AN EVALUATION OF THE UTILITY OF CAROLINA CLAYS FOR WOODLAND POTTERS

by

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Abstract. This study evaluates the physical properties of 57 clays from four drainages in the Carolina Piedmont and Coastal Plain as part of a larger endeavor to identify the sources of raw materials used to make prehistoric pottery recovered from sites in the North Carolina Sandhills. Performance and replication experiments were conducted to assess the suitability of each clay sample for making coil-built, conical-based pots. The results of these experiments suggest that Sandhills pottery was fashioned from non-local clays obtained from neighboring regions. These results inform interpretations regarding patterns of mobility and exchange in the Sandhills during the Woodland period.

This is the second of two related papers that use ceramic analysis to address mobility and resource utilization in the North Carolina Sandhills during the Woodland period (ca. 1500 B.C. – A.D. 1600). The first paper (Smith and Herbert 2004 here link to web page) compared the chemical and mineral constituents of prehistoric pottery from sites in the Sandhills and three surrounding Piedmont and Coastal Plain regions in an effort to identify possible source locations of resources used to make Sandhills pottery. While this compositional comparison of artifacts does suggest that people may have transported pottery into the Sandhills from other regions, it cannot rule out the alternative possibility that variation in local clay and temper sources accounts for the relatively variable composition of Sandhills pottery. Nor can comparison of archaeological pottery help us understand why particular resources, be they local or non-local, were selected by people in the first place (Neff et al. 1992).

To address these two unresolved issues, we launched a second phase of study consisting of a ceramic raw materials survey. The primary objective of this survey was to characterize Sandhills clays to determine if serviceable clays exist locally, and, if not, to identify the closest areas from which serviceable potting clays can be obtained. Accordingly, 57 clay samples were collected from the vicinities of key sites in the Sandhills and four surrounding regions of the Carolina Piedmont and Coastal Plain. These samples were then subjected to a series of field and laboratory performance tests designed to evaluate their suitability for making low-fired earthenwares. This second paper summarizes our clay sample collecting strategy, the results of performance tests, and the implications for interpretations of mobility patterns, social territories, and exchange during the Woodland period.

Sample Collection

Clay samples were collected during the spring and summer of 2004 (Figure 1). Operating under the assumption that prehistoric potters procured clay resources within 5 kilometers of their pottery-making activity areas (Arnold 1985), we obtained the majority of our samples in the vicinities of the same sites from which the archaeological pottery samples considered in the first phase of study were drawn.

Figure 1. Collecting clay samples with 10-cm bucket auger.

Potential clay sample locations were predicted using topographic quad sheets and, where available, soils and geologic maps. More often than not, however, we found it necessary to cover a great deal of territory in order to find suitable clays. We systematically surveyed riverbanks and lower-order streambeds near pottery site locations, a process that required canoeing and hiking many miles of shoreline.

Once an exposed or near-surface deposit of clay was located in the field, we performed a simple plasticity "coil" test before collecting a sample. This test entails rolling the clay into a 1-cm-diameter coil and wrapping it around a finger (Figure 2). With the exception of the Sandhills samples, clays whose coils broke in half during the coil test were not collected. Approximately two liters of each clay type that passed the coil test were collected for additional analyses.

Figure 2. The plasticity of each clay sample was judged in the field with a simple coil test.

In all, 57 clay samples were obtained from four drainages in the Carolina Piedmont and Coastal Plain: (1) the Lower Little River, (2) the Lumber River, (3) the Haw-Cape Fear, and (4) the Yadkin-Pee Dee (Figure 3). Eleven samples collected on Fort Bragg represent the Lower Little River basin in the Sandhills, while a twelfth sample also obtained in the Sandhills but slightly west of Bragg is the sole representative of the upper Lumber River basin. A total of 18 samples represent the eastern Piedmont source area of the lower Haw River: 14 from the banks of the Haw River and B. Everett Jordan Lake in the vicinity of the now-submerged Haw River Site (31Ch29), two from the banks of Morgan Creek, and two from the banks of New Hope Creek. An additional six samples collected near the Breece site (31Cd8) represent a clay source area in the middle Cape Fear basin on the upper Coastal Plain. Finally, 12 samples encountered along the banks of the Uwharrie and Yadkin rivers close to the Doerschuk site (31Mg22) represent the eastern Piedmont source area of the lower Yadkin River, while nine samples taken near the Kolb site in South Carolina represent the Coastal Plain Pee Dee basin (Figure 3).

During clay sample collection, we also obtained several non-plastic samples for possible use as tempering materials. We collected sand samples from the banks of B. Everett Jordan Lake and Morgan Creek, quartz from the Sandhills, and chunks of diabase from dikes cropping out along the Deep River in Carbonton.

Performance Trials

The suitability of each clay sample for making coil-built, conical-based pots was further assessed through a four-stage series of performance trials. The first stage quantifies the plasticity of the sample clays. The second and third stages examine drying and firing behavior, respectively. The final stage of experimentation, still underway, involves complete replication of coil-built ceramic vessels. At the end of every stage, all clay samples deemed unsuitable for making pottery were eliminated from further experimentation.

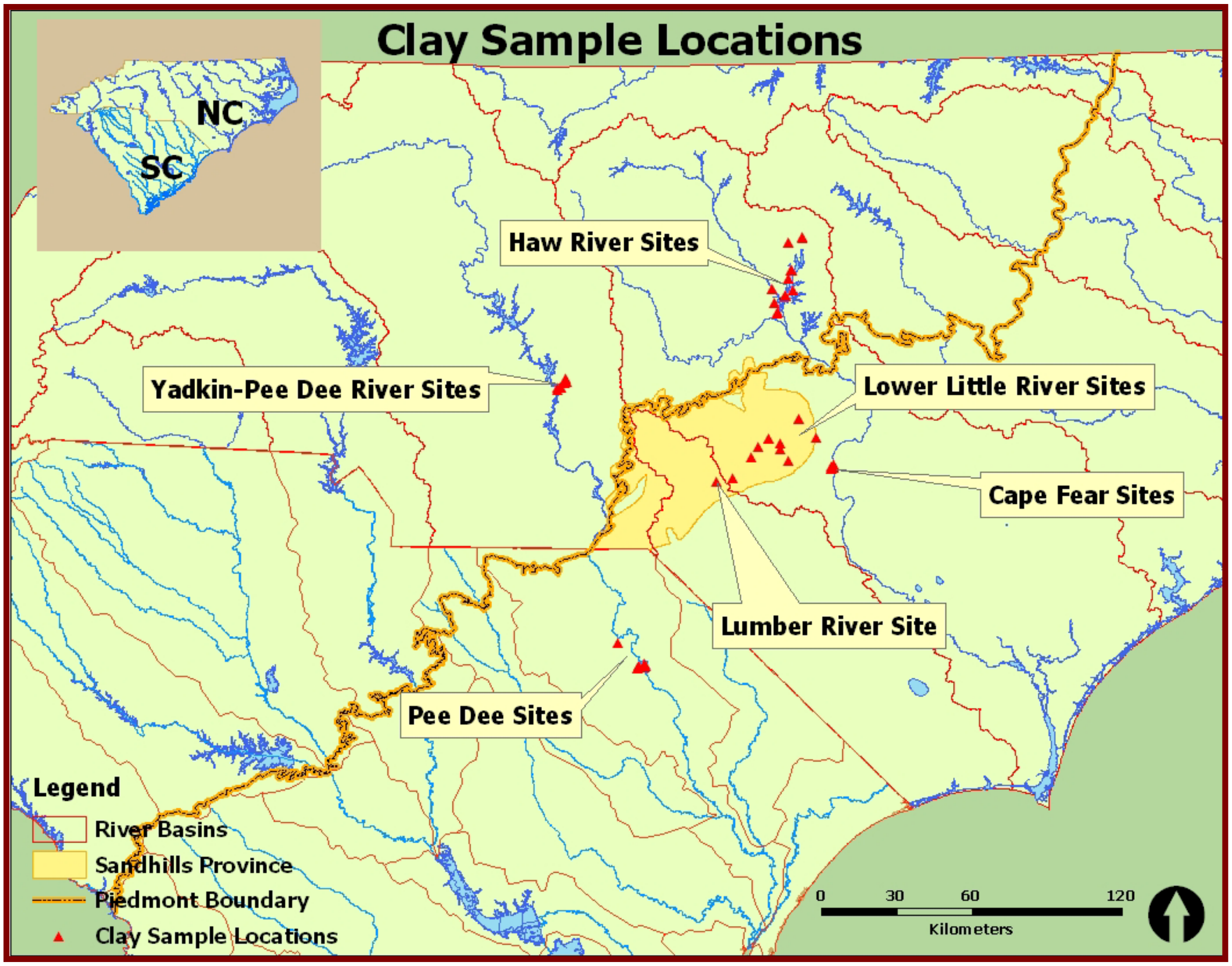

Figure 3. Clay sample collection sites in the Sandhills and in surrounding regions near key archaeological sites.

Stage 1: Plasticity

The workability of clay is judged subjectively. In this study, samples were assigned to ordinal classes designated as "lean," "moderately lean," or "good" on the basis of three tests: the "coil test," the "loop test," and the "ball test." This particular suite of tests enabled us to characterize the sample clays in terms of plasticity, stiffness, and strength.

Every sample was subjected to a coil test under the controlled conditions of the lab, regardless of whether a similar test had already been performed in the field. In the "loop" test a 1-cm coil is made into a 6- to 8-cm diameter ring or "loop" set upright on its edge for several minutes to monitor sagging (Bjørn 1969). For the "ball" test, a golf ball-sized ball is compressed with the thumb to approximately one centimeter in thickness (Figure 4). Lean clays form coils that break when wrapped around a finger, loops that sag significantly when stood on edge, and balls that develop deep cracks when compressed (Figure 5). Moderately lean clays form coils that crack but do not break, rings that sag slightly, and balls that develop shallow cracks when compressed (Figure 6). Good clays coil and wrap without breaking or cracking, stand up proudly in their loop without sagging, and do not develop cracks when compressed (Figure 7).

Figure 4. The plasticity and stiffness of each sample was judged in the lab on the basis of coil (A), ball (B), and loop (C) tests.

Figure 5. In general, lean clays are defined as those having coils that break completely when wrapped, rings that sag significantly when stood on edge, and balls that develop deep cracks when compressed.

Figure 6. Moderately lean clays form coils that crack but do not break, rings that sag slightly, and balls that develop shallow cracks when compressed.

Figure 7. Good clays coil and wrap without breaking or cracking, stand up proudly in their loop without sagging, and do not develop cracks when compressed.

In practice, however, many types of clay exhibited characteristics of plasticity, stiffness, and strength that were intermediate between these categories. In such cases, samples were assigned to the leaner of the two workability categories.

Stage 2: Drying Behavior

While the physical properties of raw clays are important to understand, it is of course the properties of the pottery made from the clay samples that are most relevant to an archaeological study. All clays characterized as good and most moderately lean samples were therefore fashioned into standard 10 x 10 x 1 cm test tiles for firing. While still in the plastic (wet) state, the test tiles were weighed and assigned Munsell color readings. They were then allowed to dry for 72 hours, with the final 24 hours of drying achieved in a 105°C oven (Ries 1927). Each tile was monitored for weight loss, linear drying shrinkage (following methods developed by Binns [1947], Rice [1987], and Ries [1927]), cracking, and warping after approximately 24, 48, and 72 hours of drying. A second Munsell color reading was assigned to the oven-dried tiles.

Tempered test tiles were also produced for all of the good and a few of the moderately lean clays. Choice of temper for Sandhills, Breece, and Haw River clays was based on the mineralogical evidence obtained for the archaeological pottery samples and summarized in the previous paper. Clays collected near the Fort Bragg and Breece sites were thus tempered with grog, which was obtained by crushing fired test tiles made from the same sample clays. Haw River site pottery was tempered with either sand or crushed quartz, and consequently sample clays from the Haw River area were tempered in both ways. Likewise, sherds from the Kolb site (which were not considered in the first phase of study) appear to be tempered with either sand or grog, and sample clays from the Kolb area were tempered accordingly. Note that because no good clays were found in the vicinity of Doerschuk, tempered test tiles have not yet been made from Yadkin River clays.

All tempered test tiles were subjected to the same drying and monitoring regimen described for the untempered tiles.

Stage 3: Firing Behavior

After drying, the test tiles were fired at 893°C in an electric kiln at UNC's art lab. The fired tiles were weighed and measured to determine firing shrinkage, and any changes in Munsell color, cracking, or warping were noted. Ultimately, segments of the fired tiles will be subjected to chemical and petrographic analyses, the results of which can be compared to those obtained for the archaeological ceramic specimens.

Stage 4: Vessel Replication

We are currently attempting to fashion replica coil-built pots from those tempered clay samples that did not exhibit excessive shrinkage or warping during firing. Several pots that have been successfully built and fired in open-fire settings at UNC's art lab and the North Carolina Pottery Center provide the ultimate proof of clay's suitability for pottery making (Figure 8).

Figure 8. Pots fired in open-fire settings provide the ultimate proof of the clay's suitability for pottery making.

Results

We recognize the improbability of sampling the very same clays exploited by Woodland potters (Neff et al. 1992), and consequently we couch the results of our four stages of experimentation in terms of relatively general regional trends in clay properties. Thus far, the results of stages 1 and 4 have proven most informative for our purposes.

Stage 1 results indicate that only 14, or approximately 25%, of 57 clay samples can be characterized as having good workability (Table 1). Approximately 54% of the samples were classified as moderately lean and 21% are lean.

Table 1. Workability of Clay Types by

Sample Region	Workability: Lean (%)	Workability: Moderately Lean (%)	Workability: Good (%)
Sandhills	75	17	8
Breece	0	50	50
Kolb	0	33	67
Haw River	0	78	22
Doerschuk	25	75	0
Total	21	54	25

Only one good clay sample came from the Fort Bragg area, and in fact the majority of Sandhills clays lack the plasticity necessary for building pots (Figure 9). In contrast, clays obtained east of the Sandhills near the Breece site on the Cape Fear River tend to be scored as good or moderately lean in lab tests. The clays most consistently rated as good, however, came from the Kolb site area on the Pee Dee River south and west of the Sandhills. Good clay sources were also found near the Haw River site in the Piedmont, while Doerschuk-area clays from the banks of the Uwharrie and Yadkin Rivers appear to be unsuitable for pottery-making.

Data collected during the second and third stages of experimentation are somewhat more difficult to interpret. Measurement of test-tile shrinkage indicated that our Sandhills samples exhibited higher shrinkage than samples from other regions (Figure 10). Doerschuk clay samples, on the other hand, exhibited low relative shrinkage. Small sample sizes, however, prohibit the extrapolation of theses results to any general conclusions about the characteristics of regional clay resources.

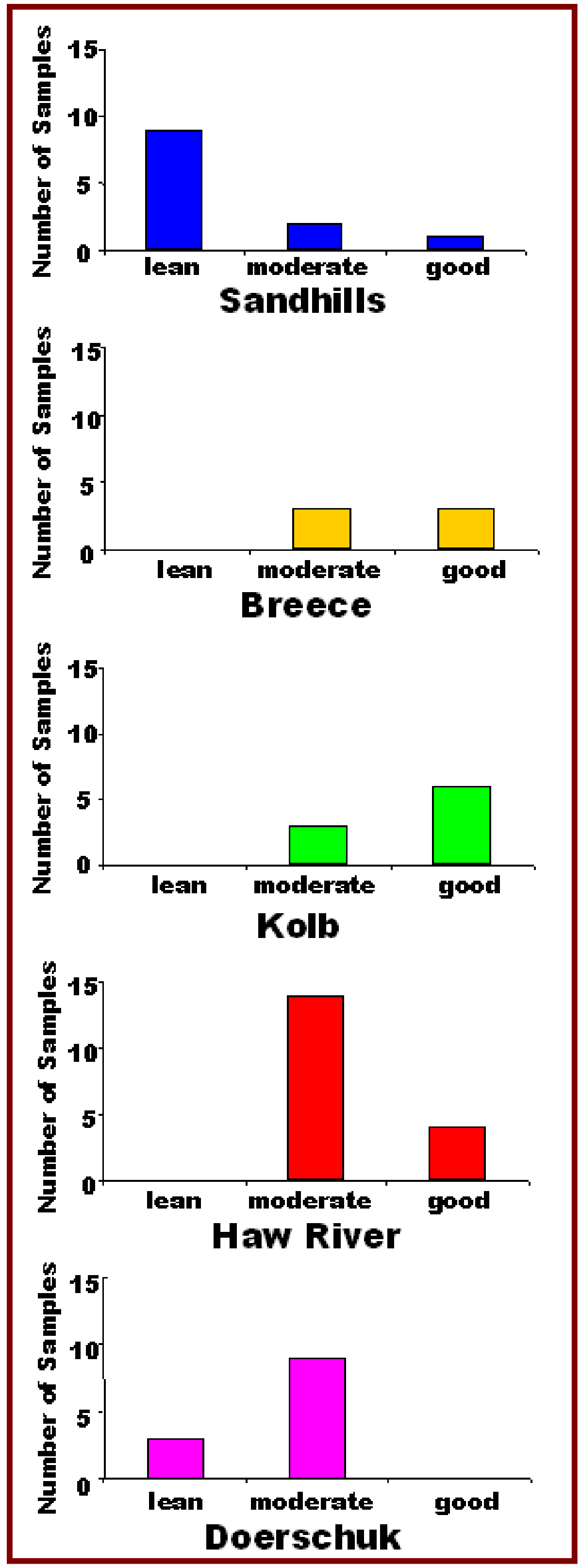

Figure 9. Bar charts showing workability of samples from each sample region.

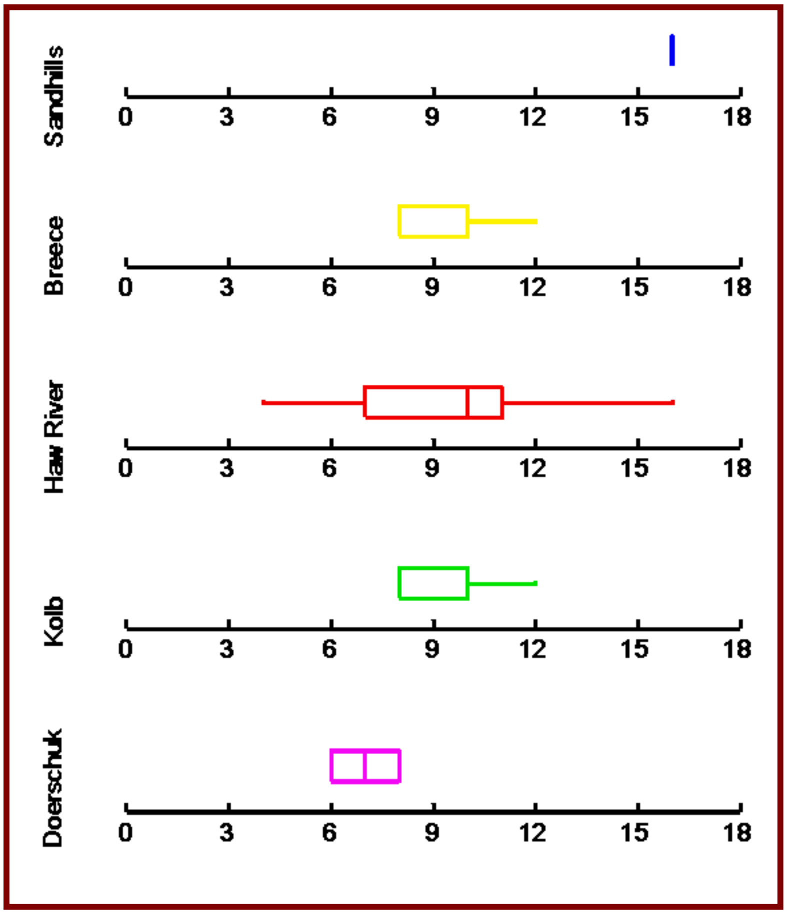

Figure 10. Boxplots of the shrinkage values for each clay sample measured as the percent difference in size between wet clay and fired ceramic test tiles.

Most of the clay samples collected from alluvial settings tend to be what contemporary potters refer to as "fat;" they have ample plasticity (too much in fact) and are "fluffy" and soft. These fat clays require little water to achieve a workable state, become excessively sticky or slimy if too much water is added, and do not have the strength to support vessel walls in the building process. When placed on a flat surface, a conical-base or pinch pot made of these clays rapidly slumps into a pancake without so much as a crack.

On the other end of the spectrum, many of the clays from upland settings in both the Piedmont and Sandhills regions are adequately stiff to support vessel construction, but lack the necessary plasticity. These upland samples typically require more water and a great deal of elbow grease to become workable. In many cases, lumps remain in the clay matrix despite much kneading, leading us to conclude that part of the lumpy texture of prehistoric grog or "clay" tempered pottery may be the result of using such stiff clay. Conical bases made of these clays have plenty of strength to retain their shapes on a flat surface, but as additional coils are added the walls come apart with large, vertical cracks.

Surprisingly, none of the test tiles broke or cracked excessively during drying or firing. As expected, however, the percentages of linear shrinkage during drying and firing indicate that, in general, the addition of a tempering material tends to reduce overall shrinkage.

Significantly, the vessel replication experiments (stage 4) reveal that even clays exhibiting good workability and no excessive cracking, warping, or shrinkage during drying and firing, may not be suitable for potting. Although this final stage of experimentation has not yet concluded, at present only one clay sample from the Haw River area has had the right combination of plasticity and strength to withstand building up, drying, and open-air firing.

Adding temper (e.g., sand, crushed rock, or grog) did not appreciably improve the workability of our clay samples, although it did affect shrinkage and thus the ultimate success of drying and firing vessels. This is probably true of most clays; temper reduces shrinkage, but does little to improve workability. Overall, our efforts lead us to conclude that while it might be possible to coax vessels out of clays that are too fat or too lean, the process would be aggravating and the resulting vessels would be poor substitutes for pots made of good quality clays.

The results of four stages of experimentation can therefore be summed up as follows:

- Clay that passes initial workability tests can be readily found in the immediate vicinities of the Haw River site in the Piedmont and the Breece and Kolb sites in the Coastal Plain, but not near the pottery-source sites in the Sandhills or the Doerschuk site in the lower Yadkin River basin.

- Clay that passes initial workability tests also makes successful test tiles.

- Nevertheless, clay that is suitable for making actual *pots* is exceedingly difficult to find.

Conclusions and Implications

As explained in the previous paper (here reference FB-CRP web page for Smith and Herbert paper), chemical and mineralogical evidence suggests that pottery at the Doerschuk, Haw River, and Breece sites was fashioned from the same ceramic resources more consistently than was pottery found in the Sandhills. Smith and Herbert (2004) propose that the greater chemical and mineralogical variability observed for the Sandhills samples indicates that either (a) pottery recovered from Fort Bragg sites was imported into the Sandhills, presumably from the Piedmont but possibly from Coastal Plain areas as well, or (b) clay and temper resources in the Fort Bragg region of the Sandhills are more chemically and mineralogically variable than their Piedmont counterparts.

The results of our ceramic raw materials survey suggest that regardless of the chemical and mineralogical variation that may characterize Sandhills clays, it is highly unlikely that local clays were used to fashion the pottery found at Woodland sites on Fort Bragg. Clays in general, but especially clays suitable for making low-fired earthenwares, do not appear to be locally abundant in the Fort Bragg region of the Sandhills. However, higher quality clays are available to the north in the lower Haw River basin and to the west and south in the middle Cape Fear and Coastal Plain Pee Dee basins.

Furthermore, our personal experiences demonstrate that finding a suitable potting clay source in an unfamiliar landscape would have been very costly in terms of time and energy. We therefore submit that the value of pots to Woodland people occupying the Sandhills was probably much greater than we assumed prior to this study. We also suggest that once a suitable clay source was discovered, it would have become a valuable, perhaps even guarded, resource, the extraction of which would likely have been scheduled into seasonal activities. Alternatively or additionally, ceramic vessels may have become important commodities of exchange between Sandhills groups and their Piedmont and Coastal Plain neighbors.

Of course, we have yet to conclusively demonstrate the exact region of the source area or areas from which raw clay was obtained for making Sandhills pots. We remain optimistic that planned chemical and petrographic analyses of our fired test tiles will provide additional information pertaining to this still unresolved question of ultimate provenience. Nonetheless, recognizing why locally available clays were not exploited in the Sandhills represents a significant step toward understanding the decisions that shaped Woodland period pottery-making practices in this region.

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