The study of land-forms in the school

G.B. Mackie M.A.

To cite this article: G.B. Mackie M.A. (1915) The study of land-forms in the school, Scottish Geographical Magazine, 31:1, 23-34, DOI: [10.1080/14702541508555182](https://doi.org/10.1080/14702541508555182)

To link to this article: <http://dx.doi.org/10.1080/14702541508555182>

Published online: 30 Jan 2008.

Submit your article to this journal [↗](#)

Article views: 4

View related articles [↗](#)

THE STUDY OF LAND-FORMS IN THE SCHOOL.

By G. B. MACKIE, M.A.,
English Master, Bathgate Academy.

(*With Diagrams and Sketches.*)

It is now more than a decade since Geography began to receive a fuller share of attention in the best of our secondary schools. Several years ago even a number of rural schools possessed a plane-table and a few other simple surveying instruments. It is to be feared that after these had lost their novelty they were in too many cases relegated to the lumber-room, and a large number of schools never went further in practical work than a survey of the school buildings and the playground. There is at least one text-book entitled *Practical Geography* that confines itself exclusively to cartography and surveying. In most cases where more practical work has been done, it has been confined to biological excursions.

I propose to show that there is a wide field for further practical work in Geography at present lying fallow. In the main, what I have to say will be an explanation of my own efforts to cultivate this field. Having held appointments in widely separated districts in Scotland, I am in a position to assert that there is no fairly well-populated area where opportunities for the work are absent. Of the multitude of these opportunities I shall have more to say presently.

There is no more fascinating branch of geographical science than the history of land-forms. Few other subjects in the curriculum make so direct an appeal to the child's love for the strange and the wonderful. The common objects of the countryside—hill and valley and stream—acquire a new and undreamt-of significance when they have their place assigned to them in the marvellous scheme of change that alters the face of the earth. To the teacher who has the power of making this revelation, access to actual examples becomes an imperative necessity.

Even under present conditions, I have no sympathy with the plea that there is no time for work of this kind. Time can always be found for work that we are determined to do. Bound down by the most arduous of curricula—that of junior students—I have found time for all that I mention here, and more. With reference to the whole-day excursion, I have never failed to obtain His Majesty's Inspector's permission in the summer session, after the oral examinations are completed; and it is only at this period that such an excursion is possible.

What is the scope of school geomorphology? In addition to the history of the commonest land-forms carried to a point in detail in proportion to the average age and capacity of the pupils or students, it should include at least a superficial explanation of all the features found within a radius of, say, two miles of the school. This will no doubt involve some difficulties, especially if the district has not come within the survey of a capable geologist; but there are few parts of Scotland that have

not been examined by the brothers Geikie, and their books, especially *The Scenery of Scotland* and *Earth Sculpture*, contain what for school purposes is an inexhaustible store of material. It is true that there are formations (*e.g.* kames¹) for which there is no adequate explanation; but conjecture will add to, rather than detract from, their interest, and will certainly stimulate the obtaining of our chief objective—first-hand explanation.

I propose, then, to deal first with practical work in the immediate neighbourhood of the school, if possible within the school precincts, afterwards to describe, and to make suggestions for, excursions farther afield.

Little apparatus is necessary, and much of that little can be constructed by the pupils themselves. The majority of secondary schools possess a plane-table, a prismatic compass, and a surveyor's chain. Most essential for our present purpose is the six-inch Ordnance Survey map of the district, from which those students who have taken a course in woodwork can construct a relief model. The scale is such that, for most districts, the relief will be sufficiently marked if the vertical scale is approximately double the horizontal. The construction is simple, and is performed in the following manner.²

Let the lowest point on the map be between 400 and 500 feet above sea-level, the highest between 1000 and 1100 feet. (These are the actual heights for the district around Bathgate Academy.) Six contour lines will therefore appear on the map, all of the same vertical interval—100 feet. The first thing necessary is a stout board similar to a drawing-board and of the same area as the Ordnance Survey map. It should be slightly more than an inch thick, so that the surface on which it rests may represent sea-level. From the Ordnance Survey map the contour lines are drawn on tracing-paper; these are then transferred to laminae of wood $\frac{1}{4}$ -inch thick, which are cut out along the traced lines, the resulting edges representing the contours. The lamina or laminae for the 500 ft. contour are then nailed or glued to the board; on these are placed those for 600 ft., and so on. The model is now ready to receive its coating of plasticene, which may be green or brown. This process will take some time, because, while the coating is being laid on, visits must be made to the actual ground to note the more prominent under-features, and these will be indicated by manipulation of the plasticene. This is not absolutely necessary, unless the model is destined for use in connection with excursions. I show streams by bands of silver paper, roads by thin twine, railways by black thread, and woods by stippling; but so many methods will suggest themselves, that the representation of such features may safely be left to individual taste. My own model, for which the vertical scale was double the horizontal, unfortunately received irreparable damage³ and has been destroyed. I

¹ But on these see Bonney's *Ice-work*.

² Cf. the method described by Mr. J. A. M'Michael for $\frac{1}{2}$ -inch maps in the *Geographical Teacher* for Spring 1909. Obviously, for such a scale, my method would involve far too much labour and time.

³ Unless great care be taken, the plasticene, for one thing, soon becomes dirty, and all the methods of cleaning I have attempted have failed.

intend next summer to construct another more restricted in area (probably four square miles) and with a more exaggerated vertical scale, in order

FIG. 1.—Rise of consequent streams in school playground.

FIG. 2.—Rise of subsequent streams.

that it may indicate some detail in the land-forms. The area may be further restricted and the horizontal scale doubled or trebled, the contouring being done by pupils at V. I. 10 ft. If this process be continued,

we pass from a relief model to a concrete diagram. If time could be found for the necessary survey work, such a model would be a valuable addition to the field excursion.

Obviously, school geomorphology must concern itself mainly with the study of rivers, and fortunately there is everywhere abundant material for practical work in this connection. Most text-books refer to what can be seen in the drainage of every highway and byway. Here, in Bathgate Academy, we are especially fortunate, the playground representing, in an *ideal* way, most of the important developments in the history of a river system. (This in no way detracts from its utility in the purpose for which it was intended, because to the untrained eye there is little evidence of the story that is written on its surface.)

When the playground was constructed in 1833, owing to a steep frontage it had to be raised some fifteen feet at one end above the street, the opposite end being at street level, and the intervening surface horizontal. The material is earth, small stones, and probably a goodly proportion of ashes. There is a slight slope on an even surface from the Academy to the street.

Originally, then, when the first showers came, the state of the surface could not have been other than that represented in Fig. 1, a series of more or less equally powerful consequent streams, flowing practically straight from the buildings to the street drains. These would have been perfectly straight but for the numerous stones which were laid bare when the upper coating of soil was removed, and which were responsible for many of the numerous changes that followed. The relatively steep gradient and the trampling of thousands of feet prevented any great widening of the streams; and the trampling, in addition to forbidding any considerable deepening of the beds in consequence of the gradient, fortunately retarded all subsequent development.

The stage represented in Fig. 2 was not reached until after a lapse of ten years: the period may have been much longer. Wind-borne seeds, little trampling, and a deposit of fertile soil brought down by the streams, resulted in a growth of grass near the Girls' Gate. As this took root and passed gradually towards turf, it had far-reaching effects on the drainage of at least half of the playground. It acted, indeed, in much the same way as many an outcrop of hard rock in the development of rivers. Its roots tended to retain the adjacent soil, which resulted in a more normal gradient and the formation of a transverse barrier. Along the edge of this barrier arose the subsequent streams, *b'*, *c'*, at first puny, but growing in strength, while the main streams remained stationary. Gradually they cut back their headwaters until the stage shown on Fig. 3 was reached. Here the subsequent streams have captured the headwaters of *b* and *c*. Similarly, *g* has captured the drainage of *e* and *f*; *c'* is obviously making for a further conquest. The grass has now taken root firmly, and with the accumulation of sediment near the railing has lost some of its original gradient and stands up as a plateau, with a well-marked semi-circular escarpment. It still retains its beheaded streams, but its drainage is becoming incoherent and sluggish, as witness the various pools in heavy rain, for pretty much the same

reasons as that of the peripheral regions of a glacier. Little change is manifest in the remaining portion of the playground. The steep gradient

FIG. 3.—Stage of piracy of subsequent streams. Grass shown of lighter area.

FIG. 4.—Present stage of development. Rise of obsequent streams from grass patch.

discourages meandering, but the stones, which are mixed with the soil, cause slight deviations. The streams are so close together that in one of these they seem likely to fall foul of each other.

The present stage of development is shown in Fig. 4. The strong stream, of which the trunk has arisen from the subsequent tributary *a'*, now dominates the drainage of the south side of the playground, and clearly the development is still immature. *k* and *j*, in their meanderings, have fallen foul of each other, and *j* has captured the headwaters of *i*. The remainder of *i* is in process of annihilation. On the eastern side of the grassy tract, the slope, and consequently the streams, are now reversed, giving rise in heavy rain to the obsequent streams shown in the figure. The drainage of the tract is less incoherent, but sluggish.

Fig. 5 represents my conjectures as to the ultimate development. A glance will show that I have not attempted to say the last word; but the diagram represents an immense development from the featureless

FIG. 5.—Probable ultimate development of streams in playground.

consequent streams in Fig. 1. The stream having its outlet at the Girls' Gate has now captured the headwaters of *e*, *f*, and *g*. There is, indeed, no reason why *h'* should not encounter the same fate. The headwaters of *h* have been captured by *j*. Half the drainage of the playground now uses the outlet by the Girls' Gate, and the major portion is carried off by two widely-ramifying systems.

This description ought to suggest numerous other opportunities to be obtained in the immediate neighbourhood of the school. While far from unique, the playground of Bathgate Academy affords a scope not to be found in the concrete surface usually met with in distinctly urban institutions, but most localities offer individual opportunities, to be developed only by those who know them well.

While no more interesting, the whole-day excursion offers a considerable latitude; so much so, indeed, that geomorphology need form only

a small part of its activities. I make this excursion, in fact, bear upon the whole field of the geography I teach. It is a kind of intensive regional survey, and begins with the first wild-flower we meet by the wayside. Here, however, we are concerned only with its geomorphology. I propose to describe this aspect of an excursion taken by the junior students of Bathgate Academy to Breich on July 8, 1914.

A word first as to its range. Most secondary pupils have access to a cycle, and a twelve miles' ride—going and returning—will fatigue no healthy young person. A radius of six miles from the school must be the limit, however, if a tolerable amount of work is going to be covered.

FIG. 6.—Plane-table survey of part of the Woodmuir Burn as actually constructed in the field. The stakes (necessary as stations) ran along the escarpments of the valleys. The area is approximately a trapezium, and the line from Telegraph Pole No. 4 to the Gate is on the south side and runs from east to west.

A preliminary survey of the ground by the teacher is, of course, indispensable. Not that material is anywhere lacking. I have sought it in three counties—Fifeshire, Banffshire, and Linlithgowshire; and everywhere I have found choice difficult, so profuse and widespread is the material. These three counties may be taken as an epitome of Scotland—of the British Isles, for the matter of that—so what has been done there can be accomplished anywhere.

Although, as I have said, geomorphology is but a part of the work of the whole-day excursion, the actual site will, for obvious reasons, be chosen because of the interest of its sculpture. I selected a portion of the Woodmuir Burn between the main highway through West Calder, about two miles to the west of the town, and a byroad a quarter of a

mile to the north, because, on a nearly level tract, the burn was widening its valley by meandering, and a little lower down dashed through a gorge with precipitous sides, laying bare the rocks of the district.

The pupils worked in sections, and each was provided with the one-inch Ordnance Survey map. Those who had taken Higher Geography at the Leaving Certificate examination made a plane-table survey of the stream-valley in the forenoon (Fig. 6), while the others, after a brief lecture, constructed a diagram, showing the present state of the valley, afterwards making others to illustrate its history, anterior and posterior. Fortunately, within half a mile was another valley, that of Breich Water, where the process was to be seen completed: as perfect an example as I have found anywhere, representing almost ideal conditions (cf. Fig. 7). In addition to the diagrams, pupils with artistic gifts made water-colour sketches of both valleys. On the previous day a list of questions had been

FIG. 7.—Diagrams to show a river developing a flat by side cutting (after Davis).

Fig. 8 corresponds to the condition shown in II., Fig. 9 to that in III.

provided relating to individual research. Those having reference to the geomorphology of the district are ¹:—

1. Can the source of the stream be remote?
2. At what point would you imagine the source to be?
3. If the stream rose on the other side of the divide, where would its waters enter the sea?
4. Where do its waters enter the sea?
5. Have you in the course of your journey hither crossed a divide?
If the answer is in the affirmative, state your reasons.
6. Is the stream a main river or a tributary? If a tributary, into what river does it flow? Is that a trunk river?
7. Can you tell by examination what is the nature of the soil or rock over which the stream flows?

¹ Obviously some of the questions could be answered only by reference to the map. Some require merely a simple negative or affirmative. None need be completely baffling.

FIG. 8.—Diagram showing the Woodmuir Burn excavating a young valley. This stage was passed, of course, *before* the construction of the railway embankment. Cf. ideal Diagram II.

FIG. 9.—Diagrammatic representation of the present state of the burn. Cf. ideal Diagram III.

8. What elements in the soil (*a*) assist, (*b*) resist denudation?
9. Is there any evidence of (*a*) soil creep, (*b*) retention of soil by roots?
10. Make a section of the valley at what you consider the most interesting point. How would the section be altered if the neighbourhood were (*a*) devoid of vegetation instead of grass-grown, (*b*) solid rock?
11. Is the stream still lowering as well as widening its valley?
12. Examine the rate of flow of the stream. Of what part of a normal river's course is the velocity more or less characteristic? If the stream were many times wider and deeper, but of unaltered gradient, would it be suitable for navigation?
13. Examine the bed of the stream. Do you notice any pebbles? Do you see any movement of solid matter? If so, is the movement continuous or intermittent?
14. What evidences are there of animal life in or immediately above the water? How many species can you particularise and name?
15. Is the water clear or muddy? Why? If muddy, will it ever be clear? If clear, will it ever be muddy?
16. Is there any evidence in the neighbourhood of the existence of springs?
17. Is the stream valuable economically (*i.e.* could it be used for *e.g.* power, dyeing or brewing purposes, or water supply)?
18. What type of stream is it—consequent, subsequent, or obsequent?
19. Did it originate in a gully?
20. Is there any evidence in the neighbourhood of the existence of gullies? If so, what can you gather as to their history, past, present, and future?
21. Near the railway bridge on the right bank is a hanging valley. Why does it hang?
22. What is likely to be the effect of the bridge on the future development of the stream?
23. Prod the bed of the stream in several places. Account for the inequalities in its consistency.
24. Examine the course of the current, if necessary by floating sticks. Where is it strongest—(*a*) in the centre, (*b*) at the bank?
25. Can you discover any eddies? What effect have they had (*a*) on the banks, (*b*) on the bed?
26. Is there any evidence of actual or imminent river-capture?
27. In the immediate neighbourhood, is there any superficial evidence of the work of ice? If so, what is the evidence? If not, what, so far as you are aware, is the nearest point where such evidence is to be found?
28. Do you think the valley-bottom is above or below ground-water surface?
29. Why are there no waterfalls in the area under examination?
30. Which of the stream-built features are likely to be (*a*) most, and (*b*) least enduring? Why?

In mid-forenoon we cheered the King and Queen, as the royal train laboured up the steep gradient on its way to Glasgow (an incident not without geographical reference); and at midday a leisurely *al fresco* lunch followed the exertion of the morning. The afternoon was devoted to an examination of the course of the stream on the north side of the railway. Here the gradient is much greater, sufficient indeed to make the stream a torrent in times of flood. There is consequently much evidence of its destructive power. Where a slight turn in the course has made the stream bear against the bank, this suffers from an attack so resolute and persistent that it has become precipitous, and the rocks underlying the soil are laid bare. A typical example of such a face is shown in Fig. 11,

FIG. 10.—Diagram of portion of valley of Breich Water, of which the Woodmuir Burn is a tributary, showing the process of valley flat formation completed. Cf. ideal Diagram IV.

but no diagram can bring out fully the possibilities of such a formation. The construction of the diagram was part of the pupils' work, and the following remarks are an epitome of what I had to say with reference to the evidence. All deductions of course were attempted by the pupils, my function being merely verification. It is to be noted that the stream is not shown in the diagram. In the foreground is the low (alluvial) left bank; the face illustrated is on the right bank.

The whole stippled surface (A) is covered with screes, rock fragments, and weathered rock. In places these are sufficiently meagre to show the underlying rocks; and at all points they can easily be removed. The whole bank shows a terrace formation indicated at (B), although, the bank being very steep, this is at some points obscured by soil creep. Here and there the soft beds of shale are bent in the direction of this move-

ment. At a very few points on the stippled surface the waste is temporarily held together by small patches of grass, most of which appear to have been islanded from the surrounding turf. The rocks are much shattered by movement, pressure, weathering, and frost (2). At the point where the destruction has been greatest, they have collected as a pile of screes (3). In crevices and joints broom has taken root and is greatly assisting disintegration (1). The rocks consist of calciferous sandstone and shale, lying in alternate strata. Specimens were collected. Shale and sandstone are both of aqueous origin. Shale is an argillaceous rock, *i.e.* it is composed chiefly of clay, although there are other ingredients present. The customary fine fissile structure was here well marked. The calciferous sandstone is probably the calcareous ooze of an ancient sea, and the alternate strata suggest several uplifts and subsidences. Most sandstones weather into poor soil; shales produce clay soils of

FIG. 11.—Diagram of a steep bank of the stream denuded of its turf. For explanation of letters and figures see text.

greater average fertility, but in some cases they are heavy and difficult to work. Limestones, as a rule, produce very fertile soil. The mixture of calciferous sandstone and shale ought therefore to produce very fertile soil, and several excellent farms are, in fact, known to exist in the neighbourhood.

By the time this work was finished it was after three o'clock. It had been a hard, but perfect day.

The description of this excursion, which is itself but partial, will have shown that there is no difficulty in filling in the day; and, far from there being any necessity for padding, much must be left undone. Suggestions are, on the whole, unnecessary, since the scheme outlined broadens out naturally to any desired limits. Speaking generally, the most suitable site will be an excavation, natural or artificial—quarries (especially on hill-sides), railway cuttings (many disused cuttings exist in mining districts), excavations for the sand used in glass-making, stream-built features, etc.