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SF 1100 (Brill specimen 5530) Unit CTR Level 37: Phase I/II
Fragment of poorly shaped cylindrical dark-blue transparent bead with large center perforation. Height is 8.9 mm, glass thickness is 4 mm, and total diameter is 12.8 mm. Glass is filled with many spherical bubbles of various sizes and colored with cobalt. Top and bottom surfaces are ground flat. Analysis unexpectedly identified the bead as of potash-silica composition, currently known only from India to East Asia.

CHEMICAL ANALYSIS OF SOME GLASSES FROM JENNÉ-JENO

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At the request of Susan and Roderick McIntosh, we have carried out chemical analyses of eight glass finds excavated at Jenné-jeno in Mali. The glasses include six beads of different types and two fragments. Of the latter, one is probably a vessel fragment and the other a piece of scrap glass fashioned into a button or bead. The eight samples span a long interval of time. One is dated to the last two centuries B.C. two are dated A.D. 300–800, and the others A.D. 900-1400.

The main questions involving the beads are where they were made and how they reached sub-Saharan West Africa. The six beads may not necessarily be representative of all the beads excavated at the site, but the excavators have made an excellent selection for analysis. Among the six specimens, we have found examples of four distinctly different glass-making technologies which, at first glance, suggest that this particular selection of beads points to four different and far-flung places of manufacture.

The analyses were carried out by a combination of atomic absorption (yielding quantitative data for the major and minor ingredients) and emission spectroscopy (for trace elements). Silica was estimated by difference from 100%. The analyses are reported in Table 5.4, along with reduced compositions. Reduced compositions are calculated by normalizing the data for seven major and minor oxides to 100%. The resulting compositions provide a somewhat sounder basis for comparing glasses with one another because the calculation offsets some of the compositional variability accompanying the addition of colorants, opacifiers, decolorizers, fining agents, etc.

The most intriguing result of the analyses is the composition of specimen 5530, from a fragment of a medium-sized, dark-blue bead. The only major components of this glass are potassium oxide (K_2O) and silica (SiO_2). Thus, this glass is of the potash-silica type, a relatively rare compositional family. In order to understand the significance of this analysis, it is necessary first to explain in some detail where these glasses are generally thought to have been made.

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Table 5.4. Chemical analyses of some glasses from Jenné-jeno

	Specimen #							
	5530	5528	5529	5522	5525	5526	5527	5531
SiO_2	80.13	73.04	70.13	59.59	67.08	66.60	53.70	70.41
Na_2O	0.93	9.87(?)	16.9	21.0	14.7	13.5	10.2	15.0
CaO	0.84	6.39	6.82	3.34	9.15	7.71	4.42	9.79
K_2O	13.0	2.67	0.69	2.37	2.95	3.50	2.27	0.32
MgO	0.32	3.55	0.62	0.90	2.51	3.90	3.52	0.64
Al_2O_3	1.9	1.77	2.28	9.46	1.53	2.09	2.55	2.46
Fe_2O_3	1.71	0.74	0.88	2.77	0.69	1.54	0.69	1.18
TiO_2	0.08	0.08	0.1	0.18	0.08	0.08	0.1	0.15
Sb_2O_5	0	0	0.52	0	0	0	0	0
MnO	0.90	0.079	0.38	0.055	1.13	0.87	0.03	0.022
CuO	0.01	1.36	0.08	0.005	0.01	0.08	0.83	0.001
CoO	0.05		0.02			0.05		
SnO_2	0.001	0.05	0.1	0.03	0.001	0.001	2.44	
Ag_2O		0.001	0.001		0.001		0.003	0.001
PbO	0.003	0.22	0.23	0.09	0.003	0.001	19.2	0.001
BaO	0.1	0.03	0.1	0.1	0.05			
SrO		0.1	0.1	0.03	0.04	0.01	0.02	
Li_2O	0.005	0.001	0.001	0.003	0.01			
Rb_2O				0.02	0.02			
B_2O_3		0.02	0.02	0.02	0.02	0.02	0.02	0.002
Cr_2O_3						0.005		
NiO						0.01		
ZnO	0.011	0.018	0.01	0.01	0.015	0.025		0.011
ZrO_2	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
SiO_2*	81.08	74.51	71.33	59.93	68.03	67.38	69.42	70.55
Na_2O*	0.94	10.07	17.19	21.12	14.91	13.66	13.19	15.03
CaO*	0.85	6.52	6.94	3.36	9.28	7.80	5.71	9.81
K_2O*	13.15	2.72	0.70	2.38	2.99	3.54	2.93	0.32
MgO*	0.32	3.62	0.63	0.91	2.55	3.95	4.55	0.64
Al_2O_3*	1.92	1.81	2.32	9.51	1.55	2.11	3.30	2.47
Fe_2O_3*	1.73	0.75	0.90	2.79	0.70	1.56	0.89	1.18
T*	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Note: Major and minor oxides were analyzed by atomic absorption, trace elements by semiquantitative emission spectrography. All analyses are by Brandt A. Rising and coworkers at Umpire and Control Services, West Babylon, New York.

* Reduced compositions calculated by normalizing data for seven major and minor oxides to 100%

Glass artifacts having this type of composition have so far been found mainly (perhaps exclusively) in East and Southeast Asia. Shi et al. (1986) have reported about sixteen examples of such glass found in China (seven small objects and nine beads). They generally date from the Han dynasties (206 B.C.–A.D. 220). However, they were not necessarily made in China. We have found six examples of this family of glass among beads excavated in Korea (Brill 1993; Lee et al. 1993). All are small or medium sized, blue transparent, drawn beads. They were found at six different sites, all in the southeastern part of the Korean peninsula, within about 150 km of one another. They are believed to range in date from the first to the fourth or fifth centuries. We have also analyzed three large biconical beads from Ban Chiang (all surface finds) which have this same composition.

Very recently, we analyzed several glass samples from Arikamedu in India. Although they came from unstratified excavations, the glasses are thought to date from the first century or somewhat later. Among these samples, which were submitted to us by Dr. E M. Stern, there are six potash-silica glasses (Stern 1987). They are all the more interesting because they are pieces of cullet (raw, unshaped nuggets of glass), or manufacturing waste. These analyses are in agreement with analyses of Arikamedu glasses reported earlier by Dr. B. B. Lal, an authority on Indian glass (Lal 1986). Such evidence strongly suggests that glass objects, and possibly the glass material itself, were being made nearby. Hence, the range of places where potash-silica glasses were being made and/or used in ancient times must now be extended westward to include southern India.

One hesitates to make too much of the analysis of a single bead, or to generalize too much from it. Nevertheless, evidence based even on a single bead cannot simply be ignored; it does beg for some sort of explanation. The Jenné-jeno bead, an isolated find, is dated to 250 B.C.–A.D. 50, which falls within the range spanned by the potash-silica glasses described above. Among Shi's Han glasses are five round blue beads ranging from 4 mm to 9 mm in diameter. One cannot be sure from the illustrations in Shi's paper whether the beads were drawn or wound. The Korean beads are drawn and range from about 3 mm to 7 mm in diameter. All are dark blue. The Ban Chiang beads are considerably larger, appearing to have been shaped while hot and later drilled. One is aqua, one is green transparent, and one is blue.

All of the dark blue potash-silica beads discussed here, including the Jenné-jeno bead, are colored with cobalt. They contain manganese but no copper.

Although not impossible, it seems unlikely that the glass from which the Jenné-jeno bead was manufactured could have been made locally, if for no other reason than that it is colored with cobalt. Hence, from all of the above observations, it seems almost inescapable (unless some other ancient source of potash-silica glasses comes to light) that the dark blue bead 5530 (SF 1100) was made somewhere in India, East Asia or Southeast Asia. Whether it found its way into West Africa by some series of direct, well-established trading contacts, or by some fortuitous meandering, perhaps from an East African entrepôt, remains to be determined. In any event, it probably left

India, East Asia or Southeast Asia along a westbound maritime route some 2,000 or more years ago.

Another bead from Jenné-jeno, specimen 5522 (dated 900–1400), might also have traveled a comparable distance. Its chemical analysis closely resembles a particular variant of soda-lime glasses (Na_2O:CaO:SiO_2) which we associate with glasses from India. Although soda-limes were ubiquitous throughout the ancient world (except East Asia), they occur in two or three major types, depending on whether they were made with natron or plant ash as their source of soda. (This difference is illustrated by some of the other glasses from Jenné-jeno, as discussed below). However, there are a few recognizable chemical sub-groups of soda-limes, one of which is characterized by low levels of lime (CaO), high levels of alumina (Al_2O_3), and often rather high levels of titania (TiO_2). The examples we know were found in India and also were probably made there. They date from Roman or Hellenistic times up through the medieval period (Brill 1987, McKinnon and Brill 1987).

The case for specimen 5522 is not quite as compelling as that for the earlier blue bead discussed above, because occasionally, colored glasses went off composition upon being worked and reworked during manufacture. Nevertheless, our feeling is that this turbid yellowish bead could very well have originated in India. From sketches in our notes, it seems that the Jenné-jeno bead may resemble certain beads and bangle fragments from India (Brill 1987; McKinnon and Brill 1987).

Because of the results of these analyses, it would be well worthwhile to run additional analyses of similar or related specimens from Jenné-jeno, if such can be located. The finding on the two beads are of sufficient importance that corroborating evidence should definitely be sought.

The analysis of the other four beads proved to be more like what one would have expected. Specimen 5528, dated A.D. 300–800, might have been made locally from scrap glass. It is doughnut-shaped, flattened on the ends, and was probably ground into its final shape. It could have been reworked from a square-sectioned, drawn bead, because squared-off striations and cords are visible around the bore when viewed end on. Alternatively, it might have been rolled out while very viscous, with the attendant "bumping" generating the squared-off striations. In any event, we feel that it was made by someone not very experienced in the handling of hot glass. Its chemical composition is that of a soda-lime of the plant-ash variety, although the soda value (9.87%) is notably low. The glass contains not only cobalt but also copper as a blue colorant. The analysis suggests that the copper colorant was introduced in a form derived from a bronze having a composition 82% Cu: 3% Sn: 15% Pb, which is within the compositional range of late Roman bronzes.

Specimen 5529, also dated 300–800, corresponds to a typical Roman glass made with natron. (Note the relatively low K_2O and MgO in Table 5.4). It contains an additive level of antimony (0.52% Sb_2O_5) suggesting it could have been made in Egypt or Italy. The use of antimony declined in about the second century, and it was not widely used in medieval Europe, except, perhaps, in Italy.

The two remaining beads (specimens 5527 and 5526) are both later (900–1400) and are both plant-ash type soda-limes. (Note the relatively high K_2O and MgO). Their compositions could be Islamic (Brill 1989; forthcoming). Specimen 5527 is heavily leaded and is opacified with tin oxide (SnO_2)

Specimen 5525, a fragment of vessel glass, could be Islamic. However, its appearance and pale-olive color make it look more like a somewhat later European glass, but it is difficult to tell for sure. Specimen 5531, dated 900-1400, is peculiar. It seems to be a bit of broken vessel glass (or flat-glass?) worked into the form of a button or bead. Its composition is that of a natron-type soda-lime. One might guess that it is more likely to have come from Fustat than medieval Europe, but that is also difficult to judge. Because it is a natron-type glass, it is unlikely to have come from anywhere east of the Levant.

In summary, the analyses of the glasses from Jenné-jeno show wide compositional variation. At least one of the two beads of A.D. 300–800 date has a composition consistent with Roman origins, while two others probably have more exotic origins. The small blue bead dated 250 B.C.–A.D. 50 seems most likely to have come from India or East or Southeast Asia, and the cylindrical turbid yellow bead could well have been made in India. The two latter findings come as something of a surprise and might shed light on important questions regarding trade connections involving Asia and sub-Saharan Africa. We strongly recommend following up these initial findings with additional chemical and lead isotope analyses of other glass beads judiciously selected from among those excavated at Jenné-jeno. Lead isotope analyses in particular offer an independent method of distinguishing between Asian and Western glasses.

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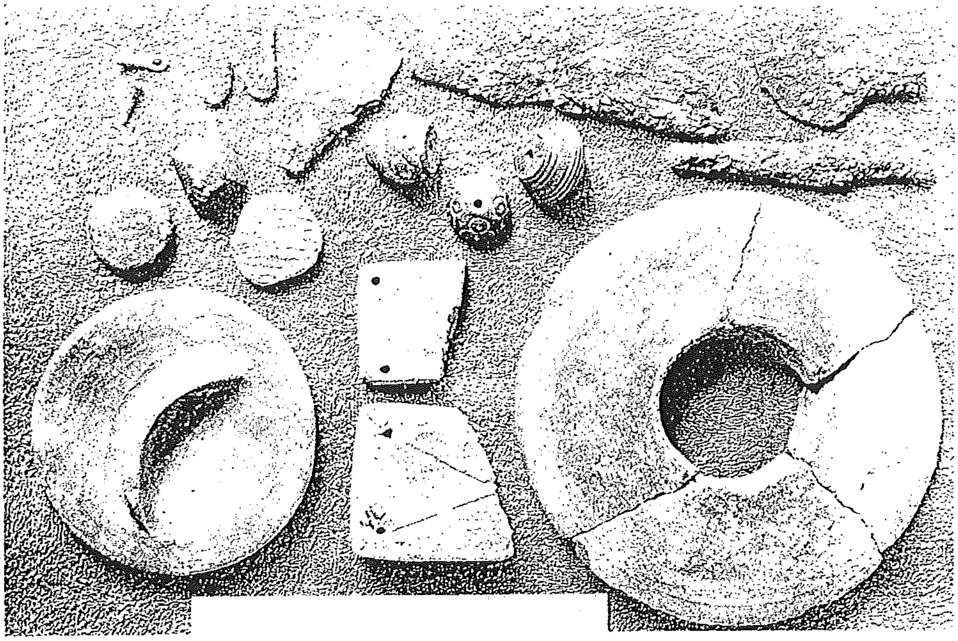
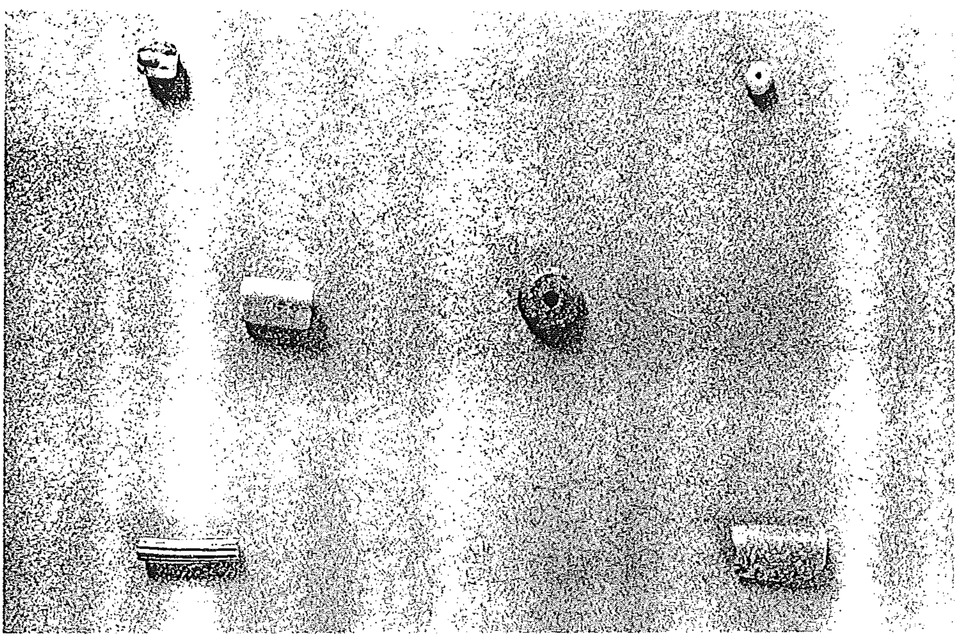


37. Selected artifacts from the Phase IV assemblage at Jenné-jeno. Top (from left): copper ornament, teardrop weight; iron fishhooks, hoe, hematite; spindle whorls. Bottom: pot smoother/potlid; ceramic pendants, ceramic ring.



38. Glass beads. Top (from left): SF 1, SF 573; Middle: SF 217, SF 907; Bottom: SF 2, SF 1281.