Keynote lecture on

India's atomic mineral resources: Prospects, challenges and future directions for sustainable development

By

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Introduction:

The accelerated agricultural and industrial growth of our country has posed a serious challenge of meeting the quantitative demand of secure and affordable energy. This vibrant development process is also resulting in a shift from the use of non-commercial energy sources to commercial energy sources, particularly electricity. The problem is all the more acute in the light of recent developments of global measures to cut emission and emphasis on producing electricity in environmentally benign means. In this context of our planned electricity generation, expansion of nuclear power generation capacity occupies a special standing in country's endeavour towards energy independence. It has also been established and appreciated in many countries of the world that the nuclear power is the reliable, environmentally benign and economically viable source of energy. Accordingly, our country is on the preferred path of generating nuclear power with the use of indigenous atomic mineral resources. Some multiplying capacity generation is though expected through the import of fuel as a result of recently concluded India-specific international agreement on nuclear co-operation, the indigenous production continues to expand with vigour.

Uranium and thorium are the two chiefly known naturally occurring atomic minerals considered as sources of power. Of the two, only uranium is fissionable and considered as the primary source for production of electricity. Thorium is a fertile material. Its use in the process of fission and potential production of electricity is linked with the technological development of transmutation and its industrial application. Presently, natural uranium is considered as the only source of power in nuclear power plants all over the world. India's nuclear power programme is strategically linked with full utilisation of indigenous uranium resources (closed cycle) and future use of thorium.

Uranium resources and production centers of the country:

The beginning of uranium exploration in India started immediately after the formation of the Atomic Energy Commission (AEC) in 1948. The exploration activities were intensified to locate good deposits of uranium, specially in geological provinces known for occurrences of multi-metallic minerals. The discovery of uranium mineralisation at Jaduguda in Singhbhum shear zone in Jharkhand (formerly in Bihar) during 1951 led to expansion of exploration activities. Early successes led to intensify search in this region with renewed vigour. As a result many new deposits in this region were brought to light of which some of them are now big operating mines, successfully catering to the need of uranium in the country. The exploration activities were later on shifted to other parts of the country in line with the concept based approaches and models increasingly being applied in many mineral exploration campaigns.

Well thought-out exploration strategy for uranium in India by AMD has led to the identification of a large number of uranium anomalies and a number of small to medium sized uranium deposits, of low to medium grade. The major deposits types in different areas, identified so far are as follows.

I. Shear-controlled vein type deposits:
   - i) Singhbhum Shear Zone (SSZ), Jharkhand
   - ii) Rohil- Ghateshwar shear zone, Rajasthan

II. Sandstone type deposits
   - i) Mahadek sedimentary basin, Meghalaya

III. Strata-bound uranium deposits
   - i) Vempalle Formation, Cuddapah Basin , Andhra Pradesh

IV. Unconformity related uranium deposits
   - i) Srisailam sub-basin of the Cuddapah basin, Andhra Pradesh

V. Fracture controlled uranium mineralisation
   - i) Gogi area of the Bhima Basin in Karnataka

The total U_3O_8 resource identified in the above areas is about 1,03,552 tonnes of which Jharkhand accounts for about 45%, Andhra Pradesh 27%, Meghalaya 17% , Rajasthan and Karnataka 4% each and remaining in other states. (Mar. '06).

The uranium production in our country to cater to the indigenous need made an exciting beginning with the formation of Uranium Corporation of India Ltd (UCIL) in 1967 under Department of Atomic Energy. The operation was launched with the commissioning of an underground mine and ore processing plant at Jaduguda (1968) in Jharkhand (the then Bihar). Later, in line with the requirement of uranium new underground mines at Bhatin (1987), Narwapahar (1995) and Turamdih (2003), Bagjata (2008) and an opencast mine at Banduhurang (2009) were commissioned. All these operating uranium mines of the country are within 25 km from Jaduguda in the state of Jharkhand. The new underground mines have been developed with layout suitable for employing trackless equipment. Ore from all these deposits are being processed in two central plants located at Jaduguda and Turamdih. These plants adopt acid leaching route following indigenously developed flowsheet. The plant at Jaduguda has been expanded thrice with a capacity to process 2500 tonnes of ore per day.

Keeping in view the nation's endeavour to expand nuclear energy base, new uranium mines and processing plants are being constructed not only in Jharkhand but also in other parts of the country. One more underground mine at Mohuldih in Jharkhand is under construction to supply additional ore to the plant at Turamdih which is under expansion to process 4500 tonnes of ore per day. One large underground mine and a process plant (alkali leaching under pressure) have been taken up for development at Tummalapalle in the state of Andhra Pradesh.

Future prospects

During last five decades, the nuclear power programme of our country has gained considerable momentum. The Government is committed to appreciable increase in contribution of nuclear power for meeting the long-term power requirement. The programme has been very strategically designed to make full use of atomic minerals (uranium and thorium) resources of our country. The uranium exploration activities have also been stepped up leading to the discovery and augmentation of uranium resource base and UCIL is in the process of developing these sites after necessary techno-feasibility study.

After successful surface exploration, exploratory mining and ascertaining the viability of regular mining operations, an underground mine and a process plant adjacent to the mine have been planned at Gogi in the state of Karnataka. The plant at Gogi has been planned with alkali leaching route. Pre-project activities are in full swing and this project is expected to be in operation during XI plan period.

Pre-mining activities are also in advance stage to develop uranium reserves at Lambapur-Peddagattu in Andhra Pradesh. Three underground mines and open cast mine have been planned for development. A large sandstone hosted uranium deposit at Kyelleng-Pyndengsohiong, Mawthabah (former name Domiasiat) in Meghalaya in N-E parts of the country has also been planned for development by opencast mining method. Ore from both these sites will be processed by acid leaching route in the plant to be constructed at respective mine sites.

The challenges ahead

With increasing need of uranium to expand the nuclear energy sector, the presently known resources are to be multiplied which in turn demands focus on advanced techniques in uranium exploration. This calls for technology up-gradation in the fields of geophysics, 3D modeling, stable isotope geology, deviation controlled drilling etc. Known uranium bearing areas are to be assessed with greater intensity and new unknown areas are to be covered on the basis of concept based approaches.

Constraints / delay in locating large tonnage high grade uranium deposits in our country, may lead to dependence on exploiting more of low grade, low to medium tonnage deposits. Thus to meet the requirement of uranium in coming years, production and processing of large quantity of ore will be necessary which will result in generation of large volume of solid waste and effluent. Though cluster of small tonnage deposits are being considered for commercial exploitation, exploitation of uranium in small scale does not in any way reduce the inherent problems of uranium mining.

New exploration areas in the country indicate possible underground mining projects. Unfortunately, underground mining practices in India have shrunk over the years inhibiting mining companies to expand their operations. In such a scenario, it is becoming difficult to find competent and resourceful contractors for underground uranium mining.

Mining of cluster of small deposits and processing the ore in a mother plant will be a priority to bring in commercial viability. With rise in production of low grade ore, the need for innovations in mineral beneficiation will greatly be felt in order to eliminate transportation of entire ore from mine sites to the far-off mother plant and also reduce volume of processing. Any breakthrough in this regard may also help in making small deposits economically viable.

Discovery of new deposits in unknown geological environment may lead to rethinking of conventional processing technology. Along with the progress and success on exploration front, processing flowsheet and parameters need to be established. A newly constructed Technology Demonstration plant at Jaduguda is a step forward in this direction to meet the challenges. The new processing plants need to incorporate measures to maximize the re-use of water, high recovery of the product and minimum discharge of effluents. A benchmark for zero discharge may pose a serious challenge for future uranium production facilities.

Uranium mill tailings impoundment in the environment has become a matter of great public concern. As uranium ore in India are generally of low grade, production and processing of large quantity of ore results in generation of large volume of tailings. With greater public awareness of health hazards and stringent environmental guidelines, the management of these tailings (solid and liquid waste) shall become a crucial part of uranium mining sector.

Negative public perceptions of uranium mining often create hindrances leading to social and legal problems in new construction sites. In the recent years, though nuclear energy is gradually becoming an acceptable option, anti-nuclear forces are still active confusing the society. This has already taken a heavy toll on the time schedule of some of the new uranium projects.

Directions for sustainable development

Uranium is the key to the growth of nuclear power programme of the country, and nuclear power is now all set to make a substantial contribution to our total electricity generation. Therefore, considering the need of the uranium and its immediate requirement to expand the power generation base, major thrust has been given towards exploration of large-tonnage higher-grade uranium deposits. Accordingly, new techniques for exploration are put in place. Quite a few small to medium size low grade uranium deposits have been located in different parts of the country notable amongst them are Chitrial and Kuppunur in northern part of Cuddapah basin and

carbonate hosted small deposits around Tummalapalle in SW part of Cuddapah basin (Andhra Pradesh), Wahkyn in Mahadek basin (Meghalaya), Rohili-Ghateswar area in Aravalis (Rajasthan), Dishnur area in Karnataka etc.

UCIL is contemplating to go for small scale mining in some of these areas in coming years. In this regard, cluster of small deposits are very attractive for commercial viability. A small underground mine at Bhatin in Singhbhum is already in operation for the last 20 years and this experience shall become very useful to make other units commercially feasible elsewhere. Small scale mining will also lead to development of innovative unconventional uranium processing technology with shorter processing route

With the search for large deposit in greater depth, UCIL also envisages to undertake deep mining in some such new finds. Ore lenses in operating mines (Tummalapalle, Narwapahar, Bagjata etc) are also extending down dip necessitating deepening of the mines. Expansion of deep uranium mining sector in the country will lead to comparable scope for growth in the field of mining technology, research and allied subjects. For construction of large deep mines, internationally well-known contracting agencies could help with modern equipment and technology. Such tie-ups are seen as an effective tool for revolutionizing mine construction in Indian uranium mining sector.

With the opening up of uranium exploration and exploitation to the private sector and favorable geo-political happenings in nuclear energy sector, it is hoped that uranium exploitation will get a great boost with the participation of leading uranium mining and processing companies of the world. Such globalisation of uranium mining sector will also help the Indian uranium industry to go global with its unique experience of mining low grade, small to medium tonnage deposits.

Conclusion

Electricity is the fundamental driver for the economic and industrial development of our country and therefore, its generation is the thrust area of development. The country is moving ahead with a decisive mandate to expand the nuclear power programme. In this context, development of uranium resources shall form a crucial part towards maintaining sustained supply of fuel.

Self-reliance in basic raw materials is the dominant paradigm of nuclear power programme of our country. Therefore, the growth of atomic mineral industry is expected to grow matching with the phenomenal growth of nuclear power generation, in spite of the present arrangement of importing fuel through international agreement on nuclear co-operation. Apart from supplying the raw material for nuclear power plants, the industry will greatly help towards development of infrastructure, mining technology and provide employment opportunity in the country.