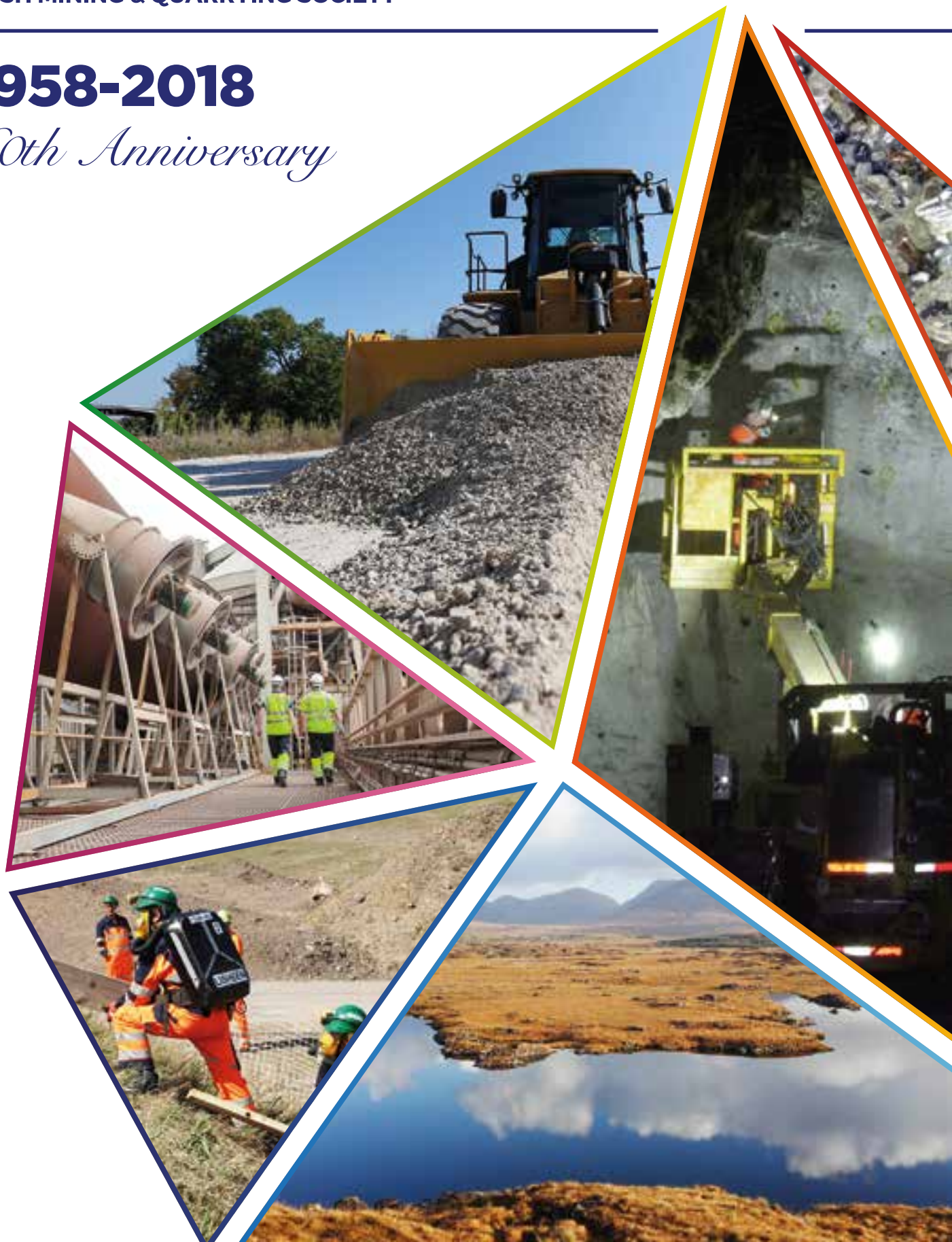
IMQS

IRISH MINING & QUARRYING SOCIETY

ANNUAL REVIEW 2018

1958-2018

60th Anniversary



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Notes from the Editors 2018

This year is a momentous one for the Irish Mining and Quarrying Society (IMQS) as we celebrate the 60th Anniversary of the association. The 2018 Annual Review celebrates this event and features a summary of the history of the Society since 1958. It should also be noted that this is the 20th edition of the Annual Review publication.

Papers from contributors from the four provinces of the island of Ireland provide the reader with updates on developments in the mining and quarrying sector. Reflecting the diversity of the Society since its establishment, this Annual Review includes a range of industry articles and case studies from operators, industry representatives, suppliers and government regulators.

In addition to a special Foreword from the Minister of State for Natural Resources, Mr. Sean Kyne T.D. and a message to industry members from the new IMQS President Mr. John Francis, this Review includes contributions from industry organisations such as ICF, IGI, EFEE, IAEG and QPANI. Details on relevant educational and training courses and upcoming events are presented by Carlow IT, iCRAG, the Institute of Quarrying (IQ), the Irish Mine Rescue Committee (IMRC) and the INQUA 2019 conference committee.

Featured papers for 2018 focus on case studies from Boliden Tara Mines, Gypsum Industries (Saint Gobain), Barleystone (O'Reilly Group), Roadstone, Dalradian Gold Ltd., Irish Salt Mining & Exploration Co. Ltd., LTMS Ltd., McGrath Limestone (Cong), Ecocem and Irish Cement. There is also a focus on Diamond Mining and a review of the quarry industry in the south west of Ireland. In addition, informative updates from Geoscience Ireland, Tellus, PDAC, MinLand and Transport Infrastructure Ireland (TII) are included in this Review.

We are also honoured to include three previously unpublished papers from the archives of Mr. Tony Killian R.I.P. (former Editor of the Annual Review).

A noteworthy feature focusing on a selection of "Industry Leaders" highlights the variety of roles within the sector and the range of specialisms that have developed in the business over the last 60 years.

As always, we thank our advertisers for their continued support for the Irish Mining and Quarrying Society; all our feature writers and regular contributors and our publisher 4 Square Media. Without the commitment and assistance of these parties, this publication would not be possible. Elizabeth Murphy (TOBIN Consulting Engineers/Geoscience Ireland) has joined the Editorial Committee this year and, although she has assisted with the Review in previous years, we are delighted to officially welcome her on board.

the Editorial Team

Siobhán Tinnelly (Chairperson)

Sean Finlay

Keith McGrath

Ronan Griffin

Elizabeth Murphy

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Minister's Foreword

by Minister Sean Kyne T.D., Minister of State for Natural Resources

The Irish Mining and Quarrying Society have a great tradition of producing a professional Annual Review with informative articles and I am delighted to contribute to the 2018 Annual Review.

The activities of the exploration and extraction industries strengthened during 2017 reflecting an upturn in the construction sector and improving metal prices, particularly for zinc. I recognise the importance of the minerals sector to Ireland in terms of commerce, responsible supply of raw materials and employment. The latter is important as it provides well paid jobs which are regionally distributed.

This last year was important from a legislative point of view. On 26th July 2017, the President, Michael D. Higgins, signed the Minerals Development Act 2017 into law. The Act provides a modern regulatory regime for exploration and development of minerals. My Department are working on the secondary legislation over the course of 2018 in order to implement the various elements of new Act.

In addition, my colleague, Minister Pat Breen T.D. enacted the new Safety, Health and Welfare at Work (Mines) Regulations in April 2018 after several years of drafting. These Regulations result in the repeal of the Mines and Quarries Act of 1965 and revoke 20 sets of regulations made under that Act. The regulations allow the mine operator to develop detailed systems, schemes and operating procedures specific to the operation of the mine rather than being generic or prescriptive. The regulations allow the operator to develop a modern management structure for both employees and contract staff for the safe operation of the mine.

Two underground mines operated in Ireland in 2017. **Ireland produced 12.8% of European zinc mine output and 4.0% of European lead mine output**, ranking Ireland 3rd and 6th in Europe, respectively. According to data published by the International Lead and Zinc Study Group, in 2017, Ireland ranked 16th and 22nd in the world for zinc and lead mine production, respectively. In recent years, there has been a fall in Ireland's rankings due to the closure of the Galmoy and Lisheen Mines; however I am confident that new mineral deposits will be found and developed leading to Ireland once again being Europe's premier producer for zinc.

The **Navan Mine**, operated by Boliden Tara Mines, is still the largest zinc mine in Europe. In 2017, Tara milled 2.3Mt of ore grading 5.92% Zn and 1.14% Pb. Since mining operations commenced in 1977, up until 31 December 2017, total production at Navan has amounted to 92.6Mt grading 7.79% Zn and 1.79% Pb. At the end of 2017, the mine's JORC classified ore reserves (proven and probable) stood at 19.5Mt grading 5.8% Zn and 1.4% Pb, whilst mineral resources (measured, indicated and inferred) were 22.1Mt at 7.1% Zn and 1.9% Pb.

Irish Gypsum Ltd., a subsidiary of the French multi-national Saint-Gobain, produced approximately 250kt of gypsum in 2017 from its **underground mine at Drummond, Co. Monaghan**. The gypsum is crushed and blended on site, before being transported by road to a production facility at the nearby town of Kingscourt for manufacturing plaster and plasterboard. A smaller tonnage of gypsum is additionally used in the manufacture of cement. In late 2017, the company received planning permission to re-commence extraction operations from the Knocknacran open pit, adjacent to the Drummond Mine.

While my Department does not have responsibility for the quarry sector, I am aware how important it is for the construction sector. I am pleased to note the improvement in the sector during 2017 and the increased production of aggregates and concrete products. The Irish Concrete Federation informs me that aggregate production was in the region of 35 million tonnes, over 100 million concrete blocks and 4.4million cubic metres of ready mixed concrete. Production and manufacturing is not confined to the Irish market and it is estimated that precast concrete products to the value of €135m were exported to the United Kingdom, in 2017.

Improving metal prices were reflected in the strong growth of the mineral exploration sector in Ireland during 2017. There were 566 active licences and 45 mineral exploration companies operating in Ireland at the end of 2017. The total exploration expenditure in 2017 amounted to €19.5m which may be attributed to the significant increase in drilling, approximately 60,000 metres in total.

My Department continues to publicize Ireland as an attractive country in which to explore for and develop mineral deposits. Once again the main focus of our information dissemination has been the Prospectors and Developers Association of Canada's (PDAC) Convention and Trade Show held in Toronto. **The Exploration and Mining Division** along with the Geological Survey of Ireland, the Geological Survey of Northern Ireland and the Department for Economy in Northern Ireland have been attending this convention since 1999 with a joint stand and since 1989 in its own right. The Convention provides an important opportunity to provide information on Ireland's minerals policy and regulation. In addition, a half day presentation on "Ireland – Open for Business", organised by Geoscience Ireland, was well attended. In 2018, **I attended PDAC in March** and was impressed at the size and energy of the convention. Almost 26,000 delegates attended. I had a busy schedule which included attending and presenting at the

PDAC 2018: (L-R) Dr. Wayne Cox, Minister Seán Kyne T.D., Dr. Eibhlín Doyle, Mr. Gerard Stanley and Ms Laurena Leacy.

International Mines Ministers Summit (IMMS), an event co-hosted by PDAC and the World Economic Forum, the first **EU-Canada Exploration and Mining Day**, a Seminar on opportunities for the minerals sector created by the recent EU-Canada Comprehensive Economic and Trade Agreement **(CETA)** and the Irish afternoon. I took the opportunity of meeting with a number of Ministers who were also attending the event and with stakeholders at the Department's stand.

The Fraser Institute's, annual survey ranked Ireland highly, once again. In 2018 Ireland ranked 4th for the overall Investment Attractiveness Index up from 5th in 2017. In relation to the Policy Perception Index, Ireland was again ranked first for the fifth year in a row.

An Economic review of the Irish Geoscience Sector was published in November 2017. The report was prepared by Indecon International Economic Consultants on behalf of the Geological Survey of Ireland. Using CSO data on all mining and quarrying activities, Indecon estimated a turnover in the sector in 2016 of €939.9m with a GVA amounting to €282.9 and employing 3,633 FTEs. The economy-wide impact which includes direct, indirect and induced impacts,

PDAC 2018

indicated an output of €1.656b with 7,822 FTE's employed in the various sectors where geoscience plays an important role.

My Department continued to support **Geoscience Ireland**, a network of Irish companies collaborating to deliver geoscientific, environmental and engineering expertise and solutions to clients worldwide. The cluster now consists of a network of 36 companies, delivering integrated expertise in water, minerals, environmental and infrastructure development to clients in over 50 countries. The Government of Ireland continues to support job creation initiatives, such as Geoscience Ireland, under the Action Plan for Jobs 2017.

The **TELLUS** Programme, continued its coverage of the country and is fast approaching 50% coverage of the Island. Further progress will be made over the coming years to provide full national coverage. The data from this programme will be beneficial to a range of end users including the mineral exploration, environmental management, agriculture, human health and research sectors across Ireland.

As Minister of State at the Department of Communications, Climate Action and Environment, I wish to confirm my support and commitment to maintain an active mineral exploration and development industry in Ireland. The Government will continue to facilitate the responsible, environmentally sustainable exploration for and extraction of mineral resources.

I wish the IMQS and the extractive industry the very best for 2018.

Message from the President

by John Francis, Customer Account Manager, Finning Ireland Ltd.

Welcome to this year's Annual Review in this the 60th Anniversary of the Irish Mining and Quarrying Society.

As I sit down to write this note for the Annual Review the first thing that comes to mind is "How did I end up here?"

Having started out my post school days as an apprentice mechanic, I was lucky enough to work for a company that always encouraged their employees to continue with their studies and attend courses at night and look to continually furthering their development. Looking back at those days as a young man covered in oil and grease, never did I think I would be one day writing as President of the Irish Mining and Quarrying Society!

When I look back at the names of the past Presidents over the last 60 years I am genuinely humbled.

I would like to express my gratitude to the members of the IMQS council for their continued support since I took up the role of President earlier this year. Brendan Morris set a very high standard as President during his term of office, his positive energy and willingness to get things done was an inspiration to us all on the council and his support and that of Vice President Mike Lowther have been invaluable.

By 2040 the population of Ireland is expected to grow by over 1 million to 5.7 million people. The recently published National Development Plan sets out the significant level of investment, almost €116 billion, which will underpin the National Planning Framework and drive its implementation over the next ten years.

The National Planning Framework highlights the employment challenge in terms of enterprise, innovation and skills of creating in excess of 660,000 additional jobs in the period up until 2040.

The extractive industries provide so much variety and opportunities I strongly believe we must encourage the youth of today to get involved in the sector, and not only that but to support starters at all levels and offer them the chance to develop their careers through continuous training and education.

So much emphasis today is placed on exam results and building an impressive CV from an early age, makes me think we may be missing out on a chance of building from the ground up and I believe the College/University route isn't for everyone.

Working with Carlow IT and Geoscience Ireland the IMQS has been involved in the development of a new Geo-Driller course which has recently been approved by the Apprenticeship Board through SOLAS. The course is set at FETAC Level 6. The course will focus on drilling and related skills in key areas of Mining/Quarrying, Geotechnical, Exploration, Directional and Water.

The course length will be either two or three years and will have an allowance to fast track drillers with significant proven practical experience. It is hoped that it will start in 2019 and more information can be found on our website.

Brexit

As someone who works both sides of the border every week I know personally how much things have changed for the better in Northern Ireland over the last 20 years, but the current political uncertainty surrounding the whole Brexit issue continues to cast a shadow over our industry, in particular the construction sector. Everyday news reports are continually dominated by Brexit and as we move ever closer to the deadlines there are still so many questions unanswered.

The lack of a functional assembly in Northern Ireland is less than ideal at a time when politicians North and South need to work together for the good of all their constituents, but you can be sure your industry and professional bodies will continue to collaborate and come together to represent our members best interests in any way we can when called upon.

This was demonstrated in February when Brendan Morris of the IMQS, Gordon Best of the QPANI and Sean Finlay of Geoscience Ireland jointly met with Sinn Féin T.D. and an MLA in Leinster House to discuss minerals policy.

We will continue to work together to represent our members on this issue and regular updates will be posted on our website.

PDAC

In March of this year Ireland was strongly represented at the Prospectors and Developers Association of Canada's Convention held in Toronto which included an "Ireland – Open for Business" day opened by Jim Kelly, Irelands Ambassador to Canada and attended by Sean Kyne TD, Minister of State for Natural Resources along with representatives from various government agencies from both the Republic and Northern Ireland.

The convention gives an ideal opportunity to showcase Ireland to investors and by all accounts was a tremendous success. A more detailed report is included in the Annual Review.

The results of the Fraser Institute's Survey of Mining Companies 2017 (published in Feb 2018) confirm, once again, the international recognition of Ireland's value as a mining destination. For the fifth year in a row, the Republic of Ireland had the highest Policy Perception Index score and Northern Ireland was also in the top ten. The latest report ranks Ireland as 4th overall amongst 91 jurisdictions surveyed by the Institute for Investment Attractiveness.

Website

The all new revamped IMQS website and LinkedIn page continue to attract much attention from both members and non-members alike. The jobs section on our website is consistently one of the most popular pages on the website and it continually receives hits from all over the globe indicating the willingness of the Irish diaspora to come home and find work in the extractive industry. Job advertisements are free for our corporate members and we are more than happy to facilitate.

We always welcome information or articles that may be of interest which can be used on either forum so please feel free to bring anything of note to the attention of any of the council members for inclusion.

Dinner Dance

Last year saw a change of date and venue for our Annual Dinner Dance and proved popular with an increase in attendance and a great night was had by all with dancing into the early hours. I'd like to take this opportunity to thank our guest speaker on the night Ms Deshnee Naidoo and congratulate her on her recent appointment as CEO of Vedanta's Africa Base Metals. The golf competition in the afternoon was well attended and competition was fierce with Jason Hobbs of the Irish Salt Mining and Exploration Company taking home the trophy, even if he did have to gently pry it from Sean Finlay's hands!

We will return to the K-Club this year and build on last year's success and the dinner dance committee will make tweaks and changes where needed and the golf tournament will be run again so get practicing.

I'm glad to report that early bookings are already in place and I'm looking forward to welcoming you all on the night.

Membership

Our membership continues to grow in

line with the economic recovery over the last number of years, and in particular our corporate membership which was recently introduced is proving very popular with our members. At the time of writing this, our corporate membership numbers 29 and is growing steadily, we very much appreciate the support of all our members for without you there is no society! I would encourage you all to get involved with the various meetings and events hosted by the society or by contributing papers or articles and sharing best practice that may be of interest to your fellow members.

Health and Safety

Health and Safety must be the top priority for us all and whatever our role in the industry, we all have a part to play in ensuring everyone is safe and well in their work environment.

The HSA conducted over 200 inspections in 2017, issuing 14 Prohibition Notices and 14 Improvement Notices. The key issues were safety management, guarding (particularly conveyors), height of quarry and sandpit faces, absence of FOPS/ Automatic Quick Hitches/Visibility Aids on Excavators. There were 20 Quarry Related Reportable Accidents in 2017.

This year sees the IMQS team up again with The Health and Safety Authority in partnership with Health and Safety Executive Northern Ireland and the Irish Concrete Federation to hold the Bi-Annual Extractive Industries Ireland - Health and Safety Conference and Exhibition.

This year's exhibition will be held at Doran's Pit, Blessington, Co Wicklow on the 26th of September with an excellent line up of speakers from across the industry to share how they are using technology to improve productivity and safety.

Field trips

This year we will hold two Field trips, the first to Aughey Screens in Monaghan and the second to Kilkenny Limestone. I'd like to take this opportunity to thank our hosts for taking time out of their production schedules to show our members around their facilities. The field trips are an important part of our year as they give our members a chance to get to know each other in a relaxed environment and at the same time they are always both interesting and educational.

Planning Seminar

Our Planning and Environmental Law Forum took place in May of this year and the topic of "Where planning meets the public" had an excellent line-up of guest speakers, the topic certainly got the attention of our members and was very well attended. The idea for the day grew out of conversations we had been having with our members and the issues some were having with their own planning, so if there are any topics that you would like to see us address in a similar format in the future please bring them to our attention.

This year saw the end of an era at the IMQS as **Carol Sanderson** decided to step down from her position as Executive Secretary, as Presidents and Council members come and go over the years Carol has been the face of the IMQS for many of our members for almost 10 years. Carol was always available at the end of the phone or email and nothing was ever too much of a problem for her. On behalf of current and past Council members I'd like to wish Carol the very best for the future.

I am pleased to welcome **Andrew Gaynor** as our new Executive Secretary (he took up his position in late June 2018).

In summary, the IMQS is in place to foster the discovery, development, processing and marketing of the mineral and other geological natural resources of Ireland.

We can't do this alone! We need the continued support of everyone involved in the sector and working together we can ensure a prosperous industry for the generations to come.

Activities of the Society
May 2017 to May 2018

by Alan Dolan, IMQS Honorary Secretary

Current Membership:

271 Ordinary
2 Fellows
13 Honorary Fellows
7 Honorary Members
29 Corporate

In 2017 we expanded our Corporate Membership. The changes make it easier for companies to renew memberships for their employees. As well as the convenience of a single electronic payment, being a Corporate Member can also eliminate the obligation on employees to pay BIK. Visit the IMQS website for a full explanation of the advantages of having corporate membership with the IMQS.

Dates of Council Meetings

2017 – September 12th, October 17th.

2018 – January 9th, February 20th (AGM), March 15th, April 11th, May 8th.

Future meetings – 2018; September 11th & October 9th. 2019; January 9th, February (AGM).

Council Members:

At the AGM **John Francis** was elected IMQS President for 2018. John is Customer Account Manager, Finning Ireland Ltd. **Mike Lowther** was elected Vice President. **Leslie Sanderson**, Director of Services for ECS Turbowash Ltd., is Honorary Treasurer and **Alan Dolan**, Ground Control Engineer at Boliden Tara Mines, is Honorary Secretary.

Jennifer Craig joined the council in 2018. Jennifer is the Centre manager of iCRAG (Irish Centre for Research in Applied Geosciences). The other council members are; **Brendan Morris**, (Managing Director at Lisheen Technical & Mining Services Limited). **Sean Finlay** (Director of Business Development at Geoscience Ireland), **Ciaran Greenan** (Location Manager at Roadstone Ltd.), **Ronan Griffin** (Property Manager at CRH Estates), **Keith McGrath** (Director with McGrath's Limestone Works Ltd.), **Sarah O'Connell** (Environmental, Health & Safety Officer at O'Connell Quarries) **Nicola Molloy** (Planning Engineer, Boliden Tara Mines) and **Siobhán Tinnelly** (Associate Director at Tobin Consulting Engineers).

Carol Sanderson has been the IMQS Executive Secretary for over 9 years. Carol will be stepping down from this role in 2018. I would like to thank Carol for the exceptional dedication and commitment she has given the society over the years.

IMQS Website, Communications & Social Media www.imqs.ie

The IMQS built a new website which was launched on November 2017.

As in 2017, the Jobs section was our most visited page. **Posting vacancies is free of charge** so please forward any vacancies you may have. Your advertisement will be viewed by members and followers who have a specific interest in the extractive industries.

The IMQS has 332 followers on LinkedIn. Group: 'Irish Mining & Quarrying Society'.

If you are not already a group member, why not join and catch up with colleagues or maybe connect with somebody in your area of business. All members of the Irish Mining & Quarrying Society are encouraged to contribute to this active group and join in the discussions.

Annual Review 2017

The editorial team for 2017 was, Siobhán Tinnelly (Chairperson), Sean Finlay, Keith McGrath, and Ronan Griffin. Sadly, Tony Killian passed away in 2017. Tony was a member of the editorial team for many years and was a prolific article writer. The 2017 publication was dedicated to him. Annual Reviews are available to download from the IMQS web site. The 2017 review was published by 4 Square Media.

Conferences / Seminars / Industry Events

(More details at www.imqs.ie)

IoQ-NI Stone Crushers Ball

The annual Institute of Quarrying (Northern Ireland) Stone Crushers Ball took place in the Europa Hotel, Belfast on November 3rd, 2017. The event was attended by John Francis & Brendan Morris.

IMQS Annual General Meeting

The IMQS Annual General Meeting was held on February 21st 2018 at the Spa Hotel, Lucan. After the AGM, members of Dalradian Resources gave a presentation outlining the discovery, development, planning and future of the Curraghinalt Gold Project.

For more information visit the Dalradian Resources web site at www.dalradian.com/curraghinalt-project.

Annual Field Trip - Irish Salt Mining and Exploration Ltd.

The annual field trip to the Irish Salt Mining and Exploration Company in Carrickfergus, Co Antrim took place on September 21st 2017.

Prospectors and Developers Association of Canada (PDAC)

The annual Prospectors and Developers Association of Canada (PDAC) Convention was held in Toronto on March 5th-8th 2018. Over 24,000 people attended. The IMQS was represented by Brendan Morris.

Planning and Environmental Law Forum

On May 22nd 2018, the IMQS held a Forum on Planning and Environmental Law titled "Where planning meets the public".

Representations

IMQS Council members represented the IMQS at the following events/committees;

- Quarry Safety Partnership and Quarry Skills Certification Scheme meetings
- The European Economic and Social Committee.
- Strategic Implementation Plan of the European Innovation Partnership on Raw Materials
- Extractive Industries All-Island Seminar
- Irish GeoScience Network
- European Federation of Explosives Engineers (EFEE)
- Prospectors and Developers Conference (PDAC)
- Quarry of the year 2018

In addition to the above, the IMQS continually make representations when requested by various mining and quarrying related bodies.

Paying your subscription could not be easier. Just log onto www.imqs.ie and click 'Becoming a member'.

Annual Dinner Dance 2017

The 2017 annual dinner dance took place on November 11th 2017 at the K-Club, Co. Kildare. The event was attended by 260 people.

Deshnee Naidoo, CEO of Vedanta Zinc International was the key note speaker. The much coveted IMQS annual golf trophy was won by Jason Hopps of Irish Salt.

Mine Rescue

IMQS vice president Mike Lowther is Chairman of the Irish Mine Rescue Committee (IMRC). A full summary of the activities of Mine Rescue can be found later in this review.

Future Events

Annual Field Trip 2018

The annual field trip took place on Monday June 18th to Aughey Screens, Killyconigan, Monaghan. There will also be a field trip to Kilkenny Limestone on September 6th. Visit the IMQS web site for more details.

Geo Driller Technician Course.

IMQS is supporting Geoscience Ireland and IT Carlow in the development of the course, which now has approval for an apprenticeship programme from Solas. Sean Finlay is leading the development for Geoscience Ireland and Brendan Morris represents the IMQS. The course is due to begin in 2019 and will award a level 6 qualification. For more information and if you are interested in achieving this qualification, see www.imqs.ie.

If you know of other courses you think may benefit our members, please let us know or share via social media.

Health and Safety Conference & Exhibition 2018

The 2018 Health and Safety Conference & Exhibition will be held on September 26th at Doran's Quarry in Blessington, Co Wiclow. Ciaran Greenan and John Francis are involved in organising the conference and Brendan Morris will present a paper titled "The effectiveness of Human Factor Safety Initiatives at Lisheen Mine".

See imqs.ie or hsa.ie.

Annual Dinner Dance 2018

This year's annual dinner dance will be held in the K-Club, Straffan, Co. Kildare on November 10th 2018. There will be a golf tournament on the day. Tickets are limited so please book early. Visit imqs.ie for more details.

Conclusion

I would like to express my sincere appreciation to our President John Francis and outgoing President Brendan Morris for their dedication and leadership.

I would also to thank our Treasurer Les Sanderson for maintaining the accounts over the past year and to the other current officers and members of the IMQS Council who often serve on several sub-committees to voice and protect the interests of our members. I would like to acknowledge the work done by Carol Sanderson during her tenure as executive secretary.

Finally, I would like to thank you, our members, for your patronage. The Society cannot exist without your continued support.

Paying your subscription could not be easier. Just log onto www.imqs.ie and click 'Becoming a member'.

IMQS; 60 Years Review

IRISH MINING & QUARRYING SOCIETY
1958-2018
60th Anniversary

by Sean Finlay, PGeo CEng

While the formative meetings launching the IMQS were held in the Autumn of 1958, the first formal General Meeting took place in February 1959.

Twelve Council members were present; Professor M.A. Hogan (UCD Engineering School) along with Messrs O'Brien, Layden, Blair, Rose, Forristal, McCormack, Wood, Fleming, Dolan, Tolan and O'Connor. There were two corporate members, Roadstone and Rossmore Collieries.

The affiliations of those founding members are interesting. The Geological Survey of Ireland was represented by Murrough Vere O'Brien. The mining companies represented were mainly coal mines e.g. Arigna, Rossmore, Castlecomer, Flemings, Ballingarry.

Gypsum Industries was represented by Ciaran Blair. The quarrying industry was comprised mainly of regional operators. Roadstone and John A Wood went on to merge and with Irish Cement Ltd, later became Ireland's largest indigenous company, CRH plc.

In 1958, the emergence of modern base metal mining in Ireland was at an embryonic stage. MV O Brien's seminal paper on the future of base metal mining in Ireland was published by the Institution of Mining & Metallurgy in late 1959.

Based on geological reasoning and a study of Irish mining in the 19th century, he foresaw vibrant possibilities for the sector. The discovery of the Tynagh copper-lead-zinc-silver mine by the Irish-Canadian Northgate Group in Tynagh, Co Galway in 1961 was the beginning of a new era in Irish mining, resulting in the discovery and development of seven base metal mines in subsequent years.

Other notable milestones in the early years of IMQS were:

- First Field Trip; June 1959; Avoca Copper Mines
- First AGM; October 1959; 77 members, 8 corporate members
- First Annual Dinner; December 1959; 69 attended; tickets 1 guinea (= £1/1/0 = €1.32!; Minster for Industry & Commerce Jack Lynch in attendance
- First Golf Competition for the ICI Trophy; 1966 at Rosses Point (following a field trip to Abbeytown zinc mine and Ben Bulben barytes mine); competition revived in 1985
- First Annual Dinner Dance 1966; 192 attended; price £1/17/6
- First Chain of Office; 1966 presented by Ballingarry Coal Mines
- First Safety Award; 1967 presented by Armstrong Taylor
- Gavel and Stand designed by Edward Delaney, made from Tynagh silver, presented to President David Fitzgerald by Pat Hughes of Northgate in August 1968
- First Overseas Visit; 1971 to Yorkshire
- First Student Scholarship; 1971; to, Athlone Regional Technical College; sponsored by IIE; later by Tara Mines

President's Chain.

- First Woman Guest Speaker at Annual Dinner; 1990, Minister Mary Harney TD
- First Woman President; a long wait - Siobhan Tinnelly in 2014!

Evolution

As new base metal mines were discovered and developed at Gortdrum, Silvermines, Avoca and Navan (Tara) in the 1960's and early 1970's, coal mines closed due to difficult mining conditions and depleting reserves. Equipment suppliers and manufacturers joined the IMQS in increasing numbers. The quarrying sector began consolidating and expanding in the 1970's with the emergence of CRH plc and of regional players such as Kilsaran and Readymix.

The 1960's saw a number of visits to Ireland by prestigious professional bodies to celebrate the emerging mining sector, including the Institution of Mining & Metallurgy, the Canadian Institution of Mining and Metallurgy in 1966 and the Commonwealth Mining Congress in 1969. The five day visit by IMM/CIMM in 1966 was addressed by the then Taoiseach Sean Lemass.

Following the closure of Gortdrum, Avoca and Silvermines by the early 1980's, Tara Mines was the sole base metal mine in operation for many years until the development of the zinc lead mines at Galmoy and Lisheen in the late 1990's. Tara is again the only base metal mine in production but the company has, in its 40 years of production, always been a strong supporter of IMQS with many officers and Presidents drawn from Tara.

The IMQS was, and remains, a forceful advocate for the sector, supporting the liberal tax and royalty regime established by Fianna Fail in 1967 Finance Act and being critical of the changes to fiscal terms during the Fine Gael-Labour government of 1973-77.

The Society has made representations to government on numerous policy issues including support for the creation of the EPA in 1990; recommending in 1991 that Local Authorities procure road building materials only from authorised sites; submissions to the National Minerals Policy Review in 1994; commentary on the Planning Act in 2000 which introduced registration for quarries; proposals for inclusion in the Mining Act 2017 and interaction with various political parties.

With the rapid growth of the Irish economy in the 1990's, quarry and related output increased significantly, from c 50 M tonnes in 1997 to over 110 M tonnes in 2006. Demand collapsed after 2009 to under 20 M tonnes but has since recovered to c 35 M tonnes in 2017. The need to regulate quarries not covered by planning laws (ie pre 1964) has led to a series of planning acts since 2000 and several subsequent amendments arising from EU directives and case law emerging from judicial reviews. Persistent changes in regulation undermine certainty in the sector at a time when the economy is recovering and aggregates are needed for the delivery of critical infrastructure.

The growth of the quarrying and construction sectors led to a marked increase in sales of machinery and

equipment, with major distributors such as PJ O Donnell, Pat O Connor, McHales and Finnings expanding their businesses.

Annual Dinner Dance

As noted above, an Annual Dinner took place every year since 1959 followed by a Dinner Dance from 1966. Attendance at the Dinner Dance varied from 192 initially to a peak of 900 (!) in 1978 and is now more typically 200 -250.

Government Ministers have frequently attended IMQS Annual Dinners, among them in the early years were Erskine Childers, George Colley, Charles Haughey, and more recently Mary Harney, Tom Kitt, Fergus O'Dowd, Joe McHugh and Sean Kyne.

Education & Training; Safety and Environment

The IMQS supported the delivery of minerals science education at Athlone regional technical college via scholarships and placements since the early 1970's. Unfortunately, with the economic downturn, this course is no longer offered.

However, many Athlone graduates went on to qualify in Mining Engineering at Camborne School of Mines and to develop outstanding careers internationally and locally.

The Society has also supported safety training via its sponsorship of a Prize for the Irish Mine Rescue Association (led by IMQS Vice President Mike Lowther for many years), co-sponsoring a bi-annual Quarry Safety Conference and is represented on the Quarry Safety Partnership. The IMQS is currently supporting the launch of an Apprenticeship for Drillers at IT Carlow which should commence in 2019.

The annual field trips, lectures and seminars presented by IMQS of course provide excellent opportunities for continued professional development for all those involved in the sector. Notable events have included trips to the UK (Yorkshire, Glensanda, Cornwall and the Hillhead Equipment Show); Aughinish Alumina, Corrib Gas and Irish Cement.

Major seminars include Environment and the Law in 1991 (sponsored by Arthur Cox); Environment and Planning issues in 1993 (jointly with the Royal Institute of Chartered Surveyors); Safety & Health in 1998; Quarry Regulations (jointly with the Health & Safety Authority) in 2006 and a Planning Forum in May 2018. The IMQS has long had a policy of urging local and national authorities to purchase aggregates from properly authorised quarries only. In 1991, IMQS successfully sought Department of the Environment support in ensuring this policy was adhered to by a local authority.

During the 1990's, in an initiative to raise awareness of the quarrying sector, IMQS sponsored a schools essay competition and also supports the Irish Concrete Federation (ICF) Sustainable Quarry Completion.

Annual Review

Since 1995, the IMQS has published – under various titles - an Annual Review. The late Tony Killian was the driving force, assisted by Darryl Magee of 4Square Media, Les Sanderson and Don Litster. Tony contributed numerous articles each year and his archive still provides papers for this year's Review.

Collaboration

The IMQS has maintained a close relationship with similar bodies in Ireland, Northern Ireland and the UK (via the Institute of Quarrying NI and the Quarry Products Association NI). IMQS, along with the Irish Association for Economic Geology and the Geotechnical Society, was a founding sponsor of the Institute of Geologists of Ireland in 1999.

Meetings of the Society took place for many years in the premises of the Institution of Engineers of Ireland. IMQS retains close links with the ICF, the trade association for the aggregates and quarrying sector.

Service and Inclusivity

One notable feature of the IMQS has been the length of voluntary service provided by so many individuals. Council members with over 25 years' service included Dr Piers Gardiner of GSI and Les Sanderson (ex Metso).

Sadly departed members Vincent McCabe, Tony Killian, PJ O'Neill, Ciaran Blair and George O'Connor all fall into that category of selfless and enduring service.

IMQS has the distinction of representing every facet of the extractive industries- explorers, miners, quarry developers and operators, researchers, service and equipment providers- in an inclusive and convivial way.

The Council is structured to provide representation from each sub-sector of the industry and Presidents tend to rotate between these sectors. Belatedly, women are better represented with four now serving on Council.

IMQS Presidents 1958-2018

1958-1960	Professor M.A. Hogan
1960-1962	Vincent Layden
1962-1964	Murrough V O'Brien
1964-1966	Ciaran Blair
1966-1969	David Fitzgerald
1969-1971	Michael Layden
1971-1973	R Anderson
1973-1975	James Walsh
1975-1977	George Flummerfeld
1977-1979	Robert Aspin
1979-1981	P J O'Neill
1981-1983	George O'Connor
1983-1984	Michael Layden
1984-1985	Robin Oram
1985-1986	John Goor
1986-1987	Thomas Weir
1987-1988	John Barnett
1988-1989	Professor Vincent McCabe
1989-1990	Noel O'Dwyer
1990-1991	Kevin Honan
1992-1993	Denis Lovell
1993-1994	Tony Flannery
1994-1995	Declan McCartney
1995-1996	Martin McCafferty
1996-1998	Les Sanderson
1998-1999	Macarten McGroder
1999-2001	John G Kelly
2001-2003	Thomas Cleary
2003-2005	Eamonn Holton
2005-2006	Gerry Clear
2006-2008	Fergus Gallagher
2008-2009	Les Sanderson
2009-2011	Sean Finlay
2011-2013	P J O'Donnell
2013-2014	Sean Finlay
2014-2016	Siobhan Tinnelly
2016-2018	Brendan Morris
2018-2020	John Francis

Acknowledgements

This paper was prepared by Sean Finlay based on research of Society archives by Les Sanderson and Macarten MacGroder.

IMQS Gavel and Stand.

Industry Highlights of 2018

Note: See www.imqs.ie and LinkedIn (Irish Mining and Quarrying Society (IMQS)) for all the latest industry news.

Dalradian Resources Inc

Dalradian Resources Inc has received a cash offer from Orion Mine Finance to acquire the company.

Dalradian, which recently submitted its planning application to develop the Curraghinalt gold deposit, made the announcement on June 21st 2018.

Under the terms of the Arrangement Agreement, Dalradian shareholders will receive C$1.47 per share held, valuing Dalradian's total equity at approximately C$537 million.

Lagan Group Sale

A recent rich list put the combined wealth of the Belfast-born Lagan brothers, Kevin and Michael, at approximately €1.3 billion. But the sale of Kevin's Lagan Group in April 2018 for €526 million is likely to propel them further up the wealth table.

Kevin (68) joined the Lagan family business in the early 1960s. Founded by haulier Peter Lagan in 1960 with the acquisition of the White Mountain Quarry outside Belfast, Kevin took over from his father in 1969, working with his brother Michael on building up the business.

They moved into asphalt and concrete production and started exporting to the Britain in 1984, later opening cement plants in the Republic and engaging in house building in Ireland and the United Kingdom.

In February 2018, the Lagan Construction Group, controlled by Michael and run by his son Kevin and unrelated to Lagan Group Holdings, appointed administrators to four of its companies. Sale of the Lagan Group may mark a significant departure for Kevin and his family, but not a complete exit; Kevin and his family are to keep Lagan Homes, one of the largest housebuilders in Northern Ireland, with turnover of some £76 million in 2017.

It will also retain LF FastHouse, which is majority owned by Kevin. A manufacturer of modular closed panel and timber frame systems for the construction industry, it employs about 100 people and is supplying about 470 luxury holiday lodges to Ireland's first-ever CenterParcs resort in Co Longford.

Connemara Mining

In June 2018, Connemara Mining PLC (LON:CON) announced that the first new hole at the Stonepark Zinc Project intersected 32.2% combined zinc and lead over 5.4m.

The AIM-listed firm said G-11-2638-01 intersected 5.40m of 25.0% zinc and 7.2% lead (32.2% Zn+Pb combined) and 12.2g/t silver, with true width estimated at 4.9m, verifying one of the high-grade zones within the Stonepark resource.

The Irish gold and zinc exploration company said this hole was drilled into a key area of known high-grade mineralisation on the presumed eastern edge of the recently announced maiden Inferred Mineral Resource Estimate.

Connemara Mining added that robust mineralisation interpreted to be open eastwards toward Glencore's neighbouring Pallas Green deposit.

Patrick Cullen, chief executive officer, said the results underline the high grade nature of the deposit.

The Stonepark Zinc Project is a joint venture between Connemara and the project operators Group Eleven Resources.

Galantas Gold

Galantas Gold (TSX, LON:GAL) announced in late June 2018 that it has reached the main gold vein in development works underground at its Omagh gold mine in Northern Ireland.

The main tunnel that Galantas has dug descends at a slope with a gradient of 1-in-7 from near the base of the former open pit, the company said. The vein intersection, it added, is located about 15 metres below the base of the Kearney open-pit and reaching it means the company can now begin limited production, with increased feed to the mill anticipated by the end of 2018.

The miner also said it planned to develop a horizontal tunnel, which is expected to provide a "limited feed to the mill", early in the third quarter. Galantas will also extend the existing decline tunnel in late 2018 or early 2019. Galantas is Northern Ireland's only producing gold mine. The firm, which kicked off the mine's expansion last year after the open-pit site was exhausted, has said it expects to produce about 8,000 ounces next year.

Northern Ireland holds the world's seventh richest undeveloped seam of gold, but political violence kept most investors away for about three decades.

Water Safety in Quarries

by Siobhán Tinnelly, Associate Director, TOBIN Consulting Engineers

Following three tragic deaths in disused quarry lakes within a 7 Day Period in late May 2018, IMQS, the Minerals Products Association (MPA) and the Quarry Products Association of Northern Ireland (QPANI) urge members to help raise public awareness of the dangers of open water and the importance of water safety during periods of good weather.

The recent tragic deaths of two teenage boys in Ennis, Co. Clare and a 28 year old father in an MPA member's site in Scotland only reinforces the importance of maintaining vigilance at all sites and supporting campaigns that help to educate the public about 'Cold Water Shock' and the hazards associated with open water such as quarry lakes and reservoirs.

Current campaigns being run by the RNLI and the RLSS (Royal Life Saving Society) have excellent resources and provide key safety messages that apply to both inland water and coastal waters. https://lnkd.in/dm_PQU7 https://lnkd.in/dzRvyKx MPA has a very informative campaign facebook page: "Stay Safe Stay Out of Quarries".

The following link from QPANI (Gordon Best) focuses on the dangers of quarry water and the cold water shock associated with entering quarry waters.

https://www.nidirect.gov.uk/articles/staying-safe-around-quarries

Please share these with your colleagues and ask them to share them with their family and friends. Hopefully, a better informed community will help prevent others from putting their lives at risk.

Your body's reaction to jumping into very cold water

If you jump into very cold water, there is a three stage response your body will follow:

length of time	body's response
0 – 4 minutes – cold shock	A sudden plunge into cold water initiates a gasp response which can cause you to drown within seconds of entering the water. It also affects breathing, heart rate and body's metabolism.
4 – 30 minutes - loss of performance	Poor circulation causes stiff fingers, reduced coordination and loss of motor skills and power. This makes it nearly impossible to grasp a rescue line or hoist. Swimming to safety or climbing out of the water is no longer physically possible. At this stage the cause of death is by drowning.
more than 30 minutes – hypothermia	Most cold water deaths result from cold shock or loss of performance. Few people survive to get hypothermia. True hypothermia only sets in after 30 minutes. However, in a quarry with steep sides, no vegetation or rafts, it is possible that you could stay in the water for 30 minutes.

Mine Rescue in Ireland
Fifty Years and Going Strong

Irish Mine Rescue Committee

by Mike Lowther (Chairman IMRC), Aoife Tallon (Secretary IMRC) and Richie Cahill (Mine Rescue Officer, Boliden Tara Mines)

What is Mine Rescue?

Mine Rescue is the practical procedure in mining, in which personnel wear breathing apparatus and use special equipment to save lives, and to recover property in case of an underground emergency (Ontario Mine Rescue Handbook, 2012).

The Basic Principles of Mine Rescue:

- Safety of the team
- Save lives
- Fight Fires
- Test for Gases
- Return the mine to safe use

Timeline of Mine Rescue in Ireland

McCaa Breathing Apparatus
- 2 hour duration

Draeger BG 174
- 4 hour duration
- Lighter than McCaa

Draeger BG 4
- 4 hour duration
- Ergonomically designed
- Air Cooling
- Positive Pressure

Early history

The first records of formal mine rescue activity in Ireland come from the Tynagh Mine in the 1960s. There was a strong Canadian influence at Tynagh and techniques introduced at that time from the Ontario Mine Rescue Handbook in Mine Rescue Training and Recovery Operations have since become embedded in the Irish standards.


THE TYNAGH MINER

Tara Mines team competing in South Crofty in 1980's.

Avoca Team in 1976.

Competition

One of the cornerstones of Irish Mine Rescue has been the **All Ireland and UK Mine Rescue Competition**.

The competition has its roots in the Irish base metal mines of the 1960s and 1970s. Famous mines such as Avoca, Tynagh and Silvermines competed for the annual trophy. As the Irish mining industry contracted and the old mines closed, Tara kept the flag flying by holding Celtic competitions with South Crofty and Wheal Jane in Cornwall. Neves Corvo from Portugal competed in 1996.

With a new phase of mining in Ireland in the 1990s, Galmoy and Lisheen entered the fray. The format of the competition was expanded at Lisheen in 2001, and Winsford Mine competed for the first time. In 2002 British Gypsum entered a team, and in 2004 the modern competition was hosted in the UK for the first time, by Winsford Mine in Cheshire. Kilroot Mine from Carrickfergus also initially competed that year.

Kilroot hosted the competition for the first time in 2006. Galmoy were the hosts in 2007, and TARA in 2008. Having initially competed in 2007, Boulby Mine hosted the event in 2009, where Maltby Colliery competed for the first time.

Lisheen held the competition in 2010, Winsford hosted in 2011, Kilroot in 2012, Tara in 2013 and Boulby in 2014.

Lisheen during the fitness test at Boulby 2014.

Also, in 2013 and 2014, an Iberian Mine Rescue Competition was held in Aljustrel, Portugal, and several Irish teams took part in those events.

With this increasing interaction between Ireland, UK, Portugal and Spain, Lundin Mining's Neves Corvo Mine hosted the 2015 All Ireland and UK Competition. The competition was re-named the **European Mine Rescue Competition** for that particular event, and was a great success (See the IMQS Annual Review 2015).

A further competition was held by Boliden Tara Mines in October 2015, as several of the Ireland/UK group of mines had been unable to send teams to Portugal.

This saw Dalradian Gold competing for the first time, and the arrival of this new mine rescue team has instigated a new phase of co-operation between mine rescue organisations and state agencies in Northern Ireland and the Republic. Dalradian Gold's efforts were commendable, including Orla McKenna becoming the first woman to compete in Mine Rescue in Ireland.

It was fitting that Vedanta Lisheen's team won three awards, including the Best Overall Team, in the last months of their Mine's operation. Guided by their Mine Rescue Officer Ian Johnstone, Lisheen Mine Rescue were integral in the Irish and UK mine rescue effort for 15 years, taking part in many real emergencies, practices and competitions.

There has been a lull in the holding of the

Winsford Captain Paul Booth receiving instructions from Michael Durnin at Tara Mines in 2015.

ISME returning to FAB with casualty at Kilroot in 2012.

Galmoy masking up ahead of Search and Rescue at Kilroot 2006, with Paddy McManus and Tony Forster (HM Inspector of Mines) judging.

Dalradian's first competition at Tara Mines in 2015.

Lisheen treating a casulty at the 2015 European Competition in Neves Corvo.

Competition since 2015, but the next one will be held at ISME's Kilroot Mine in the summer of 2019.

The MA Healy trophy awarded to the best Irish team remains the most coveted prize.

Formation of the Irish Mine Rescue Committee

The Irish Mine Rescue Committee (IMRC) was established as a co-operative body to co-ordinate mine rescue resources in Ireland enabling mutual assistance in the event of emergency at one of the participating mines.

The members of the IMRC are Boliden Tara Mines, Irish Salt Mining and Exploration, Dalradian Gold, and Gyproc Ireland.

The IMRC also acts as a liaison and consultative group to the Health & Safety Authority (HSA) on matters relating to mine rescue in Ireland.

The Irish Mine Rescue Standard was published in 2014 with endorsement from the HSA.

The purpose of the Irish Mine Rescue Standard is to:

- Provide guidance for the establishment, training, maintenance and organisation of Mine Rescue teams in Ireland.
- Ensure minimum standards to facilitate inter mine co-operation and assistance.
- Assist mine operators meet their statutory obligations.

The IMRC co-ordinates a **mutual assistance program** to allow mine rescue teams to become familiar with the methods of operation and layout of the participating mines, and for the teams to practice working together in simulated emergency conditions.

The IMRC runs the **All Ireland & UK Mine Rescue Competition**. The competition allows teams to come together and test their skills against each other in a series of pre-set tests.

The IMRC promotes **continuous improvement** in mine rescue by developing standards and **establishing links** with mine rescue organisations in other countries.

Mutual Assistance and Training

Since 2003 the IMRC have provided affiliated Irish mines with access to a mutual assistance programme between their respective rescue teams.

In the event of an emergency at an Irish mine where additional mine rescue personnel are required, the Mine Rescue Officer can make contact with another mine to request back up.

Arrangements for mutual assistance can

Boliden Tara Mines team preparing to take casualties to safety.

Mutual Training Session hosted at Galmoy Mine in 2004.

Mutual training session hosted at Boliden Tara Mines in 2013.

be written into each mine's emergency procedure on approval from the IMRC.

To allow other teams to become familiar with the layouts and equipment used at each mine, and for the different teams to integrate and practice working together in simulated emergency conditions, each mine hosts a joint training session once a year.

Air Corps Support

The IMRC recognised that the rapid transfer by air of rescue teams between the Irish mines would be a great advantage in time of need.

Arrangements were agreed in 2008 between the IMRC and the Irish Department of Defence. No.3 Operations Wing of the Irish Air Corps can be tasked with assisting the IMRC under the aegis of Aid To The Civil Power. Formal procedures must be followed and tasking is through Air Corps HQ from the Gardai.

Emergency Situations where assistance would be required include:

- Life at risk at any one of the Irish mines
- A prolonged emergency at one of the mines where backup is required

Mutual Training session hosted at Gyproc's Drummond Mine in December 2017.

- Disruption of the road network

Support from the Irish Air Corps has greatly enhanced the way we plan for emergency incidents, and strengthened the decision making of mine managers and incident controllers in emergencies, thereby protecting our people and our operations.

Boliden Tara Mines – International Mine Rescue Competition 2016

In August 2016 Boliden Tara Mine Rescue were invited to represent Ireland in the International Mine Rescue Body's 10th International Mine Rescue Competition in

Training Exercise at Boliden Tara Mines in 2012.

Tara Mines team arriving at Galmoy mine, 2009.

BTM Mine Rescue IMRC 2016 (l-r): Richie Cahill, James Connolly, David Harrington, Gary McDonnell, Ruairi Russell, Paul Smith, Kieran Brassil, Aoife Tallon, Ray Bowens

Sudbury, Canada hosted by Workplace Safety North and Ontario Mine Rescue.

Twenty seven teams representing thirteen nations competed in events including an underground search and rescue scenario, firefighting, first aid, rope rescue and a theory exam. Boliden Tara Mine Rescue finished second overall – winning the First Aid event and coming third in the Search and Rescue Scenario.

The team was captained by Davy Harrington, and supported by Richie Cahill (Mine Rescue Officer at Boliden Tara Mines, and Briefing Officer during the competition), and Aoife Tallon (Mine Rescue Administrator at Boliden Tara Mines and Secretary of the Irish Mine Rescue Committee). BTM's Mine Rescue Manager Roy Tallon was also invited to judge at the event.

It was a great honour for Boliden Tara Mine Rescue to represent Ireland and the result achieved shows the standard of Mine Rescue on the island today.

Boliden Tara Mines in Canada 2018

This year Boliden Tara Mine Rescue were invited to participate in the 69th Ontario Mine Rescue Provincial Competition hosted by Almos Gold Young Davidson Mine in Matachewan, Ontario.

Boliden Tara Mines team – Ontario 2018.

The exercise saw eight teams respond to a series of incidents underground including locating six missing personnel and bringing them to safety, building a bulkhead and using high expansion foam to extinguish a mine fire and using rope rescue rigging to assist an injured and unconscious miner approximately 80 feet down a mine shaft.

As the competition was a Provincial, Boliden Tara Mines were not eligible for any awards however, they were highly commended for their performance particularly in the Search and Rescue and First Aid elements of the competition.

As mentioned earlier, Canadian influences have always been strong in the Irish mining industry.

The emergency response program at Boliden Tara Mines has always been based on Ontario Mine Rescue principles. Roy

Preparing to lift casulty up mine shaft.

Checking gas levels.

Tallon, Mine Rescue Manager and Richie Cahill, Mine Rescue Officer are both trained by Ontario Mine Rescue.

Trainers and Judges

All of the above could not happen without the people who devote many hours to training, coaching and administering our mine rescue teams. Their efforts are incredible and most appreciated.

The system is also strongly supported by both the Irish Mines Inspectorate (HSA) and the UK Mines Inspectorate (HSE). Often very senior inspectors give up their valuable time to adjudicate and supervise our competitions.

This is very much appreciated. Chief among these men is Ireland's Senior Inspector Pat Griffin, who has been judging at Mine Rescue Competitions longer than any of us can remember! Well done Pat, and thanks.

Summary and next steps

From the first teams at Tynagh Mine way back in the 1960s, a strong and vibrant Mine Rescue system has been developed in Ireland.

Despite there being less mines active in Ireland than there once was, Mine Rescue continues to be very active across the country and is well supported by mine management and the Health and Safety Authority.

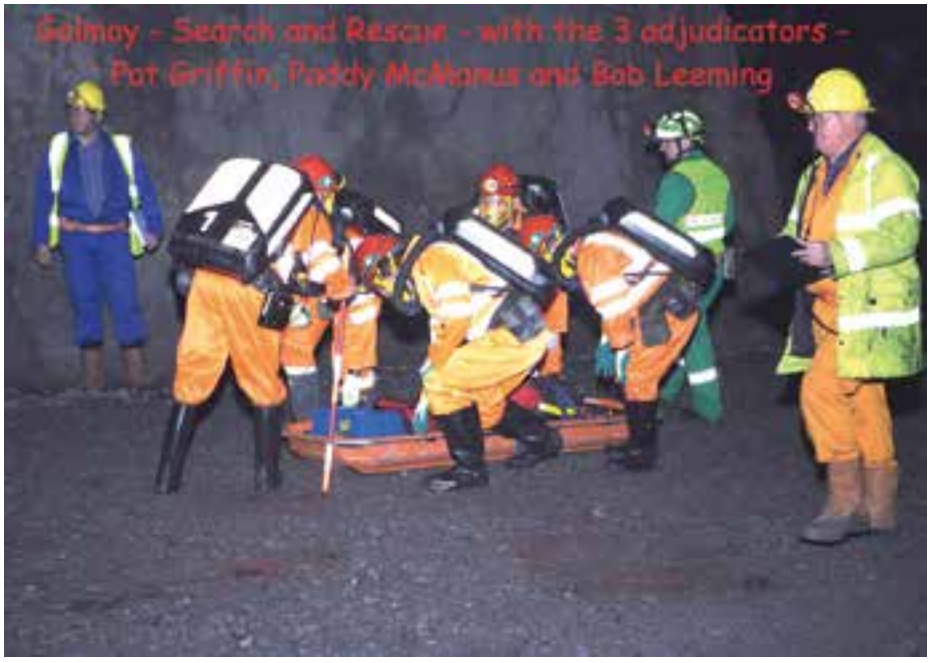
As we continue to strive towards an injury free and healthy workplace there has been a reduction in emergencies underground that require mine rescue response. As a result mine rescue personnel rely on training and simulated scenarios at competitions to ensure emergency preparedness.

The Irish Mine Rescue Committee continues to coordinate mine rescue resources in Ireland enabling mutual assistance in the event of an emergency.

Work continues on developing links with other Mine Rescue organisations outside of Ireland and also with expert training providers to ensure access to the highest standard First Aid training, techniques development and equipment.

Close links continue with the Irish Air Corps, and there have also been strong connections established with the Gardai and Police Service of Northern Ireland, and other emergency agencies; work continues in setting up cross-border air and road back-up from the emergency services for Mine Rescue, north and south.

It is expected and planned that Mine Rescue will further develop in Ireland as new mines open in the coming years.



Pat Griffin on the left, Ireland's Senior Inspector of Mines, and Bob Leeming on the right, now HM Chief Inspector of Mines, judging with Paddy McManus at the Galmoy Competition in 2007

View from the North

by Gordon Best, Regional Director QPANI

The continuing absence of a working Executive and Assembly in Northern Ireland has and continues to generate an enormous sense of frustration and anger within the business community and general public. Unfortunately so far in 2018 we seem to be taking one step forward and two steps back. Earlier this year the Department of Finance published a number of Budget Scenarios in order to make the great Northern Ireland public aware of where their taxes are spent, how vital services are funded, where the shortfalls are and where possible savings could be made. The publication of these scenarios was widely welcomed by many as a much needed wake up call to the people of Northern Ireland and our much maligned political elite that we have to recognise the need to balance the books and that we only get the services and infrastructure we are prepared to pay for.

There is no doubt that despite the political and budget uncertainty parts of our economy here in the North are showing signs of growth. Belfast is building again and with increased private sector investment, significant construction growth expectations south of the border and the significant challenge of Brexit **WE NEED CERTAINTY, WE NEED POLITICAL LEADERSHIP** if we are to achieve the society we all want for ourselves and our children.

The NI economy has been transformed by peace through the signing of the Good Friday Agreement and peace is secured by a strong and vibrant economy. QPANI, along with other Business organisations, including CBI, are continuing to make **the case for Northern Ireland and the UK to remain within the Single Market and Customs Union.** We recognise that imposing restrictions on the movement of people and goods across or between these islands for many is an existential issue and disrupting this presents a serious risk of politically destabilising consequences beyond those of trade and the economy. Securing a Customs solution which matches the current arrangements is essential for business and will benefit us all.

QPANI recently made a submission to the Northern Ireland Affairs Committee enquiry into the effect of Brexit on the Construction Industry in Northern Ireland. QPANI want to see the UK Government and the EU maintain free movement of people, goods and services between Northern Ireland and the Republic of Ireland. However maintenance of a soft border with the Republic of Ireland must not result in any restrictions of movement within the UK between NI and GB. Our colleagues in the Mineral Products Association have called for the **UK to continue to retain influence in European product technical standards** development via the British Standards Institution (BSI), the European Committee for Standardization (CEN) and design codes to maintain world leading standards for the UK industry and its customers in the UK and the rest of Europe.

Hopefully, the next 12 months will see the political rhetoric give way to a more practical and pragmatic approach which not only protects the UK and RoI economies, but enables them to thrive. We, like other key industries, want to help Governments achieve the best possible deal for NI and the UK. We hope, therefore that Government will listen and consider positive and well intentioned advice on its merits, particularly when it is evidence based. In these challenging times, it is very important that all stakeholders work together to constructively develop a strategy which will bolster confidence and encourage investment

Since last years IMQS Journal QPANI have increased our membership by 10%. I am delighted to report that we have achieved this with five new affiliate members and three new Full Members. We greatly appreciate the support of our Associate and Affiliate Members and I know they recognise the importance of QPANI and the work we do to defend the right to operate for the Industry that their business have a large stake and investment in.

While the expectations for the next 12 months are more positive than what they have been for some years, the Industry faces a growing threat from a very militant and vociferous environmental lobby who are basically "at war" with the Mineral and Aggregates Industry and those Government Departments that regulate it. I would warn of the risk of complacency, both North and South, and a belief that we can operate the way we always have. QPANI have had a number of meetings with senior officials in the Department of Infrastructure and the Department of the Economy about the need for a **Northern Ireland Minerals Forum.** This forum would be similar to the Minerals Forum set up in GB under the banner of the CBI Minerals Group and led by MPA.

There is a real need for a structured and sensible debate to take place in Northern Ireland about the current and potential economic and social benefits a developing and successful Minerals Industry means for the NI economy. We would see the make-up of the group being from Department of Infrastructure, Department of the Economy, Minerals Industry, Politicians, Strategic Planners, Local Authority Planners and Environmental NGOs. This is very much in its infancy but there is definitely a commitment to take this Minerals Forum forward. I was delighted to accompany Sean Finlay and Brendan Morris of IMQS to a meeting with Sinn Féin T.D. Brian Stanley and Cathal Boylan MLA at Leinster House in March to discuss Sinn Féins position on the Mining Industry in Ireland as set in Motion 68 passed at their Ard Fheis.

As always the top priority for QPANI is the health and safety of our Members employees and all those who visit our members sites. We have again continued our strong working relationship with the HSENI particularly this year in improving the management of dust in quarries across Northern Ireland. The strategy is aimed at improving and sharing best practice in relation to total inhalable dust, respirable dust and respirable crystalline silica in the NI quarry industry. Our QPANI health and safety committee are fully supportive of this strategy and will be assisting members in achieving the targets and practices outlined in the strategy. This year our Health and Safety Committee will have a focus on mental health and well being and we will be advising and directing Member's to sources of information that will assist them manage this very important and very real challenge. In 2018 we will again hold a number of on site workshops with HSENI focusing on priority high risk issues. We will again look forward to organising and attending the **All Island Safety Conference,** this year being hosted by our colleagues south of the border in the HAS, IMQS and the Irish Concrete Federation.

On the planning front we continue to make submissions to the ongoing local

councils local development plan process consultations. To date we are happy that those councils who have consulted on their preferred options papers have been listening to QPANI and are clearly recognising the importance of the minerals and quarry products industry in their local areas. All Councils to date have recognised the need to identify and safeguard future aggregate resources. We have been encouraging QPANI members to complete the resource and production surveys the Councils have sent to them in order to assist in developing an accurate supply and demand plan for the local aggregates industry. There is also a commitment to develop a mineral plan between Belfast City Council and its neighbouring Councils to ensure an adequate and sustainable supply of construction aggregates to meet development demands within Belfast.

I recently wrote to all Councillors in Fermanagh Omagh, Derry Strabane, Mid Ulster and Causeway Coast and Glens Councils. In the letter I highlight my growing concern over what the local Mineral and Aggregates Industry believe is a misunderstanding around "mineral exploration" and lack of appreciation that widely supported local sand and gravel and quarry Industry is deemed under legislation as "Minerals". We continue to highlight the significant economic and social benefit that a sustainable minerals industry in the Sperrins and its hinterlands could bring to the local and wider NI economy.

A continuing challenge is still the number of **old quarries** being re-opened on the basis of old planning permissions with no environmental conditions. This is totally unacceptable and needs addressed by the Department of Infrastructure and local Councils. We will continue to engage with Strategic Planning and local Councils to reach a long term sustainable solution to this issue.

I recently met with **"Womenstec"**, an organisation dedicated to increasing women's roles in key Industry sectors, and we hope to work together over the coming months and years to increase the number of women working in our Industry and show that it's "not just for boys". The Association launched a major news article on Women in Construction Materials featuring 14 women currently working in different roles within the quarry products sector here in NI. Also MPQC with the support of the local Institute of Quarrying and QPANI intend to support and roll out the new and exciting **"Inspiring Futures Initiative"** in Northern Ireland. I am delighted to report that we have 27 Stem Ambassador volunteers from our Industry who have been trained by Stem NI and MPQC to deliver talks to young people across Northern Ireland about the exciting careers that are available in the World of Construction Materials and Minerals.

QPANI have recently published the results of our 2017/18 **"Age Profiling Survey"**. Again, like 2015 the report highlights the high age profile of the workforce right across every sector but particularly in quarrying and transport. The results of the survey provide proof that our work on skills, diversity within the workforce and improving the image of the industry and conditions within it must be a priority and needs supported by everyone.

As always I am honoured to be asked to pen this short article for the IMQS Journal and may I wish IMQS and all your members every success in 2018 and the coming years ahead.

QPA Northern Ireland
Providing Essential Materials

Challenges of Recovery

by Gerry Farrell, Chief Executive of the Irish Concrete Federation

I would like to thank the Irish Mining and Quarrying Society for the opportunity to contribute to its annual review, a publication which is widely read within the quarrying and concrete industry throughout Ireland. In particular, I would like to congratulate the Society on the 60th anniversary of its formation and to wish its executive and members the very best for the coming 60 years. As somebody who has represented business over the previous two decades, I recognise the incredible amount of hard work that goes into the management of a thriving voluntary body and in this regard I would like to particularly commend the Society's outgoing executive secretary, Ms Carol Sanderson and the current President, Mr John Francis and his predecessors for their stewardship of the Association in recent years.

Similar to recent articles I have written in recent years for this publication, it is clear that the country is well on the road to recovery even if that recovery remains fragile, haphazard and certainly different to previous expansionary times. **2018 will see increased output in construction in Ireland** which should lead to an increase in activity for ICF members. However, poor weather conditions combined with a frustratingly slow increase in house building and constrained Government expenditure on infrastructure, has meant that the year to date has been disappointing. However, the overall trajectory of the industry is positive and the future for our industry is certainly brighter than some years ago, notwithstanding the many challenges it faces.

While this article will not allow me to address all of the important issues faced by our industry in the current time, I would like to highlight some which are particularly pertinent to the future success of the sector. In this regard it is clear that **a key measure of this industry's future sustainability will be its ability to attract and retain our people**. The last decade has seen a "brain drain" from all construction related trades and professions, a fact that is now impacting severely in the entire sector's ability to deliver the many societal needs faced by the country. Our own industry needs to educate and upskill our current employees, while attracting both youth and experience to the sector with the promise of a rewarding career. There are other industries, cleaner and safer, available as a career choice to potential employees. It is up to us all to promote our sector in a positive light to all potential future employees, their parents and friends to let them know that a rewarding career exists in their local quarry and concrete company. ICF recently held an event with the Department of Employment and Social Protection and local Education and Training Boards at which 200 trainees and jobseekers attended. This was ICF's first event of this type and it is likely one that we will be replicating in other locations in the coming years.

The pivotal role of our industry, both at national and local level, is rarely appreciated by those outside our industry. The Mineral Products Association's (UK) initiative on "making the link" between quarries and all of the built infrastructure that surrounds us every day is certainly worth replicating on this island. In this context, some progress was made when, in February, the Republic's Government produced its **National Planning Framework** up to the year 2040. Following ICF's submission to the draft Plan, the importance that access to aggregate resources will have in providing the buildings, infrastructure and spaces for our people over the next two decades was officially recognised. Despite this welcome and timely acknowledgement, we see this access to natural aggregate resources compromised on a regular basis by unsuitable development and delays and uncertainty in the planning process and ICF will be similarly lobbying Government to protect this natural strategic resource, so critical for all future development. Planning will undoubtedly continue to play a key role in protecting Ireland's environment by ensuring that extraction is carried out in an environmentally sensitive manner and ICF looks forward to producing a planning policy paper in the near future to outline the changes needed to ensure this objective. Indeed, a critical issue will be our industry's contribution to the circular economy and **ICF looks forward to making progress with the Environmental Protection Agency to facilitate the recovery and recycling of concrete waste and its reuse in today's built environment**.

The recovering economy also brings new safety challenges to our industry. Our industry involves the undertaking of dangerous tasks on a daily basis by some of our employees. A lack of investment in plant, machinery and people over the past decade has increased the risk of accidents and it is up to us all, in conjunction with regulatory safety organisations, to spare no resources to ensure that we keep accidents and injuries to a minimum. Sometimes the language of health and safety can alienate and be somewhat intimidating and challenging to operators and employees alike. Without diminishing the message, there is need for communication on key areas of safety of which we are all very well aware, to be communicated in an easy to understand and practical manner. ICF has just held a number of workshops with the Health and Safety Authority on safety in block manufacturing. It was notable that all of the presentations from industry and the Authority at the workshops featured the extensive use of imagery. It is said that "a picture tells a thousand words" and certainly the reaction of our members to the presentations was extremely positive. In the context of safety, ICF is also looking forward to **Quarry Safety Week later this year and the All-Island Quarry Safety Conference which will be held in September**.

In the coming years, our industry will undoubtedly need to continue to contribute to the ongoing development and improvement in standards for the products we produce. During the past decade, much time and effort has been invested by technical experts within the industry in updating standards for aggregates and concrete products and much debt is due to those experts whose work can often go unseen. These standards need to be communicated widely within the industry but particularly to those other stakeholders in the architectural, engineering and construction professions and indeed among Government bodies with the overall aim of **improving standards** throughout the entire construction chain. It is also imperative that the procurement of these products is not solely on the basis of price which unfortunately has been the case in both the public and private sector for too long. The development of standards and the resulting improvements in quality should be supported by specifiers, contractors and builders alike, with the lead coming from Government. ICF is engaging with the professional bodies and the Department of Housing, Planning and Local Government

in order to bring all the other stakeholders in the chain up to date with **developments in standards to ensure that it is only operators with the necessary certification and controls in place that prosper in the marketplace**.

Improvements in standards and quality also underpin the marketing and promotional initiatives for the products produced in our industry. ICF has recently developed a "concrete built" campaign, targeted at the general public, based on reinforcing the product's inherent or 'built in' benefits. As an industry we should not be anything but positive on the many societal benefits which this often taken for granted product has provided for generations and will so for the future.

Finally, it would be remiss of me not to mention that all too familiar word **"Brexit"** in looking at the potential challenges facing our industry. The concrete products sector, both directly through exports to Great Britain, and indirectly through its dependence on the local and national economy, is exposed to the impacts of a hard Brexit, as is the case with many other sectors. While it is tempting to try to re-write history or point the finger of blame, the reality is that this country needs to have an open and seamless trading

relationship with our nearest neighbour. For this reason, and for other political reasons with which we are all familiar, it is of **paramount importance that the threat of import tariffs, time delays, custom checks and border posts are avoided**. While the vote of the British people has to be respected, it is surely within the powers of those negotiating Brexit terms and arrangements to preserve the political, societal and trading relationship that has prospered in recent years both on this island and across the Irish Sea.

In conclusion I would like to wish all of the members of the Irish Mining and Quarrying Society a prosperous remainder of 2018.

News from the South West

by Sarah O'Connell, O'Connell Quarries

2018 saw a relatively slow start to the year in terms of aggregates and concrete sales. Extreme weather also played havoc on the industry with business closures and jobs delays.

Towards the end of quarter one there was a steady improvement in both aggregates and concrete.

There was a noticeable rise in development in the agricultural industry for government grant aid concrete for shed's, silage pits and tanks.

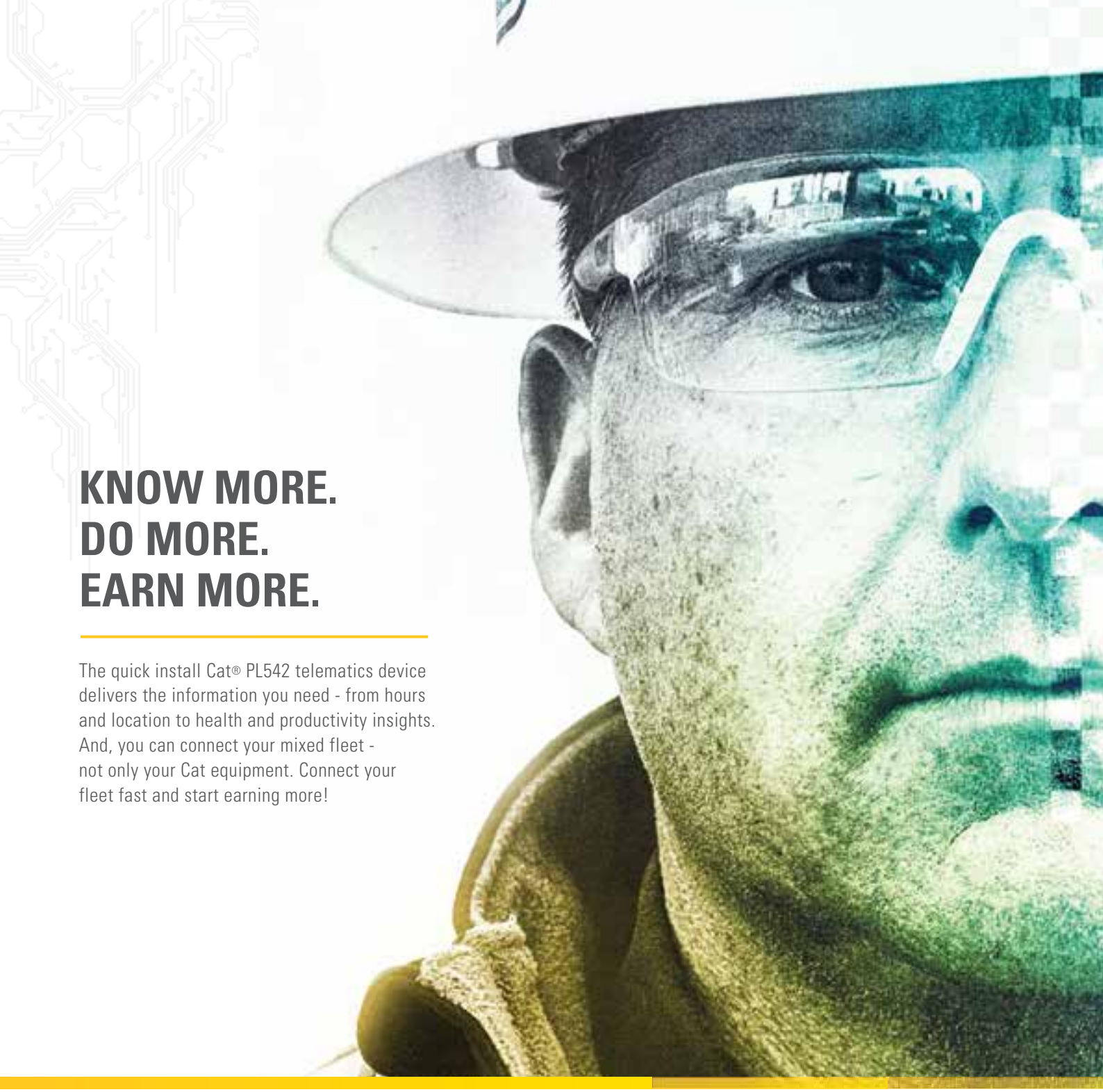
For the first time in quite a few years, there has been a rise in the number of one off houses being built in the region and a steadily increasing number of planning permissions being granted for one off houses which indicates a positive future for the region.

There is a small number of housing estates being developed in the Limerick city area; some previous ghost estates being finalised and other green field sites breaking ground; however, there is still a huge demand for more housing estates to help improve the homeless crisis in the city.

The Future looks bright for Limerick:

Limerick is investing over €1 Billion in enterprise and investment infrastructure as part of the Limerick Twenty Thirty vision. It is estimated that there will be thousands of jobs created for the city and county.

With Limerick's ideal location, just 20 minutes from Shannon Airport, motorway connections to the Dublin region, the west of Ireland and future plans for a Limerick – Cork motorway granted late in 2017, the future looks busy for the Limerick Area and the South West of Ireland.



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Dalradian Gold Limited

A Golden Opportunity for Businesses Across Northern Ireland

by Barry Turley, Director of Communications, Dalradian Gold Limited

In November 2017 we submitted our regionally significant planning application to the Department for Infrastructure (DfI) to build an underground gold mine in west Tyrone. We believe the mine will have a transformative economic impact in the local area and will provide growth opportunities to businesses and suppliers across Northern Ireland.

Our planning application was the culmination of almost a decade of exploration and environmental work by Dalradian since we took over the project in 2009. Since then we have transformed the exploration site at Curraghinalt from a small, early stage gold deposit to one of the best gold deposits on the planet.

Our project is now ranked in the top 10 percent of unmined gold deposits globally and our **latest Mineral Resource Statement** showed an increase from 4.4 million ounces to **almost 6.1 million ounces**. The report stated that there had been a 46 percent rise in Measured & Indicated gold ounces and a 32 percent increase in Inferred gold ounces.

Northern Ireland's rich geological resources have long been recognised. In the 1600s gold was reported in the Moyola River, 20 miles east of Curraghinalt, and in more recent times work has been ongoing at the Curraghinalt site going back over five decades.

The Dalradian complex is a series of highly folded and metamorphosed sedimentary and volcanic rocks that are approximately 540 million years old. The rocks are found in a 720 kilometre long belt stretching from the Scottish Highlands through Northern Ireland and into the west of Ireland. It also stretches to Scandinavia and North America, hence the gold mines in countries such as Finland and Sweden.

The geological term takes its name from the geographical region where it is found. It is a Latin derivation of Dál Riata, a kingdom of Gaels found in the north of Scotland and in Ulster, one of Ireland's four ancient provinces.

So far we have raised more than C$320 million to invest in the project and our anticipated **future investment to build and maintain a mine will come to more than £330 million**, making it one of the largest Foreign Direct Investments in Northern Ireland in recent years.

Our planning application was informed by the extensive public consultations we held with the local community and other stakeholders and as a result the majority of the application focuses on building on environmentally responsible mine that meets or exceeds all regulatory guidelines. We plan to build a state-of-the-art underground gold mine using best in industry practices.

We have already built positive and productive relationships with local businesses and suppliers and schools and colleges in west Tyrone and we plan to extend this to businesses across Northern Ireland should the mine be granted planning permission.

Currently around 100 people work full-time on our project, spread between the site at Curraghinalt, our main office in Omagh and our community office in Gortin. Our employees have a range of skills from IT and HR to drillers, welders, surveyors and geologists.

An independent feasibility study carried out in 2016 showed that **once in operation our underground gold mine will employ 350 full-time workers** with an average salary of £40,000, almost double the NI average. This will have a positive impact on a range of business from clothing and hardware suppliers to retailers across the county Tyrone area.

While gold mining is a relatively new industry to Northern Ireland, mining and quarrying are not. The industry in Northern Ireland has an annual turnover of around £400 million, contributing 1.75% of the region's GDP.

Indeed across the island of Ireland mining is a thriving industry which has sustained thousands of jobs for decades and provides billions to the economy of the Republic of Ireland annually.

Tara Mines in Navan, Co. Meath, is Europe's largest supplier of zinc and has been operating since the 1970s. It currently employs around 600 people directly and another 300 work as sub-contractors.

The underground mine, with a depth of 1,000 metres, is the major employer in the local area and around 2.6 million tonnes of ore are mined annually for the production of zinc and lead concentrates. The mine has the support of all of the Republic of Ireland's main political parties.

Globally, Ireland is ranked 11th and 16th for zinc and lead output, according to an official government report in 2017 and is ranked 4th globally in the Fraser Institute of Canada's survey of mining companies investment attractiveness index.

According to the Central Statistics Office of Ireland almost 8,000 people are employed as a result of the extractive industry, with 3,633 people employed directly and 4,189 people employed indirectly or as a result of induced jobs. The mining and quarrying sector in the Republic of Ireland is a multi-billion Euro industry.

Other mines that have operated in recent times in the Republic of Ireland include the Lisheen Mine, which ceased operations in late 2015 after 17 years of activity. Lead and zinc were extracted from this underground mine, which had an average below surface depth of 170 metres. The mine is now in its closure phase.

We are therefore building on firm foundations and the vast experience of mining and quarrying across the island of Ireland and in the knowledge that the suppliers, businesses and expertise already exist in Northern Ireland to enable our proposed mine to flourish.

If you would like to support our planning application, submitted in late 2017, you can do this via our "Build a Support Letter" tool at www.dalradian.com/opportunity.

Alternatively you may write directly to DfI by email at planning@infrastructure-ni-gov.uk, referencing LA 10/2017/1249/F.

Our planning application, one of the most extensive ever to be submitted to Northern Ireland can be viewed at DfI offices in Belfast, or Omagh Library or alternatively on the NI planning portal at www.planningni.gov.uk.

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Diamond Mining

by Brendan Morris, C. Eng, Managing Director, LTMS Limited

Overview

A diamond is the hardest material on Earth and has long-since been recognised for its beauty as a gemstone. More than 100 million carats of diamonds have been consistently produced from mines worldwide on an annual basis in recent years.

There are seven countries leading the world in the production of gem-quality diamonds for over a decade. Russia, Botswana, Canada, Angola, South Africa, the Democratic Republic of the Congo, and Namibia have all been consistently producing over one million carats per year.

Diamond is the hardest natural mineral known, which makes it ideal for cutting tools and precision instruments. Seventy-five to eighty percent of diamonds are used in industry for cutting tools, polishing hard metal, saws for cutting marble, rock drilling equipment and bearings for laboratory instruments. The remaining twenty percent is mostly used for jewellery production.

Natural diamonds account for about 12% of all industrial diamonds used, while synthetic diamond accounts for the remainder. Synthetic diamonds are produced in many countries, including China, US, Russia, SA, Ireland, Japan and Belarus. China, at an annual production of more than 4 billion carats of synthetic diamonds, produces more than 8 times the cumulative total of the next five largest producers.

Diamonds are sourced from two methods. Firstly, the mining of a kimberlite pipe from either open pit or underground mining and secondly, from alluvial mining.

Approximately 130,000,000 carats (26,000 kg) of diamonds are mined annually, with a total value of nearly US$9 billion, while approximately 100,000 kg (220,000 lb) are synthesized annually.

The word diamond comes from the Greek word meaning unbreakable.

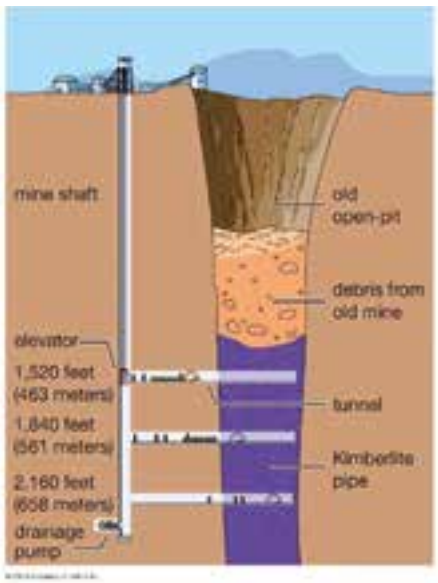
Geology overview

Diamond is a solid form of carbon with a diamond cubic crystal structure, and diamonds were formed when carbon and indicator minerals from below the earth's crust were carried to the surface during volcanic eruptions. Once the volcanic activities subsided and cooling took place, the diamonds remained encased in the solidified rock mass, known as kimberlite pipes. To find diamond deposits, geologists search for the indicator minerals and when found they were often indicative of kimberlite pipes in the area or along the path of the minerals. Kimberlite pipes are often formed in clusters and when one pipe is found, there are generally more kimberlite pipes discovered in the region.

Kimberlite is an ultramafic rock derived from the mantle and is the host for the diamond as the kimberlitic magma rises. Kimberlite is a form of peridotite, composed mostly of olivine, a type of chrome rich granite. Only 1% of kimberlite is economic and these deposits are almost always found above Archean cratons. Sub Saharan Africa and Russia produce approximately 80% of the world's diamonds.

Kimberlite minerals can be found in narrow (1–4 meters) dikes and sills, and in pipes with diameters that range from about 75 metres to 1.5 kilometres.

Many kimberlite structures are emplaced as carrot-shaped, vertical intrusions termed "pipes". Kimberlite pipes with economic ore values often allow for open pit mining in the upper area of the pipe and underground mining in the lower sections.



A typical diamond mine

Kimberlite Pipe with Open Pit and Underground Mine

The name Kimberlite is derived from the town of Kimberley in South Africa, where a major open pit diamond mine was located in the late 19th century, following the discovery of diamonds in 1871. The town previously named New Rush, was named in 1873 after Secretary of State for the Colonies, Lord Kimberley.

Synthetic Diamonds

The technology for synthetic diamonds was researched in the 1940's and the first synthetically created diamond was produced in the 1950's. There are several techniques for producing synthetic diamonds, these include high-pressure high-temperature synthesis, chemical vapor deposition and detonation synthesis (literally blowing up carbon with explosives to create extremely small diamond grains).

The synthesized material known as cubic zirconia is a crystalline form of zirconium dioxide (ZrO2). It is at times in competition with diamond because as well as being hard, optically flawless and colourless, it is also durable and cheap.

Synthetic diamonds make up the largest percentage of diamonds used for industrial purposes. Common industrial applications include diamond-tipped drill bits and saws, and the use of diamond powder as an abrasive.

Uses of diamonds

Diamond is the hardest natural material known and is the world's most sought-after gemstone and is also used for industrial cutting and polishing tools. Diamond has a hardness of 10 on Mohs scale of mineral hardness, with 1 being the softest (talc) and 10 being the hardest. Diamond is the best known thermal conductor (heat transfer) among naturally occurring substances.

Diamonds have often been a source of conflict and controversy with the term blood diamond referring to a diamond mined in an unstable area and sold to finance war.

Diamond is the world's most popular gemstone and is frequently worn as part of jewellery such as rings and necklaces. Diamonds are very well suited to jewellery because they polish well and can only be scratched by other diamonds. Diamonds

are cut with considerable precision to optimize the lustre and attention gathering shine of each specific diamond and are valued according to their cut, colour, carat and clarity.

Natural diamond accounts for about 12% of all industrial diamonds used, while synthetic diamond accounts for the remainder.

Industrial diamonds

Famous Diamonds

Over the years there have been many famous and very valuable diamonds. The following are some well-known examples:

- The **Great Star of Africa Diamond** at 530.20 Carats also known as the **Cullinan I Diamond** is the largest cut diamond in the world. Pear shaped, with 74 facets, it is set in the Royal Sceptre and is located as part of the Crown Jewel, collection in the Tower of London. It was cut from the 3,106-carat Cullinan diamond, the largest diamond crystal ever found. The Cullinan was discovered in Transvaal, South Africa in 1905 on an inspection tour of the Premier Mine.
- The **Koh-i-Noor Diamond** originated in India and once thought to be the largest diamond in the world. It is currently 105.6 carats and is now part of the British Crown Jewels in the Tower of London.

The Great Star of Africa Diamond

- The **Hope Diamond** at 45.5 carats appears blue because of boron in its crystal structure and is famous for supposedly being cursed. It is on display in the USA at the Washington National Museum of Natural History. It is also believed to have originated in India.
- The **Tiffany Yellow Diamond** discovered in the Kimberley Mine in South Africa weighed 287.42 carats (57.484 g) when discovered. It was later sold to a New York jeweller named Charles Tiffany who had it cut into a cushion shape of 128.54 carats (25.708 g) with 90 facets to show off its beauty.
- The **Regent Diamond** is a 141-carat (28.2 g) diamond owned by the French state and on display in the Louvre, is estimated to be worth £48,000,000. It is widely considered the most beautiful and the purest diamond in the world. It is rumoured to be found in India in the late 17th century at 410 carats.

The Tiffany Yellow Diamond

4 Cs Of Diamonds

Characteristics of diamonds are graded and categorized by the diamond industry to determine the value of the diamond.

The most important characteristics are the 4 Cs, as listed below:

- **Cut**
- **Clarity**
- **Colour**
- **Carat weight**

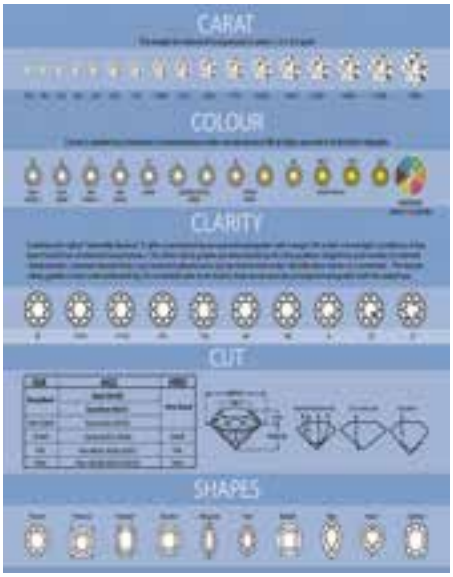
There is also a "Fifth C", a Certificate, which is a grading report, a complete evaluation of the diamond that has been performed by a qualified professional.

Cut is probably the most important characteristic and most challenging of the four Cs to understand. The brilliance of a diamond depends heavily on its cut and has the greatest effect on a diamonds beauty.

Clarity is determined by an assessment of the inner flaws, or inclusions, that occur during the formation process. The visibility, number and size of these inclusions determine what is called the clarity of a diamond. Diamonds that are clear create more brilliance, and thus are more highly prized, and priced.

Colour is important in that colourless diamonds are the most desirable since they allow the most refraction of light (sparkle). Off white diamonds absorb light, inhibiting brilliance.

Carat is the unit of weight by which a diamond is measured. Because large diamonds are found less commonly than small diamonds, the price of a diamond rises exponentially according to its size.



Locations of deposits

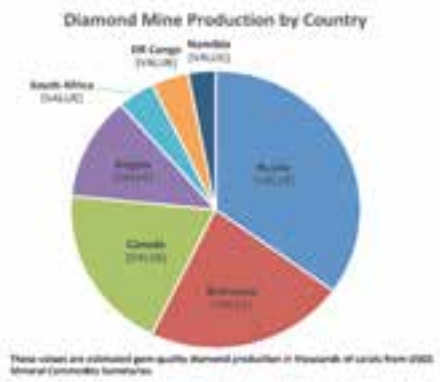
There are a limited number of commercially viable diamond mines currently operating in the world, with the 50 large mines accounting for approximately 90% of global supply.

The global diamond mining industry is largely dominated by a hand-full of companies. The top three companies – Alrosa from Russia, De Beers from Luxembourg, and British-Australian Rio Tinto, account for more than 60 percent of global diamond mine production.

Diamonds increase drastically in value through processing from production to retail. In 2016, for example, mined rough diamonds had a production value of US$15.4 billion. After polishing, this figure increased to US$25.1 billion. In 2016, the global diamond jewellery market value was worth approximately US$80.1 billion. In 2016, 47% of the world's demand for polished diamonds came from the United States.

Mined diamonds are mostly processed in and sold via the major global diamond centres in Antwerp, Dubai, New York, Hong Kong, Mumbai and Tel-Aviv. In contrast to precious metals, there is no universal market price per gram of diamonds. Nevertheless, global diamond prices have increased more than tenfold since 1960.

The graph below shows the major diamond producing countries.



Some of the largest diamond mines ranked by diamond reserves are listed below:

Mine	Country	Estimate Reserve (million carats)	Owner
Orapa	Botswana	151	DeBeers
Jwaneng	Botswana	149	Debswana (DeBeers & Botswana Govt.)
Jubilee	Russia	125	Alrosa
Catoca	Angola	110	Sociedade Mineira de Catoca (Joint Venture)
Udachny	Russia	108	Alrosa
Mir (Mirny)	Russia	97	Alrosa
Argyle	Australia	93	Rio Tinto
Grib	Russia	92	Lukoil
Venetia	South Africa	72	DeBeers
Botuobinskaya	Russia	69	Alrosa

A cluster of open pit diamond mines in Northern Canada

Mirny Diamond mine in Yakutia, Russia

Over the past few years, diamond production has remained consistent, at around 130 million carats per year. The most recent large mine discoveries have been in Canada, with the Gahcho Kue mine being the largest. This mine is set to produce around 5 million carats per year.

Diamonds are generally found in two types of deposit. The most common is a primary deposit, usually occurring near a kimberlite pipe, a volcanic pathway connecting the Earth's deep mantle to its surface. Diamonds are carried upward in these pipes, amid vast quantities of magma, in very forceful eruptions.

Face shovel loading a 100t truck at an open pit diamond mine in Russia

In addition to primary deposits, diamonds are also found in secondary or alluvial deposits. Like any other surface feature, diamond-bearing pipes are subject to natural weathering and erosion and, as the weathered and eroded material washes downhill and downstream, some eventually ends up in riverbeds or along the ocean shore near the mouths of a river.

An alluvial diamond dredger

The most common and productive type of diamond mining is open-pit mining, where the economical diamonds are mined using standard open pit mining techniques. At deeper levels of the kimberlite pipes, mining by open pit can become uneconomical and may become economical to mine by underground mining techniques. Some of the large open pit mines can mine up to 10 million tonnes of ore per annum to produce between 6-10 million carats of diamond.

Following mining in the open pit or underground, the diamonds are separated from the ore through a series of processes, including crushing, screening and washing. At this stage the ore is concentrated to achieve density separation using a variety of techniques, including rotary mixers, agitators, cyclones and heavy media separators. Collection of diamonds is then achieved using grease tables or x-ray separators, followed by visual sorting.

In summary, while diamonds have very significant uses in industry, diamond jewellery is something which will never go out of fashion and if anything, it may be considered to be the best kind of legacy which you can leave to your descendants or inherit from a family member. Diamonds are and always will be, not just a girl's best friend, but forever. LTMS, a mining and technical services provider, have provided services at diamond, zinc and gold mines in Russia, Canada, India, Kazakhstan, Africa, UK and Ireland.

Diamond sorting

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Diamond exploration in northernmost Ireland

by Barry Long, Scientific Visitor, Geological Survey Ireland

Exploration results so far are encouraging

In Inishowen, NE Co. Donegal, exploration for diamonds and other gemstones by Cambridge Mineral Resources (CMR) from 1996-2002 ended when gold exploration became a global fever that attracted companies away from other minerals. Despite the detailed work and encouraging results [1], key questions about Inishowen's geology remain unanswered. The licences formerly held by CMR were eventually acquired by Grosvenor Exploration and Mining Services Ltd. until late 2016 [2] and the company was dissolved in January 2017.

Stream sediment samples collected in Inishowen by CMR were analyzed at two specialist laboratories (Diatech Heavy Mineral Services, Perth, Western Australia and CF Mineral Research, Kelowna, British Columbia, Canada). Chuck Fipke of CF Mineral Research, who was enthusiastic about the Inishowen results, is renowned for his use of detailed geochemistry to develop and improve the use of specific pathfinder minerals [3] to find lamproite and kimberlite. These are globally the main potentially diamondiferous igneous rocks originating from great depth in the mantle. Together with Stewart Blusson, Fipke [4] discovered the first of 156 (2016 data) kimberlite pipes ranging from 75 to 45 million years old, one of which became the Ekati Diamond Mine (Canada's first), near Lac de Gras, 310km NE of Yellowknife, Northwest Territories, Canada.

Terrestrial diamonds originate at depth

Diamonds typically formed more than c. 150km below surface within deep roots of the continental lithosphere and underlying uppermost asthenosphere. Their host rock is mainly garnet lherzolite with some garnet harzburgite and eclogite. The eclogite derives from deeply subducted oceanic lithosphere that accreted to the continental roots. It may contain diamonds formed at shallower depth, though more than c. 120km.

Magma rising through diamond source rocks carries diamonds to the surface

Magma originating below the diamond source rocks rises and entrains diamonds and pieces of rock torn from the wall rocks of the conduits it passes through on its way to shallow depths or the surface. Entrained diamonds are older, sometimes very much older than the magma transporting them. Eventually the magma crystallizes as igneous rocks to form dykes, sills and diatremes (i.e. volcanic pipes), the latter usually reaching the surface. Kimberlite and to a lesser extent lamproite are globally the most important diamondiferous rocks that can be mined at the surface.

The Hebridean craton and deep geology of northernmost Ireland

Archaean cratonic areas are important globally because diamonds are associated with them. When CMR began work in Inishowen, Archaean rocks (older than 2,500 million years) of the Hebridean Craton were thought to be distributed offshore north of Ireland and west of Scotland, with small areas present on the Scottish coast (e.g. at Scourie). This view changed following discovery that the southern marginal part of the Hebridean Craton continues southwards at a depth of c. 40km beneath the northern third of Ireland. The areas of Neoproterozoic Dalradian schists, quartzite and marble, and the directly underlying Palaeoproterozoic basement gneisses (visible at the surface in Inishtrahull, NE of Malin Head, and the Mullet, Co. Mayo) all overlie a strong seismic reflector known as the W-reflector, a major shear zone marking the top of the craton. The W-reflector was discovered and interpreted by the British Institutions Reflection Profiling Syndicate (BIRPS) during offshore seismic profiling. Archaean gneisses of the Hebridean cratonic margin underlie mainly Cos. Mayo, Donegal, Fermanagh, Derry and Tyrone. Dyke or pipe-like intrusions from great depth are thought to be present in Inishowen. In the other counties they seem to be absent but may be obscured. Before CMR departed from Inishowen, the general deep sub-surface geological structure looked favourable for possible lamproite diatremes (volcanic pipes).

It is known from elsewhere that kimberlite dykes and diatremes originate more deeply than lamproite and are usually found within or directly above ancient stable Archaean cratons but distant from their margins. They are therefore perhaps less likely to occur in Inishowen with its more peripheral relationship to the Archaean craton though they cannot be ruled out. Lamproite is generally associated with cratonic margins and adjacent or overlying Proterozoic and younger rocks. Only lamproite containing olivine is potentially diamondiferous, though most olivine lamproite has no diamonds. The Argyle mine in northernmost Western Australia is globally the best known for its commercially viable diamondiferous olivine lamproite.

Igneous rocks of interest in Inishowen

Camptonite and monchiquite dykes are both types of alkali lamprophyre that are exposed in northern Inishowen and eastern Fanad. Although undated, they have been interpreted as Permo-Carboniferous (359-252 million years old). Within them are conspicuous inclusions of spinel lherzolite and some spinel harzburgite that are varieties of peridotite (olivine-rich mantle rock). Because the inclusions contain spinel (chrome spinel and chromite) without garnet, the inclusions themselves originated from shallower than c. 85km below surface which is far too shallow for diamonds.

CMR records that buried diatremes, probably lamproite of unknown age, are suspected in Inishowen based partly on high resolution, low altitude, regional and local aeromagnetic data acquired for CMR by Tesla Exploration Geophysics Ltd, U.K. Ground based magnetic studies were also carried out. Detailed modelling of one shallow sub-surface diatreme revealed a champagne glass shape typical of lamproite pipes that are often known to lack any surface expression. An attempt to drill into this diatreme was unsuccessful. No outcrops have been found.

Old shear zones provide pathways to the surface

Proximity of the old and deep Culdaff Lineament to the former CMR licence areas may have influenced the localization of intrusions there, and the Omagh Lineament in western Tyrone was probably also significant. Both lineaments trend N12-E and were originally long broad shear zones probably several km wide.

Although identified as Palaeoproterozoic in age they are more likely to be older and Neoarchaean. Upwards propagation of old lineaments such as these into overlying younger rocks is a normal characteristic. Old lineaments are known to serve as pathways for deep magma to reach the surface.

Key pathfinder minerals found in Inishowen and N. Ireland

DI (diamond inclusion and intergrowth) chromite grains are uncommon and of special interest. They were found by CMR in a few Inishowen stream sediment samples. Their compositions match only those of chromites found elsewhere as inclusions or intergrowths within diamonds, implying that they grew where pressure and temperature conditions enable diamond to form. Their presence in Inishowen's streams today is enigmatic. A recent article [5] addresses a similar problem relating to Inishowen's G9 pyrope garnets that like the DI chromites are not known in any surface outcrops. Were the DI chromites and G9 pyrope garnets eroded from diatremes or dykes of unknown age perhaps of lamproite or even kimberlite at the surface today or recently, or were they recycled into sedimentary cover rocks after reaching the surface long ago? Recent weathering of such cover rocks could explain the presence of those minerals in today's stream sediments.

Inishowen stream sediments yielded other encouraging minerals including DI clinopyroxene (chrome diopside of diamond inclusion and intergrowth composition) and eclogitic garnets. Sapphire, gem-quality corundum of blue and pink varieties, is also important and found as small crystals less than 2mm across in the areas explored. It is found as larger gem quality crystals in the Loch Roag monchiquite of Lewis, Outer Hebrides.

The Brookeborough diamond

Diamondiferous source rock, kimberlite or sometimes lamproite, is more usually found after discovery of alluvial diamonds (more than 200 years later in Brazil), so the prospect for Inishowen and Tyrone seems poor. However, to predict what may yet be discovered would be unwise. The Brookeborough diamond, allegedly from the Colebrook River, Co. Fermanagh, N. Ireland, is perhaps best forgotten [6]. Its unauthenticated discovery in 1816 would not on its own justify exploration because it may have been brought from Brazil. However, exploration by a Canadian company in Cos. Fermanagh and Tyrone from 1996-2000 yielded pathfinder minerals for both kimberlite and lamproite [7] similar to those from Inishowen, that do justify further work. Karelian Diamond Resources is currently seeking prospecting licences for parts of Co. Fermanagh and Tyrone.

Glaciation

The Ekati mine (above) is in a glaciated region of Canadian Archaean cratonic rocks. Its discovery came from airborne magnetic studies, and stream sediment and soil sampling. Pathfinder minerals were found and then tracked in the up-flow direction, opposite to the glacial transport direction, a very long distance to their bedrock source. Individual kimberlite pipes at Ekati have surface areas mostly less than 3 hectares (ha), but ranging up to 20ha, with projected extent below the current surface of between 400m and 600m depth.

Pathfinder minerals found in Inishowen, Fermanagh and Tyrone indicative of possible lamproite and kimberlite, when considered together with aeromagnetic recognition of possible lamproite diatremes in Inishowen, suggest that distances transported by Pleistocene ice and post-glacial streams may not have been far and that the local area itself is prospective. Glacial transport directions varied over time and are therefore complex. If transport was significant, NW Scotland and Greenland will remain possible source areas until a nearer source is identified. Greenland seems far away but was closer to Ireland before the Atlantic Ocean started opening c. 60 million years ago well before the Pleistocene glaciation. This may be relevant if mineral grains were recycled since reaching the surface long before glaciation (see above).

Conclusions

Northernmost parts of Ireland are of interest for potential diamonds and further exploration is justified perhaps with attention to a larger area than hitherto addressed. Searching for diamonds in Britain and Ireland is not crazy and is taken seriously [8]. Shortage of space necessitates omission of more information and references.

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In memory of Dr. Robert (Bob) D. Young, a knowledgeable and inspired geologist.

Geoscience Ireland

Delivering Irish Expertise Overseas

by Andrew Gaynor, Business Development Manager, Geoscience Ireland

Geoscience Ireland (GI) is the geoscience business development cluster which supports its Member Companies in winning business in overseas markets. The 36 Members target mineral, water, environmental and infrastructure projects in markets including the UK, France, the Nordics, the Balkan States, sub-Saharan Africa, the Middle East and North America.

In winning business overseas, GI Members are supporting and diversifying the Irish geoscience sector which in turn creates highly-skilled domestic jobs; these are pivotal jobs that act as a "gateway" to further economic development. Since its inception, GI Member Companies have created more than 750 net new jobs, employing more than 3,300 people (1,900 of which are employed by small - and medium-sized enterprises (SMEs)) and generating more than €800 million in turnover.

GI is supported in its ambition to win business overseas by Geological Survey Ireland (a division of the Department of Commutations, Climate Action and Environment), Enterprise Ireland and the Department of Foreign Affairs and Trade.

Collaboration

The common vision and ambition of GI and its Member Companies is to target and win business overseas through collaborative efforts. Such efforts include the ongoing delivery and sharing of market knowledge and experiences, the communicating and peer review of Member activities, establishing networks and access points in target markets, and joint bidding on commercial projects.

The GI initiative is led by Sean Finlay, Director, and business development activity is supported by Andrew Gaynor, Business Development Manager. A key part of GI's business development is to provide quality networking and networks to leverage on behalf of its Members; today, the established GI network comprises a diverse range of export agencies, ministries, trade associations, chambers of commerce, domestic and overseas business networks, private sector contacts and research agencies and institutions.

Elizabeth Murphy and Stephen D Walsh are GI Market Advisors and provide the platform for Members to target and track international opportunities and tenders. Earlier this year, GI procured an online platform – delivered by Compass Informatics - for its members which captures and collates tender requests, business intelligence and market reports in a one-stop-shop: the GI Procurement Hub.

Recent collaboration between Members has led to commercial ventures such as:

- **SLR (Ireland)** and **Lisheen Technical and Mining Services (LTMS)** have combined project and commercial experiences in environmental and social consultancy (SLR) and mining due diligence (LTMS) to successfully bid for a World Bank-funded project which will deliver capacity building in **Mozambique**.
- **ByrneLooby** continues to develop its operation in the Middle East and is drawing on the geophysical expertise of APEX Geoservices for a civils project in the **Gulf**.
- **Priority Drilling** continues to partner with BRG for its geo-expertise with active mineral projects in **Scotland** and **Ireland**.
- **Verde Environmental** continues to work with **PW Group** in Nigeria.
- **PW Mining** and **QME** recently bid on a mining project in West Africa.

Geoscience: Booming and Blasting

Geoscience encompasses an array of science, technology, engineering and mathematics (STEM) disciplines and applications. The geoscience sector is an important one for the Irish economy. The overall economic impact of the sector is more than €3.2 billion and employs 24,700 people in Ireland (Indecon, 2016). Geoscience impacts a number of disciplines which include mineral exploration, geophysical and geochemical surveying, geotechnical and civil engineering, civil works, drilling, ecological, environmental and social consulting.

Government of Ireland, through its **Action Plan for Jobs,** published Geoscience Ireland as a case study in the delivery of a successful cluster. This is a notable milestone for geoscience in Ireland, and Geological Survey Ireland (GSI), which is now recognised in **national economic and enterprise policy**. This builds on the great work which has been done in very recent years from a research aspect, notably the Irish Centre for Applied Research in Geosciences (iCRAG) which has now secured a further €4.7 million funding from Science Foundation Ireland to progress its research programmes.

On behalf of the Geological Survey, GI led a successful application to SOLAS – Ireland's further education and training authority- which established a **Geo-Driller Apprenticeship**. The apprenticeship is to provide drillers with a dedicated FETAC level 6 qualifications; the need for this qualification was identified by the drilling industry in partnership with GSI and the Institute of Technology Carlow.

In January 2018, GI was delighted to announce the commencement of the 'Geo-Energy for the 21st Century' (GEO-ENERGY EUROPE) project. This collaborative project is funded by the European Commission's Competitiveness of Enterprises and Small and Medium-sized Enterprises **(COSME)** programme, and is aimed at supporting SMEs in accessing geothermal markets. Pole AVENIA, the French geoscience cluster with which GI signed an MoU in 2017, lead the application and was supported by GI and 6 other European counterparts. The project will be delivered over the next two years.

Outlook: Cautious Optimism?

Through its ongoing engagement with Members and stakeholders, GI will continue to identify overseas opportunities, and encourage market diversification and agility in a changing global landscape. The looming impacts of **Brexit** and potential trade wars between the super-economies will indeed call for cautious economic outlooks.

In the UK, the Royal Institution of Chartered Surveyors (RICS) expects the rail and energy sectors - sectors to which the geoscience skill set is pertinent - to be the most prominent contributors to construction output increases in 2018/2019. The government's commitment to

its high-speed rail infrastructure is evident though investment in wider economic and transport infrastructure varies from region-to-region across the UK which is indicative of cautious decision making, investment constraints and competing priorities. In its market survey, RICS noted that 21% more contributors reported a rise in workloads though Brexit-related uncertainties and the "unpredictability" engendered by recent shocks such as Carillion's collapse, as weighing on investment decisions. Such long term uncertainty and significant shocks are compounded by short term impediments to growth such as financial constraints, planning delays and labour shortages.

Shocks to trade agreements and policies could impact the development of the economic infrastructure which is required to deliver goods and commodities, though the likes of France and the Nordics are investing in substantial transport projects at present. Globally, more and more physical routes to market are planned to connect Europe with East Asia, while the Gulf region continues to advance similar projects and strategies. International and Financial Institutions, such as the World Bank, European and global development agencies, continue to invest in low-risk commercial projects in developing economies and GI Members have a proven track record in winning business in these markets.

Rebounding commodity prices, and growth in oil and gas prices, are positive for the exploration and extraction companies though challenges remain in both of these natural resources industries. Deloitte's 'Mining Industry Trends and Challenges' (2018) notes overcoming innovation barriers, sustainable productivity and operational (cost) efficiency, and talent acquisition as key trends in the sector. The cyclical nature of the mining industry means re-stocking depleted global reserves of gold, silver, copper, and cobalt is a key objective though budgetary constraints and hesitancy in engaging in acquisitions to feed the exploration pipeline remains a risk (Deloitte).

The demand for cobalt, and other battery-related metals, is a relatively new departure for the mining sector though acts as a headwind for the oil and gas industry which notes de-carbonisation policies as a headwind. The oil and gas sector has weathered the storms of 2015 and is witnessing growth in in its prices though still faces considerable headwinds in terms of geopolitical fragility. Critical for both extractive industries is the area of public perception which requires more attention.

Future Ambitions

- GI will continue to support its Members in those sectors in which they have sustained themselves while also supporting market diversification whether this is geographical regions or sectors. Its ambition is to:
- Support its Members in creating 150 net new jobs in 2018.
- Support its Members in bidding better through the GI Procurement Hub.
- Establish Ireland as a leader in geoscience expertise, and support innovation in the sector.
- Deliver balanced regional growth; in 2017, 60% of jobs created were outside Dublin.
- Deliver on GI's commitment to its COSME project.
- Assist in the delivery of the Geo-Driller Apprenticeship.
- Gain greater traction with International and Financial Institutions.

Irish Cement - 80 years from 1938 to 2018

by Brian Gilmore, Marketing & Communications Manager, Irish Cement

Life in Ireland has changed dramatically over the past eighty years. In 1938 the Irish population was less than three million. Just half the population was connected to the electricity network, and less than one in ten households had radio licenses.

Cars were still a rare sight on the roads, some people had cars but petrol was often in short supply because of rationing during the war years so cars regularly sat idle. If you speak with people who are in their eighties today, bicycles and horses and carts are what they remember for that time. Along the narrow country roads they were the main methods of transport, apart that is from walking. Back then a new bicycle cost £5 and long cycles to visit relatives, attend funerals or sporting events were not uncommon.

ICL Limerick avenue.

1938 was a significant year for the fledgling Irish state too, with Ireland's first president, Douglas Hyde inaugurated in June and the 20,000 seat Cusack Stand opened in Croke Park in August.

It was also a significant year for Irish Cement as on **23rd May 1938, Sean Lemass, then Minister for Industry and Commerce, officially opened the cement factories in Drogheda and Limerick**.

That event was the culmination of a concerted effort to develop an indigenous cement industry. In 1933 the Cement Act was established, which provided the legal framework for the formation of a cement industry in Ireland. In 1934, the State approved the first cement licence and in May 1936, Cement Limited was registered as a Limited Liability Company and the two cement factories opened in Limerick and Drogheda in 1938.

In December 1978, the name of the Company was changed from 'Cement Limited' to 'Irish Cement Limited' to reflect the long history of indigenous cement manufacture at the two factories and more appropriately brand the Company and its products as being 100% Irish.

Irish Cement today has a skilled workforce, operating two modern energy-efficient cement factories in Platin and Limerick which manufacture high quality cement for the construction sector both in Ireland and in European export markets. The company continues to modernise and adapt both factories to reflect best practice and technology to ensure the long-term sustainability of the operations. Among the more recent investments was the installation of **Kiln 3 in Platin one of Europe's most energy efficient cement production lines**. There has also been success in reducing dependence on imported fossil fuels by establishing **alternative fuel programmes at both factories**. Platin has led the way, achieving over 50% heat input from alternative fuels. The Limerick factory has recently had success in achieving planning approval for fossil fuel replacement to begin subject to a positive outcome of the Environmental Protection Agency licence review.

Platin Cement Factory.

Inspection of the kiln shell cooling fans, Platin Cement Factory.

Central Control Room, Limerick Cement Factory.

Robot arm in the autolab, Platin Cement Factory.

The development of our modern way of life in Ireland is closely linked to the improvements in housing, transport and infrastructure, where cement and concrete continue to play a vital role. Irish Cement rightly remains proud of this close association over the past eighty years with the development of our modern Irish economy, and is well positioned to continue to support our customers with high quality cement and technical support as Ireland builds its future.

If we look 80 years in to the future to the year 2098, the eve of the next millennium it is hard to know what life will be like. Automation of our transport network is expected, artificial intelligence will be more integrated into daily life and robots will be assigned routine repetitive occupations. Healthcare will be more personalised opening up the possibility of longer healthier lives for children born today.

Cement and concrete will continue to be fundamental to our built environment. Today, concrete is the second most used substance on the planet, after water, and it is difficult to foresee an alternative construction material being developed over the next 80 years. Utilities like water and energy generation will be critical to future populations so the challenge for the cement and concrete industry will be to deliver resource efficient and technology-enabled structures for the smart cities of the future.

Institute of Quarrying

Getting Age Ready for Quarrying's Future

by Julian Smallshaw, Head of Educational Development at the Institute of Quarrying

Almost 10 million people in employment in the UK are over the age of 50, equivalent to more than 30% of the workforce[1]. The age profile of people employed in the mineral extractives sector is even more polarised than the wider national picture, with 55 per cent aged over 45 years and only 17 per cent aged 18-34[2]. In future decades, a high proportion of this group will leave work permanently, taking acquired skills and experiences with them.

Long-term demographic change means that there is unlikely to be a burgeoning supply of younger people in the UK who will enter the labour market to replace retiring workers.

Future-proofing the sector's workforce is an imperative that is being addressed across the industry as a priority. New educational pathways such as T Levels, alongside initiatives including MP Futures 'Inspiring Futures', as well as a raft of activities initiated by operators large and small, all share the common goal of attracting young people into the industry.

James Thorne is chief executive officer at the Institute of Quarrying (IQ): "There is an urgent need to understand how the sector will replace a vast proportion of its workforce in the short to medium term due to retirement.

This is an industry-wide issue. As you'd expect, IQ is playing its part. We have developed a compelling partnership with the University of Derby Centre for Mineral Products that is delivering tailored learning for young people interested in developing a career in our sector, as well as for those already working in mineral extraction.

The Centre for Mineral Products delivers industry standard and globally recognised qualifications to the mineral products sector. That's about developing the industry leaders of the future.

Qualifications are delivered using blended learning, minimising the time spent away from work and learners complete work-based projects, meaning learning is applied in the workplace straight away."

Industry relevant qualifications - from higher apprenticeships to honours level degrees - with content and materials developed by IQ, are delivered through the

University of Derby. Amongst these is the Higher Apprenticeship in Mineral Products Technology, which combines practical skill development with higher education qualifications. The course develops competence in the workplace and prepares apprentices for a supervisory position and is designed in partnership with industry and leading professional bodies.

Other organisations with a stake in the Centre for Mineral Products include the Institute of Asphalt Technology (IAT), Concrete Society, International Clay Technology Association, Road Surface Treatment Association and the Mineral Products Qualifications Council (MPQC).

Inspiring futures

MP Futures, part of MPQC, is the lead player in the 'Inspiring Futures' initiative, which promotes careers in the mineral extractives industry to the next generation. Anthony Elgey is General Manager at MP Futures. He says: "I've worked in the quarrying industry for over 20 years and this is an issue that we've been talking about for as long as I can remember. That's why 'Inspiring Futures' is so important and why the industry's employers are collaborating with this project.

"There's a lot of great work going on across the industry but 'Inspiring Futures' is about bringing all stakeholders together - from the professional institutions, trade bodies, employers to operators large and small - to promote the great things we do. We need to get out into the community and engage with young people."

"An integral part of 'Inspiring Futures' is the Industry STEM Ambassadors. These are passionate people working in quarrying and minerals extraction tasked with promoting what we do to young people with an aim to capture the imagination of a new generation. Our ambassador programme is just one touchpoint - we're also producing resources designed to connect with young people on their level, so innovative video and social media will also play a big part in how we reach out."

Inspiring Futures feeds into the UK's existing STEM (Science Technology Engineering Maths) Learning Network. This network has over 30,000 voluntary ambassadors from more than 2,500 employers, operating through a web of 19 regional hubs.

Anthony continues: "By encouraging and helping our staff to engage we can present a unified and coherent front, empower and develop our employees, engage our local communities, dispel the myths and

preconceptions about our sector thereby improving its social standing, and finally, plug the terminal skills gap that has loomed over our sector for decades and is set to grow into a full blown crisis."

Higher apprenticeships

Daniel James is Quarry Manager at Hanson UK's Penderyn quarry located eight miles north of Aberdare in South Wales. He was among the first intake on Hanson UK's LEAD Higher Apprenticeship programme.

"When I finished school back in 2012, I went to work as a trainee in dentistry, but I quite quickly realised it wasn't the career for me. While searching through the job ads and checking out courses, I spotted Hanson UK's LEAD Higher Apprenticeship programme.

I knew quite a few people who already worked within the industry as Hanson UK had a quarry in my local town, Builth Wells. Talking to them really captured my interest, so I decided to apply for a position and I was lucky enough to be successful.

I was very excited by the career opportunities available to me, whilst at the same time being able to complete a higher education qualification. I hadn't any interest in going to university, so this provided the perfect pathway for me in that I could get real work experience, further my education and earn a wage.

That was over five years ago and I've now worked my way up to the role of Quarry Manager, responsible for a site that has been worked continuously since 1890.

I have completed the MPQC Level 6 Diploma in Health, Safety & Environmental Management and I am currently coming to the end of my Honours Degree in Minerals Management at the University of Derby. I have also completed a wide range of internal and external training courses, including IOSH Managing Safely, Confined Space Entry, Management of CDM projects, First Aid at Work and Geotechnical Supervision, to name a few. This extensive training has given me the knowledge and confidence required to fulfil my job role effectively."

IQ's James Thorne concludes: "What we're seeing is a groundswell of activity, with the whole minerals extractive sector pulling together with the shared objective of securing our future. As an industry we are jointly stimulating interest and awareness among young people, creating new educational pathways to explore career opportunities in our sector that map to real jobs. The momentum is there, now is the time to work together to secure our future."

1 *Avoiding the demographic crunch: Labour supply and the ageing workforce - Chartered Institute of Professional Development June 2015*

2 *Labour Market Intelligence Study: Quarrying, mineral products and mining - MP Futures October 2016*

Minister Sean Kyne T.D. leads Team Ireland at PDAC 2018

by Ray Scanlon, Principal Geologist, Geological Survey Ireland

The Prospectors and Developers Association of Canada (PDAC) hosted its annual International Convention, Trade Show and Investors Exchange in Toronto last March. The PDAC Convention, the world's largest annual mining convention, welcomed over 25,600 delegates from 125 countries - the highest attendance since 2013. The growing attendance reflects improved investor sentiment in the sector and recovering prices in zinc, copper and battery-related metals.

Team Ireland

'Team Ireland' has been present at PDAC for over 25 years and fielded one of its largest and strongest teams at PDAC 2018. **Sean Kyne TD, Minister of State for Natural Resources**, travelled with the Irish delegation and delivered the keynote address at the "Ireland – Open for Business" forum, opened the department-hosted 'business breakfast', attended the International Mines Ministers' Summit, and met with a number of private and public sector companies and agencies.

The **Ireland Booth** at the Trade Show – co-hosted by Government Departments from the Republic of Ireland and from Northern Ireland – was the focus for promoting the minerals industry across the island of Ireland. Participants at the Ireland Booth were the Exploration & Mining Division (EMD) of the Department of Communications, Climate Action and Environment (DCCAE), the Geological Surveys of Ireland (GSI) and Northern Ireland (GSNI), Geoscience Ireland (GI) and the Irish Centre for Research in Applied Geosciences (iCRAG).

The **'Ireland – Open for Business'** forum, now in its 3rd year, attracted over 100 attendees - 57% of whom were from outside of Ireland - and was opened by **HE Jim Kelly, Ireland's Ambassador to Canada**.

The GSI and GSNI delivered updates on its respective programmes, recent initiatives and cross-border collaboration. Enterprise Ireland and Invest Northern Ireland provided overviews of doing business in their respective jurisdictions and Ireland's export capabilities.

Gold and Base Metals

The forum provided a platform for both gold and base metals exploration companies on the island of Ireland to provide overviews of recent activates and developments. The gold exploration companies included **Dalradian Gold** which has submitted its Minerals Planning Application and Environmental Statement to develop a gold mine at Curraghinalt, Northern Ireland, and **Conroy Gold** which detailed its targets on the Longford-Down gold trend.

The base metals session included updates from **Glencore's** zinc-lead (Zn-Pb) deposit at Pallas Green, Co Limerick; **Group 11 Resources** and its Zn exploration projects at Ballinalack, Stonepark and Silvermines; **Adventus** and its Zn-Pb projects in the Limerick Basin area; **Hannan Metals** Zn-Pb-Ag (silver) project at Kilbricken; **Unicorn Mineral Resources** projects in the Midlands, Clare and Waterford; and Zinc of Ireland's **(ZMI)** Zn-Pb projects in Kildare.

Geoscience Ireland Member Companies presented their service offerings and export capabilities during the export session of Ireland day; the GI companies included **Priority Drilling, Lisheen Technical and Mining Services, SLR** (Ireland), **Irish Drilling** and **ERM** (Ireland). Other GI Members which attended the PDAC Convention included **QME**, **Mincon**, **BRG**, **PW Mining International** and **PW Group**. Brendan Morris, outgoing president of the **IMQS**, provided an overview of the society.

Minister Kyne, in delivering his keynote address to the delegation, noted Ireland's strong and consistent performance in the Fraser Institute rankings in terms of 'policy perception' (ranked 1st) and 'overall attractiveness' (4th), and noted the signing of the Minerals Development Act 2017 which provides Ireland with a modern and robust regulatory regime for exploration and development. Minister Kyne focussed on the successful and ongoing delivery of **Ireland's data acquisition programmes** including GSI's Tellus programme which is Ireland's geophysical airborne survey and geochemical survey, and the EMD's new Exploration Data Discovery database which captures raw exploration data in a single database.

Domestic and Export Markets

Minister Kyne was encouraged by the buoyancy of domestic and export markets. Strong export demand has witnessed GI Member Companies create over 750 jobs since its inception in 2012, and generating over €800 million in turnover for the Irish economy - the overall impact of geoscience activity on the economy is in the region of €3.2 billion (Indecon, 2016) with the output of lead and zinc extraction being valued at €60m and €490m respectively. He was also delighted to announce the appointment of **Prof Murray Hitzman as the new director of iCRAG** as the research centre moves in to its second phase as supported by Science Foundation Ireland.

The Ireland presentation attracted some robust comments from a small number of activists opposed to gold mining in Northern Ireland. At the subsequent networking reception, several members of Ireland's delegations, including Minister Kyne, engaged constructively with the objectors.

Post Script

Team Ireland's sustained approach to accessing Canadian markets witnessed 13 Irish Ministers visit Canada in 12 months. During its visit to PDAC, Geoscience Ireland also met with Ontario government to gain insights of projected expenditure plans and public procurement opportunities for the region. The number of opportunities for Irish consultancies and contracting companies to expand their offering to the Canadian market has been enhanced by way of the EU-Canada Comprehensive Economic Trade Agreement (CETA). GI continues to **work closely with Enterprise Ireland** on the matter.

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Development of the Underground APCr Recovery Facility at Kilroot Salt Mine, Co. Antrim

by Jason Hopps (Irish Salt Mining & Exploration Co. Ltd., Project Manager)
Tim Paul (SLR Consulting, Technical Advisor to ISME)

Irish Salt Mining & Exploration Co. Ltd. (ISME) own and operate the underground salt mine at Kilroot, northeast of Carrickfergus, Co. Antrim. The company commenced salt extraction at the mine in 1965 and it has been in continuous operation to the present day.

The mine produces approximately 500,000 tonnes of processed rock salt annually for de-icing of roads during the winter period. Kilroot Mine is the only salt mine in Ireland, and one of only three rock salt producers in Ireland and the United Kingdom. The mine has extensive proven and permitted salt reserves which are expected to last for the next 25 years at current production levels.

ISME has 56 full-time employees at the Kilroot Salt Mine. In addition to the full-time employees the mine also employs 50 to 60 sub-contractors through haulage, maintenance and those involved in the supply of plant and machinery.

The mine is operated under planning permissions granted by the Planning Service and Mid & East Antrim Borough Council (MEA) and also under mining leases issued by the Department for the Economy Northern Ireland (DfE). SLR Consulting (SLR) is the geological, planning / permitting; environmental and technical advisor to ISME.

In 2017 ISME was granted a permit under the Pollution Prevention & Control (Industrial Emissions) Regulations (NI) 2013 from the Northern Ireland Environment Agency (NIEA) and full planning permission from MEA for an Underground APCr Recovery Facility to provide permanent support to the underground workings at Kilroot Salt Mine.

What is APCr?

Energy from Waste (EfW) plants produce Air Pollution Control residues (APCr). APCr is categorised as a hazardous waste owing to a high free lime content and elevated levels of certain heavy metals. There is no hazardous landfill capacity available nor are there any licensed facilities to accept and recover or dispose of APCr on the island of Ireland.

For over 20 years, APCr has been used to stabilise the void spaces of underground salt mines in Germany. These salt mines have provided a recovery outlet for a large number of EfW facilities across Europe which rely on them for managing their APCr materials.

Photograph of core of Pre-Treated APCr from the Duleek EFW plant undergoing unconfined compressive strength testing (UCS) at Queens University Belfast – August

Why Kilroot Salt Mine?

In addition to the statutory obligations under mining legislation, ISME also operates the mine under legally binding obligations set out in mining leases which require the company to maintain the long-term stability of the underground mine workings.

APCr has pozzolanic (cement like) properties which means that it is an ideal substitute to the raw materials historically used to stabilise the salt mine voids. Salt mines are highly suitable environments for containing APCr materials. The impervious nature of salt rock and surrounding strata offers an ideal long-term geological and hydrogeological barrier and a geo-technically stable environment to guarantee that the residues are permanently isolated from the biosphere.

APCr Strength Testing Programme

A programme of testing was undertaken on pre-treated specimens of APCr material. The pre-treatment process comprises of adding water to the APCr material, and following the pozzolanic reaction, it solidifies into a cemented mass. This testing programme was undertaken independently at Queen's University, Belfast.

The purpose of the testing programme was to determine the strength properties of the pre-treated APCr material. Tests were carried out on various APCr (flue gas treatment residue (FGR) & boiler ash) mixes to determine the unconfined compressive strength by subjecting the samples to axial compression tests – see Plate 1.

Based on the testing programme undertaken the test results confirm that the pre-treated APCr material provides a stronger support than the existing pfa / cement infill mix used for mine infilling. The recovery of pre-treated APCr placed within worked out areas of the existing mine will maintain permanent support to these areas.

Long Term Risk Assessment

The assessment dealt with three time periods T0, T1 and T2 and assessed the risk of water ingress to the mine for these time periods and the resultant potential contamination of the surrounding surface receptors.

T0 is the operational period of mining, T1 is 0-500 years post-mining and T2 is 500 to 50,000 years post-mining. In T0 the mine will be operational and no pathway will exist from the underground recovery facility to the external biosphere. T1 is a period of 'institutional control' where no pathway will exist from the underground recovery facility to the external biosphere.

T2 calculated the dilution of contaminants of concern in the event of inundation of groundwater to the mine workings and the resulting rate of flow to the surrounding receptors - coastal waters, lakes and agricultural land. The predicted resultant concentrations at these receptor locations were below UK drinking water standards and therefore acceptable.

Project Timelines

Key stages in the overall timeline for the project are summarised below:

2012 – 2015	ISME/SLR visited APCr recovery facilities in German salt mines; met with Indaver Ireland which operates a successful EFW facility at Duleek in Ireland; discussed principles with NIEA; and developed the facility concept best suited for ISME requirements at the mine.
June 2015	ISME/SLR met with MEA to introduce the proposal and notify them of the intention to submit a planning application. Local councillors visited the underground mine and the project concept was presented.
July 2015	A Proposal of Application Notice (PAN) was submitted to MEA.
Oct 2015	A Pre-application Discussion Document (PAD) was submitted to MEA.
July 2015	SLR Ireland commenced an Environmental Impact Assessment.
Dec 2015	ISME held public events at a local community hall which were attended by local community members, local councillors, an MLA and the local press. Press articles were published in local newspapers.
Feb 2016	A Pre-application Community Consultation (PACC) Report submitted to MEA.
March 2016	The planning application was submitted to MEA with full Environmental Statement and Habitats Regulations Stage 1 Screening.
July 2016	In response to a further information request Addendum1 to planning application was submitted to MEA.
August 2016	The Pollution Prevention Control (PPC) permit application was submitted to NIEA accompanied by Waste Management Policy & Regulatory Report, Site Condition Report, Environmental Risk Assessment, Hydrogeological Risk Assessment, Operational Plan and Management System, Closure Plan, Expenditure Plan & Financial Provisions.
March 2017	In response to a further information request Addendum2 to planning application was submitted to MEA.
March 2017	Long Term Risk Assessment submitted to NIEA and MEA.
June 2017	Planning Permission LA02/2016/0196/F was granted by MEA for the Underground APCr Recovery Facility.
Sept 2017	PPC Permit P0547/16A granted by NIEA for the Underground APCr Recovery Facility.

Photograph of ISME Surface Transfer Area – showing site office, reception area and No.2 Drift entrance – May 2018

Facility Operation

The APCr is pre-treated before arriving at the mine by mixing it with water and placing it in 1 tonne flexible intermediate bulk container (FIBC) bags. Mixing with water causes a pozzolanic reaction which solidifies the APCr into a block within the bag of sufficient strength to permanently support the mine workings.

The pre-treated and bagged APCr is then transported by heavy goods vehicle to the specifically installed Surface Transfer Area (STA) with drainage system, site office and security barrier and fencing.

The FIBC bags are transferred to mine vehicles at the STA and transported deep underground using the recently installed No.2 Access Drift. They are then placed as required to form support structures and finally sprayed with rock salt to seal gaps and stabilise the structure, refer to Plate 3. The natural convergence of the caverns closes around these structures therefore permanently encapsulating them.

The recovery facility is currently permitted to receive 50,000 tonnes of pre-treated APCr per annum and is operational 07.00 to 17.00 Monday to Saturday. It will provide direct employment for an additional 4 to 10 people depending on the APCr intake volumes. The facility is managed by qualified ISME personnel with the appropriate Operator Competence Certificate (OCC) awarded by the Waste Management Industry Training and Advisory Board (WAMITAB) for this type of facility. Acceptance, handling & placement procedures are in place and comply with the requirements of the PPC permit and planning permission.

There is considerable void space within the mine and the life of the facility is expected to be in excess of 50 years. The facility has been developed after 6 years of careful consideration and planning, and with input from SLR Consulting (ISME's technical consultants), the Northern Ireland Environment Agency, Mid and East Antrim Borough Council, and Indaver Ireland.

The objective of the facility is to provide permanent stabilisation of the Kilroot Salt Mine workings through the recovery of pre-treated APCr materials. This approach is consistent with and supports the principle of self-sufficiency and proximity, the proper application of the waste hierarchy and circular economy whereby the maximum value is being extracted from all waste through reuse, recovery or recycling.

(Source: Prognos, RSP, Schulte, J. (2012), Outlook for underground waste management in Germany)

German Salt Mine – Solidified & Bagged APCr Structure at an Underground APCr Recovery Facility

iCRAG
3 Years on...

by Prof. John Walsh, Founding Director, iCRAG

Throughout 2017, iCRAG's raw materials research has been progressing across the Centre's four main minerals aims. Here we describe some of the key research developments and highlights.

The first major aim of iCRAG's materials research programme is to develop improved models for the origin, geometry and evolution of **Irish Zn-Pb ores** and define better geological, geochemical and geophysical methods for their discovery.

So far, the Centre's investigation of 3D metal distributions has established a model for fluid flow and geochemical vectoring at deposit scale which is linked to a refined 3D structural model for mineral deposit evolution. The scaling of different fault zone components and examining the links between displacement and structural and flow connectivity are topics which are also being explored.

These studies provide a basis for defining the structural controls on fluid flow from feeders into the hanging walls of bounding faults. Our research has also progressed on the regional scale with the construction of 2D and 3D models from seismic, borehole and map data, providing improved definition of basin evolution and architecture, as a prerequisite for lithospheric and thermal modelling.

We have also begun investigating **potential sedimentary exhalative deposits in the sequences overlying North Midlands mineral deposits**, in particular Navan and Ballinalack, including examination of the origin and geochemistry of sulphides within the UDL sequence directly overlying the newly discovered Tara Deep deposit. This work should provide an improved understanding of Zn-Pb mineralisation and has the potential of underpinning new exploration models.

The second major aim of iCRAG's materials research programme is to develop improved models for the origin, geometry and evolution of several prospective **mineral deposit types in Ireland that are not currently exploited**, and define new, primarily geochemical and mineralogical, methods for their discovery.

In this regard, an investigation of Cu vein systems in the Old Red Sandstones of the Munster Basin is progressing well, with an improved definition of the origin and geometry of the veins developed within Devonian rocks of the Munster Basin, particularly concentrating on well exposed systems like those of the Allihies Deposit.

This study has led to redefinition of the geometry and timing of these structures, with our work suggesting a post-Variscan age and extensional origin.

A related study is investigating the extent to which Cu mineralisation in the South of Ireland is linked to accentuated Cu mineralisation of the Zn-Pb Orefield, and therefore the potential role of the ORS as a source of Cu.

These exciting projects could have very significant implications for the genesis of ore deposits in Ireland.

Other studies are concentrating on the genesis of Lithium pegmatites associated with the Leinster granite and vein hosted gold deposits in Northern Ireland.

Our third aim is to address the urgent global need to increase the **recovery of ECEs from Zn and Cu ores in support of the energy transition**, the reduction of energy used to process ore to mitigate greenhouse gas emissions and to develop offshore exploration methods for rare and base metals. iCRAG is developing world class in situ analytical techniques for the characterisation of trace and ultra-trace metal distribution within minerals.

A key highlight in 2017 has been the development and publication of a software tool that extracts quantitative data from semi-quantitative 2D arrays with a variety of algorithms.

iCRAG's final aim for materials is to develop a new, multi-disciplinary approach to **characterising aggregate sources**, including chemical and Raman fingerprinting of pyrite-bearing quarry products and predicting aggregate behaviour with accelerated aging in laboratory tests.

Additionally, a goal is to quantify the attributes that make certain quarry products high value and thus of export interest. In the last year, the Centre has developed a new methodology for 'fingerprinting' road aggregates with Raman Microscopy assisted petrographic methodologies.

This is already being used by Transport Infrastructure Ireland, Cork National Roads Office and Westmeath County Council and under trial for inclusion in a new Irish Standard for aggregate traceability.

Industry engagement remains a key priority for iCRAG and in April, iCRAG 2017: A Research Showcase was held in the Aviva Stadium. This large event showcased the full range of iCRAG's research mainly through poster presentations and demonstrations, with 54 industry people attending. Discussions centred around current iCRAG projects, and also key emerging trends in the applied geoscience sector with particular relevance to iCRAG materials research.

2018 promises to be an exciting year for the Centre, with the arrival of **Prof. Murray Hitzman as Science Foundation Ireland Research Professor and iCRAG Director**. Prof. Hitzman is one of the world's leading economic geologists and within iCRAG his research efforts will be focused on studying the geology, geochemistry and geophysical signature of mineral deposits in the Irish zinc-lead orefield and other mineral systems across Europe and Africa.

Pat O'Connor; Passionate & Committed To Serving the Industry

by David Stokes (4SM)

There are few in the industry who haven't heard of Pat O'Connor; he has been supplying all types of conveyor belting and associated products to quarries and mines across the island of Ireland for almost three decades.

A member of the Irish Mining & Quarrying Association since 1990, Pat is passionate about everything he does both inside and outside his highly successful business which he runs single-handedly from a six acre site just off the N7 Dublin to Naas motorway. As his broad range of customers will readily tell you, his friendly, accessible and professional approach to business is just one of the secrets of his success.

"The needs of my customers come first, no matter the time of day or night; I am 100% committed to providing a quality service 24/7," says Pat who, although past retirement age, has no intention of taking life easy just yet.

"The last three years have been among the busiest I have ever been as the economy continues to grow in the wake of the recession," adds Pat, whose very first customer back in 1989 was Roadstone; today, his client base reads like a 'whose who' of the quarrying and mining sectors.

"When I began I hadn't two coins to rub together," recalls Pat, "and there were many challenges in those early days, but taking the view that 'every good businessman runs a well calculated risk' I not only survived, but thrived."

Pat is most definitely a 'people' person, putting the interests of others before his own, which is why he often finds himself on the road criss-crossing Ireland for 24 or even 48 hours without a break, providing his customers with that really is an unrivalled service – a service that is backed up with quality belting, sourced from GB Conveyors in Doncaster, and other products that include fasteners, rollers and skirting rubber.

He recently acquired the 32 Counties agency for Kraiburg hot jointing products which has put him in touch with vulcanisers throughout the country. A German company, Kraiburg has been developing, producing and selling high quality rubber compounds since 1947.

Pat became an IMQS member nearly 30 years ago, primarily to increase his knowledge of the industry. "I wanted to learn all about the quarry business without having to go back to College; the Society's regular talks and presentations back then were invaluable to me, as were the opportunities to network with like-minded people."

So what of the future? "I don't plan to slow down," says Pat, who would be widely known among motor rally enthusiasts having raced his way to no less than seven Circuit of Ireland Rally titles in his younger days. "I have a keen interest in race horses and aim to have a legend winner sometime in the future," adds Pat, who is also planning to open a riverbank restaurant in a little Westmeath village near Mullingar.

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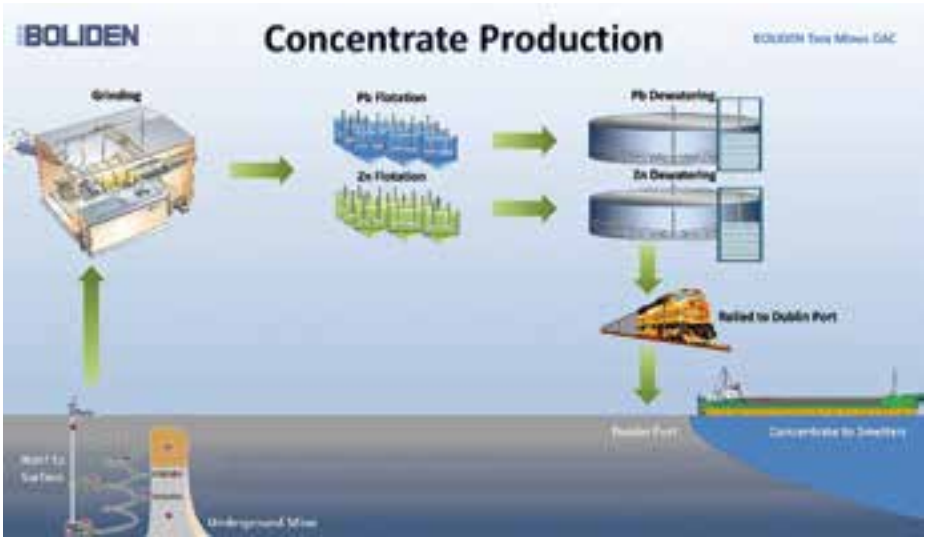
Flotation Development at Tara

by Colm Rice, Process Engineer, Boliden Tara Mines

Boliden Tara Mines is Europe's largest zinc mine. Production began in 1977 and to date over 90 million tonnes of ore have been processed. Today the mine is owned by the Swedish metals company Boliden which is a world class metals company with a focus on sustainable mining and metal production. The company has operations within exploration, mining, smelting and recycling in Sweden, Finland, Norway and Ireland. Target production in Tara is in the order of 2.6 million tonnes of ore mined annually, for the production of zinc (sphalerite) and lead (galena) mineral concentrates.

Processing Overview

There are three stages in the production of lead and zinc concentrate at Tara; Grinding, Flotation and Dewatering.



Processing Overview

Grinding

Grinding, also referred to as liberation, is the first stage of the concentration process. The objective of grinding is to break down the ore down to a size where the lead and zinc minerals are no longer surrounded by gangue, or waste, minerals and rock. At Tara, we aim to produce a grinding product of 85-90% of the particles less than 75mm.

Flotation

This is where the mineral separation happens. The grinding product is first treated with chemicals, which either aid collection of the minerals or stop unwanted gangue material from being collected. This treated material, in slurry form, is then put into tanks where it is given air and agitation. The chemicals added allow the mineral being collected to attach to the bubbles in the slurry and rise, then overflow, the tank. The overflow is collected as the product of the flotation process.

Dewatering

The products from flotation need to first be dried before they can be transported to Dublin for shipping to smelters overseas. For this, hydraulic batch pressure/air filters are used. These filters dry the zinc and lead concentrates to safe transportable moistures. Once dried the concentrates are transported offsite on trains.

Flash Flotation

Flash Flotation

Flash flotation is a new addition to the Tara concentrator process. It is currently being trialled in pilot plant scale tests. Flash flotation uses the same principle as regular flotation of attaching minerals to bubbles and collection of the overflowing froth. Where it differs from regular flotation is in the increased velocity that the particles are moving in the tank. This increased velocity is due to the decreased size of the flash flotation tank (80% less approximately). Why velocity is important is because mineral attachment to bubbles is a function of momentum and momentum is a function of velocity and mass. There is a threshold value of momentum in flotation where, if it is not exceeded, a particle will be unable to attach to a bubble. So, in flash flotation, the increasing of the velocity of the minerals going through the tank should result in an increase of recovery of minerals that would normally be too light (small or over-ground) in regular flotation to be collected.

Flash flotation is being used in Tara as a means to increase the overall recovery of lead mineral. It has been observed over years of analysis, that in the product from our grinding circuit the lead mineral particles are proportionally very small. The test flash flotation unit has been installed in a strategic location in our grinding circuit. It is still too soon to say whether flash flotation will be adopted in full-scale production at Tara, but initial indications are very promising.

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Roadstone Belgard Quarry
Integrated Constructed Wetland (ICW)
Case Study 2017

by Ciaran Greenan, Belgard Quarry Manager, Roadstone Limited

BACKGROUND

In 2017 Roadstone retained VESI Environmental Ltd. to design and oversee the development of an Integrated Constructed Wetland (ICW).

SITE SUITABILITY

The quality and quantity of the quarry's drainage, as well as its location, landscape, geology, soils and hydrology, along with necessary economic, social and biodiversity considerations were essential to the ICW's design and construction.

Land survey showed an area to the southwest of the quarry to be most suitable for the ICW. Desk-studies and field investigation to determine ground conditions (lithology and hydrogeology) were made. These showed the proposed site to be suitable, affording natural protection of ground water and soils suitable for the ICW's construction and operation.

ICW DESIGN

Critical considerations for the ICW's design was the need to address all sustainable functional and aesthetic requirements, with regard to site specific inflows and their vectored constituents, including:

Roadstone Integrated Constructed Wetland - Recently established

1. Flows from all pumped quarry drainage to the proposed ICW,
2. Physical, chemical, and biological properties of the pumped inflow,
3. Local climate including average annual rainfall.

Taking into account these factors and the land area available, a functional area 10,700m2 was considered optimum. Two treatment cells, 3,950m2 and 6,750m2 respectively, were designed. Inter-connecting pipework and channels allow inflowing water to flow in sequence through each cell, minimising priority flow, with a final discharge to the Kingswood Stream tributary.

Fig 1. Photo taken from Southern bank overlooking the ICW site prior to earthworks (February 2017).

Fig 2. Photo taken from Southern bank overlooking the ICW site prior to earthworks (February 2017).

Fig 3. Both ICW cells completed and topsoil in place during initial planting. Note the channel along the Southwest boundary, directing through-flow from Cell 1 to Cell 2 (May 2017).

CONSTRUCTION

Construction of the ICW at the Roadstone Belgard Quarry commenced in March and was completed in May 2017. The time scale set for the works was 11 weeks and included:

1. Construction of two shallow treatment cells with a combined surface area of 10,700m2 with an operational water depth of less than 150mm and a base level set at 1 meter below the top of the retaining embankment.
2. An open water channel to carry water from the first receiving cell to the second cell along the south-western boundary of the site.
3. Construction of access roadways to all sections of the wetlands
4. Installation of 3 parallel 300mm diameter interconnecting pipes between ponds.
5. Installation of 3 parallel 300mm diameter pipes at the inlet and outlet with manholes and sampling chambers.
6. Installation of a manhole and sampling chamber between the cells.
7. Planting of a range of tall-emergent plant (helophyte) species of known performance for treating through-flowing water.
8. Landscape works that included tree, shrub and grass-seeding.

VEGETATION ESTABLISHMENT

Planting was carried out by the contractor Killeen Civil Engineering Ltd. upon completion of earthworks in May 2017. Plants were supplied by VESI Environmental Ltd. from its nursery facilities and were delivered on site for each wetland cell as suitable planting conditions allowed. The ICW design focusses on the use of native plants in order to enhance the biodiversity of any given site and does not attempt to introduce non-native species for vegetation cover. The primary species list for planting was as follows:

- Glyceria maxima, Sweet water grass
- Typha latifolia , Common bullrush
- Typha angustifolia, Narrow leaved bullrush
- Iris pseudacorus, Common iris
- Schoenoplectus lacustris, Clubrush
- Carex riparia, Common river sedge

Additional marginal native plant species were planted along the margins of each cell in keeping with the establishment of complementary biodiversity and aesthetics. Small quantities of aquatic vegetation were planted along the channel between Cell 1 and Cell 2. The southern boundary of the site was planted with native tree and shrub species to further increase the biodiversity and aesthetic value.

These additional plantings were undertaken directly by VESI Environmental Ltd.

COMMISSIONING

The ICW was commissioned immediately after construction and planting was complete. As the works were completed mid-year, it will be mid-2018 before the ICW's vegetation is fully established. All water flows, including peak rainfall events, are intercepted and flow through the ICW. Treatment performance will continue to improve as the vegetation becomes more established.

The ICW has been operational since the start of August 2017. It now treats all water from the site before discharging to the stream. The ICW is closely monitored during commissioning to ensure treatment performance reaches design performance.

CONCLUSION

The ICW at Roadstone's Belgard Quarry and associated lands was constructed in 2017 to handle the quarry's drainage waters before their discharge to an adjacent stream. The available land at the facility has been transformed from a disused state to a highly aesthetic and diverse natural habitat. It demonstrates how effective treatment with optimum outcomes for the wider environment can be achieved in an economical manner. This ecologically engineered approach to water treatment is not only cost effective, but provides potential habitat for local wildlife within the conurbation of Dublin. Designed to yield optimum outcomes intercepting and treating water through the reanimation of a wetland ecosystem, its social, economic and environmental impacts deliver new perspectives for the comprehensive management of water and Roadstone's sustainable environmental commitments.

Fig 4. Cell1 fully flooded and through-flow entering Cell 2 (May 2017)

Fig 5. Aerial photo facing Southeast after completed wetland planting and flooding of ICW (July 2017).

Fig 6. Aerial photo from Southern boundary overlooking ICW (November 2017)

Ecocem Announce New Production Facility

by Micheal McKittrick, Managing Director, Ecocem Ireland Limited

In September 2016, Ecocem France announced plans to build a new production plant in Dunkirk, Northern France. This plant, which started production in May 2018, was officially opened on the 14th June 2018.

This new production plant is located adjacent to ArcelorMittal's blast furnaces in Dunkirk. Preliminary works began in September, 2016 with the foundation stone being laid at the beginning of 2017. Works completed over an 18 month period, following an investment amounting to €37 million by Ecocem France, which is a joint venture between ArcelorMittal and Ecocem Materials Ltd. The initiative will create 26 direct jobs by the end of 2018, expanding to 35 direct jobs in the longer term. The plant's activities will also generate indirect employment, particularly in the maritime and road logistics sectors.

The Dunkirk site has an initial production capacity of 750,000 tonnes, which has the potential to increase to 1,400,000 tonnes. The new Ecocem site is in excess of 5,200m² and equipped with a vertical mill, mixer and storage facilities on a 4-hectare plot in the port of Dunkirk.

Both Ecocem and ArcelorMittal share the same strategic objectives of adding value to blast furnace slag. Their willingness to pursue this strategy together was recently strengthened with ArcelorMittal's share of Ecocem France's capital increasing from 30% to 49%.

The proposed product line is similar to the Fos-sur-Mer plant in the South of France where Ecocem France invested in the construction of new silos and a mixer on the local ArcelorMittal site in 2016. The two French plants comprise state of the art facilities and equipment, which enables Ecocem supply the region of France as well as other countries through exports.

Dunkirk, a door to Northern France, the UK and Northern Europe.

With this new production plant in Dunkirk, Ecocem France has access to the markets in the North of France and the Ile-de-France region which includes the Paris region. From Dunkirk, Ecocem will supply

The opening ceremony, Donal O'Rian (in the yellow hat) standing beside Conor O'Riain watch on with members of the Ecocem and AcelorMittal management as the Irish Ambassador to France, Ms Patricia O'Brien cuts the ribbon at the opening ceremony in Dunkirk.

the markets in the United Kingdom and Northern Europe. The plant has already planned exports of 250,000 tonnes of GGBS (Ground Granulated Blast Furnace Slag) to England via existing terminals in London and Manchester/Liverpool. The plant will also export 50,000 tonnes of GGBS from Dunkirk to the Ecocem terminal in Sweden.

"With this new facility, we are doubling our production capacity on French soil and strengthening our links with our partner, ArcelorMittal. Thanks to our network of sites in Europe and the strategic location of Dunkirk, Ecocem is in a position to supply major infrastructure projects, such as those in Greater Paris in the Ile-de-France region, the Seine-North canal and even those in Northern Europe", said Donal O'Riain, Managing Director of Ecocem Materials.

"We are delighted about this new stage in our partnership with Ecocem", underlines Eric Niedziela, CEO of ArcelorMittal Atlantique et Lorraine.

"In 2016 and 2017, ArcelorMittal invested €18.5 million purchasing two granulators in Dunkirk so that Ecocem could set up there. Today we are seeing the culmination of this effort, which will enable us to add value to our slag in relation to a circular economy."

The production of GGBS, a green and worthy industry

GGBS is an environmentally-friendly material approved by new industry standards and leaders in the construction sector (Building and Public Works). It is used as a substitute for traditional cement in concrete production with its technical and environmental qualities making this material an indispensable asset for construction Northern France and Northern Europe.

The production of GGBS enables the recycling of blast furnace slag, a by-product of iron and steel-making which in turn adds value to the European Circular Economy by create a secondary raw material. GGBS facilitates significant reductions of the environmental impacts of concrete by significantly reducing CO2 emissions up to 34 times that associated with the production of traditional CEM II cement.

One year of production at the Ecocem Dunkirk plant will negate 492,000 tonnes of CO2 emissions, which is the equivalent of what 200,000 cars would produce in one year.

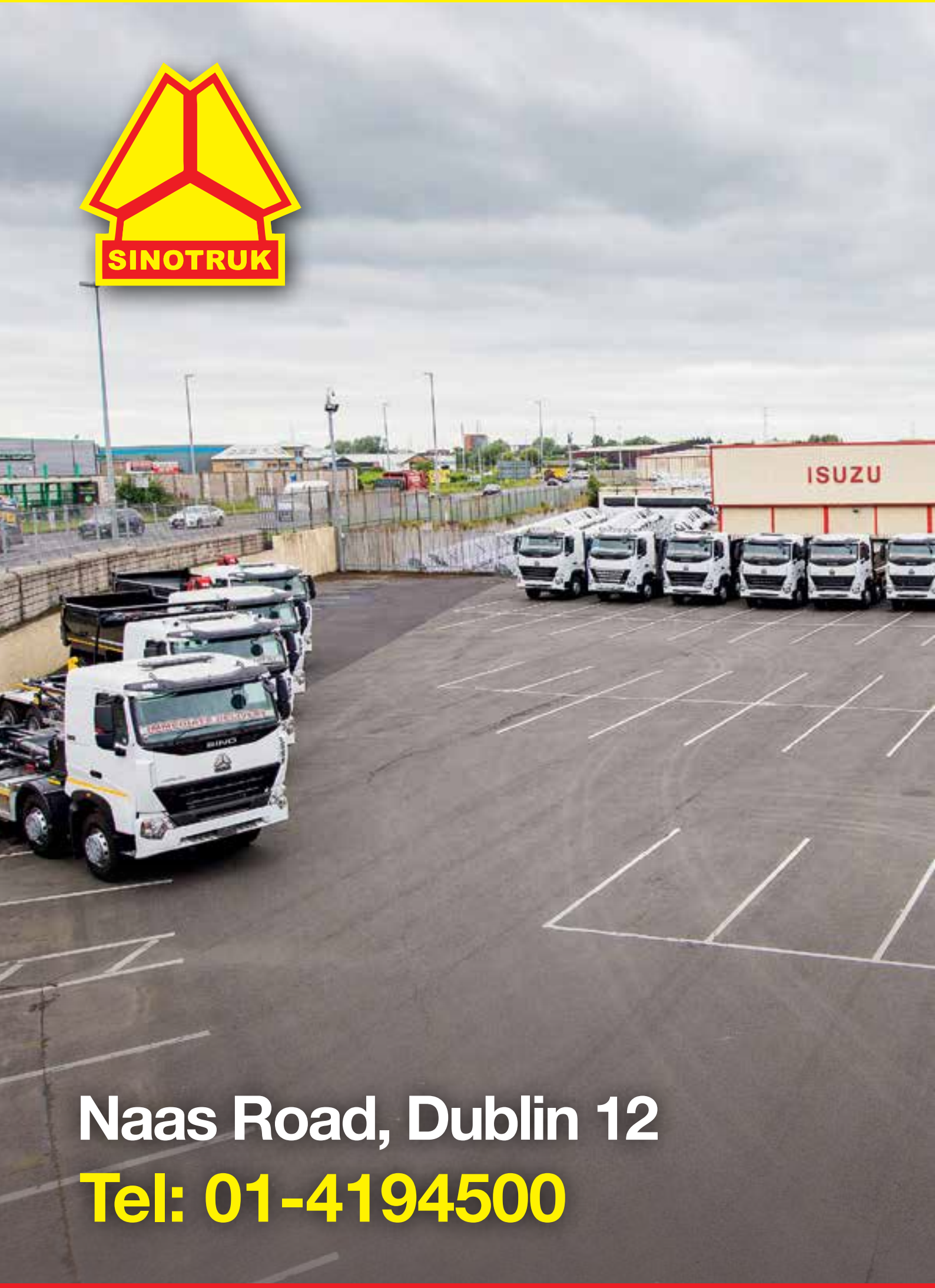
About Ecocem

The company Ecocem France was created in 2007, as a joint venture between Ecocem Materials Ltd. and ArcelorMittal to develop ground granulated blast furnace slag from the production of iron.

Production sites are closely located to two ArcelorMittal blast furnaces in Fos-sur-Mer and three ArcelorMittal blast furnaces in Dunkirk. They produce GGBS under the brand Ecocem, which is primarily used as a partial substitute for traditional cement in the manufacture of concrete.

Ecocem France has been a rapidly expanding business since its creation with a turnover of €30 million in 2015 and €36.4 million in 2017, doubling in 5 years, and with an annual production of more than 500,000 tonnes, which it aims to double in 2019.

Ecocem France is a subsidiary of Ecocem Materials LTD, founded in 2000 in Ireland. Today there are two other subsidiary companies located in Ireland (Ecocem Ireland) and in the Netherlands (Ecocem Benelux), with the Dunkirk plant being the company's fourth production site.



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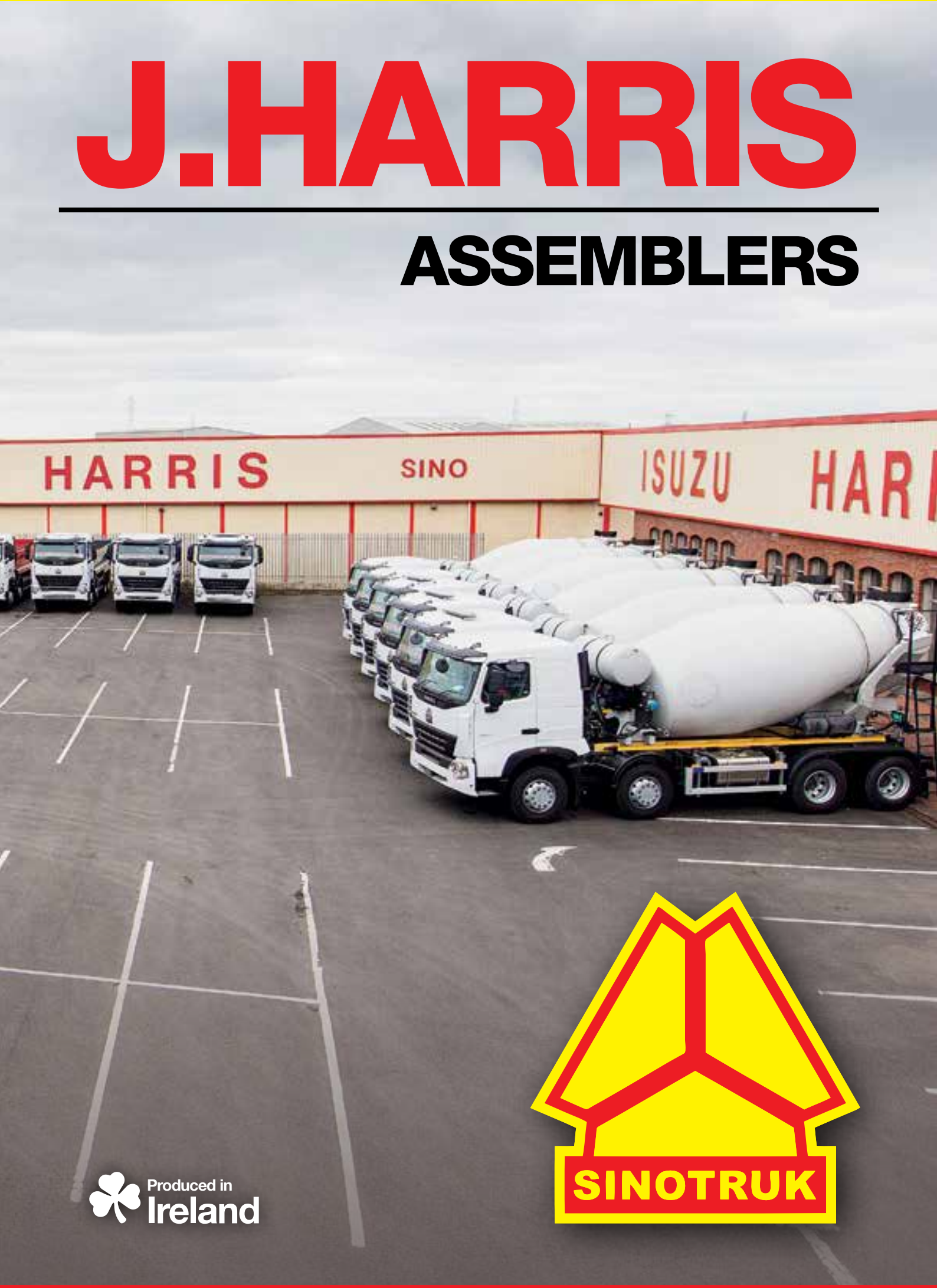

Produced in Ireland

SINOTRUK

Screeds in UK and Irish marketplace

The market and the influence of Specification

by Andy Vincent, McGraths Limestone (Cong)

A floor screed would, to the un-initiated, appear to be a very simple thing. All that we ask of it is for it to overlay the structural slab of a building and to provide a flat surface capable of receiving a floor finish. Why then are screeds such a notorious cause of expensive problems both during construction of and in the later usage of buildings?

Many things complicate the specification and application of floor screeds. Many types of "substrate" floor will need to be accommodated, there will be a large variation in the required floor finishes and an even larger variation in the potential loadings and uses of the floor. The screed makeup will often have to incorporate other elements such as heating, damp proof membranes and acoustic or thermal insulation.

With such diversity of requirement there are huge variations in type of specification. Usually the most important thing to establish will be the required thickness, which will be influenced by many factors but particularly by whether the screed is applied directly to a solid slab or over some compressible materials (insulation). Once the thickness is decided the choice of screed materials will be narrowed to those that are appropriate for this thickness but there will usually still be a large range of options. Factors such as drying time, suitability for floor finishes, thermal conductivity and many more will then need to be considered.

In UK the clearest guide to specification and installation of floor screeds is BS8204. This is a multi-part standard with Parts 1 and 7 applying to "cementitious levelling screeds" and "pumpable self-smoothing screeds" respectively. Other parts consider more specialist screeds.

The main "performance" requirement is defined by BS 8204 as the "ISCR" (In Situ Crushing Resistance) as tested by the "BRE Screed tester". In essence the depth of indentation made by repeated blows of the hammer defines the category of screed from "A" to "C" with A being suitable for the heaviest and C the lightest usage. Standards are also defined for deviation from datum and surface regularity.

BS EN 13813, whilst less concerned with selection and use of screed materials provides physical and performance requirements and definitions for factory produced materials. It is referenced in this context by BS8204.

Traditional Screeds

The term "Traditional Screed" refers to the method of laying by hand but since almost all such screeds are composed of suitable sand with cement (OPC) and water, the terms "Traditional" and "Sand and Cement" have become almost interchangeable.

Still accounting for about 80% of the market, sand / cement screeds have the advantage that they are made from only easily available and relatively cheap materials. Cement is used with sand at a ratio of 3 or 4 parts sand to one-part cement. Water is added and thoroughly mixed such that the final consistency is "semi dry". This semi dry material must then be levelled and physically compacted on the floor. Sand and cement screeds can be produced off site and delivered ready to use or can be mixed on site in mixers or combined mixer / pumps.

The combination of the skill required, and the great physical effort means that the quality of the finished floor is very dependent on the "talents" of the screed layer. The degree of compaction achieved is extremely important in ensuring the quality of the finished floor. Needless to say, quality is not always of the highest standard.

Calcium Sulphate Screeds

There were products in the 1960s that were hand applied but that were based on calcium sulphate. These were not successful because they showed no real advantage over sand and cement and were more expensive. Now when we say "calcium sulphate screed" (or Gypsum screed or Anhydrite screed) what we are referring to is a liquid applied or pumpable screed.

Calcium Sulphate has one fundamental advantage over cement as a basis of a liquid screed. As it sets and "hardens", which is a process of crystallisation rather than hydration, it doesn't exhibit the same shrinkage as would a normal cementitious material. Since shrinkage causes cracking and curling and is a major cause of problems with screeds this is a big advantage.

Pumpable Screeds are almost always manufactured offsite and delivered ready

to use: combined with lack of need for physical compaction on site this means that the quality of the finished floor is much more controlled.

Despite the obvious advantages of these screeds the usage of them in UK, whilst having grown considerably in recent years, has been very slow to grow compared with other European Countries. There persists what might best be described as a "distrust" of the materials by some floor layers and specifiers. For the most part, this can be at least partly attributed to lack of understanding but criticisms regarding drying times and compatibility with adhesives etc seem to persist and this has certainly hampered the uptake of these materials in UK.

Pumpable Cement Based Screeds

Very recently in UK & Ireland (though over ten years ago in other countries) there has been a development that may combine the best of both types of screed.

It has always been an attractive proposition to produce a screed that flows like a calcium Sulphate one but has other properties as a traditional. The problem has always been that anything based on

cement will tend to shrink as it hardens and dries. Superplasticisers can be used to help to provide a fluid mix but it will still be necessary for there to be a high-water content and this will tend to dramatically increase the shrinkage of the material as it hardens and dries.

Technology moves on. The latest generation of pumpable screeds are based on cement. Careful selection of the admixtures, fillers and aggregates used with the OPC produces a very fluid mix that can be laid in a very similar fashion to any other pumpable screeds but with very minimal shrinkage. This "next generation" technology has only recently become available in UK but is already is gaining in reputation. It is more expensive but this higher cost is offset by the lower cost of preparing the surface ready for floor finishes (most other pumpables require mechanical preparation). It must also be said that the industry just seems more "comfortable" with cement in that they know that primers, adhesives, finishes etc are compatible with it.

All three of the above Materials will, without doubt, be present in the UK marketplace for a very long time and yet it will be interesting to see the "winners and losers" in the race for market share. The biggest disadvantage that traditional screeds have may not be to do with the quality of the product at all but rather the health and safety concerns over the physical demands on the installer. In some countries, there are already constraints on its use because of this. As for the two types of flowing screed? Since liquid screeds have over 60% of the market in some other countries we seem to have a lot of catching up to do.

VHS or Betamax?
Place your bets now.

Further reading:
BS 8204. BS EN 13813. BS EN 13892 (Defines sampling and test methods)

Pre-63 Quarries - Far From Safety

by Liam Smyth, C Eng, Senior Manager, Regulatory Compliance, Irish Concrete Federation

Regulatory certainty in the extractive industry seems an elusive concept. Changes to planning legislation and ever expanding environmental legislation and case law continue to move the goalposts, making certainty of status imprecise and even precarious for the legacy quarries which owe their origins to before the appointed day, 1st October 1964, and remain legitimate pipeline projects to this day.

Section 261A showed up the Section 261 Registration Process as something of a farce, which meant nothing unless you weren't registered, and offered no degree of acceptance of status when registered, without any legitimate expectation available to pre-63 registered quarries.

Even after a gruelling Section 261A process, the position of pre-63 sites which received No Further Action (NFA) outcomes remains uncertain and far from safe, with many significant concerns for operators just as market conditions improve and the demand for aggregates increases towards the necessary levels for sustainability.

Intensification

Many quarries of pre-63 origin which received conditions under Section 261(6)(a)(i) found themselves with determinations and decisions under Section 261A which required substitute consent applications and prospective development applications thereafter (Section 34 or 37L as became available late in the day). Many others successfully avoided this long and fraught process but are hardly in the clear forever more.

The doctrine of intensification is a much abused jurisprudence applied somewhat haphazardly across the country and occasionally even within counties. Would fresh eyes in 2020 come to a different conclusion to those which reviewed NFA files in 2012, notwithstanding limited development thereafter?

If so, then the road back is likely five years of applications and waiting, all things going well!; first the Leave to Apply application to prove exceptional circumstances, then Substitute Consent, and finally a Section 34 application after substitute consent is granted (no parallel Section 37L currently available through Section 177(C)).

Reasonable Anticipation

In my experience, it is the application of the Reasonable Anticipation test that leaves most to be desired. Yes of course, the anticipation of a quarry operator in 1964 might include half the county but might more reasonably have included land bounded by roads and rivers, including contiguous parcels in separate ownership.

McGrath Limestone Ltd., Cong, the subject of the landmark case on foot of Section 261A.

As anyone who has dealt with a farmer knows, giving up grass a minute before necessary is taboo, and much quarry land was bought in tranches, with an agreement that the land was going to the quarry operator at some point but not before necessary (quarry future needs or the farmer's future impecuniosity – whichever hit first!).

However, try telling this and similar tales of phased development to a recently minted planner whose decision is accepted unless truly irrational, noting that the O'Keeffe threshold is generally beyond attainment in such cases. The mere mention, correctly applied or otherwise, of Waterford County Council v John A Wood Ltd. in a planner's report seems enough to convince every High Court that fair consideration has been applied, with curial deference thereafter rendering the judicial review process of very little value to quarries, other than breathing room after the shock of being labelled as intensified. And of course, the planner may well be correct anyway!

The Future

Both quarry operators and planners must act responsibly, and know the reasonable limits of development (and reasonable anticipation). Perhaps planners and operators who are concerned about aspects of pipeline authorisations might engage with each other pro-actively so that matters are dealt with prior to retention/intensification issues arising in the future.

This is common sense, and will result in sustainable uninterrupted development, without the unnecessary endangerment of long established businesses and rural employment which serves neither party.

Post Section 261A and subsequent case law, there is little room for getting this wrong!

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International Quaternary Congress comes to Dublin

by Kieran Craven, Marine Geoscientist, Geological Survey Ireland & Maynooth University

The International Quaternary Association (INQUA) congress is coming to Ireland and will be hosted in the Convention Centre Dublin between 25th and 31st July 2019. Occurring only once every four years, with an expected international attendance of 3,000 people the Congress will be the largest Geoscience event held in Ireland.

It will comprise delegates with interests in (among others) geology, engineering, agriculture and hydrology. INQUA's basic aim is to promote improved communication and international collaboration in experimental and applied aspects of Quaternary research, and this will be facilitated by the hosts of the conference: the Irish Quaternary Association (IQUA – visit www.iqua.ie for more information). In its current **20th iteration**, the congress will consist of a lecture programme from world experts, field trips to Irish sites of interest, space for industry exhibitors, and organised social events.

The Quaternary

The Quaternary is the geological period which began 2.6 million years ago and is characterised by ice-ages: cycles of colder, glacial conditions in mid- to high-latitudes interspersed with the warmer 'inter-glacial' periods in which we live today. It is the period during which humans evolved and includes the whole history of our species. In Ireland, our Quaternary history of repeated glaciations has resulted in sculpted landforms and thick sedimentary deposits overlying bedrock across much of the country. These deposits present challenges and opportunities for prospectors and an understanding of Quaternary geology is essential for geotechnical assessment of construction projects and to fully evaluate the suitability of different exploration, mining and processing methods.

Congress Sessions and Fieldtrips

The theme of the Congress is "Life on the Edge" and will include sessions on all aspects of Quaternary research, consisting of (but not limited to): Terrestrial Processes, Deposits and History; Palaeoclimate; Stratigraphy and Chronology; Humans and Biosphere; and Coastal and Marine Processes. This year, dedicated Applied Quaternary sessions were included for the first time and alongside other relevant sessions on landscape evolution, there are proposed sessions on topics such as "Engineering in the Quaternary" and "Recent Advances in Data Collection and Mapping Approaches".

Fieldtrips will occur before, during and after the Congress. These cover a large range of geological topics, from Quaternary sediment and coastal process in SW Ireland, to landscape evolution in the north of Ireland, and stones in urban Dublin. More details on all these trips can be found at the Congress website (www.inqua2019.org).

Sponsorship and Exhibition

The Congress provides a unique opportunity to businesses to reach an international audience and sponsors are invited to participate in the Congress. There is a full range of opportunities varying from headline status on all Congress marketing materials, press releases and media coverage to sponsoring specific social events and individual speakers. Additionally, space is available for exhibitors to present their brand.

For more information about the Congress, becoming a sponsor or availing of exhibition space, please contact expo@inqua2019.org.

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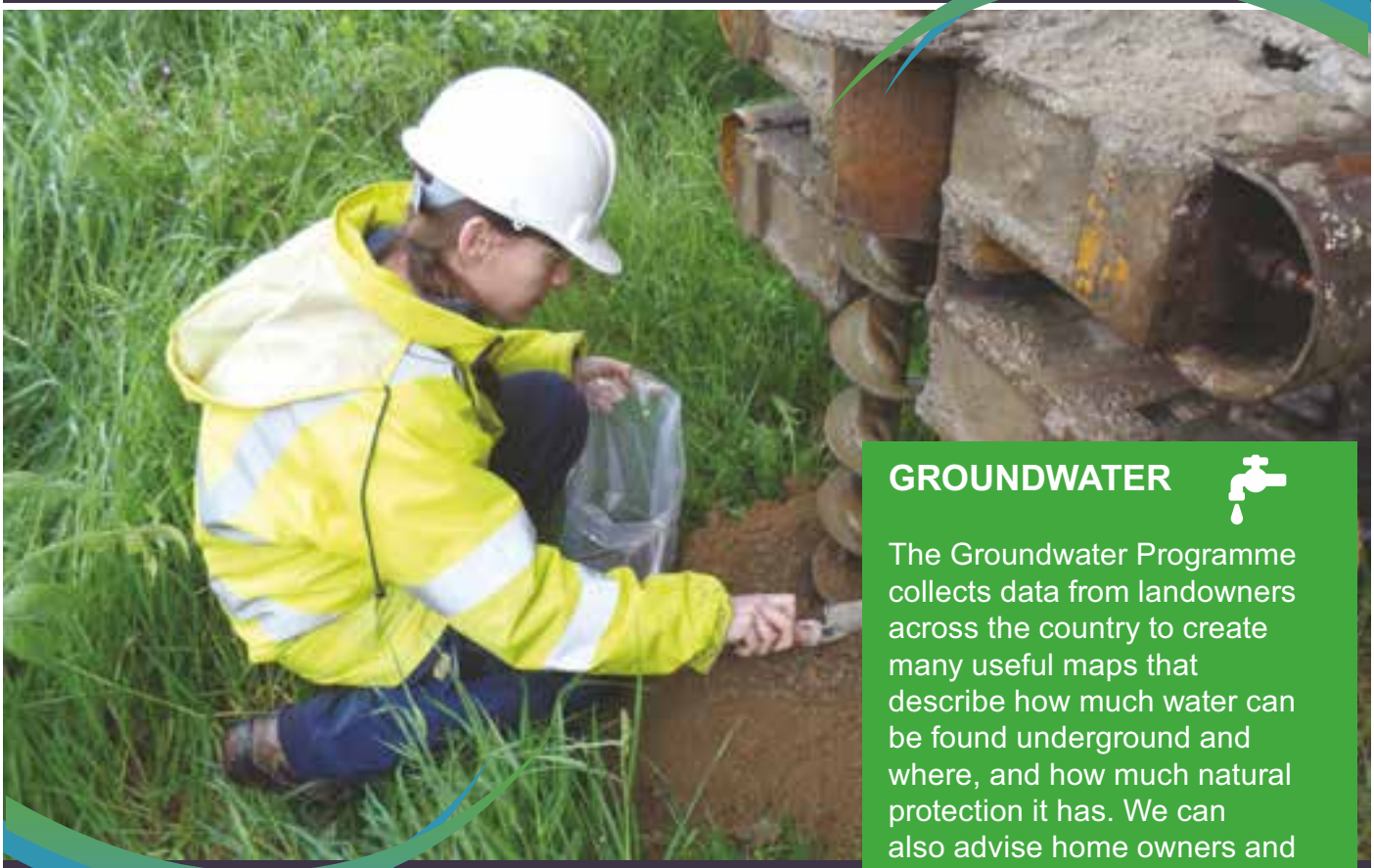

Understanding Underground

Geological Survey Ireland is your project partner in all things subsurface.

We are the public science organisation responsible for mapping and studying the underground makeup of Ireland, including its seabed.

Geological Survey Ireland is a leader in open, accessible data supporting public safety, infrastructure, public health, and a variety of economic sectors including agriculture and ecotourism.

We provide accurate, impartial information about a variety of geoscience topics, from minerals to groundwater, to natural hazards - all free of charge.

GROUNDWATER

The Groundwater Programme collects data from landowners across the country to create many useful maps that describe how much water can be found underground and where, and how much natural protection it has. We can also advise home owners and farmers on the best way to drill and site a well.

TELLUS

A national programme to gather geochemical and geophysical data across Ireland involving two types of surveying - airborne geophysical using a low-lying aircraft and ground-based geochemical sampling of soil, stream water and sediment. Acivities up to autumn 2018 include airborne surveys in Tipperary, Limerick & West Cork and geochemical survey across the west central midlands.

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Cementing status by balancing long game and deal-making

by Joe Brennan, The Irish Times (as published in The Irish Times, April 20th 2018).

Albert Manifold wasn't given time to find a desk when he turned up for his first day at CRH in its headquarters in Dublin in 1998.

"I arrived on a Monday morning and they asked for my passport," Manifold (55), chief executive of the group for the past four years, recalls. "They came back to me on the Tuesday with a Ukrainian visa. By Wednesday I was in Kiev."

Armed with a Russian language book (he didn't realise at the time that the locals spoke Ukrainian), the young executive hired a man to drive him around for $10 a day before ultimately tracking down a concrete facility on the outskirts of the city owned by Kovalska Industrial-Construction Group.

After spending a few weeks on a plastic chair in the bitter November cold observing comings and goings at the plant, Manifold finally made contact with the main man, Oleksandr Pylypenko, and – with the words of his hardware store-owning father ringing in his ears about never leaving without an order – secured a job to supply 150 bags of cement. It had to be supplied by CRH's Polish business as it didn't have a Ukrainian cement factory at the time.

"Outside of the federal US government, he's our single biggest customer in all of CRH today," says Manifold, who now spends 90 per cent of his time on the road. "To this day I still go and see him and his wife one weekend a year with my wife. We've never had a contract with the man, and price negotiations are done with me that weekend every year."

Balancing the long game and nimble deal-making have turned CRH, formed out of the 1970 merger of Cement Ltd and Roadstone Ltd, into the world's second largest building materials company.

While continuing to crank out about 1.5 million tonnes of stone from its landmark Belgard quarry on the outskirts of Tallaght, Ireland's biggest publicly-quoted company employs 89,000 people across 32 countries and had sales last year of €27.6 billion – equating to almost 10 per cent of Ireland's gross domestic product (GDP). It has about 1,700 workers in Ireland.

Relationships

Manifold, who speaks at a rapid-fire pace, likes to rattle out the maxim that "we turn big rocks into small rocks". But with up to 28 business development teams scattered across the globe scouting for deals at any given time, he places far more weight on building relationships.

CRH chief executive Albert Manifold in a Roadstone Quarry in Dublin. Photograph: Cyril Byrne

For example, Manifold makes it his business to go and see a Chinese executive that he met in 2002 when he was sent out to research that market – five years before CRH made an initial investment there – three or four times a year.

When Manifold, a qualified accountant, agreed last year to buy the fifth largest US cement group, Ash Grove, for $3.5 billion (€2.8bn), he called a now-retired former CRH business development official who had first tested the waters on a takeover with the Kansas-based group in 1979 to tell him the good news.

The deal, which is due to close imminently, along with the purchase in January of Florida's Suwannee American Cement, are expected to fuel further growth this year after CRH's earnings before interest, tax, depreciation and amortisation (Ebitda) hit a record €3.3 billion in 2017.

"Historically, two-thirds of our profit has come either directly or indirectly through the acquisitions process," says Manifold of the group, which started its international expansion in 1973 under the late Tom Roche snr by buying a Dutch builders' merchant. CRH ventured across the Atlantic five years' later to buy a concrete products company in Utah.

North America accounted for more than 60 per cent of group earnings last year, though Manifold is hopeful that Europe, which has lagged an economic rebound in the US by half a decade, is on the road to sustainable recovery.

Contraction

The extent of contraction in Europe can be seen in Roadstone's backyard in Belgard. Limestone extraction at the site, which opened in 1972 and is currently more than 100m below ground, is currently running at half the volumes of the go-go days of more than a decade ago.

Meanwhile, Manifold says the recovering European business still has not seen the full benefit of the group's largest ever acquisition, sealed three years' ago, of €6.5 billion of assets spun out from European rivals Lafarge and Holcim as they sought to appease competition authorities to deliver on their own merger.

"The minute it was announced, I knew it was game on," said Manifold, who immediately concluded that there were

very few players that could gobble up the assets in one bite. "I did a quick pull-together of the senior development team and we worked on the deal probably for seven or eight months."

Pitched in the final stages against two consortia led by private equity buyers, Manifold headed out to Paris in January 2015 with a spare shirt for what was supposed to be an overnight trip to catch up with his team working on the deal codenamed Project Cities. "I was there for 43 days and never came home. It was very important to stay close to where the Holcim and Lafarge boards were meeting and to stay close to the main action in Paris."

Manifold's prior experience in private equity – working for Dublin-based buyout firm Allen McGuire – gave him a competitive advantage as he knew how his rivals would value parts of the business. "I knew when to push and when to pull. It wasn't just about valuation – it was about certainty."

Balance Sheet

The deal, according to Manifold, was down to his predecessor Myles Lee's careful management of the group's balance sheet as more heavily-indebted peers faltered during the crisis. The group had been helped by an almost €1.3 billion share sale to existing stockholders in early 2009.

Any notion among investors that Lee's inherent caution would be replaced by a roll-up merchant in Manifold was put paid to early in his tenure. Months into the job in 2014, CRH unveiled a major sales programme for underperforming businesses or assets that no longer had a future in the group.

Lieutenants across CRH's business have learned not to get too comfortable under this boss. Initially targeting about €1.5 billion of disposals, the programme was accelerated as the Lafarge-Holcim deal was digested and the company spat out unwanted units. While the group has spent €13 billion on deals in the past five years, it has earned almost €5 billion from disposals.

"I'm employed and paid very well to deliver shareholder returns. This is not an employee benefit programme. You can't have dead capital sitting there not making money for you – and that's really an embedded part of our business now."

Most recently, CRH sold its US distribution business Allied Building Products to Beacon Roofing Supply at the start of the year for $2.6 billion. The logic was simple, according to Manifold. CRH could not find any more deals to add further scale to the business and it was being offered a price of 16 times earnings. That compared to the price of 10 times earnings it was negotiating on purchasing the higher-margin Ash Grove. Ash Grove and Suwannee will push CRH's business further into the fast-growing southern US states.

Hotel room

Manifold was in his hotel room in Virginia on US election night in November 2016, when initial reaction in Asia signalled that financial markets were set for turmoil after Donald Trump clinched the presidency.

However, CRH shares jumped 9.2 per cent the next morning as investors piled into hopes that the biggest materials company – and biggest road-builder – operating in the US would be a key beneficiary from Trump's then-mooted $1 trillion infrastructure plan.

However, the much-hyped plan to build new roads, bridges, highways and motorways – which Trump clarified in February should amount to $200 billion of federal funding, supported by more than $1.5 trillion of private investment – is now on hold until after the country's mid-term elections in seven months' time.

Shares have subsequently dropped by more than one-fifth from all-time highs reached last May, which valued the group at that time at more than €29 billion, as investors have taken a more circumspect view of Trump's plan and the value of the dollar dropped against the euro, denting group profits.

Manifold, in fairness, played down the prospect of any "Trump bump" to earnings, telling investors in February last year to look more at the US's existing $300 million-plus Fast Act highway spending programme as well as additional infrastructure spending approved by voters across a number of states at the same time as the presidential election.

The weakness in the share price has prompted analysts at Deutsche Bank to speculate that CRH might want to look at a partial or full listing of the US business in New York to unlock value, as the group's stock, mainly traded in London and Dublin, trades at a discount to US peers.

"In my 20 years in CRH we've certainly looked at it a number of times, but every time we've looked at it it's never made sense," said Manifold. "But we keep an open mind, and it's something we keep under review with our advisers."

Careful review

When asked if he may take advantage of a perceived undervaluation of the group's stock and launch a share buyback programme, the CEO said: "Again it's something we keep under careful review. We've done it in the past, and I suspect we'll do it again at some stage."

The highest-paid Iseq executive in 2016, when his remuneration hit €10 million, Manifold's package fell to €8.66 million last year as the group's first share price drop in five years dented shareholder returns.

CRH also encountered a degree of shareholder dissent two years ago when some 40 per cent of investors polled at an agm voted against a plan to increase Manifold's maximum annual cash bonus and allocation under a share plan.

The chief executive, a native of Dublin's Templeogue whose parents ran a hardware store in nearby Kimmage, has no doubt he's worth it. "I'm very well paid for what I do if I deliver the results. If the shareholders get the benefit, I get the benefit," he says, in what appears to be a well-rehearsed answer. "I work in a global business. It's a challenging business, and it's got demanding targets – and I'm remunerated based on performance."

CRH was criticised by analysts for being more reticent than rivals in expanding across emerging markets before the global financial crisis a decade ago. But its inheritance of a business in the Philippines as part of the LafargeHolcim deal in 2015 serves as a cautionary tale about the volatility of developing regions.

The loss-making business there has been buffeted in recent times by a temporary decline in infrastructure spending, rising local competition, a flood of cheap cement imports and rising fuel costs. Still, Manifold has no intention of walking away from the Philippines' second largest cement producer. "It's a cyclical industry. The thing is not to make any quick decisions at any point in the cycle. The fundamentals of that country are very good, and it has significant construction needs going forward."

Next generation

Meanwhile, Manifold said it will most likely fall to the "next generation" who lead CRH to decide on whether to invest further in China and India, markets where it acquired initial stakes in local businesses about a decade ago.

A low-profile chief executive who lives in Co Wicklow, he doesn't often get recognised at home. "It happens about twice a year." However, he recalls being in Thurles, Co Tipperary, two years ago when a man came up to him and shook his hand.

The man recalled how he had lost his shirt during the financial crash, but was able to keep his head above water as a CRH shareholder. The company continued to pay a dividend, and the businessman was able to raise some additional cash by selling some stock. "And that's who I work for. I don't work for [investment firms like] BlackRock or Wellington. I work for him. That's what keeps me going."

CV

Name: Albert Manifold.

Job: Chief executive, CRH.

Age: 55.

Lives: South Co Wicklow.

Family: Married, three children.

Something we might expect: A follower of Leinster Rugby having played prop forward at Templeogue College in Dublin, Manifold keeps fit through gym work, cycling, running and walking.

Something that might surprise: He's an avid beekeeper stemming from his childhood years in Templeogue when he helped a local priest with his beehive.

Institute of Geologists of Ireland (IGI)
An overview of activities

by Eur Geol., Catherine Buckley, P. Geo, IGI President

The Institute of Geologists of Ireland (IGI) was established in 1999 with the mission of promoting and advancing the science of geology and its professional application in all disciplines, especially the geosciences and to facilitate the exchange of information and ideas in relation thereto. IGI Members are required to uphold, develop and maintain the highest professional standards in the practise of their profession. To this end all members must undertake CPD recording for approval on an annual basis.

Professional membership of the IGI is open to all practising geoscientists who meet the required standards of qualification and experience. For information on how to apply, please visit www.igi.ie.

Relationships with other organisations

The IGI continues to represent our members on national and international committees.

These include:

- **Pan-European Reserves & Resources Reporting Committee (PERC):** The IGI has been a professional accreditation organisation of PERC since its inception. EurGeol David Dingemans PGeo of the IGI has prepared a summary guide to the PERC Reporting Standard (IGI Summary Guide to the PERC Reporting Standard).
- **Irish Geoscience Network (IGN):** The Irish Geoscience Network (IGN), convened by the IGI, was formed in early 2012 to provide a forum for communication and sharing of ideas and resources for all bodies, organizations and departments involved in the Geosciences. The body has now grown to circa 32 such bodies and meets once a year. Along with access to an exclusive Professional Indemnity (PI) insurance scheme for the IGI Members and affiliated organisations, the Geo-Calendar of Events http://www.igi.ie/events_calendar.htm is available to assist all members of the Network to plan and where possible to avoid conflicting dates in their events.
- **European Federation of Geologists (EFG):** The IGI also continues to be an active National Association Member, as well as a National Licensed Body Member, of the European Federation of Geologists (EFG). A significant milestone during 2014 was the decision taken by the EFG to lead and participate in the European Commission's Horizon 2020 (H2020) research programme; and the IGI have been participating in H2020 research projects since this time with projects including KINDRA, INTRAW and CHPM2030. The EFG were subsequently involved in a number of winning consortia.

The IGI acknowledges the continued support of our sponsoring bodies, the Irish Mining & Quarrying Society (IMQS), Geophysical Association of Ireland (GAI), Geotechnical Society of

Ireland (GSI), Irish Association for Economic Geology (IAEG) and the International Association of Hydrogeologists (Irish Group, IAH).

Recent and future training courses

The IGI have hosted a number of training events in the past year which have been well attended. These have included a 2-day soil and rock logging course run in late November, a 2-day course on 'Economic Evaluation for Mineral Exploration Projects' and a one day mentoring workshop.

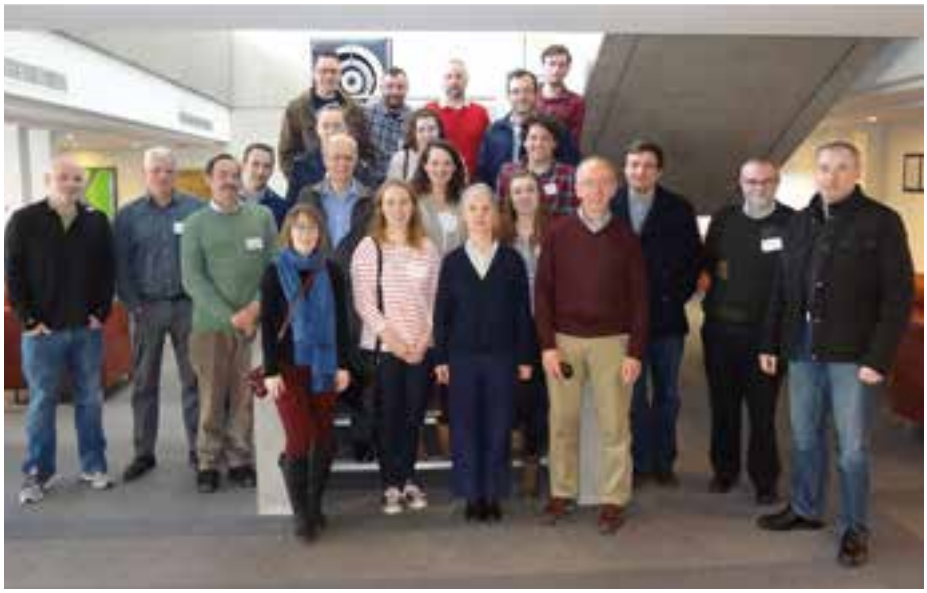
The Board will continue to organise some key training courses and workshops. Currently being considered or in the pipeline are a 1-day statistics course to be run in Autumn 2018 and a field trip. Further information will be provided closer to the date.

The Board would be interested in hearing from members about other topics which may be of interest for courses in the future. Suggestions for courses should be sent to the office: info@igi.ie.

Current and Future Direction

The Board of the IGI have established a Working Group to update the Strategy of the IGI and will shortly be circulating a questionnaire to members to input into the updated strategy document.

The Board is keen to establish greater contact with geoscience students. To this end options for funding awards, grants or other support are being considered either through interaction with academic staff or with student societies.



Delegates at the 2-day course on Economic Evaluation for Mineral Exploration Projects

Department for the Economy
www.economy-ni.gov.uk

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Managing Vehicle Movements at Quarry Locations

by Jim Holmes, C.Eng. MSc. FIM3 CMIOSH, Mines and Quarries Policy Inspector – Health and Safety Authority of Ireland

Vehicles and their movements pose a significant, and possibly the greatest, safety risk at quarry operations and need to be effectively managed; in addition to this, the control of all pedestrian movements is essential in developing a site traffic plan.

The Health and Safety Authority ran a two week nationwide inspection and awareness campaign in April 2018 focusing on the management of vehicle risks in the workplace such as driving for work, vehicle operations and load securing. During the month of May, the Health and Safety Authority delivered regional 'Transport and Logistics Safety' seminars which were free to attend. Another safety event is scheduled to take place in November 2018, as detailed at www.hsa.ie/eng/News_Events_Media/Events/HSA_Events/.

Over the last six years, just under half (45%) of all reported work related fatalities involved vehicles and in 2017 twenty-two people were killed in vehicle related accidents at work. Accident statistics show that the majority of vehicle related deaths at work occurred during the manoeuvring, reversing or coupling and uncoupling of vehicles.

Approximately 20% of all non-fatal injuries reported to the HSA every year involve vehicles, resulting in substantial losses to businesses. These injuries generally occurred during delivery and collection operations and particularly during the handling of loads or as the result of falls from vehicles.

Quarry Operators have to recognise "vehicle accidents" as a real threat to their business and must put in place a vehicle risk management policy that covers all vehicle related activities in the workplace. This includes not only vehicles operated by employees but also vehicles visiting their premises including those of customers and vehicles operated by contractors.

During my 23 years with the Health and Safety Authority, I have witnessed at first hand the devastating effects of failing to control vehicle and pedestrian movements. With the size of equipment in use at quarries, it is highly probable that any collision between a vehicle and a pedestrian will result in a fatality. I remember one particularly tragic accident at a quarry where the Quarry Manager's son was killed when he was struck by a loading shovel carrying sand in a raised bucket, with the fatality occurring in view of other family members. Quarry Operators must also realise that their duty extends beyond the quarry boundary and that there have been numerous serious incidents where vehicles inadequately loaded at a quarry have caused injury. I investigated a dreadful fatality where blocks fell from the rear of a block truck, travelled through the windscreen of a vehicle travelling behind and decapitated the driver.

How can we Control the Risks?

Let's start at the very entrance to the Quarry. The Quarry Operator needs to deliver the message that they are serious about managing health and safety and what better place to make this statement than at the entry to the quarry. Large signposts clearly stating what is expected gives the right message before people enter the quarry. There should be clear signage and directions to areas such as the employees and visitors' car parks, offices and weighbridge, and these should be placed so that there is a safe route for pedestrians to offices or wherever they need to travel to.

If you allow the collection of small loads then a 'quarantine area' is necessary to either bring the load to visiting vehicles or to organise safe travel for the vehicle to collect their load. Remember that most visitors are unfamiliar with quarry operations and should never be allowed to travel in a vehicle or on foot around the quarry as they are probably oblivious to the risks. Once inside the quarry, pedestrians must wear appropriate protective equipment including high visibility clothing. Light vehicles should not enter the quarry traffic routes and if this becomes necessary for essential work such as breakdown repairs, then the vehicle must have a flashing beacon. These are quite inexpensive and connect to the vehicles cigarette lighter if not wired in permanently. Where pedestrian routes are necessary within the quarry then they should be clearly marked and used by pedestrians, speed limits should be in place and strictly enforced. With good planning ancillary operations such as block-making, ready mix, asphalt and other manufacturing operations should be located away from the main quarry traffic circuit.

Planning Issues

One of the biggest issues I and my fellow inspectors find at quarry locations is a failure to have a long or mid-term plan in place as to how they operate the quarry and they are focused on a day-to-day or next-blast mentality. Quarry Operators need to look at their overall site map and consider how best to plan operations so that vehicles can operate safely. I have already identified the need to segregate domestic vehicles and visitors from the quarry route but using the overall site plan the Quarry Operator should design traffic routes that will minimise reversing manoeuvers and where possible eliminate vehicles travelling towards each other from opposite directions. Whilst this may take time to develop most operations should be able to put a transport circuit in place.

As part of overall planning, the quarry operator should consider the design of the haulage roads and should ensure that they are wide enough for the vehicles that are operating. If these roads are permanent or semi-permanent then adequate drainage and surfacing of the road is necessary. Too often Inspectors come across steeply inclined roadways to the quarry floor that are not wide enough for vehicles to pass safely, have inadequate berms/edge protection for the vehicles operating, have poorly drained and pot holed surfaces and often have a tight turn at the bottom to the quarry floor.

Also in relation to planning we still have operators working quarry faces well in excess of 20 metres and sand and gravel pits which are clearly too high for the equipment in use. If a working face is in excess of 15 metres then there are very few excavators that can safely scale the face to remove loose or overhanging rocks. Even though we have had a number of fatalities where an excavator or a loading shovel has been engulfed following a collapse most Operators seem to think that this will not happen at their location and carry on regardless. In the UK most stone quarry faces are around 12 metres high and sand and gravel faces are considerably lower and the UK operators have average cost per tonne values which are lower than those in the Republic of Ireland.

Mobile Crushing

Mobile Crushing has become increasingly prevalent and is generally safer, more productive and requires less maintenance.

However, it does require frequent manoeuvring and reversing of loading shovels so it is essential in these areas that pedestrian travel is avoided and that trucks awaiting loading are positioned so that they do not interfere with the loading shovel movements and the drivers remain in their vehicles. Loading shovels should only be operated by competent drivers holding the appropriate Quarry Skills Certification Card. The loading shovels should be fitted with flashing beacons, adequate mirrors, ambient noise reversing sirens and reversing lights and good quality reversing cameras. Where an excavator is involved in the process to load the crusher then it should also be operated by a competent driver with a QSCS card and in addition to mirrors should have a rear camera and/or movement/proximity sensors/radar systems.

Manufacturing Operations

A number of manufacturing operations at quarries involve substantial vehicle movements. Asphalt plants generally involve the operation of several trucks in the circuit and again there is a need to manage operations and restrict pedestrian access with the need for exclusion zones during delivery of bitumen. The same applies to ready-mix plant operations and cement deliveries. With block-making and pre-cast operations we have the additional hazards associated with forklift or teleporter movements for the loading of vehicles and traffic management needs to be in place. In a well-designed quarry these traffic movements should, where possible, be outside of the main quarry traffic circuit but this is not always the case. In 2017, the Authority carried out a detailed number of inspections of Asphalt plants and at most locations the exclusion procedures for bitumen deliveries were poor and at one location the loading shovel feeding the storage bins was constantly reversing into the main traffic vehicle route. In 2018, we are carrying out detailed inspections of block-making operations following a number of fatalities involving block-makers and strapping machines and already we have had to take action when the stop bar on these machines was defective or had been defeated.

Vehicle Checks and Maintenance

Workers who operate a vehicle should carry out a daily check of that vehicle before use.

This check should include:

- tyres,
- reversing and visibility aids,
- lights,
- access steps,
- fuel, oil and water levels,
- cab, and
- testing brakes.

This inspection should be recorded and any defects logged. Drivers should not be required to use any vehicle that has a serious defect that makes it unsafe to operate or puts anyone else at risk.

All vehicles should be maintained in accordance with the recommendations of the vehicle manufacturer.

Every year at least one person is killed in Ireland as a result of an exploding tyre. Operators should ensure that they have safe procedures for the changing of tyres and preferably this should be carried out offsite or if carried out on site, a suitable tyre cage should be used during inflation.

Inflation of any tyre should be carried out from a position of safety, some modern systems allow the driver to attach the tyre hose to the wheel valve and then walk to the control unit where they set the pressure and inflate the tyre from a position of safety.

If such systems are unavailable then there should be at least two metres of hose from the tyre valve clip to the inflating gun so that the person does not stand in the danger zone in front of the tyre being inflated.

Wheels/bodies or other parts that might collapse during maintenance operations must be adequately supported, numerous fatalities have occurred when jacks, axle stands or makeshift supports fail.

Electronic brake testing of loading shovels and excavators should be carried out at least every three months and action taken if the braking efficiency falls below that recommended by the equipment manufacturer and/or is inadequate for the conditions in which the vehicle is expected to operate.

Load Safety

Hauliers and Quarry Operators need to look at the way they operate, badly loaded vehicles leaving a quarry can have fatal consequences. Overloaded trucks carrying stone can easily lose part of the load on bends, hills or roundabouts. In my opinion, all loads of aggregates leaving quarries should be covered, however that issue is under the jurisdiction of the Road Traffic Act and An Garda Siochana.

I recall the resistance within the quarry industry when we were insisting on side rails on block trucks and sadly that resistance only dissipated following a fatality. I hope the industry moves to covered loads before another fatality focuses their minds.

Pre-cast and pre-stressed concrete loads, pipes and other concrete products should all be adequately secured and there is freely available guidance and resources on managing priority vehicle risks available at www.vehiclesatwork.ie and www.loadsafe.ie .

Conclusion

In 23 years with the Health and Safety Authority, I have investigated a considerable number of serious accidents involving vehicles. If the control measures I have identified above had been implemented, many of them would not have happened. If you have been fortunate and have avoided an incident to date, I strongly suggest you review your traffic management and implement safe traffic management systems.

Mineral Resources in Sustainable Land-Use Planning

by Sybil Berne[1], Jerry Barnes[1] and Gerry Stanley[2]

The Geological Survey Ireland (GSI) and MacCabe Durney Barnes (MDB) are pleased to announce their participation in MINLAND, a project funded under Topic SC5-15d – Linking land use planning policies to national mineral policies, in Horizon 2020. MINLAND is a pan-European consortium led by the Geological Survey of Sweden.

The project is designed to meet the challenges of competing land uses. Securing access to land for exploration and extraction of minerals, including critical raw materials is of great importance and the European Commission recognises the importance of safeguarding the supply of metallic and other mineral raw materials to meet European needs for industry.

Mineral raw materials are instrumental in the development of new green technologies for both electricity generation and storage, electric car batteries, the development of cities and access to metals for European industries.

The MINLAND project will pursue four main objectives:

- to develop a database of existing policies,
- to provide guidelines on how to link land use and mineral policies,
- to analyse land use case studies of mineral exploration and extraction with respect to mineral- and land-use policies, and
- to support a more efficient and sustainable permitting process by providing best practice examples and to ensure knowledge exchange among relevant stakeholders.

As part of the project, GSI and MDB are building a case study reflecting current planning practices in the Irish lead and zinc mining sector. Together, they will also organise a workshop in September 2018 to gather Irish stakeholder input and determine what constitutes best practice in the integration of minerals in land use planning. This will be an essential step towards the publication in 2019 of the best practice guidelines on how to link land use and mineral policies.

If you are interested in participating to this workshop, or in receiving updates on the project, please contact us via email at **planning@mdb.ie**.

MINLAND is funded from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 776679. The project officially started on the **1st December 2017** and will last for **two years**.

[1] McCabe, Durney Barnes
[2] Geological Survey Ireland

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Tellus Programme
On Target

by Jim Hodgson, TELLUS programme Manager, Geological Survey Ireland

The Tellus Programme is Ireland's ground and airborne geoscience data acquisition programme, collecting geochemical and geophysical data to inform the management of Ireland's natural resources and environment.

The programme, run by Geological Survey Ireland, a Division of the Department of Communications Climate Action and Environment (DCCAE), involves two types of surveying – airborne geophysical surveying using a low-flying aircraft, and ground-based geochemical surveying of soil, stream water and stream sediment. To date over 50% of the Republic of Ireland and all of Northern Ireland has been surveyed and plans are underway to survey the remaining 50% of the country.

The data collected by Tellus is used by a wide range of stakeholder groups across Ireland, particularly mineral exploration, environmental management, agriculture, human health and third level researchers in these areas. Tellus has recently established **a Product Development** work stream in order to produce more focused, user-centric data products, the need for which has been identified through stakeholder consultation, independent reviews of Tellus and government policy. Product development is undertaken under five main themes: Mineral prospectivity, smart agriculture, environment and health, climate action and education.

Tellus' airborne geophysical survey comprises measurements of magnetic field, gamma-ray spectrometry and time-domain electromagnetic data. The high resolution data collected is an invaluable tool for effectively 'seeing through' Ireland's often deep glacial deposits and extensive peat cover. Allowing geological features not apparent from conventional mapping techniques at the surface to be resolved.

The data collected is being used to revise the Geological Survey's quaternary and surface bedrock geology maps, assist in mineral exploration, identify potential areas of contamination and map areas of radon risk. The **Tellus geochemical surveying** is characterizing the baseline chemistry of soils, stream water and stream sediments across Ireland, taking samples at a density of approximately one every 4km2. Multi-element laboratory analysis of these samples allows a suite of some 55 maps to be produced, which are important for both agricultural productivity and environmental management, particularly for improving our understanding of how trace elements, essential for animal and crop health, are distributed in the environment.

The latest findings from the 2017 airborne survey over counties Mayo and North-West Donegal, released earlier this year, have given Geological Survey Ireland scientists a fresh look at how Ireland is assembled from blocks of ancient continents over hundreds of millions of years.

Patterns produced by differences in magnetic properties of rocks, and imaged from the aircraft, are identified and can be mapped in areas covered by layers of sediment, bog or water. The data collected provide important information to the mineral, agricultural and environmental sectors and also feed into the daily work of Geological Survey Ireland, including carrying out Geological Heritage Audits of County Geological Sites. These geological heritage audits contribute to effective planning and to the development and promotion of tourism in the regions. The Tellus data provide a new level of detail that allows us to understand Ireland's geological formation and natural resources.

Plans for this summer see the Tellus airborne survey moving southwards, into counties Limerick, north Tipperary and west Cork. Details for the Tellus ground survey will be announced on www.tellus.ie in due course.

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Saint Gobain Mining (Ireland) Ltd
Drummond Mine

by Benson Plunkett, Mine Manager, Saint Gobain Mining (Ireland) Limited

Drummond Mine is an underground Gypsum mine, situated near Carrickmacross, Co Monaghan. Employing over 30 people, it produces over 250,000t of Gypsum rock per year. Situated on the Mine site, is Knocknacran, an Open Pit Mine, which has been in operation since 1989. Currently, Gypsum rock is mined from the underground mine and Knocknacran Open Pit mine will reopen by mid-2018 following an €8m investment.

Drummond Mine supplies Gypsum rock (CaSO4.2H20) to its parent company Saint-Gobain Construction Products (Ireland) Ltd - at its factory near Kingscourt, Co Cavan - making plaster and plaster board products for the Irish and UK construction market. The mine also supplies Gypsum rock for the manufacture of cement.

The underground mine was reactivated at the end of 2013 and has been gradually increasing production of Gypsum over the last 4 years. It is a Room and Pillar mine, using traditional drill and blast methods.

The mining cycle – Drill - Charge & Blast – Muck – Mechanical Scale – Check scale (manually) – is an intensive cycle and one that requires skill and experience. Geotechnically, the Gypsum rock varies in strength, hence ground support procedures are necessary and bolting & meshing is carried out in locations where ground control is necessary.

Geologically, the deposit dips 20o to 25o in a Westerly direction. The main joint set is NE – SW, however on a micro scale this can vary. The deposit is made up of 2 Gypsum Seams - an Upper Seam 6m to 8m thick, and a Lower Seam 12m to 20m thick – Drummond Mine operates in the Lower Gypsum Seam.

The Lower Gypsum Seam is made up from 4 sections: A, B, C, D, which vary in thickness and purity. Gypsum is mined mainly from the B section, and provides 70% - 80% Gypsum.

Environment, Health and Safety are

Ongoing Stripping Project Knocknacran Open Pit Mine May 2018

Supervisor inspection Drummond Mine

the forefronts of any underground mine and Saint-Gobain Mining (Ireland) Ltd., Drummond Mine, is no different. Currently, the mine has operated for **over 3400 days without a Lost Time Injury** (9.5 years), and 2400 days without a medical intervention injury (6.6 years).

This record is maintained by a vibrant safety culture which incorporates all levels of the company using safety tools such as the 5 point safety system, Near Miss reporting, SMAT's (Safety Management Auditing Tool), unsafe acts and unsatisfactory conditions reporting.

Saint-Gobain Mining (Ireland) Limited looks forward to many years of production from both the underground Drummond Mine and the Knocknacran Open Pit Mine as market demand for Gypsum increases nationally and internationally.

Saint-Gobain Mining (Ireland) Limited (SGMI) is a wholly owned subsidiary of Saint-Gobain. Established in 1665, Saint-Gobain is a world leader in design, production and distribution of construction materials, delivering innovative products and services.

Today, Saint-Gobain operates in 64 countries, employing ca. 191,500 people across four sectors: Construction Products (including plaster, plasterboard and dry-lining systems), Innovative Materials, Building Distribution and Packaging. **Operating in Ireland since 1936**, Saint-Gobain has become a major contributor to the Irish construction industry, employing ca. 400 people.

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www.gyproc.ie **www.isover.ie**

Charging face, Drummond Mine

Drilling of 6m x 5.5m (w x h), Drummond Mine

Barleystone Expansion

by Aoife Gavin, Sales and Marketing Manager, O'Reilly Group

Investment

The fully Irish owned **Barleystone Paving** factory at Taghart, near Kingscourt, Co. Cavan, part of the O'Reilly Group, **has recently almost doubled its production capacity** by building a purpose built new Paving Flagstone factory at their factory – introducing a new range of patio flags to the market.

Barleystone continues to expand and develop due to home grown demand as well as demand from the UK market.

They have invested €1.5 million into a state of the art Flagstone Factory which is in addition to the existing Barleystone Paving manufacturing facility.

This new flag factory has created approx 10 new jobs for the local area and is now fully operational.

Those jobs are in addition to a further 60 new jobs already filled across the O'Reilly Group's local facilities in the past year.

It follows the granting of permission by Cavan County Council to the O'Reilly Concrete Group, Ireland's largest manufacturer of precast concrete products, for the construction of the new facility at the 15-acre site in east Cavan.

The new factory is built adjacent to the existing plant and three existing batching plants on the site, two of which will feed the new factory with the third providing the block mix for the company's trademark flags.

"We are feeding the new factory from the two batching plants. That new factory is producing flags for the Irish and UK Market," says O'Reilly Group Sales & Marketing Manager, Aoife Gavin, who explains that of the full investment, one third was spent in kitting out the plant for production.

"It is equipped with state-of-the-art German block making machinery, so it is fairly labour efficient."

Aerial Photo of the new Paving Flagstone factory.

Hollowcore Bary.

Heathrow Progress.

Market growth

The investment of late by O'Reilly Group is spurred by significant growth, especially in the UK market, and the businesses have ramped up production capacity accordingly to meet demand. At present, just over a third of what the company produces is exported to the UK.

But, while the shadow of Brexit looms, the company continues to look to the Irish market as a source of confident recovery, especially where high-quality precast is in high demand particularly with regard the construction of new schools.

80 Years in Business

The tough time experienced by all throughout the bust and the subsequent difficult years have now thankfully passed and the O'Reilly family are looking confidently to the future.

They have built longstanding relationships with contractors, merchants and developers across the UK and Ireland. Among the broad product offering is Precast Frame, this product secured a very prestigious contract for the O'Reilly Group in Heathrow airport, London.

They are currently (May 2018) building a Hilton Hotel at Terminal 2 Heathrow airport

Silver Grey Flags 2.

and have secured the contract with Lidl UK to build a number of new stores throughout the UK. It is an exciting time and the O'Reilly Group and family are very excited about the future.

The O'Reilly Group will celebrate 80 years in business in 2019 and are confident their varied product offering and continued investment and advancement in technology will ensure a bright future for the next O'Reilly generation.

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Barleystone Paving
THE PERFECT FINISH

Recent Activities of the IAEG

by Kieran Parker, Vice-President, Irish Association for Economic Geology (IAEG)

It is a pleasure to contribute to the IMQS special 60th anniversary edition of the annual review. The IAEG and IMQS have had a long standing relationship and we are confident that this relationship will be maintained and strengthened in the future. IAEG would like to congratulate IMQS in this special anniversary and acknowledge all the good work they have done over the years supporting and promoting the extractive industry.

2017

As always, it was a busy year for the IAEG with lecture series held throughout the year, three courses, a fieldtrip, and the AGM. The highlight of the year was the Annual Conference.

Lecture series

IAEG hosted five talks through the year which were very well attended. To start the series off, **Mike de Wit** took members through diamond exploration and mining from an African perspective.

This was later followed by **Leigh Rankin** discussing how more value can be achieved by appropriate (and targeted) data processing. The use of geophysical magnetic data carefully integrated with geological data in the Amadeus Basin in Central Australia was used as a case study where the techniques have been successfully used.

In the autumn members were presented with an overview of the Drakelands Mine by **James McFarlane**. The mine, located near the village of Hemerdon, Devon is operated by Wolf Minerals and is currently extracting tungsten and tin in an area long associated with tin mines.

Several weeks later **Lluis Fontobe** presented an overview and discussion on the future supply of mineral resources, previous flawed estimates, changing demands and how improved technologies, economies of scale and increased efficiency have combined over the past century to reduce costs allowing lower grade ore to become economic.

To finish off the year **Colin Andrew** presented prior to the IAEG AGM in December. Colin reviewed the Silvermines Zn-Pb deposit and provided new and recent research with great relevance to current understanding of Irish Zn-Pb mineralisation.

IAEG Courses

IAEG ran three courses in 2017. Starting the year off was the biennial practical **Applied Geophysics weekend course** held in Galway and attended by students, early career geoscientists and those with limited experience of using geophysical instrumentation.

In May Mike Dentith (University of Western Australia) presented two courses on **geophysics for the mineral exploration geoscientist**. The first was presented in Sligo as part of the IAEG Annual Conference weekend and a second two day course was hosted in Dublin.

Both courses were jointly hosted with Geological Survey Ireland and Exploration & Mining Division.

Students getting a briefing during the Geophysics weekend course in Clonbur, Co. Galway.

2017 Annual Conference

The IAEG 2017 Annual Conference was held over the weekend of 12th May at the Radisson Blu Hotel in Rosses Point, Co. Sligo.

The theme of **'Exploration Under Deep Cover'** was discussed by a variety of local and international speakers who provided insight into exploration techniques and research currently being employed in Irish and global companies to discover mineral deposits at depth.

Presenters and IAEG Council at the 2017 Annual Conference in Sligo.

IAEG Fieldltrip

In November the IAEG was hosted by **Dalradian Gold** at their Curraghinalt Gold Project in Co. Tyrone.

The fully subscribed trip started with a light lunch before an overview presentation on the gold quartz vein mineralisation hosted within the Dalradian metasediments.

This was followed with an underground tour of the development and a viewing of the rock core.

IAEG members attending the underground fieldtrip to the Curraghinalt Gold Project.

2018

2018 has continued to be a busy year for the IAEG with the year starting with the biennial Student Logging Course, this year kindly hosted by **Boliden Tara Mines** in Navan. The course has been running now for a number of years and aims to introduce students to practical 'hands on' experience of logging core with guidance from industry professionals.

The students are also provided with industry best practise quality control procedures. The talk series started with **Matt Grimshaw** providing a summary of gold mineralisation in the Klondike gold district of north-west Canada – the location of the famous gold rush at the end of the 19th century.

Discussions during the Applied Geophysics weekend course.

In May the 2018 Annual Conference took place at the Shearwater Hotel in Ballinsloe, Co. Galway with the topic of **Geochemistry applications and techniques**. The weekend conference also included a one day course on **geochemical interpretation tools for exploration and Mining** and a fieldtrip to the **ALS Global Laboratories** where a guided tour was provided by ALS on their laboratory facilities and practices.

The remainder of the year and beyond is looking busy for the IAEG. As well as the lecture series and short courses, work is progressing on a publication of an updated Mineral Exploration Handbook and an update to the IAEG Carboniferous stratigraphy of the Irish Midlands publication, more widely known as the blue book, in joint association with Mike Philcox and Irish Centre for Reasearch in Applied Geosciences.

The IAEG would like to congratulate the IMQS and the many other geoscience associations in Ireland for their continuing work in their respective areas to increase knowledge, and support industry while also promoting the communication of the extractive sector for better public understanding of the socioeconomic benefits.

A summary of all IAEG events and articles form industry, government and academia are provided in the IAEG 2017 Annual Review.

To keep up to date with all IAEG events and view past annual reviews visit www.iaeg.org

Recognition of Drilling Skills: A New Apprenticeship

by Brian J Byrne MSCE, CEng, FIEI, CMIOSH,
Programme Director, Civil Engineering, IT Carlow

It is always good to be able to pass on some good news. There has been significant progress in moving the new Geo-Drilling Apprenticeship through the SOLAS approval process.

The purpose of the employment initiative introduced by SOLAS in 2016, called Generation Apprenticeship, was to encourage greater participation in trades. Our consortium representing the geo-drilling sector included members from Irish Mining and Quarrying Society (IMQS), Engineers Ireland (EI), The Geological Survey of Ireland, SIPTU, The Institute of Geologists of Ireland, Geoscience Ireland and IT Carlow with a common aim to develop a new Geo-Drilling Apprenticeship to train and certify drillers.

The **geoscience sector** contributes approximately €2 billion to the Irish economy with more than 80 companies operating in a variety of sectors including mining and quarrying, directional drilling, water and well drilling, exploration and geotechnical and environmental engineering. Members of the consortium represent these sectors and have put in considerable work to advance the apprenticeship.

Geological exploration by drilling has a long history in Ireland starting out as a coal prospecting tool in the 1800's and diversifying into areas such as ground investigation, water well drilling, Underground mining and quarry Drilling and more recently geothermal drilling and horizontal directional drilling.

The person who operates heavy mechanical plant, called drill rigs to advance holes into the earth is called a

Underground Drill Rig

IGSL Rotary Rig 3 Comacchio 205

Geo-Driller and this person is a skilled worker who applies their skill and training to investigate subsurface strata (soil and bedrock), extract samples for analysis, install monitoring equipment, undertake in-situ testing, and to construct conduits for the passage of services under sensitive structures like roads, railways, canals and environmentally sensitive features.

The information gathered by drillers provides detailed information in the evaluation of economic potential for sectors such as aggregates and minerals and, in the planning, design and building of key infrastructure.

Soil and rock are naturally, highly variable and competent drilling requires care, attention to detail and an ability to record accurately the variations encountered below ground either by observation, sampling, written documentation or a combination of both.

The driller also needs the technical skills to adapt quickly to changing underground conditions, and to complete the task in a safe and environmentally sensitive manner.

Typically, they are highly trained individuals with highly transferrable skills, but at present in Ireland, there is no recognised documented training for these drillers which limits progression pathways for them to further education and does not recognise their skill base. Outside of their own sector, drillers are considered by the wider public as semi-skilled, at best making it an unattractive career option for school-leavers.

The lack of drilling qualification, means that there is also a lack of standards for acceptable quality within the industry and the quality of work across the various sectors has been and continues to be highly varied.

Irish Drilling companies seeking work in the UK are facing competition by UK competitors who are members of the British Drilling Association. Other countries also have qualifications or accreditations.

In Ireland, professional bodies such as Engineers Ireland, and companies such as Irish Water have called for a more professional approach, and have started to prepare specifications for drilling works, that are expected to insist on drillers having some accreditation.

Historically drilling skills were passed from father to son, but as qualifications have become the norm for career advancement, this system no longer supplies new workers and is not fit for purpose.

Consultation with stakeholders including Employers, Professional Bodies, Government Bodies and the drillers themselves has highlighted this lack of formal training, deficit in new entrants and variable quality of drilling.

If drilling can be made a recognised qualification it will become an attractive prospect for school-leavers. This is why a group of like-minded individuals from across the drilling fields have come together to develop a **geo-driller apprenticeship,** under the auspices of Geoscience Ireland, which to date has passed 5 stages of approval by SOLAS and is currently in the preparation of teaching syllabi. When a driller successfully completes the Geo-Driller course they will be able to progress to further education.

The aim of this programme is to provide a recognised drilling qualification for drillers working in Ireland and abroad. This programme will be set at Level 6 to allow academic progression.

Drillers completing the programme, will be certified to be competent in the areas relevant to their specified field in areas of drilling, sampling, health and safety, first aid, soil and rock descriptions, transporting rigs and equipment, rig set up, borehole/ well installation. Drillers will gain skills in report writing, mathematics, surveying, computer skills, geology, sampling and laboratory and field testing.

The programme shall consist of:

- In-house training undertaken under the supervision of the Employer
- Laboratory and classroom work provided at IT Carlow.

The Employers Certifying Person will be a competent Chartered Engineer or similar, with appropriate training, skills and training.

The next stage of the process will involve programme development and coordination of the work of the many volunteers. It is envisaged that the apprenticeship will begin in 2019 with the first cohort of students being a combination of experienced drillers and new entrants.

Successful implementation of this programme will improve quality, attract new staff to the drilling occupation, give drillers the opportunities to progress within the industry and increase safety. At the same time we would hope that the certification of Irish drillers would allow easier access to international work and reduce insurance costs.

Evolving Survey Methods at Boliden Tara Mines

by Thomas Gilleran, Mine Surveyor at Boliden Tara Mines.

When Tara Mines was established in the 1970's, little did the surveyors of the time know that talk in today's office would be of Terrestrial Laser Scanning, Total Stations, GPS, Drones, Slam Technology and Point Clouds. These terms would have been completely unrecognisable to the men who pioneered the early days of surveying in Europe's largest Zinc mine. Those early surveyors would perhaps be surprised to learn that today's survey department is made up of just 5 full time employees in comparison to the early days when the department consisted of 17 at its peak. An extraordinary statistic given that today's surveyors travel further to increasing depths, capture more data, provide greater survey support and produce far more deliverables than their predecessors, indicative of just how much the surveying and mining industries have been revolutionised through advances in technology & IT within the last 40 years at Tara.

Today most of the surveyors' time is spent surveying As-Built 3D development known as pickups, installing new survey control, issuing survey layouts for drill rigs, laser scanning of stopes, drifts and infrastructure, undertaking production mark-ups, setting out as well as all the associated processing, drafting and modelling of collected data.

Figure 1: Leica TS16 Total Station mounted onto sidewall station.

Coupled with servicing the underground environment the department has numerous surface responsibilities as well. The sheer size of the Tara site means topographical surveys, measured building surveys and stockpile volume surveys are undertaken frequently alongside an extensive annual precise levelling network to monitor for any possible deformation due to mining.

Each year two interns are employed as part of a work placement programme in conjunction with the Dublin Institute of

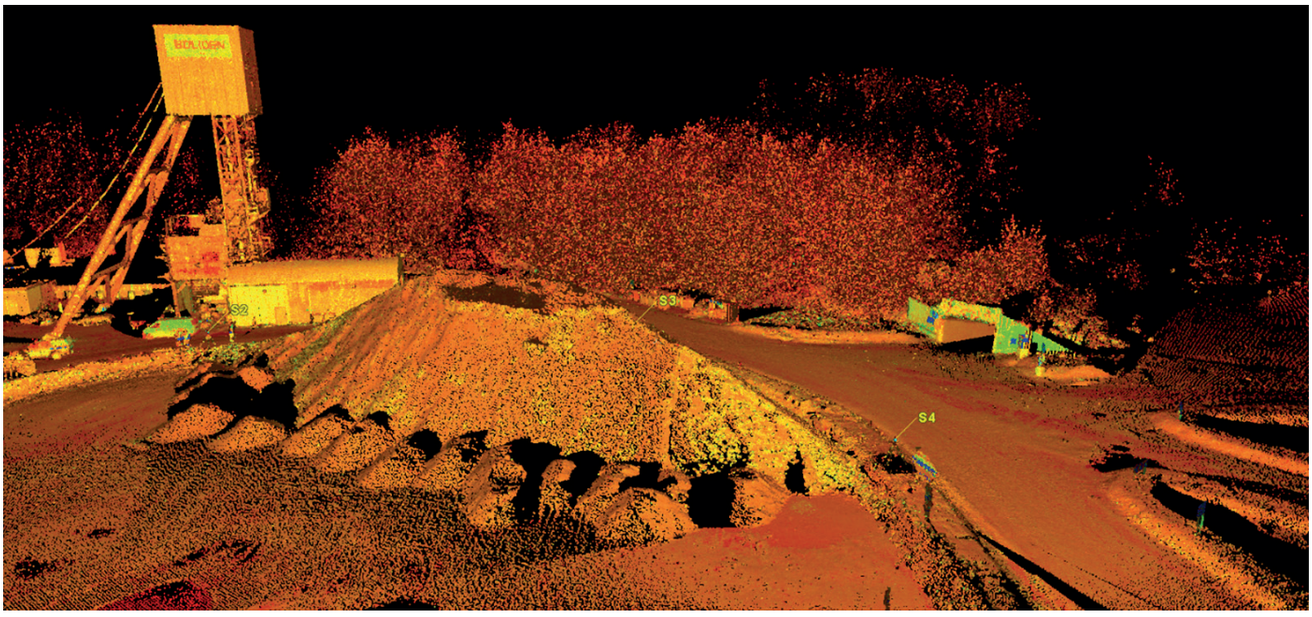


Figure 2: Point cloud data of Tara Mines site with the development shaft, old entrance portal and waste stockpile visible.

Technology Bolton Street. They are third year students of a BSc in Geography Science and the mine provides excellent experience for them, as one of the modules of their course is mine surveying. This is indeed a symbiotic arrangement as Bolton Street is the alma mater to 4 members of the survey department at present.

The Development of Survey Technology & Workflows

Throughout its 40 years lifespan Tara's survey department has always embraced new technologies and its workflows have constantly evolved, utilising new hardware, software and best practise. Many milestones have been met along the way including the introduction of electronic distance measurement by way of a Hewlett Packard 3810. The Geodimeter 420 and the Geodat 400 introduced 'Total Stations' and the ability to capture data electronically and at the same time sounded the 'Death Knell' for the Wild T16 and T2 previously in operation. In its day, the best instrument introduced into Tara was the Geodimeter 468DR. This instrument was a reflectorless Total Station with an inbuilt red laser pointer, with a capability to measure over 100 metres directly off a rock surface. Tara was one, if not the first to purchase a 468DR in Ireland and it gave us the ability to delineate our stopes.

The 'Total Station' constantly evolved from this period onwards and remains the main workhorse of the department. Unrecognizable from the instruments of the 70's, today's tool of choice is the Leica TS16, fully robotic, working in real time coordinates with the ability to take rounds of angles automatically. This instrument gives us an instantaneous indication of the accuracy of setup positions and allows intricate designs to be easily set-out from a touch screen. It also has the memory capacity to hold the entire mine station database of over 30,000 control points, together with any design files required for that day's work.

In the mid-80s Eagle software was introduced to Tara, a somewhat basic package in its infancy but now a comprehensive and bespoke piece of well-tailored software. The introduction of computers, software and development of modern survey instruments signalled the start of a survey revolution and with it the process of transitioning from a paper based mine planning and technical services department to a digital one. Log tables and manual calculations were gradually phased out as the maths and science of surveying was written into the Eagle scripting. Along with performing calculations a system of checks and balances were also built into Eagle to flag errors and inconsistencies in survey data.

The introduction of Side Wall Stations in 2006 brought about another era of change. Up until then the sole method of establishing survey control and driving tunnels was to install survey stations in the form of "spads" located in the backs or roof of tunnels. Line and grade for development drill rigs were made possible through the use of "chains" hung from these hooks to provide gradient and direction. Advancing control required surveyors to setup instruments directly beneath these stations using elevated working platforms to attach a plumb bob and measuring tape. The problems that accompany this method are numerous, with a build-up of errors due to the centering technique involved and the effects of ventilation interference on the plumb bob.

Figure 3: Laser Scanning of stope using remotely operated vehicle with spherical targets visible.

Sidewalls consist of a threaded brass sleeve cemented into the tunnel sidewall through a 30mm diameter drilled hole. These sleeves allow a special forced centering bracket to be inserted and secured thus eliminating centering error. The working from height element is also eradicated as they are located at an accessible height. The system of "Chains" was gradually phased out and today's drillers set up a total station on a designated sidewall station, turn a horizontal and vertical angle as posted on the Survey Layout for the tunnel in question. This is the 'laser line' and is used in conjunction with the design centreline of the tunnel. The drill rig's on-board navigation system is able to relate the laser line with the design thus enabling the rig to drill the next blast on azimuth, gradient and with the appropriate tunnel profile.

Tara purchased its first Terrestrial Laser Scanner in 2007 signalling the beginning of the point-cloud era. To those not familiar with the technology a laser scanner measures three-dimensional coordinates across an object's surface automatically, in a systematic high-speed manner. Rather than the surveyor dictating what points are to be observed the scanner is setup in a suitable position and a scan resolution is

Figure 4: Laser scanning the Zinc concentrates stockpile for end of year accounting figures.

set. These systems output a "Cloud" a 3D picture consisting typically of millions of points. The data can be manipulated and modelled in a multitude of ways perhaps coloured by the intensity of the returned signal, or elevation. High-resolution imagery can also be acquired and draped over the cloud to produce photo realistic results.

The scanner was initially purchased to provide a safer method of surveying stope blasts. This was achieved by deploying the scanner on a remote-control Toyota Hilux. By mounting the laser scanner on the roof of the Toyota and placing spherical targets around the light vehicle the system can be set up under supported ground and then driven remotely to the most optimum position within the stope. The spherical targets form part of the scan and they are surveyed from a safe area by Total Station. During post processing, the spherical targets are identified within the scan and given their mine grid coordinates, thus geo-referencing the scan. Tara's method of deployment of the scanner into stopes offers greater flexibility than other industry standards such as Cavity Monitoring Systems (CMS), mounted on a boom, placed at the brow position of the stope. Another upside is that the survey department have full use of the vehicle which operates as per normal when not in remote control mode.

Initially scanning was used for stope surveys, however, it quickly became a tool to scan drifts, stockpiles as well as a means of providing detailed drawings and sections for the designing of fixed plant and other mining infrastructure.

The Future of Surveying at Tara & Challenges Ahead

Whilst the amount of time spent underground has certainly been reduced, increasing time is spent behind the screens processing survey data, performing quality assurance on survey control, cleaning point clouds, drafting sections, creating set out files and issuing survey instructions.

The quality and integrity of the survey network is in excellent condition, frequently long loops of re-observations known as check surveys are undertaken. These occur typically before breakthroughs, before initiating new mining blocks, before vertical shaft connections are made, or when the survey control has advanced a substantial distance from the primary control. In the early 2000s a first order check survey was undertaken from surface down to the lower regions of the mine in conjunction with gyro-theodolite observed bearings. This survey provided primary control for the South West Extension ("SWEX") deposit and ensures that we are tunnelling towards the new Tara Deep deposit with confidence. Best practice and good equipment have allowed raise connections of 900 metres, the deepest in Europe, to be achieved with a breakthrough accuracy of centimetres. This adherence to accuracy is certainly required when you consider the 14 Km's of survey observations undertaken to connect the top and bottom of the raises.

The nature of the orebody and industry means that we often find ourselves revisiting older areas of the mine, transitioning from back stations installed decades ago onto new sidewall stations.

We can confidently do this due to the quality of work and meticulous nature of the generation of surveyors that went before us. Despite the difference in technologies the principles and fundamentals of best practice have not changed and the quality of their work is still present, a glowing tribute to their time and diligence.

The big challenge for the survey department today is the transition from Eagle into Deswik Mine Planning software. This ongoing process has changed the methods by which we undertake our daily tasks and workflows are very much at an on-going developmental stage. Deswik allows us to survey, create and draft much more detailed models than before, as it is better equipped to deal with large point clouds and heavy 3D models in a much more customisable CAD environment than its predecessor. The downside is that we are losing a very survey friendly package which was heavily tailored to suit our needs. Eagle interrogated captured survey data and highlighted errors for editing. Deswik on the other hand accepts the data captured by the instrument at the time of the survey, discrepancies may be flagged but not prevented from being accepted and imported. The very nature of the mining environment means that as surveyors we are not always afforded the time or geometrically friendly conditions to complete our tasks and must have a means to assess and correct issues. As a compromise a comprehensive survey adjustment software "Leica Infinity" was introduced as a means of performing quality assurance on survey jobs, with the

workflows being developed to work in conjunction with these two packages.

The future of surveying at Tara will almost certainly be based around acquiring and creating even more detailed 3D models. To address the increased appetite for this type of data the survey department has recently taken ownership of Zeb Revo handheld scanners. These differ to traditional terrestrial laser scanners in that they use a technology termed SLAM (Simultaneous Localisation and Mapping) which can acquire over 40,000 points per second at walking pace with the device creating a map of its environment and orientating itself correctly in real time. Although in preliminary stages of use at Tara the 3D models generated and volumes calculated are encouraging. Though, not as accurate as traditional methods its uses are apparent and will become a useful addition to the survey toolkit. The downside to this increasing level of detail manifests itself in sizeable file sizes and the time required to clean the point cloud data.

We live in the era of big data where machines and mobile equipment are monitored in real time and relay this information back to central hubs. This combined with SLAM technologies and software to process large point clouds

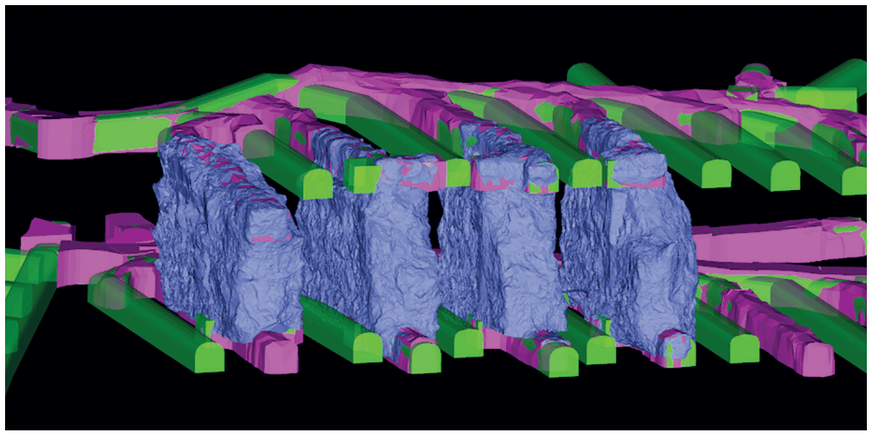


Figure 5: Deswik 3D view of stope scans (blue), survey development pickups (purple) and design solids (green) for hanging and footwall levels.

means that were at a stage where it is quite possible to acquire real time survey point cloud data. The difficulties lie with the sheer volume of data being generated, our ability to use it, as well as the reliability and accuracy of the data. Yes, we can produce quality volume calculations but how does real time big data sets tie into traditional high-end survey control and can this be used by mobile equipment to navigate or perhaps to setup and drill off autonomously? It is difficult to imagine a future where the need for underground surveyors is completely removed, rather a future where this technology and the surveyor work hand in hand, producing incredibly detailed models and deliverables tied to traditionally established survey control.

advertorial

Home-Grown Global Firm CDE on Stellar Trajectory

When it comes to excellence in engineering and manufacturing, CDE has over 25 years of experience in the field of materials wet processing.

The company has recently risen to the cream of the crop as one of only 25 companies in Northern Ireland to make it on to "The UK's 1000 Companies to Inspire Britain" report, compiled by The London Stock Exchange Group.

Add to this the recent accolades of Deloitte Best Managed Company for the 10th consecutive year and the highly coveted Manufacturer of the Year £25m+ Award at the Insider's Made in Northern Ireland Awards on 11 May 2018, and it is clear that CDE has continued on a growth trajectory that is second to none.

A CLASS OF ITS OWN

As a manufacturer, CDE takes each of its customer's vision to turn it into reality. Every plant is tailor-made to their exact specifications for optimal efficiency and return on investment, which are determined through detailed consultation and product testing.

Sean Kerr, Engineering Director at CDE said: "Our strength lies in the level of excellence of our teams, that keeps us ahead of the innovation curve, but also in the absolute care we put in everything we do.

"From the first contact with a customer, we ensure that we provide a world-class service through all milestones of their plant's journey. CDE's project management expertise is extensive and the company takes charge of all aspects of each project from initial discussions through to the installation phase and beyond."

NEW YEAR, NEW IMAGE

Celebrating 25 years in business, CDE has gone from strength to strength and sold, installed and commissioned over 1,000 turnkey systems globally, including the largest wet processing plant in the world in the Middle East. The company's recent brand overhaul sees a new look for the company and a new strapline "A New World of Resource", representing the futuristic and innovative outlook the company is taking in the industry, continually seeking to provide high tech, user- friendly and bespoke wet processing solutions to construction companies as well as mine and quarry operators.

The company has also brought to life the five sectors in which it operates with new branding and sectoral names including: CDE Primo (Sand & Aggregates), CDE Meta (Mining), CDE Reco (Construction, Demolition & Excavation Waste Recycling), CDE Solv (Industrial Sands) and CDEnviro

Creagh Concrete, Toomebridge, CDE customer for the past 20 years which incorporates many modular components engineered and manufactured by CDE

advertorial

The new CDE headquarters in Cookstown will be completed in the fourth quarter of 2018

(Environmental). The dedication and commitment to developing these sectors on a global basis is further supported with the recruitment of over 150 people in the business in 2017.

A STELLAR GROWTH

Commenting on CDE's extraordinary growth, Brendan McGurgan, MD comments: "Our recent performance is testimony to the strength, determination, culture and resilience of our team, who has skillfully navigated a path through the recession since 2008.

"A commitment to our strategic goals underpinned by a strong focus on Innovation has delivered value to our customers across five industry sectors on a global basis and we are delighted that the outlook remains positive as we concentrate our collective efforts towards the delivery of our 2020 Vision."

CDE's experience includes classification and beneficiation of minerals and value addition across these five sectors globally. The continuous focus on innovation and product development in the business saw a major development in 2017 with the launch of the company's most sophisticated M-Series wet processing model to date, alongside five new patents, with eight more in the pipeline, CDE has consolidated its position as an international market leader in its field.

Sean Kerr, Engineering Director

Sean Kerr adds: "CDE is also securing its long-term sustainability and competitiveness through improvements in efficiency. During 2017, we increased the volume of machines dispatched by 27% without the need to increase the footprint of the production space".

AN EXPANDING REACH

To support its ambitious long-term growth projections CDE has recently invested in a 300,000 square foot world-class fabrication facility in Monkstown, which will complement its current supply base and ensure that its fabrication resource meets future requirements.

With demand anticipated to double by the end of 2020, this additional facility complements the existing Northern Ireland supply base and enhances employment in the Monkstown area where a tradition of engineering has existed for many years.

With new CDE headquarters being completed in the fourth quarter of 2018, this is going to be an exciting time for the company as it will produce high quality job opportunities across the company's various divisions.

At CDE, the future is bright and the company looks forward to turning new challenges into new opportunities and to continuing to improve and provide the best expertise and customer service in the field.

CDE primo Sand & Aggregates
CDE reco Construction & Demolition Waste Recycling
CDE solv Industrial Sands
CDE meta Mining
CDE enviro Environmental

CDE
A NEW WORLD OF RESOURCE

An Aerial Survey of Kilmacow Quarry

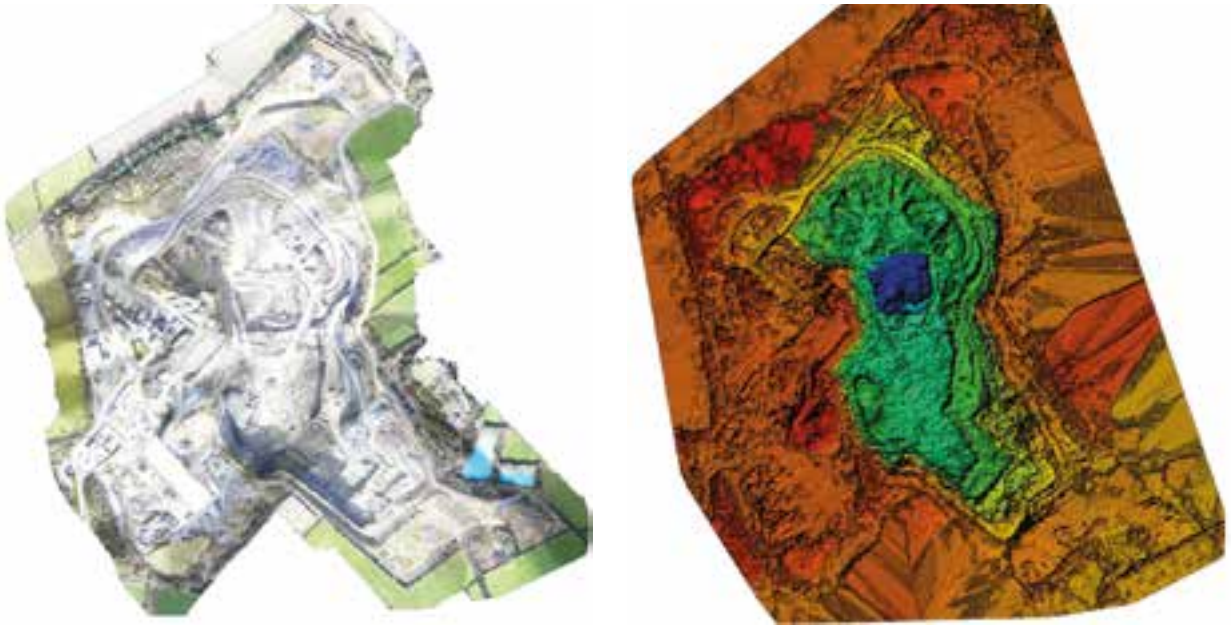
by Carl Morris, Director Land and Mineral Surveys Limited

In March 2018, Land & Mineral Surveys were contracted to survey Kilmacow quarry for the purpose of redesigning road networks, relocating overburden stockpiles and to gather information to create a year by year plan for the quarry to see it through the next 15 years. In order to do this, a 3D model along with a high resolution Orthomosaic and detailed Topographical plan would be required.

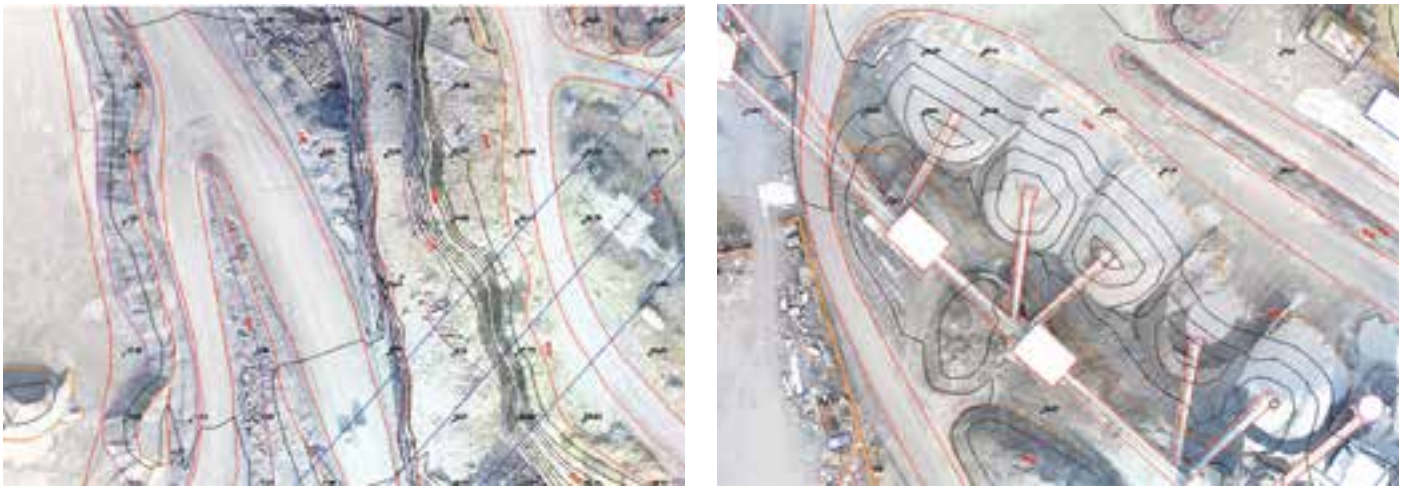
The chosen method to obtain the data was by Small Unmanned Aircraft (SUA). The main reason for this was safety. The management at Kilmacow take a lot of pride in their safety record and when given the option to eliminate people walking around in a potentially dangerous environment, whilst obtaining the accuracy needed, they were delighted to go that route. By using an SUA, production of the quarry would not be affected in any way. Another reason for using the SUA was to accurately survey the top of the quarry face, ridges and toes. This can be quiet difficult, time consuming and sometimes unsafe using the traditional surveying methods of GPS and Robotic Total Stations.

Kilmacow Quarry and the Phantom 4 Pro

For a drone survey to be precise, it must be, in surveying terms, "tied down". To do this, Land & Mineral Surveys established 13 highly accurate GCP's (Ground Control Points) by using a Trimble R10 GPS receiver. Along with the 13 GCP's, a further 7 randomly located check points were also surveyed to confirm the accuracy of the SUA survey and the photogrammetry software. After going through the processing software, these check points



Orthomosaic and the corresponding Digital Surface Model (DSM) of Kilmacow quarry.



Example of 2d drawing with high resolution Orthomosiac of Kilmacow quarry.

where all within 0.041m in elevation and 0.048m in horizontal of the original GPS values. These results were more than acceptable for the purpose of this project.

After finding a safe place to take off and land, a safety risk assessment was then completed. The main issue which arose from the safety assessment was the high voltage power lines running directly through the quarry. We used a robotic total station to find the precise height of the pylons and lines using direct reflex (DR). Resulting from this, a respectful height of 80 meters was chosen as this gave plenty of clearance from the lines and eradicate any issues. The flight plan and SUA were then double checked and the survey was put into operation. It took 5 separate missions to fly the boundaries of the quarry. A total flying time of one hour 25 minutes.

In total, 1093 georeferenced images were taken and calibrated and a GSD (Ground Sampling Distance) of 2.17cm was obtained. The GSD is the difference between two pixel centres measured on the ground. In general, the bigger the GSD value, the lower the spatial resolution of the image and the less visible detail becomes. All photogrammetry processing was completed in pix4d pro software.

Once the 3d model is created in pix4d, a point cloud densification is generated. From this point cloud the team at Land and Mineral Surveys started to extract information and create plans and sections for the client and consultants to work with. This was the most time consuming part of the whole project and is generally the final deliverable for the client.

The most common question we get asked by clients is “Do we need to purchase expensive software to view the information from the SUA survey”. The answer to this is “NO”. Once the photogrammetry software creates a densified point cloud, the Land & Mineral Surveying team then get to work digitising and extracting all the relevant information requested by the client.

At Kilmacow, it was important for every toe, crest, conveyor belt, stockpile, building, hard and soft track etc. to be extracted from the point cloud and drawn in dwg. (AutoCAD) format for quarry management and consultants to be able to view and design from. It is also possible to export the 3d model in a pdf format which can be rotated, zoomed in and out and clearly visualised by anyone with the file. Land and Mineral surveys deliver this 3d pdf with every SUA survey conducted.

A cloudy day is an ideal day for SUA surveying, generally morning or evening when the sun is not directly above the SUA. We did encounter a few problems with light reflection. At the beginning of the flight we had the perfect weather conditions until the sun unexpectedly came out in short bursts and gave us some unusable aerial photographs.

We had to cancel some flight missions and restart them later in the day when conditions got better.

We have recently purchased special filters for the camera which has removed this problem on projects since. Another issue we had was that a quantity report was needed for a large overburden stockpile. The stockpile was completely overgrown and we could not give an accurate volume from the survey due to the SUA not been able to see any of the surface of the area in question. In this case, we went back to traditional methods of cutting lines through the shrubbery and surveying spot levels by GPS and then adding this information to the SUA survey.

We were then able to give an accurate volume calculation of the overburden that needed to be relocated.

Kilmacow 3d model screenshots.

Planning & Environmental Law Forum

Where planning meets the public

by Stephen Walsh, MIPI, Planning Consultant

On the 22nd of May 2018, the IMQS held a Planning and Environmental Law forum in the Louis Fitzgerald Hotel in West Dublin. The event was well attended, with over 70 attendees present on the day.

The speakers were drawn from both the extractive industry and legal profession, with the event being lucky enough to draw on the views and expertise of eminent senior and junior counsel who are integrally involved in the cases which shape the regulatory and legal landscape in which the mining and quarrying industry operate.

In addition to the legal element, the forum also included a panel discussion on the implications of 'Brexit' – the United Kingdom's withdrawal from the European Union and the potential implications of this decision on the Irish aggregate and mining industry.

The overarching theme of the event focused in on the absence of certainty in relation to the ongoing legal and environmental challenges which bedevil the sustainable production of vital raw materials for the Irish domestic and export economy.

At a time when demand for the materials that the sector produces is increasing, there is a clear need for policy makers and the extractive industry to collaborate in order to devise a fair and equitable system for the management of Ireland's quarrying infrastructure.

The ad-hoc nature of policy maker's reaction of European environmental legislation and onerous interpretations of the same in the architecture of Ireland's quarrying registration process has created a perfect storm in terms of the removal of certainty when coupled with a strategically organised coterie of professional objectors awaiting every instance to stymy proper planning and sustainable development in the case of quarrying infrastructure through the weaponisation of judicial review proceedings.

Quarrying Sector

Following on from an overview by Siobhán Tinnelly (IMQS/Tobin Consulting Engineers) of the current challenges facing the extractive industry in Ireland the forum commenced with an update of the status of the quarrying sector provided by Liam Smyth of the Irish Concrete Federation (ICF). The ICF has 74 members and associate members operating at approximately 300 locations throughout the country, representing an estimated 80% of industry output. Liam's contribution related the issues which the ICF and the wider sector have encountered as a result of the Section 261 (of the Planning and Development Act 2000 [as amended]) registration process and applications for substitute consent through Section 177.

Mining

Professor Yvonne Scannell followed Liam with an overview of forthcoming legislative framework with particular reference to the Mining Act 2017. The Minerals Development Act 2017 was enacted on 26 July 2017.

The Minerals Development Act 2017 will provide for:

- the regulation of prospecting for the development of mineral resources;
- a statutory vesting of the exclusive right to work minerals in the Minister for Communications, Climate Action and Environment, subject to the payment of compensation;
- compulsory acquisition of other rights necessary for efficient development of minerals, subject to payment of compensation;
- the payment to the State of rents and royalties from the extraction of minerals; and
- preparation and implementation of rehabilitation plans for abandoned mine sites.

In contrast to the preceding legislation covering the operation of the mining sector in Ireland, the 2017 Act succeeds in clearly setting out a coherent legislative framework for the industry, particularly in the area of the acquisition of ancillary rights, subject to negotiation and compensation.

Professor Scannell's contribution also touched on the area of geothermal energy, in terms of exploring the implications of the Mining Act's exclusion of water from the definition of what constitutes a mineral within the enacted legislation. The status of water in terms of rights and ownership and other matters effecting regulatory certainty will need to be addressed within the mooted Geothermal Bill.

A central theme of Professor Scannell's contribution was the need for a consolidation of 'competent authorities' for the purposes of environmental impact assessment.

European Legal Issues

Rory Mulcahy SC outlined precedents emerging from Europe in terms of directives of the European Parliament as well as decisions of the European Court of Justice. The new Environmental Impact Assessment Directive is in the process of being transposed into operation.

The Department of Housing, Planning and Local Government has given some effect to updated EIA Directive through Circular PL1/2017 – 15 May 2017. In terms of recent case law, Mr Mulcahy explored the implications of European Court of Justice 'Case C-196/16, Comune di Corridonia' which found that The EIA Directive does not prohibit post-development regularisation provided that:

- national rules allowing for regularisation do not provide the party concerned with an opportunity to circumvent the rules of EU law or to dispense with applying them;
- must remain the exception;
- any assessment must consider both future environmental impacts and impacts since time of completion.

In addition, Mr Mulcahy also explored the implications of ECJ cases which relate to the Habitats Directive, 'Case C-323/17, People Over Wind v Coillte Teo' and 'Case C-164/17, Grace and Sweetman v An Bord Pleanala' which found, that it wasn't appropriate at appropriate assessment screening stage to take account of the measures intended to avoid or reduce the harmful effects of the project on the protected site in question.

The latter case outlined that measures designed to manage the habitat relied on

by a protected species (hen harrier) within an SPA could not be regarded as mitigation measures for the purpose of Article 6(3) of the Habitats Directive.

In terms of the mining sector, Mr Mulcahy explored the implications of 'Case C-147/15, Edilizia Mastrodonato' as it established that Article 10(2) of the Mining Waste Directive doesn't have the effect of making an operation involving backfilling of a quarry using waste other than extractive waste subject to the requirements of the Landfill Directive where that operation amounts to the recovery of waste. It is for the national courts to decide whether it amounts to recovery.

Enforcement

Oisin Collins BL delivered a paper focusing on planning enforcement issues facing the quarrying sector.

Mr Collin's paper dealt with matters pertaining to Section 261A of the Planning and Development Act 2000 as well as recent decisions relating to costs. Key excerpts from this paper are provided below.

Recent legislation, and in particular the continuing uncertainty arising from section 261 and 261A are having a profound effect on enforcement proceedings nationally. Perhaps the most striking feature of enforcement nationally is how much less is occurring than was expected. This has two causes. Firstly, there was a dramatic reduction in quarrying operations during the recession with many operations dropping production significantly or, closing their gates completely. This has resulted in a reduction of complaints by the public and/or investigations by local and national authorities. Secondly, there is the hiatus in the operation of section 261A caused by the dozens of judicial review proceedings that have been taken by quarries and environmentalists alike against the determinations made under the section. These proceedings have been mostly adjourned awaiting the outcome of the case of McGrath Limestone Quarries –v- An Bord Pleanala 2014 [IEHC] 382. The McGrath case has recently been resolved before the hearing of the appeal, and, it is unclear as yet what the effect of this will be. It is presumed however that another one of the challenges to section 261A will emerge and proceed to hearing.

Section 261A required each local authority to consider again all of the quarries in their functional areas and consider a number of matters, and reach certain conclusions. Broadly, there were three outcomes, no further action, a direction to apply for substitute consent, or, the service of an enforcement notice.

The latter of these is of concern here. In addition, there were provisions in certain events (such as failure to comply with directions) that had the effect of deeming quarry operations to be unauthorised.

There was also of course the possibility of a refusal of substitute consent. All of this gave rise to the expectation that there would be significant enforcement action before the Courts. This has not materialised to the extent expected. This is mostly down to the very large numbers of challenges to the section itself and, to the determinations made pursuant to its terms, most especially to determination under section 261A(4).

A large number of enforcement notices were served pursuant to this section, and, a large number of challenges were brought to these determinations, all of which remain pending before the Courts. In addition to those challenges, there were many quarries (especially those that had ceased operations during the recession) that simply locked their gates. Others complied with the notices. However, of course, there were also those that kept operating and were subject to prosecution in the District Court. Many of these prosecutions were also stalled pending the resolution of the challenges in the High Court. As a result of the foregoing, there is a large volume of enforcement proceedings that are pending before the Courts, but which are not progressing in any particular hurry. There also remains the possibility that the provisions of section 261A itself may be successfully challenged, and the process may yet start all over again. Notwithstanding, the above there have been two recent cases that are of significance in the context of enforcement in respect of quarries. These are that of An Taisce –v- McTigue Quarries 2016 IEHC 620 and that of Hayes –v- An Bord Pleanala 2016 499 JR.

Legal Costs

In relation to the costs, Mr Collin's paper explored the precedent arising from the North East Pylons Case C-470/16, which established that members of the public will have costs protection in enforcement proceedings taken to ensure compliance with national law even in circumstances where they fail to establish any damage or harm to the environment and/or even where they have been found to be acting frivolously and/or vexatiously.

Legal Trends

The penultimate contribution in the mid-morning session on legal matters came from Jarlath Fitzsimons SC whose contribution focused on the wider trends in planning and environmental law which echoed the contributions of the other counsel present on the day and posited a number of potential solutions to the issues arising from the confluence of precedents arising from case law in quarrying (and non-quarrying) related court decisions and continuing refinements to environmental regulation arising from Europe.

The solutions posited by Mr Fitzsimons related to a mixture of minor legislative amendments where necessary and consideration of a future "one-stop shop" EIAR for both retrospective regularisation and future authorisation of quarry development.

Public Engagement

Following on from the exploration of the legal issues facing the mining and quarrying sectors, the forum was addressed by Joe Heron of Murray Consultants who explored the area of stakeholder engagement.

This aspect of project development is a key phase in developing any type of infrastructure project. Mr Herron gave an overview of the process which Murray Consultants utilise in order to identify key stakeholders and engage with them in a meaningful fashion. In the renewable energy sector, pre-application consultation has been found to reduce the volume of formal objections therefore it is certainly worth further exploration in the context of the mining and quarrying sector.

Brexit

The forum concluded with a Brexit focus, drawing on the insights of Gordon Best (Quarry Products Association Northern Ireland), Paul Lynam (British Irish Chamber of Commerce), and Gerry Farrell (Irish Concrete Federation).

The central message from the panel was the need for certainty for the aggregates sector as the nature of the 'Brexit Deal' takes shape. The impact of negative investor sentiment and the potential implication of this on infrastructure on both the island of Ireland and in the United Kingdom were also identified as a threat to the sector. Forward planning and the identification of new potential markets were highlighted as a potential measure that may mitigate the impacts of Brexit. Review of the day by S. Walsh. The organisers of the event would like to thank the attendees. Through the contributions from the floor and the insights from the speakers, the event proved to be highly successful.

The level of interest from a broad cross section of the mining and quarrying industry along with consultants from a large variety of disciplines indicates the focus which all stakeholders are paying to developments in legal and environmental matters facing the sector.

Stephen Walsh closed the meeting, commenting on the challenging times facing the sector in respect of the legal and environmental parameters which they are operating under.

As a result, it is incumbent on the IMQS and its members to drive potential solutions which ensure that the mining and quarrying sector, which is integral to the day to day operation and development of the Irish economy, is capable of delivering the vital raw materials in the most efficient and sustainable way possible.

Industry Leader

Orla McKenna, P.Geo, Senior Exploration Geologist, Dalradian Gold Limited

Orla graduated from Trinity College Dublin in 2007 with a BA (Mod) in Natural Sciences (Geology). She completed an MSc in Geochemistry at the University of Leeds, graduating in 2008.

In October 2009, she started work experience with Conroy Gold and Natural Resources prior to a three-month contract at Omagh Minerals from late November 2009. The short-term contract segued into the role of Mine Geologist in the open pit at the gold mine, where she stayed for close to two years. The chance to explore for gold came up in the summer of 2011 and Orla moved to Dalradian Gold in August of that year.

Orla joined the company in the role of Project Geologist just as an intense round of resource drilling got underway. She very carefully (but not so quickly) made her way through thousands of metres of drill core just in time for spring and a full field season. She went on secondment to Norwegian Minerals Group and spent the field season carrying out greenfields exploration in Norway.

The secondment was a sudden introduction to life with mosquitoes and without fences. Helicopters were cheaper to come by than quad bikes in the Arctic Circle so many kilometres were covered by foot collecting soil and stream sediment samples. The sense of adventure sold the idea of staying in exploration longer term.

Upon returning to Northern Ireland, Orla spent another year as a member of the resource team before moving to the regional exploration team in October 2013. Initially her primary role was field sampling and internal reporting. This changed over time to include planning field programmes and external reporting and having been running the team for over a year, she officially took on the role of Senior Exploration Geologist in January 2017. In addition to planning and executing sampling and drilling programmes, Orla also monitors licence tenure.

In June 2014, Orla became the third woman in the UK to complete Mine Rescue training with MRS Training & Rescue (then Mines Rescue Service) and in April 2016 was the first woman to complete the Mine Rescue NVQ. She attended her first IMRC mutual training at the Irish Salt mine in Carrickfergus in June 2015 and in October of the same year went on to compete with the Dalradian team in the Mine Rescue Competition hosted by the IMRC at Tara.

Having been a member of the IAEG since 2007, Orla joined the IAEG council as Secretary in January 2014. She served in that role for two years before being nominated as Vice President for 2016. In 2017, she was only the fourth female President of the association in its 44 year history.

In December 2015, Orla became a Professional Geologist with the Institute of Geologists of Ireland. In a quest to stay constantly busy, when stepping back from IAEG duties, Orla decided further study was the way forward and recently completed a diploma in Project Management with the Institute of Project Management Ireland.

However, none of this would have happened without the influence of the female geologists who went before her in exploration and mining in Ireland and the guiding hand of the teachers in Loreto Balbriggan. Particularly Sister Bernadette who took it upon herself to switch Orla from a Home Economics class to a Science class in 1997 with the words “Your mother will teach you to cook…”

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Industry Leader

Prof. Murray Hitzman, SFI Research Professor and Director of iCRAG

In March 2018 iCRAG and UCD were delighted to welcome Prof. Murray Hitzman as an SFI Research Professor and as Director of iCRAG. The award includes funding of €5 million to support a body of research critical to the development of the minerals industry in Ireland.

Prof. Murray Hitzmann, who moved to Ireland following his position of Associate Director for Energy and Minerals at the US Geological Survey, is one of the world's leading economic geologists. With several decades of global experience, Prof. Hitzman's key research achievements have centered on the development of new genetic models for both established and poorly understood classes of metallic mineral deposits.

Prof. Hitzman has a proven record as an ore-finder and mine developer, primarily for copper, lead, zinc, gold, and rare earth minerals, and has successfully discovered and worked on deposits in Europe, North America, southern Africa, Australia/Oceania and South America. His particular success in Africa has been in his vital contribution to the discovery of the world-class Kamoa copper deposit in the Democratic Republic of Congo, alongside the development of three high-value mines in Zambia.

In academia Prof. Hitzman built and directed the largest economic geology research group in the United States at the **Colorado School of Mines**. Prof. Hitzman has extensive leadership experience in national policy formulation and in facilitating societal understanding. Most recently his leadership on the issue of induced seismicity from energy technologies has resulted in significant redirection of U.S. federal government research spending and policy changes in energy development in a number of U.S. states.

Prof. Murray Hitzman has a long history with Ireland. With Chevron Corporation he was jointly responsible for the discovery of the **Lisheen zinc-lead deposit** from 1990-1993. Prof. Hitzman will introduce top-level expertise in economic geology to UCD and iCRAG creating extensive synergies with the Centre's established work programme in raw materials and 3D modelling. His research programme will complement, build upon and significantly extend the raw materials research of iCRAG, and will develop advanced techniques and technologies in the search for new deposits in Ireland, Africa and elsewhere.

His research programme will study the geology, geochemistry and geophysical signature of mineral deposits in the Irish zinc-lead orefield and other mineral systems in Europe and Africa. In Ireland, a 4D model (3D + time) of the structural/stratigraphic architecture of the Carboniferous basin, and more detailed models of individual mineral deposits and prospects, will be constructed utilising existing geological, geophysical and geochemical data, and new seismic datasets.

Taken together these research initiatives will provide an improved basis for future mineral exploration in Ireland. In the Central African Copperbelt he will advance his groundbreaking fundamental scientific work utilizing new isotopic, thermobarometric, and geochronological data.

Prof. Hitzman's extensive industry and academic contacts will enable him to catalyse a new phase of investment, by deepening industry collaborations and leveraging increases in EU funding under Horizon 2020. His research programme will greatly support the development of skilled graduates for both academia and industry, and he will work to improve public understanding of the critical role of minerals to support a sustainable society.

Prof. Hitzman's work programme will attract leading researchers to UCD and iCRAG, and will develop the country's native talent pool to position Ireland at the vanguard of international minerals research.

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Industry Leader

Anne Graham, BE MEn Sc MBA CEng FIEI FIAE, Chief Executive Officer, National Transport Authority

Anne is Chief Executive Officer with the National Transport Authority (NTA). The Authority is responsible for the provision, regulation and integration of public transport services, the provision of supporting infrastructure for sustainable transport and for driving the greater use of sustainable transport as a mode of choice. The Authority has a broad remit which is outlined on www.nationaltransport.ie.

Ann holds a Bachelor's degree in Engineering and a Master of Engineering Science Degree - Transportation Engineering from University College Dublin and a MBA Local Government from Dublin City University.

Anne has previously worked for the Authority as Director of Public Transport Services responsible for the regulation

and provision of public transport services nationally. She was also responsible for the integration of public transport through the provision of Real Time Passenger Information signs and the Leap Card and integrated transport information available on the TransportforIreland website and apps.

Prior to joining the NTA, she worked in the Dublin local authorities as a civil engineer, including the drainage and roads departments. In roads, she was involved in the design of the Dublin Port Tunnel. In 2000, she moved into a managerial role in the city council and worked in the department responsible for corporate policy and business planning.

Anne was then appointed project manager for redeveloping Dublin's O'Connell Street area. That role included the management of construction of the Spire and the new street design, as well as the promotion of development in tax-designated sites. She also worked as an Area Manager in the South West area of the city bringing local authority services closer to consumers in four local offices. Housing regeneration and community development were key parts of her functions.

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Industry Leader

Moyagh Murdock, Chief Executive Officer, Road Safety Authority

Moyagh has been in the transport sector for over 20 years in various capacities. In her early career she spent 10 years in the airline industry having worked first in Bombardier in Belfast as an aircraft systems engineer and subsequently at TEAM Aer Lingus.

She spent 8 years with TEAM as Manager Demand Management and as International Line Maintenance Manager. She then moved into the heavy plant, construction and marine industry working for the Caterpillar dealership in Ireland as Group Product and Customer Support manager for seven years.

Prior to joining the Road Safety Authority (RSA), Moyagh was the Chief Operating Officer for Bus Éireann after having joined the Company in 2007 as the Deputy Chief Mechanical Engineer with responsibility for the fleet maintenance and garage operations. As Chief Operating Officer, she had responsibility for Road Passenger Operations, Schools Transport as well as the Information Technology and Business Systems for the Company.

Moyagh took up the role as CEO of the RSA on the 17th February 2014. Since her appointment as Chief Executive of the RSA, Moyagh has spearheaded the drive to make Irelands roads the safest in the world. She is committed to working closely with all partners, stakeholders and the public to save lives and prevent injuries on our roads. Ireland had the safest year on record in 2017 with 157 deaths and is now the 5th safest country in Europe when it comes to road safety.

Moyagh believes that robust action in terms of education, engineering and enforcement have contributed to the reduction in the number of fatalities. These developments are a consequence of and have contributed to a huge shift in both the behaviour of road users and attitudes to road safety.

The RSA works on the premise of the education / enforcement model in which awareness is supported by other activity helps to shape the climate of public opinion and build community support for road safety.

For example the Driving for Work programme recognises that driving for work is a high risk activity, people who drive for work are 40% more likely than other drivers to be involved in a collision. In addition to the human cost driving for work incidents create a financial burden for industry. Employers, managers and supervisors by law must manage the risks that employees face and create when they drive for work.

This educational activity is complimented by an enforcement strategy that operates on a targeted risk based approach with efforts focused on those presenting as a higher risk and allowing complaint operators go about their business with minimum disruption. This is achieved using the Commercial Vehicle Operator Risk Indicator (CVORI) during both roadside and premises inspections.

Recent progress and experience from other best practice countries proves beyond doubt that Ireland has the capacity to become one of the safest in Europe. By working together we can ensure that mission is achieved.

Moyagh comes from Newry and graduated from Queen's University Belfast with a B.Eng. Mechanical Engineering. In 2012 she was awarded an MBA from Dublin City University (DCU) and also holds a Certificate of Professional Competence in Road Transport Operations Management.

The National Development Plan 2018-2027

by Anne Graham, Chief Executive Officer, National Transport Authority.

The National Development Plan 2018-2027 was published recently, and there's no doubt that it contains some very good news for those who have been calling for significant investment in public transport. With funding earmarked for projects such as MetroLink, BusConnects and Dart Expansion we can begin to look forward to a public transport system that meets the needs of a dynamic, vibrant and competitive economy and that delivers for the people of Ireland, writes Anne Graham.

THE RECENT publication of the National Development Plan (NDP) marked the first time in a number of years, certainly since the economic crash – that funding for major infrastructural improvements in our public transport network was to be made available.

The Luas Green Line extension (or Luas Cross City) was completed in December of last year, but other than that, plans to build or extend our public transport infrastructure were largely put on hold as the country tried to weather the economic storm in the last decade.

Now as the economy continues to recover, and as more and more people are at work, there is at last, scope to address the infrastructural deficiencies that have accumulated in recent years and to tackle the bottlenecks and the congestion that are impeding progress.

Under the NDP three major public transport projects are to become a reality:

- **MetroLink**
- **Dart Expansion**
- **Bus Connects**

The completion of these projects over the next ten years or so will be good news for the travelling public, good news for communities that will be served by a vastly-improved public transport network, and good news for the country. It will also be good news for the construction sector and for the various industries and sectors that feed into that, and with €8.6bn earmarked, the level of activity from that point of view will be significant.

MetroLink

A metro for Dublin has long been mooted as piece of transport infrastructure that needs to be delivered. When we refer to a metro, we're talking about a high capacity urban railway system which is fully segregated from all other traffic. Because of its segregation it provides a high frequency of service with a high level of reliability. Metros are designed for operations in tunnel, on viaducts and on the surface with segregation and carry higher number of passengers than a standard light rail system.

A metro project connecting Swords and Dublin City Centre has been proposed and suggested for many years. A detailed proposal was developed for a scheme extending from St. Stephen's Green to Swords and the planning go-ahead was

given when a Railway Order was issued 2010, although the project was postponed the following year.

In 2015, the National Transport Authority (NTA) published the report of the Fingal/ North Dublin Transport Study, which assessed the need for a metro solution against various alternatives that had been identified. It concluded that a metro scheme was the appropriate solution to meet the public transport needs of the Swords – Airport –City Centre corridor. This was then included in the Transport Strategy for the Greater Dublin Area which was approved by the Minister for Transport Tourism & Sport in 2016. In fact a full north-south metro spine connecting Swords to Sandyford through the city centre was identified as a key project to meet the growing transport demand in the region.

The Luas Green Line opened for operation in 2004, and when it was designed, it was future proofed so that it could be upgraded to metro standard relatively easily. When NTA and TII were looking again at Metro in the context of the NDP, a **Green Line Metro Upgrade** study was carried out to determine the extent of the infrastructure works required to upgrade the current Luas Green Line to a fully segregated Metro standard, and the benefits that such investment would bring. On foot of that study, we recommended that such an upgrade should take place as part of a single MetroLink project.

So now, **MetroLink** is a north-south railway service that **will run between Swords and Sandyford**, connecting key destinations along the route, including Dublin Airport and the City Centre. Large sections of the route will be underground, including through the important city centre area.

The tunnelled section will be some 12km in length and we are still considering whether the tunnel will be twin bore or single bore.

There will be a total of 25 stations, (including 15 new stations), 3,000 park-and-ride spaces, with a journey time of about 50 minutes from Swords to Sandyford.

The **emerging preferred route** identified by NTA and TII was published in March, followed by a period of non-statutory public consultation which concluded in May. Members of the public took the opportunity to draw attention to concerns around matters such as the siting of excavation sites, continued permeability in residential areas, and existing public transport services. They also took the opportunity to let us know important they feel the project is for the future of Dublin and for their communities.

TII and NTA will consider the all submissions made and will publish a report on the consultation process later this year.

We hope to be in a position to make an **application to An Bórd Pleanála (ABP)** for

a Railway Order in **Q3, 2019**. A decision in 2020 by ABP would mean construction could get under way in 2021.

The construction will take an estimated six years to complete, with MetroLink becoming operational in 2027.

Dart expansion

The Dart Expansion Programme is a series of projects that will create a full metropolitan area Dart network for Dublin with all of the lines linked and connected. The initial sequencing of investment will focus on delivery of non-underground tunnel elements of the programme using the recently opened rail link and existing connector tunnel under the Phoenix Park.

This includes buying additional fleet for the Dart network and measures such as re-signalling, junction and station changes to provide expanded services. The next step will be to provide fast, high-frequency electrified services to **Drogheda** on the Northern Line, **Celbridge/Hazelhatch** on the Kildare Line, **Maynooth** and M3 Parkway on the Maynooth/Sligo Line, while continuing to provide services on the South-Eastern Line as far south as Greystones.

It will also include new stations to provide interchange with bus, Luas and Metro networks. The significant benefit to using the recently opened rail link and existing connector tunnel under the Phoenix Park and the proposed sequence of investment, is that it will enable additional passenger services to be put in place much earlier using existing infrastructure with some enhancements.

This integrated rail network will provide a core, high-capacity transit system for the region and will deliver a very substantial increase in peak-hour capacity on all lines from Drogheda, Maynooth, Celbridge/ Hazelhatch and Greystones.

The route for the remaining element of the overall Dart Expansion Programme, the Dart Underground Tunnel, will be established and protected to allow for its future delivery.

Bus Connects

At the heart of the BusConnects project is our proposal to develop continuous bus lanes, as far as practicable, along the busiest bus corridors in Dublin and the regional cities.

Overall, the proposal envisages the provision of about 230 kilometres of bus lanes on sixteen of the busiest bus corridors in Dublin, which we refer to as "Radial Core Bus Corridors".

At present, these busy corridors only have dedicated bus lanes along less than one third of their lengths. This means that for most of the journey, buses are competing for space with general traffic and so are affected by the increasing levels of congestion. This delays services causing real frustration for people looking for consistent and predictable journey times. This makes the overall system less efficient, less reliable and less punctual.

These new **bus corridors** will deliver a transformation in the performance of these routes, making it easier and quicker for passengers to come and go by bus.

We want to remove the current delays and uncertainties, so that in the future, bus journeys will be faster, more punctual and more reliable. That's what we mean when we talk about a vastly improved service for passengers.

In addition, we also want to provide a dedicated cycle track on each side of the road, providing safe cycling facilities, segregated from other vehicular traffic.

The standard layout also includes footpaths for pedestrians and supporting elements such as pedestrian crossings at all key road crossing points, and bus shelters for waiting passengers.

In conclusion

So without doubt, there are exciting times ahead for all of us who are involved in planning, delivering and operating public transport.

More importantly perhaps, there are exciting times ahead for those who will ultimately enjoy the benefits of the top-quality transport service that we have been asked to provide. That includes people living along the MetroLink route in places like Swords who will be able to get to the city centre in 20 minutes or so; people in places like Drogheda, Balbriggan, Maynooth and Celbridge who will now be served by the Dart; and people in all parts of the Dublin area who will be able to move around with ease, on a bus network that is among the most punctual and reliable in the world.

EFEE (European Federation of Explosives Engineers)

by Alan Dolan, Ground Control Engineer, Boliden Tara Mines

EFEE was founded in 1988 and has 25 National Associations representing 25 countries. Its purpose is to provide a European forum for professionals working in the field of commercial explosives.

The IMQS represents Ireland as a National Association at EFEE council meetings. The EFEE have many committees representing the interests of explosives users and manufacturers in Europe (see www.efee.eu). The association holds a bi-annual world conference. The 10th EFEE World Conference will take place from 15th September to 17th September 2019 in Helsinki, Finland. More details at www.efee2019.com.

One of EFEE's primary on-going projects is PECCS (Pan-European Competency Certificate for Shot Firers/Blast Designers).

Currently in Europe there is no minimum training standard to become a shotfirer/blast designer. Each country has its own training requirement and standards which makes working in more than one European country difficult and quite often prohibitive.

To help alleviate this issue, EFEE has created PECCS, the Pan-European Competency Certificate for Shot Firers/Blast Designers which aims to aid the transfer of shotfiring and Blast design skills within European member states. This accreditation will signify the achievement of a minimum standard of competency and allow a shotfirer/blast designer to work in any European country. It will be supplementary to the training already existing in respective European countries.

Two PECCS test courses have been held so far with the next course to take place on 10th to 14th September 2018 in Dresden. Participants are individuals with teaching backgrounds relating to shotfiring, as well as practical shotfirers.

Feedback from the test courses is used to refine the course structure. For more about the project's progress, learning material used or to take part in the course, visit the official web site; www.shotfirer.eu.

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Lambay Island

Was this the site of Ireland's First Quarry?

by Tony Killian, former Editor of the Annual Review (R.I.P.)

Lambay Island. In this view, looking east from Malahide, the harbour with white buildings is in front of the trees to the right of the large green pasture area. The castle is hidden from view among the trees.

Lambay Island (Reachra - "place of many shipwrecks") (pop. 10) lies off the coast of north Co. Dublin, east of Portrane and north of Ireland's Eye. It is the largest island off the east coast and the easternmost point in the Republic of Ireland.

Lambay is about 2.5 square kilometers in size, and rises to 127 metres over sea level. There are steep cliffs on the northern, eastern and southern sides of the island, with a more low-lying western shore.

The geology is dominated by igneous rocks, with shales and limestones, with two outcrops of porphyritic andesite, or Lambay porphyry, as it is more commonly known.

Lambay was important in that in the Neolithic period in Ireland and rock outcrops were utilised as a ground stone axe quarrying and production site. The quarry site is unusual in Ireland for being the only Neolithic stone axe quarry with evidence for all stages of production, from

quarrying to final polishing

History

The ancient Greek writers Pliny and Ptolemy knew about the island and referred to it as Limnus or Limni. The modern name probably originated with the practice of sending over ewes to the island in spring to lamb in a predator-free environment, and is a combination of the word "lamb" and "ey", the Norse word for island.

A number of Iron Age burials were discovered in 1927 on Lambay during works on the island's harbour. The finds included a number of Romano-British items, and these items have been interpreted as evidence for the arrival of a small group of refugees from Brigantia, fleeing the Romans from 71 to 74 AD.

St. Colmcille is said to have established a monastic settlement on Lambay c.530 A.D. Remains of an enclosure have been found to the south of the present early C20th church.

Ireland's Viking period began with a raid on Lambay in 795.AD. Dublin's greatest Norse ruler, King Sitric, granted the island to Christ Church Cathedral, and in 1181 Prince John granted it to the Archbishops of Dublin. This was confirmed by King Edward III in 1337 and by King Richard II in 1394. A later Archbishop gave the rents of the island to the nuns of Grace Dieu, including the tithes of the Lambay rabbits, at that time worth 100 shillings a year.

During the Reformation, Archbishop Brown granted the Island to John Challoner for a rent of £6.13.4, on conditions that he inhabit Lambay "with a colony of honest men" and within 6 years build a village, castle and harbour for the benefit of fishermen and as a protection against smugglers. Challoner worked four mines for silver and copper and bred falcons on the island's many cliffs...

In 1611 the island was granted to Sir William Ussher and his heirs. James Ussher lived on Lambay in 1626 The Ussher family held the Island for 200 years. During the Williamite War the island was used as an internment camp for Jacobite soldiers. More than one thousand of them were imprisoned there after the Battle of Aughrim in 1691, and more than a few died of wounds and starvation.

The 10th century saw the ownership of the Lambay change a number of times before the Baring family of banking fame purchased it in 1904. Sir Edwin Lutyens was contracted to work on renovation of the island's main residence and grounds. He designed each individual stone of the mock medieval castle, which has no right angles. Cecil Baring became Lord Revelstoke in 1929 and Lambay is privately owned by his descendants to this day.

Shipwrecks

The island has claimed a number of shipwrecks, notably RMS Tayleur, the

largest merchantman of her day, on 21st January 1854, with the loss of 380 lives. The White Star Line`s biggest, best, and most modern passenger ship, the first ever ironclad clipper, huge at 1979 tons, with masts 45m high, and at least 650 passengers on board, was on her maiden voyage en route to Australia via Dublin and trying to set a new record for the shortest ever sea passage from Liverpool to Dublin to impress the emigrants aboard.

The ship was undermanned, and the crew were inexperienced, and nobody had yet worked out how to use a compass aboard a metal craft. In thick weather, land was sighted ahead. It was misidentified, at terrible cost. The massive square-rigger struck the island and died slowly on the rocks. Escape from the ship at this critical point favoured the able bodied: some scrambled ashore, others slid down a rope.

Only 3 of the 200 women on board survived. Corpses littered the shore for weeks afterwards; 100 are buried on Lambay. It is believed that most of the remaining emigrants did eventually make it to Australia.

Wildlife

Lambay Island supports one of the largest and most important seabird colonies in Ireland, with over 50,000 Common Guillemots, 5,000 Kittiwakes, 3,500 Razorbills, 2,500 pairs of Herring Gulls, as well as smaller numbers of Puffins, Manx Shearwaters, Fulmars and other species.

Among the mammals of the island are Grey Seals (Ireland's only east-coast colony) and introduced fallow deer (a herd of about 200) and wallabies (whose ancestors were exiled to the island in the 1980s when Dublin Zoo became overcrowded).

Current status

Still privately owned by the Baring family, Lambay is home to an adapted medieval castle and an Edwin Lutyens-designed estate. The estate includes a distinctive open-air real tennis court.

Due to its deep surrounding waters, the island is a particularly popular location for scuba-divers. The island is accessible, by prior permission only, from Rogerstown Harbour, 4 km away, 27 km north of Dublin in Rush.

Lambay Island Chart

The island being privately owned, landing is not permitted without the permission of the owners. However, it is a very popular destination for anglers and for sailors who like to anchor in one of the many sheltered bays or observe the wildlife. The island is host to a very large and internationally important breeding population of seabirds and seals.
A sailing circumnavigation invariably offers a wide variety of wind, wave and tidal conditions.
Sea anglers find good fishing around the rocky shores and the various wrecks in the vicinity.

In 1905/6 Ireland's greatest naturalist, Robert Lloyd Praeger, in a Darwinian attempt to find separately evolved creatures caused by lengthy isolation, led a team of 20 professionals to examine Lambay with the intensity of a forensic police search. Although their discoveries were not quite Galapagosian, they did find 5 species new to science (3 worms, 1 mite and 1 bristletail), 17 species new to the British Isles and 90 new to Ireland.

Lambay Island supports one of the largest and most important seabird colonies in Ireland, with over 50,000 Common Guillemots, 5,000 Kittiwakes, 3,500 Razorbills and 2,500 pairs of Herring Gulls, as well as smaller numbers of Puffins, Manx Shearwaters, Fulmars and other species.

Among the mammals of the island are an ever-increasing number of wallabies (whose ancestors were exiled to the island in the 1980s when Dublin Zoo became overcrowded), thousands of rabbits, and a herd of about 200 fallow deer. Grey Seals abound in the local waters, and the island's claim to be the home of Ireland's only east-coast colony seems at best out of date.

Bird watchers flock to the island, and due to its deep surrounding waters, it is a particularly popular location for scuba-divers. Visitors also come to see the castle's beautiful fuchsia gardens, distinctive open-air real tennis court and walled cemetery.

Lambay Island is accessible, with prior permission, from Rogerstown Harbour in Rush, 4 km away.

Seabird's eggs have been harvested here on the grand scale in times of crisis. Apparently the birds all feed on municipal dumps across on the mainland and the eggs do no taste fishy at all. During WWII the eggs were collected and exported to England.

The Corinth Canal

by Tony Killian, former Editor of the Annual Review (R.I.P.)

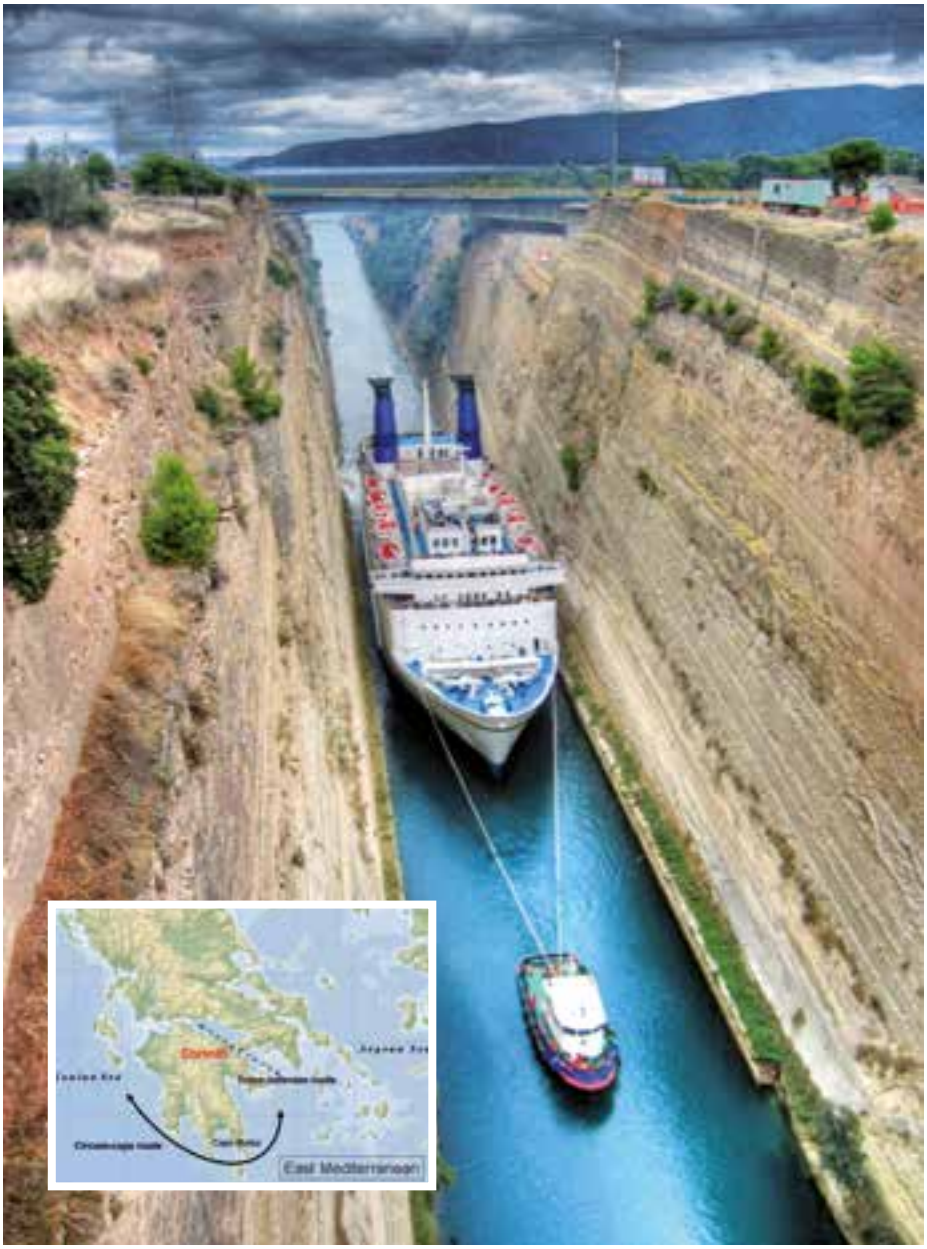
Though only completed in the late 19th century, the building of the canal was an idea and dream that dates back over two thousand years.

The Canal

When the seafaring Greeks from the Corinth area, faced with a 400 mile hazardous trip around the Peloponnese peninsula to the Saronic Gulf, an area which was plainly visible across the 4 mile narrow strip of land, they could only wish for a possible canal across the Isthmus, to allow them a short, safe passage for their ships.

Several rulers in antiquity also thought of cutting a canal through the Isthmus. The first was Periander, the tyrant of Corinth (602 BC). Such a giant project was beyond the technical capabilities of ancient times, so Periander by a daring decision which led to the greatest of technical construction works in early Greece: the building of the Diolkos or Slipway, or "movable platform" to carry ships across the peninsula.

The Diolkos was a 10 meters wide roadway which ran all the way from the Gulf of Corinth to the Saronic Gulf. Narrowing to between 3.50 and 6 metres after its starting point the Slipway was paved with porous stone throughout its length. Two deep parallel grooves, which ran at a distance of 1.50 metres from each other, still marks the Diolkos.



To reduce the weight of the ship as far as possible, it was unloaded, dragged onto the Diolkos initially on wooden cylinders and then transferred to a special wheeled vehicle to be dragged across the Isthmus. The unloaded commodities were taken by ordinary road to the other end of the Isthmus. On reaching the Slipway's terminus on the Saronic Gulf, the ship was lowered into the sea, and the cargo was reloaded to continue its journey.

This arrangement did not merely speed up traffic. It also enabled ships moving between the Central and Eastern Mediterranean to avoid the rough seas almost unavoidable in a voyage round the Peloponnese.

The Diolkos was repeatedly repaired in ensuing centuries and remained in use until the days of Augustus, though the appearance of ever-larger ships curtailed its usefulness. There is hardly any mention of its use in later centuries, and then only in connection with warlike activities.

Between 1956 and 1959, the Greek Archaeological Society carried out excavations designed to trace the course of the Diolkos. Dimitrios Poliorkitis, king of Macedon (c. 300 BC), was the second who tried to build the canal, but his engineers insisted that if the seas where connected, the more northerly Adriatic, mistakenly thought to be higher, would flood the more southern Aegean.

The most serious attempt to build a canal was that of Emperor Nero (67 AD) who provided 6,000 slaves for the job, starting the work himself by digging with a golden hoe, while music was played. However he was killed before the canal could be built.

In the 19th century, the first who thought seriously about carrying out the project was Capodistrias (c. 1830), first governor of Greece after the liberation from the Ottoman Turks, but the budget, estimated at 40 million French francs, was too much for the Greek state.

The modern attempt at construction began in the 1870's following the successful opening of the Suez Canal. A French company was hired to build it, but due to financial difficulties, the company ceased work after only the two ends had been dug. Finally, in 1881 a Greek company led by Andreas Syngros, (the main contractor being Antonis Matsas), ultimately took over the project.

Corinth Gulf.

The Diolkos.

Building

The builders dug the canal through the Isthmus at sea level; no locks were employed. A persistent problem was the heavily faulted nature of the sedimentary rock, in an active seismic zone, through which the canal is cut. The canal's high limestone walls have been persistently unstable from the start. Although it was formally opened in July 1893 it was not opened to navigation until the following November, due to landslides. It was soon found that the wake from ships passing through the canal undermined the walls, causing further landslides. This required further expense in building retaining walls along the water's edge for somewhat more than half of the length of the canal, utilising some 165,000 cubic meters of masonry. Between 1893 and 1940, it was closed for a total of four years for maintenance to stabilise the walls. In 1923 alone, 41,000 cubic meters of material fell into the canal, which took two years to clear out.

Achievement

The Corinth Canal is considered a great technical achievement for its time. It is 3.9 miles (6.3 km) long and has a water depth of 26 feet (8 m) at low tide. Its width varies from a minimum of 69 feet (21 m) at the bottom to 82 feet (25 m) maximum at the water's surface.

The job was completed and regular use of the Canal started on Oct 28, 1893, but it failed to attract the level of traffic anticipated by its operators.

World War II

Serious damage was caused to the canal during World War II, when it was the scene of fighting due to its strategic importance. On 26 April 1941, during the Battle of Greece between defending British troops and the invading forces of Nazi Germany, the Germans were able to surprise the defenders with a glider-borne assault in the early morning of 26 April and captured the bridge over the canal The bridge was defended by the British and had been wired for demolition, and the British were able to set off the charges and destroy the structure.

Three years later, as German forces retreated from Greece, the canal was put out of action by German "scorched earth" operations. German forces used explosives to set off landslips to block the canal, destroyed the bridges and dumped locomotives, bridge wreckage and other infrastructure into the canal to hinder repair work.

The United States Army Corps of Engineers began work to clear the canal in November 1947 and managed to reopen it for shallow-draft traffic by 7 July 1948, and for all traffic by that September.

The "Sinking Bridges"

An unique feature of the canal are the two 'sinking' bridges, originally called sub ducting bridges, situated at both ends of the Canal at Isthmia and Corinthand, which lower the center spans below water level when they give way to ships crossing the channel.

The primary advantage of lowering the bridge instead of lifting it above is that there is no structure above the shipping channel and thus no height limitation on ship traffic. This is particularly important for sailing vessels. Additionally, the lack of an above-deck structure is considered aesthetically pleasing. However, the presence of the submerged bridge structure limits the draft of vessels in the waterway.

They were installed in 1988.

The Motorway Bridge

The E 94 highway Olimpia Odos from Athens to Kalamata on the Peloponnese peninsula which crossed the canal, was upgraded to motorway standard as part of the A7 in 2005. The motorway bridge has walkways on both sides (as well as parking spaces on both directions of traffic) and offers a vertical view of the canal from higher above.

The Railway Bridge

The location of a new 250m High Speed Railbridge was chosen to be alongside the new motorway connecting Athens to the West over the north side of Peloponnese, with construction of the railway bridge

A bridge being submerged to allow boats to pass through.

The motorway and railway bridges.

Tourist viewing area.

completed in 2007.

This bridge is one of the most important Greek bridges,and was the first railway bridge in Greece constructed with partial seismic isolation by use of lead rubber bearings at the abutments and piers and longitudinal hydraulic shock absorbers at the abutments. It has three spans of 60 meters + 110 meters + 60 meters totalling 230 meters in length.

Its central span bridges the Canal leaving a free height of 52 meters for ship passage. The centre span was constructed using the free cantilever method while the two side spans were cast in situ. The foundation is a combination of deep concrete shafts and shallow pile groups working as anchors to avoid excessive loading imposed on the banks of the channel. The bridge structure was designed to withstand design earthquakes with an acceleration of 0.78g while the isolation system was designed for the maximum credible earthquake of 0.975g.

Provisions were made so that the bridge could also sustain tetonic movements of 0.25 meters between its first abutment and pier. Due to a fault crossing between them frame type special structures were designed at the two abutments in order to prevent uplift during extreme loading conditions. End and intermediate anchorage blocks were also designed to enable future external prestressing in case of retrolift or upgrade of the load capacity of the bridge.

It was designed by Odomichaniki SA, constructed by Michaniki SA, and completed in 2007.

Canal usage

The canal experienced financial and operational difficulties after completion. The narrowness of the canal makes navigation difficult; its high rock walls channel high winds down its length, and the different times of the tides in the two gulfs cause strong tidal currents in the channel. For these reasons, many ship operators did not bother to use the canal and traffic was far below what had been predicted. An annual traffic of just under 4 million net tons had been anticipated but by 1906 traffic had reached only half a million net tons annually. By 1913 the total had risen to some 1.5 million net tons, but the disruption caused by the First World War produced a major decline in traffic.

Some unusual features make this a visually stunning piece of engineering, but also render it impractical for modern commercial shipping. It can only accommodate ships of up to 54ft (c 16m) and a depth of 24ft (c 7m) – too small for modern ocean freighters.

Ships can pass through the canal only one at a time on a one-way system. Larger ships are towed by tugs. However, the canal is still used by many smaller craft, and there are also cruises organized where travelling along the canal with the ship almost touching the land on each side can be a memorable experience.

The Corinth Canal is not only an international shipping route but also a tourist attraction point. Hundreds of thousands of tourists from domestic and abroad visit the Canal every year and admire this great project while crossing through it, and others indulge a new activity which takes place in the Canal, bungee jumping.

Some 11,000 ships per year travel through the waterway.

The Shanxi Hanging Temple

by Tony Killian, former Editor of the Annual Review (R.I.P.)

There's no shortage of breathtaking architectural wonders in the long history of China. Some are magnificent, while some are odd, dangerous, and sophisticated. Hanging Temple, also known as Hanging Monastery or Xuankong Temple, is an outstanding representative of the latter.

Location

Shanxi Monastery stands at the foot of Mt. Hengshan, 40 miles from Datong City in China, hanging on the west cliff of Jinxia Gorge more than 50 meters above the nearest point by road, which point can only be reached after a tortuous and dangerous journey.

Construction

The building process began at the time of Northern Wei Dynasty, 1400 years ago, and according to the history of Hengshan Mountain, the whole construction started by only one person, a monk named Liao Ran. The Temple was designed skillfully and boldly constructed. The method used was to chisel horizontal holes in the cliff, with crossbeams half-inserted into the rock as the foundation, while the rock in back became its support.

Boards and pillars were placed on the beams to build various beam frames and roofs. Balusters were set around all the buildings and the temple was arranged in random from north to south, with a bluff inside and several plank passages built along the face of the cliff. Beam frames and balusters were connected to each other to form one integrated mass.

It can be seen from the foot of the mountain that the monastery is "supported" by over 20 vertical beams. It is easy to think that the temple is supported by these fragile wooden sticks, but when the temple was built, there were no sticks needed to support the temple, and the whole temple seemed to be hanging against the cliff. People didn't dare to walk onto it without the temple having visible support, so later the master of the temple had to order workers to add several wooden sticks to comfort people mentally. The existing monastery was largely rebuilt and maintained in the Ming Dynasty (1368-1644) and Qing Dynasty (1644-1911).

Construction experts from countries including Britain, Germany, and Italy, come to see the monastery. In their words, Hanging Monastery, which mixes mechanics, aesthetics, and Buddhism, is unusual. The architecture and everything it symbolizes embodies a great cultural achievement of Chinese people.

Why build a monastery like this? Location is the first reason; building a monastery on the cliff could shield it from floods. In addition, the mountain peak protects it from rain and snow; and the mountain around it also diminishes damage from long-time sunshine. The second reason is that the builders followed a principle in Taoism: no noises, including those from rooster crowing and dog baying; so from the upper ground, all noises drop away.

Serving three religions

The second attraction of Hanging Monastery is that it includes Buddhism, Taoism and Confucianism. Inside

The people shown here are making their perilous way to the most strangely constructed Hanging Temple.

The approach road.

A lone lady slowly makes her way down to safety.

Walkways at the Hanging Monastery.

the monastery, the sculptures of Sakyamuni, Confucius and Laotzu appear together, which is very unusual.

The inner temple

When stepping into the temple, one can smell ancient feelings from the old woods.

Take a deep breath... start your wonderful tour to explore the embodiment of Chinese culture in this unique place.

The buildings are arrayed in a line from the south of the cliff to the north, and heightened gradually. More than forty halls, rooms and pavilions in the temple are divided to three groups. Passing through the temple gate, one can reach a two-storied building.

At the stele pavilions and the gate towers, two tall buildings stand face to face in the yard, with two bell and drum towers on both sides of the temple gate, and there are square side pavilions.

The principal building among them is the Sanguan Hall, a place to offer sacrifice to Taoism. Statues in the hall are vivid, with undecorated faces, black eyebrows and swaying gussets.

The central part is the Sansheng Hall, which enshrines sitting Buddha statues with disciples standing submissively on the sides. The last building complex the Sanjiao Hall, the highest one in the temple, and has a three-eave gable and hip roof with nine ridges. Statues of Confucius, Laozi (a scholar in ancient China) and Sakyamuni the founders of Confucianism,

Taoism and Buddhism respectively, are enshrined in the hall. Different cultures directly encounter one another here. The statue of Sakyamuni stands in the middle, that of Laozi on the right and Confucius on the left, with different expressions.

Displaying the innermost being of three founders of different doctrines, techniques of statuaries are really exquisite and are acclaimed as the peak of perfection.

This building is a perfect combination of religion and culture of Chinese feudal society. The Hanging Monastery was built at a crossroads between towns so that travelers would use it as a place to rest during their journey. In that more religious age, travelers were reluctant to stay in places devoted to other faiths so the Hanging Monastery enshrined the three major religions of China to accommodate guests.

Visiting

Hanging Monastery is an architectural wonder as well as an amazing construction wonder, and it attracts people by its natural views and man-made landscaping. It is well worth a visit, however. In December 2010, it was listed in the "Time" magazine as the world's top ten most odd and dangerous buildings.

With the development of tourism, more and more visitors rush to this world wonder, bringing a tremendous load to the temple.

Hanging Temple is even more dangerous to visit than the Leaning Tower of Pisa was prior to its stabilisation and climbing up to the Hanging Monastery is not an easy job.

There are steps everywhere and the monastery itself is navigated via ladders and tiny trapdoors, so is completely inaccessible to wheelchairs and tricky for people with broad shoulders.

There are also narrow and steep stairs linking the three main structures hanging on the cliff. The walkways between areas are slatted, allowing the visitor to see the ground below, and the whole structure sways under the weight of too many people. Anyone suffering from acrophobia or infirmity would be well advised not to attempt the climb.

Visitor Tips

The Hanging Monastery is 65 kilometers southeast of Datong City, and takes ninety minutes by car. A taxi costs around 150rmb or 26rmb for the two-hour bus journey. There are some decent hotels in the neighboring town. The usual snacks are available in the car park, or at the local restaurant.

IMQS Annual Dinner Dance 2017

John and Sinead Francis.

David Johnston, Eileen Johnston and Sam Eccles.

Brendan Kieran, Sean Finlay, Siobhan Tinnelly, Brendan Morris.

Deshnee Naidoo, CEO of Vendanta Zinc International - Guest Speaker.

Brendan Morris (IMQS President) and Sam Eccles (IQNI Chair).

Gordon Best, Brendan Morris and Garfield Harrison.

Eibhlin Doyle and Gerry Stanley.

Conor Byrne and Helen Byrne.

Lesley and Stan Bartlett.

President Brendan Morris and family.

Les and Heather Sanderson.

Chris Stevenson and Ciaran Greenan.

Brendan Morris and Deshnee Naidoo.

Eibhlin Doyle and Carol Sanderson.

Gerard Morris, Padraig Barrett, Brendan Morris, Kevin Lonergan.

Sam Eccles - Chairman of the Institute of Quarrying Northern Ireland.

IMQS Annual Dinner Dance 2018

Saturday 10th November, 2018

This year's IMQS Dinner Dance will take place in the Kildare Hotel Spa & Country Club, Straffan, Co. Kildare.

This is a 5-star resort on a former Georgian estate on 300 rural acres along the River Liffey in County Kildare 30 minutes from Dublin International Airport and Dublin City Centre.

The resort offers golf on two internationally recognised championship courses. Our Golf Tournament will take place on 10th November at 11.00am - Email **info@imqs.ie** for more details.

Music will be supplied by Vegas Nights who are a fantastic 6 piece band fronted by both a male and female singers with a

sophisticated sound and look, the band perform a brilliant mix of music from Pop to Country and the Classics!

Followed by a DJ that will keep you dancing to the early hours!

The event will be addressed by a Guest of Honour.

There is also ample free parking.

This is a social evening with good and outstanding entertainment, a brilliant chance to meet up with old friends and make new acquaintances in the industry. Individual or small groups will be accommodated on members tables, so don't be put off if you want to come by yourself or in a small group.

Tickets are now available on the IMQS web page http://www.imqs.ie/DinnerDance.aspx

Obituary
Dr. John F. Lawlor
Geologist, Olympian

by Hugh McCullough, B.L., P.Geo

John Lawlor died in Boston on Sunday May 20th, 2018, aged 84. John was a multitalented individual, being both intellectually and physically strong. He had a passionate interest in Ancient Greek history and literature. He held the Irish hammer throwing record in the early 1960s.

He competed for Ireland in the Rome and Tokyo Olympics in 1960 and 1964 respectively, and won the British AAA hammer title in 1961. While studying geology at Boston University, he was a three - time NCAA champion in the hammer throwing event. John was from a sporting family – his older brother Paddy gained 12 caps playing rugby for Ireland and John himself was also a keen rugby player. John was pre-deceased by his wife Kathleen, who died in 2016 and he is survived by his five children Mary, Maeve, John, Paul and Owen.

I first met John in Ghana in early 1986 when he came to visit a gold project held there by my former company Glencar Mining plc. At that time, I was working in Glencar alongside another stalwart of the Irish exploration scene, Noel Kieran who sadly died in 2013. Noel and John had soldiered together in the Special Branch of An Garda Siochána in the late 1950s, and indeed Noel had many hilarious stories to tell of those early days. As it happened, both Noel and John left the Guards to go to college and study geology, John at Boston University, on a hammer-throwing sporting scholarship, and Noel at UCD.

Upon graduation, John went to work as an exploration geologist in the lead zinc mine at Silvermines, Co. Tipperary where he remained until the late 1960s, when he returned to Boston University to complete a PhD in Geology. Upon receiving his doctorate he was hired by Phil Caret of the Pioneer Group of Boston, a major mutual fund management company.

John led and managed Pioneer's investments in the natural resources sector and it was in that capacity that our paths crossed with John through another Irish friend of ours in the financial investment sector in New York, Gerry Murphy.

Gerry rang Noel one day in 1986 to say that John Lawlor was looking for gold investments for Pioneer in Africa. At that time, Glencar had secured the licence over the Teberebie deposit in the Western Region of Ghana and we were looking for a way of financing its further exploration and development. John and the President of Pioneer, Jack Cogan arrived in Accra in April 1986, the day after Ronald Reagan bombed Gadaffi in Tripoli. There were serious protests outside the US Embassy in Accra that day resulting in the death of a policeman, but luckily it did not prevent Pioneer from pursuing an agreement with Glencar on the Teberebie Project

After many visits and discussions, we concluded an agreement and this ultimately led to the development by Pioneer of the Teberebie Gold Mine which is still in production today, more than 30 years and 7 million ounces later, now under the ownership of Gold Fields.

Other Irish notables who worked on the pre-feasibility of the Teberebie deposit in the early days were geologists Noel Gillatt and Peter Strogen; electrical engineer Paddy Lord; drilling chief Andy Gailey and honorary Irish mining engineer, John Stocks. It was John Lawlor who later introduced Noel Kiernan to that other Irish explorationist of international renown, the late Joe Breen.

It was during those early years of drilling out and proving the Teberebie deposit that we got to share some of the best stories from the old days. I do remember one story told around a dinner table in Accra with John and Noel and others about John's representation for Ireland at the Rome Olympics in 1960. The bus from his hotel to the stadium got caught in a traffic jam and, realizing that he was going to be late for his allotted throwing time, John jumped off the bus and ran to the stadium.

Having arrived there, he was refused admission, because he had left his accreditation papers in his jacket on the bus. No amount of gesticulation and explanation could persuade security that he was due to throw the hammer for his country in less than 10 minutes' time! So John went around the corner and climbed a fence into the ground and made his slot with only moments to spare. Amazingly, he came within a few tens of centimetres of a bronze medal and finished in fourth place.

John Lawlor was a gentle, informed professional, and was always interesting company. He was a resourceful man working successfully in the resources industry.

May he rest in peace.

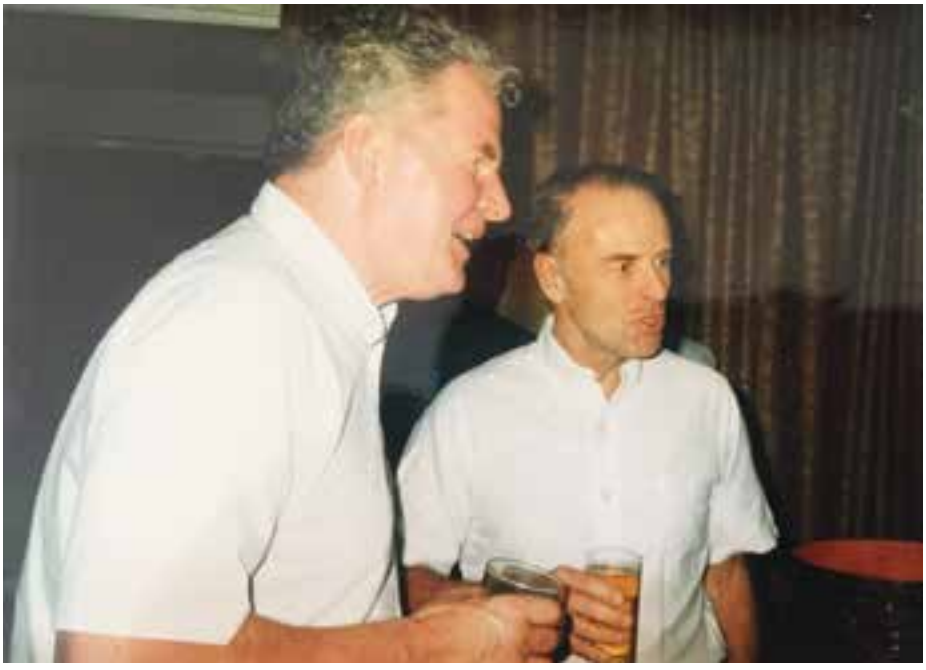


Photo of the late John Lawlor (left) with his colleague Jack Cogan of Pioneer Group taken in Accra c 1990.

Obituary
Dave Fitzgerald
1928 – 2018

by Nicholas Coy, Geologist MHTI

On 30th May 2018, Dave Fitzgerald, former Manager at the Tynagh Lead –Zinc Mine in County Galway died peacefully at his daughters home in Dublin.

Dave was born in County Kerry in 1928, the son of a railway engineer. After his early education, during which he excelled in a number of sporting activities, he graduated as a mining engineer from the Camborne School of Mines in Cornwall. One of his earliest jobs was in a chromium mine in Pakistan, and over the following years he worked in a number of mines in Asia, Canada and South America.

By the early sixties he was working in the St John D'el Rey Gold Mine in Brazil when he got a call from Ireland asking him to join the development team on the first major Lead-Zinc-Copper-Silver deposit in Ireland in the 20th century. The mine was at Tynagh in East County Galway which had only recently been discovered by Irish Base Metals Limited, a wholly owned subsidiary of Northgate Exploration. He returned to Ireland and worked as Mine Manager at Tynagh throughout its operating life, up to its final closure in 1982.

Always a keen sportsman, he played rugby with Corinthians and went fox hunting with the Galway Blazers, but sailing was his greatest passion. With Dave Whitehead

Management meeting in Tynagh in the sixties. Dave is standing in the centre. Murray Pickard, the General Manager is seated on the left with Jim Lenehan the mine accountant standing behind him.

and other members of the Tynagh staff, who were often referred to as "the Canadians" by locals in the early days of the mine, he formed a sailing club on Loughrea Lake, the first of its kind on those waters. Over the following years his sailing adventures took him around the Irish coast and as far as the Mediterranean.

He had a strong and successful management style at Tynagh, probably one of the most successful and profitable Irish mines of the 20th century. He had a wicked sense of humour, a passion for the industry, and a list of fascinating stories from the early days of mine exploration in Ireland. One of his most extraordinary stories concerned the underground exploration of the Allihies Mine in the early sixties, in which he was involved. After the mine had been dewatered, his description of descending the 1500 foot, twisting, narrow and inclined engine shaft in an open iron skip was hair raising and hilarious.

We were fortunate that he was able to attend the 50th anniversary celebration of the opening of Tynagh at the Loughrea Hotel in January 2016, where he met many of his old working colleagues and associates for the last time.

Dave passed away on 30th May 2018, just four months after celebrating his 90th birthday. This was just six months after the death of the Tynagh Mine geologist Dave Whitehead, his longtime friend, work and sailing colleague. Dave Fitzgerald was one of the last of that unique group of men who were a formative part of the revival of Irish mining in the 20th century. He was larger than life in many respects and will be greatly missed by those who knew him. Our sympathies go to his three daughters Grainne, Trish and Kathy.

Ar dheis De go raibh a anam.

L-R: M.V. O'Brien, J. Tonner, D. Fitzgerald (President), C. Blair and J. Warfield.

Dave arriving at the 50th Anniversary of the Tynagh Mine opening celebration in Loughrea. He is accompanied by his daughter Grainne. John Kelly is on his right hand side.

Obituary
William James Tilson
MIMMM CEng ACSM

by Mike Lowther FIMQS and Colleen Cairns (née Tilson)

William James (Jim) Tilson was born on 22nd February 1932 in Draperstown, County Londonderry. He grew up in the village of Moneymore with his parents Thomas and Mary, his brother Roy and his sister Anne. His father was a policeman, and the family roots are in County Cavan.

Jim attended Moneymore Primary School, where he earned a County Scholarship, and then Rainey Endowed Grammar School in Magherafelt, where he excelled academically and at sports. He enjoyed rugby, cricket, boxing and athletics, and was active in the Boys' Brigade and Scouts.

Jim qualified as a teacher from Stranmillis College Belfast in 1953, and followed this up with a post-graduate certificate and diploma from the University of Nottingham and Loughborough Training College, where he was good at the teaching of physical education.

Returning to Northern Ireland, Jim taught in a Technical Intermediate School, and then was appointed as Headmaster of a small rural school in County Fermanagh.

However, the wander-lust was beginning to set in, and in 1957 Jim set off for Northern Rhodesia (now Zambia). He joined the Northern Rhodesia Police, and also spent time as a miner at the famous Roan Antelope Mine in Luanshya. On his birthday in 1958 while still on the Copperbelt, Jim married Maisie Shields from Bushmills, County Antrim. Maisie had also studied at Stranmillis College Belfast, and had then travelled to Southern Rhodesia to work as a teacher in a brand new primary school in Amandas, north of Salisbury (now Harare). Seeing the potential for a career in the mining industry, Jim and Maisie returned to Cornwall in 1958, for Jim to study at the Camborne School of Mines. Jim excelled at his studies, and graduated in 1961 with a first class degree in Mine Engineering. He worked as a student at South Crofty Tin Mine, and also at Rio Tinto Mine in Spain. His paper "Open Pit Mining at Rio Tinto" won the William Thomas Memorial Prize from the Cornish Institute of Engineers.

Heading back to Africa, Jim's first job was for Newmount Mining, at Tsumeb, South-West Africa (now Namibia), where he initially worked as a planning engineer on the layout and design of the new Kombat Mine. After a spell as Safety Engineer, Jim then spent several years as Mine Overseer, supervising production, capital development, and shaft sinking.

Following a few months in Tasmania to check out possible jobs, (where Jim declared it was too wet to settle a family!), Jim, Maisie and their two young children returned to the Copperbelt in 1965. Jim worked as Shiftboss, Mine Captain and Assistant Underground Manager at the Rhokhana Corporation, Kitwe.

Then in 1970 a great opportunity to start a new mine in Canada came along. Jim moved his family to central Manitoba, and as General Superintendent and Acting Mine Manager he was responsible for building not only the Manibridge Mine but also the whole new town, for Falconbridge Nickel Mines Limited. Jim and his wife Maisie were instrumental in encouraging a community spirit by arranging sporting activities aimed at families and workers. The ladies' walk in the woods, children's swimming club, men's fishing competitions, pool/snooker games all evolved to a purpose built ice rink for hockey and eventually a community sports centre!

Jim returned to Ireland in 1973, and worked for several years as Mine Superintendent and then General Superintendent at Silvermines, which was owned by International Mogul of Ireland. From all accounts Jim had a very positive effect on production and labour relations, and is still mentioned in dispatches down in Nenagh!

Towards the end of 1975 Jim was appointed as General Manager (Mining) for Bula Limited, and worked for ten years on the Nevinstown Mine project.

Following this Jim spent a few years as an independent consultant, then in 1990 was appointed as Manager Production and Technical Services at Petromin's Mahd adh Dhahab Mine in the Kingdom of Saudi Arabia. Sporting facilities were good, and Jim interspersed his work duties, and development of the mine rescue team, with many games of tennis, and swimming. He enjoyed the desert life, and also greatly encouraged the multi-national workforce to take part in team events, such as the annual Mine Sports Festival.

In early 1993, Jim was appointed as Chief Operating Officer for ARCON International Resources, with responsibility for the development of the first new mine in Ireland for 20 years, at Galmoy in County Kilkenny. Jim was responsible for the detailed engineering and design, completion of the complex planning and permitting process, recruitment of key staff, selection of contractors and the heavy vehicle fleet, construction of the mine and site, and bringing the mine into production. Work began on site in the summer of 1995, and by the spring of 1997 the mine development contract was completed – on time, on budget, and with a good safety record. Jim was then appointed as Managing Director of ARCON Mines Limited, and guided the ramp-up in production and further development of the mine, and a successful exploration programme in the surrounding area. Jim also worked on several new business projects for ARCON Mines Limited, in Australia and Hunan Province, China, before retiring in 2001.

In his private life Jim continued to have a passion for sport (especially team sport, particularly rugby) and he enjoyed nothing more than watching a match with his friends and colleagues. When he took up an interest he would fully embrace the subject and this was so with his interest in music, art and later in life, property. He served for several years in the late 1990s on the IMQS Council. Jim was a tough and uncompromising character, who demanded high standards from those working for him. But he also had a caring nature and considered a workforce's welfare. Many who worked at Galmoy are grateful for the pension system that Jim worked tirelessly to establish.

Jim was also a very private person, and spent his later years in retirement in Belfast, where he was able to devote his time and energy to his family.

Jim died on 7th February 2018, just short of his 86th birthday and 60th wedding anniversary.

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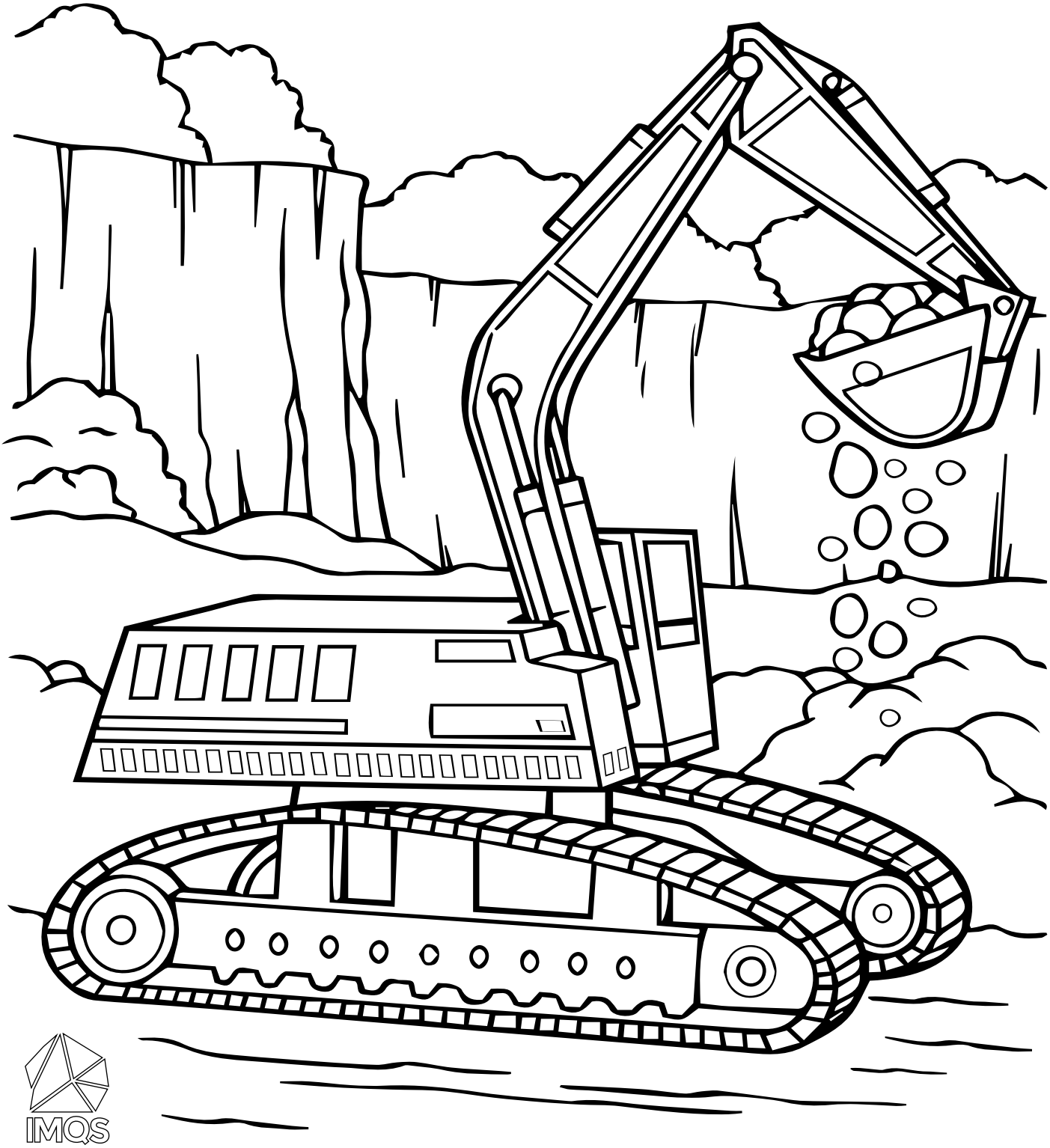

Membership Application Form

IMQS, THE LUCAN CENTRE, PRIMROSE LANE, LUCAN, CO. DUBLIN
Web: **www.imqs.ie** Email: **info@imqs.ie** Tel: **089 49 27942**

PERSONAL Details (PLEASE USE BLOCK CAPITALS THROUGHOUT)

Surname: ..... Forename(s): .....
Home Address: .....
.....
Telephone Number: .....
Mobile: .....
Home E-Mail Address: .....

EMPLOYER Details (PLEASE USE BLOCK CAPITALS THROUGHOUT)

Employer: .....
Address: .....
.....
Telephone Number: ..... Mobile: .....
Work E-Mail Address: .....

Correspondence Address (please tick both location to be sent to & by what means Home ❑ Work ❑ E-Mail (preferred by IMQS) ❑ Post ❑

Please state association with the Mining or Quarrying Industry: .....
Proposed by: ..... (Existing IMQS Member)

Note: Should the candidate be unable to obtain a proposer who is a member of the IMQS, the application will be assessed by the Council of the IMQS and membership is subject to the approval of the Council. Please send to address above enclosing payment of €50 (ordinary membership). (Membership fees are payable in January each year and are valid for that calendar year).

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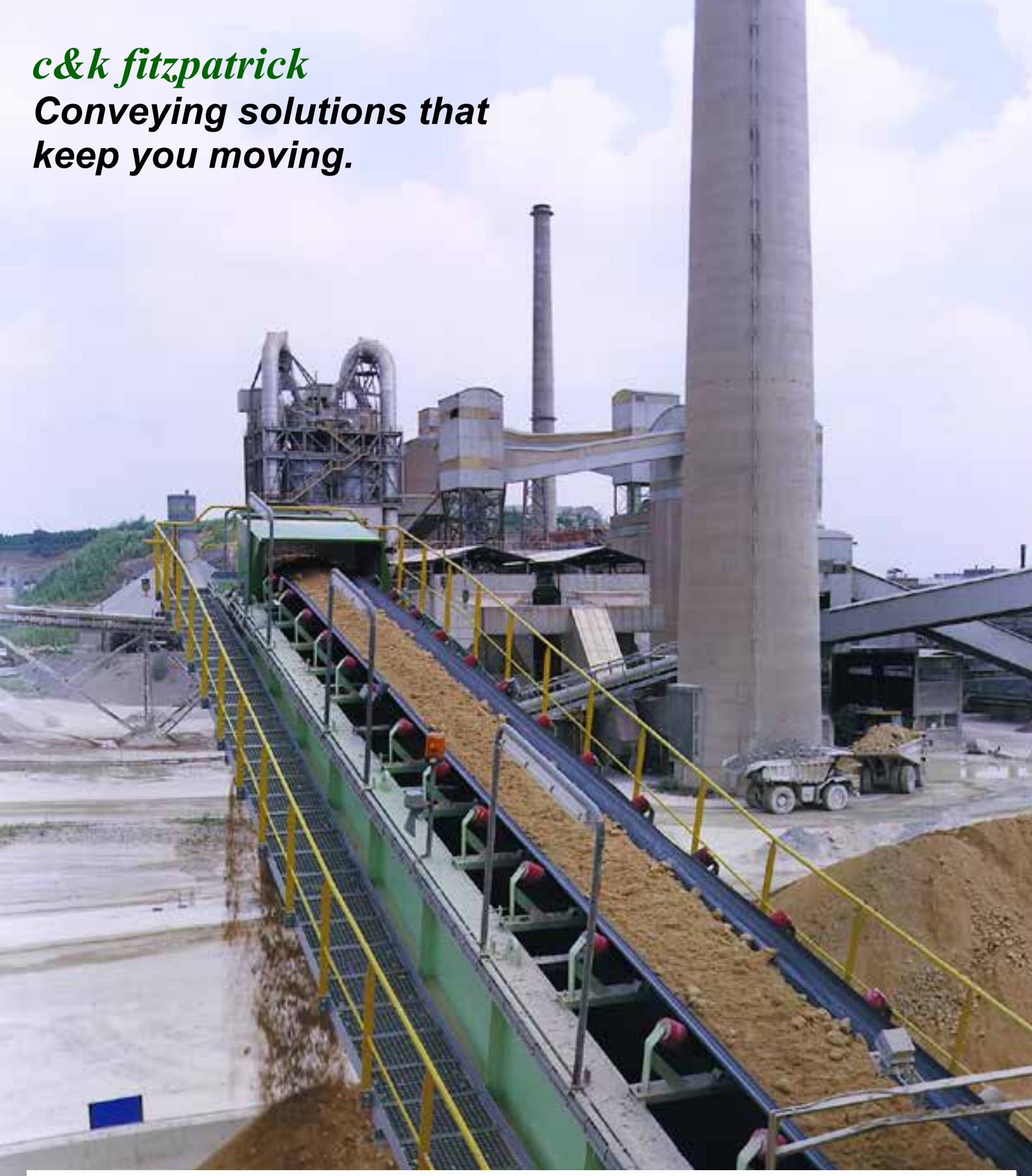

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