The Igneous Rocks Of North-east England Essay, Research Paper

The area of north-east England, east of the Pennines and between the Scottish border to the north and Teesside to the south has a variety of igneous rocks of different ages, and in this essay I will try to describe the major types that are found, concentrating on the Whin Sill, the Cheviots, and the Weardale Granite in particular, but also commenting on other igneous rocks of the region. I have included a map of the area to show the main bands of igneous rock. The main igneous rock of the north-east is the Great Whin Sill, the largest hypabyssal intrusion in Britain which was intruded approximately 295 million years ago. As the name suggests, it is an example of a common concordant intrusion known as a sill, and the whole Whin Sill complex is a number of lenses of differing thicknesses linked together at depth. The sill sweeps in an arc around the Cheviots and forms many of the most recognisable geological features of north-east England, the best known perhaps being the north facing scarp in Northumberland upon which part of Hadrian’s Wall stands. The Farne Islands are part of the sill, as are the crags at Bamburgh, which are home to the castle. The coastline between Dunstanburgh and Cullernose Point, as well as the rock that leads to High Force waterfall in Co. Durham are also parts of the Whin Sill. The Whin Sill has a total area of at least 5000 square kilometres.(Eastwood, 1971) As the sill is made up of a number of lenses, the number varying with location (5 lenses were found in certain parts of Northumberland), the thickness varies accordingly, although the common thickness is about 100ft. The greatest depth discovered was at the Burtree Pasture Lead Mine in Weardale, which had a thickness of 240ft. The sill itself is made up of a variety of rock types, the most abundant being a dark coloured, blue-grey quartz-dolerite which has a fine to medium grain size of 0.5-1mm. The rock structure is of an interlocking network of plagioclase laths which show a sub-ophitic texture, and there are also granular aggregates of augite. Phenocrysts of both strongly zoned plagioclase and pyroxene are frequently found, in lengths up to and over 2mm. Closer examination found a finer grained rock of basaltic composition, and they are commonly found to be made up of phenocrysts of pyroxene and of plagioclase or aggregates of iron ore and serpentine. The sill is also intruded by fine grained veins of basalt of varying widths (Smythe, 1930), and despite their age being younger than that of the sill, their chilled facies resemble the Whin Sill. There are many other less common rocks found in certain parts of the sill, and they include dolerite-pegmatites (found in Teesside and the South Tyne region) and a variety of acid rocks, the most abundant being pink-red apilitic veins up to 20mm wide which intrude into the sill. Vesicles up to 0.3mm in diameter in extreme cases can be found, and they usually contain small amounts of calcite, quartz and chlorite with traces of pyrite, although minerals such as stevenite have been discovered. The Whin Sill also has an associated dyke suite across the region, especially in four distinct areas, with a generally north-easterly trend. The Holy Island dyke-echelon is the furthest north, and it’s width varies from 3 to 61m. South of the Cheviot mass is the left handed dyke-echelon trending eastwards towards Holy Island called the High Green dyke-echelon. The St. Oswalds Chapel dyke-echelon starts near Haltwhistle and heads out to sea to a distance of around 6.5kms offshore. The Hett dyke system is the most southerly, and although the width is only about 10m at maximum, it can be traced for 32kms across South Durham, the longest unbroken line of outcrop. There are no variations in the make-up of the dykes and the sill, and there is also little regional variation in the sill’s composition. The Cheviot complex is the remnant of an old volcano which is deeply dissected, and has been intruded by a mass of granite and traversed by numerous dykes, and an overall age is Lower Devonian. After an initial phase of vulcanicity, there was a mass outpouring of lavas, which today still covers an area of 600 square kilometres. Two major types of lava can be distinguished, the first of these to reach the surface are known as biotite lavas or mica-felsites, and they are porphyritic rhyolites, reddish in colour. One variety of this lava is found in the Borders and it forms many of the high peaks in the area, including Windy Gale. There are large, abundant phenocrysts of biotite and much-altered feldspar in a groundmass of quartz and feldspar. The other variety is composed of only a few flows, and it weathers purple or grey, and it has phenocrysts of biotite. The bulk of the lavas in the region are classed as andesites, an intermediate lava with a silica content of 55-65%. They are porphyritic lavas generally coloured from very dark to light grey and purple, often flecked with white spots where feldspars have been altered to a clay like substance. These lavas, found throughout the Cheviot region are well jointed and usually much altered, and they have phenocrysts of andesine-labradorite. There are other lava types which are less common, one example being ‘glassy andesite’ (Carruthers et al, 1932), a very fresh variety of andesite. These pitchstone-andesites are grey to black, with plagioclase laths and unaltered phenocrysts of rhombic pyroxene and augite, set in a groundmass of glass and fresh feldspar. It is cut by thin red veins and is weathered by exfoliation. Oligoclase trachytes are only found at the head of the River Alwin. They can be recognised by their platy structure in hand specimen, and also by their groundmass of oligoclase and altered pyroxene under the microscope.Around 350 million years ago, granite was intruded into the andesites in the east of the Cheviot region, and this granite now forms the highest points in the Cheviot Hills. The granite, which has a significant metamorphic aureole around it, is thought to have a surface area up to 70 square kilometres. The granite contains three essential minerals, all visible in hand specimen, namely quartz, feldspar, and mica. Jhingren (1942) described three variations in the composition, the marginal, the standrop and the granophyric varieties. The first of these is fine grained and dark grey, and contains quartz, feldspar, diopside, biotite and iron ore. The other two are coarser grained and differ as they are richer in quartz and orthoclase feldspar, although the granophyric variety contains very little pyroxene. In the south of the Cheviots, there are a set of dykes, which have been classified as mica-porphyrites, quartz-porphyrites, felsites and pyroxene-porphyrites, then former of these being the most common. All the dykes have a groundmass of acid feldspar and quartz, but the phenocrysts differ, and they may be made up of plagioclase feldspar and biotite, or quartz. Also near the south of the Cheviot massif is a wide outcrop of mica-porphyrite, the so-called Cheviot laccolith. The lavas have been arched upwards to form the Biddlestone anticline. The last stage of igneous activity in the Cheviots probably led to the siliceous veins occurring in the vertical fractures of the lavas. These are probably due to hot solutions welling up from depth. The Weardale Granite, which is not exposed anywhere at the surface was only proved to exist after a borehole was sunk at Rookhope in 1961. It was thought that many Pennine ores had come from an intrusion buried below a cover of Carboniferous rocks, as they are associated with granite bodies. The granite intrusion was discovered to possess a weathered cap that was clearly pre-Carboniferous in age, and that mineralisation continued down into the granite itself. The granite is Caledonian in age but the origin of the mineralisation remains one of the mysteries of geology. The granite above a certain depth (670m) is found to be rich in Fe2O3, MgO, K2O, TiO2, Sr, Ba, and Zr and impoverished in Na2O and Pb compared with the granite below this depth. Various theories have been put forward to explain this. Holland (1967) suggested that the cause might have been magnetic differentiation from a common magma source, with subsequent emplacement of one granite after another. It is possible that this intrusion with an age of around 390 million years originated from a primary source, such as the upper mantle, without a protracted history prior to the intrusion. The intrusion is of biotite-muscovite granite is cut by numerous small veins of pegmatite and aplite, and the rock is non-porphyritic. Very little is known for certain about the granite, and people have speculated as to it’s origin. Lambert (1964) said that as there was no sign of forceful intrusion, the granite must have intruded very slowly, making room for itself at a rate of about 1cm per year. Evidence also seems to suggest the existence of two phases of granite. The igneous block, 7000 metres cubed in volume reaching down a depth of 10km, was thought to have had an eroded hardened surface cap above active, still evolving granite many kilometres below. This is only a theory though, it is still a bit of a mystery as to the exact formation of the granite. As well as the dykes associated with the Whin Sill and the Cheviots, there are also a number of tertiary dykes trending west-north-west to east-south-east in the north of England. These dykes have radiated out from the tertiary igneous centre on the Isle of Mull. The dykes have a framework of basaltic minerals in a devitriefied or glassy mesostasis which is either iron-rich or of a quartz-alkali-feldspar composition (Hickling et al, 1931). These rocks can be distinguished from the Whin Sill suite as they have more pyroxenes and olivine than feldspar. Various concentrations of anorthite can also be found in phenocrysts. These dykes do not form obvious topological features and are best seen at the coast, at places such as Howick. There is a cluster of dykes between Morpeth and Blyth, and they have also been found in Cleveland. The age of the Cleveland dykes is thought to be around 65-52 million years old. The north-east of England has a wide variety of igneous rocks, most of them being intrusions of one description or another rather than lavas erupting up to the surface from the mantle. The ages of these rocks can vary from 400 million years old for the Alston granite to the recent tertiary dykes just over 50 million years old.BibliographyBennison, George M, 1969, The Geological History of the British Isles, London: Edward Arnold, Pages 251-2 Carruthers, R G, Anderson, W, & Thomas, H H, 1932, The geology of the Cheviot Hills, Mem.geol.Surv.G.B. Eastwood, Tom, 1971, British Regional Geology: Northern England (Ed. 4), London: H.M. Stationery Off. Eastwood, Tom, & Woodward, Horace B, 1964, Stanford’s Geological atlas of Great Britain, London: E. Stanford, Pages 206-12 Evans, J W, & Stubblefield, C J, 1929, Handbook of the geology of Great Britain: a compilative work, London: T. Murby & Co. 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