V

THE LOCATION OF THE SETTLEMENTS

We assume that the first inhabitants of the settlements themselves chose the site where these would be founded. Many factors will have played a part in the choice of the site, a number of which will have been of a purely economic reason. However, economic reasons need not be the only determinants for the location of a dwelling site. Unfortunately we can but partly trace the motives underlying the choice of a dwelling place. We know the final result and we possess some material remains which tell us something about possible economic determinants. At first sight this does not seem very much, but still we think that the available data are sufficient to make a study of the location of the settlements viable, since it is precisely the economic factors which must have weighed the most heavily in the choice of a settlement site, as this site must have offered the actual means of existence. That is why in the following we wish to relate the location of the settlements Sittard, Stein, Elsloo and Hienheim to what we learned about the economic activities of the inhabitants.

In chapter III we divided the environment of a settlement into three zones of activity, namely a zone with a radius of 2 hours' walking distance, a zone with a radius of 6 hours' walking distance, and the world beyond. The zone with the radius of 2 hours' walking distance would be the area where most of the economic activities took place. After Higgs and Vita Finzi, we have called this area "site territory". In the scope of the locational analysis we deal in the very first place with this "site territory". It appeared in the reconstruction of the environment, that the site territory could be divided into different landscape units. According to the definition, the settlement is located in the centre of the site territory, but the different landscape units are not distributed regularly around this centre. Therefore it makes sense to submit the distribution of the different landscape units over the site territory to a closer study. The distribution has been given already in figures 2 and 3, but we have shown it again, slightly simplified, in figure 15 in the form of the circles under discussion.* It appears that a number of landscape units have a peripheral location with respect to the settlements under study. In the site territory of Sittard these are the landscape of sands and gravels which belong to the Higher Terrace, and the landscape of the Tertiary sands. These two units are absent in the site territory of Stein; here the area of the sandy loess on gravel is a peripheral unit. In its location, Elsloo is very similar to Stein, since the distance between the two settlements is only 2500 m. In the site territory of Hienheim, which is characterized by a different set of landscapes, the unit of the Tertiary sands and loams can be considered as a peripheral unit. We assume that peripheral units have played no part, at least no part of primary importance, in the choice of the settlement location. There remain four units for each settlement which may have been of importance. At Sittard they are the loess plateau, the dissected loess landscape, the river valley landscape, and the area with a thin layer of sandy loess on gravel. Stein and Elsloo have the first three units in common with Sittard, the eolian sand is the fourth unit. The site territory of Hienheim is dominated by a loess area, a limestone area, a river valley

* The loess area near Hienheim is smaller in extent in figure 15 than in figure 3. Figure 3 is based on the Geological Map of Bayern 1:25 000, no. 7136. On this map a loess layer of 5 cm is still indicated as loess. A new map by H.T.J. van de Wetering allowed the elimination of areas with a very thin loess cover. Figure 15 shows loess covers of more than 30 cm.

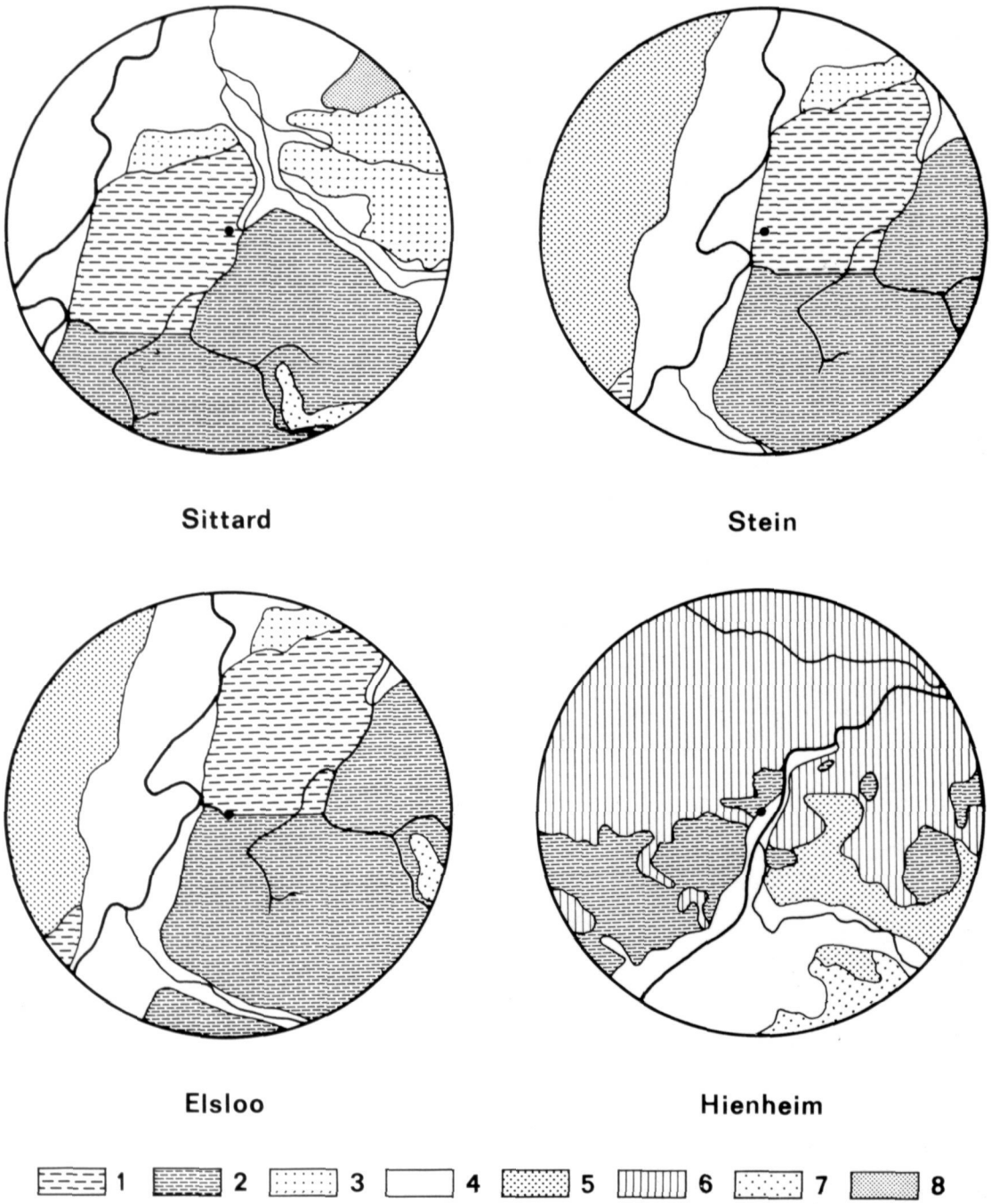

Fig. 15. Distribution of landscape units within a radius of 10 kms around the LBK settlements. 1: loess plateau, 2: dissected loess landscape, 3: thin cover of sandy loess on gravel, 4: river-valley landscape, 5: eolian sand are, 6: limestone area, 7: Tertiary deposits, 8: sands and gravels of the Higher Terrace.

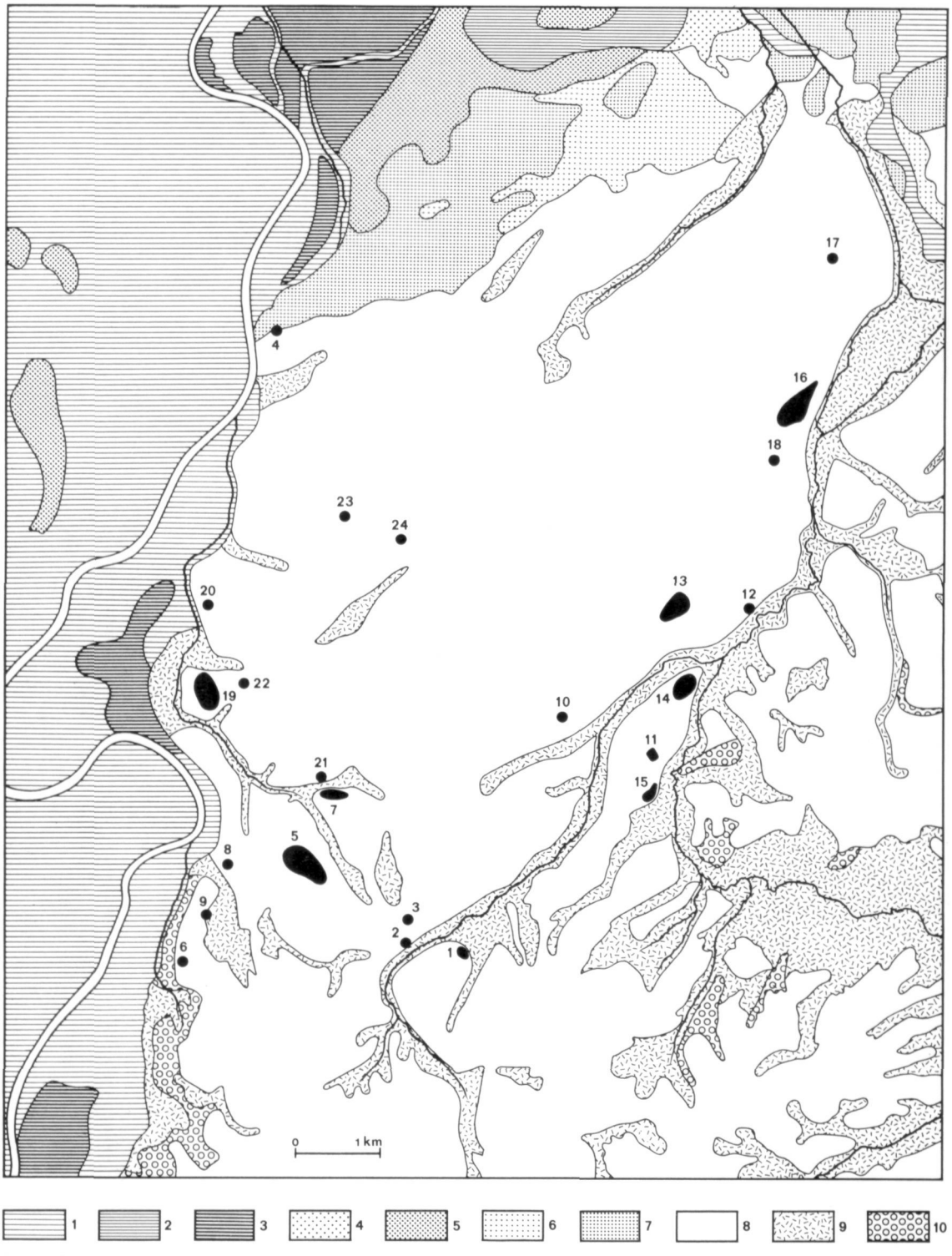

Fig. 16. Distribution of the LBK settlements in Southern Limburg. Scale 1:75 000. Names can be found in table 3. legend units: 1: younger alluvial clays, mostly wet; 2: older alluvial clays, wet; 3: older alluvial clays, dry; 4: sands, wet; 5: sands, dry; 6: sandy loess, wet; 7: sandy loess, dry; 8: loess plateau; 9: valleys and valley slopes (> 10%) within the loess landscape; 10: sands and gravels exposed in slopes.

landscape, and an area with eolian sand. When we have a look at the location of the settlements within these units, we see that Sittard, although located on the loess plateau, is not in the middle of it, but on a place where the dissected loess landscape and the river-valley landscape are nearby. The same applies to Stein and Elsloo. The last settlement is even located on the boundary of the loess plateau and the dissected loess landscape. Also Hienheim lies within a loess area and in the immediate vicinity of a river-valley landscape.

The fact that all four the settlements described were built on a loess substrate, is nothing new; the remark was made already when the settlements were discovered and Modderman mentions the fact in all his publications (Beckers & Beckers 1940, Modderman 1958/1959a, Modderman 1965/1966, Modderman 1969). The location of the settlements on a loess substrate fits precisely in the picture which archaeologists have had of the LBK since Schliz (Schliz 1906). The situation is so characteristic, that it is considered as one of the attributes of the LBK culture. That is why it is obvious to see the presence of a loess area as one of the determinants for the location of our settlements. However, it cannot have been the only factor, since not one of the settlements lies in the centre of a loess area. We think that the eccentric situation is not coincidental. On the maps 1:200 000 (figures 2 and 3) and also on the maps 1:75 000 and 1:50 000 (figures 16 and 17), which give a more accurate picture, can be seen that neighbouring settlements have a similar eccentric location (apart from two exceptions in Southern Limburg). There must have been at least one other factor that exerted a pull on the location of the settlements. The maps with a scale of 1:200 000 suggest for Sittard the dissected loess landscape or the river-valley landscape, for Stein the river-valley landscape, for Elsloo the dissected loess landscape, and for Hienheim the river-valley landscape. However, there is still another possibility, namely that not one of the large units, but a smaller landscape element is the factor sought, namely open water. The maps of figures 2, 3, 16 and 17 show that the settlements lie near streams or rivers. It is a well-known fact that LBK settlements are nearly always found along a watercourse. Schliz already mentioned this and the observation has been repeated many times (Schliz 1906). For the areas which we are studying, we refer in this respect to Modderman for Southern Limburg and to Brunnacker and Kossack for a comparable area in Niederbayern (Modderman 1958/1959a p. 3, Modderman 1970 p. 202, Brunnacker & Kossack 1957 p. 48). Therefore we consider open water as a second determinant for the place of the settlement. We are not yet ready to answer the question whether the river-valley and dissected loess landscape also played a part.

Both requirements, the presence of loess and the presence of open water, still allow some variation in the choice of a settlement site. thus it is not yet clear why in Southern Limburg so far settlements have only been found in the plateau landscape or on its edge, whereas there are no settlements in the dissected loess landscape. According to Modderman, the dissected loess landscape is unfit for occupation because the areas which are attractive on account of their loess cover lie too far from open water and the edges of the landscape in question would also be too eroded and show too much relief to meet the requirements. We fully share Modderman's opinion where the area south of the LBK occupated area is concerned. This area is dissected by only one watercourse: the Geul. The valley of this stream has very steep slopes without loess cover. Therefore it seems to us that this part of Southern Limburg does not meet the requirements for the location of LBK settlements. The situation is different in the area east and south-east of the plateau landscape described here. Water certainly occurs here and the valley slopes are not steep everywhere. The difference with the plateau landscape resides in the fact that the landscape is divided by valleys and dry valleys into a number of small plateaus, whereas the area between the stream Geleen and the Maas, which we call "plateau", is one large, flat area. It is possible that the inhabitants of the LBK settlements preferred

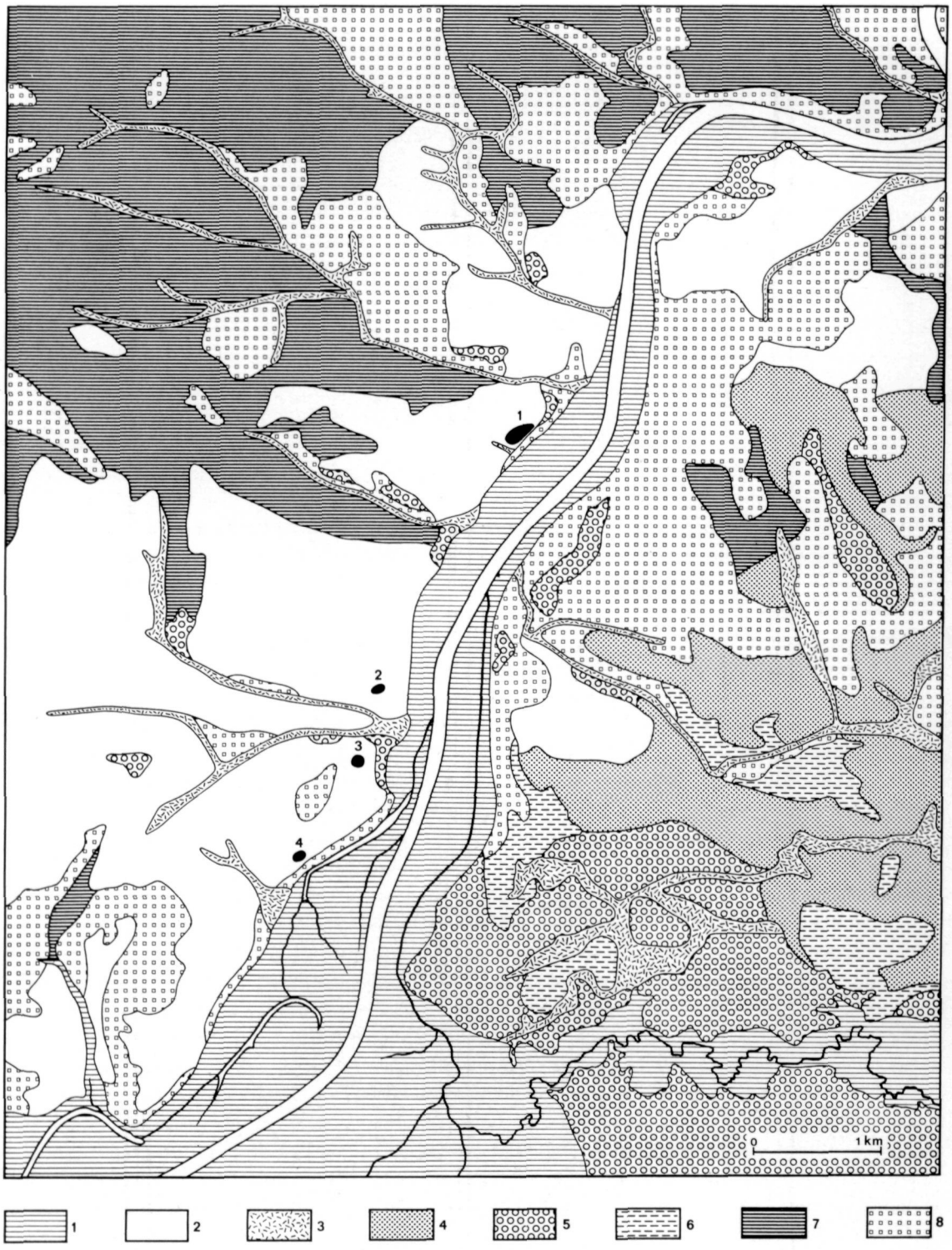

Fig. 17. Distribution of the LBK settlements near Hienheim. Scale 1:50000. 1: Hienheim "am Weinberg", 2: Hienheim-Fuchsloch, 3: Irnsing-Schanze, 4: Irnsing-1, legend units; 1: younger alluvial loams; 2: loess; 3: colluvial material; 4: sands; 5: gravels; 6: shallow, stony soils on sandstone; 7: fine sandy to silty loams on limestone; 8: shallow, stony soils on limestone.

one large plateau to a series of smaller ones. On the other hand, Elsloo lies in reality on a plateau of its own, which corresponds to the type that is found in the dissected loess landscape. This, moreover, also applies to other settlements, such as Beek-Kerkeveld-Hoolstraat and Elsloo-Geulle (fig. 15, nos 1 and 6). Therefore we are reluctant to consider the factor "dissected landscape" as a negative factor in the choice of a place for a settlement. The loess area of Hienheim plays no part in this discussion, because this area offers no choice; there is only "dissected loess landscape".

While the relief differences are not considered as a negative factor where the choice of a certain landscape unit is concerned, we do not wish to exclude that the relief played a part in the choice of a site for a settlement. It must be said that the settlements Sittard, Stein, Elsloo and Hienheim all lie on level ground. According to Van den Broek, the settlement area at Sittard has an inclination of approximately 3% in the direction of the stream Geleen (van den Broek 1958/1959 p. 12). Modderman describes the area of Elsloo as rather flat (Modderman 1970 p. 4). Stein also lies on a relatively level piece of land (Modderman 1970 p. 80). Contour-maps on which the settlements are indicated, can be found in Modderman (Modderman 1958/1959a fig. 2, Modderman 1970 plate 2). Besides, the situation becomes clear from our figure 16. This figure does not give contour-lines, it is true, but the legend unit "loess plateau" speaks for itself. Slopes of 10% and more are absent here. Hienheim is built on a loess-covered terrace of the Donau. A contour-map and a section are given in figure 18. The map has been drawn after the topographical map of Bayern 1:25 000, sheet 7136 Neustadt a/d Donau; the profile was made by Van de Wetering (van de Wetering 1975b). Thus the settlements would have been built on relatively even terrains. We must, however, draw attention to the fact that this conclusion is based on the recent situation. In III.3 it was commented that the present relief does not correspond to the relief which was present during the Atlantic, as it has been flattened by erosion since then. Even those areas which are at present flat will have shown more differences in height, as shows the reconstruction of the original surface of the area in Hienheim (figure 4). Besides, part of the settlement areas in Sittard and Stein were probably covered by a later "Plaggenboden" (Modderman 1970 p. 80 and 81). Undoubtedly this had a equalizing effect too. The said reconstruction shows, however, that the effect of the flattening was relatively small in Hienheim. We feel that the same applies to the areas of Sittard, Stein and Elsloo and we think therefore that the settlements were built indeed on relatively even pieces of land.

The question is whether evenness was a requirement essential to the location of a settlement. It is possible that our four settlements show this feature for another reason. Settlements built on slopes, and certainly settlements built on loess-covered slopes, are more subject to erosion. The entire category "settlements on slopes" might have disappeared by erosion. This aspect of the geographic distribution of the LBK settlements has not been and can hardly be studied. It is known, however, that on apparently flat areas entire settlements are in the process of disappearing or have disappeared already (Modderman 1976). Although we cannot be sure therefore, that a flat building site was a factor that counted in the choice of a settlement place, it is to be imagined that even ground was preferred over a slope. We shall return to this later. Besides, the relief can have influenced the place of the settlement in another way as well. The impression exists that the location of Hienheim was co-determined by the presence of a small valley, which joins the valley of the Donau. The LBK settlements in the surroundings have a similar location. In Southern Limburg, with its different topography, the effect of side valleys cannot be demonstrated.

When we look for factors other than the relief which may have determined the choice of a certain loess landscape, we arrive at the climate. In his dissertation Sielmann has indicated the possibility that the

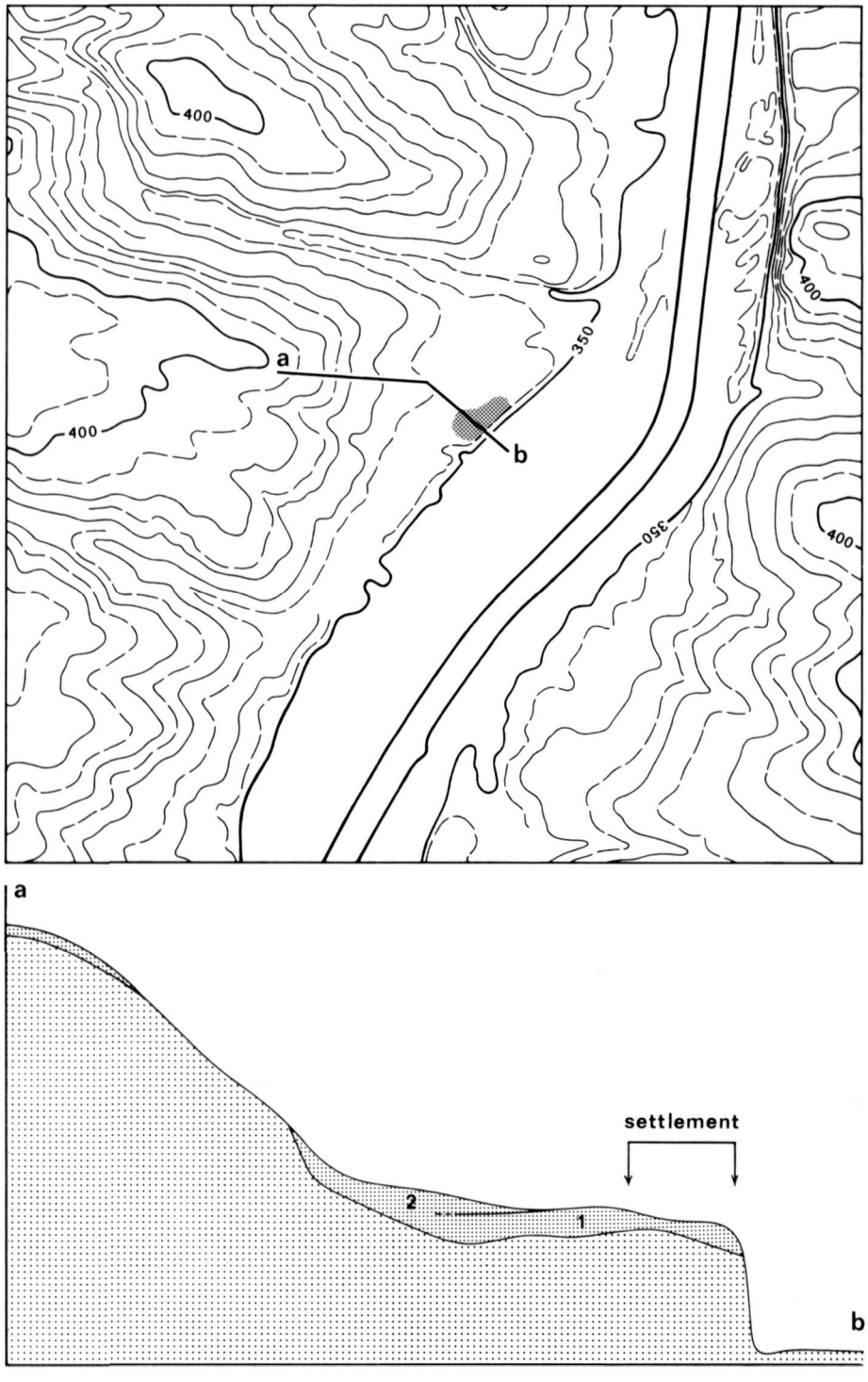

Fig. 18. Hienheim, contour map, scale 1:25 000; section, horizontal scale 1:8 000; vertical scale 1:800; 1: loess; 2: colluvium.

climate may be a factor of importance (Sielmann 1971). He related the distribution of the LBK settlements in South-Western Germany to different aspects of the climate. His conclusion is that in the first place the annual precipitation exerted an influence on the location of the settlements (Sielmann 1971 p. 185). Sielmann later extended his study to Southern and Central Germany (Sielmann 1972, 1976), which has not changed his interpretation. He adds, however, that in Bayern, besides the annual amount of precipitation, the temperature must also have played a part (Sielmann 1972 p. 33). The influence of the climate meant in essence that the driest places within a loess area were always selected (Sielmann 1972 p. 35). Following Sielmann, we have included the factors of mean annual precipitation and mean annual temperature in our considerations.

Climatological differences can hardly have carried any weight in the choice of the place for the settlement near Hienheim. The small loess area on the left bank of the Donau offers no variation in this respect. The climate might possibly have played a part in the choice of the entire loess area as living area in comparison with other loess regions in Niederbayern. In as far as we view this subject at the moment, the areas that qualify for occupation show few differences in climate. We find the study of Bayern by Sielmann unsatisfactory and hope in the future to be able to give a new analysis, using other maps and charts.

The climate of the loess area in Southern Limburg shows variation in precipitation. The distribution of the mean annual amount of precipitation over the whole of Southern Limburg is shown in figure 19. This figure is a combination of figure 2 and the precipitation chart from the Atlas van Nederland (Atlas van Nederland sheet V.2).* Figure 19 shows that the amount of precipitation increases rapidly towards the south-east (the great differences are related to the relief). The LBK settlements turn out indeed to lie in the driest part of the loess area. However, the precipitation chart offers no answer to the question why the dissected loess landscape east of the loess plateau was not occupied.

We have not looked further for climatic aspects which might have varied per loess landscape, such as the difference between day and night temperature or the mean number of days with a snow cover. We did not do so, because we feel that aspects of this type cannot be derived directly from recent climatic charts and be applied to situations within another climatic period. Sielmann thinks it is justified to use the relative distribution of independent climatic factors, because the climate has not changed basically since the Atlantic. He mentions the circulation system (westerlies), the distribution of land and sea (coastlines), the sea currents and the mountains (relief) (Sielmann 1971 p. 75). We agree with Sielmann to the extent that we also feel that the global division in dry and wet areas or in warm and cold regions will indeed have remained the same. Still there are differences. In III.2 the publications by Lamb were quoted, which indicate that especially the circulation type was slightly different during the Atlantic from what is normal nowadays. This phenomenon results in a different distribution of the precipitation over the year and a different course of the temperature curve. This is why we feel that the more detailed aspects of the climate cannot be deduced from recent climatic charts. For that purpose one would need charts of the period to be studied. Making such charts does not yet seem to be possible at the moment.

At present, no factor can be isolated which could explain the absence of LBK settlements in the dissected loess landscape east of the area which was occupied. We see no other factors in the cartographic picture which might have influenced the location of our settlements. In addition to the soil type, the relief and the climate, the vegetation is sometimes included in the list of potential pull-factors despite the fact that it is a secondary factor derived from climate and substrate. ". . .we may think of climate (temperature,

* the amounts of precipitation mentioned in the Atlas concern the period 1931–1960. The figures stated in chapter III.2 date from a preceding period and are therefore slightly different.

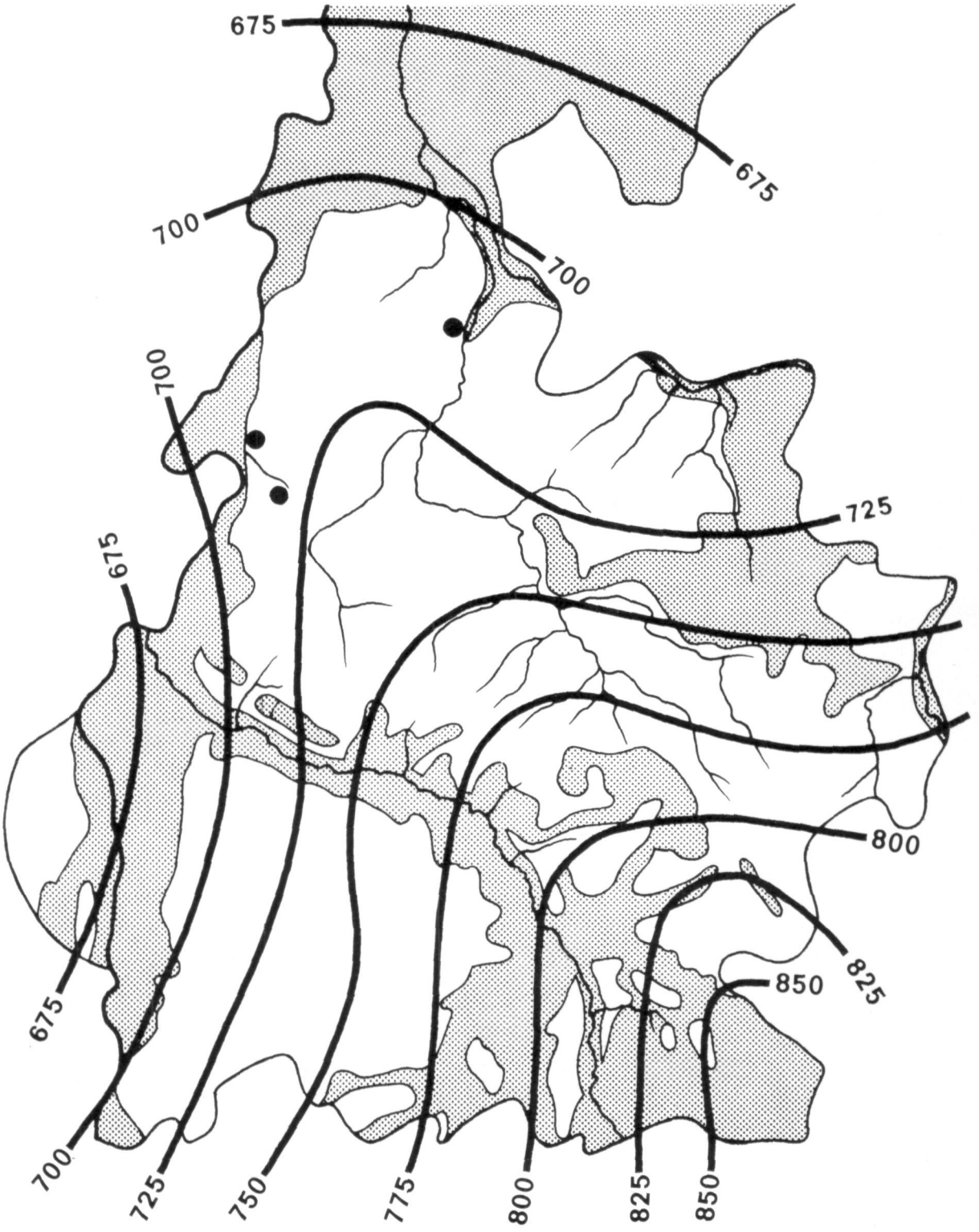

Fig. 19. Map of Southern Limburg showing the mean annual precipitation in mm, the distribution of the loess (white) and the water courses within the loess-covered areas. The dots indicate the position of Sittard, Stein and Elsloo, which represent the whole cluster of LBK settlements. Scale 1:200 000.

moisture, light etc.) and substrate (physiography, soil, etc.) as the two groups of factors which together with population interaction determine the nature of terrestrial communities and ecosystems." (Odum 1971 p. 363). We do, however, feel, in agreement with many others, that the choice of a vegetation type was the real choice made by the founders of the settlement. We consider that people, consciously or unconsciously, judged the substrate and the climate by means of the direct observation of the vegetation. However, when considering the factors that influenced the location of settlements, the vegetation type should not be considered independently beside climate and substrate. It often happens, however, that the analysis of the vegetation cannot be left out. This is the case when not only climate and substrate, but also man has had a share in determining the vegetation type. We can imagine for instance that a clearing in the forest, caused by a Mesolithic population group, was very attractive to the founders of a LBK settlement. For such an analysis, however, one must dispose over a reconstruction of the vegetation, in which local differences within a single landscape unit with a single climate type are known. Our vegetation reconstruction is insufficient in this respect. Therefore a consideration of the vegetation can bring to light no new factor that might have exerted pull on the location of the settlements.

Summarizing the above, we arrive at the conclusion that we can indicate only two factors which, in our opinion, have influenced the choice of a settlement place with some certainty. These two factors, which can be called classical, are a loess substrate and the presence of open water. Climate and relief were possibly additional factors, but this is not clear, at least in the areas which we studied. Too little is known about the vegetation. When we say that loess and water are a condition for the presence of a LBK settlement, this does not mean that there are no exceptions. We know of exceptions to both conditions in Southern Limburg. North of Sittard, outside the area under consideration, there are two settlements on a sandy soil (see the distribution map in Modderman 1970 plate 1). Furthermore, two find sites lie in the centre of the loess plateau, far beyond the reach of water (see figure 16). Not much is known about the nature of the settlements on the sand. The find sites without water must have been extremely small, considering the number of the finds. Probably we are not dealing here with settlements such as Sittard etc., but with a limited, perhaps not even permanent occupation.

At the beginning of this chapter it was stated that the location of a settlement was, for an important part, determined by factors of economic nature. The choice of the loess as substrate has long been recognized as one dependent on economic motives. In the first decades of the 20th century it was thought, under the influence of Gradmann, that the loess was preferred, because this substrate was clear of forests. Landscapes with dense forests would have been unattractive for various reasons. Firstly, Neolithic man would not have been able to lay out fields in a forest. Then these landscapes were difficult to pass through. Finally they did not offer sufficient food in the form of game to pioneers. This interpretation had to be abandoned when pollen diagrams demonstrated that the loess was covered with forests during the Atlantic (Bertsch 1928, Firbas 1949, Müller 1953/1954, Lange 1965). Buttler gave a different explanation for the choice of loess. He started from the assumption that the inhabitants of the LBK settlements lived in pit-dwellings. Loess is very suitable for digging pits. The walls remain erect, even in deep pits, and the loess itself is dry (Buttler 1938 p. 6). Since the time that the pits are no longer interpreted as dwellings, this explanation is of course no longer useful either. But Gradmann and his contemporaries like Buttler, mention still another favourable feature of the loess, namely the great fertility of this soil type. This is the interpretation that is accepted generally nowadays and with which we completely agree. The loess is still considered as the best arable soil in the two areas under study.

Sittard, Stein, Elsloo and Hienheim would thus have been founded in a place where the soil type desired for laying out fields was present in the immediate surroundings of the houses. Such a location is completely in agreement with the model that Chisholm constructed for the location of "farms", regardless the technology of the agriculturalists. We have already mentioned this model in III.1, when it was suggested that there is a limit to man's readiness to displace himself for a certain kind of work. The activities related to laying out fields and maintaining them, to the harvest and the transportation of the crop are of such a nature that the distance between the house and the field is kept as small as possible. Chisholm writes: "A point which emerges ... is the frequency with which the same orders of magnitude keep on recurring among peoples of widely different technical achievements and inhabitating areas with markedly different physical characteristics. Any distance up to about a kilometre from the dwelling is of such little moment for any but specialized systems of irrigation and garden farming that little adjustment is called for in either the pattern of settlement or of land use. Beyond about 1 kilometre, the costs of movement become sufficiently great to warrant some kind of response; at a distance of 3–4 kilometres the costs of cultivation necessitate a radical modification of the system of cultivation or settlement – for example by the establishment of subsidiary settlements – though adjustments are apparent before this point is reached. If the distances involved are actually greater than this, then it is necessary to look for some very powerful constraining reason which prevents the establishment of farmsteads nearer the land." (Chisholm 1968 p. 131).

We attempted in IV.2 to verify whether the fields were indeed laid out on loess. This was done by means of the analysis of the weed flora. Our conclusion was that on the basis of the plant remains recovered, no arguments contrary to this idea could be presented, but that absolute proof could not be given either (IV.2 p. 68).

The location of the settlements near water undoubtedly has an economic reason as well. The inhabitants needed water and this could be reached only at places with surface water. However, the settlements do not lie directly alongside the watercourse (see IV.3). The desire to have loess close to the house apparently prevailed over the wish to have water at hand.

The watercourses, by the way, can have had a second function, namely that of traffic route. Some authors reckon with this possibility (Schliz 1906, among others). We do not wish to exclude traffic over water and the use of boats. It is true that no LBK vessels are known, but this may be due to the fact that no organic material was conserved on the majority of sites (see also III.1). We do think, however, that most transportation took place over land. In the case of Hienheim it is conceivable that the contact between this settlement and its neighbours took place by boat (see figure 17). But the location of Sittard, Stein and Elsloo with respect to each other is such, that water traffic would have been devious (see figure 16). According to our vegetation reconstruction, the area between the settlements was covered with an easily traversable forest (III.4 p. 35). Therefore we think that the principal traffic routes went over land.

A third activity in which the presence of water can have been of economic significance, is fishing. Fish remains are found occasionally in LBK settlements. They appeared in Hienheim and Taute even mentions many remains in the Felsdach Lautereck (Taute 1966 p. 495). So fishing was certainly practiced. Still, the composition of the food remains from most of the settlements creates the impression that gathering food in the wild was not an important part of the daily life (IV.2). We assume therefore, that great importance should not be attached to the presence of water as fishing water where the choice of a location for the settlement is concerned.

The location of the settlements along watercourses need not be related exclusively to the open water itself. It may be that the valleys, which belong to the watercourses, also played a part because of their

vegetation, which in the valleys must have been much more varied than on the loess plateau. It was characterized by a rich undergrowth. In IV.2 it was brought forward that the valleys could have been used for grazing cattle. The vegetation there would have been more suitable for feeding relatively large numbers of animals than the forests on the loess, certainly so before agriculture had created any clearings. Should this suggestion turn out to be correct, then the valleys would be of importance to people who not only practiced agriculture, but who also kept cattle. Proof that the valleys were used for grazing cattle could not be provided so far.

Besides their importance for cattle-breeding, valleys may also have significance for agriculture. In IV.2 we pointed out, that it is possible to lay out fields on the soil in the valleys, provided at least that no flooding occurs during the growing season. However, we considered the loess soils more important than the river loams. We wish to point out nevertheless, that Kruk attributes a greater importance to the fields in the valleys than to the fields in the drier parts of the landscape. "Most of the cultivated fields were presumably situated on inundational terraces and at the edges of valley slopes. Owing to the high and durable edaphic potential of the soils that covered this zone it was possible to use constantly the same portion of land even without fertilizing it. The impoverishment of soil was naturally compensated by the surface flow of humus and inorganic materials from the higher parts of slopes, and by cyclic floods. The zone farmed might have also included the drier parts lying deep in the valley margins (or terraces situated above inundational level). These areas presumably differed somewhat in character from the more humid ones, not so much however as to necessitate the use of a different method of soil working." (Kruk 1973 p. 255). Kruk arrives at this interpretation on the basis of the location of settlements in a loess area in Poland. "The Danubian I population nearly always colonized the lower parts of the valley slopes. The settlements were situated at their edges immediately above the inundational terrace covered with silts of various rotation. The occurrence of these soils must have constituted a major criterium in the choice of the settlement sites, since the smaller valleys, the bottoms of which were covered with other formations of river accumulation (e.g. deposited loess) were neglected." (Kruk 1973 p. 250). We do not wish to adopt Kruk's interpretation, since the smaller valleys in our areas were certainly populated. Elsloo is an example. Also in Niederbayern many examples can be found of settlements along small streams. We think it possible nevertheless, that certain plants were cultivated specifically in gardens in the valleys.

The valleys were possibly also exploited as route ways as is suggested by certain authors in discussing the distribution of the LBK culture (Buttler 1938, Quitta 1960). We think, however, that the presence of traffic routes in the valleys is improbable. The natural vegetation in the valleys consisted, in our opinion, of carrs on wet places and of an Alno-Padion on the slightly drier parts. Both types of forest are characterized by much undergrowth and are therefore difficult to pass through. It is true that the seldom flooded parts supported also forests of the "Carpinion betuli", in which the going is easier, but in most cases the dry parts are discontinuous in a river valley with a meandering river. Therefore it seems more probable that the roads did not pass through, but along the valleys. The tracks then in use were possibly determined only to a small extent by the watercourses, except in mountainous terrain.

In the above the relief has been regarded as an uncertain factor as far as this study concerned. It is obvious, however, that building houses on an even ground offerend advantages over building on a slope. At least, we assume that in the past too the floor of a house was preferred to be horizontal. Special measures must be taken to obtain this result on a slope. Considerations of this nature imply that even terrain was a positive factor in the choice of a settlement site, although no direct proof is available. The possible effect that the presence of a small side valley may have had on the location of Hienheim, could be

the result of the fact that the boundary between the loess-covered river terrace and the alluvial plain consisted in a steep terrace edge. The access to the main valley is easiest by the mentioned side valley.

After the above analysis of the location of Sittard, Stein, Elsloo and Hienheim, and the possible economic significance of this location, we wish to consider again the site territory defined in III.1. We have introduced the site territory with a radius of 2 hours' walking distance or 10 km in our study to have a starting point for the investigation of the relation between the inhabitants of the settlements and their environment. Perhaps it is now possible to confirm to what extent the site territory corresponds with the area that really had economic importance for the settlements in question. By "reality" is then understood the reconstructed "reality".

One of the questions is whether the radius of 2 hours' walking distance calculated by means of data from the literature, can and must be adapted as a result of the reconstruction. It was demonstrated in III.6 that more settlements could be found within a distance of 10 km. Some of these settlements must have existed simultaneously. This means that the theoretical "site territories" overlapped each other to a very considerable extent. From this fact we draw the conclusion that no real importance should be attached to the site territories with a radius of 10 km. We see three alternatives that might replace the model of a site territory with a radius of 10 km and might describe the "reality" better. The first alternative is a reduction of the radius to such an extent that overlapping is avoided. This can be done for example by the construction of Thiessen polygons. This procedure involves a division of the available area into plots of land which each belong, more or less exclusively, to a certain settlement. The settlement is as autonomous as possible. The second alternative is that not the settlement, but a loess area with several settlements is considered as an economic entity. The settlement is then not extremely autonomous, but functions within a large entity. The territory would then be an area that might extend itself until 10 km beyond the most eccentrically located settlements. The third alternative is a combination of the first two, whereby we envisage a settlement which is autonomous as regards its food supply, but which functions within a larger entity where such activities as obtaining raw materials are concerned.

The maps of figures 16 and 17 could be used to construct Thiessen polygons, but we forgo this for different reasons. One reason is that not all the settlements are known, at any rate in Southern Limburg. New settlements are discovered here now and then, lying buried under a colluvium layer and which appear only in digging activities. A second reason is that some find sites, which are now represented by separate dots, could belong to one and the same settlement complex (e.g. Beek-Molenstraat and Beek-Proosdijveld, nos. 2 and 3 in figure 16). In the third place we think that the boundaries of Thiessen polygons are too rigid for a dissected landscape such as the south-western edge of the loess plateau in Southern Limburg. We feel that the territories of the settlements near Elsloo are not correctly described by the construction of Thiessen polygons. A fourth reason is that the settlements were probably not of the same size. The dimensions of the polygons would then have to be weighed in relation to the different sizes. As we do not even know their size by approximation such weighing is impossible.

But also without drawing polygons it is clear that a stretch of loess and a part of a valley with a watercourse can be assigned to nearly all settlements. However, these sections were only of equal value in the case of Hienheim and its neighbours. The conditions in Southern Limburg are not completely identical. Settlements, such as Stein, of which the territories border on the valley of the Maas, had a direct access to the river-valley landscape and to the gravel bars in the river, which the other settlements lacked. If the first alternative is accepted (a reduction of the radius of the "site territory"), the inevitable

conclusion is that the settlements cannot have been completely selfsufficient. The sites on the river would for example have had to supply rocks to the "hinterland". It may also be questioned whether the variability in access to river-valley landscape effected the size and the composition of the live-stock of the settlements. Unfortunately such an effect cannot be measured, because there are no animal remains.

The second alternative: no extreme local autonomy, but a regionally organized economy, is, in our opinion, not a good model. We cannot imagine how the inhabitants of a number of separate and, we think, equivalent, settlements would work together in a collective system. We see settlements as Sittard, Stein and Elsloo as settlements that co-existed. There are no indications of a central authority and it is assumed generally that the exponents of the LBK culture did not know any (Tabaczyński 1972).*

Data allowing a well founded choice between the first and the third alternative, are absent. We personally prefer the third alternative, in which the inhabitants of the settlements did exploit their own piece of loess, but also had direct access to certain commodities beyond. One could even think of the right to grazing land in the river-valley landscape.

The third model implies that the original concept of a site territory as "the territory surrounding a site which is exploited habitually by the inhabitants of the site" (Vita Finzi & Higgs 1970) is not completely applicable. The reason is that part of the economic activities took place in an area which was also used by other settlements, and another part in an area which does have a territorial character. In our case we should like to reserve the concept "site territory" for the "own" loess area with adjacent watercourse, and include the rest in the much wider concept "home range". The latter comprises also non-economic activities, has vague boundaries, and shows overlapping with the home ranges of other settlements (see also III.1). Our ideas of the location of the settlements and their exploitation of the hinterland are shown in the following scheme (figure 20).

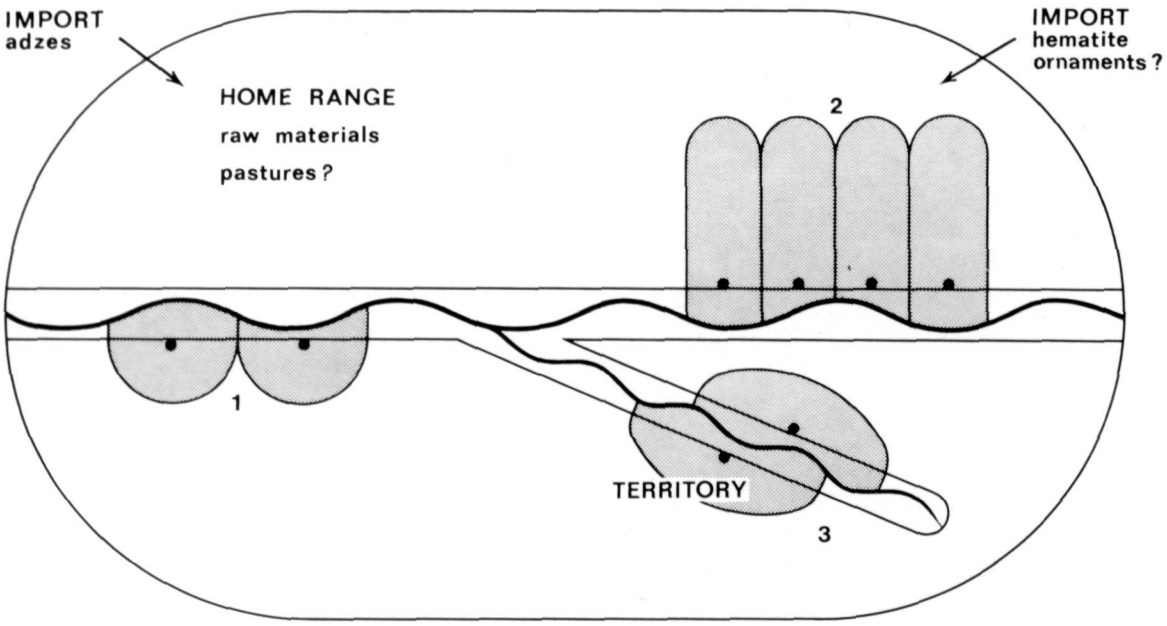

Fig. 20. Model for the location of the LBK settlements. Three alternatives are given for the shape of site territories (nos 1, 2 and 3).

* We wish to note here that some of the find sites shown on the distribution maps could perhaps have originated in subordinate settlements, such as houses that were built to guard certain fields. The find sites Urmond-Graetheide and Urmond-Hennekens should perhaps be interpreted as such.

Next, the attempt can be made to determine the size of the site territory and of the home range. As we have shown in figure 20, we think that the site territories need not necessarily have been semi-circular. A location along watercourses can imply that the dimensions parallel to the watercourse differ from the dimensions at right angles to the watercourse. The territories are then oblong and are described not by a single radius, but by two dimensions at right angles to one another. In an ideal case, these dimensions might be obtained through a distribution map, showing all contemporary settlements. Furthermore, it should be known whether the settlements counted the same number of houses or whether they were of different sizes. As has already been mentioned, our distribution maps do not meet these requirements. Still, we can say something about the dimensions of the site territory. We know, for instance, that south of the settlement Sittard (figure 16 no. 16), at a distance of 2500 m, there was another settlement on the same bank of the stream Geleen (Geleen Noord no. 12). Both settlements existed simultaneously at least during phase IIc. On the right bank of the Ur, we know not only of Stein (no. 19), but also the settlement Stein-Heideveldweg (no. 21) during period I. These settlements are at a distance of 1700 m from each other. More mutual distances cannot be given for Southern Limburg, because either the settlements are not dated sufficiently well, or they are separated by a valley. We are left with the impression that the distance from a settlement to the boundary of its territory, measured along the watercourse, was 1000 m at the most. We expect, by the way, that in the future new settlements will be discovered between the already mentioned settlements, so that the mutual distances would become even smaller. In the surroundings of Hienheim, only one of the LBK settlements has been dated sufficiently well. It is Hienheim-Fuchsloch, at a distance of 2300 m from Hienheim. For the other two settlements mentioned in III.6, namely Irnsing-Schanze and Irnsing 1, no dates can be given. Should they have existed simultaneously with the first two settlements, then the four of them were located in a row along the Donau, with mutual distances of 2300 m, 750 m and 1000 m. The dimensions of the territories, parallel to the river, would thus again be in the order of 2000 m or less.

The dimensions at right angles to the watercourse cannot have been great either. We refer to the location of a settlement like Elsloo (no. 5). At least during phase IId, Elsloo existed simultaneously with Elsloo-Heide (no. 7), Elsloo-Julianastraat (no. 8) and Beek-Proosdijveld (no. 3). The distances to these find sites are 750 m, 1000 m and 1250 m respectively. In the surroundings of Hienheim we have a hold fast in the size of the loess area. The presence of loess near Hienheim itself is restricted to a strip with a depth of 500 to 1000 m, measured from the river valley. Near Hienheim-Fuchsloch (no. 2) the loess boundary is at 2000 m from the river valley. The hinterland of the other two settlements corresponds in size with that of Hienheim. We think that we may deduce from the situation as depicted on the map, that the site territories, measured along the watercourse, were not wider than 1000 to 2000 m and, measured at a right angle to the watercourse, were not deeper than some 1000 m. In reality the territories were perhaps even smaller. The distribution of comparable settlements along the Merzbach on the Aldenhovener Platte in the Rheinland indicates, that at least the width can have been much smaller in some cases, namely some hundreds of metres. The depth is set here at 1500 m at the most (Kuper et al. 1974).

We wish to point out that our rough estimate of the maximum size of a site territory also approximately indicates the size of the available loess area, since most of the valleys are narrow and their surface covers but a small part of the total area. If one assumes that the loess soils indeed represent the area used for agriculture, then the size of this area corresponds with the ideal dimensions, namely less than 3×3 km, as described by Chisholm (Chisholm 1968 p. 131, quoted by us on p. 138). The estimated site territory seems therefore not to be unreasonable.

Another kind of check might consist of testing whether such a territory was indeed sufficient for the inhabitants of the settlements. However, carrying out such a test involves many problems. It must be known, in the first place, how many inhabitants a settlement counted. There are two methods of estimating the number of inhabitants. The first method calculates the number through the size of the settlement or the number of houses; the second method calculates the number through the graves in a cemetery belonging to the settlement. Both procedures are difficult to apply in our case, because the size of most of the settlements is unknown and cemeteries appear to be rare or at least difficult to find. The only settlement in the two areas under consideration of which the required data are available, is Elsloo. Both the size and a cemetery are known of this settlement.

200 to 250 houses would have been built in Elsloo in the course of its history (Modderman 1970 p. 204). It seems unlikely, however, that the oldest houses remained intact during the 400 $\pm$ 50 years that Elsloo was inhabited. The real number that constituted the settlement at a given moment, must therefore have been much smaller. This number depends on the life-span of the houses and therefore on the life-span of wooden posts embedded in loess. This factor is unknown, because this building technique is no longer used nowadays. We might read the maximum life-span from table 6 of IV.4 (p. 82), in which a life-span of 25 years is stated for indigenous wood in contact with the soil. As Modderman has never observed that construction elements in the houses had been replaced, the houses could have remained inhabitable for circa 25 years. The question is, however, whether in reality the houses may not have stood longer. The life-span of 25 years has been established by means of laboratory tests. We think it possible that inhabited houses, in which a fire was kept, remained intact for a longer time. Unfortunately, little information is available about the life-span of comparable prehistoric houses. Verwers is of the opinion that the houses of the Iron Age settlement in Haps, on a sandy soil, stood for 80 years (Verwers 1972 p. 121). Haarnagel mentions a life-span of 50 years for 4 "terp" houses, but the remark must be made here that the subsoil, in which the wood was embedded, has characteristics which are quite different from those of loess soils (Haarnagel 1976, written communication). All we can do at the moment is choose a life-span. We then take a short life-span, namely 25 years. This period has also been used by Modderman and Kuper et al. (Modderman 1970 p. 204, Kuper et al. 1974 p. 497). Using a life-span of 25 years means that Elsloo must have averaged between 11 and 17 houses at any one time. Modderman points out, however, that a population increase in the course of time should be taken into account. He suggests for the first phase a number of less than 9 and for the youngest phases a number of over 17 (Modderman 1970 p. 205).

The next problem is to determine the number of inhabitants per house. In our opinion this can be done only by means of etnographic data. It is difficult, however, to find acceptable etnographic parallels, that is data relating to houses that belong in a similar economic and social context. So far we hardly know anything about the social aspects of life in LBK settlements. On the other hand, the etnographic data are also scarce (Petersen 1975). Several authors have tried to develop formulae which could possess a general validity within certain economic and social limits. We name Naroll, Cook & Heizer, Clarke and Casselberry as authors who studied sedentary, non urban, population groups. Naroll suggests that the population of a settlement can be calculated by taking one-tenth of the total floor surface expressed in square metres (Naroll 1962). Milisauskas has used this formula to calculate the number of inhabitants of the LBK settlement B1 in Olszanica (Milisauskas 1972 p. 70). Cook & Heizer give a formula which relates to "Aboriginal California". "In aboriginal California the floor space per individual house was based upon a minimum average of 6 persons with 20 square feet available to each. Additional persons involved an increase of 100 square feet each." (Cook & Heizer 1968 p. 114). Later Cook refined the formula into: "For

measuring space a fair rule of thumb is to count 25 square feet for each of the first six persons and then 100 square feet for each additional individual." (Cook 1972 p. 16). The formula applies both to singlefamily and multifamily dwellings. Naroll's formula as well as the formula of Cook & Heizer are subject to criticism. They are qualified as too generalizing (Casselberry 1974, Petersen 1975). The work by Clarke relates exclusively to Pueblo cultures (Clarke 1971), whereas Casselberry dealt with multifamily dwellings (Casselberry 1974). Clarke says that the population of a Pueblo amounts to one-third of the floor area as measured in square metres. Casselberry suggests: "the population of a multifamily dwelling can be roughly estimated as one-sixth the floor area of the dwelling as measured in square metres." But he adds: "Although this formula (P = 1/6F) correlates better with the data represented here than to the other formulae, it is far from a good predictor of population size. The primary reason for this is the large amount of flexibility in human population densities due in part to the various human proxemic systems. The formulae on the chart tend to underestimate the population of the various dwellings (the formulae referred to are those of Casselberry, Naroll and Cook, C.B.). It is equally possible, in fact very likely, that the same formulae would overestimate the population if other dwelling types were being considered. Thus it should be emphasized that each dwelling type must have an unique formula." (Casselberry 1974 p. 119). Casselberry applies his formula to the LBK settlement in Olszanica, among other settlements, apparently sharing Soudský's opinion, that the LBK houses were multifamily dwellings (Soudský 1962).

It results from the above that determining the number of inhabitants of a LBK settlement on the basis of the number and the size of the houses is still no more than guesswork. For lack of better, we have applied the formulae of Cook 1972 and Casselberry 1974 to those parts of the LBK houses in Elsloo, which Modderman considers as the living section. Hereby we differ from the procedure followed by Milisauskas and Casselberry, who calculate with the total roofed surface. We have considered all excavated buildings as dwellings. The formula of Cook gives for Elsloo period I an average number of 10 persons per house. There is not much variation. The smallest calculated value is 6 and the largest is 13, but these are extreme values. The application of Casselberry's formula gives 9 inhabitants; the lowest value, 5, and the highest, 13, relate to these extremes. In period II the dwelling sections become slightly larger, which results in averages of 12 and 11 respectively. This number is valid for most of the houses. There are few real exceptions. Most conspicuous is house 13, which has a large dwelling section and which, according to the applied formulae, would have counted 17 (Cook) and 19 (Casselberry) inhabitants. When we reckon with a settlement of circa 9 houses in period I and 17 houses in period II, the population of Elsloo would have increased from 90 or 81 to 204 or 187, that is from slightly under 100 to circa 200 inhabitants.

Modderman has calculated the number of inhabitants through an estimate of the family type that would have inhabited the houses. It would have been a family of 6–10 persons, including three generations. Thus he arrives at a number of 54–90 for the earliest phase and at a number of 102–170 for the latest phases.

The calculations based on the cemetery of Elsloo relate to the population in phases IIc and IId, because the excavated cemetery was in use during these phases only. On the basis of the number of graves and the duration of phases IIc and IId, Modderman arrives at the conclusion that the dead came from a village, which counted 160 persons at the most and at least 40 persons (Modderman 1970 p. 205–207).

In a new analysis of the grave-goods, Van de Velde arrived at the conclusion that the dead in the cemetery constitute no proportional representation of the population. Modderman already pointed out that children of 10 years or younger are virtually absent, a fact which he took into account when he calculated the population. Van de Velde, however, states that women are also underrepresented. The sex

ratio is not 0.500 but 0.403. Van de Velde used this ratio to make a new calculation. He had to start of course from a number of assumptions. He sets the sex ratio at birth at 0.500. Further he assumed that 50% of the people died before they became adults. Only adults would lie on the cemetery, but for example women who died in the first childbed, would not have been buried. With the given sex ratio, 50 men and 34 women would eventually be buried out of an original population of 200. As 113 graves have been found in Elsloo, the original population would have counted 269 persons. Van de Velde thinks that the cemetery was not in use during the entire phase IIc + IId. He does not estimate the period at five generations, that is the duration of the phases according to Modderman, but at three generations. Therefore the population living in one and the same time would have comprised 90 persons (Van de Velde 1977 personal information).

The above shows that the different approaches provide divergent results. The formulae of Cook and Casselberry give a population of 200 for phases IIc or IId; Modderman's estimate on the basis of the houses gives 100–170 and his estimate on the basis of the cemetery 40–160 persons; Van de Velde arrives at 90.

The calculation of the population is not the only problem which we are faced with. If we wish to confirm whether a population could live off a certain piece of land, we need to know what that land yielded. In this respect not only food should be thought of, but also certain raw materials and firewood. With respect to the raw materials we should like to mention in particular the need of sufficient building materials. It is unlikely that the raw materials for mobile goods listed in IV.4, ever formed a problem in the quantitative sense. If they were present, they were also present in sufficient quantities.

We shall first have a closer look at the food supply. In IV.2 it is held that the food came mainly from cultivated plants and domesticated animals. Too little is known about animal husbandry and therefore we shall restrict ourselves to agriculture. The question is reduced thereby to the question whether the inhabitants of Elsloo had enough agricultural land or enough loess soil in their site territory from which to live. To answer this question we must know, among other things, what part of the daily food came from plants and what the yield was per hectare of arable. In IV.2 the problem of the ratio between food from plants and food from animals has already been discussed briefly (p. 77). This ratio cannot be established on the basis of the excavated material. Therefore an estimate has to be made and we shall reckon in the following with 50%, 65% and 80% of food from plants.*

The yield of the fields has been discussed already in IV.2. We mentioned the possibility that the yields could have been equal to those of the just deforested areas in Canada. This means a yield of circa 1 000 kg per hectare, if the yield of the first year is left out of consideration. Some part of this yield is required as sowing seed and part is lost during storage and processing. For this factor Abel states an amount of 200 kg per hectare (Abel 1967). So one hectare of arable would yield 800 kg of cereals for consumption. Perhaps this estimate is on the low side. Abel reckons with a net yield of 500 kg per hectare for the permanent cultivation of cereals in the "terpen" area (Abel 1967 p. 24). He also writes that loess areas are 2.5 times as favourable for agriculture. As there were undoubtedly still many tree-stumps in our fields, which will have reduced the effective area (like in Canada), we reckon nevertheless with 800 kg of cereals for consumption per hectare.

If, for the sake of convenience we only consider cereals and none of the other plants, then one hectare of arable would yield $800 \times 3100 = 24.8 \times 10^5$ Cal of food from plants. According to data from the FAO, a

* 65% is the share of food from plants in the diet of hunters and gatherers (Lee 1968). First we have taken this percentage and then a higher and a lower value.

population of 100, among whom 50 children, 25 adult males and 25 adult females, would need about 237500 Cal per day.* In a case where 65% of the energy demand has to be covered by the wheat yields, then Elsloo, with a population of 100, would have required circa 23 ha of loess in culture. At 50% this is 17 ha, and at the highest estimate, of 80%, 28 ha. If indeed 200 people lived in Elsloo during the last phases, these figures must of course be doubled.* When the above-mentioned areas are related to the site territory, then the surface covered by the fields is smaller than the estimated maximum size of a territory (100–200 ha). In the case of Elsloo a rather more specific definition of the territory is possible. Elsloo lies on a small loess plateau, which is enclosed by valleys. This loess plateau covers circa 170 ha. If the entire plateau belonged to Elsloo and therefore did not have to be shared with Elsloo-Heide, Elsloo-Julianastraat and Beek-Proosdijveld, then the site territory of Elsloo would have covered 170 ha. Of course, part thereof was occupied by the settlement itself, but there was room enough for 17–56 ha of arable. This does not necessarily mean that the inhabitants could live off the land, since we do not know for how long the fields were cultivated. Regular shifting could never have gone on indefinitely, since the fields covered one-ninth to one-third of the maximum possible surface. This could lead to the conclusion that the fields were kept in use for a long time or perhaps even permanently, or that they lay fallow for short times only. In our opinion such conclusions may not yet be drawn at the moment. They would be based on calculations carried out with a series of estimated quantities, among which the size of population, the share of wheat in the food and the yield of the fields are the most uncertain ones.

We shall now have a closer look at the building materials. It was stated in IV.4 that especially the availability of organic building materials may have presented problems. We shall restrict ourselves here to the question whether the site territory could have supplied sufficient timber for building a settlement. Estimates on this subject were formulated in IV.4, with the reservation (p. 85) that the lack of detailed knowledge of the vegetation made it impossible to calculate exactly how large the area was that could supply the necessary quantities of boles. On p. 86 followed an estimate of the area that could have been exploited for building the 200–250 houses. The margins turned out to differ from 50 ha in the most favourable case to 1000 ha in the most unfavourable case. It is clear that only in the most favourable situation, in which there were 1000 trees per ha of which a quarter could be used, the settlement can have been built of the wood from the site territory. Of course it is possible that timber was also imported from outside the territory, but we think that this is less probable, especially since Elsloo is surrounded by settlements, which also needed timber. However, our calculations are based on the assumption, that each house was built of new timber. The situation becomes more favourable when parts of older houses were re-used in the houses. It is possible that ridge-poles and rafters could be used for a longer time than the roof-supports or the wall. Although it does not appear from the excavated soil traces that posts were removed from the soil to be used again, the secondary use of non-embedded parts should not be excluded. Moreover, the possibility of a secondary growth of suitable trees was not included in the calculations, which is also perhaps not quite correct.

A third material which was certainly available but the quantity of which is also of importance, is firewood. Unfortunately, nothing can be said about this material.

* An adult male would consume 3200 Cal, and adult female 2300 Cal and a child 2000 Cal per day. The figures are valid for "reference people". We have not counted with the extra calory demand of pregnant and nursing women (FAO 1957).

* Similar calculations have been made by Piggott and Soudský & Pavlů. Piggott uses criteria taken from Classical Antiquity and arrives on this basis at 60 ha of arable per 100 inhabitants (Piggott 1965 p. 52). Soudský & Pavlů use data from Russian agricultural regions. They arrive at the conclusion, that for a group of 100 individuals, 20 ha of arable was sufficient (Soudský & Pavlů 1972 p. 325).

In answer to our original question, namely whether the inhabitants of a LBK settlement could live on a site territory of at the most 200 ha, but probably smaller in reality, it must be said that this has not been demonstrated to be impossible. At the moment a more concrete answer is not justified since too large a number of quantities has been chosen and these of course include a subjective element. Therefore we consider the preceding calculations of population, food and wood only as an attempt to show how we could calculate if certain quantities were known.

Besides a site territory, a home range has been postulated. We should like to know the size of this home range too. The home range extends itself theoretically to a distance of 6 hours' walking or 30 km outside the settlement. It is difficult to verify whether this limit has a real meaning. Considering separate settlements, as has been done in our study, is not sufficient a basis on which to judge the home ranges. For that purpose one should possess a survey of larger units. Perhaps an analysis of and a comparison between adjacent concentrations of settlements will show a division into larger and more complex units than the single site territory.

A few more words are needed on the landscape units, which were included in the considerations at the beginning of this chapter, because they fall within the site territory defined in chapter III. Now that it has been demonstrated that the real site territories must have been much smaller, the number of landscape units that matter has been reduced to a single, or at the most, to two units. Important for Southern Limburg are the loess plateau landscape and for the area of Hienheim the loess landscape. Perhaps the river-valley landscape should be added. The other units, which originally also seemed to cover a large surface and therefore could have played an important part, namely the dissected loess landscape, the area with a thin cover of sandy loess on gravel, the eolian sand area and the limestone area, now no longer fall within the site territory, but within the home range. We doubt whether they played an important part in the economy. The investigation has made clear that the inhabitants of the settlements obtained certain raw materials from these landscapes, such as chert from the limestone area. But then it concerns the use of a few materials, perhaps from very localized spots, and not the exploitation of an area. Therefore we feel that the landscape units themselves had no real significance.

When, at the end of this chapter, our ideas about the location of the settlements are summarized, it can be stated that the location was determined by the presence of a loess area and a watercourse. The loess area need not be larger than 100–200 ha. Most of the economic activities, and especially agriculture, took place within this area, but a number of activities were carried out beyond. A few necessary materials were not available at all and had to be imported from elsewhere. Of course we do not think that one single settlement on an isolated loess island of the given size could survive. The presence of neighbouring settlements, can have been essential, e.g. for the maintenance of the population and for social contacts. We cannot say more at the moment. The lack of especially the quantitative data which might enable detailed analysis is the greatest impediment.