Recent Advances in Exploration Geochemistry and Future Directions

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Our newest geochemical platform?

Future of Exploration Geochemistry

- New Roles of the exploration geochemist
- Recent Advances
- Searching for Buried deposits
- Research Directions

Our changing role?

- *Traditional*
- *Exploration Centered*
- *Orientations*
- *Surveys*
- *QAQC*
- *Evaluation*

- *New*
- *Complete Mining Lifecycle*
- *Baseline Environmental*
- *Exploration*
- *Development*
- *Operations*
- *Mine Closure*

What has been happening to Exploration Geochemistry?

- Geochemical staffs reduced
- More geochemical outsourcing
- Research funding disappearing
- Academic and Government Surveys moving to environmental research
- Academic training programs reduced
- Layoffs left a group of highly qualified experienced geochemists seeking new opportunities

Geochemical Entrepreneurship

- Geochemical services.
- Exploration companies that develop new resources.
- Companies that develop and implement new technologies.

The Last Decade
4 Paradigm Shifts

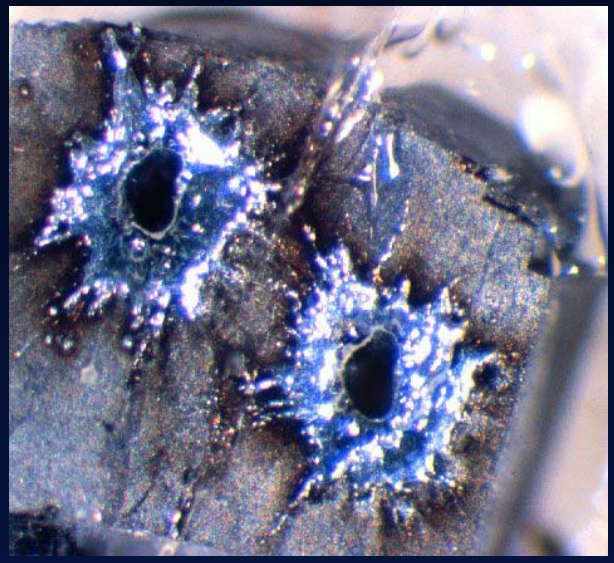
- ***Analytical*** *- down another two orders of magnitude with multielement analyses*
- ***Selective Extractions*** *- selective to isolate mineral phases or characterize dispersion process*
- ***Information Management*** *– large data systems on personal computers integrated with GIS*
- ***Interpretive Methods*** *- threshold to pattern recognition incorporating geochemical process*

Recent Advances in Analytical Technology

- *Instrumentation*
- *ICP/MS*
- *Laser Ablation ICP/MS*
- *GC/MS*

- *Extractions*
- *Selective*
- *Partial*
- *Sequential*

ICP-MS



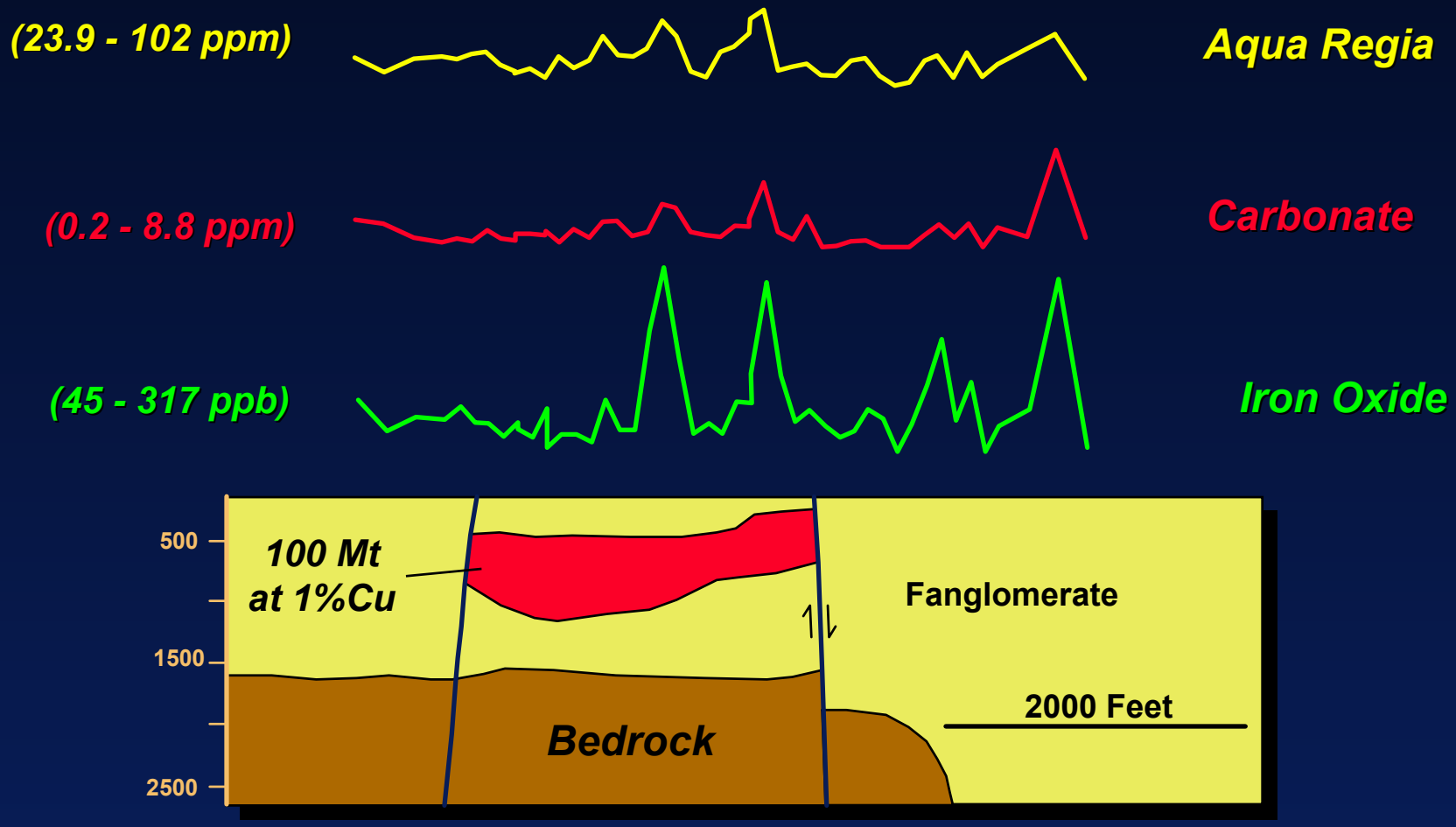
- Lower detection limits
- Reduced interferences
- Larger elemental suite
- Greater dynamic range

- Chemical Zonation
- Element Partitioning
- REE Characterization
- Fluid Inclusions
- Isotopic Analysis

"Selective" Extractions

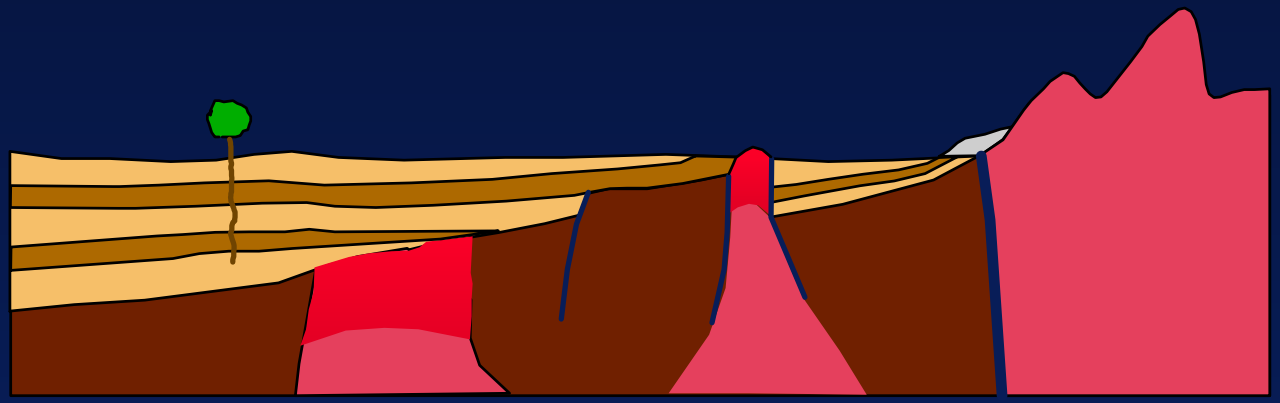
- *Allow us to focus on elemental form or phase*
- *Provide greater contrast anomalies*
- *See common patterns over deposits throughout the world*
- *Gives rise to new questions about geochemical dispersion processes*

Porphyry Project - Standardized Cu
Contrast Comparison



Where to go with Selective Extractions
Isolating Dispersion Processes

Mechanical	Sediment	4 Acid
Hydromorphic	Sediment	Aqua Regia
Electrochemical	Fe-Mn Ox	Cold Hydrox
Evaporation	Caliche	NaHOAc
Transpiration	Biogeochemistry	NAA
Vapor	Soil Gas	GC-MS
Accumulation	Soil	BCL

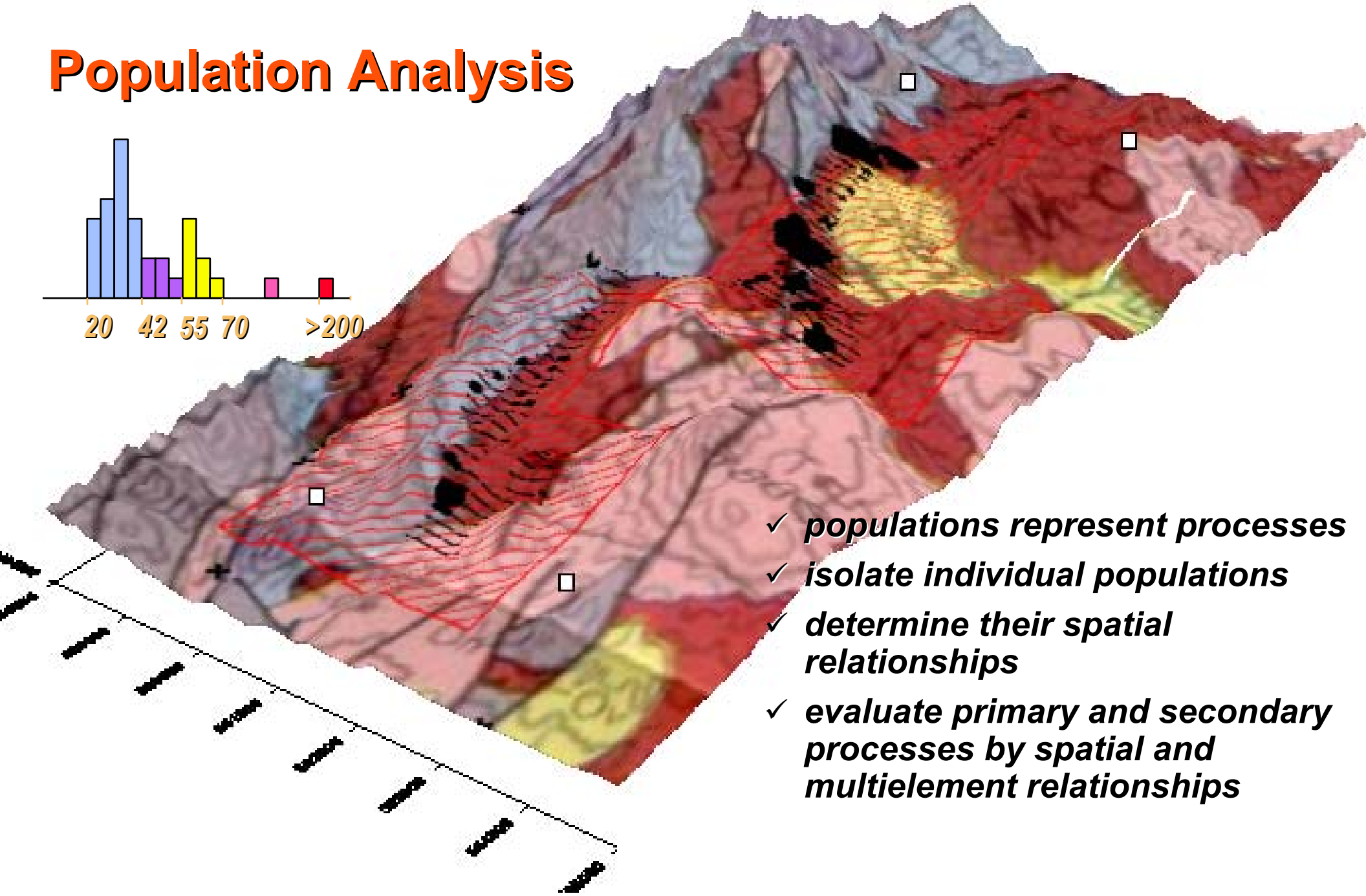


Recent Advances in Interpretive Methods

- *Threshold*
- *mean + 2s*
- *numerically oriented*
- *interpolation*
- *contouring*

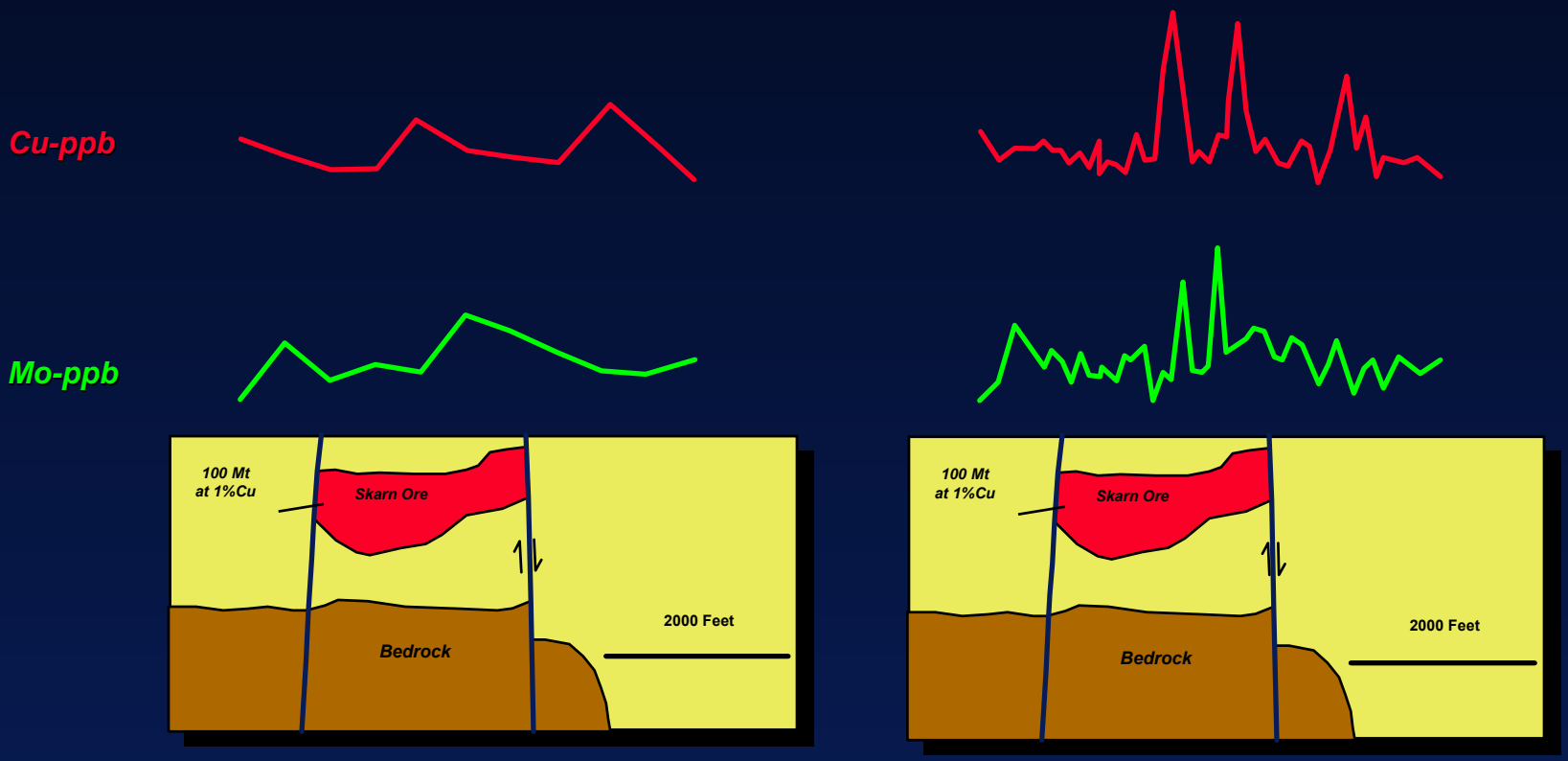
- *Pattern*
- *populations*
- *process oriented*
- *spatial clustering*
- *imaging*

Population Analysis



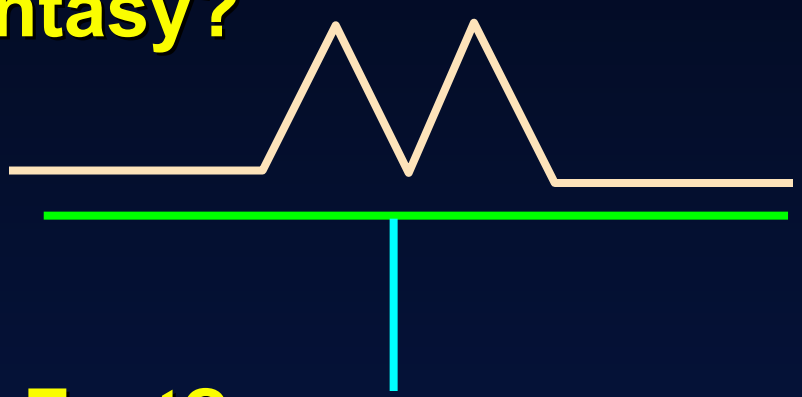
- ✓ *populations represent processes*
- ✓ *isolate individual populations*
- ✓ *determine their spatial relationships*
- ✓ *evaluate primary and secondary processes by spatial and multielement relationships*

Pattern Recognition

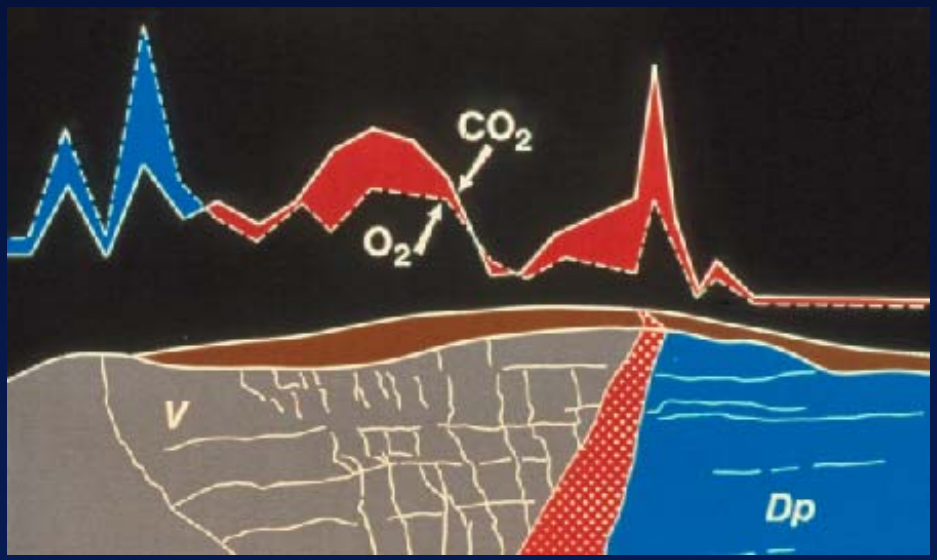


Common Patterns

Fantasy?

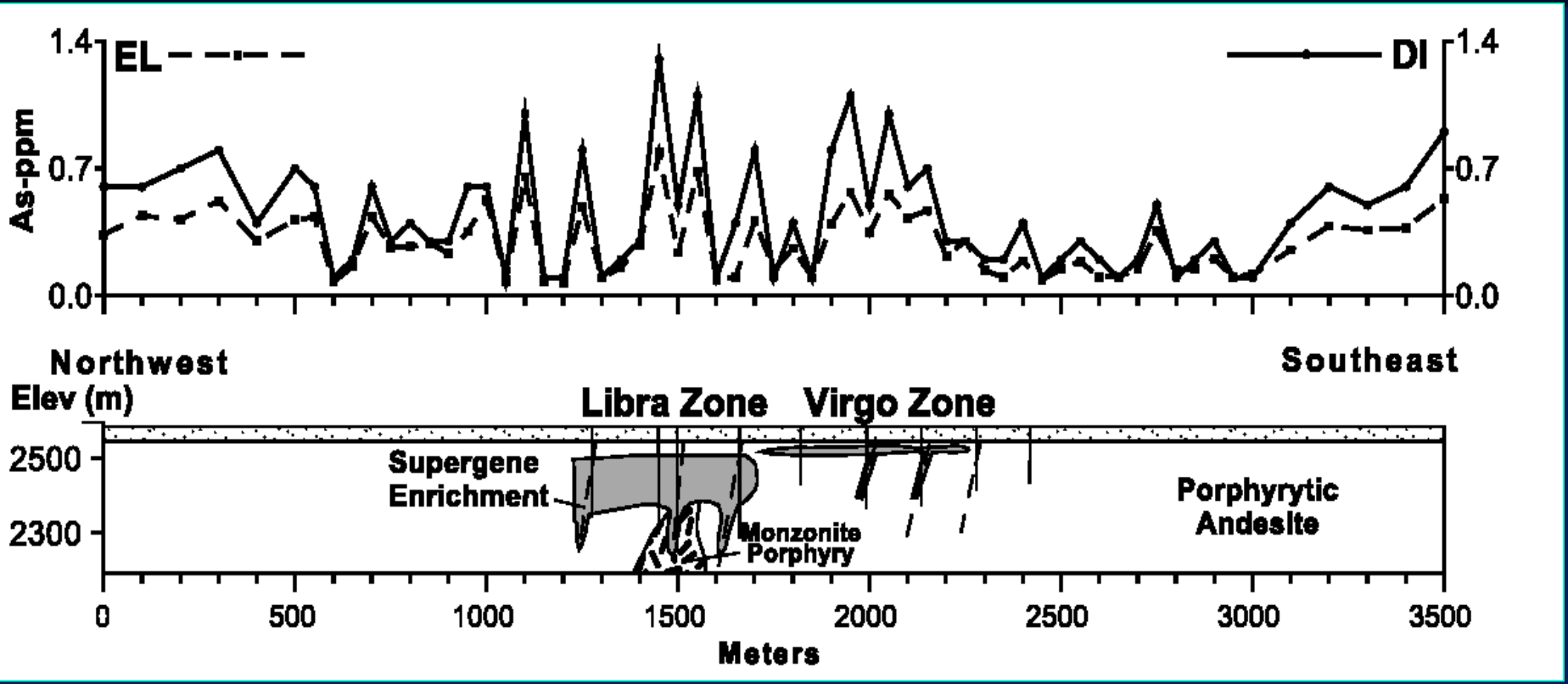


Or Fact?



- Common Patterns
- In different media
- Collected at the same scale
- Over different deposits
- Under varying climatic conditions
- Around the world

Characteristic Patterns Over Ore



Soil profile over supergene mineralisation,Chimborazo.

(from Kelley *et al*, 2002)

New Evaluation Methods?

- Pattern recognition or

  Signal Analysis

- Object oriented database design

  Pattern Libraries

New Visualization Technologies

- **Population imaging**

  In real time

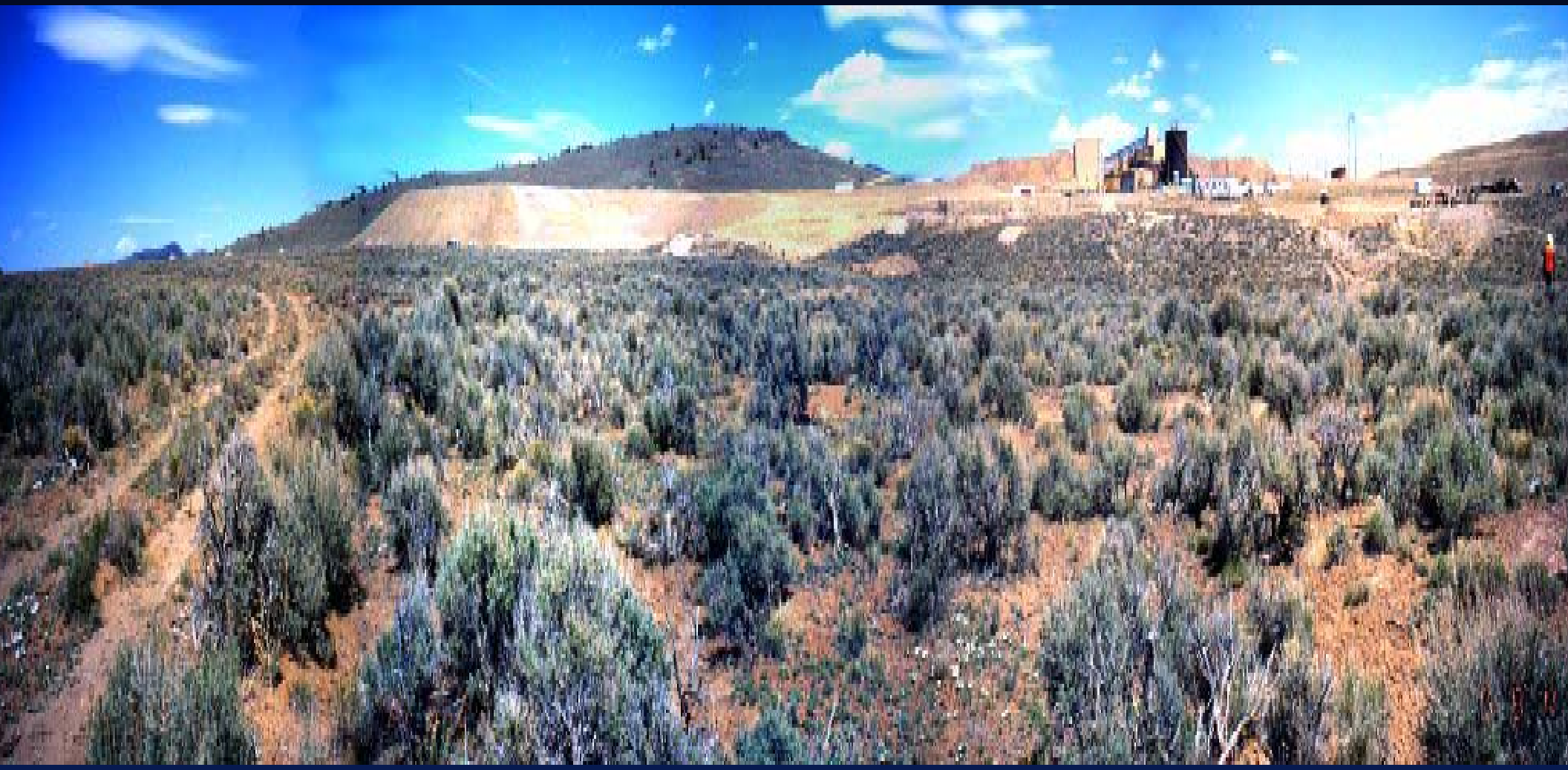
- **Pattern recognition**

  Need new visualization technologies to view and compare patterns

Summary of Recent Advances

- ***Analytical*** *- down another order of magnitude with multielement analyses*
- ***Extractions*** *- selective to isolate mineral phases or dispersion process*
- ***Information Management*** *– large data systems on personal computers integrated with GIS*
- ***Interpretive Methods*** *- threshold to process oriented*

Another Frontier – Brownfields



Great Basin, USA

Exploring Under Cover
Future Needs

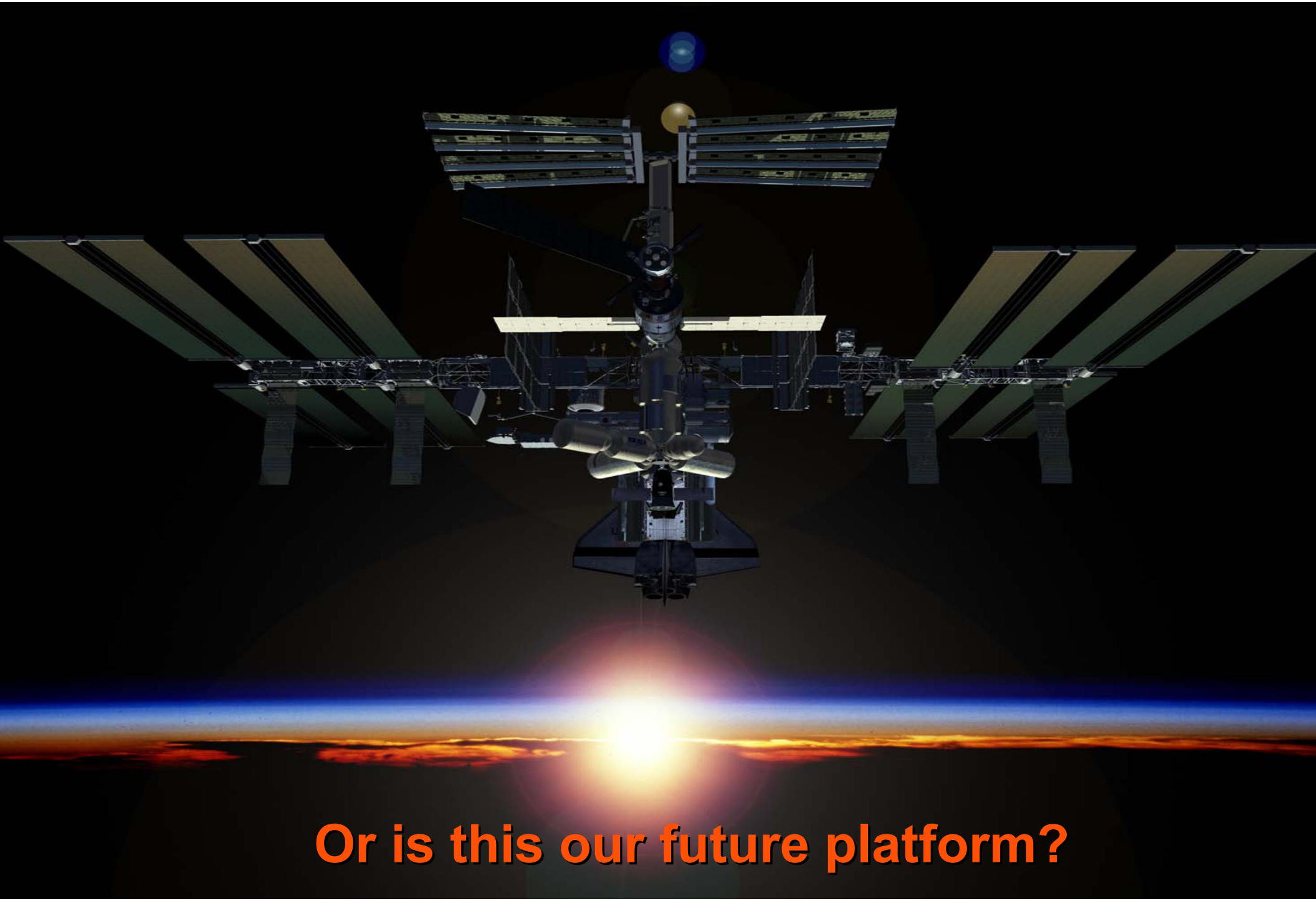
- Understand operative dispersion process.
- What do these common patterns represent and develop numerical methods to evaluate for patterns.
- Find out what the relationship is between mobile metals, soil-gas, microbes/bacteria.

Future Challenges

- Under Cover
  - Develop improved understanding of process, microbial intervention, and the role of gas in metal migration
  - Link this with surface geochemical expression
  - Develop interpretation methods to recognize these processes
- Rapid reconnaissance methods
  - Airborne geochem systems focused on gas and aerosols

Future Challenges

- Train a new generation
- Educate the current generation
- New visualization technologies
- New evaluation methods for pattern recognition
- Role of gases and aerosols in migration


Or is this our future platform?