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Uraniferous potential and occurrences of Madagascar: an overview

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I- INTRODUCTION

Geologically, Madagascar is divided in two parts: (i) the 2/3 eastern part formed the crystalline bedrock which composed by six Domains, from North to South: Bemarivo, Antongil –Masora, Antananarivo, Ikalamavony, Androyen –Anosyen, and Vohibory. These are the Precambrian shield [1]. (ii) And the 1/3 left in the western part formed the sedimentary cover: from North to South, there are three important basins: Diego basin, Mahajanga Basin and Morondava basin. A small basin in the Eastern coast is also signalized. In additional of these basins: there is a lake basin in the center part.

Uranium occurrences and uraniferous potential are hosted in two domains in crystalline bedrock: Antananarivo and Anosyen Domain. And in sedimentary cover: there are two deposits: in Morondava Basin and in lake basin.

Two types of Uranium deposits appeared in crystalline bedrock and two another types in sedimentary cover.

The present work develops these uraniferous potential and occurrences of Madagascar and proposed a new potential uranium deposit.

II- DESCRIPTION OF OCCURRENCES AND URANIFEROUS POTENTIAL

1- URANIUM IN SEDIMENTARY COVER

In sedimentary cover, there are two types of deposits: (i) sandstone Uranium deposit and (ii) surficial lacustrine deposit.

1.1 Sandstone Uranium deposit

Makay and Folakara Uranium deposit are classified in Sandstone Uranium deposit. Geographically, Makay and Folakara deposit are located in North Western part of Madagascar, in Morondava basin. Makay in the Southern part and Folakara in the Northern part. From bottom to top, there are: Sakoa, Sakamena, Isalo I and Isalo II in Morondava basin. Uranium occurrences formed by carnotite found in Isalo II. Isalo II is composed by sandstone and fine clays.

After geological prospecting, geophysical airborne survey and geochemical studies realized by CEA (Commissariat Français à l'Énergie Atomiques); OMNIS (Office Militaire National pour les Industries Stratégiques) in partnership with PNUD (Programme des Nations Unies pour le développement) –IAEA (International Atomic Energy Agency) continued to undertake geological, geochemical and drilling work on 1979 –1982, and evaluated its economic potential and estimated 272.000 tons of reserves [2].

1.2 Surficial lacustrine deposit

Vinaninkarena deposit can put in Surficial deposit type. Uranium occurrences formed by uranocircite is hosted in Lake Basin. Geographically, this deposit is situated in central part of Madagascar, south of Antsirabe. The uraniferous zone is located in the contact of crystalline bedrock and Southern part of the lake.

This deposit is considered like secondary deposit after alteration –erosion –transport phenomena from crystalline bedrock (primary deposit). Since 1910, during thirty years, CEA evaluated 140.000 tons of Uranium in Vinaninkarena deposit [2].

2- URANIUM IN CRYSTALLINE BEDROCK

In the crystalline bedrock there are: (i) Metasomatite deposits and (ii) Intrusive deposits

2.1 Metasomatite deposit

Tranomaro uranium deposit is classified in metasomatite deposit [1].

Geographically, this deposit is located in southern part of Madagascar. And geologically, in Androyen - Anosyen domain, at Anosyen sub -domain.

This Anosyan sub -domain is formed by metagabbros, granitic orthogneiss and their age were interpreted as paleoproterozoic.

This deposit is placed in Tranomaro group, which is composed by calcomagnesian paragneiss, Werneritites, cipolin, leptynite with Uranium –Thorium and quartzite. This formation is crossed by three suits: (i) Dabolava suit (1000 MY), (ii) Imorona –Itsindro suit (820 –760 MY) and (iii) Ambalavao suit (570 –550 MY) [1]. Uranothorianite mineralization is associated with pyroxenites in granulite facies.

The CEA and OMNIS have also taken an exploration work (cartography in small scale, mining work: trenches, pits, and geophysical airborne in this area) on 1947 –1969. Since 1953 –1967, OMNIS in partnership with IAEA estimated 50.000 tons of Uranium in Tranomaro deposit [2].

2.2 Intrusive deposit

Two areas are classified in this type: Ankazobe –Vohimbohitra and Antsirabe Uranium deposits which are located in Antananarivo Domain. This Domain is formed by Neoproterozoic orthogneiss and paragneiss with greenschist to granulite facies. This domain includes also three greenstones belts from West to East: Bekodoka –Maevatanana belt, Andriamena belt, and Beforona belt [1]. These three greenstones belt constitute Tsaratanana complex. These formations are crossed by Imorona –Itsindro suit (860 –720MY) with ultrabasic to acid facies [1].

- Antsirabe uranium deposit

Geographically, Antsirabe Uranium deposit is situated in East part of Antsirabe, central part of Madagascar (in Betafo town). Noted that Betafite, is a mineral ore of uranium and its name is from Betafo town. Three types of potassic –pegmatites are present in this area according to their enclosing formation. There are:

o Pegmatite crossed the granites.

Except the quartz, and mineral of pegmatite, this pegmatite is composed also by betafite, euxenite, columbite, pyrite, and garnet.

o Pegmatite crossed the gabbros

This pegmatite is appeared as veins filling the fracture; this is a pegmatite with magnetite, euxenite, betafite, and beryl.

o Pegmatite crossed the crystalline bedrock

This pegmatite filled also the fractures but in migmatite gneissic complex.

Some exploration work has already carried out in this area: the first one is an airborne overflight on 1947 –1969 by CEA. Government agency of Malagasy states (OMNIS) in partnership with UNDP (United Nations Development Programme and System) continue this work on 1976 –2000 [2]. Thirty pegmatites were exploited in this area and have collected 50 tons of ore at an average ore grade 12 à 15 % U₃O₈ [1]. Pegmatite crossed the granite (Vavato granite 860 –720MY) was the important Uranium occurrences [1].

- Ankazobe –Vohimbohitra Uranium deposits

Geographically this deposit is located in the central part of Madagascar (X: 502 500 (m) –519 800 (m) et Y: 1 048 800 (m) –1 082 300 (m)). This deposit is located in Andriamena belt with uraninite bearing pegmatite which composed by heterogenous formations, with various metamorphism degrees. But the gneissic complex in this area is in high degree [1]. This is very similar in Zimbabwe greenstone belt. “The 2014 Red Book notes 1400 tU as RAR in the \$130-260/kg bracket, and also speculative resources of 25,000 tU.” [3]. Recently, Zimbabwe is believed to have uranium reserves of around 45.000 tonnes [4].

Robert F. Bacher and Hans J Morgenthau discovered that “The pegmatites in Madagascar are the only one that have furnished appreciable tonnage of Uranium minerals. Records indicate the sale of over 100tons of autunite and uranocircite ores” [5].

III- DISCUSSION AND CONCLUSION

After geological study, exploration work by different entity (National and international), compared with Zimbabwe greenstone belt which is very similar in Andriamena belt and known that pegmatite in Madagascar are very rich in tonnage of Uranium minerals. Ankazobe –Vohimbohitra uranium deposit in pegmatite could present an important uranium pegmatite deposit. A deep exploration work in this area is needed.

IV- REFERENCES

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Country or International Organization

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