

Research and Development: In order to understand the genesis and controls of uranium mineralisation, basic research in the fields of geology, geophysics, geochemistry and also in allied topics such as physics, chemistry and electronics is being carried out.

Other Activities:

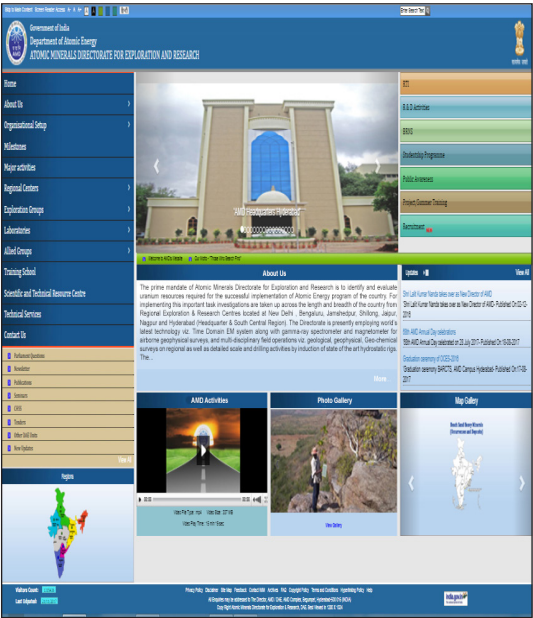
*AMD is also entrusted to carry out geological / geotechnical studies related to site selection for nuclear power plants and repositories for the disposal of radioactive wastes generated from these plants.

*AMD provides professional and analytical services.

*AMD Studentship Programme has been initiated to impart basic field training and to encourage university students to take up their dissertation work, thereby strengthening the collaboration of AMD with academic institutions. Under the aegis of BRNS, collaborative research-projects are taken up on genetic aspects of uranium deposits and related topics in order to formulate exploration strategy and prioritise areas.

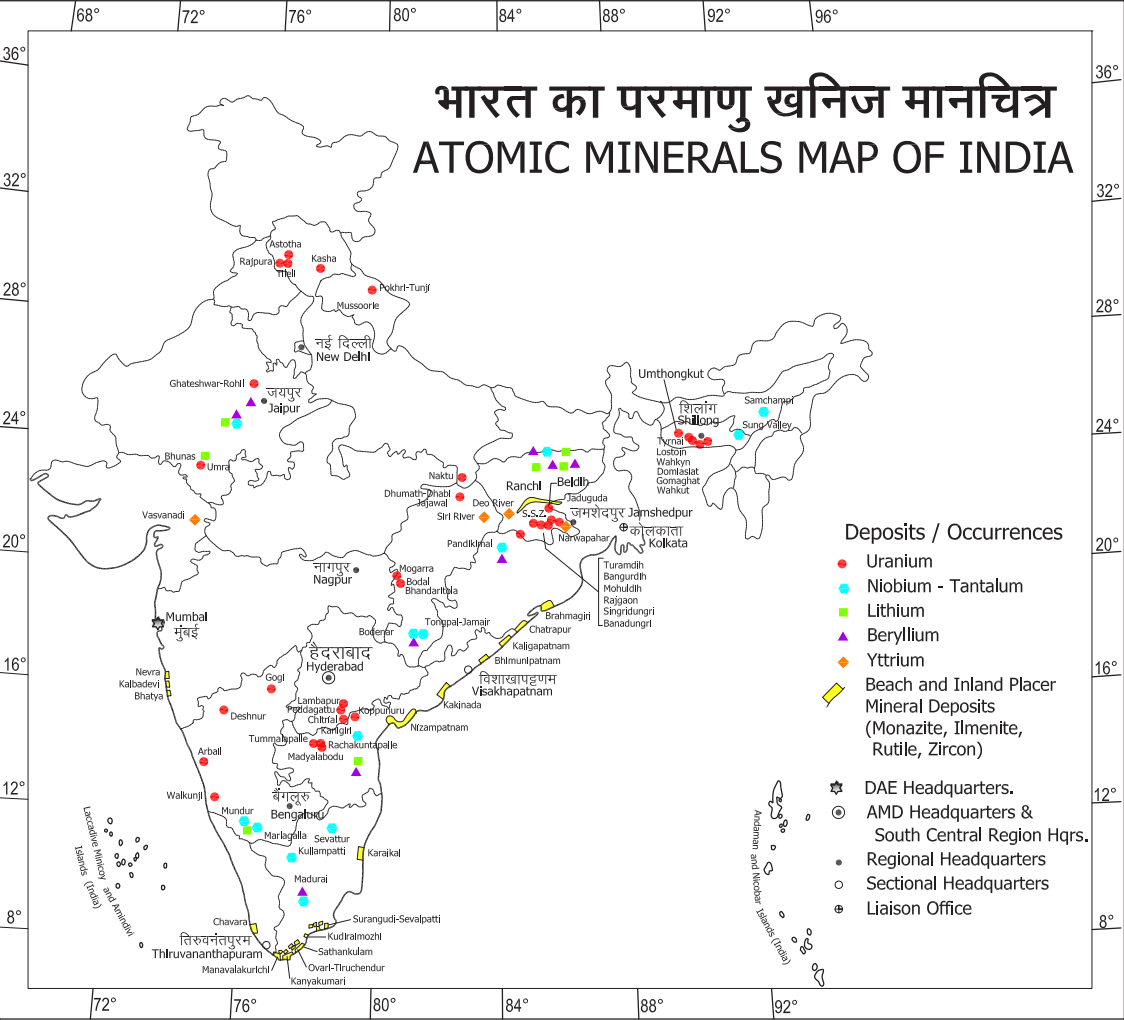
Over a period of seven decades AMD has emerged as an organisation of exemplary

multidisciplinary geoscientific skills. AMD will continue its exploration efforts to fulfil the atomic minerals requirement of country's nuclear power programme.



Please visit AMD's website: <http://www.amd.gov.in>

Our Motto - "Those Who Search Find"



Info Sheet

This material can be used freely with acknowledgement.

AMD Website: <http://www.amd.gov.in>

Published by: Head, Planning and Management Services Group, AMD, Hyderabad.



ATOMIC MINERALS DIRECTORATE FOR EXPLORATION AND RESEARCH (AMD)

Atomic Minerals Directorate for Exploration and Research (AMD) is one of the oldest units of Department of Atomic Energy (DAE) and plays an important role in the front and back end of the nuclear fuel cycle. AMD was established as Rare Minerals Survey Unit in 1949, subsequently renamed as Raw Materials Division (RMD) and brought under the Atomic Energy Commission on October 3, 1950. RMD was later renamed as Atomic Minerals Division in 1958 and rechristened as Atomic Minerals Directorate for Exploration and Research (AMD) in 1998. From a small nucleus of 17 earth scientists in 1950, AMD has grown into a large organisation with the present strength of two thousand three hundred employees, comprising scientific, technical, administrative and auxiliary personnel.

Mandate: The major role of AMD is to identify the resources of Uranium (U), Thorium (Th), Niobium (Nb), Tantalum (Ta), Zirconium (Zr), Beryllium (Be), Lithium (Li) and Rare Earth Elements (REE) required for various programmes of DAE.

Organisational Setup: The survey and exploration activities of the Directorate, with Headquarters at Hyderabad, are spread over the country and are executed through seven Regional Centres, with Headquarters located at New Delhi, Bengaluru, Jamshedpur, Shillong, Jaipur, Nagpur and Hyderabad. Besides, two sectional offices operate from Thiruvananthapuram and Visakhapatnam to carry out beach sand minerals investigations.

Exploration Methodology: The favourable target areas are initially identified based on the interpretation of photogeological and remote sensing data and available geological information. This is followed by airborne gamma-ray

spectrometric and geophysical surveys¹ to identify potential targets with abnormal radioelemental concentration.

The potential areas delineated by airborne surveys are taken up for ground reconnaissance radiometrics² using portable gamma-ray measuring instruments such as Scintillometer, Gamma Ray Spectrometer etc., regional/detailed geological, geochemical (rock, soil, radon, water and stream sediments) and ground-geophysical (magnetic, electrical, electromagnetic and seismic) surveys for further narrowing down the target areas for detailed investigations. Once the uranium potentiality of an area is established through physical examination of exposed outcrops, the area is further explored for concealed mineralisation by evaluating and integrating both airborne and ground geophysical data.

The areas having anomalous concentration of uranium (anomaly) and other favourable parameters as identified from the above investigations are evaluated by prospecting (trenching, pitting, geological and structural mapping, shielded probe logging and sampling) to establish the plan dimension of uranium mineralisation. Further, exploration in three stages (reconnoitry, exploratory and evaluation), is carried out by drilling³ using conventional as well as high-performing hydrostatic rigs to know the depth continuity of mineralisation. Based on the gamma-ray logging of the boreholes and geological considerations, the three-dimensional configuration of the ore body is mapped and ore reserve is estimated. In a few cases, exploratory mining is also carried out to establish ore body configuration and obtaining bulk samples for physical beneficiation and hydrometallurgical studies of ore, as a prelude to commercial mining



Heliborne Geophysical Survey



Radiometric and Geological Survey



Sub-surface exploration by crawler mounted Hydrostatic Rig (Departmental)

at a later stage by Uranium Corporation of India Limited (UCIL).

AMD also carries out exploration, prospecting and exploitation of rare metals (Nb, Ta, Be and Li) and rare earth minerals (La to Lu & Y) in different parts of the country. The insitu and eluvial soils, derived from the mechanical weathering of host rocks, mainly mineralised complex pegmatites, normally contain rare metal minerals namely columbite-tantalite (niobium-tantalum), beryl (beryllium) and spodumene & lepidolite (lithium). The soil containing these minerals is excavated, treated and recovered in the plants normally established near the source. Currently, such recovery plants are in operation in Odisha and Karnataka. Some of the streams in Chhattisgarh and Jharkhand also contain higher concentrations of yttrium bearing placer mineral (xenotime), which is currently recovered through recovery plant established in Chhattisgarh⁴.

The beach sands of Odisha, Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Maharashtra and parts of Gujarat contain rich concentration of heavy mineral resources of titanium (ilmenite, leucoxene and rutile), zirconium (zircon), REEs (monazite) besides magnetite. All these minerals occur as placers in the sand. AMD identifies such heavy mineral rich placer sand regions along the coast, and estimates the resources of individual minerals. The sand containing heavy mineral resources are mined and treated in the plants operated by M/s Indian Rare Earths Ltd (IREL). The inland placer sands of Odisha and Andhra



Xenotime bearing concentrate Recovery Plant, Chhattishgarh

Pradesh and Teri (red coloured) sand occurring in the southern part of Tamil Nadu also contain heavy minerals.

Laboratory Support: The multidisciplinary exploration programme of AMD is ably supported by Geochronology, Stable Isotope, Petro-mineralogy⁵, XRD, XRF, Electron Microprobe, Mineral Technology, Radiometric and Chemical laboratories equipped with state-of-the art equipments like Gamma-ray spectrometer, INAA, Radon Measuring System (RMS), ICP-MS, ICP-AES, AAS, EDXRFs, WDXRFs, EPMA, IRMS and TMS. Minerals of U, Th, Nb-Ta, REE, Be & Li⁶ are identified on the basis of their characteristic radioactive, mineralogical, physical and chemical properties.

Major Achievements: In India, the survey and exploration for atomic minerals commenced in the early 1950's in the known copper provinces of Singhbhum Shear Zone (SSZ), Jharkhand and at Umra-Udaisagar sector, Rajasthan. The first uranium deposit (metamorphite type) was located in the SSZ near Jaduguda. By 1970, many uranium deposits were established along the 160 km long arcuate belt of SSZ, which include Jaduguda, Narwapahar, Bhatin, Bagjata, Turamdih, Banduhurang, Keruadungri, Kanyaluka, Mohuldih, Nandup, etc.

Survey and exploration based on conceptual geological models, carried out in different terrains of the country resulted in the discovery of uranium deposits at Tummalapalle (Carbonate hosted



Petromineralogical Studies



Atomic Minerals containing uranium, thorium, niobium-tantalum, lithium, beryllium and REE (clockwise)



Info Sheet



Uranium mineralisation (Pitchblende veins) in brecciated limestone, Gogi area, Karnataka

stratabound type) and Lambapur-Peddagattu-Chitrial & Koppunuru (Unconformity related), Telangana and Andhra Pradesh; Domiasiat & Wahkyn (Sandstone type), Meghalaya; Gogi⁷ (Granite related), Karnataka; Rohil (Metasomatite type), Rajasthan and other small deposits. The stratabound carbonate-hosted uranium deposit at Tummalapalle, Andhra Pradesh is the single largest deposit in India with more than 1,84,000t insitu U_3O_8 .

UCIL is currently engaged in mining the deposits at Jaduguda, Bhatin, Narwapahar, Turamdih, Mohuldih, Bagjata and Banduhurang in the state of Jharkhand and Tummalapalle in Andhra Pradesh. Exploratory mining in Gogi, Yadgir district, Karnataka and Rohil, Sikar district, Rajasthan have been taken up in order to define the parameters for commercial scale mining.

Thrust / Potential areas: The thrust areas currently under exploration include: (a) Tummalapalle-Kanampalle sector, Kadapa district and Sarangapalli, Guntur district (Cuddapah basin), Andhra Pradesh; (b) Kanchankayi (Bhima Basin), Yadgir district, Karnataka; (c) Jahaz-Maota and Guman Singh ki Dhani (North Delhi Fold Belt), Sikar and Jhunjhunu districts, Rajasthan; (d) Narwapahar, Kudada, Jaduguda North and Banadungri-Singridungri, East Singhbhum district (SSZ), Jharkhand; (e) Wahkyn-Wahkut (Mahadek basin), West Khasi Hills district, Meghalaya; (f) Naktu (Chhotanagpur Granite Gneiss Complex), Sonbhadra district, Uttar Pradesh; (g) Dharangmau (Satpura Gondwana basin), Betul district, Madhya Pradesh and (h) Rajpura (Siwalik basin), Una district, Himachal Pradesh.



Heavy mineral concentration at Chavara, Kerala. (Inset: Sonic drilling for Beach sand minerals exploration)

Some of the other potential provinces are Chhattisgarh basin in Chhattisgarh; Gwalior and Bijawar basins in M.P.; Vindhyan basin in M.P. & U.P.; Aravalli Fold Belt, Rajasthan; Kotri-Dongargarh belt and Surguja Shear Zone, Chhattisgarh.

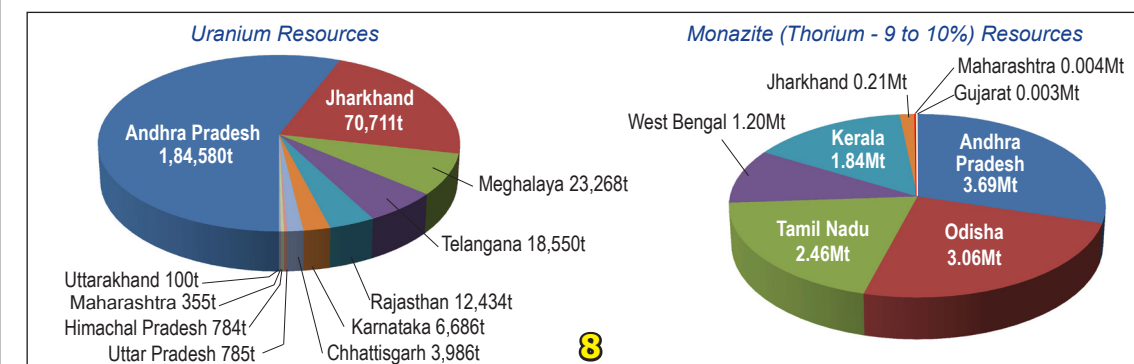
Resources (As on 31-12-2019): AMD has established:

* 3,25,000⁸ tonnes of uranium oxide under indicated and inferred categories since its inception.

* Monazite (12.47 million tonnes)⁸; ilmenite (648.35 million tonnes); rutile (33.95 million tonnes); zircon (35.75 million tonnes); garnet (187.46 million tonnes); and sillimanite (255.09 million tonnes) in the beach and inland placers of Maharashtra, Karnataka, Kerala⁹, Tamil Nadu, Andhra Pradesh and Odisha; inland placers in parts of Bihar & West Bengal and Teri red sand in Tamil Nadu.

* Columbite-Tantalite (Nb-Ta), spodumene & lepidolite (Li) and beryl (Be) in the pegmatites of Bastar district, Chhattisgarh; Jharsuguda district, Odisha; Mandya district, Karnataka and in parts of Bihar and Jharkhand.

* Xenotime (Y & HREE) in the riverine placers of Siri River in Jashpur district, Chhattisgarh; Deo River in Gumla district, Jharkhand and in apatite – magnetite veins at Kanyaluka, East Singhbhum district, Jharkhand. Further, REE exploration is being carried out in Ambadongar Carbonatite Complex, Chhota Udepur district, Gujarat and Siwana Ring Complex, Barmer district, Rajasthan.



Uranium and Monazite (Thorium - 9 to 10%) resources of India (Statewise)