SHORT TERM MINE OPTIMIZATION

Holtec Consulting Pvt. Ltd. Gurgaon, India

Holtec

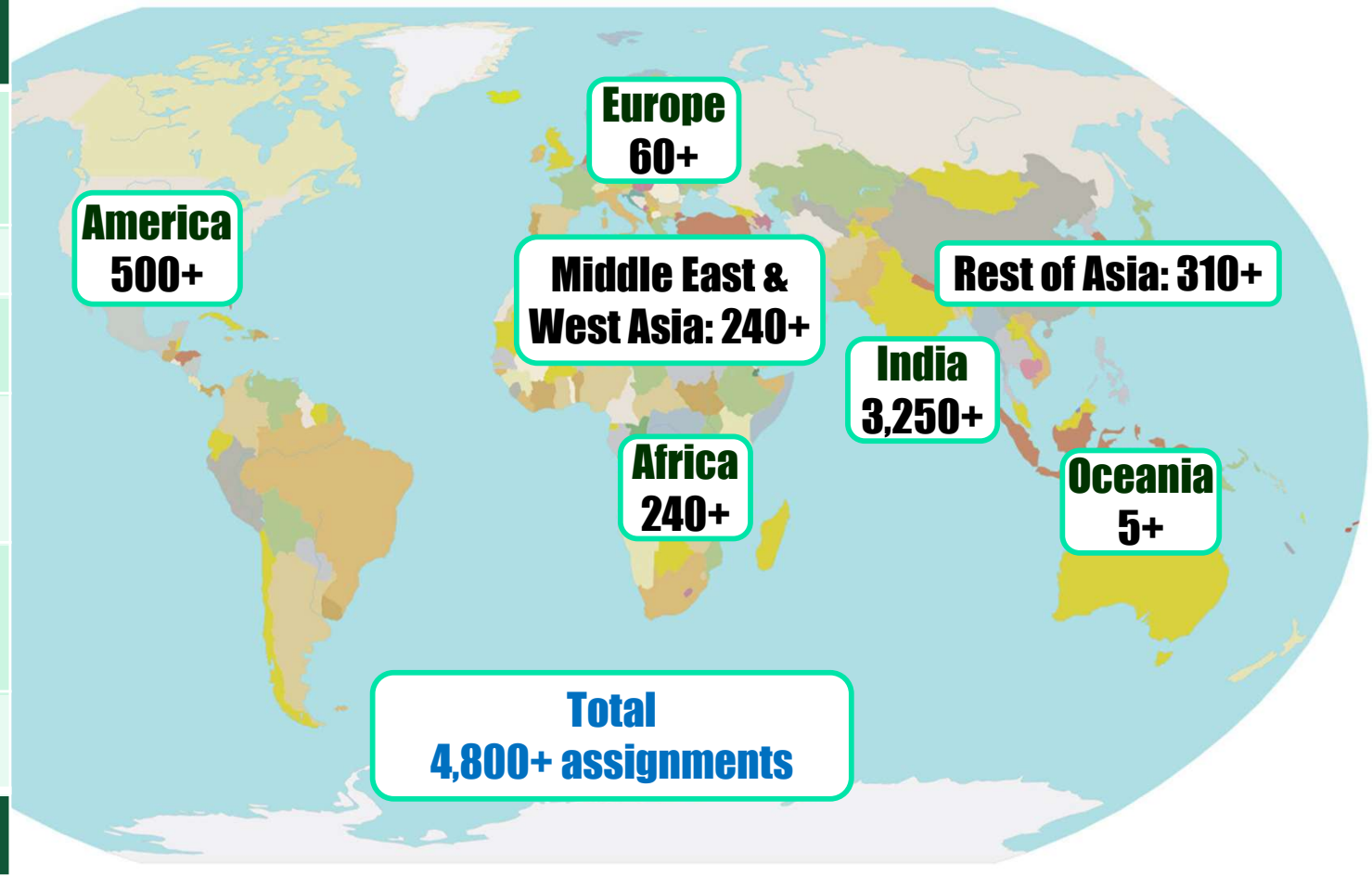
- Created in year 1967
- Services firm focused on the Global Cement Industry: Advisory, Engineering, Plant Operations & Maintenance, Solutions

  Also offer services in Highways, Power & Engineering Support Services
- 4,500+ assignments for 1,000+ clients in 90+ countries
- Full fledged engineering and business consulting firm
- Strong execution processes (ISO certified)
- Total Solutions: Integrated service from concept through commissioning and operations
- Industry expertise with 6,500 man-years experience
- Extensive database built over 50+ years

  Offices: 3 in India, 1 in UAE (Sharjah) and various other site offices

HOLTEC's Width and Depth of Experience

Type of Projects	No. of Projects
Due Diligence, Valuations and Investment Studies	190+
Raw Material Studies	750+
Feasibility, Market and Strategic Studies	1,060+
Performance Enhancement and Audit Studies	320+
Project Engineering, Procurement, Field Services, etc.	2,250+
Other Miscellaneous Studies	160+
Total	**4,800+**



Highlights

- ☞ Engineered over 100 large-sized projects, greenfield and brownfield; 20+ with kiln capacities of >8,000 tpd and 30+ with kiln capacities of 6,000-8000 tpd
- ☞ Successfully executed 165+ Mine Optimisation projects world wide

Why Short Term Mine Optimization?

Changes in mining statute

Changes in quality/availability of external limestone sources

Availability of mining equipment

Changing Fuel targets/quality (TSR)

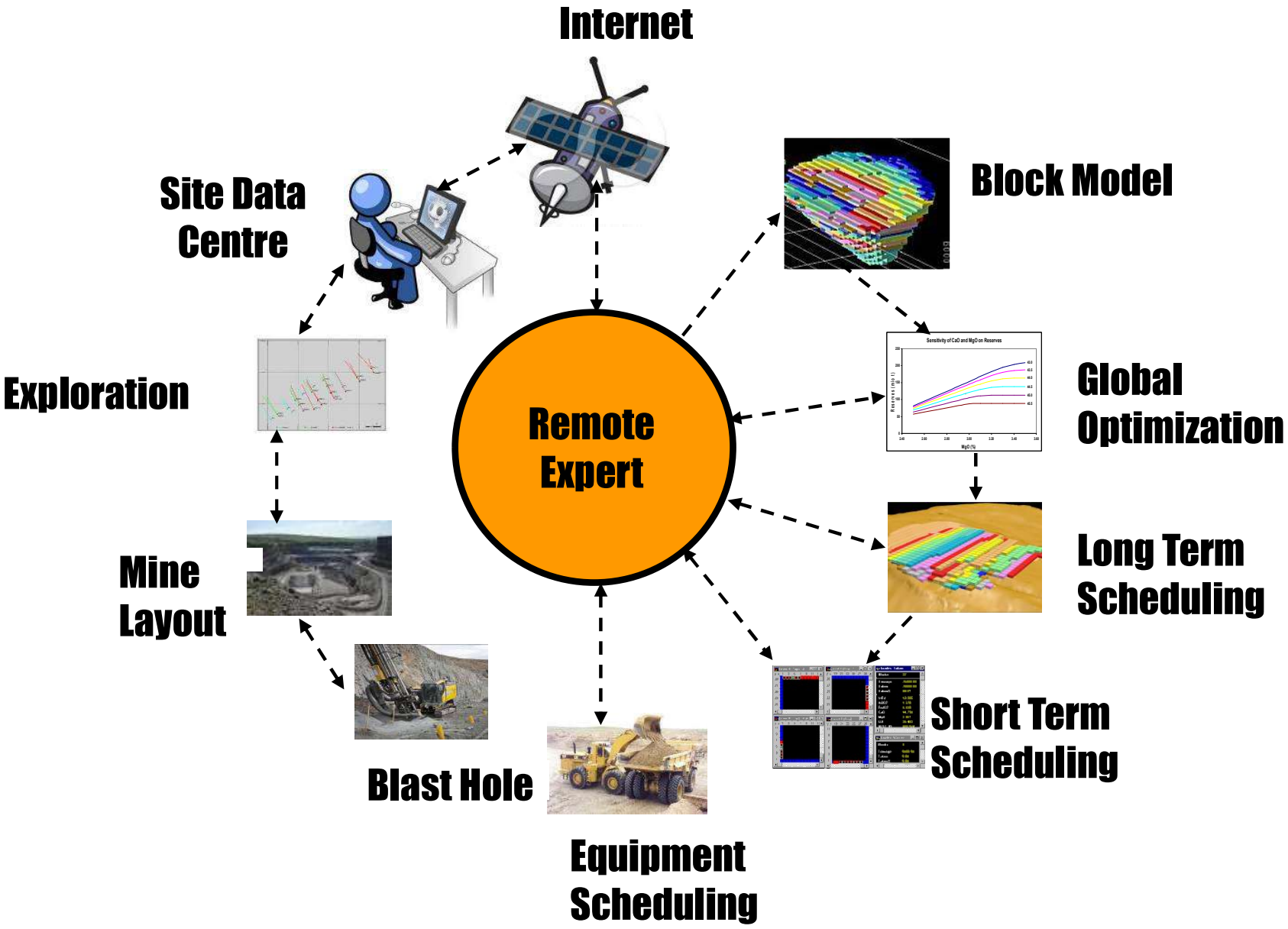
Unforeseen issues in mining

Changes in quality/availability of correctives

Changes in cement product mix

Long Term Mining Plans, while having their own use, cannot dynamically/ speedily respond to the issues mentioned above

STMO System

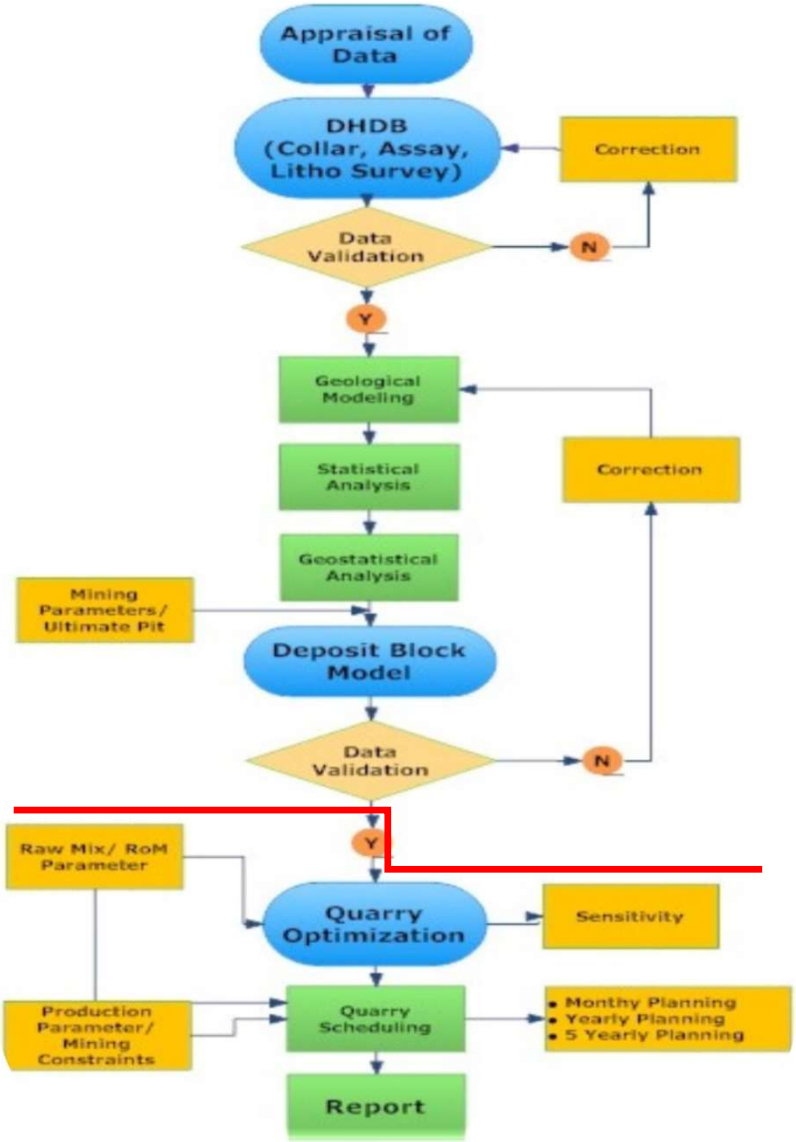

Internet
Site Data Centre
Block Model
Exploration
Remote Expert
Global Optimization
Mine Layout
Long Term Scheduling
Short Term Scheduling
Blast Hole
Equipment Scheduling

What it does?

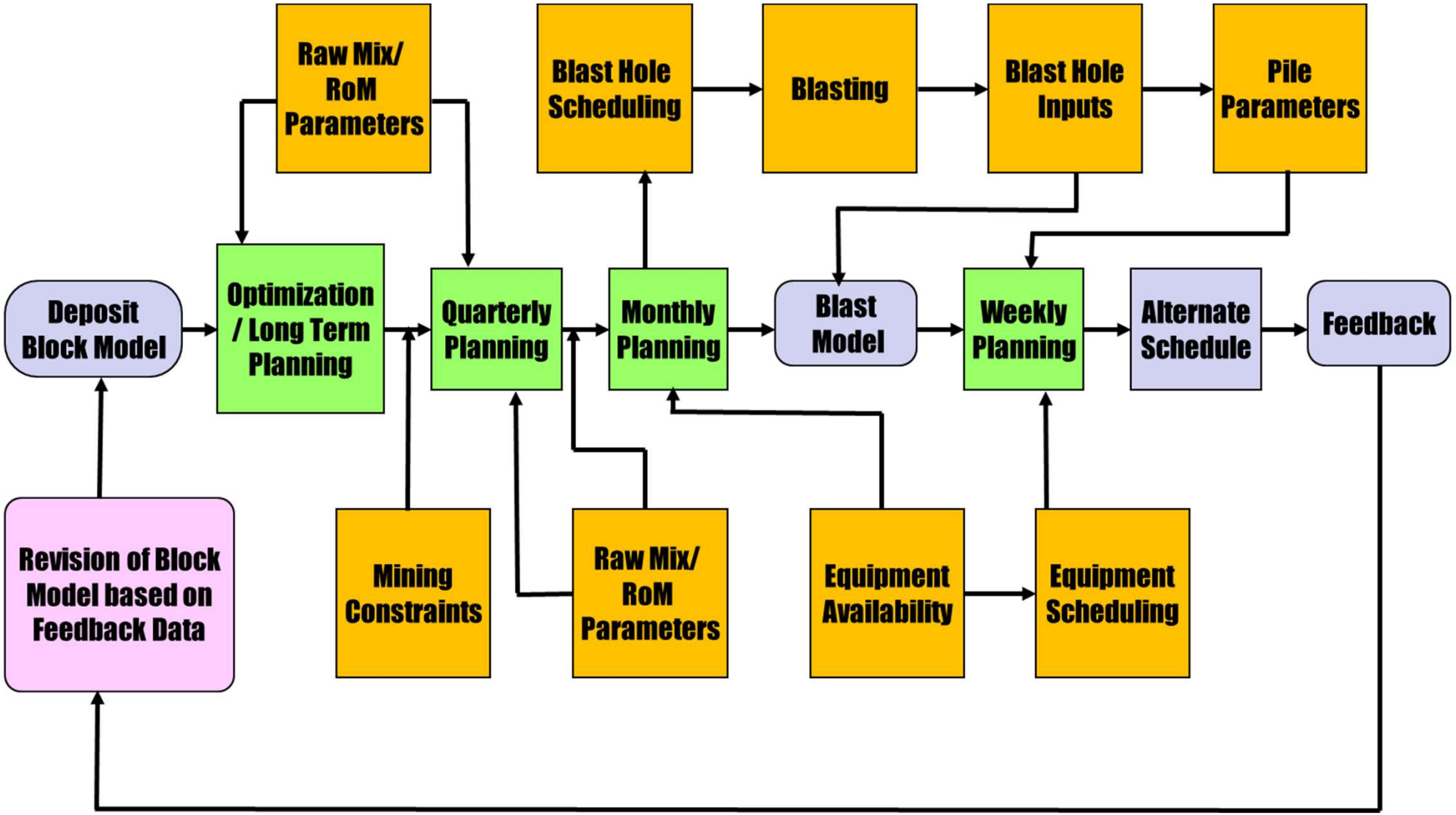
- Use of real time data and advanced analytics to make informed decisions
- Scheduling for optimal resource extraction
- Steady supply of homogenized material
- Adapting to change in quality requirements without affecting production
- Regular and continuous updation of deposit inventory on short term basis
- Savings in cost by use of optimized layout and avoidance of expert visits

Methodology

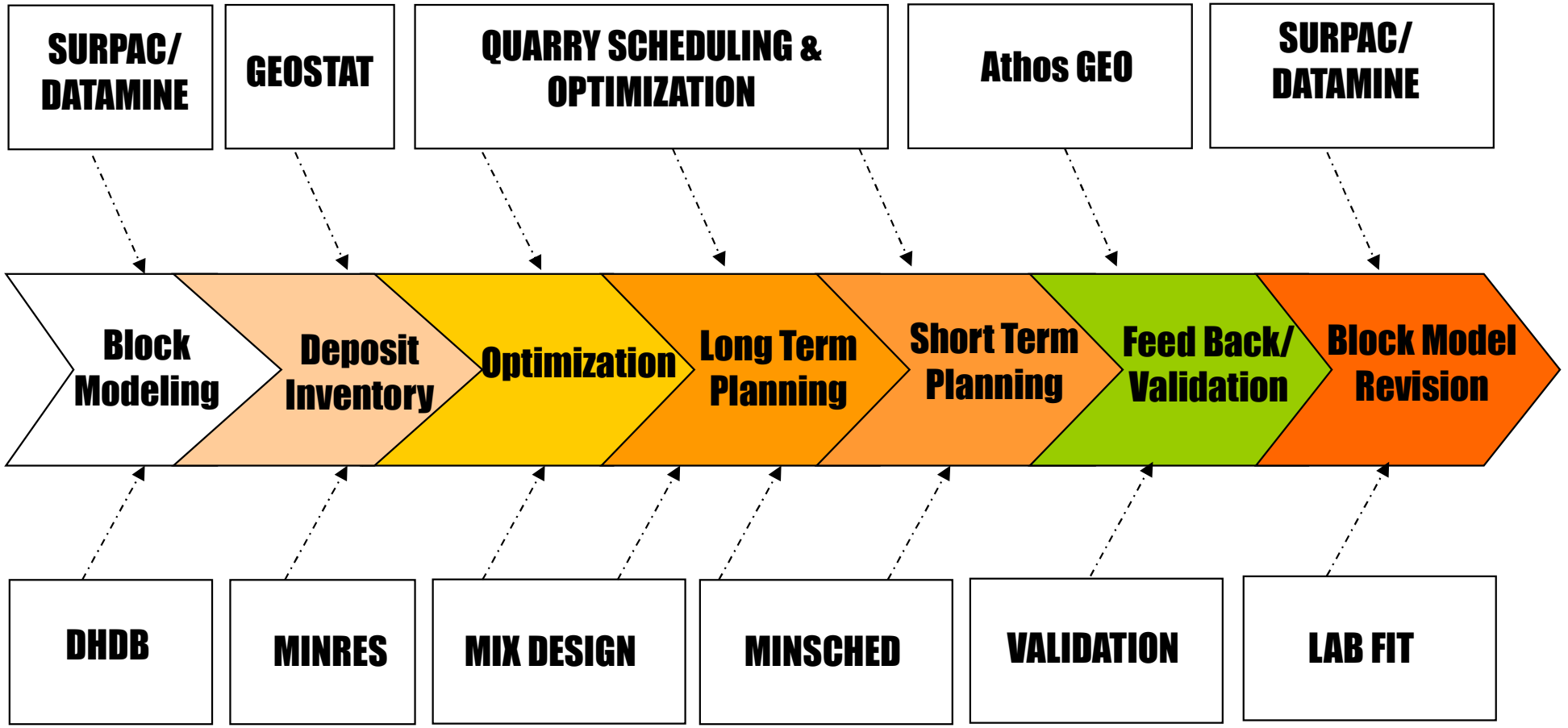
- Step-1 Data verification/Processing
- Step-2 Preparation of Sections
- Step-3 Geological Modeling
- Step-4 Data Compositing
- Step-5 Data Evaluation
- Step-6 Block Modeling
- Step-7 Pit Formation
- Step-8 Reserves Estimation
- Step-9 Mine Optimization
- Step-10 Mine Scheduling



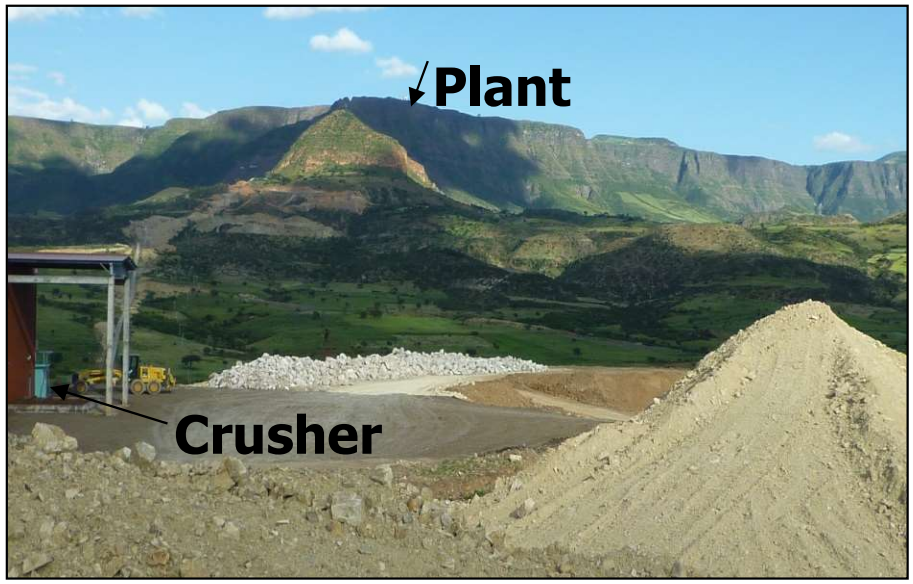
Methodology

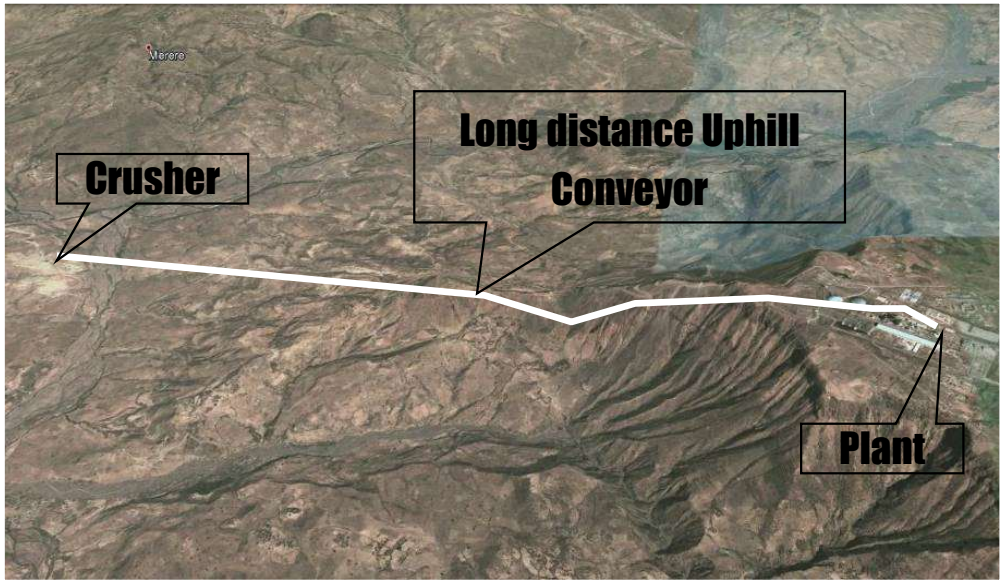


Tools

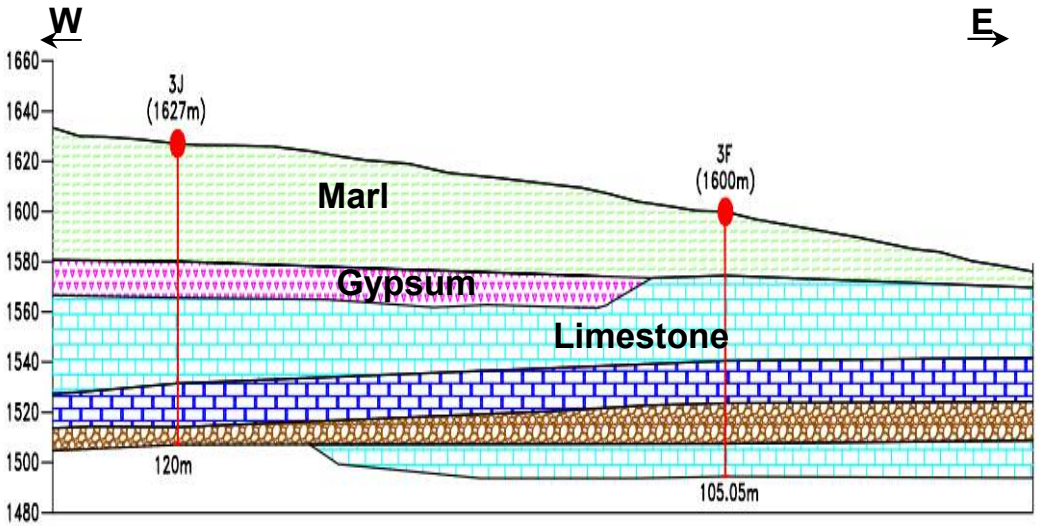

SURPAC/ DATAMINE
GEOSTAT
QUARRY SCHEDULING & OPTIMIZATION
Athos GEO
SURPAC/ DATAMINE
Block Modeling
Deposit Inventory
Optimization
Long Term Planning
Short Term Planning
Feed Back/ Validation
Block Model Revision
DHDB
MINRES
MIX DESIGN
MINSCHED
VALIDATION
LAB FIT

General Information





- Deposit belongs to a cement plant located in North Africa.
- The rock types encountered in the area are Marl, Marginal Grade Limestone, High Grade Limestone and Gypsum.



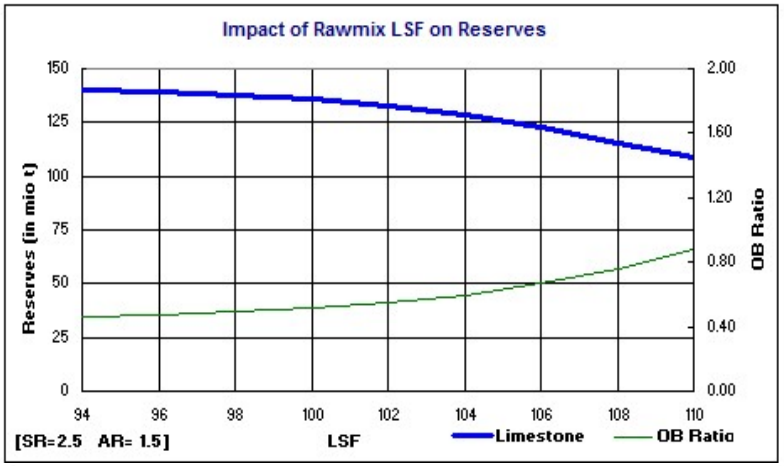
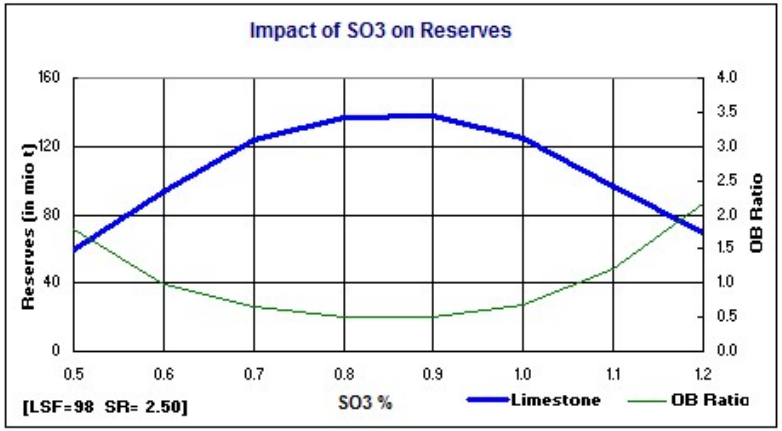
Deposit Evaluation

Chemical Characteristics

Rock Type	Resource (mio t)	Quality										LSF
		LOI	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	SO_3	Cl	
Marl	81.89	31.66	17.76	4.79	2.30	36.53	1.98	1.16	0.03	0.91	0.01	64
Limestone	108.58	37.80	8.16	1.30	1.06	47.02	1.08	0.35	0.16	0.91	0.01	188

- Marl : Overlying limestone, highly heterogeneous and low grade.
- Limestone : Heterogeneous marginal grade overlies 30 m thick bottom high grade
- Use of marl to the extent possible to achieve:
  - Lower Stripping Ratio
  - Longevity of deposit life
  - Low cost of production

Optimization

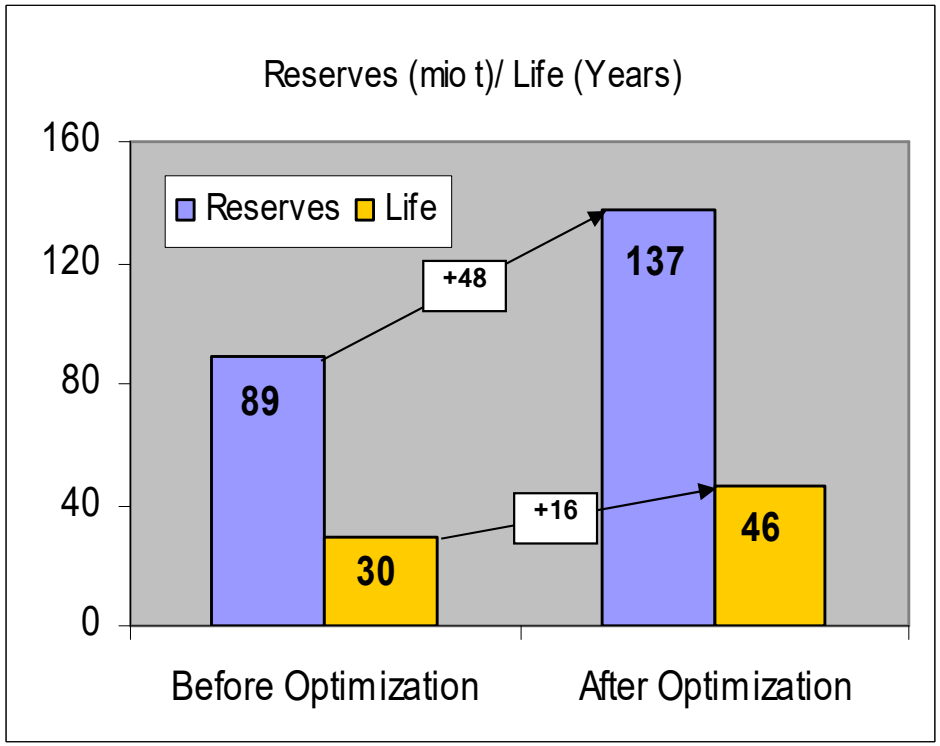
Description	Sample
Global Optimization ➢ Mining Constraints ➢ Optimal utilization of marl & marginal grade limestone ➢ Maximum permissible limit of SO_3 ➢ Minimum Rejection ➢ Lead distance to minimize the cost	**Output**  
Inputs Required ➢ Block Model ➢ RoM/ Raw mix parameter ➢ Cost data for Drilling, Blasting…	

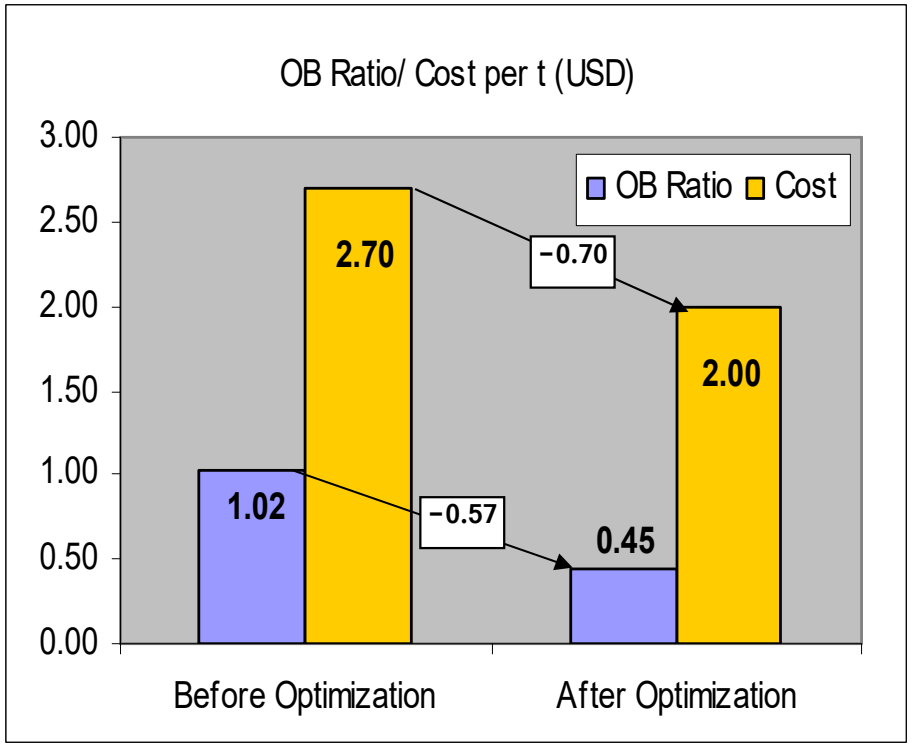
Optimization (contd.)

Salient Aspects

- Optimised Reserves : 137 mio t against 89 mio t (LSF-98.0)
- Reserves enhanced by optimization of low grade marl and it is possible to optimize about 48 mio t of marl in the process
- Overburden (OB) ratio of limestone reduces.
- SR has a positive impact on reserves i.e., reserves enhance with increase in SR up to a maximum value of 2.5
- Increasing AR up to 1.5 and maintaining SO_3 up to 0.90 in the raw mix resulted in enhancement of reserves

Gain





By optimization there is a saving of approx. 2.10 mio USD per annum just by reduction in rejection. The additional life further adds to the saving over additional 16 years .

Long term Scheduling

- Schedule is prepared considering the following objectives:
  - Optimal utilisation of marl, marginal grade limestone and high grade limestone
  - Maintaining average OB ratio within a block of 5 years
  - Optimal lead from mine face to crusher and dump area
- During 5 year plan, it is proposed to work in two pits to optimise quality parameter and take advantage of profile to expose high grade limestone
- Yearly Planning is done
- The schedule has lead to flexibility in mining, lead balancing, minimized frequent shifting of HEMM

Short term Scheduling

- Due to heterogeneity in quality, two blocks, namely Eastern and Western Blocks are made ready for production

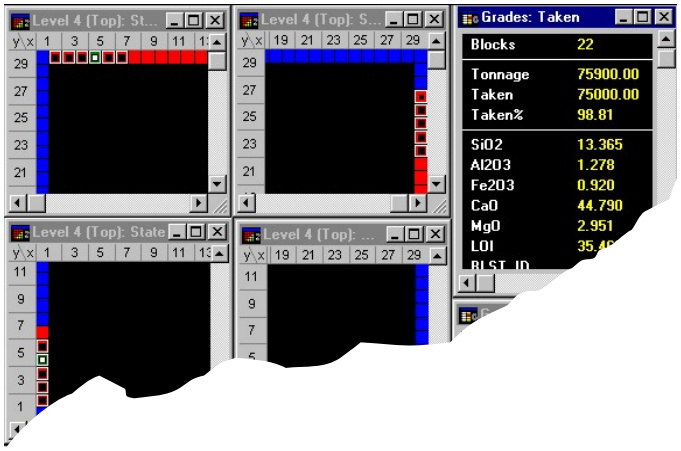
Short term Scheduling (contd.)

- Blasthole sampling with their geo coding is being done regularly and sent to Holtec.

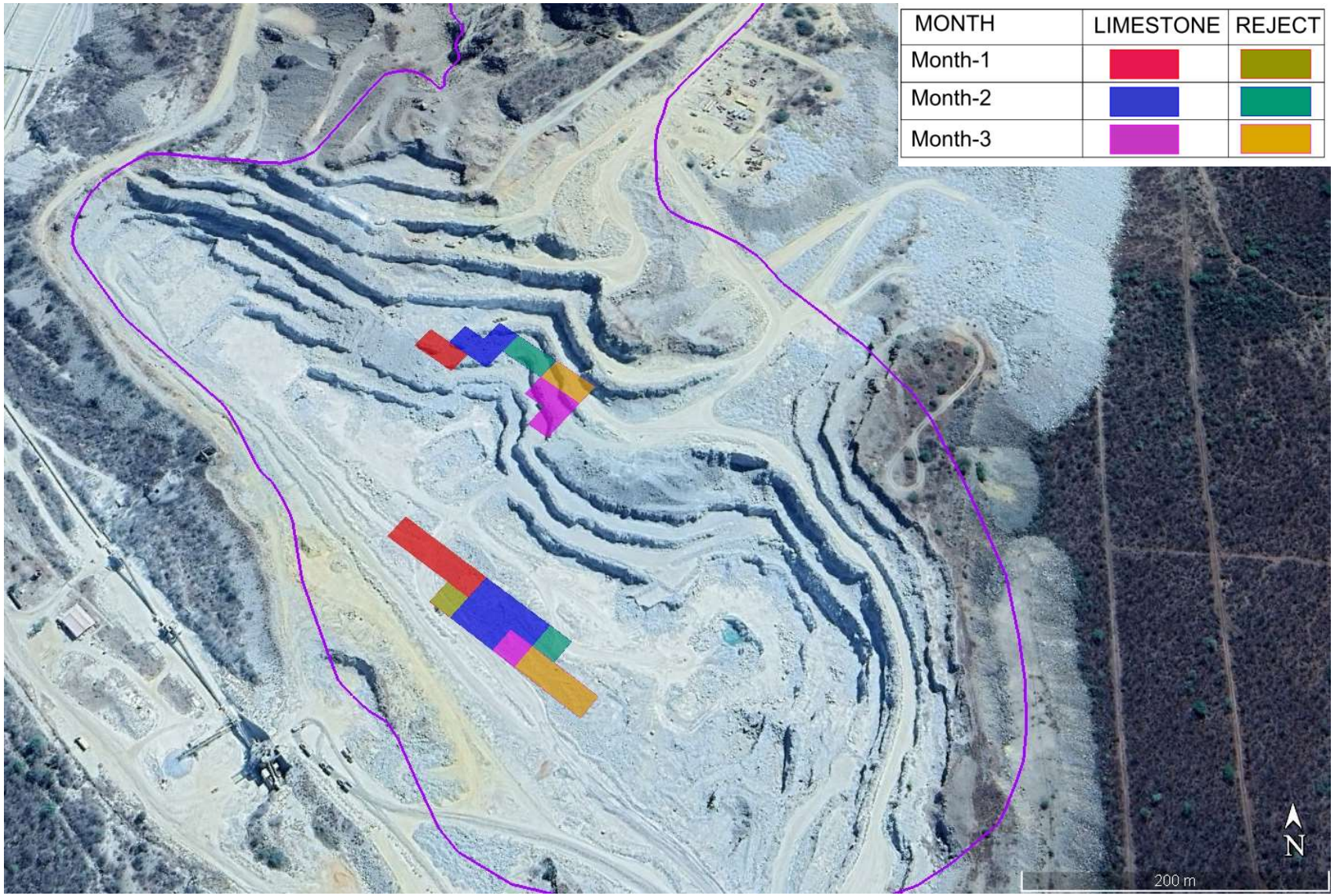
	Eastern Block					Western Block				
	SiO_2	Al_2O_3	Fe_2O_3	CaO	SO_3	SiO_2	Al_2O_3	Fe_2O_3	CaO	SO_3
Avg.	11.39	2.64	1.35	46.94	0.39	17.55	4.75	2.32	36.70	0.26
Std. Dev.	3.40	1.20	0.94	4.72	0.21	4.70	1.27	1.28	5.04	0.18

- Eastern block is close to cement grade limestone
- Western block would require blending with high grade limestone
- Both the blocks show high variability

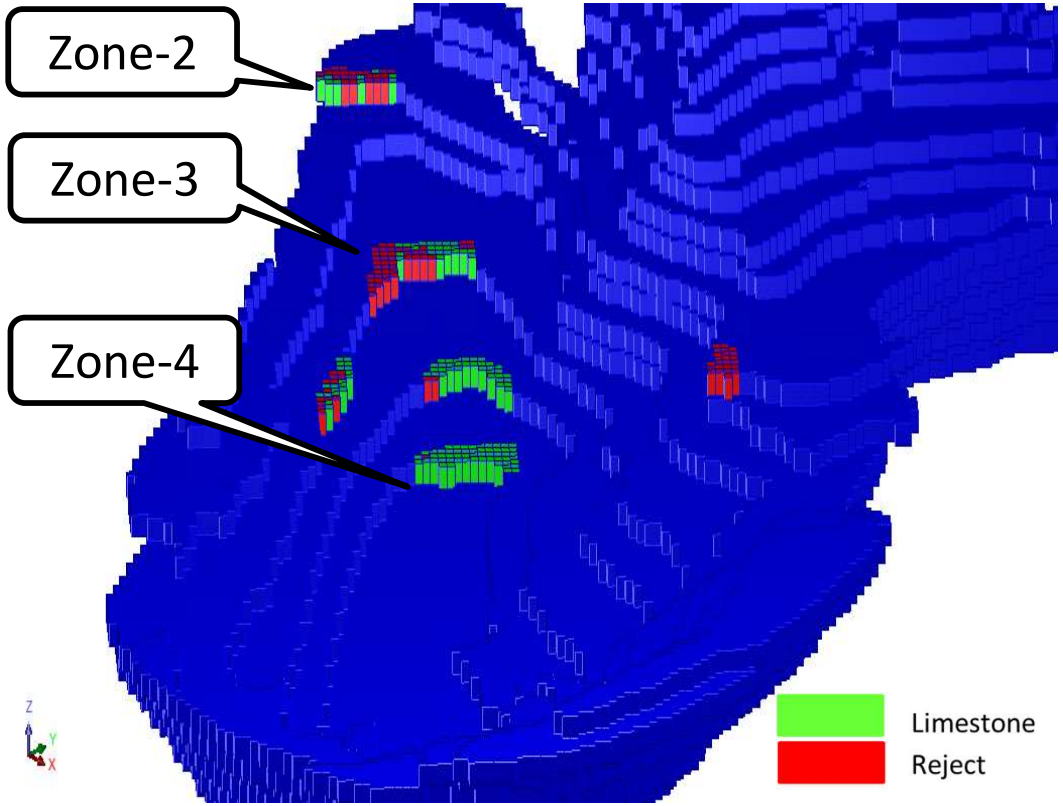
Short term Scheduling (contd.)

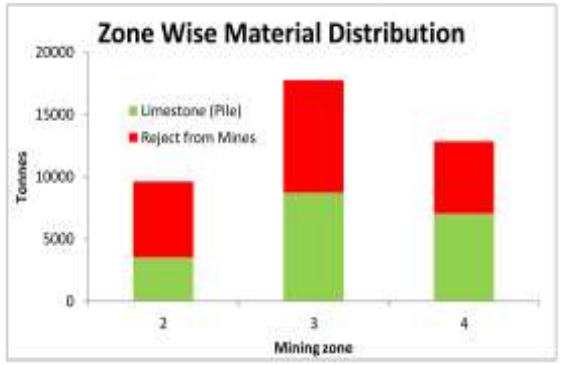
Description	Sample
Monthly/Weekly Production Scheduling ➢ Weekly blast hole planning/ sequencing, Lead balancing and planning for micro mining constraints is being done ➢ Short Term blast modelling based on blast hole data and Geo coding of model for interactive use ➢ Scheduling with alternate production plan on weekly basis meeting pile requirement ➢ Equipment placement scheduling with monthly/weekly production and development need	**Output**  **Inputs Provided** ➢ Blast Hole data ➢ Pile parameter ➢ Equipment position ➢ Budget for the quarter

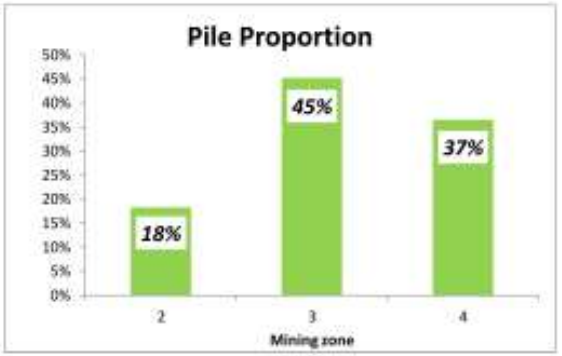
Short term Scheduling (contd.)

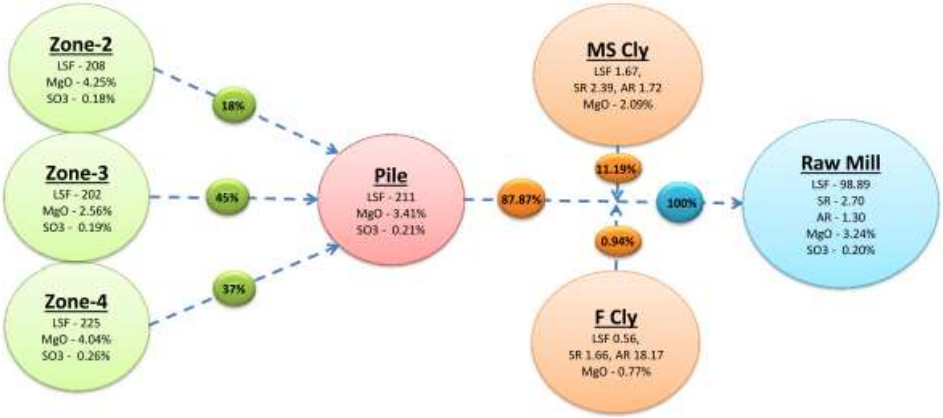


Short term Scheduling (contd.)









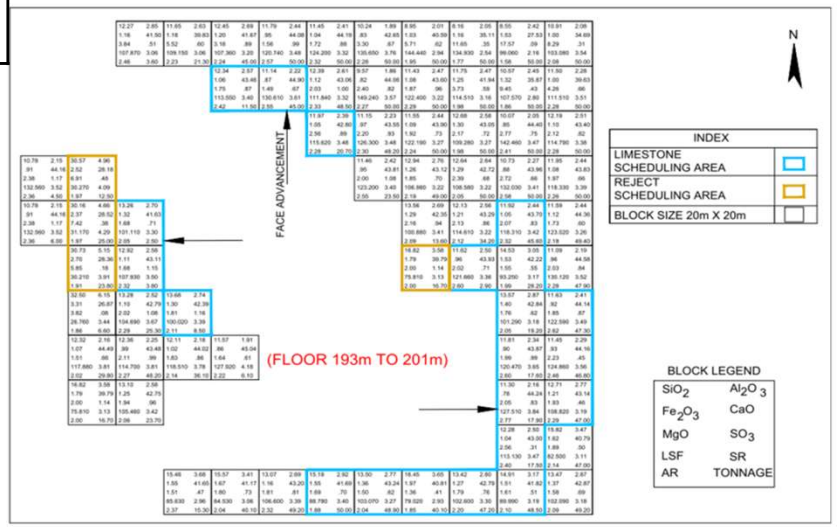
- **Address weekly pile quality maintenance**
- **Blast hole data is considered as base**

Short term Scheduling (contd.)

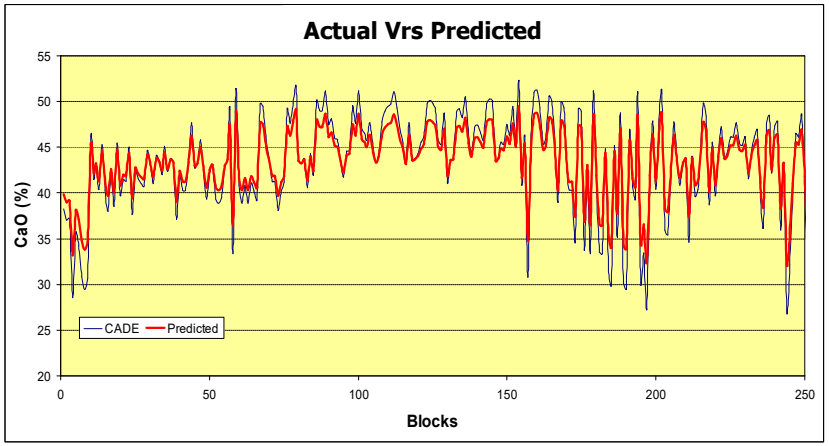
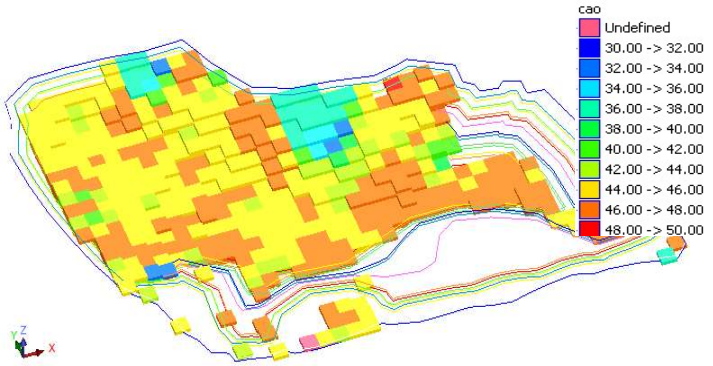
Weekly Production & Equipment Scheduling Report

Location	Blast Nos	Bench	Type of Matl.	Qty of RoM (MT)	Quality									Remarks
					SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	LOI	LSF	SR	AR	
B1/SE	554	1	RoM	18,000	9.86	1.85	1.15	45.35	2.20	38.98	148.5	3.29	1.61	Feed to Pile
B3/NW	1002	3	RoM	20,000	13.38	2.25	2.65	43.78	0.75	37.20	104.0	2.73	0.85	Standby

Month	Week	Type of M/c	M/c No	Capacity	Face	Qty. to be handled	Remarks
April	1	Shovel	1	6.0 cum	B1/SE	18000 T	
		Dumper	1,2,3	50 T	B1/SE	18000 T	
		Shovel	2	3.8 cum	B3/NW	Standby	



Feedback analysis

Description	Sample
Model Validation ➢ Block Model was validated for continuous monitoring of predicted vs actual data based on feed back data ➢ Block model is validated	**Output** 
Inputs Availed ➢ Blast Hole data in terms of Quantity, Quality and Coordinates	

Benefits

	Short Term	Long Term
Mining Engineer	➢ Quick and alternate solution ➢ Flexibility in operation ➢ Timely and Detailed analysis ➢ Avoid human biases	➢ Efficient operation management
Manager	➢ Evaluation of Multiple Scenarios ➢ Elimination of dedicated manpower	➢ Optimal use of deposit ➢ Streamlined quarry layout ➢ Continuous updation of inventory ➢ Better control over deposit
Company	➢ Saving in operating cost ➢ Continuous updation of inventory	➢ Enhanced equipment life/ uptime ➢ Enhanced Deposit Life

Benefits – Cement Plant in North Africa

Activity	Plant	HOLTEC	Benefits
Deposit Evaluation	➢ By simple classical method ➢ No deposit optimization	➢ Evaluation by mining software ➢ Grade tonnage curve established	➢ Establishment of reserves at different cut off grades
Optimization & Raw Mix Design	➢ Not done	➢ Sensitivity analysis for critical parameters and correctives carried out ➢ Optimized reserves estimated ➢ Marginal and low grade limestone used ➢ Use of correctives minimized	➢ Enhancement of deposit life by 16 years ➢ Stripping ratio reduced from 1:1 to 1:0.25
Mine Planning	➢ Not done	➢ Detail mine design developed	➢ Facilitated in developing short term exploitation plan
Quarry Scheduling	➢ Not done	➢ Quarry scheduling for long term, short term ➢ Monthly schedules prepared	➢ Improved resource utilization ➢ Enhanced decision making
Quarry Monitoring	➢ Only high grade limestone was being used ➢ 100 % drilling & blasting ➢ Marl was being rejected and dumped separately	➢ Blast hole sample analysis evaluated ➢ Fortnightly schedules prepared ➢ Weekly exploitation plan for two working faces planned from HO ➢ Blending of marginal grade with high grade limestone on a continuous basis ➢ Marl used & thus dumping area reduced ➢ Drilling and blasting reduced to 70 % as marl is amenable to ripping ➢ Block Model validated and modified as and when required	➢ Steady supply of homogenized limestone ➢ Minimized human dependency ➢ Maximum utilization of equipment ➢ Saving of USD 2.75 mio / annum

Benefits – Cement Plant in South Africa

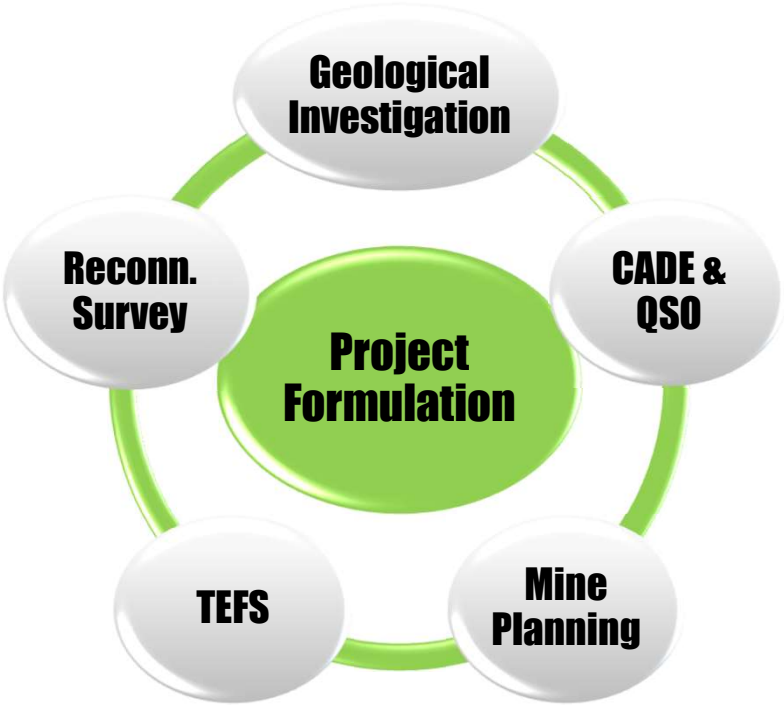
Activity	Plant	HOLTEC	Benefits
Deposit Evaluation	➢ Not done	➢ Evaluation by mining software ➢ Grade tonnage curve established	➢ Establishment of reserves at different cut off grades
Optimization & Raw Mix Design	➢ Not done	➢ Sensitivity analysis for MgO content carried out ➢ High and low MgO containing limestone optimally blended by maintaining desired LSF ➢ Use of correctives minimized	➢ Enhancement of deposit life by 5 years ➢ Stripping ratio reduced from 1:2 to 1:1.12
Mine Planning	➢ Not done ➢ Mining limit at 860 m AMSL	➢ Detail mine design developed ➢ Mining limit at depth increased to 800 m MSL	➢ Enhancement in reserves and flexibility of mining
Quarry Monitoring	➢ Only high grade limestone was being used	➢ Blasthole sample analysis evaluated ➢ Weekly exploitation plan for two working faces planned from HO ➢ Blending of high and low MgO containing limestone done ➢ Block Model validated and modified as and when required	➢ Saving of USD 0.25 mio / annum

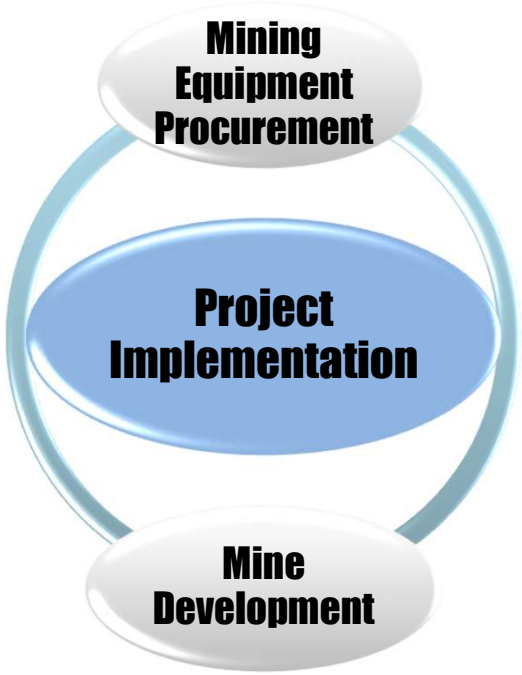
Benefits – Cement Plant in India

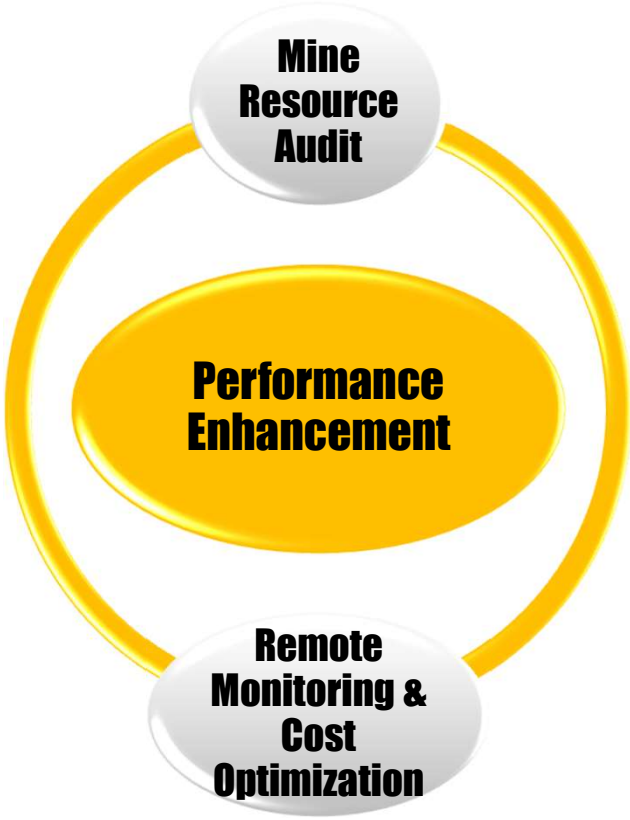
Activity	Plant	HOLTEC	Benefits
Optimization & raw mix design	➢ Use of High grade limestone	➢ Blending of high Iron containing limestone ➢ Use of correctives minimized	➢ Enhancement of deposit life by 5 years ➢ Stripping ratio reduced from 1:0.33 to 1:0.11
Mine Planning	➢ Not done ➢ Mining limit at depth 26 m AMSL	➢ Detail mine design developed ➢ Mining limit increased to (-)12 m AMSL	➢ Enhancement in reserves by 30 mio t and flexibility of mining
Quarry Monitoring	➢ Only high grade limestone being used ➢ SR at 2.1 and AR at 1.2 ➢ High Sulpur limestone being rejected ➢ High Stripping ratio of 1:0.33	➢ Blasthole sample analysis evaluated ➢ Blending of high iron containing limestone with low iron containing limestone ➢ Recommended and implemented changed SR and AR ➢ Stripping Ratio reduced to 1:0.11 ➢ High Sulphur limestone optimally blended with low sulphur limestone ➢ Block Model validated and modified based on blasthole data as and when required	➢ Saving of USD 0.24 mio/ annum

Raw Material Services

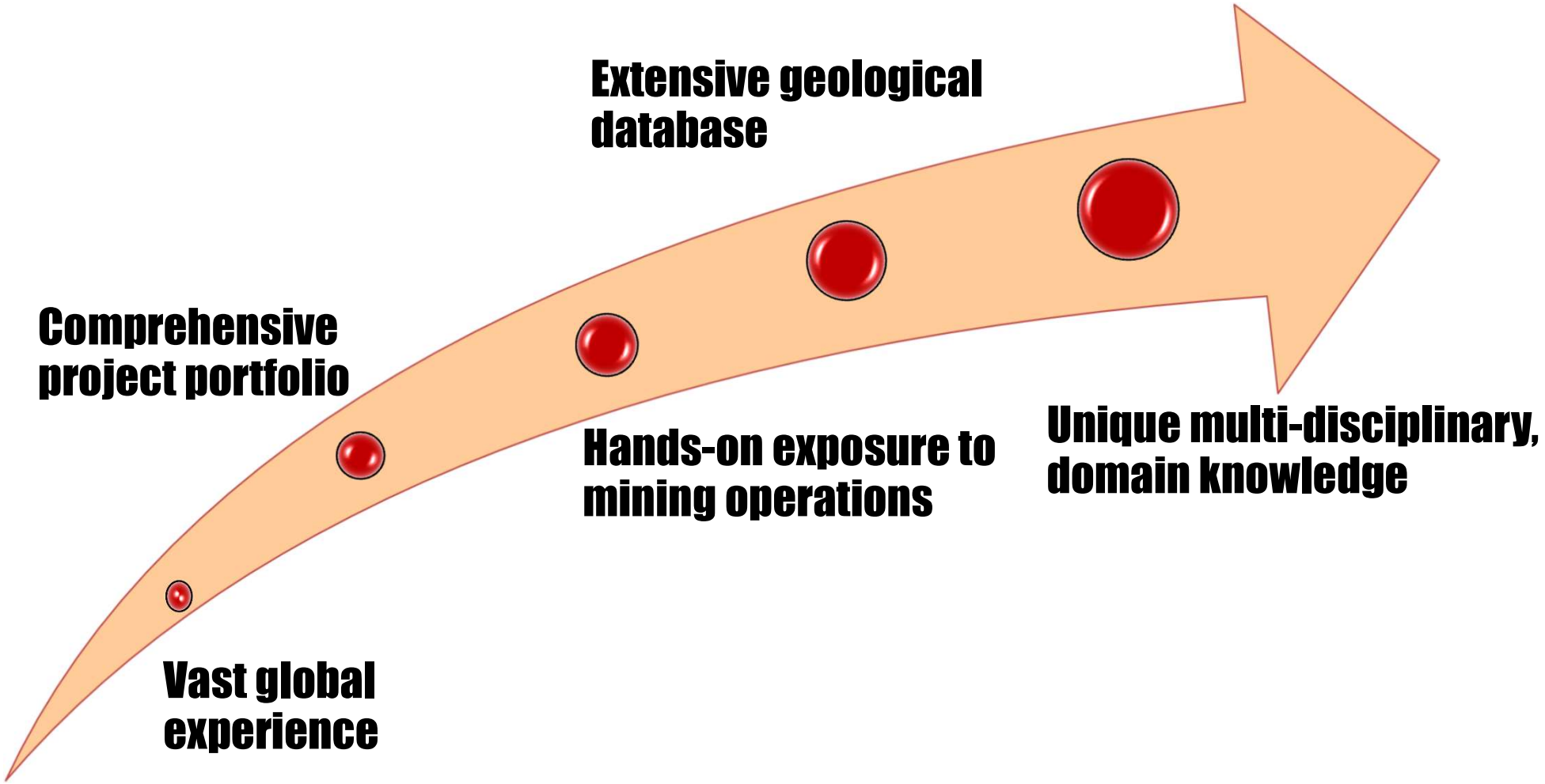
TEFS – Techno Economic Feasibility Study
CADE – Computer Aided Deposit Evaluation
QSO – Quarry Scheduling & Optimization







Raw Material Services – Holtec's USPs



- Rich global consulting experience in > 750 assignments
- Customized Mine Optimization Software

Q & A

Contact Information

Holtec Consulting Pvt Ltd

HOLTEC CENTRE

A Block, Sushant Lok-I

Gurgaon 122001, India

+91 124 4047900

info@holtecnet.com

www.holtecnet.com