

## **BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE**

**NATIONAL SCIENCE WEEK MARCH 17-26th 2000**

**A field excursion: Charles Darwin in North Staffordshire - the origins of transmutation, soils and dykes - in relation to present-day problems of conservation around Maer and the Maer Hills. Sunday 26th March 2000.**

The field excursion will repeat and update the British Association trips of 1993 and 1999, the former of which provoked initial interest and led to the flying of "The Millennium Rock" (a specimen of the Tertiary dolerite dyke from Butterson Church Quarry) to Russia's Mir Space Station from August 1998 to September 1999 and its subsequent display at Museums all over the world. The excursion will follow Charles Darwin's footsteps in North Staffordshire between c.1817 and 1843 and will visit places which have proved to be seminal in the development of ideas on evolution, the origin of soil and the geological history of the area since 65 million years ago. The visit will be set in the context of planning applications and conservation problems in the area around Maer and the Maer Hills in the last 15 years.

**Sponsors:** The North Staffordshire Group of the Geologists Association of London in co-operation with the Staffordshire Wildlife Trust.

**Leader:** David B. Thompson, former Chairman North Staffordshire Group of the Geologists' Association of London; formerly Senior Lecturer in Science Education, now Fellow of Keele University.

**Meeting place:** at 10.00hrs in the Students' Union Car Park, Keele University. Return in the late afternoon.

**Numbers:** A maximum of 25 participants.

**Travel:** By minibus or private car.

**Clothing:** Please bring suitable outdoor clothing and footwear.

**Lunch:** Please bring packed lunch and drinks.

**Safety.** Members of the excursion are reminded of their duty of care to other members of the party under the statutes of the Health and Safety at Work Act.

**Booking:** Please contact the excursion leader by telephone (01270 820514) or by post (D.B. Thompson, 3 Ladygates, near Crewe, CW3 9AN in order to book a place on this visit.

**Cost:** £5.00 per person.

## EXTENDED SUMMARY

This excursion updates the BAAS excursions (1993 & 1999) which were very well received by the public. Much of the area to be visited, containing Maer Hall and the Parkland Estate of Josiah Wedgwood II, is of great scientific and historic importance. The Darwins of Shrewsbury, cousins of the Wedgwoods of Etruria and Maer, commonly visited Maer Hall and its environs between 1803 and 1846. Charles' father, Dr Robert Wareing Darwin came to vet the books of the Wedgwood Potteries, but the family mostly came for protracted periods to socialise and holiday with their cousins. Charles learned to hunt, shoot, fish and entomologise and to take long walks in the surrounding countryside. In these parts he developed a self-apprenticeship in natural history and his very close acquaintance with the wildlife around Maer Pool (an SSSI today) and the Maer/Hanchurch Hills (the former in part a grade I historic landscape). In his subsequent education at Edinburgh and Cambridge, and during his famous voyage on HMS Beagle (1831-6), Charles kept up a lengthy and revealing correspondence with both his family and his cousins. Indeed Dr Darwin's acceptance of his son's wish to undertake the voyage had been brokered by Uncle Jos at Maer Hall (the exchange of letters is preserved in the archives of the Universities of Cambridge and Keele). Subsequently Charles returned to work on his geological and biological notes and discoveries. He found time to write down the pros and cons of marriage and summon up the courage to propose to his cousin Emma Wedgwood. They married in St Peter's Church, Maer, in 1839. After the voyage, Charles concerned himself for a while with a new theory of the origin of soil (1837) as a result of a conjecture of his Uncle Jos II concerning the role of earthworms within William Dabbs' peaty bog meadow. This was also the beginning of the time (1837-42) when he began to pull together his ideas on the transmutation of species which resulted in the writing of a pencil sketch of 35 pages (of what became the "Origin of Species") in "a crabbed scrawl". This took place in part at Maer Hall in 1842. At this time also, on the basis of his extensive geological experience in South America, Charles was asked, probably through his Uncle Jos, to look out for the presence of "igneous dykes" in North Staffordshire. Such occurrences were thought by an up-and-coming metropolitan geologist, Roderick Impey Murchison, to extend from Shropshire into Staffordshire as a series of "Lines of Elevation". Thus primed, Charles kept his eyes open and is reputed to have discovered two localities where such dykes existed: in the Hanchurch Hills and at Butterson Lodge Gates. In order to celebrate the Millenium, and make symbolic connections with these significant discoveries in the 19th century and the exploration of space in the late 20th century, a member of the North Staffordshire Group of the Geologists Association has ensured that a piece of dolerite from one of "Darwin's dykes" has been flown to the Mir Space Station. It has now returned to Earth and is being displayed in many museums and schools all over the world in order to tell its symbolic story.

The historic Grade I landscape around Maer, and that of the wider Maer Hills, has been the subject of several planning applications since 1980 involving, in various combinations, the establishment of no less than three golf courses, a leisure complex, a small housing estate, or alternatively a sand and gravel pit. The siting of a (golf) hotel at Maer Hall has always loomed large. So far permission has been granted for only one golf course, but this has proved uneconomic. Problems of conservation which arise from these initiatives are the perennial ones of exploitation versus amenity and heritage. These problems will be discussed on site at roughly a dozen localities. Basically the scientific background - geological, ecological, hydrological etc - and the archaeological-historical heritage do not change much, but the value judgements whereby their worth is decided swing to and fro somewhat wildly. So far the heritage of this remarkably harmonious landscape has survived intact. MAERBAAS

## THE EVOLUTION OF CHARLES DARWIN AS A NATURAL SCIENTIST; THE GEOLOGICAL CONTEXT

**The family context of the Darwins and Wedgwoods.** In modern parlance Charles Darwin (1809-1882) is thought of as a "biologist" and only recently has his development as a geologist - the role he wished above all to assume in his early days - been of interest. He was born at the family home, The Mount, on the Welshpool Road out of Shrewsbury.(\*).

EDITOR: FOOTNOTE \* The following accounts are based upon a vast array of excellent sources which have been made available in recent years, but principally the following: Charles Darwin's autobiography, alas written as a relatively old man who was ostensibly writing for the benefit of his children but subconsciously perhaps had posterity in mind (see De Beer 1974); the biographies of Desmond & Moore (1991) and Browne (1995), and the commentaries on Darwin's life and times by Kohn (1985) and Bowler (1990).

His father was Robert Wareing Darwin (1766-1848), a doctor, money lender and accountant to the Wedgwood potteries. He was the son of Dr Erasmus Darwin (1731-1802), of Lichfield, an early evolutionist. His mother was Susanna Wedgwood (1765-1817), the daughter of Josiah Wedgwood I of Etruria Hall, now part of Stoke-on-Trent (\*\*).

EDITOR: FOOTNOTE \*\* The hall has been renovated and is now occupied by a commercial concern; it stands at National Grid Reference SJ 870476.

A signal event in Charles' young life was the death of his mother when he was aged 8. After this event his father became notably lonely and morose and was prone, amongst other overbearing and autocratic things, to subject his children to a monologue for an hour or more before evening meal. Despite Charles' undying profession of love and respect for his father all his life, the children learned to look forward to weekends and holidays when they could escape the oft-times oppressive atmosphere of the Mount. Hence as a small boy and later, Charles frequently enjoyed visits to the home of his cousins and uncle, Josiah Wedgwood II at Maer Hall (SJ 793383) in North Staffordshire (Figs 1, 2 & 3) (**localities 2, 9**). The Hall was soon dubbed "Bliss Castle" by young Charles, a reference to its then somewhat castellate appearance and a part of the building which has since been dismantled. Occasionally he and his sisters visited other friends in the district, such as the Tollets of Betley Hall (SJ 755491) (who ran an improver's farm, Model Farm, now part of Betley Old Hall Farm) and the Sneyds of Keele Hall (the ramshackle old hall, built c.1580, not the present one constructed in 1862, but both at SJ 820448).

It was at Maer Hall that Charles learned to hunt, shoot, fish and entomologise and further develop his taste for natural history (**localities 2-6, 10 & 12**). He also learned the delights of socialising with his sisters, their cousins and the interesting visitors, many of whom were the foremost minds of the day, in a house described by Sandra Herbert (1993) as home of liberality and open-mindedness.

**Schooldays.** As a small boy in Shrewsbury, Charles had learned, and was learning, to collect all manner of plants, minibeasts, minerals and fossils and was encouraged by persons like "old Mr Cotton". He showed interest only in possessing, naming and ordering his specimens - not in understanding their deeper nature and origins. This behaviour accords well with that recorded in psychological studies of the salient events which give rise to career choices of many scientists in later life - many steps are taken in primary school well before the age of ten (see Head 1985, Woolnough et al. 1997). Charles was particularly attracted to mind-blowing theories which had to be generated to account for single accurate observations e.g. the the presence of a Lake District igneous rock in the centre of Shrewsbury (\*) with no present-day river available to transport it from its place of origin to the town; the identification of a single fossil shell of undoubted tropical affinity in the sands and gravels of the Drift close to the town. He was later puzzled, even horrified, that Adam Sedgwick appeared not to be interested in this latter anomaly when he pointed it out to him in 1831. Sedgwick is reported to have said: "If the shell was genuinely embedded there it would overthrow everything that was known about the superficial deposits of the Midlands Counties" (then considered to to be Diluvial deposits DBT). Sedgwick's hypothesis was that "It must have been thrown away by someone into the pit". This illustrates that scientists do not easily ditch their favourite explanations when a serious anomaly arises; they often invent auxiliary hypotheses to protect their ruling theories.

EDITOR: FOOTNOTE \* This rock, celebrated by a commemorative plaque, lies outside the Morris' Hall in

Shrewsbury at SJ 489126. It is described on the plaque as a boulder of granite, whereas in truth it appears to be a rhyolitic-andesitic ignimbrite of the kind well known in the Lake District in the Borrowdale Volcanic Series (Llanvirnian to Caradocian 478-448 Ma).

Charles spent his schooldays with his brother Erasmus (1804-1881) in Shrewsbury, mainly at the Free Grammar School. Neither boy was good at classics - the curriculum of the sons of gentlemen to be. His headmaster, Archdeacon Dr Samuel Butler, failed to see in him any evidence of genius. Indeed, Butler upbraided both boys severely in private and in public for their interest in chemistry and natural history. The eminent theologian had heard of the undesirable smells which emanated from the Darwin boys' experiments in their garden shed when they followed the practices recommended in William Henry's book (1819) "Elements of Experimental Chemistry" - hence Charles's schoolboy nickname "Gas". Progress of both boys was slow. Charles was believed by his father to be in danger of becoming a wastrel and a "good for nothing" and was withdrawn from school. Both boys were regarded as "failures". (The concept and implication of "failure" at school lies deep in the English psyche! Thereafter, throughout his life and possibly as a consequence, Charles always seems to have lacked confidence in himself and in anything he was doing).

**An introduction to Natural History whilst pursuing a medical course at Edinburgh University.** In 1825, at the tender age of 16, Charles was sent to follow his father and grandfather at Edinburgh University, that northern outpost of the Age of Enlightenment. There he joined his brother (recently transferred from Cambridge) in order to study medicine. The curriculum of the first years of the degree was commendably wide and depended on student choices and the payment of fees (shades of the present-day debate!). Charles was able to attend the courses given by Professor Thomas Charles Hope (1766-1844), a flamboyant lecturer and demonstrator in the Department of Chemistry and Mineralogy, and by Robert Jameson (1774-1854) of the Natural History Museum. The latter was a disciple of the world-famous Abraham G. Werner of the Mining Academy at Freiburg. Jameson was a dry old stick who lectured monotonously from notes based on his own books. Both men professed to study the same natural world, but Hope, attracting over 500 students each year, espoused the traditions of the experimental and physical sciences and favoured Huttonian Vulcanism-Plutonism and the viewing of the Earth as a machine driven by internal heat. Alas! Hope had given up researching in order to teach in extravagant ways and he never had his students perform his, or their own, experiments as did his illustrious predecessor Professor Joseph Black (1728-99). By contrast, Jameson, still favoured by as many as 250 students per year, adopted the Linnean-Wernerian approach, whereby Nature was to be investigated in order to reduce it to orderly hierarchical relationships and ranks of classified objects set out in museum cases. Fortunately, however, Jameson encouraged students to handle and investigate minerals, rocks, fossils and modern organisms for themselves in the backrooms of the museum using the simple tools and tests of the day (e.g. goniometers, physical and chemical tests). In addition he encouraged them to attend and contribute to the student Plinian Society (founded 1823) and the Wernerian Natural History Society (founded 1808). He had them read original work as published in journals like the Edinburgh Philosophical Journal (of which he was the editor). Between them, Hope and Jameson's contrasting beliefs and styles made the study of the natural world one of abiding conflict and interest - a prime example of the importance of "creative tension" in promoting effective science education and, indeed, the very progress of science itself.

It was in these circumstances that Darwin further prospered from meeting Robert Grant (1793-1874), a Lamarkian evolutionist, and from going on field trips with him. These were usually to the intertidal zone of the Firth of Forth, during which time Charles debated the theoretical issues of the day, learned the rudiments of personal research and gathered data for his first paper. This he delivered nervously but triumphantly to the student Plinian Society at the tender age of 17. He also learned from Grant, alas, of the tendency of some scientists to develop professional jealousy and an over-acute sense of property and priority. This arose when Grant appropriated a discovery made in his "own" field by his young protege and paraded it in print, albeit without a proper degree and place of acknowledgement.

Darwin later claimed that Jameson's teaching put him off geology for life, but Secord (1985) has suggested that this was not true; the annotations of Charles' textbooks and notebooks (extant in the Darwin library at Cambridge) show that he must have learned much of a practical and theoretical nature from the rich scientific learning environment that Jameson provided. (Indeed, the best schools today always attempt to provide just such an ambience; see Woolnough et al. 1997). In particular, when he was on field excursions with Jameson, Charles learned to believe only his own eyes and not be taken in by forced interpretations of phenomena e.g. the origin of the dolerite dykes cutting the Carboniferous strata on Arthur's Seat and Salisbury Crags in Edinburgh. Jameson described these dykes as *peccipitates* from a universal ocean which were emplaced within pre-existing

neptunian fissures. Having students learn from the negative is a powerful mode which is much used by the present writer!

Sadly, however, the study of medicine proved to be both dull and shocking for the Darwin sons, for in successive years they were unable to stomach the trauma of witnessing operations involving the amputation of the limbs of children without anaesthetic. Hence both withdrew from the University, Charles having learned providentially that there was a safety valve known as Natural History (which very much included Geology) lying beyond any further aspirations that his family might press upon him.

**The education of a potential Church of England minister at Cambridge.** Charles returned home after two years at Edinburgh to discuss his future with his widowed father and, despite grave religious doubts, agreed to go to Cambridge in 1827 on a £400 per annum allowance to study theology with the intention of entering the ministry of the Church of England. There he soon entered into the spirit of the exclusively male student life and became an "idle sporting man" at Christ's College. Fortunately his interests included field excursions on horseback in which he was able to extend his studies developed at Maer and Shrewsbury and collect further specimens, particularly beetles and butterflies. He took a great interest in the efforts of the established churchmen to rationalise geological and other dangerous scientific findings in terms of the revealed world of an omniscient creator and he pored over William Paley's "Natural Theology" (1802). In his leisure time, he managed to avoid the attentions of Rev. Adam Sedgwick (Woodwardian Professor of Geology since 1818) who was the chief proctor responsible for policing the male students' riotous behaviour whilst the latter were carousing about the town. Charles claimed never to have attended Sedgwick's lectures. However, Secord (1985) has found evidence of Charles' discussions of Sedgwick's lectures, perhaps at second hand, and his study of certain aspects of geology, before he left the university. In the event Charles graduated somewhat early, with only a pass degree which placed him 10th out of 178 candidates. Thereafter he was required to spend two terms in residence, during which time he may have attended some of Sedgwick's annual course of 36 lectures. He was no doubt stimulated by the latter's approach to geology as a catastrophist and as a natural theologian who was implacably opposed to the uniformitarian and rationalist approach of Hutton and Lyell. Thoughts of Charles' future career were undoubtedly generated by his stay at Cambridge, for his tutors thought very highly of his promise as a naturalist. In particular, Charles had made a deep impression on the Reverend John S. Henslow (1796-1861), his general tutor of many years standing. Henslow had produced the definitive work on the Geology of Anglesey (1818) and had formerly been the Professor of Mineralogy (from 1822), but by that time (1825) he had been translated miraculously to be Professor of Botany). Indeed, the only formal science which Darwin undertook was two years of Henslow's course in Botany. Darwin soon became known as "the man who walks with Henslow" and was held in some awe by his tutor who once remarked "What a fellow that Darwin is for asking questions!". Teachers will no doubt recognise these very desirable attributes which they aspire to develop in students and will recall how wearing it can become if they are successfully achieved!

**An apprenticeship in field geology with Professor Sedgwick.** In 1831 Charles returned home to Shrewsbury to discuss his future yet again with his father, but this time as a potential vicar of a rural parish. In order to spend his summer profitably, Charles had accepted a suggestion of the Professor Sedgwick that he should make a geological map of the Shrewsbury district. He bought appropriate instruments, practised measuring and plotting dip and strike in his bedroom, and travelled to Llanymynech to start work. Alas! he confessed that the task proved to be too daunting. It has been recently shown (Roberts 1997) that Charles had trouble with his spelling and may have been dyslexic. He recorded data in his field notebooks which, like those of many a modern student, were 180 degrees from the true readings. Help was at hand, however, for Sedgwick had suggested that Charles should accompany him that summer on part of his field season in North Wales, to which end the former would find it convenient to meet him in Shrewsbury, stable his horse at the Mount and stay the night. During these few hours, Sedgwick quickly won the swooning admiration of at least one of Darwin's sisters and was equally rapidly diagnosed as a hypochondriac by Dr Robert, Charles' father! Thereafter for 2.5 weeks Sedgwick was able to tutor Darwin personally in making and plotting geological observations and to induct him into current ways of geological thinking. Very soon, in the Vale of Clwyd, Greenough's (1820) mapping of the Old Red Sandstone beneath the Carboniferous Limestone was seen to be amenable to an alternative interpretation - the rocks could be New Red Sandstones faulted down to a position topographically beneath the older limestones. Hence Sedgwick argued that the Vale of Clwyd had originated by stretching and had sunken in order to accommodate the deposition of the New Red Sandstones - a quite prescient interpretation which hints at the presence of the initial stages of a modern Mackenzie-type extensional basin. Again Charles found this kind of reasoning, and the overturning of established ideas by reference to a few very acute and accurate observations, to be much to his taste. Note, however, that modern historians of

science caution teachers and students not to evaluate ideas from previous ages in any way other than in the historical context of their times.

**The voyage of the Beagle; the fashioning of a Lyellian disciple.** Upon return to Shrewsbury, Charles' discussions with his father resumed, but they were interrupted by a letter from Henslow notifying Charles of an opportunity to sail as a gentleman companion and naturalist with Captain Robert Fitzroy on HMS Beagle. This was a 90ft-long brig, which had been retained by the navy after a successful surveying voyage in order to chart the commercial shipping lanes of South America and parts of the Pacific Ocean over two years. In truth, Charles was 4th choice for this post (after Henslow, Robert Jenyns and one other). At first his father scoffed at the idea of Charles embarking on a career as a naturalist, but later he relented and agreed to fund the venture after Charles had made several visits to Maer in order to enlist the support of uncle Josiah Wedgwood II. The letters recording the initial rebuttal of this wild idea by Dr Robert Darwin (Darwin, R. 1831a,b and the absolutely crucial interventions by Uncle Jos II before the final acceptance of the offer by Charles (Wedgwood 1831), are held in the Wedgwood Archives in Keele and Cambridge University libraries respectively. By such delicate threads hang the career paths of even our most gifted students.

Thus it was that in October 1831 Charles gathered together appropriate instruments and books and made haste to Plymouth to await orders to sail. Meanwhile he read and re-read the books of Humboldt (1814-29) and Herschel (1830) before he received an early copy of volume 1 of Charles Lyell's "Principles of Geology" (1830) from Captain Fitzroy. He began to devour the ideas quite avidly, and quickly came to recognise the superiority of Lyell's uniformitarian methodology over previous theoretical approaches. He became eager to test Lyell's ideas at the first landfall in the Canary Islands.

The Beagle set sail in late December and did not return until nearly 5 years later in 1836. During the years 1831-1836 Charles tested Humboldt's conclusions and Lyell's Principles very successfully, first around St Jago in the Canary Islands and, later, more fully in Brazil, Uruguay, Argentina and Chile. He sent back frequent letters detailing his discoveries, ideas and conclusions (Burkhardt & Smith 1985). Boxes of specimens and new conjectures, e.g. concerning the origins of large extinct fossils like the Megatherium, were frequently received by Henslow and read out both in Cambridge and at the Geological Society of London (GSL). Because of the episodic and tardy arrival of the ship's post, Charles had no idea of the the scientific excitement that his labours were causing in the British Isles. Indeed at times he was in despair at the lack of replies to his many queries and requests for guidance. Not for the first time did he have self-doubts about his future as a geologist and naturalist. Charles collected data and generated ideas avidly and eventually published them in his "Journal of Researches into geology and natural history ..." (1839), "Geological Observations on South America" (1846) (including a vivid account of the effects of the Concepcion earthquake and a prescient theory of magmatic differentiation beneath the Andes).

As the survey moved into the Pacific, he had formulated his own theories on coral islands before he had landed on one (published seven years later in 1842) to counter those of Lyell and others. He added many facets to his notes on volcanic phenomena which were eventually published as "Geological Observations on Volcanic Islands" (1844). All this, and much more, served to confirm his standing as the most experienced and promising of the young geologists and he was even more lionised back at the GSL before the Beagle docked in Falmouth in 1836.

**A return to a scientific life in London.** After 5 years travelling, and experiencing many events (including persistent sea sickness), which he had no wish ever to repeat, he hurried home to the Mount in Shrewsbury. He was soon recounting his adventures to his father and sisters and then to his uncle Jos and his cousins at Maer Hall (localities 2, 9). Soon he settled in London in order to unwrap his voluminous specimens and enlist the support of experts in examining them and writing up the implications. At first he resisted, then accepted, the post of Honorary Secretary to the GSL (1838-1841). This act placed him at the very centre of scientific influence and power in London. Amid the radical political ambience of the 1830s and 1840s (strikes, Chartist riots, pamphleteering re slavery, sectarianism), he settled down to write and edit the many books and reports stemming from the voyage. Alas! he soon suffered from bouts of illness which have never been adequately accounted for, and these restricted his further development as a geologist. His only forays relating to field geology after his return to England were to describe and account for: (i) the Parallel Roads of Glen Roy in terms of marine erosion and uplift comparable to that of Chile (an interpretation which caused him acute embarrassment in future years) and (ii) the landscape of North Wales in terms of glacial erosional and depositional processes (as introduced into Britain by Louis Agassiz and championed by Rev. William Buckland.

the latter being readily converted to the new land-ice faith).

During all this time, Charles returned as frequently as possible to Shrewsbury and Maer, often arriving exhausted by stagecoach at the Lion Inn in Shrewsbury or the Crown Inn, Stone, Staffs., at which latter place he was picked up by phaeton for transfer to Maer. Whilst at Maer, he continued his exploration of the delightful parkland landscapes fashioned by Jos. Wedgwood II and Johnathan Webb, the landscape architect, between 1805 and 1822. Miraculously this landscape has survived intact to the present day and is preserved as a Grade I landscape (hence on a par with Castle Howard and Blenheim), together with the grade II Maer Hall and grade II tunnelled approach way to the hall and village. His long walks often took him further afield into the local countryside and to the estates of the gentry, for example at Keele, Betley, Trentham and Swynnerton.

**The Origin of Soil.** Very soon (1836-7) Charles heard from Uncle Jos of the strange dispositions of the soil in a field alongside William Dabb's peaty bog meadow and Croft (SJ 780384) (see Figs 2 & 7) (**locality 8**). "Burnt marl, lime and cinders", and other recognisable material, spread on the top of the field 80 years ago to counteract poor drainage and acidity, was now found 12-14 inches below the surface. Uncle Jos offered the conjecture that this was somehow due to the actions of the worms which were so common. This idea became known in the family as "Ye Maer Hypothesis" of Josiah II (Elizabeth Wedgwood to Charles Darwin 10.11.1837, in Burkhardt & Smith 1985, p.55). At that time there were contrasting theories of the origin of soil, the Wernerian view being that soil was the last deposit of a retreating universal ocean. Elie de Beaumont (1829) had followed this by opining that soil was the most unchangeable, inert material on earth. By contrast Hutton and Lyell explained that soil was due to the underlying rocks being physically and chemically broken down, so providing a mantle of material which could be eroded, transported, deposited, buried, lithified, uplifted and recycled endlessly. In both theories, the role of earthworms was not particularly considered. Charles seized upon Jos' conjecture and determined to put it to observation and investigation, thus beginning an interest in experiments on worms which went on and off for the whole of his life. Charles produced his initial findings in a paper to the GSL which was very well received in 1837 (Darwin 1838, 18740). These observations caused quite a stir, not least because his calculations of the annual turnover of soil by passage through the alimentary systems of worms amounted to 18 tons/acre/per annum. Charles went on to take an interest in this subject all his life, culminating in his experiments at Downe in Kent, involving the construction of his intriguing apparatus on the lawn at Down (sic) House and his best-selling book "On vegetable mould...." (1881).

By 1838, aged 29, Charles contemplated life without marriage and decided that he ought to write down the pros and cons of seeking a wife. Having answered himself in the affirmative, he thought that he should first ask his cousin Emma Wedgwood (Fig. 4) of Maer Hall (**locality 2**) whom he had known from childhood and who had supported him so staunchly whilst he was away at sea. On Sunday 11th November 1838 he summoned up courage to propose to her and, somewhat surprised and taken aback, she accepted hurriedly before dashing off to teach the children of Maer Sunday School. The couple were married on 29th January 1839 in St Peter's Church, Maer (**locality 11**), in front of a very small congregation of family friends. The registration of the marriage is the second entry in what was, until very recently, the current register (!). A copy of the now famous certificate is conveniently posted on the noticeboard in the porch of the church. Students of all ages today are always somewhat abashed to realise that Emma, then aged 31, was to bear Charles 10 children in subsequent years.

**The discovery of dolerite dykes in North Staffordshire.** Charles continued to visit Maer frequently and his interest in the area became both professional and social. In London he was in monthly contact with Roderick Impey Murchison (1792-1871) (a rising star of the geological firmament who was in process of composing his massive tome "the Silurian System" eventually published in 1839). Murchison had been scouring the Welsh Borderland looking at the Lower Palaeozoic strata and their cover rocks. He had observed the intrusive and extrusive rocks of the Breidden Hills (now known to be Ordovician) and the trend of the landscape features to which the geological structures give rise (Fig. 5). He recognized two lines of hill masses in the Breiddens. He noted that they were aligned NE towards Clive, Grinshill and Acton Reynald (where dyke rocks cutting the New Red Sandstone had been discovered by the local architect John Carline II and pointed out to Murchison on two visits in 1834). He believed that the two lines of hill masses including the dykes, passed onwards towards Hawkstone and eventually passed through Goldstone Common (SJ 71.28) (where cuttings on the Shropshire Union Canal had recently revealed severe cross faulting of more or less the right direction). The trend was said to be continued in the high ground in Staffordshire in the Ashley Hills (SJ 74.35) and beyond. Murchison was keen, perhaps overkeen, to relate these phenomena to the latest and most beguiling theory of the structural



origin of mountains; the theory of "Lines of Elevation" and "Craters of Elevation" of Elie de Beaumont (1829 and subsequently) and Leopold von Buch respectively. Confidently he predicted that dykes would be found associated with the high ground of North Staffordshire. As was his style, Murchison dashed off a letter explaining his ideas to his friend Robert Garner, physician-surgeon at the Infirmary in Stoke-on-Trent and personal doctor to Josiah Wedgwood II (Kirkby 1894; Anon 1986). Garner did not find any dykes personally, but Kirkby notes (1894 p.130) that "a dyke was discovered some time afterwards by Darwin who was on a visit to Josiah Wedgwood at Maer and told him of it. Mr Wedgwood told Mr Garner, and the latter has it marked in (sic) the map illustrating his History of Staffordshire" (1844, p.206 and map) (**locality 12**). The hand-coloured map of 1844 shows a dyke extending NW-SE for 2 km from a point 0.2km north of the Trentham-Stableford Road (SJ 838.402) southeastwards to an area SE of Harley Farm (SJ 847.387), this extent being no doubt an exaggeration due to the difficulty of locating and depicting a narrow dyke on a small-scale map. Garner's account by contrast (1844 p.206), only states that Josiah Wedgwood pointed out the dyke to him "by the road from Hanchurch to Stableford" where modern studies have confirmed the presence of 2 or 3 dykes (Fig. 6; Thompson and Winchester 1996). Darwin is furthermore credited with discovering a second dolerite dyke (now known to be of the same swarm and suite) cutting across a narrow lane near Butterton Lodge Gates (ibid.) (**locality 13**). The exact date of Darwin's discoveries of the dykes is not known but consideration of all the circumstantial evidence suggests that this occurred in 1842.

**The Origin of Species.** 1842 proved to be the year in which Charles first attempted to commit his long-lasting thoughts on the transmutation of species to written format. He had begun keeping notebooks on this topic 5 years previously. The context in which such ideas gestated owe much to his geological background. During his years at sea and afterwards, he had tested the ideas of Hutton, Lamarck, Cuvier and Lyell and was in process of slowly developing his own. Quite crucially he had witnessed the slow growth of the Huttonian concept which we now know as "Deep Time". By 1840 a more or less reliable geological timescale had been developed through the efforts of William Smith and others and was summarised by John Phillips in the Penny Cyclopaedia around 1840; thus aeons of time appeared to be available for the origin and development of life and landscapes.\*

EDITOR: FOOTNOTE \* Thus by 1859, Charles was able to speculate upon the age of the Weald. Assuming a uniformitarian rate of marine erosion of 1/2 an inch per century, he had calculated an age of origin of the Wealden pericline as 306 662 400 years. When this figure appeared in the first edition of the Origin of Species (Darwin 1859), it became the focus of immediate and sustained attack. As a result of allowing this weak line of argument to be highlighted, he had to quickly withdraw this "godless" illustration from all later editions (see Leakey 1979).

Darwin had pondered also on the multiplicity of species, their geographic distribution, their differences, their competition for food and survival etc. and he had eventually read Malthus' essay in 1838. Thus despite episodic bouts of illness, he was well enough to sit down at Maer Hall (**localities 2, 10**) at the age of 34 during May 1842 to write a "garbled" pencil sketch of only 35 pages of "crabbed elliptical scrawl" (Browne 1995) which nevertheless epitomised his salient ideas on the transmutation of species over geological time. This initial outline of what became known as Natural Selection was revised in a longer draft of c.250 pp at his new home at Downe in Kent in 1844. The final version was projected to be a 3 volume work, but this never got off the ground in the light of the arrival of Alfred Wallace's rival paper, disclosing similar ideas, which was first received in London in 1856. Eventually "Origin of Species" was published as one volume in 1859.

There have been endless speculations about the non-publication of such a major scientific and philosophical work in the years between 1844 and 1859. These relate to Darwin recognising several factors: the misgivings of his much-loved and deeply religious wife; the likelihood of his suffering social ostracism as a consequence of publishing heretical works so counter to the teachings of Genesis and/or Natural Theology, and the likelihood of public criticism bringing on further bouts of (psychosomatic?) illness.

**A quiet but scientifically productive life at Downe, Kent, 1842-1882.** The rest of Darwin's career after he "retired" to Downe in 1842, to work quietly on largely non-geological topics, need not concern us. Suffice to say that it was nearly 20 years after he returned from the voyage of the Beagle before his biological publications began to outnumber his geological contributions to our scientific and philosophical heritage. Students may be encouraged to ponder why Darwin at the height of his powers as a scientist in the 1860s was never ennobled or knighted (as had been Henry de la Beche, Lyell and Murchison before him), and why, after this rejection, he came to be buried close to his hero Lyell in Westminster Abbey.



The house, gardens, greenhouse-laboratories and sandwalk at Down (sic) House are now managed by English Heritage. Having been renovated and conserved at great cost, they are due to be opened to the public in April 1998. They are well worth a carefully planned school visit. Entry is only by timed ticket and by pre-booking at least one day in advance. Telephone 0870 6030145.

With such a background in mind, it is now appropriate to set down the details of the celebratory field excursion.

#### THE ITINERARY OF THE FIELD EXCURSION

The following is an itinerary for a half-day or full-day field visit in North Staffordshire, to Maer, the Maer Hills and adjacent localities of Darwinian interest, which seeks to capitalise upon the educational opportunities which are offered by the local area. The route and the educational strategies described are exactly those which were used for the Celebratory Excursion of the 30th ESTA Conference on Sunday 21st September 1997.

**Safety and other advice.** Almost all the localities visited present few (other than normal) dangers to visitors. Hard hats should be worn if visitors inspect the headworks of Amey Roadstone's crushing and sorting plant at Willoughbridge. The excursion leader acknowledges the kindness of Mr Melvin Stanier for permitting access to ARC's sand and gravel pit on a Sunday afternoon, and Mr Dain of Maer for ensuring that St. Peter's Church is open to visitors on the day of our visit.

#### Localities to be visited and the educational strategies adopted

1. **An introductory talk in the carpark at Keele** using maps, books, diagrams, OHPs. The identification of the whereabouts of Keele Hall which the Wedgwoods and Darwins would have occasionally visited.
2. **Travel Keele - Whitmore - Baldwins Gate - Maer village** setting the scene (Figs 1, 2 & 3). Observe the position of Whitmore Station on the Grand Junction Railway line (opened 1837) from which place Charles and Emma Darwin departed on honeymoon to London on January 29th 1839 - perhaps a 10 hour journey. It is reputed that they carried sandwiches and mineral water and that Charles worked partly on data collected on the annual migration of the local toads from church hill to the pool at Maer. Seek out the position of the roadside warning sign "Beware of the toads" alongside Maer Hall, which has unfortunately been removed by vandals recently.
3. **Retrace the route in part to enter the Maer Hills via Slymansdale, Camp Hill and Camp Hill House.** (Fig. 2). The former house was built for an unmarried daughter of Josiah Wedgwood II, Elizabeth Wedgwood, a formidable lady. The variety of trees in the grounds results from landscaping in the 1820s.
4. **Stop at the small quarry at SJ 780405.** (Fig. 2). Investigate the rock types and a small fault. Analyse the differences of ecology and soils on the Keele Sandstone and Mudstone Formation (290 my Carboniferous) to the east (brown forest soils and deciduous forest), and on the Kidderminster Pebble Bed Formation (245 my Triassic) to the west (acid podsoles with former heathland giving way to planted conifer forest). Walk southwards along a footpath running SSW towards the BBC radio transmitter on Camp Hill in order for students to investigate and record the contrasts in the two ecologies.
5. **Understand the structure of the Kidderminster Pebble Bed escarpment aligned E-W on the north of the Maer Hills and its dip slope on the south.** (Figs 2, 3 & 8). Ride westwards along the base of the scarp. Note that the present major land use is largely that of a conifer forest. Contemplate the alternative land uses of the area: (a) acid podsol heathland devoted only to leisure pursuits like rambling and shooting; (b) conifer forest (as at present); (c) a projected sand and gravel quarry of 67 acres; (d) two golf courses, a leisure/hotel complex, plus small housing developments (of luxury houses on the one hand and another group of more modest low-cost housing on the other). (See Newspaper Cuttings in the Staffordshire Evening Sentinel 1983-1991 cited in the references; see also Wild et al. 1983; Thompson 1992).
6. **Travel round the north side of the Maer Hills until the east-west scarp ends abruptly on the**

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employment prospects locally, length of period of working, reaction of the local population, regional needs for constructional aggregate, national needs for the same etc

8. **Retrace the route to the A51 and ride eastwards through Blackbrook and the turn right to take the lane to The Bogs a peat-filled glacial overflow channel.** (Figs 2 & 7). Locate William Dabbs' Cottage (SJ 780385). This broad valley is related to overflow of meltwaters from the last push of the last ice sheet (the Devensian 23000-13000 years ago; see Fig. 8). The cottage and croft is the site of the place where Josiah Wedgwood II interested Charles Darwin in devising their Theory of the Nature and Origin of Soil as a result of the actions of earthworms (see Darwin 1838, Darwin 18740).
9. **Retrace the route to the A51 and continue eastwards to Maer Hall, Maer Church and Village (SJ 79.38).** Note the nature of the Wedgwood Parkland surrounding Maer Hall, a conservation area (Fig. 9). This is the result of landscaping by Johnathan Webb (a pupil of the more famous John Eames; in turn a student of Capability Brown) between 1805 and 1822. The landscape has miraculously survived virtually intact but has been under threat of development as a golf course for the area (See Cole 1991; Keynes 1991; Thompson 1991; Richmond 1992; Newcastle Borough Council 1992; Goodway 1993; Herbert 1993). The owner has informally let it be known that the Hall is suitable as a hotel though no planning application has been made.
10. **Travel into the village and turn westwards up the lane alongside a wood towards Bates Farm.** At the right angle in the lane (SJ 787383), gain a vantage point on the old Woore-Maer road (now a grassed-over trackway surfaced by glacial erratics of Lake District-Southern Uplands types) overlooking the Maer Hills to the north. Evaluate the geological structure of the area: the effects of the Madeley and Sidway Faults in relation to the intervening block of the Maer Hills Forest. Evaluate the origins of the landscape in relation to the structure of the area (Fig. 3). Recall the palaeogeographies of Lower and Middle Triassic times with which these rocks are associated (Fig. 10; see also Steel & Thompson 1983). Evaluate whether the development of a sand and gravel pit of the kind seen at Willoughbridge could be hidden in Maer Forest, or would stand out as "an unacceptable blot on the landscape", as the conservation group, "The Friends of Maer", contend. Walk back down the lane alongside "Hogshead Wood", the woodland copse full of pheasants. This wood was scheduled to have the fairway of the 17th hole of the proposed golf course cut through it. Locate the spring and pond which form the headwaters of the River Tern and feed Maer Pool (a biological SSSI) (SJ 790381). Imagine young Charles Darwin visiting his uncle Josiah Wedgwood II between 1815 and 1831, 1836 and 1842. This area, and that of the Maer Hills generally, is where he learned to hunt, shoot and fish; to entomologise and geologise; so establishing the background and experiences upon which his book "The Origin of Species" would eventually be written. At first he wrote a 35pp pencil sketch at Maer Hall in the summer of 1842 (5 years after opening his "transmutation" notebooks). Stop and overlook the hall where all this took place from selected vantage points on the lane (SJ 790381).

This is the sublime environment in which Charles courted his cousin Emma, wrote down the pros and cons of marriage and, eventually, plucked up courage to propose to her on "his day of days", in November 1838.

Estimate the quality of the landscape hereabouts on a scale 0 (a blighted place) to 10 (a sublime vista) using the scheme developed and used with PGCE students at Keele University's Education Department.

11. **Retrace steps to St Peter's Church, Maer.** Here the marriage of Charles and Emma took place (Fig. 4). The record of the wedding is the second in the Births, Marriages, Deaths Register, being witnessed on January 29th 1839. A copy of the entry is posted conveniently in the porch of the church. Outside, to the west, note the position of the grave of Josiah Wedgwood II and his wife Elizabeth (nee Allen of Prescelly) (Welsh slate over English limestone which is weathering rather badly due to the acid drips from the branches of the yew trees). Perhaps meet Mrs Jane Cole or Mrs Mary Johnson, local persons who have been involved in leading conservation battles both in the Maer Hills and with respect to Maer Hall. In the past we have had students interview these ladies with respect to the social, scientific and other conservation issues related to Maer Hall, the Maer Estate, the Maer Hills and the area generally.
12. **Travel from Maer, following the probable route of one of Charles Darwin's long walks or**

horse rides, via Chapel Chorlton (SJ 81.37) and Stableford (SJ 816388) to the Hanchurch Hills. (Figs 1, 2 & 6). In the last area (at SJ 840400), Darwin is reputed to have located a dolerite dyke under or alongside the road from Trentham to Stableford, around 1842, having been primed to do this (whether directly or indirectly is unknown) by Roderick Impey Murchison. The latter had devised a new and beguiling theory of the origin of hill masses and other elevations in North-Central Shropshire which predicted that igneous dykes should be found in North Staffordshire. Reflect on the great value of the use of totally ill-founded theories in science!

13. **Travel to the lane near Butterton Lodge Gates (SJ 832428).** (Fig. 6). Here on the former main road from Market Drayton to Newcastle (through Butterton village), Darwin is credited with finding a further exposure of the dolerite/basalt dyke of North Staffordshire using the same ill-founded theory. Today the dyke cannot be located on the roadside but field diagrams of Walcot Gibson dated 1896 are very precise in identifying the former presence of such. The lines of two dykes hereabouts has been confirmed by geophysics by Sowerbutts (see a summary in Thompson and Winchester 1996).

**Acknowledgements.** The author is grateful to Chris King and John Stanley (University of Keele) for their kindness in commenting on an early draft of this account. Mr Melvin Stanier is thanked for permitting access to ARC's Willoghbridge Quarry over the last 10 years and Mr Dain, Senior, churchwarden of St Peter's Church, Maer, is congratulated for ensuring that this church is so often kept open for visitors on so many days per year.

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#### Captions for the figures

Figure 1. A map of part of North Staffordshire showing the route of the excursion (arrowed) and the 13 numbered localities visited in connection with the demonstration and investigation of modern conservation problems in relation to Charles Darwin's experiences and discoveries in the area c.1815-1843.

Figure 2. A 1:50000 geological map of the part of North Staffordshire to illuminate the connection between modern geological mapping, conservation problems and Charles Darwin's experiences in the area (by kind permission of the British Geological Survey).

Figure 3. A geological cross-section of the Maer Hills and the area around Maer village. KPBF = Kidderminster Pebble Beds Formation; WSF = Wildmoor Sandstone Formation; BSF = Bromsgrove Sandstone Formation; MSF = Maer Siltstone Formation.

Figure 4. Charles Darwin (1809-1882) in 1840 and Emma Darwin (1808-1896) in 1839, the latter at the time of their marriage in St Peter's Church, Maer.

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#### Captions for the figures

Figure 1. A map of part of North Staffordshire showing the route of the excursion (arrowed) and the 13 numbered localities visited in connection with the demonstration and investigation of modern conservation problems in relation to Charles Darwin's experiences and discoveries in the area c.1815-1843.

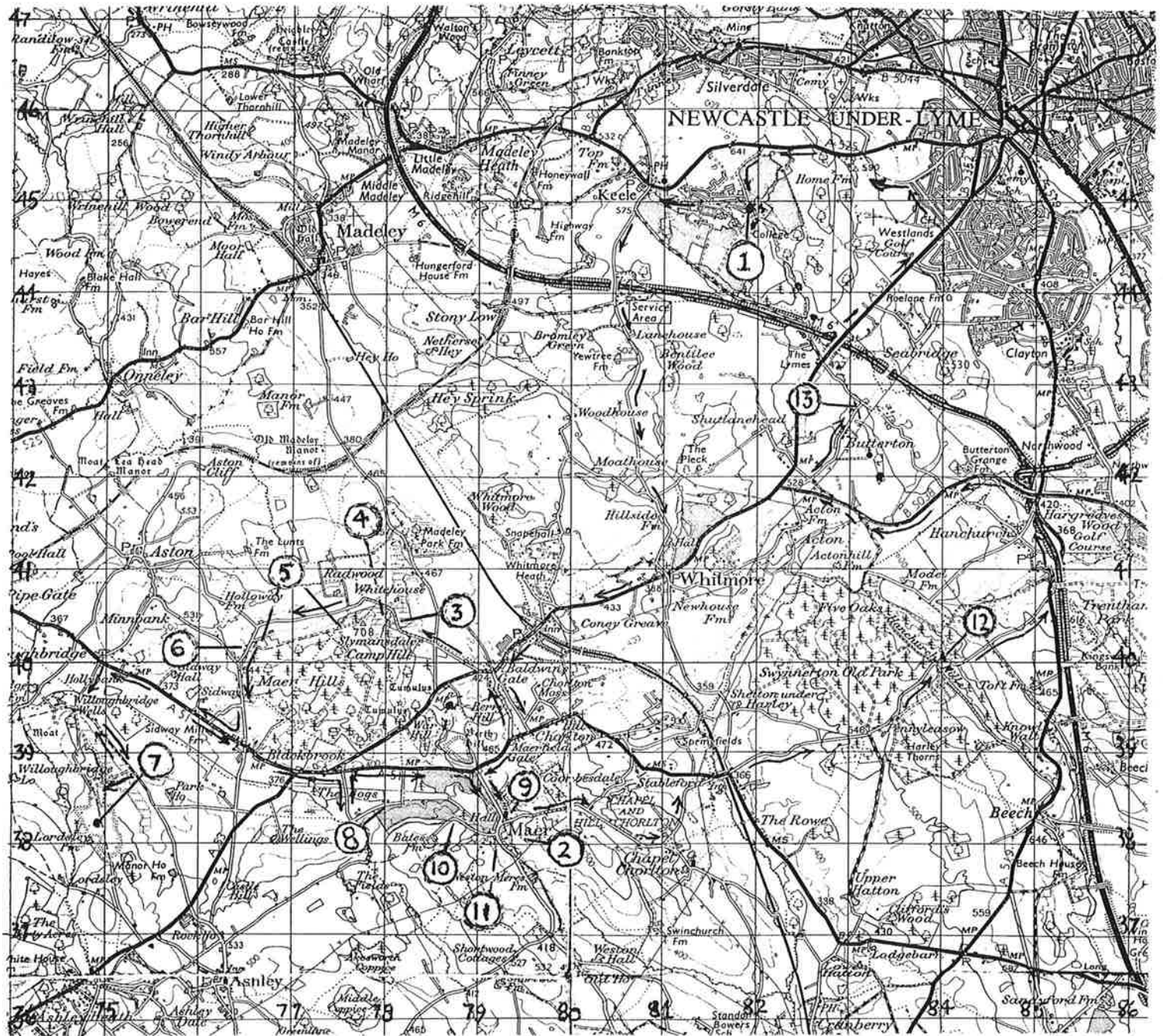
Figure 2. A 1:50000 geological map of the part of North Staffordshire to illuminate the connection between modern geological mapping, conservation problems and Charles Darwin's experiences in the area (by kind permission of the British Geological Survey).

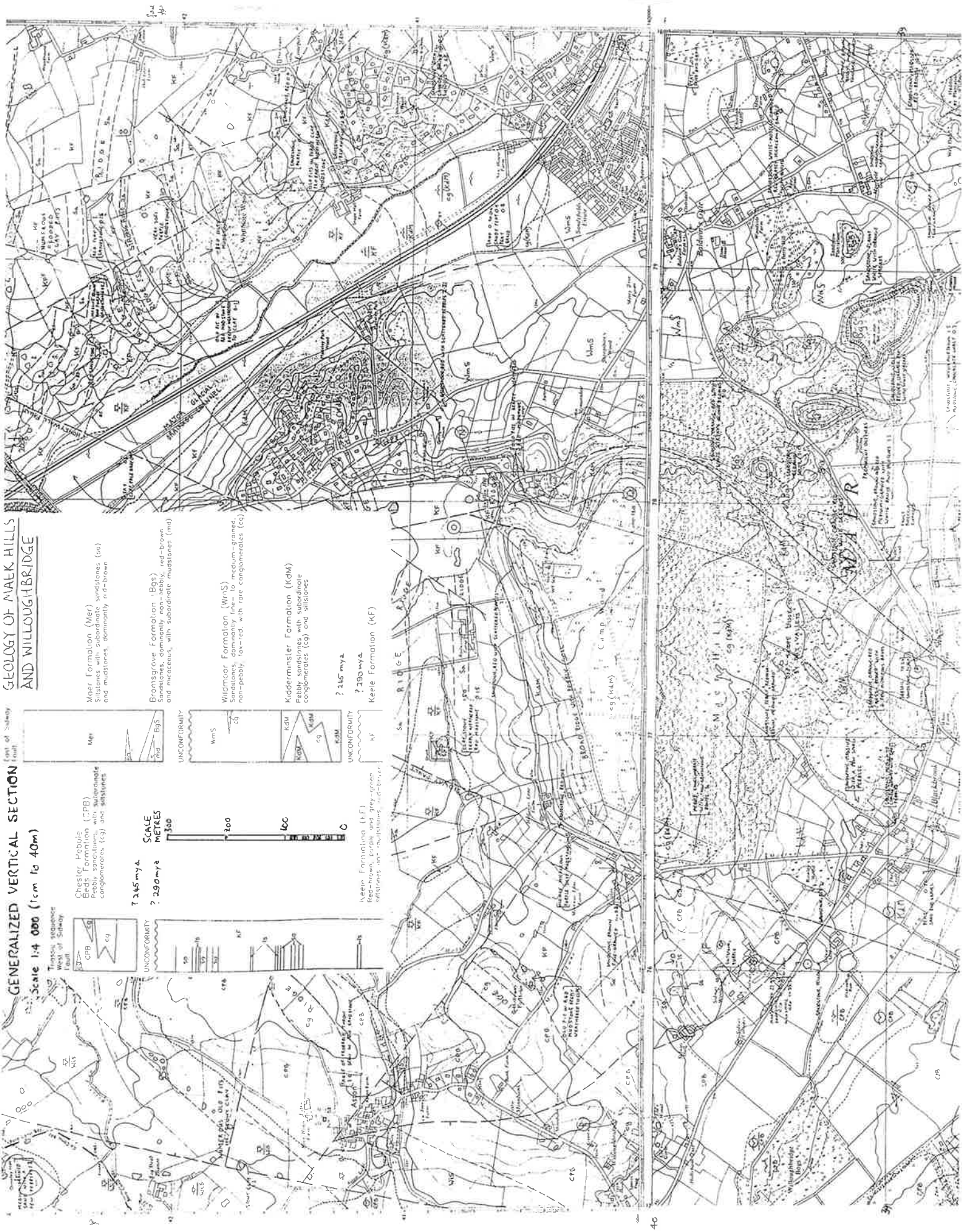
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26 March 2013







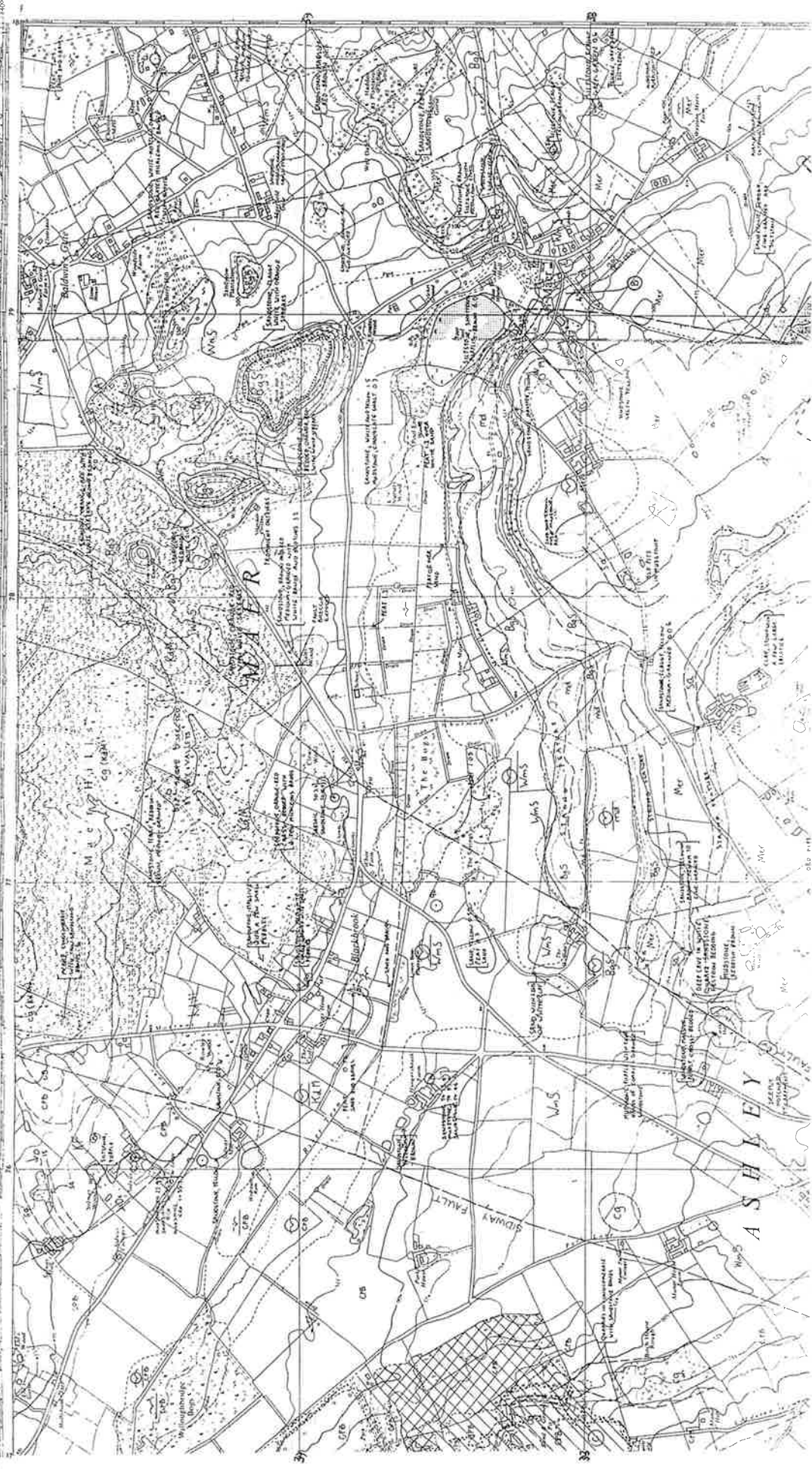






FIG 2.

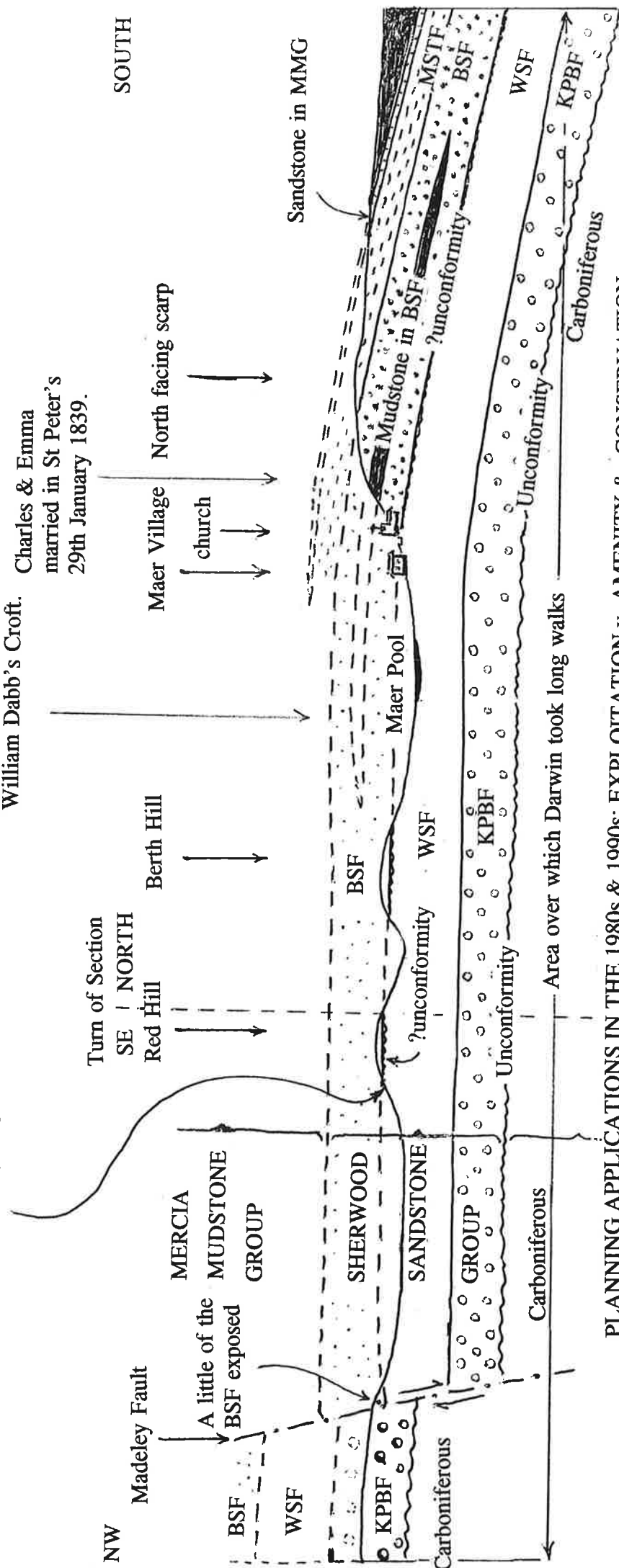
Scale 1:50 000

Contours are at 10m vertical intervals

**FIG 3** A DIAGRAMMATIC SECTION ACROSS THE MAER HILLS AND THE MAER ESTATE AND VILLAGE  
**MAER HILLS & FOREST**

The present level of erosion of the landscape  
 - due largely to glacial and post-glacial events

**THE MAER HALL ESTATE**  
 Pencil sketch (35pp)  
 of Origin of Species  
 written in Maer Hall  
 in 1842.  
 Charles & Emma  
 married in St Peter's  
 29th January 1839.



**PLANNING APPLICATIONS IN THE 1980s & 1990s: EXPLOITATION v. AMENITY & CONSERVATION**

**MAER HILLS & FOREST**

1. For sand & gravel pit of c.65 acres - refused.
2. For single golf course - accepted but not built.
3. For two golf courses, leisure complex, hotel, houses - refused.

**THE MAER HALL ESTATE**

1. For single golf course & club house - refused twice.

0 0.5 1  
 Approximate horizontal scale  
 Vertical scale very exaggerated

FIG. 4

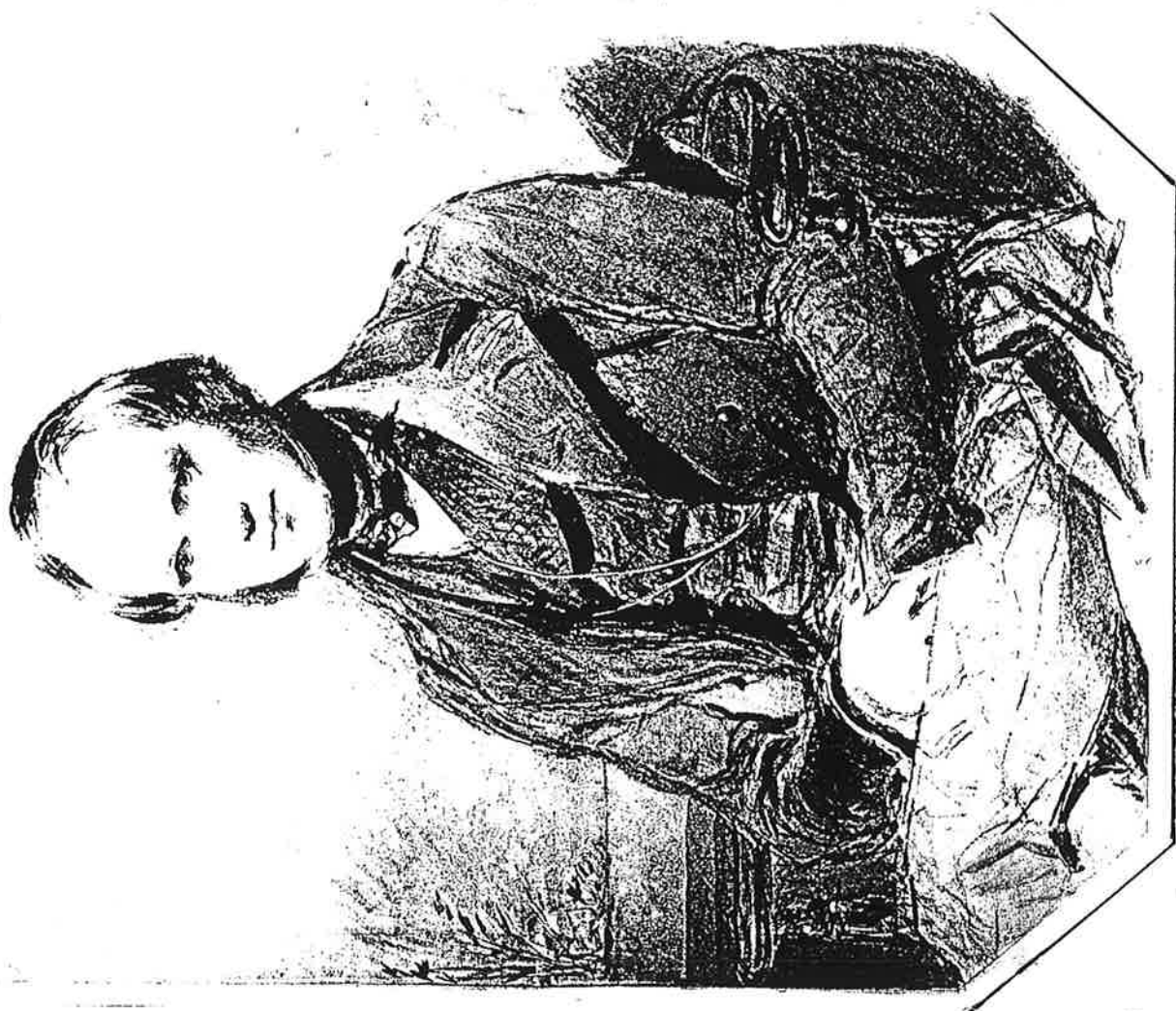
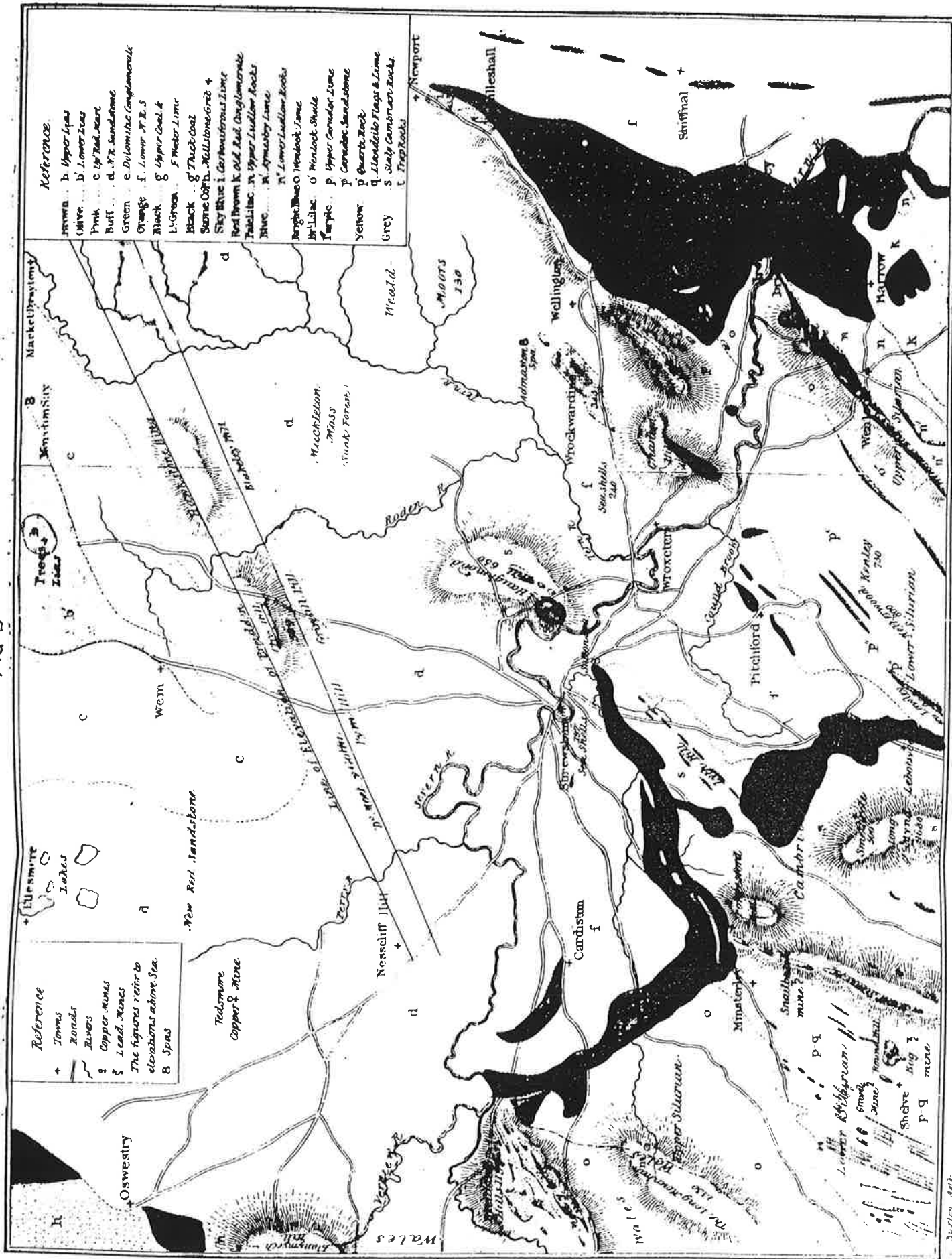




FIG 5



Map & Hinge, looking "to the future"

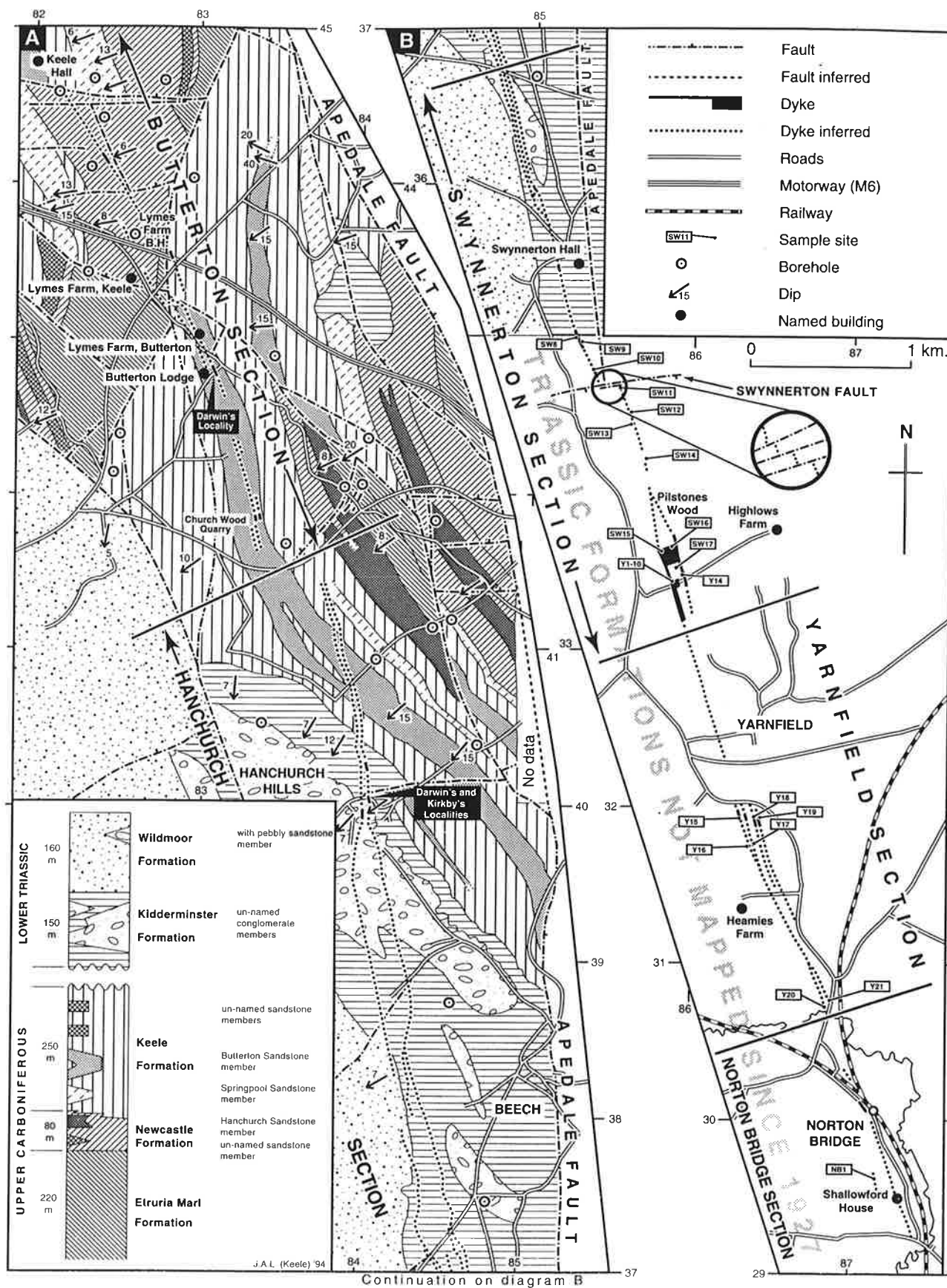


Fig. 3. Geological map showing the outcrop and near-surface existence of the Staffordshire dykes based on fieldwork by the authors and geophysical investigations (the latter by courtesy of the British Geological Survey and W. T. C. Sowerbutts 1987, 1988 and pers. comm.).

Fig 7 Madeley and adjacent areas. Present and suggested former drainage patterns and major watershed breaches

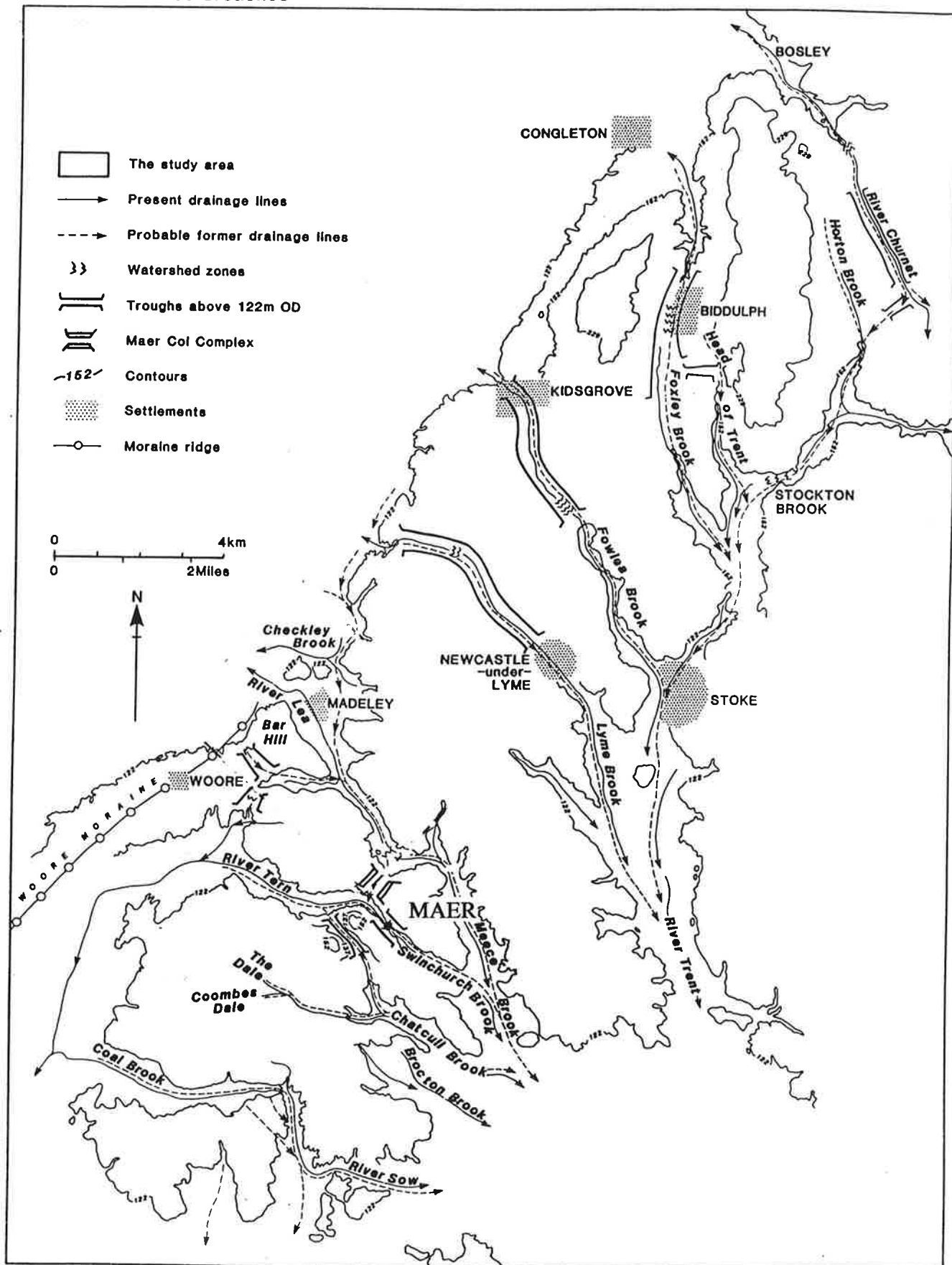


FIG. 8

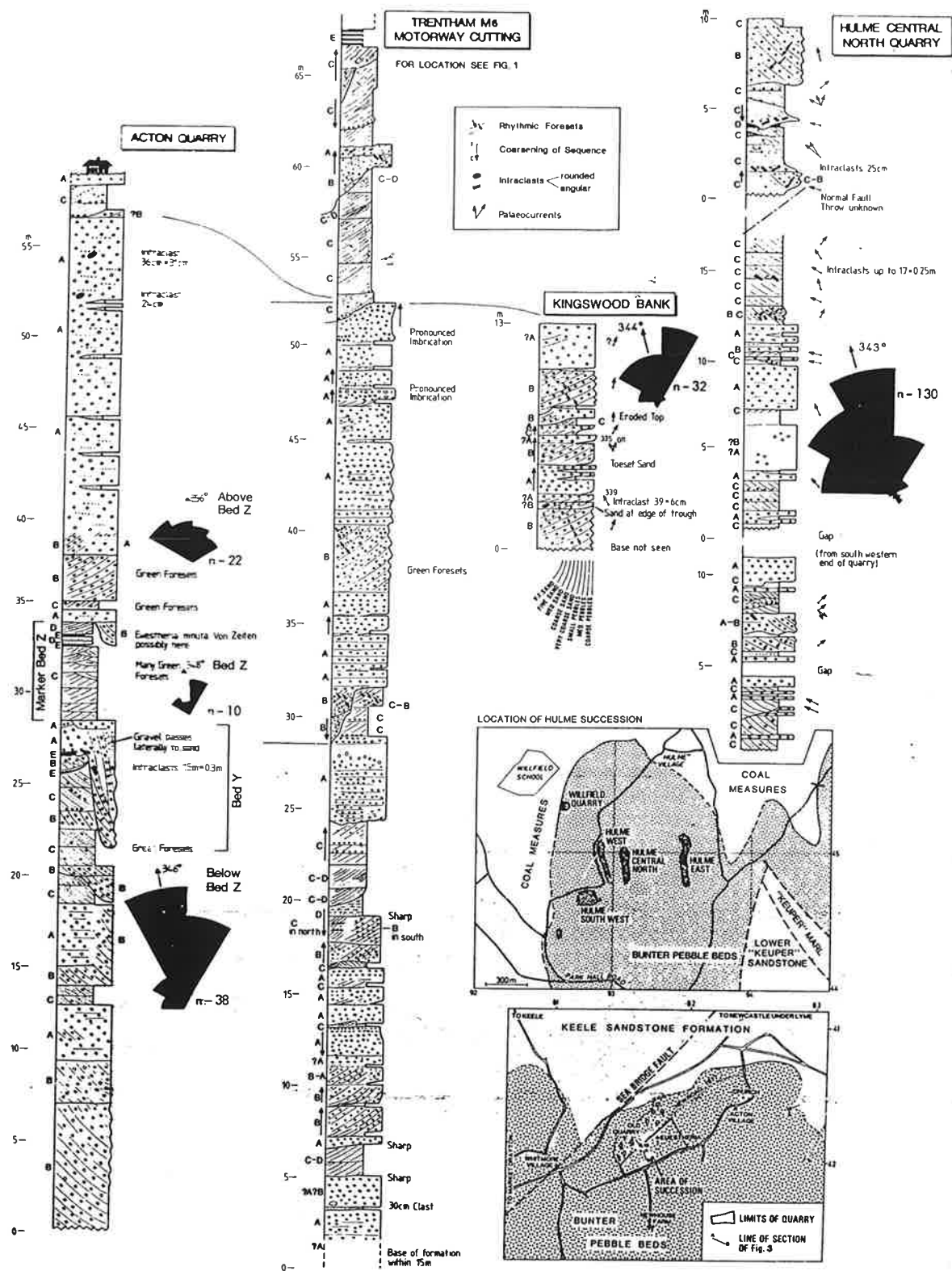


Fig. 8. Typical successions in the Bunter Pebble Beds of North Staffordshire. (a) Acton Quarry (Messrs J. Cooper of Widnes); see inset map for location. (b) Trentham M6 Motorway Cutting; see Fig. 1 for location. (c) Kingswood Bank Quarry, Trentham; see Fig. 1 for location. (d) Hulme Central North Quarry (now known as the Play Canyon); see inset map for location. Geological map of the Hulme area after the Institute of Geological Sciences 1:63360 map, 1923.





