

PETROGRAPHY AND GEOCHEMICAL STUDIES OF THE ANIA-OHAFIA IRONSTONE OCCURRENCE, SE NIGERIA: A PRELIMINARY REPORT

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ABSTRACT:

Preliminary petrographic and geochemical studies were carried out on the ironstone occurrence from Ania-Ohafia area of Southeastern Nigeria. The aim is to assess the average iron content (Fe_2O_3) of the occurrence. The occurrence is basically an iron enriched, NNW-SSE trending sandstone unit overlying the late Maestrichtian Ajali Sandstone. Petrographic studies reveal that the occurrence is made up of sandstone cemented by iron oxide with the cement accounting for up to 50% in most of the samples studied.

Chemical analyses of 10 samples revealed that the Fe_2O_3 content ranges from 20 to 70% with a mean value of 36%. Relatively low P_2O_5 values were recorded, a result that is considered unusual for sedimentary iron ore deposits. SiO_2 and Fe_2O_3 contents make up well over 85% of the individual samples in all the locations. It is thus suggested that more work be carried out with respect to beneficiation and reserves of the iron ore in the area. This will throw more light on the distribution and quality of the occurrence.

KEYWORDS: Maestrichtian, Ajali Formation, Ironstone, Transitional Zone.

Location and Accessibility

The study area lies between latitudes $5^\circ 24'N$ and $5^\circ 45'N$ and longitudes $7^\circ 36'E$ and $8^\circ 00'E$. It is located at about 55 km east of Umuahia, 20 km north of Arochukwu and is accessible through Umuahia, Bendé, Arochukwu or Ehem Ohafia roads. It is located at the eastern fringes of the sedimentary margins of eastern Nigeria (Fig. 1).

A lot of work has been done on beneficiation and chemical analyses of the banded iron ores than on the sedimentary ore formations in Nigeria. Greater amounts of phosphorus in the form of P_2O_5 in most of the sedimentary iron ores attest to this premise. The Agbaja, Korton-Karfe and Bassa Nge ores are reported to have 2.08 %, 2.14 % and 1.45 % of P_2O_5 , respectively (Mucke and Neumann, 1986; Muotoh et al, 1988)

The general opinion that P_2O_5 -rich sedimentary ores prove expensive to upgrade may be a possible overstatement since many sedimentary iron ore formations are yet to be discovered and analysed (Uwadia, 1989).

This paper gives a preliminary report on the petrographic and geochemical characteristics of the Ania-Ohafia ironstone unit of Ovim-Nguzu-Ohafia-Arochukwu ironstone occurrence, so as to assess its potential for useage in the iron and steel industry.

Stratigraphic Setting.

The Abam-Ohafia area of southeastern Nigeria is underlain principally by five geological formations of the middle Cretaceous to Tertiary age. These are:

(a) Nkporo Formation: This formation is confined to the eastern margin of the area. It is made up of sandstones, calcareous shales and occasional limestone.

(b) Mamu Formation: Dark-blue shales are typical of the Mamu Formation in the study area. It overlies the Nkporo Formation conformably.

(c) Ajali Formation: This is a Maestrichtian sandstone formation. It is uncemented and is said to be fluvio-deltaic in origin (Hoque and Ezepue, 1977). The top of this formation is iron-rich, hence the suggestion that it should be sub-divided (Reyment, 1965 and Ibe, 1998).

(d) Nsukka Formation: This is a Late Maestrichtian Formation showing a remarkably facies change from the type locality. The formation is made up of iron-rich basal sandstone. This unit is overlain by a marine sequence evidenced by the presence of a foraminifera-rich limestone (Ibe, 1998). There appears to be a break in sedimentation after the deposition of the Ajali Sandstone in the area. There is thus a close relationship between the iron-rich sandstone of the top of Ajali Formation and a similar unit at the base of Nsukka Formation in the area.

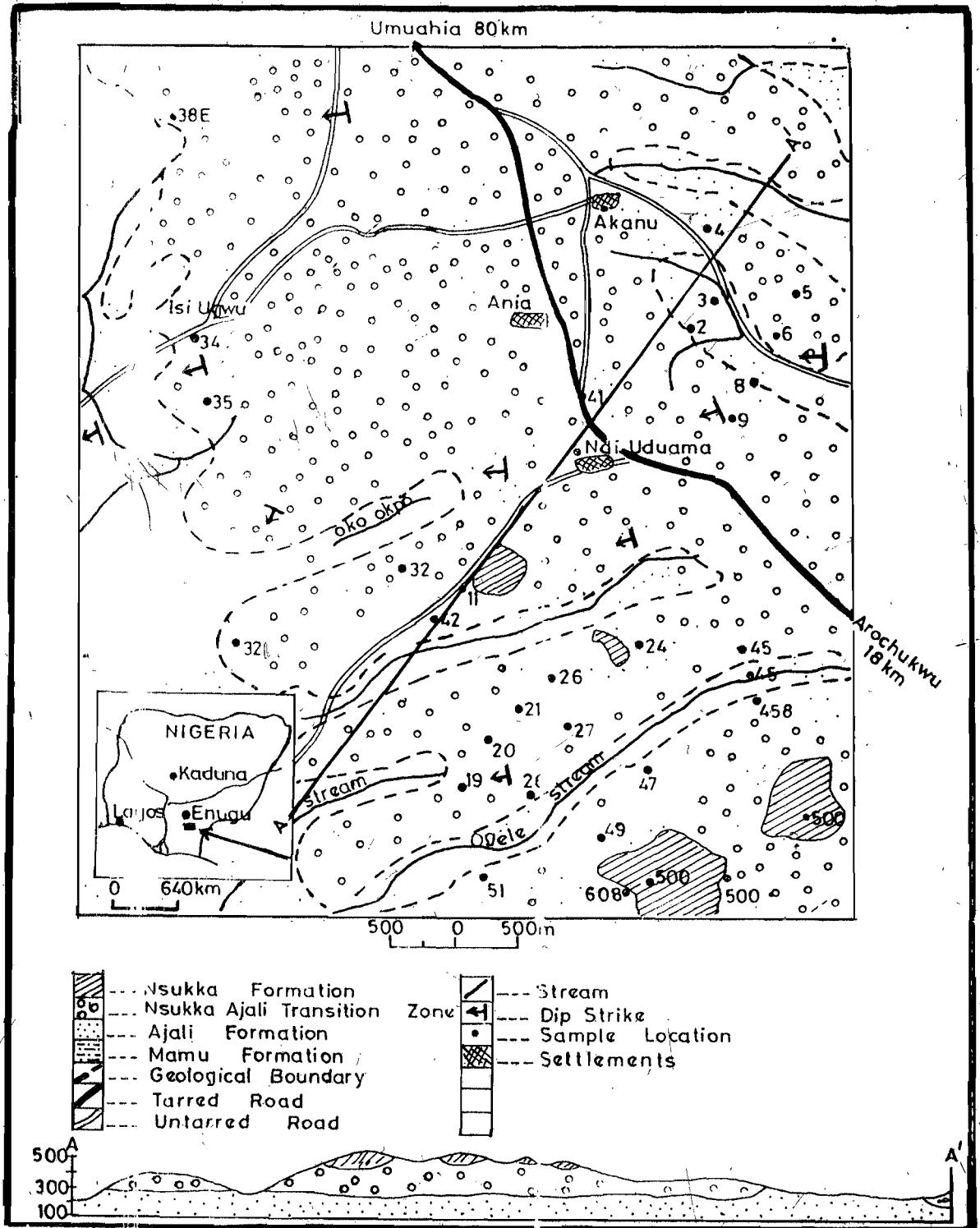


Figure 1:- GEOLOGICAL MAP OF ANIA OHAFIA AREA

The study area covers part of this transitional zone. The Nsukka and Ajali Formations are distinct units with their petrographic, paleontological and chemical characteristics.

(e) Tertiary Imo Formation: This overlies the Nsukka Formation unconformably. It is made up of purple shales.

Field Observations.

Between the highly arenaceous Ajali Sandstone and the calcareous to carbonate-rich members of the Nsukka Formation, there is a transitional zone that has the iron-rich sandstone. The lower part of the ironstone unit is conglomeratic, passing on to the highly iron-rich



Plate 1. Photomicrographs of Ironstone Samples from Ania-Ohafia Area.

(a) 500 m NE of Ndi Uduma Awoke (b) Ugwu-Eziukwu Akanu

© Sample 50 at a Location 5 km SW of Ania Hill

part at the top. In most locations, the ironstone appears as a remnant of the Nsukka Formation duricrusts that is highly resistant to weathering. (Fig. 1). The iron oxide-rich sandstone unit trends 300° to 330° with dip values ranging from 8° to 35° in the west and southwest directions. Exposures of the ironstone units are noticed along high angle slopes of the hills that rise up to 100 m above the surrounding stream valleys. The iron stains that are typical of the Ajali sandstone are visible along the numerous hill slopes in the area.

The Ovim-Arochukwu road is located on the great water divide that is underlain by the ironstone unit, hence the stable nature of the road. The ironstone unit extends from Arochukwu to Ovim but the study area is centered on the Ania area. The elongate hills that are common in the area are made up of the highly resistant ironstone units.

Petrography and Geochemical Studies

In hand specimen the samples range from fine-grained to conglomeratic. Colour ranges from deep brown to metallic grey with visible quartz grains. Under the polarising microscope, grains of quartz, sometimes of wavy extinction, are set in an iron oxide cement that accounts for between 20 and 55 %. Quartz ranges in modal amount from 20 to 70% (Plate 1). The cementing materials were identified as hematite and goethite, using their optical properties. The lower part of the unit is conglomeratic with iron cement of about 15 % and quartz content of about 85 %. The conglomeratic variety is underlain by the iron-stained part of the Ajali Formation. The disposition of the unit is shown in figure 1.

Ten out of 46 samples analysed were selected to cover the study area. These were analysed for their major oxides using the atomic absorption spectrometer (AAS), at the Nigerian Mining Corporation laboratory, Jos, Nigeria. One of the samples with exceptionally high iron content

TABLE 1 RESULT OF CHEMICAL ANALYSIS OF ANIA-OHAFIA IRONSTONE

OXIDE (%)	S	A		M		P		E		S	RANGE	MEAN
	1	2	4	9	17A	20	22	33	37	60		
SiO ₂	63.6	46.2	13.7	65.0	53.2	78.4	66.4	53.0	48.8	48.8	13-75	53.71
TiO ₂	0.17	0.42	0.4	0.20	0.20	0.99	0.25	0.63	0.53	0.19	0.19-99	0.40
Al ₂ O ₃	1.79	3.26	3.07	2.72	1.47	1.39	1.84	3.20	4.63	4.01	1.47-4.63	2.74
Fe ₂ O ₃	30.38	45.76	70.2	28.6	37.54	15.37	25.74	34.32	38.97	42.61	15.37-70	36.95
Na ₂ O	0.02	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.02-.04	0.03
K ₂ O	0.01	0.01	0.01	0.01	N.D.	N.D.	N.D.	N.D.	N.D.	0.02	0-0.05	0.01
CaO	0.78	0.55	0.50	0.73	0.76	0.35	0.88	0.58	0.29	0.29	.29-.88	0.57
MgO	0.25	0.23	0.20	0.28	0.23	0.26	0.28	0.20	0.19	0.20	0.2-.28	0.23
P ₂ O ₅	0.07	0.09	0.88	0.07	0.39	0.47	0.97	1.10	0.18	0.18	.07-.97	0.44
SO ₄	0.21	0.16	N.D.	N.D.	N.D.	0.13	N.D.	N.D.	N.D.	0.04	0-.21	0.05
L.O.I	2.72	3.28	10.54	2.0	5.43	2.90	3.5	6.78	5.78	3.46	2-10.5	4.65
TOTAL	100.00	99.99	99.53	99.64	99.24	99.88	99.88	99.83	99.41	99.87	99.24-100	99.74

ND: Not in determinable amount

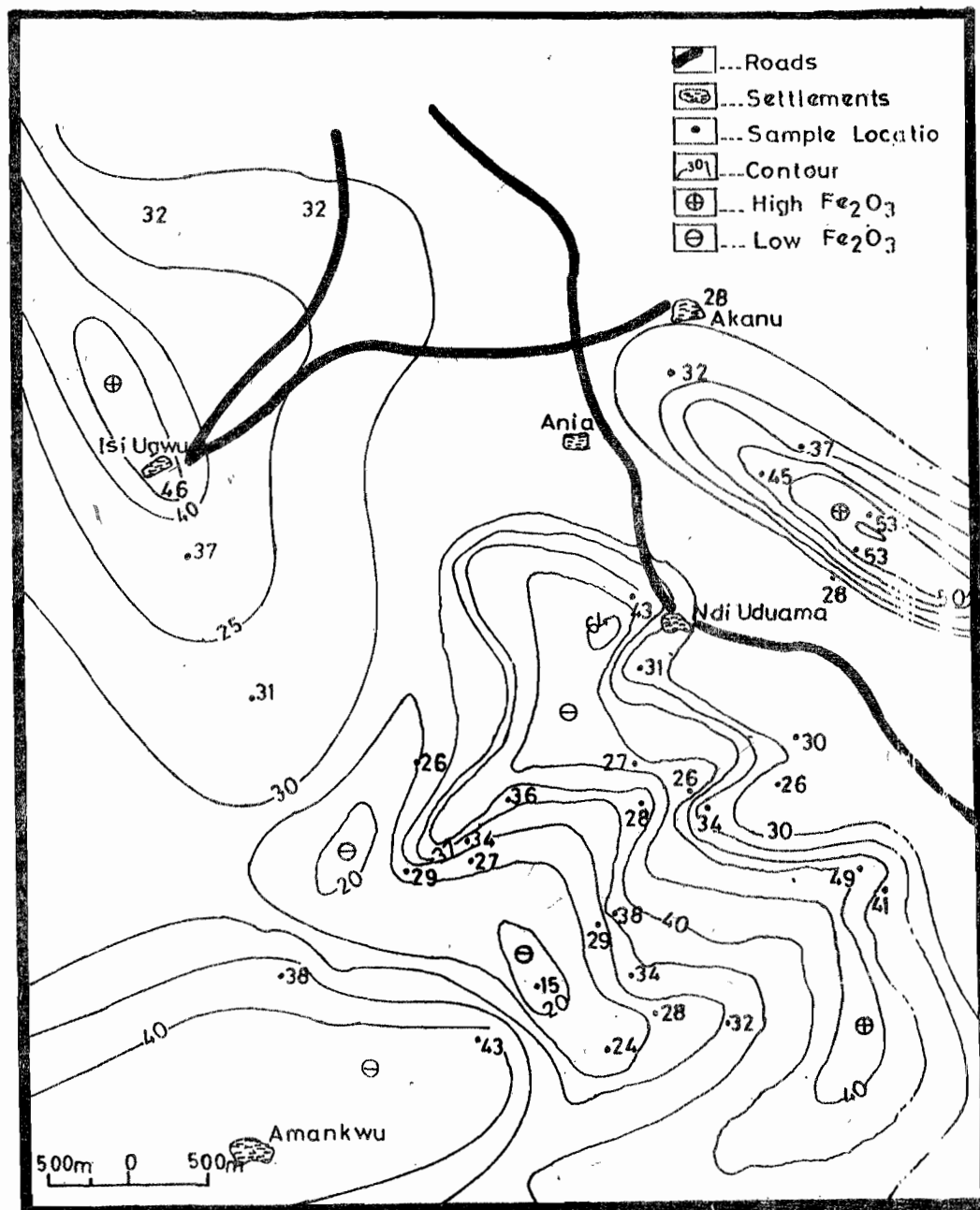


Figure 2:- DISTRIBUTION PATTERN OF Fe_2O_3 CONTENT IN ANIA - OHAFIA IRONSTONE

was collected from a vein in a ridge located at about 1 km northwest of Ndi Uduma Awoke (Figs. 1 and 2).

Geochemical analyses revealed the following outstanding results as shown in Table 1:- Fe_2O_3 content is between 15 and 70 %, alkalis are low, SiO_2 contents range from 13 to 78 % and relatively low P_2O_5 values of between 0.066 and 1.10 % were recorded. $Fe_2O_3 + SiO_2$ values constitute over 85 % in all the samples, with Al_2O_3 making up less than 5 % in all the samples analysed. When compared with data for some Nigerian iron ores (Uwadiale, 1989) and ironstones in other parts of

the world (Honot, 1983; Sparks and Sirianni, 1974; Uwadiale and Hall, 1985), these units have relatively low P_2O_5 content. A contour map for the Fe_2O_3 values correlates well with the NNW-SSE trend of the hills that characterise the units (Fig. 2).

Discussion

As revealed from the field mapping, the regional character of the units, results of petrographic and chemical analyses, there is a clear distinction between the Ajali sandstone that has been confirmed as a quartz arenite (Hoque and Ezepue, 1977; Ladipo, 1986) and the iron-bearing

part. Furthermore, the overlying Nsukka Formation in the area bears the imprint of a marine succession as evidenced by the occurrence of foraminifera limestone (Reyment, 1965 and Ibe, 1998). There is thus strong possibility of a major break in sedimentation in the area after the deposition of the Ajali Sandstone. This break in sedimentation was typified by the preponderance of iron (possibly oxygen-rich conditions). After the deposition of the Ajali Sandstone in the area, there was the Late Maestrichtian transgression that led to the deposition of the Ohafia limestone unit in the Nsukka Formation (Ibe, 1998).

This iron-rich transitional zone is rather significant and should not be ignored. Reyment (1965) suggested a sub-division of the Ajali Sandstone on the basis of this zone. However no serious attention has been given to this iron ore over the years. Fe_2O_3 content of up to 40 % is significant especially as the two major oxides in the samples are SiO_2 and Fe_2O_3 . The low value for P_2O_5 also makes the beneficiation cheaper than most P_2O_5 -rich ores in Nigeria. Located above the quartz arenitic Ajali Sandstone and below the marine unit of the Nsukka Formation, the deposit is of interest to most stratigraphers in the Niger Delta area of Nigeria. There is also probably the need to sub-divide the Ajali and lower part of the Nsukka Formation as suggested by Reyment (1965).

Conclusion and Recommendation

The Ania-Ohafia ironstone deposit in southeastern Nigeria has not received any attention until now. Petrographic and geochemical studies reveal that between Ajali and Nsukka Formations, there is an ironstone unit. The unit is sandstone with iron oxide content of between 15 and 70 %, low P_2O_5 and alkali values. Furthermore, electrical resistivity soundings are suggested within and outside the study area. Coring at systematically-selected points should be carried out to give more controls for proper modeling and reserve estimation.

Acknowledgement

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