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VEGETATION DISTRIBUTION AS A GUIDE TO MINERALIZATION IN NORTH EAST OF NIGERIA.

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ABSTRACT

*A study of the composition of vegetation from orebodied and unorebodied areas of northeastern zone of Nigeria was carried out. Using spectroscopic techniques, the following elements: magnesium (Mg), calcium (Ca), zinc (Zn), copper (Cu), iron (Fe), silver (Ag), lead (Pb), nickel (Ni), molybdenum (Mo), chromium (Cr), phosphorus (P) and vanadium (V) were confirmed present in the vegetation. Chemical analysis of systematically sampled trees (**Khaya senegalensis (Desr.)** A. Juss and **Azadirachta indica** A. Juss) of the family Meliaceae showed that they contain Ca, P and Fe up to 103 mgdm-3. However, the elements Mg, Cu, Ag, Pb, Ni, Mo, Cr and V are lower.*

INTRODUCTION

Observations have shown that local but extremely corrosive environments near the root tips of plants can extract mineral matter well in excess of what is present in readily exchangeable form (Lovering, 1959; Cole, 1971). Even the primary silicate minerals can be broken down and the components made available to the plants.

Lead, for example is an element that is apparently largely immobilized by precipitation around root tissues of plants (Hammet, 1928). If the amount of Pb in the soil solution is too high, the precipitated Pb compound apparently impedes the flow of solution. The toxic elements U, As and V are apparently precipitated in the root and stem of plants in the same way.

However, these elements normally occur in plants in lower concentration than in the supporting soil. In spite of this impoverishment, the geochemical pattern formed by the toxic elements may be a more faithful reflection of the composition of the soil. Plants sometimes act as indicators of ore deposits and are affected by chemically altered rocks.

The aim of this work was to study the nature and properties of the vegetation from various orebodied and unorebodied areas of northeastern zones of Nigeria. This is in order to use the elemental composition of the plants to predict the secondary minerals in the oxidized zone deposits of the areas. This work highlights the concentration of some elements in Azadirachta indica A. Juss and Khaya senegalensis (Desr.) A. Juss both of the family Meliaceae.

MATERIALS AND METHODS

Sample collection

The family of plants Meliaceae has been described as the mahogany family to which belong several important Nigerian timber trees (Keay, 1964). Khaya senegalensis is a dry zone mahogany and is widely distributed in the savannah regions. Azadirachta indica appears to be the only representative of this genus in Nigeria. It is the well-known neem tree, which is one of the most important trees of eastern India.

Stem-barks of neem and K. senegalensis were collected at Kirawa and Pulka, representing orebodied areas; Damaturu and Maiduguri representing unorebodied areas (Fig. 1).

The elevation of Kirawa and Pulka is 230 m (approximately 700 feet) above sea level. This topographic height should not be construed as a gentle terrain rather they are rugged and consist of a series of sawtooth ridges and steep-sided canyons arising from sand deposition as a result of wind action. Most of the rock surfaces are blocked with desert varnish and pitted with small cavities. Temperatures in these remote areas of the low desert are almost continuously about 45°C from February to May, and it is not usual for the temperature to reach 45°C in June.

The vegetations occur in brecciate sand seams at Kirawa and Pulka, and they are apparently restricted to a small stope at about 5 m level. The stem-barks of these trees were collected around the zones.

So far as is known, no ore was ever mined from these areas since these prospecting days, except for the periodic visits of mineral collectors.

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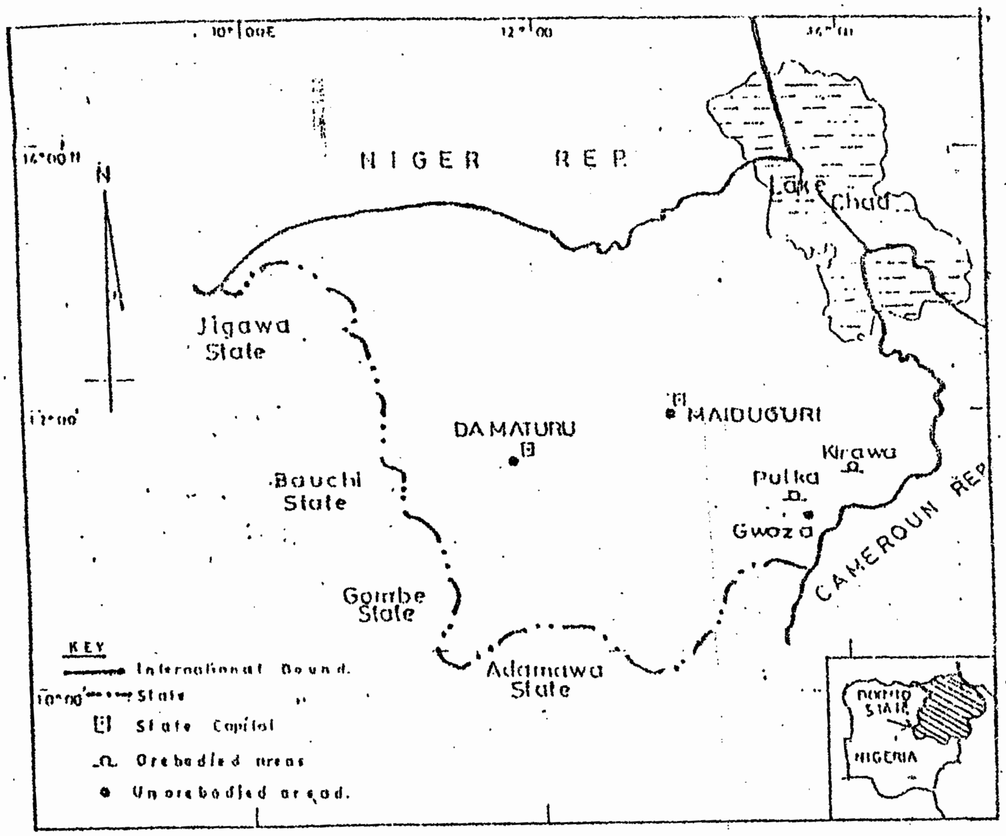

Fig. 1: Location of site from where samples were collected in Borno and Yobe States.

<u>Experimental procedure</u>

The dried powdered stem-barks (10g of each sample) obtained from Kirawa, Pulka, Damaturu and Maiduguri were extracted by addition of concentrated HNO_3 and H_2O_2 (30% v/v 1:1), this dissolves the sample. This was followed by filtration of the extract into a volumetric flask (100 ml) using filter paper (Whatman GF/F Fibreglass 0.3()) and the flask was made to volume with distilled water.

Phosphorus and vanadium were determined colorimetrically (Harwood et al., 1969). Other elements were determined by atomic absorption spectrophotometer (AAS), using Perkin Elmer model 5000 applying standard addition methods.

The preparation of 0.06 and 0.05 moldm-3 standard buffer solutions at 37(C were carried out using potassium hydrogen phthalate and sodium tetraborate. The pH values were measured at 37(C with a cell glass electrode using this solution and presented in Table 1.

The amounts of elements obtained together with the pH readings were used in COMICS program (Perrin and Sayce, 1967) calculations. The computer program was used to predict the activities of the elements in the samples. The equilibrium constant data used as input to the COMICS program were taken from Smith and Martell (1976) and Barner and Scheuerman (1978). The results were those listed in the table. Samples from bedrocks of Kirawa and Pulka were treated as above with pH measured an.! soil analyzed for metal concentration by AAS.

RESULTS AND DISCUSSION

Table 1 shows the values for the average elemental contents for A.indica (A) and K.senegalensis (B) from orebodied and unorebodied areas of northeastern zone of Nigeria.

The values for Ca, Zn, Fe, Pb and P are between 102 and 103 mgdm-3. The amounts of Ca in A and B for example (see Table 1) at Kirawa and Pulka are 1505, 1990; 1900, 1720 respectively and at Damaturu and Maiduguri are 1880, 1860, 1820 and 1780 mgdm-3 respectively. These elements are particularly toxic to plants (Evan et al., 1951; Ahmed and Twyman, 1953; Cole, 1971). Such a pattern of ore metal distribution may tend to suggest that plants in the arid zone region, which grow during the short rainy season, may be susceptible to toxicity by the amounts of these elements present. However, it is believed that a level is reached at which absorption from the soil is considered to be reduced due to precipitation of their compounds around root tissue (Evan et al., 1951; Ahmed and Twyman, 1953; Cole, 1971).

Cole (1971) pointed out that Pb, as an element, is apparently largely immobilized by precipitation in the tissue of plants. Thus, if the quantity of Pb in the soil solutions is too high, the precipitated Pb compounds apparently impede the flow of solutions and the plant dies (Saucelliv, 1969; Sindeeva, 1961). This interface marks the beginning of depositions of Pb and associated mineral phases. which extend down deep for some way into the host ground.

In these results (Table 1) the values of Cu at Kirawa and Pulka for plants A and B are 168 and 191; 180, 192 mgdm-3 as against the amounts obtained at Damaturu and Maiduguri of 72, 65, 60 and 78 mgdm-3. Similar patterns are recorded for Cr, Zn and Ni.

The amounts of Cr for plants A and B at Kirawa and Pulka are 15, 18; 18 and 20 mgdm-3, for Damaturu and Maiduguri the values are 13, 15; 19 and 08 mgdm-3. The values of A and B for Zn at Kirawa and Pulka are 750, 820; 880 and 1390 mgdm-3, for Damaturu and Maiduguri the amounts are 660, 780; 850 and 900 mgdm-3. Amounts of Ni for plants A and B at Kirawa and Pulka are 78,112; 91, 87 mgdm-3 and for this element at Damaturu and Maiduguri the values are 75, 81; 64, 80 mgdm-3.

Cannon (1960) reported that Ni, Cu, Co, Cr, Zn and Mn are all antagonistic to Fe in plants. Excesses of these elements produce a deficiency of Fe necessary in the formation of chlorophyll, with a resulting discoloration of leaves. It is possible that excesses of these mineral-forming elements are present in the bedrock (Table 1) beyond the 5 m level at Kirawa and Pulka. It may be recalled that these vegetations were restricted to brecciate sand seams at about a slope of 5 m level at Kirawa and Pulka. These species are apparently grown preferentially on the mineralized ground within limited areas, but grew over non-mineralized ground in other regions in a wider range. These plants may be used as local indicator following the observation of Cole (1971).

Lag and Bolvikan (1974) also pointed out that the absence of vegetation cover rather than its presence is useful as an ore guide. For these elements analyzed (Table 1), particularly for elements that are essential to plant growth, that is Ca, Fe, Pb and P at above 5 m level a level is reached at which absorption from the soil to the upper parts of the plants are considerably reduced so that the plant is unhealthy, deformed or dies (Evan et al., 1951; Sindeeva, 1961; Sauchelliv, 1969). However, in the bedrock, the association of Fe with P and V as minerals is noteworthy feature of many deposits (Sindeeva, 1961). Deposition of such components can give rise to concentration of Fe of ore grade.

Table 1: Average elemental content (mgdm-3) in the ash of Azadirachta indica and Khaya senegalensis growing in Pulka, Kirawa, Damaturu and Maiduguri, northeastern Nigeria.

Element	Kirawa		Pulka		Damaturu		Maiduguri		Kirawa	Pulka
	A	B	A	B	A	B	A	B	C	D
Mg	910	930	750	850	800	980	620	900	1480	1640
Ca	1505	1990	1900	1720	1880	1860	1820	1780	3330	10530
Zn	750	820	880	1390	660	780	850	900	1300	400
Cu	168	191	180	192	72	65	60	78	180	100
Fe	1300	1450	1550	1760	1965	1760	1020	1050	63500	39000
Ag	55	60	65	70	40	380	28	22	40100	20000
Pb	205	210	118	175	125	125	115	130	5200	10000
Ni	78	112	91	87	75	81	64	80	7000	5000
Mo	71	78	65	80	25	19	50	35	98	130
Cr	15	18	18	20	13	15	19	08	44	40
P	1720	2020	2050	1970	1880	1500	1650	1450	2030	1500
V	40	65	45	38	<5	<5	ND	<5	55	70
PH	5.90	6.01	5.75	5.85	5.98	6.00	6.20	6.10	6.10	5.83

NB: A = Azadirachta indica B = Khaya senegalensis
C and D = Average elemental contents (mgdm^{-3}) of Kirawa and Pulka bedrocks.

CONCLUSION

It may be concluded that the elementology of A.indica and K.senegalensis can serve as a useful guide to the mineralization of Kirawa and Pulka. These compositions would bear a fairly simple relationship to the metal content of the bedrock. To this extent, some Fe, Pb, Cu, Zn, Cr and P containing secondary minerals are expected from these orebodied areas.

REFERENCES

Ahmed MB and Twyman ES (1953). The relative toxicity of manganese and cobalt to plants. J. Exp Bot., 4: 164-172.

Barner HB and Scheuerman RV (1978). Handbook of compounds and aqueous species. John Wiley and Sons, New York.

Cannon HL (1960). Botanical prospecting for ore deposits. Science, 132 (3427): 591-598.

Cole MM (1971). The importance of environment in biogeographical/geobotanical investigations. Toronto Symposium, Volume 1: 414-425.

Evans HJ, Purvis ER and Bear FE (1951). The effect of soil reaction on availability of molybdenum. Soil Science, 71: 117-124.

Hammett FS (1928). Studies in the biology of metals I: the location of lead in growing roots. Protoplasma, 4: 183-186.

Harwood JE, Steedern and Kuhn AL (1969). Method for the determination of phosphorus, arsenic and vanadium. Water Res., 3: 417-420.

Keay RWJ, Onochie CFA and Stanfield DP (1964). Nigerian Field, Volume 2. Forest Research, Ibadan.

Lag J and Bolviken B (1974). Some naturally occurring prospecting substances. Norges Geol., Undersok., 204: 73-96.

Lovering TS (1959). Significance of accumulator plants in rock weathering. Geol Soc Am Bull., 70: 781-800.

Perrin OD and Sayce IG (1967). Manual for computer programme. Talanta, 14: 833-837.

Rowland P (1991). The circulation of water and minerals in tropical soil; Current concepts on agroeconomical consequences. Vol. 1: 4-7; Orsten-Lome, Togo.

Sauchelliv A (1969). Trace elements in agriculture. Vannostrand Reinhold Co.

Smdeeva ND (1961). Mineralogy of deposits. Interscience, New York.

Smith RM and Martell AE (1976). Critical stability constant, Volume 4. Plenum Press, New York.