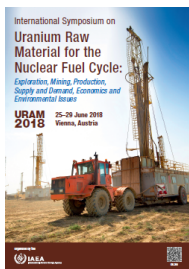


# International Symposium on Uranium Raw Material for the Nuclear Fuel Cycle: Exploration, Mining, Production, Supply and Demand, Economics and Environmental Issues (URAM-2018)



Contribution ID: 11

Type: ORAL

## Uranium exploration and mining activities of Turkey as a newcomer

*Wednesday, 27 June 2018 10:00 (20 minutes)*

Countries embarking on a nuclear power programme that called “a newcomer” need to make sure that the development of their legal, regulatory and support infrastructure keeps pace with the construction of the power plant itself. This is the only way to ensure that the programme proceeds in a safe, secure and sustainable way, concluded participants of a workshop on nuclear power infrastructure development.

Through several initiatives, the transfer of information and knowledge from states with extensive experience in uranium mining and production to “newcomers” to the sector. Growing demand from a much anticipated nuclear power renaissance and consequent soaring prices for nuclear fuel have recently spurred greater investment in uranium exploration in an increasing number of countries.

Nuclear power is an inevitable option for Turkey to meet energy security. Turkey has distinctly progressing its nuclear energy program in nuclear milestones. As being aware of that uranium mining and activities would be a significant role in the nuclear power plant projects. This paper wholly investigated the recent uranium exploration activities, drilling efforts, identified conventional resources, environmental activities and regulatory regime of Turkey with the details.

### INTRODUCTION

Background: uranium for nuclear power

Uranium resources are an integral part of the nuclear fuel cycle. To increase the capability of interested Member States for planning and policy making on uranium production, the IAEA works together with the OECD Nuclear Energy Agency (NEA) to collect and provide information on uranium resources, production and demand.

With uranium production ready to expand to new countries, efforts are being made to develop transparent and well-regulated operations similar to those used elsewhere to minimise potential environmental and local health impacts [1].

The general energy policy of Turkey focuses on the supply of secure, sustainable and affordable energy by diversifying energy supply routes and source countries, promoting usage of domestic resources and increasing the energy efficiency and renewable energy usage to decrease the energy intensity of production. Nuclear energy is considered for diversification of electricity generation and also for mitigation of GHG emissions from energy sector.

The Akkuyu NPP project started with the IGA between Turkey and Russia for construction and operation of 4 VVER-1200 reactors in Akkuyu site situated on the Mediterranean coast of Turkey. A comprehensive EIA report had been prepared by the PC taking into consideration the requests from a wide range of stakeholders which was approved in December 2014. EMRA had granted electricity generation licence in June 2016 which will form the basis of the PPA. The revised site parameters report was approved by TAEK on February 2017 and granted limited work permit for construction of non-nuclear safety related facilities in October 2017. The full construction of the first unit is planned to start in the first quarter of 2018 with the grant of construction licence by TAEK.

The other nuclear power plant project IGA which includes construction and operation of 4 ATMEA1 reactors in Sinop site and development of nuclear industry in Turkey was signed between Turkey and Japan in 2013 and ratified in 2015. EÜAŞ ICC established in November 2015 will participate to the project as shareholder of the project company which will be established based on the results of the feasibility study. The feasibility study started in July 2015 and the further support from Japanese government was provided with the MoU signed between MENR and METI in September 2016. The feasibility study is expected to be completed in the first quarter of 2018.

The strategic goal of nuclear energy usage is mentioned in the strategic plan of MENR under the goal for optimum energy resource diversity. Turkey has a high energy import and fossil fuel dependency which makes it vulnerable to external shocks in global markets. Nuclear energy is considered as one of the options together with local resources and renewable energy to strengthen the energy sector in Turkey. Radioactive minerals have been historically explored in Turkey which requires further studies for their feasibilities to start production [2].

As a result the strategic plan includes the target for reserve determination of radioactive minerals together with their respective feasibility studies for usage in the nuclear energy sector [3].

#### DESCRIPTION

##### General Directorate of Mineral Research and Exploration (MTA)

Uranium exploration in Turkey began in 1956-1957 and was directed towards the discovery of vein-type deposits in crystalline terrain, such as acidic igneous and metamorphic rocks. As a result of these activities, some pitchblende mineralisation was found but these occurrences was not accepted as economic deposits. Since 1960, studies have been conducted in sedimentary rocks which surround the crystalline rock and some small orebodies containing autunite and torbernite mineralisation have been found in different parts of the country. In the mid-1970s, the first hidden uranium deposit with black ore, below the water table, was found in the Koprubaşı area of Manisa. As a result of these exploration activities, a total of 9 129 tonnes U<sub>3</sub>O<sub>8</sub> (7 740 tU) in situ resources were identified in the Manisa-Köprübaşı (2 852 tonnes U<sub>3</sub>O<sub>8</sub>; 2 419 tU), Uşak-Eşme (490 tonnes U<sub>3</sub>O<sub>8</sub>; 415 tU), Aydın-Koçarlı (208 tonnes U<sub>3</sub>O<sub>8</sub>; 176 tU), Aydın-Söke (1 729 tonnes U<sub>3</sub>O<sub>8</sub>; 1 466 tU) and Yozgat-Sorgun (3 850 tonnes U<sub>3</sub>O<sub>8</sub>; 3 265 tU) regions.

##### Eti Mine Works General Management (Eti Maden)

State-owned organization Eti Maden is responsible for a total of six uranium mine sites with uranium resources. Geological exploration has been performed by MTA at these sites in the past. Between 1960-1980 uranium exploration was performed by aerial prospecting, general and detailed prospecting on-site, geologic mapping studies and drilling activities. These uranium sites were transferred to Eti Maden as possible mines which can be operated by the state under law number 2840 on the "Operation of Boron Salts, Trona and Asphaltite Mines and Nuclear Energy Raw Materials"(10 June 1983).

##### Recent and ongoing uranium exploration and mine development activities

##### General Directorate of Mineral Research and Exploration (MTA)

In 2012, granite, acidic igneous and sedimentary rocks around Manisa, Denizli and Aydın (an area of approximately 5 000 km<sup>2</sup>) were explored for radioactive raw materials. Exploration for radioactive raw materials was also performed in sites licenced by MTA inside Manisa, Uşak and Nevşehir.

In 2013, granite, acidic igneous and sedimentary rocks around Aydın and Denizli (an area of approximately 5 000 km<sup>2</sup>) will be explored for radioactive raw materials. Exploration for radioactive raw materials was also performed in sites licenced by MTA inside Manisa, Uşak and Nevşehir.

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In 2015, Exploration for radioactive raw materials will be conducted in sites licenced by MTA inside Manisa and Nevşehir [4].

##### Private sector exploration

Adur, a wholly owned subsidiary of Anatolia Energy, a Turkish uranium exploration company with current and active drill programmes at the Temrezli and Sefaatlı uranium sites, has carried out exploration and resource evaluation drilling with a total of 206 drill holes completed for a total drill advance of over 26 000 m since 2011 in both Şefaatlı and Temrezli projects. Over 16 000 m of drilling was in Temrezli region. Until now, 112 holes have been completed in Temrezli project. The drilling in Temrezli, mostly twinning the earlier MTA drill holes but also in-fill and step-out holes, confirmed work conducted in the 1980s and extended the uranium mineralisation to the north-east over a strike length of more than 3 000 m.

In 2011, CSA Global Pty Ltd prepared a JORC compliant mineral resource estimate for the Temrezli deposit of 13.282 Mlb U<sub>3</sub>O<sub>8</sub> (6 025 tU) (measured, indicated and inferred) in situ uranium at an average grade of 1 157 ppm (0.117% U<sub>3</sub>O<sub>8</sub>).

Preliminary metallurgical bottle-roll leach test work confirmed MTA's earlier work and returned 93% and 90% uranium recovery was obtained by using an acid or alkali leach method, respectively.

Several hydrological test wells were constructed at Temrezli since 2012 in order to assess the regional ground-water conditions and to conduct hydraulic testing of the mineralised horizons at a scale typically seen at in-situ recovery (ISR) operations. Test work was performed by HydroSolutions, a US-based hydrogeologist with considerable experience in ground water conditions relating to uranium ISR operations throughout western United States. The test confirmed the aquifer has sufficient flow rate for ISR mining.

Regional exploration identified new areas of mineralisation, at West Sorgun and Akoluk. The rotary and diamond drill programme tested a number of regional sites that are considered prospective for Eocene-aged sediment-hosted uranium mineralisation, similar to what is seen at the Temrezli uranium deposit.

Since early stage studies indicate that the Temrezli uranium deposit will be amenable to ISL mining, a preliminary economic assessment (PEA) contract was awarded to US based WWC Engineering of Sheridan, Wyoming. The PEA is completed and followed by PFS study which was awarded to Tetra Tech, US origin company PFS was completed and issued in early 2015 which indicated that the project is economically feasible to proceed, with a total expected recovery of 9.7m lbs. over 12 years, with operating costs of less than USD17 per lb U<sub>3</sub>O<sub>8</sub> (USD44.2 per kg U). Adur initiated the Environmental Impact Assessment (EIA) process by preparing and submitting a Project Description to the Ministry of Environment and Urban Planning in 2015. Adur will also initiate the permitting process with Turkish Atomic Energy Commission regarding licensing Temrezli site as a nuclear facility since ISR operations are considered as nuclear facilities. In 2015, the permits and licenses will be obtained prior to initiating the construction in early 2016.

#### DISCUSSION AND CONCLUSION

##### ☒ Identified conventional resources (reasonably assured and inferred resources)

Identified conventional uranium resources in Turkey determined from exploration activities performed by MTA in the past are listed below, with the addition of JORC compliant resources identified through recent work by Adur exploration, described in more detail:

- Manisa-Köprübaşı: 2 419 tU in ten orebodies and at grades of 0.04-0.05% U<sub>3</sub>O<sub>8</sub> (0.034 0.042% U) in fluvial Neogene sediments.
- Uşak-Eşme: 415 tU at 0.05% U<sub>3</sub>O<sub>8</sub> (0.042% U) in Neogene lacustrine sediments.
- Aydın-Koçarlı: 176 tU at 0.05% U<sub>3</sub>O<sub>8</sub> (0.042% U) in Neogene sediments.
- Aydın-Söke: 1 466 tU at 0.08% U<sub>3</sub>O<sub>8</sub> (0.068% U) in gneiss fracture zones.
- Yozgat-Sorgun: 4 633 tU at 0.117% U<sub>3</sub>O<sub>8</sub> in Eocene deltaic lagoon sediments.

Temrezli (Yozgat / Sorgun) uranium deposit is one of Turkey's largest and highest grade uranium deposits, with a JORC compliant Mineral Resource estimate of 13,282 Mlb of contained uranium at an average grade of 1,157 ppm (0.117%) U<sub>3</sub>O<sub>8</sub> with an average depth of 120 m.

##### ☒ Undiscovered conventional resources (prognosticated and speculative resources)

Temrezli Project: The ongoing exploration and development drillings is to be continued and is expected to increase the resource by a potential of 1-3 Mlb U<sub>3</sub>O<sub>8</sub>.

Şefaati Prospect: exploration and development drillings is being conducted in 2015 and is expected to increase the known uranium resource values by approximately 5-6Mlb U<sub>3</sub>O<sub>8</sub>. The recent drill results include 1,10m at grade 2,150ppm e U<sub>3</sub>O<sub>8</sub> from 39m [4].

##### ☒ Unconventional resources and other materials

None reported, but grassroots exploration is in place.

#### REFERENCES

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## Country or International Organization

Ministry of Energy and Natural Resources/ Turkey

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**Session Classification:** Uranium Newcomers

**Track Classification:** Track 12. Uranium newcomers