Archaeological Prospecting: Geophysical Methods using 3D Modeling Techniques, Champagne Springs Ruins, Dolores County, Colorado

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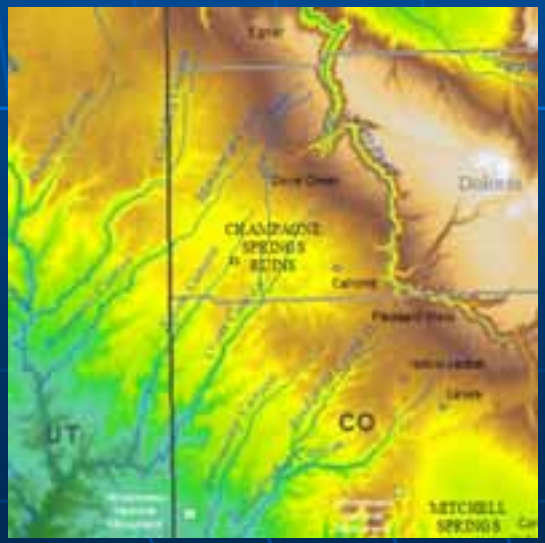

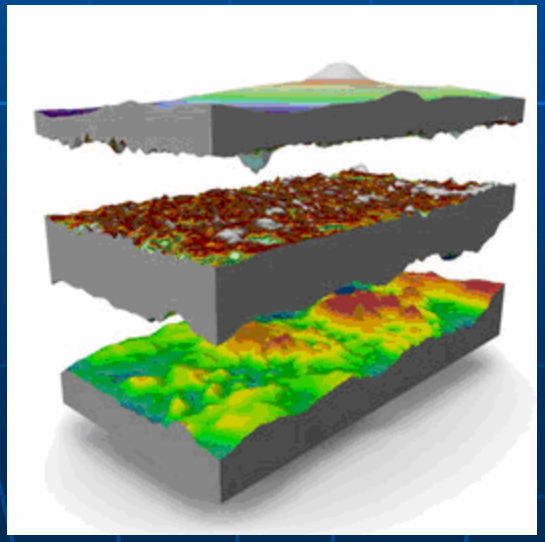

ABSTRACT

Where subtle topographic irregularities suggested the presence of several subsurface archaeological structures, and where lithics and other artifacts were abundant, the importance of the Champagne Springs Ruins was evident. In the interest of historical preservation and cultural best practices, a non-invasive approach to archaeological prospecting was implemented. Geophysical exploration methodologies, including Electromagnetic Induction, Ground Penetrating Radar, Electrical Resistivity, and Cesium-Vapor Magnetic Gradiometry, permitted a unique and comprehensive examination over three field seasons. Precision GPS facilitated acquisition of over 8000 data points on the 160 acre site and allowed Georeferencing of all explorative and archaeological activities. Geophysical, topographical, and archaeological field data were processed using the ESRI 3D Analyst extension. Pattern recognition of geophysical anomalies using color-differentiation, three dimensional stack-mapping, and enhanced rendering, indicate areas of potential archaeological interest and provided an insight as to where to place excavation segments for the 2005 summer field season.

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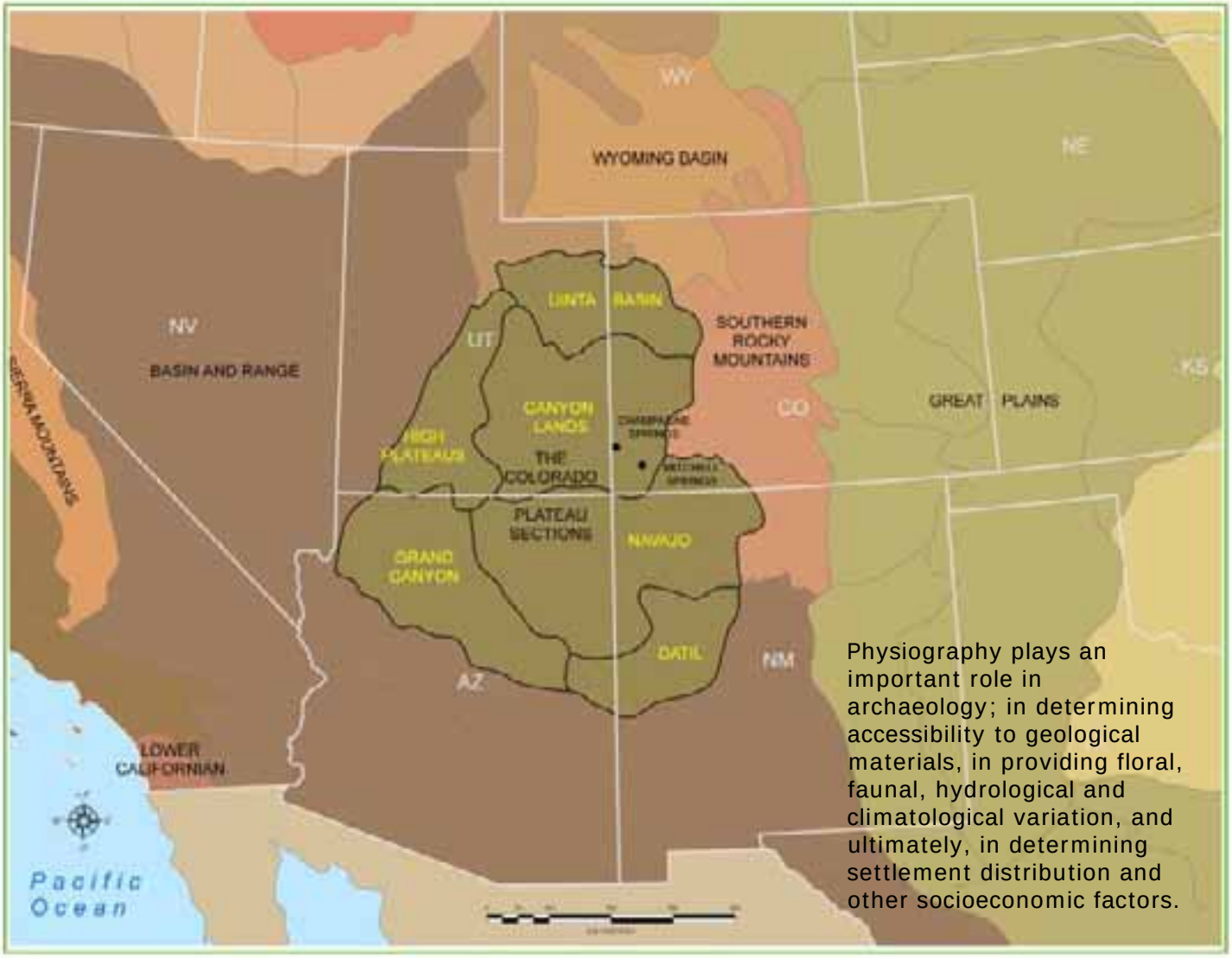
Significance of the study…

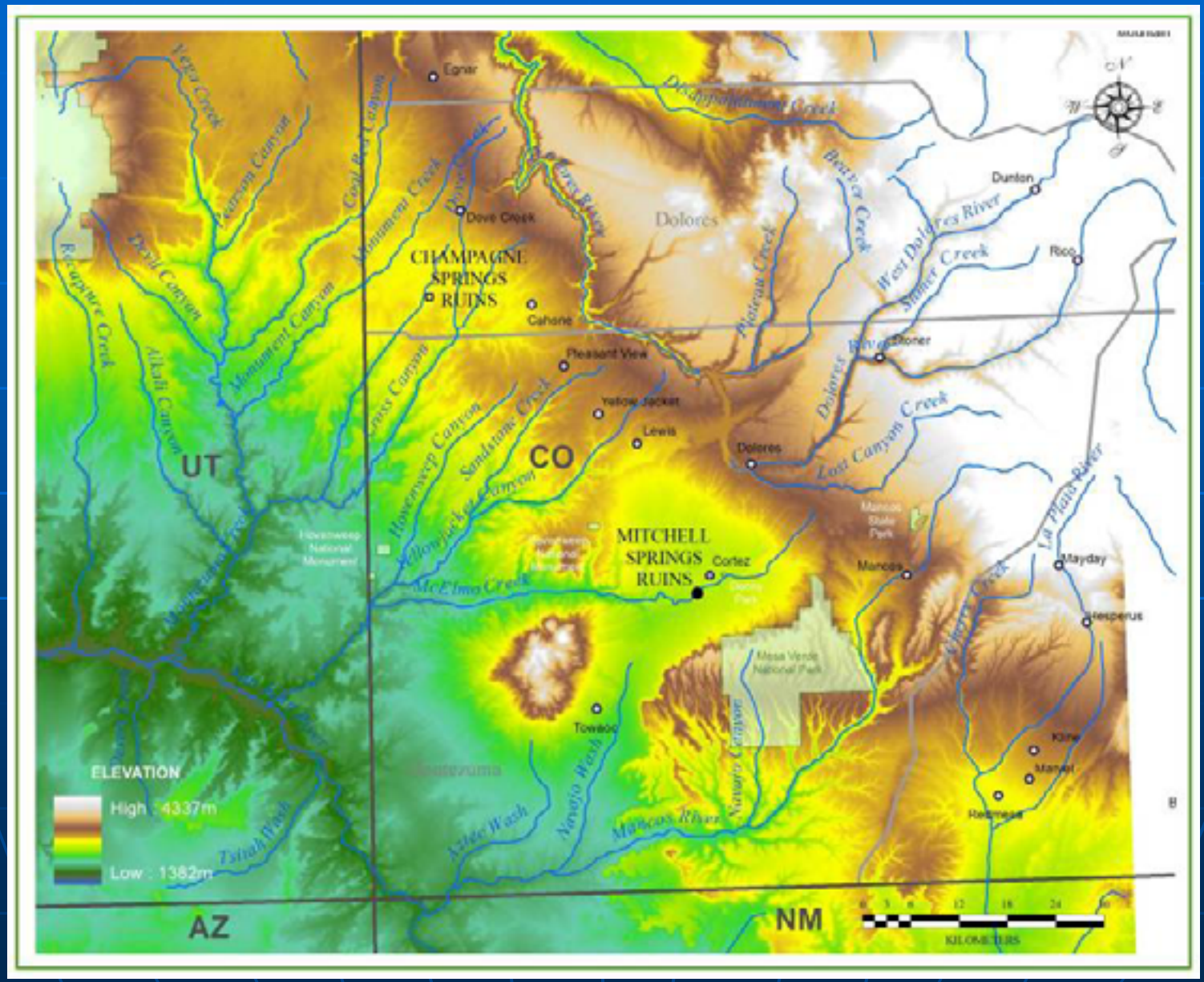
- Historical preservation and cultural best practices
- Non-invasive approach to archaeological prospecting
- An era in prehistory little studied in the Four Corners area
  - Late Puebloan I to Puebloan II of the Anasazi sequence
- Multifaceted geophysical exploration methodologies
  - Electromagnetic Induction
  - Ground Penetrating Radar
  - Electrical Resistivity
  - Cesium-Vapor Magnetic Gradiometry

The Champagne Springs Ruins site is located in the Canyon Lands Section of the Colorado Plateau Province…

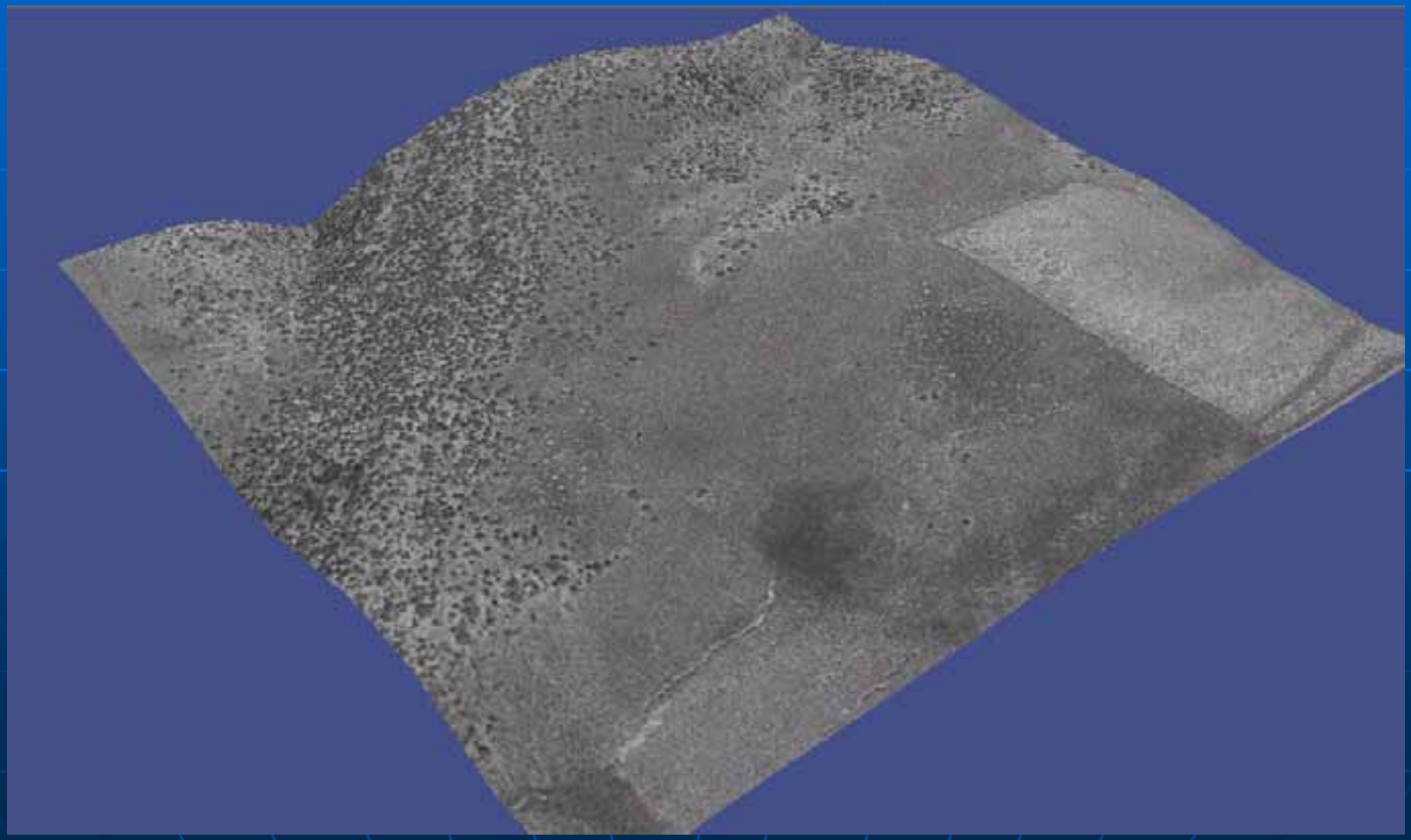


Physiography plays an important role in archaeology; in determining accessibility to geological materials, in providing floral, faunal, hydrological and climatological variation, and ultimately, in determining settlement distribution and other socioeconomic factors.

Regional Geomorphology and Geology…



The Champagne Springs Ruins…



Cultural Prehistory

-The prehistoric Anasazi Culture of the American Southwest, also known in more recent times as Ancestral Puebloan, has its roots in the pre-agricultural Archaic period.

- Anasazi, means 'ancient stranger' or 'ancient enemy' in the Navajo language and is the name most commonly applied to the early pueblo dwellers who once lived on the Colorado Plateau or Four Corners Area. The Hopi are the likely descendents of the Anasazi called these predecessors the "Hisatsinom" for "The Ones Who Came Before."

-The Champagne Springs Ruins represents era in prehistory little-studied in the Dove Creek area.

Archaeological artifacts, pottery, and masonry suggest the site is of Late Puebloan I to Puebloan II of the Anasazi sequence, Dove, 2005

The Anasazi Sequence

Archaic	Basketmaker II	Basketmaker III	Pueblo I:	Pueblo II:	Pueblo III:
6500 - 1200 B.C.	~ A.D. 50 - 500	A.D. 500 - 750	750 - 900	900 – 1150	1150 ~1300
Pre-Anasazi Period		**Anasazi Period**			

Champagne Springs Chronology…

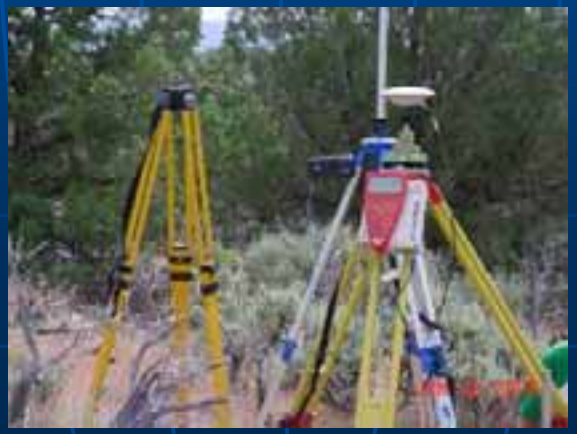
Pueblo I 750 – 900: Large villages and great kivas appear. Deep pithouses still in use. Above-ground construction is generally of jacal or crude masonry. Plain pottery and gray with neck bands predominate; there is some black-on-white and decorated redware.

Pueblo II 900 – 1150: Appearance of Great Houses, (Chaco) great kivas and roads. Small blocks of above-ground masonry rooms. Pottery consists of corrugated gray and decorated black-on-white in addition to some decorated red and orange vessels.

Geodetic Control…

- Permits accurate Horizontal & Vertical Control
- Places the area of interest “on the map”
- All endeavors use same coordinate grid system
- Georeference & locate points of interest

Precision GPS facilitated acquisition of over 8000 data points on the 160 acre site and allowed georeferencing of all explorative and archaeological activities…

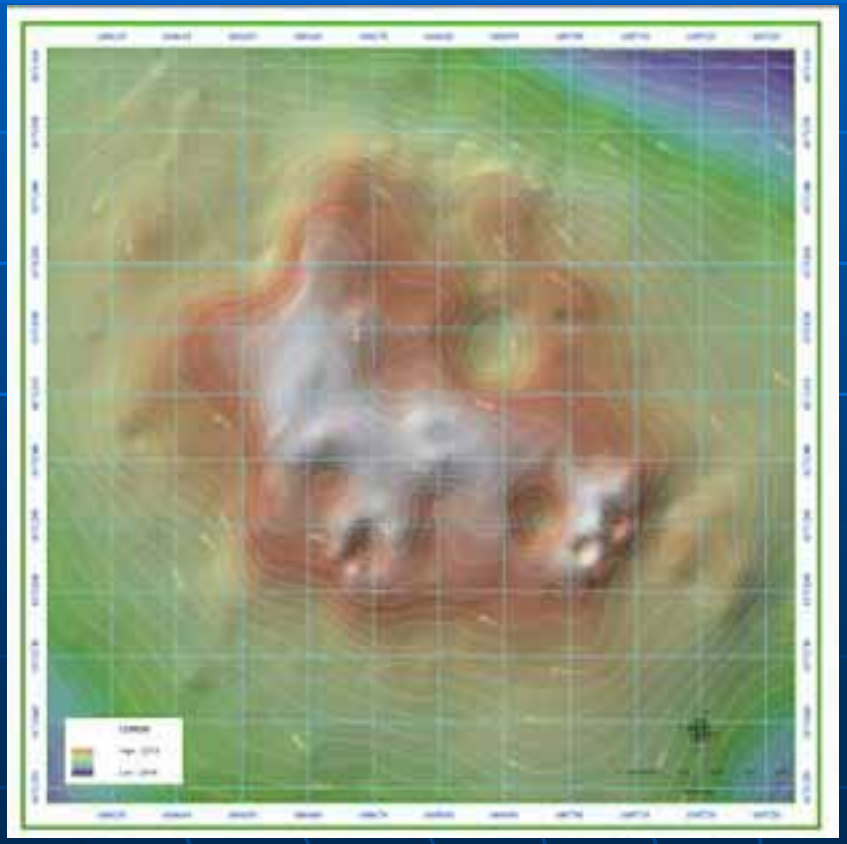


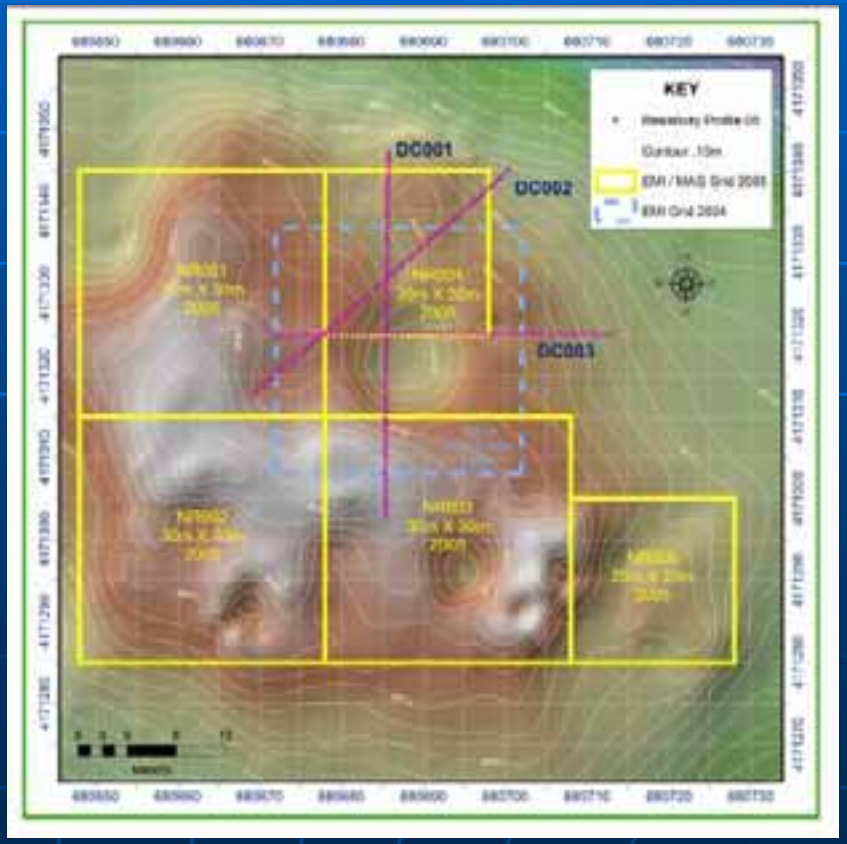
Topographical, Geophysical, and Archaeological Mapping…

All grids, archaeological or geophysical, placed in Universal Transverse Mercator Zone 12N, North American Datum 1983.

GPS & Total Station point data were processed using the ESRI ArcGIS 3D Analyst extension.

Topographical maps and scattered lithics / artifacts provided an insight as to where to place geophysical exploration grids for the following summer field season…

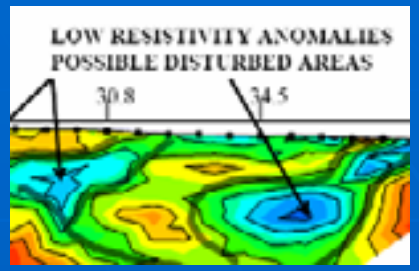




Geophysical Exploration…

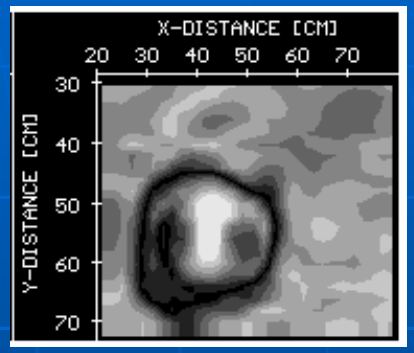
Resistivity:

The DC resistivity method relies on the application of Ohm's Law. V=IR. (dipole-dipole array of “geophones”) Clays, organic soils, and weathered rock; smaller grain size and larger pore-water content = high conductivity (low resistance). Bedrock, gravel, and sand have low conductivity (high resistance)



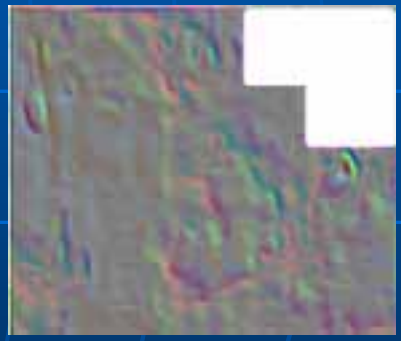
GPR: Ground Penetrating Radar:

An active method that transmits electromagnetic pulses from surface antennas into the ground, and then measures the time elapsed between when the pulses are sent and when they are received back at the surface (called two-way travel time). Dependent on soil and sediment mineralogy, clay content, ground moisture, depth of burial, topography and vegetation. (Sage & Salt Bush)



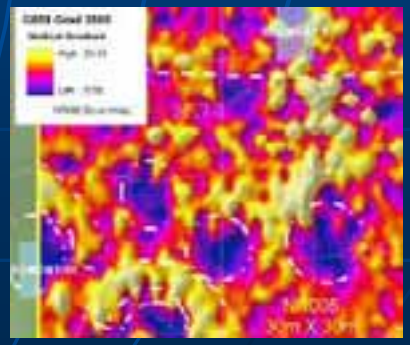
EMI: Electromagnetic Induction

Measures apparent conductivity of the substrate. Broad-band; multiple frequency, measures in-phase & quadra-ture in PPM, in addition to Qsum or ECTotal, MSus.



Cesium-Vapor Magnetic Gradiometry:

Measures earth’s total field or vertical component of the magnetic gradient. “Magnetic potential.” Self-oscillating split-beam Cesium Vapor (non-radioactive Cs133) with automatic hemisphere switching; Operating Range: 17,000nT to 100,000nT

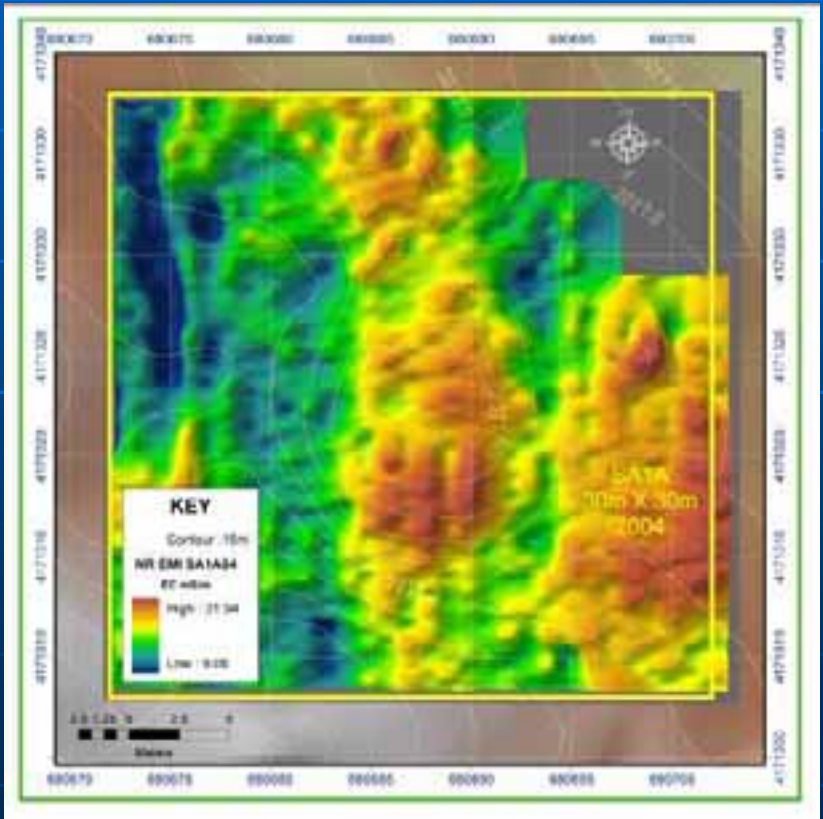


Geophysical Anomalies…pattern recognition

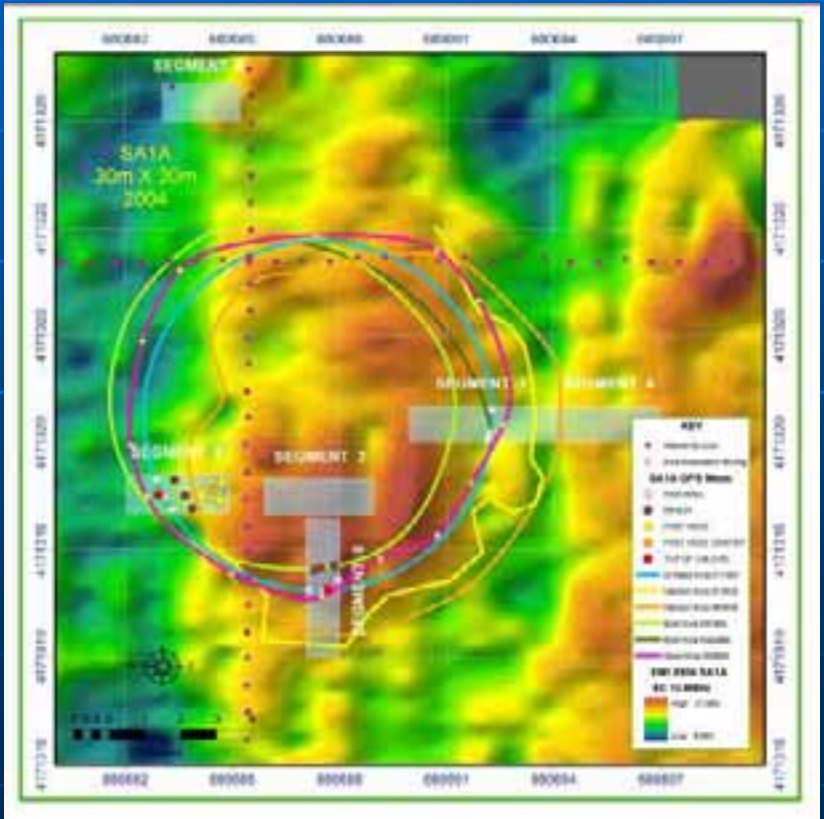
Pattern recognition of geophysical anomalies using color-differentiation, three dimensional stack-mapping, and enhanced rendering, indicate areas of potential archaeological interest…

Electromagnetic Induction:

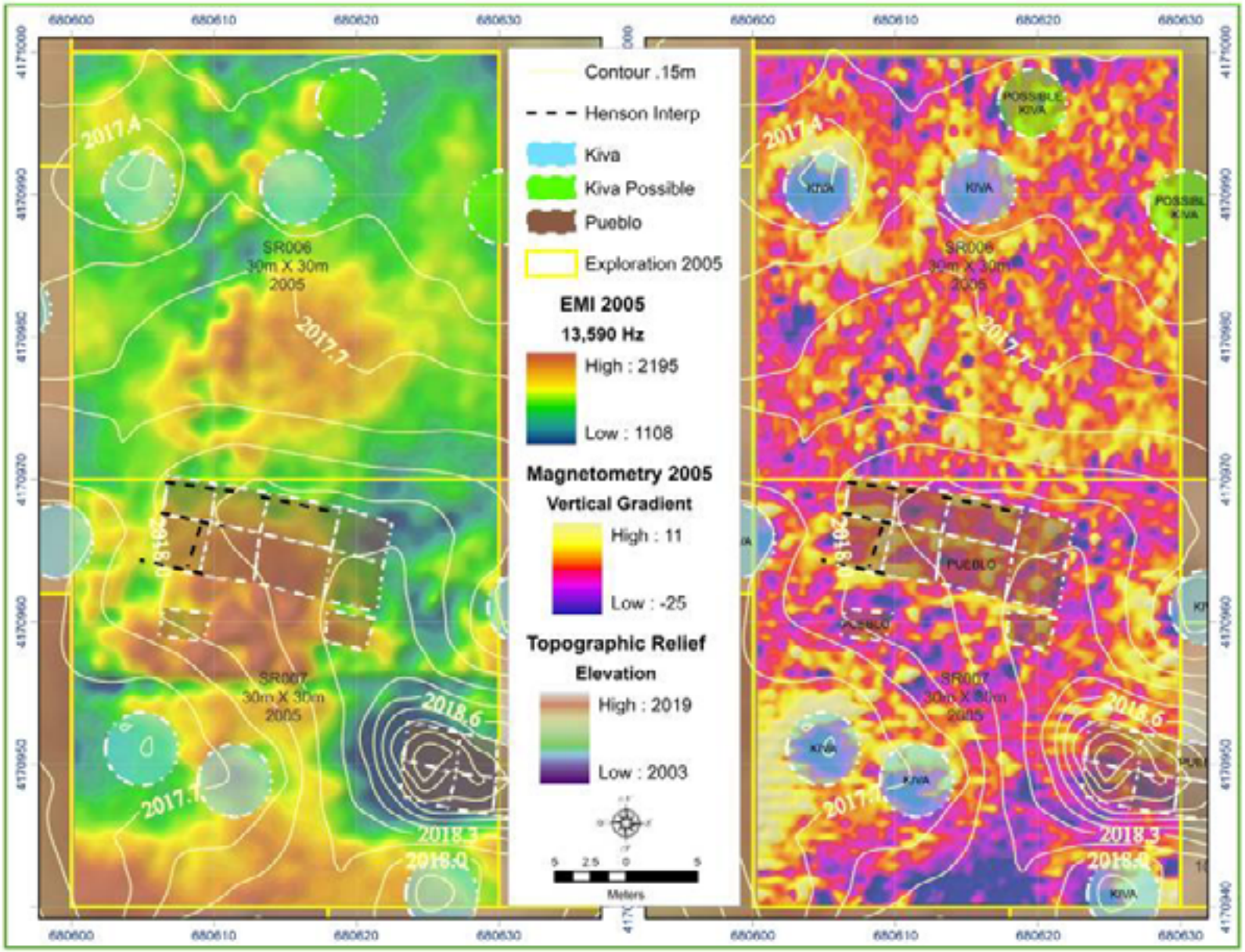
Total Conductivity, mS/m



Kiva structure interpretation, excavation segments, and resistivity profile lines…

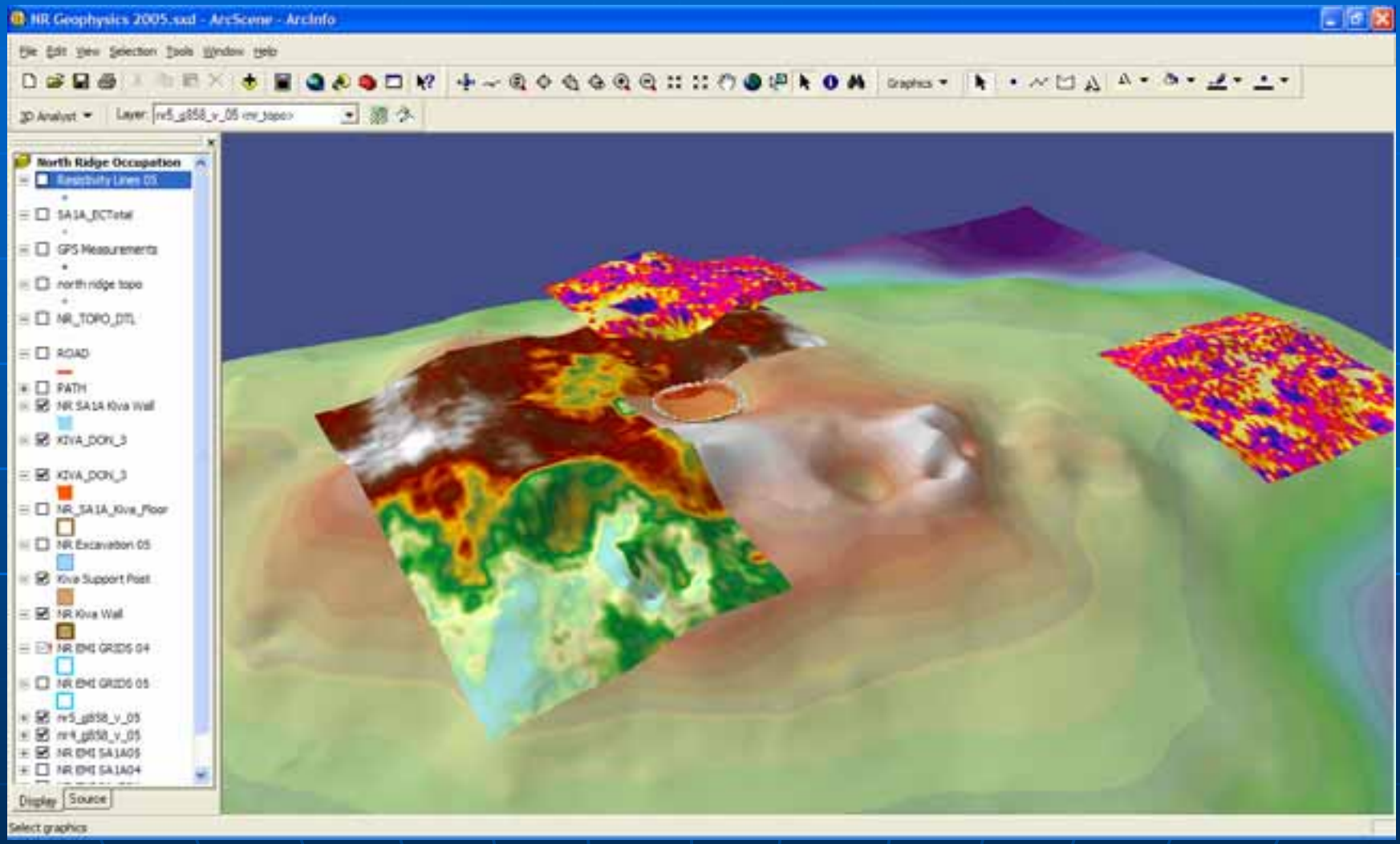


Geophysical Anomalies : EMI or CVMG?



3D Analyst ArcScene

ESRI 3D Analyst Extension



Archaeological Exploration: Selective Excavation

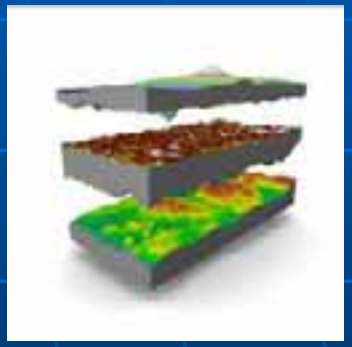
Segment 10-2, South ridge kiva structure and post support

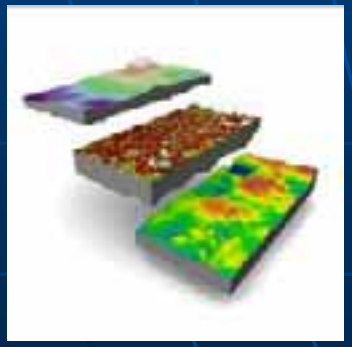
Segment 11-PD52-4, South ridge kiva structure and post supports

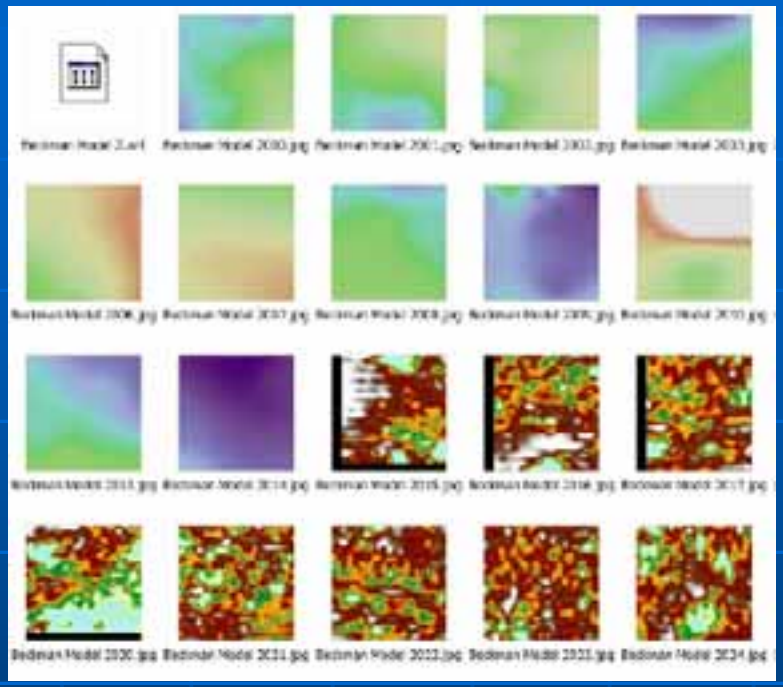
South Ridge Occupation: Mapping an underlying, older wall structure using GPS.

Sieving…

Geophysical & Topographic Modeling: A New Approach…



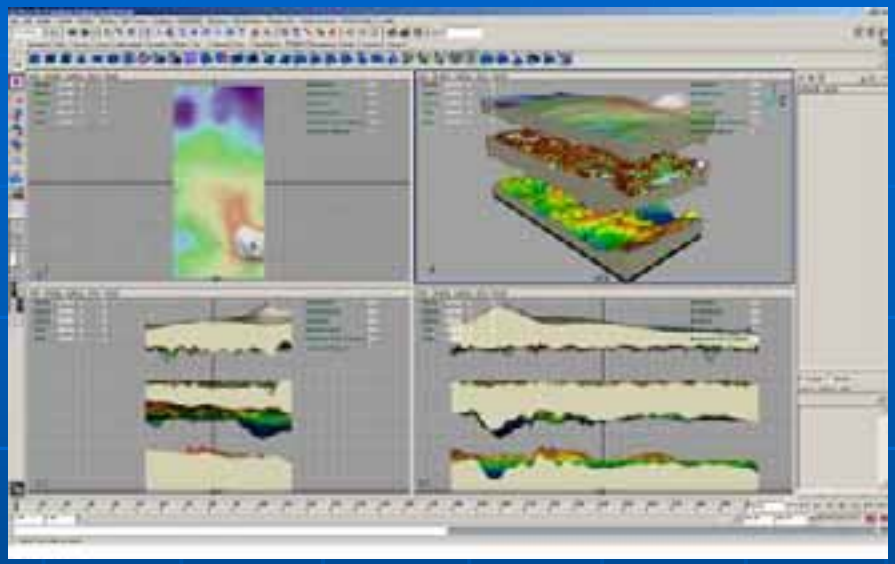


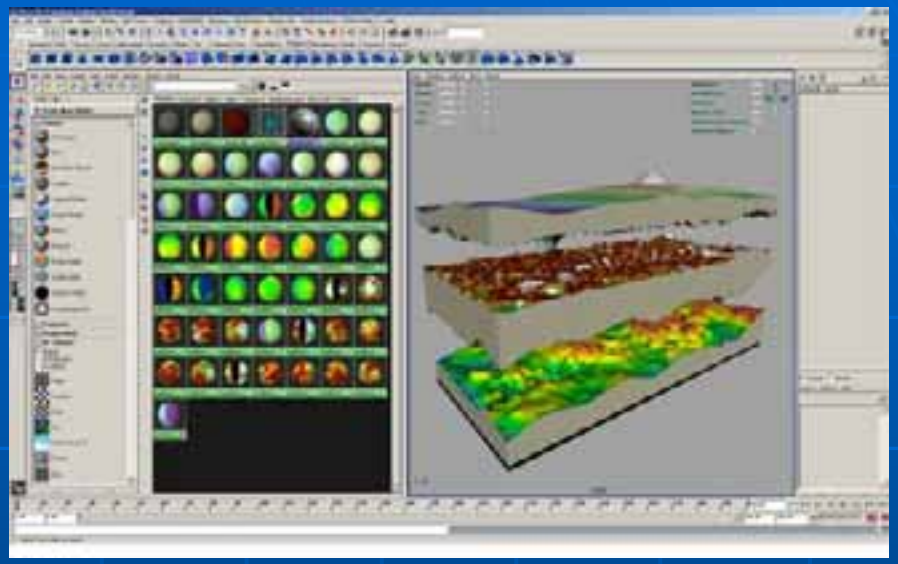


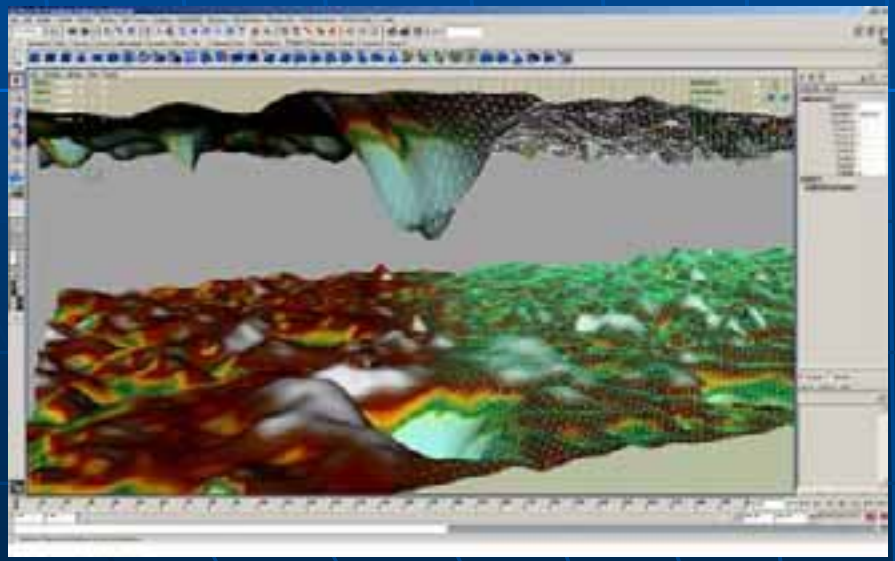
Export data using a common language…

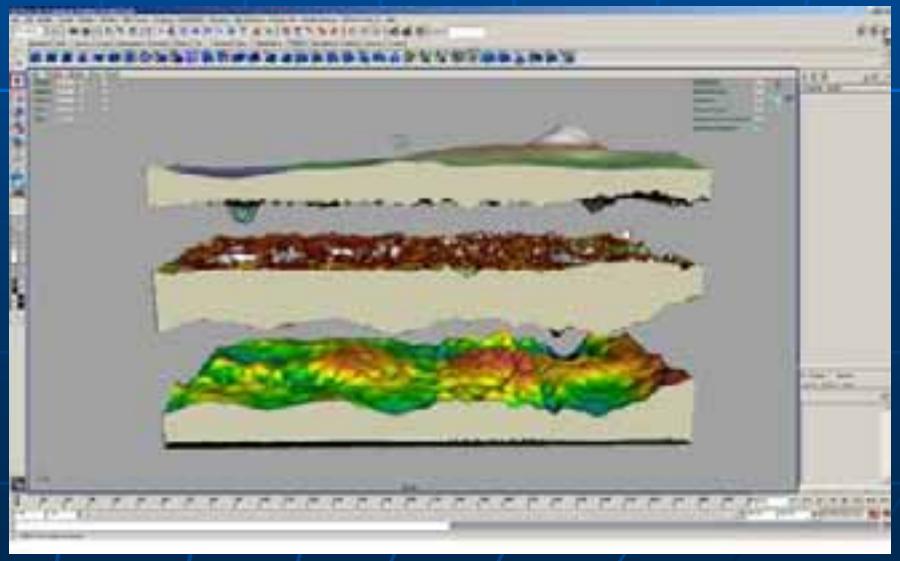
VRML format permitted 3D modeling of the topography, electromagnetic induction and magnetic gradient anomalies using ESRI 3D Analyst – ArcScene and Maya software and the Z Corp Z402 3-D printer. The VRML are used to produce the first 3D stack maps of EMI, CVMG, and topography.

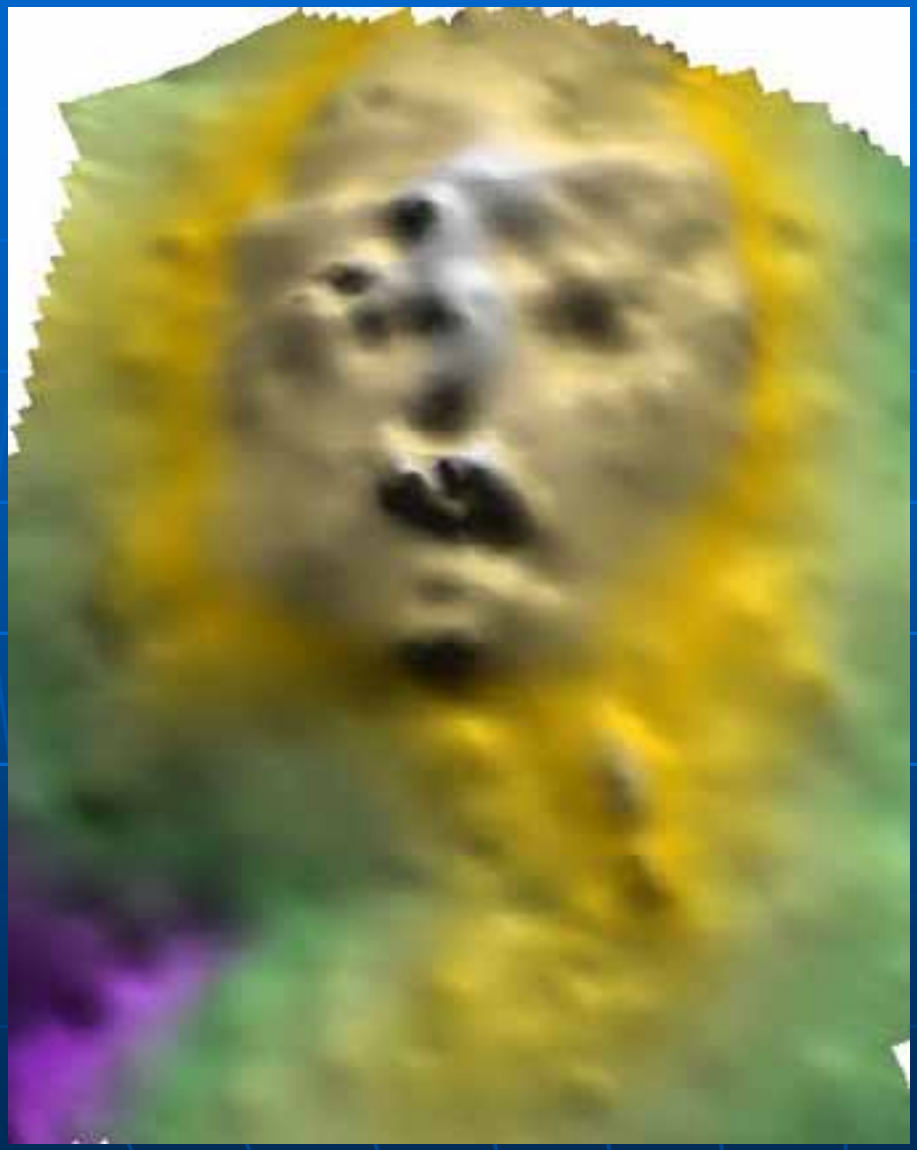
Geophysical & Topographic Modeling:
A New Approach using 3D Printing and Visualization











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Ongoing Research Endeavors:

Provenance: Sherd Analyses

Geophysical Modeling Techniques

Great Kiva Reconstruction (Jerez – Di Naso)

Dendrochronology (Di Naso – Weber)

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Ray and Bernie Kara, Ryan Leonard, Paul Hughes and Emin Emini of Kara Company, Countryside, IL; for their more than gracious support in providing Global Positioning System and Total Station equipment, their collective contributions allowing us to map the Champagne Springs Ruins.

Dan Weber, Scott Robinson, Alex Jerez, Imaging Technology Group, Beckman Institute; for providing Environmental Scanning Electron Microscopy, visualization and 3D modeling / reconstruction, and in the creation of the first and only 3D models and animations of the Champagne Springs Ruins.

EIU Students; for their participation in the mapping of the Champagne Springs Ruins.

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