Bathgate Hills

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O.S. 1:50000 Sheet 65 Falkirk and West Lothian

B.G.S. 1:63360 Sheet 31 Airdrie B.G.S. 1:50000 Sheet 32W Livingston

Route: (Map 27)

Introduction

The Bathgate Hills owe their general elevation to the presence of a considerable thickness (up to 500 m) of hard, resistant volcanic rocks of basaltic composition. These replace much of the normal sequence of softer, less resistant, sedimentary rocks between the top of the Upper Oil-Shale Group and the middle of the Upper Limestone Group. Individual hills, often craggy, are formed by east-west trending dykes and inclined sills of the late-Carboniferous quartz-dolerite suite. Intercalated sediments within the volcanic pile include several limestones of both freshwater and marine origin. It is difficult to correlate these limestones with the established successions in sedimentary basins outside the Bathgate Hills. The thickest and most persistent limestone-bearing strata the Petershill Formation formed around an elevated volcanic land area lying to the north of Bathgate (Jameson 1980). Lateral changes in the lithology and fauna of these strata can be traced from the seaward side northwards towards the inferred land area.

The East Kirkton Limestone, in contrast to the Petershill Limestone, is of freshwater origin but demonstrates an unusual lithology which is thought to be associated with hot springs. These beds have yielded an important and distinctive flora and fauna. The limestones of the Bathgate Hills have been extensively worked in the past for agricultural use both by quarrying and mining. An example of the latter will be seen at Hillhouse.

The aims of the excursion are: (i) to contrast the sedimentology and palaeontology of the freshwater East Kirkton Limestone with those of the marine Petershill and Hillhouse limestones; (ii) to examine the intercalated basaltic tuffs and lava flows; (iii) to examine the late-Carboniferous quartz-dolerite intrusions; and (iv) to see the remains of 17th, 18th and 19th century silver-nickel-lead workings at Hilderston Mine. In (Map 27) showing the route the geology is based upon recent mapping, boreholes and air-photo interpretation. The outcrops are all easily accessible from public roads, making visits by vehicle convenient. but they may be traversed on foot, in the order described, involving a 9 km walk from the first to last outcrop or 12 km between public transport centres in Bathgate and Linlithgow, both of which are on Eastern Scottish service bus routes.

1. East Kirkton Quarry: East Kirkton Limestone

Park at the gate to the quarry [NS 990 689].

The East Kirkton Limestone is a laterally impersistent sedimentary sequence within a thick succession of basaltic lavas and tuffs. The lithological succession consists of limestone overlain by black mudstones (Muir and Walton 1957) but is laterally variable in detail. Within the limestone occur bands with contorted laminae, tuff horizons where spherulitic structures are common, and beds of impure limestone with chert nodules. These lithologies have been interpreted as having been laid down in shallow pools associated with hot springs.

The limestones have recently yielded an unusual flora and fauna including amphibians, Millipedes, eurypterids, scorpions, the earliest known harvestman (opilionid) and much plant material (Milner 1985; Wood el al. 1985). The presence of these forms, together with a striking absence of fishes, suggests a palaeoecology where amphibians were an integral part of the terrestrial fauna. The black mudstones, lying stratigraphically above the limestone, are also associated with laterally impersistent bands of tuff and have yielded a fauna containing both ostracods and fish remains.

2. Petershill Reservoir: seaward development of the Petershill Limestone

Park in rough lay-by at the bend in the road [NS 985 694]. On the east bank of the reservoir, the Petershill Limestone has a high carbonate content and is only slightly argillaceous. It was originally horizontally-bedded and contains an abundant fauna of solitary corals and low mounds of *Lithostrotion junceum* (a colonial coral giving rise to the popular name 'spaghetti rock'). The fauna also has delicate elements, epifaunal spinose productids and echinoids, which are well preserved with little disturbance, indicating quiet sedimentation. The trace fossil *Thalassinoides* is characteristic of this facies.

The southern wall of the reservoir is the central portion of a bioherm, built-up of successive beds composed mostly of skeletal remains. A three-part ecological succession shows a basal, small productid-fenestellid association with few species (low-diversity), passing up into a high-diversity productid-sponge-rostroconch association, replaced towards the top by an echinoderm-dominated association. The succession can be interpreted in terms of regional shallowing with regression and eventual exposure. About midway up the southern wall of the reservoir a thin (1–2 cm) impersistent band of clay can be seen. This is a bentonite horizon, consisting largely of montmorillonite formed from a weathered local ash fall.

3. Craigs: quartz-dolerite sill

Park 500 m west of Wester Drumcross [NS 995 700]; roadside parking may be difficult. A quartz-dolerite sill of the late-Carboniferous suite trends NNW–SSE across the hills. Here it dips moderately steeply ENE, contrary to the regional dip of the sediments and lavas, and forms a prominent west-facing scarp with brown, spheroidal-weathering outcrops. From the north of the road the scarp can be seen trending north-west towards Raven Craig. It is cut, and in some places displaced, by E–Wtrending valleys, interpreted as fault-lines scoured out by glacial action. A track follows the foot of the scarp northwards and eastwards for 300 m to the ruins of Craigs and a small quarry. Here, above the sill, 4 m of ill-sorted tuffs rest on 3.5 m of pale grey, well-bedded limestone with shale partings and some tuffaceous bands. The rocks show signs of baking and disturbance by the sill, the top contact of which may be traced in outcrops NNW of the ruins. These are some of the few natural outcrops of the tuffs near the base of the Bathgate Hills volcanic sequence, which are known from boreholes to reach considerable thicknesses. Other outcrops occur at Whitelaw [NS 994 692], in a stream [NS 998 695] and in a roadside quarry [NS 996 700]. All are close to the top of the sill and probably crop out owing to an increased resistance to erosion produced by contact metamorphism. Dips, where seen, tend to conform to the top of the sill, rather than to the regional dip.

4. The Rifle Range Quarries: landward development of the Petershill Limestone

Park in the roadside quarry at The Knock [NS 991 711]. In the Rifle Range Quarries, which extend south-west for a kilometre, the Petershill Limestone consists of heterogeneous packstones, medium-grained bioclastic limestones, located north and palaeogeographically shoreward of the laterally equivalent limestones exposed at the Petershill Reservoir (locality 2). In the lower 3–4 m of the quarry-face, cross-stratified crinoidal packstones, large cerioid coral colonies, bands of *Gigantoproductus* and large *Chaetetes* colonies can be seen. Although most of the fauna is in situ, signs of extensive hydrodynamic influence on the original life-surfaces are present throughout the sequence. Overturned corals with the open ends (calices) of the corallites downwards and coral debris, as well as separated and stacked brachiopod shells all suggest that currents were at times a major destructive force. The heterogeneous packstone facies is interpreted as having accumulated in a relatively turbulent, nearshore zone.

At the northern end of the quarries, a blue-grey basalt lava flow rests directly upon the limestone. The quarries terminate at a vertical E–W dyke of quartz-dolerite which exhibits good columnar jointing perpendicular to its margins.

5. Triangulation Station [NS 987 712]: basaltic lavas of Dalmeny Type

To the north-west of the north end of the limestone quarries (locality 4), several low scarp features trend NNE across the hillside as far as the triangulation point. Outcrops on these features are of a fresh, fine-grained, blue-grey basalt-the hard, central parts of lava flows. The basalts appear non-porphyritic, but in thin-section abundant 1 mm microphenocrysts of fresh olivine show them to be of Dalmeny type (MacGregor 1928). The presence of abundant interstitial analcime suggests gradation from olivine-basalt to basanite. Between the scarp features, topographic hollows with no exposure are due mainly to rubbly, altered flow tops or may in some cases indicate thin intercalations of sediment or pyroclastic horizons.

6. The Knock: quartz-dolerite sill, viewpoint

Cross the road to The Knock, where the quartz-dolerite sill seen at locality 3, trends NNW and dips steeply ENE at 60°, probably marking a step-like transgression between stratigraphic levels. The sill forms the rocky knoll of The Knock and its top surface forms the steep slab on the east side. In the back wall of the quarry on the south-west side, the lower chilled contact is well exposed where it cuts blue-grey basalt lava dipping north-west at about 20°.

From the top of The Knock the regional geology of the Bathgate Hills and that of the Midland Valley as a whole may be appreciated. The underlying bedrock of the Midland Valley shows itself in the landforms, with the harder igneous rocks forming the hills and the softer sediments the lowland. Far to the north are the metamorphic rocks of the Grampian Highlands, with the andesitic lavas of the Ochil Hills in the middle distance. To the south-east, the Old Red Sandstone sediments and lavas of the Pentland Hills can be seen with the Lower Palaeozoic rocks of the Southern Uplands due south. Eastwards most of the prominent topographic features such as Arthur's Seat, the Bass Rock and North Berwick Law, all correspond to areas of igneous rock. Also to be seen are the flat-topped, red bings which are the remains of West Lothian's oil-shale industry and which pick out the outcrop of the Oil-Shale Groups. The oil-shale was mined and burned in large retorts to extract the hydrocarbons; the red bings are made up of the burnt oil-shale. Looking to the west, black conical bings can be seen. These are the spoil from coal mining and their distribution picks out the of the Coal Measures. Note the marked cast-west valleys due to glacial scouring along fault-lines. and crag-and-tail features such as The Knock itself, which indicate west to east ice movement.

7. Hilderston Mine: silver-lead-zinc mineralisation

Park in the lay-by for Cairnpapple at the top of the hill [NS 989 718]. Immediately west of the road, the quartz-dolerite sill of localities 3 and 6 crops out forming a good N-S feature some 40 m wide. The sill dips steeply to the east as at The Knock, and is really a dyke-like step between levels of sill. A diversion may be made at this point to the bronze-age burial mound of Cairnpapple Hill. 250 m to the south-west, which is also a good viewpoint.

Follow the sill/dyke southwards into the valley to the ruins of Windywa's which are on the site of the original 17th century Hilderston silver mine (Cadell 1925. 359–378; Stephenson 1983). The mine was in operation initially from 1606 to 1614 but made little or no profit after the first two years (i.e. after it had been 'nationalised' by King James VI). The silver occurred in a vein as filaments of native silver in a gangue of baryte and niccolite. This vein was located on the margin of a thin E–W dolerite dyke which cut sandstones and siltstones above the Petershill Limestone. The economic vein extended for only 80 m to the east of the N–S dyke/sill and for 18 m below the surface. In the 18th century the mine was reopened and worked for lead and zinc which occurred within a baryte and calcite gangue at deeper levels, where the vein cut the Petershill Limestone. A second, much longer vein, some 60m to the north, was also worked at this time, but this phase of working ceased in 1772. The original workings were re-excavated during the period 1865 to 1873 using money from the sale of the niccolite and again from 1896 to 1898. However, no further economic deposits of silver or lead were discovered.

The full list of known minerals from the mine is: baryte, calcite. Dolomite, quartz, galena, sphalerite, niccolite, erythrite (nickel bloom), annabergite (cobalt bloom), bravoite, pyrite, chalcopyrite, albertite (solid hydrocarbon) and native silver. Most of these, with the exception of the nickel. cobalt and silver minerals, have been obtained recently from the waste heaps.

Three depressions close to the road at Windywa's mark the site of the main group of 17th century shafts. A large mound in the field east of the road marks the main 18th century shaft on the northern lead vein. The 1873 shaft is probably marked by a pile of debris, crescentic in plan, south of the burn and 35 m east of the road. Two adits in the west wall of the flooded Silvermines quarry mark two branches of the northern lead vein, probably excavated in the 19th century. If the water level is low, these adits can be examined. Do not attempt to enter them. Thin calcite veins with galena can be seen cutting the sandstone roof of the northernmost one.

The Petershill Limestone is no longer visible in the quarries, but the overlying clastic sediments can be examined in the cut to the south. Here an upward-coarsening sequence of clastic sediments can be seen with mudstone at the base of the quarry, gradually passing upwards to sandstone at the top. Fallen sandstone blocks at the foot of the quarry show good examples of trace fossils, both burrows and feeding trails. This type of upward-coarsening succession is typical of that associated with deltaic sedimentation. A thin N-S tholeiite dyke in the west wall of the southern quarry is altered to 'white trap' at its northern end.

8. North Mine Quarry: Petershill Limestone, dyke

Park by the roadside [NS 995 722]. In the quarry, only massive sandstone is now seen, with a capping of basalt lava forming knolls in the plantation above the north face. An E–W dyke of quartz-dolerite, 30 m wide, forms a feature which is followed by the road. Just over the fence on the south side of the road, immediately east of the plantation. the southern contact of the dyke with the Petershill Limestone is exposed. The limestone contains colonies of *Lithostrotian* and is intensely baked. Both limestone and dolerite are impregnated with pink baryte. 'Copper ore' has also been recorded from this locality.

9. Riccarton Hills: basalt lavas

From North Mine drive east, past Tartraven (small, overgrown limestone quarries). At South Mains, take the road left (north) towards Beecraigs. From this road views are seen of good trap features in basalt lavas of the Riccarton Hills to the east.

10. Beecraigs Wood: quartz-dolerite dyke

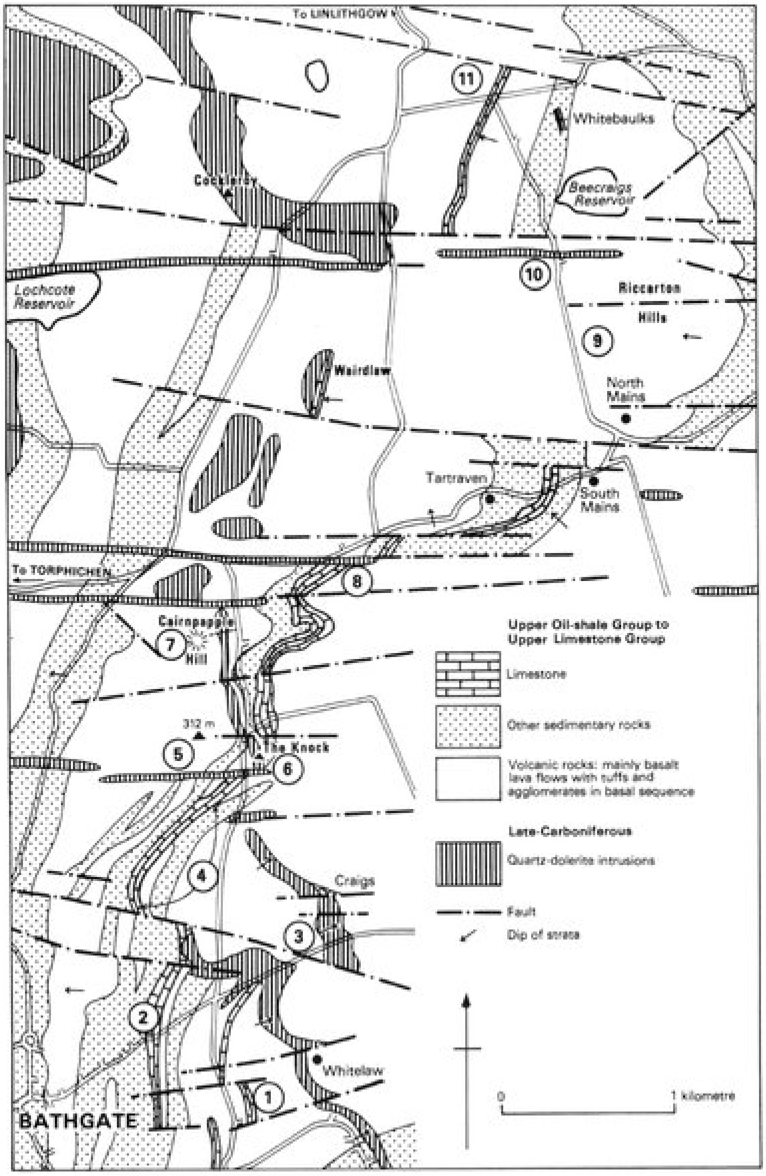
Park at Beecraigs Country Park [NT 007 743] and walk south to the quarry on the west side of the road, cleared as a climbing wall. The face shows a section across an E–W quartz-dolerite dyke. The dolerite is very fresh and exhibits horizontal columnar jointing. The fine-grained edge of the dyke can be seen beside the ladder.

11. Hillhouse Quarry and Mine: Hillhouse Limestone

Park at Beecraigs Visitors' Centre [NT 006 746], walk northwards and turn left at the T-junction. Quarries trend N–S on both sides of the road where the Hillhouse Limestone (possibly a lateral equivalent of the Petershill Limestone) has been worked by both surface and underground methods. The strata dip west at 30–40 degrees and consequently the stoop and room workings north of the road, which are still open, slope very steeply underground. Do not enter these workings. There have been roof collapses in recent years, some of which have caused subsidence in the overlying road.

The limestone is 9 to 12 m thick, the most complete section being exposed north of the road. Here the limestone is mostly massive with fossiliferous bands rich in crinoids, solitary and colonial corals and productid brachiopods. South of the road only 2 m of limestone is seen, overlain by over 2.5 m of cross-bedded sandstones and siltstones. The upper part of the section consists of a sill of very fresh basalt having well-developed. sub-vertical columnar joints. This sill is the type locality for the Hillhouse type of olivine-basalt (MacGregor 1928). The characteristic abundant microphenocrysts of olivine and augite are clearly visible on the weathered surfaces of the basalt.

References



(Map 27) Bathgate Hills.