ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

*(An ISO 3297: 2007 Certified Organization)*

**Vol. 3, Issue 8, August 2014**

# Mineral Resources of Telangana State, India: The Way Forward

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**ABSTRACT**: The paper presents a summary of mineral resources available in the newly formed Telangana state and associated aspects for socio-economic development of the State in time to come. The region was not given much attention in past decades for large scale exploration though it has rich mineral wealth and production is present is limited to coal, limestone, dolomites, quartz, feldspar and building stones. The hidden mineral wealth requires systematic investigations to obtain reliable data on uniform pattern for making policy and plans, through professional agencies in terms of terrain consideration, quantity and quality assessment of the mineral deposits; exploration techniques and its environmental impact assessment; policy and legal framework etc. The recent discovery of uranium is economically very promising which can be utilised for electric power generation. There is a substantial scope for other premier minerals like zinc, base metal sulphides, and platinoid group in the State. The coal deposits need to be further investigated for CBM and gasification. Investigations are vital to discover new deposits in Telangana with existing mineral occurrences as path finders, in light of modern technology. It is suggested to set up mineral based industries/plants, such as fertilizer, cement and calcium carbide, coking plants, refractory and abrasive units and cutting and polishing units for state's socio-economic growth.

**KEYWORDS**: Mineral Resources, Telangana, Sustainable development, Mining, Management.

## I. INTRODUCTION

Minerals are of great economic value and have occupied a characteristic place amongst all the economic resources. Minerals and mineral industries have significant macro links with the economy of a country. Mining activity generates employment opportunities; is obviously an important source of tax revenue and contributes to national income thereby leading to economic growth. In view of the significance minerals-hold in Telangana, the paper makes an attempt to list out all the mineral occurrences of the State and the way forward for socio-economic growth.

The newly separated Telangana state from the state of united Andhra Pradesh has a unique geological set up that can host a variety of mineral deposits of economic value. The state Telangana has an area of 112955 Sq.Km, bounded by N latitudes $15^{o}$ 46' and $19^{o}$ 47' and E longitudes $77^{o}16'$ and $81^{o}43'$ (Fig.1). Though several public organizations have discovered various mineral deposits, still there exists a huge scope for further detailed exploration in search of new mineral deposits in the state and involvement of private/multinational companies has been started just in the last decade. There is significant mineral potential that still lay untapped in Telangana for the growth of mining industry. Now that a separate State has been formed, a systematic regulatory and administrative procedures, infrastructure facilities leading to sustainable exploration and mining activity needs to be formulated. The challenges like lack of sufficient water storage systems, infrastructure etc. have limited the overall investment in mining and exploration activities in the state for the past few decades.

## II. LITERATURE SURVEY

Several organizations have extensively worked to identify mineral occurrences in this part of the country. Amongst all, work carried out by Geological Survey of India (GSI) is of pioneering importance in discovering a variety of mineral deposits. The first report published by GSI in 1975 describes all the minor and major mineral occurrences in the undivided Andhra Pradesh. This edition was modified and released in 2005 by GSI. These publicly available reports are used to extract information relevant to frame this article. Also reports published by academicians and other public organizations were gathered from open web sources.

DOI: 10.15680/IJIRSET.2014.0308052

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

*(An ISO 3297: 2007 Certified Organization)*

**Vol. 3, Issue 8, August 2014**

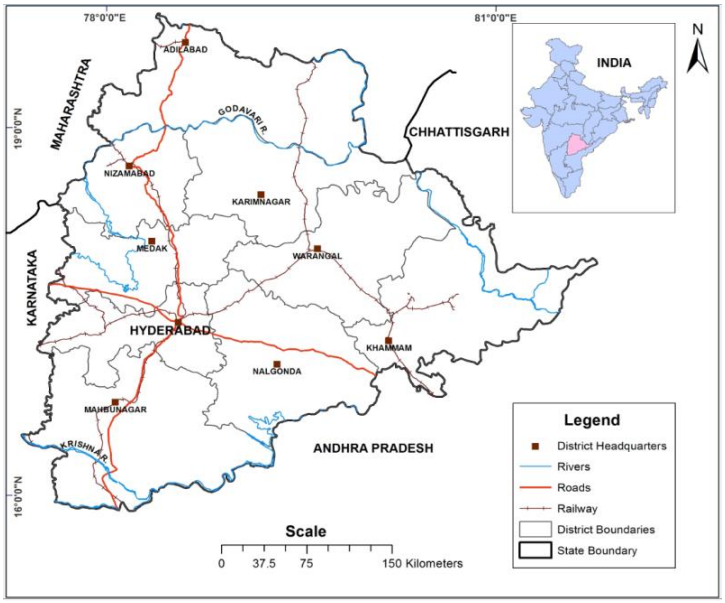


Figure 1. General geographic map of Telangana state

## III. REGIONAL GEOLOGY

Geologically the State, Telangana is endowed with various rock tyes belonging to Archean to Quaternary age. Major part of coal-bearing Pranhita-Godavari Gondwana sedimentary sequence is distributed in this state and the rest is occupied by igneous-metamorphic hard rock terrain. A generalized geological map with mineral occurrences is shown in Fig 2.

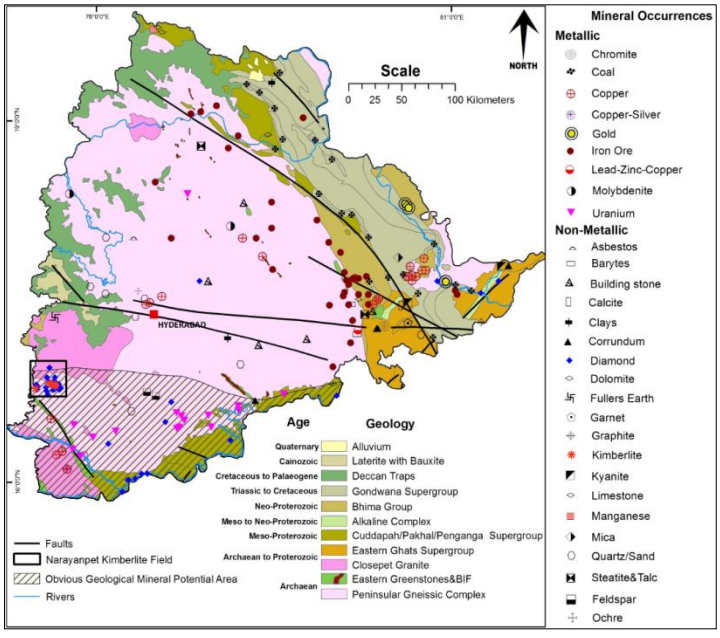


Fig. 2. Geological map showing mineral occurrences in Telangana state.

DOI: 10.15680/IJIRSET.2014.0308052

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## IV. MINERAL RESOURCES

The following sections deal with various metallic, non-metallic and radioactive mineral occurrences encountered in the State (GSI, 1975 and 2006).

**Metallic minerals**

**Chromite:** In the Khammam district the mineral occurs mostly as float ore. Though at places it is noticed *in situ* in the form of lenticular pockets in ultrabasic rocks like pyroxenite, serpentinite etc. In localities near Bhimavaram (16° 56′ 80° 31′), Gauraram (16° 47′ 78° 36′), Jannavaram (17° 20′ 80° 24′), and Imamnagar (17° 22′ 80° 28′) and Enkuru (17°18' 80°26'), a total of 2,500 tonnes of float and few hundred tonnes of *in situ* ore are estimated for these occurrences. This area deserves further exploration not only for chromite but for minerals of platinoid group.

**Copper: C**opper mineralisation is observed in the Mailaram area (17° 43′ 80° 37′) of Khammam district in Dharwar quartz-chlorite schist's, intruded by grey and blue quartz veins with Cu% between 1.5-1.7. Chalcopyrite occurs as disseminations and stringers associated with pyrite and pyrrhotite. As per GSI the zone of copper mineralisation extends for a strike length of 800 m with a reserve of 0.814 metric tonnes. At Venkatapuram (17° 46′ 80° 45′), chalcopyrite associated with pyrite and pyrrhotite is observed in minor veins of quartz traversing the Pakhal quartzites and dolomites and in the quartz-chlorite schists of the Dharwars holding a mineralised zone ranging in thickness from 1.5 to 5.30 m. for a strike length of 200 m. The Cu content ranges from 0.64 to 1.58 per cent. Indications of sparse Cu mineralisation are also noticed near Banjar (17° 48′ 80° 39′), Mainkawaram (17° 29′ 80° 20′), Rabingudem (17° 30′ 80° 23′), Sarkal (17° 43′ 80° 42′) and Yellambailu (17° 41′ 80° 40′). In current scenario of copper metal prices, this area deserves further exploration with advanced technology.

**Gold:** Alluvial gold is said to have been worked from near the confluence of Kinnerasani river with the Godavari in the Khammam district and also near Mangampet (18° 15′ 80° 30′) in the Warangal district. Of late, exploration activity by GSI is being carried out to test the gold potential in Atkur Block, Gadwal Schist Belt, Mahbubnagar district (GSI, 2011).

**Iron-ore:** Isolated patches of banded magnetite quartzites occur near Chityal (19° 04′ 78° 48′), Kallada (19° 08′ 78° 53′), Dasturabad (19° 05′ 78° 52′) and Robanpalli (18° 57′ 79° 01′), Lakshettipet (18° 53′ 79° 12′) and Utnoor (19° 22′ 78° 46′) in the Adilabad district mostly as NW-SE trending BIF bands. About 16 million tonnes of low grade ore are estimated here. In the Khammam district iron-ore deposits exist between Cheruvupuram, Bayyaram and Navapadu (17° 21′ 80° 10′) and Kothagudem (17° 53′ 80° 04′). These are broadly classified into iron-ore associated with Pakhals and iron-ore associated with banded-hematite quartzite of Dharwar age. The deposits of first group are richer and larger. The total reserve in this area on the basis of a preliminary investigation has been estimated at 11 million tonnes. The hill 1905 about 5 km. north of Bayyaram (17° 35′ 80° 06′), contains two bands of high grade iron-ore one of the bands having an average thickness of 6 m. is estimated to contain 1,06,000 tonnes of high grade ore and 6,00,000 tonnes of low grade ore. The other band with an average thickness of about 15 m. is estimated to contain 72, 60,000 tonnes of all grades of ore. Along the northern flank of the hill, reserve of 6,25,000 tonnes of high grade ore and 3,12,000 tonnes of low grade float ore is estimated. Detrital iron-ore occurs near Ramagundal (17° 39′ 80° 08′), Hematite-quartzite suitable as iron-ore is present in the Motala-Timmapur area (17° 41′ 80° 07′).

**Manganese:** In the Adilabad district manganese ore with very low phosphorous content occurs as thin lenses admixed with chert and jasper within Penganga limestones at Gowlighat, Goatkur, Jamdapur and Chanda (19° 46′ 78° 29′) for a strike length of 7.8 km. A reserve of 1,17000 tons with average grade of 39.6% of Mn. Low grade manganese-ore occurs as encrustations near Ratampet and Kandali in the Nizamabad district.

**Molybdenite:** Molybdenite occurs at 0.6 km. N.15$^0$ W. of Maisamoalle (18° 08′ 79° 08′), at 0.6 km. S75$^0$ W of Kochamapalle (18° 07′ 79° 08′) at 1.6 km. S50$^0$E of Kundannapalle (18° 02′ 79° 10′) and in the south of Chegurumandi (18° 14′ 79° 11′) in the Karimnagar district, as specks, disseminations and stringers hosted in narrow pegmatites, in blue coloured quartz veins traversing porphyrite granite and at places in granite itself. The width of the veins varies from 15

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

*(An ISO 3297: 2007 Certified Organization)*

**Vol. 3, Issue 8, August 2014**

cm. to 40 cm. and the length from 5 m. to 20 m with grade ranging from 0.01% to 0.2%. Minor occurrences of molybdenum as disseminations in pegmatites or granites are also seen in these districts.

**Non-metallic minerals**

**Asbestos**: Cross-fibre chrysotile asbestos varying in length from a few mm. to 40 mm. occurs in the serpentinised Vempalle dolomites at Somsil ($18^o$ 02′ $78^o$ 19′). The cumulative fibre length exceeds 50 mm. A zone of serpentinization with intermittently developed asbestos fibres has been identified for a length of 800 meters.

**Amethyst:** To the south of Karimnagar, at Sandral, crystalline amethyst forms several layers alternating with white quartz in drusy cavities of fissure veins which trend between WNW-ESE and NW-SE. Amethyst and amethestene quartz veins occur also at Ramanapalli near Siddipet, Medak district, and at Abdul Nagaram, Mekalgattu and Peddapadu in Warangal district.

**Barytes:** In the Khammam district occurrences of barytes are confined to a narrow belt of the Pakhals about 6.5 km east of Khammam town. The important occurrences are at Rudramkota ($17^o$ 14′ $80^o$ 12′), Venkatayapalem ($17^o$ 15′ $80^o$ 14′), Gopalpur ($17^o$ 15′ $80^o$ 12′), Ballapet ($17^o$ 16′ $80^o$ 12′), Kodamur ($17^o$ 11′ $80^o$ 13′) and Cheruvupuram ($17^o$ 31′ $80^o$ 10′), Barytes occurs as lenses, stringers and veins varying in width from a few centimetres to six metres. Barytes is reported from near Bollaram ($16^o$ 04′ $78^o$ 26′), and 1.6 km. NE of Virabhadradurgam in the Mahbubnagar district. Veins ranging in thickness from 1 m. to 3.2 meters are noticed in sheared zones in the Vempalle dolomite and quartzites.

**Building stones:** A variety of rocks like granite, dolerite, amphibolite, sandstone, marble which can be used as ornamental building stones are available in Warangal, Khammam, Karimnagar, Rangareddy districts. There are numerous polishing units are in operation especially in Khammam, Rangareddy and Waranagal districts. Bands of white marble are found near Jestalpane ($17^o$ 24′ $81^o$ 16′), Bethumpudi ($17^o$ 34′ $80^o$ 27′), Chimalpahad ($17^o$ 28′ $86^o$ 24′), Kotturu ($17^o$ 41′ $80^o$ 28′), Mallamallupadu ($17^o$ 19′ $80^o$ 14′), Manditog ($17^o$ 38′ $80^o$ 20′), Pubali ($17^o$ 37′ $80^o$ 22′) and adjoining places, Kommuguda ($17^o$ 35′ $80^o$ 16′) and Mallaipalle areas of Khammam district. There are about 105 quarries around Hyderabad city itself, which are actively operated for production of road metal. Mines & Geology department has identified 11 special mining zones exclusively for eco-friendly dimensional stone mining (Phani & Balamurugan, 2014).

**Clays:** White clay suitable for making low grade potteries occur within the Kampthis and upper Gondwana sediments at Panchagoan and Ralapet ($19^o$ 19′ $79^o$ 29′) and Katterala ($19^o$ 20′ $79^o$ 13′) villages of Adilabad district. A reserve of 5 metric tons of clay is estimated here. Sizeable deposits of clay suitable for the manufacture of porcelain-ware occur near Hyderabad city, about 3.2 km. west of Golconda fort and south of the Kutubshahi tombs. White residual clay is reported from Shekapur village ($17^o$ 37′ $77^o$ 37′) of Medak district. Small pockets of white clay are also present at Gambirpet in the same district. In the Nalgonda district occurrences of clays are reported from Chintriyal ($16^o$ 38′ $79^o$ 24′). Highly refractory clay occurrences are reported from Konasamudram ($18^o$ 44′ $78^o$ 31′) area in the Nizamabad district.

**Coal:** The Pranhita- Godavari valley is known for its coal reserves for more than a century. Coal bearing Gondwana rocks occupy parts of the Adilabad, Karimnagar, Khammam, Nizambad and Warangal districts. The coal bearing Barakar occurs at numerous localities, but is always overlain by the younger Kamthi sandstones and shales. The Gondwanas, mainly the younger Kamthis occupy an area exceeding 11,000 Sq.Km. in the state, but the exposures of the Barakar are few and far berween. The coalfields of the State have been divided into separate units and they are North Wardha, Asifabad, Tandur, Kanala, North Godavari and Sarangapalli, Chinnur, South Godavari, Kamawaram, Allapalli, Singareni, Kothagudem, Polancha and Sivapuram and being mined by Singareni Colleries Company Ltd., (SCCL). The SCCL has made the estimates of the reserves of coal in their lease-hold areas (Table 1, Richard, 2011). The proposed open-cast and underground extractable reserves are 223.4 and 149.1 respectively (SCCL, 2008). Total district-wise reserves are given in Fig.3. As per Indian Bureau of Mines, reserves as per UNFC standards are given in Table 1.

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| District | Depth (m) | GRADE | | | | | | | Total Reserve (m.t.) |
|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | G | |
| Adilabad | 0-300[a] | 0.06 | 25.89 | 279.62 | 701.96 | 427.25 | 509.55 | 67.97 | 2012.28 |
| | 300-600[b] | 0.06 | 21.93 | 250.94 | 477.48 | 342.49 | 332.73 | 12.34 | 1437.97 |
| | >600[c] | 0 | 0 | 0.02 | 0.01 | 0 | 0 | 0 | 0.03 |
| | **Total** | **0.12** | **47.82** | **530.58** | **1179.44** | **769.73** | **842.28** | **80.31** | **3450.28** |
| Karimnagar | 0-300[a] | 0 | 45.43 | 417.09 | 306.71 | 292.88 | 52.03 | 0.66 | 1114.8 |
| | 300-600[b] | 0.15 | 67.7 | 133.86 | 390.01 | 299.73 | 34.84 | 0.1 | 926.39 |
| | >600[c] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | **Total** | **0.15** | **113.13** | **550.95** | **696.72** | **592.61** | **86.87** | **0.76** | **2041.19** |
| Warangal | 0-300[a] | 32.27 | 90.05 | 145.42 | 99.47 | 198.29 | 229.84 | 24.5 | 819.84 |
| | 300-600[b] | 20.35 | 46.8 | 70.56 | 49.68 | 61.84 | 102.04 | 3.01 | 354.28 |
| | >600[c] | 2.64 | 3.6 | 1.34 | 0.9 | 1.56 | 0.09 | 0 | 10.12 |
| | **Total** | **55.26** | **140.44** | **217.32** | **150.04** | **261.69** | **331.98** | **27.51** | **1184.24** |
| Khammam | 0-300[a] | 13.88 | 62.26 | 374.69 | 155.65 | 297 | | 405.24 | 2039.76 |
| | 300-600b | 6.62 | 41.26 | 232.54 | 127.17 | 108.21 | | 39.4 | 668.85 |
| | >600[c] | 0 | 0 | | 0 | 0 | | 0 | 0 |
| | **Total** | **20.5** | **103.53** | **607.22** | **282.82** | **405.21** | | **444.65** | **2708.61** |
| Total | 0-300[a] | 46.21 | 223.63 | 1216.82 | 1263.79 | 1215.42 | | 496.37 | 5986.7 |
| | 300-600[b] | 27.18 | 177.7 | 687.9 | 1044.33 | 812.26 | | 54.86 | 3387.49 |
| | >600[c] | 2.64 | 3.6 | 1.35 | 0.9 | 1.56 | | 0 | 10.14 |
| | **Total** | **76.04** | **404.92** | **1906.07** | **2309.02** | **2029.24** | | **553.23** | **9384.33** |

Table 1. Total proven coal reserves exclusively in SCCL blocks in Telangana districts (Source: Richard Heede, 2011). a-Proved, b-Probable and c-Inferred.

The coal is classified as low rock, non-coking with high ash and high moisture contents. This coal is meta-lignite with a carbon content of 81-82 percent and a hydrogen content of about 5 percent. Production of coal by SCCL in 2013-2014 is expected to be 50.47 Million Tons. SCCL operates 13 open cast and 37 underground mines currently. Additional 3/2 million tonnes of coal is expected to occur outside the leased areas of the SCCL in Bellampalli, Golatomagudem, Chilpur and Paloncha. Currently GSI, MECL and SCCL are carrying out exploration activities in Narayanapuram-Pattayagudem, Pagaderu, Bugga- Khammamtogu sector, Vutasamudram-Venkatapuram area, Khammam district is being prospected (GSI, 2011).

**Corrundum:** Corundum occurs in nepheline synites at Rangapur ($17^o$ 26′ $81^o$ 10′) and in ultrabasic rocks at Gobbuguriti ($17^o$ 17′ $80^o$ 22′), Near Tadakalapudi ($17^o$ 31′ $80^o$ 27′). The mineral is associated with kyanite and fuchsite-muscovite-sericite rock. Occurrence of semi-precious corundum of abrasive variety and rare occurrences of gem variety are observed in the exploration pits at Lakshmipuram where the host rock is sillimanite-corundum schistose rock. At Gobbagurti and Singaraipalem corundum occurs in association with kyanite schists. However, at Lallurgudem corundum occurs as placer concentrations in the upper soil (Narayan and Pavanguru, 2013). In the Nalgonda district corundum occurs around Pedagudem, Timmapur, Lingampalle and Anvalgudem villages of Miryalguda taluk.

**Diamond:** Diamonds have been worked in the past in the Krishna river gravel around Bollaram ($16^o$ 04′ $78^o$ 26′), Amargiri ($16^o$ 03′ $78^o$ 23′), Somasil ($16^o$ 02′ $78^o$ 20′) and Maddimadugu ($16^o$ 18′ $79^o$ 08′) in Kollapur and Achampet taluks respectively of Mahbubnagar district. About 29+ kimberlite pipes were discovered by GSI and currently regional

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

*(An ISO 3297: 2007 Certified Organization)*

**Vol. 3, Issue 8, August 2014**

exploration in search of new pipes in Koilkonda- Devarakadra block in Mahboobnagar and Rangareddy districts is in progress (Ministry of Mines, 2012). Although Golconda has been the main trading center for diamonds in Nizam's reign but no occurrences of diamondiferous pipes have been reported except few famous alluvial diamond occurrences to date. The 29+ kimberlite pipes discovered by government agencies so far in Narayanpet Kimberlite Field, Mahbubnagar district are reported to be barren. However owing to the fact that within a single pipe, there can be different phases of diamond hosting potentiality, a more comprehensive sophisticated investigation, with the help of modern technology, may give rise to some positive information. GSI is carrying out reconnaissance stream sediment sampling at Amangal, 50km west of Narayanpet, Mahbubnagar district. Of late exploration is being carried out by multinational companies like Rio Tinto in other parts of the State, in Nalgonda and Rangareddy districts. The exploration is in preliminary phase and no positive results were hitherto publicly reported.

**Dolomite:** The good quality flux grade dolomite is reported between Raghunathapalem (17° 18′ 80° 12′), Madharam (17° 31′ 80° 13′) and Vemulanarava (16° 59′30″ 80° 17′00″) in Khammam district. A reserve of 88 m. tonnes is estimated for a 150 m. thick band for over a strike length of 32 km. upto a depth of 6 m. Currently Madharam mines cater to the needs of Vizag Steel Plant.

**Feldspar:** Pegmatites around the village Nidmanur, Damarcherla and Charkonda of Nalgonda district contain good quality feldspar which can be easily separated from the gangue minerals by hand picking. Also minor incidences of feldspars are reported from granitoids and gneisses of Mahbubnagar district.

**Fullers Earth:** Occurences of Fullers Earth associated with inter-trappeans and infratrappean beds are known from Rudravaram (17° 22′ 77°39′), Tinsanpalli (17° 22′ 77° 39′), Marepalli (17° 22′ 77° 47′) and Alipur (17° 19′ 77° 48′). An inferred reserve of 22.5 metric tons is estimated in these localities.

**Garnet:** A garnet-kyanite-mica schist constitutes an entire hill at Garibpet (17° 20′ 80° 38′), in the Khammam district, with garnet % of 11 to 19. The reserve is estimated to be 31 million tonnes. In the localities south-west of Yellandlapad in the Khammam district, garnet is found in abundance in garnet-staurolite schist.

**Graphite:** Numerous isolated occurences of graphite are present in the Khammam district between Ipalapadu (17° 04′ 81° 16′) and Sigurumamidi (17° 29′ 81° 19′) and the important occurrences are in the vicinity of Gopannagudem (17° 20′ 81° 15′). Kantlum (17° 20′ 81° 16′), Kavarigundla (17° 22′ 81° 16′), Gundlamadugu (17° 25′ 81° 27′), Bolapalle (17° 28′ 81° 19′), Chittemreddipadu (17° 22′ 81° 20′), Sidharam (17° 18′ 81° 25′) and Kunkulgoyapaka (17° 27′ 81° 19′).

**Kyanite:** Kyanite is noticed at Garibpet and Rudrampur (17° 29′ 80° 38′) in Khammam district. The reserves are estimated to be ~ 48 million tonnes. The mineral occurs in quartz-muscovite-kyanite schists.

**Galena:** In Khammam district, galena is noticed as sporadic disseminations in episodotised granites in the locality about a kilometer SSW of Niradu (17° 09′ 80° 14′). Sparse disseminations of galena are found in tremolite marble belonging to the Pakhals in the locality about 2 km NE of Jestaipalle (17° 22′ 80° 10′). Similar occurences of galena associated with malachite and azurite are noticed in barytes veins in Pakhal limestone in the Rudramakota (17° 14′ 80° 12′) of Khammam district.

**Limestone:** Deposits of limestone of cement and flux grade are wide spread in the State. Limestones of Precambrian age are noticed in localities various parts of parts of the Adilabad, Karimanagar and Khammam districts (Table 3).

| District | Location | Resources (Million Tons) | | Grade |
|---|---|---|---|---|
| | | Proved/Inferred | Inferred | |
| Adilabad | Jamadpur | 10.62 | | Cement |
| | Bhimsari | 35.56 | | |
| | Dantampalli | 5.40 | | |
| | Bellampalli | - | | |
| | Mancherial | 25 | | |

DOI: 10.15680/IJIRSET.2014.0308052

ISSN: 2319-8753

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| | | | | |
|---|---|---|---|---|
| | Ara | | 50 | Flux |
| Karimnagar | Putnur | | 87 | Cement |
| | Narella | | 57 | |
| Khammam | Sudibaka, Bhumalanka & Mallaipalle | 200 | | Flux |

Table 3. Limestone resources of Adilabad, Karimnagar & Khammam districts. (Modified after GSI, 2006).

Cement grade limestone occurs at Bhavipur, Toyaguda, Maktapur (19° 43′ 78° 37′), Kamta (19° 41′ 78° 38′), Badi (19° 42′ 78° 43′), Ramai, Makora (19° 43′ 78° 41′), Gamarkhurd (19° 47′ 78° 33′), Metguda (19° 39′ 78° 39′), Kanpa, Narala (19° 44′ 78° 36′), Chanda, Bhimsari, Rampur (19° 48′ 78° 31′) and Korta (19° 48′ 78° 31′) of Adilabad district. Limestone of Bhima Group quarried for flooring slabs occurs in the Tandur area of Rangareddy district. In Karimnagar district (Table 3), limestone deposits also occur near Muknur (18° 35′ 80° 18′), Kamalapur (18° 55′ 79° 05′), Ganeshpalli (18° 57′ 78° 57′) and Vilkurti (18° 42′ 79° 23′). The Vilurti deposit supplies to factory at Peddapalli. Flux grade dolomitic limestone occurs widely in Khammam district (Table 3). Limestone belonging to the Kurnool Group occurs in parts of the Alampur and Kollapur taluks of the Manbubnagar district. Limestone of the Palnad Group is found at Miryalguda and Hazurnagar of the Nalgonda district, also promising flux-grade deposits are found near Yepal Madhawaram (16° 48′ 79° 56′). Cement grade limestone is being mined near Mellacheruvu of Nalgonda district by Maha Cement group. In the Warangal district limestones belonging to the Pakhals and Sullavais are noticed at several places near Tekmetta (18° 23′ 79° 38′).

**Mica:** Occurences of mica are observed in pegmatites traversing the quartz-muscovite schist near Gosavidu (15° 56′ 80° 29′), Kannaru (17° 00′ 80° 34′), Vavilala (17° 05′ 80° 32′) and Kallur (17° 52′ 80° 33′) in Khammam district. Also at Garibpet muscovite occurs in quartz-kyanite-muscovite schists.

**Ochres:** In Hyderabad district ochre occurs near Pirmapalli, Velchal and Thimmareddipalle. No estimates on reserves are available.

**Quartz:** Large deposits of vein quartz occur cutting across the granites near Kukatpalli (18° 14′ 79° 11′), Ghamsabad and Timmapur (17° 10′ 78° 18′) close to Hyderabad city. These are being extensively exploited for crushing to silica sand by local factories. Glass-grade vein quartz occurs in Tadepalle (17° 14′ 80° 37′) in the Khammam district. White quartz veins extending for few 100s of meters are noticed near Shadnagar railway station in Mahabubnagar district. Quartz veins occur at Andole (17° 48′ 78° 40′) and Palampet (18° 02′ 78° 05′) in the Medak district. Glass-grade quartz quarries are also reported from Chimarajupenta in Nizamabad district. Not only for glass, but also fine powder (100 micros) of milky quartz is being exported for making artificial building stones from mines in Andhra Pradesh, a similar industry needs to be developed in the Telangana state too.

**Steatite and Talc:** In Karimnagar district minor steatite occurrences occur near Israjpalli (18° 49′ 79° 50′), Lachimidevipalle (18° 48′ 78° 53′), Potaram (18° 49′ 78° 51′) and Kondapuram (18° 37′ 78° 54′). Poor quality steatite occurs in Khammam district at Jestaipalle (17° 24′ 80° 16′), Sudimella (17° 36′ 80° 32′) and Singareni (17° 30′ 80° 16′). In Mahbubnagar district poor quality steatite occurs sporadically between Somsil (16° 02′ 79° 19′) and Kollapur (16° 07′ 78° 19′) and near Amargh (16° 04′ 78° 22′). Small occurences of soapstone are seen near Gunpur (18° 03′ 79° 04′) and Rajagopalpet (18° 06′ 78° 57′) in Medak district. Minor occurences of steatite are present in Choutpalli, Nizamabad district.

**Zircon:** Crystals of zircon occur as minor constituent of the nepheline syenite in Khammam district. But no estimates on reserves could be made.

**Radioactive minerals**

Of late, extensive exploration work being carried out by Atomic Minerals Directorate for Exploration and Research (AMD) in the undivided State of Andhra Pradesh has located several uranium deposits of unconformity proximal, strata

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

*(An ISO 3297: 2007 Certified Organization)*

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bound and fracture controlled type in the Proterozoic sediments of parts of Cuddapah basin. A promising deposit at Lambapur- Peddagattu, Chitrial, Kuppunur and RV Tanda of Nalgonda district, Telangana is an outcome of this exploration. The $U_3O_8$% is 0.02 in this new discovery, which is very much promising and viable for mining with tentative reserves of 1600 tons (Sinha et al., 1994). At Wanaparti, Manabubnagar district, uranium minerals occur as fine dissemination in granite. Secondary uranium minerals oxidised by groundwater form coating along joint planes in granite but not mineable. A rare mineral, Ianthinite was reported for the first time in India by Parihar et al., (Singh, 2013) in granites and quartzites with $U_3O_8$% 0.25 and 0.031 at Akkaram, Mahbubnagar districts respectively. Several radioactive U an Th anomalies in the metasedimentary enclaves (Archaean) within granite (Archaean to Early-Proterozoic) have been recorded in parts of Granulite Terrain, Karimnagar district at Peddur and Kottur ($18^o$ 22′ $78^o$ 46′) with uraninite mineralization assaying as high as 1.96% and in Kottur up to 0.059% $U_3O_8$ with negligible thorium (Som el al., 2010).

**Production**

Production statistics available for 2011-2012 is shown in Tables 4 & 5 (Source: www.telangana.gov.in).

| District | Quantity (Tonnes) | |
|---|---|---|
| | Iron ore | Manganese |
| Khammam | 267 | |
| Adilabad | | 483725 |
| Karimnagar | 17459 | |
| Warangal | 41596 | |

Table 4. Production of principal metallic minerals in 2011-2012.

| District | Production Quantity (Tonnes) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Barytes | White Clay | Coal | Felspar | Fireclay | Dolomite | Laterite | Limestone | Mica | Quartz |
| Adilabad | | 288670 | 11456377 | | | | 3958 | 17225000 | | |
| Karimnagar | | | 17724291 | | | | | 1040000 | | 1905 |
| Khammam | 9832 | | | | | 670026 | 1326 | | 357 | 2833 |
| Mahbubnagar | | | | 371058 | | | | | | 168970 |
| Medak | | | | | | | 18303 | | | 83321 |
| Nalgonda | | | | 19800 | | | 30693 | 14325786 | | 24974 |
| Nizamabad | | | | | | | 7896 | | | 6741 |
| Rangareddy | | 100 | | 179583 | 240 | | 525422 | 4160215 | | 168716 |
| Warangal | | | 1440410 | | | 3120 | 710657 | | | 19850 |

Table 5. Production of principal non-metallic minerals in 2011-2012.

## V. THE WAY FORWARD: SUSTAINABLE MINING, PLANNING & MANAGEMENT

The pace of development and processes of economic growth depend upon the availability and the extent and intensity of niche resources utilization. The State is blessed with good number of mineral occurrences and has the geological environment for many others. The above listed mineral resources indicate that Telangana is rich in niche resources. Unfortunately only few of these occurrences are exploitable at present, either because of poor survey, or lack of detail information, or not economically viable for extraction. However mere availability of minerals is not sufficient for socio economic development, because mineral exploitation involves various steps.

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

*(An ISO 3297: 2007 Certified Organization)*

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- Inviting applications from World class companies & transparency in award of leases.
- Detailed geological investigations.
  - Area prioritization
  - Terrain investigations.
- Planning & Execution of prospecting.
- Qualitative & Quantitative studies.
- Selection of mining method.
- Techno-commercial feasibility.
  - Order of magnitude studies
  - Environment impact assessment & Management Plan
- Mining policy and legal framework.

These steps involve a long time and heavy capital investment with modern technical know-how, which may yield results in terms of a potential source of revenue and employment. But there are equal chances of failure also during their economic exploitation. In the present socio-economic circumstances it may not be possible for the State to afford such a luxury at the cost of other priorities of the State. To exploit the Sate's geological potential for the sustainable development, it is important that scientific and detailed prospecting is to be carried out systematically in the entire geologically conducive mineral bearing area of the State using state-of-the-art techniques in a time bound manner. Minerals being a valuable resource, the extraction of mineral resources located through exploration and prospecting have to be maximised through scientific methods of mining, beneficiation and economic utilisation. For sustainable and environment friendly mining, a zero-waste mining has to be the goal and mining technology will need to be upgraded to ensure extraction and utilisation of the entire run-of-mines in the most efficient and sustainable manner. To achieve both these goals of large scale prospecting and optimal mining, large investments will be required together with the latest technologies in prospecting and mining. As the State develops and mining industry grows, assured availability and proximity of mineral resources will play an important role in giving a competitive edge to Indian industry in general and manufacturing in particular. The multiplier effect of minerals processed into metals on downstream industrialisation cannot be over emphasised. Value addition must, therefore, be actively encouraged to the extent appropriate with the long term development of the mineral sector in the State. However, such value addition will need to go hand in hand with the growth of the mineral sector as a standalone industrial activity.

About 13.5% of the world's electricity is being produced by more than 440 nuclear reactors. With global climate change as a high-profile concern, nuclear power is increasingly seen as an indispensable part of the mix. The recent uranium mineral discovery in Nalgonda district should be properly developed in an eco-friendly manner and it can be a future source of electric power. The government has to make necessary economic and environmental legislation for providing better deal in prospecting this mineral wealth for the welfare of the State with private and public sector participation. It will be worthwhile if the investigations are carried out through professional foreign agencies in terms of location, reserves and techno-economic feasibility by creating detailed and authentic database for proper planning and utilization.

Few MNCs have been granted reconnaissance permits recently, otherwise exploration by government organisations was limited to reporting only occurrences but no large scale investments on commercial exploration were made. GSI has identified an area of 131662.46 Sq.Km. as an Obvious Geological Mineral Potential (OGP) zone in undivided Andhra Pradesh but only 21151 Sq.Km. falls in Telangana, the remaining area in the State needs to be assessed thoroughly (Fig.2). While Government agencies are continuing to conduct the exploration and survey in their way, the private sector is now the main source of investment in reconnaissance and exploration with modern technologies, for which the State government should liberally invite the world class investors.

## VI. CONCLUSION

Telangana state is endowed with a variety of mineral occurrences present in different geological environments. The mining operations are limited to only few principal minerals currently. The need for a well-planned programme of

DOI: 10.15680/IJIRSET.2014.0308052

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

*(An ISO 3297: 2007 Certified Organization)*

**Vol. 3, Issue 8, August 2014**

survey and exploration, transparent system in awarding reconnaissance, prospecting and mining permits, management of resources which have already been discovered and those which are in the process of discovery and their optimal, economical and timely use are the matters of vital importance requiring comprehensive planning, adequate funding and coordinated successful execution and setting up mineral based industries like fertilizers, glass, abrasives and refractories etc. Such sort of innovative thought process will definitely help boosting socio-economic growth, by the mineral and mining sector, in the newly separated Telangana state.

## VII. ACKNOWLEDGEMENTS

The author thanks Mr. V. Krishnamohan, Mr. D. Umasankar, & Mr. Venu for facilitating infrastructure and manpower. Mr. T. Jayaram, Mrs. G. Jayalaxmi and Mrs. U. Jyothy deserve acknowledgements for drafting the preliminary manuscript and preparing the relevant inputs. The opinions in this paper are solely of the author and not of the organisation where he is currently working. Thanks are due to anonymous reviewer whose careful reading of the manuscript and comments have helped in improving the presentation.

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