Geospatial Applications in Exploration at HZL

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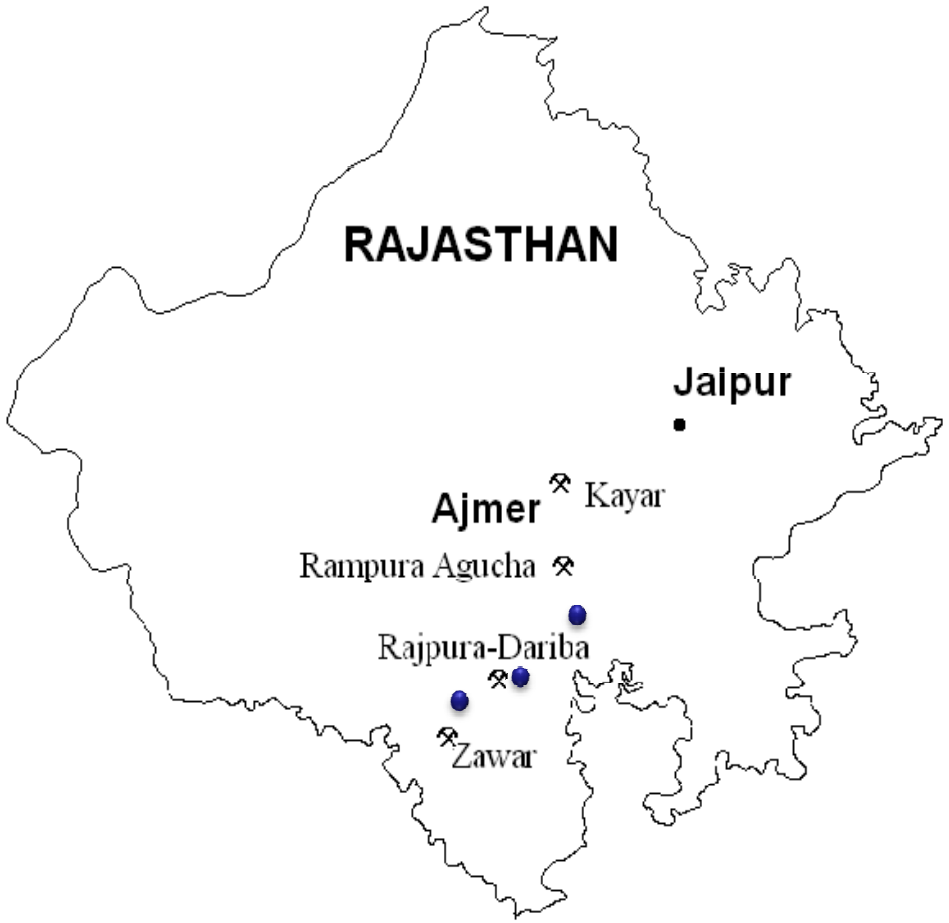
Presentation Outline

- About HZL
- HZL Exploration Frame work
- Exploration Track Record
- Geospatial to Geo-special
  - Data Acquisition
  - Exploration Applications Areas
- Geospatial – Rocks to Riches
  - Brownfield : Rampura Agucha Lead-Zinc Mine
  - Greenfield : Pur-Dariba Copper Prospect
- Conclusion

About HZL

Largest Integrated Producer of zinc-lead

A Vedanta Group company in zinc-lead-silver business



- **1st** Rampura Agucha Largest zinc mine globally
- **2nd** Largest zinc-lead miner globally with: 10 million+ MT of ore production capacity
- **3rd** Largest zinc-lead smelter globally: 1 million+ MT of production capacity

HZL

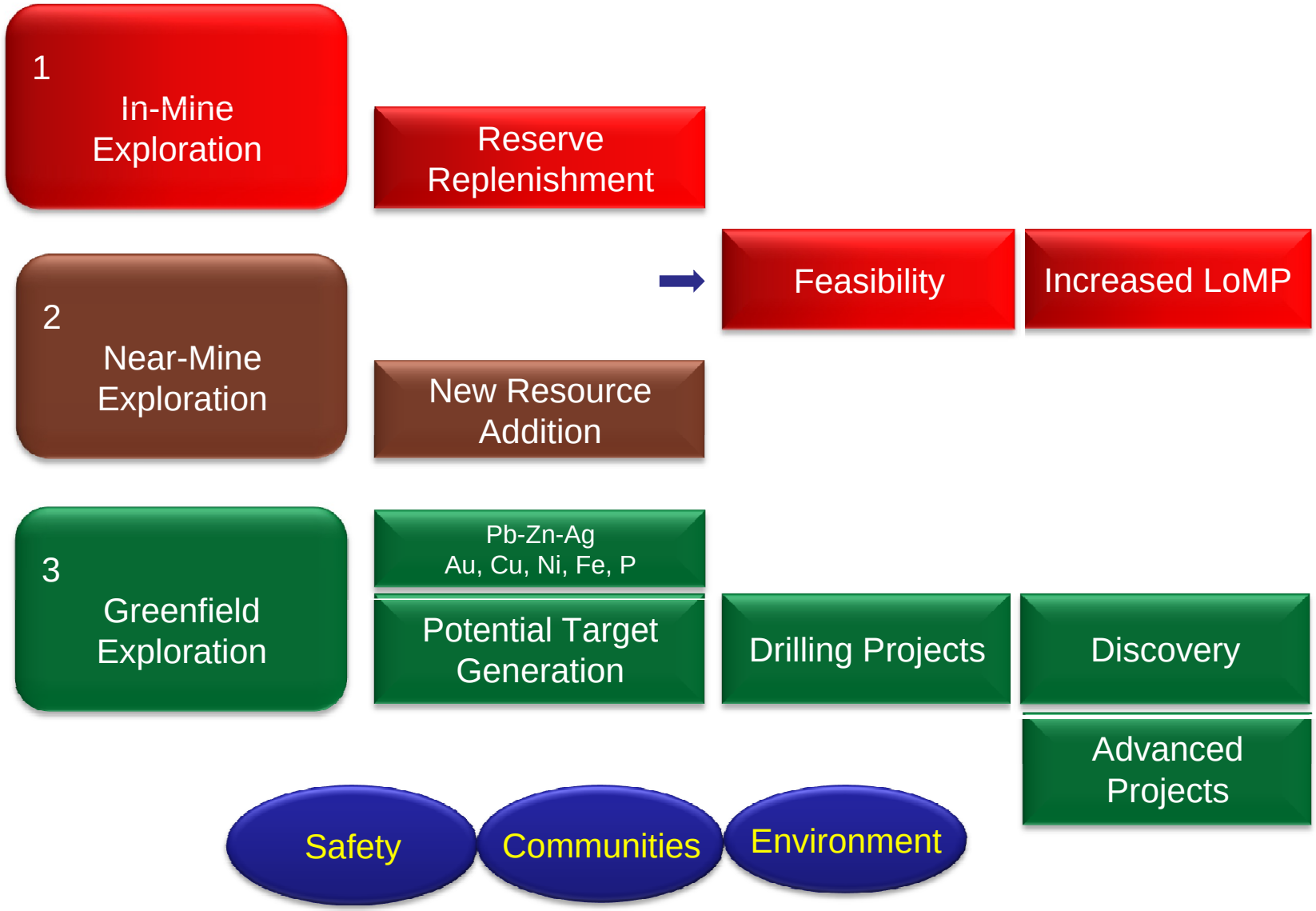
Vision

- Be the world's largest and most admired Zinc-Lead & Silver Company

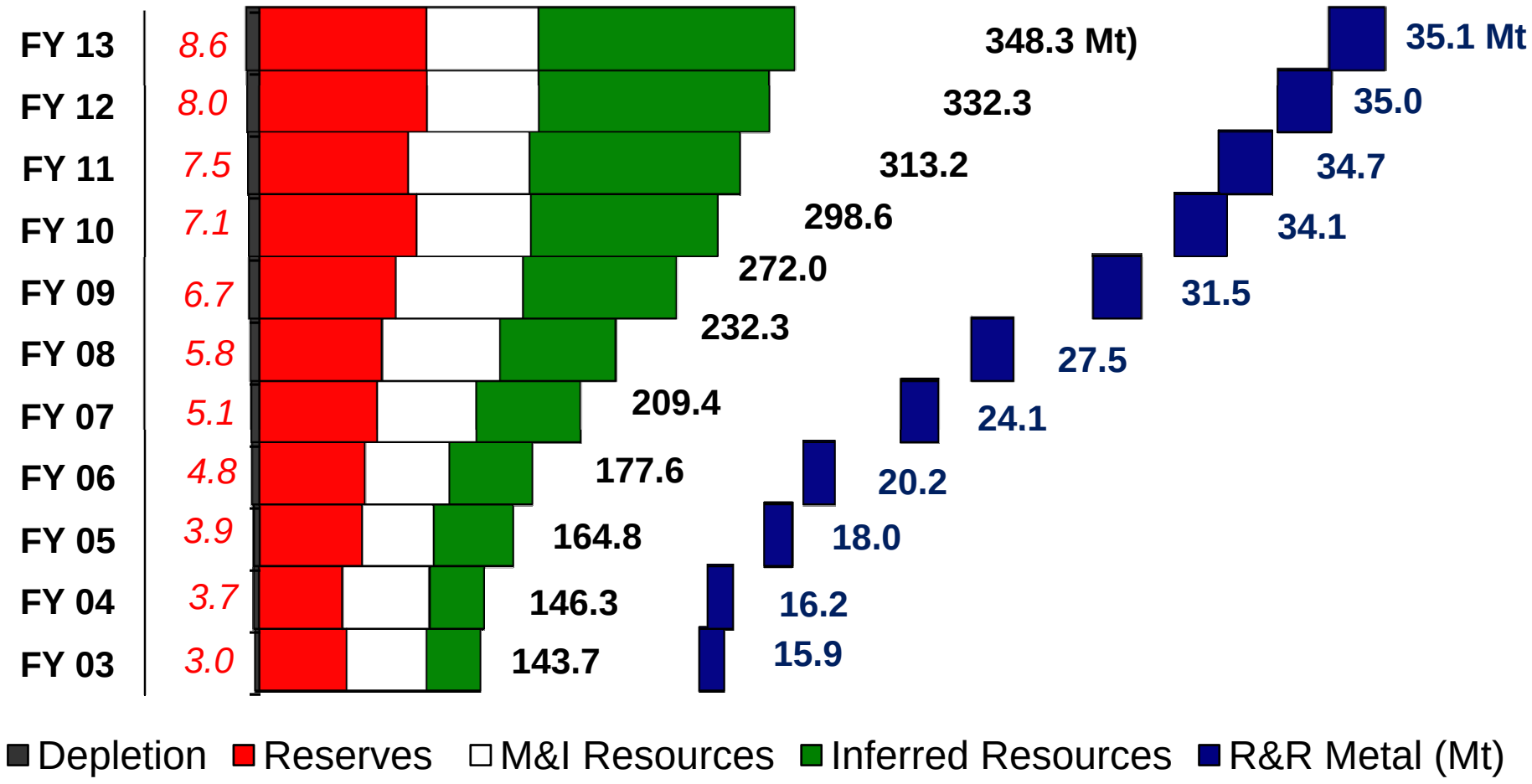
Mission

- Enhance stakeholders value through exploration, innovation, operational excellence and sustainability
- Be a globally lowest cost producer
- Maintain market leadership and customer delight

HZL Exploration Framework



Exploration Success



Added ~260Mt of Resources prior to depletion of some 60Mt

Geospatial to Geo-special

- Data Acquisition

$$\phi_i = f(x, y, z)$$

- Data Treatment
  - QAQC and Data Arrangement
- Data Analysis
  - Relationships among attributes
  - Spatial Behaviour : Discreteness, Domaining & Dependency
- Data Modelling
  - Enhancement & Derivatives (improved understanding)
- Data Integration
  - Prediction
  - Potential for *Rocks to Riches*

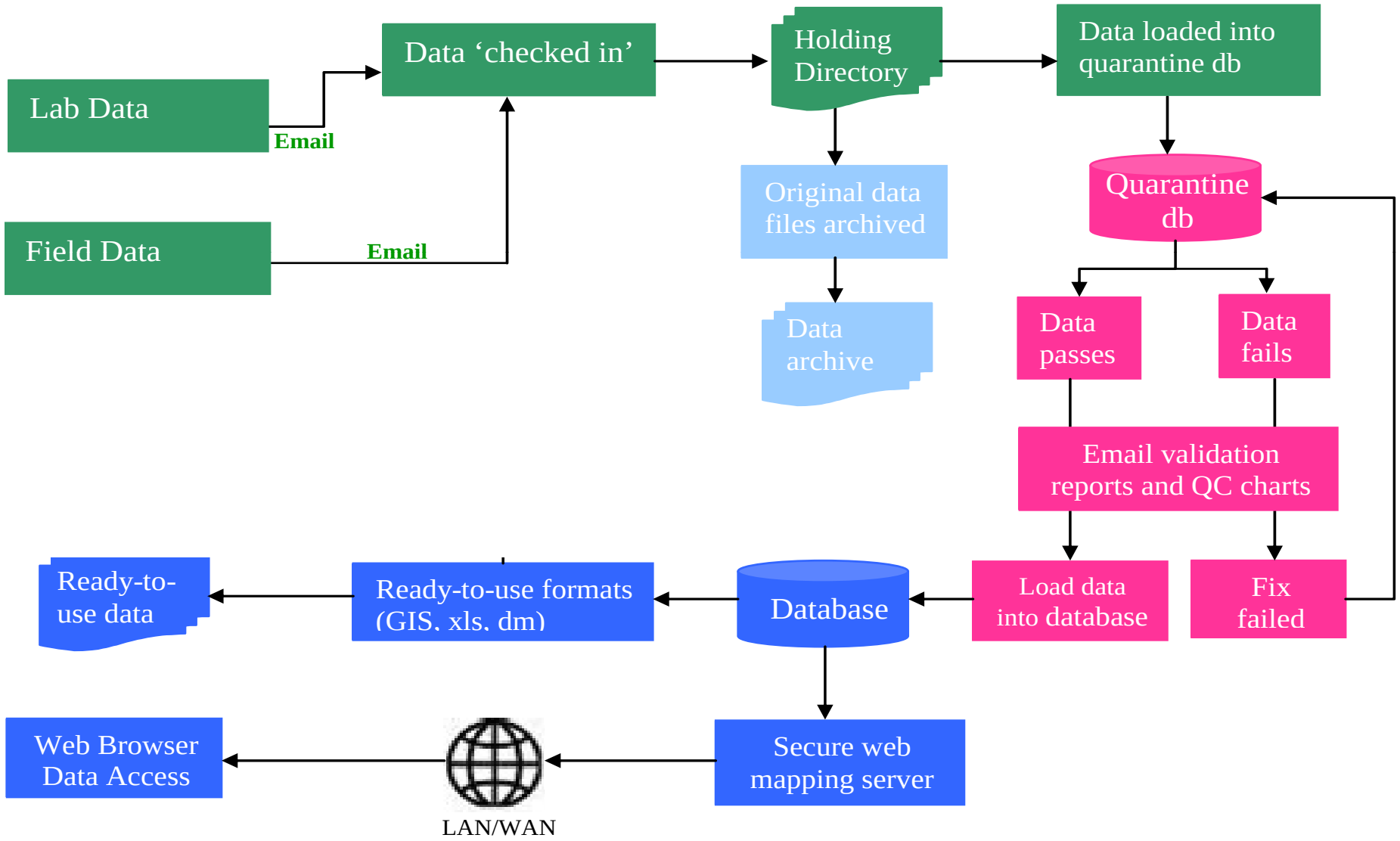
Geospatial Data Acquisition

- VTEM & Geotem (EM & Mag)
- Multispectral Satellite Data Analysis
- On-site Geochem Survey with hand held XRF
- Ground Geophysics
  - Titan
  - 32 channel 50 KW IP-Resistivity
  - 24 bit Time Domain System (Moving & fixed loop configurations) SMARTem, infiniTEM, BHEM surveys
  - GPS integrated Cesium Vapour Ground Magnetometers
  - Gravity
- Drilling - High speed, High capacity, all hydraulic, MDD
  - Oriented Core & Digital Deviation Surveys
  - +1,700m long holes

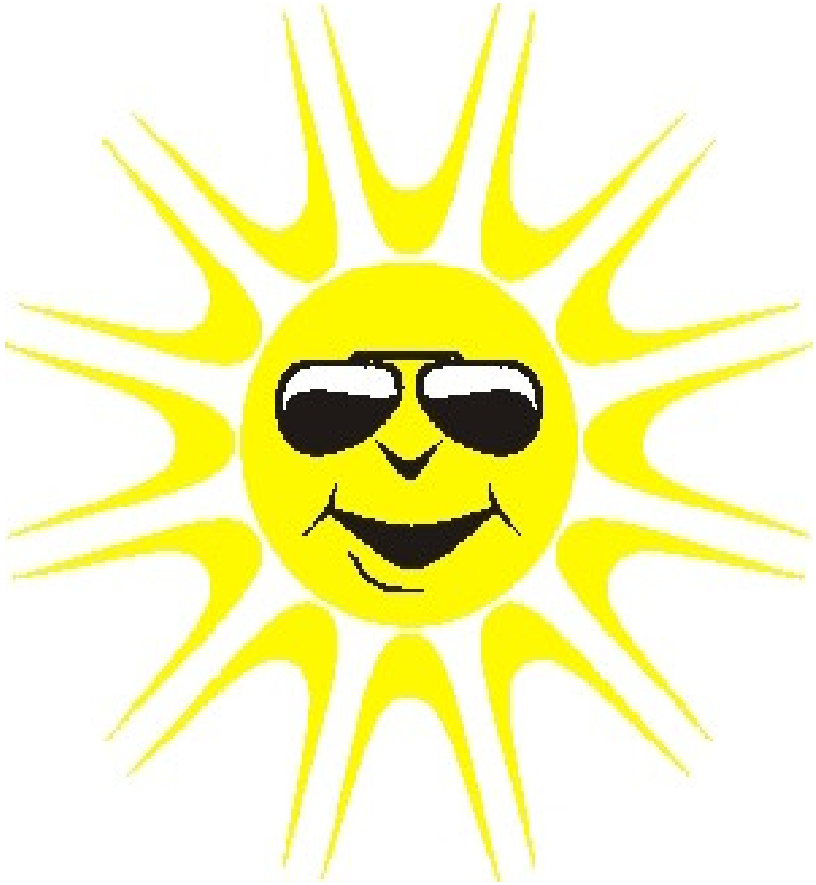
Data Play

- Modern Modelling and Data Integration for meaningful interpretation on GIS Platform

vedanta Database Management Flowchart



What is Important ?



Exploration Applications Areas

- Project Generation
  - Geo-Data Gathering & Management
  - Identification of Prospective areas
  - Tenement Applications
- Collection of Base Line Environmental Data
- Search for Hidden Mineral Treasure
- Orebody Resource Modelling
  - Grade Control & Reconciliation
  - Annual BP Preparation

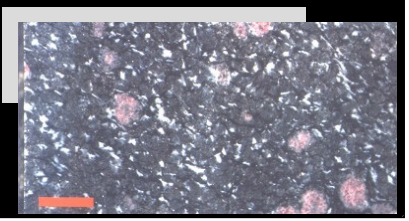
1. Brownfield Exploration Success

Rampura Agucha Lead-Zinc Mine, Rajasthan

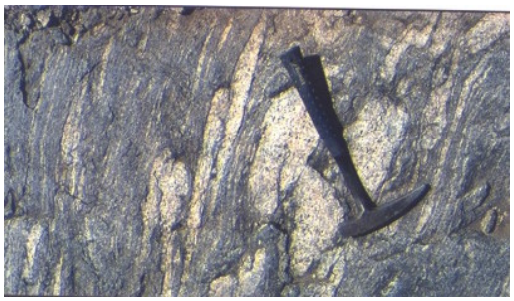
Rampura Agucha - Broad Geology

[redacted]

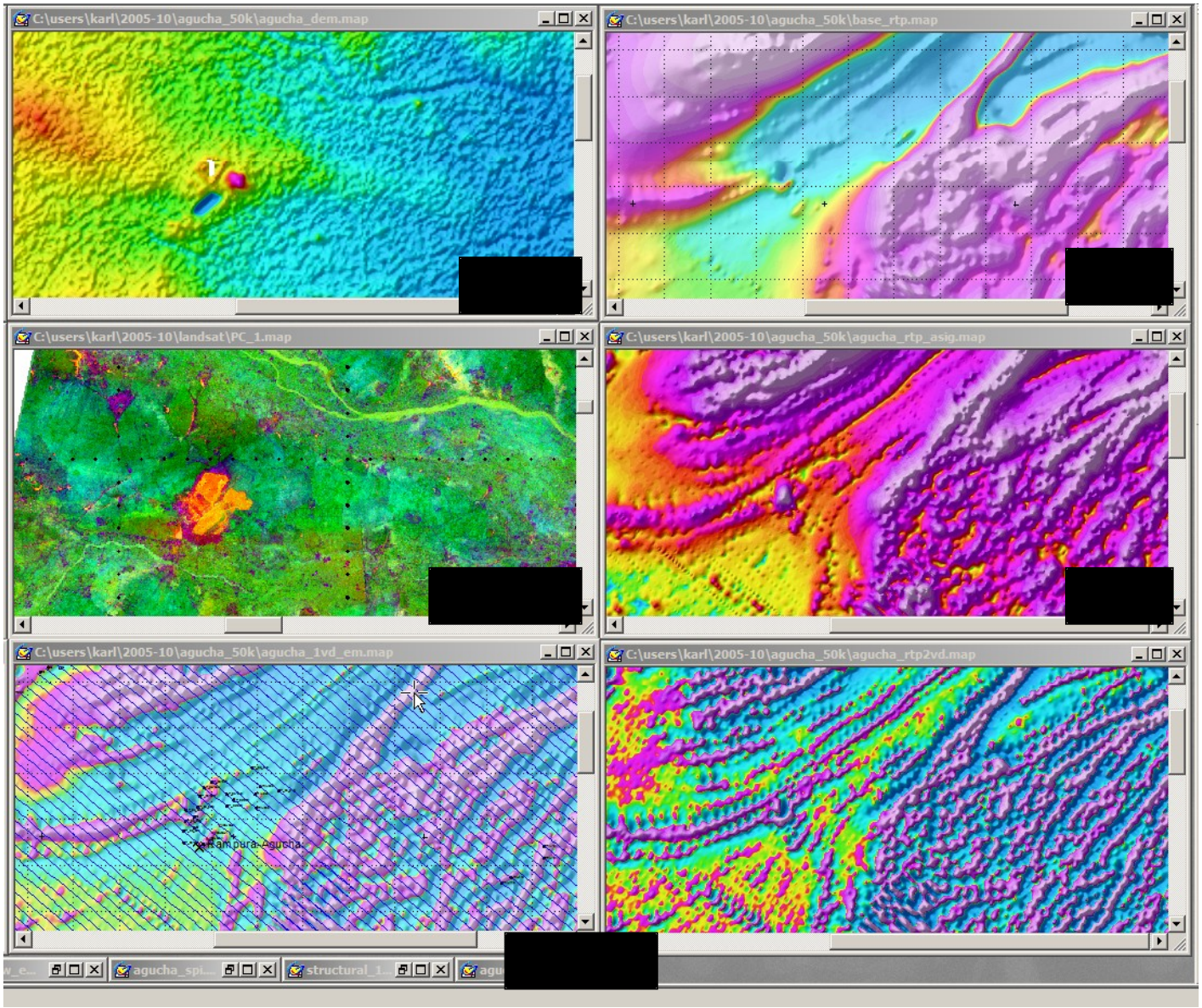
[redacted]



- Discovered 1977
- 1.6km long X 50m wide tabular orebody.
- Shear controlled Mylonitised massive sulphides
- Sharp HW and FW contacts
- Dominant aluminous package (garnet-biotite-sillimanite
- Mineralisation with strong chloritic alteration and graphite



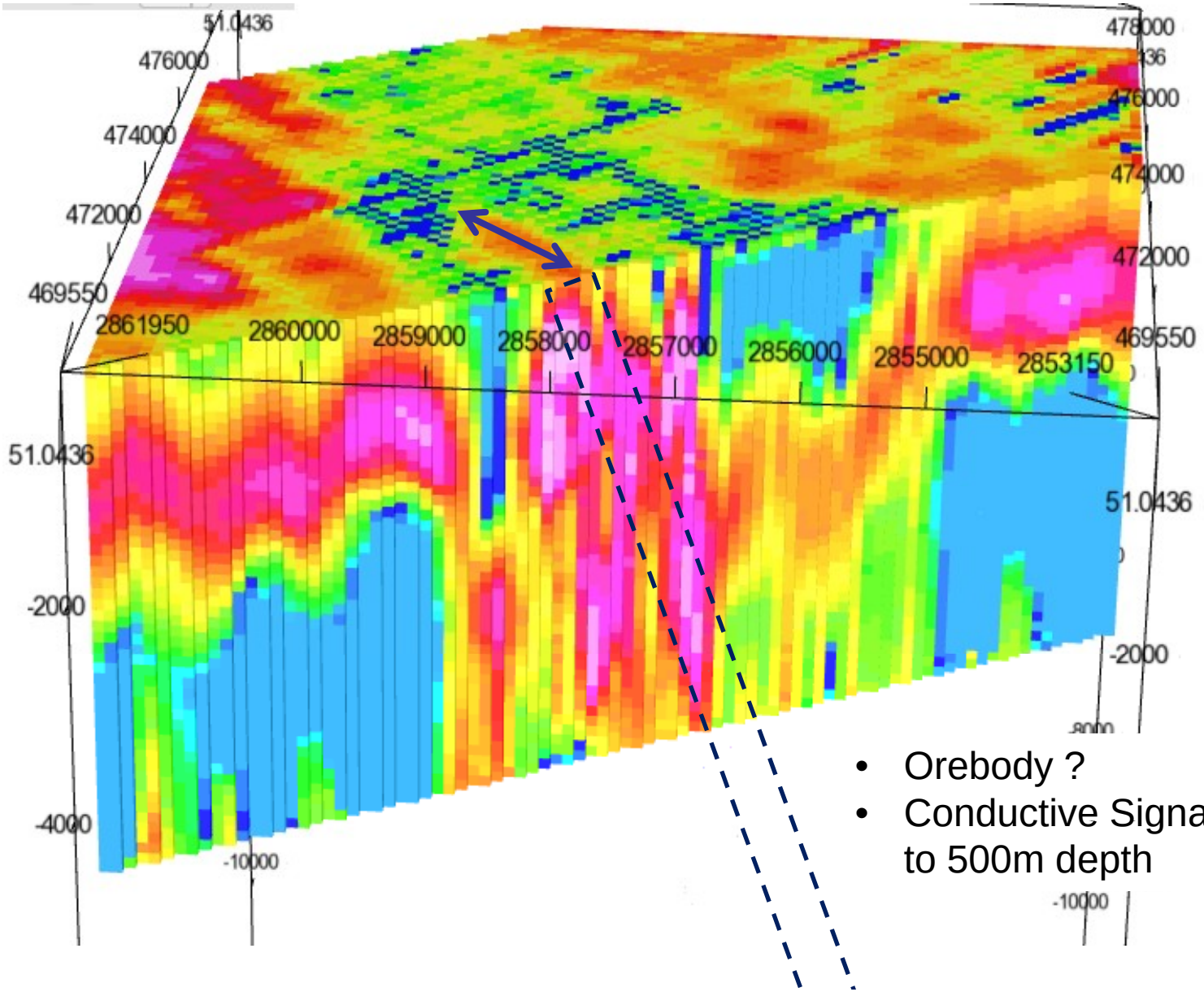
Rampura Agucha - Airborne



Geospatial Approach

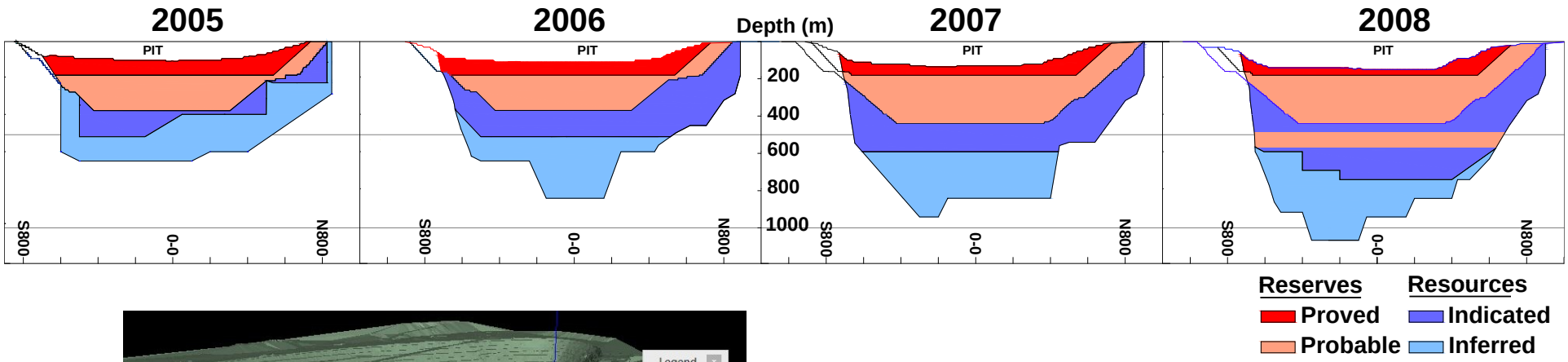
- Local mine geology information was geo-referenced by matching the mine infrastructural features on Aster Image. The transformation enabled:
  - Direct comparison of geology and mineralization with airborne mapping data
  - Comparison of responses of Agucha (Mag - 20nT, EM - 3 Tau) in its vicinity
  - Visualization from map overlays and image manipulation
  - Linking the data of drilling (1980's).
- Conductivity Depth Modelling of Geotem Data indicated that the orebody could be open in depth.
  - Geometry of mineralization linked to the CDT
  - A sequential drilling programme formulated
  - Successful augmentation of resources at Agucha.

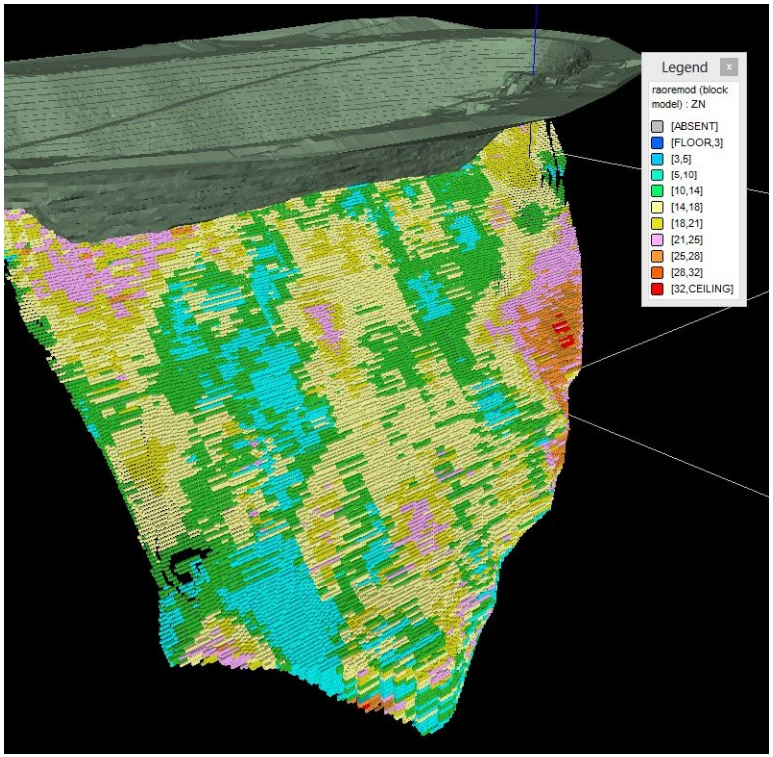
Conductivity Depth Transformation Model
Central Section



- Orebody ?
- Conductive Signature to 500m depth

Rampura Agucha
Sequential Exploration Results





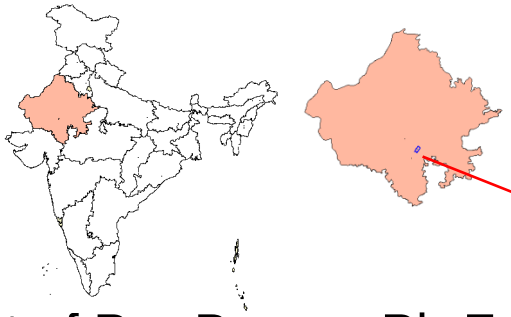
- Orebody extended from 330m (1982) to +1 km depth
- Achieved +2 fold increase in R&R
- Currently 109.8Mt @ 13.5 Zn, 1.5 Pb

2. Greenfield Exploration Success

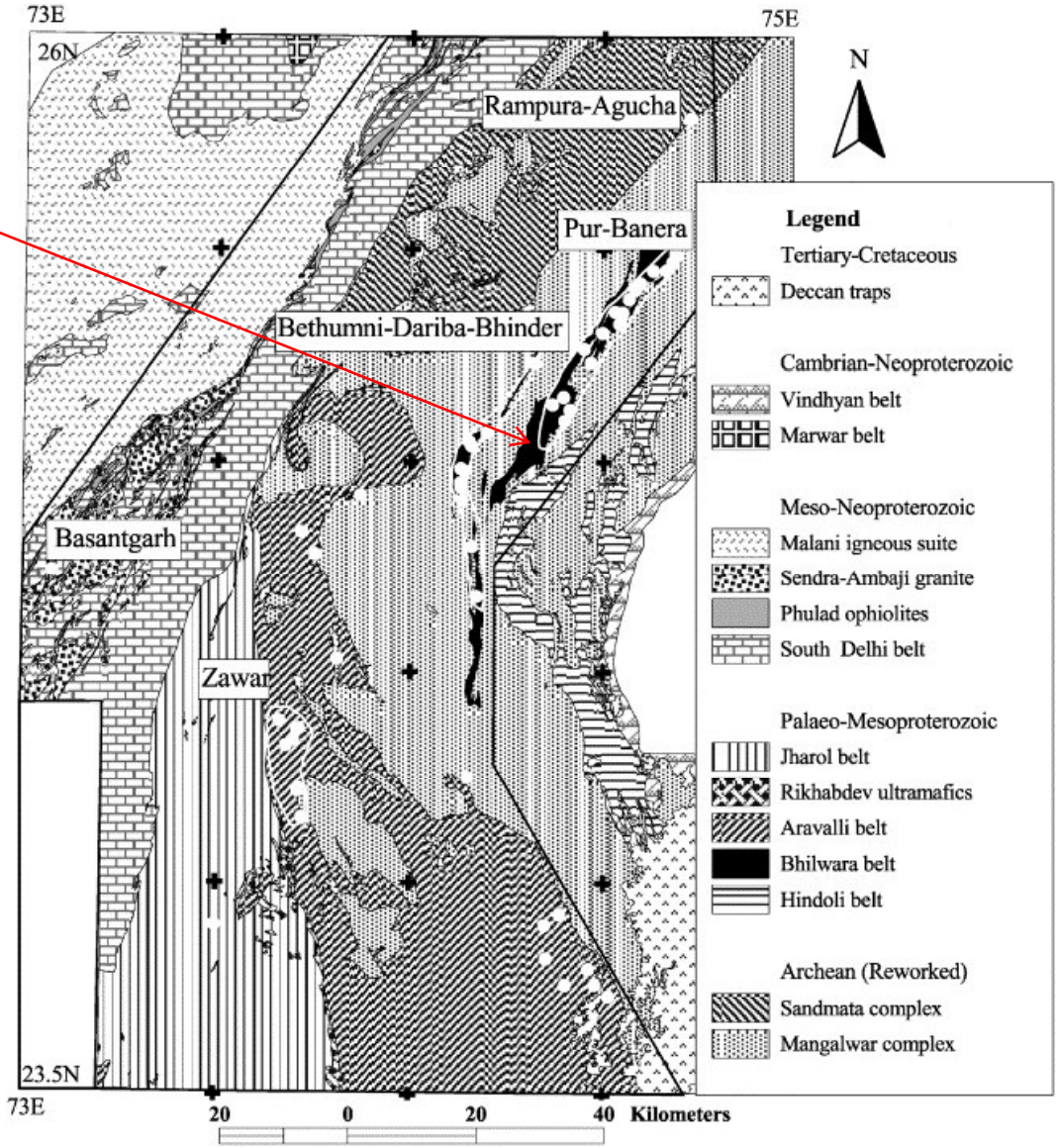
Pur Dariba Copper

Prospect, Bhilwara, Rajasthan

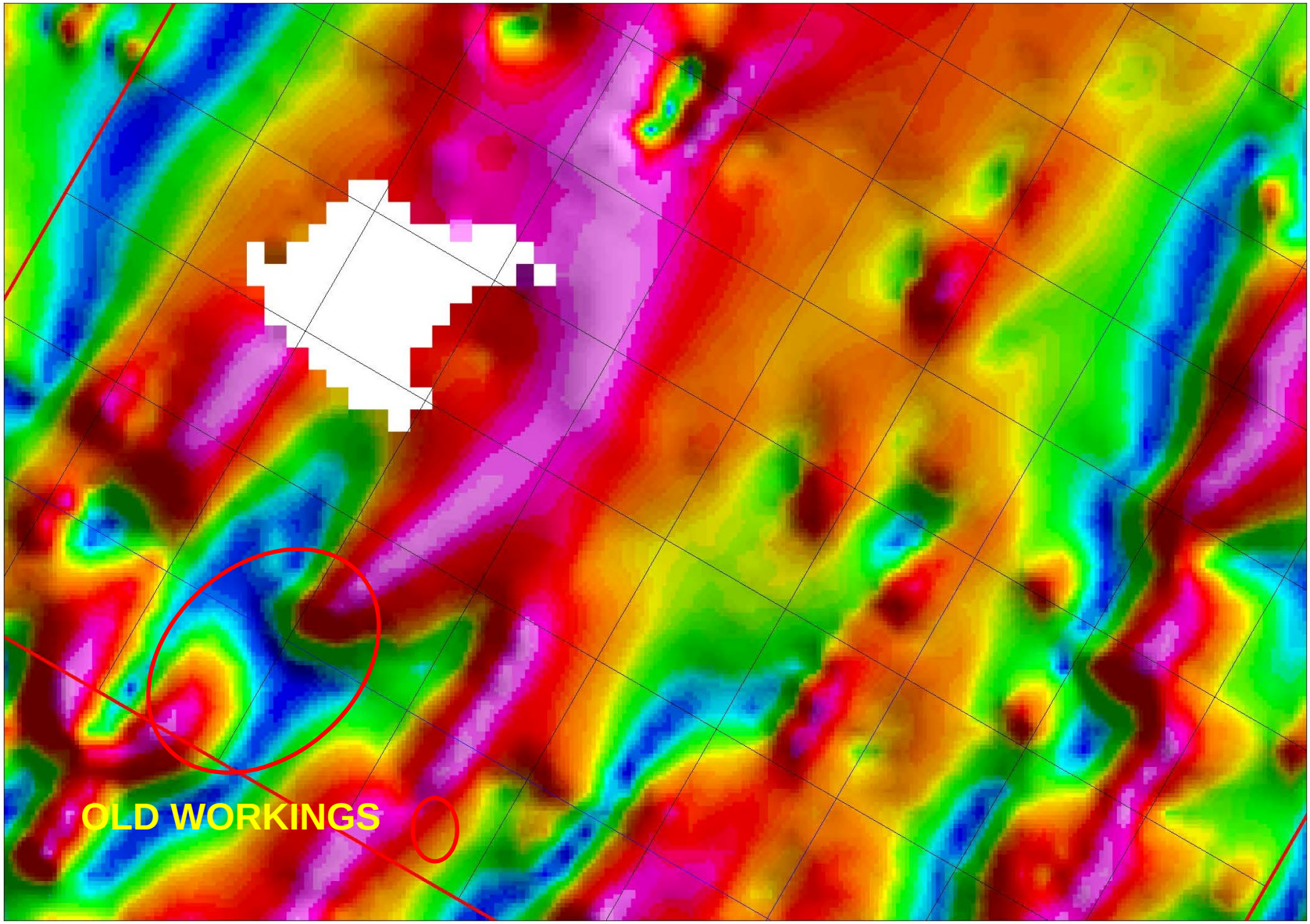
Pur-Dariba Copper Prospect



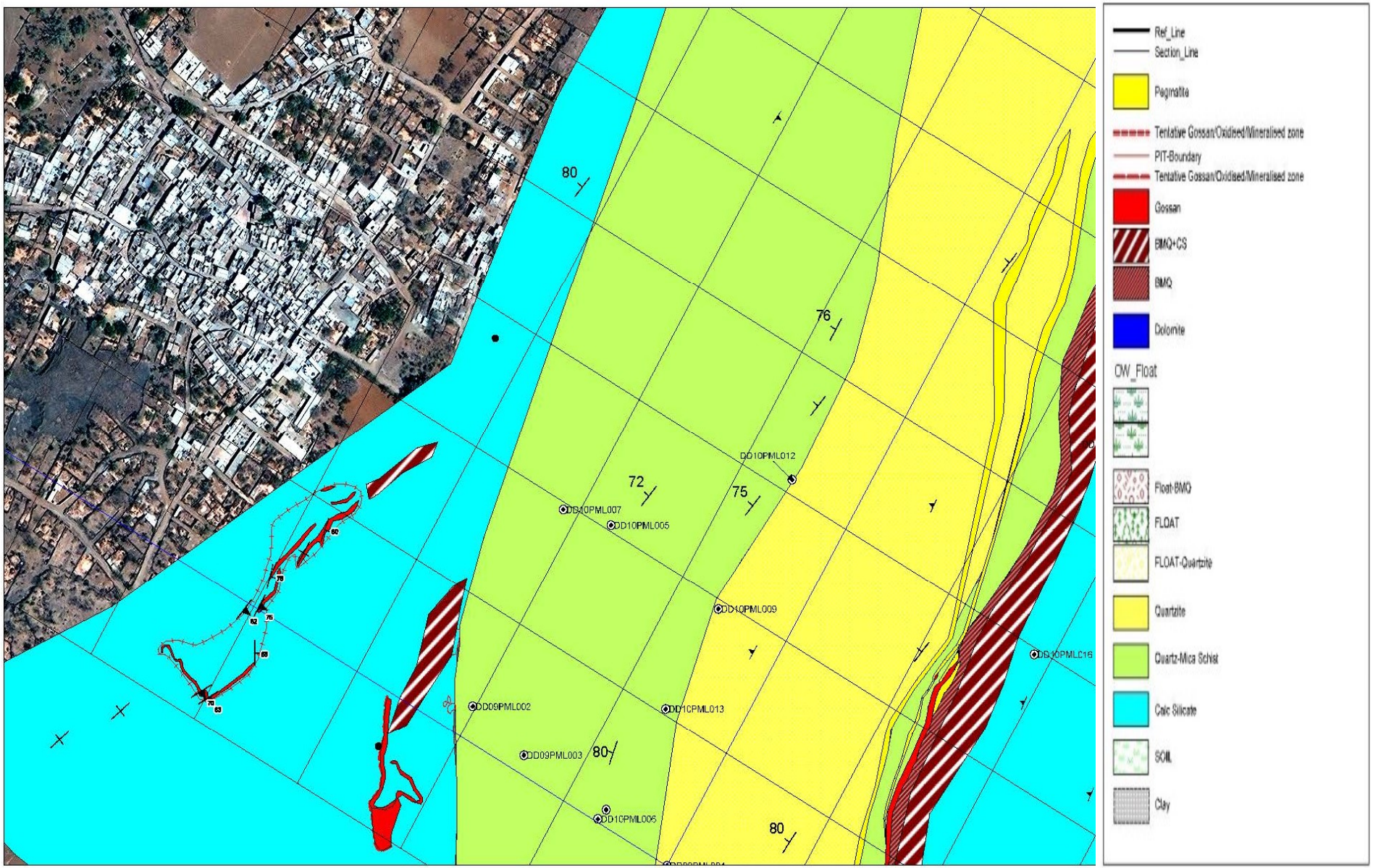
- Part of Pur-Banera Pb-Zn-Cu Metallogenic Province
  - Ancient Mining
  - Historical investigation by GSI
  - Identified approx. 1Mt @ 1% Cu
- Reconnaissance Geo Surveys by HZL during 2010-13



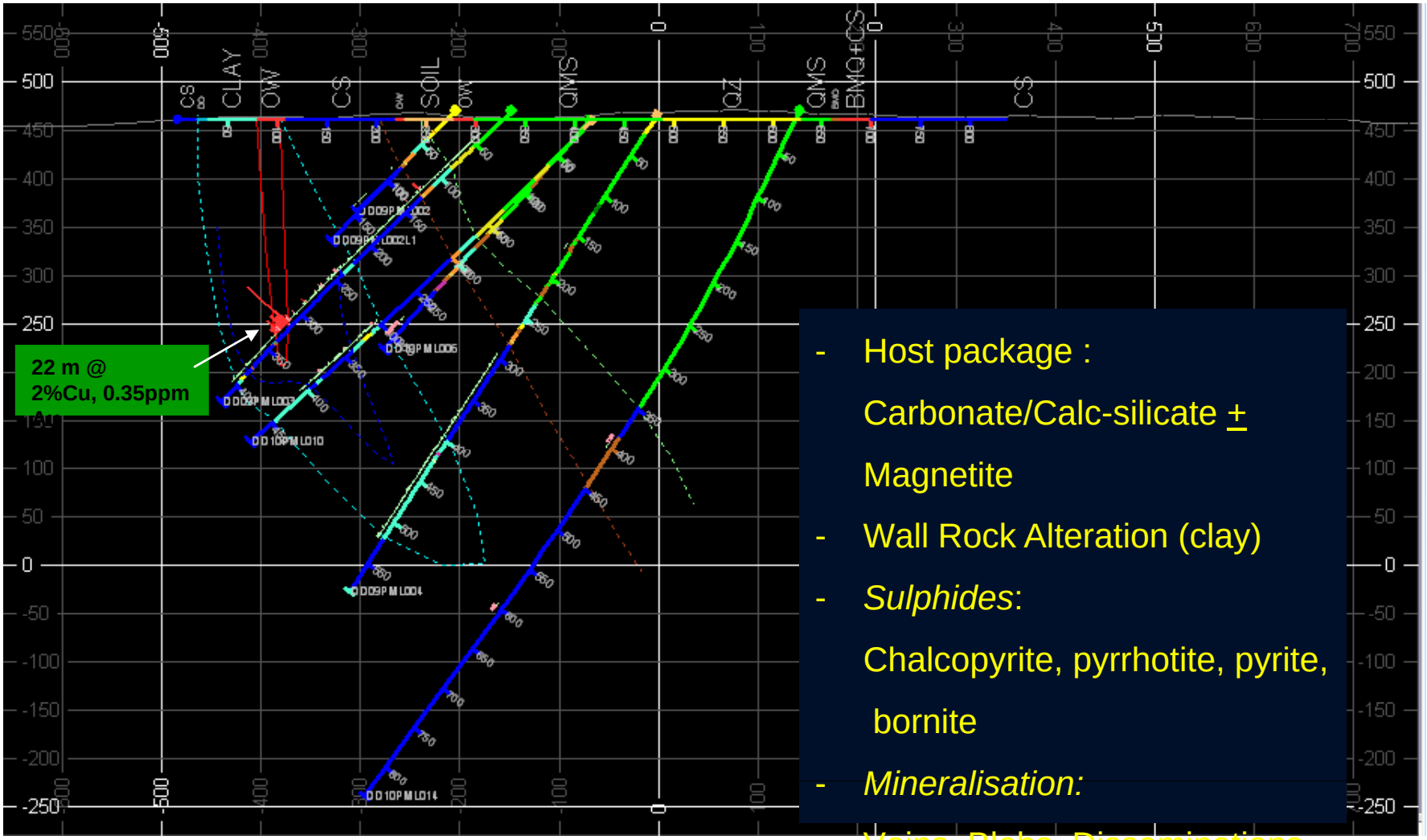
Ground Magnetic (RTP)



Prospect Geology



Section: 0N

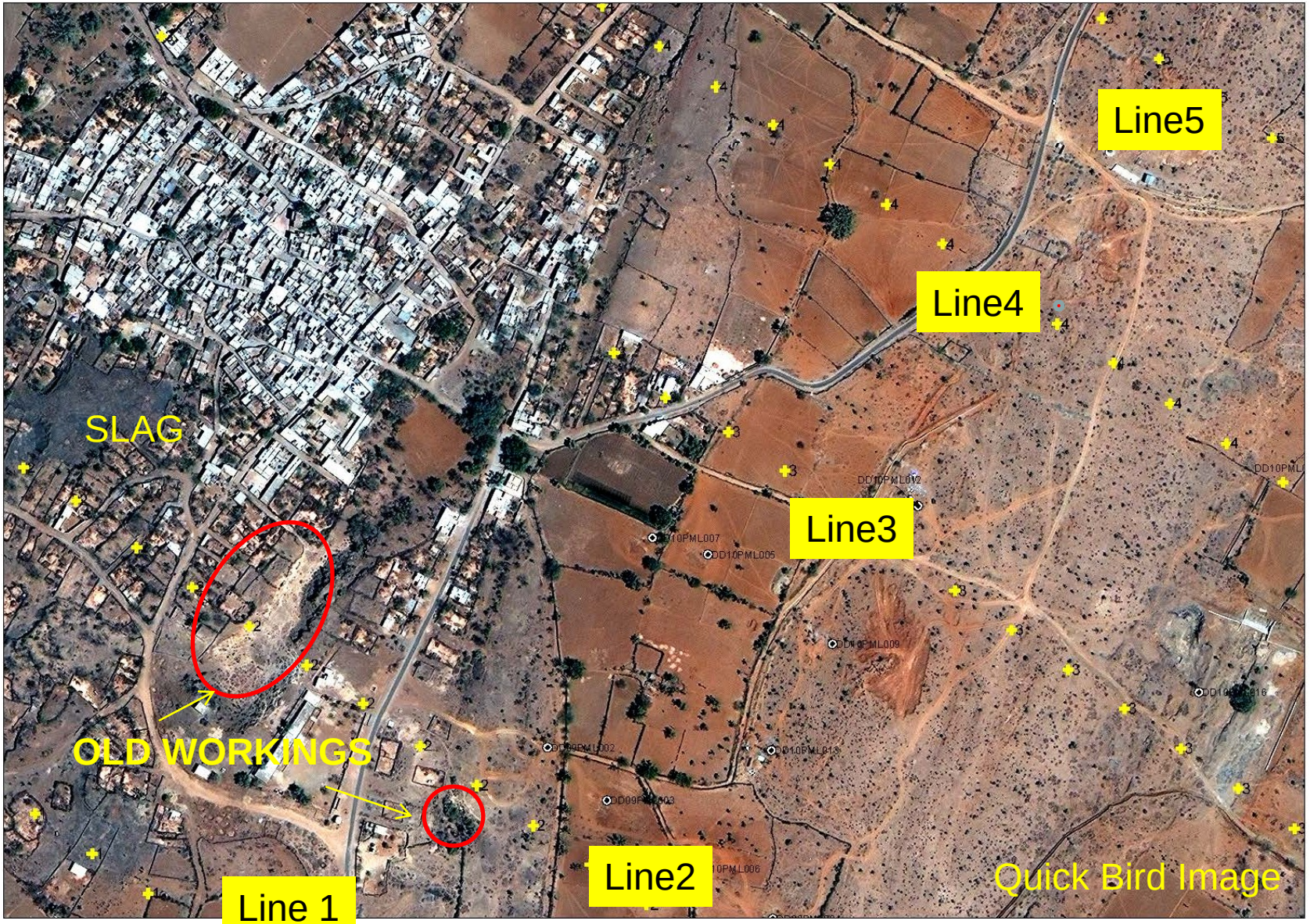


- Host package :
  Carbonate/Calc-silicate ± Magnetite
- Wall Rock Alteration (clay)
- *Sulphides*:
  Chalcopyrite, pyrrhotite, pyrite, bornite
- *Mineralisation:*
  Veins, Blebs, Disseminations

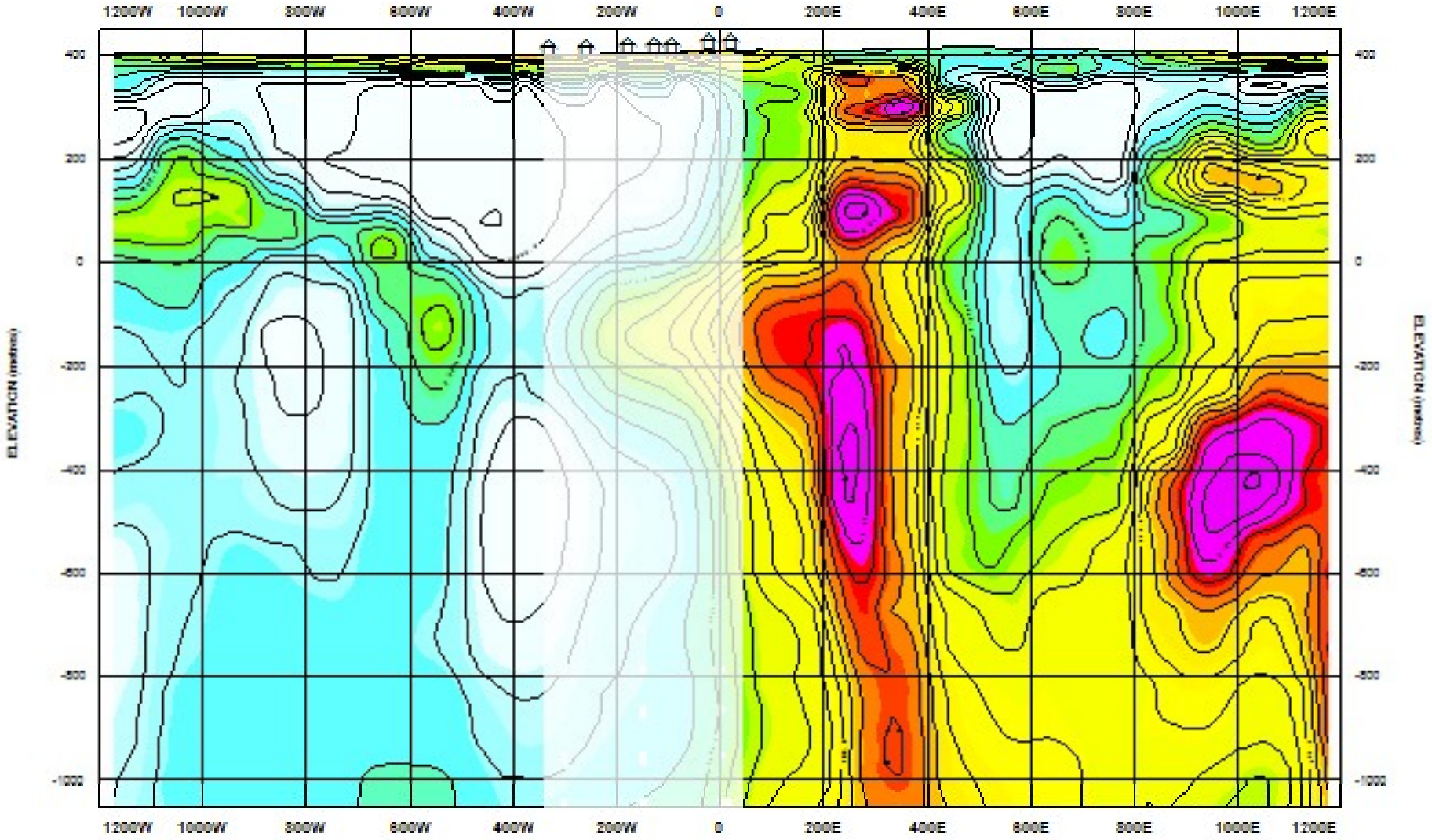
TITAN 24 DCIP & MT

- Two geophysical techniques in one survey:
  DC resistivity/IP chargeability and Magnetotellurics.
- DC and IP use and low frequency (4 s cycle) injection current and measure the Earth's response during "on" time (DC) and "off" time (IP). MT measures the response of the Earth due to large ionospheric electrical phenomena (passive method).
- Array layout typically 2.4 km length (100m dipoles), with all receiver dipoles active during a measurement cycle.
- 24 bit hardware and current monitor for accurately sampling very small voltages.
- Data are measured as resistivity (DC and MT) and chargeability (IP).

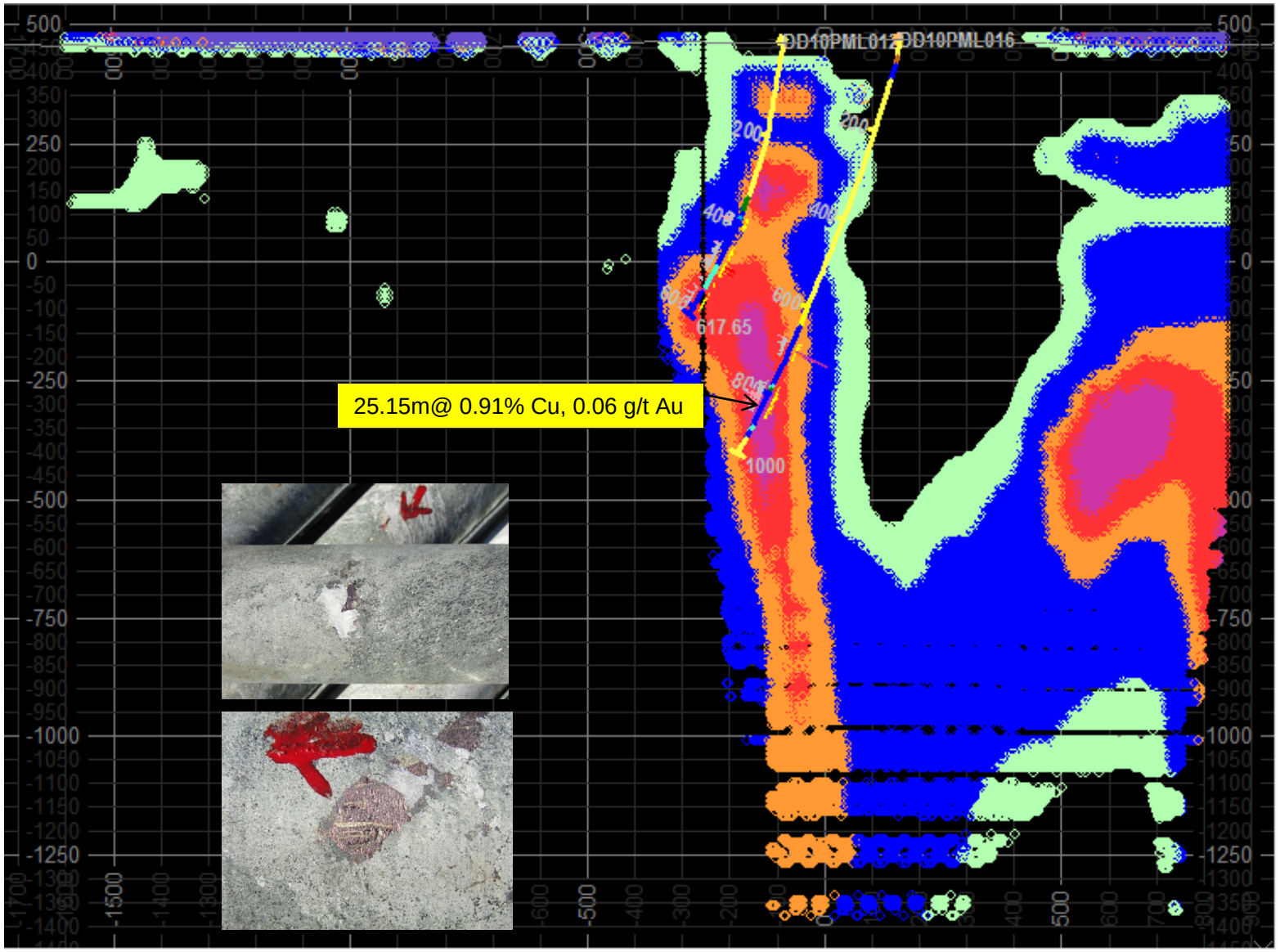
Prospect Area with Titan Lines



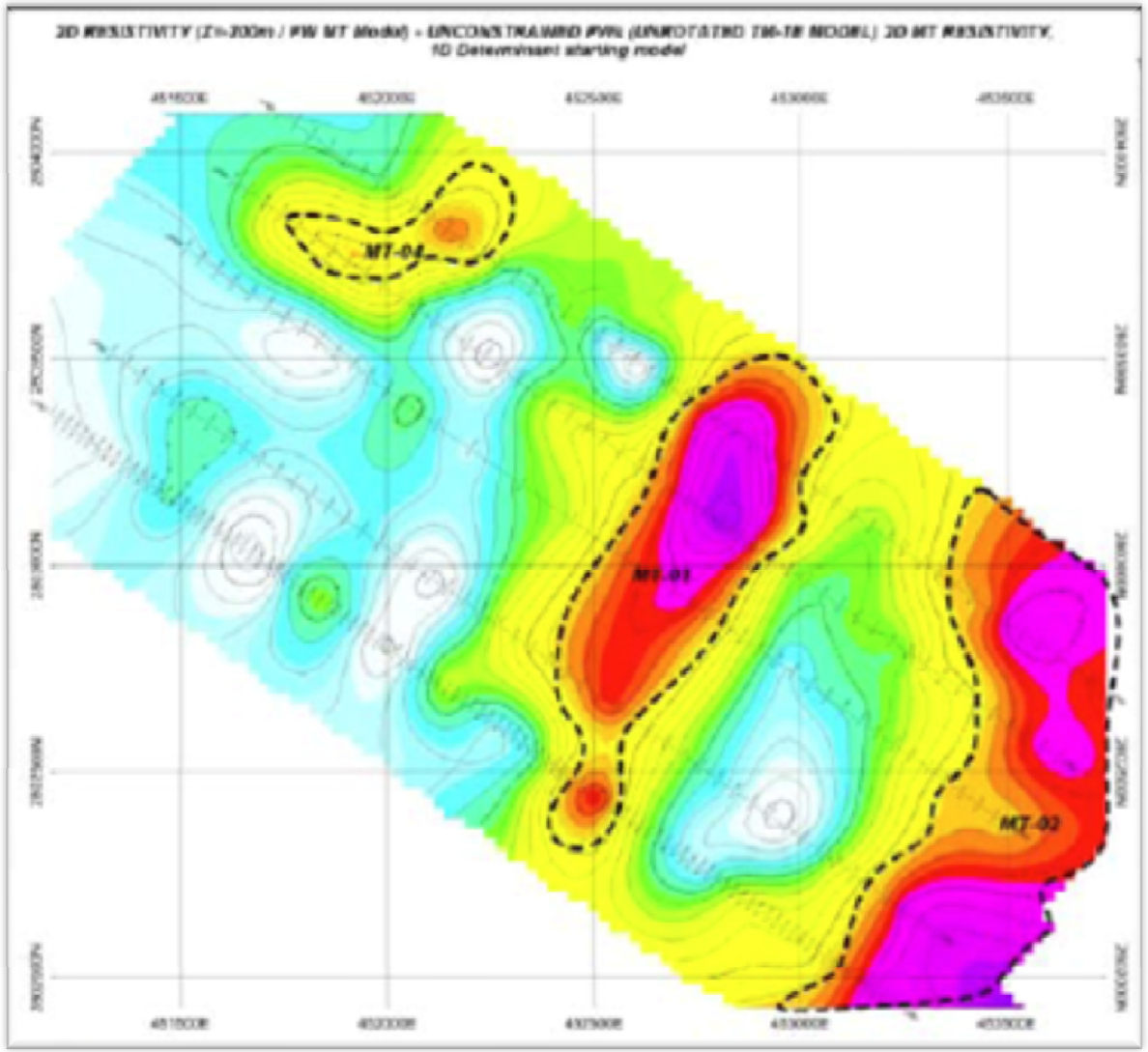
vedanta Titan 3rd Line: MT Section



Titan 3rd Line: MT Drill Section

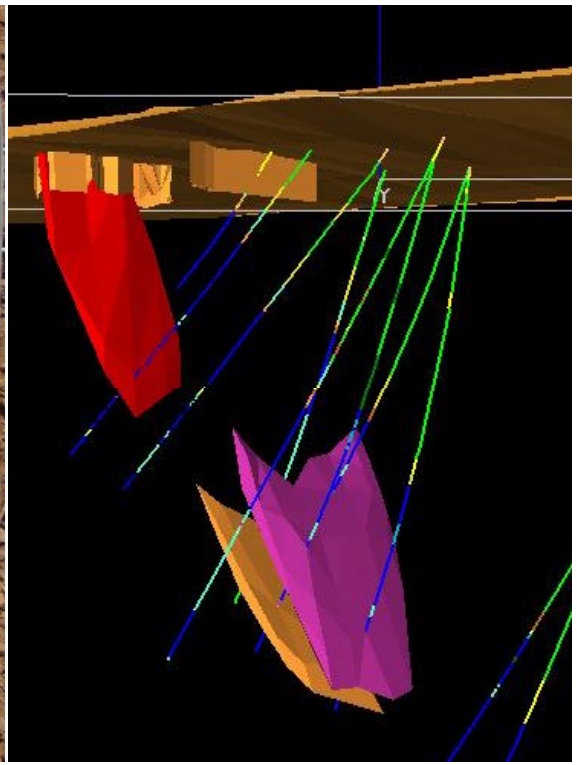


MT Resistivity Plan 600m Deep



Results in MT Zone

Hole #	From	Intercept (m)	Cu %	Au g/t
DD10PML012	502.5m	0.50	0.81	0.39
DD10PML015	673.0m	12.00	1.23	0.08
DD10PML016	821.3m	25.15	0.91	0.06
DD10PML017	685.0m	12.00	0.50	0.07

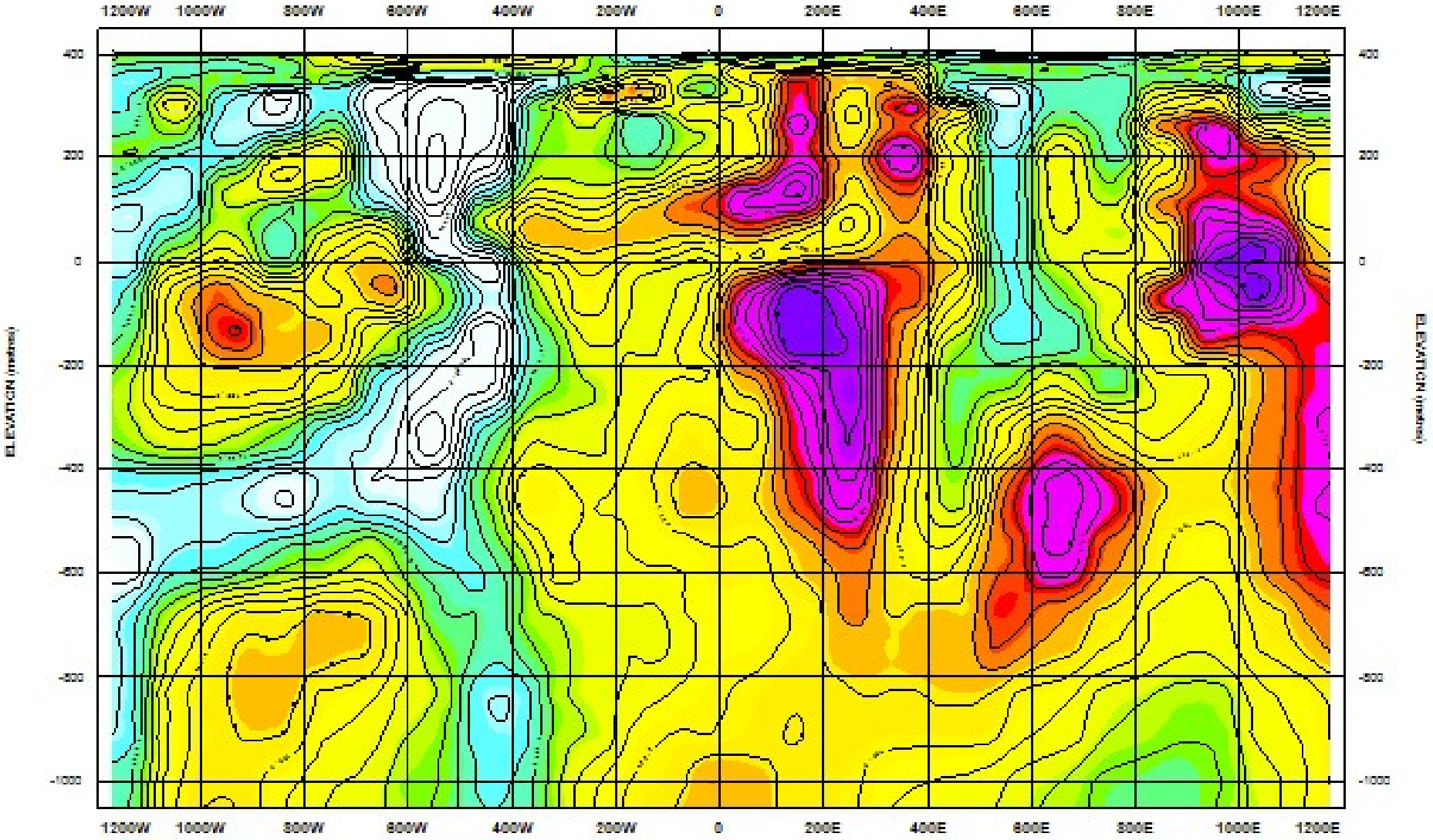


Conclusion

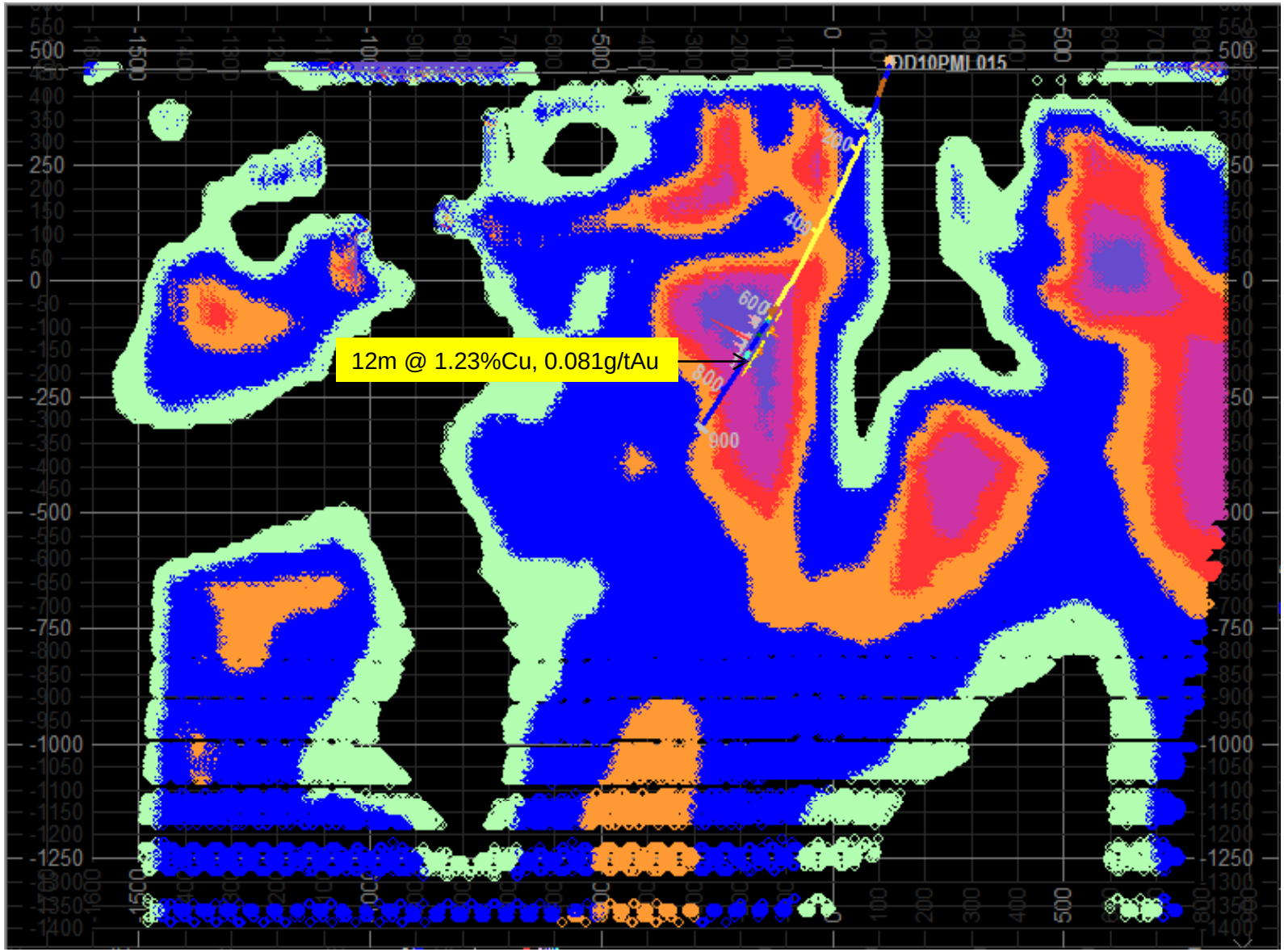
- HZL Exploration is deploying *fit-for-use* geospatial technologies to identify targets and better management of drilling budgets
- Acquisition of right data and its plausible interpretation is eseential to minimise the risk

Thanks

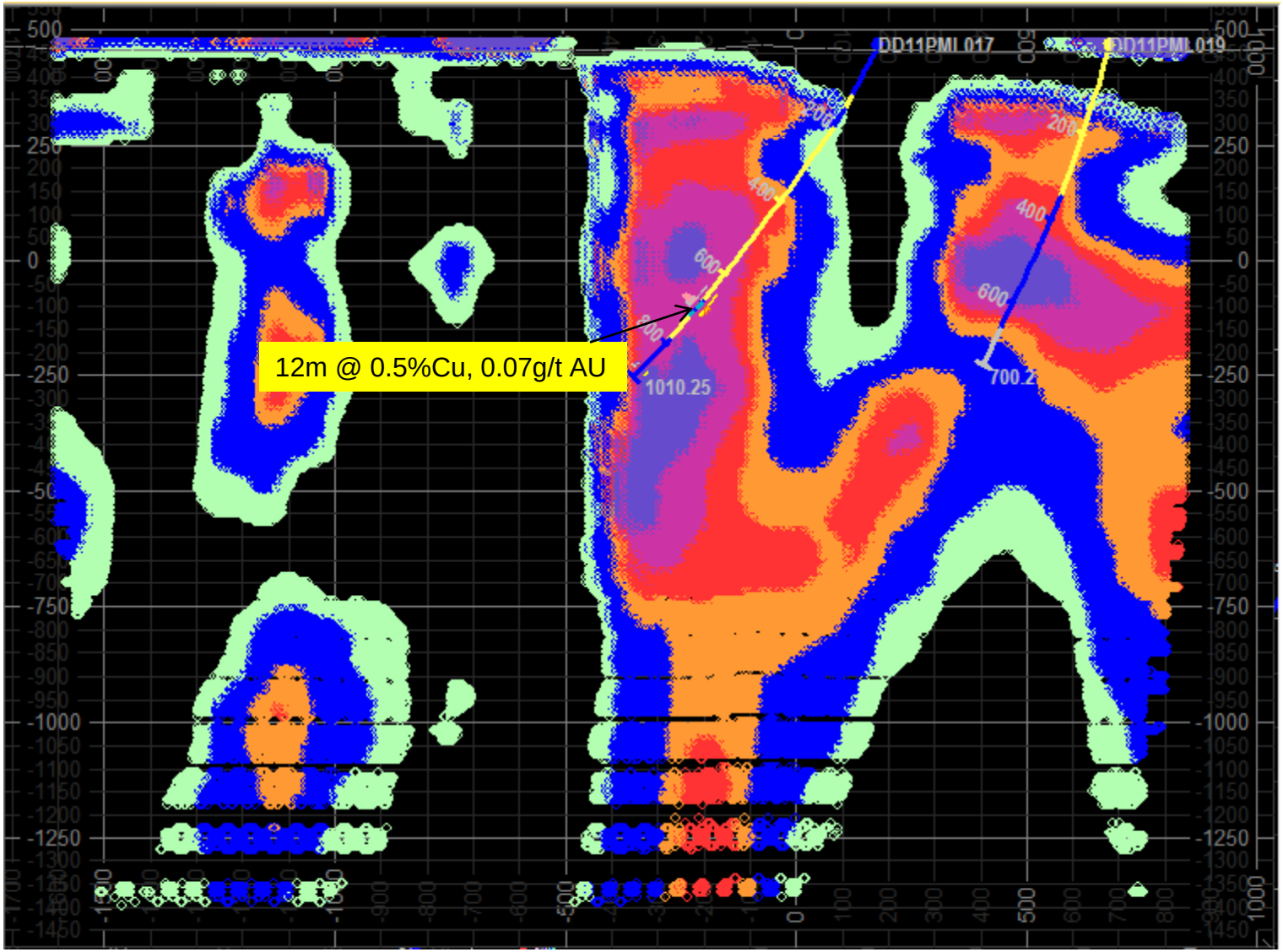
Titan 4th Line: MT Section

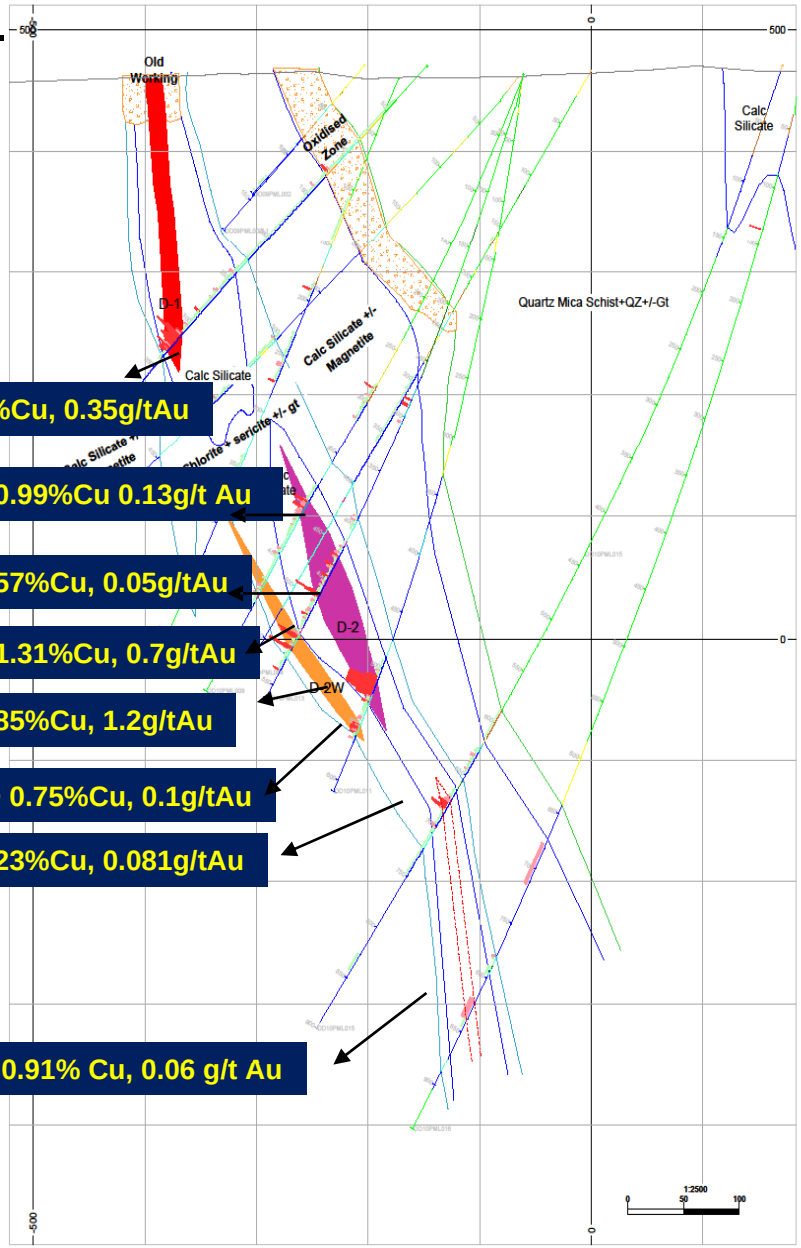


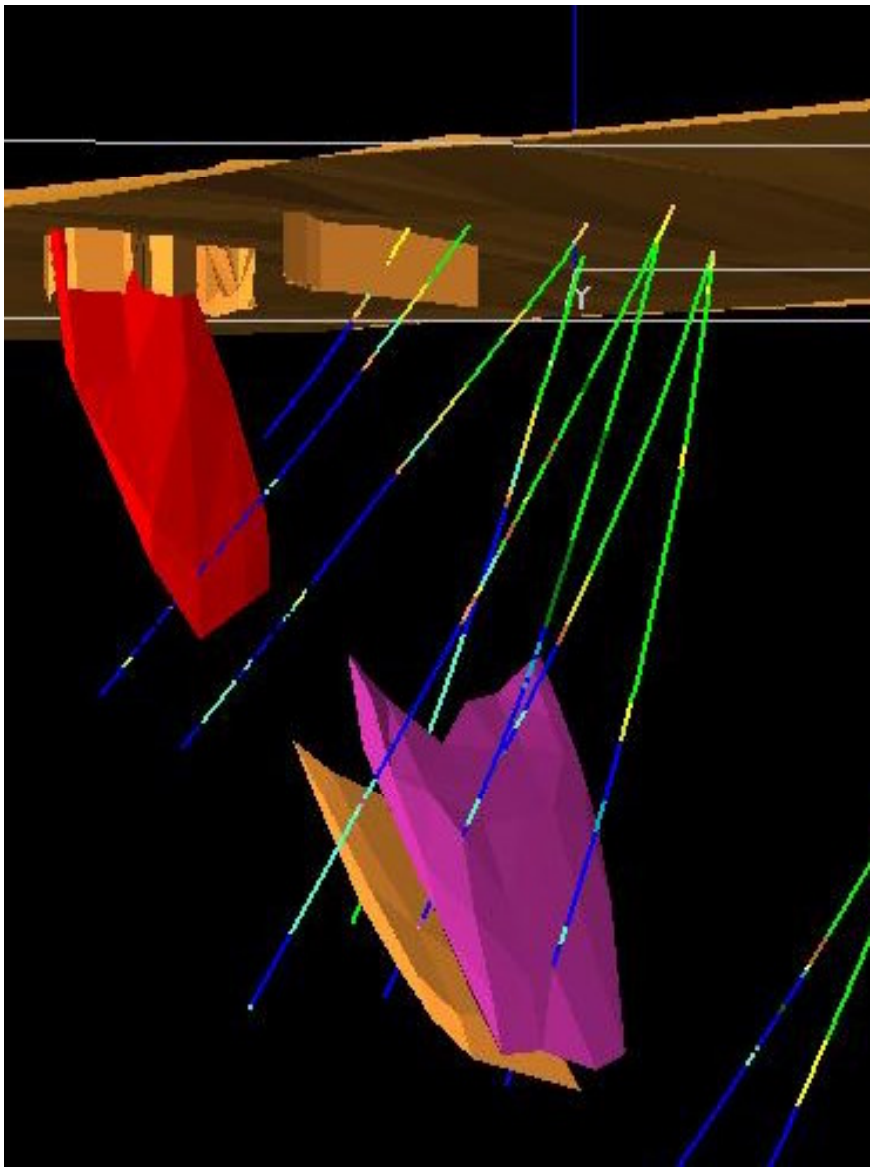
Titan 4th Line: MT Drill Section



Titan 5th Line: MT Drill Section




Old Working
Oxidised Zone
Calc Silicate
D-1
Calc Silicate
Calc Silicate +/- Magnetite
Quartz Mica Schist+QZ+/-Gt
Chlorite + sericite +/- gt
D-2
D-2W
22m @ 2%Cu, 0.35g/tAu
14.6m @ 0.99%Cu 0.13g/t Au
47m @ 0.57%Cu, 0.05g/tAu
14.9m @ 1.31%Cu, 0.7g/tAu
23m @ 3.85%Cu, 1.2g/tAu
14.65m @ 0.75%Cu, 0.1g/tAu
12m @ 1.23%Cu, 0.081g/tAu
25.15m@ 0.91% Cu, 0.06 g/t Au

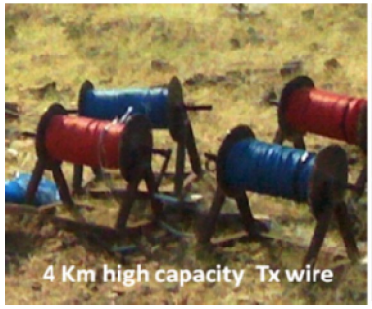


Technology


EM Receiver
Magnetometer
Data Recorder

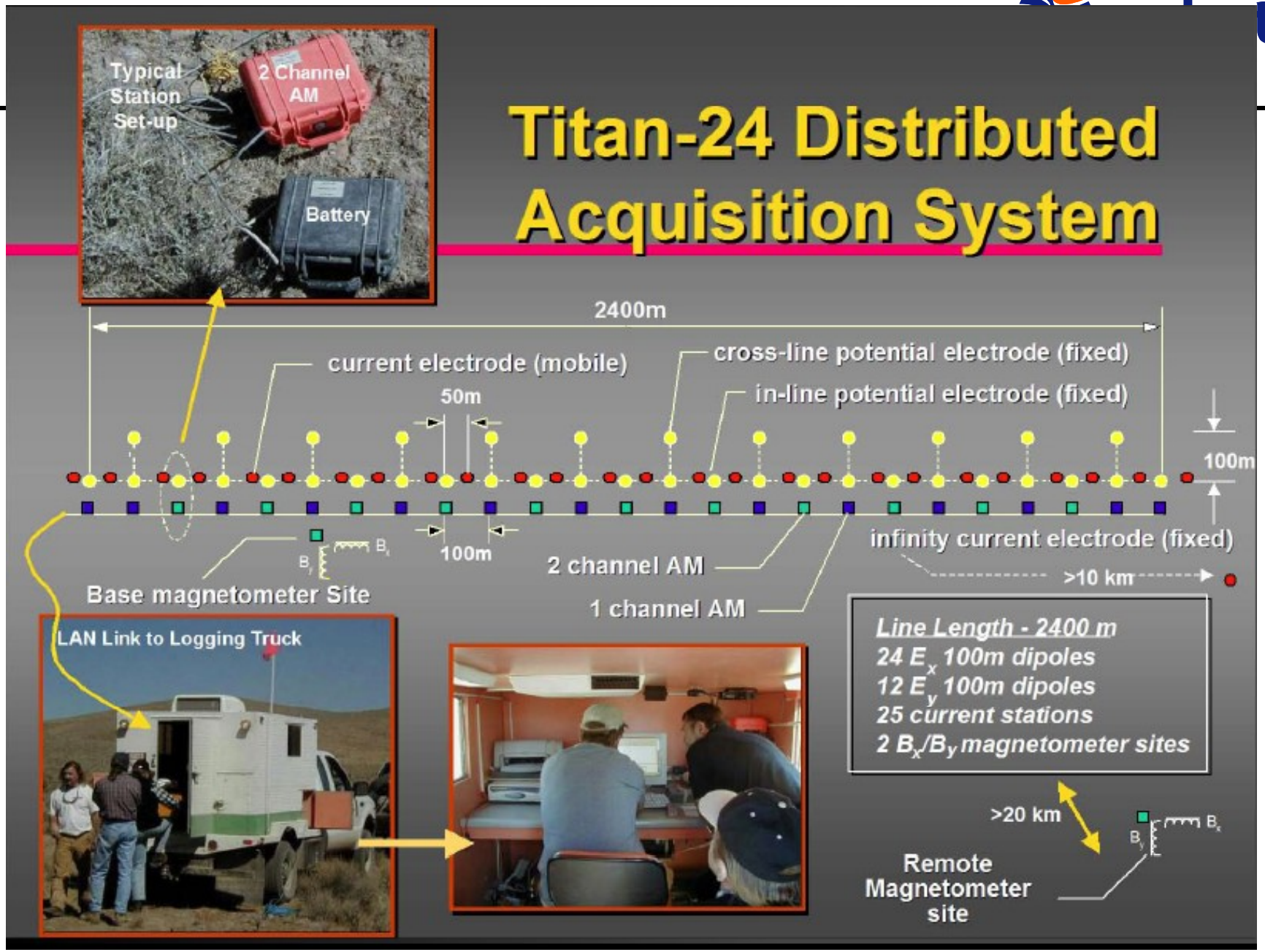

10 KW Generator


Transmitter, DC Power Supply


4 Km high capacity Tx wire


SMARTem 24 Tx Controller

Ancient Mining Signatures


Titan-24 Distributed Acquisition System
Typical Station Set-up
2 Channel AM
Battery
2400m
current electrode (mobile)
cross-line potential electrode (fixed)
in-line potential electrode (fixed)
50m
100m
100m
infinity current electrode (fixed)
>10 km
2 channel AM
1 channel AM
Base magnetometer Site
LAN Link to Logging Truck
Line Length - 2400 m
24 Ex 100m dipoles
12 Ey 100m dipoles
25 current stations
2 Bx/By magnetometer sites
>20 km
Remote Magnetometer site