THE CAROLINA BAYS OF RIDGE SPRING, SC

A narrow, sinuous terrace known locally as The Ridge forms a contiguous drainage divide arcing ~100 km from Augusta, GA, northeastward toward Columbia, SC. A new one-meter-resolution digital elevation map was crafted for the terrace using LiDAR data from the SC Department of Natural Resources, providing a crisp perspective of the surficial features present. From their lofty perch at ~200 m elevation, the low-relief terrain surrounding Ridge Spring, SC represent a surviving island of flat Cretaceous terrace that is being encroached upon by headward fluvial erosion. Edisto River basin headwaters are eating away the southeastern flank, while along the northwestern flank, tributaries of the upper Santee River drainage basin are collaborating with those of the Savannah River to remove the divide. Of the 45,000+ East Coast bays in the Carolina Bay Geospatial Survey, only 171 bays exist at elevations above 185 m. The Ridge Spring terrace is home to 160 of those high-elevation bays, making the assemblage unique in many ways. These bays maintain robust conformance to the archetype “baySouth” teardrop planform common to over 16,000 neighboring bays; their major axis range from 1.22 km down to 140 m, with a mean of 380 m; the orientations of that axis range from 148º to 165º, with a mean of 154º. The bays of Ridge Spring are visualized in LiDAR as basins recessed into a surrounding pediment (here, the terrace), exhibit no raised southeastern rim, and have no aeolian dune formations in their vicinity. The headward erosion has been dissecting the terrace since the time of bay formation, as the LiDAR elucidates a history of systematic bay destruction. Some clearly-defined bays have been penetrated by headward erosion, and are no longer hydraulically closed. Former closed-rim bays - recognizable by surviving rim fragments - have become mere “headwater basins”. At some point in the future the last vestiges of the terrace surface and the imbedded Carolina bays will be gone. How long will that take? These observations indicate that Carolina bays are not wispy, ephemeral shorelines, but rather represent the surficial expression of robust structures deeply rooted into the landscape. Ridge Spring represents an ideal locale to investigate the burial chronology of Cretaceous strata by surficial sands using Beryllium-10 cosmogenic exposure techniques.
Goals of Talk

- Ridge Spring, SC Cretaceous Terrace Remnant
  - ~200 bays
- Valley Head Basins – Juvenile Carolina bays?
- Geomorphology hypothesis
- Future directions

• All work product freely available @ cintos.org
“No one has yet invented an explanation which will fully account for all the facts observed” Douglas Johnson

“Their very randomness of grouping and scatter demands an explanation. As a statistical phenomenon, they deserve to be studied statistically.” W.C. Rasmussen

A comprehensive survey might provide the statistics to inspire that “invention”.
Carolina Bay Survey

http://cintos.org/SurveyBayMap
Carolina Bay Survey

http://cintos.org/SurveyQuadMap
Search for “flat” remnant terrace surfaces which may hold bays
115 km of continuous drainage divide between Augusta and Columbia
Ridge Spring Elevation Profile

Distance: **70.4 km**  
Elevation: **155 m min, 221 m max, 192 m avg**
Ridge Spring Cretaceous Terrace

Traversing The Ridge from Augusta to Columbia
<table>
<thead>
<tr>
<th>Bay Name</th>
<th>Major Axis</th>
<th>Bearing</th>
<th>Elevation</th>
</tr>
</thead>
<tbody>
<tr>
<td>134327_2472</td>
<td>0.76</td>
<td>158°</td>
<td>146 m</td>
</tr>
</tbody>
</table>
Mathis Lake Bay, Augusta Suburbs

Tiled DEM using Hue-saturation-value (hsv) rendering, 20x elevation exaggeration. USGS sub-m resolution data rendered at 1.5 or 3 m for network presentation through GE.
baySouth Archetype Template @ 0º

Please reference movie to view GroundOverlay manipulation:
https://gsa.confex.com/gsa/2017SE/webprogram/Handout/Paper291016/MathisBayMeasurment.pdf
Keyhole Markup Language Data in GroundOverlay

```xml
<GroundOverlay>
  <name>134327_2472</name>
  <Icon>
    <href>http://cintos.org/ge/overlays/baySouth.png</href>
  </Icon>
  <LatLonBox>
    <north>33.56496759262686</north>
    <south>33.55789073070017</south>
    <east>-81.92816781208678</east>
    <west>-81.93459628710748</west>
    <rotation>-157.3564252687467</rotation>
  </LatLonBox>
</GroundOverlay>
```

The GroundOverlay meta data’s bounding box defines (with a bit of trig) the major and minor axis of the bay, a bay center, and an approximate surface area. Coordinates define the box with zero rotation applied.
GroundOverlay LatLonBox Computations

<north>33.5649</north>

<west>-81.9345</west>

<east>-81.9281</east>

<south>33.5579</south>
GroundOverlay LatLonBox Computations

<north>33.5649</north>

<west>-81.9345</west>
<east>-81.9281</east>

<south>33.5579</south>
An exclusive index is generated for the bay based on lat & lon, and the summary geospatial data is uploaded into a Google FusionTable. The table today has just under 44,000 entries.
Bay in Aiken, 20 km due east, at same elevation as Mathis Bay
<table>
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<td>134326_2483</td>
<td>0.61</td>
<td>159°</td>
<td>155 m</td>
</tr>
</tbody>
</table>
Aiken, SC

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<td>0.61</td>
<td>159°</td>
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</tbody>
</table>
Streetview along Abbyville Ave, on bay floor looking at rim 240 meters away
Trenton, SC

Bay near Trenton, 23 km NNW, with a 20 m rise in elevation
Bay near Trenton, 23 km NNW, with a 20 m rise in elevation
Trenton, SC

Bay near Trenton. 23 km NNW. with a 20 m rise in elevation

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<th>Bearing</th>
<th>Elevation</th>
</tr>
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<tbody>
<tr>
<td>134327_9632</td>
<td>0.87</td>
<td>152°</td>
<td>181 m</td>
</tr>
</tbody>
</table>
Headward erosion compromising nearby bays
Progression of headward erosion compromising bays – largest here is exactly same size and orientation as previous bay
We look at other bays on Ridge, using Trenton as the new Archetype @ .87 km major axis
Bay 135327_0810

Major axis: 0.7 km  Bearing: 158º  Elevation: 183 m
Bay 135327_1834

Major axis: 0.45 km  Bearing: 154°  Elevation: 197 m
Bay 135327_3511

Major axis: 0.89 km  
Bearing: 159º  
Elevation: 201 m
Aggrading or Degrading?

6 meters of relief across 1.5 km
Bays in Johnston, SC Area

Please reference movie to view cookie-cutter in action:
Bay 135326_3977

Major axis: 0.68 km  Bearing: 161º  Elevation: 194 m
Bay 135326_3957

Major axis: 0.5 km    Bearing: 158°    Elevation: 192 m
Bay 135326_3756 viewed from 2700 m

Major axis: 1.22 km  
Bearing: 153º  
Elevation: 190 m
Bay 135326_5927

Major axis: 0.47 km    Bearing: 152º    Elevation: 193 m
Additional bays near 135326_5927

Terrace dissection leaving remnants along edge
Bay 135326_6405

Major axis: 0.49 km  Bearing: 156°  Elevation: 196 m
Streetview to West along Hampton Terrace, on bay floor looking at rim 150 meters away
Carolina Bays of Ridge Spring

Grey scale comparison, image normalized for size
Carolina Bays of Ridge Spring

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Grey scale comparison, image normalized for size
Carolina Bay Survey

217 bays selected: Lat >= 33.5 AND Lat <= 34 AND Long >= -82 AND Long <= -81.5

Major axis: 140 m to 1.22 km, mean 380 m

Orientations of major axis: 148º to 165º, mean of 154º (clockwise from North)
Taxonomy of landform Genus “Carolina Bay”

- Six tightly constrained archetypes as Species

Bell  Oval  Shore  Carolina  South  West
baySouth represents ~40% of all 48,132 bays in Survey
Histogram of Bay Sizes by Elevation Buckets

- 100 - 125 m, 1121
- 150 m Up, 372
- Ridge Spring, 217
- 0-25 m, 10577
- 50 - 75 m, 13949
- 25 - 50 m, 10577

25 m Buckets
Family Resemblance

All Eastern bays compared to bays in Ridge Spring area
Heavily Eroded bay Carolina Species

Sandra Kimble bay, NC

Bullard Pond bay, NC

Platt bay, NC

Southampton bay, VA
Erosion Control – who’s running the show?

Differential erosion of the Midlothian Plateau
Erosion Control – who’s running the show?

Differential erosion of the Midlothian Plateau
Bay 150310_0969, just 20 km West of Here

Major axis: 1.76 km  Bearing: 130º  Elevation: 96 m
Wilmington, NC – a bay “Gentrified” in past 2 years

Major axis: 1.0 km  
Bearing: 136º  
Elevation: 13 m
Wilmington, NC – a bay “Gentrified” in past 2 years

Major axis: 1.0 km  Bearing: 136º  Elevation: 13 m
Carolina bays are not ephemeral, wispy landforms, but rather represent the surface topology of a sheet of unconsolidated quartzose grains, deposited as ejecta during the Mid Pleistocene Transition impact event ~780 Ka. The planforms and orientations have been robustly imprinted into the landscape, and have resisted ongoing erosional and accretionary processes.
Carolina bays are not ephemeral, wispy landforms, but rather represent the surface topology of a sheet of unconsolidated quartzose grains, deposited as ejecta during the Mid Pleistocene Transition impact event ~780 Ka. The planforms and orientations have been robustly imprinted into the landscape, and have resisted ongoing erosional and accretionary processes.

The hypothesis seems easily falsified:

... “they don’t look that old!”
... “there is no erosion!”
... “bay sediments dating does not supported a singular event!”
... “they are too far away from the MPT Impact Event!”
OSL dating fieldwork at Herndon Bay, NC

Moore, et al documented rim construction at 36.7 +/- 4.1, 29.6 +/- 3.1, and 27.2 +/- 2.8 ka

Moore’s GPR trace clearly illustrates that a structure lying at depths below the sampled strata are actually controlling the relief. What’s down there?
Herndon Bay, NC

Herndon bay is on the lower right here in my LiDAR imagery. What is quite enigmatic is that it has two sibling bays which are perfect matches to the same 1.17 km bayCarolina overlay. Exact, just copy and place in Google Earth.
And each sibling bay has a correlated shadow bay which are perfect matches to the same 1.17 km bay Carolina overlay. Exact, just copy and place in Google Earth.
Summary

Eroded Carolina bays exhibit indications of great age.

Dissection of Costal terraces generates Valley Head Basins when Carolina bays are penetrated by headward stream erosion.

Extensive Deep Coring (10 m) is required to identify deposits controlling surface expression.

Cosmogenic \(^{26}\text{Al}^{10}\text{Be}\) burial dating needed to reach back beyond 50ka to 200 ka limits of classic dating tools.
The Carolina Bays of Ridge Spring