

STATE UNIT: ANDHRA PRADESH
PROJECT: MANGANESE & GRAPHITE
SUPERVISORY OFFICER:

| | | | | | | | |
|---|---------------------------------------|---|-------------------|-------------------------|------------------------------------|-----------|------------------|
| Mission-IIA | Mineral Resource Assessment | | | | | Item No. | NEW ITEM |
| Field Season Year | FSP Number | | | | | | |
| 2018-19 | ME | | SR | AP | 2018 | | |
| | Type Code | Com/IGC code | Region Code | State Unit code/Mission | Year of Initiation | Sl. No. | |
| Participating Unit(s)/ Region (s) | | | | | | | |
| FM | SR | AP | Geophysics | SR | | | |
| Division/Project | Region | State Unit | Division/Project | Region/SU | Division/Project | Region/SU | Division/Project |
| Geographic Information | | | | | | | |
| State (Code) | District (s) | Degree Sheet (s) | Toposheet (s) | | Mineral/ Tectonic Belt, Basin etc. | | |
| AP | SRIKAKULAM & VISAKHAPATNAM | 65N | 65N/3 | | EGMB | | |
| Personnel | | 2G | | | | | |
| Name of item in-charge | | | | | | | |
| Name of other officers | | | | | | | |
| Title | | Preliminary investigation for Manganese and Graphite mineralization around Kondamasuru area, Srikakulam and Visakhapatnam districts, Andhra Pradesh. | | | | | |
| Stage | | G4 | | | | | |
| Key words | | Manganese, Graphite, EGMB. | | | | | |
| Objective (s)/ Projected Outcome | | i. To delineate zones of manganese and graphite mineralization ii. To study the controls of mineralization | | | | | |
| Total duration of item | | | | One Year (FS 2018-19) | | | |
| Item linked with | | | | Annual plan of GSI | | | |
| Whether GCM has been done in the area | | | | Yes (FS:2016-17) | | | |
| Whether GPM has been done in the area | | | | No | | | |
| Whether the item is a spinoff of any other item | | | | Yes (STM, FS 2016-17) | | | |
| Whether item is collaborative | | | | No | | | |
| Whether the item is sponsored | | | | No | | | |
| If yes, Name of the sponsor | | | | NA | | | |
| Outsourced work component, if any (specify) | | | | NA | | | |

Nature and Quantum of work and time schedule

| Nature of work | Total Workload envisaged | (a) Expected Year of completion (b) Circulation of final report | Work already completed | Work proposed for FS 2018-19 |
|---|--------------------------|--|------------------------|------------------------------|
| 01. Geological Survey LSM (Sq. Km) ^1: 10,000 DM (Sq.Km) 1:2000 | 80 1.5 | (a) March 2019 (b) September 2019 | New Item | 80 1.5 |
| 02. Technological Survey (a) Surface exploration PT (Cum) (b) Sub-surface exploration Scout Drilling (m) | 100 - | | | 100 - |
| Geophysical Survey a) Suitable methodology Resistivity/IP/Magnetic (L km) | 20 Line Km (20 sq.km) | | | 20 Line Km |

| | | | |
|---|-----|--|-----|
| 04. SMPL: | | | |
| BRS(Nos.) ** | 100 | | 100 |
| SS (Nos.) ** | 50 | | 50 |
| PTS(Nos) ** | 100 | | 100 |
| PS# | 30 | | 30 |
| PCS** | 10 | | 10 |
| Ore microscopy# | 20 | | 20 |
| XRD+ | 5 | | 5 |
| Fluid Inclusion study\$ | 10 | | 10 |
| EPMA# | 5 | | 5 |
| Proximate Analysis ++ | 10 | | 10 |
| 05. Chemical Analysis** (Cu, Pb, Zn, Ni, Co, Au, Ag, W, Sn, Mo, As) | 260 | | 260 |

Petrology lab, SR, Hyderabad;

** Chemical laboratory, SRO, Hyderabad

++ Proximate Analysis for fixed C of graphite at Chemical Lab, SU: TN & P
at NCEGR- Bengaluru

+ at NCEGR- Bengaluru

\$ at NCEGR- Bengaluru

^^ **Boundary coordinates to be fixed by DGPS**

TIMELINE PROPOSED FOR EACH WORK COMPONENT

| Field Studies | | | |
|---------------------|---|------------------------------|------------|
| Name of the officer | Expected field stay (number of days) | Expected period of fieldwork | |
| | | From | To |
| 1G | 120 | April 2018 | March 2019 |
| 1G | 120 | April 2018 | March 2019 |
| Supervisory Officer | 20 | April 2018 | March 2019 |

| Laboratory Studies | | |
|---|-----------------------------|----------------|
| Activity | From | To |
| Pre-field laboratory component and reconnaissance for the assignment under consideration, finalization of report of the previous field season and planning for current programmes | April 2018 | September 2018 |
| Geological study (fieldwork and collection, processing of samples and their submission) | April 2018 | March 2019 |
| Geophysical study (consultation of interpreted geophysical data) | April 2018 | March 2019 |
| Chemical study (last date of sample submission) | 30 th April 2019 | |
| Chemical study (acquisition of analytical data) | April 2018 | May 2019 |

| Report Submission | |
|---|--|
| Submission of the first draft of report | 30 th June 2019 |
| Scrutiny of the report by supervisory officer | 1 st July to 31 st July 2019 |
| Scrutiny of the report by RMH office | 1 st August to 31 st August 2019 |
| Finalization of the report | September 2019 |
| Circulation of the report | 30 th September 2019 |

| Operational Expenses | |
|----------------------|----------------|
| Heads | Expenses(Rs) |
| POL | Rs. 1,50,000/- |
| WAGES | Rs. 3,50,000/- |
| OC | Rs. 1,25,000/- |

Background Information:

Manganese ore deposits in Andhra Pradesh occur as localised pockets in the Eastern Ghats Metamorphics of the Archaean and Proterozoic Penganga sediments. The deposits associated with the Archaean metamorphics are found in Visakhapatnam, Vizianagaram and Srikakulam districts and those with the Penganga in Adilabad district. The proposed area falls in the Garbham-Garividi Manganese Belt in the Vizianagaram-Visakhapatnam belt.

The area in and around the proposed area for LSM and DM has been investigated by several workers. A detailed account of the works carried out so far in and around the study area is given below.

During FS 1960-61, Rao (1962) carried out detailed geological mapping and investigation of the manganese-ore deposits in Garbham-Bangaruvalasa-Ramabhadrapuram area in the western part of the Vishakapatnam manganese belt in Srikakulam district, Andhra Pradesh. The work under report was in continuation of that carried out during 1957-58 and 1958-59 field seasons. An area of about 400 sq. km. on 1:63,360 scale, was mapped during the period between 16-2-1961 and 29-4-1961, with a view to bring out the regional geology and structure. The area mapped falls between 18°19' and 18°30' N latitudes and 83°15' & 83°30' E longitudes. It is included in the north-east half of Survey of India T.S. No. 65N/7 and falls within the revenue taluks of Salur, Bobbili, and Chipurupalle of Srikakulam district, Andhra Pradesh. Besides regional mapping of the belt, the different quarries and prospects for manganese-ore around Bangaruvalasa, comprising an area of about 225,000 sq. metres, were mapped on 1: 1,000 scale by tape and compass survey. This report describes briefly the geology and structure of the area and the various manganese-ore workings in the western part of the Vishakhapatnam manganese belt. A generalised succession has been established, fixing the stratigraphic positions of the manganese-ore horizons that are being worked. The three stratigraphic horizons are - (1) associated with garnet-granulites above the calcgneisses (2) associated with garnet-granulites below the calc-gneisses and (3) associated with feldspathic quartzites within the coarse grained quartzites. All these horizons and the associated rocks form a part of the Precambrian Khondalite suite of rocks. Detailed large scale mapping of the quarries in the Bangaruvalasa, Garbham and neighbouring areas revealed that the manganese-ore in these areas is associated with feldspathic quartzites in coarse-grained quartzites but the ore-bearing layer as are comparatively thicker than in the other quarries reported earlier. This is in variance with the earlier views expressed that the manganese-ore in the Garbham quarry is associated with rocks similar to those in the Koduru quarry, the garnet-granulites. Manganese-ore in the ore horizons is localised along the noses of anticlinal drag folds and workable deposits of ore are in areas of intense drag folding. The drag folds plunge at angles varying from 25° in the Garbham area to 35° in the Bangaruvalasa area in S60°E and E directions respectively. Cross folding about a N-S axis plunging north at about 20° of the earlier south-east plunging folds is clear in the Pulugummi area. The average grade of ore mined contains about 35% Mn and 15% Fe, the phosphorous content increasing in the vicinity of apatite bearing pegmatite intrusives.

Chandra Chowdary et al (1978) carried out regional assessment of manganese in Srikakulam and Visakhapatnam (manganese Belt) districts which falls between Lat. 18°13' to 18°30' N and Long. 83°13' to 83°45' E in Survey of India Toposheets nos. 65 N/7, 11, 12 & 3 and is about 1200 sq km in areas extent. The manganese-ore mines are located in Chipurupalle, Bobbili, Palakonda and Salur taluks of Srikakulam district and a few in Vizianagaram taluk of Visakhapatnam district. The available ore reserves of indicated and inferred categories are of the order of 1.24 m.t. of 28-36% Mn grade. The manganese ore shows two distinct lithological affinities, one with the feldspathic quartzite and the other with calc-granulite. A detailed study of the present and old workings clearly shows that the alignment of manganese ore bodies generally with the trend of the host rocks, thus suggesting their syndimentary nature. This feature is particularly conspicuous in the case of the ore bodies associated with quartzite due to sharp contacts between the two, whereas the contacts in the case of calc-granulite are diffuse and irregular due to intensive weathering. The total production of manganese ore from this belt starting from 1982 is of the order of 4.79 m.t. The yearly production varies from 70,000 to 221,804 tonnes. Inventories of manganese ore reserve as on 1.1.1975 indicate an available reserve of 1.24 m.t. in Srikakulam manganese belt. The manganese ore reserves in the Srikakulam - Visakhapatnam manganese belt indicated and inferred reserves of the order of 2.55 m.t. are estimated upto a depth of 50 m through joint inspection.

Jagannadham (1962) continued gravity and magnetic surveys (geophysical survey) during FS 1960-61 for manganese ore in Srikakulam District, Andhra Pradesh, which was taken up during the FS 1959-60 in the Garbham area (Toposheet no. 65 N/7). Gravity and magnetic measurements were taken along traverse perpendicular to the general strike of the formations in the region. In all about 4500 gravity and 4800 magnetic measurements were made covering an area of About 2.49 sq. km. The magnetic response of the manganese ore in this region was found to vary over wide limits and very high positive and negative anomalies were obtained associated with the ore bodies, while in some cases no anomalies were obtained near the known ore bodies. In the residual gravity map of the area east of Garbham main pit a few interesting positive closures were obtained.

During FS 1992-93, search for wolframite and scheelite was carried out by Kazimi and Rajeshwar (1994) in toposheet Nos. 65G/15, 2, 3, 65N/7, 8 with the objective of identifying extension areas of graphitic occurrences in east and west Godavari, Khammam and scheelite bearing skarn zones if any, in Vizianagaram district. Tungsten values of 1000 ppm and 30 ppm from grey quartz is reported for the first time east of Chinnagalikonda. Some samples gave > 1000 ppm Zr values indicating the presence of zircon. One granitoid sample from Ozubanda assayed 300 ppm yttrium and one quartzite sample gave 100 ppm lanthanum. The grey quartz rich pegmatite extending over a few km. gave positive glows under UV and assayed 1-2 ppm silver. The areas examined in the districts of East Godavari, West Godavari, Khammam and Vizianagaram are poor with respect to wolframite/scheelite mineralisation and the only positive value of 1000 ppm W recorded from east of Chinnagalikonda needs further study. The silver values recorded from pegmatites of Vizianagaram are of good

areal extent. The bismuth and silver values recorded from Kavadigundla graphite mine is also significant. (Kazimi and Rajeshwar, 1994)

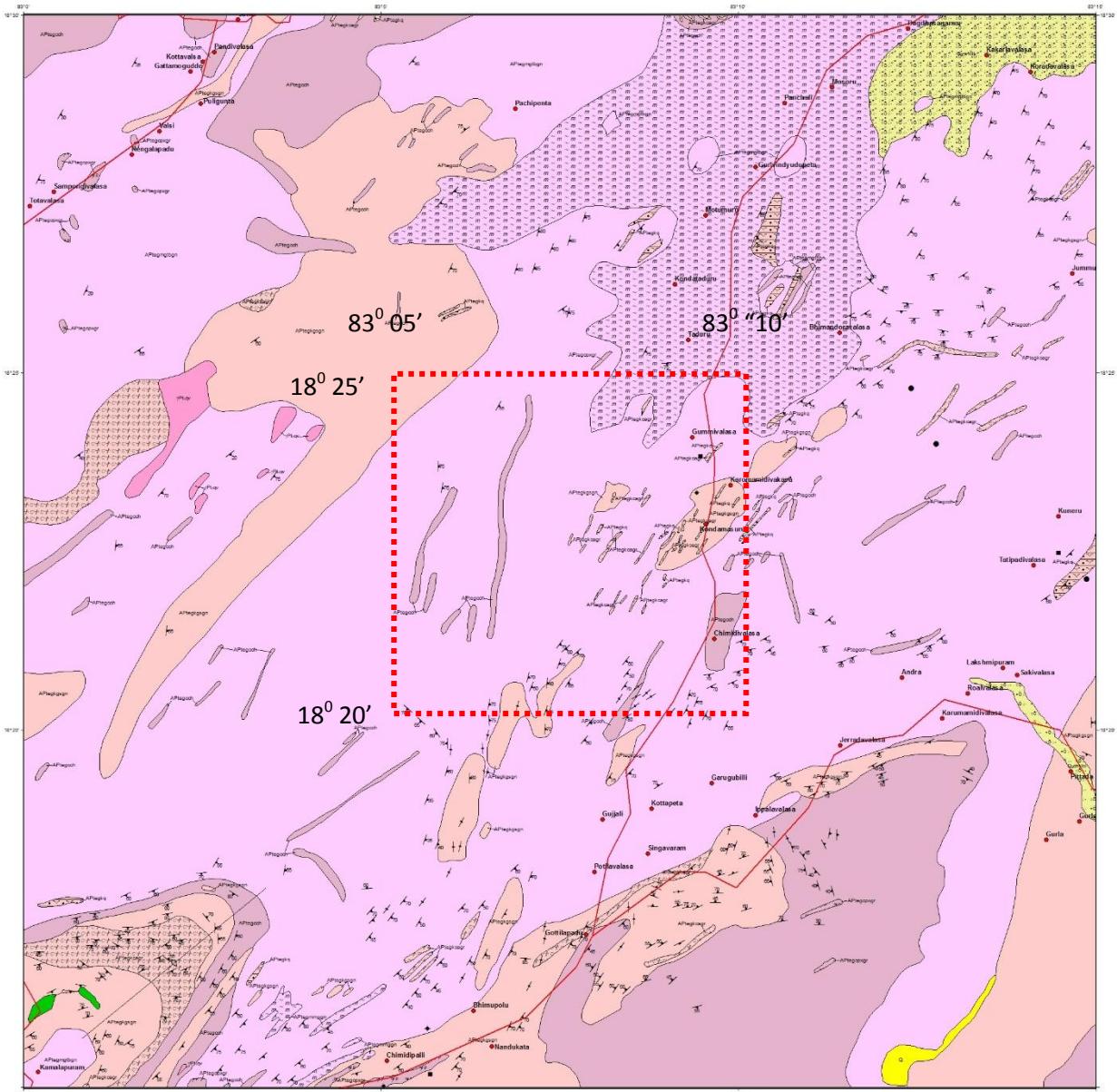
Based upon the utilisation in the user industries, an Expert Group of the Deptt. of Mines in their report of Oct'87 recommended the following specification for the manganese ore viz. (1) Battery Grade: MnO₂ (dry basis) 72% min, Fe (dry basis) 7% max., Cu, Pb, Cr and Ni Trace; (2) Chemical Grade: MnO₂- 75%, Fe 1.5 max, Cu Traces; (3) Ferromanganese Grade: Mn 46% min, Mn:Fe ratio 4.6:1 min, P -0.2% max.; (4) Blast Furnace Grade: Mn 25-35%, P 0.2% max, Al₂O₃ 7.5% max, SiO₂ 13% max, (5). Medium Grade: Mn 35-45%, (6) Conditional ore: Mn less than 25% etc. So, the grade of the manganese occurring in the area has to be determined accordingly. (GSI, 1994, DID on Manganese)

During STM carried out by Meshram & Sahoo (2017) in toposheet no 65N/3, a manganiferous zone of 500m long trending NE-SW from south-west of Karamamidivalasa to Kondamosuru has been delineated. The ore body is intimately associated with the calc-silicate granulite and pelitic variants of khondalite. The manganese content decreases from calc-silicate granulite and khondalite. The ore is of lumpy type in calc-granulite near Kondamosuru and only coating occur within khondalite. Ore band measuring 500m x 20m with more than 20%Mn has been delineated in the northern part at average height 550m where the ground level is 370m.

In the light of above facts, it is proposed to carry out LSM on 1:10,000 scale covering 80 sq.km. between Long 83° 5'-83° 10' and Lat 18° 20'-18° 25' (TS No. 65N/3) out of which, graphite and manganese mineralized zones to be mapped on 1: 2,000 scale (DM) covering 1.5 sq.km in selected parts with the objectives to (i) delineate the manganese and graphite bodies through mapping and sampling for determination of grade, (ii) study the control of mineralization of manganese and graphite.













Bibliography:

- 1.Chandra Chowdary, Y.M.K., Krishna Rao, S.V.G and Sarma, K.J, 1978: A Scheme On Manganese Ore Exploration And Regional Assessment In Srikakulam And Vishakhapatnam (Manganese Belt) Districts, Andhra Pradesh, Unpubl. Rep. Geol. Surv. India, (FS: 1977-78), Accession No.: SRO-6129
- 2.GSI, 1994: Detailed Information On Manganese Ores In Orissa-Andhra Pradesh-Bihar (India)
- 3.Jagannadham M., 1962: Report On The Gravity And Magnetic Investigations For Manganese Ore In Garbham Area, Srikakulam District, Andhra Pradesh, Unpubl. Rep. Geol. Surv. India, (FS 1960-61), Accession No.: CHQ-1200
- 4.Krishna Murthy A., Satyanarayana Murthy D. S. 1969: Geology of Parts of Salur and Bobbili Taluks, Srikakulam Dist. Andhra Pradesh, Unpubl. Rep. Geol. Surv. India, (FS 1968-69), Accession No. SRO-1962
- 5.Krishna Rao, S.V.G. (1980-81). A progress report on the investigation for lime-kanker in Vizianagaram district, AP Unpubl. Rep. Geol. Surv. India, (FS 1980-81), Accession No. SRO-10180
- 6.Kazimi, S.M.K.. and Rajeshwar, J. 1994: Search For Wolframite And Scheelite And To Understand The Nature Of Tungsten Mineralisation Associated With The Graphites Within Eastern Ghats In Andhra Pradesh, Unpubl. Rep. Geol. Surv. India, (FS 1992-93), Accession No.: SRO-12047
- 7.Meshram, T.M. & Sahoo, R.K. (2017): Specialized Thematic Mapping In The Zones Of Manganese Rich Bodies In Pachipenta-Pittada Area Of Srikakulam And Visakhapatnam Districts, Andhra Pradesh, Unpub. GSI Final Report for Field Season 2016-17.
- 8.Rao, G.V. 1962: Report On The Geology And Manganese-Ore Deposits Of The Western Part Of The Vishakhapatnam Manganese Belt, Srikakulam District, Andhra Pradesh, Unpubl. Rep. Geol. Surv. India, (FS 1960-61), Accession No.: SRO-208/CHQ-800



Geological map of T.S. No. 65N/3 showing the location of study area




LEGEND

| | Lithology | Formation | Group | Supergroup | Age |
|---|---|-----------------------------|---------------|-------------|---------------------|
|  | Unclassified quaternaries |] Unclassified quaternaries | | |] Quaternary |
|  | Silty clay | |] Champavati | | |
|  | Silty clay |] Nagavali | | | |
|  | Laterite | | | |] Cenozoic |
|  | Quartz vein |] Acid intrusives | | |] Palaeoproterozoic |
|  | Garnet biotite gneiss | | |] Migmatite |] Eastern Ghats |
|  | Migmatite gneiss | | | | |
|  | Charnockite | |] Charnockite | | |
|  | Pyroxene granulite | | | | |
|  | Calc granulite | |] Khondalite | | |
|  | Garnet-sillimanite-gneiss + graphite+cordierite | | | | |
|  | Quartzite | | | | |

Structural symbols

| | | | |
|---|----------------------|---|-------------------------|
|  | Foliation (Inclined) |  | Joint (Inclined) |
|  | Foliation (Vertical) |  | Axial trace of antiform |

Mineral symbols

| | | | | | |
|---|----------|---|----------|---|---------------|
|  | Graphite |  | Iron Ore |  | Manganese Ore |
|---|----------|---|----------|---|---------------|

STATE UNIT: ANDHRA PRADESH
PROJECT: MANGANESE & GRAPHITE
SUPERVISORY OFFICER:

| | | | | | | |
|---|---------------------------------------|---|-------------------|-------------------------|------------------------------------|-----------|
| Mission-IIA | Mineral Resource Assessment | | | | Item No. | NEW ITEM |
| Field Season Year | FSP Number | | | | | |
| 2018-19 | ME | | SR | AP | 2018 | |
| | Type Code | Com/IGC code | Region Code | State Unit code/Mission | Year of Initiation | Sl. No. |
| Participating Unit(s)/ Region (s) | | | | | | |
| Mn | SR | AP | Geophysics | SR | | |
| Division/Project | Region | State Unit | Division/Project | Region/SU | Division/Project | Region/SU |
| Geographic Information | | | | | | |
| State (Code) | District (s) | Degree Sheet (s) | Toposheet (s) | | Mineral/ Tectonic Belt, Basin etc. | |
| AP | SRIKAKULAM & VISAKHAPATNAM | 65N | 65N/3 | | EGMB | |
| Personnel | | 2G | | | | |
| Name of item in-charge | | | | | | |
| Name of other officers | | | | | | |
| Title | | Reconnaissance survey for Manganese and Graphite mineralization around Ippakonda area, Srikakulam and Visakhapatnam districts, Andhra Pradesh. | | | | |
| Stage | | G4 | | | | |
| Key words | | Manganese, Graphite, EGMB. | | | | |
| Objective (s)/ Projected Outcome | | i. To delineate zones of manganese and graphite mineralisation ii. To study the controls of mineralisation | | | | |
| Total duration of item | | One Year (FS 2018-19) | | | | |
| Item linked with | | Annual plan of GSI | | | | |
| Whether GCM has been done in the area | | Yes (FS:2016-17) | | | | |
| Whether GPM has been done in the area | | No | | | | |
| Whether the item is a spinoff of any other item | | Yes (STM, FS 2016-17) | | | | |
| Whether item is collaborative | | No | | | | |
| Whether the item is sponsored | | No | | | | |
| If yes, Name of the sponsor | | NA | | | | |
| Outsourced work component, if any (specify) | | NA | | | | |

Nature and Quantum of work and time schedule

| Nature of work | Total Workload envisaged | (a) Expected Year of completion (b) Circulation of final report | Work already completed | Work proposed for FS 2018-19 |
|---|--------------------------|--|------------------------|------------------------------|
| 01. Geological Survey LSM (Sq. Km) ^1: 10,000 DM (Sq.Km) 1:2000 | 80 1.5 | (a) March 2019 (b) September 2019 | New Item | 80 1.5 |
| 02. Technological Survey (a) Surface exploration PT (Cum) (b) Sub-surface exploration Scout Drilling (m) | 100 - | | | 100 - |
| Geophysical Survey a) Suitable methodology Resistivity/IP/Magnetic (L km) | 20 Line Km (20 sq.km) | | | 20 Line Km |

| | | | |
|---|-----|--|-----|
| 04. SMPL: | | | |
| BRS(Nos.) ** | 100 | | 100 |
| SS (Nos.) ** | 50 | | 50 |
| PTS(Nos) ** | 100 | | 100 |
| PS# | 30 | | 30 |
| PCS** | 10 | | 10 |
| Ore microscopy# | 20 | | 20 |
| XRD+ | 5 | | 5 |
| Fluid Inclusion study\$ | 10 | | 10 |
| EPMA# | 5 | | 5 |
| Proximate Analysis ++ | 10 | | 10 |
| 05. Chemical Analysis** (Cu, Pb, Zn, Ni, Co, Au, Ag, W, Sn, Mo, As) | 270 | | 270 |

Petrology lab, SR, Hyderabad;

** Chemical laboratory, SRO, Hyderabad

++ Proximate Analysis for fixed C of graphite at Chemical Lab, SU: TN & P
at NCEGR- Bengaluru

+ at NCEGR- Bengaluru

\$ at NCEGR- Bengaluru

^^ **Boundary coordinates to be fixed by DGPS**

TIMELINE PROPOSED FOR EACH WORK COMPONENT

| Field Studies | | | |
|---------------------|---|------------------------------|------------|
| Name of the officer | Expected field stay (number of days) | Expected period of fieldwork | |
| | | From | To |
| 1G | 120 | April 2018 | March 2019 |
| 1G | 120 | April 2018 | March 2019 |
| Supervisory Officer | 20 | April 2018 | March 2019 |

| Laboratory Studies | | |
|---|-----------------------------|----------------|
| Activity | From | To |
| Pre-field laboratory component and reconnaissance for the assignment under consideration, finalization of report of the previous field season and planning for current programmes | April 2018 | September 2018 |
| Geological study (fieldwork and collection, processing of samples and their submission) | April 2018 | March 2019 |
| Geophysical study (consultation of interpreted geophysical data) | April 2018 | March 2019 |
| Chemical study (last date of sample submission) | 30 th April 2019 | |
| Chemical study (acquisition of analytical data) | April 2018 | May 2019 |

| Report Submission | |
|---|--|
| Submission of the first draft of report | 30 th June 2019 |
| Scrutiny of the report by supervisory officer | 1 st July to 31 st July 2019 |
| Scrutiny of the report by RMH office | 1 st August to 31 st August 2019 |
| Finalization of the report | September 2019 |
| Circulation of the report | 30 th September 2019 |

| Operational Expenses | |
|----------------------|----------------|
| Heads | Expenses(Rs) |
| POL | Rs. 1,50,000/- |
| WAGES | Rs. 3,50,000/- |
| OC | Rs. 1,25,000/- |

Background Information:

Manganese ore deposits in Andhra Pradesh occur as localised pockets in the Eastern Ghats metamorphics of the Archaean and Proterozoic Penganga sediments. The deposits associated with the Archaean metamorphics are found in Visakhapatnam, Vizianagaram and Srikakulam districts and those with the Penganga in Adilabad district. The proposed area falls in the Garbham-Garividi Manganese Belt in the Vizianagaram-Visakhapatnam belt.

The area in and around the area proposed for LSM and DM has been investigated by several workers. A detailed account of the works carried out so far in and around the study area is given below.

During FS 1960-61, Rao carried out detailed geological mapping and investigation of the manganese-ore deposits in Garbham-Bangaruvalasa-Ramabhadrapuram area in the western part of the Vishakhapatnam manganese belt in Srikakulam district, Andhra Pradesh. The work under report was in continuation of that carried out during 1957-58 and 1958-59 field seasons. An area of about 400 sq. km. on 1:63,360 scale, was mapped during the period between 16-2-1961 and 29-4-1961, with a view to bring out the regional geology and structure. The area mapped falls between 18°19' and 18°30' N latitudes and 83°15' & 83°30' E longitudes. It is included in the north-east half of Survey of India topographic sheet No. 65N/7 and falls within the revenue taluks of Salur, Bobbili, and Chipurupalle of Srikakulam district, Andhra Pradesh. Besides regional mapping of the belt, the different quarries and prospects for manganese-ore around Bangaruvalasa, comprising an area of about 225,000 sq. metres, were mapped on 1:1,000 scale by tape and compass survey. This report describes briefly the geology and structure of the area and the various manganese-ore workings in the western part of the Vishakhapatnam manganese belt. A generalised succession has been established, fixing the stratigraphic positions of the manganese-ore horizons that are being worked. The three stratigraphic horizons are - (1) associated with garnet-granulites above the calcgneisses (2) associated with garnet-granulites below the calcgneisses and (3) associated with feldspathic quartzites with the coarse grained quartzites. All these horizons and the associated rocks form a part of the Precambrian Khondalite suite of rocks. Detailed large scale mapping of the quarries in the Bangaruvalasa, Garbham and neighbouring areas revealed that the manganese-ore in these areas is associated with feldspathic quartzites in coarse-grained quartzites but the ore-bearing layer as are comparatively thicker than in the other quarries reported earlier. This is in variance with the earlier views expressed that the manganese-ore in the Garbham quarry is associated with rocks similar to those in the Koduru quarry, the garnet-granulites. Manganese-ore in the ore horizons is localised along the noses of anticlinal drag folds and workable deposits of ore are in areas of intense drag folding. The drag folds plunge at angles varying from 25° in the Garbham area to 35° in the Bangaruvalasa area in S60°E and E directions respectively. Cross folding about a N-S axis plunging north at about 20° of the earlier south-east plunging folds is clear in the Pulugummi area. The average grade of ore mined contains about 35% Mn and 15% Fe, the phosphorous content increasing in the vicinity of apatite bearing pegmatite intrusives.

Chandra Chowdary et al (1978) carried out manganese exploration and regional assessment in Srikakulam and Visakhapatnam (manganese Belt) districts which falls between Lat. 18°13' to 18°30' N and Long. 83°13' to 83°45' E in Survey of India Toposheets nos. 65 N/7, 11, 12 & 3 and is about 1200 sq km in areas extent. The manganese-ore mines are located in Chipurupalle, Bobbili, Palakonda and Salur taluks of Srikakulam district and a few in Vizianagaram taluk of Visakhapatnam district. The available ore reserves of indicated and inferred categories are of the order of 1.24 m.t. of 28-36% Mn grade. The manganese ore shows two distinct lithological affinities, one with the feldspathic quartzite and the other with calc-granulite. A detailed study of the present and old workings clearly shows that the alignment of manganese ore bodies generally with the trend of the host rocks, thus suggesting their synsedimentary nature. This feature is particularly conspicuous in the case of the ore bodies associated with quartzite due to sharp contacts between the two, whereas the contacts in the case of calc-granulite are diffuse and irregular due to intensive weathering. The total production of manganese ore from this belt starting from 1982 is of the order of 4.79 m.t. The yearly production varies from 70,000 to 221,804 tonnes. Inventories of manganese ore reserve as on 1.1.1975 indicate an available reserve of 1.24 m.t. in Srikakulam manganese belt. The manganese ore reserves in the Srikakulam - Visakhapatnam manganese belt indicated and inferred reserves of the order of 2.55 m.t. are estimated upto a depth of 50 m through joint inspection.

Jagannadham (1962) continued gravity and magnetic surveys (geophysical survey) during FS 1960-61 for manganese ore in Srikakulam District, Andhra Pradesh, which was taken up during the FS 1959-60 in the Garbham area (Toposheet no. 65 N/7). Gravity and magnetic measurements were taken along traverse perpendicular to the general strike of the formations in the region. In all about 4500 gravity and 4800 magnetic measurements were made covering an area of About 2.49 sq. km. The magnetic response of the manganese ore in this region was found to vary over wide limits and very high positive and negative anomalies were obtained associated with the ore bodies, while in some cases no anomalies were obtained near the known ore bodies. In the residual gravity map of the area east of Garbham main pit a few interesting positive closures were obtained.

During FS 1992-93, search for wolframite and scheelite was carried out by Kazimi and Rajeshwar (1994) in toposheet Nos. 65G/15, 2, 3, 65N/7, 8 with the objective of identifying extension areas of graphitic occurrences in east and west Godavari, Khammam and scheelite bearing skarn zones if any, in Vizianagaram district. Tungsten values of 1000 ppm and 30 ppm from grey quartz is reported for the first time east of Chinnagalikonda. Some samples gave > 1000 ppm Zr values indicating the presence of zircon. One granitoid sample from Ozubanda assayed 300 ppm yttrium and one quartzite sample gave 100 ppm lanthanum. The grey quartz rich pegmatite extending over a few km. gave positive glows under UV and assayed 1-2 ppm silver. The areas examined in the districts of East Godavari, West Godavari, Khammam and Vizianagaram are poor with respect to wolframite/scheelite mineralisation and the only positive value of 1000 ppm W recorded from east of Chinnagalikonda needs further study. The silver values recorded from pegmatites of Vizianagaram are of good

areal extent. The bismuth and silver values recorded from Kavadigundla graphite mine is also significant. (Kazimi and Rajeshwar, 1994)

Based upon the utilisation in the user industries, an Expert Group of the Deptt. of Mines in their report of Oct'87 recommended the following specification for the manganese ore viz. (1) Battery Grade: MnO₂ (dry basis) 72% min, Fe (dry basis) 7% max., Cu, Pb, Cr and Ni Trace; (2) Chemical Grade: MnO₂- 75%, Fe 1.5 max, Cu Traces; (3) Ferromanganese Grade: Mn 46% min, Mn:Fe ratio 4.6:1 min, P -0.2% max.; (4) Blast Furnace Grade: Mn 25-35%, P 0.2% max, Al₂O₃ 7.5% max, SiO₂ 13% max, (5). Medium Grade: Mn 35-45%, (6) Conditional ore: Mn less than 25% etc. So, the grade of the manganese occurring in the area has to be determined accordingly. (GSI, 1994, DID on Manganese)

During STM carried out by Meshram & Sahoo (2017) in toposheet 65N/3, a manganiferous zone trending in NNE-SSW and discontinuously exposed over a strike length from northeast of Kondagudivalasa to southwest of Ippakonda has been delineated. The cumulative strike length of the ore body is 300m having average width of 4m. Ore body is associated with calc-silicate granulite just near the closure of regional F₂ fold at Kondagudivalasa and extended to another limb up to Ippakonda respectively. The exposed ore is of powdery type and at places it is lumpy having potential with more than 20%Mn. This area comes under the private mine i.e. Girija Pvt Mining and they are exploring this area from last 5 to 10 year.

In the light of above facts, it is proposed to carry out LSM on 1:10,000 scale covering 80 sq.km. between Long 83° 10'-83° 15' and Lat 18° 24'-18° 29' (TS No. 65N/3) out of which, graphite and manganese mineralized zones to be mapped on 1: 2,000 scale (DM) covering 1.5 sq.km in selected parts with the objectives to (i) delineate the manganese and graphite bodies through mapping and sampling for determination of grade, (ii) study the control of mineralization of manganese and graphite.

Bibliography:

Jagannadham M., 1962: Report On The Gravity And Magnetic Investigations For Manganese Ore In Garbham Area, Srikakulam District, Andhra Pradesh, Unpubl. Rep. Geol. Surv. India, (FS 1960-61), Accession No.: CHQ-1200

Rao, G.V. 1962: Report On The Geology And Manganese-Ore Deposits Of The Western Part Of The Vishakhapatnam Manganese Belt, Srikakulam District, Andhra Pradesh, Unpubl. Rep. Geol. Surv. India, (FS 1960-61), Accession No.: SRO-208/CHQ-800

Krishna Murthy A., Satyanarayana Murthy D. S. 1969: Geology of Parts of Salur and Bobbili Taluks, Srikakulam Dist. Andhra Pradesh, Unpubl. Rep. Geol. Surv. India, (FS 1968-69), Accession No. SRO-1962

Chandra Chowdary, Y.M.K., Krishna Rao, S.V.G and Sarma, K.J, 1978: A Scheme On Manganese Ore Exploration And Regional Assessment In Srikakulam And Vishakhapatnam (Manganese Belt) Districts, Andhra Pradesh, Unpubl. Rep. Geol. Surv. India, (FS: 1977-78), Accession No.: SRO-6129

Krishna Rao, S.V.G. (1980-81). A progress report on the investigation for lime-kanker in Vizianagaram district, AP Unpubl. Rep. Geol. Surv. India, (FS 1980-81), Accession No. SRO-10180

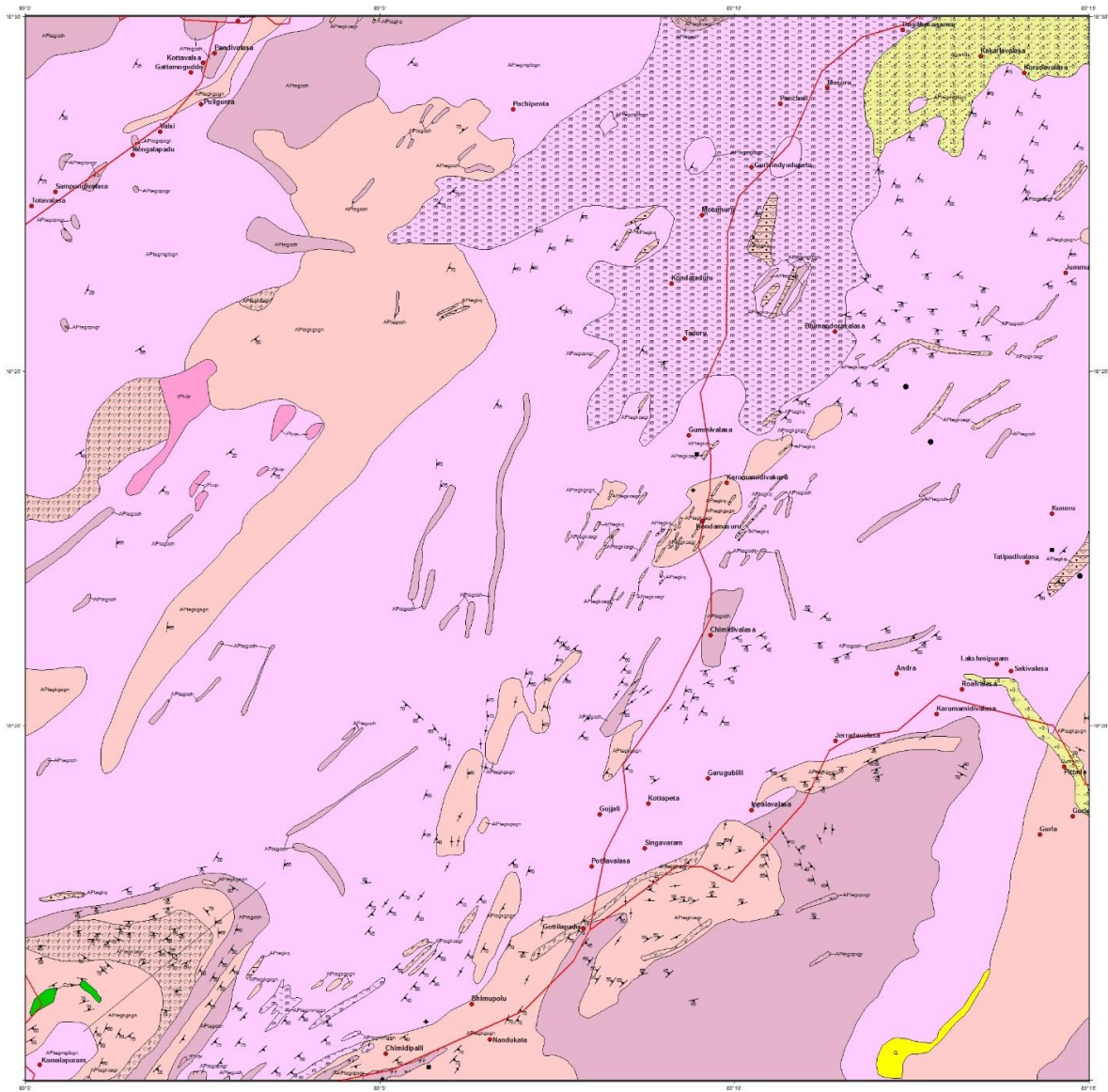
Kazimi, S.M.K.. and Rajeshwar, J. 1994: Search For Wolframite And Scheelite And To Understand The Nature Of Tungsten Mineralisation Associated With The Graphites Within Eastern Ghats In Andhra Pradesh, Unpubl. Rep. Geol. Surv. India, (FS 1992-93), Accession No.: SRO-12047

GSI, 1994: Detailed Information On Manganese Ores In Orissa-Andhra Pradesh-Bihar (India)

David, J.S., Srihari, J., Basha, S.M.J., Durga Rao, C. and Augustine, P.F. 1995: Report on the specialized thematic mapping along Vizianagaram-Sunki (NH43) and Gajapathinagaram-Bhimapolu transects in parts of Vizianagaram district, A.P., Unpubl. Rep. Geol. Surv. India, (FS 1994-95). Accession No. SRO-12252













Paul, U. and Chakraborty, S. 2015: Geochemical Mapping in parts of Vizianagaram and Visakhapatnam districts, Andhra Pradesh. Unpubl. Rep. Geol. Surv. India, (FS 204-15), Accession No.:

Meshram, T.M. & Sahoo, R.K. (2017): Specialized Thematic Mapping In The Zones Of Manganese Rich Bodies In Pachipenta-Pittada Area Of Srikakulam And Visakhapatnam Districts, Andhra Pradesh, Unpub. GSI Final Report for Field Season 2016-17.



Geological map of T.S. No. 65N/3 showing the location of study area




LEGEND

| | Lithology | Formation | Group | Supergroup | Age |
|---|---|---------------------------|-------------|---------------|----------------------------|
|  | Unclassified quaternaries | Unclassified quaternaries | | | Quaternary |
|  | Silty clay | Champavati | | | Holocene |
|  | Silty clay | Nagavali | | | |
|  | Laterite | | | | Cenozoic |
|  | Quartz vein | Acid intrusives | | | Palaeoproterozoic |
|  | Garnet biotite gneiss | | Migmatite | Eastern Ghats | Archaean-Palaeoproterozoic |
|  | Migmatite gneiss | | | | |
|  | Charnockite | | Charnockite | | |
|  | Pyroxene granulite | | | | |
|  | Calc granulite | | Khondalite | | |
|  | Garnet-sillimanite-gneiss + graphite+cordierite | | | | |
|  | Quartzite | | | | |

Structural symbols

| | | | |
|---|----------------------|---|-------------------------|
|  | Foliation (Inclined) |  | Joint (Inclined) |
|  | Foliation (Vertical) |  | Axial trace of antiform |

Mineral symbols

| | | | | | |
|---|----------|---|----------|---|---------------|
|  | Graphite |  | Iron Ore |  | Manganese Ore |
|---|----------|---|----------|---|---------------|