Journal Homepage: -www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI:10.21474/IJAR01/18260
DOI URL: http://dx.doi.org/10.21474/IJAR01/18260

RESEARCH ARTICLE

MAPPING RADIOACTIVITY IN CONTINENTAL TERMINAL 3 (CT^3) FORMATIONS: THE CASE OF THE "THREE SISTERS", NIAMEY REGION (EASTERN EDGE OF THE WEST AFRICAN CRATON, ILLUMMEDEN BASIN)

Sofiyane Abdourahamane Attourabi[1], Mallam Mamane Hallarou[1], Assagaye Agaissa[2], Mahamane Moustapha Sanda Chékaraou[2], Gambo Ranaou Noura[1] and Lawali Idi Chamsi[1]

1. Université Abdou Moumouni de Niamey, Faculté des Sciences et Techniques, Département de Géologie, Laboratoire Eaux Souterraines et Géoressources, BP: 10662, Niamey, Niger.
2. Université Djibo Hamani de Tahoua, Faculté des Sciences de l'Education, BP : 255, Tahoua, Niger.

Manuscript Info

Manuscript History
Received: 05 December 2023
Final Accepted: 09 January 2024
Published: February 2024

Key words:-
Iullemmeden Basin, Continental Terminal 3 (Ct^3), Radioactivity, Niger

Abstract

The Continental Terminal 3 (Ct^3) formations, which rest in major unconformity on the Birimian basement of the West African Craton, correspond to the last filling deposits of the Iullemmeden basin in the Niamey region (West, Niger). The general objective of this study is to produce a surface radiometric map of the Niamey "Three Sisters" Hills area. The methodology used included field and laboratory work, with radiometric data processed using Surfer software. Radioactivity values in the "Three Sisters" area ranged from 5 to 25 shocks per second (C/s). High radioactivity values (15 to 25 c/s) are recorded in the upper terms, corresponding to the breastplates. Low values of radioactivity (5 to 15 c/s) are measured in the basal layers, corresponding to clays and alluvium. This radioactivity is thought to be due to trace amounts of uranium in these outcrops.

Copy Right, IJAR, 2024,. All rights reserved.

Introduction:-

The Iullemmeden Basin is a vast intracratonic basin covering most of Niger and extending into Algeria, Mali, Benin and Nigeria (Radier, 1957). The geological history of this basin begins in the Cambrian in the Tin Séririne syncline in Algeria(Joulia, 1959). Subsequently, the areas of sedimentation shifted southwards, resulting in the establishment of margino-littoral and continental formations (Bellion, 1987).

The Iullemmeden basin is made up of alternating marine sediments and continental deposits deposited during the various transgressive and regressive episodes that have marked its geological history (Greigert, 1966). Its stratigraphy comprises six (06) geological formations that rest in major unconformity either on the Birimian or Pan-African basement: (i) Paleo-Mesozoic formations (Cambrian to Lower Cretaceous); (ii) (iii) Continental Intercalary (CI) formations (Permian to Lower Cenomanian); (iv) marine formations (Upper Cenomanian to Lower Eocene); (v) Continental Hamadian (CH) formations (Lower Cenomanian to Maastrichtian); (vi) Continental Terminal (Ct) formations (Oligocene to Miocene). In Niger, the Terminal Continental (Ct^3) of the Iullemmeden Basin is known for its iron mineralization.Ousmaneet al. (2023)have shown that these iron mineralizations are accompanied by other elements such as uranium.Previous work on Ct^3 has focused on iron mineralization and its emplacement conditions.

Corresponding Author:- Sofiyane Abdourahamane Attourabi
Address:- Université Abdou Moumouni de Niamey, Faculté des Sciences et Techniques, Département de Géologie, Laboratoire Eaux Souterraines et Géoressources, BP: 10662, Niamey, Niger.

The present study focuses on uranium associated with iron mineralization. The overall objective of the study is to produce a surface radiometric map of the Niamey "Three Sisters" Hills area.

Geological context

The study area corresponds to the Niamey region, which straddles the south-eastern edge of the West African Craton and the south-western termination of the Iullemmeden Basin (Figures 1A).

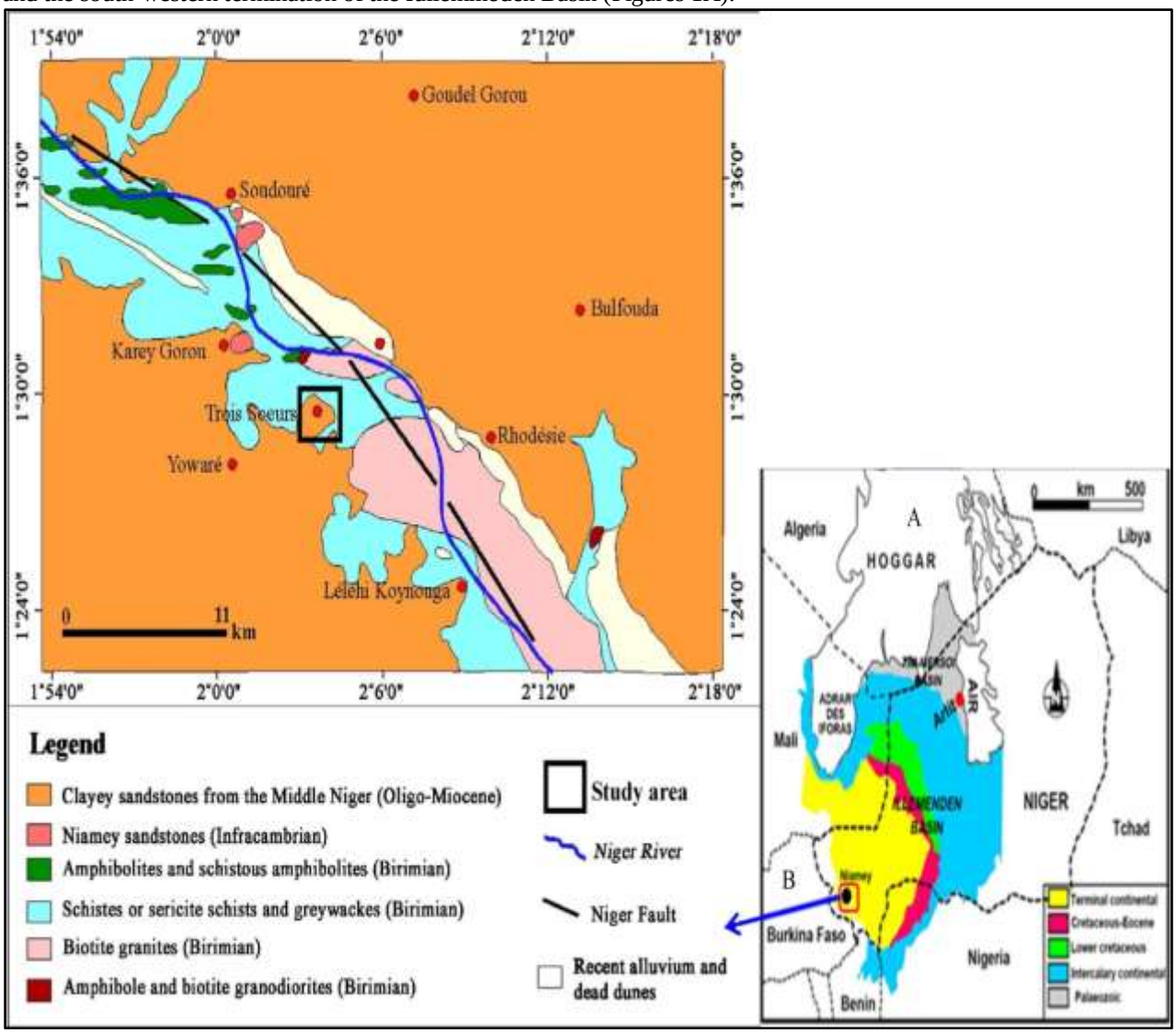

Figure 1:- (A) Simplified geological map of the Iullemmeden basin (Greigert, 1966)and location of the Niamey region; (B) Simplified geological map of the Niamey region(Ousmane et al., 2023)showing the location of the study area.

The geology of the study area is represented by two main geological units (Figure 1B). These are:

1. At the base, the Paleoproterozoic basement (2300 à 2000 Ma,Soumaila (2000)) comprises granitoid plutons alternating with greenstone belts.
2. At the top, the sedimentary cover, comprising Neoproterozoic deposits known as the "Niamey Sandstone" (Maharou, 2020), surmounted by lateritic, oolitic ferruginous sandstones of Oligocene age from the Terminal Continental 3 and Quaternary deposits (dune and alluvial deposits).

The Oligocene-age deposits of the Terminal Continental (the subject of this study) represent the upper terms of the sedimentary deposits of the Iullemmeden Basin(Greigert, 1966). The latter defined three groups within this

formation, from base to top (Greigert, 1966): (i) la sériesidérolithique de l'Ader(i) the AderDoutchisiderolithic series (Ct^1); (ii) the lignite-bearing sandy-clay series (Ct^2); (iii) the Middle Niger claystone series (Ct^3).

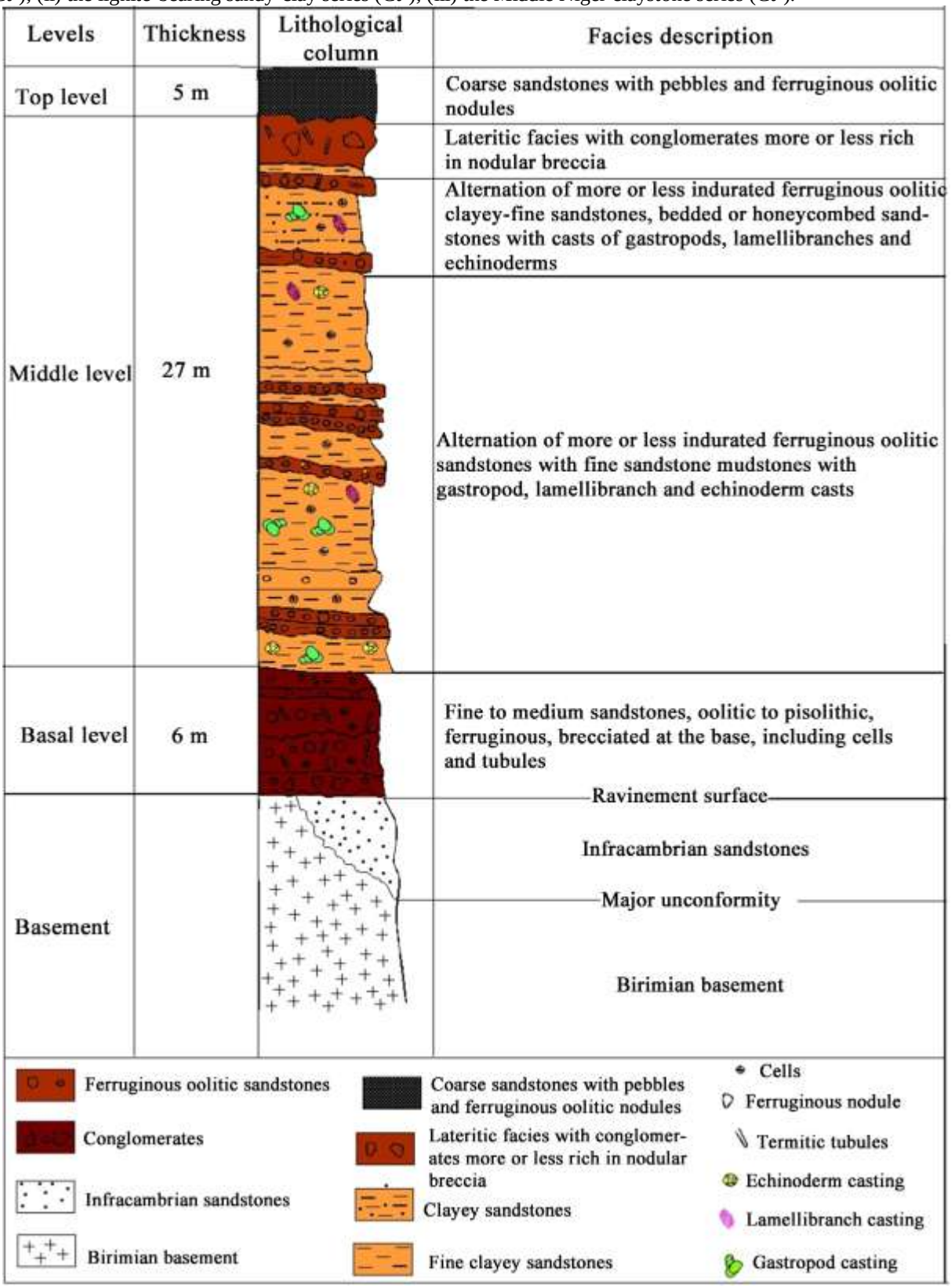

Figure 2:- Synthetic lithological column of the Niamey region (Ousmane et al., 2020, 2023).

In the Niamey area, only the Ct^3 formation outcrops(Ousmane et al., 2020, 2023; Ousmane, 2023). This Ct^3 formation, classically referred to as the "Middle Niger Sandstone"(Greigert, 1966), represents the last deposits to fill the Iullemmeden basin (Figure 1A). These deposits, consisting of alternating clayey sandstones and ferruginous oolitic sandstones with indurated levels(Ousmane et al., 2020, 2023; Ousmane, 2023) (Figure 2), rest in major gully unconformity on Neoproterozoic deposits and in major unconformity on Paleoproterozoic (or Birimian) basement.

The Ct^3 formation consists of clayey sandstones and ferruginous oolites, more or less associated with termite tubules (Ousmane et al., 2020, 2023; Ousmane, 2023). The top of Ct^3 is generally a ferruginous "lateritic" cuirass, covered in places by Quaternary sand dunes. The Ct^3 formation forms the broad plateaus overlooking the Niger River on either side (Ousmane et al., 2020, 2023; Ousmane, 2023)(Figure 2).

The age of Ct^3 deposits has long been unclear. It was considered to be post-Middle Eocene and pre-Quaternary (Lang et al., 1986, 1991). Recently, the work ofBeauvaiset al. (2008)andIssoufou-Fatiou et al.(2019)assign an Oligocene age to these deposits.

Materials and Methods:-

Material:-

Fieldwork required the use of topographic and geological maps of the Niamey region at a scale of 1/200,000, a compass to measure directions and dips, and a GPS (Global Positioning System) to determine the geographical coordinates of formations and sample points. A Portable Prospecting Scintillometer (PPS) was used to measure rock radioactivity. The laboratory equipment used included Excel and Surfer software for data processing.

Methodological approach

The methodology adopted can be summed up in two phases: the field phase and the laboratory phase. In the field, rock outcrops were described and samples taken. Given the continuous nature of the outcrops, 400 GPS coordinates were taken, corresponding to one coordinate every 15 m. In the laboratory, Surfer software was used to produce a radiometric map of Niamey's "Three sister" hills.

Results:-

Petrographic description of the rocks of the "Three Sisters"

The "Three Sisters" Terminal Continental rests in major unconformity on the Birimian basement. Sedimentological analysis has enabled us to distinguish four (04) facies, comprising from base to top: (1) ferruginous oolitic sandstones, (2) sandstone clays, (3) sandstones intercalated with ferruginous oolitic sandstone levels, the upper term of which is represented by a ferruginous cuirass (40 cm thick), (4) conglomerates with iron oxide nodules. These four types of facies have been subdivided into fourteen (14) levels from base to top: (i) basic conglomerates around 30 cm thick, (ii) termite-structured ferruginous sandstones around 2 m thick, (iii) ferruginous, sometimes oolitic sandstones around 3 m thick, (iv) whitish sandstone mudstones about 2 m thick, (v) reddish sandstone mudstones about 10 m thick, (vi) a hardened, armoured surface about 50 cm thick, (vii) variegated clayey sandstones about 25 m thick, (viii) a hardened and armoured surface about 20 cm thick, (ix) porous ferruginous sandstones about 1 m thick, (x) ferruginous to very poorly cemented conglomerate, (xi) clayey sandstone, (xii) well-cemented conglomerate, (xiii) very coarse well-cemented conglomerate and (xiv) large armoured boulders(Figure 3).

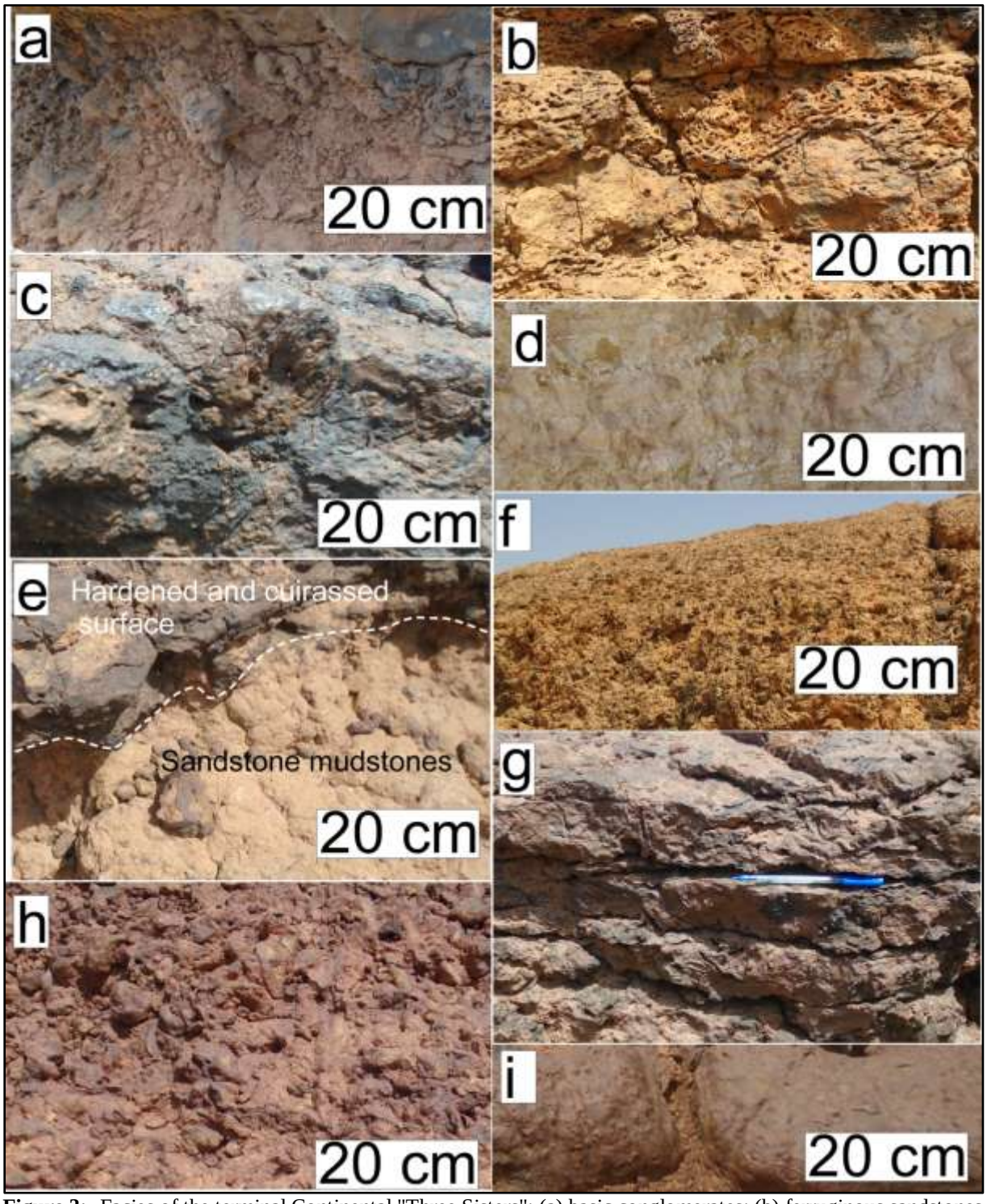

Figure 3:- Facies of the terminal Continental "Three Sisters": (a) basic conglomerates; (b) ferruginous sandstones with termite mound structure; (c) oolitic ferruginous sandstones; (d) whitish-colored sandstone mudstones; (e) reddish-colored sandstone mudstones topped by a hardened, cuirassed surface; (f) variegated clayey sandstones; (g) porous ferruginous sandstones; (h) conglomerates (i) large cuirassed boulders.

Radioactivity of rocks from the "Three sisters"

Radioactivity values measured on the "Three sisters" range from 5 to 25 c/s (shocks per second) (Figure 4). Low radioactivity values (5 to 15 c/s) correspond to the areas colored pink and orange. These low values are measured in

the bed of the koris (wadi), made up mainly of colluvium and alluvium (clay and some sand). The high radioactivity values (15 to 25 c/s) correspond to the red to dark red areas measured on the outcrops.

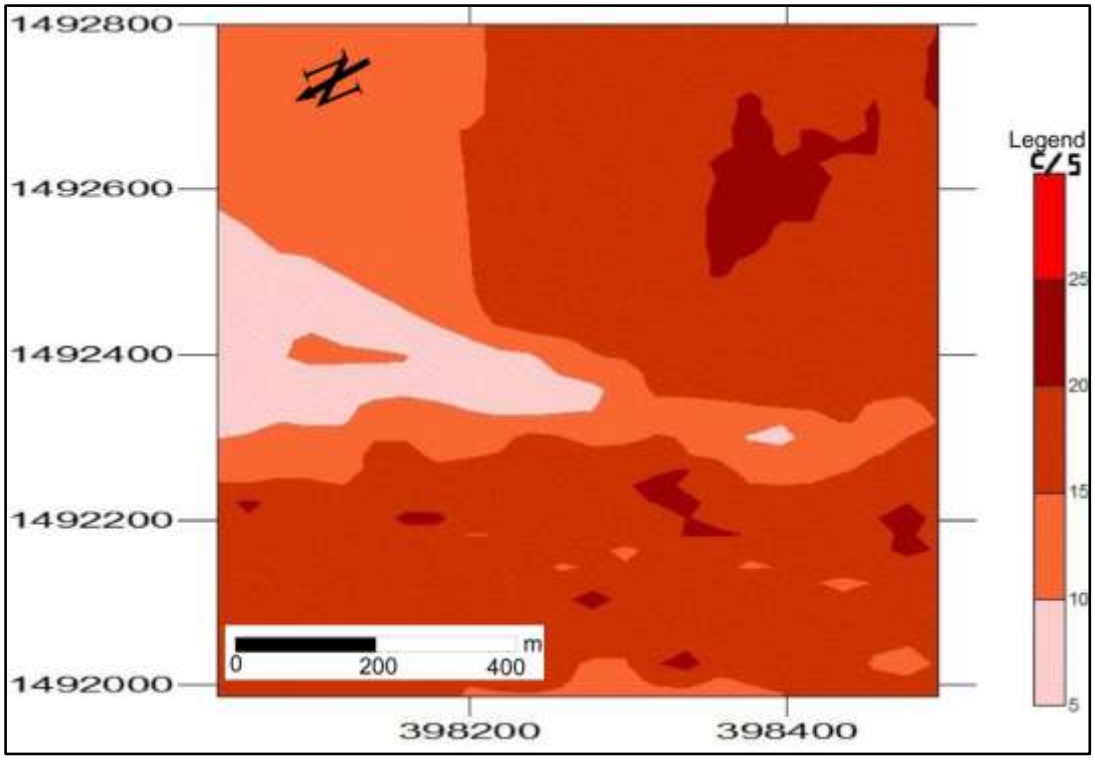

Figure 4:- Radiometric map of the terminal Continental "Three Sisters".

On the 3D map, we can also see that the higher elevations are practically colored dark red, corresponding to 20-25c/s of radioactivity. These values correspond to the armour and carapace zones. The lower elevations are marked by a pinkish tinge, corresponding to areas dominated by clay (Figure 5).

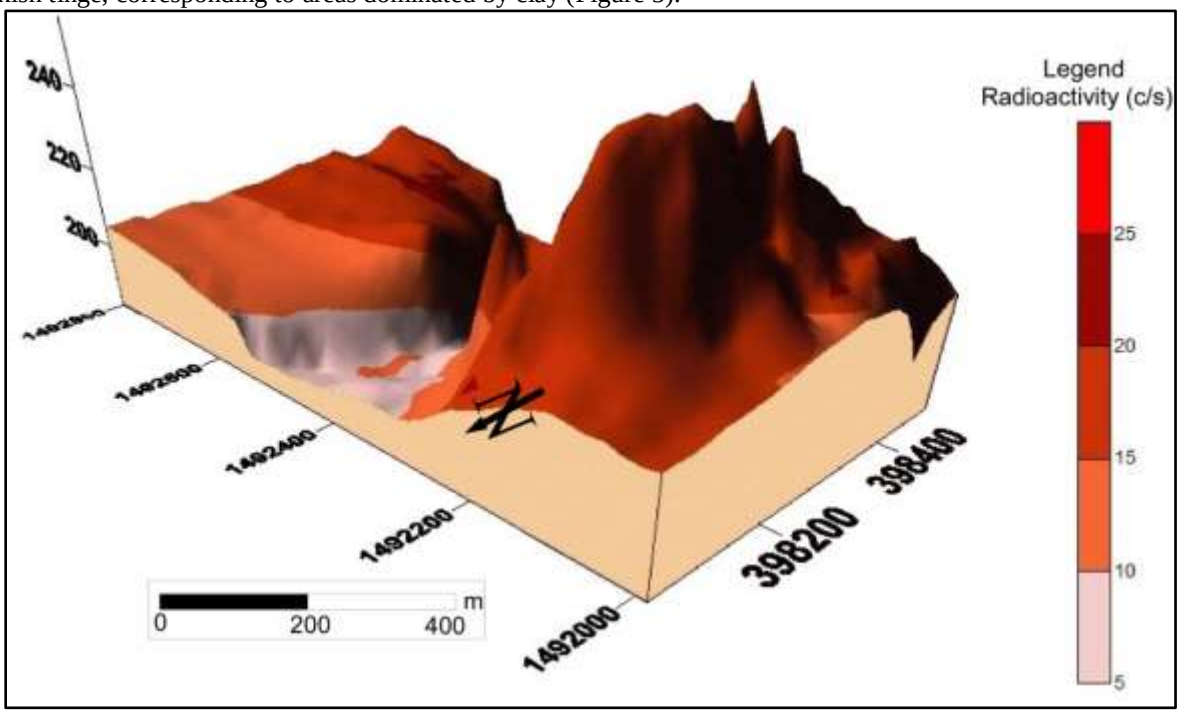

Figure 5:- 3D model of the radiometric map of the terminal Continental "Three Sisters".

Conclusion:-

Radioactivity values in the "Three Sisters" zone range from 5 to 25 shocks per second (C/s). High values of radioactivity (15 to 25 c/s) are recorded at the level of the upper terms, corresponding to the breastplates. Low values of radioactivity (5 to 15 c/s) are measured in clays and alluvium. This radioactivity is thought to be due to trace amounts of uranium in these outcrops.

References:-

1. Beauvais, A., Ruffet, G., Henocque, O. & Colin, F. (2008). Chemical and physical erosion rhythms of the West African Cenozoic morphogenesis: The 39Ar-40Ar dating of supergene K-Mn oxides. Journal of Géophysical Research113, 15 p.
2. Bellion, Y. (1987). Histoire géodynamique post-paléozoïque de l'Afrique de l'Ouest d'après l'étude de quelques bassins sédimentaires. (Sénégal, Taoudenni, Iullemmeden, Tchad). Thèse de l'Université d'Avignon et des Pays de Vauclus.
3. Greigert, J. (1966). Description des formations crétacées et tertiaires du bassin des Iullemmeden (Afrique occidentale). BRGM éd., 229 p.Paris, France: Ministère des Travaux publics, des Transports, des Mines et de l'Urbanisme de la république du Niger. Direction des mines et de la géologie, 2.
4. Issoufou-Fatiou, A. K., Konaté, M., Glodji, L. A., Youssouf, S., Tossou, M., Heckmann, M. &GarbaSaley, H. (2019). Étude préliminaire du contenu sporopollinique et caractérisation des grès ferrugineux de la formation du Continental terminal, Bassin de Kandi (Nord-Est Bénin). European Scientific Journal15, 222–229.
5. Joulia, F. (1959). Les séries primaires au N et au NW de l'Aïr (Sahara central). Discordances observées. Bull. Soc. Géol. Fr 192–196.
6. Lang, J., Kogbe, C. A., Alidou, S., Alzouma, K. A., Dubois, D., Houessou, A. & Trichet, J. (1986). Le sidérolitique du Tertiaire ouest-africain et le concept de Continental terminal. Bull. Soc. Géol. France8, t 2, 605–662.
7. Lang, J., Yahaya, M., El Hamet, M. O., Besombes, J. C. &Cazoulat, M. (1991). Dépôts glaciaires du Carbonifère inférieur à l'Ouest de l'Aïr (Niger). Geologische Rundschau80, 611–622.
8. Maharou, H. I. (2020). Dynamique sédimentaire des grès de Niamey (Niger occidental) : indices de glaciation et déformations associées. Thèse de Doctorat Unique, Niger, Université Abdou Moumouni de Niamey.
9. Ousmane, H. (2023). Environnements de dépôts de la formation du Continental terminal 3 (Ct3) de la région de Niamey et déformations associées. Ph.D. Thesis, Université Abdou Moumouni, Niame.
10. Ousmane, H., Dia Hantchi, K., Abdou Ali, I., Hamidou, L. B., Maâzou, A. A., Issoufou-Fatiou, A. K. & Konaté, M. (2023). Metallogeny and Emplacement Conditions of Continental Terminal 3 (Ct3) Iron Formations of the Niamey Region (Western Niger). Open Journal of Geology13, 720–739.
11. Ousmane, H., Dia Hantchi, K., Hamidou, L. B., Abdou Ali, I. & Konate, M. (2020). Caractérisation de la déformation des dépôts oligocènes du Continental terminal 3 (Ct3) dans la région de Niamey (Bordure Orientale du Craton Ouest Africain, Bassin des Iullemmeden). European Scientific Journal16, 1857–7431.
12. Radier, H. (1957). Contribution à l'étude géologique du Soudan oriental (A.O.F.). Bulletin du service géologique et de prospection minière, n°26, Dakar 1959.
13. Soumaila, A. (2000). Etude structurale, pétrographique et géochimique de la ceinture de Diagorou-Darbani, Liptako, Niger Occidental (Afrique de l'Ouest). Thèse de Doctorat, Univ. Franche- Comté.