REPORT OF THE NEW ACTIVITIES STRATEGIC IMPLEMENTATION COMMITTEE TO THE 71th IUGS EXECUTIVE COMMITTEE MEETING, PARIS, 15/18 FEBRUARY 2017

1. I am pleased to report on behalf of the New Activities Strategic Implementation Committee (NASIC) on the progress of advancing the Resourcing Future Generations (RFG) initiative.

2. Since NASIC was established following the 66th IUGS Executive meeting in Paris in February 2013, we have:

   i. Published an article on RFG in *Episodes* (Lambert et al, 2013)*;*

   ii. Produced a 8-page brochure on RFG;

   iii. Organised a Pardee symposium at the GSA 2013 Annual Meeting in Denver;

   iv. Promoted RFG on the AGI, GSA, GSL and IUGS websites;

   v. Organised a symposium and launched a White Paper at China Mining, October 2014 (Nickless et al, 2014);

   vi. Convened a workshop in Windhoek, Namibia in July 2015 and published a report of the discussion (Nickless et al, 2015);

   vi. Published a one-page policy note ahead of the Conference of the Parties to the Climate Change discussion in Paris in December 2015.

   [RFG publications are listed at Annex H]

3. Specific activities during 2016 have included:

   i. Updating the membership and structure of NASIC. There is a Core Group responsible for the overall direction; groups of supporters and affiliates comprise those who at various times have been involved with the RFG initiative either as attendees at the China mining meeting in 2014, as attendees at the work shop in Namibia in July 2015 or as former members of Core group. Details are at Annex A. During the year John Thompson, General Chair of inter-IGC RFG2018 meeting, joined the Core Group;

   ii. An Open Call for proposals to advance an aspect of RFG was launched in April at the European Geosciences Union meeting in

Vienna, Austria (Annex B). The eleven applications received were evaluated by a group comprising, Roland Oberhänsli, Larry Meinert of the USGS and myself. Six were funded, the average award being a little over $3k. Details are a Annex C;

iii. In August/September at the 35th IGC in Cape Town I gave five presentations on RFG as listed at Annex D; Tom Graedel, Patrice Christmann and I took part in a panel discussion organised by AGU; and with Pat Leahy of AGI and others I organised a two-day symposium. The programme is at Annex E;

iv. The RFG Second Open Call for proposals, at Annex F, was announced during the fourth IUGS/IGC Congress. A total of 200 hard copies of the announcement were distributed at the IUGS, RFG2018 and GSL booths. Thirty-five left email addresses and have been contacted subsequently. At the time of writing three submissions have been received. With the agreement of the President and past President, the closing date for submission of proposals has been extended by one month until 31 January 2017. .

v. Four half-day session proposals as detailed at Annex G have been submitted to the RFG2018 Technical committee but a decision on the success of any or all will not be made until the Spring of next year;

vi. A paper has been accepted for publication in Nature Perspectives, and another will be published shortly in the European Geologist Journal. I have submitted a paper for publication in a special issue of Natural Resources Research. (RFG-related publications published, in press or submitted are at Annex H);

vii. The past President has submitted an application for funding to the German Engineering Academy, in an attempt to attract sponsorship but also to engage with the engineering community. At the time of writing the outcome of the bid is unknown.

viii. The Geological Society of London has agreed to administer the IUGS grant to NASIC. Delegated authorities have been agreed allowing me to authorise minor expenditures. Larger sums require countersignature by the President.

The coming year

4. If the session proposals submitted to RFG2018 are successful, considerable effort will be needed to develop programmes aimed at involving a broad range of disciplines spanning geoscience and social science, but also those involved in policy advice and decision making. The aim will be to attract the widest possible range of discipline interests and large audiences including future leaders.

Subject to funding it should be possible to announce a third and possibly a fourth Open Call during the year. But the current threshold of an average $3k award is unlikely to be attractive to established researchers. Although the objective is to provide top up grants, arguably the effort involved in making a

bid is disproportionate to the amount of funding on offer. More resource is needed if this aspect of promoting RFG is to be successful and, in particular, to attract those whose discipline is in engineering and the social and political sciences, which will be crucial for delivering RFG. The continued lack of engagement of the adhering members and affiliated bodies is disappointing.

5. I will participate in an EFG/UNFC workshop: International cooperation on natural resources (9/10 February 2017, Brussels, Belgium) and the World Circular Economy Forum (5/6 June 2017, Helsinki, Finland). And with the Geological Society of London, which has designated 2018 as the 'Year of Resources', a session is being organised as part of the Mines and Money meeting in London during October 2017 to build awareness and as a precursor to RFG2018.

Concluding comments

6. Some progress has been made in raising the profile of the Resourcing Future Generations among various audiences. More needs to be done in promoting the initiative as a key programme of the IUGS and within the context of RFG2018 meeting in Vancouver in June 2018.

7. As I have commented on a number of occasions, a fundamental difficulty in moving the initiative forward and developing a coherent, planned programme of activity is the total absence of any identified financial commitment by IUGS for NASIC/RFG over a number of years. The absence of a budget, even at indicative levels and covering a number of years, seriously undermines the effort. To move the initiative forward, at the very minimum there must be a commitment of base funding over a number of years. Without such a commitment it will be increasingly difficult to enthuse those who serve on NASIC to volunteer their time. The accumulated spend on RFG since February 2013 to date is a little over $100k, half of which had come as sponsorship from ICSU and UNESCO. Although RFG is *the* IUGS flagship initiative does it command the support of all IUGS adhering bodies and affiliated organisations? If we are to attract external funding then the 'offer' to sponsors needs to be convincing, and part of that proposition will be being able to show that that initiative commands the active support of the Union as a whole.

Edmund Nickless

30 December 2016

Annex A

NEW ACTIVITIES STRATEGIC INITIATIVES COMMITTEE (NASIC)

CORE GROUP MEMBERS

Edmund Nickless (Chair), formerly Executive Secretary Geological Society of ondon, London, UK edmund@geolsoc.org.uk

Saleem Ali, Director of the Centre for Social Responsibility in Mining at the University of Queensland, Australia s.ali3@uq.edu.au

Ray Durrheim, Senior Lecturer, University of Witwatersrand, South Africa raymond.durrheim@wits.ac.za

Damien Giurco, Research Director, Institute for Sustainable Futures, University of Technology, Sydney, Australia damien.giurco@uts.edu.au

Pat Leahy, formerly Executive Director, American Geosciences Institute, Alexandria, West Virginia, USA pleahy@agiweb.org

Fabio Masotti, Director, Mineral Exploration, Vale, Brazil fabio.masotti@vale.com

Larry Meinert, Program Coordinator, Mineral Resources Program, United States Geological Survey, Reston, Virginia, USA lmeinert@usgs.gov

Roland Oberländsli, Professor of Mineralogy, University of Potsdam, Germany, Past President IUGS r.oberhaensli.iugs@geo.uni-potsdam.de

John Thompson, General Chair, RFG2018 Steering Committee jfhthompson@gmail.com

Anjian Wang, Chinese Academy of Geological Sciences ajwang@cags.ac.cn

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Maria Amélia Enríquez, Professor of Economics, Federal University of Pará, Brazil amelia@ufpa.br

Murray Hitzman, Charles F. Fogarty Professor Economic Geology, Colorado School Of Mines, USA mhitzman@mines.edu

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Gabi Schneider, Director, Uranium Institute, Namibia director@namibianuranium.org

Natalia Yakovleva, Senior Lecturer in International Business Strategy, Newcastle University London, 102 Middlesex Street, London, E1 7EZ, UK Natalia.yakovleva@ncl.ac.uk

SUPPORTERS

Andrew Bloodworth, Science Director for Minerals and Waste, British Geological Survey, Keyworth, Nottingham, UK ajbl@bgs.ac.uk

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Paul Lusty, Team Leader Ore Deposits and commodities, British Geological Survey, Keyworth, Nottingham, UK plusty@bgs.ac.uk

Jeannette McGill, Co-President 35th IGC, Jeannette.mcgill@gmail.com

Harsh Gupta, President IUGG, National Geophysical Research Institute, Hyderabad, India 500-007 harshg123@gmail.com

Resourcing Future Generations:

OPEN CALL FOR PROPOSALS

Resourcing Future Generations (RFG) is a major initiative of the International Union of Geological Sciences (IUGS)[1]. It was launched in 2013 to bring world attention to the challenges of sustaining resource supplies and to outline a pathway to the future, including a route to nation-building and poverty alleviation through resource development[2]. The RFG initiative includes a diverse group of geoscientists, economists, and environmental and social scientists drawn from a range of institutions with diverse private and public experience in exploration, mining, processing, environmental protection, and sustainable development. RFG aspires to be a fundamental service to humanity, not to vested interests in resource development.

IUGS now invites bids for small top-up grants to take forward discrete pieces of work in support of RFG. Details of the application process are below. The invitation is open to all though, in the event of equally judged applications, preference will be given to those from adhering members or affiliated organisations of IUGS[3]. The closing date for the first round of applications is noon UTC 31 May 2016. A second round will be announced after the 35th IGC[4]. Applications will be decided on the basis of excellence, novelty, timeliness and relevance to RFG by an awards panel comprising members of the RFG Core Group[5].

A Global Effort to Meet the World's Future Needs Head-on

The 20th century and early part of this century saw a dramatic increase in living standards and improvement in the quality of life for many of the world's poorest. That improvement has been underpinned by the ubiquitous use of metal and mineral resources in technology and infrastructure. The demand for raw materials to satisfy the higher standards of living that the developing world has every right to expect is apparently insatiable and challenges from where these materials are to come. To maintain this trajectory while addressing climate change and rising world population, sustainable sources of raw materials are required, by both developed and developing countries (see figure 3).

Regardless of whether known supplies are enough to cover demand in the near term, efforts must be made now to forestall unpredictable yet inevitable supply shortages in the decades to come — shortages that would dramatically impact deployment of low-carbon technology to mitigate climate change as envisaged by the Paris Accord agreed at COP 21 (see figure 4).

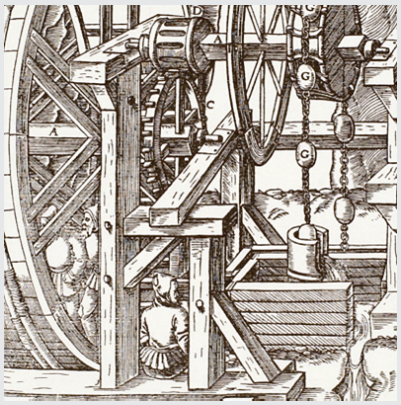


Figure 1

Winding gear and shaft, from 'De Re Metallica' (Agricola, 1556)

Figure 2 Bingham Canyon, Utah

When Georgius Agricola wrote "De Re Metallica" (On the Nature of Metals (Minerals)) in the 16th century, he could not have foreseen how the scale and technology surrounding mineral extraction would evolve. Mining has progressed from being a small-scale artisanal activity (Figure 1) to a highly technological one on a vast scale – as at Bingham Canyon, Utah (Figure 2), a mine 4km wide and 1.2km deep.

REMIT OF THE CALL

Applications are invited for

- Novel work on an aspect of RFG, which develops an ongoing piece of work or an already separately funded research grant;
- Organising and running a workshop to promote RFG or an RFG theme.

All awards must start by 1 August 2016 and the work completed and outcomes reported by 31 January 2017. Grants will average $3000, though exceptionally a larger sum may be awarded.

Application procedure

Applications must describe the work proposed and how it will advance one of the three themes of RFG

- Balancing resource supply and demand in the 21st century;
- The challenge of mineral supply: Accessing new resources from the Earth;
- Building additional capacity to facilitate responsible development in less developed nations.

The work must be capable of completion within 6 months of the agreed start of the award. Applications are to be submitted electronically as a word document stating:

i The name, position and host institution/body of the principal investigator together with the names and affiliation of any co-workers;

ii The title of the project together with a brief description of the proposed work (no more than 200 words);

iii The work proposed (in no more than 2000 words) including the research question to be addressed (if appropriate), the technical approach to be adopted, why it is important and timely, a project management plan, foreseen outcomes and how they link to and the benefits arising to RFG;

iv Details of the funds sought with outline budget and how it links to existing research grant or other existing funding support.

Submissions should be completed in single-spaced typescript of minimum font size 11 point Arial or another sans serif typeface of equivalent size to Arial 11, with margins of at least 2 cm. References must also be presented in a minimum font size of 11 point. Arial Narrow and Calibri are not allowable font types as they are smaller and any proposal which has used either of these font types within their submission will be rejected. Applicants referring to websites should note that the Awards Panel may choose not to use them.

Assessment procedure

The main assessment criteria will be the scientific and technological excellence of the proposal together with consideration of the novelty. Applications will be assessed by an Awards Panel comprising recognised experts, assisted, if necessary, by written external peer review. Principal investigators may be invited to respond to reviewers' comments.

Call timetable

Call opens	1 April 2016
Deadline for proposals	Noon (UTC) 31 May 2016
Assessment panel	June 2016
Grants awarded	July 2016
Grants start	1 August 2016
Report submitted	31 January 2017

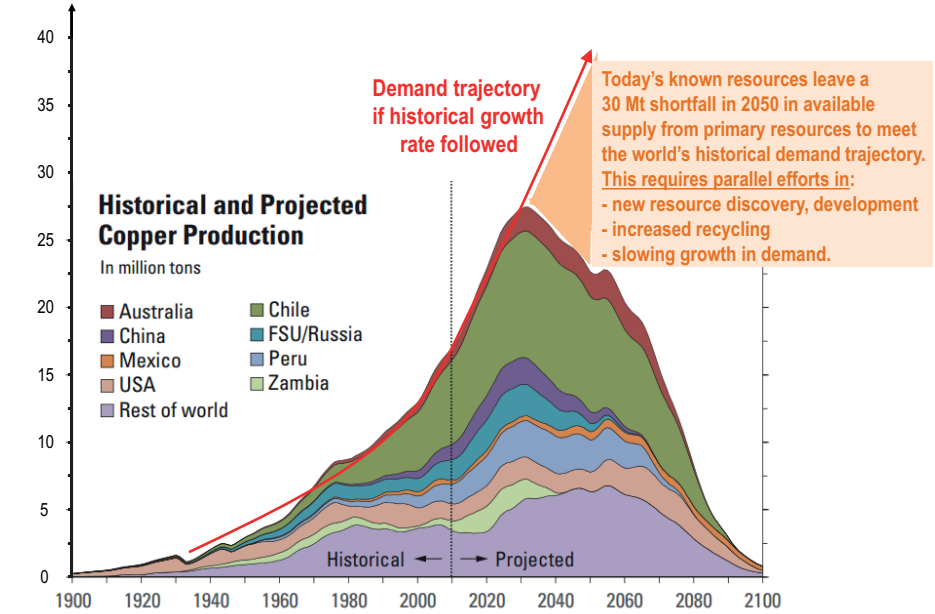
Applicants will be informed as soon as possible of the funding decision. Awardees will be required to provide a written report.

Contact details

Grant applications should be sent to edmund@geolsoc.org.uk. Questions of clarification may be sent to the same address.

Figure 3

Primary Copper Production – Historical & Projected. Modified from Kerr 2014 and Northey et al 2014



A growing global population and continuing urbanisation will significantly increase demand for the basic metals required for future infrastructure development, such as copper, especially in the developing world. The same is true of many other bulk metals.

Copper is a key component in building construction, power generation and transmission and the production of industrial machinery and equipment. As can be seen in figure 3, even optimistic current projections see a peak in supply likely to occur around 2030. Without action, demand will outstrip supply. Recycling has an important role to play, but given that resources may remain 'locked away' in infrastructure for 80-120 years, its contribution will be limited for the foreseeable future, necessitating continuing primary production at scale. New reserves must be found to fill this entirely predictable gap.

Progress so far

Since the launch of RFG in 2013, we have held Town Hall discussion events at meetings of AGU and GSA, published an article in *Episodes*[6] and a brochure[7].

In October 2014 at the China Mining meeting in Tianjin, we launched *Resourcing Future Generations White Paper: Mineral Resources and Future Supply*[8].

In July 2015, with support from IUGS, the International Council for Science and the United Nations Educational, Scientific and Cultural Organisation, a group of seventeen geoscientists and social scientists, including economists, met on retreat at the Goche Ganas Nature Reserve near Windhoek, Namibia. The discussion and our recommendations are brought together in a 78-page report[9] and summarised in a one-page briefing note for legislators, policy advisers and opinion formers[10].

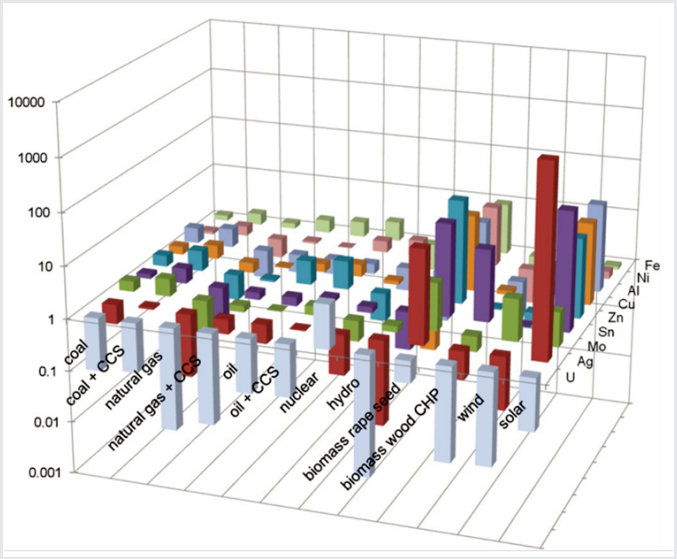


Figure 4

Demand for selected metals in different power generation technologies. Source: Klein, 2012

As we move from carbon-intensive forms of energy (coal, natural gas and oil) towards more environmentally friendly forms (biomass, hydro, wind and solar), there will be steep increases in the quantity (between 2 and 100 times as much) and variety of metals we need for power generation. Figure 4 illustrates demand for iron, nickel, aluminium, copper, zinc, tin, molybdenum, silver and uranium for different power technologies. Wind turbines also require rare earth elements for magnets, and PV solar cells depend on cadmium, tellurium, indium, gallium, germanium and ruthenium. Transmission systems and innovative energy storage technologies will also bring new mineral demands.

Resourcing Future Generations:

WORK PLAN FOR 2016

Action is needed now to address future supply problems that are unpredictable in time and detail, but foreseeable and inevitable. Over the coming year we will continue to raise awareness of RFG with stakeholders such as the International Union for Conservation of Nature and Natural Resources and the International Resource Panel (IRP) of the United Nations Environment Programme, and those with relevant experience and expertise, both within and beyond IUGS (including in other communities such as engineers), by:

- **i** Promoting the White Paper and report of the Namibian workshop in the context of the Paris Accord after COP21;
- **ii** Seeking to work with partner organisations and link to existing initiatives. Horizon 2020 could be a mechanism if there was willingness by the EU to raise the issue at a G8/G20 meeting;
- **iii** In the UK, working with government officials and advisors, in particular through the Government Office of Science. There will be parallels in other countries, in particular in Germany and the USA;
- **iv** Building links with high technology industries as 'users' of critical materials;
- **v** Engaging with industry, governments, national geological surveys and funding agencies through multiple approaches seeking their participation and that of the wider research communities;
- **vi** Considering if there is scope to address social issues and to engage with different audiences (possibly straddling bodies such as the United Nations Environment Programme, UNESCO, the World Bank, the World Economic Forum and the International Council on Mining and Metals);
- **vii** Working with UNEP International Resources Panel on its proposed review of future mineral and metal supply in the circular economy;
- **viii** Identifying and publishing about RFG in high impact journals bridging economics, foreign affairs and science policy.

In addition, a two-day symposium on resourcing future generations is being planned for the 35th IGC at Cape Town, South Africa from 27 August to 4 September 2016 and the topic is the basis of the RFG2018 conference to be held in Vancouver, British Columbia in June of that year.

If you have comments or wish to become involved email Edmund Nickless, Chair, IUGS New Activities Strategic Implementation Committee edmund@geolsoc.org.uk

Footnotes

1. The International Union of Geological Sciences (IUGS) is one of five geosciences-related scientific unions within the International Council for Science (ICSU). With 121 national members, the IUGS aims to promote development of the Earth sciences through the support of broad-based scientific studies relevant to the entire Earth system; to apply the results of these and other studies to preserving Earth's natural environment, using all natural resources wisely and improving the prosperity of nations and the quality of human life; and to strengthen public awareness of geology and advance geological education in the widest sense. Further information on IUGS is at http://www.iugs.org/. The International Council for Science (ICSU) is a non-governmental organisation with a global membership of national scientific bodies (122 Members, representing 142 countries) and International Scientific Unions (31 Members). See http://www.icsu.org/
2. Resourcing Future Generations was launched in February 2013. Background is at http://iugs.org/index.php?page=resourcing-the-future-initiative and http://www.geolsoc.org.uk/RFG
3. Membership of IUGS comprises Adhering members and Affiliated organisations. Adhering members are listed at http://iugs.org/index.php?page=adhering-members; Affiliated organisations are listed at http://iugs.org/index.php?page=directory#AO
4. The 35th IGC will be held in Cape Town, South Africa from 27 August to 4 September 2016. Further details are at http://www.35igc.org/
5. Membership of the RFG Core Group (listed as 'Strategic Implementation Committee') is at http://iugs.org/index.php?page=directory#spc
6. Lambert, I., Durrheim, R., Godoy, M., Kota, M., Leahy, P., Ludden, J., Nickless, E., Oberhaensli, R., Anjian, W., Williams, N. Resourcing Future Generations: A proposed new IUGS initiative. Episodes. June 2013 http://www.episodes.org/index.php/epi/article/view/57474/44844
7. RFG brochure http://www.geolsoc.org.uk/~/media/shared/documents/RFG/ResourcingFutureGenerations%20%20%20FINAL.pdf?la=en
8. Nickless, E., Bloodworth, A., Meinert, L., Giurco, D., Mohr, S., Littleboy, A. Resourcing Future Generations White Paper: Mineral Resources and Future Supply. International Union of Geological Sciences. 2014, 30pp. http://iugs.org/uploads/Consultation%20Paper%202014_Oct_12_AL_EN_DG%20FINAL.swf
9. Nickless, E., Ali, S., Arndt, N., Brown, G., Demetriades, A., Durrheim, R., Enriquez M.A., Giurco, D., Kinnaird, J., Littleboy, A., Masotti, F., Meinert, L., Nyanganyura, D., Oberhänsli, R., Salem, J., Schneider, G., Yakovleva., N. Resourcing Future Generations: A Global Effort to Meet The World's Future Needs Head-on. International Union of Geological Sciences. 2015, 78pp. http://iugs.org/uploads/RFG%20Report-sm.pdf
10. RFG policy statement http://www.geolsoc.org.uk/~/media/Files/RFG%20Policy%20Statement.pdf?la=en

RFG FIRST OPEN CALL: FUNDED PROPOSALS

Principal Investigator	*Institution*	*Title of proposal*	*$k*
Qiuming Cheng & others	China Univerisity Beijing & York University, Canada	Quantitative assessment and prediction of deeply buried mineral resources in covered regions	2.0
Kedia Chi & others	University of Buea, Cameroon	Capacity building for stakeholders in artisanal gold mines, Eastern Cameroon	3.7
Judith Kinnaird & others	University of Witwatersrand, South Africa	Germanium for Society – now and in the future	3.4
Gavin Mudd/Simon Jowitt	Monash University, Melbourne, Australia	Validating New Methods for Global Resource Estimates of Critical Metals	3.0
Andrea Rielli	Monash University, Melbourne,Australia	Metasomatic alteration of the sub-arc mantle: implication for arc metallogeny and the redox state of the Earth	3.1
Isobel Yeo	GEOMAR, Kiel, Germany	Acoustic properties of ferromanganese crusts and substartes as a tool for e-tech exploration	3.1

Annex D

PRESENTATIONS RELATING TO NASIC/RFG GIVEN TO 70th IUGS EC, 4th IUGS/IGC COUNCIL & 35th IGC

70th IUGS EC: 26/27 August 2016

1. I attended the Executive Committee meeting as Chair of the New Activities Strategic Implementation Committee and spoke on the Resourcing Future Generations initiative.

4th IUGS/IGC Council: 31 August/1 September

2. I gave a short presentation on NASIC and a longer presentation on RFG

35th IGC: 29 August/2 September

3. With Pat Leahy (AGI), Tom Graedel (Yale), Brian Skinner (Yale), Neil Williams (Woolagong) I organised a day and a half-long symposium on Resourcing Future Generations (29/30 August, Annex E) and gave a paper.

4. With Tom Graedel and Patrice Christmann I participated in an AGU Hot topic discussion on 30 August.

5. I delivered a keynote address to a session on Geoethics and Professionalism (31 August.

Edmund Nickless

28 December 2016

Schedule and Speakers

Plenary	Paper #	Title	Speaker
Monday, August 29		**Symposium 1 - Understanding the Mineral Life Cycle**	
14:00-14:30	3510	Impact of global change on resources - exploration to markets	John Thompson (keynote)
14:30-14:45	815	African Copper	Murray Hitzman, Colorado School of Mines
14:45-15:00	175	Mineralisation in the Bushveld Complex	Morris Viljoen
15:00-15:15	4006	Mineral Resources -Supply, Demand, and the Future	Larry Meinert, USGS
15:15-15:30	3121	Innovative uses of geological materials as crop nutrients	David Manning
15:30-16:00		Tea Break	
16:00-16:15	1158	Submarine Mineral Resources: Who will mine them and who will reap the benfits	Nick Arndt
16:15-16;30	1805	Resourcing Future Generations	Edmund Nickless
16:30-16:45	5509	Promoting RFG in conjunction with China's 'The Belt and Road' initiative	Anjian J. Wang
16:45-17:00	3987	EIT Raw Materials, a new European initiative in Raw Materials	Karen Hanghoj
17:00-17:15	4825	Europe and Japan: Common challenges and threats on the supply of mineral raw materials	Vitor Correia, Harmeed and Hartai
17:15-17:30	3048	The Dynamic Nature of Resource Availability: The Cases of Copper and Rare Earths	Rod Eggert, Colorado School of Mines
17:30-17:45	3372	Global trends in mineral commodities for advanced technologies	Steve Fortier, USGS
Tuesday, August 30			
08:00-08:15	1184	The role of African Geological Surveys in attracting mineral investment into Africa	Gabriele Schneider
08:15-08:30	5433	Key enablers of a successful mining industry: lessons from South Africa	Fathella Brovko
08:30-08:45	3319	3D Mapping for mineral exploration under cover: Continental to regional scale examples in Australia	Richard Blewett
08:45-09:00	2988	Reforming Kyrgystan's Mining Sector	Duishenbeck, Zilaliev
		Symposium 2 - Criticality and Possible Resource Limits	
09:00-09:15	3389	Global Resource Assessments of Primary Metals: An Optimistic Realty Check	Gavin Mudd, Monash University
09:15-09:30	2731	Resource Depletion Scenarios – How should we address the limitations?	Northey, Stephen.A.and Mudd, G.M., Monash U.
09:30-09:45	2993	Global rare earth element resources and challenges to production	Kathryn Goodenough, British Geol. Survey
09:45-10:00	5530	Technological Dreams: Building Additional Human and Technological Capacity in Developing Countries and Development	Jeannette E. McGill
10:00-10:30		Tea Break	
10:30-10:45	5435	An implementable strategy for riding the perfect storm facing the mining sector	Navin Singh
10:45-11:00	3068	Finland's Green Mining concept aims to promote sustainable and acceptable mining	Pekka Nurmi
		Symposium 3 - The Urban Mine	
11:00-11:30	3916	Process Metallurgy: A key enabler of a circular economy	Markus Reuter, Helmholtz Institute (keynote)
11:30-11:45	5287	The industrial approach to metal recycling-opportunities and challenges to close the loop for technology metals	Christian Hagelueken
11:45-12:00	5508	Urban Infrastructure in Africa: Alternatives for the 21st Century	Mark Swilling
12:00-13:00		Plenary	
13:00-14:00		Lunch	
14:00-14:15	4155	Green Mining and Sustainable Resources Prospecting of New Technology in China	Wang, Jionghui
14:15-14:30	3708	Geology for Society - engaging geoscientists, policy-makers, and the public in meeting our future resource needs sustainability	Nic Bilham
14:30-14:45	5365	Toward a More Equitable Use of Resources	Patrice Christmann (keynote)
14:45-15:30		Panel Discussion and Closing Remarks	
15:30		RFG Session ends	

Resourcing Future Generations:

SECOND OPEN CALL FOR PROPOSALS

IUGS International Union of Geological Sciences

Resourcing Future Generations

The first Open Call, which closed on 31 May 2016, attracted an encouraging number of proposals. Six were funded. In total $18.3k was awarded.

Qiuming Cheng & others	China University Beijing & York University, Canada	Quantitative assessment and prediction of deeply buried mineral resources in covered regions	$2.0k
Kedia Chi & others	University of Buea, Cameroon	Capacity building for stakeholders in artisanal gold mines, Eastern Cameroon	$3.7k
Judith Kinnaird & others	University of Witwatersrand, South Africa	Germanium for Society – now and in the future	$3.4k
Gavin Mudd & Simon Jowitt	Monash University, Melbourne, Australia	Validating New Methods for Global Resource Estimates of Critical Metals	$3.0k
Andrea Rielli	Monash University, Melbourne, Australia	Metasomatic alteration of the sub-arc mantle: implication for arc metallogeny and the redox state of the Earth	$3.1k
Isobel Yeo	GEOMAR, Kiel, Germany	Acoustic properties of ferromanganese crusts and substrates as a tool for e-tech exploration	$3.1k

Applications are now invited for a Second Call. The remit of the Call, Application and Assessment procedure and timetable are as follows:

REMIT OF THE CALL

Applications are invited for

- Novel work on an aspect of RFG, which develops an ongoing piece of work or an already separately funded research grant;
- Organising and running a workshop to promote RFG or an RFG theme.

All awards must start by 1 March 2017 and the work completed and outcomes reported by 31 August 2017. Grants will average $3000, though exceptionally a larger sum may be awarded.

Application procedure

Applications must describe the work proposed and how it will advance one of the three themes of RFG

- Balancing resource supply and demand in the 21st century;
- The challenge of mineral supply: Accessing new resources from the Earth;
- Building additional capacity to facilitate responsible development in less developed nations.

The work must be capable of completion within 6 months of the agreed start of the award. Applications are to be submitted electronically as a word document stating:

i The name, position and host institution/body of the principal investigator together with the names and affiliation of any co-workers;

ii The title of the project together with a brief description of the proposed work (no more than 200 words);

iii The work proposed (in no more than 2000 words) including the research question to be addressed (if appropriate), the technical approach to be adopted, why it is important and timely, a project management plan, foreseen outcomes and the benefits arising to RFG;

iv Outreach and possible socio-economic relevance (max 200 words);

v Details of the funds sought with outline budget and how it links to existing research grant or other existing funding support.

Submissions should be completed in single-spaced typescript of minimum font size 11 point Arial or another sans serif typeface of equivalent size, with margins of at least 2 cm. References must also be presented in a minimum font size of 11 point. Arial Narrow and Calibri are not allowable font types as they are smaller and any proposal which has used either of these font types within their submission will be rejected. Applicants referring to websites should note that the Awards Panel may choose not to use them.

Assessment procedure

The main assessment criteria will be the scientific and technological excellence of the proposal together with consideration of the novelty. Applications will be assessed by an Awards Panel comprising recognised experts, assisted, if necessary, by written external peer review. Principal investigators may be invited to respond to reviewers' comments.

Call Timetable

Call opens	1 October 2016
Deadline for proposals	Noon (UTC) 31 December 2016
Assessment panel	January 2017
Grants awarded	February 2017
Grants start	1 March 2017
Report submitted	31 August 2017

Applicants will be informed as soon as possible of the funding decision. Awardees will be required to provide a written report.

Contact details: Grant applications and questions of clarification should be sent to edmund@geolsoc.org.uk

Background

Resourcing Future Generations (RFG) is a major initiative of the International Union of Geological Sciences (IUGS)[1]. It was launched in 2013 to bring world attention to the challenges of sustaining resource supplies and to outline a pathway to the future, including a route to nation-building and poverty alleviation through resource development[2]. The RFG initiative includes a diverse group of geoscientists, economists, and environmental and social scientists drawn from a range of institutions with diverse private and public experience in exploration, mining, processing, environmental protection, and sustainable development. RFG aspires to be a fundamental service to humanity, not to vested interests in resource development.

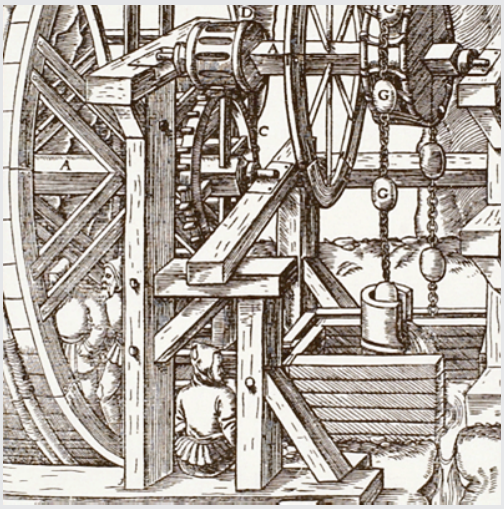


Figure 1

Winding gear and shaft, from 'De Re Metallica' (Agricola, 1556)

IUGS now invites bids for small top-up grants to take forward discrete pieces of work in support of RFG. Details of the application process are below. The invitation is open to all though, in the event of equally judged applications, preference will be given to those from adhering members or affiliated organisations of IUGS[3]. The closing date for the first round of applications is noon UTC 31 May 2016. A second round will be announced after the 35th IGC[4]. Applications will be decided on the basis of excellence, novelty, timeliness and relevance to RFG by an awards panel comprising members of the RFG Core Group[5].

A Global Effort to Meet the World's Future Needs Head-on

The 20th century and early part of this century saw a dramatic increase in living standards and improvement in the quality of life for many of the world's poorest. That improvement has been underpinned by the ubiquitous use of metal and mineral resources in technology and infrastructure. The demand for raw materials to satisfy the higher standards of living that the developing world has every right to expect is apparently insatiable and challenges from where these materials are to come. To maintain this trajectory while addressing climate change and rising world population, sustainable sources of raw materials are required , by both developed and developing countries.

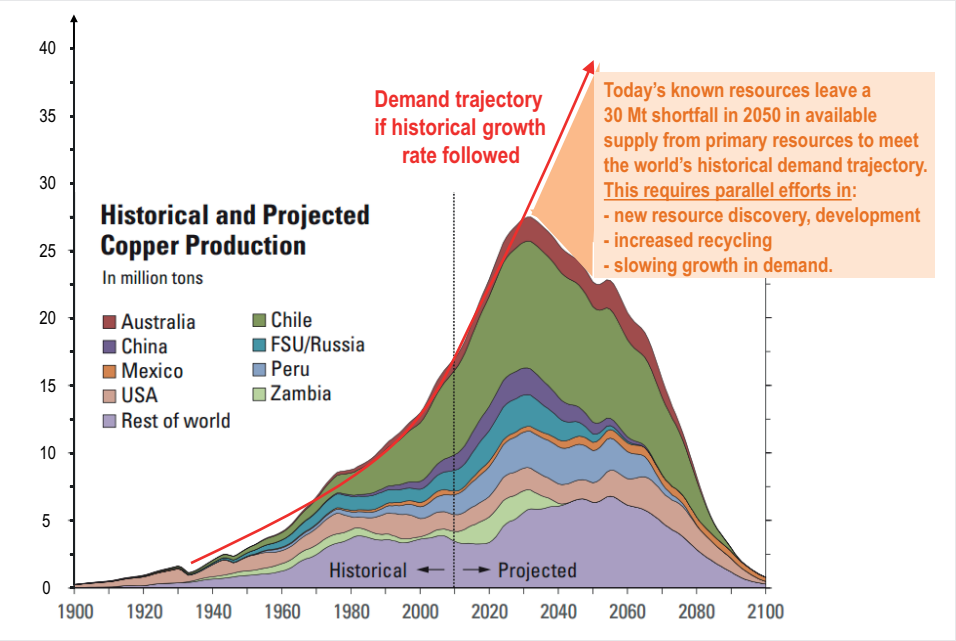
Figure 2 Bingham Canyon, Utah

When Georgius Agricola wrote "De re metallica" (On the Nature of Metals (Minerals)) in the 16th century, he could not have foreseen how the scale and technology surrounding mineral extraction would evolve. Mining has progressed from being a small-scale artisanal activity (Figure 1) to a highly technological one on a vast scale – as at Bingham Canyon, Utah (Figure 2), a mine 4km wide and 1.2km deep.

Regardless of whether known supplies are enough to cover demand in the near term, efforts must be made now to forestall unpredictable yet inevitable supply shortages in the decades to come — shortages that would dramatically impact deployment of low-carbon technology to mitigate climate change as envisaged by the Paris Accord agreed at COP 21 (see box on page 3).

Figure 3

Primary Copper Production – Historical & Projected. Modified from Kerr 2014 and Northey et al 2014



A growing global population and continuing urbanisation will significantly increase demand for the basic metals required for future infrastructure development, such as copper, especially in the developing world. The same is true of many other bulk metals.

Copper is a key component in building construction, power generation and transmission and the production of industrial machinery and equipment. As can be seen in figure 3, even optimistic current projections see a peak in supply likely to occur around 2030. Without action, demand will outstrip supply. Recycling has an important role to play, but given that resources may remain 'locked away' in infrastructure for 80-120 years, its contribution will be limited for the foreseeable future, necessitating continuing primary production at scale. New reserves must be found to fill this entirely predictable gap.

Progress so far

Since the launch of RFG in 2013, we have held Town Hall discussion events at meetings of AGU and GSA, published an article in *Episodes*[6] and a brochure[7].

In October 2014 at the China Mining meeting in Tianjin, we launched *Resourcing Future Generations White Paper: Mineral Resources and Future Supply*[8].

In July 2015, with support from IUGS, the International Council for Science and the United Nations Educational, Scientific and Cultural Organisation, a group of seventeen geoscientists and social scientists, including economists, met on retreat at the Goche Ganas Nature Reserve near Windhoek, Namibia. The discussion and our recommendations are brought together in a 78-page report[9] and summarised in a one-page briefing note for legislators, policy advisers and opinion formers[10].

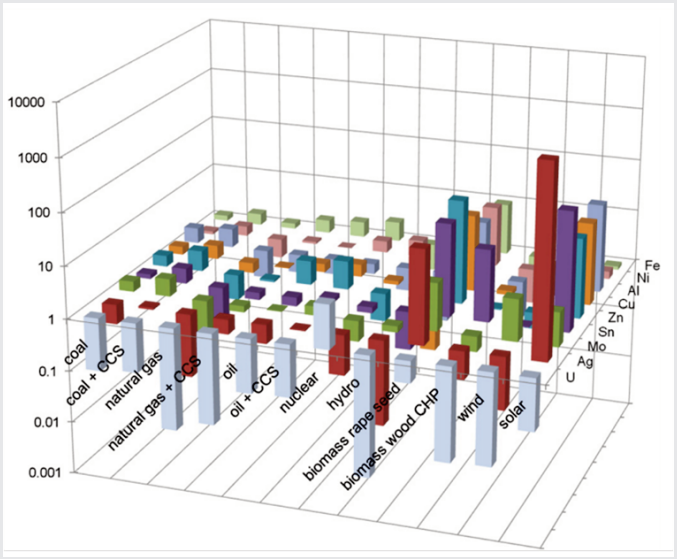


Figure 4

Demand for selected metals in different power generation technologies. Source: Klein, 2012

As we move from carbon-intensive forms of energy (coal, natural gas and oil) towards more environmentally friendly forms (biomass, hydro, wind and solar), there will be steep increases in the quantity (between 2 and 100 times as much) and variety of metals we need for power generation. Figure 4 illustrates demand for iron, nickel, aluminium, copper, zinc, tin, molybdenum, silver and uranium for different power technologies. Wind turbines also require rare earth elements for magnets, and PV solar cells depend on cadmium, tellurium, indium, gallium, germanium and ruthenium. Transmission systems and innovative energy storage technologies will also bring new mineral demands.

Resourcing Future Generations:

WORK PLAN

Action is needed now to address future supply problems that are unpredictable in time and detail, but foreseeable and inevitable. Over the coming year we will continue to raise awareness of RFG with stakeholders such as the International Union for Conservation of Nature and Natural Resources and the International Resource Panel (IRP) of the United Nations Environment Programme, and those with relevant experience and expertise, both within and beyond IUGS (including in other communities such as engineers), by:

i Promoting the White Paper and report of the Namibian workshop in the context of the Paris accord after COP21;

ii Seeking to work with partners organisations and link to existing initiatives. Horizon 2020 could be a mechanism if there was willingness by the EU to raise the issue at a G8/G20 meeting;

iii In the UK, working with government officials and advisors, in particular through the Government Office of Science. There will be parallels in other countries, in particular in Germany and the USA;

iv Building links with high technology industries as 'users' of critical materials';

v Engaging with industry, governments, national geological surveys and funding agencies through multiple approaches seeking their participation and that of the wider research communities;

vi Considering if there is scope to address social issues and to engage with different audiences (possibly straddling bodies such as the United Nations Environment Programme, UNESCO, the World Bank, the World Economic Forum and the International Council on Mining and Metals);

vii Working with UNEP International Resources Panel on its proposed review of future mineral and metal supply in the circular economy;

viii Identifying and publishing about RFG in high impact journals bridging economics, foreign affairs and science policy;

ix Actively contributing to meetings including the European Geosciences Union (Vienna, April 2017), Mines and Money (London, November 2017) and the RFG2018 conference to be held in Vancouver, British Columbia in June of that year.

If you have comments or wish to become involved email Edmund Nickless, Chair, IUGS New Activities Strategic Implementation Committee edmund@geolsoc.org.uk

Footnotes

1. The International Union of Geological Sciences (IUGS) is one of five geosciences-related scientific unions within the International Council for Science (ICSU). With 121 national members, the IUGS aims to promote development of the Earth sciences through the support of broad-based scientific studies relevant to the entire Earth system; to apply the results of these and other studies to preserving Earth's natural environment, using all natural resources wisely and improving the prosperity of nations and the quality of human life; and to strengthen public awareness of geology and advance geological education in the widest sense. Further information on IUGS is at http://www.iugs.org/. The International Council for Science (ICSU) is a non-governmental organisation with a global membership of national scientific bodies (122 Members, representing 142 countries) and International Scientific Unions (31 Members). See http://www.icsu.org/
2. Resourcing Future Generations was launched in February 2013. Background is at http://iugs.org/index.php?page=resourcing-the-future-initiative and http://www.geolsoc.org.uk/RFG
3. Membership of IUGS comprises Adhering members and Affiliated organisations. Adhering members are listed at http://iugs.org/index.php?page=adhering-members; Affiliated organisations are listed at http://iugs.org/index.php?page=directory#AO
4. The 35th IGC will be held in Cape Town, South Africa from 27 August to 4 September 2016. Further details are at http://www.35igc.org/
5. Membership of the RFG Core Group is at http://iugs.org/index.php?page=resourcing-the-future-initiative
6. Lambert, I., Durrheim, R., Godoy, M., Kota, M., Leahy, P., Ludden, J., Nickless, E., Oberhaensli, R., Anjian, W., Williams, N. Resourcing Future Generations: A proposed new IUGS initiative. Episodes. June 2013 http://www.episodes.org/index.php/epi/article/view/57474/44844
7. RFG brochure http://www.geolsoc.org.uk/~/media/shared/documents/RFG/ResourcingFutureGenerations%20%20%20FINAL.pdf?la=en
8. Nickless, E., Bloodworth, A., Meinert, L., Giurco, D., Mohr, S., Littleboy, A. Resourcing Future Generations White Paper: Mineral Resources and Future Supply. International Union of Geological Sciences. 2014, 30pp. http://iugs.org/uploads/Consultation%20Paper%202014_Oct_12_AL_EN_DG%20FINAL.swf
9. Nickless, E., Ali, S., Arndt, N., Brown, G., Demetriades, A., Durrheim, R., Enriquez M.A., Giurco, D., Kinnaird, J., Littleboy, A., Masotti, F., Meinert, L., Nyanganyura, D., Oberhänsli, R., Salem, J., Schneider, G., Yakovleva., N. Resourcing Future Generations: A Global Effort to Meet The World's Future Needs Head-on. International Union of Geological Sciences. 2015, 78pp. - http://iugs.org/uploads/RFG%20Report-sm.pdf
10. RFG policy statement http://www.geolsoc.org.uk/~/media/Files/RFG%20Policy%20Statement.pdf?la=en

Annex G

RFG2018 SESSION PROPOSALS SUBMITTED BY NASIC

1. The International Resource Panel and the Emergence of a Science-Policy Consensus on Mineral Governance

   Convenors: Saleem H. Ali (University of Delaware), Maria Baptista (UNEP Secretariat) and Janet Salem (UNEP Bangkok).

   This session will focus on the ways in which science has informed policy dialogue through the International Resource Panel, an epistemic community created by UN Environment in 2007 to provide an effective means for international planning around natural resource scarcity. The International Resource Panel has developed a format by which the scientific panel interacts with the steering committee, comprising government representatives, for more effective conversations around the application of scientific knowledge for more sustainable use of natural resources. We will examine the effectiveness of this process over the 10 year history of the Panel and specific ways in which such interactions have improved policy outcomes. The establishment of the UN Environment Assembly (UNEA) in 2015 has also provided an additional avenue for the Panel to influence international policy. We will document the development of a report to the UNEA as a synthesis of the panel's activities.

   The session will elaborate on the output that emerges from the resource governance working group of the International Resource Panel and some of the salient features of the report prepared by this working group as a means of policy guidance under the framework of a "sustainable development license to operate" for the extractive resources sector. This will be discussed in the context of ongoing environmental and social conflicts over various aspects of the mining industry. More effective resource planning that considers the demand for resources and the disjuncture with exploration investment will be considered in the light of the research also presented by the Resourcing Future Generations (RFG) project which complements some of the report findings of the International Resource Panel.

   Finally, we will consider the emergence of hybrid governance structures and institutions around the extractives sector such as the Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development; the African Mining Vision of the African Union; The International Copper, Lead and Zinc Study Groups; The Extractive Industries Transparency Initiative; and the Common Fund for Commodities. How have these organizations improved the overall governance and development outcomes of the extractive industries locally, while also providing the raw materials needed globally to deliver the UN Sustainable Development Goals? Based on our exploratory responses to this fundamental question, we will suggest some key policy recommendations that are emerging from the broad international conversations between scientists and government decision-makers.

2. Ensuring the supply of critical materials to meet the UN 2030 Sustainable Development Goals

   Convenors: Larry Meinert (USGS), Gavin Mudd (Monash) and Damien Giurco

(University of Technology, Sydney

It is widely known that world population growth combined with rising standards of living requires increasing amounts of natural resources to sustain modern civilization. It is an open question as to where these resources will come from, whether recycling and substitution can significantly augment newly mined supply, and whether the social license exists to allow society to fill its needs. This session will focus on multiple aspects of this problem including: 1) modelling to forecast production and demand, 2) the roles of recycling and substitution, 3) environmental impacts and energy requirements of resource extraction, 4) mineral supply chains and the possibility of disruption, and 5) the adequacy of exploration, production, and underlying resources to meet future demand. These challenges require input from geoscientists, social scientists, economists, and metallurgists, among others. This interdisciplinary session invites experts from all relevant fields to contribute to the overall theme focused upon meeting the UN 2030 Sustainable Development Goals.

3. Exploration under deep cover"

Convenors: Ray Durrheim (Univerity of Witswatersrand), Qiuming Cheng (York University, Canada) and Steve Blewett (Geoscience Australia)

In well-explored parts of the world, such as Western Europe, North America and Australia, most easy-to-find near-surface deposits were discovered decades or even centuries ago. Consequently, the average depth beneath the surface of new discoveries in these regions has increased, particularly since the middle of the 20th century when geological, geochemical and geophysical methods that can "see" hundreds of metres or even kilometres beneath the surface were developed and applied. New mineral deposits are likely to be found at even greater depths or in regions where the geology is complex. Furthermore, new mineral treatment methods may allow metals to be extracted from rocks that were not previously considered as ore.

We invite papers that describe exploration for resources under deep cover. The topic includes both 'greenfields' and 'brownfields' exploration. For example:

- New concepts in orebody formation;
- Target generation methods, such as the application of artificial intelligence techniques to integrated geophysical, geochemical and geological information
- Advances in exploration technologies, such as data mining, penetrating geochemical exploration, reflection seismics, magnetotellurics, deep drilling and in-mine geophysics;
- Characterization of rock mass properties that influence safe and profitable mining, such as rock strength and temperature; and
- Economic models, as deep mines are likely to be costly and have significant lead times.

4. Learning from and Empowering Young Leaders: Early-career geoscientists implementing sustainable development.

Convenors: Joel Gill (Director, Geology for Global Development, UK), Meng WANG (President of YES Network, China), Elyvin Nkhonjera Chawinga (Extractive

Industries Coordinator, Oxfam, South Africa), Cecilia Mukosi Ndivhuwo (Geologist, Geological Council of South Africa).

The session will explore the role of young leaders and scientists in fostering the North-South, South-South, and triangular partnerships required to effectively deliver the UN Sustainable Development Goals (SDGs), and ensure equitable access to natural resources. Sustained, inclusive economic growth and improved human welfare in the Global South will require improved access to and management of natural resources. Development megatrends (e.g., increased globalisation and inequality, major demographic changes, and increased environmental degradation) will result in greater pressure on such resources. These trends, alongside the SDGs, highlight the need for long-term, coherent, and integrated development strategies that encompass economic and social development, environmental management, and good governance. Young leaders, those at an early stage of their career demonstrating influence in academia, private and public sectors, and civil society, are well placed to drive forward this approach and deliver the long-term partnerships essential to resourcing future generations. Broad themes within this session include (but are not limited to): (i) case studies of cross-national/cross-institutional capacity building; (ii) skills development and transdisciplinary training programmes for young leaders; (iii) cross-sector partnerships, with a focus on engaging with civil society, academia, industry and government; (iv) the role of early-career led organisations in facilitating improved access to, and management of, natural resources, and (v) the development and communication of pioneering science by young leaders. We welcome submissions on all of the above topics, and others within this theme, from early-career geoscientists, representatives from NGOs and development agencies, policy advisers, and those with ambition to be future decision makers and politicians.

RFG PUBLICATIONS

Lambert, I., Durrheim, R., Godoy, M., Kota, M., Leahy, P., Ludden, J., Nickless, E., Oberhäensli, R., Anjian, W., Williams, N. Resourcing Future Generations: A proposed new IUGS initiative. June 2013. Episodes. Vol. 36/2, pp 82-86. http://www.episodes.org/index.php/epi/article/view/57474/44844

Resourcing Future Generations: A Global Effort to Meet the World's Future Needs Head-On. October 2013. http://iugs.org/uploads/RFG.pdf

Nickless, E., Bloodworth, A., Meinert, L., Giurco, D., Mohr, S., Littleboy, A. Resourcing Future Generations White Paper: Mineral Resources and Future Supply. International Union of Geological Sciences. 2014, 30pp. http://iugs.org/uploads/Consultation%20Paper%202014_Oct_12_AL_EN_DG%20FINAL.swf

Nickless, E., Ali, S., Arndt, N., Brown, G., Demetriades, A., Durrheim, R., Enriquez M.A., Giurco, D., Kinnaird, J., Littleboy, A., Masotti, F., Meinert, L., Nyanganyura, D., Oberhänsli, R., Salem, J., Schneider, G., Yakovleva., N. Resourcing Future Generations: A Global Effort to Meet The World's Future Needs Head-on. International Union of Geological Sciences. 2015, 77pp. http://iugs.org/uploads/RFG%20Report-sm.pdf

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First Open Call for proposals. April 2016. http://iugs.org/uploads/RFG%20Call%20for%20Proposals%202016.pdf

Second Open Call for proposals. September 2016. http://iugs.org/uploads/29942%20Second%20Open%20Call%20for%20Proposals%20proof.pdf

Ali, S.1., Giurco, D., Arndt, N., Nickless, E., Brown, G., Demetriades, A.,Durrheim, R., Enriquez M.A., Kinnaird, J., Littleboy, A., Meinert, L.0. , Oberhänsli, R., Salem, J., Schodde, R., Schneider, G., Vidal, O. Yakovleva., N. Sustainable Mineral Sourcing Requires International Action. In press. Nature Perspectives.

Nickless, E. In press. Resourcing Future Generations: a global effort to meet the world's future needs head-on. European Geologist Journal. Vol 42, p 48-52.

Nickless, E. Submitted for publication. Resourcing Future Generations – a contribution by the Earth science community. Special issue publication on "Mineral Resources of the Future", Natural Resources Research, Springer