RECORD: Roberts, M. B. 2023. A longer look at the Darwin-Sedgwick tour of North Wales, August 1831. In John van Wyhe ed., 2002- *The Complete Work of Charles Darwin Online* (http://darwin-online.org.uk/)

A LONGER LOOK AT THE DARWIN-SEDGWICK TOUR OF NORTH WALES, AUGUST 1831

Michael Roberts

Summary

Before he received the invitation to join the *Beagle* Darwin spent most of August 1831 in North Wales. By comparing Darwin's and Sedgwick's notes this study works their route from Shrewsbury to Bangor in detail and discusses the geology learnt by Darwin. Darwin's geological notes at Quail Island make it certain that he went to Anglesey. It is highly probable that Darwin spent a week there with Sedgwick and possibly accompanied him to Dublin. During his time with Sedgwick Darwin learnt much about sedimentary rocks in the Vale of Clwyd; igneous rocks in Snowdonia and Anglesey and, most importantly, 'altered' rocks in Anglesey. They both made considerable use of Henslow's 1822 Memoir and Darwin's visit to Anglesey which may help explain why he made so much use of this publication in relation to his geology on the *Beagle* voyage.

Contents

A LONGER LOOK AT THE DARWIN-SEDGWICK TOUR OF NORTH WALES, AUGUST 1831

Michael Roberts

1. Introduction

Darwin spent most of the summer months of 1831 living at home in Shrewsbury, having come down from Cambridge in the spring. He spent his time geologising and learning Spanish for a proposed expedition to Tenerife. As well as studying the geology of Shropshire with varying degrees of success, he was also invited by Adam Sedgwick to join him on his first visit to North Wales to elucidate the Transition strata, now known as the Lower Palaeozoic. That geological tour of North Wales with Sedgwick was extremely important to him. There is no doubt about this, as he mentions it in his *Autobiography* and in several letters to friends and family. The deceptively simple route is familiar to readers of his *Autobiography* or one of the biographies.

The first detailed study of the tour was made by Paul Barrett[1] in 1973, which raised more questions than answers concerning the precise route and duration. Secord[2] continued his work on the Cambrian–Silurian controversy with an overview of Darwin's development as a geologist. My own interest stems from the reading of that paper[3]. This account continues that work and I have sought to elucidate the route and purpose in detail. Initially I accepted that the Darwin-Sedgwick tour lasted a mere week and that they travelled from Shrewsbury to Capel Curig where they parted company as Darwin wrote in his *Autobiography*[4]. As the route and duration of that part of Darwin's tour seemed straightforward I focused on his solo walk across the hills to Barmouth and showed that his route did not follow a compass bearing from Capel Curig to Barmouth but rather 'meandered' through the mountains.[5] Further, it became clear that Darwin and Sedgwick parted company before visiting Cwm Idwal and from a reference made in his notes of Quail Island on 17 January, 1832, he had also visited Anglesey. I thus concluded that Darwin went with Sedgwick to Holyhead and then continued on his own to Barmouth. This gave a seemingly coherent account of the route and chronology, with Darwin arriving in Barmouth on 17 August. However, further research on manuscripts and the use of Henslow's *Geological Description of Anglesey*[6] while on the *Beagle* points to Darwin spending longer on Anglesey, almost certainly with Sedgwick.

Darwin returned to The Mount at Shrewsbury from Cambridge in June 1831. His letters of that summer[7] and his *Autobiography*[8] indicate that he began to study geology and Spanish for his proposed expedition to Tenerife. After 11 July when his clinometer arrived, he visited Llanymynech

[1] P. H. Barrett, 'The Sedgwick–Darwin Geologic Tour of North Wales', *Proceedings of the American Philosophical Society,* 118, (1974), pp. 146-64.
[2] J. A. Secord, 'The Discovery of a Vocation: Darwin's Early Geology', *British Journal for the History of Science*, 24 (1991), pp. 133-57.
[3] M. B. Roberts, Just before the *Beagle*, *Endeavour,* vol. 25 (1) 2001, pp. 33-37. This gives a summary of my work on all Darwin's geology of 1831 and is available here; https://michaelroberts4004.wordpress.com/2020/07/03/just-before-the-beagle-darwin-in-wales-1831/
[4] Darwin & Huxley, *Autobiographies*, edited by Gavin de Beer (Oxford: Oxford university Press, 1983), p. 40.
[5] M. B. Roberts, 'Darwin's Dog-leg', *Archives of Natural History*, 25 (1998), pp. 59-73. https://michaelroberts4004.wordpress.com/2023/03/13/darwins-dog-leg-the-last-leg-of-his-1831-welsh-visit/
[6] J. S. Henslow, *Geological Description of Anglesey, Transactions of the Cambridge Philosophical Society*, vol. 1, 1822, pp. 359-452.
[7] Darwin to Fox (9 July 1831), in: Burkhardt and Smith, *The Correspondence of Charles Darwin,* vol. 1. 1821-1836 (Cambridge: Cambridge University Press, 1985), p. 124.
[8] Darwin & Huxley, *Autobiographies*, edited by Gavin de Beer (Oxford: Oxford university Press, 1983), p. 39.

Hill,[9] made several tracings of topographic maps, took notes, and began to make a geological map[10] of the environs of Shrewsbury.[11] His surviving maps and notes demonstrate the problems he had. Thus the impending arrival of Adam Sedgwick, Woodwardian Professor of Geology at Cambridge, must have seemed to him almost providential.

Sedgwick had long intended to carry out fieldwork in North Wales. With William Conybeare he planned to produce a second volume to Conybeare and Phillips, *Outlines of the Geology of England and Wales*, on the Primary and Transition strata, which had scarcely been studied in 1822, when Volume I of that work was published. During the late 1820s Sedgwick had been working on these strata in northern England and in 1830 he planned to visit North Wales after working in the Lake District. However bad weather persuaded him to take refuge in his home village of Dent in the Yorkshire Dales.[12] Thus Sedgwick's plans pre-dated any suggestion of Darwin accompanying him. Secord discusses both the events leading up to the simultaneous visits of Sedgwick and Murchison to Wales in 1831 and relates their work and later controversies.[13]

Sedgwick's opportunity to visit North Wales came in 1831, and in late July he left Cambridge in his gig and travelled west. His route and geological notes are recorded in his field notebooks and the importance of his work, both in 1831 and in subsequent years is treated comprehensively by Secord. As well as being of primary importance in understanding how Sedgwick elucidated what came to be called the Cambrian in 1831, Sedgwick's notebooks provide an independent check on Darwin's notes. The most important part of Sedgwick's work in North Wales took place after Darwin left him and thus is of no concern to us here. For many years from 1831 Sedgwick spent the summer in North Wales, while Murchison began in the south and worked northwards. Secord has recounted and analysed that story in detail.

Until Sedgwick went to North Wales in 1831 there had been little systematic field geology in the area and publications in journals for this era are sparse.[14] North Wales had been visited by Arthur Aiken, Thomas Underwood, John Hailstone and William Smith. Hailstone, Sedgwick's predecessor as Woodwardian Professor at Cambridge, had written to Sedgwick in 1831 with advice on his impending visit to Wales.[15] The best map was that of Greenough which marked much Old Red Sandstone, whose existence Sedgwick was to challenge. What lay below the Old Red Sandstone was unknown and was mostly marked as Greywacke or Greenstone, along with some limestone. Thus Greywacke referred to rocks other than volcanics and limestone, which subsequently were allocated to the Cambrian, Ordovician or Silurian systems. Greenstone included both igneous rocks associated with the Greywacke and also some hard sedimentary strata (often indurated sandstones). What came to be considered as the Cambrian grits north of Barmouth were also designated Greenstone.

---

[9] M. B. Roberts, 'Darwin at Llanymynech: The Evolution of a Geologist', *British Journal for the History of Science*, 29 (1996), pp. 469-78. Available here; https://michaelroberts4004.wordpress.com/2020/09/23/darwins-first-attempt-at-geology-llanymynech/

[10] Darwin's geological notes, with other manuscripts are located in the Darwin Archive at Cambridge University Library. "CUL-DAR" numbers represent manuscript volumes or folders; they alone will be cited in subsequent notes. [All of these are published in John van Wyhe ed., *Darwin Online* here: http://darwin-online.org.uk/manuscripts.html]

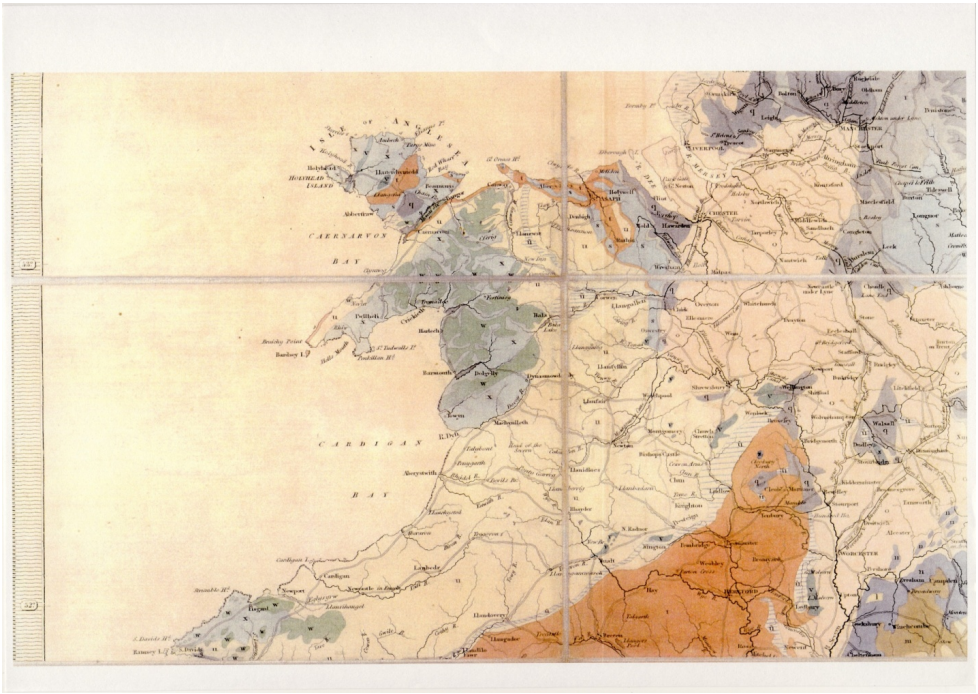
[11] M. B. Roberts, 'I coloured a map', *Archives of Natural History*, 27 (2000) 59-73; S. Herbert and M. B. Roberts, 'Darwin's Shropshire notes,' *Archives of Natural History*, 29 (2002) 27-29. These two papers can be found here https://michaelroberts4004.wordpress.com/2023/05/08/i-coloured-a-map-charles-darwin/

[12] J. W. Clark and T. McK. Hughes, *The Life and Letters of the Reverend Adam Sedgwick* (Cambridge: Cambridge University Press, 1890), I, p. 365.

[13] J. A. Secord, *Controversy in Victorian Geology* (Princeton: Princeton University Press, 1986).

[14] D. A. Bassett, *Bibliography and Index of Geology and Allied Sciences for Wales and the Welsh Borders 1536-1899* (Cardiff: National Museum of Wales, 1963), pp. 20-23.

[15] Hailstone to Sedgwick, 6 June, 1831 (CUL: Add. ms 7652IIIH56).



Greenough, *Geological Map of England and Wales*, 1818. Note the brown of ORS running from Denbigh to the Orme.

In 1831 the geological column from the Old Red Sandstone up to the Cretaceous was fairly well understood, though the terminology differed from today.[16] Hence Sedgwick followed both Greenough's and Henslow's 'Old Red Sandstone' in the hopes of finding the older strata lying conformably underneath (see Figure 1 which shows the coincidence of Sedgwick's route with Greenough's and Henslow's Old Red Sandstone.). In this Sedgwick was disappointed and after his abortive visit to Anglesey (and after Darwin left him) he started work on the steeply dipping strata at Llanberis for which he had no stratigraphical markers and few fossils to guide him. Murchison fared much better in Mid-Wales, with the succession passing conformably from the 'Devonian' down into the 'Silurian' near Ludlow. (The terms 'Devonian' and 'Silurian' are used here anachronistically.)

The most thorough previous geological work for North Wales was Henslow's publication on Anglesey in 1821. His paper is a geological classic and was closely studied by Darwin. As Sedgwick discovered however, much of Henslow's Old Red Sandstone was, in fact, much older. That near Llannerchymedd was later ascribed by Greenly to the Ordovician. Much of Anglesey is Precambrian and metamorphosed. In the absence of these later concepts Henslow divided these into Quartz Rock, Chloritic Schist and Granite (though he recognised many of these to be 'altered').

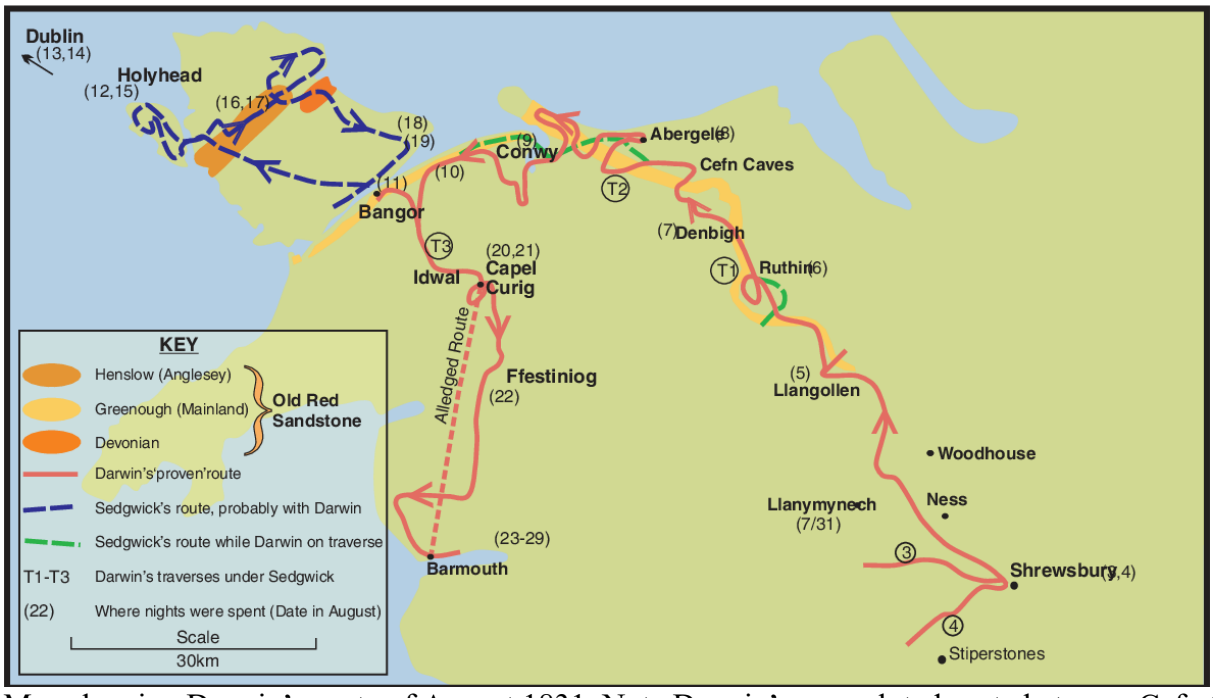
This searching for the base of the Old Red Sandstone by Sedgwick determined the route followed by Darwin when he was with Sedgwick. But Sedgwick only began to put the older strata into some stratigraphical order after Darwin left him at the Menai Bridge. It was to take him several years and cost him much labour.

[16] In modern terms Old Red Sandstone is largely Devonian with a little Upper Silurian including at times what is now considered basal Carboniferous. Mountain Limestone is Lower Carboniferous limestone (Mississipian). Coal Measures are Upper Carboniferous (Pennsylvanian). The New Red Sandstone includes the uppermost beds of the Carboniferous, and all the Permian and Triassic.

Darwin's notes reflect a competent understanding of the geological column down to the Old Red Sandstone, but his descriptions of the 'Older' strata were more generalised with no sense of geological chronology for the strata as that simply had not been elucidated at the time of his Welsh field excursion.

2. The Sedgwick–Darwin Tour of Wales

Ever since Darwin wrote in his *Autobiography*: "This tour was of decided use in teaching me a little how to make out the geology of a country" and the references to the tour in the Clark and Hughes' *Life and Letters of Adam Sedgwick*, there has been no doubt of the value of the tour to Darwin. Clark and Hughes said that it lasted two to three weeks[17] but a simple reading of Darwin's notes alongside his *Autobiography* suggests only seven days, before Darwin left Sedgwick to strike out across the mountains to Barmouth. However both Barrett and I have found the topographical and chronological data confusing and we have come to different conclusions both as to Darwin's route and the duration. The possible chronologies of August 1831 are included in Appendix II which shows how the conclusions here differ from a simple reading of the *Autobiography*, Barrett's work and my previous work. The Lowe brothers' diary[18] states that Darwin reached Barmouth on 23 August, which is also the most likely date if Darwin accompanied Sedgwick around Anglesey. Darwin had arranged to meet his Cambridge friends, Robert, a future Chancellor of the Exchequer, and Henry Lowe at Barmouth in August 1831 along with Charles Whitley. Their diary stated that Darwin arrived in Barmouth on the evening of 23 August and that he had walked that day from Ffestiniog. My conclusion, based on Darwin travelling around Anglesey with Sedgwick, that Darwin arrived in Barmouth on 23 August predated Lucas's work by several years, so he gave a useful confirmation.



Map showing Darwin's route of August 1831. Note Darwin's convoluted route between Cefn Caves and Conwy.

[17] Clark and Hughes, op. cit. (note 9, 1890), I, p. 379.
[18] Lowe diary, cited in. P Lucas, '"A Most Glorious Country": Charles Darwin and North Wales, especially his 1831 Geological Tour', *Archives of Natural History,*29 (1): 1-26. 2002.

This paper argues that Clark and Hughes' suggestion of two to three weeks, given without supporting evidence, is correct and that Darwin was with Sedgwick from 3 August through to 20 August, meaning that they spent fifteen days together in the field (and eighteen if Darwin went to Dublin). Darwin's notes cover only the period from 6 to 11 August and then there was his journey from Cwm Idwal to Barmouth, which is undated. However as I argue below, Darwin and Sedgwick carried out fieldwork on 3 and 4 August to the south-west of Shrewsbury, on 5 August at Llangollen, and from 12 to 20 August on Anglesey, with a possible flying visit to Dublin on 13 and 14 August (see Figure 1). Thus Darwin spent another nine days in the field with Sedgwick and this more than doubles the length of their joint tour. That is a considerable length of time and ought to belie suggestions, encouraged by Darwin's self-disparagement, that Darwin was an unskilled geologist when he boarded the *Beagle*. The quality of Darwin's notes by the end of his visit to North Wales also reflects his considerable expertise. The early notes taken at Llanymynech are indifferent but those made at Cwm Idwal and Moel Siabod are very competent, demonstrating a considerable improvement in those few weeks. Previously, Darwin had received instruction in geology at Edinburgh under Jameson and at Cambridge with Sedgwick,[19] so had some knowledge of geology before the summer of 1831.

3. Methodological Matters.

A reading of Darwin's account in his *Autobiography* gives the impression that the route of the Sedgwick–Darwin tour might be easily worked out. That is not the case, and as this study progressed elucidation of the route became more, rather than less, complex. Some of the complexity of the problem is apparent in Barrett's paper. The complexity could be resolved only by using a wide range of sources, past and present such as the following:

1. Darwin's 1831 field notes. CUL-DAR5.B1-B15.
2. Sedgwick's 1831 field Journals volumes XXI and XXII.
3. Sedgwick's 1831 field maps (Evans with annotations.)
4. Greenough *Geological Map of England and Wales*, 1818.
5. Walker's map of North Wales of 1824.[20]
6. Evans' map (7/8in to 1 mile) of North Wales of 1795.[21]
7. 1st edition Ordnance Survey maps of North Wales (1840s).
8. *Wild Wales* (1862) by George Borrow (1803-1881). Though written thirty years later, it gives moderately contemporary descriptions of the area and often illuminates aspects of the Darwin–Sedgwick tour.
9. Various histories e.g. Dodd,[22] useful on bridges, roads, slate quarries, ferries, etc.
10. Advice from geologists, museum curators, and local historians.

It is impossible to describe my exact methods in using these, but an essential part has been to traverse, re-traverse and experiment on possible routes and physically retrace Darwin's likely steps. Much has been by using a car, some by bicycle, but considerable portions have been on foot

[19] J. M. Rodwell to F. Darwin (8 July 1882), CUL-DAR112.A94-A95 Text.
[20] J. and A. Walker, 1824 *Map of North Wales* (London and Liverpool: no publisher given, 1824.)
[21] John Evans (1723-1795), *Map of the Six Counties of North Wales* (inscribed to Sir Watkin Williams-Wynn of Wynnstay Hall, Ruabon, June 1 1795) (London & Liverpool: n.p., 1795).
[22] A. H. Dodd, *The Industrial Revolution in North Wales* (Wrexham: Bridge Books, 1990).

especially where the route was 'off-road'. My timings are approximate and estimated by assuming that in the gig Darwin and Sedgwick travelled at 9 M.P.H. on good roads, dropping to about 6 or less on lanes.[23] I allow 2 M.P.H. for walking in rough country, which is my speed, and 3 M.P.H. on roads and allow time for fieldwork. As well as walking almost all of Darwin's 'back-country' routes I have also retraced some of Sedgwick's longest days in Snowdonia after Darwin left him, which gives me a wider picture. That involved the ascent of Snowdon, parts of the Glyderau and Carneddau.

I have identified the outcrops described by Darwin and then compared his description with the outcrops themselves, re-measuring dip and strike. Complications frequently occur from odd spellings of Welsh place-names and Darwin's infuriating habit of inverting compass directions. In general my methods are similar to those advocated[24] and practised[25] by Oldroyd.

To build up a full picture of the tour both Darwin's and Sedgwick's notes have been used but these notes do not always interlock. Sedgwick's notes are dated, enabling daily routes to be determined. Darwin's notes are dated only for 6, 7 and 8 August, and other dates have to be made by comparison with Sedgwick's, or by inference. At times, Darwin's notes concur with Sedgwick's, as they do from Llangollen to Ruthin, above Penmaenmawr and at the Bethesda slate quarry. Neither Darwin's nor Sedgwick's notes indicate when or where Darwin left Sedgwick to continue southward to Barmouth.

4. The Traverses

In his *Autobiography* Darwin wrote how "Sedgwick often sent me on a line parallel to his, telling me to bring back specimens of the rocks and to mark the stratification on the map".[26] In their notes neither Darwin or Sedgwick state that Darwin was sent off on his own, but a comparison of the two sets of notes and Sedgwick's letter to Darwin of 4 September, 1831 indicate that he was sent on several traverses. These are described briefly here and more fully at the appropriate part of the account.

The proven traverse is Darwin's walk on 8 to 9 August from Glascoed, near St Asaph to Conwy, while Sedgwick sped on in his gig to Conwy.

Darwin walked about 27 miles traversing back and forth over the Mountain Limestone–Greywacke boundary to the Great Orme, vainly looking for Old Red Sandstone.

The other traverses are more tentatively reconstructed. The first was near Ruthin starting at Llysfasi. Though Darwin and Sedgwick visited the same places in the environs of Ruthin on 6 and 7 August, the notes do not cohere, as is discussed later. It makes better sense to suggest that Sedgwick and Darwin parted at Llysfasi and Sedgwick inspected the limestone outcrops of the Vale of Clwyd. Darwin continued to Ruthin and went to check out the Old Red Sandstone in the neighbourhood of Pen Stryt quarry.

The last traverse took place as Darwin left Sedgwick at the Menai Bridge on 20 August. The route entailed visiting Cwm Idwal and ascending Moel Siabod the following day. Darwin made considerable notes and summarised these in a letter to Sedgwick, which was left at Plas y Brenin.[27]

---

[23] These figures were given to me in the late 1990s by Miss Joan Hamner, the former groom at Chirk Castle near Wrexham.

[24] D. R. Oldroyd, 'Non-written Sources in the Study of the History of Geology', *Annals of Science,* 56 (1999), pp. 395-415.

[25] D. R. Oldroyd, *The Highlands Controversy: Constructing Geological Knowledge through Fieldwork in Nineteenth-Century Britain* (Chicago & London: University of Chicago Press, 1990).

[26] Darwin, op. cit. (note 5, 1983), p. 39.

[27] Sadly, this vital letter is catalogued in the Sedgwick manuscripts at CUL but is stated to be 'missing'.

It is also possible Sedgwick sent Darwin on mini-traverses but these are not discernible from the notes.

Portion of Sedgwick's copy of Evans' map from St Asaph to the Orme. Near the coast the shaded parts are Mountain Limestone. Did Darwin draw them?

The Sedgwick–Darwin Tour, 3–20 August 1831

5. To the West of Shrewsbury

Sedgwick arrived at Shrewsbury on Tuesday 2 August, 1831,[28] but did not record his lodging place. In his *Autobiography* Darwin wrote that Sedgwick, "came and slept at my father's house". Sedgwick had left Cambridge a few days earlier and visited the Transition Limestone outcrops near Dudley and hoped to use these to guide him on what he expected to find in North Wales.[29] Sedgwick's notes and Darwin's *Autobiography* both state they left Shrewsbury for Llangollen on Friday 5 August. On 3 and 4 August Sedgwick explored the area to the west of Shrewsbury (see Figure 1).

The first day he went as far as Alberbury on the Llanfyllin road and on the following day to Pontesbury, including Pontesford Hill. One of his aims was to find the Old Red Sandstone on top of Transition strata, to give him a fixed stratigraphic marker. On 4th August had he journeyed further west to the top of Long mountain he may have found it, as there the Devonian lies above Silurian, which would have saved him a lot of trouble!

Sedgwick gave no indication where he spent Wednesday night or whether Darwin accompanied him, except in his letter to Murchison in September, "I spent ... two days at Shrewsbury", which implies that he overnighted there on 3 August as well.[30] As neither day

[28] A. Sedgwick, Journal August 1831, XXI. 10. (manuscript and transcript at the Sedgwick Museum, Cambridge).
[29] Secord, op. cit. (note 2, 1991), p. 53.
[30] Sedgwick to Murchison 13 Sept. 1831, cited Clark and Hughes, op. cit. (note 9, 1890), I, p. 378.

involved more than twenty miles in a gig, it is possible that Sedgwick stayed at The Mount, thus giving Dr Darwin plenty of time to diagnose hypochondria in him. Darwin probably accompanied Sedgwick and this is borne out by Darwin's comparison of the limestone in Penstryt Quarry, near Ruthin, with the "magnesian conglomerate" at Cardeston.[31] When writing his notes at Denbigh he could have 'quoted' Sedgwick, but it is more likely that he went to Cardeston himself. Thus it is proposed that Darwin's tour with Sedgwick began with two days geologising west of Shrewsbury. The evidence is circumstantial. He may have taken some notes, but these have not been found, nor have his notes on Anglesey, and those for the maps he made of the Shrewsbury area have only recently come to light.[32]

Sedgwick looked briefly at the largely Carboniferous strata of the area, presumably to provide the context for the older Primaries, repeating what he had done near Dudley. On Pontesford Hill Sedgwick identified the igneous rocks now recognised to be Precambrian — "hornstone, trap, greenstone, porphyry etc". — but reckoned that these were comparatively recent and "probably has indurated the graywacke and tilted the coals and Young Red". After Darwin's attempts at field geology in the previous weeks, he was now introduced to a wide variety of rock-types by a geological master; magnesian conglomerates at Cardeston (GR 388124), Coal Measures at Alberbury, 'Ordovician' limestones above Pontesbury (GR 3905) and igneous rocks at Pontesford Hill. These two traverses in familiar countryside would have afforded excellent instruction.

From Darwin's reminiscences, meals at The Mount in August 1831 were enlivened by geological discussions, especially over the famous volute shell. Darwin's comments about Sedgwick's reaction to these shells are often taken to imply that Sedgwick had a closed mind, which is unjust. Darwin's memory fifty years on was at times defective. It is equally possible that Sedgwick's comments were made during a lively and well-lubricated discussion. Others, such as Dr Thomas Dugard, F.G.S. (1777-1840), Robert Darwin's colleague, may have been present. The following year on 17 June 'Mr Sedgwick called for half an hour'[33] at The Mount but dined with Dugard[34] as he passed through Shrewsbury on the way to the British Association at Oxford.

6. Shrewsbury to Denbigh 5 to 7 August.

Sedgwick and Darwin left Shrewsbury in Sedgwick's gig[35] on 5 August to travel along the new London-Holyhead road to Llangollen. A comparison of their notebooks shows that they travelled together most of the way until they reached the road junction west of St Asaph (GR 034738) on 7 August. On the morning of 5 August they travelled thirty-two miles to Llangollen, where they spent the night. Several hours that day were spent ascending Castell Dinas Bran (GR 223431), a hill of Silurian 'calcareous slate' topped by a 13th century castle and rising 200 metres above Llangollen and then visited the Carboniferous Limestone scarp beyond.[36] The sites visited were dictated by Sedgwick's aim of checking the Old Red Sandstone on Greenough's map. Thus they ascended the greywacke strata of Castell Dinas Bran and dropped down to the col beyond and collected two samples of Mountain Limestone from the Eglwyseg escarpment. In places along the faulted contact between the greywacke and Mountain limestone, a reddish yellow conglomerate (now thought to be Basal Carboniferous – Fron Fawr Formation[37]) is present and crops out more clearly two miles to the north (GR 220460), and in 1831 Sedgwick suspected that this was not Old Red Sandstone.

[31] CUL-DAR5.B6i. [In *Darwin Online* Text.]
[32] Roberts, op. cit. (note 8, 2000), Herbert and Roberts, op. cit. (note 8, 2002).
[33] Caroline Darwin to Darwin, June 1832, in: Burkhardt and Smith, op. cit. (note 4, 1985), p. 243.
[34] Sedgwick, Journal XXIII, June 1832.
[35] Sedgwick had probably brought a driver with him. (Secord, private communication 2001.) See note 56.
[36] Sedgwick, Journal XXI, 5 August, 1831.
[37] M. F. Howells, British Regional Geology- Wales, 2007, p123-7

Neither Sedgwick nor Darwin recorded this in their notes, but Sedgwick wrote to Murchison on 13 September 1831: "There are some red beds (which may pass for Old Red for want of better) in a ravine west of Ruthin, and in one or two places near Llangollen under the Mountain Limestone escarpment".[38] From this letter it is most probable that Darwin and Sedgwick worked their way down the Carboniferous succession from the limestone to the Basal beds and could not decide whether or not these were Old Red Sandstone.

Sedgwick probably hoped to find older strata below the Old Red. However only Sedgwick made notes. While at Llangollen they met the surveyor Robert Dawson (1776-1860), who, while surveying for the Ordnance Survey map, carried out some geological investigations and had an unsurpassed knowledge of North Wales topography. Sedgwick recorded Dawson's information, which was mostly of Carboniferous outcrops in the Vale of Clwyd.

Next day, 6 August, they met Dawson again before going to Valle Crucis Abbey (GR 206443). There, Sedgwick sketched the east window of the ruined abbey. Both visited some roadside exposures on Velvet Hill (GR 202443) and made only brief notes, probably due to the poor weather. Darwin wrote: "Saturday 6th Vale of Crucis. The bank facing the valley consists of Clay slate. which breaks out at regular intervals. striking N W. by N. dipping 25 to the N E by N".[39]

View of Eglwyseg escarpment from Castle Dinas Bran. Sedgwick and Darwin looked for ORS below the limestone.

[38] Sedgwick to Murchison, 13 September 1831, cited Clark and Hughes, op. cit. (note 9, 1890), I, p. 378.
[39] CUL-DAR5.B5i. [In *Darwin Online* here.]

View of Castell Dinas Bran from the east. There is a fault running through the col separating "Transition" strata from Mountain Limestone

Transition strata at Velvet Hill GR showing bedding and cleavage.

Sedgwick's notes were briefer: "6th After seeing Mr Dawson ascend to Valle Crucis abbey — greywacke dip variable but on the whole N.E.? ... At the top [Horseshoe Pass] the range of the

cleavage seems to be E. by S. and dip N.45 (but obscure)".[40] Velvet Hill is a superb site for demonstrating the relationship of cleavage to bedding (which distinction Sedgwick had become familiar with during his Lakeland work in the early 1820s) yet no mention was made of this either in their notes nor in Sedgwick's 1835 paper. However cleavage was described at the top of the Horseshoe Pass, which they ascended in the gig. (The present route dates from 1811 to enable the transport of slate so it has a steady gradient. It is popular with all road users. I first cycled up it in 1962 and then frequently from 1987 to 2001. Since 2022 there has been a 40m.p.h. speed limit which I confess to have broken most times I descended the pass on my bicycle!!) The brevity of the notes can be explained first, by the poor weather, as they "were almost drowned in a thunderstorm"[41] and secondly, by Sedgwick's concern to press on to the Vale of Clwyd to find Greenough's Old Red Sandstone and ascertain what lay underneath.

North of Valle Crucis, Darwin also recorded "diluvium" and "boulders of trap". The latter are erratics and probably come from near Arenig Fawr down the Dee valley and he contrasted the diluvium with that of Shropshire for containing no sand.[42] He also contrasted the vegetation on the Greywacke and the limestone. The former "generally covered by Gorse, Heath & Fern: the limestone either bare or the verdure very green". Today the bareness and greenness are still apparent today, but there is some gorse on the limestone. Without quibbling about the gorse this demonstrates how Darwin was observing the different vegetation on different strata. From Valle Crucis the two sped on to Ruthin in the Vale of Clwyd making few stops. *En route* they crossed over the Horseshoe Pass and dropped down to the cross-roads with the Corwen road by Dafarn Dowarch, the 'turf tavern' described by George Borrow in *Wild Wales*.[43] The two outcrops described by Darwin near Dafarn Dowarch are difficult to identify, as shallow quarries are easily buried. The first is probably on the south side of the road by Pentre Bwlch (GR 193496) but no outcrops are visible. The second — of "black bituminous limestone" — is probably some dark Carboniferous Limestone near the junction of A525 and A542 (GR 183517). The low limestone outcrops to the north of the road have the appearance of being a long disused quarry. Sedgwick's notes are very different and record "that the limestone comes up nearly to Tafarn Dowrah" and extend northward beyond the Wrexham–Ruthin road". Sedgwick's notes record the limestone outcrops (usually 10 to 15 ft high and 50 ft long) in the vicinity of the old toll house (GR 170517) and the Millstone Grit which overlies to the north-east of Llandegla, three miles away. This was probably geological observation from afar and is consonant with that day's weather, as after rain the atmosphere is ideal for viewing a distant scene.

Soon they joined the Wrexham–Ruthin road (A525), which a few years earlier had been improved. After the old gatehouse at Ty'n-y-pwll (GR 179517) they descended the Nant y Garth (GR 1551) described by Darwin as "a tortuous valley", where they both made similar notes. Darwin recorded, "Clay Slate, generally dipping to the east" and Sedgwick: "Greywacke … dip very obscure but a prevailing dip to the east". Darwin's imprecision in recording dips here indicates a more cautious use of the clinometer than at Llanymynech, where, a few weeks earlier, he did not discriminate between clear and obscure dips.[44]

Although the bottom of the Nant y Garth at Llysfasi is only four miles from Ruthin neither Darwin nor Sedgwick give a clear indication of their route from there. Sedgwick wrote "Descend to Ruthin and verify the notes of Dawson etc".[45] However, one cannot easily determine their route as

[40] Sedgwick, Journal XXI, 6 August, 1831.
[41] Sedgwick to Murchison, Sept. 13 1831, cited Clark and Hughes, op. cit. (note 9, 1890), I, p. 378.
[42] CUL-DAR210.17, Herbert and Roberts, op. cit. (note 8, 2001).
[43] George Borrow, *Wild Wales* (London: John Murray, 1905), p. 95.
[44] Roberts, op. cit. (note 6, 1996), p. 474.
[45] Sedgwick, Journal XXI, 6 August, 1831.

the two sets of notes are almost contradictory as to places visited. The main possibilities are that either Darwin and Sedgwick remained together for the rest of 6 August, or Sedgwick sent Darwin on a traverse from Llysfasi to the other side of Ruthin.

Considering the first alternative, Darwin and Sedgwick visited some of the limestone outcrops between Rhyd-y-meudwy (GR 1251) and Craig Fechan (GR 1454) and then continued to the White Lion, now the Castle Hotel, at Ruthin. On Sunday 7 August they worshipped at St Peter's Church in the morning and thus had time for only half a day's work. As Sedgwick was a Moderate Evangelical this shows that Sabbatarianism was less widely held in 1830 than it was in the 1840s when Sedgwick was likely to have studied the bible with Salter. (Sedgwick never had any time for those who insisted that early Genesis points to a date of creation a few thousand years ago, and could be combatative on the subject!![46]) The geology of the Vale of Clwyd is a sequence of Carboniferous and Permo-Triassic, which a faulted due to being in a rift valley graben. After worship they went to near Pen Stryt quarry (GR 111578). Darwin's notes imply that he visited the quarry on Saturday, as his notes on the quarry precede the date Aug 7",[47] but Sedgwick wrote, "7th Church, find the O.R. in the brook to the N.E. of Llanfwrog".[48] This would mean that Darwin put the date "Aug 7" in the wrong place, or took Sedgwick to see what he had found the day before. Sedgwick's notes here are brief and make no mention of Pen Stryt quarry. They then followed the lane south to Efenechtyd, to record the junction of the Limestone and greywacke. They joined the main road at Pwll-glas (GR 109509) and then followed the turnpike through Ruthin to Denbigh where they spent the night. From Ruthin, both Darwin's and Sedgwick's notes were very brief. They had travelled only 14 miles that Sunday.

Alternatively, Darwin was sent on his first traverse on Saturday 6 August and had dismounted from Sedgwick's gig at the crossroads at Llysfasi. Sedgwick then visited the limestone outcrops catalogued by Dawson, while Darwin was sent on to observe the strata on the way to Ruthin and then to the Old Red Sandstone, which Greenough had marked on his map to the west of Ruthin. They later met at the hotel in Ruthin. If so, this would explain why Darwin recorded a different date from Sedgwick for his visit to the quarry and why their notes were so different. After spending the night in Ruthin and attending church, the next afternoon, both geologists went to the quarry (or at least to the vicinity), before moving on to Efenechtyd. This alternative has the advantage of not positing emendations to Darwin's notes and seems to be the simplest and most probable solution.

Though the precise route Darwin and Sedgwick took from Llysfasi is a matter of doubt, the geology of their route is clear. The aim was to clarify the relationship of the Old Red Sandstone, New Red Sandstone and Carboniferous marked on Greenough's map. Their notes are terse. Darwin wrote: "About a mile from Ruthvin. Beds of sandstone". Sedgwick wrote: "Descend to Ruthin and verify the notes of Mr Dawson etc". Sedgwick visited some of the limestone outcrops from Llanelidan to Llangynhafal, most probably those of Graigwilt (GR 1454) and Ty'n Llanfair (Tynyllan Fair) (GR 136520).

The most important site visited was Pen Stryt quarry (GR 111578), which is an overgrown sandstone quarry, with the east-west aligned quarry face of about 30 metres long and less than 5 metres high. (It is now a RIGS site because of its Darwin associations.) Both Darwin and Sedgwick recorded finding Old Red Sandstone, Limestone and New Red Sandstone at, or near, this quarry.

---

[46] Roberts, M. B., *Adam Sedgwick (1785-1873): Geologist and Evangelical*. Kolbl-Ebert, M. (ed.) *Geology and Religion: A History of Harmony and Hostility.*The Geological Society, London, Special Publications, 310, pp. 155-170, 2009. https://michaelroberts4004.wordpress.com/2018/02/03/how-to-deal-with-victorian-creationists-and-win/

[47] CUL-DAR5.B, fol. 6ii. [In *Darwin Online* here.]

[48] Sedgwick, Journal XXI, 7 August, 1831.

Darwin's notes are more fulsome and correctly describe the rock-types. The New Red Sandstone he describes as "very irregularly Stratified", as it is a cross-section of intersecting channels, with minimal dip. He described some of the strata in the quarry as "spotted with brown, like the stone at Cardeston, overlying Magnesium conglomerate".[49] This is probably the fault-brecciated limestone on the west of a fault in the present quarry, which has a similar *appearance* to the sedimentary breccia at Cardeston Quarry. To the west and above the quarry are outcrops of Carboniferous Limestone which *topographically* lie above the red sandstone of the quarry, thus apparently giving support to Greenough's identification of Old Red Sandstone lying below the Limestone. At that time neither Darwin nor Sedgwick had fully grasped the structural relationships. There is no Old Red Sandstone and the western part of the quarry straddles a fault (which may not have been exposed in 1831), where the New Red Sandstone is downthrown to the east. Neither observed the fault and thus initially perceived the succession as Old Red Sandstone, Mountain Limestone, and New Red Sandstone, as Greenough had done in 1819. The map in Howell's work shows the complex faulting in the Vale of Clwyd[50]. Two days later Sedgwick was raising doubts at Henllan (GR 019683) where he considered the red sand "in the rivulet [Afon y Meirchion] near the mill"[51] asking: "?are they derived from beds of O.R.?", despite Greenough marking Old Red Sandstone in the vicinity.

Sedgwick's notes did not question the existence of the Old Red Sandstone, but in his letter to Murchison on 13 September, he categorically rejected the existence of any Old Red Sandstone to the west of the Vale of Clwyd: "The Old Red all round by Orm Head &c. &c. is a pure fiction. At least I can't see a particle of it between Denbigh and the Isle of Anglesey. There are, however, some red beds (which may pass for Old Red for want of better) in a ravine west of Ruthin (i.e. near Pen Stryt), and in one or two places near Llangollen under The Mountain Limestone escarpment".[52] Sedgwick's notes from Glascoed (GR995740), where Darwin set off on his traverse to Conwy, are terse in the extreme "and from Abergelley no greywacke is seen". This implies that he did not visit either the Great or Little Orme and relied on Darwin's observations.

From the quarry they briefly observed the limestone escarpment east of Efenechtyd before turning north at Pwll Glas to Denbigh. Both sets of notes are terse, Darwin's being vaguer. Neither record any Old Red Sandstone and Sedgwick recorded that "the limestone takes a snap to the west", which presumably referred to a fault. Modern maps show that the western part of the Vale of Clwyd is cut by a series of faults running more or less north-south, which cut all strata from the Silurian to the New Red Sandstone.

In his letter to Murchison, Sedgwick said that he had hoped "to do some work among the secondaries", meaning the Carboniferous, but he spent only part of the weekend and Monday in the Vale of Clwyd, before speeding off to Conwy in his gig. However this gave him sufficient to doubt the presence of Old Red Sandstone and thus he set Darwin the task of a long traverse on foot to examine the problem.

7. Alone to Conwy, 8 to 9 August

For Darwin's development as a geologist, these two days were very significant as Sedgwick sent him off on his own. The traverse he undertook gives an insight into both Darwin's growing geological skill and Sedgwick's method of teaching. Despite Darwin's apparently comprehensive notes it has proved difficult to work out the route precisely, despite frequent visits. These involved

[49] CUL-DAR5.B6i. [In *Darwin Online* here.]
[50] M. F. Howells, British Regional Geology- Wales, 2007, Figure 40, p1. 23.
[51] Sedgwick Journal XXI, 8 August, 1831.
[52] Sedgwick to Murchison, 13 September, 1831, cited in Clark and Hughes, op. cit. (note 9, 1890), I, p. 378.

the use of Evans' and Walker's maps and a knowledge of the history of roads around Kinmel Hall (GR 9874) to work out his route from the perspective of the purpose of his journey, which was to confirm or deny the existence of the Old Red Sandstone.

The day from Denbigh to Abergele on 8 August, when Darwin and Sedgwick initially travelled together, was a far longer day than the Sunday. The first part from Denbigh to St Asaph was punctuated by several stops. They passed through Henllan and then followed the lane to Berain before dropping down to the north to Dolben and the Cefn caves. The most spectacular visit was to the Cefn caves, which geologically was a diversion from attempting to find Old Red Sandstone. However it gave Darwin some instruction in mammal-rich diluvial deposits, of which he found many in South America. After the Cefn caves they followed the lanes to the St Asaph-Abergele road, now the B5381. Sedgwick and Darwin went their separate ways at the road junction by the present entrance to Kinmel Park (GR 992740) after visiting some lead workings a few hundred yards to the N.N.E, on the Bodelwyddan road, where "a shaft was sunk for lead ore in the Limestone, which contained sulph. Barytes &...".[53]

Neither Darwin nor Sedgwick actually say that they separated here but up to this point Darwin used 'we' in his notes and thereafter 'I'. He described the route as "St Asaph to *Abergele* by Bettys [yn Rhos] at the point where the road to Bettys divides from Abergele". This road junction is the most obvious point to separate as Evans, and Walker's maps show the road from St Asaph to Abergele passing through the centre of Kinmel Park. It was probably closed in 1843 after the re-building of Kinmel Hall. Whilst Sedgwick sped to Conwy in his gig, Darwin walked about thirty miles in the next two days. From Sedgwick's notes it would appear that he, himself, scarcely stopped to geologise.

Darwin's route is not straightforward and the map of his whole visit indicates a probable reconstruction of his route. He walked towards Bettys-yn-Rhos, but there is no indication that he walked that far. Darwin stated "a little SW of Abergele, first saw an escarpment",[54] showing that Darwin had walked beyond the present A548. There are several possibilities for Darwin's route. It could be another case of Darwin's infuriating compass inversion, as one can see the escarpment on the Betws yn Rhos road the SE of Abergele, but "A Valley running through the escarpment"[55] is probably the River Dulas, which passes through Llandulas. Figure is a likely location, within a mile or so.

His notes imply he walked under the escarpment, which he would have done if he walked east to Abergele to spend the night. The roads on Walker's map in the area north-west of Betws-yn-Rhos do not coincide with modern O.S. maps and may be due either to Walker's inaccuracy or a changing pattern of lanes. From a consideration of the geology, his geological notes, the pattern of lanes and some 'intuition', the two possible routes are, first along the Betws-yn-Rhos road (B5381) to the junction west of the A548, along the minor road to the river Dulas, and, secondly, through Betws yn Rhos and then joining the road going down the Dulas valley. The road passes upwards from the Greywacke to the Mountain Limestone just south of Rhyd-y-Foel, where there are limestone outcrops and outcrops 150 feet above sea level near Llandulas. According to Greenough's map he ought to have crossed the 'Old Red Sandstone' between Betws-yn-Rhos and the limestone scarp. From thence Darwin walked to Abergele.

[53] CUL-DAR5.B6i. [In *Darwin Online* here.]
[54] CUL-DAR5.B7ii. [In *Darwin Online* here.]
[55] CUL-DAR5.B8i. [In *Darwin Online* here.]

The limestone escarpment from the road to Betws yn Rhos. According to Greenough's map there is Old Red Sandstone between this location and the Mountain Limestone.

My tortuous elucidation of Darwin's route that day is necessary to understand Sedgwick's intentions. He had begun to doubt the existence of Old Red Sandstone in Denbighshire and sent Darwin on a traverse to check this. Darwin's route followed an arc covering first Greywacke keeping more or less to Greenough's alleged boundary between the Greywacke and the Old Red Sandstone, and then through to the Carboniferous. He was clearly looking for Old Red Sandstone and wrote: "I observed the greatest number of bits of Sandstone. But in no place could I find it in situ"[56] and then concluded that "the sandstone does not crop out anywhere near Abergele". He attributed the red colour to "the *very* ferruginous clay seams… and not to supposed sandstone beneath it". If Greenough were right Old Red Sandstone should have been found between the Greywacke and the Limestone. Darwin had recorded what was not there!

On Tuesday 9 August, Darwin walked to Conwy but his precise route is not obvious from his notes. His disjointed notes are not in geographical sequence, as they go from Abergele, to Colwyn, back to Llandulas, to the Little Orme and back to Abergele. He followed the limestone escarpment to Colwyn and visited the southern edge probably at Pen-yr Poorddyn-mawr which is "about 2 w of Abergele". From Colwyn he probably walked as far as the Great Orme. Then he cut back to meet up with Sedgwick in Conwy after walking over twenty miles.

It is vital to work out the route, as when this is compared with the underlying geology the purpose becomes clear. The route taken on 9 August was too complicated to have been specified by Sedgwick, except to visit the alleged junction of Old Red Sandstone with Mountain Limestone or Greywacke. Darwin's notes are confusing, but the overall pattern and direction of his movements is clear, as he was more or less travelling along the contact of the Limestone with the underlying strata. He had followed the intermittent line of Mountain Limestone hills from Abergele to the Great Orme and from there he left the limestone to walk south to Conwy. The marking in of the

[56] CUL-DAR5.B8i. [In *Darwin Online* here.]

Limestone on Sedgwick's copy of Evans' map is probably Darwin's work and includes limestone at Llandudno.

The Mountain Limestone of the Great Orme at Llandudno.

As he wrote in his *Autobiography* Sedgwick made him, "mark the stratification on the map". The reasonable conclusion is that he was looking for the Old Red Sandstone and all his diversions were to serve that end. His conclusion was clear: "From several observations, I am sure, the Sandstone does not outcrop anywhere near Abergele".[57] Presumably it was late evening when Darwin crossed the new Conwy suspension resplendent in its limestone towers, to meet Sedgwick. In the last day and a half Darwin had walked more than thirty miles, and had left no stone unturned to find Old Red Sandstone, and found none.

As a historical afterword, the Geological Survey accepted Old Red Sandstone in North Wales until the end of the century, though in the 1840s neither Greenough nor Daniel Sharpe[58] marked Old Red Sandstone on their maps. Ramsay's *Memoir of North Wales* recorded Old Red Sandstone from Colwyn to Ruthin and above Llangollen.[59] But by 1927 the Geological Survey Memoir ascribed the Old Red Sandstone to the basal Carboniferous.[60] Perhaps it says something for the judgement of both Darwin and Sedgwick that it was nearly a century before the Geological Survey adopted the conclusions made by Darwin in 1831.

[57] CUL-DAR5.B7ii & 8i. [In *Darwin Online* here.]
[58] D. Sharpe, 'Contributions to the Geology of North Wales', *Quarterly Journal of the Geological Society*, 2 (1846), pp. 283-316. Daniel Sharpe geologised in North Wales in the 1840s controverting Sedgwick. (Secord, op. cit. (note 10) 150ff.)
[59] A. C. Ramsay, *The Geology of North Wales*, Memoir of the Geological Society, 3 (London: Longmans, Green, Reader and Dyer, 1866), pp. 222-27.
[60] *The Geology of the country around Wrexham*, Memoir of the Geological Survey (Sheet N.S. 121) (London, His Majesty's Stationery Office, 1927), Part 1, pp. 108-109.

8. Conwy to Bethesda, 10 to 11 August

These two days were the most mountainous part of the joint field trip, during which Sedgwick was carrying out reconnaissance for his work on Snowdonia. The two sets of notes are occasionally verbally identical in wording and are almost synoptic. They give the impression of having been written together, and the most likely way is that they were written up together in the evening, with Sedgwick giving some further tuition. Even so, the route they took considerable unravelling and initially following Barrett and Secord, I thought that the pair kept fairly close to the coast, probably going over the Sychnant Pass. Topographical details are rare in Darwin's notes, which are also undated, but Sedgwick's are clearer and give the first day's route in reasonable detail. He wrote: "Ascend the valley of Llanrwst to the chapel of Llanbedr ... Ascend the watercourse and cross to the top of Voel Llwyd ... –descend towards Penmaenmawr".[61] Thence he journeyed to Aber, giving a walk of sixteen miles.[62] The chapel mentioned by Sedgwick is probably the ancient chapel (Anglican) at Caerhun (GR 776704), rather than a non-conformist conventicle in Llanbedr (-y-cennin). With that my understanding of the day's journey fell into place – after several attempts at trying to find their route.

Much of the route would be impassable to a gig as the track over Foel Llwyd to Penmaenmawr is a moorland path (formerly a quarryman's track from Llanbedr to Penmaenmawr). Thus Sedgwick must have made alternative arrangements for the transport of his gig. One possibility is that his servant drove it to Aber.[63]

Darwin wrote to Hughes in 1875: "We left Conway early in the morning, and for the first two or three miles of our walk he [Sedgwick] was gloomy, and hardly spoke a word. He then suddenly burst forth: I know that the d-d fellow never gave her the sixpence. I'll go back at once;' and turned round to return to Conway".[64] Sedgwick was convinced that the waiter had not passed on the tip to the chambermaid. However, Darwin persuaded him to continue and they had an excellent day. This story shows that they *walked* from Conway and Sedgwick must have sent his gig on to Penmaenmawr. The watercourse, mentioned by Sedgwick, is the Afon Roe leading to the Afon Tefolog and the lane which leaves the main road at Caerhun follows the watercourse to about 300 metres altitude. Neither made any notes on the geology of the streambed. A little further on a track strikes NNW over Foel Lwyd towards Penmaenmawr. From Sedgwick's reference to the "top of Penmaen Mawr" one may conclude they went to the highest point of Clip yr Orsedd (429m). From there a variety of tracks descend and they probably continued to Aber, keeping above the lowest route so as to observe the Greywacke.

---

[61] Sedgwick, Journal XXI, 10 August, 1831.

[62] This day included 600m or 2000ft of climbing but was considerably less than the route over the Carneddau that Sedgwick followed on 26 August, which was eighteen miles with 5000ft or 1500m of ascent. See Sedgwick's Journal XXI, 26 August. In September, 1999, I took over ten hours to walk Sedgwick's route of 26 August, without stopping to make geological notes.

[63] Sedgwick, Journal XXII, 22 September, 1831; 'My servant ascends Cefn Amlwch …'. This indicates that Sedgwick had a servant/driver with him on this journey.

[64] Darwin to Hughes, 14 May 1875, cited in Clark and Hughes, op. cit. (note 9, 1890), I, p. 381. In notes for his father's biography, Francis Darwin incorrectly described this incident occurring as they left Bangor: http://darwin-online.org.uk/content/frameset?pageseq=1&itemID=CUL-DAR112.B7-B8&viewtype=image.

Near the summit of Foel Lwyd

Next day (11 August) they made a diversion and visited Aber Falls, and then travelled by a picturesque lane contouring around the mountainside to Bethesda. After passing through Llanechlid they descended to Bethesda and went to Penrhyn Quarry, owned by the Pennant family, who paid minimal wages and built the pretentious Penrhyn Castle between 1820 and 1845 on profits from the Penrhyn Quarry and his Caribbean slave estates. I have long wondered who was treated the worse. The quarrymen, according to Rev William Bingley (1774-1823), lived in "the extreme of wretchedness and poverty".[65]

After the quarries, there is no correlation between Darwin's and Sedgwick's notes and it is difficult to work out Darwin's itinerary, as will be discussed below. Darwin's notes are undated and give no chronological fix. Most writers have accepted Darwin's claims in his *Autobiography*, in which he said they "spent many hours in Cwm Idwall" and "At Capel Curig I left Sedgwick". These statements, written nearly half a century later, are not supported by Sedgwick's notes, which make it clear that Sedgwick spent the night of the 11 August near the Menai Bridge and the following day crossed to Anglesey, catching the Dublin ferry at Holyhead on 12 or 13 August.

Sedgwick's notes recorded a visit to the slate quarries at Penrhyn, which are similar to Darwin's. He then recorded "Descend to Bangor – Menai Bridge etc", and made no mention of visiting either Cwm Idwal or Capel Curig. Further, there was insufficient time for Sedgwick to visit Cwm Idwal and Capel Curig. A visit to Cwm Idwal would have added on four or five hours and if they went there it is remarkable that Sedgwick made no notes. Darwin concluded his notes by stating: "Sedgwick says there are same names in Cumberland" referring to terms for slate dimensions – Queens, Ladies etc. If, as seems most probable on previous occasions, Darwin wrote up his notes in the evening this gives support to the view that Darwin spent the night of 11 August with Sedgwick at Menai Bridge.

[65] Dodd, op. cit. (note 19, 1990), p. 206.

Bethesda quarry, now the location of a very long zip wire.

And now to the geology. Wednesday, 10 August, was a far less intellectually taxing day for Darwin, than the traverse from Abergele. He tagged along with Sedgwick on a reconnaissance traverse of the northern Carneddau and received tuition in the field. Darwin's notes are the briefer of the two and describe the central part of the traverse from Foel Lwyd to Penmaenmawr, and when considered in isolation from Sedgwick's notes, they may allow a misinterpretation of their route. Sedgwick's notes for the five miles between Conwy and Caerhun record only the Greywacke and the doubtful cleavage. No notes were made when following the road above the watercourse, the Afon Tefolog, because large rounded mossy boulders hid any exposures. Darwin made no notes until they left the watercourse.

Sedgwick made full notes from Foel Lwyd (GR 721723) to the summit of Penmaenmawr and Darwin's appear to be a précis of them. Sedgwick's notes record the intrusive rocks of Foel Lwyd and Penmaenmawr with various sedimentary rocks in between. He marked the intrusions on his field map. Darwin's notes bear the mark of Sedgwick's tutoring with a detailed description of the greenstone at Foel Lwyd: "quartzose greenstone, sometime porphyritic with crystals of quartz & feldspar with a prismatic cleavage".[66] This contrasts with Sedgwick's "greenstone (felspar, hornblende and quartz) some parts almost Syenite".[67] Most significant is the comment: "The coloured seams in the rock P. Sedgwick remarks generally indicate the strata".[68] Evidently Sedgwick explained to Darwin the difference between cleavage and bedding.

Sedgwick made brief notes at Aber Falls and collected some specimens (numbers. 18, 19, 20), which he left at Caernarfon.[69] In his letter to Darwin of 4 September Sedgwick referred to "the rough crags of Porphyry (we saw at a distance)"[70] at Bera Mawr (GR 675684), demonstrating that Darwin was aware of the basic geology at the Aber Falls. Sedgwick made no notes between Aber and Bethesda and Darwin's notes are rather confusing, largely due to his statement: "at about 2

[66] CUL-DAR5.B, fols. 10ii & 11i. [In *Darwin Online* here.]
[67] Sedgwick, Journal XX1, 10 August, 1831.
[68] CUL-DAR5.B, fol. 11i. [In *Darwin Online* here.]
[69] Sedgwick, Journal XX1.
[70] Sedgwick to Darwin 4 Sept 1831, in: Burkhardt and Smith, op. cit. (note 4, 1985), p. 137.

miles to the NW of the great slate quarry contains a good deal of arsenical copper which is worked somewhere near the Quarry".[71] This simply does not make topographic sense as this would involve a complicated diversion and contradicts Darwin's next sentence: "Four observations on the road (over The Mountain from Aber to Slate Quarry" which is clearly the road from Aber to Llanllechid, coinciding with the present National Park boundary. In view of Darwin's tendency to invert compass directions, the site is probably somewhere between Rachub and Bethesda. And so that came to Penrhyn quarries.

Penrhyn Quarry is a superb site to observe cleavage. As Darwin said: "The rock is divided into cleavages, joints & dip".[72] His and Sedgwick's notes here have close verbal parallels, indicating the tutoring hand of Sedgwick. Again Darwin's notes were far more detailed than Sedgwick's, indicating professorial tuition. Darwin's notes were highly mineralogical and referred to the presence of "Carb of Lim. Quartz. Chlorite. Talc. Molybdene" and "hard chloritic quartzose veins".[73] Some of the fruits of the visit are to be found in the section on cleavage and foliation in *Geological Observations on South America*.[74]

From this time the two sets of notes diverge. The next extant page of Darwin's notes describes Cwm Idwal, but Sedgwick's state: "Descend to Bangor … Over the bridge to Holyhead" and thus it may seem clear that they parted there and then. However that was not the case.

9. To Anglesey and Dublin?, 12 to 20 August

The Problem

To suggest that Darwin went with Sedgwick round Anglesey, and also visited Dublin runs counter to the commonly accepted understanding of the Darwin-Sedgwick tour and needs strong evidence to be accepted. Evidence there is, but it needed time and some 'eureka' moments to find it, both in the field and library. I shall describe parts in the first person. As I researched Darwin's route across the mountains to Barmouth I came to the view that he could not have visited Cwm Idwal with Sedgwick and left Sedgwick before going to Cwm Idwal and Capel Curig, thus contradicting his *Autobiography.*[75] In his pioneering paper Barrett[76] discussed the problems of chronology without resolving them. He wrote: "Darwin was with Sedgwick for no more than a week", which is a reasonable conclusion from Darwin's field notes. He then argued, from Sedgwick's letter to Darwin of 4 September: "For whatever reason Darwin left Sedgwick no later than August 20". Barrett's argument to reconcile this is of interest and somewhat confusing. He argued that Darwin and Sedgwick had separated on 11 August near Penrhyn quarry, but the letter of 4 September indicates that they met up again as Sedgwick had only recounted his journey from 21 August so "Darwin already knew of Sedgwick's activities through 20 August". Barrett then stated, "The two men must therefore have met on that day, or perhaps there was an exchange of letters now lost". Barrett then suggested that "the two men met, probably at Caernarvon, when Sedgwick returned on the twentieth. … Where Darwin was between August 12 and 20 is unknown". Barrett's argument revealed the confusing nature of the events that August and destroyed the simple view of Darwin leaving Sedgwick after Penrhyn quarry, or at Capel Curig, and immediately hiking over to Barmouth. Barrett implicitly questioned the reliability of the account in Darwin's *Autobiography.* However Barrett is correct to say that Sedgwick and Darwin were together on 20 August.[77]

---

[71] CUL-DAR5.B, fol. 11i. [In *Darwin Online* here.]
[72] CUL-DAR5.B, fol. 12i. [In *Darwin Online* here.]
[73] CUL-DAR5.B, fol. 12. [In *Darwin Online* here.]
[74] Darwin, *Geological Observations of parts of South America* (London: Smith, Elder & Co., 1846), pp. 162-8.
[75] Roberts, op. cit. (note 3, 1998).
[76] Barrett, op. cit. (note 1, 1974), p. 148.
[77] Barrett, op. cit. (note 1, 1974), p. 149.

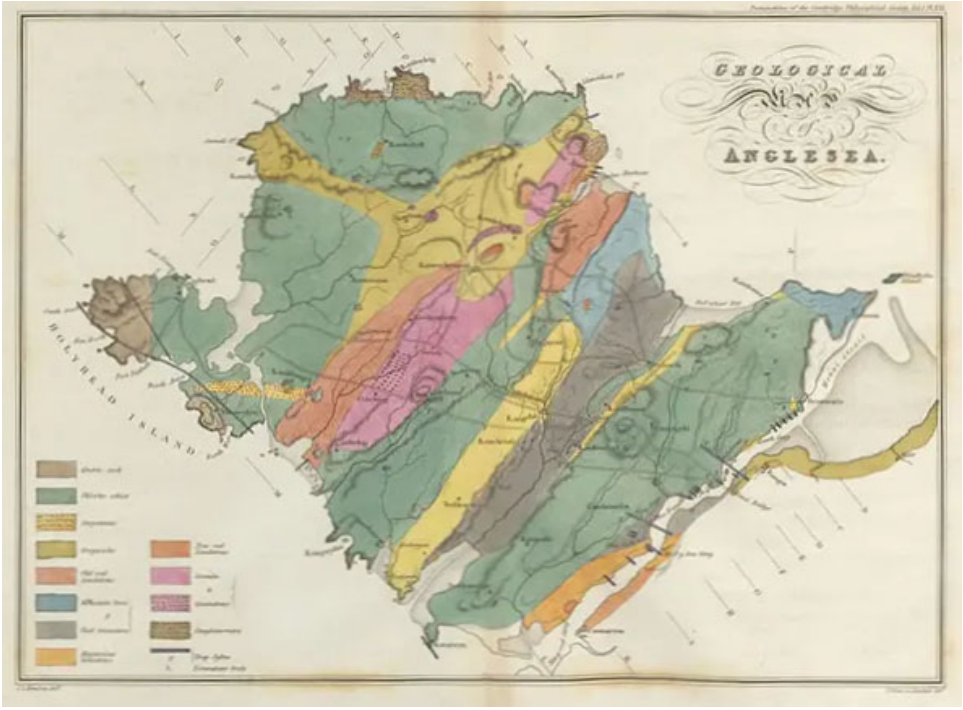
The Argument

I then came across a reference, dated 17 January 1832 in Darwin's geological notes about Quail Island, which is off St Jago in the Cape Verde Islands. He wrote of a recent shoreline conglomerate (sample numbers 35, 36, 75 &76): "as hard as the conglomerates of older formations (viz of red sandstone formation of Anglesey)".[78] In itself this reference to what I take to be the Old Red Sandstone is inconclusive and may imply no more than he was quoting Henslow's paper, in much the same way as he quoted Lyell, or rather Daubeny,[79] on the Temple of Serapis. However he was not referring to nor quoting Henslow's paper, as Henslow nowhere mentioned the hardness of his Old Red Sandstone (later seen as Ordovician). This is part of the Carmel Formation of the Ordovician[80] A few days later Darwin rewrote his description of the same conglomerate giving the same sample numbers: "When breaking it I was forcibly reminded of the very tough conglomerates of the old red sandstone formation".[81] His comparison to its toughness is telling as he must have experienced the hardness of Anglesey rocks. These rocks are very hard as one discovers by hitting with a hammer! He described this recent conglomerate in the *Geological Observations on the Volcanic Islands*: *"Recent Conglomerate.* On the shores of Quail Island, I found fragments of brick, bolts of iron, pebbles, and large fragments of basalt… To show how exceedingly firm this recent conglomerate is, I may mention that I endeavoured with a heavy geological hammer to knock out a thick bolt of iron,…, but was quite unable to succeed".[82] These two references give conclusive evidence that Darwin visited Anglesey in 1831, but give no indication where or for how long. On Henslow's map the Old Red Sandstone is far more extensive than was later accepted and the main area of Henslow's Old Red conglomerate is to be found between Llannerchymedd and Llanfaelog, and thus Darwin almost certainly visited that area in the middle of the island.

With the fact that Darwin had inspected some 'Old Red Sandstone' on Anglesey as a starting point, we are led to the questions where else did Darwin go, with whom and for how long. Sedgwick's letter to Darwin of 4 September 1831[83] needs to be considered. Sedgwick wrote in response to the letter from Darwin he collected at Capel Curig on 2 September, which is now missing from the Sedgwick papers at Cambridge University Library. After making some geological comments on Darwin's letter, which described the geology of Cwm Idwal and Moel Siabod, Sedgwick gave an account of his activities of the last two weeks. However he began with his leaving Caernarfon on 21 August and made no mention of his travels around Anglesey or to Dublin. This omission makes most sense if Darwin was with Sedgwick until 20 August and left Sedgwick at Menai Bridge on 20 August. The alternative by Barrett that they met at Caernarfon on 20 August raises more questions than it solves. At least some of the time from 12 to 20 August Darwin was on Anglesey and both Darwin and Sedgwick visited the 'Old Red' conglomerates south of Llannerchymedd, either separately or together.

---

[78] CUL-DAR34i, fol. 19 / 5. Transcribed by Kees Rookmaaker, edited by John van Wyhe (*Darwin Online*, http://darwin-online.org.uk/) Itemized.
[79] CUL-DAR34i, fol. 24. [In *Darwin Online* Itemized]
[80] M. F. Howells, *British Regional Geology; Wales,* Keyworth, Nottingham, British Geological Survey, (2007), p. 45.
[81] CUL-DAR34i, fol. 35. [In *Darwin Online* Itemized]
[82] Darwin, *Geological Observations on the Volcanic Islands* (London, Smith: Elder and Co., 1844), p. 22.
[83] Sedgwick to Darwin, 4 Sept, 1831, in: Burkhardt and Smith, op. cit. (note 4, 1985), p. 137.



Henslow's geological map from his Geological description of Anglesea. 1822.
[The corrected proof is in the Old Library of Christ's College, Cambridge and reproduced in *Darwin Online* here: http://darwin-online.org.uk/content/frameset?itemID=CC-Oldlibrary0.12.14-9&viewtype=image&pageseq=8 and as a PDF A599. JvW]

Henslow's probable Old red conglomerate GR3377. The scale here is a cycling mitt.

As the evidence pointed towards Darwin going round Anglesey with Sedgwick, (presumably to study the geological work of his mentor Henslow), to test this hypothesis, I plotted Sedgwick's Anglesey route on a map and then superimposed Darwin's references to Henslow's memoir in the *Red Notebook* and other writings. In Darwin's geological notebooks, the *Red Notebook* and *Notebook A* there are ten references to Henslow's paper on Anglesey and a general reference to the island's granites. Of these eight lie directly on the route followed by Sedgwick from 12 to 20 August 1831.[84] One at Llanfihangel lies less than a mile off Sedgwick's most likely route,[85] and one at Bodorgan lies five miles off Sedgwick's route[86] and is from the *Notebook A*.

A further reference from the *Notebook A*[87] is taken up in his paper on Falkland geology where he compared the: "old quartz-rock of Anglesey, as described by Professor Henslow …, with that of the Falkland Islands".[88] If Darwin had accompanied Sedgwick he would have visited some of this "quartz-rock". Writing to Henslow in 1833, Darwin compared the rocks of the Falklands "with those of the oldest fossiliferous rocks of Europe",[89] but was referring largely to its fossils. While in the Falklands in 1834 he compared Falklands geology to that of Anglesey, as described by Henslow, in a six page discussion in his notes on Falkland Islands geology.[90] Darwin seems to have been familiar with the geology of Anglesey but these notes furnish no absolute evidence that he went to the island – or did not.

The reference to granites on page 6 of the *Red Notebook* is worth quoting in full as it demonstrates Darwin's *personal* familiarity with Anglesey geology: "Epidote seems commonly to occur where rocks have undergone action of heat. it is so found in Anglesey amongst the varying and dubious granites".[91] In his description of the granites of Anglesey[92] Henslow made one reference to epidote[93] but no reference to 'action of heat'. Sedgwick recorded "a contorted chloritic very quartzose schist with veins of epidote"[94] near Gwalchmai. The description sounds almost like gneiss and thus a "varying & dubious" granite, though there are intrusive granites in this area. No example is given of epidote occurring "where rocks have undergone action of heat" by either Henslow or Sedgwick, so unless Sedgwick told Darwin about epidote in 'granites' (and there is no evidence to suggest this) it is a reasonable conclusion that Darwin found epidote himself while inspecting 'granites' with or without Sedgwick. On Sedgwick's route 'granites' lie on the Holyhead road near Gwalchmai, on the road to Llannerchymedd, and around Llanellian Mount (Mynydd Eilian). If Darwin had found Epidote in several of these it would be sufficient for him to make the generalisation in the *Red Notebook.* The comments on epidote in Anglesey granites suggest personal observation rather than a reading of Henslow's memoir on the *Beagle* without having

[84] Darwin, *Red notebook*, pp. 5 & 7, transcribed and edited by Sandra Herbert in Barrett et al eds., *Charles Darwin's Notebooks, 1836-1844* (Cambridge, Cambridge University Press, 1987), pp. 21-22 and in *Darwin Online*: Text F1583e
[85] Darwin, *Red Notebook*, p. 7, op. cit. (note 76, 1987), p. 22. Text F1583e
[86] Darwin, *Notebook A*, p. 52, transcribed and edited by S. Herbert, op. cit. (note 76, 1987), p. 100; and in *Darwin Online*: CUL-DAR127.-
[87] Darwin, *Notebook A*, p. 97, transcribed and edited by S. Herbert, op. cit. (note 76, 1987), p. 115.
[88] Darwin, 'On the Geology of the Falkland Islands', *Quarterly Journal of the Geological Society*, pt. I, 2, (1846), pp. 267-74, in John van Wyhe ed., 2009, *Charles Darwin's shorter publications 1829-1883*. Cambridge: Cambridge University Press, 2009 and in *Darwin Online*: Text Image PDF F1674.
[89] Darwin to Henslow, 18 April, 1833, in: Burkhardt and Smith, op. cit. (note 4, 1985), p. 307.
[90] CUL-DAR33.217-222. Transcribed by Kees Rookmaaker, edited by John van Wyhe (*Darwin Online*, http://darwin-online.org.uk/) Text.
[91] Darwin, *Red Notebook*, p. 6, transcribed and edited by S. Herbert, op. cit. (note 76, 1987), p. 22. Text F1583e
[92] In his Memoir of Anglesey Henslow included both what are now considered granite and gneiss as granite. Darwin seems to use 'dubious' as a private way of referring what came to be considered as metamorphism.
[93] J. S. Henslow, 'Geological description of Anglesey', *Transactions of the Cambridge Philosophical Society*, 1 (1822), p. 425.
[94] Sedgwick, Journal XX1, 12 August, 1831.

visited Anglesey. Darwin also made reference to the geology of Anglesey in the first half of the *Beagle* voyage and wrote a summary on it while in the Falklands[95].

Soon after visiting the Cape Verde islands, he landed on the tiny St Paul's Rocks in the Atlantic, near the equator, and some 540 miles from South America, and correctly identified them as being made of serpentine. One of the specimens in the list of rocks, entitled 'Trap' discussed below, is serpentine and Sedgwick had visited such rocks just north of Rhoscolyn on 16th August. Exactly six months on 16th February 1832 later Darwin visited St Paul's Rocks and identified serpentine;

"The rocks are serpentine. & in the lower parts mixed with much Diallage."

and then commented:

"Is not this the first Island in the Atlantic which has been shown not to be of Volcanic origin?"[96]

Serpentine at Darwin's likely locality

Both here in his notes and in his work on volcanic islands Darwin cited these serpentines as almost unique among oceanic islands for not being volcanic.[97] Apart from Anglesey, Darwin had not

[95] Darwin, n.d. Geological diary: (Falkland Islands, in comparison with Henslow's account of Anglesea). CUL-DAR33.217-222. Transcribed by Kees Rookmaaker, edited by John van Wyhe (*Darwin Online*, http://darwin-online.org.uk/)

[96] Darwin, 2.1832. Geological diary: St Pauls. CUL-DAR32.37-38. Transcribed by Kees Rookmaaker, edited by John van Wyhe (*Darwin Online*, http://darwin-online.org.uk/)

visited any area of serpentine and his basically correct identification of serpentine, or rather serpentenite, at St Pauls Rocks is best explained by Darwin having visited Anglesey[98] .
When he visited the Falkland Islands he likened the Holyhead quartzites to the Falklands quartzite as 'the lowest formations' rather than mentioning the Stiperstones quartzite, near Shrewsbury, which would be the obvious choice for a Shropshire lad. These examples are highly suggestive that Darwin was personally familiar with the geology of Anglesey, rather than through Henslow's paper alone. Darwin heavily annotated his own copy of Henslow's memoir, with underlining, addition of quotation marks, references to South America and the occasional correction. However, though Darwin's marginalia strongly *suggest* that he had visited Anglesey it does not *prove* that he did so. The evidence is not totally unequivocal.

However, located in the Darwin papers at Cambridge are two sheets of notes entitled Trap[99] associated with notes from his North Wales tour and on similar paper. These give brief and cryptic notes on nearly twenty rock samples, but give no date or place. They are included in Volume 5 of the Darwin manuscripts, immediately between the Llanymynech notes (CUL-DAR5.B1-B2), and the main 1831 tour notes (CUL-DAR5.B5-B16), which indicates that the original collator of the manuscripts thought they were related, possibly because they were in the same part of Darwin's manuscripts. Before discussing the content of the notes, the actual paper needs description.

The notes on Llanymynech[100] are written on a single folded sheet, giving a page size of 22.3 by 18.4 cm. The paper is thinner that that used for the later tour and has become darkish brown over time. It is very clearly different paper. The paper for the notes numbered 3 to 15 are on a creamy paper, which is far thicker. The pages of the tour from Llangollen to Barmouth are on folded sheets, giving a page size of 25.1 to 25.4 cm by 16.3 to 16.5 cm which have a horizontal crease in the middle. The paper used for his maps is the same and the sheets are double the size. It is likely that Darwin cut these larger sheets and folded them, rather than using a note-book. Those of the chemical notes and 'Trap' are single sheets of the same size also with a horizontal crease, but sheet 4 has had the unwritten portions torn off. The writing on all sheets from 3 to 15 is in ink and is of a similar and distinctive style. They differ from Darwin's notes both of his *Beagle* voyage and from his notes made of Shropshire and Wales from 1837 to 1842. The paper used was wove and is poorly and variably sized. On most of the sheets from folio 5 to 14 the writing is clear with no ink spreading, but on several sheets (folios. 6, 7, 12 and 14) there has been some spreading on one half of the folded sheet, but this only mildly affects legibility. Folios 3, 4, and 15 are poorly sized and the ink has spread reducing legibility. Folio 15 is illegible in places and the writing on folios 3 and 4, on trap, is similar to the notes on poorly sized paper on his main Welsh notes, where there has been some ink spreading. Darwin used a similar paper for the maps he made in 1831[101] and also for some of his letters sent between 1828 and 1831, for example those he wrote to Charles Whitley in 1828 and 1831, which are held at Shrewsbury School.[102] From this it is safe to conclude, from both the paper and the style of writing, these notes were made at a similar time to his Welsh tour. As Darwin left Shrewsbury in October 1831 for five years, they must have been written before then, thus indicating a date of summer 1831, i.e. July to September.

---

[97] CUL-DAR34 i, fol. 25. Transcribed by Kees Rookmaaker, edited by John van Wyhe (*Darwin Online*, http://darwin-online.org.uk/) Darwin, *Geological Observations on the Volcanic Islands* (London: Smith, Elder and Co., 1844), f125.
[98] See Howells pp. 14-17 and map below.
[99] CUL-DAR5.B, fol. 3-4. [In *Darwin Online* here.]
[100] CUL-DAR5.B1-B2, discussed in Roberts, op. cit. (note 6, 1996). [In *Darwin Online* here.]
[101] Roberts, op. cit. (note 8, 2000).
[102] Darwin to Whitley [10 August1828] and [12 July 1831], in: Frederick Burkhardt and Sydney Smith, *The Correspondence of Charles Darwin,* vol. 7: 1858-1859, supplement 1821-1857 (Cambridge: Cambridge University Press, 1991), pp. 465-67.

The brief rock descriptions give sufficient information to enable one to identify the rock type, and approximate locations, which Darwin was describing, but this is apparent only if one is familiar with the geology of Anglesey, North Wales and Shropshire. Thus, the only place in Britain, which Darwin had visited, where all of the rock types described could come from is Anglesey. The traps, serpentine, quartzite and 'dubious' granites (often gneiss) were diagnostic.

From the descriptions, all the specimens can be placed on Sedgwick's route on Anglesey, as Table 1 shows, where likely locations are placed next to Darwin's descriptions. The three trap rocks are a fair description of the Plas Newydd dike, but as they contain hornblende could be from the easterly dike on Holyhead Island.[103] Also immediately following the notes on the Darwin--Sedgwick tour are two pages of details of chemical tests on rock samples.[104] Several of these probably come from Anglesey, and the tests were carried out in September 1831 immediately before Darwin left to join the *Beagle* on 2 October. However there is no indication when Darwin wrote these notes on Trap and there are three possibilities. The most obvious time is either while he was in Anglesey or immediately afterwards. The second is that he wrote them up on return to Shrewsbury but this is less likely, due to his preparations for the *Beagle* voyage. There is also a smaller possibility that these were a description of Henslow's own specimens at Cambridge, made when Darwin visited Henslow on 3 September (or even before he left Cambridge in June), which then begs the question why Darwin should want to make a list of rock specimens he had not seen in the field or perform tests thereon. A date after the *Beagle* voyage can be eliminated because of the paper and style of writing and the relative immaturity of geological description. The most likely alternative to the notes being written during August 1831 is that these could be notes made while Darwin was still at Cambridge. Against is the nature of the paper discussed above. The quality of mineralogical description is better than Darwin's mineralogy during the early days of his tour with Sedgwick and more on a par with those made after Conwy. The lithological descriptions have an immaturity and had these been made in Cambridge they would have indicated the more mature hand of Henslow, either from Henslow's descriptions or his tutoring.

To summarise the argument: the references to Anglesey in Darwin's notes on Quail Island prove that he visited the Welsh island; later references to the Holyhead Quartzites, serpentine and epidote in granites support his visit; the rocks described in his notes entitled 'Trap' show that he had geologised over much of the island and the coincidence of the references on pages 5 and 7 of the *Red Notebook* with Sedgwick's route suggest that Darwin followed the same route. Taking into account Sedgwick's letter of 4 September the simplest and most likely solution is that Darwin accompanied Sedgwick around Anglesey and either travelled with him to Dublin or was sent on another traverse. This is clearly not proof nor a logical argument of 'rational compulsion', which would require either actual field notes or a reference in a letter. It is rather what C. S. Peirce termed 'abduction' or the 'inference to the best explanation'. Following on from Oldroyd's insistence on the *neccessity* of fieldwork,[105] the conclusion that Darwin went round Anglesey, thus doubling the time he spent with Sedgwick, could only have been 'discovered' by fieldwork in the manner Oldroyd recommended. This is because it required familiarity with the manuscripts, but also the geology and topography of Wales and Anglesey, along with the communication systems in 1831.

It is reasonable to expect that Darwin would have made notes on a visit to Anglesey beyond the two pages entitled 'Trap'. However as Darwin was not using a notebook but rather loose sheets as described above, it would be easy to lose or misplace two or three sheets, especially if they were removed for a particular reason. I also suggest that Darwin made notes on Anglesey and these notes

[103] 'Hornblende diabase', Harker No. 553 and Henslow. No 626. Henslow specimens at Sedgwick Museum.
[104] CUL-DAR5.B5-B16. [In *Darwin Online* here.]
[105] Oldroyd, op. cit. (note 21, 1999), p. 415.

are either "missing" or no long extant. My hunch, and hunch it is, that he separated them and took them on the *Beagle* so as to refer to them alongside Henslow's Memoir. My hope is that they are lying unidentified in the midst of geological notes on the voyage.

If my argument is correct then Darwin accompanied Sedgwick for eighteen days, which concurs with Clark and Hughes' unsupported suggestion that Darwin accompanied Sedgwick for "two to three weeks".[106] If Darwin did not go to Anglesey, then their tour was no more than nine days, or seven days if one excludes the days south west of Shrewsbury. There are several further arguments, which strengthen the case for a longer tour. The first is the improvement of Darwin's notetaking, both in general geological comment and mineralogy, which will be discussed below. Secondly Darwin was keen to visit Anglesey and study its geology and in July had made a topographic map of the island from Evans' map.[107] However the place names on this map are not in Darwin's hand. In fact, they are in a hand very similar to Sedgwick's handwriting in his 1831 notebooks.[108] (Darwin also made a tracing of Anglesey, but this has not been consulted as it is missing in Cambridge University Library.) And thirdly, if Darwin had left Sedgwick on 12 August he would have arrived at Barmouth on the 15 or 16 August, giving him nearly a fortnight there. If Darwin left Sedgwick on the 20 August he would have arrived in Barmouth on 23 August, giving him six days there. Lucas found confirmation for this in the Lowe brothers' diary.[109] Darwin's walk from Cwm Idwal to Barmouth took four days, with two nights spent at Capel Curig and one at Ffestiniog.[110] That concurs with Darwin leaving Sedgwick at Menai on 20 August as he could easily have taken a stage coach to Idwal Cottage, visited Cwm Idwal, and walked to Capel Curig for the night. He would have had sufficient time whether he walked along the road (2 hours) or over the Glyders (3 hours as a yomp). In his *Autobiography*, Darwin wrote, "I visited Barmouth to see some Cambridge friends",[111] implying a shorter rather than a longer stay.

To conclude this argument, it is all but certain that Darwin visited Anglesey and at the very least visited 'Old Red' conglomerates, and 'dubious granites' in the centre of the island. It is highly probable that Darwin visited Anglesey with Sedgwick and possible he accompanied him to Dublin as well.[112]

The Route

From the argument above the route and geology of Darwin's visit to Anglesey is considered to be the same as Sedgwick's (Figure 3), though this is probability rather than certainty. Sedgwick had taken Henslow's Geological description of Anglesea as the most detailed work on the geology of North Wales available and hoped to use it as a basis for his future work in Snowdonia but found the geology too different to be of any use. As he wrote to Murchison on 13 September: "I spent some days in the Isle of Anglesey in the hopes of learning my lesson for Snowdonia. Henslow's paper is excellent, but the lesson is worth next to nothing; for Anglesey is almost as distinct in structure

[106] Clark and Hughes, op. cit. (note 6, 1890), I, p. 379.
[107] Roberts, op. cit. (note 4, 2000).
[108] I am grateful to A. Campbell of Cardiff for this insight.
[109] P. Lucas, op. cit. (note 15, 2001). [In *Darwin Online*: Transcribed by Peter Lucas. Edited by Kees Rookmaaker and John van Wyhe 'Journal kept by H. P. Lowe & R Lowe during 3 months of the summer 1831. at Barmouth. North Wales. Forsitan haec olim meminisse juvabit.' [Nottinghamshire Record Office] NRO-DD.SK.218.1 Text.]
[110] Roberts, op. cit. (note 6, 1996).
[111] Darwin, op. cit. (note 5, 1983), p. 40.
[112] 'I have a hard time imagining CD going to Dublin & not mentioning it. I don't have a hard time imagining him walking across the Menai Bridge & not mentioning it'. Sandra Herbert, personal communication, 2000.

from Snowdonia as if they had been separated by the Atlantic sea rather than the straits of Menai".[113]

If Darwin had accompanied Sedgwick around Anglesey, and either accompanied him to Dublin or explored Anglesey on his own, the itinerary (based on Sedgwick's notes) would probably have been as follows. On 12 August they travelled along the new Holyhead Road, stopping to look briefly at the geology. The mail coach took two hours over this section and a gig would have been slightly faster. Thus the pair would have been in Holyhead by mid- or late-morning in order to catch the Packet, which took six hours to cross to Dublin.[114] Sedgwick wrote only: "13 – 14 to Dublin. 15. Return from Dublin", in his Journal,[115] but gave no reasons for his journey. Nothing else is known about the visit and Herries Davies suggests that it may have been in connection with the setting up of The Geological Society of Dublin or the Geological Survey of Ireland.[116] Assuming their boat left about midday they would have had two full days in Dublin. They returned on 15 August sufficiently early to visit Holyhead Mount before evening. Sedgwick gave no indication how far they walked over Holyhead Mountain, but it is only a five mile round trip from Holyhead to South Stack – a mere stroll for both men requiring about three hours. With the magnificent lithographed plate of South Stack in Henslow's Memoir[117] it is unlikely that they did not go there.

For 16 August, Sedgwick's notes are brief and give only a rough outline of their route. They first crossed Holy Island (Ynys Gybi) to Rhoscolyn in the south and then made their way to Llannerchymedd in the middle of Anglesey, having seen a horse-fair at Bodedern. The following day they visited Parys Mountain, the scene of much mining, but spent little time there. From thence they went to Llanelian mount probably via Amlwch. The geology here and by Dulas harbour occupied them for some time. Sedgwick wrote "walk home in the evening"[118] to Llannerchymedd, which was possible given that Sedgwick often had a servant with him. This enabled him to mix walking with the more rapid travel by gig. For 18 August the notes are extremely brief and record a diversion to go up Mynydd Bodafon. They travelled over much Carboniferous Limestone and at Pentraeth heard of the loss of the *Rothesay Castle* on the Dutchman Bank off Llanfairfechan, from where Sedgwick saw the wreck on 29 August. They spent the next two nights of 18 and 19 August at Beaumaris. On 19 August they followed the coast road to Plas Newydd and back, with a diversion over to Bangor at Garth ferry, and spent much time looking at Dikes and "chloritic schist" near Plas Newydd. For 20 August Sedgwick wrote "drive to Caernarfon".[119] It is most likely that they crossed the Menai Bridge. *En route* to Caernarfon, Sedgwick studied the strata by the Moel-y-don ferry on the mainland side at Port Dinorwic. Darwin probably left Sedgwick at the Menai Bridge to make his way to Cwm Idwal that day, to arrive in Barmouth on 23 August and where he met the Lowes and Whitley. According to his *Autobiography* he wished to see some Cambridge friends and be at Maer in time for the beginning of the shooting season. To do this he needed to leave Sedgwick by the 20 August.

[113] Sedgwick to Murchison, 13 September, 1831, Clark and Hughes, op. cit. (note 9, 1890), I, 378.
[114] According to Dodd, op. cit. (note 15, 1990, 128-9) steam was introduced in 1821 and crossing times rapidly dropped to six hours; and by 1828 there were six Irish boats. John Cave, of the Holyhead Maritime Museum, was unable to locate any timetables.
[115] Sedgwick, Journal XX1, 13, 14, 15 August, 1831.
[116] G. Herries Davies, personal communication, January 2000.
[117] Henslow, op. cit. (note 77, 1822), plate. 15.
[118] Sedgwick, Journal XX1, 17 August, 1831.
[119] Sedgwick, Journal XX1, 19 August, 1831.

The Geology

The geology Darwin would have observed in Anglesey was very different from what he had seen before, except for Mountain Limestone. Before this Darwin had not studied 'altered' rocks, which are "dubious" granites, not to mention quartzites and conglomerates. As Henslow used the expression "altered" for what are clearly metamorphic rocks, that term will be used here. Darwin had heard Jameson give a field lecture on a trap-dyke at Salisbury Crags"[120] while at Edinburgh. All this experience of various lithologies was to prove very useful on the *Beagle* voyage. The few days with Sedgwick also gave Darwin the opportunity to study another geologist's memoir in the field — that of his mentor Henslow, -which would prove very useful on the *Beagle* voyage where he also used works by Daubeny, von Buch, Lyell and others.

Rather than deal with the geology in a chronological order of being visited, the geology will be considered under types.

The first are the igneous dikes, which are of Tertiary age. Sedgwick commented only on the Plas Newydd dike and those at Dulas harbour. In his *Red Notebook,*[121] Darwin referred to these and the two long dikes running south east from Holyhead mountain and near Porth Dafreth, and compared each of these to aspects of geology he observed in South America. The features Darwin noted were; "disseminated carbonate of lime" in the Plas Newydd dike, "great variety in nature of a dike (Rhoscolyn), veins of quartz exceedingly rare (Holyhead and Llanelian)" and "Much chlorite in some of the dikes" (Llanfihangel). Henslow described the dikes as basalts[122] and this may explain why Darwin described all igneous rocks at Cwm Idwal as basalts.[123] In the writing up of his South American geology Darwin did not compare South American dikes with those in Anglesey as he did in the brief notes in the *Red Notebook.*

The two geologists looked at the quartzite rocks of Holyhead Mountain and then carried out a traverse to Amlwch and Llanelian. On Holyhead Mountain these were taken by Henslow, Sedgwick and Darwin as the oldest fossiliferous strata, but later were recognised as Precambrian (Monian). Subsequently Darwin compared, and incorrectly correlated such rocks with the quartzites of the Falklands on lithological similarites. He recognised the latter as Silurian due to their fossil content. Two of Darwin's samples are most probably from Holyhead Mountain; the fine-grained white hard sandstone and the white quartzite. Further south at Rhoscolyn are the Serpentines which Henslow did not consider to be igneous, though work in the 1970s identified metamorphic aureoles.

Two different types of conglomeratic material were visited. The first was Henslow's conglomerate of allegedly Old Red Sandstone age to the south of Llannerchymedd. This is an extremely hard conglomerate consisting of smallish angular fragments up to a centimetre across in a quartz-rich matrix and clearly of sedimentary origin and is today regarded as Ordovician.

[120] Darwin, op. cit. (note 5, 1983), p. 29.
[121] Darwin, *Red Notebook*, p. 7, transcribed and edited by S. Herbert, op. cit. (note 76, 1987), p. 22. Text F1583e
[122] Henslow op. cit. (note 85, 1822), p. 401.
[123] CUL-DAR5.B11. [In *Darwin Online* here.]

Holyhead mountain – quartzite.

It is the most likely rock to have been compared to that at Quail Island, though the fragments there were considerably larger. This is also the most likely identification of Darwin's "coarse red one approaching to conglomerate". The second are the "curious coast conglomerate" north of the Dulas harbour. Henslow described these as conglomerates, but noted the concretionary nodules, which are aligned parallel to the schistose laminae. Despite his description, Henslow did not suggest an 'altered' origin for the 'conglomerates 'at Dulas,[124] but did suggest an 'altered' origin for the similar rocks by the Menai Strait.[125] Sedgwick clearly did so for the Dulas conglomerates and his notes for that area postulate considerable alteration.[126] Humorously he suggested some rocks were "broiled greywacke" and then described the "curious coast conglomerate" stating that: "it is not a true fragmentarian but an altered rock, full of great irregular concretionary masses – some parts resemble gneiss or mica slate, lower part coming round to Dulas harbour resembles O.R. [presumably the Ordovician conglomerate described above]". In his *Red Notebook* Darwin likewise recognised the 'altered' nature of this curious conglomerate and underlined Henslow's comments on the nodules and laminae in his copy of Henslow. In his *Red Notebook* this was followed by the comments "Quote this. Valparaiso Granitic nodules in Gneiss".[127] In his *Geological Observations on South America* Darwin described the lithography at Valparaiso, "the prevailing rock is gneiss, … : concretionary balls formed of feldspar, hornblende and mica, from two to three feet in diameter, are in very many places conformably enfolded by the foliated gneiss"[128] and did not quote the Anglesey parallel as originally intended.

[124] Henslow, op. cit. (note 85, 1822), p. 379.
[125] Henslow, op. cit. (note 85, 1822), pp. 386-7.
[126] Sedgwick, Journal XX1, 17 August, 1831.
[127] Darwin, *Red Notebook*, p. 5, transcribed and edited by S. Herbert, op. cit. (note 76, 1987), p. 21. Text F1583e
[128] Darwin, op. cit. (note 67, 162).

It is difficult to see how Darwin could conclude that Henslow was inadequately describing a gneiss with concretions rather than a dubious sedimentary conglomerate unless he had seen the "curious conglomerate" for himself. From the descriptions by both Henslow and Sedgwick it is difficult to locate these precisely but from a comparison with the description in the Geologists' Association Guide they lie between Porth Helgyn and Tyllau Duon. Along this stretch are coarsely crystalline gneisses, foliated crush breccias and 'Precambrian' conglomerates,[129] each of which could be "curious conglomerate". Sedgwick's notes provide the link in the argument from Henslow to that developed by Darwin in the *Red Notebook* and later in his *Geological Observations on South America.*

In the course of their route Darwin and Sedgwick traversed much granitic or gneissic terrain and also schists and greywackes, all of which proved to be most useful to Darwin in South America. Sedgwick made many comments beyond those of Henslow in his notes, for example at the coast beyond Llanelian he wrote, "well stated by Henslow – seek in vain for the Llanelian granite" and even asked whether a quartz rock was "broiled greywacke"[130] This rock is very gneissic in appearance and is a gneiss with many quartz veins.

Transcription of CUL-DAR5.B6-, undated notes entitled 'Trap'.

No	Transcription	Description	Locality
1.	*a red one in which crystals of Feldspar, Hornblee very visible.*	Trap dike Plas Newydd?	A, w
2.	*queer one in which Feldspar is decomposing.*[131] _	Another dike	Aw
3.	*+ pale one*	+ another	Aw
4.	*Green rock*	either Greenstone, or hard chloritic schist	AW
5.	*do approaching Sandstone*	do, more gneissic? South of Llannerchymedd[132]	A*
6.	*Clay slate with mica scales*[133]	'Greywacke' near Llangefni	A*ws
7.	*Do with organic rema(ins) genus allied to Pecten*[134]	difficult to locate	A
8.	*2 largish ?? Granite + close grained Limestone*	contact of Gneiss, Gwalchmai?	A
9.	*Manganese*		
10.	*In air. Calcareous cement*		
11.	*a Fine grained white hard sandstone*	Holyhead Mountain	A*S
12.	*a coarse red one approaching to conglomerate*	Henslow's ORS south of Llannerchymedd	A
13.	*Quartzite. White*	Holyhead Mountain	AS
14.	*red sandstone*	ORS Anglesey, NRS Clwyd & Salop	AWS
15.	*a Pale o. red Limestone*	Too vague for identification	AWS
16.	*a very dark . close grained organic limestone*	Carb or Ord limestone from anywhere	AWS
17.	*Serpentine*	**SE of Holyhead and nowhere else**	A****
18.	*a hard large greenish Granite*	Henslow's Granites[135]	A*
19.	*do qtz fine greenish do*	do	A*

Only the writing in italics are Darwin's notes. The numbers on the left are not part of the manuscript. The letters on the right indicate the likely provenance of the samples; A – Anglesey, W – North Wales, S – Shropshire, The likelihood is indicated by: X* = unique to the locality and diagnostic; X = definite, and x = likely.

[129] D. E. B. Bates and J. R. Davies, *Anglesey*, *Geologists' Association Guide No.40,* (London: The Geologists Association, 1981), pp. 18-19.
[130] Sedgwick, Journal XXI, 17 August, 1831.
[131] These sound similar to the Plas Newydd dike described by Henslow, op. cit. (note 85, 1822), pp. 402-3.
[132] Henslow, op. cit. (note 85, 1822), p. 392.
[133] Henslow describes 'green talcose clay slate,…, and scales of mica'. Henslow, op. cit. (note 85, 1822), p. 384.
[134] Henslow referred to an anomia, which resembled the 'common pecten' and was about 1/2 inch wide. Henslow op. cit. (note 85, 1822), p. 392.
[135] Henslow op. cit. (note 85, 1822), pp. 424ff.

Finally there is the list of rocks on the sheet titled "Trap"[136]. Before considering the localities of the rocks, some comments can be made on the content. First, there is considerable identification of minerals. It is only after Conwy on 10 August that Darwin began to describe minerals in such detail and competence. Thus the notes were probably written after 10 August. Secondly in several places the notes contain quotations and echoes from Henslow's Anglesey paper. In the cases of the trap with decomposing feldspar and the clay slate with scales of mica, one (Plas Newydd dike) was visited by Sedgwick on 19 August.

In the list of rock types (above) there are three "traps", a serpentine, three 'granites', two white quartzites, two clay-slates, a "sort of a conglomerate", two limestones, two 'green rocks' like sandstone and two unidentifiable samples. Below is a transcription of the 'Trap' list with suggestions as to localities and whether each sample could come from Anglesey, the rest of North Wales or Shropshire.

This collection can be compared with Darwin's work in 1831 in the North Wales and Shropshire and my postulated visit to Anglesey to see from where they most probably originated. Of the samples all could come from Anglesey, and only six each from mainland North Wales and Shropshire. Further the 'granites', 'conglomerates' and Serpentine could come only from Anglesey. The serpentine is conclusive, though a little might be found in the Lleyn peninsula. The trap rocks are similar to those described by Henslow. Rock 12 "a coarse red one approaching to conglomerate" is a better description of the allegedly ORS conglomerates south of Llannerchymedd than simply conglomerate.

The samples also show Darwin's improving understanding of palaeontology as for Rock 6 organic remains were described as "genus allied to Pecten". The use of *Pecten* for both Brachiopods and bivalves was disappearing from 1810[137] and is also reflected by Henslow's comments on fossils in what he termed ORS south of Llannerchymedd (actually Ordovician).[138] Though a very brief comment this gives a significant insight into Darwin's grasp of palaeontology in late-August 1831.

All sixteen samples are rock types, which would be found on the actual route Sedgwick took thus giving another coincidence.

Though this undated sheet gives no locations it is arguably a list of Anglesey rocks. From the mineralogy described it dates from after 10 August and before 29 August because by then Darwin had other things on his mind.

In many ways Darwin's visit to Anglesey was the most useful part of his tour with Sedgwick though in the absence of any notes much has to be hypothetical. However there is more than enough evidence to show what variety of rocks Darwin studied there. The study of volcanic dikes, gneiss, 'dubious' conglomerates, quartzites and serpentine proved very useful on his *Beagle* voyage and echoes of this fieldwork and his use of Henslow's Memoir may be found throughout both his geological notes on the *Beagle* voyage and his published works.

10. Separate Ways. 20 August

Darwin, I have argued, left Sedgwick at Menai on 20 August. Sedgwick spent the next six weeks geologising in Snowdonia and the Lleyn peninsula. Darwin travelled through Nant Ffrancon to Capel Curig, and thence, after ascending Moel Siabod, to Barmouth following well-worn paths,[139] rather than a compass bearing, as he claimed in his *Autobiography*.

---

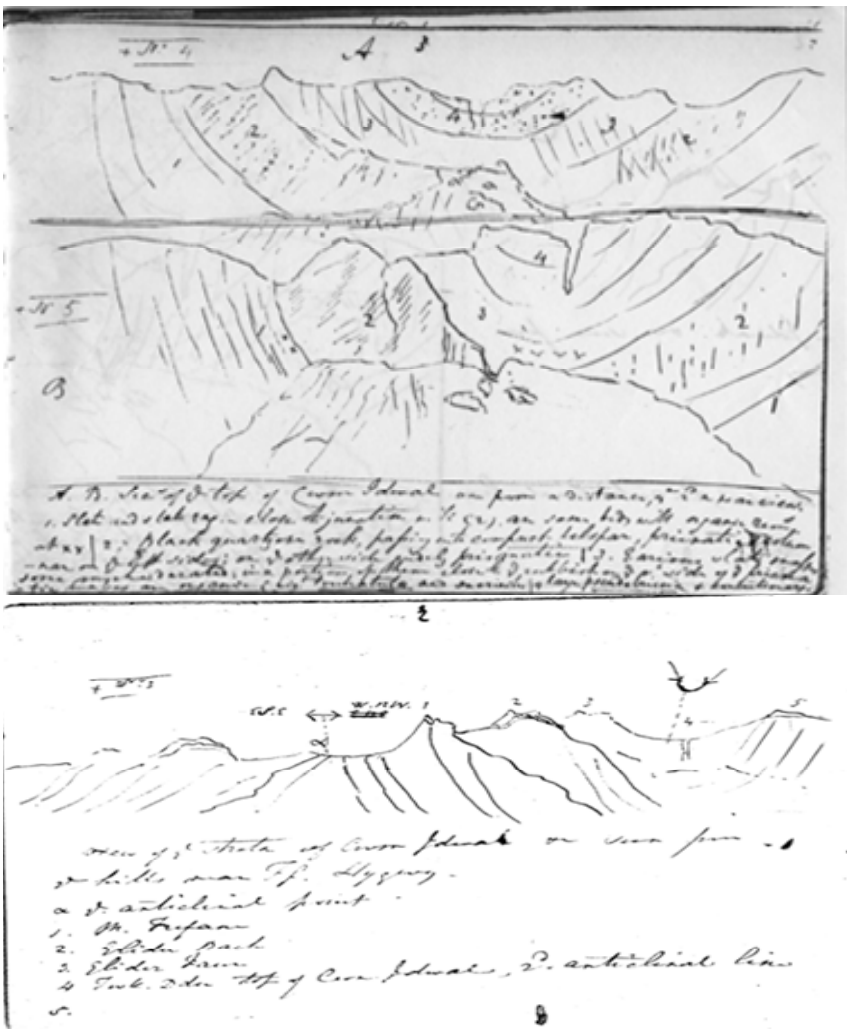
[136] CUL-DAR5.B3-B4. [In *Darwin Online* here.]
[137] H. S. Torrens, 'Arthur Aiken's Mineralogical Survey of Shropshire, 1796-1816', *British Journal for the History of Science*, 16 (1983), pp. 111-153.
[138] Henslow, op. cit. (note 85, 1822), p. 392.
[139] Roberts, op. cit. (note 8, 2000).

Darwin probably took the Holyhead-Shrewsbury coach from Menai to Ogwen cottage and walked up to Cwm Idwal. From the quantity of notes made in Cwm Idwal – two sides – he was there several hours. He probably walked the six miles to the King's Hotel (now Plas y Brenin), the old coaching inn by Llynnau Mymbyr, near Capel Curig. Darwin stayed there on several occasions and, like Queen Victoria, scratched his name on a windowpane. This conflicts with the statement in his *Autobiography* that he spent hours in Cwm Idwal with Sedgwick. However Sedgwick's letter to Darwin on 4 September 1831 makes it clear that Darwin visited Cwm Idwal alone, and this is borne out by Sedgwick's field notes.

Twll Du or Devil's Kitchen from Llyn Idwal showing the syncline of Twll Du.

Darwin gave a sound description of the geology in Cwm Idwal,[140] but interpreted the syncline at the Devil's Kitchen as an inverted cone and described the volcanic rocks variously as "slate resembling basalt" or "basalt". This was probably due to the influence of visiting the trap-dikes of basalt on Anglesey. Sedgwick disagreed with Darwin's identification of basalt and in a postscript to his letter of 4 September wrote: "I saw no *basalt* at Lake Ogwen [sic] but a very black pyritous variety of rock something between Lydian stone & compact felspar". Continuing in tutorial mode, he wrote: "It differs from basalt in being extremely siliceous".[141] Darwin's notes on Cwm Idwal represent a considerable advance from those taken between Conwy and Menai and contain much lithographic and mineralogical description. He was also bold in attempting to elucidate the structure.

[140] Roberts, op. cit. (note 6, 1996), p. 476.
[141] Sedgwick to Darwin, (4 September 1831), in: Burkhardt & Smith, op. cit. (note 4, 1985), pp. 137-8.



Sedgwick's sketches of Twll Du, drawn after Darwin's visit. (Sedgwick Museum)

It was a repeat performance the next day 21 August when he climbed Moel Siabod above Capel Curig and gave a similarly good description of the geology.[142] As well as recording this in his notes he wrote a report in a letter to Sedgwick, to which Sedgwick responded on 4 September. Sedgwick replied at length with a series of constructive remarks and inserted the words "Madrepores found by Mr Darwain" into the notes he had made a couple of days earlier at Llyn Idwal.[143] Thus Sedgwick commented on Darwin's last traverse and his tutoring of Darwin was over, but his influence was not.

11. The Significance to Sedgwick

It is difficult to discern any tangible benefit to Sedgwick in taking along Darwin as a companion, beyond that of training up another student as a geologist and simply to have company on a long journey. This is, of course, what Henslow had done for Darwin on natural history while he was at Cambridge. Some of the pride Sedgwick felt for his young pupil can be seen both in the fact that it was Sedgwick rather than Henslow who read out Darwin's letters to Henslow to the Geological

[142] Roberts, op. cit. (note 3, 1998), p. 67.
[143] Sedgwick, Journal XX1I, 31 August, 1831.

Society on the geology of South America on 16 November, 1835.[144] Sedgwick also wrote a "bonne bouche" to Dr Butler of Shrewsbury School. Dr Butler sent an extract of this letter to Robert Darwin, which Susan Darwin copied out in a letter to Charles: "He is doing admirably in S. America, & has already sent home a Collection above all praise. – There was some risk of him turning out an idle man: but his character will now be fixed, & if God spare his life, he will have a great name among the Naturalists of Europe".[145] Dr Butler had clearly changed his mind since he regarded the schoolboy Charles as "poco curante",[146] according to his *Autobiography*[147] for wasting his time over such useless subjects as chemistry. It is difficult not to see that Sedgwick was congratulating himself, with good reason, on tutoring Darwin so well in geology.

12. Darwin as Sedgwick's (and Henslow's) Disciple

As the field trip was one in which the novice geologist accompanied Sedgwick, an experienced and leading geologist, it would be unreasonable to expect that Darwin made any profound geological discoveries. The relationship was entirely that of pupil and tutor. As both made notes, a comparison of their respective notes, shows how Darwin developed over these weeks.

By the time Sedgwick arrived in Shrewsbury on 2 August, Darwin had a moderate grasp of geology and knew the rudiments of mapping, rock identification, and the use of a clinometer. Darwin had also acquired much geological understanding during the previous decade. From his reference to Cotton and the Bellstone in his *Autobiography,*[148] he was familiar with some basics of geology as a young teenager. At Edinburgh, he learnt geology from Jameson and Hope. Despite Darwin claiming in his *Autobiography* that he did not attend Sedgwick's geology lectures at Cambridge, contemporaries claimed he did.[149] Thus by June 1831, he had acquired general notions of vast ages, strata, geological ages and fossils, as would any competent natural historian at that time. His father's circle included men familiar with geology, including his father's colleague, Dr Dugard, and thus Darwin would have had access to publications of the Geological Society and other geological works. He probably knew the work of Arthur Aiken on Shropshire and North Wales and that of Robert Townson on Shropshire.[150] His mentor in entomology, the Reverend F. W. Hope (1797-1862), was well-informed in geology, who had his own copy of Fleming's response to Buckland.[151] This evidence is circumstantial, but it would be surprising if the budding naturalist, who carried out chemical experiments in his garden laboratory, was not also familiar with geology. However, Darwin was in need of competent tuition in field geology. He had, of course, spent some time in the field in July 1831 but his notes and maps indicate that he was need of guidance. He had tried to make maps and visited Llanymynech and the sandstone ridge at Nesscliff. Before Sedgwick arrived he had spent at least six or seven days in the field, and as well as time at home, both making his maps, trying out his clinometer and reading up on geology.

During their time together Sedgwick introduced Darwin to a wide range of geology. There was the additional frisson of working with someone who was on the cutting-edge of geology. Into today's terms, Darwin had to consider strata from the Precambrian to the Triassic, though, of

[144] Darwin, 'Extracts from letters addressed to Professor Henslow', in: van Wyhe, op. cit. (note 80).
[145] Susan Darwin to Charles Darwin (22 November 1835), in: Burkhardt and Smith, op. cit. (note 4, 1985), p. 469.
[146] Henry Matthew to Darwin (March/April 1831), in: Burkhardt and Smith, op. cit. (note 4, 1985), p. 119.
[147] Darwin and Huxley, op. cit. (note 2, 1983), p. 24.
[148] Darwin and Huxley, op. cit. (note 2, 1983), p. 28.
[149] J. M. Rodwell to F. Darwin (8 July 1882), CUL-DAR112. [In *Darwin Online* Itemized]
[150] Torrens, op. cit. (note124, 1983).
[151] J. Fleming, 'The Geological Deluge, as Interpreted by Baron Cuvier and Professor Buckland', *Edinburgh Philosophical Journal,* 14 (1826), pp. 205-39. The copy of this publication at the Oxford Museum has Hope's name on it.

course, the elucidation of the Lower Palaeozoic and below was then in its infancy. In descending stratigraphic order Darwin and Sedgwick looked at the drift at Valle Crucis and the Cefn caves, New Red Sandstone in the Vale of Clwyd; Mountain Limestone above Llangollen, the vale of Clwyd, the North Wales coast and Anglesey; alleged Old Red Sandstone in the Vale of Clwyd and Anglesey, and the real McKoy in Anglesey; various slates and volcanics of 'Primary' age between Llangollen and Ruthin and in Snowdonia; trap dikes in Anglesey; Serpentine; and finally various facies of what was to be later known as the Mona Complex in Anglesey.

Sedgwick also taught Darwin to observe and describe the lithologies of these rocks and thus he was familiarised with greywackes, slates, conglomerates and sandstones and limestones, as well as a wide variety of igneous and 'altered' rocks. His knowledge of mineralogy increased greatly during the trip and he became able to recognise a variety of minerals, although he long had had an interest in minerals. His increasing skill in mineralogy is shown by the absence of minerals recorded at both Llanymynech and the early stages of the tour, whereas after leaving Conwy he recorded a variety of minerals. His mineralogy was even more detailed after leaving Sedgwick on the final leg from Cwm Idwal to Barmouth.

Sedgwick also introduced Darwin to aspects of structural geology and how to measure the dip and strike of both bedding and cleavage. Both Darwin's and Sedgwick's notes contain many references to cleavage and on some 'Greywacke' above Penmaenmawr Darwin commented: "The coloured seams in the rock P. Sedgwick remarks generally indicate [the bedding of] the strata".[152] Sedgwick included his findings about cleavage in his article of 1835,[153] Darwin recorded many examples of cleavage on his voyage especially on the Falkland Islands and emphasised the difference of stratification and cleavage.

Though the geology of Anglesey rocks was of little use to Sedgwick in preparation for Snowdonia, it was of great use to Darwin for the rest of the world. The manifold dikes they investigated showed Darwin the variation in similar igneous rocks and were good preparation for the volcanic islands. The "altered" terrain of Anglesey gave an insight into both granitic and gneissic terrains and of schists and altered, even '*broiled*', greywacke, along with the distinction of 'altered' and unaltered conglomerates and breccias. Using the brief comments in the *Red Notebook* as signposts, the influence of both Henslow and Sedgwick on Anglesey on his geology of South America becomes manifest.

Reading his notes straight through from Llangollen to Moel Siabod improvement is evident. It shows a considerable, and gradual improvement, but between Penrhyn quarry and Cwm Idwal (adjacent pages in his notes) the improvement is dramatic, especially when one considers that the Cwm Idwal notes were written after Darwin left Sedgwick and thus without Sedgwick's guidance. These notes show some competence in dealing with igneous rocks, which were some of the very rocks Sedgwick visited in Anglesey, as he particularly commented on trap dikes as did Darwin in his notes in the *Red Notebook.* The only other day Darwin described igneous rocks was on 9 August of rocks in the vicinity of Foel Lwyd above Penmaenmawr. He also made detailed descriptions of mineralogy. There is, in fact, less of an improvement between the notes at Cwm Idwal and those taken at Quail Island on the Cape Verde Isalnds[154], than those of the Conwy-Bethesda traverse and those taken at Cwm Idwal. This becomes more significant because by the time Darwin visited Quail Island he had had time to read Charles Daubeny's *A Description of Active and Extinct Volcanoes*

[152] CUL-DAR5.B10i. [In *Darwin Online* Text]
[153] A. Sedgwick, 'Remarks on the Structure of Large Mineral Masses', *Transactions of the Geological Society*, Series 2, 3 (1835), pp, 47-68.
[154] P. Pearson & C.J Nicholas, *Marks of extreme violence': Charles Darwin's geological observations at St Jago (São Tiago), Cape Verde islands,* Geological Society, London, Special Publications vol. 287 (2007), pp. 239-253 https://doi.org/10.1144/SP287.19.

(1826), which Sedgwick advised Darwin to obtain in his letter of 18 September 1831.[155] This sets the scene for his geological work on the *Beagle*, which has been expounded in Wesson's *Darwin's First theory*.[156]

One of the ironies of popular accounts of the 1831 field trip is the assertion that Darwin and Sedgwick went on a walking holiday combined with a fossil-hunting trip. Nothing could be further from the truth, but old myths die hard. By and large fossils were incidental to their work and the notes of both geologists make few references to fossils. However Sedgwick recorded the presence or absence of fossils at many localities and on several occasions when Darwin and Sedgwick visited localities together only Darwin recorded fossils, presumably having been urged to look for them. While travelling on his own Darwin recorded fossils at Cwm Idwal and on Moel Siabod and clearly understood the various types of fossils, sufficiently so to identify them on the *Beagle* voyage as he did in the Falkland Islands.

Darwin was not taken to a classic area and shown the long-understood geology by an experienced teacher, as happens to most novice geologists. Instead he was taken to a relatively unknown area by an experienced geologist, who first wished to check out the previous work of Greenough in the Vale of Clwyd, secondly to work out the mass of strata in Snowdonia which were loosely known by the Cornish name of Killas, or lumped together as Greywacke, or even as Greenstone, with associated igneous rocks, and thirdly (I have argued) to the complex terrain of Anglesey. This resulted in a very different learning experience and would satisfy some modern theories of teaching, as the approach was one of discovery rather than being taught 'eternal verities'. He was not only taught to observe but also to think.

In the Vale of Clwyd Darwin was introduced to Sedgwick's doubts about the existence of Old Red Sandstone marked on Greenough's map, and then was sent on a traverse to test whether or not it was present. Much of the time Darwin was shadowing Sedgwick and receiving direct tuition, indicated by a frequent near verbal agreement in the two sets of notes.

13. The Effect on the *Beagle* Geology

Of the importance of the tour with Sedgwick teaching Darwin a wide range of field geology skills there is no doubt. However the effect of this tour on Darwin was wider than the acquisition of geological skills, as the actual geology Darwin studied, especially on Anglesey, influenced his approach and understanding of the geological features he studied while on the *Beagle*. During the first part of the voyage Darwin made greater reference to Henslow than to Lyell as may be seen in his discussion of Henslow's Anglesey paper which was probably made while on the Falkland Islands.[157]

Apart from his work on coral reefs and the uplifting of South America, which owed much to Lyell, most of Darwin's work concentrated on volcanic islands and the metamorphic terrains of South America. For that, the geology of North Wales and Anglesey were of inestimable value. That story has been taken by Rob Wesson in *Darwin's First Theory.*

14. Conclusion

In conclusion, the field trip with Sedgwick had far more influence than the reading of Lyell's *Principles of Geology* in Darwin's developing practical skills in geology. Lyell gave Darwin a theoretical framework, which is very evident when one compares *The Principles of Geology* with

[155] Sedgwick to Darwin (18 September 1831), in: Burkhardt and Smith, op. cit. (note 4, 1985), p. 157.
[156] R. Wesson, 2017, *Darwin's First Theory,*
[157] CUL-DAR33.217-22. Transcribed by Kees Rookmaaker, edited by John van Wyhe (*Darwin Online*, http://darwin-online.org.uk/) Text.

the three volumes written on the geology of the *Beagle* voyage. Sedgwick gave Darwin something no less important, by teaching him the skills of geological observation in the field and rigorous geological note taking, and this was enhanced by Henslow's memoir. But a comparison of *Geological Observations of South America* and Darwin's paper on the Falklands with the geology of North Wales and especially that of Anglesey indicate that the influence of this trip went far beyond the mere teaching of geological skills.

This is evidenced first by both the content and the style of Darwin's notes and how they evolved from his first notes at Llanymynech and around Shrewsbury and, for our purposes, culminating with those made at Quail Island.[158] The development of Darwin's skill can be seen graphically by simply reading through his notes in sequence from those taken at Llanymynech, then those taken during his Welsh field trip, and finally the first few days of notes taken on Quail Island, which were his first field days on the *Beagle* voyage. The notes taken at Llanymynech are simply indifferent and represented little more than his first use of a clinometer. The notes which Darwin made in Cwm Idwal and on Quail Island both show the influence of Sedgwick in the detailed recording.

It is evidenced secondly by the way Darwin used and developed both Henslow's Anglesey memoir and Sedgwick's interpretation of it. Darwin's notes on Anglesey may be missing, but the threads of thought can be traced through his notebooks of the *Beagle* voyage into his published work.[159]

Darwin's comment; "This tour was of decided use in teaching me a little how to make out the geology of a country" is a typically Darwinian understatement of his debt to Sedgwick, as it served him well on his voyage. He should also have acknowledged Henslow, as he studied Henslow's memoir in great detail. Were it not for Sedgwick's tutoring the reading of Lyell would very likely have been of limited value. Sedgwick and Henslow taught Darwin the practical geological skills and a sound basis of geology, whereas Lyell gave Darwin a daring conceptual and theoretical framework. Without the practical skills learnt from Sedgwick and the study of Henslow's Anglesey Memoir during these few weeks Darwin's three volumes on the geology of the *Beagle* voyage might have 'started up a machinery as wild ... as Bishop Wilkin's locomotive that was to sail with us to the moon.'[160]

[158] Roberts, op. cit. (note 6, 1996), S. Herbert, 'Charles Darwin as a Prospective Geological Author', *British Journal for the History of Science,* 24 (1991), pp. 159-92.
[159] This requires a detailed study in its own right.
[160] Sedgwick to Darwin (24 November 1859), in: Burkhardt et al eds., *The Correspondence of Charles Darwin,* vol. 7: (Cambridge: Cambridge University Press, 1991), p. 396.

APPENDIX I

Darwin's Maps

Darwin had access to several topographic and geological maps and information about these can be gleaned from notes or maps he made in 1831. His copies of maps made in July 1831 were from Evan's large-scale map of Wales and Baugh's map of Shropshire respectively.[161] He most probably took Evans' map on his tour and his route from Capel Curig to Barmouth is clear from using the map. In 1842 Darwin took Walker's map on his glacial trip as did Sedgwick in 1831, but there is no evidence that he took it in 1831, though Sedgwick had a copy.

BAUGH, R., 1808, *Map of Shropshire* (reproduced by the Shropshire Archaeological Society 1983, edited by Barrie Trinder, published by Alan Sutton Publishing Limited.)

EVANS, John, 1795, *Map of the Six Counties of North Wales* (inscribed to Sir Watkin Williams-Wynn of Wynnstay Hall, Ruabon, June 1 1795.) London & Liverpool. Publisher; unknown

WALKER, J. and A., 1824, *Map of North Wales*. London and Liverpool; n.d.

GREENOUGH, G., *Geological Map of England and Wales, 12 miles to One Inch* J. Gardner, Edinburgh, July 21st 1826. Cambridge University Library, Map Room, C.35.82.16.

APPENDIX II

Chronologies for Darwin's visit to Wales in August 1831.

Date	Lodging	Route	Geology
July	Mount	Llanymynech	receives clinometer & tests it at Llanymynech
July	Mount	N & S of Shrewsbury	"I coloured..a map"
2 August	The Mount	Sedgwick arrives and stays with Darwins	
Sedgwick spent two days looking at the geology west of Shrewsbury, likely took Darwin with him. Notes only for Sedgwick			
3 August	Mount	Alberbury	Mountain Lime, coal Measures
4 August	Mount	Pontesbury	Mountain Lime, coal Measures, missed ORS
Main Tour with Sedgwick. Separate notes by Darwin and Sedgwick			
5 August	Llangollen*	New turnpike (A5)	Transition, Mt Lst, looked for ORS
6 August	Ruthin*	Horseshoe pass	Transition, NRS, Mt Lst, looked for ORS
7 August	Denbigh*	Direct route	NRS
8 August	Abergele*	S to Conwy, D on traverse	Look for ORS between Mt Lst & Transition
9 August	Conwy*	Conwy via Orme	Look for ORS between Mt Lst & Transition
10 August	Aber *	Up Conwy Valley, over Foel Lwyd	Transition
11 August	Menai Bridge	Bethsaida slate quarry	Transition

[161] Roberts, op. cit. (note 8, 2000).

Almost certainly Darwin accompanied Sedgwick from 12th to 20th August. Only notes by Sedgwick

12 August	Holyhead			
13-14 August	Dublin			
15 August	Holyhead	return, visit Holyhead mount	Quartzites	
16 August	Llanerchymedd	via Rhoscolyn	Serpentine and "ORS"	
17 August	Llanerchymedd	Paris mount, Dulas	Mine at Paris Mt,various "metamorphosed" rock	
18 August	Beaumaris	via Bodafon	Mt Limestone & Millstone Grit	
19 August	S of Plas Newydd?	Plas Newydd	Various Carboniferous, & Plas Newydd Dyke	

After some field work Sedgwick dropped Darwin off somewhere near Menai after visiting Moel-y-Don. Darwin was on his own to Barmouth. Undated notes by Darwin.

20 August	Capel Curig*	Dropped off by Menai, coach to Ogwen!	Cwm Idwal volcanics
21 August	Capel Curig*	Moel Siabod	Transition volcanics
22 August	Ffestiniog**	Dolwyddelan Ffestiniog	Transition volcanics
23 August	Barmouth*	Bwlch Drws Ardudwy in Rhinogau	Transition
24-29 August	Barmouth*	A blank!	
30 August	The Mount*	Coach to Shrewsbury	Letter about Beagle!!!

Beagle voyage

1832

Jan	Cape Verde Islands	Volcanics and a "conglomerate"	
Feb 16th	St Pauls Rocks	Serpentine	

ACKNOWLEDGMENTS

The Darwin manuscripts (DAR) are quoted with permission of the Syndics of Cambridge University Library. The Sedgwick Notebooks and Maps are cited or reproduced with permission of the Sedgwick Museum, Cambridge. This work has benefited from the kindly and constructive criticism of Michael Bassett, Sandra Herbert, Janet Browne, Jim Moore, David Norman, David Oldroyd and especially Jim Secord, who has encouraged me for many years. More locally I have been encouraged by Margaret Wood and Stewart Campbell of the Countryside Commission for Wales, Cynthia Burek, many members of the Shropshire Geological Society, and local groups who have invited me to speak on various occasions. This work was entirely self-funded.

REFERENCES

BARRETT, P. H., 1974, The Sedgwick-Darwin geologic tour of North Wales. *Proceedings of the American Philosophical society* 118: 146-164.

BARRETT, P. H., Gautry, P. J. et al., 1987, *Charles Darwin's Notebooks, 1836-1844*. Cambridge: Cambridge University Press.

BATES, D. E. B. and J. R. Davies, 1981, *Anglesey, Geologists' Association Guide No. 40*. London: The Geologists Association.

BURKHARDT, F. and SMITH, S. eds., 1985 *The correspondence of Charles Darwin*, vol. 1 (1821-1836). Cambridge: Cambridge University Press, pp. 702.

BURKHARDT, F. and SMITH, S. eds., 198, *The correspondence of Charles Darwin*, vol. 2 (1837-18430. Cambridge: Cambridge University Press, pp. 603.

BURKHARDT, F. and SMITH, S eds., 1991, *The Correspondence of Charles Darwin*, vol. 7 (1858-1859, supplement 1821-1857). Cambridge: Cambridge University Press.

CLARK, J. W. & HUGHES, T. McK, 1890, *The Life and Letters of the Reverend Adam Sedgwick.* Cambridge: Cambridge University Press.

CONEYBEARE, W. & PHILLIPS, W., 1822, *Outlines of the Geology of England and Wales.*

DARWIN, C. R., n.d. Geological diary: (Falkland Islands, in comparison with Henslow's account of Anglesea). CUL-DAR33.217-222. Transcribed by Kees Rookmaaker, edited by John van Wyhe (*Darwin Online*, http://darwin-online.org.uk/)

DARWIN, C. R., 1839: *Journal of researches into the geology and natural history of the various countries visited by H.M.S. Beagle*. London: Henry Colburn.

DARWIN, C. R., 1844, *Geological Observations on the Volcanic Islands,* London.

DARWIN, C. R., 1846, *Geological Observations of parts of South America*, London.

DARWIN, C. R., 1846, On the Geology of the Falkland Islands, *Quarterly Journal of the Geological Society of London*, pt. I, 2: 267-74, (in van Wyhe ed., Darwin's *Shorter publications*, 2009 and in *Darwin Online* here: Text Image PDF F1674.)

DARWIN, C. R. & HUXLEY, T. H., 1983 *Autobiographies*, ed. by G. de Beer, Oxford.

DESMOND, A., 1994, *Huxley: the devil's disciple,* London.

DODD, A. H., 1990, *The Industrial Revolution in North Wales*. Wrexham.

EVANS, John Evans, 1795, *Map of the Six Counties of North Wales* (inscribed to Sir Watkin Williams-Wynn of Wynnstay Hall, Ruabon, June 1 1795.)

HENSLOW, J. S., 1822, Geological description of Anglesey. *Transactions of the Cambridge Philosophical Society*. 1: 359-452.

HERBERT, S, 1990, Charles Darwin as a prospective geological author, *British Journal for the History of Science* 24: 159-92.

HERBERT, S., 2005, *Charles Darwin, geologist*, Cornell University Press.

HOWELLS, M. F., 2007, *British Regional Geology; Wales, Keyworth, Nottingham*, British Geological Survey,

LUCAS, P., 2002, "A Most Glorious Country": Charles Darwin and North Wales, especially his 1831 Geological Tour', *Archives of Natural History*, 29 (1): 1-26

LYELL, C., 1833, *Principles of Geology*, vol iii, London.

NUMBERS, R., 1998, *Darwinism comes to America,* Harvard.

RAMSEY, A. C., 1866, The Geology of North Wales, Memoir of the Geological Society, 3 London: Longmans, Green, Reader and Dyer, 222–27.

ROBERTS, M. B., 1996, Darwin at Llanymynech: the evolution of a geologist. *British journal for the history of science* 29: 469-78.

ROBERTS, M. B., 1998, Darwin's Dog-leg. *Archives of natural history* 25: 59-73.

ROBERTS, M. B., 1998, Geology and Genesis unearthed, *The Churchman,*
ROBERTS, M. B., 2000, I coloured a map, *Archives of natural history* 27: 59-73.
ROBERTS, M. B., 2001, Just before the *Beagle*, *Endeavour*, vol. 25 (1), pp. 33-37.
ROBERTS, M. B., 2009, Adam Sedgwick (1785-1873): Geologist and Evangelical. In KOLBL-EBERT, M. ed., 2009, *Geology and Religion: A History of Harmony and Hostility.The Geological Society, London, Special Publications*, 310, pp. 155-170.
SECORD, J. A., 1986, Controversy in Victorian Geology, Princeton: Princeton University Press.
SECORD, J. A., 1991, The discovery of a vocation: Darwin's early geology. *British Journal for the History of Science* 24: 133-57.
SEDGWICK, A., Journal XX1I, 31 August, 1831. (Transcription in Sedgwick Museum)
SEDGWICK, A., 1835, 'Remarks on the Structure of Large Mineral Masses', Transactions of the Geological Society, Series 2, 3, 47-68.
TURNER, F., 1978, The Victorian Conflict between Science and Religion: a Professional Dimension*, Isis.*
WEDD, SMITH & WELLS, 1927, *The Geology of the country around Wrexham, Memoir of the Geological Survey* (Sheet N.S. 121) London, His Majesty's Stationery Office.
WESSON, R., 2017, *Darwin's First Theory*, Pegasus books, London & New York.
WYHE, J. VAN ed., 2002, *The Complete Work of Charles Darwin Online* (http://darwin-online.org.uk/)
WYHE, J. VAN ed., 2009, *Charles Darwin's shorter publications 1829-1883*. Cambridge: Cambridge University Press, 2009.

RN1

Return to homepage

Citation: John van Wyhe, ed. 2002-. *The Complete Work of Charles Darwin Online* (http://darwin-online.org.uk/)