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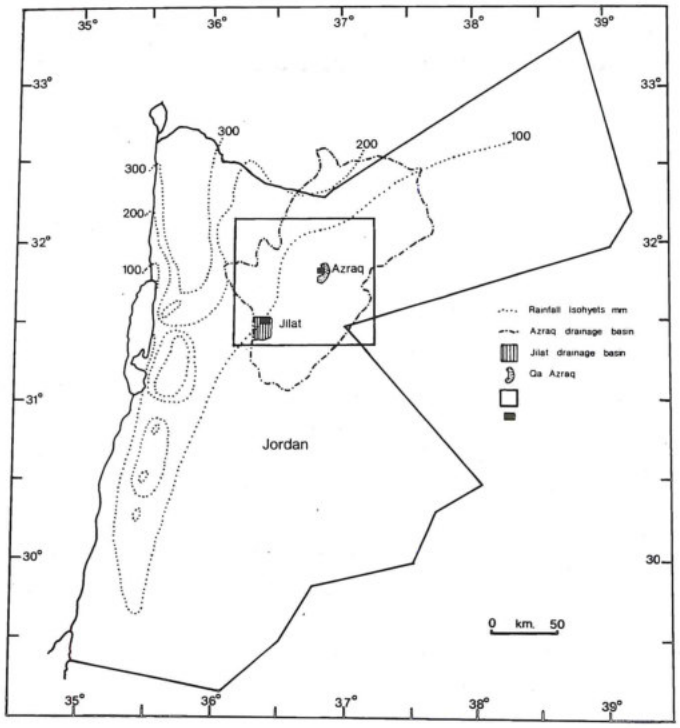
Chipped Stone Raw Material Procurement and Selection in the Neolithic Azraq Basin: Implications for Levantine Neolithic Cultural Developments

Recently, there has been a tendency to direct attention to procurement and the selective use of raw materials in chipped stone studies (Binford 1979; Torrence 1989). Studies of Neolithic chipped stone assemblages from the Levant have also been concerned with raw material use and procurement. Analysts have reported evidence of the use of distinctive materials, selected for the manufacture of specific items, notably points, sickles and burins, in Neolithic chipped stone assemblages (Lechevallier 1978: 41; Gopher 1989: 16, 74; Nishiaki 1992: 340-346). Shifts in the use of raw materials have been seen as part of the widespread changes in behaviour at the end of the seventh and in the first half of the sixth millennium BC. In occupations apparently spanning these periods at 'Ayn Ghazāl, Baṣṭa and Būqrās knappers shifted from the use of significant quantities of tabular slabs or large, flat, unrolled cobbles to the use of smaller, irregularly surfaced, wadi cobble material (Rollefson 1990: 123; Nissen *et al.* 1987: 98; 1991: 23; Roodenberg 1986: 205 and FIG. 9). In all these cases it is reported that the wadi cobbles are of poorer quality. This pattern has also been detected in sequences of shorter term occupations spanning these periods (Gopher 1989; Nishiaki 1992: 340-346).

The distinctiveness of these two main raw material types (tabular slabs and wadi cobbles), their visibility in the landscape and proximity to the sites, makes the situation in Wādī al-Jīlāt (henceforth Jīlāt) (FIG. 1) particularly favourable for the study of raw material procurement and use. This is because we can assess the relative expenditure of energy in procurement and the role of the variability of the material in the manner of its use. We can, thus, reconstruct behaviour in terms of the choices made by the prehistoric producers. Further, the settlement pattern in Jīlāt is characterised by a series of short term occupations punctuating the period from the eighth to the early sixth millennium BC. We can, therefore, assess the nature of changes in procurement and raw material selection through time.

In particular we have an opportunity to investigate the nature of the transformation at the end of the seventh and beginning of the sixth millennium BC in the light of raw material usage and the extent to which deliberate choices by prehistoric producers were involved in the shifts in raw material use patterns. Two alternative hypotheses might account for a widespread change in raw material use patterns and thus any related technological changes. 1) Such changes might be contingent merely upon a change in certain activities in which raw material procurement was embedded. In other words access to raw materials might change as an indirect reflection of the changing nature of the exploitation of the landscape, in conjunction with the differential distribution of raw material types across the landscape. Nishiaki (1992: 346-



1. Location of Wādī al-Jīlāt.

352) has advanced just such an explanation to account for technological change at the end of the seventh millennium BC. 2) Such changes might reflect a deliberate choice as part of a change in production requirements.

The detailed chronology of the Jīlāt sites has been outlined elsewhere (Garrard *et al.* 1994a; 1994b). A brief resumé is offered in TABLE 1 for the purposes of this paper.

Table 1. Chronology of the Wādī al-Jīlāt sites.

Site	*Phase*	*Period*	*Date b.c.*
WJ7	I	Early PPNB	7,600-7,200
WJ7	II	Middle PPNB	7,200-6,500
WJ7	III	Middle/Late PPNB	7,200-6,000
WJ26		Middle PPNB	7,200-6,500
WJ32		Middle PPNB	7,200-6,500
WJ13	I	Early Late Neo	6,000-5,600
WJ13	II	Early Late Neo	6,000-5,600
WJ25		Early Late Neo	6,000-5,600

There are indications in the chipped stone assemblages (Baird 1993: 84-106 and in Garrard *et al.* 1994a) that: 1) WJ7 Phase III may not long post-date Phase II; 2) WJ26 probably does somewhat post-date WJ7 Phase II; 3) WJ32 is broadly contemporary with WJ7 Phase II; 4) WJ25 probably post-dates WJ13 Phase I and may pre-date WJ13 Phase II.

Seven main types of raw material were distinguished in Jīlāt. These raw material categories were: 1) tabular, 2) wadi, 3) nodular, 4) exotic red, 5) exotic translucent, 6) obsidian. The tabular and wadi material was all readily available in Jīlāt. Only one source of nodular material was located in Jīlāt, next to WJ32, and the assemblage at this site was the only one that saw extensive use of this material. Nodular material was very similar in character to the wadi cobbles and it seemed appropriate to group it with wadi material in analysis.

The tabular material consisted of slabs with plane, upper and lower surfaces, usually flat, occasionally uneven, covered with thick, white or beige cortex. Most wadi cobbles are rounded nodules with curving and uneven surfaces, quite distinct from the tabular material. The cortex on wadi cobbles consists of the altered, heavily patinated and battered main body of the material, unlike the tabular flint. In addition, some wadi material is transported, and thus modified, tabular flint. Tabular material thus captured in wadi systems soon loses its characteristic surface qualities. For the most part the wadi material was of the same quality as the tabular. However, material with flaws is encountered more frequently amongst the wadi cobbles. Whilst their morphology is different the size range of the tabular slabs and wadi cobbles is similar. If tabular material was quarried then the size of slabs would be, to some degree (Baird 1993: 236), at the discretion of the miners. Cores of each of these material types fall in the same size range (Baird 1993: 178).

A range of materials were considered as exotics because they were uncommon on Jīlāt and al-Azraq sites and because they were not encountered in raw form in a raw material source survey of Jīlāt. These exotics include material which, for ease of reference, I have labelled exotic red material. This material is, in fact, lustrous, yellow, orange, dark purple, pink, and red brown in colour. It derives from both nodular and tabular sources. Its colouration and lustre strongly distinguishes it from any of the other materials so far mentioned. The common component of colouration, using the Munsell colour system, is an element of red. The cortex of the exotic red materials is different from that found on the common wadi and tabular materials on Jīlāt sites. All this material is characterized by very smooth fracture surfaces. The reddish component in the colouration might indicate colour changes attendant upon the oxidization of iron in flint/chert that can be induced by heat treatment (Domanski and Webb 1992). Observation of heated Jīlāt tabular and wadi material, and the differences in cortex, suggest that it may not be heated Jīlāt material. However, it may be heat treated material from outside of Jīlāt.

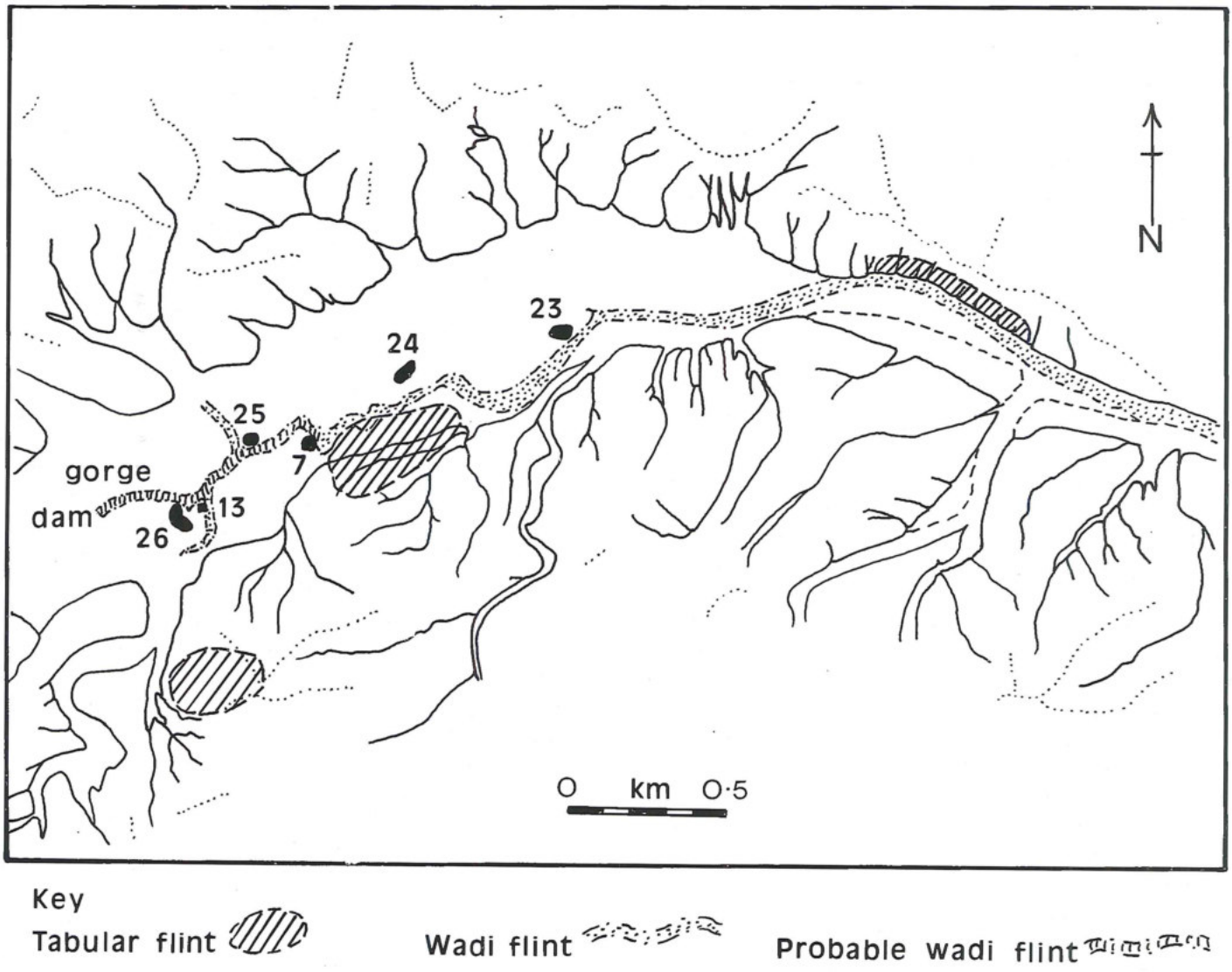
There is also an exotic translucent yellow material. It derives from tabular and wadi cobble sources. The partially translucent character of this material, along with its yellow to yellow white colour, distinguishes it clearly from all other materials in Jīlāt or al-Azraq.

Having documented discrete material types encountered in Jīlāt and al-Azraq Neolithic assemblages, we can outline the distribution of the various raw material sources across the landscape in relation to the sites. By comparing acquisition patterns with availability, we can assess whether acquisition was directed or possibly directed/possibly random and thus search for factors which may have produced any choices evidenced. To document correctly past availability and choice, we must be sure we have identified the location of all proximate sources and the sources of all the most important materials used on sites. We must be sure no sources have been significantly altered, i.e. disappeared, appeared, become significantly more or less abundant. As may be appreciated our ability to satisfy these conditions in most areas is very difficult. In Jīlāt we have what is perhaps a unique opportunity to satisfy all conditions. The reasons for this are:

1) the abundance of suitable raw material sources in Jīlāt and their proximity to the sites;
2) the visibility of material sources in this desert environment lacking significant vegetational or soil cover;

3) the absence of Holocene depositional or erosional events of sufficient order to mask or remove sources;
4) the permanent or predictable character of the sources in the relevant geological and geomorphological terms;
5) our consequent ability to determine fairly precisely the distance of sites from sources;
6) the ability to make significant distinctions in raw material type applicable to the archaeological material on an extensive scale.

The position of choice in relation to each site in Jīlāt is summarised in TABLE 2. All the sites almost certainly had relatively immediate access to some supplies of wadi cobbles. Tabular material was located c. 500 m from



2. Distribution of flint sources in relation to Neolithic sites in Wādī al-Jīlāt.

Table 2. Degree of access to main Jīlāt raw material types from each site.

	Sites				
	WJ7	WJ13	WJ25	WJ26	WJ32
Material					
Wadi	Immediate	Immediate	Immediate	Immediate	Immediate
Tabular	Immediate	500m	500m	500m	3km

WJ13, 25 and 26; 3 km from WJ32 and immediately adjacent to WJ7 (FIG. 2; TABLE 2).

It remains to compare the actual procurement of raw material, occupation by occupation, with availability, in the light of reduction strategy preferences, to assess procurement practices. It seems advisable to reconstruct procurement on the basis of proportions of cores of each material type. Cores provide an indication likely to be closer to raw material nodules procured than any measure based on proportions of debitage. At least that is the case when there is clear evidence for on site production, through all stages of the reduction sequence, for all material categories, as there is on the Jīlāt sites. TABLES 4-6 document raw material use in each occupation in relation to the main reduction strategies. By reduction strategy is meant the broad approach to the reduction of a block of raw material. That is the nature of preparation, location of striking platforms and order of removals. Based on extensive analyses (Baird 1993: Section 6) it appeared that the number and relative location of platforms on cores was the best guide to strategies. Three main categories were used: 1) single platform cores; 2) change of orientation cores, where new platforms were created by rotating the core in a number of directions; and 3) opposed platform cores, with two platforms directly opposite one another. This last category was dominated by naviform cores. There are a variety of reasons for suggesting that change of orientation strategies represent an extension of single platform strategies. Therefore, when evidence for similar relationships between raw material use for single platform and change of orientation strategies exists, these strategies are considered together in contrast to opposed platform strategies.

A consideration of all cores from all the Azraq project Neolithic sites tends to suggest that there are relationships between opposed platform strategies and tabular material, and wadi material and single platform and change of orientation strategies over a considerable time period (TABLE 3). If naviform and related cores are considered separately, an even stronger relationship can be documented between naviform strategies and the use of tabular material. Thus there are 114 naviform and related cores of tabular raw material, but only 36 of such naviform cores that are wadi material. These relationships are strong enough to suggest some preference in the use of certain raw materials for certain strategies, procurement practices aside. In this light, procurement practice and evidence for selectivity can be considered in each occupation in Jīlāt.

If we compare the use of raw material on the different sites during the different phases, as attested by cores (TABLE 4), with the available resources the following becomes clear:

1) In the Early PPNB on WJ7 Phase I, a pattern occurs that differs significantly from that which might be expected in a random use of local sources. If random acquisition occurred from the adjacent sources, or sources in the general area, roughly equal proportions of tabular and wadi types might be expected. In this occupation wadi material outnumbers tabular by more than 2:1 (TABLES 4 and 6). In this case procurement appears directed. In this phase there is also an indication of the selective use of raw material which suggests procurement was directed to fulfil the requirements of the different reduction strategies. Tabular material occurs as a disproportionately large proportion of opposed platform cores compared to the proportion of tabular material in the overall assemblage (TABLE 6). Opposed platform cores make up disproportionate proportions of tabular material compared to their occurrence in the total assemblage (TABLE 5). A relationship appears to exist between opposed platform production and tabular material which may reflect a preference on the knappers part. Thus, it may well be that because single platform and change of orientation strategies dominate reduction in the Early PPNB here, wadi material dominates material acquisition. Clearly wadi material was used for opposed platform cores and tabular material for single and change of orientation cores, so these relationships reflect only preferences. It seems probable that here the minority reduction strategy had to operate in the procurement environment of the dominant strategy. The other notable feature is the relatively high proportion of exotic material exploited; exotic red material forms 16.5% of cores. Exotic translucent yellow material was also used, but no cores were retrieved.
2) In Middle PPNB WJ7 Phase II (seventh millennium BC), there is some indication of a preference for the procurement of tabular material (TABLES 4 and 6). If

Table 3. Relationship between main reduction strategies and raw material used for all cores from the Azraq Project Neolithic sites.

Core platform class	*Raw material*			
	Wadi	Tabular	Exotic red	Translucent
Opposed	74	164	9	2
Single	96	47	6	0
Change of orientation	91	34	9	3

Table 4. Raw material use in relation to reduction strategies in each occupation.

Occupation	*Wadi*	*Tabular*	*Exotic red*	*Exotic translucent*
WJ7 Phase I				
Opposed	15	11	5	
Single	20	4	2	
Change	13	4	6	
WJ7 Phase II				
Opposed	1	5		
Single	1	1		
Change	2	1		
WJ7 Phase III				
Opposed	13	18	2	
Single	6	5	3	
Change	4	3	1	
WJ26				
Opposed	13	91	1	2
Single	10	18		
Change	4	13		
WJ32				
Opposed	1	1		
Single	3	1		
WJ13 Phase I				
Opposed	2	8		
Single	4	4	1	
Change	4	2	1	
WJ13 Phase II				
Opposed	24	25		
Single	31	7		
Change	34	7	1	
WJ25				
Opposed	5	5	1	
Single	21	7		
Change	30	4		1

procurement was directed it may have been for the use of tabular material for opposed platform strategies, as a disproportionate proportion of tabular material was used for opposed platform strategies (particularly naviform strategies; TABLES 4 and 6). Exotic red cores are absent. Caution must be exercised as the sample size is small.

3) There are indications of relationships between tabular material and opposed platform strategies, and wadi material and single platform and change of orientation strategies in WJ7 Phase III (seventh millennium BC), but these relationships do not appear strong (TABLES 4-6). Exotic red material occurs in lower proportions than in WJ7 Phase I and there are indications, particularly in core type and size, that many of these cores are residuals. There is, however, at least one exotic red material naviform core and Byblos points made of this material occur occasionally in this phase. Both are good indicators that exotic red material continued to be used, but to a limited extent, in the seventh millennium BC on WJ7.

4) The evidence from Middle PPNB WJ26 (seventh mil-

Table 5. Proportions of each of the main reduction strategy categories in each raw material category compared to the proportions of each core type in each phase.

	(Percentage of each material type)		
	Wadi	Tabular	Core Type
WJ7 Phase I	%	%	%
Opposed	31.25	57.89	38.81
Single platform/ change of orient	68.75	42.10	61.19
WJ7 Phase II			
Opposed	25.	71.43	54.55
Single platform/ change of orient	75.	28.57	45.45
WJ7 Phase III			
Opposed	56.52	69.23	63.27
Single platform/ change of orient	43.48	30.77	36.73
WJ26			
Opposed	48.14	74.59	69.80
Single platform/ change of orient	51.85	25.41	30.20
WJ32			
Opposed	25.	50.	33.33
Single platform/ change of orient	75.	50.	66.67
WJ13 Phase I			
Opposed	20.	57.14	41.67
Single platform/ change of orient	80.	42.86	58.33
WJ13 Phase II			
Opposed	26.97	64.10	38.28
Single platform/ change of orient	73.03	35.90	61.72
WJ25			
Opposed	8.93	31.25	13.89
Single platform/ change of orient	91.07	68.75	86.11

lennium BC) is unequivocal. In a situation where the most proximate and abundant sources were wadi cobbles, tabular flint dominates to a dramatic extent (TABLES 4 and 6). Such an acquisition profile can only be seen as a result of directed procurement. On WJ26, where interest in tabular material was clearly strong, tabular material even outnumbers wadi material in single platform and change of orientation cores (TABLES 4 and 6). However, wadi material is used disproportionately for these strategies, disproportionate that is to its overall frequency in the assemblage (TABLE 6). The extra efforts to obtain tabular material, but relationship between wadi and single platform and change of orientation strategies, suggest that procurement was driven by reduction strategy preferences and directed towards satisfying the needs of opposed platform production, and that occasional single and change of orientation production then had to function in that procurement environment. A similar argument, in reverse, is made for the situation on Early PPNB WJ7. Exotic red material was obtained very

Table 6. Proportions of each raw material category in opposed platform and single platform/change of orientation core categories compared to proportions of each raw material category in each phase.

	Wadi	Tabular
WJ7 Phase I	%	%
Opposed	57.69	42.31
Single platform/		
Change of orientation	80.48	19.51
% of total material	71.64	28.36
WJ7 Phase II		
Opposed	16.67	83.33
Single platform/		
Change of orientation	60.	40.
% of total material	36.36	63.64
WJ7 Phase III		
Opposed	41.94	58.06
Single platform/		
Change of orientation	55.56	44.44
% of total material	46.94	53.06
WJ26		
Opposed	12.5	87.5
Single platform/		
Change of orientation	31.11	68.89
% of total material	18.12	81.88
WJ32		
Opposed	50.	50.
Single platform/		
change of orientation	75.	25.
% of total material	66.67	33.33
WJ13 Phase I		
Opposed	20.	80.
Single platform/		
change of orientation	57.14	42.86
% of total material	41.67	58.33
WJ13 Phase II		
Opposed	48.98	51.02
Single platform/		
change of orientation	82.28	17.72
% of total material	69.53	30.47
WJ25		
Opposed	50.	50.
Single platform/		
change of orientation	82.26	17.74
% of total material	77.78	22.22

rarely (TABLE 4). Whilst exotics are relatively rare compared to WJ7, including consideration of the obsidian recovered from WJ7 and not WJ26, an interest in exotic translucent yellow raw material is much more marked than on WJ7 (TABLE 4).

5) At Middle PPNB WJ32 an analogous, although dissimilar phenomenon, may exist. Here the very small core sample is dominated by nodular material from the surrounding hillside, but tabular raw material occurs in significant proportions (Baird 1993: 240, TABLE 6.10). The small core sample size may make conclusions suspect. To counterbalance this reference is made to the debitage. The fact that a considerable interest existed in obtaining tabular material at some distance (c. 3km), when perfectly worthy local sources were available, is indicated by the relatively high proportion of flakes attesting to the preparation of tabular slabs (Baird 1993: 259-261). It seems clear that extra efforts must have been expended in procuring significant quantities of this material. Tabular material occurs as a disproportionate proportion of opposed platform cores (TABLE 6) and opposed platform cores occur as a disproportionate portion of tabular cores (TABLE 5), suggesting a preference for tabular material for opposed platform production possibly directing procurement.

6) On Early Late Neolithic WJ13 Phase I, more tabular than wadi material is present (TABLES 4 and 6). This is in an environment where abundant wadi material is available immediately adjacent to the site and tabular material must be procured at a distance of c. 500m (FIG. 2). It seems extra efforts were expended on the procurement of tabular material. Tabular material was clearly preferred for opposed platform strategies (TABLES 4 and 6). Wadi material was used more frequently for single platform and change of orientation strategies relative to its occurrence in the total assemblage (TABLE 6). It is significant, however, that in a situation where single platform and change of orientation strategies considered together are the most important, tabular material still dominates overall. The needs of opposed platform production may have had considerable influence on procurement.

7) In Phase II on WJ13 (Early Late Neolithic), there is a clear shift to the acquisition of the immediately available wadi material (TABLES 4 and 6). Extra effort was still taken to procure a significant quantity of tabular material. Disproportionate quantities of the tabular material were used for opposed platform production (TABLES 4 and 5).

8) At WJ25 (Early Late Neolithic), there is a more extreme version of the pattern observed for WJ13 Phase II. Locally abundant wadi material completely dominates, some of it, in this case, of poorer quality. However, an interest in tabular material is still maintained, procured probably with extra effort (FIG. 2 and TABLE 4). A disproportionate amount of this tabular material was used, for the now less frequent, opposed platform strategies (TABLE 4). In the cases of both WJ13 Phase II and WJ25 it is interesting that extra energy was still expended to acquire material considered most suitable for a subsidiary component of the reduction repertoire.

A marked feature of this data is the dramatic decline in the use of exotic red material after the eighth millennium BC.

Throughout the Jīlāt sequence there is evidence that raw material was used differentially for different reduction strategies (TABLES 3-6). Since opposed platform reduction is quite separate from single platform and change of orientation reduction strategies, the knapper would have had to choose which strategy to execute upon a given block of raw material. Such relationships can only indicate preferences upon the part of the knappers. The strength of such preferences appear to have varied greatly. The reasons for such choices are easy to appreciate, however. The overall morphology of the tabular slabs is well adapted to the development of opposed platform removal surfaces, with minimal preparation. Further, single platform production would represent only a limited use of available surfaces of such slabs. The irregularity in the surface contours of wadi cobbles might favour single platform reduction or the positioning of platforms, in change of orientation strategies, to optimise production with given surface contours.

There is some evidence that these preferences influenced procurement patterns. Extra efforts were made to acquire tabular material when it was clearly preferred for opposed platform strategies (WJ26, WJ32, WJ13 and WJ25). Non-random procurement from adjacent sources (WJ7 Phases I and II) also seems to reflect reduction strategy preferences.

This data suggests that in certain settings marked differences in the availability of different raw material types, cobble as opposed to tabular/large, flat cobble sources, for example, might influence frequency of use of particular reduction strategies. In Jīlāt extra efforts were made to procure materials desired for required production strategies, but these efforts were not great. Tabular sources were located only a little further from some sites than wadi sources. At other seventh millennium BC sites in the Levant, what were almost certainly extra efforts were invested to obtain tabular or tabular-like material from a distance greater than that at which wadi material was located. Examples of this are Bayḍa (Mortensen 1970: 14-15), 'Ayn Ghazāl (Quintero and Wilke, pers. comm.), Baṣṭa (Nissen *et al.* 1987: 98) and Būqrās (Roodenberg 1986: 6). On this evidence, if tabular or tabular-like material became less accessible for some reason, it is

plausible that this might induce a change in the relative importance of single platform and change of orientation strategies.

In Jīlāt the situation at the beginning of the Late Neolithic is instructive because access to alternative sources was relatively easy. Minimal extra effort was required to acquire tabular material; in other words access was not an issue. At WJ13 in Phase I, despite the growth in importance of single platform and change of orientation strategies, such limited extra efforts were made to acquire tabular material, which was used more frequently overall. At WJ13 Phase II and WJ25, despite the lesser role of opposed platform production relative to single platform and change of orientation strategies considered together, extra efforts were still made to acquire tabular material, which was used disproportionately in opposed platform production. The situation in Jīlāt suggests that access to material was not necessarily a major factor in the growth in importance of single platform and change of orientation strategies and disappearance of naviform strategies at the beginning of the sixth millennium BC. There are, further, clear indications that extra efforts might still be made to procure material appropriate to particular strategies in the Early Late Neolithic.

The evidence of Jīlāt is that changes in procurement are intimately related to changes in overall production requirements and that reduction strategies are not conditioned by procurement factors.

However, an alternative hypothesis might still allow a role for procurement factors in the changes at the beginning of the Late Neolithic. If tabular and large, flat, cobble material was much more difficult of access in many areas of the Levant, a diminished desire to invest in the procurement of this material might promote an increase in importance of single platform and change of orientation strategies and the disappearance of naviform strategies by many communities. In which case the behaviour of the communities using Jīlāt might be a reflection of the broader technological context in which their behaviour was based and in which they as mobile communities had to operate. In this case a diminished willingness to invest in procurement in general, excluding reduction strategy preferences, would have to be explained.

If raw material supply/procurement factors may not have been responsible for the changes in the relative importance of reduction strategies at the beginning of the sixth millennium BC, then other factors must be examined. Opposed platform production, in particular naviform production, required considerable initial investment in preparation. In the case of naviforms this involved the creation of an elaborate, specifically shaped preform with multiple crests. This was followed by the problematic creation of suitably angled platforms. This was time consuming, required skill, and (preferably) suitable raw material, the acquisition of which in itself was often time consuming. The purpose of this effort was the obtainment of considerable numbers of relatively long, flat blades. The disappearance of naviform, and decline in opposed platform strategies, is likely to be ascribed to: 1) a diminished willingness to invest the necessary energies in preparation; or 2) a diminished interest in the production of long, flat blades.

The replacement of large Byblos and Amuq points with smaller and more elaborately flaked versions of these types, and the appearance of more elaborately shaped sickle segments, clearly for the manufacture of composite sickles (Gopher and Tsuk 1991: XVI-XVII), are an indication of the decline in importance of long, flat blanks. However, it is unclear whether they are the reason for it. An actual preference for these new tool types could be responsible, but we lack evidence for this. A lack of interest in maintaining previous investments of energy in chipped stone production might also be a factor.

Evidence for any shifts in the demands upon communities' energy expenditure may well be pertinent to this last issue, and also pertinent if a general reduction of investment in procurement is envisaged as responsible. In Jīlāt, at least, one major new factor at the beginning of the sixth millennium BC is the appearance of pastoralism (Baird *et al.* 1992; Garrard *et al.* 1994b). It appears as an *addition* to existing subsistence practices, as elsewhere. It seems likely that the exigencies of integrating new subsistence practices into existing behavioural systems may well have required redispositions of energy. A major question, then, is whether pastoralism generally appears around the end of the seventh/beginning of the sixth millennium BC in the southern Levant or whether it is present some time earlier. At Azraq 31 it may be present in the Late PPNB, but this issue is highly problematic (Baird *et al.* 1992). At Baṣṭa it is claimed to be present in the Late PPNB (Becker 1992), but it seems this occupation can placed at the very latest in the seventh millennium BC. At 'Ayn Ghazāl it may be present considerably earlier, as is claimed, but the evidence is problematic (Köhler-Rollefson *et al.* 1988: 425; Köhler-Rollefson 1989: 145); at 'Ayn Ghazāl pastoralism can only be confirmed at the beginning of the sixth millennium BC (Köhler-Rollefson *et al.* 1988: 426; Köhler-Rollefson 1989). Pastoralism is apparently not present at a number of other PPNB sites in the southern Levant (Horwitz 1989: 169) or Sinai (Bar-Yosef 1984). It is plausible that the appearance of pastoralism, and the demands it made upon the way in which society organized its activities, was ultimately responsible for technological change. However, we require better evidence of the date of the appearance of pastoralism before we can con-

firm or deny such a proposition.

Whether or not we eventually confirm or deny this proposition, we are still required to account for the changes in tool types. Such an account might have a role in explaining broader technological and behavioural change.

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