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Overton Down Experimental Earthwork, Wiltshire 1968

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GEOMORPHOLOGY OF THE DITCH SECTION

ABSTRACT. The ditch section of the Overton Down experimental earthwork provides a dated record of the degradation of two free faces with opposing aspects. The earthwork constructed in 1960 was excavated in 1968 and a record of the geomorphology of the ditch section is given. A detailed description and mechanical analysis of the ditch deposits is given as a basis for a discussion on the processes leading to asymmetrical infilling. The significance of falling turves in breaking the stratigraphy of the deposits is noted.

The construction of the Overton Down Earthwork with a ditch section through chalk and its subsequent excavation at periodic intervals during the last eight years provides an opportunity to investigate the processes leading to the infilling of such a ditch.

The earthwork was constructed in the Upper Chalk. The site (SU413170) is at 760 feet above O.D. about 4 miles N.W. of Marlborough. There is a surface slope of approximately 2·5° in a direction of 250° from north. The soil profile as described by Dimbleby (in Jewell, 1963) is that of a rendzina with up to five inches of stone free soil overlying a thin layer of nodular or patinated flints, above some eight inches of rounded, weathered chalk rubble. Beneath this is the weathered chalk extending to unweathered chalk at about twenty inches from the surface.

The ditch was constructed in the summer of 1960 with the following dimensions:

Length: 93 feet (base 68 feet)
Depth: 5 feet 9 inches (9 inches topsoil).
Width: 10 feet at top; 8 feet at base.

The stated accuracy of construction is given as to within one inch, although occasional greater deviations may occur in the ditch where a solid flint or chalk block projected or was excavated in error (Jewell, 1963).

The excavation of a section across the line of the ditch in 1968 permits a controlled study of slope recession and talus accumulation in the ditch over a period of eight years to be made. The theoretical aspects of these processes are discussed by Jewell (1963). He notes that Fisher (1888) described how material falling from an abandoned quarry face collected as scree or talus at the base of the cliff. The scree protected the cliff from further weathering as it steadily accumulated. The original straight cliff evolves into a curved slope, recession continuing until the whole face is protected by a talus cover. In practice other weathering agencies (e.g. solution) will be active so that even the 'protected' face may be subject to some erosion.

The ditch orientation is north-west to south-east and hence the two faces of the ditch face respectively north-east and south-west. Aspect is likely to be a major factor in any discernible differences in scree accumulation at the foot of the two faces. The lithology of the two faces is considered to be similar. The Upper Chalk at the site has a regional dip of about 2° in a S.S.E. direction (i.e. almost at right angles to the land surface slope and about 15° towards south of the orientation of the ditch). The net result is that the dip of the chalk in the exposed faces is virtually identical on both sides of the ditch.

In the initial exposure the depth of weathering was the same on both faces of the ditch. A feature of this initial state will have been that during ditch construction, blocks will have been disturbed and broken, and hence the first fragments dislodged and forming the talus slope are likely to be smaller in size than later fragments. This is illustrated in fig. 38. A second feature also indicated diagrammatically in fig. 38 is that as the chalk blocks are larger in size at depth where they are unweathered, then as the talus slopes protect more of the lower portions of the 'cliff' face, the size of the supply material is likely to decrease.

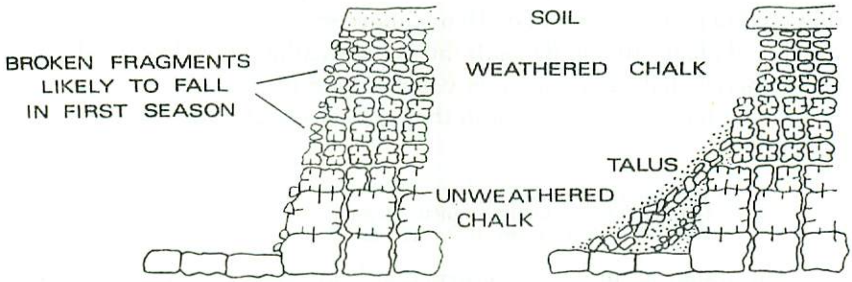

Fig. 38

In examination of the section, the distinct alternating layers of coarse and fine chalk rubble noted by Jewell and Dimbleby (1966) were plainly visible in the scree. Fig. 39 is based on the field drawing compiled by P. J. Fowler and the author in 1968. On the north-east facing slope, some five distinct coarser layers were discernible, separated by lines of finer

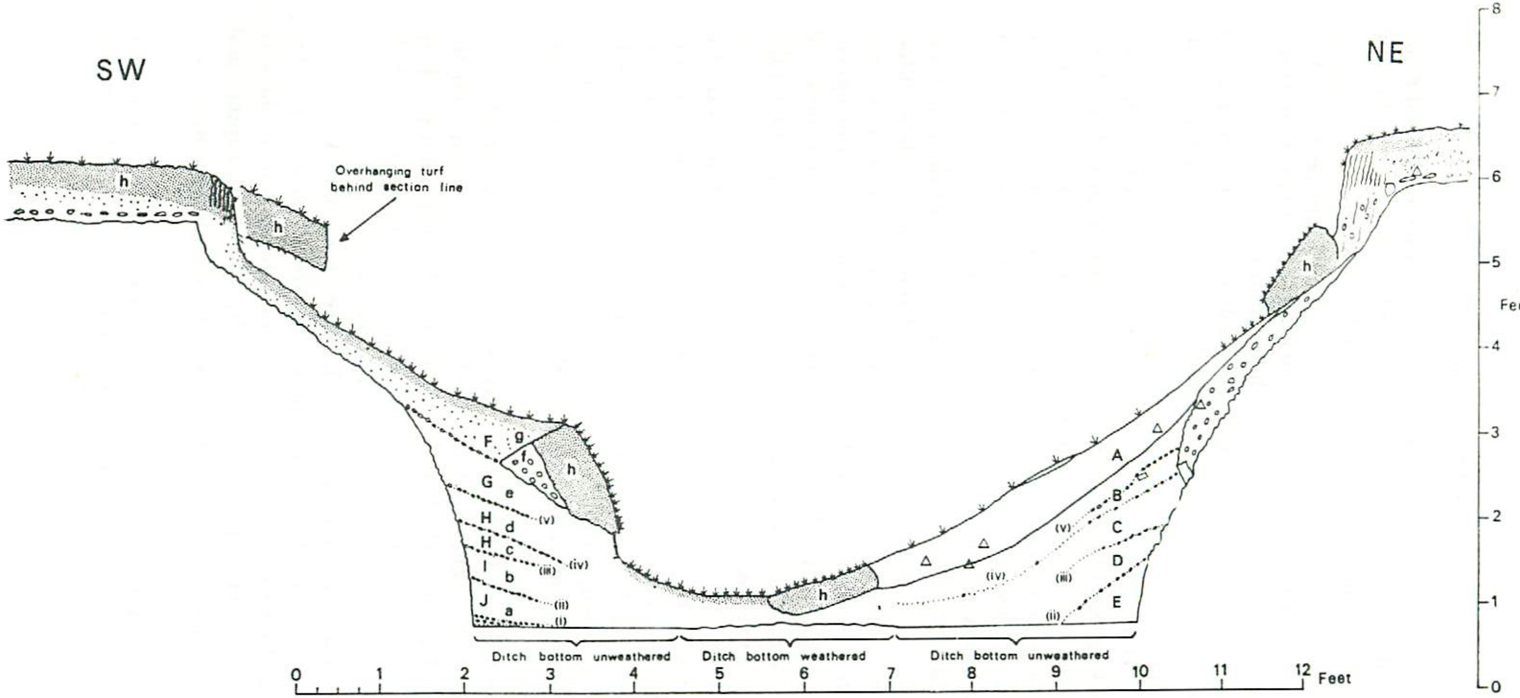

Fig. 39
Section through the ditch at pole VI, taken in July, 1968.

Key: A – J	Sample positions for the mechanical analyses.	f	humus and rounded chalk lumps
a	angular chalk blocks	g	humus stained angular medium sized chalk debris
b	larger chalk blocks	h	humus stained soil and turf
c, d	angular chalk blocks plus weathered material	i – v	humus stained fine debris
e	some cementation of debris		

material with humus staining. Overlying all this was much finer material, humus stained throughout but still showing some signs of stratification parallel to the slope. Samples were taken from the sites marked by letters A–G on fig. 39 in 1968 in order to obtain some data on the particle sizes within the layers. Only the coarser band materials were sampled, and only small (about 1 Kg) samples were taken. The normal methods of mechanical analysis were not possible because of the fragile nature of the chalk and so the material was gently hand sieved, at field moisture state. The results are given in Table 1.

Before considering the results, it is useful to take account of the descriptions given by Jewell and Dimbleby (1966) of the appearance of the ditch at six separate occasions during the first four years. The first, relatively mild winter resulted in scree extending 10–12 in. up the face and 24 in. across the floor of the ditch on either side. The description of the deposits was as follows: "The lowest level, resting on the chalk floor consisted of a sprinkle of dark soil, derived from the topsoil at the lips of the ditch. Above this the major part consisted of fine chalk rubble interspersed with soil crumbs. Only the top-most 1–2 in. was of coarse clean chalk fragments presumably detached by occasional frosts during the early months of 1961." After the first summer a further 3 in. of rubble had been added to the ditch, indicating slow disintegration of the ditch sides during the summer months.

The following winter was also mild but the rate of infilling was greatly accelerated. The scree had reached a vertical height of 36 in. and undercutting of the turves was occurring. Jewell and Dimbleby point out that the amount of undercutting was not materially greater on the north-east (weather) face than on the south-west (sheltered) face. Some turves fell in the following winter, by which time the lower margins of the screes had coalesced.

The severe winter of 1962–3 resulted in a large number of turves falling into the ditch, some reaching the base and some resting on the slopes forming a barrier to the falling scree material which then piled up behind them. In March 1963 the scree was 12 in. from the top of the chalk surface but 16 months later it was 14 in. from the surface, indicating some compaction or downward movement of the scree material. Actual new material accumulating in the severe winter was very much less than that of the previous mild winters. This in part was undoubtedly due to the very much reduced free-face exposed to erosion by the third winter, and possibly also due in part to prolonged frost and possible protection by snow drifts.

In 1968, the general appearance of the ditch was very similar to that in 1964. The talus slope is now up to soil level and no free chalk is exposed, On the talus slope there is only a minor amount of colonisation by vegetation, and this is primarily associated with the fallen turves.

The section drawing and the particle size analysis show that infilling has occurred slightly asymmetrically, that the particle size differs with the aspect, and that the rate of accumulation has varied over time. The causes of these phenomena may now be considered.

The lithology has already been taken as uniform and the significance of the weathered surface horizons in relation to particle size has already been mentioned. Vegetation is often considered a factor of importance in the production of asymmetric valleys, but as yet higher vegetation has not colonised the talus slopes to any extent. Dimbleby (1966) has recorded the rapid formation of an algal (*Cyanophyceæ*) mat at about 1 in. below the surface of the bank material, in the bank constructed adjacent to the ditch. A similar algal mat does not appear to be present in the talus layers.

Aspect must be taken as one key factor in the production of asymmetrical infills, though Ollier and Thomasson (1957) point out that there is considerable debate as to whether increased erosion results in steepening or decline of a slope. In the Chilterns Ollier and Thomasson (1957) found that the original chalk surfaces had been weathered asymmetrically and this had been further accentuated by later deposition. They concluded that there was a possibility that the Chiltern valleys were in part relics of a former periglacial or interglacial period. In general the steeper slopes were to be found on the south and west facing sides.

The mechanical analysis data (Table 1) and the section drawing (fig. 39) show that it is the south-west facing slope which in general has the finer material and the lower angle of rest. Samples E and J and samples D and I represent the first and second winter accumulations. In both cases the second year's material is coarser than the first year. A possible explanation for this was mentioned in connection with fig. 38. However, comparing the slopes year by year, it is the north-east facing slope which has the coarser material in the first year and the opposite slope which has the coarser material in the second year. Assuming that this really was the situation and that subsequent breakdown of the material has not occurred, then the explanation of the phenomenon may lie in one of two directions: there might be a limited amount of coarser material and that if much of this falls in the first year then finer material will fall in the second year. Alternatively the balance of processes affecting erosion of the exposed chalk face may vary from year to year.

The second possibility is the more likely reason and is deserving of more consideration. Aspect leads to variations in insolation and of rain-beat and wind. Dealing with the latter first, the predominant wind direction (as indicated by the wind rose diagram in the Atlas of Britain)

TABLE I

SAMPLE CODE	A			B			C			D			E		
	gms	%	Cum %	gms	%	Cum %	gms	%	Cum %	gms	%	Cum %	gms	%	Cum %
> 1½″	0	—	—	0	—	—	0	—	—	628.1	50.3	50.3	146.5	12.3	12.3
3/4 — 1½″	0	—	—	58.1	5.9	5.9	100.5	11.9	11.9	386.5	31.0	81.3	409.9	34.5	46.8
3/8 — 3/4″	132.7	17.8	17.8	288.95	29.2	35.1	238.8	28.2	40.1	100.5	8.0	89.3	358.1	30.1	76.9
3/16 — 3/8″	150.5	20.2	38.0	292.0	29.5	64.6	245.6	29.0	69.1	66.3	5.3	94.6	146.0	12.3	89.2
< 3/16″	463.3	62.0	100.0	349.7	35.4	100.0	262.6	30.9	100.0	67.2	5.4	100.0	127.8	10.8	100.0
TOTAL	746.5	—	—	988.75	—	—	847.5	—	—	1248.6			1188.3		

(These samples are from the south-west facing slope)

SAMPLE CODE	F			G			H			I			J		
	gms	%	Cum %	gms	%	Cum %	gms	%	Cum %	gms	%	Cum %	gms	%	Cum %
> 1½″	0	—	—	0	—	—	606.5	46.5	46.5	394.7	27.0	27.0	378.8	25.9	25.9
3/4 — 1½″	179.2	16.9	16.9	361.2	35.8	35.8	271.8	20.8	67.3	509.4	34.8	61.8	425.0	29.0	54.9
3/8 — 3/4″	442.7	41.8	58.7	189.2	18.8	54.6	136.5	10.5	77.8	257.1	17.6	79.4	338.0	23.1	78.0
3/16 — 3/8″	134.8	12.7	71.4	117.5	11.7	66.3	103.0	7.9	85.7	121.3	8.3	87.7	135.6	9.3	87.3
< 3/16″	303.4	28.6	100.0	340.1	33.7	100.0	187.4	14.4	100.1	179.7	12.3	100.0	186.0	12.7	100.0
TOTAL	1060.1	—	—	1008.0	—	—	1305.2	—	—	1462.2	—	—	1463.4	—	—

(These samples are from the north-east facing slope) and the predominant rain direction is from a westerly or south-westerly direction. In a rock as susceptible to mechanical action in the form of rainbeat as chalk one might expect there to be much more mechanical action on the south-west facing side compared with the opposite side. This factor alone might account for the differences in particle size of the two talus slopes. On the adjacent bank section, Jewell and Dimbleby (1966) noted the breakdown of material so that after four years bank material to a depth of 3 in. had been broken down to particles less than 1·5 in. in diameter. On the bank with slopes of only 30° no differences in the depth and form of the weathering were discernible between the two aspects.

The effect of insolation is more difficult to assess. In the case of chalk, freeze-thaw action and alternate wetting and drying are probably the two other major forms of mechanical breakdown. It is the south-west facing side which will receive the greatest insolation and hence might be expected to suffer more drying out than the north-east facing side. The result of this would be to increase the rate of supply of material to the south-west facing talus slope and to reduce the overall particle size of that material. Coupled with mechanical rainbeat, the south-west facing talus slope might be expected to be composed of finer material having a lower angle of rest and to be eroding back further into the original chalk surface compared with the north-east facing slope. The general appearance of the material in the section (fig. 39) is in keeping with this.

Freeze-thaw processes are, in temperate latitudes such as Britain, normally regarded as being more active on north and east facing slopes than on south and west facing slopes. However, this is really dependent upon the exact local climatological conditions. Under prolonged frost conditions during the winter, direct insolation from the sun may raise temperatures across the thawing point more frequently on the south and west facing sides. Furthermore, under such conditions snow lie may be more effective on the north-east facing slope. Hence under certain conditions one might expect the amount of erosion to be greater on the south-west facing side due to freeze-thaw action as well as to other mechanical processes already considered. As the ditch infilled the mechanical action would be confined more and more to the breakdown of already dislodged blocks of chalk, rather than to unweathered chalk and hence one expects a general decrease in particle size up the profile.

Looking at the results of the mechanical analysis then it is possible to suggest that in the second winter more coarse debris fell on the south-west facing side than on the north-east facing side and that this may be interpreted as indicating that freeze-thaw action was probably greater on that side during that winter and spring, while the other forms of mechanical erosion were less significant than they were in the preceding or succeeding years. In future years it will be instructive to note how much weathering and compaction takes place below the present surface, now that coarse material is no longer supplied to the talus slopes.

A feature not considered so far, is the actual surface area and angle of free face available each year for mechanical action. This varies with time as the scree extends up the slope and also with the gradual reduction in angle of the chalk slope. Since the infilling and the erosion is asymmetrical, then the area also varies with aspect after the first year. The decline in the amount of erosion in the later period is indicated by the flexing of the curve near the top of the section as seen in fig. 39. This may well have been due to some protection of the surface layers by the overhanging turves. Overall the south-west facing slope retreated and became shallower in angle more rapidly than the north-east facing slope, a feature further emphasised by the finer debris of the talus slope on this side and its consequent lower angle of rest.

At the base of the ditch the present width is 7 feet 10½ inches which is very close to the original 8 feet. The decrease in width may be due to some expansion of the *in situ* chalk following excavation of the ditch. The contact face was noticeably moister than the chalk infill. The floor of the ditch was smooth except for the central 2½ feet which did show some signs of weathering. This was the part open to the atmosphere until the end of the first two years. A fine deposit of chalk mud was present across the base of the ditch. Solution activity is probably negligible because water reaching the base of the ditch is probably already fully charged with calcium bicarbonate.

A feature of interest on the section (fig. 39) is the part played by fallen turves in preventing normal sequential accumulation down slope from the resting site of the turf, until the turf itself is overtopped by falling talus. Also a large chalk block weathering out of the south-west facing side, formed a similar barrier to down slope movement of angular debris.

The Overton Down ditch section described above, probably poses more doubts and questions than it answers on the interpretation of sections in geomorphology and archæology. The complexity of the stratigraphy after only eight years suggests the need for extensive excavations of archæological sites if stratigraphy is to plan a major part in interpretation.

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