A "Marginality" Model to Explain Major Spatial and Temporal Gaps in the Old and New World Pleistocene Settlement Records

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A key argument currently invoked to cast skepticism on certain South American sites, that suggest a first peopling of the New World by ca. 35,000 B.P., is the perplexingly low visibility of the archaeological record until 12,000 B.P. But, contrary to a popular misconception, great spatial and temporal discontinuities are common in the Old World Paleolithic settlement record. In Southern Africa, carefully controlled archaeological stratigraphies show that the now semiarid interior was unoccupied for 50,000 and more years at a time. Episodes of widespread settlement in marginal environments were relatively brief, limited to periods of substantially wetter climate, and closely linked with moist habitats. A risk-minimization model is proposed to explain these discontinuities. Plant and animal resources in the region, given a climate as dry or drier than today, were of low productivity and low reliability for unspecialized hunter-gatherers during the dry seasons of poor years. This would require large foraging territories and very wide spacing of proximal bands, so that the exchange of vital information on temporary or migratory resources was minimal. Finally, during extended droughts, fat-depleted animals provided an unsatisfactory source of food. These variables suggest that environments with low productivity and predictability were too risky for unspecialized hunter-gatherers with a pre-Upper Paleolithic technology, such as those who would have been able to enter the New World 35,000 B.P. Major spatial and temporal gaps in the New World settlement record should therefore be *expected* prior to the appearance of specialized Paleoindian hunter-gatherers ca. 12,000 B.P. Implications for geoarchaeological strategies are discussed.

INTRODUCTION

There is mounting archaeological evidence from South America that makes it increasingly difficult to discount the presence of people in the New World by 35,000 B.P. One of these is a rock shelter, Pedra Furada, in northeastern Brazil (Guidon and Delibrias, 1986; Guidon, 1984, 1986, and personal communication, 1988). Substantial hearth features, plausible but primitive stone artifacts that lack evidence of blade technology, and even fragments of ochre-smeared rock, have been dated back to 32,000 years by 17 consistent radiocarbon dates.[1]

The other is a low-energy fluvial site, Monte Verde, in Southern Chile (Dillehay, 1986; Dillehay and Collins, 1988; Collins and Dillehay, 1986 and personal communication, 1987). Stratigraphically lower than an incontrovertible archaeological horizon with a regular set of square, wooden structures, dated ca. 13,000 B.P., is a unit of laminated sand that seals an earlier horizon with two hearths and two dozen modified pebbles, originating in an older, strongly weathered alluvial terrace; several of these larger stones from the lower horizon, dated ca. 33,000 B.P., are unmistakable artifacts.[2]

Whether or not we are inclined to accept such evidence, the low archaeological visibility of settlement earlier than 12,000 B.P., remains a major problem that demands explanation. If Paleolithic people were already present in the New World, why do there appear to be so few sites over such a vast area, even if we include sites far more controversial than Pedra Furada and Monte Verde?

The expectation of large numbers of prominent sites—first met in North America with the Paleoindian phenomenon—is a function of Americanists' perception of the Old World record as one of high and essentially continuous archaeological visibility, in both time and space. This is indeed the case in some parts of Western Europe and the Near East. But in many regions of the Old World

[1] Dr. Niède Guidon has kindly provided me with copies of the illustrated sections and artifacts recovered through 1987. These carefully documented excavations are currently down to one m below a level that has a new date of greater than 39,200 B.P. The background sediment is a sand with abundant fine rubble and occasional roof blocks, all derived from the local sandstone, whereas the artifacts are made of quartz and quartzite. Two hearth complexes, rich in laminated ash and dated to 17,000 B.P. and 25,000 B.P., have strong, three-dimensional definition (up to 20 cm thick), with artifacts concentrated around them. A slab in the 17,000 B.P. horizon has two parallel red lines painted on it. Blades and micro-blades first appear after 8000 B.P., most made of chert imported from some distance away; pressure-flaking is first verified in the level dated 6200 B.P. The geoarchaeological profile compares closely with those of Paleolithic caves in Europe and Africa and indicates repeated, high-intensity human occupation long before the advent of blade or pressure-flaking technologies. Suggestions that the hearths may reflect forest fires and that the artifacts are stream-battered rocks (Turner, 1986) are somewhat specious, particularly for a shelter located 20 m up in a sandstone escarpment overlooking a broad pediment plain.

[2] Dr. Michael Collins allowed me to examine this collection which, in my considered opinion, includes a range of pieces that could not possibly have been produced by non-human agencies. The technology is remarkably similar to that of contemporaneous artifacts in Pedra Furada.

the Paleolithic settlement record is remarkably spotty.

The object of this paper is to demonstrate how discontinuous this record can be, and to propose explanations for this fact.

Most of my fieldwork during the 1970s was devoted to systematic geoarchaeological investigation of Pleistocene sites in southern Africa. This research was carried out with the benefit of prior experience with early sites in Spain and Egypt, and in the perspective of two seasons of work in the Rift Valley of East Africa. Some three dozen major previously excavated archaeological or fossiliferous sites were studied in southern Africa, ranging from the australopithecine breccias to Later Stone Age sediments, and including Middle Stone Age surveys as well as examination of numerous rock-art locations (Butzer et al., 1979; Butzer, 1982:266–273; Butzer, 1984a,b).

This research effort, which included 13 months in the field and laboratory analysis of 4000 sediment samples, showed that an area of over 200,000 square kilometers (25% the size of Texas) lacked human occupation for periods of over 50,000 years at a time. Specifically, Pleistocene settlement in the semiarid interior of Southern Africa was limited to a series of relatively brief and disjunct events, coincident with times of wetter climate, and separated by immense periods of time during which people evidently shunned marginal, semiarid, or arid environments.

PLEISTOCENE TECHNOCOMPLEXES IN THE SOUTHERN AFRICAN INTERIOR

The study focus in southern Africa centers on the Vaal and upper Orange drainage basins, and more specifically where Precambrian andesitic lavas and Karoo-age intrusive volcanics are exposed (Figures 1 and 2). These sources provided andesite and hornfels (a contact metamorphic, also known as lydianite), two rock types providing quarry sources for lithic artifacts. These rocks outcrop in what is a semiarid, grassy, erosional landscape, with many similarities to the Southern Plains of North America. The limited range of raw materials facilitates recognition of three successive technocomplexes (in the sense of Clarke, 1978)—the Acheulian, the Middle Stone Age (MSA), and the Later Stone Age (LSA).

The Acheulian (see Volman, 1984; Sampson, 1985) was characterized by large, bifacial handaxes and cleavers, in addition to a range of sidestruck flakes, with little or no evidence for prepared-platform cores. Almost aways, artifacts were made from the pale greenish and somewhat coarse-grained andesite, exposed primarily in the Tertiary and Pleistocene alluvial gravels of the lower Vaal and middle Orange valleys. Somewhat distinctive, but still part of the regional Acheulian technocomplex, was the youngest industry of this type, correctly labelled Final Acheulian, but more conveniently designated by

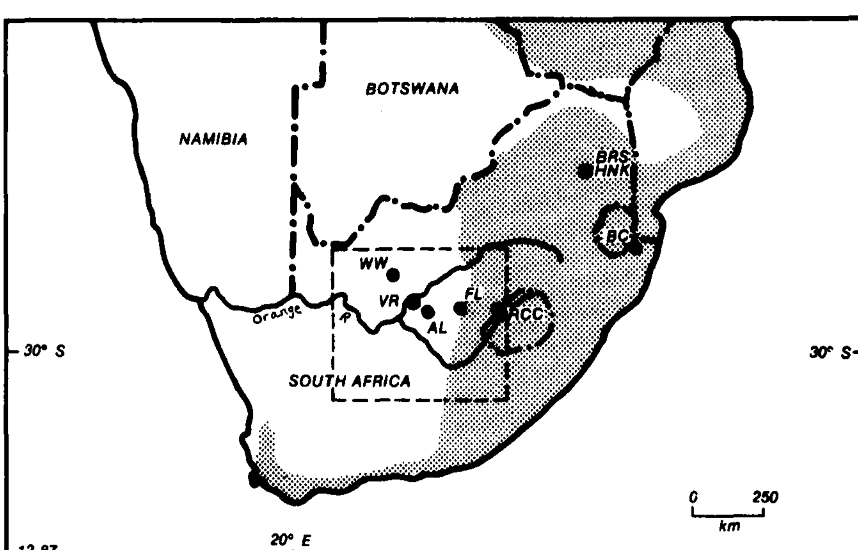

Figure 1. Southern Africa, showing location of key sites mentioned in text. Humid and subhumid areas are shaded. Key sites, from left to right: WW, Wonderwerk; VR, Vaal-Riet floodplains; AL, Alex; FL, Florisbad; RCC, Rose Cottage Cave; BRS, Bushman Rock Shelter and Heuningneskrans Cave; BC, Border Cave.

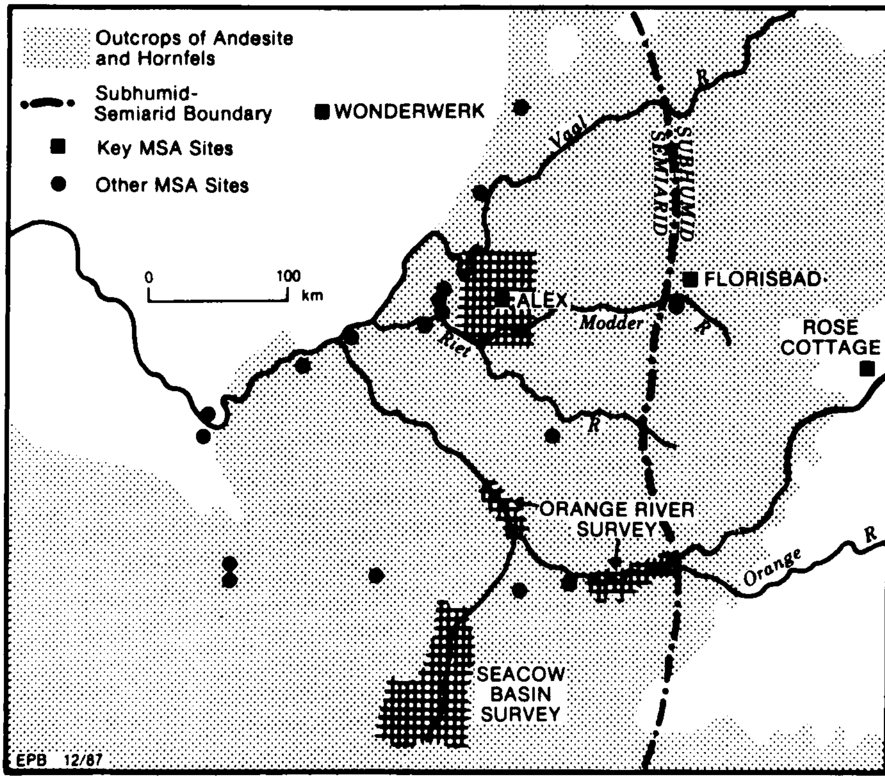

Figure 2. Middle Stone Age visibility in lower Vaal–middle Orange basin in the interior of Southern Africa (see frame in Figure 1). Site density in the Orange River Survey areas (Sampson, 1968) and the Seacow Basin (Sampson, 1985) exceeds the possibility of depiction at this scale. For the Alex area, see Figure 4.

the regional name of Fauresmith. This terminal industry was notable for its smaller handaxes, often more slender or symmetrical, but also broader in profile, and for flakes sometimes struck from prepared-platform cores. There are also unifacial tools that approximate the profiles of a handaxe and suggest a technological transition to the MSA. In most areas Fauresmith stone-knappers shifted almost exclusively to the use of hornfels, which favored a reduction of tool size, since veins of the black, fine-grained hornfels weather out as relatively small nodules.

The Middle Stone Age lacks handaxes or cleavers, and the most diagnostic artifacts are triangular points (typical frequencies 1%–6%), struck by convergent flaking from Levallois cores and then trimmed unifacially. Also characteristic is a variable but substantial proportion of blades (10 to 30% or more), as well as a range of retouched tools, almost exclusively made of hornfels. The regional MSA conforms with Volman's (1984) "MSA 2" and, despite variation in facies, derives from a single stratigraphic unit and is of roughly the same age. Specifically, the "Phase I" (type site Elandskloof 13), "Phase II" (type site Orangia 1, shallow and possibly mixed with younger artifacts), and "Phase III" (type site Zeekoegat 27) of Sampson (1968, but collapsed to "Orangian" and "Zeekoegat" in Sampson, 1985), all come from the alluvial Riverton Formation, Member III, in as far as they are "primary" (Butzer, 1984a). Nonetheless, Zeekoegat collections have minimal retouch, lack points or evidence of Levallois technology, have much higher blade ratios, and are dominated by prismatic cores. The matter seems to suggest similarities to the problem of partly coeval Mousterian "facies" in Western Europe (see Butzer, 1986), since the differences of patina are inconclusive—Zeekoegat being in a fine calcified sediment, and Orangia being in an oxidized, sandy matrix. At the Florisbad spring site, an MSA occupation was found between Peats 2 and 3 (Kuman and Clarke, 1986; Butzer, 1988); these artifacts are compatible with the regional MSA. But a different MSA, with unusually high frequencies of retouched tools (the "Florisian" of Sampson, 1972), was encountered in a lower stratigraphic unit, below Peat 2, making it somewhat older than the regional MSA complex; it is here labelled "Early," as distinct from "Late" MSA, and its occurrence is limited to the subhumid margins of the study area.

Peripheral to the andesite–hornfels outcrop region, MSA artifacts were made of other raw materials and are to some degree different. Early forms of MSA are well represented in the more humid parts of southern Africa, and there is also a distinctive industry, the Howieson's Poort, which includes large geometrics (Volman, 1984).

The Later Stone Age technocomplex is characterized by high variability. The "Early" LSA contains few formal, standardized, or retouched tools, and sometimes includes little more than amorphous debitage; the subsequent Albany industry is more macrolithic in character and includes a variety of large circular and end-scrapers, as well as grinding stones; finally, the "Late" LSA is represented by the Smithfield, marked by a high ratio of fully retouched, small scrapers, and the microlithic Wilton, peripheral to the study area, and notable for its dominant use of raw materials other than hornfels (see Deacon, 1984). The LSA collections lack characteristic MSA tool types and the Levallois technique was no longer used.

Dating is discussed further below, but the basic technocomplexes and industries can be summarized in Table I. Temporal contacts are time-transgressive in different parts of the subcontinent. The shift from Fauresmith to MSA may have been gradational, although the MSA and LSA are technologically very different.

LOCAL ARCHAEOLOGICAL STRATIGRAPHIES AND PALEOENVIRONMENTS

Basic archaeostratigraphy is shown in Figure 3, representing seven key sites or site complexes, arranged from southeast (Border Cave, on the Swaziland–Natal border) to northwest (Wonderwerk Cave, northern Cape Province). This direction also represents a precipitation gradient, from 1250 mm in the southeast to 300 mm in the northwest. Vegetation today ranges from open, subtropical woodland at Border Cave and Bushman Rock, to a mosaic of grass and temperate woodland at Rose Cottage Cave, temperate grassland at Florisbad, and subtropical savanna or bush to the west of Alex. The columns represent local stratigraphies, calibrated to 40,000 or 50,000 years by radiocarbon, and beyond that by extrapolated sedimentation rates, crosscorrelated by climato-stratigraphic criteria (Butzer, 1984a,b). Occupation levels are indicated in black (Figure 3).

Border Cave represents the most complete MSA occupation sequence, spanning deep-sea oxygen isotope stages 3 to 6, with some weathering lacunae or sterile levels (Butzer et al., 1978; Butzer, 1984b). "Bushman Rock" refers to two major sites, near Ohrigstad, eastern Transvaal: Bushman Rock Shelter and Heuningneskrans Cave. Here there is a long hiatus of 50,000 years between the LSA and MSA (Butzer, 1984a,b), but the MSA occupations are difficult to classify (Volman, 1984). At Rose Cottage Cave (near Ladybrand, Orange Free State) a series of essentially sterile deposits separate the LSA and MSA, representing an archaeological break of over 30,000 years (Butzer, 1984a,b, with references).

"Florisbad" (near Bloemfontein, Orange Free

Table I. Lithic technocomplexes and industries in Southern Africa (after Volman, 1984; Deacon, 1984; Butzer et al., 1978; Butzer, 1978, 1982, 1984b: Szabo and Butzer, 1979).

Technocomplex/Industry	Approximate Age
Late LSA (Smithfield, Wilton)	About 3500 B.P. to 19th century in study area, beginning 8000 B.P. elsewhere.
Mid-LSA (Albany)	About 13,000–5500 B.P. in study area, terminating 8000 B.P. elsewhere.
Early LSA	About 40,000–13,000 B.P. in study area, beginning 30,000 B.P. elsewhere.
Late MSA	Probably about 100,000–90,000 B.P. in study area, but partly coeval with Howieson's Poort in humid Southern Africa; Late MSA may have begun earlier elsewhere, and persisted to 30,000 B.P. in some places.
Early MSA	Perhaps 175,000–115,000 B.P., not represented in immediate study area.
Final Acheulian (Fauresmith)	Perhaps 250,000–175,000 B.P.
Acheulian	Probably prior to 300,000 B.P., extending back into Lower Pleistocene, with a very discontinuous record.

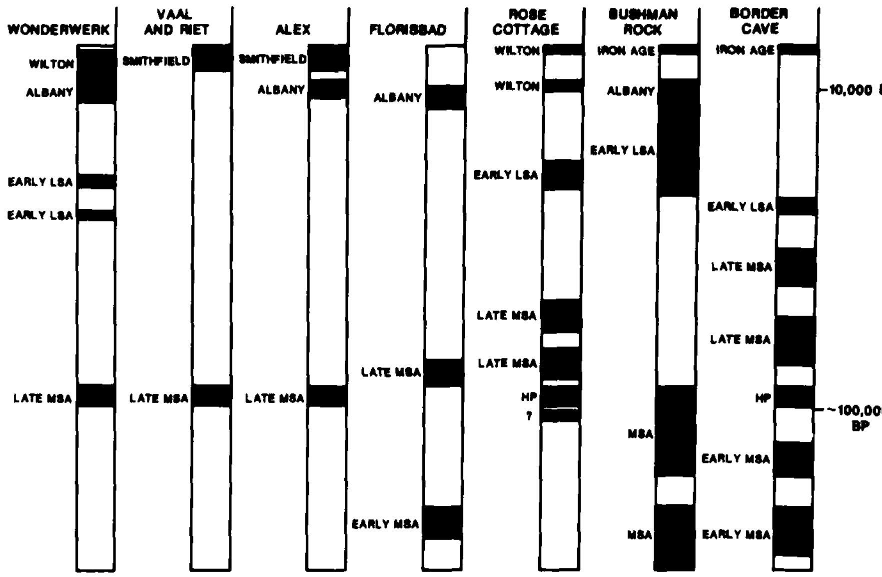

Figure 3. Archaeo-stratigraphy of key late Quaternary sites or site complexes in Southern Africa arranged in southeast (right) to northwest (left) order. For explanations, see text.

State) includes the hominid-bearing spring site of that name (Kuman and Clarke, 1986; Butzer, 1988), the adjacent gully and nearby Modder River alluvia (Butzer, 1984a), as well as another spring at Vlakkraal.

"Alex" refers to a complex of playa sites between Florisbad and Alexandersfontein (near Kimberley, Northern Cape), including the farms Deelpan, Voightspost, Uitzigt, Benfontein, and Mauritsfontein (Butzer, 1984a,b). The last three of these were the subject of a survey and test excavations (Figure 4). The MSA is invariably associated with heavily calcified spring accumulations or the lakeshores of much-expanded playas. A long period of deflation ensued, and even when high lake levels and spring sedimentation resumed a little before 20,000 B.P., these basins remained unoccupied for ten more millennia. During the early Holocene, some Albany settlement can be linked with seasonal playa lakes, but more conspicuous settlement is only recorded after 3500 B.P., when Smithfield peoples favored reactivated springs where organic mucks accumulated. "Vaal and Riet" refers to the alluvial formations of these two rivers and of the Modder, which have been extensively studied along many kilometers of exposures. A few MSA sites are associated with the Riverton Formation, Member III, but their scarcity suggests that seasonally-inundated floodplains were not particularly attractive; a period of soil formation ca. 19,000–15,000 and a moderately wet period of alluviation ca. 13,800–7800 B.P. (Member IVa) failed to attract settlement, but Smithfield sites are associated with marshy floodplain conditions after 3000 B.P. (Member IVb) (Butzer et al., 1979; Butzer, 1984a,b).

Wonderwerk lies west of the region (near Kuruman, Northern Cape), but as a major cave, provides a yardstick for settlement on one periphery of the region, as does Rose Cottage Cave on the other. A palimpsest of MSA artifacts appears to be found between Acheulian deposits (below) and Upper Pleistocene frost debris (above) (Beaumont et al., 1984); the latter includes traces of undiagnostic, presumably Early LSA artifacts between levels dated by carbonized grass matting at ca. 39,000 and by hearths at 28,000 B.P.[3] Erosion prevailed within the cave from ca. 25,000–13,000 B.P., after which there is a more or less continuous settlement record of Albany and Wilton type (Butzer, 1984a,b, with references).

Figure 3 summarizes the aggregate evidence of a large array of excavated sites and extensive sur-

[3] Whether or not there was a "primary" MSA level in Beaumont's excavation remains undocumented. Derived MSA points are found in LSA horizons dating about 12,000 B.P., and the debitage in the units dated 39,000–28,000 B.P. is definitely not compatible with the flaking of Levallois points. The typology of the (derived) points that I examined from Wonderwerk is comparable with that of other, regional "late" MSA collections.

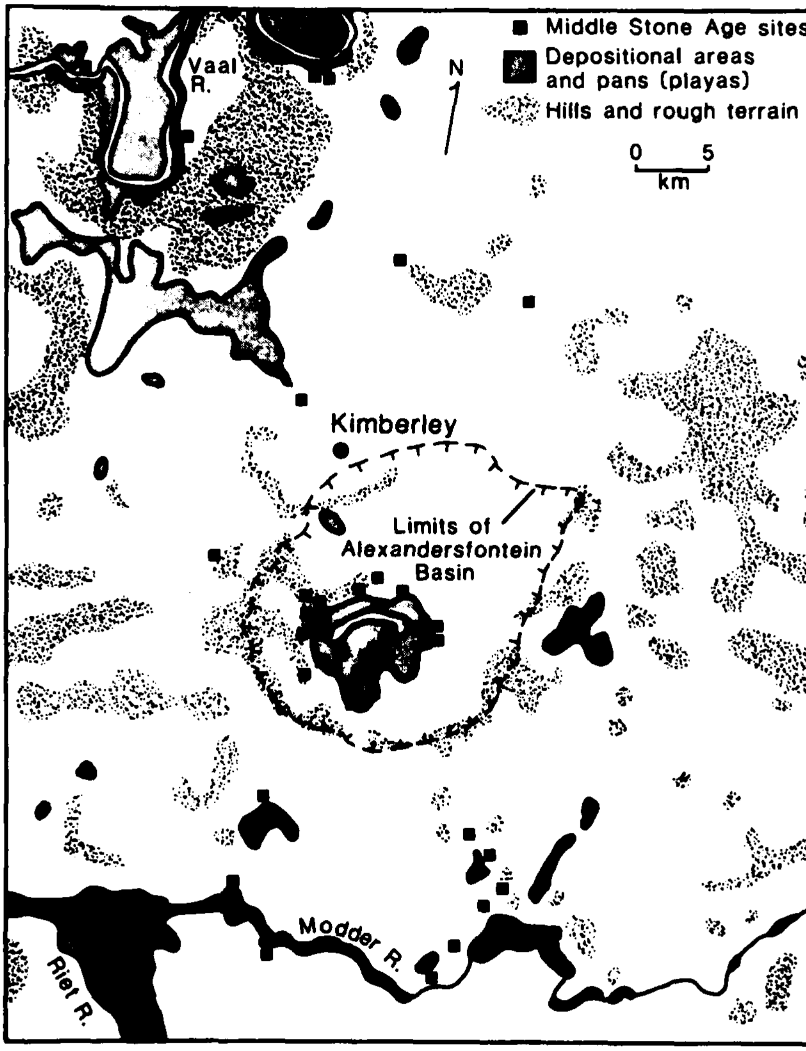

Figure 4. Middle Stone Age sites recorded in the Alexandersfontein Basin and other such occurrences currently identified between the Vaal and Modder rivers (after Butzer, 1982: Fig. 14-4). The MSA groups that exploited Alex at the time of the expanded lake ca. 100,000 B.P. probably ranged widely between the two riverine floodplains.

vey. Except for Border Cave, there is a yawning hiatus of many tens of millennia between the latest MSA and the earliest LSA, a break in settlement that ranges from over 30,000 to almost 80,000 years. The longest interruption is in the lower Vaal and middle Orange basin. Within the same region, the record of even earlier settlement is equally discontinuous. Figure 5 provides an overview of the spotty nature of Acheulian and Fauresmith sites in the fossil lakes (Doornlaagte, Rooidam) west of Alex (Butzer, 1974; Szabo and Butzer, 1979; Butzer, 1984a), as well as in the adjacent Vaal and Riet valleys (Helgren, 1978; Butzer, 1984a). Time scales are more inferential for this Middle Pleistocene record, but sites are distinctly linked with moderately expanded lakes or broad floodplains with high-energy channels, where gravel bars formed ideal quarries for stone-knapping.

The situation of the studied or surveyed sites is informative in its own right, as Table II shows. Acheulian "occurrences," in the generic sense, ap-

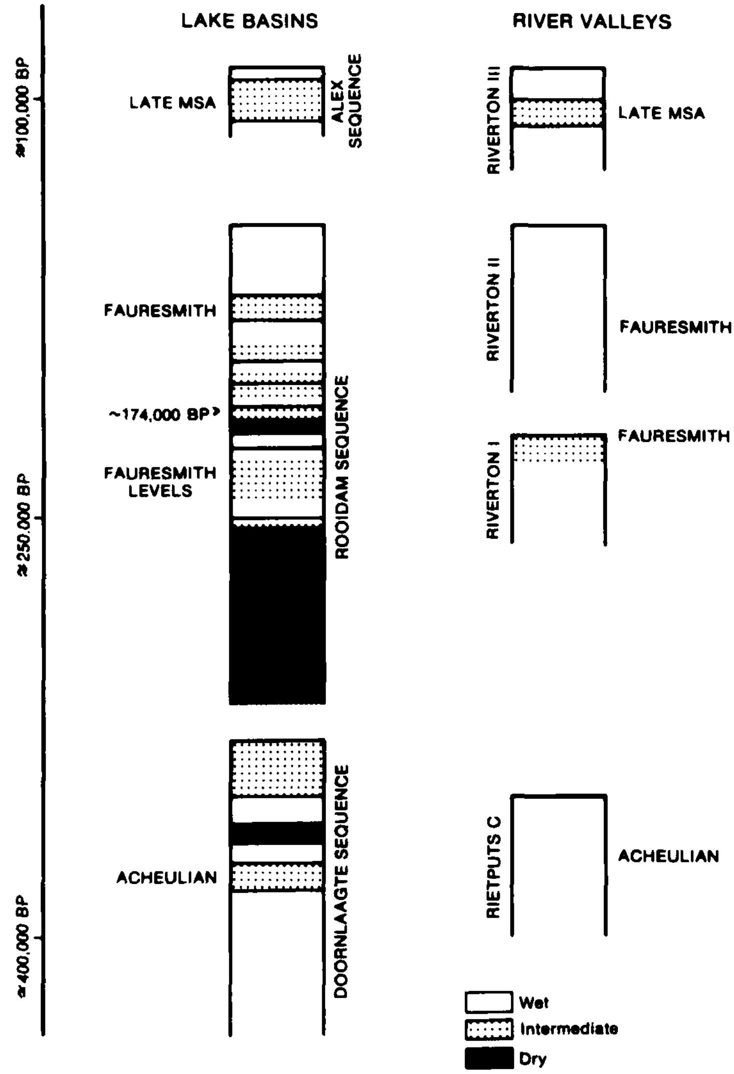

Figure 5. Mid-Quaternary depositional sequences and Acheulian/Fauresmith archaeological associations in the fossil lake basins and river valleys west of Alex and along the Vaal and Riet. The length of the columns is proportional to sedimentary thickness. Dating is limited to a uranium-series determination on the Rooidam sequence. After Butzer (1974, 1984a), Helgren (1978), and Szabo and Butzer (1979).

pear to be closely tied to ready sources of raw material, but specific Fauresmith settlement focused increasingly on formerly active springs and seasonally-wet floodplains. The MSA shows a distinct shift to the shores of expanded lakes and proximity of then active springs. The Early LSA is very rare and limited to caves around the periphery of the region. The Albany is also rare and suggests a preference for springs. Finally, Smithfield evidence is primarily found on slopes and ridges, relevant to hunting activities and rock art execution, with further preference for floodplains, springs, and seasonal lakeshores. This pattern is predicated on the particular range of habitats available in the broader study area, a region of relatively limited relief.

For purposes of comparison, the results of an exhaustive, well-funded survey in a small basin,

Table II. Preferred context of archaeological sites in the interior of Southern Africa (in numerical order with sample size in parentheses).

A. Alex and Vaal-Orange Area (Author)	
Acheulian (8)	Braided channels, slopes (quarries)
Fauresmith (10)	Spring, floodplain, quarry
MSA (48)	Lakeshore, spring, floodplain
Early LSA (2)	Cave
Albany (3)	Spring
Smithfield (69)	Slope, floodplain, spring, lakeshore
B. Seacow Basin Survey (Sampson, 1985)	
Acheulian (7)	No data
Fauresmith (510)	Quarry, riverine, spring
MSA (968)	Riverine, quarry, spring
Early LSA	Not identified
Albany (1250)	Quarry, riverine, spring
Smithfield (6624)	Slope, spring, riverine

with considerable relief, that of the Seacow River (Sampson, 1985, see Fig. 2), are also included in Table II. Fossil lakes are a minor feature here, and play only a limited role in site location. The concept of "riverine" does not correspond with our "floodplain" sites, the former defined as within one km of relatively minor streams, the latter directly associated with a large, well-defined floodplain. Even allowing for these differences, it appears that site preferences cannot be generalized, but reflect the range of available environmental variation. What does emerge is that almost all Pleistocene open-air living sites were linked to lakes now reduced to generally dry playas, springs now defunct, or floodplains now entrenched. By comparison, late Holocene peoples, although still dependent on water availability, spread their activities over all parts of the landscape in an expanded repertoire of activities.

Two primary conclusions can be drawn: (1) Pleistocene settlement was remarkably discontinuous in time and space, with repeated spans of many tens of millennia during which the interior of Southern Africa was essentially uninhabited and unutilized, except for sporadic and peripheral hunting forays; and (2) Pleistocene settlement was limited to periods of substantially moister climate and closely linked to dependable sources of water, although not all periods of moister climate were accompanied by an expansion of settlement into the interior.

Two secondary inferences can be drawn by way of extension. Firstly, Pleistocene populations in the region appear to have been demographically very conservative, not necessarily responding to improved environmental resources by automatic territorial expansion. And, secondly, late Holocene peoples had markedly improved technologies and organizational modes (also Deacon, 1984), that allowed more flexible demographic adjustment, coupled with effective settlement across the entire region.

A RISK-MINIMIZATION HYPOTHESIS

The evidence for major spatial and temporal gaps in the Pleistocene settlement record of Southern Africa raises a fundamental question. There always were some perennial streams and springs in the area, even during periods as dry as or drier than the present. Why, then, didn't small Paleolithic groups seek out such discontinuous habitats within the broader environmental mosaic? I suggest that people avoided drier macroenvironments because unspecialized hunter-gatherers in prehistoric times preferred to avoid risk.

(a) Given the high interannual variability of precipitation, plant foods during the dry seasons of poor years would have been characterized by low predictability as well as low net productivity. A succession of dry years furthermore decimates the herds of medium and large-sized antelopes, which eventually withdraw to moister grasslands in the east. The small springbok (*Antidorcas marsupialis*) is a gazelle that thrives in the region during relatively dry years, but it is very fleet and at 40 to 60 pounds weight, its pursuit provides little net caloric gain for hunters without the bow and arrow, or snares and traps, or unfamiliar with complex game drives. In addition, during protracted droughts, 19th century travellers report that springbok aggregated in huge migratory herds of several hundred thousand animals, that would have left vast areas devoid of game. Such low productivity and predictability of food and water resources would require an extremely high mobility response by unspecialized hunter-gatherers (see Dyson-Hudson and Smith, 1978), implying small bands (of under 50 people?), large operational areas (many 1000 km^2?), and very low population densities.

(b) The radius of foraging territories or "operational areas" of the Kalahari Bushmen at Dobe is about 15 km in an unusually productive environment, with protein-rich and reliable mongongo nuts (see Yellen, 1976). If this radius were expanded from 15 to 75 km for unspecialized hunter-gatherers in a much poorer setting, a roughly circular operational area expands from about 700 to 17,500 km^2, with a mean distance of 150 km between the centrally located camps of neighboring bands, and space for only 11 such bands in an area of 200,000 km^2. Such bands would have been spread so thinly that they would have had incomplete information on the state of resources within their own operational area. With several dozen hunting forays per year, by groups of adult males, the probability is that members of a neighboring band would have been fortuitously encountered only once every few years. But up-to-date information on animal movements and the condition of plant foods is essential to hunters and, in quasiisolation, a lack of such information is hazardous. For bands on the fringes of such a thinly-inhabited area, there is an additional danger; very small human populations need to exchange mates and genes with other groups, in order to remain biologically viable.

(c) During severe drought stress, game animals commonly lack body fat. Speth (1987) has assembled a convincing body of data to show that starving animals provide a poor and, at times, deadly diet for people suffering from acute famine. Fat-starved humans eating superlean meat crave for more, consuming protein to excess. This speeds up the metabolic rate, and may lead to diarrhea, dehydration, and death within a week or two. This "fat-depletion model" cautions that starving animals provide a poor or unsuitable source of food at times of severe food stress. In other words, the true capacity of a drought-prone, low productivity, and low predictability environment to sustain human life is a great deal less than its overall resources—averaged over time and space—would suggest.

These ecological, informational, and biological variables suggest that dry and unpredictable environments were too risky for early people. Being conservative in their strategies, they probably avoided marginal environments such as the semiarid interior of Southern Africa, except during times of ameliorated productivity. Such risk-prone environments will have, during the course of the Pleistocene, periodically expanded to cover vast areas of the Old World, so favoring great temporal and spatial gaps in the settlement record.

IMPLICATIONS FOR NEW WORLD SETTLEMENT

If the New World was first settled about 35,000 B.P. or so, during the intermediate glacial climate of deep-sea oxygen isotope stage 3, the human stock would probably have derived its technology from the older Paleolithic of eastern Asia. Despite considerable recent work (see Aikens and Higuchi, 1982; Rukang and Olsen, 1985; Chung and Pei, 1986; Larichev et al., 1987), Asian sites of this general age are still few and of relatively low visibility. Standardized tool types are at a premium, with choppers, chopping tools, rough bifaces, trihedral picks (anomalously labelled "points"), and a variety of modified flakes. The earliest dated evidence for the prepared core technique and a blade technology is about 21,000 B.P. (Japan), with pressure flaking (foliate points) in evidence by 14,000 B.P. and a micro-blade technology shortly thereafter (China, Japan, Northeast Siberia). These Late Paleolithic innovations are absent from the older levels of Monte Verde and Pedra Furada, whose affinities are with the older Paleolithic.

As a provisional working hypothesis, two separate periods of late Pleistocene immigration to the New World can be suggested. The first appears to have introduced people with a simple lithic technology, limited to processing (as opposed to hunting) tools, akin to the Asiatic "Middle" Paleolithic. If this migration took place before 35,000 B.P., there are as yet no documented sites of this type and age in the United States, despite strong candidates in South America. The second would be the Paleoindian phenomenon, with an explosion of sites notable for their fluted projectile points and micro-blade technology, after about 12,000 B.P., with intriguing antecedents at Meadowcroft by 14,000 B.P. (Adovasio and Carlisle, 1988). The Paleoindians were demographically expansive and skilled hunter-gatherers, their lithics sharing many traits with those of the Asiatic Upper Paleolithic.

The risk-minimization model, proposed here to explain major spatial and temporal discontinuities in the African archaeological record, can be applied to geoarchaeological exploration strategies for the New World. The African case study emphasized negative factors, concluding that semiarid or arid environments with low resource predictability and reliability were unlikely to be inhabited in Pleistocene times. At the other end of the spectrum, the Middle Paleolithic Neanderthals of Western Europe thrived in those subarctic environments of southwestern France and northern Spain (contra Diamond, 1987) where game was predictable and standing animal biomass high; these same people shunned most of the interior of the Iberian Peninsula, where large herbivores were highly migratory (Butzer, 1986).

Regions must therefore first be identified, by various paleoecological criteria, where late Pleistocene resources would have been abundant and predictable, and where environmental hazards would not have been a major threat. Such conditions would eliminate most of the Great Plains, where game resources have never been predictable. The valley systems of the Mountain West appear more suitable, although the revised pluvial lake chronologies now account for only a small part of Wisconsinan time. In effect, the denser clusters of Paleoindian sites do not overlap with environments likely to have attracted unspecialized and vulnerable hunter-gatherers, thus requiring a search in different parts of the United States.

Open-air sites will not be easy to locate in the 40,000 to 15,000 year time span. Suitable sediments of the appropriate age must be exposed. Most of the studied alluvial sequences in the Southwest begin with terminal Wisconsinan, low-energy deposits; earlier sediments are either fragmentarily preserved or of much greater antiquity, and they tend to be high-energy, gravelly deposits, in which artifacts such as those of Pedra Furada or Monte Verde would be very difficult to recognize. Lacustrine deposits will not be easier to examine since the highest lake stands are now dated about 15,000 B.P. (see Thompson et al., 1986, with references), so that older shorelines are generally buried under later lake beds or were eroded during lake expansion. Backhoe trenching is an expensive, hit-or-miss proposition. Raised beaches on mobile coasts are more promising, although cobble beaches were repeatedly quarried by later peoples and coeval artifact recognition will again pose severe challenges to all but a few lithics specialists. Much the same applies to other quarry sites.

Cave or shelter sites are undoubtedly the most promising, provided that sediments of appropriate age are preserved—near the entrance, rather than far back in a dark, dank cavern. It is here that such rudimentary artifacts could be more easily identified, provided that the archaeologist or geoarchaeologist can recognize lithics rather more problematical than those of a Paleoindian assemblage. In fact, the best clues are provided by hearths, identifiable in sections by three possible criteria: dark lenses with organic enrichment or carbonization; ash lenses or laminae, often but not necessarily white; and reddish, baked, or oxidized laminae (Butzer, 1982:82–85). Combinations of such thin-bedded strata obviously need closer examination, by more rigorous criteria, to confirm their identification, but they offer the easiest features to spot and examine.

The risk-minimization model and the South American site examples imply that pre-Paleoindian sites will neither be simple to locate nor numerous, and this brief sketch for a geoarchaeological strategy illustrates why such sites will have limited visibility and have not yet been documented in the United States. Martin (1987), in arguing that a "pre-Clovis" record, if it exists, should have been as conspicuous as the (Upper) Paleolithic of Japan, exhibits serious misconceptions of Old World archaeology. The "Middle" Paleolithic of East Asia is a more appropriate reference point: the few known sites have all been documented very recently, and most remain poorly dated and understood.

Recent archaeological experience in many regions has repeatedly required a complete revision of prevailing paradigms. Potassium-argon assays for Olduvai Bed I in the early 1960s pushed back the age of the earliest hominid sites in East Africa from less than 1 million to 1.75 million years. Radiocarbon and other dating of the African MSA since the early 1970s increased its age from 30,000 to almost 200,000 years. The mid-1960s discovery of one good site in Australia increased the accepted age of earliest settlement on that subcontinent from 10,000 to almost 33,000 years, and a half-dozen other sites older than 20,000 B.P. were located shortly thereafter. The key was to know what to look for and where. Each of these breakthroughs came about when a new fact convinced a number of pragmatic researchers to explore alternative concepts. Possibly, completion and publication of the excavations at Monte Verde and Pedra Furada will have a similar impact by illustrating what a "pre-Clovis" site looks like.

Disillusioned by a series of unconvincing "pre-Clovis" sites, Americanist archaeologists—understandably—tend to be conservative. But skepticism can go too far. There now is a real danger that new sites that do not conform with the conservative paradigm may be rejected out of hand by contrived arguments. We must, however, be prepared to accept the unexpected, provided that it is properly studied and verified according to reasonable criteria. For a time, very early sites may prove easier to find in South America, for whatever paleoecological reasons. If that is indeed the case, the Old World model of discontinuous settlement outlined here may at least allow skeptical archaeologists to examine such sites on their own merits, rather than to insist *a priori* that there be counterparts everywhere else. If such sites do stand up to closer examination, then it would only be a matter of time before a radical restructuring of research strategies would replicate such records in certain other areas.

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