# The Oldowan in Arabia

**Norman M. Whalen and Glen A. Fritz**

***Abstract.*** *Various routes have been proposed for the initial migrations out of Africa into western Asia. A potential route traversing Yemen and Oman contains three Paleolithic sites with artefacts presumed to be Oldowan. One site was a stratigraphic cave site while the other two were surface sites. The artefacts of the surface sites were statistically compared with those of the cave. These three Arabian sites were then compared with the Oldowan artefacts of Olduvai Gorge, Africa. Analysis of Variance on the tool dimensions and Multidimensional Scaling of artefact frequencies suggest that the Arabian artefacts have Oldowan affiliation.*

## Introduction

The last decade of the twentieth century and the opening years of the twenty-first witnessed in both Africa and Asia a spectacular series of hominid discoveries and a rising interest in early human migration into Asia (Etler 1996; Gabunia et al. 2000; Larick and Ciochon 1996; Petraglia 2003; Swisher et al. 1994; Wood and Turner 1995). No less than four new hominid species were reported during the past few years, all found in Africa. The emerging interest in human migration may be attributed to two events: 1) the discovery of several human cranial and assorted skeletal remains in association with stone artefacts dated 1.77 million years ago (mya) at the site of Dmanisi in Georgia (Gabuma and Vekua 1995; Gabunia et al. 2000; Vekua et al. 2002); and 2) the surprisingly early dates of 1.8 mya at Longgupo Cave in China (Wanpo et el. 1995); together with the redated cranial remains found at Mojokerto (1.81 mya) and at Sangiran (1.66 mya) in Java (Swisher 1994).

Despite the Asian discoveries, the wealth of relevant Pliocene data still resides in Africa. Of the hominid findings that appear in Pliocene deposits, the earliest evidences date from about 3.6 mya at Laetoli, Tanzania and from about 3 mya at Hadar, Ethiopia and Sterkfontein, South Africa (LaPorte and Zihlman 1983). The oldest known stone artefacts, those found in 1992-1994 at Gona in northern Ethiopia, have been securely dated at 2.6-2.5 mya using magnetostratigraphy and radioisotope methods (Semaw et al. 1997; Semaw 2000). In addition, Omo, Ethiopia and Turkana, Kenya have yielded stone tools dated at about 2.3 mya (Semaw et al. 1997). Finds such as these affirm the priority of Africa as a likely birthplace of the hominid lineage.

Semaw (2000) observed that many of the African tool assemblages in the period of 2.6-1.5 mya conveniently group into the prototypical Oldowan Industry associated with Bed I at Olduvai Gorge in Tanzania (Leaky 1971). Olduvai Gorge has been one of the most informative Plio-Pleistocene sites owing to the richness of the finds and a stratigraphic column that is supported with radiometric dates. Olduvai has also yielded slightly later, and perhaps transitional, industries known as Developed Oldowan A and Developed Oldowan B. In the succeeding period of 1.5-0.2 mya at Olduvai Gorge and

elsewhere, most industries are labeled as Acheulean. In lieu of the questions surrounding early migrations from Africa and the geographical distribution of artefact types, the archetypal nature of the Oldowan industry has value as a benchmark for evaluating Oldowan-like finds in the Arabian Peninsula.

The discovery of human remains at remote sites in eastern and southeastern Asia from the range of 1.8 mya would seemingly mandate a departure from Africa many thousands of years earlier in view of the great distances to be traveled and the wide range of environments to be exploited along the way. Although the original locus of the early migrants currently appears to have been in East Africa, questions regarding the migratory mechanisms and routes remain open.

Only two routes out of Africa appear feasible and both of them traverse Arabia. The first could proceed from Ethiopia down the Nile and across the Sinai Peninsula into the Levant and western Asia. The other would follow the arching trajectory of early man sites in East Africa from Olduvai Gorge to Djibouti, then across the mouth of the Red Sea at Bab al Mandab directly into Yemen (Fig. 1). At this juncture, three further routes were open, the first being along the flat coastal plain of the Tihama located between the mountains and the Red Sea. The second, paralleling the first, ranges between the east side of the mountains and the vast stretches of the Arabian desert. The third, continues eastward across Yemen and Oman in the southern Arabian Peninsula, across the Strait of Hormuz, into Iran, and to points east.

The apparent presence of Oldowan artefacts in a series of sites arching from Africa to Oman suggests the existence of an eastward human migration route in Plio-Pleistocene times. However, from the relative abundance of Acheulean artefacts in the Arabian Peninsula, one must also assume that some long term settlement and later population movements occurred as well.

With the onset of a cooler climate during the Upper Pliocene, heralding the beginning of the Ice Ages of the Pleistocene, sea levels declined as much as 100 meters, possibly exposing intermittent land bridges at the Bab al Mandab. In the same timeframe, the distance between the continents was likely less than today, which would also facilitate the passage of early human bands toward eastern and southeastern Asia (Walwer 1995). The same may apply to the Gulf of Hormuz separating Oman and Iran.

The decline in sea level had the potential to convert both the Red Sea and the Arabian Gulf into landlocked seas. Present day Perim Island, located between Djibouti and Yemen may be the sole remnant of a land bridge that once connected Africa and Asia. In this paper, we shall consider the southern route out of Africa, across Yemen and Oman as an option for the infiltration of early human migrants into Asia.

**Survey and Excavation**

Along the southern route, three sites have been identified as possible early way stations in the journey to the east. Two are in Yemen and one is in Oman and all were tentatively identified at the time of their discovery as pre-Acheulean or Developed Oldowan. The first area was found in 1983-1988 near Wadi Dauan in the Hadhramaut of southern Yemen (Amirkhanov 1987, 1991, 1994). It consisted of three stratified cave sites and two stratified open-air sites, with all five sites having layers of different ages. Two of the cave sites had very few artefacts but the third, Al Guza Cave, harbored many more. In its deepest level, in situ deposits of 187 Oldowan artefacts appeared, mainly choppers with some

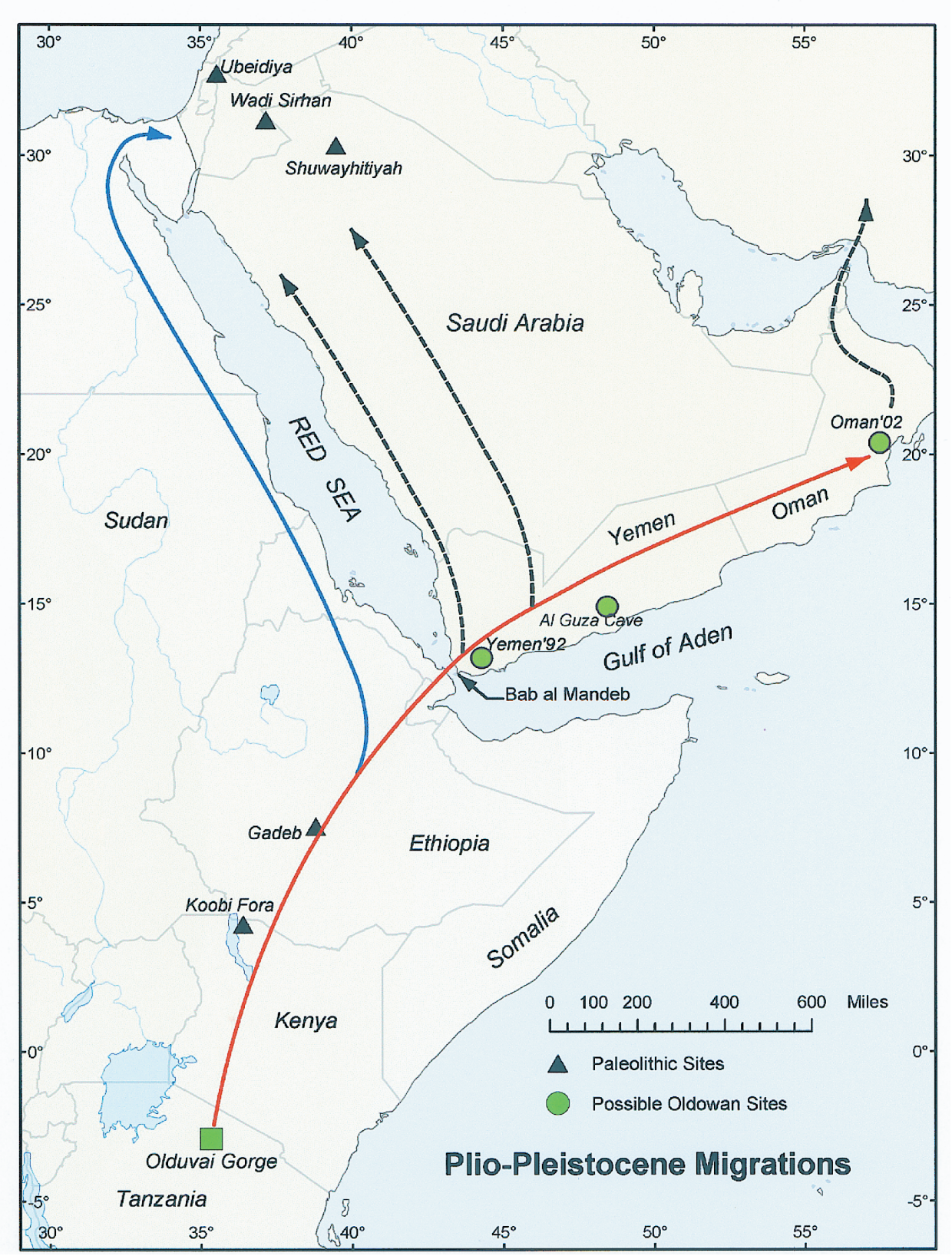


**Fig. 1: Map of proposed migration routes and the Paleolithic sites mentioned in the text.**

polyhedrons, discoids and scrapers. Several layers of Acheulean artefacts were located above the Oldowan level but a distinction existed between the Oldowan and Acheulean layers. The Acheulean levels were characterized by numerous handaxes and several choppers (Amirkhanov 1994).

In 1992, from a series of 16 sites located on an escarpment overlooking Wadi Shahar in southwest Yemen, a survey team collected 729 Oldowan artefacts. Nearly half of the artefacts consisted of choppers, with scrapers, polyhedrons, and discoids comprising most of the remainder (Whalen and Schatte 1997). The Oldowan (or Developed Oldowan) component of these sites will be referred to as Yemen'92-DO.

In 2002, a survey undertaken in the Huqf district of central Oman revealed a grouping of 43 sites that yielded 2,113 Oldowan artefacts (Whalen 2003, in press). Within the Oldowan assemblages, choppers accounted for 59% of the tool inventory in addition to scrapers, polyhedrons, spheroids, discoids and protobifaces. The Oldowan (or Developed Oldowan) component of this survey will be referred to as Oman'02-DO.

The Oldowan artefacts found in southwestern Yemen in 1992 (Yemen'92-DO) and in central Oman in 2002 (Oman'02-DO) were all surface finds. In contrast, the 187 Al Guza Cave artefacts that Amirkhanov classified as pre-Acheulean or Oldowan were excavated from an intact, stratified site. In light of the overriding migratory questions and the circumstances of these discoveries, two research questions arise:

1) To what extent do the surface finds from Yemen'92-DO and Oman'02-DO correspond to the in situ Oldowan artefacts in the base level of Al Guza Cave?

2) Is there a potential relationship between artefacts from these three southern Arabia sites and the Oldowan artefacts recovered from Olduvai Gorge in East Africa?

To provide firm answers to these intriguing questions is important but difficult. First, except for the stratified Al Guza Cave site, the Lower Paleolithic assemblages of the Arabian Peninsula are only known from surface collections, which provide a very limited framework for classification and dating. Skeletal evidences, such as have been found in Africa and Asia, have not yet emerged in the Arabian Peninsula, and the Paleolithic tool finds have no diagnostic fossil associations to provide clues. Finally, radiometric dating opportunities, such as are associated with East Africa, have thus far been lacking in the archaeology research of the Arabian Peninsula.

**Methodology**

The statistical techniques employed in this investigation utilized artefact frequency counts and tool dimensions to evaluate potential relationships between the sites under discussion. The tool frequency is often the product of specific functional activities carried out in a particular environment. Artefact dimensional patterns may be dependent on the available raw material as well as the prevailing tradition of the culture in which they occur (Kimura 1999).

Two separate statistical approaches were required to address the study questions because of the differences between the databases available for the Arabian Peninsula sites and Olduvai Gorge. Analysis of Variance (ANOVA), using artefact dimensions, was selected to test the relationships between the two Arabian surface sites and the in situ Oldowan at Al Guza Cave. These Arabian sites

| Tool | Site | n | length | | width | | thickness | | length/width | | thickness/width | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mean | st. dev. | mean | st. dev. | mean | st. dev. | mean | st. dev. | mean | st. dev. |
| Choppers | AL Guza Cave | 114 | 104.73 | 21.658 | 85.06 | 15.893 | 59.80 | 11.910 | 1.25 | 0.215 | 0.72 | 0.139 |
| | Oman'02-DO | 505 | 98.52 | 21.804 | 75.98 | 16.186 | 52.21 | 11.622 | 1.32 | 0.296 | 0.70 | 0.168 |
| | Yemen'92-DO | 323 | 118.81 | 28.446 | 93.90 | 20.747 | 54.49 | 14.029 | 1.27 | 0.206 | 0.59 | 0.149 |
| | | | | | | | | | | | | |
| Scrapers | AL Guza Cave | 37 | 90.97 | 19.609 | 70.49 | 14.325 | 46.90 | 10.370 | 1.30 | 0.191 | 0.68 | 0.172 |
| | Oman'02-DO | 258 | 85.65 | 18.572 | 68.32 | 15.746 | 41.67 | 9.786 | 1.29 | 0.301 | 0.63 | 0.157 |
| | Yemen'92-DO | 75 | 98.12 | 23.037 | 76.55 | 17.589 | 41.53 | 13.253 | 1.30 | 0.213 | 0.55 | 0.162 |

**Table 1: The descriptive statistics of the tool dimensions used in the ANOVA study that compared the surface finds of Oman' 02-DO and yemen'92-DO with the in situ Oldowan finds at Al Guza Cave.**

were suited to ANOVA because they were characterized by numerically sufficient collections of choppers and scrapers with detailed dimension measurements. However, this approach was not suited for the second question, which sought to compare the Arabian sites with Olduvai Gorge, because the African records lacked the needed dimension data detail. Therefore, the second question utilized tool frequencies and a technique called Multidimensional Scaling (MDS).

Question One Methods. The dimensions of choppers and scrapers were selected for the comparison because these tool types were the most plentiful and may also be the most diagnostic. Eight separate ANOVA tests were required, one for each chopper and scraper tool dimension comparison: length, width, length-to-width ratio and thickness-to-width ratio. Each ANOVA tool dimension test had an associated null hypothesis that stated that the tools from the two Arabian surface sites belonged to the same population as the Oldowan tools of the Al Guza Cave. A significance value of 0.05 (95% confidence level) was selected as the level required to reject any individual null hypothesis. Post-hoc testing was necessary because the means of the groups were not homogeneous. The Tamhane method was applied in this study. Table 1 summarizes the descriptive statistics of the data from the three Arabian sites.

*Question Two Methods.* The second question, concerning the potential relationship between the three Arabian sites and the Oldowan of Olduvai Gorge, was approached on the basis of tool frequency counts because these data were amply available. Due to the complex nature of the dataset, MDS was selected as the most appropriate analysis tool. In the MDS procedure, a computer algorithm creates a mathematical composite of all of the various tool frequency variables associated with each site. The program then calculates the relationships of the sites using multiple spatial dimensions or axes and Euclidian distance measures. In evaluating the net results, shorter distances between sites are suggestive of higher similarity.

Although Olduvai Gorge is the prime Oldowan site to employ as a standard of comparison, it was necessary to include additional sites of Plio-Pleistocene affiliation to demonstrate the MDS results in a meaningful perspective. Including the sites already under discussion, a total of nine Paleolithic sites were used, some having both Acheulean and Oldowan components. The tool frequency categories for these sites were determined on the basis of relative artefact prevalence: choppers, scrapers, bifaces, polyhedrons, discoids, spheroids and others. The final MDS calculations therefore involved fifteen tool assemblage groups, each with seven different tool frequency classes. A summary of the tool frequencies is shown in Table 2.

In regard to the MDS database, Olduvai Gorge was represented by four different subgroups: Oldowan (OG-Old), Developed Oldowan A (OG-DOA), Developed Oldowan B (OG-DOB), and Acheulean (OG-Ach) (Leakey 1971). The advantage of testing the Arabian sites against the Olduvai subgroups is that any unanticipated similarities or dissimilarities are given a chance to emerge. Overall, the inclusion of more artefact groups in the MDS increases the range of data available for comparison and may add greater specificity to the results.

The other African sites appearing in the MDS were Gadeb and Koobi Fora. Their data include the Gadeb Acheulean (Gadeb-Ach) and the Gadeb Developed Oldowan B (Gadeb-DOB) (Clark and Kurashina 1979a, 1979b, 1980) and Koobi Fora (KF) (Isaac

**Table 2.** Tool frequency data used in the MDS to compare the Arabian Peninsula Oldowan to the Olduvai Gorge Oldowan.

| | Site | Chopper | | Scraper | | Biface | | Polyhedron | | Discoid | | Spheroid | | Other | | Σn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | n | % | n | % | n | % | n | % | n | % | n | % | n | % | |
| Olduvai Gorge | OG-OLD | 283 | 52.1 | 92 | 16.9 | 0 | 0.0 | 55 | 10.1 | 49 | 9.0 | 4 | 0.7 | 60 | 11.0 | 543 |
| | OG-DOA | 177 | 34.9 | 79 | 15.6 | 0 | 0.0 | 33 | 6.5 | 20 | 3.9 | 27 | 5.3 | 171 | 33.7 | 507 |
| | OG-DOB | 463 | 20.2 | 491 | 21.4 | 162 | 7.1 | 48 | 2.1 | 131 | 5.7 | 134 | 5.8 | 868 | 37.8 | 2297 |
| | OG-Ach | 14 | 15.4 | 6 | 6.6 | 49 | 53.8 | 5 | 5.5 | 8 | 8.8 | 2 | 2.2 | 7 | 7.7 | 91 |
| Arabia | Saudi'85-DO | 278 | 40.3 | 217 | 31.5 | 48 | 7.0 | 37 | 5.4 | 17 | 2.5 | 6 | 0.9 | 86 | 12.5 | 689 |
| | Yemen'92-DO | 323 | 71.0 | 75 | 16.5 | 7 | 1.5 | 11 | 2.4 | 11 | 2.4 | 1 | 0.2 | 27 | 5.9 | 455 |
| | Jordan'99-DO | 423 | 64.2 | 134 | 20.4 | 17 | 2.5 | 13 | 1.9 | 12 | 1.8 | 3 | 0.4 | 51 | 7.6 | 653 |
| | Oman'02-DO | 505 | 58.9 | 258 | 30.1 | 9 | 1.0 | 21 | 2.4 | 9 | 1.0 | 1 | 0.1 | 55 | 6.4 | 858 |
| | Oman'02-Ach | 335 | 42.6 | 253 | 32.2 | 122 | 15.5 | 4 | 0.5 | 5 | 0.6 | 0 | 0.0 | 67 | 8.5 | 786 |
| | Al Guza Cave | 114 | 61.0 | 36 | 19.3 | 11 | 5.9 | 5 | 2.7 | 1 | 0.5 | 0 | 0.0 | 20 | 10.7 | 187 |
| Other | Gadeb-Ach | 25 | 35.2 | 8 | 11.3 | 31 | 43.7 | 6 | 8.5 | 0 | 0.0 | 0 | 0.0 | 1 | 1.4 | 71 |
| | Gadeb-DOB | 96 | 21.5 | 147 | 33.0 | 27 | 6.1 | 123 | 27.6 | 0 | 0.0 | 6 | 1.3 | 47 | 10.5 | 446 |
| | KF | 112 | 22.0 | 196 | 38.4 | 4 | 0.8 | 88 | 17.3 | 88 | 17.3 | 0 | 0.0 | 22 | 4.3 | 510 |
| | Ub-Ach | 103 | 28.6 | 27 | 8.1 | 144 | 40.0 | 39 | 10.8 | 5 | 1.4 | 9 | 2.5 | 31 | 8.6 | 358 |
| | Ub-DO | 747 | 28.9 | 704 | 27.3 | 71 | 2.8 | 141 | 5.5 | 49 | 1.9 | 72 | 2.8 | 799 | 30.9 | 2583 |

Olduvai Gorge: Oldowan (OG-OLD), Developed Oldowan A (OG-DOA), Developed Oldowan B (OG-DOB), Acheulean (OG-Ach). Koobi Fora in Kenya (KF). Gadeb in Ethiopia (Gadeb-DO and Gadeb-Ach), Ubeidiya in the Jordan valley (Ub-DO and Ub-Ach). See text for other site abbreviations.

| | | *Significance Values* **Oman'02-DO** | *Significance Values* **Yemen'92-DO** | |
|---|---|---|---|---|
| Scrapers | length | **0.335** | **0.249** | *versus* **Al Guza Cave** |
| | width | **0.783** | **0.155** | |
| | length/width | **0.994** | **1.000** | |
| | thick./width | **0.188** | 0.001 | |
| | | | | |
| Choppers | length | 0.019 | ≤0.0005 | |
| | width | ≤0.0005 | ≤0.0005 | |
| | length/width | 0.005 | **0.625** | |
| | thick./width | **0.797** | ≤0.0005 | |

**Table 3: Summary of the ANOVA results after applying Tamhane post-hoc testing. All null hypotheses stated that the Oman'02-DO and Yemen'92-DO chopers and scrapers were from the same population as the in situ Al Guza Cave Oldowan choppers and scrapers on the basis of their dimensions. The bold numbers indicate where null hypotheses could not be rejected at the 95% confidence level. In 7 of 8 scraper comparisons, the Oman and Yemen sites were not shown to be statistcally different from the Oldowan of Al Guza Cave. Two of the chopper dimensions were also not shown to be significantly different from the Oldowan of Al Guza Cave.**

1997).

The sites (and sub-sites) from the Arabian Peninsula included the three Arabian sites under discussion plus neighboring sites for which suitable frequency data were available. The Oman and Yemen data consisted of the Oldowan from Al Guza Cave (Amirkhanov 1987, 1991, 1994), the Yemen'92-DO (Whalen and Schatte 1997), the Oman'02-DO (Whalen 2003) and an Oman'02 Acheulean component (Oman'02-Ach).

Other data from the Arabian Peninsula involved the Developed Oldowan from Wadi as Sirhan, Jordan in 1999 (Jordan'99-DO) (Whalen and Kolly 2001), the Developed Oldowan from Saudi Arabian site 201-49 at Shuwayhitiyah (Saudi'85-DO) (Whalen et al. 1986, 1989), and the Ubeidiya Acheulean (Ub-Ach) and Ubeidiya Developed Oldowan (Ub-DO) (Bar Yosef and Goren-Inbar 1993; Goren-Inbar and Sargusta 1996).

## Results

The ANOVA tested the relationship of two Arabian surface sites with Al Guza Cave, the only known in situ Oldowan site in the Arabian Peninsula. The variables consisted of the chopper and scraper dimensions of length, width, length-to-width ratio and thickness-to-width ratio. Table 3 presents the ANOVA results. Of special interest is the finding that seven of eight scraper dimensions from the two surface sites were shown to be statistically indistinguishable from the Oldowan scraper dimensions of Al Guza Cave. In other words, 87.5% of the scraper null hypotheses were not able to be rejected at a 95% confidence level.

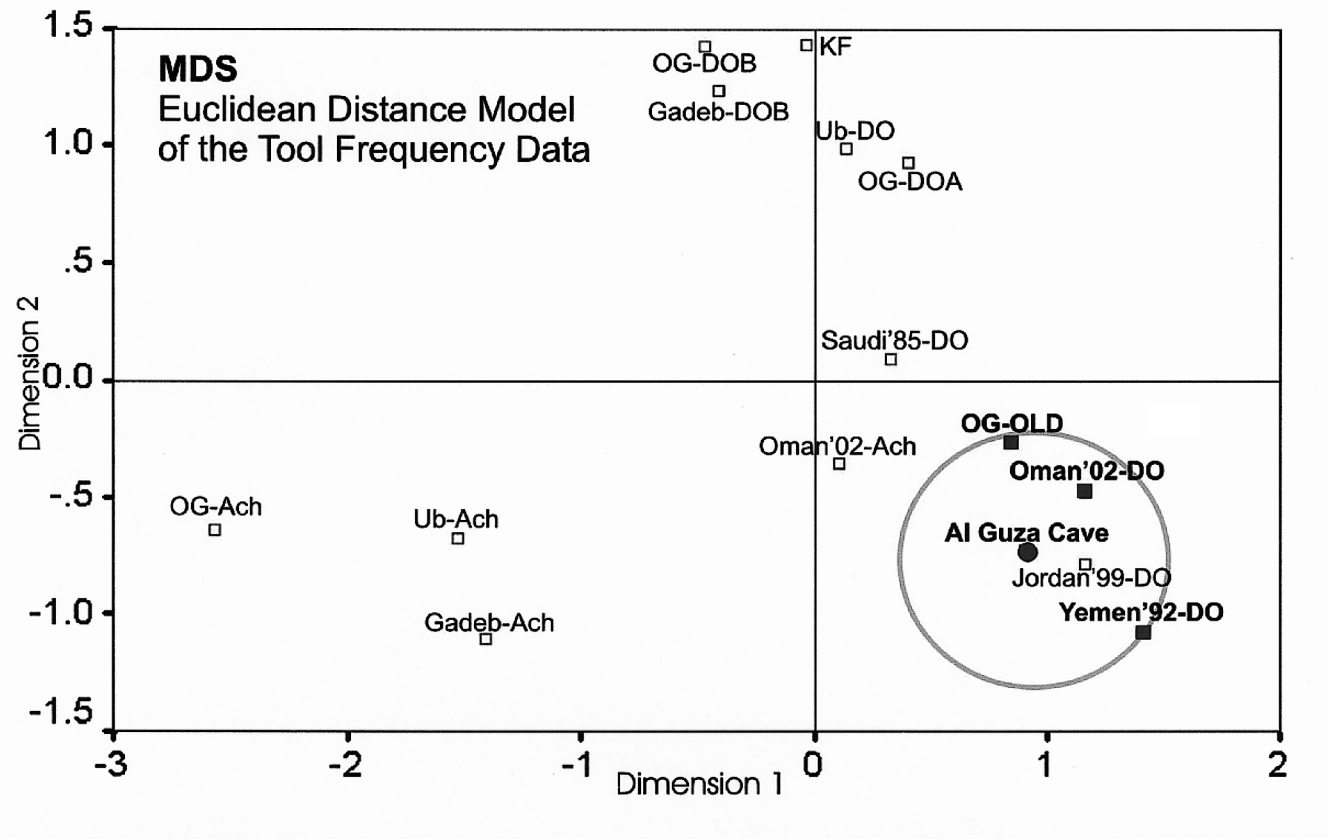


**Fig 2: The MDS plot of the tool frequencies of selected sites from Africa and the Arabian Peninsula. The results show a grouping of the Yemen'92-DO and the Oman'02-DO sites with the Al Guza Cave site. In turn, these three Arabian sites appear to be related to the Olduvai Gorge oldowan (OG-OLD). Note the separate clusters for Acheulean (Ach) on the left and other Developed Oldowan (DO, DOA, DOB) sites at the top.**

In the chopper category, the relationships were less conclusive as only two of eight null hypotheses were not rejected. However, taken as a whole, membership of the surface artefacts in the population of the Al Guza Oldowan artefacts could not be rejected in 62.5% of the ANOVA tests. Considering the extreme antiquity of these artefacts and their wide geographical separation, this result is rather interesting.

The MDS results (shown in Fig. 2) are based on the tool frequency characteristics of fifteen different sites/sub-sites. As explained previously, some of the sites were included for purposes of comparison and not because of suspected cultural relationships. The discrimination ability in the MDS mapping is illustrated by the grouping of Acheulean sites in the lower left quadrant and of several Developed Oldowan sites in the top center. Most importantly, the plot demonstrates a cluster involving the three Arabian Oldowan sites and the Oldowan of Olduvai Gorge. This pattern implies that a greater similarity exists between these sites than with any of the remaining sites which are plotted farther away. From a standpoint of specificity, the Arabian sites with Oldowan components show an affinity to the Olduvai Gorge Oldowan but not to the Developed Oldowan or Acheulean of Olduvai Gorge. Conversely, minimal relationships are suggested between the Arabian sites and the other African sites, or with Ubeidiya in the Levant. Finally, the

clustering of the Yemen'92-DO, Oman'02-DO and Al Guza cave sites reinforces the relationships between these sites that were implied in the ANOVA tool dimension study.

**Conclusion**

In the absence of radiometric dating for any of the Arabian sites considered here, definitive conclusions cannot be drawn. However, the findings in the ANOVA suggest that Oldowan artefacts from the Arabian surface sites correlate with the Oldowan of the stratified Al Guza cave site to a degree that precludes mere chance. The comparison is interesting because it raises the possibility that certain Arabian surface sites, despite their deflated conditions and potential multi-component character, may retain relevant information. Furthermore, the MDS procedure relates these Arabian sites with the Plio-Pleistocene Oldowan of Olduvai Gorge, which has been substantiated with radiometric dating to be in the range of 1.8 million years old.

The southern route across Yemen and Oman, upon which the premise of this study was based, follows the trajectory emanating from early man sites in East Africa (see Fig. 1) but was not the only path accessible in the penetration and colonization of Asia. The other potential avenue was down the Nile and across the Sinai Peninsula to the eastern (Najd) or western (Tihama) side of the mountains that comprise the Arabian Shield, with a continuance eastward across Yemen and Oman. Obviously, much more survey and excavation work is needed in the regions of these potential routes--the Nile and both flanks of the Arabian Shield. In addition, Yemen and Oman have only been partially explored. All indications suggest that Arabia does contain Oldowan sites scattered along the paths of human migrations and occupations and may well hold the key to the time and place of the earliest human advance into Asia.

**Norman M. Whalen: Department of Anthropology. Texas State University, San Marcos. Texas, USA. email: n4wdx@satx.rr.com**
**Glen A. Fritz :Department of Geography. Texas State University, San Marcos, Texas, USA.**

**ملخّص:** لقد اقترحت عدة طرق، لتفسير حركة النزوح من إفريقيا إلى غربي آسيا؛ إحداها كانت الطريق، الممتدة جنوبي شبه الجزيرة العربية، عبر اليمن وعُمان، إذ توجد ثلاثة مواقع تحتوي على مشغولات يعتقد أنها من العصر الأولدواني. وأحد هذه المواقع، كان كهفاً من طبقات؛ بينما الآخران كانا موقعين سطحيين. وقد قورنت مواد الموقعين السطحيين إحصائياً مع مواد الكهف، كما تمت مقارنة مواد مواقع شبه الجزيرة العربية الثلاثة، مع أدوات الحقبة الأولدوانية المعروفة بـ "أولدوفاي جورج" في إفريقيا. كما أن تحليل التغيّر في أبعاد الأداة، والقياس متعدد الجوانب لهذه الأدوات، يشيران إلى علاقة مواد الجزيرة العربية بمثيلاتها في الحقبة الأولدوانية.

## References


Amirkhanov, Kh. 1987. "Understanding the Acheulian in Southern Arabia", **Sovietskaya Arkeologiya**, 4: 11-23 (in Russian).

Amirkhanov, Kh. 1991. **The Palaeolithic of Southern Arabia**, Moscow: Russian Academy of Sciences (in Russian).

Amirkhanov, Kh. 1994. "Research on the Palaeolithic and Neolithic of Hadhramaut and Mahra", **Arabian Archaeology and Epigraphy**, 5: 1-12.

Bar Yosef, O. and N. Goren-Inbar. 1993. **The Lithic Assemblage of Ubeidiya, a Lower Palaeolithic Site in the Jordan Valley,** Hebrew University, Jerusalem.

Clark, J. Desmond and H. Kurasbina. 1979a. "An Analysis of Earlier Stone Age Bifaces from Gadeb (Locality 8E), Northern Bale Highlands, Ethiopia", **South African Archaeology Bulletin**, 34: 93-109.

Clark, J. Desmond and H. Kurashina. 1979b. "Hominid Occupation of the East-Central Highlands of Ethiopia in the Plio-Pleistocene", **Nature**, 282: 33-39.

Clark, J. Desmond and H. Kurashina. 1980. "New Plio-Pleistocene Archaeological Occurrences from the Plain of Gadeb, Upper Webi Shebele Basin, Ethiopia, and a Statistical Comparison of the Gadeb Sites with Other Early Stone Age Assemblages". **Anthropologie**, 18(2-3): 161-187.

Etler, Dennis A. 1996. "The Fossil Evidence for Human Evolution in Asia". Annual Review of **Anthropology**, 25: 275-301.

Gabunia, L. and A. Vekua. 1995. "A Plio-Pleistocene Hominid from Dmanisi, East Georgia, Caucasus", **Nature**, 373: 509-523.

Gabunia, L., A. Vekua, et al. 2000. "Earliest Hominid Pleistocene Remains from Dmanisi , Republic of Georgia: Taxonomy, Geological Setting, and Age", **Nature**, 288: 1019-1025.

Goren-Inbar, N., and I. Sargusti. 1996. "An Acheulean Biface Assemblage from Gesher Benot Ya'aqov, Israel: Indications of African Affinities", **Journal of Field Archaeology**, 23(1): 15-30.

Isaac, Glenn L. 1997. **Plio-Pleistocene Archaeology, Vol. 5, Koobi Fora Research Project**, Clarendon Press, Oxford.

Kimura, Yuki. 1999. "Tool-using strategies by early hominids at Bed II, Olduvai Gorge, Tanzania", **Journal of Human Evolution**, 37:807-831.

LaPorte, Leo F. and Adrienne L. Zihlman. 1983. "Plates, Climate and Hominid Evolution", **South African Journal of Science,** 79: 96-110.

Larick, Roy and Russell L. Ciochon 1996. "The African Emergence and Early Asian Dispersals of the Genus Homo", **American Scientist**, 84: 538-551.

Leakey, M. D. 1971. **Olduvai Gorge: Excavations in Beds I and II 1960-1963**, Cambridge University Press, Cambridge.

Petraglia, Michael D. 2003. "The Lower Paleolithic of the Arabian Peninsula: Occupations, Adaptations, and Dispersals", **Journal of World Prehistory**, 17(2): 141-179.

Semaw, S., Harris, J. W. K., Feibel, C. S., Renne, et al. 1997. "Stone Tools of 2.5 Million Years Old from Gona, Ethiopia", **Nature**, 385(6614): 333-336.

Semaw, Sileshi. 2000. "The World's Oldest Stone Artefacts from Gona, Ethiopia: Their Implications for Understanding Stone Technology and Patterns of Human Evolution Between 2.6-1.5 Million Years Ago", **Journal of Archaeological Science**, 27(12): 1197-1214.

Swisher, C. C., C. H. Curtis, T. Jacob, et al. 1994. "Age of the Earliest Known Hominids in Java, Indonesia", **Science**, 263: 1118-1121.

Toth, Nicholas. 1985. "The Oldowan Reassessed: A Close Look at Early Stone Artifacts", **Journal of Archaeological Science**, 12(2): 101-120.

Vekua, Abesalom, David Lordkipanidze, C. Philipo Rightmire, Reid Herring, et al. 2002. "A New Skull of Early Homo from Dmanisi, Georgia", **Science**, 297: 85-88.

Walwer, Gregory E. 1997. Preliminary Evidence for Plio-Pleistocene Migrations from Africa through South-

western Arabia (unpublished manuscript).

Wanpo, Huang, Russell I. Ciochon, Gu Yumin, Roy Larick, et al. 1995. "Early Homo and Associated Artefacts from Asia", **Nature**, 378: 275-278.

Whalen, Norman M., Jamaludein S. Siraj Au, Hassan O. Sindi, and David W. Pease. 1986. "A Lower Pleistocene Site Near Shuwayhitiyah in Northern Saudi Arabia", **Atlal**: The Journal of Saudi Arabian Archaeology, 10: 94-101.

Whalen, Norman M., Wilbon P. Davis, and David W. Pease. 1989. "Early Pleistocene Migrations into Saudi Arabia". **Atlal,** 12: 59-75.

Whalen, N. M. and K. E. Schatte 1997. "Pleistocene Sites in Southern Yemen", **Arabian Archaeology and Epigraphy**, 8: 1-10.

Whalen, Norman M. and Christopher M. Kolly. 2001. "Survey of Acheulean Sites in the Wadi al Sirhan Basin, Jordan, 1999", **Annual of the Department of Antiquities of Jordan**, 45: 11-18.

Whalen, Norman M. 2003. "Lower Palaeolithic Sites in the Huqf Area of Central Oman", Journal of Omani Studies, Vol. 13 (in press).

Wood, Bernard and Alan Turner. 1995. "Out of Africa and Into Asia", **Nature**, 378: 239-240.