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SYNCHRONOUS FLUORESCENCE SPECTROSCOPY: APPLICATION FOR IDENTIFYING LIQUID HYDROCARBONS ANOMALIES IN SURFACE GEOCHEMICAL STUDIES

Elias Kassabji

SENIOR PETROLEUM GEOCHEMIST AT
FUGRO INC, USA

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INTRODUCTION

Fluorescence analysis in shallow core sediments is a useful tool for detecting aromatic hydrocarbons, such as polycyclic aromatic hydrocarbons (PAHs). Fluorescence intensity and color can be used to infer the presence and composition of hydrocarbons, respectively. While single wavelength UV lamps are commonly used for rapid oil assessment in the field, synchronous fluorescence spectroscopy (SFS) offers a more objective, sensitive, and consistent method for qualitative characterization of oil-range hydrocarbons. SFS can differentiate liquid hydrocarbons and identify thermogenic anomalies. The study aims to evaluate the effectiveness of SFS in detecting and characterizing hydrocarbons in shallow core sediments by comparing results obtained from different oil and extract samples.

EXPERIMENTAL

Oil samples with different characteristics, surface sediment extracts, and perylene were analyzed using a Perkin Elmer fluorescence spectrometer LS-55, with data processed using BL Studio software. To prepare the samples, a small amount of sample was placed in a cuvette and filled with optima grade *n*-hexane, then homogenized. Synchronous mode was used with a $\Delta\lambda$ of 40 nm, based on previous research (Lloyd, 1971 and Patra & Mishra, 2002).

RESULTS AND DISCUSSION

The results obtained from the spectra analysis of the oil and surface samples are presented in Figures 1 and 2. The spectra clearly indicate that the fluorescence intensity of light oil is highest over 260 nm, while the maximum intensity for medium oil is observed in the 270-360 nm range. This is consistent with previous studies that suggest that petroleum products contain a complex

mixture of aromatic hydrocarbons that fluoresce in proportion to the number of aromatic rings present.

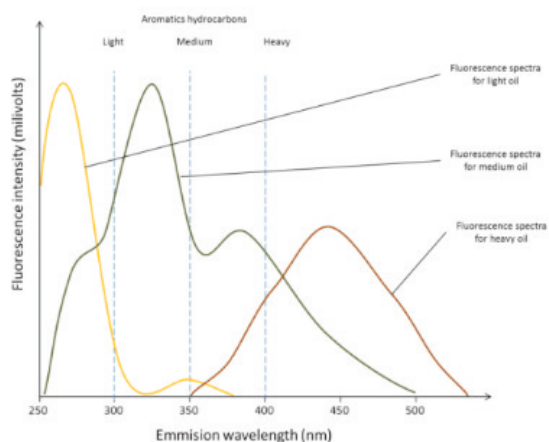


Figure 1. Synchronous fluorescence spectra for oil samples in *n*-hexane.

The spectral fingerprints of lighter and medium oils were observed to have peaks mainly in an intermediate wavelength region (260-400 nm), while heavy and biodegraded oils showed maximum fluorescence in the emission wavelength region (410-550 nm). A distinct group of samples was also observed, corresponding to non-thermogenic or 'background' samples that were dominated by recent organic matter. The predominant peaks of this group matched those of the perylene spectra.

Monoaromatic compounds, such as benzene, toluene, and xylene, emit fluorescence between 250-290 nm, while two aromatic ring compounds, such as naphthalene, show a peak at 310-330 nm, and three and four aromatic ring compounds, such as phenanthrenes and pyrene, emit fluorescence between 345-355 nm.

Perylene and other compounds with more than 5 aromatic rings, emits fluorescence above 400 nm (Pharr et al., 1992; Abbas et al., 2006) (see Figure 3).

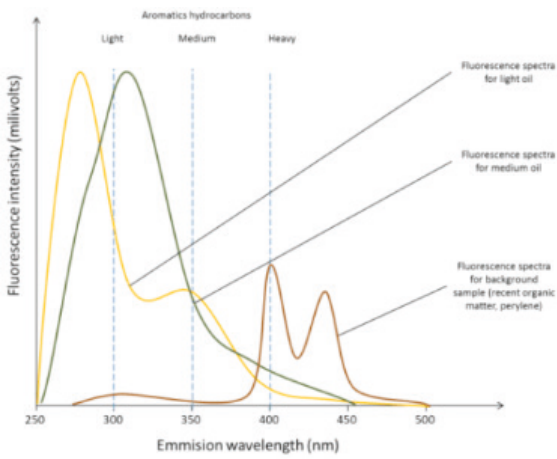


Figure 2. Synchronous fluorescence spectra for extract surface samples in *n*-hexane.

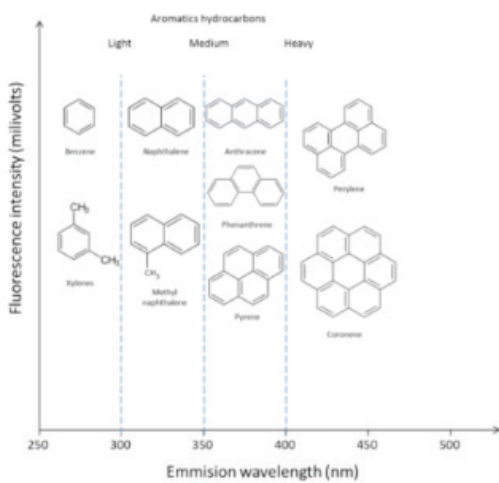


Figure 3. Fluorescence responses of oil compounds.

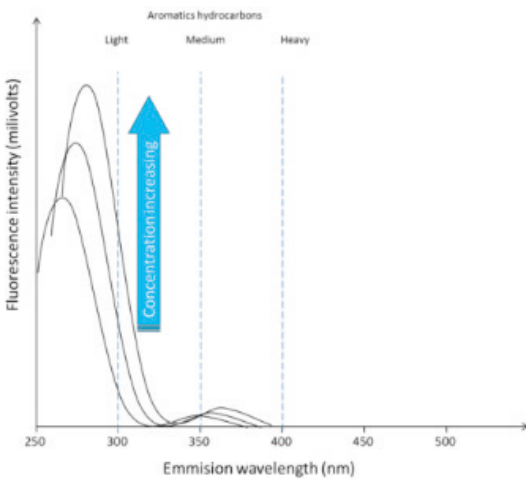


Figure 4. Fluorescence responses for light hydrocarbons at different concentrations.

Furthermore, the fluorescence intensity was noted to change according to the concentration of the oil/extracts, although the change differed for lighter/medium oils and heavy/biodegraded oils. For the first group, the fluorescence intensity increased with increasing concentration (see Figure 4), while for the heavy/biodegraded oils, the fluorescence intensity decreased with increasing concentration (see Figure 5). Quenchers, such as asphaltenes, are responsible for the decrease in fluorescence intensity of the latter group.

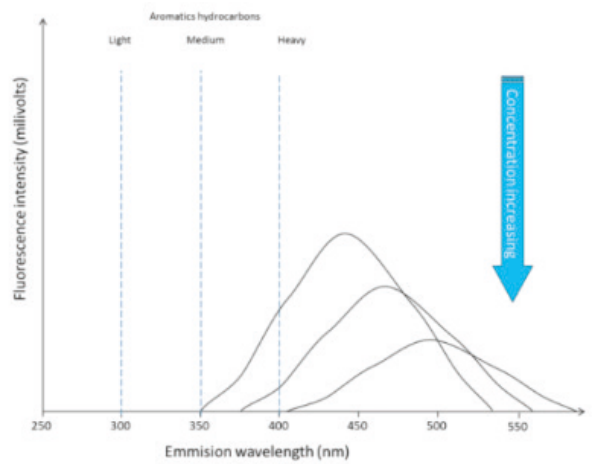


Figure 5. Fluorescence responses for heavy hydrocarbons at different concentrations.

CONCLUSIONS

This study demonstrates the potential of synchronous fluorescence spectroscopy to differentiate and characterize different types of oils based on their synchronous spectra at a fixed wavelength-interval. This method can serve as a useful tool to identify and investigate oil anomalies in surface sediment samples and can complement other exploration techniques for oil detection.

ACKNOWLEDGEMENTS

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