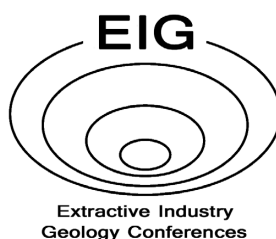


**PROCEEDINGS OF THE
18TH EXTRACTIVE INDUSTRY GEOLOGY CONFERENCE 2014
AND TECHNICAL MEETING 2015**

**HELD AT
UNIVERSITY OF ST ANDREWS, 11TH TO 14TH JUNE 2014
AND
STRATFORD-UPON-AVON, WARWICKSHIRE 17TH JUNE 2015**

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EDITORIAL

Since 1978, Extractive Industry Geology (EIG) has held 18 conferences, normally biennially. One of the aims of EIG is to publish proceedings of conferences, and this edition of the proceedings marks the 10th publication prepared after a main conference. Of the remaining 8 conferences, either no publication was prepared, or a number of papers were published in Transactions of the Institution of Mining and Metallurgy.

The proceedings are always evolving and this edition is no different. In addition to presenting papers from the 18th EIG conference held at the University of St. Andrews, Fife, Scotland in June 2014, it contains papers from the EIG 1-day technical meeting held in Stratford-upon-Avon, Warwickshire in June 2015. The 1-day meeting entitled 'Surface water, groundwater and flooding in mines and quarries' was the 2nd meeting of its type (the first focussing on rockfall in 2013) held in the intervening years between main conferences.

Overviews of the 18th EIG conference 2014 and the technical meeting 2015 follow this editorial, and are written by the Chairman of the 2014 conference, Clive Mitchell and the convenor of the 1-day technical meetings, Geoffrey Walton, respectively.

In a packed programme a total of 47 oral papers and 3 posters were presented at the 2014 EIG conference. Of these, 18 of the oral presentations and 1 of the poster presentations are provided here as full papers. Edited abstracts for the remaining presentations are also included as are guides from the field trips held both pre- and post-conference. Of the 9 oral papers presented at the technical meeting in 2015, 4 are presented here as full papers and edited abstracts for the remaining papers are provided.

Preparing a conference proceedings takes considerable time and requires a substantial effort from many people. The editors would like to sincerely thank the authors of all papers for carefully and thoroughly preparing and finalising their manuscripts; without your efforts there would not be a proceedings. We also wish to thank the independent technical reviewers. Every paper is reviewed and edited by at least one technical reviewer and one editor, and we as editors often rely heavily on the detailed comments these specialists take the time to provide on the content of a paper. The authors and reviewers often undertake this work in their own time and their contribution is much appreciated.

Looking forward to the 19th EIG conference in Birmingham in September 2016 and the following 1 day technical meeting in 2017, we would like to encourage all presenters to prepare a manuscript for consideration in the proceedings and we very much welcome any volunteers willing to act as independent technical reviewers.

Attendees at this and any future EIG Conferences may obtain a copy of these proceedings at a cost of £10, for others the cost is £25. The individual papers will be made available at www.eigconferences.com

Editors

Emily Hunger, Rock Options Ltd.

Teresa Brown, British Geological Survey

CHAIRMAN'S ADDRESS AND OVERVIEW OF THE 18TH EIG CONFERENCE; 11TH TO 14TH JUNE 2014

It is my privilege to introduce the proceedings for the 18th Extractive Industry Geology (EIG) conference which was held at the University of St. Andrews in Fife, Scotland in June 2014. As a young geologist I studied for my Industrial Mineralogy MSc at the University of Hull with Professors Peter Scott and Ansel Dunham. In 1987 the whole course (there were only 6 of us!) piled into a minibus and went to the EIG conference at the University of Keele. This was my first introduction to the world of EIG. Little did I know then that one day I would be writing this as the Chairman of the conference organising committee!

2014 was only the second time in its 36-year history that the EIG conference had ventured north of the border to Scotland, the first time being Edinburgh in 2006. Also for the second time, the EIG welcomed colleagues from the North American Forum on the Geology of Industrial Minerals (FGIM), who held their 50th anniversary forum at St. Andrews. The conference provided a unique forum for practitioners in both the UK and US minerals sectors to meet and learn how things are done across the pond! St. Andrews is Scotland's first university and the third oldest in the English-speaking world, founded over 600 years ago in 1413. Our University of St. Andrews sponsor for EIG 2014 was the Department of Earth and Environmental Science. I would like to extend my thanks to the Head of Department Dr Adrian Finch and his colleague Ruth Robinson for their help and support in the organisation of the conference.

The icebreaker reception was held in the Museum of the University of St Andrews, surrounded by the historical and artistic collections and with views over the coast. The conference dinner and ceilidh were held in the historic Lower College Hall, opposite St Salvators Chapel, while the conference sessions and trade exhibition were held in the modern campus facilities close to the Royal and Ancient Golf Club.

An impressive range of field trips were held. In Scotland the Glensanda coastal superquarry in Oban, the Muirdean open cast coal site and the Burrowine Moor silica sandstone quarry in Fife were visited. Delegates also enjoyed a geology and culture trip along the Fife Coastal Route and beyond Scotland, a visit to the Shap Beck limestone quarry in Penrith, England. In addition to these half or full day visits, Professor Peter Scott, assisted by Adrian Charters, organised and ran an extended three day field trip excursion for the FGIM delegates to Southern Scotland/Northern England and the Scottish Highlands.

The conference and field trips were very well attended and a record number of companies (19) exhibited trade stands; making the event a great success. There was a diverse mix of consultants, contractors and service providers, plus software providers and professional bodies. It was good to see some regular exhibitors as well as some new faces too.

We had a packed programme for the 2014 EIG conference sessions covering every aspect of the extractive sector. The conference themes included applied mineralogy, building stone, the environment, geotechnics and ground control, industrial minerals, planning, resources, shale gas and water. Thank you to our presenters, both those speaking and with posters, for sharing your time, expertise and experience with us all. An opening address was given by Dr. Adrian Finch of the Department of Earth & Environmental Sciences at the University of St. Andrews. The Ansel Dunham lecture was given by Duncan Wardrop a stalwart of the UK extractive industry. Well-known and respected, Duncan was for many years a senior geologist with Lafarge and now runs his own consultancy. He pondered the question 'Plus Ça Change', or put another way 'the more things change, the more they stay the same' – sound familiar?

EIG conferences are founded on the enthusiasm and experience of its committee members, all of whom are willing volunteers and represent the breadth of the UK extractive sector including mineral companies, universities, consultancies, and research organisations. To everyone who has been involved in the organisation of the EIG 2014 conference I extend a warm and grateful thank you for all of your hard work, time and support. The Conference was managed by an organising committee with Clive Mitchell as Chairman, Craig Arditto as Secretary and Graham Smith as Treasurer and supported by a consultative committee. Members of the committees and others who have kindly reviewed the manuscripts prior to accepting them for publication in these proceedings are thanked for their time and effort.

The success of EIG Conferences depends on sponsors for their financial support and assistance at a variety of different levels. On this occasion the sponsors included Blast Log Ltd, British Geological Survey, Cuesta Consulting Ltd, DustScan Ltd, Edge Hill University, GWP Consultants LLP, Lafarge Aggregates, Mineral Products Association, PGW&A LLP, Quarry Design, SRK Consulting and Tarmac.

Without doubt EIG is the friendliest conference you will ever attend where making new contacts is never a chore, more like making new friends. I hope that you enjoyed attending the conference in 2014, found it to be a valuable and rewarding use of your time and you left thinking 'I must come again!'

Chairman Extractive Industry Geology Conference 2014
Clive Mitchell, British Geological Survey

OVERVIEW OF THE 2ND ONE DAY TECHNICAL MEETING OF THE EIG; 17TH JUNE 2015

The EIG has relied upon its biennial Conferences for its raison d'être since its inception in 1978. It published occasional articles and more extensive collections of papers through its original sponsors – the Geological Society of London and the Institute of Mining and Metallurgy and also through the Institution of Geologists and in 2004 through the Minerals Industry Research Organisation (MIRO). As the EIG has become a self-supporting professional interest group during this century, so it has taken over the publication of the biennial meeting and pressure has grown for other meetings. Hence the author set up a one day meeting on rockfall in 2013. There were no papers directly coming out of this, but the second one day meeting in 2015, on 'Surface water, groundwater and flooding in mines and quarries' and held in Stratford-upon-Avon, Warwickshire has produced several, enabling their delayed publication here, for which the EIG apologises.

Nine presentations were given, each in a 30 minute slot and a further 70 minutes was allowed for three separate Q&A sessions. Many agreed that there was sufficient time for matters to be more fully discussed, which is not necessarily the case with shorter presentation times. Attendance at the event was interesting. The EIG has no formal membership, but exists on its appeal from year to year, on information given on its website, on e-mails to those attending previous meetings and on the success of those meetings. Of those attending there were 40 from the extractive industry, 40 from consultancy, 14 from government and Non-Governmental Organisations (NGOs) including academia and 14 from equipment suppliers; a reasonable mix for the exchange of ideas and the identification of needs. The numbers also reflected the extent to which the meeting's topic was a live issue.

The meeting started with a paper by Claire Howarth on an overview of show stoppers. These were of course primarily hydrogeological in nature, but ranged from planning and regulatory to technical issues and problems arising from perception. With appropriate prior investigations, often of long drawn-out, herculean proportions (and expense?) there should only be 'bumps on the road' not 'show stoppers'. Interestingly it was implied that unforeseen ground conditions were not the problem that they sometimes appear to be in geotechnics. Cath Pickett of the Health and Safety Executive (HSE) then provided the health and safety contribution to the meeting concentrating on risk assessments with respect to both industry workers and subcontractors, but also covering members of the public. The responsibility for closed quarries, which lies with local authorities, not the HSE was noted; there was much interest in how to accommodate risks arising from unforeseen flooding events. The final paper in the first session was on the regulatory issues of water in quarries and given by Nicola Owen of the Mineral Products Association. Various Acts and Regulations were due for revision and the resolution of currently unresolved matters was of much concern with uncertainty surrounding water abstraction arrangements. The split between Local Authority planning and licencing arrangements by the Environment Agency (EA) was a serious concern that was raised in questions following this and other presentations; and as Duncan Wardrop said when he chaired the final Q&A session, it was unfortunate there were no representatives from the EA – something to be addressed in future meetings.

The next two presentations dealt with floodplain issues. Richard Lansley discussed the investigations that went into a planning application for a gravel operation near to the River Thames in southeast Oxfordshire. Attention was given not only to the mitigation of flooding potential during working, but to the water levels following the backfilling with inert materials in a sensitive setting where flood risk required careful quantification. Clive Carpenter then gave a paper on flood control and water management, based in part on flood storage techniques and how concerns in respect of groundwater flooding were unjustified. Implications for quarry water storage in respect of revisions of the Reservoir Act were also considered and could include some quarry operational and restoration matters that are not currently covered under the Act.

The second part of the day commenced with two presentations of general interest on dewatering and water footprinting and water security. Martin Preene considered developments in dewatering starting with an overview of drainage techniques and the problems that occur. He concluded with a future vision of the extractive world in which CAPEX was reduced by transferring the capital cost to OPEX where the plant, which might include pumping equipment, was owned and operated by the manufacturers, rather than the mining and quarrying companies, in a similar manner to the supply and use of aero engines. Chris White then spoke on water footprinting and water security starting with an indication that this was increasingly perceived as a serious business risk. Water use is inextricably linked to energy use and more appropriate and careful monitoring of water usage was essential to understand the true situation at many quarries and especially where current and future water was being, or would be, sourced. Only when this was done could future long term planning be assured.

The final session of the day dealt with inrush issues into active underground mines. Firstly Alan Cobb outlined the steps needed to demonstrate that grounds for the manslaughter prosecution of the mine manager at the Gleison Mine, following the death of 3 miners, were not beyond reasonable doubt. He showed that there was a real possibility of a sudden collapse of flooded old mine workings such that an inrush of water from nearby workings that had been dry the previous day could have occurred. Jeremy Elvins gave a detailed account of the potential hazards associated with gypsum mining operations in Leicestershire, Nottinghamshire and Cumbria. The attention given to checking on and looking for fissures within the cover zone was particularly interesting and an example of the use and benefits of cross-sector knowledge and understanding.

An extended Q&A session concluded the meeting; during which several themes that were brought up; such as the need for more monitoring and diligent investigations, but there appeared to be three principle areas of concern: three principle areas of concern: (1) uncertainty over regulations and water licencing issues, (2) how in the future runoff discharge consents will be managed in the regulatory regime and the role of local flood authorities, and (3) issues around groundwater flooding risks in the context of quarry backfilling.

As noted, there was an apparent need for more transparent discussion with government and agencies than appears likely in the short term; the absence of attendees from government and regulators was regrettable. Joined-up government is missing at present and industry and consultants need to push for changes in the status quo.

Convenor of the EIG one day meeting
Geoffrey Walton, Dustscan Ltd

CONTENTS

PAGE

2014 EIG CONFERENCE: UNIVERSITY OF ST. ANDREWS, 11TH TO 14TH JUNE 2014

The Ansel Dunham Lecture Plus ca change: Reflections on 40 years in the UK minerals industry, and a look to the future	1
<i>D.R. Wardrop</i>	
 <i>MINERAL RESOURCES AND MINERALOGY</i>	
The responsible reporting of mineral assets	12
<i>E.P. Bailey</i>	
Thinking big – defining resources for major coastal defence projects	14
<i>T. Bide</i>	
UK frac sand resources	21
<i>C.J. Mitchell</i>	
Back to the future: a new UK room and pillar coal mine	31
<i>T.J. White, W.J. Birch and A. Bilton</i>	
Mineralogical aspects of selected economically important carbonatite-related deposits	41
<i>R.D. Hagni</i>	
Crushed rock aggregates: their mineralogy and textures using automated scanning electron microscopy	49
<i>P.W. Scott and G.K. Rollinson</i>	
 <i>PLANNING AND ENVIRONMENT</i>	
Sustainability and future aggregates provision in Wales	69
<i>Dr. A. Thompson</i>	
The use of modern data management systems in the CEMEX UK aggregate business	76
<i>K.S. Wilson</i>	
The use of multi-criteria analysis in the extractive industry	86
<i>R. Lansley and G. Digges La Touche</i>	
 <i>HYDROGEOLOGY AND UNCONVENTIONAL HYDROCARBON DEVELOPMENT</i>	
Analysis of aquifer pumping tests within glacial sand and gravel using Function.xls	91
<i>C.B. Ogilvie</i>	
Fractures, shale gas and the environment: The application of discrete fracture network modelling to environmental risk management for unconventional hydrocarbons	105
<i>G. Digges La Touche</i>	
Hydrogeological risk screening for unconventional oil and gas development	110
<i>B.C. Harding, A. Gennarini, H. Karam, M. Beatty and A. Coffey</i>	

WORLD CASE STUDIES

From empire to enterprise: 100 years of history through mineral extraction statistics 125
T.J. Brown

The minerals sector contribution to stabilisation and development in Afghanistan 132
A.G. Craig

Rockfall protection to Dudley Ward Tunnel, Northern Approach, Gibraltar 146
S.W. Lightbody

Advantaged by location 158
R.D. Boyd

Quarry arts: Playing with aggregates 165
B.J. Millar

POSTERS

Aspects of empirical dust modelling associated with quarries 170
J. Bruce, G. Walton and H. Datson

2015 TECHNICAL MEETING: WARWICKSHIRE, 17TH JUNE 2015**SURFACE WATER, GROUNDWATER AND FLOODING**

Unexpected intrushes into a small mine 176
A.E. Cobb

Techniques and developments in quarry and surface mine dewatering 194
M. Preene

Developing quarries on floodplains – a case history 207
R. Lansley

Water footprinting and water security in the minerals industry 217
C.C. White

APPENDIX 1

Edited abstracts of other oral and poster presentations from the 18th EIG Conference 2014 and technical meeting 2015 227

APPENDIX 2

Edited fieldtrip guides from the 18th EIG Conference 2014 238