

In the name of Allah the most beneficent the most merciful

Dedication

I dedicate this work

to

My Parents, Brothers and all Family members



Acknowledgement

I would like to thank my supervisors professor Dr. Nafie A. AlMuslet and professor Dr. J. J. Laserna. They have always been there for me, helping me, encouraging me, and made me believe in myself and in my work. Even in tight schedules, they found time for me. I am grateful to have had two supervisors who are so passionate about the field of laser science; discussion with them has always been a source of inspiration for me.

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My family has always encouraged me to study hard and follow my dreams. I am really glad.

Abstract

This thesis addresses the issues of chemical characterization of crude oil and soil samples with respect to identification of organic, inorganic materials and heavy metal components. In this work, a new method to identify the compounds in crude oil and soil samples was established.

Laser Induced Breakdown Spectroscopy has been used to identify the constituents and the differences between crude oil and soil samples in ambient air. An exhaustive analysis of crude oil and soil samples (collected from Heglig Oilfield, Bamboo Oilfield, Defra Oilfield, Unity Oilfield, Adaril Oilfield, Balela Oilfield, and Hamra well) was performed in the Laser Research Center at University of Malaga- Spain. Characteristics elements (organic and inorganic materials) in petroleum such as C, H, N, O, Na, and Ca were detected. The spectra due to heavy elements in crude oil and soil samples such as Fe, Mg, Cu, Zn, Na, Ni, K, Ti, Ba, Cr, Li, Sr, Bi, Zr, Co, P and V were recorded using this technique; Different statistical tools (Avantes, atom origin) were used.

In addition, contributions from Ca, Si and Al were noticed. The use of intensity ratios of line and band emissions in the crude oil samples allowed a better characterization of the samples than the simple use of peak intensities. Concentration of heavy elements in the soil samples was detected using Inductively Coupled Plasma Mass Spectroscopy (ICP-MS). The chemical composition of the crude oil samples was found completely different from sample to other. As well, a statistical method was employed in order to discriminate crude oil and soil samples. Although significant differences were observed, no structural identification of the hydrocarbons components has been obtained.

In conclusions: using Laser Induced Breakdown Spectroscopy and Inductively Coupled Plasma Mass Spectroscopy techniques for the analysis of crude oil and soil samples led to the detection and determination of be possible detected and determined concentration of organic, inorganic materials and heavy elements in these samples e.g.(H , N, C, O, Ca and Na), which is the main subject of our attention and study.

The number of heavy elements detected in crude oil was: thirty element in the Adaril oilfield, twenty eight element in the Balela oilfield , twenty three element in the Bambo oilfield, fourteen element in the Diffra oilfield, eighteen element in the Unity oilfield and sixty nine element in the soil of Hamra oil well located in the Hegleg oilfield.

Concentrations of heavy metals were ranging from very high concentration e.g (Ca, K, Na, Si, Ba, F, Al, Ni, Mg and Mn) to medium concentration (Cu, Bi, Sr and Zn) and low concentration e.g. (vanadium and sulfur).

Using laser technology in the oil industry can make a real addition because of its countless benefits, (e.g. real time, precision, sensitive, selective and fast technology).

المستخلص

هذه الدراسة تتناول توصيف العناصر الكيميائية في عينات مختلفة من خام البترول السوداني وتربة بئر الحمراء النفطية بحقل هجليج النفطي باستخدام تقانة الانهيار الكهربائي المستحث بالليزر ، وذلك بغرض التعرف على الماد العضوية وغير العضوية والعناصر الثقيلة (الندرة) في كل عينة وتراكيز العناصر الثقيلة ومن ثم التمييز بين العينات جُمعت العينات من حقول بليلة وعداريل، بامبو دفرا النفطية، وحقل الوحدة النفطي ونقطة تجمع النفط الخام المركزية بحقل هجليج النفطي ، حُللت العينات البترولية في المعمل المركزي لليزر بجامعة ملقا-باسبانيا وذلك باستخدام تقانة طيف الانهيار الكهربائي المستحث بالليزر وقورنت النتائج مع النتائج المتحصلة باستخدام جهاز البلازما الحثية المزدوج و طيف الكتلة. وباستخدام هذه التقنية أمكن التعرف على بعض المواد العضوية وغير العضوية في عينات خام البترول مثل عنصر الكربون، الهيدروجين، الأكسجين، النيتروجين، الصوديوم والكالسيوم وكذلك العناصر الثقيلة في تربة بئر الحمراء مثل عنصر الصوديوم، البوتاسيوم، الكالسيوم، الحديد، السيلكون، التيتانيوم، الباريوم، الماغنسيوم، المنجنيز، الألومنيوم، الكروم، الليثيوم، الفناديوم، الاسترانشيوم، النحاس، الزنك، البزموت، الزركونيوم، النيكل، الكوبالت، الفسفور وذلك بمعرفة أطياف هذه العناصر ومن ثم وباستخدام علاقة نسب شدة خطوط طيف الانبعاث تم تحديد الاختلاف بين مكونات عينات خام البترول .

من النتائج المتحصلة في هذه الدراسة أمكن الاستنتاج بان باستخدام تقانة الليزر (تقانة طيف الانهيار الكهربائي المستحث بالليزر و جهاز البلازما الحثية المزدوج و طيف الكتلة) لتحليل عينات خام النفط السوداني وتربة بئر الحمراء النفطية ، أمكن إكتشاف وتحديد تراكيز بعض المواد العضوية وغير العضوية وكثير من العناصر الثقيلة في تلك العينات مثل عنصر الأكسجين ، النيتروجين ، الكالسيوم ، الصوديوم ، الهيدروجين و الكربون

بلغ عدد العناصر الثقيلة المكتشفة بتحليل عينات خام النفط السوداني 30 عنصراً في خام حقل عداريل النفطي، 28 عنصراً في خام حقل بليلة النفطي ، 23 عنصراً في خام حقل بامبو النفطي ، 14 عنصراً في خام حقل دفرا النفطي ، و 18 عنصراً في خام حقل الوحدة النفطي و 69 عنصراً في تربة بئر الحمراء النفطية في حقل هجليج النفطي كانت تراكيز العناصر الثقيلة تتراوح ما بين التركيز العالي جداً مثل الكالسيوم ، الصوديوم، البوتاسيوم ، السيلكون، الباريوم، الحديد، الألومنيوم، النيكل

والمغنسيوم، والتركيز المتوسط مثل النحاس ، البزموت، الاستراشيوم والزنك والتركيز المنخفض جداً
مثل الفناديوم والكبريت أثبتت النتائج أن باستخدام تقانة الليزر في مجال الصناعات النفطية يشكل
إضافة حقيقية يجب الاستفادة منها لما لها من مزايا متعددة، مثل الدقة العالية، الحساسية، إمكانية
الكشف المباشر للمركبات بالإضافة الى السرعة الكبيرة

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