EXCURSION REPORT

THE GEOLOGY OF THE DURHAM AREA

Leader: Sir Kingsley Dunham FRS

Friday, 16th to Sunday, 18th September, 1983

On Friday evening, Dorothy Morrow (Vice-President) and about 35 members assembled in the Shepherd Room of St. Mary's College at 9 p.m. to hear an introductory talk. This dealt with Holocene physiography, Pleistocene erosion and glaciation; it reviewed briefly the Permian succession from the Yellow Sands and Marl Slate (local representatives of the Rotliegendes and Kupferschiefer) up to the extensive carbonate/evaporite sequence above. Then followed a description of the Westphalian Coal Measures, particularly the beds from the Hutton Coal up to the Maudlin Post Sandstone on which the city is built, and an account of the Dinantian and Namurian rocks of Weardale and Teesdale which contain the Pb, Zn, F and Ba ores. The Permian rests unconformably on gently folded Carboniferous, the Carboniferous on tightly folded Lower Palaeozoic slates, shown by the 1960/61 Rookhope Borehole to have been invaded by a granite pluton.

The morning's excursion on Saturday began with exposures of the Maudlin Post Sandstone and underlying shale on The Banks, and near Prebends Bridge in part of the system of quarries, now much over grown, the Low Main Post Sandstone was noted. According to Johnson and Dunham (1982), these were the principal sources of the stone use for building the cathedral and its surroundings. An IGS boring nearby had proved the locally worked Hutton Coal about 90 ft. (27 m) below the thin Low Main seam which underlies the sandstone; the Hutton here is close to sea level. From the bridge consideration was given to the incised meander of the River Wear, (celebrated since Arthur Holmes published his *Principles*, in 1944) which almost surrounds the peninsula on which stands the Mediaeval castle, defences and monastery. The following simplified explanation of the gorge was offered:

1. Removal of water from the oceans to form the extended Pleistocene ice-caps caused a eustatic lowering of sea level long before the ice reached Britain. The ancestral Wear became adjusted to this new base and its buried valley, east of the peninsula, bottoms at about 70 ft. (21 m) below present sea level; the bottom is at -140 ft. at Chester le Street (Smith and Francis, 1967), and -180 ft. (55 m) where it joins the ancestral Tyne near Blaydon. Coal mining revealed the old valley, now drift-filled, at many points.
2. Continental ice at least 1000 ft. (330 m) thick reached the area during the Devensian (Weichselian) stage, causing isostatic depression of the land surface, perhaps of about 250 ft. (76 m).
3. During the retreat of the ice a lake became trapped between the Permian scarp, the Pennine foothills and ice standing along the Rainton ridge. The floor of the lake was at about 180-200 ft. (55-61 m) above present sea level. Sand and gravel with thin clays were deposited as deltas; their tops with rough summit-accordance at 360 ft. (119 m) O.D. indicating the probable water level in the lake. On the bottom varved clays were laid down. Part of the water escaped through a till floored gap in the Permian escarpment at Perryhill, 265 ft. (81 m) above present sea level.
4. When the ice had melted and the lake was drained, the returning Wear began to meander across the drift deposits on the lake bottom, causing lateral planation except where a buried hill of solid rock was encountered at an early stage. Isostatic uplift of the land was now more important than eustatic rise of sea level, and around the peninsula, the meander, caught in solid rock, no longer migrated laterally and the river cut down vertically to 60 ft. (18 m) O.D.

With this geomorphological background the party ascended towards the cathedral, passing through the dark entry in the defensive walls to the outer ward of the former Benedictine Monastery (founded 1083 AD), now The College where reside the cathedral clergy. The inner buildings surround the cloister and include refectory, dormitory and chapter house; it was noted that some now believe the last-mentioned building with its apsidal end was on the site of the chancel of the Saxon church. Inside the cathedral a pause was made to appreciate the noble proportions of the romanesque nave and choir; everything visible from the back of the nave save the eastern rose window and the choir and alter screen was erected in the 40 years beginning 1093, during the bishoprics of William of St. Calais and Ranulf Flambard. Its greatest architectural achievement was the stone vault of the roof, complex as a result of the clerestory windows and made of vertically - oriented sandstone slabs. The empirical discoveries included the use of slightly pointed main arches (approaching the catenary curve within which the forces can be resolved) and the erection of the massive flying buttresses, concealed in the triforium gallery, to transmit the

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weight to the 2-3 m thick outer walls. Next, as the party stood around the gravestone of St. Cuthbert (636-692 AD) in the refectory behind the High Alter, his part in the coming of Christianity from Celtic roots in Scotland to the Anglo-Saxon Kingdom of Northumbria was outlined, and the way in which his uncorrupt body was brought from its original burying place, when Lindisfarne fell to invading Norsemen, by many wanderings to be buried, at the end of the tenth century, here in the finest of defensive sites. Here in 1074 came William I to be impressed with the possibilities of the site as a strong point from which to control the North and the added possibility of securing its loyalty with a great church around the shrine of Cuthbert. Here through later Mediaeval times came numbers of pilgrims, so many that in 1240 the apse at the east end of the cathedral was abandoned in favour of the large Nine Altars Chapel. This was built in Salisbury style but using, instead of Purbeck 'marble' for the inner flutings on the columns, the coral biostrome (with great numbers of *Dibunophyllum bipartitum*) from Frosterley in Weardale. Among the palatine prince-bishops of Durham (necessarily warriors as well as ecclesiastics) there were also some scholars; one Richard de Bury, whose tomb is in the Nine Alters, is credited (Adams, 1938) with the first use of the word geology (geologia) in his posthumously printed *Philobiblon* of c.1340. Thomas of Hatfield (Bishop 1346-1380) was Keeper of the Seal to Edward III at the time of Crecy and in his absence a great army of Scotts was repulsed from Durham; the Neville Screen behind the High Alter, delicately carved from Jurassic Caen Limestone (Dunham and Dunham, 1957) was a memorial to this deliverance. The cathedral tour ended in the Galilee (Lady) Chapel, built across the West Door by Hugh de Puiset in 1167; here lies buried the Mediaeval historian, the Venerable Bede.

While energetic members of the party climbed the 320-odd steps of the central tower, others had coffee in the crypt. Then the monk's dormitory, 200 x 61 ft. (61 x 18 m) with its thirteenth century timber-beam roof was visited to see the collection of Saxon crosses, including some relics from the pre-Norman church; and finally the Treasury was entered to see the remains of St. Cuthbert's 7th century carved coffin, and the gold pectoral cross which the Commissioners of Henry VII failed to find when the shrine was destroyed at the time of the dissolution of the monastery in 1544.

Returning to St. Mary's for lunch, the party crossed the river by the high footbridge over the river where traditionally William I also crossed it. The footbridge of Shap granite concrete was said by its architect, Sir Ove Arup, to be his favourite achievement.

The afternoon was devoted to a visit to the ruined Finchale Priory. Situated in a bend of the river north of Durham, it grew up around the cell and chapel founded by St. Godric (1065-1170) after a most adventurous life as pedler, mariner, shipowner-trader, visitor on more than one occasion to Rome and finally a hermit. In the thirteenth century the priory became a daughter house of Durham and of its eight monks, four were on holiday, in succession, from Durham. Across the river there are good exposures of the Low Main Post Sandstone, also used in the Priory; indeed some have maintained that the cathedral stone was brought from Finchale. To complete the day the party drove to Ferryhill Station, to look back over Durham's glacial lake through the spectacular overflow channel now followed by the British Rail's north-east main line.

On Sunday attention was turned from the stones and the church history of Durham to the minerals of the Dales country to the west. The Romans or even their Brigantes predecessors may have been the first miners, but records begin only with those of the monastery. From the reign of Henry I there are mentions of grants of lead mines and iron mines, and the palatine bishops issued their own coineage, made from silver extracted from Weardale lead ore. At Tow Law the site of one of the several iron furnaces using goethite-carbonate ore from the gossans of veins in the lower Carboniferous was noted, but the site has been totally restored to agriculture. Passing through Frosterley, the first visit was to Rogerley Quarry, exposing the Great Limestone at the base of the Namurian, with Coal Sills Group sandstones and shales exhibiting the developments of washouts, interpreted as delta distributaries. From the limestone good specimens of the Frosterley Band biostrome were found, and a small N.E. vein with an associated metasomatic flat, at present being mined on a small scale by two mineral collectors, provided many members with good examples of the rather uncommon green crystals of fluorite. Next, at Rookhope, the cores from the University of Durham/D.S.I.R. borehole was examined. The purpose of this hole was to test a speculation that a concealed granite under the Alston Block might explain its extensive mineralization (Durham, 1934); and to clinch the positive evidence that such a granite exists, after speculation arising from the gravity measurements of Bott and Masson Smith (1957). The hole was sited close to the minimum of the gravity field, in the angle between Boltsburn Vein and Red Vein, and at the centre of the flourite zone. The cyclothemic sequence of Brigantian strata is fully displayed, with a somewhat attenuated Asbian succession before thin conglomeratic beds are seen resting on the granite. The pre-Carboniferous age of this intrusion precludes a role as a source of hydrothermal fluids, but its importance as a central channel both for heat and convected brines can hardly be doubted. It might also have yielded lead and barium from its feldspars, florite from micas (in which it is very rich) and zinc from biotite and amphiboles. Beyond the limits of the granite cupola, florite in the veins gives place laterally to barium minerals. After lunch at and outside the Inn, the party left Rookhope, noting the remains of Redburn fluorspar mine, and the former lead smelt mill, and climbed over the watershed to Middlehope. Here the Slitt Vein, one of the principal W.N.W. channels of the field was seen standing as a pillar in West Rigg opencut between excavations where flats of iron ore have been removed.

Dropping down the steep valley side to Westgate, the journey continued through St. John's Chapel to the summit of Harthope, where a brief stop was made to look back at the tracks of the E.N.E. veins (Blackdene, Lodgefield, Old Fall) crossing the north slope of Weardale. But the weather, so fair up to this stage was turning stormy, and after passing workings in the intermediate fluorbarium zone beside Langdon Beck, the party disembarked at Cowgreen Reservoir in a gale. Sheltering as far as possible, the barite-ankerite-galena mineral suite characteristic of the barium zone was seen in debris from East Cowgreen and Winterhush veins (Dunham, 1948). Finally, at High Force, a cloudburst descended, and only the most energetic, oil-skin-clad members of the party succeeded in visiting this well-known waterfall over the dolerite of the Whin Sill, here intruded into shale between the Single Post and Tynebottom Limestones, of mid-Brigantian age. Torrential rain made formal farewells difficult, but all but the final objective of the excursion had been achieved.

References

Adams, F.D. 1938. *The birth and development of the geological sciences*. Dover Publications Inc., New York. 166 pp.

Bott, M.H.P. & Masson Smith, D. 1957. The geological interpretation of a gravity survey of the Alston Block and the Durham Coalfield, *Q. Jl. geol. Soc. Lond.*, 113, 93-118.

Dunham, K.C. 1934. On the genesis of the N. Pennine ore deposits, *Q. Jl. geol. Soc. Lond.*, 90, 689-717.

Dunham, K.C. 1948. Geology of the northern Pennine orefield. *Mem. Geol. Surv. G.B.*, 281, 357 pp.

Dunham, M. & Dunham, K.C. 1957. The stone of the Neville Screen in Durham Cathedral. *Durham University Jnl.*, for March, 47-50.

Holmes, A. 1944. *Principles of physical geology*. Nelson, Edinburgh. 197, 532 pp.

Johnson, G.A.L. & Dunham, K.C. 1982. The stones of Durham Cathedral: a preliminary note. *Trans. Arch. & Arch. Soc.*, Nland & Durham, 6, 53-56.

Smith, D.B. & Francis, E.A. 1967. Geology of the country between Durham and West Hartlepool *Mem. Geol. Surv. G.B.*, 198, 354 pp.

ERRATUM

The editors wish to apologise to Sir Kingsley Dunham for a number of typing errors in his field excursion report "The geology of the Durham area" which was published in vol. 9, no. 3, pp. 179-181. The most serious error was the change from *feretory* (where St. Cuthbert is buried in the cathedral) to *refectory* in the final printed version. For example at the top of p. 180 "*the refectory behind the High Alter*" should read "*the feretory behind the High Altar*".

Apologies are also due to Dr. Frank Moseley for mis-spelling his name and omitting the name of the publishers (the Macmillan Press Ltd.) when reviewing his recently published book, *The volcanic rocks of the Lake District* (reviewed in the Mercian Geologist vol. 9, no. 3, pp. 185-186).