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## Application of UNFC to uranium resources discovered in Algeria

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### I. INTRODUCTION.

The national mining sector is undergoing deep changes and fast evolution towards market economy. In this context, and in order to ensure the adequate and rigorous management of uranium resources discovered and evaluated in the Hoggar (southern Algeria), with a view to their development and integration into national economy in its current transition phase, a re-evaluation of these deposits and indices according to internationally accepted criteria, standards and models (NEA / IAEA, UNFC, CRIRSCO) turns out to be an unavoidable event.

In this perspective and in order to contribute effectively to the preparation of this new stage, a first attempt to classify discovered and evaluated uranium occurrences in the Hoggar, according to generic specifications of the United Nations Framework Classification for Resources (UNFC) [1], is presented. It is developed with the aim of serving as a basis for the revival of uranium resources exploration and development program throughout the national territory.

### II. EXPLORATION WORK CARRIED OUT AND MINING DEVELOPMENTS UNDERTAKEN.

The first evidence of uranium mineralization found in the Hoggar (Central Sahara, Algeria) was discovered in 1958 in Precambrian basement of Timgaouine-Abankor region during the implementation of the first Hoggar mineral exploration program undertaken by the Mining Research Bureau of Algeria (BRMA) between 1953 to 1960 [2, 3]. These first results were followed by the discovery of uraniferous indices around the circumscribed granite of Aït Oklan - El Bema in Tesnou region in the North of Timgaouine, by the Commissariat à l'Énergie Atomique (CEA, France) between 1958 to 1960 [3]. These uranium occurrences identify with intrabatholithic vein-type mineralization, all of which are contained in the eastern branch of the pan-African chain (western Hoggar).

In a second step (1969 - 1974), marked by a significant investment effort, the detailed exploration work undertaken by the National Company of Research and Mining (SONAREM) with the assistance of the Romanian partner GEOMIN, have allowed the development of known uranium indices in two economically important uranium deposits of Timgaouine and Abankor and the evaluation of the uraniferous resources of Tinef deposit of [4, 5, 6].

The extension of this exploration work to sedimentary cover of basins on the outskirts of Hoggar (Tassilis) resulted in the discovery of Tahaggart deposit and the indices of Timouzeline and Tamart N Iblis, uranium occurrences collected respectively in the Precambrian basement - Paleozoic cover interface, and in continental sandstone horizons of lower Devonian of the Tin Séririne sedimentary basin (Southeast of Hoggar) [7, 8, 9].

At the same time, with the continuation of general exploration of uranium in the Hoggar, development studies of Timgaouine and Abankor deposits, launched in 1976, were initiated in successive phases with the assistance of several specialized companies, for determine the technical, social and economic conditions for the exploitation of these two deposits.

The main objectives of this first phase focused on:

- The expertise of geological and hydro geological work undertaken by SONAREM;
- The collection of ore samples for treatment trials;
- The identification of the main development variants.

This expertise, preceded by the work of the GTZ group (FRG), was entrusted to six (06) operators: DAVY Mc KEE - COTECNA (USA - Switzerland), KAISER (FRG), KILBORN (CANADA), TRACTIONAL - MINING UNION ( BELGIUM), STEC (FRENCH CONSORTIUM) and CHARTER - CKB (ENGLAND) [10, 11, 12, 13].

At the end of this first phase, completed at the end of 1977, SONAREM awarded in December 1978 two groups of companies (among the six of the first phase) the second phase. This one had for objectives:

- The technical-economic optimization study;
- Preparation of preliminary project files;

The two groups selected for this second phase:

- The association DAVY Mc KEE (USA), TRACTIONNEL (Belgium), UNION MINIERE (Belgium) and COTECNA (SWITZERLAND); - The FRENCH CONSORTIUM composed of STEC, SOGEREM, MINATOME and SOFREMINES.

At the end of this second phase, the results obtained are presented as follows [14, 15, 16]:

- Location: 20km apart from each other, the two deposits of Timgaouine and Abankor are 180km south-west of Tamanrasset;
- Geological reserves: 21,000 tons of uranium metal with an average grade in place of 0.18%.
- Recoverable reserves: approximately 14,000 tons of metal (ex-works);
- Production capacity: with the use of an alkaline treatment process, 600 000 tons per year in all round products corresponding to 900 T / yr of uranium metal.
- Life expectancy: 15 years on average based on recoverable reserves.

With a Distance of 35km from Timgaouine, Tinef deposit is located in the same geological context as Timgaouine and has the same types of uranium mineralization [4, 10].

Work carried out on an area of 21km<sup>2</sup> consisted of recognition soundings spaced 2 to 3km apart, narrowed to 1km (on the ground anomaly) and destructive soundings to 200x200m, tightened in the mineralized zones at 50x60 m and 25x50 m for the estimated category C2 reserves estimated at 374 000 t of ore at 0.1% U, ie 374 tU metal [4, 5].

In the North of this potential zone and situated in the same geological context, the El Bema-Aït Oklan-Tidjeldamine, indices in the Tesnou region, have not been subject of detailed exploration work likely to give a preliminary assessment.

Exploration work in the sedimentary basin of Tin Séririne (south-east of Hoggar) initiated by an airborne geophysical survey (spectrometry and magnetism) allowed, after verification carried out on the ground by soundings and ground survey works [7, 8, 9, 17]:

- Confirm the existence of the small Tahaggart deposit whose metal tonnage is estimated at 1677 tons of uranium with a uranium content of 0.217%.
- To individualize, in the area of Tamart-N-Iblis and Timouzeline, mineralized levels in the sandstones of the Lower Devonian. These indices thus suggest a great potentiality of this stratigraphic level.

### III. APPLICATION OF UNFC TO URANIUM RESOURCES DISCOVERED AND EVALUATED IN ALGERIA.

The discovery and mining development of Timgaouine, Abankor and Tinef deposits in the Precambrian basement of the Hoggar and the Tahaggart deposit in the Tin Séririne sedimentary basin have gone through three stages:

- Discovery of the Timgaouine, Abankor, Tinef and Tahaggart indices by general exploration work;
- Discovery of the Timgaouine, Abankor, Tinef and Tahaggart deposits through detailed exploration work;
- Technical-economic evaluation, mineral processing tests and mining works for the Timgaouine and Abankor deposits;

- Evaluation of the uranium resources of the Tinef and Tahaggart deposit.

These detailed investigations provided access to a good knowledge of these deposits to undertake the mining process.

On the basis of this information, we have determined categories E, F and G as well as the class and subclass of Timgaouine, Abankor, Tinef and Tahaggart Projects.

- E2: Probable economic viability of extraction and sale in the foreseeable future.
- F2.2: Need for further evaluation of extraction feasibility through a specified development project or mining operation.
- G1, 2, 3: Quantities associated with a known deposit that can be estimated with a high level of confidence.

These four projects are classified in E2 F2.2 G1,2,3 Categories, POTENTIALLY COMMERCIAL PROJECT Class and DEVELOPMENT ON HOLD Sub-Class.

After the discovery of the Aït Oklan - El Bema - Tidjelamine indices in the Tesnou region, north of Timgaouine, and the Timouzeline and Tamart-N-Iblis indices in the Tin Séririne sedimentary basin in the south of the Tahaggart region, only general exploration work was carried out in these two zones.

On the basis of all the information collected, we have determined categories E, F and G as well as the class and subclass of the Tesnou and Tin Séririne projects.

- E3: The assessment is at a very early stage to determine economic viability.
- F3: Need to gather more data in order to confirm the existence of a deposit whose shape, quality and quantity make it possible to evaluate extraction feasibility.
- G4: Estimated quantities associated with a potential deposit, calculated in the first analysis on the basis of indirect evidence.

These two projects are classified in E3 F3 G4 Categories and EXPLORATION PROJECT Class.

### III. CONCLUSION.

The notification of uranium resources discovered and evaluated in Hoggar (southern Algeria) according to the generic specifications of the United Nations Framework Classification for Resources (UNFC) provides access to a harmonization of multitude classification systems used by the various groups involved in different phases of exploration and development of these resources.

Based on the Project concept, this uniform international system that meets the criteria of the market economy can be a relevant tool for reviving the revaluation and development program of uranium resources of the national mining sector.

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## Country or International Organization

Algeria

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