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Surface Geochemical Exploration – Implication for Trace Elements as Tracers for Oil Exploration.

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Summary

Surface geochemical exploration for petroleum is the search for chemically identifiable surface or near-surface occurrences of hydrocarbons, or hydrocarbon-induced changes, as clues to the location of oil and gas accumulations. It extends through a range of observations from clearly visible oil and gas seepage (macro seepage) at one extreme to identification of minute traces of hydrocarbons (micro seepage) or hydrocarbon-induced changes at the other.

Surface geochemical methods have been used since the 1930s, but the past decade has seen a renewed interest in geochemical exploration. The principal objective of a geochemical exploration survey is to establish the presence and distribution of hydrocarbons in the area and, more importantly, to determine the probable hydrocarbon charge to specific exploration leads and prospects. For reconnaissance surveys, seeps and micro seeps provide direct evidence that thermogenic hydrocarbons have been generated; i.e. they document the presence of a working petroleum system and identify the portions of the basin that are most prospective. Additionally, the composition of these seeps can indicate whether a basin or play is oil-prone or gas-prone. If the objective is to evaluate individual exploration leads and prospects, the results of geochemical surveys can lead to better risk assessment by identifying those associated with strong hydrocarbon anomalies, thereby high-grading prospects on the basis of their probable hydrocarbon charge.

Trace metals have long been used to help identify areas of alteration due to hydrocarbon micro seepage. All native petroleum contains some inorganic constituents. Trace metals occur in petroleum in one of two forms, either as an organo-metallic porphyrin related to the original organic material or as a non –porphyrin metal found in the resin or asphaltic fraction of the oil. Possible sources of trace metal in oils are through incorporation and diagenesis of metal complexes of the original biological material or through incorporation into the organic matrix during diagenesis of the biological material in the source rocks either from clay material or interstitial aqueous solution or may be through uptake from an aqueous phase or mineral phases during primary or secondary migration from formation waters or from reservoir rock minerals. Gases encapsulate Rn, liquid hydrocarbons and other trace elements, such as As, Ba, Cd, Ce, Co, Cr, Cu, Ga, Ge, La, Mn, Mo, Nd, Ni, Pb, Pr, Rb, Sb, Sc, Sm, Sn, Se, Ti, Th, U, V, Y, Zn and carry them to surface. Twenty eight metals have been identified as indirect indicators of which Nickel, vanadium are widely used.

Dissolution of the sample is a fundamental and critical factor controlling the accuracy in geochemical analyses; complete dissolution is essential to obtain accurate analytical results. In the present study, the sediment samples collected from Bay of Bengal from different water depths and different locations (Lat; Long) were dissolved following open and closed acid digestion procedures, using a combination of HF, HNO_3 and $HClO_4$ were evaluated and compared. About 50mg of the sample powder was used in both digestion techniques with an appropriate dilution, making the solution suitable for ICP-MS analysis. The potential of ICP-MS as a powerful tool for the simultaneous multi-element determination associated with its low detection limit, high sample throughput, small sample quantities and isotopic capabilities have made it excellent spectroscopic technique for precise determination of trace elements. Both decomposition procedures namely open and closed vessel digestion, are effective for the analysis of majority of

elements. However, the closed digestion system was found to provide very accurate data which may be due to increased reactivity of the acids at high temperatures and pressure.

When referring to surface geochemical exploration, trace metals are primarily used to identify anomalous areas of hydrocarbon microseepage. Nickel and vanadium occur as near surface "haloes" which define the periphery of the accumulation at depth. This is due to local changes in Eh and PH indirectly related to vertically seeping hydrocarbons. Past studies show that as the amount of metal in crude oil increases the gravity of the oil decreases. Hence Nickel and Vanadium are also used in characterizing some reservoir attributes.

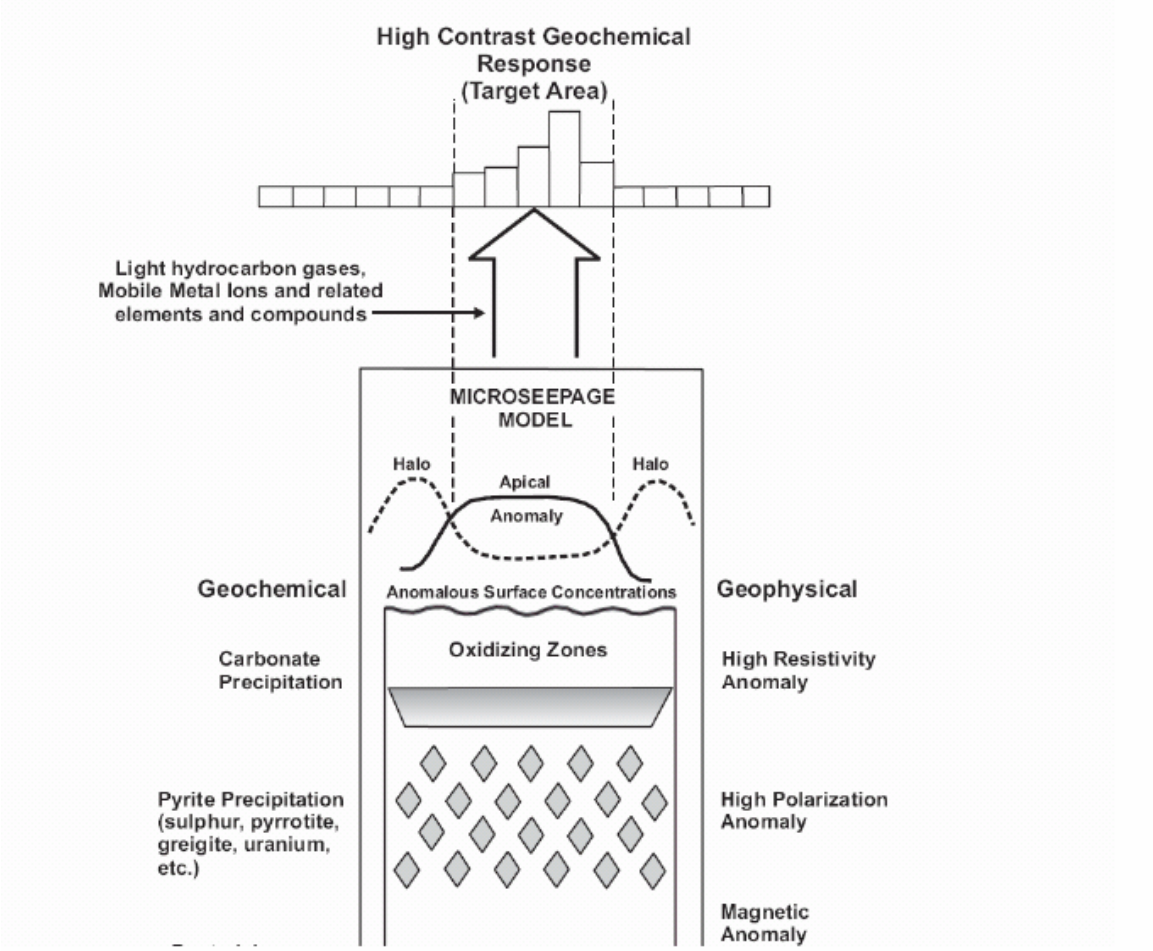

Figure 1. Vertical migration of elements and compounds, mineralogical haloes and geophysical responses over a hydrocarbon reservoir (modified after Schumacher, 1996).