Excursion 23 Lugar Sill and Mauchline

Key details

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Themes	The picrite-teschenite Lugar sill; New Red Sandstone sediments and lavas.
Features	At Lugar, the nature and relationships of the various units within the sill–teschenite, theralite, picrite, peridotite and lugarite. At Howford Bridge, dune-bedding, millet-seed grains, pyroclastic material.
Maps	O.S. 1: 50 000 Sheet 71 Lanark and Upper Nithsdale B.G.S. 1: 63 360 Sheet 14 Ayr 1:50 000 Sheet 14E Cumnock
Terrain	The best section for examining the sill is along the banks of the Glenmuir Water. The river bank varies in steepness and difficulty of descent and it must be emphasised that great care is necessary at all times. In certain cases, it is considered that supporting ropes are essential.
Distance and Time	The sill lies some 0.5 to 1.0 km east of Lugar, which itself is about 3.0 km NE of Cumnock. The latter is 21 km (13 miles) from Kilmarnock, on the A76. The total length of sill exposed is some 300 m, with 9 exposures described. With normal examination and collecting of specimens this excursion should be accomplished in about three hours.
Access	Cross the Lugar Water at the footbridge mentioned below. Cars can normally be parked a t the roadside in the vicinity of the bridge; otherwise in Lugar itself. A rough track follows the south bank of the Glenmuir Water, climbing up beneath the viaduct then descending and following the river bend towards the final exposures of the section at Locality 1. It should be noted that this section is designated an SSSI.

Introduction

Due mainly to the detailed investigations of G.W.Tyrrell (1917, 1948, 1952), the Lugar Sill became one of the best known and most closely studied differentiated sills in the world. It is post-Carboniferous, possibly New Red Sandstone in age, and is intruded into Passage Group and Coal Measures sediments. In addition to the exposures seen at Lugar, complete sections of the sill have been obtained in borings at Mortonmuir, about 1.6 km. (1 mile) away and at Craigston House, Lugar (Tyrrell 1948, 1952). A further boring has been made through the sill at the confluence of the Bellow Water and the Glenmuir Water (Henderson and Gibb 1987).

At Lugar, the sill is about 44 m (140 ft) thick and is composite in character. Its upper and lower units, each showing chilled margins against sandstone, consist of teschenite, while the central portion consists, from above downwards, of layers of theralite, picrite and peridotite. The junction of the upper teschenite with theralite is sharp and the base of the latter is often separated from the picrite by a thin sheet of lugarite which sends veinlike offshoots into both picrite and theralite (see Geology of Central Ayrshire, fig. 16, for a generalised vertical section).

Different views have been advanced to explain the origin and mode of emplacement of the constituent layers. Tyrrell's original interpretation of the sequence of events was as follows: firstly, the intrusion of a sheet of teschenite magma;

secondly, when this magma had solidified but was still hot, olivine-rich magma was injected as a thick median layer in which gravitative differentiation, involving the sinking of olivine crystals, gave rise to layers of theralite, picrite and peridotite; lastly, before the sill had cooled, the lugarite was injected as thin sheets and veins.

The Geological Survey Officers, during a subsequent re-examination of the sections in the Lugar and Glenmuir Waters obtained evidence which they interpreted as the theralite layer representing a 'separately injected magma fraction' (1949, Geology of Central Aryshire p.112). In his later paper (1952), Tyrrell modified his original views and suggested (p. 374) ' that the arrangement of the various facies within the sill is due to gravity differentiation of a picroteschenite magma at depth, followed by the injection of the resulting fraction, and possibly much of the original magma, at higher levels in one or more successive pulses.'

Henderson and Gibb (1987) obtained from drill cores a complete section through the sill. They concluded that it was formed by multiple injections of successively less-evolved teschenitic magmas followed by a larger pulse of theralitic liquid carrying abundant olivine phenocrysts; subsequent differentiation gave rise to the lugarite. In some aspects this modern petrological study produces a differentiation model not dissimilar from that of Tyrrell (1917), to whose pioneer work tribute is paid by the authors of this paper.

Itinerary

Cross the Lugar Water at the footbridge, some 180 m. (200 yds.) off the west of the map (Figure 23.1) . Follow the south bank of the river to the site of the old weir, now largely destroyed. This track is often very heavy mud and it may be preferable to follow somewhat higher ground away from the river bank for some 300 m. and then regain the bank near Locality 9 (Figure 23.1).

The section may be examined systematically downwards through the sill starting at Locality 9: some may prefer to proceed to Locality 1 on the map, and work their way back up through the succession of rock units. Localities 1 to 4, shown on the east bank of the Glenmuir Water on the map, may also be examined on the opposite bank.

Locality 1. [NS 601 214]

Sandstones underlying the sill.

Locality 2 The Lower contact facies of the teschenite

The Lower contact facies of the teschenite is well exposed close to the stream at this point, but its contact with the underlying sediment is only seen in the bed of the river when the water is low.

Within 1m (3 ft) of the contact the rock is medium to fine-grained. In several specimens, bands or lenses differing in many subtle gradations of colour and texture may be seen. Thin veins of coarse flesh-coloured teschenite cutting across the schlieren are quite common.

Microscopically the rock is holocrystalline, generally very fine-grained, and shows numerous variations in texture and composition. The minerals present are plagioclase, augite, biotite, analcime, magnetite and occasional olivine.

Locality 3 Lower contact zone

The contact facies gradually merges into teschenite by increasing granularity and increased proportion of analcime. The lower contact zone is approximately 3 m (10 ft) thick.

Locality 4. Peridotite

The contact between the lower teschenite and the peridotite is assumed by Tyrrell to be a sharp one, but it is not seen in the field. The peridotite, in a highly-weathered state, forms extensive outcrops in the east bank. Specimens of relatively fresh peridotite can be obtained from road cuttings near Bellow Bridge (see map); fresh specimens are unobtainable from the section along the Glenmuir Water.

Locality 5. Picrite

With decreasing olivine and increasing feldspar content the peridotite grades upward into picrite which is exposed on both banks up to the railway bridge: also in the west bank 14 m (15 yds) north of the bridge.

Locality 6. Lugarite

The lugarite is intercalated near the transition between the picrite and overlying theralite. It is 1.2 in (4 ft) thick at a maximum, and is intimately welded to both adjacent rocks. It also occurs as irregular, anastomosing veins ramifying through the picrite, varying in thickness from 2.5–12 cm (1 to 5 ins).

In hand specimen the rock presents a striking appearance, especially when weathered. It is pegmatitic and consists of a greyish-green groundmass containing analcime, nepheline and alteration products with abundant large prismatic crystals of black kaersutite (previously named barkevikite) and equidimensional crystals of black titanaugite and occasional whitish rectangular feldspars.

The exact position of Locality 6 is in the west bank at a point 1.2 m (4 ft) above normal winter stream-level and 14 in (15 yds) north of the bridge (viaduct).

Great care must be taken descending to this locality, and supporting ropes are considered essential.

Locality 7. Theralite

The main mass of the theralite layer, well seen at the path junction immediately underneath the viaduct, is composed of a dark-grey compact doleritic rock. The lower part of this horizon contains abundant hornblende and is slightly coarser in grain, while near the junction with the overlying teschenite the rock is veined and shot with patches of a medium-grained, light grey, analcitic variety. Neither upper nor lower facies are, however, well seen at this locality.

Locality 8. Upper teschenite

The junction between the theralite and upper teschenite layers is a sharp one but is not visible at this locality. The upper teschenite is exposed at the water's edge near Locality 8 where it exhibits both fine and coarse-grained varieties.

Locality 9 Upper contact of the sill.

Upper contact of the sill is exposed here, fairly high in the river bank: white sandstones of the Passage Group overlying spheroidally weathering coarse teschenite. An inclusion of indurated sandstone occurs about 3.7 m (12 ft) below the contact.

The Permian Rocks, Howford Bridge

Access Proceed about 2 km south-eastwards from Mauchline on the A76, turn off at [NS 513 257] on to a minor, largely disused, road forming a loop crossing the old Howford Bridge. Proceed to the bridge, which is still in good order, near which roadside parking is possible, as little traffic uses the road.

The main outcrop of New Red Sandstone rocks in the West of Scotland occurs in the Mauchline region, (Mykura 1967) where massive, brick red, dune-bedded sandstones overlie basalt lava flows with intercalated tuffs, sandstones and

marls. The discovery of fossil plants in a thin layer of sediment between two lava flows on the north shore of the River Ayr near Stairhill (Mykura 1965), [NS 462 245] has shown that the lavas are either of Upper Stephanian (topmost Carboniferous) or Autunian (lower Permian) age (Wagner 1966).

Looking upstream from the old Howford Bridge an olivine-analcime dolerite sill can be seen in the cliff forming the north bank of the river. It contains pale-coloured 'segregation' veins of analcime-syenite but is not readily accessible. Its age is uncertain, but it may well be of the same general age as the Lugar Sill. Mauchline lavas, with sedimentary intercalations, are seen at the side of the path going upstream from the sawmill at the bridge and in the river bed.

Proceed some 300 m (330 yds) back along the road to the top of the cliff section [NS 513 254], where there is good road-side parking along the road-cutting. From here a rough path descends to the river: it is steep in parts, but not dangerous if reasonable care is taken; keep away from cliff edges.

In this excellent cliff section the tuffs which form the top of the volcanic sequence are interleaved with and overlain by the Mauchline Sandstone. The tuff contains some wind-rounded sand grains. This is the classic section where Sir A. Geikie deduced that the lavas are of the same general age as the overlying sandstone. At reasonably low water it is possible to follow the north bank of the River Ayr downstream from this point. This 'path' affords an excellent opportunity for the detailed study of the intercalated sandstones and tuffs and the overlying

Mauchline Sandstone

The lower part of the Mauchline Sandstone is not dune-bedded. Excellent sections of dune-bedded sandstones can , however, be seen in the bright orange-red Mauchline Sandstone exposed in the cliffs along the River Ayr north of Stairhill. The best access is by the track which starts at the railway bridge across the Mauchline-Ayr road at Failford [NS 455 262].

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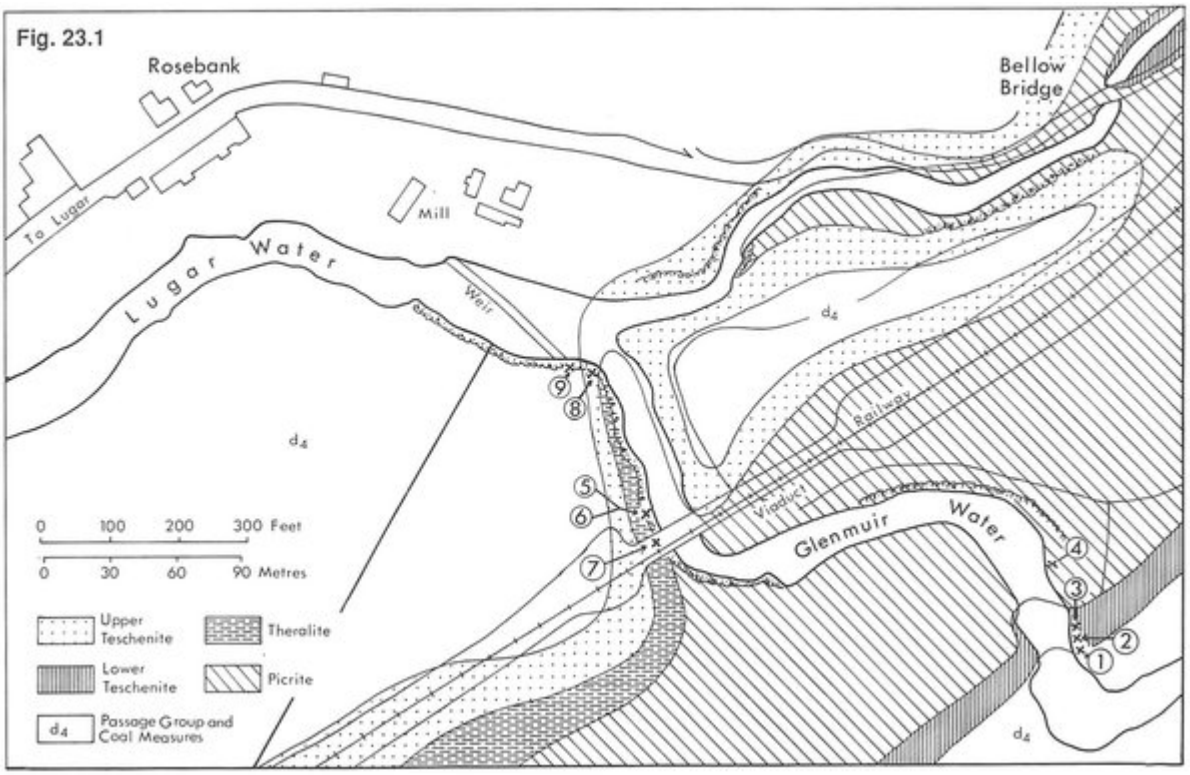

(Figure 23.1) Geological map of the Lugar Water.