republic that showed signs of hydrocarbon generation and/or proved oil production.

Sampling was carried out through transects of 20 to 40 km long and a separation between sample units of 300 to 400 meters. More than 2,000 samples were analyzed. Soil samples were taken at 50 cm depth that determined their geological formation of origin with granulometric and mineralogical characteristics. X-ray fluorescence for trace elements detection was also used. Modified MPOG method was considered to quantify the microbial flora capable to use butane for survival. It is based on the elimination of other carbon sources from the sample and the subsequent development in a minimum culture medium that only contributes with elements to provide viability, in a mainly butane atmosphere. The quantifying evaluation is done by filtration after extraction in sterile distilled water. These conditions permit the selection of the interest flora minimizing interference from the associated microbial community.

The results for the different sedimentary basins showed many common characteristics like:

a) Lognormal multimodal distribution, b) Differences of 1000 % between anomalous and background values, c)three well defined populations in the vast majority of cases: background data (with or without source rock signal), oil deposit derived anomalies, and fault derived anomalies (the most permeable way of escape for microseepage gases).

The sensitivity of this modified MPOG method, its values range, the reasonable variance present in repetitions over the same sample, guarantees the reliance indifferent types of applications in exploration and production, from wildcat exploration to temporal variation of production wells through microseepage analysis.

References

Wagner, M., M. Wagner, J. Piske, and R. Smit, 2002, Case histories of microbial prospection for oil and gas: AAPG Studies in Geology No. 48 and SEG Geophysical References Series, v. 11, pp. 453–479.

Rasheed, M., M. Veena Prasanna, T. Satish Kumar, D. Patil, and A. Dayal, 2008, Geo-microbial prospecting method for hydrocarbon exploration in Vengannapalli Village, Cuddapah Basin, India: Current Science, v. 95/3, pp. 361-366.

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A Modified MPOG[1,2] Method of Microbial Analysis

OUTLINE

Methodology: How does the technique work ?

Factors influencing the development of micro-organisms

Technical description

Microorganisms Count

Results: Leading Cases in Argentina

Conclusions

[1]Wagner, M., Wagner, M., Piske, J. and Smit, R., Case histories of microbial prospection for oil and gas. *AAPG Studies in Geology 48 and SEG Geophysical References Series*, 2002, vol. 11, pp. 453–479.

[2]Rasheed, M., Veena Prasanna, M., Satish Kumar,T. , Patil, D. and Dayal, A., Geo-microbial prospecting method for hydrocarbon exploration in Vengannapalli Village, Cuddapah Basin, India. *Current Science*, 2008, Vol. 95, No. 3, pp. 361-366.

How does the technique work ?

In a soil sample, we will find different types of microorganisms. Each one will have various factors that promote their viability and development of colonies.

The purpose is to identify within this mixed flora if there are micro-organisms capable of using gases such as butane, as carbon source.

However, other alternative sources of carbon that are found in soil will have to be eliminated.

Using these premises as a starting point, we are working in a microbiological technique that combines the washing and filtration of the sample to eliminate alternative sources of carbon.

Later the incubation under appropriate conditions and the incorporation of butane as the only carbon source, would measure the concentration of bacteria in each sample.

Factors influencing the development of micro-organisms

- Nutrients
- Humidity
- Temperature
- pH
- Potencial of Oxide Reduction (Oxigen availability)
- Inhibitors

As a fundamental condition, microorganisms need to incorporate within their nutrients some source of carbon. In general they use carbohydrates such as glucose. Without carbon, organisms have no possibility of viability, since for example are not capable of forming membranes.

This technique is based on the concept of working in the laboratory reproducing the bacterial habitat in all the factors mentioned previously.

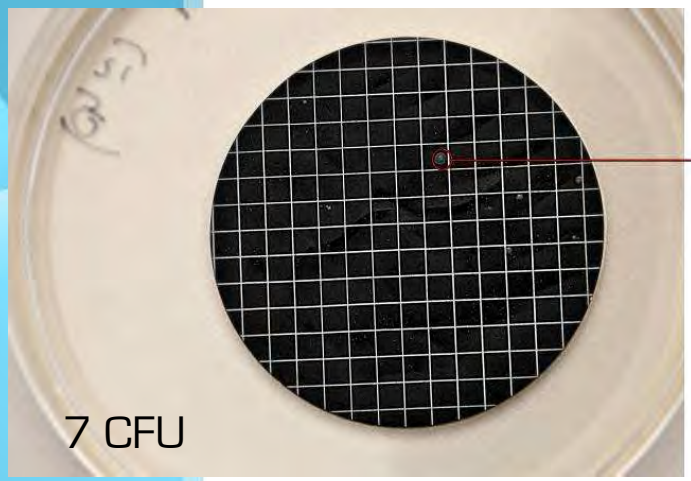
However in this habitat we find multiple microbial flora. The aim therefore is to select the flora that is able to survive with a sole carbon source such as butane.

Technical description

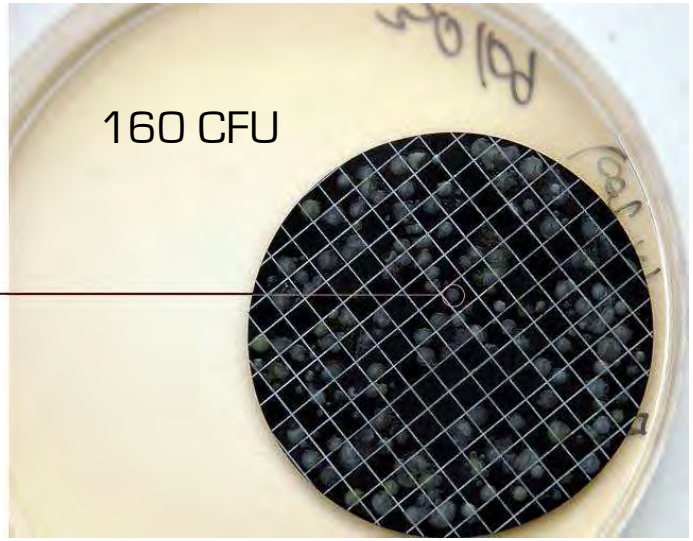
- Weight the soil sample
- Add sterile distilled water
- Filter organic matter filtering pad and membrane
- Remove the pad and discard
- Remove the membrane
- Put on a plate containing agarized Mineral Salt Medium
- Put in the sealed container
- Incubate in atmosphere with air and butane at 35 ° C for 5 days

Microorganisms Count

After incubation, colonies of microorganisms are counted



Microorganism colony



Count and report **cfu per gram** of sample

Results: Leading Cases in Argentina

More than 2000 samples

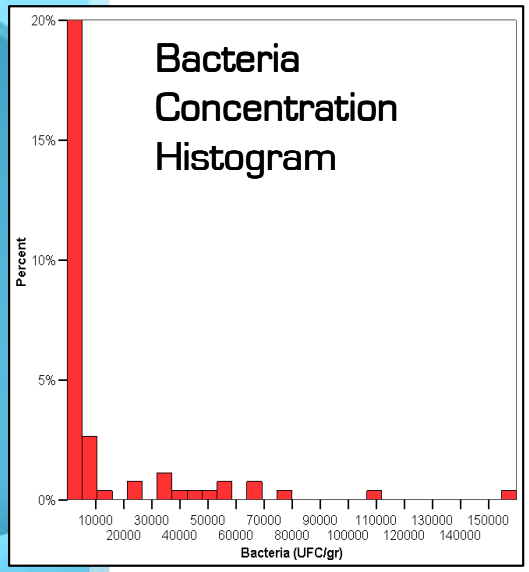
5 different basins

Scenarios

- Exploration area with discovery well
- Producing Field and Exploratory upside
- Exploration area with no wells

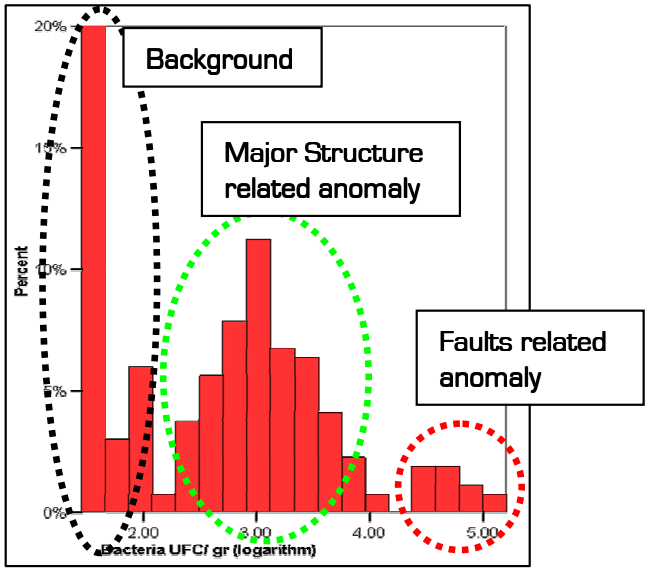
Exploration area with discovery well

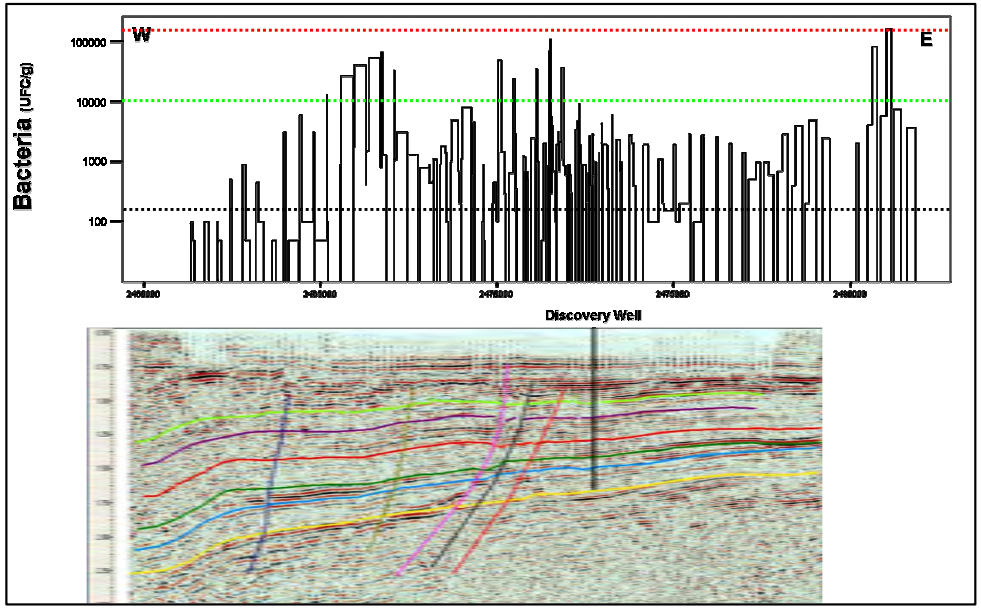
Lognormal Distribution property



Logarithm

Transformation

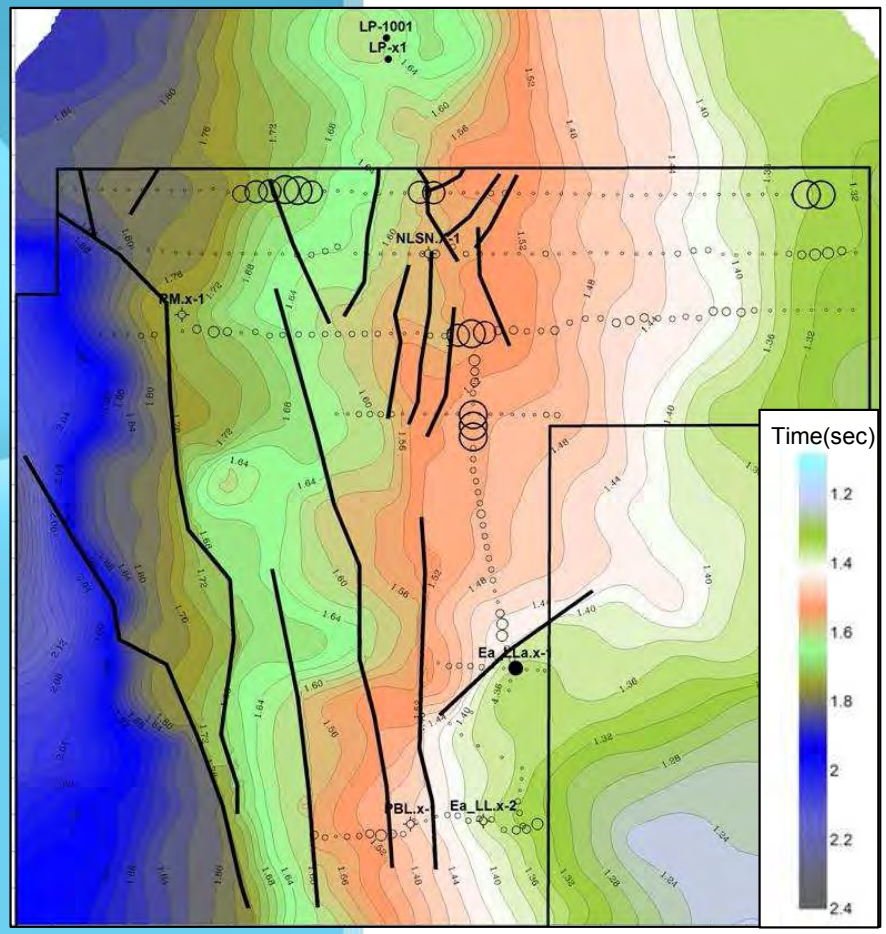


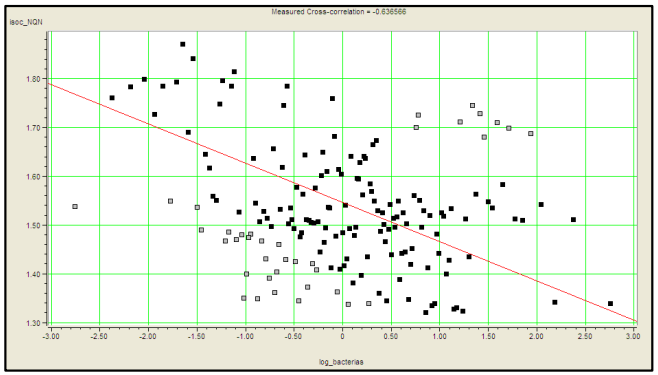


Exploration area with discovery well

GEOSTATISTICAL INTEGRACION: Surface Time Map / Normalized Bacteria Data

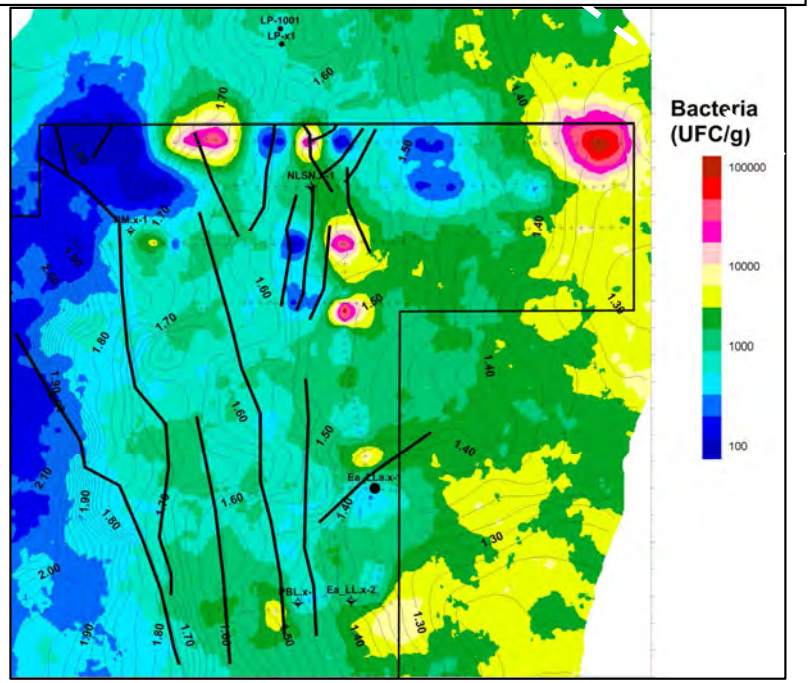
Seismic horizon related to reservoir beds





Secuencial Gaussian Simulation

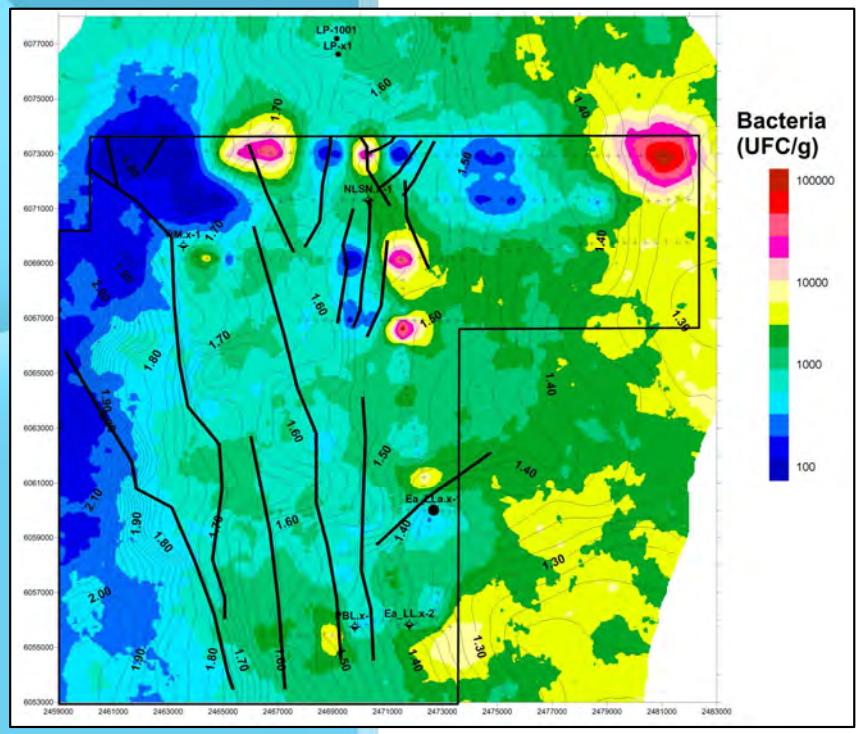
Bacteria Conc. Map after 300 realizations

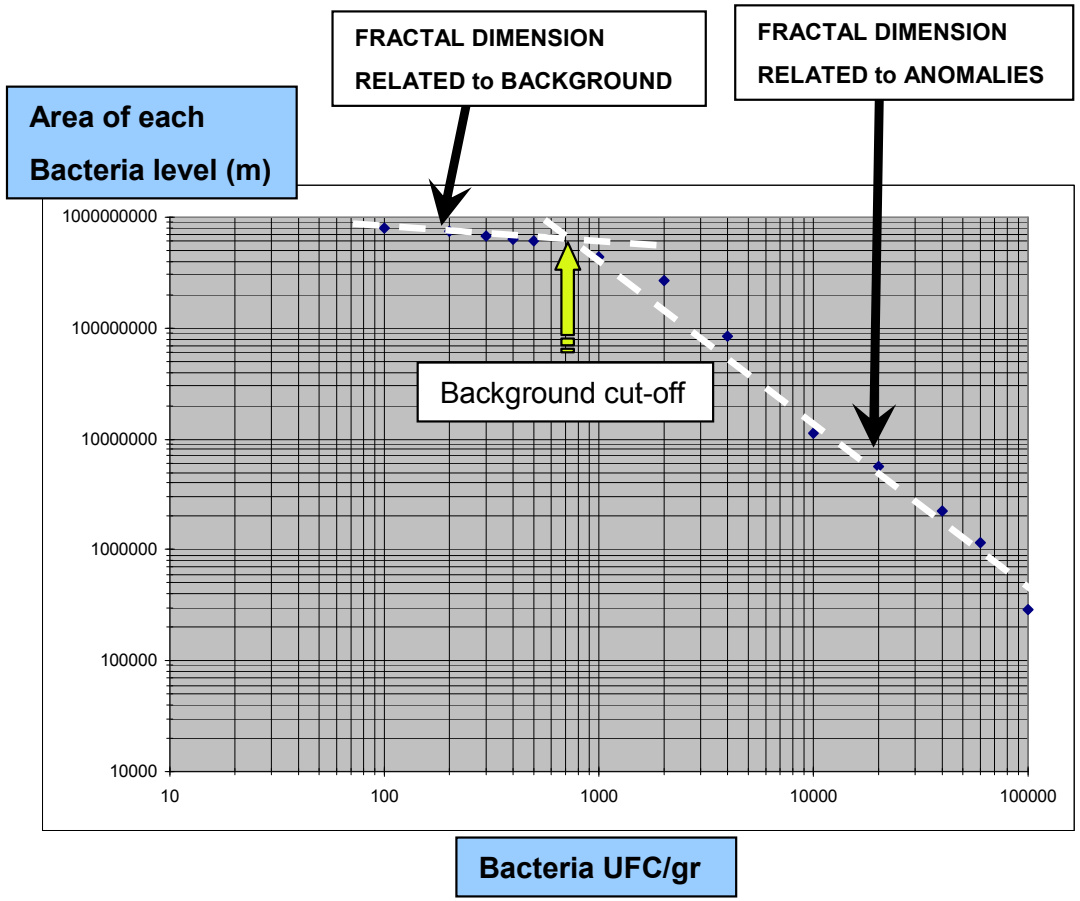


Exploration area with discovery well

Multifractal property[1] of Bacteria Concentration Map

Bacteria Conc. Map after 300 realizations

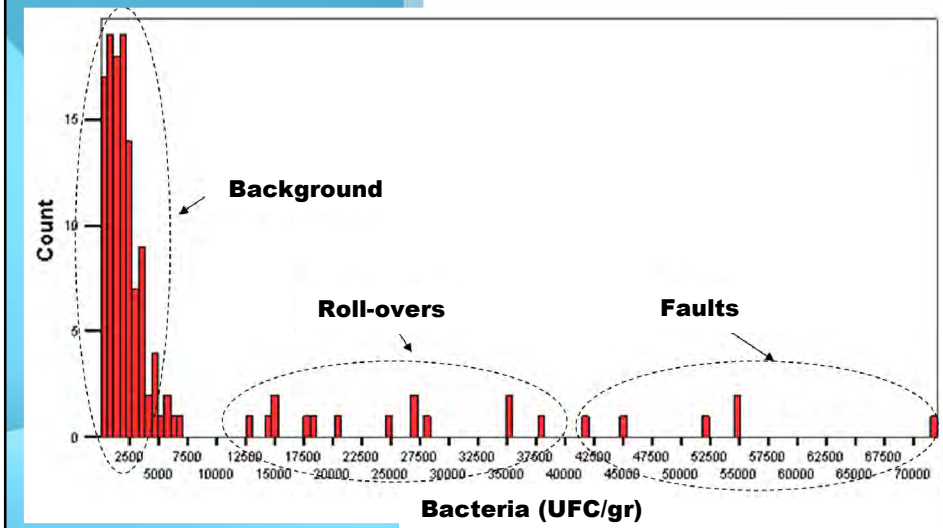


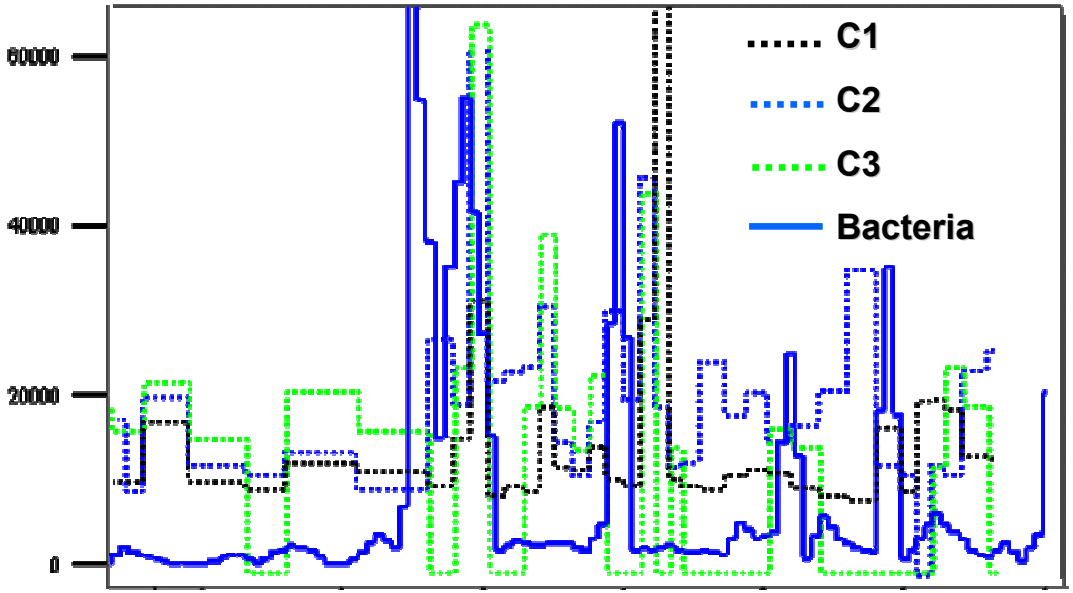


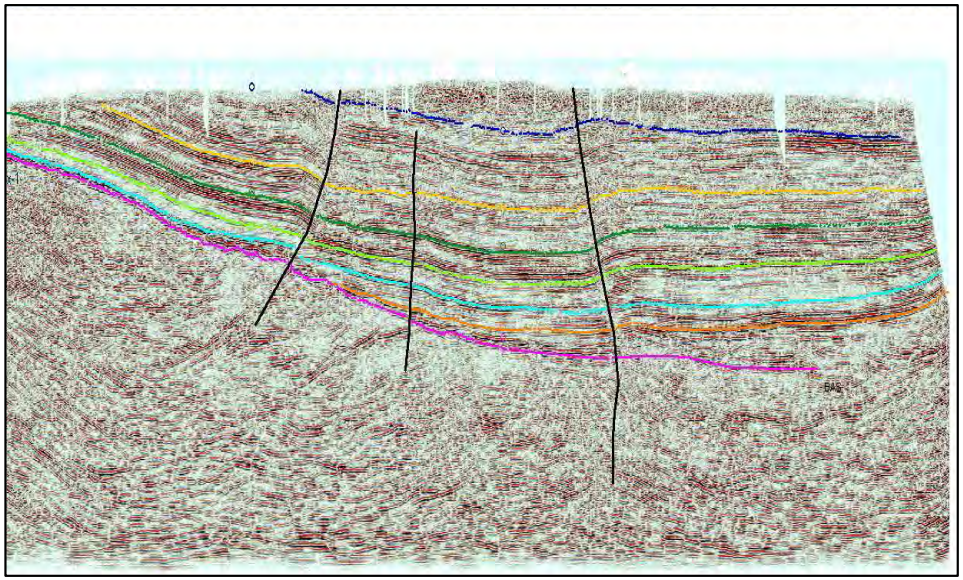
[1]Carranza Emmanuel J., 2009, "Geochemical Anomaly and Mineral Prospectivity Mapping in GIS", Handbook of Exploration and Environmental Geochemistry 11, M. Hale editor, Elsevier, The Netherlands.

Mandelbrot plot

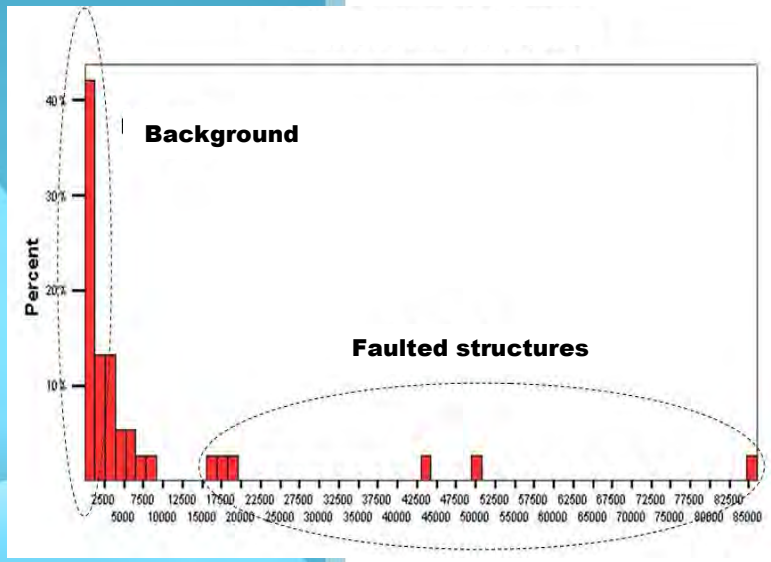
Exploration area with no wells

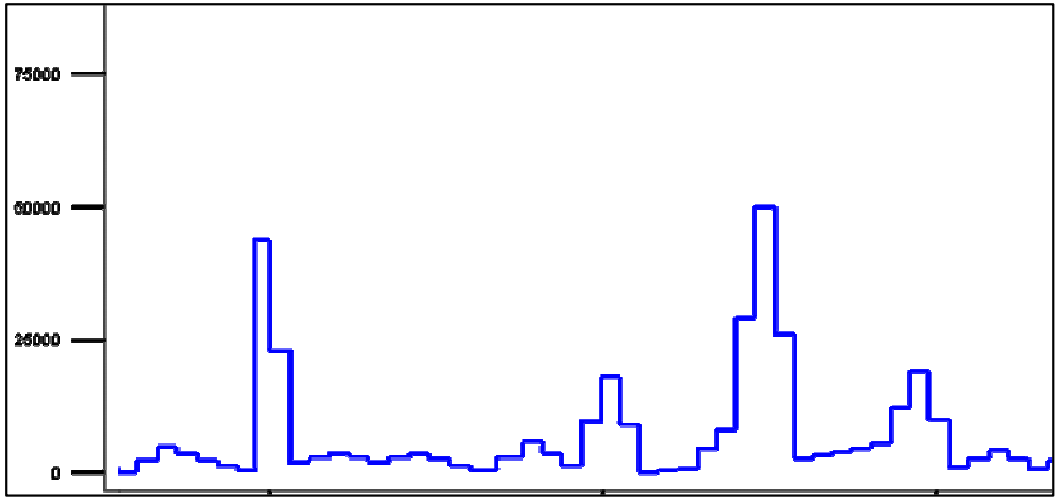


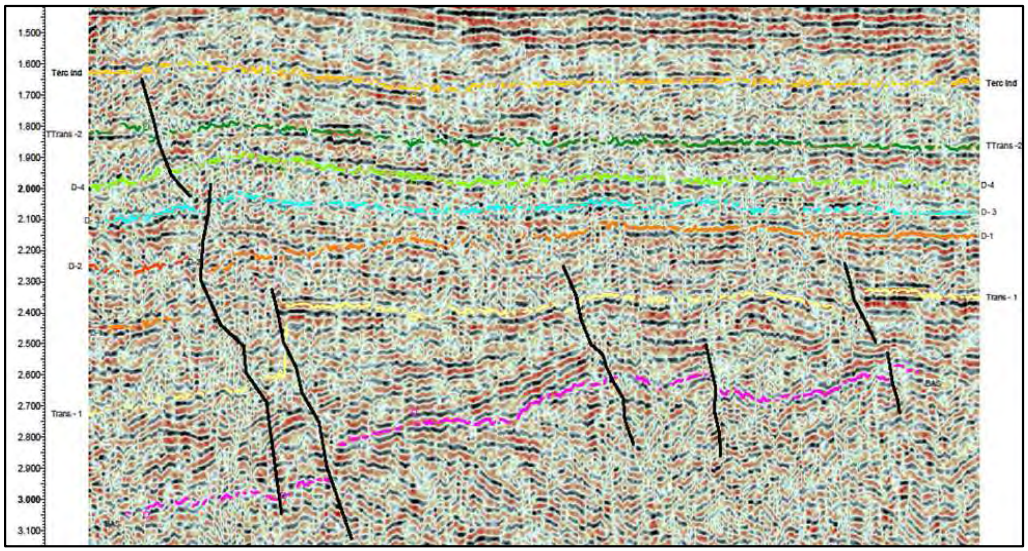




Exploration area with no wells







Conclusions

MICROBIOLOGY

- The technique allows to obtain results between 100 and 200,000 cfu/g and increasing the amount of dilutions, increase the upper limit.

- While there is a possibility that *any contribution from organic matter could be used as a source of carbon*, the results may be confirmed by reinoculating the colonies developed in the same culture media and under the same conditions.

Conclusions

HYDROCARBON EXPLORATION

- Lognormal distribution of bacteria concentration values
- Multifractal spatial behavoir of bacteria values
- Significant differences between background and anomalies
- High sensitivity to structural changes
- High Bacteria species diversity
- Simple, low cost and fast method

Final Remarks

It is recommended to use this method associated with:

- Gases in soil (Head Space or Soil Sorbed Gas methods)
- Trace Elements in Soil (specialy *V, Ni, Cr, Zn, I* among others)
- Plant community structure (Diversity indices and Species Richness)
- Multispectral information analysis (NDVI and Tasseled Cap algorithm)

Informacion Integration using Geostatistical Simulation

- with Seismic Data
- with Micromagnetic and Microgravimetric Data

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THANK YOU!