# PROPOSAL FOR PRELIMINARY EXPLORATION (G-3 STAGE) FOR LIMESTONE IN KULUMUR BLOCK (7.64 SQ KM), ARIYALUR AND PERAMBALUR DISTRICTS, TAMIL NADU.

**COMMODITY: FOSSILIFEROUS LIME STONE**

**(PROPOSED BLOCK AREA = 7.64 Sq km;**
**TOPOSHEET Part of 58M/03)**

By


## GEO EXPLORATION AND MINING SOLUTIONS

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**PLACE: Salem**

**DATE: 06-11-2024**

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## Summary of the Block for Preliminary Exploration (G3 Stage)

**GENERAL INFORMATION ABOUT THE BLOCK**

| | Features | Details | |
|---|---|---|---|
| | Block ID | Kulumur, Block | |
| | Exploration Agency | **GEO EXPLORATION AND MINING SOLUTIONS**<br>No.17 Advaitha Ashram Road, Fairlands,<br>Salem – 636004, Tamilnadu, India. | |
| | Commodity | Fossiliferous Lime stone | |
| | Mineral Belt | Ariyalur Cretaceous formation | |
| | Completion Period with entire Time schedule to complete the project | 12 months | |
| | Objectives | 1. To demarcate the various limestone grade occurrence within the area by drilling of 20 boreholes.<br>2. To estimate grade wise Limestone inferred resources in the Block area as per UNFC norms at G3 (333) level of exploration.<br>3. To carry out exploration as per Minerals (Evidence of Mineral contents) Rules 2015, Mineral (Auction) Rules 2015 and MMDR Amendment act 2015 in turn to facilitate the State Govt. (Tamil Nadu) in auctioning of the block. | |
| | Whether the work will be carried out by the proposed agency or through outsourcing and details thereof. Components to be outsourced and name of the outsource agency | Work will be carried out by the proposed agency | |
| | Name/ Number of Geoscientists | Geologist - 3 Nos (Field Geologist:2 Nos & HQ geologist:1 Nos); Surveyor -1 Nos; Samplers -2 Nos;<br>Labors – 4 Nos. | |
| | Expected Field days (Geology) Geological Party Days | Field Geologist | 240-man days |
| | | Headquarters Geologist | 120 – man days |
| | | Geophysicist | 30-man days |
| | | surveyor | 60-man days |
| | | Sampler | 240-man days |
| | | Labours (4 nos) | 480-man days |
| | | | |

| | | | | | |
|---|---|---|---|---|---|
| **1.** | **Location (Plate-I)** | **A** | **B** | **C** | **D** |
| | **Latitude** | 11°16’58.71’’N | 11°18’19.13’’N | 11°18’16.84’’N | 11°15’16.87’’N |
| | **Longitude** | 79°7’45.68’’E | 79°8’37.03’’E | 79°8’42.04’’E | 79°8’42.04’’E |
| | | **E** | **F** | | |
| | **Latitude** | 11°18’10.21’’N | 11°16’28.16’’N | | |
| | **Longitude** | 79°9’50.70’’E | 79°8’52.03’’E | | |
| | Villages | Kulumur, Thungapuram(N), Thungapuram(S), Vanjinapuram, Namanganam. | | | |
| | Tehsil/Taluk | Sendurai Taluk of Ariyalur District; Kunnam Taluk of Perambalur District | | | |
| | District | ARIYALUR AND PERAMBALUR DISTRICTS, TAMIL NADU | | | |
| **2.** | **Area (hectares / Sq. kilometers)** | | | | |
| | Block Area | **7.64 Sq. km** | | | |
| | Forest Area | NIL | | | |
| | Government Land Area | No data | | | |
| | Private Land Area | No data | | | |
| **3.** | **Accessibility** | | | | |
| | Nearest Rail Head | Sendurai railway station, about 3 Km, lies in the South East direction from the proposed block on Ariyalur-Villupuram railway line of southern Railway | | | |
| | Road | The proposed block is about 3 km west from the Sendurai and can be reached via state highway running from Ariyalur to Sendurai. | | | |
| | Airport | Tiruchirappalli (73 km) in SW Direction. | | | |
| **4.** | **Hydrography** | | | | |
| | Local Surface Drainage Pattern (Channels) | The drainage pattern of the area is sub-parallel to dendritic in nature. The regional slope is towards east. Denudational, structural and fluvial processes mainly control the geomorphic evolution of the area. Mainly the varying resistance of geological formations to those has governed the evolution of various landforms. | | | |
| | Rivers/ Streams | Mostly first and second order streams are observed in the proposed block. | | | |
| **5.** | **Climate** | | | | |
| | Mean Annual Rainfall | Mean annual rainfall: 949 mm<br>NE Monsoon (October to December) :- 314.7mm | | | |
| | Temperatures (December) (Minimum) | (minimum): 21<br><br>(maximum): 39 | | | |

| | | |
|---|---|---|
| | Temperatures (June) (Maximum) | |
| **6.** | **Topography** | |
| | Toposheet Number | Part of 58M/03 |
| | Morphology of the area | The proposed block area is mainly pediplained and no major topographical highs or lows and shows gradual change in the slope towards east. |
| **7.** | **Availability of baseline geoscience data** | |
| | Geological Map (1:50K/ 25K) | 1:50K map available in Bhukosh & NGDR (Plate-II) |
| | Geochemical Map | Available (NGCM, GSI) |
| | Geophysical Map (Aeromagnetic, ground geophysical, Regional as well as local scale GP maps) | Not available |
| **8.** | **Justification for taking up Reconnaissance Survey / Regional Exploration** | 1. The Kallankurichchi Formation is traced from Kulumur in the north to Vellipirangiyam in the south for a distance of 28 km with a width ranging from 200 meters to 3 km. The main rock type of this formation is fossiliferous limestone. Among 28 km strike length, more exploration activities are done in the southern part of this Formation and existing limestone mines are also occurred in the southern part of this Formation.<br>2. Though in the proposed area, fossiliferous limestone occurrence of Kallankurichchi Formation is well established previously, but, exploration activities are less as compared to the southern part. Therefore, G3 stage of exploration is required for quantitative and qualitative evaluation and to convert the Geological resource to mineable reserves with higher level of confidence.<br>3. Limestone mines exists in the south of the proposed block in the same Kallankurichchi Formation.<br>4. Most limestone deposits in India exhibit significant variability in grade. The silica ($SiO_2$) and magnesium oxide (MgO) content in limestone are crucial factors influencing the chemical composition of raw materials used in cement manufacturing. In sedimentary limestones, the levels of these components, along with calcium oxide (CaO), can vary consistently both laterally and vertically, even within a small area. This variability |

| | | |
|---|---|---|
| | | makes it challenging to accurately estimate the quantity and quality of limestone based on data from nearby locations, especially for key factors like silica and MgO, which are critical to determining the suitability of the limestone for use in cement and other industries. Limestone with high silica and MgO content is unsuitable for cement manufacturing without blending with higher-grade limestone and may not be ideal for clinker production. Therefore, thorough exploration is essential to identify and quantify different grades of limestone according to the specific requirements of various industries.<br>5. The augmentation of limestone resources, which are fundamental to infrastructure development, is crucial for making this block eligible for auction in compliance with existing rules and regulations.<br>6. The demand for cement in the construction industry is expected to rise in the coming years, which will, in turn, drive an increased demand for limestone. As investments in infrastructural projects such as railways, water supply, transportation, electricity, and telecommunications grow, the need for limestone will also escalate. |

**PROPOSAL FOR PRELIMINARY EXPLORATION (G-3 STAGE)**
**FOR LIMESTONE IN KULUMUR BLOCK (7.64 SQ KM), ARIYALUR AND PERAMBALUR DISTRICTS, TAMIL NADU**

## 1. Introduction

Limestone is a vital industrial mineral in Tamil Nadu, extensively used in the production of lime, cement, chemicals, fertilizers, and in metallurgical industries. In Tamil Nadu, limestone occurs in two primary forms:

**(a) Crystalline limestone:** Found in the Southern Granulite Terrain (SGT) across parts of Salem, Tiruchirapalli, Karur, Dindigul, Madurai, Virudhunagar, Tirunelveli, Thoothukudi, Coimbatore, and Kanniyakumari districts, with an estimated total reserve of about 200 million tonnes.

**(b) Non–crystalline limestone or fossiliferous limestone:** Predominantly located in the Cauvery Basin and parts of Tiruchirapalli, Ariyalur, and Thoothukudi districts, with an estimated reserve of approximately 670 million tonnes.

With the construction industry's demand for cement expected to rise in the coming years, the demand for limestone is also set to increase. This demand will be further driven by growing investments in infrastructure projects such as railways, water supply, transportation, electricity, and telecommunications.

Limestone is essential for the country's infrastructure development, making its exploration increasingly important.

In response to the enactment of the MMDR Amendment Act 2015, along with the Minerals (Evidence of Mineral Contents) Rules 2015 and Mineral Auction Rules 2015, the Government of India has directed state governments to expedite exploration efforts for various mineral commodities to prepare them for auction. Recent amendments to the MMDR Act have further enabled state governments to auction blocks with lower confidence levels of exploration, thereby increasing the number of blocks available for auction.

## 2. Location and Accessibility

The block is situated in Sendurai Taluk of Ariyalur District and Kunnam Taluk of Perambalur District, Tamil Nadu. It is located approximately 3 km northwest of the Sendurai railway station on the Ariyalur-Villupuram railway line of Southern Railway. The block can be accessed by road, about 3 km northwest of Sendurai, which is connected via a state highway running from Ariyalur. The nearest airport is in Tiruchirappalli, approximately 75 km to the South West. The area is covered by Survey of India Toposheet No. 58M/03.

## 3. Physiography & Drainage

The proposed block area is primarily a Pediplain, characterized by a lack of major topographical highs or lows and a gradual slope that trends eastward. The drainage pattern is predominantly sub-parallel to dendritic, with the regional slope also directed towards the east. The geomorphic evolution of the area is largely influenced by denudational, structural, and fluvial processes, with the varying resistance of geological formations playing a key role in shaping the landforms. The area primarily features first and second-order seasonal streams.

## 4. Climate

The area experiences hot and dry climate during February-June and September-October and it is hot and humid during remaining months. The average annual rainfall is 949 mm. The climate of the area is mainly sub-tropical.

## 5. Flora and Fauna

The area is a barren land, Seasonal agriculture practice based on the monsoon conditions. The area is devoid of wild life, except for reptiles.

## 6. Regional Geology

The Cauvery sedimentary basin covers a vast coastal region of Tamil Nadu and Puducherry, extending from Puducherry in the north to Tuticorin in the south and stretching into the Bay of Bengal. Cretaceous sediments in the Cauvery basin are divided into three sub-basins: the Puducherry sub-basin in the north, the Vriddhachalam sub-basin in the central part, and the Tiruchirappalli sub-basin in the south. Both the Tiruchirappalli and Puducherry sub-basins are known to be significant sources of cement-grade, chemical-grade, and marginal-grade limestones (Figure-1). The rocks exposed in these sub-basins range in age from Cretaceous to Paleocene. The Tiruchirappalli sub-basin is further categorized into three groups: the Uttatur Group, which is the oldest, followed by the Tiruchirappalli Group and the Ariyalur Group.

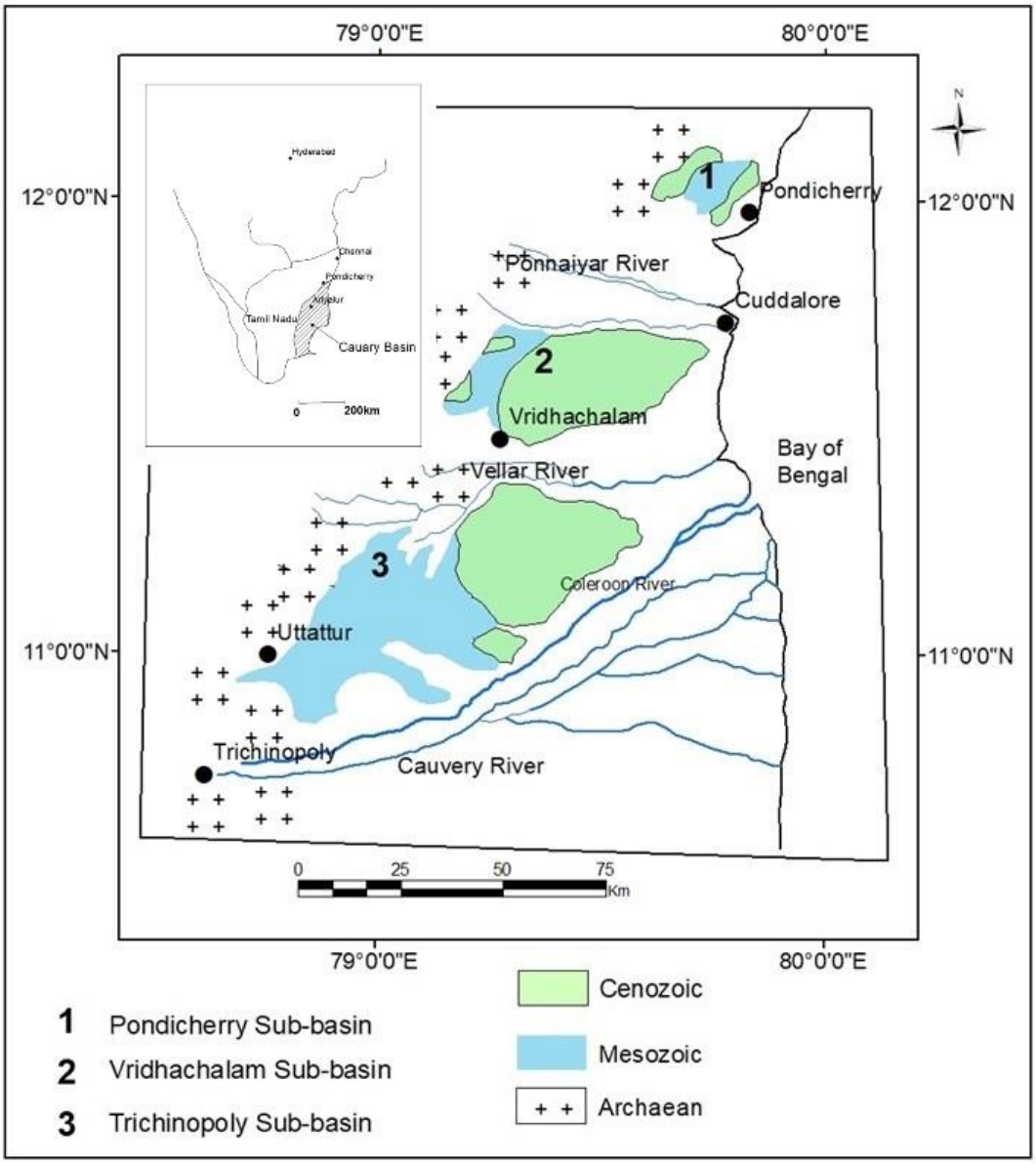



**Figure 1: Location map of the Cauvery Basin**

Blanford (1862) divided the Cretaceous Formations of Tiruchirappalli district into three distinct groups, viz. Uttattur, Trichinopoly and Ariyalur groups. He divided the Ariyalur Group into three subdivisions. (i) lower fossiliferous beds, (ii) middle fossiliferous beds and (iii) upper fossiliferous beds. Leveilee (1889), while reviewing the geology of the area, proposed to include the upper fossiliferous Ariyalur beds of Blanford into Niniyur stage, corresponding to Danian on the occurrence of Hercoglossadanica, a characteristic Danian form. The upper fossiliferous beds (of Ariyalur Group of Blanford) have been recognised as 'Niniyur Group' on the basis of lithological and palaeontological (find of rich algal flora) considerations by Rama Rao (1956). Sastry et al., (1972) brought out litho-biostratigraphic classification of Ariyalur

Group for the first time. They divided the group into four Formations: Sillakkudi, Kallankuruchchi, Ottakkovil and Kallamedu Formations in the ascending order.

Uttatur Group of rocks occur over the Gondwana Group of rocks is consisting of two Formations namely Maruvattur and Karai Formations. The Maruvattur Formation consists of coralline limestone, bedded limestone, marl, clay, sandstone and grey shale, while the Karai Formation consists of shale and concretionary shale. The Uttatur Group of rocks is deposited during marine transgression in oscillating basin.

The Uttatur Group is followed by the Trichinopoly Group of sediments. It unconformably overlies Karai shale in Kulakalnattam, Kunnam, Mungilpadi, Karambiyam - Garudamangalam, Anaipadi and Kottur-Pilimisai and is enriched in ammonites, gastropods, brachiopods and fossil wood fragments. The lower Kulakkanattam Formation consists of calcareous sandstone and thin bands of shell limestone. The Upper Anaipadi Formation comprises lower shale dominant and upper sandstone dominant members.

Ariyalur Group unconformably rests over Trichonopoly Group and is divisible into four Formations, viz. Sillakkudi, Kallankuruchchi, Kallamedu and Niniyur Formations in ascending order. Sillakkudi Formation is chiefly composed of argillaceous sandstone with bands and lenses of hard calcareous sandstone. The Formation is unconformably overlain by Kallankuruchchi Formation.

Kallankurichchi Formation is traced from Kulumur in the north to Vellipirangiyam in the south for a distance of 28 km with a width ranging from 200 metres to 3 km. To the north, it is covered by the alluvium of the Vellar River and in the south by the alluvium of the Marudaiyur. It is reported to occur as outcrops at Esanai and also south of the Coleroon River in Tanjavur District. The country occupied by Kallankurichchi Formation is a relatively elevated undulating plain for fossils of gryphea, Pyenodonite Inoceramus, bryozoon debris etc. scattered on the surface. This Formation starts with 1 to 3 metre thick conglomerate at the base, Rounded cobbles and pebbles of gneiss, ferruginous quartzite, quartzite, grey and pink felspar, yellowish and argillaceous limestone are encased in a calcareous and gritty matrix. Conglomerate grades upward into conglomeratic limestone and fossiliferous limestone. The conglomerate is well exposed in a nala section about 3 km east of Ariyalur town on Ariyalur-Kallankurichchi road and also in the Kallar river section one km east of Konerirayapuram. The main rock types of this formation are fossiliferous limestone, calcarenite and calcareous sandstone. Limestone, in general, is massive, made up fully of fossils including grypheainocramus, electryonia, stygmatophygus, corals broyozooms, etc., with aragonite veins and minute grains of quartz and tiny mica flakes. Biotite believes in common in some intervals cross lamination and crude planar lamination are locally represented in some bech show normal grading Limestone is of 1) biohermal type-without any bedding formed by biomechanical accumulation with marly and ferruginous cement: 2) biostromal type showing

faint developed of bedding and 3) cream coloured hard fine grained fossiliferous limestone. Ferruginous contents in the limestone are variable. Towards the northern end, this limestone grades into calcarenite and calcareous sandstone/gritstone. The calcareous grit carries coarse angular grains of quartz and feldspar. It becomes extremely difficult to demarcate sharply this Formation from the overlying Kallamedu Formation. But towards south (i.e. south of Kulumur) the contact between the two formations is sharp. This formation is characterised by extensive development of 1 to3 meter thick Kankar, 'terra rosa' and laterite pisolites. This feature is conspicuously observed in Nallampettu-Nerinjikorai section along its strike direction. Limestone of this Formation is cement grade. It is being quarried just west of Periyanagalur by M/S Sastry, Dalmia cement (Bharat Ltd.), The Tamil Nadu Cement Corporation is setting up a cement plant based on this limestone 2 km east of Ariyalur town.

Kallankuruchchi Formation is conformably overlain by a sequence of arenaceous sediments known as Kallamedu Formation. Main rock types of the Kallamedu Formation are fine to coarse grained white, light green or light yellowish to yellowish brown micaceous and argillaceous sandstone with thin bands and lenses of hard calcareous sandstone and occasional clay intercalations. The hard thin bands of calcareous sandstone are more prominent in the lower beds and almost absent in the upper ones. The Formation is significant as it contains dinosaurian bone remains.

Kallamedu Formation is overlain by a sequence of fossiliferous marine sediments (upper fossiliferous beds of Ariyalur Group of Blanford). The contact zone between Kallamedu Formation and Niniyur Formation is concealed throughout except at a very few localities. Niniyur Formation is composed of thin bands of limestone, light greenish, whitish and light yellowish shale, soft marl, soft agrillaceous sandstone and occasional thin bands and lenses of chert. The bulk composition of the formations marl and shale though the thin bands of limestone are more prominent as they stand out as white ribbons on erosion. Individual bands vary in thickness from 15 cm to 30 cm.

Niniyur Formation is overlapped by Cuddalore Formation of Mio-Pliocene age consisting conglomerate, ferruginous sandstone, pinkish clay and laterite.

The detailed regional stratigraphic succession of these groups (Sundaram and Rao, 1979 and S. Nallappa Reddy and R. Nagendra, 2017) is given in Table-1.

## Table 1: Regional stratigraphy of the area

**(Modified after Sundaram and Rao, 1979 and S. Nallappa Reddy and R. Nagendra, 2017)**

| FORMATION | LITHOLOGY |
|---|---|
| Alluvium | Sand, Silt and Clay |
| Cuddalore | Mottled Sandstone and Clay |

| GROUP | Ariyalur Area (Tiruchirapalli sub-basin) | | Vridhachalam area (Vridhachalam sub-basin) | | Puducherry area (Puducherry sub-basin) | |
|---|---|---|---|---|---|---|
| | FORMATION | LITHOLOGY | FORMATION | LITHOLOGY | FORMATION | LITHOLOGY |
| ARIYALUR | Niniyur | Limestone, marl / calc shale | Aladi | Limestone | Manaveli | Fossiliferous clay / sandy clay and siltstone |
| | | Sandstone | | Clay / shale with limestone | Karasur | Fossiliferous limestone / sandy limestone with marl / calc shale |
| | Kallamedu | Sandstone with shale / clay | | Fossiliferous sandy limestone | Nesal | Fossiliferous shale / clay argillaceous sandstone with shell limestone / calcareous sandstone |
| | | | | Calcareous sandstone | | |
| | | | | sandstone | | |
| | Kallan-kurichchi | Fossiliferous limestone with conglomerate at base | Mattur | Argillaceous sandstone | | |
| | | | | Fossiliferous calcareous sandstone / sandy limestone | | |
| | Sillakkudi | Sandstone with shale, gritstone and conglomerate | Patti | Clay / shale with limestone | Vanur | Argillaceous sandstone with sandy limestone |
| | | | | Fossiliferous limestone with calcareous shale | | Argillaceous and micaceous sandstone |
| | | Limestone and calcareous sandstone | Parur | Conglomerate / pebbly and cobbly sandstone with shale | | |
| TRICHINOPO | Anaipadi | Sandstone / gritstone with limestone | Not exposed | | Not exposed | |
| | | Shale / siltstone with limestone | | | | |
| | Kulakkal-nattam | Shell limestone (Coquinite), pebbly hard calc. Sandstone band | | | | |
| | | Gypseous clay / shale | | | | |

| | | | | |
|---|---|---|---|---|
| **L Y** | | Pebbly and cobbly sandstone / conglomerate | | |
| | | Gypceous clay sandy clay, sandstone, limestone | | |
| **U T T A T U R** | Karai | Conglomerate | Not exposed | Not exposed |
| | | Gypseous clay / shale | | |
| | | Conglomerate | | |
| | | Gypseous clay / shale mud with marlstone | | |
| | Maruvattur | Clay / shale with limestone | | |
| | | Limestone with marl / clay | | |
| Upper Gondwana | Terani | Gritty ferruginous sandstone Claystone with sandstone intercalation | Not exposed | Not exposed |
| Kovandankurichchi Formation | | Boulder conglomerate | | |
| Archaean Crystallines | | Gneisses/charnockite and granulites | | |

## 7. Block Geology

Previous work by various agencies has reported several lithologies, including limestone, in the block (Plate-III). The limestone is typically yellowish in color but can range from dirty white to brown, and is noted for its abundance of fossils, including pelecypods and gastropods, with comparatively fewer corals. It is hard and compact, featuring dissolution cavities and often associated with thin bands of marl. The limestone matrix is calcareous, and the presence of a rich assemblage of Gryphea, Alectrionia, Inoceramus, and broken shell fragments makes it suitable for the cement industry. Marl, a calcareous clay, is commonly intercalated within the limestone, with marl bands varying in thickness from millimeters to a few centimeters. Marly limestone tends to be poorly consolidated, resulting in a softer texture. The tentative stratigraphic sequence of litho units exposed in the block area, based on GSI data, is provided in Table-2.

**Table 2: Tentative stratigraphic succession of the proposed block**

| Group | | Formation | Lithology |
|---|---|---|---|
| | | | Alluvium |
| Ariyalur Group | Maestrichtian | Kallamedu Formation | Sandstone |
| | | Kallankurichi Formation | Kankar<br>Limestone (fossiliferous) with marl intercalation<br>Sandy limestone and calcareous sandstone<br>Conglomerate |
| | Campanian | Sillakudi Formation | Sandstone /calcareous sandstone |

## 8. Previous works

The detailed investigation for limestone in the east of Ariyalur town (erstwhile Trichy district) was taken up by the Department of Geology and Mining in 1975 on behalf of the Tamil Nadu Cements Corporation with a view to locating suitable grade of limestone in the area for the setting up of a cement plant of 1,500 tonnes per day capacity. The Department of Geology and Mining carried out the prospecting operations in different places at different phases (Phase I to Phase V) and assessed the limestone reserves quantitatively and qualitatively in the Kallankurichchi Formation of the Ariyalur Group.

During the first phase of investigation (1975-76), an area of about 411 hectare was covered and estimated 24 million tonnes of cement grade limestone on the basis of 23 drill holes and 54 wagon drill holes.

The phase II investigation (1976-77) was carried out in an area bounded by Kallar River in the north and Periyanagularodai near its junction with the Kil Palavur-Jayamkondam road, near Nerinjikorai. The length of the limestone belt is about 7.0 km and its width ranges from 300 to 500 meters on an average, while at places it may be as wide as 1km (Near the Periyanagalur mines of Dalmia). The investigation involved drilling 22 bore holes at an approximate interval of 600m and 62 wagon drill holes at an inter grid distance of 200m. The drill holes ranged in depth from 13.95 to 50.65m while for the wagon drill the depth ranged from 5 to 13.50m. A total reserve of 78 million tonnes of cement grade and high grade limestone was estimated over an area of 365 hectares (up to a depth of 40m). The Phase III investigation was carried out in the area falling in south of the area investigated under Phase II.

The Department of Geology and Mining, Tamil Nadu carried out Phase IV investigation and reassessed the high iron limestone deposits in the areas reserved for TANCEM in Valajanagaram area and demarcated the high and low iron limestone horizons for planning the mining operations.

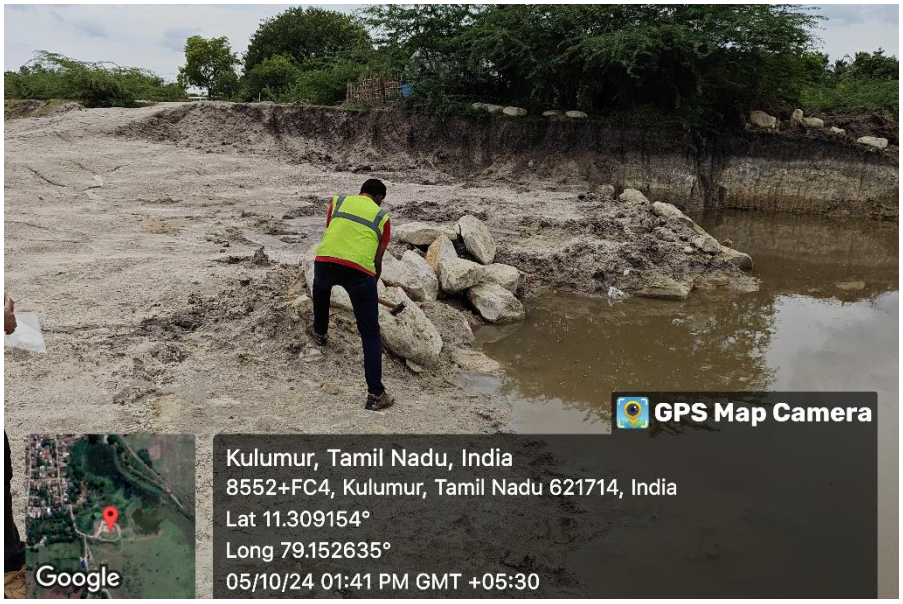
The Phase-V (1988) investigation was carried out by the Department of Geology by drilling in the free hold area in Puduppalayam and Reddipalayam villages (Bhaskaran, 1994). The area prospected covered part of both Department of Geology of Mining and TANCEM. A total of 21 vertical boreholes were drilled for a total depth of 701.40m. Limestone reserves of 23.75 million tonnes were estimated in the area covered under prospecting Phase V.

The Tamil Nadu State Department of Geology, MECL, KIOCL, and GSI conducted extensive geological exploration in the vicinity of our proposed block to assess mineral resources and evaluate geological potential.

| BLOCK | Exploration Agency |
|---|---|
| Phase I to Phase V inKallankurichchi Formation of the Ariyalur Group. | State DGM on behalf of Tamil Nadu Cement Corporation |
| Adanakurichi Limestone Block | MECL – G2 Stage - 15.1NE |
| Alathiyur Limestone Block | MECL – G2 Stage -16.1NE |
| Anandawadi Limestone Block | MECL – G2 Stage - 7.5SE |
| Unjini-Anandwadi Limestone Block | MECL – G2 Stage - 7SE |
| Periyathirukonam Limestone Block | GSI – G2 Stage -19.7S |
| A-03 Reddipalayam Limestone Block | KIOCL - G2 -16.7S |
| A-06 Reddipalayam (Sub Blocks A, B) Limestone Block | KIOCL - G2 - 16.8S |
| Uchimedu Limestone Block | GSI – G3 Stage - 22.5NE |
| Sendurai – Maravathur Limestone Block | MECL – G3 Stasge - 7E |
| Unjini-Anandwadi Limestone Block | MECL – G2 Stage - 7.4SE |

## 9. Site Visit

As per the TCC's directive, Geo Exploration and Mining Solutions conducted a field visit, collecting bedrock and auger samples. These samples were analyzed in a NABL-accredited laboratory, yielding an average grade of 43.11 % CaO. This result highlights the limestone's high calcium oxide content.




GPS Map Camera
Nallanayagapuram, Tamil Nadu, India
75P3+CGV, Nallanayagapuram, Tamil Nadu 621718, India
Lat 11.284836°
Long 79.152971°
05/10/24 12:37 PM GMT +05:30
Google


GPS Map Camera
Ariyalur, Tamil Nadu, India
Perumpandi Village , Sendurai Taluk , Ariyalur-621714, Tamil Nadu 621718, India
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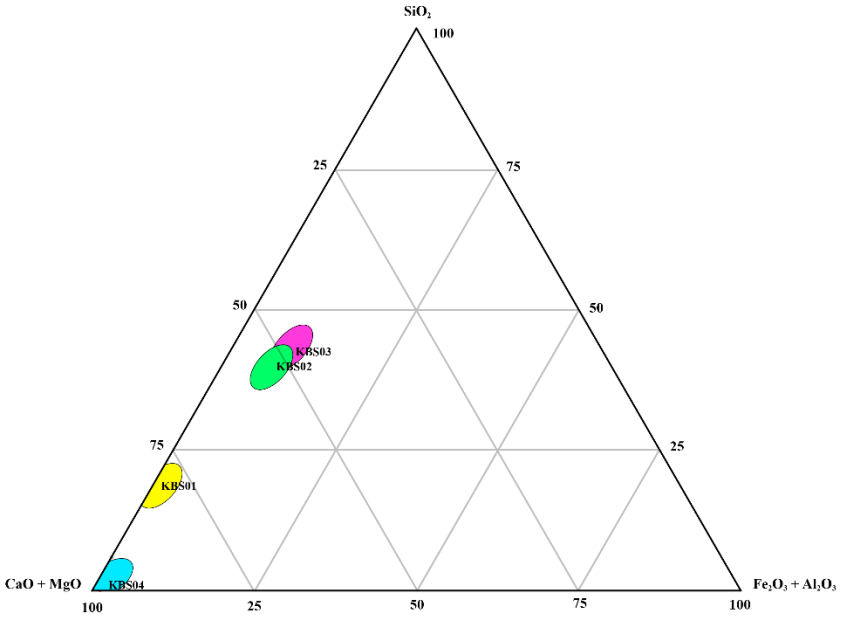
Google


GPS Map Camera
Kulumur, Tamil Nadu, India
8552+FC4, Kulumur, Tamil Nadu 621714, India
Lat 11.309154°
Long 79.152635°
05/10/24 01:41 PM GMT +05:30
Google

| SAMPLE NUMBER | Sample Description | Sample Description | Sample Code | LATTITUDE | LONGITUDE | LOI | SiO2 | CaO | MgO | Al2O3 | Fe2O3 | Total | CaCO3 | MgCO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | KBS01 | Limestone -7 | 5007 | 11°17'10.13"N | 79° 9'8.43"E | 39.6 | 10.16 | 47.4 | 1.45 | 0.38 | 0.55 | 99.49 | 85.18 | 3.03 |
| 7 | KBS02 | Limestone -8 | 5008 | 11°17'41.32"N | 79° 9'0.17"E | 34.5 | 22.06 | 37.1 | 2.22 | 1.53 | 2.15 | 99.6 | 66.72 | 4.63 |
| 8 | KBS03 | Limestone -9 | 5009 | 11°18'2.86"N | 79° 8'55.29"E | 34.5 | 25.61 | 33.6 | 1.49 | 1.92 | 2.43 | 99.56 | 60.48 | 3.12 |
| 9 | KBS04 | Limestone -10 | 5010 | 11°18'32.15"N | 79° 9'9.02"E | 43.5 | 0.44 | 54.3 | 0.48 | 0.19 | 0.29 | 99.26 | 97.69 | 1.01 |
| | | | | | **Minimum** | 34.5 | 0.44 | 33.6 | 0.48 | 0.19 | 0.29 | 99.26 | 60.48 | 1.01 |
| | | | | | **Maximum** | 43.5 | 25.61 | 54.3 | 2.22 | 1.92 | 2.43 | 99.6 | 97.69 | 4.63 |
| | | | | | **Average** | 38.04 | 14.57 | 43.11 | 1.41 | 1.01 | 1.36 | 99.48 | 77.52 | 2.95 |




The analytical data was subsequently plotted on a trilinear diagram, which serves as a valuable tool for classifying and interpreting geochemical compositions. Upon careful examination of the plotted diagram, it becomes evident that all the collected samples distinctly fall within the cement-grade limestone category.

## 10. Block description

The proposed G-3 block for Limestone falls in Survey of India Toposheet No. 58M/03 and encompasses an area of 7.64 Square Kilometers around villages of Kulumur, Thungapuram(N), Thungapuram(S), Vanjinapuram, Namanganam, Killiyapatti, Nallanayagapuram and Perumandi in Ariyalur districts, Tamil Nadu. The block location is given in PLATE-I and II. The Co-ordinates of the corner points of the block area are given in Table-3.

**Table 3: Block co-ordinates of the proposed block**

| Corner Point | Latitude (DMS) | Longitude (DMS) |
|---|---|---|
| A | 11°16’58.71’’’N | 79°7’45.68’’E |
| B | 11°18’19.13’’N | 79°8’37.03’’E |
| C | 11°18’16.84’’N | 79°8’42.04’’E |
| D | 11°18’37.77’’N | 79°8’53.20’’E |
| E | 11°18’10.21’’N | 79°9’50.70’’E |
| F | 11°16’28.16’’N | 79°8’52.03’’E |

## 11. Planned Methodology

The current exploration plan for the proposed Kulumur block involves geological mapping, topographical surveys, and exploratory drilling (at G-3 level) with an overall grid interval of 800 meters. The planned activities are detailed as follows.

**DGPS of Boundary Corner Pillars Survey, Topographical Surveying & Geological Mapping**

The block boundary and borehole locations will be surveyed using DGPS with WGS-84 datum to delineate the 7.64 sq km area. Fourteen boreholes will be established, and their relative levels (RLs) and coordinates will be recorded. Topographical surveying will be conducted at a scale of 1:4000 with 1-meter contour intervals using a Total Station. Detailed geological mapping will be performed at a 1:4000 scale to outline the limestone and associated lithologies, facilitating the planning of G-3 level exploration. All geological features will be documented, and litho-contacts will be plotted to finalize the geological map. This map will serve as the base map for subsequent work.

**Geo-physical survey (Resistivity survey)** – In order to establish the extent and thickness of the soil over the bed rock 10 line Km resistivity survey is proposed. The resistivity profiling will be carried out within the DM block

**Surface Drilling**

The present exploration scheme is prepared by proposing total core drilling of 1990.00m in 14 boreholes of NQ size. The borehole location map is enclosed as PLATE -IV and the details of proposed boreholes at G-3 level are listed below in Table-4.

**Table 4: Details of Proposed Boreholes in proposed G-3 Block**

| S. No. | Section No. | Borehole No. | Inclination (°) | Total depth (m) |
|---|---|---|---|---|
| 1 | T1-T1’ | BH-1 | 90 (Vertical) | ~60 |
| 2 | T1-T1’ | BH-2 | 90 (Vertical) | ~150 |
| 3 | T1-T1’ | BH-3 | 90 (Vertical) | ~200 |
| 4 | T2-T2’ | BH-4 | 90 (Vertical) | ~60 |
| 5 | T2-T2’ | BH-5 | 90 (Vertical) | ~150 |

| | | | | |
|---|---|---|---|---|
| 6 | T2-T2′ | BH-6 | 90 (Vertical) | ~200 |
| 7 | T3-T3′ | BH-7 | 90 (Vertical) | ~60 |
| 8 | T3-T3′ | BH-8 | 90 (Vertical) | ~150 |
| 9 | T3-T3′ | BH-9 | 90 (Vertical) | ~200 |
| 10 | T4-T4′ | BH-10 | 90 (Vertical) | ~60 |
| 11 | T4-T4′ | BH-11 | 90 (Vertical) | ~150 |
| 12 | T4-T4′ | BH-12 | 90 (Vertical) | ~200 |
| 13 | T5-T5′ | BH-13 | 90 (Vertical) | ~150 |
| 14 | T5-T5′ | BH-14 | 90 (Vertical) | ~200 |
| **Total proposed drilling** | | | | **1990** |
| Note: BH depth is tentative and this estimation is calculated on the basis of regional strike and dip of the body. BH will be closed after intersection of lower contact of fossiliferous limestone. | | | | |

**Drill Core Logging and Sampling**

Detailed drill core logging will be conducted, taking into account factors such as weathering, grain size, fossil content, color of various formations, intercalation or parting of marl, and structural features. Based on these parameters, the limestone grade can be broadly assessed, which will also aid in sampling. Primary samples will be collected at 1meter intervals, with adjustments made according to changes in lithology and core recovery. For sample preparation, the borehole core will be longitudinally split into two equal halves using a core splitter. One half will be powdered to a -120 mesh size, while the other half will be preserved for future studies. The powdered material will be thoroughly mixed, and about 100 to 250 grams of sample will be taken for chemical analysis through successive coning and quartering as primary samples. The remaining material (at -120 mesh size) will be retained as a duplicate for future reference.

Total number of primary samples likely to be generated would be 1380 nos. for Limestone. Internal check samples (5% of primary samples) would be 70 samples and External check samples (10% of primary samples) would be 138 samples. External check samples 10% of primary samples i.e. 65 Nos. will be sent to NABL accredited Labs for analysis of CaO, MgO, $Al_2O_3$, $SiO_2$, $Fe_2O_3$, $SO_3$, $P_2O_5$ and LOI.

**Laboratory studies**

**Chemical analysis for limestone**

Primary BH samples for Limestone (1380 Nos.) will be analyzed for 8 radicals, CaO, MgO, $Al_2O_3$, $SiO_2$, $Fe_2O_3$, $SO_3$, $P_2O_5$ and LOI by XRF method. 5% of primary samples (70 nos.) will be analyzed as internal check for 8 radicals CaO, MgO, $Al_2O_3$, $SiO_2$, $Fe_2O_3$, $SO_3$, $P_2O_5$ and LOI. 10% of primary samples (138 Nos.) will be sent to NABL external labs as external check samples for analysis of 8 radicals CaO, MgO, $Al_2O_3$, $SiO_2$, $Fe_2O_3$, $SO_3$, $P_2O_5$ and LOI.

**Petrological studies**

Petrological studies will be done on 10 nos. of drill core and surface specimen.

**Identification of Mineral Composition:** Limestone primarily consists of calcium carbonate minerals like calcite and aragonite, but it may also contain other minerals like dolomite, quartz, clay minerals, and organic material. Petrographic analysis helps in identifying these components, which is crucial for understanding the rock's properties and behavior.

**Classification and Typing:** Limestone can vary significantly based on their origin, whether they are biochemical, chemical, or detrital. Petrographic studies help in classifying the limestone, which can be important for its industrial use (e.g., in cement production) or in geological research.

**Quality Control for Industrial Use:** In industries like cement manufacturing, steel production, and construction, the quality of limestone is critical. Petrographic studies help in assessing the purity, homogeneity, and potential impurities in the limestone, ensuring that it meets the required standards.

**Exploration and Resource Evaluation:** In the context of mining or quarrying, petrographic studies are used to evaluate the quality and extent of limestone deposits, guiding exploration efforts and helping in the assessment of the economic viability of the resource.

Petrological studies will be done on 20 nos. of core sample and surface specimen.

**Specific Gravity /Bulk density Determination**

Specific Gravity will be determined on 10 nos. drill core specimen.

**Mineral Identification and Characterization:** Different minerals have characteristic specific gravities. By measuring the specific gravity of rock samples, geologists can infer the mineral composition, which helps in identifying economically valuable minerals and understanding the overall rock makeup.

**Ore Grade Estimation:** Specific gravity is crucial for determining the density of ore, which is necessary for estimating the ore grade and the volume of the deposit. This information is vital for assessing the economic viability of a mineral deposit.

**Resource Estimation:** Accurate resource estimation requires knowledge of the specific gravity of the material being explored. The specific gravity helps convert volume measurements obtained from drilling or sampling into weight, allowing for accurate calculation of the total amount of material available.

Specific Gravity will be determined on 20 nos. drill core specimen.

**The Quantum of Work Proposed**

**Table 5: The Quantum of work proposed**

| S. No. | Description and Nature of Work | Unit | Target |
|---|---|---|---|
| **A. Geological Work and Surveying** | | | |
| 1 | Geological Mapping (1:4000 scale) | sq km | 7.64 |
| **2. Survey work** | | | |
| i | Topographical Survey (1:4000 scale) | sq km | 7.64 |

| | | | |
|---|---|---|---|
| ii | Borehole fixation | Nos. | 14 |
| iii | RL and co-ordinate determination by DGPS | Nos. | 20 |
| **B. Pitting and Trenching** | | | |
| 1 | Pitting and Trenching | CuM | 150 |
| **C. Exploratory drilling** | | | |
| 1 | Drilling | m | 1990 |
| 2 | Drill core preservation | m | 1990 |
| **D. Laboratory studies** | | | |
| 1 | BEDROCK SAMPLES(CaO, MgO, Al2O3, SiO2, Fe2O3, SO3, P2O5 and LOI) by XRF | Nos | 50 |
| 2 | PITTING AND TRENCHING SAMPLE (CaO, MgO, Al2O3, SiO2, Fe2O3, SO3, P2O5 and LOI) by XRF | Nos. | 100 |
| 3 | Primary BH Samples (CaO, MgO, Al2O3, SiO2, Fe2O3, SO3, P2O5 and LOI) by XRF | Nos. | 1050 |
| 4 | BH Check Samples Internal 5% (CaO, MgO, Al2O3, SiO2, Fe2O3, SO3, P2O5 and LOI) by XRF | Nos. | 53 |
| 5 | BH Check Samples Internal 5% (CaO, MgO, Al2O3, SiO2, Fe2O3, SO3, P2O5 and LOI) by XRF | Nos. | 53 |
| **E. Petrological samples (Surface & BH Core Samples)** | | | |
| I | Preparation of thin section | Nos. | 10 |
| ii | Study of Thin Section | Nos. | 10 |
| **F. Specific Gravity Determination** | | | |
| i | Specific Gravity Determination | Nos. | 10 |
| **G. Report Preparation** | | | |
| **1** | **Report Preparation (5 Hard copies with a soft copy)** | Nos. | 5 |
| **E** | **Geophysical Survey (Resistivity)** | L. Km | 10 |

**PROPOSAL FOR LIMESTONE IN KULUMUR BLOCK (7.64 SQ KM), ARIYALUR AND PERAMBALUR DISTRICTS, TAMIL NADU FOR PRELIMINARY EXPLORATION (G3 STAGE) UNDER NMET COMMODITY: FOSSILIFEROUS LIMESTONE**

| S. No | Nature of work | unit | Rate as per NMET SoC March 2020 | | Estimated Cost of the Proposal | | Remarks |
|---|---|---|---|---|---|---|---|
| | | | SoC- Item-S. No. | Rates as per SoC | Qty | Total Amount (Rs) | |
| 1.1 | Headquarters geologist (PGRS, Map generation, statistical & geological interpretation and report work) | 1 no | 1.2 | 9000/- | 120 Man days | 10,80,000 | |
| 1.2 | Field Geologist (Geological Mapping, sampling, pit & trench logging, core logging, sampling, sample processing) | 2 nos | 1.2 | 11,000/- | 240 Man days | 26,40,000 | |
| 1.3 | Field Geophysicist (Resistivity Survey Field Collection) | 1no. | 3.18 | 11,000/- | 20 days | 2,20,000 | |
| 1.4 | Headquarters geophysicist (for processing and interpretation resistivity survey data collected from the field) | 1nos | 3.19 | 9,000/- | 10 man days | 90,000 | |
| 1.5 | Surveyor | 1nos | 1.6.1b | 8300/- | 60 days | 4,98,000 | |
| 1.6 | Casual labour ( field work including geological mapping, surveying, pitting & trenching) | 4nos | 5.7 | 534/- | 480 days | 2,56,320 | As per rates prescribed by Central Labour Commission rates or respective State Govt. whichever is higher. |
| 1.7 | Sampler (marking of cores, core splitting, crushing, powdering, cone & quartering, sample packing, labeling) | 2nos | 1.5.2 | 5100/- | 240 days | 12,24,000 | (Per day per sampler) Processing of 1000 CS, 30 BRS, 75 PTS and 15 PCS @ 3 samples per day per sampler (approx) |
| **Total (1)** | | | | | | **60,08,320** | |
| 2.1 | Core Drilling (sedimentary rock) | m | 2.2.1.4a | 5242/- | 1990m | 1,04,31,580 | |
| 2.2 | Land or crop compensation | Per borehole | 5.6 | 20000/- | 14nos | 2,80,000 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2.3 | Construction of concrete Pillar (12"x12"x30") | Per borehole | 2.2.7a | 2,000/- | 14nos | 28000 | |
| 2.4 | Rig mobilization charges (Transportation of Drill Rig & Truck associated per Drill) | Km | 2.2.8 | 36/- | 1400 km | 50400 | |
| 2.5 | Monthly Accommodation Charges for drilling Camp | Rig/month | 2.2.9 | 50,000/- | 6 | 3,00,000 | Period required for drilling 1990m @ 14 boreholes |
| 2.6 | Drilling Camp Setting Cost | nos | 2.2.9a | 2,50,000/- | 1 | 2,50,000 | |
| 2.7 | Drilling Camp Winding up Cost | nos | 2.2.9b | 2,50,000/- | 1 | 2,50,000 | |
| 2.8 | Approach Road Making | Km | 2.2.10.a | 22,020/- | 8 | 1,76,160 | |
| 2.9 | Bore Hole Fixation and determination of coordinates& Reduced Level of the boreholes and by DGPS | Nos | 1.6.2 | 19,200/- | 14nos | 2,68,800 | 14 boreholes + 1 base station |
| 2.1 | Drill Core Preservation (complete borehole plus mineralized cores of all the remaining Bhs) | m | 5.3 | 1,590/- | 1990 | 31,64,100 | Entire drill core including soil will be analysed. |
| 2.11 | Pitting & Trenching | Cu.m | 2.1.2 | 3,800/- | 150Cu.m | 5,70,000 | |
| **Total (2)** | | | | | | **1,57,69,040** | |
| 3 | Laboratory studies | | | | | | |
| 3.1 | Primary BH Samples (CaO, MgO, Al2O3, SiO2, Fe2O3, SO3, P2O5 and LOI) by XRF | Nos | 4.1.15a | 4,200/- | 1040 | 43,68,000 | Major oxide |
| 3.2 | BH Check Samples Internal 5% (CaO, MgO, Al2O3, SiO2, Fe2O3, SO3, P2O5 and LOI) by XRF | Nos | 4.1.15a | 4200/- | 90 | 3,78,000 | Major oxide 5% internal sample |
| 3.3 | BH Check Samples Internal 10% (CaO, MgO, Al2O3, SiO2, Fe2O3, SO3, P2O5 and LOI) by XRF | nos | 4.1.15a | 4200/- | 150 | 6,30,000 | Major oxide 10% internal sample |
| 3.4 | Bedrock Samples (CaO, MgO, $Al_2O_3$, $SiO_2$, $Fe_2O_3$, $SO_3$, $P_2O_5$ and LOI) by XRF | nos | 4.1.15a | 4200 | 50 | 2,10,000 | |
| 3.5 | Pitting and trenching samples(CaO, MgO, $Al_2O_3$, $SiO_2$, $Fe_2O_3$, $SO_3$, $P_2O_5$ and LOI) by XRF | nos | 4.1.15a | 4200 | 100 | 4,20,000 | |
| **Total (3)** | | | | | | **60,06,000** | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4 | Petrological studies | | | | | | |
| 4.1 | Preparation of thin section | Nos. | 4.3.1 | 2,353/- | 20 | 47,060 | |
| 4.2 | Petrological Study of thin section for optical properties | Nos. | 4.3.4 | 4,232/- | 20 | 84,640 | |
| 4.3 | Specific gravity | Nos. | 4.8.1 | 1605/- | 20 | 32,100 | |
| **Total (4)** | | | | | | **1,63,800** | |
| 5 | **Geophysical survey (resistivity survey)** | Per station | 3.5a | 70,650/- | 10 station | **7,06,500** | 10X1km = 10km |
| **Total (1+2+3+4+5)** | | | | | | **2,86,53,660** | |
| **6. Miscellaneous** | | | | | | | |
| 6.1 | Preparation of Exploration Proposal | Nos | 5.1 | 2% of project cost | 1 | 5,73,073.20 | 5 hard copies with 1 soft copy |
| 6.2 | Geological report preparation | Nos | 5.2 | A Minimum of Rs. 7.5 lakhs or 3% of work whichever is more | 1 | 8,59,609.80 | 5 hard copies with 1 soft copy Additional copy @Rs.3000/- per copy |
| 6.3 | Report Peer Review Charges | | | lumpsum | | 30,000 | |
| **Total (1+2+3+4+5+6)** | | | | | | **3,01,16,343** | |
| 7 | GST (18%) | | | | | **54,20,941.74** | |
| **GRAND TOTAL (1+2+3+4+5+6+7)** | | | | | | **3,55,37,284.74** | |

## 12. Time schedule

| Components | Months | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | 9th | 10th | 11th | 12th |
| Camp set up, Detailed geological Mapping on 1:4000 scale &geophysical survey | | | | | | | | | | | | |
| Subsurface drilling | | | | | | | | | | | | |
| Core sample (CS) | | | | | | | | | | | | |
| Chemical assay studies | | | | | | | | | | | | |
| Synthesis of all available data | | | | | | | | | | | | |

## 13. Reference

1. Blanford, H. F. (1862): On the cretaceous and other rocks of South Arcot and Trichinopoly districts, Madra; Mem. Geol. Survey of India, Vol. IV, pt. 1, Page 144-150.

2. Bhaskaran, S (1988): Report on the detailed prospecting for limestone in Pudupalaiayam and Reddipalayam villages, Ariyalur Taluk, Trichirappalli district, Tamil Nadu; Report of Department of Geology and Mining, Chennai.

3. Geology and mineral resources of Tamil Nadu and Puducherry, GSI, Miscellaneous publication No. 30 part-VI (Third revised edition), 2014.

4. General Exploration for Cement Grade Limestone in Puthuppalayam and Periyathirukonam Block, Ariyalur District, Tamil Nadu, GSI, FS 2018-19.

5. GSI, Bhukosh website (www.bhukosh.gsi.gov.in).

6. Leveille H (1889): Geologic de L'Inde Francaise. Bull. Soc. Geol. Fran., 3rd Series, v.18, pp.1-144.

9. Rama Rao (1956): Recent contribution to our knowledge of the Cretaceous rocks of South India. Proc. Ind. Acad. Sci. Sec B, v. 44(4), pp. 185-245.

10. Sastry M.V.A, Mamgani V.D. & Rao B.R.J. (1972): Paleontological India Mem. Geological Survey of India New series, Vol. XL.

11. S. Nallappa Reddy and R. Nagendra, 2017: Major geologic events of the Cauvery Basin, India and their correlation with global signatures-A Review Journal of Paleogeography, 69 (1), 69-83.

12. Sundaram, R. and Rao, P.S. (1979): Lithostratigraphy of Cretaceous and Palaeocene rocks of Tiruchirapalli district, Tamil Nadu, South India, Geol.Surv.Ind., Misc. Pub. 45, pp. 111-119.

13. Survey of India website (www.onlinemaps.surveyofindia.gov.in)

14. Reference Source: https://link.springer.com/chapter/10.1007/978-981-15-2806-4_51

For **GEO EXPLORATION AND MINING SOLUTIONS**

**Dr. M. IFTHIKHAR AHMED**

Managing Partner & Project Coordinator

**PLATE - I**

## Plate – I: Location and Accessibility of Ariyalur District Map

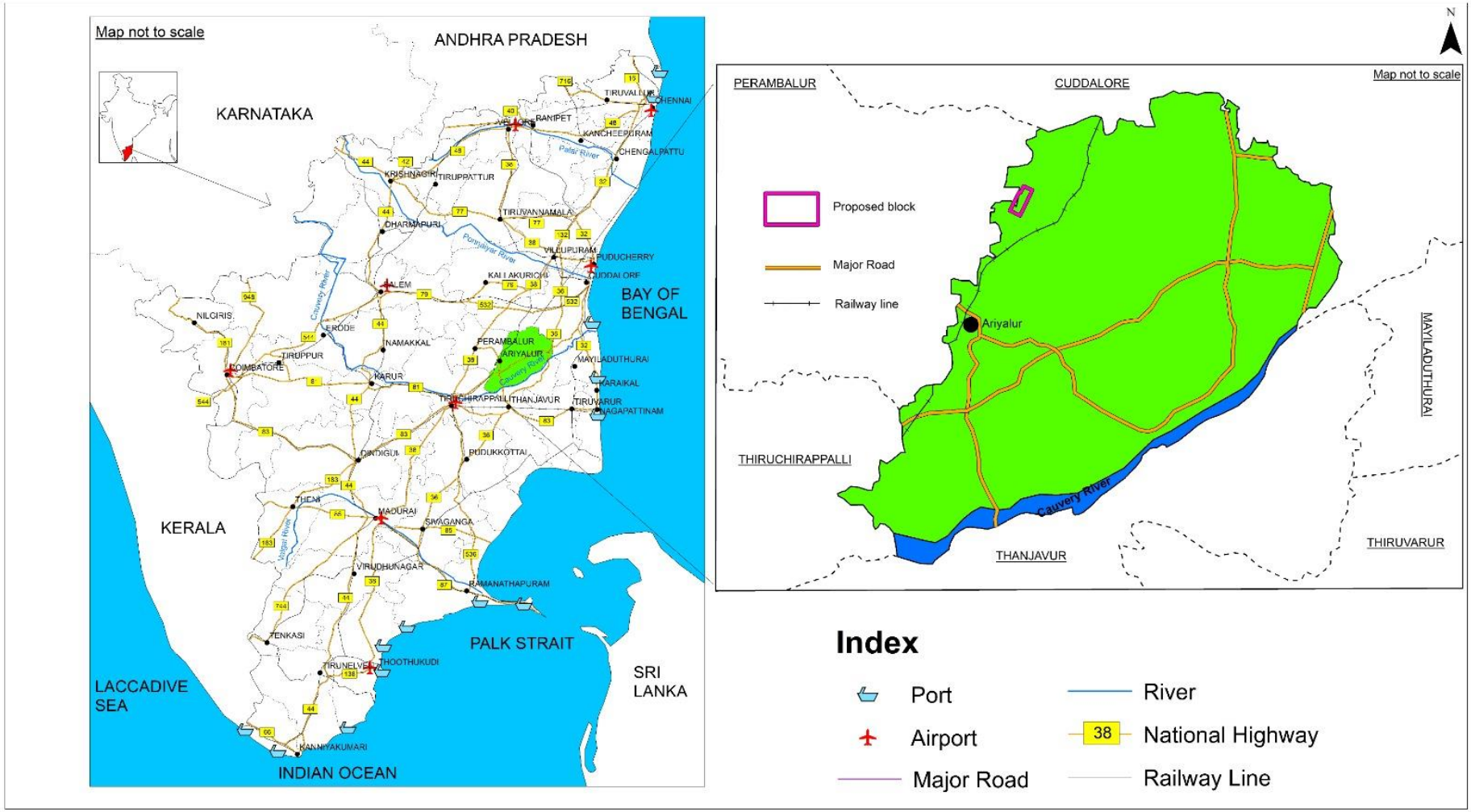


**PLATE-II**

## Location of the proposed KULUMUR block (G-4) in T. S. No, 58M/03

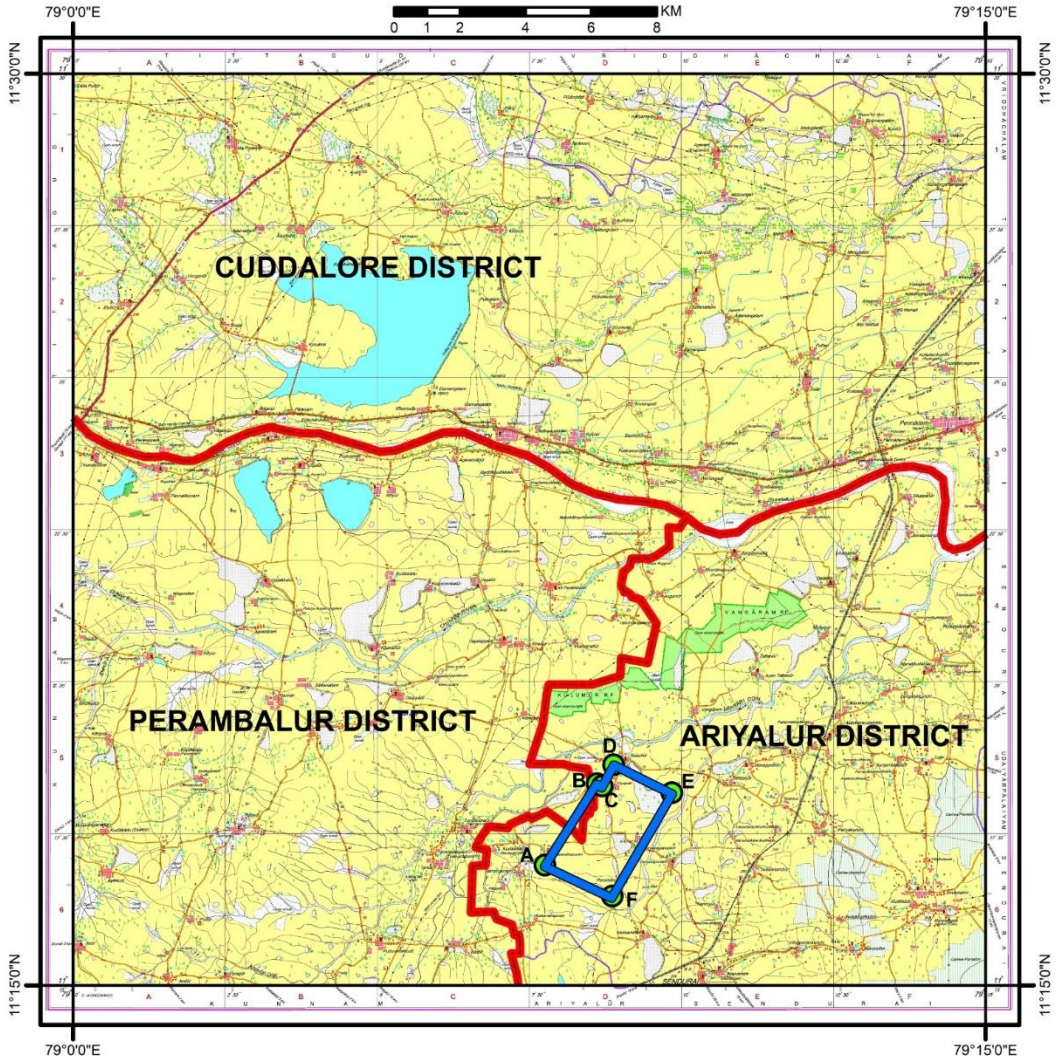
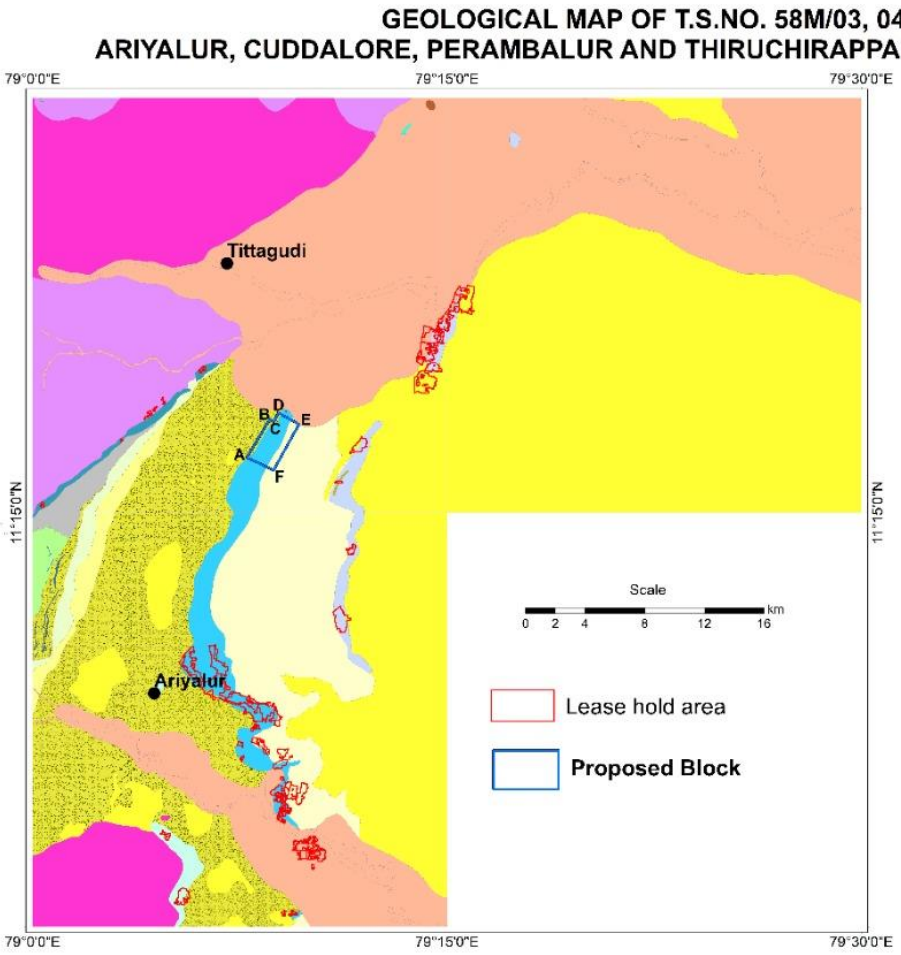


**PLATE-III**

## Geological Map T. S. No. 58M/03, Ariyalur and Perambalur Districts Tamil Nadu

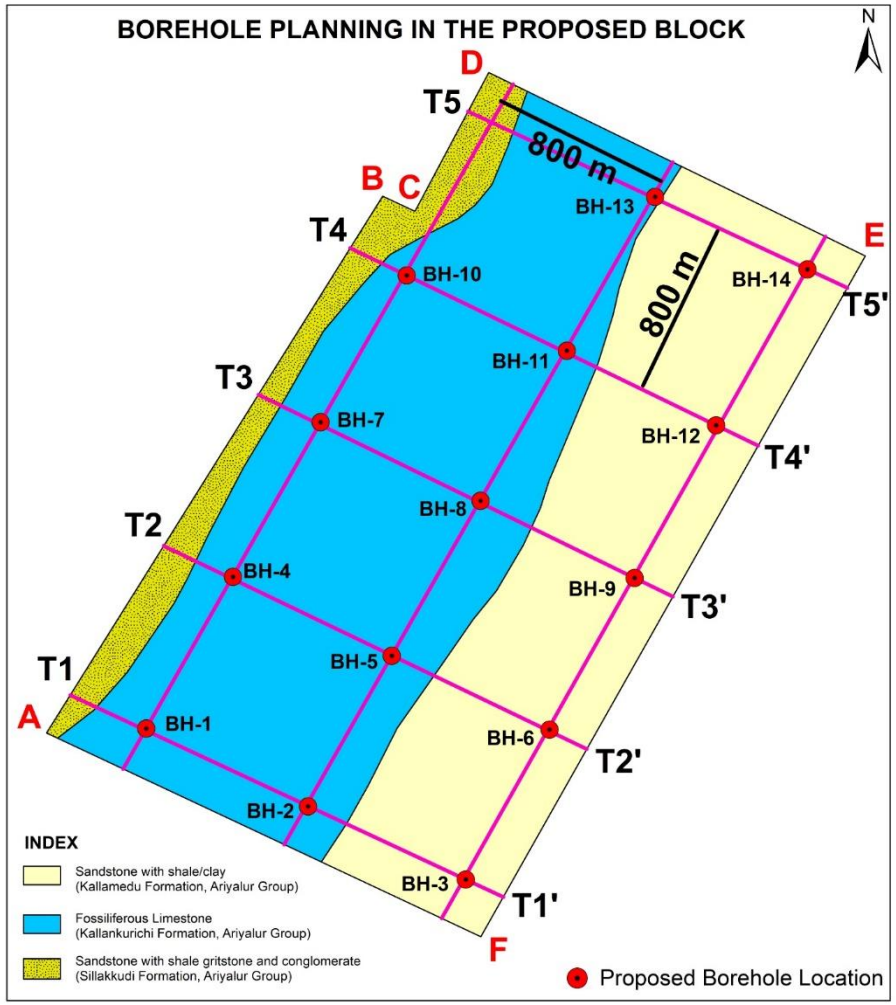



LEGEND

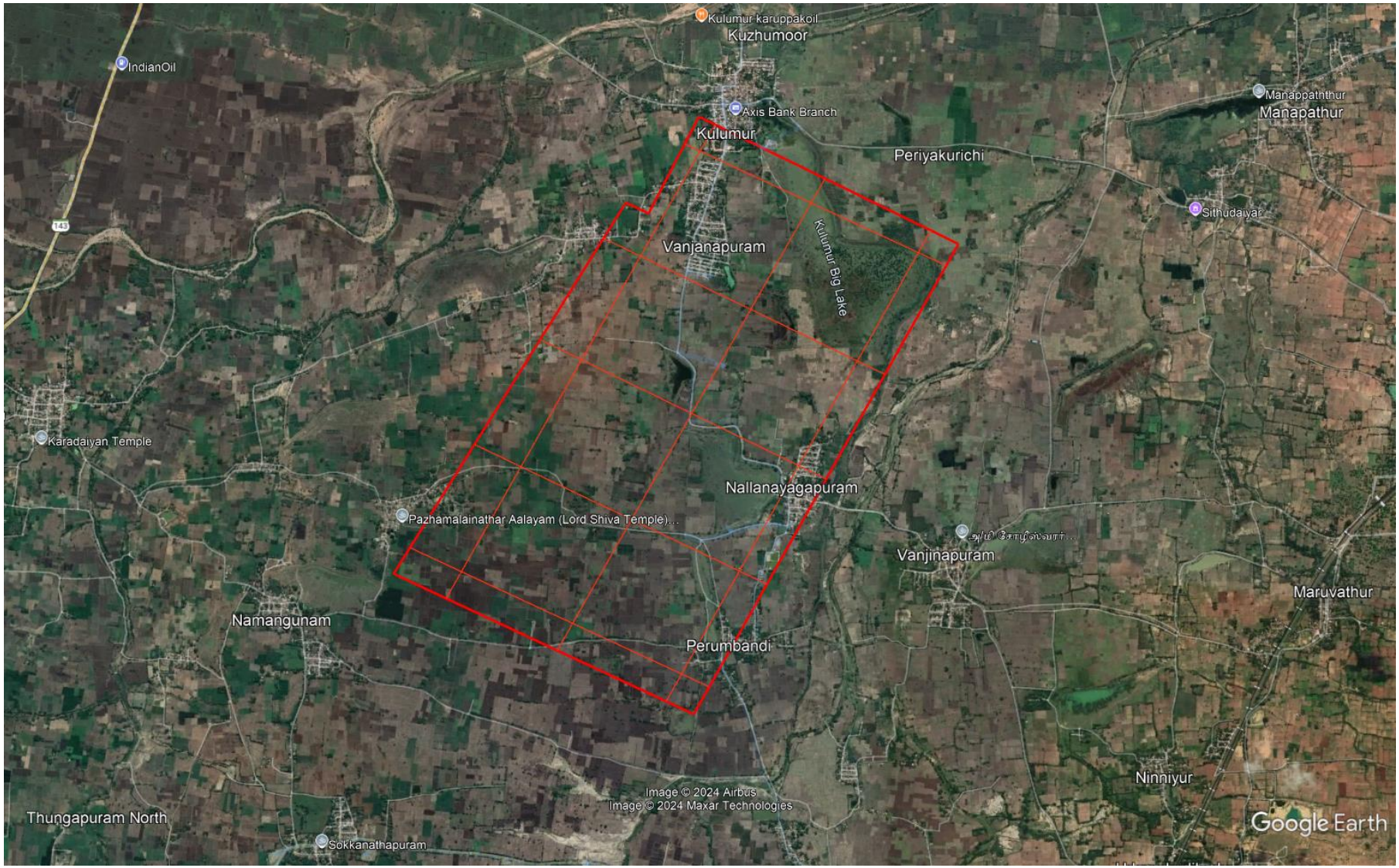
| Lithology | Formation | Group | SuperGroup | Age |
|---|---|---|---|---|
| Black clay/sand/silt | Cauvery-Kollidam/ Tiruchendur (Younger) | | | HOLOCENE |
| Mottled sandstone and clay | Cuddalore | | | MIO-PLIOCENE |
| Limestone with marl / calcareous shale<br>Sandstone | Niniyur | | | LOWER PALAEOCENE |
| Sandstone | Ariyalur | Vriddhachalam | | UPPER CRETACEOUS |
| Fossiliferous limestone with calcareous shale | Pariyur | | | |
| Sandstone with shale / clay | Kallamedu | | | |
| Fossiliferous Limestone | Kallankurichi | Ariyalur | | |
| Sandstone with shale grit stone and conglomerate<br>Limestone and calcareous sandstone | Sillakkudi | | | |
| Sandstone / gritstone with limestone | Anaipadi | | | |
| Shale / siltstone with limestone | | Trichinopoly | | |
| Shell limestone (Coquinite) with pebbly sandstone | Kulakkalnattam | | | |
| Clay / shale with limestone<br>Gypseous clay / shale | Karai | Uttatur | | |
| Limestone with marl / clay | Marovattur | | | LOWER CRETACEOUS |
| Hornblende biotite gneiss / composite gneiss | | Peninsular Gneissic Complex-II | Peninsular Gneissic Complex | ARCHAEAN-PALAEOPROTEROZOIC |
| Charnockite (Unclassified)<br>Pyroxene Granulite | | Charnockite | Southern Granulite Complex | ARCHAEAN |

**PLATE-IV**

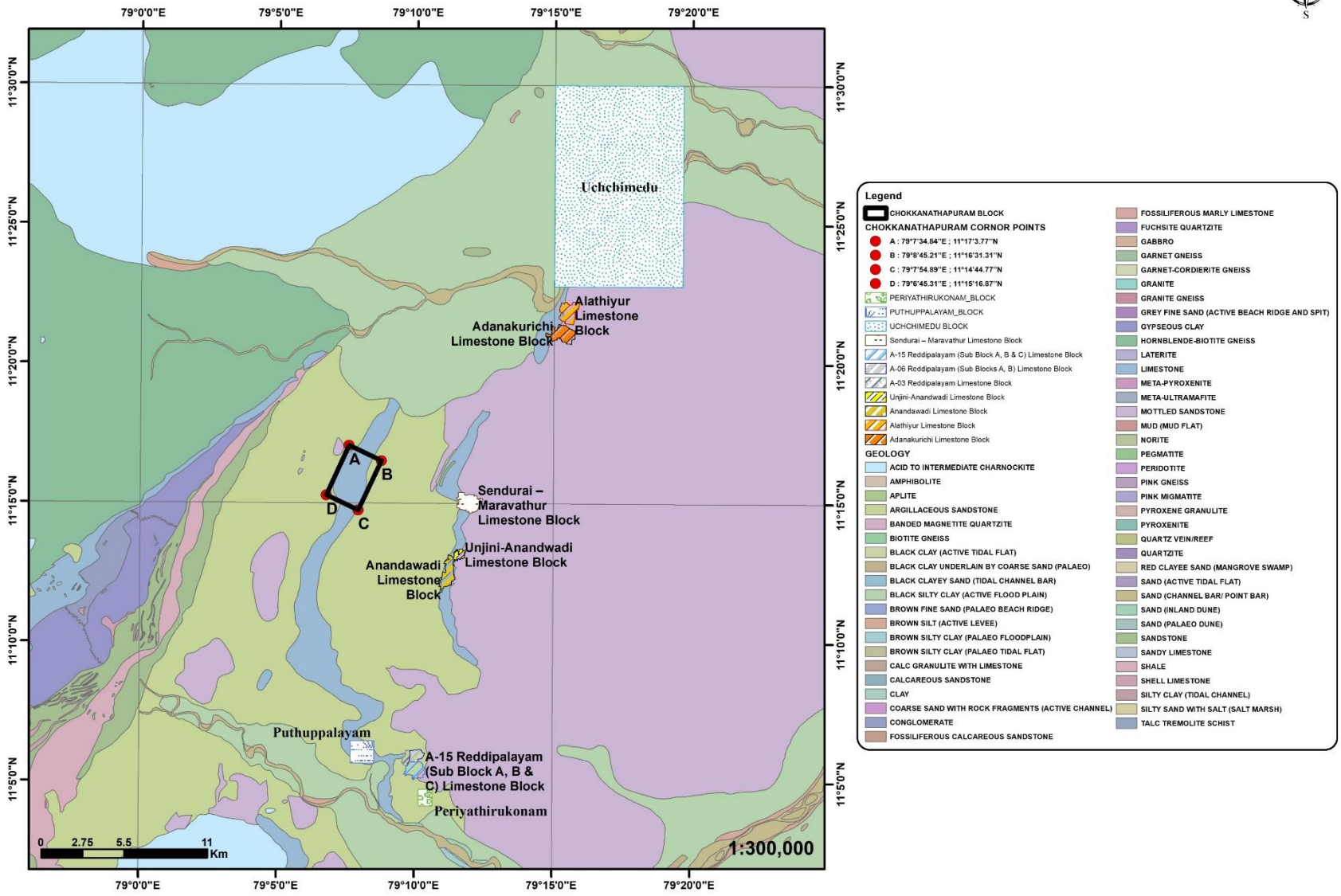
## Proposed Borehole location map



**Satellite Image with Drilling Grid**



# OTHER EXPLORATION BLOCKS AND THE PROPOSED CHOKKANATHAPURAM BLOCK
## (Source : NGDR and GSI)



# MINING LEASE AREA AND THE PROPOSED CHOKKANATHAPURAM BLOCK

(Source : NGDR and GSI)