it appears certain they must both have existed under similar circumstances; hence it would appear injudicious to come to conclusions with regard to physical conditions from the examination of a single set of remains.

In the preparation of this paper I have been assisted by the loan of specimens by my friend the Rev. P. B. Brodie, who is heartily thanked for this and other assistance; also by Mr. W. Binfield of Cheltenham, whose cabinet is rich in fossils from the lower lias limestones.

MAY 22, 1850.

The Hon. George Stephens Gough was elected a Fellow.

The following communications were read:—

1. *On a GAP in the GREYWACKE FORMATION of the EASTERN LAMMERMUIRS filled by OLD RED SANDSTONE CONGLOMERATE.*
By WILLIAM STEVENSON, ESQ.

[Communicated by Sir R. I. Murchison, V.P.G.S.]

THE occurrence of vast masses of conglomerate on both sides of the Lammermuir chain has been well known to geologists since the days of Hutton and Hall. It appears, however, never to have been suspected that the formations of the north and south sides were connected by a band of considerable breadth running completely across the chain from Doon Hill, about two miles from Dunbar, to the Hardens Hills, about the same distance west from Dunse.

The position, extent, and relations to the adjoining strata of this interesting formation of conglomerate will be best understood by reference to the accompanying sketch (see Map).

The whole district occupied by the greywacke, conglomerate, and trap rocks is almost uniformly hilly, the height of the hills ranging from about 800 to 1400 feet above sea-level, those composed of conglomerate being in general fully as high as those consisting of greywacke or igneous rocks. The tracts occupied by the strata of the old red sandstone and lower carboniferous formations are much lower and flatter, and generally rise no higher than 300 or 400 feet above the level of the sea.

The conglomerate occupies a trough in the greywacke, evidently the result of an ancient dislocation of great extent. At the margins it is seen overlapping the upturned ends of the greywacke strata, which are generally either vertical, or dip at angles of 45° or upwards, to about W.N.W., the dip being rather steeper on the east side of the conglomerate than on the west. The thickness of the mass of conglomerate towards its central parts cannot be readily ascertained, as the deepest ravines do not expose its base. In Shippith Glen it is seen to be several hundred feet thick; but even here there are no symptoms of the underlying greywacke. In regard to composition, it is pretty uniform, consisting chiefly of waterworn masses of greywacke, together with a few of speckled porphyry, and occasionally a

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- // Claystone Dykes.
 ■ Felspathic Trap.
 ▨ Augitic Trap.
 ▩ Old Red Sandstone.
 ▧ Greywacke.
 ▦ Conglomerate.
 ▤ Carboniferous.

- a.* Vertical. Strike N.E. by E.
 to N.E. by N.
b. Dip W.N.W. 45°.
c. Dip W.N.W. 45°.
d. Dip W.N.W. 45°.
e. Vertical. Strike N.E. by E.
 to N.E. by N.
f. Dip W.N.W. 60° or 70°.
g. Vertical. Strike N.N.E.
h. Vertical. Strike N.N.E.
i. Vertical. Strike N.N.E.

1. Luggate.
2. Presneman Hill.
3. Pitcox.
4. Thurston.
5. St. Denis Chapel.
6. East Aikengall.
7. Shippith Glen.
8. Bransly Hill.
9. Spartleton.
10. Monynut Water.
11. Eye River.
12. Herriot Water.
13. Redstone Rig.
14. Priestlaw.
15. Dye Water.
16. Watch Water.
17. Whin Rig.
18. Windshiel.
19. White Adder Water.
20. Whitechester.
21. Cockburn Law.

very few pebbles of quartz. The size of these fragments varies from that of peas up to blocks of a ton or more in weight, the general size being that of ordinary sea-shore shingle. These are frequently cemented by carbonate of lime, and in some instances by hæmatitic matter. Where the blocks are largest the cliffs in general readily crumble down, the masses being incoherent from want of a proper mixture of sand. Where the latter is in sufficient quantity, the result is a very hard and tenacious rock. All the materials of which the conglomerate consists appear to have been derived from the adjoining greywacke and porphyritic rocks, chiefly those lying to westward. The dip of the beds is almost invariably nearly E.N.E. at angles varying from 0° to 20° or 30° , and averaging perhaps about 10° . In one or two places, however, in the immediate vicinity of dislocations, the direction and amount of dip are considerably changed.

A remarkable feature connected with this formation of conglomerate is the occurrence therein of numerous veins or dykes of a species of claystone which has been poured from below, in a state of fusion, into fissures, which appear to have been opened during the elevatory process by the subjacent fluid matter struggling to obtain an outlet. This claystone is of a brown or drab colour, hard, and frequently very porous, apparently destitute of augite, but occasionally showing crystals of quartz and hæmatite, together with a little earthy chlorite. In the numerous ravines which intersect the conglomerate I have observed twenty-six of these dykes, and this is probably but a small part of the whole. (See map, in which the positions, and, as far as possible, the directions of some of these claystone dykes are laid down.) They strikingly resemble each other in almost every respect. The great majority are about 3 feet thick, but one or two are under 1 foot; whilst one is 15, and another not less than 33 feet in thickness. They are generally nearly vertical, but undulate a little both vertically and horizontally. Their directions are almost in every instance W.N.W. to E.S.E., or at right angles to that of the trough in which the conglomerate has been deposited. The alteration produced upon the conglomerate adjoining these dykes is very interesting, showing in a very striking manner the intensely-heated state of the molten claystone at the period of its eruption. On each side of the 33-feet dyke the conglomerate has been *fused* to a distance of a few feet, beyond which the half-melted pebbles begin to be distinguishable. The smaller dykes have melted down all the projections of the walls of the fissures which they occupy. The central and deeper-seated portions of these dykes are more compact and crystalline, showing quartz and hæmatitic crystals, whilst towards the surface they become very porous and slaggy.

Fissures other than those occupied by the dykes above described are of frequent occurrence in the conglomerate. In Shippith Glen a great number of minute fissures are seen running in a W.N.W. or N.W. by W. direction. The 'glen' itself is merely a deep ravine with very precipitous sides, and so narrow at bottom that in many places a person cannot force a passage. It is about 200 feet deep, and has obviously originated in a fissure running west by south.

Between East and West Aikengalls is a deep and wide hollow, with a marshy bottom, but without any stream running through it. This runs in a W.N.W. direction, and has evidently had a similar origin.

The conglomerate, both on the East Lothian and Berwickshire sides of the Lammermuirs, is separated from the upper members of the old red sandstone and the lower beds of the carboniferous system by a series of dislocations of great complexity, and many of them of very great extent. These appear all to run in certain determinate directions, or at least as near to such as the nature of the strata with regard to the degree of resistance opposed, would admit. These directions are N.N.E. (or parallel to the strike of the greywacke in this part of the Lammermuirs), W.N.W. (or at right angles to the said strike, being also the direction of the claystone dykes and fissures before mentioned), N.N.W and E.N.E. (these last being *intermediate* to the former directions).

Of these dislocations the most remarkable is that which extends from a point near the Knock Hill (about two miles from Dunse) in a direction nearly S.S.W., passing along the east side of the conglomerate hills of Hardens, and proceeding by way of Choicelee, Marchmont, &c., crossing the Tweed near the mouth of the Teviot, and traversing Roxburghshire by way of Hunthill, Southdean, the upper part of the Jedwater, the east side of Lariston Fells, &c. The strata all along this line of fault are thrown down on the east side. The amount of displacement along the east side of the Hardens is probably at least 500 or 600 feet. Near Choicelee the old red sandstone strata adjoining the line of fault are *retroflexed* for some distance. A very interesting circumstance may here be mentioned. This is the occurrence in Roxburghshire of a gap in the greywacke precisely similar to that which forms the subject of the present notice. This gap is filled up by strata of the old red sandstone and lower carboniferous formations, and runs parallel with the line of dislocation referred to. Its situation is also exactly the same with regard to the dislocation as the Lammermuir gap, both occurring about three miles to the westward of the course of the fault*. The width of the two gaps is also very nearly the same. In fact that part of the county of Roxburgh which lies to westward of this line of fault is almost the counterpart, in its geological features, of the corresponding portion of Berwickshire. The Hawick trap dyke intersects this line of fault near Fallside, in Chesters parish.

Besides this, there are several other dislocations connected with the conglomerate. One runs E.S.E. from Elmford for a few miles, throwing down the strata on the south side. Another proceeds S.S.E. from Elmford to the east side of the Knock Hill, where it meets the great dislocation first described. It throws down on the east side to the extent, in some parts, of probably 800 feet. On the Lothian side of the Lammermuirs, in the prolongation of this line, is a similar dislocation, which passes near Halls, and also throws down on the east side. A fault running nearly at right angles to this (E.N.E.)

* See map attached to Mr. Milne's paper on the Geology of Roxburghshire.

passes by way of the village of Spot and the north side of Doon Hill, throwing down the old red sandstone strata to north. On the east side of Doon Hill another N.N.W. slip cuts off the conglomerate from the newer strata, which it throws down to east. The amount of displacement here must be many hundred feet. Connected in all probability with the two last-mentioned faults is the great dislocation, which may be seen on the line of the North British Railway, in a cutting near Broxburn (about two miles from Dunbar). The strata are here seen to be vertical for a considerable distance with a N.N.E. strike. From the sea-shore at Thornton Loch a line of fissure appears to run in a westerly direction by way of Innerwick, Thurston, &c., and across the conglomerate to Barnhead. The aspect of the country near this line is remarkably broken and irregular. In the course of the rivulet between Braidwood and Thornton, and in that which runs past Branxton at a point about 400 yards above that place, sections are exposed which show a great dislocation running apparently N.N.E. to S.S.W. At these places the lower carboniferous strata come close up to the conglomerate, and are much crushed and tilted at high angles. At one place they are seen to be retroflexed to a distance of about 100 yards from the slip.

The above are only some of the chief dislocations which have affected this disturbed district. To investigate the whole would be a work of very great labour and difficulty, though certainly of great interest. In an investigation of this kind, however, the want of exact maps, furnishing an accurate and trustworthy topographical basis for a survey, is felt to be an insuperable barrier. This obstacle will no doubt be removed in due time by the publication of the maps of the Ordnance Survey.

2. *On the STRATIFIED FORMATIONS of the VENETIAN ALPS.* By COUNT ACHILLE DE ZIGNO, F.G.S.

THE region to which the present memoir refers contains localities which at all times have attracted the attention of naturalists. The labours of Arduini, Fortis, Da Rio, Marzari, Brongniart, Catullo, Pagini, Brocchi, Trettenero, have pointed out its more remarkable features; and some of the Members of this Society have cast a rapid glance on the more interesting phænomena. Feeling convinced that this portion of our mountains would furnish the clue to the geology of Northern Italy, I have prosecuted my researches for several years, with the object of bringing the stratified formations of the Venetian Alps into co-ordination with the classic deposits of Europe. I have at length succeeded in recognising and establishing certain geological horizons, in rectifying some of the earlier observations, and in satisfying myself of the correctness of others subsequently made. I have had occasion to avail myself of stratigraphical and palæontological reasoning, according to the localities; and I indulge the hope that the result of my studies will be a more rational explanation of the structure of our mountains.