Geological hazards, geology and man, Northern England

From Earthwise

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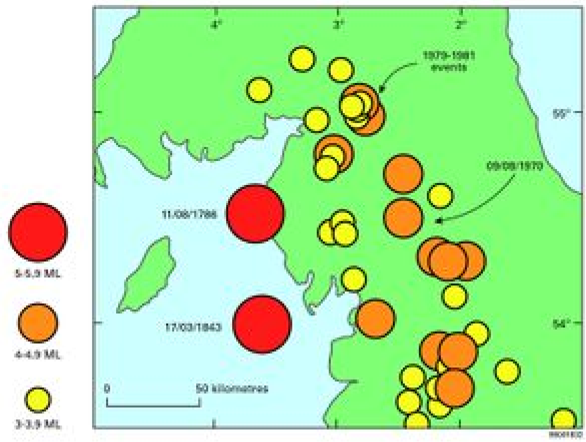
Introduction



Distribution of earthquakes above 3.0 ML in northern England, 1650 to 2006. P916108.

This surface collapse above old mine

workings at Dinnington [NZ 209 731], close to Newcastle airport, occurred in November, 2000. (P266690).

Flooded collapse hollow over the Park Sop haematite workings, south Cumbria [SD 211 753], with the Duddon estuary in the background. (P222846).

The region's geology has a profound effect on a wide spectrum of land use and environmental issues, and in some circumstances may influence natural hazards that constrain or limit development. Some hazards are discussed briefly below.

Seismicity

The north of England does not face a high risk of major, damaging earthquakes, but neither is the region seismically quiescent. Indeed, the 26 December 1979 Carlisle earthquake, with instrumental magnitude of 4.7 ML, was one of the larger British earthquakes of the 20th century. It was felt over most of southern Scotland, Cumbria and north-east England. Prior to that, an earthquake near Kirkby Stephen on 9 August 1970, with an instrumental magnitude of 4.1 ML, was felt throughout northern England.

The regional seismicity of the north of England is characterised by a band of relatively intense activity up the spine of the Pennines, with some activity to the west of this but with practically nothing to the east (P916108). This pattern terminates at the line of the Solway Firth, north of which there is little activity (although an earthquake near Dumfries on 26 December 2006 had an instrumental magnitude of 3.7 ML). It seems likely that the pattern of seismicity is related to the geometrical reaction of structural components, most likely the major geological blocks, to the overall pattern of crustal stress. There is currently a maximum compressive stress from the north-west or north-north-west arising from the widening of the Atlantic Ocean. Such a regime could induce generally rotational movements of the Pennine and Lake District blocks, with shearing movements on their flanks.

The 1979, 4.7 ML Carlisle earthquake was generated at a depth of about 5 km. There was a marked directionality to energy release, resulting in the earthquake being much more perceptible to the north than to the south. The strongest effects were felt around Carlisle, Longtown (close to the epicentre) and Canonbie (across the border in Scotland), with damage caused to roofs and chimney stacks, debris falling and cracks appearing in walls. A series of significant aftershocks continued until 1981. The fault plane solution of the aftershock sequence, and the lineation of aftershock epicentres, shows lateral movement on a near-vertical plane with a strike of 123°.

There are two contenders for the strongest earthquake in the region, though magnitudes of both have been estimated from historical records: a 5.0 ML earthquake on 11 August 1786 had an epicentre just offshore from Whitehaven and a depth of about 16 km; a 5.1 ML earthquake on 17 March 1843 had an epicentre well offshore from Barrow and a depth of about 15 km.

Landslides

Landslides, developed on a great variety of substrates and in many different geological settings, are a common feature across the region and their deposits are generally underrepresented on existing geological maps. They were widely initiated during the late glacial period, especially during ice sheet deglaciation, when glacially over-steepened slopes became unstable. Thawing of permafrost led to water over-saturation and high pore-water pressures that reduced rock shear strength and facilitated failures. The landslides range from deep-seated rotational slides to relatively shallow translational slides and include progressive multiple slope failures. These landslides may be stable under present-day conditions though human intervention such as excavation or loading, or any alteration of the local groundwater regime, could renew instability. The following brief account touches on only a small selection of illustrative examples.

Very large slope failures, involving many thousands of cubic metres of rock and superficial materials, and covering many hundreds of square metres of hillside, have occurred in several upland parts of the region. Examples of substantial landslides include: Skiddaw Group rocks at Latrigg, near Keswick, at Buttermere Fell on the south face of Robinson, and near Whicham on the south-east flank of Black Combe; Ennerdale microgranite and Skiddaw Group rocks at Crag Fell, Ennerdale (NY 095 147); mostly Yoredale Group limestone, sandstone and shale at Mason’s Holes and elsewhere on the Pennine escarpment; and Coal Measures on hillsides near Moorside Colliery, west Cumbria (NY 055 216). Smaller scale slope failures are particularly common in the northern Pennines, where competent, permeable sandstone overlies incompetent and impervious mudstone.

In the Isle of Man, large coastal landslides affect Manx Group strata, for example at Marine Drive to the south of Douglas, with incipient movement opening up deep clefts at The Chasms on the south side of Meall Hill. Another area of extensive coastal landslides affects the mainland to the north of St Bees Head in Cumbria. There, marine erosion of the St Bees Shale Formation has caused extensive rotational slipping of strata in the overlying St Bees Sandstone Formation. Substantial coastal landslides are also seen near Whitehaven where marine erosion has induced slip in seaward-dipping Coal Measures strata.

Slope failures involving mostly superficial deposits are comparatively common. Low-angle failures in till, perhaps resulting from groundwater flow through interbedded sand- or gravel-rich horizons or to movement above water-saturated sands and laminated clays, have been widely recognised in the northern Pennines, notably in parts of East and West Allendale, and along parts of the Coquet Valley in Northumberland. Similar slope failures are active in the steep-sided valley system forming the Durham denes, adjacent to the North Sea coast. Comparable features have been widely noted in the Lake District and Isle of Man.

Limestone and gypsum dissolution

Dissolution of soluble rocks such as limestone and gypsum may create underground voids, collapse of which eventually propagates upwards and causes subsidence. Where such voids are numerous or large, or are actively developing, they may constitute a significant geological hazard. The many Carboniferous limestones of northern England are comparatively thin and extensive cave systems are unusual. However, sinkholes, or dolines, are extremely common in areas of limestone outcrop and in places may present stability problems. The dolomitic rocks which comprise much of the Zechstein Group are much less soluble than ordinary limestone, so dissolution is not widespread, though small solution caves are recorded locally, for example in the Sunderland area. Permo-Triassic gypsum beds in the Carlisle, Vale of Eden and Darlington areas locally exhibit dissolution features, including a phreatic cave system at Kirkby Thore, Cumbria, whilst surface collapses have been reported locally. Amongst the best-known examples are the subsidence hollows known as Hell Kettles, south of Darlington, which are reputed to have appeared suddenly in the late 12th century.

Mining subsidence and fault reactivation

Centuries of coal mining in parts of the region have left a legacy of surface collapse and instability. Even subsidence due to modern coal mining, which is generally predictable and manageable, may become less so if the fill material has a low bearing capacity and so allows further incremental collapse. More significantly, the extent and nature of earlier mining, particularly shallow pillar and stall working, may be less well known. Voids created during this early work may remain open long after abandonment, with collapse taking place unpredictably over many years (P266690). Should such old workings be present above modern longwall workings, the subsidence difficulties are compounded. Although reliable plans exist for a high proportion of the region’s coal workings, small but significant areas of very old workings near seam outcrops are unrecorded.

Groundwater levels typically rise following the reduction of pumping after mine abandonment. In addition to the risks of surface discharge of contaminated water (see below), such groundwater rebound may affect ground stability. Renewed subsidence may be caused in long-abandoned workings, and in some circumstances faults may be reactivated, resulting in the sudden appearance of surface collapse features in linear belts. Numerous examples have recently been identified on the Zechstein Group outcrop above the concealed portion of the Durham Coalfield, though the phenomenon may be more widespread across the region.

Underground extraction of very large bodies of haematite in west and south Cumbria, and of non-ferrous ores and spar minerals in the northern Pennines and Lake District, have created a legacy of localised, but commonly substantial, surface subsidence (P222846).

Minewater discharges

The recovery of groundwater levels following the abandonment, or reduction, of pumping in areas of former mining, may impact upon the local and regional groundwater regime. Mine waters may be highly acidic and contain a variety of chemical elements, some potentially toxic; commonly present are iron, manganese, aluminium, lead, zinc, arsenic and cadmium. In certain circumstances, contaminated groundwater may discharge to the surface via mine openings or through natural pathways such as faults or permeable formations. It may also threaten to contaminate aquifers. Despite a variety of groundwater management measures being in place across northern England, uncontrolled discharges still occur.

Natural and mine gas emissions

Radon is a radioactive gas derived from the decay of the naturally occurring uranium that is found in small quantities in all rocks and soils. The rate of release of radon is largely controlled by the uranium concentration in the source material and the type of minerals in which it resides. Once radon is released, it is quickly diluted in the atmosphere and does not normally present a hazard. However, radon that enters poorly ventilated or enclosed spaces can reach high concentrations. The health risk arises from decay of the gas to form radioactive particles that may be inhaled.

Regional variations in radon levels are related principally to geology. Some granites release radon and the Shap, Skiddaw and Cheviot plutons present a limited hazard. Of greater importance is the well-established link between limestone and high levels of radon emission, with Carboniferous and Permian limestone presenting the greatest hazard in northern England. Radon monitoring is only considered advisable in the limestone areas.

Most coals and coal-bearing rocks generate methane, known to generations of miners as 'fire damp' and the cause of numerous catastrophic underground explosions. Methane continues to be released into old workings whence it may be discharged to the surface through abandoned mine openings or through natural pathways such as faults or permeable formations, driven by rising groundwater or falling barometric pressure. Several instances are known of methane discharges igniting.

Air trapped in poorly ventilated, old workings may become depleted in oxygen and enriched in carbon dioxide as a result of the decomposition of timber, coal or sulphide minerals. Such oxygen-deficient air, known to miners as 'black damp' or 'stythe', can, like methane, be discharged to the surface and being heavier than air it may become a significant hazard in tunnels, cellars, trenches, or any poorly ventilated space. The region has witnessed several potentially hazardous discharges of 'stythe', and at least one fatality has occurred.

Bibliography

Cooper, A H. 1998. Subsidence hazards caused by the dissolution of Permian gypsum in England: geology, investigation and remediation. 265–275 *in* Geohazards in engineering geology. Maund, J G, and Eddleston, M (editiors). *Geological Society of London Special Engineering Publication*, No. 15.

Hughes, D B, and Clarke, B G. 1997. The glacial tills of Northern England in relation to the stability of screening and spoil mounds at opencast coal sites. *Proceedings of the International Association of Engineering Geology Symposium on Engineering Geology and the Environment, Athens*. 2419–2424. (Rotterdam: Balkema.)

Knott, S D. 1994. Fault zone thickness versus displacement in the Permo-Triassic sandstones of NW England. *Journal of the Geological Society of London*, Vol. 151, 17–25.

Musson, R M W. 2007. British Earthquakes. *Proceedings of the Geologists' Association*, Vol. 118, 305–337.

Musson, R M W, and Henni, P H O. 2002. The felt effects of the Carlisle earthquake of 26 December 1979. *Scottish Journal of Geology*, Vol. 38, 113–126.

Patrick, C K. 1978. Hydrogeology and Environmental Geology. Chapters 17 and 18, 250–275 in *The Geology of the Lake District*. Moseley, F (editor). *Yorkshire Geological Society Occasional Publication*, No. 3.

Ryder, R, and Cooper, A. 1993. A cave system in Permian gypsum at Houtsay Quarry, Newbiggin, Cumbria, England. *Cave Science*, Vol. 20, 1, July 1993.

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