Request for Proposal

For

Technical Services for the Preparation of Pre-feasibility Study for Setting up of Beneficiation Plant for Copper Project, Ambaji, Gujarat

RFP NO.: GMDC/PP&D/008/2025-26

Answer to Pre- Bid Queries and Corrigendum document-2

Gujarat Mineral Development Corporation

May 2026

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
1	Section II, Clause 1.2(a)(viii) Page no. 9	The Service Provider shall be responsible for the packaging and transportation of samples from the mine site to its lab. The transportation costs shall be reimbursed by GMDC at actual on submission of requisite supporting evidence. The Service Provider shall need to present the options for the mode of transport and take GMDC's consent prior to sending sample to its lab.	Confirm whether split or parallel dispatch of representative samples to more than one approved laboratory is permissible with GMDC concurrence. Some of the tests require specialized facilities, allowing split samples improves technical quality and reduces risk.	Please note there is no restriction on split or parallel dispatch of representative samples to designated lab. However, if the Bidder does not own lab in such case, it can either form Consortium with Lab provided maximum number of members in consortium should not exceed 2 or subcontract the lab work provided it meets requirements stated in clause 5.1 (vii). The RFP envisaged only one Lab in line with the Consortium criteria and not multiple labs.
2	Section II, Clause 1.2(c) Page no. 10	All test works mentioned in the RFP are broad and indicative and the Service Provider would be required to prepare a detailed Test Work Plan to establish the beneficiation amenability of the ore, for affirmation by GMDC. Based on the results of characterization, a beneficiation system will be developed. Note: The Service Provider may include or remove tests from the indicative list if deemed extraneous with GMDC approval.	Clarify whether additional bench-scale tests, reagent trials or pilot-scale recommendations may be added, if required technically, without cost penalty. Polymetallic ore behaviour may warrant additional testing beyond initial scope of PFS.	As per the notes under Task 2 , the lists of tests provided are indicative and the Service Provider may include or remove tests from the indicative list mentioned if deemed necessary for the purpose of establishing the beneficiation parameters in line with the project objective with the approval of GMDC. The Service Provider would be required to prepare a detailed Test Work Plan to establish the beneficiation amenability of the ore without any additional costs other than the Lumpsum costs quoted as per the Price Proposal.
3	Section II, Clause 1.7 Page no. 13	The Service Provider shall ensure the representativeness of the metallurgical test samples with respect to ore type, ore mix, dilution, and proposed production and shall assume responsibility of ensuring representative sample.	Clarify whether responsibility for representativeness is limited to execution as per GMDC-approved sampling plan and does not cover inherent geological variability. Geological heterogeneity is beyond consultant control and may otherwise create unlimited liability.	GMDC has undertaken an extensive exploration exercise across its mine lease areas of Copper Project Ambaji. From 1977 to 2026, total of apprx. 50,000 meters of exploration drilling has been completed. Of which, apprx. 50% of the drill core is available.

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
				In order to identify the representative sample, GMDC shall share borehole data of apprx.50000 meters of exploration drilling with the selected Service Provider. Basis, the analysis of this data, the Service Provider may identify the borehole for collecting representative samples. GMDC shall share sample of existing drill core with the Service if it is readily available it after retaining mandating core sample with it. If any additional drilling is suggested by the Service Provider, in such case GMDC shall undertake such additional drilling at Service Provider's suggested location within the GMDC's lease areas. The purpose of preparing representative sample is to identify grade variations and collect the sample encompassing all the grades to the extent possible. While the Service provider shall try to formulate the representative sample , however inherent geological variability of the ore deposit, being a natural characteristic of the mineralised body and beyond the Service Provider's control, shall not be construed as a failure of representativeness attributable to the Service Provider. The Service Provider shall document and disclose any observed geological heterogeneity in its sampling report.
4	Section II, Task 2 (overall) Page no.9	Task 2 comprises sampling, sample preparation, mineralogical studies and metallurgical testing as per the detailed Test Work Plan prepared by the Service Provider and affirmed by GMDC.	Please confirm whether the GMDC-approved Test Work Plan will be treated as baseline scope, beyond which additions require formal scope adjustment.	Indicative list of tests is provided. The Service Provider may include or remove tests from the indicative list mentioned if deemed necessary for the purpose of establishing the beneficiation parameters in line with the project objective and

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
			Prevents scope addition and commercial ambiguity after technical approval.	Scope with the approval of GMDC without any additional costs as described in answer to Pre Bid query no 2.
5	Section II, Task 2 (Note) Page no. 9	Such test work should be undertaken at any NABL accredited laboratory in India or ILAC / APAC accredited agencies or internationally approved laboratories accredited by national or regional accreditation bodies.	Confirm whether Government laboratories (CSIR, NML, IBM, MECL, NMDC etc.) are acceptable even if NABL accreditation scope is partial. Reputed national labs have specialized capabilities essential for polymetallic studies.	Please refer to answer to Pre Bid query No 1 . The lab should be accredited as per the clause 5.1 (iv)
6	Section II, Clause 1.7 Page no.13	The Service Provider shall be required to return the remaining part of samples after completion or earlier termination of the contract and destroy the same in presence of authorized GMDC officials failing which liquidated damages shall apply.	Clarify whether retention of small residual composite samples by labs for QA/QC archive is acceptable with GMDC information. Retaining reference samples is standard metallurgical practice for verification and audits.	The Service Provider and/or its sub-contracted laboratories may retain a small residual composite reference sample for internal QA/QC archiving purposes, subject to the following conditions: (i) prior written intimation to GMDC specifying the quantity and location of retained samples; (ii) such retained samples shall be separately inventorised; and (iii) retained samples shall be destroyed or returned to GMDC upon GMDC's written request. This provision shall not be construed as a waiver of the sample return/destruction obligation under Clause 1.7 of Section II.
7	Section II, Task 3(e) Page no. 11	The Service Provider shall submit the digital flowsheet (Editable in METSIM/DWSIM), mass balance, reagent consumption, equipment list and plot plan at pre-feasibility level.	Confirm whether equivalent industry-standard simulators such as JKSimMet or HSC Sim may be accepted in editable format. These platforms are widely accepted for flotation and polymetallic modelling.	The RFP specifies METSIM/DWSIM as the preferred digital flowsheet format. However, equivalent industry-standard process simulation platforms such as JKSimMet, HSC Sim, or METSIM shall also be accepted, provided: (i) the digital flowsheet is submitted in an editable and industry-standard format; and (iii) the format is accompanied by a brief

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
				note confirming compatibility with standard mineral processing design workflows. In case the Service Provider can not provide editable version of the digital flowsheet, in such case it has to provide mutually agreed simulated scenarios of mass balance and its impact on yield and tailings.
8	Section II, Task 4 Page no. 12	The Service Provider shall suggest tailings disposal systems in line with sustainable practices. While the preference shall be for dry stack tailing, the Service Provider may suggest another environmentally friendly option as well.	Clarify that alternative tailings or water management solutions may be recommended if dry stacking is technically or economically unviable. PFS should remain technology-neutral and recommend technically feasible solutions.	Task 4(a) of Section II explicitly states that "while the preference shall be for dry stack tailing, the Service Provider may suggest another environmentally friendly option as well." Accordingly, the PFS study is technology-neutral with respect to tailings disposal. The Service Provider is expected to evaluate all technically feasible and environmentally sound options, including dry stack, paste tailings, thickened tailings, or hybrid systems, and recommend the most appropriate solution based on the tailings characterisation results and site-specific conditions.
9	Section II, Task 4(b) Page no. 12	Service Provider shall provide best suitable dewatering facility design in line with sustainable and Zero Liquid Discharge (ZLD) approach.	Confirm whether hybrid tailings solutions may be evaluated if dry stack is not viable at PFS stage. Enables practical evaluation without rejection risk for non-dry stack solutions.	As stated in Task 4(b) of Section II, the preference is for dry stack tailings; however, the Service Provider may suggest another environmentally friendly option. Hybrid tailings management solutions (e.g., partial dry stack with thickened underflow discharge) may be evaluated and recommended at the PFS stage if dry stacking alone is technically or economically unviable. The Service Provider should assess and present trade-off options at a high level, with recommendations for the subsequent feasibility stage.

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
10	Section III, Clause 5.1(ii) read with Clause 5.1(vii) Page no. 25	The RFP permits participation through a Consortium and limits the maximum number of Consortium members to two (2). It is further stated that in case the Bidder is a Consortium, it shall not be permitted to subcontract the testing work involving laboratories.	Kindly consider amending the RFP to either (a) permit more than two Consortium members, or (b) allow subcontracting of specialized laboratory/testing work under a Consortium structure, subject to GMDC approval and compliance with qualification requirements. The scope of work covers diverse and specialized activities (mineralogy, metallurgy, flotation, tailings, simulations), which may require multiple domain-specific entities. Additional flexibility would facilitate optimal technical coverage while retaining clear accountability to GMDC.	RFP Conditions remain unchanged.
11	Clause 5.1 (iv) Page no. 26	The Bidder should have testing facility/laboratory for the mineralogical/metallurgical testing and flowsheet development. Such testing facility/laboratory should have accreditation from any national accreditation authority of respective countries OR international authority which is a member/ signatory of ILAC / APAC OR quality certification by verification body accredited by national	it is requested to clarify and permit flowsheet development as an optional requirement, and to consider bidders as qualified if they possess established mineralogical and/or metallurgical testing facilities, even if dedicated in-house flowsheet development facilities are not available at the qualification stage. Mineralogical and metallurgical testing facilities represent the core	RFP conditions remain unchanged.

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
		accreditation authority of respective countries / international accreditation authority signatory of ILAC / APAC. The Bidder must provide the evidence for this.	technical capability for beneficiation studies. As flowsheet development is generally undertaken after test work and refined at later study stages, making it optional at the qualification stage would support wider participation while remaining consistent with industry practice.	
12	Section III, Clause 5.1(vii) Page no. 26	Replacement of subcontractor after award shall not be permitted except in exceptional circumstances upon approval of GMDC.	Request allowing replacement with equivalent or higher accredited labs with GMDC approval in case of force majeure. Ensures project continuity without reducing technical standards.	The RFP at Clause 5.1(vii)(f) permits replacement of a subcontractor only in exceptional circumstances upon GMDC's approval, subject to the replacement bearing equal or higher credentials than the previous subcontractor. Events constituting genuine Force Majeure under Clause 3.6 of the Contract (including statutory/regulatory closure of a laboratory) shall qualify as exceptional circumstances.
13	Section III, Clause 5.1(vii) Page no. 26	Subcontracting of testing work is permitted subject to fulfilment of specified conditions and bidder remains responsible.	Clarify whether multiple laboratories may be engaged for different test categories under a single bidder. Different test streams require specialised facilities.	Please refer to answer to Pre Bid query No 1.
14	Section III, Clause 5.1(vii)(a–h) Page no. 26	Subcontracted lab must meet accreditation and experience criteria and bidder remains fully responsible.	Confirm acceptability of flowsheet inputs generated at subcontracted labs provided final integration is done by bidder. Reflects standard industry collaboration practices.	This is acceptable but complete responsibility for the Scope of Work as well as the quality of the deliverables as per the RFP terms shall remain with the Service Provider/ Lead Member.

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
15	Section III, Clause 5.1(vii)(d) Page no. 27	The bidding firm must have prior experience with the subcontractor for at least one similar assignment.	Confirm whether experience across multiple past projects with same lab network is acceptable. Long-term working relationships may span multiple projects.	Yes.
16	Section III, Clause 6.2(c)(2) Page no. 32	Presentation on Approach and Methodology is considered for technical score.	Confirm whether lab partners may participate in presentation under bidder supervision. Improves clarity for complex metallurgical aspects.	Yes, lab partner's participation (Sub contractor or Consortium member) in the A&M presentation is desirable.
17	Section IV, Clause 2(b) Page no. 44	Payment shall be made upon satisfactory provision of services against defined milestones.	Request flexibility in Task-2 milestone certification where iterative lab testing is required. Metallurgical test loops are inherently iterative.	Task 2 milestone payment shall be released upon Submission of the complete Task 2 report covering all required test work. The iterative nature of metallurgical test work is acknowledged and does not require modification of the milestone structure. Such iteration can be undertaken so as to complete the Task 3 as per the Scope of Work.
18	Section IV, Clause 2(b) Page no. 44	Milestones are linked with submission and acceptance of deliverables.	Clarify whether partial or conditional milestone acceptance is permissible. Supports cash flow without compromising technical integrity.	No. This will be difficult to accept.
19	Section IV, Clause 2(b) Page no. 44	GMDC may verify milestones prior to payment and timelines are submission based.	Confirm that GMDC-directed additional testing will be treated as variation with separate compensation. Protects bidder from unplanned cost escalation.	Indicative list of Tests is provided. The Service Provider may add/ remove based on its due diligence and prior work experience. Please refer to answer to Pre Bid query No 2. This will be difficult to accept at this stage.

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
20	Section IV, Clause 2(b) Page no. 44	Delays in commencement may occur due to sample availability or approvals.	Clarify that milestone timelines and payments will be adjusted for GMDC-caused delays. Ensures balanced risk allocation.	As per the Clause 3.4(b) of Section V, GMDC may extend the Contract Period where delays are not attributable to the Service Provider. No liquidated damages shall accrue for periods of delay not attributable to the Service Provider. In case of extension beyond 12 months due to reasons not attributable to the Service Provider, an annual escalation based on prevailing inflation in India on the remaining fees amount shall be provided as per the clause 3.4(b).
21	Section V, Clause 4.4(ii) Page no. 54	Service Provider shall obtain GMDC's prior approval before entering into a subcontract.	Clarify whether subcontractor approval is deemed granted if details are included in Technical Bid. Avoids post-award procedural delays.	Yes but it should meet the criteria and conditions provided in clause 5.1 (vii).
22	Section V, Clause 4.2.2 Page no. 54	Service Provider and sub-service providers shall not disclose confidential information without GMDC approval.	Confirm that back-to-back NDAs executed by bidder with labs are acceptable. Practical confidentiality management for subcontracting. Practical confidentiality management for subcontracting.	Please refer to Answer to Pre Bid query No 1. Back-to-back Non-Disclosure Agreement executed by the Service Provider with its sub-contracted laboratory is acceptable. A copy of any such NDA shall be made available to GMDC upon request, and the Service Provider shall ensure that the terms of such NDA are at least as stringent as the confidentiality obligations under Clause 4.2.2 of the Contract.
23	Section V, Clause 3.6 Page no. 50	Force Majeure includes events such as natural calamities, strikes, pandemics and government actions.	Confirm that statutory or regulatory laboratory shutdowns qualify as Force Majeure. Such shutdowns are beyond bidder control.	Statutory or regulatory closure of a laboratory ordered by a competent government or regulatory authority, being an event not caused by the Service Provider's or its consortium member or its subcontractor's negligence, shall qualify as a Force Majeure event under Clause 3.6.1 of the Contract.

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
				The Service Provider shall notify GMDC in writing within the prescribed timeline and shall take all reasonable measures to mitigate the impact, including identification of an alternative accredited laboratory for GMDC's approval.
24	Section V, Clause 8.2.2 Page no. 60	Liquidated damages apply for delays solely attributable to the Service Provider.	Exclude delays due to GMDC-directed re-testing or force majeure events from LD calculation. LDs should apply only to controllable delays.	As Per Clause 8.2.2 of Section V, liquidated damages are explicitly applicable only to delays 'attributable to the Service Provider.' Delays arising from Force Majeure events, or any other cause outside the Service Provider's reasonable control shall be excluded from the LD calculation .
25	Section V, Clause 8.2.2 Page no. 60	No liquidated damages shall apply for delays beyond Service Provider's control.	Clarify applicability for technically essential re-testing. Prevents penalty for quality-driven iterations.	Iterative re-testing that is technically essential to establish reliable beneficiation parameters and which is included within the GMDC-approved Test Work Plan, shall not attract liquidated damages. Where such technically necessary iterations result in timeline extensions, the Service Provider shall notify GMDC in writing with technical justification, and GMDC shall consider appropriate timeline adjustments in case to case basis.
26	Definitions, Clause 23 Page no. 6	Battery Limit is defined from ROM receiving hopper to final concentrates and tailings disposal.	Confirm whether ROM crushing assumptions may be modified if indicated by test results, within battery limits. Enables technically justified optimisation without scope breach.	Modifications to ROM crushing circuit design assumptions based on test work results are within the Service Provider's scope and represent the expected outcome of Task 2 and Task 3. Such modifications do not breach the defined battery limit, as they remain within the prescribed upstream boundary.
27	Multiple clauses across Section II, Section III and	The RFP at several places uses the expressions "metal beneficiation", "beneficiation plant for metal projects", and "metal-based mining projects" in	Kindly amend and replace the term "metal beneficiation" with "mineral beneficiation" throughout the RFP document wherever it appears.	The terms 'metal beneficiation,' 'beneficiation plant for metal project,' and 'metal-based mining projects' used across the RFP are to be read and interpreted as **meaning beneficiation of metallic mineral ores**

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
	Technical Evaluation Criteria	the Scope of Work, Qualification Criteria and Technical Score Criteria.	Beneficiation is technically and universally applied to ores and minerals. This will ensure consistency in terminology across the document and provide greater clarity and uniform understanding during bid evaluation and subsequent execution.	(specifically copper, lead, and zinc in the context of this assignment).
28	"Clause 4.4 Sr. No 2, Annex 2" Page no. 65	Documentary evidences for work experience from the client such relevant portion of Work Order/contract/Client completion certificate to be submitted. For confidential engagements, bidder may submit sanitized details supported by the Auditor of the firm or a registered Chartered Accountant / registered CPA / equivalent OR self-certification from the Managing Director/CEO of bidder's firm to ascertain authenticity.	Request to consider the experience of Preparation of Detailed Project Report / Feasibility Study / Pre-Feasibility Study / Detailed Engineering / Basic Engineering for a beneficiation plant of a metal project involving flotation studies, carried out internally by the Owner/Client for its own use shall be considered as eligible experience for meeting the qualification criteria In several cases, Owners/Clients execute feasibility and engineering studies internally through their in-house technical teams without issuing formal work orders or completion certificates. Acceptance of such internally executed and duly certified work will ensure fair evaluation and avoid exclusion of technically competent bidders, in line with the intent of the qualification criteria	RFP does not restrict the eligible experience for the in-house Project. However, the Bidder should substantiate such experience through (i) Self-certification by the Managing Director/CEO of the bidding firm confirming the nature, scope, and completion of the study and (ii) Supporting evidence such as the internally approved study report (or sanitized relevant portions thereof), internal project completion records, or equivalent documentation authenticated by the Auditor/CA/CPA of the firm. Such experience shall be evaluated on the same basis as externally contracted experience.

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
29	SoW Task 2 a. ii. Page no. 9	Sample collection methodology is to be defined by the Service Provider based upon the sample point identified. GMDC shall assist in collection of samples from the site under the supervision of the Service Provider in terms of drilling, carving out ore etc by deploying manpower and machineries. However, it may be noted that the grinding, crushing, packing and transportation of samples from the site shall be the responsibility of Service Provider at its own cost and risk. Service provider may use GMDC's lab facilities for this work.	"in SoW 2 a. vii says GMDC shall provide resources in terms of labourers and equipment for the sample preparation from site including the crushing, grinding, coning and packaging of the samples.	Please refer to answer to Pre Bid query No 3. Please note the clause The Clause 1.2(a)(vii) describes GMDC's facilitation role . GMDC shall deploy labourers and equipment at the mine site to assist in the physical sample preparation activities under the Service Provider's supervision. The Service Provider remains responsible for supervision and overall management of the sample preparation process. GMDC's support under (vii) reduces the Service Provider's on-site resource burden but does not transfer the risk responsibility.
30	Sow Task 2 a. v. Page no. 9	In case the Service Provider's technical team deems it necessary to carry out any additional exploratory drilling work for sample collection, they shall recommend bore hole locations / areas for generating representative samples and quantify the same. Upon affirmation by GMDC, GMDC shall arrange to carry out the additional exploratory drilling through a separate agency at its own cost and provide the samples.	In case of Additional Exploration / Drilling is required than Timeline needs to extend hence time schedule should be revised	Please refer to Please refer to answer to Pre Bid query No 3. In case of Additional Exploration / Drilling is required than Timeline shall be suitably extended. Please also note that the Timeline for the Task 2 onwards is linked with receipt of Sample at the Service Provider/s designated lab location.
31	Clause 5.1 (v)	The Bidder should have satisfactorily completed Preparation of at least one Detailed Project Report/ Feasibility Study/Prefeasibility study/ Detailed	The Bidder should have satisfactorily completed Preparation of at least one Detailed Project Report/ Feasibility Study/Prefeasibility study/ Detailed	RFP Condition remains unchanged

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
		Engineering/ Basic Engineering **for beneficiation plant of metal project involving flotation studies**, in the last ten completed years and current year (2014 to 2025).	Engineering/ Basic Engineering **for beneficiation plant of metal / Mineral involving flotation studies / washability studies / similar studies**, in the last ten completed years and current year (2014 to 2025)	
32	Section II, Point 1.2 (a), ii, Pg No. 9	Service providers may use GMDC's lab facilities for crusing, grinding and sample preparation	Request you to please clarify that the GMDC facilities will be chargeable or free of cost for the aforementioned purpose.	GMDC's on-site laboratory facilities made available to the Service Provider for sample preparation purposes (as referenced in Clause 1.2(a)(ii)) shall be provided free of cost for the purpose of this assignment. Consumables, reagents, and any other materials consumed during sample preparation by the Service Provider at GMDC's facilities shall be procured and borne by the Service Provider.
33	Section II, Point 1.2 (a), v, Pg No. 9	Upon affirmation by GMDC, GMDC shall arrange to carry out the additional exploratory drilling through a separate agency at its own cost and provide the samples.	Request you to please confirm whether there is any on number's of additional boreholes which can be requested to GMDC	Please refer to answer to Pre Bid query no 3
34	Section II, Point 1.3 (h), Pg No. 11	It is hereby clarified that overall flowsheet shall only include separation level up to the level of Concentrates of Cu, Zn, Pb and any trace minerals. The Service Provider shall suggest possible technologies for separation of Cu, Zn, Pb and any trace mineral based on the characteristics of the concentrate envisaged as per this study.	Request you to please clarify whether individual metal concentrates need to be prepared as final product or mixture of Cu, Zn, Pb and trace minerals	The objective of the flotation study under this PFS is to develop a flowsheet for selective flotation to produce separate, individual concentrates of Cu, Pb, and Zn (and any trace minerals), rather than a bulk mixed concentrate. As stated in Task 3(h), the overall flowsheet shall include 'separation level up to the level of Concentrates of Cu, Zn, Pb and any trace mineral.'
35	Section III, Point 5.1 (iii), Pg No. 26	The Bidder must have an average annual audited revenue of INR 100 crore OR USD 11.54 million or	Request you to please include relaxation as per Govt. of India gazette notification for MSME startups	RFP Conditions remain unchanged

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
		equivalent (for foreign firms) for last three years.		
36	Section III, Point 5.1 (iv), Pg No. 26	The Bidder should have testing facility/laboratory for the mineralogical/metallurgical testing and flowsheet development. Such testing facility/laboratory should have accreditation from any national accreditation authority of respective countries OR international authority which is a member/ signatory of ILAC / APAC OR quality certification by verification body accredited by national accreditation authority of respective countries / international accreditation authority signatory of ILAC / APAC. The Bidder must provide the evidence for this.	Please clarify whether the bidder is allowed to hire a sub-contractor or tie-up with some standard laboratory for testing purpose if they do not own the same	The Consortium or Sub contracting with the lab is permitted provided it meets the criteria specified in clause 5.1 (ii) or 5.1 (vii).
37	Section III, Point 5.1 (v), Pg No. 26	The Bidder should have satisfactorily completed Preparation of at least one Detailed Project Report/ Feasibility Study/Prefeasibility study/ Detailed Engineering/ Basic Engineering for beneficiation plant of metal project involving flotation studies, in the last ten completed years and current year (2014 to 2025).	Beneficiation involving flotation is applicable to the Minerals / Ores mined out from the mine. Hence, requested to change the terminlogy from "metals" to "Minerals"	As clarified in the response to Query 27, the terms 'metal beneficiation' and 'beneficiation plant for metal project' used in the RFP are to be read as synonymous with **beneficiation of metallic mineral ores**
38	Section V, Point 4.7, Pg No. 55	Documents and materials made available to the Service providers by GMDC shall be the property of GMDC and shall be marked accordingly. Upon	Please confirm that all data and Geological models will be provided in editable files as the same will be	GMDC shall provide all available study reports, data, and documents pertaining to the Ambaji Project in their existing digital format upon signing of the NDA.

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
		termination or expiration of this Contract, the Service providers shall make available to GMDC an inventory of such documents and materials and shall dispose of such equipment and materials in accordance with GMDC's instructions.	required to desktop study before sample collection	
39			1. Detailed information on ore composition, mineralogical distribution, and grade variability (Cu, Pb, Zn), along with the presence and distribution of deleterious and trace elements (e.g., As, Sb, Ag, Au). 2. Additionally, please confirm the availability of any 3D geological/block model or domain-wise classification.	1. Minerology details of the ore is specified in Annexure 2 of this Report . 2. GMDC shall share all available information i.e Mine Plan, Geological Resource Report , exploration report, data/drawings/bore hole log sheets , geological block models, assay logs, lithology data, and spatial distribution to the successful Service Provider upon signing of the NDA.
40			1. Details of any existing mineralogical and metallurgical test work conducted, including key outcomes. 2. Further, clarity on the availability, representativeness, and quantity of samples/drill cores for testing, and whether composite samples representing Life-of-Mine (LOM) conditions are available.	1. GMDC has undertaken (i) Chemical Analysis of Core samples and (ii) Ore microscopic studies of core samples. These shall be shared with the successful Service Provider. 2. Representative samples are not available at present. The Service Provider shall need to assess and guide for the collection of representative samples. Please refer to answer to Pre Bid query No 3.
41			The expected concentrate grades, recoveries, and any penalty limits,	Flowsheets designed to a level of accuracy of at the most ± 50% is prescribed in Task 5 Scope of Work .

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
			along with any preferred or benchmark processing routes (e.g., flotation strategy), if available.	GMDC does not prescribe specific floatation strategy. The Service Provider shall establish flotation with maximum yield possible with minimum feed grade.
42			Information on tailings characteristics, geochemical behavior, and preferred tailings disposal approach (dry stack/paste/slurry), along with any site-specific environmental or regulatory constraints.	No information/ data on tailing characteristics and geo chemical behavior are available presently.
43			Clarification is requested on water availability and quality, power supply, land availability, and key infrastructure considerations relevant to beneficiation plant and tailings storage facility planning.	Sources of water availability shall be specified by GMDC but quality of water shall be determined by the Service Provider The Service Provider is expected to assess and quantify broad infrastructure requirements for the beneficiation plant at PFS level of accuracy (±50%) as part of Task 4(c), and to identify any critical infrastructure constraints or dependencies in the risk assessment under Task 6.
44			The extent of scope regarding trace element recovery, downstream processing considerations, and expectations with respect to identification of technology partners.	The overall flowsheet scope under this PFS is limited to separation of ore up to the level of individual concentrates of Cu, Pb, Zn, and trace minerals if possible (as stated in Task 3(h) and Clause 23). Recovery of trace elements (e.g., Ag, Au, Cd) in both concentrates and tailings shall be assessed and reported, to the extent possible as explicitly required in Task 3(h).

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
				The Service Provider shall also identify key technology partners and players for downstream processing of concentrates as required under Task 3(h). Detailed downstream processing design is outside the battery limit of this Pre-Feasibility Study
45			Clarification is needed on the proposed plant capacity (throughput basis), the mine production schedule, and the design criteria to be considered. Additionally, specify any benchmark CAPEX/OPEX assumptions or costing guidelines that must be followed.	Proposed Plant capacity is 0.5 million tons per annum. CAPEX and OPEX estimates shall be developed at PFS level with accuracy of ±50% as prescribed in Task 5.
46	Section II Cl. 1.2 Page no. 10	Task 2: Mineralogical Testing c) Mineral Processing and Metallurgical Testing	Please confirm the test work protocol shall be designed for Sulphide ore and the flowsheet shall be designed for Sulphide ore only.	Yes, your understanding is correct.
47	Section II Cl. 1.1 Page no. 8	Task 1: Preliminary Review and Site Visit	If any further drilling is required to get a representative sample, whether time extension for the project will be considered accordingly.	The equivalent timeline shall be added, and such shall be considered to be extending the timeline of the respective milestone. Please refer to answer to Pre Bid query No 3
48	Section II Cl. 1.3 Page no. 11	Task 3: Flowsheet Development based on Lab scale flotation tests in closed circuit	Please confirm, Flow sheet and Mass balance shall be provided in editable excel sheet	Please refer to answer to Pre Bid query No 7.
49	Section II Cl. 1.1 Page No. 8	Task 1: Preliminary Review and Site Visit	Geological block model alone is not sufficient to decide the location of samples to be collected. Mining plan shall also be required from GMDC.	The Mining Plan shall be shared with the selected Service Provider upon signing of the NDA.
50	Definitions, Clause 23	"Battery Limit" for the project shall be considered as starting from the	Battery limit for tailings shall be at discharge conveyor of tailings	

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
	Page no. 6	receiving hopper of ROM from the Mine before primary crushing facility and the end point is output of Cu, Zn and Pb concentrates as well as tailings disposal.	dewatering plant. Excluding overland conveyors, stackers and TSF.	Design preparation for the TSF is not required at this stage, however, Service Provider is expected to specify the followings for the TSF. • Nature, characteristics, and chemical composition of the tailings, as well as settling time data. • Suggest an appropriate disposal method that aligns with sustainable practices and minimizes environmental impact. • Broad layout and planning. This means Facility Type required for TSF storage and conceptual elaboration of the tailing's pipeline/conveyor route from the processing plant to the TSF
51	Section II Task 4 (a) Page no.	Tailing Storage Facility / Infrastructure: ..... - Broad layout and planning.	Metso will not provide any planning for the TSF. The term "broad layout" is very vague. However, Metso can include space envelope in the layout if the area requirements are provided by others.	
52	Section II Task 2 (a) (vii) Page no.9	The Service Provider shall deploy its personnel to guide and supervise the sample preparation, and it shall assume the responsibility of ensuring representative sample. GMDC shall provide resources in terms of labourers and equipment for the sample preparation from site including the crushing, grinding, coning and packaging of the samples.	Metso's will only provide expertise on advisory level. Suggest to change "supervise" to "observe" or delete and leave "guide" only.	Please also refer to answer to Pre Bid query no 3
53	Section II Task 4 (c) Page no. 12	Other Facilities: Service Provider shall also indicate the is expected to provide broad/ high level layout and capacities for the other facilities such as required power, water, land etc.	Layout shall strictly be limited to the facilities within battery limits. Utilities, Infrastructure, warehousing, electric substation, etc. is not part of current scope. Metso will provide typical	Agreed.

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
		related to beneficiation plant based on its previous experiences. It is to be noted that design preparation is not required at this stage.	consumptions and make space allowances in the layout.	
54	Section II Task 3 (e) Page no. 11	Flowsheet. The Service Provider shall submit the digital flowsheet (Editable in METSIM/DWSIM)	Metso will need to use own propriety Software for flowsheet development. Only Reports would be available.	Please refer to answer to Pre Bid query No 7.
55	Section II Task 6 (d) Page no. 13	The risk analysis shall also include geological uncertainty, i.e., how mineralogy/ore hardness/ reagent demand could vary year-on-year during mine life.	This can only be done on a very high level with nomination of what risks may need to be looked at without quantifying the risks. We suggest to further clarify the extend of such risk assessments before we can commit to that.	Under the risk assessment , the Service Provider shall need to provide mutually agreed various simulated scenarios of mass balance and its impact on yield and tailings.
56	General Queries		The anticipated feed grades of 2% Cu, 4% Pb, and 4% Zn and also Au, Ag, and in assays need to be tracked. Could you kindly **confirm if you have any indicative feed grades for Au, Ag, and in as well**	Presently no such information is available.
57	Annexure 9: Format of power of attorney	WHEREAS the Company deems it expedient to appoint or authorize Mr___ son of __ resident of _____, holding the post of _____ as the authorized signatory of the company/ firm in connection with the request for proposal titled (Name of the RFP) RFP Number: _____ dated	WHEREAS the Company deems it expedient to appoint or authorize [insert name] Mr___ son of __ resident of _____, holding the post of _____ as the authorized signatory of the company/ firm in connection with the request for proposal titled (Name of the RFP) RFP Number: _____	This can be accepted

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
		_____, issued by the (Name of the other party) (the "RFP") and to execute and deliver for and on behalf of the Company the RFP documents and to comply with any other requirements connected to or arising from the RFP documents and/or from the RFP process for the firm/company in its name and on its behalf, that is to say: To act as the Company's/firm's official representative for submitting the Bid comprising Technical Bid and Price Bid for the said project and other relevant documents in connection therewith; To sign all the necessary documents, papers, testimonials, applications, representations and correspondence necessary and proper for the purpose aforesaid RFP; To RFP documents, receive and make inquiries, make the necessary corrections and clarifications to the Proposal and other documents, as may be necessary;	dated _____, issued by the (Name of the other party) (the "RFP") and to execute and deliver for and on behalf of the Company the RFP documents and . and to comply with any other requirements connected to or arising from the RFP documents and/or from the RFP process for the firm/company in its name and on its behalf, that is to say: Tto act as the Company's/firm's official representative for submitting the Bid comprising Technical Bid and Price Bid for the said project and other relevant documents in connection therewith.; The procurement authority of [insert name] within the Company is established and governed by [insert document name], attached herein for your reference. To sign all the necessary documents, papers, testimonials, applications, representations and correspondence necessary and proper for the purpose aforesaid RFP; Any representations, warranties, assurances, or commitments made beyond the scope of the submitted documents shall not be binding on the Company unless and until they are expressly	

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
			agreed upon in writing by duly authorized representatives of the Company. WHEREAS the Company deems it expedient to appoint Mr. Ashvani Sahu to To RFP documents, as the primary point of contact for all matters related to project management and official correspondence between the Parties, including, to receive and make inquiries, make the necessary corrections and clarifications to the Proposal and other documents, as may be necessary	
58	ANNEXURE 11: Undertaking	It is certified that the information furnished here in and as per the document submitted is true and correct and nothing has been concealed or tampered with. We have gone through all the conditions of RFP and we are liable to any punitive action for furnishing false information / documents.	It is certified that the information furnished here in and as per the document submitted is true and correct and nothing has been concealed or tampered with. The documents have been prepared with degree of skill, diligence and workmanlike manner ordinarily expected from a professional engineer applying the standards generally adopted by professional engineers for the technical disciplines involved. We have gone through all the conditions of RFP. and we are Metso does not accept and shall not be liable for liable	This undertaking concerns the submittal of technical proposal submitted in response to this RFP for technical evaluation purposes. However, any error/ variation/ deficiencies in work after the award of the work shall be dealt with as per Cl. 8.2.1 of SECTION V of the RFP (pg. 59). Therefore, proposed changes in in the undertaking which is at the Technical Proposal stage is difficult to accept. Therefore, RFP conditions remain unchanged.

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
			to any punitive action for furnishing false incorrect information / documents, unless such incorrect information is issued by fraudulent misrepresentation.	
59	ANNEXURE 16: Non discloser	Please see Annexure 16	Metso requires that the entire NDA is formed in mutual fashion, protecting each party's confidential information respectively. If GMDC cannot change the NDA template of the Annexure 16 at this stage, Metso notes that before Metso can accept any work and share any information with GMDC, a separate NDA must be agreed between the parties to also protect Metso's confidential information. "Disclosing Party" shall mean the party to this Agreement that discloses Confidential Information to the other party ("Receiving Party"), whether directly or indirectly, through any means including written, oral, electronic, or visual communication, in connection with the purpose set forth in this Agreement);	Please note the format of NDA provided in the Annexure 16 specifically defines Disclosing party as GMDC. This is catering to the information disclosed / shared by GMDC with the Service Provider. However, any fresh NDA should not conflict, or violet provisions stated in RFP
60	3.7.2(a) "Termination by the Service Provider"	GMDC fails to pay any amount due to the Service provider pursuant to this Agreement and not subject to dispute pursuant to Clause 9 hereof within 45	GMDC fails to pay any amount due to the Service provider pursuant to this Agreement and not subject to dispute pursuant to Clause 9 hereof within 45	The clause 3.7.2 (a) refers to the Events leading to Termination and not the number of days in which the payment shall be made usually.

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
		(forty-five) days after receiving written notice from the Service provider that such payment is overdue;	(forty-five) days after receiving written notice from the Service provider that such payment is overdue. Notwithstanding the foregoing, Service provider shall have the right to suspend performance of Services after 7 days ,GDMC's failure to pay any amount due pursuant to this Agreement, with the effect of Service provider being eligible for time extension corresponding the period of such suspension (and delayed payment);	Please note, GMDC shall make payment for Services delivered as per the payment milestone within 15 days as per the Payment Terms specified in Section IV. Therefore, this insertion is not required.
61	4.3.2. "Liability of Service provider":	4.3.2: Notwithstanding anything to the contrary, the aggregate maximum liability of the Service provider under this Contract shall not exceed the Contract Value subject to that this cap shall not apply to damages specified in clause 8.1 and 8.2.	4.3.2: Notwithstanding anything to the contrary, the aggregate maximum liability of the Service provider under this Contract shall not exceed the Contract Value subject to that this cap shall not apply to breach of Intellectual Property Rights and Confidentiality obligations.	Agreed
62	4.6 "Intellectual Property Rights	All plans, drawings, specifications, designs, documents, reports, frameworks, test outcome report, flow sheet, databases, content and documents prepared by the Service providers solely in performing the Services under this Contract shall become and remain the property of GMDC, and the Service providers shall, not later than upon termination or	(i) All plans, drawings, specifications, designs, documents, reports, frameworks, test outcome report, flow sheet, databases, content and documents prepared by the Service providers solely in performing the Services under this Contract shall become and remain the property of GMDC, and the Service providers shall, not later than upon termination	There is no discernable difference between the bidder's proposed Clause and the Clause published as a part of the RFP.

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
		expiration of this Contract, deliver all such documents to GMDC, together with a detailed inventory thereof.	or expiration of this Contract, deliver all such documents to GMDC, together with a detailed inventory thereof.	
63	4.6 "Intellectual Property Rights	Any pre-existing Intellectual Property Right (IPR) developed by the Service provider independent of the Contract, including know-how, technology, testing methods, software, databases, models etc. ("Service provider Tools"), for which the Service provider at the time of signing of this Agreement has a legal right, will be and remain owned by the Service provider, or otherwise, if it does not have a legal right, which would meet the commonly used tests and criteria for IPR identification, will be and remain owned by the Service provider. If the specific IPR is developed during the execution of this assignment/ Project for this assignment/ Project, then such IPR shall be owned by GMDC.	Any pre-existing Intellectual Property Right (IPR) developed by the Service provider independent of the Contract, including know-how, technology, testing methods, software, databases, models etc. ("Service provider Tools"), for which the Service provider at the time of signing of this Agreement has a legal right, will be and remain owned by the Service provider, or otherwise, if it does not have a legal right, which would meet the commonly used tests and criteria for IPR identification, will be and remain owned by the Service provider.	RFP conditions remain unchanged.
64	New Clause 11.	11. "Sanctions":	Both Parties warrant that it is not subject to EU financial or trade restrictions the U.S. Treasury Department Office of Foreign Assets Control list of U.S. Specially Designated Nationals and Blocked Persons or any similar list maintained by any EU member state or the	**Following clause stands added.** GMDC agrees that it shall be the sole end user of the Goods, Deliverables of Services and related documentation provided pursuant to this Agreement. GMDC shall not provide Service provider's Goods, Deliverables or Services and related documentation to any third

Sl. No.	Clause No. & Page no.	Clause Description	Pre-Bid queries/ Clarification	Response / Addendum / Corrigendum if any
			country of registration of Purchaser or Metso ("Trade Restrictions"). GMDC agrees that it shall be the sole end user of the Goods, Deliverables of Services and related documentation provided pursuant to this Agreement. GMDC is prohibited to provide Service provider's Goods, Deliverables or Services and related documentation to any third-party or country under Trade Restrictions, even if the project or the third-party is outside of Trade Restricted country. A breach of this warranty shall be a material default for the purpose of this Agreement. Each Party shall be entitled to suspend or, if required terminate the Agreement if continuing the Agreement creates a Trade Restrictions violation risk to the other Party.	country during the Agreement Period. A breach of this warranty shall be a Material default Breach for the purpose of this Agreement. Service provider shall be entitled to raise this issue by issuing a written notice of such Material Breach explaining in detail with substantial documentary evidence of such Material Breach and providing an opportunity to remedy/ cure the same within 90 days from the date of receipt of such written notice from the Service Provider. GMDC shall respond in writing to such notice if GMDC is of the opinion that it has not breached the above warranty and in such a scenario both the Parties shall try to resolve the dispute as per the Dispute Resolution mechanism provided in this Contract. If the Parties are unable to resolve the dispute, the Service Provider shall have a right to terminate the Contract and in such an event GMDC may exercise such rights as maybe available under this Contract and law.

Annexure 1: Schedule of Bidding

Clauses 1.6 of Section III, (i.e.: Schedule of Bidding) Bid submission events stand amended as below.

Sr. no.	Event Description	Amended Clause as per Corrigendum 1	Amended Clause
4	Last Date and Time of Submission of Technical Bid and Price Bid in Physical Hard Copy	Bidders shall be required to submit the Technical Bid and Price Bid physically in hard copy in sealed cover duly super scribed as mentioned in the RFP clause 4.4 to the GMDC addressed as below through **registered post/courier / Speed Post/Hand delivery.** **Address:** Gujarat Mineral Development Corporation Limited, Khanij Bhavan, 132 ft. Ring road, Gujarat University Ground, Vastrapur, Ahmedabad - 380001 Gujarat, India. Land Lines: 079-27912443 **The submission should be made strictly on or before: 03/06/2026 16:00 Hrs. IST (Indian Standard Time)**	Bidders shall be required to submit the Technical Bid and Price Bid physically in hard copy in sealed cover duly super scribed as mentioned in the RFP clause 4.4 to the GMDC addressed as below through **registered post/courier / Speed Post/Hand delivery.** **Address:** Gujarat Mineral Development Corporation Limited, Khanij Bhavan, 132 ft. Ring road, Gujarat University Ground, Vastrapur, Ahmedabad - 380001 Gujarat, India. Land Lines: 079-27912443 **The submission should be made strictly on or before: 18/06/2026 16:00 Hrs. IST (Indian Standard Time)**
5	Opening of Technical Bid	On **03/06/2026** at 17:00 Hrs. IST (Indian Standard Time) at GMDC office situated at Ahmedabad as per the address specified in sr. no 4	On **18/06/2026** at 17:00 Hrs. IST (Indian Standard Time) at GMDC office situated at Ahmedabad as per the address specified in sr. no 4
6	Opening of Price Bid	To be indicated at later date after completion of Technical Evaluation	To be indicated at later date after completion of Technical Evaluation

Annexure 2: Minerology Information

MINEROLOGY BY

RTZC

4.2 REGIONAL GEOLOGY

The Ambaji copper, lead and zinc deposit is situated at the south-western extremity of the Delhi synclinorium in meta-sediments belonging to the Ajabgarth series of the Pre-Cambrian Delhi System. Ambaji is the largest of a number of similar multi-metal deposits in a belt which extends in a northerly direction over a distance of 50 km. (See Plate 6).

The regional structural trend is NE-SW although this has been locally modified by later folds with an E-W trend (cross-folds).

The Ajabgarth series comprises a succession of calcareous, arenaceous and argillaceous sediments containing intercalated lenses of impure calc-magnesian material - the host rock for sulphide mineralisation. A series of basic igneous rocks has intruded this sedimentary sequence.

Regional medium grade metamorphism accompanied the main phase of folding which produced the regional trend of the rocks.

Intrusions of large granite bodies (as seen at Mt. Abbu, and Gabba Hill near Ambaji) followed the regional metamorphism. This was closely associated in time with the cross-folding.

4.3 DEPOSIT GEOLOGY

4.3.1 LOCAL GEOLOGICAL ENVIRONMENT

The Quartzites - A group of predominantly siliceous meta sediments of varying mineral composition, grain size and texture. They can be fine grained (cherty) and massive with only minor micaceous minerals. Elsewhere chlorite, biotite, and/or muscovite can become dominant and the rock is best described as a quartz mica schist. To the east of the present mine and in the vicinity of the proposed mill site (see Plate 5) the quartzite contains visible, rounded, feldspathic grains and can be termed a meta-arkose.

The Talc-Schists - This group of rocks is host to the sulphide mineralisation. Like the quartzites it displays considerable variation in its characteristics over short distances in both dip and strike directions. The most important mineral constituents are talc and tremolite with lesser and variable amounts of quartz, chlorite, biotite and muscovite. Occasionally lenses and bands of serpentine marble occur within the talc-schist.

The talc-schists occur as discrete lenses arranged *en echelon* within the quartzites. Within each rock unit the lithologies show considerable variation due to facies changes. The relationship between the talc-schists and the quartzites can be complex with an interfingering of the two rock types. The sequence is assumed to become younger from SW-NE.

A well defined horizon of marble and calc-silicates outcrops immediately to the NE and SW of the quartizites. The repetition of this rock unit has been interpreted by the GSI as due to folding. The marble and calc-silicates are considered by the GSI to be older than the quartzites and talc-schist and therefore a synclinal fold axis is shown between these two outcrops, (see Plate 7). This interpretation is accepted for the present study although in future work it should be critically reviewed before beginning an exploration programme. The Ambaji deposit is considered to be on the SW limb of this syncline. The NE limb dips steeply to the SW and in places to the NE - i.e. it is locally overturned.

The original sediments were intruded by a series of igneous rocks, ~~(see Plate 7)~~, which are listed here in order of intrusion.

(Oldest) Gabbro/Dolerites	-	Pre-folding and regional metamorphism which produced epidiorites and amphibolites. In the Ambaji area the intrusive contacts are concordant with the surrounding meta-sediments.
Granites and Aplites	-	Post-regional metamorphism
(Youngest) Dolerites	-	Seen as black, fine grained comparatively fresh-looking rocks which cut the other intrusives.

4.3.4 MINERALISATION ④ → See MEC-Vol. Page 18.

The lithology of the host rock exercises a strong control over the sulphide mineralisation in the following respects:

- Most of the mineralisation is confined to the talc schist lithologies;
- Lead and zinc values tend to be higher in the tremolite rich talc schists;
- Copper values tend to be higher in the quartz-biotite-chlorite varieties of talc schist.

The mineralisation occurs as stringers and disseminations, in massive and banded forms. The most abundant minerals are pyrite, sphalerite, galena and chalcopyrite. Magnetite, ilmenite and pyrrhotite occur as minor minerals. The results of a detailed petrographic study are shown ~~in Appendix B2.~~

The banding is developed by variations in the proportions of the sulphide mineral composition and/or gangue minerals from band to band. Individual bands vary in width from a few centimetres up to about 3 metres.

In the Northern Zone individual bands become progressively richer in copper towards the footwall of the zone, (~~see Appendix A2.1~~). In addition there is a progressive decrease in lead and zinc values with increasing depth. Similar zoning probably exists in other areas, but as yet the drill hole spacing is not close enough to ascertain whether such trends are present.

MINEROLOGY BY

MECL

5.00 MINERALISATION

5.01 Aerial extent of the Ambenata mineralised zone is about 2 kms. long in the WNW direction and is about 0.7 kms. wide in the central portion.

Surface indications of mineralisation

5.02 Compared to the metal contents of ore zones found at depth, surface manifestations of mineralisation are not as impressive as would normally be expected. The reason for this appears to be that at least part of the evidence appears to have been obliterated by ancient workings and mine debris. Further, smeary crusts, nodular films etc., resulting from the leaching of pyrite, have obscured the typical box work produced by the base metal sulphides. However, limonite encrustations derived from the oxidation of sulphide minerals are observed at several places along the entire length of individual zones, sometimes in the insitu outcrops, and more commonly in the debris of ancient workings. The limonites are of various shades of red, brown, black, yellow, maroon and ocherous colours and occur as films and veinlets along the foliation, bedding and fracture planes of talc schist and arenaceous group of rocks. Gossan outcrops with box structures of coarse cellular honeycomb, rectangular and diamond-mesh patterns with thin rigid or soft walls partly or fully filled up by limonite, goethite or cerusite, are noticed at a few places.

5.03 Surface indications of copper mineralisation are noticed in the form of sporadic encrustations of malachite and rarely azurite, generally in the debris of ancient workings. They are best seen in the two saddles located in the southeastern and northwestern blocks. Malachite stains are also observed at some places in the main basic rock band.

5.04 Rare occurrence of tiny specks of primary sulphides, such as pyrite and chalcopyrite, are observed in the brecciated quartzite and metamorphosed basic rocks.

5.05 The most impressive indications of mineralisation are the large number of old workings which have been located practically at all the surface showings of mineralisation. Slag heaps amounting to about 0.75 million tonnes also indicate that ore has been extracted and smelted in the area.

5.06 It has been possible to roughly demarcate important mineralised zone with the aid of surface manifestations of mineralisation and old workings. These have been designated as 'blocks' for purposes of exploration (Plate 7)

Name of block	Strike length at the surface in m	General dip of mineralised zone	Surface R.L. in metres
Northern	450	35°	470 to 520
Central zone and its eastern extension	1100	60°	470 to 505
Southern zone	680	80°	460 to 490
Northern western	670	60°	480 to 515
Southeastern	840	55°	460 to 510
Zone north of shaft No. 2	160	80°	470 to 510

Total strike length : 3900 m.

Nature of Mineralisation

5.07 The sulphide-bearing lodes at Ambamata occur as a series of close-spaced, parallel to subparallel lenses separated by sulphide-poor or barren partings. Richer mineralisation is generally associated with calc-magnesian metasediments, and less commonly with the calc-arenaceous ones. The main host rock for mineralisation is the talc-tremolite-biotite-chlorite schists and their variants.

5.08 A conspicuous feature of the ore bodies and the metasediments is their short range variability both in their as well as in the mineral composition.

5.09 Mineralisation occurs as massive and bedded sulphide zones, structure and disseminations.

5.10 A shear pattern in the incidence of the four principal metals of sulphide component of the ore is discernible, the various combination being represented by the following :

Iron	...	Pyrite
Iron-Copper	...	Pyrite-chalcopyrite
Iron-Copper Lead-Zinc	...	Pyrite-chalcopyrite-galena-sphalerite
Iron-lead-zinc	...	Pyrite-galena-sphalerite

5.11 Ignoring iron, this reveals a pattern of Cu-Pb-Zn relation. There are thus layers containing only copper, followed by addition of lead-zinc, and finally only lead-zinc. In addition, copper-lead association is also noticed occasionally. These associational and segregational tendencies amongst these metals,

particularly between copper on the one hand and lead-zinc on the other, are broadly correlatable with their preference for the aronaceous and calc-magnesian metasediments respectively.

5.12 Stanton (1972, p 521) has also discussed the preferences shown by copper-rich and lead-zinc rich ores to specific stratigraphic horizons within the same mineral district.

5.13 Sulphides, particularly of Pb-Zn or Pb-Zn-Cu are generally massive, but often show poor to well-developed banding The stratification is developed by the variations in sulphide-silicate, sulphide-sulphide and rarely sulphide-oxide (magnetite) proportions from band to band, the individual bands varying in width from a few mm to a few cms. The linear structures in the ore zones run parallel to those of the country rocks.

5.14 Pyrite, sphalerite, galena and chalcopyrite form the major sulphide minerals. Magnetite, ilmenite and pyrrhotite occur as minor minerals. Besides these, a number of accessory minerals are also noted (appendix No.II, (In report on mineragraphy).

5.15 The ores exhibit a variety of textures which reflect the complicated geological history of the deposit. Texture of ore is poly-crystalline, comprising minerals with different crystal shapes and of varying grades and sizes. Various textures like the deformation, recrystallisation, replacement and exsolution are noted in the ores.

5.16 Most of the Ambaji ores are very fine to fine grained in size, only the segregation veins and veinlets of galena, sphalerite and chalcopyrite are medium to coarse grained.

5.17 Various combinations of intergrowths and inclusions are noticed in polished section. Some of the combinations observed are the chalcopyrite-sphalerite, chalcopyrite-galena, sphalerite-galena, sphalerite-chalcopyrite-galena, magnetite-ilmenite, inclusions in sphalerite and chalcopyrite, cubanite-pyrrhotite, pyrrhotite-pyrite/marcasite and arsenopyrite-pyrite intergrowths and silver-gold mineral inclusions in basemetals and gangue.

5.18 The ore bodies, along with the rocks of the areas have been subjected to metamorphism and other deformational disturbances. Due to this reason, paragenesis could not be

worked out. However the following crystalloblastic series is given below, arranged in the decreasing order of the force of crystalisation of important opaque minerals under metamorphic conditions. They are Magnetite, ilmenite, pyrite, arsenopyrite, sphalerite, pyrrhotite, chalcopyrite and galena.

5.19 All the above minerals mutually replace one another or enclose the others giving poikiloblastic textures.

5.20 Analysis of data gathered from the ore assemblage indicates that the deposit is of mesothermal grade.

5.21 No secondary enrichment has been noticed in the deposit. Chalcocite and covellite contents of the deposit are quite low and they occur mostly as transitional phases during oxidation of chalcopyrite. Oxidation of ilmenite, pyrite, magnetite, chalcopyrite, sphalerite and galena has taken place to a limited extent giving rise to sphene, goethite, martite, malachite/azurite, greenockite/smithsonite and cerusite respectively. Supergene enrichment in the deposit may therefore, be considered of no economic significance in the deposit.

5.22 Host rock : The main host rock for mineralisation is talc-tremolite-biotite-chlorite schist and its varients. Other rock type containing mineralisation is the biotite-quartz schist in which the mineralisation occurs as dissemination in the biotite-quartz schist.

5.23 Control of Mineralisation : Both lithology and structure have played a part in the localisation of mineralisation. Mineralisation generally occurs along foliation and bedding planes. Mineralisation has been involved in the structural disturbances effecting the rocks in the area. The ore shoots show a NNE trend related to the F_1 fold movement and the reoriented NW to WNW trend of F_2 tectonic activity. In addition, particularly the massive Pb-Zn-Cu ore bodies show the effects of thickening and thinning along the nose and limbs of the folds respectively. Effects of faulting and fracturing are also noticed in the ore bodies.

5.24 Genesis : The problem of the genesis of ore bodies at Ambamata was not studied in detail during the course of present investigation. Not much work has been carried out by other workers also on this subject. However, the available published views (Deb, 1973 and Shekar, 1973) suggest that the ores are protectonic and prometamorphism in age and are likely to be of stratiform origin.

Minor Constituents

7.39 Apart from zinc, lead and copper, the ore bodies contain a number of other constituents. Full potentiality of the ore elements could be known only after detailed tests are conducted; however, a general idea of their potential may be arrived at from the results of spectroscopic analysis, fire assay and beneficiation tests conducted on three bulk samples. Results are dealt with under the following heads:

i) Minor valuable constituents
ii) Elements which occur as traces and rare elements
iii) Deleterious constituents.

7.40 A number of composite samples have been analysed from exploratory workings and the A, GM and UB series of boreholes, in the deposit by fire assay and spectroscopic analysis. Samples have been analysed both from the ore and non-ore zones. The number of samples analysed are 601.

7.41 Details of results are given in table nos. V, VI, VII, IX. Plate No. 54 is the assay plan for gold, and silver and cadmium.

Minor Valuable Constituents

7.42 Important minor valuable constituents are the following:

1) Silver
2) Gold
3) Cadmium
4) Sulphur

7.43 Relevant beneficiation results for silver, gold and cadmium are summarised in table A in beneficiation chapter.

7.44 [illegible]- 189 composite core samples from the mine block were subjected to fire assay. Semi-quantitative determinations (spectroscopic analysis) for 277 samples from all the zones (blocks) were made. Details are as follows:

Fire Assay		Spectroscopic analysis	
No. of samples	Range gms/tonne	No. of samples	Range ppm.
55	Traces	182	⟨ 20
54	⟨ 10	45	20-⟨ 30
35	10-⟨ 19	22	30-⟨ 50
21	20-⟨ 29	18	50-⟨ 80
11	30-⟨ 49	3	80-⟨100
9	50-⟨ 79	6	100-⟨150
4	80 and above	1	225

7.45 For the ore zones in the mine (aggregate length samples 250.65), the average comes to 15.24 gms/t, Results for the hanging wall portion of N_1 shoot (main x-cut north x-cut of No.2 east drive and north and south x-cuts of No.2 west drive) give an average of 32.8 g/t, over an aggregate width of 68.08 m. Results for the footwall portion of shoot N_1, (main x-cut, north and south x-cuts of No.3 east drive and north x-cut of 3 west drive) give an average of 12.4 gms/t over an aggregate width of 123.99 m. In case of shoot C_1, an average of 8.1 gm/t over an aggregate width of 40.30 m is obtained. All widths given are along the cross-cut and not true widths.

7.46 Beneficiation results indicate that silver and gold are concentrated mostly in lead and copper concentrates.

Gold

7.47 189 composite core samples from the mine block were subjected to fire assay. Spectroscopic analysis was conducted on 32 samples, of which 8 were from the mine block. Details are as follows:

Mine block

No. of samples		Range gms/tonne
136	.....	
3	.....	Traces
20	.....	Upto 0.29
9+8[x]	.....	0.3 to 0.49
17	.....	0.5 to 0.99
2	.....	1.0 to 2.9
2	.....	3.0 to 4.9
	.....	5.0 and above

X spectroscopic analysis,

ppm values; rest are results of fire assay

Other Zones - Spectroscopic Analysis

7.48 24 samples have analysed from traces to 2 ppm. Average value of the entire mine, covering a width of 250.65 m is 0.35 g/t. For the H.W. portion of N_1 ore body, the average value is 0.51 gm/t over a width of 68.08 m. For the F.W. portion covering 123.99 m, the grade is 0.4 gm/t. The C_1 shoot analyses only 0.1 g/t over 40.30 m.

7.49 Cadmium:- 421 composite core samples were analysed by the spectroscopic method. The results are semi-quantitative. Details are as follows:

No. of samples	Range ppm.
96	ND
150	< 50
56	50 - < 100
28	100 - < 200
16	200 - < 300
27	300 - < 500
31	500 - < 800
6	800 - < 1000
11	more than 1000

N.D.: Not detected

7.50 Values for ore zones in the mine are 185.7 ppm 0.19 kg. over an aggregate width of 250.65 m. Values for H.W. and F.W. of the ore body of N_1 are 442.6 ppm 0.44 kg. over 68.08 m. and 94 ppm 0.09 kg. over 123.99 m. Values for ore body C_1 are 121.7 ppm 0.12 kg over 140.30 aggregate width.

7.51 Beneficiation results indicate that major part of the cadmium goes with zinc concentrates.

Sulphur

7.52 Beneficiation results indicate that pyrite concentrates of good grade can be obtained both in the bulk sulphide and individual concentrates analysing more than 40 percent S. Pyrite recovery is anticipated to be more than 75 percent of the pyrite contained in the ore. Sulphur contained in Cu-Pb-Zn could be recovered during smelting.

Elements Which Occur as Traces and Rare Elements

7.53 Elements included under the above head are not of economic significance in the deposit.

7.54 Incidence of these elements in the bulk samples are given in Beneficiation reports in Vol. III of the report.

7.55 Results of analysis of individual and composite samples are given below:

7.56 Tin:- 303 mine samples were analysed and the results range from trace to less than 50 ppm.

7.57 Cobalt:- 600 samples were subjected to spectroscopic analysis. 573 samples indicate values of 50 ppm and less and the rest 27 samples range in values of more than 50 ppm and less than 200 ppm.

7.58 Nickel:- Spectroscopic analysis was conducted on 592 samples. 587 samples indicate values less than 50 ppm. 5 values range from 100-500 ppm.

7.59 Molybdenum:- Of the 250 composite core samples analysed, 207 have shown less than 50 ppm and the rest 43 samples range in values from 60-420 ppm., of this about 50 percent of the samples analyse less than 100 ppm.

7.60 Gallium:- Spectroscopic analysis of 303 core and channel samples from the mine block indicate the range in values from traces to 50 ppm.

Deleterious Constituents

7.61 Complete analysis results given in table indicate that the deleterious constituents are either absent or present well below the permissible limits, except in the case of bulk sample No.3 from the footwall side of lode No. N_1 of northern zone (table on page 39). In this case, the value of bismuth in lead concentrate is 0.24 percent Bi. Generally in lead smelters anything above 0.05 percent Bi is penalised (Deco Trefoil Nov-Dec. 64).

7.62 Arsenic:- Number of samples analysed are 315 and they are all from the mine block. Arsenic has not been detected in any of the samples; however incidence of arsenic has been noted in the bulk samples, the details of which are given in tables VI, VII and IX.

7.63 Antimony:- 303 samples from the mine block were analysed. Antimony has not been detected in 263 samples and the range of values in the remaining 40 samples vary from $<$ 100 - 720 ppm.

7.64 Bismuth:- 303 samples were analysed from the mine block. Details are as under:

No. of samples		Range ppm.
132	....	N.D.
90	....	$<$100 -
30	....	100 - $<$ 200
12	....	200 - $<$ 300
15	....	300 - $<$ 500
9	....	500 - $<$ 800
3	....	800 - $<$1000
2	....	$>$ 1000

TABLE INDICATING THE RESULTSOF BENEFICIATION - MINOR VALUABLE CONSTITUENTS OF SILVER, GOLD AND CADMIUM

Bulk Sample No.	Element	Ore gms/t	Individual Concentrates			Bulk Concentrates		Pyrite concentrates gms / t
			Cu concentrate gms /t	Pb Concentrate gms/t	Zn concentrate gms/ t	With Pyrite gms /t	Without Pyrite gms/t	
I	Gold	0.8	6.4	8.0	Trace	1.3	0.7	
II	-do-	1.7	-	-	-	-	-	
III	-do-	0.6	4.3	1.9	1.6	2.2	4.0	
I	Silver	48	96	300	18			
II	-do-	80	-	-	-	-	-	50
III	-do-	25	68	460	16	60	72	-
I	Cadmium	1 Kg/t	0.25 Kg/t	0.4 Kg/t	2.5 Kg/t	Bulk concentrate a) first sample 0.8 Kg/t b) second sample 0.3 Kg/t		30
III	-do-	0.1 Kg/t	0.25 Kg/t	0.01%	2.4 Kg/t	Bulk concentrate a) first sample 0.3 Kg/t b) second sample 0.6 Kg/t		

RELEVENT INFORMATION ABOUT DELETERIOUS CONSTITUENTS OF ARSENIC , ANTIMONY AND BISMUTH

Bulk Sample No. 1	Element	Ore	Individual Concentrate			Bulk Concentrate
			Cu	Pb	Zn	
I	Arsenic	0.031	0.019	0.048	0.035	Not detected
II	-do-	0.01	0.02	0.04	0.05	
III	-do-	0.007	0.02	0.03	0.03	Not analysed
I	Antimony	0.042	0.048	0.074	0.012	0.043 - 0.042
II	-do-	0.02	NIL	NIL	NIL	
III	-do-	⟨0.01	0.01	0.02	⟨0.01	0.01 - 0.026
I	Bismuth	0.002	ND	0.008	ND	0.002
II	-do-	-	-	-	-	
III	-do-	0.014	0.044	0.24	0.007	0.03 - 0.065

N.B. :- Antimony and Bismuth - spectroscopic analysis - semiquantitative

GOLDER ASSOCIATES

SECTION 2. MINERALOGICAL EXAMINATION

2.1 FEED

Assay:

0.62% Cu = 1.8% chalcopyrite
2.96% Pb = 3.4% galena
8.77% Zn = (~ 8.2% sphalerite
(+ 6.2% smithsonite

Particle size:

100% <250µ, 80% <125µ

Composition:

Sphalerite and pyrite are the two dominant ore minerals, with smaller amounts of galena and chalcopyrite. Chalcocite and covellite are present in trace quantities, as thin rims and veins replacing chalcopyrite. Covellite also occurs mixed with non-sulphide minerals replacing galena, and rarely locked to sphalerite and filling pores in pyrite. Oxidation of the ore is also apparent as limonite grains with a zoned structure, and as carbonate grains, thought to be mainly zinc carbonate smithsonite. Magnetite is also present as an accessory mineral.

X-ray diffraction shows chlorite to be the major gangue mineral, with minor talc, amphibole, mica and quartz.

Locking:

Chalcopyrite: 80% to 90% free. Locking mainly to sphalerite with release 25 to 100µ, and rarely to pyrite, gangue and galena. About 30% of the chalcopyrite grains show evidence of oxidation in the form of thin rims and veins of covellite and chalcocite. Chalcocite also occasionally completely replaces chalcopyrite.

Galena:

About 90% free, with locking mainly to sphalerite, sometimes to gangue, or pyrite, and rarely to chalcopyrite. Release mainly 10 to 50µ. A considerable proportion of the galena grains are partly replaced by a thin rim of oxidation products. These include some covellite, but are mainly non-sulphide, possibly anglesite.

Sphalerite:

>90% free, the remainder locked mainly to chalcopyrite and galena, and rarely to pyrite and gangue.

Pyrite:

>95% free. Locking to all other minerals.

2.2 TALC CONCENTRATE

Assay:

0.47% Cu = 1.4% chalcopyrite
2.61% Pb = 3.0% galena
6.28% Zn = ~9.4% sphalerite (+ smithsonite)

Particle size:

10% <150µ, 80% <150µ, 80% <80µ

Composition:

X-ray diffraction shows the composition to be:

Major	Talc
Minor	Chlorite
Trace	Quartz, amphibote, mica, galena, sphalerite/pyrite and smithsonite.

Traces of chalcopyrite are also seen in the polished section, and very rare molybdenite.

Locking:

Chalcopyrite: Some locking to gangue is apparent, but most of the chalcopyrite appears to be present as fine free grains, <25µ and often <10µ.

Galena:

As with the chalcopyrite, most of the galena appears to be fine and free.

Sphalerite:

Also appears to be mainly free and <40µ.

2.3 COPPER/LEAD BULK CONCENTRATE I

Assay:

1.97% Cu = 5.7% chalcopyrite
16.9 % Pb = 19.5% galena
34.1 % Zn = 50.8% sphalerite

Particle size:

100% <100µ, 80% <75µ

Composition:

Sphalerite is the dominant ore mineral, accompanied by galena and some chalcopyrite, and trace covellite, chalcocite and pyrite.

Locking:

Chalcopyrite: About 80% to 90% free (including locked covellite and chalcocite). The remainder is mainly locked to sphalerite with release 10µ to 20µ, and rarely to galena and pyrite/marcasite. A small proportion of the copper is present as free chalcocite/covellite grains.

Galena:

<90% Free. Locking mainly to sphalerite with release 10µ to 20µ. The galena sometimes has a corroded appearance and is rarely rimmed by covellite/? anglesite.

Sphalerite:

<90% free. Locking mainly to galena and chalcopyrite. Sphalerite is also very rarely rimmed or veined by covellite.

Pyrite:

Very little present - mainly free grains.

Gangue:

Little seen - mainly free.

2.4 COPPER/LEAD BULK CONCENTRATE II

Assay:

3.42% Cu =	9.9% chalcopyrite
12.2 % Pb =	14.2% galena
24.8 % Zn =	37.0% sphalerite

Particle size:

100% <25µ, 80% <125µ

Composition:

Mainly sphalerite with some chalcopyrite and galena, and a little pyrite. Rather more gangue than in bulk conc. I.

Locking:

Chalcopyrite: About 90% effectively free (i.e. released or locked to a small proportion of sphalerite or covellite/chalcocite). The remainder is locked mainly to sphalerite, and rarely to galena or gangue, with release 10µ to 50µ.

Chalcocite and covellite occur as free grains and rims and veins in chalcopyrite, and very rarely locked to galena and sphalerite.

Galena:

About 90% free, with the remainder locked mainly to sphalerite - release 10µ to 50µ. The galena is sometimes partially replaced at grain boundaries and along clearage planes by oxidation products. These products are sometimes sulphides e.g. covellite, but are mainly non-sulphides, possibly anglesite.

Sphalerite:

<90% free. Locking mainly to galena and chalcopyrite with release mainly 20µ to 50µ.

Pyrite:

Mainly free, but some locking to the other sulphides, release ~30µ.

Gangue:

Very largely free.

2.5 ZINC CONCENTRATE I

Assay:

2.35% Cu =	6.8% chalcopyrite
5.27% Pb =	6.1% galena
12.2 % Zn =	18.2% sphalerite

Particle size:

100% <200µ, 80% <125µ.

Composition:

Mainly gangue, with some sphalerite and chalcopyrite, and a little pyrite and galena. Very little fine sulphide grains, mainly <25µ.

Locking:

Chalcopyrite: About 90% free, the remainder locked mainly to sphalerite with release 10µ to 30µ.

Galena:

About 50% free, 50% locked to sphalerite and rarely to gangue, pyrite and chalcopyrite, release 10µ to 30µ. The 'free' galena grains are generally almost entirely encased by a thin rim of non-sulphide alteration products.

Sphalerite:

90% free - the remainder locking mainly to chalcopyrite and galena, and occasionally to pyrite and gangue. Release ~25µ.

Gangue:

Very largely free.

2.6 ZINC CONCENTRATE II

Assay:

1.42% Cu =	7.0% chalcopyrite
5.24% Pb =	6.1% galena
12.3 % Zn =	18.3% sphalerite

Particle size:

100% <250µ, 80% <150µ.

Composition:

Gangue with coarse sulphides grains, very largely coarser than 50µ. Mainly sphalerite with some chalcopyrite and pyrite, and a little galena.

Locking:

Chalcopyrite: About 75% free, the remainder locked mainly to sphalerite and rarely to pyrite, gangue and galena, with release 25µ to 50µ.

Galena:

About 50% free, 50% locked, mainly to sphalerite, but sometimes to gangue and a little to pyrite and chalcopyrite. Release ~25µ. Again, the free galena grains frequently have a partial surface coating of oxidation products.

Sphalerite:

90% free, the remainder locked mainly to chalcopyrite and galena, with release 20µ to 50µ.

Pyrite:

>90% free - remainder mainly locked to sphalerite.

Gangue:

Appears to be very largely free - with locking mainly to galena.

2.7 TAILINGS

Assay:

0.17% Cu =	0.5% chalcopyrite
0.80% Pb =	0.9% galena
4.39% Zn =	(~ 0.5% sphalerite
	(+ 7.8% smithsonite

Particle size:

100% <250µ, 80% <150µ.

Composition:

Gangue with some pyrite. Sphalerite and chalcopyrite are present in small, approximately equal quantities, and there is a trace of galena. Magnetite is present as a minor mineral, with trace ilmenite.

Oxidation of the ore is apparent as chalcocite and covellite replacing chalcopyrite and as numerous limonite grains, mainly free but occasionally replacing pyrite. X-ray diffraction also indicates the presence of a considerable amount of smithsonite.

Locking:

Chalcopyrite: About 75% free, the remainder locked to sphalerite, gangue and pyrite. Release ~25µ.

Galena:

A few coarse free grains (up to 250µ), but mainly locked to pyrite and gangue with release ~25µ.

Sphalerite:

Mainly present as coarse free grains 100µ to 250µ. Some locking to pyrite, chalcopyrite and occasionally to gangue or galena.

Comments:

The level of Pb in the tailings is higher than expected from the galena seen in the polished section. To determine if this could be due to the presence of $PbCO_3/PbSO_4$, a heavy liquid separation was performed on the tailings sample at SG 3.33. X-ray diffraction of the sinks fraction (13%) shows the main component to be smithsonite with a minor amount of pyrite and trace sphalerite and chalcopyrite. No lead minerals were detectable.

XRF scans of the sinks and floats fractions showed a higher concentrationof Pb in the floats, indicating that the Pb minerals in the tailings are mainly finely locked to gangue. Unfortunately the concentration of Pb minerals in the floats fraction is too low for detection by XRD, so the original problem remains unresolved.

2.8 FEED SAMPLE SECTIONS

Two polished sections labelled Location 2. Ambaji Feed Sample LII, prepared at Ambaji were received for examination.

The samples do not appear to be representative and are inadequately polished for any useful microscopic study to be undertaken. No attempt was made to study or repolish the sections as all necessary information on the feed was obtained from the ground sample (see Section 2.1).

2.9 MINERALOGICAL CONCLUSION

The feed material for this testwork is similar to previously examined Ambaji ore samples, but it represents an extreme type. It has a much higher ratio of chlorite to other gangue minerals and contains less chalcopyrite than previous samples. Oxidation of chalcopyrite in the form of rims and veins of chalcocite and covellite is not excessive, about 30% of the chalcopyrite grains being affected, however other minerals indicate a higher degree of oxidation. Smithsonite and limonite are more abundant than in previous samples, and there is some replacement of galena not previously seen.

The grind size chosen for the test is possibly a little too coarse, however this is not the main cause of misplacement of minerals in the concentrates. Oxidation of the ore leads to 'activation' of the sphalerite causing it to be recovered in the Bulk Cu/Pb concentrates, and also reduces the flotability of the galena due to its partial rimming of non-sulphide oxidation products. The high zinc loss to tailings is also a result of oxidation in the form of zinc carbonate, smithsonite.

The two polished sections of the feed material prepared in Ambaji fail to show the fine textures associated with oxidation due to their poor surface finish. They also indicate that insufficient care was taken to ensure that the samples are representative.