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Evaluation of Hydrocarbon Prospects in Kutch-Saurashtra basin using Surface Geochemical Prospecting studies

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Summary

Surface geochemical prospecting studies comprising of Gas Chromatographic determination of adsorbed light gaseous hydrocarbons and determining the signatures of stable carbon isotopes of methane in near surface soil samples has been carried out in Kutch-Saurashtra to evaluate the potential of the area for hydrocarbon resources. It is based on the concept that the light gaseous hydrocarbons (methane through butanes) from oil and gas reservoirs migrate to the surface and gets adsorbed to the near surface soils and sediments which on desorption by acid extraction technique and quantification gives an idea of spatial distribution of hydrocarbons. The concentration (ppb) of methane (C_1) varied from 4-291, ethane (C_2) from 0-84, propane (C_3) from 0-37, i-butane (iC_4) from 0-5and n-butane (nC_4) from 0-4 suggesting that the generation of hydrocarbons has taken place in the basin. The carbon isotopic (VPDB) signatures of methane ranged from 32.2‰ to 13.3‰ suggest a thermogenic source for hydrocarbons. The increased occurrence of hydrocarbons in near surface soil samples signifies the area potential for oil and gas.

Key words: *Hydrocarbons, Microseepage, Thermogenic and Kutch-Saurastra.*

Introduction

The light gaseous hydrocarbons, methane through pentane migrate to the surface from the subsurface through microseepage and get adsorbed in the near surface soil matrix, which on acid extraction and further quantification gives an inference on the potential of the area (Jones and Drozd, 1983; Klusman, 1993; Kalpana et al., 2010; Tedesco, 2005; Madhavi et al., 2009; Mani et al., 2010; Bernard et al., 1977). The tectonic features such as faults and fractures provide a pathway for the hydrocarbon migration showing hydrocarbon mass at the surface.Micro seeps are invisible and can be recognized by the presence of anomalous concentrations of light hydrocarbons (C_1 to C_4) in the near surface soils/sediments along with other surface manifestations of hydrocarbon seepage which can be in the form of microbial and trace element anomalies, mineralogical changes, altered electrical, magnetic and seismic properties. The carbon isotopic studies of the desorbed hydrocarbons help in finding whether they are thermogenically or biogenically generated.These near surface anomalies provide clues on the nature and composition of sub-surface petroleum occurrences and help to demarcate the anomalous hydrocarbon zones and grade the frontier basins (Madhavi et al., 2011; Abrams, 2005).

Field work and Analytical Procedures

203 soil samples were collected in reconnaissance pattern from the depth of 2.5 to 3.0mby manual hammering. The samples were wrapped in aluminum foils with their GPS positions marked(Madhavi et al., 2009). The 63 micron size soil sample was treated with ortho phosphoric acid under partial vacuum to desorb the soil gases. The CO_2 evolved was trapped in KOH solution and the hydrocarbons released were collected through water displacement in a graduated tube fitted with rubber septa. The 0.5 ml of the gas was injected in to the Varian CP-3380 Gas chromatograph equipped with Flame ionization detector. The calibration of GC was done by external standard with known

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concentrations of methane, ethane, propane, i-butane, n-butane. The quantitative estimation of light gaseous hydrocarbons constituents in each sample was made using peak area measurement as a basis and the correction for moisture content was applied. The % RSD for C_1 to C_4 components is < ±20%.

The carbon isotopic composition of methane from the soil sample and head space gas was measured by GC-C-IRMS comprising of Agilent 6890 Gas Chromatograph (GC) coupled to a Finnigan – Delta PlusXP Isotope Ratio Mass Spectrometer via a GC combustion III interface. The carbon isotope ratio in the sample was compared with NIST RM 8560(IAEA NGS2) using ISODAT software. The precision of the isotopic measurement was ±0.5% (Mani et al., 2010).

Results and discussion

The concentrations (ppb)of methane (C_1) varied from 4-291, ethane (C_2) from 0-84, propane (C_3) from 0-37, i-butane (iC_4) from 0-5and n-butane (nC_4) from 0-4. The carbon isotopic (VPDB) signatures of methane ranged from 32.2‰ to 13.3‰ indicating a thermogenic source of hydrocarbons. The Gas Chromatographic analysis of hydrocarbons indicated the occurrence of methane through butanes in the study area. The cross plots among the various hydrocarbon components suggests a single source for the hydrocarbons and they did not get altered during its migration from subsurface to the surface as indicated by linear correlation coefficients which is 0.98 for C_1-C_2, 0.98 for C_2-C_3 and 0.9 for C_1-C_2+.The compositional ratio of C_1/C_2+C_3<100 and the $\delta^{13}C$ value of methane ranging between -250/00 to -550/00(VPDB) as suggested by Bernard are typical for the thermogenic hydrocarbons. In the present study, the ratio of C_1/C_2+C_3 is less than 100 and the δ^{13} C_1 is ranging between 32.2‰ to 13.3‰(Fig.1), indicating a thermogenic source for hydrocarbons.The high concentrations of hydrocarbons were found to be characteristic of the areas near Anjar of Kutch and the area south to Rajkot of Saurashtra which is shown in the concentration distribution maps of methane and $\sum C_2$+ hydrocarbons (Figs.2&3) signifying the area's potential for hydrocarbons.

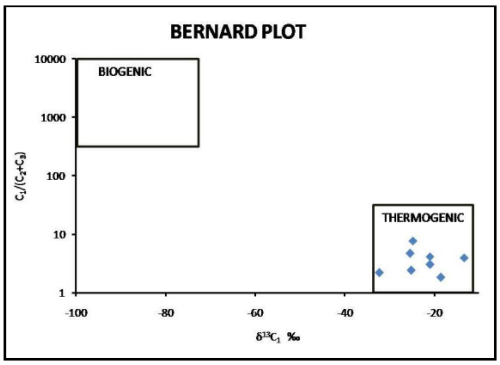

Fig. 1 Log $C_1/(C_2+C_3)$ versus $\delta^{13}C_1$ (Bernard plot) for the adsorbed light gaseous hydrocarbons from the Kutch Saurastra Basin

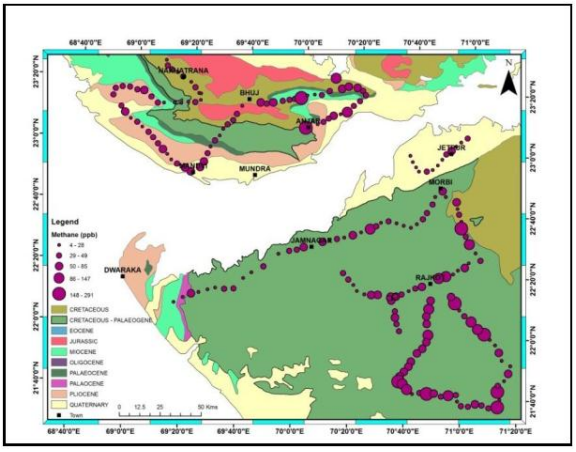

Fig. 2 Concentration distribution map of Methane (ppb)

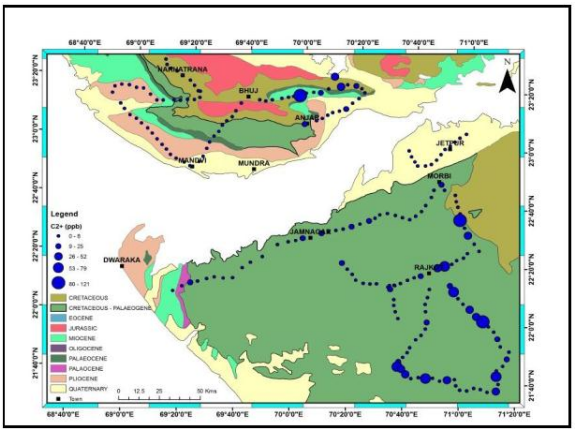

Fig.3Concentration distribution map of C_{2+} (ppb)

Conclusions

The surface geochemical prospecting studies carried out in Kutch-Saurashtra indicated the occurrence of methane through butanes in the area. The carbon isotopic values of methane suggest a thermogenic source for hydrocarbons. High concentrations of hydrocarbons are characteristic of the areas near Anjar of Kutch and Rajkot of Saurashtra signifying a promising potential for hydrocarbons.

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