



Application of Microbial Prospecting Method for Hydrocarbon Exploration: Case studies

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Summary

The hydrocarbon microseepage of light hydrocarbon gases (C₁ – C₄) using geochemical means provides direct evidence of charge traps and structures. These light hydrocarbon microseepage gases likewise directly influence shallow anaerobic soil and sediment environments, creating a spectrum of microbial activity. The indicator light hydrocarbon oxidizing bacteria are isolated and enumerated using microbial techniques. Therefore, an integrated and complementary microbial microseepage signature can identify gaseous hydrocarbon microseepage, which occurs directly above charged oil and gas reservoirs in on/offshore region. This method has been applied in Jamnagar sub-basin, Saurashtra, Gujarat, and Deccan Syncline, Maharashtra. The paper presents the microbial prospecting studies carried out in these areas and its importance in hydrocarbon exploration. The results of microbial studies are promising for hydrocarbon exploration in the above areas.

Introduction

Microbial prospecting for hydrocarbon is a surface exploration method based on the premise that light hydrocarbon gases from the sub surface petroleum accumulations migrate upward, in more or less coherent mass, by diffusion, effusion and buoyancy. These lighter hydrocarbon gases (C₁-C₄) are utilized by a variety of microorganisms present in the sub-soil ecosystem. The methane, ethane, propane, and butane-oxidizing bacteria exclusively use these gases as carbon source for their metabolic activities and

growth. These bacteria are found mostly enriched in the shallow soils/ sediments above hydrocarbon bearing structures and can differentiate between hydrocarbon prospective and non-prospective areas (Fig.1). The ethane, propane, and butane oxidizers are more reliable in hydrocarbon prospecting than methane, as it may also generate biogenically. These light hydrocarbons utilized by number of bacteria belonging to genera of *Brevibacterium*, *Corynebacterium*, *Flavobacterium*, *Mycobacterium*, *Nocardia*, *Pseudomonas* etc.

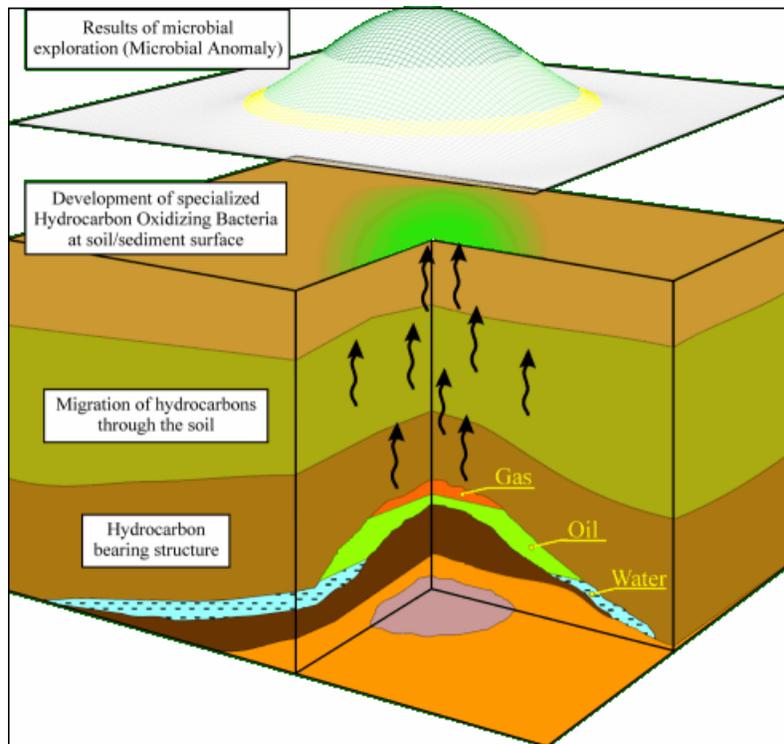


Fig.1 Microseepage model of Microbial prospecting for Hydrocarbon (Modified after Wagner et al., 2004)

National Facility for Surface Geochemical Prospecting of Hydrocarbons has been nucleated at NGRI with a grant from Oil Industry Development Board (OIDB). As a part of this National Facility and under its own research and development programme, NGRI is carrying out Surface Geochemical Prospecting Surveys, comprise of microbial, adsorbed soil gas and isotope studies for hydrocarbon prospecting in the Frontier onland/offshore basins of India. Microbial prospecting studies have been carried out in Jamnagar sub-basin, Saurashtra, Gujarat, and Deccan Syncline, as part of in house R&D projects to study the signatures of hydrocarbon in these regions. The results of microbial studies have been presented in this paper.

Methodology

About 50gms of soil/sediment, samples were collected from the field in pre-sterilized whirl pack bags under aseptic conditions from a depth of about 1m and were stored in cryogenic conditions. The isolation of light hydrocarbon oxidizing bacteria is carried out using standard plate count method. The Mineral salts medium (MSM) plates were incubated in the environment of hydrocarbons and zero air (50:50), respectively. The bacterial colonies were reported in Colony forming unit (Cfu/gm) of soil sample. The bacterial population and anomaly maps were prepared using SURFER-8 software.

Examples

1. Jamnagar sub-basin:

The Jamnagar sub-basin is a part of Saurashtra basin, Gujarat, consists of mostly Mesozoic and Cenozoic rocks. Integrated geophysical studies have shown that Jamnagar sub-basin have significant sediment thickness below the Deccan traps and can be considered for future hydrocarbon exploration.

Geomicrobial prospecting studies was carried out in Jamnagar sub-basin, Saurashtra, Gujarat, 150 soil samples were collected in a grid pattern of 1 x 1 km. The propane oxidizing bacteria ranges from near zero to 6.86×10^5 cfu/gm of soil sample. The microbial results indicate the high propane oxidizing bacterial concentrations in parts of Khandera and significant bacterial population found in Haripur region (Fig.2). Earlier geochemical prospecting survey was carried out by Kumar et al., (2004), in Jamnagar sub-basin for light gaseous hydrocarbons, the samples around Jamnagar, Kalavad, and Lalpur were characterized by higher ΣC_{2+} values. The same areas were selected for detailed sample collection in detail in a close grid pattern, to obtain additional leads in the exploration by microbial prospecting survey. The study reveals good correlation between adsorbed soil gas and microbial survey.

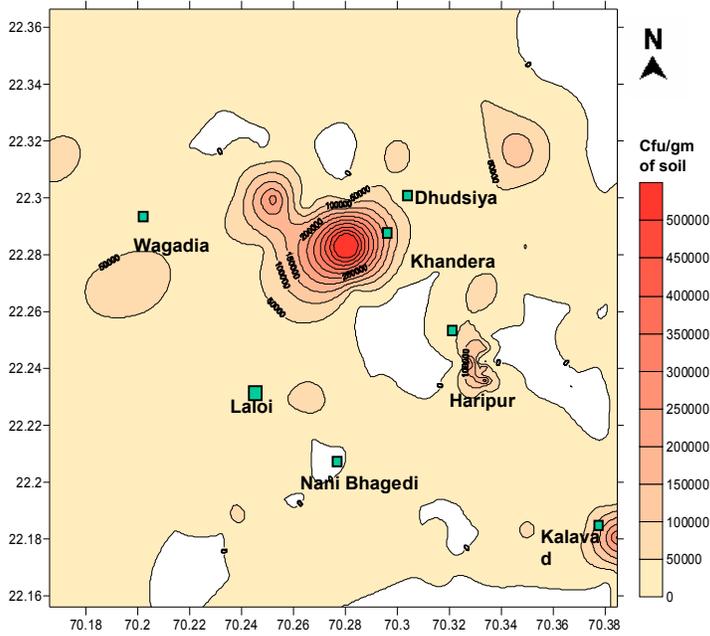


Fig.2 Contour map showing concentrations of propane oxidizing bacteria in soil samples of Jamnagar sub-basin, Saurashtra, Gujarat.

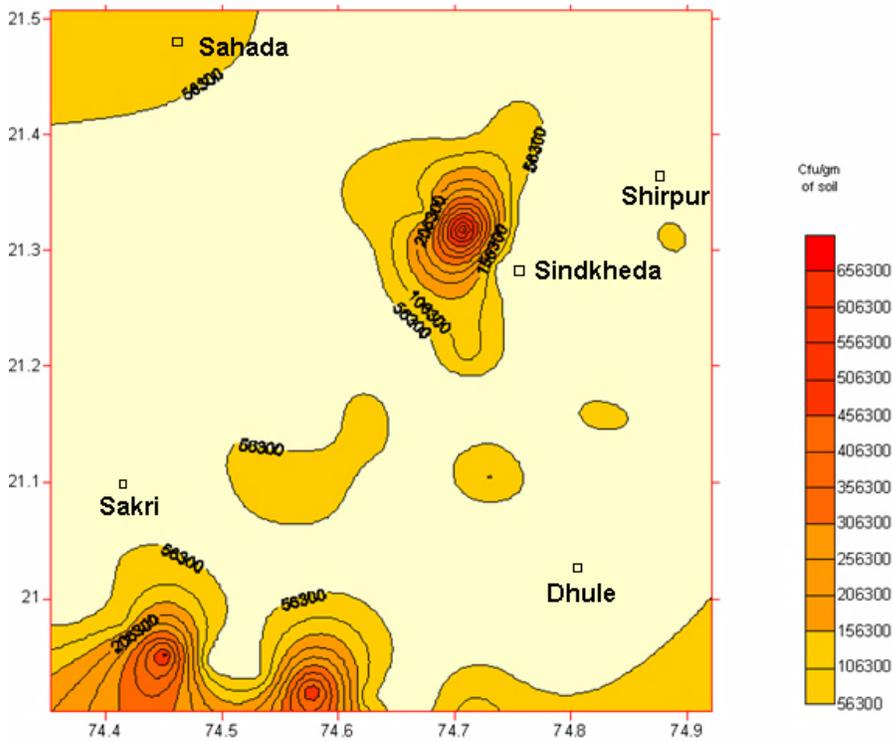


Fig.3 Contour map showing concentrations of propane oxidizing bacteria in soil samples of Deccan Syncline, Maharashtra.

2. Dhule, Deccan Syncline:



The study area is located in part of Deccan Syncline, exposes highly weathered, zeolitized basalt lava flows of the compound pahoehoe type. Along the Tapi River, Tertiary and Quaternary alluvium, 30-km-wide and 200–400 m thick, caps the basalt pile.

The propane oxidizing bacterial count in the soil samples of the studied area ranges from 1.0×10^2 to 6.7×10^5 Cfu/gm of soil. The propane oxidizers anomalies map (Fig.3) indicates that the bacterial population is distributed in the north and south western parts of the studied area.

Integration with Geochemical Studies

Adsorbed soil gas analysis for light hydrocarbons (C_1 – C_5) showed the presence of methane, ethane, propane, butanes and pentanes. The propane oxidizers anomaly map have been superimposed on adsorbed propane anomaly map. The overlay map (Fig.4) indicates that bacterial and adsorbed gases anomalies are adjacent and follow the natural model depicting 'Halo' pattern. The study reveals a good correlation as the presence of light hydrocarbon utilizing bacteria depicted scanty adsorbed hydrocarbon gases in that particular area and bacterial anomalies were seen adjacent or away from the adsorbed gas anomalies.

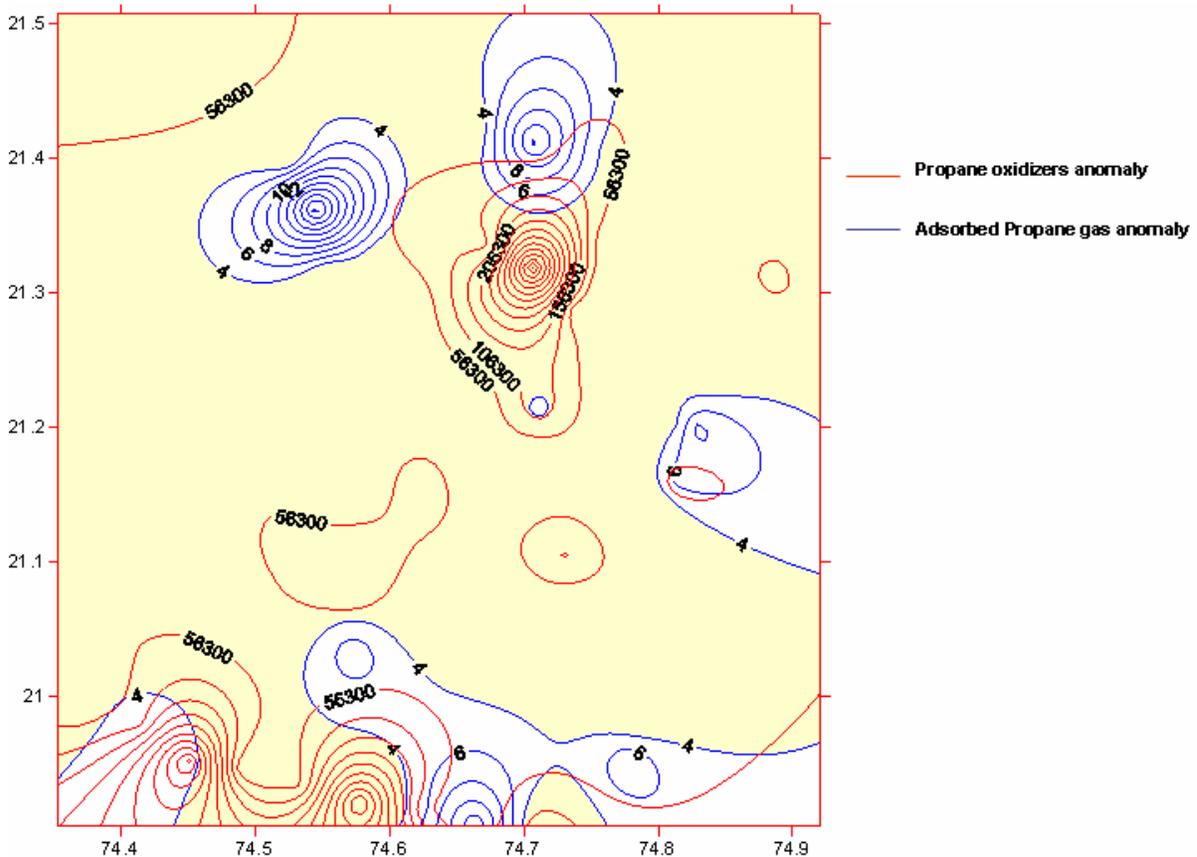


Fig.4 Overlay map of Propane-oxidizers and Adsorbed propane gas anomalies

Advantages of Microbial Prospecting

Microbial prospecting method has advantage over adsorbed soil gas survey. There is a possibility that chemically detectable petroleum gases will be deficient where high soil microbial activity exists.

Microbial prospecting method had increasingly becoming a reliable and dependable tool in hydrocarbon research and exploration. Since the drilling operations are costly, it is essential to use appropriate and efficient exploratory methods, either alone or in combination, in order to cut down the drilling cost of dry holes, on proper integration with geological and geophysical data, it can contribute to the successful high grading of exploration leads and prospects and helps in risk reduction.



Conclusion

The application of Microbial Prospecting method has proved to be a useful and successful supplementary tool in Petroleum exploration and integration of microbial data with Geochemical (adsorbed soil gas), along with geological and geophysical data, can lead to the successful grading of exploration leads and prospects.

The present study reveals good correlation between microbial and adsorbed soil gas surveys. The Jamnagar sub-basin, and Deccan Synclise study area appears to be positive prospects for hydrocarbon.

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