

**PEER REVIEW COMMENTS/SUGGESTIONS AND CORRECTIONS FOR  
GEOLOGICAL REPORT ON PRELIMINARY EXPLORATION (G3) FOR COPPER AND ASSOCIATED MINERALS IN  
THAKURDIH AREA-1 BLOCK (4.10 sq.km.), SINGBHUM COPPER BELT,  
EAST SINGBHUM DISTRICT, STATE JHARKHAND**

Geological report peer reviewed by Dr. Rajgopal Mohanty, Former Additional Director, AMD/Department of Atomic Energy  
Observations/suggestions received from peer reviewer through letter dated 09.07.2025.  
Peer review comments/suggestions have been attended and incorporated in the Geological Report.

S.No.	Comments/Suggestions	Compliance
	<b><u>Understanding the Ore Geometry</u></b>	
1	Structurally controlled Cu-mineralisation and three phases of deformation are reported in the area, with hinge zones of D1/D2 folds influencing ore localisation. Hence, detailed large-scale mapping and stereonet analysis are recommended to demarcate axial zones, which may help trace additional mineralised bands and define ore geometry more precisely.	<p>Attended.</p> <p>Copper mineralization in the area is structurally controlled and mainly conforms to S1 foliation, which is refolded during D2 deformation, enhancing ore localization around D2 hinge zones—similar to patterns seen in other Baharagora blocks. Stereonet analysis confirms multiphase deformation, with the D2 fold axis plunging 64° ENE and an axial plane of 058/84S. The northern ore band is hosted in porphyroblastic garnetiferous schist, while the axial zone shows no surface oxidation or consistent geophysical anomalies.</p> <p>Therefore, presence of additional mineralised band along axial planar region are unlikely. However, Some more bedrock and pit soil sampling recommended in further exploration to confirm the same.</p>
2	As per Plate IV-A, Para 19.6.3, and Table 19.1, two ore bands—Northern (NB) and Southern (SB)—are identified. While the arenaceous quartzite/quartz schist shows an easterly fold closure with an EW to ESE-WNW axial trend, it is unclear if NB and SB follow the same folding. Notably, strong to moderate IP anomalies along profiles NW-	<p>Noted</p> <p>NB and SB are co folded in similar manner as evident from the stereographic analysis of the NB and SB data, the spread of pole of the planar data,</p>

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	<p>60, NW-90, and NW-120 coincide with the projected axial zone. copper mineralisation cannot be ruled out along this axial trace.</p> <p>Therefore, in my view, some more boreholes are required to be drilled (at 200m spacing) at least along two Transverse section lines, say the line joining MTB-08 &amp; MTB-07, and MTB-17 &amp; MTB-09 to explore presence of new ore bands along the axial trace. Out of this, one or two boreholes may be drilled deeper to examine depth continuity and to confirm any improvement in grade, before considering completion of G3 level of exploration in this block.</p>	<p>concentration of the linear data and the attitude of the calculated Beta(<math>\beta</math>) axis is almost comparable in both the plot.</p> <p>Therefore, it could be concluded that the both the area deformed in single deformational event, which in turn probably indicate the co-folding of NB and SB together.</p> <p>G3 Exploration concluded. Hence, additional drilling recommended in phase of exploration (G2).</p>
3.	<p>An attempt should be made to prepare an integrated interpretative map including all the three blocks projecting the ore bands on a single plan. The structural analysis including the stereonet projections should be prepared both for the entire area as well as domain wise depending on the randomness of structural elements. It will help to understand to unravel the structural complexity both for the lithic horizons and ore bands</p>	<p>Attended</p> <p>A composite interpretative map prepared including all three blocks (Mundadevta-Darkhuli &amp; South Jharia, Thakurdih Charakmara &amp; Thakurdih Area-1 Block) projecting the ore bands and available geological, geochemical and geophysical survey data on a single plan and given as an integrated geological map for sub-blocks as Plate No. IV.D</p>
4.	<p>It is reported under para 7.8.8 that 'ore bodies are conformable with S1/S2 surfaces and are co-folded along with enclosing rock'. Observations supporting this conclusion such as any micro-folding of sulphide layers under the microscope, if any, may be mentioned.</p>	<p>Noted.</p> <p>Micro-folding of sulphide minerals not observed within a limited scope of mineragraphy studies. However, it can be evidenced in certain samples in petrography studies &amp; bore hole cores as well. Core photo graph Photo-22, 23 &amp; 24 incorporated in the report.</p>
5.	<p>Since the area is complexly folded and the sub blocks are contiguous to each other, it is suggested that a structural map (large scale : may be 1:5000) containing all the structural elements may be prepared along with stereonet projection for the entire area for better appreciation and understanding.</p>	<p>Attended.</p> <p>A separate map (Plate No. IV.D) composite map has been prepared for all sub-blocks of Baharagora, including Mundadevta-Darkhuli &amp; South Jharia</p>

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		Block, Thakurdih Charakmara Block, and Thakurdih Area-1 Block, depicting the interpreted anomalous zones by integrating geological, geochemical, and geophysical data from both previous and present investigations carried out by GSI and MECL.
	<b><u>Ore Band (Lode) Nomenclature</u></b>	
6.	As reported under para 7.8.9, there are mainly 8 mineralised zones commonly found in both Southern Band and the Northern Band (Table 19.1). More clarification/justification is required how the Lode-1 of Southern Band is same and also interpreted as Lode-1 in the Northern Band. If the nomenclature starts from the Footwall lode, no lode should be named Lode-1 in the Northern band, unless structurally they are modelled in 3-D correlation or detail structural interpretation to be the same. To understand better, surface projection of all the ore zones indicating the lode nomenclature may be prepared.	Attended.  Northern band lodes renamed prefixing NB & Southern band lodes renamed prefixing SB (eg. Lode-1 renamed as Lode-NB1) to avoid confusion. A separate Geological map prepared and shown surface projection of ore zones and litho units and shown in Plate No. IV.B.
7.	Following inconsistencies in nomenclature were also observed even while considering them at different cut-off grade – refer Annexure-XII-A and Annexure-XII-B. a. Lode-6 along Bh MTB/13 from 29.50m to 38.50m at 0.2% cut-off is shown as Lode-4 from 31.00m to 34.00m at 0.5% cut-off. b. Lode-6 along MTB/14 at 0.2% cut-off is shown as Lode-4 at 0.5% cut-off. c. Lode-3 along MTB/7 at 0.2% cut-off is shown as Lode-2 at 0.5% cut-off. d. Lode-4 along MTB/6 at 0.2% cut-off is shown as Lode-5 at 0.5% cut-off. e. Lode-3 along MTB/6 at 0.2% cut-off is shown as Lode-4 at 0.5% cut-off. Such inconsistencies will certainly impact the correlation and also the resource estimation. A paragraph may be added on how are the Lodes numbered.	Attended. Corrections attended and the same has been incorporated in the respective Text and Annexures.
8.	It is reported under para 10.2.8 read with Annexure-1A that one of the Bedrock sample from Garnetiferous Mica schist analysed highest Cu values. Reason for not deciding any borehole against it may be mentioned under the	The Garnetiferous mica schist exposure showing malachite staining is small (50×70 cm) and isolated within forest area with no similar surface signs or

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	same para. Even along the adjoining section S-13, the borehole MTB-12 is positioned further up-dip of this occurrence.	encouraging Cu values nearby. A trench made beside it revealed no further exposure due to thick soil cover, so no borehole was planned solely on this basis. However, borehole MTB-12 was proposed in Section S-13 to confirm strike continuity from mineralization intersected in MTCB-10. One borehole in Section S-12, near the said bedrock point, may be considered in the next phase of exploration.
	<b><u>Map preparation</u></b>	
9.	<p>The Geological map at Plate-IVA appears extremely clumsy. The hatch lines and symbols suppress other information. It is therefore suggested that</p> <p>(a) Instead of hatch symbols, light colour code may be used.</p> <p>(b) Since adequate information is available through boreholes on sub-surface geology, lithic boundaries may be interpolated and such inferred contact may be drawn by dashed lines. It will help to a great extent correlation of lithology along the boreholes with those of surface.</p> <p>(c) In view of structural complexity and the area being dominantly soil covered, it is better if another map (at the same scale) is prepared integrating Geology and interpreted IP (Text Figure- 6B) and ground EM (previous GSI work as mentioned in para 3.2.3) geophysical signatures.</p> <p>(d) Several old workings are plotted along section lines passing through Boreholes MTB-03, MTB-07, MTB-12, MTB-13, MTB-16. But they are not shown on the Geology map (Plate IV-A) although an index is made for it.</p> <p>(e) The Index on Lithology should be same both in Plan and Sections. In case local variation is observed in the boreholes, it should be grouped into the broad lithology.</p> <p>(f) Symbols for a particular lithology should not be different in Plan and section. For example, it is observed that Metabasic schist is represented by Light Green NE-SW hatched lines on the Plan (Plate IV-A) whereas it is Light orange horizontal hatched lines in the section.</p>	<p>Attended.</p> <p>Necessary suggestions and corrections attended in relevant Plates.</p> <p>A separate map (Plate No. IV.D) composite map has been prepared for all sub-blocks of Baharagora, including Mundadevta-Darkhuli &amp; South Jharia Block, Thakurdih Charakmara Block, and Thakurdih Area-1 Block, depicting the interpreted anomalous zones for expected mineralisation by integrating geological, geochemical, and geophysical data from both previous and present investigations carried out by GSI and MECL.</p>

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10.	Geological information may be overlayed on the Level plan (Plate-VI).	Attended. Litho projections based on borehole data overlayed on Level plans.
11	From the Level Plan (Plate- 6A), it is observed that (a) The MTCB -11 appears under-drilled. The Lode intercepted in MTB-2, if joined with the one along MTB-4, passes at a deeper level along MTCB-11. (b) The lodes intercepted along MTB-6 are likely to be present and continue further NE and downdip of MTB-17. Few boreholes as proposed at para 2 above will confirm it.	Noted. MTCB-11 was a scout borehole drilled (91.50m) to test the geophysical anomaly during previous exploration. Close spaced drilling shall be taken in next phase of exploration.
12	It is suggested that the geophysical logging results (multi-para logger) may be plotted on the Transverse sections. This will help in integrated reading and understand better the geophysical properties and the mineralisation.	Attended. Interpreted Borehole geophysical logging results pertaining to integrated anomalous zones plotted on sections (Plate No.)
13	In Plate-V.A and Plate V.B and Text Figure-9, effort should be made to corelate surface geology with the lithology intercepted in the boreholes.	Attended.
	<b><u>Miscellaneous</u></b>	
14	It is reported in para 3.2.3 that ‘ground evaluation of electromagnetic (EM) coupled with magnetic signatures (work done by GSI in the past) indicated presence of potential mineralisation in Baharagora area’. Since EM data is very useful for sulphide mineralisation, it is suggested that the interpreted EM map should form a part of this report. Further it is also mentioned in the same para that GSI had carried out exploratory drilling during 1975-78. However, it is not clear from the report whether any borehole previously drilled by GSI lie in the present Thakurdih area-1 block. If not, the same may be mentioned.	Noted. GSI’s Interpreted EM map of the area is not available.  GSI (1975-78) not carried out any drilling in present Thakurdih Area-1 Block.

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15	In the Table-7.1, the 'Newer Dolerite' is shown as a Supergroup having Kolhan, Dhanjori and Singhbhum groups as its subdivision – which is not true. As per the most of the works, the 'Newer Dolerite' is considered as the last geological formation, post all the deformational episodes. The most accepted stratigraphy of Singbhum-Odisha craton is that of Saha et.al 1988.	Attended. As suggested stratigraphy of Singbhum-Odisha craton after Sahat et.al 1988 incorporated in the report.
16	In Text Figure- 4, a basic exposure is denoted as 'Newer Dolerite'. It may be re-confirmed whether it is not part of Dhanjori metabasics.	Noted.
17	In para 7.2.4 the stratification plane (Bedding) is denoted as S1, whereas in para 7.7.0, the same is denoted as S0. It is suggested that an uniform denotation may be adopted.	Attended. Corrected.
18	In Photo-13, the Hook shaped fold is described as Type-2 interference pattern - which is not true. The Hook shaped Fold is actually a Type-3 Interference pattern as coined by J.G.Ramsay – usually resulted from nearly co-axial nature of two deformations.	Attended.
19	In para 7.7.2.2, an important observation is made that Intersection lineation due to intersection of Bedding and Cleavage is seen at many places. Since they represent hinge zones either in small scale or large scale, it is suggested that they may be plotted and highlighted on the map. It will help to delineate axial trace on the map which may indirectly define the target locales.	Attended.
20	As reported under para 19.5.2 to 19.5.5 and Table-19.3 (received separately by email dated 30.6.2025), an encouraging REE content (average 2462 ppm at 0.5% cut-off of Cu) was reported by ICP-MS analysis. In my view, these values are corroborated to the presence of Allanite (para 7.5.3 and Pmg-5) which is the most difficult mineral to extract REE from. Concerned Petrologist may be requested to confirm, in case Bastnaesite or any other easily leachable REE minerals was ever observed.	Noted. Apatite is present in the mineral assemblage and may potentially host significant REE enrichment. Additionally, a few doubtful specks of xenotime and monazite have been observed. However, their confirmation remains uncertain due to their occurrence as accessory phases in only one specimen and their extremely fine grain size.
21	Since the present block is in continuity with Mundadevta block where G2 level of exploration has been completed with substantial resources, it is suggested to include a paragraph on possible mineralisation or absence of it	Attended.

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	in the gap area of these two blocks.	
	<b><u>Minor corrections</u></b>	
22	The spelling of 'Planar' structure in para 7.7.2 may be corrected.	Attended. Corrected the same.
23	Para 7.7.2.3 – The borehole MTB-17 lies along section no. S-16 and not S-17. Secondly, the inference that presence of fractured zone along MTB-17 is due to the interpreted fault near MTB-07 may not be correct, as they lie very far from each other.	Attended.
24	Under para 10.2.9.1, the trench name (MTB/TS) may be corrected.	Attended.
25	Refer para 19.6.5 : As per Table 19.1, 15 boreholes and not 16 boreholes intercepted mineralisation at 0.2% cut-off. Similarly, 8 boreholes and not 9 boreholes intercepted mineralisation at 0.5% cut-off.	Attended.
26	In Plate-V-A, the TD of the Bh MTB-09 should be 130.00m – not 30m.	Attended.
	<b><u>Recommendation</u></b>	
27	The Recommendation as at para 21.2.1. is agreed. However, the undersigned is of the view that some more drilling is required at G3 level as suggested in aforesaid para. There may not be any requirement of additional petrological or other lab studies except analysing Cu-content of the visually segregated borehole samples.	Noted. Work carried out as per approved quantum. Additional drilling recommended in next phase exploration.
28	Considering the technological advancement in Geophysics, unless there is any budgetary constraints, Ground EM survey (e.g. LOUPE survey portable Time Domain EM survey) can be considered for the area which will fast delineate conducting bodies. This can be contemplated as a separate project by NMET.	Noted. TDEM survey recommended next phase exploration.

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29	Petrographic and Ore- Microscopic report are of good quality. However, radiometric dating of different sulphide phases will throw more light on the timing of the mineralisation and the deformation events. The photo micrograph at Pmg-8 clearly establishes later remobilisation of chalcopyrite around intergranular spaces.	Noted. Radiometric dating studies are not scope of present exploration.
30	All the corrections and suggestions as above, if accepted, may be incorporated in the final GR proposed to be submitted in August, 2025 (para 3.2.14)	Attended. All necessary corrections and suggestions attended and incorporated in the Geological Report.