

Granite formations and granite cavities in northern Nigeria

Formaciones graníticas y cavidades graníticas en el Norte de Nigeria

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Abstract

The Author worked as geologist in Northern Nigeria during several years. This study presents his experiences concerning the granite formations of the region. The geological base of Northern Nigeria is the so-called Basement Complex. A significant part of this basement is the Older Granite Formation, which has been intruded in the late Precambrian and in the Lower Palaeozoic. The ring tectonic complexes of Jurassic age - Younger Granites - intruded into late Precambrian basement rocks in a N - S trending zone. Most of the landscape is characterized by the occurrence of large, almost level peneplains formed by intensive erosion over long periods. The most spectacular landforms are the granitic inselbergs, the woosack shaped boulders with cavities and the balanced rocks. The Author had studied the rock shelters and cavities, between and below the woosack shaped granite blocks near the town of Birnin Kudu in Jigawa State. He describes the formations and the development of the three largest cavities. They contain rock paintings and may have provided shelters or religious places for the ancient inhabitants. These paintings are typical of those found along the sahel belt of West Africa and were probably made by the ancient Fulani cattle herders.

Key words: Basement Complex, Older Granite Formation, Younger Granite Formation, peneplains, inselbergs, woosacks, Birnin Kudu Rock Shelters, ancient rock paintings

GEOLOGICAL SETTING

The Basement Complex in Northern Nigeria is underlain by gneiss, migmatites and metasediments of Precambrian Age, which have been intruded by a series of granitic rocks of late Precambrian to lower Palaeozoic. The plutonic rocks are known as Older Granite and have been dated to about 500 to 600 million years, representing the Pan-African orogeny in Nigeria. The granite bodies are widespread in the north and range in size from the smaller elliptical plutons to the masses of batholithic dimensions over 100 km in length. The contacts with the gneisses are gradational passing from granite into metasomatic gneiss with marginal migmatites. The contacts between granites and metasediments are sharp with no marginal migmatites (OYA-VOYE, 1964).

The granitic rocks are all compositionally similar, containing quartz, microcline, plagioclase and biotite with accessory apatite and zircon. The porphyritic granite is the most typical type of the Older Granite. It is coarse to very coarse grained with large white or pink prismatic phenocrystals of microcline. The granites are variably foliated becoming almost gneissose in places. Occasionally, medium to fine grained granodiorite, quartz syenite and microgranite also appear.

The youngest rock of the Basement Formation is a series of rhyolites and rhyodacites that were intruded into the Older Granite bodies during the lower Palaeozoic uplift following the Pan-African orogeny. They occur in several places in North-East and North-West Nigeria.

The ring tectonic complexes of the Jurassic age - Younger Granites - intruded into late Precambrian Basement rocks in a N - S trending zone. The Younger Granite is 160 to 170 million years old. Its emplacement was associated with epirogenetic uplift. The ring structure and the petrology follow a general pattern. Their evolution can be summarized in three stages as the early volcanic stage, the caldera and ring dyke stage and the intrusive stage. The earliest rocks are volcanic, composed of rhyolite with minor associated basalts and trachytes. They are closely associated with the outer ring dykes of granite porphyry. Within the ring dykes there are stock-like intrusions of biotite granite. The centre of the complexes is composed mainly of massive biotite granite with smaller intrusions of porphyry (KOBKE, 1976).

The granites are composed of alkali feldspar, quartz with a small proportion of mafic minerals and are classed as alkali feldspar granites. They are unfoliated.

The Younger Granite is the source of the tin mineralization in the Jos Plateau region.

To the south and southeast and partly to the west the Basement Complex is unconformably overlain by the Cretaceous sediments. In eastern Kano State, and in Borno and Bauchi States of the Quaternary limnic sediments of the Chad Formation are the characteristic covering series.

The weathered Basement rock and also the Younger Granite Formation is, in many places, overlain by a 5 - 10 m thick laterite crust, which had developed gradually in the Tertiary and Quaternary. Further drift and fluvial deposits comprise overlying strata of the Basement surface (Fig. 1.).

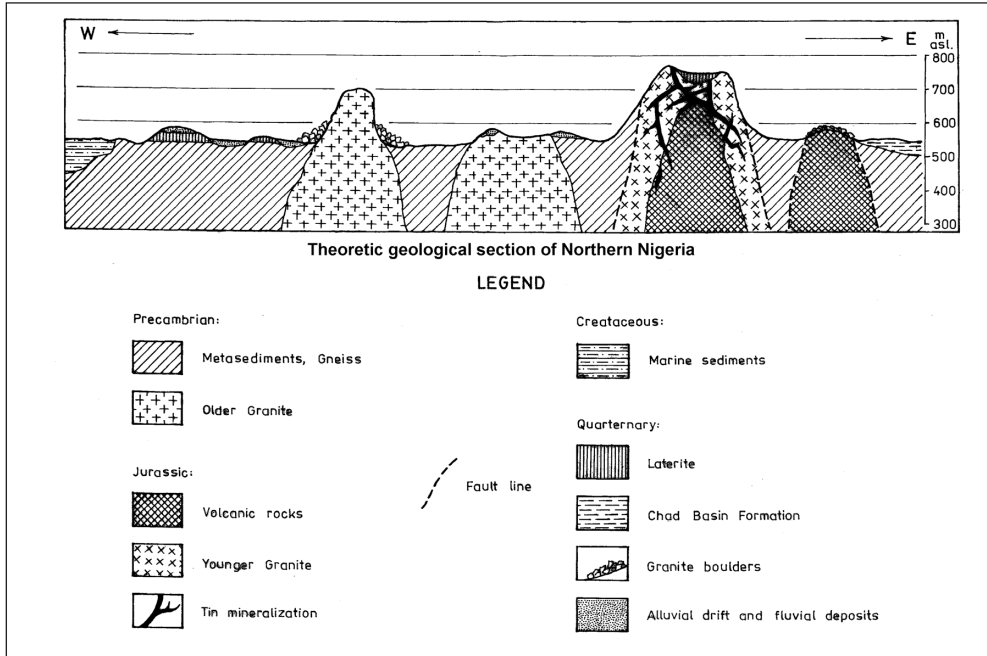


Fig. 1: Theoretic geological section of Northern Nigeria

Landforms of the Older Granite

Most of the landscape in West Africa is characterized by the occurrence of large, almost level plains (peneplains), formed by intensive erosion over long periods. This began with the erosion during the Jurassic era after the disruption of the Gondwana land, followed by the Cretaceous Post-Gondwana erosion (e.g. Cameroon Highlands).

Most of the plains and plateaux in northern Nigeria are the result of Plio-Pleistocene erosion, the so-called African and Post-African planation. These plains and plateaux have an undulating relief 400 - 600 m above the sea level and are dissected by streams and rivers, usually in a dendritic drainage pattern which, in some places, form deep gorges. Locally, steep-sided remnants of older plateaux

and granitic inselbergs, and hill ridges rise from these plains. Granitic inselbergs and ridges have resisted ongoing weathering and erosion because of their hardness. They can be as high as 200 - 300 m. The mesas, which can rise to about 100 - 200 m above the ground level, have formed because of the occurrence of ironstone hardpans on their surfaces. These hardpans have been formed through a downward movement and subsequent accumulation of minerals in the lower soil horizons notably iron oxides, under conditions of alternating moisture and drought (THOMAS, 1974).

On the level peneplains formed by the various erosion cycles, massive sheets of lateritic iron accumulation were able to develop. The stripping of overlying soil material during new erosion cycles, caused by either

the uplifting or alternatively the lowering of the erosion base, proceeded down to the indurated iron pan, which now appears at, or near, the surface.

Some remarkable geological formations, such as woolsack shaped boulders with cavities, balanced rocks have been formed by spherical weathering. They have developed from the combination of mechanical weathering (which cracked the rocks) and chemical weathering (which flaked the off surface).

The boulders were originally part of a solid mass of coarse-grained granite which formed deep within the Earth's surface about 1640 million years ago. The development of these granite blocks is related to the formation of the woolsack caves and it will be discussed in the chapter on the Birnin Kudu Rock Shelters.

I would now like to describe some characteristic examples of the Older Granite landforms in Northern Nigeria (Fig. 2.).

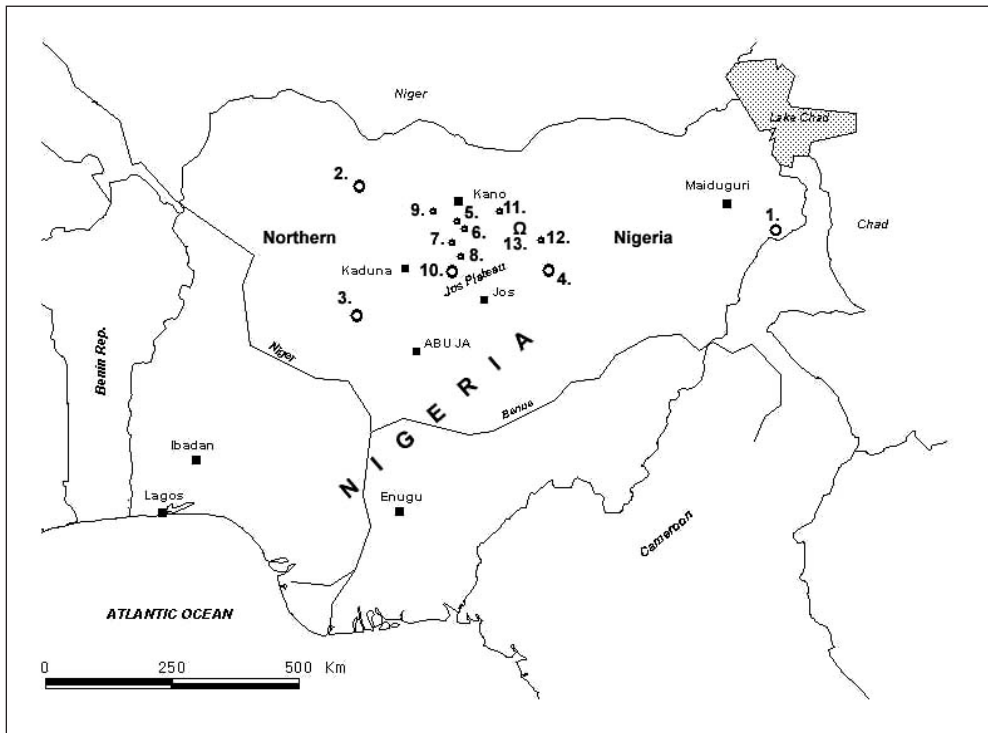


Fig. 2: Locations of the studied granite formations. Older Granite Formation: 1: Granite blocks near Gwoza village (Borno State), 2: Inselberg near the town of Gusau (Zamfara State), 3: Inselberg near the town of Tegina (Niger State), 4: Inselberg near the town of Bauchi (Bauchi State), 5: Granite surface near Rano village (Kano State), 6: Granite Surface near the Tiga Reservoir (Kano State), 7: A shield inselberg near Rurum village (Kano State), 8: Partly disintegrated inselberg in the Kano River Forest (Kano State), 9: Challa Gorge (Kano State). Younger Granite Formation: 10: Ririwai Hills and tin ore mining (Kano State), 11: Disintegrated inselberg near the town of Dutse (Jigawa State), 12: Pile of granite blocks near Gwaram village (Jigawa State), 13: Birnin Kudu Rock Shelters in Older Granite Formation (Jigawa State)

The Gwoza Hills, along the Cameroon border in Borno State, are part of the larger granite chain of the south-west part of Borno State. The mountains and their sur-

roundings are covered in scattered rock pieces and comprise spectacular inselbergs, balanced rocks and other related features (Picture 1.).



Picture 1.: Older Granite Formation, Granite blocks near Gwoza village (Borno State)

In the west, in *Zamfara State* near the town of *Gusau* a huge inselberg several hundred meters high rises from the Basement surface.

The southern part of the Basement Complex in the *Niger State* is also characterized by granitic outcrops and spectacular inselbergs which can be found in the vast topography of rolling landscape. Such inselbergs dominate the landscape, for instance those near the town of *Tegina*.

Further to the north in *Bauchi State* there is a highland area of hill ranges, including the northern edges of the Jos Plateau complex. This is also part of the crystalline rock area of central northern Nigeria. The hill ranges have developed mainly on the Older

Granite of the Basement Complex rocks, in an area which is composed of by extensive plateau surfaces. The base of the hill ranges is generally at the 600 m level, while peaks rise to over 700 m on the some significant inselbergs.

In *Kano State* various interesting features can be observed in the Older Granite. Near the *Tiga Reservoir* an undulating granite surface covered by thin bush vegetation crops out. Intermittent streams are breaking through the granite hills and forming gorges. In one of these gorges the dam for the Tiga Reservoir was constructed, and the nearby *Challawa River* had formed a similar gorge (Picture 2.). Spectacular inselberg is rising near town of *Rano* and an interesting

shield inselberg can be found near *Rurum* village (Picture 3.). Disintegrated granite hills dominate the landscape along the Kano River in the *Kano Forest Reserve* area.

Near the town of *Birnin Kudu* town in *Jigawa State* the granite surface consists of woolsacks, tors and balanced rocks with some interesting cave development.



Picture 2: Older Granite Formation of the Challawa Gorge (Kano State)



Picture 3.: Older Granite Formation ,A shield inselberg near Rurum village (Kano State)

Landforms of the Younger Granite

Nearly fifty younger granite massifs are known, varying greatly in size. They occur in an broad N-S zone, 400 x 150 km, centred in Jos Plateau (Fig. 2). Typical of this formation are the ring complexes.

In central Nigeria, the Jos Plateau is a granitic plateau with some volcanic hills and basalt flows up to 1,600 m a.s.l. At its southern margin, the Jos Plateau is separated from the high plains of Hausaland by extremely deep and steep scarps of approximately 600 m (TURNER 1972).

One of the best examples of the several Younger Granite Formation forming ring complexes is the *Ririwai Hills* in *Kano State* (Picture 4.). These rugged hill ranges follow the outer ring tectonic lines whilst the inner ring area has a relatively flat or gently undulating granite surface. The inner area has been considerably altered as a result of anthropogenic influences due to the surface and underground tin mining. In the SE corner of the state near *Gwaram* village a strongly disintegrated granite formation covered with large boulders can be observed. This is probably the remains of a smaller ring complex.



Picture 4.: Younger Granite Formation, Ririwai Hills (Kano State)

In the ring complexes several inselberg shaped hill ranges and outcrops of volcanic rocks are part of the Younger Granite Forma-

tion. In *Jigawa State* near the town of *Dutse* a long hill range composed of younger biotite granite is a spectacular landscape form.

The granite is mainly disintegrated. The hill is covered with large woolsack shaped granite boulders (Picture 5). These boulders have not yet been studied speleologically.

In the town of Birnin Kudu, near the rock shelters, a hill composed of rhyolite represents the volcanic stage of the Younger Granite Complex.



Picture 5.: Younger Granite Formation, Disintegrated inselberg near the town of Dutse (Jigawa State)

Birnin Kudu Rock Shelters

Birnin Kudu administrative centre is 130 km ESE of Kano town, in Jigawa State, northern Nigeria (Fig. 2.).

Geologically the area consists of an Older Granite plateau with residual monolithic granite boulders, which slopes gently southwards to a small river. To the east of the area hills rises up from the plateau, consisting of rhyolite of the Younger Granite Formation.

The development of the rock shelters is associated with the spherical, chemical and physical, weathering of the granite. They can be considered according to the nomen-

clature of the non-karstic caves as woolsack caves (ESZTERHÁS, 2005). Their formation within the subsurface several hundred million years ago. As the molten magma cooled and hardened to form granite the mass shrank and cracked and these cracks (known as joints) effectively split the granite body into a series of tight fitting blocks. The erosion of the lateritic regolith and the tectonic movements brought the granite boulders to the surface. Erosion has since stripped away the overlying material, and weathering processes have shaped them into the forms in which they appear today (TWIDALE, 1984).

The monolithic granite boulders have partially disintegrated under the influence of the tropical weathering.

The rock shelters, between and below the woolsack shaped granite blocks, have formed both along fault lines and where the

blocks slipped into favourable positions.

Three larger rock shelters were investigated (Fig. 3.). They contain rock paintings and may have provided shelters or religious places for the ancient inhabitants (St PIERRE-SZENTES, 1977).

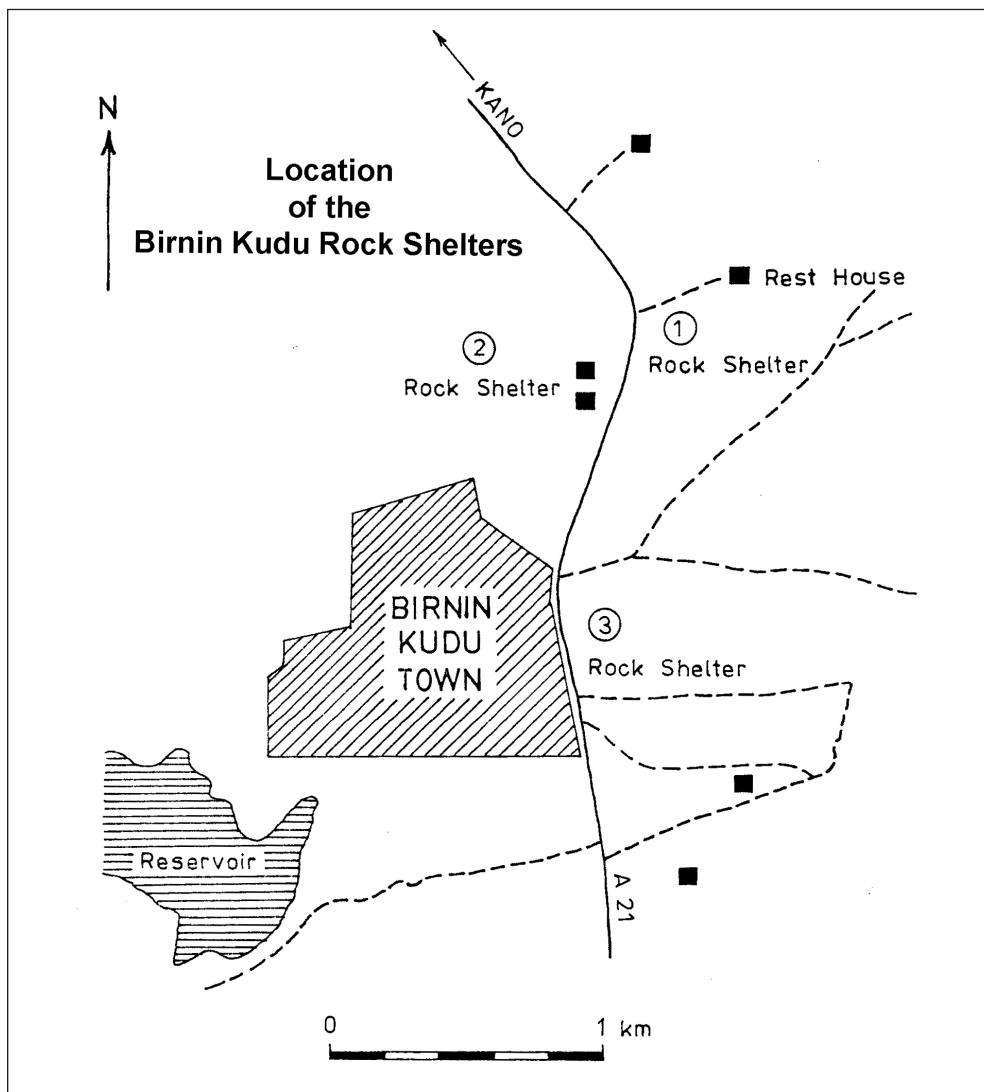


Fig. 3. : Location of the Birnin Kudu Rock Shelters

The Rock Shelter No. 1 has formed along NW-SE and E-W fault lines (Fig. 4., Picture 6.). The E-W passage shows the tectonic origin nicely. The floor is filled with granite gravel partially covered by bat

guano which spills out of the narrow E-W passage where a large number of bats were roosting. The rock paintings are to be found beneath an enclosed overhang on the outer wall of the shelter.

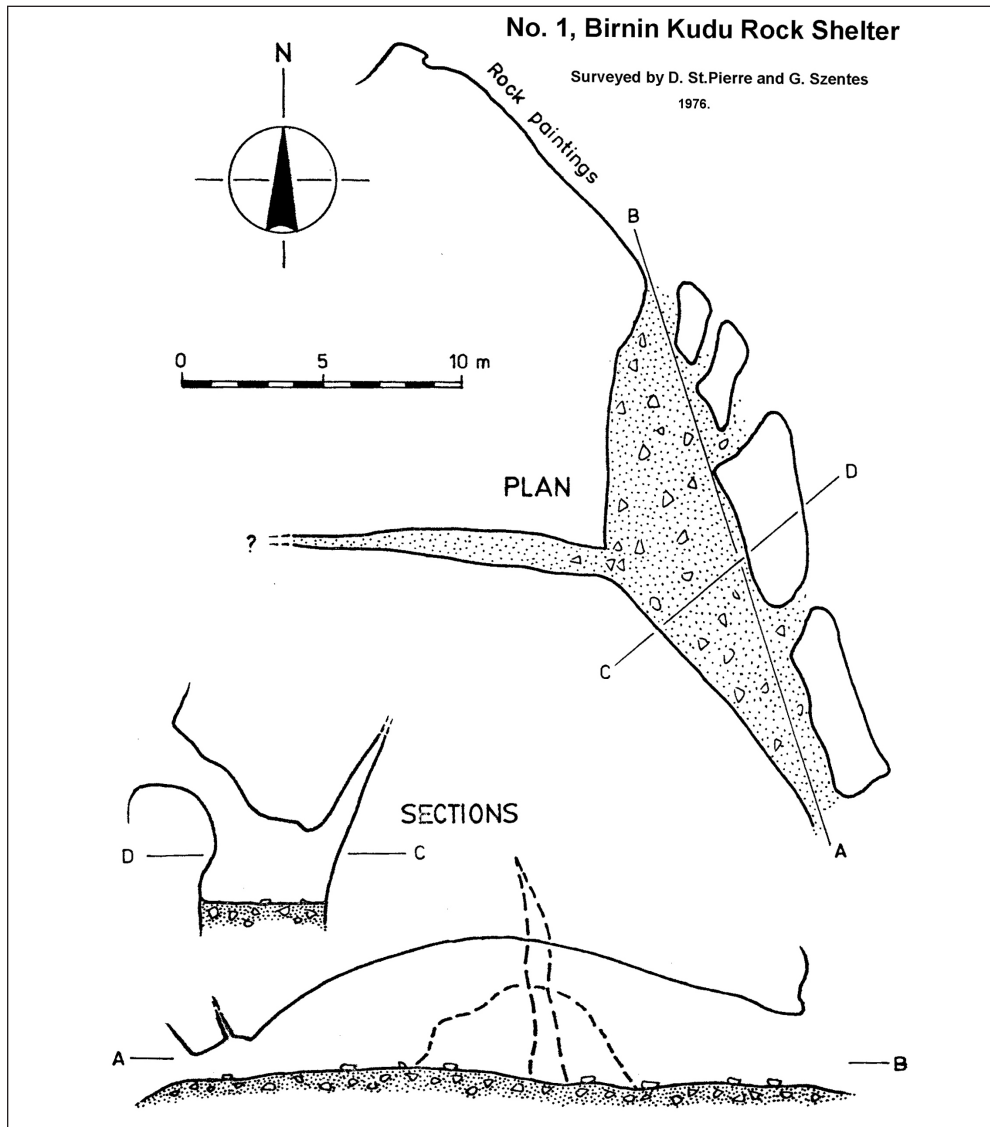
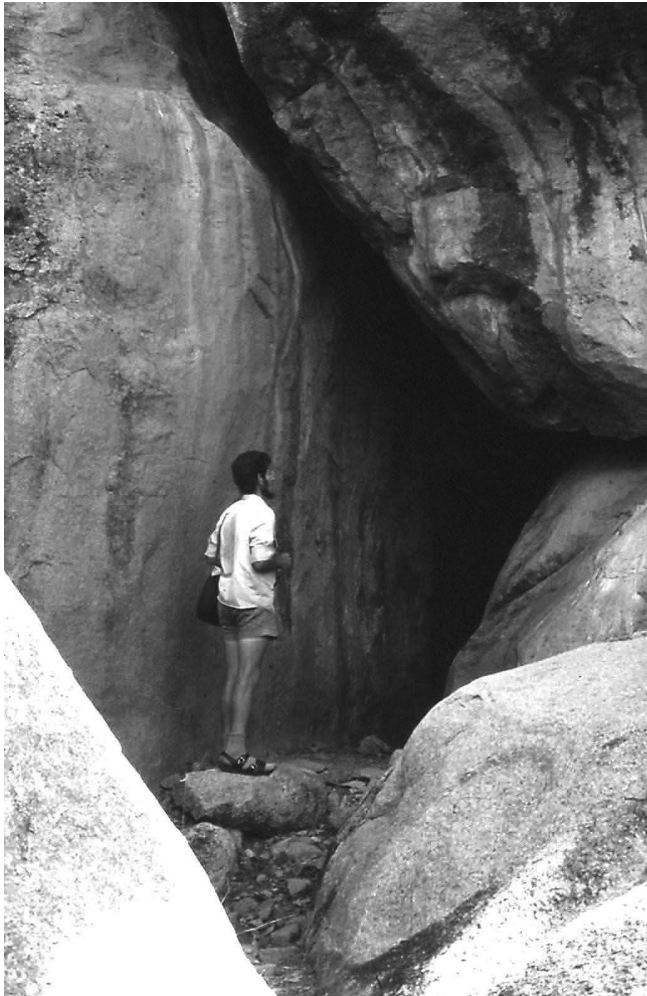


Fig 4.: Survey of the No. 1 Birnin Kudu Rock Shelter



Picture 6.: Birnin Kudu No.1 Rock Shelter in Older Granite Formation (Jigawa State)

The Shelter No. 2 is in a mound of large boulders (Fig. 5). The shelter has developed along N-S and E-W fault lines with a labyrinth on its north-west side formed

by slipped boulders. Bats were roosting in the E-W passage. The rock paintings are on the E-W trending outer wall beneath two overhangs.

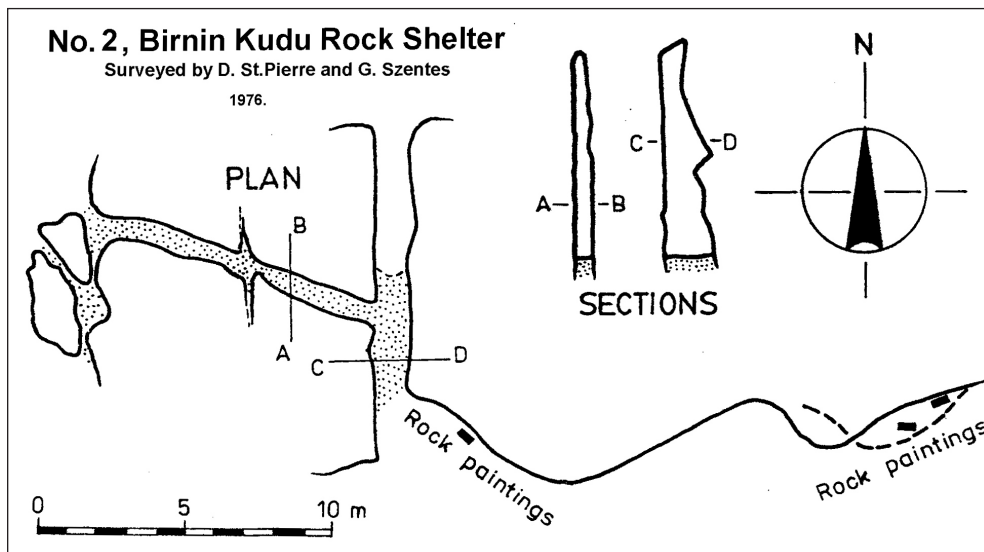


Fig 5.: Survey of the No. 2, Birnin Kudu Rock Shelter (Jigawa State)

The Shelter No. 3 has formed along a NE-SW fault line and is roofed by a flat granite slab which has rock paintings on the underside (Fig. 6., Picture 7).

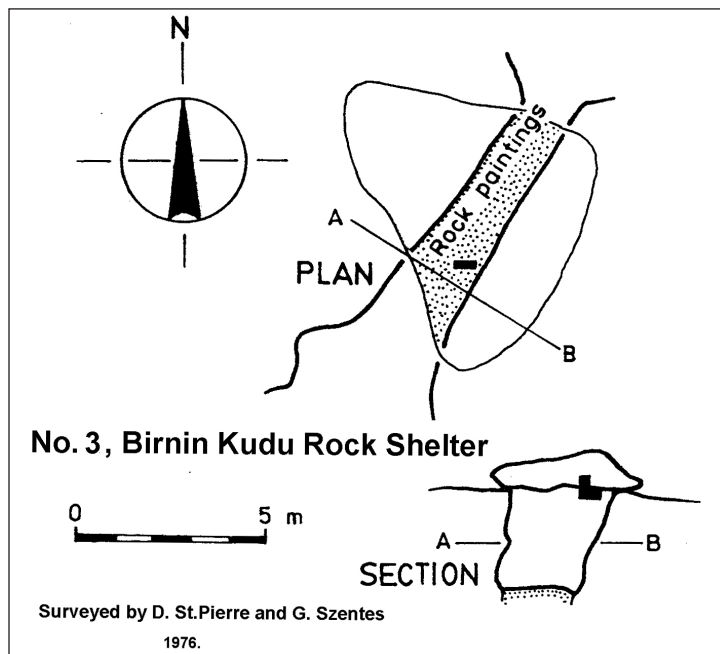


Fig 6.: Survey of the No.3, Birnin Kudu Rock Shelter (Jigawa State)



Picture 7.: Birnin Kudu No.3 Rock Shelter in Older Granite Formation (Jigawa State)

The rock paintings (Picture 8), which are generally sparse and indistinct, show mainly in red outline, animal figures resembling cattle, goat, sheep and dog or jackal.

These paintings are typical of those found along the sahel belt of West Africa and were probably made by the ancient Fulani cattle herders.



Picture 8.: Birnin Kudu. Ancient rock painting in the No3. Rock Shelter (Jigawa State)

SUMMARY

The study of the Birnin Kudu Rock Shelters provides an important contribution to the speleology of West Africa. This is a neglected subject due to that fact that large caves are unlikely to occur in this region. Apart from the sandstones caves in southern Nigeria, and the lava caves of the Mount

Cameroon, no caves have been described from this part of Africa (CRAVEN 1975).

The geology and geomorphology of the granite formations in northern Nigeria warrant further investigation in order to find more woosack cavities and rock shelters. This will increase the speleological importance and also the archaeological knowledge of the area.

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