

Summary of Workshop-1
on
Technology Roadmap to Coal Sector
organized by CMPDI Ranchi

(Volume-II Part A)

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Summary of workshop on Technology Roadmap for Coal Sector

Name of the event: Workshop on Technology Roadmap for coal Sector

Date: 18th Jan 2022

Venue: Online

No. of person attended: 200 (approx.)

Organizers: Central Mine Planning & Design Institute, Ranchi

1. Overview

Workshop on Technology Roadmap for Coal Sector: Technologies to Meet Future Challenges was an effort to accelerate deployment of new technologies for increasing efficiencies across operations, fast tracking implementation of projects and enhanced safety, Ministry of Coal has prepared a "Draft Technology Roadmap for Coal Sector". The Draft roadmap was displayed on CMPDI website (www.cmpdi.co.in) for stakeholder consultation. With this backdrop, the workshop was organized on 18th January, 2022 at CMPDI (HQ), Ranchi, in which technologies for Exploration, Underground Mining Technologies, In-pit & Surface Coal Transportation, Geospatial Technologies and Communication was covered.

It was a golden opportunity for the Equipment Manufacturers/Suppliers, Technical Service Providers, Innovators, Mining Professionals etc. to showcase their products & technologies to prospective clientele.

1.1. The objective of this workshop was threefold:

2. To provide a robust platform for delegates and equipment manufactures for showcasing new technological upgradation in coal sector and promote research among all the active participants in the conference.
3. To foster discussion and strengthen connections between experts and delegates on various issues.
4. To provide an opportunity to enhance knowledge and skills of participants in new technologies in coal sector which is required to have positive effects on the work environment etc.

2. Workshop Format

The one-day online conference comprised 8 plenary sessions, with 4-6 speakers per session. Each speaker was given 15 minutes to present, followed by 5-10 minutes for questions. The conference was structured to foster discussion between participants around the technological themes. This was achieved by hosting online questions through chat boxes, concluding remarks by each session coordinator which were experts in their fields following each session.



3. Workshop Sessions:

Each workshop session related to core themes of the Technology Roadmap, with a particular focus on the new innovations in respective fields, upgradation of current technologies, current and future ramp-up for the mines.

Opening the conference, Chief Patron, Shri Manoj Kumar, Chairman cum Managing Director, CMPDI, Shri Anandji Prasad, Advisor (Projects) Ministry of Coal and Binay Dayal, Director Technical, Coal India Ltd., highlighted the importance of Technology roadmap to coal sector.

3.1. Session 1: Transportation

5 Technical presentations were present in the session on topics such as following:

1. Long Distance Conveying: Overland Curved Conveyors & Pipe Conveyors- By M/s Thyssenkrupp Industries India Pvt. Ltd.

Details:

- Discussed two technologies namely long-distance conveying & second was Blendomat.
- In long distance conveying comparison was showed between belt conveyor and truck haulage system
- In terms of material transport a 100T truck transports only 39 percent of material as rest is dead weight while belt conveyor transports 81 percent of material.
- Further discussions was about pipe conveyors and trough belt conveyors. In this material is totally enclosed by the pipe belt, thus spillage is restricted
- Pipe Conveyor offers better protection to the material and environment
- Pipe Conveyor has better flexibility in conveyor routing from tighter curves
- Light Weight Triangular Truss with Maintenance Trolley was another feature shown which is Self-propelled Maintenance Trolley to service the entire length of the conveyor.
- 2nd technology shown in presentation was Blendomat- controlled silo discharge mechanism. Blendomat prevent the accumulation of material on the sides of silo and gives the smooth flow.

2. Inpit Crushing & Conveying System with Sizer- By M/s Takraf India Pvt. Ltd.

Details:

- In this presentation Mr. Srikant discussed the comparative assessment of shovel dumper and IPCC system. It was observed that as depth of mine increases, the initial investment pure truck system increases at much higher rate than IPCC systems
- Additionally, he revealed the pros and cons of IPCC as compared to conventional shovel dumper system.
- In terms of sizers different type of crushers were discussed and it was shown that sizers will be able to crush approximately upto 200 Mpa material with capacity 12000TPD.
- Further various advantages of sizers over crusher was acceptance of large size feeds, low height and very compact, ideal for sticky or high moisture feed material, no vibration and less consumed motor power.

3. Variable Speed Fluid Coupling- By M/s Premium Transmission Pvt. Ltd.

Details:

- Started with milestone they have achieved currently they started assembly of Fluid Couplings at PSH Germany.
- Shown wide standard range as well as customized fluid couplings.
- Various advantages shown for their product was Scoop tube requires a feedback loop to control output speed. No VFD and Solenoid valve, so better reliability. Oil flow control is through the scoop tube, hence there is no noise and vibration, so stable system. Self-supported design, no load on the motor bearing.

4. Belt Speed & Tension Control on Conveyor Using Multiple Hydro-viscous Clutch Type drives- By M/s Dodge India Pvt. Ltd.

Details:

- Highlighted the importance of Multiple Hydro-viscous Clutch Type drives as it provides Belt conveyor to control the drive acceleration torque by providing a smooth soft start while maintaining belt tensions within specified safe limits.
- Various advantage of soft starts shown was High Capacity of system, High Productivity, Energy Efficiency, High Plant Availability, Safety and Lower costs.
- Dodge CST is simple, reliable and rugged reducer that has a unique feature, a multi plate wet clutch, located on low-speed side of gearbox. It act like a shock absorber and dampens the belt tension spikes.

5. Advantages of Chromium Carbide Wear Plates/ Liners- By M/s Federal Synergies India Pvt. Ltd.

Details:

- Wear Plate is a member of an equipment or assembly which is subject to wear & tear and replaced at the end of its useful life. It is sacrificed to protect the equipment or assembly from wear and tear.
- Various type of wear plate are made of Mild Steel, Stainless Steel, Manganese Steel, Quenched Steel, Ceramics, Poly Urethane, Chromium Carbide etc.
- Common areas where we see wear and tear in mining are Hoppers, silos, chutes, fans, mills, crushers and generally all areas where abrasive and corrosive materials such as limestone, coal, coke, sinter, iron ore, sand etc are handled.
- Chromium Carbide coating can be used to prevent abrasion, erosion and impact.

3.2. Session 2: Communication

3 Technical presentations were present in the session on topics such as following:

1. Survivable Intrinsically Safe WiFi based Communications Tracking System for UG Coal Mines- By M/S Adcept Technologies Pvt. Ltd.

Details:

- In brief introduction of company, showed that they have focused on design, development, manufacturing and support of communication technologies for the Mining industry for the global market. 9 Worldwide Sales and Service centres, distributors in 7 Countries and installations in more than 500 Mines focused on improving productivity and safety in underground mines.
- Main concept of technology is surface control centre with software hardware control systems, fibre optics combined with network switches. Switches gives the coverage of around 300-500m inside a mine.
- Miners will be carrying phone which are connected to network switches which further connected to PBX and then worldwide.
- System can also give location of the miners via RFID tags which can be included with ICCL Cap Lamp (with PED as receiver) or could be Self Contained Tag carried by person or fitted on equipment.

2. Underground Mobile Communications and Men Tracking Systems in A Modern Mine- By M/S Geo Spark Solutions.

Details:

- System is based on Industrial Ethernet Ring (Blue Star System) integrate advanced 3G Technology (WCDMA) & WiFi Technology.
- System functions as ordinary communication, rapid report, command emergency evacuation and the command rescue.
- Layout of system contains application layer (application server, control stations, Video server etc.), fibre optic ethernet ring, positioning system, tags, monitoring system, video surveillance system etc.
- System includes operation hardware and software, 3G CoreNet servers, wireless base station, intrinsically safe cell phone cables.
- Helmet of person fixed with tags. High speed data transmission capability based on the system Industrial Ethernet ring network, it will be easy to connect with the underground monitoring equipment and surveillance cameras with the help of suitable connection equipment.
- The equipment and all parts are tested at CIMFR, Dhanbad, SAMEER-Kolkatta & Karandikar Labs Mumbai recognized test laboratories. Based on tests DGMS granted Field Trial Approval vide letter no. E-29021/59/2017/ Electrical (HQ) /FT_E_23394 dated 31-7-2018 to use in below ground Coal Mines.

3. Indigenous development of Integrated Voice, Video and Data communication System in underground along with Wireless IoT-based gas detection and monitoring system for monitoring of

different environment parameters of UG mine- By M/S Easy M2M Technologies Pvt. Ltd.

Details:

- In opening remark discussed about the various problem face by mines in terms of communication.
- Objective of the system to develop Integrated Voice, Video and Data communication indigenously along with Wireless IIoT based gas detection and monitoring system for monitoring of different environment parameters of UG mines, 24x7 video streaming from underground coal mine to surface control room, 2 way video and voice calling from underground mine to surface, Open Standard Wi-Fi / Optical LAN technology, high bandwidth, Digital wireless infrastructure for digital transformation of mines and Indigenous hardware design, and development.
- Their system contains IS Wireless Gas Detector, IS Environment detector, Lightweight FLP enclosure, WiFi wireless node, FLP CCTV: night color vision, ICCC Control room for 24x7 monitoring, Indian Optical fiber cable network, Optical network redundancy, Roof/wall fall resistant network design, Roof/wall fall resistant network design, High tech IS mobile and 24x7 surveillance, software.
- DGMS approved underground communication system for degree 3 mines having Smart Kavach, Smart Tracker, Smart Phone, Wireless Station.

3.3. Session 3: Geomatics/Surveying

5 Technical presentations were present in the session on topics such as following:

- 1. Esri Geospatial Platform for Mining- By M/s Esri India Technologies Pvt. Ltd.**

Details:

- Esri Geospatial Platform contains ArcGIS includes ready to use content basemaps , imagery and a living atlas of the World.
- Key area where Esri is working are Target mineral exploration, evaluate mining conditions, Geological mapping, Model mine construction, display geochemical and hydrology data, GIS based mining permits, assess environmental impact, manage land titles, Plan reclamation activities, Drone based mine analysis, Illegal Mining using RS and GIS and State Mineral Portal.
- Geospatial portal contains all the mining and geology related data as per the need of different stakeholders. These data shared as open standard format can be integrated with any application without giving hardcore data sets by maintaining its proper security.

- 2. Overview & Various Domains Served by Roter Products- By M/S Roter Precision Instruments Pvt. Ltd.**

Details:

- 6 products were shown by presenter of which 1st was Trinity F90+ drone which is currently in use by govt of India under Swamitva scheme. Survey drone which can fly for 90 Minutes. Further showed the performance parameters and ease of operation. Drone is fitted with Lidar and it can cover the whole mines in single flight.
- 2nd product shown was Ground Penetrating Radar, which can be used in coal bed mapping, volumetric assessment, cavity and sink hole detection, Cracks and fracture detection, In situ water content, geological features etc.
- 3rd Product shown OPMMS (open pit mine monitoring system). System is based on Laser scanner setup and which can totally replace the RADAR system. Contains 360-degree setup, automatic scans, auto alert and analysis of critical system.
- 4th Product was Rescue Radar which is currently being used by NDRF also. Used for pinpoint accuracy to find the person who is buried alive. It can detect the heartbeat of person buried alive.
- 5th product shown was for underground mining. Which was world only explosion proof 3D laser scanner of underground mines approved by DGMS.
- 6th product was Cavity Monitoring system in underground mines. It is used to explore the safety hazard areas.

3. Integrated Solutions to Every Survey Need- By M/s Pan India Consultants Pvt. Ltd.

Details:

- Hand Held GPS/GNSS Receiver: Can be used for mapping as well as surveying applications.
- L Band services (SP20 & SP60/85): Unique 6G GNSS centric technology & Exclusive Z Blade processing technology. No dependency on the GPS signals. Availability in very difficult environments. SP85 is advanced technology having 7G chip system.
- MARSS(Mobile and Aerial Remote Sensing Solution): This is a lighter radar payload solution for mobile and aerial applications which is a complete end to end highly accurate plug and play LiDAR payload solution.

4. Photogrammetry & LiDAR Technology For Mining Application- By M/s TerraGeoTechnologies.

Details:

- TerraGeo offers industry leading geospatial software products for highly advanced softwares which brings GIS, Image Processing, Photogrammetry and LiDAR together to cater to many industries and

paves the path for various private, public surveying and mapping organizations

- **Summit Evolution software** provides a set of powerful tools for discovering and capturing 3D information from stereo data. The software includes CAD and GIS interfaces, 3D stereo vector superimposition, automated feature editing, contour generation and many more tools.
- **Summit UAS** gives users control over their data. Summit UAS consists of two powerful applications, Summit Evolution Lite and LandScape, which among their many features offer ways to further explore and edit the point cloud and orthomosaic created by UAS processing software.
- **TerraSolid Software** is the industry standard software for point clouds and images processing, developed specifically for the demanding requirements of geospatial, engineering, operations and environmental professionals. This software is designed to give 360-degree view of data.
- It can handle Handle huge volumes of input data and Accurately measure active mining area. Further, automatic tools for bench line creation. export output as AutoCAD format with elevation information and calculate volume of mining or pit area.

5. **Geospatial Mining Solutions-** By M/s Hexagon India

Details:

- Main moto of Hexagon is to minimize the gap between data creation and data usage with its state-of-the-art technologies.
- Hexagon Geospatial having three portfolios such as Power portfolio, M.app portfolio and Luciad Portfolio.
- Case study of Rampura Agucha mines taken for photogrammetry and it was found that areas measures was upto 95 percent correct.
- IMAGINE UAV also one of the solution which they have applied in mines in south India to get accurate DEM.
- Mining Tenement System is also one of the geospatial platform built on Haxagon Platfrom by IBM.

3.4. **Session 4: Underground coal mining Technologies**

4 Technical presentations were present in the session on topics such as following:

1. **Carlson Technologies to meet Future Mining Challenges-** By M/s Shotam Instruments Pvt. Ltd.

Details:

- Carlson 2K Terrestrial Laser Scanner: Used for Mine optimization Stockpile volume calculation, Tunnel & Underground mine mapping & convergence analysis, Vertical field of view allows the Scan2K to conduct high-wall scans, high-wall monitoring, general pit scanning.

- Carlson Quarryman Pro (Laser Scanning for Quarry Surveying and Stockpile Monitoring): delivering laser-scanning solutions to the quarrying industry worldwide. It's our most robust system yet and is designed to offer mine and quarry Improved safety, Increased profitability, Improved productivity.
- Carlson Fix1 (Carlson Fixed Installation Scanner): Automated delivery of volumetric results. Provides stockpile volume information or detailed scans in geographically remote areas without assigning manpower and measurement tools. After installation, no knowledge of surveying, data processing or point cloud manipulation is required by users

2. Mechanical Cutting, Highwall Mining "Made in India"- By M/s Sandvik Asia Pvt. Ltd.

Details:

- 3 no. of Bolter Miners and Road Headers of Sandvik are in operation in India. Beside above two machines, the feeder brakers, loaders, continuous miners, cutting attachments are also offered in India.
- Core products for underground workings are Bolter mlner for Longwall Panel development, Continuous miner for bord and pillar development, Road Header for rapid incline development, Cutting attachments for dressing work.
- Main focus of Sandvik for Indian Mines are continuous miner and bolter miner. Key features of Bolter miners shown area highest safety standard with integrated temporary roof support, Rock support installed immediately upon excavation, No people exposed to unsupported ground, Integrated wet dust exhaust scrubber. Unique concept to Longwall mining as it contains two equipment combined in one machine with fast advance cycle of 1m/10min. Another feature of Bolter miner is for every one-meter cut machine does need to move.
- MB 670-1 XLH is extra low height bolter miner (2-3.3m) while MB 670-1 is Standard height Bolter Miner (2.8-5m). Also, various ranges of continuous miners shown which are globally supplied with cutting height from 1.8 to 5 m.
- Another product shown was F12 T FLP loader with bucket capacity of 4 m³. Upcoming product this year LS170 low height diesel scoop.

3. Highwall Mining "Made In India"- By Gainwell Commonsales Pvt. Ltd.

Details:

- Benefits and need of Highwall Mining shown. Typical coal reserve recovery of 50 to 70% depending on geological conditions and overburden depth. Mines coal from exposed coal seams when economical surface mining limits are reached. Mines parallel entries to a depth of 1000 feet (300 m) without personnel working underground Flexible System can mine multiple seam heights.

- “Made in India” Highwall Miner of Gainwell: Gainwell received license from CAT to manufacture the Highwall product in Sept 2017. New dedicated facility built in Asansol for the Highwall manufacturing. First machine manufactured and delivered to SECL SARDA Highwall Mining Project in Jan 2019.
- 2nd Machine manufactured & supplied to Tata Steel West Bokaro in Nov 2020. 3rd Machine is ready at factory to be deployed to ECL Sripur Nimcha Project in July 2021.
- Four interchangeable cutter modules produces versatility such as
 GCM210 Range Height : 0.9 1.7m; Width : 3505mm
 GLM210 Range Height : 1.0 3.1m; Width : 3505mm
 GMCM235 Range Height : 1.2 3.1m; Width : 3505mm
 GHCM235 Range Height : 2.4 4.5m; Width : 3505mm
 Max. Penetration of these equipment 305m.

4. **Underground Mechanization - Way Forward**-By M/s Komatsu India Pvt. Ltd.

Details:

- Discussed about continuous miner technology. Komatsu has supplied 29 packages till now since 2002. Suggestions for the future are Introduce High-capacity equipment – Battery Hauler, SC. Mass scale conversion of LHD/SDL mines to CM technology. In case of limited reserve, plan a group of mines with similar mining conditions to relocate the same CM package Improve ventilation, Provide Man Riding System.
- Launched Battery Operated equipment (Haulers & Scoops) recently. BH18 Low Seam (1.4m – 2.0m) with pay load of 16T & BH20 Mid Seam (above 2.0m) with payload of 18 T. Both are approved by DGMS.
- Battery hauler are working 2 nos in CCL and 1 no in SECL. Battery operated multi utility vehicle (Battery Scoop 02ESV56) with payload of 15T and bucket capacity 3.96 m³.
- Alternative Mining Layouts : **Supersections**- In this method instead of 4 pillar 5 heading more pillar such as 10-12 pillar heading will be there. Objective is double the production with less capital investments.
- Another alternative method shown is **Wongawilli**: This is more about rib pillar extraction. Driving 3 to 5 roadways out of the boundary. Pillars ranging from 50-150 m one side of it.

3.5. **Session 5: Exploration**

7 Technical presentations were present in the session on topics such as following:

1. **Seismic — A Tool for Accelerated Coal Exploration**- By M/s Gujarat Energy Research And Management Institute (GERMI)

Details:

- Germi deals with G&G and Petro physical Data Analysis (Oil & Gas and Coal) under which Reserve estimations, Categorization, Seismic Data Interpretation, Reservoir Characterization, Certification and Auditing.
- Main importance of seismic is in coal extension, structure, Thickness, Thin seam mapping, accurate fault and fracture mapping and computing the density of coal. Coal resource estimation requires the estimation of coal quality parameters like ash content, In situ moisture and coal ranking from limited bore wells and seismic data.
- CIL SPE Collaborative software developed GERMI and CMPDI. The technique of Spectral Bandwidth Enhancement (using Continuous Wavelet Transform is developed, which can improve the resolvability of seismic data using the Holder exponents.
- GERMI is presently working on Faults and Fracture prediction from Seismic using Machine Learning Techniques.
- GERMI proposes to develop such an integrated work under “ Make in India campaign and Aatma Nirbhar Bharat”Bharat”, to enhance the capabilities of Coal exploration to accelerate the efforts cost affectively.

2. **Passive Seismic: a robust tool for geothermal and mineral exploration-** By M/s South West Pinnacle Exploration Ltd.

Details:

- Passive seismic is a novel, non-destructive and economically feasible technology that can be applied in exploitation of mineral deposits.
- Passive seismic methodologies, exploit low frequency seismic signals that are generated naturally, either in the form of pure ambient seismic noise or local, regional and tele seismic events.
- Passive seismic signals occur in abundance in majority of the earth's locations and can be extracted from same dataset. Thus, using only one acquisition scheme, a no. of Passive seismic methodologies can be individually applied and jointly interpreted.
- Various methodologies of passive seismic are Local earthquake travel time tomography, ambient noise tomography, surface wave tomography, Reflective wave Seismic Interferometry (2D/3D visual seismic reflection)
- Current example of passive seismic is being under process by ONGC in West Tripura. Passive seismic tomography for HC exploration (2020-2020)

3. **De-risking of Coal Exploration by adopting innovative workflows in Integrated Subsurface Modelling of Geoscientific Data using INTREPID GEOPHYSICS Software-** By M/s Samit Spectrum EIT Private Ltd.

Details:

- Key challenges in in Coal Exploration such demarking metamorphic boundaries, Mapping dyke and faulted features, inaccessible area for

detail drilling survey, misinterpretation of data etc. was discussed and as a solution innovative workflow for subsurface modelling using IG application shown.

- INTREPID GEOPHYSICS has designed such work flows which help to address above issues. In which geophysical data integrated with modelling. Geological maps, geological drillhole and any feature that already interpreted using mapping etc. all these data can be integrated into model so that complete simulation of 3D model can be generated.
- IG's latest innovation is 2.5 D AEM inversion tool that supports almost all type of possible time and Frequency domain EM configuration. 2.5D inversion scheme is highly accurate to map the features, conductivity contrast and groundwater investigations.
- Some other IG's leading edge technologies are
 - Integrated 3D Modelling and constrained Joint Inversion – Geology from Geophysics.
 - Airborne and Ground Data Processing and Interpretation
 - Airborne Magnetic and Gravity Gradiometry – Processing and QC
 - Water modeling with integration of FEFLOW to understand the fluid movement from 3D modelling.

4. Geophysical Techniques for Determination Of Sub Surface Anomalies & Its Use In Assessment Of Damage And Integrity Of Coal Mine Structures- By M/s Parsan Overseas (Pvt.) Ltd

Details:

- In this paper issues of subsurface anomalies such as cavities, faults, unknown tunnels, damage and integrity of mine structures etc.
- Flooding and subsidence is another problem in mining industries which needs new technologies to address.
- Solutions to above are to understand shear modulus, Poisson's ratio, Modulus of elasticity and other parameters at site for civil contractions or open cast mining for coal/lignite and studies can be taken up by using surface wave techniques.
- This will help to meet the requirements of bearing capacity and settlement of a foundation, slope stability of an open pit, ground control for underground mining.
- Various techniques can be used are surface wave techniques, resistivity imaging technique, GPR survey technique and seismic refraction technique. Further some case studies such as using ground penetrating radar for roof hazard detection in underground mines.

5. Application of Airborne Full Tensor Gravity Gradiometry (FTG) Technology for Structural Mapping and to Assess, Delineate Coal Potential Zones in Unexplored Sedimentary basins including Raj mahal Basin- By M/s Bell Geospace Ltd.

Details:

- Airborne FTG Surveys will not be affected by challenges such as insufficient geological information due to Deccan traps, Alluvial/Sand cover, Sediment cover and inaccessible areas for ground surveys.
- Gravity measure only vertical component while FTG measure all 9 component which gives 3D figure. Hence the signal strength is higher in Air FTG dataset.
- Bellgeo recommends adding Advanced Gravity Technology for Structural mapping, Faults and delineation of potential in alluvial and sub trappean areas in cost effective way with a quick turnaround time without disturbing environment.
- Further a case study of Indonesian coal mine was discussed. In case of India, Bellgeo has acquired Air FTG Data over 65,000 sq.km area in Assam, Rajasthan and Gujarat. Some of the Studies has delineated Lignite zones and Coal zones in some of the blocks.

6. Drilling Productivity Improvement- By M/s Kores India Ltd.**Details:**

- For productivity improvement use of latest machines and better utilisation of machines, selection of machine, use of mud mixer for polymer, selection of bits as per formation, automation of drill rigs and increase the drilling through new operation model.
- Comparison of mechanical drills and hydrostatic drills was shown. M/s Kores having machines of all depth ranges such as 150m to 1000m.
- In case of polymer mixer, use of hydraulic operated polymer mixer will improve the performance of polymer.
- Further operation control on Rig operations such as, live camera from HQ, GPRS tracking from HQ, Diesel level & consumption from HQ, Oil level consumption from HQ.

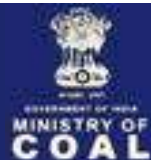
7. Upgradation of Technology in Exploration Drilling- By M/s Epiroc Mining India Ltd.**Details:**

- Various equipment currently running in India are IDM series, followed by machine which are under U.S. guidelines are DM series, then PITVIPER series (computerized rigs, highest productivity, Autonomous operations) and future technologies are Diesel free operation, Auto bit change, self-thinking Bots.
- Talking about the 6th sense approach which is combination people, process and technology showed a cut model in which different machines are operated at different level related each other with controlled towers and support services.
- Examples of 6th sense solution shown are **My Epiroc a mobile app** through that we can track our machines, **Cetiq portal** is a web based

portal by which sitting at any part of the world we can track how the machine is operating, what are the performance parameters etc., **office Teleremote** (operating a machine from certain distance).

- Also discussed the product Autonomous drill with PV351 which world's first electric Pit Viper Drill. This machine increase safety, increase productivity by 30 percent, machine utilisation by 35 percent.
- **Rod Handling system**: As normally it is done manually but with this system it reduces the intervention of operator and assistant.
- **Explorac 100**: Reverse circulation drill rig for exploration drilling. Prevents cross contamination and enables collection of a large no of sample bags in short amount of time. It can cut drilling cost upto 40 percent.

In the concluding remarks Shri A.K. Rana, Director (T/P&D) CMPDI thanked all the presenters for their contribution to workshop and also thanked chief guest of workshop Shri Binay Dayal, Director Technical, Coal India Ltd., Advisor Projects Shri Anandji Prasad, Ministry of Coal and CMD CMPDI Shri Manoj Kumar.



**Workshop
On
Technology Roadmap For Coal Sector**

**Technologies to Meet Future
Challenges**



Program - Flow for Workshop on Technology Roadmap For Coal Sector: Technologies to Meet Future Challenges
18th January, 2022

1. Welcome Address by CMD, CMPDI 2. Address to Delegates by Advisor(Projects), MoC, Gol 3. Key note Address to Delegates by Hon’ble Chief Guest : Shri Binay Dayal, Director (Technical), CIL				10:00 am to 10:30 am
Sl. No	Subject	Manufacturers/ Suppliers	Technical Presentations	
4	Transportation	1.M/s THYSSENKRUPP INDUSTRIES INDIA PVT. LTD	Long Distance Conveying: Overland Curved Conveyors & Pipe Conveyors	10:30 am to 11:45 am
		2.M/s TAKRAF INDIA PVT. LTD.	Inpit Crushing & Conveying System with Sizers	
		3.M/s PREMIUM TRANSMISSION PVT. LTD.	Variable Speed Fluid Coupling	
		4.M/s DODGE INDIA PVT. LTD.	Belt Speed & Tension Control on Conveyor Using Multiple Hydro-viscous Clutch Type drives	
		5.M/s FEDERAL SYNERGIES INDIA PVT. LTD.	Adavntages of Chromium Carbide Bear Plates/ Liners	
		Session Closing Remarks by Coordinator		
5	Communication	1. M/s ADCEPT TECHNOLOGIES PVT. LTD.	Survivable Intrinsically Safe WiFi based Communications Tracking System for UG Coal Mines	11:45 am to 01:00 pm
		2.M/s GEO SPARK SOLUTIONS	Underground Mobile Communications and Men Tracking Systems in A Modern Mine	
		3.M/s EASY M2M TECHNOLOGIES PVT. LTD.	Indigenous development of Integrated Voice, Video and Data communication System in underground along with Wireless IoT based gas detection and monitoring system for monitoring of different environment parameters of UG mine	
		Session Closing Remarks by Coordinator		
-----Lunch Break-----				1:00 pm to 2:00pm

6	Geomatics/ Surveying	1.M/s ESRI INDIA TECHNOLOGIES PVT. LTD.	Esri Geospatial Platform For Mining	02:00 pm to 03:30 pm
		2.M/s ROTER PRECISION INSTRUMENTS PVT. LTD.	Overview & Various Domains Served by Roter Products	
		3.M/s PAN INDIA CONSULTANTS PVT. LTD.	Integrated Solutions to Every Survey Need	
		4.M/s TERRAGEO TECHNOLOGIES LLP	Photogrammetry & LiDAR Technology For Mining Application	
		5.M/s HEXAGON INDIA	Geospatial Mining Solutions	
		Session Closing Remarks by Coordinator		
7	Underground Coal Mining Technologies	1.M/s SHOTAM INSTRUMENTS PVT. LTD.	Carlson Technologies to meet Future Mining Challenges	03:30 pm to 04:30 pm
		2.SANDVIK ASIA PVT. LTD.	Mechanical Cutting	
		3.GAINWELL COMMONSALES PVT. LTD.	Highwall Mining “Made in India”	
		4.M/s KOMATSU INDIA PVT. LTD.	Underground Mechanization - Way Forward	
		Session Closing Remarks by Coordinator		
8	Exploration	1. GUJARAT ENERGY RESEARCH AND MANAGEMENT INSTITUTE (GERMI)	Seismic – A Tool for Accelerated Coal Exploration	04:30 pm to 05:45 pm
		2.M/s SOUTH WEST PINNACLE EXPLORATION LTD.	Passive Seismic: a robust tool for geothermal and mineral exploration	
		3.M/s SAMIT SPECTRUM EIT PRIVATE LTD.	De-risking of Coal Exploration by adopting innovative workflows in Integrated Subsurface Modelling of Geoscientific Data using INTREPID GEOPHYSICS Software	
		4.M/s PARSAN OVERSEAS (PVT.) LTD	Geophysical Techniques For Determination Of Sub Surface Anomalies & Its Use In Assessment Of Damage And Integrity Of Coal Mine Structures	
		5.M/s BELL GEOSPACE LTD.	Application of Airborne Full Tensor Gravity Gradiometry (FTG) Technology for Structural Mapping and to Assess, Delineate Coal Potential Zones in Unexplored Sedimentary basins including Raj mahal Basin	
		6.M/s KORES INDIA LTD.	Drilling Productivity Improvement	
		7.M/s SANDVIK ASIA PVT. LTD.	Upgradation of Technology in Exploration Drilling	
		Session Closing Remarks by Coordinator		
9. Closing Remarks by Director (Tech./Planning & Design), CMPDI				05:45 pm to 06:00 pm

Workshop on Technology Roadmap for Coal Sector in Mining

Technologies to Meet Future Challenges

January 2022 | Indranil Roy

engineering. tomorrow. together.



Discontinuous mining: Dominant choice in India, presents many challenges



- High population of moving vehicles: Safety a challenge, operations in inclement weather disrupted, high diesel consumption
- Slow, affected by weather conditions, high diesel consumption



Common situation in open-pit mines

Conventional heavy truck haulage

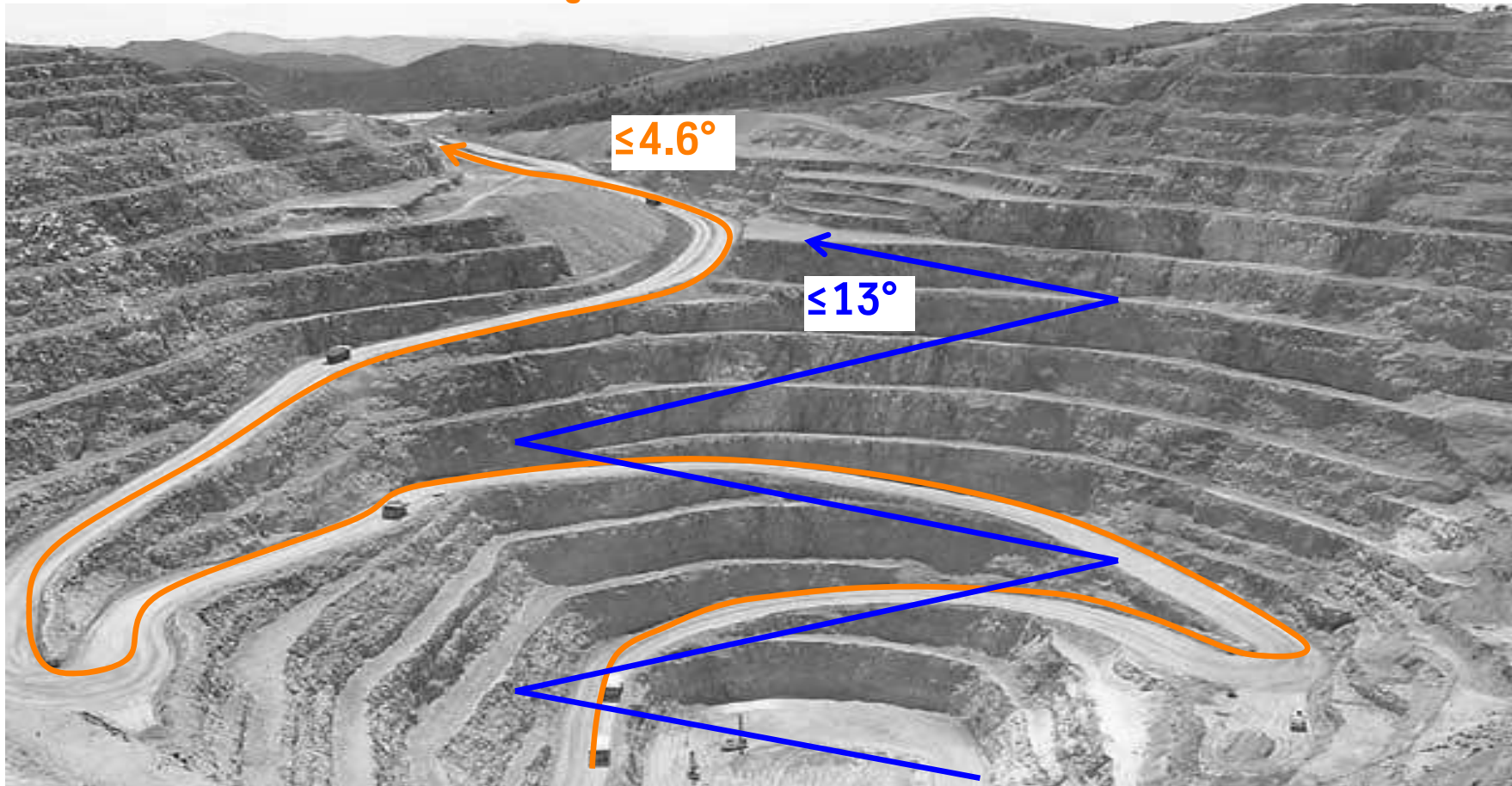
- Transportation on slowly rising ramps with an inclination of merely up to 5°.
- Trucks weigh between 30 up to 260 tons whereas the payload on each truck is between 40 and 400 tons.
- The average travelling speed is about 15-20 km/h.
- A fleet of trucks including maintenance equipment are necessary.
- The haul roads have to be renovated frequently due to wear and the progress of mining.
- Under inclement weather conditions (fog, snow, rain) truck haulage is significantly limited.



Ore and overburden haulage in open-pit mines, depending on slope angles

1. Truck Haulage

2. Belt Conveyor



Common situation in open-pit mines

Comparison – Truck v/s Belt Conveyor

Comparison of Material Transport 1 Km

Truck



100 sh ton Truck

Payload weight: 91 t

Service weight: 70 t

Total moved weight on one round trip:

$$2 \times 70 \text{ t} + 91 \text{ t} = 231 \text{ t}$$

Ratio moved material to total moved weight:

1 : 2.5

Percentage of material moved:

39%

360 sh ton Truck

Payload weight: 326 t

Service weight: 271 t

Total moved weight on one round trip:

$$2 \times 271 \text{ t} + 326 \text{ t} = 868 \text{ t}$$

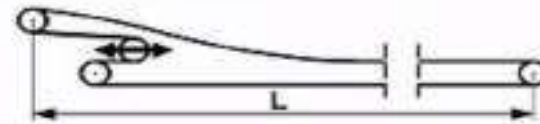
Ratio moved material to total moved weight:

1 : 2.7

Percentage of material moved:

38%

Belt conveyor



L=1000 m , belt speed: 5 m/s

Throughput: 12000 t/h

Moved material on the conveyor: 605 t

Moved weight of the conveyor: 140 t

Total moved weight: 745 t

Ratio moved material to total moved weight:

1 : 1.2

Percentage of material moved:

81%



Agenda

State of mining

A new paradigm

- Long Distance Conveying
- Blendomat



Agenda

State of mining

A new paradigm

- Long Distance Conveying
- Blendomat

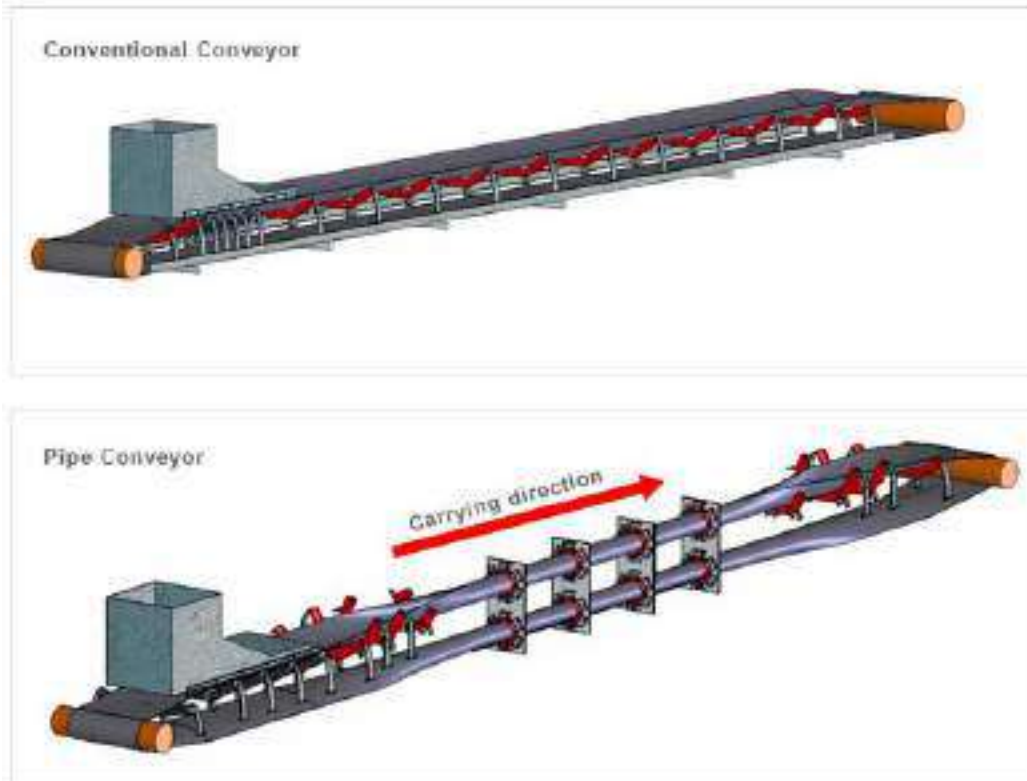


Long Distance Conveying

- ✓ Can be either Trough or Pipe Conveyors depending on the horizontal radii and environmental aspect
- ✓ Multiple Drives @ both ends and/ or intermediate location as required
- ✓ Variable Speed Drive
- ✓ Belt Turn Over Stations
- ✓ Energy Efficient LRR / SLRR Belt – power requirement reduces by 15 to 30%
- ✓ Low Rolling Resistance Idlers
- ✓ For trough conveyors horizontal radius depends on the local tension at the turning point (generally 1000 M minimum)
- ✓ Pipe conveyor radius may vary from 300 to 1000 times of the pipe diameter
- ✓ Pipe diameter shall be at least 3 times of large lumps



Introduction to Pipe Conveyor



- ❖ Material is totally enclosed by the pipe belt, thus spillage is restricted
- ❖ Pipe Conveyor offers better protection to the material and environment
- ❖ Pipe Conveyor has better flexibility in conveyor routing from tighter curves



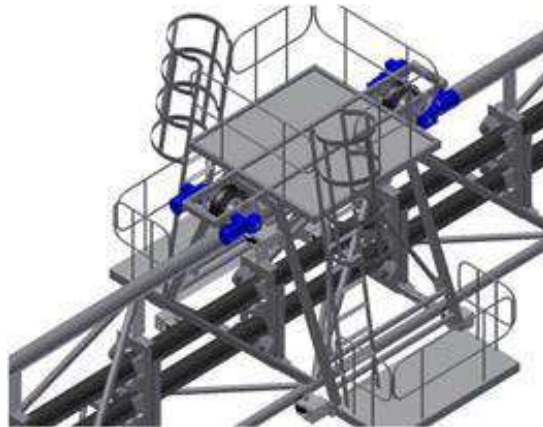
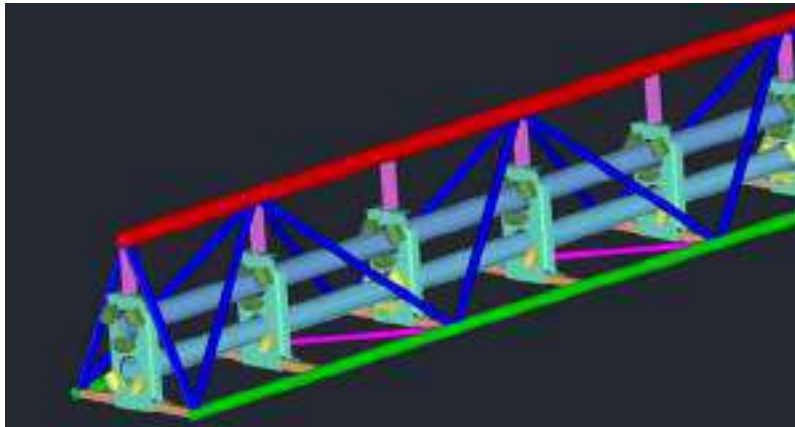
Pipe Conveying compared to Conventional Conveying

Benefits and advantages

- ✓ Can negotiate tight horizontal and vertical curves and eliminate transfer points
- ✓ Encloses the transported product, is an environmentally preferred solution
- ✓ Can be designed for two-way conveying
- ✓ Spillage Free Transportation
- ✓ No build-up on idlers
- ✓ Reduced structural costs by eliminating walkways
- ✓ Has excellent belt edge damage control
- ✓ Unaffected by wind and rain thus requires no covers



Light Weight Triangular Truss with Maintenance Trolley



- Self-propelled Maintenance Trolley to service the entire length of the conveyor
- Specifically designed to have complete access to all parts of the conveyor structure
- Driving lights and overhead flood light to facilitate operation during dark/night conditions.



Key References (Indian)

IOCL – Coke Handling & Storage System at Panipat Refinery



Major Scope

- **Pipe Conveyors 2 Kms, 825 TPH**
- Trough Belt Conveyors
- Motorised Tripper

Year of completion - 2006



Key References (Indian)

NALCO - Mine Conveyor System at Damanjodi



Major Scope

- Trough Conveyor 4.2 Kms with horizontal and vertical curves, 900 TPH

Year of completion - 2017



Key References (Indian)

Bharat Petroleum Corporation Ltd. Kochi – Petcoke handling system



Major Scope

- **Pipe Conveyors 1.6 Kms, 650 TPH**
- Circular Stackers Cum Reclaimers
- Single Roll Crusher
- Circular Dome 120 Mtrs.
- Rail Loading System
- Truck Loading System

Year of completion - 2017



Key References (Indian)

MAHAGENCO – Chandrapur TPS



Major Scope

- **Pipe conveyors 5.5 Kms, 500 TPH**
- Trough Conveyers – 4 x 650/ 850 TPH
- Maintenance Trolley – 2 Nos.
- Wagon Loading System – 1 No.

Year of completion - 2021



Key References (Indian)

NTPC – External Coal Handling System for 3X660 MW North Karanpura Power Plant (Under Execution)



Major Scope

- **Pipe conveyors 2 x 7.5 Kms, 2,000 TPH**
- Trough Conveyers – 3.5 kms
- Apron Feeders – 8 Nos



Key References (Indian)

Adani - Conveyor system for Kurmitar Iron Ore Mines (Under Execution)



Representative Image

Major Scope

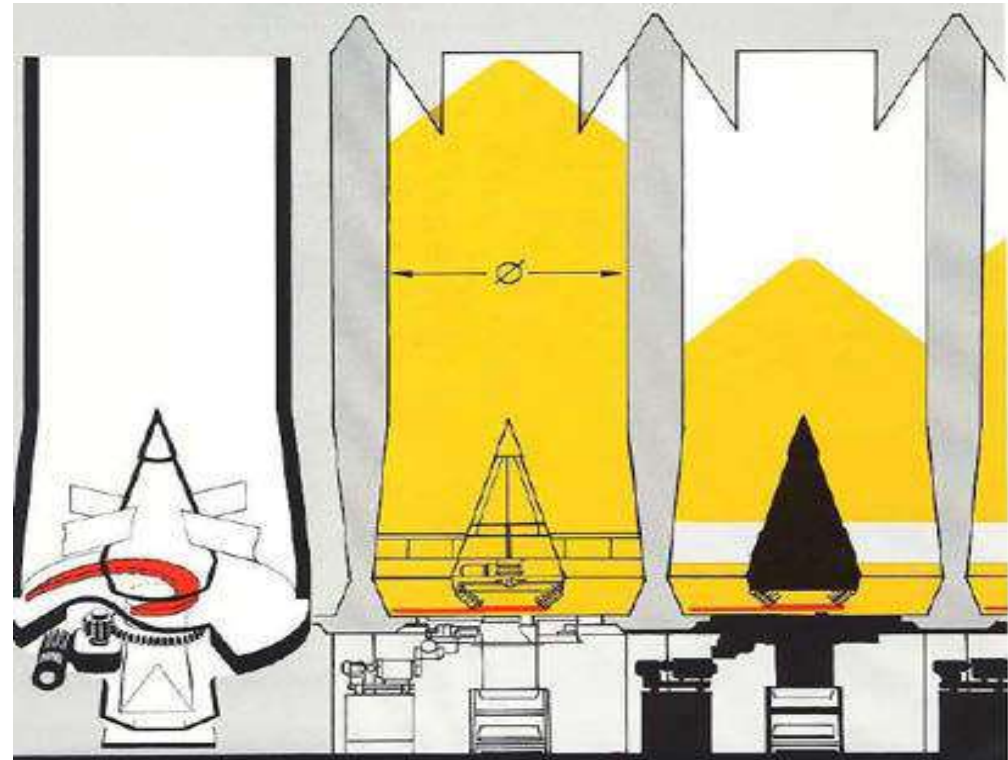
- **Down Hill Pipe Conveyor 8.5 Kms, 1800 TPH**
- Trough Conveyors - 3.2 kms



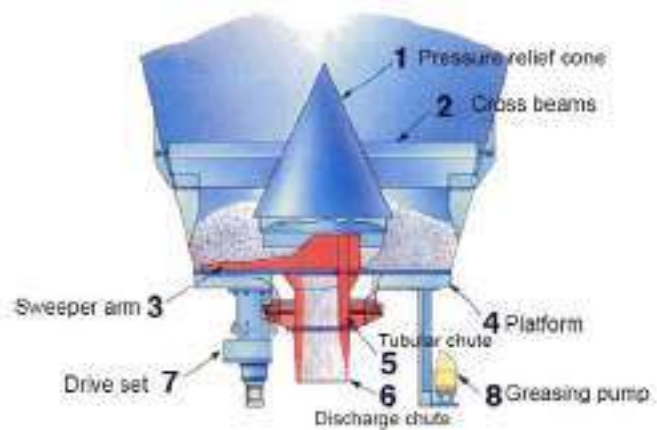
Blendomat

The types depend on the silo diameter

Ø 1,0 m
Ø 1,5 m ; Ø 1,7 m ; Ø 2 m
Ø 2,5 m ; Ø 3,0 m ; Ø 3,5 m
Ø 4 m ; Ø 4,5 m
Ø 5 m ; Ø 5,5 m
Ø 6 m
Ø 7 m



Components overview and Major parts



Major parts overview

- ❖ Rotor arm on bottom plate/ platform
- ❖ Rotor arm drive
- ❖ Pressure relief cone

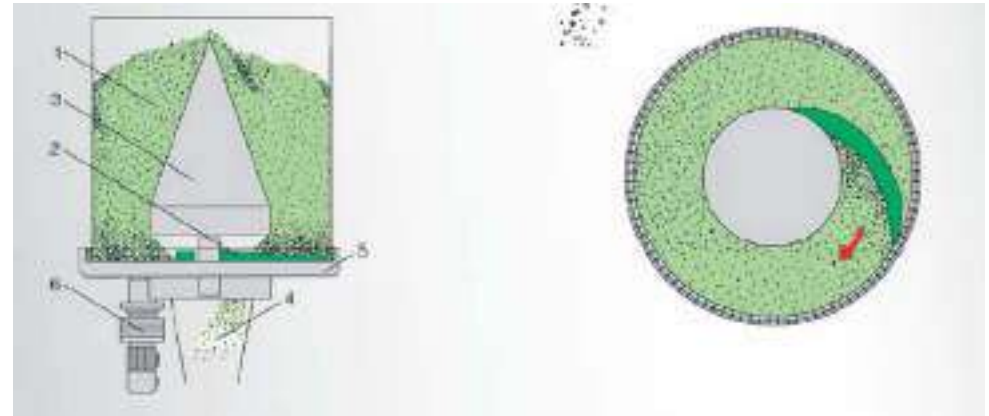


Blendomat

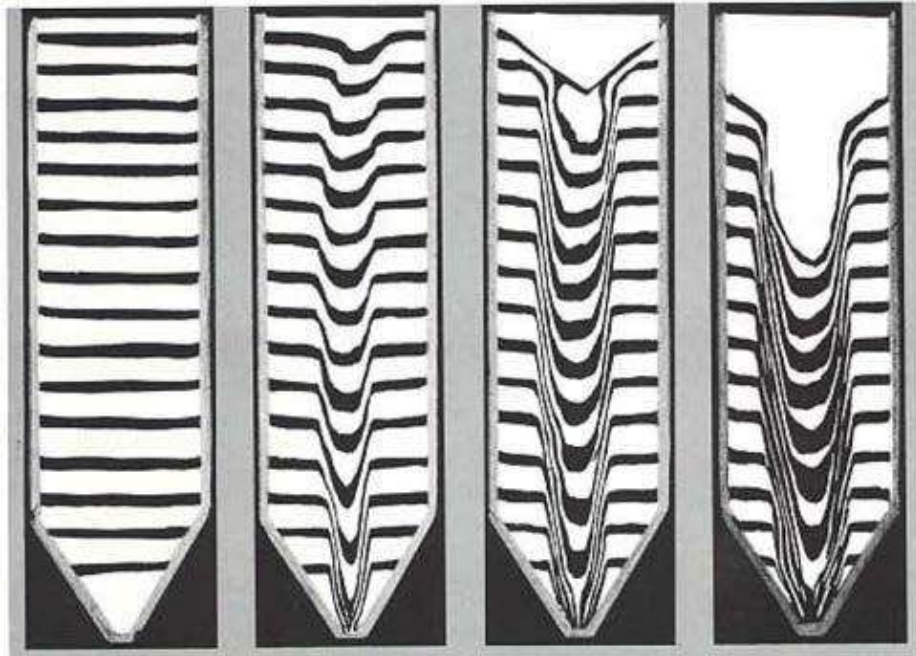
Functional overview

The major components of Blendomat are the free-spinning inner cone (3), the silo floor (5), the discharge arm (2) and the drive system (6). The complete Blendomat unit is bolted underneath the silo. The silo floor (5) has a central outlet opening (4), which is covered by the inner cone (3). An angle of repose forms naturally beneath the cone, preventing uncontrolled bulk-material flow.

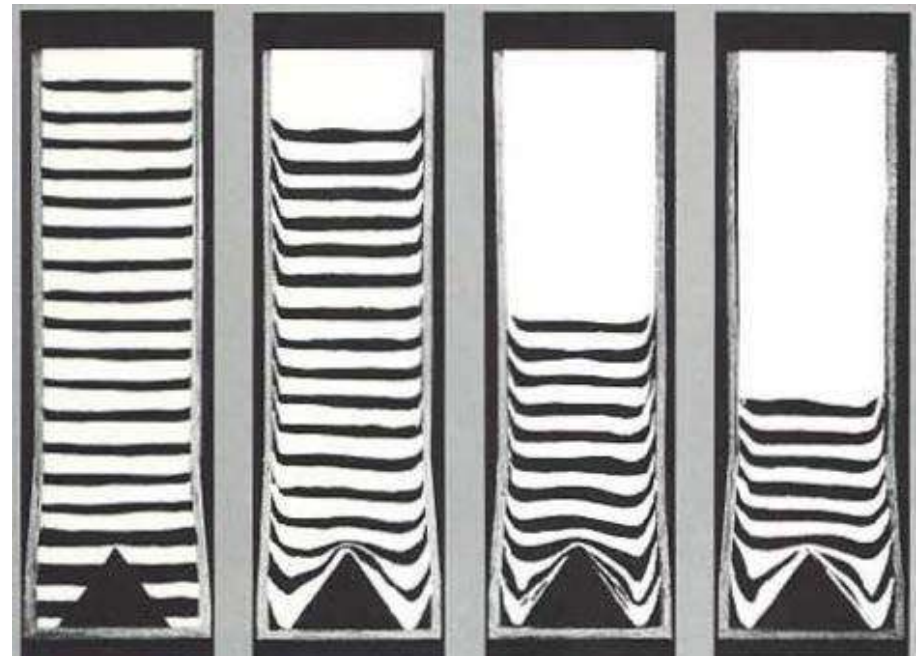
The discharge arm (2) rotates and conveys the bulk material to the central outlet (4). The material flow-rate is determined by the speed of the discharge arm. Bulk material build-ups at the corners between the silo wall and floor are avoided by the special undercut design of the Blendomat silo floor.



Flow Pattern



Conventional Silo Bin Flow without Bin Extractor (Blendomat)



Silo Bin Flow with Bin Extractor (Blendomat)



thyssenkrupp ideally placed to support in India

- ✓ Rich experience of 75 years in India
- ✓ Pioneers in material handling and crushing and screening business in India
- ✓ World Class Technology
- ✓ Technological Focus and Investment in R & D
- ✓ Large Reference Base
- ✓ Strong EPC capability
- ✓ “Make in India”
- ✓ In-house manufacturing of Idler Rollers & Pulleys
- ✓ Wide Range of Products & Services (one stop solution provider)
- ✓ Reliable Operation and After Sales



TAKRAF – In Pit Crushing and Conveying System with Sizers

B V SRIKANT
PRODUCT MANAGER - CRUSHING

January 2022

Mining Systems & Equipment



For all your excavating, crushing, conveying and dumping requirements, as well as other auxiliary equipment

About us

1. Mining Systems & Equipment

- **Excavating**

- Bucket-wheel excavators (BWE)
- Bucket-chain excavators (BCE)

- **Primary Crushing Plants**

- **Conveying**

- Belt conveyors
- Mobile transfer conveyors
- Conveyor bridges
- Belt feeders
- Apron feeders

- **Dumping**

- Spreaders
- Mobile stacking bridges
- Cross-pit conveyor bridges

- **Auxiliary Equipment**

- Transport crawlers
- Cable-reel cars
- Shifting heads
- Jib cranes
- Maintenance carts



TAKRAF compact bucket-wheel excavator (BWE)



TAKRAF spreader – part of largest ECS system in Asia, all supplied by TAKRAF*



TAKRAF primary crushing plant



TAKRAF transport crawler

* ECS = excavator, conveyor and spreader

Bulk Material Handling



For all your various material handling requirements including stockyard and port facilities

About us

2. Bulk Material Handling

- **Stockyard/Disposal Facilities**
 - Scrapers
 - Reclaimers
 - Stackers
 - Combined stacker/reclaimers
- **Loading/Un-loading Equipment**
 - Wagon unloading
 - Wagon/truck loading
- **Conveying**
 - Overland conveyors
 - Tube/pipe conveyors
 - “In-plant” conveyors
- **Port Facilities**
 - Ship/barge un-loaders
 - Ship/barge loaders
- **Various “In-Plant” Handling Equipment**
 - Feeders
 - Chutes
 - Galleries



TAKRAF stockyard/disposal facilities



TAKRAF conveyors (“in-plant” on left and pipe on right)



TAKRAF port facilities



TAKRAF wagon loading

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Minerals Processing & Beneficiation



Enhanced minerals processing portfolio

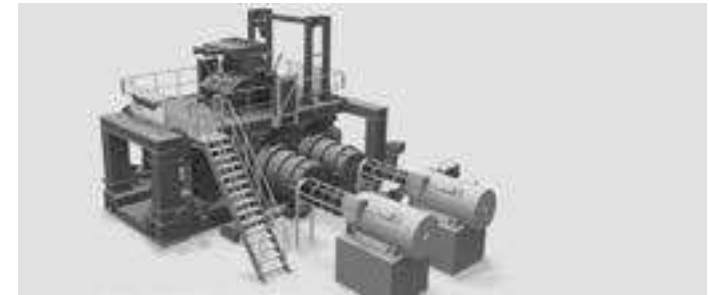
About us

3. Minerals Processing & Beneficiation

- **Comminution**
 - Roll crushers
 - Sizers (standard and X-treme class)
 - High-Pressure Grinding Rolls (HPGRs)
- **DELKOR: Solid/Liquid Separation and Wet Processing – equipment or systems**
 - DELKOR thickeners and clarifiers
 - DELKOR horizontal vacuum belt filters
 - DELKOR F.A.S.T./conventional filter press
 - DELKOR BQR flotation cells



TAKRAF X-treme class sizer



TAKRAF High Pressure Grinding Rolls



DELKOR thickener



IPCC Technology

B V SRIKANT
PRODUCT MANAGER - CRUSHING
OCT 2021

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Who should be interested

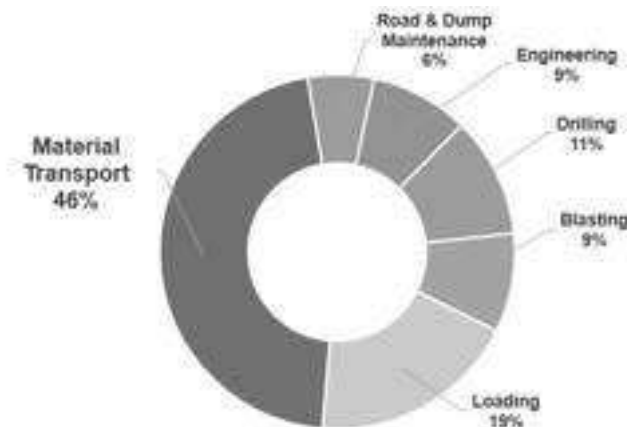


- Concerned about the environment
- Large Mine capacities – ore / burden
- Deep Mine
- Long mine life
- Long Haul distances
- Need more control
- Want Lesser Interfaces – Lesser reasons to worry
- Have problem with pilferage

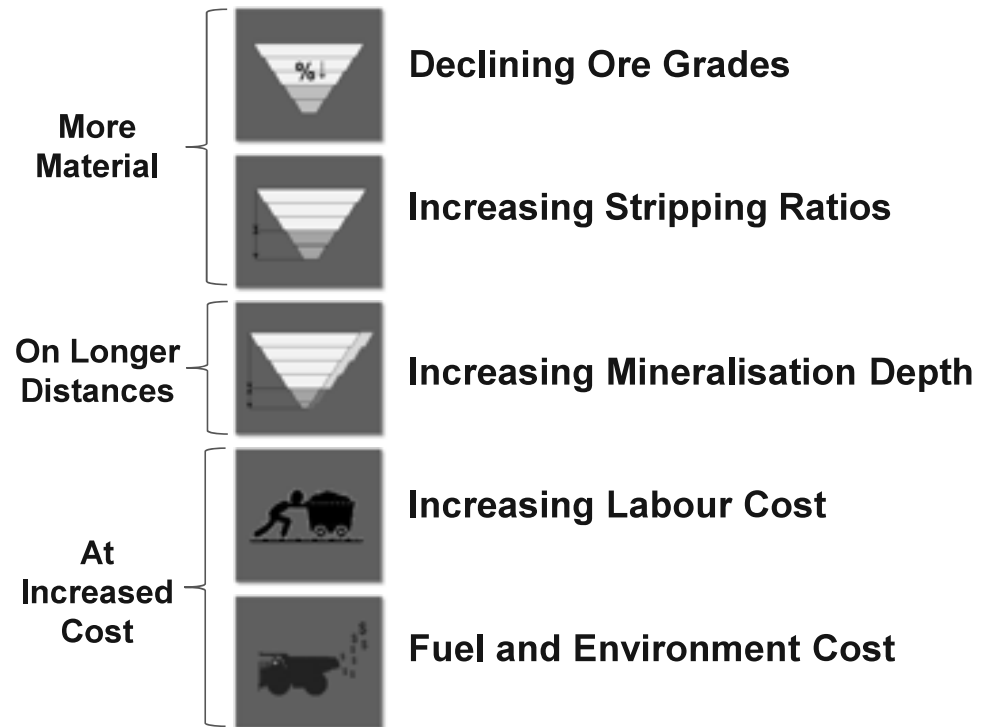
The Context



- Mine Planning Context
- Main Process: Material Transport
- Predominate → TRUCKS
- Overall Operational Cost Increase
- Material Transport Cost Increase



The Context



Belt Conveyors

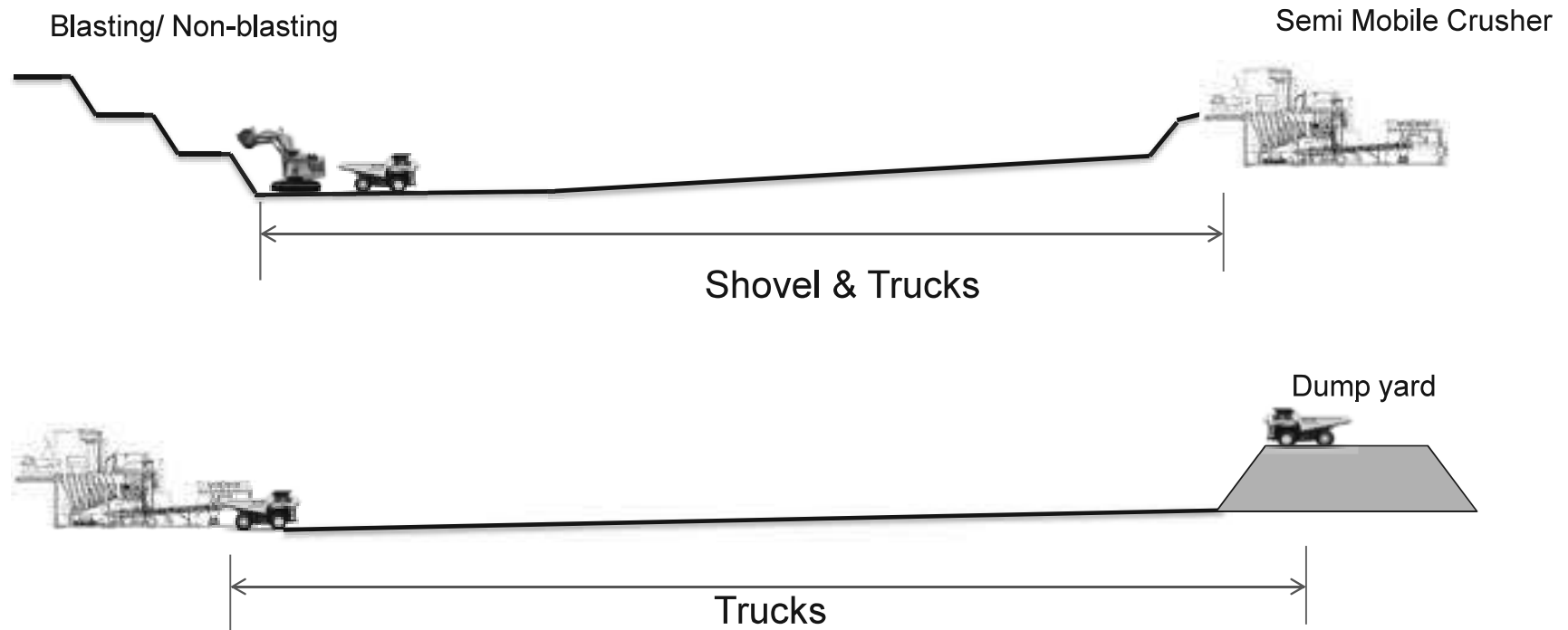


Requires Crushing



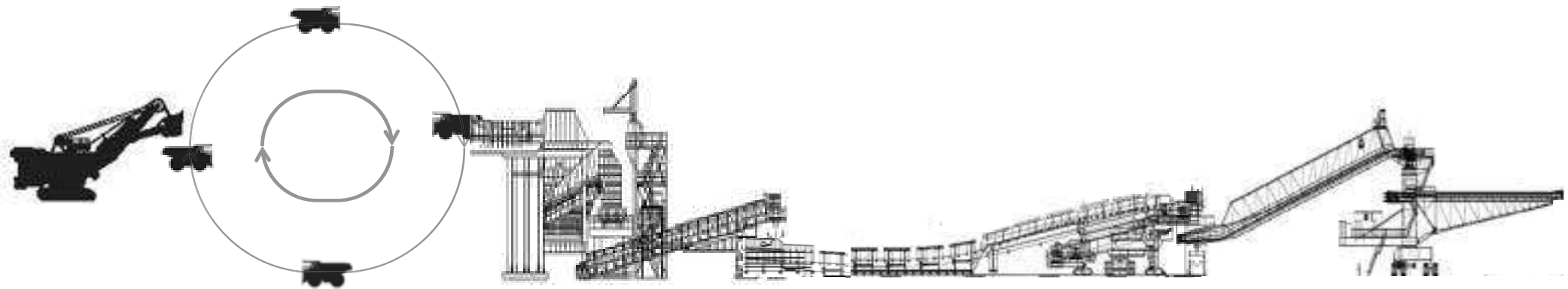
In-Pit Crushing and Conveying Systems

Introduction to IPCC



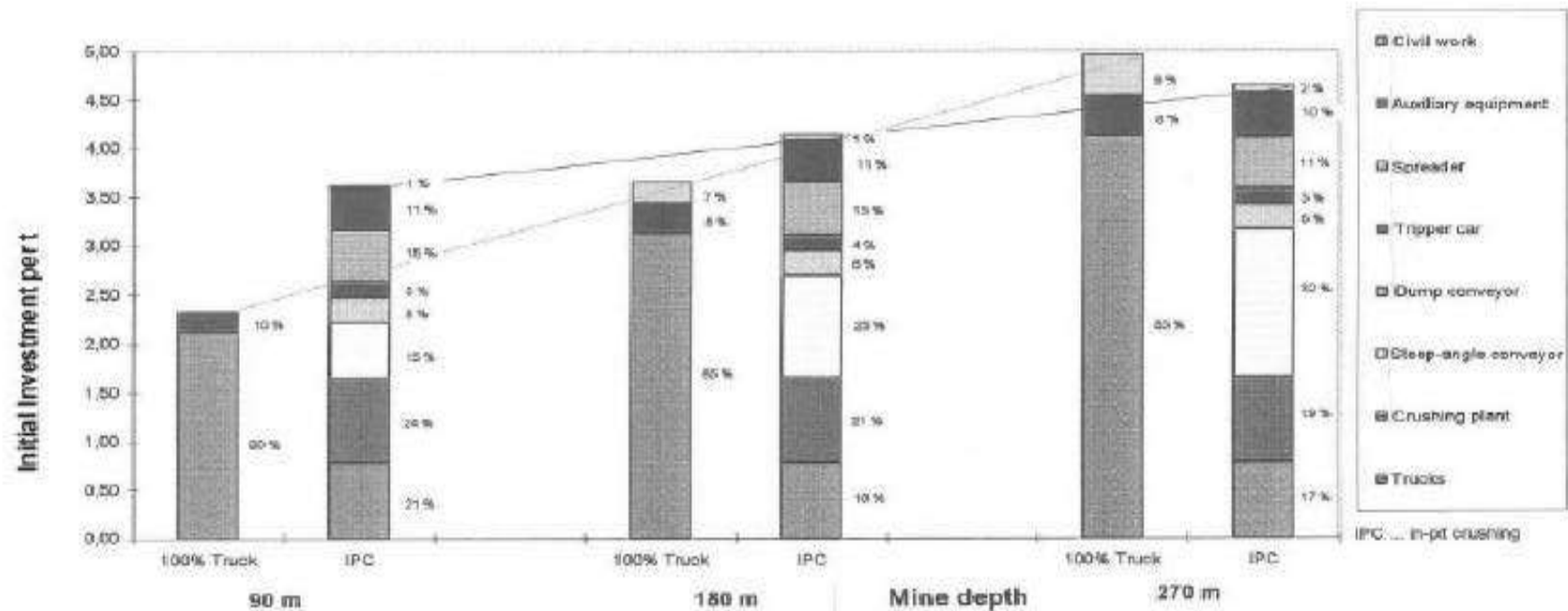
Pure trucking case – Discontinuous / Cyclic mining

In-Pit Crushing and Conveying System



Loading	Intermittent Truck Haulage	Crushing	Conveying	Discharge
Discontinuous Part		Continuous Part		

Comparative of Shovel-truck vs IPCC – Depth & Capex



- From past studies, it is observed that as depth of mine increases, the initial investment for pure truck systems increase at a much higher rate than IPCC systems.

Techno-commercial evaluation is essential!

Pros & Cons

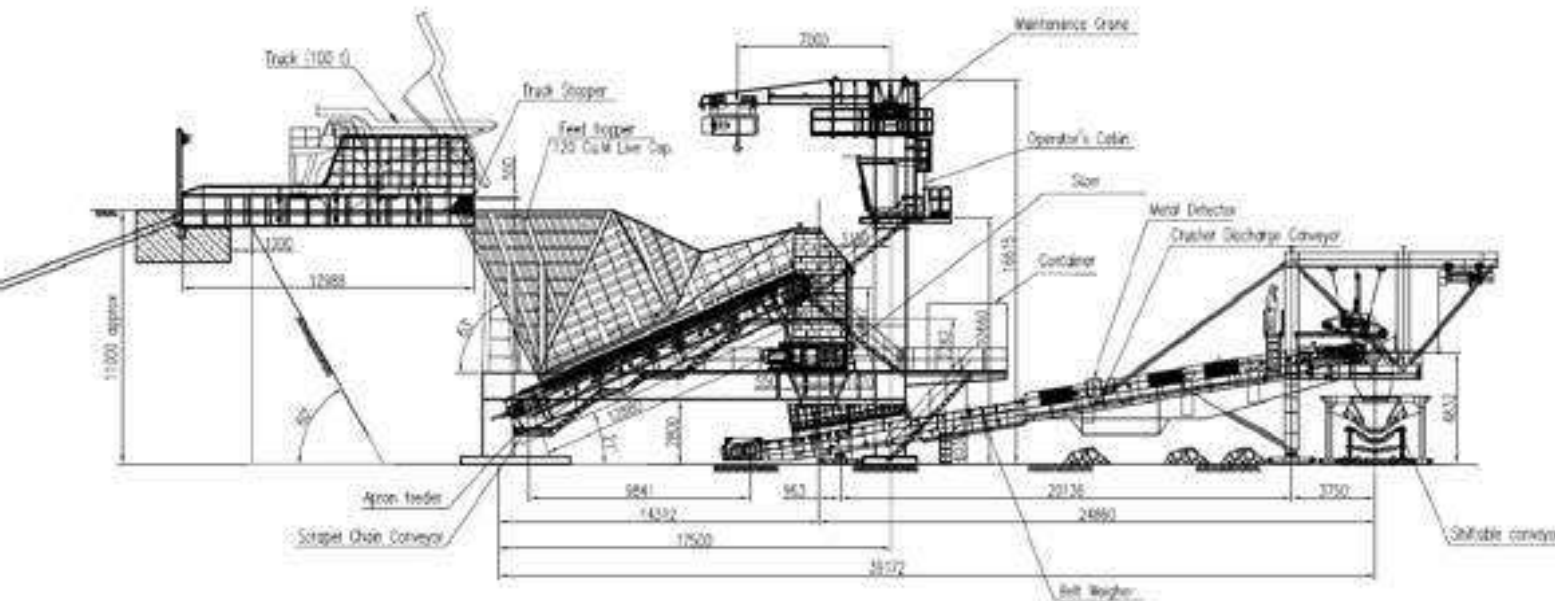


Shovel & Truck (Pure)	IPCC (Full or partial)
<ul style="list-style-type: none">- High operational cost- High carbon footprint (more pollution)+ High flexibility, low planning-intensive- Very expensive in capacity escalation- Labor intensive and related issues	<ul style="list-style-type: none">++ Very low Operating Cost+ Low or negligible carbon footprint- Low flexibility, advanced planning necessary+ Low cost on capacity improvement+ Very low employment needed

Conclusion

- Considerably lower costs of spare and wear parts
- Extensive independence from crude oil products
- Lower personnel costs and independence of Labor problems
- No or very low environmental pollution (dust, exhaust fumes etc.)
- Often 3 times (and more) longer service life

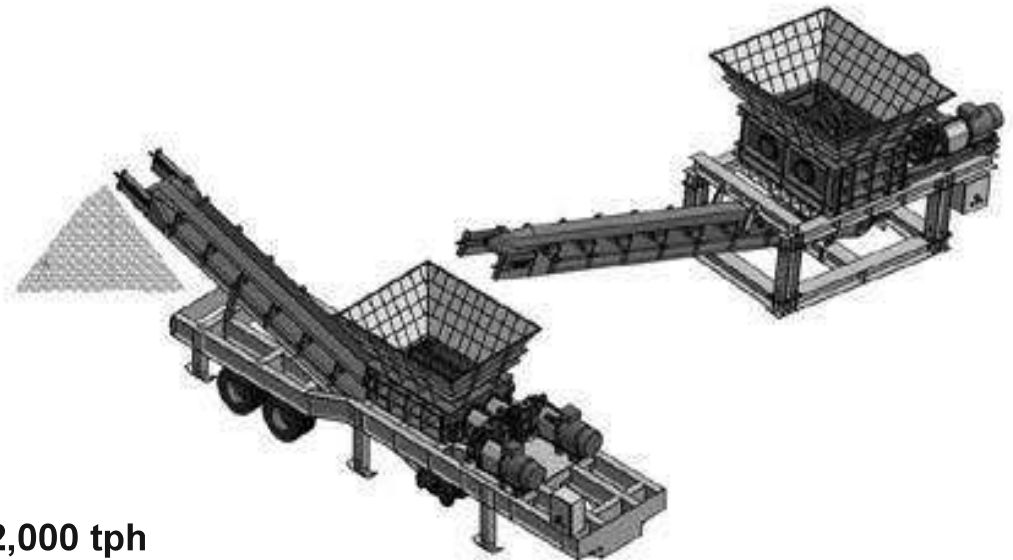
TAKRAF – Semi Mobile Crushing Plant



System Capacity – 500 tph to 12,000 tph

- **Truck Bridge**
- **Dump hopper**
- **Operator's Cabin**
- **Apron feeder**
- **Primary Sizer**
- **Intermediate conveyor**
- **Hydraulic rock breaker**
- **Bag Filter**
- **Dust Suppression**
- **Maintenance Crane**
- **Metal detector**
- **Magnetic Separator**
- **Secondary Sizer**
- **Support as per requirement**
- **Discharge Conveyor**

TAKRAF - MOBILE CRUSHING UNIT



System Capacity – 500 tph to 12,000 tph



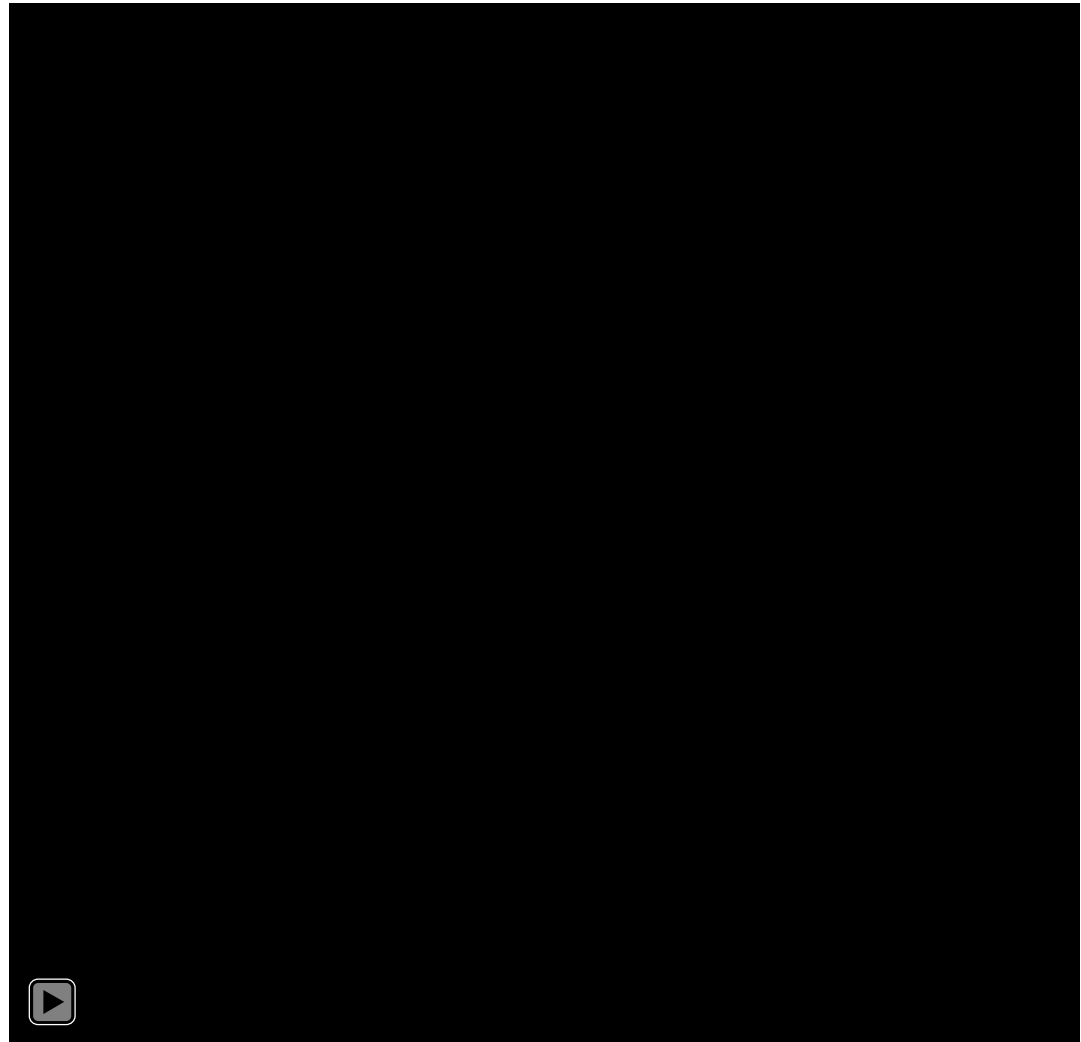
SIZERS

Crushing Technology Basics

WHAT IS A SIZER AND HOW DOES IT WORK?

1. Material is gripped and swallowed into the crushing zone between the rolls. For oversize material, a chunk is bitten out of the lump and the lump is re-oriented.

2. Smaller material passes through between the rolls un-broken in shear and compression. Smaller teeth and crushing ridges also help control the final product size.



Advantages of Sizer over other crushers

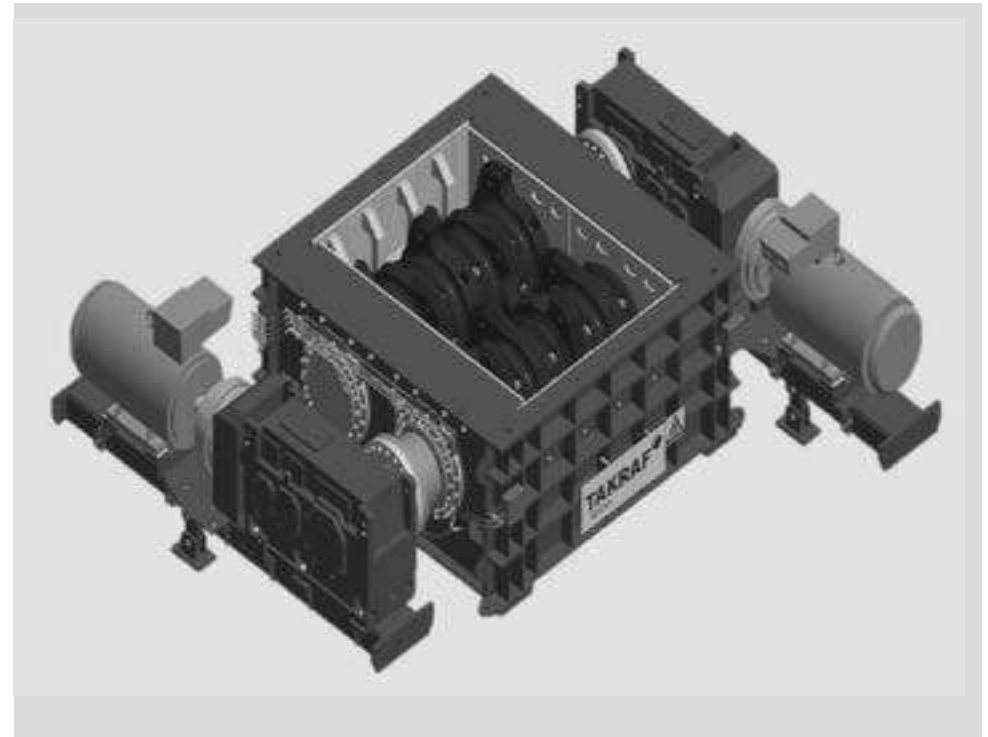


Advantages

- Acceptance of Large feed size
- Low Height & Very Compact
- Roll Speed is kept to minimum, Torque is maximum.
- Ideal for Sticky or high moisture feed material
- Focus on Sizing and not on Crushing
 - Smooth Reduction ratio of around 4:1
 - Inherent fines are not crushed further
 - Very low ultra fines (-10μ) generation
- Product size Gap setting can be easily adjusted at site
- No Vibration
- Less consumed motor power

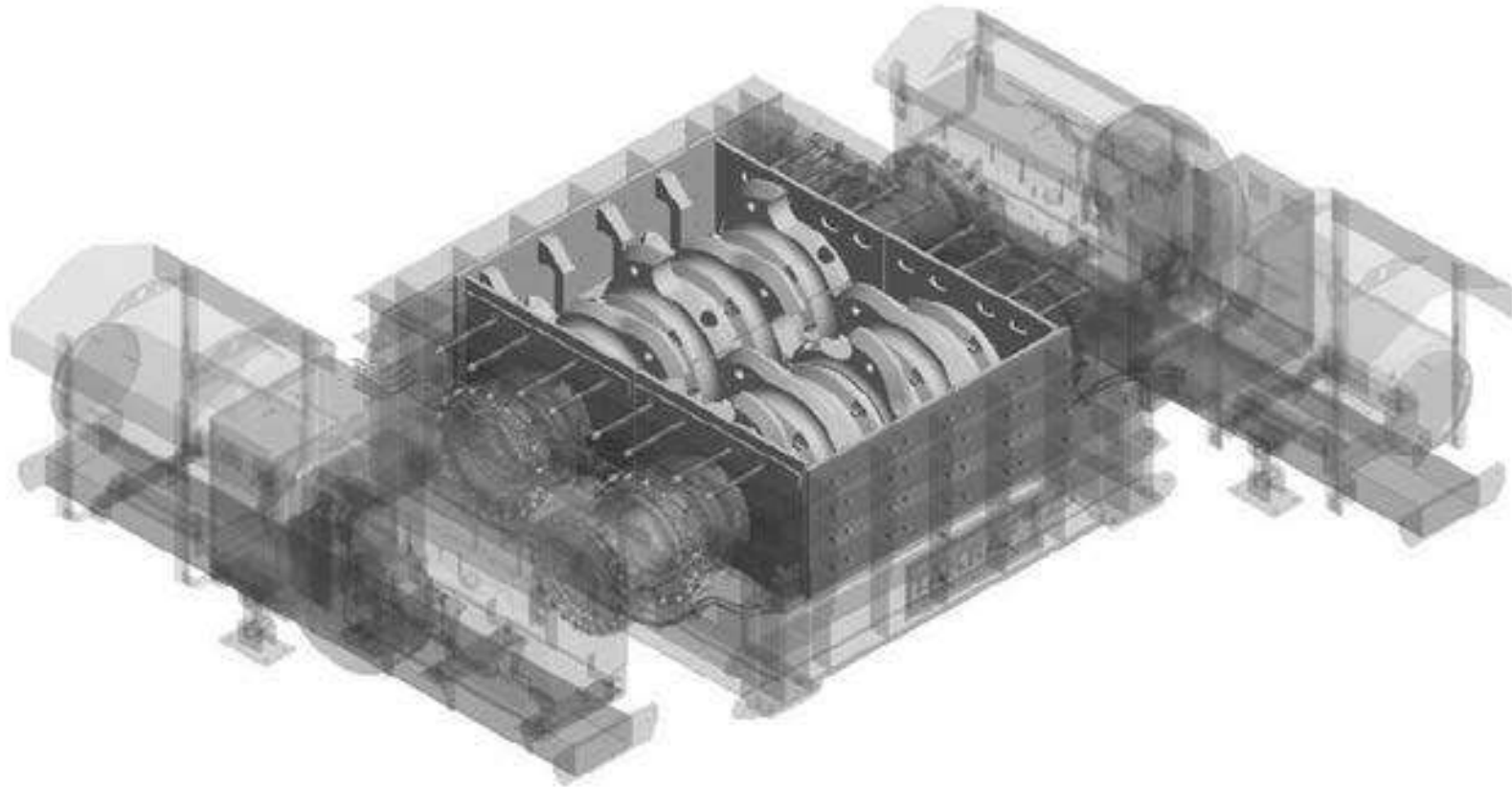
Indirect Advantages

- Lesser ramp height reduces Diesel consumption
- Sizer availability is over 95% in a year which cannot be matched with any other crusher
- Claim it's a Green plant as the dust generation is minimal



TAKRAF - Differentiators

QUALITY

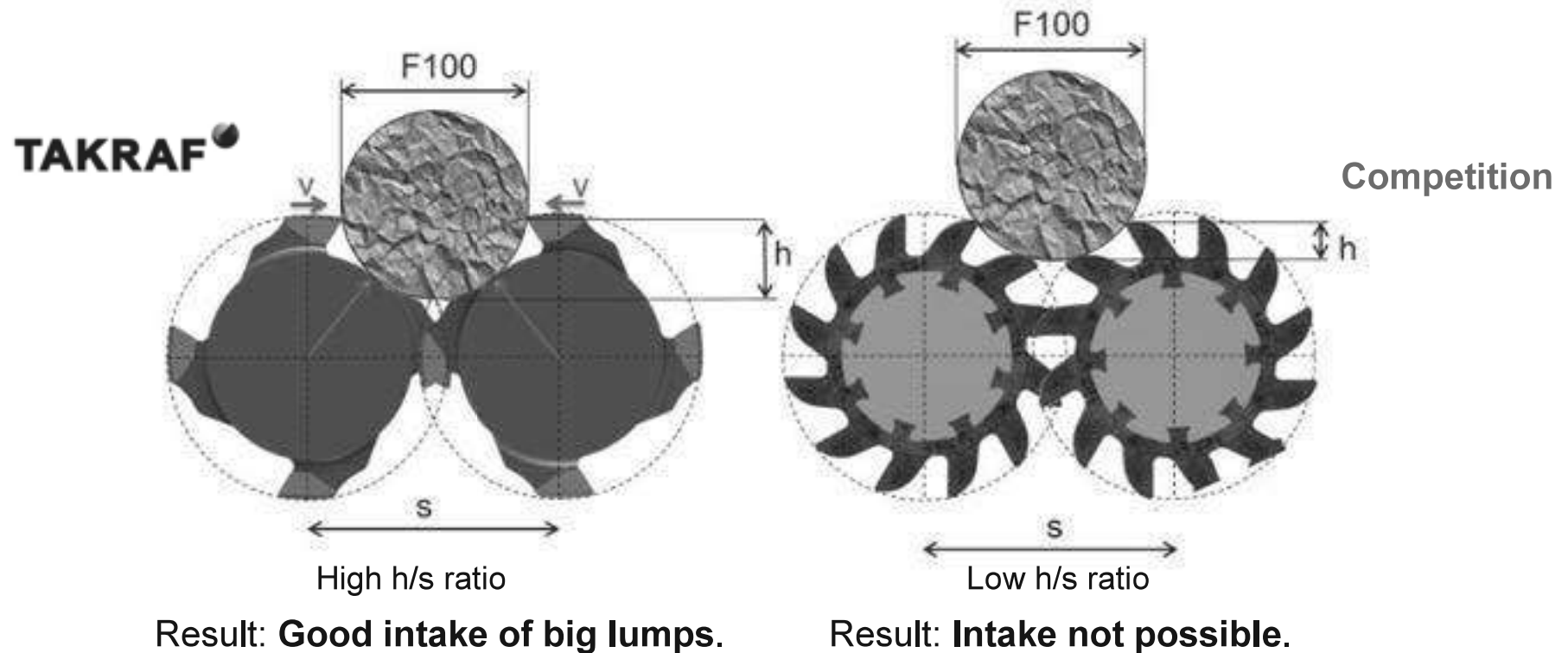


Localized supply of all operational parts strictly complying with
TAKRAF Germany Quality Standards.

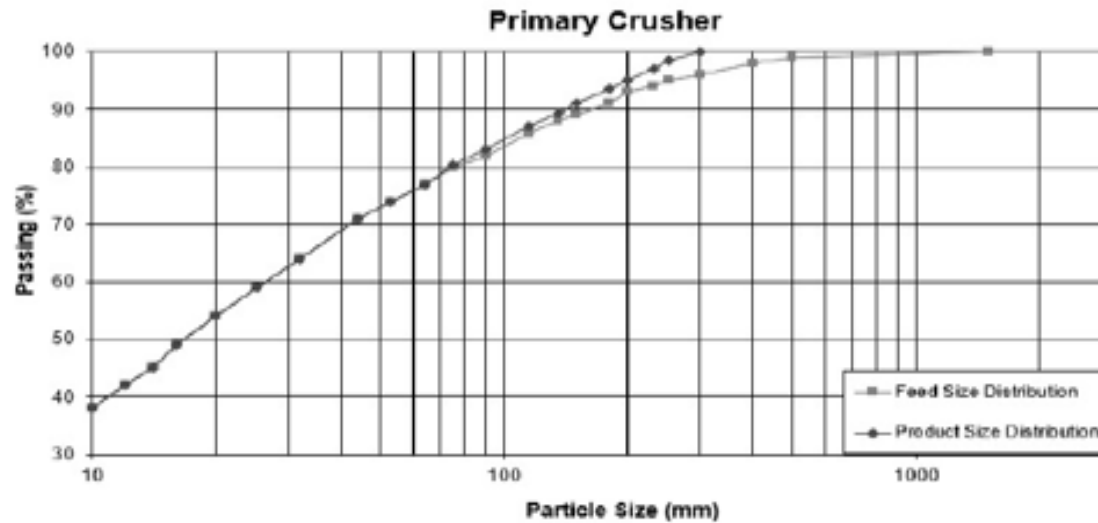
TAKRAF - Differentiators

DESIGN

Good intake behaviour is paramount to the success of the sizer and fundamental to the sizer geometry selection. Good intake is a function of max lump size, roll center distance, relative tooth height, and roll speed. TAKRAF tooth configurations include a combination of Primary and Secondary Teeth with Crushing Ridges to ensure optimum balance between intake and product size.

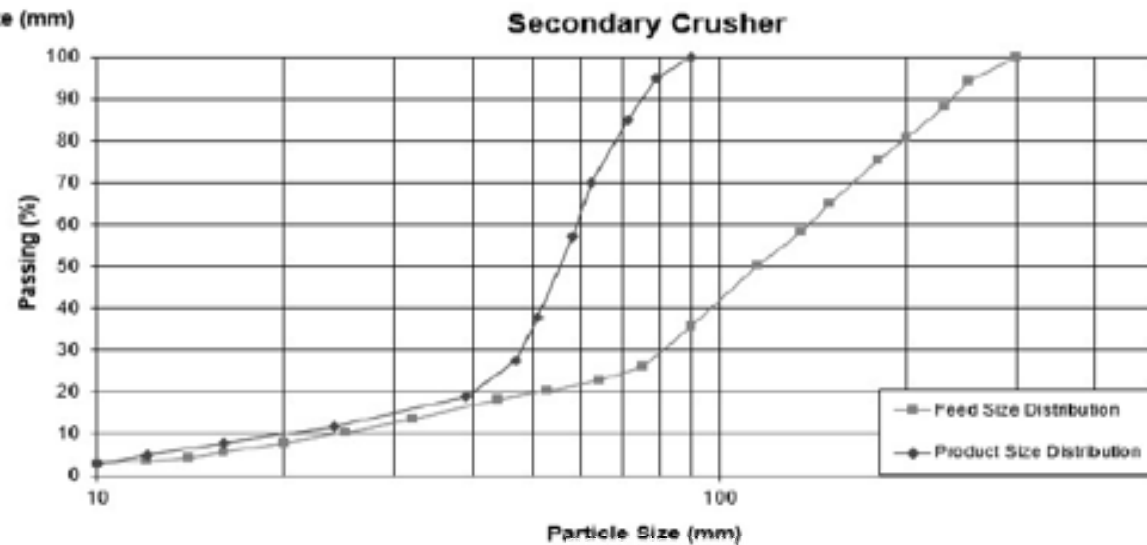


Crushing Process – Primary vs Secondary



- High crushing ratio for F100 particles.
- Lots of crushing above the rolls and not much crushing between rolls.

- More constant crushing ratio throughout the PSD.
- Much smaller gap size so much more crushing between the rolls.



Sizer Design Philosophy



Item	Primary	Secondary
Main Process Focus	Intake	Product Size
Crushing Philosophy	Majority of crushing done above the roll and to larger particles.	Majority of crushing happening between the rolls.
Main Intake Consideration	Intake through re-orientation	Intake based on roll size.
Product Size Considerations	Not so important but needs to work with Secondary machine.	Very important. Need roll gap adjustment to ensure consistent product.
Drive Considerations	Low normal absorbed power, but drives need to be sized for maximum lumps.	High absorbed power, relatively few torque spikes.
Roll Speed	Lower speed but need enough impact to re-orient lumps	Higher speed for throughput, but slow enough to let smaller particles pass through without crushing

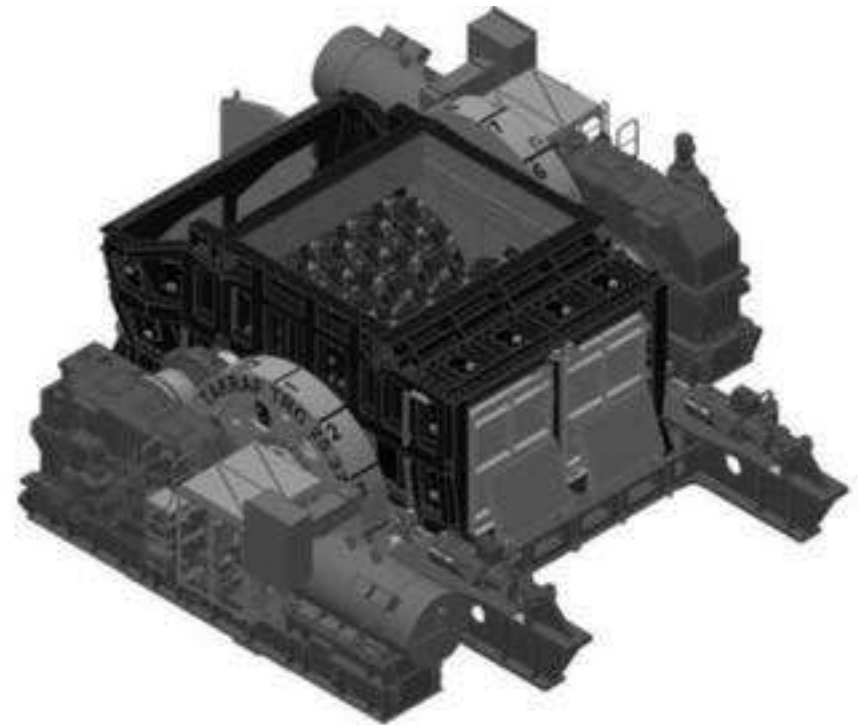
TAKRAF CRUSHING EQUIPMENT



SIZER



ROLL CRUSHER



SIZER vs Roll Crusher



Parameters for Crusher	Sizer	Roll Crusher
Ability to start under Feed Hopper full load (Choke feed) condition - Ideal for Primary application - Feed by Dumpers / wagons / excavators can be more independent of the Crushing plant	Yes	No
Ability to handle Larger Lumps - Reserve Power to address Choke feed / larger lumps	Yes	No
Ability to handle shale / sandstone / inherent impurity requiring a crushing strength of 150 Mpa or more	Yes	No
Availability of Crusher over a year	95%	Lower
Life of Crusher above 20 years	Yes	No
Ultra fines generation (responsible for air pollution)	Lowest	High
Fines Production	Low	High
Specific Power Consumption (kW/t)	Low	High
Protection of drive	Yes, Fluid Coupling	No
Vibration Level	Very Low	High
Noise level	Least	High
Smaller footprint - floor space	Yes	No
Smaller Height - Impacts building height	Yes	No
Closer to 3 dimension product	Yes	Yes
Roll Speed	Low	High
Drive type	Direct	V-Belt
Life of Wear items	Higher	Lower

Sizer in Operation



A sizer has two slow rotating rolls that are covered in crushing teeth. The teeth engage the material and impart a tension/compression that **breaks** the “oversize” material in a given feed while smaller material simply passes through.

TAKRAF Sizers Product Range

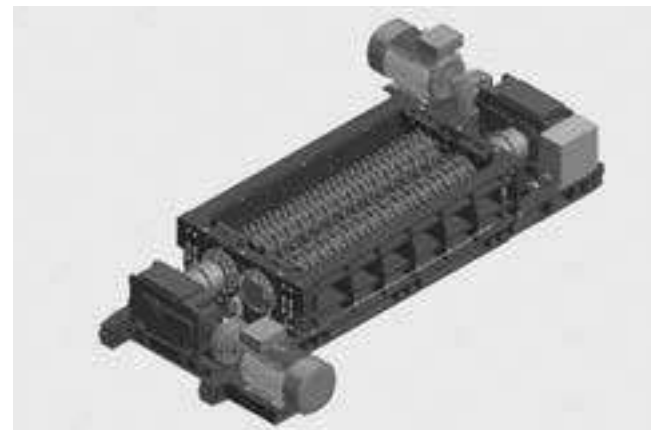


06 SERIES

Property	Model					
	TCS 06.10	TSS 06.10	TCS 06.20	TSS 06.20	TCS 06.30	TSS 06.30
Max Feed (mm)	400	300	400	300	400	300
P90 Product Size (mm)	40	35	40	35	40	35
Throughput (m ³ /hr)	500	670	1000	1350	1500	2000
Machine Weight (t)	15	16	20	22	25	28



TCS 06.20 – Single Motor Configuration



TSS 06.30 – Double Bevel Drive Configuration

TAKRAF Sizers Product Range

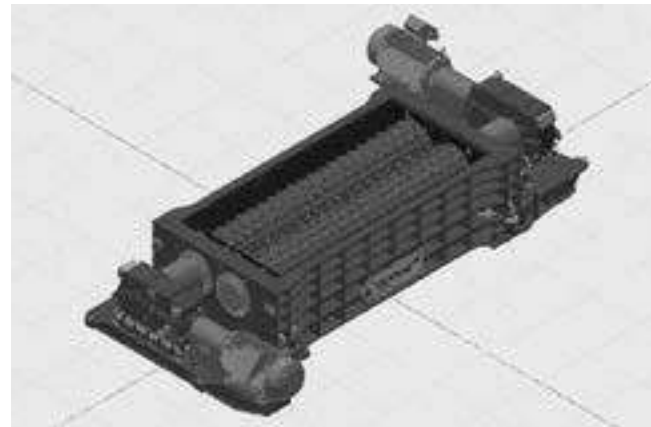


08 SERIES

Property	Model					
	TCS 08.10	TCS 08.20	TCS 08.30	TSS 08.30	TCS 08.40	TSS 08.40
Max Feed (mm)	600	600	600	450	600	450
P90 Product Size (mm)	125-50	125-40	125-50	40	125-50	40
Throughput (m ³ /hr)	600	1200	1800	2250	2400	3000
Machine Weight (t)	20	30	43	45	48	51



TCS 08.30 – Double Helical Drive Configuration

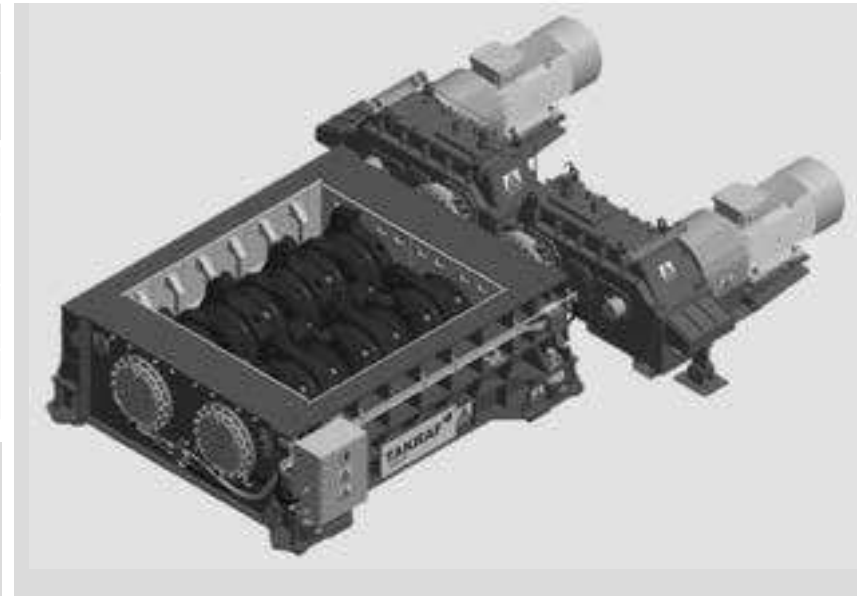
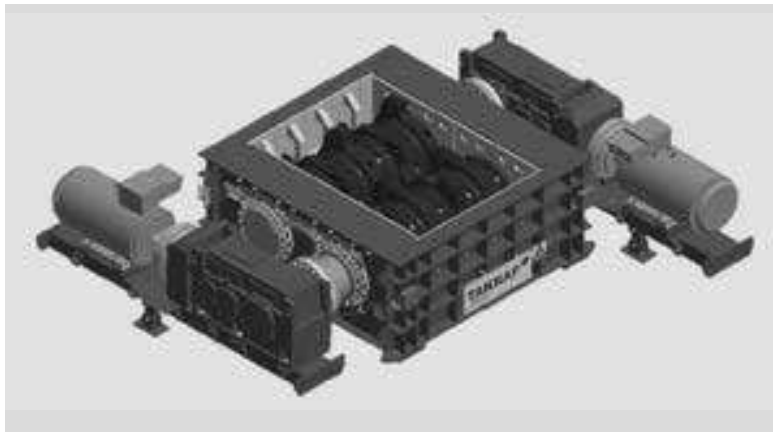


TSS 08.40 – Double Bevel Drive Configuration

TAKRAF Sizers Product Range

12 SERIES

Property	Model	
	TCS 12.16	TCS 12.24
Max Feed (mm)	1200	1200
P90 Product Size (mm)	350-200	350-200
Throughput (m ³ /hr)	2700	4000
Machine Weight (t)	38	52



TCS 12.24 – Single Side
Helical Configuration

TCS 12.16 – Double Side
Bevel Helical Configuration

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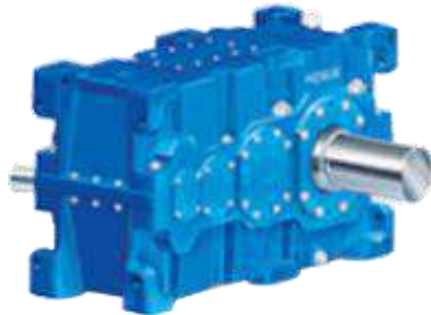


PREMIUM
Your addition in transmission

WIDE STANDARD RANGE AS WELL AS CUSTOMIZED



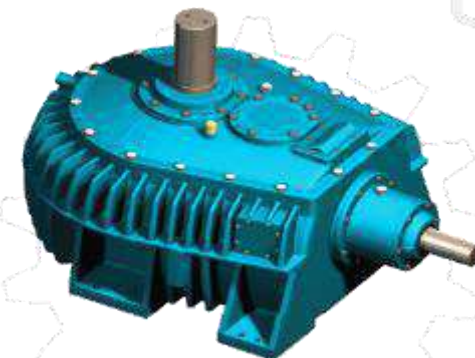
Worm Gearbox
Altra, Adaptable



Helical Gearbox
M-series, H-series,
Special



Planetary Gearbox
Modular, Standard,
Special



Cooling Tower Gearbox
3-Foot/4-Foot Design



Fluid Couplings
Variable, Fixed Speed, Modular



Geared Motors
Inline, Parallel Helical, Bevel
Helical



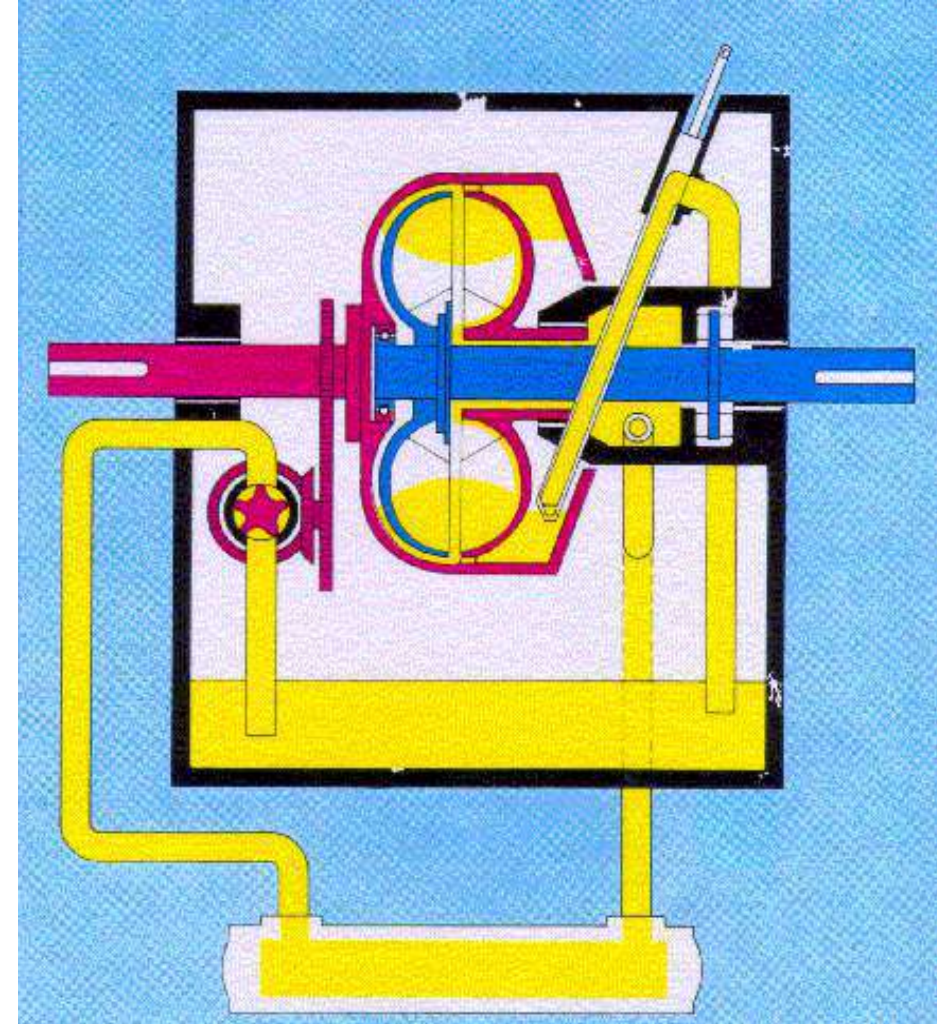
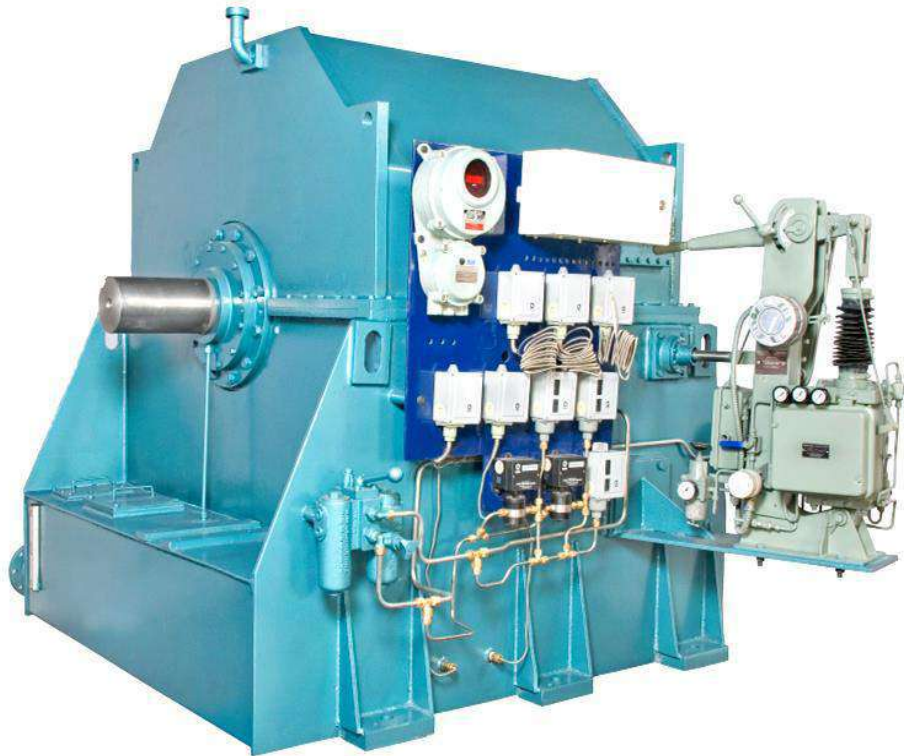
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- Size 430 to 1320
- Variable speed through Scoop Trimming
- Speed Regulation - 3:1 for constant Torque & 5:1 for variable torque / centrifugal machines

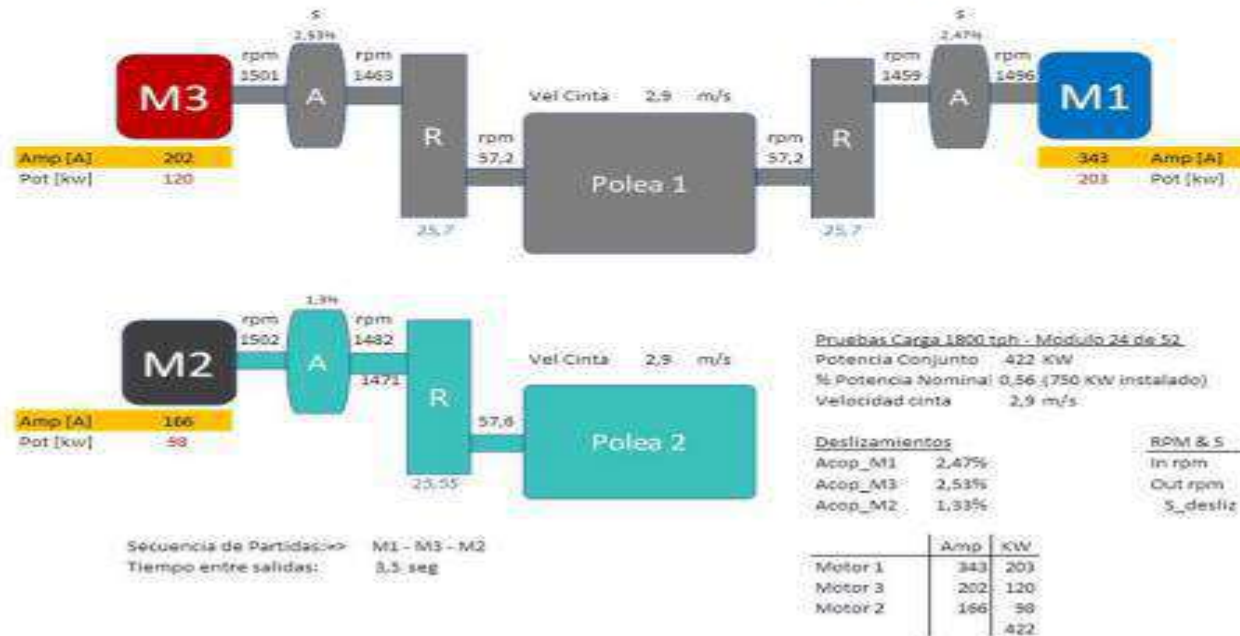


Udupi Power : Load sharing

Deslizamientos

Acop_M1	2,47%
Acop_M3	2,53%
Acop_M2	1,33%

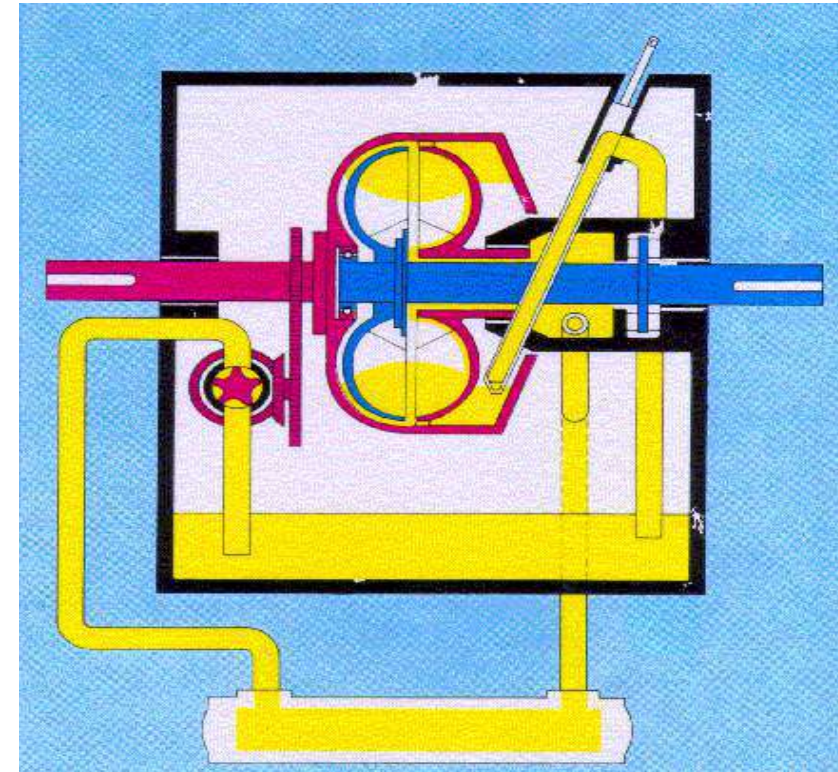
Motors assembly diagram



Premium: VARIABLE SPEED PST type advantages



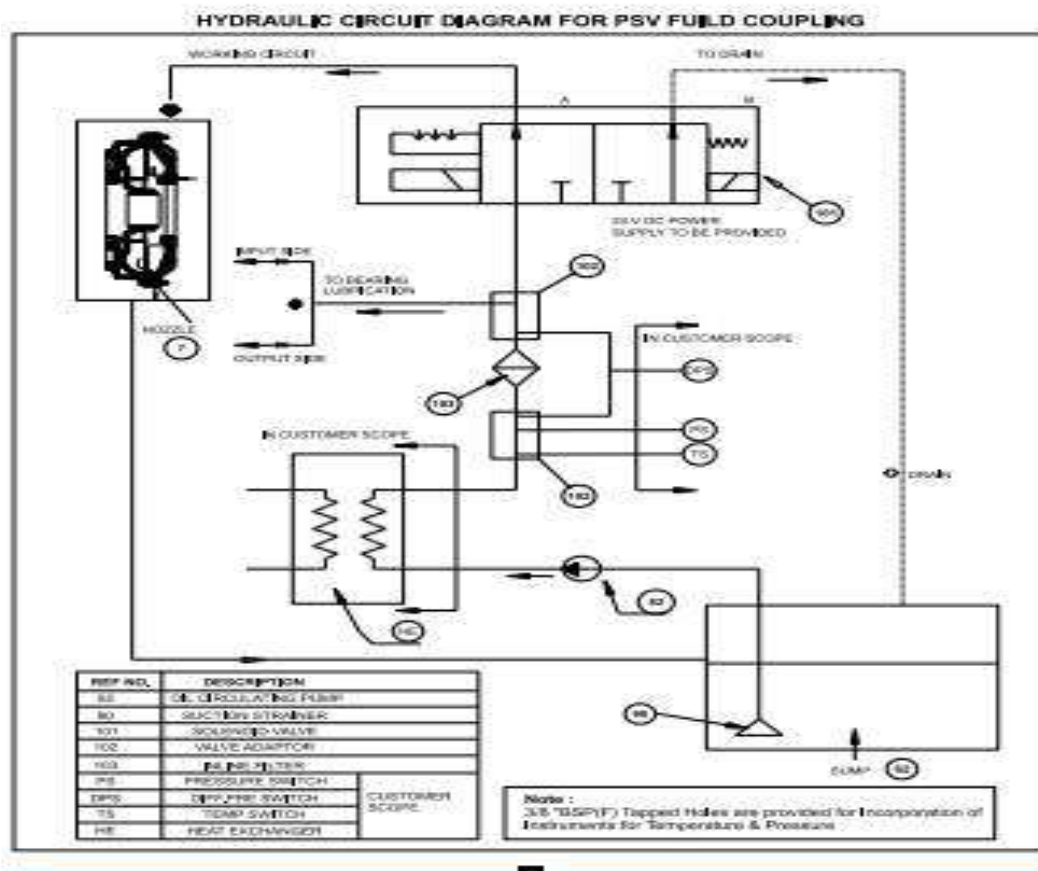
- Scoop tube requires a feedback loop to control output speed
- No VFD and Solenoid valve, so better reliability.
- Oil flow control is through the scoop tube, hence there is no noise and vibration, so stable system.
- Self supported design, no load on the motor bearing.

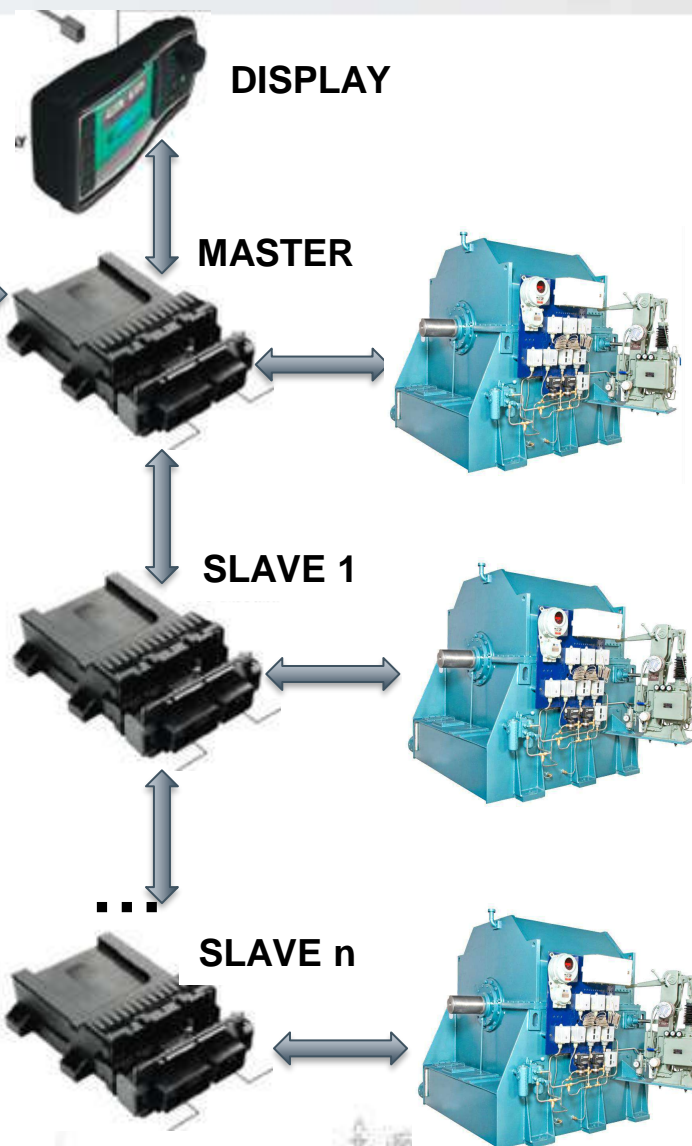


PREMIUM: DRAIN TYPE PSV COUPLING



PREMIUM
Your addition in transmission



REMOTE CONTROL ROOM

- PREMIUM CONTROL SYSTEM FEATURES ONE MASTER CONTROLLER UNIT PLUS “n” SLAVES
- THE MASTER COMMUNICATES THROUGH CAN-OPEN PROTOCOL WITH REMOTE CONTROL ROOM (IF REQUIRED) AND WITH EACH SLAVE
- LOCAL AND REMOTE DISPLAY FOR READING AND INPUT PARAMETERS
- EACH CONTROLLER READS MAIN MOTOR CURRENT AND ADJUSTS FLUID COUPLING FEED PUMP SPEED IN ORDER TO OBTAIN DESIRED START UP RAMP

The Premium Master Controller



PREMIUM
Your addition in transmission

REMOTE CONTROL ROOM



DISPLAY



MASTER



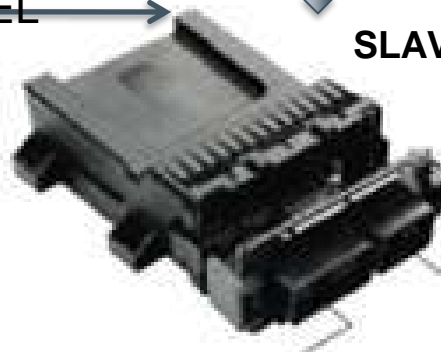
F.C. 1



E.M. n CURRENT LEVEL



SLAVE n



FEED PUMP

EV1
TSH
TSHH
HOP
LOP



Belt speed and Tension control on Conveyors using multiple Hydro-viscous-clutch type drives

Abstract:

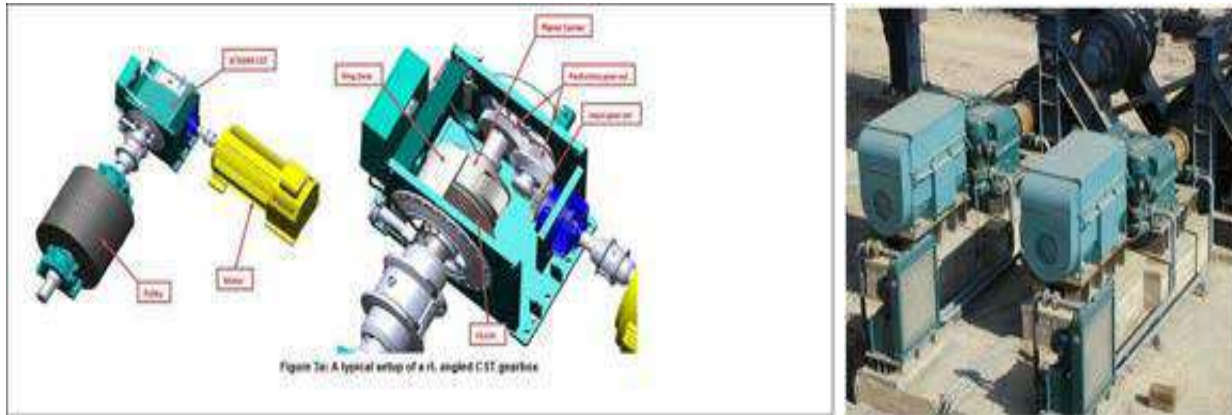
Critical to most belt conveyors performance is the ability to control the drive acceleration torque providing a smooth soft start while maintaining belt tensions within specified safe limits. Torques and speed control is also necessary for load sharing on multiple drives or tension control on tripper booster drives. Soft Controlled Start CST drive on a conveyor in multiple configurations at the head end, mid-section tripper and tail end booster from Dodge, protect the belt and other conveyor components and help reduce investments costs by 15% while providing maximum power transmission at the same time. Over 4,500 of such hydro viscous CSTs have been in operation for past 25 years in several mines around the world with a proven average availability >98%.

Conveyor belt Velocity/Acceleration control:

A conveyor belt is a non linear visco-elastic medium in which strain can propagate at some finite wave speed. Conveyor belt is a gigantic rubber band, a python full of elasticity and load inertia dynamics which can result in destructive consequences if not properly understood. Perhaps the most difficult conveyor characteristics to overcome are the velocity and tension waves present in the belt. They seem to be always present in one form or another. In a conveyor with head drives only, these waves tend to propagate to the slack side of the belt where they are attenuated by friction and the take-up mechanism. When a fully loaded conveyor belt is started abruptly or with no control on the starting acceleration, high acceleration forces induce tension waves that can adversely affect the belt fabric, belt splices, drive pulleys, idler pulleys, shafts, bearings, speed reducers, motors and couplings. This can cause conveyor belt system performance problems with vertical curves, excessive belt take-up movement, loss of drive pulley friction, spillage of materials, and festooning of the belt fabric. Therefore, the drive system must produce a minimum torque powerful enough to start the conveyor and controlled such that the acceleration forces are within safe limits.



The Hydroviscous Drive System:



A hydro viscous drive system comprise of a standard low cost industrial AC induction motor coupled to a gearbox which has a multi-stage gear reducer with a multi-disk wet clutch on the output side. Such type of a gear case, having a 2-in-1 feature, is known as the CST (Controlled Start Transmission) which is manufactured by the Dodge. In an application, the CST gearbox is coupled in between the AC motor (prime mover) and a high-inertia load, such as conveyor belt pulley (Figure-3a). On conveyors employing multiple drive systems, CST provides excellent load share and torque limiting characteristics.

CSTs are available in wide range of models starting from 150 kW rating up to 2,500 kW. Specific models are available to suit hazardous environments in underground coal mines also. CSTs have an air-cooled heat exchanger for oil cooling. The CST clutch operation is PLC controlled. Once the conveyor start / stop belt speed ramps are firmed up based on the dynamic analysis, the CST PLC is programmed to achieve the designed speed ramps. The motor power, belt speed are continuously monitored and the PLC ensures planned stoppage also. During normal running, CST ensures load share amongst the drives as per design. This feature protects the conveyor from unnecessary excess torques and belt tensions.

CSTs offer many unique advantages for belt conveyor drive systems. These include:

- Precise and smooth control of torque transmitted to the drive pulley. As the conveyor is accelerated to full speed, the speed v/s time is controlled to follow an “S” profile. This will result in significant reduction in peak motor torque demand, reduction in potential drive pulley belt slip, reduction in jerk and belt tensile stress wave impulse on all non-drive pulleys & structure.

- CSTs deliver just enough torque to the pulleys so that the conveyor always starts in a pre set time under any loading condition. The conveyor will face peak tensions rarely and only when needed. This greatly enhances life of all the conveyor components.
- CSTs reduce belt stretch and take up travel.
- CSTs achieve excellent load sharing amongst multiple drives in belt conveyors.
- CSTs have a proven long service life (The gears last for more than 20~25 years whereas the clutch needs overhauling in 9~10 yrs).
- The CST drive system gives the operator the flexibility of stopping the conveyor by simply de-clutching gradually and no need to turn off the motor(s). This avoids the frequent ON and Off of large motors and high inrush current.
- CST controls also allow the operator full operational flexibility, e.g., if one drive on a conveyor with multiple drive systems has to be temporarily taken offline, the conveyor operation can still continue albeit at a lower loading. On the other hand, if material haulage is low, simply operate two out of four drives, thereby save energy.

Not only because the CST is a simple straightforward reliable and rugged drive system, but it has a unique feature which is the wet clutch, located at the low-speed side of the gearbox. The hydroviscous clutch has the following advantages which no other drive system offers:

1. The CST clutch at the low-speed side acts as a “Shock absorber”. This protects the gearbox, couplings and motor bearings. Also, as shocks are absorbed, they do not get reverberated to conveyor idlers, frame structure and belt splice section.
2. The reaction to a sudden load change is very gracefully handled by the CST. The controller’s PID (Proportional + Integral + Derivative) algorithm is able to respond to load change without causing the system to be over or under damped thus aperiodic wave oscillations on long conveyors do not occur. Whereas, in fluid couplings or VFD drive system, as torque correction is done before the gearbox, a slight over or under damped error signal gets multiplied (amplified) by the gear box which demands a very fine PID tuning. If the gains of the system are not properly tuned, the conveyor can go into uncontrollable wave oscillations.

Conclusions:

On conveyors, aperiodic tension waves caused by very erratic load switching and oscillating load share among multiple drives must be contained to prevent the failure of belt splices, drive system reducers, and other mechanical elements. A very low reflected inertia of the drive is the



key to successful control and management of the aperiodic tension waves. It is necessary that the drive torque control element has a very low inertia and is located at the output of the drive. The CST hydro-viscous clutch, which controls the torque is located at the output of the of the drive system. The dynamic responsiveness of this torque-limiting feature eliminates the possibility of a major load surge on the belt conveyor passing through the torque limiting section into the reducer and motor. Distributed drive systems have enabled installation of longer, economical conveyors. In order to maximize its advantages, the sizing, selection and location of such drives and their control system need careful design. The drives chosen have also to be amenable to the desired control to ensure that the designed objectives are practically achieved. Several such conveyors are in operation with Dodge CST drives and have proved to be very economic and reliable with significant benefits in investment and operating costs.



CMPDI HQ, Ranchi

18th January 2022

Loss Reduction

Chromium Carbide Hard Overlay
Composite

Wear Plates



What is a
wear plate?

A member of an equipment or assembly which is subject to wear & tear and replaced at the end of its useful life.

It is sacrificed to protect the equipment or assembly from wear and tear.

Materials commonly used for Wear Plates

- Mild Steel
- Stainless Steel
- Manganese Steel
- Quenched Steel
- Ceramics
- Poly Urethane
- Chromium Carbide



**Common
Recurrent**

Areas of
Wear &
Tear

Hoppers

Chutes

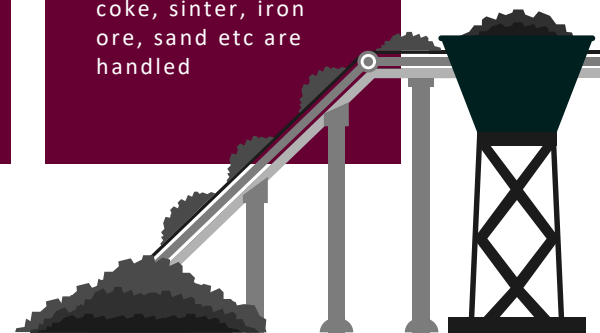
Silos

Fans

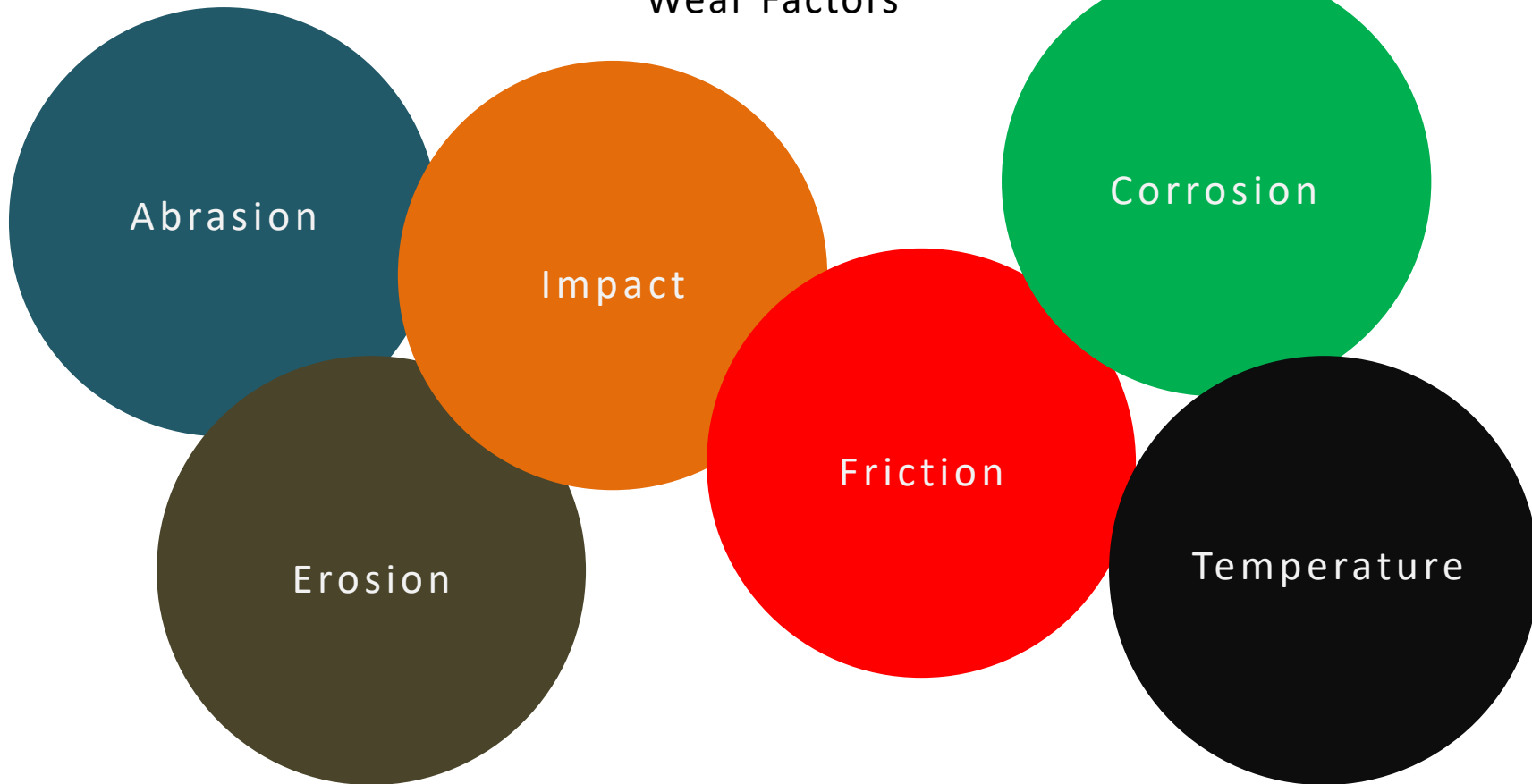
Mills

Crushers

And generally all
areas where abrasive
and corrosive
materials such as
limestone, coal,
coke, sinter, iron
ore, sand etc are
handled



Wear Factors



Why should we use Wear Plates?

Quality

Assured, standard and custom-made alloy chemistry
unlike manual hard facing done at site

01

02

Fast to Install

Ready-to-install components in
different forms and shapes

03

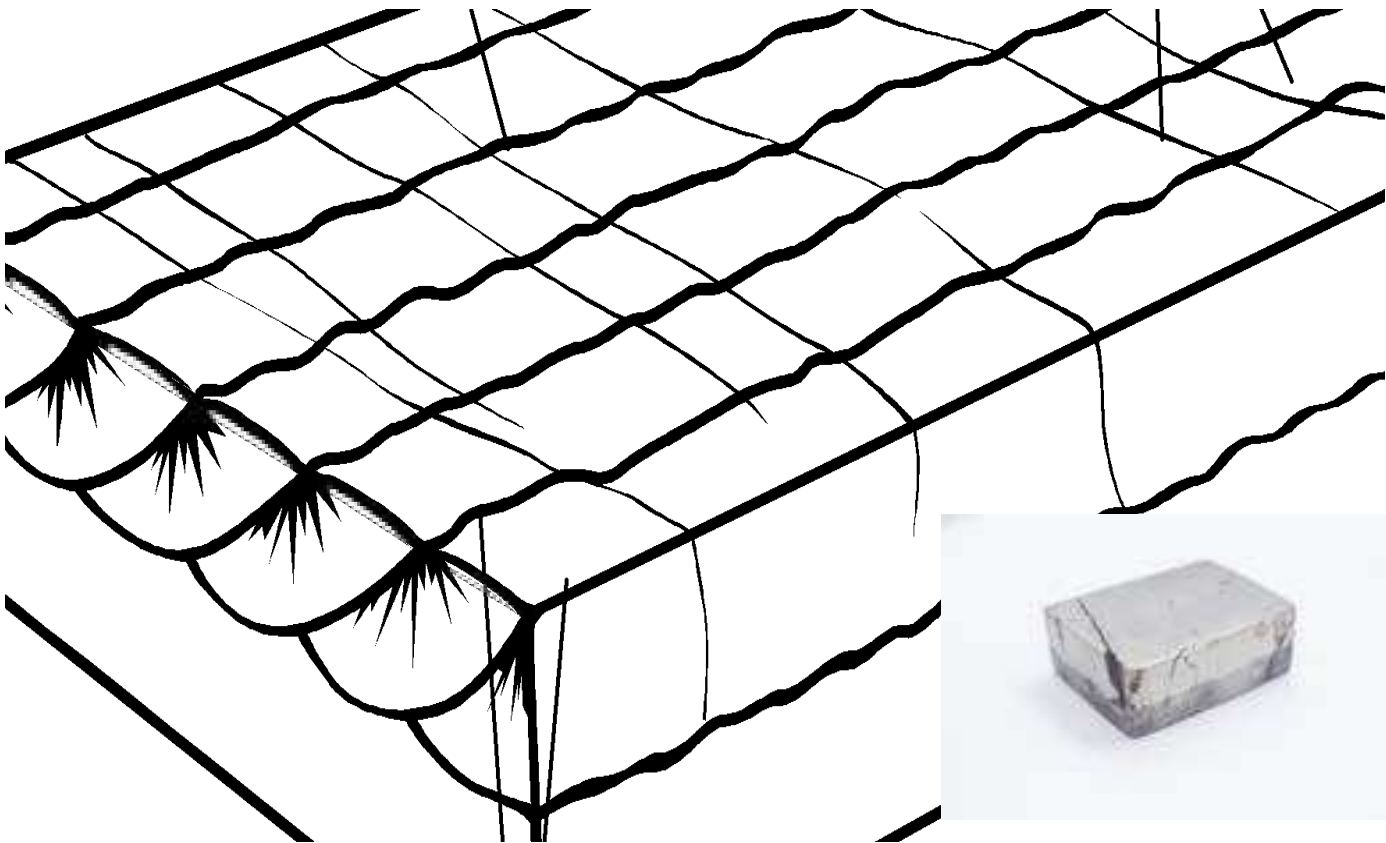
04

Resource Reduction

Saves time and labor

Surprisingly economical

Surprisingly economical



Structure of a wear plate



Pictures

Composite Wear Plates

Key Elements in a Composite Wear Plate

Mn

Manganese for Impact

Nb

Niobium for erosion,
fine particle abrasion

V

Vanadium for
temperature

CR C

Chromium Carbide for
abrasion, erosion and
impact

B

Boron for hardness and
wear resistance

Mo

Molybdenum for
temperature

W

Wear resistance



Hard Facing/ overlaying process

Hard-facing is done by
unique metal arc process
where carbides are fed to
the molten pool directly
without passing through the
arc

Process Advantages

- ❑ Lower burn-out losses resulting in increasing proportion of primary carbides in the surfacing layer
- ❑ Fully saturated carbide deposits which are present up to interface
- ❑ Uniform carbide distribution with minimum variation in carbide percentage
- ❑ Lower dilution level due to lower melting energy requirement



Wear Testing

ASTM G65

Silica Sand used as
Abrasive



Various Materials after Dry Abrasion Test



Coal Silo CHP



Truck Loading Stn & Wagon Loading Stn



Dumper Body



Liners with CSK Drilling



Integrated Digital Wireless Communication and Tracking Systems for Underground Coal Mines

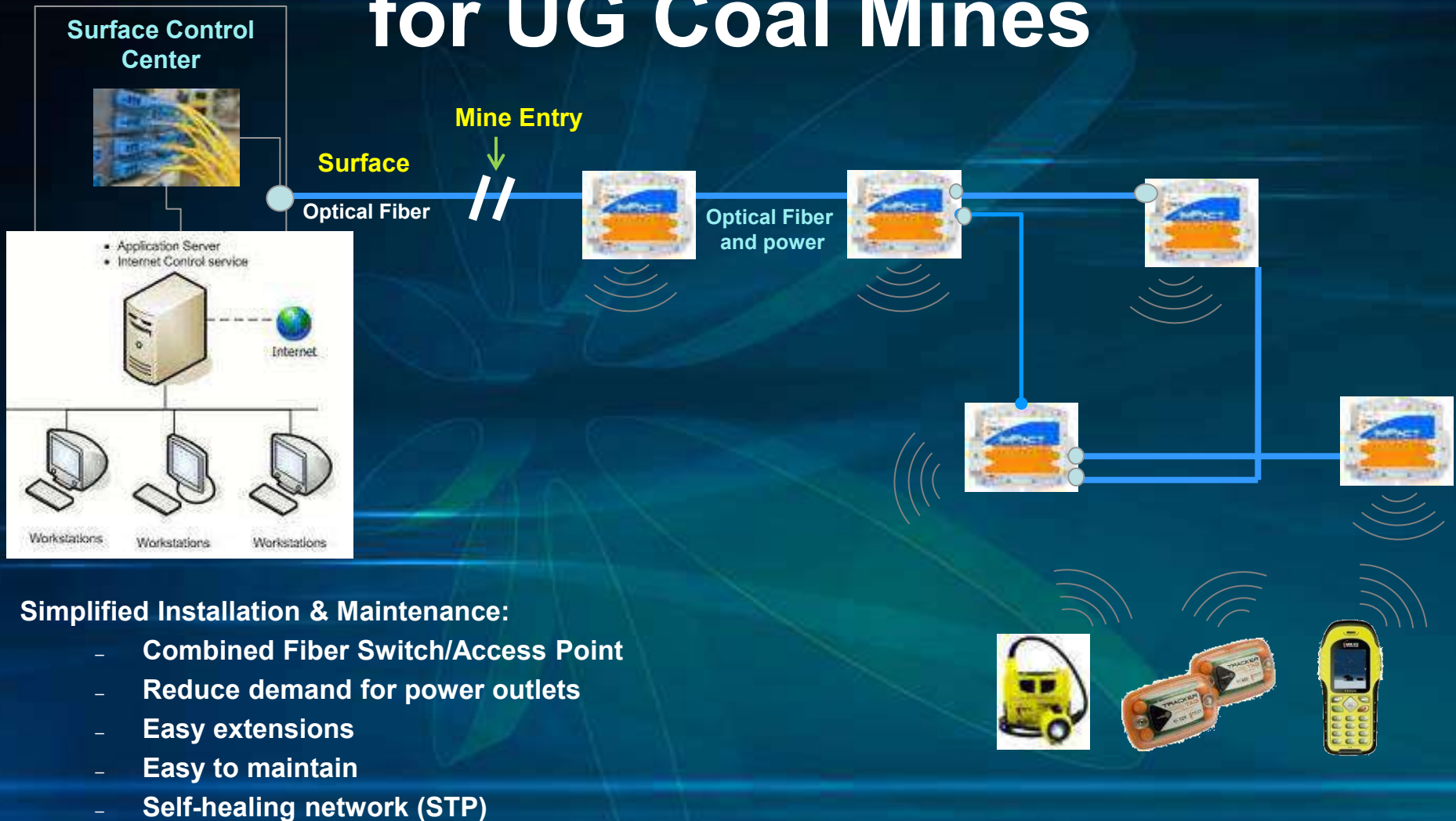
Intrinsically Safe High-speed Communication Infrastructure for:

- **Wireless Telephony(VoIP)**
- **Active RFID Tracking**
- **Environmental Monitoring**
- **Longwall Production Reporting (PRS) Tracking Capabilities**

**Presentation by:
AdCept Technologies Pvt. Ltd., India**



High-speed Network Infrastructure for UG Coal Mines



Digital Wireless Voice Communication



Two-Way Voice between

- miners underground and anywhere on the surface
- miner to miner underground

- PTT function
- IP PBX Integration with PSTN
- Unlimited channels
- Use model as a cell phone



Digital Voice Communication

Surface Control Station

System Line Diagram



Mine Entry

Fiber



Wireless Network Switch



Fiber



Wireless Network Switch

Active RFID Tracking of Miners Equipment and Man-riders

System comprises of:

- Tags can be included with ICCL Cap Lamp (with PED as receiver) or
- could be Self Contained Tag carried by person or fitted on equipment



Active RFID Tracking

System Line Diagram

Surface Control Station



Fiber



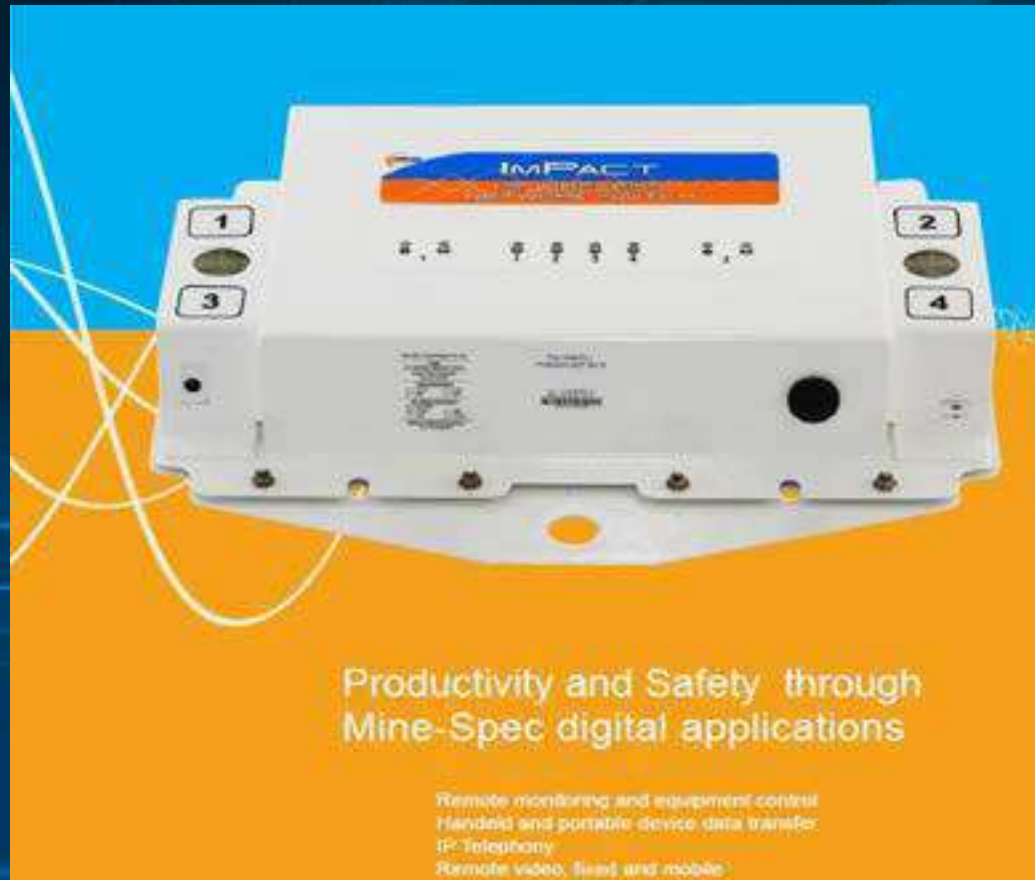
Fiber



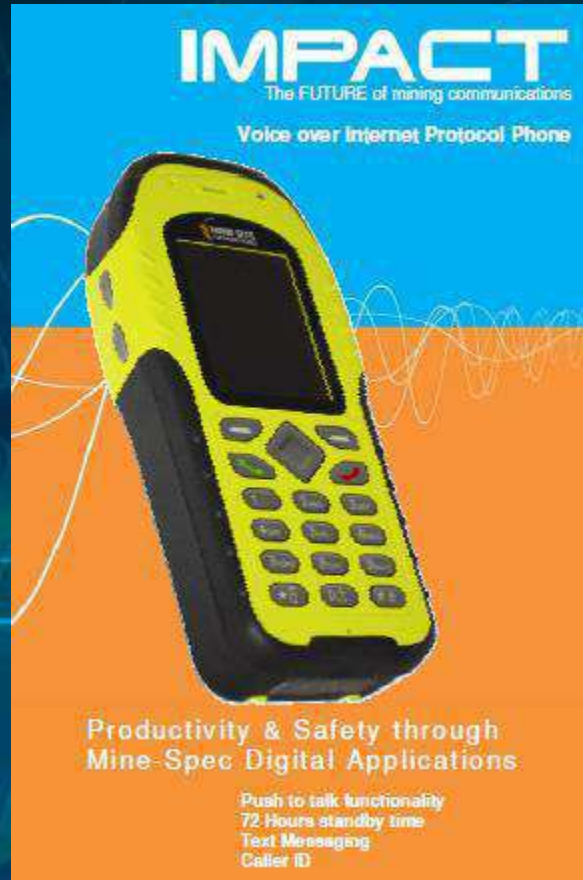
Wireless Network Switch

Wireless Network Switch

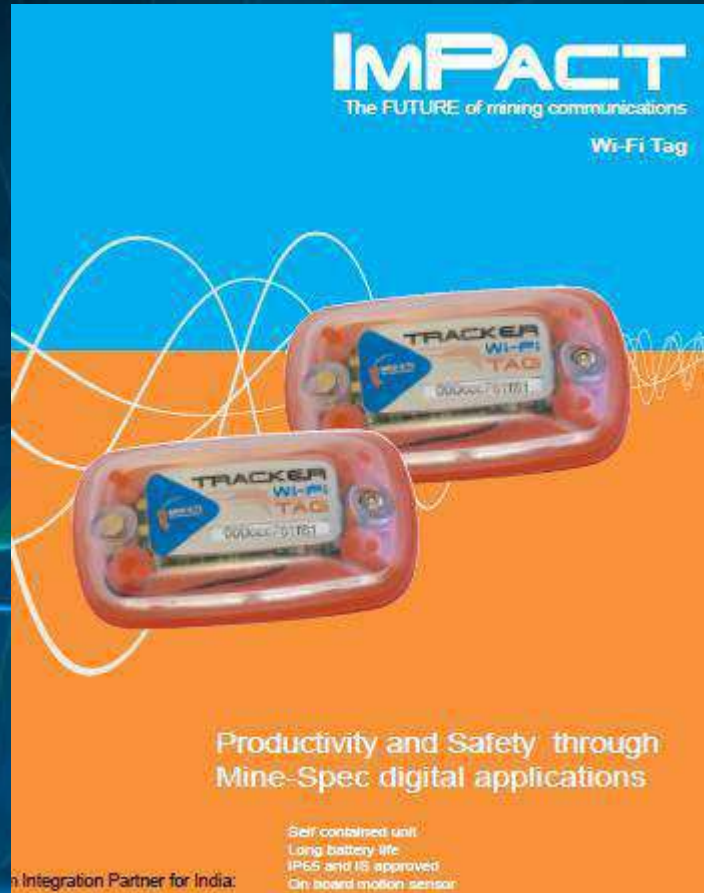
System Components – ImPact Wireless Network Switch



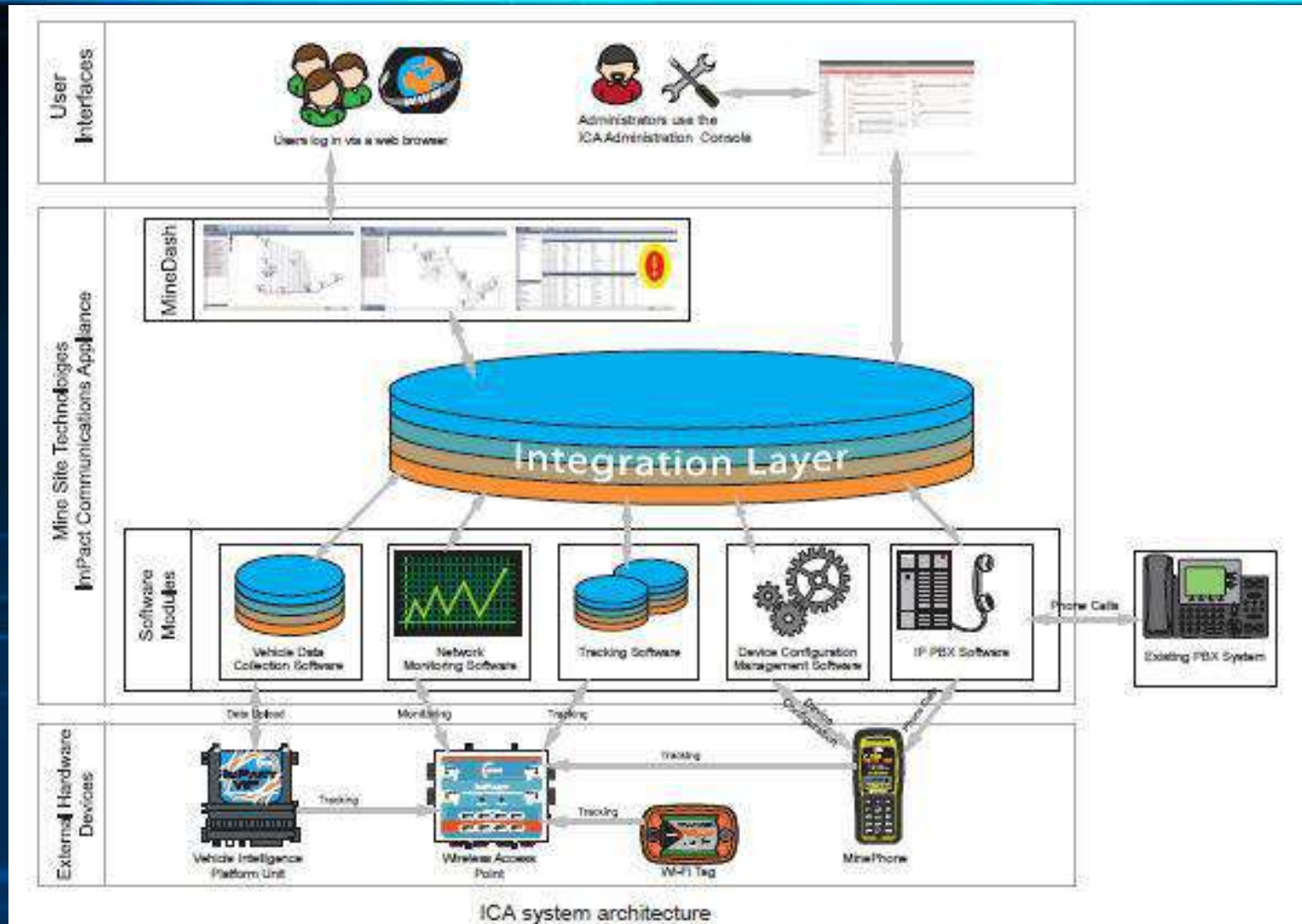
System Components – ImPact Wireless Phone



System Components – ImPact Wireless Tag



ImPact Communications Appliance



PRODUCTION VISIBILITY

ONE SYSTEM – USED FOR MULTIPLE BUSINESS APPLICATIONS

MST TAG
IMPACT NS40

ICA

MINEDASH

PRS Tracking

+

PRS Planned
Route

+

Business
Rules

=

Automated
PRS Location
Monitoring

PRS TRACKING

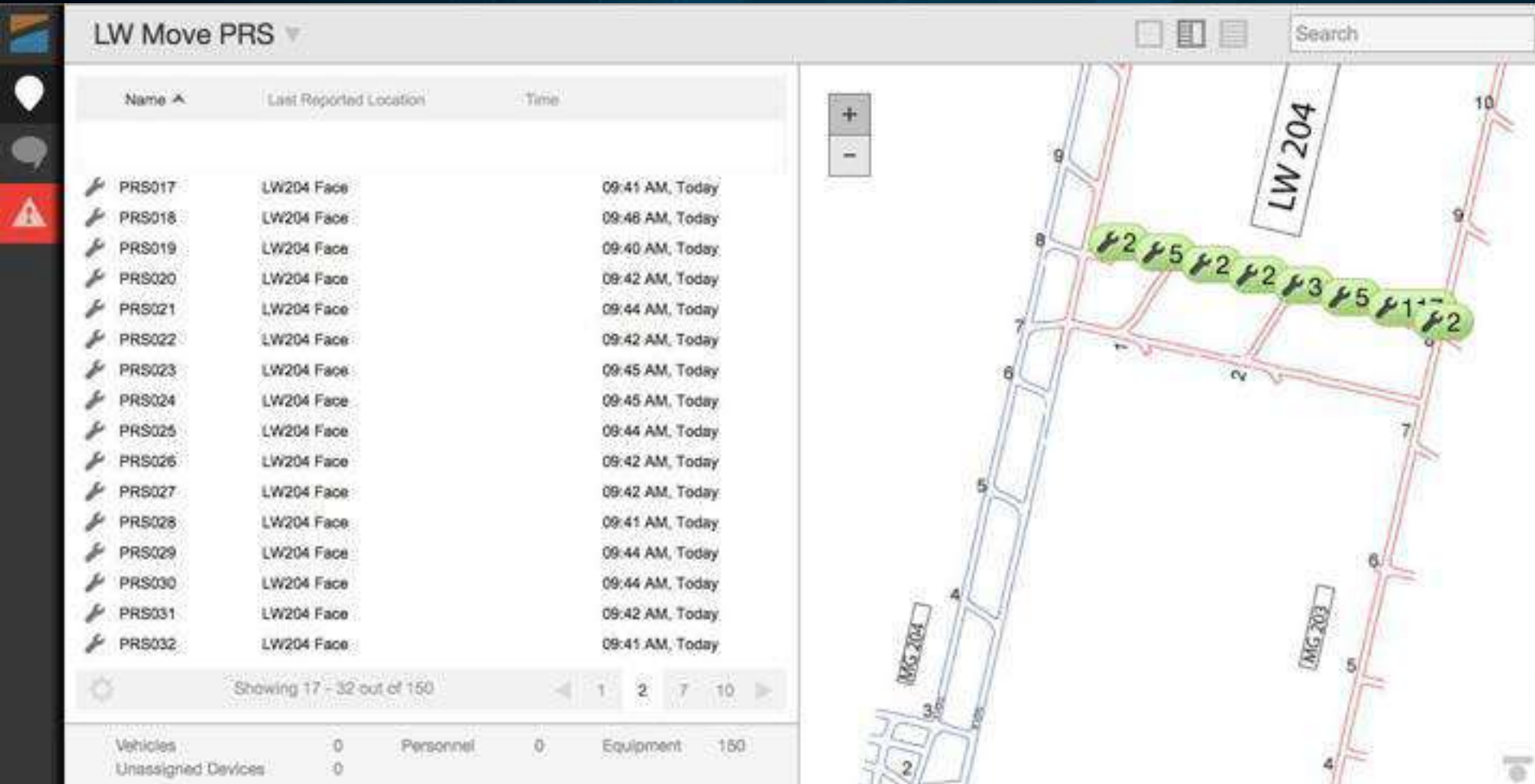
PRODUCTION VISIBILITY

- Each PRS has been fitted with a MST Tracking Tag on the PRS Rudlink
- 150 Tags in Total deployed



MINEDASH: TRACKING

PRODUCTION VISIBILITY



MINEDASH: TRACKING

PRODUCTION VISIBILITY

The screenshot displays the MINEDASH: TRACKING interface. On the left, a table lists equipment with columns for Name, Last Reported Location, and Time. The first row, PRS001, is highlighted. On the right, a map view shows the location of PRS001, with a detailed information popup for this equipment. The popup includes details such as Equipment Type (PRS), Tags (000CCC766F16), and various timestamps. It also displays two alerts: a Critical (Site Rules) alert for a Zone Breach where PRS001 exits 'PRS 204 to 110 Route', and an Info (Site Rules) alert for a Zone Breach where PRS001 enters 'Transit Zones'.

LW Move PRS

Name	Last Reported Location	Time
PRS001	BHDG 56-60CT	08:31 PM, 3/4/2014
PRS002	MG110 BHDG 13-16CT	09:17 AM, Today
PRS003	LW204 Face	09:23 AM, Today
PRS004	LW204 Face	09:26 AM, Today
PRS005	LW204 Face	09:25 AM, Today
PRS006	LW204 Face	09:27 AM, Today
PRS007	LW204 Face	09:27 AM, Today
PRS008	LW204 Face	09:26 AM, Today
PRS009	LW204 Face	09:27 AM, Today
PRS010	LW204 Face	09:24 AM, Today
PRS011	LW204 Face	09:25 AM, Today
PRS012	LW204 Face	09:27 AM, Today
PRS013	LW204 Face	09:26 AM, Today
PRS014	LW204 Face	09:23 AM, Today
PRS015	LW204 Face	09:23 AM, Today
PRS016	LW204 Face	09:23 AM, Today

Showing 1 - 16 out of 150

Vehicles 0 Personnel 0 Equipment 150
Unassigned Devices 0

PRS001

Equipment Type PRS
Tags 000CCC766F16
Underground 06:45 AM, 21/3/2014
MAINS 3 08:14 PM, 3/4/2014
BHDG 56-60CT 08:31 PM, 3/4/2014
Last Read 08:31 PM, 3/4/2014
Alarms: 1 Critical, 1 Info
Critical (Site Rules)
Info (Site Rules)

ZONE BREACH: PRS001 exits 'PRS 204 to 110 Route'
ZONE BREACH: PRS001 enters 'Transit Zones'

LONGWALL MOVE CONTROL

PRODUCTION VISIBILITY



WORKSHOP
ON TECHNOLOGY ROAD MAP FOR COAL SECTOR
TECHNOLOGIES TO MEET FUTURE CHALLENGES

PAPER ON
UNDERGROUND MOBILE COMMUNICATIONS
AND
MEN TRACKING SYSTEMS IN A MODERN MINE

CMPDI, RANCHI

DATE 18-01-2022

Yang Quizen, Lolla Anirudh
& P.Ranganatheeswar

Underground Wireless Mobile Communication & Men Tracking systems



**Geopark solutions, Hyderabad.,
&
China Coal Overseas Development Coal Ltd. (CODCO)**

Presentation Profile

- System overview
- UG Wireless communication
- UG Men Tracking
- Surface ControlRoom
- Safety Features
- Certification
- Experience

Mobile Communication



Mobile terminal:

Classic mobile phone

- with keypad
- Basic model



Android phone

- 4" Screen
- IP-67 Shield

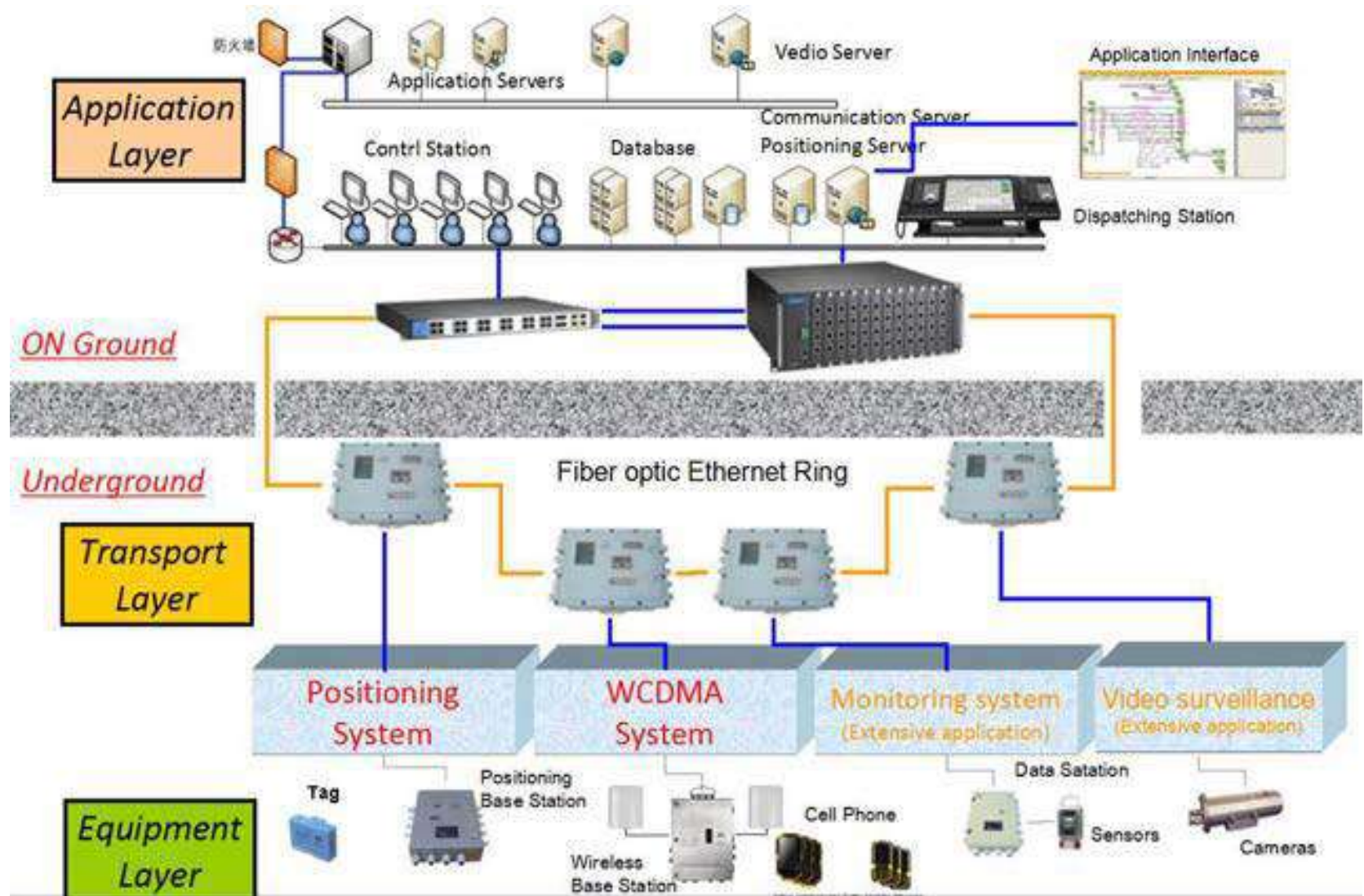


Android tablet

- 7" Screen
- High performance



SYSTEM ARCHITECTURE DIAGRAM



Underground Wireless Communication

1. Based on Industrial Ethernet Ring (Blue Star System) integrate advanced **3G Technology (WCDMA) & WiFi Technology.**

1. The system includes:

- operation hardware and software,
- 3G CoreNet servers,
- wireless base station
- intrinsically safe cell phone
- cables

2. System capacity

- Maximum number of registered mobile phone: 2000
- Maximum simultaneous call number: 500

3G core net servers :

- On ground servers with operation software inside.
- Provide connection interface and management services for base stations and mobil phones .



3G BASE STATION:

- Intrinsically safe
- Provide 3G and WiFi signals

Important technical parameters:

(1) Operating frequency: 1920-1980MHz; 2100-2170MHz

(2) Maximum transmitting power: 23dBm(200mW)

(3) Receive sensitivity: superior to -110dBm

(4) Wireless data rate:

The maximum downlink data rate of 3G : 14Mbps

The maximum uplink data rate of 3G: 5Mbps

The maximum data rate of WiFi module support : 54Mbps



Dispatch station

On ground management:

- Individual Call,
- Group Call,
- Force Insert,
- Force Disconnect,
- Status Display,
- Monitor And Record Call
- Conference Call,



2 SYSTEM FUNCTIONS

2.1 **ORDINARY COMMUNICATION:** The system is mainly used for production contact between the workers.

2.2 **RAPID REPORT:** Report hazards, accidents, and other status, or ask for rescue by making a phone call to the dispatcher very quickly, especially when it is not possible to get a fixed telephone.

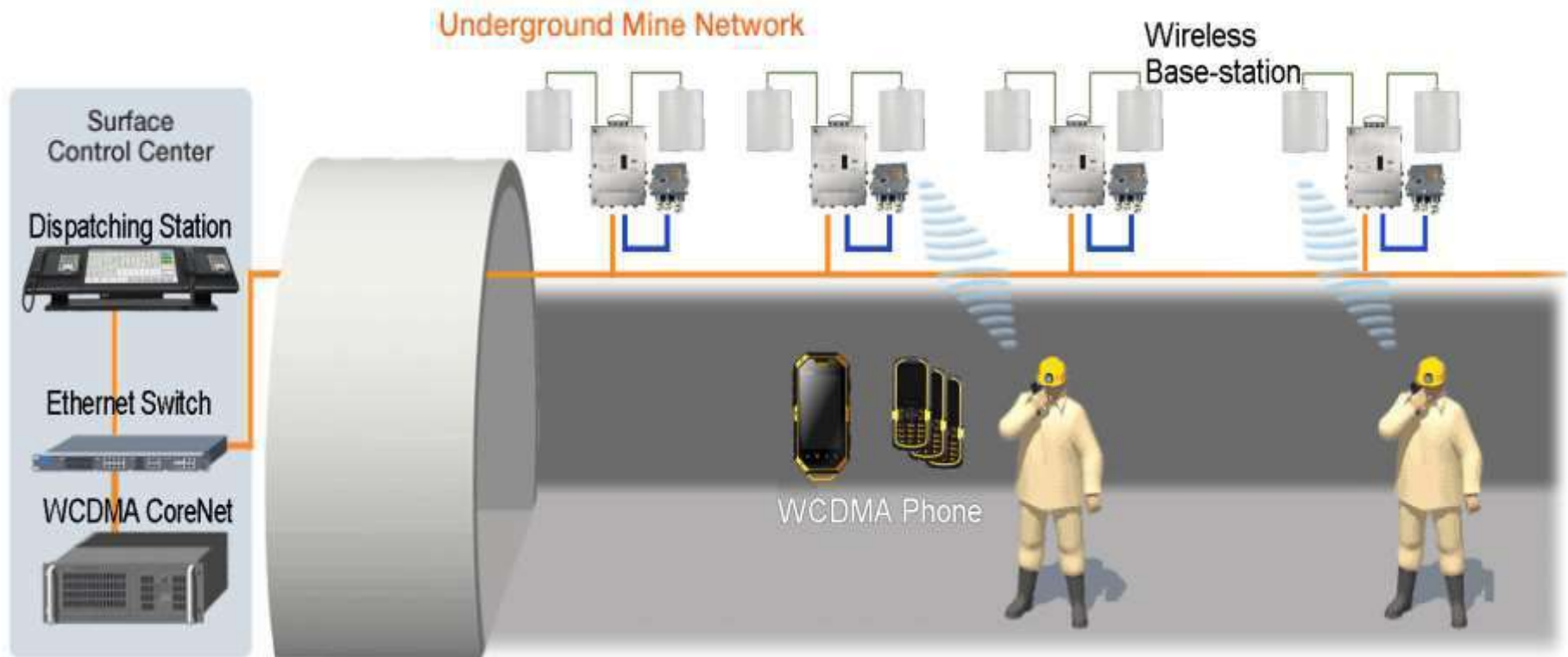
2.3 **COMMAND EMERGENCY EVACUATION:** If there is an accident, the dispatcher can notify all the workers by phone call or text, so that they can evacuate immediately.

2.4 **THE COMMAND RESCUE:** The system can also be used for rescue after disaster.

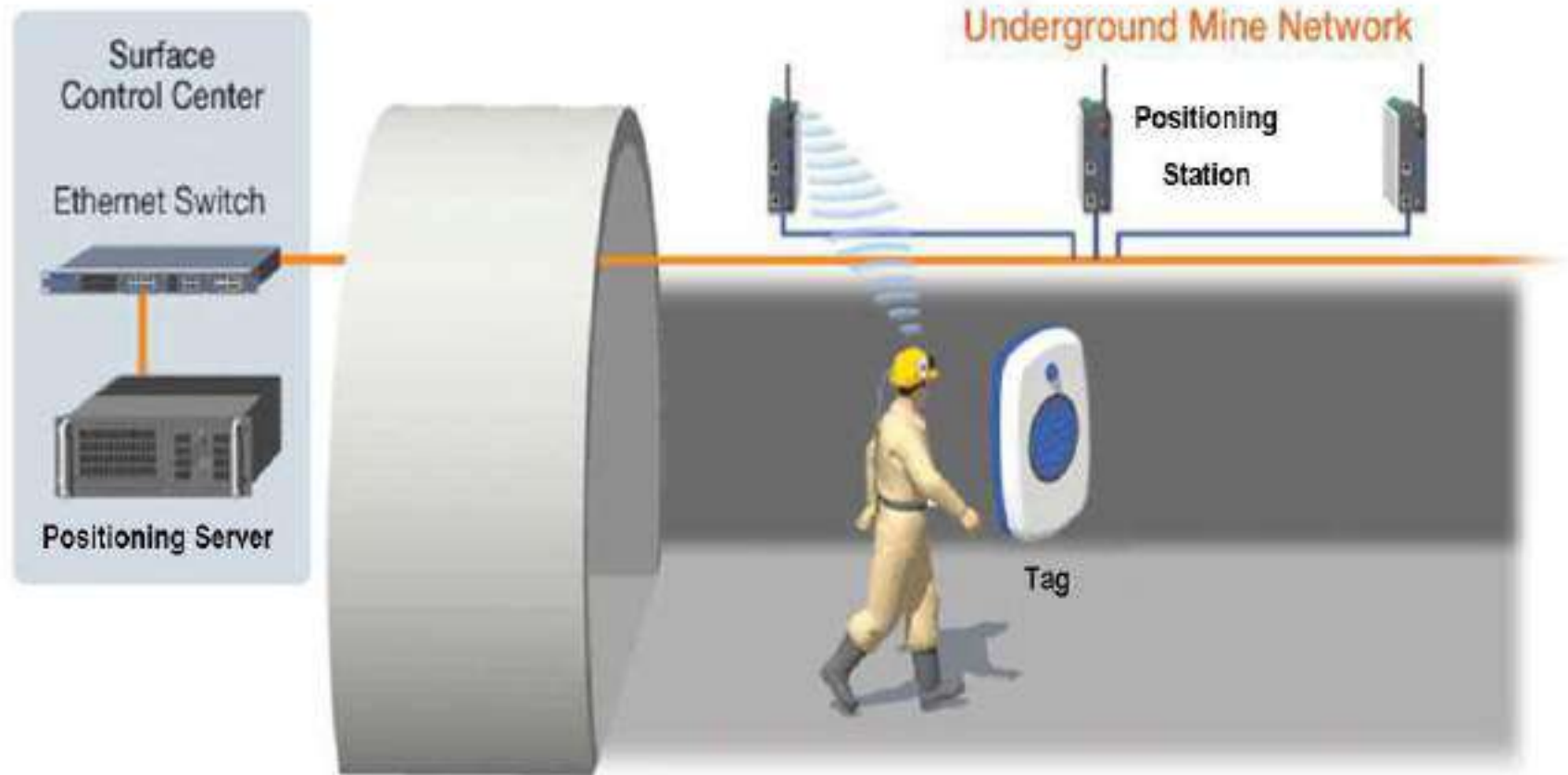
2.5 The system has the advantages of timely and convenient communication, especially for the underground environment and mobile workers.

2.6 Usually, mine leaders, underground engineer, district captain, foreman and gas inspector are equipped with the cell phone, so that they can make quick response to the situation.

- ✓ Voice Call
- ✓ SMS
- ✓ Data transmission(Photos or Video)



Men tracking

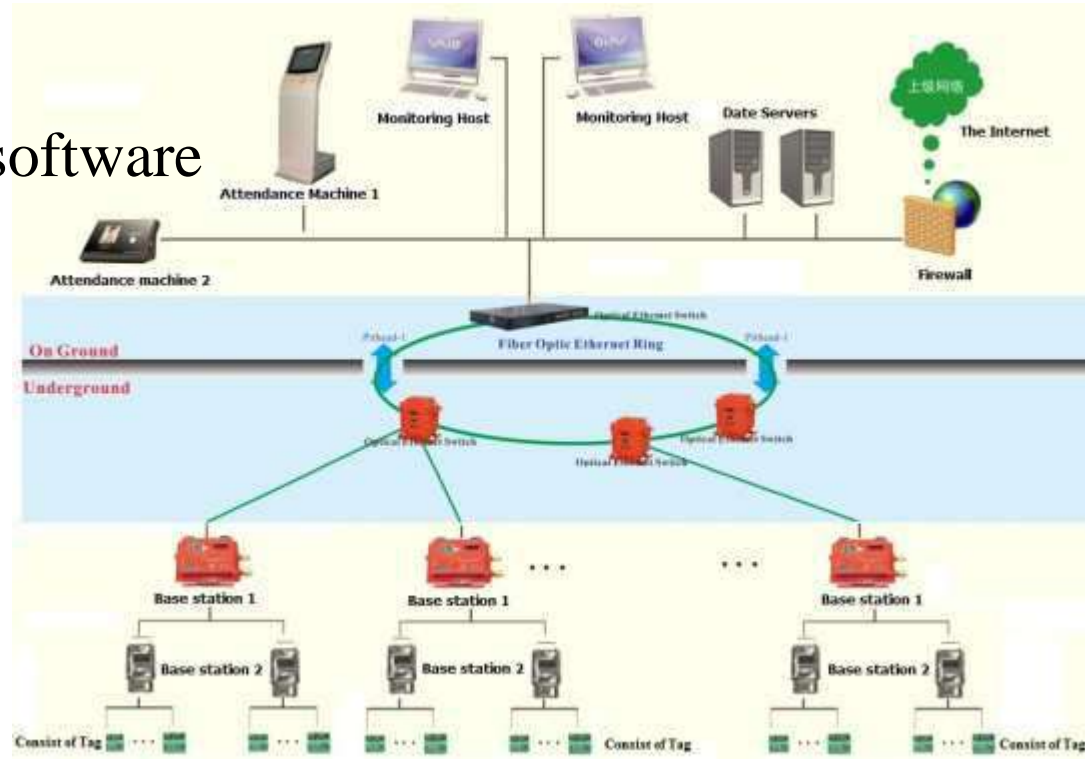


1. Based on Industrial Ethernet Ring (Blue Star System)

integrate advanced **Zigbee Technology**.

2. The system includes:

- Servers with operation software
- Database servers
- UG base station
- positioning Tag
- cables



3. System capacity

- Maximum number of registered tag: 8000

POSITIONING TAG

(Radio Frequency Card Base On Zigbee Communication Protocol)

Important technical parameters:

- (1) Operating Voltage: 2.4~3.4 V
- (2) Working Frequency: 2.40 Ghz \pm 0.08 Ghz
- (3) Communication Protocol: **Zigbee**
- (4) Modulation Mode: OPSK - QPSK
- (5) Transmission Distance: 10 M
- (6) Transmission Power: \leq 4 dBm
- (7) Receiving Sensitivity: - 90 dBm
- (8) Explosion-Proof Type: Intrinsically Safe, Exib I



EMERGENCY EVACUATION NOTICE FUNCTION

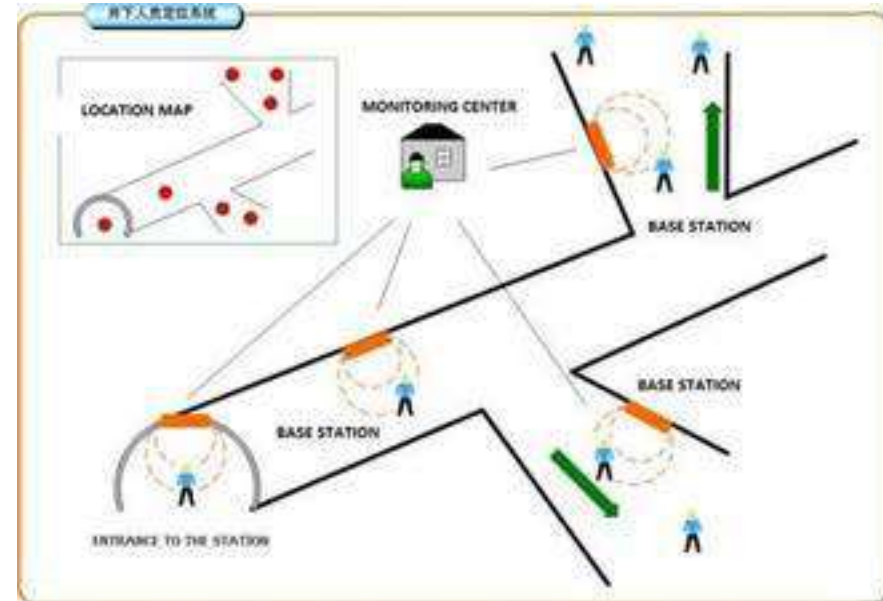
- Press help key to give an alarm to the surface control room
- Surface control room can give an evacuation command to any group of underground workers



Help key

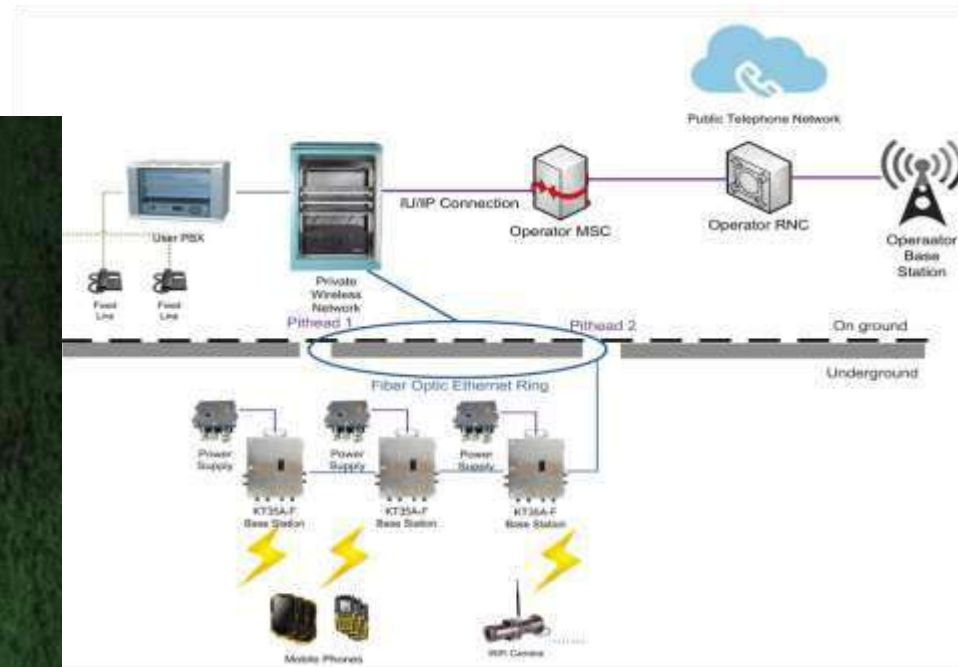
High reliability

- 2 hours backup power supply for UG positioning base station
- 1.5 year battery life for Tag
- Less than 1 in 10000 misreading rate



SYSTEM CONNECTIVITY TO DIFFERENT APPLICATIONS

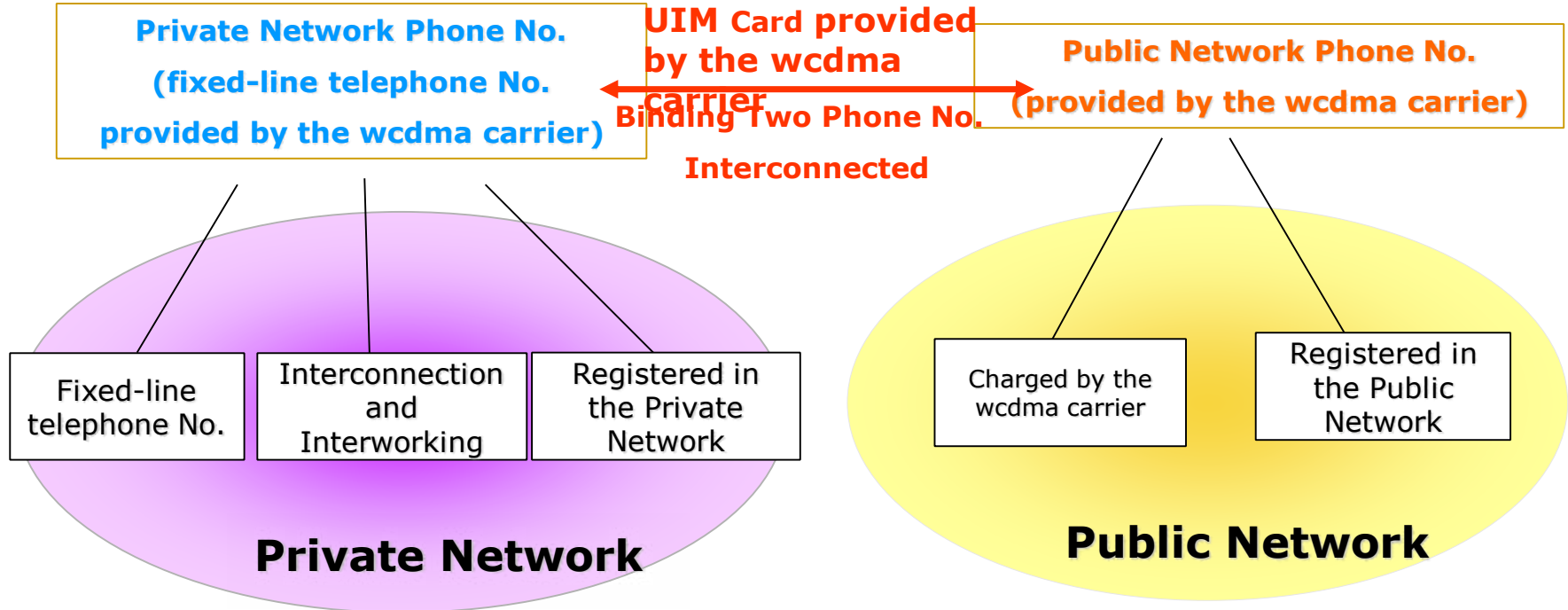
1. Because of the high speed data transmission capability based on the system Industrial Ethernet ring network, it will be easy to connect with the underground monitoring equipment and surveillance cameras with the help of suitable connection equipment.



2. Men Tracking System, system user can find any underground vehicle's (LHD, CM, Shuttle car)location and track which installed positioning Tag, if its speed is lower than 30km/h through the base station area.



- Based on a necessary data connection with the wireless operator (like AIRTEL), user's private network can interconnect private (internal) network with the public network, so that the manager of the user's company can call his(or her) workers directly and see information during the business travel around the world, just like to call his (or her) home.



International accreditations

1. All the underground equipment are inspected according to the Chinese standard GB3836-2010, which is equivalent to IEC60079-2006,2007 standards, and already have the explosion-proof certificate and obtained permission from Chinese Authorities for the coal mine use.
2. All the communication and radio frequency signals transmitted by underground fire resistant cables (optical cable and electric cable) are intrinsically safe.
3. The radio emission frequency has been inspected by China Mining Products Safety Approval and Certification Center, which is accord with ITU (International Telecommunications Union) standard.



Tests conducted in India

The equipment and all parts are tested at CIMFR, Dhanbad, SAMEER-Kolkatta & Karandikar Labs Mumbai recognized test laboratories as per the International standards of IS/IEC 60079-0, 2007; IS/IEC 60079-1, 2007; IS/IEC 60079-11,2006 etc. for Flameproof (FLP), Intrinsic Safety (IS) & Radio Frequency etc.

Approvals: Based on the test reports issued from the recognized laboratories, **DGMS granted Field Trial Approval vide letter no.E-29021/59/2017/ Electrical(HQ) /FT_E_23394 dated 31-7-2018** to use in **below ground Coal Mines.**



**Geospark Solutions Ltd., Hyderabad
&
China Coal Overseas Development Coal Ltd.
(CODCO)**



Technical paper

Indigenous development of Integrated Voice, Video and Data communication System in underground along with **Wireless IIoT** based gas detection and monitoring system for monitoring of different environment parameters of UG mines



Priya Ranjan Kumar
Founder & CTO,
EasyM2M Technologies Pvt Ltd,
Bangalore-560103
Mobile: +91 9739963333

PROBLEMS

- **No video or picture** record of any incident
- **Indian wireless** multi gas **monitoring** device
- Rare communication about accident to officers
- **Unknown repair time** few hours to days
- **Idle manpower** using handheld LMD
- Loss of production, Delay in production
- **Longer delay & higher cost** of repair, production
- **No reliable tracking** of manpower/asset
- No Indian Video communication over WiFi
- Language/usage difficulty of imported device
- Limitations of Wired tele-monitoring system
- **Costly imported device:** support issue
- No **Indian wireless** multi gas **monitoring**
- **Delay in rescue** from UG accident site
- **Time wasted in Multiple visit** to the breakdown site
- Less than planned usage of manpower, production cost increase
- Issues of gas, environment, machine monitoring from surface
- Paper Register or manual reports

OBJECTIVES

- To develop **Integrated Voice, Video and Data communication indigenously** along with **Wireless IIoT** based gas detection and monitoring system for monitoring of different environment parameters of UG mines.
- **24x7 video streaming** from underground coal mine to surface control room
- **2 way video** and voice calling from underground mine to surface
- Open Standard Wi-Fi / Optical LAN technology, high bandwidth
- Digital wireless infrastructure for digital transformation of mines
- **Indigenous** hardware design, and development

IMPORTANCE



- Research & development for Digital Mine under Make in India, Atmanirbhar Bharat
- Foundation of Digital Mine and Digital Transformation infrastructure
- Indian wireless multi gas monitoring or IIoT device from UG to the surface
- Indian coal mines operation **needs modern sensor technology**
- 24x7 Alert/Notification system from UG to control room & officers
- Real time video surveillance from UG mines
- Network available even if electrical power is down
- Miner tracking on the dashboard at control room
- Multi party Video call/conferencing

BENEFIT TO COAL INDUSTRY

- 2 way Video and chat from anywhere in the UG mine to surface
- UG or Surface to anywhere (Officer/ technician) thru internet
- 24x7 miner and machine tracking from surface
- **Online** wireless node **fault detection and alert management**
- Real time location tracking system of the miner available on the map
- 24x7 monitoring of the face of underground coal mine saves officer time
- Reduce repair/maintenance time
- Support in production increase
- **Indian** primary and backup network
- **Reduces manpower** wastage
- Recorded video helps faster repair/decision/officer without visit to UG
- Open Standard Wi-Fi technology
- Modern sensor technology (**NDIR, Ultrasonic**) for Wireless Sensing Device
- **Plug and play** Wireless Sensing Device (WSD).

R&D Components

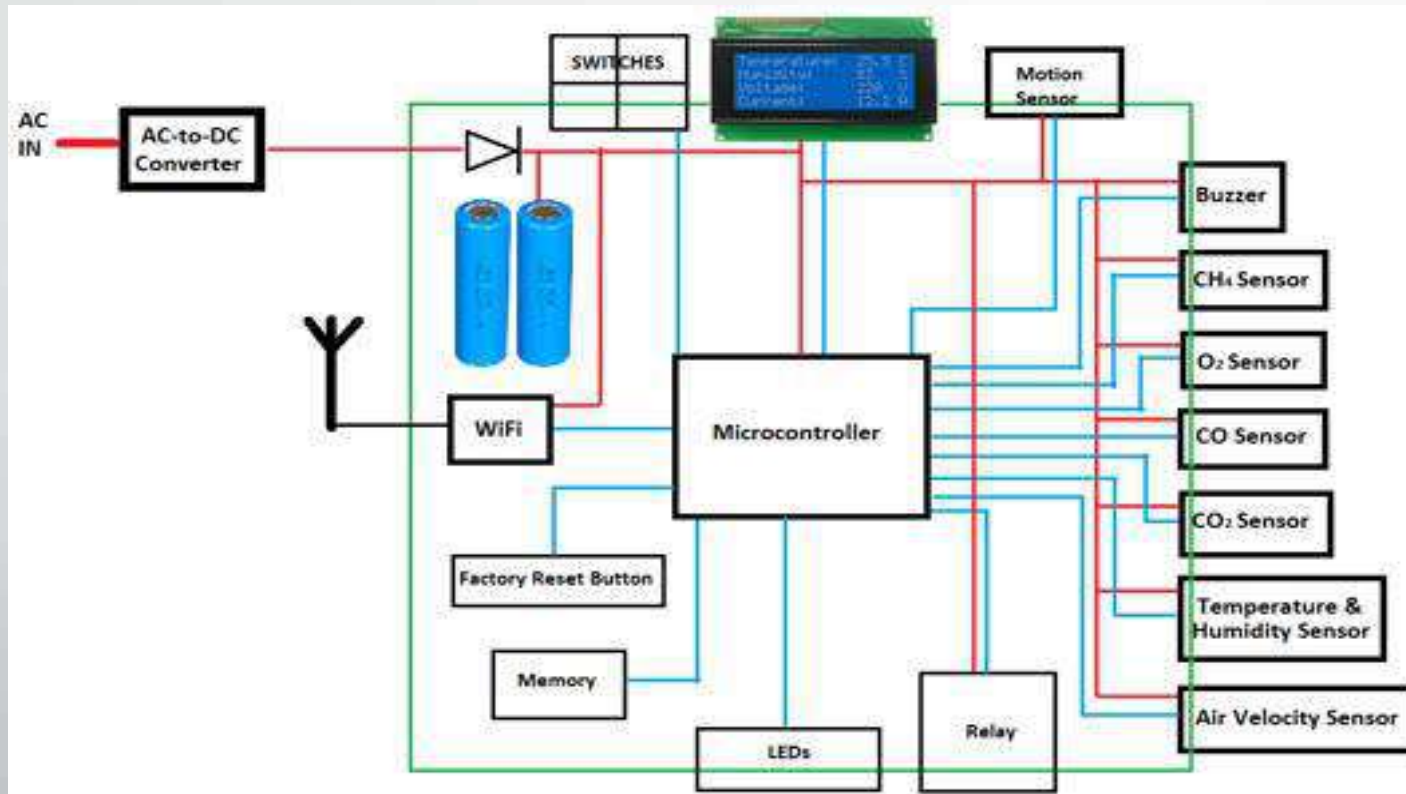
- IS Wireless Gas Detector
- IS Environment detector
- Lightweight FLP enclosure
- WiFi wireless node
- FLP CCTV: night color vision
 - Live video streaming
- ICCC Control room for 24x7 monitoring
 - Data center
 - CCTV recording
 - Audio/video Helpdesk
- Indian Optical fiber cable network
- Optical network redundancy
- Roof/wall fall resistant network design
- Power backup for availability
- High tech IS mobile
 - Audio/video conferencing anywhere
 - Picture/video live streaming
 - Recording online
- 24x7 surveillance, software

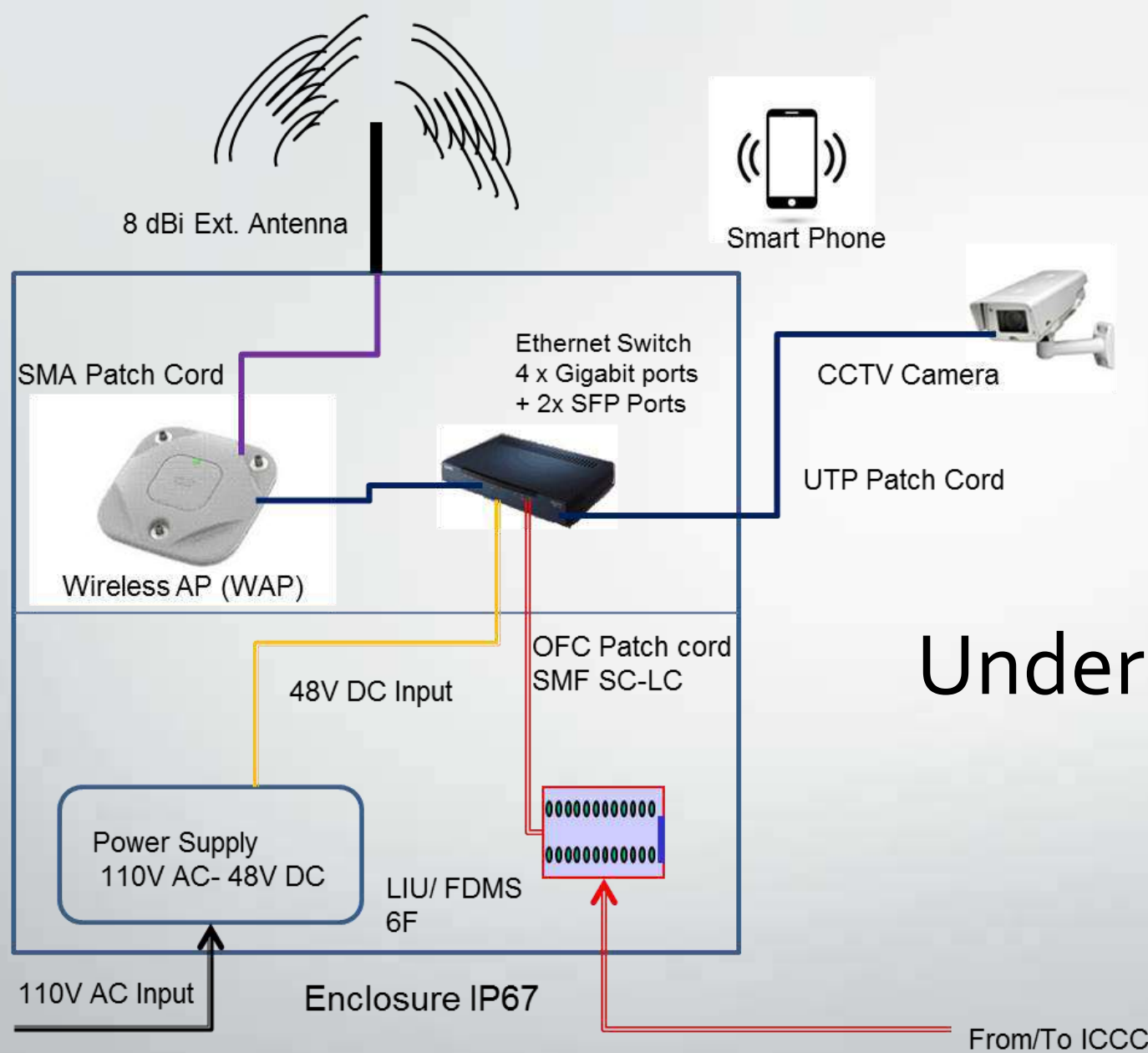
Work Plan/Methodology

- Site survey, literature study and Compare sensor technologies
- Optical, Broadband LAN, Application of Mesh topology
- Procurement of equipment, sensor element and other materials
- Study, purchase & Testing IEC-Exi 60079 part 28 for OFC and Laser device
- Design, Manufacturing, supply, development of equipment and software
- Video streaming technology evaluation and purchase of equipment, testing
- Testing in CIMFR lab, DGMS permission for field trial
- Installation, commissioning of UG equipment, Surface control room setup
- 6 months maintenance

Industrial Internet of Things -IIoT

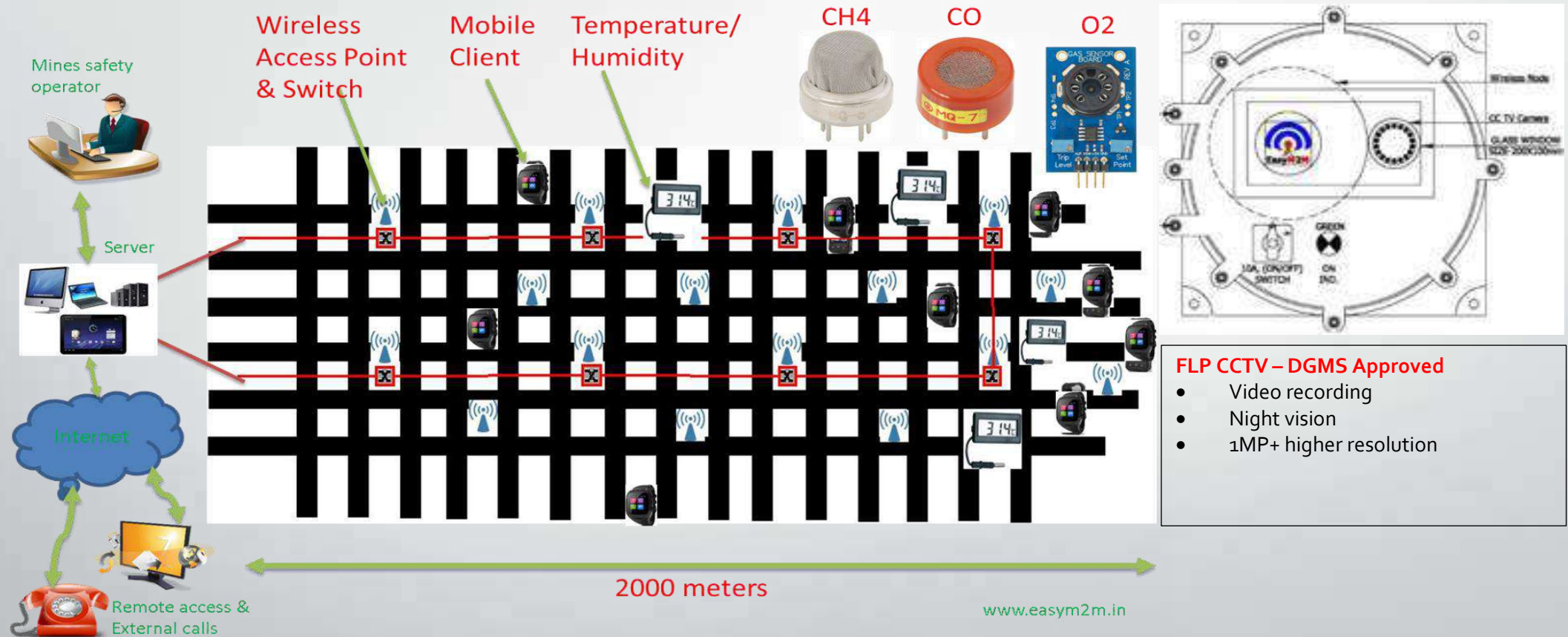
Proposed Wireless sensing device



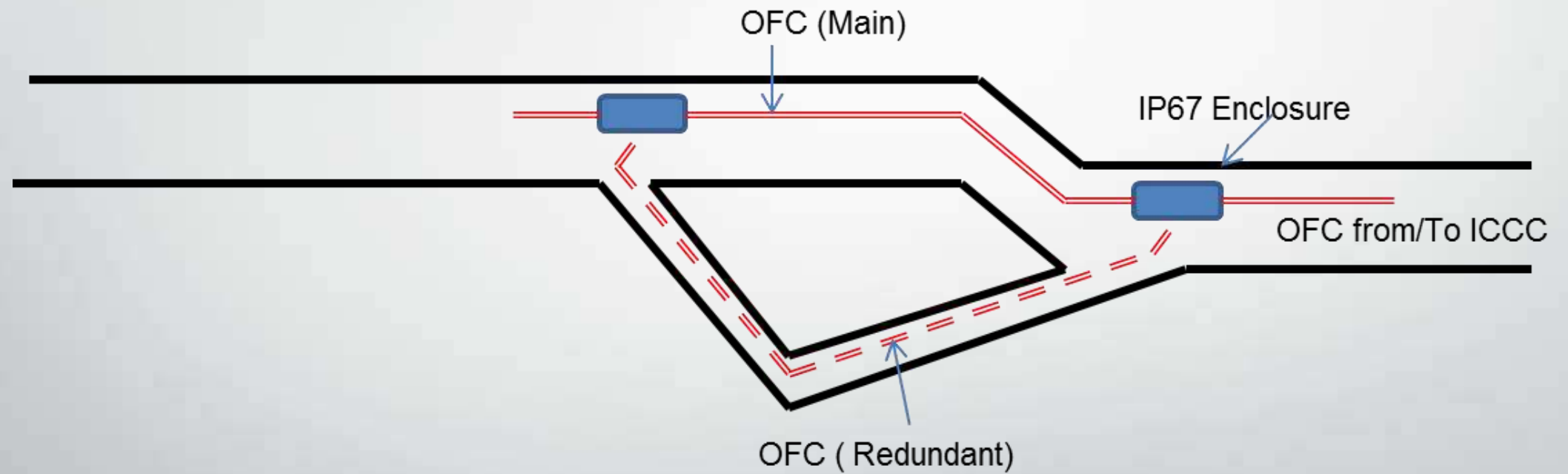


Underground network diagram

Complete system diagram



High bandwidth wired network



PAST EXPERIENCE OF EASYM₂M



- Wearable mobile solution for health care and Video As A Service for Industrial application
 - **Idea to implementation** to product delivery, 2 product flavor and 2 enterprise solution
 - Solution architecture, user behavior & requirement survey, Android App and AWS SaaS platform using Java, JS
 - Successful paid beta trial with miners, elderly and hospital
- Wearable wireless camera phone and Tracker using IoT, IIoT for Industrial application
 - Circuit design, PCB design, IP65 enclosure design
 - Embedded application, Over the Air upgrade,
 - Server side software application development, and Machine learning(ML) based Android App
- Cloud based Multi-tenant monitoring and analytics application for Femto cells
- End 2 End Multi-tenant M2M Application for temp monitoring, GPS tracking, Location based advt
 - ETSI M2M standard implementation for **IoT device to Verizon wireless network**, Idea to implementation
 - Embedded application for Device, Cloud based Backend server development, Enterprise application for B2B
- ETSI-M2M transaction framework for Smart metering using SOA
 - Research and development of Smart meter simulator as IoT device, Cloud server, and web interface development
- EMS development/Maintenance for Optical network monitoring/control
- Management of Worldwide Multi-Location Embedded and application team

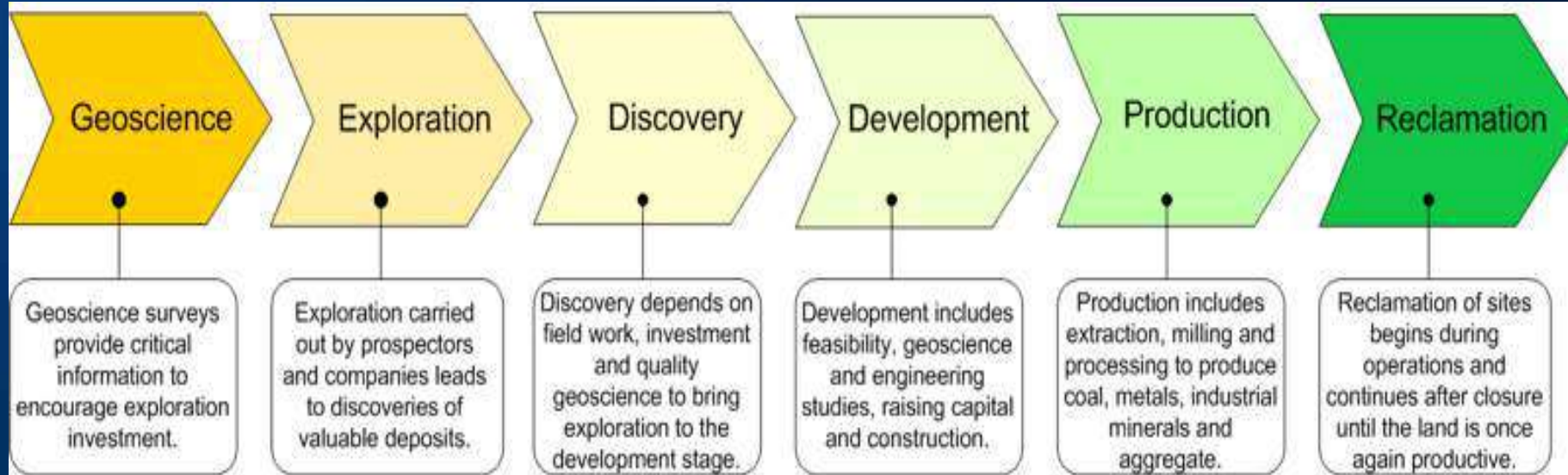


Esri Geospatial Platform For Mining

Workshop on Technology Roadmap for Coal

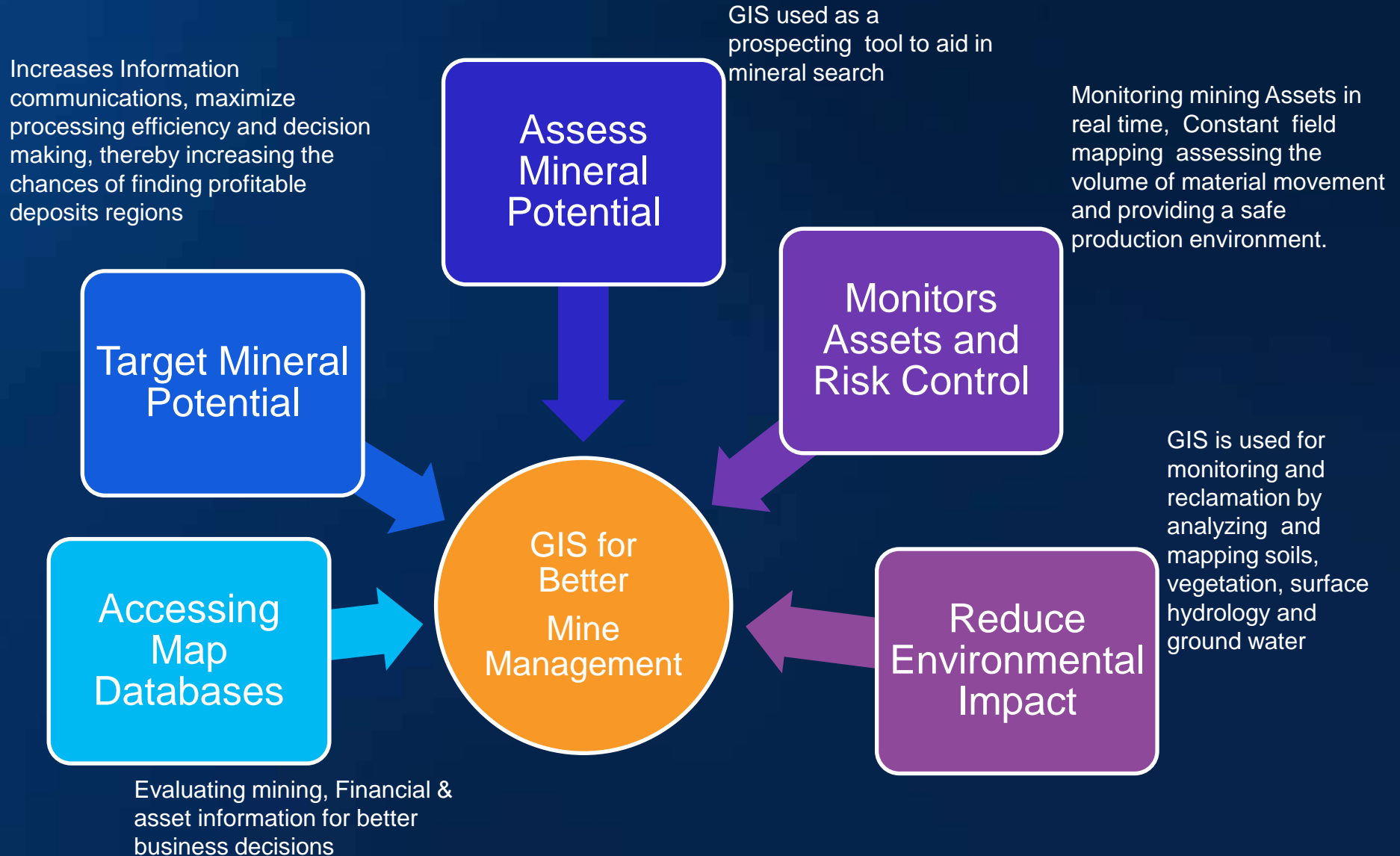
Sector: Technologies to Meet Future Challenges

Phases in a mining domain



Today GIS has replaced old map-analysis processes, traditional drawing tools, and drafting and database technologies

The Geographic Advantage



GIS Applies the Geographic Approach

For Efficient Planning and Management of Mining Activities across Various Phases



GIS For Mining

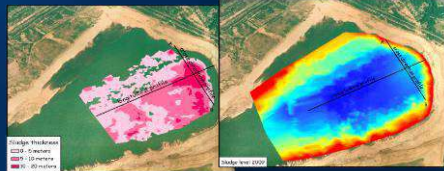
- Standardization of data collation, evaluation and management of data.
- ICT based delivery of industry-centric services through effective usage of spatially enable Information
- Provide the State mining organizations and Officers with tools, technologies and information required for faster and informed decision making.
- Facilitate collection, storage, retrieval, analysis, transfer and sharing of data and Information among various stakeholders and other organizations/agencies.
- Establishing and automation of standards based processes
- Customized tools and functionalities to meet specific regulatory and administrative requirements
- Integration with Enterprise systems like SAP for effective Mine Asset Management, Project management and progress & status monitoring
- Access to multiple and diverse datasets required for Exploration, Prospecting, Overburden and potential estimation
- Effective management of mine related records, documents, permits, plans etc
- Mining Vehicle tracking and fleet management for optimal resource usage
- Map based reports including regulatory and procedural reports, status reports and management reports

Key Application Areas

Exploration Geology



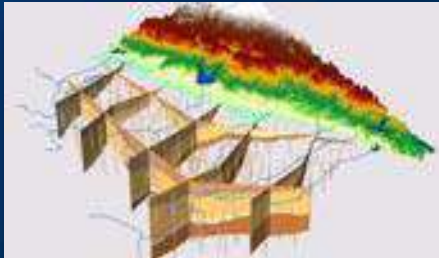
Coal Mine
Sludge



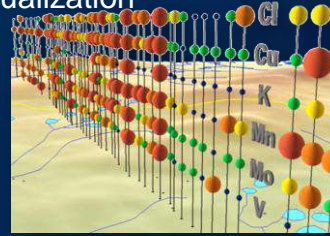
Surficial Geology



Groundwater



Geochemical Visualization



- Target mineral exploration
- Evaluate mining conditions
- Geological mapping
- Model mine construction
- Display geochemical and hydrology data
- GIS based mining permits
- Assess environmental impact
- Manage land titles
- Plan reclamation activities
- Drone based mine analysis
- Illegal Mining using RS and GIS
- State Mineral Portal

ArcGIS Includes Ready-to-Use Content

Basemaps, Imagery and a Living Atlas of the World

Living Atlas

Transportation Environment Business
Landscape Habitats Hydro
Infrastructure Movement
Basemaps Elevation
Boundaries Land Cover Traffic
Imagery Oceans POI
Demographics Weather
Hazards Authoritative
Community Content
Soils

Updated Land Cover (NLCD)



OpenStreetMap
Layers



Real-Time
Observations



NatureServe
Imperiled Species



Policy Maps



Protected Areas



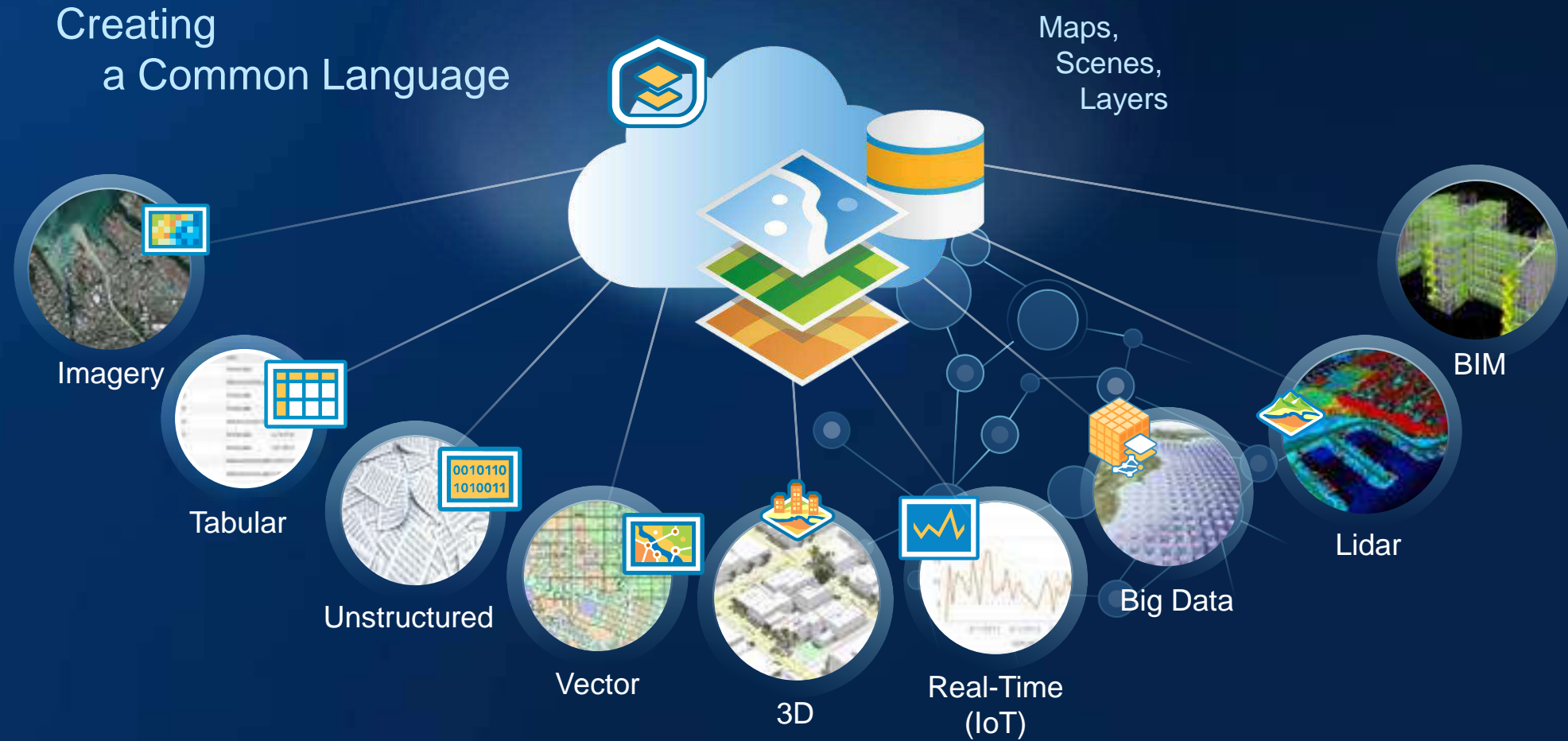
- Expanded POIs
- Better OSM Integration
- Global Demographics
- Enhanced Imagery
- New Content
 - Landcover Forecast
 - Biodiversity
 - Air Quality
 - Global River Flow
 - . . .

- Millions of Maps, Layers and Datasets
- Billions of Requests Daily

*Global Geographic Data . . .
About Everything*

ArcGIS

Integrates All Types of Data



Smart Mapping Enabling Everyone to Make Amazing Maps in a Browser

Dynamic and Data Driven



Layer Blending



Dot Density



Dynamic Clustering



Data-Driven 3D



New Map Viewer

Beautiful Visualization



Exploratory Mapping



New & Improved

- Map Viewer
- Dot Density
- Dynamic Clustering
- Layer Blending
- Vector Feature Tiles
- Integrated Charting
- Performance
- No Feature Limits

Operations Dashboard | Dynamic Visual Reporting & Analytics

Totally New App

- Web-Based
- Improved Performance
- Easy Configuration
- Easily Embedded
- New Widgets



Accidents



Crime



Wildfires

Imagery and Remote Sensing

A Comprehensive Platform

Supporting Hundreds of
Innovations and Workflows

Map & Data Production

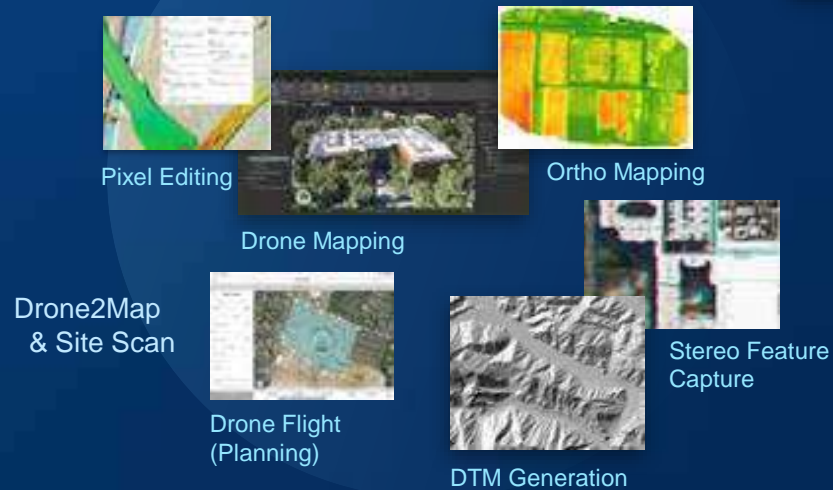


Image Analyst
& Image Server

Analysis

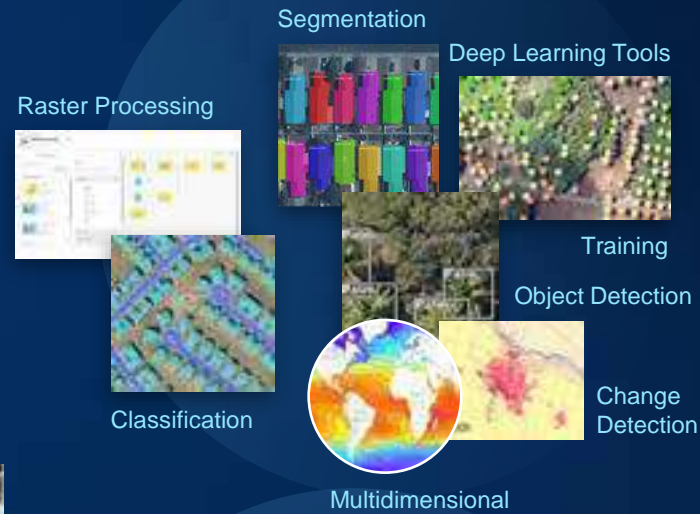
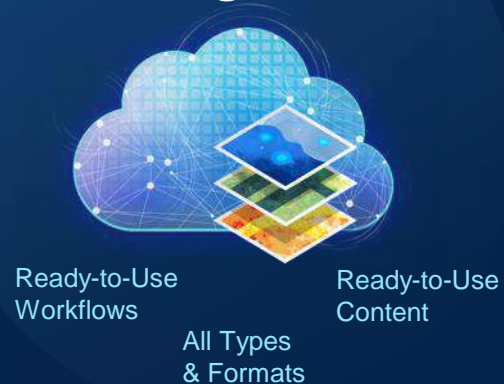


Image Management



Visualization & Exploitation



New & Improved

- Visual Analytics
- Management
- Deep Learning Tools
- Multidimensional Tools
- Drone Integration
- Exploitation

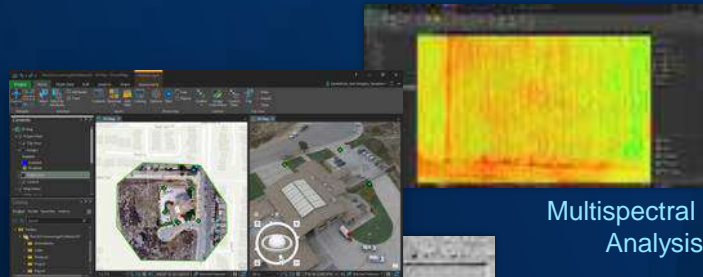
Coming to ArcGIS Online

Drone Mapping

Flight Planning, Collection and Processing

Desktop

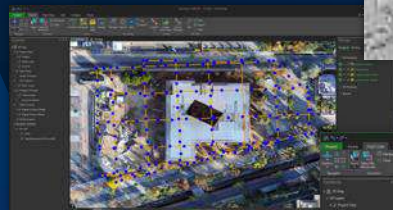
Drone2Map



Dynamic Processing

Multispectral Analysis

DEMs



Simple Workflows



Interactive 3D Meshes

Point Clouds

3D Integrated Meshes

Orthomosaics

DSMs

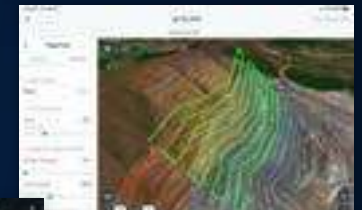
Cloud (SaaS)

Flight Planning and Fleet Management

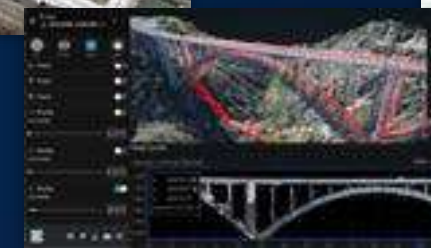


Site Scan

Vertical Scan



Perimeter Scan



Process Management



3D Point Clouds and Meshes with Volumetric Tools

A Complete Solution for Integrating Drones Into Your Workflows

Field Operations Location-Enabling All Aspects of Field Work



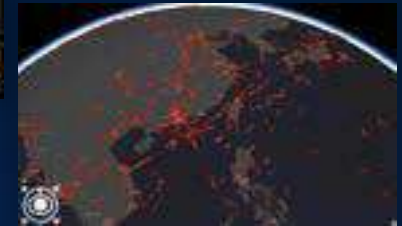
Real-Time Analytics | Integrating Sensor Networks and the IoT

Supporting High-Velocity Data Streams

Tracking, Monitoring, and Alerting

New & Improved

- Performance (2.5x)
- Scalability (10x)
- Resiliency
- Cloud IoT Connectors
- Actuation



Supporting Real-Time Applications



Overview of ROTER Products

UAV/DRONE



Trinity F90+

Uniqness Trinity F90+



**VTOL FIXED-
WING SYSTEM**



**HIGHLY INTEGRATED
DESIGN**



**LONGEST FLIGHT
TIME IN ITS CLASS**











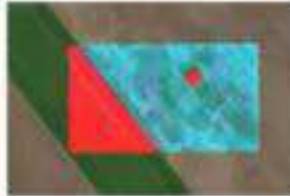
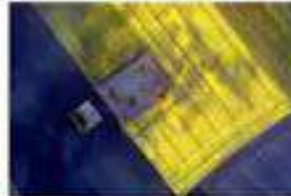




**EASY AND SAFE
HANDLING**



HIGH PAYLOAD

Trinity F90+ PAYLOADS: Quantum-Systems UAS are compatible with various payloads, allowing them to be customized for every mission as required

			 <i>Only double payload on market!</i>				 <i>Only double payload on market!</i>
Sony RX1 RII		Sony UMC-R10C	Sony UMC-R10C & RedEdge-MX	MicaSense RedEdge-MX	MicaSense RedEdge-MX Dual	MicaSense Altum	UMC & Flir Double Payload
Spectral Channels	RGB	RGB	RGB & RGB NIR RE	RGB NIR RE	RGB NIR RE	RGB NIR RE / LWIR: thermal infrared 8-14um	RGB / LWIR: thermal infrared 8-14um
Resolution @ 100m AGL	1.3 cm (42.0 MP)	2.6 cm (20.1 MP)	2.6 cm (20.1 MP) + 7.0 cm per band	7.0 cm per band	7.0 cm per band	4.3 cm per band ca. 60 cm thermal	2.6 cm (20.1 MP) + 9.0 cm thermal
Bands	-	-	- / 5	5	10	6	
Software Output							

Double payload configuration enables simultaneous capture of RGB and NIR data in a single flight, doubling mission efficiency



Qube 240

A geomatics grade, high-speed scanning LiDAR

The **Qube 240** payload is a geomatics grade LiDAR Scanner for the **Trinity F90+ UAS** and it endures **up to 60 min** of flight time with this combination. It is offered as a complete solution, all encompassed with **YellowScan CloudStation Software pack, and license**.

The unique key data:

- Geomatics Grade LiDAR
- Class 1 (Eye Safe)
- Wave length: 905 nm
- Maximum altitude: 140 m AGL
- Precision: 1.8-2.5 cm
- Accuracy: < 3 cm
- Scanner field of view: 70°
- 240,000 shots per second
- Point density @100m: 50-100 points/m²
- Multi-echo technology: up to 3 echoes per shot
- Applanix POSPac™ UAV, GNSS, and INS software for PPK
- Qube 240 data processing software to generate survey-grade LAS Files.



Ground Penetrating Radar



Sensors & Software Inc. is the pioneer in Ground Penetrating Radar technology worldwide since 1988.

Provides solutions for each application which falls in the GPR domain in more than 100 countries.



Conquest 100
Concrete Scanner



LMX Series
Utility Mapping



Pavement Density Profiler



Pulse Ekko



Rescue Radar
Find survivors



Findar
Forensic Investigations



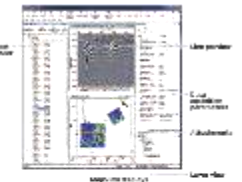
Ice Map
Mapping of Ice



Snow Scan
Mapping of Snow



Noggin



EKKO Project

Various Domains Served By GPR



FENO Drivable Anchored Survey Markers

- super-secure,
super-fast, no
digging

- A super-secure monument that requires no digging! The galvanized FENO monument is as easy to drive in as any rod monument, and when the 6-step process is complete, the marker has 'roots' that anchor it into the ground.

- The FENO anchored survey mark system offers a unique solution to surveyors who want to use a small, easy-to-drive, quality galvanized steel survey mark. Using the unique FENO concept, two conditions must be fulfilled in order to guarantee the correct position and the secure placement of marks:

- 1. It should be possible to move a temporary mark into a permanent position. If the marker is fitted with wings or lugs (or any other type of anchoring device) this is not possible. However, with the FENO system, the position of the marker can be easily changed at any time prior to the extension of the anchors.

- 2. Once the marker has been finally positioned, it must be possible to lock the marker firmly and securely in the ground. With FENO markers, when the correct position has been achieved, the strong steel anchors can be extended to secure the marker into position, much like the roots of a tree.



Airborne Lidar

Who we are



We design, develop and produce aerial drone imaging sensor systems for professional applications.

YellowScan is committed to delivering the highest level of performance, reliability and robustness for our solutions.

Fully integrated, ultra-light and easy to use, these highly automated data collection tools are employed by customers around the world in fields such as surveying, forestry, environmental research, archeology, industrial inspection, civil engineering and mining.

With more than 10 years of experience, our platforms are field tested all over the world in multiple environments (tropical forests, bare soils, mountains, rivers, coast lines, open-pit mines, power lines).

Located in Montpellier, an attractive city in the South of France, YellowScan's headquarters is right in the heart of the European Union, with good transportation connections in all directions.

Product Comparison



YellowScan Mapper >

The best cost-performance ratio UAV LiDAR

System Accuracy	3cm
System Precision	2cm
Weight battery excl.	1.30kg 2.87lbs
Weight battery incl.	1.50kg 3.31lbs
Typ. flight speed	10m/s
Typ. AGL altitude	70m
Point density @50m AGL 5m/s	400pts/sqm



YellowScan Surveyor >

The most versatile UAV LiDAR solution

System Accuracy	5cm
System Precision	4cm
Weight battery excl.	1.43kg 3.16lbs
Weight battery incl.	1.60kg 3.53lbs
Typ. flight speed	5m/s
Typ. AGL altitude	50m
Point density @50m AGL 5m/s	85pts/sqm



YellowScan Surveyor Ultra >

The versatile & long range UAV LiDAR solution

System Accuracy	5cm
System Precision	10cm
Weight battery excl.	1.53kg 3.38lbs
Weight battery incl.	1.70kg 3.75lbs
Typ. flight speed	18m/s
Typ. AGL altitude	80m
Point density @50m AGL 5m/s	340pts/sqm

Product Comparison



YellowScan Fly&Drive >

Fly when you can, drive when you must to map with YellowScan's Surveyor or Surveyor Ultra

System Accuracy	up to 5cm
System Precision	up to 4cm
Weight battery excl.	5.43kg 11.97lbs
Weight battery incl.	5.60kg 12.35lbs
Typ. driving speed	25-50km/h
Max. range	100-200m
Point density @50m AGL 5m/s	Surveyor or Ultra



YellowScan Vx15 series >

The long range & high precision UAV LiDAR solution using miniVUX-1, 2 or 3

System Accuracy	5cm
System Precision	1cm
Weight battery excl.	2.37kg 5.23lbs
Weight battery incl.	2.60kg 5.74lbs
Typ. flight speed	5m/s
Typ. AGL altitude	100m
Point density @50m AGL 5m/s	up to 150pts/sqm



YellowScan Vx20 series >

The most accurate and high precision UAV LiDAR solution using miniVUX-1, 2 or 3

System Accuracy	2.5cm
System Precision	1cm
Weight battery excl.	2.87kg 6.33lbs
Weight battery incl.	3.10kg 6.84lbs
Typ. flight speed	5m/s
Typ. AGL altitude	100m
Point density @50m AGL 5m/s	up to 150pts/sqm

The background is a dark, teal-colored abstract image. It features several concentric, slightly blurred circles that create a tunnel-like or lens-like effect. Scattered throughout the image are numerous small, out-of-focus light spots, known as bokeh, in shades of white, yellow, and light blue. The overall composition is centered and symmetrical, giving it a futuristic or technological feel.

Terrestrial Laser Scanner



TELEDYNE OPTECH

POLARIS LR

Terrestrial Laser Scanner

ACCURATE • LONG RANGE • FAST • VERSATILE

POLARIS LR

2mm
@100m
resolution

2000 m
long
range

500,000
pts/sec

Adjustable
FOV
(120° V x
360° H)

5mm
range
accuracy

Int./Ext.
Camera

Touch
Screen
GUI

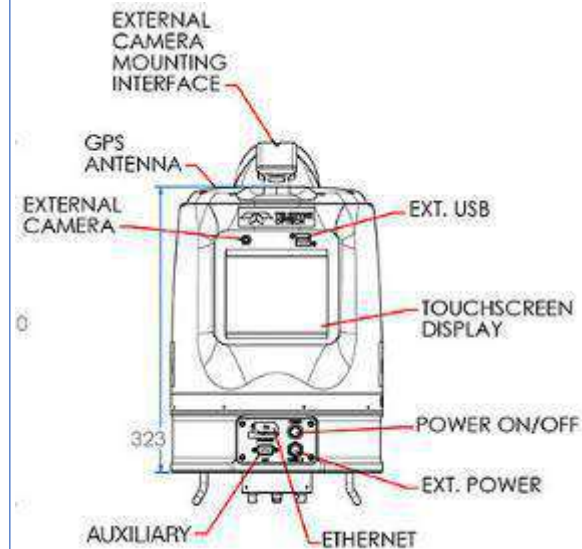
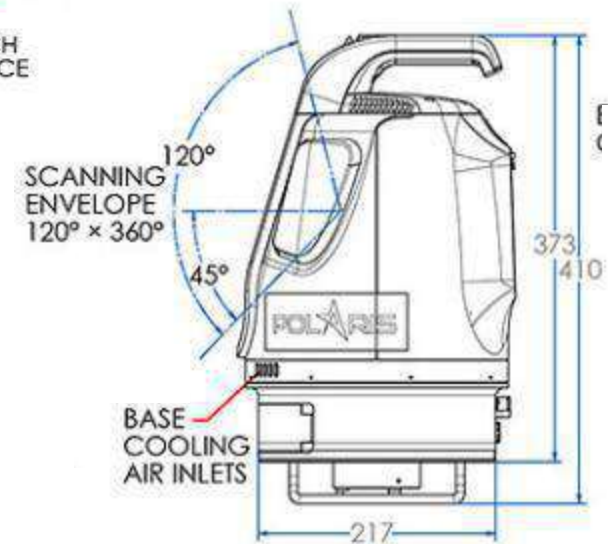
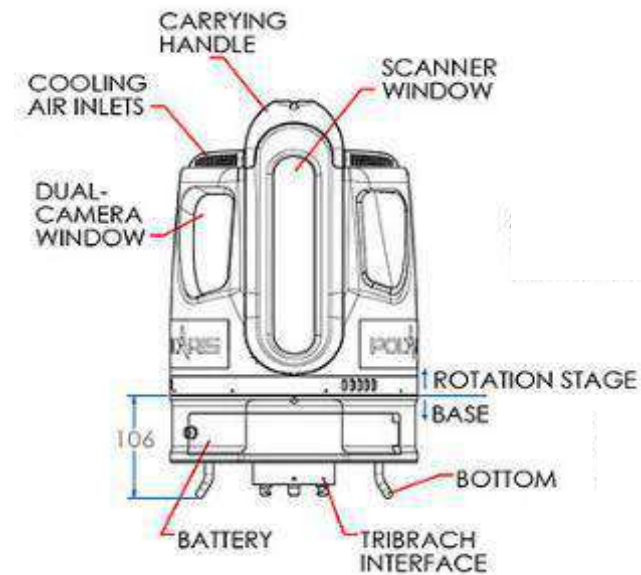


Polaris Features

Storage
Temp :
-40° to
+80°C

Operating
Temp : -
20° to
+50°C

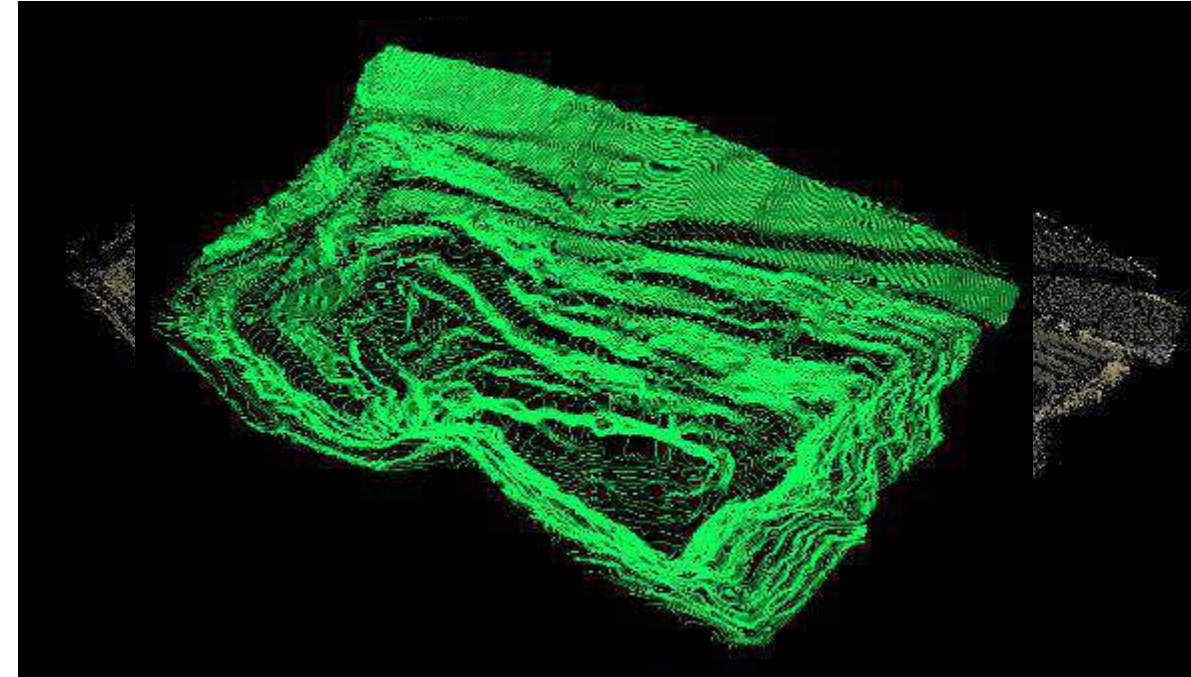
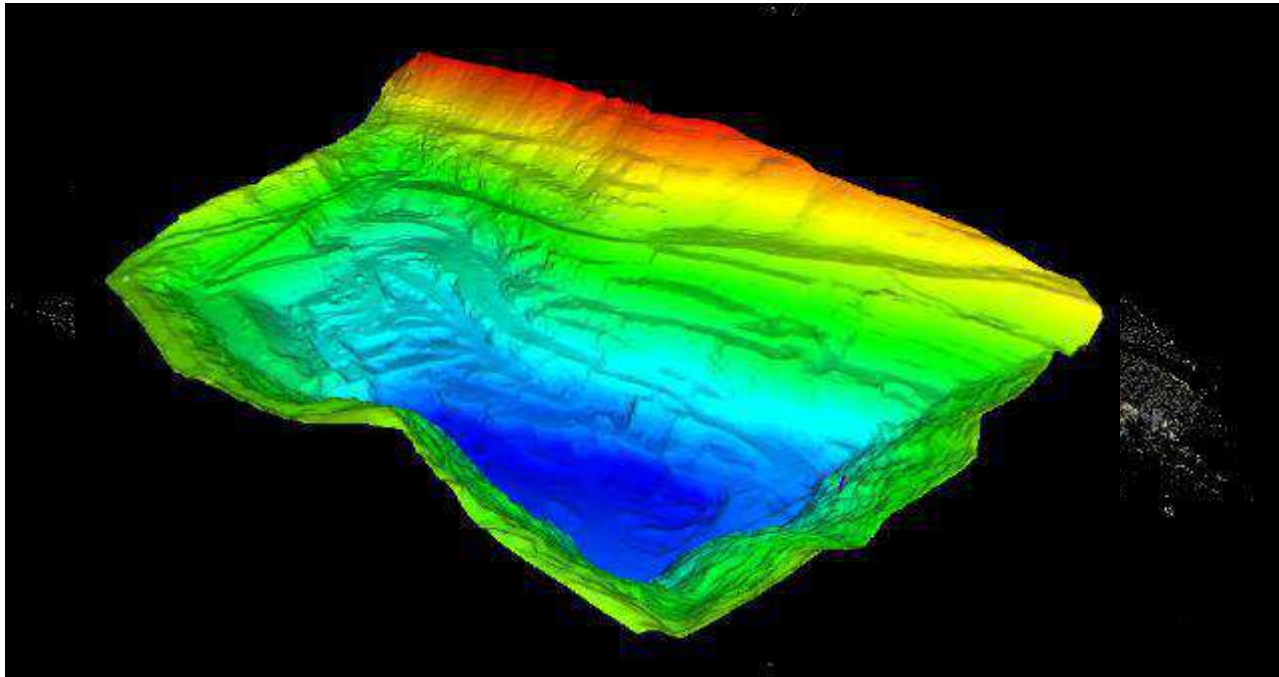
2 hot swap
battery
(2.5 hr)



Polaris Dimensions

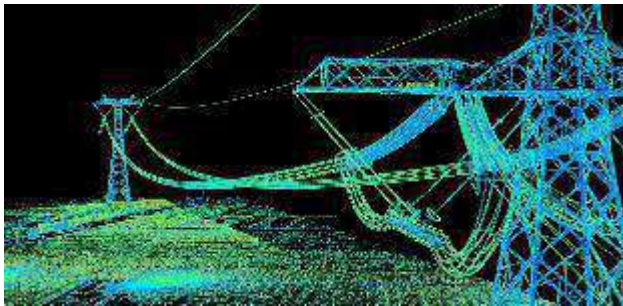
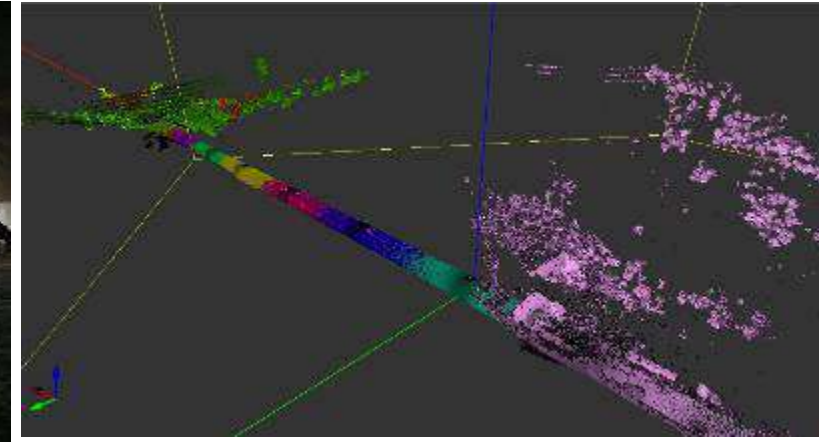
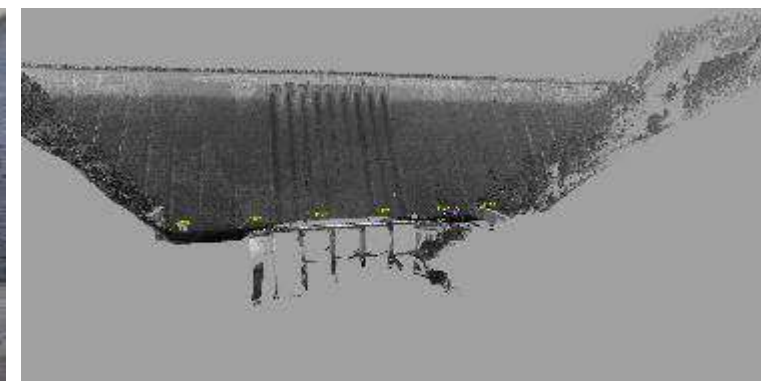
New Akash Kinari Coal Mine, Dhanbad

- Date of scanning- 01.03.19
- Number of scans –3 at the mines
- Total Time of scanning – 15 mins + 15 mins + 15 mins
- Data processing – 1 day in office



Versatility of POLARIS

- Civil/Structure mapping- Dam, Building, Bridge, etc..
- Tower/Electrical Line Mapping
- Mine mapping
- Tunnel Mapping
- Forensic Analysis
- Topographic mapping
- Glacier/ice/snow analysis
- Archeology/Heritage scanning



Z+F IMAGER 5006EX

The safe way to scan...

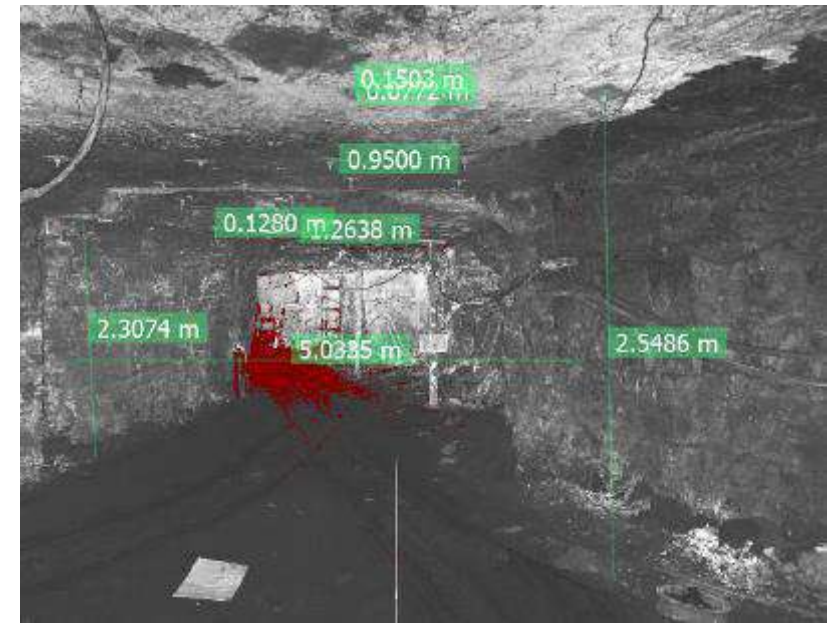
Explosion-proof, robust, reliable: the Z+F IMAGER® 5006EX

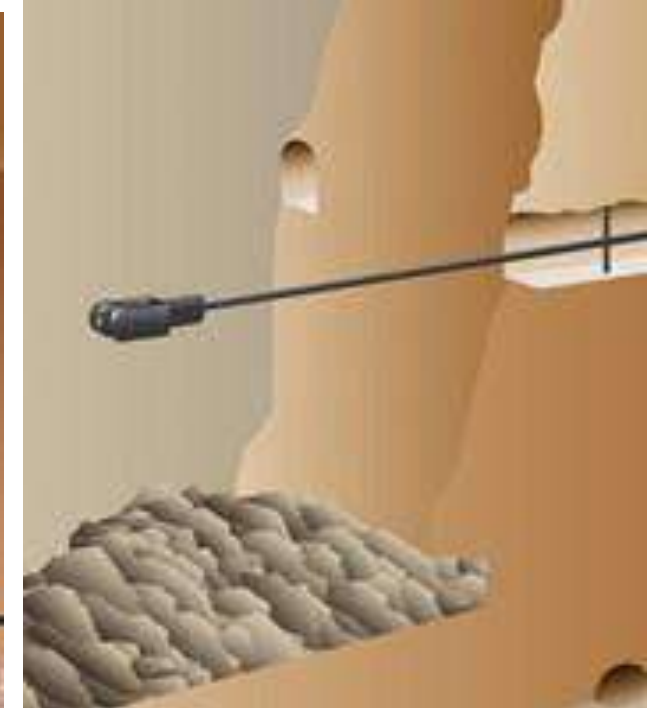
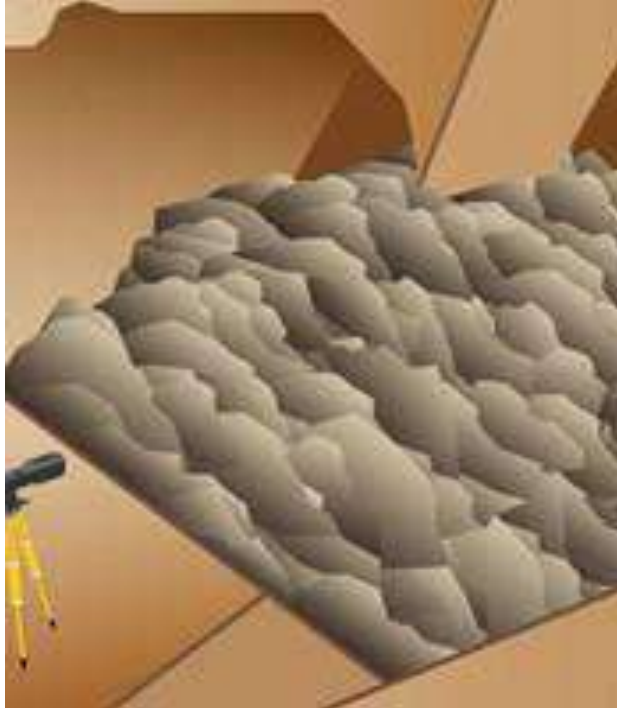
FEATURES

The Z+F IMAGER® 5006EX offers a lot of benefits which raise your productivity and safety, and reduce costs at the same time.

- DGMS certified
- ATEX certified
- 100 % stand-alone
- Battery change in explosive environment possible
- Direct scanner control through built-in control panel
- Scanner control via WLAN possible
- Range 79 metres
- Able to work under high humidity and dusty environment

First explosion proof
laser scanner worldwide.





CMS V500 : Cavity Monitoring System

- The industry-leading Teledyne Optech CMS is an ideal scanning solution for dangerous and inaccessible cavities in standard mining operations—the CMS head extends into the cavity while the operator stands clear, improving safety.
- The system is easy to transport and set up and is fully programmable, allowing the operator to define scan parameters.
- CMS delivers data in universally adopted data formats suitable for any software workflow, improving mine efficiency and operations by giving insight into the mine's actual structure.

Heron Mobile Scanner

WEARABLE . PROFESSIONAL . POWERFUL

THE PROFESSIONAL 3D MOBILE MAPPING SYSTEM

Powerful SLAM-based scanner for fast 3D mobile mapping, ideal everywhere: indoors, outdoors, underground mines, geospatial applications, multi-level buildings, tunnels, cultural heritage sites, forensic procedures, forests, urban areas... but especially harsh and complex environments.

Some unique features:

- Loop closure not mandatory
- Initialization procedure not required
- Usage in every light conditions
- Automatic self-localization in a reference model, when available
- Large reduction of drift effects typical of the SLAM process (patented algorithms)
- Static scans used as constraints (patented algorithms)
- Full post-processing software with third-party compatibility



Heron Mobile Scanner: Product



TECHNICAL SPECIFICATIONS

	AC-2	AC-2 Color	MS-2	MS-2 Color	LITE	LITE Color
Weight (Control Unit excluded)	6 Kg	6.25 Kg	11 Kg	11.25 Kg	2.5 kg	2.75 Kg
Weight of Control Unit:	1.4 Kg					
Time of initialization	~ 30 sec				~ 15 sec	
Working time (1 batt./continuous use)	~ 3 hrs	~ 2 hrs	~ 3 hrs	~ 2 hrs	~ 6/8 hrs	
Indoors/Outdoors usage	Yes					
Real-time visualization	Yes					
Operating temperature	-10°;+60°	-10°;+40°	-10°;+60°	-10°;+40°		-10°;+60°
Output data	e57, las, ply					
Scanning rate	700.000 points/sec				300.000 points/sec	
Final global accuracy*	~ 5 cm					
Local accuracy	~ 2 cm					
Final survey resolution	~ 2 cm				~ 3 cm	
LiDAR sensor (safety class 1)	Velodyne HDL-32E				Velodyne Puck LITE	
Wave length	903 nm					
Max range	80-100 m					
Angular FOV	horiz.360° vert. +10.67° ; -30.67°				horiz. 360° vert. +15° ; -15°	
Battery	NiMH 12V 9Ah				Li-polymer 12V 4.5Ah	

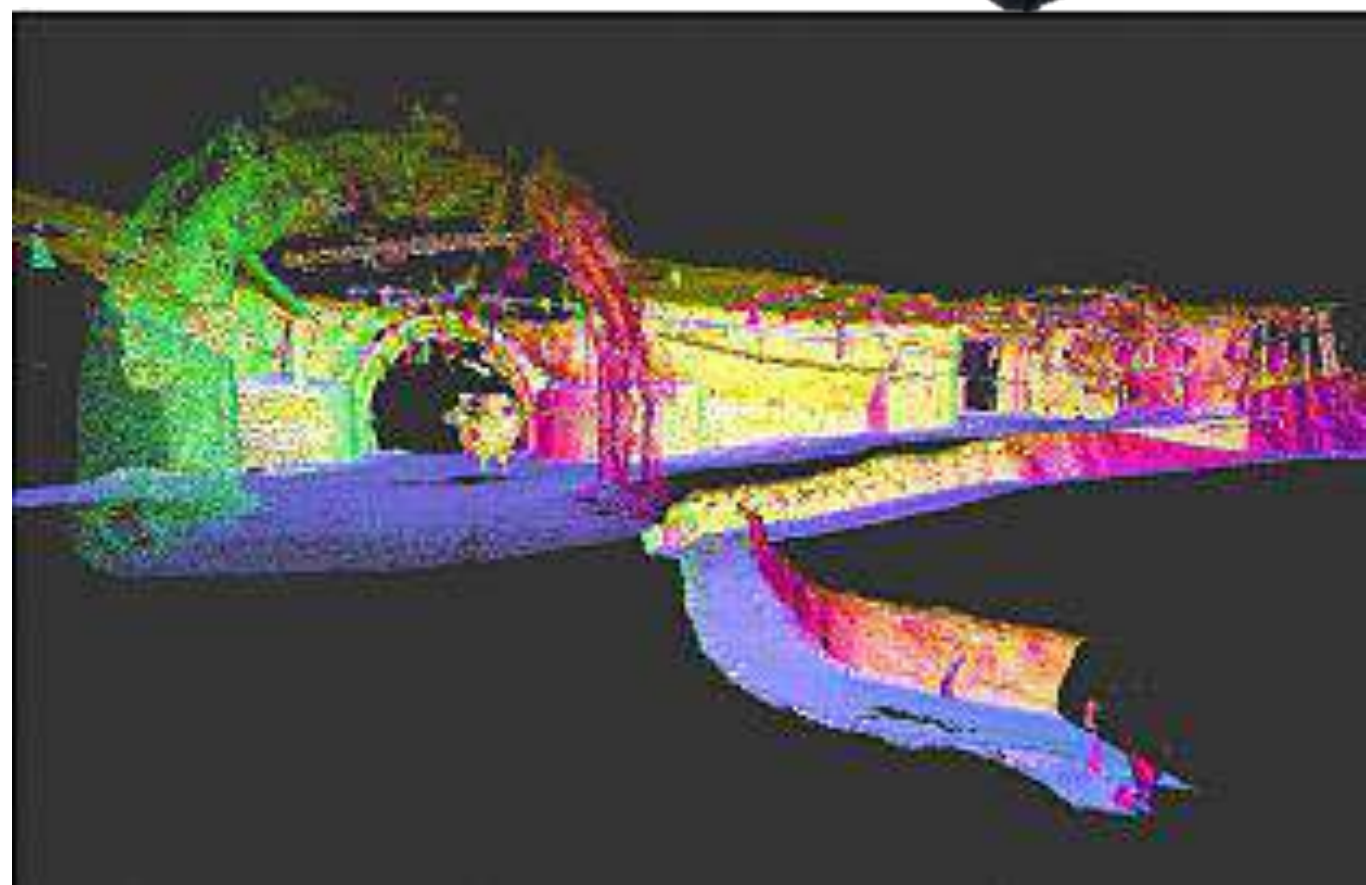
PANORAMIC CAMERA

Resolution	Full HD	35 mm equivalent focal length	1.036 mm
Max frame rate	60 FPS	Depth of focus	40 cm to ∞
Horizontal and Vertical FOV	360°	Automatic color and light balance	Yes
Interface	USB 3.0	Automatic exposure control	Yes

*Global accuracy depends on the effectiveness of the SLAM registration algorithm, which can be influenced by the geometry of the surveyed data. Long paths in absence of loop closures and cross passes, and different conditions as narrow tunnels and stairs, can downgrade the global accuracy to 20 - 50 cm, partially or fully improvable using the advanced control parameters available in the HERON® Desktop software. Ask to Gexcel support team for more details.

Heron MS Twin : Double laser sensor and 5k pano camera

Heron MS Twin mounted onto the mining truck





PAN INDIA CONSULTANTS PVT. LTD.

Integrated Solutions to every Survey need..



Hand Held GNSS SP20

SP20 Specifications

- Android 6.0
- CPU speed 1.2GHz
- High accuracy : cm RTK capable
- Dual frequency, Full constellation
 - 240 GNSS channels
 - GPS/GLONASS; L1/L2
 - BeiDou (B1, B2), Galileo (E1, E5b)
 - QZSS , SBAS
 - L-band
- 5.3 '' display (Gorilla)
- Memory: 16 GB storage + SDHC
- Wireless: Cellular, WiFi, Bluetooth 4.0
- Cameras
- Full day autonomy (8 hours)
- Weight ~ 850g
- Extremely strong (shock resistant, Waterproof, MIL STD 810)



SP60

- Unique 6G GNSS-centric technology
 - Exclusive Z-Blade processing technology
 - Spectra Precision 240-channel 6G ASIC
 - 6 GNSS systems:
GPS, GLONASS, BeiDou, Galileo, QZSS, SBAS
 - No dependency on the GPS signals
 - Availability in very difficult environments
- **Operation**
 - RTK network rover
 - RTK UHF Base and Rover
 - RTK Long Range Bluetooth Base and Rover
 - Central Cloud Corrections (CCC)
 - NTRIP / Direct IP
 - Post-processing
 - RTX



SP85 GNSS Specifications

- Next-generation “6G” ASIC with 600 GNSS channels
 - Patented Z-Blade GNSS-centric technology
 - Patented SBAS ranging (used in RTK processing)
 - Patented Strobe Correlator for reduced GNSS multi-path
 - Fast Search engine for quick GNSS acquisition
 - Support of RTCM 3.2 (including MSM)
- GNSS Performance
 - Real-time accuracy
 - RTK: 8 mm + 1 ppm HRMS / 15 mm + 1 ppm VRMS
 - DGPS: 25 cm + 1 ppm HRMS / 5 cm + 1 ppm VRMS
 - Post-processing accuracy
 - Static: 3 mm + 0.5 ppm HRMS / 5 mm + 0.5 ppm VRMS
 - High-precision static: 3 mm + 0.1 ppm HRMS / 3.5 mm + 0.4 ppm VRMS



GNSS Specifications (continued)

- CenterPoint® RTX capable
- Real-time ambiguity fixing, PPP positioning service for static and kinematic applications



- True Multi-GNSS service: GPS, GLONASS, QZSS, (BeiDou)
- Available through Internet and Satellite Delivery (L-Band)

RTX Service	Accuracy 95%	Convergence time
CenterPoint® RTX™	HRMS < 4cm, VRMS < 9cm	< 30 minutes < 5 minutes with Quick Start*

* RTX Quick Start availability to be confirmed



PAN INDIA CONSULTANTS PVT. LTD.

A Trusted Name In Geo-Informatics

Trimble RTX

- Get Trimble RTX To Work For You

- CenterPoint® RTX

- <2.5 cm horizontal RMS accuracy.

- FieldPoint RTX

- accuracy of less than 10 centimeters

- RangePoint® RTX

- accurate to less than 50

- ViewPoint RTX

- Submeter Accuracy



MARSS – Survey Methods

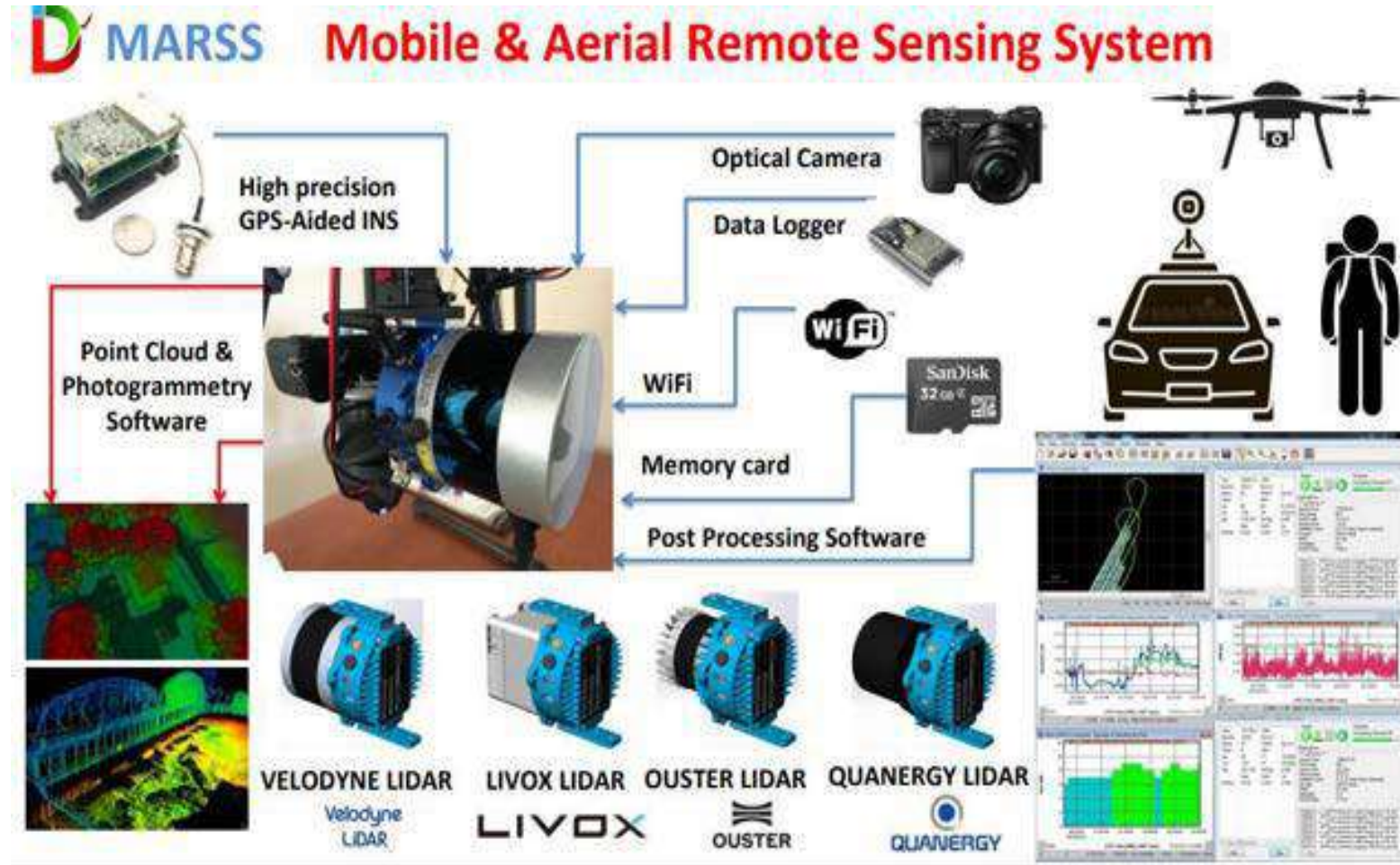
AERIAL VEHICLE MOUNT



GROUND VEHICLE MOUNT



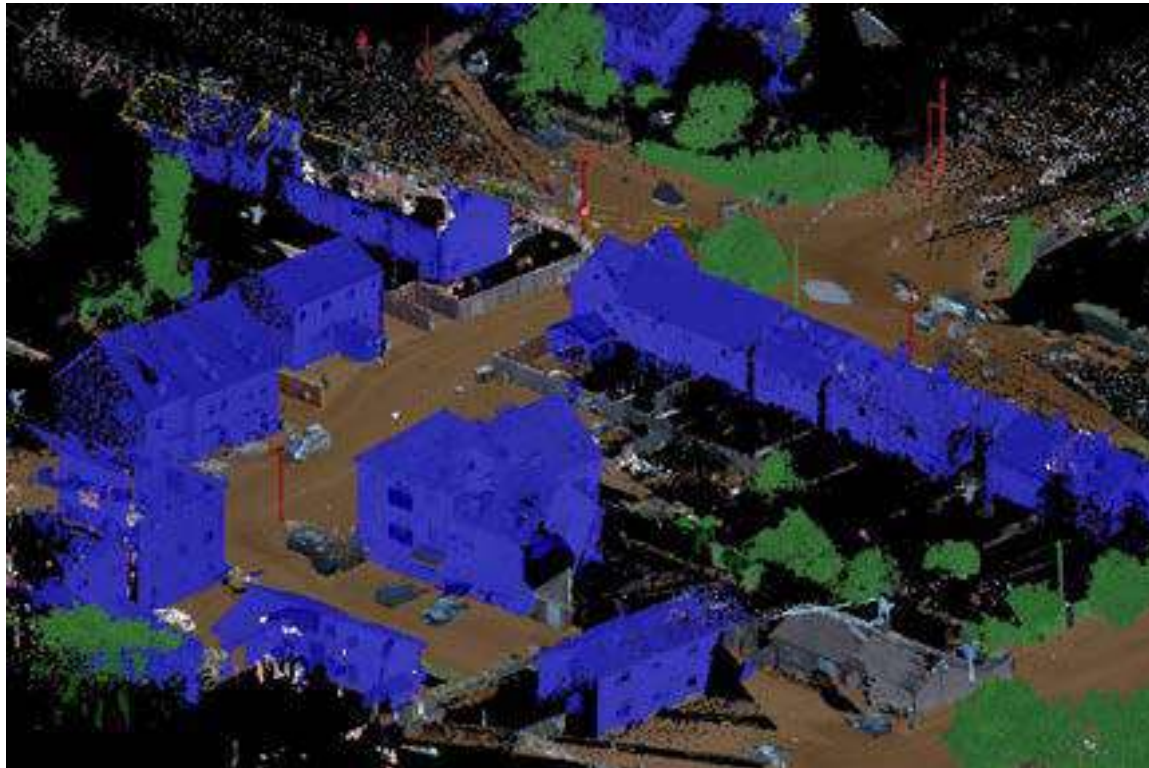
MARSS H/W- Components



PAN INDIA CONSULTANTS PVT. LTD.

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Classified Point Cloud Data- TBC



Buildings

Ground

High vegetation

Poles and signs

Power lines



PAN INDIA CONSULTANTS PVT. LTD.

A Trusted Name In Geo-Informatics

Supply & Training of UAVs under SVAMITVA SCHEME



Photogrammetry & LiDAR Technology For Mining Application



**TerraGeo
Technologies**

Mapping Solution For All

[www. terrageotechnologies.com](http://www.terrageotechnologies.com)

151, Sardarpara, Kaikhali, Kolkata, West Bengal – 7000 052
info@terrageotechnologies.com | +91 9830426829 | +91 9836786535



**TerraGeo
Technologies**
Mapping Solution For All

Remote Sensing

TerraGeo has built a reputation on the quality and precision of the work we've delivered. From the retrieval of satellite image data to the final image processing, we understand the need for impeccable accuracy, image quality and fast delivery.



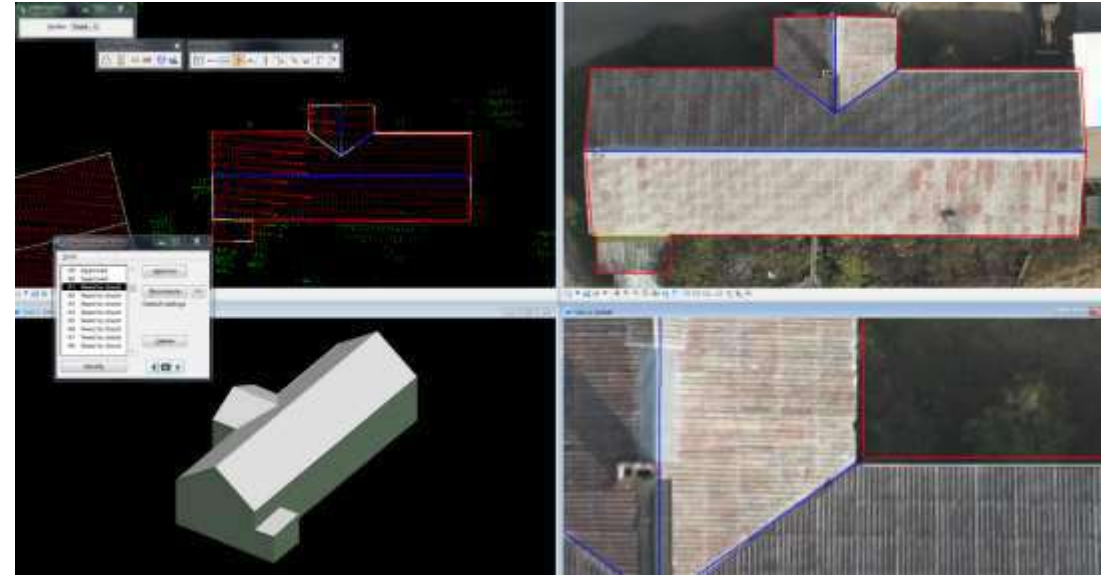
- ✓ Satellite imagery interpretation and classification
- ✓ Classification-supervised and unsupervised
- ✓ Change detection
- ✓ Slope aspect analysis
- ✓ Land cover classification and mapping
- ✓ Forestry mapping
- ✓ Agricultural mapping
- ✓ Mining and geology mapping
- ✓ Environmental impact assessment mapping
- ✓ Watershed management
- ✓ Wetland mapping
- ✓ High resolution image processing



Our Technology Domain

LiDAR

We have team of highly qualified Remote Sensing LiDAR professionals with experiences in different domains. The group has developed several processes and algorithm to automate the process of LiDAR data classification and analysis. Various tools have been developed to undertake stringent quality checks to provide world-class quality data.



- ✓ Powerline
- ✓ Bare-earth classification
- ✓ Forest Mapping
- ✓ Detailed Classification
- ✓ 3D modelling and Volumetric analysis
- ✓ Terrestrial Mobile LiDAR / Mobile Mapping
- ✓ Terrestrial Static LiDAR
- ✓ Ground and non-ground Classification.
- ✓ Advanced classification Building, Road, Vegetation etc.
- ✓ Ortho generation & contour generation using DEM.
- ✓ Feature Extraction.
- ✓ 3d Building modelling.



**TerraGeo
Technologies**

Mapping Solution For All

Our Technology Domain

Photogrammetry

TerraGeo produces clear, captivating simulated 3D digital terrain views of almost any location from high resolution stereo satellite imagery. We have the capability to produce the elevation data necessary to generate realistic and detailed perspectives for any of your project needs.



- ✓ Aerial Triangulation
- ✓ Height Model (DEM/DTM/DSM)
- ✓ Orthophoto Creation
- ✓ Stereo Digitization/Mapping
- ✓ UAV Data Processing
- ✓ Land Surveying
- ✓ Real Estate
- ✓ Sports
- ✓ Film and Entertainment
- ✓ Topographic Mapping
- ✓ DEM & DTM



**TerraGeo
Technologies**

Mapping Solution For All

Our Technology Domain

Geographic Information System (GIS)

Our company provides a wide range of GIS and mapping services along with the detailed knowledge of the field investigation which provides an advantage of accuracy and highest quality.

- ✓ Mapping
- ✓ Telecom and Network Services
- ✓ Accident Analysis and Hot Spot Analysis
- ✓ Urban planning
- ✓ Transportation Planning
- ✓ Environmental Impact Analysis
- ✓ Agricultural Applications
- ✓ Disaster Management and Mitigation
- ✓ Navigation
- ✓ Flood damage estimation
- ✓ Natural Resources Management
- ✓ Banking
- ✓ Taxation
- ✓ Surveying
- ✓ Geology



**TerraGeo
Technologies**

Mapping Solution For All

Our Principal



DAT/EM Systems International® develops products to efficiently extract and edit 3D terrain and object features from stereo imagery, point clouds and Unmanned Aircraft Systems (UAS) data. DAT/EM serves over 500 clients by building and maintaining quality systems, staying alert to industry trends and advances, and always leading by example with value, technology and service.

Based in Anchorage, Alaska, DAT/EM has been developing digital mapping and photogrammetric software and hardware since 1987. DAT/EM serves photogrammetric firms, engineering companies, and government and non-government agencies in more than 70 countries worldwide. DAT/EM also provides technical universities throughout the world with software tools to offer students a current and employable skill-set.



Our Principal (DAT/EM)



Summit Evolution provides a set of powerful tools for discovering and capturing 3D information from stereo data. The software includes CAD and GIS interfaces, 3D stereo vector superimposition, automated feature editing, contour generation and many more tools. Through the Capture™ interface for enabled Summit products, image features from a Summit Evolution project are digitized directly into AutoCAD®, MicroStation®, ArcGIS® or Global Mapper®. With DAT/EM Superimposition™, those image features are overlaid on the Summit Evolution project for immediate feature verification.



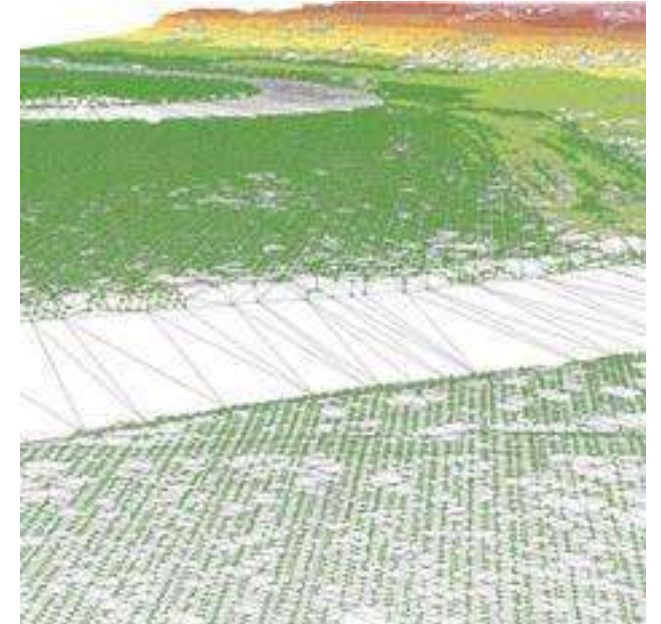
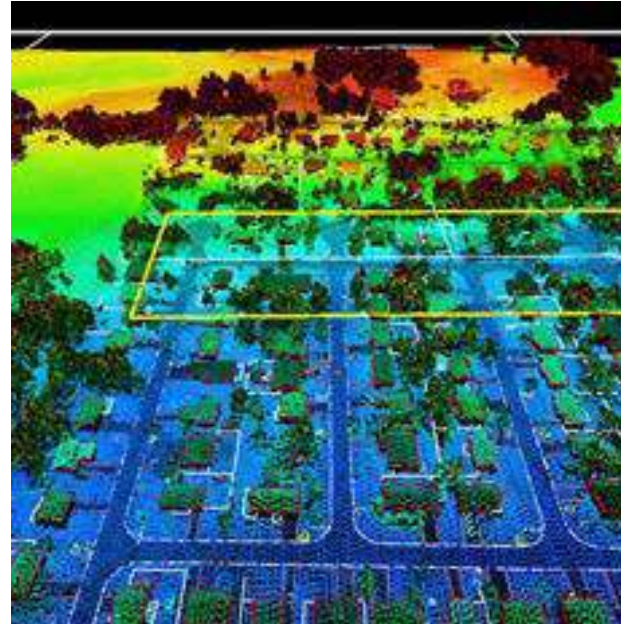
**TerraGeo
Technologies**

Mapping Solution For All

Our Principal (DAT/EM)



View and edit 3-dimensional point clouds using LandScape from DAT/EM Systems International to provide an advanced and efficient portal into one's terrain dataset. LandScape is capable of operating on very large terrain point clouds such as from LiDAR or SfM. The operator may choose options to view terrain datasets in stereo within LandScape in standalone mode or interacting with and superimposed over a Summit Evolution imagery project. LandScape contains a wide variety of automatic and interactive tools to enhance understanding of one's data by creating, modifying and classifying points as well as drawing vectors based on those points.



**TerraGeo
Technologies**

Mapping Solution For All

Our Principal (DAT/EM)



As a UAS post-processing toolkit, Summit UAS gives users control over their data. Summit UAS consists of two powerful applications, Summit Evolution Lite and LandScape, which among their many features offer ways to further explore and edit the point cloud and orthomosaic created by UAS processing software. The two products can be used separately to visualize and alter data or together to superimpose a point cloud onto stereo or orthomosaic imagery for targeted digitizing and editing tasks. Summit UAS is the right choice to explore and analyze your UAS data in 3D stereo and capture that understanding as fully-georeferenced 3D points and vectors.



**TerraGeo
Technologies**
Mapping Solution For All

Our Principal



Terrasolid is the industry standard software for point clouds and images processing, developed specifically for the demanding requirements of geospatial, engineering, operations and environmental professionals.

Our software suite provides versatile and capable tools to create 3D vector models, feature extractions, orthophotos, terrain representations, advanced point cloud visualizations, etc., no matter the data source, no matter the sensor. The finest tools for calibration and matching of point clouds for LiDAR data are included.

Terrasolid 30+ years industry experience and more than 20 years in LiDAR business ensures that you have access to reliable and versatile software products that can solve problems extensively, both in different application areas and with different types of data.

Our Principal (Terrasolid)



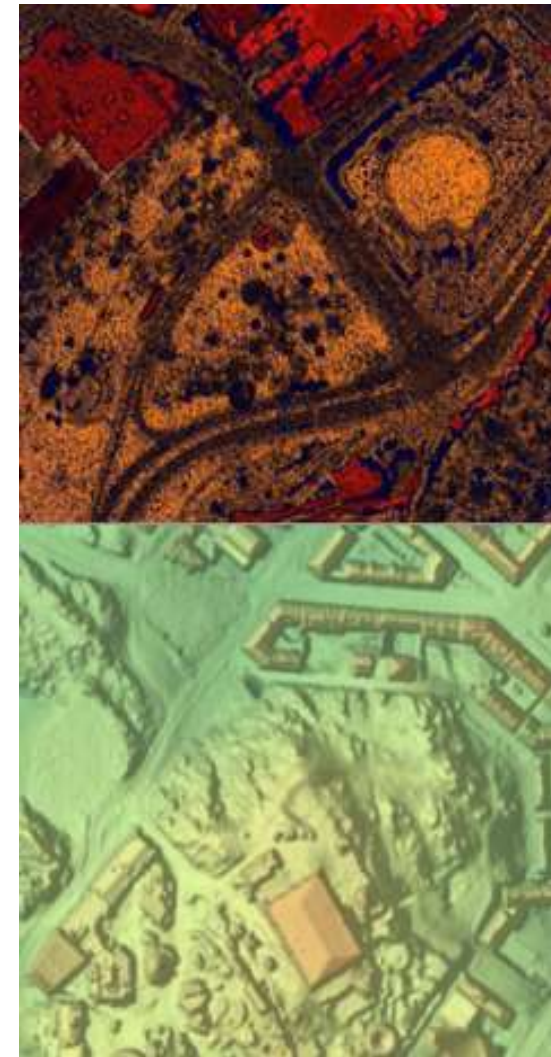
TerraScan

TerraScan is the main application in the Terrasolid Software family for managing and processing all types of point clouds. It offers import and project structuring tools for handling the massive number of points of a laser scanning campaign as well as the corresponding trajectory information. Various classification routines enable the automatic filtering of the point cloud.



TerraModeler

With TerraModeler you can create, edit, and utilize surface models. TerraModeler creates surface models (TINs) from various sources, such as LiDAR points stored in binary files or loaded in TerraScan, XYZ ascii files and graphical design elements. The software offers versatile visualization options including colored shaded surfaces, contour lines, grids, colored triangle nets, elevation texts, slope directions and textured surfaces (in combination with TerraPhoto).



**TerraGeo
Technologies**

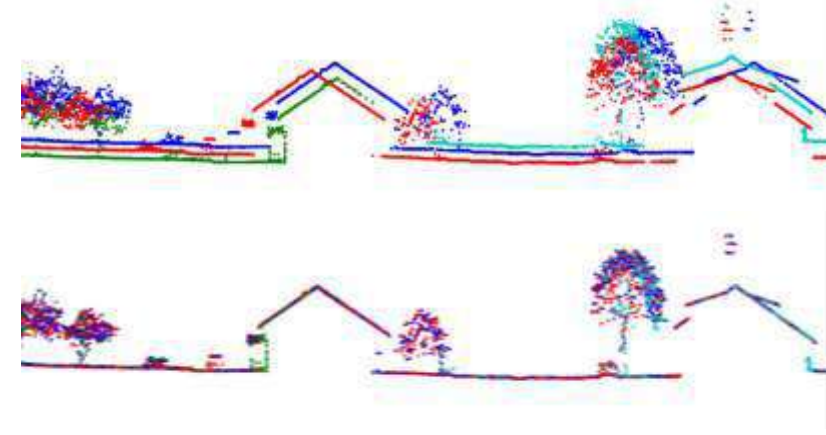
Mapping Solution For All

Our Principal (Terrasolid)



TerraMatch

TerraMatch is a sophisticated tool for improving the accuracy and quality of the raw laser point cloud. It compares laser data from overlapping flight or drive paths and calculates correction values for the misalignment angles as well as xyz location errors.



TerraPhoto

TerraPhoto is specifically developed for processing images captured together with laser data during a survey mission. The software enables the production of rectified images and ortho mosaics based on ground model that has been extracted from the laser data.



**TerraGeo
Technologies**

Mapping Solution For All

Our Principal (Terrasolid)



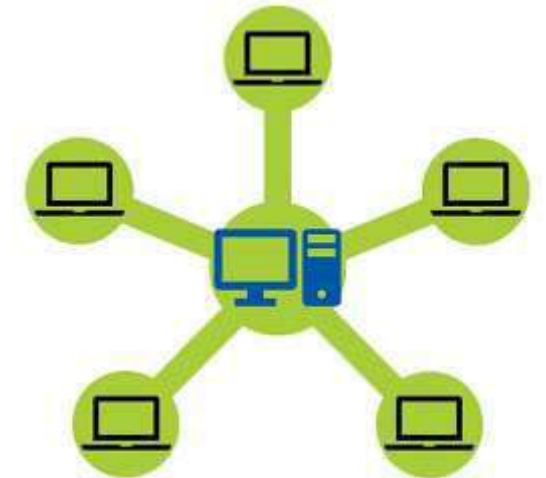
TerraStereo

TerraStereo is a stand-alone application for visualizing very large point clouds. It uses high-performance graphics boards for rendering huge amounts of points fast and in high quality. Visualize up to 50 billion points, view laser data in stereo mode and create stereo screen captures and animations.



TerraSlave

Processing massive amounts of laser points and images can be a real challenge to a single PC. With TerraSlave you can distribute time- and resource-consuming tasks such as TerraScan macro execution to several PCs over a LAN and thus, free your own workstation for other processing steps

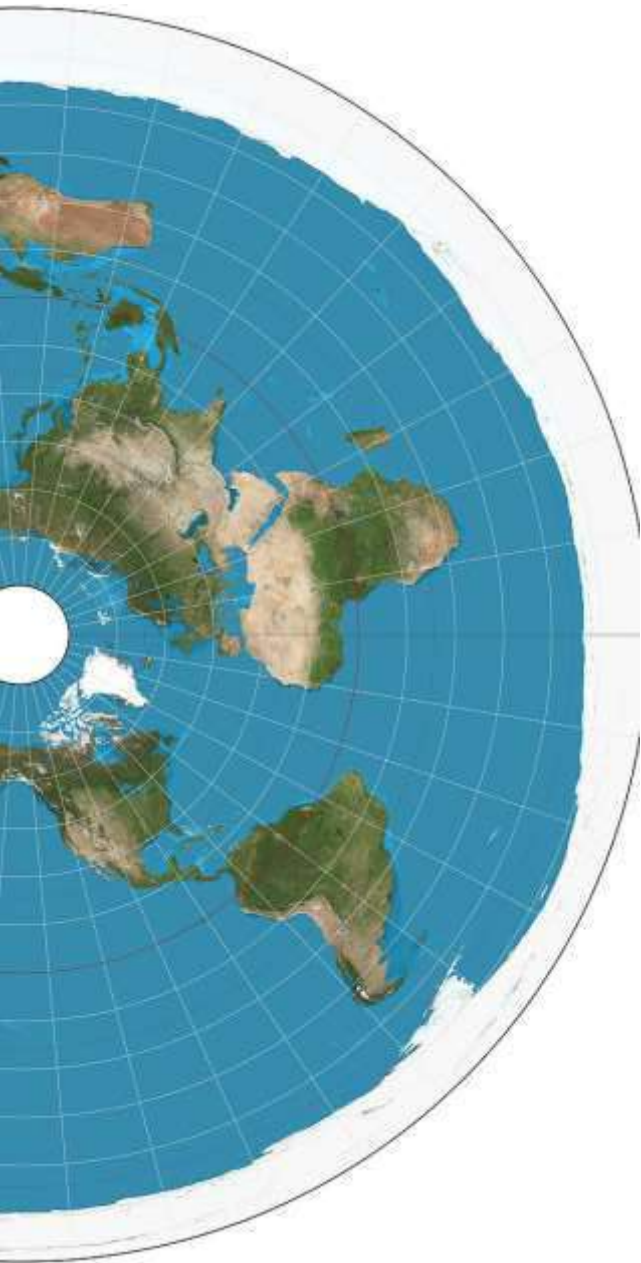


**TerraGeo
Technologies**
Mapping Solution For All

Handle huge volumes of input data

- Easily work with high volume of input point cloud data from *TLS/ALS/MLS/UAS* platforms.
- Create *Indexed Grid project* tiles for easy & seamless continuation of workflow.
- Successfully tested with *Riegl TLS VZ* series 3D Laser scanner data & *DJI Phantom 4A Pro* UAS data.
- Supports *LAS/LAZ/FBI/ENZ/Text* formats.





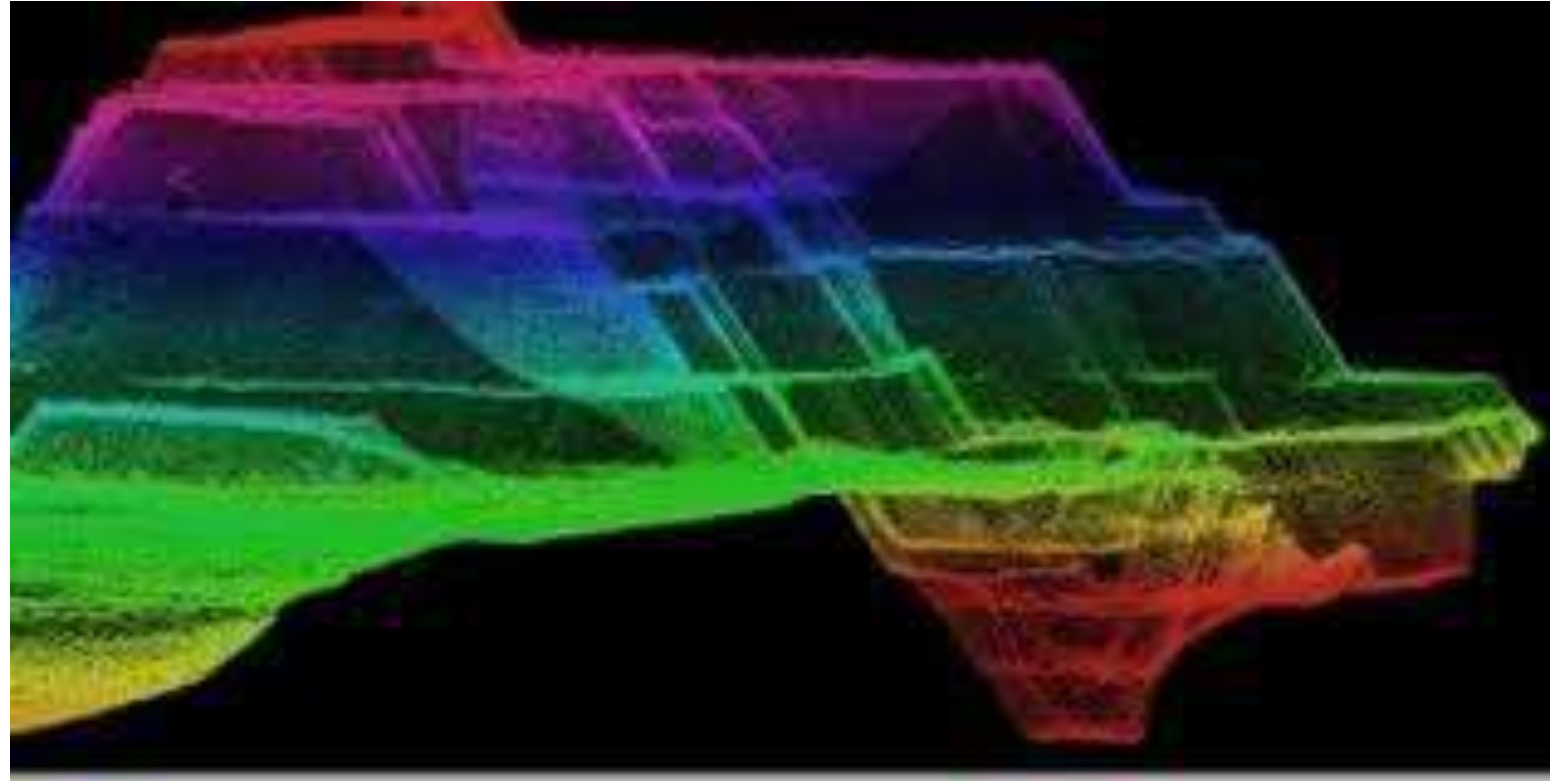
Use Custom Projection System Parameters

- Define customised *Coal-Grid projection* parameters.
- Easily define *Projection Transformation parameters* for laser data & image data.
- Enhance vertical & horizontal accuracy in point clouds & stereo image data using *External Ground Control Points*.



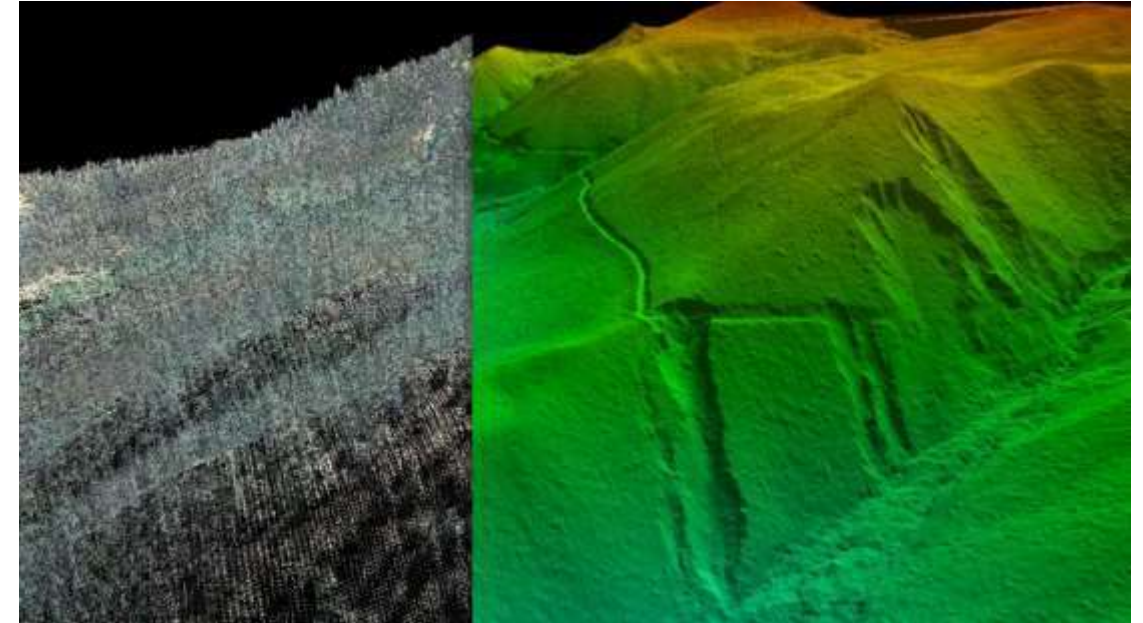
Accurately measure active mining area

- Precisely clean data noises caused by surface penetrated & scattered laser.
- Automatic classification routine generate accurate ground model.
- Generate Ground model with very high Vertical depth & Horizontal distance accuracy.



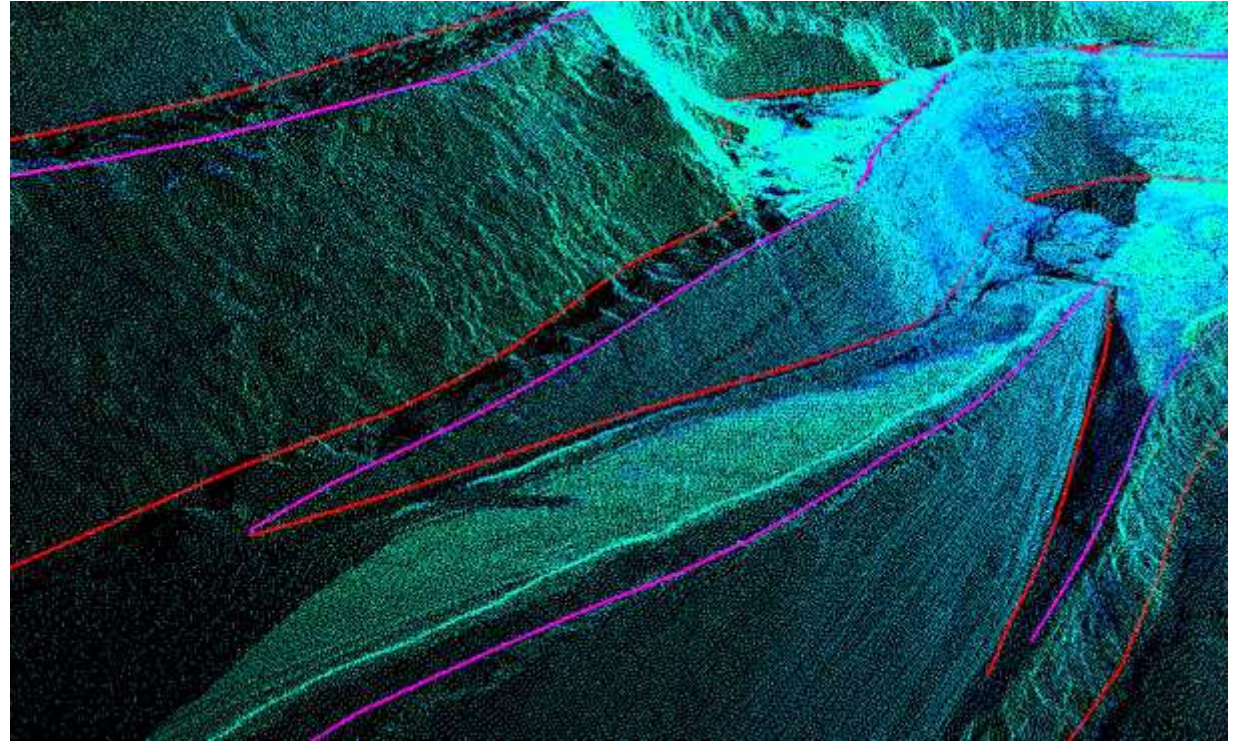
Data Cleaning & Classification

- Classify High / Mid/ Low Vegetation levels using calculated distances from ground for virgin mining lands.
- Easily map vegetation canopy to understand vegetation cut count.
- Clean off-ground objects and create smooth surface



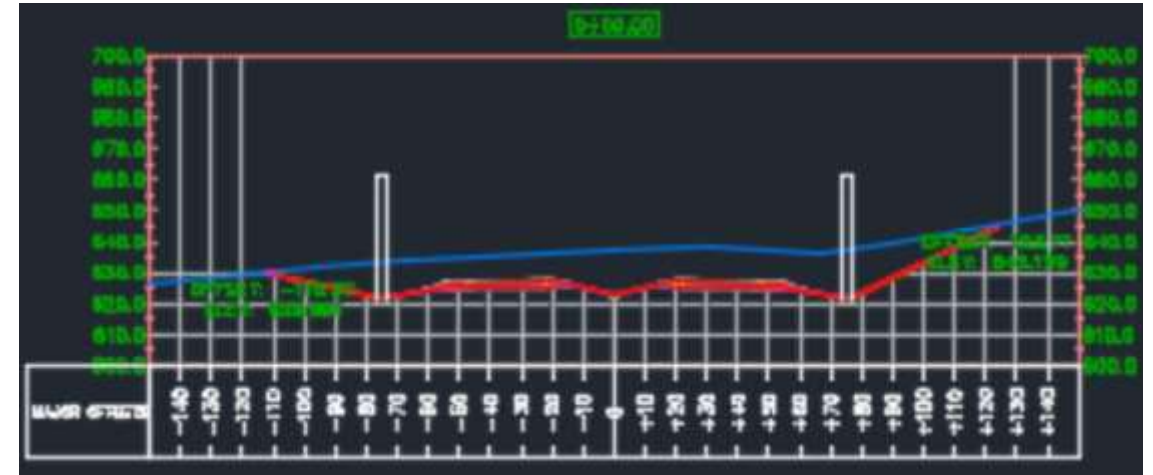
Automatic and Manually Bench Line (Toe and Crest) Creation

- Automatic tools for bench line creation.
- Export output as AutoCAD format with elevation information.



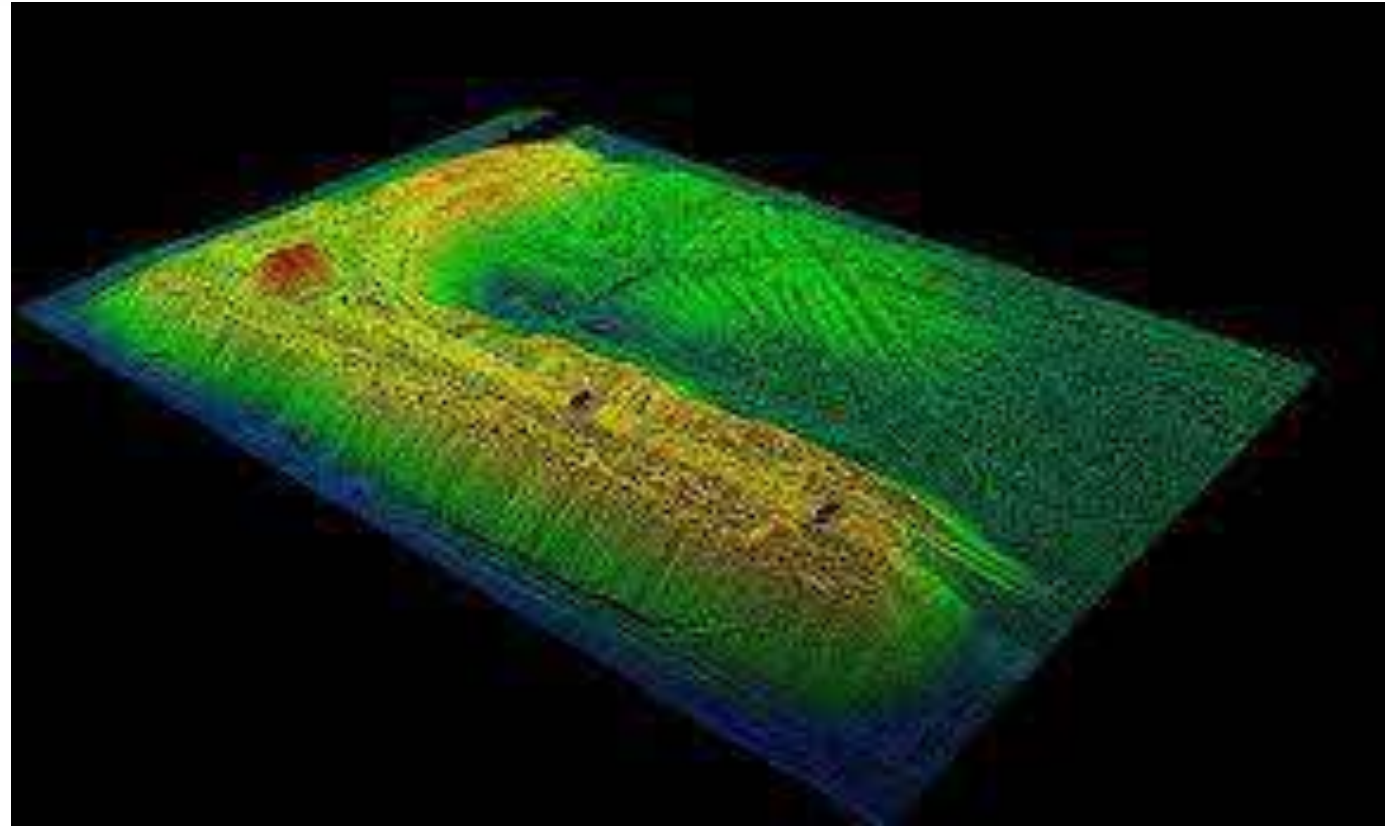
Profile, Cross Section & Plan Map

- Generate Profile and Cross section with user define baseline and interval.
- Create plan map with user define grid interpolation.
- Export in AutoCAD format



Calculate Volume of Mining or Pit Area

- Accurately compute Quantity & calculate Volume between two surfaces.
- By comparing surface models captured at different points of time, materials volume can be easily monitored and documented.



Thank you

for your attention...



**TerraGeo
Technologies**
Mapping Solution For All

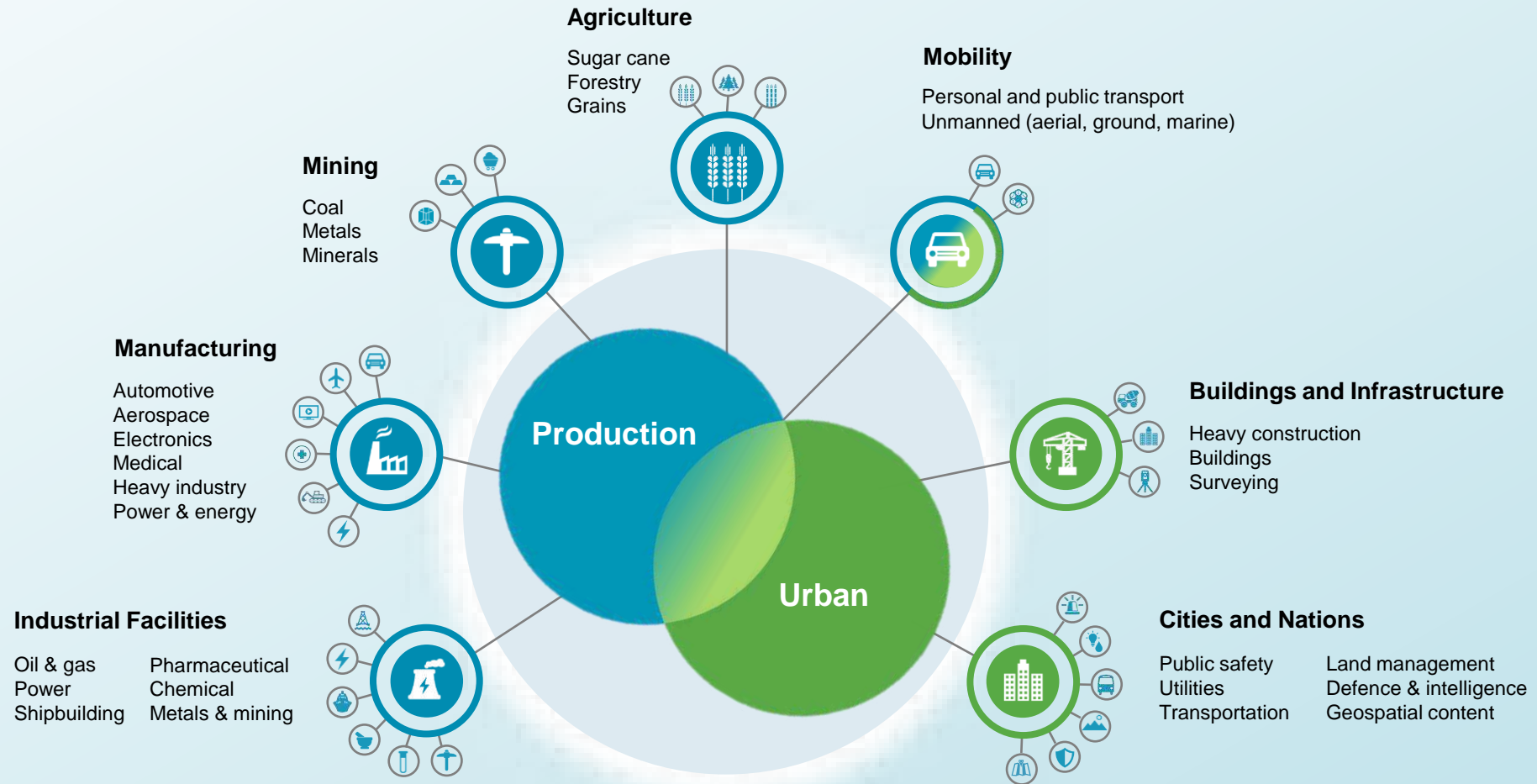


Geospatial Mining Solutions

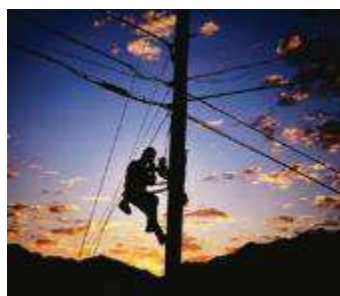


Customers served

Ecosystems vs. markets



Geospatial Data Value chain



Capture

Geospatial



Process



Share



Deliver

Hexagon Geospatial Power Portfolio

POWER PORTFOLIO



M.APP PORTFOLIO



HEXAGON GEOSPATIAL LUCIAD PORTFOLIO



Desktop

LuciadLightspeed



Browser

LuciadRIA



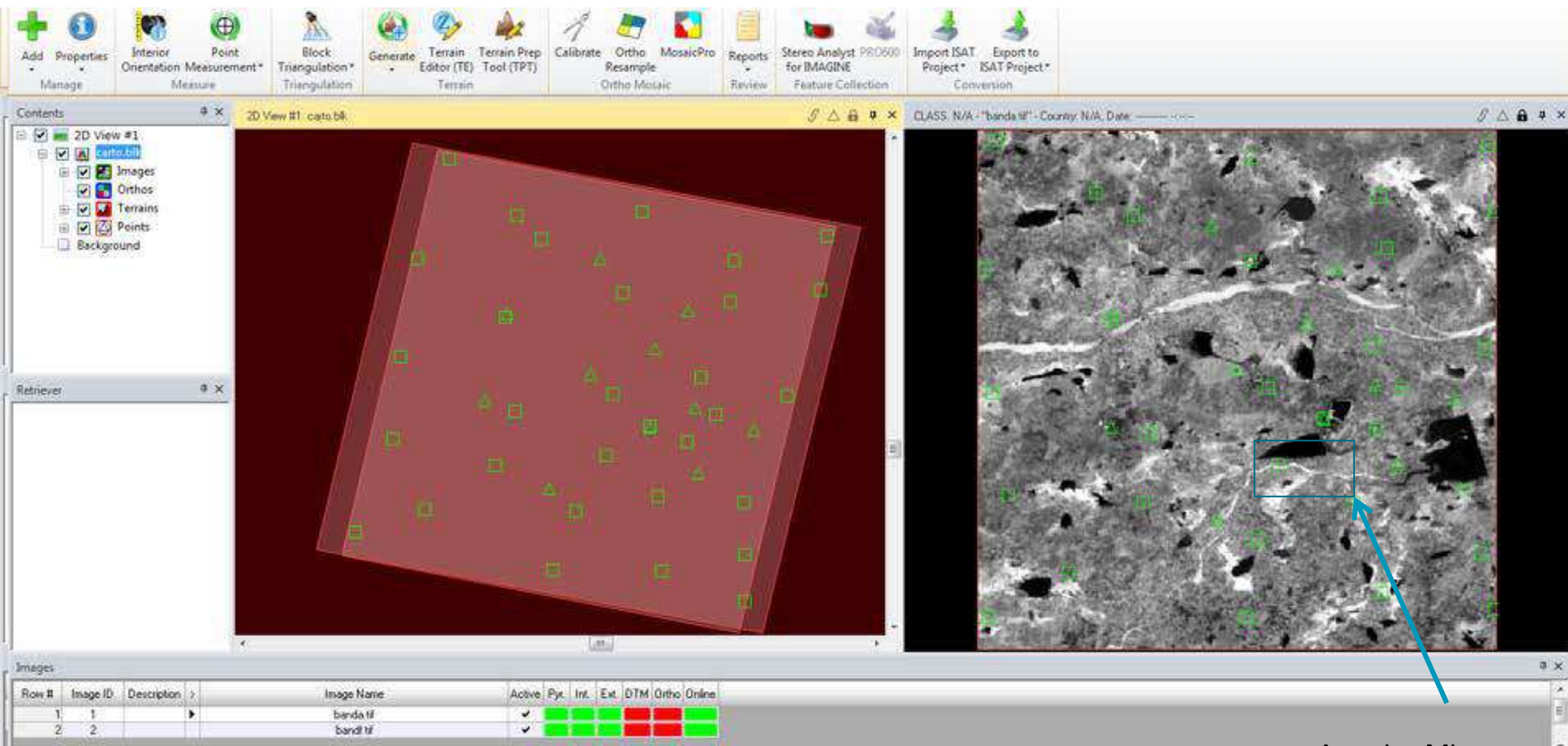
Mobile

LuciadMobile

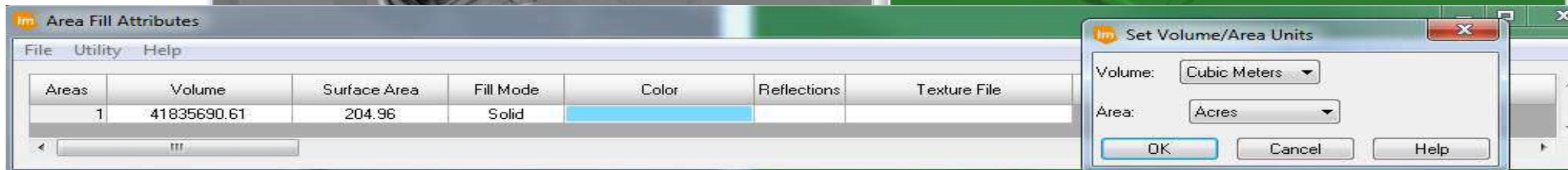
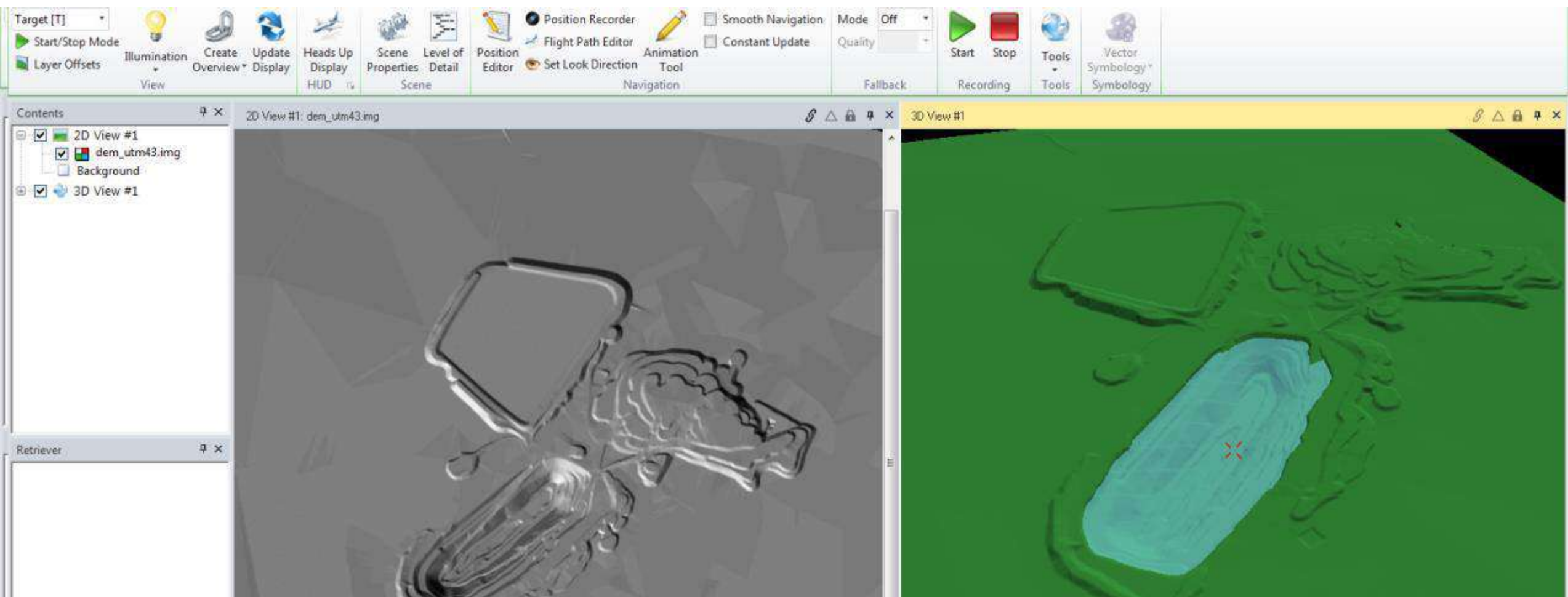


Server

LuciadFusion



Agucha Mines



Change Analysis in Mining area

Oct 2006, cartosat

Agucha Mines

3000 acres

Mining Boundary

32 Acres





Nov 2013, cartosat

Agucha Mines

Mining Boundary

25Acres

42 Acres

23 Acres

Mar 2015, Worldview

Agucha Mines

Mining Boundary

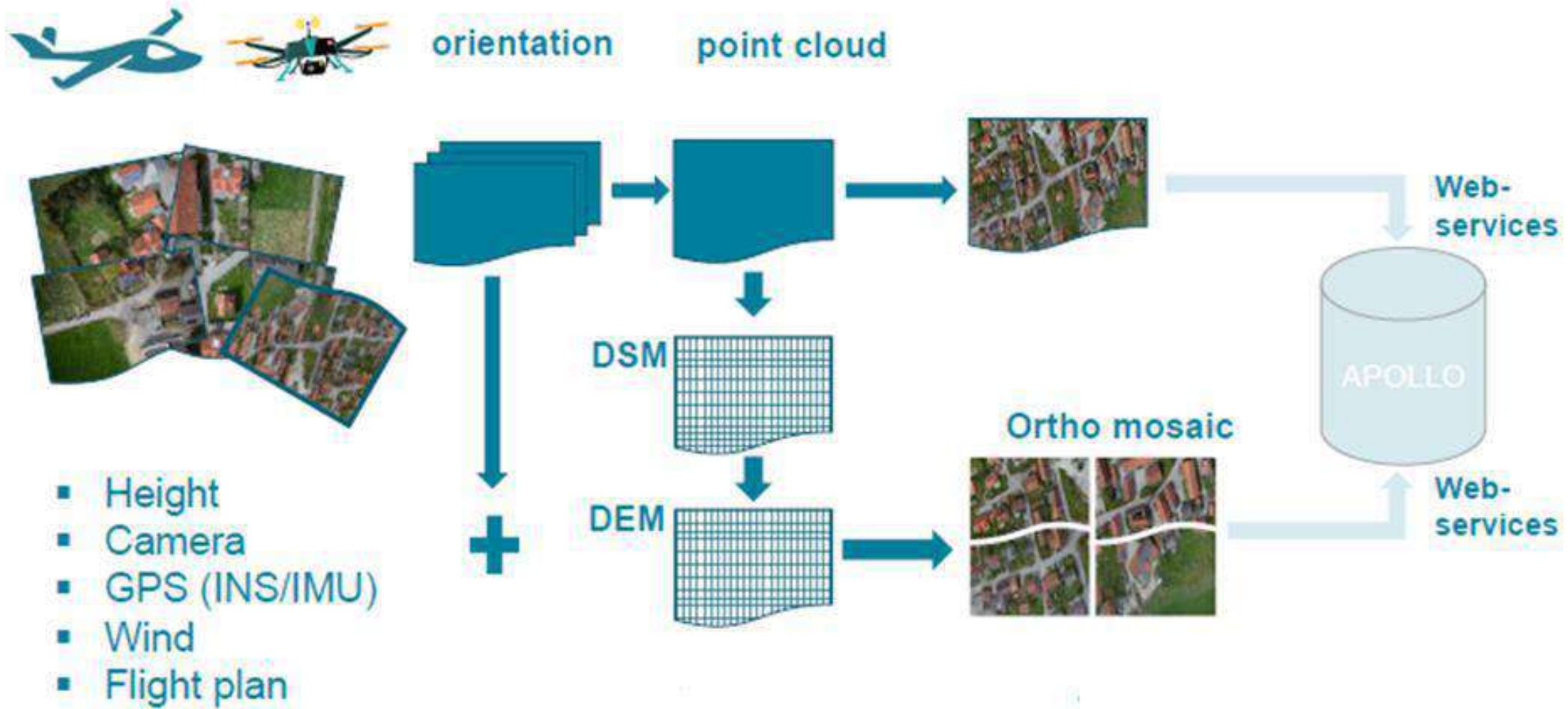
25 Acres

42 Acres

23 Acres

IMAGINE UAV

POWER Portfolio
**Producer
Suite**



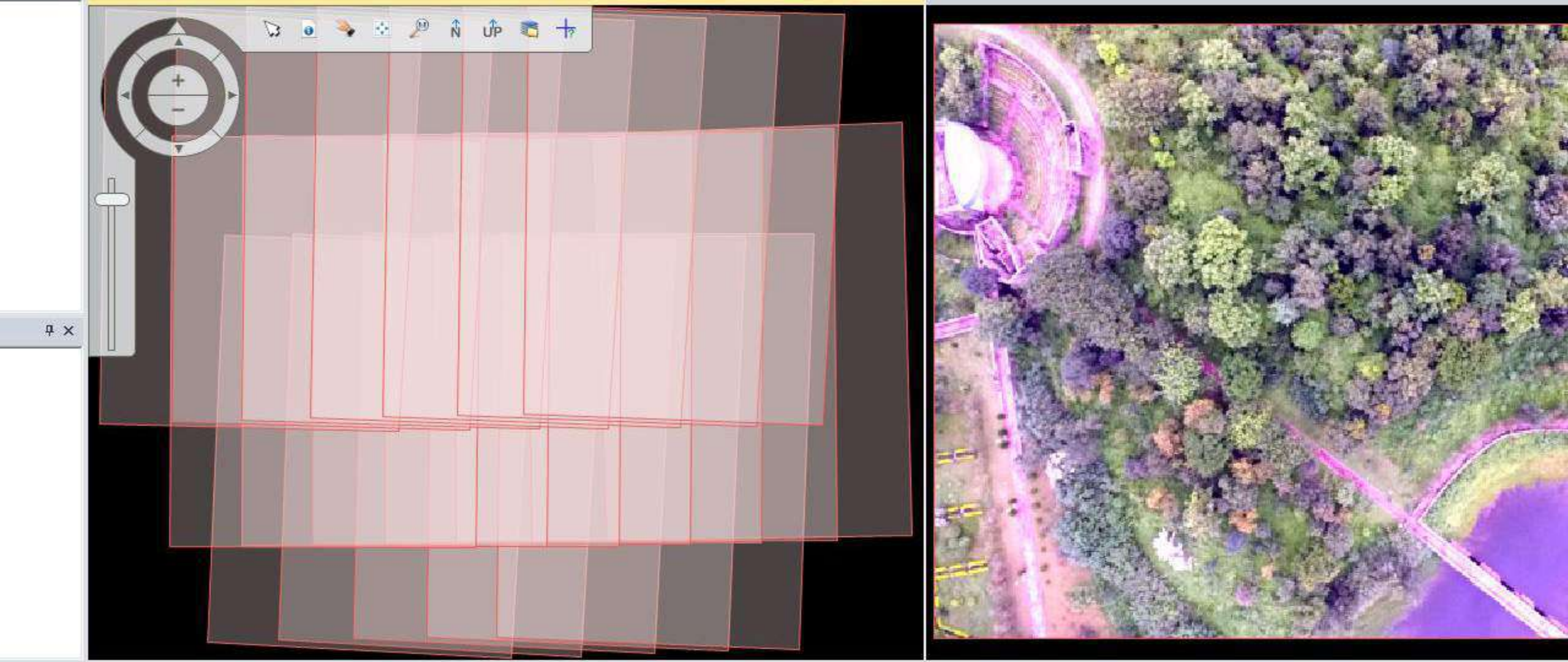
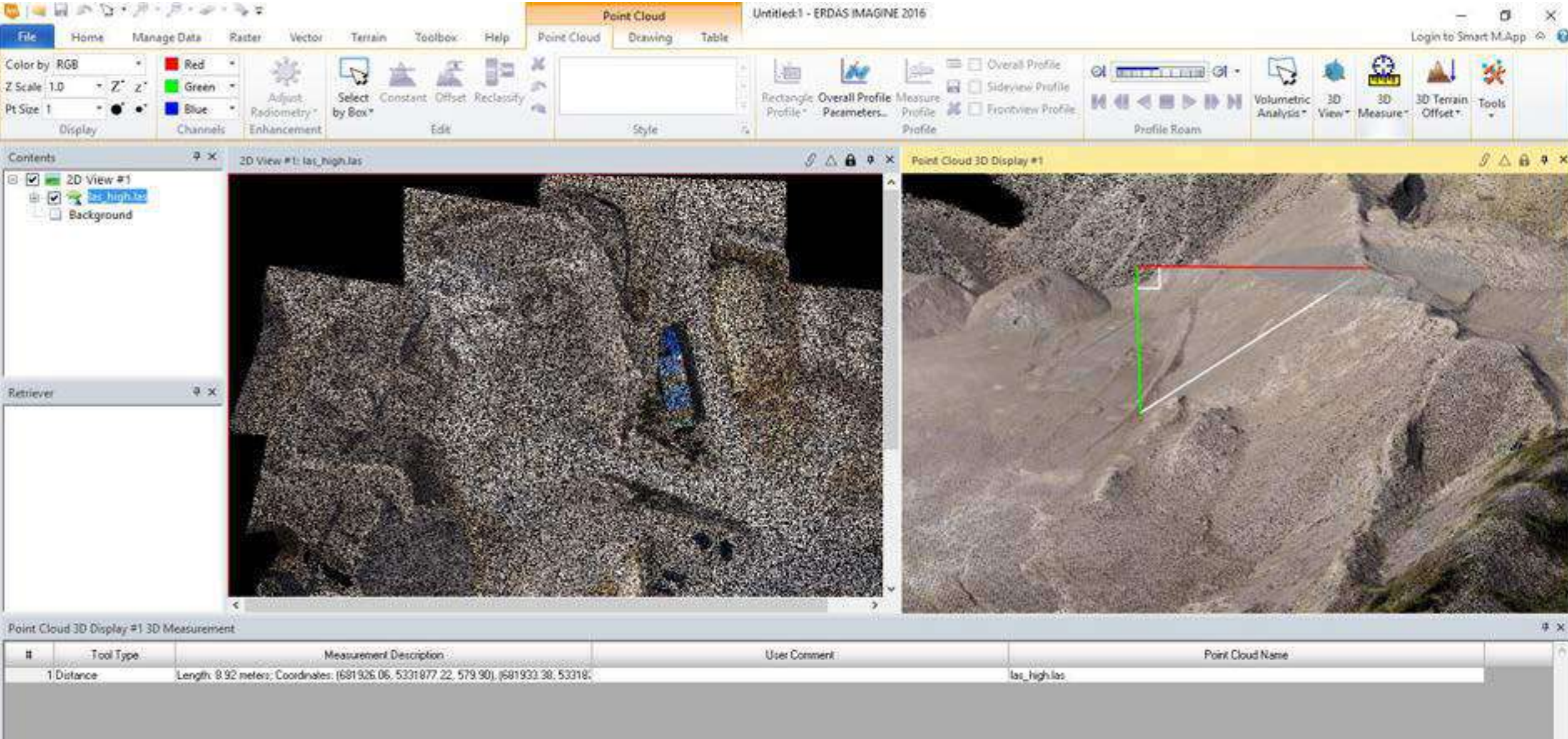
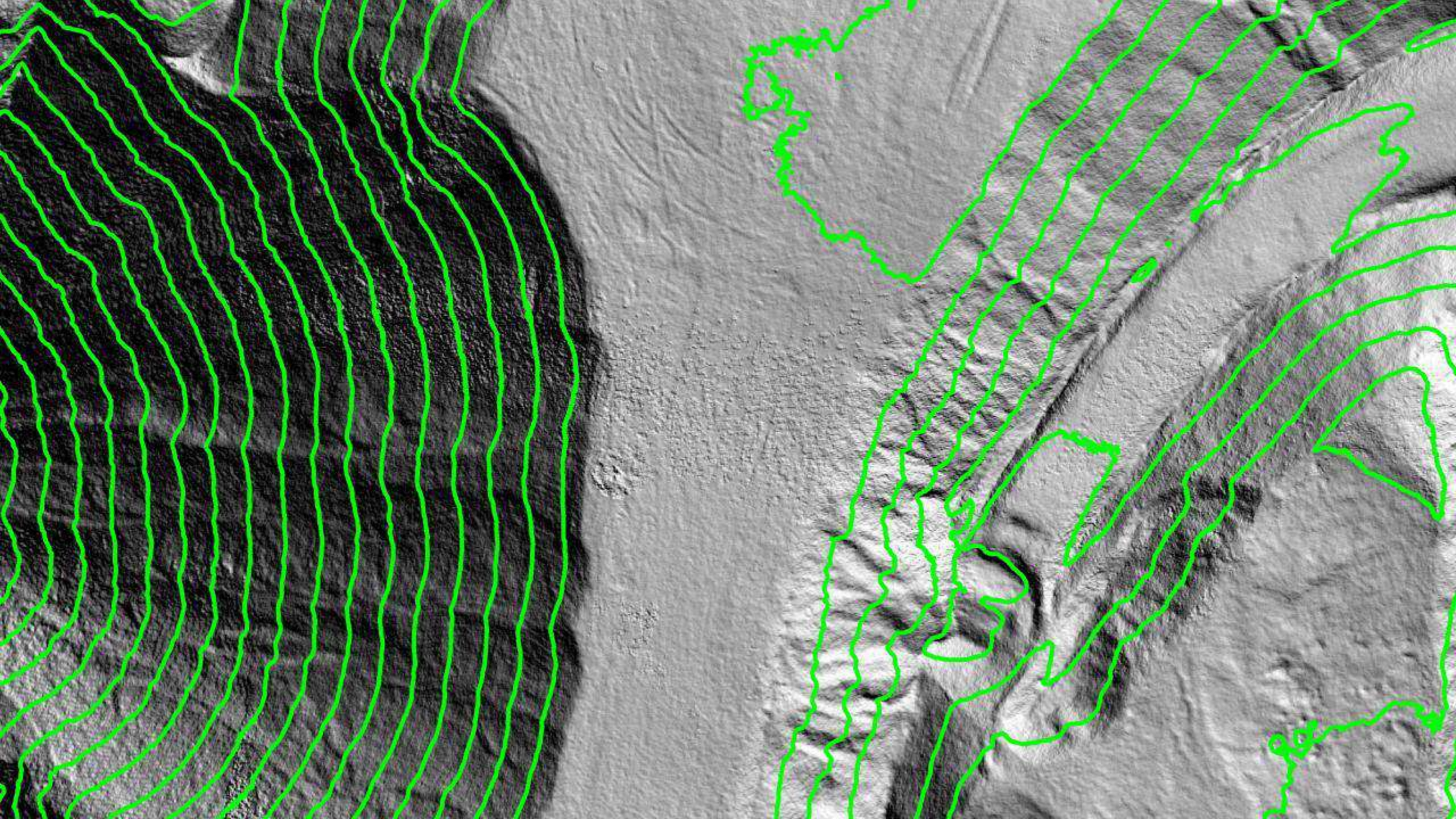


Image Name	Active	Pyr.	Int.	Ext.	DTM	Ortho	Online
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c:/soi_estate/DJI_0119.JPG	✓						
c:/soi_estate/DJI_0120.JPG	✓						



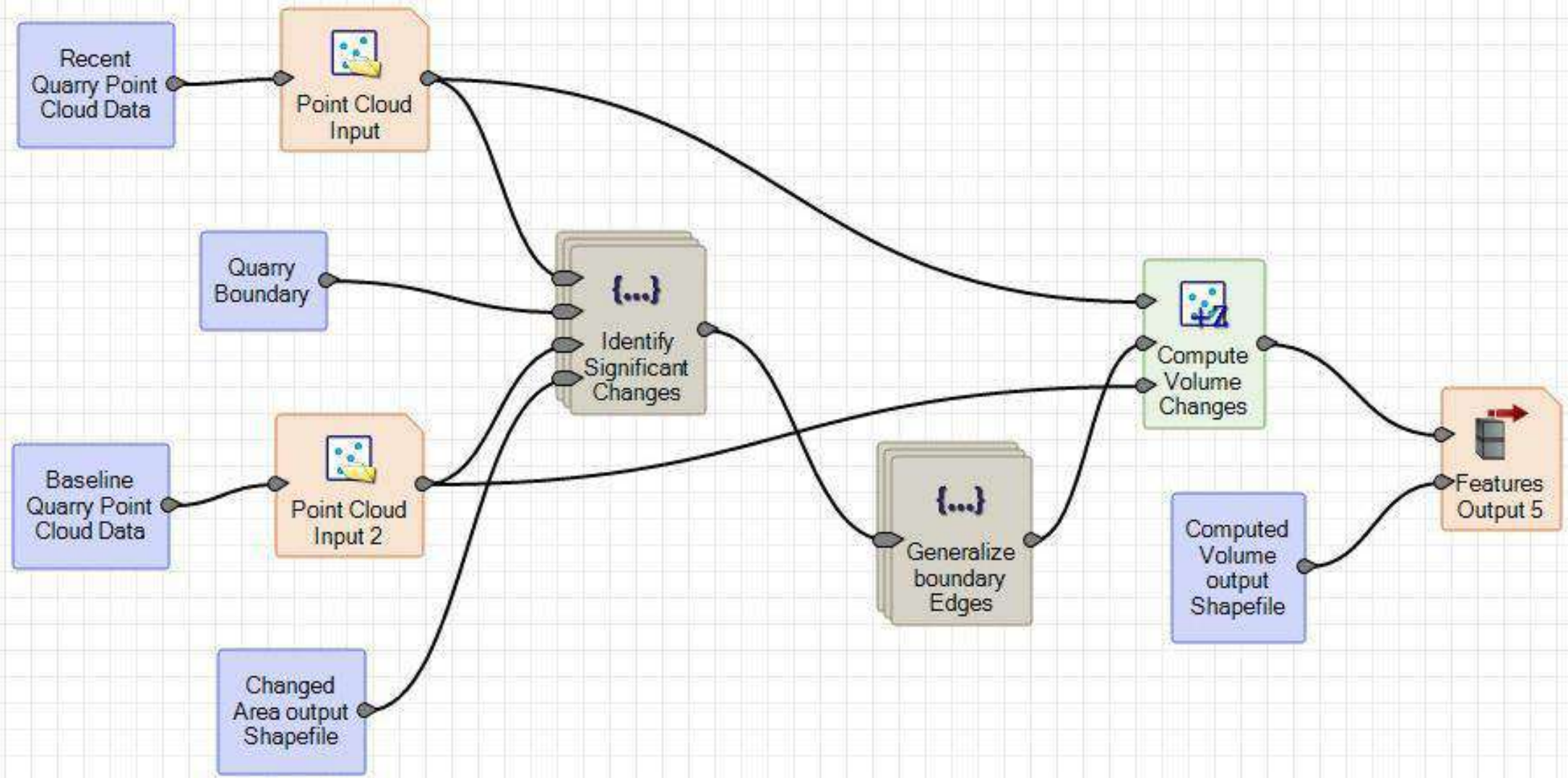


3D Visualization

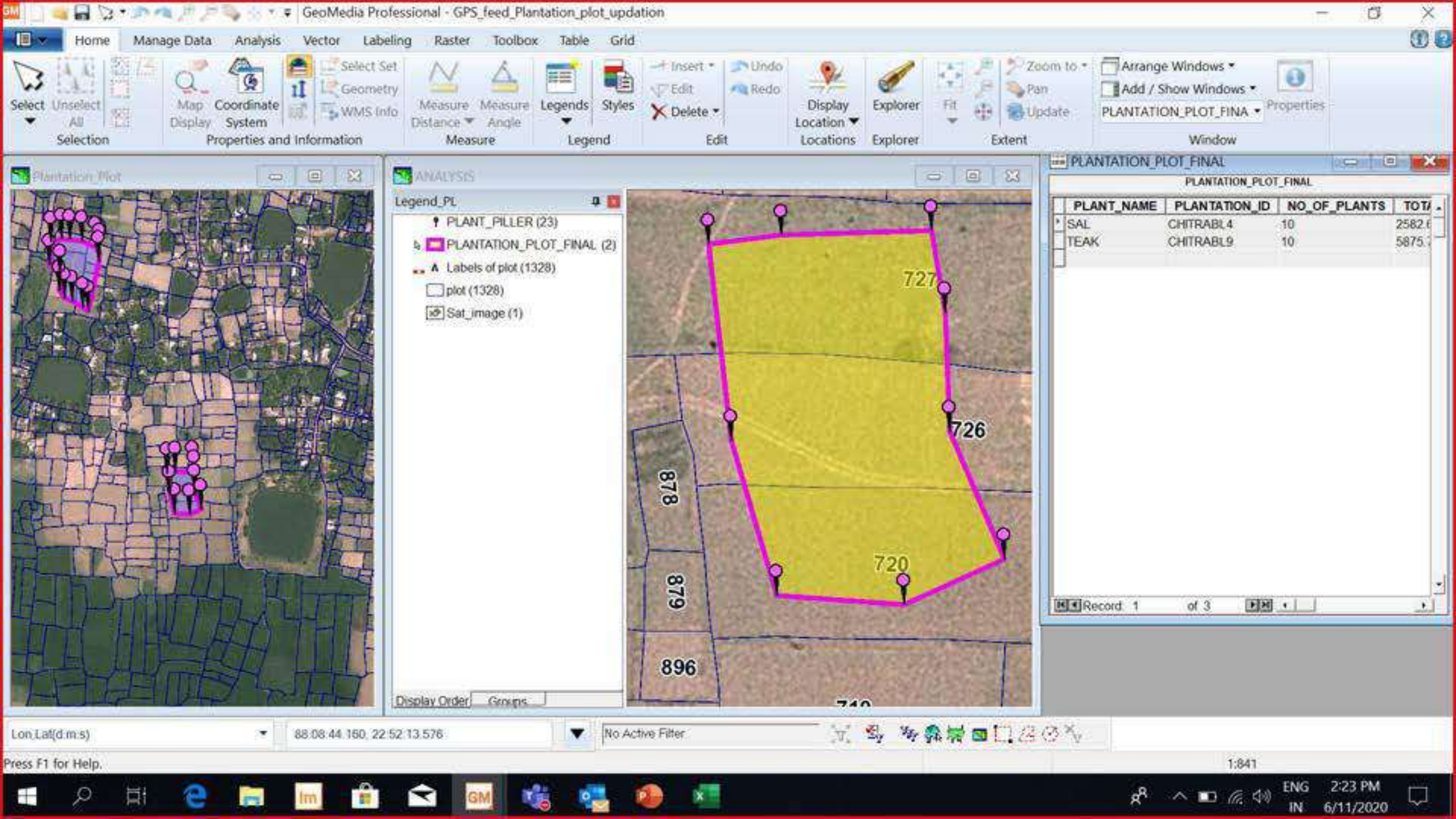
powerful yet easy-to-use visual analysis tool that offers GIS functions and capabilities in a 3D environment. Beyond simple 3D renderings and basic fly-throughs, VirtualGIS enables you to create realistic 3D interpretations of your projects for interactive presentations.



Volume change using two point cloud from UAVs

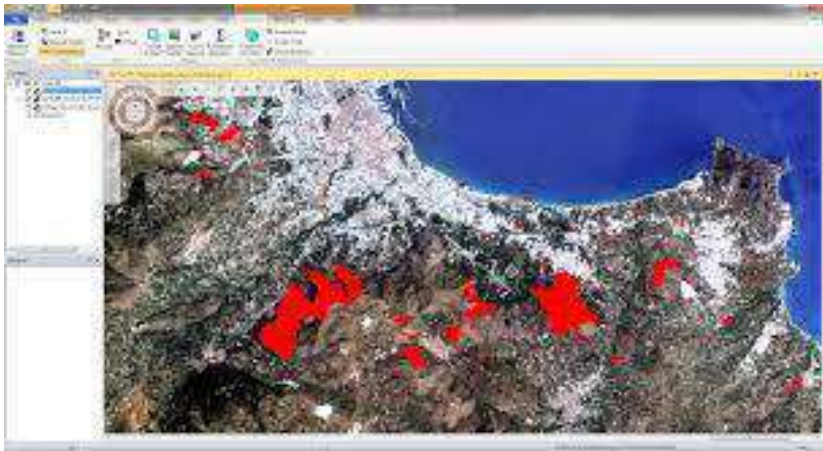


	A	B	C	D	E	F	G	H	I	J	K
	PILLER_ID	Plantation_ID	EASTING	NORTHING	PLANT_NAM	NO_OF_PLANTS					
1											
2	1	CHITRABL4	617372.7103	2529757.241	SAL	10					
3	2	CHITRABL4	617364.5851	2529784.866	SAL	10					
4	3	CHITRABL4	617360.5225	2529819.805	SAL	10					
5	4	CHITRABL4	617373.5228	2529821.43	SAL	10					
6	5	CHITRABL4	617400.3361	2529822.243	SAL	10					
7	6	CHITRABL4	617402.7737	2529807.617	SAL	10					
8	7	CHITRABL4	617403.5862	2529786.492	SAL	10					
9	8	CHITRABL4	617413.3365	2529763.741	SAL	10					
10	9	CHITRABL4	617395.461	2529755.616	SAL	10					
11	10	CHITRABL9	617238.644	2530070.875	TEAK	10					
12	11	CHITRABL9	617230.5188	2530075.75	TEAK	10					
13	12	CHITRABL9	617213.4558	2530085.5	TEAK	10					
14	13	CHITRABL9	617202.0805	2530090.375	TEAK	10					
15	14	CHITRABL9	617193.9553	2530101.75	TEAK	10					
16	15	CHITRABL9	617195.5803	2530126.126	TEAK	10					
17	16	CHITRABL9	617178.5173	2530142.377	TEAK	10					
18	17	CHITRABL9	617180.9549	2530177.315	TEAK	10					
19	18	CHITRABL9	617197.2054	2530182.19	TEAK	10					
20	19	CHITRABL9	617210.2057	2530180.565	TEAK	10					
21	20	CHITRABL9	617228.8938	2530178.128	TEAK	10					
22	21	CHITRABL9	617250.0194	2530169.19	TEAK	10					
23	22	CHITRABL9	617256.5195	2530158.627	TEAK	10					
24	23	CHITRABL9	617254.8945	2530147.252	TEAK	10					
25											
26											





Post Disaster assessment of damage using Satellite imagery and drone data



burned area mapping and change detection with free satellite imagery

IMAGINE Fire Mapper a new software tool, designed specifically for burned areas mapping and change detection, can help users to perform these activities automatically.



UAV Video Draping and Realtime analysis



Network Alert – space-based pipeline monitoring subsidence & land slides.

Predictive Maintenance

- Smart Infrastructures
- Internet of Everything
- Continuous Surveillance from Space



Subsidence for Pipeline / Utilities
Rheticus® Network Alert



Risk-mitigation intelligence
Rheticus® Safeland



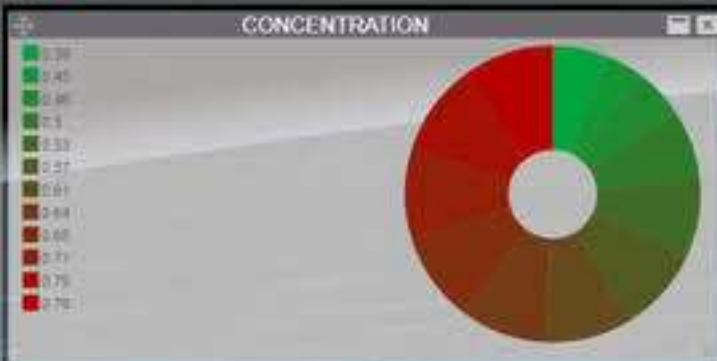
Blowout with plume analysis



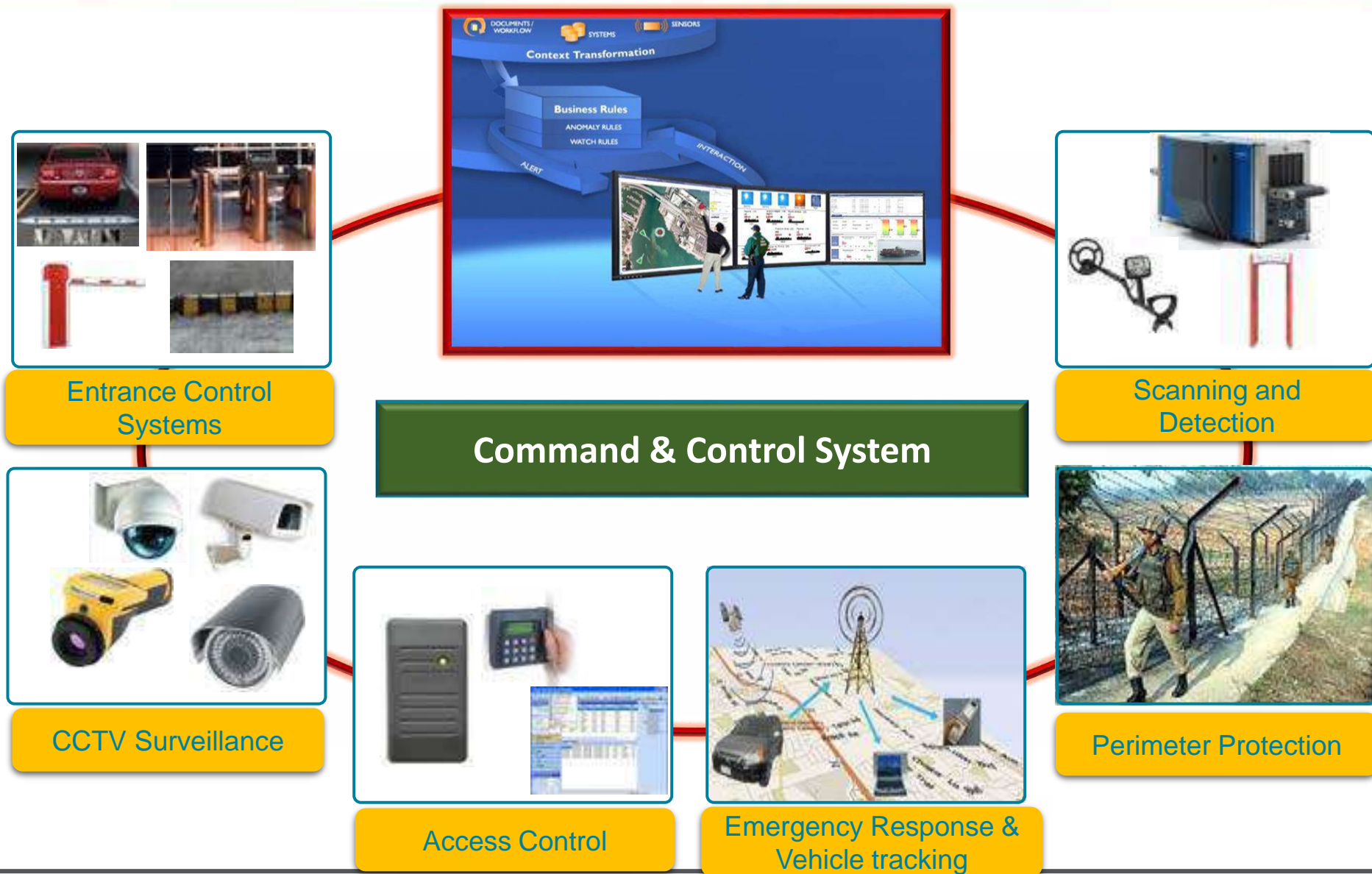
All risks heat mapping



EXAMPLE OF PLUME DISPERSION MODEL (3 DAY SPAN)



Security Systems for CIP



Emergency Operations Centre.

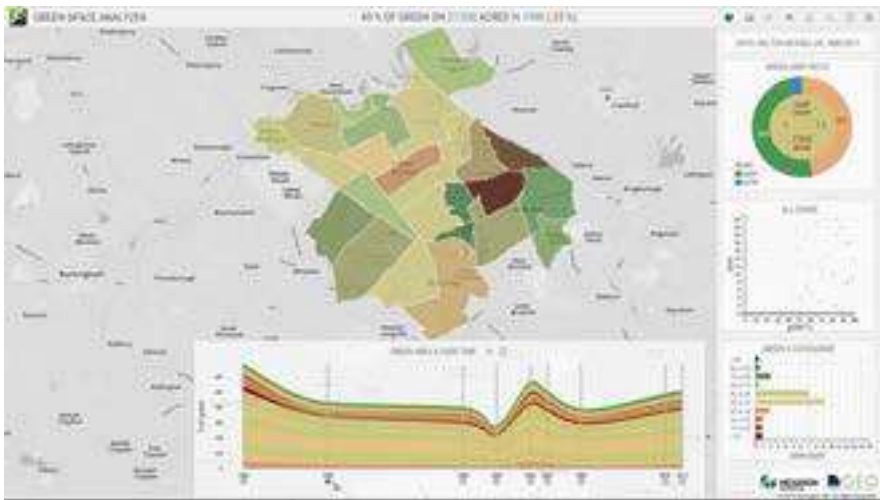


This display is fed via networking of different systems such as SmartGrid, sensor grid, traffic management, public safety, security, transportation and hospitals. The result is a total picture of conditions in the area so that appropriate decisions can be made to deal with issues.

Proven Technology World Wide



Geo-enabled dashboards



CARLSON TECHNOLOGIES TO MEET FUTURE MINING CHALLENGES

PRESENTED BY
MOHAMMAD AZAD
SHOTAM INSTRUMENTS
PVT LTD



CARLSON SCAN2K

TERRESTRIAL LASER SCANNER

The Carlson Scan2K bridges the gap between small, light-weight, short-range sensors and large, long-range, pulsed time-of-flight scanners. Built with surveyors in mind, the Carlson Scan2K has a user-friendly on-board operator interface with menu-driven operations for quickly collecting and referencing data.

Whether on a **tripod**, **vehicle**, or **moving platform**, the outstanding performance of the Scan2K makes it the most versatile terrestrial laser scanner on the market.

Application of Scan2K

- Mine optimization
- Stockpile volume calculation
- Tunnel & Underground mine mapping & convergence analysis
- Vertical field of view allows the Scan2K to conduct high-wall scans, high-wall monitoring, general pit scanning



SPECIFICATIONS

Scanning range (Max range capability @90% reflectivity)	2000m
Short (Min range capability @90% reflectivity)	250m
Data collection rates up to	500,000 points per second
Range accuracy	5 mm @ 100 m
Range resolution	2 mm
Angular accuracy	80 μ rad
Max. field of view (vertical)	120° (-45 to +75°)
Max. field of view (horizontal)	360°
GNSS receiver	L1 GPS + GLONASS
Data storage capacity	250 GB internal SSD
Internal camera resolution (camera DSLR)	80-Mpix panoramic image
Battery power	2.5 hours
Operating temperature	-20°C to +50°C

SOFTWARE

The Carlson Scan2K comes bundled with ATLAScan software, a powerful yet simple solution for registering the point cloud, as well as Carlson Point Cloud Advanced for feature extraction into Carlson's suite of CAD office products.



CARLSON QUARRYMAN PRO

Using Carlson's Quarryman Pro rock-profiling and laser-scanning system not only improves site safety, it also gives you the data to make decisions that increase productivity.

Carlson's new Quarryman Pro builds on over 20 years experience of delivering laser-scanning solutions to the quarrying industry worldwide. It's our most robust system yet and is designed to offer mine and quarry managers the following benefits:

- **Improved safety:** Plan safer blasts based on accurate data to protect workers and the local environment, and keep you legally compliant.
- **Increased profitability:** Blast planning using Quarryman Pro helps cut the cost of transport hire and fuel, explosives and secondary breakage.
- **Improved productivity:** Calculate stockpile volume quickly to produce fast and accurate material stock valuations.
- **Stockpile volume calculation**

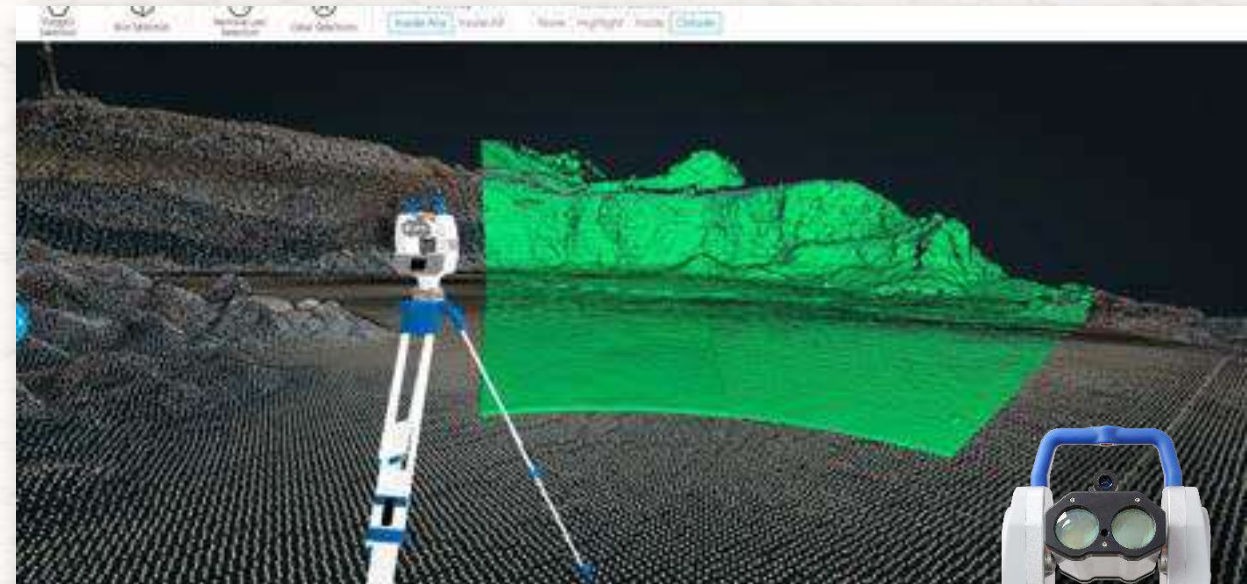


SPECIFICATIONS

Quarryman Pro Long range	Up to 1,200 m
Laser module	Class 3R**
Minimum range	10 m
Fast scanning capability	250 points per second
Range: Vertical	-45° to +90 °
Horizontal	0° to 360 °
Scan time	210 min
Supplied logging media	8 GB USB drive
Water and dust resistant	IP66
Operating temperature range	-20 °C to +45 °C
Total Weight	16.5 kg
Display	3.5-in, sun-readable TFT
Resolution	320 × 240

SOFTWARE

AUTO PROCESSING IN CARLSONOPS SOFTWARE

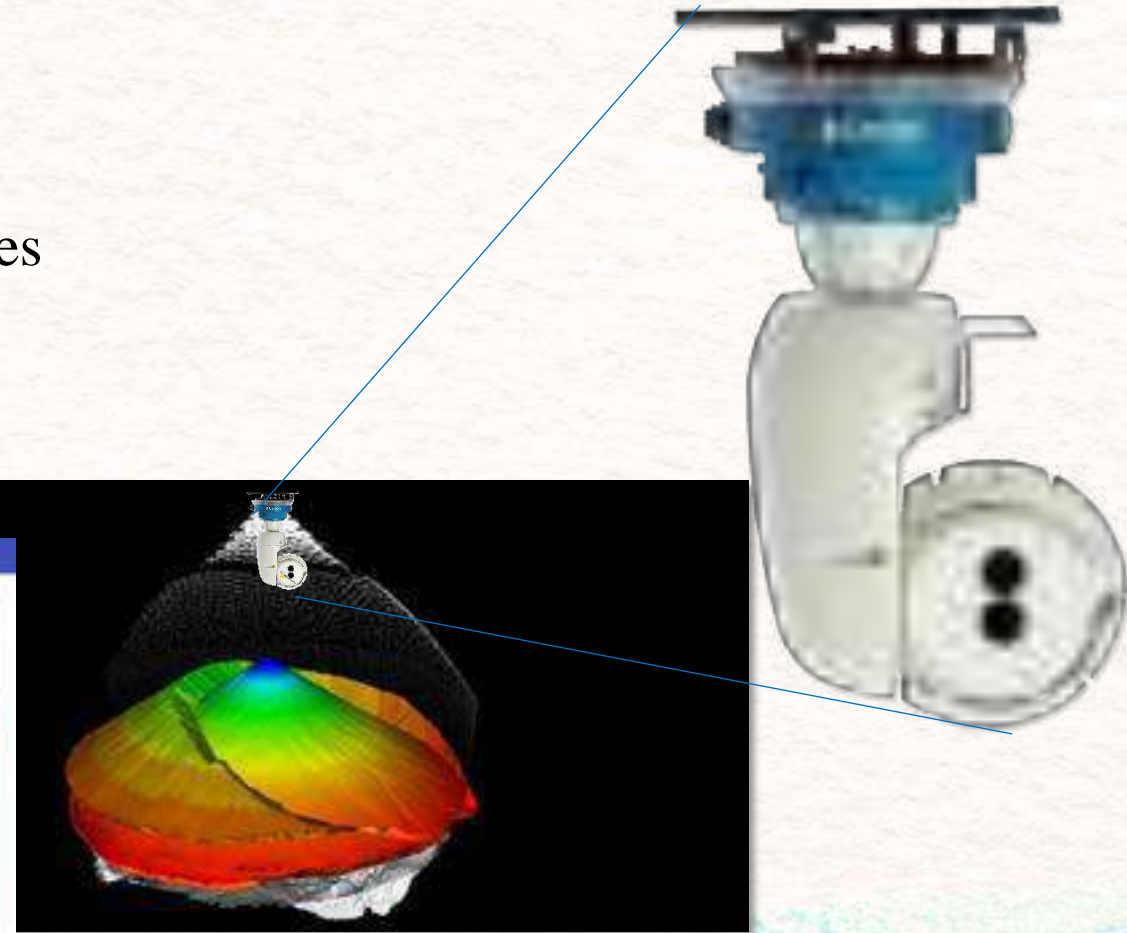
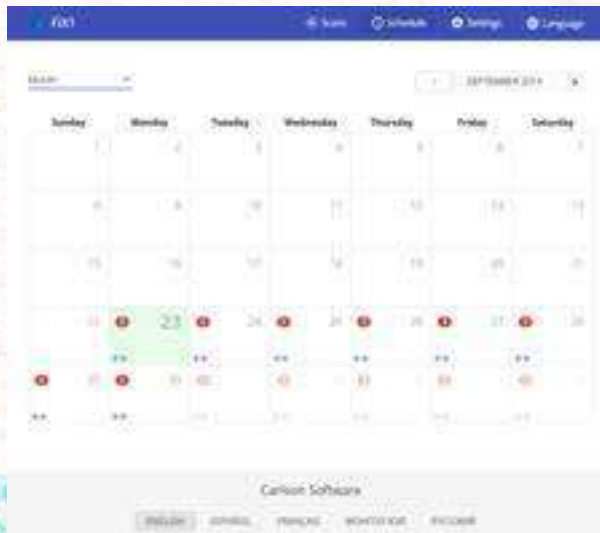


CARLSON FIX1

Fixed installation scanner for obtaining **volumetric data of stockpiles, stockyards and mining operations**

The Fixed Installation Scanner (**FIX1**) from Carlson provides:

- Simple, automated method for obtaining point cloud and volumetric data of monitoring areas and stockpiles in many different installation scenarios.
- Connectivity options to ensure continuous operation and multiple systems in a network.

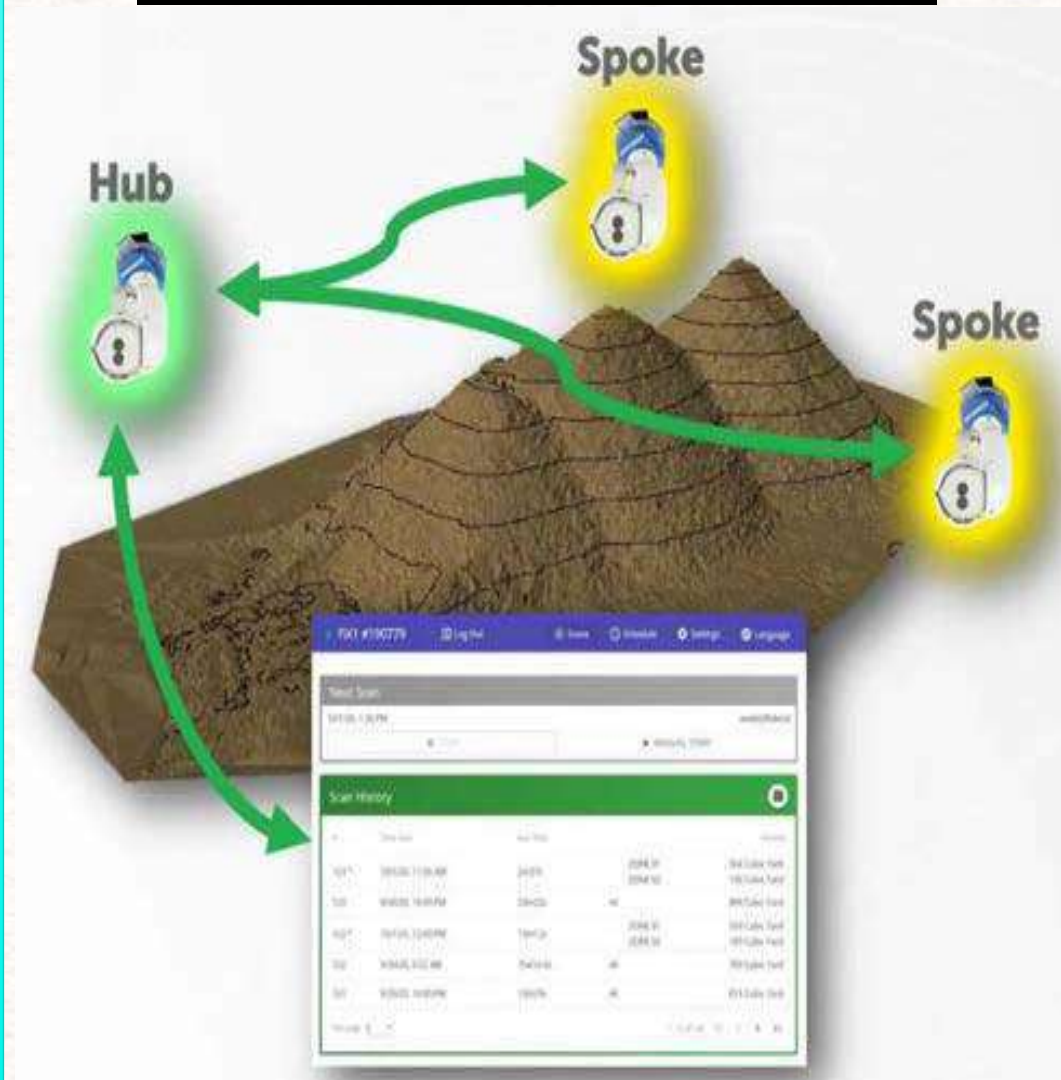


FIX1- SPECIFICATIONS

Maximum Range to Passive Target	250m
Minimum Range	0.5m
Accuracy	±10mm
Maximum Measurement Rate (points per second)	15,000Hz
Weight	12.5kg
Water & Dust Resistance	IP67
Operating Temperature	-40°C to +50°C
Storage Temperature	-40°C to +85°C
Angular Accuracy	0.0055°
Pan Angle Resolution	0.0055°
Tilt Angle Resolution	0.0055°
Tilt Head Range	360°
Scanning Field of View (Pan)	360°
Scanning Field of View (Tilt)	200°

All point cloud data is store in the FiX1. This information can be downloaded from the FiX1 in the common “.las” format

FIX1- HUB/SPOKE CONFIGURATION



CarlsonOPS Software

FIX1 – Web UI – Point Cloud Viewer Window

- The point Cloud Viewer Window will allow the user to display and manually interact visually with the point cloud.
- It will also display the reference surface that is being used for the volumetric calculations.



BORETRAK®2 GYRO

The Boretrak2 borehole deviation measurement system is a simple-to-use, gyro-based system for [measuring the deviation of boreholes drilled in underground mines](#) or on the [surface in quarries](#) or [open-pit mines](#).



GYRO BASED BOREHOLE DEVIATION PROBE



SPECIFICATIONS

Construction		
Downhole cable	5mm plastic-coated steel cable with metre markers	
Push cable	9mm Fibreglass rod with aluminium frame and reel	
Physical		
Weight	Probe (inc batteries)	3.1 kg
	System in case (inc 50m cable & optional PDA)	13.3 kg
Inclination accuracy	+/-0.1°	
System deployment accuracy	Final position within 1% of hole depth*	
IP rating	IP68 waterproof (pressure rated to 300 m)	
Operating temperature**	-10° C to +60° C	
Storage temperature**	-20° C to +70° C	

DOWNHOLE

- Downhole only $\pm 60^\circ$ (Vertical 0°)
- Deployment cable supplied
- Gyro IMU for accurate survey data
- All data automatically processed with Carlson Scan app (Windows and Android)
- Data is visualised in 2D and 3D within Carlson Scan
- Standard exports for all CAD packages

FULL 360°

- Full 360° survey capability
- Use our semi rigid reel and telescopic ramp for up-holes
- All data automatically processed with Carlson Scan app (Windows and Android)
- Data is visualised in 2D and 3D within Carlson Scan
- Standard exports for all CAD packages

CARLSON BORETRAK APP

- Available on Windows 10 and Android 7+
- Analysis of the Boretrak®2 data is quick and simple with our field app, Carlson Scan
- Boretrak®2 data is downloaded via Bluetooth after each hole or after the pattern has been completely surveyed
- Users can import models into Carlson Scan to immediately check for deviations or issues:
 - Patterns
 - Drilling data
 - Strata layers
 - Other data of interest such as 3D Cad models of dams, water tables etc
- Results are stored in Carlson Scan for viewing and analysis and easily exported for CAD



CARLSON C-ALS®

C-ALS (Cavity Auto-scanning Laser System) is a unique specialist **underground laser cavity monitoring** system that **enables mapping of previously inaccessible parts of mines**, safely and quickly.

C-ALS cavity monitoring system can be used in a wide range of applications, where an **inaccessible void exists** and **accurate data is required to monitor excavations, assess risk or design solutions**.

Once deployed, **C-ALS** gives more detailed, accurate data than alternative technologies, such as ground-penetrating radar, and is the only borehole-deployable laser solution on the market.

Laser module	Class 1
Maximum range to a passive target ¹	Up to 150 m
Minimum range	0.5 m
Range Accuracy ²	± 5 cm
Angular Accuracy	0.2°
Range	Vertical -90° to 90° Horizontal 0° to 360°
Water and dust resistant	IP67
Probe	-10° C to +60° C
Surface Unit	-10° C to +50° C



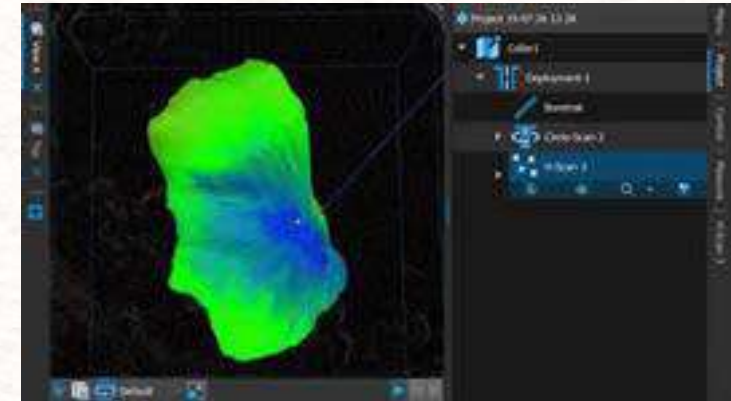
C-ALS SUPPORTS SUCCESSFUL PROJECTS

C-ALS gives you new underground mapping capabilities. You can safely, quickly and reliably scan inaccessible underground workings. Our Carlson Scan software gives you modelling, manipulation and export capabilities. The system enables you to collect the data you need in order to:

- Protect worker safety
- Report to project stakeholders in greater detail
- Cost out planned works accurately
- Design and engineer solutions based on accurate data
- Minimize disruption, drilling and disturbance in populated areas

APPLICATIONS WHERE C-ALS PROVIDES DATA WHEN MANNED ENTRY MAY NOT BE POSSIBLE

- sub-surface voids and cavities
- undercrofts
- underground chambers and tanks
- duct surveys
- inaccessible roof spaces
- collapsed mine workings
- culverts
- shafts and bunkers
- underground caverns
- industrial production facilities where access is limited or unsafe



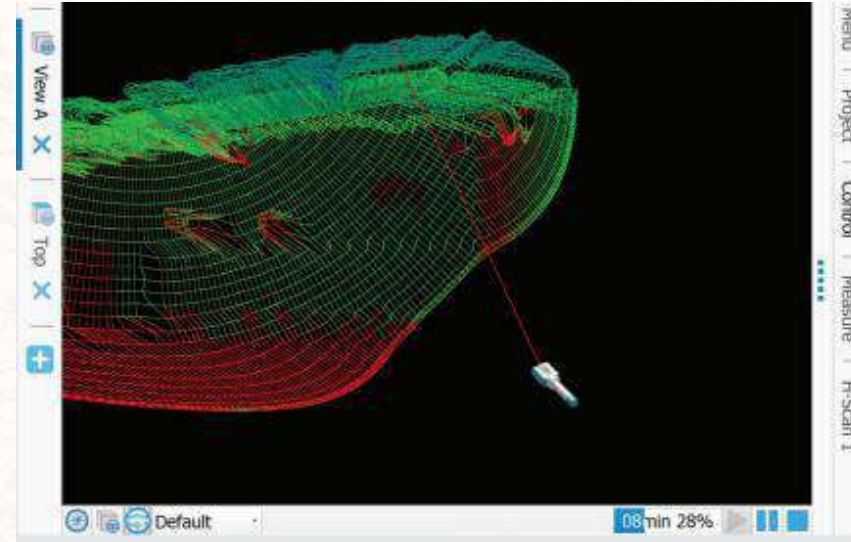
CARLSON VOID SCANNER+

The laser-based cavity monitoring system that helps you to solve underground surveying challenges quickly and at low cost, the Carlson Void Scanner+ is a specialized, ruggedized instrument. Void Scanner+ uses time-of-flight laser measurement to map the shape, position and spatial location of voids, which helps ensure both the safety of personnel, and the protection of stock and underground sites.

APPLICATIONS FOR MINING AND CIVIL ENGINEERING

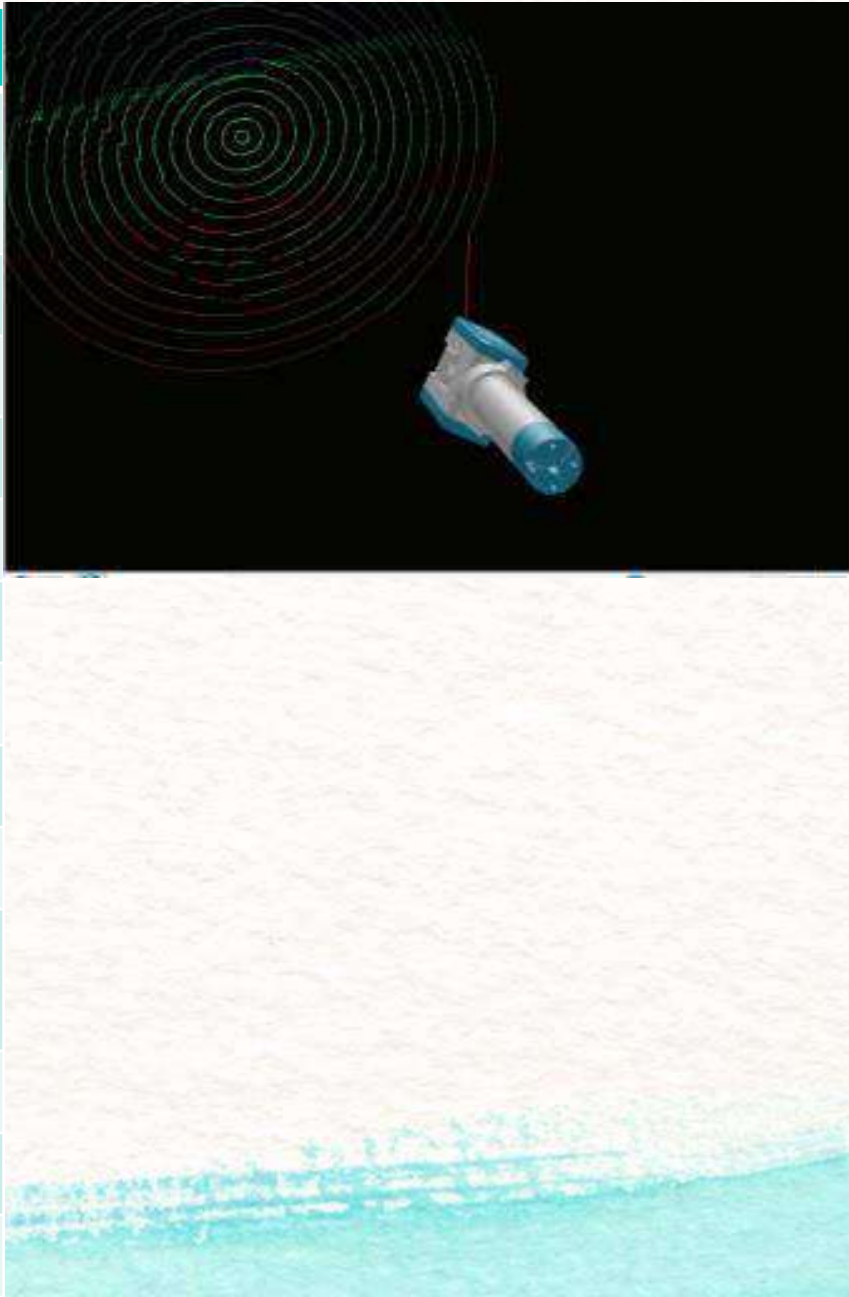
VS solves a wide range of underground surveying challenges at a low cost, including the following:

- Gallery, void, and stope surveying
- Ore pass monitoring
- Mine design management
- End-of-shift extraction volume scanning
- Compliance, environmental, and safety management
- Underground blast planning
- Drive surveys
- Pre- and post-excavation mapping
- Storage silo volume measurement
- Project profitability/feasibility planning



SPECIFICATIONS

Maximum range to a passive target	Up to 150 m
Minimum range	0.5m
Laser	Class 2*
Range: Vertical	+ 135° to -135°
Horizontal	0° to 360°
Accuracy	± 5 cm
Angle accuracy	0.2°
Angle resolution	0.1°
IP degree of protection	IP65
Operational temperature range	-10 °C to 45 °C
Weight	7.5 kg
Internal battery	14.4 V dc, 6.8 Ah lithium-ion battery
Continuous scanning time (typical)	6 hours
Charge time	3 hours (approx)
Control software	Carlson Scan for Windows



WELCOME TO MECHANICAL CUTTING SANDVIK MINING AND ROCK TECHNOLOGY



CORE PRODUCTS

HARDROCK MINING

- Box hole borers
- Reef miners
- Roadheaders
- Rapid mine development system



SANDVIK

CORE PRODUCTS

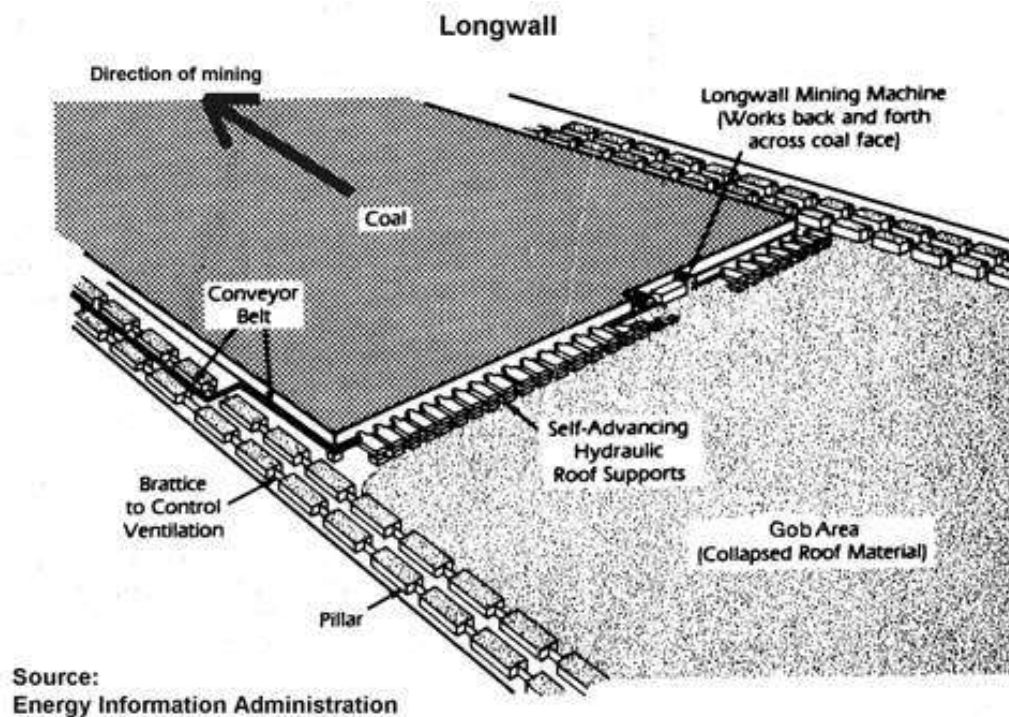
CONSTRUCTION AND TUNNELING

- Roadheaders for soft rock and hard rock tunneling with CUTRONIC and ICUTROC technology
- Cutting attachments



LONGWALL: ROADWAY DEVELOPMENT

- Depth
- Seam Thickness



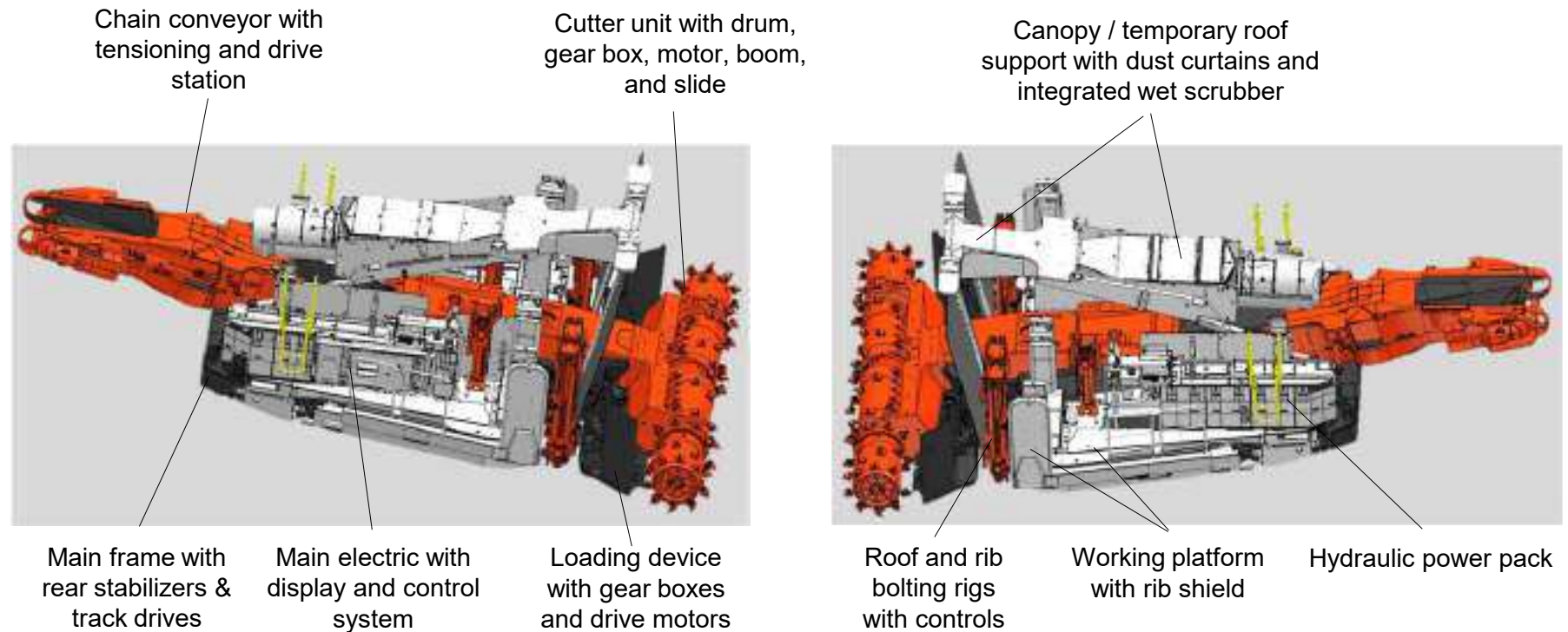
14

BOLTER MINER



SANDVIK

OVERVIEW AND WALKAROUND



KEY CUTTING & BOLTING TECHNOLOGY

Safety

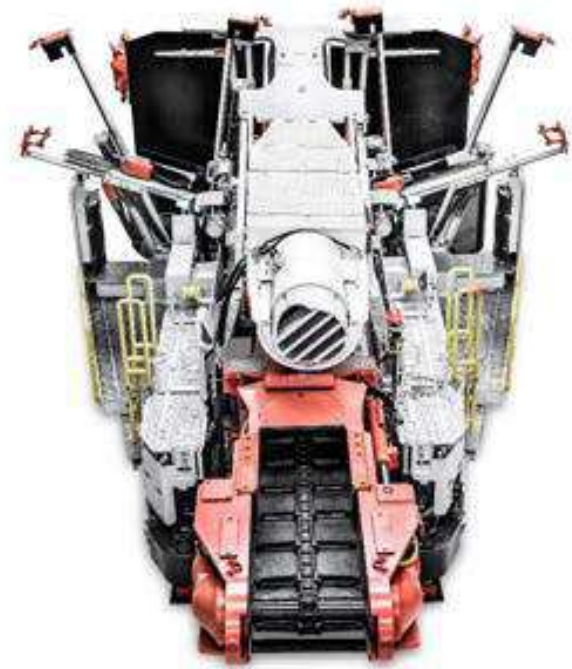
- Highest safety standard with integrated temporary roof support
- Rock support installed immediately upon excavation
- No people exposed to unsupported ground
- Integrated wet dust exhaust scrubber

Selection Criteria

- Applications requiring immediate roof- & rib bolting with flat roof top
- Applications with the need for high advance rates
- Applications with the need to improve time to mass production
- Applications requiring stabilized sump frame cutting concept due to floor conditions and ability to cut material up to 80 MPa with intrusions in small layers beyond this limit

Key Value

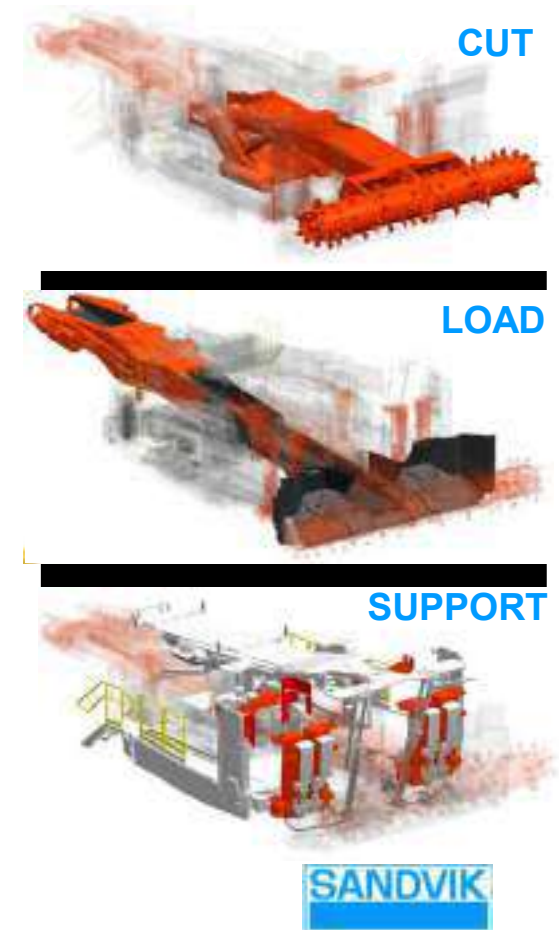
- Rapid roadway development system in Coal or Industrial minerals
 - Simultaneous cutting & bolting provide advance rates up to 6m per hour
 - Support high return on Investment – faster Long Wall start up
- Immediate roof support for high quality roadway
- 4 roof & 2 rib drill rigs for simultaneous cutting & bolting operation
- No to little floor destruction due to stabilized sump frame concept



UNIQUE CONCEPT

FOR LONGWALL DEVELOPMENT

- **Simultaneous excavation and support operation**
- **Two equipment combined into one machine:**
 - **High Safety:** - supported roof during cutting operation
 - no exposure of personnel to unsupported roof
 - built in wet dust exhaust scrubber system
 - **High Quality:** - on bolt installation
 - on roadway alignment
 - **Single Pass:** - for constant roadway width and smooth rib walls
 - **High Advance Rates:** - to keep pace with longwall productivity
 - **Fast Advance Cycles:** - of 10 minutes per meter*



KEY FEATURES AND VALUES

CUTTING MODULE



- ITP spray system for ignition and dust control
- Low revolution drum speed
- Heavy duty boom structure with
 - Heavy duty gear case
 - Narrow structure to minimize centre bolt spacing
 - Heavy duty pin / bushing connection for long life time
- 1m sump distance out of stabilized machine position
- Shear & sump speed controlled via cutter motor feedback

LOADING & CONVEYING DEVICE



- Up to 25 t / min loading capabilities for fast shuttle car and continuous haulage loading
- Loading & conveying device follows cutting module 550 mm for efficient loading
- Hydraulic adjustable side extensions to support single pass operation
- Triple bearing at conveyor slewing section for long lifetime
- ITP spray system for ignition and dust control

BOLTING STATION, ATRS & EXHAUST UNIT



- Bolter stations build for various requirements with adjustable drill rig position
- Automated temporary roof support for initial ground support and machine stabilisation
- Integrated wet scrubber with encapsulated fan and exhaust section for noise reduction
- Adjustable capacity from 3.0 to 5.7 m³ / sec
- Exhaust scrubber noise level 77 to 90 db

ELECTRIC & CONTROL SYSTEM



- Compact main panel with integrated display for set up & control functions
- SIL 2 rated emergency stop circuit
- Water cooled motors
- PLC controlled cutting operation
- Integrated spool monitoring
- RRC Control



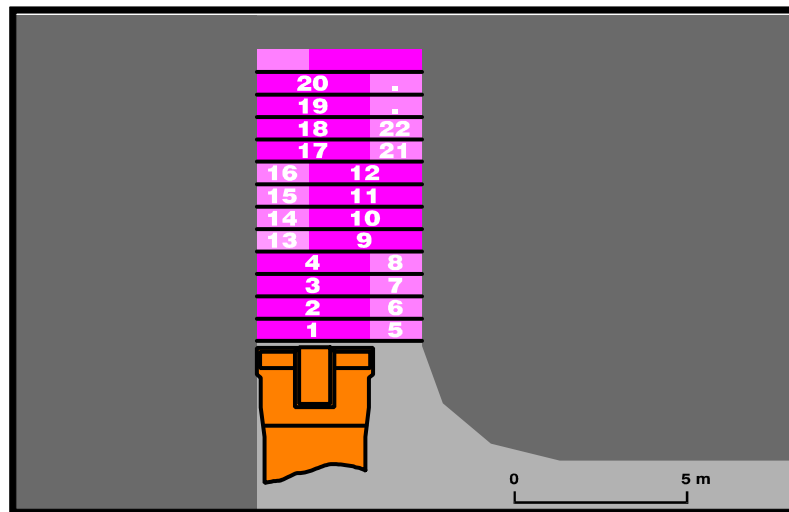
TECHNICAL DATA MB670-1

Total length, approx.	[m]	11.25
Total weight, approx.	[tons]	105
Working height modules	[m]	2.8 - 3.8
		3.2 - 4.2
		3.5 - 4.5
		4.0 - 5.0
Working width set ups	[m]	5.2 / 5.4 / 5.5 / 5.6 / 5.7 / 5.8 / 6.0 & 6.24
Sump distance	[m]	1.0
Distance roof bolter to face at 2.8 m	[m]	2.49
Distance temporary roof support to face	[m]	1.40
Loading and conveying capacity	[t/min]	25
Tramming speed	[m/min]	3.5 - 15
On board dust exhaust system	[m³/sec]	3.0 - 5.7
	[db]	77.1 - 89.4
Cutter motor power	[kW]	315
Total installed power	[kW]	555

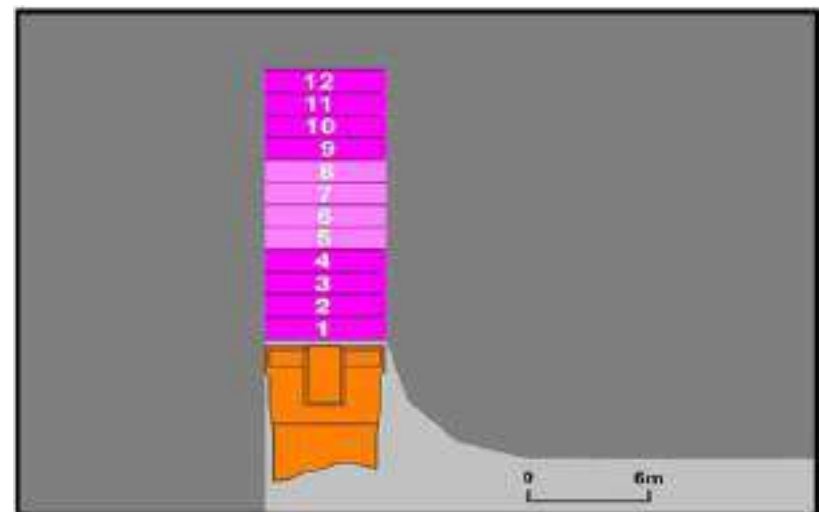


CUTTING SEQUENCE

CONTINUOUS MINER & ROAD HEADER / BOLTER MINER



Continuous Miner & Road Header



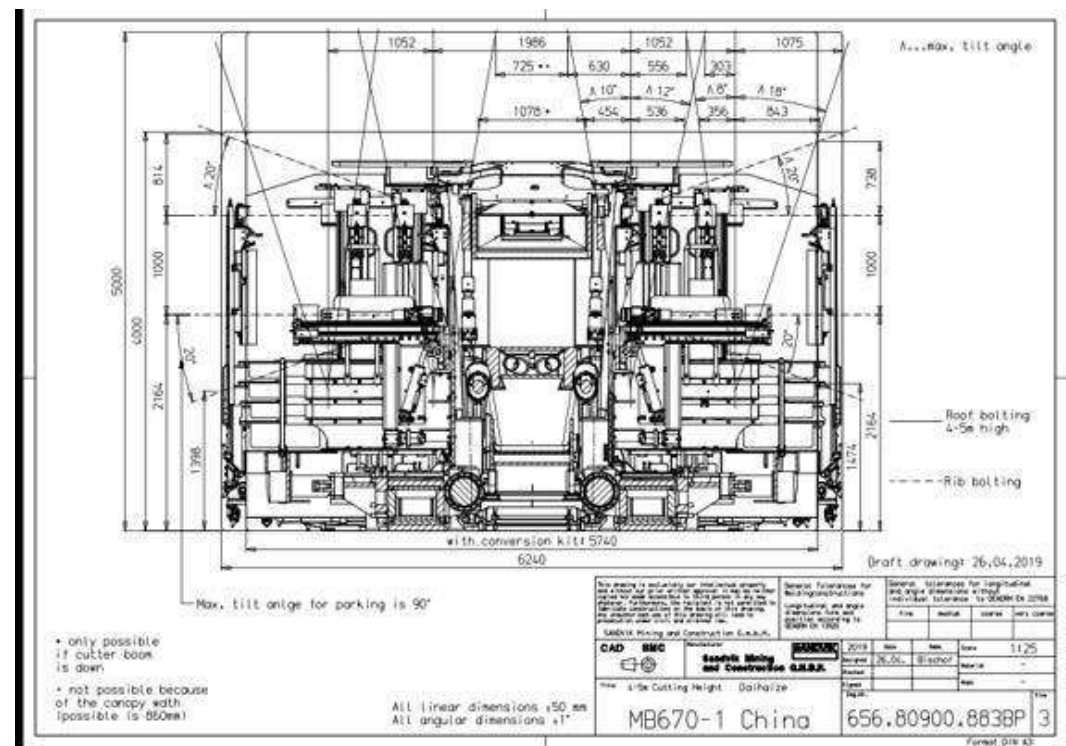
Bolter Miner

CUTTING DIMENSION – SIDE VIEW



SANDVIK MB670-1

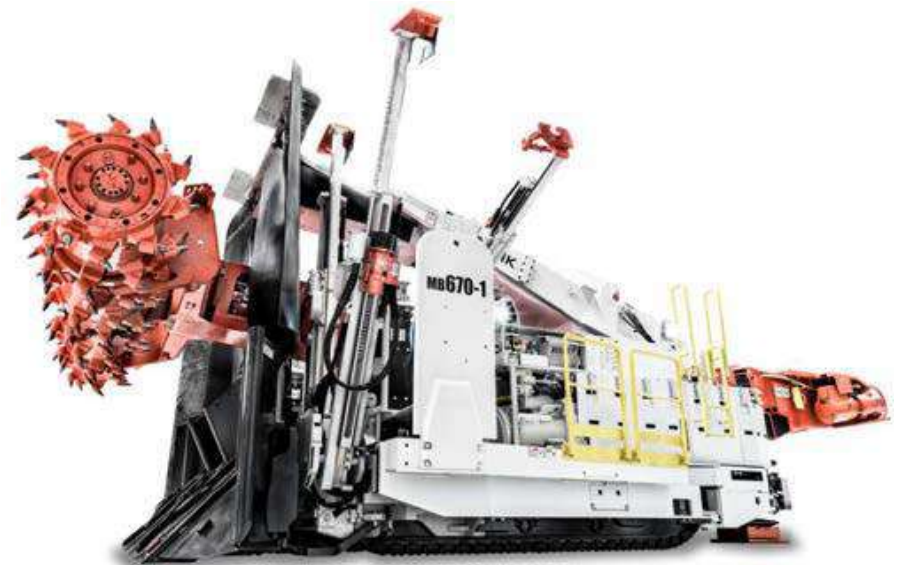
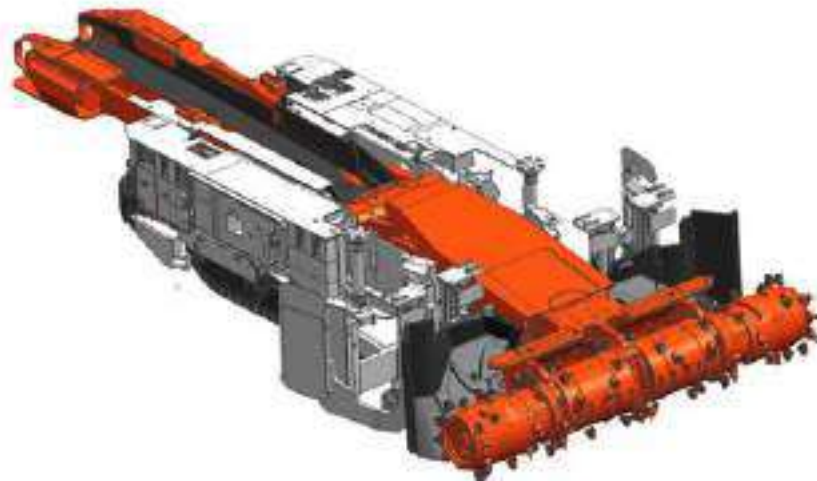
CUTTING HEIGHT 5METER – BOLTING PATTERN



SANDVIK BOLTER MINER

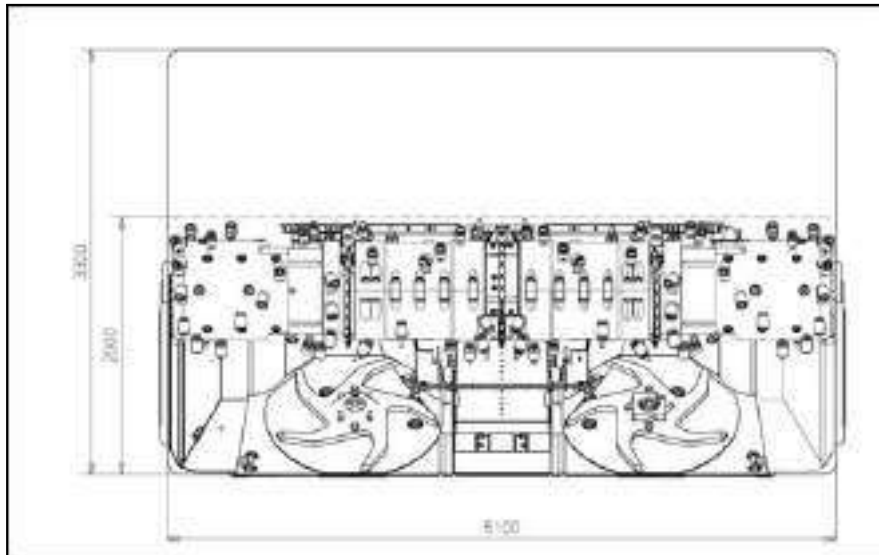


MB670-1 XLH V/S MB670-1

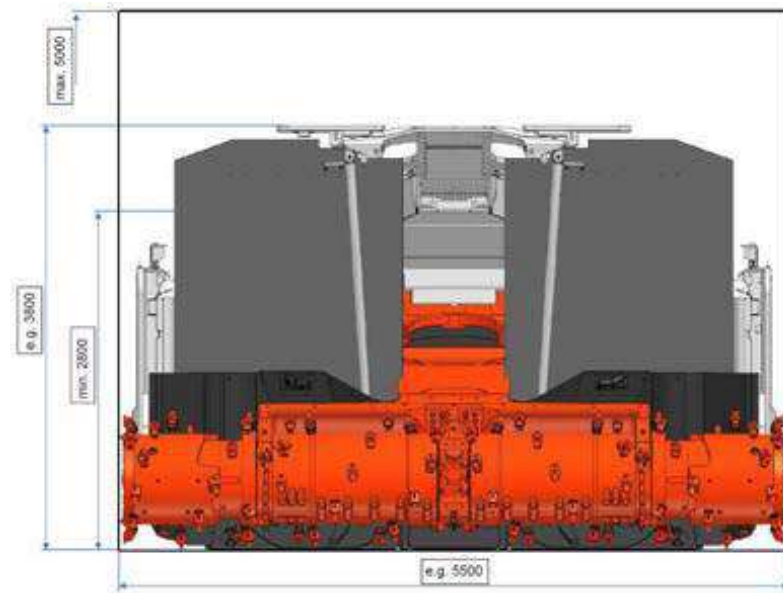


CUTTING RANGE

MB670-1XLH : 2000 TO 3300 MM



MB670-1: 2850 TO 5000 MM



MB670-1XLH V/S MB670-1V/SMB670-1LH

COMMON DIFFERENCE

	Extra Low Height	Standard	Low Height
MODEL	MB670-1XLH	MB670-1	MB670-1 LH
Cutting range, mm	2000-3300	2.8 – 3.8 / 3.2 – 4.2 / 3.5 -4.5/ 4.0 - 5.0	2300-3300
Tramming height, mm	1800	2650/ 3250	2150
Overall length, mm	11550	11250	11350
Total Weight, t	98	105	98
Ground Pressure (tramming), N/cm ²	30	28	27
Ground Pressure (cutting), N/cm ²	22	19	21
Total Available Power, kW	510	546	546
Cutting width, m	5.1/5.6	5.2 / 5.4 / 5.5 / 5.6 / 5.8 / 6.2	5.0 / 5.2 / 5.4
Loading width, mm	5100-5600	5000-6240	5000-5440
Tramming speed, m/s (variable)	3 / 7.0 / 15.0	3.5 / 7.0 / 15.0	3.5 / 7.0 / 15.0
Track chain, mm	560	570	570



LEADING THE WORLD OF BOLTER MINERS

SUCCESS STORIES AND REFERENCES

450+

- Dominant market leadership
- Delivered to our customers around the globe



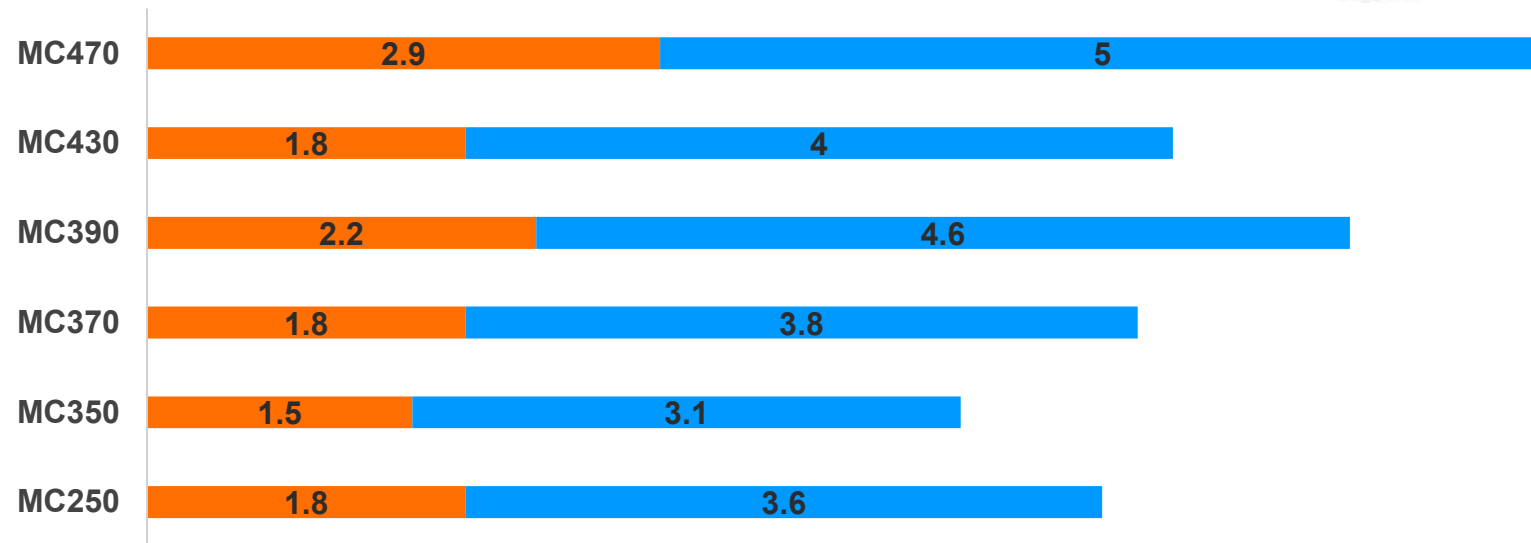
MB670-1 in operation at Menkeqing coal mine, Inner Mongolia

"The sides of the roadway could easily collapse, but we have instant support from the Sandvik MB670-1," Han Wang Hai, Menkeqing's vice chief engineer says, praising the equipment's safety and reliability. "With other machines, different roadheaders, we advanced around 300 metres per month, but with the Sandvik MB670-1 we advance 600 metres per month."



SANDVIK CONTINUOUS MINER

WORKING HEIGHT RANGE



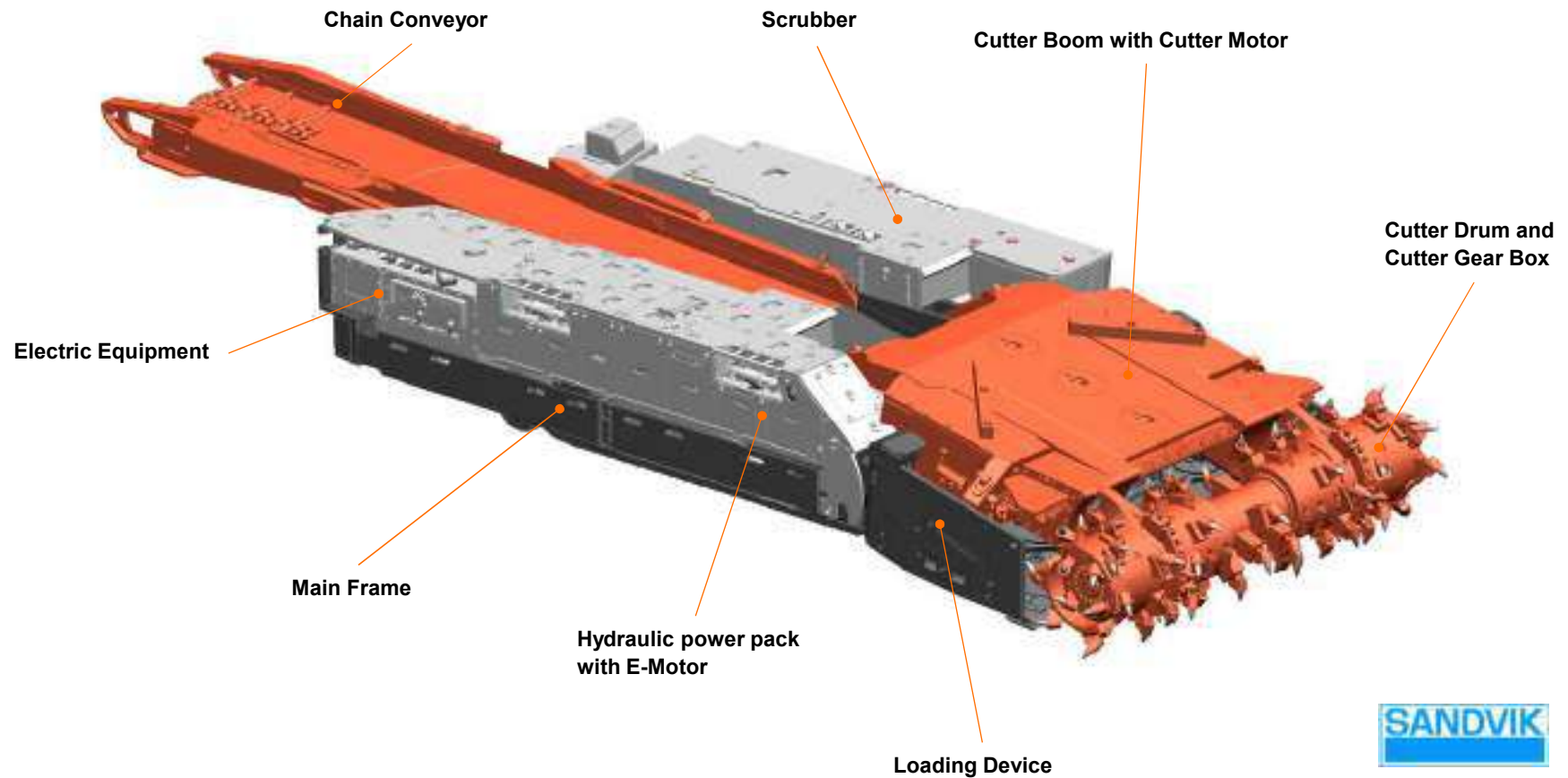
SANDVIK MC350/390 CONTINUOUS MINER



BRIEF OVERVIEW



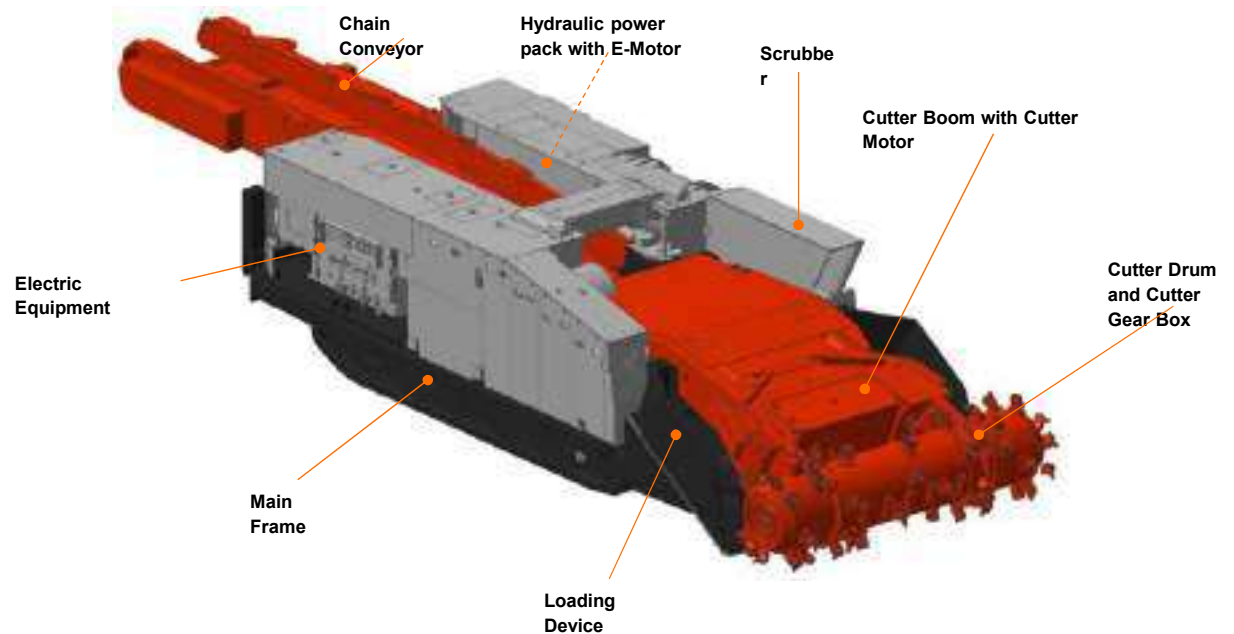
MAJOR COMPONENTS



WALK AROUND

CONTINUOUS MINER

- Electrically powered, track-mounted continuous miners
- Designed to cut coal and soft minerals in a continuous process, eliminating the need for drilling and blasting.
- Sandvik double-pass miners use the most advanced cutting technology for the continuous mining of coal and soft materials.
- Continuous miners cut and gather the material simultaneously and convey it into shuttle cars, haul trucks or a continuous haulage system.
- The flameproof design of these machines is certified according to national regulations, such as MSHA (USA), SANS (South Africa) and DGMS (India).



SANDVIK CONTINUOUS MINER

BASIC INFO

		MC250	MC350	MC370	MC390	MC430	MC470
Basic Info	Figure						
Weight	t	45	68	77	72	100	126
Ground pressure	[N/mm2]	14	16	17	17	19	27
Cutting Ht. min.	mt	1.8	1.5	1.8	2.2	1.8	2.7
Cutting Ht. max.	mt	3.6	3.1	3.8	4.6	4	5
Cutter Motor power	kW	1 x 132	2 x 175	2 x 175	2 x 175	2 x 200	2 x 270
Total installed power	kW	370.5	641	650	650	672	860



SANDVIK LS312 FAMEPROOF UG LOADER 12 TONNE C7.1 POWERED LHD



SANDVIK LS312

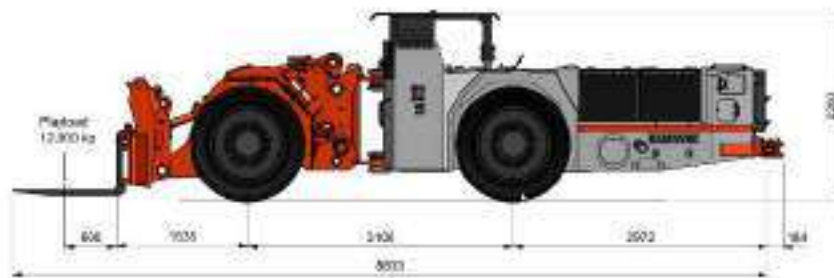
OVERVIEW OF MACHINE

- | | | | |
|---|--|---|------------------------------------|
| ① | Ejector bucket | ⑪ | Power fill hydraulic oil fill pump |
| ② | Front frame | ⑫ | Upgraded pin design |
| ③ | Lift and tilt cylinders | ⑬ | Hydraulic tank |
| ④ | Rear frame | ⑭ | Transmission and torque converter |
| ⑤ | Engine bay with covers | ⑮ | Tow hitch |
| ⑥ | ROPS and FOPS canopy | ⑯ | Flameproof LED lights |
| ⑦ | Operator cabin | ⑰ | Rear frame |
| ⑧ | Wheels | | |
| ⑨ | Axle and brake hub | | |
| ⑩ | Quick detachment system (QDS) available for various purposes and functions | | |



LOAD & HAUL

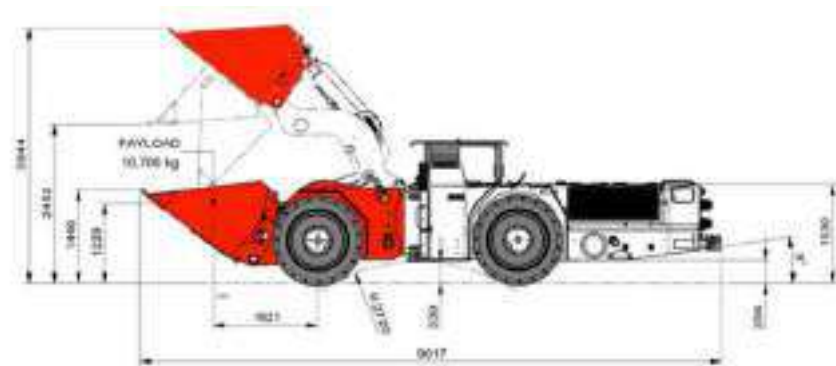
LS312 PAYLOAD ON FORK



MAX. PAYLOAD : 12 TONNES

FLEXIBLE AND AGILE FOR
MATERIAL TRANSPORTATION

LS312 PAYLOAD IN BUCKET



MAX. BUCKET CAPACITY : 4 M3

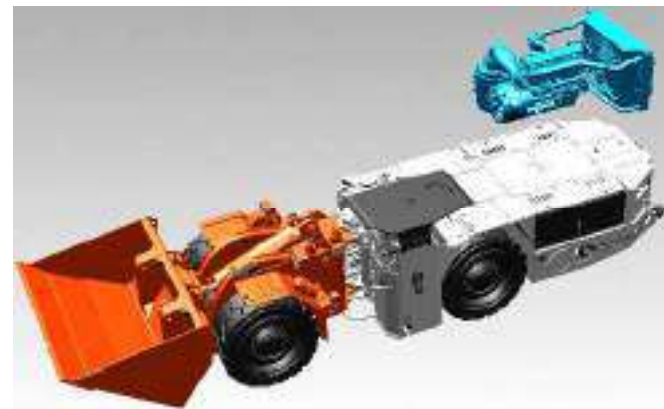
SUITABLE FOR COAL
PRODUCTION IN DEG – 1 MINES



SANVIK LS312

MOVING FORWARD BIGGER & BETTER ENGINE – C7.1

- Integration of Caterpillar C7.1 DES package into an improved LS190 style frame
- Product improvements based on industry feedback
 - Increased payload capacity – 12,000kg
 - Increased towing capacity – 14,725kg
 - Aluminium/Copper radiator options
 - Multiple shutdown system options
 - Improved hydraulic cylinder design
 - Joystick/steering wheel options
 - Redesign of lift arm & QDS pins
 - Articulation hosing improvements
 - Improved air filter efficiency



SAFETY

OPERATOR CAB ERGONOMICS

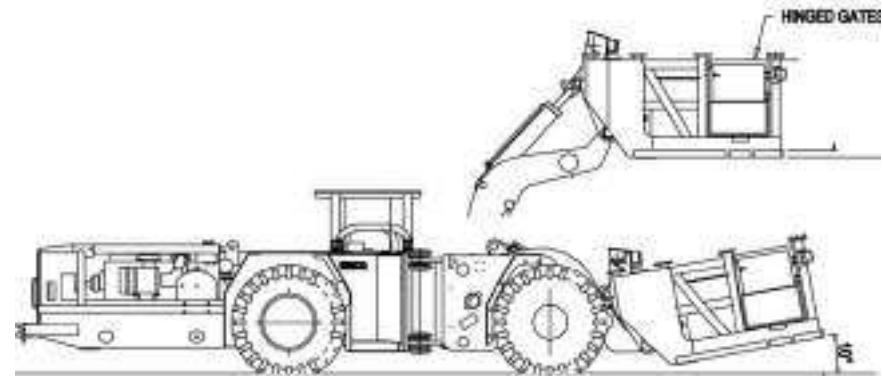
- ISO Certified ROPS/FOPS Canopy
- Easy access 3-point contact
- Joystick bucket control standard
- Increased operator comfort dual gel arm rests and air cushion, self levelling seat with seat belt
- Controls and gauges integrated into dash panel and positioned with ergonomics in mind
- Metal enclosed foot well for reduced risk of high-pressure exposure



QUICK DETACH SYSTEM

WORK PLATFORM

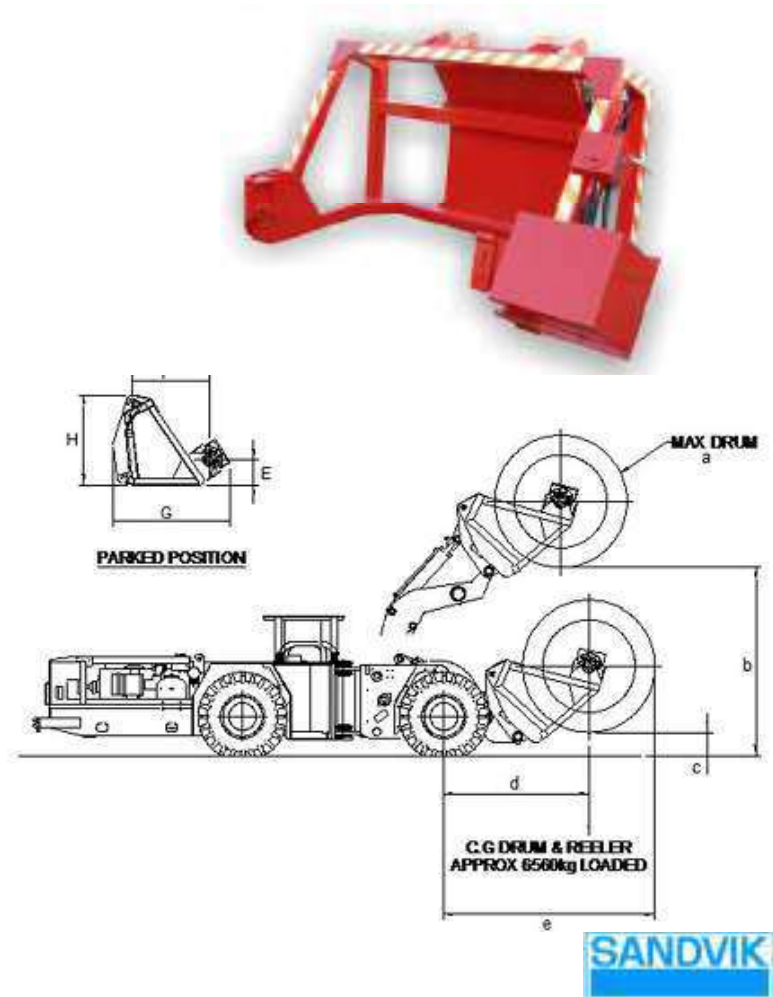
- The QDS work Platform is designed to provide safe access to high working areas in an underground mine.
- Safety features:
 - ☐ Non Slip Floor
 - ☐ Emergency Exit Ladder
 - ☐ Full Railing Protection
- Operator functions
 - ☐ Lift function
 - ☐ Tilt function
 - ☐ Emergency Stop function
 - ☐ Driver Isolate function



QUICK DETACH SYSTEM

CABLE BELT REELER

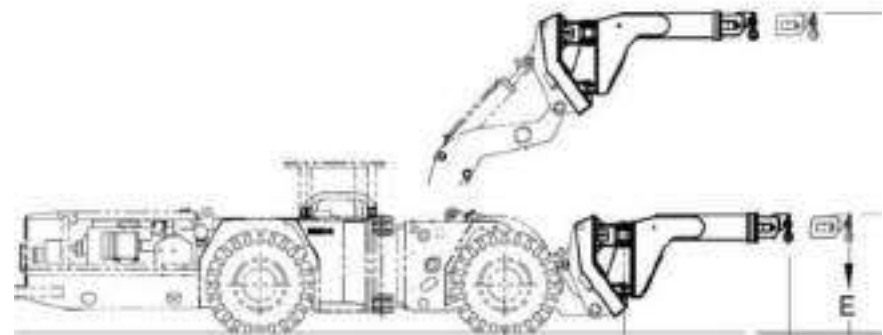
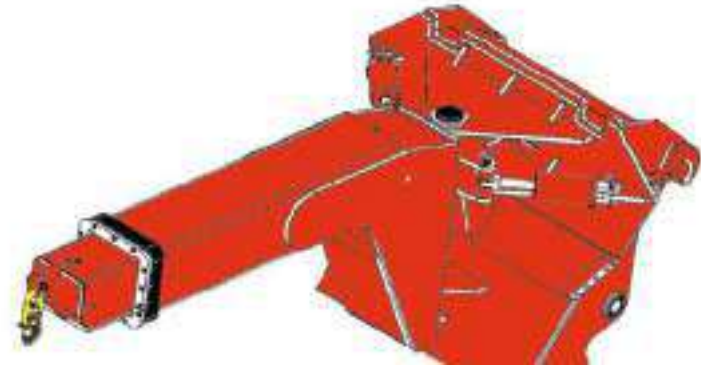
- Using a hydraulic driven single drum the cable and belt reeler can carry cable drums up to a maximum diameter of 2000mm.
- Belts as wide as 1600mm can be carried with the belt reeler.
- Designed for quick and easy unwinding of belt during shifting operation within panel. Saves manpower costs and exposed hours
- The QDS design allows the cable belt reeler to be quickly attached to a Sandvik utility vehicle



QUICK DETACH SYSTEM

TELESCOPIC JIB

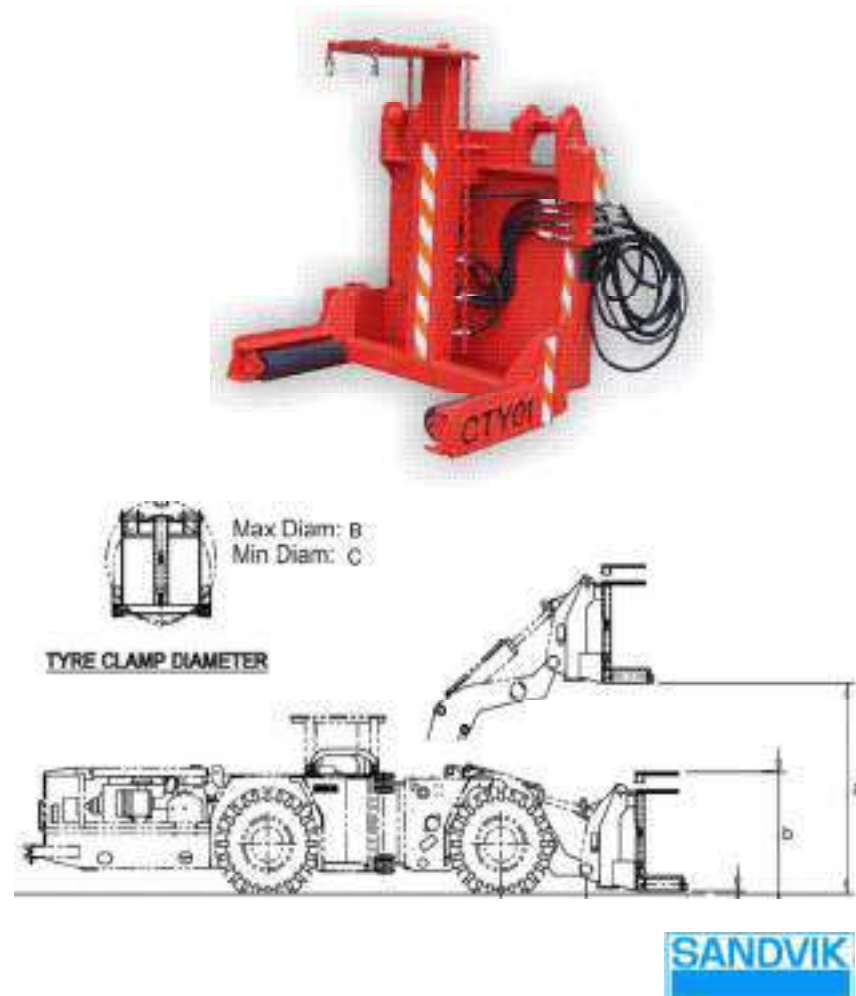
- The telescopic jib crane is designed to be used with our 10 and 12 tonne capacities loaders.
- The telescopic jib crane can lift and carry loads up to 3,000 kg within panels. Brings flexibility in underground maintenance operations or load carrying.
- The QDS design allows the jib to be quickly attached to a Sandvik utility vehicle



QUICK DETACH SYSTEM

TYRE HANDLER

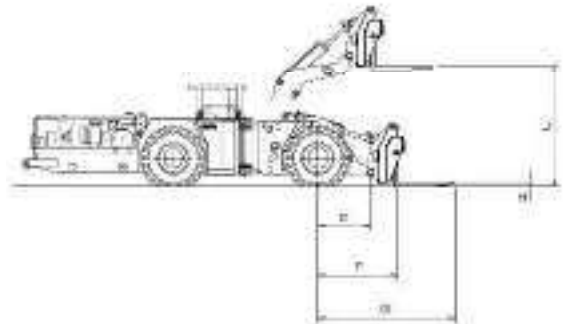
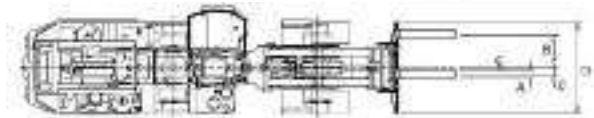
- The QDS tyre handler is a universal lifting and transporting QDS attachment module designed for use with QDS compatible underground coal mining loaders.
- It is capable of handling tyres up to 1.8 tonne and eliminates the risks of manual handling.
- Eliminate risk of injury while carrying out tyre handling job and reduces manpower.



QUICK DETACH SYSTEM

SIDE SHIFT FORK

- The QDS forks are available to suit our 10 and 12 tonne capacities loaders.
- Hydraulic Side Shift Fork assist for tough alignment jobs in challenging underground conditions such as alignment of electric motors, and increases safety



QUICK DETACH SYSTEM

DIESEL SERVICE POD

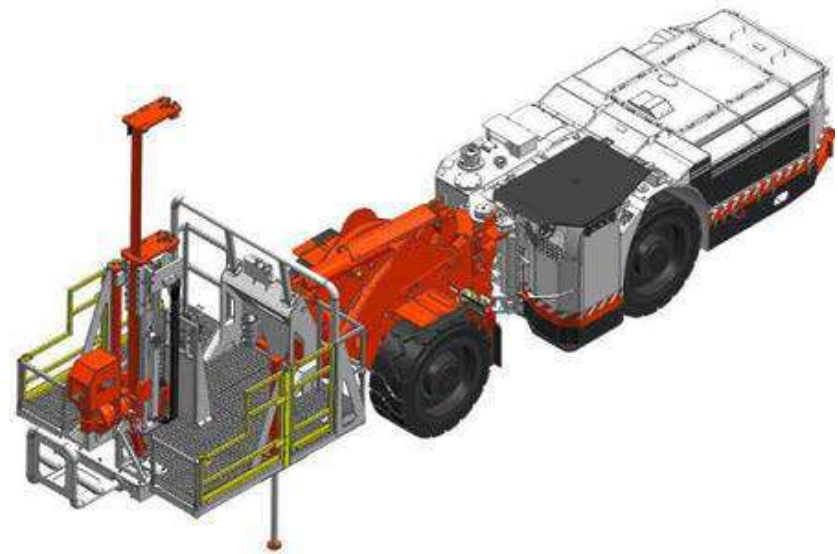
- The Sandvik QDS Diesel Pod has a 2,000 Litre capacity tank of stainless steel construction.
- The Pod has a QDS interface allowing it to be connected directly to the Sandvik loader range, it also has fork sleeves allowing it to be transported by forklift.
- A pneumatic pump is fitted to allow fast and efficient refuelling of mobile plant equipment.
- A fire suppression unit is also on board in the event of a fire.
- Fuel pod eliminates the risk of spillage and contamination, thus making it safe and reliable in harsh working condition



QUICK DETACH SYSTEM

DY700 – BOLTING PLATFORM

- The Sandvik DY700 QDS Bolter is a mobile bolting platform designed for secondary roof and rib bolting in areas where primary roof and rib support are already in place.
- Designed for quick and easy secondary roof and rib support, the DY700 is a critical tool for secondary bolting suite.
- The QDS design allows the platform to be quickly attached to a Sandvik utility vehicle.
- The bolter is compact for storage and can be easily transported to the bolting location without using any production machinery.
- Safety features include onboard emergency stops, hard piping and an escape ladder, slip-resistant flooring, safety railing, grab rails, harness points and overhead stop.
- Stab jacks provide stability during bolting operation.



SANDVIK LS312

KEY TECHNICAL SPECIFICATIONS

Machine model	SANDVIK LS312
ENGINE	Caterpillar C7.1
Output	162 kW @2200 rpm
Torque	932 Nm @1400 rpm
Emission standard	Tier II
CAPACITIES	
Payload on forks	12,000 kg
Payload in bucket	10,700 kg
Standard bucket	3.1 m ³
Optional buckets	4.0m ³ stone bucket
SPEEDS FORWARD & REVERSE (LEVEL/LOADED)	
1st gear	4.4 km/h
2nd gear	9.0 km/h
3rd gear	15.5 km/h
4th gear	25.5 km/h
BUCKET MOTION TIMES	
Raising time	7 sec
Lowering time	5 sec
Dumping time	6 sec
OPERATING WEIGHTS	
Unladen weight	22,000 kg
Laden weight	35,000 kg
LADEN GROUND PRESSURES	
Loader end	1,011 kPa
Power module	305 kPa



MUV WITH QDS ATTACHMENTS

QDS – HINGED FORK WITH LS190



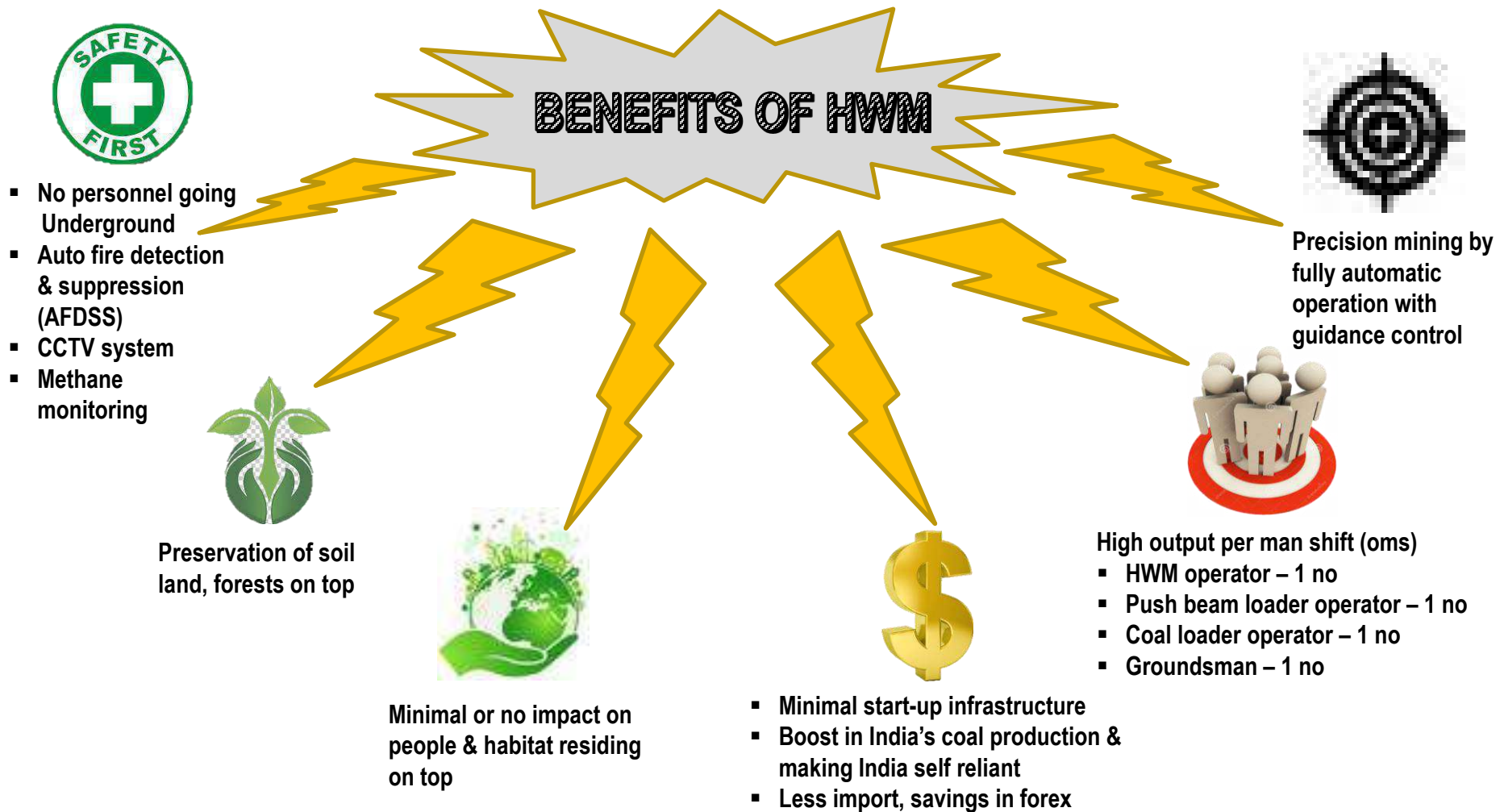
QDS – TELESCOPIC JIB WITH LS170L



HIGHWALL MINING

DEFINITION & BENEFITS

Benefits of Highwall Mining



Exploring trapped coal which cannot be extracted by any other mining method

Highwall Mining Technique

- Highwall Mining development started in the late 1970's in the US
- The purpose was to extract coal that could not be mined economically by Underground or Open Cast Mining
- In Eastern US, HWM was used primarily with contour and mountaintop open cast mines
- Production is dependent on many factors, seam height and overburden depth are the primary factors
- Consistent Monthly Production ranges from 40K Tonnes in low seams to 100K Tonnes for High Seams



What is needed for Highwall Mining ?

- Exposed coal seam
- Competent immediate overburden
- If overburden is not competent, coal may be left as roof
- Mine clean coal by leaving parting as interburden as shown on right
- Coal seams dipping from +5 to -12 degrees is ideal for Highwall Mining, however coal seams +8 to -20 degrees can also be mined with specialized technique
- Relative flat seams, no faults
- Minimum Coal Seam thickness 1m & above



What can Highwall Miner do ?

- Typical coal reserve recovery of 50 to 70% depending on geological conditions and overburden depth
- Mines coal from exposed coal seams when economical surface mining limits are reached
- Mines parallel entries to a depth of 1000 feet (300 m) without personnel working underground
- Flexible System – can mine multiple seam heights



Potential Highwall Miner Sites

- **Greenfield Project:**

- Maximum reserve has +/- 300m cut depth
- Minimum Seam thickness 1m
- Minimum extractable coal reserve 2 million

- **Existing Open Cast Mine:**

- Minimum Highwall Miner Machine available 500m
- Minimum Seam thickness 1m
- Minimum extractable coal reserve 2 million

HIGHWALL MINING MACHINE

CONSTRUCTION, FUNCTION, VARIANTS & TEAM

Construction of Highwall Miner



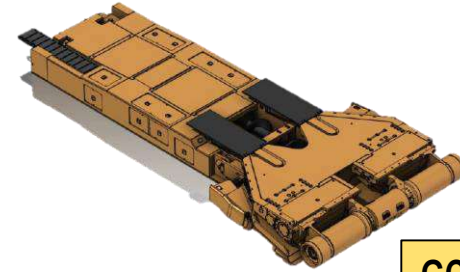
Base Miner

+

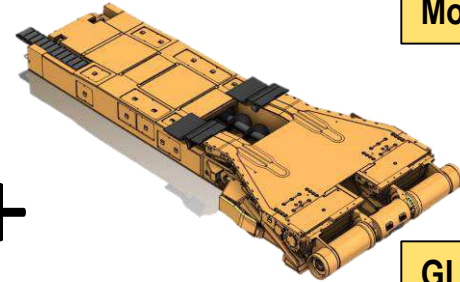


Push Beams

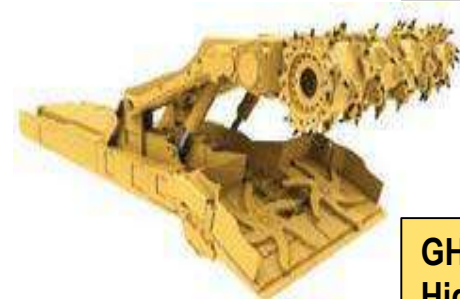
+



**GCM210
Low Seam Cutter
Module**

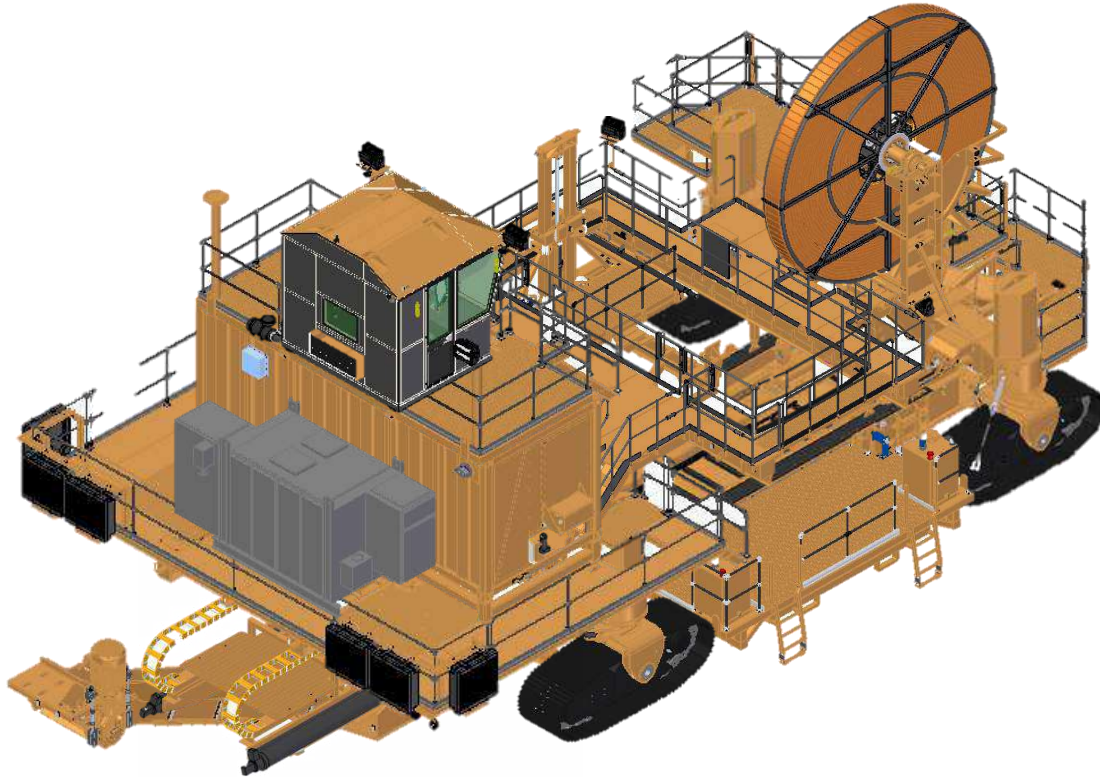


**GLM210
Low-to-Mid Seam
Cutter Module**



**GHCM235
High Seam Cutter
Module**

Base Miner – Sub Assemblies & Functions



1.Base Frame

Supports weight of the miner & carry coal

2.Rear Super Beam

Supports ECM BPM, substation, op cab & carry tracks

3.Front Super Beam

Supports hose reel & carry tracks

4.Storage Rack

Grease & oil storage

5.Power Head

Sumping & retraction

6.Straight Discharge

Convey coal & discharge

7.BPM Catwalk

Walkway for ECM BPM & SS

8.PTM II

Load push beams into powerhead during mining & vice versa

9.ECM BPM

Switchgear & hydraulic power pack room

10.Substation

Primary switchgear & step down transformer

11.Cab Catwalk

Walkway around op cabin

12.Operator Cabin

Miner operation control

13.Front Catwalk

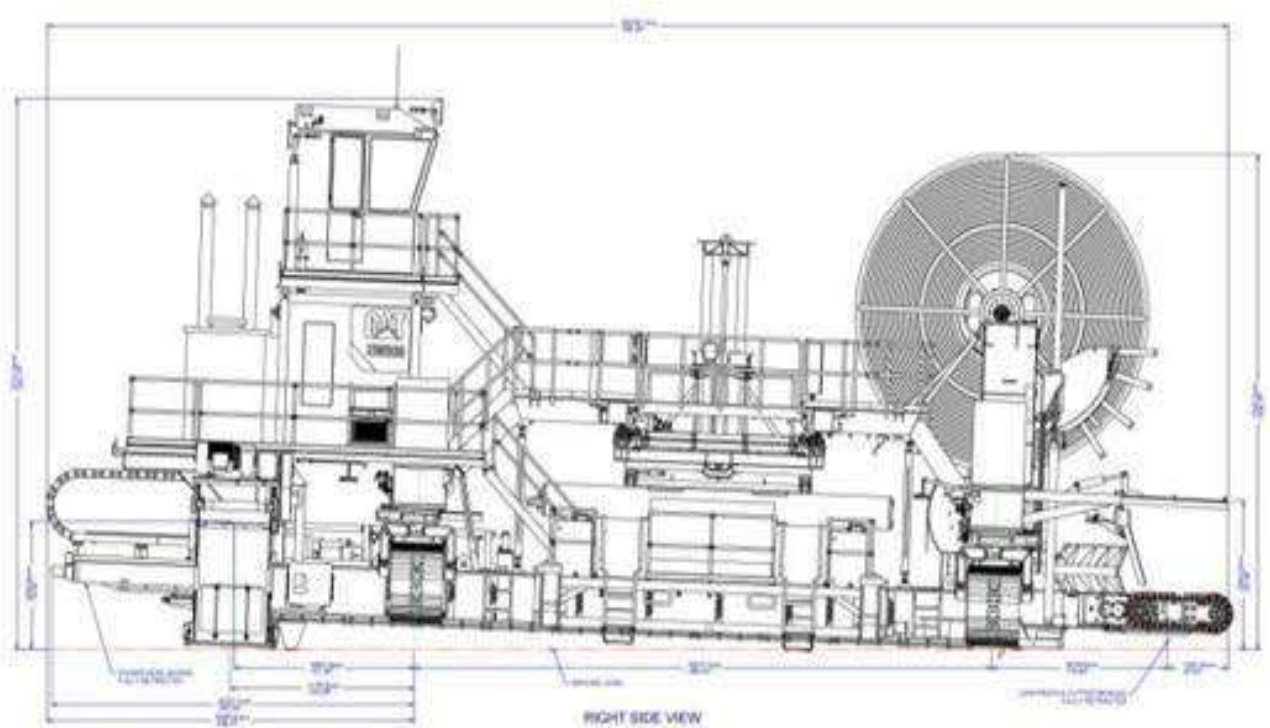
Walkway around hose reel

14.Hose Reel

Wind & unwind cables & hoses running up to cuter module during retraction & mining

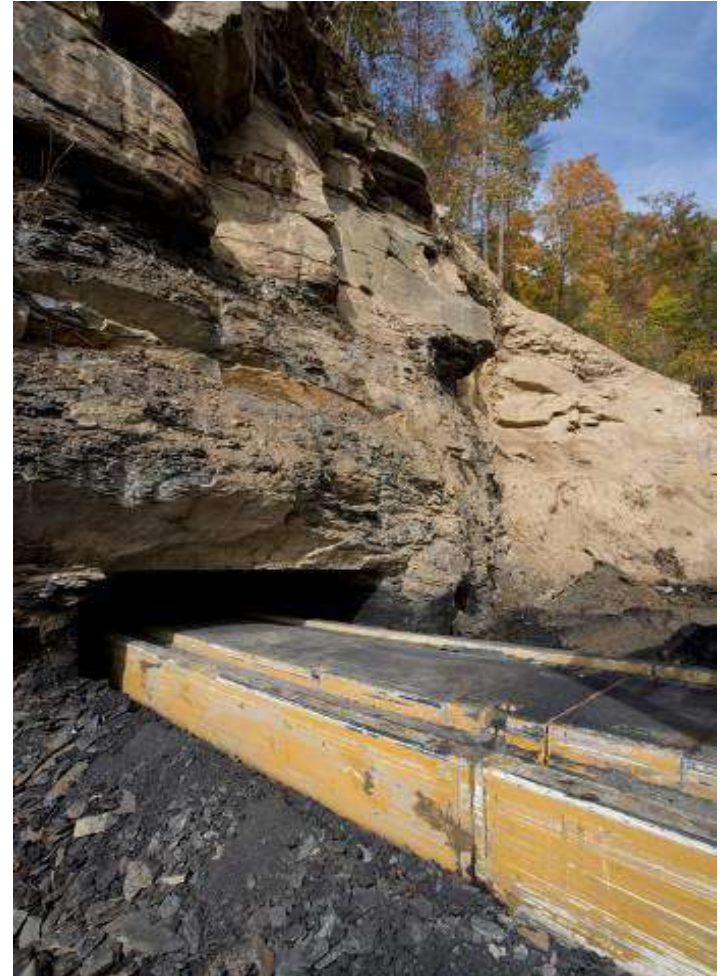
Dimension of Highwall Miner

- Length (base)
 - 55.3 ft. (16.6 m)
- Width (base)
 - 33.6 ft. (10 m)
- Height
 - 28.0 ft. (8.4 m)
- System weight
 - 496,040 lb. (225,000 kg)

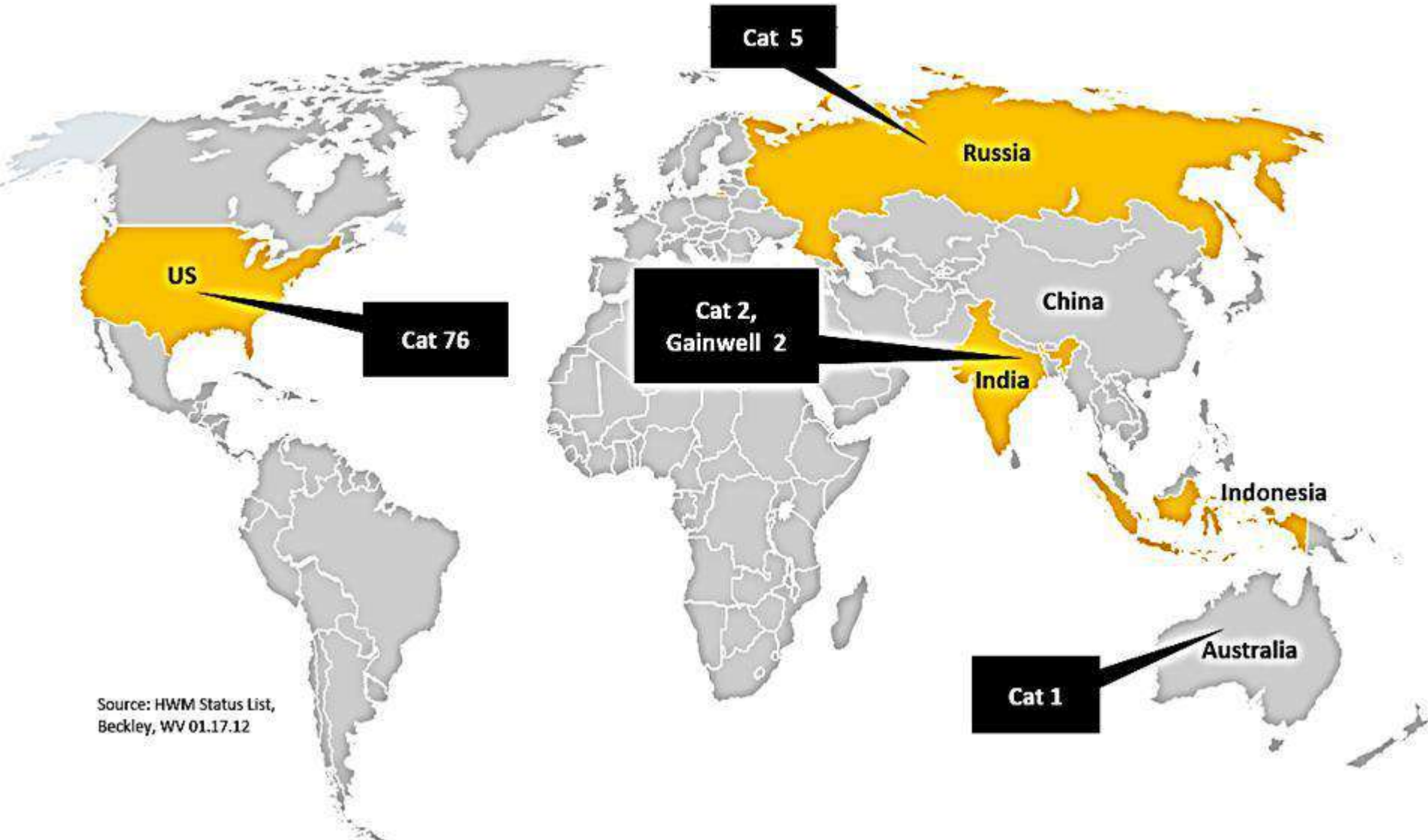


Push Beam

- Pushing / pulling cutter module
- Conveying coal
- Sturdy, simple, two moving parts only
- Enclosed, no external ash
- Low ground pressure
- Protect cables / hoses, coupled to a string
- Horizontally rigid — straight drives
- Vertically hinged — follow seam undulations
- Push beam length : 20 ft. (6.1 m)
- Push beam weight : 12,400 lb. (5,624 kg)
- 54 push beams per miner



Global Current Installed Base



“Made in India” Highwall Miner

- Gainwell received license from CAT to manufacture the Highwall product in Sept 2017
- The Highwall team in CAT is now working for Gainwell India
- Only dealer in the world to manufacture Highwall and allowed to sell anywhere in the world
- New dedicated facility built in Asansol for the Highwall manufacturing
- Supplier base to be moved to India (*as of today we are approx. 70% there*)
- **First machine** manufactured and delivered to **SECL SARDA** Highwall Mining Project in **Jan 2019**
- **2nd Machine** manufactured & supplied to **Tata Steel West Bokaro** in **Nov 2020**
- **3rd Machine** is ready at factory to be deployed to **ECL Sripur Nimcha** Project in **July 2021**

Highwall Miner & Cutter Module brief Details

- **Four interchangeable cutter modules produces versatility**
 - GCM210 Range – Height : 0.9 - 1.7m; Width : 3505mm
 - GLM210 Range – Height : 1.0 - 3.1m; Width : 3505mm
 - GMCM235 Range – Height : 1.2 - 3.1m; Width : 3505mm
 - GHCM235 Range – Height : 2.4 - 4.5m; Width : 3505mm
- **Max. Penetration 305m**
- **CM's equipped with Navigation and Steering – Maintain Heading**
- **Max. Conveyance Rate 1000 TPH**
- **Highly maneuverable Base Unit**
- **Machine Controlled through Touch Screen and PLC System**
- **Manufactured in India**
- **Engineering and Support Staff based in India**
- **HWM can be operated by mobile Generator Power (2000 kVA)**

Photograph of Gainwell Manufactured Machine at Asansol Facility



Gainwell Capabilities

- Supply of made in India highly sophisticated HWM equipment.
- New Training facility in Asansol to provide the quality computer based training for in-house and customers
- Pool of experienced technical experts team and operators in the USA to assist the projects in India
- Subject matter expert for mine Survey to identify Highwall Mining Property for all customers

Gainwell offers end to end solutions from mine survey, asset finalization, machine manufacturing, machine maintenance & repair, machine operation and production contract

Tata Steel West Bokaro Highwall Miner Site



1st Turnkey Project undertake by Gainwell at Tata Steel West Bokaro Colliery

Strong & Experienced Team



Head Highwall Project “Made in India”

Paul Mulley is currently responsible for complete operations of Highwall mining business in terms of design manufacturing sales and aftersales internationally. Has extensive experience of over 40 years in mining equipment and Mining operations at the coal face. A Mechanical Engineer by Profession educated in the UK. A seasoned veteran of the Global Coal business and managed the entire Room and Pillar and Highwall Equipment Management inc. Sales, Design, Manufacturing and aftermarket customer care in Caterpillar



Head of Engineering & Technical Advisor Highwall Miner

Stewart L. Myers has a BS in Mechanical Engineering and has worked in the coal mining industry for over 38 years. 25 Years of his career has been devoted to the design, development, manufacture, maintenance sales and operation of Highwall mining systems globally.



Head of Design Highwall Miner

Robert E. Henry, Jr. is a Mechanical Engineer with over 38 years of experience in the design of coal mining and coal processing equipment. He has more than 14 years of experience working with the Highwall Mining System



Head of Technical Training & Maintenance Highwall Miner

David S Spooner. Has 30+ years in the maintenance field with experience in construction, military & Mining equipment. He has spent past 11 years in Mining industry working on Highwall mining system.



Head of Manufacturing Highwall Miner

Jayanta Bhattacharya is currently leading the manufacturing operations of Highwall Miner. A Mechanical Engineer by profession who has got 22+ years of experience in Mining, Construction & Power Gen Industry. He worked both in Manufacturing & After market operations.

Comments and/or Questions



Thanks !

The background of the slide is a dense, colorful collage of numerous small images. These images depict various scenes related to construction and mining, including heavy machinery like excavators and bulldozers, workers in hard hats, and industrial settings. Overlaid on the left side of this collage is a large, semi-transparent portrait of a man with glasses and a mustache, wearing a suit and tie. The text "Underground mechanization - Way forward" is centered over the collage in a bold, blue, sans-serif font.

Underground mechanization - Way forward



Prasenjit Maity
National Sales Head - UG

Change the Gear....

Present

Stimuli for mechanized Room & Pillar

- Modular & flexible system
- Proven availability of Continuous Miner package
- Technology established
- Higher percentage of recovery
- Good ecosystem to support the advanced mining method
- Long term partnership with OEM + Operator
- Increased private participation driven by profit

Annual Production

- Low Height CM sets: 360,000 Tonnes
- Standard Height CM set: 500,000 Tonnes

Future

Mechanized Room & Pillar – next steps

- Introduce High-capacity equipment – Battery Hauler, SC
- Mass scale conversion of LHD/SDL mines to CM technology
- In case of limited reserve, plan a group of mines with similar mining conditions to relocate the same CM package
- Improve ventilation
- Provide Man Riding System
- Try alternate mining method - **SUPERSECTIONS**

Annual Production – Raise the bar

- Low Height CM sets: 400,000 Tonnes
- Standard Height CM set: 600,000 Tonnes



Battery Operated equipment: Haulers & Scoops

Battery Hauler



Productivity Features

- Priority steering and Electronic differential
- Cable free machine
- Higher pay load than shuttle cars
- Vertical 25 degree Articulation – better operator comfort
- One button ejection and Automated bed retract
- Onboard diagnostics and data acquisition
- On board methane monitoring system with battery back up and audio visual alarm



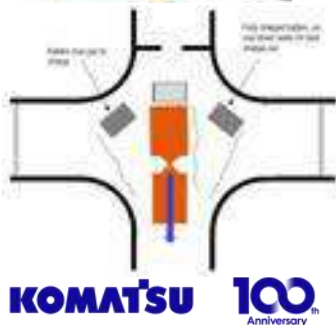
AC VFD Optidrive

- AC VFD provides smooth reliable service
- Electronically activated steering assist
- Regenerative braking ; Increased torque



240V DC Battery assembly

- Lead acid Battery , 240 V, long battery life
- Higher voltage leads to lower ampere draw for same horsepower – longer component life
- Easy battery change out for maximum run time



BH18: Low Seam (1.4m – 2.0m)

Pay Load

16 tonnes

BH20: Mid Seam (above 2.0m)

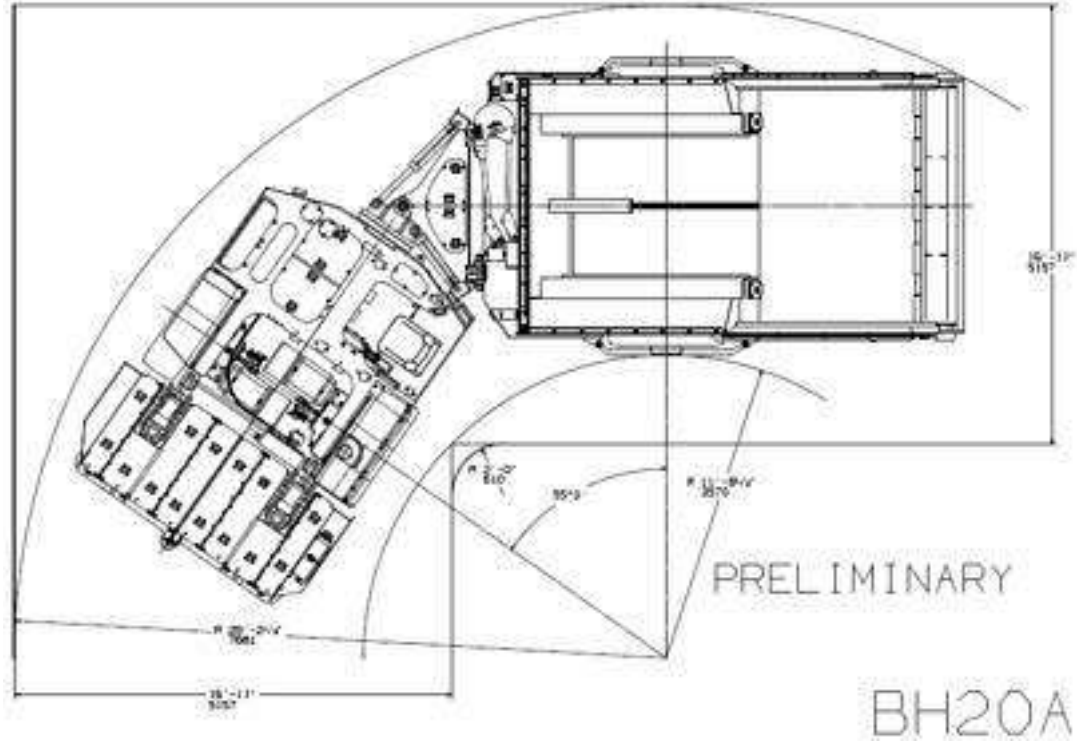
Pay Load

18 tonnes

Battery Hauler

Battery Hauler, BH-20 Technical specifications

Length (mm)	11,510
Width (mm)	Tractor 3400 mm Trailer 3880 mm
Nominal height (mm)	1475
Unladen weight (Kg)	34,400
Total Power (KW)	109
Ground clearance (mm)	445



Battery operated Multi Utility Vehicle (Scoop)

Versatile

- Cable less machine
- Long battery life
- Improved motor efficiency and motor life

Productivity Features

- Opti-drive technology
- Robust Axle and reducers with enhanced braking

AC VFD Optidrive

- Uses 240 V battery
- New electronics eliminate switches
- Onboard color display for real time operational and fault information

240V DC Battery assembly

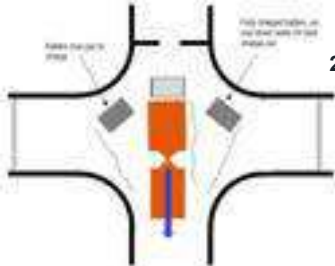
- Lead acid Battery , 240 V
- Easy battery change out for maximum run time

SL No.	PARAMETERS	VALUES
1	Min. extraction height	1.50 m
2	Max. extraction height	2.50 m
3	Min. mining width	5.00 m
4	Est. weight with batteries	26,308 kg
5	Maximum payload	27,590 kg
6	Inside turning radius	3.824 m
7	Outside turning radius	7.138 m
8	Bucket capacity	3.96 m ³
9	Gradeability	1 in 4.5
10	Fork attachment	Yes



Battery Scoop 02ESV56

Pay Load	60,827 lbs
Bucket capacity	140 ft. ³



The background of the slide is a dense, multi-colored collage of numerous small images. These images depict various scenes related to mining and construction, including heavy machinery like excavators and trucks, workers in safety gear, and industrial settings. Overlaid on the left side of this collage is a large, semi-transparent portrait of a man with a mustache and glasses, wearing a suit and tie. A small white rectangular box is positioned over the lower-left portion of this portrait.

Alternative Mining Layouts “Supersections”

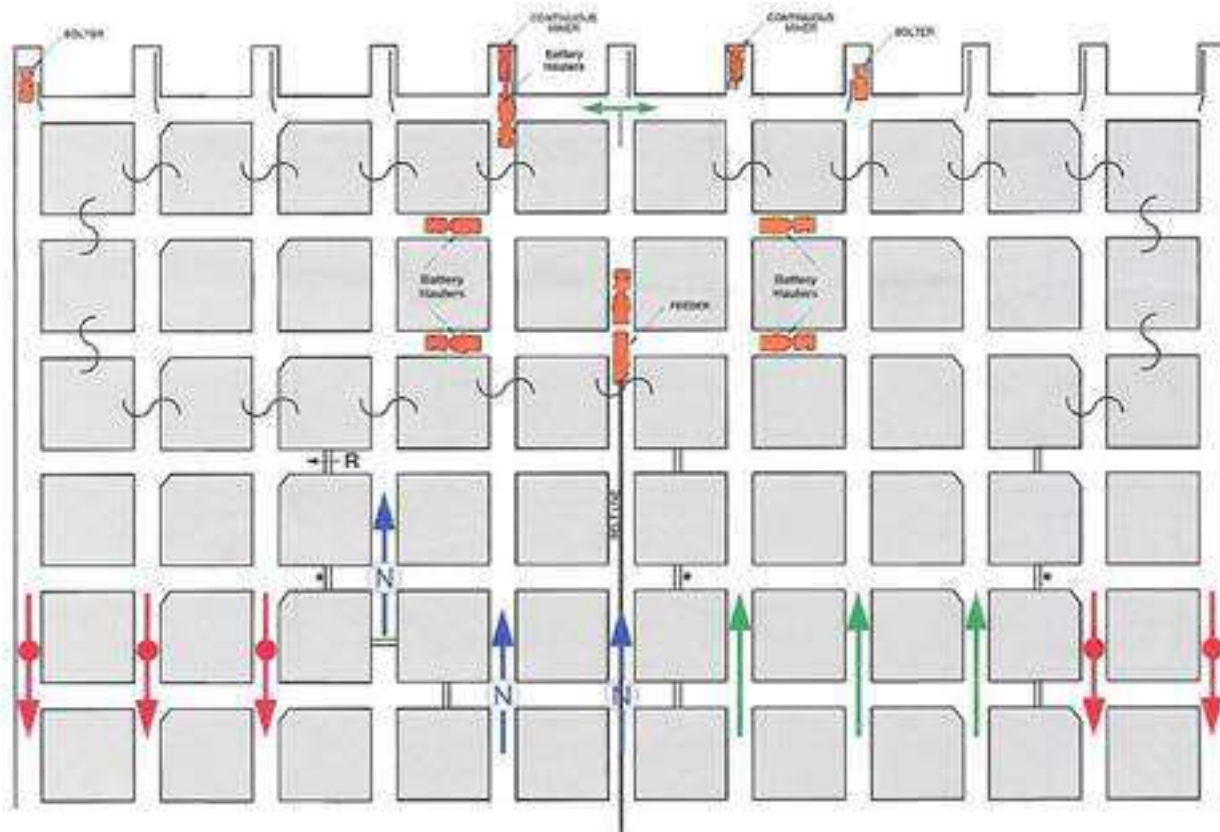
100th
Anniversary

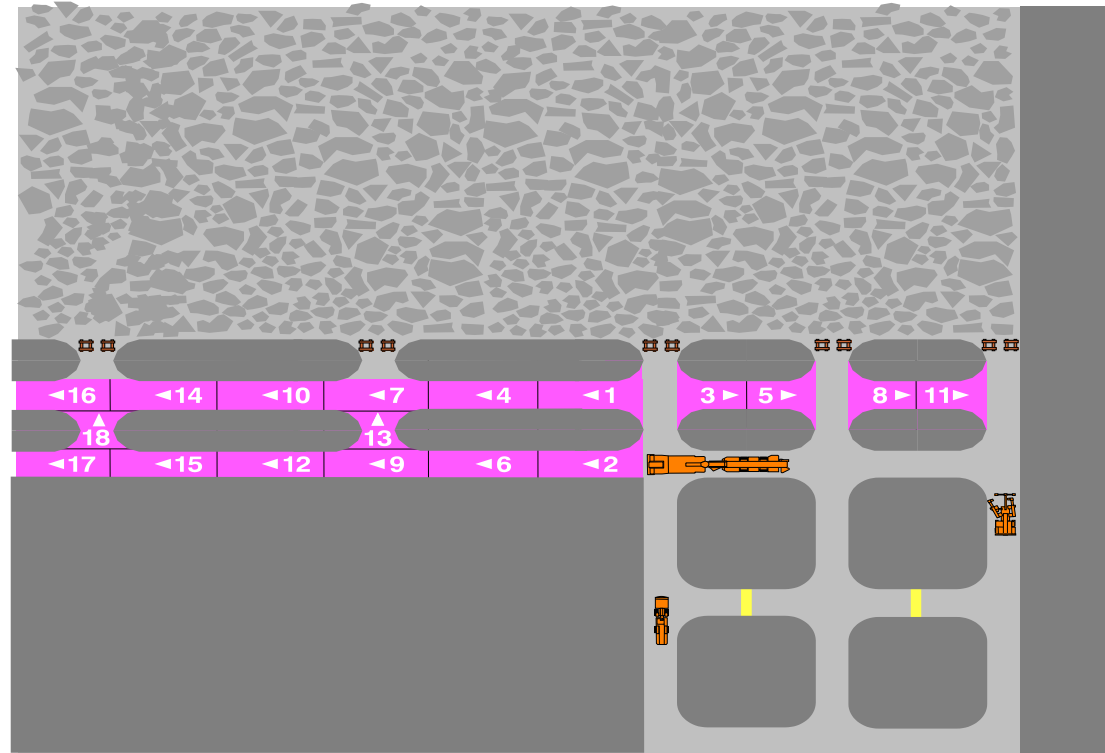
Adrian Carley
Chief Mining Engineer

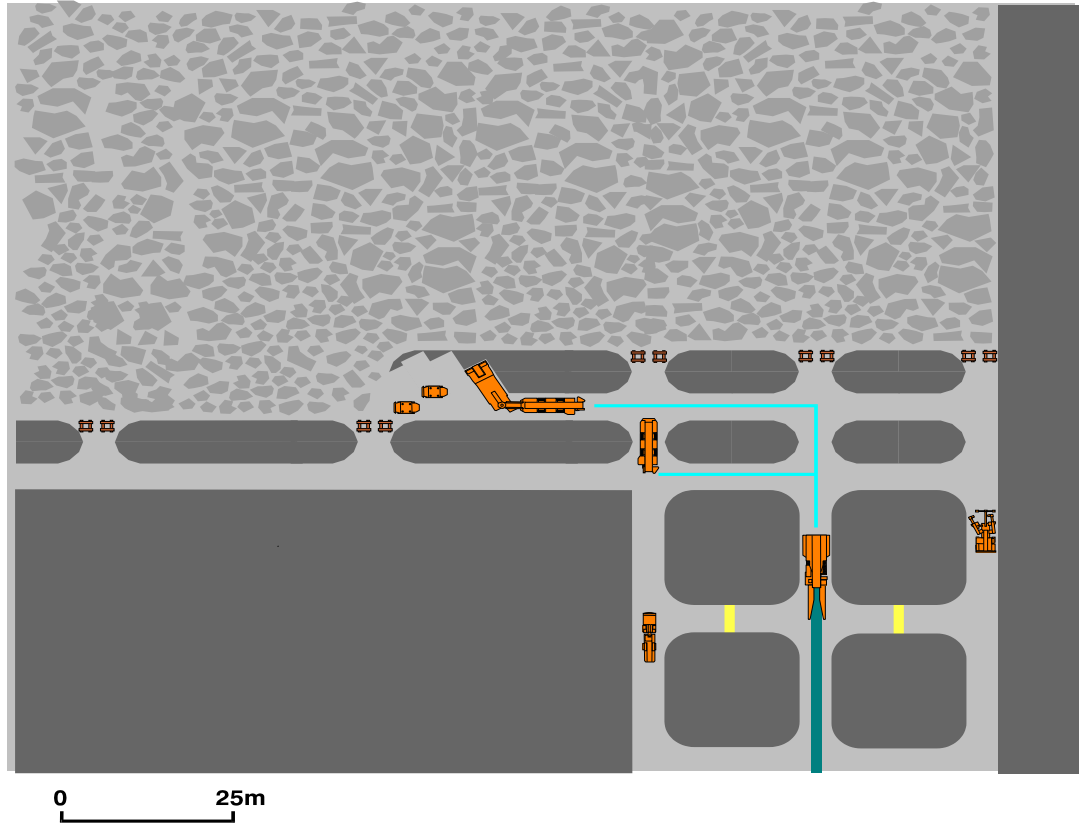
CM Supersections

Supersections

- 10/12 Pillar entries
 - 2 x CM's.
 - 4/6 Haulers.
 - 2 Bolters (could be more depending on density).
 - 1 Feeder breaker.
 - 1/2 Loadcentres.
- One CM mines at a time but utilises all the haulers.
 - Virtually eliminates CM wait time.
 - CM operating continuously.
 - Second CM place changes and prepares ready to cut.
 - Haulers move to this CM on completion of cut









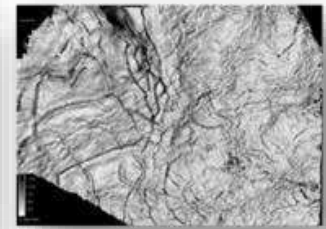
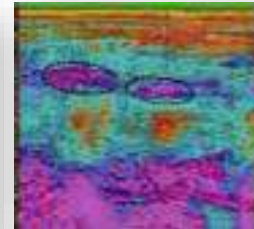
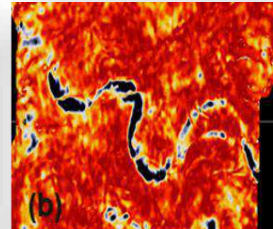
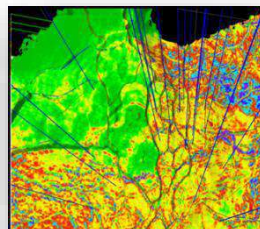
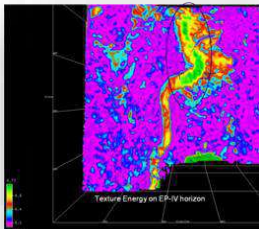
Thank you

Data Interpretation Center
Gujarat Energy Research & Management Institute

A Presentation on
Seismic –A tool for Accelerated Exploration

***Workshop on “Technology Roadmap for Coal Sector : Technologies to Meet Future Challenges”
organized by CMPDI, Ranchi
on
18th January 2022***

By
***Gujarat Energy Research and Management Institute,
1st Floor Energy Building, PDPU Campus, Raisan Village, Gandhinagar-
382007, India.***



Presentation Out Line

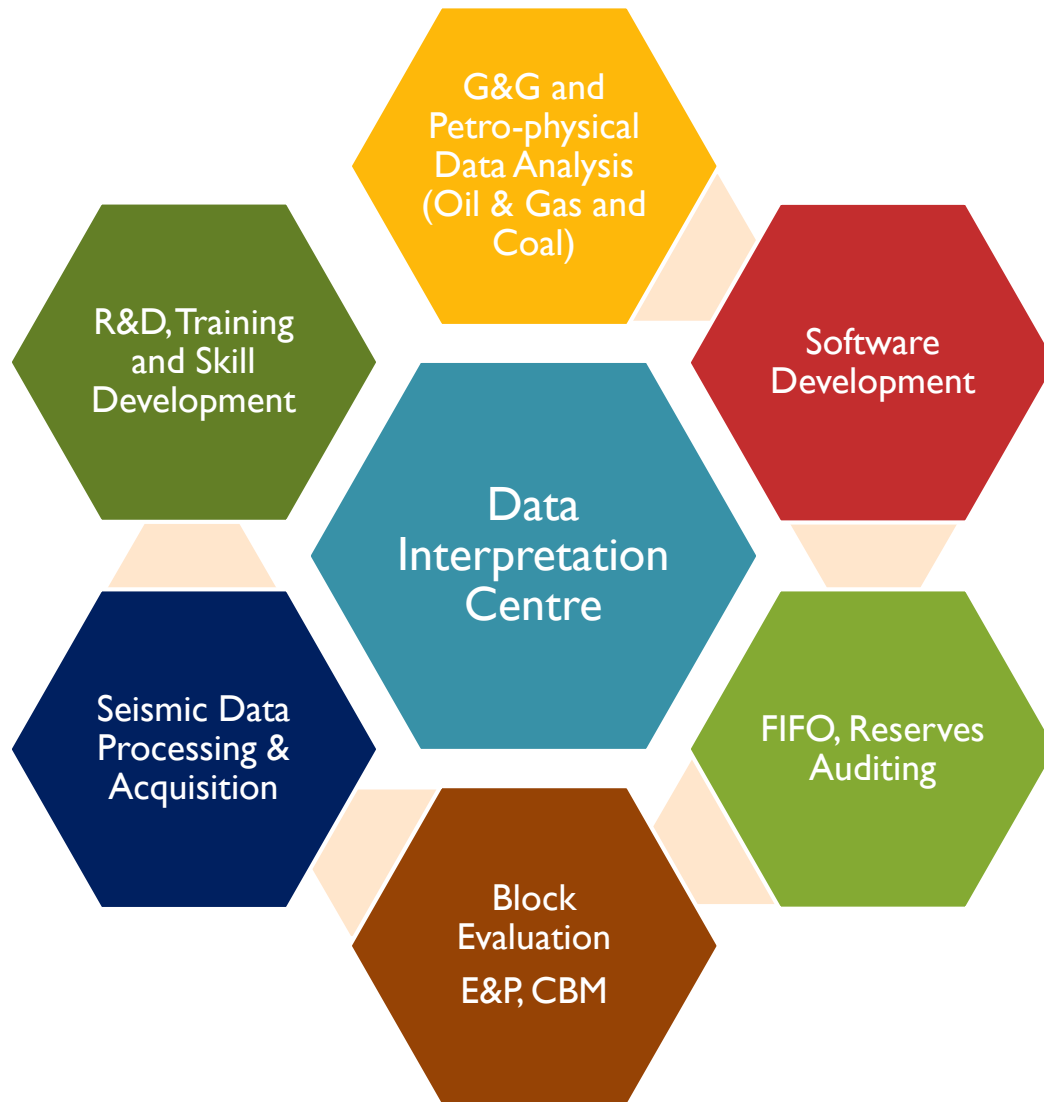
- About GERMI
- Seismic – A tool for Accelerated Coal Exploration
 - Role of Seismic
 - Seismic Attributes
 - Inversion Analysis
 - Application of CIL-SPE software for coal characterization
 - Coal Quality Parameter Estimation from Seismic Data

Gujarat Energy Research & Management Institute

About GERMI.....

- ▶ **Autonomous Body under the Government of Gujarat**
 - ▶ Promoted by Gujarat State Petroleum Corporation Limited (GSPC), a State PSU, with a mandate to provide R&D, Consultancy and Skill development in Renewable and Non Renewable Energy Sectors and Environmental Management
 - ▶ Created in 2004-5
- ▶ **Society** under the Societies Registration Act, 1860
- ▶ **Trust** under the Bombay Public Trust Act, 1950
- ▶ **Not for Profit**
- ▶ Recognized as a **Scientific and Industrial Research Organization** (SIRO) by Department of Scientific and Industrial Research (DSIR), Govt. of India.
- ▶ **Schedule-I Environmental Auditor** recognized by the Gujarat Pollution Control Board (GPCB).
- ▶ **Energy Auditor Consultant** recognized by the Gujarat Energy Development Agency (GEDA).
- ▶ **IT exemption** under Section 35(1)(ii), non-profit Trust & Society
- ▶ **ISO 9001:2015**

Data Interpretation Center (DIC) Activities



- ▶ **G&G Data Analysis**
 - ▶ Seismic Data Interpretation
 - ▶ Reservoir Characterization
 - ▶ Reserve estimations, Categorization, Certification and Auditing
- ▶ **Software Development/Scientific Computation**
 - ▶ Development through indigenous R&D efforts
 - ▶ Conversion of R&D output to Plugins (WLC, Monte Carlo Simulation)
- ▶ **Block Evaluation**
 - ▶ Discovery Small Fields
 - ▶ HELP, OALP blocks
 - ▶ Field Development Plans
 - ▶ CBM
- ▶ **Seismic Data Acquisition & Processing**
 - ▶ Advanced Algorithm
 - ▶ 2D/3D Seismic Processing
 - ▶ 2D/3D survey design Quality control
- ▶ **R & D**
 - ▶ Coal resource estimations using ICWT-Decon
 - ▶ Multidisciplinary approach
 - ▶ Deep Learning/ Artificial Intelligence
- ▶ **Training**
 - ▶ Skill Development & Workshops to Geoscientists
 - ▶ Internships to students
- ▶ **FIFO**
 - ▶ Farmin and Farmout of E&P Blocks

Seismic –A Tool for Accelerated Exploration

Introduction

- ▶ With the advancements in seismic reflection technology, the high resolution 2D/3D reflection seismic is currently being used by the coal industry, Globally, to accelerate the Coal Exploration to Mine planning.
- ▶ The main emphasis has been to define *coal extension, structure, Thickness, Thin seam mapping, accurate fault and fracture mapping and computing the density* of coals.
- ▶ **Coal resource estimation requires the estimation of coal quality parameters like *ash content, Insitu moisture and coal ranking* from limited bore wells and seismic data.**
- ▶ Deliberate designing of 3D seismic Acquisition, Advanced Processing and Interpretation provides, important parameters of the coal seams characterization, their extension and Ranking.

Introduction

- ▶ The characteristic physical property of coals is its exceptionally large acoustic impedance contrast with surrounding rocks results in distinct reflections.
- ▶ Often the limit of resolution of coal beds is closer to $\lambda/8$ rather than $\lambda/4$ and the limit of detection of coal seams is as small as $\lambda/40$.
- ▶ **Coal resource estimation requires the estimation of coal quality parameters from limited bore wells and seismic data. This problem needs developing of suitable techniques/work flows to resolve and segregate different layers and characterizing its content.**
- ▶ Advanced ML techniques will find a solution by developing work flows for integration of Seismic with Core and Log data.

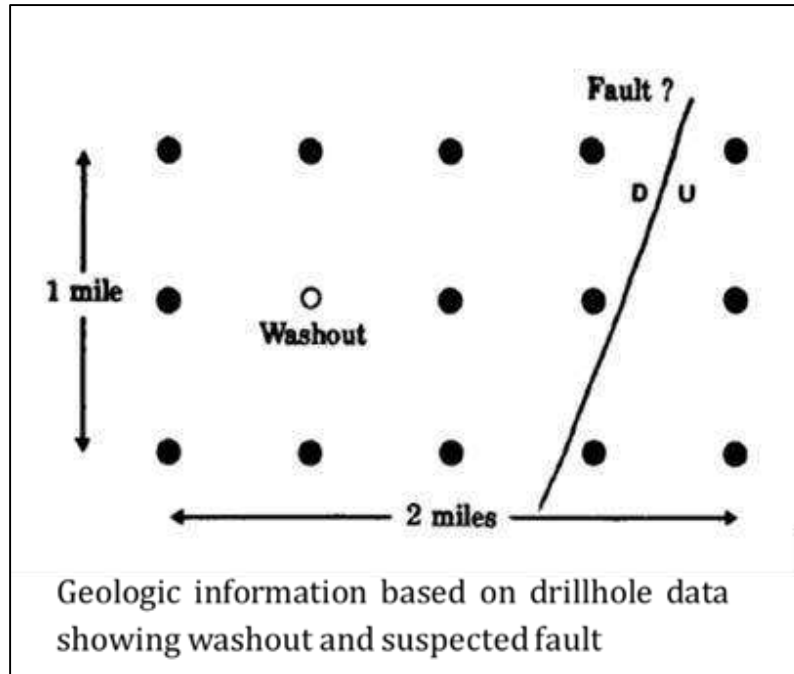
Seismic is a cost affective tool for accelerated Coal Exploration and Mine planning.

Key Parameters for Estimating Coal Resources – Role of Seismic

- ▶ **As Seismic API techniques continued to advance for oil and gas exploration, paved a way for coal characterization.**
- ▶ **The parameters like Structure, thickness and areal extension, faults and fracture Geometry, density, porosity and coal quality parameters like ash content, volatile matter and insitu moisture are required for coal resource estimation.**
- ▶ **The following table demonstrates the effective delineation of various geological properties of coals through seismic.**

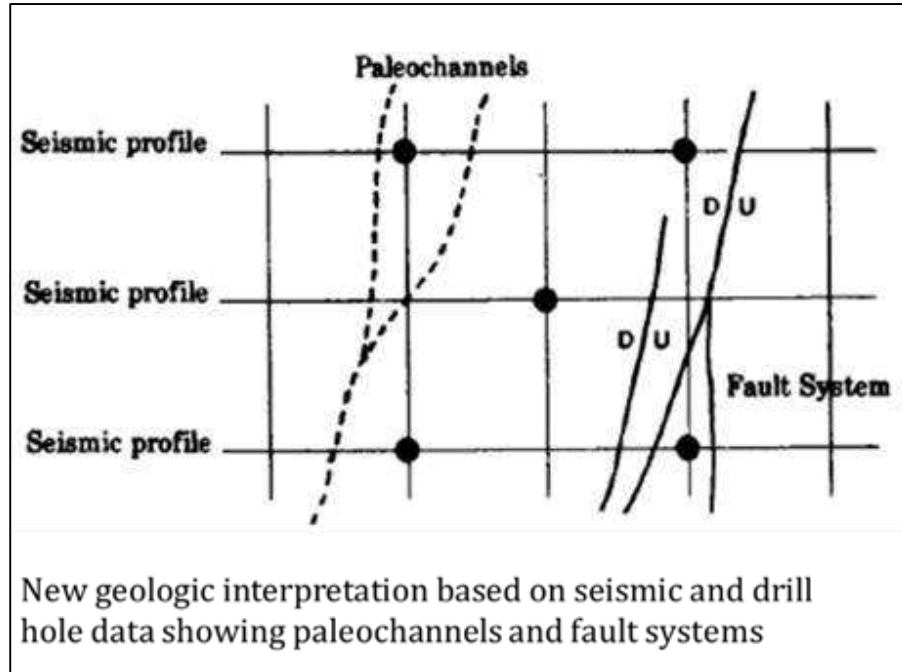
S.No.	Geological Properties	Seismic Properties
1.	Structure, Thickness and areal extent of coals	Detailed 3D volumetric image from PSTM/PSDM data, Physical attributes and Spectral Decomposition Techniques.
2.	Depth of Coal Seam	3D PSDM / PSTM seismic Data.
3.	Density, porosity and Permeability	Seismic AVO, Pre and Post-stack inversion and Log data.
4.	Brittleness, cleats architecture	Detailed 3D Seismic attributes like Curvature, Dip Semblance, Similarity and Coherency
5.	Faults and Fractures	3D Seismic Geometrical Attributes, Anisotropy from P-P data, P-SV Data
6.	Pore Pressure	Seismic inversion, Well log data and cross plots
7.	Stress and Orientation	Seismic attributes, Multi-component data
8.	Ash content, Moisture and Volatility	Log and Core data and cross plots
9.	Coal Volume (Resources)	Integration of Seismic, Core and Log data using static Modelling
10.	Gas in Place	Detailed integration of 3D Seismic, Log and Core using advanced data interpretation Techniques

Example of Seismic method applied to coal exploration



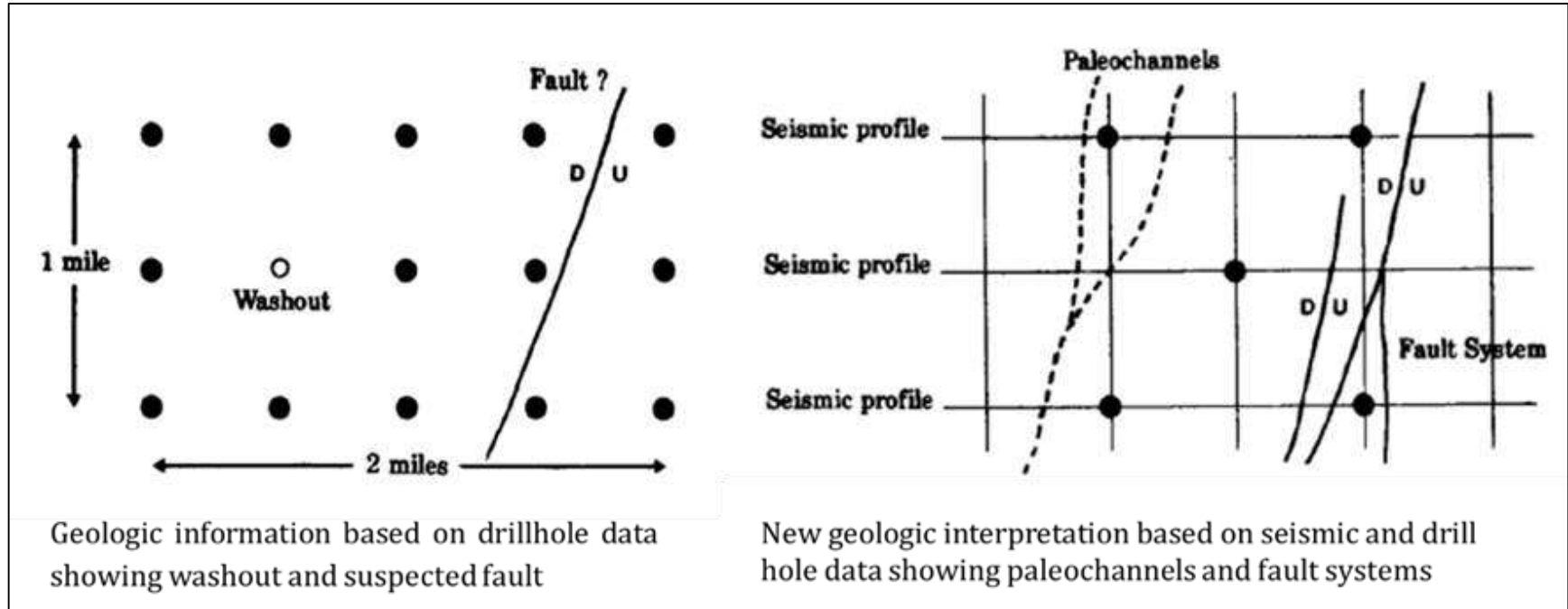
Seismic surveys for coal exploration and mine planning with combined high-resolution seismic and drilling programs have proved cost-effective. The above example by Lawrence M Gochioco, (1990) shows how a 2D seismic survey, using only five boreholes for correlation, would yield detailed information about complex faulting systems as well as mapping the course and meander of paleo channels against drilling of 15 drill wells in 2 sq. miles for the initial investigation.

Example of Seismic method applied to coal exploration



Seismic surveys for coal exploration and mine planning with combined high-resolution seismic and drilling programs have proved cost-effective. The above example by Lawrence M Gochioco, (1990) shows how a 2D seismic survey, using only five boreholes for correlation, would yield detailed information about complex faulting systems as well as mapping the course and meander of paleo channels against drilling of 15 drill wells in 2 sq. miles for the initial investigation.

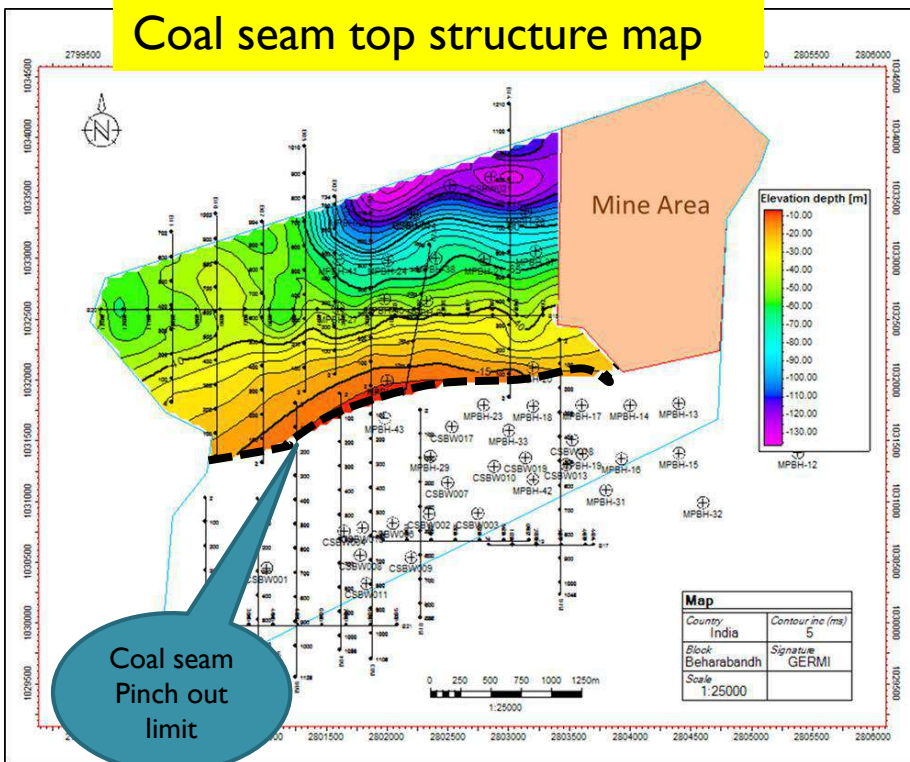
Example of Seismic method applied to coal exploration



Seismic surveys for coal exploration and mine planning with combined high-resolution seismic and drilling programs have proved cost-effective. The above example by Lawrence M Gochioco, (1990) shows how a 2D seismic survey, using only five boreholes for correlation, would yield detailed information about complex faulting systems as well as mapping the course and meander of paleo channels against drilling of 15 drill wells in 2 sq. miles for the initial investigation.

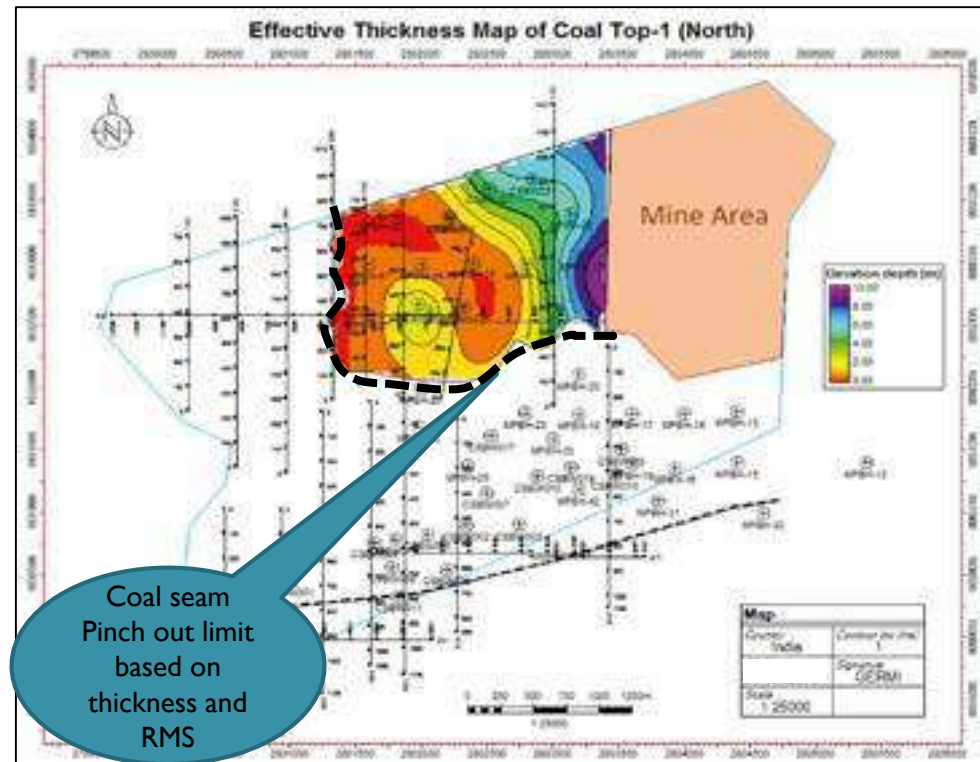
Structure and Thickness Maps

Coal seam top structure map



Coal seam
Pinch out
limit

Effective Thickness Map of Coal Top-1 (North)

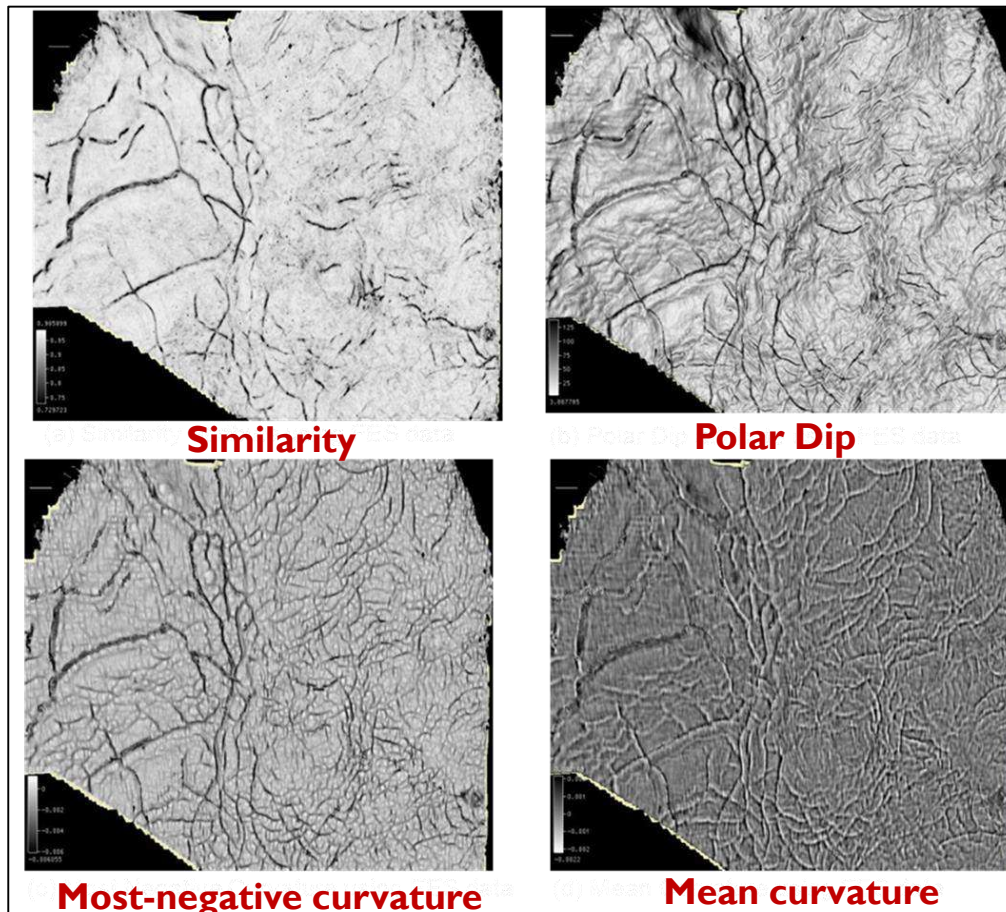


Coal seam
Pinch out limit
based on
thickness and
RMS

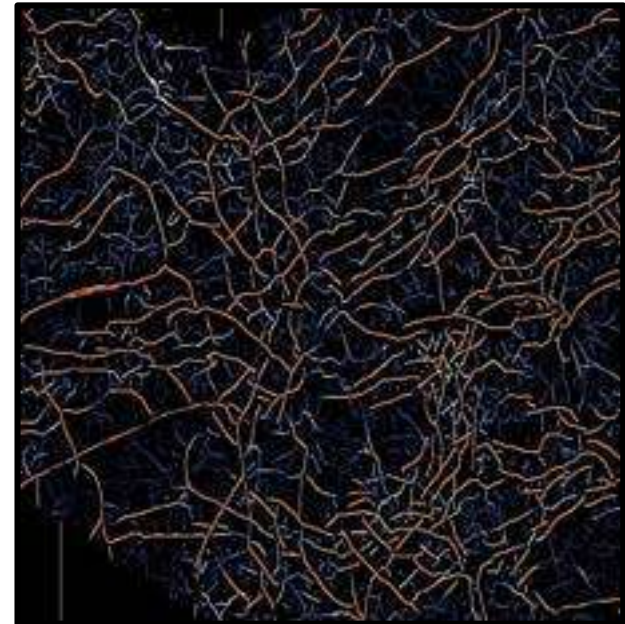
- Introduction of 3D seismic data will enhance the delineation structure mapping, thickness, discontinuities like pinch-outs, Faults and fractures, density and porosity, extension of coal seams.
- *This will be more accurate when integrated with limited number of bore wells*
- This is an example from our study in Behrabandh

Fault Delineation

- ▶ The seismic geometric attributes like Curvature, Dip, Semblance, Similarity and Coherence, Thinned Fault Likelihood etc., brings out the fault geometry integrating with fault mapping of individual coal seams.



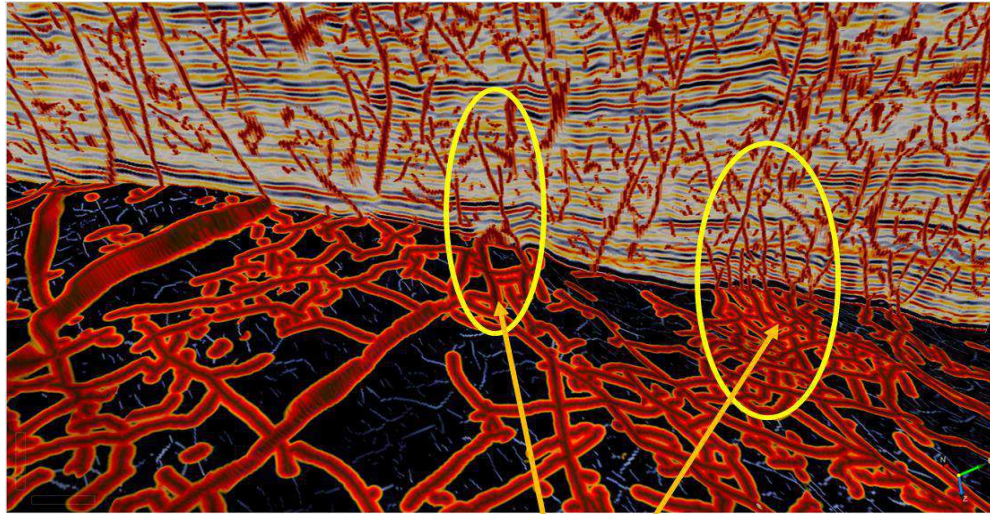
Thinned Fault Likelihood attribute



Integrated interpretation using combination of structural attributes leads to precise Fault & Fracture Characterization.

Fracture Proximity & Density attributes

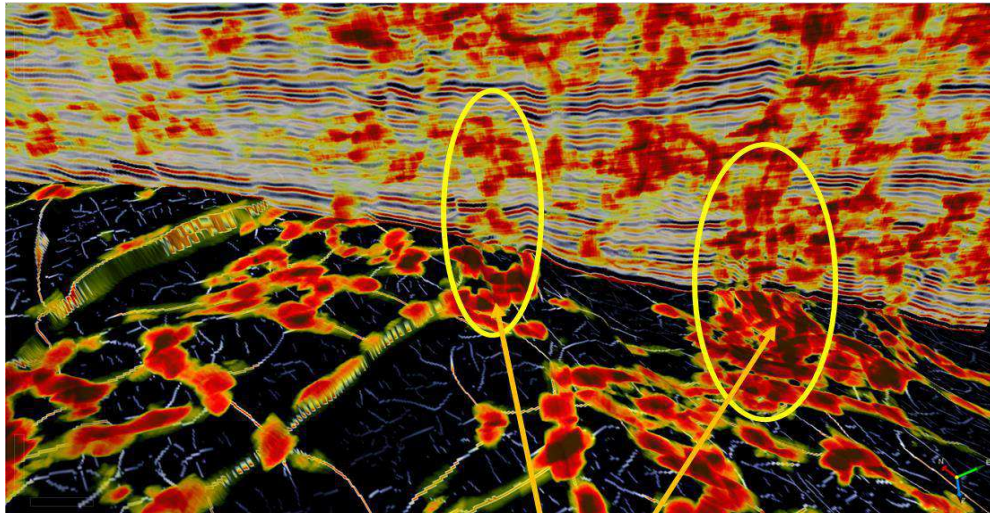
This attribute is more useful for mapping cleats.



Zones with most Fracture Proximity

Fracture Proximity

- Fracture proximity is a useful tool in visualizing the fault/fracture network and connectivity between them.
- Connected fault/fracture network and proximal fracture zones have been depicted using this attribute and some of them are indicated with arrow mark.

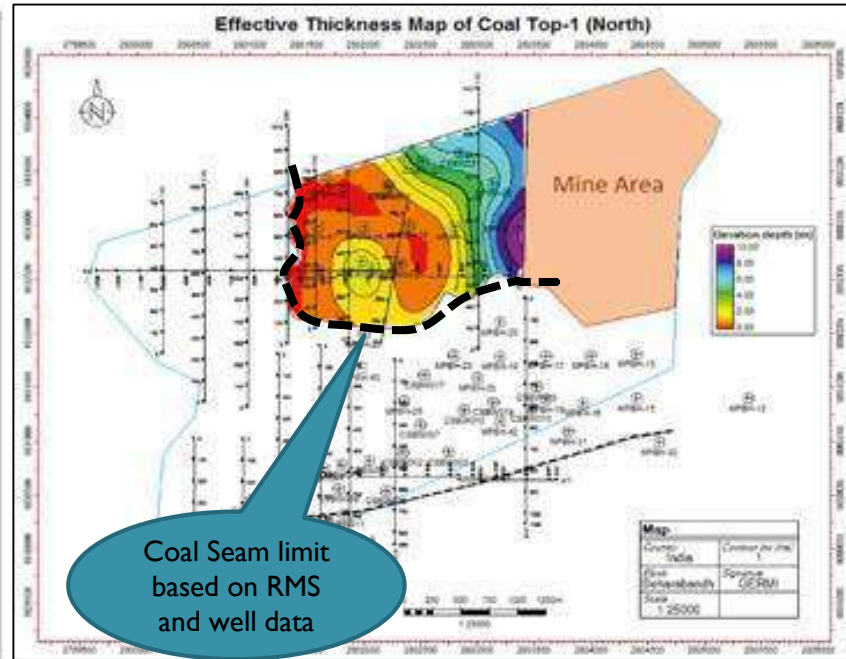
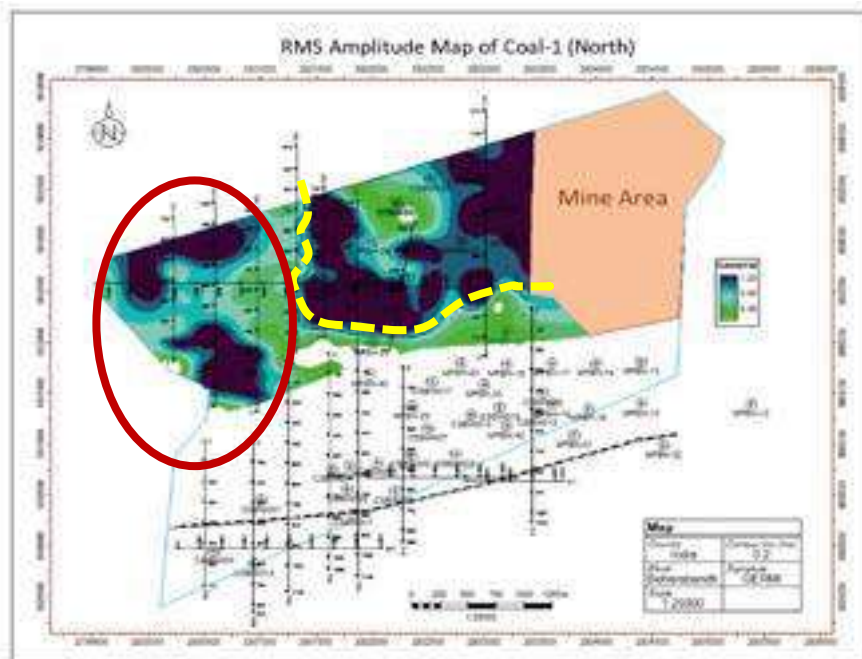


Zones with high Fracture Density

Fracture Density

- Fracture Density is useful for highlighting the fracture concentration within a user-defined radius.
- Higher Fracture Density zones have been brought out through this attribute and coincide with most proximal fracture zones corresponding to the densely connected network of faults & fracture.

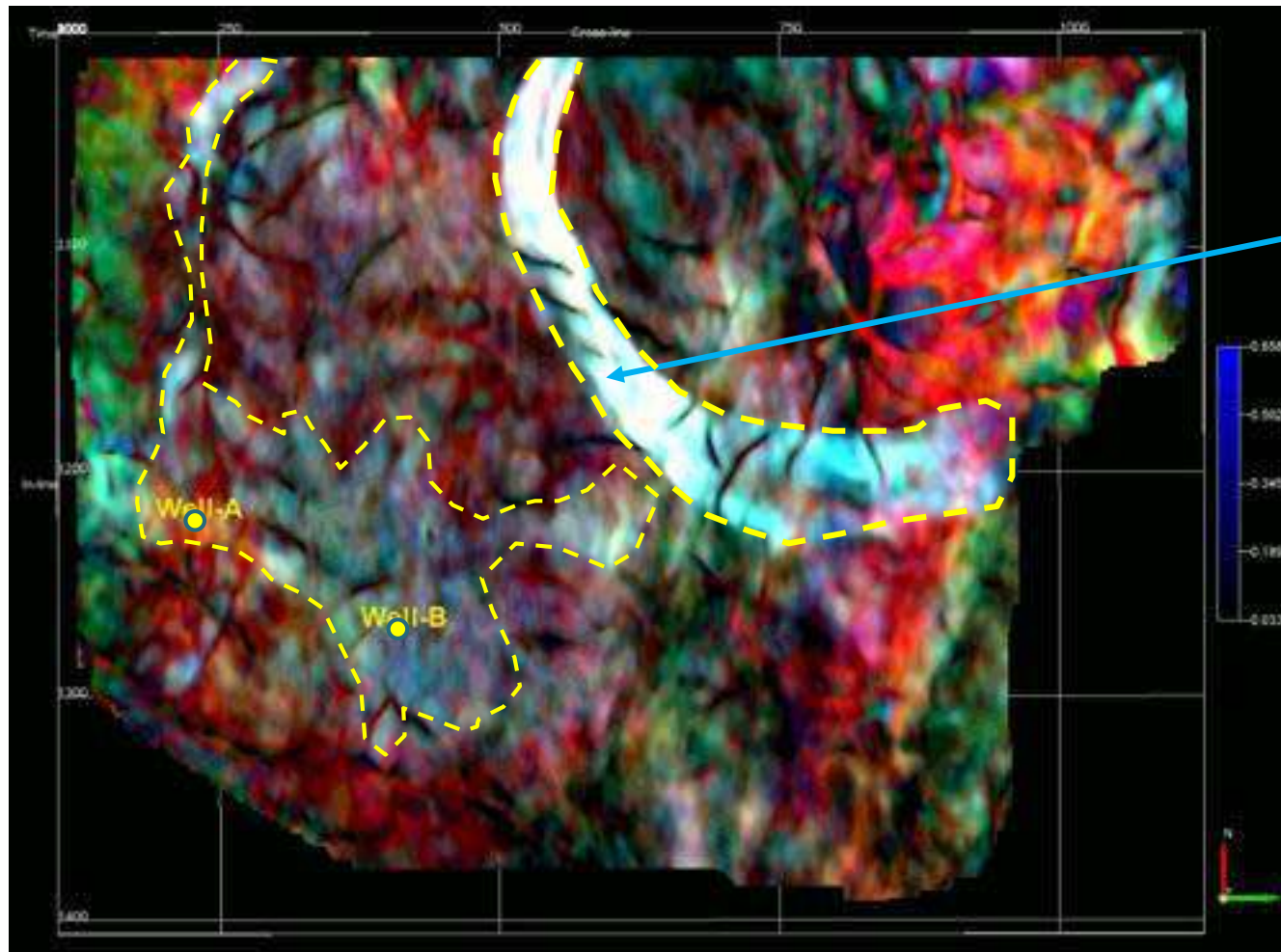
Seismic Attributes : RMS Amplitude



Coal Seam limit
based on RMS
and well data

- RMS amplitude map indicates the High RMS amplitude in coal seam area in the central and eastern part of the area.
- The coal thickness is increasing towards the Behraband area, which is clearly indicated in the RMS map and the coal thickness map
- However the high amplitude in the eastern part is due to interference of Dolerite.

Seismic Attribute : Spectral Decomposition and RGB Blending at 24Hz, 36Hz and 44 Hz Frequencies



Channel complex

An RGB blend of spectral frequencies 24Hz, 36Hz and 44Hz extracted onto the top EP-IV surface indicating channel. RGB blending displayed majority of the channel with bright white color, indicates containing all three frequencies.

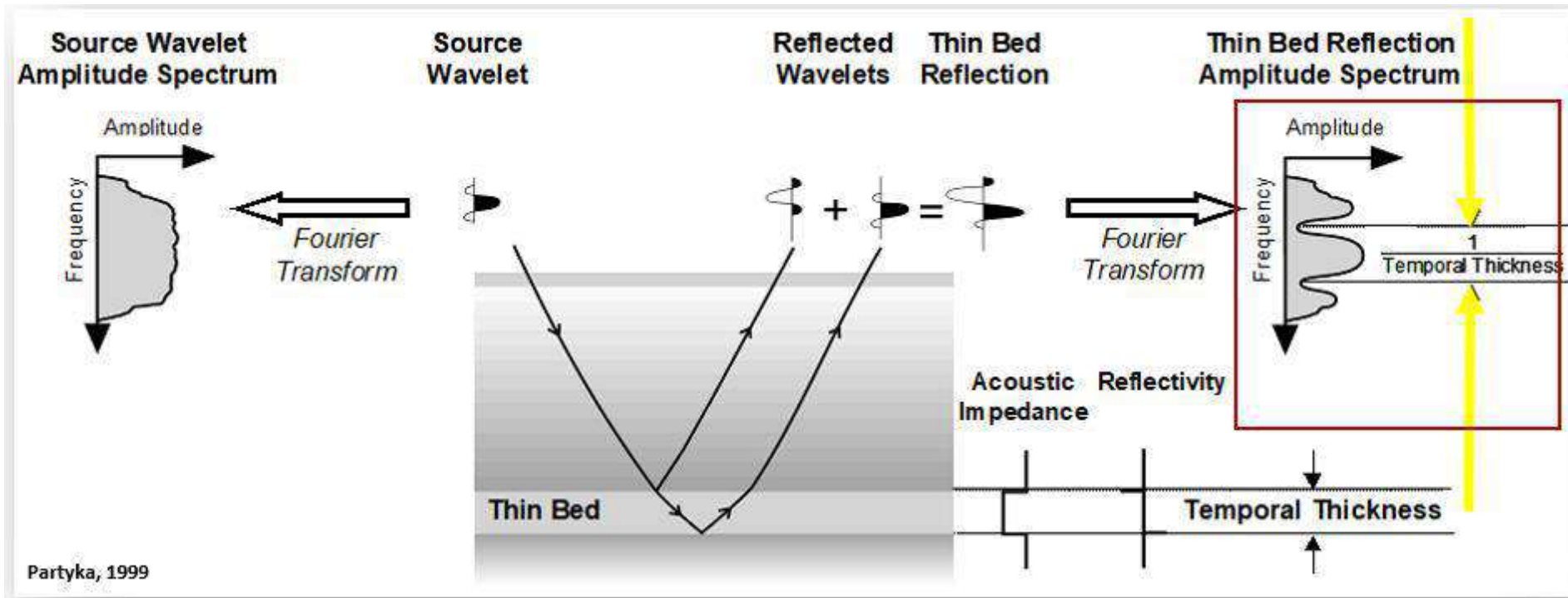
Estimation of Thickness through Spectral Decomposition Technique



- ▶ The Thickness can be estimated through Spectral Decomposition techniques. Spectral Decomposition technique divides entire frequencies spectrum into a unique frequency volumes.
- ▶ Tuning frequencies are extracted and tuning thickness (time) is estimated using first peak frequency.
- ▶ Tuning Depth thickness is computed using time tuning thickness and interval velocity.

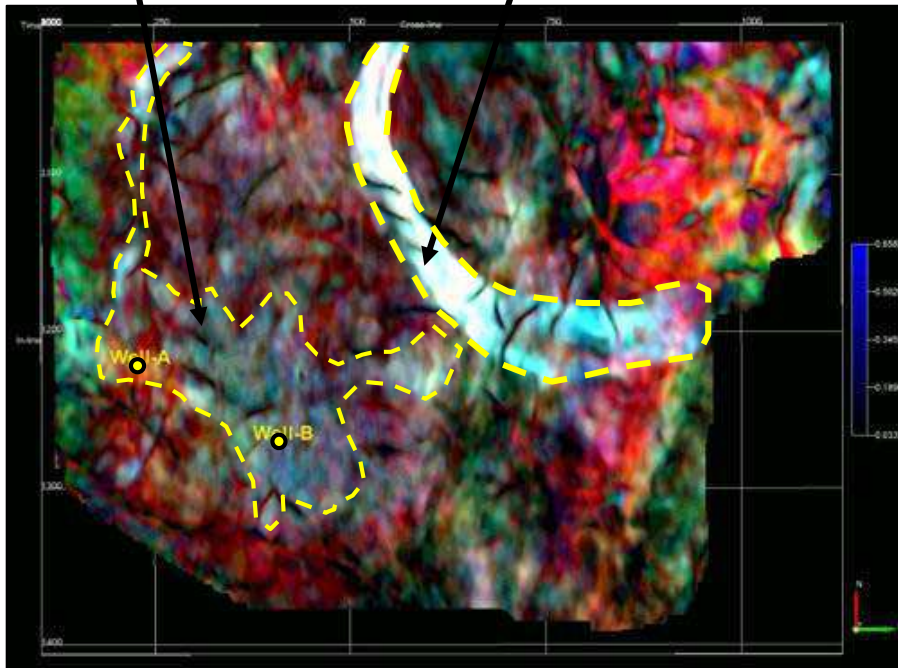
Spectral Decomposition – Methodology for thickness estimates

- Spectral decomposition is used as the time-frequency analysis and found wide range of applications in seismic analysis including estimation of thickness of layers. The thickness of layers is estimated using following workflow :
 - Computation of various frequency cubes from Continuous Wavelet Transform (CWT) based spectral decomposition using the morlet wavelet.
 - Computation of First Spectral peak to compute the tuning thickness in Time.



Estimation of Thickness of Coal (Kalol formation of Cambay) through Spectral Decomposition Technique

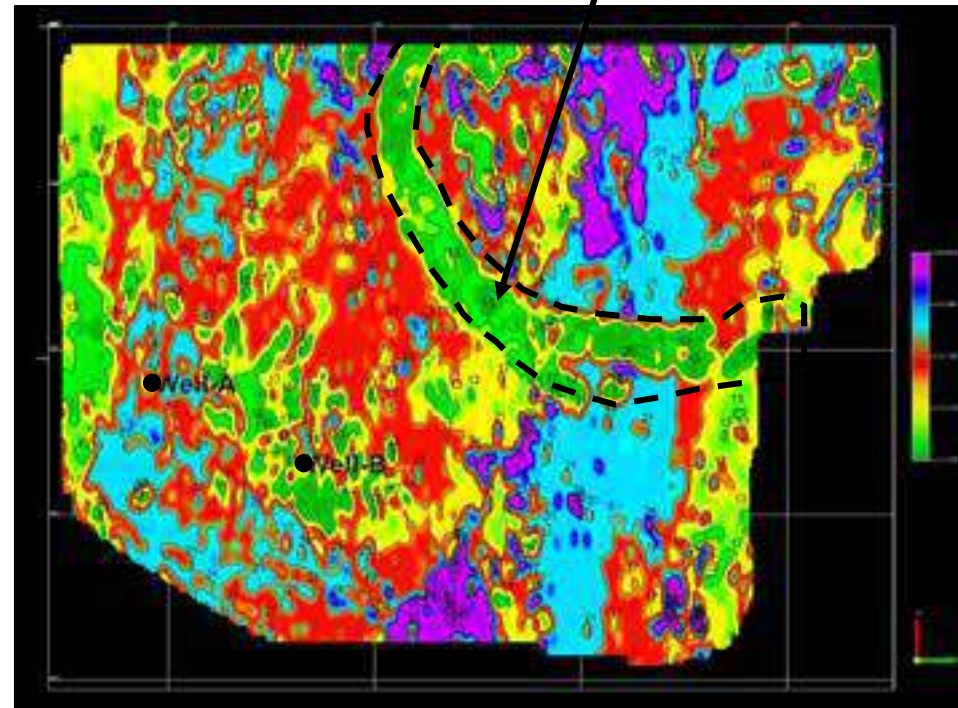
Crevasse splay Channel complex



RGB Blending at 24Hz, 36Hz and 44 Hz
Frequencies

Tuning Depth thickness has been computed using Tuning Time Thickness. Thickness at well A is 14.25m and Well B is 18m. Tuning Depth thickness from map at well A is 16m and well B is 17m.

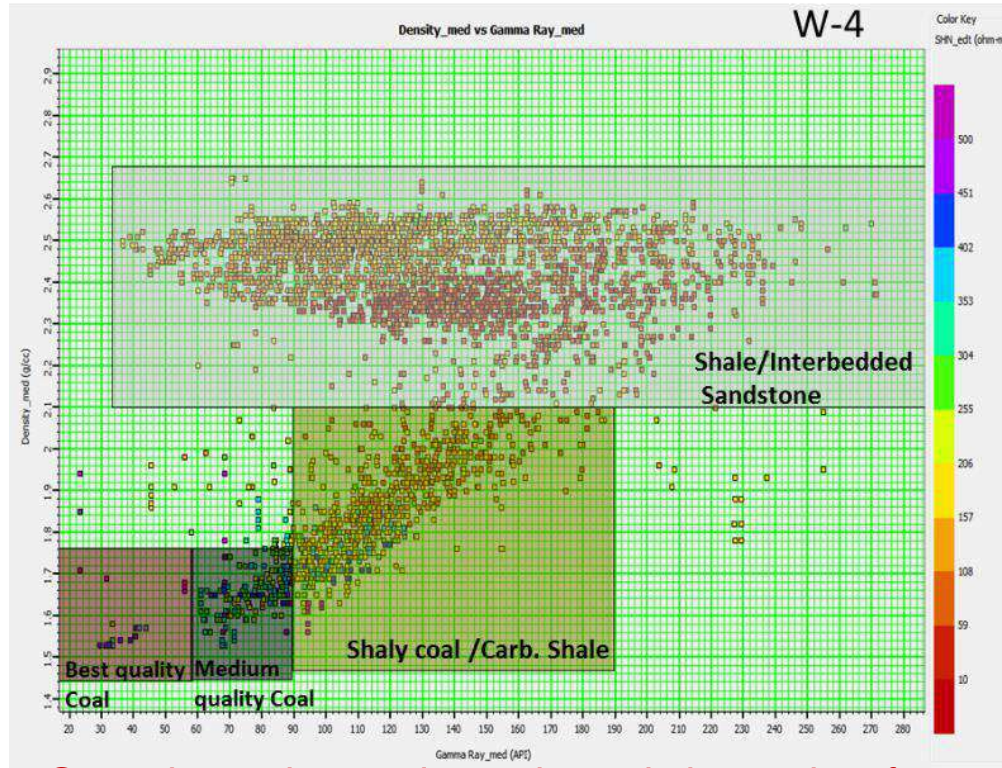
Channel complex



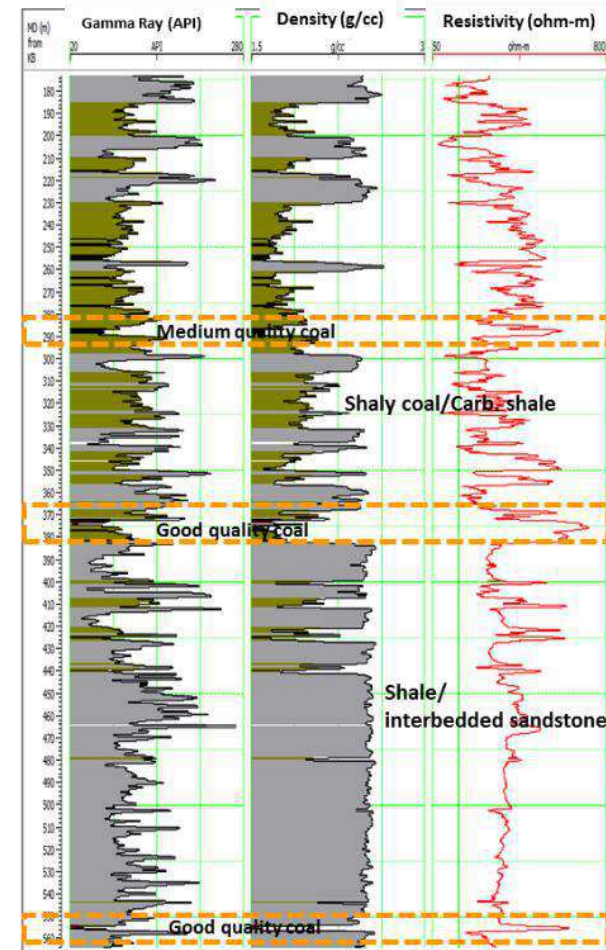
Tuning Thickness estimated through spectral
decomposition technique

Spectral Decomposition techniques coupled with log data for calibration can lead to precise thickness mapping

Coal identification and categorization/ranking



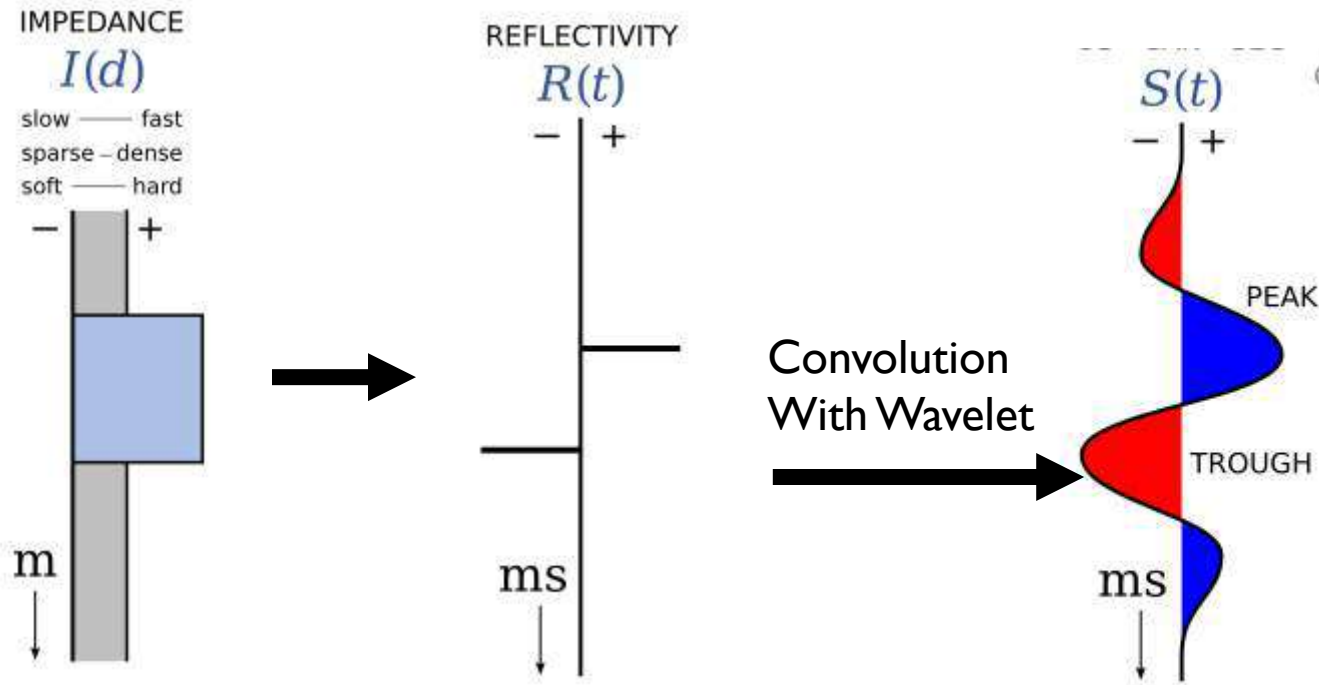
Crossplot analysis and correlation helps in identifying the coal and intermittent shales in the area.



- Coal identification and categorization/ranking using well log data.
- Through the cross-plotting analysis based on the Density, GR and Resistivity log properties, different categories of coal such as best quality coal, medium quality coal, Shaly coal could be identified.

Coal Characterization using Inversion Analysis

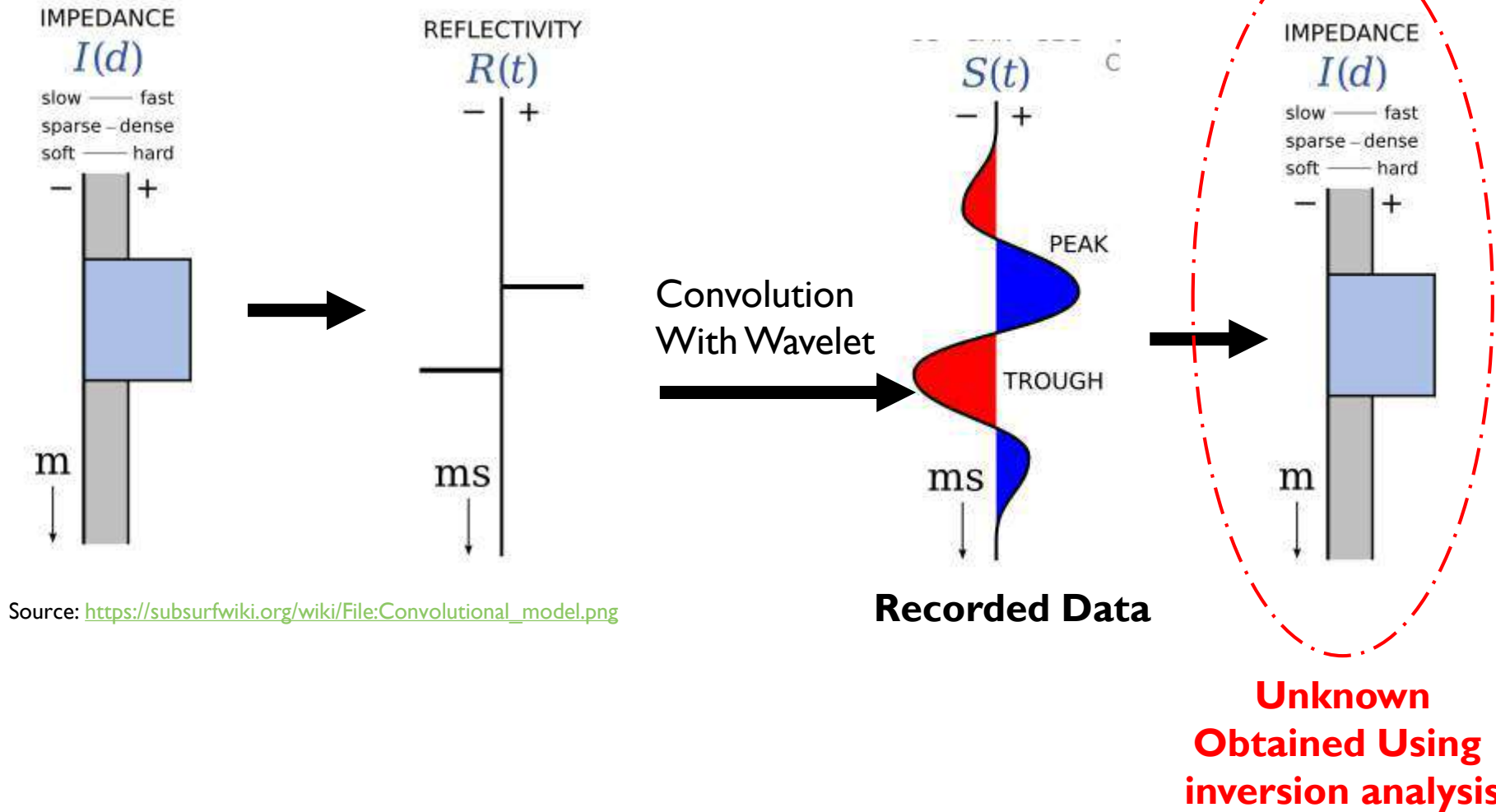
Convolution Model



Source: https://subsurfwiki.org/wiki/File:Convolutional_model.png

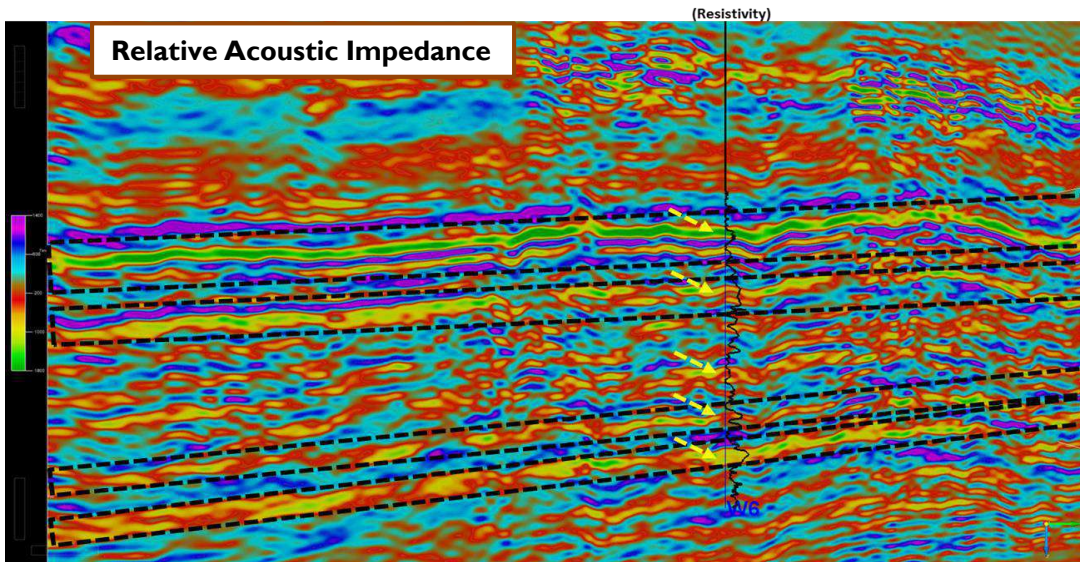
Recorded Data

Convolution Model

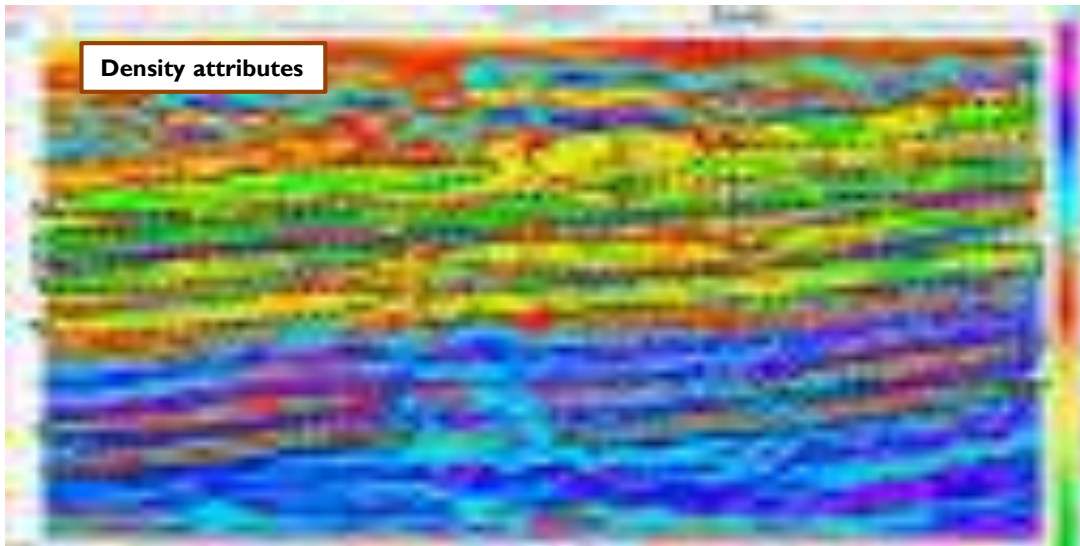


Source: https://subsurfwiki.org/wiki/File:Convolutional_model.png

Acoustic Impedance and Density attributes



- Relative Acoustic Impedance section of 2D line passing through well along with the resistivity log curve overlain on the section.
- Individual coal units as observed from the resistivity log, appears to match reasonably well with the Relative Acoustic Impedance section.



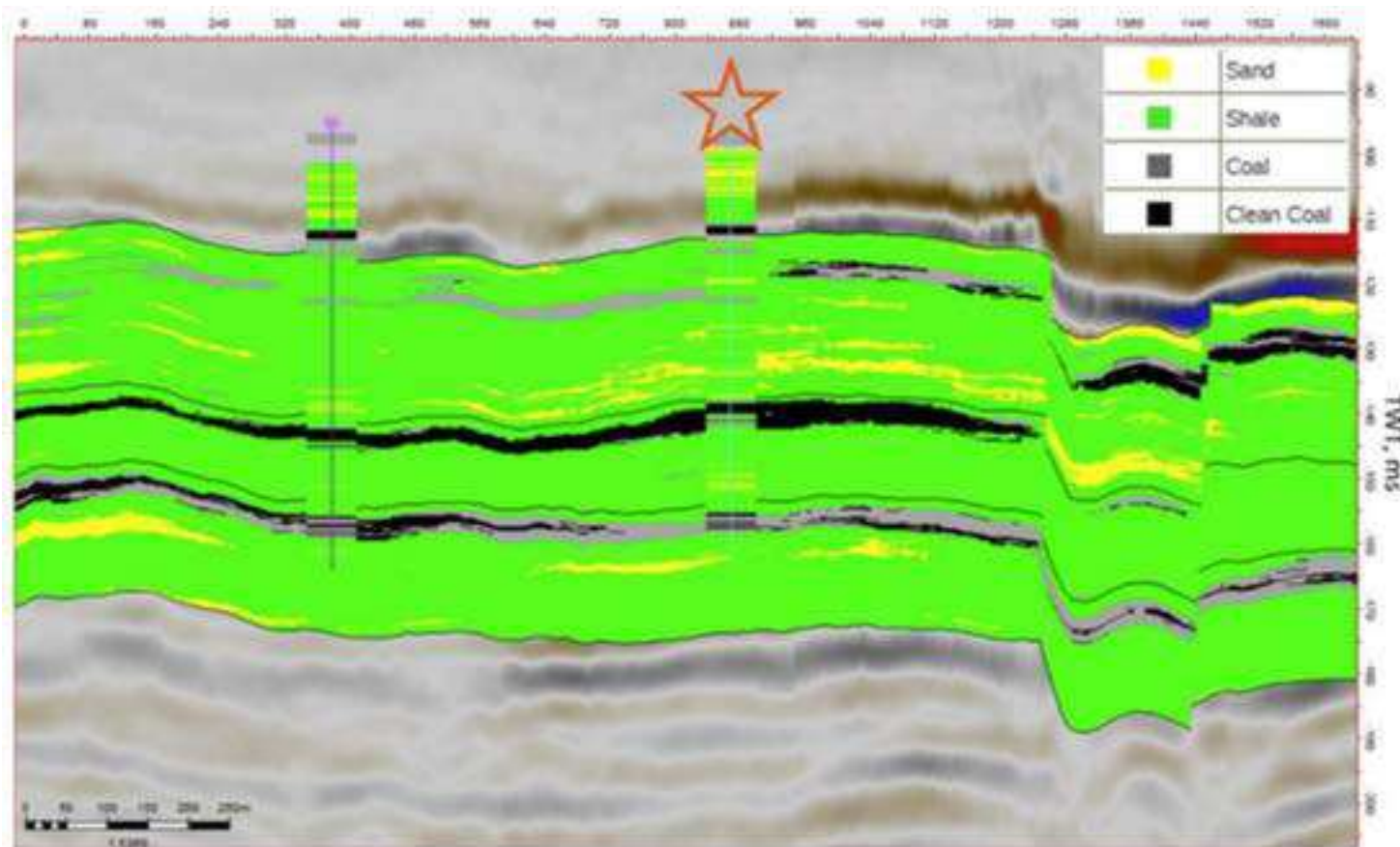
- Density attribute section computed from the P-impedance using relationship derived from well log data.
- Very good match between the Density log and computed Density attribute is observed at the well location.
- Low density zones are probable coal zones and marked by dotted black shapes. Better coal quality is expected with lower Density, as has been observed from the well log cross-plot shown in previous slide.

Seismic Inversion

- ▶ Seismic Inversion analysis also plays important role in bringing layer properties by bringing out impedance from inverting seismic and well data.
- ▶ Geostatistical inversion can also improve the resolution and directly provide attributes for model filling by combining several data.
- ▶ During inversion process, multiple plausible models of log properties are generally created using Pdfs, variograms, etc., while minimizing the mismatch with the seismic data. At the fine scale, inversion is highly non-unique, but the generated multiple high-frequency realizations can quantify this non-uniqueness.

Geostatistical Inversion

Seismic section showing most probable facies from Geostatistical Inversion of shallow coal targets (M. Palova (2020)). The good match of coal thickness (below seismic resolution) was found at the blind well. The log of the blind well is indicated by start mark.



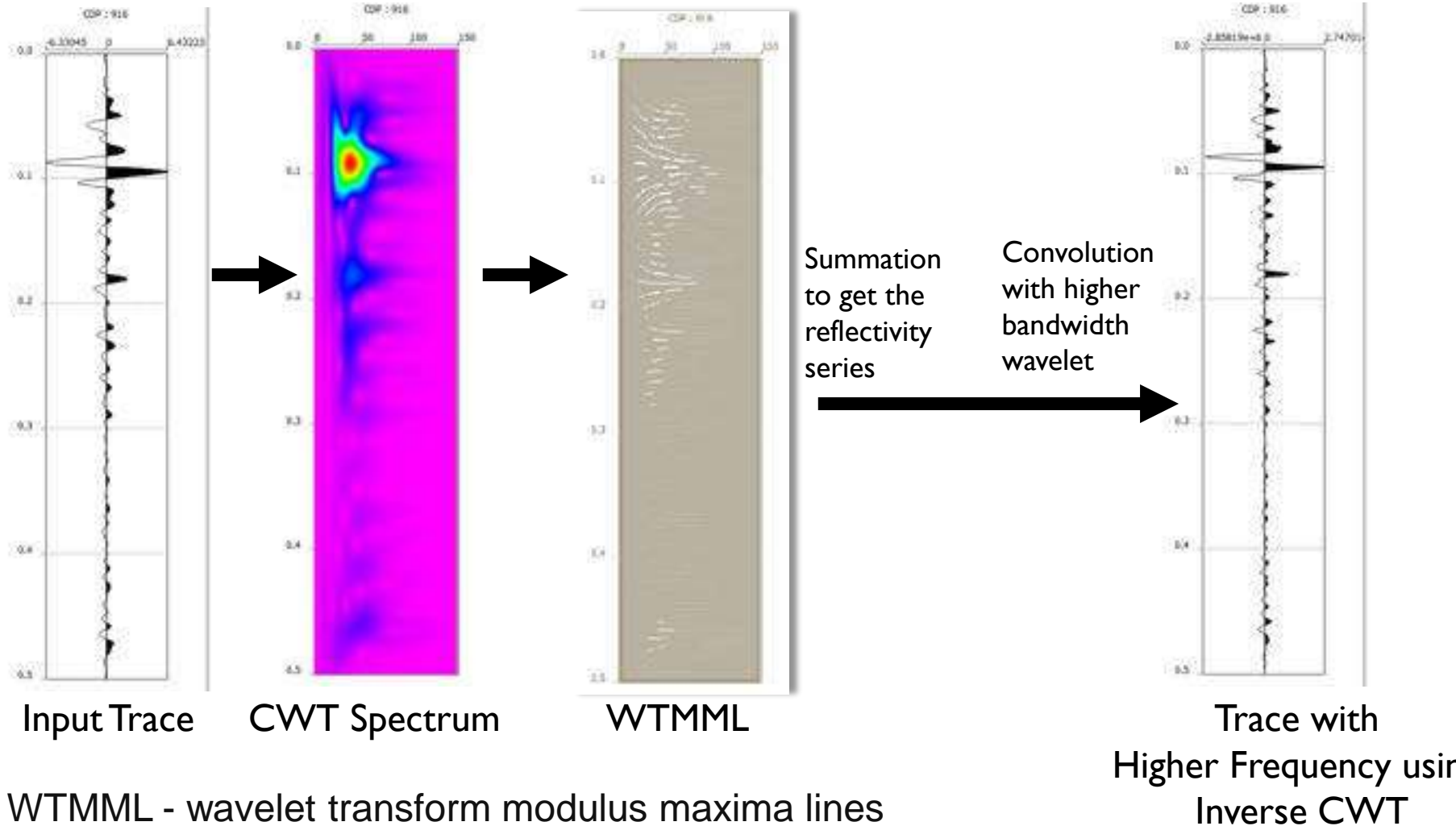
Spectral Enhancement Software-SPE

Developed under collaborative Research Project between
GERMI and CMPDI

***“Seismic Data Processing, Interpretation and Identification
of thin Coal seams using Inverse Continuous Wavelet
Transform Deconvolution for Resource Estimation”***

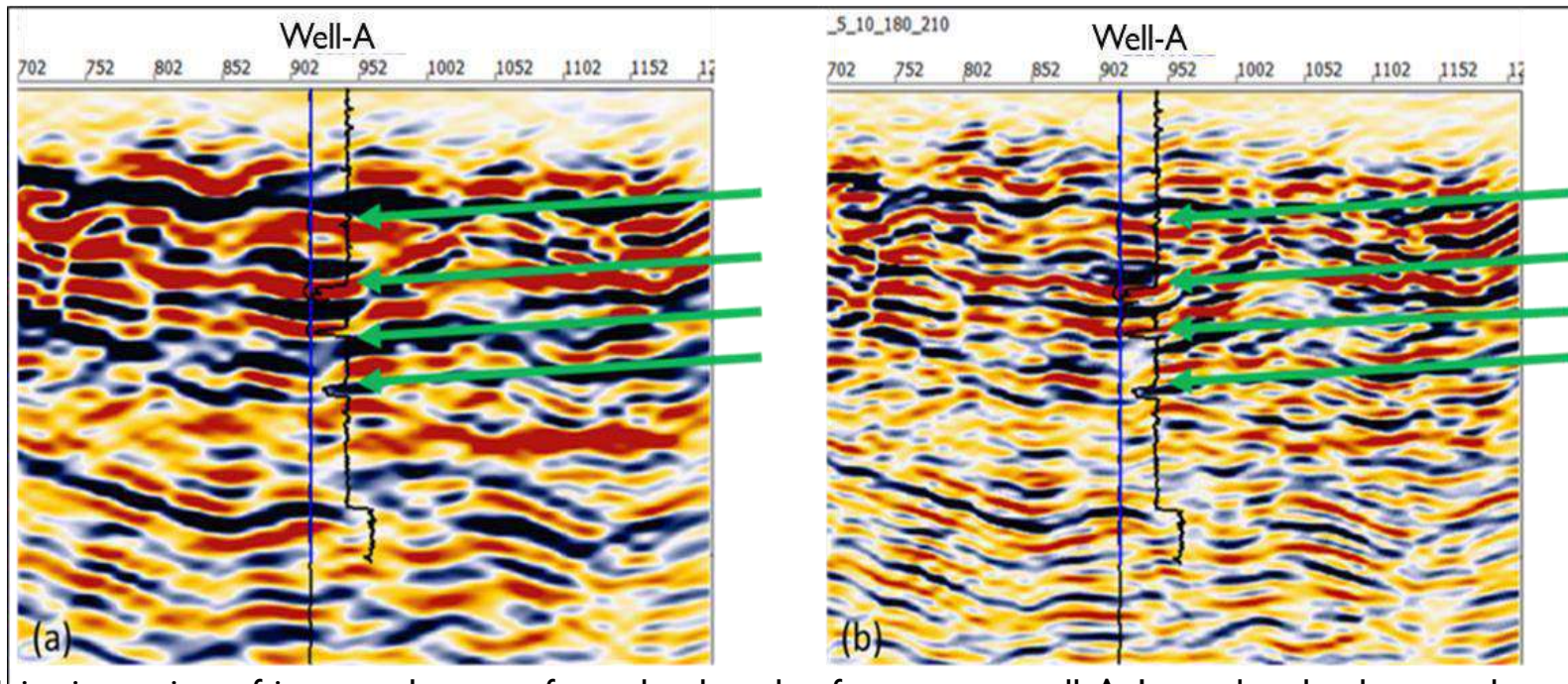
***This software is recently released by the
R&D Board of CIL.***

WTMML Based Spectral Enhancement



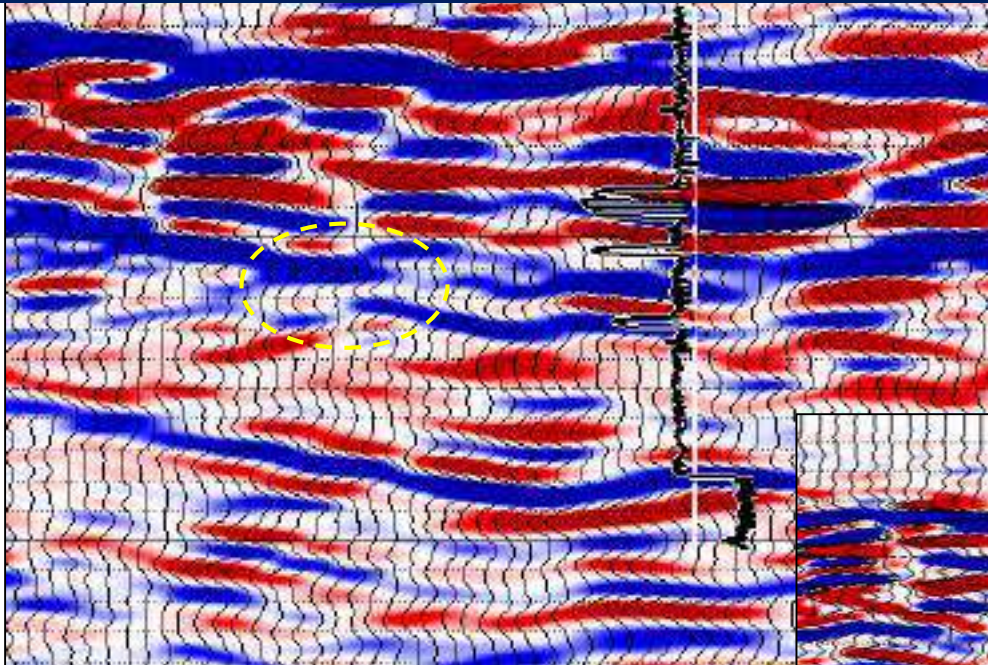
CIL SPE – Collaborative software developed GERMI and CMPDI

- ▶ The technique of Spectral Bandwidth Enhancement (SPE) using Continuous Wavelet Transform is developed, which can improve the resolvability of seismic data using the Holder exponents to distinguish singularities that are due to a change of facies from those of noise.



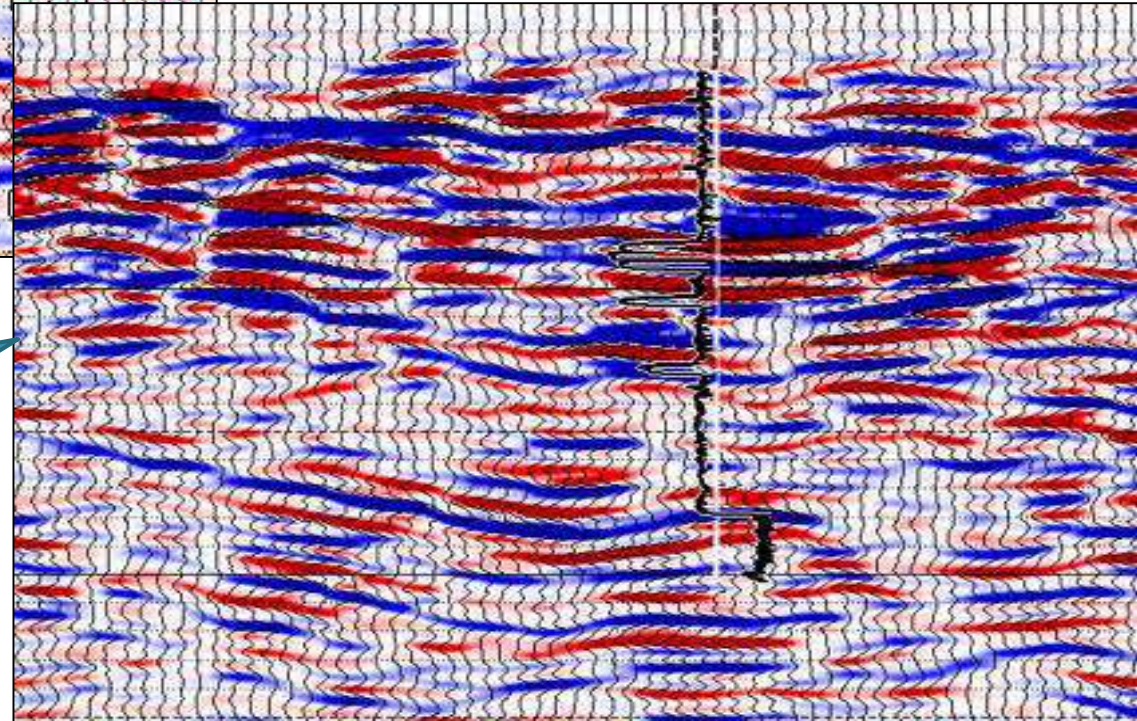
Seismic section of input and output from developed software near well A. It can be clearly seen that the developed software has increased the frequency content of the seismic dataset. Green arrows show some of the improved reflections with improved resolution. This demonstrates that developed software (b), helps in resolving thin coal seams.

Conditioned Seismic and Spectral Enhanced (SPE) Seismic Section



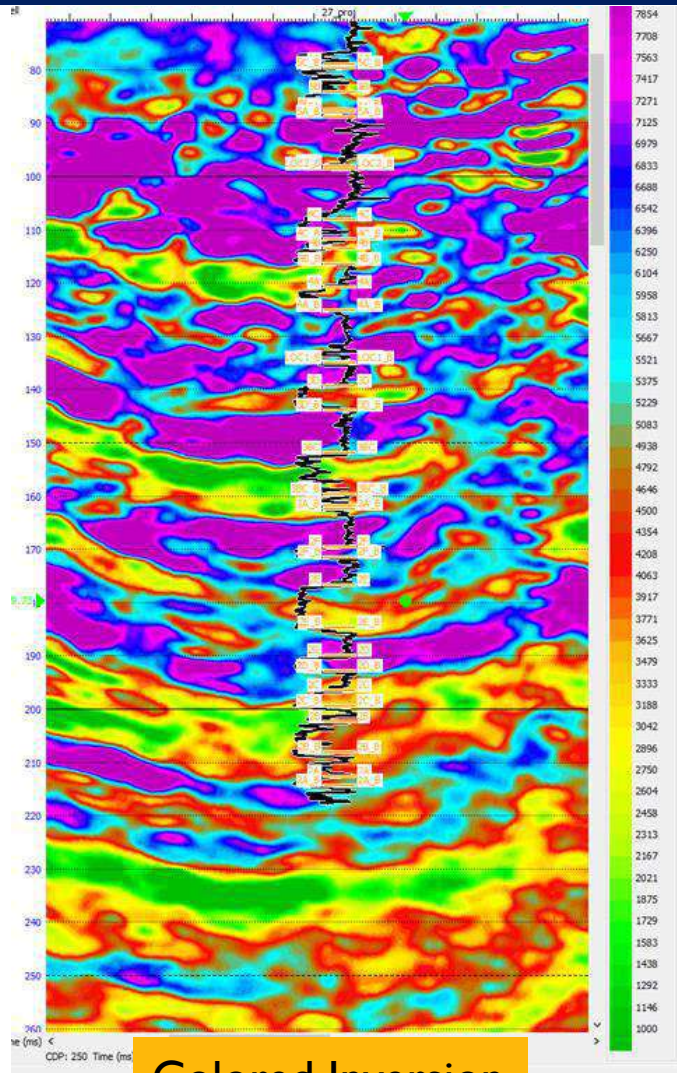
Conditioned nad
conventional
processed section

Conditioned and
conventional
processed section
with Spectarl
Enhancement applied

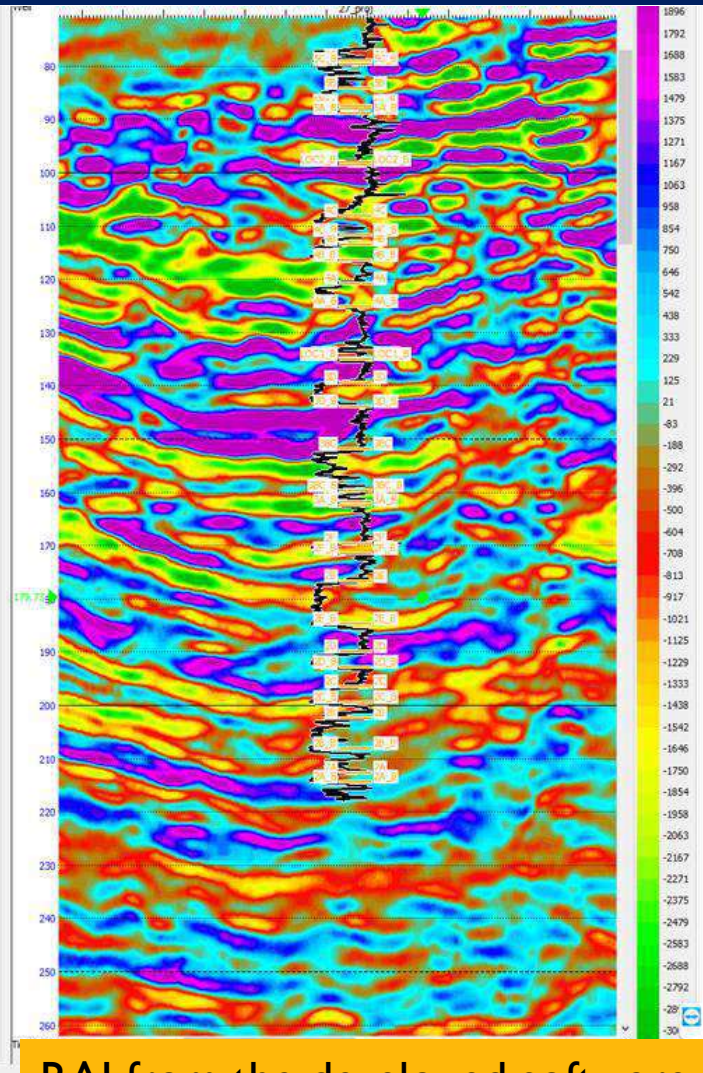


Spectral Enhanced (SPE) Seismic

Comparison of Relative Acoustic Impedance from developed software and Colored Inversion

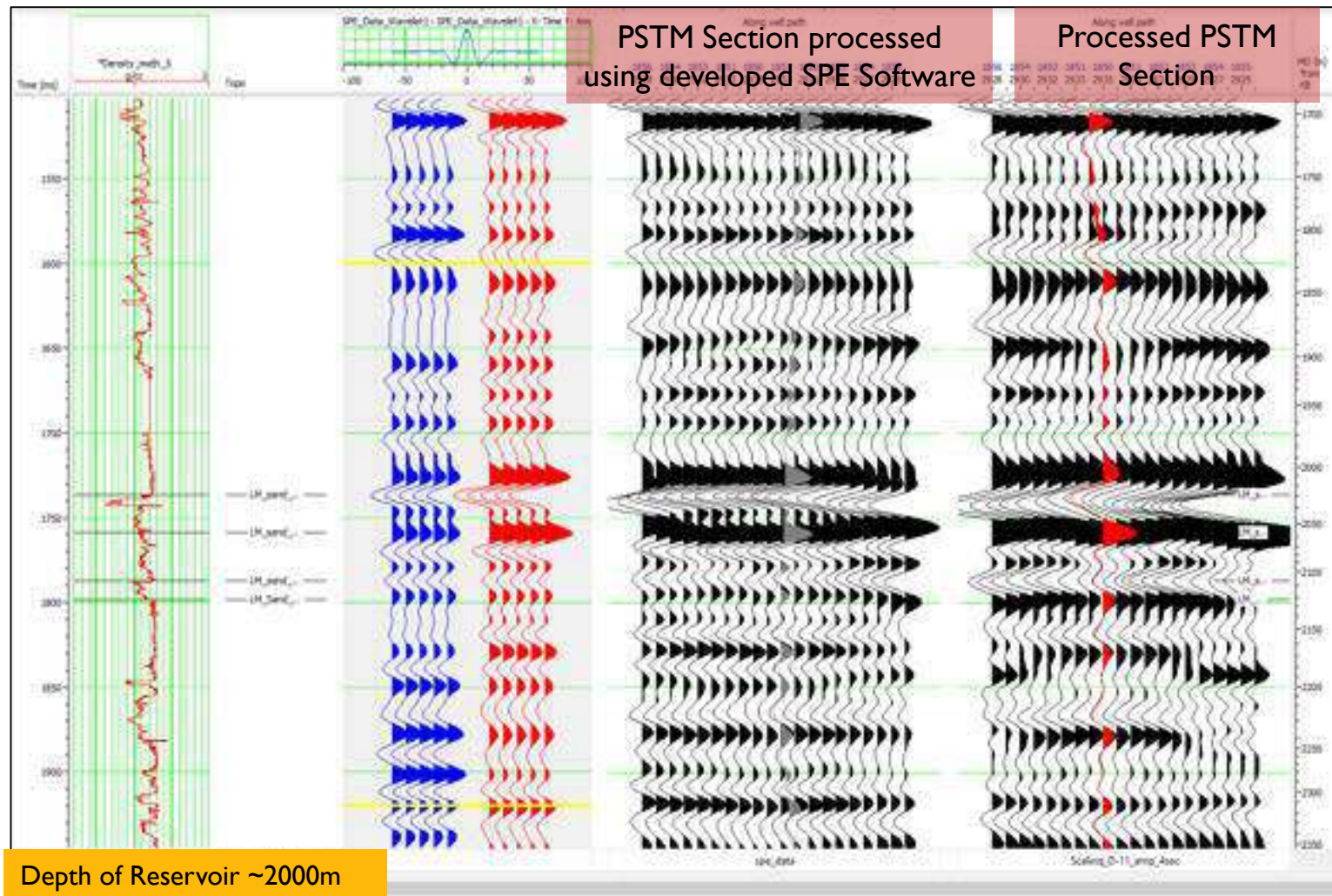


Colored Inversion



RAI from the developed software

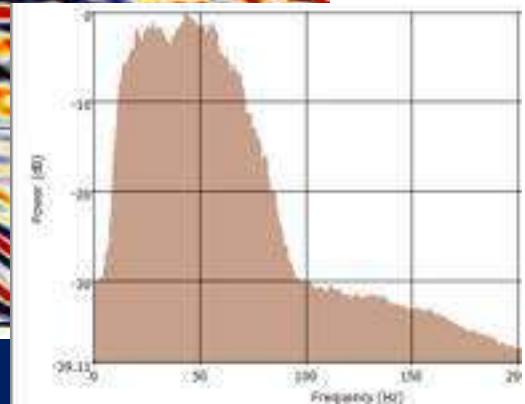
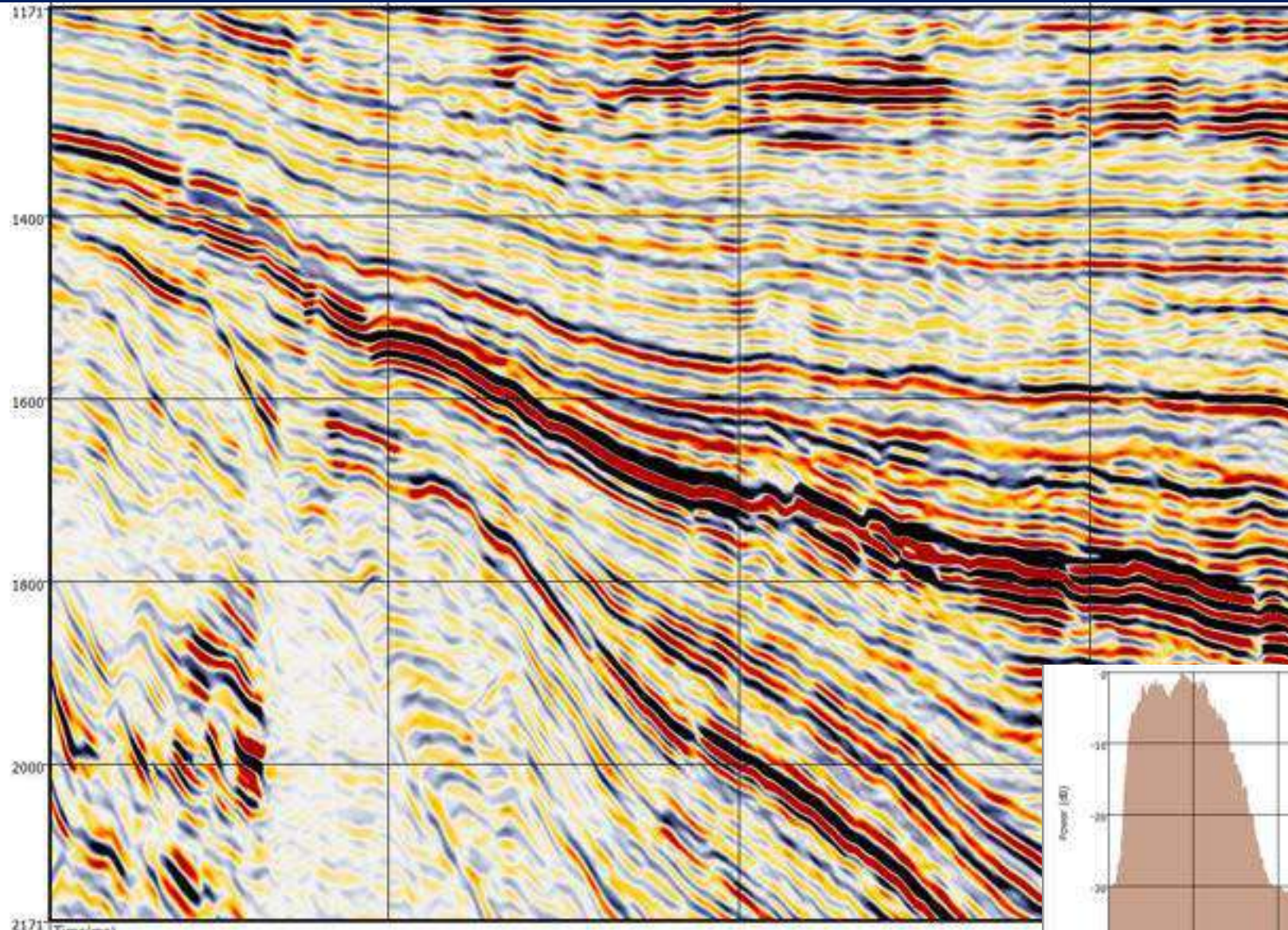
Enhancement of Spectrum for delineation of coals and thin sands through recently developed SPE software



The figure indicates the synthetic is derived from the density and sonic log. Whereas, seismic processed with SPE is clearly indicating the data is close to synthetic data and is comparable with the log data.

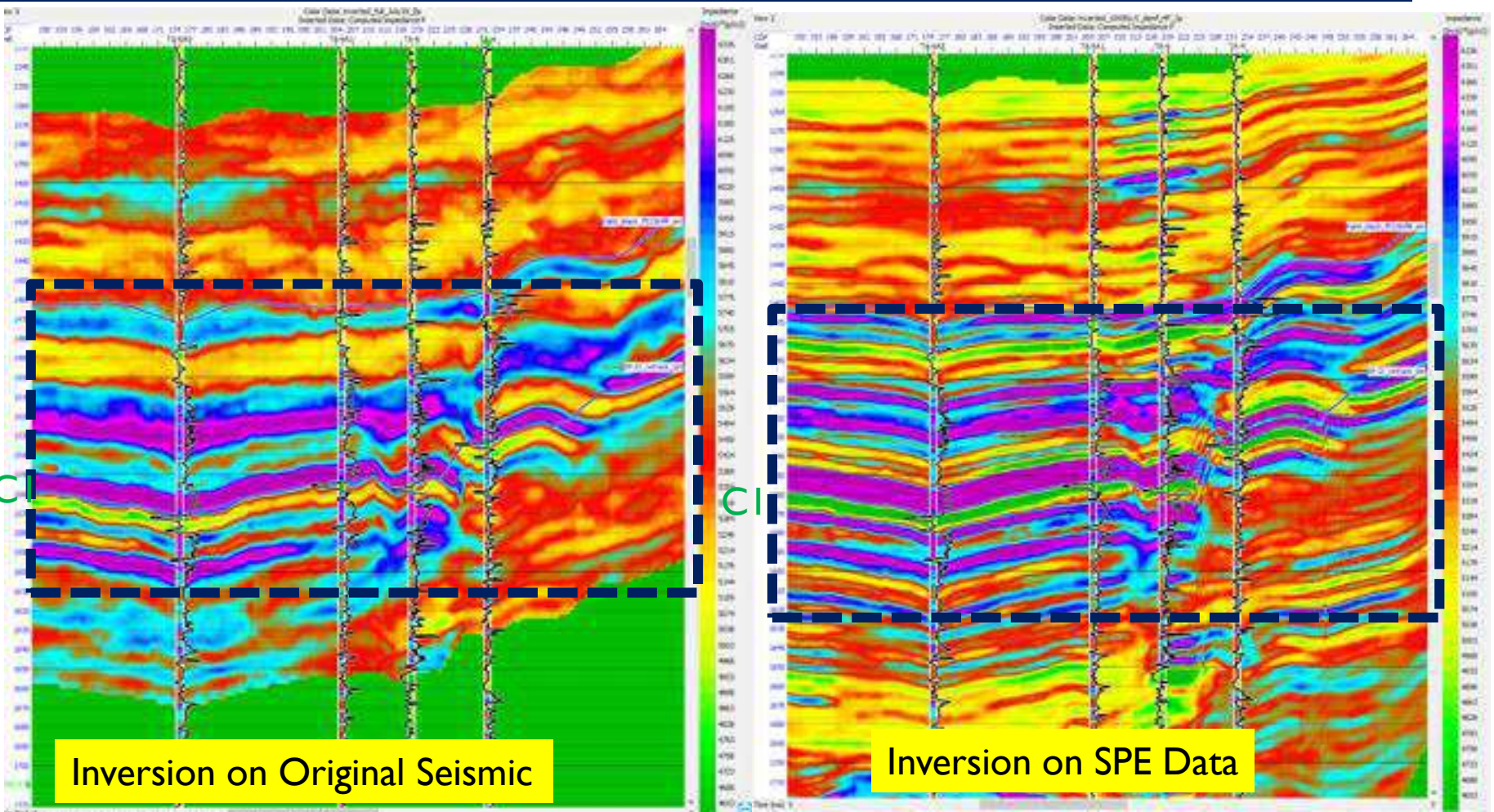
Application of developed software on 3D Seismic

Inline with Seismic Data



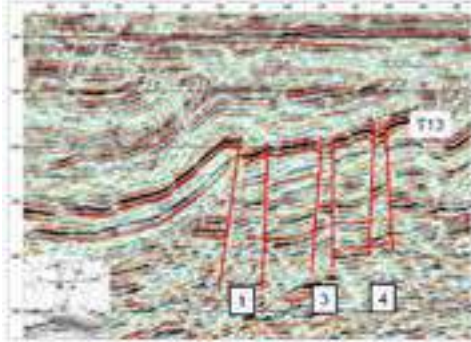
Inversion Analysis on 3D Land Data

Comparison of Inversion from original seismic and SPE data from the developed software

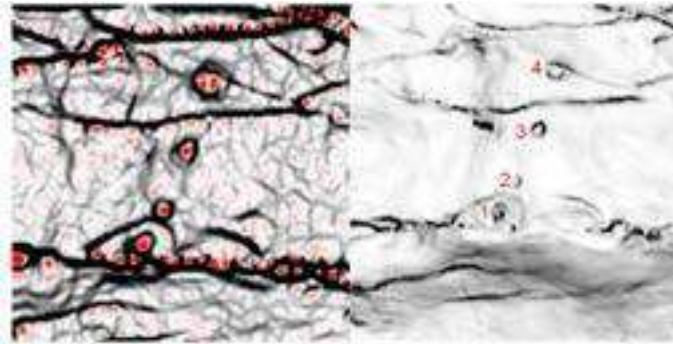


An Example of enhancement of spectrum by SPE and its power to resolve thin coals. The section with in the highlighted square conspicuously prove that the thin coal layers (CI) are extending beyond the fault.

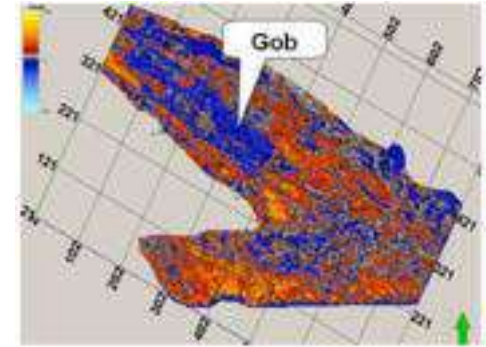
Some more examples of Seismic application in Coal Mine Planning.



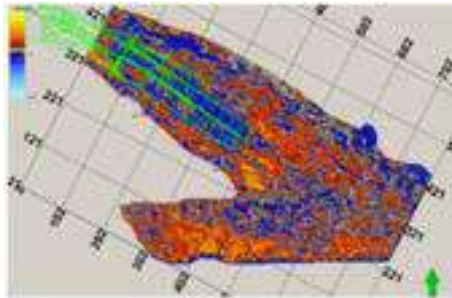
Subsidence Columns



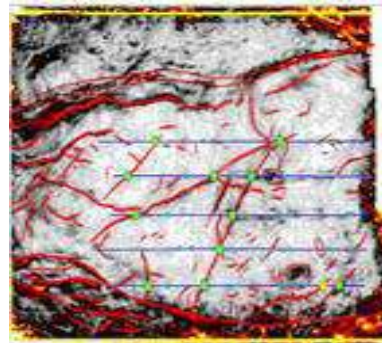
Time slice showing subsidence columns from Curvature, Variance attribute



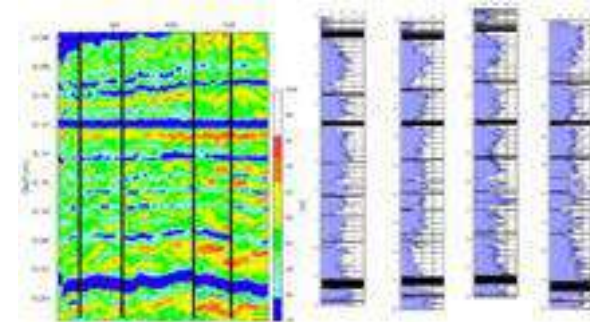
Seismic Amplitude showing Gob zone



Seismic Amplitude showing Gob zone overlain Coal with mine plan



Variance attribute slice showing Actual Faults, Interpreted Faults & Tunnels



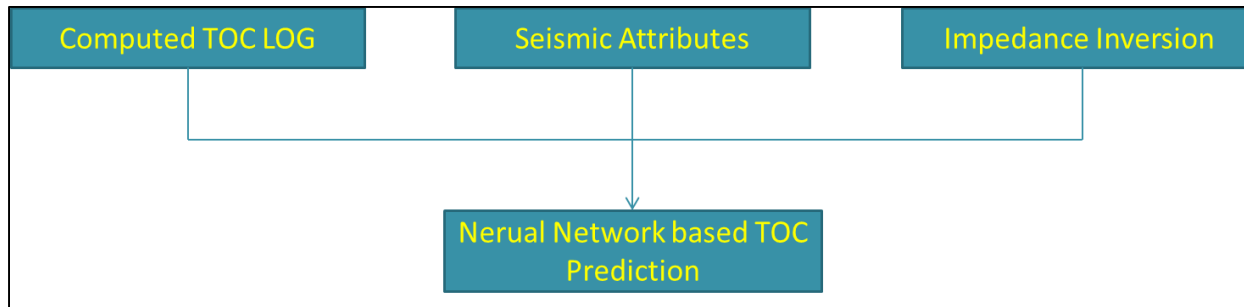
A section is shown from a 3D seismic survey, inverted, converted to depth and plotted against a drill hole section. The overall trends in the drill hole data are clearly represented in the seismic results.

Estimation of Coal Quality Parameters using Machine Learning Techniques

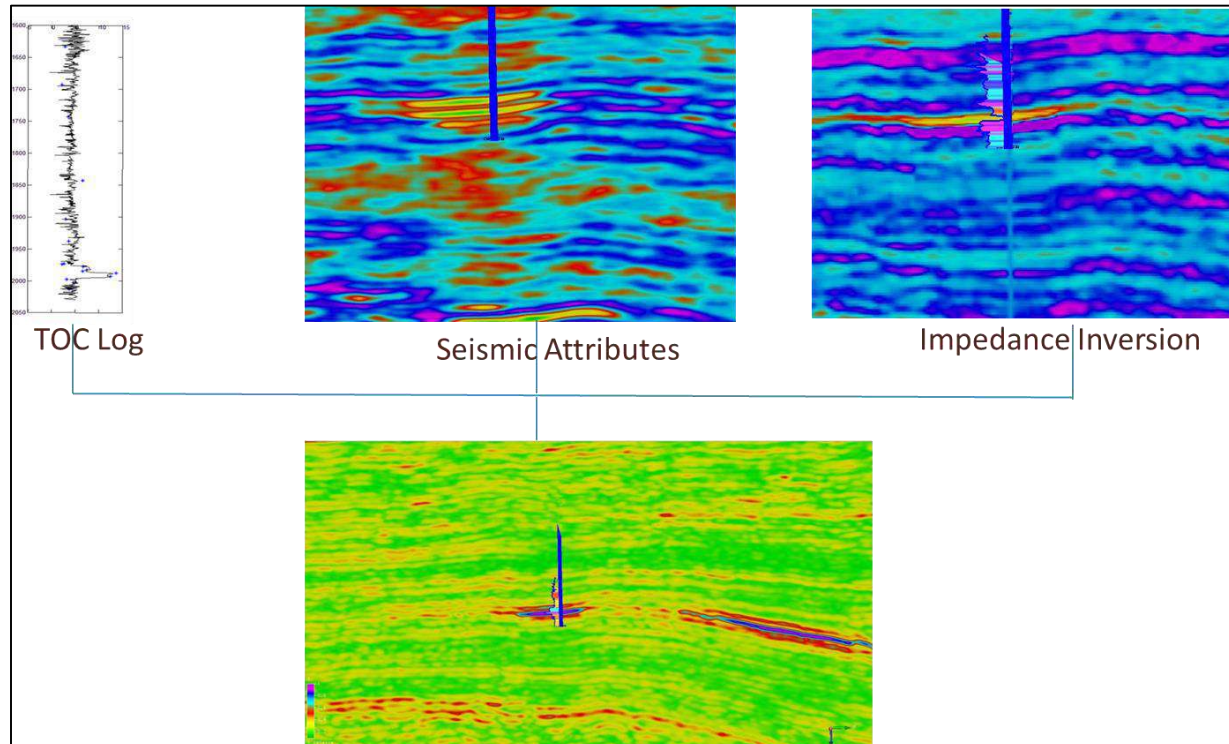


- ▶ The vital parameters required for successful coal resource estimation are: Structure of the coal seams, thickness and areal extension, faults and fracture Geometry, density, porosity and coal quality parameters like ash content, Volatile matter and insitu moisture
- ▶ **Seismic methods can provide parameters like thickness and areal extension, faults and fracture Geometry, density and porosity. Coal Quality parameters are traditionally obtained through laboratory measurements conducted on drill-core samples.**
- ▶ **The Coal market value is established based on the coal quality attributes such as ash content, volatile matter, Sulphur content, coking and thermal attributes.**
- ▶ The workflows for estimating core data like **Total Organic Content (TOC)** in oil and gas reservoir can be used in association with advance **Inversion methods** and recently developed software like SPE.

Neural Network based TOC Prediction



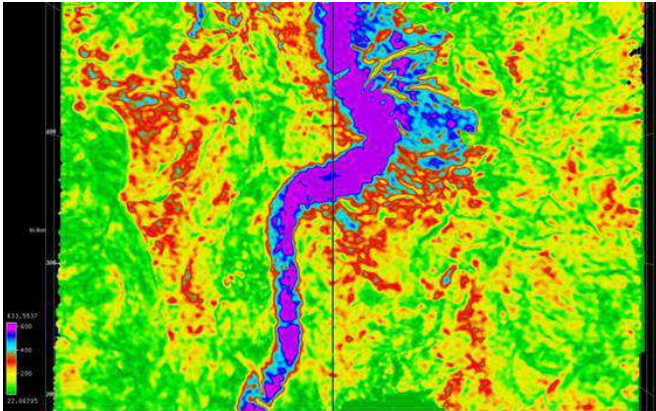
- ▶ Total Organic Content (TOC) has an important role in resource potential of the shale plays and organically richer shales with higher TOC values are good exploration target.



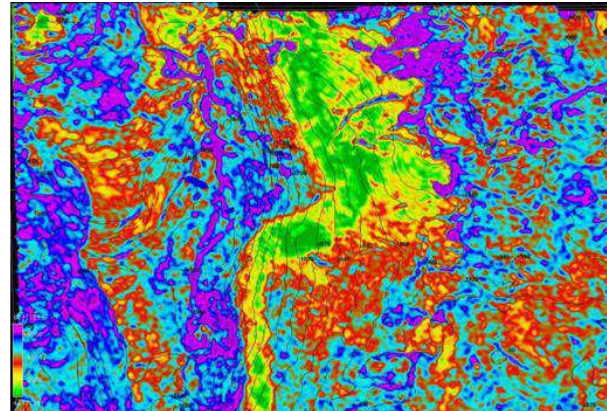
- ▶ TOC log is generated through Passey's method ($\Delta \log R$ technique) using Resistivity and Velocity log curves. As TOC content in shale affects both resistivity and velocity, these logs are good indicator of TOC content in shale. TOC logs thus derived is calibrated with the core derived TOC points.
- ▶ Neural Network technique is then used to calculate the TOC volume using the seismic and well log TOC data. The TOC volume thus generated is helpful in delineating the sweet spots in shale plays.

TOC Prediction using ANN using Seismic Attributes and Impedance inversion results

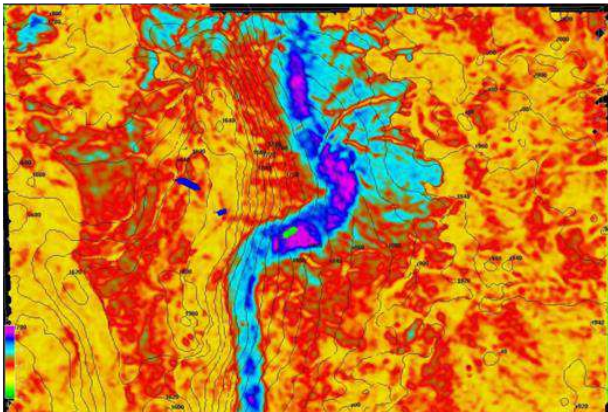
Predicted TOC Analysis



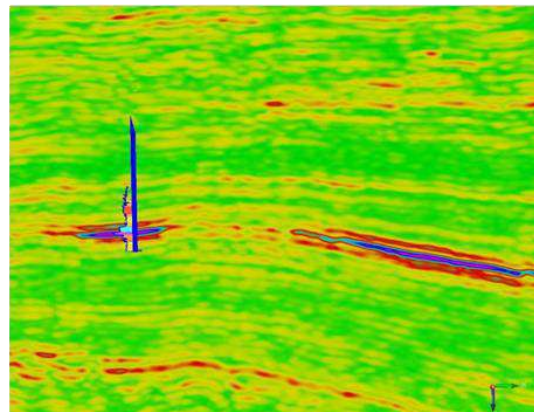
RMS Amplitude Attribute



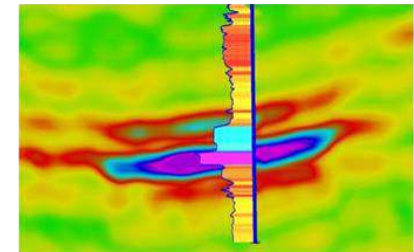
Impedance Inversion result



Predicted TOC using ANN

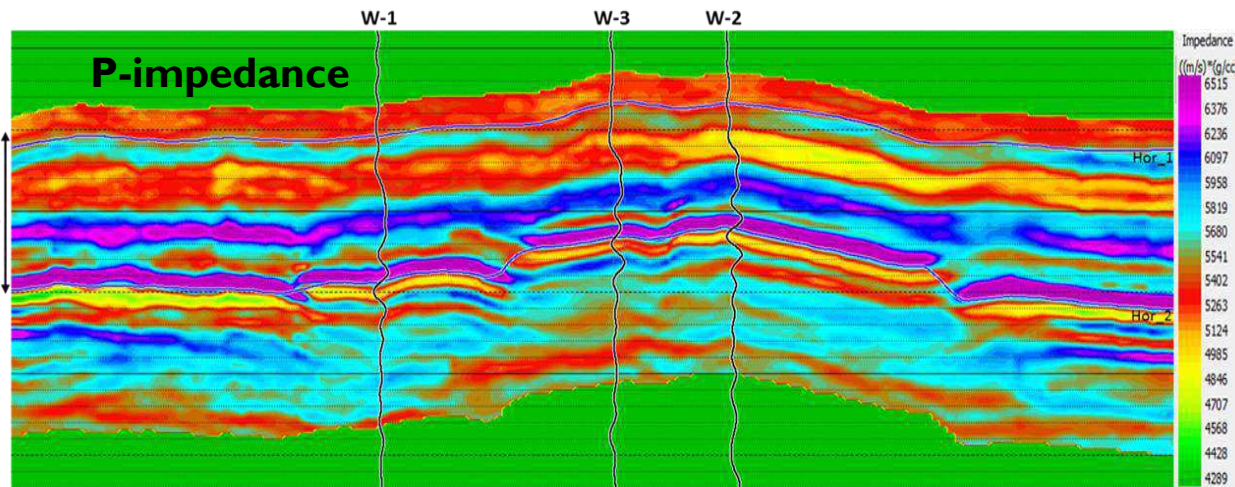


Predicted TOC on Crossline



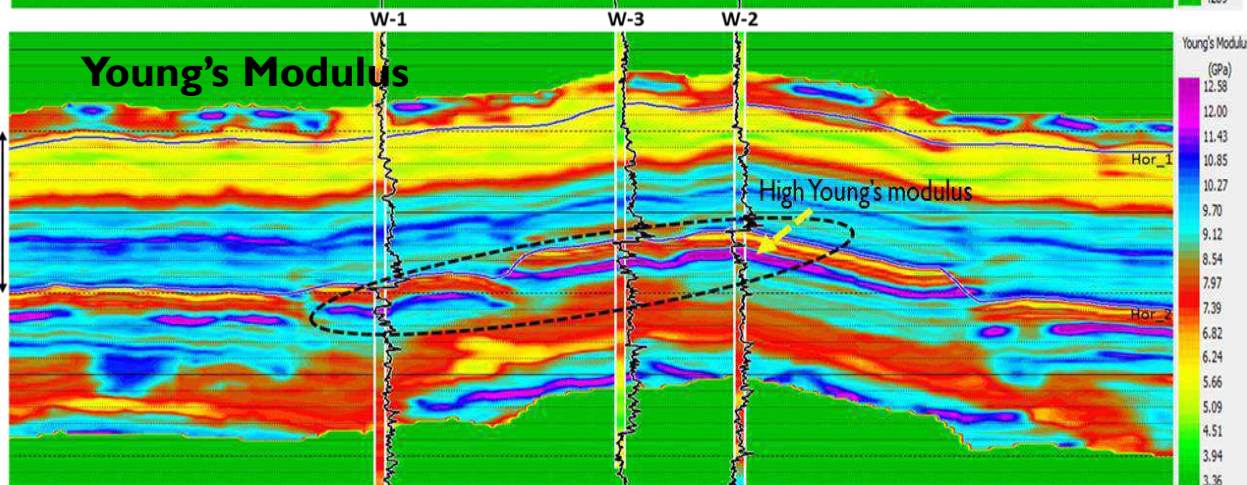
Predicted TOC on Crossline
(Zoomed Section)

Rock Physics Parameters from Seismic: P-impedance and Young's modulus from Seismic Data

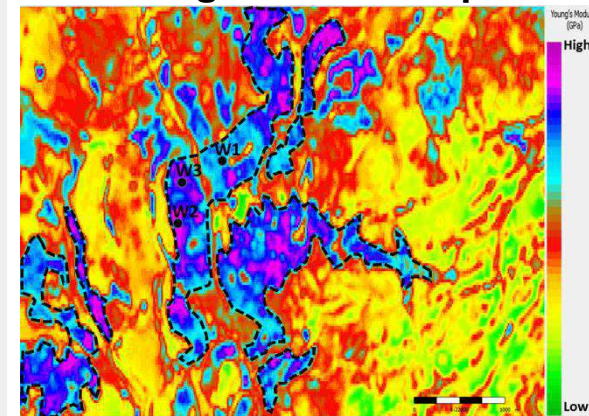


- Probabilistic Neural Network (PNN) was used for estimating Young's modulus property using P-impedance and other seismic derived attributes.
- High validation correlation (Blind well analysis) of 84% achieved in the PNN study lends confidence in the robustness of the process.

Rock Physics Parameters from Seismic

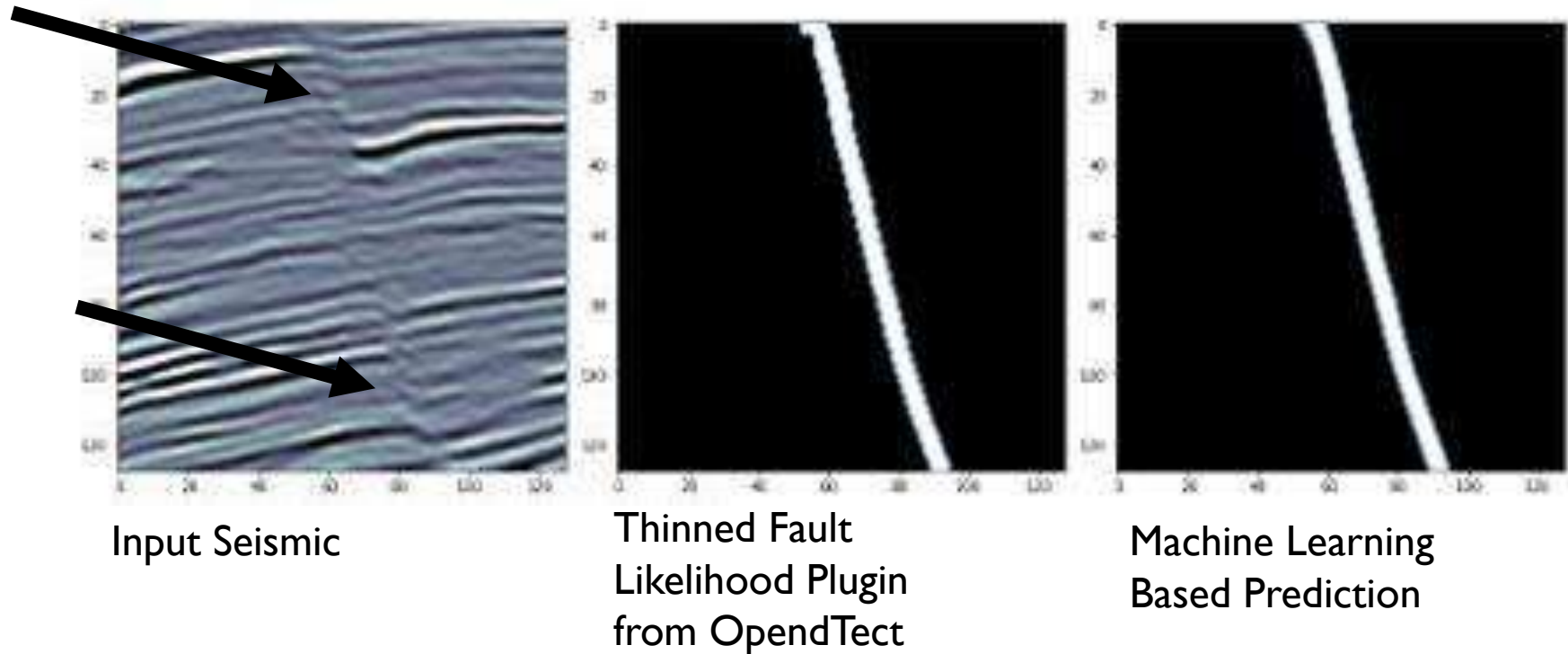


Young's Modulus map



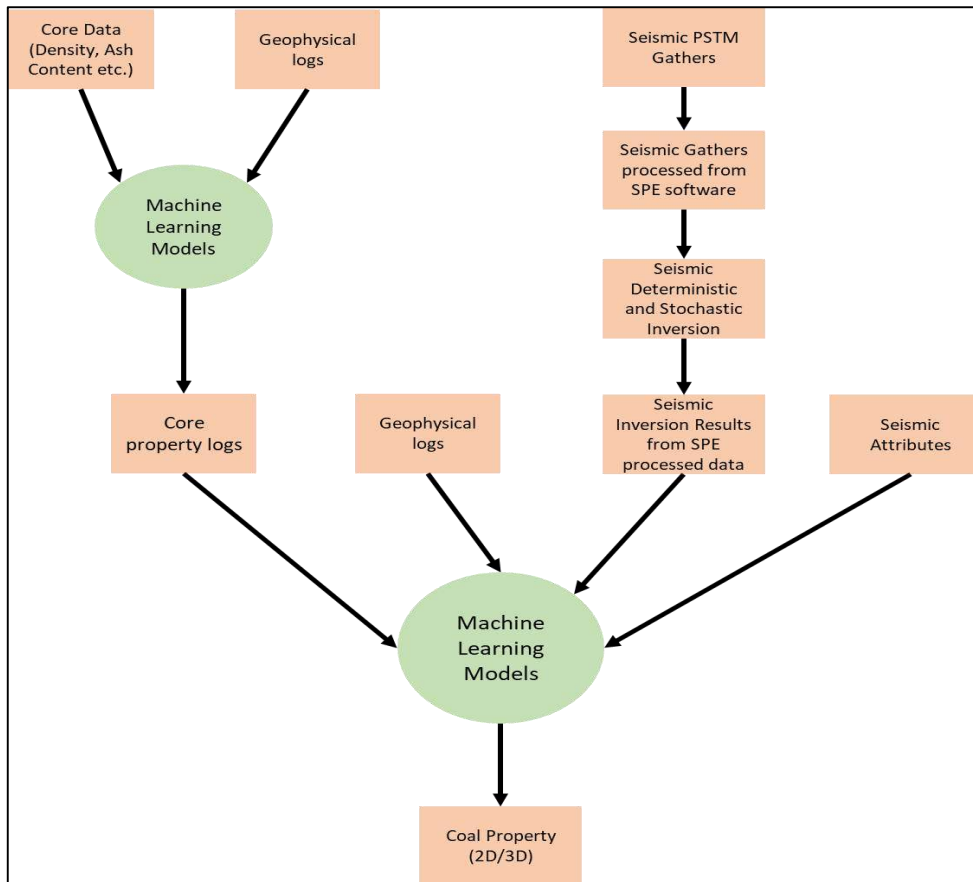
- Predicted Young's modulus section (below) and the corresponding P-impedance section (above). Are shown. Well log derived Young's modulus (colour) and Gamma Ray (curve) logs are overlain on the Young's modulus section.
- Excellent match between the well log derived & seismically derived Young's modulus properties are observed.

Machine Learning Based Fault Prediction from 3D Seismic Data



GERMI is presently working on Faults and Fracture prediction from Seismic using Machine Learning Techniques.

A Method for Integration of Seismic, Core and Well log data for Estimation of Coal Quality Parameters for accelerated Coal Exploration- GERMI's Proposal



S.No.	Geological Properties
1.	Structure, Thickness and areal extent of coals
2.	Depth of Coal Seam
3.	Density, porosity and Permeability
4.	Brittleness, cleats architecture
5.	Faults and Fractures
6.	Pore Pressure
7.	Stress and Orientation
8.	Ash content, Moisture and Volatility
9.	Coal Volume (Resources)
10.	Gas in Place

Seismic Reflection technology is a highly powerful tool for identification of thin coals to minor faults.

When integrated with Core data and log data it can provide an integrated solution for coal exploration and mine planning. This is being done globally.

Advantages of workflow to the Industry

- ▶ The rapid estimation of coal quality parameters from geophysical logs and seismic data powered by Machine Learning will result in faster estimation of parameters required for accelerated coal resource estimation.
- ▶ This will bring out a workflow for effective prediction of coal quality parameters from integration of core, seismic and geophysical logs.
- ▶ **This will provide scope for accelerated exploration for coal and estimation of coal reserves.**
- ▶ The predictive models will provide coal quality parameters logs, which can be used with the seismic data to drive aerial distribution of parameters for reliable computation of coal reserves.
- ▶ Development of such methodologies with production level application of Machine Learning for exploration and exploitations of coal seams will accelerate the exploration and drastically reduces the turnaround time.

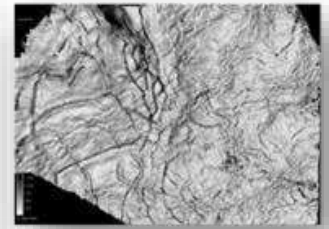
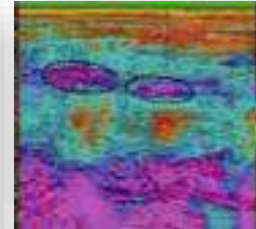
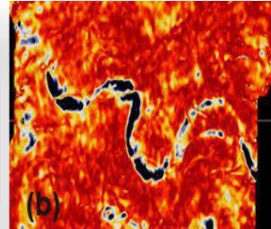
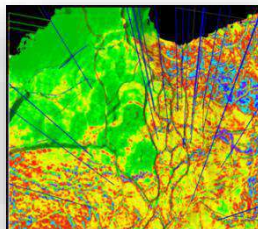
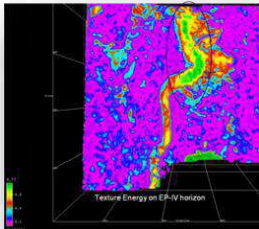
Conclusions

- ▶ Seismic plays a vital role in coal characterization and Coal Resource estimation.
- ▶ The vital parameters required for successful coal resource estimation to accelerate the exploration like Structure of the coal seams, thickness and areal extension, faults and fracture Geometry, density, porosity and coal quality parameters like ash content, Volatile matter and insitu moisture can be derived from the integrated analysis of Seismic, core and Log data.
- ▶ However, an integrated approach is require using limited well data and available 3D seismic data. New techniques like Machine Learning and development of advanced technical work flows are required to properly estimate the coal quality parameters and estimation of coal resource estimation.

GERMI proposes to develop such an integrated work under “ Make in India campaign and Aatma Nirbhar Bharat”, to enhance the capabilities of Coal exploration to accelerate the efforts cost affectively.



Thank You very much for providing an opportunity to present GERMI's capabilities in the field of Seismic data processing, interpretation and software development towards Accelerated Coal Exploration program.



Passive Seismic: A robust tool for Mining and Geothermal Exploration

Presenter: Dr. Nick Martakis, Seismotech S.A, Greece

Workshop

***Technology Roadmap for Coal Sector:
Technologies to Meet Future Challenges***



cmpdi
A Mini Ratna Company

18 January 2022

SeismoTech

GEOPHYSICAL SOLUTIONS

From Regional Seismology to Exploration Geophysics

Viewing Nick Martakis's screen

Seismology

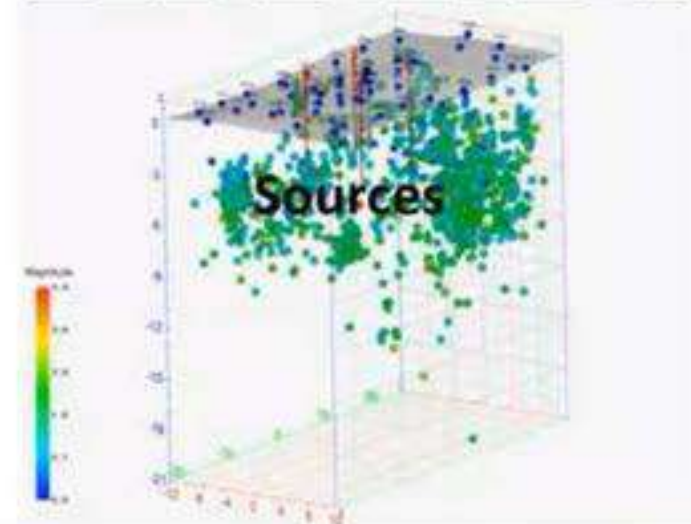
Dense Seismological Network

(stand-alone recording systems / frequency range:
0.1-100Hz / continuous records)

Naturally-occurring seismic signals

(pure ambient seismic noise, as well as local,
regional and teleseismic events occurring during
the recording period within or around the area of
interest)

Geophysics



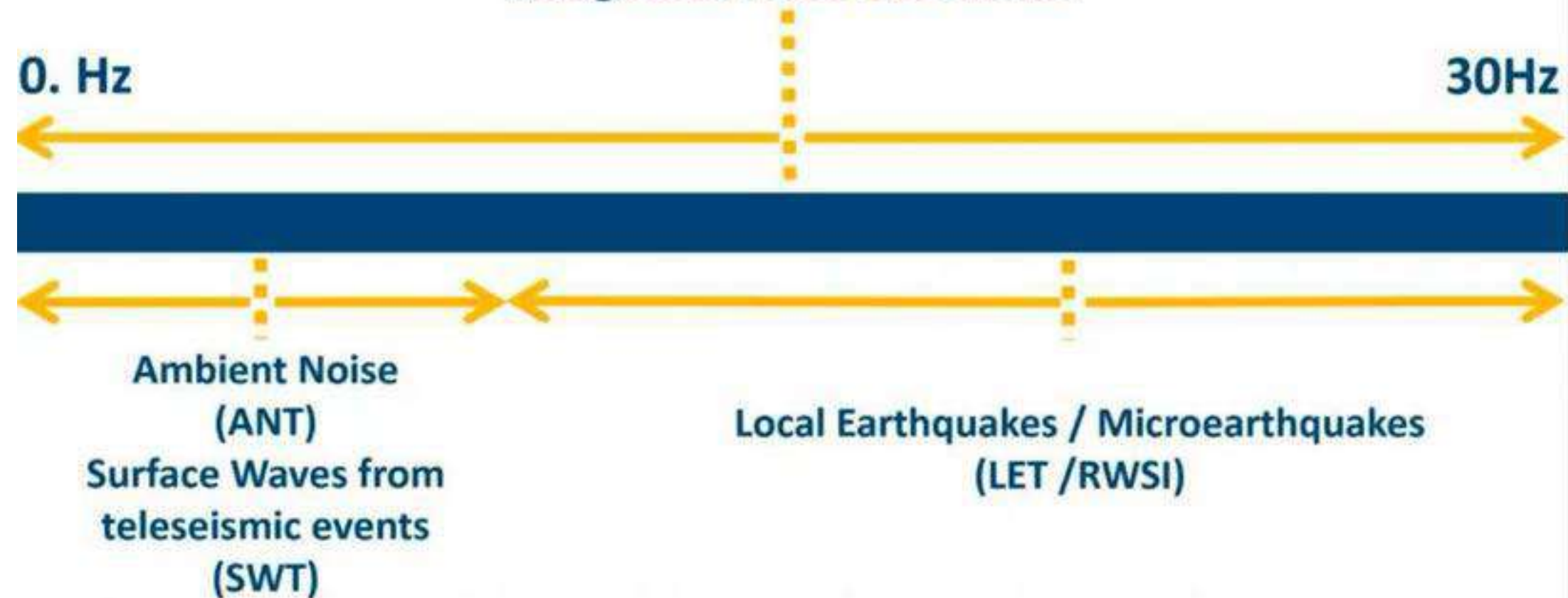
SeismoTech

GEOPHYSICAL SOLUTIONS

Low Frequency Seismic Exploration

Viewing Nick Martakis's screen

Integrated Passive Seismic



Passive Seismic methodologies, exploit **low frequency seismic signals** that are **generated naturally**, either in the form of pure **ambient seismic noise** or **local, regional and teleseismic events**

Passive seismic signals occur in abundance in the majority of the earth's locations and can be extracted from the **same dataset**. Thus, using **only one acquisition scheme**, a number of Passive Seismic methodologies can be individually applied and jointly interpreted.

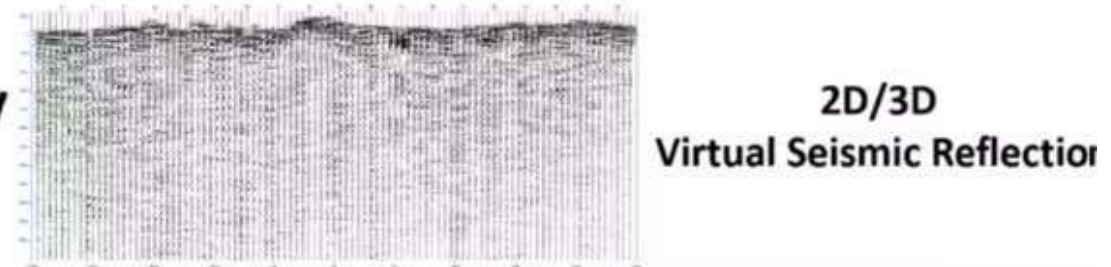
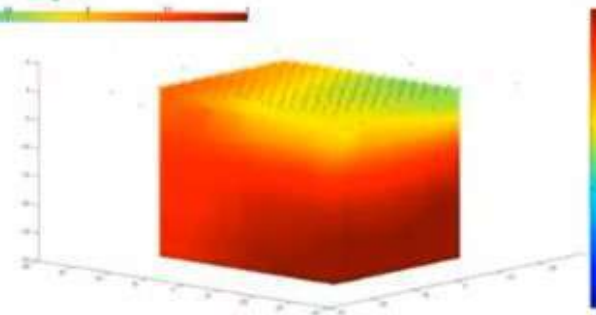
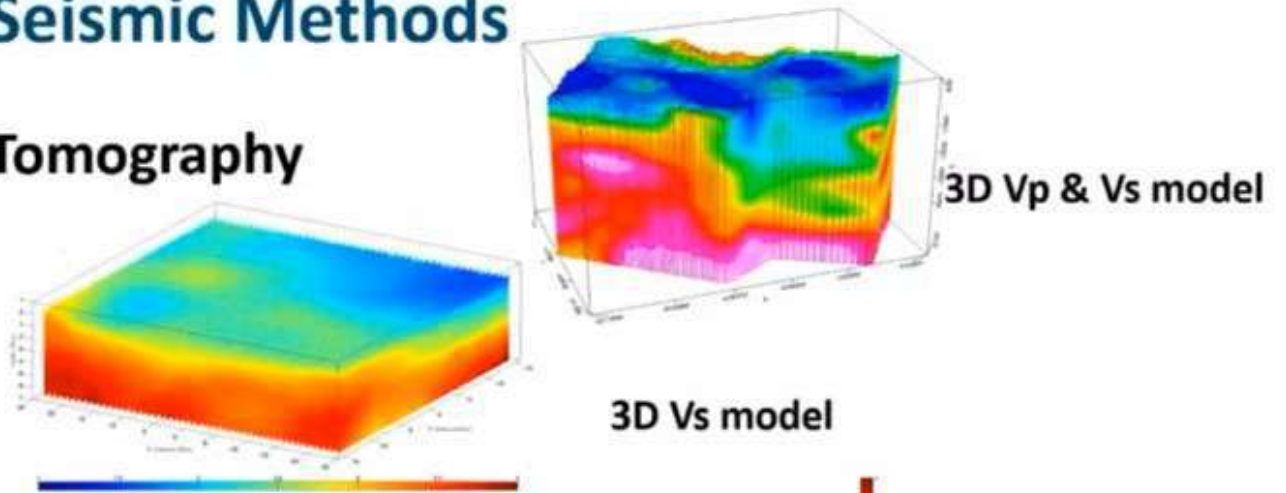
Passive Seismic Methods

1. Local Earthquake Travel-time Tomography

2. Ambient Noise Tomography

3. Surface Wave Tomography

4. Reflected Wave Seismic Interferometry



Get
ACTIVE

Choose
PASSIVE

**Passive Seismic
for
Hydrocarbon Exploration**

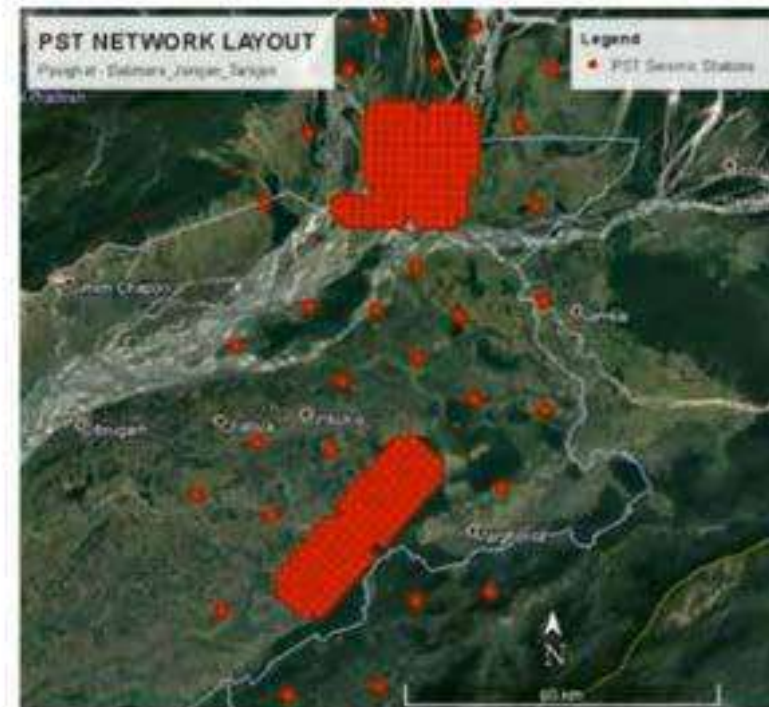
Passive Seismic Exploration

Viewing Nick Martakis's screen

Passive Seismic in India [West Tripura | 2020-2022] Passive Seismic Tomography for HC exploration – IN PROGRESS



Passive Seismic in India [North Assam | 2021-2022] Passive Seismic Tomography for HC exploration – IN PROGRESS



SeismoTech

GEOPHYSICAL SOLUTIONS

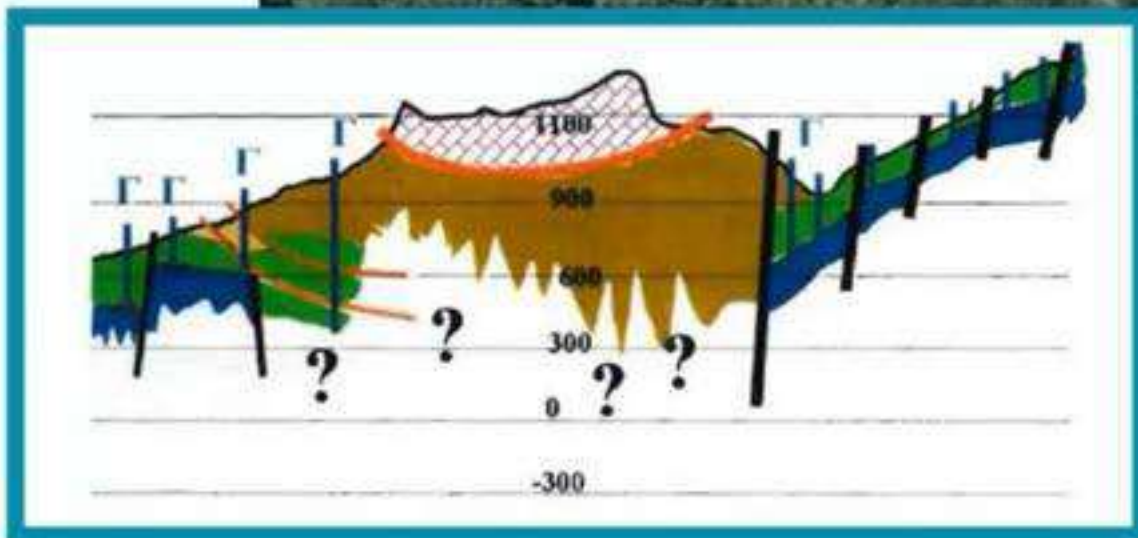
Get
ACTIVE

Choose
PASSIVE

Mining Case Study

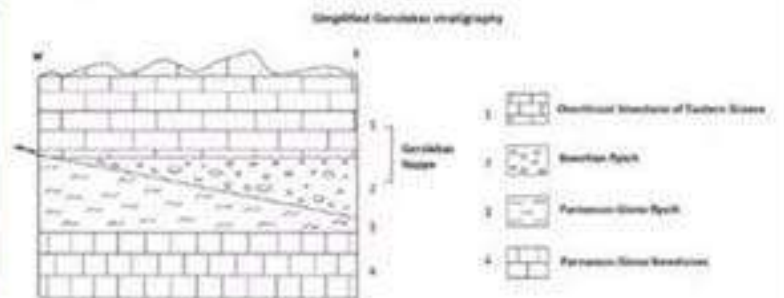
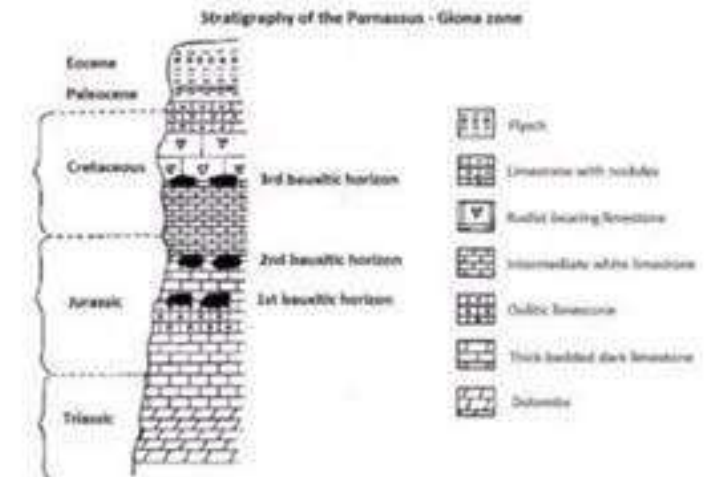
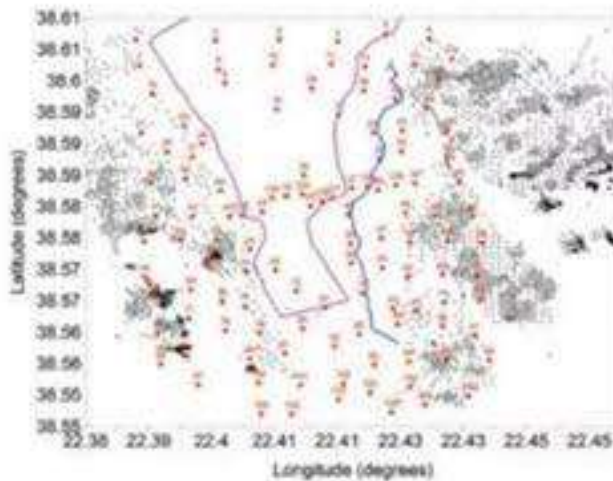
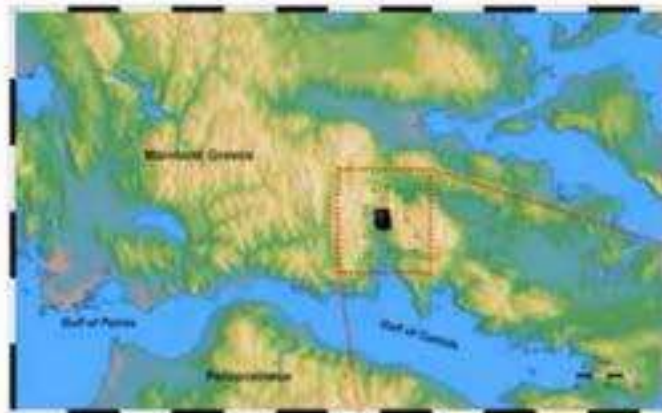
SMART EXPLORATION project
Earthquake-based Passive Seismic
[Gerolekas Bauxite Field – Greece]

The **purely passive survey** provided a solution for the **first imaging approach** of an extremely difficult exploration area (accessibility, topography, deep mining target)



The Gerolekas Study area

Viewing Nick Martakis's screen



Instrumentation: 129 short-period stations

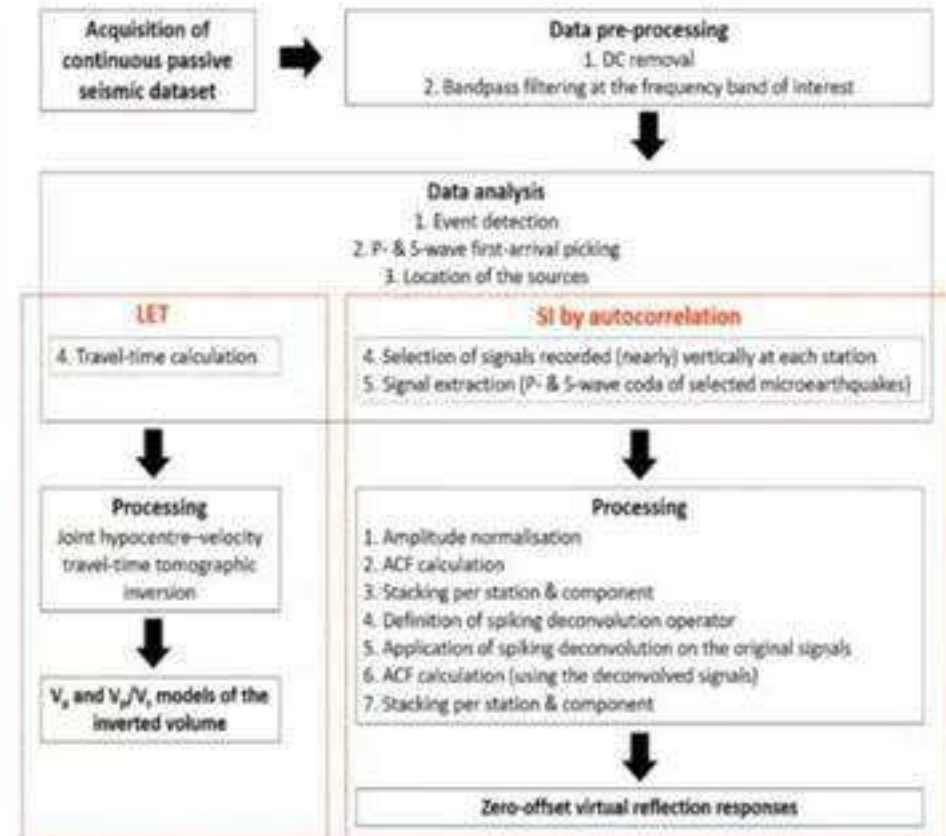
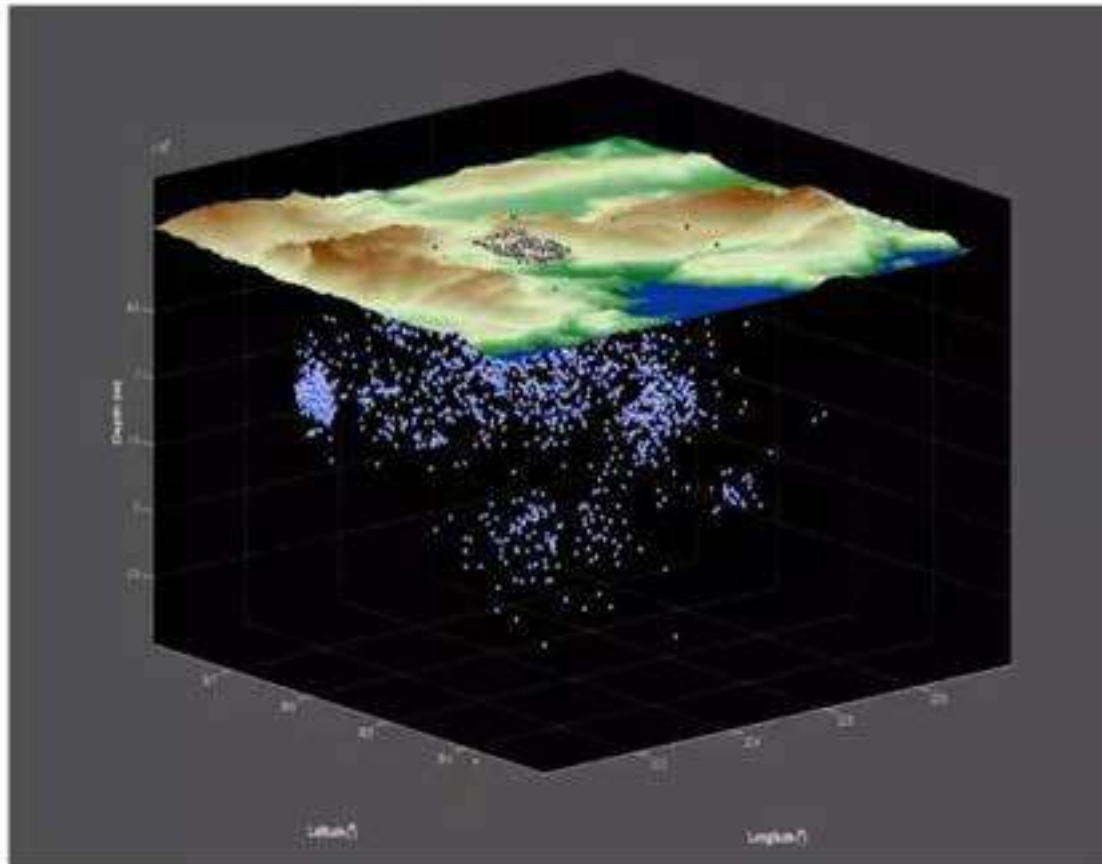
Recording period: 3 months

Area of Interest: 35 Km²

The Gerolekas Passive Seismic Survey

Viewing Nick Martakis's screen

Local Earthquake Tomography and Reflected-wave Passive Seismic Interferometry using earthquake sources



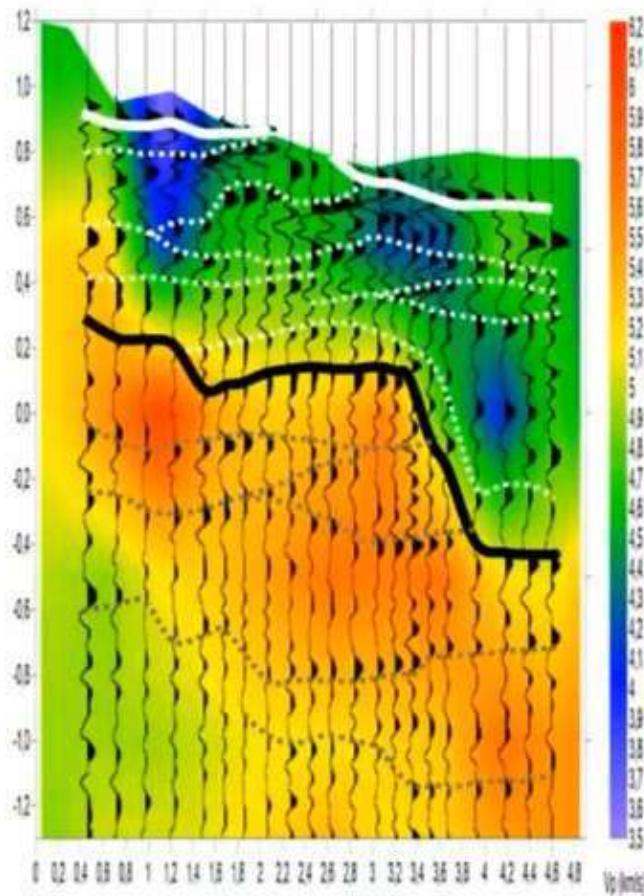
Reflected-wave Passive Seismic Interferometry

Viewing Nick Martakis's screen

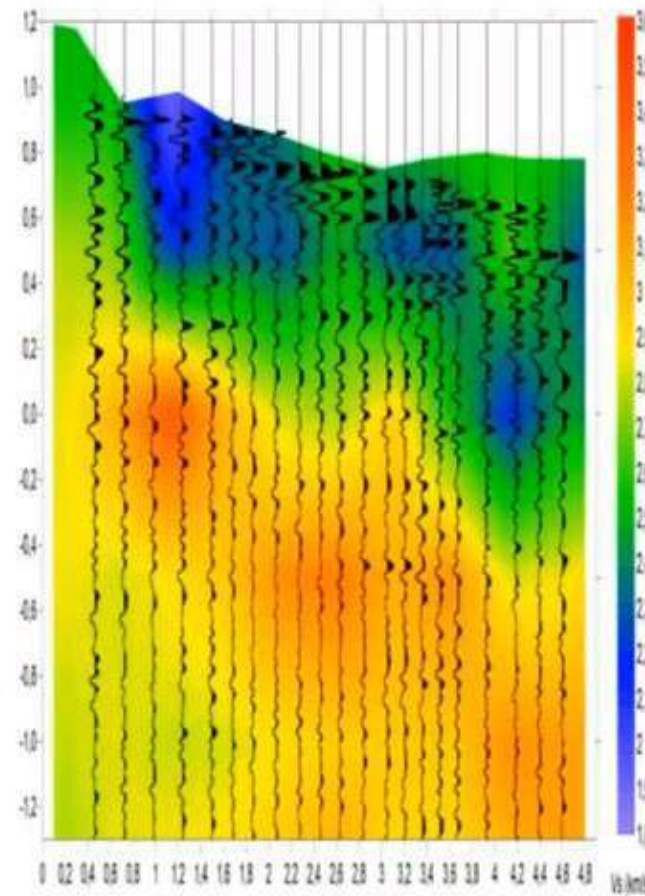
Retrieval of **virtual reflection responses** below each of the recording stations

Virtual reflection responses (SI) superimposed on the LET models along the seismic line PARV-1 [relocated events]

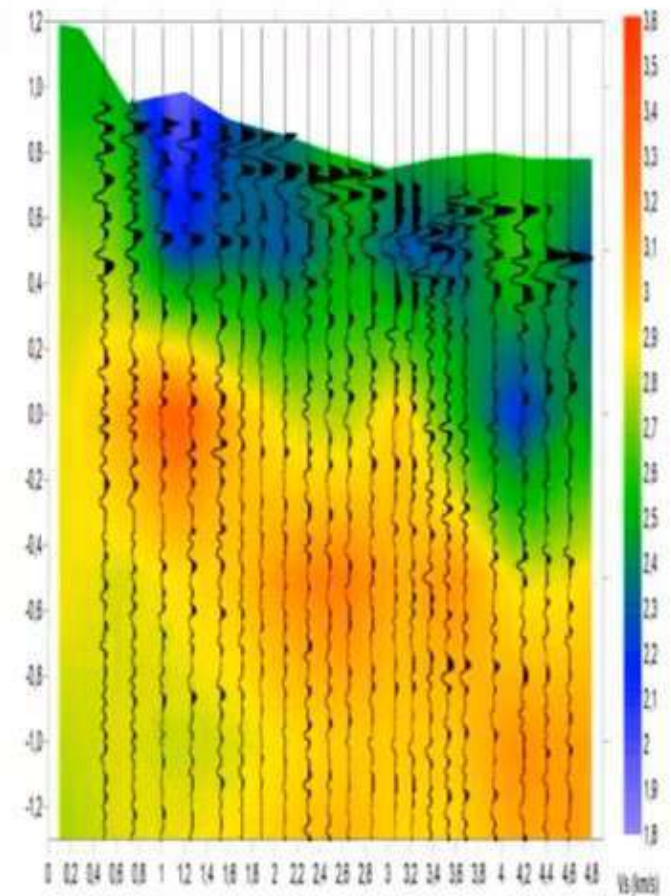
Vp model/rotated L-component



Vs model/rotated Q-component



Vs model/rotated T-component



Re-processing of legacy active seismic data

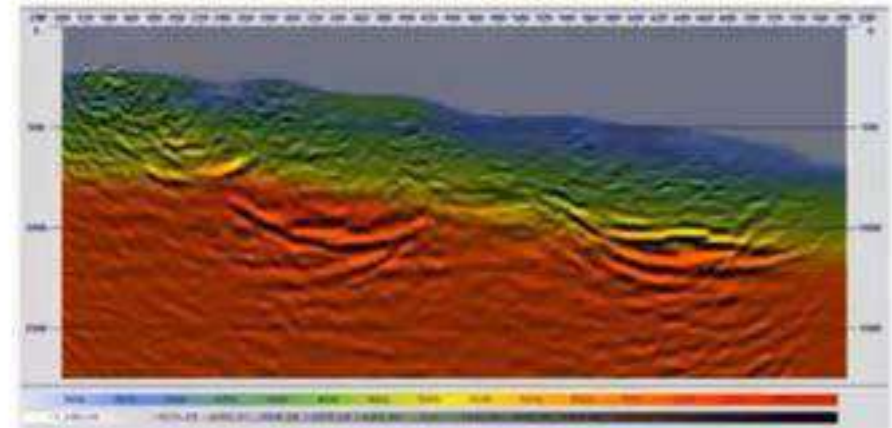
Viewing Nick Martakis's screen

The use of **passive seismic models** improved the pre-stack **depth migration** during the reprocessing of existing active seismic data (seismic line PARV-1)

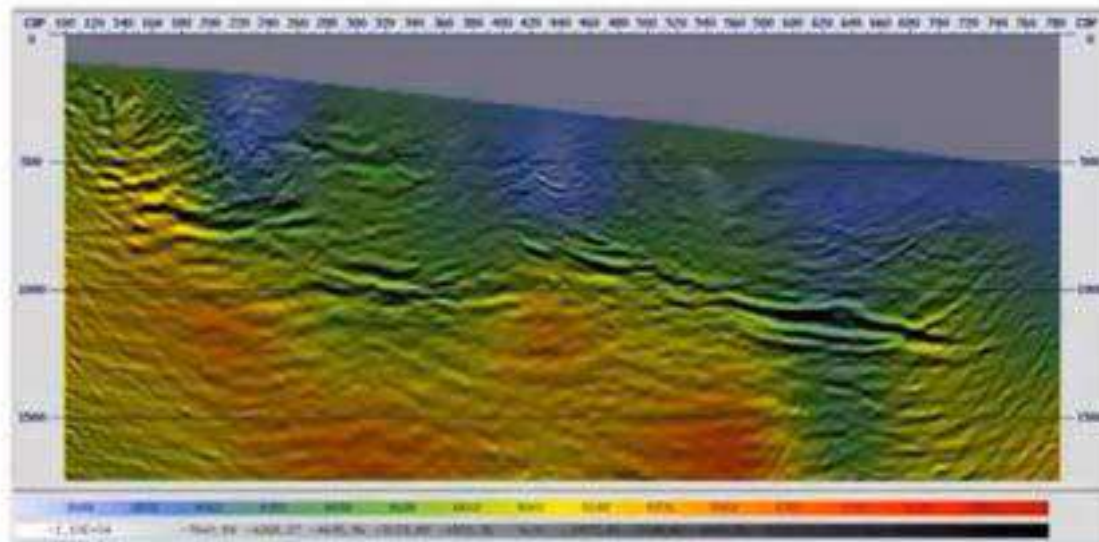
Courtesy of Delfi-Distomon S.A.



Pre-stack depth migration using tomography model from seismic data



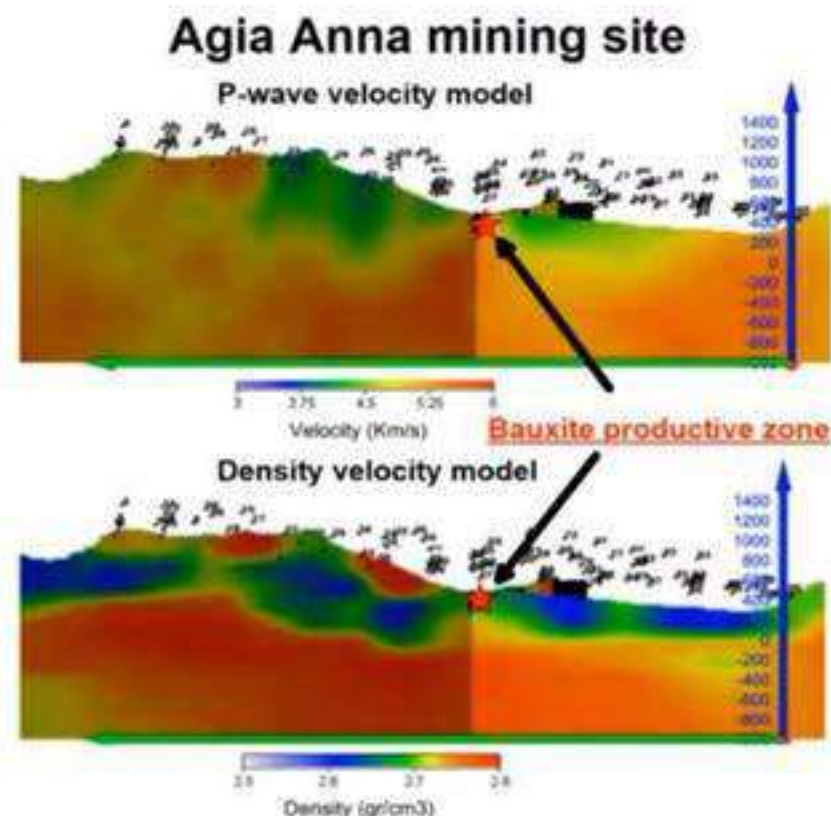
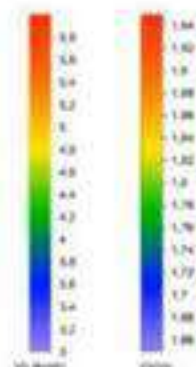
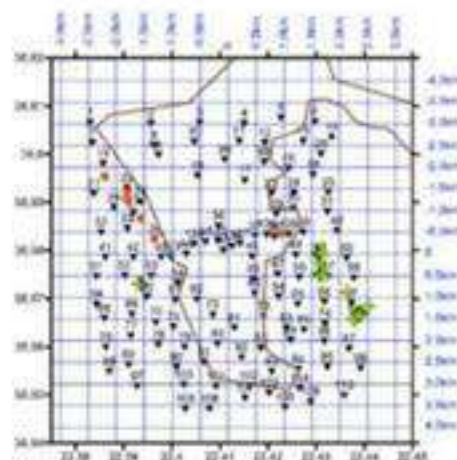
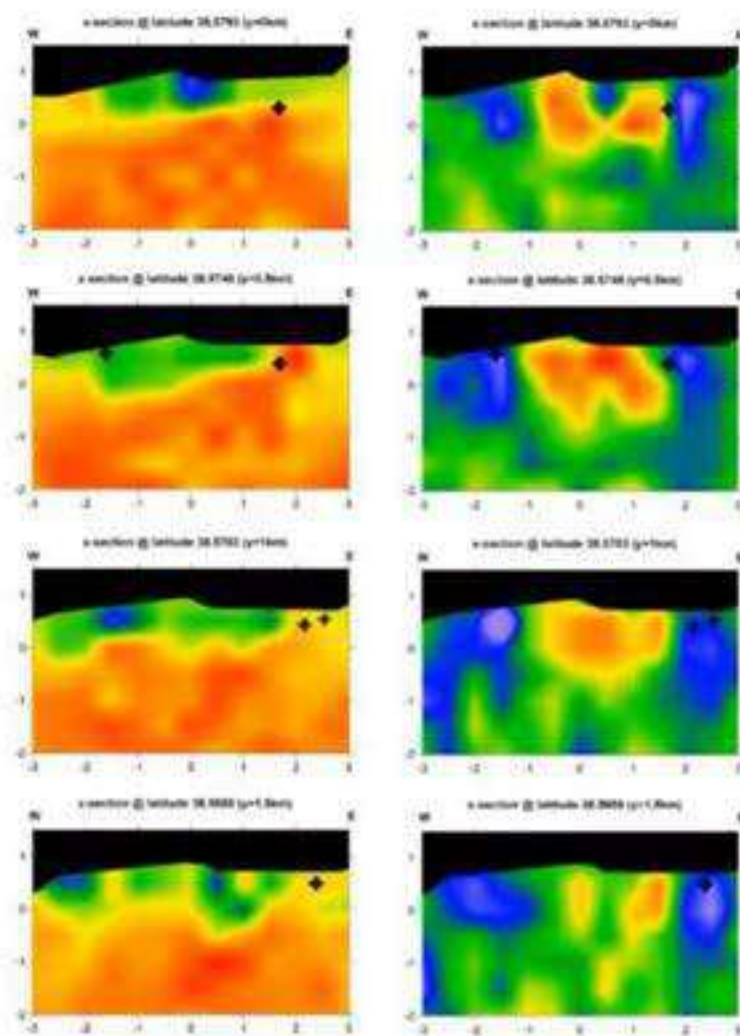
Pre-stack depth migration using LET tomography model over LET Vp model



SeismoTech

GEOPHYSICAL SOLUTIONS

The **integrated interpretation** of all passive models provided a **robust answer to the exploration question** that was set



Passive Seismic for Mining Exploration-Innovation Award

Viewing Nick Martakis's screen



Innovation Radar

Dear EU-funded innovator(s),

We are writing to you as you are an official contact person for your organisation's participation in the **Smart Exploration** project funded by the European Commission under Horizon 2020.

We are delighted to inform you that one of the innovations developed in the project has been analysed by the European Commission's Innovation Radar. Details of this innovation, and how it was categorised by the analysis, are as follows:

- **Innovation Title:** An innovative and environmentally friendly passive seismic method for imaging mining targets;
- **Market Maturity of the Innovation:** Business Ready (based on a method [described in this paper](#));
- **Market Creation Potential of the innovation:** Addresses needs of existing markets (based on a method [described in this paper](#));

In this analysis Innovation Radar also identified the following project partner(s) - including your organisation - in the project as a 'Key Innovator' in the development of this innovation:

- SEISMOTECH GEOFISIKES MELETES ANONIMOS ETAIREIA
- TECHNISCHE UNIVERSITEIT DELFT

SeismoTech

GEOPHYSICAL SOLUTIONS

Get
ACTIVE

Choose
PASSIVE

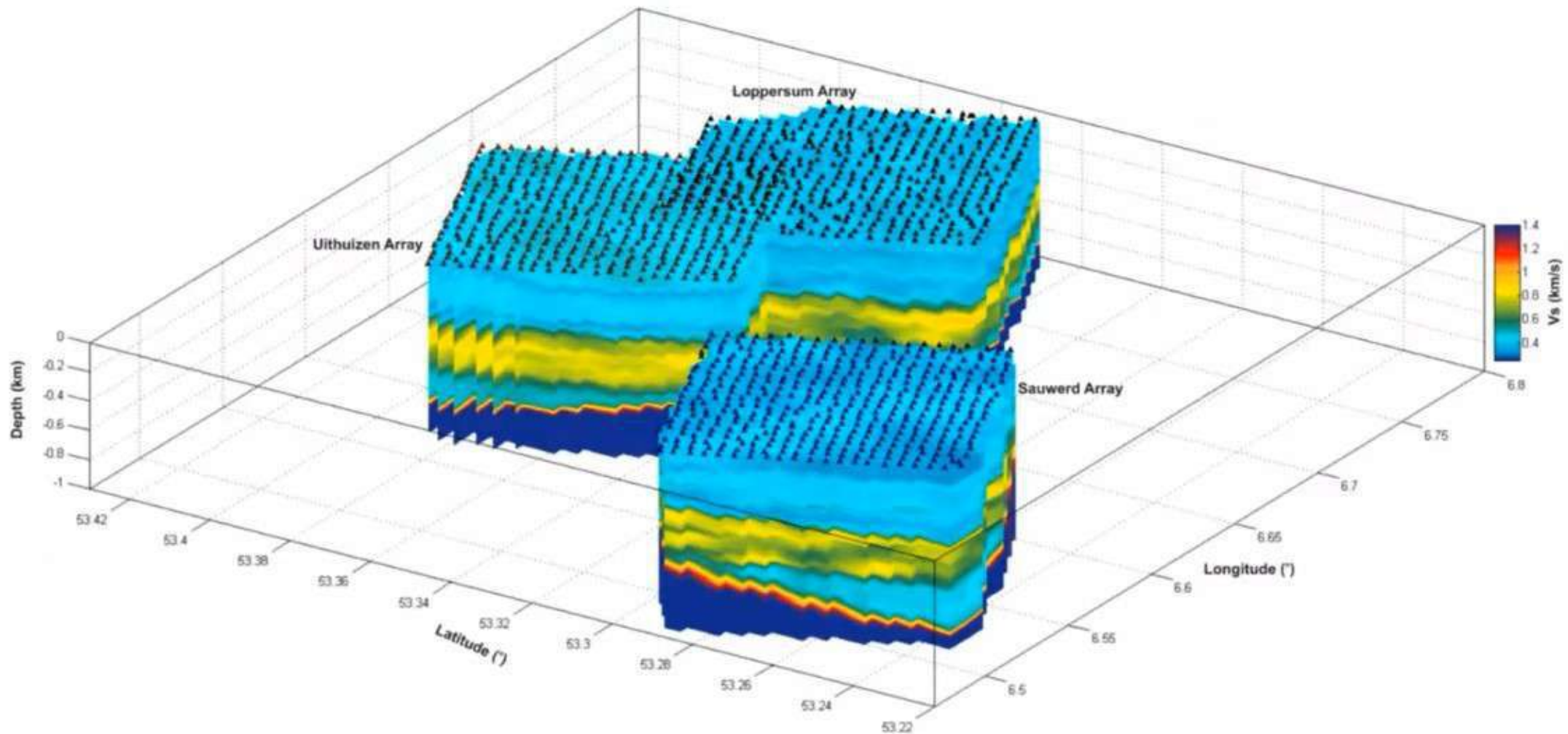
Environmental Case Study

Noise-based Passive Seismic
[The Groningen Field - The Netherlands]

Tomographic Inversion – Vs models (Using only Ambient Noise)

Viewing Nick Martakis's screen

3D Vs models



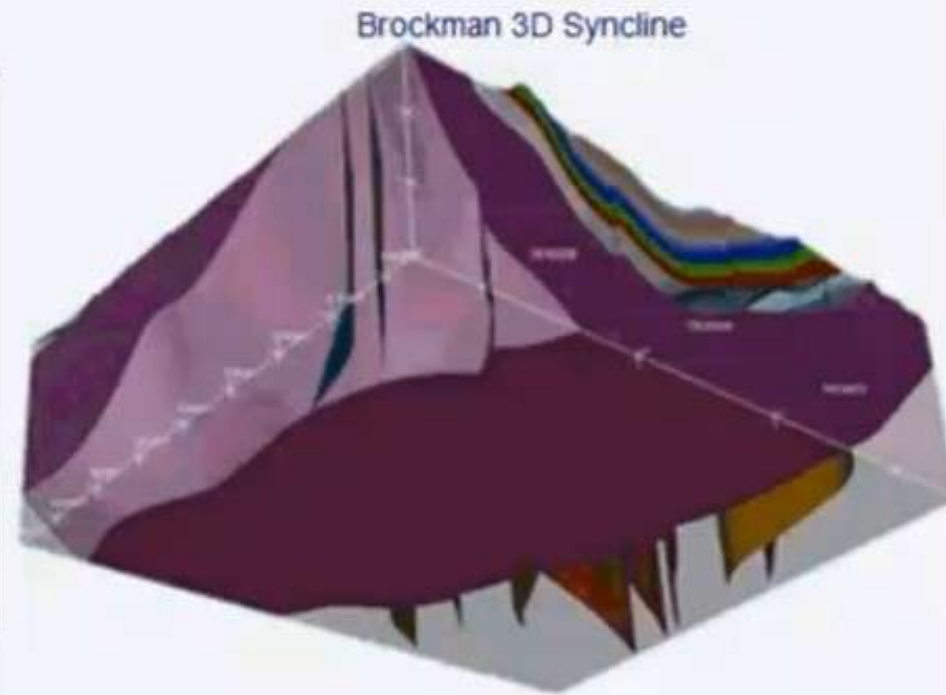
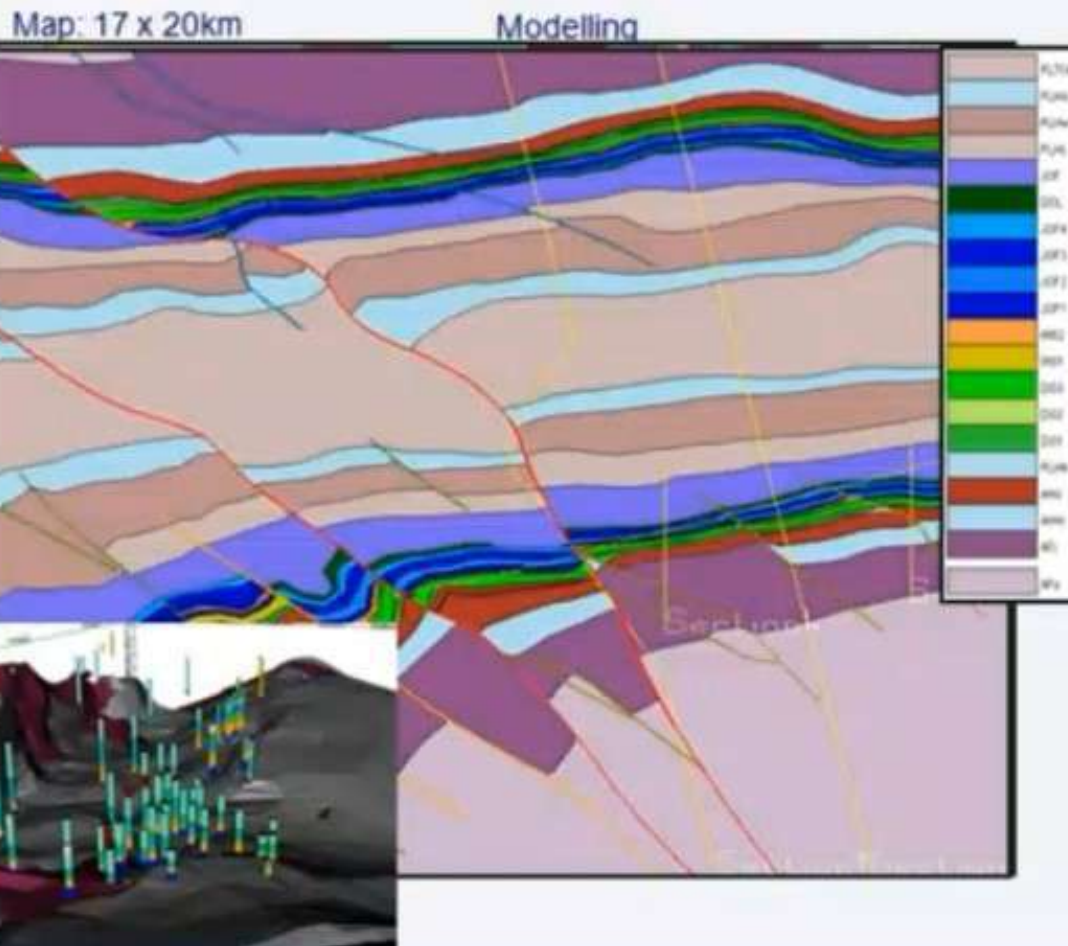
What could a Passive Seismic survey bring to your exploration program?

Viewing Nick Martakis's screen

- ✓ A cost-effective and environmentally friendly technique for subsurface mapping for Hydrocarbon, mining and geothermal exploration.
- ✓ 3D velocity models (V_p & V_s) of the area of interest down to the depth of interest, providing useful structural & lithological information, even in very complicated regimes.
- ✓ 2D/3D virtual reflection seismic imaging for both P- & S-waves (using Reflected-Wave Passive Seismic Interferometry).
- ✓ Shear-wave information that is almost impossible to be obtained using active seismic surveys.
- ✓ Active fault characterization using Focal Mechanisms of the recorded events (Stress/Moment Tensors).
- ✓ Continuous monitoring of the survey area for security purposes, especially useful for geothermal operations during drilling & production.

samit

3D Geology Example: Brockman Syncline



Derived from a geology map in the public domain
Rio Tinto's Brockman Syncline Project area

Viewing Prakash Kumar's application

samit

De-risking of Coal Exploration by adopting innovative workflows in Integrated Subsurface Modeling of Geoscientific Data using "Intrepid Geophysics" Software



Safety Moment: Avoid the Three Cs

There are three certain places where COVID-19 spreads more easily



1
Crowded places
with many people nearby



2
Close-contact settings
Especially where people have close-range conversations

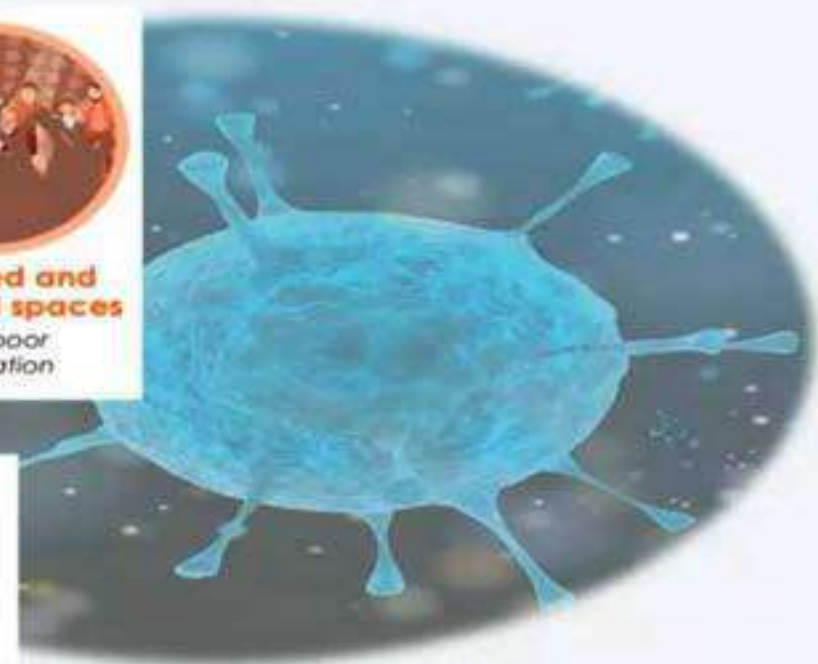


3
Confined and enclosed spaces
with poor ventilation



The risk is higher in places where these factors overlap.

Even as restrictions are lifted, consider where you are going and #StaySafe by avoiding the Three Cs.



Key Challenges in Coal Exploration

Identifying geological features and the contact zones associated with the country rock

- Demarcate metamorphic boundaries
- Mapping dyke and faulted features
- Depth of weathering, Overburden thickness
- location and extent of magnetic and non-magnetic materials
- Basalt flows, other structure

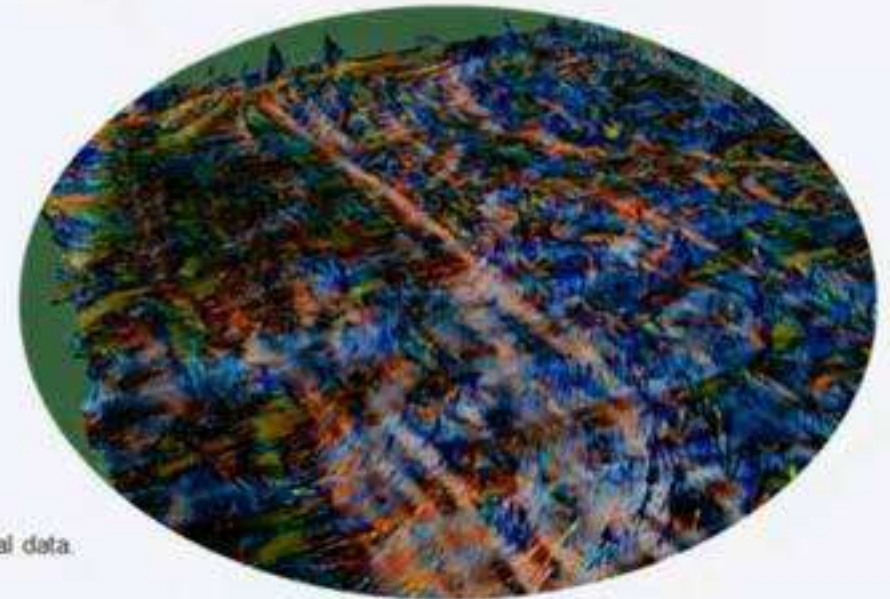
Insufficient geological information due to

- Inaccessible area for detail drilling survey
- Poor data quality and processing techniques
- Misinterpretations of the data

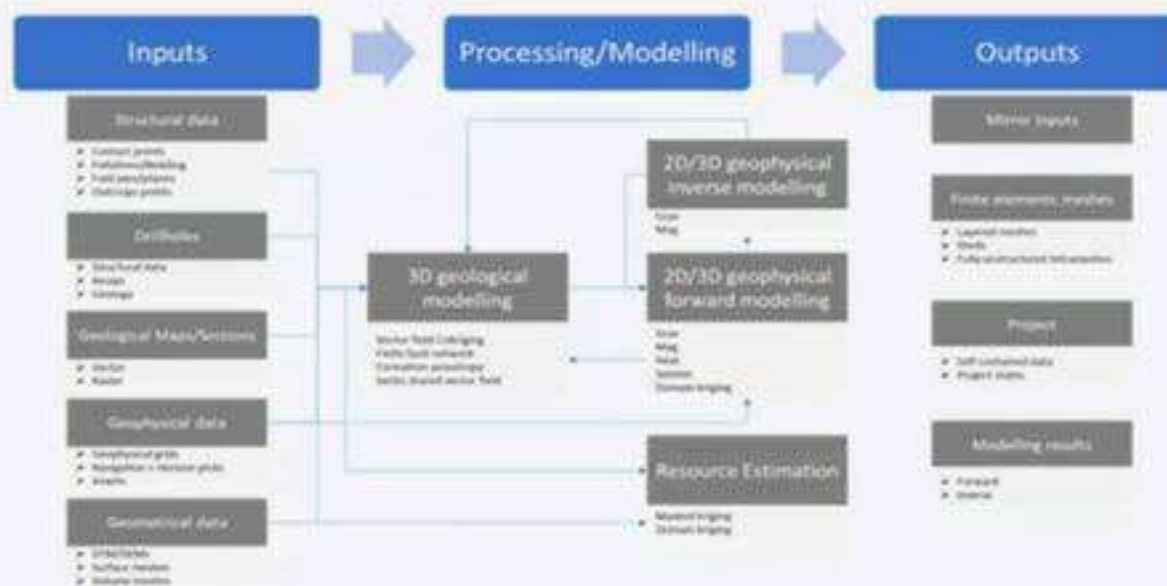
Integrated regional study approach and proper validation workflow

- Volumetric measurement of the overburden thickness based on geophysical data
- Extrapolation of proven coal seams into unexplored areas
- Geological Model validation with geophysical data

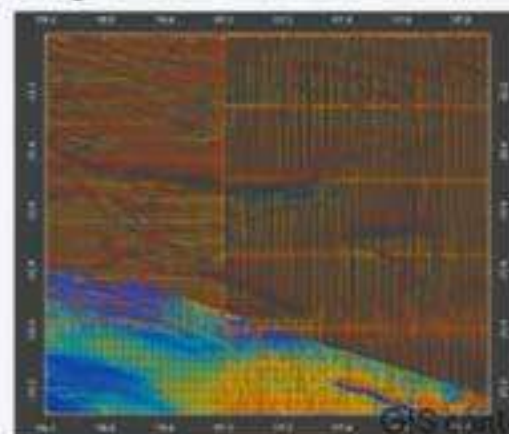
Solution: Innovative workflows for subsurface modelling using IG applications



Automated Geology and resource exploration with Geophysics workflows that validate data

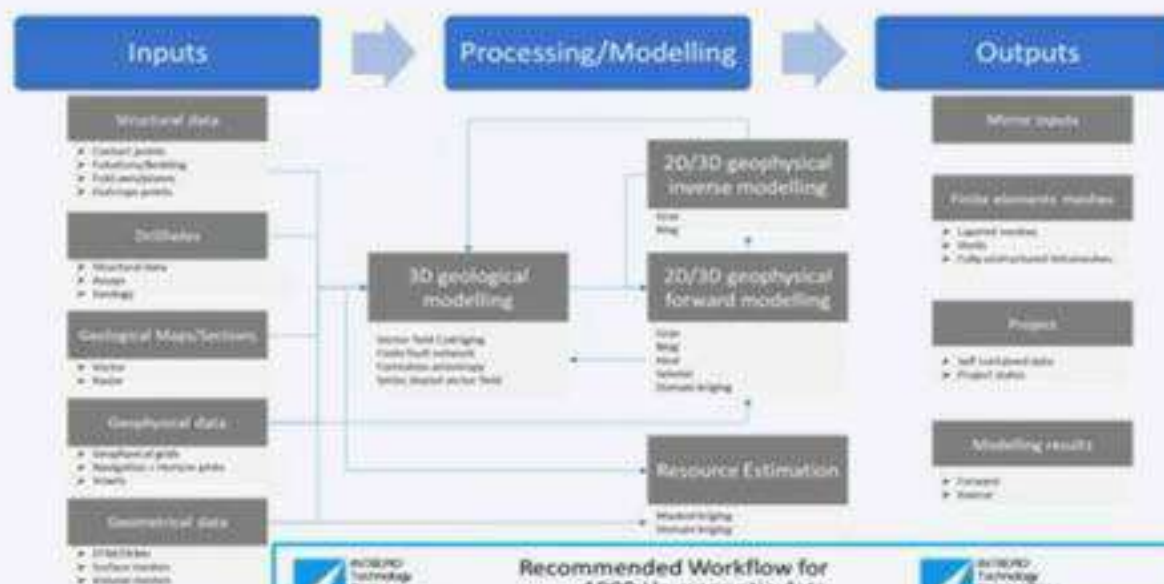


Original Diurnal/levelled

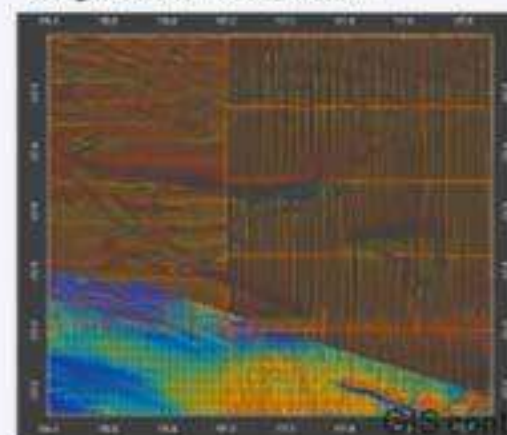


GIS content creator

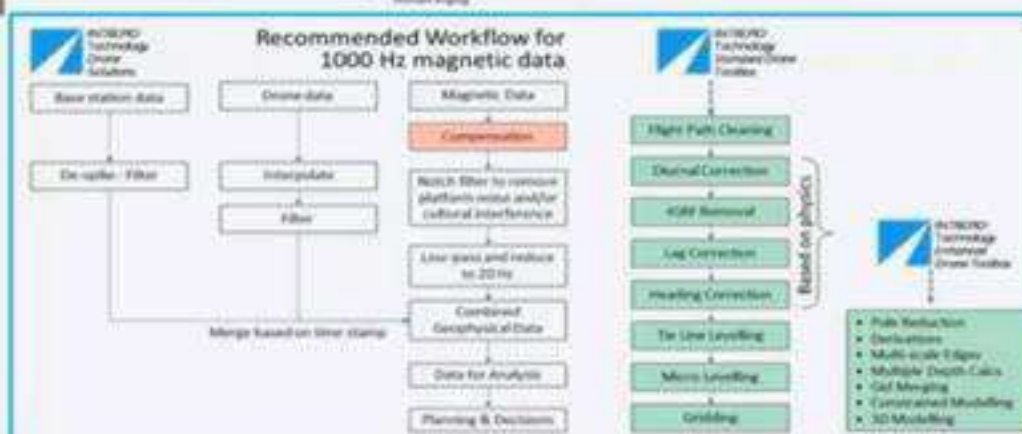
Automated Geology and resource exploration with Geophysics workflows that validate data



Original Diurnal/levelled

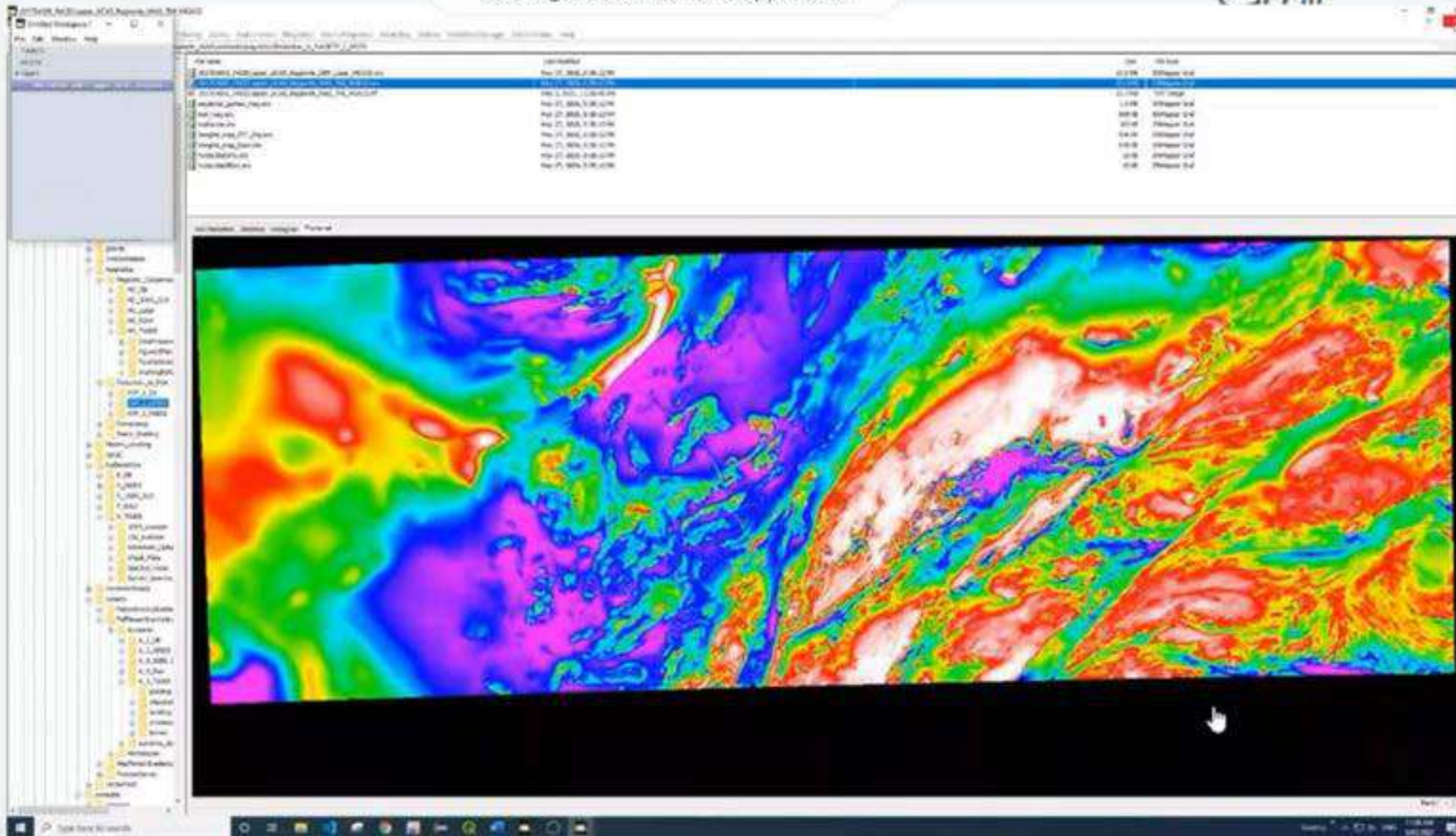


GIS content creator



Viewing Prakash Kumar's application

camit

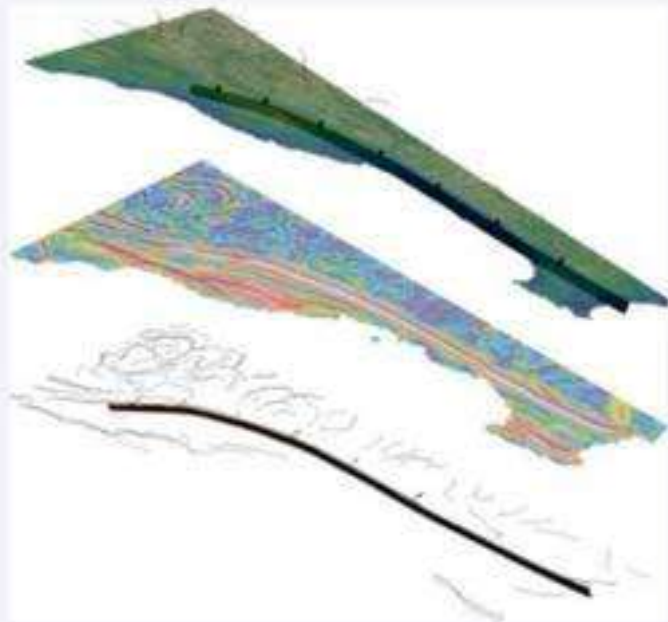


Viewing Prakash Kumar's application

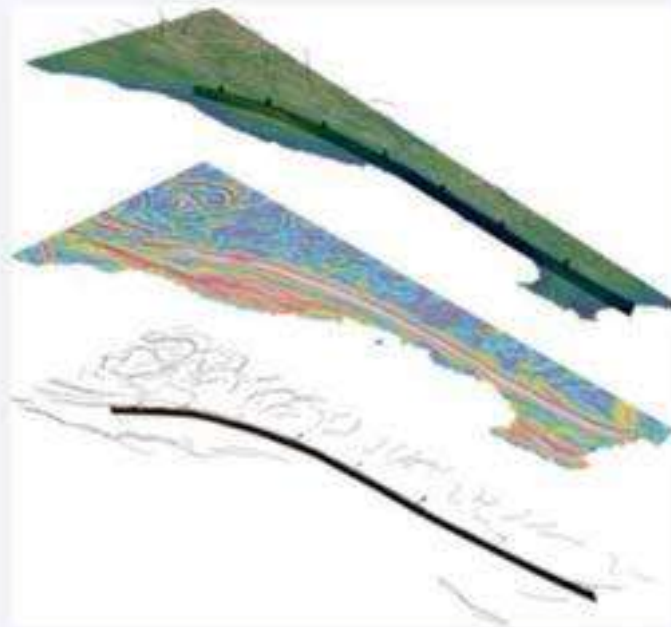


Geology from Geophysics

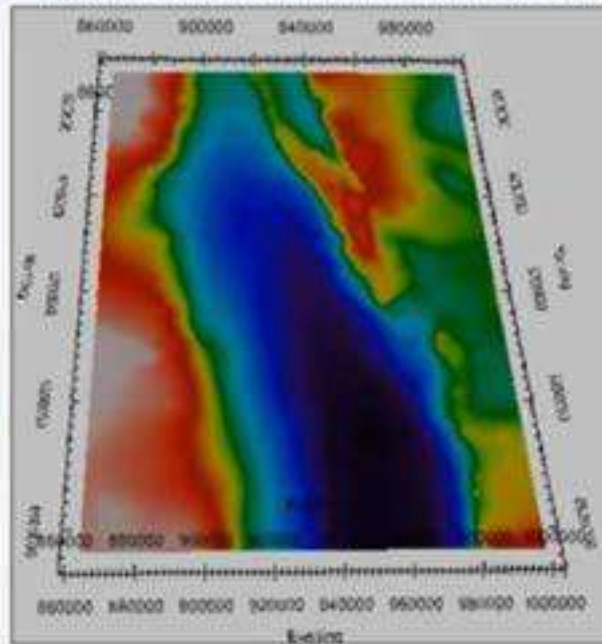
Perth Basin Model fault and Basement



Geology from Geophysics

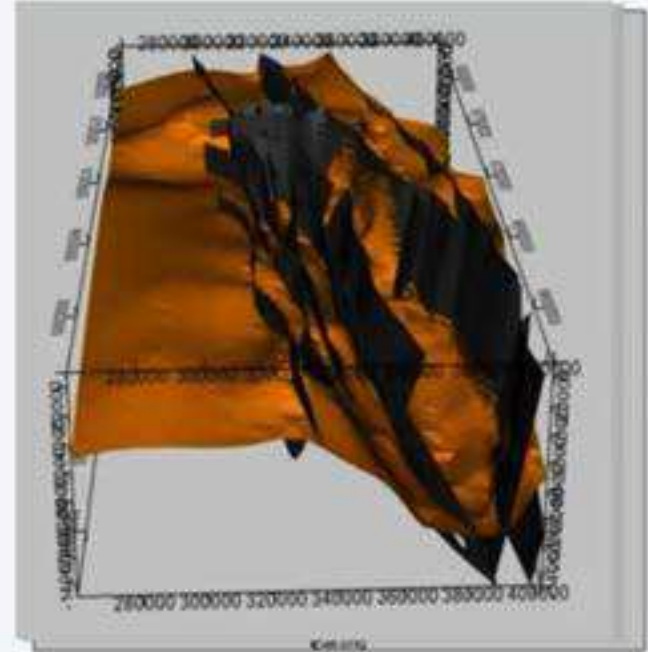
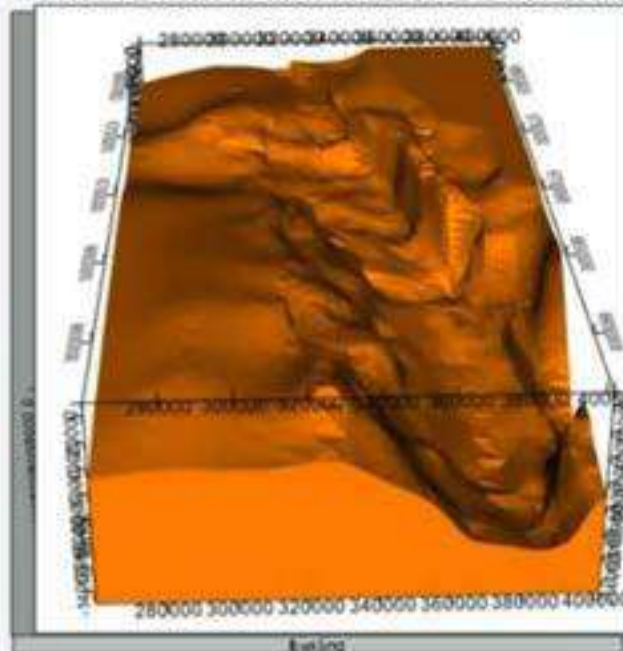


Perth Basin Model fault and Basement



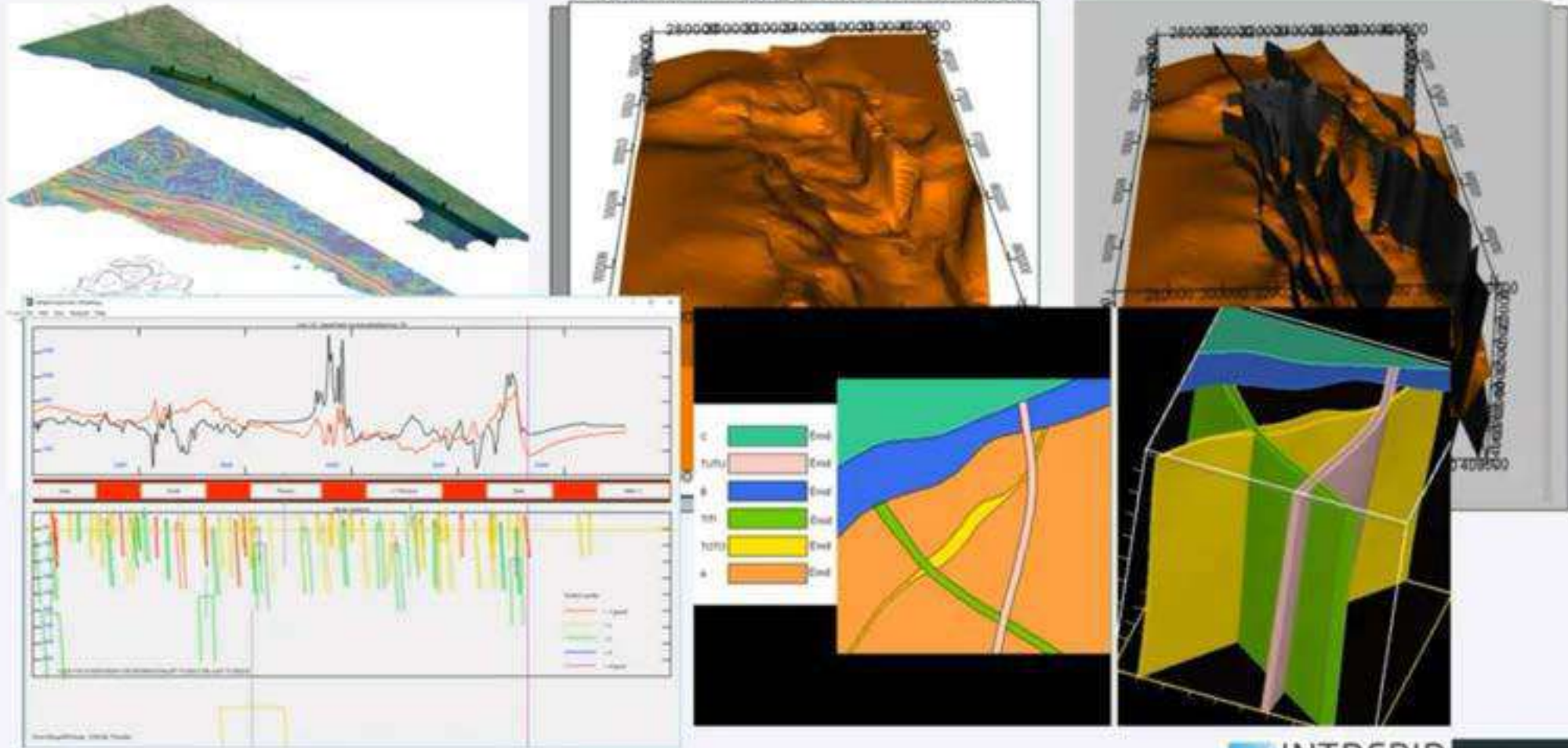
Geology from Geophysics

Perth Basin Model fault and Basement



Geology from Geophysics

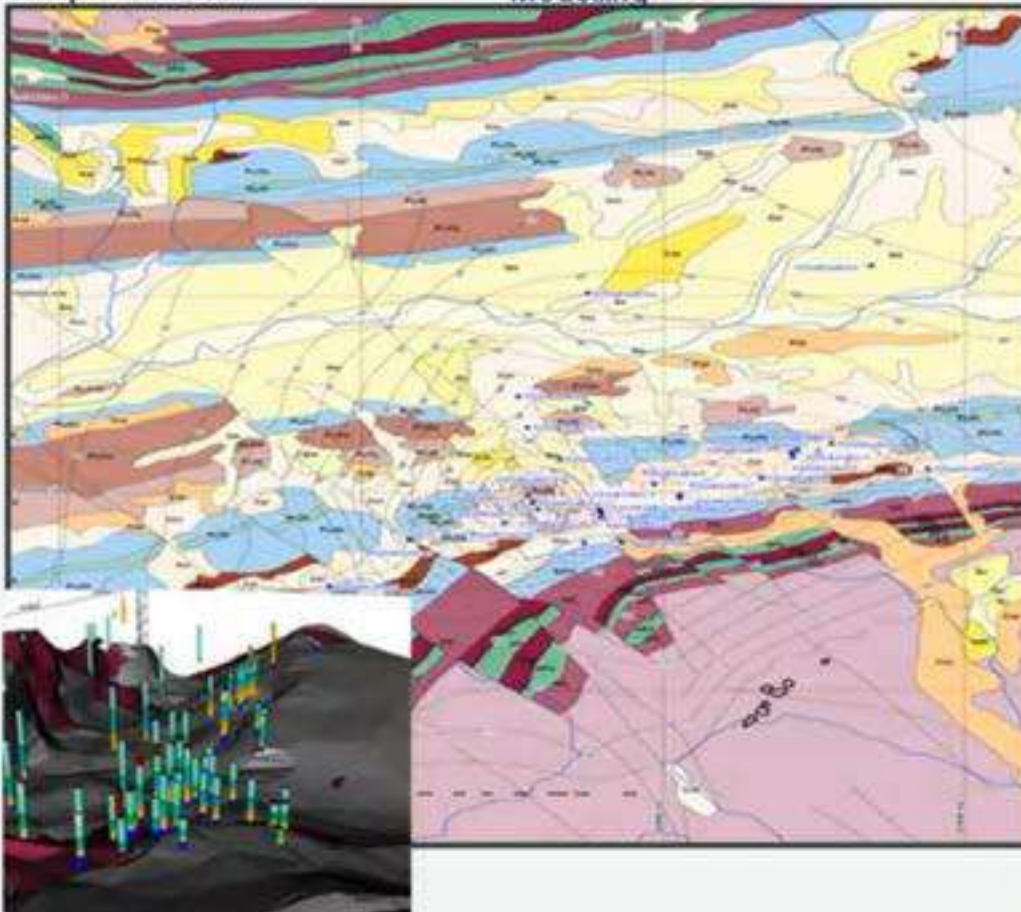
Perth Basin Model fault and Basement



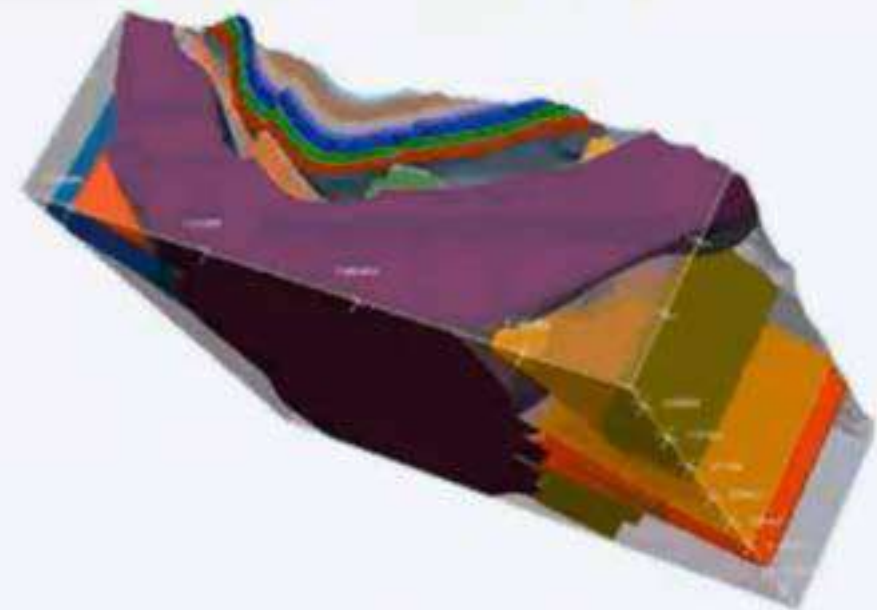
3D Geology Example: Brockman Syncline

Map: 17 x 20km

Modelling



Brockman 3D Syncline

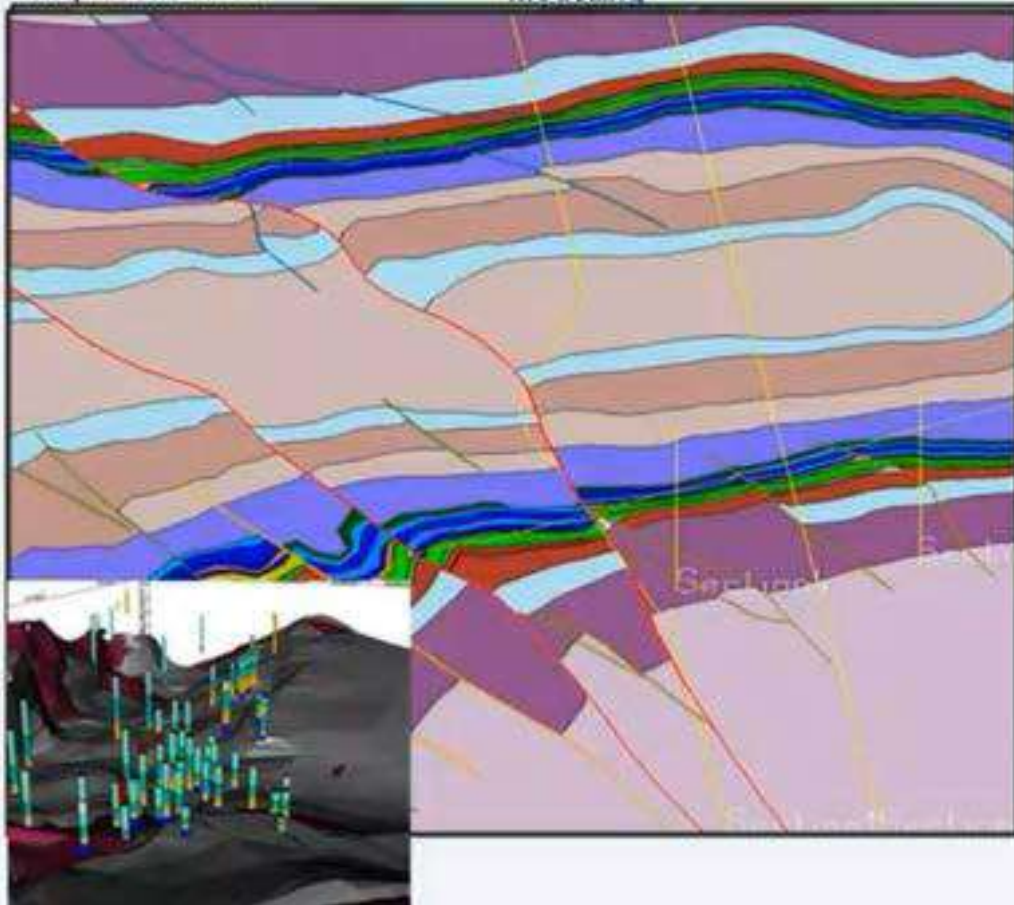


Derived from a geology map in the public domain
Rio Tinto's Brockman Syncline Project area

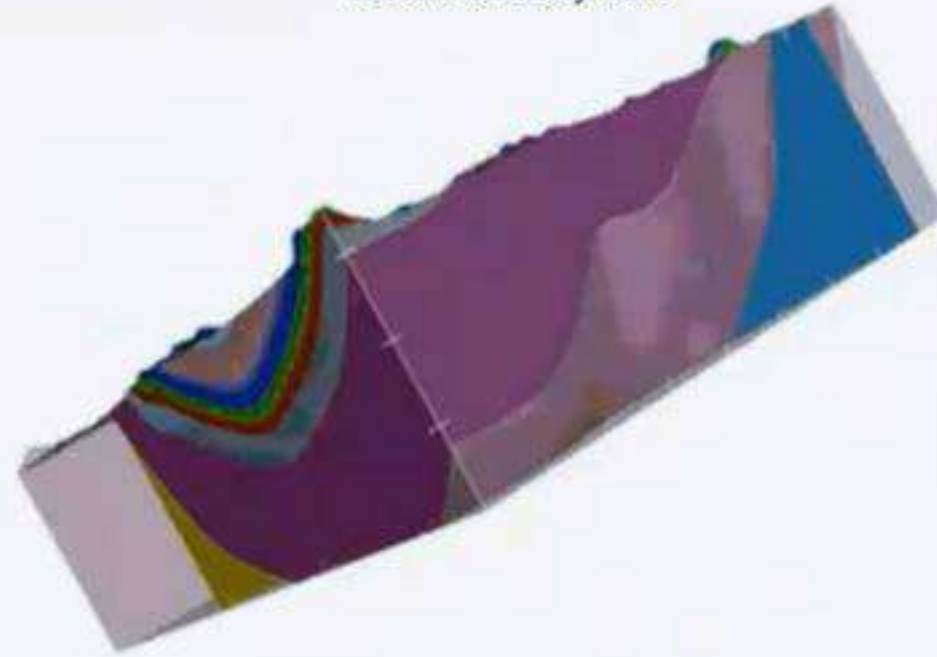
3D Geology Example: Brockman Syncline

Map: 17 x 20km

Modelling



Brockman 3D Syncline



Derived from a geology map in the public domain
Rio Tinto's Brockman Syncline Project area

Viewing Dr. Sanjay Rana's application

Geophysical Techniques for Determination of Sub Surface Anomalies & Its Use in Assessment of Damage and Integrity of Coal Mine Structures



Dr. Sanjay Rana

Viewing Dr. Sanjay Rana's application

Issues.....

The presence of subsurface anomalies, such as cavities, faults, unknown tunnels, etc., either natural or man-made, can cause public safety hazards.



Issues.....

- The damage & integrity of mine structures, such as the roofs, ribs, face and supporting pillars, is difficult to assess beyond the exposed surface. To mitigate potential rock fall hazards is an important issue.
- Flooding & subsidence are another serious problem and best example of damage in mining industry. They are closely related to the cost and the safety of mines. These situations occur, when cracks & fissures get created during mining operation



Viewing Dr. Sanjay Rama's application

Solutions.....

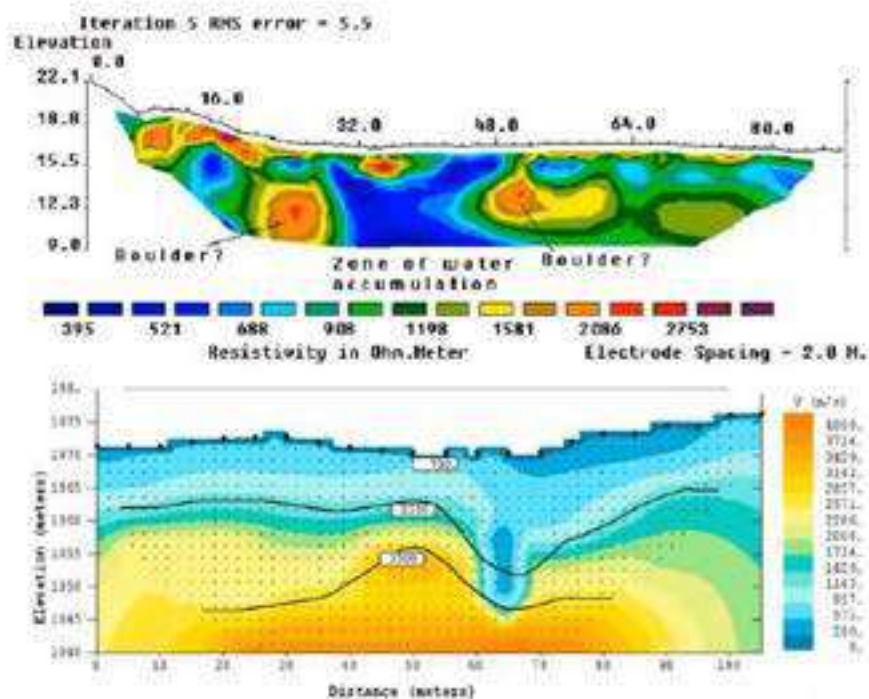
To understand geo-technical properties- Shear Modulus, Poisson's Ratio, Modulus of Elasticity and Bulk Modulus & other parameters of the site for civil constructions or open cast mining for coal/ lignite, studies can be taken up by using surface wave techniques. This will help to meet the requirements of bearing capacity and settlement of a foundation, slope stability of an open pit, ground control for underground mining.



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Solutions.....

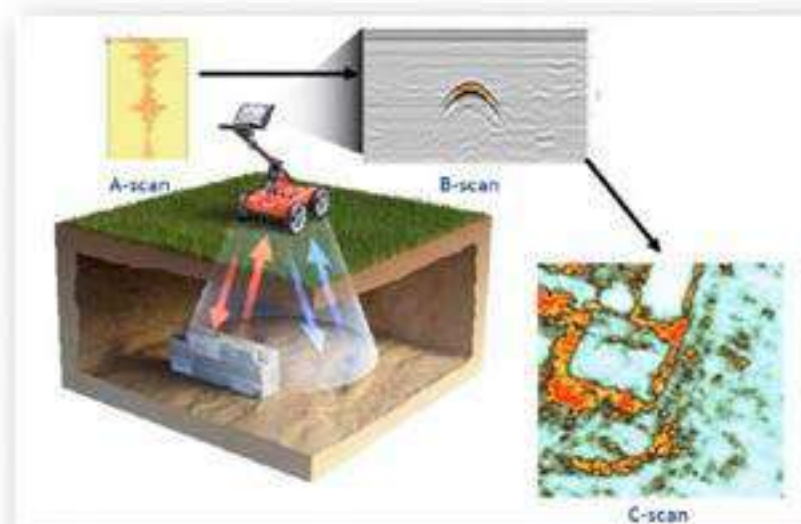
To detect and delineate fractures and zones of damage in coal mine structures for the **prevention of rock falls** and control of structural instability hazards by using surface wave techniques, Resistivity Imaging technique, GPR survey technique and seismic Refraction survey.



Viewing Dr. Sanjay Rana's application

Solutions.....

To detect subsurface anomalies, such as **cavities or old abandoned Mine workings** existing in shallow level (within 100m), faults, unknown tunnels, and the weak zones from which possibilities of water rushing in mine- Surface wave techniques, Resistivity Imaging Technique and Ground Penetrating Radar Technique can be used.



Viewing Dr. Sanjay Rana's application

Case Studies.....

case studies.....

Viewing Dr. Sanjay Rana's application

SHEAR WAVE VELOCITY FIELD FROM SURFACE WAVES TO DETECT ANOMALIES IN THE SUBSURFACE

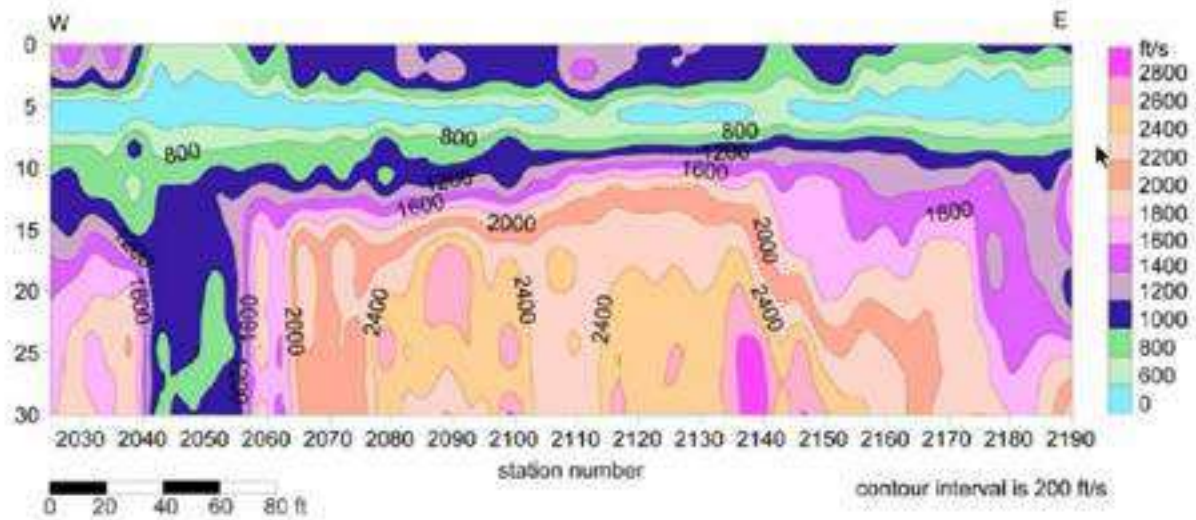
Richard D. Miller, Jianghai Xia, Choon Byong Park, and Julian Ivanov

Kansas Geological Survey, Lawrence, Kansas

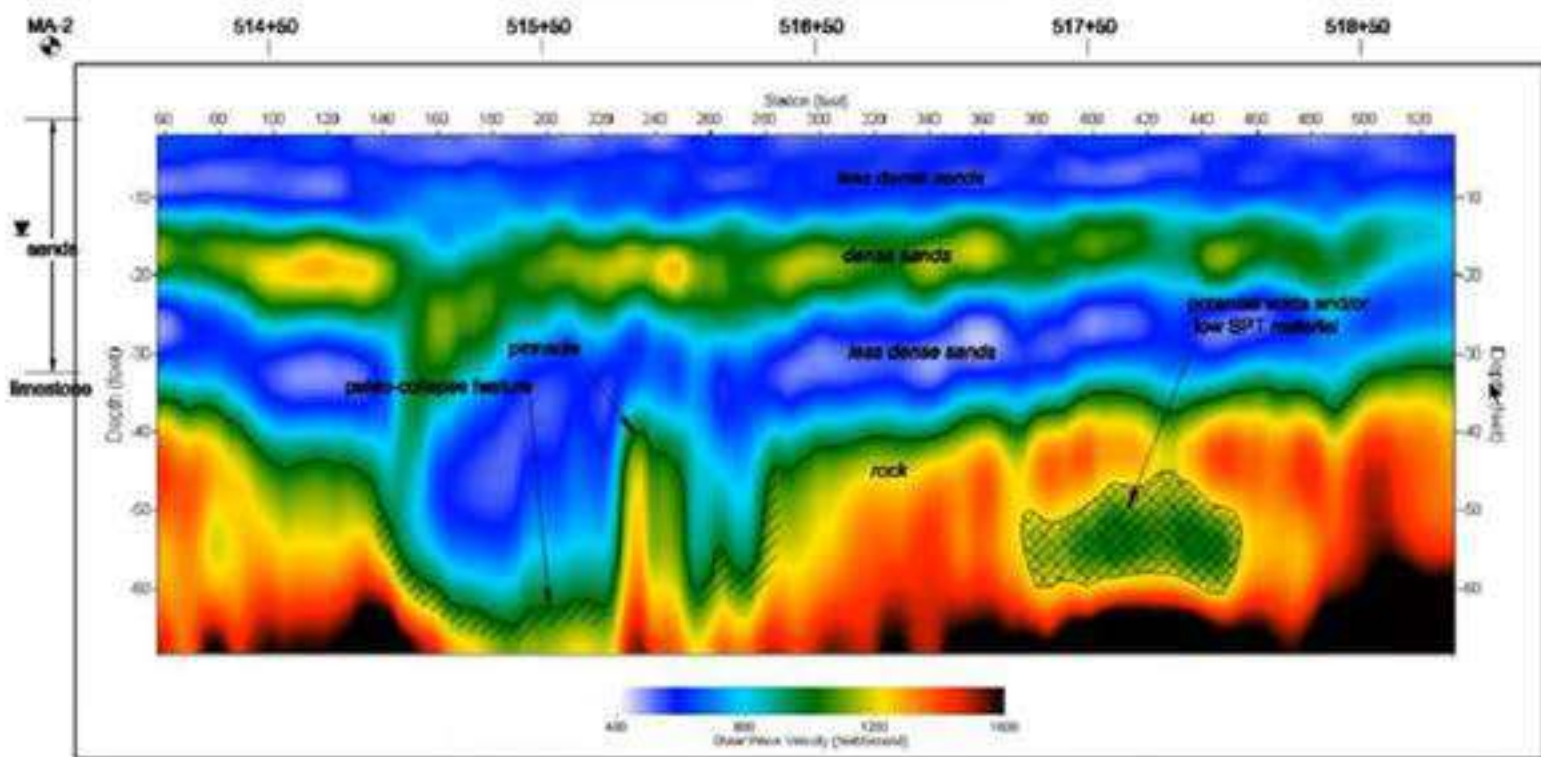
miller@kgs.ukans.edu, xia@kgs.ukans.edu, park@kgs.ukans.edu, and jivanov@kgs.ukans.edu

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Example of Fault/ Fracture



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Using Ground Penetrating Radar for Roof Hazard Detection in Underground Mines

By Gregory M. Molinda, William D. Monaghan, Gary L. Mowrey
and George F. Persetic



Conclusions:

Viewing Dr. Sanjay Rana's application

- The presence of subsurface anomalies, such as cavities, faults, unknown tunnels, etc., either natural or man-made, can be detected using geophysical methods, and this are useful in hazard mitigation
- The most widely used techniques include
 - Ground Penetrating Radar
 - Electrical Resistivity Imaging
 - MASW/ ReMi
 - Seismic Refraction Tomography

DRIVING EXPLORATION WITH AIR-FTG®

Application of Airborne Full Tensor Gravity Gradiometry (FTG) Technology For Structural Mapping and to Assess, Delineate Coal Potential Zones in Unexplored Sedimentary basins including Raj mahal Basin

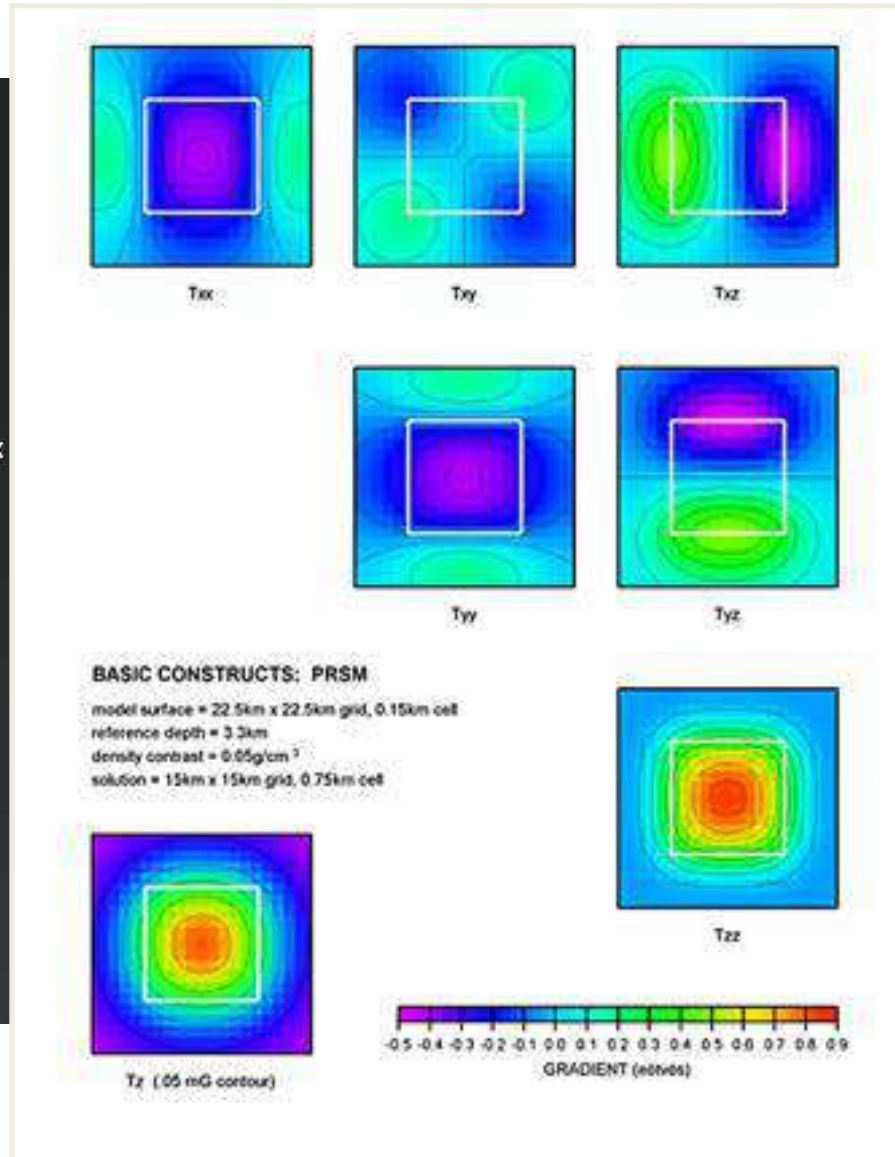
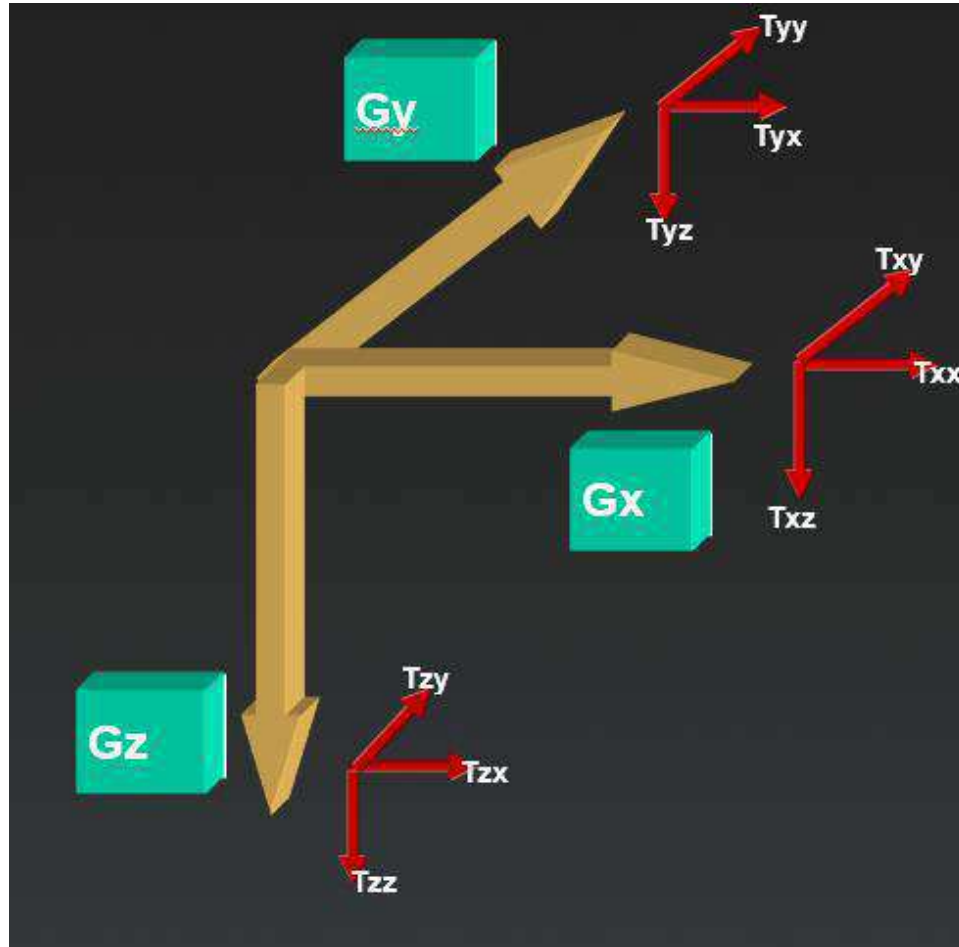


Airborne Full Tensor Gravity Gradiometry, Gravity & Magnetic Methods

KEY CHALLENGES FOR COAL EXPLORATION AND AIR FTG TECHNOLOGY APPLICABILITY

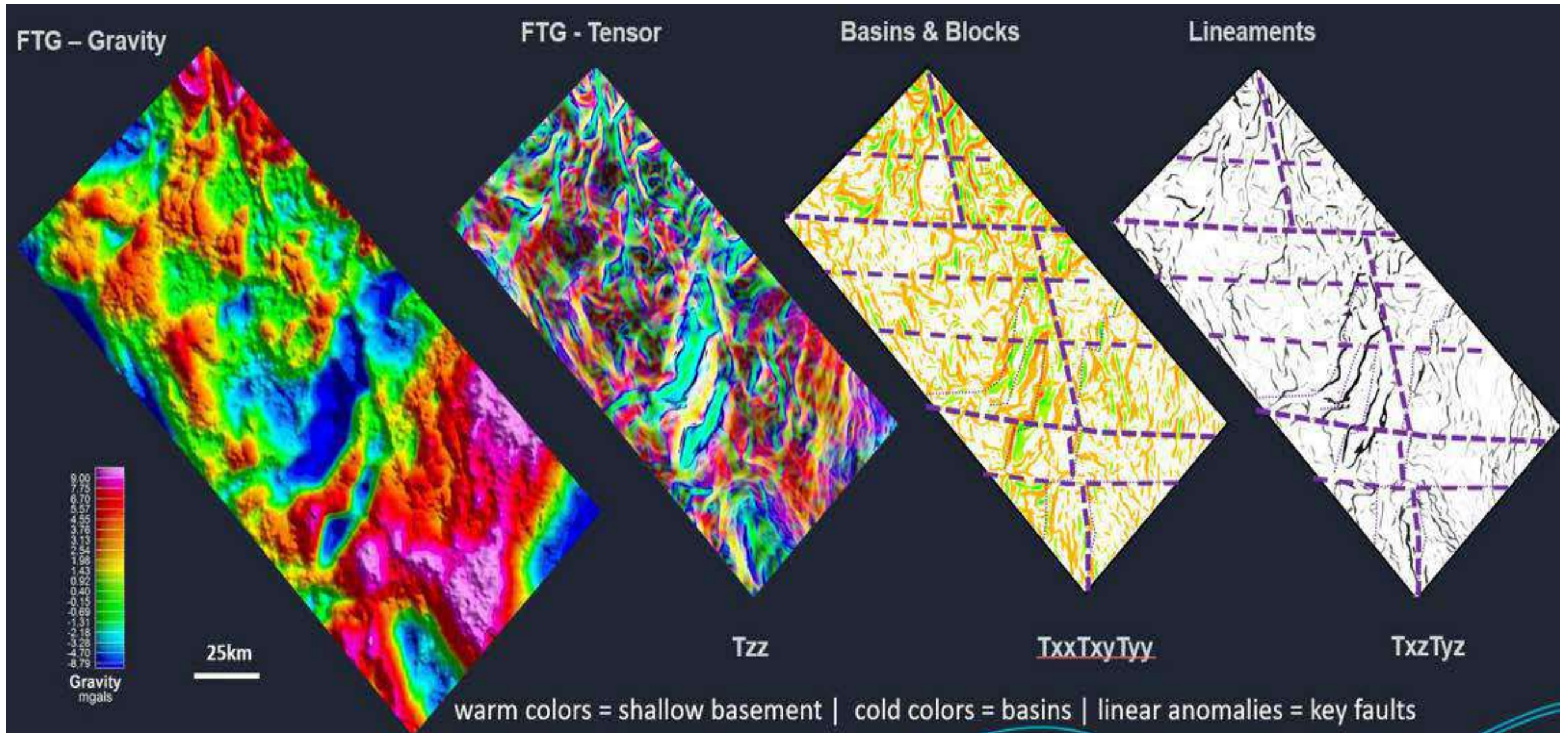
- Identifying Coal formations and the contact zones with the country rock under cover / traps
- Insufficient geological information due to
 - Deccan traps
 - Alluvial/Sand cover
 - Sediment cover
- Many of the target locations are in inaccessible areas for ground surveys
 - Remote areas
 - For Safety Law and Order issues and
 - Swamp or Water covered
- **Airborne FTG Surveys will not be affected by Above Challenges**

AIR-FTG[®] TECHNOLOGY – HOW IT WORKS?



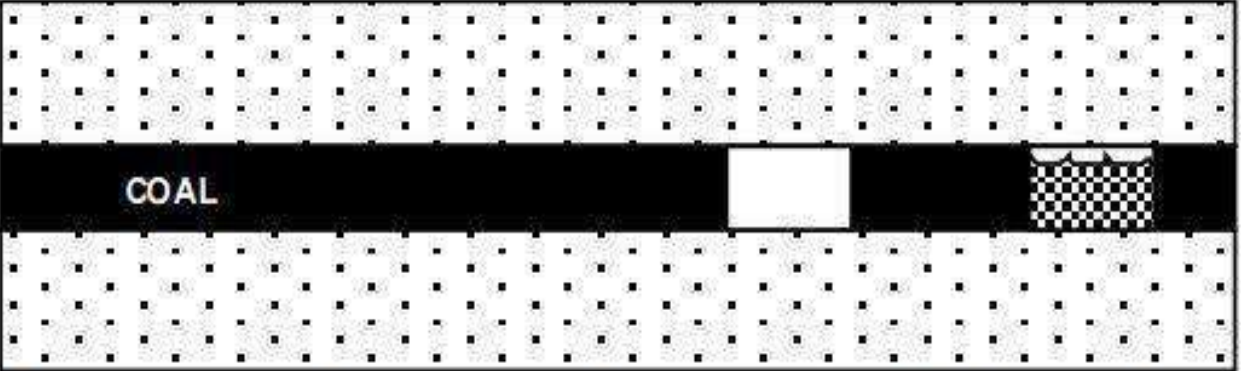
- Tz locates the center of mass, but not size and shape
- Tzz also locates center of mass and offers some information on shape
- 5 Independent Tensors yield shape information:
- Txx points to N-S edges of target (point of inflection on anomaly)
- Tyy identifies E-W edges of target (point of inflection on anomaly)
- Txz and Tyz locate N-S and E-W central axes of target (points of inflection on anomalies)
- Txz and Tyz also locate edges of target (maxima and minima of anomalies)
- Txy always show 2 positive - 2 negative anomalies associated with 'corners' of target

FTG RESULTS – HOW THEY LOOK?



COAL PHYSICAL PROPERTIES AND HOW AIR FTG FINDS COAL POTENTIAL AREAS?

Physical Property	Intact Coal	Open Void	Flooded Void
Electrical resistivity	high*	high**	usually low***
Seismic velocity	low	barrier	low
Density	low	very low	very low

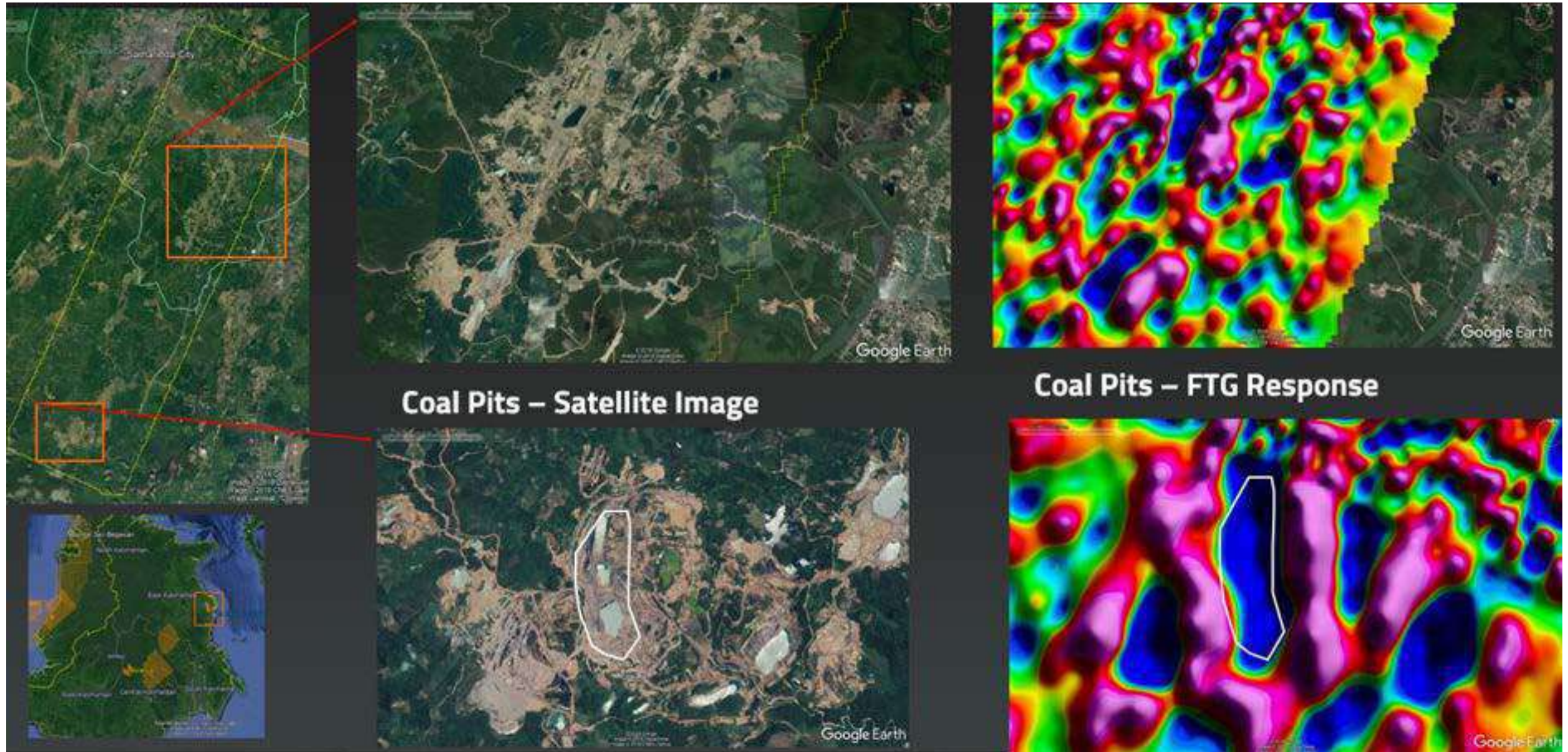


* Intact coal normally has a high resistivity, but can be of a relatively low resistivity if weathered or flooded with acidic water.
** Open voids are expected to be of a high resistivity, but the authors have encountered several examples where voids are marked by resistivity lows, possibly because of chemical interactions at the face of weathered pillars.
*** A flooded void could have a high resistivity if the water has a neutral pH.

Illustration of physical properties associated with mine openings

- ❑ We understand, CMPDI is currently using Seismic and sparse ground geophysical methods like gravity and magnetics.
- ❑ Bellgeo recommends adding Advanced Gravity Technology for Structural mapping, Faults and delineation of potential in alluvial and sub-trappean areas in cost-effective way with a quick turnaround time without disturbing environment
- ❑ In Seismic method, various lithologies are delineated using measured velocities information and in any type of Gravity method, geological mapping and delineation of formations is done using density information

INDONESIA – AIR FTG RESPONSE OVER COAL



Full Tensor Components map coal outlines successfully

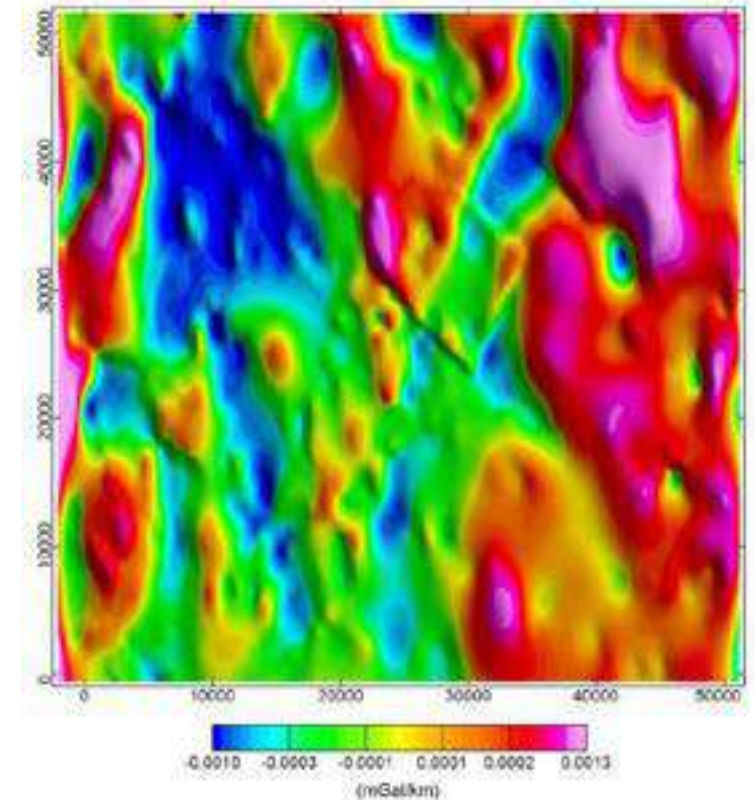
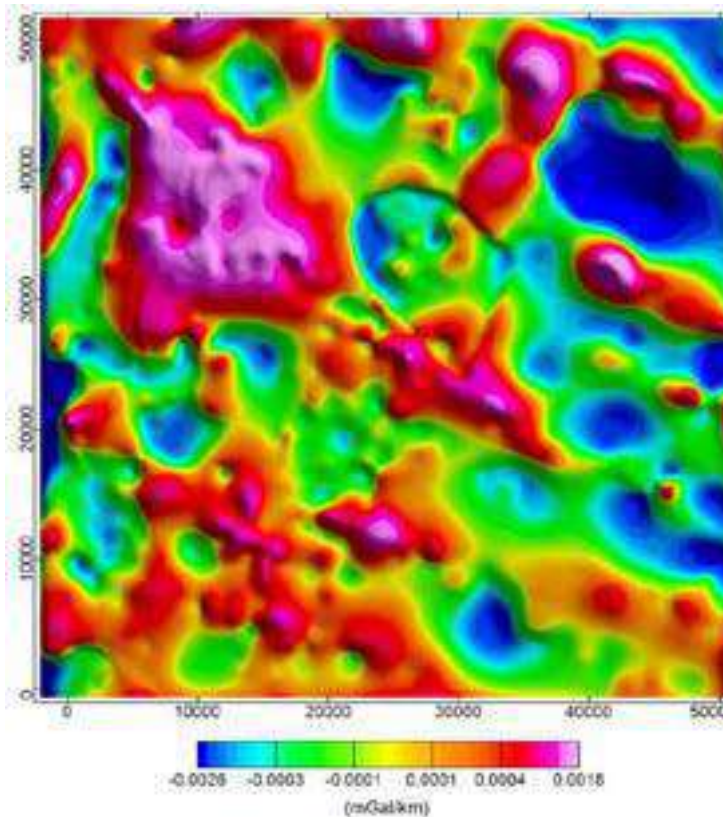
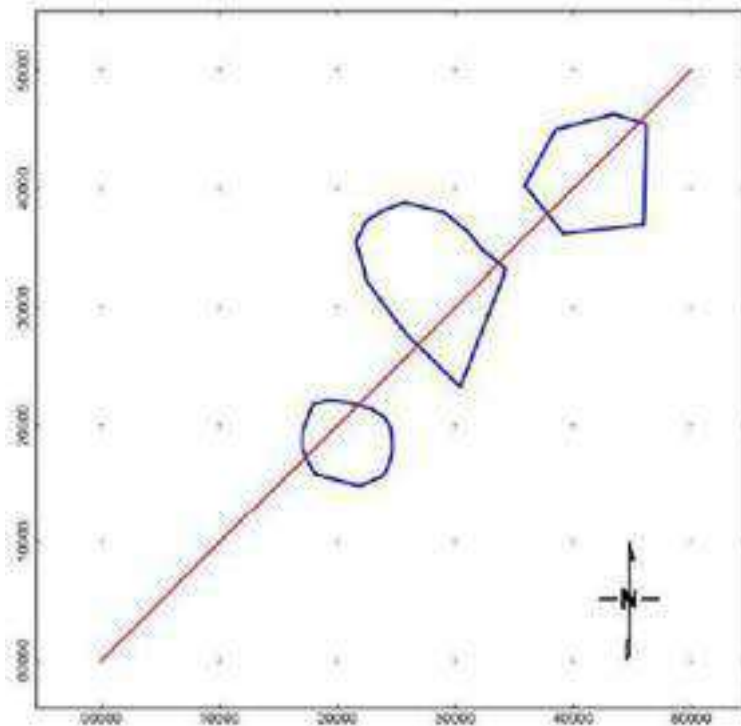
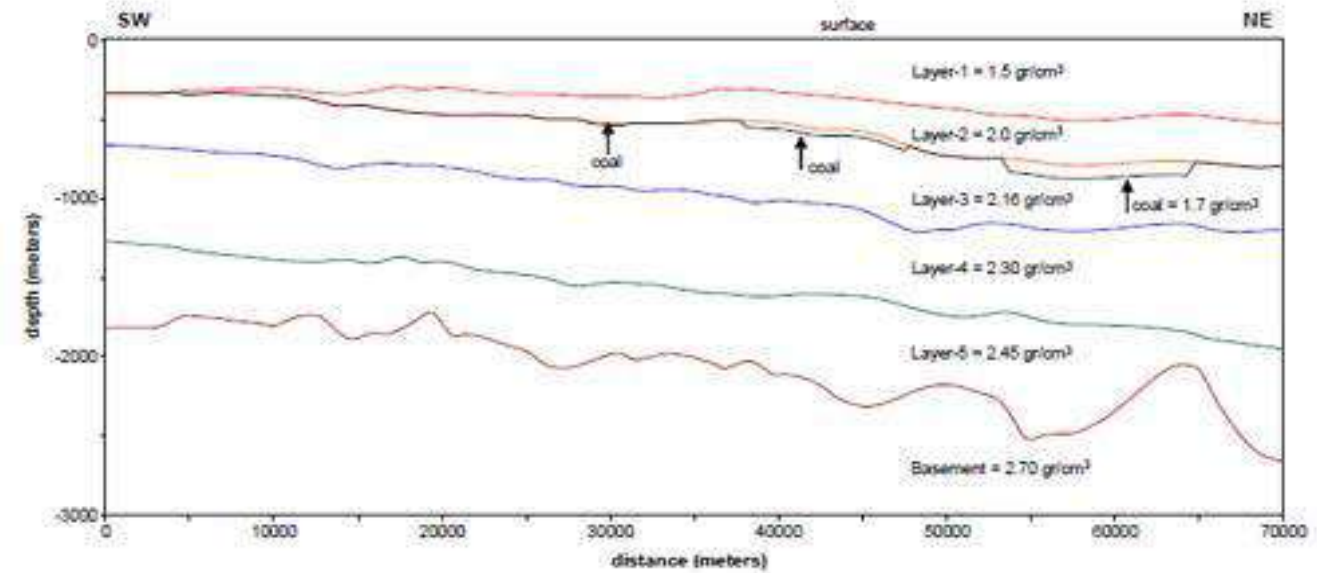
AIR FTG STUDIES IN INDIA

- Bellgeo has acquired Air FTG Data over 65,000 sq.km area in India in Assam, Rajasthan and Gujarat.
- Some of the Studies has delineated Lignite zones and Coal zones in some of the blocks. Due to Data restrictions and confidentiality of data, these results cannot be shared.

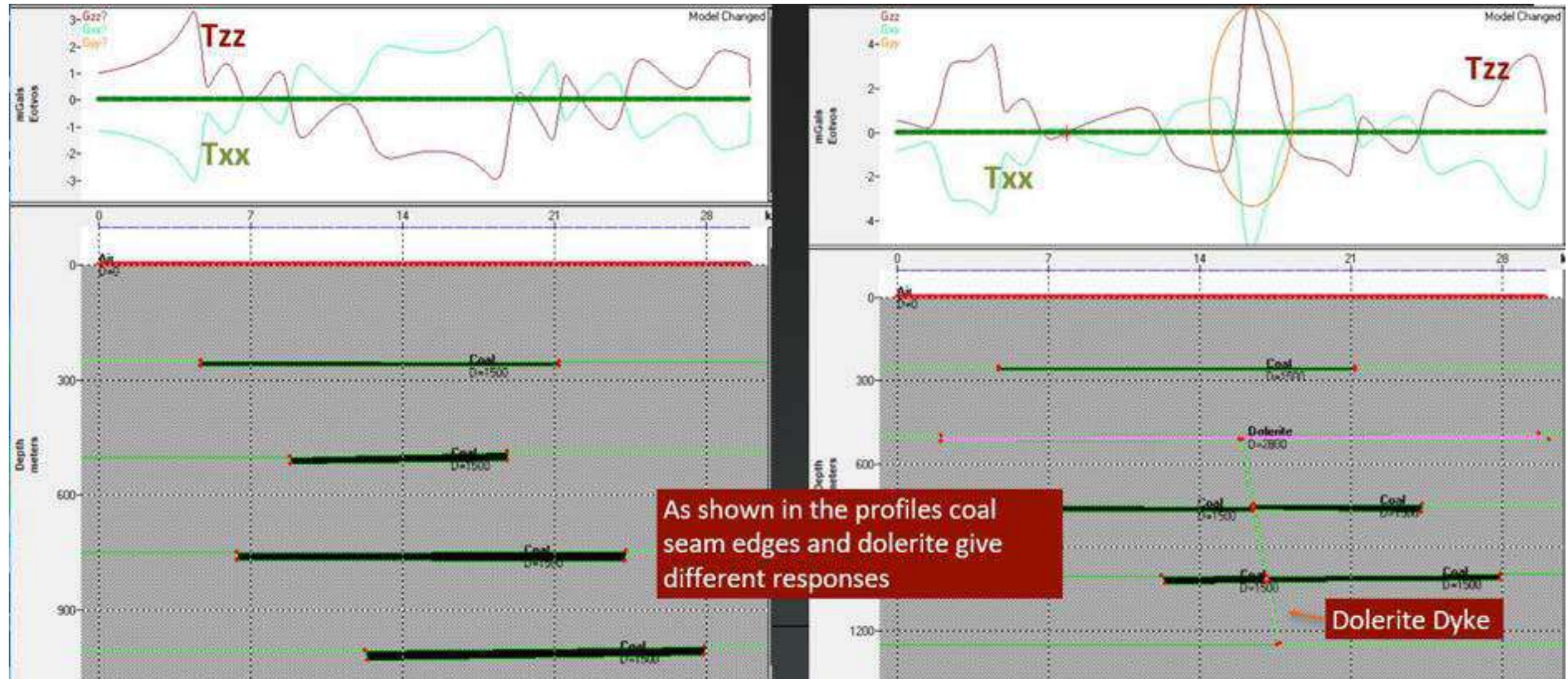
AIR FTG SYNTHETIC MODELLING ON COAL ZONES



A Published modelling study from One of the Indonesian based Coal property

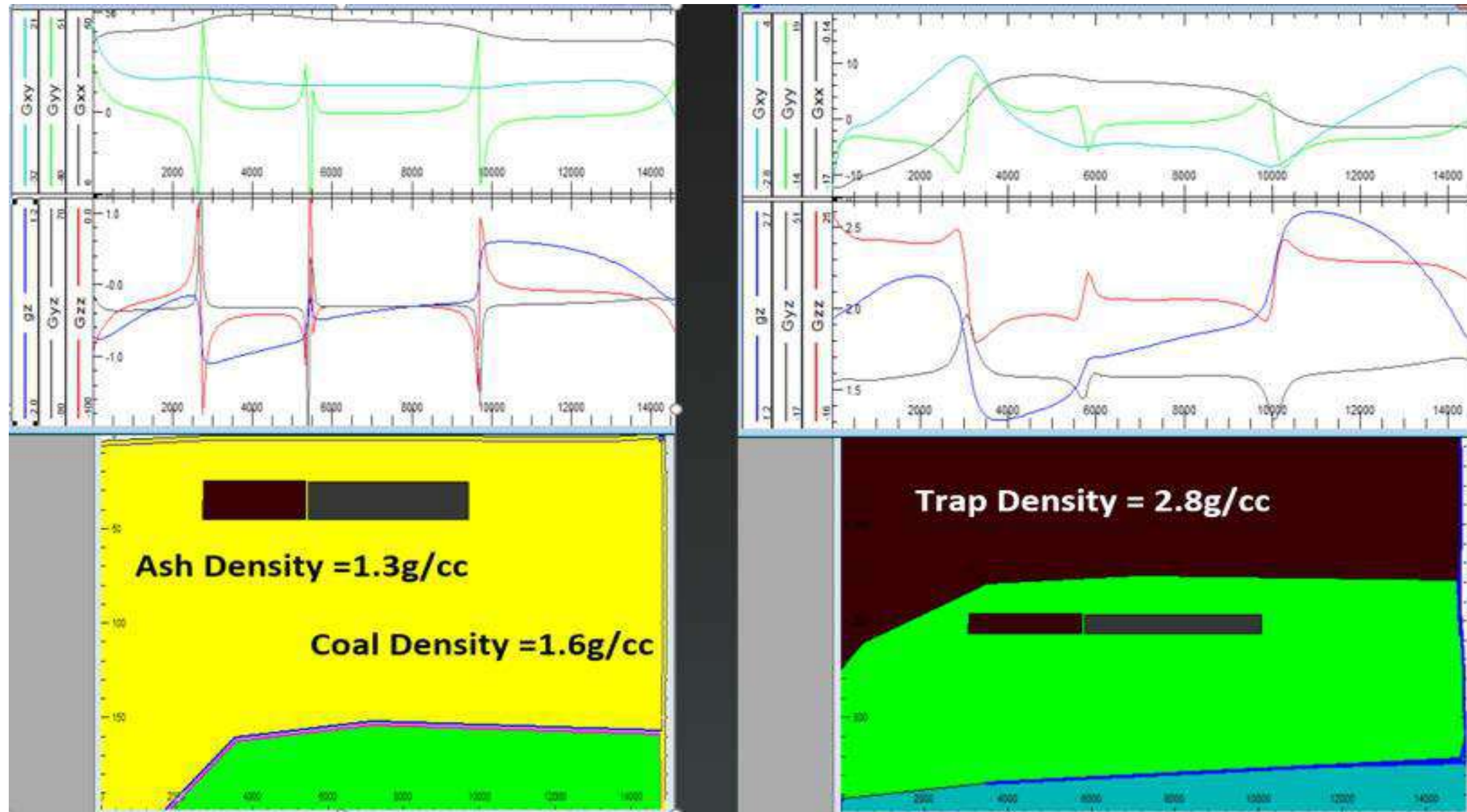


SYNTHETIC MODELS WITH AND WITHOUT DOLERITE DYKES



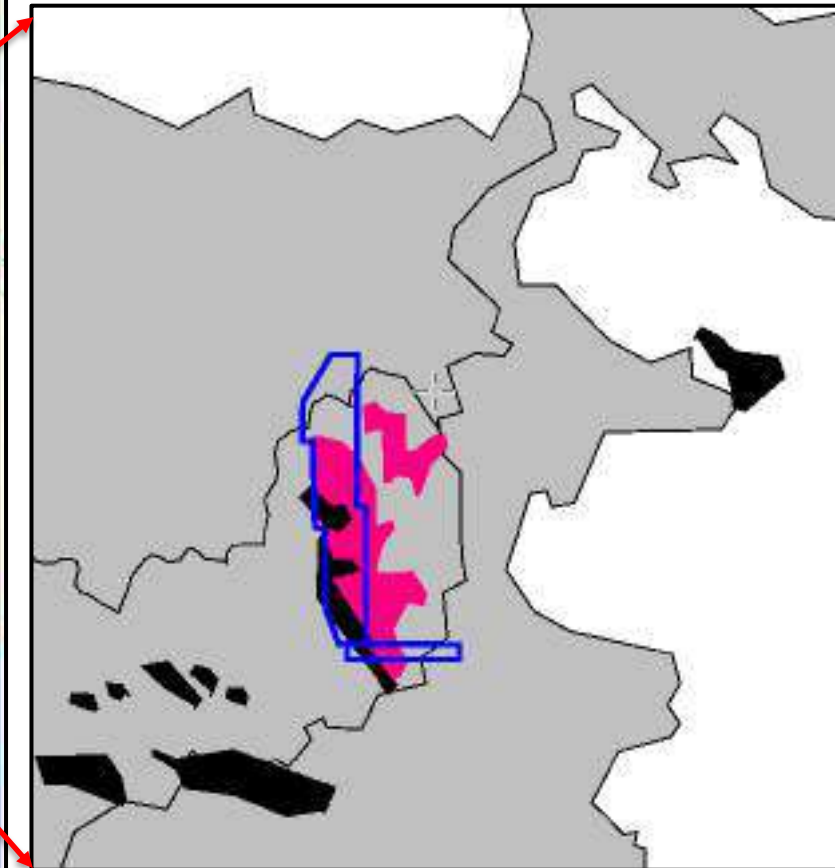
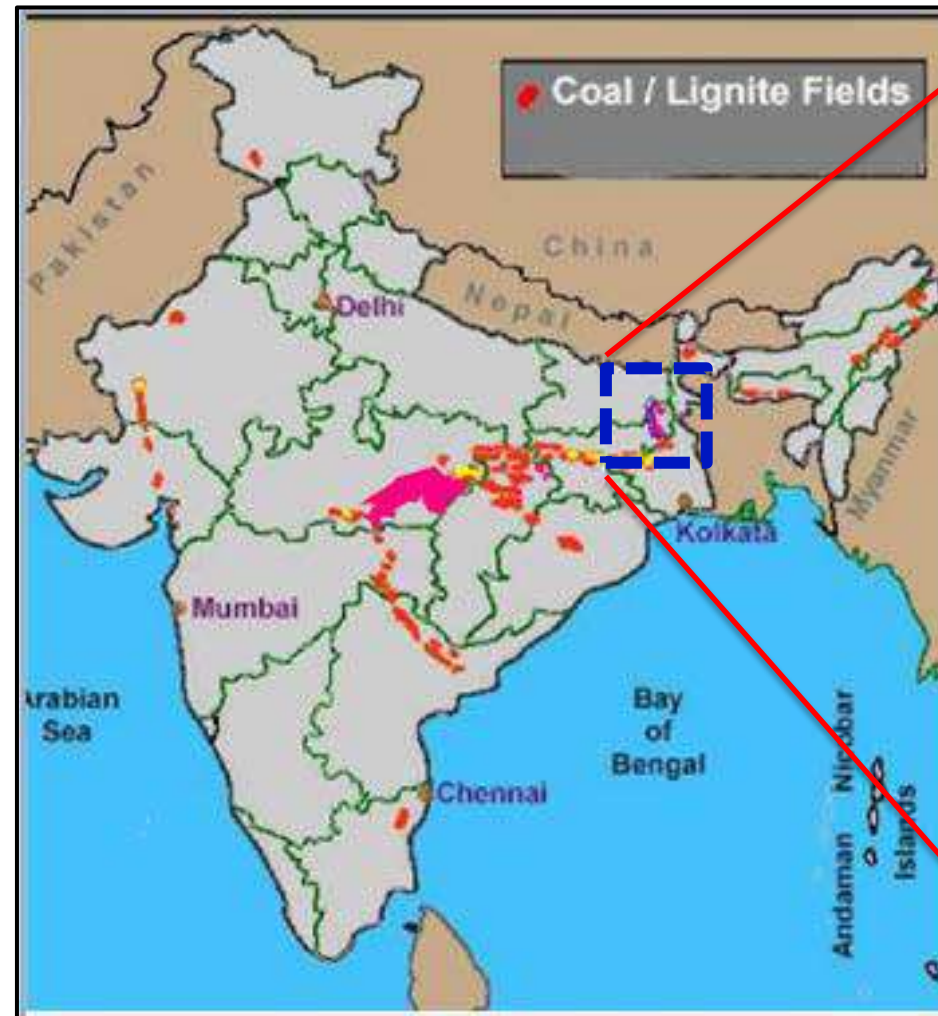
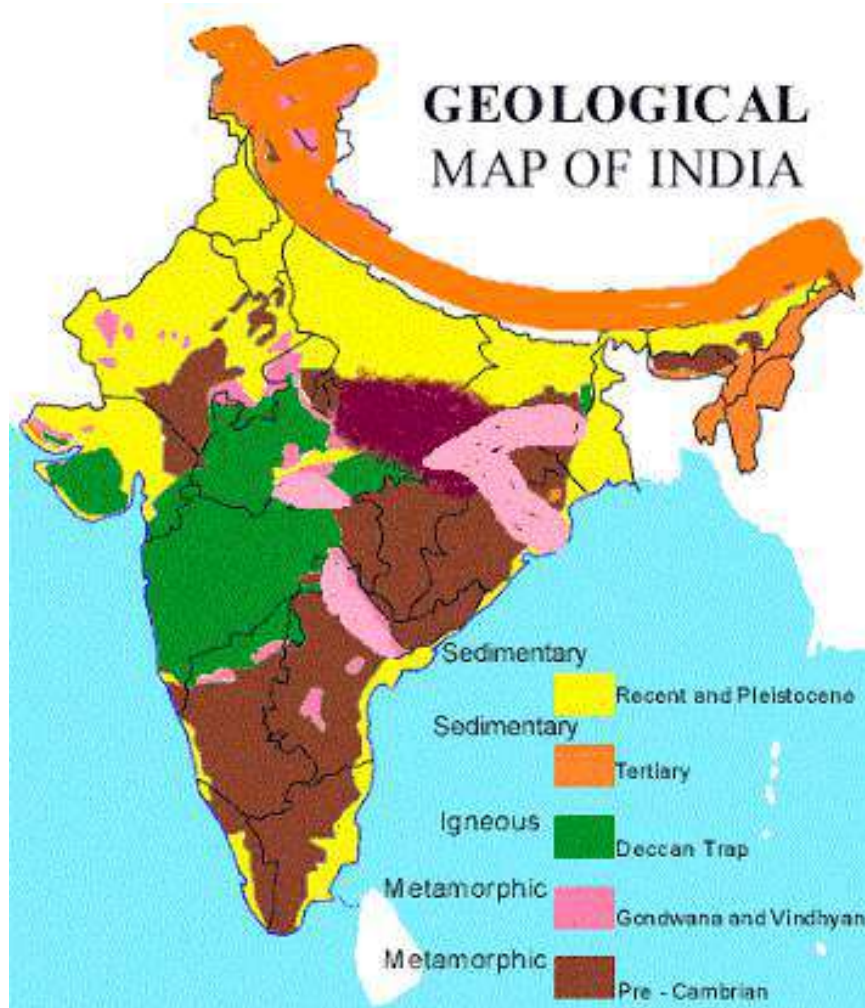
Various Tensor Components produce sharp differences If there are unwanted geological units

SYNTHETIC MODELS AT ASH AND COAL CONTACT



❑ *Various Tensor Components produce sharp differences If there are unwanted geological units*

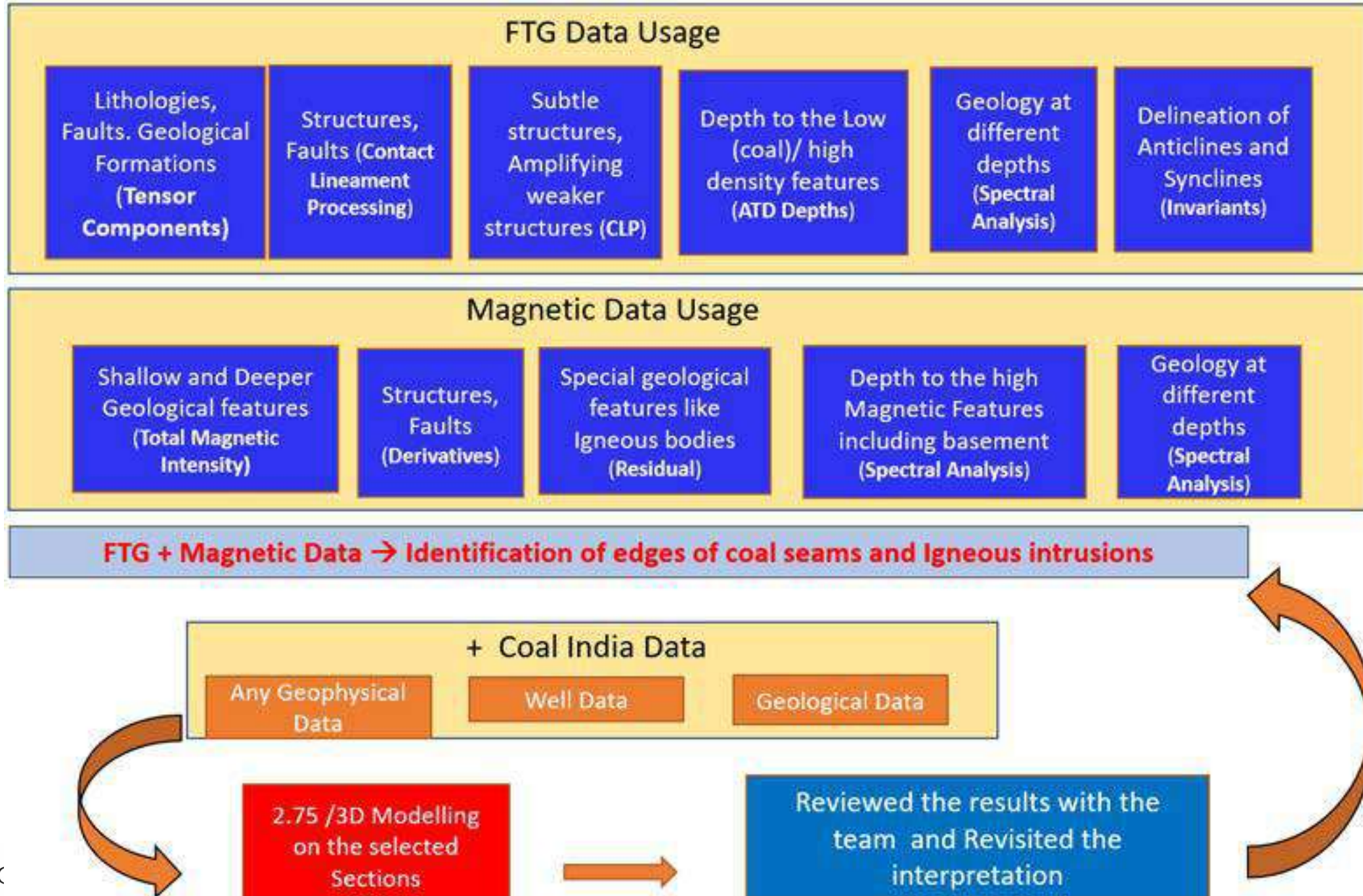
INDIA REGIONAL GEOLOGY, COAL FIELDS AND PROPOSED AIR FTG



- ***At the moment, known Coal fields are shallow or in well known areas only. However, a Pilot Project can be done covering known and Unknown trap/soil-covered areas to discover new deposits to increase the current reserves in the new areas***

2500 sq.km area in known and unexplored Raj mahal basin (be done in 3 to 5 months) on pilot basis, and synergies will be developed to fly in other areas

AIR FTG COAL EXPLORATION - SUMMARY



AIR FTG SURVEY, KEY ADVANTAGES AND WAY FORWARD

- Known Case studies and Physical property contrast clearly shows that Air FTG can delineate potential coal zones quickly without any major logistical challenges.
- Modelling studies show that if there is thick Coal seam (>60m) with proper density contrasts at below 500m then, there is a possibility that Air FTG can delineate those zones.
- Air FTG survey over a 2500 sq.km block can be completed in 6-8 weeks time and for Processing and Interpretation it takes another 8 weeks. Hence, **in less than 4 months, a decision can be reached on delineating potential coal zones**, structural mapping and way forward on a project.
- Additional advantage with Air FTG survey is that, it can also identify **if there are any potential base metal, Kimberlites and Iron ore** targets.

As soon as the pilot project is completed successfully, much larger areas can be mapped and high-potential large areas can be focused to delineate potential coal zones with a minimum time and with no logistical, safety and law and order issues.

Kores

Presentation for Improvement on Productivity

↓ Resources = ↑ Money

↑ Progress = ↑ Money

More progress in less resources = Productivity

Productivity is the ratio of outputs to inputs. It refers to the volume of output produced from a given volume of inputs or resources.

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Manager (S&M)

Kores India Ltd, Head Office, Mumbai



Kores

Where Value Is Tradition

Viewing Tushar- Kores India Ltd's screen

Complete
Drilling
Solutions

KORES Engineering division is part of Kores stationary group & leading Indian manufacturer of Hi tech multipurpose hydrostatic drilling rigs. Kores acquired Acker, USA & Gefco, USA technology & started make in India in 1990.

Kores is having state of art manufacturing plant at Pithampur, MP for production of world class exploration rigs & have service network all over India & abroad.

Kores is supplying core drilling rigs to CMPDIL & MECL from last 35 years.



Leaders in Manufacturing of :

Multipurpose Hydrostatic
Drilling Rigs

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Duplex & Triplex
Pumps

Kores

Presentation for

Improvement on Productivity

- 1- Use of latest hydraulic machines & better utilization of machine**
- 2- Selection of Machine**
- 3- Use of Mud mixer for polymer**
- 4- Selection of Bits as per formation**
- 5- Automation in Drilling rigs**
- 6- Increase drilling through new operation model**

Cost & Operating Comparison for Mechanical drill Vs Hydrostatic Drill



→ Skid mounted drilling rig,
Skid mounted mud
pump & Tripod

→ Crawler mounted
hydrostatic drilling rig
→ Skid/ Trailer/Truck

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Movement from Workshop to Site

Viewing Tushar- Kores India Ltd's screen



Mechanical Drill

- Skid mounted drill, Mud pump, Tripod/ Derrick Separately
- Arrange Crane for loading in to Truck
- Arrange 1 no Truck for machine & 1 no for mud pump & Derrick
- Arrange Crane for unloading at site
- Cost for movement :-
- Rs.80000/- + more time



Hydrostatic Drill

- Crawler/Truck/Trailer mounted drill (Consist of drill/pump/Derrick)
- Arrange Crane for Crawler/Trailer -No need for Truck mounted
- Arrange 1 Truck for complete drill
- Arrange crane for unloading
- Cost for movement
- Rs.50000/- + less time

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Mechanical Drill

- Arrange Crane for loading in to Truck
- Arrange 1 no Truck for machine & 1 no for mud pump & Derrick
- Arrange Crane for unloading at site
- Prepare foundation for Skid mounted drill
- Cost for movement :-
- Rs.30000/- + 2 Days time



Hydrostatic Drill

- No need for Crane – Self propelled
- No need for Truck – Self propelled & can be operate by own crew only
- No need for crane for unloading
- No need for foundation mounted on Jack
- Cost for movement
- Rs.100/- + 2 Hours time



Mechanical Drill

- 1 Driller – Operate machine
- 1 Asst Driller- Asst. other people & mud pump operating
- 1 rig man- to handle drill rod, Derrick & repair
- 3 helper to handle core & pipes
- Cost per month :-
- Rs.100000/- per month
- Rs.333 per Mtr (300 Mtr)



Hydrostatic Drill

- 1 Driller – Operate machine
- Driller operate mud pump with control panel
- Driller operate with control panel
- 3 helper to handle core & pipes
- Cost per month :-
- Rs.60000/- per month
- Rs.60 per Mtr (1000 Mtr)



Mechanical Drill

- Need to operate with 2 chucks – Hydraulic /Mechanical
- Manual foot clamp
- Manual Breakout wrench
- Manual gear change – very hard in some case
- No operating control – All manual based
- More time for manual operations – less safety & low progress



Hydrostatic Drill

- Operate machine with control panel –No chucks operation required
- Hydraulic foot clamp
- Hydraulic Breakout
- operate with control panel
- All Hydraulic control panel
- Time saving for above operation result more progress with safety



Mechanical Drill

- Feed Stroke – 600 mm (2 feet) – need to reopen Mechanical & Hydraulic chuck at every stroke more manpower & time consumption
3 Mtr Feed = 5 Stroke
3 Mtr feed = 15+15=30Min
- Low wire line winch speed more time consumption for removing core
- Less rotation & Torque



Hydrostatic Drill

- Feed Stroke – 3.35 Mtr (11 Feet) – No hydraulic or mechanical chuck, need to open only hydraulic foot clamp & hydraulic breakout to open threade
3 Mtr feed = 1 Stroke
3 Mtr feed = 15 Min
- High wire line winch speed – less time for removing core
- More rotation & torque



Mechanical Drill

- Rotation, Hoist, winch is mechanical operated so wear & tear is more resulting more frequent breakdowns
- Suitable for only core drilling
- Manual control over formation & feed
- less stroke during borehole washing



Hydrostatic Drill

- Rotation, Hoist, Winch is Hydraulic operated so wear & tear is less resulting less breakdowns
- Suitable for DTH Drilling / RC Drilling
- Get idea about formation & feed from control panel
- can do more up & down for borehole washing



Hydrostatic Drill

- Selection of best Hydrostatic drill based on various application



Hydrostatic Drill

- Up to 300 Mtr depth range – 300 Mtr Machine
- Up to 600 Mtr depth range – 600 Mtr Machine
- Up to 1000 Mtr depth range – 1000 Mtr machine
- To use option of Core & Non core drilling in same machine to improve.

Selection of Best Machines

Viewing Tushar- Kores India Ltd's screen



150 Mtr Depth



300 Mtr Depth



600 Mtr Depth



Depth

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Kores



Polymer for Drilling

- Polymer in Drilling
- Polymer-based drilling fluids used in the Coal fields can increase penetration rates, improve core recovery, minimize formation damage.



Hydraulic mixer for polymers

- Use of Hydraulic operated Polymer mixer, will improve the performance of polymer

Selection of Diamond bits for Drilling

Viewing Tushar- Kores India Ltd's screen



Core drilling bits

- Selection of Diamond bits
- For Soft formation ---
SPC Bits
- For Soft formation Fast
progress---
PCD Bits
- For Hard formations
Impregnated Bits



Non Core Drilling Bits

- Selection of Bits
- For Non Core drilling
Non Core PCD Bits

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Automation / Control of Rig operations

Viewing Tushar - Kores India Ltd's screen



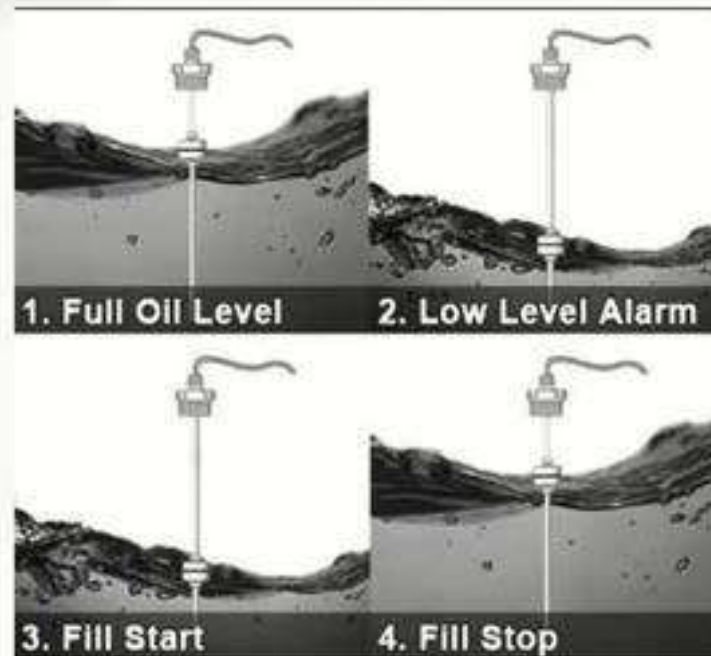
AUTOMATION CONTROLS

Live Camera view from HQ

GPRS Track location live from HQ

Diesel level & consumption from HQ

Oil level & Consumption from HQ



Camera on panel / Fuel levels / Machine location

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Kores

Additional drilling with machine on Rent



MACHINE ON RENT- BUSINESS MODEL

Machine, Accessories are available on rent

Maintenance is under scope of supplier

Operate machine like own machine

Rent payable on per meter Drilling

Achieve desired target of drilling without
Long term CAPEX & team on roll.

Machine available
for Rent for drilling

Rent per meter drilling basis

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Epiroc Product Presentation

Ranchi, DT: 06-01-2022



Christensen - Boyles

Definition and strategy for the future

Premium segment (*Christensen*)

Best in class for TCO focused customers

- World class productivity and lowest cost per produced sample.
- RCS control system to allow functional development and leverage.
- Value adding automation and data retrieving capabilities.
- Easy to operate and maintain. Highest safety standard.
- Capability to incorporate next generation MWD/AWD tools

Basic segment (*Boyles*)

Best in class for Capex focused customers.

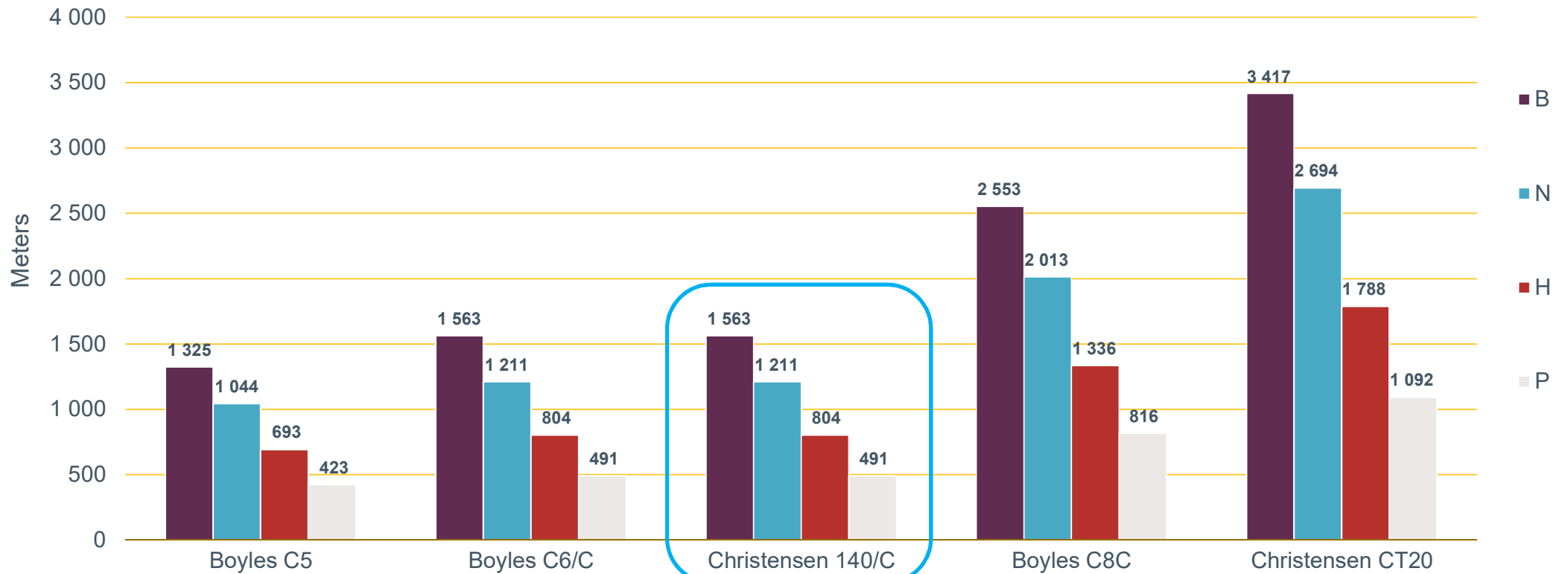
- Good enough productivity. Simple to maintain with low investment cost.
- Basic control system, DHC or PHC
- Limited automated features or operator assist functions



Drilling depth capacity - Standard



Vertical 90°



Meeting the highest standards

Christensen 140

- **Safety on site** Compliance with the latest EN 16228 safety standards
- **Productivity** due to a new two gear rotation unit which allows increased time between overhaul with minimal maintenance
- **High efficiency** thanks to a sturdy mast, capable of handling 6 meter core barrels



Customer Benefits

Safety by design

- Safety guard is equipped with an interlock function which will trigger an automatic stop if the guard is opened during operation
- Roof platform protects the operator from falling objects and moving parts
- Reduced sound emissions means a safer operator environment
- Rod Handling System (RHS) option available



Customer Benefits

Drill longer and more consistently

- Gear-driven rotation unit requires less maintenance and makes more productive
- Strong and sturdy mast supports the full weight of the drill string
- Constant penetration rate reduces wear and tear on bits and rods, increasing uptime
- Handles 6-meter core barrels, allowing you to extract more core per shift
- Swingable control panel allows the operator to optimize their working environment



Customer Benefits

Flexibility on site

- Quick and easy transportation due to a foldable mast
- Radio remote control, for crawler version, allows for easy tramming
- Tier III and Tier IV engine options available
- High altitude kits available for drilling above 3000 meters
- Choose between a crawler or trailer version
- Option available for Rod Handling System (RHS)

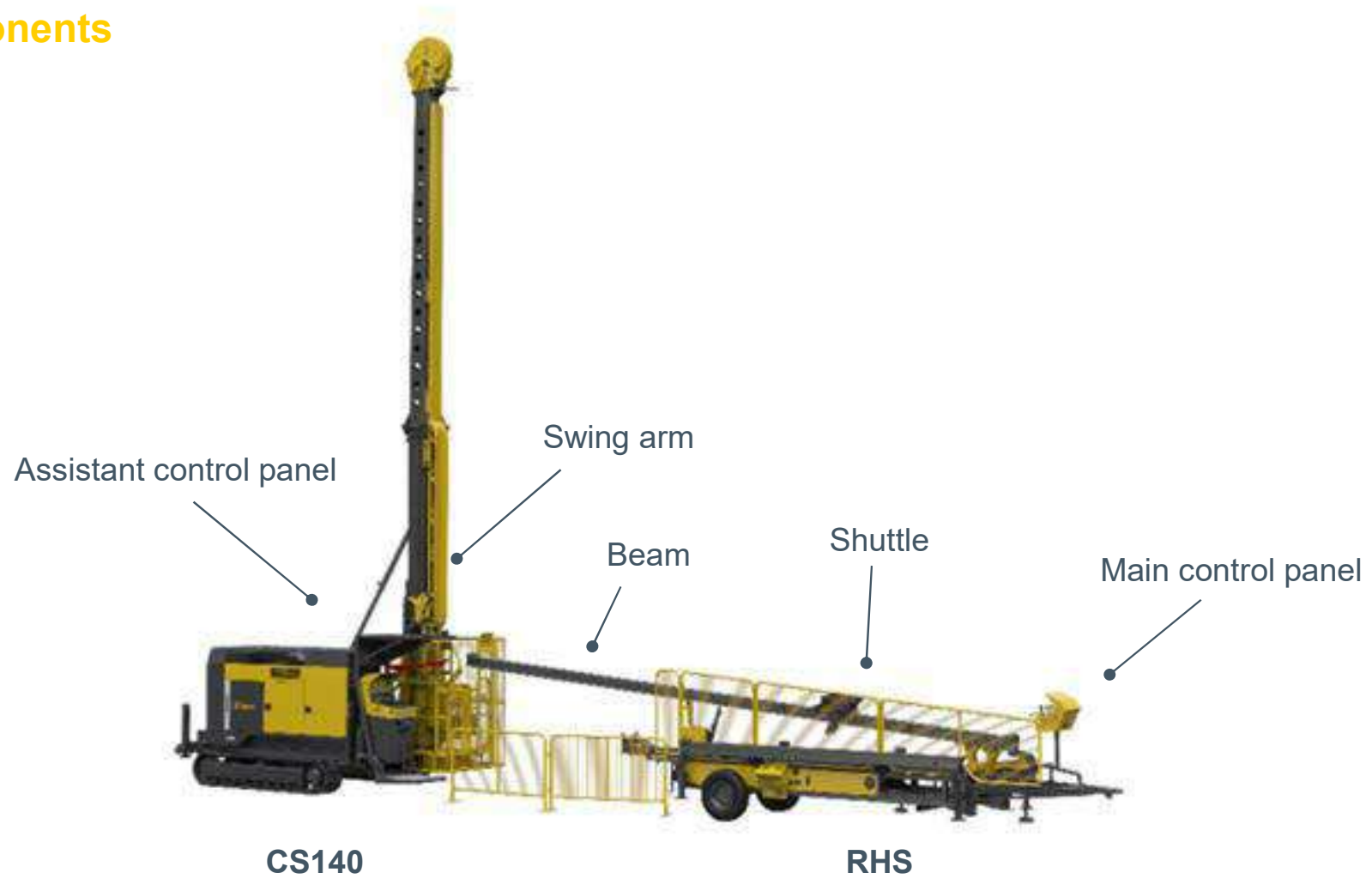


Rod Handling System (RHS)

Optional Item

Rod Handling System

Main Components



Safety – Hands-free

Less Fatigue / No Injuries

- Enables ***hands-free rod tripping***, in and out, throughout the drilling cycle
- Hands-free adding and removing of rods from rod table to drill center and back
- Handles the complete core barrel and inner tube in the same way
- The operator assistant is able to operate the assistant control panel instead of manually handling the rods. This means ***less fatigue*** for the operator assistant
- Safety is further improved by ***reducing the risk of injuries*** during the rod and core barrel loading process



Mast and feed system

- **Chuck Type:** hydraulic open/spring close
- **Clamping capacity:** 178 kN (40,000 lbf)
- **Two gear speed:** high-speed for coring, low-speed for OB
- **Max** 1300 rpm, **max** 7600 Nm Torque
- **Hydraulic gear shifting** from control panel
- **Feed travel:** 3.5 m (11.5')
- **Thrust:** 59.6 kN (13,390 lbf)
- **Pull:** 138 kN (31,020 lbf)
- **Rod and core-barrel pull length:** 6.09 m (20 ft)
- **Mast dump:** 1.2 m (3.9')
- **Hinge design** foldable mast



Highlights



- Multi-function display
- Safety stop within reach of controls and levers
- Constant penetration and torque limiter functions
- Protective roof
- Swingable panel
- Operated via radio remote control
- Tramming up to 15 degrees slope
- Tramming speed 3 km/h (1.86 mph)





Tools & Attachments division



DiscovOre & Arrow 3S



- New solutions to make drillers life easier, safer and more productive



Discover & Arrow 3S



Epiroc portfolio



DiscovOre – new core barrel design

DiscovOre Core barrel

- Safety
- Reliability
- User-friendly



Arrow 3S Overshot

- Safety
- Speed
- Simplicity

Epiroc DiscovOre



New core barrel concept - Safety & Productivity

Old Spearhead type core barrel



New **DiscovOre** core barrel



1. No weak spear head
2. No weak spring pins
3. Increased life span for parts
4. Leveraged latches - no jammed inner tubes.
5. Unique latch design - robust and easy to replace.
6. Reduced length - underground 10" (254mm) shorter.
7. Quick conversion from underground to surface.
8. Robust spindle hard to bend during rough handling.
9. Loading Tool for easy UG operation
10. Improved bearing assembly for better inert tube stabilization and increased life









Epiroc Arrow 3S



New Overshot concept - Speed, Safety, Simplicity

Standard overshoot

Arrow 3S overshoot

	Standard Overshot	Arrow 3S Overshot	
B Size Rods			-18%
N Size Rods			-13%
H Size Rods			-56%
P Size Rods			-5%

Reduced
Arrow 3S area

1. The patented auto-lock design
2. The one handed operation for release
3. The pointed profile and deep body grooves will cut through the water for faster descent.
4. Short, lightweight underground overshoot
5. Designed to be centralized in the drill string for smoother, faster pump in speeds



Epiroc Tubular products

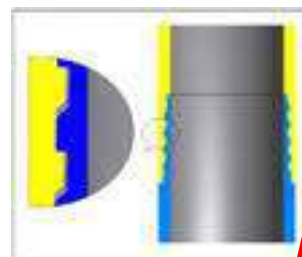
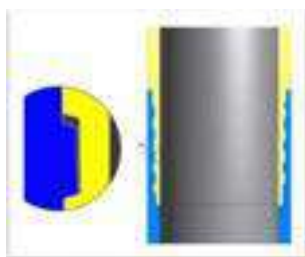
R wireline rods

1 step	2 step	3 step
Through Heat treatment	Precise CNC thread machining	Case hardening
Both ends 10" (250mm)	100% quality control – every thread checked with gauge	Pin end + 4,5" (114mm) above pin
Hardness 32-34 Rockwell	Perfect load transition and joint seal	Skin hardness 55 Rockwell
Strong joint with flexible body	Deep drilling capacity	Prevention from galling and excessive wear



Example of the heat treatment profile

Revised Portfolio | Parallel wall Rods

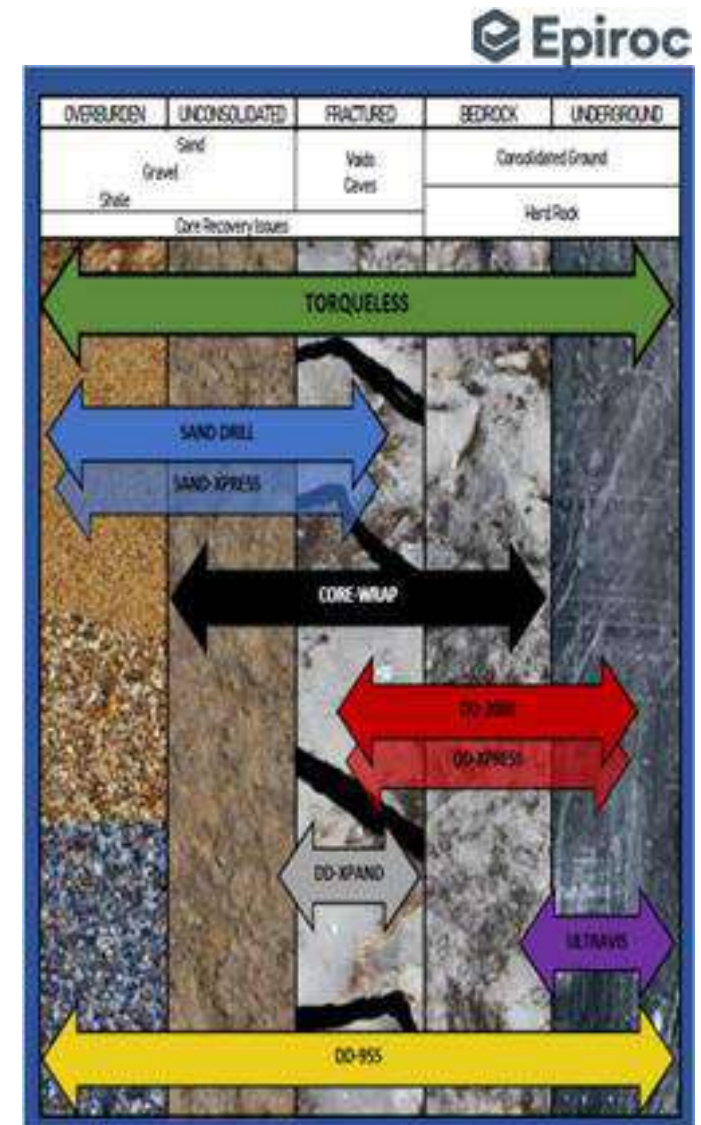


Rod type	O Rods (WL)	T Rods	MO Rods	R Rods
Definition	<i>Original</i>	<i>Tough</i>	<i>Modified Original</i>	<i>Reverse Flank</i>
Sizes available	BO, NO, HO	BT, NT, HT, PT	BMO, NMO, HMO, PMO	BR, NR, HR
Product positioning	Industry standard. Rods widely available from all suppliers	Deep hole rods regionally popular in South Africa and Canada. Available from selected suppliers	Deep hole rods based on modification of „Q“. Predecessor of 'RQ'. Niche markets. Available from selected suppliers.	Ultra deep hole rods with reversed flank to improve thread seal and pull force. Popular globally. Now available from selected suppliers
Steel tube mat.	Seamless 1541	Seamless 1541	Seamless 1541	Seamless 1541
Heat/Chemical treatment	Through wall HT + phosphate	Through wall HT + phosphate	Through wall HT + phosphate	Through wall HT + Case HT
Target customer	Shallow/medium deep holes	Shallow to deep holes	Shallow to deep holes	Shallow to ultra deep holes
Price	\$	\$	\$	\$\$

CONTROL CHEMICAL - PRODUCTS

Drilling fluid additives are great products that can help resolve a lot of issues that are a result of difficult ground conditions often found in mineral exploration, geotechnical and environmental drilling. Using drilling fluid additives can have a significant positive impact on drilling performance. Drillers routinely encounter abrasive or fragmented ground, flowing sands and dry hole conditions. In the past bentonite was often used but bentonite is very abrasive and can wear down drilling equipment prematurely. Drilling additives are a better alternative to bentonite because they do not have the abrasive qualities of bentonite.

- Our products are 100% non toxic & biodegradable.



EDDY Water Treatment System

Enabling water recycling in the most remote drilling areas



Up to 70%
water can be
recirculated

Treat drill water
to remove
cuttings and
reuse in a loop

Lower environmental impacts without
compromising operations on drill
sites, mines and core shacks

