Metamorphic rocks

Metamorphic rocks have formed through the alteration of other rocks by heat or pressure, or both. The original constituents of the rock may have been recrystallised to produce an assemblage of new minerals, textures and grain size. Metamorphism is the term applied to these processes. During mountain building, rocks buried deep within the Earth's crust may be affected by both intense heat and pressure, or by pressure alone, and hence undergo regional metamorphism. By contrast, when igneous rocks are emplaced the adjacent rocks are heated by the intrusion and experience thermal, or contact metamorphism; the zone of affected rocks surrounding an intrusion is known as a metamorphic aureole.

Metamorphic rocks in Great Britain

The most extensive outcrops of metamorphic rocks in Great Britain occur in the Scottish Highlands. Here a great variety of original rock types have been subjected to regional metamorphism of varying intensity during episodes of mountain building in the geological past, in some instances on several occasions. Elsewhere, for example in the Southern Uplands of Scotland, the Lake District and Central and North Wales, the lower Palaeozoic sedimentary and volcanic rocks also have undergone regional metamorphism, though at lower temperatures and pressures than those that affected rocks of the Scottish Highlands.

Contact metamorphic aureoles are associated with igneous intrusions of all ages throughout Great Britain. Those adjacent to large igneous bodies can be extensive, but the intensity of metamorphism declines with distance from the intrusion margin. Metamorphic aureoles adjoining smaller intrusions, including most sills, are typically narrow, and may be almost imperceptible adjacent to thin dykes. The approximate outer limits of the more extensive metamorphic aureoles are shown on some Geological Survey maps.

Metamorphic rocks in the district

Regional metamorphism has not affected any of the rocks of the region. In contrast, contact metamorphic rocks occur adjacent to all of the intrusive igneous rocks present. Here, metamorphic aureoles are best developed adjacent to the Cheviot Granite Pluton and to the Whin Sills. The aureoles associated with the Devonian and Cainozoic dykes are typically narrow and the metamorphics effects limited.

Emplacement of the Cheviot Granite thermally metamorphosed the adjacent volcanic rocks and the effects are evident at outcrop for a distance of up to 2 kilometres from the contact. The most intense metamorphism is seen within 1 kilometre and is particularly well developed in eroded cappings of volcanic rocks that rest upon the granite well within its peripheral limit. Examples of these occur south-east of Langleeford, forming the tors of Long Crags, Housey Crags and Tathey Crags. Here the volcanic rock has been recrystallised into a 'sparkling' dark grey to black very finely granular hornfels, characterised by the growth of biotite, pyroxene and magnetite. The presence of the last mineral makes the hornfels more magnetic than the unaltered volcanic rocks.

Adjacent to the contacts of the Whin Sills, representatives of all of the district's sedimentary rocks display the effects of contact metamorphism. The degree of alteration is variable, though its intensity is greatest within a few metres of the igneous contact and within the rafts and fragments of sedimentary rock that have been engulfed by the intrusion. In many instances, alteration has been accompanied by the introduction of chemically active fluids associated with the intrusion, a process known as metasomatism. The metamorphic effects may be clear to the naked eye, for example where a rock is completely recrystallised, though in some rocks the alteration may only be detectable by microscopic examination. Examples are known where well-preserved fossils retain their original detail even though they are located within a few centimetres of the intrusion margin at Walltown Quarry and are also seen at Ward's Hill Quarry. Beautifully preserved spiriferid brachiopod shells occur in a fine- grained sandstone within a few centimetres of the lower contact of the sill.

The limestone has typically recrystallised to form white, saccharoidal limestone or marble. Good examples may be seen at several localities including Sewingshields Crags, Barrasford Quarry, Clay Walls and West Whelpington. A purple marble containing abundant disseminated crystals of fluorite, recently described from a raft of Oxford Limestone at Barrasford Quarry, appears to be a unique example of fluorine metasomatism accompanying metamorphism; all exposures of this rock have since been removed by quarrying. Impure limestone and calcareous mudstone may be metamorphosed to form a calc-silicate rock characterised by an abundance of garnet, feldspar, vesuvianite, and chlorite. Fine examples of this rock, sometimes with clearly visible crystals of garnet and vesuvianite are common at Barrasford Quarry.

In mudstone, a ‘spotting’ effect is sometimes seen as the first signs of metamorphism as the contact is approached. The spots are small aggregates of minerals such as chlorite, cordierite and feldspar. Close to the contact, the mudstone is typically converted into a flinty-looking very fine-grained hornfels, which is sometimes referred to locally as ‘whetstone’.

Coal may be converted into natural coke adjacent to dolerite intrusions. No surface exposures of this are known in the district today, though substantial amounts of coal were altered in this way, and rendered unworkable, adjacent to the late Carboniferous Haydon Bridge Dyke in the underground workings of Blenkinsopp Colliery.

Influence on the landscape

Several of the tors in the higher parts of the Cheviot massif are developed on contact metamorphosed volcanic rocks. In addition to those mentioned above, tors in hornfels are present to the west of the granite on The Schil [NT 870 223], West Hill [NT 894 213], Auchope Cairn [NT 892 198], and Hanging Stone [NT 892 190]; to the east are Middleton Crags [NT 977 215].

Because of their very limited extent, contact metamorphic rocks associated with the Whin Sills have a little or no impact upon landscape in the district.

Influence on biodiversity

Because of their very limited surface extent, contact metamorphic rocks within the district have very limited impact on biodiversity although some species may persist on ledges away from grazing animals. The metamorphic rocks in the Cheviots often have a rich lichen flora with good mosaics of crusts competing for space.

Economic use

None of the metamorphic rocks of the district have been specifically exploited. However, some of the harder calc-silicate-rich rocks, formed by thermal metamorphism of the Oxford Limestone within the contact zone of the Whin Sill at Barrasford Quarry, are included within certain crushed whinstone products supplied by this quarry. Apart from such use it is extremely unlikely that any of the district’s metamorphic rocks will ever attract commercial interest.

Conservation issues

Natural exposures of metamorphic rocks within the district are mainly closely associated with exposures of intrusive igneous rocks and, like them, may be assumed to be generally robust. Comments made on the conservation of intrusive igneous rocks in working quarries (p. 52), applies equally to metamorphic rocks.

Wider significance

Despite the great importance of the Whin Sills in the development of understanding of such rocks, as evidenced by the voluminous technical literature on their form, composition, age and mode of origin, little attention has been directed towards the metamorphic effects associated with them. Thus, although of limited extent, the metamorphic rocks associated with the Whin Sills, in particular, offer considerable potential for future research on metamorphic processes in such geological environments.

Although the volume of metamorphic rocks within the district is small, they are extremely important in giving clues to the district’s geological evolution.

Figures

(Figure 39) Major tor in andesite at Housey Crags © Simon Fraser.

(Figure 39) Major tor in andesite at Housey Crags © Simon Fraser.