ELEMENTAL AND PHYSICOCHEMICAL ANALYSIS OF CRUDE OIL EXTRACT FROM UGWUEME TAR SAND DEPOSIT

H.C. Okeke

Abstract

Crude oil extracts from Ugwueme Tar sand deposit were collected and analyzed for elemental components using an automatic carbon-sulpur-nitrogen analyzer. Chemical stoichiometry method was used to calculate the percentage of C.N. and H present in the crude oil extract results of the elemental analysis of the oil extracted from the Tar sand deposit indicated the presence of six different elements (ionizer) namely Aluminum (Al^{3+}),
Lead (Pb^{2+}), sulphur (S), Bismuth (Bi_2+), Antimony (Sb^{+2}) and N,S,0, compound plus residue. Al, Pb, Bi and Sb were present in trace amount (<3.4 x 10^{5}ppb) while the percentage of S^{+2} and N, S, O, compounds plus residue were 1.38% and 3.1% respectively. The percentage value of sulphur (1.38%) is very high suggesting water washing and biodegradation process which is generally common in most degraded crude oil.

Introduction

The ability to discover hydrocarbon impregnated sandstones (tar sand) and determine the elemental components of the various' types of Hydrocarbon Geochemistry (Ekweozor and Unomah 1989, Ekweozor and Murhopadhyay 1989). As a result in intended to investigate and determine the elemental and physiochemical components of the crude oil extracts from the Ugwueme Tar sand (Anyeneh, 1991). This was accomplished through the collection and analysis of the exposed Tar and samples.

Ugwueme in Awgu Local Government Area of Enugu State lies between latitude of 6° OO'OO **N** and **6° 15[1] N** and longitude **7° 30[1] E** and **7° 45° (figures 1 and 3).**

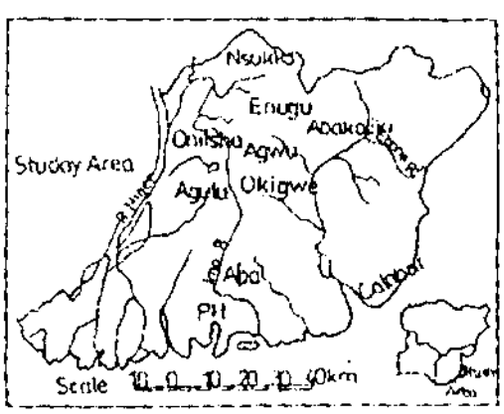


Fig 1: Map of Southeastern Nigeria showing the study area modified from Iwuagu (1983)

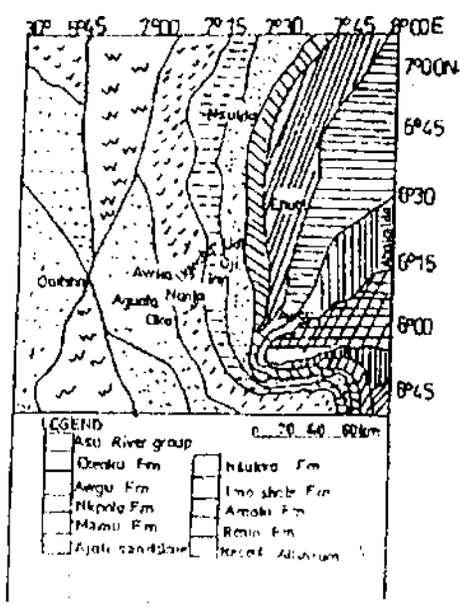
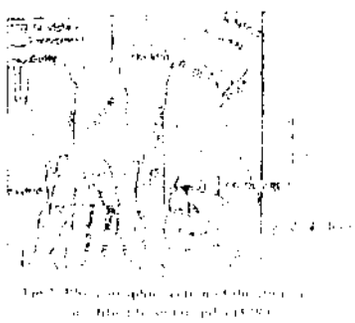


Fig 3: Regional Geological map of southeastern Nigeria (After Rayment 1965) study area lies in Awgu Formation

The Tar sand deposit is emplaced within the Nsukka-Enugu-Agwu escarpment and at about 60 kilometers south of Enugu (fig 2).



The identified Tar sand zone is of campanian Age which lies within the Owelli sandstone formation (Ezeji, 1973). The area experiences heavy rainfall especially during the months of June. July and September with mean rainfall record of 1,837 22mm/a (Aneke 2006) which usually leads to heavy flooding, soil leaching, Erosion, extensive outwash, ground water infiltration and percolation. This physiographic and climatic condition of the study area especially as regards the rainfall intensity and the attendant high infiltration rate, is believed to cause the oil bitumen to be flushed out from the Tar sand as heavy tarry and sticky crude Orajaka 1989). The above assertion could be supported by the frequent reports of oil associated seepages at the cuesta slope in Ugwueme area during and immediately after each rainy season period every year.

Geologic Setting

Stratigraphically, the regional geology of southern Eastern Nigeria within which lies the study area consists of Asu River Group. Ezeaku, Awgu, Nkporo, Mamu, Ajali sandstone, Nsukka, Imo shale, Ameki and Benin formation as well as recent Alluvium as shown on figure 3. The Asu River group stratigraphic unit is composed of dark micaceous sandy shale and fine grained sandstone with a rich ammonite fauna of Albian age. The sediments were believed to have been derived from the basement complex (Kogbe, 1976). The Turonian Ezeaku deposits consists of hard grey to black shales and silstones with frequent facies changes, to sandstones or sandy shale. The thickness through variable in some places, attains up to lOOOmetres (Reyment, 1965). The Awgu formation with thickness of about 300 metres overlies the Ezeaku formation and it consists of thick bluish grey, well-bedded shales with occasional intercalations of fine grained sandstones and often thin marly shelly Limestones. It is of coniacian in age with beds rich in ammonites, other molluses and fish teeth (Awgu Shale of Reyment 1965).

Nkporo Formation overlies the Awgu formation and its major part is of maestrichtian in age. The Owelli sandstones, Enugu and Asata shales are lateral equivalent of Nkporo Formation. The owelli sandstones consists of massive ferruginous and cross-bedded medium to coarse grained sandstones with thin siltstone or shale bands (Simpson, 1956). With Awgu locality, the Owelli sandstone has a thickness of about 250nreters. Structurally, it maintains a low westernly dip, resting uncomfromably on the folded shales of the plains east of the great cuesta. At the crude oil seepage site in Ugwueme, the Owelli sandstone is over 130metre thick and it rests conformably on the Awgu shale **figures 4 and 5).**

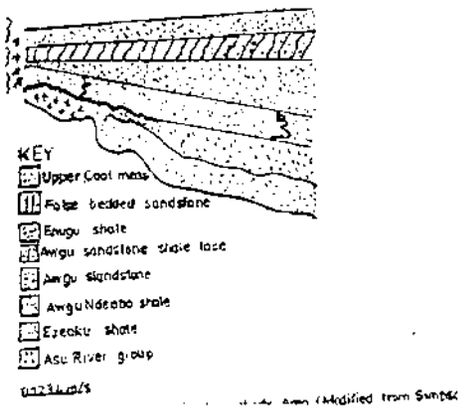


Fig 4: Stratigraphic sequence in the study area (*modified from Sampson 1956*)

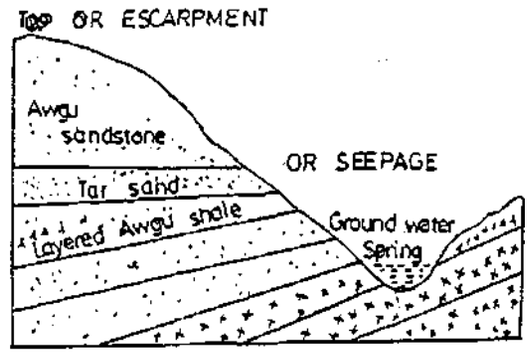


Fig 5:Stratigraphic Sequence in Ugwuene Agwu area showing layered Awgu shale

East of the Niger, the maestrictian is represented by the deltaic Mamu Formation, Ajali sandstone and Nsukka Formation containing coal seam at several levels. The marine influence becomes less positively identifiable from Mamu Formation upward, giving way to regression in later cretaceous time when the proto-delta became initiated. Marine transgression was widespread southern Nigeria throughout the tertiary (Short and Stauble, 1967). The main stratigraphic unit of the Paleocene (Into shale) outcrops as an acuate belt from Western Nigeria to the East. It is typically bluish grey, commonly fossiliferous, locally sandy and ranges into early Eocene. The onset of the regressive phase and the formation of the modern Niger Delta occurred with the deposition of Ameki Formation. It is predominantly shaly west of the Niger except north of Lagos where it grades into the sandy Ilaro Formation and the Lagonal clay (Oshosun Formation). East of the Niger, it is heterogeneous, being composed of sandstones, shales, calcareous shales, marl and fossiliferous limestone. This heterogeneity is a positive proof of shallow water sedimentation.

Surface evidence of the Oligocene and Miocene units is limited and often questionable. The main units representing these ages are probably the Ogwashi Asaba and Ijebu Formations, both of which are sandy with lignite seams (Reyment, 1965). The Benin Formation of Miocene being of recent age, is the youngest stratigraphic unit and consists of yellowish white continental sands with pebbly bands.

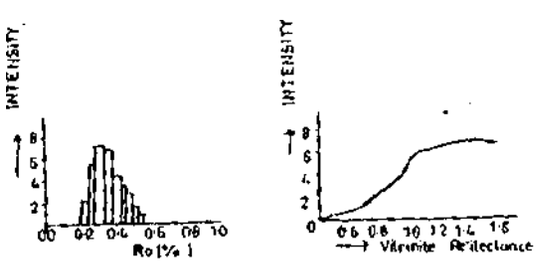


Fig 6: Vitrinite reflection (Ro) Index developed from the analysis of Ugwuana

Materials and Methods

Crude oil samples collected from the seepage sites at Ugwueme were subjected to laboratory analysis inorder to determine the elemental components of the crude oil extract. The elemental analysis of the samples were determined using an automatic carbon-sulphur-nitrogen analyzer. About 0.5 grams of Tar sand sample was exposed to high temperature of about 120°C and burnt in the instrument chamber in a stream of oxygen. The quantity of carbon dioxide, nitrogen and water produced by the equipment were automatically measured with appropriate technical adjustments and compensation. Chemical stoichiometry was used to calculate the percentage of Carbon, Nitrogen, and Hydrogen present in the crude oil derived from the Tar Sand (Cooper 1990, Demaison 1977 and Dow 1977).

Results and Discussions

The result of elemental analysis of the oil extracted from Ugwueme Tar sand indicated the presence of six different elements namely Aluminum, Lead, Sulphur, Bismuth, Antimony and N.s.O compounds with residue (Ekweozor, 1982).

Aluminium, Lead, Bismuth and Antimony were present in trace amount (< 3.4 x 10'ˢ ppb) while the percentage of sulphur and N, S, O, compounds plus residue were 1.38% and 3.1% respectively. The percentage value of sulphur (1.38%) is very high and this could be due to the effect of water washing and biodegradation process which is very common in most degraded crude oil (Bailey, 1973b)

Table 1: Elemental Analysis of Extracted Oil from the Ugwueme Tar sand deposit

Element present	Value of individual element present
Aluminum (Al)	Trace amount (less than 3.4 x $10._4$ppb)
Lead (as Pb^{+2})	Trace amount
Sulphur (as $S^{\wedge 2}$)	1.38%
Bismuth (as Bi^{+2})	Trace amount
Antimony (as Sb^{+2})	Trace amount
N,S,Q, compound + Residue	3.1%

Conclusion

The crude oil extracts from Ugwueme Awgu Tar sand were subjected to elemental analysis. Six different elements namely Aluminum, Lead, Sulphur, Bismuth, Antimony and N,S,0, compounds plus residue were identified. The analytical results revealed that intense flushing and alteration of oil through water-washing and Biodegradation had been going on for over long period of geologic time. This could be the reason for the very high value of 1.38% for sulphur from the result of the analysis.

References

Anyeneh, V. N. (1991). *Petroleum geochemistry of tar sand deposit at Ugwueme Awgu South Eastern Nigeria.* Uncompleted M.Sc Thesis, Anambra state University of Technology (ASUTECH), Awka Campus.

Bailey, N.J. L. (1973b). *Alteration of crude oil by waters and bacteria* AAPG Bull P. 1276-1290 Cooper, B. 1990;

Practical petroleum geochemistry. London Robertson Scientific Publications 174. Demaison, G.J. (1977). Tar sand and

supergiant oil field AAPC 1950.

Compper, B. (1990). Practical petroleum geochemistry, Robertson Scientific Publications London 174.

Dow, G. G, (1977). Kerogen studies and geological interpretations *J. Geochem. Explanation* pp. 79- 99.

Ekweozor, C. M. and Unomab G. 1.(1989). *First discovery of oil shale in the Benue Trough Book of Abstract;* 25th Annual Conf. Nigeria Mining and Geosciences Society Ibadan 5th -9th March, 1989 p. 9

Ezeji, V.C. (1973). Geology and Ugwueme and its environs; B.Sc Thesis University of Nigeria Nsukka.

Kogbe C.a. (1976). *The Cretaceous and Paleogene sediments of southern Nigeria.* In Geology of Nig. (C.A. Kogbe ed) University of 1EE Press.

Orajaka, I.P. Egboka, B. C. C. and Anwuemesi A.G. (1989). *The Ugwueme tar sand deposit, Awgu, South Eastern Nigeria*

Rayment R.A. (1965). *Aspect of geology of Nigeria,* University of Ibadan Press, 1969. Ammonite Biostratigraphy, Continental drift and oscillatory transgressions, vol.il pp.137-140

Short, K.C. & Stuable A. J. (1967). *Outline of geology of Niger Delta.* Am. Assoc. Petroleum Geologist Bull. 51; 701-779.

Simpson, A. (1956). *The Nigerian coals fields. The geology of Owerri and Benue provinces.* Bull Geol. Surv of Nigeria (24)