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SUMMARY OF ISOTOPIC AGES FROM OBAN-OBUDU MASSIF OF SOUTH-EASTERN NIGERIA AND ITS IMPLICATION FOR THE EVOLUTION OF THE PRECAMBRIAN BASEMENT COMPLEX OF NIGERIA.

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ABSTRACT

The first set of isotopic ages for basement rocks of Southeastern Nigeria which constitute the Oban-Obudu Massif were obtained using the Rb-Sr method. These rocks were mapped in the Oban Massif and yielded ages ranging from 527Ma to 1313Ma implying that the Precambrian crust in the area evolved through Kibaran to Pan African orogenies. The Kibaran event has remained a subject of dispute and the amphibolites which yielded the Kibaran window crop out at Akor near Oban village. They should be sampled for further analysis and study. ^{40} Ar / ^{39} Ar ages were obtained from the amphibolites in Obudu and gave a plateau age of 811 ±1.1 Ma whilst the dolerite in the Obudu plateau gave a plateau age of 140.5 ± 0.7 Ma. The age of the dolerite is significant since it shows that most dolerites in the Nigerian basement may be younger than the Pan-African orogeny and that the Obudu dolerites were emplaced during the early tholeiitic magmatism which preceded the separation of Africa and South America. K-Ar ages have been obtained on many rocks in the Oban massif. They range from a maximum age of 930Ma from the homogeneous amphibolites at Akor to 512 Ma in granodiorites and 204 Ma in the dolerite. These ages are interpreted as cooling ages of the rocks and in the case of granodiorite a time lag of ca. 100Ma was required for the magma to cool and crystallize the outcrop in Igbofia western Oban Massif. Zircon ages obtained were by single grain Pb/Pb evaporation method and the ages were those of emplacement of the rocks. A maximum zircon age of 2504.5 ± 0.5Ma was obtained from banded schists in Bagga in the Obudu Plateau and was interpreted as an indication that Archaean crust occurs in Southeastern Nigeria. The maximum zircon age obtained in the Oban massif is the 1932 ± 5Ma from the banded gneisses in Oban village. Pan-African zircon ages were obtained from granodiorites in Oban massif and from gneisses and charnockites in the Oban and Obudu areas. Multifaceted zircons in Obudu area gave evaporation ages ranging from 750 to 2062 Ma. These have been interpreted to imply that the Precambrian crust of Southeastern Nigeria underwent episodes of amphibolite and granulite facies metamorphism. The sources of the sediments which were deposited at Ca 605 Ma and metamorphosed at 574 Ma include older igneous and metamorphic protoliths which were demolished during the Neoproterozoic. The older Paleoproterozoic protolith may be product of Pan-African melting of a nuclei of that age incorporated in the series. This is similar to what happened in the Central African Fold Belt where tectonically juxtaposed Neoproterozoic and palaeoproterozoic units are described.

KEYWORDS: Isotopic ages, Kibaran, Zircon, Central African Fold Belt, Oban-Obudu massif.

INTRODUCTION

Nigeria is 923, 768km^2 in size and composed of fifty percent basement rocks and fifty percent sedimentary rocks (Fig. 1). The country is situated within a Pan-African mobile zone lying between the West African craton in the West and Gabon-Congo craton in the Southeast. Rock units of the Nigerian basement consists of: (i) the Migmatite-gneiss complex (MGC) mostly orthogneisses. (ii) the Schist belts mostly Metasediments (iii) the Older Granites which are of Pan-African age.

Polymetamorphism and polyphase deformation affected the basement rocks resulting in complexly deformed rocks with structures trending dominantly N-S to NE-SW. Relict E-W and NW-SE structures have been interpreted as imprints of a pre-Pan-African orogeny.

The geochronological units of the Nigerian basement include: (i) Archaean rocks which are believed to be product of Liberian orogeny (2800 ± 200Ma), (ii) Palaeoproterozoic rocks (2000 ± 200Ma) interpreted as belonging to the Eburnean event (iii) Mesoproterozoic rocks (1000 ± 200Ma) thought to belong to the Kibaran event and (iv) Neoproterozoic rocks which are the dominant rocks in the basement and show Pan-African ages (750-450Ma). For some time the existence of rocks of Liberian ages were disputed but recent data from Dada et al. (1993) and Kroner et al. (2001) have confirmed the existence of Archaean rocks in the Nigerian basement. The Kibaran event is still disputed (Rahaman 1988) but zircon age data from NW Cameroon (Toteu et al. 2005) and from SW Obudu area (Ukwang 2006) indicate that the Kibaran orogeny may have affected parts of the Southeastern Nigeria basement which appears to be an extension of the Central African Fold Belt (Ekwueme and Kroner 2006)

ROCK UNITS IN THE OBAN-OBUDU MASSIF

The three major rock units in the Nigerian basement have been mapped in the Oban-Obudu Massif (Rahaman et al. 1981, Ekwueme 1985, 1990, Ukaegbu 2003, Ephraim 2005, Ukwang 2006). These are the migmatite gneiss complex, the schists and the older granites (Figs. 2 and 3). These rocks form two giant spurs and constitute the Eastern Nigerian Highlands. A detailed mapping of the region showed that schists, gneisses, amphibolites, charnockites, granites, pegmatites, dolerites occur in both the Oban massif and Obudu Plateau. Phyllites, granodiorites, diorites and syenites occur in the Oban massif whilst granulites and meta-ultramafites are restricted to the Obudu Plateau.

These rocks are complexly deformed (Ekwueme 1987, 1994a) and folds, faults, foliations, shear zones and lineations occur with dominant structural trends in the N-S to NE-SW (0-30^0). Relict NW-SE and E-W trending structures have been mapped and are interpreted as representation of pre-Pan-African events.

The metamorphism is the Barrovian type and zones and isograds have been mapped in the Oban massif (Ekwueme and Onyeagocha 1985) and metamorphic grades in the area range from middle greenschist facies in the west to uppermost amphibolite facies in the East. The charnockite area in Northeast Oban massif has been interpreted as having been intruded 584.5 ± 1.0Ma ago near the peak of granulite facies metamorphism. No isograds have been mapped in Obudu Plateau. It is a high-grade terrain which attained granulite facies grade with pockets of retrogressive phases to

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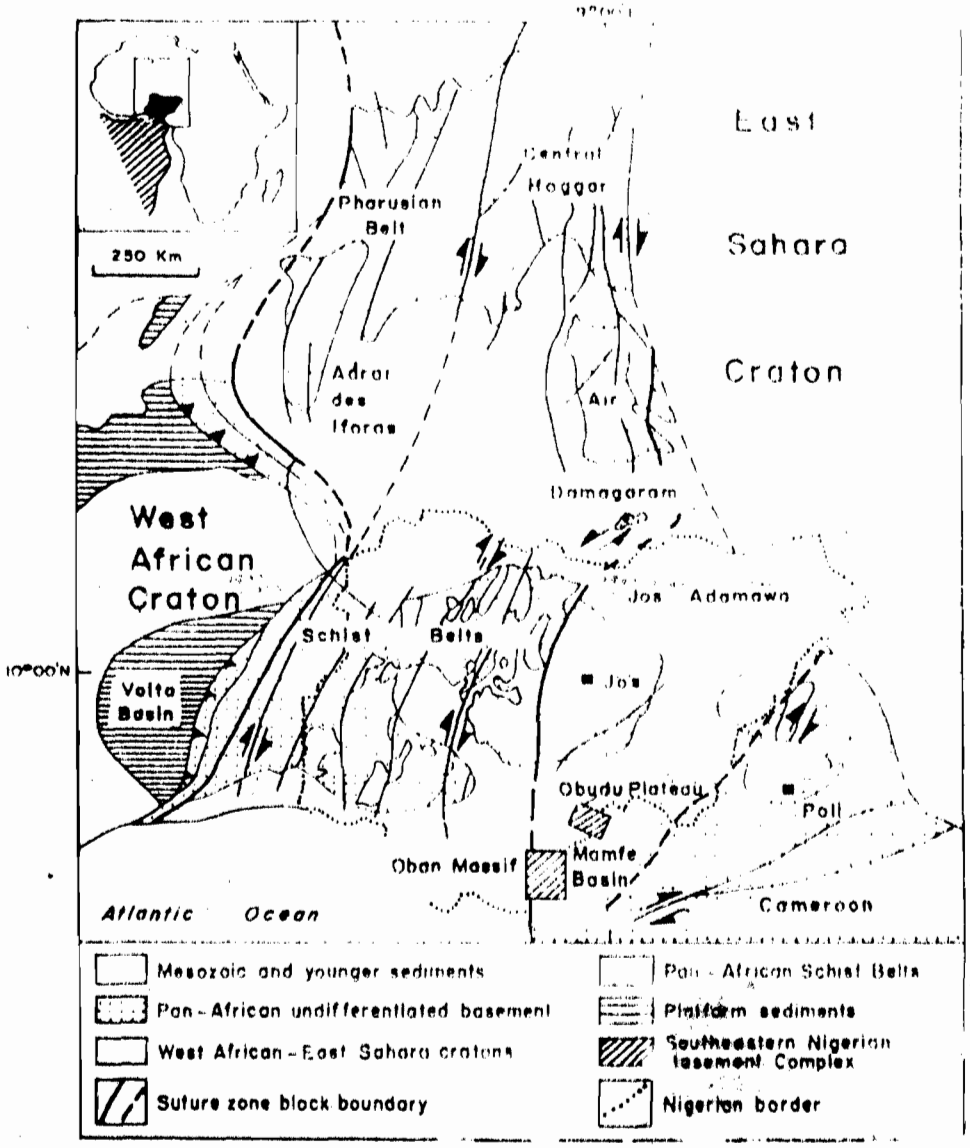

Fig. 1: A generalized map showing the Pan-African Belt of Nigeria and the location of the Southeastern Nigerian Basement Complex (modified from Ferre et al., 1995)

amphibolite facies (Ekwueme and Kroner 2006, Ephraim et al. 2006). The average P-T distributions in the Obudu area according to Ephraim et al. (2006) are T~ 691°C and P ~ 6.88kbars for schistose rocks, T ~ 575°C and P~7.02 kbars for the gneissose rocks translating to a depth of burial of at least 20km and an average thermal gradient ranging from ~ 27.3°C/km to 34.6°C/km.

Ukaegbu and Ekwueme (2005, 2006) and Ekwueme and Onyeagocha (1986) discussed the geochemistry of the rocks in Oban and Obudu massif and pointed out that the protoliths of the schists are pelitic whilst gneisses range from igneous protolith to rocks derived from a shale-greywacke sequence. The dolerites and amphibolites were tholeiitic whilst the charnockites and granitic rocks, are generally calc-alkaline and emplaced in the field of orogenic and volcanic arc granite of Pearce et al. (1984).

GEOCHRONOLOGICAL UNITS OF OBAN-OBUDU MASSIF

Rocks in the Oban Obudu massif have been dated using Rb-Sr, $^{40}Ar/^{39}Ar$, K-Ar and single zircon evaporation methods. The details of these methods are in Ekwueme (2003) and the ages obtained are as listed below.

METHODS OF DATING

- Rb-Sr
- 40Ar/39Ar
- K-Ar
- Single zircon evaporation

The following ages and events are represented

- 2504 5 ± 0 5 Ma-Neo-Archean - Migmatitic schist in Obudu
- 2062.4 ± 0.4 Ma Palaeoproterozoic – Granulite in Obudu
- 1931.9 ± 0.8 Ma Palaeoproterozoic – Banded gneiss Oban
- 1788.8 ± 2.1Ma Palaeoproterozoic – Migmatitic schist in Obudu
- 1676 - 1869 Ma Palaeoproterozoic – Garnet sillimanite gneiss in Obudu
- 1540 Ma – Mesoproterozoic – Leucogranite in Obudu
- 1313 ± 37 Ma Mesoproterozoic – Amphibolite in Oban
- 1289 ± 153 Ma – Mesoproterozoic – charnockite in Oban

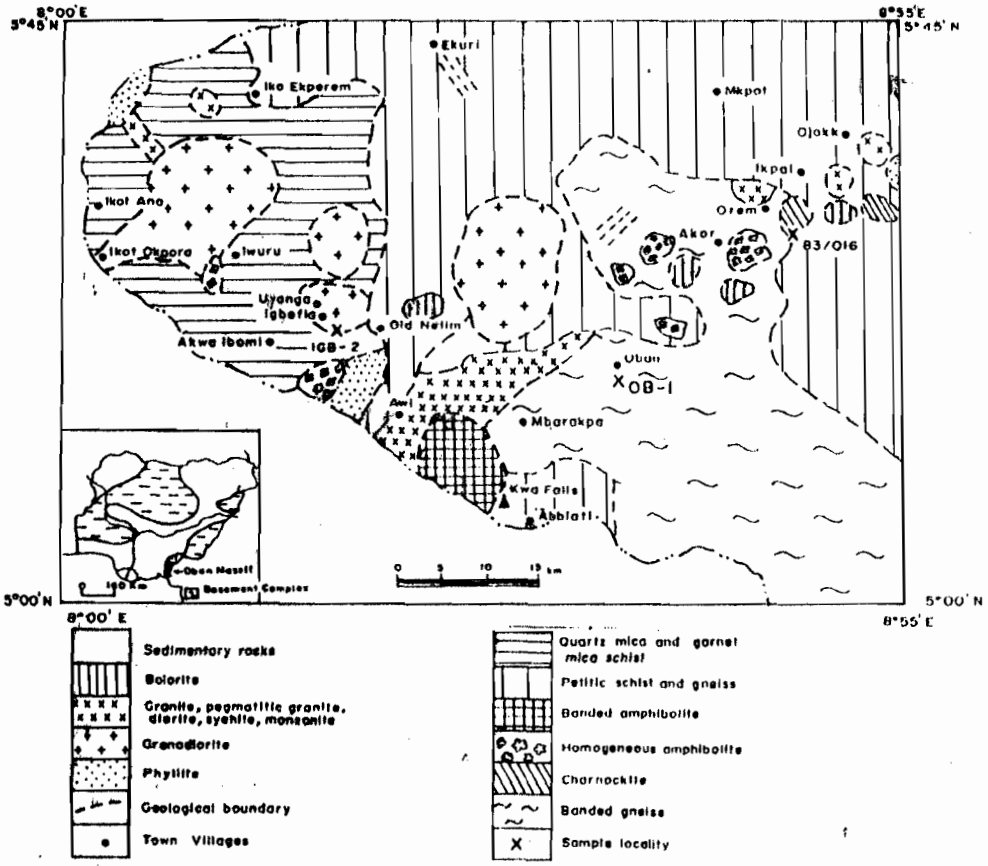

Fig. 2: Geological Map of Oban massif Southeastern Nigeria (Ekwueme and Kroener 1998)

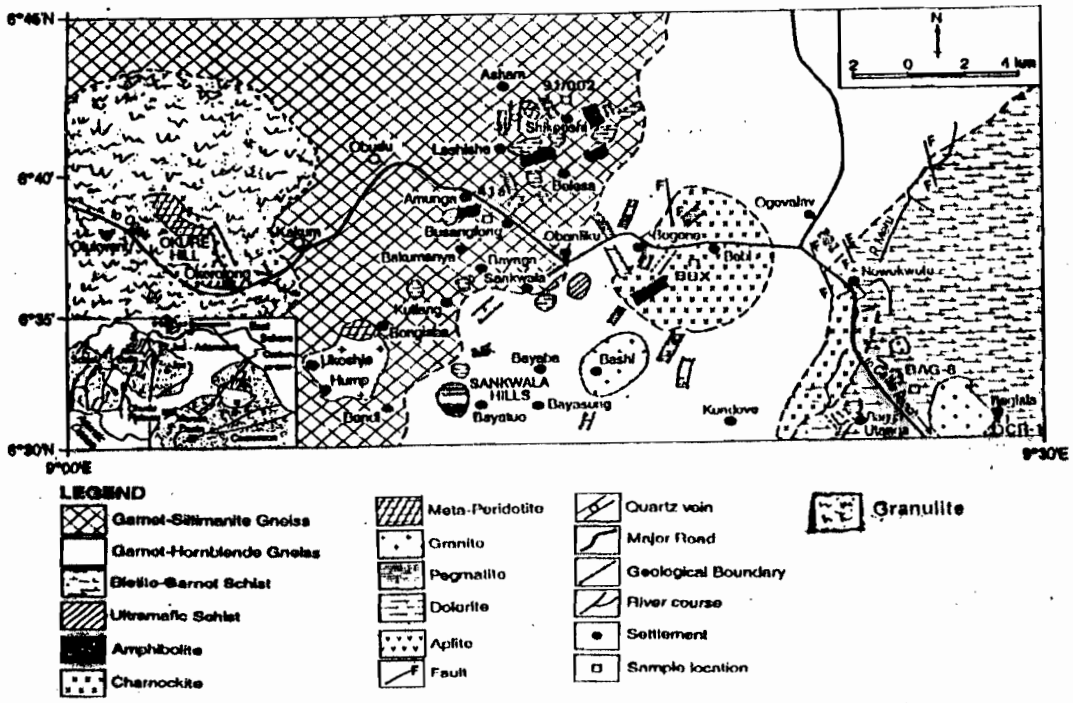

Fig. 3: Geological map of Southern Obudu Plateau, Southeastern Nigeria (After Ekwueme and Kroener, 1997)

- 811 ±1.1Ma- Neoproterozoic - Meta-ultramafite in Obudu
- 784 ±31 Ma – Neoproterozoic – Banded amphibolite in Oban
- 750.0 ±0.9 Ma – Neoproterozoic – Granet-sillimanite gneiss in Obudu
- 676 ±26 Ma – Neoproterozoic - Kyanite gneiss in Oban
- 664.8 ± 1.5 Ma – Neoproterozoic – Migmatitic schist in Obudu
- 616.9 ± 1 Ma –Neoproterozoic – Granodiorite in Oban
- 605.3 ± 1.4 Ma-Neoproterozoic – Migmatitic schist in Obudu
- 584.5 ± 1 Ma – Neoproterozoic – Charnockite in Oban
- 574.1 ±1.0 Ma –Neoproterozoic – Charnockite in Obudu
- 510 ± 11 Ma -527 ± 16 Ma - Neoproterozoic - Migmatites in Oban
- 140.5 ± 0.7Ma – Mesozoic – Dolerites in Obudu

From these ages, the dominant event in the region was Neoporoterozoic. Relicts of Palaeoproterozoic, Mesoproterozoic and Neoarchaean crusts have been mapped. Granulite facies metamorphism took place between 574.1Ma and 584.5 ± 1.0Ma ago, (Ekwueme and Kroner 1998), uppermost amphibolite facies Barrovian type of metamorphism occurred 605-676 Ma ago (Ekwueme et al. 1988) whilst the emplacement of Proterzoic crust occurred 2062 to1932 Ma ago (Ekwueme and Kroner 2006). Main phase Pan-African intrusion occurred Ca.617 ± 2 Ma ago (Ekwueme and Kroner 1995). Intrusion of dolerite occurred 140Ma ago and marked the opening of the South Atlantic and separation of Africa and South America (Ekwueme 1994b).

RELATIONSHIP OF THE OBAN-OBUDU MASSIF WITH THE CENTRAL AFRICAN FOLD BELT (CAFB)

Three field conferences (two in Cameroon in 2002, 2004 and one in Oban-Obudu massif in 2005, this volume) have shown that the Oban-Obudu massif is more related to the rocks in the Central African Fold Belt than those in the West African craton. The Oban-Obudu massif evolved as a result of successive tectonothermal events. This is also true for CAFB. Archaean ages in the two regions are inheritances in high-grade terrains and reworking of older crust occurred in the Oban-Obudu massif and CAFB (Toteu et al. 2005; Ekwueme and Kroner 2006). Poli schists may be an extension of the Obudu schists and the schists in the Oban massif. They have similar ages. The metarhyolite age of 830 Ma in Poli (Toteu et al. 1990) is similar to age of 811Ma for Obudu amphibolite (Ekwueme and Shiling 1995). Two age groups have been reported for CAFB:1990 ± 70 Ma or older and between 656 ± 15 Ma and 495 ± 10 Ma (Toteu et al. 2001). These are similar to the ages of the Oban-Obudu basement. In addition, CAFB and Oban-Obudu basement massif have similar lithologies and Mesoproterzoic ages have been reported in both regions (Toteu et al. 2006; Ekwueme and Caen-Vachette 1991; Ukwang 2006).

CONCLUSION

It is evident that the rocks of the Oban-Obudu massif are closer in relationship to the rocks of Central African Fold Belt than the West African cratons. A model of continent-continent collision that involved the Congo craton and North Central Cameroon active margin showing Archaean to Palaeoproterozoic inheritances was proposed by Toteu et al. (2001) and (2004). According to him, the Eburnian event fused the Congo craton with the Sao Francisco craton of Brazil to form a larger, middle Palaeoproterozoic Congo–Sao Francisco craton. It is my opinion that this event extended to the Oban-Obudu massif of southeastern Nigeria.

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