RICE UNIVERSITY

ARCHAEOLOGICAL RECONNAISSANCE IN THE REGION OF TIMBUKTU, MALI

by

Roderick J. McIntosh and Susan Keech McIntosh

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Appendix A: Survey Data

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Archaeological Reconnaissance in the Region of Timbuktu, Mali

Susan Keech McIntosh, Ph.D., Associate Professor of Anthropology,
Department of Anthropology, Rice University, Houston, Texas 77252.
713-527-8101, ext. 3380, 4847

Roderick J. McIntosh, Ph.D., Associate Professor of Anthropology,
Department of Anthropology, Rice University, Houston, Texas 77252.
713-527-8101, ext. 4003, 4847

Susan Keech McIntosh has advanced degrees from Cambridge University and from the University of California at Santa Barbara and has excavated in Britian, Sweden, Ghana, and Mali. Her teaching and research specializations are human evolution, human osteology, ceramics, urbanism and complex societies. She is currently the Associate Editor for Archaeology of Current Anthropology.

Roderick J. McIntosh received his Ph.D. from the University of Cambridge (1979). He has extensive field experience in Ghana and Mali and at historic sites in the United States. His research interests include geomorphology and palaeoclimate, prehistoric art, urbanism, and complex societies.

Indexing Terms: Archaeology; Geomorphology; Timbuktu; Mali

Figure 2: Taoudenni salt caravan approaching Timbuktu from five kilometers to the east, January 1984. The caravan followed the El Ahmar *wadi* through the dunefield.

BACKGROUND

Timbuktu has long evoked in the Western mind an image of a city at once wealthy and unattainably remote. This is not simply an image generated by nineteenth century romaticism; it accurately describes both the preeminance of the city as a center of commerce and Islamic learning from the 15th to 19th centuries and the position of the town at a point where the Niger River touches the Sahara. The importance of the Timbuktu location on the Niger Bend to the historical development of the Western Sudan can scarcely be overestimated. Control of trade to middle Niger commercial centers, Timbuktu included, was instrumental to the rise of the great empires of Mali, Songhay, Hamdullahi, and perhaps Ghana (Levtzion 1973: 124-170; Abitol 1979; Cissoko 1975). Remarkably, the Niger Bend region, including Timbuktu itself, has never been subjected to serious archaeological investigation. As a result, almost nothing is known concerning its development during the late prehistoric and early historic periods, which must have witnessed the major changes in economic and social organization that preceded empire formation.

We designed the preliminary survey of January 1984 to procure quantitative and qualitative data on the region's prehistory. We collected a variety of basic data on the range of sites present along the Niger Bend and on how these sites vary with respect to size, surface features, artifacts

and location on different landforms and soils. This survey provides the first systematically-collected archaeological data from the Niger Bend, derived with a view towards linking these data with evidence for a changing environment. The research provides an initial test for the authors' hypothesis, based on previous work further upriver at the site of Jenne-jeno, that first millennium trade centers existed in the Niger Bend area. The results of this survey, tentative though they may be, indicate an urgent need for more extensive follow-up excavation to clarify what now appears to be a chronology of settlement development in the Niger Bend quite differrent from that reconstructed on the basis of history and oral tradition.

Historical Sources: Historical Timbuktu is the subject of several recent books and essays which rely upon Arab visitor accounts and, especially, upon the locally-composed *Tarikh al-Sudan* (al-Sa'di 1964: 35-37) for the received account of the city's earliest centuries. According to this standard history, at the turn of the present millennium, the Niger Bend was marginal to the two great Sahelian exchange spheres centered to the west on Ghana (Koumbi Saleh?) and Awdaghost and, to the east on Tadmekka (es-Suk) and Koukia-Gao (**Figure 1**). As late as the 12th century, according to this account,the Niger Bend region was a "région peu éveillée à la vie commerciale" (Cissoko 1975: 23). At this time (before AD 1100, cf.,

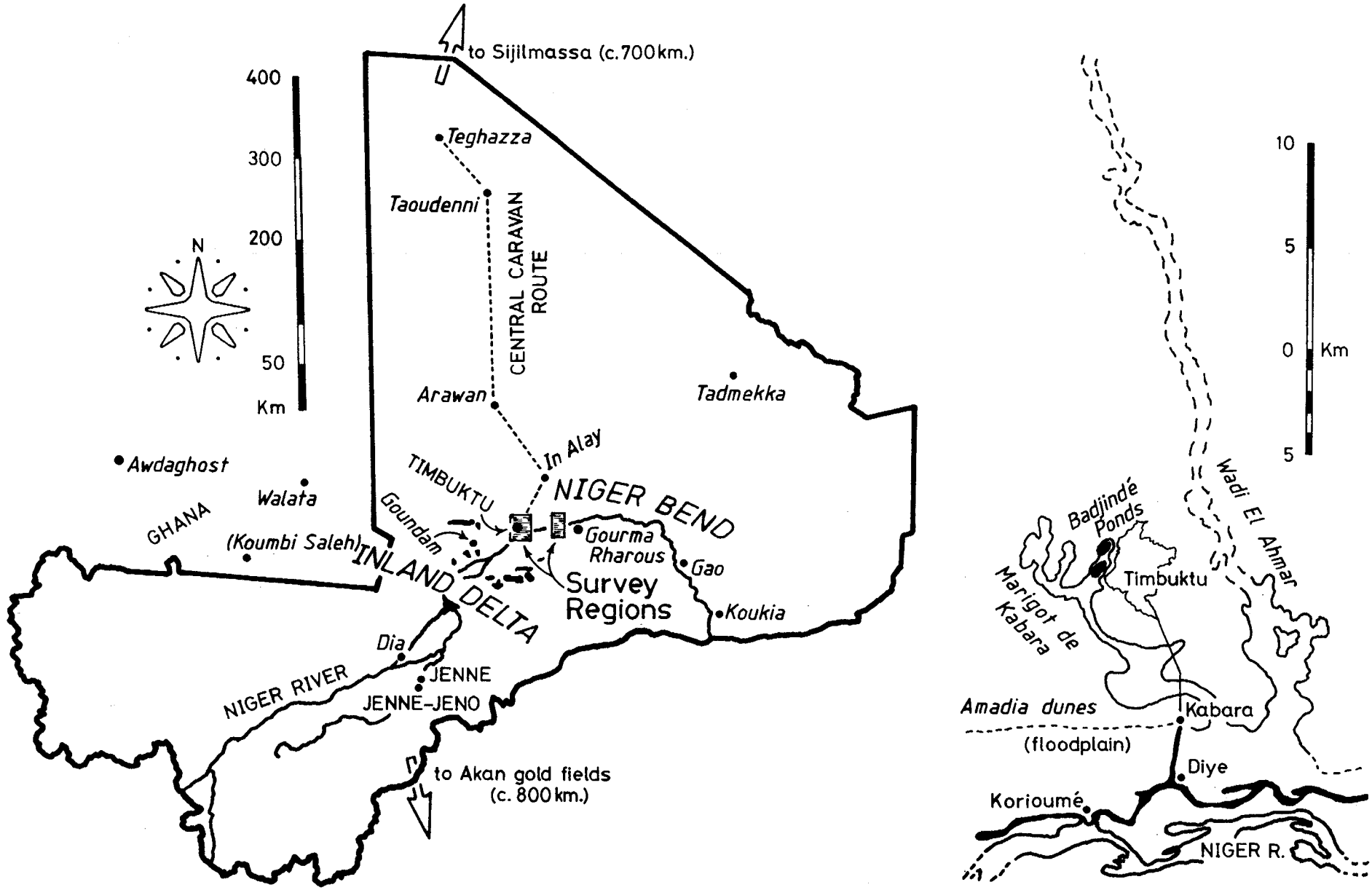

Figure 1: **Location in Mali of Timbuktu and the Niger Bend, with historical towns and regions mentioned in text. Map illustrates the two 1984 survey regions: the larger covering the Timbuktu hinterland and the smaller located 22 km west of Gourma-Rharous. The inset map shows details of the *wadis* near Timbuktu.**

al-Sa'di's date of the end of the 5th century AH), the Maghcharen nobles of the Mdâsa Tuareg from Arawan founded a camp along the Niger at the southernmost (summer) point of their yearly transhumant grazing round. Upon their return to the Sahara, they left the camp in the charge of a female slave named Timbuktu.

The hamlet languished, unremarkable except for the slow immigration of Soninke clerics from the southwest and other Tuareg (especially the Messoufa who controlled the western Saharan trade routes and the salt mines (Teghazza and Taoudenni; Figure 1)(Cissoko 1975:17-23,26-30; Saad 1983: 28-29). The emergence of Timbuktu as an important trade center has often been linked to the growth of Jenne, located 500 kilometers upriver in the upper Inland Niger Delta, as an entrepôt servicing the gold trade from the Akan gold fields, which opened around the 13th or 14th century (Herbert 1980: 433; Saad 1983: 31; Abitol 1979: 34). Timbuktu is not mentioned by Arab visitors or chroniclers until Ibn Battuta visits in 1354; his account of the trip compares Timbuktu unfavorably to Gao and Walata (Cuoq 1975: 314-315). Most scholars follow al-Sa'di (1964: 37) in placing Timbuktu's commercial ascendancy at the end of the 15th or early 16th century, when it replaced Walata as the southern terminus of the salt route - **Figure 2** (Abitol 1979: 33; Cissoko 1975:30; Herbert 1980: 434). In 1512 Leo Africanus described it as constructed largely of straw

huts, curious for a town of 25,000 or even 50,000 at the height of its prosperity and scholarly prestige (Mauny 1961: 497; Saad 1983: 27; Cissoko [1968:810] estimates a population of 80,000 during the 16th century).

Given the apparent lateness of Timbuktu's development, it is perhaps not surprizing that archaeologists thought this an area of little potential. Indeed, Raymond Mauny who earlier had conducted brief surface collections (Mauny 1952a and 1952b) wrote "Aucune fouille n'a été practiquée à Tombouctou et, sauf un hasard heureux, l'on ne voit pas quelle trouvaille pourrait s'y faire" (Mauny 1961: 115; see other brief mention of surface finds in Monod 1938 and Lhote 1952). What is the source of this pessimism? This is a prime example of the historical or city-centric school of urban archaeology as practiced in West Africa (S. & R. McIntosh 1984:76-77). Members of this school excavate to identify a site with a town mentioned in the arabic sources, in order to validate and supplement those sources. With the late foundation date and even later climax of Timbuktu presented in the standard historical reconstruction, of course this site would attect less attention than, for example, earlier towns such as Awdaghost, Gao, Tadmekka or the Ghana and Mali capitals. For Mauny, the destruction at Timbuktu of 'medieval' structures, such as the Mali period Madougou (palace), and the recent rebuilding of the ancient mosques meant there would be little monumental architecture to excavate in the manner to which

archaeologists of the historical school are accustomed.

In many respects, this situation is similar to the one we encountered at Timbuktu's sister-city, Jenne, before we began archaeological investigations there in 1977. Jenne was not mentioned in historical accounts until the 14th century, hence the prevailing presumption that the town was not founded before the 13th century. Archaeological excavation had not been undertaken at either Jenne itself or at its ancestral site, Jenne-jeno ("ancient Jenne"), partly for the same reasons set forth above regarding Timbuktu. Our research in 1977 and 1980-81 at Jenne-jeno and environs demonstrated that an urban community had developed there by AD 500, apparently supported by trade. Among the imported goods were gold from the south and copper, probably from the Sahara.

In discussing the lack of congruence between the archaeological and historical reconstructions for this area (R. & S. McIntosh 1981: 2-10, 21) we have suggested that the desire of a Muslim community (as Jenne was, after conversion by the 13th century) to repudiate or at least deemphasize its preislamic past (cp., Saad 1983: 24), a possible name change, or a successful policy to limit access to information about the city's sources of wealth may have conspired to prevent the outside world from learning about Jenne until the mid 15th century. Could the same process, we wondered, have occurred at Timbuktu, shrouding in historical obscurity the true

chronology of the region's development? Only archaeological investigation could provide an answer.

In formulating a research strategy for investigating urban development on the Niger Bend, we have emphasized the same regional perspective that proved so useful in the Jenne investigations (S. & R. McIntosh 1980: part ii and 1984: 84-95 ; R. & S. McIntosh 1983b). A regional approach permits an appreciation of the circumstances and process by which a landscape of undifferentiated hamlets and villages generates a city. This is an issue of great importance to the understanding of Timbuktu's rise, because most authors agree that the agricultural and pastoral potential of the Niger Bend in Timbuktu's immediate vicinity is insufficient and too prone to climatic instability to suppport an urban population of any size (Abitol 1979: 180-183; Herbert 1980: 432; Cissoko 1968: 811). Did Timbuktu develop as the apex of an urban settlement hierarchy whose agricultural hinterland extended some distance along the Niger Bend (see Grandet 1957) or did the boundaries of that settlement hierarchy reach even farther, into the lower Inland Delta around Goundam and Niafunke, the region of somewhat more extensive cultivable terrain near the great lakes where numerous ancient settlements, tumuli and megalithic arrangements are found? Recent archaeology in this latter area has yielded radiocarbon dates between AD 600-1000 (Saliège, *et al.* 1980). On the other hand, it may be

that Timbuktu functioned as "port city" (Boone and Redman 1982), isolated on the sahelian shore of the Saharan sand sea, its existence dependant on trans-Saharan trade and on a distant agricultural source, such as the upper Inland Niger Delta, for provisioning. Documenting Timbuktu's urban personality (central place within a regional hierarchy? port city? shift though time from one to another?) would speak volumes about the environmental and commercial circumstances of its emergence and growth.

Another, more peripheral, objective of the 1984 research was to test the possibility that an early urban center of another name existed along the western Niger Bend (perhaps at Timbuktu's location). Most scholars discount the tale in Herodotus (II, 32-33) of the Saharan trip of five Nasamonians who, in the "savanna", found a city of Blacks on the banks of a crocodile-infested river flowing west to east. Some, however, are willing to credit this as proof of a city on the Niger at Timbuktu's present location (Ferguson 1969: 10; cp., Fage 1981: 284). More credit, perhaps, can be attached to the search on the Niger Bend or lower Inland Delta for several unlocated cities mentioned by al-Bakri in 1068, such as Awghom, Safankû, Tirekka, and Bûghrat (Cuoq 1975: 105-106). Working from the details of al-Bakri's itinerary and Idrisi's account a century later, one of us has argued that Tirekka was on the Niger Bend in the general vicinity of Timbuktu (S. McIntosh 1981: 156-157; cf., Saad 1983: 29). Others (Cissoko 1975: 25-26)

suggest that the Mdâsa settlement of Bûghrat was the first Maghsharen camp on the low Amadia dunes near Kabara. When the settlement was later relocated several kilometers north (perhaps to escape seasonal flooding), it was renamed Timbuktu. In any event, the existence along the Niger Bend of entrepôts predating Timbuktu (or at least predating its traditional foundation date) is a possibility and contradicts the traditional view of this region as marginal to serious commerce until the fourteenth or fifteenth centuries.

Lastly, we wished to investigate the implications for settlement and commerce in the Niger Bend of our past research results at Jenne-jeno in the upper Inland Delta. Historians are unanimous in their assertion that the sister-cities of the Middle Niger gold-for-salt trade, Jenne and Timbuktu, developed simultaneously (Abitol 1979: 34, 178-180; Saad 1983: 30-32; Herbert 1980: 433-434; see al-Sa'di 1964: 22-23). Prior to our 1977 and 1981 excavations at Jenne-jeno, scholars had generally assumed that the Middle Niger trade axis did not develop until the 14th century. Because of the firm evidence now available of rapid urbanization underway at Jenne-jeno by A.D. 250, however, we have argued that exploitation of the river thoroughfare began much earlier (R. & S. McIntosh 1981:20-21; S. McIntosh 1981: 153, 158). From the 1984 research along the Niger Bend , we hoped to secure evidence for the existence of first millennium trade centers

which exchanged goods with Jenne-jeno in a manner analogous to Timbuktu and Jenne in later times. Of course, after a preliminary season of survey, only tentative conclusions may be drawn from comparative artifact studies about shared cultural expressions or shared participation in a sphere of influence. However, we hoped the preliminary survey would suggest the chronology and extent of links with Jenne one the one hand, alternative ties to Gao on the other, or provide evidence of completely independent growth during the earliest centuries of Timbuktu.

Methodology and Geomorphological Context

Because the 1984 Niger Bend survey was purely exploratory, our principal concern was to search for sites in a systematic manner and to record the ceramic assemblage and other artifacts on their surface. By so doing, we would also contribute to the long-term project of the Institut des Sciences Humaines of the Malian Ministry of Culture, which is intended to provide a complete inventory of archaeological sites in Mali. We were interested to collect settlement pattern data in a manner that would make them comparable with data already available for the Jenne hinterland. This

necessitated the application of the survey methodology created and tested satisfactorily during our research since 1977 in the Jenne-jeno hinterland and the investigation of the geomorphological background to settlement preferences. Changing landform preferences provided a key to the ancient urban settlement dynamics of Jenne-jeno (R. McIntosh 1983). Lastly, we sought to test the reliability of air photos for use in identifying sites on the different landforms or soil groups of the Niger Bend.

Based on careful examination of air photos, we selected for examination two areas of the Niger Bend which appeared particularly promising. The larger of the two areas covers 260 square-kilometers (20 x 13 km) immediately east of Timbuktu (see **Figure 3**). Approximately 90 kilometers farther downriver (22 km west of Gourma-Rharous), we also defined a smaller area of 50 square-kilometers (10 x 5 km)(see **Figure 4**). Both study areas were stratified by appropriate geomorphological units: 1) Scoured Floodplain near the river; 2) Fluvially-Modeled Dunes ; and 3)Dunefields of longitudinal dunes .

We selected these soil and landform units after perusal of the available aerial photography and initial ground reconnaissance. They remain, however, gross classifications because no detailed geomorphological study is available for Timbuktu's immediate surroundings (cf., Blanck 1968). Consequently, the reasons for the foundation of the city at that particular

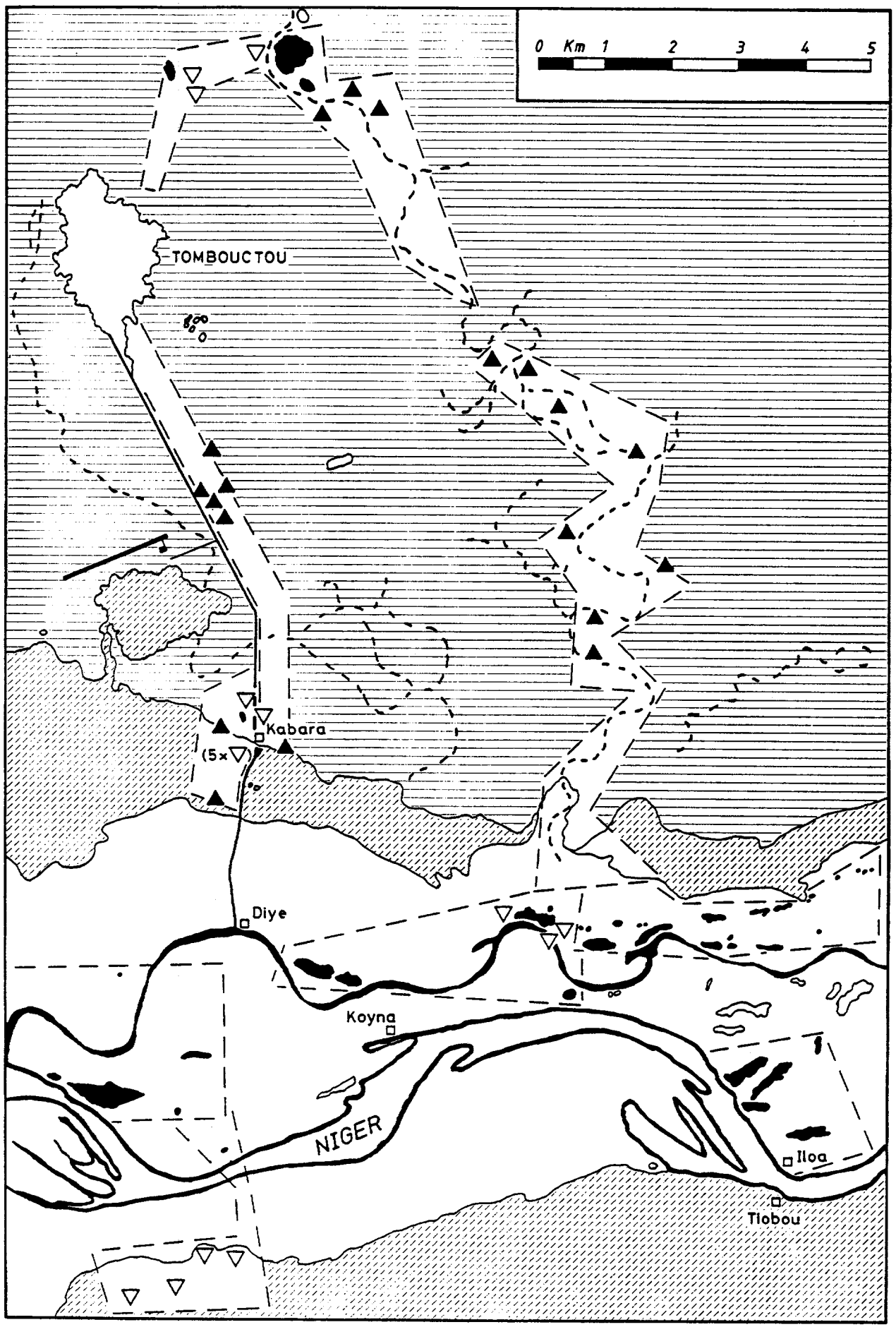

Figure 3: Survey region near Timbuktu, showing landforms, putative and verified sites and survey blocks. For legend, see Figure 4.

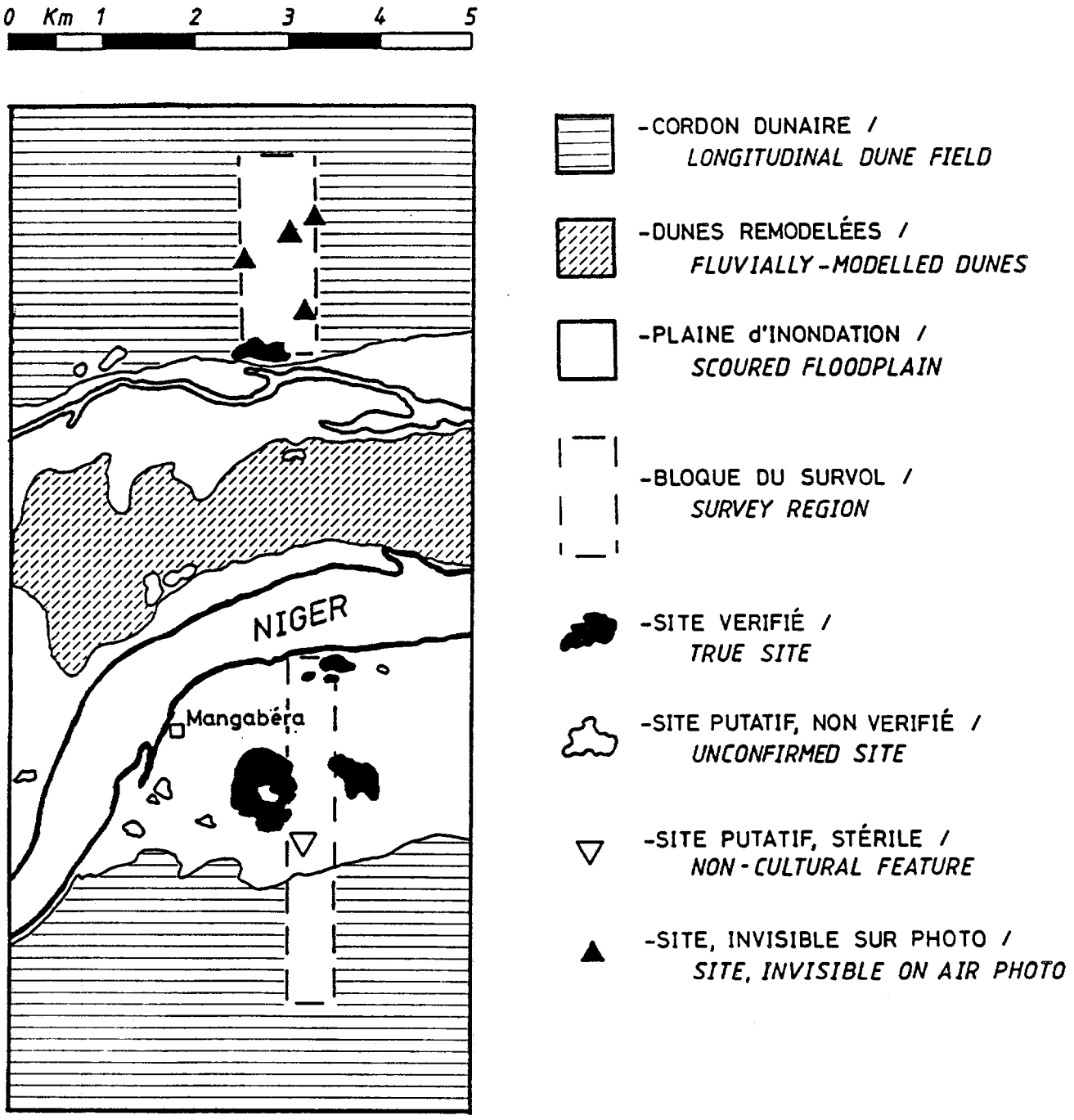

Figure 4: Survey region near Mangabéra (90 km. east of Timbuktu).

location remain speculative. Some argue that the floodplain is wider here than elsewhere in the Niger Bend, allowing greater local agricultural production (Saad 1983: 5-6; Kervran 1959: 53). Others suggest that Timbuktu was located on dunes seven kilometers away from the floodplain margin in order to avoid the fevers of the inundation period (Mauny 1961: 498) and to avoid seasonal flooding by the Niger (Herbert 1980: 432). Others take a more sanguine view of seasonal inundation. They suggest that the town was built on crests of two parallel (longitudinal) dunes in order to take advantage of standing water available in the seasonally-filled interdunal depression between the crests (see **Figure 5**). It may be this situation that inspired the name "Badjindé", or "Stream of the Hippos" in Songhai, for the residential quarter located at that interdunal depression (see Figure 1) (Cissoko 1975: 18; Blanck 1968: 24). Large ponds supplying the town's drinking water appear on historical maps of the city (see Fig. 106, p. 496 of Mauny 1961 for its appearance before 1894) and, indeed, even during the horrific drought year of 1984, the gardens excavated into the beds of former ponds at the western edge of the city were producing in January.

Most agree on two transport advantages of the location. Timbuktu has a seasonal water link to the deep Niger channel. Recently during exceptional floods, and arguably each January in past centuries, boats could travel to

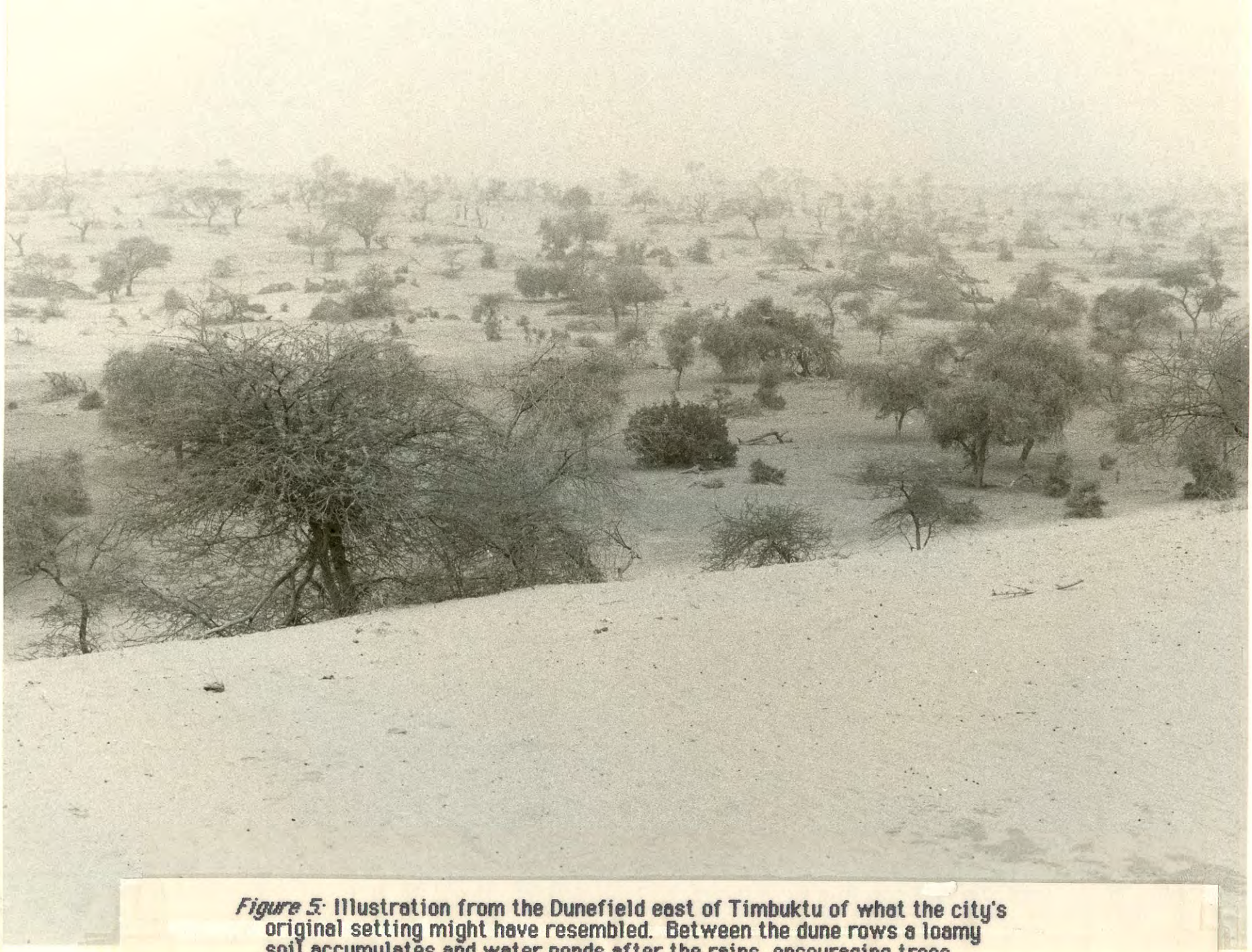

Figure 5. Illustration from the Dunefield east of Timbuktu of what the city's original setting might have resembled. Between the dune rows a loamy soil accumulates and water ponds after the rains, encouraging trees which in turn stabilize the dunes.

Timbuktu along the *wadi* feeding the Badjindé ponds. Locally this *wadi* is called the Canal du Pacha Djouder or the Marigot de Kabara (Mauny 1961: 498; Miner 1953: 3, note 1; Cissoko 1975:17). Boats travel to Kabara in February to April, Diye (or Daï) in April to June and only to Korioumé in July (with the succession reversed as the waters rise)(see Figure 1). These ports service a Niger navigable from Jenne to Gao. The second, and complementary advantage is that Timbuktu is the port best situated to sevice the central salt-for-gold caravan route passing through Arawan (Miner 1953: 3, note 1; Herbert 1980: 432; Mauny 1961: 497). Timbuktu's advantage over any other location along the Niger Bend is that it is in a direct line with the line of wells south of Arawan (In Alay being one of these caravan stops north of the city). If, as circumstantial evidence suggests (Cissoko 1975: 27; Mauny 1961: 328), Teghazza was exploited in the eighth century or earlier, this route directly south may be of some antiquity and a "port" in Timbuktu's general location may have had a much more ancient relationship with the cities of the upper Inland Delta, such as Jenne-jeno, than is usually admitted (R. & S. McIntosh 1981: 20 and 1983b: 40).

In the sahelo-saharan zone, the availability of water is critical to the history of human settlement. The importance of reconstructing from geomorphological evidence the fluctuations in surface water in the Niger Bend is twofold. Firstly, these fluctuations may help to explain changes in

preference for one landform or soil group over another for permanent or temporary occupation. Secondly, the geomorphological evidence points to the Timbuktu vicinity as the source of recent periodic drainage along ancient channels into southern Saharan depressions or, alternatively, as the recharge source for the subterranean channel (aquifer) along which the wells and oases of the central salt caravan route are situated. Timbuktu's location at the Niger River terminus of this north-south alignment of wells is highly significant to our reconstruction of the city's earliest history. Thus it is pertinent briefly to review the evidence of Niger River and nearby *wadi* activity and of subterranean drainage into the Sahara.

Until quite recently it was widely accepted that the joining of the upper and lower Niger courses at the Niger Bend occurred only within the last 10,000 years (Furon 1929; Grove and Warren 1968: 198-199; Palausi 1955). According to this theory, the upper Niger deviated north in the general vicinity of Timbuktu and fed vast lakes in the Arawan syncline and Taoudenni basin throughout the Pleistocene. The upper and lower Niger were finally united at the Tosaye sill when access to the southern Saharan basins was blocked at the beginning of the lower Holocene climatic improvement by the dramatic longitudinal "red dune" erg (the Dunefield of the 1984 survey regions) erected during the 20,000-12,500 bp hyperarid period (for a summary of the palaeoclimate, see S. and R. McIntosh 1983:

219-225). Initially most investigators thought that the longitudinal dunes blocked surface flow entirely, creating truly senescent *wadis* of the former river channels coursing north through the Sahara (Grove and Warren 1968: 199; Palausi 1955: 218). The oases and wells along the Arawan-Taoudenni caravan route, which follows one of these *wadis*, would therefore represent a subterranean aquifer only, with piezometric recharge from the Niger .

Several potential channels have been identified on aerial photographs (Palausi 1955, Tricart 1965; Blanck 1968). The most prominent of these is the El Ahmar *wadi* three kilometers east of Kabara (Figure 1), named the "Paléo-Niger" by Kervran (1959: 53; cf., Paluasi 1955: 217). This author describes an integrated thalweg running 120 km north to In Alay, where the channel is lost to lake deposits and to swamps in interdunal depressions (cf., Petit-Maire and Riser 1983: 414). The thalweg is well defined from the Niger floodplain north for approximately 7 km. (just beyond the site Wadi-8 (W-8) on Figure 29). There, the low Amadia longitudinal dunes give way to high-crested longitudinal dunes that disorganize the channel. The clear implication is that a pre-existing channel was overlain by late Pleistocene dunes and that these dunes had to be breached during a Holocene return of surface flow. The *wadi* El Ahmar was a particular focus of the 1984 survey because of our interest in determining during which periods this channel may have supported human settlement on its banks.

The concept of a complete separation until c.20,000 bp of the upper and lower Niger is now questioned by Petit-Maire (pers. comm., 1985) and by Beaudet *et al.* (1977). The latter believe the "Paléo-Niger" to in fact have been a temporary diversion north of some Niger water at the beginning of the lower Holocene pluvial, before the Niger regained the former course blocked by dunes. Recently, the belief that Holocene surface flow into the Sahara was epiphenomenal at best has suffered a blow by the discovery of Lates maliensis, radiocarbon dated to 6970+130 B.P., northwest of Arawan or some 300 km north of Timbuktu (Petit-Maire & Riser 1983: 413; Petit-Maire & Gayet 1984: 21-22). This enormous fish entered the Arawan lake from the Niger and requires absolutely a permanent, uninterrupted and well-oxygenated flow of water. Clearly, the late Pleistocene longitudinal dunes could not have permanently terminated surface flow along the old channel, although this flow may have been interrupted during times of low precipitation and reduced Niger floods. We were particularly interested in our research to recover evidence of surface water in the *wadi* during more recent times. If, for example, we found evidence of flow in *wadi* El Ahmar during the 1st or 2nd millennium AD, this would be an important key to understanding Timbuktu's placement.

We are only beginning to reconstruct the late Quaternary history of the Niger and sorely need more finely detailed geomorphological field

studies. These will supplement larger scale surveys, such as that conducted by Blanck (1968) for the Niger Bend and lower Niger from Timbuktu to Labbezanga (c. 160 km downstream of Gao). Blanck's preliminary description of present fluvial and aeolian modeling near Timbuktu is a point of departure for our own classification of landforms pertinent for the 1984 survey. Blanck identifies a fluvially-lain sand terrace along the river (our Fluvially-Modeled Dunes, see Figures 3& 4), the sands of which were subsequently reshaped by river meander (Scoured Floodplain) and, during dry periods more recent than the hyperarid phase to which the longitudinal Dunefield dates, by deflation and dune erection. Blanck's lower Holocene Niger, "quelques kilometres" north of the present channel (1968: 21-22), may be the vestigial channel visible north of the Niger in Figures 3 & 4. The former river erected the sand banks, supplemented by active aeolian dune building, evidently preferred for ancient and modern settlement (see location of Diye and concentration of archaeological sites to the east, in Figure 3). The three-part landform classification suggested by Blanck and careful viewing of aerial photographs was the basis of our stratification of the survey regions.

We designed reconnaissance strategies independently on each of the three landform strata in order to investigate their very different potentials for settlement distribution. Because the 1984 survey was so preliminary in

nature, we decided against a statistically random selection strategy. Too often, probability samples result, quite by chance, in a concentration on one or a very few types of sites. We decided to investigate, on foot, large blocks within the survey area, thereby increasing our chances of discovering sites of many different types and sizes. The floodplain of the large survey area was divided into five transects of arbitary size, comprising approximately 50% of the total area of that landform (see Figure 3). The surface of each transect was walked thoroughly and all putative sites (i.e., those identified on aerial photographs) were visited. Within each transect, we selected for intensive surface collection 50% of the archaeological sites thus discovered and verified. Although the selection of sites for surface collection was arbitrary, the primary concern in the selection process was to include examples of all classes of sites discovered in the course of survey.

Within the fluvially-modeled dunes, we likewise walked the surface of three transects. The dunefield north of the Niger presented three different aspects, each of which had to be investigated. We selected a small transect immediately northwest of Kabara in order to investigate that part of the dune closest to year-round water. Secondly, we searched a long transect (7.5 x 0.5 km) from Timbuktu to Kabara, which is perpendicular to the river and to the longitudinal orientation of the major dunes. Within this transect, we discovered six sites, of which three were intensively surface recorded.

Lastly, we searched the bed and banks of the massive *wadi* El Ahmar which begins three kilometers east of Kabara. Within the zone of fluvially-modeled dunes and along the *wadi*, all sites encountered were intensively surface-recorded.

In the vicinity of Mangabéra, a Songhai village 22 km west of Gourma-Rharous, survey preceded within two transects (see Figure 4). A transect of 2.0 x 0.75 km north of the river and a second of 3.75 x 0.5 km cut through a region particularly rich in putative sites. The survey of the Mangabéra region serves as a test of the applicability of survey results in the Timbuktu region to other parts of the Niger Bend. In both the Mangabéra and Timbuktu regions, we recorded surface features and the presence of miscellaneous surface artifacts and we collected samples of surface pottery by the same methods developed during the Jenne hinterland surveys of 1977 and 1981. Thus we now possess preliminary data on ancient settlements in the Niger Bend which are comparable to those available from the Inland Niger Delta. Raw data for surface-collected sites are presented in Appendix A.

Settlement Pattern: Survey Data

By looking at the spatial data available for all sites investigated, independent for the moment of their chronology, some interesting remarks

can be made about overall locational preferences by landform, comparison with settlement patterns in the Jenne-jeno hinterland, and the efficiency of the aerial photos.

We devised in the field a crude typology of sites based on area and on depth of cultural deposit. Since we did not excavate, it may be somewhat premature to divide these sites into those with a substantial accumulation of sandy-loam matrix with abundant artifacts (labelled permanent) and those of a simple sherd scatter on top of little-modified dune sand or floodplain soil (temporary). In the field the differences are immediately visible, but until excavation is done the labels permanent and temporary occupation remain likely, but tentative. The four categories in this typology are presented in **Figure 6**: 1) large sites (larger than one hectare) of deep deposits; 2) small, but intensively- occupied, deep-deposit sites; 3) superficial deposits (usually of small area) on dunes; and 4) temporary occupation elsewhere (usually on the banks of *wadis* or within deflation hollows in the dunes.

Within the floodplain near Timbuktu, 77% of the sites we surface-collected showed evidence of extended occupation. The majority (62%) were large (**Figure 7**). In contrast, 12 of 20 (or 60%) of the sites on the remodeled dunes and dunefield were the remains of temporary settlement only (**Figure 8**). The contrast between occupation on the floodplain and on

Geomorphological Unit	No. Sites Studied	Permanant Occupation (deep deposits)		Temporary Occupation (superficial deposits)	
		Large sites	Small Sites	Large Sites	Small Sites
TIMBUKTU Survey	33	13	5	6	9
Scoured Floodplain	13	8	2	3	0
Remodeled Dunes	1	0	0	0	1
Dunefield	19	5	3	3	8
MANGABERA Survey	10	5	0	2	3
Scoured Floodplain	5	3	0	0	2
Remodeled Dunes	0	0	0	0	0
Dunefield	5	2	0	2	1
TOTAL	43	18	5	8	12

Figure 6: **Typology of sites discovered during the 1984 survey.**

Figure 7: Surface of a large floodplain site in the Timbuktu vicinity (930-3). The surface scatter is appreciably denser than that at sites of temporary occupation and cultural deposits here have accumulated to 3.0m. above the alluvium.

Figure 8: Light surface scatter on a dune (site 929-5) in an illustration of a typical termporarily-occupied settlement.

dune soils is more striking still when one notes that six of the eight permanent sites on the dunes are concentrated narrowly along the major *wadi* east of Timbuktu. During the period of these sites' occupation, the *wadi* El Ahmar almost certainly contained water on more than an ephemeral basis. Today, this *wadi* probably retains water on the surface only after individual storms and never flows significantly. Hence, these six sites represent a very special case of dunefield occupation. Similar percentages obtain for the Mangabéra hinterland. There, 3 of the 5 floodplain sites have deep deposits, while 3 of the 5 on the dunes represent shorter occupations (**Figure 9**).

The Conclusion of this report will integrate these settlement pattern data and the chronological inferences that may be made primarily from surface ceramic analysis. We will discuss our preliminary conclusions about settlement and geomorphological dynamics after presenting the artifact analysis. Those chronological conclusions hold implications for the history and strength of ties between the upper Inland Niger Delta and the Niger Bend, discussion of which will come also in the Conclusion. Several more immediate observations may be made comparing the major differences between the 1984 survey results and those obtained from the Inland Delta near Jenne-jeno. In both the Timbuktu and Mangabéra regions, one finds as many or more sites on soils permanently above flooding as one does on the

Figure 9: On the crest of a very high dune north of the Niger opposite Mangabéra (north edge of site 711-1). The river-side slope of the dune was rich in remains of temporary and permanent settlements.

floodplain. In the Jenne hinterland, for all periods in the past, the floodplain was almost exclusively preferred. Many Niger Bend floodplain sites, like those near Jenne, are *tells*, or mounds built entirely of cultural material, but those of the Niger Bend are much lower than those of the Inland Delta, perhaps implying an occupation of shorter duration (or of semi-permanance only). The permanent and large sites of the Niger Bend floodplain appear most similar, not to Jenne-jeno and Hambarketolo (*tells* created during the course of long and highly concentrated habitation), but to an unusual site north of Jenne, called Kaniana. At Kaniana, we excavated remains of a briefly occupied settlement, where structures were more dispersed over the surface than at more typical *tells* (S. & R. McIntosh, in prep.).

The active erection of dunes over all soil groups poses a serious obstacle to the detailed comparison of the Inland Niger and Niger Bend sites. This does not affect the chronological information obtained from the surface ceramics, but does affect the conclusions about functional differentiation and population heterogeneity that can be drawn from surface features and other artifacts (see R. & S. McIntosh 1983a and 1983b). In the Timbuktu vicinity it is rare to find a site with more than 50% of its surface clear of dunes. The few exposed sections of ancient sites are quite poor in artifacts (other than ceramics and tobacco pipe fragments). Locally this is explained as the result of scouring by local antiquarians for objects to sell to tourists in Timbuktu,

but it is interesting that the Mangabéra sites are equally poor in different surface artifact types. Even in the case of those sites not affected by the moving dunes, it will be difficult to establish whether or not one finds in the Niger Bend analogies to the two presumed principal settlement pattern rules of the Inland Delta (R. & S. McIntosh 1983a and 1983b; R. McIntosh 1983), namely the tight clustering of contemporaneously, not sequentially, occupied sites, and the apparent functional differentiation of the sites within a cluster. In order to obtain the quality of information necessary to make these observations, it will be obligatory to excavate, rather than just surface-collect these Niger Bend sites.

Figure 10 provides the basic data for a test of air photo reliability. In such a test, the archaeologist evaluates *visibility* (whether sites can be seen on the photo) and *identification* (verification, by ground survey that putative sites are indeed true ancient settlements). On the floodplain near Timbuktu, 40 of the 50 putative sites were within surveyed transects. 37 of these were true sites; 3 were geomorphological features without cultural traces. We discovered no sites which could not be seen on photo. The floodplain has a perfect visibility and an identification of 93%. These results apply broadly to the Mangabéra floodplain. They are, however, not quite as good as those obtained on the Jenne floodplain, where all sites are visible and identifiable.

Geomorphological Unit	No. Putative Sites	STERILE Putative Sites	Sites Invisible on Air Photo	Putative Sites within Transects	VERIFIED Putative Sites	No. Sites Studied
TIMBUKTU Survey	80	17	19	58	41	33
Scoured Floodplain	50	3	0	40	37	13
Remodeled Dunes	11	9	1	9	0	1
Dunefield	19	5	18	9	4	19
MANGABERA Survey	8	1	4	7	6	10
Scoured Floodplain	6	1	0	6	5	5
Remodeled Dunes	1	0	0	0	0	0
Dunefield	1	0	4	1	1	5
TOTAL	88	18	23	65	47	43

Figure 10: **Data for the test of air photo reliability for survey of Niger Bend landforms.**

On the remodeled dunes, none of the 9 putative sites proved to have cultural remains and the single true site found was not visible on photo. In the dunefield, 4 of the 9 putative sites were confirmed in the field (identification of 44%). Worse yet, 18 of the 22 sites discovered on this landform were invisible (visibility of 18%). Whereas air photos have proved extremely reliable for the development of survey and excavation strategies in the Inland Delta near Jenne, their value will be far more limited in the Niger Bend.

Artifact Analyses

Pottery

Our goals in studying the ceramics collected in the course of surface survey were threefold: 1) to identify, insofar as possible, different ceramic assemblages and to describe them in a preliminary manner; 2) to suggest a basic relative chronological framework for the assemblages identified, based on comparisons with the pottery of known date from neighboring regions; 3) to explore the extent of similarities among pottery assemblages from the Niger Bend with those known from excavations around Jenne-jeno in the Inland Niger Delta, as a means of assessing the evidence for

communication and/or commerce along the Middle Niger during different time periods.

Methods: Pottery data recording began with a thorough traverse of every site investigated, at which time the character of the surface pottery (sherd density, color, rim types, decorative motifs) was noted. This was a highly subjective procedure, of course, but it quickly permitted the experienced observer to recognize the regular co-occurrence of certain rim types and decorative motifs. This recurring set of ceramic features could then be interpreted as broadly synchronous and, in a non-statistical sense, "characteristic" of the larger ceramic assemblage of which it formed a part. With the limited time available and surface survey as the only investigative device, there was no question of recognizing and describing entire ceramic assemblages. Rather, we sought to identify a number of ceramic attributes which, by their frequency and their consistent co-occurrence at a number of sites, could be identified as characteristic of a particular assemblage. Sherds with these characteristic features (i.e., certain rim types, or decorative motifs, as well as established chronological markers such as tobacco pipes) were the subject of preferential collecting activities. As we walked over each site, we preferentially picked up between 50 and 100 sherds from all over the surface. As we walked over each site and collected sherds in this manner, we also noted whether the surface pottery appeared

to be generally similar over the entirety of the site, or whether localized areas of sherd scatter appeared to have a different character, suggestive of a different assemblage. In the latter case, material collected from the different areas of a site was bagged and analysed separately.

In addition to the collection techniques described above, non-preferential collection was undertaken at 25% of the sites surveyed. This technique, in which all of the sherds within one or more 2x2 m. squares are collected, serves two useful functions: 1) by focussing the researcher's attention on a large number of sherds that would not ordinarily be collected preferentially, it is enormously useful at the beginning of survey in signalling a wide range of potentially significant attributes; 2) it provides information relevant for characterizing the ceramic assemblage that would not normally be available from a preferential collection, e.g., relative frequency of undecorated sherds or of different decorative motifs. Note that these non-preferential collections are not intended to have any statistical validity for describing surface pottery, however.

For all sherds collected non-preferentially, body sherds were described and counted in terms of their decorative treatment and then discarded, with the exception of a small number of sherds retained for study and photographing. Rim sherds were analysed in greater detail, with information on rim type, rim angle, rim diameter, temper, and decoration

recorded, as well as drawings and photographs for a large number of the rim sherds. For both rim and body sherds, great care was taken to identify instances of multiple sherds from the same pot so that, insofar as we were able to control it, each recorded sherd observation refers to a different original vessel. Preferential collections, which had a high percentage of rim sherds and decorated body sherds, received the same recording treatment, but the data were kept separate from the non-preferential collection data.

Results: The Timbuktu Survey Area Pottery. Three apparently chronologically distinct pottery assemblages were easily identified [these data are summarized in **Figure 24**]. One or more of these assemblages was present on the majority of sites surveyed around Timbuktu.

RECENT ASSEMBLAGES. Fourteen of the thirty-three sites surveyed around Timbuktu exhibited a characteristic ensemble of pottery, accompanied by numerous fragments of tobacco pipes, thus identifying them as recently inhabited sites (the tobacco pipe was introduced to Africa only after 1591 - Mauny 1961: 59; Daget & Ligers 1962: 12). As further confirmation of this recent chronology, several of the sites were identified as 18th or 19th century precursers of existing villages by the inhabitants of these villages. The most characteristic rim types of this ensemble include three kinds of everted rim (**Figure 11: g,h,i**), distinctively decorated

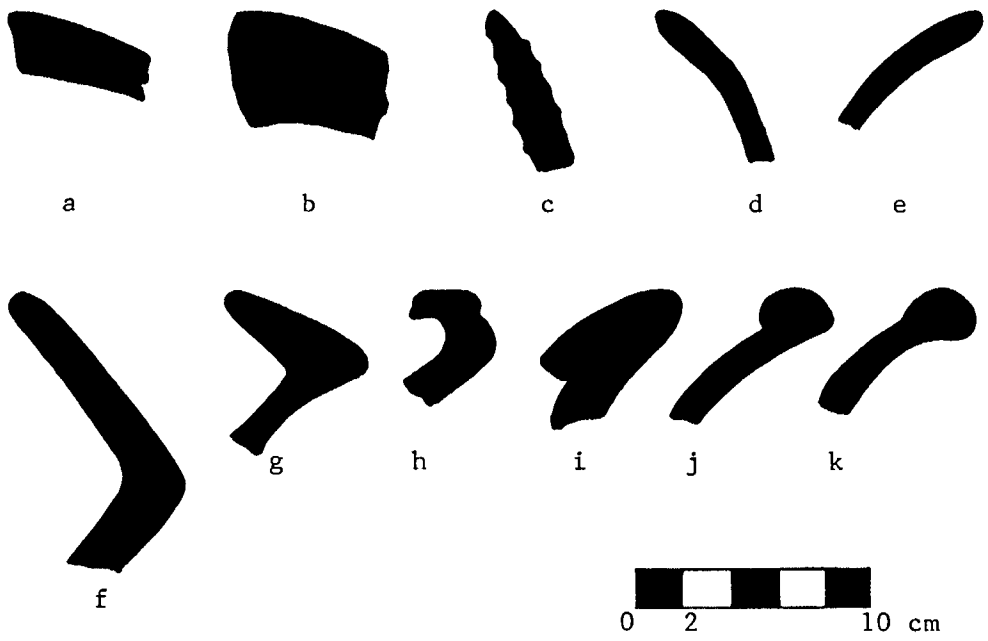

Figure 11: Recent Assemblages: common rim types. a,b - simple open rims, often with red slip, and channelling and stamped decoration on interior (see Figure 12: a,h,i for examples); c - simple open rim with red slip and shallow channelling; d - simple open rim, red slipped; e - simple closed rim, red slipped; f,g,h - everted rims, usually red slipped; i - collared rim, frequently decorated with red cross-hatching (figure 12: c); j,k - beaded rims, either undecorated or red slipped

Figure 12: Recent Assemblage: characteristic pottery. Clockwise from upper left: a - stamped decoration of fragment of thick plate; b - "stabbed" decoration; c - collared rim with painted design; d,e,f - tobacco pipe fragments; g - twisted twine roulette and finger nail impressed decoration; h,i - red slipped plate fragments with channelling and deep roulette impression.

dark-red slipped plates (**Figure 12: h,i**), and stamped and stabbed decorative motifs (**Figure 12: a,b**). The majority of body sherds in this ensemble are either red slipped only (1/3 to 1/2 of all body sherds in non-preferential collections) or twine-decorated only (10-25%), with a particular twisted twine roulette (**Figure 12: g**) accounting for 65-80% of all twine motifs. Braided twine roulettes (**Figure 16**) are frequently present in small quantities, accounting for up to 15% of all twine motifs. The remaining body sherds are either undecorated (30-40%) or have plastic decorative motifs (stamping, stabbing, shallow channeling, fingernail impression). Painted decoration is rare, occurring on body sherds in only a handful of cases, and then always as a geometric design (usually cross-hatching) executed in red slip over twine impression. One particular rim type (**Figures 11: i & 12: c**) is frequently decorated with a red cross-hatch motif. The fabric of 80-100% of the sherds collected from sites with this assemblage is well-prepared and grog-tempered. At some sites, chaff-tempering was used in addition to grog in 10-20% of the sherds.

MIDDLE ASSEMBLAGES. The pottery ensemble that we describe as characteristic of Middle Assemblages was not found in association with tobacco pipes, placing it earlier in time than the sixteenth to nineteenth century material just described. For reasons that will be discussed below, this pottery ensemble appears to be later in time than the third assemblage

we have identified. Our reference to this material as Middle Assemblage reflects its inferred intermediate chronological position.

The most characteristic ware of this ensemble is a chaff-tempered, rolled, everted rim, decorated along the top and inside of the rim with shallow channelling (**Figures 13: j-p & 14**). Frequently, the outermost margin of the lip is painted a dark red/purple, while the inside of the rim may be painted deep orange. In addition, the outer margin of the lip may be decorated with a narrow zone of twisted or knotted twine impression. The use of chaff temper has left large pits in the fabric where firing burned away the organic material. The increased porosity of the fabric that resulted may be related to the function of this particular kind of pot (eg., water pot?). Other characteristic wares identified in this ensemble are grog-tempered, some with an extremely finely prepared fabric that provides a striking contrast to the coarseness of the chaff-tempered material.

Owing to the high relative frequency of chaff-tempered material (up to 50%), generalizions about decorative treatment are difficult to make. The uneven surface of the chaff-tempered pottery weathers very rapidly, and at a number of sites where sherds have been exposed to water, most of the original decoration has disappeared. At sites where weathering has been less severe, however, several decorative trends are apparent. Twine impression, which occurs on about one-fifth of the body sherds as the sole

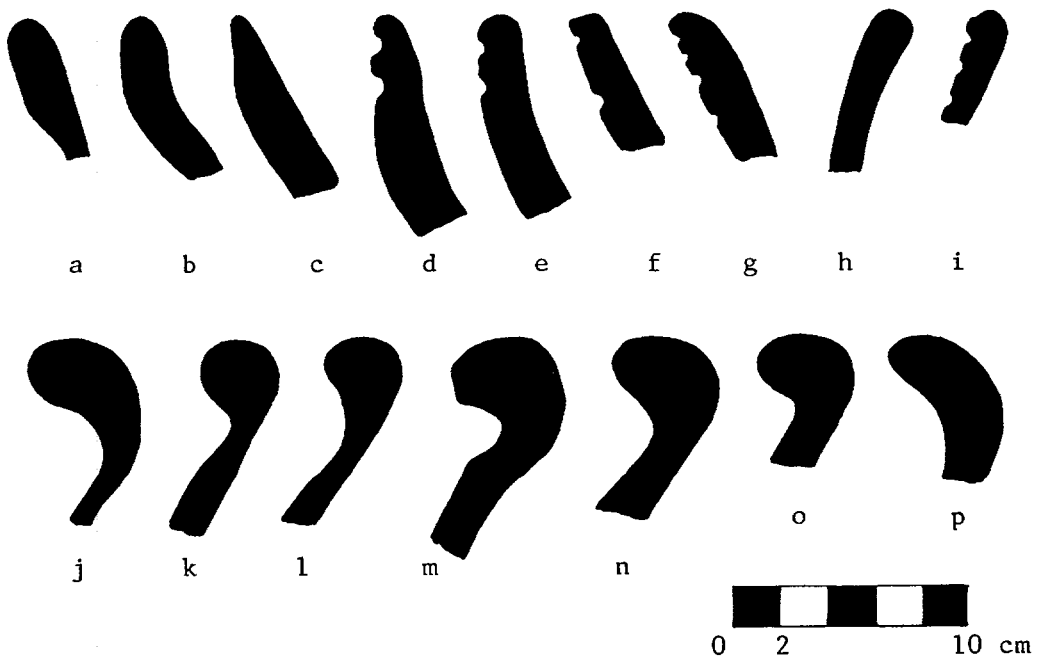

Figure 13: Middle Assemblages: common rim types, Timbuktu and Gourma Rharous survey areas. a,b,c - simple open rims, either undecorated or twine impressed (knotted twine motif) always with one or more bands of dark red/purple paint on inner rim; d-g - simple open rims with deep channelling. At Gourma-Rharous sites, frequently unslipped with dark red paint in channels; near Timbuktu, also unslipped but frequently with black or dark red paint in grooves, plus parallel vertical lines painted between channels (Figure 15: center): h,i - closed simple rims, with or without channelling, usually dark red slipped; j-p - rolled everted rims, with shallow channelling on inner rim, often extending over entire rim surface - frequently with twine impression on outer rim margin. Usually has band of dark red/purple paint on rim and sometimes another around neck of vessel (for example, see Figure 14).

Figure 14: Middle Assemblages: Everted, chaff-tempered rims, Timbuktu (T) and Gourma Rharous (GR). Clockwise from upper left: a - channelling and dark red/purple paint inside rim (T); b - channelling all over rim, dark red/purple paint inside as well as on neck (GR); c - shallow channelling inside rim (GR); d - shallow channelling all over rim, deep orange paint on inside neck, dark red/purple on outer rim margin and neck (T); e - shallow channelling inside rim, traces of dark red/purple paint above and below outer rim margin (GR); f - shallow channelling inside rim, dark red/purple above and below outer rim margin (GR)

decorative motif, is represented about equally by knotted (**Figure 16: d,e**) and twisted (**Figure 16: f,g**) roulettes. Braided twine roulettes (**Figure 16: a,b,c**) are virtually absent. Another 20% of the body sherds have painted motifs as their only decoration. The colors used are reds ranging in value from dark red/orange (Munsell value 2.5YR 5/8) to dark red/purple (Munsell value 2.5YR 3/2, 2.5/2). The painted decoration on body sherds is most frequently applied in parallel bands or a cross-hatched design, on either an unslipped or a dark red/orange slipped surface (**Figure 15**). Painting is often found as part of a composite decorative treatment that includes channelling. This is particularly frequent on rim sherds, including the rolled everted rim described above where the channelling is shallowly executed (perhaps by comb dragging?) and then painted with a zone of dark red/purple along the outer lip margin (horizontal stripes of paint may also be found on the neck and shoulder of the vessel). It also occurs on the other characteristic rim of this assemblage, the simple open rim with deep, well-defined channelling, sometimes executed in a very fine fabric of a distinctive light orange color (Munsell value 7.5YR 7/6). This channelled rim often has dark red/purple paint in the channelling. Other distinctive occurrences of paint in this ceramic ensemble include red paint over linear incisions made on a buff colored (10YR 8/3, 7/3) pottery. Frequently, paint and incision overlie knotted twine rouletting (**Figure 16: e**).

Figure 15: Middle Assemblage painted ware - Timbuktu and Gourma Rharous survey regions.

Figure 16: Twine impressed decorative motifs - Timbuktu and Gourma Rharous. Top row, l-r: a,b - braided single twine; c - braided double twine; d- knotted twine. Middle row: e - knotted twine; f - twisted twine (pressed above, rolled below); g - twisted twine roulette; h - unknown twine. Bottom row: i-m - unknown, probable twine roulettes

Three of the sites investigated had assemblages whose dominant pottery forms were not those already described for Middle Asseblages. Nevertheless, their affinities with these Middle Assemblages are revealed by the presence of certain shared decorative motifs and rim types. None of the three sites in question has tobacco pipes.

Site 999-4. The pottery from this site appears to be very similar to late Phase IV (AD1200-1400) pottery at Jenne-jeno, 500 km. upriver. Braided twines, both single and double, are present in substantial frequencies, in addition to twisted and knotted twine roulettes. We collected sherds of red-slipped carinated pots that are identical to a very characteristic Phase IV ware at Jenne-jeno (S. & R. McIntosh, in prep.) with channelling and braided twine roulette on the shoulder above the carination. This is the only site at which this distinctive pottery was found. Comb impressed motifs, similar to those on Phase IV pottery at Jenne-jeno, were also noted.

Sites 929-5 and 930-2. At both these sites, similar assemblages dominated by chaff-tempered, red-slipped, simple open rims were found in apparent association with human burials and shallow midden deposits. The open rims frequently had shallow channelling on the outside (**Figure 17**).

Early Assemblages. The sand-tempered, twisted twine rouletted pottery characteristic of these assemblages (**Figures 18 & 19**) is so

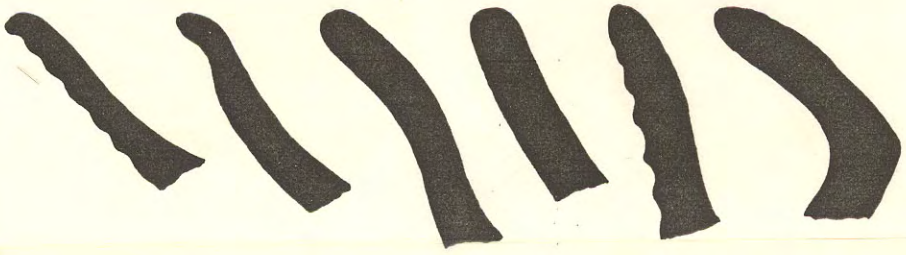

Figure 17: Rim types found in association with middens and human burials at sites 929-5 and 930-2, Timbuktu environs.

Figure 18: Early Assemblages: characteristic pottery.

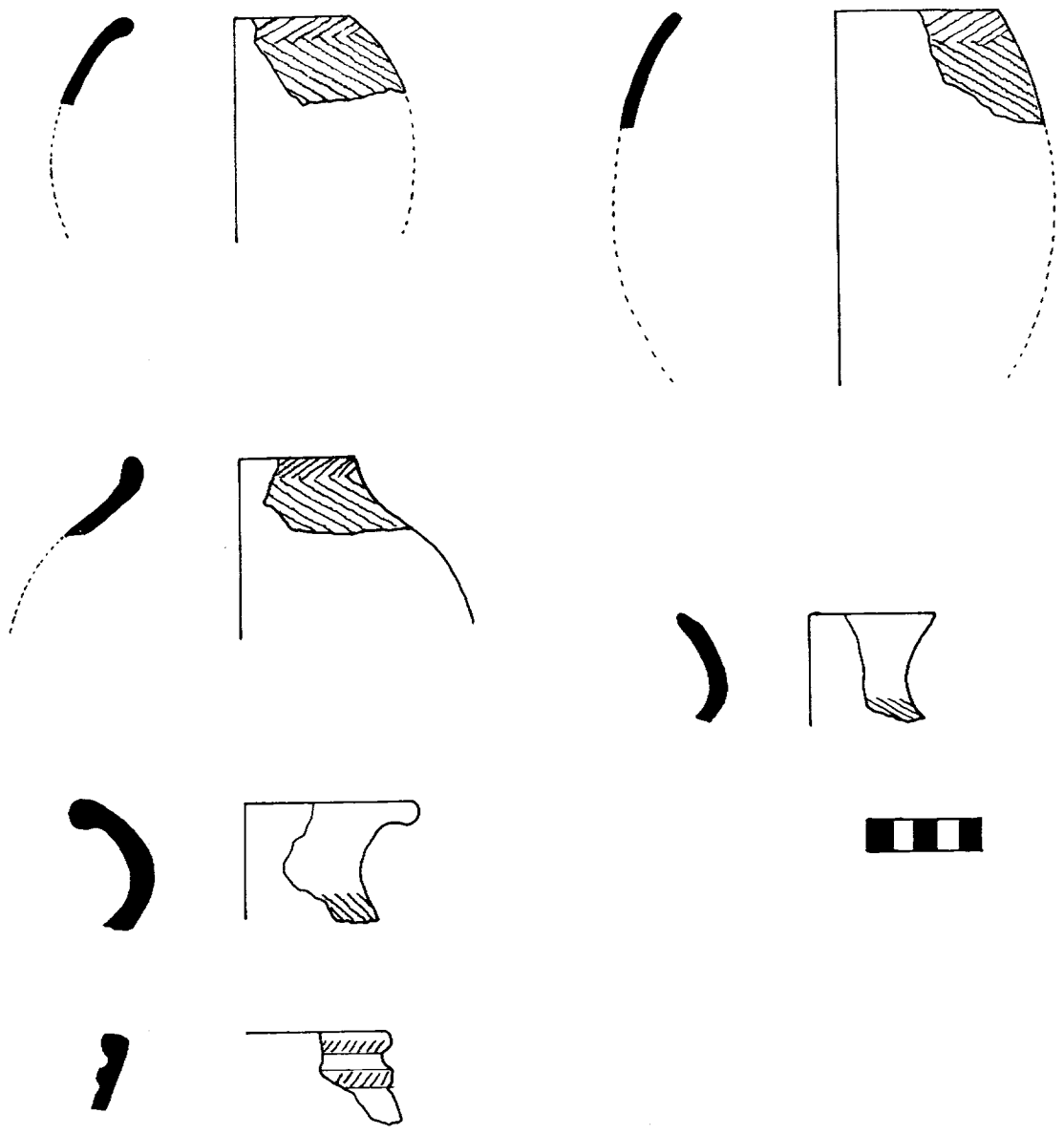

Figure 19: Early Assemblages: common rim types.

similar to the Late Stone Age and earliest Iron Age ceramics in the southern Sahara and sahel that we have confidently identified this material as the earliest known ceramic ensemble in the survey area. No flaked or polished stone artifacts suggestive of a Late Stone Age chronology for this pottery were found. At eight of the nine sites that produced this material, the pottery was scattered on the floodplain or *wadi* margin, and was stained a yellow/rust color, presumably from water action. This material has clearly been secondarily deposited, but from where, it is impossible to say. The localized nature of the scatters suggests that movement has not been great.

Results: The Gourma-Rharous Survey Area Pottery. It was an interesting fact of the sites investigated upriver from Gourma-Rharous that no Recent Assemblages could be identified. The ten sites investigated produced only one tobacco pipe fragment (from site 809-5), despite careful searching. Surface pottery from all of these sites is, however, demonstrably similar to the Middle Assemblage material described above for the Timbuktu area sites. With the exception of site 711-4, all surveyed sites have present in the surface collections one of more of the following wares already known from the Timbuktu area: Rolled, everted rims with shallow channelling, frequently with dark red/purple paint along the outer lip margin (**Figures 13 & 14**); Buff-colored pottery with twine impression, incision and red paint; simple open rims with deep channels

Figure 20: Gourma Rharous Middle Assemblage Wares: red slipped and painted

filled with dark red/purple paint; Thin-walled, finely prepared pottery of a characteristic light orange color (Munsell 7.5YR 7/6). Two other distinctive pottery types were recognized at several of the Gourma-Rharous sites: a shallowly channelled simple open jar rim with dark red slip and, often, white paint applied in verical stripes along the neck (**Figure 20**); a jar rim in black burnished fabric, decorated with comb impression (**Figure 21: a,c,d,e**). Neither of these was noted around Timbuktu. The fact that these latter two wares are not found in association with other identified Middle Assemblage wares at one site, (711-4), may suggest that we are dealing with chronological differences (see **Figure 25**), but which ensemble is the earlier is impossible to say.

General aspects of both identified pottery ensembles include a high proportion of body sherds with red slip as the sole decorative treatment (40-65% at most sites), and exclusive use of twisted and knotted twine motifs. Braided twine roulette is absent. The pottery generally falls into two categories: coarseware, which is thick, usually chaff-tempered, and comprises the majority of the surface sherds, and fineware, a thin, finely-prepared, grog-tempered ware which is smooth to the touch and usually decorated with deep channelling and paint. Possible chronologically significant decorative trends include a shift from dark red/purple paint on primarily unslipped surfaces to white paint on primarily dark red slipped

Figure 21: Gourma Rharous Middle Assemblage Ware: black, burnished

surfaces, and also the introduction of comb impression. Only controlled excavation can verify the existence and relative ordering of these apparent trends. Other noteworthy aspects of the Gourma-Rharous pottery include the presence of small carinated bowls (**Figure 22**) and the frequent occurrence of the narrow, broken necks of various kinds of red-slipped pottery bottles and jugs (**Figure 23**).

The absolute chronology of the Early, Middle, and Recent Assemblages described above cannot be determined, of course, without excavation and radiocarbon dating. Broad probable time brackets for these three periods can, however, be suggested. As we have mentioned, the Recent Assemblages are associated with tobacco pipes and thus cannot be any earlier than the late 1500's. The identification of some Recent Assemblage sites as 18th or 19th century precursors of existing villages makes a span of at least three centuries (A.D. 1600-1900) probable for these assemblages.

Middle Assemblages likely belong somewhere between A.D.500-1500. Because many of the Middle Assemblage sites were large, permanent settlements, the surface material probably represents a span of several centuries. Wares with painted motifs similar to those at sites around Timbuktu and Gourma Rharous (eg., dark red/purple or black cross-hatching, bands of paint over channelling) first appear in the well-dated sequence at Jenne-jeno in the mid-first millennium A.D. Also present at Jenne-jeno in

Figure 22: Gourma Rharous Middle Assemblages: carinated bowl and geometric comb-impressed motif, consisting of a "checkerboard" of slipped and unslipped area delineated by comb impression. Unslipped areas are filled with rocker comb impressions.

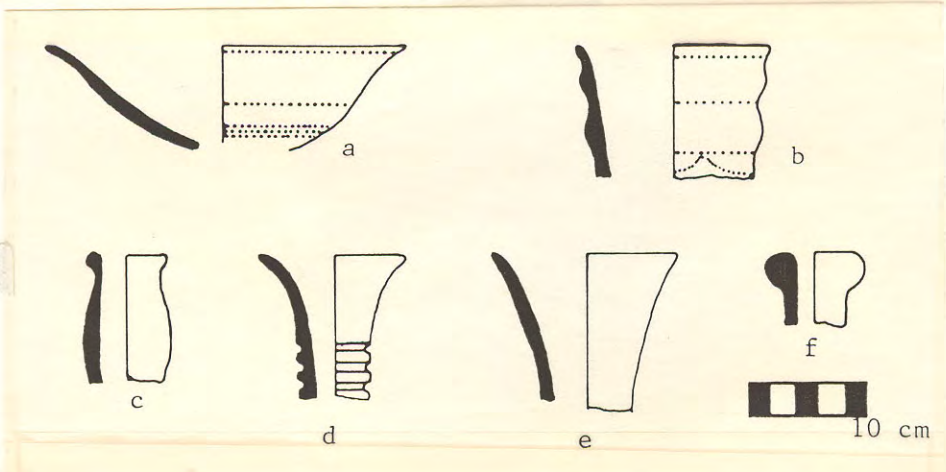

Figure 23: Gourma Rharous Middle Assemblages: special wares. a,b - black burnished comb-impressed wares; c-f - red slipped bottle necks

this period is a very distinctive red burnished ware with intricate white painted geometric motifs. Both these types of painted decoration are documented in the lakes region near Goundam at funerary tumuli dated to 1050+100 (Kouga - Mauny 1961:110) and 1025+70 (El Oualadji - Fontes *et al.* 1985), although the pot types on which it appears are not identical to those at Jenne-jeno. We suspect that the channelled and painted Middle Assemblage wares along the Niger Bend are related to those farther upriver. If this is true, then a date for these Niger Bend wares somewhere between A.D.900-1200 seems likely. No geometric white on red painted pottery was found at Niger Bend sites, however.

Comb impression, present at several Gourma Rharous sites (**Figure 25**) and at three Timbuktu area sites (Wadi-3,-7,-14), becomes common at Jenne-jeno after c. A.D.800, and is present in the Lakes region at El Oualadji tumulus (A.D. 1025+70). It is also present on the eastern side of the Niger Bend at Gao (Mauny 1952c), although its chronology there is unknown. The presence of similar comb-impressed, carinated bowls at El Oualadji (Lebeuf and Paques 1970: 28), Gourma Rharous sites (**Figure 22**), and Gao (**Figure 26**) and of a distinctive comb-impressed geometric decoration at Gao as well as sites Wadi-7, 809-4, and 711-4 (**Figure 22**) suggests connections all along the middle Niger in the early second millennium.

In summary, the available information, indirect and inferential though

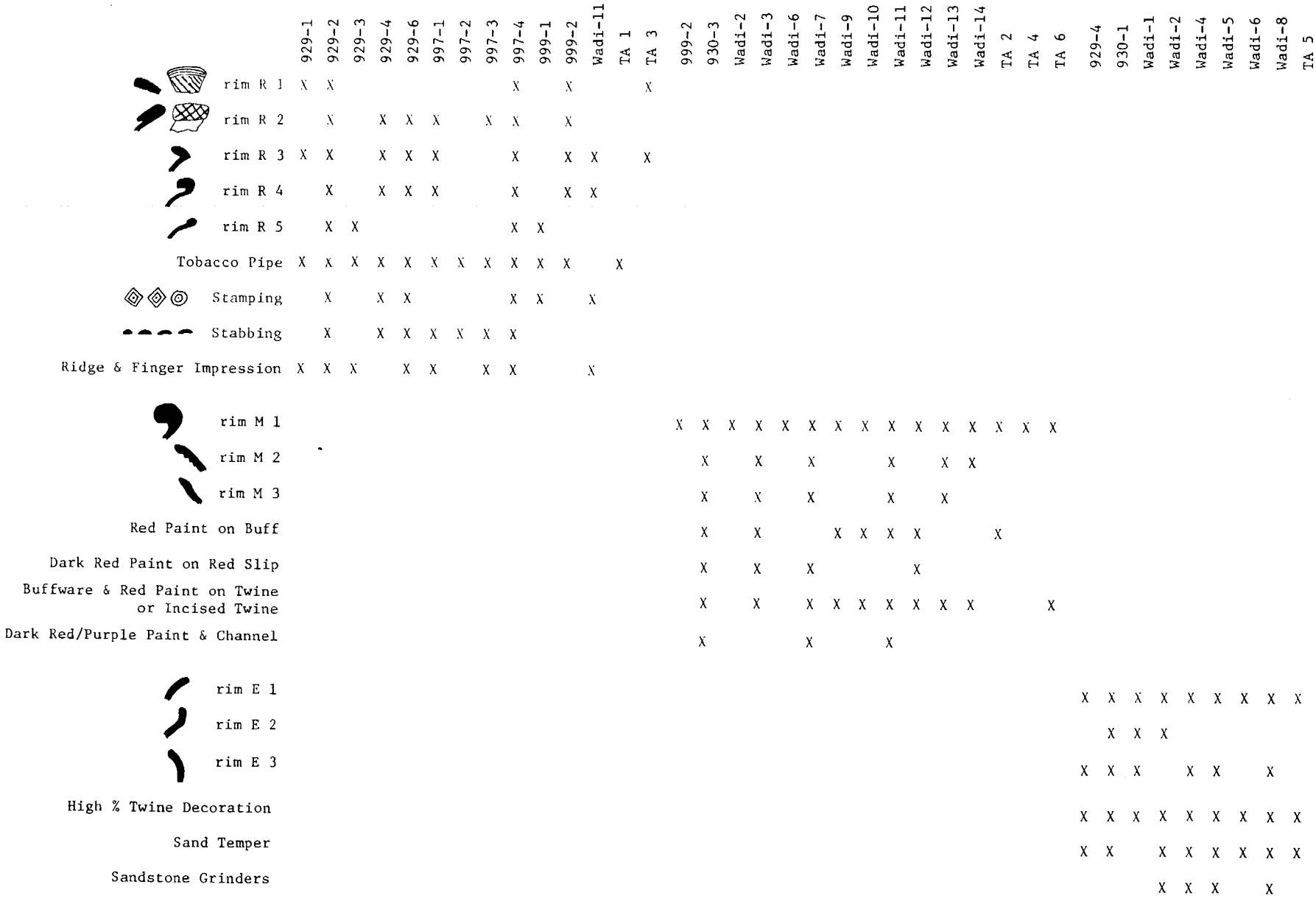

Figure 24 **Distribution of ceramic elements at surveyed sites around Timbuktu**

	711-1	711-2	711-5	Mangabéra	809-1	809-4	809-5	809-3	711-4
 rim M 1	X	X	X	X	X	X	X		
Buffware & Red Paint on Twine or Incised Twine	X	X	X		X				
 rim M 2	X	X	X	X	X	X	X	X	
Light Orange Fineware	X	X	X						
Knotted Twine >50% of all Twine Dec.	X	X	X	X	X			X	X
Red Slip over Twine Impression (>50% of all twine dec. sherds)				X			X	X	X
Red Slip Open Rim with Channelling				X		X	X	X	X
Same Plus White Paint						X	X		X
Black Burnished Ware				X	X	X	X		X
Comb Impression					X	X	X	X	X

Figure 25: **Distribution of ceramic elements at surveyed sites around Gourma Rharous**

Figure 26: Carinated bowl and sherd with geometric comb-impressed motif from Gao. Both pieces in collections of Institut Fondamental d'Afrique Noire, Dakar.

it is, favors a late first millennium/early second millennium A.D. date for the painted and comb-impressed wares of the Middle Assemblages. Only excavation and radiometric dating can confirm or refute this tentative chronological placement.

Early Assemblages are similar to the unslipped, twine impressed pottery found throughout much of the southern Sahara and Sahel in the Late Stone Age and Early Iron Age. Since no polished or flaked stone tools were found in the course of the survey, we assume that the Early Assemblages are Iron Age in date. Their tentative temporal placement would thus be between 500 B.C. and 500 A.D.

Other Artifacts: Metallurgical Activities

In keeping with survey recording practices perfected in 1977 and 1981 during regional survey of the Jenne-jeno hinterland, non-ceramic artifacts on the surface were recorded without being picked up. This practice precludes a detailed specialist study of these artifacts. This is a temporary sacrifice, but costly specialist studies are of considerably less utility for surface material than for artifacts recovered from precise, stratigraphically controlled excavation. More importantly, this practice allows the archaeologist to return to the site to conduct systematic surface collection unbiased by the prior removal of material. The purpose of

systematic collection, be it total or sampling directed by probabilistic sampling strategies, is to plot accurately the position of each artifact on the site's surface in order to predict different functional areas. Prior removal of artifacts during a preliminary survey would, of course, defeat this purpose.

We were struck by the negligible quantity of non-ceramic artifacts compared to that which characterizes the ancient sites near Jenne-jeno. Only site 929-2 had artifacts approaching the diversity of the Inland Niger Delta sites. Many of the 929-2 artifacts were modern (glass, tin cans, china) and of little value in the tourist market. Many temporary beehive-huts were pitched in the general vicinity of Kabara and we suspect that this site was very recently used as a campsite. We suspect that a great deal of surface collecting has been done by modern inhabitants of the region in order to find material for the tourist trade.

The exception to the rule of not removing non-ceramic artifacts was in the case of four slag samples exported for laboratory analysis (**Appendix B**). We were interested in analysis of slag of different kinds and from different locations in order to investigate the smelting technology, the ores used, and to see if some slag was forging waste (inclusions removed from bloomery iron) rather than remains of a smelt. These questions required investigation in view of the unexpectedly abundant evidence of iron

smelting that we enountered. Iron has rarely been mentioned in historical documents as an item of local production (see, however, Abitol 1979: 181).

That iron was smelted on the Niger Bend is not now in doubt. One site with Early Assemblage pottery, 930-1, has an extensive associated slag exposure in an adjacent meander scour, where the density of slag is quite high. It is at certain sites with Middle Assemblage pottery, however, that primary evidence for smelting abounds. Sizeable exposures of densely concentrated scatters of slag fragments are associated with sites 930-2 and Wadi-3 in the Timbuktu hinterland and with site 809-4 near Mangabéra. In the last case, the slag is a flow slag of dendritic structure, observed ethnographically to be the waste from a shallow bowl furnace with grass or cereal stalks as the lowest layer of combustible material (P.Darling: pers. comm., 1983). Remains of more than twenty furnace bottoms and walls, associated with over a dozen discrete slag concentrations were found immediately west of the Timbuktu to Gourma-Rharous road, 1.5 km from the left bank Niger ferry terminus (see **Figure 27**). Pottery collected at this site was characteristic of Middle Assemblages.

Furnace remains with large slag exposures were recorded also at the Recent Assemblage site 929-1 (an extensive exposure of >20 ha. adjacent to Kabara) and at 997-2 & 3 (laterite chunks, possibly the ore, was found at the former). 999-2 and 929-4 were other Recent period sites with slag

Figure 27: Illustration of a dense scatter of slag, furnace parts (tuyères in foreground) and furnace bottoms from a site 1.5 km. north of the left bank ferry terminus at Gourma Rharous. Visible cross-sections of furnace bottoms are 1.0-1.3 meters in diameter.

concentrations, but without furnace remains visible on the surface.

The presence of furnaces bottoms with splays of flow slag and the vastness and density of the slag exposures demonstrate that a significant amount of iron was being produced in the Niger Delta at least by the end of the Early period or beginning of the Middle period. It is now possible to add the Niger Bend to the list of middle Niger regions with sizable iron production traditions. This list includes the upper Inland Niger Delta near Jenne (S. & R. McIntosh 1980: ii, 437-438, see map, 303), the Mema (Haaland 1980), the Bénédougou (Caillié 1830: I, 421; Monteil 1903: 193), and perhaps the region of lakes near Goundam (Fontes *et al.*, 1985).

The energy dispersive X-ray analysis reported in Appendix B establishes that all four Timbuktu-region slag samples are smelting slags rather than smithing waste. It is often difficult to differentiate between the two by sight alone (Bachmann 1982: 5, 31). The evidence against these samples being smithing waste is threefold: 1) none are light-colored, low specific gravity, porous and cinder-like in structure as are the smithing waste of sample SF 1586 (first page of Appendix B). This last sample was collected in 1981 from a working, traditional smithy in Jenne (in which, however, iron of European origin is worked); 2) all Timbuktu-region samples were collected from extensive concentrations of slag - usually indicating smelting rather than smithing alone; and 3) all of the samples

have Fe higher and Si lower than SF 1586 and all Fe:Si ratios of the Timbuktu-region samples agree with that established by Bachmann (1982:30) for slag of typical pre-modern industrial smelts.

The high Fe remaining in these slags implies an inefficient smelt with temperatures well below 1535^{0}C (Bachmann 1982: 17) or suggests the samples are of slags mixed with incompletely reduced ores left in the furnace bottoms after the abandonment of the furnaces (F.Brotzen 1985: pers. comm.). In the latter case, these would be "furnace slags" as opposed to "tap slags" which flow from the furnace during the smelt (Tylecote 1983:7). Furnace slag is indistinguishable chemically from flow slag, but differs morphologically (Tylecote 1983: 7; Bachmann 1982: 4-5). The sample labelled "Wadi-3" is the only one with a near-certain flow texture characteristic of tap slag. Samples "South of Niger" and "809-4" are dendritic, a structure of furnace slag commonly found by archaeologists working in those parts of West Africa in which prehistoric furnaces are lines with grass or sorghum/millet stalks (discussed above). The cylindrical form of sample "920-1" is rarely reported.

The heavy element (energy dispersive X-ray) and trace element (atomic absorption spectrometry) analyses of Appendix B will in the future be useful when compared to similar analyses of slag collected elsewhere in the Inland Niger Delta and neighboring parts of West Africa. Such

comparisons may help us narrow down the cases in which ores sources are shared or, where ores themselves have been analysed, may point to specific ore sources an transport routes into the raw material deficient Inland Delta. Comparative metallurgical studies are in their infancy in West Africa and comparable information exists for a handful of sites only, all far removed from the Inland Niger Delta (Echard, ed., 1983).

Iron production near Timbuktu has specific implications for climate, desertification and trade. The slag fields recorded during the 1984 survey represent an important consumption of trees for conversion to charcoal. The process and accompanying environmental damage is documented by Haaland for the Mema (1980: 42-44) and by Goucher (1981: 182-183), who calculates that a one hectare slag field at Dapaa (Ghana) required the felling of over 300,000 trees. Comparable figures applied to the Niger Bend would suggest a staggering catchment area for fuel for each smelting site, given the low tree density in the sahelo-saharan zone. Of the four slow growing and burning, dense structured and high alkali/silica species mentioned by Goucher (1981:181) and the National Research Council (1983:39-40) as appropriate for charcoal, *Burkea africana, Prosopis africana* (mimosa), *Zizyphus mucronata*(jujuba), *and Acacia* sp. (esp. *nilotica and tortilis*)(gum arabic), only the later two grow commonly along the Niger Bend. This may imply that, at the time of maximum Middle period iron production,

precipiation was high enough to maintain a denser cover of these slow-regenerating trees. Alternatively, there may have been a regular practice of shipping charcoal (and ore?) from southern regions to Timbuktu. This practice would run counter to an "optimizing" strategy prescribing smelting as close as possible to ore and fuel. But it would agree with the growing evidence for early West African iron technology that it was the skill and knowledge of the process, rather than the raw materials, which were the monopoly items.

We can be more certain about the ultimate environmental consequences of such large scale deforestation in a dune-based landscape. Fuel for iron is presently a principal contributor to the destruction of trees documented by the National Research Council for the sahelo-saharan region (1983: 25-41). Other causes specific to the Timbuktu hinterland include the setting of bush fires (mistakenly thought to improve grazing), provisioning caravans with charcoal, perimeter clearance of brush and trees around human settlements on preferred dune crest locations (wood needed for fuel, building material), and expanding herds (trees as emergency fodder, seedlings trampled or eaten by goats, soil compacted). Erosion and water loss by runoff is minimal where a good dense tree root system (eg., that of the *Acacia*) are in place, and increases only slightly if woods are replaced by continuous grass cover (see Goudie and Wilkinson 1977: 41-43, Figures

45 & 46). But along the Niger Bend, where trees might be sustained by tapping the deep water retention of the dune, but where grass growth coincides with the very short rainy season, dunes rapidly become destabilized. Even when precipitation is too little to create much gullying and large sediment movement, the old dune soils are exposed to the winds. Thus it is very likely that the recent penetration of dunes into the Scoured Floodplain and invasion by aeolian sands of archaeological sites are manifestations of anthropogenic desertification, to which the iron production made a not insignificant contribution.

Conclusion

Among the 43 sites investigated in the course of the 1984 survey, it is somewhat surprising to us that no trace of Late Stone Age (LSA) occupation was detected. Despite extensive transect searches, we found no flaked or polished stone tools. Presumably, the Niger and its floodplain were as attractive to LSA herder/farmers as they were to Iron Age populations. If this is the case, then the most likely reasons for their archaeological invisibility are: 1) burial of LSA material under either dune sands, recent alluvium, or later occupation deposits; 2) removal of LSA

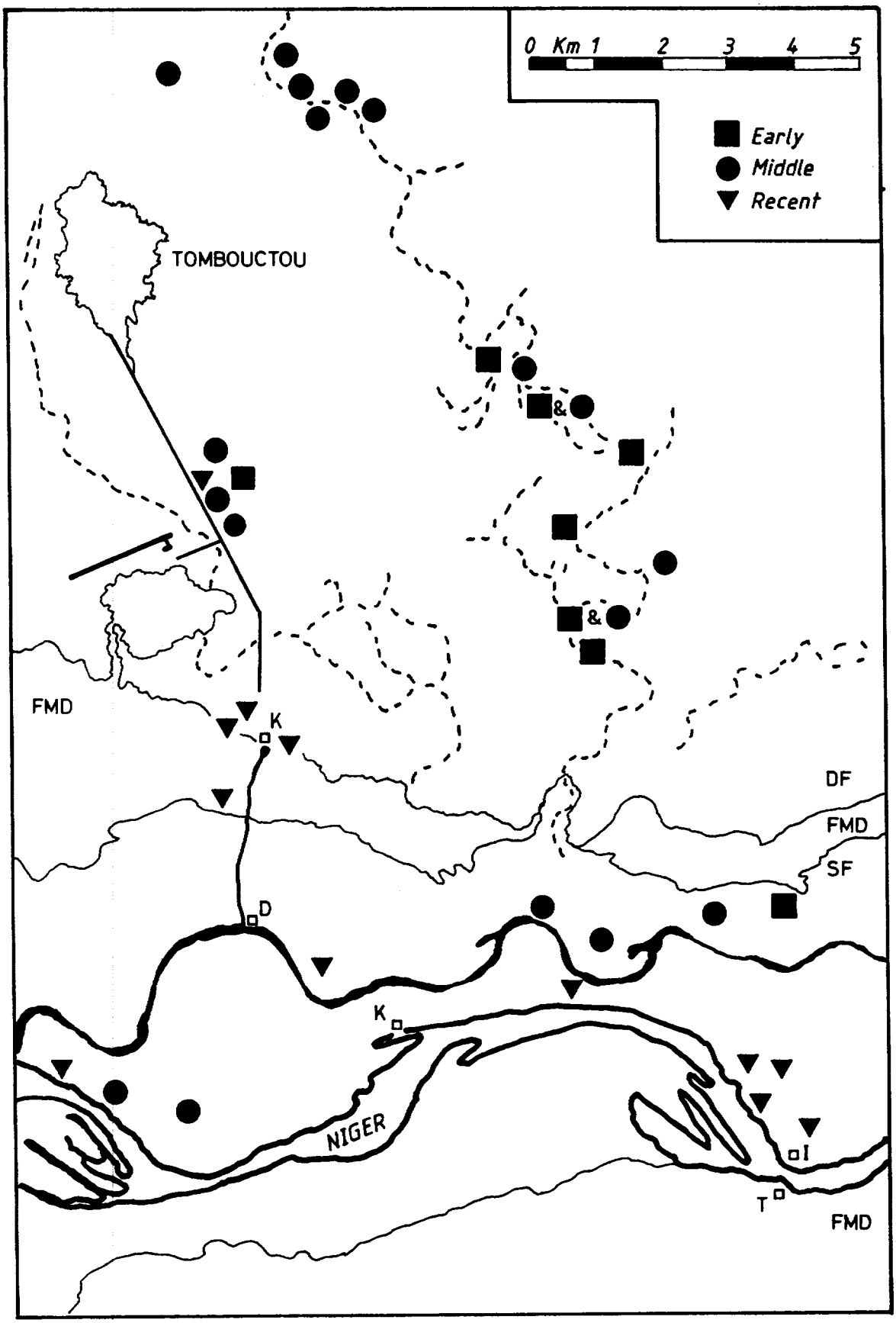

Figure 30: **Timbuktu Hinterland: location of dated sites**

material by an active fluvial regime (involving meandering and channel cutting); 3) sampling error - i.e., our survey for some reason did not cover the areas favored by LSA populations for settlement. Only further archaeological investigation (including excavation) and geomorphological studies can resolve this question. We note in passing, however, that the LSA is similarly absent from the upper Inland Niger Delta, where intensive archaeological investigations have made it increasingly clear that alluvial deposition and rapid meandering associated with a more active fluvial regime for the Bani River during the first millennium A.D. could plausibly have obliterated most traces of LSA occupation (R.McIntosh 1983).

Along the Niger Bend, our research similarly suggests the existence of a more active fluvial regime in the first millennium A.D. and of more surface water in general sometime prior to the mid-second millennium. Evidence for this includes the abundant remains of iron smelting activities, almost always associated with Middle Assemblage ceramics, and the unexpected discovery of large permanent sites (up to 50 hectares in area) with Middle Assemblage ceramics, located on the dunefields around both Timbuktu and Gourma Rharous (Mangabéra) - (**Figure 28**). While we were not surprised to also find large permanent sites on the floodplain, where settlement in this arid region would naturally be concentrated, it is clear that only extraordinary fluvial conditions could have allowed such

settlements in the dunefield along the margins of wadis and interdunal depressions. This settlement distribution must have been supported by significantly increased water flow (through recharge from the Niger) in the wadis, which also would have augmented surface ponding in the interdunal depressions. The change in fluvial regime can be tentatively reconstructed from patterns of settlement change in the Timbuktu dunefield, through which the El Ahmar wadi runs (**Figure 29**).

In the El Ahmar *wadi*, all Early sites are small, without significant accumulation, and located in the channel (**Figures 29 & 30**). These probably represent the remains of tiny communities situated for very short periods of time near a temporary stream or a surface pond where the *wadi* floor dips below piezometric surface. It implies that the *wadi* flowed ephemerally, perhaps only for weeks or for at most a month or two after the August rains. Alternatively, temporary occupation may have been permitted only after spill-over from the most exceptional Niger flood. Occassionally, small or large temporary settlements in the channel date to the Middle period. However, the majority of the population of that time lived in the five permanent settlements with deep accumulation of cultural debris located on the high margins of the *wadi*.

The geomorphological implication is that the *wadi* disposition had changed from ephemeral in the preceeding period to seasonally

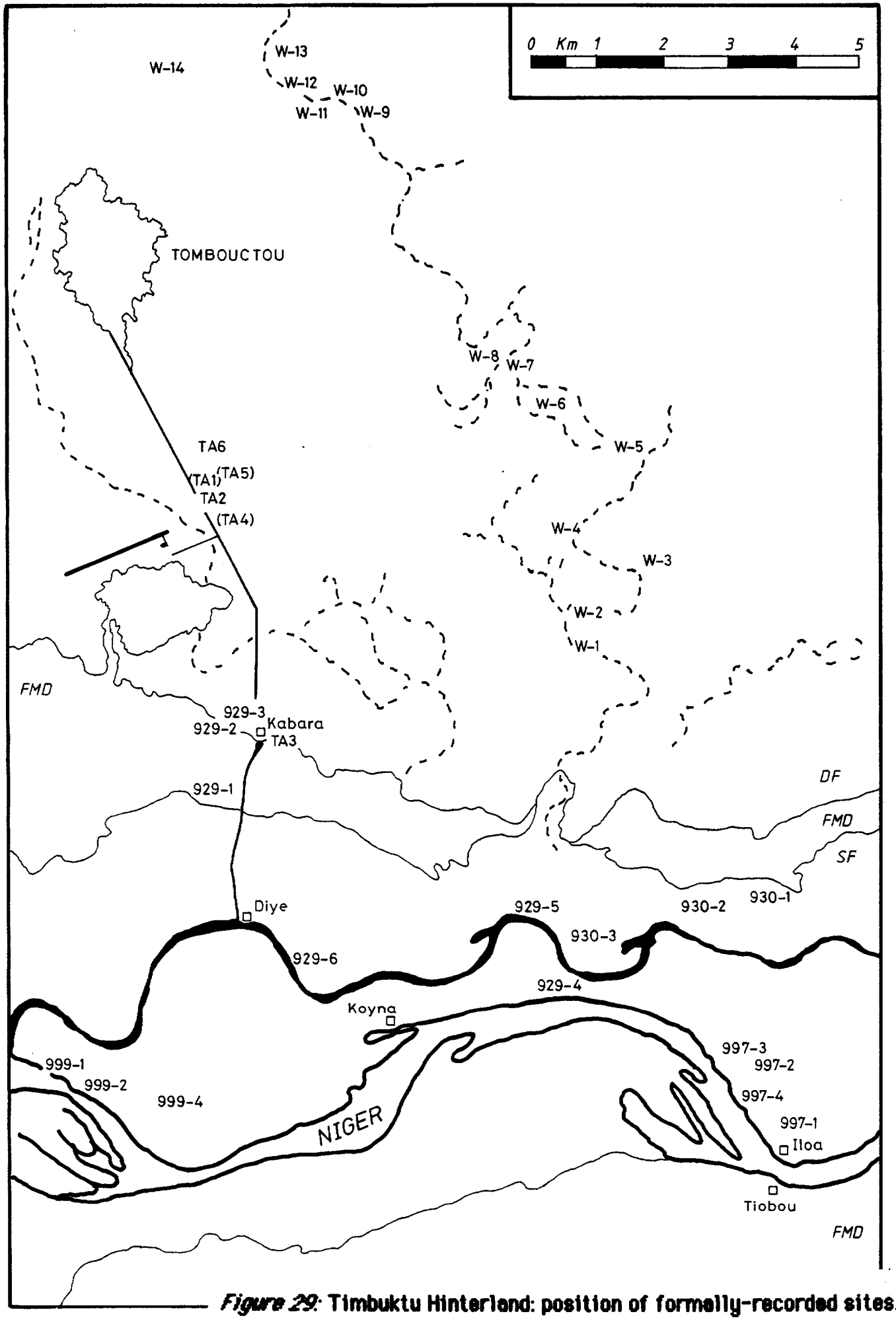

Figure 29: **Timbuktu Hinterland: position of formally-recorded sites.**

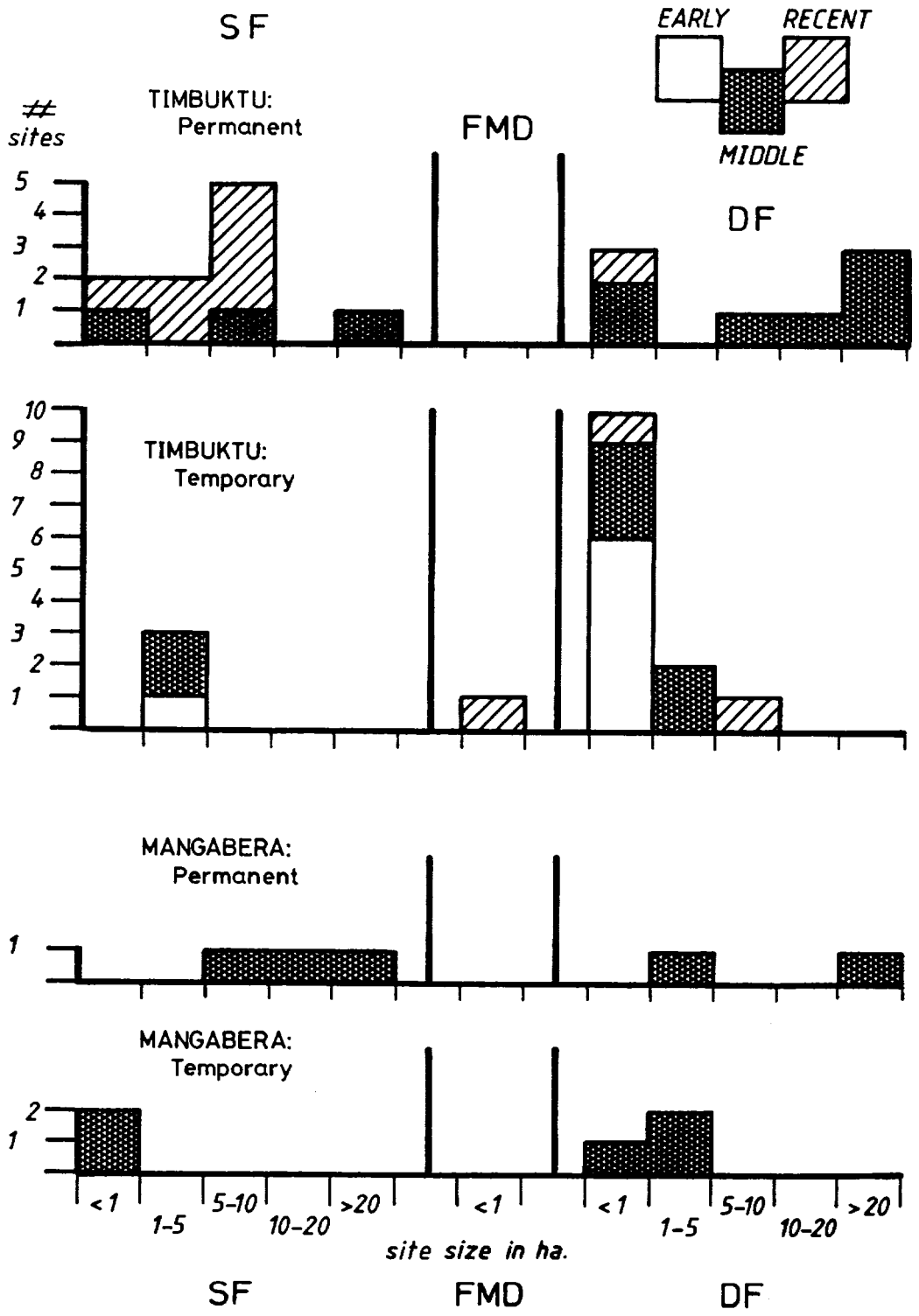

Figure 28: Bar chart showing site size correlated with assemblage period and landform location. Sites are separated by presumed duration of occupation (permanent or temporary) for the Timbuktu and Mangabéra vicinities. SF=Scoured Floodplain; FMD=Fluvially- Modelled Dunes; DF= Dunefield.

semi-permanent (i.e., with discharge for several or most months every year) or permanent in the Middle period. Gullying of the early Pleistocene longitudinal dunes implies that local rainfall rarely if ever exceeded twice that of today (P.Jacobberger: pers. comm., 1985); hence, the most likely source of water for the Middle period *wadi* flow was the annual Niger flood or recharge of the aquifer presumed to underly the El Ahmar *wadi*. No evidence of Recent period occupation has yet been found along the El Ahmar *wadi*. From this we assume that a modern hyperarid rainfall regime and restrained Niger inundation were attained by the 17th century (i.e., at the end of the minor pluvial coincident with the upper latitude "Little Ice Age"; S. & R. McIntosh 1983: 224; National Research Council 1983: 23, Figure 7).

This hypothetical El Ahmar discharge profile has inescapable implications for that of the Marigot de Kabara. We can imagine no reason why recharging of one *wadi* would not procede simultaneously in the other. Hence, if the Marigot de Kabara was draining local precipitation run-off or was flooded from the Niger ephemerally during the Early period and at least seasonally during the Middle, the interdunal Badjindé ponds would have been larger and more permanent than they were even in historical times. During much of the late first and early second millennia A.D., and perhaps as early as the last centuries B.C., the location of modern Timbuktu may have been blessed with a permanent water supply and seasonal access by boat to the

Niger. A precocious dominance of the central salt caravan route over other trans-Saharan routes would perhaps have been facilitated because the wells of this route may have been higher and possibly more abundant due to piezometric recharge at the distal (Timbuktu) end of the El Ahmar channel. In other words, there are sound geomorphological reasons for believing that a major trade center could have existed at or near Timbuktu in the late first/early second millennium A.D. The presence in the area of very large Middle Assemblage sites, tentatively assigned to this time period, is certainly consistent with an early trade hypothesis, although excavation is required to determine the precise chronology and commercial activities of these sites. The presence of certain distinctive Middle Assemblage pottery types on both Timbuktu and Mangabéra region sites (**Figures 31 & 32**) indicates close ties between the two regions, but the nature of those ties (commercial? political? ethnic?) remains to be ascertained. Furthermore, the discovery at these sites of ceramics with strong affinities to wares reported from Gao, the lakes region, and the Inland Delta suggests the existence of connections (possibly due to trade?) all along the Middle Niger at this time.

A question that we cannot answer at present is the relationship of these large Middle Assemblage sites to Timbuktu. If we assume that Timbuktu was in existence by its traditional founding date of A.D.1100, then

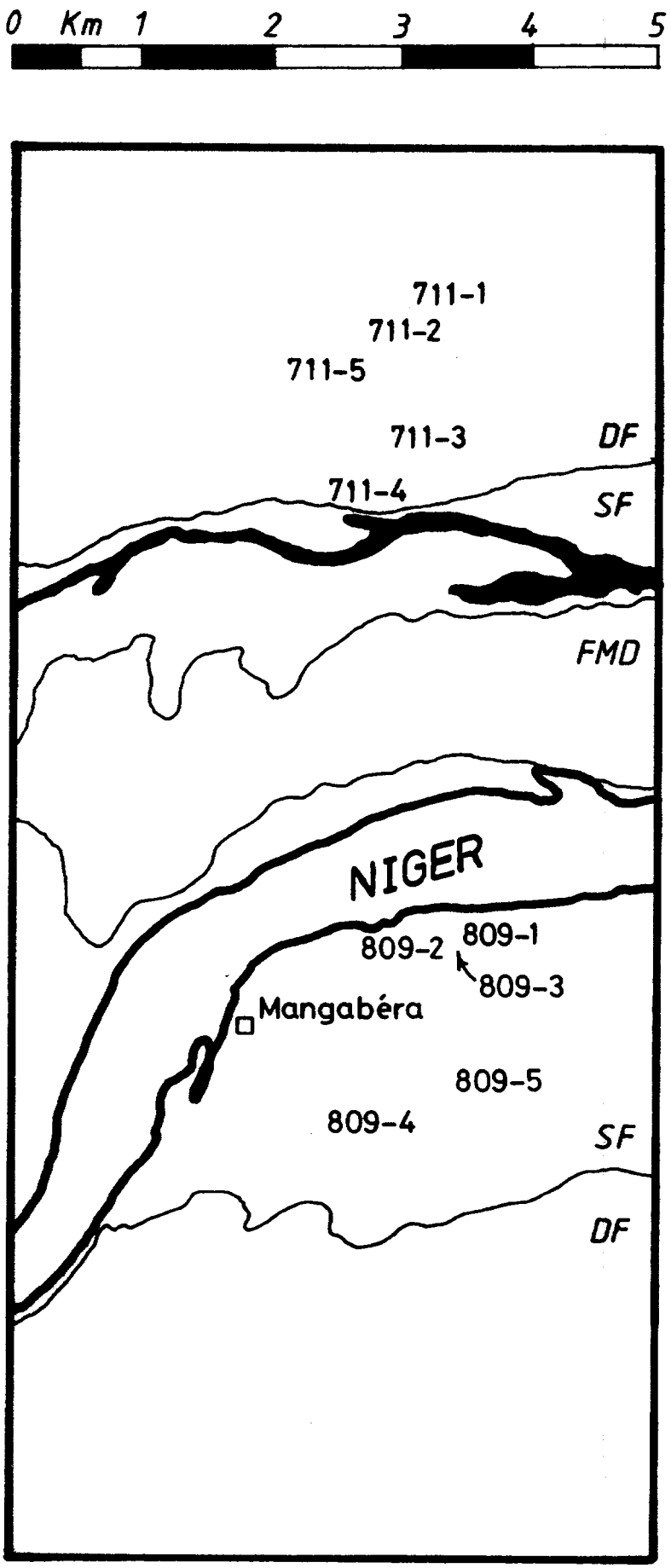

Figure 31: Mangabéra Hinterland: position of formally-recorded sites.

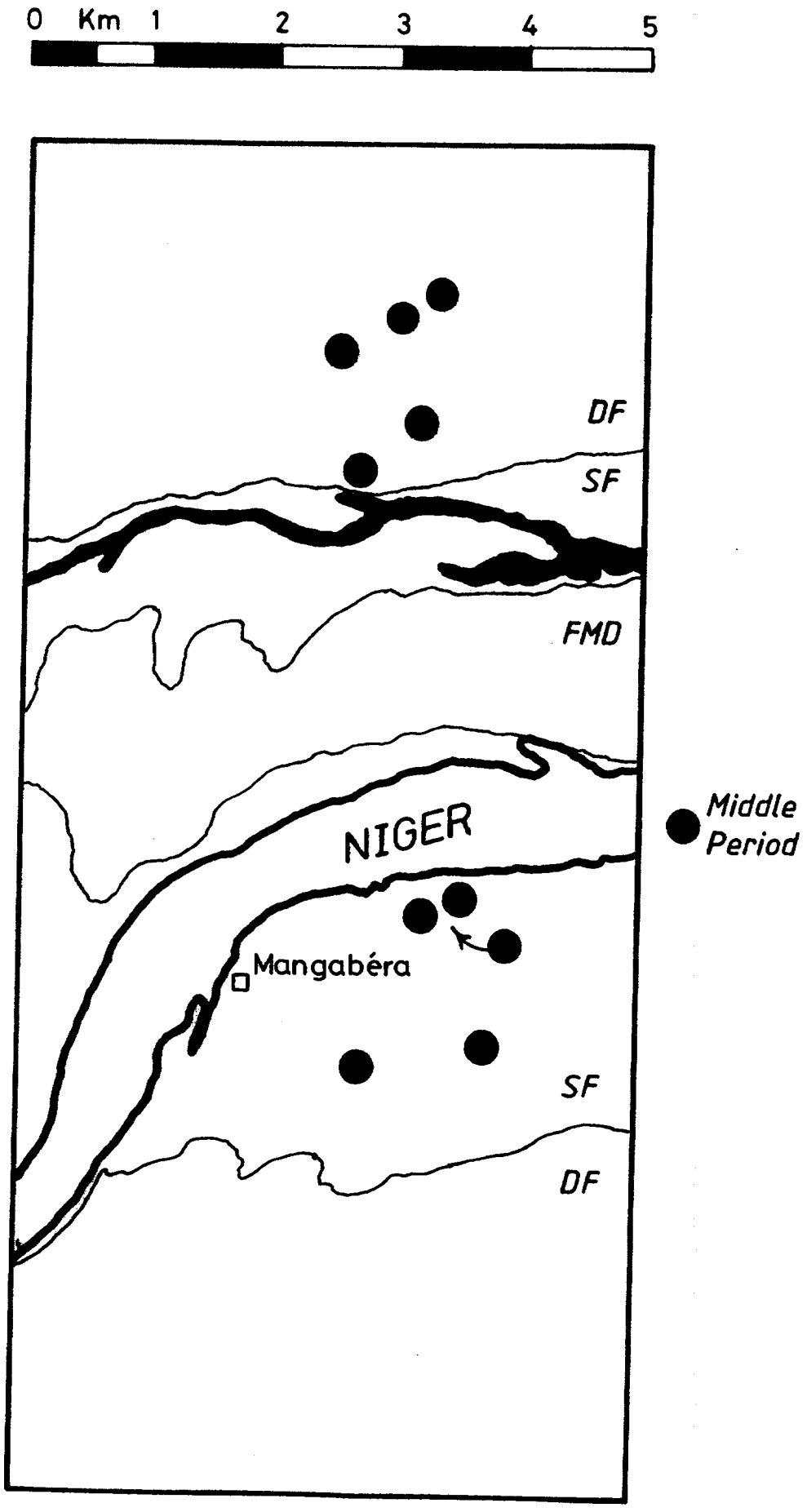

Figure 32: **Mangabéra Hinterland: location of dated sites.**

most, if not all of the Middle Assemblage sites in the vicinity of the town were almost certainly contemporaneous with it . The regional population at that time was apparently greater than today. There are hints, in the size distribution of these settlements (Figure 28), that a regional site hierarchy existed, although without specific demonstration of the simultaneous occupation of all the Middle Assemblage sites in question, the existence of an urban hierarchy must remain speculative. The possibility of such a hierarchy is intriguing, however, in view of the quite different settlement distribution in the region today.

In this century, urban Timbuktu has enjoyed a primate domination over a reduced number of generally small sedentary villages and temporary camps of nomadic or transhumant fishermen or pastoralists. As consequence of this primate distribution, Timbuktu is forced to rely on distant producers in the Inland Delta for food. In its isolation, it plays a more classically "port" role, i.e., the logic of its location and its very existence depends on providing transport and warehousing services to the caravan-riverine trade rather than on distributing goods and services to an integrated hinterland population. It will be interesting to investigate, by understanding in greater detail the changing pattern of settlement from the Middle to Recent periods and thence to the present, the reasons for this apparent shift in the hypothetical Niger Bend regional settlement hierarchy.

We cannot, at present, know whether population declined after the Middle period, or merely reconsolidated at a central location, i.e., Timbuktu. Survey data suggest that there was a strong shift in settlement preference for permanent occupation on both floodplain and dunefield wadis in the Middle period to floodplain exclusively in the Recent period. This shift is accompanied by a decrease in settlement size (there are no Recent sites, Timbuktu excepted, larger than 7.1 hectares). While this may be the result of population decrease due to climatic deterioration or political instability, these settlement pattern changes could also reflect an "implosion" of population towards Timbuktu in a manner similar to that proposed for Jenne in the early second millennium. (R. & S. McIntosh 1983b: 46). Whatever the reason, it is clear that the bulk of the population in the recent period was concentrated at Timbuktu, which means that much of the archaeological information on this period lies, inaccessible, under the currently occupied town.

This preliminary research has clearly raised a number of unexpected and fascinating questions concerning the development of commerce and urbanism along the Niger Bend. The apparent and unanticipated importance of iron production in this region at some point in the past requires further investigation. And the central issues of the chronology and connections of Middle Assemblage sites cannot be resolved without excavation.

Unfortunately, the kind of archaeological investigation that this important area deserves will be difficult to accomplish, in view of the widespread invasion of these sites by mobile dune sands. Extensive excavation cannot be seriously considered at any of these sites, in our opinion. The most appropriate research strategy would seem to be a well-focused program of limited test excavations at a number of sites, supplemented by radiocarbon dating, in order to establish the nature and chronology of the deposits. Based on the results of the 1984 survey, we confidently predict that such a program of excavation and dating will confirm that the Niger Bend supported urban centers and long-distance commercial activity substantially earlier than the 15th century date allowed by historical reconstruction.

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Appendix A

SURVEY DATA (see **Figure 29 & 31**)

FORMAT OF DATA DISPLAY:

Site Number:
Aerial Photo No. - Site No.

Survey Region:
(T)Timbuktu or (GR)Gourma Rharous

Nature of Occupation:
Permanent - Large or Small
Temporary - Large or Small

Period of Occupation:
Early , Middle, or Recent
(based on pottery study)

Landform:
(DF)Dunefield
(FMD)Fluvially-Modelled Dunes
(SF)Scoured Floodplain

Site Dimensions:
(in hectares [ha.])

Artifacts:

Features:

Remarks: (including location of different ceramic assemblages on multi-component sites)

Timbuktu Survey: Each survey block is labelled with the number of the appropriate aerial photograph (IGN Mission: 75 Mali - 23/500). In each survey block, all putative sites were labelled and all identified as cultural or not. Of the verified sites, approximately half in each survey block were intensively surface recorded and surface collection made of the ceramics. The selection of sites to be recorded was not conducted as a probability sample; we attempted to include an example of each different type of site as determined from aerial photo and by the preliminary field examination. This procedure was followed also during the **Gourma-Rharous Survey**.

929-1
Temp. - Sm. (occupation)
FMD

A: Ø

T.
Recent
>20 ha. (occupation = <0.1 ha.)

F: dozen iron furnace shafts (NE & NW)
40-50 slag concentrations

Remarks: Site invisible on aerial photo; the several putative features in this region visible on the photos are coppice and nebka dunes only. There is a negligible pottery scatter to the NE only. The concentrations of cinder slag are exposed n deflation hollows and we suspect the slag distribution is continuous over the entire area. *Significant industrial activity.*

929-2
Perm.-Sm.
DF (at edge of FMD)

A: 2 tobacco pipes
10 modern glass
3 hollow iron cylinders
7 misc. iron
4 mod. tin cans
1 stone bracelet
8 slag
6 sandstone
1 terracotta animal
1 modern china sherd

T.
Recent
0.4 ha.

F: 4 bone concentrations
1 iron concentration

Remarks: Not visible on aerial photo. Site disturbed by recent gardening. Note amount of iron and proximity to the industrial site, 929-1.

929-3
Temp. - Sm.
DF
A: 1 plastic sandel
scatter of modern glass
tobacco pipes

T.
Recent (small Middle component)
0.1 ha.
F: Ø

Remarks: Site is built upon a dune crest so it is visible on aerial photograph, but two putative sites nearby are unusually prominent, albeit sterile, Amadia dunes. Modern debris may be from temporary encampements of beehive mat huts, many of which occupy the 150m between this site and Kabara.

929-4 T.
Perm. -Lg. Recent (small Early component)
SF 3.1 ha.
A: 6 sandstone F: 2 slag conc. (NE & SW sectors
8 tobacco pipes of site)
1 misc. iron
Remarks: Site is c. 40% dune covered and, at 2.5-3.0 m., is somewhat higher than usual.

929-5 T.
Temp. - Lg. Middle
SF 4.7 ha.
A: 1 pipe F: 6 burials
1 modern glass
2 misc. iron
5 slag
1 sandstone
1 iron arrowhead

Remarks: What appeared on the aerial photo as several discrete sites is in fact a long, continuous, light-medium superficial scatter of sherds on a linear dune. 90-80% of the surface is obscured by recent dunes; artifacts are exposed ony by deflation. Apparently repeated temporary occupation. Muslim cemetery of a half dozen burials at center, river side.

929-6 T.
Perm. - Lg. Recent
SF 7.9 ha.
A: 2 tobacco pipes F: Ø
1 misc. iron
Remarks: Chef d'Arrondissement claims this was the former location of Koyna village. Site surface almost entirely obscured by recent sand and heavy sherd scatters seen at the margins only.

930-1 T.
Temp. - Lg. Early
SF 1.0 ha.
A: half dozen slag F: Ø

Remarks: Large slag concentration found in former river beds or meander scrolls of the floodplain adjacent to the river side of this site. Another example of superficial deposits on a linear dune feature. Does the early date imply that the dry channel adjacent once held water?

930-2 T.
Temp. - Lg. Middle
SF 4.7 ha.
A: tobacco pipes F: 1 burial
Remarks: Extensive, but superficial sherd scatter on a dune; very similar to 929-5. Very large slag concentration on the floodplain south of this site.

930-3 T.
Perm.-Lg. Middle
SF 7.9 ha.
A: 5 misc. slag F: 1 slag conc. (N-Cent.)
9 sandstone 3 burials
1 tobacco pipe
Remarks: Medium-heavy sherd scatter over entire site, unlike the majority of Timbuktu region sites and this site is only perhaps 10-12% dune obscurred. The pipe is probably intrusive, given the low pipe/sherd ratio compared to evry other site with pipes. Built up 3.0-3.5m above floodplain. Best prospect for excavation.

997-1 T.
Perm. - Lg. Recent
SF 7.7 ha.
A: 1 cowrie F: 3 houses
16 tobacco pipes
Remarks: First of a set of sites along a multiple meander scroll north of the village named Iloa. Wished to investigate the hypothesis of village diplacement with growth of the convex bank of this particular meander. This, like many sites, appears to have been a low cultural feature which then acted as an anchor for a long, east-west oriented dune. A sief dune on the site's surface obscurs c.70% and sherd scatters really only visible in deflation hollows.

997-2 T.
Perm. - Lg. Recent
SF 8.2 ha.
A: 1 lateriate block F: Ø
1 sandstone
2 tobacco pipes
Remarks: Site probably originally placed atop a levee, but this feature now serves to anchor a long dune. The dune obscurs c.90% of the site surface, but sherd scatters are found along the edges and in every deflation hollow.

997-3
Perm. - Lg.
SF
A: 4 sandstone
1 shotgun shell
1 spindle whorl
8 tobacco pipes

T
Recent
8.6 ha.
F: slag conc. (adjacent)

Remarks: Site placed on an old, low levee and is also somewhat badly obscured by sand. The site is named "Askiahondo", "dune of the Askia (Mohammed)". The slag concentration in the channel between this and 997-2 is quite thick and some furnace parts are visible (but no burface bottoms). The concentration measures c.200m E-W by c.50M N-S.

997-4
Perm. - Lg.
SF
A: 1 stone bracelet
4 modern glass
4 tobacco pipes
1 sandstone
1 net weight

T.
Recent
3.5 ha.
F: 1 bone conc. (SE; human?)
3 houses

Remarks: This is a very low site (<1.5 m versus 2.0-2.5m for the rest in this series) and has much less relief than those with which we are familiar in the Jenne region. Initially, we were unsure of this on the aerial photo. The western half of the site is reasonably clear of sand; the east is perhaps 30% obscured.

999-1
Perm. - Sm.
SF
A: dozen tobacco pipes

T.
Recent
<1.0 ha. (1.6 ha. with slight scatter)
F: slight slag scatter

Remarks: Small site serving to anchor recent dunes. The moderate-heavy sherd scatter is seen only at the water's edge. Note slag and proximity to slag field on the opposite bank of the Niger (see *Remarks*, 999-2). Site name: "Tamtaledjenela".

999-2
Perm. - Lg.
SF
A: 2 sandstone
1 misc. iron
1 slag
1 tobacco pipe (intrusive ?)

T.
Middle (small Recent component)
29.8 ha.
F: 1 house
(modern cemetery)

Remarks: Site name: "Hondo-niyne" and name of village built on its western tip: "Djejedja". This site is badly sand obscured, with a large sief dune grown across the northern two-thirds. But the sherd scatters at the northern margin, in deflation hollows, and on the water-side are as heavy as one will see in this region. Given the high sherds density, the one tobacco pipe is almost certainly an intrusion after abandonment. On the right bank of the Niger, slightly downstream at the meander bend, were four putative sites which proved to be dunes without cultural material. However, immediately at the water's edge on the right bank at this meander was a vast and dense bed of slag, about 20m wide and 300-400m long. Site 999-2 is the nearest site of any size to this slag field. The slag is long and narrow, much like the cylinders collected at site 929-1. c. 750 m. further inland, at the dunes which looked like sites on the aerial photos, were elongated ironstone chunks, perhaps formed by the collection of indurated iron salts in the polygonal cracks of clay soils. Was this the ore of the iron workings?

999-4
Perm. - Sm.
SF
A: 1 tobacco pipe
2 slag
3 sandstone

T.
Middle
0.8 ha.

Remarks: Small site named "Bandikoujeno", with a single Songhai fishering family hut. Site is only 10% dune covered and the sherd scatter is moderately heavy.

TA Transect: This was a 500m. wide transect parallel to the paved road linking Timbuktu and Kabara. The transect's western edge was 100m. from the road. The location of the sites are: (**TA-1**), 3km from Timbuktu on the west side [all (TA-) sites were verified and pottery collections made, but were otherwise not recorded in standard detail]; **TA-2**, 3.250km on west side; **TA-3**, at DF/FMD boundary 0.5km directly east of Kabara; (**TA-4**), 5km from DF/FMD boundary, center of transect; (**TA-5**), c.5.5km from DF/FMD boundary on east side; and **TA-6**, 6km from DF/FMD boundary on east side.

(**TA-1**): Recent occupation

TA-2	T.
Perm. - Sm.	Middle
DF	0.3 ha.
A: Ø	F:Ø

Remarks: This is the only site along the transect from Timbuktu to Kabara with any appreciable depth of deposit (built up to 2.0m). All others appear to be the remains of very brief and not too often occupation by nomads.

TA-3	T.
Temp. - Lg.	Recent
DF (at FMD boundary)	7.1 ha.
A: sandstone	F: Ø

Remarks: This site of light to moderate sherd scatter on dune is immediately on the DF/FMD boundary. This appears to be a high-water edge, temporary settlement.

(**TA-4**): Middle period occupation
(**TA-5**): Early period occupation

TA-6	T
Temp. - Sm.	Middle
DF	0.3 ha.
A: Ø	F: Ø

Remarks: Simple scatter on a dune crest.

Survey of Wadi El Ahmar (Wadi - *): Boundary between low Amadia dunes to the south and the high-crest (6-10m) longitudinal dunes is immediately north of site Wadi-8. The high dunes obscure the wadi on the aerial photographs and disorganize the channel on the ground.

Wadi-1	T.
Temp - Sm.	Early
DF	<0.1 ha.
A: Ø	F: Ø

Remarks: Very small and light scatter of pottery mid way between the thalweg and left bank (in the wadi channel). These small sites in the channel show no preference for right or left, concave or convex bank.

Wadi-2 T
Temp. - SM. Early and Middle
DF <0.1 ha.
A: 3 wire-shaft Fe arrowheads F: Ø
c.6 iron blades
c.4 sandstone grinders
1 sandstone mortar
Remarks: Dense scatter of early sherds at this small site. Location similar to Wadi-1.

Wadi-3 T.
Perm. - Lg. Middle
DF est. 50-75 ha.
A: some misc. iron and sandstone F: sign. slag, but no concentrations
Remarks: The boundaries of this massive site are difficult to determine because of dune drifting, but the sherd scatter is quite dense overall. This is on the right bank, on the dune overlooking the wadi.

Wadi-4 T
Temp. - Sm. Early
DF <0.1 ha.
A: Ø F: Ø
Remarks: Left bank, in channel. Position and character similar to Wadi-1 & 2.

Wadi-5 T.
Temp. - Sm. Early
DF <0.1 ha.
A: (intrusive modern glass) F: Ø
Remarks: Center channel; see above.

Wadi-6 T.
Temp. - Sm. Early and Middle
DF <0.1 ha.
A: Ø F: Ø
Remarks: Left bank, in channel.

Wadi-7 T
Perm. - Lg. Middle
DF c. 25 ha.
A: Ø F: Ø
Remarks: Large sherd concentration on a dune and deeper occupation

accumulation overlooking a small cul-de-sac leading from the right bank of the wadi.

Wadi-8 T.
Temp. - Sm. Early
DF <0.1 ha.
A: Ø F: slag scatter
Remarks: Left bank, in channel.

Wadi-9 T.
Temp. - Lg. Middle
DF 1.0 - 0.5 ha. (?)
A: Ø F:Ø
Remarks: Right bank, in channel.

Wadi-10 T
Temp. - Lg. Middle
DF 1.0 - 0.5 ha. (?)
A:Ø F: Ø
Remarks: Right bank, in channel. <100 m from previous site.

Wadi-11 T.
Perm. - Lg. Middle (small Recent component)
DF 12.6 ha.
A: Ø F:Ø
Remarks: Very large site with deep accumulation built on a dune overlooking the left bank of the wadi. The astounding lack of artifacts other than ceramics demonstrates how severely this region has been picked over.

Wadi-12 T
Perm. - Sm. Middle
DF (not recorded; <1.0 ha.)
A:Ø F:Ø
Remarks: Center channel; somewhat larger than most channel sites, and slightly greater depth of accumulation.

Wadi-13 T
Perm. - Lg. Middle
DF 23.6 ha
A: Ø F:Ø
Remarks: This massive mound rises 8-10 meters above the rest of the dune field. Settlement may originally have been on a high dune crest, but there hbas clearly been a great depth of cultural material accumulation. The

surface was examined in some haste, but there are undoubtedly very few other than the moderate density of sherds. The putative sites between this site and Wadi-14 were simply dune crests.

Wadi-14 T
Perm. - Lg. Middle
DF 5.9 ha.
A: Ø F: Ø
Remarks: Deep accumulation on a dune overlooking a side branch of the wadi. The sherd scatter is medium-heavy. Unknown why some dune crests, such as Wadi-13 & 14 were once occupied, while many others nearby were not.

Gourma-Rharous Survey: We had originally intended to survey a section 10 x 0.5 km transecting the left and right banks. Unfortunately, it was impossible to cross either the Niger or the channel to the north, thereby eliminating the FMD soils from this survey. We expanded the northern section to a transect of 1.0 km width, in partial recompense. Because of time constraints, non-ceramic artifacts were not recorded as carefully at this survey region as in the Timbuktu region. Small site (809-Near Village) immediately northeast of Mangabéra, beyond the survey blocks but examined also, dated to the Middle period.

711-1 G-R.
Temp. - Lg. Middle
DF (c.1.0 ha. ?)
(A: 2-3 slag only; no pipes F: Ø)
Remarks: Not visible on aerial photo. Located immediately south of the crest of the massive longitudinal dune (last before the river of the erg). Moderate scatter of sherds, but superficial only.

711-2 G-R.
Perm. - Lg. Middle
DF 4.0 ha.
(A: 40 grindstones; few slag; F: Ø
no pipes)
Remarks: Not visible on aerial photo. This site is on the same part of the dune crest as 711-1 and c.150m. to the west. It is long and narrow (c.500 x 100m), oriented parellel to the dune. The depth of accumulation is greatest to the west.

711-3 G-R.
Temp. - Lg. Middle

DF (c. 1.0 ha. ?)
(A: Ø F: Ø)
Remarks: Not visible on aerial photo. Located approximately 0.5 km south of the dune, on the very sandy soil marking the transition from DF to floodplain (possible interdunal corridor, the southern part of which is occupied by the Niger). Sherd scatter is medium to light.

711-4 G-R.
Perm. - Lg. Middle
DF c. 25 ha.
(A: few grinders/slag; no pipes F: Ø)
Remarks: Massive site (c. 900 x 400 m) oriented parellel to the dunes. This is located overlooking the floodplain, but securely on the elevated dune soil. Sherd scatter is quite dense and vertical deposits appear to be significant, perhaps indicating an occupation of some duration. As at 711-2, these deposits are an unusual grey ashy clay (melted mud bricks made of floodplain soils?).

711-5 G-R.
Temp. - Sm. Middle
DF (<0.5 ha.)
(A: Ø F: Ø)
Remarks: To the west of 711-2 and equally invisible on aerial photograph. Sherd scatter is light.

809-1 G-R.
Perm. - Lg. Middle
SF 6.4 ha.
(A: 1 bead; 1 iron; 1 terracotta toy F: Ø)
Remarks: Location on the bank of the Niger, but mound is quite low. Site is c.30% dune obscured.

809-2 G-R.
Temp. - Sm. Middle
SF (<0.5 ha.)
(A: Ø F: 1 abandonded recent mud hut)
Remarks: Apparently a satellite of 809-1, with very light accumulation.

809-3 G-R.
Temp. - Sm. Middle
SF (<0.5 ha.)
(A: some lg. slag F:several 1.25m diam. granary stumps)
Remarks: Medium-density sherd scatter on a remodelled dune. Only the

relief of the dune allows one to see it and 809-1 & 2 on the aerial photograph.

809-4 G-R.
Perm. - Lg. Middle
SF 46.7 ha.
(A: Ø F: slag conc. to NE and SSE)
Remarks: Possibly built on a former dune, becuase in places the sherd scatter is on the surface only. But the majority of the site shows clear signs of long occupation, esp, near the "industrial" sections NE and SSE. Slag is abundant and is flow or dendritic. The center was once a pond. Site is 50-60% dune covered.

809-5 G-R.
Perm. - Lg. Middle (small Early component)
SF 19.2 ha.
(A: 1 pipe; iron ring, stone bracelet, few slag F: Ø)
Remarks: Initial occupation on a dune, as with 809-4, but the superficial occupation covers more of this site. The are dense sherd scatters and deeper deposits here- and-there, and especially to the SE.

APPENDIX B

Laboratory Analysis of Slags

by Peter Loos, Hughes Tool, Co.

HUGHES TOOL DIVISION
HUGHES TOOL COMPANY

ENERGY DISPERSIVE X-RAY ANALYSIS OF ARCHEOLOGICAL SPECIMENS FROM MALI, WEST AFRICA

RELATIVE ABUNDANCE OF HEAVY ELEMENTS (Z=13 OR GREATER) BY WEIGHT PERCENT

Specimen	Fe	Si	Al	Ca	K	Ti	P	Mn	Cu	Cl	S	Cr	Ni
SF601	76.	16.	4.	2.	1.	.2	.4		.2	.2	.1		
SOIL #34	19.	48.	23.	.8	5.	3.	Tr						
SF1584	62.	21.	8.	3.	2.	1.	.4	.4	.1			.2	.2
SF1583	69.	11.	7.	5.	2.	.3	.6			Tr	Tr		
SF1586	51.	32.	8.	4.	4.	.8		.5	.4	Tr			
SF1582	80.	11.	6.	1.	1.	.4					Tr	Tr	
SF1580	57.	22.	8.	6.	4.	.5	2.	Tr					Tr
WADI-3	60.	20.	7.	5.	1.	.4		7.					
False Slag? Survey South of Niger	73.	19.	6.	.1	.3	.3		.4					
929-I Slag Cylinder	76.	21.	2.	.1	.4	.3	Tr	.3					
809-4 Dendritic Slag	72.	14.	2.	9.	.7	.3		1.4					

Tr denotes a trace amount too small to measure

Peter Loos

Peter Loos
Research Laboratory

HUGHES TOOL DIVISION
HUGHES TOOL COMPANY

NOTES CONCERNING THE ENERGY DISPERSIVE X-RAY ANALYSIS

(1) All energy dispersive x-ray analyses are surface analyses. The material that is analyzed is only a few microns thick and roughly a milimeter square, amounting to a volume of about a millionth of a cubic centimeter. Such a small volume may not be representative of the whole specimen. Two to four such spots were analyzed on each specimen and the analyses were in reasonable agreement. All of the surfaces which were examined, except for two, were fresh fracture surfaces. On specimens SF1582 and SF1586 the analyzed surface was an original smooth glassy surface of the specimen.

(2) The tabulated values are relative abundances, not concentrations. Actual concentrations must be estimated from the stoichiometry of the oxides:

NiO, TiO_2, SiO_2, Al_2O_3, CaO and K_2O are highly probable stiochiometries
Fe_2O_3, MnO, P_2O_5, Cu_2O and Cr_2O_3 are best guesses
FeO, MnO_2, Mn_2O_3, Mn_3O_4, CuO, CrO and CrO_2 are other possibilities.

(3) It was not possible to get reliable data for Mg due to the detector characteristics and interference from Al K shell x-rays. Mg, however, is almost certainly present in significant quantity.

(4) Element P is likely present in the form of phosphates, PO_4 . Note that

$2(K_3PO_4) = 3(K_2O) + P_2O_5$, $2(CrPO_4) = Cr_2O_3 + P_2O_5$
$Mn_3(PO_4)_2 = 3(MnO) + P_2O_5$, etc.

(5) A lot of the material is probably hydrated, especially the K, Ca and phosphate compounds. Cr compounds may be responsible for the violet color of some of the samples.

(6) Secondary electron images indicte that a lot of different phases are present. Some phases are apparently rather pure compounds and others are a solution of many compounds. In some specimens there were many dendrites which had been the result of some solidification process. Even within a single specimen, it appeared that cooling rates varied considerably from one location to another. The specimen identified as, "false slag? survey south of Niger" contains large closely packed spherical iron oxide particles in one region while in another region the iron oxide is present in smaller, more angular grains that are arranged in parallel striations. The microstructures are very complicated and there may not be a lot of purpose in studying them.

(7) Inaccuracies in the numerical data result from the rough surface of the specimens, imperfect knowledge of the average x-ray takeoff angle, no absorption correction for the considerable amount of oxygen that is present in the sample and the necessarily finite counting time that is used. The inaccuracies are greatest for the lighter elements and least for the heavier elements. Also, accuracy depends on relative abundance. Data for the more abundant elements are more accurate than data for the less abundant ones. Data for heavy abundant elements should be within a factor of 1.05 of the correct value while data for light elements that are less abundant should only be within a factor of 1.5 or so of the actual value.

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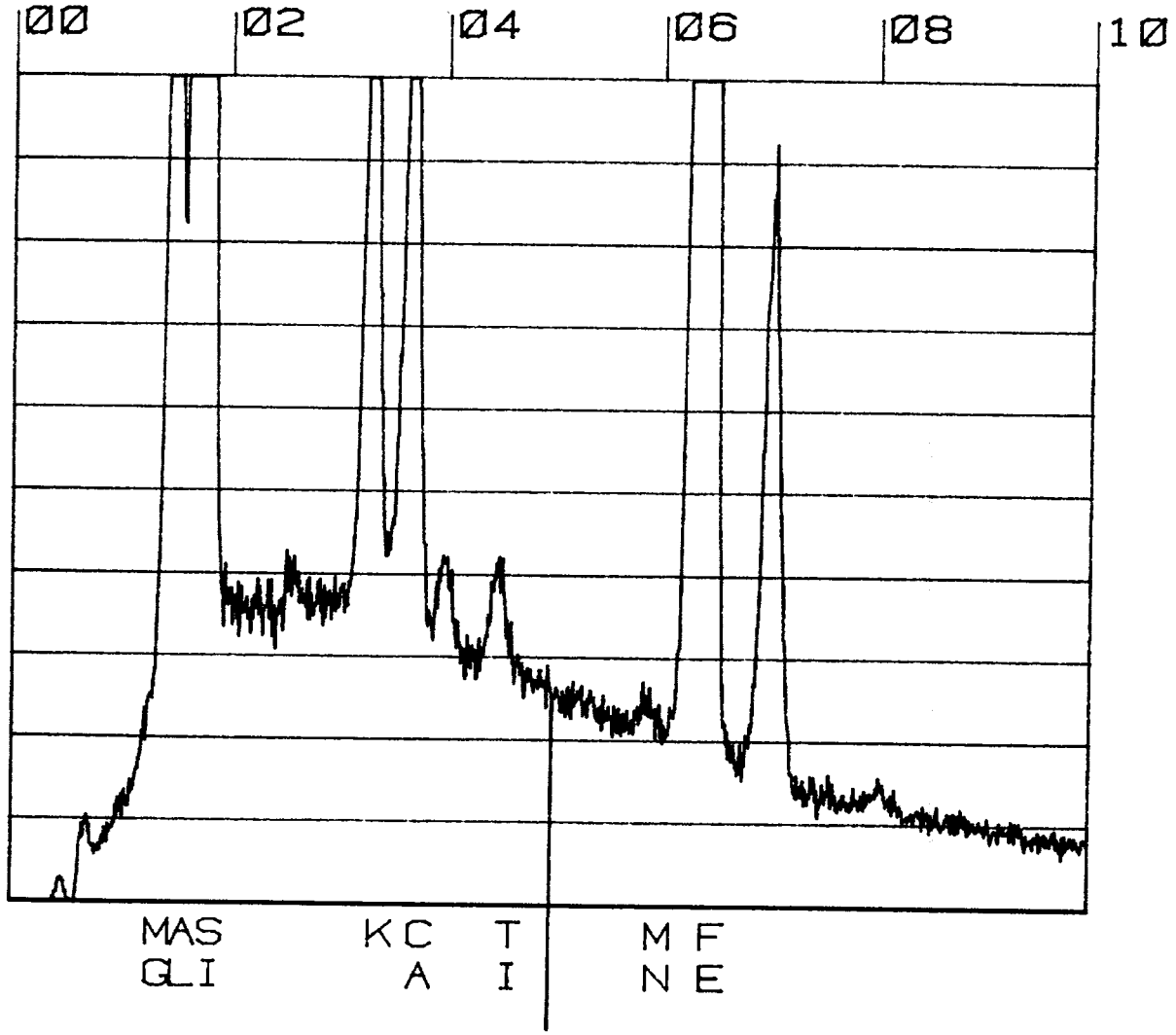

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EDAX
CPS

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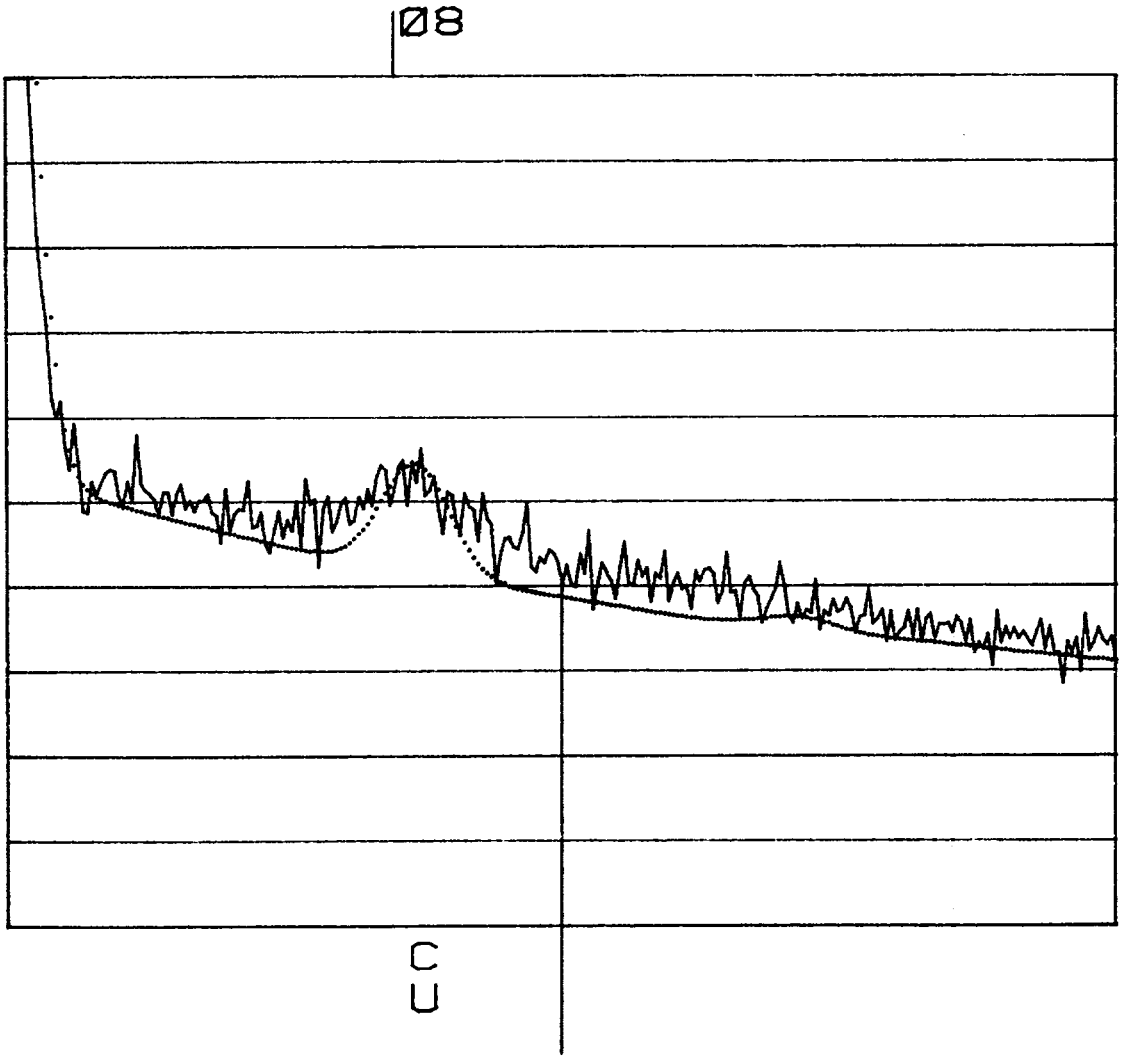

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EDAX
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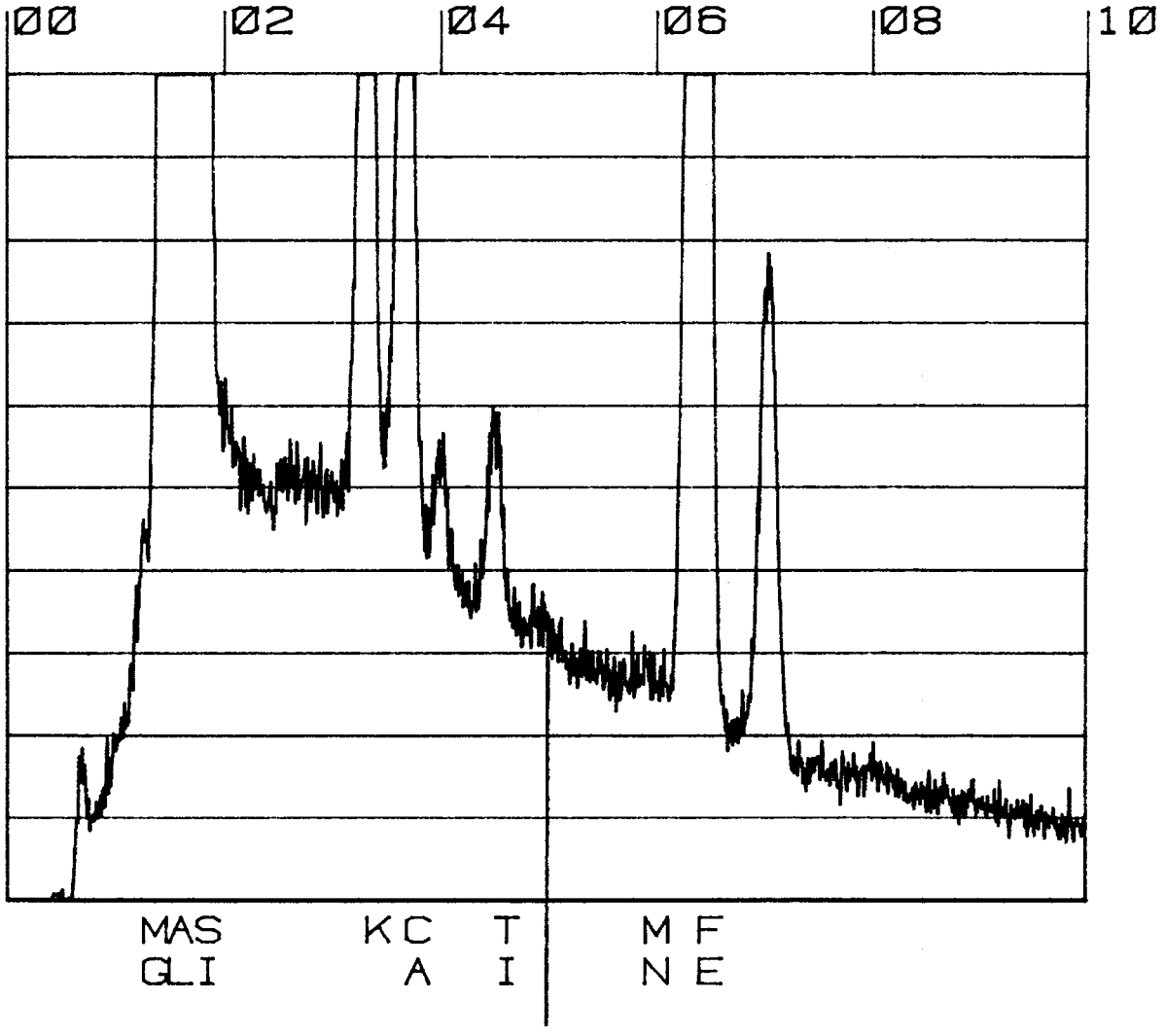

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CPS

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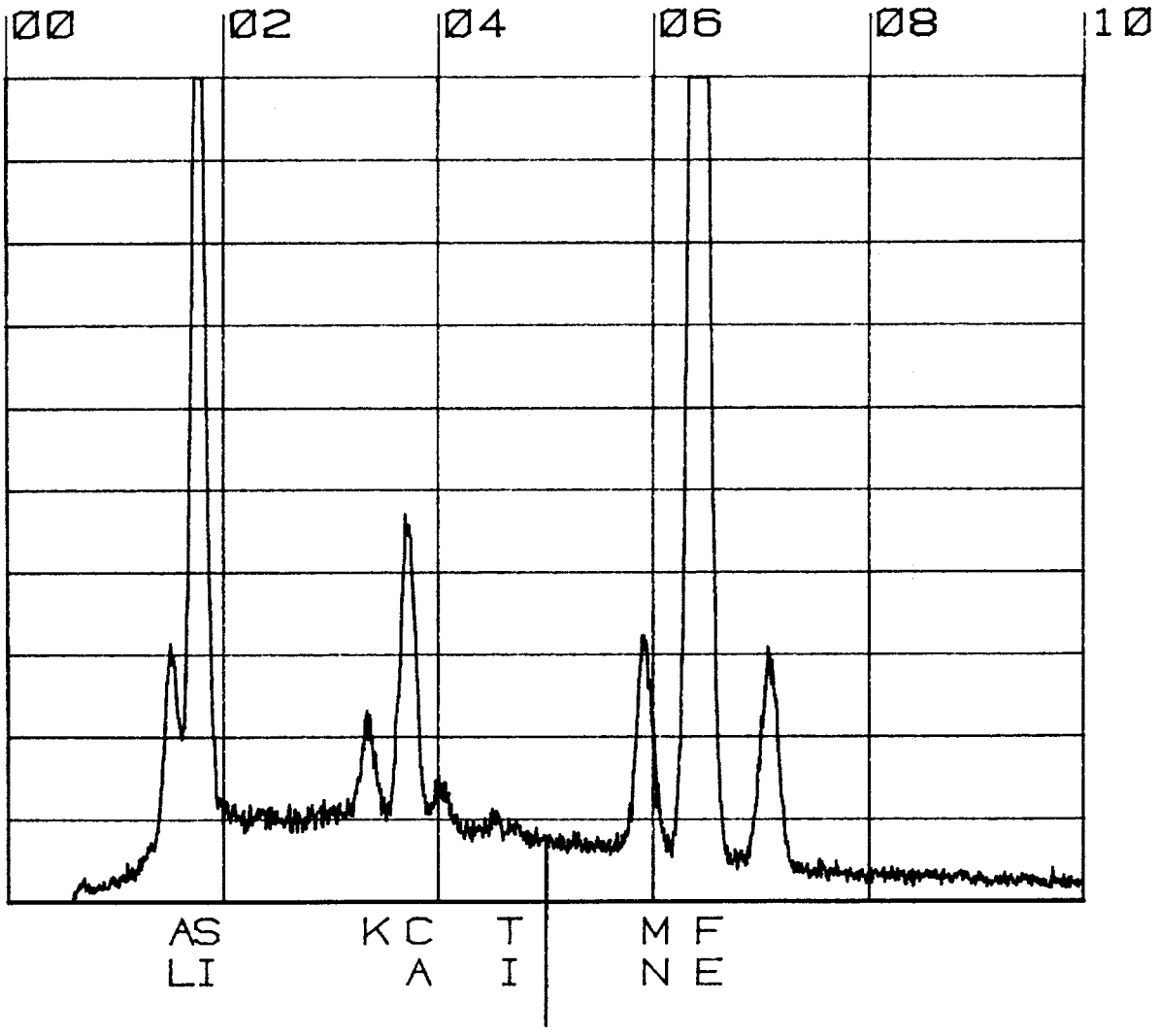

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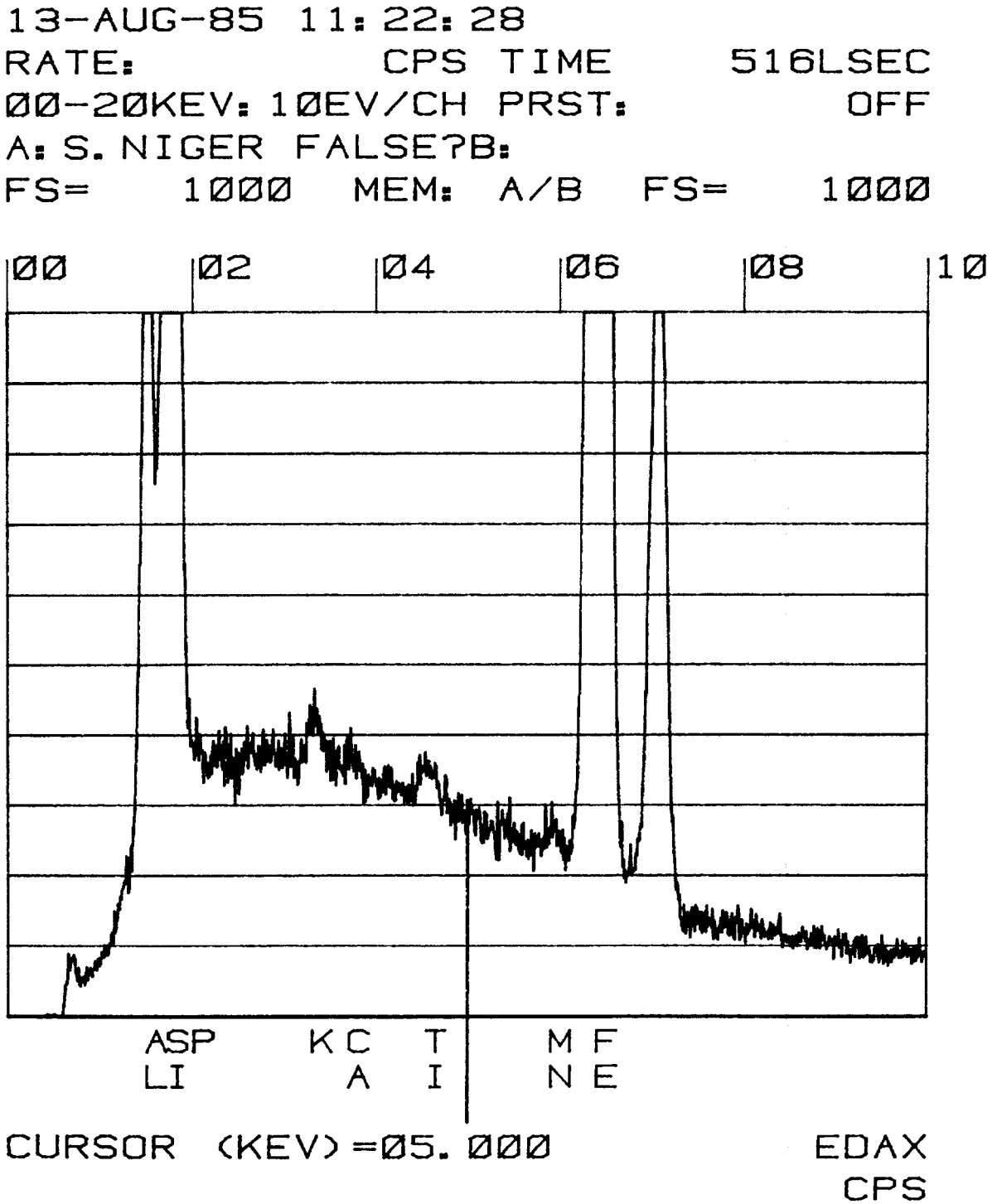
CPS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FS= 1000 MEM: A/B FS= 1000
00
02
04
06
08
10
ASP
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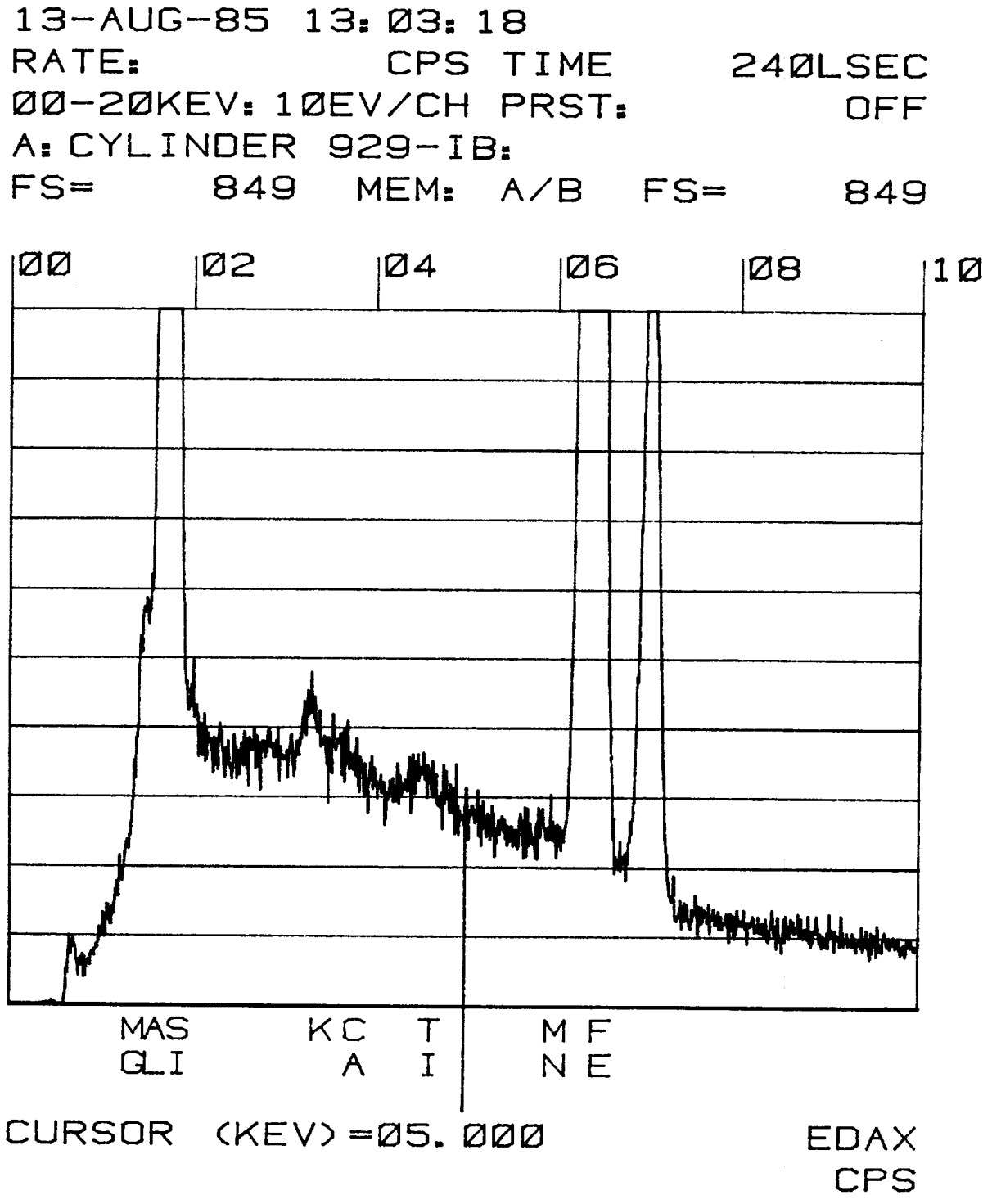
K C
A
T
I
M F
N E
CURSOR (KEV) =05.000
EDAX
CPS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00
02
04
06
08
10
MAS
GLI
KC
A
T
I
M F
N E
CURSOR (KEV) =05.000
EDAX
CPS

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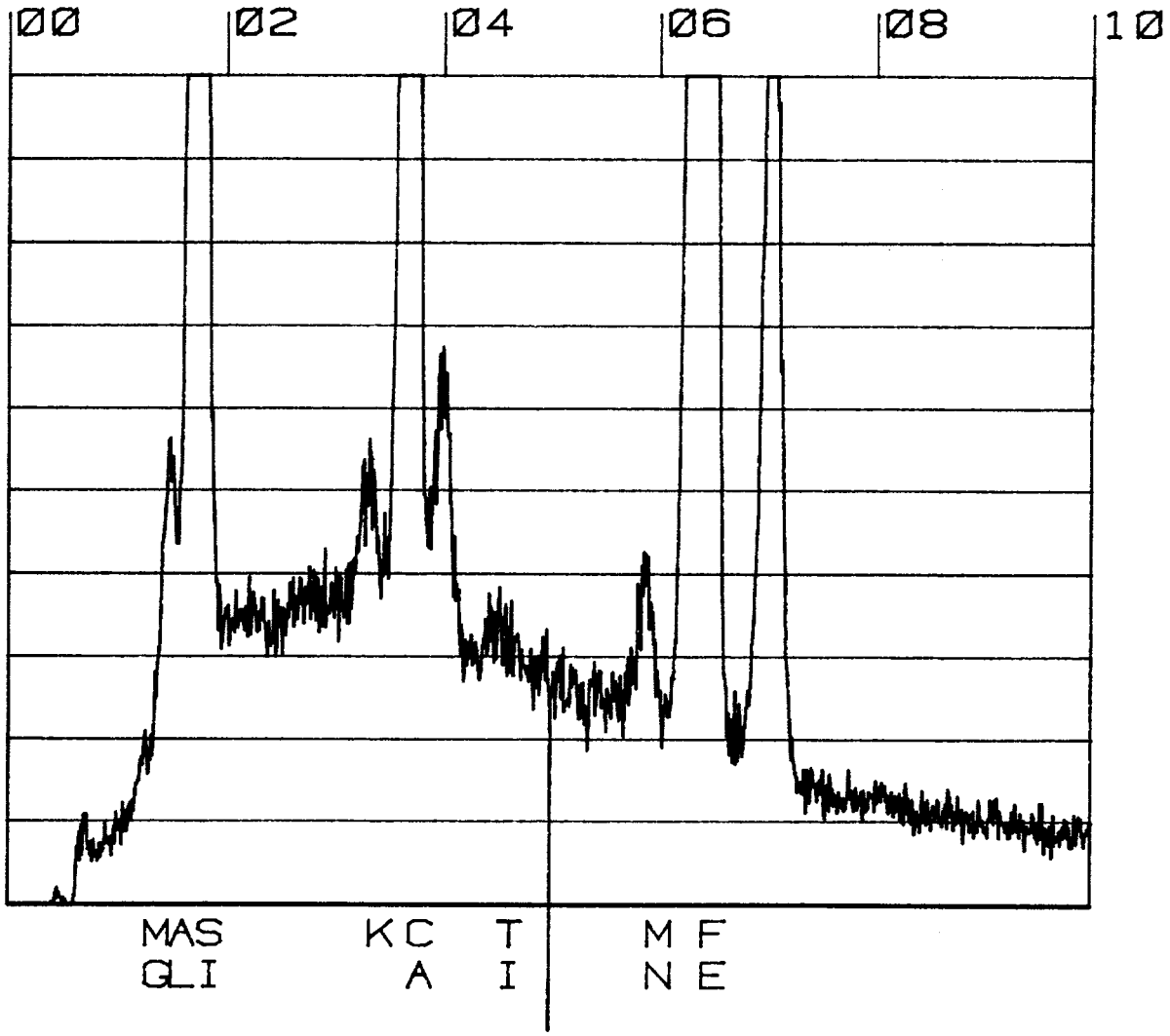
FS= 559 MEM: A/B FS= 559



CURSOR (KEV) =05.000

EDAX
CPS