Archaeological Site Taphonomy:
The Interplay of Biologic Activity and Geomorphic Processes

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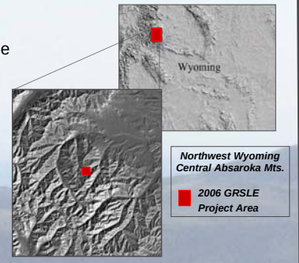
Burrowing organisms significantly influence the physical, chemical, and biological structure of ecosystems. In archaeology, sub-surface faunalturbation is often associated with site disturbance, particularly the loss of stratigraphic integrity. While horizontal and vertical translocation of cultural material can occur, fossorial activity, coupled with geomorphic processes of erosion and deposition, is capable of preserving archaeological contextual information. Research conducted in 2006 investigated the interaction of landscape features, pocket gopher (*Thomomys talpoides*) activity, and sedimentation processes on site formation at a high altitude lithic scatter in northwestern Wyoming. Located in an alpine parkland (elevation 3100m), the terrain is characterized by hummocky, gentling sloping hills which terminate in shallow, concave depressions known as sag ponds. Sediment disturbed by pocket gopher tunneling and mound building is overtime redistributed by wind and sheetwash into the sag ponds creating a depositional environment capable of burying cultural material. To determine the extent of sub-surface archaeological deposits, test units and auger probes were excavated at the site. Topography was mapped to sub-centimeter accuracy. Pocket gopher mounds were extensively documented, the sediment screened and sampled. To better understand the timing and rate of deposition, radiocarbon dating and sediment analysis were conducted. The relationship between artifact size, geographic position, and biological activity was examined to determine the surface and sub-surface extent post-depositional artifact movement. Research assesses the overall influence of fossorial rodents on archaeological site formation to aid in the interpretation of patterns present in the material record.

GRSLE
GREYBULL RIVER SUSTAINABLE LANDSCAPE ECOLOGY PROJECT

SCIENCE, STEWARDSHIP, AND SUSTAINABILIY

Begun in 2002, the GRSLE project conducts multi-disciplinary research focused on landscape taphonomy. The environment is viewed as a dynamic conglomeration of cultural, biological, and physical processes that evolve on multiple spatial and temporal scales. Inferring human behavior from the archaeological record requires the consideration of both the physical and cultural processes leading to site formation.

The GRSLE project area centers on the Greybull River drainage basin, part of the Greater Yellowstone Ecosystem in northwestern Wyoming. Prior to GRSLE little archaeological research had been conducted in the remote, little accessed tributaries of the upper Greybull watershed. To date, graduate students and field school participants from Colorado State University have surveyed over 1100 hectares, recorded over 45,000 artifacts, and identified nearly 225 previously undocumented sites in the Shoshone National Forest and Washakie Wilderness.



High Elevation Archaeology: Site 48PA2874

High altitude environments are shaped by unique physical processes. To investigate the effect of biologic and geomorphic interactions on archaeological sites, the Colorado State University 2006 field school conducted systematic survey and test excavations at 48PA2874.

48PA2874

The site, 48PA2874 (3100m), is located in a hummocky alpine parkland overlooking the Big Horn Basin. 48PA2874 is distinguished from other local sites by the shear number of pieces of chipped stone (over 2,500 items), the diversity of artifacts, the diversity of tools, and the presence of spatially discrete artifact concentrations.

2006 Data Collection Methods
I. Systematic Survey
- 102 ha (1700 m east-west by 600m north-south) surrounding site 48PA2874 surveyed at 5-m spacing

II. Subsurface Testing
- Two 1 x 2 meter areas excavated in 50 x 50 cm quadrants
- Excavated in 5 cm levels
- Approximately 0.02% of site area

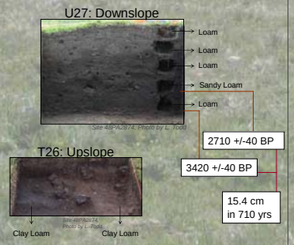
III. Auger Probes
- Auger probes (92.25 mm diameter) were used to estimate sediment depths across site area
- Arranged in linear transects and mapped with EDM

IV. Gopher Burrow Documentation
- Numerous characteristics were recorded *(see gopher section)*

48PA2874: Test Excavation

Two 1 x 2-m test units were excavated in the catchment area of a small alpine sag pond. Unit placement was based on topographic characteristics, artifact density, and the presence of fossorial mammal activity. Researchers hypothesized that present-day features, at a landscape-scale, resulted from a series of mass movements, potentially slump events or rotational slides. To obtain information on relic geomorphic processes test units were strategically placed at one of the numerous shallow, spoon shaped depressions typically feed by seasonal snowmelt. One unit, T26, was located upslope of the currently dry pond, the other unit, U27 at the water-slope boundary.

Unit T26 contained 331 pieces of flaked stone; U27 contained 46. A Late Archaic projectile point was recovered from U27 approximately 40cm below the ground surface.

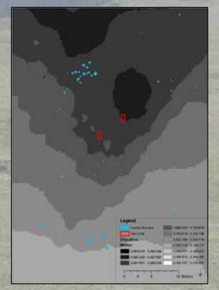


Despite being located upslope, the texture of sediment in unit T26 contains a higher percentage of clay than the downslope unit U27.

HIGH ALTITUDE LANDSCAPE TAPHONOMY
Pocket Gophers and Archaeological Site Formation

Although typically small in size, fossorial rodents significantly impact ecosystem dynamics. Pocket gopher activity influences the chemical and textural properties of soil, vegetation composition, and micro-topographic features. Sediment exposed by pocket gopher borrowing is susceptible to erosion by rainsplash, overland flow, and aeolian deflation. While often considered a disturbance to archaeological sites, researchers studying alpine environments in the Greybull River watershed propose sediment ejected by gopher activity has overtime been redistributed by physical processes and resulted in burying prehistoric cultural material. To investigate the impact of pocket gopher activity on archaeological sites and micro-topographic features, sediment characteristics of active and inactive burrows were compared. Sediment analysis and radiocarbon dates from test excavation units were examined in conjunction with the pocket gopher data. A GIS based sediment movement model was employed to predict the travel path and amount of material eroded.

Pocket Gophers: Ecosystem Engineers



Gopher burrow distribution, test units mapped on DEM. Darkest area represents the alpine pond.

Pocket gopher activity was documented in an area measuring 0.36 ha (50 x 70m) at site 48PA2874 (see map). Of the 53 burrows encountered, 17 were occupied and 34 had no signs of activity . The total volume of material disturbed by gopher activity within the survey gopher area measured 301 liters, of which 59 liters consisted of rock and 242 liters consisted of sediment.

Burrow Attributes Documented
- Total volume of disturbed material
- Volume sediment/rocks
- Counts of rocks over 64mm
- Diameter of burrow opening
- Length/width of ground covered by ejected material
- Evidence of current activity
- Rock and sediment samples collected
- Chipped stone collected

Pocket Gopher Data Summary	
Area Investigated	0.35 ha
Total Borrows	53
Active Burrows	17
Inactive Borrows	34
Unspecified Activity	2
Sediment Volume	242
Rock Volume	59
Total Volume	301

Literature on pocket gophers indicates gophers will typically avoid rocks >5cm. Gophers in the present study area moved material as large as 12.8cm (n=5) and 9cm (n=11); even one 25cm rock was displaced. Reasons for anomalous rock movement may be related to local sediment characteristics, however a greater number of burrows needs to be sampled to validate the initial data.

Activity	4mm	5.7mm	8mm	11.3mm	16mm	22.6mm	32mm	45mm	64mm	>64
Inactive	200	1857	1963	1044	487	225	71	15	0	3
%	50.9%	64.8%	67.4%	66.5%	64.4%	58.7%	49.7%	62.5%	.0%	17.6%
Active	191	1008	879	426	208	103	44	4	1	14
	48.6%	35.2%	30.2%	27.2%	27.5%	26.9%	30.8%	16.7%	100 %	82.4%
US	2	2	72	99	61	55	28	5	0	0
	.5%	.1%	2.5%	6.3%	8.1%	14.4%	19.6%	20.8%	.0%	.0%

BURROW	ACTIVE	TEXTURE
RBB-10	Y	SANDY CLAY
RBB-25	Y	CLAY LOAM
RBB-26	Y	SILTY CLAY LOAM
RBT-13	Y	CLAY LOAM
RBT-14	Y	CLAY LOAM
RBT-24	Y	CLAY LOAM
RBB-09	N	LOAMY SAND
RBB-12	N	SANDY LOAM
RBB-19	N	SAND
RBT-05	N	SANDY CLAY LOAM
RBT-12	N	SANDY CLAY LOAM
RBT-22	N	LOAM

A sample of three inactive tunnels, three inactive three active mounds, three active mounds, and three active tunnels were selected for texture analysis.

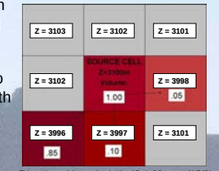
Active burrows contained more clay than inactive burrows; inactive burrows contained significantly more sand.

Similarly, active tunnels contained more clay than their inactive counter-parts, inactive tunnels contained more sand.

A GIS BASED EROSION MODEL

The model predicts the path of erosion by comparing elevations adjacent to a given starting point. The starting point (or source cell) is linked to a number representing the volume of material available for erosion. The model evaluates the neighboring cells and moves a user defined percentage of total volume into a user specified number of cells (not exceeding eight). The program then uses the same method to evaluate the cell containing newly moved material. Material is moved into cells with elevations **lower** than the source cell. The percent of sediment moved is ranked, meaning a higher percentage of material will be moved to the neighboring cell with the lowest elevation, a lower percent will move to the next lowest elevation and so forth.

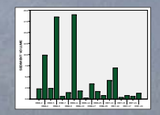
The program loops through all the cells. When sediment moves into a cell previously evaluated, the new material is added to and the algorithm is re-run.



This erosion model was written in Visual Basic 6.0 as part of NR521, an Advanced GIS Modeling class. Dr. Denis Dean (Geomorphologist) developed the model for the California Transportation Department to predict Landslide Susceptibility.

The process per cell is terminated when either 1. no more sediment is available to move or 2. No neighboring cell has a lower elevation. The model creates a database where each raster cell is represented by a number indicating the cumulative volume of deposited material deposited in each cell.

Inputs to Erosion Model



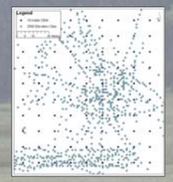
Starting Points and Sediment Volumes

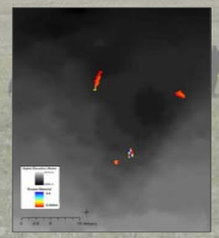
Starting points and associated sediment volumes were obtained from data collected on **ACTIVE** mounds/burrows. Only the **SEDIMENT** portion of the total volume per mound/burrow was input into the model.

Elevation Data

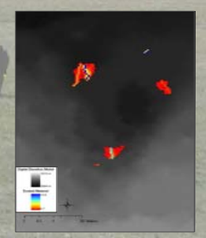
Precise elevation data was collected in the summer of 2006 by taking over 947 total station shots in the catchment basin surrounding the excavation units and pocket gopher burrows.

A 10-m Digital Elevation Model (*downloaded from www.seamless.usgs.gov*) was merged with elevation data collected in the field. A new database containing the combined elevation data was input into the Erosion Modeling Program along with the starting point data base containing the location of gopher burrows and sediment volumes.

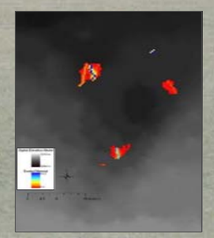




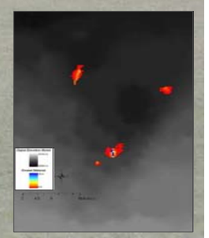
Breakdown : 75%, 25%



Breakdown : 84%, 8%, 8%



Breakdown : 80%, 10%, 8%, 2%



Breakdown : 82%, 8%, 8%, 2%

The analysis showed some variation in sediment movement when the percent composition was altered. Sediment becomes most concentrated *(blue cells on map*) in small rills, the areas with the lowest elevation.

The predicted path of material originating from the active gopher burrows in July 2006 clearly moves toward the ephemeral pond (*black area on map*). Imagining slight shifts in burrow locations, which is likely overtime, the excavation units were well placed to obtain information on the sedimentation.

Future Research
1. Return to field and record elevation every 50cm on a grid spanning the pond area. (This would negate need to merge the 10-m DEM with data taken at a finer resolution, a possible source of error).
2. Sample additional pocket gopher mounds to gain information on the size of rocks displaced and sediment texture
3. Obtain additional information on macro-scale landscape processes through continued excavation of U27