

II.—*The New Geological Map of the Edinburgh District.\** By  
HENRY M. CADELL of Grange, B.Sc., F.R.S.E.

(Read 18th January 1894.)

THE publication in 1892 of the Second Edition of the Geological Survey Map of the Edinburgh District illustrates the progressive nature of geological science, and the continual advances that are being made in our knowledge of the rocks beneath us. When the first edition of sheet 32 was published in 1859, the Geological Survey of Scotland was in its infancy, and during the thirty-three years that have elapsed great additions have been made to our knowledge, both of the geological structure of the district and of the petrographical characters of many of the rocks included within its boundaries.

As a large part of the western division of the map between the Pentland axis and the Firth of Forth is deeply covered with drift, and the natural sections are not extensive enough to reveal the true nature of the complex stratigraphy of the district, it was in 1859 impossible to indicate with any certainty the correct structure of a great part of that area. Since then the discovery of productive oil shale and the rapid development of the paraffin oil industry has led to the opening up, by pits, mines, and mineral workings, of many districts whose structure would otherwise have still remained wrapped in their ancient darkness, impenetrable even to the searching eye of the geologist. Notwithstanding the thousands of borings and mineral workings, however, there is still a considerable tract of country west of the Pentland axis remaining to be deciphered, and this will fall to be done by some future geologist bent on handing on the lamp of truth and showing to a future generation that in geology, as in other branches of human knowledge, the goal of finality can never be perfectly attained to.

Beginning with the oldest rocks, which appear along the ridge of the Pentlands, we note several important changes on the map. These are due not to any newly exposed sections, but to improvements in the mapping and petrographical nomenclature

\* The original map was surveyed geologically by Mr Arch. Geikie, who worked on the Western area, and by Mr H. H. Howell, who mapped the Dalkeith Coalfield, and was published in 1859, Sir Roderick Murchison being Director-General and Mr A. C. Ramsay Local Director. The second edition was published in July 1892, after revision by Sir A. Geikie, F.R.S., H. H. Howell, B. N. Peach, F.R.S., J. S. G. Wilson, and H. M. Cadell, Sir A. Geikie being Director-General and Mr H. H. Howell Local Director.

of the massive rocks of the range. The rocks denoted as Felstones on the old map, and composing the greater part of the north-eastern end of the Pentlands, are now denoted Porphyrites and Andesites, while several of the more ashy spots are now recognised as volcanic necks—the plugged up pipes of old volcanos piercing the bedded lavas. Interbedded with the basic porphyrite lavas are a series of mere acid rocks consisting of rhyolites, trachytes, liparites and ashy beds, well exposed along the crests of Carnethy and Scald Law. At the base of these volcanic beds there is a great mass of conglomerates and sandstones now recognised as the base of the middle division of the Old Red Sandstone, resting in violent unconformability on the upturned edges of the Upper Silurian and Lower Old Red Sandstone core of the range. In Monksburn these basal conglomerates have a local thickness of nearly 2000 feet, and many of the overlying acid lavas have recently been found to show beautiful perlitic structure and well marked rhyolitic banding along their outcrops. The most conspicuous of the “necks” shown on the new map are those of the Braid Hills and Torduff reservoir, while the Black Hill, overlooking Threipmuir reservoir, is now shown as an intrusive mass of Felsite of pre-carboniferous age, piercing the Ludlow-Wenlock shales and cut off from the inter-bedded rhyolites on the south by a powerful fault.

The Lower and Middle Old Red rocks, with their volcanic series, are covered unconformably by the Upper Old Red Sandstone, which graduates upwards conformably into the base of the Carboniferous system. At some places, however, the Lower Carboniferous strata overlap the Upper Old Red sedimentary beds, and in the neighbourhood of Warklaw Hill rest directly on the volcanic series. As the basement beds of the Carboniferous system are also red and conglomeratic at places, it has often been a matter of opinion where the dividing line should be drawn, in absence of clear palæontological evidence on the point. The new map differs markedly from the earlier one in this respect, as it will be seen that a wide area of moorland at the S.W. end of the Pentland ridge which was formerly included in the Calciferous Sandstone series, is now relegated to the Upper Old Red, and at the north end of the range the red rocks at Liberton and in the district north and west of Morningside are included in the same formation.

With these modifications the general outline of the Carboniferous system remains comparatively unaltered, and the changes now to be noted are confined chiefly to the details of the individual beds, faults, and eruptive rocks in the Carboniferous area.



THE NEW GEOLOGICAL MAP OF THE EDINBURGH DISTRICT. 17

The Calcareous Sandstone series, situated between the Upper Old Red and the Mountain Limestone, includes in its upper part the economically important Oil Shale series. Before passing on to this, however, we may note that a great improvement has been made in the part of the map north of the Forth, which now includes in the Calcareous series a considerable part of Fife which was formerly regarded as of Carboniferous Limestone age. It was very difficult to understand the structure as explained by this part of the old map, since the strike of the rocks along the south shore westwards from Queensferry is, roughly speaking, north and south, and the boundary line of the Calcareous series could not well be drawn east and west down the centre of the Firth at right angles to the strike, without presupposing a very large fault of whose existence there is no clear evidence otherwise. It is, however, now made plain that the Calcareous series extends across into Fife, along a flat anticline, the continuation of that which is well exposed on the south shore below Hopetoun House.

The most important additions to the map are to be found in the triangular area between the Firth of Forth and Cobbinshaw reservoir, at the south-west corner of the sheet, within which the more important fields of oil shale are situated. A glance at the West Calder district shows how complicated the structure is in some localities. The rocks are not only very variable in thickness, but are bent about into multitudes of irregular folds, basins, and domes. These are in turn cut up in all directions by faults of varying dimensions, some of which run for miles across the country and extend westwards into the adjoining sheet, where their continuations may be followed into the coal-fields of Lanark and Linlithgowshire. It is a curious fact that immediately after we pass westwards beyond the boundary of sheet 32, into the Carboniferous Limestone series in sheet 31, we go out of this excessively "troubled" area, and for many miles the strata are found striking north and south and dipping steadily westwards with few important local variations, the only breaks in their outcrop being at those places where the strike of the beds is interrupted by the more powerful of the faults just referred to.

In the West Calder district the whole succession from the Burdiehouse or Camps estuarine Limestone may be traced upwards to the Hurler or Mountain Limestone, and it is within this zone that the majority of the workable oil shales have hitherto been found. A list of the seams of shale is given on the map, and several descriptions of the section of the oil shale group of the Calcareous Sandstone series have been published within the last few years from information derived from mining sections.

In the Broxburn and West Calder district the general section of the series, as published in a paper by me in the *Journal of the Iron and Steel Institute* for 1888, is as follows:—

	Ft.
Strata below the Hurlet Limestone, about	400
Raeburn's Shale 3 to 4 feet.	
Strata	190
Mungals Shale about 1 ft. 9 in.	
Strata	170
Coal and Grey Shale 2 feet.	
Strata, Houston Marl Group	200
Houston Coal and Shale 3 to 12 feet.	
Strata, usually laminated sandstones	240
Fells Shale 3 to 5 feet.	
Strata, Broxburn Marl Group	80 to 270
Broxburn Shale 2½ to 8 feet.	
Strata, including the Binny Sandstones	450
Dunnet Shale 6 to 13 feet.	
Strata, thickness imperfectly known, say	400
Barracks Shale, resting at places on the Burdiehouse, Camps, or Queensferry Limestone, thickness very variable.	
Strata about	780
Pumpherston Shales.	
Apparent approximate thickness of oil shale group	3100

These figures are only rough approximations, as the local variations in the thickness of the strata between the recognisable horizons are so great that it is impossible to draw up any general section applicable to an extensive area. At some places the shales which are elsewhere of economic value disappear as oil producers, and at others it is often a matter of great difficulty, in the absence of well-marked horizons, to identify the positions of some of the seams that are being mined. The Pumpherston Shales are, for example, apparently situated below the Burdiehouse Limestone, and are found cropping up round the crest of a very sharp steep anticlinal dome, on the west side of which a bed resembling the limestone has been traced in boring. In mining circles the position of this shale has given rise to much discussion, as the evidence for its geological position is by no means so clear as could be desired. The limestone outcrop shown on the map indicates a deep basin immediately to the west of Pumpherston Farm, the centre of which is occupied on the surface by a sheet of intrusive basalt, which at places cuts completely across the strata. The north end of the Pumpher-



THE NEW GEOLOGICAL MAP OF THE EDINBURGH DISTRICT. 19

ston shale outcrop approaches very near an outcrop of the Broxburn shale—a horizon situated, according to the section, upwards of 1600 feet higher up in the series, so that, in the short space of half a mile, we have to explain a juxtaposition of two widely separated seams. There is no clear evidence of an ordinary fault, and as the dip is not sufficient to dispose of all this thickness of strata, it seems that here there must either be a local unconformability, or what is more likely, a thrust plane such as are found in the classic thrust region of the north-west Highlands, and have been ascertained to exist in nearly all the areas of great geological disturbances that have been carefully investigated within recent years.

The seams of the Mid-Calder basin again, which are superficially isolated from any well-known beds, are now known to lie above the Camps Limestone, and may thus be approximately correlated with the shales of the Broxburn series.

At Broxburn the Camps Limestone does not appear at the surface, the outcrop of limestone shown on the old map having now been proved to be nothing but thin calcareous beds in the Broxburn Marl group, with which the true Burdiehouse Limestone has no connection whatever. The thin blue line on this part of the old map therefore disappears in the new edition, and it is thus clear that over a considerable area two perfectly distinct horizons have been originally confounded, to the complete mystification of the geological structure of the district.

Passing northwards through a complex mass of small basins and faults, we come to another of the great east and west faults, a small part of which was recognised when the original survey was made. This dislocation has now been traced for a distance of about nine miles from the shore at Dalmeny, past Craigton, and thence westwards to near the complicated mass of igneous intrusions below Binny Craig, where it seems to run out and disappear along the strike of the beds. The Craigton fault has a branch running north-westwards through Hopetoun wood towards Blackness, the course of both faults being clearly traceable from the position of the limestone and shales which they truncate at various places between Hopetoun and Queensferry. Few changes have been made in the part of the map embracing the coalfield at Bridgeness, the geology of which has been tolerably accurately known for many years.

One notable change is, however, to be seen in the mapping of many of the volcanic rocks. The isolated patches of ash shown on the old map are now nearly all known to be necks piercing the calciferous strata, and are mapped accordingly. The more conspicuous ash necks are those at Carriden, Binns Hill, Niddry, Ecclesmachan, and the vicinity of Parkly Craigs and the canal aqueduct at Linlithgow.

Two considerable changes are noticeable in the mapping of the eruptive sheets in the oil shale area. The first of these is in the district east of Murieston, on the Murieston and Linhouse Waters. On the old map the 'ridge of eruptive rock extending for about three miles eastwards from the Murieston limeworks, and forming the high ground of Corston Hill, is regarded as interbedded Felstone. This is now mapped as one of the older interbedded basalt rocks, situated a short distance below the Burdiehouse Limestone, and coming up along the shoulders of an anticlinal dome, which is cut off on the north-west by one of the large north-east faults. If this reading of the sections is correct, the trap must represent the top of an ancient ridge, against the steep west side of which the overlying strata have been deposited. There is no evidence of its existence immediately below the limestone on the west side of the fault. The latter rock here crops out at several places at high angles, and is apparently resting on a thick sedimentary series of beds, under which the trap must therefore within a very short distance, have become deeply buried. Further exposures may, however, clear up this somewhat doubtful point at some future date.

The other notable change is in the district west of the Pumpherston shale outcrop. The small patches of intrusive basalt shown on the old map have now been proved by numerous borings to be all parts of a thick sheet of trap extending continuously over several square miles between Uphall Station and Howden, and cutting at places completely across the strata.

Very little alteration has been made in the mapping of the Dalkeith coalfield, the boundaries of which are tolerably well defined. The chief change is in the separation of the limestones on the east into zones, and the addition of the oil shales at Straiton and Burdiehouse on the west. The shale series, which crops out in that limited belt east of the Pentland axis, is, as a whole, much thinner than the corresponding group on the west; but still there appears to be a general similarity in the succession, showing that the conditions favourable to the deposition of oil shale extended continuously over the site of what is now the Pentland ridge, thus leading us to the conclusion that new fields of oil shale may still be found throughout a considerable part of the district now included within this classic geological area.