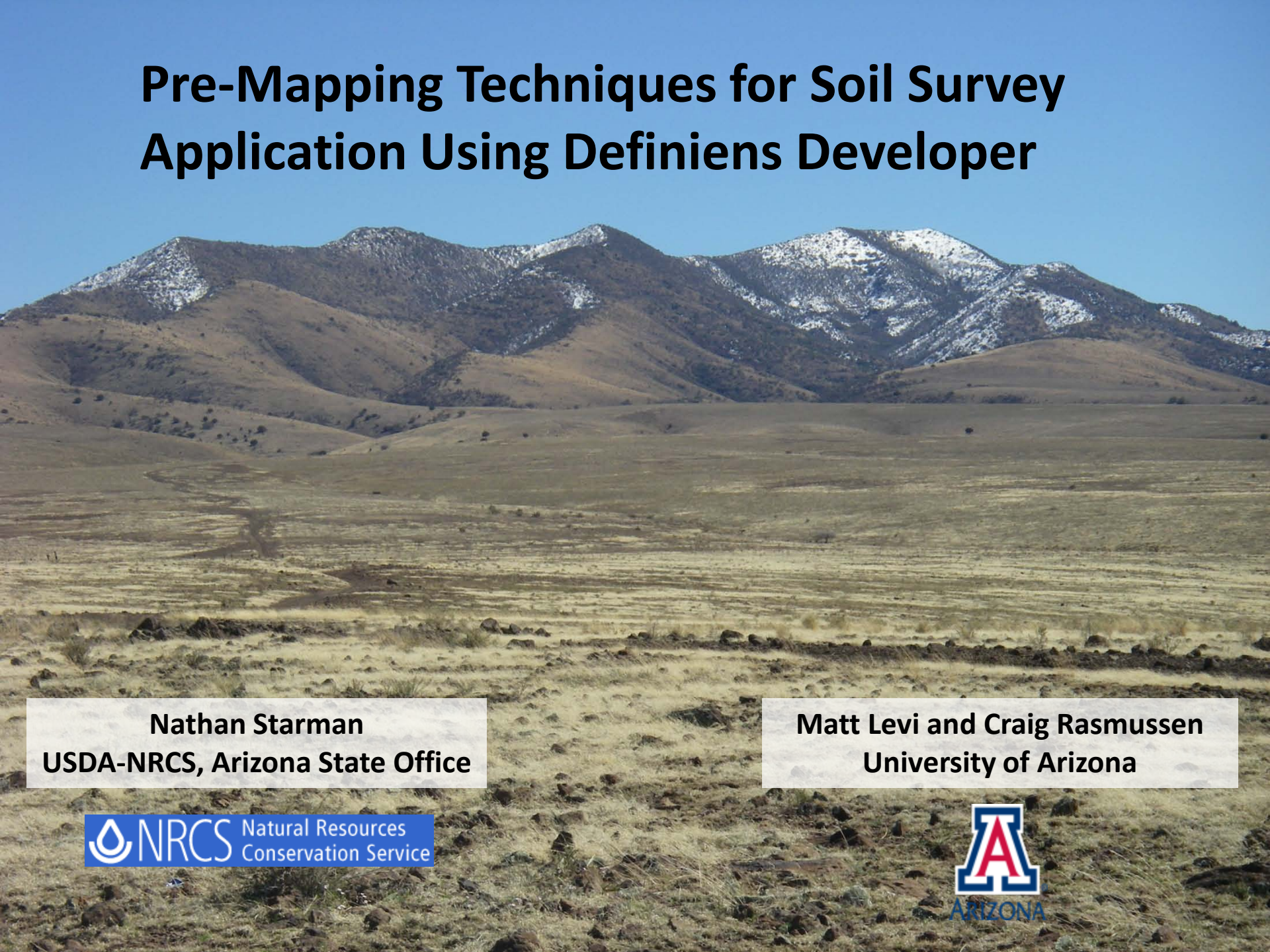
Pre-Mapping Techniques for Soil Survey Application Using Definiens Developer



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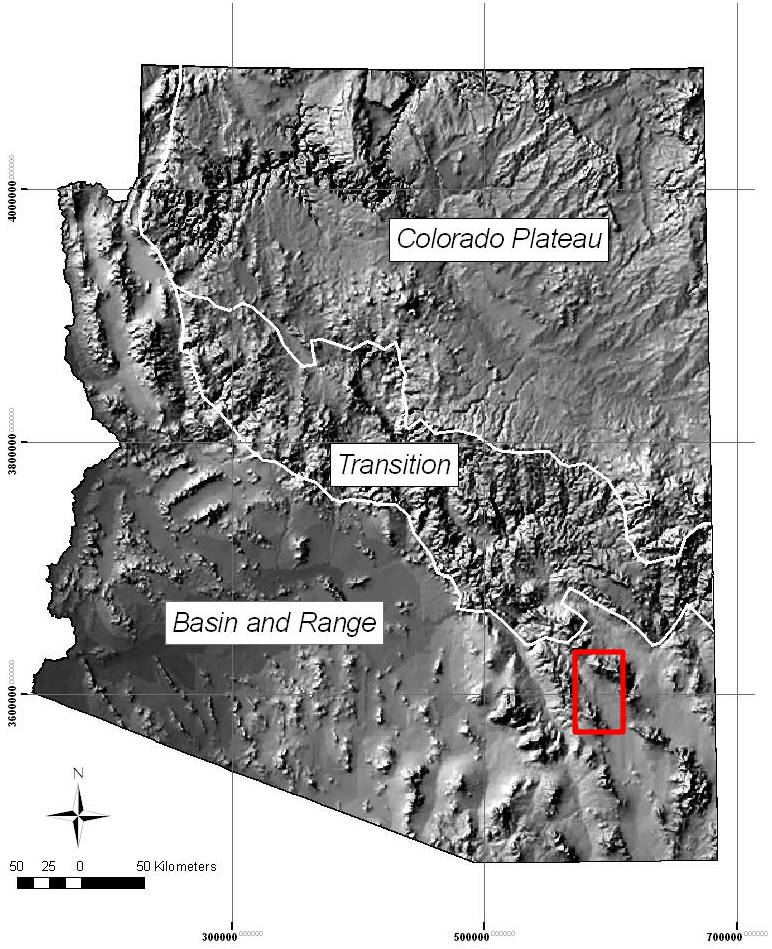
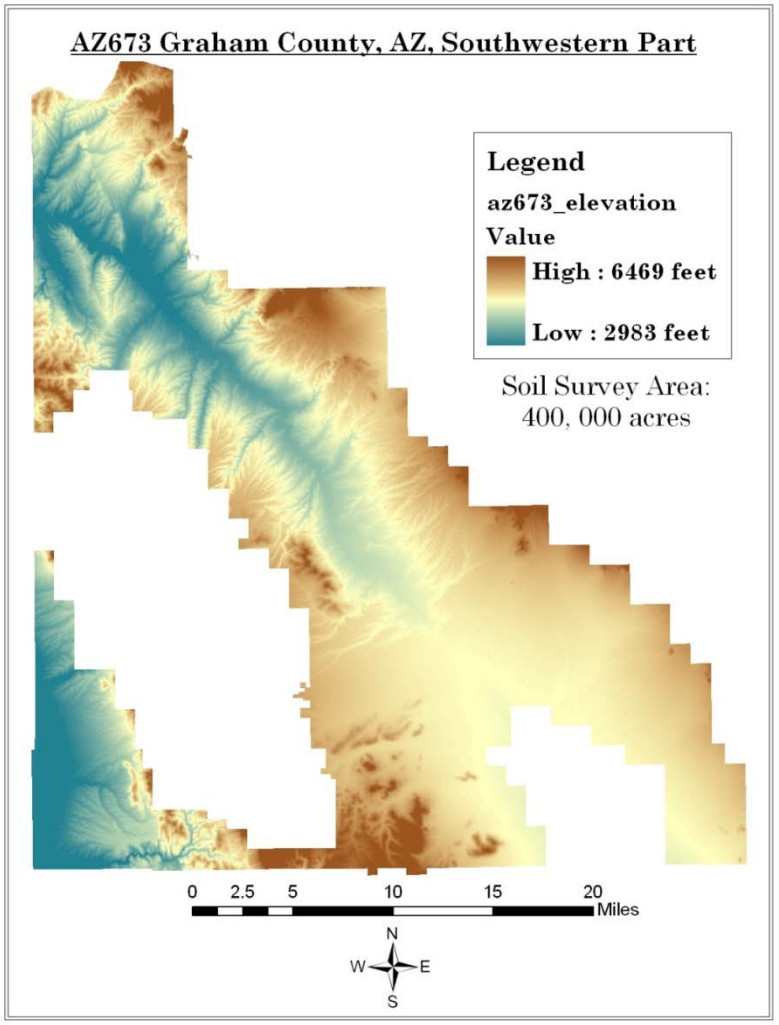
ARIZONA

Overview

1. Research software and related applications throughout U of A Cooperative Agreement
2. Focus on Definiens Developer 7.0
3. Assess multi-resolution segmentation tool for soil survey utility
4. Implement 3 phase approach
5. Publish AZ673

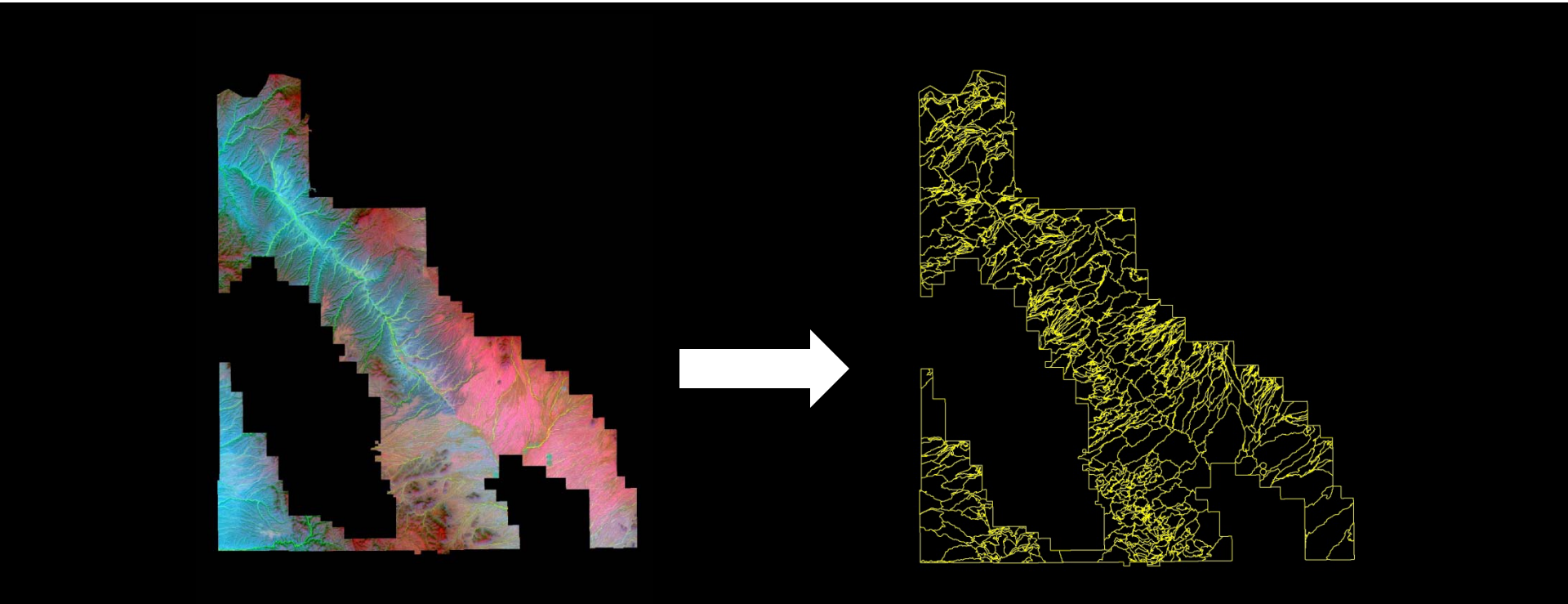
Study Area


Colorado Plateau
Transition
Basin and Range
N
50 25 0 50 Kilometers
4000000
3800000
3600000
300000
500000
700000


AZ673 Graham County, AZ, Southwestern Part
Legend
az673_elevation
Value
High : 6469 feet
Low : 2983 feet
Soil Survey Area:
400, 000 acres
0 2.5 5 10 15 20
Miles
N
W
E
S

Multi-resolution Segmentation

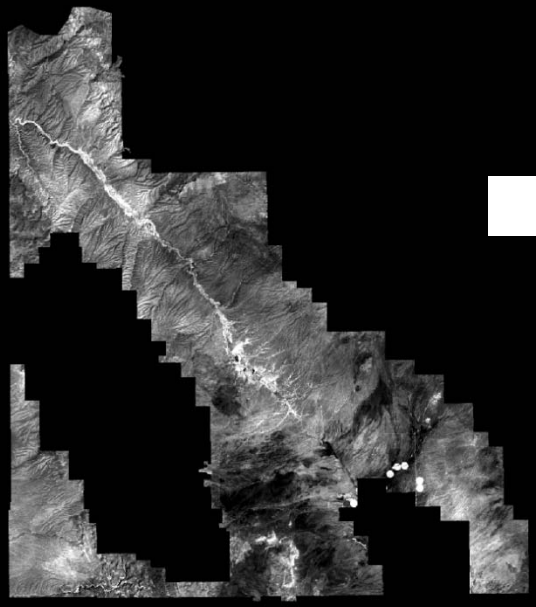
- Algorithm developed to extract image objects, which are homogenous both based on pixel value and on object shape
- Extraction of homogenous image object primitives using a pair wise region merging technique (i.e. bottom up)
- Image layer weights assigned to input layers
- Raster → Vector



Segmentation Methods

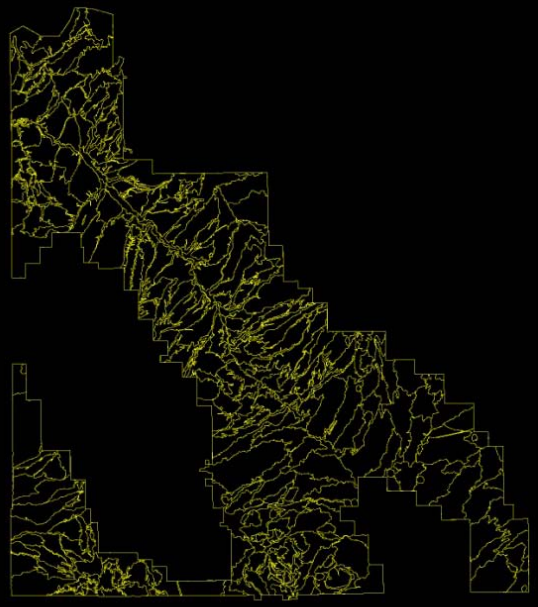
- Rulesets were created in Definiens Developer 7.0 to execute multi-resolution segmentation
- Input layers evaluated included slope (5m IFSAR), ASTER and Landsat imagery, and a variety of indices
- Scale was manipulated to determine appropriate polygon density

Expert Knowledge

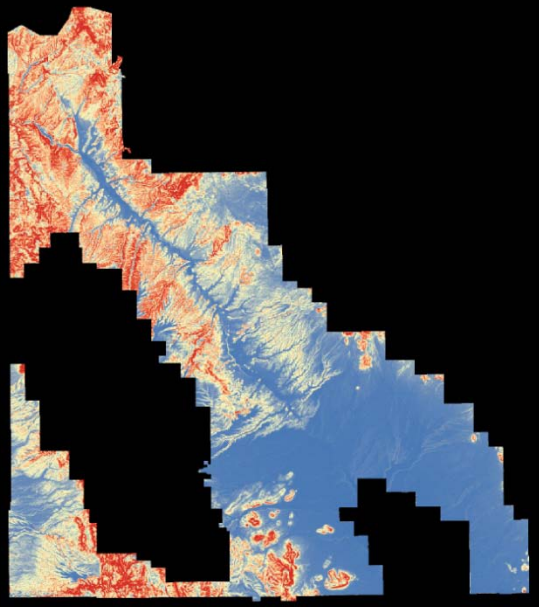


Landsat B4 (30m)

Near Infrared
(0.75 – 0.9 µm)
Vegetation
Soil color



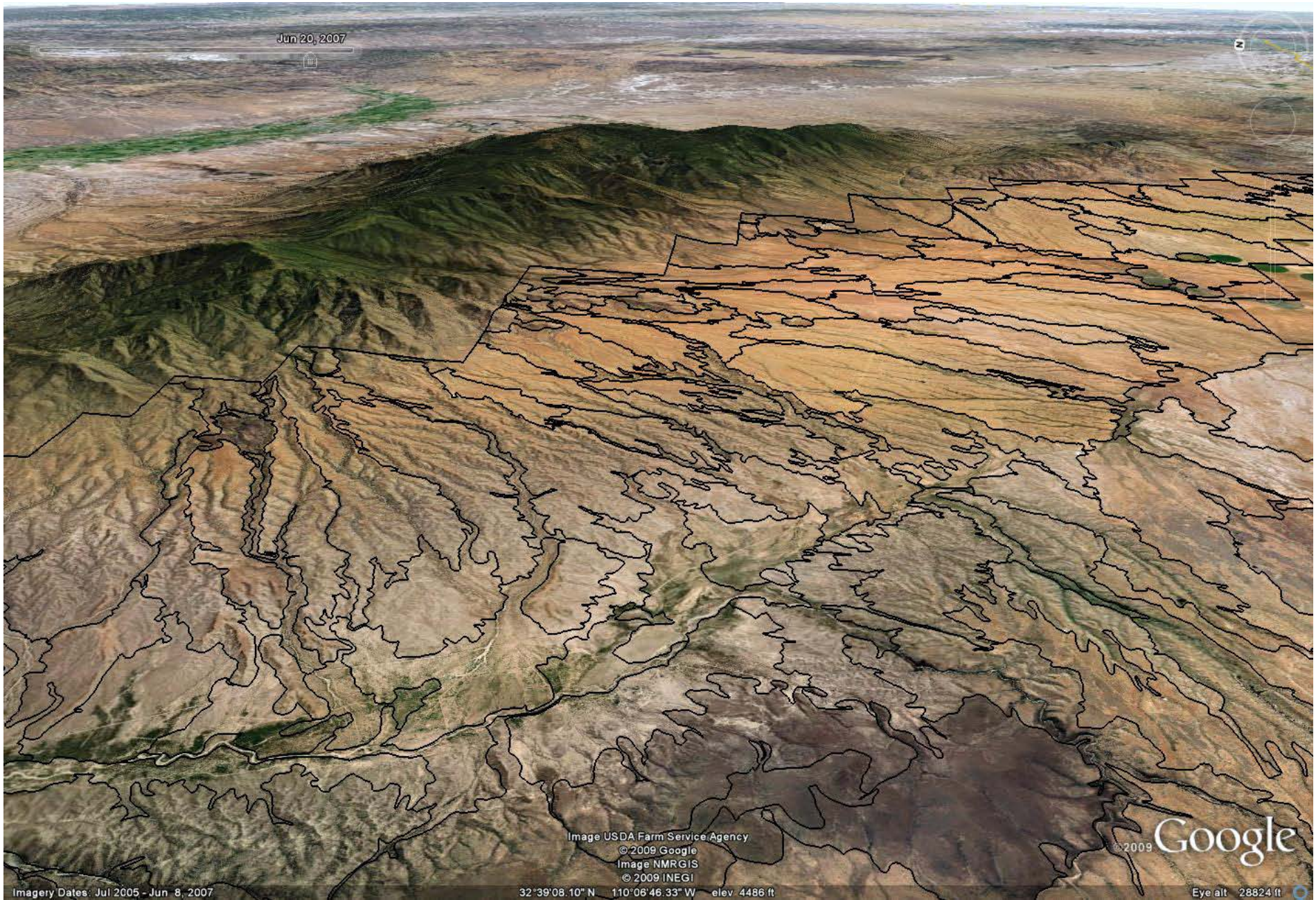
Segmentation



Slope (5m)

Landscape position
Soil depth

Landsat B4 + Slope (5m)



Segmentation Results

- Segmentation of Landsat B4 and slope (5m) layers produced an accurate polygon network of soil-landscape relationships
  - Pre-mapping tool for soil survey
  - Useful on soil survey updates
  - Natural breaks for land management

Implement 3 Phase Approach

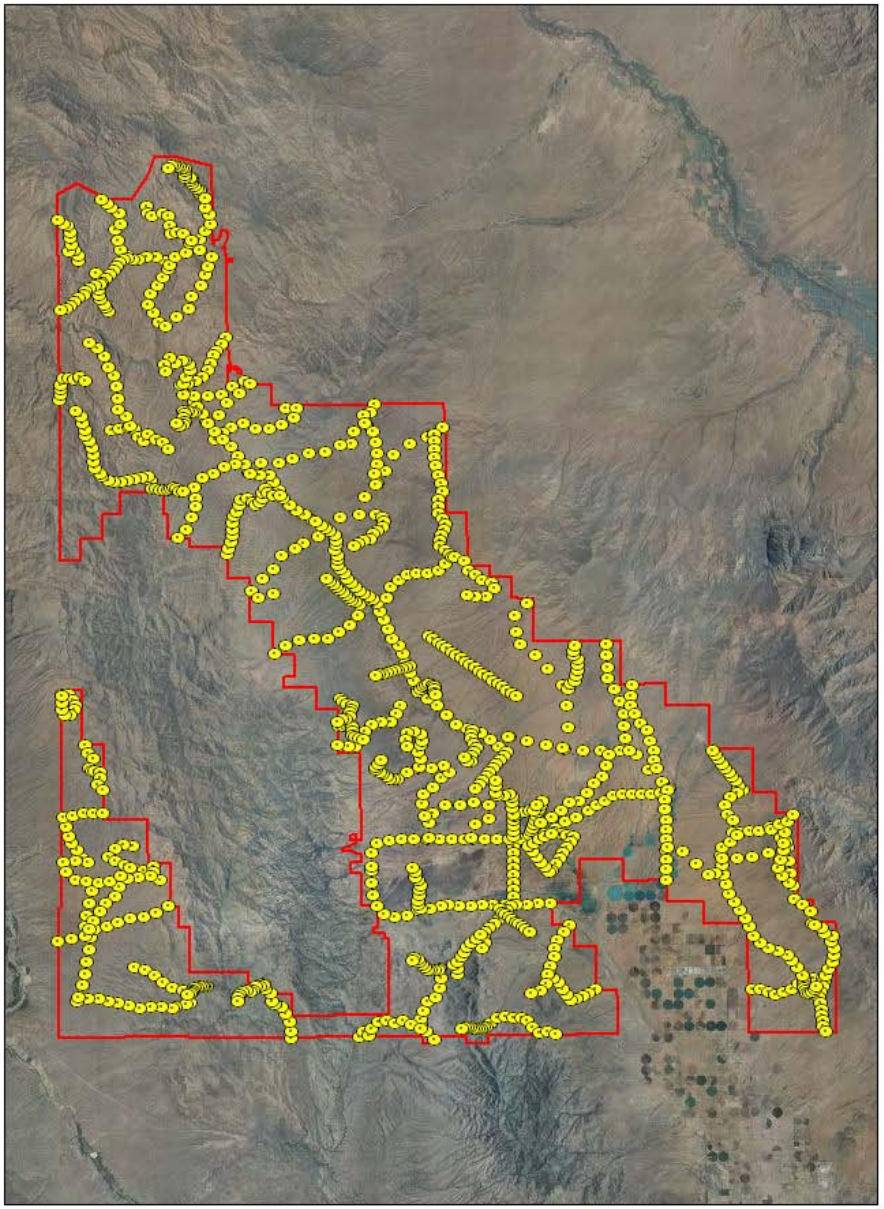
1. **Landform transects**
   -1,080 points
   -crossed multiple landforms and segmentation lines

2. **AOI's**
   -3 areas of approximately 15,000 acres
   -mapped independently by 2 soil scientists

3. **Conventional Soil Survey**
   -utilize existing data to produce final product

Phase 1
Landform Transects

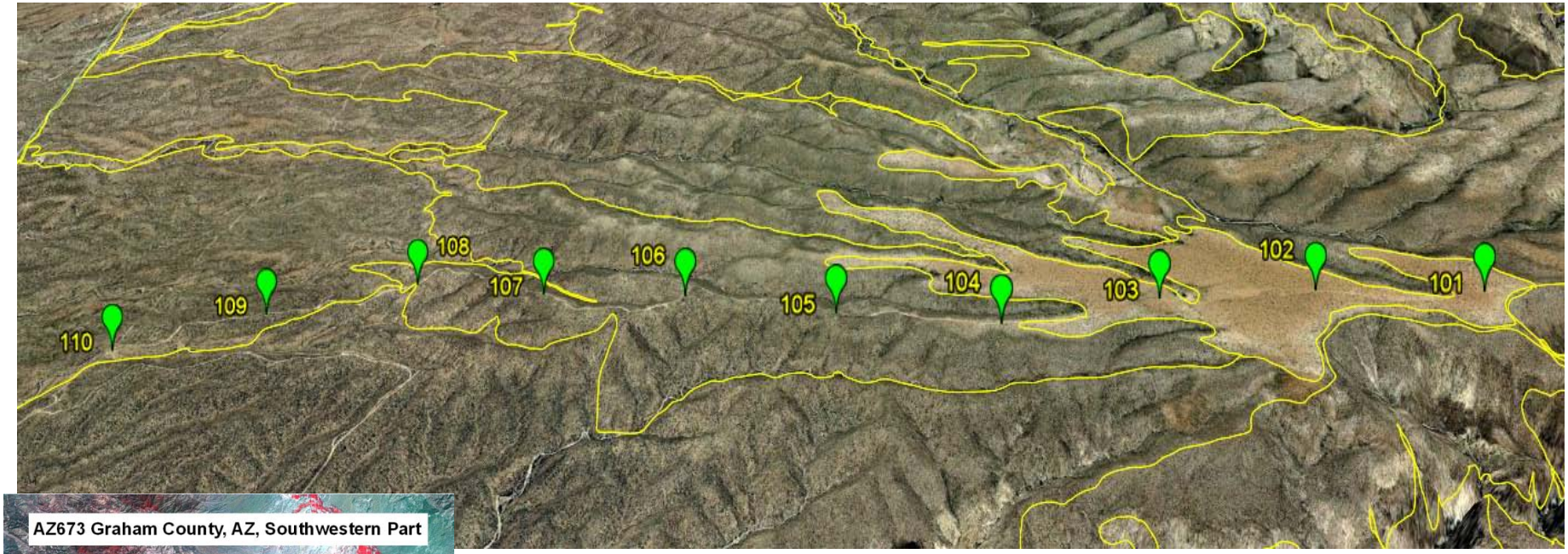
- 1,080 points
- Multiple landforms
- Across segmentation lines
- Field validation descriptions:
  -genetic horizons, depth, texture, color, diagnostic horizons, surface fragments, plant community, slope, aspect, pm, classification

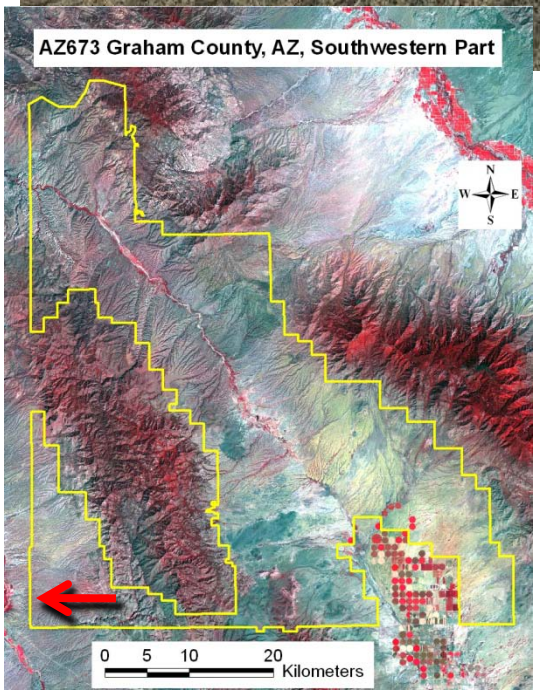


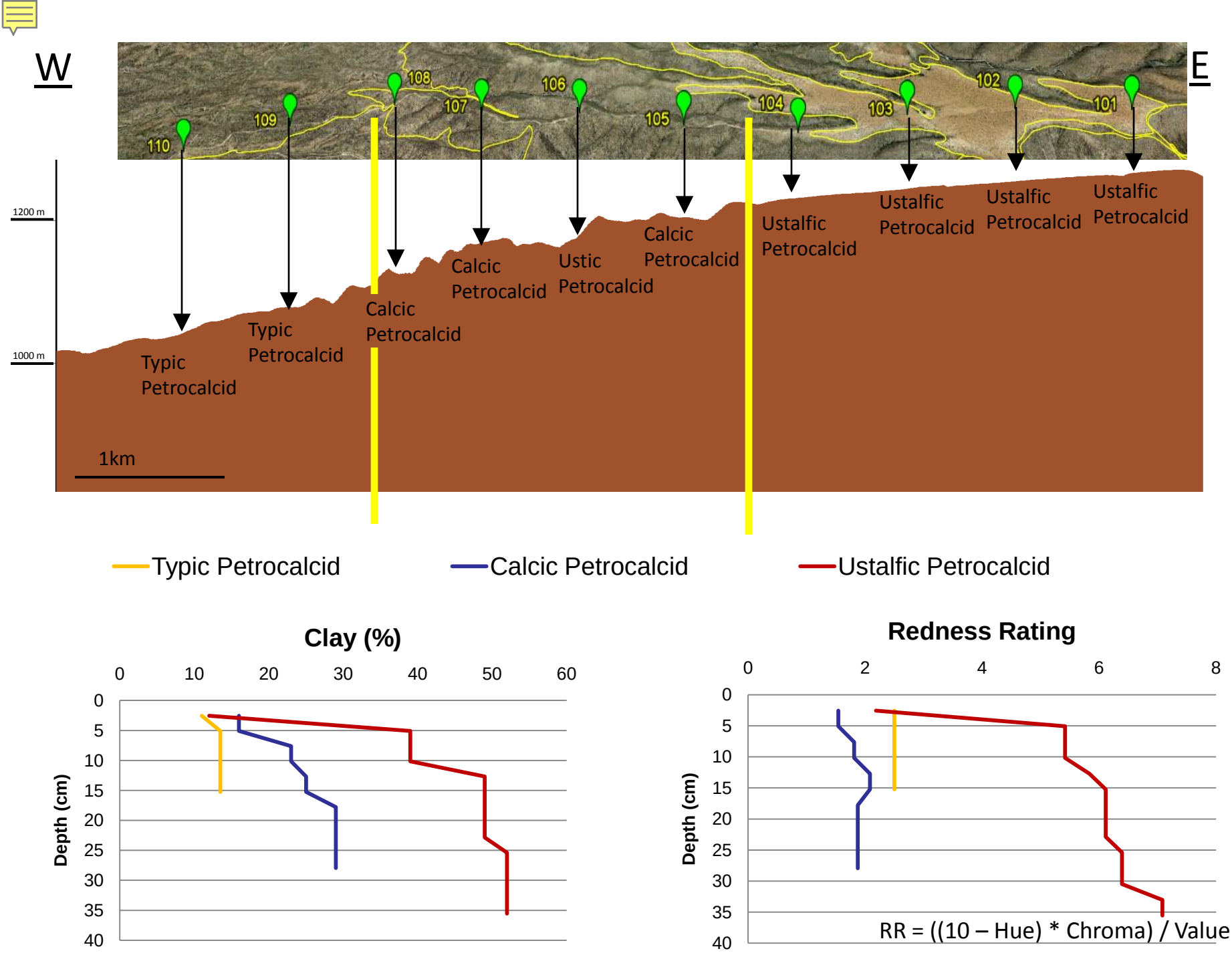
Transect 1 - Fan Terraces and Mesa (volcanic)

W

E



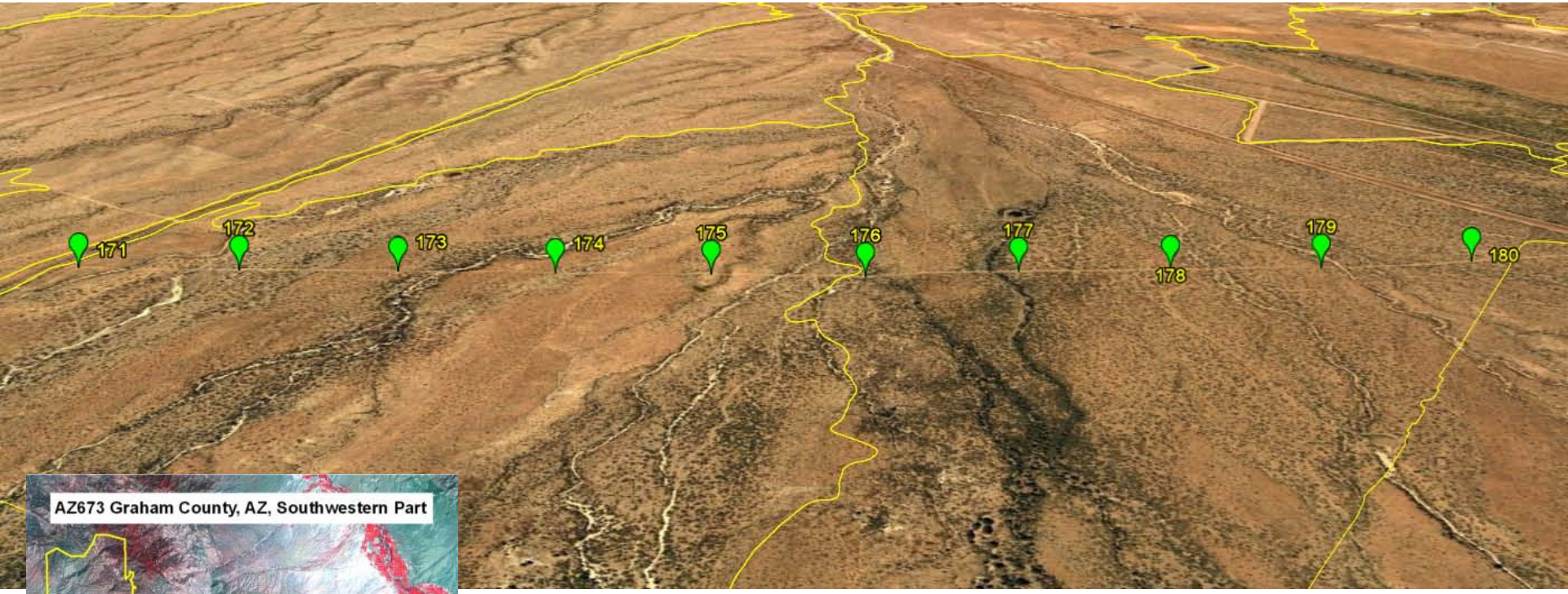


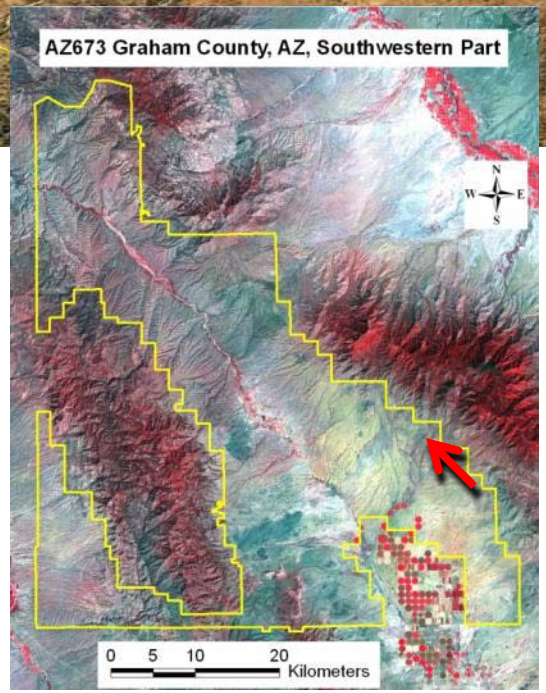

W
E
110
109
108
107
106
105
104
103
102
101
1200 m
1000 m
1km
Typic Petrocalcid
Typic Petrocalcid
Calcic Petrocalcid
Calcic Petrocalcid
Ustic Petrocalcid
Calcic Petrocalcid
Ustalfic Petrocalcid
Ustalfic Petrocalcid
Ustalfic Petrocalcid
Ustalfic Petrocalcid
Typic Petrocalcid
Calcic Petrocalcid
Ustalfic Petrocalcid
Clay (%)
0 10 20 30 40 50 60
Depth (cm)
0 5 10 15 20 25 30 35 40
Redness Rating
0 2 4 6 8
Depth (cm)
0 5 10 15 20 25 30 35 40
RR = ((10 – Hue) * Chroma) / Value

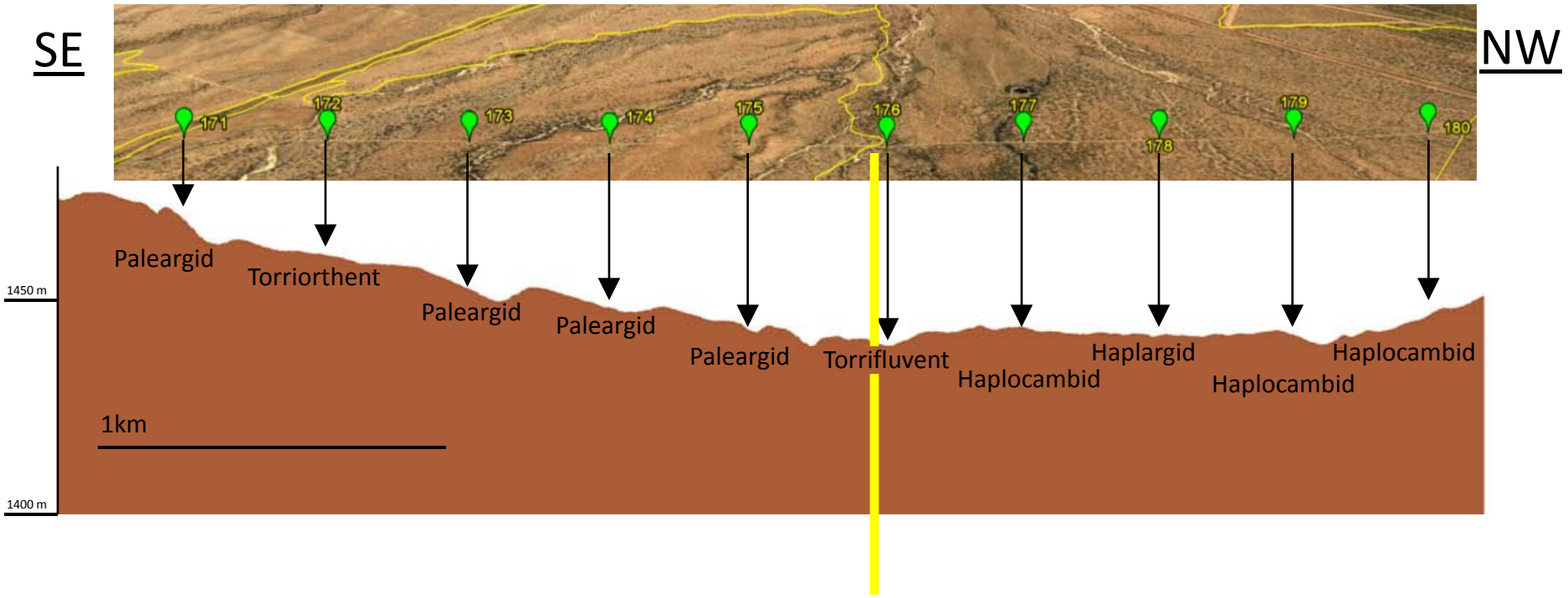
Transect 2 – Fan Terraces and Alluvial Fans (granitic)

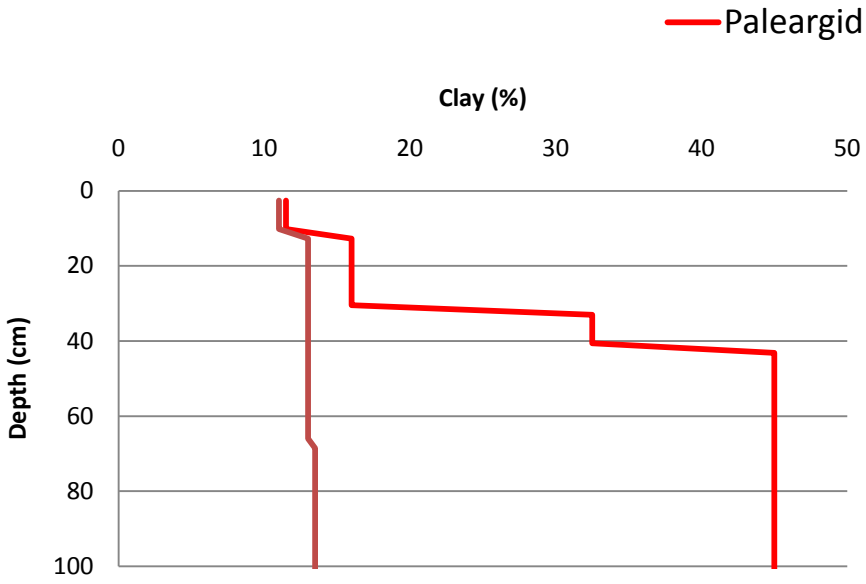
SE

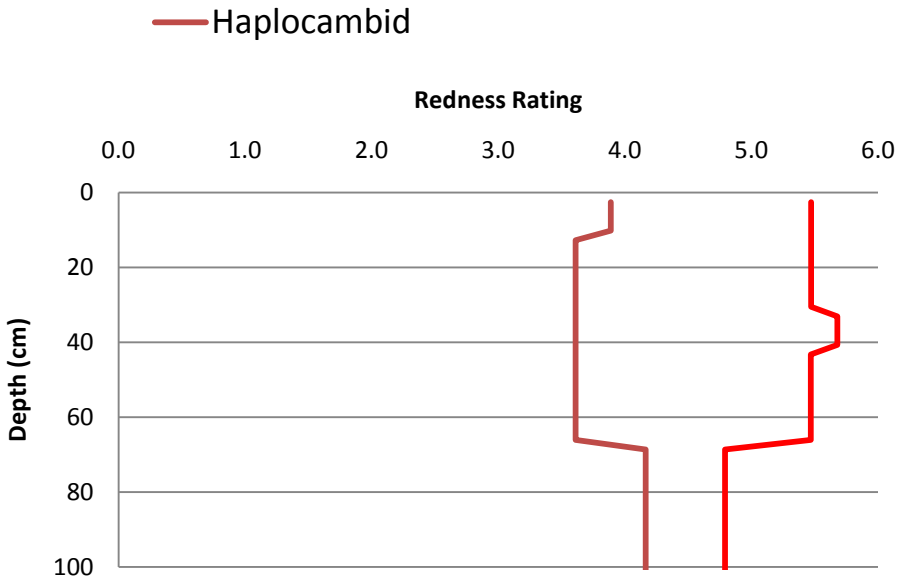
NW






SE
NW
171
172
173
174
175
176
177
178
179
180
Paleargid
Torriorthent
Paleargid
Paleargid
Paleargid
Torrifluvent
Haplocambid
Haplargid
Haplocambid
Haplocambid
1450 m
1400 m
1km

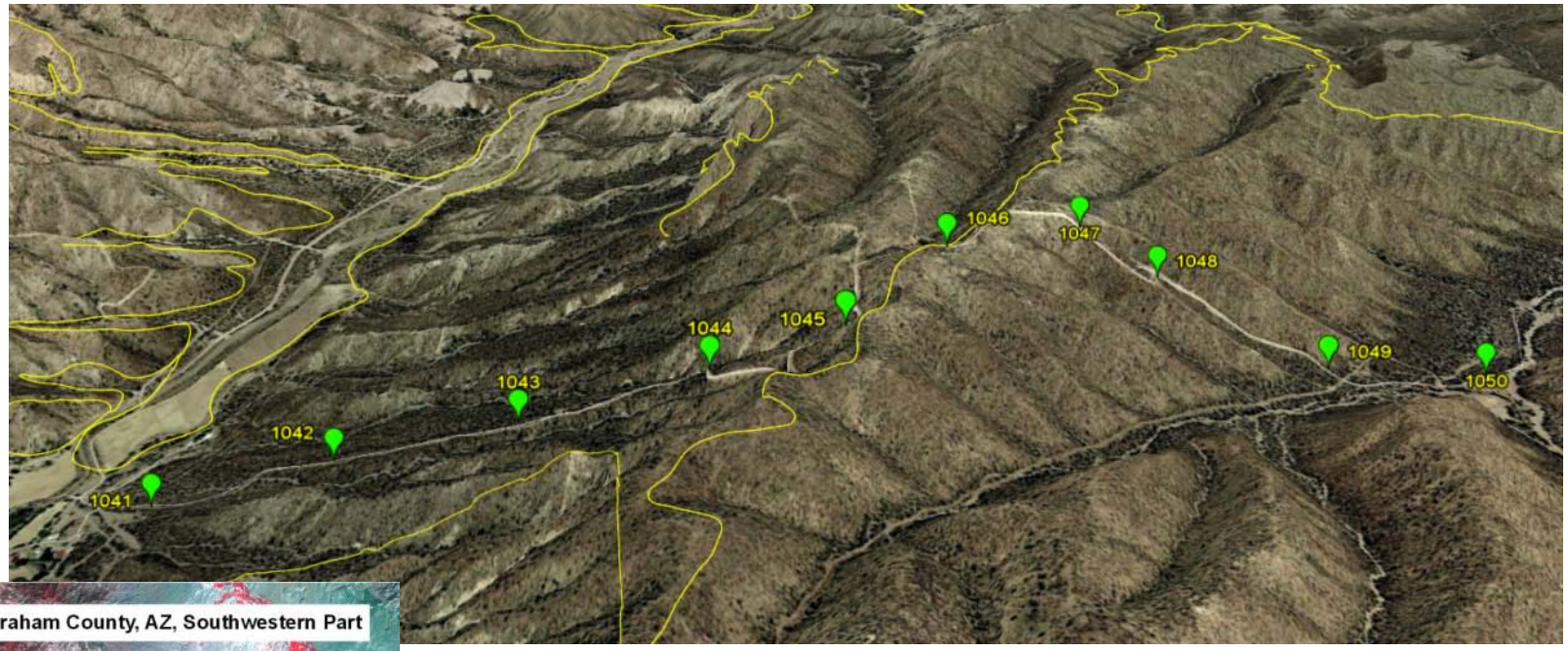

Paleargid
Clay (%)
0
10
20
30
40
50
Depth (cm)
0
20
40
60
80
100

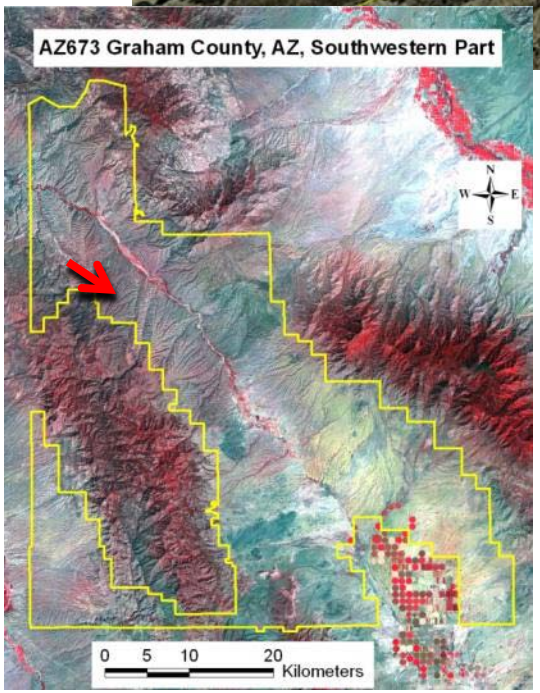

Haplocambid
Redness Rating
0.0
1.0
2.0
3.0
4.0
5.0
6.0
Depth (cm)
0
20
40
60
80
100

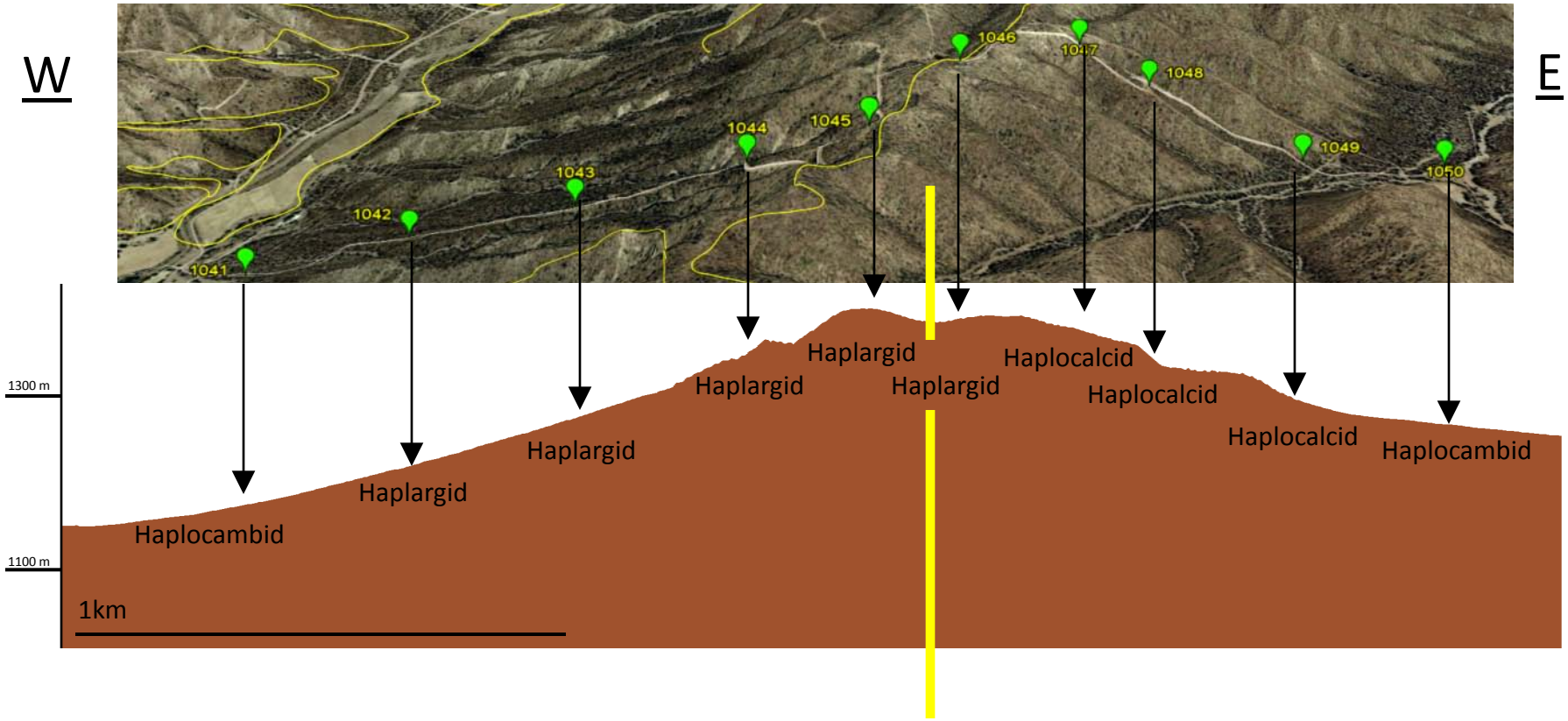
Transect 3 – Fan Terraces (mixed volcanic)

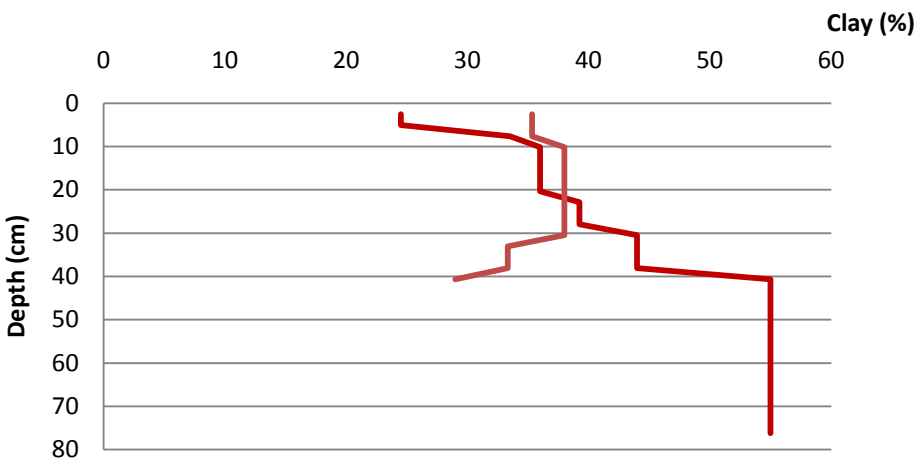
W

E






W
E
1041
1042
1043
1044
1045
1046
1047
1048
1049
1050
1300 m
1100 m
1km
Haplocambid
Haplargid
Haplargid
Haplargid
Haplargid
Haplargid
Haplocalcid
Haplocalcid
Haplocalcid
Haplocambid


Haplargid
Haplocalcid
Clay (%)
0
10
20
30
40
50
60
Depth (cm)
0
10
20
30
40
50
60
70
80

Redness Rating
0
2
4
6
8
Depth (cm)
0
10
20
30
40
50
60
70
80

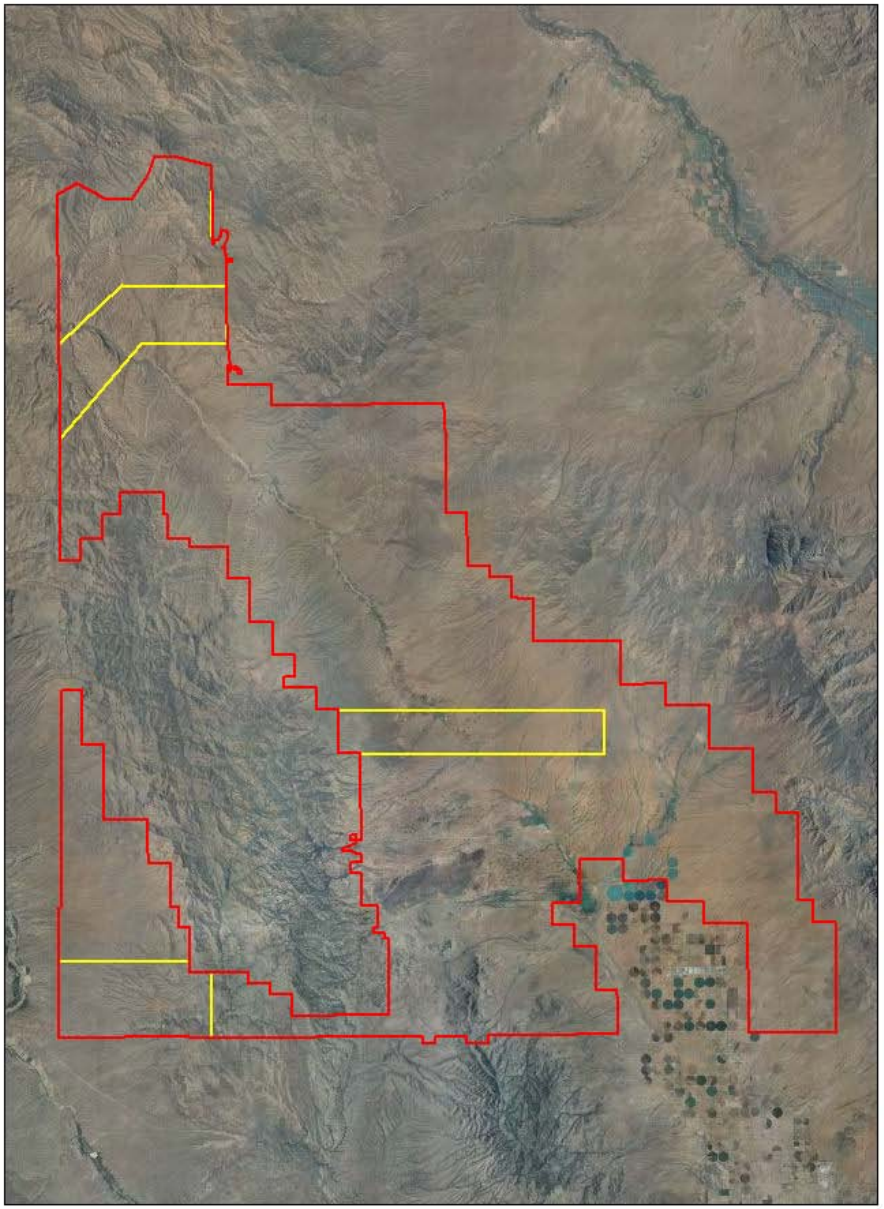
Results

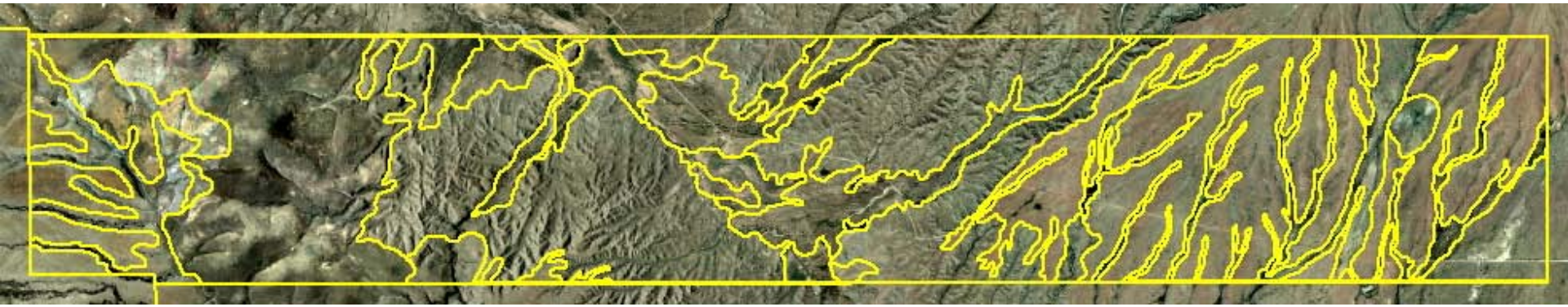
- Segmentation boundaries effectively differentiated soil map units and geomorphic surfaces
  - indicated by depth to diagnostic horizon, texture, and redness rating (Munsell color)

- All lines may not exactly reflect soil map unit boundaries; however, segmentations effectively separated soils based on physical properties, taxonomic classification, and landscape position.

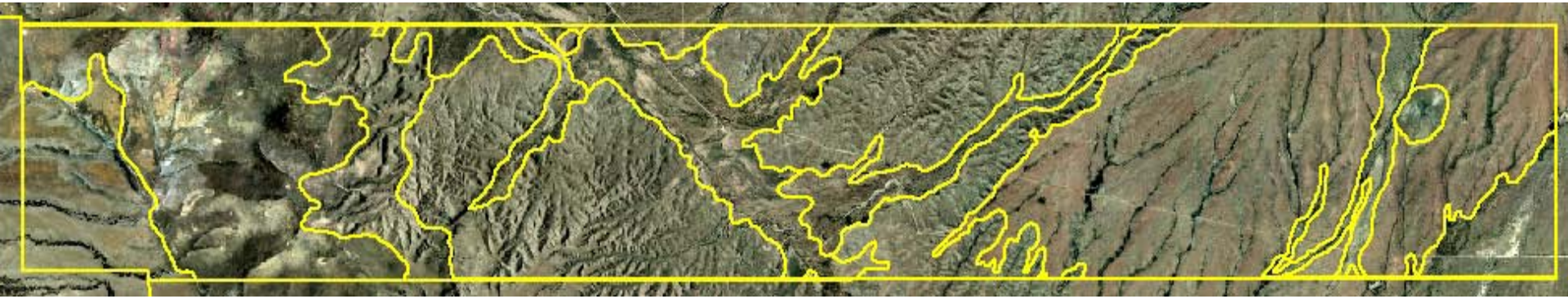
Phase 2 AOI

- 3 areas of interest
- Approx. 15,000 acres each
- Mapped independently by 2 soil scientists in each AOI
- Software vs. Soil Scientist
- Differences between mappers
- Experience and interpretation reflected in map unit design

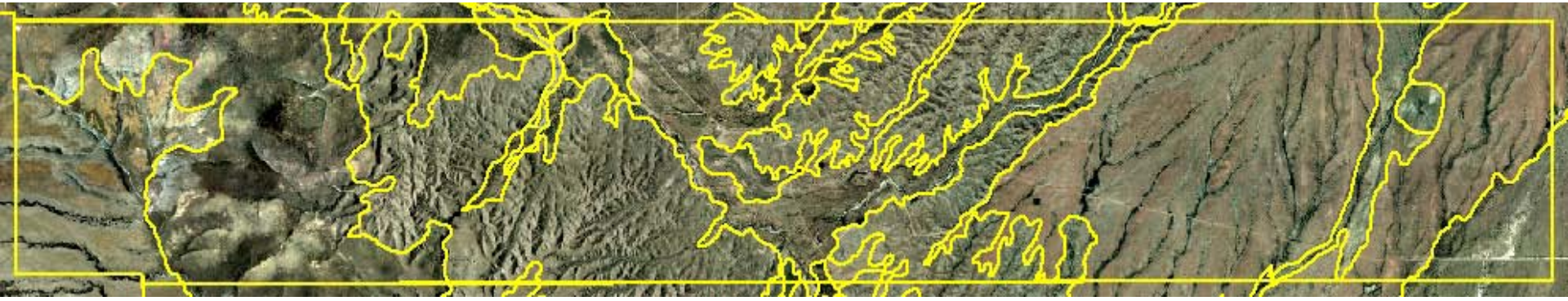




Soil Scientist #1



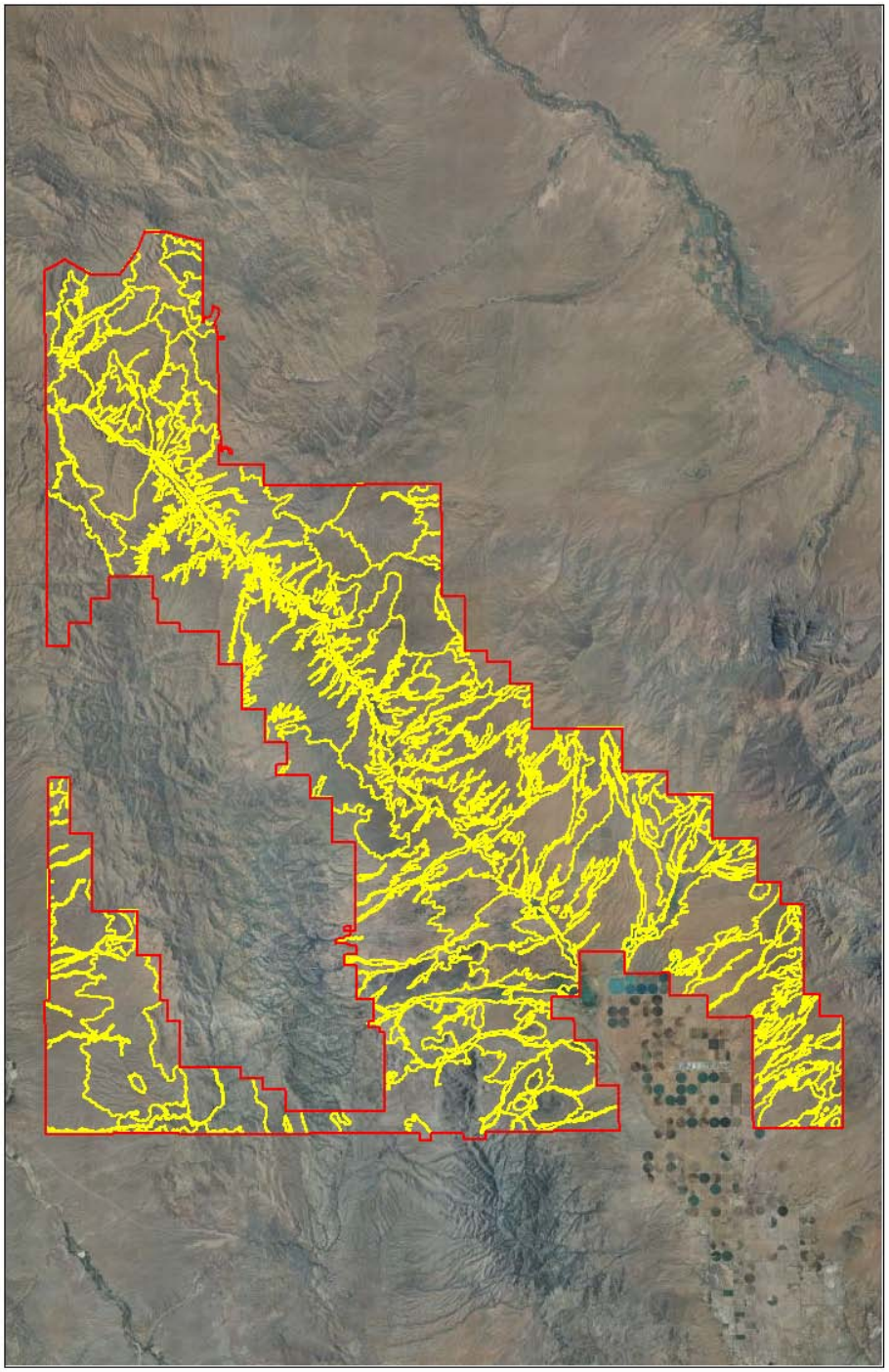
Soil Scientist #2



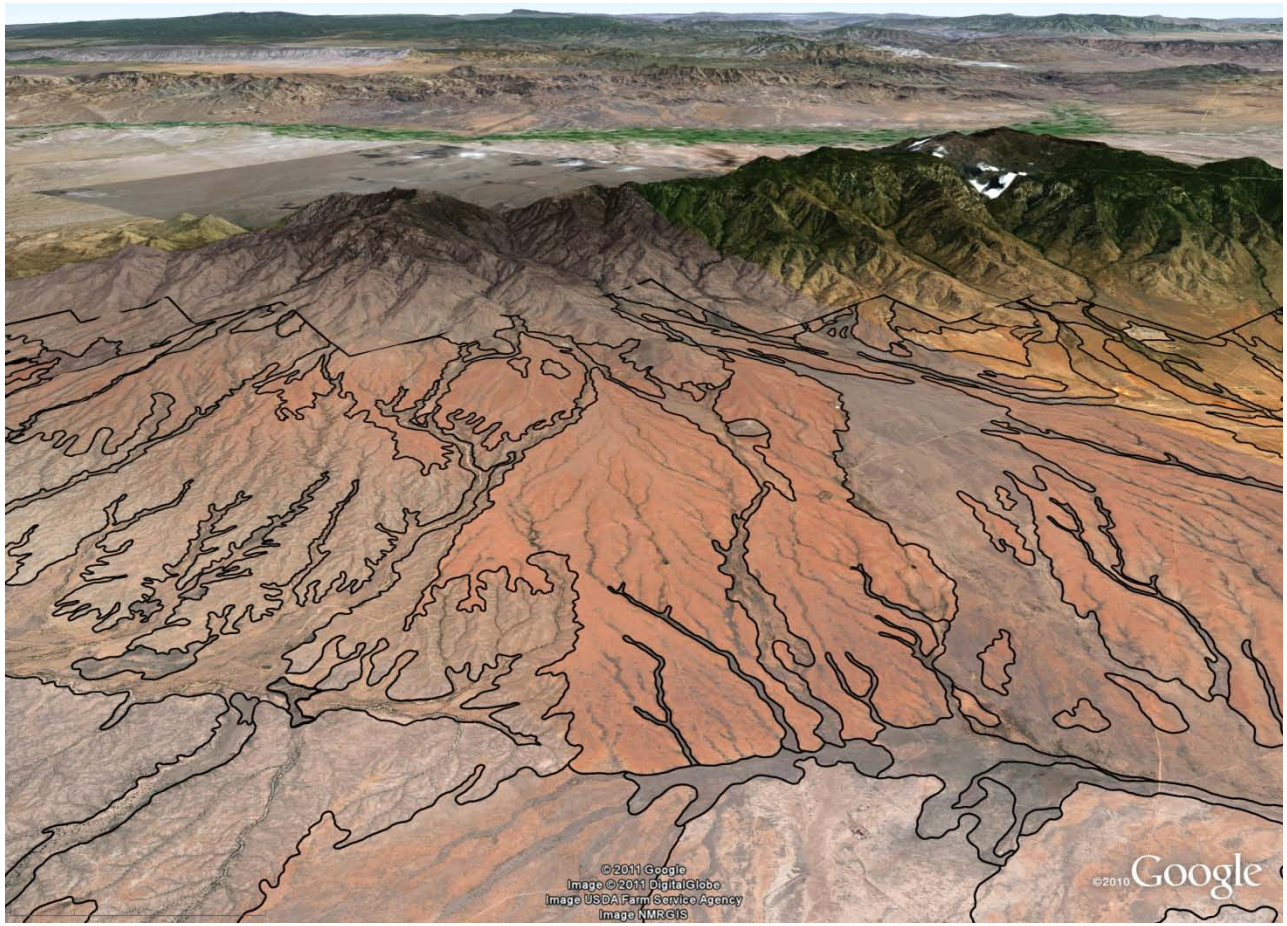
Published

Phase 3 Conventional Soil Survey

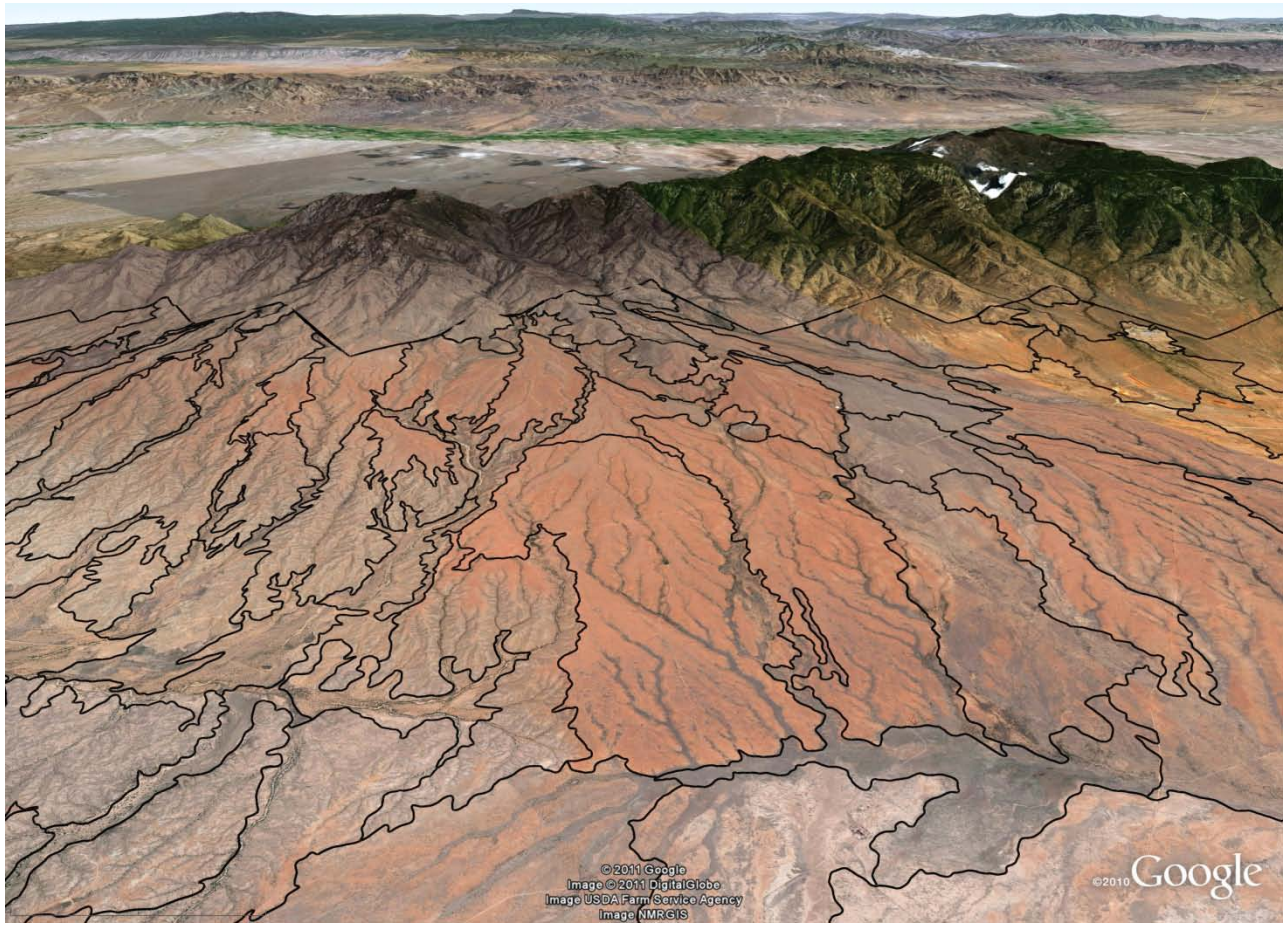
- Data produced in phases 1 and 2 facilitated completion of the soil survey
- Traditional map unit transects were appended to landform transects
- AOI mapping created legends
- Cooperative agreement advanced research and development for soil survey



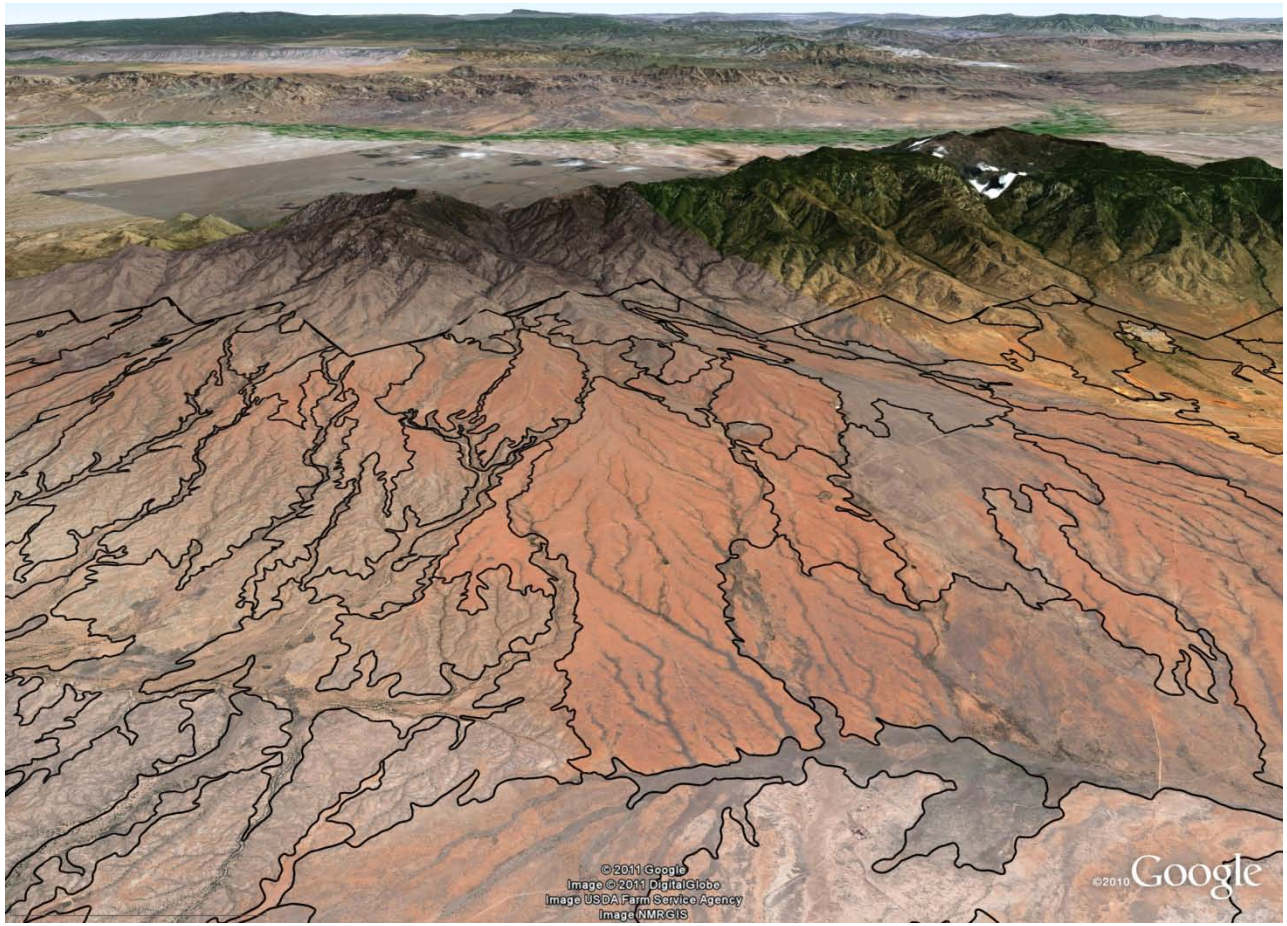
AZ673 Published



Landsat B4 + Slope (5m)



Landsat B4 + Slope (5m) Atmospherically Corrected



Conclusions

- Multi-resolution segmentations clearly separated soil types
- Slope classes and surface reflectance were important for differentiating taxonomic soil classes and individual soil properties

Conclusions

- Results illustrate the utility of automated image segmentation for soil mapping
- Connection between soil properties/classes and auxiliary data (reflectance and DEM)

References

- Torrent, J., U. Schwertmann, H. Fechter, and F. Alferez. 1983. Quantitative relationships between soil color and hematite conent. Soil Sci. 136:354-358.

Thank You