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THE ACCONIA SURVEY: NEOLITHIC SETTLEMENT AND THE OBSIDIAN TRADE

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PREFACE

Prior to the start of our survey in 1974, there was still some question about the extent of neolithic occupation in Calabria. Only a few neolithic sites - mostly caves located in the rugged northern part of the region - had been reported in the literature. There was uncertainty with regard to what might be found in the rest of the region. This monograph on our survey work at Acconia makes a start at documenting the dense patterns of neolithic occupation that actually occur in Calabria. It also reveals the central role that the region played in the exchange of obsidian between Lipari and peninsular Italy during neolithic times.

There are many people to thank for their help in conducting the project. I would like to thank A. Remmelzwaal of the FAO for his study of the soils and geomorphology at Acconia. I am indebted to D. Aldridge and G. Diamond, both former students of the Institute of Archaeology in London, for the contributions that they made on the study of pottery and lithic material respectively. My gratitude is extended to J. Crummett and S. Warren of the University of Bradford for the neutron activation analysis of obsidian samples from Calabria. Special thanks are given to D. Aldridge and M. Carrara who participated in each field season of the Acconia Survey. We also wish to thank the following for their participation in the fieldwork: S. Bonardi, S. Gaywood, M. Pitts, S. Rosen and I. Zeiler. For their collaboration in the study of soils, we acknowledge our gratitude to M. Jansma, C. Snabilie, O. Spaargaren and A. Van Geel of the Institute of Physical Geography and Soil Science, University of Amsterdam. Appreciation is expressed to various staff members of the IRPI (Consiglio Nazionale di Ricerca, Cosenza) for their advice on the geology of the region and to Geom. L. Ferretti of Parma for his consultation on aerial photography. For the drawings of artefacts and maps, we would like to thank S. Gaywood (pottery and site complexes), S. Milne (lithic material) and E. Peletz (maps). We also wish to acknowledge the contribution made by J. Hwang of Stanford University to the development of the computer programs used for the storage and display of information recovered during the course of the survey. A catalogue of the site reports from the survey has been placed on file in the library of the Institute of Archaeology in London.

We would also like to express our gratitude to the late Professor G. Foti and Dr P. Guzzo of the Archaeological Superintendency in Calabria for their assistance and to Professor G. Ghiara, who as the former rector of the University of Calabria saw the need for such survey work in the region. Funds for the project in Calabria were generously made available by grants from the Istituto per lo Sviluppo delle Ricerche Scientifiche in Calabria and the National Science Foundation. Finally, I wish to express a more personal note of gratitude to Professor J. D. Evans of the Institute of Archaeology in London, Professor L. L. Cavelli-Sforza of Stanford University, and Professor A. Moroni of the University of Parma, for their encouragement over the years.

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CHAPTER 2 PHYSIOGRAPHY AND SOILS

This chapter on the landscape and soils of the Acconia area is organised in five main sections.[1] In trying to interpret patterns of prehistoric settlement and the factors influencing site location, a knowledge of these two aspects of the environment is of fundamental importance. The first section provides an introduction to the Acconia area - its geology, hydrology and climate - and includes a discussion of the diagnostic criteria used in the description and classification of soils. In the second section, the main physiographic units of the area are identified and described: a map showing the location of the respective units is provided in Fig. 2.1. The third section outlines the basic sequence of formation of the different units of the landscape and deals with general aspects of their relationship with prehistoric sites. In the fourth section, a more detailed account of the Acconia dune area and the soil profiles found there is presented. Emphasis is placed on the multiple genesis of the observed profiles, which have during the course of their development been affected by such factors as deposition, soil formation, prehistoric occupation and erosion. The final section is concerned with a description of patterns of sedimentation and erosion in one part of the Acconia dune area. Attention is drawn to the relationship between areas subject to local erosion and the 'visibility' of archaeological material on the surface of the landscape, which has implications for the interpretation of patterns of prehistoric settlement recognised during survey work.

2.1 General Setting

As mentioned in the first chapter, the Acconia area is located in the southern part of the S. Eufemia Plain in the province of Catanzaro. The coastal plain is bounded on the west by the Gulf of S. Eufemia and on the east by a dissected plateau (see Fig. 2.1). For a general outline of the geology of Calabria, reference is made to Ogniben (1973). It is worth commenting that the area near Acconia (like many other parts of Calabria) is tectonically unstable, as evidenced by a series of earthquakes which are known to have occurred, for example, during recent historical times. According to available geological maps (*Carta Geologica della Calabria 1968*), the basement of the area is formed by Palaeozoic metamorphic rocks (gneiss and schists) which form a plateau that is obviously delimited by faults. Pliocene and Calabrian deposits of marine origin are found in the valleys of the plateau (to the east of the area shown in Fig. 2.1). Younger Pleistocene deposits are indicated on the geological map as '*depositi continentali rossastri*' and are not further differentiated.

In terms of hydrology, the drainage pattern of the area can be classified as consequent. The northern and southern parts are controlled by two main rivers, the Amato and the Angitola. The small streams which occur between them are largely canalised in the lower coastal plain. The internal drainage of the fluvial terraces

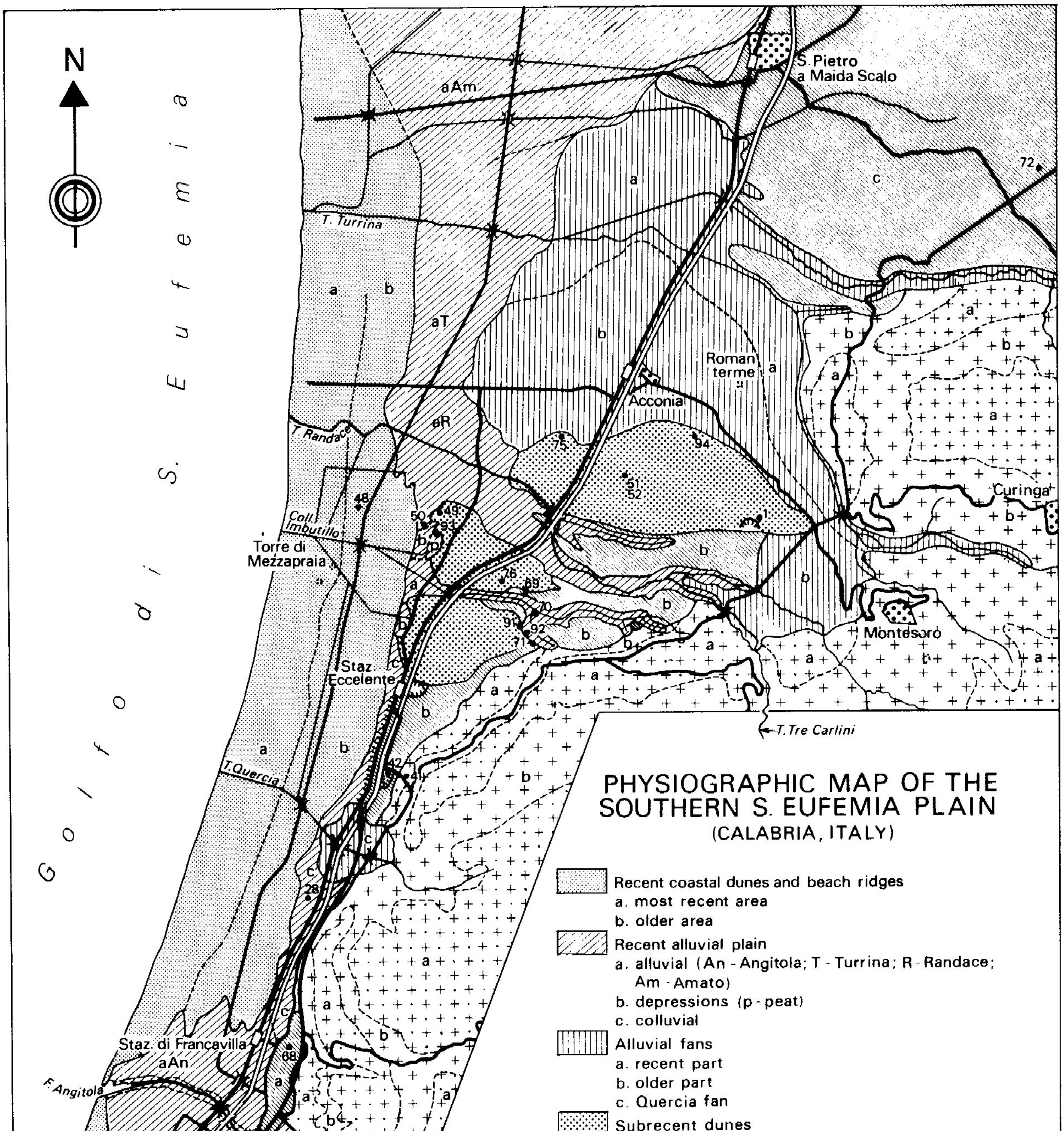

Fig. 2.1 Physiographic map of the southern S. Eufemia Plain.

is controlled by lithology (ie. the occurrence of impermeable layers) and dip slope. In the Amato river terrace, many springs are found where clay layers outcrop. The coarse-grained alluvial fans and aeolian deposits are well to excessively drained. The groundwater flow in the Acconia dune area is controlled by the surface of the underlying fluvial terrace which slopes in a west or southwest direction. Poorly drained areas are found in the recent alluvial plain, especially in the case of depressions formed between sand areas and the fluvial terraces where water coming from the interior collects. In these areas, swamps with peat growth have locally developed.

Climatic conditions are characteristic of coastal areas in the Mediterranean. The Acconia area has a dry, hot climate during the summer months, while humid and mild conditions prevail during the winter months (see Table 2.1). According to the classification system of Köppen (1936), the climate is Mediterranean (Csa). The UNESCO-FAO (1963) classification would be accentuated Mesomediterranean. The soil moisture regime (Soil Survey Staff, 1975), which is important for soil classification, is xeric except for poorly drained areas.

As part of the background for this chapter, it is worth mentioning some of the criteria used in the classification of soils (for a more detailed discussion of the methods and criteria employed in soil classification, see Remmelzwaal, 1978). In this study, soils are described according to the FAO (1967) guidelines for soil profile description. The colours (of moist soils unless otherwise stated) are given following the systems of the Munsell (1954) soil colour charts. The classification systems employed are those of the Soil Taxonomy (Soil Survey Staff, 1975) and the Legend of the Soil Map of the World (FAO-UNESCO, 1974), which are abbreviated respectively as ST and FAO.

A few explanatory notes on soil horizons and the classification of soils need to be made for the non-specialist. The commonly used soil horizon designations (A-B-C) have essentially the following meanings:

A horizon - a mineral horizon formed at or adjacent to the surface that shows an accumulation of humified organic matter;

B horizon - a mineral horizon in which rock structure (including sedimentary stratification) is largely obliterated and in which features such as soil structure and alteration or translocation of material can be recognised;

C horizon - a mineral horizon from which the overlying horizons are presumed to have formed (usually equivalent to the parent material).

Roman suffixes are used to indicate lithological discontinuities and separate phases of deposition and soil formation. The identification of diagnostic horizons is essential to the classification of soils. In the Acconia area, the following horizons are the most important ones:

ochric A horizon - a weakly or moderately developed surface horizon (epipedon);

mollic A horizon - an A1 horizon that is characterised by a sufficiently developed soil structure and dark colour, an organic matter content of at least 1 per cent, and a thickness of at least 18 cm.;

cambic B horizon - an altered subsurface horizon, where the alteration is expressed, for example, by the presence of soil structure rather than rock structure, stronger chroma or redder hue in comparison with the underlying horizon, and evidence of removal of carbonates or evidence of oxidation-reduction processes;

argillic B horizon - a subsurface horizon that shows evidence of illuviated clay or displays a higher clay content than the overlying and underlying horizons.

The highest levels of classification employed in this study are orders (ST) and soil units (FAO). The following orders were recognised in the Acconia area:

entisols (ST), - soils with a weak soil development, usually having only ochric horizon; they correspond basically with regosols (FAO) in this area;

histosols (ST and FAO), - soils with horizons high in organic matter close to the surface;

inceptisols (ST) - soils in this area which have a cambic horizon; they correspond with cambisols (FAO) and gleysols (FAO), the latter being characterised by hydromorphic properties;

vertisols (ST and FAO) - clayey soils that show deep and wide cracks during the dry season, together with other special features such as gilgai or intersecting

Table 2.1 Modern Climate of the Acconia Area

Mean monthly precipitation and number of raindays for the station of Torre di Mezzapraia during the period from 1921 to 1950

	j	f	m	a	m	j	j	a	s	o	n	d	year
Precipitation (in mm)	128	90	72	56	54	26	13	19	47	93	117	133	848
Number of raindays	13	10	8	7	5	3	1	2	5	9	11	13	87

Mean monthly temperature for the station of S. Eufemia Lamezia during the period from 1933 to 1955

	j	f	m	a	m	j	j	a	s	o	n	d	year
Maximum (in °C)	13.6	14.5	16.4	19.2	22.4	26.9	29.3	30.0	27.9	23.7	19.4	15.5	21.5
Minimum	6.7	7.2	7.9	10.5	13.5	17.3	19.5	19.8	17.8	14.4	10.8	8.2	12.8
½ (Max. + Min.)	10.2	10.8	12.2	14.8	18.0	22.1	24.4	24.9	22.8	19.0	15.1	11.8	17.2

The station of Torre di Mezzapraia (see Fig. 2.1) has an elevation of 4m above sea level. The station of S. Eufemia Lamezia, which is located along the coast 10 km north of Torre di Mezzapraia, has an elevation of 25m above sea level. The data are drawn from publications by the Servizio Idrografico in Italy (Ministero dei Lavori Pubblici).

slickensides (self-mulching soils);

mollisols (ST) - soils characterised by the presence of a mollic horizon; they correspond in this area with phaeozems (FAO);

alfisols (ST) - soils that have in this area an argillic (or possibly natric) horizon and do not have a mollic horizon. In contrast with ultisols (ST), alfisols have a relatively high base saturation (>35%). Base saturations have not been determined for soil samples but the pH value (see Appendix 2) may be considered as indicative of the base saturation. In this area alfisols correspond with luvisols (FAO) and probably also with nitosols (FAO). Ferric luvisols are distinguished from other luvisols by the occurrence of ferric properties (for example, a CEC or cation exchange capacity of less than 24 me per 100 gm of clay). The CEC has not been determined for soil samples from the area;

ultisols (ST) - soils which possess a low base saturation (<35%) in the B horizon and which may occur in certain parts of units 5 and 6 of the Acconia area; they correspond roughly with acrisols (FAO).

2.2 Landscape and Soils. Basic Mapping Units

A physiographic reconnaissance map of the southern part of the S. Eufemia Plain is given in Fig. 2.1. This map is based on a combination of aerial photographic interpretation using two sets of photographs (one in black and white at a scale of approximately 1:30,000 flown in 1954 and the other in colour at a scale of approximately 1:15,000 flown in 1974) and field investigations concerned with checking on the nature and boundaries of mapping units. The latter also involved the examination of sedimentological aspects of the deposits found in various parts of the area and the description of soils. Six main mapping units have been identified. In the description of each of the units below, the discussion is divided into (a) physiographic aspects (geomorphology and sedimentology) and (b) soils, including taxonomic classification.

1. RECENT COASTAL DUNES AND BEACH RIDGES

This unit includes the coastal dunes and beach ridges and also some small local alluvial deposits in depressions between the ridges. In most cases, the larger flood basin and channel fill deposits are included in unit 2, the recent alluvial plain. The subdivision of unit 1 into a recent area (essentially the present coastline) and a slightly older area is based mainly on the degree of soil development observed in the two areas. The recent area consists almost entirely of well sorted coarse aeolian sands. These sands commonly cover beach ridges and interdune depression fills of the Fiume Angitola and other small streams. The older area contains most of the beach ridges found inland from the present coastline; these beach ridges are characterised by moderately to well sorted gravelly coarse sands.

The present day beach reaches a height of 3 to 4 m above sea level and consists predominantly of very coarse sands: they are locally coarser and less sorted than the dune sands observed in unit 4 (see below). The sands along the present coast are often strongly stony and gravelly and contain almost no shells. Most of the stony material is, in fact, found either half-way up the beach in a level, trough-like strip or on the top of the ridge (ie. the storm level). In the latter case, there is a conspicuous abundance of gravel-size pieces of pumice, transported by the sea from volcanic sources such as those found in the nearby Aeolian Islands. The adjacent dune area is sometimes lower than the beach ridge but usually the dunes reach heights of some 4 to 5 m above sea level. The dunes themselves consist of a series of ridges which run parallel to the coast.

The orientation, shape and dimensions of the older inland beach ridges (subunit 1.b) are similar to those of the present beach. The maximum height of the older ridges is about 6 m above sea level. The common occurrence of pumice and gravel on the ridge tops confirms their origin as beach ridges. It is worth noting that pumice is found only occasionally in aeolian and alluvial deposits. The somewhat greater height of the older beach ridges in comparison with that of the present one can be explained in several ways. Of these, the two most reasonable would be the following: (1) formation of the older ridges in a period with stronger storm activity; or (2) recent tectonic activity resulting in a slight uplift during Holocene times. These two explanations would appear to be more likely than others such as the assumption of a higher Holocene sea level during the last two or three thousand years of the Holocene, which seems to be unlikely (eg. Pirazzoli, 1976). Boundaries with unit 2, the recent alluvial plain, are usually sharp, although gradual transitions also occur locally where marine-lagoonal sands (see the diatom analysis of sample 28b in Appendix 2) are covered by thin colluvial deposits.

The soil classification for this unit is the following:

1.a-1 In the most recent zone which is a few hundred metres wide, the sands are still slightly calcareous and differentiation of the soil profiles has not been established.

Classification: typic xeropsamment (ST)
calcaric regosol (FAO)

1.a-2 In the more inland part of this subunit, the sands are non-calcareous (decalcified) and an ochric epipedon has formed. The transitions to the most recent zone and the older 1.b subunit are gradual.

Classification: typic xeropsamment (ST)
eutric regosol (FAO)

1.b The epipedon has developed into a mollic horizon in this zone. A weak sub-surface (BC) horizon has formed which can be distinguished from the C horizon only by its colour (see profile 48 in Appendix 2).

Classification: entic haploxeroll (ST)
haplic phaeozem (FAO)

2. RECENT ALLUVIAL PLAIN

This mapping unit, which varies in height from 3 to 15 m above sea level with the river valleys being slightly higher, consists of alluvial and colluvial deposits which range from stony and gravelly sands to clayey and peaty deposits. The alluvial deposits are related to the alluvial fan deposits of unit 3 and the boundaries between these units are gradual. Because the transition between deposits is sometimes very gradual (eg. near the alluvial fan of the Torrente Quercia) and their size is often small in relation to the scale of the map, the alluvial and colluvial deposits have not been mapped as separate units. In many cases, colluvial covers appear to be relatively thin (0.5 to 1 m). This is seen, for example, in the area just north of the Francavilla Station, where they occur on top of sediments of the Fiume Angitola. Alluvial and colluvial deposits alternate locally and are sometimes found inter-fingering with one another. With due allowance being made for the gradual character of boundaries, this unit has been subdivided in the following way: (2.a) areas that are predominantly alluvial; (2.b) depressions with hydromorphic conditions; (2.c) colluvial deposits; and (2.p) areas with peat.

The alluvial areas of river floodplains (2.a) have been subdivided according to the stream regimes of the main rivers: (An) Fiume Angitola; (T,R) Turrina, Tre Carlini and Randace; and (Am) Fiume Amato. The fluvial deposits are non-calcareous, usually yellowish-brown in colour (10YR in the Munsell soil colour charts) and vary from stony sandy-loamy near the alluvial fans to clayey in the depression areas. The deposits of some of the smaller streams are reddish brown coloured (7½-5YR on the Munsell charts) and show a relationship with the source of the material (ie. the older fluvial terraces found in unit 5 and the gneiss and schist found in unit 6). The relationship of most of the colluvia with the original material from units 5 and 6 is even stronger. This is seen in the corresponding reddish colours (5-7½YR on the Munsell charts) of sediments and their sandy, clayey or gravelly textures.

Peat has grown in two small marshy areas: one area (location 93 on Fig. 2.1) between the recent dunes of unit 1 and the subrecent dunes of unit 4 and another area (location 92) in a valley in the fluvial terrace of unit 5.b. At location 93, which is situated at the border of a depression, 4 to 5 m of peat cover well sorted grey humose coarse sands, most probably of littoral or aeolian origin. The peat at location 92 is also at least 4 m thick and is found under a permanent water level of about 1 m. The diatom analysis of samples from locations 93 and 50 indicates that fresh water conditions were predominant but that marine influences were also present (see Appendix 2). This suggests that lagoonal environments existed at least locally in the alluvial plain (see also sample 28b in Appendix 2).

The soils of this unit are classified as follows:

2.a The soil development in the alluvial deposits (generally loam to clayloam) is moderate and characterised by ochric and cambic horizons. The Angitola deposits and the overflow deposits of the Randace are reddish coloured and are classified as chromic cambisols (FAO).

Classification: typic xerochrept (ST)
eutric and chromic cambisol (FAO)

Where locally weak argillic horizons have formed, the soils are classified in the following way:

Classification: typic or mollic haploxeralf (ST)
chromic or orthic luvisol (FAO)

2.b The soils in the depressions are characterised by hydromorphic properties (gley phenomena) due to permanent or temporary saturation with water. The soil formation in these predominantly clayey deposits is weak to moderate and soils with gradually varying hydromorphic properties are found in association with one another.

Classification: association typic fluvaquent,
mollic haplaquept,
aquic xerochrept (ST)
association eutric fluvisol,
eutric gleysol,
gleyic cambisol (FAO)

Some other subgroups (fluventic, typic, aeric) of the inceptisols (ST) are also locally present. The peaty soils are classified as histosols (ST and FAO).

2.c The colluvium is predominantly derived from the fluvial terraces (unit 5) and the inland plateau (unit 6) and has a clayey texture and a reddish colour (5-7½YR 4/6 on the Munsell charts). In most of the soils, an argillic horizon has formed: locally this horizon may be deeply and strongly developed.

Classification: mollic and vertic haploxeralf,
vertic palexeralf (locally) (ST)
chromic and vertic (and ferric?) luvisol (FAO)

3. ALLUVIAL FANS

As mentioned above, the alluvial fan deposits are closely related and transitional to the alluvial-colluvial deposits of the coastal plain (unit 2). The deposits are non-calcareous and generally coarse textured, poorly sorted, and very stony. They are subdivided into three parts: (3.a) the most recent area comprising the present floodplain of the Torrente Turrina and its tributaries; the deposits are in general strongly stony and gravelly, especially in the higher parts; (3.b) the older and slightly higher parts of the alluvial fans of the Turrina and Tre Carlini, where the deposits consist of a series of alternating fine gravelly loams and clay-loams to stony sands; the topography is irregular and the transitions to the more recent parts, 3.a, are gradual; and (3.c) the alluvial fan deposits of the Torrente Quercia, where the material is quite similar to the weathered schist and gneiss of the interior; an important factor here would appear to be the short distance of transport. From the stabilised surface and the degree of soil formation, it can be concluded that the Quercia alluvial fan is relatively old in comparison with the Turrina fan.

The soils of this unit have the following classification:

3.a The soils are pale brownish in colour and usually have only a weak profile differentiation.

Classification: typic xerorthent (ST)
eutric regosol (FAO)

3.b A cambic or argillic B horizon has formed in these brownish coloured soils.

Classification: association typic xerochrept,
typic haploxeralf (ST)
association eutric cambisol,
orthic luvisol (FAO)

3.c The soils of the Torrente Quercia alluvial fan are reddish coloured (5YR 4/6 in the Munsell charts), have an argillic B horizon and a well developed dark ochric A horizon.

Classification: mollic haploxeralf (ST)
chromic luvisol (FAO)

4. SUBRECENT DUNES

The subrecent dunes show no connection with the recent dune of unit 1 as they are separated from them by the alluvial plain. The coarse to very coarse aeolian sands cover alluvial deposits of units 2, 3 and 5. The sands have in places been eroded by streams and also locally by wind action. This indicates that the deposition of the aeolian sands falls within the time span of the formation of the recent alluvial plain. The dunes reach altitudes ranging from 5 to 125 m above sea level and are in some places up to 40 m thick. The availability of sand along the coast is essential for the formation of bodies of sand of such large size. An environment involving a relatively lower sea level and a broad coastal (littoral) plain would seem to be more favourable for the formation of the dunes than conditions with a high sea level. Another important factor that needs to be taken into account is the prevailing climate, which has a strong influence on the vegetation and stabilisation of the coastal sands. In their mineralogical composition and grain-size distribution, the dune sands are quite similar to the sandy deposits of the local rivers. This suggests a provenance predominantly from the local alluvial plain and deltas. Other sources that may have contributed to the supply of material would be longshore currents and older, submerged beaches.

The subrecent dunes are of particular importance for prehistoric sites and a more detailed description of this unit will be presented in sections 2.4 and 2.5. There is evidence from several large sand quarries and sand pits (locations 1 and 76 in Fig. 2.1) that the bulk of the sand was transported and deposited within one consecutive period without a clear hiatus, since there are no signs of soil formation or erosion in the entire lower section of exposed profiles. From the study of soil formation among recent dunes in unit 1 (to be discussed in section 2.3), a period of about one thousand years is sufficient to produce positive signs of soil formation under a modern climatic regime. From the presence of impressed ware neolithic sites on the dunes of unit 4, it is also evident that the main period of formation of the dunes precedes 4,000 BC. In the upper part of profiles in the subrecent dunes, several phases of sedimentation and soil formation can normally be recognised. The more recent sand covers are, however, in most cases quite thin (often less than 1 m thick). There are indications that at least one phase of volcanic ash deposition has occurred (see profile 76), although it is difficult to recognise this loamy intercalation in most exposed sections.

Several soil profiles from this unit (1, 49, 75 and 76) are briefly described in section 2.4 and an analysis of samples of sand from the subrecent dunes is provided in Table 2.2. The grain-size distribution of the samples analysed and also other sands from the subrecent dunes is very similar. The sand is coarser than that of the recent dunes of unit 1 (see the samples from location 48 in Table 2.2). The soils, unless eroded, have a mollic epipedon, sometimes cumulative, and a B horizon that is distinguished by its colour and weak soil structure. The pH values indicate that the epipedons are mollic and not umbric. Classification as pachic haploxeroll is restricted to soils with a thick (50 cm or more) mollic horizon with a loamy texture. This textural condition is usually not fulfilled in soils with a thick A1 horizon.

Classification: entic haploxeroll,
pachic haploxeroll (locally),
typic xeropsamment (when eroded) (ST)
haplic phaeozem,
eutric regosol (when eroded) (FAO)

5. FLUVIAL TERRACES

The fluvial terraces are found elevated above the recent alluvial plain. All terraces show moderate to strong evidence of erosion, mainly caused by incised streams and gullies. This unit is subdivided into three parts: (5.a) a southern terrace which is related to the Fiume Angitola; (5.b) terraces in the central part of the mapped area which are related to several relatively small streams such as the Turrina and Tre Carlini; and (5.c) a northern terrace which is related most probably to the Fiume Amato and its tributaries.

The Angitola terrace reaches a height of 36 m above sea level. This is about 30 m above the present floodplain of the river. The stony and gravelly sediments are horizontally stratified and become less coarse towards the top (ie. fining upwards). The central terraces, which range from 15 to 80 m in elevation, are similar to the Angitola terrace. The sediments are also coarse (stony, gravelly) with a tendency towards fining upwards. Sedimentary structures are confined to subhorizontal stratification with only very few marked foreset beds. Textures and

and structures suggest that high energy conditions existed during deposition although with somewhat of a decrease in the upper strata. A braided river system is indicated. In two exposed sections each several hundred metres long (locations 42 and 44 in Fig. 2.1) tilting of the strata can be observed: at location 42 about 5% in an east-west direction and at location 44 about 10% in a north-south direction. It seems unlikely that these phenomena have a sedimentary origin. Most probably tectonic activity caused differential tilting of certain parts of the terrace. Tectonic movements are indicated by small faults with slight vertical displacement. It is also likely that some of the valleys within the terrace area are structurally determined. The western edge of the terrace between the Torrente Quercia and the Imbutillo canal has been cut off sharply. The cliff face has been subjected to extensive damage as a result of construction work for the railway and the autostrada. The cliff was most probably formed by marine action as is indicated by the straight cliff line which is oriented parallel to the coast. Diatom analysis of a sample take from a clay layer at several metres depth in the terrace (see sample 71 in Appendix 2) does not indicate that marine conditions existed during deposition.

The northern terrace, subunit 5.c, has maximum heights of about 130 to 150 m above sea level and is shaped as an alluvial fan. Sedimentary structures and textures are comparable to those of the other terraces but clay layers are intercalated more often. The clay layers are impermeable and give rise to many springs. The average slope is about 7% and is directed from east to west and locally from northeast to southwest. It is conspicuous that the lower part of the terrace has an equal or even steeper slope than the upper part. This is uncommon for alluvial fans and a tectonic cause is again the most likely explanation of the tilting. The situation and dimensions of the terraces imply deposition by a large stream, the Fiume Angitola or its predecessor. Compared with the other fluvial terraces, this terrace reaches higher elevations and also shows evidence of stronger soil formation and erosion (especially along its northern and western edges). It is reasonable to infer that this terrace is probably older than the others in the Acconia area. The fluvial sediments rest on Calabria and Pliocene formations as can be observed from outcrops in the steeply incised valley of the Torrente Pongerevite, a tributary of the Fiume Amato which is located just outside and to the northeast of the area shown in Fig. 2.1. A further comment that is worth adding is that some small terraces at a lower level are found on the south side of the large Amato terrace. There is a possibility that rather than belonging to the Amato system these lower terraces form part of the Turrina system.

The soils on the terraces are characterised by strongly developed argillic horizons. Well developed soils are found not only on the flat parts of terraces but also occur in those areas that have been eroded. This indicates that several phases of pronounced soil formation have probably occurred since the deposition of the terraces. Only those areas which have been recently affected by erosion show weak soil formation. The differences between soils are largely due to variations in parent material and the length of time involved in soil formation (either since the formation of the various terraces or since the latest phase of erosion). Frequently found in the terrace deposits are buried paleosols showing various degrees of soil formation.

The soils are non-calcareous and predominantly coarse grained (gravelly and sandy), although as a consequence of weathering the clay content of the upper part of profiles has increased substantially over that of the parent material. In some cases, heavy clay soils which display vertic and hydromorphic properties are found locally. In general, the epipedons of the soils are usually well developed ochric horizons transitional to mollic horizons but having chroma values that are too high. Most of the argillic horizons are (dark) reddish brown in colour (5-7½YR 3-2/4 moist; 5-7½YR 4-3/4 dry on the Munsell charts). Stronger reddish colours (2½YR 3-2/4-6) also occur especially in the soils of the Amato terrace. The structure of the argillic horizons can be described as ranging from moderate subangular blocky in the sandy soils to strong coarse anglular blocky and prismatic in the more clayey soils. The consistency of most of the soils is hard to very hard, when the soils are dry.

Thin section analysis of a number of samples from argillic horizons in different parts of the terraces show usually a fair amount of illuviation cutans of clay (ferri-argillans). The degree of disintegration of the cutans observed in several samples provides an indication of the age of the soil. Similar phenomena have been observed in soils elsewhere in Italy which are considered to be middle to early Pleistocene in age (Remmelzwaal, 1978).

The classification of soils for this unit is based essentially on four factors: the degree of development of the argillic horizon; the presence of vertic and hydromorphic properties; the base saturation; and the CEC or cation exchange capacity of the clay fraction. The pH values for the terrace soils at Acconia range from about 5 to 6.5. These values suggest that the base saturation of many of the soils is high enough for them to be classified as alfisols (ST) or luvisols

(FAO). While this interpretation is adopted in the classification that is presented below, allowance should also be made for the probable occurrence of ultic alfisols and ultisols (ST) or arcisols (FAO), which have relatively low base saturations. The difference between chromic and ferric luvisols depends upon CEC values which have not been determined in this study. Apart from recently eroded areas, which have inceptisols and entisols (ST), the soils in the three terrace areas are classified as follows:

5.a Angitola terrace:

Classification: mollic palexeralf and haploxeralf (ST)
eutric nitosol, chromic or ferric luvisol (FAO)

5.b Central terraces: northern area

Classification: mollic palexeralf (ST),
(aquic) vertic haploxeralf,
typic and aquic chromoxerert (locally) (ST)
eutric nitosol or ferric luvisol,
vertic luvisol,
chromic vertisol (locally) (FAO)

Central terraces: southern area

Classification: mollic and typic haploxeralf (ST)
chromic or ferric luvisol (FAO)

5.c Amato terrace:

Classification: mollic palexeralf, haploxeralf and rhodoxeralf (ST)
eutric nitosol, chromic or ferric luvisol (FAO)

6. HILLS

Only a limited amount of fieldwork was carried out in this unit which forms a plateau with incised valleys and steep slopes along its edges. As mentioned earlier, the geology of this area consists of Palaeozoic metamorphic rocks, gneiss, and schists. In Fig. 2.1, this unit is subdivided into (6.a) relatively flat areas and (6.b) steeper ones. It is worth noting that the lower flat areas are strongly influenced by mass wasting from the steeper slopes, which themselves are covered to a considerable extent by slope deposits. Colluvium which is derived from this unit is found in its lowest position over the fluvial terraces (unit 5) and in the recent alluvial plain (unit 2).

The parent rock is often strongly weathered, although the observed depth of the weathering zone is highly influenced by the extent of local erosion. Both the depth of soils and the degree of soil formation vary considerably over short distances. Most of the soils are (dark) reddish brown in colour (2½-7½YR on the Munsell charts) and have an argillic horizon. Depending upon the base saturation, the soils can be classified either as alfisol (ST: haploxeralfs, palexeralfs and chromoxeralfs) or as ultisol (ST: xerults). A corresponding distinction can be made between luvisols and acrisols (FAO).

2.3 Development of the Landscape

A knowledge of the relative and absolute age of the main components of the landscape is essential to an interpretation of prehistoric settlement in the Acconia area. The aim of this section is to outline the sequence of events involved in the formation of the landscape units shown in Fig. 2.1. Attention will also be directed toward the subsequent alterations and modifications of the landforms: these modifications include processes of deposition, erosion, and soil formation as well as human influences.

The numbers assigned to the six main physiographic units identified in the previous section correspond essentially with their relative ages. It is apparent that units 5 and 6 represent older formations. It should be emphasised at the outset that there are gradual transitions in age between some of the younger components (units 1-4). The basic sequence of events contributing to landscape formation in the southern part of the S. Eufemia Plain can be summarised as follows:

- Plateau formation in the Palaeozoic basement rocks; the schist-gneiss hills (unit 6) form an old planation surface (probably of Tertiary age) that has been eroded by fluvial action.

- Deposition of Pliocene and Calabrian deposits; these deposits of marine origin have partially filled the valleys incised in the plateau during early erosional phases. The region was strongly influenced by tectonic movements which is shown by the differentiation of the plateau into distinct levels at different altitudes and also the heights of the Plio-Pleistocene deposits. Erosional processes such as river incision and mass wasting were active, apparently until today.

- Deposition of early to middle Pleistocene alluvial sediments (unit 5) at the foot of the hills; several depositional phases may be distinguished. The Amato terrace probably represents the oldest of these: terrace 5.c covers unconformably Pliocene and Calabrian sediments.

- Tilting and probably uplifting of the fluvial terraces. Subsequent incision caused by the uplifting or the lowering of the erosion base (ie. lower sea levels). The front part of the terrace was shaped into a cliff due to marine action during a transgression. Alluvial fans and colluvium derived from the hills cover the back (inland) parts of the terraces.

- Formation of a (subrecent) coastal plain by alluvial deposition.

- Deposition of aeolian sand forming the subrecent dunes (unit 4); the sands cover parts of the fluvial terraces (notably the central ones, 5.b) as well as parts of the subrecent alluvial coastal plain.

- Erosion of the subrecent dunes (unit 4) and the terraces (unit 5) by stream action (eg. the Torrente Turrina and Randace).

- Aggradation of the subrecent coastal plain by interaction of streams and the sea; alluvial fans (unit 3) transgrade gradually into the recent alluvial (lagoonal) plain (unit 2); a series of parallel beach ridges and recent dunes build up along the coast (unit 1).

Superimposed on these major events in the formation of the landscape are alterations on a smaller scale. These modifications, which are concerned primarily with the land surface, are caused by processes of deposition, erosion, and soil formation. These can be grouped as follows: accumulation (eg. colluviation and inflation); erosion (eg. deflation); and homogenisation (certain soil forming processes and human activity). Processes of erosion and colluviation (or mass wasting in general) were and are active, especially in the hills (unit 6). The coastal plain is affected only slightly by erosional processes. The subrecent dunes (unit 4) are stabilised for the most part: inflation and deflation of the surface of the dune areas have occurred as complex, localised processes (see the following two sections). The main processes of homogenisation in soil formation are self-mulching and biological activity. The former process is characteristic of vertisols (ie. clayey soils that seasonally swell and shrink) which are not all that common in the Acconia area. Biological activity is largely restricted to the upper horizon (epipedon) of the soil; almost no signs are found in the lower horizons.

The strongly developed soils of the older formations (units 5 and 6) do not need further discussion here. The extent of soil formation in the sandy soils (units 4 and 1) is of interest since several phases of soil development in buried and uncovered soils can be distinguished. The soils that have formed all seem to be quite similar to one another. The soil formation in the recent dunes and beach ridges (unit 1) is characterised by the presence of dark epipedons. They show a gradual increase in development as seen in the classification of ochric and mollic horizons as one moves from the sea toward the inland ridges. Soil profile 48 on an inland ridge of the recent dunes (see Fig. 2.1) has a mollic horizon similar to those which occur in the subrecent dunes (unit 4). The presence of two medieval towers near the coast makes it possible to estimate the time that is required for the formation of such a mollic horizon. The towers - a square shaped Aragonese one and a round shaped Genovese one (Torre di Mezzapraia) - occur respectively at distances of 450 m and 600 m from the present coastline. Assuming that they were built close to the sea since they served as watch towers along the coast, it can be argued that the soils in the area of the towers have an age similar (if somewhat older) to the towers themselves. Mollic horizons are observed in soil profiles just landward of the Torre di Mezzapraia: this indicates that the minimum age of a mollic horizon is on the order of one thousand years. If the rate of aggradation has been more or less constant, the oldest inland beach ridges would be approximately two thousand years old. According to Pirazooli (1976), the sea level in the northern part of the Tyrrhenian during the period from 300 BC to AD 150 was about 0.5 m below the present value.

An indication of the age of the recent alluvial fan deposits and the soils that have developed in them is given by the ruins of a large Roman structure (Arslan, 1966; 1967; 1974) in the central part of the Turrina alluvial fan (see Fig. 2.1). Since the construction of this so-called Terme, there has been the deposition of a layer some 2 m thick in which a soil with a cambic or weak argillic horizon has developed. Since soils with stronger development are not found on the alluvial fan, this suggests that the main part of the alluvial fan is younger than two thousand years. From the point of view of soil development, several of the colluvial areas in the coastal plain seem to be the oldest belonging to this unit.

The subrecent dunes, which constitute a reasonably large sand body, were obviously formed during a period when large amounts of sand were available in the coastal plain. Such conditions would occur only when the sea level is relatively low. For this reason, the age of unit 4 can be estimated to have a minimum age of at least four thousand years. The general opinion is that it was only prior to 4,000 BP that sea levels were significantly lower than their present level (eg. Mörner, 1971; Fairbridge, 1976). Soil formation in unit 4 is similar in many respects to that seen in the recent sands of unit 1. However, in most of the sections examined in this unit, more than one soil can be distinguished. While the occurrence of at least one buried soil is common in the subrecent dunes, three and even four buried soils with a mollic horizon are observed in some cases (eg. soil profile 75). Based on the observation of exposed deep sections at sand quarries and sand pits (locations 1 and 76 in Fig. 2.1), all of the paleosols occur in the top of the sand sequence (usually the upper 2-3 m). In the basal and middle parts of the sand, no evidence of soil formation is found. This implies that the bulk of the sand was deposited within one continuous period. Subsequent to this period of deposition, alternations between unstable phases with drifting sands and phases of stability with soil formation have contributed to the modification of only the dune surface. On the basis of soil evidence alone (ie. the sequence of mollic horizons), the minimum age of the subrecent dunes may be estimated at about four thousand years.[2] Comparison of the B horizon in the basic sequence of the subrecent dunes with the B (BC) horizon in the recent dunes (unit 1) shows that the B horizon in the soils of unit 4 is definitely in a more advanced stage of development with regard to depth, colour and structure and that the soils are clearly older than those found in unit 1. On the other hand, the absence of evidence of severe erosion and the still weak development of the B horizon in the soils of the subrecent dunes indicates a relatively young age in terms of Pleistocene chronology (for a discussion of the chronological sequence of soils formed in dune sands in the Tyrrhenian coastal area of south-central Italy, see Remmelzwaal, 1978: 231). A late Weichselain or early Holocene age may be suggested.

In terms of their relationship with prehistoric sites, the landscape units can be seen as falling in three main groups. The first group would include units 5 and 6, which are definitely much older than the other units. The terraces of unit 5 most probably have an early to middle Pleistocene age, as is suggested by the degree of erosion and soil formation. The marine cliff at the front of the fluvial terraces was formed prior to the deposition of the subrecent dunes, which points to the last interglacial period (Eemian) or perhaps older. Evidence in terms of prehistoric artifacts is found in the hills and on the fluvial terraces for both palaeolithic and neolithic occupation. It may be expected that processes of erosion and colluviation active in the past and at present have not favoured the survival of prehistoric sites. Those sites that have been identified in these two units are likely to have been subject to considerable damage due to these processes. In areas with vertic soils, processes of soil formation may have had an obliterating effect with respect to the context in which prehistoric remains are found.

The second group comprises the units of the recent coastal plain (units 1, 2 and 3) which are for the most part considered to be younger than two or three thousand years old. Such a recent date of formation implies that these landscape units are not a good place to look for prehistoric sites, although they may represent productive areas for the discovery of classical and more recent sites. There may, however, be small local areas within the recent coastal plain that are older in age and where it may be possible to locate sites with later prehistoric material (eg. bronze age).

The third group contains the subrecent dunes (unit 4) which were formed either in the early part of the Holocene or the late Pleistocene. An extensive series of prehistoric sites (neolithic through bronze age in date) have been located in this unit during survey work. The sandy soils of this unit seem to provide a good context both for the practice of subsistence forms of agriculture and the survival of prehistoric sites. The preservation of sites has undoubtedly been aided by the inflation of the land surface that took place in various parts of this unit during prehistoric and historic times. A more detailed description of the subrecent dunes

A common feature of all three of the dune areas is the complexity of their top strata in which one or more buried paleosols can be seen. Several soil profiles from the subrecent dunes are described in Appendix 2 (for the locations of the profiles, see Fig. 2.1). The profiles show a similar sequence of soil horizons - A - B - BC - C - in the lower part of the soil. This will be referred to as the 'basic sequence' in the following discussions. The transition from the B to C horizon is usually very gradual and is expressed by a decrease with depth of the soil structure and the soil colour. Only a summary description of four of the profiles from unit 4 will be given in this section. These have been selected to provide an idea of the range of soil profiles encountered in the Acconia dune area.

Profile 49 at the western edge of the middle dune area seems to be a singular profile, consisting of a thick cumulative A1 horizon, obviously influenced by colluviation, on top of the basic sequence. In lateral directions, separate layers in the A1 horizon can be distinguished. Notable is the admixture of volcanic material in the lower part of the A1 horizon. Prehistoric pottery is found in association with the paleosol in the exposed section here (see Appendix 2 for a fuller description of this profile).

Profile 76 is located to the east of profile 49 in the central dune area. A volcanic tuff layer is present here as a distinct IIB horizon between the more recent sand cover and the basic sequence of soil I. The position of the thin layer would seem to indicate a date after the bronze age and yet prior to recent historical times. More recent stratigraphic work at archaeological sites in the Acconia area has made it possible to date this volcanic horizon, which can be seen in the upper part of soil profiles in all three of the dune areas of unit 4, to the classical period.[3] This horizon, when it can be recognised, serves as a useful marker horizon in reconstructing local patterns of sedimentation and erosion on the dunes during the last two thousand years.

Profile 75, which occurs at site 3 as an exposed section measuring some 150 m in length, shows a more detailed and complex series of soils within the sand covers overlying the basic sequence. Some local variation along the section can be observed in terms of the thickness and number of sedimentary and pedogenetic phases. There is no evidence for occupation in the lowest paleosol of the profile. Stentinello pottery is not represented at site 3 and the Diana or late neolithic material which is seen in the section occurs only in the horizons of soils IV and III and not those of soil V. The occurrence of numerous stones at a depth of about 100 cm and the artifacts within the IVB horizon would seem to indicate Diana occupation during the course of development of soil IV. The buried mollic IIIA horizon also contains Diana material and locally also presents several lines of stones at different depths suggesting that the III sand cover consists of more than one phase and has been homogenised into one mollic horizon. Subsequently, a sand cover measuring about 30 cm in thickness was deposited and a mollic horizon has again formed within it. In this IIIA horizon, prehistoric remains which are post-neolithic in date are found. The present surface horizon contains cultural remains of recent historic date. The overall sequence indicates that there have been repeated episodes of sedimentation and the consequent inflation of the land surface in this part of the dune area since neolithic times.

Profile 1 is located near the eastern end of the northern dune area. It consists of two main parts: a buried soil and a more recent sand cover. The Stentinello occupation at site 25 is associated with the surface of the buried paleosol. From the horizon designation of the buried soil, it can be inferred that the original B horizon has been largely eroded and that a new A1 horizon has formed in the truncated soil. The sand cover is comparatively thin here and due to soil formation, thin sand layers which may have been deposited at different times are not recognisable. It is likely that more complete profiles can be found in the neighbourhood of site 25.

Based on the soil profiles that have been described (see Appendix 2), some general remarks on the thickness of the sand covers on top of the basic sequence can be made. In the case of the northern dune area, the covering layers usually consist of a complex with a thickness which ranges between 30 cm and as much as 200 cm. The middle part of the Acconia Flats has only a thin recent sand cover of about 30 cm in which a mollic horizon has formed (see Section 2.5). There is a thickness of about 100 cm at site 3 which is located at the western end of the dune area. The thickest covers are observed on the northern edge of the dune area where bronze age material can occur in places at depths of up to 150 cm below the modern land surface. The central and southern dune areas also show a varying complex of sand covers which have an average thickness of about 100 cm. In the case of some of the deeper covers which can measure up to 180 cm in thickness, a series of as many as five paleosols can be distinguished. Many deep profiles were recorded during the excavations at the site of the Piana di Curinga which were initiated in 1977; the characteristics of these profiles will be presented in a subsequent publication.

is presented in the next two sections. Before taking a closer look at this unit, it is worth adopting a wider perspective and commenting on what might be called the mosaic character of the landscape of the Acconia area; the close juxtaposition of a variety of landforms - subrecent dunes, fluvial terraces, stream valleys incised in the terraces, and slopes of the inland hills - was clearly instrumental in making the area an attractive one for neolithic settlement.

2.4 The Acconia Dune Area

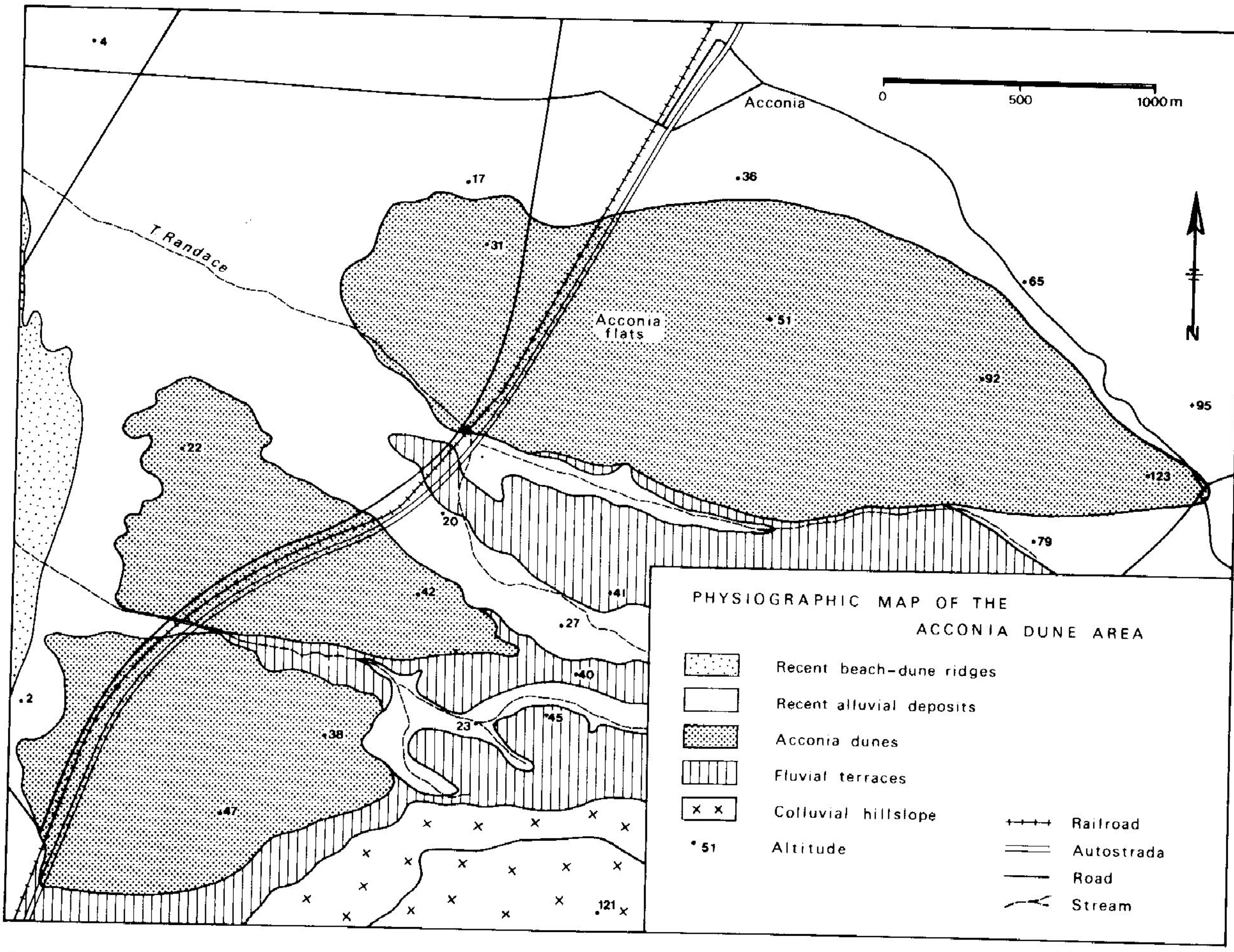

Fig. 2.2 Physiographic map of the Acconia dune area.

A more detailed map of the subrecent dunes which consist of three areas separated by stream valleys is given in Fig. 2.2. Each of the three dune areas starts in front of the coastal cliff of unit 5 and extends inland to the back part of the fluvial terraces. The largest of the three dunes is the northern one which reaches a height of 123 m above sea level near its eastern end. The stream valleys which separate the dune areas are incised in the fluvial terraces that underlie the sand dunes. Evidence that the valleys had developed before the deposition of the sand is provided by the soil formation of the fluvial terraces, which follows largely the eroded surface of the terrace. Fluvial action obviously has removed the sand deposited in the valleys and has also modified the edges of the dunes.

Table 2.2 Analysis of Samples of Aeolian Sand from the Acconia Area

sample number	depth in cm	soil horizon	1700-420	420-300	300-210	sand 210-150	150-105	105-75	75-50	silt 50-2	clay 2	pH H_2O	pH $CaCl_2$	C	CO_2
1a	65-100	IIA1	64.5	17.0	9.0	3.0	1.5	0.9	0.3	1.0	2.5	6.0	5.2	0.4	0.0
1b	130-140	IIBC	69.5	15.0	9.0	3.0	1.5	0.5	0.3	1.0	0.5	6.1	5.4	0.2	0.0
48a	0- 40	A1	38.5	30.5	19.0	4.0	1.5	0.8	0.3	3.0	2.5	6.4	5.7	0.9	0.0
48b	170-180	C	28.5	33.5	28.5	6.0	1.5	0.6	0.3	0.6	0.2	7.1	6.3	0.1	0.0
49a	0- 40	A1	64.0	14.0	7.5	3.0	1.5	0.8	0.3	5.0	3.5	6.6	5.5	1.3	0.0
49b	250-260	C	61.0	22.5	10.5	2.5	0.8	0.2	0.0	1.5	1.0	6.6	5.6	0.1	0.0
51	0- 40	A1	59.5	19.5	9.0	3.0	1.5	0.8	0.3	4.0	2.5	6.4	5.4	0.7	0.0
52a	0- 25	A1	56.5	21.0	11.0	3.5	1.5	0.6	0.3	3.5	2.0	6.3	5.3	1.0	0.0
52b	270-280	C	59.0	23.5	12.0	3.0	1.0	0.2	0.0	0.5	0.5	6.3	5.3	0.2	0.0
75a	80- 90	IIIA1	59.0	16.0	10.0	3.5	2.0	0.8	0.4	5.5	3.0	5.7	4.7	1.3	0.0
75b	270-280	VC	54.5	23.5	14.0	5.0	1.5	0.3	0.0	0.5	1.0	7.1	6.1	0.1	0.0

The grain-size distribution is measured in µm and gives the percentage by weight for the respective size classes.

Some brief comment should be made here about current agricultural practices on the dunes which may have some relevance for the interpretation of patterns of neolithic occupation in the area. The sands are highly permeable and do not retain much water unless a mollic horizon has formed. It was observed in the field that cereals such as wheat and oats can be grown on the dunes without irrigation. This can be done if the soils have a mollic horizon but not in situations where the mollic horizon has been eroded. It is also worth recalling that the Acconia area receives a fair amount of precipitation each month during the period from October through May (see Table 2.1). The dune soils are obviously quite easy to work and given a primitive technology they would have been more attractive to cultivate than the clayey soils of the terraces with their strong soil formation.

2.5 Erosion Patterns and the Surface Visibility of Prehistoric Scatters at Complex E

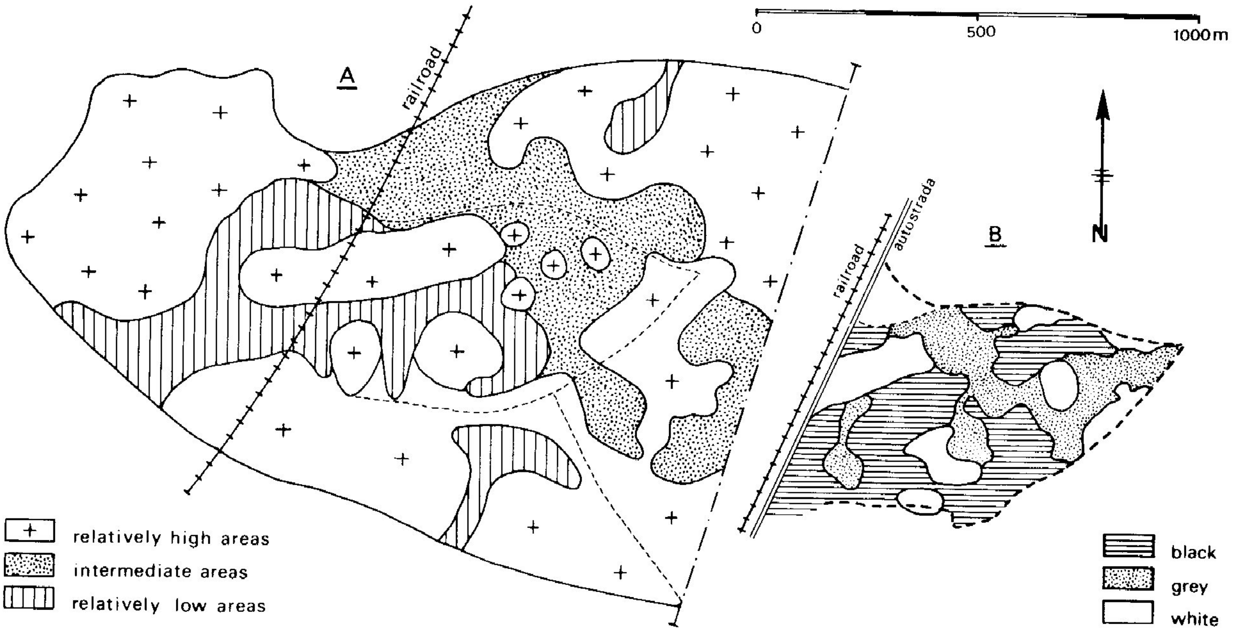

Fig. 2.3 Maps of the relief and soils at Complex E. The map on the left shows the relief as seen on aerial photographs taken in 1954 (see the text). The map on the right gives the texture of soil colours as seen on aerial photographs taken in 1974.

In this section, the relationship between local geomorphology and patterns of erosion in particular and the visibility of prehistoric sites on the surface of the landscape is examined at one of the main site complexes in the Acconia dune area. The section also provides a further description of soil profiles and soil patterns in this part of the subrecent dunes. The landform of this site complex, which is located in the central part of the northern dune, is undulating but relatively flat in comparison with the rest of the dune areas of unit 4. At the time that the prehistoric sites were initially located here in the autumn of 1974, the archaeologists had the impression that the area seemed to be on the whole too flat and it was accordingly referred to as the Acconia Flats. There was the thought that parts of the area may have been levelled either by intentional human activity or natural processes. Subsequent field observations and the examination of aerial photographs of the area taken in 1954 and 1974 have revealed a close relationship between scatters of prehistoric material located during survey work and soil patterns.

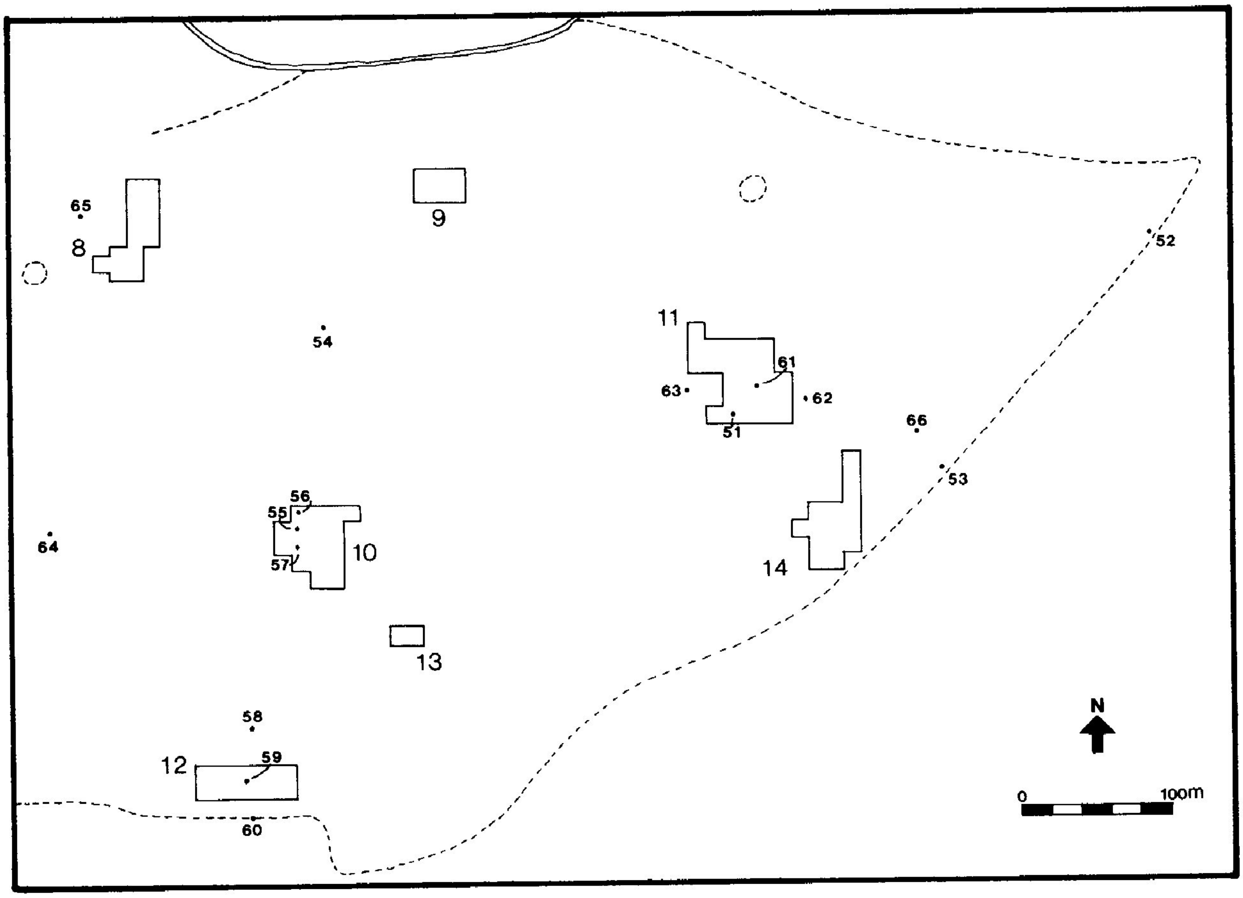

Fig. 2.4 Map of Complex E showing the locations of prehistoric sites and the points where soil observations were made in the field (see Table 2.3).

Prior to and partly during the neolithic period a soil had formed in the sand. This soil, which is now found buried in the profiles of all non-eroded locations that were examined in the field, can be considered to have covered more or less the entire area of complex E. The soil is characterised by a well developed dark A1 horizon (mollic horizon) and a B horizon distinguished by its colour and weak soil structure (eg. profile 52 in Table 2.3). It is classified as an entic haploxeroll (ST) or as a haplic phaeozem (FAO). After the main phase of soil formation, the area was occupied during several different prehistoric periods starting with the neolithic. This occupation may have contributed to the local compactness that is regularly observed in the A1 horizon. A good example of a hardened and quite massive A1 horizon is found along the south side of site 11 (see location 51 in Fig. 2.4). After the occupation, overdrifting sands covered the major part, if not all, of the area. The covering layer is generally about 30 cm thick: a thickness of more than 40 cm was not observed during the field examinations. A mollic A1 horizon, which is similar to the underlying (original) IIA1 horizon, has formed in the sand cover. Because of the modest thickness of the covering layer, there is no B or C horizon in the more recent soil. The mollic horizons of the two soils rest directly on top of one another. In many cases, the present and buried A1 horizon can only with difficulty be distinguished. For this reason, Roman suffices have not always been used in Table 2.3, especially in those cases where the soils have been partially eroded. Until recently, the area appears to have remained basically stable, as indicated by the general occurrence of the mollic A1 horizon and the absence of more recent soils. The minimum time required for the development of such a mollic horizon (see Section 2.3) is estimated to be in the order of one thousand years.

The examination of a set of aerial photographs taken in 1954 shows no evidence of major erosion in the area. In comparison with the situation observed at present, the area was characterised by a more pronounced relief. In the northwestern part of the area (ie. near site 8 in Fig. 2.4), a long ridge running in a north-east to south-west direction was present in 1954 and several isolated small 'humps' that are no longer seen also existed in other places. These features are shown in Fig. 2.3 where they have been mapped according to their relatively higher or lower relief in comparison with the situation obtaining in 1974-1976. The examination of a more

Table 2.3 Soil Observations at Complex E

The locations of the observations are shown in Fig. 2.4 The soil textures are all coarse sand with some small gravel. The colours are given for the soils when moist after the Munsell charts.

location	depth (cm)	horizon	colour	structure	consistency	boundary
51	0- 40	A1	10YR 2/3	massive	hard	gradual
	40-110	B	10YR 3-4/5	very weak subangular blocky	very friable	diffuse
	110+	BC	10YR-2½Y 4-5/5	structureless	loose	
52	0- 25	A11	10YR 2/3	weak crumb	very friable	clear
	25- 60	IIA12	10YR 2/3	weak crumb	very friable	clear
	60-105	IIB2	10YR 3/4	very weak subangular blocky	very friable	diffuse
	105-155	IIB3	10YR 3-4/4	structureless	very friable	gradual
	155-250	IIBC	10YR-2½Y 4-5/5	structureless	loose	gradual
	250+	IIC	2½Y 5/4	structureless	loose	
53	similar in profile to 52; A12 horizon stands out along the exposed section face.					
54	central part of gully, eroded into BC or C horizon; accumulation of material at the head of the gully.					
55	small hump, slightly eroded; approximately half of the A1 horizon is present.					
56	similar to 55.					
57	strongly eroded into the BC or C horizon.					
58	slightly eroded; similar to 55.					
59	BC horizon at the surface.					
60	at the southern edge of the blow out; slightly eroded A1 horizon (0-20 cm) with a clear boundary to the B2 horizon (20-70 cm).					
61	in the central part of the prehistoric scatter; B horizon at the surface.					
62	at the east edge of the prehistoric scatter; return of the A1 horizon at the surface.					
63	3 cm thick cover of overdrifted 'white' sand over hard A1 horizon.					
64	BC horizon at the surface.					
65	C horizon at the surface.					
66	C horizon at the surface.					

recent set of aerial photographs flown in 1974 in combination with field observation made in 1976 (see Table 2.3) confirmed that several of the higher features had definitely been levelled. Comparison of the two maps shown in Fig. 2.3 revealed that the whitish areas seen in 1974 coincide largely with the relatively high areas of the 1954 map.

The interpretation of the 1974 aerial photographs is based on the texture of the colour of the photographs (see Fig. 2.3). It is worth commenting that the map, as an enlargement from the photographs, should not be regarded as possessing a high degree of resolution in terms of the exact boundaries of the mapping units. The field check (see Table 2.3) was concerned primarily with clarification of the nature of soil profiles rather than the systematic definition of individual boundaries. Two further considerations related to the interpretation of the aerial photographs need to be mentioned. The first involves knowledge gained from observations on the ground that cultural material is found for the most part within the IIA1 horizon or just below it. The second consideration is that recently overdrifted sand may lead to misinterpretations of the photo-texture. In eroded areas without vegetation, the sands of the C horizon drift easily. At the time that the field check was made in 1976, such covers of whitish overdrifted sand were usually quite thin (less than 2.3 cm in thickness). In practice, they are confined to the areas immediately adjacent to deflated surfaces and their effect on the map as a whole is a slight one.

The following mapping units have been distinguished in Fig. 2.3:

B1. Black to very dark grey. These areas present complete or almost complete soil profiles. There is a complete IIA1 horizon and all or most of the A1 horizon is present. An eroded IIA1 horizon at the surface should in theory also give the same texture but from the field observations, it became evident that this seldom occurs. There is almost no chance of finding prehistoric material on the land surface in such areas.

B2. Very dark grey. The IIA1 horizon is generally not affected and it is still covered by at least part of the A1 horizon. The somewhat lighter colours are probably due to the partial erosion of the A1 horizon, which in its lower part is slightly less dark in colour. Here the 'findability' of material is also low and depends mainly upon local human activity.

G1. Medium grey. The IIA1 horizon is usually present at the surface but remnants of the A1 horizon still cover locally the complete IIA1 horizon. Occasionally the soil has been eroded into the B horizon. There is a fair to good chance of finding material in such areas. However, the surface distribution of material may not provide a good reflection of the original prehistoric scatter (ie. only certain parts of the scatter may be exposed).

G2. Light grey. The erosion has reached the lower part of the IIA1 horizon or the upper part of the B horizon and in some places even the lower B and BC horizons. The surface visibility of material can be expected to be good in such areas which also offer a reasonably comprehensive idea of the extent of prehistoric scatters.

W1. In such areas, both the A1 and the IIA1 horizons have been more or less completely removed. The B horizon or BC horizon is normally found at the present land surface. While the chances of finding prehistoric material are good, especially in those places where the least deeply eroded profiles occur, the original scatter of material is likely to have been subjected to disturbance as a result of the extent of its exposure.

W2. Almost white. The mollic horizons are completely absent and also the B horizon has been more or less completely removed. The BC and C horizons are found at the surface and superficial overdrifting and artificial mixing of the sand is observed on the surface of such areas. It is possible to find prehistoric material on the surface but it is even less likely to be found in undisturbed condition.

A number of inferences can be drawn from the examination of the soil and erosion patterns at complex E. As mentioned above, the major levelling in the north-western part of the area and also along its eastern edge is clearly artificial. The levelling has been followed by wind erosion in the disturbed areas: the exposed surfaces of the B and C horizons are much more susceptible to wind erosion than the A horizon. Other areas also appear to have experienced some levelling but of a more superficial nature and with the cause - artificial or by wind - being less clear. Active wind erosion can be observed in the area but in several cases this may have been started by small scale human activity such as the digging of sand pits or the grazing of cattle. This is probably the situation at site 10, for example, where there is evidence for the removal of about 1 m of material from the central part of the scatter area and yet a remnant part of the landscape with a complete soil profile is found only a few metres away. The wind erosion that is observed tends to occur in highly localised areas; the IIA1 horizon is often exposed at the edges of such deflated areas. A close relationship is seen not only between erosion patterns and the visibility of prehistoric scatters but also between the extent of deflation (whether caused by artificial levelling, wind erosion or a combination of the two) and the 'quality' of scatters. The map of surface scatters in an area such as complex E provides an incomplete picture of the original distribution of scatters or sites, since sites either may have been removed completely (ie. during levelling operations) or are not observable on the present land surface (ie. the sites are buried beneath cover sands). The assumption often made in archaeological surveys that sites are equally visible or 'findable' on all parts of the landscape is not supported by what is observed in the Acconia area. Geomorphology is an active filter that has to be taken into account in both the conduct of field work and the interpretations of prehistoric settlement patterns.

NOTES

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2. Radiocarbon dates that are now available for Stentinello sites on each of the three dunes at Acconia indicate that the subrecent dunes had formed prior to about 6,500 BP. It is worth adding that the Stentinello wattle and daub structures at Piana di Curinga occur in association with the lowest paleosol in soil profiles. This paleosol consistently shows a well developed B horizon: since at least about 1,000 years is needed for the formation of such a well developed B horizon in the dunes at Acconia, the main period when the bulk of the sand was deposited would be prior to 7,500 BP.
3. In 1977, it was possible to recognise a thin horizon with a different parent material of volcanic origin. This horizon has been observed in the upper part of the sequences of paleosols on all three dunes. On the basis of archaeological stratigraphy, it can be dated to the classical period. During the spring, it is comparatively easy to recognise when it is present in a soil profile, since it is better at holding humidity that is in the soil. When a profile is cleaned and allowed to dry out, it appears as a thin, moist horizon. This marker horizon is of considerable use in studying local inflation and erosion on the dunes during the last two thousand years. It also provides useful information related to the dating of different parts of the recent coastal plain.

REFERENCES

Alessio, M., Bella, F., Cortesi, C. and Turi, B. 1980 Datazione con il carbonio-14 di alcuni orizzonti degli insediamenti preistorici dell'Acropoli e di Contrada Diana, Isola di Lipari. *In* B. Bernabò Brea and M. Cavalier (eds.) *Meligunis Lipara IV*. Palermo.

Ammerman, A. J. 1979 A study of obsidian exchange networks in Calabria. *World Archaeology* 11: 95.

Ammerman, A. J. 1981 Surveys and archaeological research. *Annual Review of Anthropology* 10: 63.

Ammerman, A. J. and Andrefsky, W. 1982 Reduction sequences and the exchange of obsidian in neolithic Calabria. *In* J. E. Ericson and T. K. Earle (eds.) *Contexts for Prehistoric Exchange*. New York.

Ammerman, A. J. and Bonardi, S. 1981 Recent developments in the study of neolithic settlement in Calabria. *In* G. Barker and R. Hodges (eds.) *Archaeology and Italian Society*. British Archaeological Reports, International Series 102. Oxford.

Ammerman, A. J. and Bonardi, S. 1982 Lo studio dei 'settlement patterns': ricerche in Calabria. *Antropologia Contemporanea* 5: 119.

Ammerman, A. J., Bonardi, S. and Carrara, M. 1976 (1980) Nota preliminare sugli scavi neolitici a Piana di Curinga (Catanzaro). *Origini* 10: 109.

Ammerman, A. J., Diamond, G. P. and Aldridge, D. 1978a Un insediamento neolitico presso Curinga (Catanzaro). *Rivista di Scienze Preistoriche* 33: 161.

Ammerman, A. J. and Feldman, M. W. 1978 Replicated collection of site surfaces. *American Antiquity* 43: 734.

Ammerman, A. J., Matessi, C. and Cavalli-Sforza, L. L. 1978b Some new approaches to the study of the obsidian trade in the Mediterranean and adjacent areas. *In* I. Hodder (ed.) *The Spatial Organisation of Culture*. London.

Ammerman, A. J. and Shaffer, G. D. 1981 Neolithic settlement patterns in Calabria. *Current Anthropology* 22: 430.

Arslan, E. A. 1966 L'edificio termale romano detto 'Tempio di Castore e Polluce' presso Curinga (Catanzaro). *Klearchos* 8: 23.

Arslan, E. A. 1974 Ville e città romane in Calabria. *Magna Graecia* 9: 1.

Aspinall, A., Feather, S. W. and Renfrew, C. 1972 Neutron activation analysis of Aegean obsidians. *Nature* 237: 33.

Barker, G. W. W. 1975 Prehistoric territories and economies in central Italy. *In* E. S. Higgs (ed.) *Palaeoeconomy*. Cambridge.

Belluomini, G. and Taddeucci, A. 1971 Studi sulle ossidiane italiane. 3: elementi minori. *Periodico di Mineralogia* 40: 11.

Bernabò Brea, L. 1966a *Sicily before the Greeks*. London. 2nd edition.

Bernabò Brea, L. 1966b Abitato neolitico e insediamento maltese dell'età di bronzo dell'isola di Ognina (Siracusa). *Kokalos* 12: 40..

Bernabò Brea, L. and Cavalier, M. 1956 Civiltà preistoriche delle isole Eolie d del territorio di Milazzo. *Bullettino di Paletnologia Italiana* 65: 7.

Bernabò Brea, L. and Cavalier, M. 1957 Stazioni preistoriche delle isole Eolie. *Bullettino di Paletnologia Italiana* 66: 97.

Bernabò Brea, L. and Cavalier, M. 1960 *Meligunis Lipara I*. Palermo.

Bernabò Brea, L. and Cavalier, M. 1980 *Meligunis Lipara IV*. Palermo.

Bigazzi, G. and Bonadonna, F. 1973 Fission track dating of the obsidian of Lipari Island (Italy). *Nature* 242: 322.

Bigazzi, G., Bonadonna, F., Belluomini, G. and Malpieri, L.	1971	Studi sulle ossidiane italiane. *Bollettino della Società Geologica Italiana* 90: 469.
Braudel, F.	1966	*La Méditerranée et le Monde Méditerranéen à l'Epoque de Philippe II*. Paris. 2nd edition.
Brézillon, M. N.	1968	*La Dénomination des Objets de Pierre Taillée*. Gallia Préhistoire. Supplement IV. Paris.
Buchner, G.	1949	Ricerche sui giacimenti e sulle industrie di ossidiana in Italia. *Rivista di Scienze Preistoriche* 4: 162.
Cafici, C.	1915	Stazioni preistoriche di Trefontane e Poggio Rosso in territorio di Paterno. *Monumenti Antichi Lincei* 23: 486.
Cafici, C.	1920	La stazione neolitica di Fontane di Pepe (Belpasso). *Accademia di Scienze, Lettere e Belle Arti di Palermo* 12: 3.
Calci, C.	1978	Insediamenti neolitici nella provincia di Catanzaro. *Antiqua* 3: 36.
Calvi-Rezia, G.	1971	Rapporti fra Toscana e Sicilia durante il neolitico a ceramica impressa. *Atti della XII Riunione Scientifica*. Istituto Italiano di Preistoria e Protostoria. Florence.
Cann, J. R. and Renfrew, C.	1964	The characterisation of obsidian and its application to the Mediterranean region. *Proceedings of the Prehistoric Society* 30: 111.
Cardini, L.	1970	Praia a Mare: relazione degli scavi 1957-1970. *Bullettino di Paletnologia Italiana* 79: 31.
Cavalier, M.	1971	Il riparo della Sperlinga di S. Basilio (Novara di Sicilia). *Bullettino di Paletnologia Italiana* 79: 7.
Cornaggia Castiglioni, O. Fussi, F. and D'Agnolo, M.	1962-3	Indagini sulla provenienza dell'ossidiana in uso nelle industrie italiane. *Atti della Società Italiana di Scienze Naturali e del Museo Curcio di Storia Naturale in Milano* 102: 310.
Costabile, F.	1972	La stazione neolitica di Prestarona in Comune di Canolo. *Klearchos* 14: 5.
Coulon, C.	1971	La genèse du massif rhyolitique du Mt. Traessu (Sardaigne septentrionale): évolution de son dynamisme volcanique. *Bollettino della Società Geologica Italiana* 90: 73.
Courtin, J.	1967	Le problème de l'obsidienne dans le néolithique du Midi de la France. *Rivista di Studi Liguri* 33: 93.
Courtin, J., Hallam, B. R., Warren, S. E. and Williams, O.	1976	The obsidian trade in prehistoric Southern France. *IXth Congress of the International Union of the Pre- and Proto-historic Sciences*. Nice. Section VI 2.
Diamond, G. P.	1974	A Study of Microscopic Wear Patterns on the Chipped Stone Artifacts from the Neolithic and Bronze Age Levels at Knossos. Unpublished PhD thesis, University of London.
Diamond, G. P.	1979	The nature of so-called polished surfaces on stone artifacts. *In* B. Hayden (ed.) *Lithic Use-Wear Analysis*. New York.
Dixon, J. E.	1976	Obsidian characterization studies in the Mediterranean and Near East. *In* R. E. Taylor (eds.) *Advances in Obsidian Glass Studies*. Park Ridge, New Jersey.
Dixon, J. E., Cann, J. R. and Renfrew, C.	1968	Obsidian and the origins of trade. *Scientific American* 218: 38.
Evans, J. D.	1971	*The Prehistoric Antiquities of the Maltese Islands*. London.
Evans, J. D.	1977	Island archaeology in the Mediterranean: problems and opportunities. *World Archaeology* 9: 12.
Fairbridge, R. W.	1976	Shellfish-eating preceramic indians in coastal Brazil. *Science* 191: 353.
FAO	1967	*Guidelines for Soil Profile Description*. Rome.
FAO-UNESCO	1974	*Soil Map of the World at 1:5,000,000*. Volume 1, Legend. Paris.
Flanagan, F. J.	1973	1972 values for international geochemical reference samples. *Geochimica et Cosmochimica Acta* 37: 1189.
Franco, S.	1968a	La tecnica vascolare dello stile di Stentinello. *Sicilia Archeologica* 4: 51.
Franco, S.	1968b	*La Civiltà Preistorica Etnea*. Museo Archeologico del Castello Normanno. Adrano, Sicily.
Godelier, M.	1977	'Salt money' and the circulation of commodities among the Buruya of New Guinea. *In* M. Godelier (ed.) *Perspectives in Marxist Anthropology*. Cambridge.
Guerreschi, G.	1967	Tecnologia e decorazioni della ceramica pre e protostorica. *Sibrium* 9: 339.
Hallam, B. R. and Warren, S. E.	1973	Neutron activation analysis of pre-Chalcolithic Western Mediterranean obsidians. *Proceedings of the International Conference on Nuclear Physics*, Munich, Paper 10.5: 718.
Hallam, B. R., Warren, S. E. and Renfrew, C.	1976	Obsidian in the Western Mediterranean: characterisation by neutron activation analysis and optical emission spectroscopy. *Proceedings of the Prehistoric Society* 42: 85.

Harding, T. G. 1967 *Voyagers of the Vitias Strait.* Seattle.

Hay, C. A. 1977 Use-scratch morphology: a functionally significant aspect of edge damage on obsidian tools. *Journal of Field Archaeology* 4: 491.

Hayden, B. (ed.) 1979 *Lithic Use-Wear Analysis.* New York.

Hunter, R. 1975 Neutron activation analysis of St. Neots type ware. Unpublished MA dissertation, University of Bradford.

Jarman, H. E. and Bay-Petersen, J. L. 1976 Agriculture in prehistoric Europe - the lowland. *In, The Early History of Agriculture.* Philosophical Transactions of the Royal Society of London. Biological Sciences, 275.

Jarman, M. R. and Webley, D. 1975 Settlement and land use in Capitanata, Italy. *In* E. S. Higgs (ed.) *Palaeoeconomy.* Cambridge.

Katz, A. and Grossman, L. 1976 Intercalibration of 17 standard silicates for 14 elements by instrumental neutron activation analysis. *In* F. J. Flanagan (ed.) *U.S.G.S. Professional Paper 840.*

Keeley, L. H. 1980 *Experimental Determination of Stone Tool Use.* Chicago.

Keller, J. 1967 Alter und Abfolge der vulkanischen Ereignisse auf den Aeolischen Inseln (Sizilien). *Berichte Naturforschende Gesellschaft Freiburg* 57: 33.

Kendall, M. G. and Stuart, A. 1969 *The Advanced Theory of Statistics. Vol. 1. Distribution Theory.* London. 3rd edition.

Köppen, W. 1936 Das geographisches System der Klimate. *In* W. Köppen and R. Geiger (eds.) *Handbuch der Klimatologie.* Band 1. Berlin.

La Geniere, J. 1979 The iron age of southern Italy. *In* D. Ridgway and F. R. Ridgway (eds.) *Italy before the Romans.* London.

Lewestein, S. 1981 Mesoamerican obsidian blades: an experimental approach to function. *Journal of Field Archaeology* 8: 175.

Maggi, R. 1976 Gli scavi nelle Stufe di San Calogero sul Monte Kronio (Sciacca) e i rapporti fra la Sicilia e Malta durante il neolitico. *Kokalos* 22-23: 510.

Mörner, N. A. 1971 Late Quaternary isostatic, eustatic and climatic changes. *Quaternaria* 16: 65.

Muñoz, A. M. 1965 *La Cultura Neolitica Catalana de los Sepulcros de Fosa.* Barcelona.

Munsell, 1954 *Munsell Soil Color Charts.* Baltimore.

Odell, G. H. 1977 The Application of Micro-wear Analysis to the Lithic Component of an entire Prehistoric Settlement: Methods, Problems, and Functional Reconstruction. Unpublished PhD dissertation, Harvard University.

Ogniben, L. 1973 Schema introdottiva alla geologia del confine Calabro Lucano. *Geologia Romana* 8: 453.

Orsi, P. 1890 Stazione neolitica di Stentinello (Siracusa). *Bullettino di Paletnologia Italiana* 16: 177.

Orsi, P. 1916 Curinga (Prov. di Catanzaro): Tesoro di monete greche archaiche rinvenute nel territorio del Comune. *Notizie degli Scavi*: 186.

Perlman, I. and Asaro, F. 1969 Pottery Analysis by neutron activation. *Archaeometry* 11: 21.

Phillips, P. 1975 *Early Farmers of West Mediterranean Europe.* London.

Pichler, H. 1967 Neue Erkentnisse über Art und Genese des Vulkanismus der Aeolischen Inseln (Sizilien). *Geologische Rundschau* 57: 102.

Pirazzoli, P. A. 1976 Sea level variations in the northwest Mediterranean during Roman times. *Science* 194: 519.

Remmelzwaal, A. 1978 *Soil Genesis and Quaternary Landscape Development in the Tyrrhenian Coastal Area of south-central Italy.* Publikaties Fysisch Geografisch en Bodemkundig Laboratorium, University of Amsterdam, 28. Amsterdam.

Renfrew, C. 1977 Alternative models for exchange and spatial distribution. *In* T. K. Earle and J. E. Ericson (eds.) *Exchange Systems in Prehistory.* New York.

Renfrew, C., Dixon, J. E. and Cann, J. R. 1968 Further analysis of Near Eastern obsidians. *Proceedings of the Prehistoric Society* 34: 319.

Salvatori, S. 1973 Materiali preistorici di tipo Stentinelliano da Capo Alfiere (Catanzaro). *Klearchos* 15: 29.

Semenov, S. A. 1964 *Prehistoric Technology.* London.

Soil Survey Staff 1975 *Soil Taxonomy. A Basic System of Soil Classification for Making and Interpreting Soil Surveys.* United States Department of Agriculture. Handbook 436. Washington DC.

Tinè, S. 1962a Scavi preistorici in Calabria (1870-1962). *Klearchos* 4: 7.

Tinè, S. 1962b Successione delle culture preistoriche in Calabria alla luce dei recenti scavi in provincia di Cosenza. *Klearchos* 4: 38.

Tinè, S. 1964a Il neolitico in Calabria alla luce dei recenti scavi. *Atti delle VIII e IX Riunione Scientifica.* Istituto Italiano di Preistoria e Protostoria. Florence.

Topa, D. 1927 *Le Civiltà Primitive delle Brettia*. Palmi. 2nd edition.

Tringham, R. E., Cooper, G., Odell, G., Voytek, B. and Whitman, A. 1974 Experimentation in the formation of edge damage: a new approach to lithic analysis. *Journal of Field Archaeology* 1: 171.

Trump, D. H. 1966 *Central and Southern Italy before Rome*. London.

Tusa, S. 1977 La ceramica preistorica della Grotta dell'Uzzo. *Kokalos* 22-23: 798.

UNESCO-FAO 1963 *Bioclimatic Map of the Mediterranean Zone*. Arid Zone Research, 21. Paris.

Wagner, G. A., Storzer, D. and Keller, J. 1976 Fission track dating of quaternary volcanic glasses from the Mediterranean. *Neues Jahrbuch für Mineralogie, Monatshefte* 2: 84.

Warren, S. E., Williams, O. and Nandris, J. 1977 The sources and distribution of obsidian in Central Europe. International Conference on Archaeometry and Archaeological Prospection, University of Pennsylvania.

Washington, H. S. 1920 The Rhyolites of Lipari. *American Journal of Science*, 4th series, 300: 446.

Whitehouse, R. 1969 The neolithic pottery sequence in southern Italy. *Proceedings of the Prehistoric Society* 35: 267.

Wright, G. A. 1969 Obsidian Analysis and Early Trade in the Near East: 7,500-3,500 BC. Unpublished PhD dissertation, University of Michigan.

Wright, H. and Zeder, M. 1977 The simulation of a linear exchange system under equilibrium conditions. *In* T. K. Earle and J. E. Ericson (eds.) *Exchange Systems in Prehistory*. New York.