

## A review of the geological setting and economic potential of uranium occurrences in the proterozoic part of the Reguibat Shield of the west African Craton, in northern Mauritania

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### ABSTRACT

Uranium mineralisation is formed in a wide range of geological settings, including deep magmatic to surficial conditions, and ranges in age from Archean to recent. The success of exploration planning and the choice of efficient extraction methods in an environmentally sustainable manner depend clearly on the understanding of the uranium genesis model and the detailed knowledge of the mineralogy of the deposit.

Mauritania hosts eighty known uranium occurrences, mainly located in the oriental part of the Reguibat Shield. Some of these occurrences have been evaluated with the publication of estimated resources, and even exploratory mining works have been performed on some of them. However, the detailed genetic conditions prevailing for the genesis of most of these occurrences remain poorly studied. Exploration reports indicate that uranium mineralisation in the Reguibat Shield mainly occurs as high temperature deposits hosted by shear zones in granites (hydrothermal Na-metasomatic deposits) and low temperature deposits hosted by calcretes (Calcrete deposits), which form more than 70% of these occurrences.

This paper focuses on the dominant uranium mineralisation systems (uraniferous calcretes and Na-metasomatite) of the oriental part of the Reguibat Shield and, to a lesser extent, other types of uranium deposits. Na-metasomatites are mainly originating from Neobirimian granite and basic rocks and occur through hydrothermal fluids, inducing regional metasomatism along NNW–SSE trending shear zones. While uraniferous calcretes in the area are found as subsurface layers covering a Proterozoic basement made of granitoid and associated gabbro-diorite massifs intersected by a network of mafic dykes. The uraniferous calcretes result from the weathering of the Neobirimian (Paleoproterozoic) granitic basement. Carbonate and uranium minerals (carnotite and tyuyamunite) crystallize as cementation materials within the granite arena. Two types of Neobirimian granites have been identified: the first one being an orientated coarse-grained porphyritic brown to pink granite, while the second one is a porphyritic grey medium-grained granite, whose mineralogy is mostly made up of plagioclase, K-feldspar, quartz, and chloritized biotite, while magnetite, apatite, titanite, zircon, uranorthorite, and monazite are the accessory minerals.

### 1. Introduction

The Reguibat shield is located over a large segment of northern Mauritania and contains the largest amount of known U deposits and resources in Mauritania (it contains all U deposits discovered) (Aur

Energy, 2021; Brahim et al., 2024; Fernette, 2015). Its Proterozoic part hosts the most important uraniferous province in Mauritania. Two types of uranium mineralisation systems, largely dominant and based on decreasing economic potential, are classified into: (i) evaporation-related uranium systems (calcretes) and (ii) hydrothermal

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sodium metasomatic systems.

Calcretes uranium deposits are considered one of the surficial uranium mineralisation found in near-surface sedimentary rocks or soils (Dahlkamp, 1993; IAEA, 2018; 2009, 2020). These deposits typically form in specific geological settings, such as fluvial valleys and lacustrine-playa environments (IAEA, 2018; Hall et al., 2019; Smedley and Kinniburgh, 2023). They often occur above basement rocks that date back to the Archean to Paleoproterozoic eras (IAEA, 2018; Bonnetti et al., 2017, 2020; Wilde, 2023). The presence of uranium-enriched bedrock in close proximity is a crucial factor in the formation of calcrete uranium deposits (Hou et al., 2017; IAEA, 2020; Smedley and Kinniburgh, 2023). This proximity ensures a continuous supply of uranium from the bedrock, enhancing the potential for significant uranium mineralisation in the overlying sedimentary layers (Smedley and Kinniburgh, 2023). The uranium-enriched bedrock acts as a source of uranium. Subsequently, uranium is mobilized by groundwater and deposited in more recent geological settings (calcrete) (Chudasama et al., 2018; Hou et al., 2017). The process involves the dissolution of uranium from the primary igneous sources and its transport via hydrological systems to areas where it precipitates and concentrates in calcrete formations. Calcrete uranium deposits are widespread, with notable examples found across various continents. The most extensively documented deposits are located in Namibia (Langer Heinrich) and Australia (Yellerrie deposit) (Chudasama et al., 2018; Liu and Jaireth, 2011; Wilde, 2023).

On the other hand, hydrothermal sodium metasomatic systems result from extensive sodium metasomatism along fault networks (IAEA, 2020; Yu et al., 2020). These deposits manifest as veins of varying forms, disseminated, and structurally controlled ores. This type of uranium mineralisation is particularly found in Precambrian cratons, associated with metasomatic alteration zones extending along significant strike lengths (Bonnetti et al., 2020; Wei et al., 2021).

The eastern region of the Reguibat Shield in northern Mauritania is notable for its Proterozoic rocks, which form part of the West African Craton (WAC) (Key et al., 2008; Lahondere et al., 2003). This area is particularly significant for its substantial uranium mineralisation, primarily found in surficial deposits like calcretes and shear zone granite-hosted deposits (Aura Energy, 2021; Brahim et al., 2024; Fernette, 2015). Exploration activities in the Reguibat Shield led to the discovery of significant uranium potential. There are two exploitation projects located in this region: the Tiris Project, focusing on uranium deposits within calcrete formations, and the Bir en Nar Project, targeting uranium within sheared granite rocks.

Despite advanced exploration activities in the Reguibat Shield, there is still a significant lack of research and publications undertaking U mineralisation processes, geological constraints, and genetic models. Therefore, it is essential to increase research and detailed geological investigations, providing insights into the geological processes, identifying mineralisation patterns, and guiding future exploration efforts. Such investigations may improve our understanding of the post-Eburnean geological evolution of the Proterozoic bedrock of the Reguibat Shield, an important part of the West African Craton.

Two previous studies, Brahim et al. (2024) and Ishagh et al. (2021), employed remote sensing techniques to investigate uranium mineralisation in the study area. They used satellite imagery to map lithological units, identify alteration minerals, and delineate uraniumiferous zones in the Bir Lemjed region of the Reguibat Shield. However, these studies did not systematically provide an overview of the occurrence, conduct an environmental assessment, or compare their genesis with the proposed model.

Through a detailed overview, the main purpose of this paper is to present a comprehensive analysis of the uranium mineralisation potential in Mauritania, with a focus on selected deposits within the Proterozoic part of the Reguibat Shield. It seeks to identify the different uranium mineralisation styles and discuss their genesis and controlling factors based on a comparison with the most known similar deposits around the world.

## 2. Geological setting of the Reguibat Shield

The Reguibat Shield, located in northern Mauritania, is the northern outcrop of the West African Craton (WAC) and features a flat, desert landscape (Fig. 1a). It comprises two distinct terranes: a southwestern terrane of Archean rocks and a central and northeastern terrane of Paleoproterozoic rocks (Bessoles, 1977; Dillon and Sougy, 1974; Montero et al., 2014; Schofield et al., 2006). These terranes are separated by a large fault zone (Key et al., 2008; Lahondere et al., 2003; Pitfield et al., 2004). The Archean terrane consists of gneiss, acidic rocks, migmatites, ultramafic and mafic rocks (greenstones), quartzites, and banded iron formations (e.g., Bronner and Chauvel, 1979; Key et al., 2008; Portel, 1997; Rocci et al., 1991; Schofield et al., 2006; Schofield and Gillespie, 2007; Schofield et al., 2012). In contrast, the Paleoproterozoic terrane includes granitoid intrusions (granite, tonalite, and syenite) and volcano-sedimentary series (Lahondere et al., 2003; Merabet et al., 2016; Mohammed et al., 2020; Rocci et al., 1991; Schofield et al., 2006). The granitoid massifs were emplaced during the Eburnean orogeny (2150-2000 Ma), a tectonothermal event characterized by plate-tectonic processes, including sedimentary basin formation, subduction-related magmatism, and collisional tectonics (Deschamps and Rocci, 1975; Feybesse et al., 2006; Lahondere et al., 2003; Milési et al., 1992; Perrouy et al., 2012; Schofield et al., 2006; Grenholm, 2019).

The Eburnean events in the Paleoproterozoic portion of the Reguibat Shield have been detailed, with four episodes of sedimentation and magmatism such as Eobirimian, Mesobirimian, Late-Birimian, and Neobirimian, respectively (Lahondere et al., 2003; Rocci et al., 1991; Taylor et al., 1992). The Precambrian bedrock is partially covered by more recent (Cenozoic) sedimentary layers, including sand dunes, gravel, sebkha, and calcretes (carbonate-rich soils). Calcretes, known as the Hamada Formation, formed during the Mio-Pliocene, are significant in this region as they represent the primary host rock for uranium deposits in the area (Aura Energy, 2021; Lahondere et al., 2003; Mestraud, 1975).

## 3. Types of uranium mineralisation in Mauritania

The Islamic Republic of Mauritania (Fig. 2) covers an area of 1,030,700 km<sup>2</sup> and is geographically located in the northwestern corner of the African continent. Mauritania is surrounded by Western Sahara and Algeria to the north, Mali to the east and southeast, the Senegal River to the southwest, and the Atlantic Ocean to the west, with a coast of about 750 km.

Geologically, Mauritania is part of the WAC (Fig. 1a) and has been affected by the Eburnean, Caledonian, and Hercynian orogenies, and finally by quaternary marine transgressions (Ennih and Jean-Paul, 2008; Lahondere et al., 2003; Schofield and Gillespie, 2007; Trompette, 1973).

The five main geological units of Mauritania are from the oldest to the most recent: the Reguibat Shield, the Taoudeni Basin, the Tindouf Basin, the Mauritanide Belts, and the Coastal Basin (Figs. 1b and 2) ((Benan and Deynoux, 1998; Beghin et al., 2017; Deynoux et al., 2006; Leprêtre et al., 2014; Pitfield et al., 2004; Taleb, 1994; Villeneuve, 2005).

Exploration for uranium in Mauritania's geological units dates back to the 1960s (Marot et al., 2003). During the years 1960–1961, the French Atomic Energy Commission (CEA) discovered numerous calcrete-type showings (called “hamadas”) in the Bir Moghreïn region. These showings were considerably extended eastward by Total Mining Company (TCM) between 1972 and 1975, which also discovered uranium concentrations along the large Ghallaman shear zones further south. This basement mineralisation was investigated by Minatome between 1980 and 1983. Then all uranium exploration activity ceased in Mauritania until 2006.

At least six junior companies have explored Mauritania for uranium in recent years (Fernette, 2015), but only Forte Energy and Aura Energy have provided resource estimations. The reported uranium occurrences

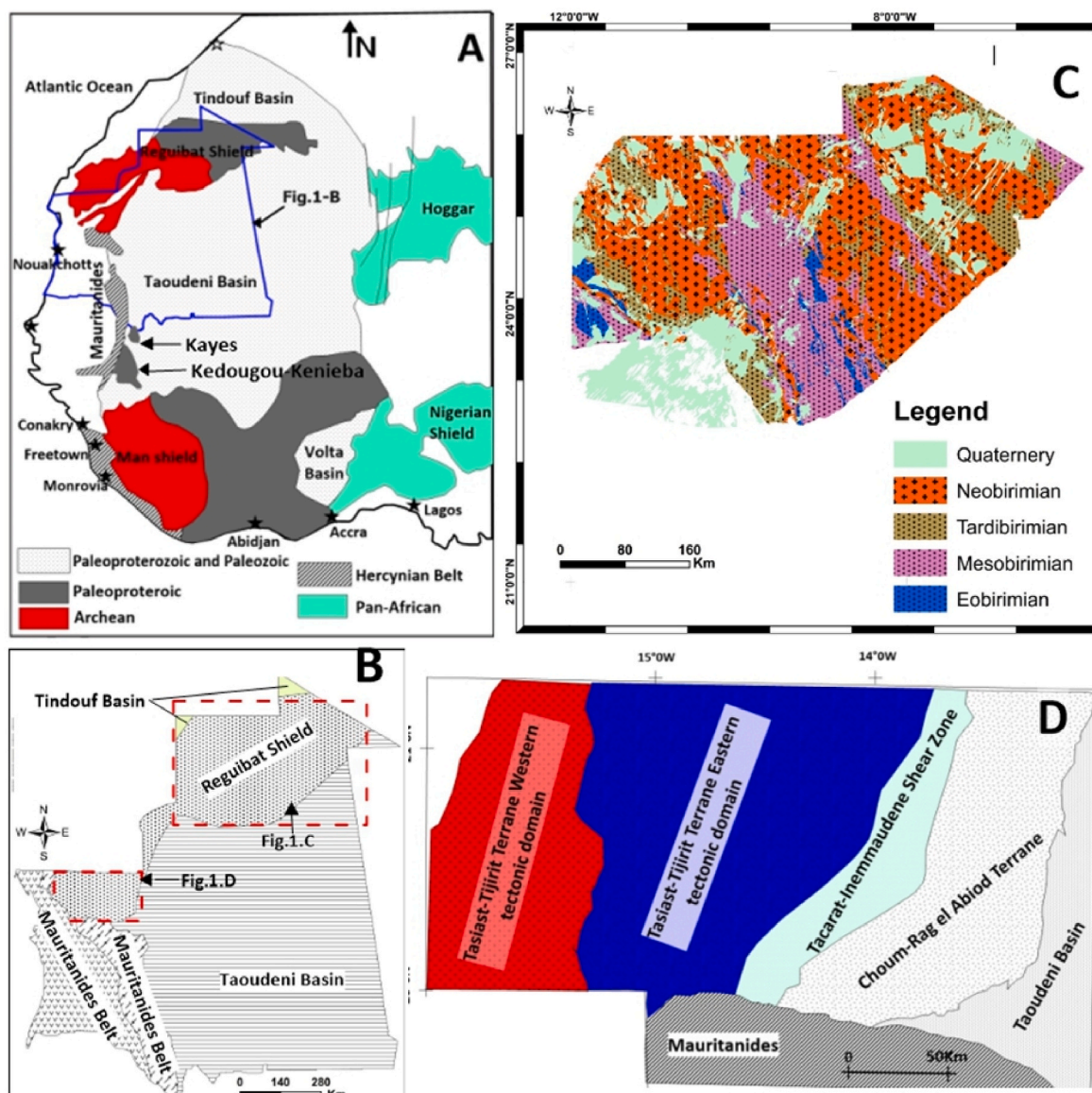


Fig. 1. Geological maps of the studied area (modified after Schofield et al., 2006; Key et al., 2008). A: Map of the West African Craton (star shape: represent country capital cities); B: Simplified geological map of Mauritania; C: Geological map of the Eastern part of the Reguibat Shield; D: Simplified geological map of the Archean terranes in the southern part of the Reguibat Shield.

are preferentially located in the Paleoproterozoic part of the Reguibat Shield and mainly correspond to calcrete and granite-hosted types. The granite-hosted deposits at Bir en Nar were discovered by Cogema during the 1970s (Marot et al., 2003). The latest compilation of geological and exploration data reports 80 uranium occurrences (Fig. 2) (Marot et al., 2003). Most of the northern part of the Reguibat Shield is anomalous in U, as shown by widespread airborne radiometric anomalies (Fig. 2). The granite-hosted occurrences are controlled by major NW-trending fault zones. The Proterozoic (Birimian) granitic rocks (Figs. 2 and 3) of the basement provide the source for the U deposits (Fernette, 2015). Total resources for the two types of deposits are 183.8 Mt of ore at an average grade of 263 ppm  $U_3O_8$  (223 ppm U). The calcrete deposits represent 138.3 Mt of ore at 331 ppm  $U_3O_8$  (281 ppm U) (Aura Energy, 2021), whereas the granite-hosted deposits (Forte, 2009) represent 46.5 Mt of ore at 248 ppm  $U_3O_8$  (210 ppm U). The Bir en Nar deposit includes an indicated and inferred resource of 1.33 Mt at 704 ppm  $U_3O_8$  and 2.1 Mt at 0.0597% U.

The majority of uranium occurrences in Mauritania are located in the eastern part of the Reguibat Shield (Fig. 2). Among the 80 known

occurrences, only 17 have an estimated resource (Fig. 4) (Aura Energy, 2021; Forte, 2009).

Using the uranium deposit classification scheme of the International Atomic Energy Agency based on the host rock type (IAEA, 2018), uranium occurrences in Mauritania can be regrouped into five groups (Table 1). Most of them are hosted in calcretes.

#### 4. Uranium mineralisation system in the Reguibat Shield

The various uranium mineralisation systems result from a diversity of geological settings, mineralisation processes, and uranium geochemical behaviour. Uranium deposits are found in a wide range of geological settings, from deep magmatic settings to surficial conditions, and range in age from Archean to recent (Cuney, 2009, 2010). Different classifications have been proposed, either descriptive, essentially based on the nature of the enclosing rocks (Dahlkamp, 1993; IAEA, 2018), or genetic (Cuney, 2009).

Based on the theoretical description of uranium deposit systems, geological, structural, and mineralogical features of each uranium

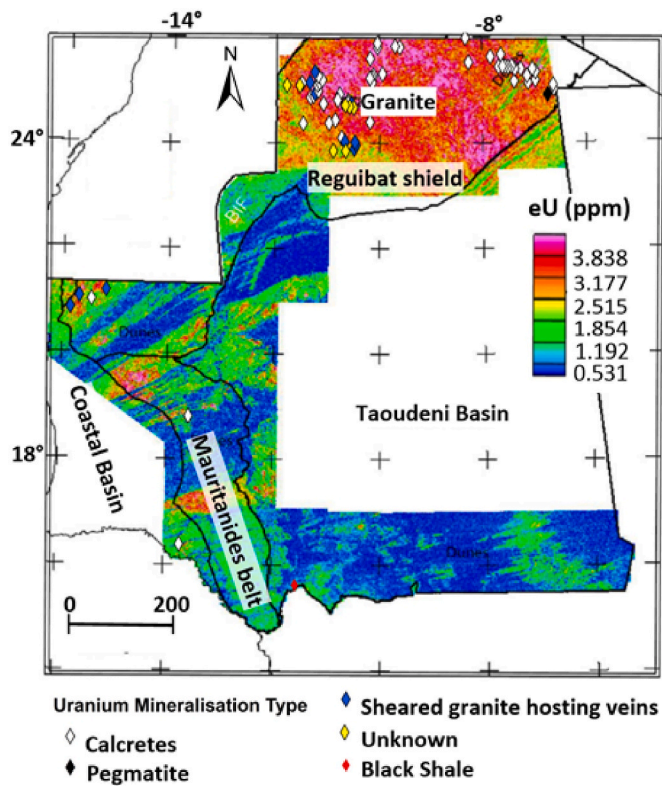


Fig. 2. Distribution of the different types of uranium occurrences in Mauritania plotted on a uranium spectrometric map (modified from Fernette, 2015).

occurrence found in the Reguibat Shield. The occurrences have been compiled (Table 1) and categorized into three main uranium mineralisation systems.

- i) Calcrete deposits (evaporation system),
- ii) Intrusive-related deposits (related to partial melting or magmatic fractionation), and
- iii) Deposits along tectonic structures with different origins (hydrothermal granitic or hydrothermal Na-metasomatic) (Table 2).

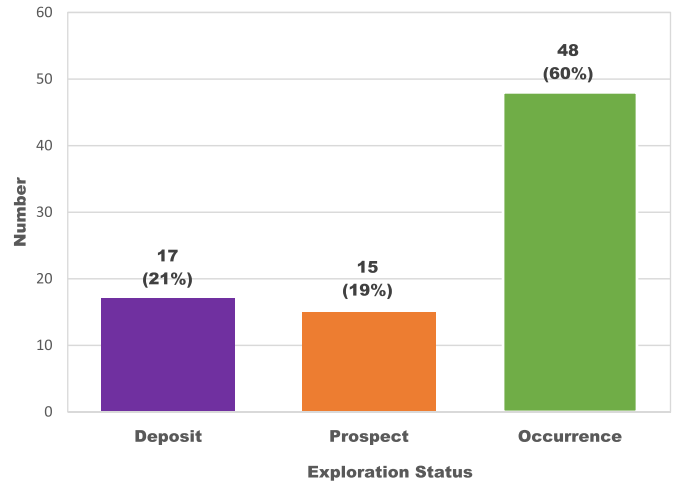


Fig. 4. Number and exploration status of uranium occurrences-deposits-prospects in Mauritania (from Fernette, 2015).

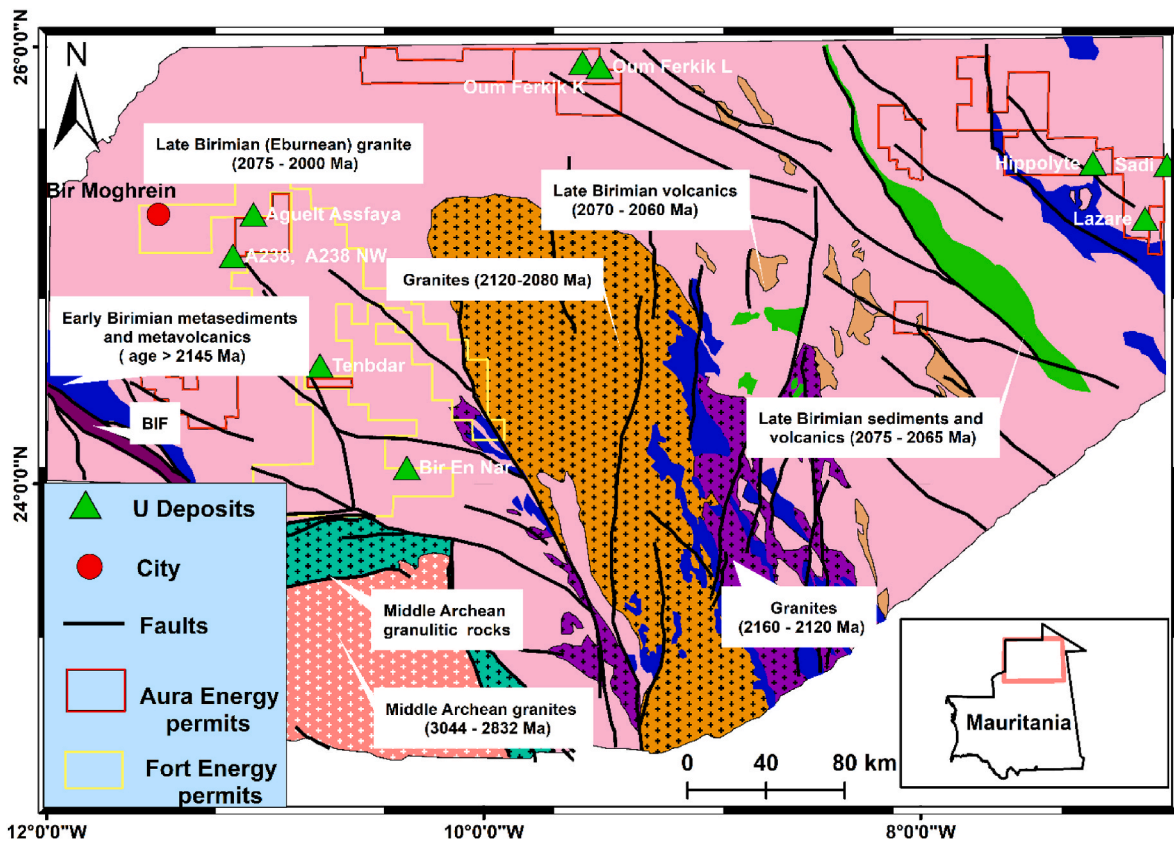


Fig. 3. Spatial distribution of the exploration permits of Aura Energy and Forte Energy and Birimian granites (modified after Lahondere et al., 2003).

of clay minerals and carbonates. The lower hamada consists of a sandstone formation with abundant calcrete and gypcrete, and the higher white hamada is represented by limestone with detrital quartz and ending in a siliceous slab or silcrete. Hamadas originally derive from a sandstone material mainly composed of quartz and feldspar with a minor clay matrix. Detrital grains are generally angular and therefore have a short provenance. Some rounded and sub-rounded grains indicate an additional river or eolian contribution. The clay material mainly consists of montmorillonite and attapulgite, with minor proportions of sepiolite and illite (Briot, 1978). The proportion of attapulgite increases upward along the profile. The paleovalley sedimentary filling can be incised more recently by extremely shallow valleys partly filled by sandy deposits. The uranium mineralisation which consists of carnotite, is essentially developed in the low hamada, but may extend into the Iguetti conglomerate and the arenite (Fig. 6). Carnotite is developed within the clastic deposits when carbonatation related to the evaporation of highly chlorine (up to 64 g/1 Cl<sup>-</sup>), and U-rich (23–110 ppb U) phreatic waters occurs (Minatome, 1974; in Briot, 1978).

In the Tiris uranium project of Aura Energy (Beeson et al., 2014), a simpler geometry of the stratigraphic succession is proposed (Fig. 8). The uranium mineralisation forms horizontal tabular bodies ranging in thickness from 1 to 12 m within weathered granite incised by very shallow paleovalleys filled by colluvial sediments (Figs. 8 and 9).

**5.2.1.2. Petrography and mineralogy of the ore.** The Proterozoic bedrocks of the mineralized areas of Oued el Foule and Ain Sider of the Tiris uranium project are represented by two main types of granite (Ishagh et al., 2021). The first type is a coarse-grained porphyritic granite of brown to pink colour, that correlates with the granite most often found in the Yetti region (Fig. 10A), while the second type is a porphyritic microgranite of grey colour. Its texture presents a microgranular matrix with large idiomorphic or rounded feldspars (Fig. 10B) (Ishagh et al., 2021; Lahondere et al., 2003).

The two granite types have been strongly weathered with the development of a one-to several-meter-thick arena. The fresh, weathered and mineralized rocks from Oued el Foule and Ain Sider are presented in Table 4 below and in Fig. 10C and D.

According to Lahondere et al. (2003), the granitoids consist mostly of plagioclase phenocrysts, while K-feldspar is common in the matrix associated with large quartz crystals and red-brown biotite, occasionally chloritized. Magnetite, apatite, titanite, zircon, and monazite are the accessory minerals.

Carbonates and uranium minerals can precipitate as cementation materials in weathered and altered granite. Uranium minerals are mainly represented by carnotite and tyuyamunite (Aura Energy, 2021, 2023) (Fig. 10F).

Brahim et al. (2024) conducted (XRF) analysis on selected samples of the rock types within the Tiris project area provide detailed insights into the elemental concentrations highlighting high average of uranium (Table 5).

Carnotite is uranyl vanadates; therefore, it is considered potential source of vanadium. Aura Energy Company, the owner of the Tiris Uranium project, has launched an estimate effort in order to evaluate the vanadium potential associated with the uranium mineralisation. As a consequence, the findings indicated high uranium-vanadium concentrations, with an estimated resource of 18.4 million pounds of vanadium (V<sub>2</sub>O<sub>5</sub>) contained within calcrete uranium deposits.

### 5.2.2. Hydrothermal Na-metasomatic deposits

**5.2.2.1. Structure of the mineralisation.** The Bir en Nar, A238, and A238 NW occurrences of the Reguibat Shield are attributed to this type of uranium deposit (Fig. 3). The U mineralisation is hosted by granites within NNW–SSE trending shear zones (Fernette, 2015; Forte, 2009) (Fig. 3). The deposits were discovered from airborne radiometric anomalies that initially revealed uraniferous calcretes. The drilling of the anomalies intercepted U mineralisation in a shear zone below the calcrete layer. The Bir en Nar orebody is located within three parallel cataclastic zones along a mylonitized contact between two granitoid bodies steeply dipping to the NE (Fig. 11).

The A238 deposit is located 55 km south-east of the town of Bir Moghreïn and 135 km north-west of the Forte Energy Bir En Nar project (Figs. 3 and 12). The A238 NW deposit occurs on a splay of the main shear zone to the northwest of the A238 deposit (Fig. 12).

**5.2.2.2. Petrography and mineralogy of the ore.** The host rock within the three deposits is a biotite-hornblende monzogranite of Neobirimian age belonging to the complexe d'Adem Esseder. The mineralized rocks are qualified as pink coloured medium-grained granite with a low biotite and quartz content which may result from an albitic alteration front associated with dequartzification, also named syenite or episyenite (Forte, 2009; Lahondere et al., 2003; Taylor et al., 2012). A large unmineralised silica-hematite alteration zone and smaller silicification zones occur to the northeast of the A238 deposit (Fig. 12). Although not clearly stated in the available descriptions of the deposits, such rocks correspond to dequartzified granites associated with albitization, typical of Na-metasomatic uranium deposits. The structures hosting the albitic episyenite alteration can be brecciated and crosscut by quartz veins. The ore bodies can be slightly displaced by low dipping structures hosting mafic sills (Fig. 11).

5000 m of RC drilling, followed by 1500 m of diamond drilling, were performed on the A238 deposit. Wide intersections of low-to medium-

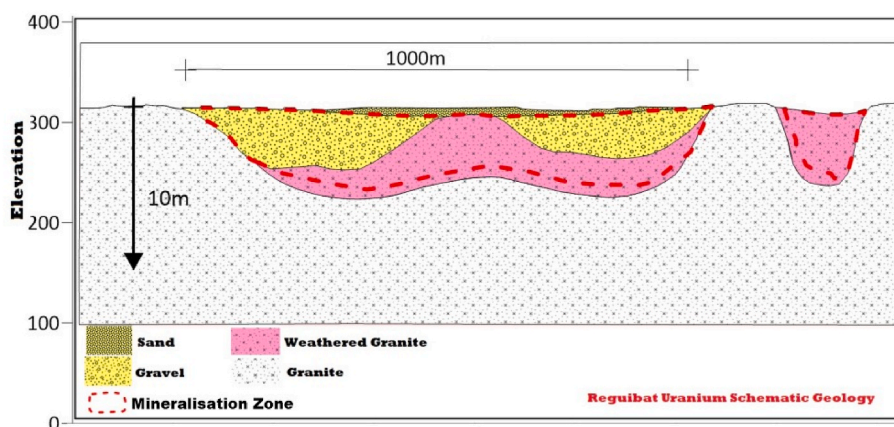


Fig. 8. Typical schematic section of a uraniferous calcrete occurrence from the Tiris uranium project in the northeast part of the Reguibat Shield (modified after Beeson et al., 2014).



**Fig. 9.** Field view of calcretes U-deposit of Tiris project: A- Field appearance; B- surficial uraniferous layers; C- uranium bearing mineral (carnotite) (Aura Energy, 2022).

grade uranium mineralisation over a strike length of 1.2 km were evidenced. The best intersections have reached a length of 80 m at 362 ppm U, including 12 m at 704 ppm U, and the highest grade corresponds to 1 m at 1352 ppm U. The uranium mineralisation remains open at depth and over 2 km along strike.

## 6. Discussion

### 6.1. Neobirimian granites potential as uranium rock sources: fractionation and U enrichment

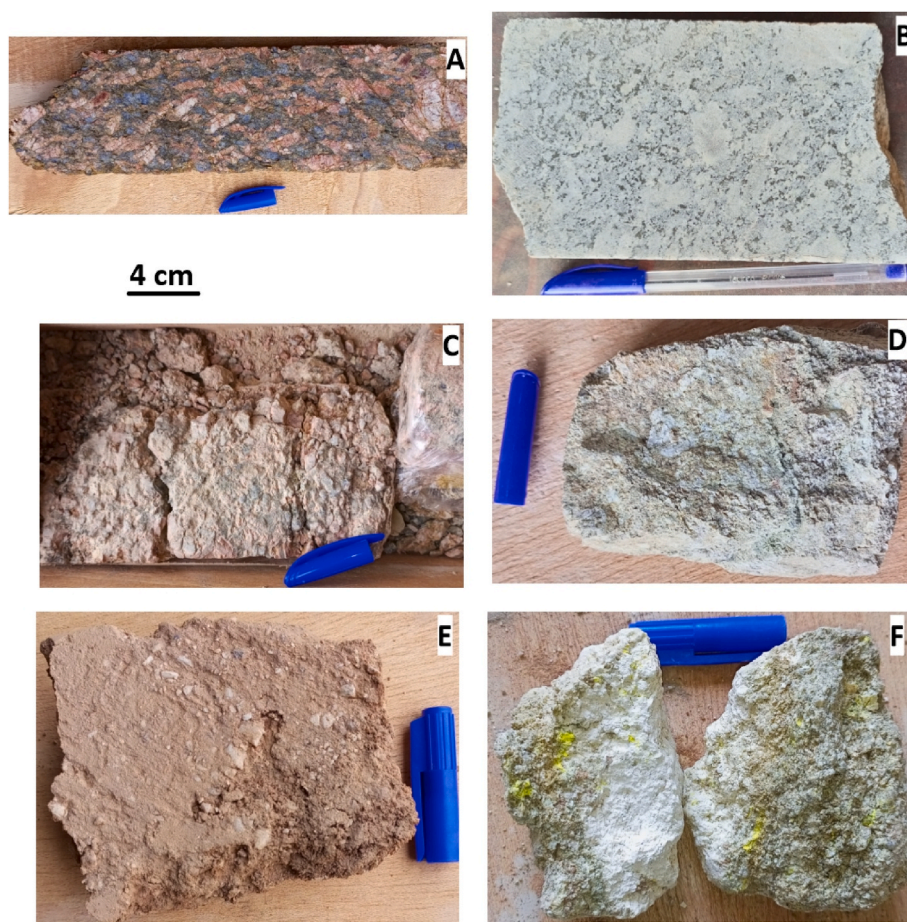
Geochemical data on Neobirimian granites from the Complexe d'Adam Esseder, comprising the Bir El Nar and Steilet Zednes monzogranites, and the Tourassin and Archeouat granites are available in the report by Lahondere et al. (2003). The extracted data have been plotted in the Q-P and A-B chemical-mineralogical diagrams proposed by Debon and Le Fort (1988). The data of the Complexe d'Adam Esseder clearly define a high-K calc-alkaline magmatic trend both in the Q-P and A-B diagrams (Figs. 13 and 14, respectively).

In the Q-P diagram, the Bir El Nar and Steilet Zednes monzogranites and associated diorites, and other plutonic rocks of the northeastern part of the Reguibat Shield in Mauritania, define the same steep trend from quartz monzonitic to highly quartzose (up to 77 wt% SiO<sub>2</sub>) granitic composition corresponding to the fractionation of plagioclase and amphibole leading to simultaneous enrichment in quartz and K-feldspar. Some samples are strongly enriched in K-feldspar either by filter-press effect in magmatic shear zones or K-feldspathization (i.e., REN4097 with up to 6.76 wt% K<sub>2</sub>O). One sample (TB0281) is albitized. One sample of microdiorite (TEN4150) and one sample of Bir Moghreïn (a basic

enclave) display a low to medium K-calc-alkaline composition (only 1.19 wt% K<sub>2</sub>O). The Guelb Tourassin, Alous Tmar, Tenedbar, Leg Beya and Yeti granites are among the most fractionated members of this high-K calc-alkaline series, whereas the Cortage Zednes samples are among the less fractionated. One sample from Bir en Nar plot near the average monzonite, but has low Fe and Ca contents, and corresponds to a mineralized (2235 ppm U) dequartzified (Q = 49.9) and albitized (P = -142) granite, a composition typical of U mineralized metasomatic albitites. The sample from Tenedbar is also mineralized (513 ppm U), strongly albitized (P = -193), but only slightly dequartzified (Q = 166).

In the A-B diagram, the Bir El Nar and Steilet Zednes monzogranites and associated diorites, and most other plutonic rocks of the northeastern part of the Reguibat Shield in Mauritania define the same trend from metaluminous quartz monzodiorites (A as low as -80) to mildly peraluminous granitic compositions (An up to 25), with decreasing fractionation index parameter B. Such a trend is interpreted as corresponding to the fractionation of Ca-rich and Al-poor (amphibole and/or pyroxene leading to A parameter increase) and Fe-Mg-rich minerals (amphibole and/or pyroxene leading to B-parameter decrease) inducing the simultaneous enrichment in quartz and K-feldspar. However, the gap of composition between the strongly metaluminous mafic rocks and the slightly metaluminous to peraluminous leucocratic rocks can be interpreted as a mixing between a mildly peraluminous granitic magma and a metaluminous basic magma. The majority of the granites are very leucocratic (B < 30) and thus have suffered a limited amount of mixing with the basic magma, whereas the metaluminous basic magma composition presents a large spreading of their composition indicating a much higher degree of mixing with the granitic magma.

In a Th versus U diagram (Fig. 15), the plutonic rocks of the



**Fig. 10.** Lithological facies associated with calcrete uranium mineralisation in the Proterozoic domain of the Reguibat Shield: A- Porphyritic granite of Oued el Foule, B- Grey granite of Ain Sder, C- Weathered granite (from granite A), D- Weathered granite (from granite B), E- Clayey sandstone, and F- Calcareous grey weathered granite with visible carnotite (pictures taken from Aura Energy drill cores taken by the first author, 2022).

**Table 4**  
Lithostratigraphic succession at the Lazare and Hyppolite deposits (modified from Aura Energy drill cores, 2017).

Zone	Deposit	Rock	Rock description			
			Texture	Colour	Cement	Comment
Ain Sider	Lazare	sandstone	granular medium-grained	Brown	calcareous	surficial layer 0–2m thick
		weathered granite fresh granite	granular massive	grey or dark grey Grey	calcareous	dark grey due to high biotite content locally with yellow U minerals broadly starts from 4 m depth
Oued El Foule	Hyppolite	siltstone	unconsolidated medium-grained	grey or brown	sandy	surficial layer 0–1m thick
		sandstone	granular coarse-grained	grey or brown	sandy clayey calcareous	located between siltstone and weathered granite
		weathered granite	granular coarse-grained	Pink	calcareous	from 2 to 4m depth
		fresh granite	massive	Pink		pink feldspar megacrysts

Complexe d'Adam Esseder, Yetti, and most other plutonic rocks of the northeastern part of the Reguibat Shield define a global trend with a simultaneous U and Th enrichment and an average Th/U ratio close to the average crustal ratio of 4, typical of high-Fe-K calc-alkaline magmas transitional with peralkaline magmas (Cuney, 2014). In fact, the Th/U ratio evolves from a value of about 6 to less than 3. The lowest ratios indicate the presence of uraninite in addition to uranothorite and/or allanite as the main U-bearing minerals. Uranothorite and allanite were identified in the samples of Alous Tmar and Bir Moghrein (Daval, 1982).

Some samples (TEN4100B, Legbeya 15 and 22) are anomalously enriched in uranium with a Th/U lower than one, indicating that

uraninite is the major U-bearing mineral. Two samples have very high U contents (515 and 2235 ppm U). In contrast, samples with a Th/U ratio close to or higher than 10 (i.e. TEN4097 and ZD0333) are strongly depleted in uranium. The mineralized samples are enriched in U at constant Th content, as usually observed in hydrothermal sodium metasomatic type deposits (Cuney, 2014).

Sydorchuk and Zagnitko (2021) have reported a uranium content in a sample of pegmatite from the Reguibat Shield reaching 1080 ppm U, but its Th content has not been measured. The main uranium minerals identified in the pegmatite are a primary magmatic mineral: uranothorite, a high temperature hydrothermal mineral: brannerite, and a