Provenance of Stone Celts

FROM THE MIAMI CIRCLE ARCHAEOLOGICAL SITE, MIAMI, FLORIDA

JACQUELINE EABY DIXON, KYLA SIMONS, LORETTA LEIST, CHRISTOPHER ECK, JOHN RICISAK, JOHN GIFFORD AND JEFF RYAN

1 Rosenstiel School of Marine and Atmospheric Science, Division of Marine Geology and Geophysics, University of Miami, 4600 Rickenbacker Causeway, Miami, FL 33146

2 Miami-Dade Office of Community and Economic Development, Historic Preservation Division, 140 W. Flagler St., Suite 1102, Miami, FL 33130

3 University of South Florida, Dept. of Geology, 4202 East Fowler Ave., Tampa, FL 33620

Introduction

The Brickell Point archaeological site (8DA12) is located on a 2.2-acre parcel of land at the mouth of the Miami River in downtown Miami, Florida (Figure 1). Extensive black earth midden deposits, associated with pre-Columbian aboriginal habitation characterize the site, and it is believed to have been an early component of a major Native American village that became known as "Tequesta" during the historic contact period (A.D. 1513-1750). A distinguishing feature of the site is the presence of hundreds, perhaps thousands, of holes in the surface of the underlying oolitic limestone basement that exhibit evidence of human manufacture. Of particular note is a series of larger "basins", as well as smaller holes, which collectively form a circle approximately 11.5 meters in diameter known as the "Miami Circle" (Figure 2).

The discovery of the "Miami Circle" has received an extraordinary amount of media attention, leading to a bewildering array of popular interpretations as to its nature and origin. The Circle feature's apparent orientation to the cardinal directions, and the alignment of certain holes within and outside of it, have fueled public speculation of a possible affiliation with pre-Columbian cultures in Mesoamerica; in particular, the Maya. If correct, this would radically revise our concept of the geographic extent of Mayan or other pre-Hispanic Mesoamerican cultural influences.

Salvage archaeological excavations were conducted on the site between August 1998 and February 1999. Cultural material recovered at Brickell Point included large quantities of bone and shell artifacts and refuse, ceramics, and numerous examples of non-local stone, including ground stone celts and celt fragments made from basaltic rock. A preliminary assessment of the ceramic artifacts suggests the site was occupied primarily during the Glades IIa through IIIa periods (A.D. 750-1400); however, radiocarbon dating indicates that the earliest occupation of the site dates to at least 1,900 years B.P. (Carr and Ricisak, this issue).

The presence of stone tools made of basaltic rock is important because this rock type is not exposed at the surface anywhere in Florida; therefore, these artifacts could not have been derived from local sources and indicate that the site's aboriginal occupants had access to a far ranging trade network. Possible source rocks are found at many localities within a 1000 km radius of Miami including Central America, lending some, albeit tenuous, support to the Mesoamerican connection hypothesis. Here we determine the geological provenance of the Miami Circle celts to characterize the exchange networks of prehistoric southeastern Florida and to demonstrate that the celts are not of Central American origin.

Description of Hand Axes

Two complete, ground stone celts and fragments of at least three others were found at Brickell Point. Each of the complete celts is typical in form; with a sharpened blade or "bit" end (for cutting or chopping) and with sides that taper to a blunt "poll" end (appropriate for pounding). Of the two complete specimens that were collected, only one was recovered in situ. FS #350B (Figure 3A) was found within a shallow (11 cm deep) circular "posthole" feature cut into the limestone bedrock outside of the eastern perimeter of the "Miami Circle". This artifact is made of medium-grained greenish-gray stone that has been ground to a smooth finish. Its bit end is convex and is beveled on one side, possibly as a result of resharpening. Its sides taper to a slightly rounded poll. The celt is generally oval in cross section with some flattening near the bit end. Visible use wear includes a small chip and minor nicks along the bit edge and some minor wear on the poll. Maximum dimensions are approximately 91 mm on the poll. The celt is generally oval in cross section with some flattening near the bit end. Visible use wear includes a small chip and minor nicks along the bit edge and some minor wear on the poll. Maximum dimensions are approximately 91 mm from bit to poll; 60 mm width at bit; 25 mm width at poll; and 31 mm thick approximately 40 mm from bit edge.

The second complete celt (FS# 520; Figure 3B) was recovered from a disturbed context in a spoil pile comprised of mixed midden soil and modem fill removed during on-site building demolition activity from an area along the east side of the Circle feature. This artifact is particularly well made of a fine-grained gray stone ground to a very smooth finish. It shares the same general shape as FS# 350-B, but with distinct...
differences. Its sides are slightly broader, its poll end is less rounded, and its bit end is not beveled. This celt also exhibits use wear as evidenced by a few very minor nicks on its bit end and a lack of finish and some minor chipping on its poll. A patch of an unidentified foreign substance (pine resin?) occurs on one of the celt's broader sides and may be related to hafting. The maximum dimensions of this artifact are 75 mm, from bit to poll; 59 mm width at bit; 31 mm width at poll; and 30 mm thick at approximately 40 mm from bit edge.

Samples 516 and 517 (Figures 3C and D) were each stone celt fragments recovered from intact midden deposits overlying the bedrock surface within the area circumscribed by the Circle feature. Sample 518 was a small fragment found within the overlying midden just outside of the Circle's northwestern quadrant. Each sample is believed to be from a different original artifact.

It is interesting to note how well the Brickell Point celts conform to the general description of other stone celts found in southern Florida given by Goggin in his unpublished manuscript. *The Archeology of the Glades Area* (n.d.). Goggin states "All the specimens seen are small, 75 to 92 mm long ... roughly rectangular in shape with sides that taper to a gently rounded or square [poll]. The bit is square or slightly rounded. The surface is well finished but not polished."

**Methods**

Mineralogy and textures were identified using a petrographic microscope at the Rosenstiel School of Marine and Atmospheric Science, University of Miami. Two of the fragmentary celts (516 and 518) were crushed and prepared for major and trace element analysis using direct coupled plasma

![Figure 1. Location of Brickell Point archeological site on the Miami River near downtown Miami, Florida.](image)
Figure 2. Map of the "Miami Circle." Celt and celt fragment locations are indicated by labels set to the right of their recovery locations. Circle diameter is 11.5 meters.
Figure 3. Photographs of celts and celt fragments. A) complete celts: FS#350-B (left) and FS#520 (right); B) celt fragment 516; C) celt fragment 517; D) celt fragment 518.

(DCP) and inductively-coupled plasma-mass spectrometry (ICP-MS) at the University of South Florida according to the methods described in Klein (1989) and Savov et al. (in press). Fragment 517 was held in reserve, in case additional analyses requiring larger sample volumes (i.e., radiogenic isotopic analysis or age dating) were required to solve the problem.

Results

The intact celts are made of massive, fine- to medium-grained, basalt. Vesicles (gas bubbles) and phenocrysts (larger crystals) are absent. Grain size varies from <1 to 2 mm. The primary mineralogy is dominated by plagioclase and pyroxene. Both celts appear relatively fresh in hand sample, though the
amount of secondary alteration is difficult to access without a thin section.

Celt fragments 517 and 518 are fresh (dark grey with no foliation) and similar to the intact celts. Celt fragment 516, however, appeared metamorphosed in hand sample (green with foliated texture). A thin section of sample 516 reveals pervasive replacement of pyroxene by fibrous to platy, pale green to pale brown amphibole, replacement of plagioclase by a paler amphibole (not clay minerals), and replacement of Fe-Ti oxides by titanite (sphene). Sulfides are the only opaque oxides present. No thin section was made of celt fragment 518 because of insufficient sample size.

Major and trace elements of the celt fragment 516 and 518 are listed in Table 1. Both celt fragments are basaltic (~52 wt% SiO$_2$, 14.3 wt% Al$_2$O$_3$, and 0.76 wt% TiO$_2$) and moderately differentiated (7-8 wt% MgO, ~10 wt% FeO) in composition. Thus, the source rock for these two celt fragments is probably the same quarry or closely related sites. The composition of celt fragment 516 differs significantly from celt fragment 518, however, with respect to the more mobile chemical components (easily modified during alteration and metamorphism) Na$_2$O (enriched by 23 %) and K$_2$O (depleted by 74%). Sample 516 also has a lower total of major element oxides than 518 (total of 96.4 and 98.0 wt%, respectively), indicating a greater abundance of secondary hydrous minerals. Determination of the metamorphic history of celt fragment 516 based on one thin section of an isolated sample is not possible, but it probably has suffered some combination of non-oxidative, hydrothermal alteration (Natland et al. 1984; Puffer and Student 1992) and metamorphism up to amphibolite grade.

**Discussion**

In order to determine the provenance of the Brickell Point celts, we compared the mineralogy, texture, and major and trace element analyses of sample 518 to published analyses of possible source rocks. Since celt fragments 516 and 518 and the whole celts are similar in their gross physical characteristics (mafic, fine- to medium-grained, and non-vesicular), we assume that they are chemically similar and will use the chemistry of the fresher celt fragment (518) to determine the provenance of the axes found at the circle.

We compiled a database of 776 major and trace element analyses of basaltic rocks from Mexico, Central America, South America, the Caribbean, and North America including Canada and Newfoundland (Table 2). In addition, we included analyses from locations unlikely to be the source of the celts (Africa, Hawaii, Tazmania and the seafloor). The complete database is available on our website (http://www.miami.edu/geology/basaltdata).

An important objective of this study is to distinguish between a Caribbean region (Mexico, Central America, Puerto Rico) and a non-Caribbean basin (North America, South America, and the seafloor). Determination of the provenance of the axes found at the circle was facilitated by the presence of excess K$_2$O in Cambrian-age rocks from the Caribbean region, which is unusual for most basaltic rocks. This excess K$_2$O is likely due to the influx of seawater during the regional magmatism of the Cambrian period (Bugayevskaya et al. 1986; Zartman and Smith 1978).

Table 1. Major and Trace Element Analyses of Celts from Brickell Point. Major elements by direct coupled plasma (DCP). Trace elements by DCP and inductively-coupled plasma - mass spectrometry (ICP-MS). Numbers in parentheses are the number of analyses used to calculate mean and standard deviation. Celt fragment 518 appeared fresh in hand sample. Celt fragment 516 appeared metamorphosed in hand sample, n.a. means not analyzed.

<table>
<thead>
<tr>
<th>Oxide (wt%)</th>
<th>518 (4)</th>
<th>516 (2)</th>
<th>Element (ppm)</th>
<th>518 (2)</th>
<th>516 (1)</th>
</tr>
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<tbody>
<tr>
<td>SiO$_2$</td>
<td>51.8 ±0.2</td>
<td>51.1 ±0.2</td>
<td>Sr</td>
<td>129 ±7</td>
<td>170</td>
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<tr>
<td>TiO$_2$</td>
<td>0.76 ±0.06</td>
<td>0.76 ± 0.03</td>
<td>Ba</td>
<td>111±6</td>
<td>52</td>
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<tr>
<td>Al$_2$O$_3$</td>
<td>14.3 ±0.2</td>
<td>14.4 ± 0.2</td>
<td>Ni</td>
<td>47 ±2</td>
<td>54</td>
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<tr>
<td>FeO</td>
<td>10.3 ±0.5</td>
<td>9.10± 0.25</td>
<td>Sc</td>
<td>39 ±3</td>
<td>43</td>
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<tr>
<td>MnO</td>
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<td>0.17± 0.01</td>
<td>Cr</td>
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<tr>
<td>MgO</td>
<td>7.62 ±0.44</td>
<td>6.98 ± 0.24</td>
<td>V</td>
<td>233±10</td>
<td>223</td>
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<tr>
<td>CaO</td>
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<td>11.2 ± 0.40</td>
<td>Zn</td>
<td>83 ±1</td>
<td>81</td>
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<td>Na$_2$O</td>
<td>2.03 ±0.07</td>
<td>2.50 ± 0.09</td>
<td>Cu</td>
<td>56 ±3</td>
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<tr>
<td>K$_2$O</td>
<td>0.54 ±0.04</td>
<td>0.14± 0.01</td>
<td>La</td>
<td>7.20 ± 0.07</td>
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<td>Total</td>
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<td>Ce</td>
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<td></td>
<td></td>
<td>Pr</td>
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<td></td>
<td></td>
<td></td>
<td>Nd</td>
<td>7.86 ± 0.03</td>
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<td></td>
<td></td>
<td></td>
<td>Sm</td>
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<td></td>
<td></td>
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<td>Dy</td>
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<td></td>
<td></td>
<td>Lu</td>
<td>0.41 ±0.01</td>
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Table 2. Summary of sources for database on basaltic rocks. There are a total of 776 chemical analyses considered. Each of the analyses is a combination of major and trace elements, a) Arculus (1976: Tables 1A and 5D); b) Arculus (1978: Table 1); c) Ariskin et al. (1987: Table 1); d) Bedard (1992: Tables 2 and 3); e) Bertrand and Coffrant (1977: Table 1); f) Bryan et al. (1977: Table 3A); g) Donnelly et al. (1990: Table 1); h) Donnelly and Rogers (1978: Tables 1 and 2); i) Dostal and Greenough (1992: Table 2); j) Goosens and Rose (1973: Tables 1 and 4); k) Goosens et al. (1977: Tables 3 and 4); l) Goring and Naslund (1995: Tables 1 and 2); m) Hawkesworth and Powell (1980: Tables 1-3); n) Houghton et al. (1992: Table 1); o) Husch (1992: Tables 1,2 and 4); p) Luhr et al. (1989: Table 1); q) MacRae and Metson (1985: Table 1); r) Milla and Ragland (1992: Table 4); s) Papezik and Hodych (1980: Tables 1,3 and 2); t) Pe-Piper et al. (1992: Table 2); u) Philpotts (1992: Table 1); v) Philpotts and Martello (1985: Table 1); w) Philpotts and Reichenbach (1985: Table); x) Puffer (1992: Tables 1 and Alb-Aid); y) Puffer et al. (1981: Table); z) Puffer and Student (1992: Table 1); aa) Ragland et al. (1992: Tables 1-4); bb) Ross (1992: Table 2); cc) Shirley (1987: Tables 1 and 2); dd) Smith and Barnes (1994; Tables 3,5 and 6); ee) Smith et al. (1975: Tables 1 and 2); ft) Steiner et al. (1992: Tables 1 and 2); gg) Swinden et al. (1997: Table 1); hh) Venna and Nelson (1989: Table); ii) Walker (1969: Tables 8-10,12-13 and 17-18); jj) Warner et al. (1985: Tables 4 and 5); kk) Warner et al. (1992: Table 3); 1) Weigand and Ragland (1970: Tables 1 and 2); mm) numbers include all single rock analyses and averages considered; nn) any analysis given as located in the states of Virginia or West Virginia without a published latitude is defined as upper Appalachian as well as some Maine samples not related to Canada or Newfoundland. Data used may not be original data from paper cited.

<table>
<thead>
<tr>
<th>General Location</th>
<th>Region</th>
<th>Description and Comments</th>
<th>No. of analyses</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle America</td>
<td>Mexico</td>
<td>Guatemala, El Salvador, Nicaragua, Panama, Costa Rica</td>
<td>11</td>
<td>p, hh</td>
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<tr>
<td></td>
<td>Central America</td>
<td></td>
<td>27</td>
<td>g, j, k</td>
</tr>
<tr>
<td>South America</td>
<td>Colombia</td>
<td></td>
<td>12</td>
<td>k</td>
</tr>
<tr>
<td></td>
<td>Venezuela</td>
<td></td>
<td>6</td>
<td>h</td>
</tr>
<tr>
<td></td>
<td>Ecuador and Peru</td>
<td></td>
<td>5</td>
<td>j, k</td>
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Rico, Lesser Antilles) or North American source. In general, basalts from the Caribbean region are relatively young (less than 30 million years), subaerial lavas, associated with convergent, subduction zone tectonic environments (e.g. Robin 1982; Donnelly et al. 1990). In contrast, basalts from eastern North America (ENA) are older (approximately 200 million years), shallow crustal dikes currently exposed at the surface by uplift and erosion, formed in a divergent tectonic environment during rifting of Pangea to form the Atlantic Ocean (Weigand and Ragland 1970; Puffer 1992; Marzoli et al. 1999). Basalt that crystallizes in a shallow crustal environment tends to form fine to coarse-grained basaltic rocks commonly referred to as diabase or dolerite. Basaltic magmas from divergent and convergent tectonic environments are both generated by partial melting of mantle rocks, but the mantle above subduction zones is infiltrated by hydrous fluids released from the subducting plate, which imparts a characteristic geochemical fingerprint to the magmas.

Basalts from the Caribbean region and ENA are texturally distinct. One important distinction is that Caribbean lavas tend to have abundant vesicles (gas bubbles) related to their higher initial gas content and low pressure of eruption and crystallization, whereas ENA basalts are typically massive (vesicle-poor) because of their lower initial volatile content and higher pressure of crystallization. Thus, the massive, non-vesicular texture of the stone source for the celts suggests derivation from a North American source. While most publications describe ENA dike rocks as massive (e.g., Lester and Alien, 1950; Sundeen and Huff, 1992), detailed descriptions of vesicle contents are not commonly provided. However, diabase from Georgia has been described as "remarkably free of cavities" (Lester and Alien, 1950) and is a possible source rock.

Chemically, convergent margin lavas typically have compositions extending to higher SiO$_2$, Al$_2$O$_3$, Na$_2$O, and K$_2$O concentrations than divergent margin lavas. Figure 4 shows that the ENA and Mid-Atlantic Ridge basalts have distinctly lower total alkalis (Na$_2$O + K$_2$O) at the same Al$_2$O$_3$ content than do most basalts from Mexico, Central America, and the Lesser Antilles. Celt fragment 518 clearly lies in the fields defined by divergent margin related basalts. Therefore, the geochemistry of the celts is consistent with a North American source and inconsistent with a provenance from recent arc volcanics in Mexico, Central America, or the Lesser Antilles.
Table 2. (Continued).

<table>
<thead>
<tr>
<th>General Location</th>
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<th>Description and Comments</th>
<th>No. of analyses</th>
<th>References</th>
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<td>The Caribbean</td>
<td>Greater Antilles: Cuba, Hispaniola, Jamaica, Puerto Rico</td>
<td>Calk-Alkaline Association.</td>
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<td></td>
<td>Primitive Island Arc and Mid-Ocean Ridge Basalt Association.</td>
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<td>Lower Lesser Antilles</td>
<td>South of 16 deg. North latitude. Includes the Venezuela Islands. Calk-Alkaline Association.</td>
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<td>a, b, g, m</td>
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<td>g, h, gg</td>
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<td>Anubia Mid-Ocean Ridge Basalt Association.</td>
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<td>Not Antilles</td>
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<td>g</td>
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<td>North America</td>
<td>Canada and Newfoundland</td>
<td>Includes some parts of Maine.</td>
<td>28</td>
<td>d, e, i, s, t</td>
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<td>The United States</td>
<td>Palisades Sill, New Jersey and New York.</td>
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<td>157</td>
<td>c, l, q, cc, ff, ii</td>
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<td>Upper Appalachians. North of 37 deg. North latitude.</td>
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<td>293</td>
<td>e, l, n, o, u, v, w, x, y, z, aa, bb, dd, ee, ll</td>
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<td></td>
<td>Lower Appalachians. South of 37 deg. North latitude.</td>
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<td>64</td>
<td>r, s, aa, jj, ll, kk</td>
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<td>Unlikely Sources</td>
<td>Africa (Morocco and Karoo), Tazmania, Hawaii, Sea Floor.</td>
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<td>13</td>
<td>d, c, f, k, gg, ii</td>
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The ENA basaltic dikes can be subdivided into 5 main chemical groups based mainly on the relative abundances of SiO$_2$, TiO$_2$, and Fe$_2$O$_3$ (e.g., Weigand and Ragland 1970; Ragland et al. 1992; Milla and Ragland 1992): 1) Low-TiO$_2$ quartz-normative (LTQ); 2) High-TiO$_2$ quartz-normative (HTQ); 3) High-Fe$_2$O$_3$ quartz-normative (HFQ); 4) Low-TiO$_2$ olivine-normative (LTO); and 5) High-TiO$_2$ olivine-normative (HTO). On a plot of TiO$_2$ versus SiO$_2$, 4 of the 5 groups are clearly distinguishable, with overlap of the HTQ and HFQ group. Celt fragment 518 lies within the LTQ group to better than 95% confidence (Figure 5).

The 5 main chemical groups have unequal geographical distribution. Low-TiO$_2$ quartz-normative basaltic dikes are most common in Georgia-Alabama, where they occur together with olivine normative compositions, and they are also found as dikes and flows in Virginia, Pennsylvania, New Jersey, and Connecticut (Weigand and Ragland 1970; Smith et al. 1975; Manspeizer et al. 1989). In order to determine the precise source, we narrowed our search to those LTQ basalts having chemical compositions defined by a restricted range of oxide component abundances in weight percent (13 wt% <Al$_2$O$_3$< 16.0 wt% and Na$_2$O + K$_2$O > 2.0 wt%). Figure 6 plots K$_2$O versus Fe$_2$O$_3$ and shows that the composition of celt fragment 518 is most similar (within 1 standard error or 66% confidence level) to the low-TiO$_2$ quartz-normative basalts in Georgia and Alabama. The Georgia-Alabama (GAA) LTQ analyses include an individual (GAA8; Weigand and Ragland 1970) and a regional average (GAA AVG; Milla and Ragland 1992).

We are unable to pinpoint an exact quarry site; however, the largest concentration of these NW-SE trending dikes in the Georgia Piedmont area occurs within a 50 X 50 km area north of Macon, Georgia (Lester and Alien 1950; Figure 7), and we
suggest this is the most likely source area.

Implications for Defining Prehistoric Exchange Networks in Southeast Florida

In southeast Florida, ground stone artifacts made of any material other than native limestone are, by definition, evidence of long distance exchange. Locally available stone is limited to limestones that are generally unsuitable for making durable tools. Volcanic pumice can also occur "naturally" in south Florida coastal areas and has been frequently found in archaeological contexts in Miami-Dade County, including at Brickell Point. This material probably floated to south Florida shores, however, and is not necessarily the result of long distance exchange. Although easily carved and an excellent abrasive, it also is far too soft for most other uses.

There is substantial archaeological evidence for the use and trade of non-local stone, in both raw and finished form, in southeast Florida. Ground stone celts, although not a common artifact type, are well represented in Miami-Dade County prehistoric assemblages. Examples include whole stone celts and/or celt fragments from the Snapper Creek Site (8DA9), the Granada Site (8DA11), the Surfside Midden (8DA21), Oleta River 1 (8DA25), Opa-Locka 1 (8DA48), Dolphin Stadium (8DA411), the Cheetum Site (8DA1058), and the John Site (8DA1081) (Robert Carr, personal communication 2000; Willey 1949; Goggin 1964; Griffin et al. 1982). All of these artifacts are believed to have been associated with pre-contact, Glades period midden deposits and several share similar characteristics of size and form with the Brickell Point celts. Most are reported as being made of igneous rock, although Willey (1949) described one fragment (from Opa-Locka 1) as being of weathered sandstone. Unfortunately, specific information about their temporal associations is scant. Only the Granada example, a miniature celt 21 mm in length, was reported as having been found in a "Glades III" context (i.e., after A.D. 1200) (Griffin et al. 1982). The Granada Site, now mostly destroyed, is located immediately across the Miami River from Brickell Point and was also a component of the village of Tequesta.

It is significant, but not surprising, that a basaltic celt with a Macon-area quarry source might be found in southeast Florida. Exotic ground stone artifacts recovered from southeast Florida sites have traditionally been attributed to trade with locations to the north (Fairbanks 1949; Goggin n.d.; Willey 1949), a reasonable assumption given an overall dearth
of archaeological evidence for prehistoric maritime-based exchange between southeast Florida and points south. Goggin (n.d.) describes the occurrence of stone celts on archaeological sites outside the Glades Area as "steadily increasing ... as one goes northward" and notes their relative abundance on the lower St. Johns River. Willey (1949) also notes that the presence of ground stone celts was a feature shared by sites in Florida's central and northwest Gulf Coast as well as in the St. Johns River region of northeast Florida.

While Goggin (n.d.) assigns both Glades II and Glades III period dates to ground stone celts found in southeast Florida, Willey (1949) suggests that they were "recently diffused" from the north, presumably during the Glades III period (after A.D. 1200), and that they are one of several manifestations of the Hopewellian and Mississippian-influenced Weeden Island and St. Johns cultures on the Glades region. A Macon area provenance of the Brickell Point celts suggests an affiliation with the Late Woodland (A.D. 500-900) or the Mississippian (A.D. 900-1685) cultures of the Macon Plateau, which were characterized by well-developed ground stone complexes and participation in far-ranging networks of material exchange (Fairbanks 1956). The Mississippian horizon in Central Georgia emerged contemporaneously with the beginning of the Glades IIb period (A.D. 900-1000) in southeast Florida and lasted into the period of European contact (Fairbanks 1956; Goggin 1949). Mississippian-related influences have been noted in other aspects of Glades material culture in the Glades II and III periods, most recently by Wheeler and Coleman (1996).

The route and means by which the Brickell Point celts arrived in southeast Florida, and the time period in which they were introduced, are unknown. Further investigations at the site and the processing and analysis of previously excavated material may serve to answer these questions. Additional research and geochemical analysis of stone celts found elsewhere in southeast Florida, and throughout the Florida peninsula, is also needed to help define the nature and extent of the distribution of this artifact type.

Conclusions

Ground stone celts from the Brickell Point archaeological site were made from low-TiO₂ quartz-normative basaltic rock characteristic of basaltic dikes from the Piedmont region of Georgia, in the vicinity of Atlanta and Macon. These dikes formed approximately 200 million years ago along the North American margin associated with the break up of Pangea and the formation of the Atlantic Ocean. The identification of this
Figure 6. K<sub>2</sub>O plotted against Fe<sub>2</sub>O<sub>3</sub>(Fe<sub>2</sub>O<sub>3</sub> = 1.1 X FeO) for LTQ-basalts from eastern North America and celt fragment 518 (filled square). Analyses shown have 13 wt% < Al<sub>2</sub>O<sub>3</sub>< 16 wt%, Na<sub>2</sub>O + K<sub>2</sub>O > 2 wt%, and chemistry similar in most respects to celt fragment 518. Samples from Georgia and Alabama (GAA) are shown as open squares. GAA AVG is an average of 20 analyses of basaltic dikes from Georgia and Alabama (Milla and Ragland 1992). Error bars are 1 standard error of the mean of multiple samples (regional mean). GAA8 is a single analysis of a basaltic dike located southeast of Atlanta at 33° 36' 42" N and 83° 53' 48" W (Weigand and Ragland 1970; Weigand 1970). The open triangle is sample LC-102C2 (Ragland et al. 1992), the closest match of samples from South Carolina through Virginia. The open circles are samples from Connecticut through New Jersey including: 1-LTQ Preakness (Husch 1992); 2-P6c (Puffer 1992); 3-LSR10 (Husch 1992); 4-avg LSR 8,9,10,11 (Husch 1992); 5-Holyoke Ave Fdr (Philpotts 1992); and 7-WR7 (Weigand and Ragland 1970). Error bars (lc) on the single analyses are 3% for Al<sub>2</sub>O<sub>3</sub> and 6% for K<sub>2</sub>O (Milla and Ragland 1992).

At a one standard error (66% confidence level), celt fragment 518 is consistent with an origin from Georgia and Alabama low-TiO<sub>2</sub> quartz normative basalt.

area as the stone's likely source supports previous assumptions that ground stone celts from prehistoric archaeological sites in southeast Florida originated from the north. It does not support trade or interaction with pre-Columbian cultures in Mexico, Central America, or the Caribbean.

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Figure 7. Map of Southern Appalachian basaltic dikes and a few relevant archaeological sites. Latitude, longitude, state boundaries and dike locations are composed and modified from Ragland et al. (1983: Figure 1) and Smith and Noltimier (1979: Figure 1). Above the fall line is the Piedmont area. a) Kolomoki. Late Woodland Sites: b) Aspalga; c) Crystal River; d) McKeithen; e) Banks. Mississippian Sites: f) Lake Jackson; g) Etowah; h) Beaverdam; i) Hollywood; j) Ocmulgee. Information about the debated Kolomoki site origin and the locations of all of the sites are found in Bense 1994 (Figures 6.25, 7.24 and pages 174-175); Hally 1994, and Jenkins 1985 (page 82).


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