In order for local and national government authorities to make appropriate strategic decisions with regard to exploitation of mineral and water resources, conservation and management of the natural environment, assessment of hazardous ground conditions, waste management and pollution control, etc., an understanding of the bedrock and superficial geology of a particular region is necessary. The following sections provide a summary of the geological resources and hydrogeology of the Huntly–Turriff district. Both hard rock and sand and gravel resources have been quarried until relatively recently, but currently there is no such activity.

**Resources**

**Aggregate (hard rock)**

Resources of hard rock for crushed rock aggregate are abundant in the Huntly–Turriff district. They include the fine- and coarse-grained mafic rocks of the North-east Grampian Basic Subsuite, quartzitic and psammitic rocks of the Grampian, Appin and Argyll Group and wacke sandstones of the Southern Highland Group. Metamorphosed limestones have also been quarried for this purpose (see below). Large former workings include the quarries in the Huntly Pluton in the Bin Forest [NJ 498 431] and at Battle Hill [NJ 539 395].

**Building stone**

Granites and other hard rock lithologies have been used locally as building stone in the past, but resources are limited and they have not been used extensively. There is no current commercial extraction of rock within the district for this purpose. Disused granite quarries are present at Carvichen [NJ 542 389] and Avochie [NJ 542 470].

**Limestone and dolostone**

Although limestone is not currently quarried, it has been worked for decades for the production of lime, building and road stone, commonly in a piecemeal fashion, especially for lime. Abandoned quarries are restricted to the north-west part of the district, where the bulk of the Dalradian metamorphosed limestone outcrops occur. Most of the disused quarries are small, but some of the more recent operations have resulted in considerably larger quarries, notably those of Lime-hillock [N 515 518] and Blackhillock [N 450 483]. The quarries and pits are located within the crop of Appin and Argyll Group rocks and mostly exploited calcite-rich metalimestones. The metalimestones are generally hard and fresh, particularly where thickly bedded; intercalated pelitic laminae are only rarely present. Their lithostratigraphy is discussed in Dalradian Supergroup. Metamorphosed dolostones are uncommon, the main occurrence being thin units interbedded with siliciclastic rocks within the Tarnash Phyllite and Limestone.

The major oxide and trace element geochemistry of fifty-seven samples from several of the more important limestone- and dolostone-bearing units is summarised in Table 5. The majority of the
limestones are reasonably pure. The main impurity is silica (SiO₂), median values for which are less than 15 per cent. Strontium (Sr) is the most abundant trace element, reaching several thousand parts per million (ppm) in most samples. The metadolostones show greater amounts of impurities, characterised by higher SiO₂, Al₂O₃, Na₂O and K₂O contents and, with the exception of Sr, higher trace element concentrations than the metalimestones. More detailed information on the geochemistry of Dalradian metacarbonate rocks in the district is available from BGS, as listed in the section on Sources of Information at the end of this explanation.

Table 5 Summary of the geochemistry of major Dalradian limestones within the Huntly and Turriff districts (major elements are shown as oxides (weight %) and trace elements as ppm).

<table>
<thead>
<tr>
<th>Lithostratigraphy</th>
<th>Dufftown Limestone</th>
<th>Tarnash Phyllite and Limestone</th>
<th>Fordyce Limestone, Keith Limestone</th>
<th>Argyll Group, unassigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>n =</td>
<td>6</td>
<td>4</td>
<td>43</td>
<td>4</td>
</tr>
<tr>
<td>SiO₂</td>
<td>4.33</td>
<td>18.70</td>
<td>14.46</td>
<td>6.95</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>0.71</td>
<td>4.22</td>
<td>2.93</td>
<td>1.53</td>
</tr>
<tr>
<td>TiO₂</td>
<td>0.03</td>
<td>0.17</td>
<td>0.11</td>
<td>0.07</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>0.34</td>
<td>2.07</td>
<td>1.04</td>
<td>0.72</td>
</tr>
<tr>
<td>MgO</td>
<td>1.33</td>
<td>8.44</td>
<td>0.59</td>
<td>3.83</td>
</tr>
<tr>
<td>CaO</td>
<td>50.91</td>
<td>32.90</td>
<td>44.41</td>
<td>46.73</td>
</tr>
<tr>
<td>Na₂O</td>
<td>0.09</td>
<td>0.38</td>
<td>0.33</td>
<td>0.02</td>
</tr>
<tr>
<td>K₂O</td>
<td>0.10</td>
<td>0.20</td>
<td>0.61</td>
<td>0.95</td>
</tr>
<tr>
<td>MnO</td>
<td>0.04</td>
<td>0.09</td>
<td>0.03</td>
<td>0.08</td>
</tr>
<tr>
<td>P₂O₅</td>
<td>0.04</td>
<td>0.05</td>
<td>0.06</td>
<td>0.04</td>
</tr>
<tr>
<td>LOI</td>
<td>41.42</td>
<td>30.74</td>
<td>35.49</td>
<td>38.84</td>
</tr>
<tr>
<td>Ba</td>
<td>37</td>
<td>59</td>
<td>64</td>
<td>82</td>
</tr>
<tr>
<td>Ce</td>
<td>10</td>
<td>37</td>
<td>24</td>
<td>13</td>
</tr>
<tr>
<td>Cr</td>
<td>12</td>
<td>23</td>
<td>30</td>
<td>16</td>
</tr>
<tr>
<td>Ga</td>
<td>2</td>
<td>10</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>La</td>
<td>9</td>
<td>32</td>
<td>19</td>
<td>7</td>
</tr>
<tr>
<td>Nb</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Ni</td>
<td>11</td>
<td>11</td>
<td>6</td>
<td>b.d</td>
</tr>
<tr>
<td>Pb</td>
<td>7</td>
<td>10</td>
<td>9</td>
<td>7.5</td>
</tr>
<tr>
<td>Rb</td>
<td>7</td>
<td>8</td>
<td>22</td>
<td>19</td>
</tr>
<tr>
<td>Sr</td>
<td>1574</td>
<td>336</td>
<td>1485</td>
<td>679</td>
</tr>
<tr>
<td>V</td>
<td>8</td>
<td>16</td>
<td>14</td>
<td>24</td>
</tr>
<tr>
<td>Y</td>
<td>3</td>
<td>11</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Zn</td>
<td>10</td>
<td>27</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td>Zr</td>
<td>30</td>
<td>58</td>
<td>41</td>
<td>26</td>
</tr>
</tbody>
</table>

Slate

Quarrying of Dalradian Southern Highland Group pelitic rocks for roofing slate was once a major activity in the ‘Slate Hills’ along the southern margin of the district. The resultant slates were heavy and variable in quality, due mainly to the presence of silty and sandy laminae, but also due to local minor folding. In addition, in many places the slates were quarried in an uncoordinated and somewhat haphazard manner. However, Read noted that the local people considered Foudland slates to ‘withstand the somewhat boisterous Aberdeenshire climate better than do modern Welsh
Quarrying was most extensive on the Hill of Foudland [NJ 603 332], where workings and waste tips occur over about 3 km$^2$. Quarries are also present on the hills of Kirkney, Corskie, Wishach, Skares and Tillymorgan. The quarries are all sited on the northern side of the hills, to avoid the main effects of the contact metamorphism caused by the Insch Pluton and Kennethmont diorite and granite intrusion. Within their contact metamorphic aureoles, the slates lose their fissility and become more massive and recrystallised, with the growth of andalusite and cordierite. Quarrying commenced on the Hill of Corskie in 1700, followed by the Hill of Tillymorgan in 1750 and Foudland in 1754 (Blaikie, 1834). Slate production peaked in the early part of the 19th century coincident with the spread of turnpike roads, but declined with the coming of the railway in the 1840s and 1850s (Walsh, 2000). The railways allowed the import of Welsh slate and Ballachulish and Easdale slates, resulting in the demise of local slate quarrying. An assessment of the quality and extent of the slates on the Hill of Foudland was made by Walsh (2008) who found that they were unsuitable for redevelopment as a source material for remedial roofing work on historic buildings.

**Sand and gravel**

Sand and gravel resources are restricted largely to the Deveron and Ythan river valleys and their tributaries (Figure 15). They are concentrated mainly in the northern part of the Turriff district. The deposits are principally glaciofluvial and alluvial in origin, although limited ice-contact sand and gravel deposits do occur as hummocks, kames and eskers. Several deposits have been worked in the past, but there is no known commercial exploitation at present. Several of the larger deposits reach 7 to 10 m in thickness, but most are rather less. Notable deposits underlie glacio-fluvial terraces in the Ruthven area [NJ 510 470], in the course of the Burn of King Edward in the north-east of the district, in ground extending south-east from Turriff, and within the area of an isolated glaciofluvial terrace at Tippercowan [NJ 815 551]. Sand and gravel underlies terraces upon which the southern half of Turriff has been built, effectively sterilising these resources. The deposits shown around Huntly occur in raised alluvial terraces. Formerly, they have been worked locally in pits but their thickness and resource potential is now likely to be very limited. Available information indicates that the sand and gravel deposits in the Huntly and Turriff districts contain a greater proportion of gravel rather than sand, but proportions are variable, even within individual deposits (Peacock et al., 1977).
resources within the Huntly and Turriff districts (modified after Peacock et al., 1977).

Sand and gravel have also been worked from the Buchan Gravels Formation at Windy Hills [NJ 809 399]. This deposit reaches over 10 m in thickness and lies on schistose pelite thoroughly decomposed to silty clay (Merritt, 1981). It comprises well-rounded vein quartz and quartzite gravel, bound locally by white, kaolinitic, sandy clay. Similar deposits also occur at Delgaty, north-east of Turriff [NJ 745 508] and at Dalgatty Forest [NJ 736 459] to the south of Turriff; the latter containing brown sandstone clasts in addition to the vein quartz and quartzite. Weathered, disaggregated conglomerates of the Gardenstown Conglomerate Formation (Inverness Sandstone Group) form clayey bouldery gravel and constitute a minor resource within the crop of the Devonian Turriff Outlier in the Turriff–Fyvie area.

More detailed information on the character of the deposits and their economic potential is given in Peacock et al., 1977, Merritt, 1981, and in Merritt et al., 2003 (see section on Sources of information).

**Brick clay**

Eyles and Anderson (1946) undertook a comprehensive survey of brick clay deposits in north-east Scotland, including physical testing. Two sources of brick clay were identified within the district, one at Plaidy [NJ 730 550] and the other at Parkseat [NJ 561 246], north-east of Huntly (Parkseat was formerly shown as Kinnoir Brickworks on the 1954 Ordnance Survey 1-inch topographical map).

At Plaidy, an erratic of Jurassic clay was discovered in the railway cutting immediately north of the station. It was used for the local manufacture of bricks and tiles, but was considered worked out by 1946 (Eyles and Anderson, 1946). The brick clay worked at Kinnoir is part of an extensive area of glaciolacustrine deposits underlying flat-lying ground extending from north from grid line 39 to ground around Parkseat. Examination of the worked pits and subsequent, more recent investigation by BGS indicates that although the deposit is up to 2.5 m thick or more in places, the clay thins laterally and becomes more impure, containing sand and stones. The clay is brown, plastic and laminated, with silty and micaceous laminae. Firing tests revealed it yielded poor quality products of low strength (Eyles and Anderson, 1946). The clay was used to manufacture tiles, bricks and drainpipes.

**Peat**

Peat commonly occurs throughout the Huntly and Turriff districts on hills and in basins and its distribution is discussed in Cenozoic superficial deposits. Basin peat is economically more important as it is generally thicker than hill peat, but deposits are less extensive and commonly waterlogged. The main peat mosses have been worked extensively in the past, but there is no current exploitation beyond local piecemeal cutting. Formerly, peat was cut widely for fuel (both for domestic use and commercially for the fish curing industry) and for agricultural and horticultural purposes. Small quantities are still used in the whisky industry. Estimates of current resources are difficult to determine, there being no more recent account of the extent, thickness and worked state of peat in the district since the assessment and wartime pamphlet of Fraser (1948).

The main peat mosses, worked or unworked, are shown in Figure 16. The most extensive mosses occur in the north-west part of the district, with some recorded in 1948 as covering about 100 ha. Abandoned worked mosses have commonly reverted to poorly drained, low-grade pasture.
Fraser (1948) noted that true basin peat in the districts generally consists of lower layers of sedge and reedgrass (*Phragmites*) peat, with upper layers of cottongrass and sphagnum moss peat forming the raised moss. Many basin peat mosses have an intermediate transitional layer of peat (‘grenze’) derived from pine and birch debris, commonly containing stumps and branches of *Pinus sylvestris* (Scots pine). Although dominantly occurring in topographical depressions on low-lying ground, basin peat may also occur in concave depressions on hill slopes. In contrast, hill peat is more consistent across the district, with little or no variation in structure or composition, though there is local hagging and erosion.

**Metalliferous minerals**

There is a long history of mineral exploration and related geological investigations in the mafic-ultramafic intrusions of the Huntly district (Gunn, 1997). Commercial exploration for copper-nickel (Cu-Ni) has been carried out intermittently since the late 1960s, while investigations by BGS in the 1980s concentrated on the evaluation of the potential of these bodies as sources of economic platinum-group element (PGE) mineralisation.

The largest exploration programme for copper-nickel was conducted by Exploration Ventures Limited (EVL), a joint venture between Rio Tinto Zinc and Consolidated Goldfields, between 1969 and 1973. Work undertaken included extensive mapping, geochemical and geophysical surveys, and diamond drilling. Attention was focused on the Littlemill–Auchencrieve area in the south-eastern part of the Knock intrusion. Drilling in this sector outlined a ‘geological reserve’ of 3 million tonnes grading 0.52% Ni and 0.27% Cu in two subparallel zones dipping towards the north-west. Copper and nickel occur in massive discontinuous lenticular sulphide bodies in a structurally complex contact zone at the edge of the Knock intrusion (Fletcher and Rice, 1989). The sulphide zone, up to 20 m thick at Littlemill, is roughly conformable with the banding in the enclosing olivine cumulates interlayered with modified, contaminated and granular gabbroic and noritic rocks and metasediments (Figure 17). Pyrrhotite, chalcopyrite and pentlandite form the main primary assemblage that displays some magmatic textures, although intense deformation and hydrothermal reworking are commonly evident. Fletcher and Rice (1989) reported elevated precious metal concentrations in these ores, up to a maximum of 574 ppb Au + Pt + Pd (gold + platinum + palladium).
Disseminated sulphide mineralisation of primary magmatic origin is widespread in the cumulate lithologies of the Knock and Huntly intrusions at concentrations of 0.5 to 1 vol%, but locally up to about 15% in olivine-bearing units (Gunn and Shaw, 1992). No significant enrichments in Cu, Ni or PGE have been reported in association with this style of mineralisation. However, some irregular discordant bodies of graphite- and sulphide-bearing orthopyroxene-rich pegmatites in the West Huntly cumulate body contain elevated precious metal contents, up to about 700 ppb Au + Pt + Pd (Fletcher and Rice, 1989). Two such occurrences have been located in the Bin Quarry, but drilling by BGS failed to establish any significant continuity between the bodies at depth.

BGS also conducted exploration for PGE in the deformed mafic-ultramafic intrusions along the Portsoy Lineament in the upper Deveron valley south-west of Huntly (Gunn et al., 1990). Elevated PGE contents occur in the clinopyroxene-bearing ultramafic rocks of the Succoth–Brown Hill intrusion and drilling in one zone revealed Pt + Pd values up to about 270 ppb. Local enrichment of Pd relative to Pt, accompanied by elevated Au (up to 370 ppb), indicate the possible importance of late hydrothermal processes in producing the precious metal enrichments.

Following identification in 1979 of the world-class barium-zinc-lead (Ba-Zn-Pb) deposits at Aberfeldy in Perthshire, systematic exploration for stratabound mineralisation of this type was undertaken by BGS elsewhere in the Argyll Group, including the north-east Grampian area. In the Huntly district geochemical and geophysical surveys were conducted in the Wellheads and Succoth–Gouls areas to the west and south-west of Huntly respectively (Chacksfield et al., 1997). Results were most encouraging from the Wellheads area, but the further drilling of six boreholes by BGS in 1986 encountered no significant bedrock mineralisation (Coats et al., 1987).

The potential for the discovery of additional mineralisation in the Huntly district remains, although thick superficial deposits make exploration difficult, especially over the Knock Pluton. Further Cu-Ni ± PGE may be present in zones of deformation within the Huntly and Knock bodies, while the pre-TECTONIC intrusions within the Portsoy Shear Zone are also prospective for PGE mineralisation. There is also potential for the occurrence of stratabound mineralisation in Argyll Group rocks within and adjacent to the Portsoy Shear Zone in the Huntly district, for example, Chacksfield et al.
(1997) identified further targets for investigation in the Wellheads and Succoth–Gouls area.

**Hydrogeology**

**Bedrock**

Although the Dalradian Supergroup is lithologically variable, the rocks within it have been grouped into one hydrogeological unit because of their negligible intergranular porosity. Movement of groundwater in these rocks depends on interconnected fractures and fissures, resulting in widely varying and complex flowpaths influenced not only by the direction of the hydraulic gradient, but by structural features such as faults, joints and fracture zones. The steeply dipping attitude of Dalradian rocks precludes flow along secondary voids on bedding planes remnants, a common feature within gentler-dipping rocks of negligible porosity.

The hydraulic conductivity of Dalradian rocks is very low (~0.05 m/day), with transmissivity values normally <10 m²/day. Zones of higher permeability are common within 10 m of the surface where weathering processes have increased the amount of interconnected void space available for groundwater storage. Where overlain by granular superficial deposits such as sand and gravel, a useful, although localised, resource may be present because of the increased availability of recharge from infiltrating rainwater. The presence of a large number of springs across the Huntly and Turriff districts is evidence of shallow, active groundwater movement in bedrock. Over 80 springs have been used as sources of water across the district, including 14 that have been developed for public supply. Threats to water quality such as bacterial contamination have reduced the number in use over the years, but many are still relied upon for local usage. The full implementation of the Deveron Water Supply Scheme has also resulted in abandonment of ground water sources, at least for domestic and industrial use.

Groundwater from deeper boreholes drilled into Dalradian rocks number around 20 in the district. Individual yields range from 0.2 to 2 litres/second (l/s). Most boreholes are no deeper than 30 m and supply domestic water to individual houses. Water-bearing voids can exist in hard rocks at great depths, but experience in other parts of Scotland suggests that most groundwater circulation occurs within 60 m of the surface, with much reduced flow below. Water quality is generally very high from borehole sources. The water is weakly mineralised with a carbonate concentration around 10 mg/l (Robins, 1990), reflecting the low carbonate content of the country rock.

On the western margins of the area, the Pitlurg Calcareous Flag Formation and other minor limestone units are thought to have the same aquifer characteristics as the remainder of the Dalradian. However, in limestone and carbonate-rich rocks in other parts of the Highlands carbonate concentrations in groundwater are raised to around 50 mg/l (Robins, 1990). The presence of a shallow, weathered zone increases the possibility of localised pollution of near-surface groundwater, especially where bedrock is exposed. Within recharge areas the transmission of contaminants from the surface can occur rapidly in fissured hard rocks, and springs, in particular, can be vulnerable.

Around Huntly, almost 20 springs and one borehole are present in areas underlain by Ordovician mafic and ultramafic rocks, although some of the springs originate from river alluvium around the town. A single borehole to the north of Huntly provides a good supply of high quality water to a farm, and indicates that aquifer characteristics are similar to those found in areas underlain by the Dalradian rocks, with yields of less than 1 l/s on average.

The shaly mudstones of the Devonian Dryden Flags Formation in the extreme south of the area have been studied and assessed hydrogeologically in the Rhynie area, 4 km south of the district. Drilling
investigations revealed that fissure flow was dominant, with groundwater inflow largely restricted to a small number of points. A promising yield from one of the 2 trial boreholes of 15 to 20 l/s was tempered by the chemistry of the water, which showed very high concentrations of iron and manganese associated with low oxygen contents (Robins, 1990[15]). This borehole was rejected for use as a public supply source. The second borehole contained lower amounts of these substances, indicating significant variation in the aquifer. The outcrop of the Dryden Flags Formation within the Huntly district in Strath Bogie likely has a moderate to good permeability of 1 m/d and reasonable water quality. As such it represents a presently untapped but potential water resource.

Near Turriff, the Devonian Gardenstown Conglomerate Formation forms a relatively large aquifer. Investigations in two deep boreholes north-east of Turriff [NJ 757 509] (Robins, 1989[16]) show groundwater flow to be fissure-controlled. Porosity and permeability tests on core samples of sandstone gave results of 8 to 12% and $10^{-4}$ m$^2$/day respectively. Pumping tests indicate that the difference between the proportion of flow via fissures and that in pore spaces is four orders of magnitude.

One of the boreholes has been in use for public supply for over 10 years and has performed reliably and consistently. The two boreholes indicate long-term borehole yields in this aquifer between 10 and 15 l/s. Water quality tests show the groundwater to be moderately mineralised and similar to that found in Devonian aquifers in other parts of Scotland (Robins, 1989[16]). Only one other borehole is recorded as being in use in the Devonian aquifer, so there is potential for further development (Ball, 1999[17]).

Hydrograph data from one of the Turriff boreholes shows the groundwater level to be largely unresponsive to rainfall events, with consistent levels of water storage throughout the year (Robins, 1989[16]). This suggests a relatively high rate of infiltration and throughflow in the mainly fissured aquifer, particularly where only patchy till cover is present. The likelihood of surface pollution entering the unsaturated zone and reaching the water table in a relatively short space of time is possible across the aquifer, particularly at the numerous localities where rock is close to surface.

**Superficial deposits**

Superficial deposits contain only small amounts of groundwater and form localised, discontinuous aquifers where granular material is present. Shallow groundwater flow within layers of gravelly drift results in many small springs and seepages. Thin gravel layers in alluvial deposits within the main river valleys, such as the Deveron valley around Huntly, provide the main storage in the area. River gravel permeability can be very high, although the thickness of these deposits is normally restricted to a few metres. Consequently, the overall volume of groundwater moving through the gravels is quite low. An important function of valley gravels is to provide temporary storage for groundwater prior to entering rivers as baseflow and help to maintain river flow during periods of dry weather. These deposits provide a significant element of the total river flows in the district during the summer months.

**References**


5. ↑ 5.0 5.1 MERRITT, J W. 1981. The sand and gravel resources of the country around Ellon, Grampian Region: Description of 1:25 000 resource sheets NJ 93 with parts of NJ 82, 83 and 92, and NK 03 with parts of NK 02 and 13. *Institute of Geological Sciences Mineral Assessment Report*. No. 76.


Retrieved from
'http://earthwise.bgs.ac.uk/index.php?title=OR/15/026_Applied_geology&oldid=24498'

Category:
- OR/15/026 Geology of the Huntly and Turriff districts