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And more ....
The Co-Editors have sourced some interesting articles in this issue, including work as a Geopark geologist and shale gas extraction in the USA.

On the overseas theme there are two Australian contributions and one from Africa. I hope this isn’t too much straying away from Ireland but the authors are all home grown.

We have lost a number of friends from the geological community recently. All much missed but Phil Doughty was extra special. He was a founding member of the ES2k group, now Earth Science Ireland. He was one of the half dozen who sat in a small room in the fading Geology Department at Queen’s University and pledged to try to keep Earth science going in Northern Ireland in some form or other. He didn’t give up and to the end was worried about how young people would get into the science and by the lack of professional staff to look after the collections of the Ulster Museum. These are battles those remaining must not avoid.

I draw your attention again to the new website. I wish you all a happy summer doing those things you most enjoy, being it just lazing in the sun or walking the hills with an eye on all the glorious environment they have to offer. The weather can make life easier, so apologies for allowing Barry Long a final word on the climate change debate - he doesn’t think it is going to get any warmer. Is that good or bad news?

Acknowledgements

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Message from our Chairperson

Earth Science Ireland (ESI), or ES2K as it was then, was established in the year my eldest child Clara was born. Just as Clara has moved to secondary school to begin the next phase of her career path, I think ESI is entering a new phase also.

ES2K opened it’s doors when those of the Geology Department at Queen’s University Belfast (QUB) were closed. It was a bittersweet development; the Ulster Museum was our adopted home and the magazine was first published. The magazine, a biannual publication, is now distributed from 19 centres across the island of Ireland and has a readership of 12,500. The founding sponsors who have supported ESI from the beginning despite budget cuts include the Northern Ireland Environment Agency and the Geological Surveys in Belfast and Dublin. We are very grateful indeed, as well as to the London-based Geologists’ Association who gave us our very first ‘start-up’ grant.

Secondary Schools Initiative

In the past three years a new initiative has taken ESI into secondary schools across Northern Ireland. Bob Dickey, Chair of our Outreach Committee, has rolled out a programme of school conferences modelled on that established by Peter Richardson at Enniskillen Collegiate. Last year, with the help of geoscientists from across academia, government and industry, Bob ran eight conferences with a total of 600 pupils and teachers in attendance. Presentations vary between course-specific content to career-inspiring montages. There is now a list of schools which can rotate as hosts on an alternating annual basis. We are always on the lookout for more schools to host these events on ‘an area learning community’ basis; in particular we want to hear from schools in the RoI so if you are a teacher who wants to hear more please contact me at marie.cowan@detini.gov.uk.

In the past year we have worked with 10 post-graduate students at the QUB School of Geography, Archaeology and Palaeoecology on an outreach project. It involved the students visiting participating schools and working with a class on a role-play decision-making exercise which considers a fictitious gold mine planning application in an Area of Outstanding Natural Beauty of NI. The project ultimately involved the pupils debating the issue in the Long Gallery at Stormont after having questioned the MLAs in round table discussions on how they would address such an issue. This exercise not only highlighted how such decisions are made but also how geoscience is at the heart of policy making. The post-graduate students were excellent role models to their school ‘buddies’ but also developed their own skills in the process.

Primary Schools

We are now turning our attention to the primary syllabus and Bob has just developed a series of topics which fit ‘the World around Us’ strand of the NI curriculum. Through the new All Party Science and Technology Group at Stormont we met Martin Brown who runs the STEPS program in NI which helps support teachers to bring physics alive in Primary schools. Martin came to speak to us last month and we now plan to produce a series of lessons incorporating geoscience content which we will trial with a couple of teacher focus groups. We will make it freely available online as soon as it is finalised.

As a call to action; if you are a geoscience professional working in any sector on the island of Ireland and can spare a morning to visit a school and give a practical or presentation we would love to hear from you. By working together in partnership under the umbrella of geoscience you would be surprised what we can achieve. I am buoyed by the profile of geoscience not only here but in GB, the EU and beyond; I look forward to more exciting developments for ESI in future years.

Marie Cowan

Ammonite

Split the rock, left of line, owl eyes draw into mine. Sight that has not seen since monster serpents swam the oceans green, and terrible lizards walked in sun bathed forests. Split the rock, left of line, owl eyes draw into mine.

Mark Cooper

October 2012
A Day in the Life of a Geopark Geologist

Dr. Eamon Doyle, Burren & Cliffs of Moher Geopark, County Clare.

My day usually begins with a look out the window to see what the weather is like; actually if I need to look out the window then I know its fine.

A lot of my fieldwork is associated with our Geosites (fig 1). The Burren & Cliffs of Moher Geopark has nine main sites of geological interest called Geosites. These are key locations in the area with good accessibility for geological, archaeological or cultural heritage. We are currently developing new information signs for these Geosites; these signs will explain the geology and cultural heritage of each site. These sites, which form the core of the Geopark are monitored for litter, erosion and general maintenance.

I was at one of those Geosites, Lough Bunny the other morning, meeting John Boyd and Emma Glanville. John does most of the maintenance at our Geosites and had reported a minor graffiti issue, Emma works with the National Parks and Wildlife Service and as some areas of the Geopark are designated as special areas of Conservation (SAC) we work very closely with them when developing new trails.

We were discussing a new walking trail and removing the graffiti, which simply said ‘I love David Beckham’ when my phone rang and a much bigger graffiti issue arose; there was graffiti on the Cliffs of Moher!

The rest of the morning was spent at Hag’s Head talking to local and national radio and TV reporters about the impact of the graffiti, how it was inappropriate to the location and how we encourage a ‘Leave No Trace’ policy for all visitors to the area.

Most mornings are not like that however.

That afternoon I brought a group of Finnish geologists around the Burren and the highlight of the trip for them was a guided cave walk lead by Colin Bunce of the Burren Outdoor Education Centre

Usually fieldwork will involve meeting groups of university students from Ireland or abroad or bringing school children out to show them geology for the very first time. Whether specialist groups or first-timers, the enthusiasm of all students is very rewarding. Where possible I liaise with local guides such as Frank O’Grady of Farm Heritage Tours or Tony Kirby, author of ‘The Burren & Aran Islands-A walking Guide’.

Usually before bringing a group of school children into the field we spend a few hours doing a basic introduction to the geology of the Burren; the highlight of this is inevitably putting dilute HCl onto limestone; a close second is showing fossils and building a picture of how they might have lived.

If I’m not doing some fieldwork then, like the rest of the world, I check my emails. Cooperation and collaboration are very important parts of my job and this means meetings and phone calls as well as emails.

There are usually inquiries about our evening adult education course, and our new summer Field school. There are events for European Geopark Networks Week and Heritage week which I organise. These events need the collaboration of many different people. I also get emails with requests for our publication ‘Stone, Water & Ice’, a really successful guide to the geology of the
Geopark. Later today I’ll be preparing the new edition for this year.

Any funding project which we are involved in generates extra emails and then there are meetings for the EU LFE project which is examining how tourism and conservation can co-exist in a sensitive area like the Burren. I give talks and guided walks for events organised by other groups in the Burren too, currently I’m writing up a talk for the Burren in Bloom festival in May. Recently I gave a talk on the changing landscape of north Clare to the Shannon Archaeological and Heritage Society. I will spend a hour today finishing an article about sand volcanoes for their publication ‘The Other Clare’

I try to add information to our Facebook page (www.facebook.com/burrengeopark) as often as possible and have recently starting Tweeting.

My real love is the geology of course and every time I’m out and about in the Geopark I keep looking out for something new. Despite the many thousands of geologists that have passed through here over the last hundred years, we are still finding new things in the rocks and still learning.

As I went home that evening I was thinking about some geological features I had seen in the cave and at Hags Head and I was trying to piece together a little bit more of the information we have about how the rocks were formed and ultimately how we came to be here. Then my phone rang it was Cormac McGinley, Head Ranger at the Cliffs of Moher, he had found an interesting fossil, could I go and have a look...? Tomorrow was shaping up nicely already...

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ENQUIRY FILES 3 - PAWS FOR THOUGHT

This is part of a series in the magazine, where in each issue we can highlight some of the oddities of the geological world, brought to light by ordinary people in their lives and travels, and brought into the Natural History Museum in Dublin or to the Ulster Museum for identification.

Many enquiries that I receive from members of the public concern what they believe are some kind of animal footprint or trace fossil. The rock illustrated here was found by Mr Eamon Grogan, a resident of the area near Portrane in County Dublin. The rock was found beside a path in a ploughed field in the grounds of the hospital. Not unreasonably, Mr Grogan queried if the shape was a fossil paw print of some kind.

The rock on close examination revealed itself as most likely a piece of 450 million year old Portrane Limestone, with silicified crinoids. However, the impressions were simply the result of karstic (water) solution, in a pattern of scalloped dimples that resembled a large dog paw.

Matthew Parkes
Ten rules for a fun field trip!

David Kirk, just slightly tongue in cheek, passes on some useful advice for those thinking of leading a group on a geological day out

1. Plan to visit far more sites than anyone could expect to get round during the time available. And before you start gather them round for a briefing lecture of at least an hour, especially when it is exceptionally hot, cold, or wet.

2. Make sure that your field trip involves the maximum possible amount of hill-climbing. If the outcrop on top of a hill is the same as at the bottom climb it anyway. Then you can show people how thick the unit is. If there is no outcrop on top of the hill, climb it anyway. Summits are unsurpassed as settings for arm-waving - and getting to the top gives a wonderful sense of superiority over those who don’t.

3. Be sure to include stops that you’ve never visited before, or haven’t visited for 30 years. Spending hours looking for a new or half-remembered feature is part of the fun of a field trip. The fun can be maximized if the outcrop is at the end of a long hike through brambles, nettles and cow-claps.

4. Be sure to include stops that have plenty of sentimental value for you, even if there’s nothing to see. “This is the black shale outcrop where I collected the first rock for my thesis.” Also include sites of historical interest. “This concrete dam wall covers the spot where C H Emeleus identified a fine example of stoping in the Western Mournes”. Don’t let the fact that there is nothing to see at an outcrop stop you from visiting it.

5. Never, ever postpone the field trip for weather conditions. Remember that blizzards, floods, hurricanes, and freezing rain are just part of Earth’s dynamic system, and will make the field trip more realistic.

6. During the field trip, make sure that you move your group from one outcrop to the next as fast as possible. The faster you go, the better a geologist you prove yourself to be. But - spend as little time at each outcrop as possible. A good way to judge how much time to spend at a site is to wait until the last stragglers come into view, and then move on.

7. During long uphill sessions set a cracking pace even if it half-kills you. You can then relax and spend a fair bit of time on the top while waiting for people to stop having asthma attacks - you can go into a grand, sweeping lecture on the stratigraphy of the region, pointing out distant features of regional significance. You should do this even if the features are obscured by rain, snow, sleet or haze.

8. Don’t waste time scheduling stops for meals or toilets. Meals can be eaten on the run from one fascinating outcrop to another. And anyone who can’t figure out how to do what they have to do outdoors, and on the run, shouldn’t be in geology.

9. Likewise make it clear from the outset that you’re not going to have any unscheduled stops for any reason: injuries incurred on the trip (people need to learn to be careful), forgotten lunch, drinks or medicine (tell them to grow up and do without), diarrrhea attacks (they can hold it until the next stop), and other lame excuses that wimps will come up with to get you to stop.

10. When talking about an outcrop, use the most technical language possible to prove that you’re the best geologist there. If you don’t know any really technical-sounding stuff, use abbreviations that will awe your followers and humble your colleagues.

Finally, remember, the success of a geology field trip is measured by how much ground you cover, the number of outcrops you visit, and how fast you do it! People won’t learn much and remember less – but they’ll convince themselves they have had an enlightening and uplifting experience.

Stop Press!

Congratulations to Mike Young, Director GSNI, on his very recent election to the Council of the Geological Society of London.
After University – Australia

Studying or wanting to study geology? This could be you!

Cassidy Lewis writes about her experience of starting a job with her now husband Stephen Fullerton. They emigrated after graduating from Glasgow University and if you recognise Stephen’s name it is because he wrote of his first year at university in Issue 2 (page 35) of this magazine. Cassidy is Scottish and Stephen lived across the road from the editor in Co Down.

One of the first Europeans to travel through the Mackay region on the eastern coast of Queensland was a Captain James Cook. Just 240 years later, my partner and I arrived there, to the presently acclaimed “gateway to the Bowen Basin”; the single largest coal reserve in Australia.

Whilst Captain James Cook’s objective was to explore new climes, our objective was to explore for black gold – coal. On both graduating with an honours degree in Earth Science at the University of Glasgow, we were able to secure a job as Exploration Geologists with a contractor company based in Queensland.

Coming in to land I was somewhat thrown by the tropical greenery I observed from the window seat of the Qantas plane. A naïve part of me expected to see a Mars-like landscape of desert red, when in fact, it was quite the opposite. Generally the region is referred to as the Mackay-Whitsunday region and, for those of you who know, the Whitsundays are a paradise collection of islands a stone’s throw away from the Great Barrier Reef. With that in mind, Mackay leans more toward the tropical setting, boasting acres of lush sugar cane fields.

As the wheels of the plane skidded to a halt, the reality of our generous move set in. The cargo hold contained everything we had in the world: a meagre swag of clothes and toiletries. With family and friends now far behind us, our only option was to step out of the cabin and open up a new chapter in our lives. Outside the air was clammy and the sun shone hot in the sky. It was not cold and spitting rain as it had been when our feet had left the damp, grey ground of Glasgow. We were not in Kansas anymore.

Why the Degree?

Choosing to study Earth Science came from a documentary-style interest in Earth processes, as well as an interest in the job prospects that could arise from such a degree. Of course at first you expect you will become a volcanologist or you might change your mind and decide you will become a seismologist. Either way, you were going to save the world from devastation in some kick-ass way. Think Volcano or 2012. I would say most geologists, in their infancy, have entertained the same such glamorous aspirations.

Not to say that this is not a possibility for some. Unfortunately, job advertisements for a “Kiss-Ass Geologist” were few and far between. But every cloud has a silver lining and the role of “Exploration Coal Geologist” based in Queensland was available. Although we were degree qualified, applying for the role whilst in the UK, without a scrap of industry experience was like taking a shot in a darkness blacker than black. But the contract arrived in the post, as though it was the most normal thing in the world, and that was it – our professional career had begun. We might not be headlining a role in Dante’s Peak but we were certainly headed on another kind of adventure – Down Under.

Training

Naturally I was astonished at the opportunity of starting my career so fresh out of university. Whether or not we were in the “right place at the right time” we were going to make it work. Great opportunities have a nature of being habitually rare, and letting one like this slip through our fingers was certainly not an option. Of course when the excitement waned and reality sunk in, I became apprehensive about my ability to apply my academic skills in a workplace environment. But contrary to the doubtful beliefs that had begun to plague my mind, no one thrust a geological hammer into my hand shouting “Go!” We were given plenty of training – the 4X4 driving course (a necessary skill for a geologist negotiating rough outback terrain) was a particular favourite! By the time we were deployed to the field to work for a client, we received further on-the-job training under the supervision of experienced geologists and, once deemed competent, were able to take on the responsibility of manning a drilling rig by ourselves.

The Job

Being an Exploration Geologist means you are working outdoors, often in remote and somewhat barren bushland with only the iconic wildlife for...
company. Get lost out there and you are undoubtedly relegated to bush-meat; Bear Grylls would become “Grylls Burger with Cheese”.

The general objective of the job is to drill into the ground and bring to the surface the desired coal seams below. We handle the field data, produce lithological logs, sample the coal for the laboratories for coal quality purposes and generally collect and provide field information that will go towards the understanding of the coal seam stratigraphy below the surface. We are the grass roots level of what could ultimately become a working coal mine.

With around 34 coal mines in the Bowen Basin area, statistics dictated I work on at least one, and funnily enough, I did. An open-cut coal mine is basically a colossal hole in the ground where mammoth machines dig out the black treasure trove beneath. Driving my 4X4 Toyota Hilux amongst the heavy machinery, namely dumper trucks, is comparable to an ant scurrying between a man’s’ feet. To boot, blasting is a frequent occurrence on a mine site. You observe the explosion once and immediately envision the day when you will be the one to push the big red button. After all, a childish part of you knows all too well that although building blocks are fun, knocking them over is the best part!

The Roster

Many people in the industry work a roster lifestyle. For us we presently work a 2 week hitch followed by a two week break (one of the most desirable rosters). Although the hitch can be long and arduous, the break has a holiday feel and can never come soon enough! Whether we travel on our break or enjoy the local area in which we live, it is always worth the long days of hard work.

Travel

For the first 6 months or so, we lived out of our suitcase; we travelled as far as our break would allow. We were able to enjoy the backpacker lifestyle in harmony with our career and this gave us a certain sense of comfort and reassurance.

From road-tripping on the Bruce Highway (a main road skirting the eastern coast of Queensland from Far North Cairns all the way south to the state capital of...
Brisbane) to 4X4 driving on Fraser Island, the largest sand island in the world; from visiting the Sydney Opera House to posing in Ramsay Street (as one must do whilst on the continent); from island hopping in the Whitsundays by speed boat or jet-ski (whichever takes your fancy) to taking a night time cruise on the Brisbane River whilst an impressive city-scape glitters in the background. I cannot mention all we have had the good fortune to be able to do and certainly not in any detail; I would have to write a novel to do so. But I will say that we are not even halfway through exploring the continent (I'm ashamed to say that despite many opportunities we have not yet done the Great Barrier Reef), never mind jumping the Tasman Sea to New Zealand or exploring East Asia, now so much more readily accessible to us.

Living on a landmass that could swallow the whole of Europe within its borders completely resets your perception of distance. I’m sure we can be forgiven for not yet making it to the west coast; I’m sure the travel bug will do something about it sooner or later.

**Settling**

But the nomad lifestyle soon took its toll. Our suitcases had taken a beating and my wardrobe...well...my wardrobe cried out for a wardrobe. We decided to plant our roots in the city of Brisbane, a place we’d come to love. After spending a hitch somewhat removed from civilisation, whether it is a small, remote mining town or a campsite in the middle of nowhere, we relished the thought of putting our feet up in a vibrant city.

**The People**

Since working as a geologist, I have noticed one thing: it is a culturally diverse job to be in. Being in Australia, I expected to hear a lot of “G’day mate” and “That’s not a knife – this is a knife”. But instead, my ear picked up many more accents and languages, all hailing from a myriad of different countries – New Zealand, the Philippines, India, China, Italy, the UK and the Republic of Ireland, USA and Canada. I thought that studying Earth Science would afford me work in far off places; I didn’t expect them all to come to me. Not only that but we have come across familiar voices belonging to old
university friends who too have made the leap to many parts of Australia, some of whom we have had the pleasure to work with. And in a funny way any inklings of homesickness were kept at bay with the sweetly familiar expression “Aye, ken wit ah meen?”

I cannot talk about Australia and neglect to mention the diverse group of people we have since met. The professional relationships, but more importantly, the friendships we have built have been a huge boost to the experience and in a way they have helped us grow another root; solidifying the bond we share with this place, with our new home.

From an outsider’s perspective, the Australian people are a noticeably happier crowd. Why? Simple elementary, my dear Watson: the glorious weather. With a climate that attracts sun worshippers all year round, Queensland in particular is a place where the outcome of a sunny day shines through the personalities of the people. I too have noticed my general mood brighten. A BBQ by the pool on a beautiful day with an ice-cold stubby in your hand whilst donning a fashionable pair of thongs (that’s flip flops to you and me) is almost certain to cheer up the dourest of the dour-faced.

The Climate

No doubt the Queensland climate is good for the soul, but it can be temperamental and its physical manifestations can be nothing short of the extreme. In Queensland, you may be casually sunbathing on one of the many white sandy beaches, watching on as the surfers sweep elegantly along the clear blue swells of the Coral Sea, and all of a sudden, the sky could turn dark and you may find yourself in the eye of a fearsome cyclone. During our time in Australia, we have borne witness to incredible electrical storms, hailstorms, cyclones and floods, not to mention the intense heat. And for the record, you can add “geologist” to the saying “only mad dogs and Irishmen go out in the midday sun”. Not only can the heat be extreme, it frequently causes bush fires across the continent; another of Mother Nature’s fury’s that we have witnessed so far. All things considered, the incessant drizzle of UK weather is somewhat trumped by the Queensland climate; the sort of weather that knows what it wants, when it wants it.

Conclusion

One thing I have noticed since being in Australia is the sky. In some strange way, it seems bigger than the skies I have seen before. The sun rising and falling over an endless horizon harvests the most perfect watercolours, and at night, the topsy-turvy moon shares the sky with the brightest Milky Way I have ever seen. Maybe the vast, flat-lying landscape opens it up; your eyes must literally widen to capture it. And I wonder, perhaps this is the new frontier; perhaps this is the new land of opportunity.

Like any adventure, there is always an element of risk. We took a risk moving halfway across the world. We went for gold and with courage, support, determination and a little bit of good luck; the stars aligned and we got it – albeit black. We have found a career and a new place to grow old; a place that has seen me grow from a graduate student to a bona fide geologist; a place that has seen me grow from a girlfriend to a wife.

Moving to Australia has been an acclimatising process, and a steep
learning curve in terms of industry. We have challenged ourselves and I have found myself doing things I never thought I would. And although working a rather unconventional lifestyle, where getting to work does not mean hopping on the bus (rather hopping on an eleven seated propeller plane), or where the workplace is not an office but a remote part of the Australian outback, or where going to work does not mean coming home at night, we would not have had a home to go back to without it. We may not technically be a “Kick-Ass Geologist” but we have certainly had a kick-ass adventure, and have had the good fortune to be able to live the Australian motto: we work to live. And shouldn’t everyone.

Stephen Fullerton and Cassidy Lewis, Photo: Adam Callister

ENQUIRY FILES 4

Continuing this series highlighting some geological curiosities that people kindly bring to the attention of museum curators, we have a contender for the best ‘fossil egg’ impression.

Eggs-actly what is it?

Mr John Quigley in Nenagh, Tipperary sent this pebble in for identification, very reasonably believing it was a fossil egg. The shape is distinctly like an egg, the size of a blackbird or thrush’s egg. The outer surface is a pale brown colour like a chicken egg and, with a highly crazed appearance, it looks as though the fragile shell had been broken. To add to the impression, a small breakage exposes a hole with a rich yellow interior, looking distinctly like a yolk.

The pebble is actually a flint, with the yellow interior intact, but the outside crazed surface due to weathering and breakdown of the flint. Some of this may be a chemical breakdown that occurs with most flints. However, as the flint probably came from Tertiary or Quaternary gravels imported from southeast England, it may be more from the impacts and abrasion as it was transported in rivers, after being eroded out of the Chalk.

Matthew Parkes

Letters to the Editor

I’ve just received the most recent issue - thanks very much. Although I haven’t read all of the articles, I felt prompted to drop you a line on Bernard Anderson’s contribution. It was fantastic, a great mix of personal experience over a long number of years with honest and valid opinions from a professional’s point of view. I first met him as a civil engineering student at Queen’s in the Geology Dept (before it was closed) when he and his colleagues awakened an interest in geology, and I have seen him many times since riding his bike. There is quite a forceful promotion of anti-creationism in the publication. In my view I do not think that this is necessary. One is a matter of science and the other of faith, and condescending and aggressive writing (as at least one article has been) does nobody or anything any good. Sorry for the negative comment! Dawson Wray, Rasharkin, Co Antrim

I have a very real need to receive copies of your magazine. If this necessitates you making me a member of ESI, then this must happen. Name withheld, Co Leitrim
Irish ‘Rock Stars’

Patrick Wyse Jackson, Trinity College Dublin, continues his series

Michael Tuomey – (1805–1857)

In the history of geological cartography in the United States, William McLure’s 1817 map stands out. It was the first attempt to illustrate the geology of the eastern part of the North American continent, but it had its limitations. The area west of the Appalachian Mountains was coloured grey to represent the ‘Secondary Rock’ (Upper Palaeozoic). However, by 1860 far more was known of the geological structure of the various states of New England, and of those states that were laid out from the lands of the Louisiana Purchase—this was due to the establishment of state geological surveys, that began with North Carolina (1823), South Carolina (1825), and later included Ohio (1837), Indiana (1837) and Arkansas (1857) among others.

For two of these states, the Irish scientist Michael Tuomey (Figure 1), drew up the first state-wide geological map. In 1843 he was appointed State Geological Surveyor of South Carolina, before moving westwards to Alabama in 1847 when he was appointed State Geologist.

Tuomey was born in Cork on St Michael’s Day 29 September 1805, son of Thomas, an engineer, and Nora (née Foley). Following a home-based education under the watchful eyes of his mother and grandmother who instilled in him a love of natural sciences, he commenced a career as a school teacher in England. He emigrated to the United States in 1830 and following some unsuccessful attempts at farming enrolled at the Rensselaer Institute in New York, one of the premier scientific schools at the time. On graduation he married and worked as a railway engineer, but later established his own school in Petersburg, Virginia where he assembled an important geological collection. In January 1842 he met with Charles Lyell who was on an extensive lecture tour, and they discussed Tuomey’s fossil collections which impressed Lyell. Tuomey was in correspondence with many eminent scientists and in late 1842 he was recommended for the appointment as State Geologist for South Carolina.

Between 1843 and 1846 Tuomey traversed the state recording geological information. He worked without assistants, occasionally benefiting from the help of volunteers. For his surveys in 1844 and 1845 he was granted $2000, but from this he was expected to pay all his own expenses and draw a salary. He produced a report that documented the complex metamorphic geology of the Blue Ridge Mountains and mapped out the younger units of the Coastal Plain (Figure 2).

In 1847 he was appointed Professor of Geology at the University of Alabama and settled with his wife Sarah (née Handy) and two daughters Margaret and Manora in Tuscaloosa. Additionally he was expected to spend 4 months a year on geological fieldwork producing information on hitherto unsubstantiated reports of mineral occurrences that could be of benefit to the state. His initial reports were also printed in local newspapers and in 1848 he was additionally appointed the first State Geologist for Alabama. His responsibilities were to report annually to the State Legislature on the mineral wealth, resources and geology of the state. He resigned his chair in 1854 when the Survey was fully funded and devoted himself fulltime to the geological survey, although later returned to part-time academic life when funding ran out.

He died on 30 March 1857 of pneumonia and heart disease, at the age of fifty-two, and was buried in the New Cemetery, Tuscaloosa. A number of his unfinished reports were edited for publication by his fellow Irishman John William Mallet, Professor of Chemistry at the University of Alabama and chemist to the geological survey. Mallet was the son of the seismologist and engineer Robert Mallet with whom he collaborated in assembling in 1854 the first map to show the global distribution of earthquakes.

Tuomey’s importance to Alabama lies in his geological map of 1849, and the two comprehensive reports that followed in 1850. These noted the extensive mineral wealth of the state, including coal and iron-ore, on which later were based the important iron-smelting and steel industries centred on the city of Birmingham. There is no doubt that Tuomey’s geological work was instrumental in the development of these important industries. He is today commemorated in the University of Alabama building Tuomey Hall that originally housed the geological survey and chemistry laboratories.

Further reading:

Geological map of South Carolina 1845
SPARKING INTEREST

We lose a leader and friend - Philip Doughty (1937 – 2013)

Early days

Philip came from the small mining town of Wombwell in the West Riding of Yorkshire. He went to nearby Barnsley Grammar School, overlapping with Michael Parkinson, then on to Nottingham University where he graduated in Geology and completed a Master’s degree. While writing his Master’s thesis he married Janet and taught at Giggleswick School, Settle, North Yorkshire. His thesis, Joint densities in the Great Scar Limestone, was published in the Proceedings of the Yorkshire Geological Society.

His first museum job was as a general natural history curator at Scunthorpe Museum. Then in 1965 he became an Assistant Keeper in the Natural History department of the Ulster Museum. Phil always stressed that he was appointed as a geologist to care for and develop the geology collections – a specialist geologist on the staff for the first time in the Museum’s long and complicated history. This was an exciting time to join the Ulster Museum – with its recent elevation from local authority to national status, its growing staff numbers and a large new extension to the existing building being planned.

In 1970 he became Keeper of the new Department of Geology and over the next few years he built up a small team of geologists: Terry Bruton, John Wilson, Rab Nawaz and Ken James. His top priority was rescuing the stored geology collections from where they had languished since World War Two – at the bottom of a lift shaft in the Museum and in rat-infested lock-ups beneath the railway bridge on Tate’s Avenue, Belfast.

Phil and his team were responsible for creating a series of innovative and award-winning geology galleries which opened sequentially through the 1970s – Variety of Life, Geology of Ireland, Landscape and Earth’s Treasures. They were all developed from detailed briefs Phil had prepared and remained popular with visitors for some three decades.

The geology collections were supplemented by astute purchases of display material and by systematic field collecting. Phil also knew that good research projects helped to boost the Museum’s credibility - projects such as the 1969 Bovedy meteorite, the 1972 Pollnagollum cave excavations in Fermanagh, and the 1986 Aghnadarragh mammoth discoveries near the Antrim shore of Lough Neagh.

Personal mission

His personal mission, to raise the profile of geology, geology collections and museums generally, took him beyond Northern Ireland. He was a prominent member of the UK-wide Museum Assistants Group, editing their newsletter, and he helped to found the Geological Curators’ Group in 1974. It was for this Group that he organised a ground-breaking survey of museums published in 1981 as The State and Status of Geology in UK Museums. This helped to change attitudes towards long-neglected geology collections across the country. He chaired the Group in the mid-1980s and was recently awarded its prestigious Brighton Medal for outstanding services to museum geology.

While a Council member of the UK Museums Association in the late 1970s and 80s, he helped to pioneer new methods of managing information about museum objects. This put the Ulster Museum in at the start of the digital revolution in museum data handling.

But Phil knew better than most that there’s little point in having good museums if you don’t get out there and communicate the excitement and relevance of collections to the public. He was a great communicator, with an ability to inspire his audience. From answering enquiries one-to-one, to the many extra-mural classes he taught for Queen’s University Belfast in the 1970s and 80s, and establishing the Geology Tamed! lecture series at the Ulster Museum in 2002, his ability to grab and hold people’s attention was clear. That same talent was just as evident in the field when leading trips for the local societies or the annual Rocks Around the North week. This ability to get the message across extended to his many radio and TV broadcasts, and to the written word – from articles in the popular press to the formality of site conservation reports – most famously perhaps, his words to UNESCO which helped bring World Heritage Site status to the Giant’s Causeway in 1986.

Nothing beats a good show

Phil also knew that to effectively engage with an audience, you needed to put on a good show! The legendary Moon Rock display in 1970 attracted 27,000 people to the Museum in a single day – that has never been beaten. The Dinosaurs Alive! exhibition in 1992 brought giant, robotic dinosaurs to Ireland for the first time – attracting 200,000 paying visitors in three months, which is another record.

His love of fieldwork meant that site conservation and interpretation were constant threads running through his career. At site level, for instance, he helped with the development of Marble Arch Caves by Fermanagh District Council, whilst at a national level he was a founder and chairman of the Geological Society of London’s GeoConservation Committee. And in his retirement, he wrote hundreds of ‘plain-language’ site summaries for NIEA’s Earth Science Conservation Review – all of which are...
GRAPTOLITES

By Patrick Gaffikin.

No fixed law seems to determine the length of time during which any single species or any single genus endures.

Charles Darwin (1809-82)

Graptolites generally

Graptolites are in the phylum Hemichordata (hemichordates) because they show some affinity with the chordates, that is animals with a backbone or notochord. The name graptolite is an anglicised form of the formal name Graptolithina from the Greek graptos meaning ‘written’ and lithos meaning ‘stone’ because some graptolite fossils look like pencil scribbles on rock surfaces. In total there were six groups of these animals of which the dendroids and graptoloids are the best known. The dendroids lived between the Mid Cambrian and Early Carboniferous and the graptoloids evolved in the Early Ordovician and became extinct in the Early Devonian. It is the graptoloids that are usually referred to as just ‘graptolites’ and these are the most important group and the only type you are likely to spot in rocks. The graptoloids are thought to have evolved from the more primitive dendroids. Here we will only deal with the graptoloids or ‘true’ graptolites.

What do fossils of graptolites (graptoloids) look like?

Many look like small hacksaw blades varying in size from about 1cm to 3cm. Some fossils have one serrated edge while others have two. The serrations can be seen better if you employ a hand lens. The remains often occur as black/grey carbonised films but sometimes they are white. While some graptolite fossils have one “branch” (called a stipe) others have two or more. These fossils commonly turn up in black shale and, to a lesser degree, in limestone and chert. (Chert is chemically the same as flint and has similar properties to flint but occurs in limestone, whereas flint is only found in Chalk.)

A simplified sketch of a graptolite fossil called Monograptus. While the graptolite was living, each theca contained a minute creature called a zooid.

How do graptolite fossils form?

A graptolite fossil just consists of the skeleton of a colony of minute creatures called zooids. Zooids are similar in some respects to the polyps of corals but are more anatomically advanced than polyps. The skeleton was composed of an insoluble protein, probably collagen, that was built up as fusellar tissue, which after death could be converted into a film of carbon because, due to compression, volatiles such as oxygen, hydrogen and nitrogen in the protein vapourised leaving a thin film mostly composed of...
carbon. However, graptolite fossils can also appear as white films. These are composed of a phyllosilicate, which is a layered silicate, that occurs, for example, in clays. They form around the organic material in the graptolite fossils when the rock (black shale) containing them undergoes low-grade metamorphosis. (That is, metamorphosis involving low pressure and/or low temperature.)

The living graptolites

While the graptolite was living, individual zooids lived in tubes (called thecae), these appearing as the serrations at the side/s of the ‘branches’. Zooids, because they were composed of soft material, are rarely preserved in fossils.

Graptolites only lived in seas, in which they usually floated or swam, some being perhaps attached to sea-weed. Provided there were no strong currents, after death the graptolites drifted down to become embedded in accumulating sediment on the sea bed. However, if strong currents prevailed, they were so light in weight that they would have been prevented from settling on the sea bed. You could search for years in, say, the greywackes along the County Down coast and never find even one graptolite fossil because these rocks were laid down by strong turbidity currents – note, however, that fossils of related organisms could very easily be found in these rocks. Graptolites were at their numerical zenith during the Ordovician Period eventually becoming extinct in the Early Devonian.

The usefulness of graptolite fossils

Because genera and species of graptolites only lived for a short geological time, they are very useful for dating rocks. If a known genus or species of a graptolite fossil occurs in a rock then, knowing its narrow time span, we can ascertain the age of the rock. The age of the fossil and the age of the rock are the same. In contrast to graptolite fossils, for example, the brachiopod Lingula, which evolved in the Cambrian Period still lives today and has not changed very much over geological time hence; its fossils are of little use for dating the rocks in which it is found. While living, graptolites were well scattered by ocean currents so they have a wide geographical distribution. This enables rocks in one area to be correlated with rocks from a vast distance away.

Places in Ireland where graptolite fossils have been found

At Coalpit Bay, Co. Down, graptolite fossils referable to Monograptus and other genera have been found. The genus Didymograptus has turned up at Conlanstown, Co. Kildare in Ordovician exposures and at Belvoir, Co. Clare, graptolites of Ordovician age occur. Graptolites – for instance the genus Cyrtograptus – have been found in Silurian rocks at Garrangrena, Borrisoleigh, Co. Tipperary and at Coalpit Bay, Co. Clare – for example the genus Neodiversograptus.

What caused the extinction of the graptolites?

The demise of these animals could have been due to the emergence of the fishes, which thickly populated the seas towards the end of the Silurian Period, and they may have fed on graptolites. But, as with many extinctions in the geological past, a combination of factors probably was involved.

Are there any creatures like graptolites living today?

Graptolites per se have been extinct for very many millions of years and hemichordates are rare today. But, there is one group of tiny marine animals – called the pterobranchs – which show some similarities to graptolites. Pterobranchs, like the graptolites, are classed as hemichordates and consist of zooids living in colonies with each zooid living in a tubular skeleton made of fusellar tissue like that of the graptolites. Today they live on sea floors including parts of the North Sea and North Atlantic.

Graptolites in some perspective

Graptolites would have shared the seas with invertebrates like the trilobites, brachiopods, corals, bryozoans, sponges, crinoids, bivalves, nautiloids and gastropods. Life on land was just starting to develop with the emergence of land plants and the appearance of the first terrestrial animals which, according to the fossil record, were millipedes. While the graptolites were living the vertebrates (fish) had not yet made the transition to land; there was absolutely no sign, for example, of the dinosaurs on land – these were not to appear until many millions of years after the graptolites became extinct. So, keeping these facts in mind, if you are able to collect any graptolite fossils you should consider them a real treasure!

The editor acknowledges with thanks advice from Dr Jan Zalasiewicz, his photographs and the graph of graptolite numerical variation which is derived from a paper of the British & Irish Graptolite Group.
YOuNG SCIenTISTS TRIUMPH AGAIN

Dublin Exhibition packed out

If you saw this exhibition presented on RTE then you will appreciate the size of the operation. The young people interviewed also showed remarkable maturity and a high level of skill both in science and presentation. It perhaps was a triumph for the teachers and parents more than the students because those are the ones passing on knowledge and encouragement.

The BT Young Scientist and Technology Exhibition was again held in January at the Royal Dublin Society in Ballsbridge, Dublin. The Geological Survey of Ireland organised and coordinated a stand at the Exhibition in association with partners from across the island of Ireland. Joining the GSI on the stand were the Exploration Mining Division, the Dublin Institute for Advanced Studies, the Natural History Museum, and the Geological Survey of Northern Ireland. Also on the stand were representatives of the Irish Geological Association, Institute of Geologists of Ireland, and Earth Science Ireland. These organisations, staff and members, combined to showcase topics including earthquakes, water, and minerals in particular as well as Ireland’s rocks. Geoscience projects highlighted included Tellus Border and INFOMAR. Promoting the fact that geoscience makes a big contribution to our lives, those on the stand helped to explain to students, teachers and visitors the excitement of Earth science and being a geologist. The GSI also sponsored a Special Award to the project that best demonstrated the use of new geological data. The award was won by Tom McDonald for a project entitled: “Predicting changing sands on Skerries South Strand”.

As for the Exhibition itself, it is the final stage of a competition which is open to all second level students from Ireland, both North and South. 550 of the best projects were chosen to compete for the prizes. For more details see http://www.btyoungscientist.com

Although not part of the competition 121 primary schools also were given an opportunity to exhibit a class project at the RDS Primary Science Fair. 3,000 primary school students in all showcased their STEM (Science, Technology, Engineering and Mathematics) projects, received feedback from experts and learning from viewing other projects at this major exhibition.

http://www.rds.ie/primarysciencefair
“RUSSIAN METEOR” = ‘SUPERBOLIDE’

Terry Mosely gives us an expert account

The mass of the Earth is $5.9736 \times 10^{21}$ tonnes. At least it was before 15 February 2013, when roughly another 10,000 tonnes was added when the Chelyabinsk ‘meteor’ impacted our planet.

**Terminology**

A *meteor*, or ‘shooting star’, is a tiny piece of space dust which burns up due to its high speed entry into our atmosphere, usually about 60 – 90 km up. A larger and brighter than usual meteor, caused by a body about the size of an apple pip to that of a grape, is called a *fireball* or *bolide*: these also burn up, at heights above 50 km. We don’t see the objects themselves, just their incandescent ionisation trail. If a much larger one survives its high-speed journey through our atmosphere and is found on the planet, it is then called a *meteorite*. There are three main classes: stony, iron and stoney irons, with many sub-classes and sub-sub classes, depending on composition.

Such a body, while it is still in space, is termed a *meteoroid*. These range in size right up to the crossover definition size of roughly 500m, when they would be termed *asteroids*, or minor planets. Asteroids range in size up to about 960km diameter for the largest, Ceres (now actually reclassified as a dwarf planet). Thus there is a continuum of sizes, and masses, from that of Ceres down to the tiny dust particles mentioned at the beginning. There is an approximately inverse relationship between numbers of these bodies and their size: Only about 30 are larger than 200km in diameter, but there are many tens of thousands known down to about 5 km diameter, and probably many billions down to the size of a pip.

**Good fortune**

Fortunately all of the larger ones are in stable orbits that never come near us, but there are a few in the ‘small-medium’ category (0.5km – 3km) which come uncomfortably close. There are smaller ones which have not been detected yet, or don’t have accurately known orbits, and occasionally one of these hits us, as happened over Russia on 15 February. Although the media dubbed it the ‘Russian Meteor’, it was so much bigger and brighter than usual that it has now been classed as a ‘superbolide’. And any bits of it which have been found are meteorites.

**Chelyabinsk Superbolide**

The Chelyabinsk object was about 17-20m in diameter, with a mass of about 11,000 tonnes, and hit us at a speed of about 18.6km sec (~42,000 mph), with an impact energy of about 440kt, or about 30 times more powerful than the A-bomb dropped on Hiroshima. The internal stresses produced in it as it punched ever deeper into denser atmosphere caused a massive explosion at a height of about 23km, producing a fireball brighter than the Sun, and a shock wave which caused an estimated £25 million in property damage, mainly shattered windows and weakened walls. It also injured about 1,200 people; most of them by flying glass. The airburst shockwave registered on seismographs as magnitude 2.7.

Fragments from the explosion which were not themselves burned up fell in an elongated oval called a ‘strewn field’. Pieces recovered indicate that it was of the commonest type, an ‘ordinary chondrite’, rich in silica. Some pieces have already been put on sale, at ridiculous prices: up to $100 per gram.

Samples collected from around a 6m diameter hole in the ice on Lake Chebarkul are meteoritic, but no large fragment has yet been found at the bottom of the lake.

This event was the largest impact on our planet since the famous Tunguska event in Siberia in 2008. But it is only a matter of time before an even bigger one hits us, with catastrophic consequences. Just ask the dinosaurs....
First Findings of ‘TELLUS BORDER’

Minister for Natural Resources, Mr Fergus O’Dowd, T.D. and the Chief Executive of the Special EU Programmes Body, Mr Pat Colgan in early February unveiled the preliminary findings of this €5 million EU INTERREG IVA-funded geological project.

The Tellus Border project, which commenced in July 2011 under the stewardship of the Geological Survey of Ireland, in partnership with the Geological Survey of Northern Ireland, is one of the most significant mapping projects ever to take place in Ireland. It involved an extensive airborne geophysical and ground-based geochemical survey covering the six border counties – Donegal, Sligo, Leitrim, Cavan, Monaghan and Louth. Completing the survey phase in the summer of 2012 – having flown 60,000 km and collected close to 21,000 soil, water and sediment samples – the Tellus Border team has been analysing the data, integrated with that collected in Northern Ireland from 2004-2007, to produce preliminary findings set to improve cross-border collaboration in the management of natural resources and the environment.

The airborne survey has revealed extraordinary new detail to regional geological features which extend throughout the border region. New information on subsurface structures is already helping to improve and update the Geological Survey of Ireland’s existing geological maps, which support sustainable planning countrywide. It also saw a preview of the geochemical data, which will be released later in 2013 following continuing quality checks and interpretation. The data will reveal important natural and man-made influences on the soil and water chemistry of the area, significant for managing the environment and optimising agricultural productivity.

Minister O’Dowd said: “The maps released today represent a significant body of work which characterises in great detail the geology and environment of the border region. Sustainable environmental management not only protects our environment but supports many sectors of the cross-border economy including agriculture and tourism”.

And the details our readers will want to see? A conference will be held in October 2013 to present the full findings from the survey and accompanying academic research projects. Further details can be found at www.tellusborder.eu. To register for notifications for upcoming data releases, please email your details to tellusborder@gsi.ie.

Stormont, Belfast Schools Event

This January young people were encouraged to consider Science, Technology, Engineering and Maths (STEM) subjects at a Schools and Science event in Stormont. The event provided secondary school students with the opportunity to learn how government uses science to inform its policy decisions and to engage directly with MLAs, geoscientists from the Geological Survey of Northern Ireland and Queen’s University. Pictured L-R are: Professor Alice Brown, Alastair Ross MLA and Clare Robinson, Methodist College Belfast. Picture: Michael Cooper
Unconventional Oil and Gas Production and the Role of Hydraulic Fracturing

Jake Booth* explains

The US is seeing a major rejuvenation of its oil and gas industry largely attributable to production from unconventional sources, particularly shale formations previously considered non-commercial because of low permeability. Shale gas, which was 2% of US production in 2000 is now 37%. Ironically, the rapid increase in gas production resulted in oversupply and operators became victims of their own success as prices dropped from more than $10 per thousand cubic feet (mcf) in 2008 to less than $2 per mcf in 2012. This led to a rapid decline in gas drilling activity. However, with oil prices still high and generally driven by global rather than local supply, drilling activity shifted to shale formations capable of producing oil or other hydrocarbon liquids. The success has been repeated. U.S. production of crude and other liquid hydrocarbons has increased by almost 40% in five years and is on track to rise 7% this year to an average of 10.9 million barrels per day. This reverses a longstanding trend whereby US oil production peaked in 1984 at 11.2 million barrels per day and had declined by 44% by 2008. Supply is growing faster than consumption with a projected increase in domestic liquids production of 2.6 million barrels per day over the next ten years, an amount equivalent to about three times current North Sea production. The new scenario is driving broad long term change ranging from increased reliance on gas for electricity generation, transportation, and the possibility of LNG gas exports. The prospect of a robust supply of relatively clean energy at low cost is having a beneficial effect on manufacturing industries and those which use natural gas as a feedstock, such as petrochemicals and fertilizers.

This newfound ability to squeeze oil out of rock previously considered too difficult and expensive to tap is the result of convergence of two technologies. Geologists and engineers have developed the ability to drill long horizontal wells into thin seams of gas or oil rich shale and then open fractures to significantly increase the area of reservoir rock exposed to the wellbore. The first process is better described as high angle geosteering. Success depends upon the ability to precisely navigate the progress of the well based upon sound a priori understanding of subsurface geology followed by accurate geological interpretation while drilling in order to place the wellbore in that part of the formation with the highest concentration of hydrocarbons. The second process is hydraulic fracturing or ‘fracking’ whereby large volumes of water and additives are pumped into prospective formations at high pressure and rate to create and propagate fractures.

Both of these processes have been around for a long time. The first horizontal well was drilled in the 1930’s and horizontal drilling has been commonplace since the late 1970’s. Long horizontal geosteered wells have played a key role in extending the life of N. Sea fields by precise targeting of remaining reserves in fields where detailed sub-surface geological models have been developed.

Fracking has been available as a commercial service to stimulate well production since the 1950’s, but was applied infrequently, often to stimulate additional production from aging wells in conventional reservoirs. The widespread application of high-volume, multi-stage frac treatments is an integral part of the unconventional oil and gas revolution. The process is not well understood by the general public and has received a good deal of attention and scrutiny.

Used with permission of Chesapeake Energy Aerial view of a drilling location in Pennsylvania. Note the proximity to the farm house and buildings. The landscape is reminiscent of Ireland.
Fracking is part of the post-drill well completion and stimulation process, and its effects are intended to be confined to the oil and gas producing formation. However in the public dialog and in particular those who oppose unconventional oil and gas operations, the term fracking is often used to refer to all or many activities associated with these operations and the attendant risks, both downhole and on surface.

To better understand those risks it is useful to look at the overall process of drilling and completing a typical unconventional shale gas well. The example used is representative of wells drilled to develop the Marcellus Shale in Pennsylvania. This lower-middle Devonian marine shale is rich in organic material and was long known as a source rock for oil and gas reservoirs in the Appalachian Basin\(^1\) but generally considered non-commercial because of low flow rates and rapid decline in production. Soon after demonstrating commercial viability in the Barnett Shale around Fort Worth Texas, the strategy of combining horizontal drilling and fracking was applied to the Marcellus, which is close to East Coast centers of population.

Figure 1 shows a generic plan for a Marcellus gas well. Drilling and completion of this well would typically take two months and cost three to five million dollars.

While the commercial objective of the well is to drill, hydraulically fracture and complete a 2,000 to 5,000 ft horizontal section of hole in the Marcellus formation at around 8,000 ft vertical depth, much of the well’s design and cost is associated with drilling the vertical hole section and managing the associated risks.

One of the most consequential risks is the potential for contamination of freshwater aquifers, generally replenished by surface water and encountered in the shallow section of the hole. Contamination could occur during the drilling process or as a result of flow of fluids, including gas, from deeper formations during the producing life of the well. Isolation of aquifers is the primary purpose of the 16 in conductor casing in this well. Detailed knowledge of local geology is used to determine the setting depth. State regulations often apply as for example in this case where the state of Pennsylvania requires that the conductor casing be set at least 50 feet below the deepest fresh groundwater or at least 50 feet into consolidated rock, whichever is deeper, and cemented to surface (ref. 1).

The next casing string, the 11 in. or surface casing is set with the primary purpose of isolating and protecting coal seams which are common in Pennsylvania. State regulation again applies, requiring that the casing be set “at least 30 ft below the lowest workable coal seam”. As with the 16 in. casing, the 11 in. string must be cemented to surface. This affords further protection of shallow aquifers which by this stage are behind two steel and two cement barriers.

The 8 5/8 in. or intermediate casing is set at a depth where formation strength is sufficient to sustain all the pressures applied or encountered during the drilling of the remainder of the well. As with all proposed setting depths for casing, and the well design in general, approval must be obtained from State regulatory agencies before drilling can commence.

After setting the intermediate casing, drilling proceeds down to the Marcellus formation at approximately 8,000 ft.

Landing a horizontal well in the target formation is similar to calculating a flight

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\(^1\) Devonian shales were the source rock for oil encountered in the Drake well in Pennsylvania which is generally considered as the first well purposely drilled to produce oil. It was drilled in 1859 to a depth of 69 ½ ft.
path for an aircraft using an instrument landing system. The approach must be planned with precision otherwise the runway will be encountered sooner or later than expected, requiring significant late adjustments to the trajectory and compromising the quality of the result. In the case of the gas well, geologists must get their bearings during the vertical section of hole and decide when to start deviating the well such that it achieves horizontal at precisely the depth at which the target section of the Marcellus is encountered. The well is then geosteered to place it in the most prospective part of the target formation. This is challenging work since drilling operations proceed on a 24/7 basis. Experienced geosteering geologists are in high demand.

Logging While Drilling (LWD) tools transmit data back to surface from downhole sensors to provide positional information and rock property measurements, usually a Gamma Ray Log which measures naturally occurring radiation and can be used for lithological correlation. Drilling proceeds until the well reaches its planned Total Depth (TD) and the final string of 5 ½ in. production casing is run and cemented to surface. As the name implies, the production casing is designed to withstand the pressures, and forces which will be encountered during the producing life of the well. There are now four steel and cement barriers between the flow-path for produced fluids and shallow aquifers. It is worthy of note that activities up to this point represent sound design and implementation practices which are part of the normal construction process for onshore oil and gas wells. The risks are well understood and the experience base is large. There are over 840,000 oil and gas wells in the U.S. and in mature oil producing states a public awareness and acceptance of these activities which spans four generations.

Fracking, although a long established process, has received a great deal of attention because of the extent to which it is being applied on these unconventional wells. As with the general drilling process described above, there are risks and these must be understood and mitigated. However, the process itself is not well understood by the public at large.

When the well is completed, a fracking program is developed based upon final interpretation of the geology encountered. Parts of the wellbore which are not satisfactorily located within the prospective layer may not be fractured. The rest of the well bore is then partitioned into sections of approximately 400 ft. length. The production casing is perforated and packers run to isolate each stage prior to injection of fluid, additives and proppant.

Figure 2. Principal Stresses and Preferred Fracture Orientation

Figure 2. Is a schematic representation of part of the horizontal section of the wellbore. Generally the well is drilled taking into account the prevailing orientation of natural joints and fissures in the targeted formation. The frac process will exploit natural weaknesses so drilling the well in a direction normal to the dominant local trend for these natural joints will maximize wellbore intersection with them.

Orientation of new fractures will be controlled by the in-situ stresses. Traditional practice is to resolve these stresses in three principal directions. In general the maximum stress $\sigma^1$ is close to vertical and is generated by the weight of rock or overburden. The two horizontal stresses are usually the result of lateral transmission of a portion of the vertical load, which depends upon the in-situ elastic properties of the rock.

Reasonable numbers for illustration purposes are an overburden load of 1 psi per foot of depth, giving a vertical stress of approximately 8,000 psi in our example well. A minimum horizontal stress ($\sigma^3$) of approximately 80% of this value (6,400 psi) is assumed.

Some of the misconceptions associated with fracking arise because rock properties and behaviour at depth are quite different to the surface properties with which we are familiar. In the case of a surface sample, breaking the rock by pulling it apart would require overcoming its tensile strength. In the case of shale this would be of the order of a few hundred psi. However, test values are scarce particularly in a direction normal to bedding since the shale, even in small samples, tends to have planes of weakness. At the depth and scale in question, tensile strength has little bearing on the overall pressures required to execute the frac job. As mentioned above the target shales typically have well established joint systems and the drilling of the well will have resulted in near wellbore stresses and small scale fractures which will be exploited by the frac process.

In light of the above, the force required to open an existing fracture must exceed the minimum horizontal stress, which in our example is 6,400 psi. In these circumstances, a fracture or plane of weakness can be opened or parted allowing the injection of fluid into the formation. The resultant tensile stresses at the leading edge of the fracture are very high so little additional pressure is required to extend or propagate it. When the pressure is reduced to below the
minimum horizontal stress, the fracture will close and indeed it will return much of the fluid which was injected and take essentially the same pressure as before to reinject fluid. This is the essence of the hydraulic fracturing process.

Since closed fractures would have low permeability, it is necessary to prop the fractures open to promote flow and increase the wells ability to produce gas or oil. High purity silica sands with round grains of a uniform size are generally used as a proppant although in situations where closing stresses are very high, higher strength ceramic beads may be used.

A typical procedure would be to first pump water to open the fracture, then a fine sand (100 mesh, [0.006 in.±]) followed by coarser batches of sand (60 mesh [0.01 in.±], then 40 mesh [0.03 in.±]). This ensures that the fractures remain open and that there is a high permeability flow path from the formation to the wellbore.

This is a large scale operation involving significant volumes of water and proppant and high surface pressures. A single stage may involve 400,000 gals of water and 500,000 lbs of sand. High pump rates of around 2,000 gallons per minute can result in surface pressures in excess of 5,000 psi and the procedure might take up to six hours. The surface equipment configuration is large and complex with multiple truck-mounted pumping units and the process is energy intensive.

The direction and distance of fracture propagation is determined by stress orientation and rock properties. Sedimentary rocks are comprised of strata of varying mineral composition and physical properties and are often highly anisotropic in horizontal and vertical directions. Typically a fracture will extend vertically until it contacts a formation with a higher minimum principal stress (i.e. a higher Poisson’s ratio resulting in higher horizontal stresses) and will grow laterally in a given formation several hundred feet away from the wellbore. As the fracture grows, increasing the contact area with the formation and intersecting other joints and fractures, energy is dissipated and eventually there would be insufficient force at the leading edge for further propagation. Fracture growth can be mapped by placing geophones in nearby wells or on surface to detect microseismic events associated with movement in the rock. There is a large body of such information confirming the general statements made above (ref. 2). In the example well, since the deepest aquifer is separated from the frac zone by more than 7000 ft. of rock, there is essentially zero risk that the fractures will connect to the aquifer.

As discussed above, many of the risks associated with the drilling of the well are the same as for any oil and gas well and are well understood and generally accepted, at least in communities with a long history of oilfield operations. The risks specific to fracturing operations are by now also well understood. More than 1,000,000 frac stage jobs have been completed in the U.S. Clearly there are risks associated with the large scale pumping operations and the heavy road traffic and emissions involved. However these operations normally occur once during the life of a well. Once on production, the only surface equipment is a relatively inconspicuous wellhead generally tied into a buried pipeline. The microseismic events associated with the frac treatment and subsequent events associated with changing stresses in the rock as fluids are produced and pressures change are very small and only detectable using highly sensitive equipment. Additives used in the fracking process to help support the proppant during pumping (Guar Gum is the primary one), to reduce friction pressure while pumping, and to inhibit the growth of bacteria are another area of concern. While the risk of contamination of shallow aquifers as a direct result of the fracking process is negligible, spillage and disposal of recovered frac liquids present risks and operating companies must demonstrate transparency and diligence in managing these materials.

The ability to extract oil and gas from low permeability formations is having a profound effect on energy supply in the U.S. The need for imports is decreasing rapidly, improving national balance of trade and energy security. Low price gas is replacing coal in electricity generation, reducing emissions and making manufacturing industries more competitive. Local economies are benefitting from tax and royalty revenue and employment growth.

This rapid development in the U.S. has been facilitated by particularly favorable circumstances, beyond geological factors. There is a long history of and broad public awareness and acceptance of onshore production activities. The necessary skills, equipment and services are available. Mineral rights are connected to land ownership. This both provides an incentive to develop and helps assure prudent stewardship of the environment, since farming and oil and gas production must often co-exist on a single lease. Tax regimes and royalty payment mechanisms are well established and easily modified to accommodate the specifics of new production. Pipelines and storage infrastructure are in place.
From a geological perspective, opportunities for unconventional oil and gas production exist on a broad global basis. China, South America, Europe and Russia all have good potential. The decision to proceed will initially depend largely on social and regulatory constraints and thereafter on the pragmatic aspects of development. There are risks and impacts. However, these are well understood and must be balanced against the benefits, all within the context of meeting a growing global demand for affordable energy from viable sources.

Ireland relies heavily upon energy imports. The business case for development of unconventional gas is compelling and highly likely to occur in some European countries and Russia. Ireland will have to decide whether to become a producer, rather than just a consumer of this additional production.

References


* Jake Booth was born and raised in N. Ireland, Following Queen’s University he started working in the oil industry in the North Sea in 1976. Moved to the U.S. in 1982 and worked for ExxonMobil for 26 years. Jake is now an independent consultant, President and Owner of Booth Consulting LLC and currently lives in Houston Texas

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Another paperback in the same series and at the same price, published last autumn (ISBN 978 1 78046 001 7) is Introducing Oceanography by David Thomas & David Bowers. Again it is very colourful and is aimed at non-specialist readers. Like the above book there is a good glossary of terms but your reviewer does miss not having an index.


Why introduce a book on weather in an Earth science magazine? The answer is climate change. Earth scientists are accused of entering the climate change debate without the necessary scientific knowledge. Yet historically climate drove many changes now only preserved in the geological record. Speed of climate change in the distant and nearer past will have significance for the present, unless there are now drivers of change that haven’t previously existed.

This nicely colour illustrated paperback gives the sort of succinct overview many amateurs want. From seaweed to supercomputers and Hadley cells to sting jets. It will answer many of your questions about climate. Question: which gas has the largest impact on our weather? Answer: water vapour. And where does the energy come from to drive our weather systems? The Sun. What is the impact of carbon dioxide in the atmosphere? An unanswered question because as the slight warming cycle of the past century (0.6°C) stuttered to a halt the carbon dioxide concentrations soar.

A short chapter on ‘The Changing Climate’ ends the book with the wise words ‘we need to bear in mind that the climate will continue to change, and that we will need to adapt to it’.

AND
‘Fingal’s Geological Heritage’ is Launched

Patrick Roycroft witnessed the lift off.

The morning of Thursday, 4th October, 2012, dawned beautiful, sunny and clear – and a crowd were gathering at the White Sands Hotel in Portmarnock, in the county of Fingal, north Dublin. Previous days had been rough, weatherwise; this afternoon’s forecast was bad. But now, at 11:00 a.m., superb autumnal conditions prevailed. During that window, the genial giant of Irish geology, Dr. Matthew Parkes (Assistant Keeper of the National Museum of Ireland), helped launch the new book, *Islands, Coast and Quarries: The Geological Heritage of Fingal*, and led a large, and very diverse, group on a post-launch field trip.

Matthew is a well-known figure on the Irish geological landscape. Prior to his current museum post, he worked at the Geological Survey of Ireland where he was heavily involved in geological heritage and conservation. His subsequent move to the museum let him continue that work and to develop into a force for geological education. And being a professional palaeontologist, there could be none better to write a book, with his co-authors, extolling the geological heritage of the predominantly sedimentary rocks of Co Fingal.

Before the launch proper we were treated to coffee and biscuits and given the chance to chat to others. And there were plenty of others. Matthew was surrounded by a small army of friends, colleagues, and members of the public, plus the entire 6th Class from St Oliver Plunkett’s School (Malahide) and various local dignitaries. Among these latter were the Lord Mayor of Fingal, Councillor Cian O’Callaghan; the Director of Planning and Strategic Infrastructure at Fingal County Council, Gilbert Power; and the Heritage Officer at Fingal County Council, Gerry Clabby.

The formal launch took place in a large enclosed room at the back of the White Sands Hotel, which was decked with a suitable rostrum and contained a huge painted backdrop of the Portmarnock seascape. And on everyone’s seat was a free copy of the book - yes, one for everybody in the audience. Short speeches were made variously praising the authors hard work, explaining the book’s wider significance in terms of fulfilling Fingal County Council’s heritage brief, and emphasising it’s potential to explain geology to the general public and to promote more visitors to the county. Matthew gave a short talk and the final item was the formal book launch by the Lord Mayor.

After the official business had ended, the real fun began - the field trip. Matthew himself confessed to never having led so large and so diverse a group in his life...
and was, I think, a little shocked. The rocks were literally across the road from the hotel, forming a coastal section only a few hundred meters in length but with a multitude of geological attractions. In essence, the section comprises a near-continuous set of well-bedded fossiliferous Lower Carboniferous limestones, with crinoids, gastropods and spectacular colonial corals. However, they have been sheared and one outcrop in particular displays a wonderful en echelon vein set. The large audience lapped it all up as Matthew expounded on the site’s delights and deftly dealt with a continuous barrage of questions. The 6th Class excitedly cascaded over the outcrops like a human waterfall, all clutching their copies of the new guide. Everyone stayed to the end and had, if overheard comments are to be believed, a grand time.

A lot of effort has gone into making the text of the book accessible to the general public: I think it succeeds. And the book’s structure is original in that it is based not on a linear stratigraphic (through time) approach but on Fingal’s 21 sites of geological interest. Don’t despair - the traditional overview of Fingal through time is in there, too, though left to last as a separate chapter. A sort of tying everything up. I am a fan!

And so it was, that, within an hour of the field trip ending, the rain that had been forecast started to positively deluge down. But it didn’t matter. The triumph had been achieved. I would like to personally thank both Matthew Parkes and Gerry Clabby for organising and pulling off a genuinely memorable book launch.


The Irish Geoscience Network

The existence of this group was news to your editor when he was sent the minutes of its last meeting held in February in Dublin. The meeting was chaired by Deidre Lewis of the Institute of Geologists of Ireland (IGI). Members present included a good cross-section of the leaders of Irish geology including notably some from outside academia and the government service. Maybe this leaning towards industry is why the organisation was originally formed.

The IGN describes itself as an informal grouping of all the geoscience related groups across Ireland, latterly including the Geological Surveys and Teaching Universities. It serves as an annual opportunity to share issues of mutual interest.

The members discussed some industry related matters and a number of issues which seemed to be actioned for Institute of Geologists of Ireland attention. There is a clear need in Ireland for a geological grouping that helps with industry questions – quarrying, minerals and petroleum. How does this network, meeting just once a year, fit in with the IGI and the Royal Irish Academy? Certainly the former should be championing industry geology and geologists.

Maybe this note will encourage an article for the next issue that explains all.
School of Geography, Archaeology and Palaeoecology

Professor Bernard Smith

Bernie described himself first and foremost as a Geographer who practiced Geomorphology in its broadest sense. He was proud to be a Geographer and in my many conversations with him over the years he was at pains to emphasize the unique nature of a discipline, which focuses on providing explanations of how the human and physical environments operate and the complexity of their interactions. He always felt privileged to be able to earn a living from his ‘hobby’, a ‘hobby’ which required him to travel the world and experience first-hand many of the planet’s most impressive landscapes and the peoples that inhabited them.

Bernie graduated with his PhD from the University of Reading in 1975 and relocated to Nigeria with Dorothy his wife, where he taught in Ahmadu Bello University, Zaria. On his return to the UK Bernie took up a lecturing position in Queen’s University Belfast in 1979 and held the Chair in Tropical Geomorphology from 1998. He continued in post until illness necessitated his early retirement in 2011.

Bernie supervised the launch of many geomorphological careers (my own included) with his thoughtful and generous PhD supervision and influenced the career decisions of many of the undergraduate students who came into contact with him. He was an inspiring teacher.

His research interests were rooted in his love of hot deserts and tropical landscapes and his desire to better understand the processes that shape them. Whilst this was the core of Bernie’s career, his fascination with weathering processes led him onto some of his most significant geomorphological work and the establishment of the Weathering Research Group at Queen’s in the early 1990s. The focus of this group was on improving our understanding of stone weathering in both natural and built environments. It resulted in Bernie’s involvement with local conservation architects and the wider building conservation community in the UK, Europe and further afield.

In the last decade or so, Bernie’s core interest in landscape interpretation came back to the fore as he became increasingly involved with UNESCO initially through his advisory role for Northern Ireland’s own World Heritage Site at the Giant’s Causeway and then on a broader global stage as a world heritage evaluator. He performed a similarly important local role as a member of the Council for Nature Conservation and the Countryside which advises the NI Environment Agency.

Throughout his career Bernie has been appreciated for his quiet advice and influence. It is very sad that he left us at the end of last October at just 61 years of age; he will be much missed. We offer our sympathy to his family.

Patricia Warke

Welcome to Dr Rob Raine

Rob Raine graduated in 2003 with an MSci in geology from the University of Birmingham and remained there to study for a PhD in carbonate sedimentology and biostratigraphy. During this time he undertook the role of assistant curator for the Lapworth Museum of Geology and took time out to work as a museum conservator.

In 2008 Rob joined Ichron Limited as a reservoir geologist (sedimentologist) working on projects in India, Sri Lanka, Algeria and the UK and Norwegian sectors of the North Sea. He also led a number of field trips for oil companies to Portugal and Yorkshire and core logging courses in India. He still assists Birmingham University with their mapping training course in NW Scotland.

Rob has recently joined the Geological Survey of Northern Ireland as a petroleum and energy geologist to provide scientific support to the Department of Enterprise, Trade and Investment on petroleum licences and conduct research to promote the petroleum and geothermal exploration potential of Northern Ireland.
ROCK ART IN ‘THE TOP END’

Steve & Karis Thompson travel to the Northern Territories

I doubt if many of Earth Science Ireland readers will know where ‘The Top End’ is but not too long ago we decided to go take a closer look at the place.....

From Dili, where we live, to find this amazing place you must fly south and east, across the oil and gas rich Timor Sea to Darwin, capital of Australia’s Northern Territories, proudly inhabited by beefy and very independent ‘Territorians’ who like nothing more than to buy you a cold beer in welcome of your arrival into ‘The Top End’.....“Wouldn’t want to live anywhere else, Mate!”

One of ‘The Top End’s’ tourist jewels is Australia’s Kakadu National Park. Kakadu (http://www.environment.gov.au/parks/kakadu) is an ancient landscape of exceptional beauty and great diversity. It stretches over 20,000 square kilometres, from mangrove-fringed tidal plains in the north across the vast floodplains of the Alligator River, to lowland hills with dry savannah forests, all dominated by the sandstone cliffs of the Arnhem Land escarpment with, behind it, the barren ‘Stone Country’ of myth and legend.

Spiritual ancestors created the landscape, the wildlife, Aboriginal people and their way of life today. As stories about these ancestors are retold, important information about traditional Aboriginal land and laws is passed through generations.

It is a living cultural landscape. For countless generations the Aboriginal tribes, the Binnji and the Munngguy, have lived on and cared for this land. Their spiritual connection with the land is globally recognized in Kakadu’s World Heritage listing.

Quoting from the Park Visitor’s Guide:

‘Mimi’ spirits were the first of the creation ancestors to paint on rock. They taught the Binnji how to paint...At the end of their journeys, some Creation Ancestors put themselves on rock walls as paintings and became djang (dreaming places). Binnji/Munnggay artists continue to paint on rock, bark, paper, canvas and fabric....The act of painting puts the artist in touch with their Creation Ancestors – a powerful experience....”

This is what we came to see and feel in this truly amazing place.

Having let Darwin’s welcoming beers and the inevitable kangaroo steak for dinner subside, Kakadu is a long day’s drive, again south eastwards on the long straight Arnhem Highway, 350K’s to Jabiru, the gateway to the park.

On the way you cross the vast wetlands of the Alligator River with its abundance of bird and reptile life and on across the dry savannah plains laid out beneath the Arnhem Land escarpment. When you first see this immense feature, it takes your breath away.....

The escarpment rises to 330 metres above the plains and extends over 500K’s along the eastern boundary of the park. Huge, often stepped, sandstone cliffs dominate the plains below, as do immense plateau outliers, as at Nourlangie Rock. The rock platforms of the plateau are dissected by a network of chasms and gorges which in the wet season display stunning waterfalls and superb plunge pools for a swim...if the resident crocs are NOT around!

The top of the plateau is a harsh, dry place, the ‘Stone Country’, already as hot as hades and so inhospitable that the park Rangers would not let us trek there....

The Kombolgie Formation, of Proterozoic age, is composed of massive quartz sandstones, up to 1,000 metres thick, which were deposited +/-1000 mya by an immense Pre-Cambrian fluvial system. What is remarkable about these rocks is that they have remained stable and...
undeformed since deposition and exist now in almost the same condition as they were when deposited. Massive, often cross-bedded, rusty red and ochreous quartz sandstones predominate, frequently with interbedded quartz pebble conglomerates and breccias.

About 140 million years ago, during the Mesozoic era, a shallow sea spread across most of Kakadu from the north. The escarpment and outliers were then the sea cliffs at the edge of this vast, shallow sea. More recently, about 10,000 years ago, marine transgression again inundated the lowland areas of the park and the final twist of geological fate, about 7,000 years ago, saw a sea level drop and the growth of the freshwater swamps of the modern wetlands.

The escarpment, gorges, and rock outliers of Kakadu hold one of the world’s greatest concentrations of rock art sites: approximately 5,000 art sites have been recorded and a further 10,000 sites are thought to exist.

The paintings, estimated to range in age from 20,000 years to the present, constitute one of the longest historical records of any group of people in the world. The rock art sites of Kakadu are recognised internationally for their cultural value and are one of the reasons that Kakadu is inscribed on the United Nations list of World Heritage properties.

Aboriginal rock art tells the story of the Creation Ancestors and the changes in the landscape over thousands of years. Paintings are naturalistic, often in classic Aboriginal ‘X-Ray’ form and they can also tell the more recent history of the first European contact. With an immensity of rock art to photograph our choice for this travelogue was less than easy.....

In Kakadu, winter, summer and spring don’t exist as we know them, rather there are six seasons recognized on the grounds of the weather and how it affects the plants and animals as seen through Aboriginal eyes... we were there in ‘Gunumeleng’, the October pre-monsoon storm season and ‘Namarrgon’ the ‘Lightning Man’ was much in evidence......

He could be heard each evening banging, crashing and rumbling in the distance all along the escarpment as his spectacular...
electrical storms, which occur here in Kakadu at this time every year, let us mere mortals know who really was in charge.

All human life is here in Kakadu and human failings too. Namarrdjolg took a fancy to his sister and was punished for his sins, banished to become ‘Ginga’ the great saltwater crocodile… and there lies a connection to Timor, as in Timorese mythology it was ‘Lafaek’ the great saltwater crocodile who saved a boy at sea and died in the act, with his remains becoming the island from which we write…

There is of course more than a little geological background to Aboriginal rock art and we shall again refer to the Park Visitor Guide and to the Park website to describe that, as we can do no better:

‘Several naturally occurring minerals are used to make the basic colours common in rock paintings:

- **Haematite** I An iron-rich rock used to make red
- **Limonite and goethite** I Used to make yellow/orange
- **Ochre** I An iron-stained clay that is used to make red, orange and yellow and can be made darker by baking it in a fire before grinding
- **Kaolin (pipeclay) and huntite** I Used to make white

Manganese oxide and charcoal I Used to make black, although charcoal is not a mineral and does not last long.

Of all the pigments, haematite lasts longest. Over time it penetrates and bonds with the rock surface. As a result, the majority of old paintings visible today are completely red. The other white and yellow pigments commonly used in X-ray paintings form a layer on the surface of the rock; they are very vulnerable to damage by wind, water, animals and humans.

Pigments are crushed on a stone palette and mixed with water to form a paste. Paint is applied using brushes made from human hair, chewed sticks, reeds and feathers. Wet pigments are also blown from the mouth around objects to create stencils, the hand stencil being the most common.’

Kakadu is immense, in every sense of the word, and in a week you can barely scratch the rock surface of this stunning place. The Aboriginal way of life, their spiritual history and total connection to the ancient land leaves you wondering just what we ‘western’ and supposedly ‘educated’ folk are all about.

The way home to Dili took us, in retreat, back across the teeming wetlands of the Alligator River, clearly misnamed considering the wetland’s most savage inhabitants…..the brooding saltwater crocodile.

Is he ‘Ginga’….or his Timorese cousin, ‘Lafaek’ on holiday ?

No matter, all Timorese holiday makers to Australia must eventually go home but if any reader, makes it to Kakadu, stay an extra day and cruise the wetlands at sunset. You won’t regret it……nor will you regret that kangaroo steak in Darwin…..
NEW ‘GEOPARKS IRELAND FORUM’

Kirstin Lemon reports

The Irish Geoparks Forum was first established in 2008 as a joint initiative of the Geological Survey of Ireland (GSI) and the Geological Survey of Northern Ireland (GSNI). The aim of the forum was to inform and guide both existing and aspiring Geoparks across the island of Ireland and to provide the opportunity to network with each other. Now in its fifth year, the Irish Geoparks Forum 2012 was hosted by the Causeway Coast and Glens Heritage Trust. The forum took place in October 2012 in the Londonderry Arms Hotel in Carnlough, Co Antrim.

Relationships formalised

Across the Global Geoparks Network, each country has established a similar forum to help coordinate activity and share expertise on Geoparks. However, in the past year this has become even more important with some significant changes being proposed to the way that the Global Network is operated and managed. It was, In the past, supported by UNESCO in an ad hoc way but plans are in place to formalise the relationship, a move that will be aided by the support of each national Geoparks forum in conjunction with each relevant national commission to UNESCO.

All change

Given the recent developments with UNESCO, the forum began with a meeting taking place between the three existing Global Geoparks (Burren & Cliffs of Moher Global Geopark, Copper Coast Global Geopark and Marble Arch Caves Global Geopark), in addition to representatives from the geological surveys in Belfast and Dublin plus other relevant statutory bodies. It was then proposed that the annual Irish Geoparks Forum be replaced with an annual Geotourism Conference, with the members of the existing Global Geoparks on the island of Ireland, as well as the geological surveys, to meet as the Geoparks Ireland Forum on a more regular basis. Dr Kirstin Lemon from the Geological Survey of Northern Ireland was voted as the new Chairperson for the forum, with Dr Sarah Gatley from the Geological Survey of Ireland as the new Vice Chairperson and will remain so for the next three years.

Aspiring Geoparks

Later in the meeting there were presentations from all of the existing Global Geoparks, as well as presentations on the changing relationship with UNESCO and on how to become a member of the Global Network. Other presentations were also given by the newly established Mourne Cooley Gullion Geotourism Project, from the Causeway Coast and Glens Heritage Trust and from the aspiring Joyce Country Geopark.

And the members of the Forum then went on a field trip, as every good Earth science group should!

ESI wishes the new Forum every success in promoting Earth science tourism and conservation.

Irish Geological Research Meeting, March 1-3 2013

The meeting was held in Derry/ Londonderry, City of Culture 2013. Two excellent guest speakers, Jan Zalasiewicz and Gerald Roberts, spoke respectively on the Anthropocene (the most recent ‘formation’) and earthquakes in Italy.

Your editors were unable to attend. They have seen the programme and it clearly was a meeting that showcased the best of Irish geological research. If anyone likes to write anything about the meeting for the next issue of this magazine we will be delighted to include it.
Now in its second year, the Galway Geology Association (GGA) finds itself in a vibrant condition with interested and committed new members continuing to enrol. We can now boast a fully paid-up membership totalling 57. Such is the broad appeal of geology in the region that we are a mix of 20 student members (NUIG), 33 individual and 2 family memberships.

For the 2012/13 season we are conducting 2 different short courses for members, both in the post-Christmas period. The first, which has just come to an end, ran over a period of 8 weeks on a one-night-a-week basis (2 lectures per night) and covered such diverse subjects as ‘Deep Time’, ‘A biography of Earth’ and ‘Deserts vs. Glaciers’. The second course, which is much more ambitious, is being conducted over a series 6 Saturday mornings (one a month) and includes subjects such as gemmology, geological map reading and geohazards. This course will finish in June. These courses, run by Dr Alessandra Costanzo together with Dr Ronan Hennessy, are organised on a thematic basis with the designated topic being covered on the one date, thus allowing a degree of flexibility for attendees – a method found to be best suited by our members.

In addition to our formalised courses we are hosting a series of visiting lectures, some of which are in conjunction with the Galway Earth and Ocean Society (GEOS) - the NUIG student geology club. Among our very interesting and informative lecturers were such luminaries as Prof. Martin Feely - NUIG, Prof. John Parnell - University of Aberdeen and Dr Tony Bazley – magazine. We are very much looking forward to upcoming lectures from Prof. Charles Cockell - University of Edinburgh, Prof Paul Mohr - NUIG and Dr Davinia Moreno, Museum National d’Histoire Naturelle de Paris.

As the weather improves we are anticipating the resumption of our fieldtrips; those to come will include a day in Connemara with Prof. Martin Feely of NUIG (13th April), an overnight to the ‘Copper Coast’ (Waterford coastline Geopark) and the Marble Arch Geopark (Fermanagh/Cavan) on the 15/16 June. Since our inception we have had close links with the Earth and Ocean Sciences (EOS) department in NUIG. Indeed one could not stress enough how the welcoming and facilitating manner of the academic staff of EOS has acted as a catalyst to the growth of the GGA. Indeed it is an exemplar of how universities and their public should interact. The majority of our meetings, courses and lectures are held in the university and it is used as our point of departure and return from fieldtrips. Any of our members who were interested were invited to accompany the NUIG geology diploma course on their weekend trip to Cooley/ Mournes/ Sliabh Gullion districts on 20/21 April, which was conducted by Dr Sadhbh Baxter.. This diploma course, along with the Gemmology one, is a natural recruiting base for the GGA who in return can source new students for these courses.

On general discussion with members this writer is happy to state that our membership report enhanced enjoyment of their holiday experiences due to their increased knowledge and interest in geology. Along with the fantastic geological sites of interest here in Ireland, some members recently visited the Kalahari of Namibia, the Caves of Dirou on the Greek Peloponnese and Iceland, to mention but a few locations of interest. It is true to state that with knowledge and learning come appreciation, understanding and respect for our natural environment. Indeed one member (whose poetic anonymity I have been asked to respect) whilst pondering the ‘rock cycle’ on a sunny foreign beach was moved to pen the following:

“Tumbling, crumbling, as they fall, Carried by a river from a mountain tall, Rocks now lie beached as pebbles small.”

Looking to the future, we are about to embark on a search for corporate sponsorship, to both assist in a small way in our administration but more importantly to be in a position to assist a full-time student of geology at NUIG with an annual bursary. We are more than willing to discuss this idea with any interested sponsor. We anticipate an increasing membership and interesting courses and hopefully some formalised foreign travel. Our website (designed by Chris Randolph) is to be found at http://galwaygeology.weebly.com – please pay us a visit. We also look forward to meeting with other like-minded associations here in Ireland to share our and their events.

Alex Costanzo
Tina Keating, Copper Coast Geopark talks about

DAYS IN THE LIFE OF A GEOPARK GEOLOGIST

The title of this article was to be “A Day in the Life of a Geopark Geologist” but I have to say in all honesty there is no such thing as a typical day for a geopark geologist, every day offers a different experience and a diverse but always interesting group to work with, whether it is a class from a national school, secondary school, third level, the general public or a professional body. My day could consist of anything from a hands-on activity, creating a 3-D solar system or clay plate tectonics jigsaws with a national school class, to tailor-making a field trip for a society such as the International Association of Hydrogeologists or the Cork Geological Association, or to addressing a meeting of the Regional Geography Teachers Association.

But before going on I should introduce myself: my name is Tina Keating and for the past five years I have worked as the consultant geologist for the Copper Coast Geopark (CCG), County Waterford. My role as geologist is fully supported by the Geological Survey of Ireland and I work with a small team of very dedicated people, based at our newly refurbished Geopark Centre in Bunnahoon. In addition to meeting with the local management team, the board or geoparks network, with the help of Paula, our office manager, I organise events to promote the natural, built and cultural heritage of the area. CCG takes part in various festivals such as Heritage Week, Bealtaine (the festival of outdoor science run through Calmast, Waterford Institute of Technology’s Centre for the Advancement of Learning of Maths, Science and Technology) and our own European Geoparks Network Week.

As the work is so interesting and diverse, I have decided that instead of describing just one day in the life of a geopark geologist, I will share some of the projects that fill my days working with the Copper Coast Geopark.

Appreciating our landscape

One of my first activities with the Copper Coast, when the area achieved UNESCO-supported Global Geopark status’ was to co-coordinate an eight week geology course with Dr Bettie Higgs from UCC. The course was run for the local communities, to teach them about the area’s unique geology and to explain why this small stretch of coastline achieved worldwide recognition. Understanding the significance and learning about the area from the ground up, so to speak, gives people a deeper appreciation of the area, why the landscape has formed in this way, the mineralisation which led to the copper and silver mines and even to the type of flora and fauna that inhabit the area. Learning about your environment and what it has to offer, fosters a sense of pride in your place, and it is seen as something worthwhile, valuable and worth preserving. As a result, CCG has a group of trained local volunteer guides leading geological, historical and ecological walks and we have gained three more volunteers this year. Nine years on I am still running an ‘introduction to geology’ course, the next one being scheduled for the autumn.

National School Education Programme

First-hand experience with natural phenomena plays a huge part when it comes to environment and preservation. When we encourage an interest in the environment and a sense of pride of place from an early age, “sense of place” and environmental preservation becomes second nature.

As part of our National School Education Programme we take school kids on fieldtrips to the beaches and bog areas. To help them understand the geology, ecology, habitats and environment we use various games and scavenger hunts to separate what is natural to the beach and what shouldn’t be there. Fun activities create a positive feeling towards the place and the kids are learning without it being a drudge - and who knows, we might be inspiring our future Earth Scientists!

The first thing I get them to do is to close their eyes and listen to the sounds of the area. Then we have a short talk about what they heard before moving onto other activities, which include tasting the foods of the bog and feeling the textures of the rocks. In this way they experience the area through all their senses – hearing, touch, taste, as well as sight.

The final activity at the beach is the ‘Pebble Pledge’; we draw a design in the sand and create a mosaic using the pebbles on the beach. Before placing their pebble into the mosaic each child
makes a pledge to do something to help their environment, and their teachers also have to make a pledge. The design is then replicated in the classroom, and each child writes their pledge on a piece of paper which is stuck on the classroom wall. It serves as a reminder every day of their promise to the environment and their visit to a wonderful and fascinating beach.

**Integration between Art and Science**

One of my favourite projects was undertaken with the 5th Year Art students from Stella Maris Secondary School in Tramore, who took part in the “Geology through Art” Project in association with the Copper Coast European and Global Geopark. The project sought to fully integrate the two subject areas, which are typically perceived in education as being intrinsically different and separate. Mediating between the two disciplines were myself and Sinead Driver, the art teacher with Stella Maris.

The project began with a full day’s ‘geology and sketching’ fieldtrip. The pupils spent the day along the coast from Kilfarassy to Bonmahon, soaking up the geology, archaeology and heritage of the area whilst sketching and taking photographs.

The aim of this project was to take a science subject and build an art exhibition around it, thereby creating a link between two topics which would appear to differ greatly from each other, but in fact share commonalities. They are both extremely visual and imaginative and by taking part in this project, the pupils of Stella Maris endeavoured to create and encourage a more imaginative, explorative and enthusiastic response to science education. I’m sure George Victor Du Noyer, the 19th Century Irish artist and geologist would have approved.

Over the following six months the students produced works of art and craft inspired by the geology and landscape of the Copper Coast, which encompassed volcanoes, closing oceans, mountain building events, deserts with seasonal flooding and the Ice Age. They included archaeological elements from the rich 19th Century copper mining heritage of the area, lime kilns dotted along the coastline and Iron Age promontory forts.

All works produced as part of this project were exhibited at the Copper Coast Geopark Centre during European Geopark Network Week. The centre was adorned with paintings, sketches, lino prints, photographs, batiks and ceramics. The fabulous coastline and rich heritage truly captured the imagination of the students and stretched it even further to include an adaptation of Lewis Carol’s famous fantasy novel. However, in our version Alice, instead of falling down a rabbit hole, fell down a mine shaft in Tankardstown. The handmade twelve foot papier-mache model of Alice and various characters including White Rabbit, Queen of Hearts, Tweedledum and Tweedledee, looked right at home in our centre and were a talking point for months afterwards.

**International Biodiversity Day**

Again, our celebration of International Biodiversity Day explored the dualities of art and nature. With temperatures hitting 25 degrees, word had got around that there was something happening at Annestown, one of the many beautiful sandy coves of the Copper Coast Geopark families gathered on the beach to create one of our signature mosaics using the natural materials of the beach:
shells, pebbles and sea weed. While sea creatures may be washed up on a beach, slowly decaying until they ultimately disappear, this celebration of biodiversity conjured a creature out of the sea, beach and cliff - a starfish!

Coastal Erosion and Geographical Investigations

In keeping with the geology and art theme, erosion (nature’s sculptor) creates some of the most spectacular features along our coast; however it is worrying to see the amount of coastline we are losing to the sea every year.

It is very appropriate that the topics of the 2013 Geographical Investigation include testing the hypothesis that erosion is an active process in a coastal environment. I adapt our coastal survey to the requirements of each year, and the students undertake a series of investigations at Kilfarassy or Benvoy. In doing these investigations over the current year I couldn’t fail to notice the changes to the beaches, so I decided to initiate a photographic study at Benvoy. Every Tuesday a series of photographs have been taken along the beach and the aim is to have a photographic record of the erosional effects on the coastline at Benvoy over the period of a year. Progress can be followed on our Facebook page.

Working as the Copper Coast Geopark Geologist is one of the most interesting, varied and rewarding careers. In addition it has opened up new realms for me such as archaeology, social history, human geography and geotourism, and I have had the opportunity to meet so many interesting people with a varied range of experience, knowledge and skills.

CONGRATULATIONS KOEN

Koen Verbruggen has been confirmed as Director of the Geological Survey of Ireland. We offer our congratulations to him on being awarded this position, one of the most prestigious in geology in Ireland. For a picture see him awarding the GSI prize at the Young Scientist Exhibition elsewhere in this issue.

Interesting times for Belfast Geologists’ Society

David Kirk reports

Belfast Geologists’ Society members are now half way through their current season, having enjoyed another stimulating series of winter lectures and looking forward to a summer of field trips which as usual will have them ranging far and wide.

The winter season opened with Ian Enlander from the NI Environment Agency sharing with members, in a talk entitled ‘Beyond the Earth Science Conservation Review’, the future plans for the Agency’s work in gathering and sharing information of the many elements of the Province’s rich geological heritage. In November the members joined the public for one of the ‘Meteorites Tamed’ lecture series by Ulster Museum’s Mike Simms on the dramatic impact meteor strikes can have on our planet (which turned out to be a fortuitous scene-setter for February’s dramatic meteor ‘strike’ in Russia!)

In December Tony Bazley faced up to the controversies over what some regard as the ‘life-saver’ of the energy industry and others regard as a potential environmental hazard - the use of rock-fracturing, or fracking, to release the vast reserves of gas trapped far beneath the surface, with special reference to the west of Ireland, and explaining the geological principles behind the process and the engineering challenges involved.

In January Paul Anderson expounded his theories about the mode and time of the formation of the Newry igneous complex in a talk entitled ‘Taken for Granite; New Ideas on the Newry Igneous Complex’ - new ages for old rocks.

The Eighth Harold Wilson Memorial Lecture in February ‘Bubbles in Crystals: What Fluid Inclusions Can Tell Us’ was the intriguing subject of the talk given by Professor Michael Feely, Head of Earth and Ocean Sciences at NUI Galway.

Peter Crowther’s Presidential address in March was entitled ‘To a Land Down Under’ and told the remarkable stories of two sometime Belfast-based geologists who both became giants of nineteenth-century Australian geology.

Among the field trips being organised for members to look forward to this summer are expeditions to study the structures and rocks created by volcanic activity on our North Coast (on May 11), Geoarchaeology of Ballynoe (stone circle) and the Mournes (May 25) and Building Stones of Newtownards (June 13).

They are also hoping to visit Earth Science Conservation sites in Fermanagh, to have a trip to look at glacial geology at a locality as yet to be decided, and possibly to visit Connemara in the autumn.

Details of planned field trips can be seen on the Society’s website – www/belfastgeologists.org.uk
Millions of years ago in Namaland

by Maire Lohan

As a member of the Galway Geological Association I’ve enjoyed taking part in the activities of its first year of existence – completing the course in Geology in the Moycullen VEC, going on wonderful field-trips in the Burren and Connemara and attending some fascinating lectures at NUI Galway. In November I ventured further afield and travelled to Namibia on holiday with my husband, David, who took the photos below. Not knowing much about the country, I did some research before we left and realised that there were so many places with wonderful geology that it would be difficult to plan an itinerary for our limited time. When I visited a region there called Namaland I realised that the word has meanings other than the gloom-laden one it has in this country……….

Millions of years ago Namaland was a very different place and over that time it has become imprinted by some amazing geological events. Namibia is an enormous country – 825,418 km² compared with Ireland’s 84,412 km² – with a population of just 2.3 million, so there are vast, open areas of desert, thorn-scrub, savannah and salt pans. The Namib desert stretches along the entire coastline and is backed by the Great Escarpment beyond which is the Central Plateau. The Kalahari desert lies to the east. The only perennial river in Namaland is the Orange River which forms its southern boundary with the Republic of South Africa.

Situated in complete wilderness and second only in size to the Grand Canyon, this gigantic gorge is 160 km long, up to 27 km wide and in places almost 550 m deep. Some 770 million years ago the original layers of sediments and volcanic rocks were invaded by doleritic magma which formed prominent dark dykes that can be seen on the canyon walls. By c. 350 million years ago erosion had removed most of the Nama rocks and the initial river valley had formed as a wide meandering depression, which was eventually filled up with glacial sediments, sandstone and shale. The canyon as we see it today began to form during uplift after the break-up of Gondwanaland c. 130 million years ago. The increased velocity of the river caused it to incise deeply, revealing the deepest layers as outcrops on the canyon floor. Along the fault zones forming the sides of the canyon groundwater rises to the surface to create a number of sulphate- and fluoride-rich hot springs believed to have natural curative properties. The Fish River is an exception among Namibian rivers in that it retains perennial pools outside the rainy season.

Though not as jaw-dropping in perpendicular scale as the most-photographed sections of the Grand Canyon, the sense of isolation and absolute wilderness here is unsurpassable. The hotel where we stayed is the only one permitted on its entire rim and is some 2 hours journey from the nearest road. A hair-raising trip right into and along the floors of canyons within canyons will not be quickly forgotten.

The Petrified Forest lies further north in Namibia (Damaraland) in a dry, rugged area. Scattered all over the site are many fossilised trunks of tall trees, lying vertically, which are estimated to be c. 280 million years old. Members of the early Cordaites family of trees, they grew to heights of over 40 m. and are ancient ancestors of present-day conifers and ferns. About 320-270 million years ago Namibia was covered in ice fields and glaciers during the Great Gondwana Ice Age. As the waters melted, floods ripped through this ancient forest, tree trunks were literally snapped off and carried far distances. At this site they were buried almost immediately under a thick layer of sand and rubble. Further sedimentation over many millions of years resulted in the trees being buried under hundreds of metres of overburden. Immense pressures caused quartz in
the sediments to dissolve and the silica-rich solution permeated the wood and replaced it with crystalline quartz. When the ancient continent of Gondwana split apart surface levels rose. In the following millions of years ice ages came and went and erosion, first by water wash and later by desert wind, eventually uncovered the tree trunks.

Wandering around this site and following the haphazardly-scattered tree trunks until they became covered by the ground made us really appreciate the power of water and wonder where these trees might have originated. Unfortunately, our guide could only say ‘from a far distance’.

**Dinosaur Footprints at Otjihaenamaparero**

In the Otjiwarongo district of northern Namibia, we travelled to a privately-owned farm where crossing tracks of dinosaur footprints can be seen on flat sandstone outcrops of the 190 million year old Etjo Formation – think a flat Burren landscape except with very hot red sandstone. These sands accumulated under increasingly arid conditions as wind-blown dunes - similar to dunes further south in the Namib desert today. Imprints in wet sediments around waterholes - fed by occasional rainfalls and thunderstorms - were covered by other layers of wind-blown sand. They were preserved as trace fossils when the sand solidified into rock due to immense pressure. All tracks show the form of the 3-toed, clawed hind foot of a bipedal animal. The longest track (which can be followed for about 28m) contains 30 imprints (c.45 by 35cm) spaced some 70-90 cm apart which are believed to be made by Ceratosaurus.

Some tracks contain smaller imprints c.7cm long spaced about 28-33cm apart; these are believed to be those of Syntarsus. Due to the unfavourable changes in climate, it is assumed that the animals became extinct not long after they left their footprints. However, as no body fossils of these creatures have been found in the area, the identification is based on comparison with other sites.

Tracing the tracks of these animals of such different sizes that were forced to concentrate near shallow waterholes brought into sharp focus the fragility of life in times of climate change.

The Petrified dunes are situated near Sesriem, on the eastern edge of the Namib desert which is the oldest desert in the world; they are sometimes called the Fossil dunes because they contain fossils of the ancestor of the modern-day ostrich. They provide wonderful visual evidence of an earlier desert. Towering red sandstone cliffs, some reaching 90 m, are remnants of a dune system that was created during a period of accumulation of wind-blown sand c.65 million years ago. As the climate changed,
gradually getting wetter, the additional moisture caused the sand to solidify into sandstone which is estimated to be 23 million years old. The establishment of the cold Benguella Sea current along the west coast of Africa, some 5 million years ago, heralded a return to very dry conditions and the development of the current dune system.

The Meteorite at Hoba

In the north of Namibia near Grootfontein, the Hoba meteorite is the largest known single meteorite in the world. Tabloid-shaped, it measures 2.95m by 2.84m and its thickness varies between 122cm and 75cm; when found in 1920 it was estimated to weigh 66 tons but erosion, scientific sampling and vandalism have reduced its bulk to a present estimate of 60 tons. It comprises 82.4% iron, 16.4% nickel, 0.76% cobalt and other trace elements. It is classified as an ataxite, a structure-less relatively rare and very dense iron meteorite. The presence of a rare radioactive nickel isotope has enabled scientists to date its fall to earth at less than 80 000 years. Analyses of the age of the meteorite vary between 190 and 410 million years.

Ease of access to this huge meteorite encourages one to touch it and examine it closely. The imagination can go into overload when one sees it hurtling through space and landing at Hoba without leaving any perceptible crater. Tourist literature rightly proclaims Namibia to be ‘a geologist’s paradise’. Having visited these sites it is very easy to see why. I certainly wish I could have stayed longer to explore further – and that my geological knowledge was much, much deeper.

To find out more:

Dinosaur Footprints: info from a leaflet printed by the owner in which he refers to www.dinosaurtracks.com
Fish River Canyon: www.fishriverlodge-namibia.com/ ; www.gond-collection.com?id=57
Hoba Meteorite: Info from leaflet at site. Further info at www.giantcrystals.strahlen.org/africa/hoba.htm
Petrified Dunes: Info from leaflet at Namib Desert Lodge Hotel which refers to www.namibian.org/travel/lodging/private/namib_desert_lodge.html
Petrified Forest: www.namibia-1on1.com/petrified-forest.html

It is situated on the edge of the Kalahari plain which is underlain by white calcrite, under which are ancient granites, dolomites and limestones. No crater or altered rocks have been found associated with the impact site; the flatness of the meteorite on both major surfaces possibly slowed its terminal velocity sufficiently to allow it to skip across the lower atmosphere in the way a flat stone skims across water. After the meteorite fell it was gradually covered with a layer of calcrite formed by the evaporation of near-surface groundwater – suggesting a more humid climate in the recent geological past.

It is with great sadness that I must bring to the attention of the membership the unexpected and untimely death of Gonzalo Gonzales. Gonzalo passed away on Thursday the 8th of November in hospital in Barcelona after a short illness.

Gonzalo had a long association with Ireland which started in the early nineteen eighties when he completed a PhD on the SEDEX mineralisation of the Cork Black Shales. He then went on to become the exploration manager for Dana Mineral Resources working on their gold exploration programme in the southeast of Ireland. During this time he was responsible for the discovery of some significant new occurrences of gold mineralisation, in particular the Mary Ellen and Maclaren Zones near the Goldmines River. In recent years Gonzalo returned to his first love, geochemistry, working as a consultant geochemist for companies such as Rio Tinto, Boliden, Outokumpu, Noranda and Falconbridge to name but a few. His particular approach to exploration geochemistry was novel. He assessed and interpreted the data from a petrochemical perspective and he was always trying to link complex multielement lithogeochemical data back to the context of the underlying geology.

Those who had the pleasure of knowing Gonzalo will undoubtedly remember him as a kind and generous person who had a deep understanding of geochemistry and its application to mineral exploration. He was particularly unstinting with his time, experience and expertise and I have fond memories of long and fruitful discussions, which I will sadly miss. I would like to extend to his partner Isobel and his family our deepest condolences.

Dave Blaney
Barry Long replies to readers’ comments on his climate change article of Issue 11

Sincere thanks to those provoked to respond to my climate change article whereby broadening ESI Magazine coverage of the topic.

Robert Reid, Leeds.

CO₂ in excess of 3,000ppm and ice ages

I made the point that even when atmospheric CO₂ levels were above 3,000ppm in the geological past, warmth was not always an accompanied, there sometimes being major glaciation, e.g. Sturtian, Marinoan and Gaskiers glaciations – all Neoproterozoic.

Oxygen isotope studies show temperature changes over a few years.

Also mentioned by Zalasiewicz & Williams (below).

Whether climate is warming or cooling depends on choice of starting and ending points and the slope of the regression line in between. Measured to the present day, there has been warming since 16,000 years ago from the last glaciation; cooling since 10,000 years ago; and other warming and cooling trends for shorter intervals, including warming since 100 years ago and cooling since 1998. By choosing different starting dates Earth today is both warming and cooling. Overconcern with very short time periods, as by the IPCC, is meaningless.

Rapid temperature changes as short as 3 years are too short to derive a meaningful climatic temperature trend. The Greenland Dye 3 ice core temperature record from oxygen isotope studies shows many fluctuations with rapid temperature swings, e.g. the 5.2°C fall from years 526 to 531 at the beginning of the Dark Ages. But averaging this temperature record using the 22 year Hale Cycle reveals an orderly temperature decline over the last 4,000 years at a rate of 0.3°C per 1,000 years. The Greenland GISP2 ice core when averaged over 100 year intervals throughout the last 50,000 years shows the highest rate of change was about +15°C and -8°C per century relative to today. The Holocene fluctuations over 11,600 years were +/-2.5°C relative to today. The same core shows 20th century temperature to rise. From Greenland and Antarctic ice cores, studies of deuterium, a

Colm Ryan, Midleton, Co. Cork.

Claims I cherry-pick and distort or refute arguments of professional climate scientists.

The length limit imposed on my article necessitated omission of many topics, details and references. I had to cherry-pick. My choice of topics offered broad coverage and could not possibly match the preferences of all readers.

There are more than 1200 peer reviewed papers by professional scientists opposing the views of other professional scientists believing that human activity is causing dangerous global climate change. Widespread politicization of the subject has spawned misconceptions and distorted or ignored the scientific method. In some cases, for individuals or institutions, research funding has apparently become dependent on reinforcing ‘the correct view’ and has not been awarded for objective open-minded research. News media daily spread misinformation that is largely consumed uncritically. Improved understanding of climate science in all its complexity is necessary. The science is far from settled.

Jan Zalasiewicz and Mark Williams, University of Leicester.

Models, success of predictions and improvement of models.

The UN Intergovernmental Panel for Climate Change (IPCC) was tasked in 1988 to assess peer-reviewed research relevant to understanding the risk of human-induced climate change. In its makeup and functioning it is essentially a political organization. Successively published predictions of short term mean global temperature (IPCC Assessment Reports, AR 1 to 4, 1990, 1995, 2001 & 2007) have, despite ongoing revisions of computer models, all plotted below the predicted model temperature range for each prediction period. Inadequate models producing unrealistic results should be discarded. Instead of this, actual temperature records have apparently been adjusted for model results to appear less unrealistic. Natural climate variation has been played down over this period and dangerous human induced change has been steadily emphasized.

That there is more to temperature control than atmospheric carbon dioxide is apparently being acknowledged in the recently leaked Second Order Draft (SOD) of the forthcoming IPCC Fifth Assessment Report (AR5) due for publication in 2014. Although temperature predictions for longer than a few years are unlikely to be reliable, governments use them as a basis for taxes and energy policies. Closure of coal-fired power stations and proliferation of inefficient alternative energy sources already bring rising costs that will all too soon become crippling large (Sinclair 2011).

Speed of change and climate versus temperature.

Discussed under Robert Reid (above).

Scientific consensus is that CO₂ is a major climate driver.

Consensus is the language of politics and has nothing to do with science. An increase in atmospheric CO₂ does not cause temperature to rise. From Greenland and Antarctic ice cores, studies of deuterium, a
between cosmic radiation (using $^{14}$C) and rainfall (using oxygen isotopes). Galactic cycles, including relative abundance of supernovae, may seem insignificant, but relatively recent passage of the solar system close to supernovae has probably been significant.

Current CO$_2$ emissions by human activity are an order of magnitude higher than encountered previously from natural sources.

Estimates of the percentage of atmospheric CO$_2$ contributed by human activity are controversial and widely ranging. Some consider the increase of CO$_2$ since 1958 to have resulted mainly from volcanic eruptions and by global warming causing its liberation from the ocean, gas hydrates and permafrost.

Advocate use of alternative little- or no-carbon energy sources to pay smaller price now than larger price later.

Many factors contribute to global temperature change; some well understood, some poorly understood and others largely ignored or perhaps as yet undreamt of. Paying now for something forecast by inadequate models based on poorly understood and deficit data sets, perhaps where factors beyond human control are actually responsible, will be far more expensive than funding contingency plans to cope with specific natural threats including those from climate change. Threat of global cooling should not be overlooked as it would have far greater adverse consequences than warming.

Jan and Mark referenced their engaging book (2012) spanning four billion years of Earth’s climate that I commend to readers.

**Bibliography**

(see references in original article.)


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**Join the Earth Science Ireland group.**

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The GGA organises fieldtrips usually guided by a fully qualified geology leader, and it runs a series of evening lectures with all talks and meetings taking place within the School of Earth and Ocean Sciences, NUI Galway.

Saturday Lecture Series
Saturdays, 21st March
Geohazards, Earthquakes, Deeds and mud etc.

Sunday, 27th April (provisional date)
Landslides along the Galway Clifden Railway.

25th May - The rocks on your doorstep.

29th June - Geology of the Irish Cheese Landscape

Tuesday Night Lectures
30th April: Dr. Davinia Moreno, Museum National d’Histoire Naturelle de Paris.
21 May: Prof. Paul Mehr, Dept of Earth Sciences, NUIG.

10 June: Prof. Charles Cockell, University of Edinburgh.
Forthcoming Fieldtrip
13 Apr - Field trip to Connemara with Prof. Martin Feely.

For information on the GGA and membership please take a look at our website or contact us at the link below.

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