MINING, EXPLORATION AND GEOSPATIAL TECHNOLOGY

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Presentation Format

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- Future Applications

Introduction

- Mining industry is a major building block of World Economy
- With expected increase in population to 9 billion by 2050 and emergence of millions of new consumers, demand of limited natural resources is expected to be high, mining thereby is being seen as an important strategic sector for sustainable growth
- Transportation, energy, manufacturing, health, agriculture, construction are likely to remain heavily dependent on raw materials such as iron, copper, aluminium & industrial minerals

Cont…

- As geological targets for most metals become larger, deeper and lower-grade, advances will be needed in the technologies used to discover and define deposits and in organization of the exploration process

- Programme such as CSIRO Australia's 'Mining Down Under' and Rio Tinto's 'Mine of the Future' are promoting innovations such as in-situ mining, autonomous haulage, drilling and rapid tunneling

- Non-invasive technologies such as Electrical Resistivity Tomography (ERT) will be used for rapid assessment of larger & more diffuse mineral deposits

Cont…

- Such developments are likely to be common place in the near future, made more efficient by systems innovations in spatial positioning, data management and analysis

- GIS, combined with remotely sensed data, is going to be an important factor in the quest for locating new mineral targets promoting systematic and sustainable mining

About FIMI

- FIMI is the only India-wide body representing the entire mining industry in the country
- It has around 400 members including all large and medium mining companies, and 20 Regional Associations & Federations representing most of the small miners
- FIMI has established two subsidiary bodies:
  - Sustainable Mining Initiative (SMI) – for promoting sustainable mining in Indian Mining sector
  - Programmes and Training Pvt. Ltd. (PTPL) – for providing a platform for sharing good practices
- Skill Council for Mining Sector (SCMS) promoted by FIMI has been approved by National Skill Development Council (NSDC), Government of India for developing skill competency standards and qualifications, bench marking it with international standards

Overview of Indian Mining Industry

- Mining sector is strategically very important for India
- Produces 87 minerals
  - 4 Fuel
  - 10 Metallic
  - 47 Non-metallic
  - 3 Atomic
  - 23 Minor
- GDP from mining sector in 2011-12 (at current prices) was Rs.2,01,076 cr
    - Fuel Minerals: Rs.1,32,505 cr (66%)
    - Major Minerals: Rs.43,780 cr (22%)
    - Minor Minerals: Rs.24,791 cr (12%)

Cont…..

- Mining in India is dominated by State sector; accounting for over 66% of overall production
- Almost 100% of Gold, Lignite & Gypsum
- 90% of Coal
- 80% of Tin concentrates

Mining Lease Distribution as per area in India

S.No.	Frequency (ha)	No. of Leases	% of Total Leases	Area in '000 Ha
1	0 to 10	6,714	61	27
2	10 to 20	1,064	10	15
3	20 to 50	1,358	12	45
6	50 to 100	919	8	68
7	100 to 200	447	4	63
8	200 to 500	293	3	89
9	Above 500	208	2	241
Total		**11,003**	**100**	548

Source: IBM (As on 31st March 2011)

- 61% of leases < 10 ha
- 22% of leases between 10 to 50 ha
- Only 17% of leases are > 50 ha

Constitutional / Legal Position on Minerals

- Union List: Entry 54 states -

  "Regulation of Mines & Mineral Development to the extent to which such regulation and development under the control of the Union is declared by parliament by law to be expedient in the public interest"

- State List: Entry 23 states -

  "Regulations of Mines & Mineral Development subject to the provision of List 1 with respect to regulation and development under the control of the Union"

- Mines & Mineral (Development & Regulations) Act, 1957 governs the sector

- Exceptional arrangement for Coal, Petroleum & Natural Gas

Elements of Governance

- Constitutional & Legislative framework
  - Center & State
  - multiple laws: MMDR Act, Mines Act, FC Act, EP Act, etc.
  - no single point responsibility
- Implementation & monitoring of the policy & legislative framework
  - multiple authorities: IBM, DGMS, DMG, MoEF, State Forest Department, SPCB etc.
- Judiciary

2012 – 13 "Annual Survey of Mining Companies" by Fraser Institute

- "To measure, study and communicate the impact of competitive markets and government interventions on the welfare of individuals"
- "To assess how mineral endowments and public policy factors such as taxation and regulation affect (encourage or discourage) exploration investment"
- Results based on responses received from 742 explorations / mining Companies around the world

Contd…

- It examines 17 policy factors with maximum score of 100. For eg.

Interpretation and enforcement of existing regulations	Environmental regulations
Legal system	Taxation regime
Infrastructure	Socio-economic agreements / community development conditions
Political stability	Quality of the geological database
Uncertainty in mining policy and implementation	Disputed land claims, etc.

Where India Stands

Composite Scores	India's Score	Rank	Remarks
1. Policy Potential index (PPI) (provides a comprehensive assessment of the attractiveness of mining policies in a jurisdiction) – all above factors except 16 and 17	21.1 / 100 (Finland 95.5)	81 / 96	Score reflects 'encourage investment'
2. Current mineral potential (assuming current regulations and land use restrictions)	28 / 100	76 / 96	Score reflects 'encourage investment'
3. Policy / Mineral Potential assuming no land use restrictions in place and assuming industry "best practices"	69 / 100	25 / 96	Score reflects 'encourage investment'
4. Room for improvement (Shows the gap between "Current" and "best practices' mineral potential and the greater "room for improvement")	41 / 100	12 / 96	

Increased chances of FDI if policies improve

FDI can contribute to improving socio-economic status

- Case studies conducted by International Council on Mining & Metals (ICMM), Oxford Policy Management (OPM) gave valuable insights into the macro-economic contribution of FDI in mining

- FDI combined with foreign exchange earnings can increasingly create positive development efforts such as creation of employment opportunities and poverty alleviation

Mining Life Cycle

- Primary raw materials for almost all the products come from Mining
- Several challenges but high returns
- Mining Stages are:

Exploration

- Reconnaissance and Prospecting
- To identify target areas using aerial surveys, satellite data, etc.
- Proving reserves by detailed exploration, GIS based modelling

Production

- Devising suitable method of extraction of minerals : Opencast / Underground
- Processing and Waste Management – Process Technology

Rehabilitation

- Closure of mine
- Land rehabilitation / stabilization
- Environment Management
- Community concerns

EXPLORATION

- Key For Development Of Mines

- Mineral Exploration is a Stand-alone Economic Activity with each Stage of Exploration adding value to the Mineral-Bearing Land

- It Demands Collection of a Variety of Highly Accurate Geospatial & other Technical data & Highly reliable Data & Image Processing softwares

- Acquisition of SATELLITE REMOTE SENSING DATA ; Eg. Regional Airborne Magnetic, EM., Radiometric & gravity ASTER & Hyperspectral data & Satellite Images)

- Integration, Analysis & Interpretation of Layers of Information

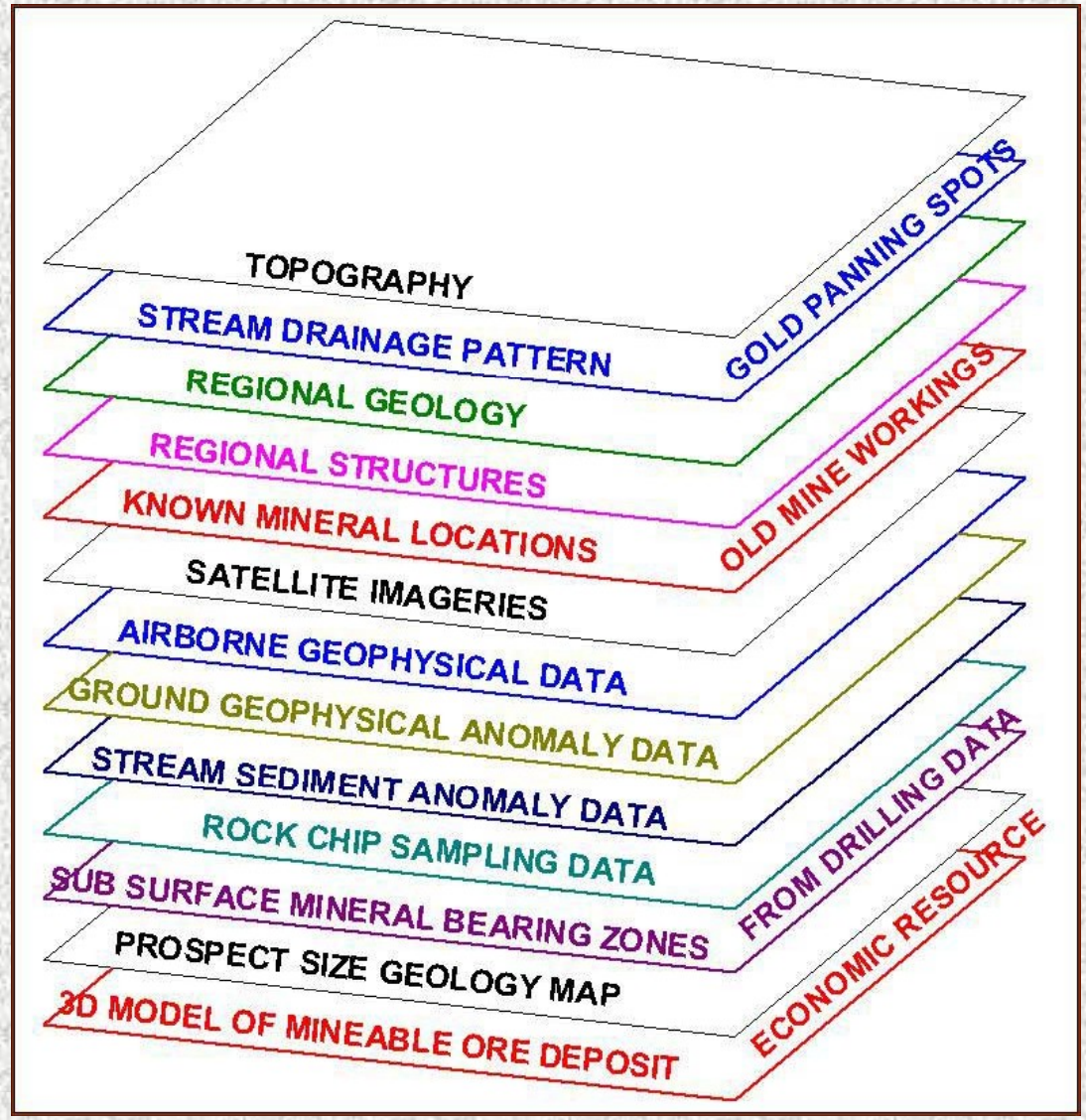
GIS in Exploration & Mining

GIS is a great tool for integration of a variety of technical data in the understanding of the impact of a mining project on other kinds of natural resources including environment & People

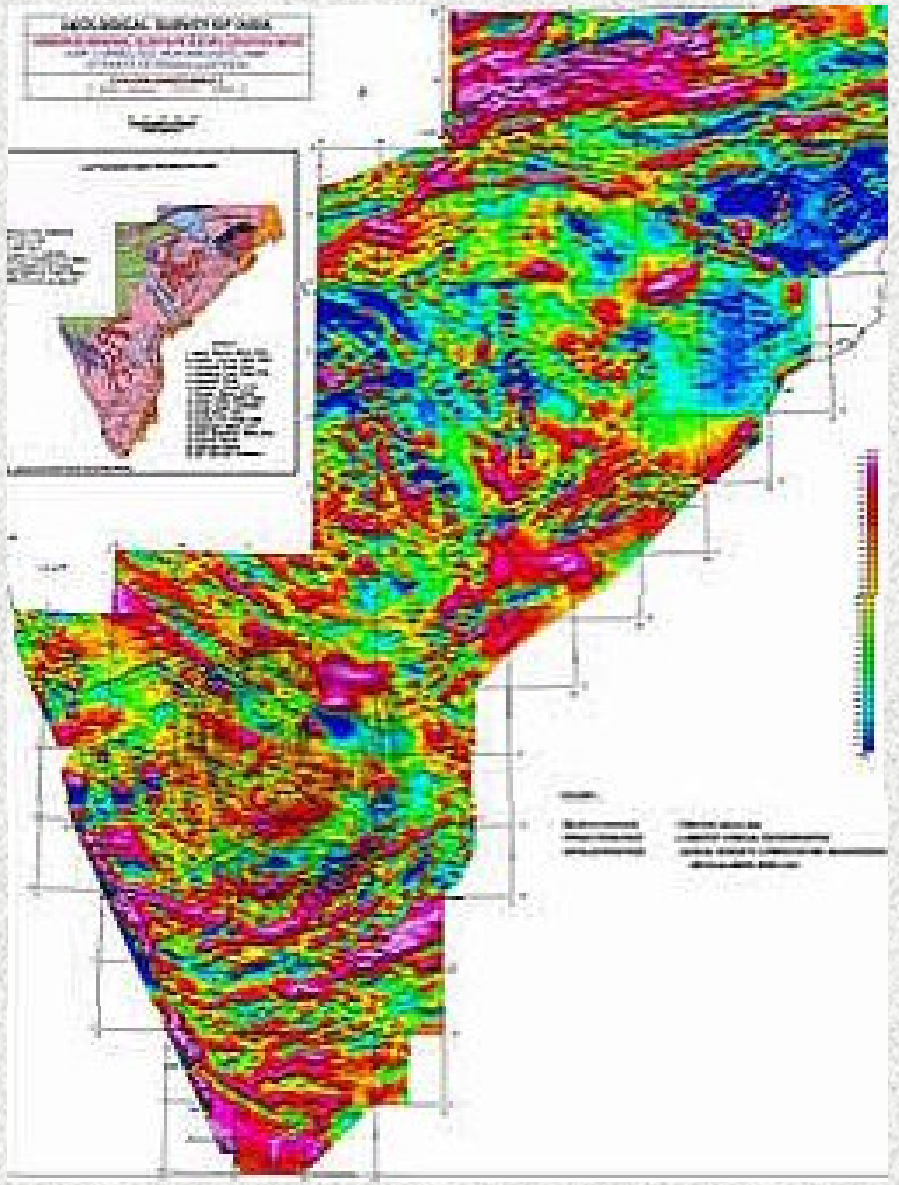
Processing of Several Layers of Exploration Data using GIS Techniques

• Data obtained by different methods of exploration are stored as several layers of information in a computer

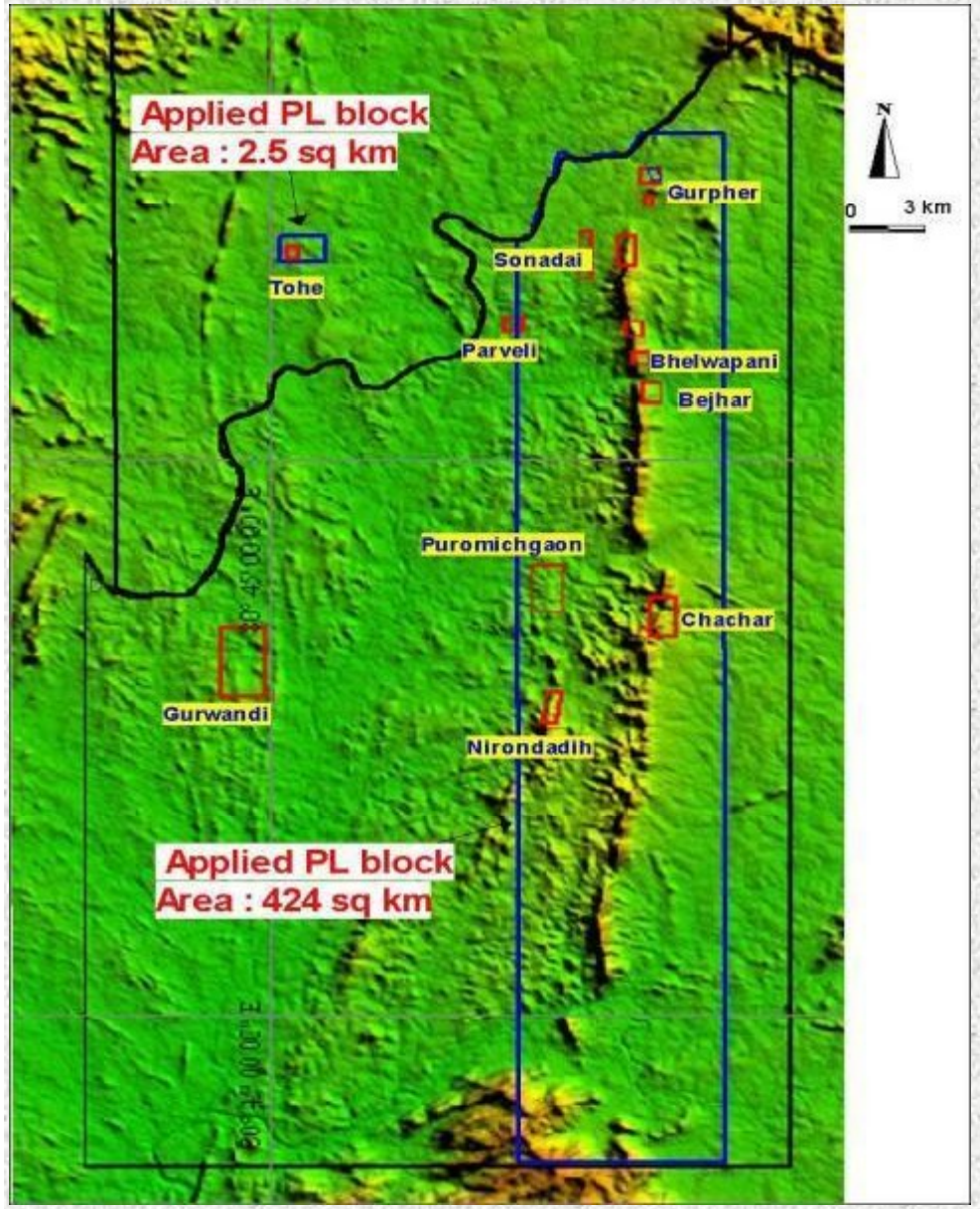
These data are processed using appropriate softwares like Mapinfo or ArcInfo to generate the required maps, Mineral Resource Estimation and 3D Mine Models

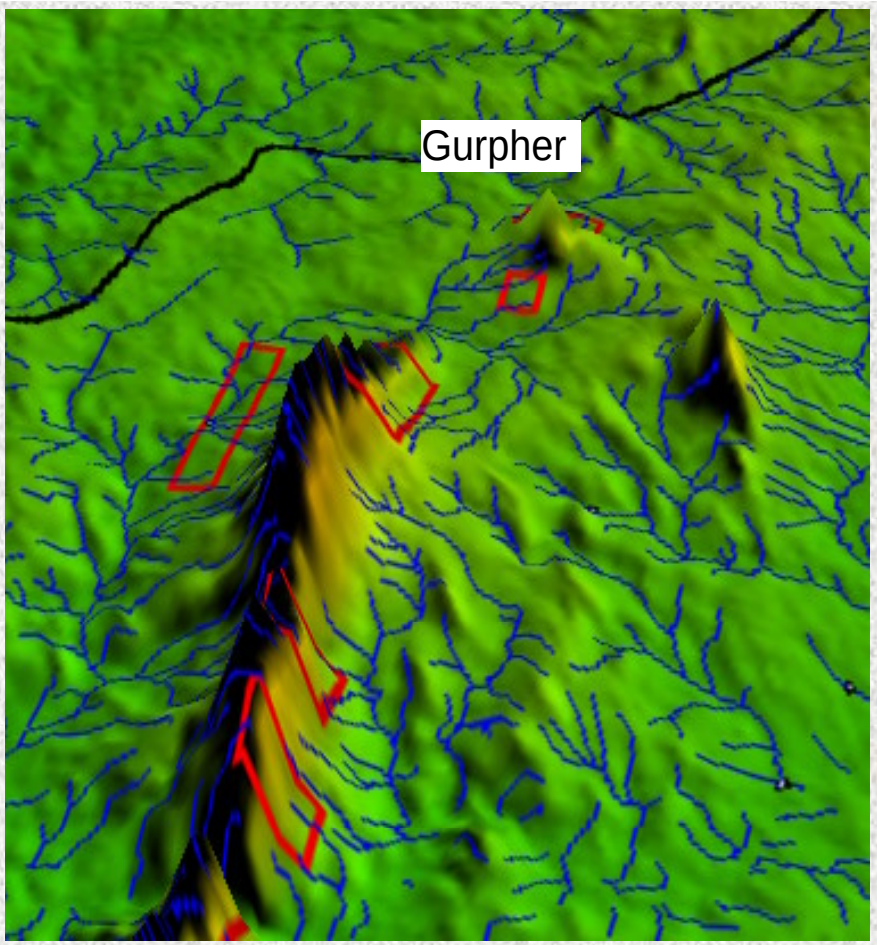


Production of Digital Data Base & Integration on a GIS Platform (Eg. Mapinfo)



Use of Digital Elevation Model Images & it's Integration into Geology & Structure



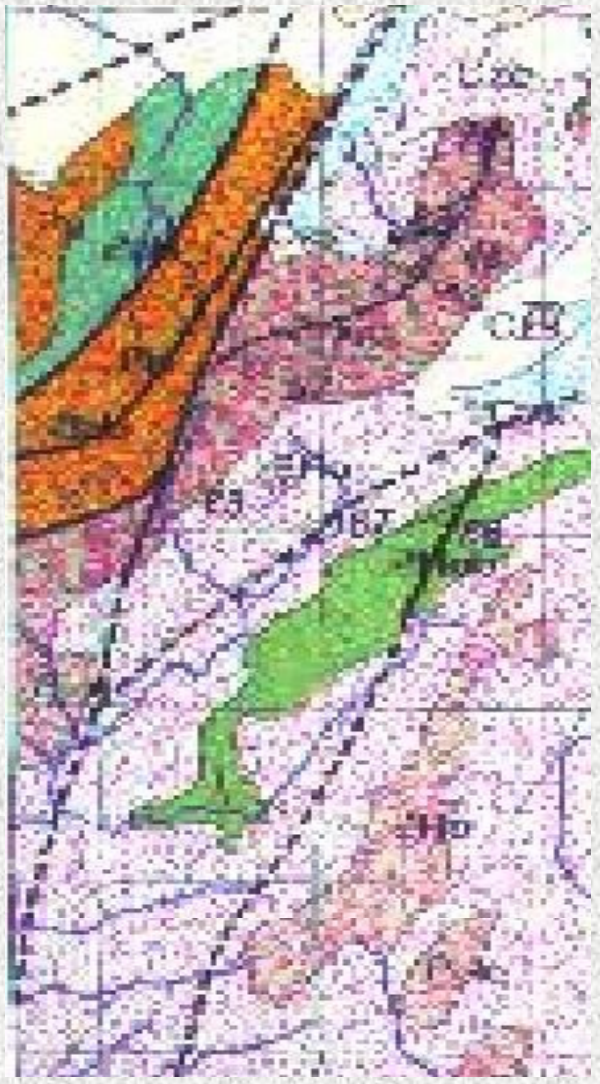


Eg. KOTRI BELT

Digital Elevation Image of Kotri Belt, Rajnandagaon and Kanker Districts, Chhattisgarh showing gold prospects

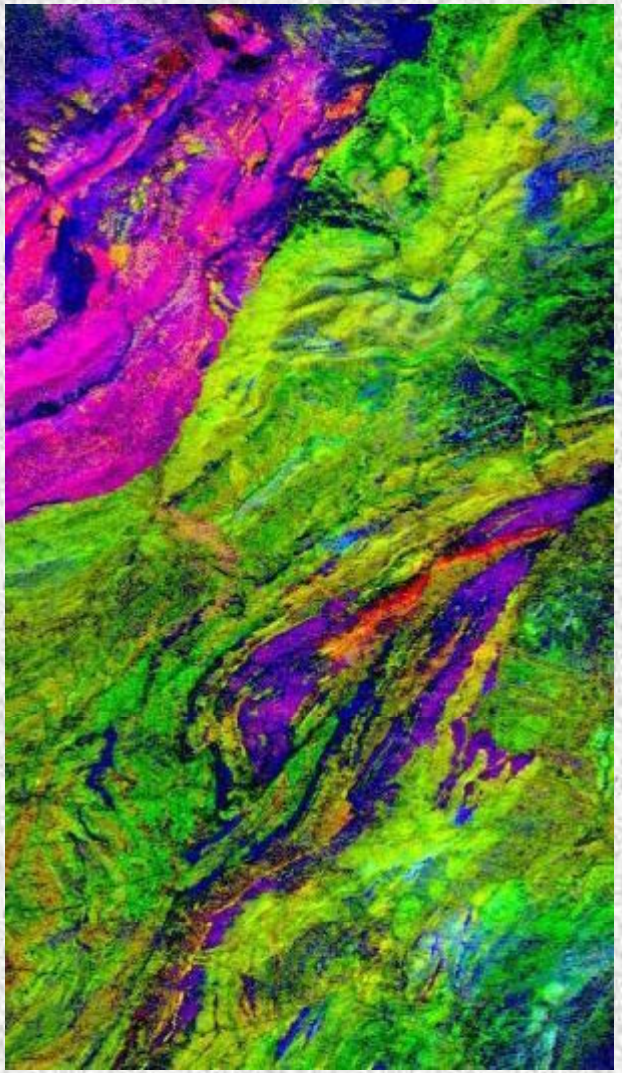
Satellite & Hyperspectral Data (Images) & their Integration

Geology



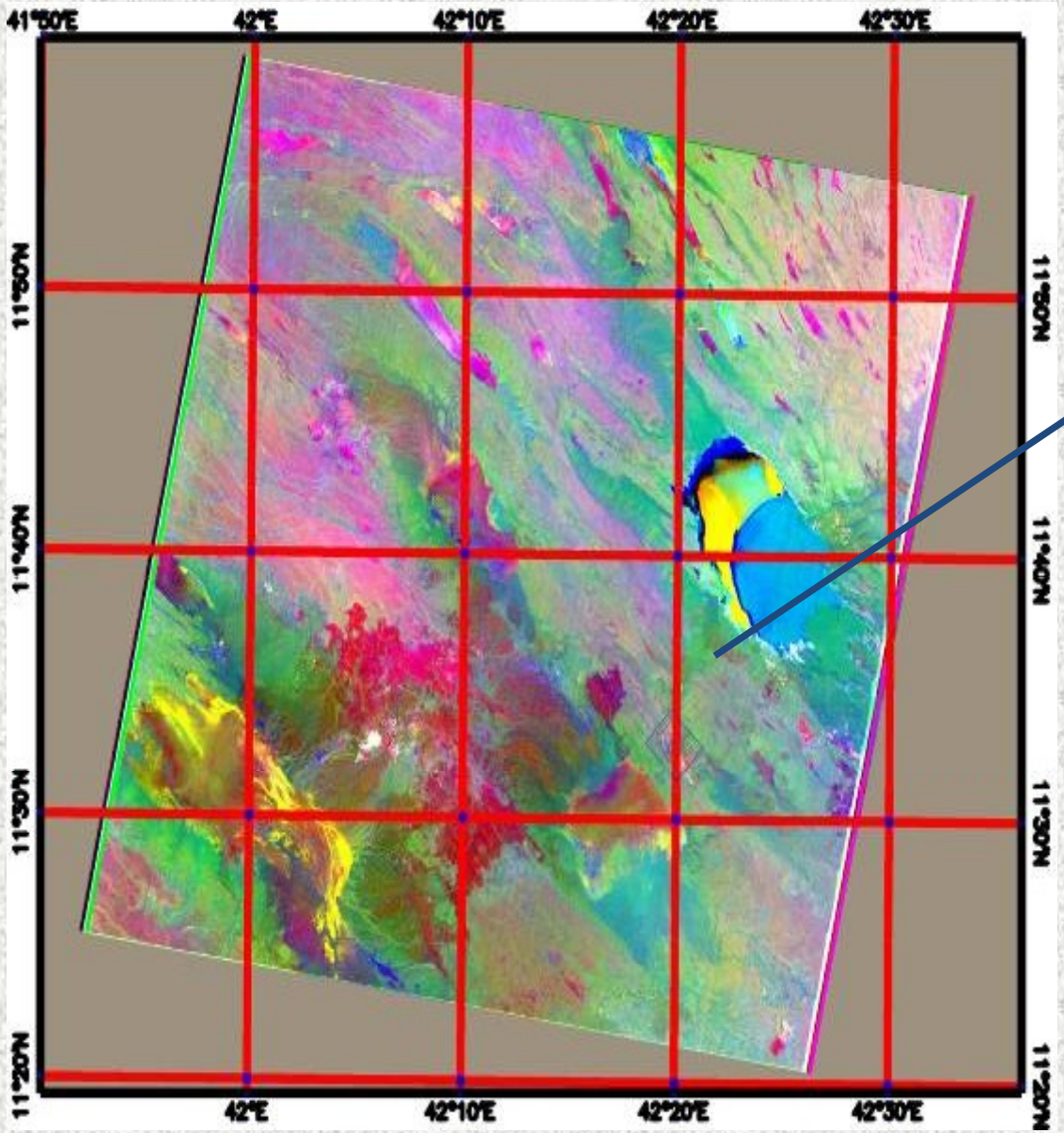
Satellite - TM

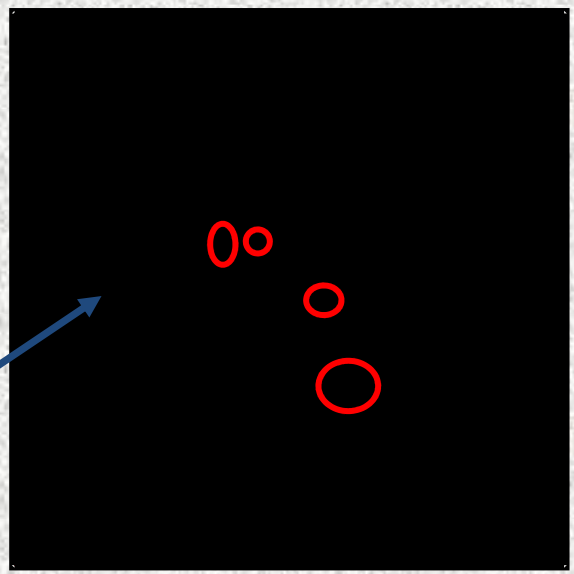
Hyperspectral



Aster Data: Gossan Identification Using Spectral Band Combination

Aster Data: Alteration (Ferrugenous & Argillic) Zones



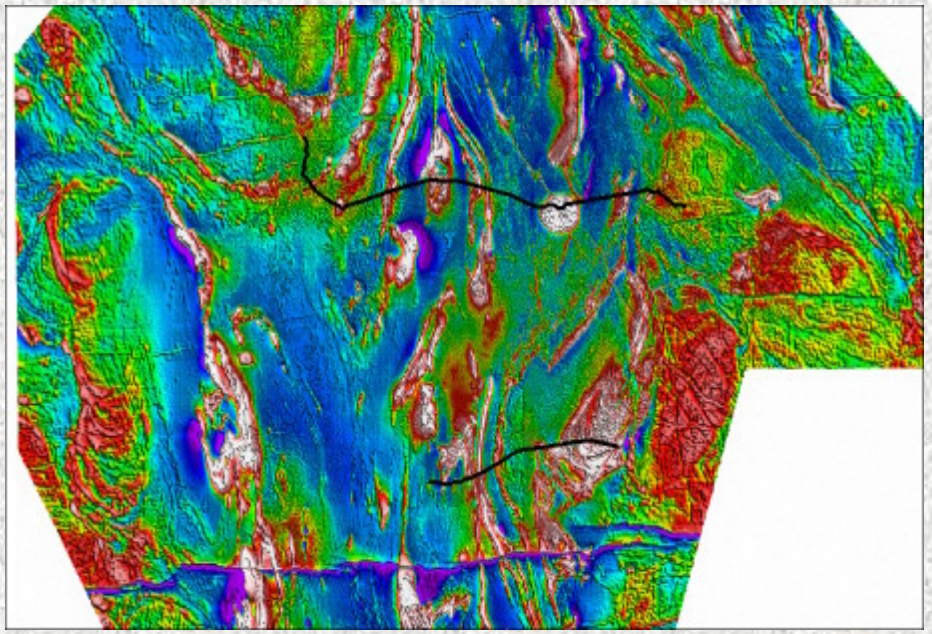


Aluminous alteration haloes

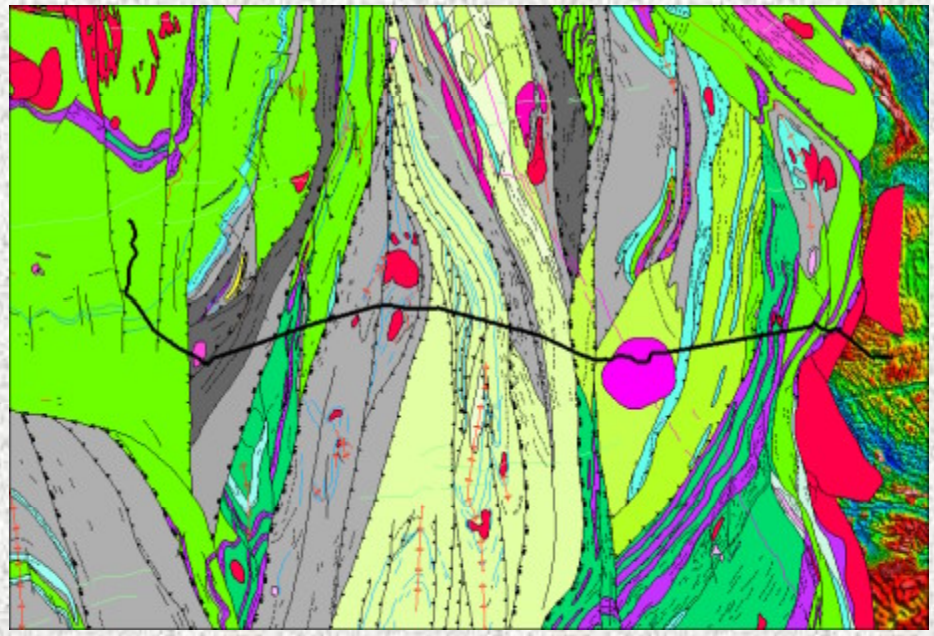
Ferruginous alteration zones

Exploration: Integration of Magnetics & Seismic & Structural Geology of an Area

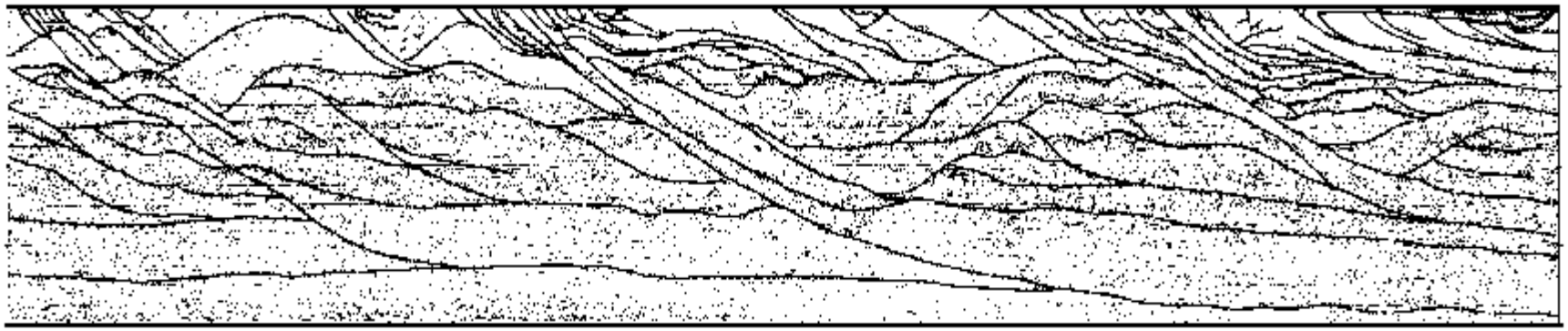
Magnetic Image



Structural Geology



Seismic Image



Gravity Survey Data; Airborne & Ground

- Helicopter borne gravity gradiometer survey; 120m altitude; low and slow flying can detect both large and small target sizes.
- Time-lapse microgravity mapping (gravity values at the scale of microgals) survey to detect very small changes in subsurface density. Relatively high anomalies correspond to fault distribution patterns.
- The following picture is a combination of Mag and Gravity

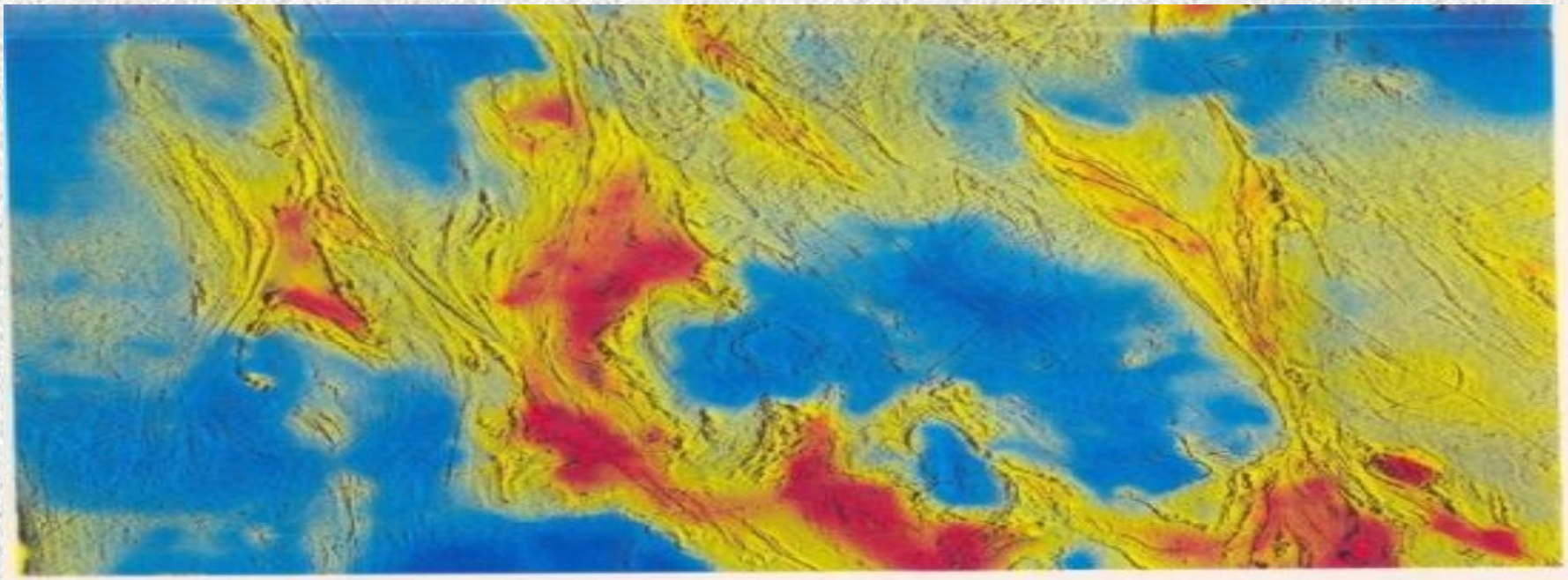
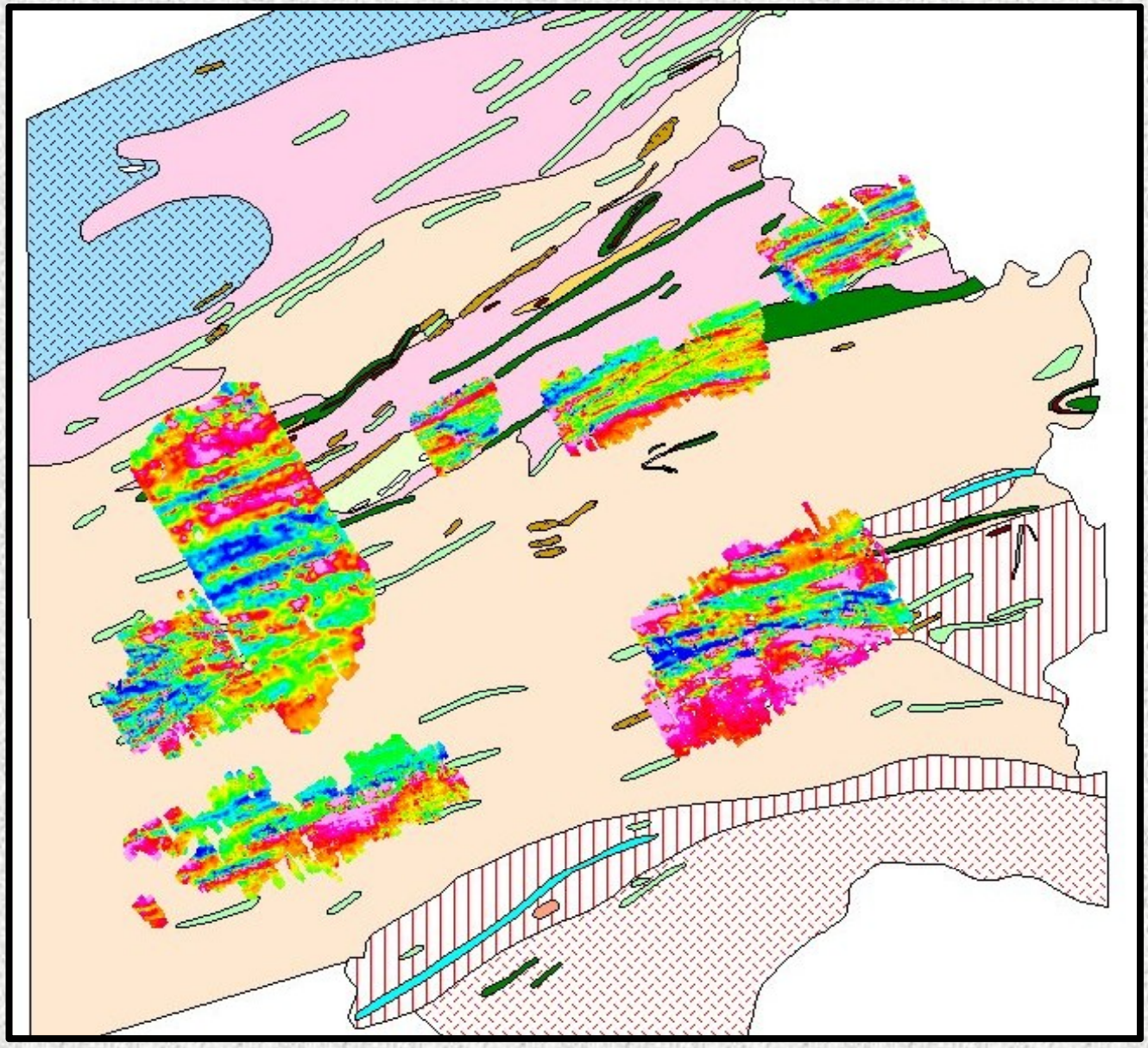


Figure 3. Combined image of 4 km spaced gravity data as hue (blue–gravity low to red–gravity high) and east gradient of the 400 m aeromagnetics as intensity for the same area as Figure 2. Granite correlates with low gravity (blue), mixed gneiss, migmatite and granite with intermediate gravity anomalies (lemon), and greenstone with high gravity (deep yellow–red). Very high gravity values are not evenly distributed throughout the greenstones and may represent local abundance of dense lithology, including basalt, dolerite and ultramafic rocks.

Magnetic Survey as an Excellent Tool for Mapping & for Locating Iron -Rich Rocks



Example from Attappady Valley, Kerala

Use of Satellite Imagery in Structural Geological Mapping

Satellite Imageries can be used more effectively as a Regional Mapping tool in Mineral Exploration.

The images when integrated with magnetic data, structural geological & spot geochemical data on an appropriate GIS Platform would greatly aid Exploration Programmes.

Geological & Structural Mapping & Delineation of Prospective Ground: Example from Hutti Gold Fields Region, Karnataka

Use of Google images for a first pass understanding of the distribution of Mining Pits in an area: This data may be integrated with many other layers of information such as Topographic survey data; Digital Elevation Images, Revenue Survey data & Forest distribution maps

GPS Tracking is a fine way of dealing with illegal mining

Geospatial Technology in Mining Industry

- Geospatial Technology – remote sensing, GPS, aerial surveys and a GIS system are a part of its workflow
- Geospatial Technology plays a very crucial role in exploration as well as in monitoring the progress on mines
- Profitability and quality of mineral extraction is increasingly dictated by use of IT & Geospatial technology
- Enables rapid, flexible assessments which yield an easy-to-interpret visual product as an output
- Spade of new mining softwares are benefiting the mining industry; 60% of the global mining software are now produced in Perth (Western Australia)

Geospatial Technology in Mining Industry

- More and more mining companies are using geospatial technology in their operations. For eg. -
  - Rio Tinto has a fleet of driverless trucks which use GNSS to transport ore at a mine site in Australia;
  - It could save about $72 million per annum, cut workforce and reduce costs by 30 cents per tonne of iron ore if 50%
  - Many more companies are using geospatial applications in exploration in mining

Geospatial Technology in Mining Industry

- Mining sector in India has been slow in adopting geospatial technology due to its fragmented nature

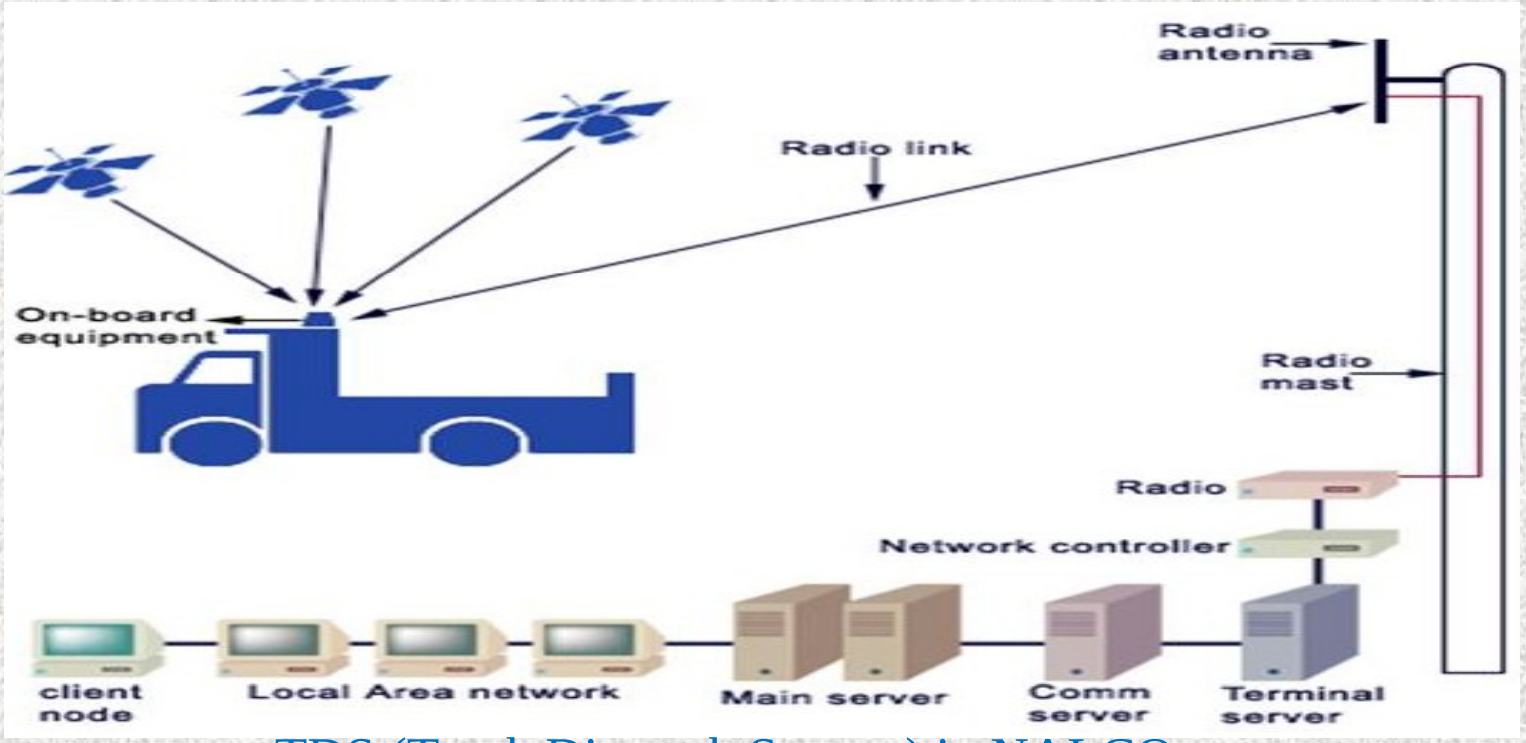
- GSI has also adopted geospatial technologies in their mapping and exploration programmes, development of hyper spectral sensor for mineral mapping. It has acquired a heliborne platform with state of the art, time domain, EM system

- HZL has systematically used the Geospatial technology both in brown field and green field exploration viz. heliborne VTEM, speed state-of-art drilling; most modern geophysical surveying systems viz. heliborne VTEM, deep penetration (IP, Resistivity, EM), remote sensing and hyper-spectral alteration mapping generating high volume GIS compatible Geospatial data

- NMDC is using Geospatial related softwares – Mapinfor, Surpac, Mine Sched, Whittle (Mine Planning Software) and ISATIS (Geospatial software) for generally mine planning and design, geological ore body modelling, pit optimization and digital terrain modelling etc.

Geospatial Technology in Mining Industry

- NALCO uses geospatial technology in real-time trip counting system at opencast mines, truck movement monitoring etc.



TDS (Truck Dispatch System) in NALCO

- Coal India uses geospatial technology in the pre-mining phase, surveying, exploration and compiling baseline data of environmental situation and land-use patterns;
- Some of the large and medium mines in private sector are also adopting use of geospatial technology to maximise efficiency and profit

Mining Tenement System (MTS)

- The geomatics applications for management of prospecting and mining licences / leases data facilitates mining / tenement related information
- To facilitate e-enabled processes associated with mineral concession regime, MTS is being developed by Indian Bureau of Mines (IBM), Ministry of Mines
- It is expected to bring change in governance with more transparency and timely approvals / clearances

Future Applications

- The mining industry continues to struggle with ongoing volatility and market uncertainty in the form of rising taxes, mounting government inference and escalating community expectations

- IT & Geospatial Technologies can help to mitigate some of the challenges through:

  - Programmable Logic Controllers (PLCs)
    - Used in various processes such as blasting, drilling, excavation, transportation etc.
    - Remotely controlling drill environment, handling explosives, managing conveyor systems
    - PLC can improve mine safety, handling explosive, managing conveyor belts

Cont....

- Supervisory control and data acquisition (SCADA) systems so as to enhance
  - Collecting information from remote sites and communicate it back to regional or central location
  - Improve plant performance
  - Reduce labour cost
  - Capture more pertinent business data and metrics
- Business Intelligence Systems
  - Capture the data collected by PLCs & SCADA systems and other applications and deliver non-conventional metrics
  - Enhance productivity
  - Improve safety performance to strengthening regulatory compliance
  - Realising energy efficiency

In addition to maximizing efficiency and profit, there is a general consensus that use of geospatial technologies and the data it provides in the public domain will increase transparency of the mining sector as a whole, benefiting the mining companies

THANK YOU!