PROPOSAL FOR PROCUREMENT OF MINERAL LIBERATION ANALYSER THROUGH NMET FUND FOR CAPACITY BUILDING AT CSIR-IMMT BHUBANESWAR

Submitted by

CSIR-Institute of Minerals and Materials Technology, Bhubaneswar

November 2024

Summary of the proposed procurement

Sl. No.	Name of the equipment	Rate (approx..)	Unit	Amount including taxes (approx..)	Specifications	Availability within the Department
1	Mineral Liberation Analyser/ FE-SEM with Dual EDS & Mineralogy Software (Automated Mineralogy Solution)	₹ 1047 Lakhs	1	₹ 1350 Lakhs	Detailed specifications are appended in section no. 4	Nil QUEMSCAN (Quantitative Evaluation of Minerals by Scanning Electron Microscopy) purchased during 2009 and at present it is not in a working condition

1. Introduction

1.1. Overview

CSIR-IMMT deals with mineral processing activities of different types of ores. Mineral characterization is one of the major techniques essentially required for the development of beneficiation flowsheets. CSIR-IMMT has 01 no. of Mineral Liberation Analyser (MLA) which was procured in the year 2009 and presently it is out of service.

The present proposal is prepared for a Mineral Liberation Analyzer (MLA) in mineral characterization for beneficiation studies. The MLA's utility lies in its ability to provide detailed, automated mineralogical data, such as mineral composition, associations, and liberation characteristics, which are essential for developing efficient beneficiation processes.

The growing global and domestic demand for critical minerals (e.g., tungsten, rare earth elements, and lithium) necessitates advanced tools for their characterization and processing. MLA aids in understanding the mineralogical complexity of ores, ensuring efficient recovery of these scarce resources. Indian ores often exhibit wide variations in mineral composition and intricate mineral associations. MLA provides high-resolution data critical for tailoring beneficiation strategies to the unique properties of each sample. An MLA enables rapid, accurate analysis of mineral liberation, particle size distribution, and phase associations. This data is instrumental in optimizing grinding, flotation, or other separation processes. With detailed liberation and association data, the beneficiation processes can be designed to maximize recovery and minimize losses of valuable minerals. It also aids in reducing processing costs and environmental impact by improving resource utilization. The proposal aligns with national initiatives to achieve self-reliance in critical mineral supply. Enhanced characterization capacity will support research institutions, industries, and government projects working on strategic and critical minerals.

1.2. Background

Mineral liberation analysis is a very important subject for applied mineralogy and metallurgical processing. Mineral liberation data are fundamental parameters used in processing plant design and optimization. There are several systems developed in the past for mineral liberation analysis. However, industrial applications of liberation data have previously been limited because the acquisition of mineral liberation data has been difficult and expensive.

Recent advances in technology, especially in electronics and computing technology, have allowed for the development of an accurate, fast, and user-friendly mineral liberation analyzer. Very stable back-scattered electron (BSE) signals from a modern scanning electron microscope (SEM) can be used to generate quality sample images, from which the most important minerals can be differentiated using modern image analysis methods. Each mineral grain delineated from the BSE image can be positively identified with a single X-ray analysis well positioned inside the grain. Minerals of similar BSE intensities can be discriminated using simple X-ray mapping.

2.0 Mineral Liberation Analyser

The Mineral Liberation Analysis system mainly consists of a Scanning Electron Microscope, Image Capturing and Analysis, and EDS X-ray spectra. In general, MLA captures 40 to 100 images (containing 4000 to 10,000 particles) for each sample block, and a dozen blocks (of 30 mm in diameter) are measured overnight. The MLA off-line processing program transforms raw particle images with X-ray data into particle mineral maps and calculates bulk and liberation data from particle mineral maps.

Key components

- Scanning Electron Microscope,
- Image Capturing and Analysis, and
- EDS X-ray spectra

Key features

Measurement Modes

There are seven basic MLA measurement modes to handle different sample types and to meet different mineralogical information requirements. They are:

1) Standard BSE liberation analysis (BSE)
2) Extended BSE liberation analysis (XBSE)
3) Sparse phase liberation (SPL) analysis
4) Particle X-ray mapping (PXMAP) analysis
5) Selected particle X-ray mapping (SXMAP) analysis
6) X-ray modal (XMOD) analysis and
7) Rare phase search (RPS) methods

Applications/justifications

- Characterization of Ferrous, Non-Ferrous, Industrial minerals, etc.
- Characterization of Critical Minerals, Rare Earth Elements (REE), Platinum group of Minerals (PGMs), Precious metals (Au, Ag), etc.
- Invaluable tool for evaluating the beneficiation feasibility
- MLA is a very powerful analytical tool which can be used for ore bodies, concentrates and tailings
- Quantitative mineralogical analysis of primary ores, sinter products, briquettes, etc.
- MLA also finds applications in the characterization of secondary resources like (a) Mineral industry waste (ferrochrome slag, copper slag, flue dust, GCP sludge, red mud, etc.)
- This facility can be a NATIONAL FACILITY and shall be operated through CSIR-IMMT

Advantages

Prudent use of both BSE and X-ray signals from SEM is the key to an automated SEM-based mineral liberation analysis system. BSE image acquisition is very fast compared with x-ray spectrum analysis. BSE image can provide fine details of mineral intergrowth and fine grains of inclusions, such as PGM and gold, etc. However, X-ray analysis can provide elemental information, which can be used to uniquely identify almost all the minerals in a sample.

The seven MLA measurement modes vary from a purely BSE-based technique (BSE method) to a mostly x-ray analysis-based technique (PXMAP method). Considerable speed, resolution, and accuracy have been achieved in the current MLA system. Further improvements in the flexible combination of BSE and X-ray analysis can potentially raise the capability of the system substantially.

3. Technical Specifications for FESEM based mineralogy solution with Dual EDS and Software

Sl. No.	Parameter	Specifications
1.	Resolution	1.0 nm @15 kV with In lens SE detector (This resolution should be achieved in 300 nA or more current configuration)
2.	Magnification	2x to 10,00,000x
3.	EHT /Landing Energy.	200 V to 30 KV
4.	Chamber	Large chamber with at least 15 accessory ports to accommodate various future add-on like CRYO, WDS etc. Width: 300 mm or more Depth: 300 mm or more
5.	Stage	5 axes motorized stage with movements equivalent to or better. X = 100 mm or more, Y = 100 mm or more, Z = 100 mm or more Tilt= − 10° to + 90°, R = 360°
6.	Probe Current & Stability	100 nA or more.
7.	Detectors	a) Chamber mounted SE Detector for SE detection. b) YAG type Retractable BSD detector. c) IRCCD camera d) 4 or 2 Nos. EDS detector, total detection area 120 mm^2 or more, 129 eV, Boron to uranium or more and capable of doing qualitative, quantitative analysis and mapping. It should be fully integrated into FESEM software and control from FESEM GUI. e) The supply should include design of flange & Electronic interface between SEM & EDS. f) Probe current detector/monitor. g) CL Detector: Motorized, retractable, panchromatic cathodoluminescence (CL) detector, sensitive to photons emitted from luminescing materials in the ultraviolet to infrared 185 - 850 nm wavelength range.

8.	User Interface	SW Control panel with multifunction for the control and adjustment of frequently used SEM parameters like contrast, focus, scan rotation, etc.
9.	Electron Optics	Intermediate lens to take care of low spot size for higher probe current which should get high resolution even in high current. cooling system to maintain lens stability without need for external chiller. All apertures should be automated one.
10.	Display	32" TFT Monitors for FESEM without loss in resolution. Capability to store images in various formats like JPEG, TIF etc,Image store resolution of 16 K x 16 K or more. Dwell time of 20ns or less for high-speed scanning and dynamic experiments. Dual Channel: An option that displays live from two detectors onto separate monitors eg. SE on screen 1 and BSD on screen 2. A second monitor must be available for this option. Split Screen: Side by side live display with most scan-rates and image resolutions of the same image using the input from any combination of installed detectors. Image halves may be selectively processed and frozen. Quad mode: Side by side live display, on a single monitor, of the same field of view using input from up to four detector channels. Images may be selectively processed and frozen.
11.	Vacuum System	Suitable vacuum system having turbo molecular pump, ion pump, Oil-free Rotary pump and system should have penning/Pirani gauge for accurate vacuum measurements. Ultra high vacuum condition System should maintain vacuum & lens stability without the need for an additional water chiller.
12	Software	Histogram Display and Adjustment tool for the real-time visualization and adjustment of image grey values from a histogram. Measurements tool measure, Space between two lines, length along the line or manually defined areas can be measured. Data should be further exported in CSV or HTML format. Image Processing tool for image post-processing operations such as image extraction, image rotation, grayscale conversion, infobar addition brightness/contrast adjustment, structure detection, color models adjustment, geometric transformation, sharpen/blur adjustment, noise reduction, image combining and info bar manipulation. Presets tool to store and recall specific SEM operating parameters and setups from the preset panel, such as column alignments, beam current, brightness and contrast settings, landing energy, field of view, working distance or stage coordinates. Positioner tool to navigate to a region of interest with the help of a positioning template. The template can either be an image from a camera, light or (other) electron microscope, or a schematic drawing. image formats should be aligned manually/automatically using a 3-point or more alignment recipe.

		Animated 3D visualization of stage movements, that should intercepts intended stage movements that could lead to collision of stage and/or sample with internal SEM components such as pole piece or detectors. Object Area tool for area measurement of selected regions of interest in the live SEM image. Up to 4 different areas should be segmented and the results exported for subsequent numerical analysis. Switch-off Timer tool to automatically switch the microscope to power save or sleep mode, or even shut down, upon finalization of an unattended (e.g. overnight) automated imaging and analysis routine.
13	Computer	Latest configuration
14	Essential Features of Mineralogy Analyzer Software	The software should also have following features: **Throughput** – The system should be able to upgrade with 4 EDS detectors and each should be equipped with dedicated digital pulse processor. **Automated calibration** – Automated, robust BSE/EDS calibration procedure that can be rerun based on user-defined time interval and makes use of a built-in calibration standard sample set. **Data segmentation** – System should perform segmentation of both the elemental and backscattered images to identify homogenous areas formed by individual mineral grains to be used as an input for spectral summing. Segmentation algorithm can be chosen by the user with respect to the sample type and the focus of the study. Standard segmentation mode fits well with common samples whereas AI based deep segmentation better suits fine-grained rocks or oscillatory zoned minerals. **Spectral summing** – System should have the capability to combine low count spectra from pixels within the segments that increases sensitivity for less abundant elements while maintaining high data acquisition speeds. **Minimum amount of X-ray data needed for mineral identification** – System should be able to identify mineral grains even when collecting only 1000 X-ray counts per pixel. In the case of suitable samples even just 100 counts per pixel should be sufficient for positive identification. **Smart analytical modes** – Geological samples can be highly variable and the same can be said of geological research itself. System should provides necessary flexibility to fit needs of specific research using broad choice of analytical modes such as plain BSE/CL imaging without EDS, centroid EDS phase analysis, line mapping, high resolution mapping and dot mapping allowing to quickly cover large sample areas without the danger of misidentification of phases similar in BSE. All these modes can be applied either to all minerals, bright phases (as defined by user) or specific mineral searches. **Fast sample preview** – Fast preview of the entire samples in BSE/CL/SE allowing the user to specify area of interest for the mineral analysis. **Specific mineral search** – Software analysis can be set in a way that it searches the samples for grains of specific mineral or group as defined by the user (e.g. any gold containing grain). **Mineral identification based on raw element line intensities** – Minerals should be identified based on raw element X-ray line intensities not based on spectral matching or element quantification. This approach eliminates the error of low count spectrum quantification as well as the need for smooth spectra better suitable for matching. Quantification of low count spectra

		results in very high variation forcing the user to introduce very broad compositional ranges to define. System should allows identification of minerals based on low count spectra and provides user with option to apply EDS spectrum quantification only on good enough sum spectra representing the entire segment. **Ease of new phase introduction** – System should allows the user to introduce new phases into the database easily. Element line intensity ranges should be generated automatically based on reference spectrum. **General mineral rules** – System should allows to create broad mineral definition covering entire mineral groups. The system is thus capable of searching for phases containing specific elements (e.g. all mineral grains containing phosphorus – the phosphates). **Hyperspectral datasets** - The instrument should collect the X-ray spectra, backscattered and secondary electron and optionally cathodoluminescence intensities from each pixel covering entire sample surface or user defined area. Users obtain a virtual copy of the samples which can be browsed offline offering a similar level of interactivity like the live work on the SEM. Combined elemental maps, spectra and quantification are readily available. **Built-in EDS single/batch quantification of** spectra **-** Sum spectra obtained because of the segmentation and spectral summing can be used to obtain quantitative elemental information (composition of selected mineral grain or multiple grains). This is the means to obtain information on variability or average composition for large grains populations. **Stoichiometric calculations as a part of the EDS** spectrum **quantification** – System should provide means to calculate content of elements not detectable by the EDS using stoichiometric calculations. **Built-in database of several minerals -** A tool to ease identification of spectra which were not identified automatically. The database also includes information on the formula, composition, and densities as well as a link to the full version of the webmineral.com internet mineral database. **Side by side elemental, BSE, and phase map to explore particles/grains and panoramas** – System should provide side by side view allowing simultaneous browsing different analytical outputs (BSE, different elemental maps etc.). This view is available both for grains of individual minerals, for particles as well as for the entire samples. **Advanced particles/grains filtering and sorting** – Users can filter the grains/particles based on their chemical properties (content of an element in grain), mineral composition (mineral content of a particle), texture (association), morphology. **Element mass/raw intensity-based particle/grain sorting** – This feature should be available even for unclassified grains allowing to quickly identify grains hosting element of interest coming handy when trying to identify phases hosting polluting element such as lead phases occurring in soil. **Customizable particle texture reporting tool (particle categorizer)** - The key benefit of automated mineralogy is the texture particle characterization. Reporting must allow users to sort the particles into categories based on their textural properties (single or multiple properties combined using mathematical expressions). Particle properties cannot be presumed and so the user must have freedom to categorize them based on the properties he selects or combines to address the complexity of geological samples. Mass

		percentage of particle of specific textural type is a characteristic output of particle categorization. **Lithotyping -** A method used to quantify fragments of specific rock types present in the particle sample. This way it is possible e.g. to quantify the content of shale, sandstone, or limestone particles. Each rock is defined using both particle and grain properties. Sandstone definition would be based on the grain size being bigger than 63 microns and prevailing quartz. **Single supplier and single service contact** – System should be an integrated system and so the EDS detectors, digital pulse processors as well as the SEM and necessary SW are serviced by a single manufacturer.
15	Vibration free table	Vibration free table for mounting of machine and other essential items for installation and commissioning of the equipment should be quoted
16	Calibration samples	As per standards
17	UPS	Suitable UPS with back up time of minimum 1 hour
18	Manual	All manuals related to the installation, calibrations, maintenance and regular operation of entire system
19	List of end users	List of end users within India and abroad in last five years
20	Training	Training at IMMT Bhubaneswar free of cost for 1 week. Advanced training at OEM site
21	Warranty and AMC	5 Years of comprehensive warranty and 3 years of AMC

4. Cost of the equipment (quotations)

As per the market survey, CSIR-IMMT obtained quotations from the following industries:

Sl. No.	Supplier/Make	Cost (Rs in Lakhs) including GST
1	TESCAN MAKE MINERALOGY ANALYZER (TIMA) FESEM model TIMA GMS with CL detector Labindia Instruments Pvt. Ltd Nano Bio Process Division Sukriti Building, 130E, Raja S. C. Mullick Road, 2nd Floor, Kolkata -700 047 Ph : 033-3511-9403/033-3508-4516 Email: nbp.kolkata@labindia.com	1350
2	FE-SEM with Dual EDS & Mineralogy Software (Automated Mineralogy Solution) Carl Zeiss India (Bangalore) Pvt. Ltd., Bangalore Regd. Office: Carl Zeiss India (Bangalore) Pvt. Ltd. Plot No.3, Bommasandra Jigani Link Road 560099 Bangalore India	640

Both quotations are appended in the annexures I&II.
Technical Comparison is attached in Annexure III

5. Justification of Procurement

The importance of quantitative mineral analyses to mineral processing and the design and optimization of plants is well documented (Petruk, 2000; King, 1993). Quantification of mineralogy can be an important component of laboratory data. Ore variability is a challenge to most mining and processing operations. Variability in the host lithology, alteration and weathering profiles, structure, texture, fabric, and ore-mineralogy are all potential risks in the design and development of process flowsheets. These characteristics impact the properties of an ore and thus have implications in the processing. The mineral and textural variability of a deposit has implications for concentrate grades and recoveries. The deportment of deleterious and precious elements is important to minimize environmental impacts and to maximize process economics. Design and development of a processing flowsheet is a greater challenge without an understanding of the characteristics and variability of the orebody.

Geometallurgical mapping is described by Williams et al, (2004) as an important means of reducing project risk when conducted in the pre-feasibility or feasibility stages of either a new project or a major expansion. The subsequent use of metallurgical data in the modeling of an orebody is described by Bulled et al, (2005) as the key to maximizing the value of a mining and processing operation. Quantitative mineralogy data (concentration of mineral phases, grain sizes, elemental deportment, and mineral associations) is a vital component of geometallurgical characterization. Automated scanning electron microscope (SEM) based technology is highly desirable due to the resultant fundamental mineralogy data that dictate the processing strategies.

6. Work projection for next 5 years and utilization of the instrument

CSIR-IMMT, Bhubaneswar would be one of the public funded institutes in India having a Mineral Liberation Analyser facility, if funded. The institute is working on a wide variety of ore minerals such as iron, manganese, chromite, alumina, limestone, base metal minerals, strategic minerals, precious metals, critical minerals, etc. from various sources within India and abroad. Hence establishment of MLA will benefit the Indian mineral and metallurgical sector a lot. Presently, many mineral processing projects are done in the institute. The addition of MLA would reduce the project duration and increase the scientific output.

The purpose of establishing a mineral liberation analyser is to carry out mineral quantification to characterize the ore minerals. CSIR-IMMT is interested in establishing this facility to cater to the needs of public, private, and government parties.

7. Details of Technical Capabilities of CSIR-IMMT for running the instruments

Mineralogy and liberation analyses of ores and minerals play a vital role in prospecting new reserves, processing, and extraction of metals. Present characterisation techniques have limited access to in depth analyses such as identification, quantification, mineral association, grain liberation size, deportment of values, etc. This information is very much essential for the processing of low-grade ores, rare earths, critical minerals, precious metals, etc. Wherein, metal content in such ores is present in traces in ultrafine size and associated with various gangue minerals. Procurement of a Mineral Liberation Analyser would strengthen Indian mineral processing research capabilities and expand the horizons of developing process flowsheets for low-grade complex ores.

Labindia Instruments Pvt. Ltd.

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QUOTATION OF TESCAN MAKE MINERALOGY ANALYZER (TIMA) FROM LABINDIA

Ref.: LIPL/NBP/E/2024/TESCAN/IMMT/TIMA/R3
Date: 26th November 2024

To,
The Director,
CSIR- Institute of Minerals and Materials Technology,
Council of Scientific & Industrial Research,
Bhubaneswar - 751 013, Odisha, INDIA

Dear Sir,

We are pleased to submit our budgetary offer for FESEM model TIMA GMS with CL detector on behalf of our principals TESCAN Brno, s.r.o., Czech Republic.

The most important features of the FE-SEM microscope are;

- High brightness Schottky emitter for high-resolution / high-current / low-noise imaging
- Extraordinary resolution with powerful optional **In-Beam SE Detector**
- Unique three-lens **Wide Field Optics™** design offering the variety of working and displaying modes embodying the TESCAN proprietary Intermediate Lens (IML) for the beam aperture optimization.
- Real time **In-Flight Beam Tracing™** for the performance and beam optimization integrating the well-established software Electron Optical Design. It includes also direct and continual control of beam spot size and beam current.
- Fast imaging rate
- High-throughput large-area automation, e.g. automated particle location and analysis
- Superior specimen handling using a motorized comp centric stage.
- Ideal geometry for EDX and EBSD, non-distorted EBSD pattern
- Fast and easy obtaining of the clean chamber vacuum by powerful turbo molecular and dry fore vacuum pump. Electron gun pumping by ion getter pump
- Fully automated microscope setup including electron optics setup and alignment.
- Sophisticated software for SEM control, image acquisition, archiving, processing and analysis. Multi-user environment localized in many languages.
- Network operations and built-in remote access/diagnostics, all come as the TESCAN standard.

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Sr. No.	Particular	Unit Price in RUPEES
1.	**TESCAN TIMA Mineral Analyzer - FIELD EMISSION SCANNING ELECTRON MICROSCOPE** HR analytical FE-SEM column with Schottky electron source and chamber SE, operated with trackball and control PC with Essence™ operating software displayed on two 32-inch screens. Two retractable Essence EDS detectors (Mn K alpha best resolution 129 eV, 30 mm2), TESCAN DPP with 4 modules are included. 1600 mm table is part of the standard delivery. Large size, high-vacuum chamber with 20+ ports for detectors or other options that require an interface to the SEM specimen chamber. The chamber-mounted Everhart-Thornley secondary electron and BSE detector is standard, all other chamber-mounted detectors can be chosen to fit application needs. A 5-axis (with rotation assembly mounted) motorized goniometer stage with 130 (X) x 130 (Y) x 100 (Z) mm travel range is mounted to the drawer-type vacuum chamber door. The vacuum system can be switched from high vacuum to low vacuum (30 Pa) to eliminate charging of non-conductive samples. Also included: EDS standards (Pt Faraday cup, Au, Cu, Mn, C, SiO2), one sample holder for 15 epoxy blocks 30 mm in diameter. TIMA online SW (including Liberation, Bright Phase Search and Fine segmentation modules) and two TIMA offline licenses (including Fine segmentation module and delivered on HW dongles).	**Included**
	ELECTRON OPTICS Electron Gun : High brightness Schottky emitter Resolution : High Vacuum Mode In Lens SE : 1.0 nm at 15 kV Magnification at 30kV : 2× – 1,000,000× Field of View : 8.0 at WDanalytical 10 mm Accelerating Voltage : 200 V to 30 kV Probe Current : 2 pA to 400 nA Electron Optics Working Modes Resolution : High-resolution mode Depth : Sets the column up in a mode that enhances focus depth Field : Optimizes the column to provide a large non-distorted field of view Wide Field : Provides an extra-large non-distorted field of view for extra low magnification imaging	

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	SCANNING • Dwell time: 20 ns–10 ms, in steps or continuously adjustable • Full frame, selected area, line or point • Image shift, scan rotation, tilt correction • Line and frame accumulation • Dynamic focus • Drift-corrected frame accumulation (DCFA)	
	VACUUM SYSTEM **Chamber Vacuum :** High Vacuum Mode: $< 9\times10^{-3}$ Pa **Gun Vacuum :** $<3\times10^{-7}$ Pa **Pumping Time after Specimen Exchange:** typically < 3.5 minutes	
	CHAMBER Width: 340 mm Depth: 310 mm Ports : 20+ *+configuration and number of ports can be modified to customer's needs* **Chamber and Column Suspension:** Pneumatic	
	SPECIMEN STAGE **Type:** Compucentric, fully motorized **Movements:** X = 130 mm or more Y = 130 mm or more Z = 100 mm or more **Rotation:** 360° continuous **Tilt:** – 60° to +90° (WD and sample size dependent) **Maximum Specimen Height: 100** mm or more Maximum Sample Size : 180 mm diameter Note: Range of the movements can be dependent on WD	
	DETECTORS **SE :** Secondary electron detector Everhart-Thornley type (YAG Crystal) **Retractable BSE :** Fully Retractable backscattered electron detector with YAG scintillator **EDS Detector** : 4 Nos. EDS detector, 30 mm2 129 eV, Boron to uranium or more and capable of doing qualitative, quantitative analysis and mapping. It should be fully integrated into FESEM software and control from FESEM GUI. **CL Detector:** Motorized, retractable, panchromatic cathodoluminescence (CL) detector, sensitive to photons emitted from luminescing materials in the	

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	ultraviolet to infrared 185 - 850 nm wavelength range. **pA Meter** Probe Current Measurements integrated with faraday cup **Touch Alarm** Stops movements when sample touches any part of the chamber. **IR Camera** For live "Chamber View".	
	MICROSCOPE CONTROL All microscope functions are controlled by keyboard, mouse and trackball via the program MiraTC using Windows™ platform. **Computer:** Intel Core i7-8700, RAM Hyper Fury 2x 8GB 2400MHz DDR4, 250 GB SSD M.2 and 2 TB S-ATA 7200 RPM, Nvidia GTX 1060 3GB GDDR5 PCI-E x16, Windows 10 Pro 64-bit **Image Display:** 32" QHD Monitor **Image Size:** Up to 16,384 × 16,384 pixels, adjustable separately for live image (in 3 steps) and for stored images (10 steps), selectable square or 4:3 or 2:1 rectangle **Image Formats:** BMP, TIFF, JPEG, GIF, PNG etc. **Image Depth:** Up to 16 bits per channel **Remote Control:** Via TCP/IP, open protocol	
	AUTOMATED OPERATIONS • SEM emission control • Electron source alignment • Contrast and brightness, autofocus. • In-Flight Beam Tracing™	

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	TESCAN Essence™ Software: • Customizable GUI layout • Multi-user account management • Quick search bar • Undo/Redo commands • Single, dual, quad or hexa live image(s) display • Multi-channel coloured live image. **Advanced Essence™ Modules** • Measurement, Tolerance Measurement, Image Processing • Presets, Histogram and LUT • SharkSEM™ Basic (Remote Control) • Object Area • Positioner • Switch-off Timer • Different kind of sample holder,	
	INSTALLATION REQUIREMENTS • Power supply: 230 V ± 10% / 50 Hz (or 120 V / 60 Hz-optional), power 1300 VA • Compressed air: 6–7 bar (87–102 psi), clean, dry, oil free • Compressed nitrogen for venting: 1–7 bar (15–102 psi),99.99% purity (4.0 purity level) • Room for installation: min. 3 × 3 m; minimum door width 1.0 m	
	ENVIRONMENTAL REQUIREMENTS Temperature of environment: 17 – 24 °C **Relative humidity**: < 80 % Background magnetic field: synchronous < 3×10^{-7} T asynchronous < 1×10^{-7} T **Vibrations**: For pneumatic suspension: < 5 µm/s below 30 Hz < 10 µm/s above 30 Hz Acoustic noise: Less than 60 Dbc	
2.	Sputter coater with touch screen and an option to enter the coating thickness, target can be mounted down and sample on top to avoid any loose particles entering SEM, Suitable pump and gold, platinum, palladium target and carbon fibre will be supplied along with coater.	**Included**
3.	Suitable UPS with back up time of minimum 1 hour	**Included**

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4.	Training will be provided at IMMT Bhubaneswar free of cost for 1 week. Advanced training for 2 Person for 1 Week at OEM Site has been quoted.	**Included**
5.	• 5 Years of comprehensive warranty for Mineralogy Analyzer and Quoter has been quoted. • 3 years of AMC after 5 years of Warranty has been quoted • Operator to run the Mineralogy Analyzer for 5 Years has been quoted	**Included**
	SYSTEM PRICE IN INDIAN RUPEES :	**Rs. 11,44,29,543.00**
	ADD GST @ 18% :	**Rs. 2,05,97,318.00**
	TOTAL FOR DESTINATION PRICE IN INDIAN RUPEES :	**Rs. 13,50,26,861.00**

TERMS AND CONDITIONS

Sl. No.	Item	Terms of our offer
1	Validity of Offer	90 days.
2	Price basis	All prices are in INDIAN RUPEES
3	Warranty	Offered system shall be warranted against manufacturing defects or faulty workmanship for the period of twelve (60) months from the date of installation or fifteen (62) months from the date of shipment, whichever is earliest
4	Delivery	Within 6 to 8 months from the date of receipt of L/C and export clearance from Czech government.
5	Custom Duty and clearence	As applicable and should be borne by Purchaser
6	Mode of payment	100 % Irrevocable Letter of Credit
		in favour of Labindia Instruments Pvt. Ltd. 201, Nand Chambers, LBS Marg, **Near Vandana Cinema** **Thane – 400 602**
7	Taxes	Customs Duty and GST is included
8	Installation & Commissioning	Shall be done by factory trained engineer free of charge. Training on operation and preventive maintenance shall be imparted during installation

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9	Country of Origin	Czech Republic
10	Mode of shipment	Air

Yours Faithfully,
For Labindia Instruments Pvt. Ltd.
Pulakesh Panda
Sales Manager - East
Mob – 99322 39989
Email – pulakesh.panda@labindia.com

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560099 Bangalore
India

CIN NUMBER
U33125KA2009PTC049465

Your Commercial Contact
Name: Arindam Sarkar

Customer Contact
Name: Shivakumar Angadi

Date: 26.11.2024

Quotation

Quotation Number: QU27388
Customer Number: 775441

Sub: Quotation for FE-SEM with Dual EDS & Mineralogy Software (Automated Mineralogy Solution)

Dear Sir,

With reference to our discussion on the above subject matter, we are pleased to enclose herewith our quotation for Field Emission **Scanning Electron Microscope model SIGMA 360 with Oxford Dual EDS, Mineralogy Software & other related accessories manufactured by Carl Zeiss.**

The offered system configuration is best suited for your application requirement.

We wish to bring to your kind notice that Carl Zeiss Microscopy is the pioneer in the field of Scanning Electron Microscopy. We have a large number of installation base of Scanning Electron Microscopes in India which includes reputed academic and research institutes like IITs, NITs, IISc., Central & State Universities, CSIR, ICMR, ICAR, DAE, DRDO, DBT, DST labs etc. Carl Zeiss is also the most preferred imaging tools in Industrial Quality Controls and R&Ds.

We have factory trained engineers located at the offices in Bangalore, Kolkata, Delhi, Mumbai, Pune, Chennai who take care of installations & commissioning, application support, preventive maintenance & Annual Maintenance Contracts. The nearest service location to your place is Kolkata.

We trust the enclosed quotation is in line with your requirement. In case you need any further technical / commercial clarifications, please do not hesitate to contact us.

Thanking you and assuring you of our best attention at all the times.

Thanking you,

For Carl Zeiss India (Bangalore) Pvt. Ltd.
Thanks & Best Regards
Arindam Sarkar
Mob: +91 9311953780
Email: arindam.sarkar@zeiss.com

Quotation No:	QU27388
Date:	26.11.2024
Page:	2 of 6

Item	Product ID / Product Description	Quantity
1	Basic Unit Sigma 360 HV Sigma 360 Field emission SEM High resolution Schottky-FESEM with patented GEMINI-electron optics comprises combined electromagnetic / electrostatic objective lenses and crossover-free beam path. Resolution: 0.9 nm @ 15 kV, 1.3 nm @ 1kV Acceleration voltage: 0.02 kV to 30kV. Probe current: 3pA - 20nA; with optional high current mode (100 nA) Beam current stability better als 0.2%/h Automatic function for focus, stigmation, brightness and contrast. Digital store with max. resolution of 32768 x 24576 Pixel. Windows® 10 Enterprise 2019 LTSC (64 bit) multi-language operation system; user-friendly control software SmartSEM® Standard configuration: 7 pin-hole apertures with electromagnetic changeover. In-lens SE Detector: Patented column-mounted scintillator detector with optically coupled photomultiplier for high efficiency Inlens SE detection. ETSE: Chamber secondary electron detector(Everhart-Thornley); Chamber scope: Color CCD scope with illumination. SCM: Specimen current monitor Specimen chamber: 365 mm inner diameter and 275 mm height for large specimens. 10 chamber ports, including coplanar EDS and EBSD ports for simultaneous analyses, as well WDS port. Stage: 5-axes motorised Cartesian specimen stage with simulated eucentric movement X, Y = 125 mm, Z: 50mm, T= -10° to + 90°, R = 360° continuous Vacuum system: Automatic controlled pumping system, consists of turbomolecular pump and ion getter pump (IGP) for ultrahigh vacuum in the column and the emitter region. High vacuum in specimen chamber and rotary pump with oil filter. (optional: oil free pump system). Carousel 9x sample holder for standard stub sample holder. (ø 13mm) Dual channel mode: Enables the display of two different detector signals in different SmartSEM windows. Quad mode: Side by side live display, on a single monitor, of the same field of view using input from up to four detector channels. Images may be selectively processed and frozen. Dual mag: Enables a user defined area on the left-hand half of a split screen display to be zoomed from 1x to 10x. Images from different detectors can be displayed at different magnifications. Fisheye: Enables you to acquire a fisheye image of the specimen holder and the interior of the specimen chamber. Reduced raster: Adjustable in size and position, reduced area scanning for fine adjustment of stigmation, focus, etc Focus Compensation: Automatic compensation to minimise focus changes over the entire acceleration voltage range.	1 PC

Quotation No:	QU27388
Date:	26.11.2024
Page:	3 of 6

Item	Product ID / Product Description	Quantity
	Tilt compensation: correct the perspective foreshortening caused by the scan of a tilted specimen. Dynamic Focus: allows the dynamic adaptation of the focus to tilted specimen surfaces. Drift correction: Image analysis software to compensate for image drift by beam shift control. Drift Corrected Frame Averaging / Integration: Enables drift compensated frame integration and averaging. Center point: Enables you to mark a spot in the image which is then automatically moved to the center of the Image Area. Compucentric stage: Compucentric functions enable you to maintain the focus when the stage is tilted or rotated, even in case of a non-eucentric stage Macro generator: for automatization of routine work. Stage scan: Enables you to scan an exactly defined series of regularly distributed image fields. Stage registration: Enables users to define specific coordinate systems for the specimen stage. Sample type selection: select from collection of predefined specimen types including the appropriate settings. User accounting: Automatic registration of special parameters during a working session to enable the instrument administrator to trace who worked on the microscope. For each user, the number of saved *.tiff images, output photos and prints are saved. Advanced measurement: Provides further measuring possibilities such as measuring of rectangles, inserting horizontal/vertical measuring lines. remote access module SmartImage: advanced image processing algorithms for improving noisy and/or low contrast images.	
2	Specimen holder L46+L76 Geo	1 PC
3	24"-monitor kit 24" flat panel TFT colour display monitor	1 PC
4	100nA High current mode 100nA High current mode Gemini 1	1 PC
5	Control panel with rotary controls - UK Control panel with rotary controls and keyboard UK English	1 PC
6	Inlens Detector Kit - M1 In-lens SE Detector: Patented column-mounted scintillator detector with optically coupled photomultiplier for high efficiency Inlens SE detection.	1 PC
7	CL-360-FLHS (ASAP) Cathodoluminescence detector for Sigma 360 Front LHS Port	1 PC

Quotation No:	QU27388
Date:	26.11.2024
Page:	4 of 6

Item	Product ID / Product Description	Quantity
8	Dual Joystick Controller Dual Joystick Controller	1 PC
9	SW SmartSEM 8.01 Perpetual DLic	1 PC
10	SW SmartSEM Toolkit Sigma DLic	1 PC
11	5S-HDBSD-360-LHS (ASAP) 5 segment high definition solid state BSE detector, side retractable, 16 mm diode, for Sigma 360 LHS 72mm port	1 PC
12	Chiller air-cooled Water chiller Air-cooled 110 - 230V (50/60 Hz)	1 PC
13	EXTIF cable f/SVSEM External interface for communication with 3rd party EDS detector	1 PC
14	Air Compressor - 240V PT5 Bambi Compressor 230V 50Hz / 60Hz (oil free)	1 PC
15	AVI 400-EM2-LP HWL Active Vibration Isolation AVI 400-EM2-LP-700x720x20	1 PC
16	Consumables (Stubs, Carbon Tape,), Online UPS (10kVA)	1 PC
17	Training	1 PC
18	5 years warranty & 3 years AMC cost	1 PC

Quotation No:	QU27388
Date:	26.11.2024
Page:	5 of 6

Item	Product ID / Product Description	Quantity
19	Customs Duty & Clearance Charges	1 PC
20	AZtecLive EDS system inclusive of Ultim Max 65 SDD EDS detector (2 Nos) SDD sensor area: 65mm2, Premium EDS detector Energy Resolution: <127eV on Mn-Kα, 48eV on C and <60eV on F Motorised EDS detector Movement. Detection Beryllium to Californium Dual Detector Kit for UM65 Premium Latest X4 electronics, AZtecLive system software for observing the Realtime 'Live Imaging, Live Spectrum, Live Auto Peak Labelling and Live Mapping' allowing to chemical navigation of sample surfaces. Live Trace to check the elemental distribution into all the scanned areas and to revisit them later. AZtec – TruQ based Quantitative Analysis, Mapping with spectral imaging, Line Scanning, Reporting with MS-Office, Auto Phase Mapping Cobalt Sample for Energy Calibration Aztec Mineral – Automated Minerology package Automated mineralogy solution based on AZtecFeature. Performs dedicated ore characterisation, provides vital data on metal recovery, enables process yield characterisation and automates the analysis of solid rock sections. Mineral Class. DB for AZtec Mineral - database for the automated classification of data acquired with AZtecMineral. global item	1 PC

Subtotal			5,42,28,636.00 INR
Integrated GST	18.00	%	97,61,154.00 INR
Total Including Taxes			**6,39,89,790.00 INR**

In accordance with the applicable export control regulations including the stipulations of European and US export control law, this quotation shall only become effective in the event of a sales ban if this ban is lifted, or shall only become effective in the event that a sale is subject to a license if all required official licenses are granted. If the agreement does not come into force on the basis of applicable export control regulations, any claims against us, in particular claims for damages, shall be excluded.

Quotation No:	QU27388
Date:	26.11.2024
Page:	6 of 6

Terms and Conditions

Prices:
Prices are in INR currency. GST and any other taxes and government levies are included.

Validity of the quote and prices:
The offer is valid for 60 days. The offer is valid as per our current technical documentation and your requirement. In the event of product updates and other changes done by our factory and if there is a change in your requirements, we reserve the right to correct the quote partially or in total in terms of price , performance and delivery time.

Order to be placed on
Carl Zeiss India (Bangalore) Pvt Ltd,
Plot # 3, Jigani Link Road,
Bommasandra Industrial Area,
Bangalore - 560 099
TIN No: 29390843067
PAN No: AABCC1589Q
GST no:29AADCC6152H1ZM

Payment:
100% Payment in the form of Demand Draft in favour of " Carl Zeiss India (Bangalore) Pvt. Ltd.," along with Purchase order. In case the payment is to be made by wire transfer, we will share our banker details in the order acknowledgment.

Warranty:
The equipment is warranted for a period of 62 months from the date the risk of loss passes to the Purchaser or 60 months from the date of installation, whichever is earlier.
All the consumables are not part of standard warranty.

Export Licence:
This quotation shall only be valid if the intended legal transaction does not infringe on applicable export control regulations including the stipulations of European and US export control laws. If Export licence is applicable , the mandatory End User Undertaking in the prescribed format will be required from the purchaser so that our factory can apply for export licence.

Delivery:
24-26 weeks from the date of receipt of your order with payment

Installation & Demonstration:
Will be done by our trained Engineers without any additional cost.

Annexure III. Comparison of Specifications of Mineral Liberation Analyser

Sl. No.	Parameter	Specifications	Zeiss compliance/comment	TIMA compliance/comment
1.	Resolution	1.0 nm @15 kV with In lens SE detector (This resolution should be achieved in 300 nA or more current configuration)	Comply	Comply
2.	Magnification	2x to 10,00,000x	10 x – 10,00,000x	Comply
3.	EHT /Landing Energy.	200 V to 30 KV	Comply	Comply
4.	Chamber	Large chamber with at least 15 accessory ports to accommodate various future add-on like CRYO, WDS etc. Width: 300 mm or more Depth: 300 mm or more	Only 10 accessory ports	Comply
5.	Stage	5 axes motorized stage with movements equivalent to or better. X = 100 mm or more Y = 100 mm or more Z = 100 mm or more Tilt= − 10° to + 90° R = 360°	Z: 50 mm	Comply
6.	Probe Current & Stability	100 nA or more.	Comply.	Comply
7.	Detectors	a) Chamber mounted SE Detector for SE detection. b) YAG type Retractable BSD detector. c) IRCCD camera d) 4 or 2 Nos. EDS detector, total detection area 120 mm^2 or more, 129 eV, Boron to uranium or more and capable of doing qualitative, quantitative analysis and mapping. It should be fully integrated into	Comply. Comply. Comply. Interface included	Comply

Annexure III. Comparison of Specifications of Mineral Liberation Analyser

		FESEM software and control from FESEM GUI. e) The supply should include design of flange & Electronic interface between SEM & EDS. f) Probe current detector/monitor. g) CL Detector: Motorized, retractable, panchromatic cathodoluminescence (CL) detector, sensitive to photons emitted from luminescing materials in the ultraviolet to infrared 185 - 850 nm wavelength range.	Comply Comply	
8.	User Interface	SW Control panel with multifunction for the control and adjustment of frequently used SEM parameters like contrast, focus, scan rotation, etc.	Comply	Comply
9.	Electron Optics	Intermediate lens to take care of low spot size for higher probe current which should get high resolution even in high current. cooling system to maintain lens stability without need for external chiller. All apertures should be automated one.	Comply	Comply
10.	Display	32” TFT Monitors for FESEM without loss in resolution. Capability to store images in various formats like JPEG ,TIF etc,Image store resolution of 16 K x 16 K or more. Dwell time of 20ns or less for high speed scanning and dynamic experiments. Dual Channel: An option that displays live from two detectors onto separate	Comply Comply Dwell time 50 ns Comply	Comply Comply

Annexure III. Comparison of Specifications of Mineral Liberation Analyser

		monitors eg. SE on screen 1 and BSD on screen 2. A second monitor must be available for this option. Split Screen: Side by side live display with most scan-rates and image resolutions of the same image using the input from any combination of installed detectors. Image halves may be selectively processed and frozen. Quad mode: Side by side live display, on a single monitor, of the same field of view using input from up to four detector channels. Images may be selectively processed and frozen.	Comply Comply Comply	Comply Comply
11.	Vacuum System	Suitable vacuum system having turbo molecular pump, ion pump, Oil-free Rotary pump and system should have penning/Pirani gauge for accurate vacuum measurements. Ultra high vacuum condition System should maintain vacuum & lens stability without the need for an additional water chiller.	Comply Need an additional water chiller	Comply
12	Software	Histogram Display and Adjustment tool for the real-time visualization and adjustment of image grey values from a histogram. Measurements tool measure, Space between two lines, length along the line or manually defined areas can be measured. Data should be further exported in CSV or HTML format.	Comply Comply	Comply Comply

Annexure III. Comparison of Specifications of Mineral Liberation Analyser

		Image Processing tool for image post-processing operations such as image extraction, image rotation, grayscale conversion, infobar addition brightness/contrast adjustment, structure detection, color models adjustment, geometric transformation, sharpen/blur adjustment, noise reduction, image combining and info bar manipulation.	Comply	Comply
		Presets tool to store and recall specific SEM operating parameters and setups from the preset panel, such as column alignments, beam current, brightness and contrast settings, landing energy, field of view, working distance or stage coordinates.	Comply	Comply
		Positioner tool to navigate to a region of interest with the help of a positioning template. The template can either be an image from a camera, light or (other) electron microscope, or a schematic drawing. image formats should be aligned manually/automatically using a 3-point or more alignment recipe.		Comply
		Animated 3D visualization of stage movements, that should intercepts intended stage movements that could lead to collision of stage and/or sample with internal SEM components such as pole piece or detectors.	Comply	Comply

Annexure III. Comparison of Specifications of Mineral Liberation Analyser

		Object Area tool for area measurement of selected regions of interest in the live SEM image. Up to 4 different areas should be segmented and the results exported for subsequent numerical analysis. Switch-off Timer tool to automatically switch the microscope to power save or sleep mode, or even shut down, upon finalization of an unattended (e.g. overnight) automated imaging and analysis routine.	Comply Comply	Comply Comply
13	Computer	Latest configuration	Comply	Comply
14	Essential Features of Mineralogy Analyzer Software	The software should also have following features: **Throughput** – The system should be able to upgrade with 4 EDS detectors and each should be equipped with dedicated digital pulse processor. **Automated calibration** – Automated, robust BSE/EDS calibration procedure that can be rerun based on user-defined time interval and makes use of a built-in calibration standard sample set. **Data segmentation** – System should perform segmentation of both the	Oxford Aztec Mineral Comply Comply	Comply Comply

Annexure III. Comparison of Specifications of Mineral Liberation Analyser

		elemental and backscattered images to identify homogenous areas formed by individual mineral grains to be used as an input for spectral summing. Segmentation algorithm can be chosen by the user with respect to the sample type and the focus of the study. Standard segmentation mode fits well with common samples whereas AI based deep segmentation better suits fine-grained rocks or oscillatory zoned minerals.	Comply	Comply
		Spectral summing – System should have the capability to combine low count spectra from pixels within the segments that increases sensitivity for less abundant elements while maintaining high data acquisition speeds.	Comply	Comply
		Minimum amount of X-ray data needed for mineral identification – System should be able to identify mineral grains even when collecting only 1000 X-ray counts per pixel. In the case of suitable samples even just 100 counts per pixel should be sufficient for positive identification.	Comply	Comply
		Smart analytical modes – Geological samples can be highly variable and the same can be said of geological research itself. System should provides necessary flexibility to fit needs of specific research using broad choice of analytical modes such as plain BSE/CL	Comply	Comply

Annexure III. Comparison of Specifications of Mineral Liberation Analyser

		imaging without EDS, centroid EDS phase analysis, line mapping, high resolution mapping and dot mapping allowing to quickly cover large sample areas without the danger of misidentification of phases similar in BSE. All these modes can be applied either to all minerals, bright phases (as defined by user) or specific mineral searches.		
		Fast sample preview – Fast preview of the entire samples in BSE/CL/SE allowing the user to specify area of interest for the mineral analysis.	Comply	Comply
		Specific mineral search – Software analysis can be set in a way that it searches the samples for grains of specific mineral or group as defined by the user (e.g. any gold containing grain).	Comply	Comply
		Mineral identification based on raw element line intensities – Minerals should be identified based on raw element X-ray line intensities not based on spectral matching or element quantification. This approach eliminates the error of low count spectrum quantification as well as the need for smooth spectra better suitable for matching. Quantification of low count spectra results in very high variation forcing the user to introduce very broad compositional ranges to define. System should allows	Comply	Comply

Annexure III. Comparison of Specifications of Mineral Liberation Analyser

		identification of minerals based on low count spectra and provides user with option to apply EDS spectrum quantification only on good enough sum spectra representing the entire segment. **Ease of new phase introduction** – System should allows the user to introduce new phases into the database easily. Element line intensity ranges should be generated automatically based on reference spectrum. **General mineral rules** – System should allows to create broad mineral definition covering entire mineral groups. The system is thus capable of searching for phases containing specific elements (e.g. all mineral grains containing phosphorus – the phosphates). **Hyperspectral datasets** - The instrument should collect the X-ray spectra, backscattered and secondary electron and optionally cathodoluminescence intensities from each pixel covering entire sample surface or user defined area. Users obtain a virtual copy of the samples which can be browsed offline offering a similar level of interactivity like the live work on the SEM. Combined elemental maps, spectra and quantification are readily available.	Comply Comply Comply	Comply Comply Comply

Annexure III. Comparison of Specifications of Mineral Liberation Analyser

		Built-in EDS single/batch quantification of spectra **-** Sum spectra obtained because of the segmentation and spectral summing can be used to obtain quantitative elemental information (composition of selected mineral grain or multiple grains). This is the means to obtain information on variability or average composition for large grains populations.	Comply	Comply
		Stoichiometric calculations as a part of the EDS spectrum **quantification** – System should provide means to calculate content of elements not detectable by the EDS using stoichiometric calculations.	Comply	Comply
		Built-in database of several minerals - A tool to ease identification of spectra which were not identified automatically. The database also includes information on the formula, composition, and densities as well as a link to the full version of the webmineral.com internet mineral database.	Comply	Comply
		Side by side elemental, BSE, and phase map to explore particles/grains and panoramas – System should provide side by side view allowing simultaneous browsing different analytical outputs (BSE, different elemental maps etc.). This view is available both for grains	Comply	Comply

Annexure III. Comparison of Specifications of Mineral Liberation Analyser

		of individual minerals, for particles as well as for the entire samples. **Advanced particles/grains filtering and sorting** – Users can filter the grains/particles based on their chemical properties (content of an element in grain), mineral composition (mineral content of a particle), texture (association), morphology. **Element mass/raw intensity-based particle/grain sorting** – This feature should be available even for unclassified grains allowing to quickly identify grains hosting element of interest coming handy when trying to identify phases hosting polluting element such as lead phases occurring in soil. **Customizable particle texture reporting tool (particle categorizer)** - The key benefit of automated mineralogy is the texture particle characterization. Reporting must allow users to sort the particles into categories based on their textural properties (single or multiple properties combined using mathematical expressions). Particle properties cannot be presumed and so the user must have freedom to categorize them based on the properties he selects or combines to address the complexity of geological	Comply Comply Comply	Comply Comply Comply

Annexure III. Comparison of Specifications of Mineral Liberation Analyser

		samples. Mass percentage of particle of specific textural type is a characteristic output of particle categorization. **Lithotyping -** A method used to quantify fragments of specific rock types present in the particle sample. This way it is possible e.g. to quantify the content of shale, sandstone, or limestone particles. Each rock is defined using both particle and grain properties. Sandstone definition would be based on the grain size being bigger than 63 microns and prevailing quartz. **Single supplier and single service contact** – System should be an integrated system and so the EDS detectors, digital pulse processors as well as the SEM and necessary SW are serviced by a single manufacturer.	Comply Comply	Comply Comply
15	Vibration free table	Vibration free table for mounting of machine and other essential items for	Comply	Comply

Annexure III. Comparison of Specifications of Mineral Liberation Analyser

		installation and commissioning of the equipment should be quoted		
16	Calibration samples	As per standards	Comply	Comply
17	UPS	Suitable UPS with back up time of minimum 1 hour	Comply	Comply
18	Manual	All manuals related to the installation, calibrations, maintenance and regular operation of entire system	Comply	Comply
19	List of end users	List of end users within India and abroad in last five years	Comply	Comply
20	Training	Training at IMMT Bhubaneswar free of cost for 1 week. Advanced training at OEM site	Comply	Comply
21	Warranty and AMC	5 Years of comprehensive warranty and 3 years of AMC	Comply	Comply