Implementing GPS and GIS Tools in an Abandoned Mine Land Program

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Topics Covered:

- Texas AML Program - adoption of GPS hardware and GIS software
- How we use GPS and GIS tools to conduct site assessments
- Benefits/obstacles encountered with GPS and GIS

Pre-GPS Geospatial Tools

- Surveying crew with a total station
  - 2+ people needed
- Low-tech approach:
  - Compass and pacing
  - Topographic map and/or aerial photograph

Traditional Surveying Obstacles:

- Inefficient use of staff time
  - Surveyor wait time
  - Two people dedicated to surveying
- Impractical for site assessments
  - Scheduling problems
  - High data density hard to obtain

Problems with Low-tech Method:

- Accuracy variable and difficult to measure
- Cumbersome to link data to locations in CAD-based map
- Time-consuming / transcription involved

Adoption of GPS and Progress

- GeoExplorer II
  - Borrowed in 1998
  - Post-processing
  - < 5-m accuracy
  - $4,200 (with FM DGPS Receiver)
- ProXRS
  - Bought in 1999
  - Differential GPS
  - < 1-m accuracy
  - $11,000

Data collection

GPS Comparison:

- GeoExplorer II
  - 60 positions/location
  - 1 camcorder battery
  - 4.6 pounds
  - 1,000 point locations:

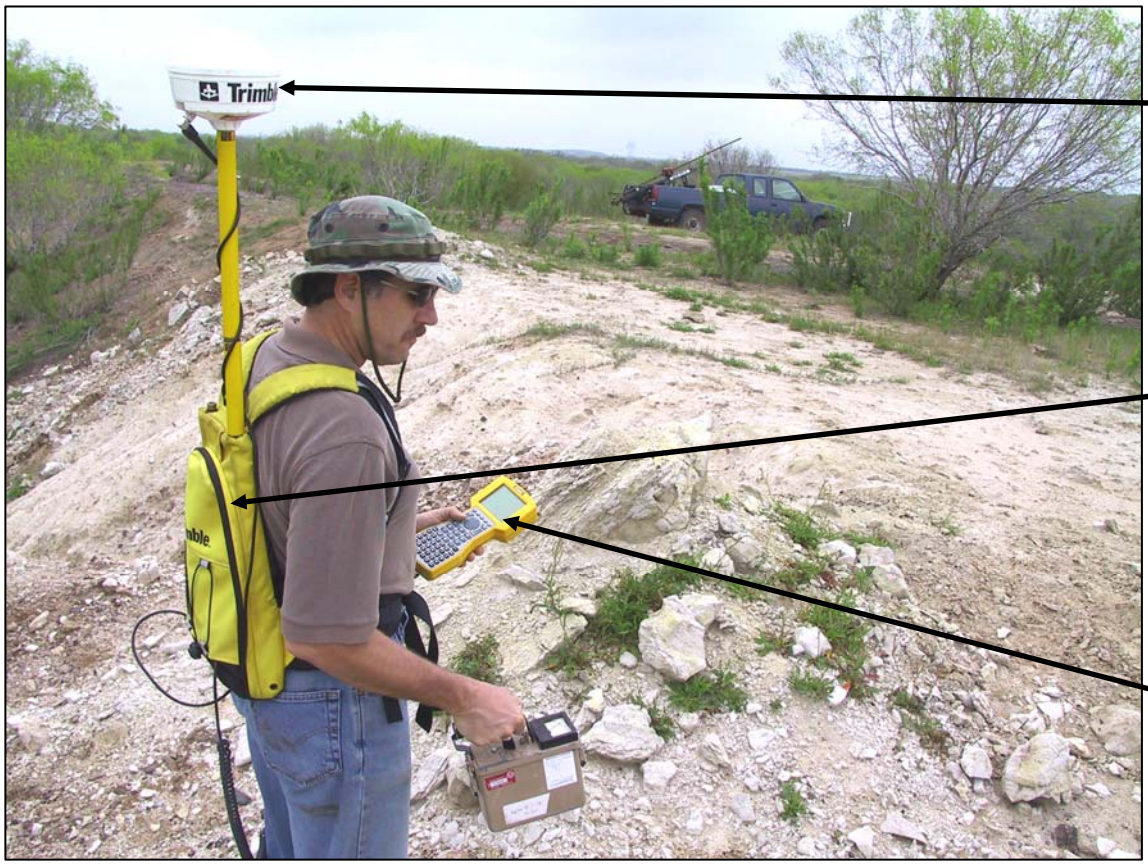
    Approx. 16.7 hours recording features

- ProXRS
  - 5 positions/location
  - 2 camcord. batteries
  - 14.7 pounds
  - 1,000 point locations:

    Approx. 1.4 hours recording features

GPS Equipment

Trimble ProXRS System



Integrated antenna: beacon or satellite differential GPS

GPS receiver in backpack

TSC1 datalogger

TSC1 Datalogger

Asset Surveyor software

Easy alphanumeric data entry

Can display current data at same time as data from another file (background map)

GIS Software

- ArcView 3.1 and 3.2a in 2000
- ArcGIS 8.1 in 2002, v. 8.3 in late 2003 (ESRI)
- Export GPS files in shapefile format with Pathfinder Office (Trimble)
- The GPS and GIS seamlessly work together -- connect field and office.

Site Assessments

- Infrastructure locations
- Nature of different earth materials
- Extent of potential environmental hazards and safety risks
- Condition of resources:
  - Soil
  - Plant
  - Water

In-House Site Assessments

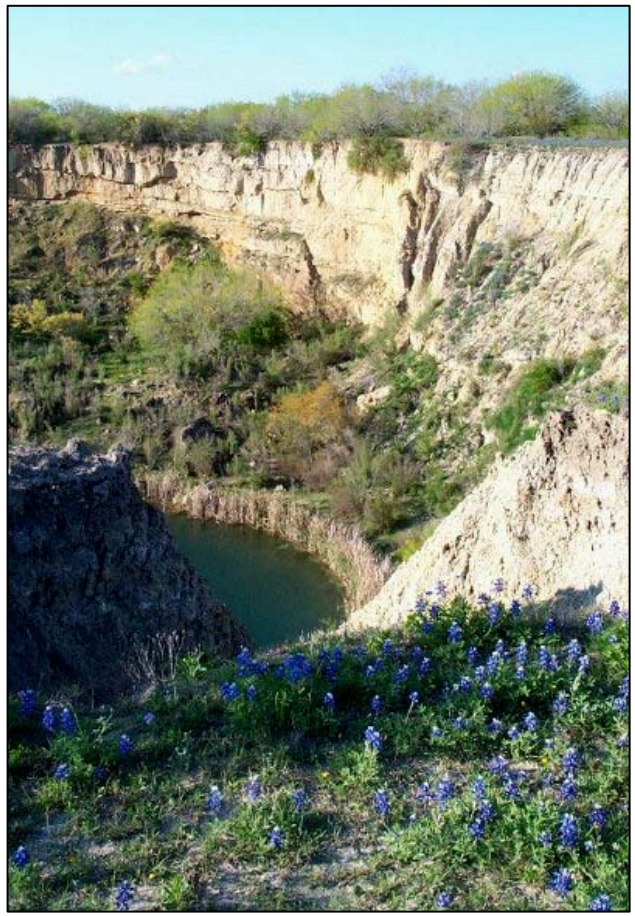
- Advantages:
  - Cost probably lower
  - Scheduling flexibility
  - Institutional memory
- Drawbacks:
  - Ties up personnel
  - Learning curve for new technology
  - May take more time

GPS and GIS Tools

- Greatly facilitate site assessments
- Quality of data has improved
  - Horizontal accuracy
  - Increased number of points
- Quickly collect enough data
- Data compilation and mapping

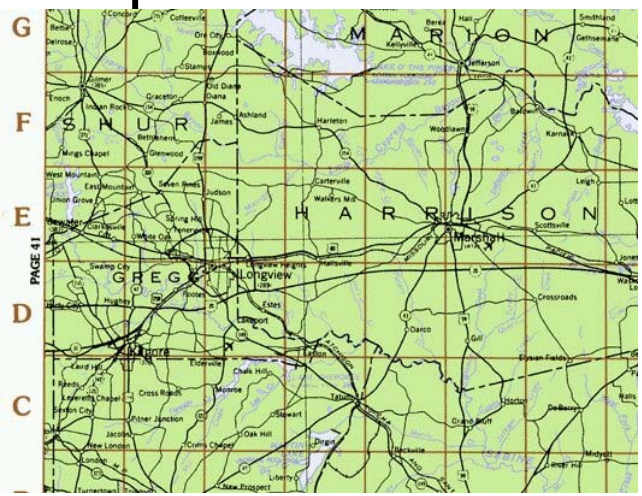
How We Use GPS and GIS

- Background information
- Reconnaissance
- Data collection
- Data analysis



Background Information

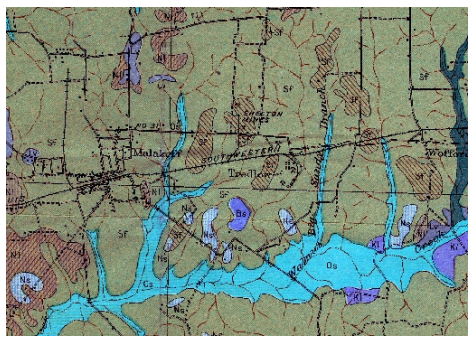
- Maps



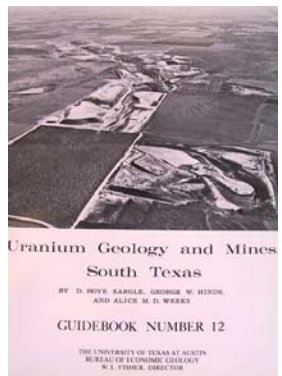
Portion of 7.5-min USGS quad sheet

- Aerial photographs

- Historical documents



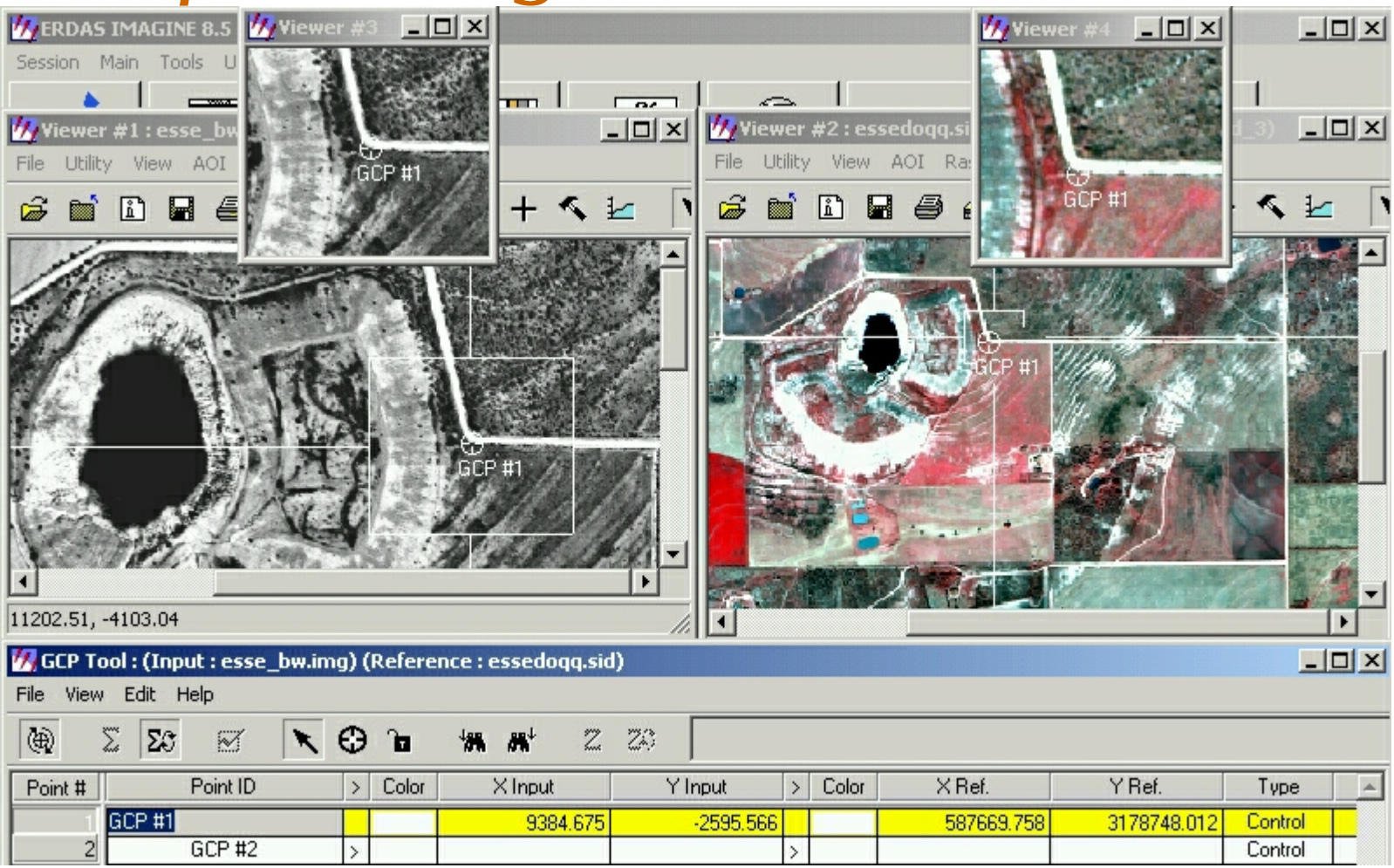
Soil Map from 1929



External Data Available:

- Digital elevation models
- Hypsography
- Hydrology
- Transportation infrastructure
- Soils
- Geology
- Precipitation

Georeferencing

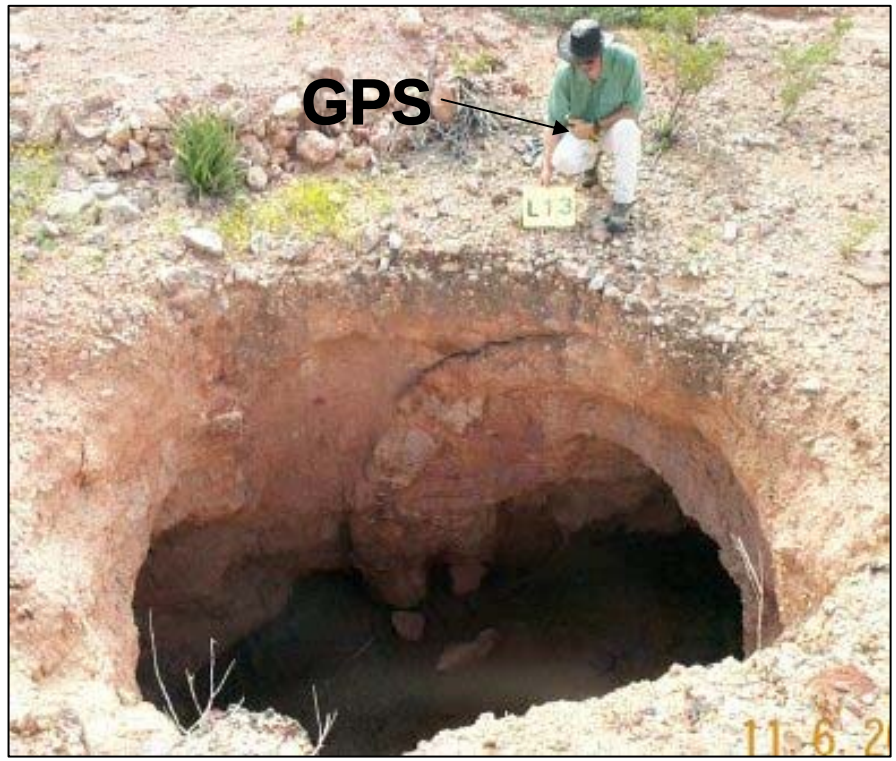


Reconnaissance

- Helps with database design
- Familiarization with site
- Equipment portability

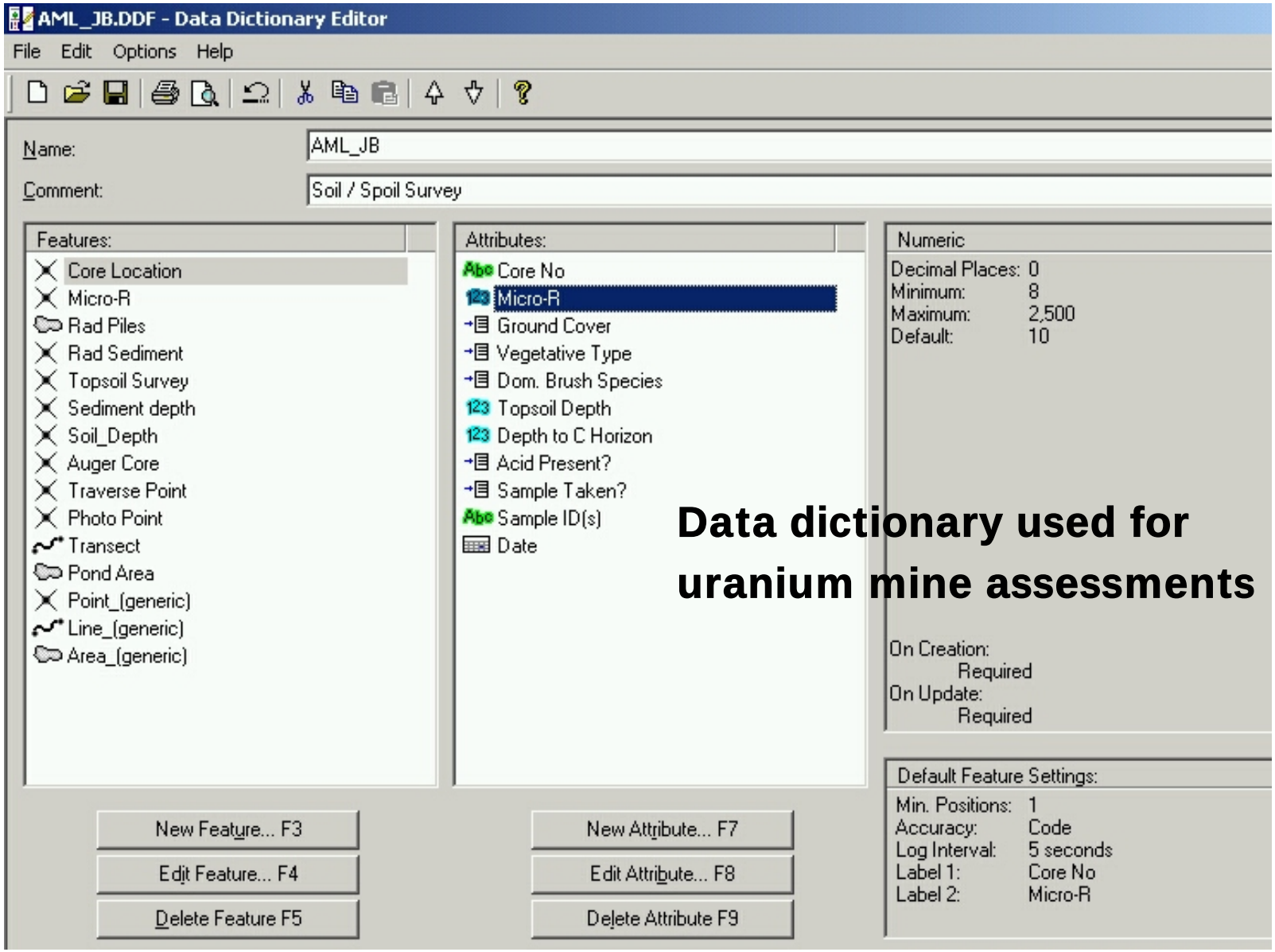
Data Collection with GPS

- Data dictionaries
- Background maps
- GPS Configuration
- Field Work



Data Dictionaries

- Pathfinder Office – edit dictionary
- GPS database for data collection
  - Ideally, it mirrors the structure of the GIS
  - Feature → Shapefile
  - Balance between specific and general
  - Data dictionary tailored to type of project
  - # Features and attributes → GPS memory



Data dictionary used for uranium mine assessments

Data Collection with GPS

- Data dictionaries
- <u>Background maps</u>
- GPS Configuration
- Field Work

Data imported from GIS

GPS display

Data Collection with GPS

- Data dictionaries
- Background maps
- <u>GPS Configuration</u>
- Field Work

2 MB internal memory

PC card slot (expand to 20 MB, Compact Flash w/ card adapter)

Set antenna height

Adjust logging intervals for points, lines, and areas

Activation of DGPS Service

Data Collection with GPS

- Data dictionaries
- Background maps
- GPS Configuration
- <u>Field Work</u>

GPS Features:

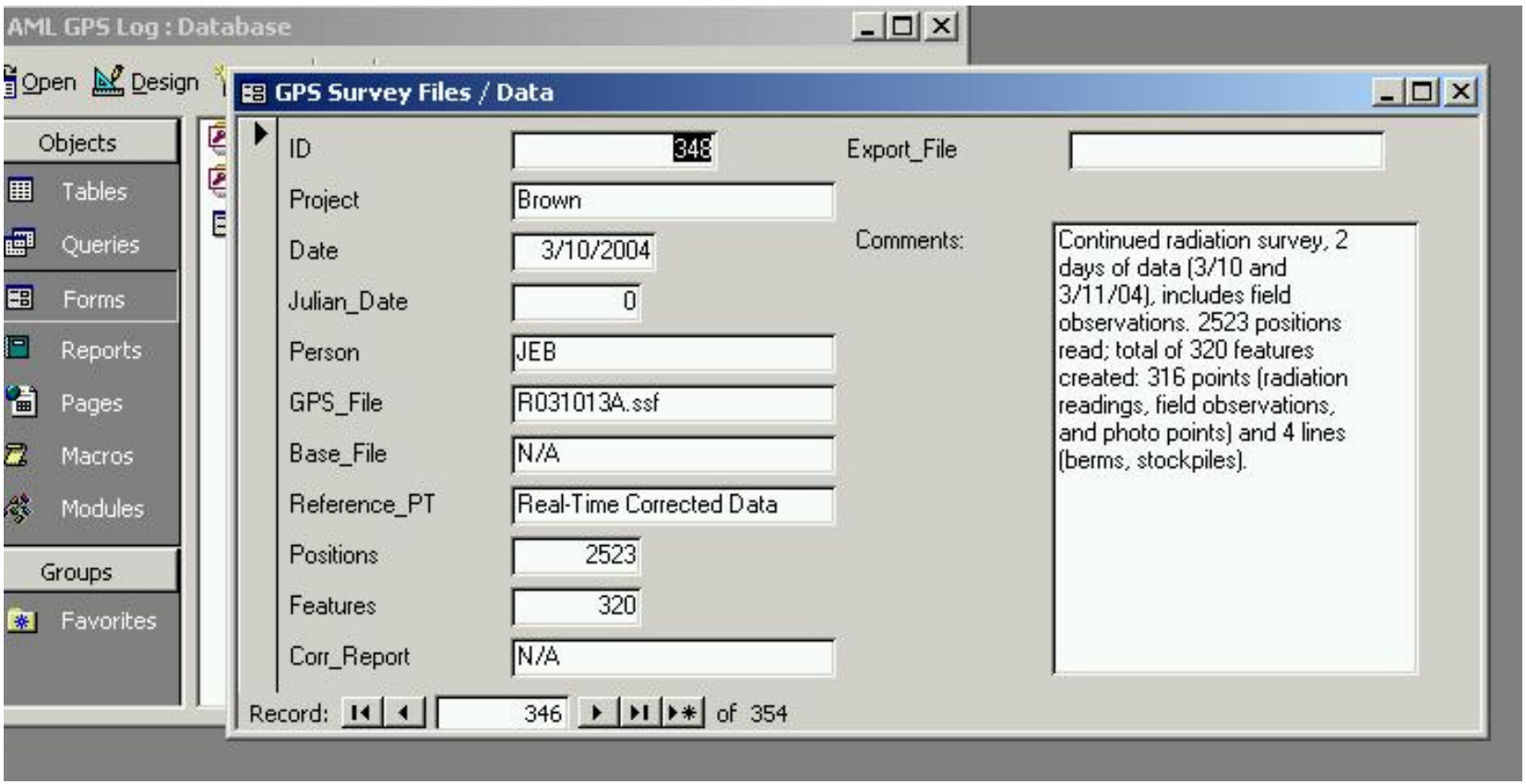
- Sampling and photo locations
- Radiation observations
- Infrastructure locations
- Soil/spoil characteristics
- Extent of bare areas, vegetation types
- Extent of underground mine subsidence
- Bathymetric data

GPS Files

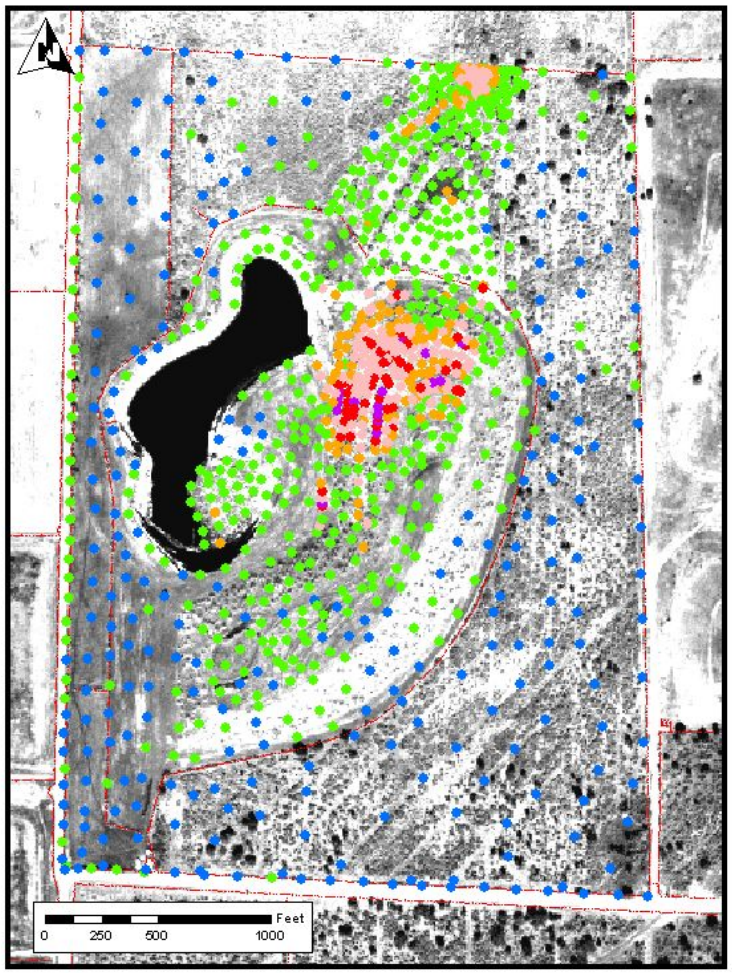
19,000 features,
in 374 files

Types of Data	Proportion of all Files
Core locations	27%
Radiation surveys	25%
Sampling locations	10%
Sub-surface radiation	9%
General infrastructure	9%

Keeping Track of GPS Files



Example of Field Data



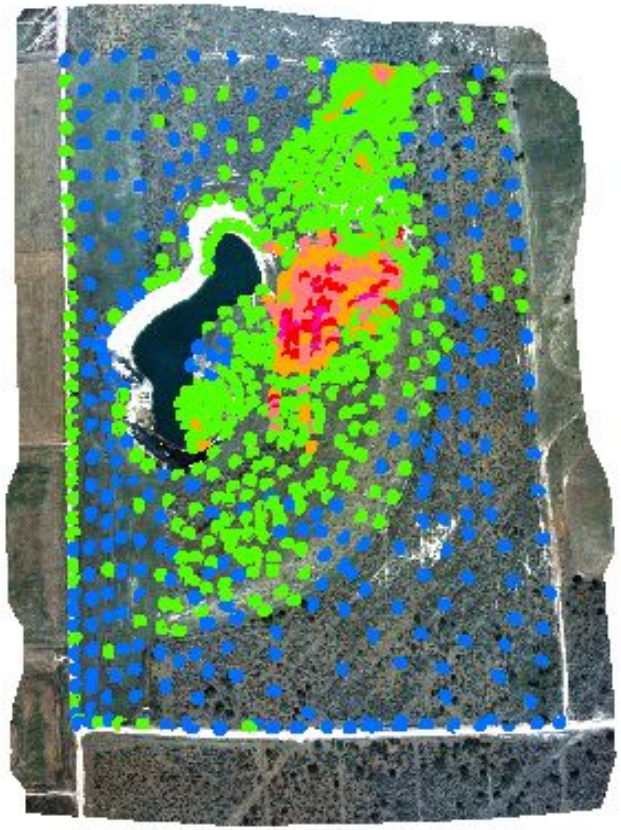
Surface Radiation Survey

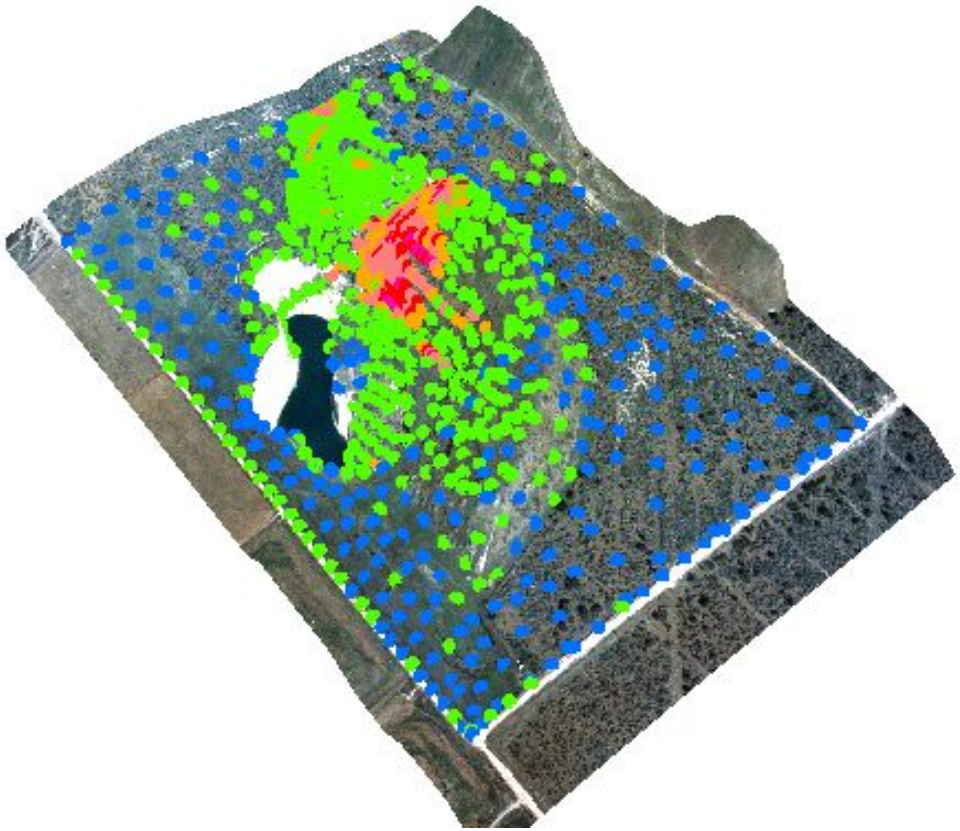
Micro-R/hr @ 1 m height

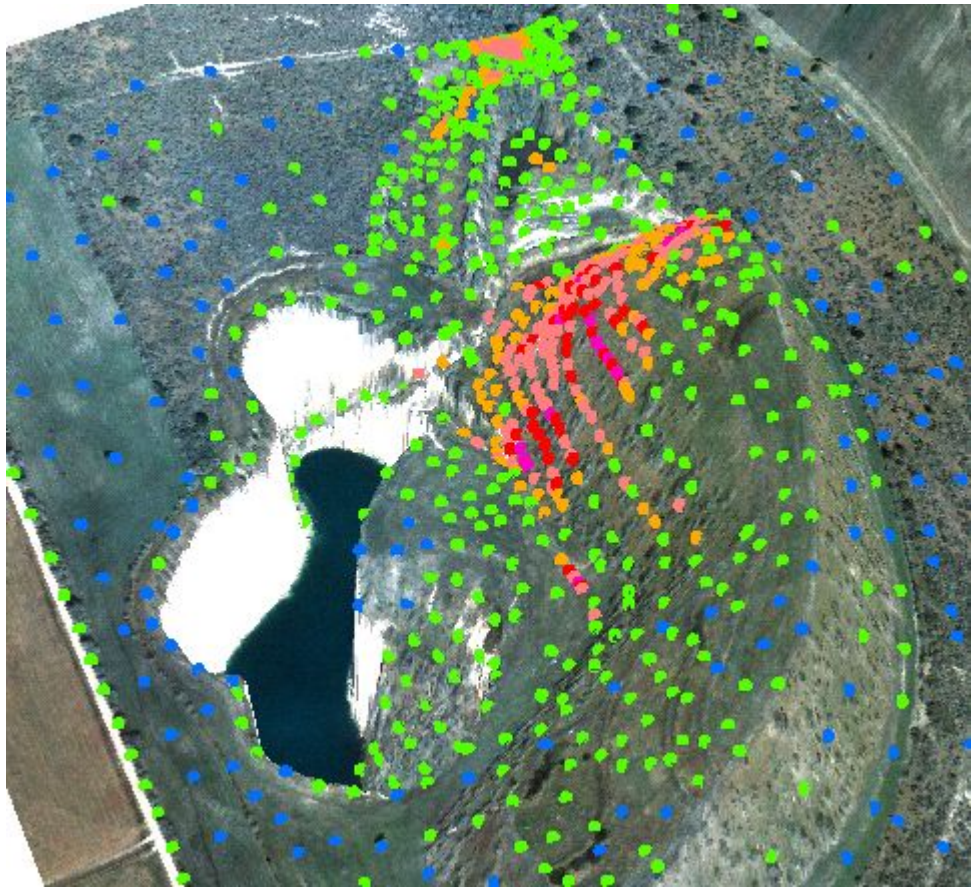
- 8 - 12
- 13 - 18
- 19 - 24
- 25 - 45
- 46 - 70
- 71 - 110
- Fence

Brown Mine

1,077 observations





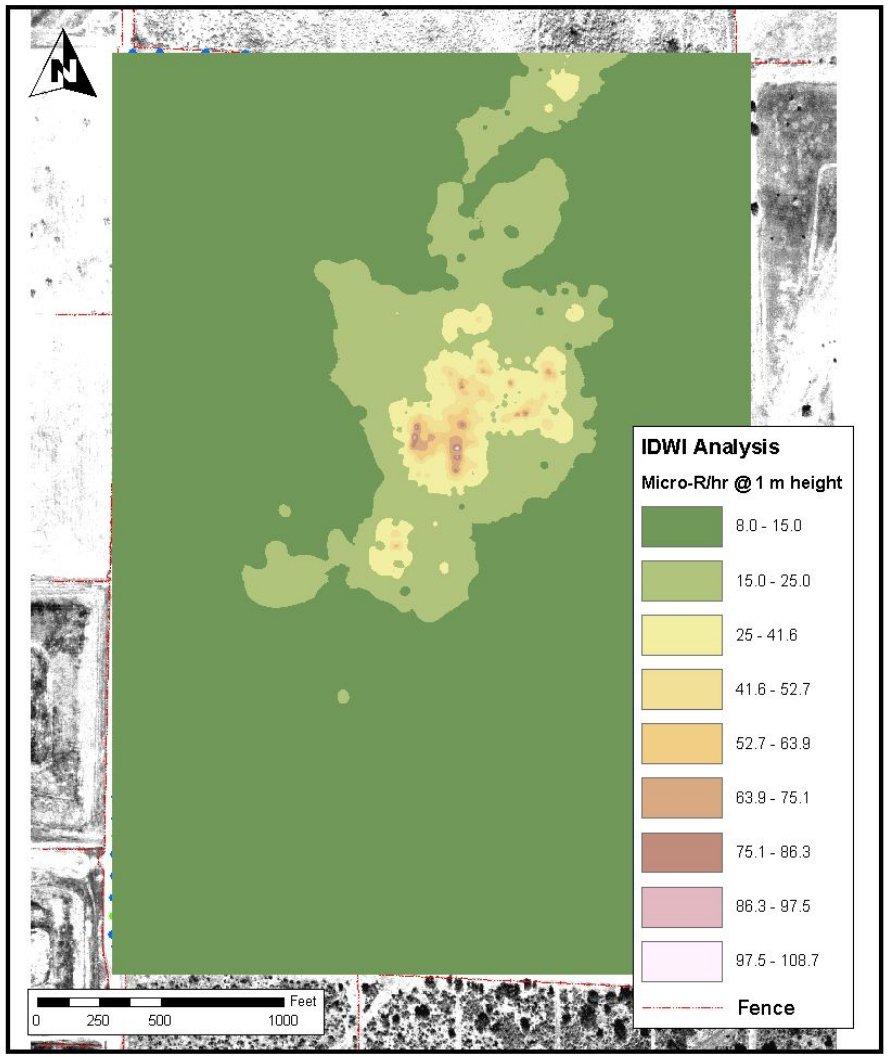


Data Analysis

- ESRI ArcMap 8.3 and its extensions used 95% of the time
- ERDAS Imagine 8.5 used for image processing and georeferencing
- Evaluate data collected with GPS and compare to other external data (maps, photographs, vector data)

Data Analysis

- Radiation Data
  - Change symbology
  - Rasterize point data and evaluate with Inverse Distance Weighted Interpolation
  - Contour radiation levels



Brown Mine

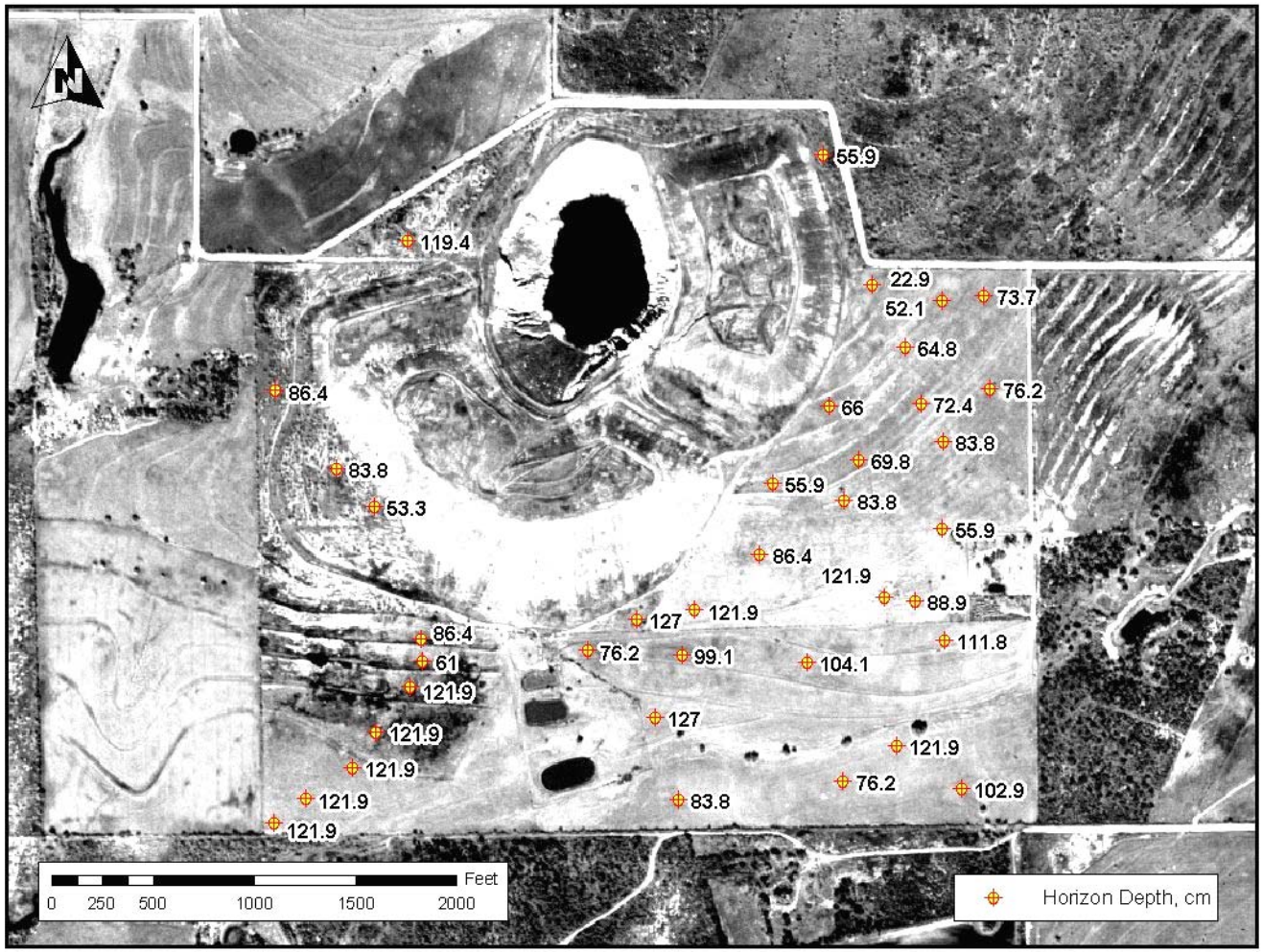
Data Analysis

- Soil Data
  - NRCS soil data mapped at 1:24,000 scale
  - We need soil information at larger scale (1:3,600)
  - We collect soil core information with GPS and export it to GIS
  - Use ArcGIS Geostatistical Analyst extension

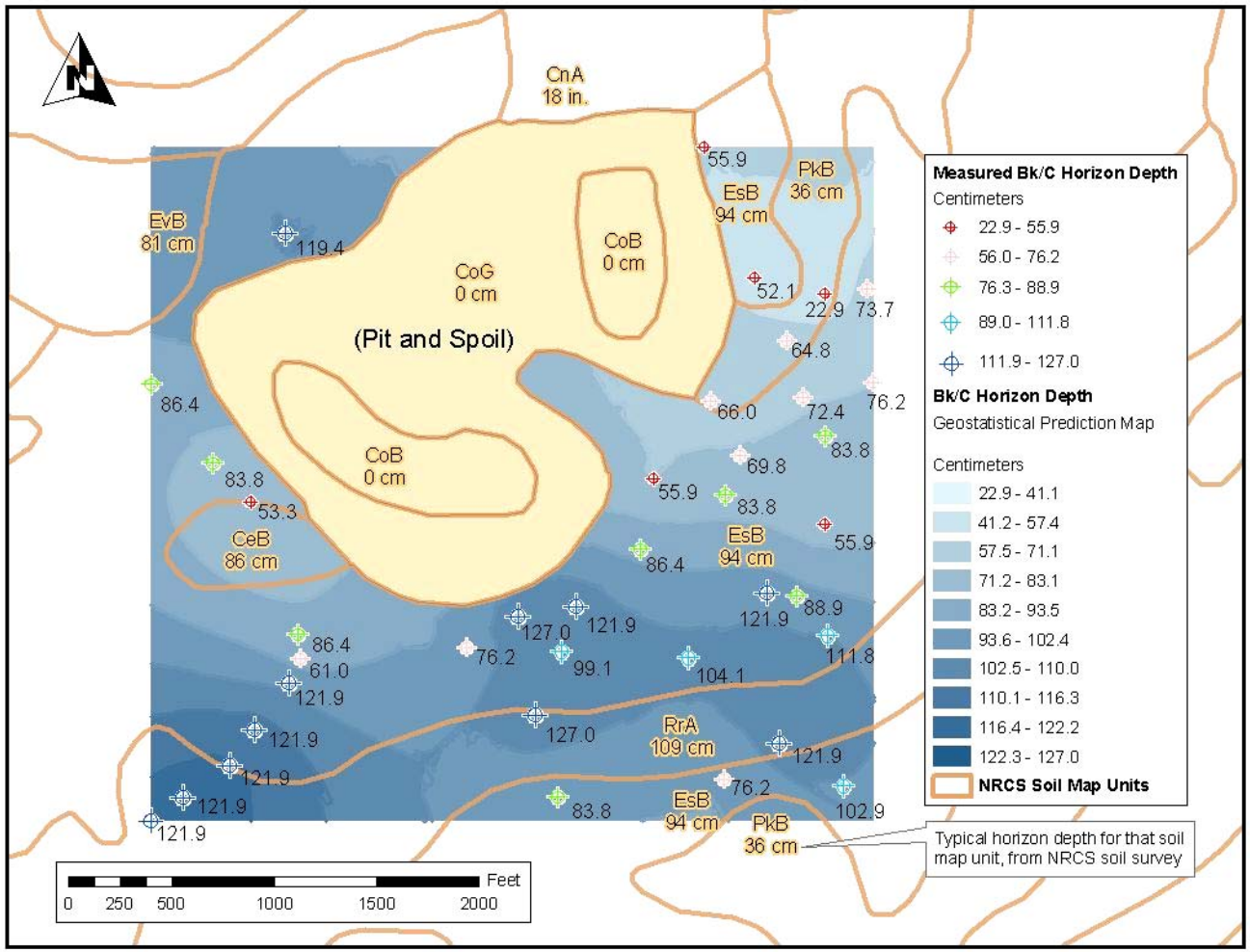
Locations of Soil Cores

Esse

Mine



Soil Data Comparison

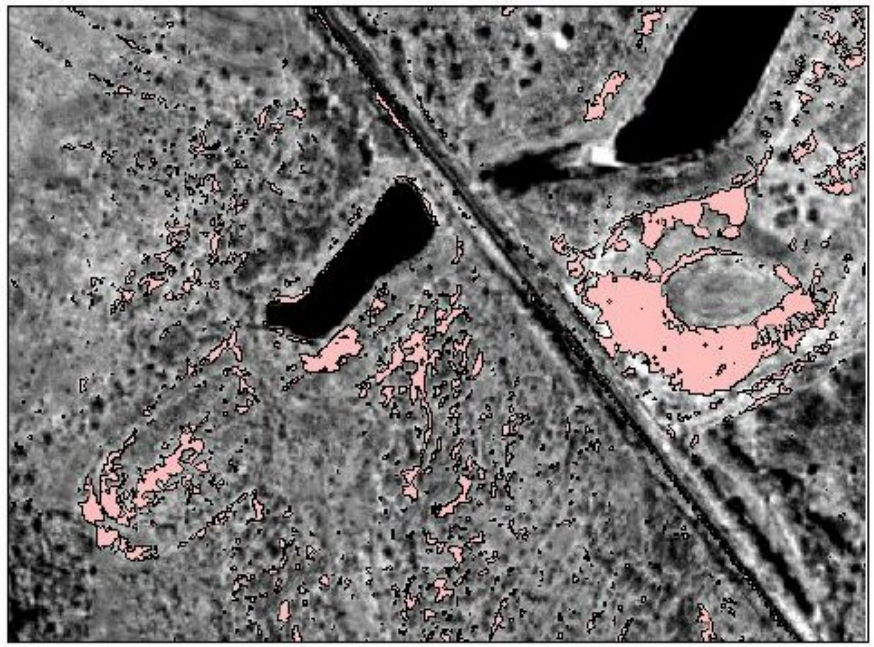


Esse

Mine

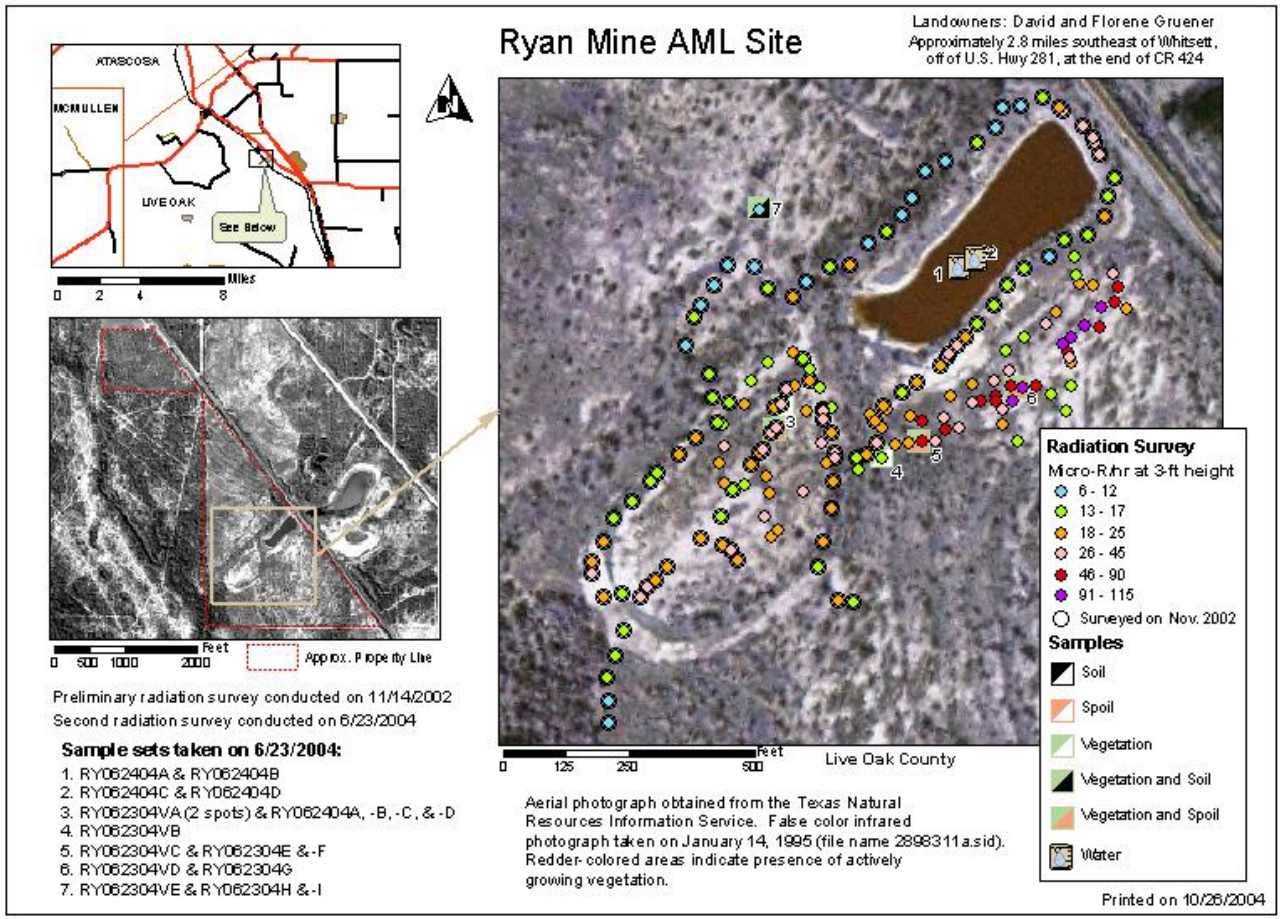
Data Analysis – Landscape Features

Result of decorrelation stretch on the principal components of the image (ERDAS 8.5, Image Interpreter, Spectral Enhancement).



Result after converting raster into features (vector data), using Spatial Analyst 8.3. Potential bare areas (pink) are measurable polygons.

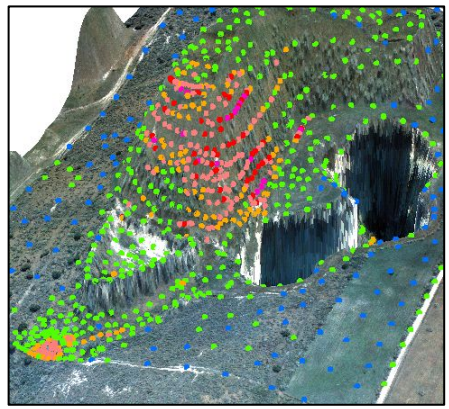
Maps for Landowners



Observations

- GPS Equipment
  - Hardware exceedingly durable
  - Battery cable harnesses and TSC1 data cable have been replaced
  - Timely upgrades to firmware – GPS receiver and datalogger & Pathfinder Office

Observations - continued



- GIS Software
  - ArcView easy to use
  - Migration to ArcGIS more difficult
  - Data frames in ArcMap very useful
  - Still have not moved to geodatabases
- Coordinate Systems
  - Complete metadata essential

Benefits of GPS and GIS

- GPS - time savings
  - More data (quality), greater accuracy
  - Fewer people needed to collect data
- Seamless data exchange between both
- GIS – multiple uses
  - Information compilation
  - Data analysis

Obstacles

- Lack of time, competing priorities
- No data models for AML work

Conclusions

- GPS is essential for site assessments
- GIS provides best way to compile and evaluate information from different sources
  - Analytical tools
  - Mapping capabilities

Acknowledgments

- TIPS instructors – GPS equipment and GIS software
- OSM – providing geospatial software