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# Southern Region

## General Information

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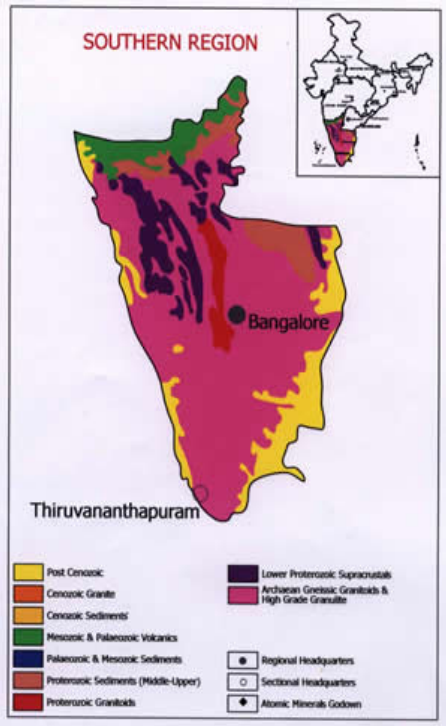
|---|---|
| Area | :3,96,000 sq km |
| States | :Andhra Pradesh(South of 15° N latitude), Karnataka and Maharashtra (South of 17° N latitude), Goa, Kerala, Tamil Nadu and Pondicherry |
| Headquarter | :Bangalore |
| Address | :Regional Centre for Exploration and Research (RCER),Nagarabhavi, Bangalore – 560 072 |
| Contact Person | :D. K. Choudhury, Regional Director |
| | Ph : 080-23210246 |
| | Fax : 080- 23211511 |
| | e-mail : rdsr.amd@gov.in |

This Region was set up in 1956 in a rented accommodation at Patan Bhavan, Bangalore. AMD's own office/ laboratories and residential quarters were established in 1986 in Nagarabhavi, Bangalore.

## Broad Geological features




**The following are the broad geological domains of the Southern Region.**

**(i) Archaean Basement Rocks (>2500 Ma) :**The basement rocks comprise Archaean granulite facies containing quartzites, garnet-sillimanite gneiss, marble, amphibolites and charnockites in Tamil Nadu, Kerala, Andhra Pradesh, Karnataka and Goa. The Peninsular Gneisses, which are mainly composed of migmatites and banded grey granites are fairly homogeneous and are exposed over large tracts in these states.

**(ii) Late Archaean Dharwar Supergroup rocks:** They comprise piles of volcano-sedimentary sequence broadly divisible into a lower Bababudan and an upper Chitradurga Group. The Bababudan Group is characterized by platformal sediments with quartz pebble conglomerates, pebbly quartzite, fuchsite quartzite and banded magnetite quartzites which were followed by sub-aerial mafic volcanics. The Chitradurga Group is typified by geosynclinal sediments with subordinate volcanics and well developed linear tracts of limestone, manganese and associated iron formations. They occur mostly in Karnataka and parts of Andhra Pradesh.

**(iii) Lower Proterozoic Closepet Granites :** Granites of this age extend in a north-south direction as a 50 km wide narrow belt. This belt of younger potassic granite is believed to mark a major geo-suture separating two distinct crustal blocks of Archaean age. The western block is characterized by a number of well-developed low grade granite-greenstone belts with their iron-manganese ores and the eastern block is marked mainly by younger gneisses of granitic and granodioritic composition enclosing within them a number of narrow, linear bands of auriferous schist belts.

**(iv) Middle to Upper Proterozoic Cuddapah Supergroup rocks and their equivalents such as Bhima Group & Kaladgi Group of rocks:** These are the most significant geological domains of Indian geology. The Cuddapah basin comprises sedimentary sequence of ~12 km thickness and volcanic sequences in the form of sills and dykes, which are resting on the Archaean Peninsular Gneissic Complex marked by a pronounced Eparchaean unconformity. This basin comprises of rocks of Cuddapah Supergroup which includes Kurnool Group.

The Kaladgi and Bhima basins occur in the northern parts and extend below the Deccan Traps. These basins comprise of rocks of clastic/chemogenic origin.

**(v) Deccan trap of Mesozoic-Tertiary age :** These formations spread over very small parts of the Region and overlie the northern extensions of the Dharwar craton.

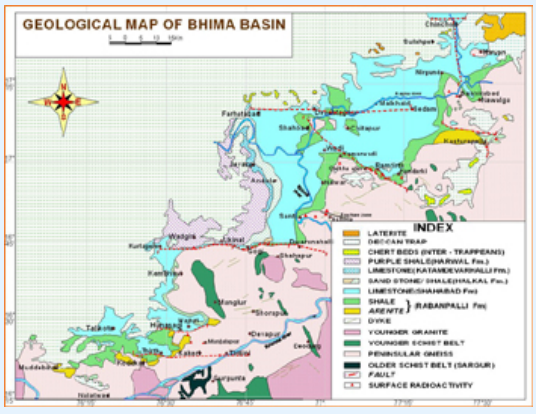
**(vi) Younger basins(Mesozoic - Tertiary) :**These sediments include Gondwanas of Palar basin, Cretaceous rocks of Tiruchinapally, Cuddalore Sandstone, Warkala beds, Quilon beds etc.

**(vii) Beach and Inland Placers :** These are part of Quaternary group of rocks. The beach and inland placers of Tamil Nadu and Kerala host some of the richest deposits of ilmenite, monazite, rutile, garnet, zircon and sillimanite.

## Present Thrust areas of Investigations

The present thrust on uranium exploration is on Proterozoic unconformities with the basement rocks. As such the three basins viz. Kaladgi-Badami and the Bhima basin in Karnataka and the Cuddapah basin in Andhra Pradesh are under active exploration.

## Uranium Exploration in Bhima Basin




Uranium exploration programme in Bhima basin was taken up in 1995 in analogy to other Proterozoic basins in India and abroad. An integrated exploration programme was launched viz., satellite image analysis and litho-structural mapping, 2,100 line km Car borne radiometrics, 16,330 line km airborne gamma ray spectrometry and magnetics, 7,000 sq km hydro-geochemistry, ground radiometrics, gamma ray logging of domestic borewells and sub-surface core and non-core drilling. All these led to identify number of surface uranium occurrences along Gogi-Kurlagere (KG) and Wadi fault zones besides number of potential target zones delineated by hydro-geochemical survey, heliborne time domain electromagnetic (TDEM), magnetic and gamma ray spectrometric surveys.

Extensive sub-surface exploration (55,600m) at Gogi has established uranium mineralisation hosted in limestone and granite. It is a granite related deposit, which is structurally complex. Pitchblende and coffinite are the main uranium minerals. The ore contains anomalous concentration of REE, Pb, Ag and Au. Gogi uranium deposit is located 12 km west of Shahapur, the Taluk town and 75 km south of Kalaburgi. The nearest rail head is Yadgir about 40 km to the east, which is also the district headquarter.

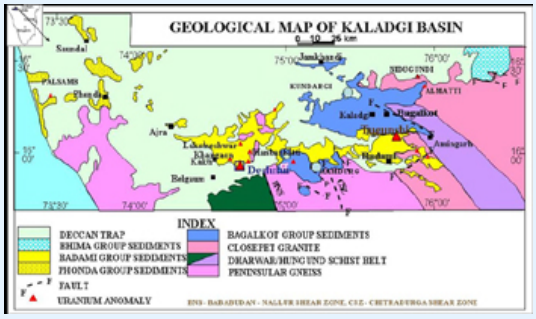
Exploratory mining to study the ore body characteristics and to obtain bulk ore for process studies was carried out earlier. Sub-surface exploration in the extension areas of Gogi uranium deposit, along tectonic contact between the basement granitoid and sediments of Bhima Group defined by KG fault resulted in establishing another uranium deposit with a strike length of 2,000m with 20-90m width in Kanchankiyi-Hulkal area hosted by brecciated limestone having carbonaceous matter. The northeastern trend of the subsidiary arm of the KG fault associated with uranium mineralisation in Kanchankiyi-Hulkal continues eastward and is under active exploration. Bhima basin has got immense potential for discovering more uranium deposits.

## Uranium Exploration in Kaladgi Basin

The meso to neo-Proterozoic Kaladgi basin, covering an area of 8,300 sq km occupies the northwestern fringes of the western Dharwar craton, in parts of Karnataka, Maharashtra and Goa. The northern and western extensions of the basin are covered by Deccan Trap. The basin exposes sediments of older Bagalkot and younger Badami Groups of Kaladgi Supergroup. The Bagalkot Group consists of ortho-quartzite, shale, dolomite and limestone, which are highly deformed. Conglomerate, arenite, shale and limestone constitute the main rock types of Badami Group, which are undeformed. Archaean Peninsular Gneiss, Chitradurga Schist of Dharwar Supergroup and intrusive Closepet Granite and its equivalents form the basement rocks for these sediments. E-W, NE-SW and NW-SE trending faults and fractures have affected both basement rocks and the sediments.

Uranium exploration was initiated in the sixties with a multipronged strategy. An area of 6,600 sq km has been covered by Airborne Gamma Ray Spectrometric (AGRS) and magnetic surveys in the eastern and western parts of the basin, along the basin margin during 1984. Interpretation of litho-structural map based on LANDSAT imagery and aero-radiometric data of 3,000 sq km indicated that eastern part of the basin is favourable for uranium mineralisation. Hydro-uranium anomalous zones around Deshnur, Yadwad, Chipalkatti, Hulikeri and Tugunshi areas were delineated by regional geochemical survey, carried over an area of 7,500 sq km. Uranium, thorium and mixed anomalies were located in basement granite, conglomerate and arenite at Tugunshi, Siddankola, Hulikeri, Khanapur and Almatti in the eastern part and Deshnur, Khangaon and Hanbarhatti in the western part of the basin as a result of extensive ground radiometric survey carried out over an area of 8,000 sq km. Ground geophysical survey viz., resistivity, magnetic and electro-magnetic surveys were also carried out along favourable zones, covering an area of 20 sq km, around Deshnur and 7 sq km around Hulihatti.

Reconnoitory drilling (25,000m) was carried out around Tugunshi, Siddankola, Murdi, Hulikeri, Khanapur and Deshnur to locate unconformity type of mineralisation. Uranium values ranging from 0.010% to 0.034% $U_3O_8$ were recorded in Badami arenite in boreholes around Tugunshi area whose thickness varies from 0.50 to 1.70m. Significant uranium mineralisation has been located in the year 2005 near Deshnur, which is about 30 km east of Belgavi. The mineralisation is confined to the unconformity surface in feldspathic conglomerate and arenite of Badami Group. The grade and thickness varies from 0.015% to 0.13% $U_3O_8$ and 2.50 to 63.20m, respectively. Correlatable mineralisation has been established over a strike length of 360m hosted by highly altered, fractured, sulphide bearing feldspathic lower conglomerate along NE-SW direction. Pitchblende and coffinite are identified as main uranium minerals. Bravoite, arsenopyrite, chalcopyrite, covellite, bornite, sphalerite and galena are the sulphide phases associated with mineralisation.




Systematic multipronged approach resulted in identifying uranium mineralised zone in Gujanal block. A total of 102 boreholes were completed in Gujanal with a cumulative drilling of 34,052.40m. In the first phase of exploration, significant uranium mineralisation of 0.020 - 0.16% $eU_3O_8$ x 0.20 - 6.50m over 1800 m strike length with the width of 40 to 360m was intercepted in sulphide bearing feldspathic conglomerate / arenite intercalated clay bands, mainly confined along bedding planes. In the second phase, exploration targeted along NE - SW trending fault zone intercepted high order correlatable mineralisation of 0.012 - 0.075% $eU_3O_8$ x 0.20 to 22.70m over 700m, hosted by sulphide bearing feldspathic conglomerate / arenite and basement chlorite schist in fracture zone. Pitchblende, traces of coffinite, uraninite along with pyrite, bravoite, galena, bornite and sphalerite are identified by petrography.

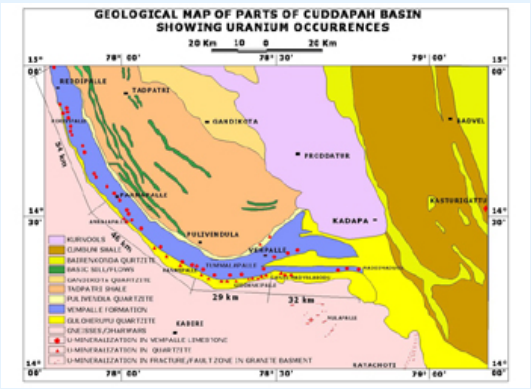
Active exploration is being continued and Kaladgi basin offers an ideal geological setting for hosting typical unconformity type uranium deposit.

**Cuddapah Basin a Uranium Province**

**Tummalapalle Uranium Deposit:** Cuddapah basin in South Indian Shield is an established uranium province. Different types of uranium mineralisation of varying age are reported here viz. Granite-related (Granite hosted: Mullapalle), Granite-related (Gulcheru quartzite hosted : Gandi-Madyalabodu), Carbonate deposit (Strata-bound, dolostone hosted: Tummalapalle) and Proterozoic Unconformity deposits (Stratiform structure-controlled deposits, between basement granite and Srisailam quartzite: Chitrial and Lambapur).

Tummalapalle uranium deposit situated in YSR (Kadapa) district of Andhra Pradesh, falls in toposheet no. 57J/7. Pulivendla is the nearest town at a distance of 12 km from mine site. This town is linked by road with major cities such as Bengaluru (220 km), Hyderabad (400 km) and Tirupathi 250km. This deposit and its extension areas are located at the south-western part of Proterozoic Cuddapah basin over an area of 21 km x 2 km from Gidankivaripalle village in east to Motnutalapalle in west.

Association of uranium with the impure phosphatic dolostone in Vempalle Formation was first reported by Geological Survey of India in 1986. Subsequently, surface and sub surface investigation by AMD in two phases i.e. from 1986 to 1995 and 2007 till date have proved substantial uranium resources. Here uranium mineralisation is in the form of strata-bound, dolostone (Vempalle Formation) hosted carbonate deposit, in the western margin of Papaghni sub-basin. It extends from Reddipalle in the northwest to Maddimadugu in the southeast over a belt of 160 km. Vempalle Formation overlies the Gulcheru Formation with transitional boundary. Vempalle Formation is around 1900m thick and study of the complete sequence




of Vempalle Formation in the explored areas reveals that the carbonate facies commences with massive dolostone, followed by thin band of conglomerate, uraniferous phosphatic dolostone, red shale and cherty dolostone. Ultrafine pitchblende and uraninite are the main uranium minerals while coffinite, U-Si-Ti complex and some U in the adsorbed form with collophane have been identified as minor U mineral phases. The associated ore minerals are mainly pyrite, molybdenite, chalcopyrite, bornite, digenite and covellite.

During first phase of investigation, uranium mineralisation in Tummalapalle area was proved over 6.6 km along strike length and 1.2 km along dip from 15 m to 250 m depth. Uranium mineralisation occurs as two bands, hangwall and footwall bands with a vertical separation of 1m to 3m. Both the bands show isotropic character along and across the strike in terms of grade and thickness. Average thicknesses of these bands are 2.3m and 1.75m for hangwall and footwall respectively with average grade of 0.05% e$U_3O_8$ at 0.02% cut off. During this phase 37,635m was drilled in 264 boreholes and about 14,600te of $U_3O_8$ proved. Investigation in this area was suspended in 1993 due to hydrometallurgical constraints and shift in priority areas of AMD.

Considering the demand of uranium for the ongoing Indian Nuclear programme and after successfully overcoming the constraints of hydrometallurgical process, commercial mining of Tummalapalle uranium deposit commenced. Foundation was laid for mining and processing plant of Tummalapalle deposit on November 19 - 20, 2007. The mining of the footwall band of the deposit was first taken up for exploitation. As a part of target expansion programme (second phase), exploratory drilling in the extension areas of Tummalapalle was initiated during the 2007-08.

During second phase of exploration programme, about 4,46,500 m of drilling has been completed in 1,437 boreholes and about 1,78,300 te of $U_3O_8$ has been added in Tummalapalle deposit and its extension areas as on October 2020. Tummalapalle Mill was inaugurated on April 20, 2012. Sub-surface exploration in the area is in progress.

**Investigations in Cuddapah basement fracture zones:**

The basement complex of crescent–shaped Cuddapah basin in the eastern Dharwar craton comprises Archaean greenstone-granitoid association with profuse mafic (doleritic) dykes and felsic (quartzo-feldspathic reef/veins) intrusions along reactivated fracture zones. Geological and radiometric investigations of the crystalline basement initiated in 1980s by AMD led to location of number of thorium free uraniferous fracture zones right from Nagari - Kurvapalle area in the east to Bimunipalle area near Gooty in the west. These fracture zones show varying trend ranging from NNE-SSW (Sanipaya - T.Sundupalle), ENE-WSW (Mulapalle) and NW-SE (Lakshmipuram). Among these, ENE-WSW trend is predominant and shows significant mineralisation. The mineralised fracture zones show strike extent ranging from 250 m to 16 kms (intermittently) with a width of <1 m to 5 m. Mineralisation is associated with cataclsite and mylonites along fault/shear zone. Though the fracture zones are widespread, mineralised fracture zones are confined to fertile granites of Closepet affinity.

Alterations like chloritisation, haematitisation, phosphatisation and silicification associated with the granite related uranium mineralisation have been observed. Three types of granitoids namely Peninsular Gneiss, K-rich Closepet Granite and Na rich microgranites are reported in the terrain. About 68 fracture zones associated with uranium mineralisation are reported in the southwestern margin of Cuddapah basin.

Exploratory drilling commenced in 1989 at Sanipaya-T Sundupalle fracture zone, where 33 boreholes (3,454.95m) were drilled. A lean mineralised zone over 500 m strike length was established in the area. Subsequently, emphasis was shifted to Mulapalle fracture zone, which was also located during, 1987-88 and detailed investigations were carried out during 1989-90 and 1991-92. Exploratory drilling in Mulapalle commenced in May 1993. This fracture zone was under active exploration till September 1998 and has given the most promising results of all the fracture zones. A total of 38 boreholes were drilled (6,479.85 m) in this area covering a total strike length of 500m. Mineralisation in the form of three different lenses was delineated in the area. Exploratory drilling was carried out during the period 1995-98 in six other fracture zones such as Chenchalapalle, Burjupalle, Timmareddigaripalle, Payalopalle (N), Mulapalle-II and Varikuntapalle.

In Kamagutapalle area, surface uranium mineralisation was traced for about 3 km along fracture trending N20°E-S20°W in the 90's. Shielded probe logging revealed 9 lenses distributed over a length of 710m in the southern part of the fracture zone. Based on further rechecking during 2014-15, encouraging result lead to reopening the Kamaguttapalle area for subsurface exploration by contract drilling in 2015-16. Currently, sub surface exploration is in progress, which has resulted in proving uranium mineralisation over a strike length of 320 m in Kamaguttapalle Main block.

## Other facilities available at Southern Region

The Region is equipped with various facilities in different laboratories such as:

- Physics Laboratory
- Chemistry Laboratory
- Petrology Laboratory
- WDXRF Laboratory

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# South Central Region

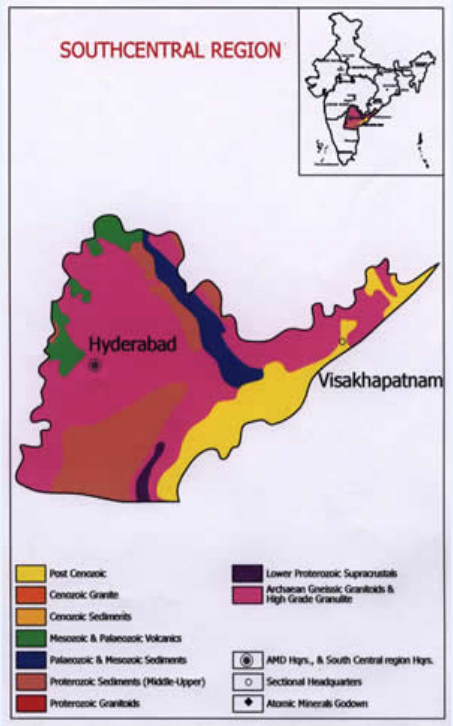
## General Information

| | |
|---|---|
| Area | : 2,03,000 sq km |
| States | : Telangana and Parts of Andhra Pradesh(North of 15° Lat.) |
| Headquarter | : Hyderabad(Cherlapally) |
| Address | : Regional Centre for Exploration and Research,<br>AMD Campus, Cherlapally,<br>Rampally Road,<br>Hyderabad-501301. |
| Contact Person | : Shri V. Anil Kumar<br>Regional Director,<br>Ph. 040-29708128 ,<br>Fax : 040-29708129<br>Email: rdscr.amd@gov.in |

The Region was carved out from Southern Region in 1988.Prior to it, all the investigations were carried out from Southern Region, Bangalore. The Office of the South Central Region was initially started in a rented building in Hyderabad and since 1993 to 2016, it was functioning within the premises of AMD Headquarters, Begumpet, Hyderabad. in may 2016, the South Central Region was shifted from headquarters to Cherlapally Campus.

## Broad Geological Features

Broadly following geological domains occupy major part of the region:




(i) **Archaean Basement rocks :** These comprise Peninsular Granite Gneiss, Karimnagar Granulite Belt and Eastern Ghat Mobile Belt. Closepet equivalent granites occur as discrete plutons within the basement complex. Besides, number of younger intrusive also occur in the northwestern part of the Cuddapah basin. Number of mafic dyke swarms intrude the basement complex.

**(ii) Lower Proterozoic Green Stone Schist Belt:** major Schist Belts are : Nellore Schist Belt, Veligallu-Gadwal Schist Belt, Ramagiri-Penakacherala Schist Belt and Peddavoora Schist Belt .

**(iii) Middle to Upper Proterozoic rocks :** These rocks are exposed in two major geographic domains, viz. (1) Cuddapah Basin comprising sedimentary and igneous rocks of Cuddapah Super group and the Kurnool Super group and (2) Pranahita-Godavari Nasin comprising sediments pf Pakhal Supergroup. Besides in the western part sediments of Bhima basin slao occur.

**(iv) Gondwanas (Mesozoic) along Godavari basin :** Along the Godavari basin, the Mesozoic Gondwana sediments overlie the Proterozoic rocks of Pakhal Supergroup.

**(v) Beach Sand and Inland Placers :** These from part of Quaternary group of rocks. Number of rich beach sand mineral deposits are located along the coastal stretch of Andhra Pradesh.

Small exposures of Deccan Trap (Mesozoic age) occur in the northwestern part of the Region.

## Thrust areas Investigationss

**Srisailam Sub-basin:** During 1990's, with the evolving concept of unconformity type uranium deposits worldwide, radiometric surveys in the environs of Cuddapah Basin, led to the discovery of uranium mineralisation close to the unconformity between Paleo-Proterozoic fertile Mahbubnagar (Closepet equivalent) granite and overlying quartzite of Srisailam Formation. The Srisailam Formation rocks, the youngest sediments of Cuddapah Supergroup, are exposed in the Srisailam sub-basin, having an area of 5,000 sq. km. Detailed exploration in parts of the sub-basin by drilling led to delineation of well-established unconformity related uranium deposits at Lambapur, Peddagattu and Chitrial. In these uranium deposits, the Srisailam Formation is represented by a basal pebbly-gritty sequence followed upward by intercalated grey shale-quartzite with massive quartzite layer at the top.

**Important uranium deposits are summarized below:**

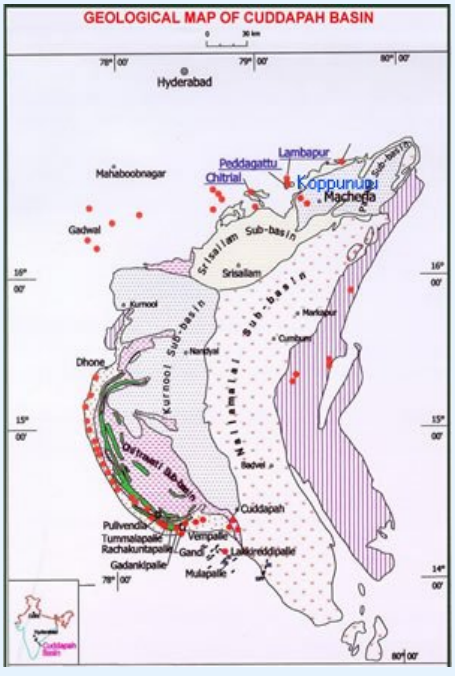
**Lambapur :** Unconformity related uranium mineralisation has been established in two ore bodies over an outlier of Srisailam Formation having dimension 1.8km x 0.70km. Mineralisation is largely hosted in the basement granite and partly in the altered basic dyke intrusive into the basement and in gritty quartzite of Srisailam Formation. The ore bodies have a maximum depth of 45m.

**Peddagattu :** This deposit occurs ~1km south of Lambapur deposit and has similar geological and mineralisation set-up as that of Lambapur. Eight uranium-mineralized blocks occur in an outlier of Srisailam Formation exposed over 10km x 2km. All the ore bodies are confined to a maximum depth of 60m.

**Chitrial :** The deposit is located about 25km southwest of Peddagattu. The deposit occurs in an outlier of Srisailam Formation. It has similar geological and mineralisation set-up as that of Lambapur-Peddagattu uranium deposits. In Chitrial, the ore bodies have been established having considerable strike length with depth range of 30m-90m in western and eastern sectors.

Four other outliers, with Srisailam quartzite unconformably overlying the basement Mahbubnagar Granite spread over total areal extent of 83 sq. km have been recognised for detailed exploration by drilling to augment additional uranium resources.

**Palnad Sub-basin:** Palnad sub-basin, which is equivalent of the Kurnool sub-basin with an aerial extent of 3,400 sq. km is exposed in the northern part of Cuddapah Basin. The unconformity contact between Banganapalle quartzite and basement granite is a potential horizon for uranium mineralisation. A small uranium deposit has been located at Koppunuru, Guntur district, Andhra Pradesh near the unconformity. Exploration is underway in similar geological setting in Sarangapalli area in Guntur district, Andhra Pradesh.




Unconformity proximal uranium mineralisation at Koppunuru is largely associated with Banganapalle quartzite. Uranium ore bodies in the form of three sub-horizontal lodes occur in the Banganapalle quartzite, 5-40m above the unconformity and along the unconformity contact transgressing into the Basement granite.

p>**Eastern margin of Cuddapah Basin: :**

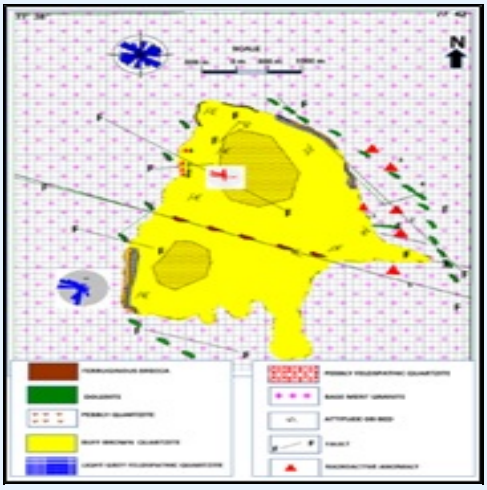
Eastern margin of Cuddapah Basin along Nellore Schist Belt has been explored for vein type / shear controlled uranium mineralisation. Detailed exploration at Kasturigattu (Kasuri Gutta), Gudarukoppu, Kulluru and Chinnagutta area, SPSR Nellore district, Andhra Pradesh has led to better understanding of the mineralisation in Nellore Schist Belt. Seven borehole drilled during F.S. 2018-19 in Kasturigattu area indicated promising uranium mineralisation.

**Significant achievements of South Central Region in last three years are enlisted below:**

**(i)Kappatralla area, Kurnool district, Andhra Pradesh:**

Unconformity proximal uranium mineralization has been identified in one outlier at Kappatralla lying 35km west of Kurnool located in the western margin of Cuddapah Basin. The uranium mineralisation occurs along the contact of Paleo-Proterozoic granite basement and overlying quartzites of Gulcheru Formation. The outlier has been explored during the period 2016 to 2018. The uranium ore resource estimation has been made for the northern part of Kappatralla outlier by considering correlatable ore bands intercepted in 16 boreholes within an area of 0.63 sq.km and substantial resource has been identified. Future exploration in the entire outlier having approx. 4.50sq.km area is planned to further augment the resource.


Geological map of Telangana and Andhra Pradesh showing areas potential for uranium mineralisation




Geological map of Kappatralla outlier showing uranium occurrences, Kurnool district, Andhra Pradesh.

**(ii) Rudravaram line:**

The Rudravaram Line marks the contact of undisturbed sediments of Kurnool Group and folded and deformed sediments of Nallamalai Group. The area closure to the eastern margin of the Palnad sub-basin in the vicinity of Rudravaram line, wherein the undeformed Kurnool Group of rocks overlie the folded and deformed sedimentary rocks of Nallamalai Fold Belt, represents a potential zone for hosting unconformity type uranium mineralization. Several hydro-uranium and Rn-in water anomalous zones have been delineated over the Kurnool Group of rocks. Several conducting bodies along structural loci have been identified by ZTEM techniques. Uranium mineralisation is expected to occur at deeper levels in proximity to the unconformity surface.

**(iii) Sarangapalli area:**

Sarangapalli area, located in the northern part of Palnad sub-basin, exposes Neo-Proterozoic Banganapalle quartzite and Narji limestone of Kurnool Group unconformably overlying Closepet equivalent granite in Guntur district, Andhra Pradesh. Subsurface exploration commenced in the area in 2018 and indicated fairly good uranium potential. Small uranium resource has been inferred in the area based on correlatable ore bands intercepted in 10 boreholes. Primary uranium minerals (coffinite, pitchblende and uraninite) occurring only the microfractures and weak planes have been identified. Drilling is in progress to delineate extension of ore body.

**National Core Library:**

National Core Library, hosting boreholes core of various uranium deposits of India is developed in 2020 at AMD campus, SCR, Cherlapally. Borehole cores from Lambapur, Peddagattu and Chitrial deposits of SCR, Tummalapalli, Gogi and Kanchankai deposits of SR, Rohil deposit of WR, deposits of SSZ from ER and borehole core from CR have been arranged in core racks. It is a unique national facility that would facilitate examination of core samples with all relevant technical information to AMD as well as outside scientists, and definitely aid in conceptualising mineral deposit occurring in newer areas on earth.

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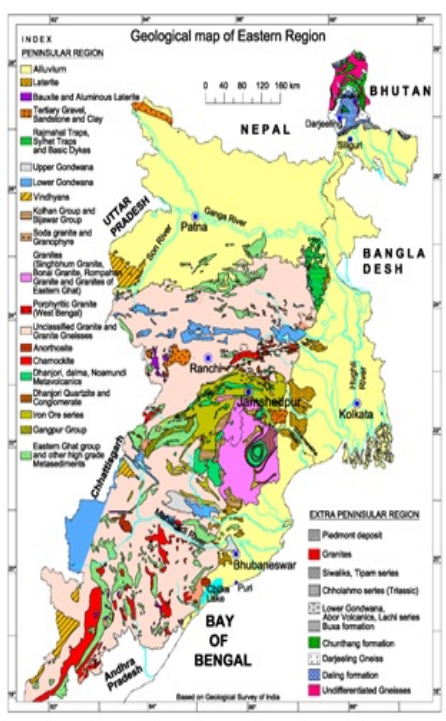
# Eastern Region

## General Information

Area :4,38,000 sq km
States :Bihar, Jharkhand, Orissa, W. Bengal and Sikkim
Headquarter :Jamshedpur
Address :Regional Centre for Exploration and Research, AMD Complex, Khasmahal,P.O.: Tatanagar, Dist. East Singhbhum, Jharkhand - 831002.
Contact Person :Dr. Kalyan Chakrabarti, Regional Director
Ph. : 0657-2299807
Fax : 0657-2297689
Email : rder.amd@gov.in

Eastern Region was set up during 1959 with headquarter at Kolkata. Subsequently the headquarter was shifted from Kolkata to Jamshedpur in its own premises during 1994. The major thrust of uranium exploration has been in the Singhbhum Shear Zone. The first uranium deposit of the country was established at Jaduguda in 1951. Subsequently, 16 other uranium deposits like Bhatin, Narwapahar, Turamdih, Bagjata, Mohuldih Banduhurang, etc. have been established.

## Broad Geological Features




Broadly, following geological domains are exposed in Eastern Region.

**(i) Archaean basement gneiss and Proterozoic and other sediments** are predominant in the states of Jharkhand, Odisha and West Bengal. The oldest rock (3,800 Ma) found in India (Champua Gneiss) occurs in this geological terrain. The Archaean basement is overlain by Iron Ore Group (IOG) of Odisha and Jharkhand.

**(ii) Proterozoic sediments and granites :** Lower Proterozoic rocks comprising Singhbhum Group of metasediments and Singhbhum Granite.

**-Singhbhum Thrust Belt** Lower Proterozoic rocks comprising Singhbhum group of metasediments and Singhbhum granites.

**--Dhanjori and IOG Basins–** Meso-Archaean to Palaeo-Proterozoic metasediments.

**-Eastern Ghat Mobile Belt** comprising mostly Khondalites.

**-Middle to Upper Proterozoic metasediments** of Gangpur, Kolhan and Kunjar basins.

**-Rocks of extra peninsular region** in the Sikkim Himalaya.

**(iii) Gondwana Sediments** in Damodar, Mahanadi

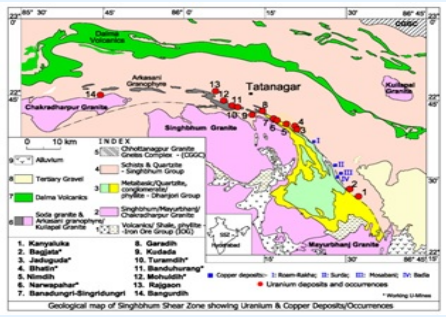
**(iv) Inland and beach placers** of Quaternary period.

## URANIUM MINERALISATION AND DEPOSITS

Singhbhum Province was well known during pre-independence period for its mineral wealth, particularly copper deposits. **Singhbhum Shear Zone (SSZ)**, an established uranium belt of the country since 1950, hosts a number of uranium deposits, a few of which are presently under exploitation. Radiometric surveys in this province resulted in identifying hydrothermal vein type of uranium mineralisation hosted in chlorite schists ± apatite, magnetite quartzite at many locations soon after the formation of AMD.

Uranium occurrences are spread all along the 180 km long arcuate SSZ. Exploration by AMD has helped to establish economically viable deposits over several of these occurrences. The important deposits are as follows.

**a) Jaduguda :** Located in East Singhbhum district, it is the first deposit where mining was undertaken by UCIL in 1967. Mining is still continuing beyond 1,000 meters vertical depth. The mineralisation is associated with conglomerate and chlorite schist of Singhbhum Group. Presently exploration is under progress in the faulted northern block at Jaduguda to establish additional resources. New findings of uranium in the vicinity of Jaduguda have increased the life of this mine.




**b) Bhatin :** It lies 3 km west of Jaduguda along the Singhbhum Shear Zone. Mineralisation is associated with quartzite and biotite-chlorite schist. Bhatin deposit is being exploited by UCIL since 1986.

**c) Narwapahar :** It lies 10 km west of Jaduguda along the Singhbhum Shear Zone. The uranium mineralisation, hosted by chlorite-quartz schist spreads over 2,000 meters strike length. This deposit is under exploitation by UCIL since 1995. This is the single largest deposit in SSZ.

**d) Turamdih :** A cluster of deposits (Turamdih-East, Turamdih-South, Keruadungri) occur in proximity to each other at Turamdih, located nearly 24 km west of Jaduguda. Uranium mineralisation is associated with chlorite-quartz schist. At Turamdih (East) the mineralisation is spread over 2 km X 1 km area and the entire resource occurs within a vertical depth of 200m. Mining of Turamdih (East) deposit is in progress by UCIL. from 2003.

**e) Banduhurang:** The uranium deposit at Turamdih West is known as Banduhurang deposit. The host rock is chlorite-quartz schist and to a lesser extent, feldspathic schist. The mineralization is spread over 1.2 km strike length and 600m across the strike. The deposit is being exploited by UCIL by open cast mining since 2007.

**f) Mohuldih :** It is located 5 km west of Turamdih. The host rock is tourmaline bearing quartz schist, quartzite and chlorite quartz schist. Mineralisation is established over 1 km strike length and within a vertical depth of 250m. Mining by UCIL has commenced from April 2012.

**g) Bagjata :** It is located nearly 25 km southeast of Jaduguda. Uranium mineralisation is hosted by quartz-chlorite-biotite schist. The mineralisation is spread over 450m strike length with a vertical persistence of 260 m. Mining by UCIL commenced in 2008.

**h) Banadungri-Singridungri: :** It is located to the west of Narwapahar. Uranium mineralization is hosted by sericite-chlorite-quartz schist. The deposit has been established and is currently under advanced consideration for opening of a new mine.

Other smaller uranium deposits along this shear zone, in a similar geological set up are (i) Kanyaluka (ii) Nimdih (iii) Garadih and (iv) Rajgaon.

Apart from uranium, rich resources of xenotime (mineral containing heavy REE) associated with garnetiferous biotite schist of Singhbhum Group of rocks have also been located by AMD at Kanyaluka.

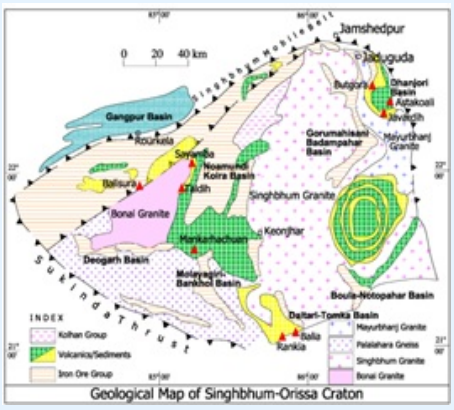
Quartz Pebble Conglomerate hosted uranium mineralization has also been located at a number of places at the base of the Iron Ore Group (IOG) and Dhanjori basins. Important localities are Butgora, Phuljari, Chakri in Jharkhand and Sayamba, Taldih in Odisha.

## Uranium exploration: Present thrust areas

Uranium exploration programme in parts of Eastern Region currently gives emphasis for identification of (i) Metamorphite/ vein type uranium deposits in Singhbhum Shear Zone (SSZ), (ii) QPC type mineralization in Meso- to Neoarchean Iron Ore Basin of Bonai sector and Dhanjori Basin in Odisha and (iii) Migmatite-related pegmatoid leucosome hosted uranium

mineralization in Garhwa sector of Chhotanagpur Granite Gneissic Complex (CGGC) in Jharkhand. Helium investigation has been initiated in Bakreshwar-Tantloi geothermal fields of CGGC in Jharkhand.

**Singhbhum Shear Zone (SSZ)** is the known uranium province in the country hosting a number of uranium deposits, a few of which are presently under production by UCIL. The current phase of exploration in SSZ was initiated in 2008-09 with the objective of exploring the extension areas of known uranium deposits in the eastern part of the shear zone and also to explore the western part of the shear zone to convert known occurrences to deposits. Exploration inputs in the current phase have resulted in delineation of deposits at Banadungri-Singridungri area adjacent to Narwapahar deposit and also proved additional resources in the deeper extensions of Narwapahar deposit. A modest deposit has also been established at Bangurdih in the western sector of SSZ. At present, exploratory drilling is being continued in Narwapahar-Banadungri-Singridungri-Garadih sector and Baglasai-Mechua-Jaduguda North sector to delineate the ore bodies and assess the deposits. Exploration has also been initiated in the other potential zones in the eastern sector of SSZ at Pathargora, Purandungri, Khadandungri and Khejurdari. In addition, a new type of deposit is coming up at Kudada, hosted by serpentinised peridotite occurring at a lower stratigraphic level in comparison to the other deposits in the belt.



Geological Map of Singhbhum-Orissa Craton

**Quartz Pebble Conglomerate (QPC)** The The Singhbhum Craton comprising basement granite with overlying early Proterozoic supracrustals constitute a favourable setting for Quartz Pebble Conglomerate (QPC) type uranium mineralization. Efforts since 1980 led to identification of the QPC type mineralisation in Dhanjori Basin in 1983 followed by the discovery of a number of uraniferous QPC occurrences in Dhanjori and IOG Basins of Singhbhum-Odisha Craton. Significant uraniferous occurrences were identified in Butgora, Phuljhari, Chakri in Dhanjori Basin, Jharkhand, and Sayamba-Taldih and Birtola-Bagiyabahal in Koira-Noamundi Basin, and QPC occurrences overlying Pallahara Gneisses near Mankarhachua, Angul district, Odisha. QPC hosted uranium mineralization is also associated with precious metals like gold, silver and platinum group of elements (PGE).

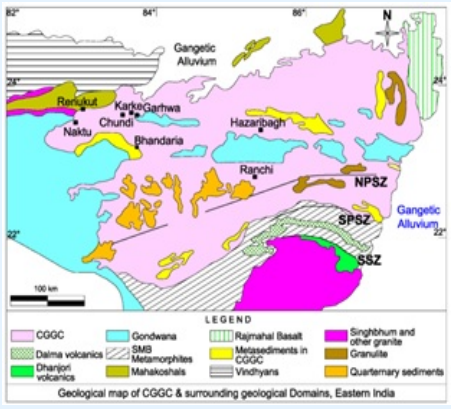
Basin-wise details of uraniferous QPC areas are as follows:

**a) Birtola-Bagiyabahal area:** The area is located near the base of the Koira-Noamundi Iron Ore Group sequence along the northwestern margin of Bonai Granitic Complex in Sundargarh district, Odisha. Presence of radioactive QPC has been established around Birtola, Phuljhari Pahar, Balisura, Bagiyabahal and Baratangra areas. The QPCs in the area are both basal and interbedded in nature and are associated with IOG quartzite over an appreciable strike length. Association of gold (Au) with uranium mineralization has enhanced the scope of investigation of the area for other metals.

**b) Mankarhachua area:** The area is located north of Pallahara, Angul district, Odisha around western margin of Singhbhum Craton. The uraniferous Quartz Pebble Conglomerate horizons are exposed over an appreciable strike length, having best exposures around Mankarhachua village. This horizon is unconformably overlying Pallahara Granite Gneiss along southern margin of the basin. This QPC hosted uranium mineralization is also associated with significant content of precious metals like gold, silver and PGE.

**c) Phuljhari-Chakri-Astakoali area:** The area is located in the southern and western margins of Dhanjori Basin. A number of potential QPC horizons have been established at Astakoali, Javardih and Butgora areas at the base of Dhanjori Basin.

**Chhotanagpur Granite Gneissic Complex (CGGC):** The Proterozoic CGGC is an E-W trending sub-arcuate belt of the East Indian Shield that covers approximately 1,00,000 sq km across the states of Chhattisgarh, Jharkhand, Bihar and West Bengal. Uranium mineralisation in the migmatite terrain of CGGC was located at several places in Sonbhadra district of U.P. A small deposit has been established at Naktu area, which is located to the west of Garhwa district of Jharkhand. Based on the analogy of Naktu, radiometric surveys were initiatied in the contiguous areas in Garhwa district in 2016-17 and in the same year uranium mineralisation was located over significant strike length in pegmatoid leucosome in migmatite rocks near Karke. Subsequent surveys in the CGGC has resulted in identification of uranium mineralisation in younger granites and pegmatites at Chundi, besides several other minor occurrences in the CGGC of Garhwa district.

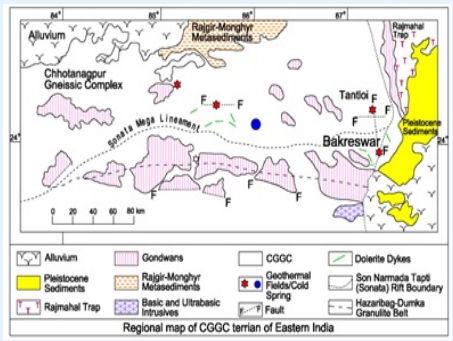


Geological map of CGGC & surrounding geological Domains, Eastern India

**a) Karke area:** This area is located about 20 km west of Garhwa. Migmatites dominate the terrain, with abundant leucosomes and melanosomes. The other constituents consist of biotite granite gneiss. Several uraniferous lenses are established over considerable strike length, associated with pegmatoid leucosome in migmatitic rocks. Besides, several pegmatitic intrusions along the migmatite zone and in granite gneisses are also radioactive.

**b) Chundi area:** This area is located about 1.5 km SW of Karke occurrence. Porphyroblastic granite gneiss, granite gneiss, pink granite, basic bodies, quartzite and pegmatite are the main lithounits exposed. Pink granite is younger and occurs as intrusive within the gneisses. The uranium mineralisation is associated with granite and pegmatitic intrusions, and significant strike extension has been established.

**Helium investigations in Bakreshwar-Tantloi:** Bakreshwar-Tantloi area is located in the northeastern part of CGGC and is a well-known geothermal province. The area exposes granite gneiss with aplite, vein quartz and basic intursives. Since the early 1970s hot water springs of Bakreshwar and Tantloi, located on the eastern continuation of Narmada Son Lineament Zone, are known to emanate appreciable quantity of helium (upto 1.8%). Past investigations by various organisations including AMD have revealed that the area around Bakreshwar and Tantloi have the potential to host helium gas reserve. Soil gas radon emanometry using closed circuit technique has indicated two significant trends in Bakreshwar - i) NE-SW and ii) N-S, while at Tantloi, the radon anomalies trend N-S and E-W. Radon surveys are being continued in adjoining areas which would help in identifying the extension of the subsurface fracture zones. Gas samples from the thermal springs and soil have analysed significant helium values.



Regional map of CGGC terrian of Eastern India

## Other Facilities

The Region is equipped with following laboratory facilities.

- Physics Laboratory
- Chemistry Laboratory
- Petrology Laboratory
- Remote Sensing Laboratory

Regional Centers

- Northern Region
- Southern Region
- Eastern Region
- North Eastern Region
- Western Region
- Central Region
- South Central Region

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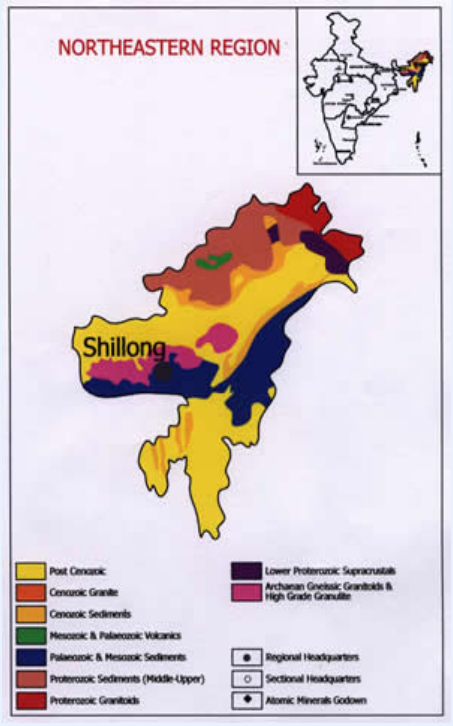
## North Eastern Region

### General Information

**Area** :2,55,000 sq km
**States** :Arunachal Pradesh, Assam, Manipur, Meghalaya, Mzoram, Nagaland,and Tripura.
**Headquarter** :Shillong
**Address** :Regional Centre for Exploration and Research, AMD Complex, Nongmynsong,PO : Assam Rifles, Shillong – 793 011.
Contact Person :Dr. Kamalesh Kumar,,Regional Director
Ph. : 0364-2537656
Fax : 0364-2534855
Email :rdner.amd@gov.in

Northeastern Region of AMD with Regional Headquarters at Shillong shoulders the responsibilities for the exploration of atomic minerals in the Northeastern part of the country. Exploration for atomic minerals in this part of the country began way back in the 1950's;initially, in Meghalaya and later extended to other states of Northeast India. Based on the outcome of exploration, AMD has concentrated its efforts mainly in the states of Meghalaya, Arunachal Pradesh and Assam, which have been identified as the most potential states. These states hold the potential for sandstone-type, hydrothermal vein-type and unconformity related uranium deposits, besides rare metal and rare earth deposits.




The country's largest and richest sandstone-type uranium deposits are located in Domiasiat and Wahkyn areas of West Khasi Hills district,Meghalaya and are hosted by Lower Mahadek sandstone of Upper Cretaceous period. The Mahadek sediments are exposed along the southern fringe of Meghalaya Plateau over 180 km from east to west in Jaintia,East Khasi and West Khasi and Garo Hills.

Nearly 131 km of drilling by completing about 1,800 boreholes has resulted in proving of 16,000 tonnes $U_3O_8$ accounting 14% of the country's total uranium reserve. This includes, 9,500 tones $U_3O_8$ at Domiasiat, 5,300 tonnes $U_3O_8$ at Wahkyn, 570 tonnes U3O8 at Tyrnai and 760 tonnes U3O8 at Lostoin.

Secondly the interface between Lower Proterozoic Tyrsad metapellites and Middle Proterozoic Barapani quartzites of the Shillong basin of Meghalaya and Assam holds promise for unconformity-related uranium mineralisation. Similarly Garo crystallines of Meghalaya are potential for hydrothermal vein- type of mineralisation.

In Arunachal Pradesh, hydrothermal vein-type of uranium mineralisation has been located in Proterozoic Siang Group in brecciated silicified and sericitised quartzites in parts of West Kameng and West Siang districts. Economically viable deposit of uranium is yet to be found in this state.

**Broad Geological Features:** Broadly following geological domains occupy major part of the region

**i. Archaean basement rocks** mostly exposed in Meghalaya and Assam.

**ii. Proterozoic supracrustals** comprising Shillong group of metasediments in Meghalaya and extra peninsular rocks of Arunachal Himalayas comprising Bomdilla gneiss, Dirang schist, Sela groups of rocks, etc.

**iii. Mesozoic rocks** represented by Mahadek sandstones and Carbonatites of Cretaceous period and Sylhet traps of Jurassic period.

**iv. Tertiary sediments** exposed in the states of Arunachal Pradesh, Assam, Meghalaya, Manipur, Tripura, Nagaland and Mizoram. Oil wells are located in some of these areas.

**v. Younger granites** of 479 to 881 m.y. emplaced into Proterozoic and Archaean rocks.

## Summary of Investigations:Important Uranium Deposits

DOMIASIAT/KYELLENG-PYNDENGSOHIONG, MAWTAHBAH (KPM) URANIUM PROJECT

The Domiasiat uranium deposit now known as Kyelleng-Pyndengsohiong-Mawtahbah (KPM) located in West Khasi Hills district of Meghalaya was discovered in 1984 as a result of reconnaissance survey. Exploration drilling and all geological studies in the area were completed in 1992. Subsequently exploratory mining was undertaken and pilot scale testing of flow sheet for recovery of uranium was also carried out. Uranium mineralisation is hosted by arkose to sub-arkose and feldspathic wacke associated with organic matter and pyrite. Pitchblende and coffinite are ore minerals. The ore body is tabular and occurs within a vertical depth of 50 m. A total of 9,500 tonnes uranium oxide contained in 9.22 million tonnes of ore with av. Grade 0.104%e $U_3O_8$, av. thickness 4.07m have been estimated at Domiasiat.


WAHKYN URANIUM DEPOSIT

The Wahkyn Uranium Deposit located at the confluence of Wahblei and Kynshi rivers, about 12 km west of Domiasiat in West Khasi Hills District of Meghalaya is another sandstone-type of uranium deposit. This deposit has gross similarity with Domiasiat uranium deposit in respect of geological set up and host rock characteristic and uranium mineralisation. Detailed investigations in Wahkyn area,have established mineable ore reserve of 5,300 tonnes $U_3O_8$ with an average grade of 0.130% e$U_3O_8$ contained in 3.58 million tonnes of ore.

**TYRNAI :** Tyrnai area is SW of Shillong and 5.5 Km SSW of Mawkyrwat connected by all weather motorable roads. A reserve of 570 tonnes of uranium oxide contained in 0.609 million tonnes of ore at 0.094 %e$U_3O_8$ average grade and 1.53m average thickness was estimated in inferred category.

**LOSTOIN :** The Lostoin block is located just 800m NW of Wahkyn deposit. A total of 760 tonnes of $U_3O_8$ in 1.18 million tonnes of ore have been proved in inferred category.

## PRESENT THRUST AREAS

**UMTHONGKUT :** Significant uranium mineralisation hosted by Lower Mahadek sediments was located at Umthongkut area in the western fringe of West Khasi Hills district. This is considered highly potential block and is under active exploration at present.

**WAHKUT :** Southern continuity of Wahkyn deposit is being taken up for sub-surface exploration for augmenting additional uranium resources.Wahkut block is to the immediate south of Wahkyn ore body, which is open towards this block. This is also considered to be potential for uranium mineralisation and is under active exploration.

**GARO CRYSTALLINES, MEGHALAYA :** The Precambrian crystalline terrain of West Garo Hills district in the western part of Meghalaya Plateau has geological and tectonic features favourable for hosting hydrothermal vein-type uranium mineralisation. The migmatitic terrain of Garo Hills has witnessed anorogenic alkali granitic, pegmatitic and mafic igneous activities and shows extensive alteration of iron oxide along shear zones. The alkali granite has at places appreciable concentration of iron oxides (up to 12.5%), Cu (up to 2004 ppm), Pb (up to 242 ppm),Zn (up to 190 ppm) and total REE (up to 1233ppm).

The terrain is known to host a number of radioactive anomalies.Since 1959, more than 100 anomalies mostly uraniferous in nature have been recorded in the Garo crystalline around Rasubelpura,Ringi nala, Dasol nala, Dumal nala, Madarigiri in Simsang river section hosted by pegmatoids, quartzo-feldspathic injections and sheared granites at Anek.

**ARUNACHAL PRADESH :** Arunachal Pradesh, is the second significant state for uranium exploration wherein the rock formations from Precambrian to Mocene are exposed. The Meso Proterozoic Siang Group (Eq. Daling Group) hosts Fe-U mineralisation. The Group consists of a lower volcano-argillaceous sequence and an upper psammo-pelitic sequence. Significant uranium occurrences associated with sulphide mineralisation have been located at a number of places along 400 x 400 km belt extending from Kameng in the west to Siang in the east.

Hydrothermal vein-type of uranium mineralisation hosted by quartzite-phyllite sequence of Siang Group has been located in West Kameng and West Siang districts at Jamiri – Rukhu (silicified and sericitised phyllitic quartzite, 0.036-0.27% $U_3O_8$), Tai (brecciated silicified and sheared quartzite, up to 37.95% $U_3O_8$) and Kaying (sheared silicified phyllitic quartzite). The main uranium minerals identified are uraninite,brannerite and secondary uranium minerals such as uranophane, beta uranophane and torbernite.

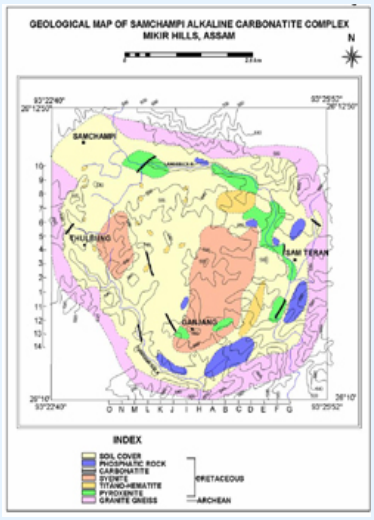
Hydrothermal vein-type of uranium mineralisation associated with Fe-Cu-REE hosted by metavolcano-sedimentary rocks (Iron Formation) of Siang Group has been located in West Siang and Upper Subansari districts at Gamak (quartzo feldsphathic veins traversing the fractured and brecciated iron stones, 0.008–0.170% $U_3O_8$), Kau nala (quartzo-feldsphathic veins following foliation planes of the muscovite magnetite-quartz schist, 0.010 – 0.020% $U_3O_8$), Maro-Baririjo area (brecciated pyrite-magnetite-quartz-chlorite-phyllite and iron stone, 0.010 – 0.130% $U_3O_8$) and in New Badak area (magnetite and sulphide bearing quartz-sericite schist, 0.011 – 0.58% $U_3O_8$).Uranium occurs as uraninite, brannerite and absorbed in iron hydroxide.Detailed radiometric checking, geological mapping and drilling of all these areas are envisaged to probe the sub-surface continuity of uranium mineralisation and identifying the uranium reserves.

## RARE METALS AND RARE EARTHS

Rare earths and rare metals are mainly hosted by Carbonatites and associated alkaline rocks.In North eastern Region, carbonatite and alkaline complexes are identified at Jasra and Sung valley of Meghalaya and Barpung & Samchampi of Assam.

## SAMCHAMPI ALKALINE COMPLEX :

The samchampi-alkaline carboantite complex forms part of the carbonatite–alkaline province emplaced along the ENE-WSW Tyrsad – Barapani- Kalyani lineament in the Mikir Hills Massif of Assam (FIG. 5).Pyroxinites, titano- hematite rock, syenite, carbonatite and phosphatic rock bodies are present at Samchampi.




Detailed exploration has indicated 12,124 tonnes niobium, 2,685 tonnes tantalum and 1,821 tonnes yttrium in the soils. The titano-hematite rocks source of iron and titanium contains about 400 million tonnes of iron ore with 61% Fe and 3.4% $TiO_2$. Moderate reserve of about 15 million tonnes of phosphate ore has also been estimated besides 4,364 tonnes of uranium oxide and 17,738 tonnes of REE.

## SUNG VALLEY

In Sung Valley, rare earths and rare metals are hosted by carbonatites which occurs mainly as dykes or sheet like bodies intruding the pyroxenite, peridotie and ijolite. The carbonatite bodies range in size from 40 x 60m to 400 x 120m with NE trend. Fission track dating of apatite in carbonatite indicated 84±13-90±10Ma.Chemically,carbonatite contain 34.7 to 53.2% CaO, 31 to 40.10% $CO_2$. The trace elements analysed are Ba (513-622 ppm), Sr (1399-3396 ppm), Ce (149-471 ppm),U (0.5-29 ppm), Th(<0.6-65.1 ppm),La (30-100ppm),Y (10-100ppm) and Zr (10-628ppm). Exploration by hand auger drilling at 250m grid interval upto a average depth of 1.0m over an area of 11 sq km has indicated 1,600 tonne of niobium in the soil.

## Other Facilities

The region is equipped with facilities such as

- Physics Laboratory
- Chemistry Laboratory
- Petrology Laboratory

Regional Centers

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- Eastern Region
- North Eastern Region
- Western Region
- Central Region
- South Central Region

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# Western Region

## General Information

| | |
|---|---|
| Area | :5,49,000 sq km |
| States | :Rajasthan,Gujarat and parts of Madhya Pradesh |
| Headquarter | :Jaipur |
| Address | :Regional Centre for Exploration and Research,AMD Complex,Sector-5 Extension,Pratap Nagar,Sanganer,Jaipur – 302033 (Rajasthan) |
| Contact Person | :Dr. B.S. Bisht, Regional Director Ph : 0141-2795401<br>Fax : 0141-2795488, 0141-2795489<br>e-mail : rdwr.amd@gov.in |

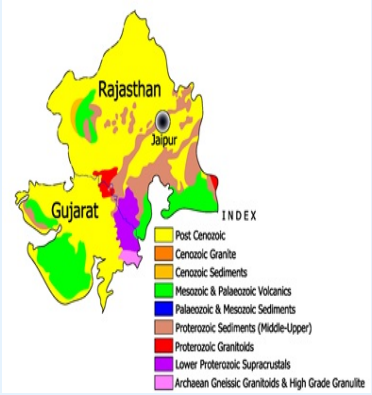
The Region was set up initially as North Western Region in 1988 with headquarters at Jaipur, Rajasthan, when it was originally carved out of Northern Region. It was later re-designated as Western Region. Presently, the Region has its own office-cum-laboratory complex and residential quarters at Jaipur, catering to the requirements of officers and staff.

## Broad Geological features

The following are the broad geological domains in which activities of Western Region are focussed.

(i) Archaean Basement Rocks (>2500 Ma):

The Banded Gneissic Complex (BGC) with enclaves of amphibolites and intrusive granitoids such as Untala Granite, Gingla Granite, Berach Granite, etc form the basement for Aravalli and other younger meta-sediments.




(ii) Palaeoproterozoic Aravalli Supergroup:

The rocks of Aravalli Supergroup deposited in rift related basins form the most prominent geological feature. The Aravallis consist of conglomerate, arkose, greywacke, quartzite, carbon phyllite, marble etc. These rocks are well known for their polyphase folding and multiple deformations. Some synkinematic granitic bodies e.g. Darwal Granite, Amet Granite are emplaced into it. Several Aravalli equivalent basins like Jahazpur, Pur-Banera, etc. also form part of the Palaeoproterozoic sequence of the Region.

(iii) Meso-Neoproterozoic Delhi Supergroup and equivalents:

The succeeding Delhi Fold Belt comprises limestone, quartzite, arkose, quartz-mica schist and contemporaneous volcanic rocks. These rocks were deposited mostly in northeastern parts of Rajasthan and are intensely folded with emplacement of several granitoids.

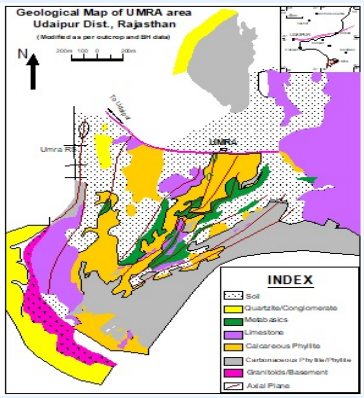
(iv) Neoproterozoic and younger rocks of Western Rajasthan:

A number of younger (~800 Ma) intrusive/ extrusive bodies belonging to the Erinpura and Malani Igneous Suite (MIS) occur in the western part of Rajasthan. Marwar Supergroup of rocks comprising mostly arenaceous and mixed arenaceous - argillaceous rocks was deposited over the MIS.

Besides, the rocks of Neoproterozoic Vindhyan Supergroup and Deccan Traps of Mesozoic age occupy small parts of the Region.

## Summary of Investigations: Important finds

A major part of investigations have been directed to locate metasomatite, surficial and metamorphite types of uranium deposits in Proterozoic and younger basins. Some of the uranium deposits identified in the Region are: /p>




## ARAVALLI SUPERGROUP

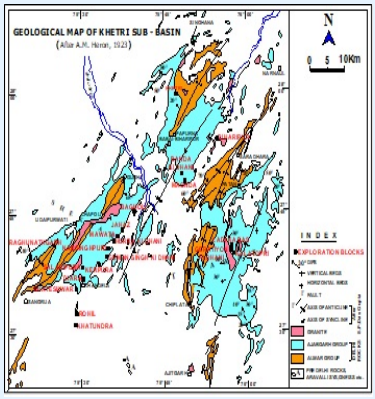
Umra – Udaisagar:

It is a metamorphite type deposit located along Umra-Udaisagar-Kalamagra tract in Udaipur district, Rajasthan. The host rocks are calcareous/carbonaceous phyllites and dolomites of Aravalli Supergroup. The ore bodies occur over 650m strike length in Umra main and 750m in Umra north-east blocks and extend up to vertical depths of 315m and 400m respectively. This area is being re-investigated for unconformity-type of uranium mineralisation.

## NORTH DELHI FOLD BELT (NDFB)

Rohil:

It is a metasomatite type deposit located in Sikar district, Rajasthan. The deposit occurs along a NNE-SSW trending zone of extensive albitisation in the North Delhi Fold Belt. The host rocks are albitised biotite schist and quartzite of Ajabgarh Group (Delhi Supergroup). The ore bodies occur over 1,850m strike length and extend up to a vertical depth of 650m. Exploration in contiguous blocks is in progress.



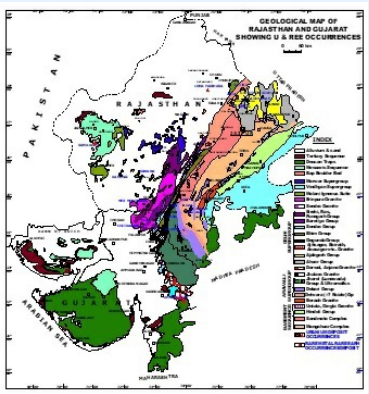

**Jahaz:**

It is located in Jhunjhunu district, Rajasthan, about 120 km NNW of Jaipur. This deposit also lies along the albitite line of North Delhi Fold Belt. Exploration is progressing in contiguous areas of Jahaz.

**Thrust areas of Investigations:**

The following geological environments are the main thrust areas for uranium exploration:

**(a) Metasomatite type uranium deposits:** The zone of albitisation in North Delhi Fold Belt is considered as potential for Metasomatite type uranium mineralisation. Exploration is being carried out along the albitite line of NDFB to prove uranium deposits similar to Rohil and Jahaz.




**(b) Unconformity-type uranium deposits:** The Paleoproterozoic Aravalli-Delhi metasediments and Neoproterozoic Marwar Supergroup of rocks are considered as potential horizons for hosting uranium mineralisation.

**(c) Sandstone type uranium deposits:** The pericratonic Jaisalmer Basin occupying 42,000 sq km in parts of Jaisalmer and Barmer districts, Rajasthan overlying predominantly granites and rhyolites of Malani Igneous Suite comprises Lower Jurassic, fluvio-deltaic Lathi formation which has been identified to be potential for sandstone type mineralisation.

**(d) Surficial type uranium deposits (Calcrete/ playa):**

Physiography and climatic conditions of western Rajasthan along with favourable geological setting associated with restricted drainage systems form an ideal set up for exploration of Surficial-type uranium and lithium deposits.

**(e) Rare Metal & Rare Earth (RM&RE) Investigations:** The Neoproterozoic Siwana Ring complex of southwest Rajasthan and the Ambadongar Carbonatite Complex in Chhota Udepur district, Gujarat have been identified to be potential for RM & RE minerals. The exploration for Rare Metals & Rare Earths (RM&RE) is in progress both at Siwana Ring Complex, Barmer district, Rajasthan and Ambadongar Carbonatite Complex, Chhota Udepur district, Gujarat. In addition, a number of columbite-tantalite, beryl, lepidolite-bearing pegmatite occurrences have been located in Rajasthan Mica Belt at Deoria, Sangwa, Lakhola, Soniana and Danta-Bhunas.

## Other facilities available at Western Region:

The Region has the following analytical laboratories

- Physics Laboratory
- Chemistry Laboratory
- Petrology Laboratory
- WDXRF Laboratory

Regional Centers

- Northern Region
- Southern Region
- Eastern Region
- North Eastern Region
- Western Region
- Central Region
- South Central Region

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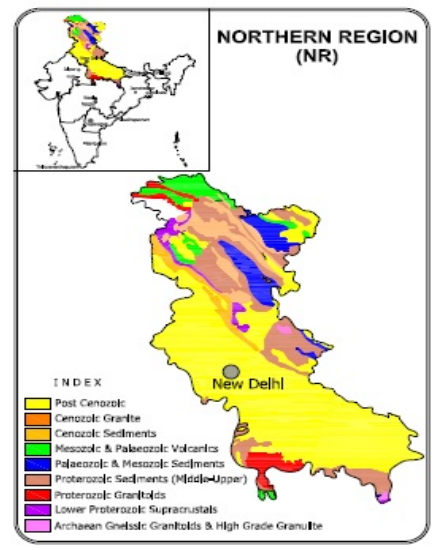
# Northern Region

## General Information

Area :6,06,000 sq km
States :Uttar Pradesh, Uttarakhand, Himachal Pradesh, Jammu & Kashmir, Ladakh, Haryana, Punjab and parts of Madhya Pradesh and Rajasthan
Headquarter :New Delhi
Address :West Block VII, R.K.Puram, New Delhi - 110 066
Contact Person :Dr. K. K. Pandey, Regional Director
Ph : 011-26101450
Fax : 011-26107358
e-mail : rdnr.amd@gov.in

The New Delhi office was set up during 1949 as the AMD headquarter, which was shifted to Hyderabad in 1974 and the office at New Delhi remained as the headquarter for Northern Region. Rajasthan was initially a part of the Northern Region, but during 1988 it was included in the newly created Northwestern Region (now Western Region). (now Western Region).

## Broad Geological features




The Northern Region comprises great Himalayan mountain range exposing igneous and metasedimentary rocks of various ages in the Higher and Lesser Himalayas, the trans-Himalayan sedimentaries, the Siwalik sediments, the vast Gangetic alluvial tract and the Archaean granitoids and Proterozoic sediments in the south

**The Higher Himalayas :** comprises of granite gneisses and high grade metamorphic rocks, also known as the Central Crystalline axis. To the south, across the Main Central Thrust **(MCT),** the **Lesser Himalayas** are represented by metasedimentary and metabasic rocks with some well known nappes and Klippes, with or without intrusive granites. The Main Boundary Thrust(MBT) separates the Lesser Himalayan rocks from the Siwalik belt.

**The Siwalik belt :** extending from Jammu & Kashmir through Himachal Pradesh to Uttarakhand is a prominent geological feature of the Region. The Siwalik sediments are divided into Lower Siwalik (mainly argillaceous), Middle (arenaceous with shaly inter layers) and Upper Siwalik (conglomerates with sandy lenses).

The **Himalayan Frontal Fault (HFF)** to the South separates the Siwaliks from the Indo-Gangetic plains.

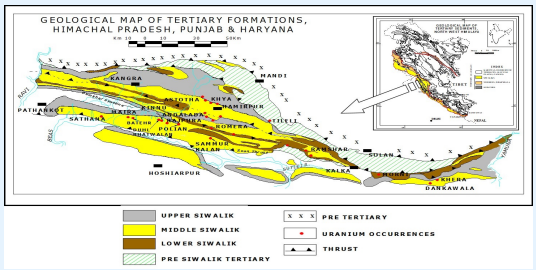
Further south of the Indo-Gangetic plain, the Proterozoic **Bijawar - Gwalior-Vindhyan Groups** of rocks are exposed over the Bundelkhand Granitic Complex as basement. The southern margin of the Vindhayan basin is bound by the Mahakoshal Group and Chhotanagpur Granite Gneisses.

## Summary of Investigations: Important finds

Although no economically viable deposit has been delineated, so far, a few important uranium occurrences have been discovered in almost all geological domains of the Northern Region.

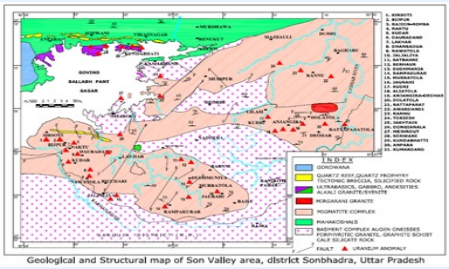
In the **Upper-Middle Siwalik** transition zones of Himachal Pradesh, Haryana, Uttarakhand and J&K, lenticular uraniferous bodies, both in the sandstones as well as in conglomerates occur over large areas. The lenses are a few metres to few tens to hundreds of metres in dimension with low average grade. A large number of blocks have been drilled and exploratory mining was also carried out in three blocks, viz. **Asthota, Khya** and **Andalada**, Hamirpur district, Himachal Pradesh. **Rajpura**, Una district is the best known occurrence, so far. Other occurrences of similar nature are in **Danaur** and **Naugajia Rao-Shakumbari Rao** areas in Uttarakhand, **Maler** and **Thein** in J&K and **Morni** in Haryana.

In the **pre-Siwalik Tertiary** sediments also, a number of anomalies have been located in the Dharamsala Group in Solan and Mandi Districts, H.P. out of which Tileli is the largest occurrence so far identified. At Tileli, uranium mineralisation associated with lithic arenites at the contact of Lower & Upper Dharamsala formations, was located over a strike length of 500m x 10m, that was traced down to a vertical depth of 300m by exploratory drilling.




While the gnessic rocks of the **Higher Himalayas** show profuse development of secondary minerals, e.g. as in **Chaura**, Kinnaur district, H.P., significant uranium mineralisation associated with sheared gneisses and quartzites of Rampur Group have been traced in several localities in the **Lesser Himalayas**, across the MCT, important among which are in **Kasha, Kandi** and **Kaladi**, Shimla district, Himachal Pradesh. The mineralisation occurs in the form of small veinlets along the fractures.

Similar uranium occurrences have also been located in the,**Berinag** quartzites of Uttarakhand. Shear-controlled uranium mineralisation of significant dimension and grade is hosted by chlorite-sericite schists of Pokhri area, Chamoli Dt, and by granite gneisses in **Brijranigad** area, Tehri district, Uttarakhand. Exploration in the Himalayas is greatly hindered by geological complexities and lack of infra-structural facilities.



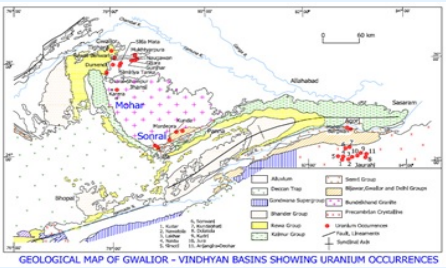
Geological and Structural map of Son Valley area, district Sonbhadra, Uttar Pradesh

In parts of the Peninsular India, uranium mineralisation was observed at a number of places like **Naktu, Kudar, Nawatola-Dhanbadua** in cataclastic breccia and migmatites in Sonbhadra district, Uttar Pradesh. The area forms part of Chhotanagpur Granite Gneiss Complex. Exploratory drilling is in progress in some of these areas for establishing the potentials of these occurrences.

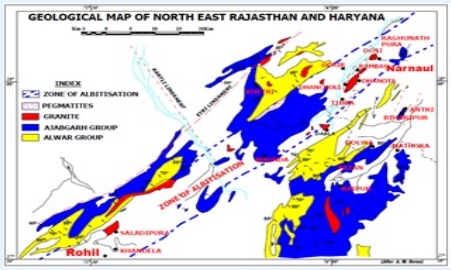
Uranium mineralisation was also found associated with fracture-filled bitumen in chloritic shale, Bandai sandstone and Rohini carbonate of Bijawar Group around Sonrai, Lalitpur district, Uttar Pradesh.

**Present thrust areas of investigations**

The present areas of investigations are mainly concentrated in (i) Chhotanagpur Granite Gneiss Complex (CGGC) which is the prime target for migmatite hosted mineralisation in parts of Uttar Pradesh; (ii) the unconformity contact between Vindhyan Supergroup and Gwalior Group of rocks in parts of Madhya Pradesh; (iii) Siwalik Group in parts of Himachal Pradesh and Uttarakhand and (iv) northern continuity of the albitite line from Rajasthan to Haryana.



GEOLOGICAL MAP OF GWALIOR - VINDHYAN BASINS SHOWING URANIUM OCCURRENCES




## Other facilities available at Northern Region

The Region is equipped with

- Physics Laboratory
- Chemistry Laboratory
- Petrology Laboratory

Regional Centers

- Northern Region
- Southern Region
- Eastern Region
- North Eastern Region
- Western Region
- Central Region
- South Central Region

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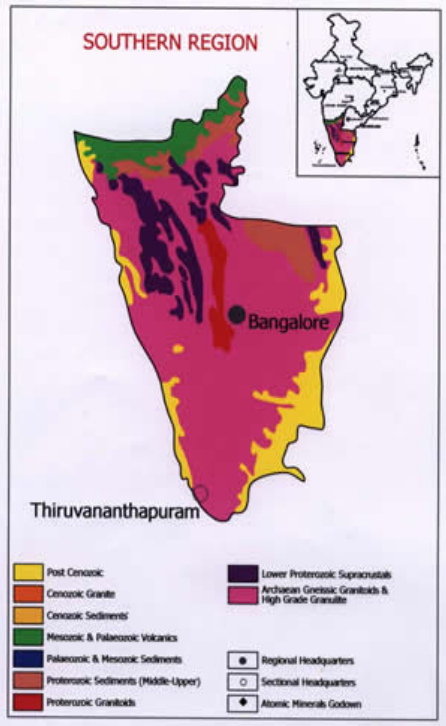
# Southern Region

## General Information

| | |
|---|---|
| Area | :3,96,000 sq km |
| States | :Andhra Pradesh(South of 15° N latitude), Karnataka and Maharashtra (South of 17° N latitude), Goa, Kerala, Tamil Nadu and Pondicherry |
| Headquarter | :Bangalore |
| Address | :Regional Centre for Exploration and Research (RCER),Nagarabhavi, Bangalore – 560 072 |
| Contact Person | :D. K. Choudhury, Regional Director |
| | Ph : 080-23210246 |
| | Fax : 080- 23211511 |
| | e-mail : rdsr.amd@gov.in |

This Region was set up in 1956 in a rented accommodation at Patan Bhavan, Bangalore. AMD's own office/ laboratories and residential quarters were established in 1986 in Nagarabhavi, Bangalore.

## Broad Geological features




**The following are the broad geological domains of the Southern Region.**

**(i) Archaean Basement Rocks (>2500 Ma) :**The basement rocks comprise Archaean granulite facies containing quartzites, garnet-sillimanite gneiss, marble, amphibolites and charnockites in Tamil Nadu, Kerala, Andhra Pradesh, Karnataka and Goa. The Peninsular Gneisses, which are mainly composed of migmatites and banded grey granites are fairly homogeneous and are exposed over large tracts in these states.

**(ii) Late Archaean Dharwar Supergroup rocks:** They comprise piles of volcano-sedimentary sequence broadly divisible into a lower Bababudan and an upper Chitradurga Group. The Bababudan Group is characterized by platformal sediments with quartz pebble conglomerates, pebbly quartzite, fuchsite quartzite and banded magnetite quartzites which were followed by sub-aerial mafic volcanics. The Chitradurga Group is typified by geosynclinal sediments with subordinate volcanics and well developed linear tracts of limestone, manganese and associated iron formations. They occur mostly in Karnataka and parts of Andhra Pradesh.

**(iii) Lower Proterozoic Closepet Granites :** Granites of this age extend in a north-south direction as a 50 km wide narrow belt. This belt of younger potassic granite is believed to mark a major geo-suture separating two distinct crustal blocks of Archaean age. The western block is characterized by a number of well-developed low grade granite-greenstone belts with their iron-manganese ores and the eastern block is marked mainly by younger gneisses of granitic and granodioritic composition enclosing within them a number of narrow, linear bands of auriferous schist belts.

**(iv) Middle to Upper Proterozoic Cuddapah Supergroup rocks and their equivalents such as Bhima Group & Kaladgi Group of rocks:** These are the most significant geological domains of Indian geology. The Cuddapah basin comprises sedimentary sequence of ~12 km thickness and volcanic sequences in the form of sills and dykes, which are resting on the Archaean Peninsular Gneissic Complex marked by a pronounced Eparchaean unconformity. This basin comprises of rocks of Cuddapah Supergroup which includes Kurnool Group.

The Kaladgi and Bhima basins occur in the northern parts and extend below the Deccan Traps. These basins comprise of rocks of clastic/chemogenic origin.

**(v) Deccan trap of Mesozoic-Tertiary age :** These formations spread over very small parts of the Region and overlie the northern extensions of the Dharwar craton.

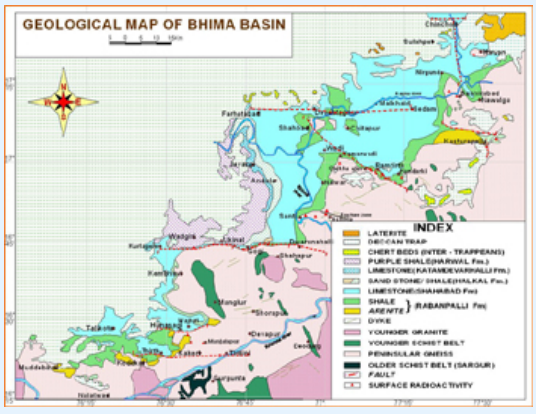
**(vi) Younger basins(Mesozoic - Tertiary) :**These sediments include Gondwanas of Palar basin, Cretaceous rocks of Tiruchinapally, Cuddalore Sandstone, Warkala beds, Quilon beds etc.

**(vii) Beach and Inland Placers :** These are part of Quaternary group of rocks. The beach and inland placers of Tamil Nadu and Kerala host some of the richest deposits of ilmenite, monazite, rutile, garnet, zircon and sillimanite.

## Present Thrust areas of Investigations

The present thrust on uranium exploration is on Proterozoic unconformities with the basement rocks. As such the three basins viz. Kaladgi-Badami and the Bhima basin in Karnataka and the Cuddapah basin in Andhra Pradesh are under active exploration.

## Uranium Exploration in Bhima Basin




Uranium exploration programme in Bhima basin was taken up in 1995 in analogy to other Proterozoic basins in India and abroad. An integrated exploration programme was launched viz., satellite image analysis and litho-structural mapping, 2,100 line km Car borne radiometrics, 16,330 line km airborne gamma ray spectrometry and magnetics, 7,000 sq km hydro-geochemistry, ground radiometrics, gamma ray logging of domestic borewells and sub-surface core and non-core drilling. All these led to identify number of surface uranium occurrences along Gogi-Kurlagere (KG) and Wadi fault zones besides number of potential target zones delineated by hydro-geochemical survey, heliborne time domain electromagnetic (TDEM), magnetic and gamma ray spectrometric surveys.

Extensive sub-surface exploration (55,600m) at Gogi has established uranium mineralisation hosted in limestone and granite. It is a granite related deposit, which is structurally complex. Pitchblende and coffinite are the main uranium minerals. The ore contains anomalous concentration of REE, Pb, Ag and Au. Gogi uranium deposit is located 12 km west of Shahapur, the Taluk town and 75 km south of Kalaburgi. The nearest rail head is Yadgir about 40 km to the east, which is also the district headquarter.

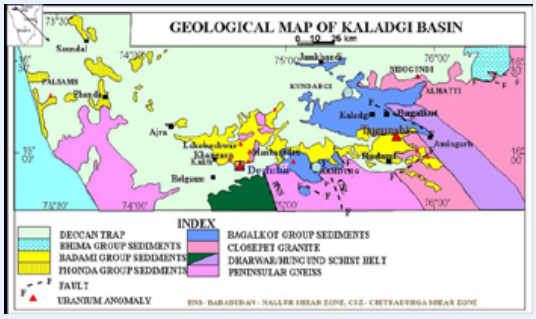
Exploratory mining to study the ore body characteristics and to obtain bulk ore for process studies was carried out earlier. Sub-surface exploration in the extension areas of Gogi uranium deposit, along tectonic contact between the basement granitoid and sediments of Bhima Group defined by KG fault resulted in establishing another uranium deposit with a strike length of 2,000m with 20-90m width in Kanchankiyi-Hulkal area hosted by brecciated limestone having carbonaceous matter. The northeastern trend of the subsidiary arm of the KG fault associated with uranium mineralisation in Kanchankiyi-Hulkal continues eastward and is under active exploration. Bhima basin has got immense potential for discovering more uranium deposits.

## Uranium Exploration in Kaladgi Basin

The meso to neo-Proterozoic Kaladgi basin, covering an area of 8,300 sq km occupies the northwestern fringes of the western Dharwar craton, in parts of Karnataka, Maharashtra and Goa. The northern and western extensions of the basin are covered by Deccan Trap. The basin exposes sediments of older Bagalkot and younger Badami Groups of Kaladgi Supergroup. The Bagalkot Group consists of ortho-quartzite, shale, dolomite and limestone, which are highly deformed. Conglomerate, arenite, shale and limestone constitute the main rock types of Badami Group, which are undeformed. Archaean Peninsular Gneiss, Chitradurga Schist of Dharwar Supergroup and intrusive Closepet Granite and its equivalents form the basement rocks for these sediments. E-W, NE-SW and NW-SE trending faults and fractures have affected both basement rocks and the sediments.

Uranium exploration was initiated in the sixties with a multipronged strategy. An area of 6,600 sq km has been covered by Airborne Gamma Ray Spectrometric (AGRS) and magnetic surveys in the eastern and western parts of the basin, along the basin margin during 1984. Interpretation of litho-structural map based on LANDSAT imagery and aero-radiometric data of 3,000 sq km indicated that eastern part of the basin is favourable for uranium mineralisation. Hydro-uranium anomalous zones around Deshnur, Yadwad, Chipalkatti, Hulikeri and Tugunshi areas were delineated by regional geochemical survey, carried over an area of 7,500 sq km. Uranium, thorium and mixed anomalies were located in basement granite, conglomerate and arenite at Tugunshi, Siddankola, Hulikeri, Khanapur and Almatti in the eastern part and Deshnur, Khangaon and Hanbarhatti in the western part of the basin as a result of extensive ground radiometric survey carried out over an area of 8,000 sq km. Ground geophysical survey viz., resistivity, magnetic and electro-magnetic surveys were also carried out along favourable zones, covering an area of 20 sq km, around Deshnur and 7 sq km around Hulihatti.

Reconnoitory drilling (25,000m) was carried out around Tugunshi, Siddankola, Murdi, Hulikeri, Khanapur and Deshnur to locate unconformity type of mineralisation. Uranium values ranging from 0.010% to 0.034% $U_3O_8$ were recorded in Badami arenite in boreholes around Tugunshi area whose thickness varies from 0.50 to 1.70m. Significant uranium mineralisation has been located in the year 2005 near Deshnur, which is about 30 km east of Belgavi. The mineralisation is confined to the unconformity surface in feldspathic conglomerate and arenite of Badami Group. The grade and thickness varies from 0.015% to 0.13% $U_3O_8$ and 2.50 to 63.20m, respectively. Correlatable mineralisation has been established over a strike length of 360m hosted by highly altered, fractured, sulphide bearing feldspathic lower conglomerate along NE-SW direction. Pitchblende and coffinite are identified as main uranium minerals. Bravoite, arsenopyrite, chalcopyrite, covellite, bornite, sphalerite and galena are the sulphide phases associated with mineralisation.




Systematic multipronged approach resulted in identifying uranium mineralised zone in Gujanal block. A total of 102 boreholes were completed in Gujanal with a cumulative drilling of 34,052.40m. In the first phase of exploration, significant uranium mineralisation of 0.020 - 0.16% $eU_3O_8$ x 0.20 - 6.50m over 1800 m strike length with the width of 40 to 360m was intercepted in sulphide bearing feldspathic conglomerate / arenite intercalated clay bands, mainly confined along bedding planes. In the second phase, exploration targeted along NE - SW trending fault zone intercepted high order correlatable mineralisation of 0.012 - 0.075% $eU_3O_8$ x 0.20 to 22.70m over 700m, hosted by sulphide bearing feldspathic conglomerate / arenite and basement chlorite schist in fracture zone. Pitchblende, traces of coffinite, uraninite along with pyrite, bravoite, galena, bornite and sphalerite are identified by petrography.

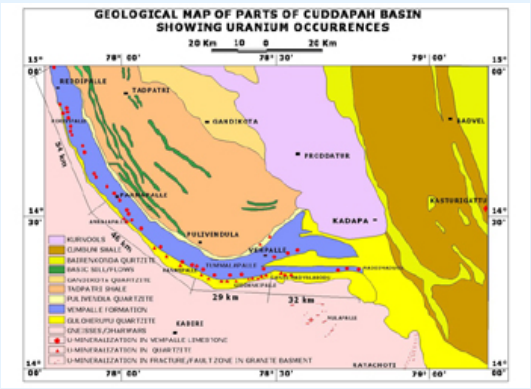
Active exploration is being continued and Kaladgi basin offers an ideal geological setting for hosting typical unconformity type uranium deposit.

**Cuddapah Basin a Uranium Province**

**Tummalapalle Uranium Deposit:** Cuddapah basin in South Indian Shield is an established uranium province. Different types of uranium mineralisation of varying age are reported here viz. Granite-related (Granite hosted: Mullapalle), Granite-related (Gulcheru quartzite hosted : Gandi-Madyalabodu), Carbonate deposit (Strata-bound, dolostone hosted: Tummalapalle) and Proterozoic Unconformity deposits (Stratiform structure-controlled deposits, between basement granite and Srisailam quartzite: Chitrial and Lambapur).

Tummalapalle uranium deposit situated in YSR (Kadapa) district of Andhra Pradesh, falls in toposheet no. 57J/7. Pulivendla is the nearest town at a distance of 12 km from mine site. This town is linked by road with major cities such as Bengaluru (220 km), Hyderabad (400 km) and Tirupathi 250km. This deposit and its extension areas are located at the south-western part of Proterozoic Cuddapah basin over an area of 21 km x 2 km from Gidankivaripalle village in east to Motnutalapalle in west.

Association of uranium with the impure phosphatic dolostone in Vempalle Formation was first reported by Geological Survey of India in 1986. Subsequently, surface and sub surface investigation by AMD in two phases i.e. from 1986 to 1995 and 2007 till date have proved substantial uranium resources. Here uranium mineralisation is in the form of strata-bound, dolostone (Vempalle Formation) hosted carbonate deposit, in the western margin of Papaghni sub-basin. It extends from Reddipalle in the northwest to Maddimadugu in the southeast over a belt of 160 km. Vempalle Formation overlies the Gulcheru Formation with transitional boundary. Vempalle Formation is around 1900m thick and study of the complete sequence




of Vempalle Formation in the explored areas reveals that the carbonate facies commences with massive dolostone, followed by thin band of conglomerate, uraniferous phosphatic dolostone, red shale and cherty dolostone. Ultrafine pitchblende and uraninite are the main uranium minerals while coffinite, U-Si-Ti complex and some U in the adsorbed form with collophane have been identified as minor U mineral phases. The associated ore minerals are mainly pyrite, molybdenite, chalcopyrite, bornite, digenite and covellite.

During first phase of investigation, uranium mineralisation in Tummalapalle area was proved over 6.6 km along strike length and 1.2 km along dip from 15 m to 250 m depth. Uranium mineralisation occurs as two bands, hangwall and footwall bands with a vertical separation of 1m to 3m. Both the bands show isotropic character along and across the strike in terms of grade and thickness. Average thicknesses of these bands are 2.3m and 1.75m for hangwall and footwall respectively with average grade of 0.05% e$U_3O_8$ at 0.02% cut off. During this phase 37,635m was drilled in 264 boreholes and about 14,600te of $U_3O_8$ proved. Investigation in this area was suspended in 1993 due to hydrometallurgical constraints and shift in priority areas of AMD.

Considering the demand of uranium for the ongoing Indian Nuclear programme and after successfully overcoming the constraints of hydrometallurgical process, commercial mining of Tummalapalle uranium deposit commenced. Foundation was laid for mining and processing plant of Tummalapalle deposit on November 19 - 20, 2007. The mining of the footwall band of the deposit was first taken up for exploitation. As a part of target expansion programme (second phase), exploratory drilling in the extension areas of Tummalapalle was initiated during the 2007-08.

During second phase of exploration programme, about 4,46,500 m of drilling has been completed in 1,437 boreholes and about 1,78,300 te of $U_3O_8$ has been added in Tummalapalle deposit and its extension areas as on October 2020. Tummalapalle Mill was inaugurated on April 20, 2012. Sub-surface exploration in the area is in progress.

**Investigations in Cuddapah basement fracture zones:**

The basement complex of crescent–shaped Cuddapah basin in the eastern Dharwar craton comprises Archaean greenstone-granitoid association with profuse mafic (doleritic) dykes and felsic (quartzo-feldspathic reef/veins) intrusions along reactivated fracture zones. Geological and radiometric investigations of the crystalline basement initiated in 1980s by AMD led to location of number of thorium free uraniferous fracture zones right from Nagari - Kurvapalle area in the east to Bimunipalle area near Gooty in the west. These fracture zones show varying trend ranging from NNE-SSW (Sanipaya - T.Sundupalle), ENE-WSW (Mulapalle) and NW-SE (Lakshmipuram). Among these, ENE-WSW trend is predominant and shows significant mineralisation. The mineralised fracture zones show strike extent ranging from 250 m to 16 kms (intermittently) with a width of <1 m to 5 m. Mineralisation is associated with cataclsite and mylonites along fault/shear zone. Though the fracture zones are widespread, mineralised fracture zones are confined to fertile granites of Closepet affinity.

Alterations like chloritisation, haematitisation, phosphatisation and silicification associated with the granite related uranium mineralisation have been observed. Three types of granitoids namely Peninsular Gneiss, K-rich Closepet Granite and Na rich microgranites are reported in the terrain. About 68 fracture zones associated with uranium mineralisation are reported in the southwestern margin of Cuddapah basin.

Exploratory drilling commenced in 1989 at Sanipaya-T Sundupalle fracture zone, where 33 boreholes (3,454.95m) were drilled. A lean mineralised zone over 500 m strike length was established in the area. Subsequently, emphasis was shifted to Mulapalle fracture zone, which was also located during, 1987-88 and detailed investigations were carried out during 1989-90 and 1991-92. Exploratory drilling in Mulapalle commenced in May 1993. This fracture zone was under active exploration till September 1998 and has given the most promising results of all the fracture zones. A total of 38 boreholes were drilled (6,479.85 m) in this area covering a total strike length of 500m. Mineralisation in the form of three different lenses was delineated in the area. Exploratory drilling was carried out during the period 1995-98 in six other fracture zones such as Chenchalapalle, Burjupalle, Timmareddigaripalle, Payalopalle (N), Mulapalle-II and Varikuntapalle.

In Kamagutapalle area, surface uranium mineralisation was traced for about 3 km along fracture trending N20°E-S20°W in the 90's. Shielded probe logging revealed 9 lenses distributed over a length of 710m in the southern part of the fracture zone. Based on further rechecking during 2014-15, encouraging result lead to reopening the Kamaguttapalle area for subsurface exploration by contract drilling in 2015-16. Currently, sub surface exploration is in progress, which has resulted in proving uranium mineralisation over a strike length of 320 m in Kamaguttapalle Main block.

## Other facilities available at Southern Region

The Region is equipped with various facilities in different laboratories such as:

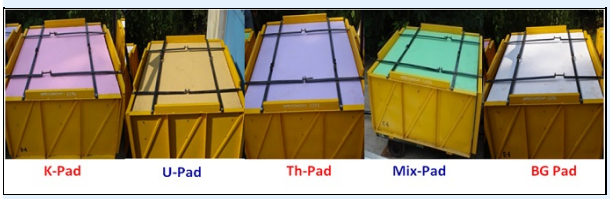
- Physics Laboratory
- Chemistry Laboratory
- Petrology Laboratory
- WDXRF Laboratory

## Calibration Facility for Radiometric Instruments

**Air borne gamma-ray spectrometer, portable/ground gamma-ray spectrometers and jeep/car borne gamma-ray spectrometers:**

Five concrete calibration pads (K, U(I), U(II), Th and Mx pads) were constructed at Civil Airport, Nagpur in 1984. The distinctive features of the pads are large size (12.2m diameter), homogeneity in radio elemental concentration, negligible leachability with the rain water, low radon emanation and high density. These pads are used for calibration of air borne and ground gamma-ray survey equipment.

Five transportable calibration pads (K, U, Th, Composite and BG pads) were also constructed in 2014 which have same features as the fixed calibration pads. These pads can be transported to the airbase where airborne surveys are in progress and can also be used for the calibration of portable gamma-ray spectrometers.



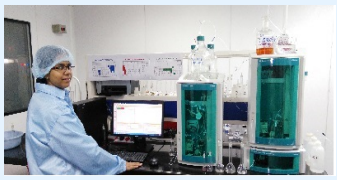

**Calibration facilities for Borehole and shielded probe gamma-ray logging systems:**

Primary standards facility for calibration of gamma-ray logging systems is available at RSA, HQ, Hyderabad.

Facilities of calibration of gamma-ray logging systems are available at RSA, HQ, Hyderabad.

## Chemistry

Chemistry laboratories provide analytical support to the exploration activities and carry out chemical analyses of rock, soil and core samples for major, minor and trace elements. Chemistry laboratories are located at six Regional Centre i.e. Northern Region, New Delhi; Southern Region, Bengaluru; Eastern Region, Jamshedpur; North Eastern Region, Shillong; Western Region, Jaipur; Central Region, Nagpur and AMD, HQ, Hyderabad. Two mobile geochemical vans are deployed in field areas during hydro-geochemical survey.



The Chemistry laboratories are equipped with Pellet and Light Emitting Diode (LED) induced Fluorimeter (LIF), UV-VIS Spectrophotometer, Flame-Atomic Absorption Spectrophotometer (Flame AAS), Graphite Furnace-Atomic Absorption Spectrophotometer (GF-AAS) and Inductively Coupled Plasma-Optical Emission Spectrometer (ICP–OES). In addition, HQ laboratory is also equipped with High Resolution-Continuum Source-Atomic Absorption Spectrophotometer (HR-CS-AAS), Ionchromatograph and Total Organic Carbon (TOC) Analyser. The laboratories at HQ, Hyderabad and Jaipur are equipped with Ion chromatograph and at Bengaluru and Jaipur are equipped with Carbon-Sulphur (C-S) Analyser./p>

All the laboratories have microwave assisted pressure digestive system for dissolution of samples. In addition, Class 10,000 clean room is also available at HQ, Hyderabad. Mobile geochemical vans are equipped with LED induced Fluorimeter, UV-VIS Spectrophotometer, Atomic Absorption Spectrometer,pH and conductivity meter for analyses of water samples in the field areas. Our laboratories have expertise in chemical characterization of rocks, core, soil, water samples and minerals (uranium, monazite, xenotime, ilmenite, rutile, zircon, garnet,siliminite, beryl, niobate and tantalate, beneficiation products, geo-botanical samples, coal and fly ash samples for more than 60 elements:

►Major & minor oxides and trace elements ($SiO_2$, $TiO_2$, $Al_2O_3$, $Fe_2O_3$, FeO, MgO, CaO, $Na_2O$, $K_2O$, MnO, $P_2O_5$ and LOI; V, Cr, Co, Ni, Pb, Cu, Zn, Ga, Rb, Sr, Y, Mo, V, Zr, Nb,Ta, Ba, Sr, REEs, Th and U).

►Major cations, anions and trace elements in water samples.

►Gold and other platinum group elements are also analysed using “Fire Assay technique”


**NABL Accreditation:**

The HQ Chemistry Laboratory, Hyderabad is recognized by National Board for Accreditation of Testing Calibration Laboratories (NABL) in April 2016 for chemical characterization of monazite and Nb-Ta minerals as per ISO 17025:2017, (Certificate No. TC-7163).

**Research activities:**

The need based research & development works from the laboratories have resulted in developing new procedure as well as in improving the existing methods of analysis.

**Technology development:**

A unique filter for removal of uranium and arsenic from potable water has been developed and Technology Transfer and Collaboration Division (TT & CD), BARC has approved the same for releasing them in public domain for technology transfer.

Mineralogy Petrology Geochemistry

- Petrology Laboratory
- Stable Isotope Laboratory
- Geochronology Laboratory
- Electron Probe Micro Analysis Laboratory
- X Ray Diffraction Laboratory
- Wavelength Dispersive Xray Fluorescence Laboratory
- Energy Dispersive Xray Fluorescence Spectrometry Laboratory

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## Petrology Laboratory

Petrology laboratories are located at Hyderabad (Headquarters); New Delhi (Northern Region); Bengaluru (Southern Region); Jamshedpur (Eastern Region); Shillong (Northeastern Region); Jaipur (Western Region); Nagpur (Central Region) and Cherlapalle, Hyderabad (South Central Region). All the petrology laboratories are equipped with state-of-the-art polarising research microscopes with image analysing softwares for transmitted and reflected light studies of rocks, ores and minerals, stereomicroscopes for grain counting and advanced facilities for preparation of thin and polished sections. The laboratories at Hyderabad, New Delhi, Jamshedpur and Jaipur are also equipped with micro-thermometry apparatus with heating and freezing stages for fluid inclusion studies.

Laboratories have a large spectrum of work ranging from characterisation of radioactive and associated non-radioactive rocks, minerals, soils, sands and stream sediments besides SSNTD studies. The laboratories are engaged in comprehensive petro-mineralogical investigations of different geological materials with emphasis on identification and characterisation of radioactive minerals and rocks.

## X Ray Diffraction Laboratory

X-ray diffraction is one of the most powerful tools for mineral identification, structural refinement and crystallite size determination. X–Ray Diffraction Laboratory, located at Hyderabad, is equipped with GE-XRD-3003 TT automated system, which uses monochromated characteristic CuK(α) radiation for powder diffraction studies. The laboratory is engaged in carrying out a variety of studies, which include:

1. Identification and characterisation of primary and secondary uranium and associated minerals; rare metal and rare earth bearing mineral phases and related minerals.
2. Characterisation of metamict minerals and influence of the degree of metamictisation on uranium beneficiation.
3. Identification of clay and iso-structural minerals.
4. Determination of unit cell parameters of atomic minerals.
5. Determination of the oxidation grade of uraninite for elucidating genesis of uranium ores from diverse geological settings.
6. Determination of Triclinicity and structural state of potash feldspar from rare-metal and rare-earth-mineralised granites and pegmatites to elucidate the evolutionary history of parent rocks and hosted mineralization.
7. X-ray crystallographic and substitutional solid solution studies, mainly on U, Th, Nb, Ta, Sn ore-minerals. Characterisation of phases in solid solution series.
8. Qualitative mineralogical studies of rocks of igneous, metamorphic and sedimentary origins.
9. Investigations on degree of structural ordering in primary minerals of niobium and tantalum to unravel the attendant physicochemical conditions during ore genesis.
10. Characterisation of leached residue, beneficiated and heat-treated products of uranium ores.
11. Characterisation of atomic mineral phases associated with beach sand and off-shore mineral deposits.