Manchester Geological Association

President: Niall Clarke MSc

September 2020

www.mangeolassoc.org.uk

Founded 1925

Quick Diary

Zoom Meetings

John Price Memorial Lecture **Wednesday 14 October 2020**	Archaeopteryx and the dinosaur - bird transition	John Nudds
Broadhurst Lecture 1 **Wednesday, 11 November 2020**	South Italian Volcanics	Mike Burton
Broadhurst Lecture 2 **Wednesday, 2 December 2020**	East African Rift Volcanism	Celine Vidal
Tony Adams Memorial Lecture **Wednesday, 13 January 2021**	Plate tectonics explained	Prof. Peter Burgess
Wednesday, 10 February 2021	Annual General Meeting	Niall Clarke
March	Joint with Geogs	

All meetings will start at 7pm with a log in time from 6.30pm. The meetings will last one hour including questions so say 45 mins of talk + 15 mins questions.

OTHER SOCIETY LINKS

Yorkshire Geological Society http://www.yorksgeolsoc.org.uk/

BCGS http://bcgs.info/pub/

Leeds Geological Society http://www.leedsga.org.uk/

GeoLancashire https://geolancashire.org.uk/lectures-and-excursions/

OUGS North West Branch https://ougs.org/northwest/

Who's Who in the MGA

Officers

President: Niall Clarke MSc

Vice-President: Dr Margaret Hartley

General Secretary: Sue Plumb BSc

Membership Secretary: Niall Clarke MSc

Treasurer: Jennifer Rhodes BA

Indoor Meetings Secretary: Jane Michael BSc (Hons)

Field Excursions Secretary: Vacant

Newsletter Editor: Lyn Relph BSc (Hons)

Webmaster: Peter Giles Msc

Other elected members of Council
Prof. Ray Burgess
Nicola Fowler BSc (Hons)
Peter Gavagan BSc (Hons)
Penny Heyworth Mphil
Ken Jacobs

Ex officio members of Council
The Immediate Past President, Manchester Geological Association: Prof. Cathy Hollis

RIGS Representative: Dr Chris Arkwright

The Association's representative on the North West Geologist's editorial team: Peter del Strother MBE Mphil

President of the Student Geological Societies of the University of Manchester
MGA Archivist: Dr Derek Brumhead MBE

MGA email addresses
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To contact our General Secretary: secretary@mangeolassoc.org.uk

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For field visit enquiries: outdoors@mangeolassoc.org.uk

For indoor meeting enquiries: lectures@mangeolassoc.org.uk

For newsletter correspondence: newsletter@mangeolassoc.org.uk

For other enquiries: info@mangeolassoc.org.uk

From Siderite to Mediaeval Iron Making

By Peter del Strother

The operating principle of a bloomery was to heat iron oxide in a reducing environment to make iron and iron silicate slag, using charcoal for fuel. Charcoal was the only fuel which produced high enough temperatures and its availability in mediaeval times was strictly controlled by the major landowners, with very severe punishments for those who disobeyed the rules, but that is another story.

Bloomeries were the only process for iron manufacture in the Middle Ages and the examples near Clitheroe date from the C13. The operating temperature had to be high enough to melt the slag but not high enough to melt the iron, particles of which welded together in the furnace to form a 'plastic' lump known as a bloom. Iron is malleable and can be forged into ploughs and knives for instance. If the temperature inside the bloomery became too hot, the iron would absorb more carbon and melt, flowing out of the furnace as cast iron, which is brittle and unsuitable for forging. An experimental bloomery is illustrated in Figure 1 and an example of mediaeval bloomery slag, known as tap slag in Figure 2, which has a superficial resemblance to pahoehoe.

Figure 1: Experimental bloomery, https://www.heritagecouncil.ie/ga/news/news-

Figure 2: Example of tap slag from a mediaeval bloomery site near Clitheroe

The Wealden Iron Research Group (WIRG) has done a lot of work with experimental bloomeries and their website https://www.wealdeniron.org.uk/ is well worth a look. They have also produced a video of bloomery operation, see https://www.youtube.com/watch?v=zsywnQJMJEk

The iron silicate in the slag is in the form of fayalite, $(FeO)_2SiO_2$, the iron rich member of the olivine group of minerals. The amount of silica constrains the utility of the ore because, with more silica, more fayalite and less iron are produced. A local example of tap slag contained over 50% fayalite (expressed as Fe_2O_3), so with a typical siderite ore containing only about 60% iron (expressed as Fe_2O_3) the iron yield would have been low. Modern blast furnaces reach temperatures at which both iron and slag melt and the slag, being less dense, is tapped off from the top of the furnace. Subsequent treatment of the iron controls its properties.

Iron in modern slag is less than 0.5% (expressed as Fe_2O_3), because of the addition of lime (CaO) to the furnace. Calcium silicate, with an 'average' formula of $CaO.SiO_2$ is formed preferentially to fayalite, so iron yield is very high. Analyses of bloomery slags suggest that mediaeval iron smelters did not add lime, but the WIRG has demonstrated its efficacy experimentally.

Although the ore haematite, iron oxide (Fe_2O_3), was available in Furness, elsewhere in the northwest and over much of Europe the ore used was siderite, iron carbonate ($FeCO_3$). Siderite forms as nodules, or less commonly as tabular beds, in coal-measure sediments. It is easily recognisable, Figure 3, because it weathers a rusty brown colour and is very dense SG 4.0, compared with about 2.7 for limestone and sandstone and 3.2 for peridotite (which is not of course found as a sediment). The reactions involved in its formation are very complex, but can be summarised as requiring firstly reducing conditions and secondly the absence of sulphate ions (SO_4^{2-}), which are abundant in sea water. In the presence of sulphate, bacteria reduce the available iron to pyrite (FeS_2) and no siderite is formed. Only in the absence of sulphate does bacterial activity lead to the formation of siderite. Coal measure swamps provide suitable conditions and it is in local Westphalian strata that siderite is commonly found, associated with coal seams.

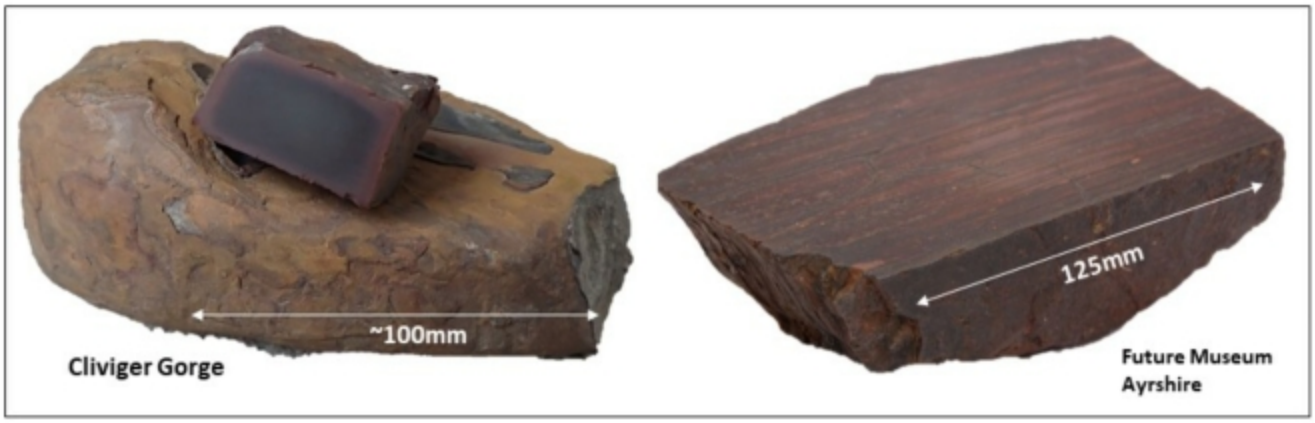

Figure 3: Hand specimens of siderite, left, and black band ore (also siderite but with carbon content of 10-20%).

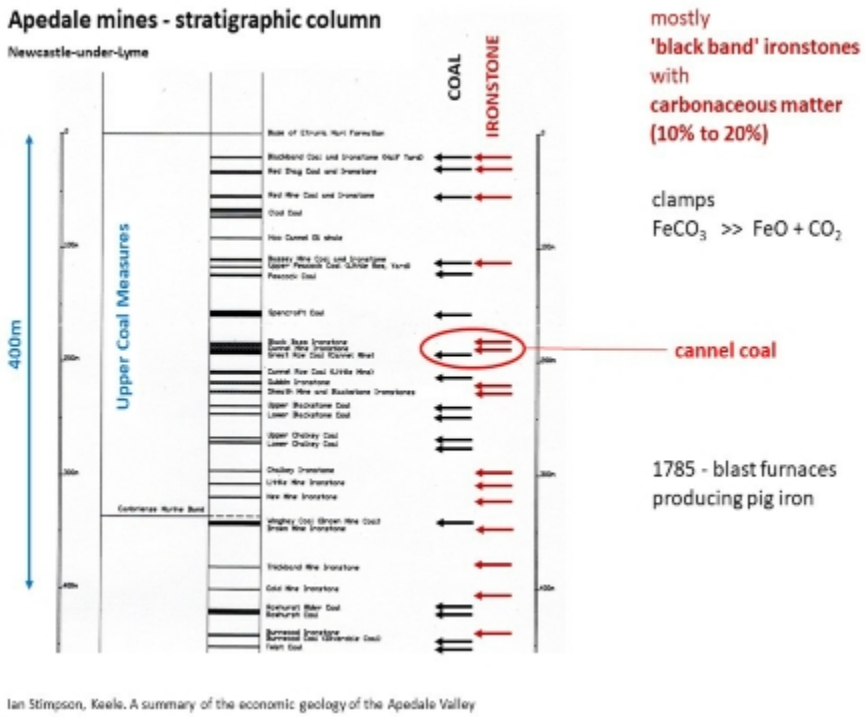

Figure 4: Stratigraphic column of the Apedale coal measures, showing coal seams and siderite bands.

The manufacture of iron was so important that in places it was mined, for instance in the Cliviger gorge where horizontal underground passages follow a band of several siderite seams for several hundred metres. This was a particularly advantageous spot because the seams were only a few metres beneath the Arley Mine, a coal seam which was mined in bell pits and via at least one adit.

A heat source was important because siderite ore had to be roasted, to remove the CO_2 by calcining, before it was fed into the furnace. Calcining absorbs a considerable amount of heat and would cool the bloomery furnace requiring the use of more charcoal, which was the scarce and most expensive resource. Because charcoal does not travel well by packhorse, the ore was usually taken to the charcoal rather than vice-versa. Calcining also reduced the weight of the ore. Black band siderite contains 10-20% carbon and those MGA members who visited Apedale coal mine earlier this year will remember being told that the ore was spread out in piles, about 6m by 2m by 100-300m long, and ignited at the windward end. Calcination was free! The oxide ore was then smelted on the mine site. Between the coal seams at Apedale, siderite was abundant, see Figure 4 which is based on a stratigraphic column by Ian Stimpson, who led the excursion.

In summary, siderite was available widely in northern England. The Coal Measures provided ideal conditions for its formation and the local availability of coal provided heat for calcination. Tap slag, which is unequivocal evidence of bloomery operation, is found throughout the United Kingdom. Bloomeries operated at a high enough temperature by using charcoal, but from the early C18 the technology developed so the ore could be smelted using coke as a fuel, a process which was the foundation of the Industrial Revolution and the source of our national wealth.

Tony Adams
1951 to 2020

We have just heard the very sad news that Tony (Anthony) Adams died last week. He served as President of the Manchester Geological Association from 2010 to 2012.

Tony was born in Twickenham on 4th August 1951. He attended Lincoln College, Oxford for his first degree, and undertook his PhD at Swansea University. On completing his PhD he joined Manchester University as a lecturer in 1976 where he worked for 35 years until his retirement in 2011.

Tony was a pivotal member of the School of Earth, Atmospheric and Environmental Science (now the Department of Earth and Environmental Science), until his retirement 9 years ago, as well as being a highly regarded teacher and a true inspiration to students and researchers alike. His focus was on ensuring undergraduates had a great experience and he always had time for them. Tony carried out research in carbonate sedimentology as well as co-authoring several books on rocks and minerals under the microscope, which are used by most students of geology.

His importance to the Department is indicated by the fact that on his retirement his administrative work was assigned to over eight members of staff! This included the Director of Teaching, four programme directors, an admissions officer as well as staff to arrange demonstrating and time-tabling.

In the words of one ex-Head of Department "He was a wonderful member of staff and someone who was much loved and respected by all. I really enjoyed his dry wit and lovely warm humour." (Hugh Coe). Tony was a great colleague and a lovely man and will be much missed.

Manchester Geological Association sends sincere condolences to his wife, Bryony and children, Matthew and Bethany.

His funeral was held in Darlington on Monday September 14th.

By Kate Brodie

EIG Webinar - 1st October 2020

The next Extractive Industry Geology #EIGWebinar will be "Analysis of fractured rock slopes and benches using drone data with DFN analysis" by Mark Cottrell Principal Geomechanics Engineer & Technical Director Fracman Technology Group, Golder Associates at midday on Thursday 1st October 2020 on Zoom.

FREE registration for this & future EIG Webinars here: https://forms.gle/PAg1cnUNB5yyff418 - the talk will be followed by a Q&A session (the talk & Q&A combined will be approximately 1 hour 15 minutes).

Photo Competition Entries: part two

Please vote for your favourite picture by emailing the newsletter Editor:
newsletter@mangeolassoc.org.uk

19 Whin Sill at Low Force, Teesdale

20 Caninia siphonofilia, solitary coral in the Hodderense

21 Bradgate Formation, Bradgate Park, Charnwood

22 Penrhyn slate quarry

23 Tenerife

24 South Stack, Anglesey

25 Moeraki Boulders (concretions) - Otago – New

26 Productids

27 Wind-sculpted grit-stone-boulder on the edge of The Roaches above Lud's Church.

28 Bradgatia in Bradgate Park, Charnwood Forest

29 Theropod dinosaur footprint (Dilophosaurus) – Tuba City, Arizona

30 Kathryn meets Kathryn

31 Mantle Xenoliths in basalt dyke – Nr Elie, Leven Scotland

32 Zanskar_river_confluence

33 Nathan on Moine Thrust

Mugearite columns, at Ana Ferreira - the elongated conduit of an ancient volcanic chamber,

Quiz Questions September 2020

Question 2

Question 4

Quiz Questions September 2020 cntd.

Q1. If I was working in the following locations what would I be mining and where?
Flemings level, *Horse Level*, *Red Dell Bonsor* and *Paddy End workings*

Q2. Where is this and what is represented?

Q3. Cornish mine names often include the word *Wheal*. What is a *wheal*?

Q4. Where is this and what rocks form it?

Q5. Where was the last operating coal mine in Ireland?

Q6. Where is this, what does it represent and of what age are the rocks?

Q7. Where do you find *Barmote Courts*?

Q8, What is this?

Q9. What is a *Buddle*

Q10. Where is this and what is the age and type of rock?

Question 6

Question 8

Question 10

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Photo Competition Voting

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The MGA June Geological Quiz Answers

Question 1: Norber Erratics, Crummack Dale, North Yorkshire

Question 2: Mississippi Valley type

Question 3: Clogau St David's mine at Bontddu in North Wales.

Question 4: You could well have a pasty. It is a Cornish mining term for the mid-shift break.

Question 5: Windy Knoll, in the Lower Carboniferous limestone

Question 6: Both are techniques for using water to expose a mineralise vein close to the surface.

Question 7: Triassic, Sherwood Sandstone Group (formerly Bunter Sandstone)

Question 8: The last operating deep coal mine in the UK was Kellingley colliery in North Yorkshire, closed in December 2015.

Question 9: North Face of the Eiger, Grindelwald, Switzerland. A hanging wall of a thrust fault, supposedly the largest hanging wall in the world.

Question 10: Mount Everest at dawn – the sun hits it first as it's the highest mountain despite what appears to be a higher mountain nearby (trick of perspective).