



RESOURCING FUTURE GENERATIONS: THE CHALLENGES

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INTRODUCTORY REMARKS: IUGS

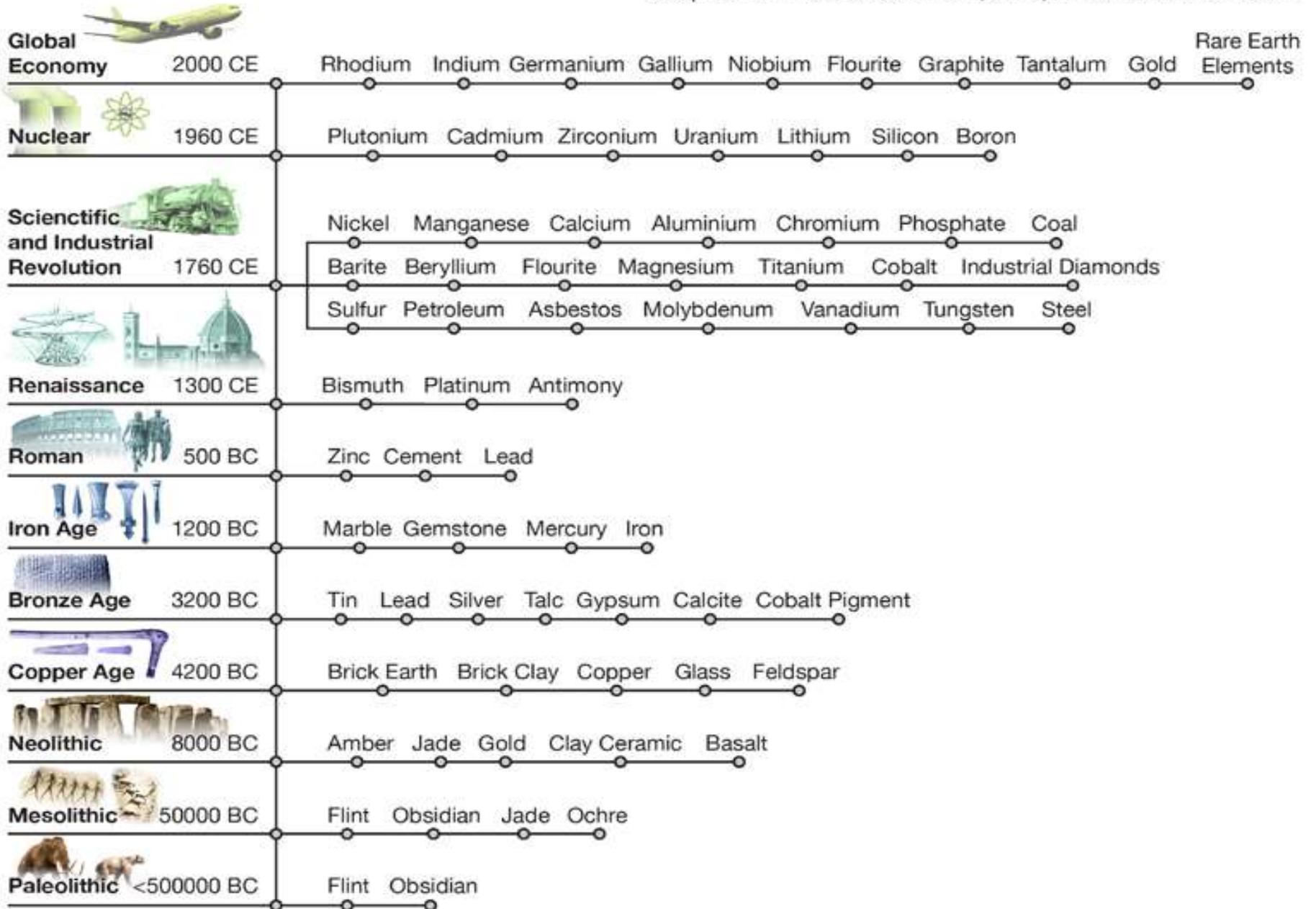
- **International Union of Geological Sciences**
 - Represents the international geoscience community
 - Scientific sponsor of the IGC
 - **Global geographic coverage and influence through its approximately 120 member countries**
 - **Most major international geosocieties are affiliates**
 - Promotes development of the geosciences through the **support of international, broad-based, and interdisciplinary scientific studies and training programs**
 - **Develops international geostandards**
 - **Member Union of the international Council for Science (ICSU)**
 - Links to expertise in a range of disciplines (geophysics and geodesy, social sciences, material sciences, remote sensing, geoengineering, health, etc.)

MINERALS AND SOCIETY

- **As societies have become more sophisticated the consumption of mineral commodities has not only grown, but also diversified**
- **To date, supply has been broadly adequate to meet demand**
 - **Discovery of new resources of mineral commodities**
 - **Increasing recycling**
 - **Improving efficiency of use**
 - **Substitution of one commodity for another**

Critical Mineral Commodities through Western Civilization

adapted from Roland Oberhansli, 2013, Personal communication



MEETING THE NEEDS OF FUTURE GENERATIONS FOR MINERAL RESOURCES

- **It appears inevitable that the demand will continue to rise for most commodities**
 - **Global population continues to burgeon**
 - **Populous BRIC economies continue their rapid development**
 - **Africa strives to develop its cities and deliver services**
- **It is a priority to find and develop natural resources for future generations**
 - **Greater efficiency of use, recycling and substitution will all be vital, but insufficient**
 - **Apart from major minerals such as iron, bauxite, etc., major new sources of high tech commodities for renewable energy generation, electric cars, etc. need to be found/developed**

KEY RAMIFICATIONS

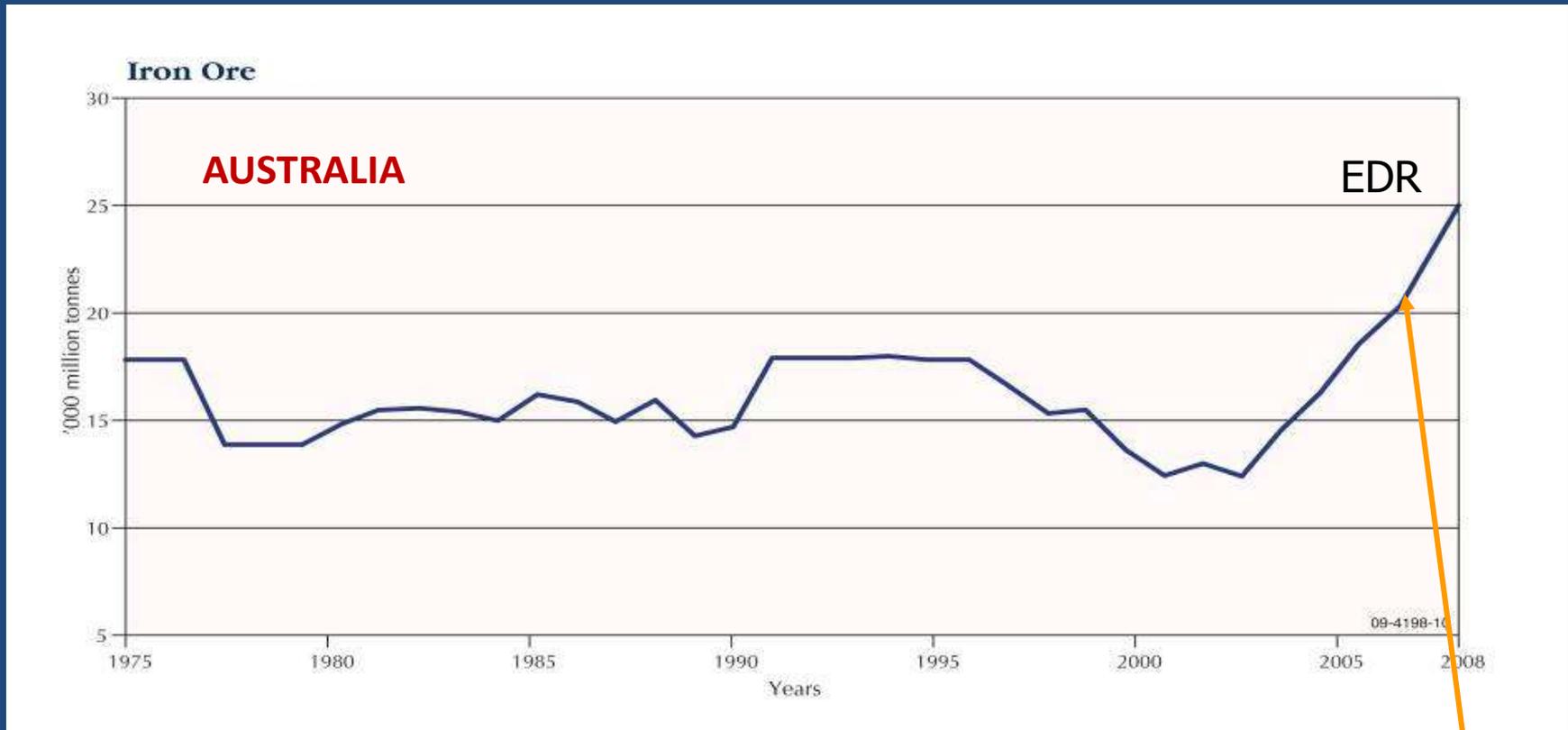
- Mining will continue to be an essential activity
 - To meet the needs of future generations
 - While this is not easily accepted by all, it cannot be ignored in deliberations of the future
 - **Any goals or visions for the future that simply ignore mining, or assume it will phase out, will be seriously compromised**
 - Need to have responsible production of natural resources - as part of integrated regional/national development plans - accepted as a pathway to global Sustainable Development and a component of Future Earth
- **The geoscientific data, skills and infrastructure required for locating mineral and energy have wider public-good applications**

OPPORTUNITIES FROM MINING

- Responsible natural resource production offers major opportunities for development of countries with good mineral and energy endowments
 - Australia and Canada are good examples of countries that have developed on the back of thriving resources sectors
 - Namibia is an example of a less developed country which has set itself up well to reap similar benefits
 - Kazakhstan also has a strong economy based on its natural resources
 - **Geoscientific data, skills and infrastructure are also essential for delineating groundwater systems, managing pollution, constructing cities, etc.**

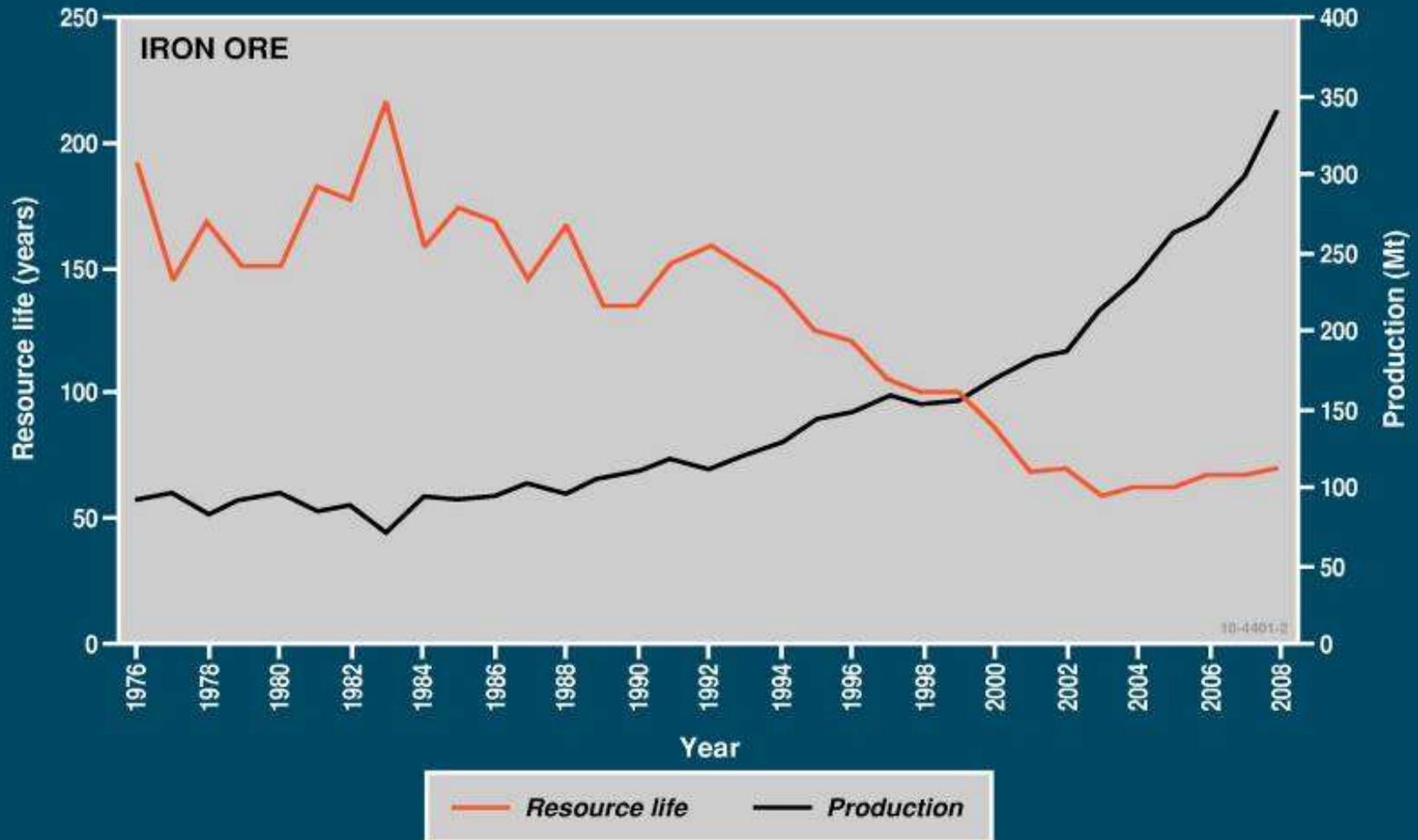
A RANGE OF RELEVANT EXISTING INITIATIVES, MANY WITH LINKS TO IUGS, ARE SUMMARISED AT THE END OF THIS PRESENTATION

A CASE STUDY OF TRENDS: IRON ORE - AUSTRALIA'S ECONOMIC DEMONSTRATED RESOURCES ("RESERVES")



EDR increase mainly due to inclusion of higher cost resources and decrease in cut off grade from 55% to 50% Fe

A CASE STUDY OF TRENDS (Cont.): AUSTRALIA'S IRON ORE PRODUCTION AND RESOURCE LIFE*

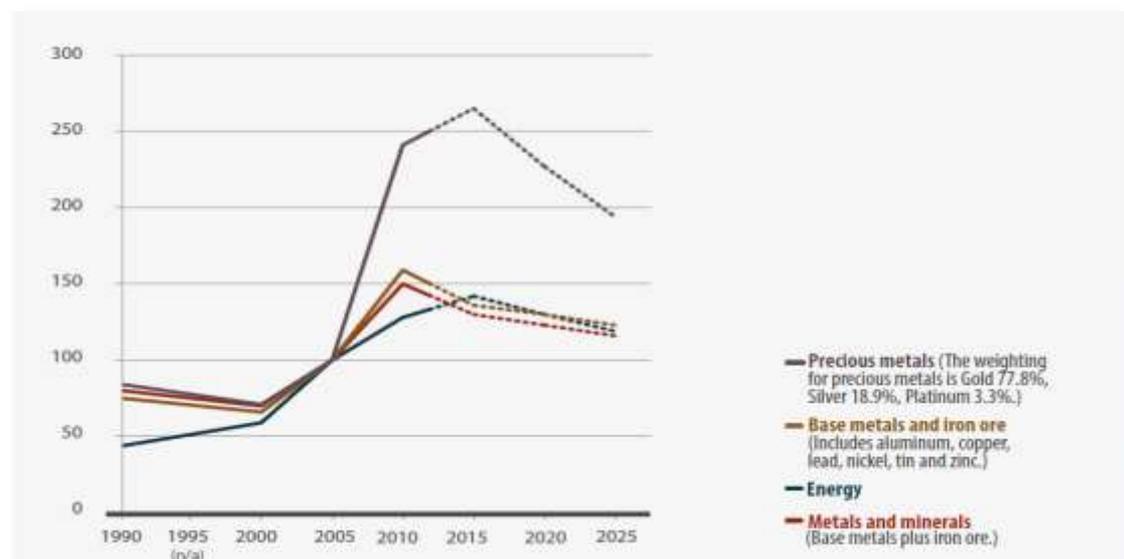


* "Resource life" = EDR/Production. NOTE THIS "INDICATOR" HAS DECREASED MARKEDLY

PRESSURES ON SUPPLY CHAIN

- Unprecedented growth in demand for some commodities over the past decade has caused pressures on the supply chain
 - Prices of the sought after commodities at highest levels ever. Likely to remain elevated as long there are perceptions of supply shortfalls
 - Including some critical dependencies on unstable sources

Figure 15: GLOBAL COMMODITY PRICES ARE SET TO REMAIN HIGH: WEIGHTED INDICES FOR SELECTED COMMODITIES (2005=100)



SATISFYING FUTURE GENERATIONS NEEDS OF MINERAL RESOURCES

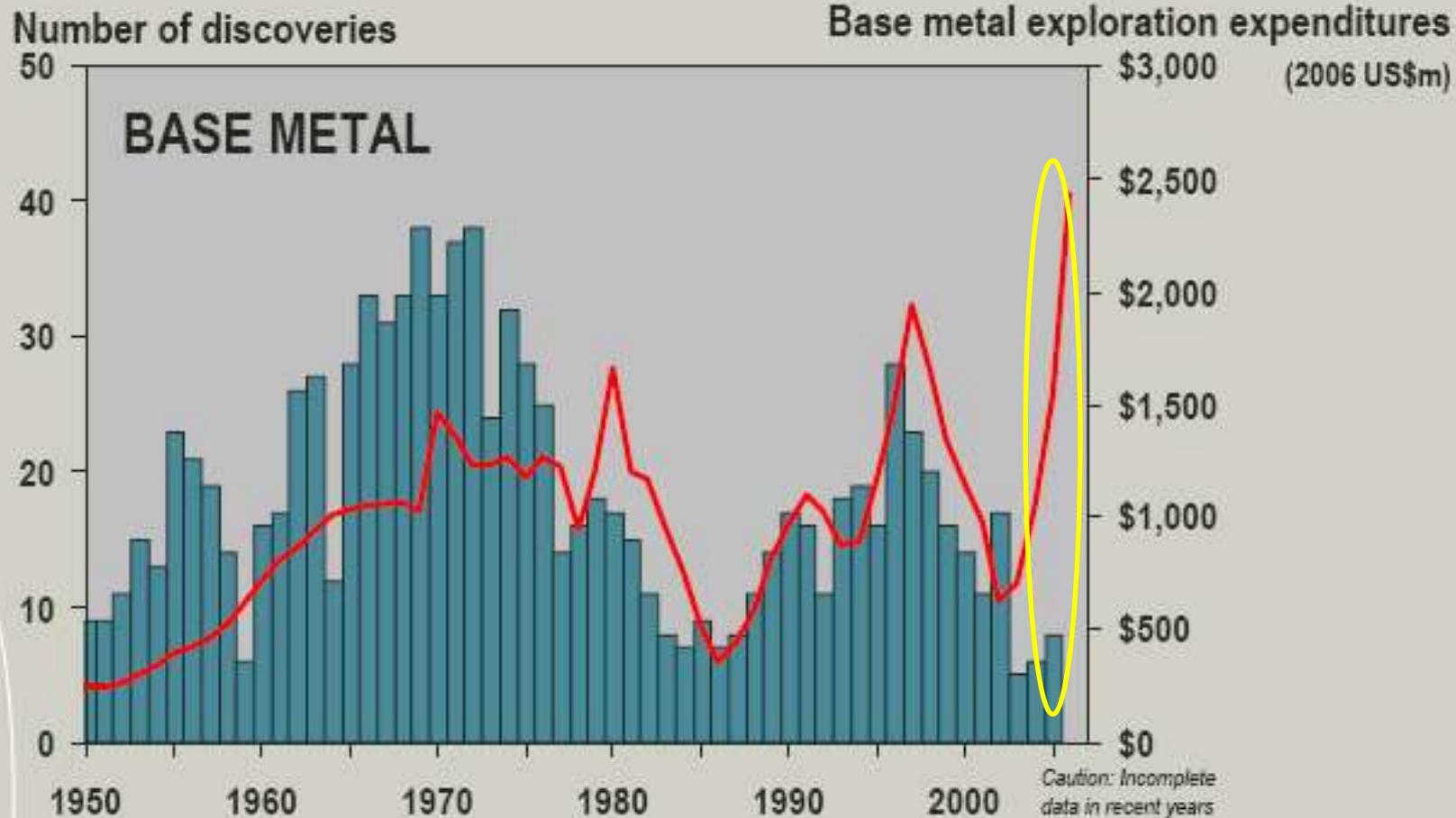
- **It is a challenging goal to ensure a supply of natural resources for global society for the next century**
 - While meeting the environmental and social imperatives for sustainable development
 - Researchers, academics, government agencies and industry globally will need to play roles
- **In general, available technologies and good practices can minimise lasting impacts from resource production**
 - **Corruption, conflicts of interest and incompetence are major reasons for bad economic and social outcomes**

HARDER TO FIND NEW RESOURCES

- **Falling rate of discovery of large mineral deposits over the past quarter of a century, despite high levels of exploration expenditure**
 - **Exploration expenditure decoupled from discovery**
 - **Reflects the successes of earlier exploration**
 - **Most easily accessible mineral resources of commercial interest in the developed world have been tapped already**
- **There are still opportunities at depth**
- **The bulk of the mineral resources for the future are in the less developed world**

Industry performance - how many deposits were found ?

Base metal (Cu, Ni, Zn, Pb) discoveries > 0.1mt Cu-equiv: western world: 1950-2005



OTHER MAJOR CHALLENGES

- **Continuing to mine lower grade and lower quality deposits is unlikely to be the answer**
 - Higher energy and water use
 - Larger areas of disturbance
- **Decreasing land area accessible for exploration and production**
 - More land is tied up for housing, feeding and servicing people and sustaining natural systems
- **Changing widespread negative perceptions of mining and demonstrating how it can be conducted with sustainable benefits**

OTHER CHALLENGES

- Shortage of the suitable physical and political infrastructure, and trained workforce in the less developed world
- Roles of multinational mining companies may continue to evolve
 - Resource nationalism likely to increase
 - Greater in-country benefits from the exploitation of a country's endowment
 - Greater indigenization at the professional and technical levels, as well as use of local goods and services
 - Less harm to the environment

ADDRESSING THE CHALLENGES

- IUGS established a New Activities Strategic Implementation Committee (NASIC) to scope a proposed new initiative
 - = **Resourcing Future Generations (RFG)**
 - To identify and address key challenges involved in securing natural resources to meet global needs post-2030
- This presentation is restricted to mineral resources, which are intended to be the initial focus of RFG
 - Planned to phase **in water and energy**

ADDRESSING THE CHALLENGES

- **IUGS is not an organisation with permanent staff and research capacity, but it does have some international influence**
 - **All in the global geoscience community are involved with IUGS' through IUGS' 120 member countries**
 - **And most major societies are affiliated with IUGS**
 - **It is well-placed to play an international honest-broker role circumventing potential concerns about roles of some individual contributing countries/organisations**
- **RFG's ambitious goals require member organizations and geoscientists internationally to participate, and work as appropriates with others on socioeconomic issues**

RFG WILL PARTNER, COORDINATE COLLABORATE AS REQUIRED

- **RFG will bring an independent, non-government, international framework**
 - **It will provide/facilitate a beneficial international framework within which**
 - » **Current activities would have the opportunity to be incorporated if they see enhanced opportunities for links to other activities**
 - » **New activities can be developed in a coordinated manner**
- **Researchers, academics, government agencies, industry and international facilitation and funding groups will need to be involved**
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ADDRESSING THE CHALLENGES

- Addressing the multi-generational needs for mineral commodities requires four fundamental actions by the geoscience community:
 1. **Comprehensive evaluation and quantification of 21st century supply and demand**
 2. Enhanced understanding of subsurface as it relates to mineralisation
 3. Evaluation of where new resources are likely to be found
 4. **Building additional capacity and other actions to facilitate discovery and responsible development of mineral resources in less developed nations**
 - This is most relevant to *Future Earth*

ADDRESSING THE CHALLENGES THEME

1. SUPPLY AND DEMAND

- The first step toward addressing the world's mineral resource needs for coming generations is to comprehensively understand the available supply and future demand for commodities
 - Resources needed beyond 2030 need to be identified and developed in the near future
- IUGS plans to commission research into trends in supply and demand beyond 2030
 - By which time shortages of some major commodities will be likely, **including commodities required for renewable energy generation**
 - China likely to provide funds

THEME 2. STUDYING THE SUBSURFACE

- **We now have a veritable arsenal of geophysical techniques**
 - **Such as reflection seismology and 3-D tomography to magnetometry and gravimetry**
- **As the rate of resource discovery is declining**
 - **There is an ongoing need for more innovative applications of data currently available and for additional and ever-more sensitive tools and techniques to sniff out new finds beneath cover**

THEME 2. STUDYING THE SUBSURFACE

- **Facilitate applications in less developed regions**
- **Improve user access to “big data” sources**
 - **Promote integration between global observation programs like EarthCube and the Group on Earth Observations**
 - **Maintain a database of the availability and use of current and emerging exploration tools, including details about training opportunities**
- **Encourage development of novel, advanced exploration tools**

3. WHERE ARE THE RESOURCES?

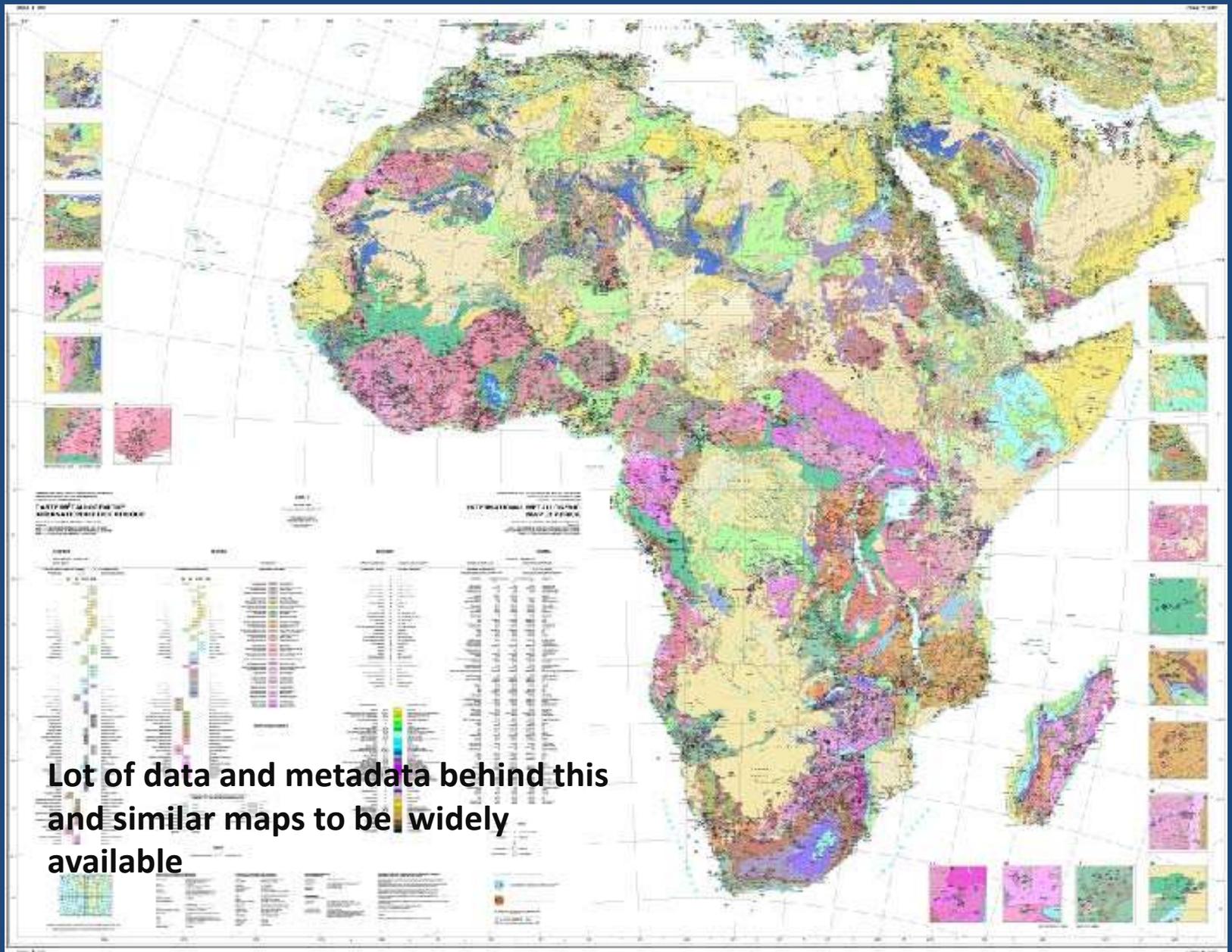
Regional scale understanding of the potential localities and processes of mineral-deposition that have guided past exploration need updating

Declining rates of discovery also underscore that current ore deposit models are insufficient for guiding the coming generations of exploration

THEME 3. WHERE ARE THE RESOURCES?

- **RFG plans to**
 - **Promote innovative approaches to spur new understanding of how and why mineral deposits occur where they do**
 - **Facilitate access to archived and scattered databases of geological and geophysical data**
 - **Focus on under-explored regions**
 - **Compile existing geological maps, particularly Africa and the Tethyan Belt, and support training for new mapping campaigns as needed**
 - **Build on existing compilations and metadata**
 - **Influence decisions on future satellite mapping capabilities**

METALLOGENIC MAPS - CGMW



Lot of data and metadata behind this and similar maps to be widely available

THEME 4. BUILDING SUPPORT AND CAPACITY IN THE DEVELOPING WORLD

- Parts of developing world undoubtedly host rich, untapped mineral deposits
 - **Responsible mining** can be a major contributor to development – given holistic planning/life cycle of region
 - General lack of the infrastructure, governance, geological knowledge and trained workforce necessary to undertake the large scale minerals assessment and mining efforts that can responsibly and equitably supply future generations
 - Need to clearly articulate needs and aspirations - moving beyond the paradigm of development aid
 - Clearly not worked over the past 50 years
 - Partnerships based on specific needs

THEME 4. BUILDING SUPPORT AND CAPACITY IN THE DEVELOPING WORLD

- RFG = an international ‘honest broker’ which will help to improve the ability of developing nations to create world-class and regionally self-sufficient mining industries. It could:
 - Work in complementary ways with, existing initiatives such as **listed at the end of this paper**
 - Facilitate public outreach programs promoting knowledge/benefits of responsible mining
 - Lobby for inclusion of **responsible production of natural resources as a pathway to Sustainable Development**
 - Address negative perceptions of mining in many areas, possibly including endorsing high level international principles for responsible mining activities, as a fall-back where nothing better in place

THEME 4. BUILDING SUPPORT AND CAPACITY IN THE DEVELOPING WORLD

- **RFG could also:**
 - Show how tensions between mining activities and other land uses, like agriculture, can be addressed
 - Support /facilitate/coordinate training programs on geological mapping and regional scale assessments to locate potentially resource-rich areas as a first step to better characterizing under-explored areas
 - Encourage learning opportunities in which students from developing countries can gain and subsequently return home with expertise in geology, engineering and other mining-related fields
- **This RFG Theme would particularly benefit from partnership between IUGS-UNESCO-ICSU**

AFRICA MINING VISION (AMV)

- **AMV was adopted in 2008 by the First African Union (AU) Conference of African Ministers responsible for mineral resources development with the ultimate goal of using Africa's mineral resources to meet the Millennium Development Goals**
 - **Eradicate poverty, and achieve rapid and broad-based socio-economic development**
- **It is important that this vision was developed by Africans**
 - **RFG SHOULD INVESTIGATE OPPORTUNITIES AS AN NON-GOVERNMENT, INTERNATIONAL, INDEPENDENT HONEST BROKER/FACILITATOR**

AFRICA MINING VISION (Cont.)

- **The AMV action plan presented in 2011 by AU Ministers in charge of Mineral Resources Development comprises clusters of activities constructed around the key pillars:**
 - **mineral rents and management**
 - **geological and mining information systems**
 - **building human and institutional capacities**
 - **artisanal and small scale mining**
 - **mineral sector governance**
 - **research and development**
 - **environmental and social issues**
 - **linkages and diversification**
- **The Action Plan contains an institutional framework for implementing the proposed activities**

CONCLUDING REMARKS

- We are asking some important questions about what needs to be addressed in the near term if we are to secure natural resources for the very long term
 - It is not the intention that RFG do everything
 - Need to refine the scope by deciding on what the priority goals and activities should be
 - **Outlines of relevant existing initiatives, most of which have links to IUGS, follow**

Global: OneGeology : Supported by IUGS

- **OneGeology is an international initiative of the geological surveys of the world 's to create dynamic digital geological map data for the world designed to**
 - **Make existing geological map data accessible in whatever digital format is available in each country**
 - **Transfer know-how to those who need it, adopting an approach that recognises that different nations have differing abilities to participate**
 - **Stimulate a rapid increase in interoperability, achieved through the development and use of the web mark-up language = GeoSciML**
- **Linked with IUGS mainly through the CGI**

Global: Commission for the management and application of geoscience information (CGI)

- **CGI is an activity of IUGS, which aims to enable the global exchange of knowledge about geoscience information and systems**
- **Major initiative of the CGI is the development of GeoSciML - to develop international standards for the structure of geological information to enable interoperability, particularly among national geological survey agencies**
 - **Vital role in OneGeology**

Global: Commission for the Geological Map of the World (CGMW): Affiliated with IUGS

- **CGMW is responsible for designing, promoting, coordinating, preparing and publishing small-scale thematic (geology, geophysics, ore deposits, natural resources, climate, etc.) Earth Science maps of continents, major regions, and oceans**
 - **CGMW plays a leading role in the use and diffusion of digital cartographic techniques, as well as in the development of international standards**

International Mining for Development Centre

- **In 2011, University of Western Australia and University of Queensland (Sustainable Minerals Institute) were allocated Australian Government funding to establish the International Mining for Development Centre (IM4DC)**
 - **To assist in lifting the quality of life in developing nations through a more sustainable use of mineral and energy resources**
 - **Improving incomes, employment, enterprise opportunities and life outcomes for people in rural and urban areas of developing countries**
- **RFG and IM4DC will investigate mutually beneficial opportunities for collaboration**

International Mining for Development Centre

- **Consistent with RFG goals**, IM4DC facilitates establishment of world class mining industries to boost overall economic development
- The benefits are realised principally through:
 - Increased skill levels of key personnel within government, universities, research institutions and civil society organisations to bring about:
 - Improved policies and practices in the governance and management of extractive industries and their interactions with society and the environment
 - Improved legislative frameworks
 - Improved knowledge of a country's resources base
 - An ability to continue to build local capacity in minerals governance and mining

European Innovation Partnership on Raw Materials (EIP)

- EIP aims to involve a large number of partners across the European Union and the entire raw materials value chain
 - The EC has launched a call for commitments from the private, public and non-governmental sectors including academia
 - The aim is to mobilise a substantial part of the European raw materials community
 - The Strategic Implementation Plan lists action areas and specific actions, including on mineral inventories, exploration methods, international cooperation, education and training.
- RFG could investigate partnering in some of these

ERA-MIN

- **ERA-MIN is a network of European organisations owning and/or managing research programs on raw materials which is growing to form a major network for the European non-energy mineral raw materials research community (ENERC).**
- **It aims to contribute to overcome the current state of fragmentation and to foster research in the field of industrial production and supply of raw materials by :**
 - **Networking stakeholders**
 - **Roadmapping research priorities**
 - **Implementing joint actions**

Africa: Geoscience Information in Africa (Giraf) Network: Under the auspices of IUGS/CGI and UNESCO

- **GIRAF encompasses geosurvey organisations, research institutes, universities and companies. It aims to**
 - **Ensure that knowledge-based geoscience information contributes to improve the environmental & economic prosperity of people in Africa. Including to:**
 - **Build a pan-African geoscience information knowledge network of geological surveys, universities, research institutes and companies**
 - **Bring together relevant African authorities, national experts and stakeholders in geoscience information**
 - **Support those Institutions who have demonstrated a considerable lack of resources and capacities**

African-European Georesources Observation System (AEGOS) :IUGS involved through GEO/GEOSS

- **AEGOS main objectives are :**
 - the definition of operational procedures for data management (spatial data infrastructure, metadata and data)
 - user-oriented products and services including the preparation of innovative spin-off projects
 - strengthening and development the African-European partners network
 - a geoscience contribution to GEOSS, in the context of the Infrastructure for Spatial Information in Europe (INSPIRE).
- **AEGOS is:**
 - setting-up the preparatory phase for an information system containing and making accessible data and knowledge on African natural resources
 - Compiling a unique archive of Africa related geoscientific observation data
 - Developing Earth observation capacity building activities

Geological Society of Africa (GSAf): Affiliated with IUGS

- **GSAf encourage geoscientific collaboration and cooperation across the continent to:**
 - **Promote understanding of the earth sciences and improve standards of earth science education and research in Africa**
 - **Provide a forum for discussion and dissemination of information across national boundaries between scientists, associations and institutions engaged in African geology and earth resources**
 - **Promote the development and sustainable management of the continent's earth resources, to advance its socio-economic development**
 - **improve natural hazards assessment and disaster mitigation**

African Association of Women in Geosciences: Affiliated with the IUGS

- **The objectives of the AAWG is to bring a particularly female geoscientists' perspective to:**
 - **Promote the advancement of scientific and technological knowledge**
 - **Disseminate information on scientific and technical research and discoveries and promote public understanding of the role of geosciences in Africa's development**
 - **Establish and maintain relations between African scientists and the international scientific community**
 - **Provide a forum for discussion and cooperation in geosciences and other related professions in Africa**
 - **Highlight and seek solutions to problems faced specifically by women and grassroots communities in Africa in the area of geosciences**
 - **Encourage education, training and research to assist African women achieve leadership in geosciences**

AfricaArray: IUGS supported

- **AfricaArray is a response to the call for continent-wide cooperation in human-resources development**
- **Its mission is to create new geoscientific research and training programmes and rebuild existing ones in Africa with /for Africans**

Long-term vision is to support training in many geoscience fields

- **Initial efforts have focused on geophysics, including development of new geophysical training programmes and expanded support of existing ones; promotion of geophysical research; and design and establishment of a network of geophysical observatories**

Africa: West African Exploration Initiative (WAXI) No IUGS Involvement

- **Aim of WAXI is to enhance the exploration potential of West Africa through an integrated program of research and data gathering into its “anatomy”, and to build capacity of local institutions to undertake such work**
 - **Principally funded by the Australian govt (AusAID and the ARC) and the mining industry via an AMIRA International consortium.**
 - **includes Burkina Faso, Guinea, Guinea Bissau, Ivory Coast, Liberia, Ghana, The Gambia, Mali, Mauritania, Senegal, Niger, Sierra Leone and Togo**
- **A large Exploration GIS underpins research and training activities**
- **WAXI directly funds/works with others on, capacity building activities (led by researchers from University of the Witwatersrand, South Africa and the Institut de Recherche pour le Développement, France)**

Asia and the Pacific: Coordinating Committee for Geoscience Programs in East and Southeast Asia (CCOP): IUGS Affiliate

- **CCOP is an intergovernmental organisation whose mission is to facilitate and coordinate the implementation of applied geoscience programmes to contribute to economic development and the improvement of the quality of life. It promotes**
 - **capacity building, technology transfer, exchange of information and institutional linkages for sustainable resource development, management of geo-information, geo-hazard mitigation and protection of the environment**
- **CCOP has twelve member countries**
 - **Cambodia, China, Indonesia, Japan, Korea, Lao PDR, Malaysia, Papua New Guinea, Philippines, Singapore, Thailand, Timor-Leste and Vietnam**
- **Supported by Australia, Belgium, Canada, Denmark, Finland, France, Germany, Japan, The Netherlands, Norway, Poland, Russian Federation, Sweden, UK and USA**

CCOP (cont.)

- **CCOP secretariat is in Bangkok and its technical activities are focussed on the following topics:**
 - **Small Scale Mining**
 - **Exploration promotion**
 - **Resource assessment**
 - **Groundwater assessment**
 - **Institutional capacity building**
 - **Preparing regional thematic maps**
 - **Geo-environment**
 - **Geo-information Enhancing public petroleum management**
 - **PETRAD (International Programme for Petroleum Management and Administration; Norwegian program)**