Future Ocean, Kiel Marine Sciences
March 20, 2013

World metal production and future demands

Peter Buchholz, Ulrike Dorner

German Mineral Resources Agency at the

Federal Institute for Geosciences and Natural Resources (BGR), Berlin, Germany

German Mineral Resources Agency (DERA) at the German Geological Survey (BGR)

DERA Deutsche Rohstoffagentur

Bundesanstalt für Geowissenschaften und Rohstoffe

Founded 10/2010, opening of DERA in Berlin
28. August 2012

„Mineral supply for the German industry has a high priority for us. Moving the German Mineral Resources Agency to Berlin is a consequent next step.“

Securing raw material supply for Germany

Aim

A Improve market transparency in the mineral resources sector by providing minerals information and analysis and advise companies about price and supply risks

B Professional backing of measures taken by the German government and companies to secure raw materials supply

Services

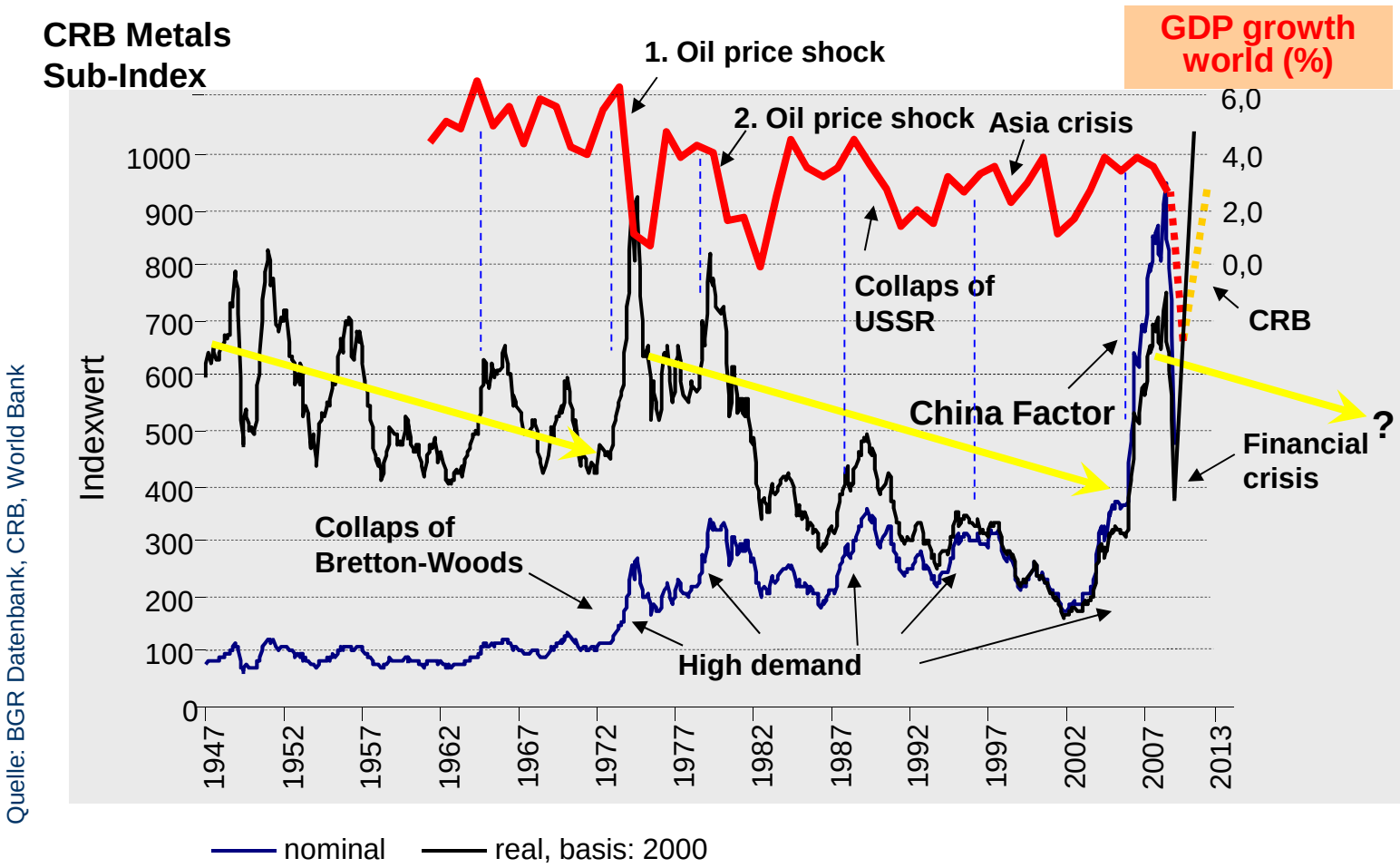
Raw Materials Information and Analyses			Contributions to a secure raw materials supply	
1. Raw Material Information System	**2. Risk Assessment**	**3. Raw Material Potentials**	**4. Strategies for Security of Supply**	**5. Diversifiying Supply**

Network Building, Raw Material Dialogues, Industry Workshops, Conferences

1. Future Demand
   - Industrialization
   - Influence of emerging technologies
2. Future Supply
   - Major supply sources
3. Which raw materials are critical?
   - Price and supply risks
4. Outlook for copper, terrestrial and marine – some thoughts

Future Demand

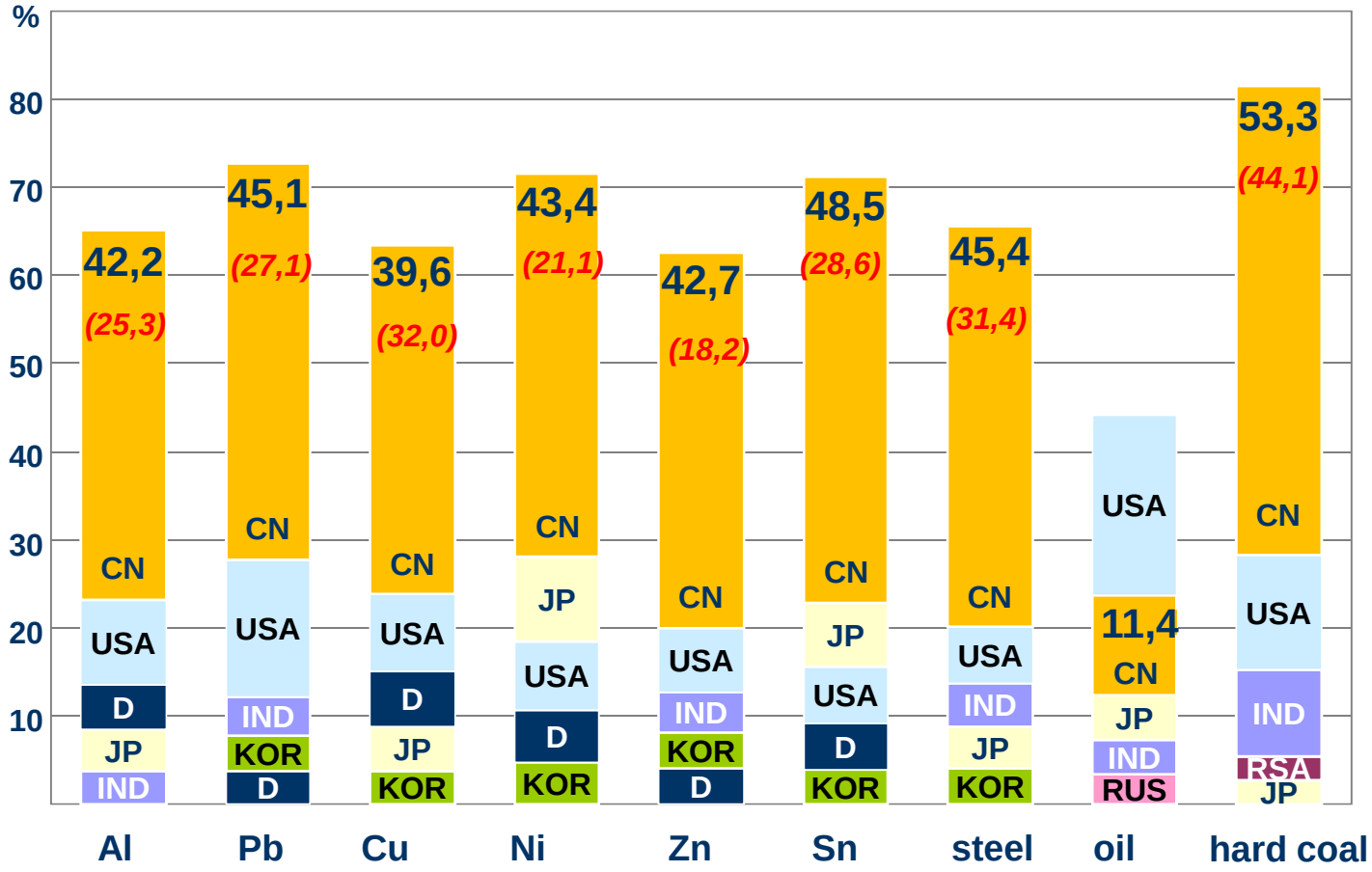
Cyclical raw material markets: Price and GDP



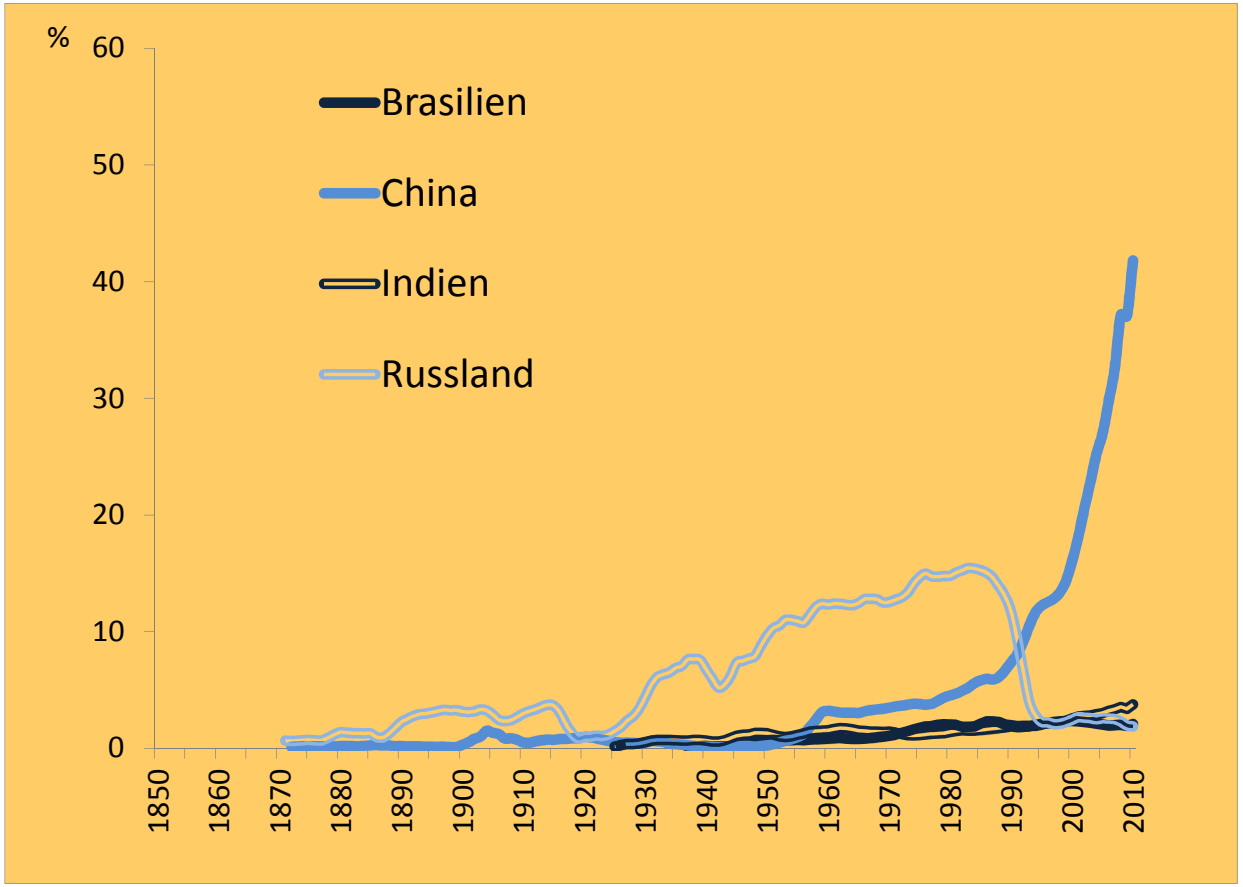
Quelle: BGR Datenbank, CRB, World Bank

Reuters CRB-Metals-Subindex copper-, steel- and lead scrap, zinc, tin

Major raw material consumers 2011 (2005)



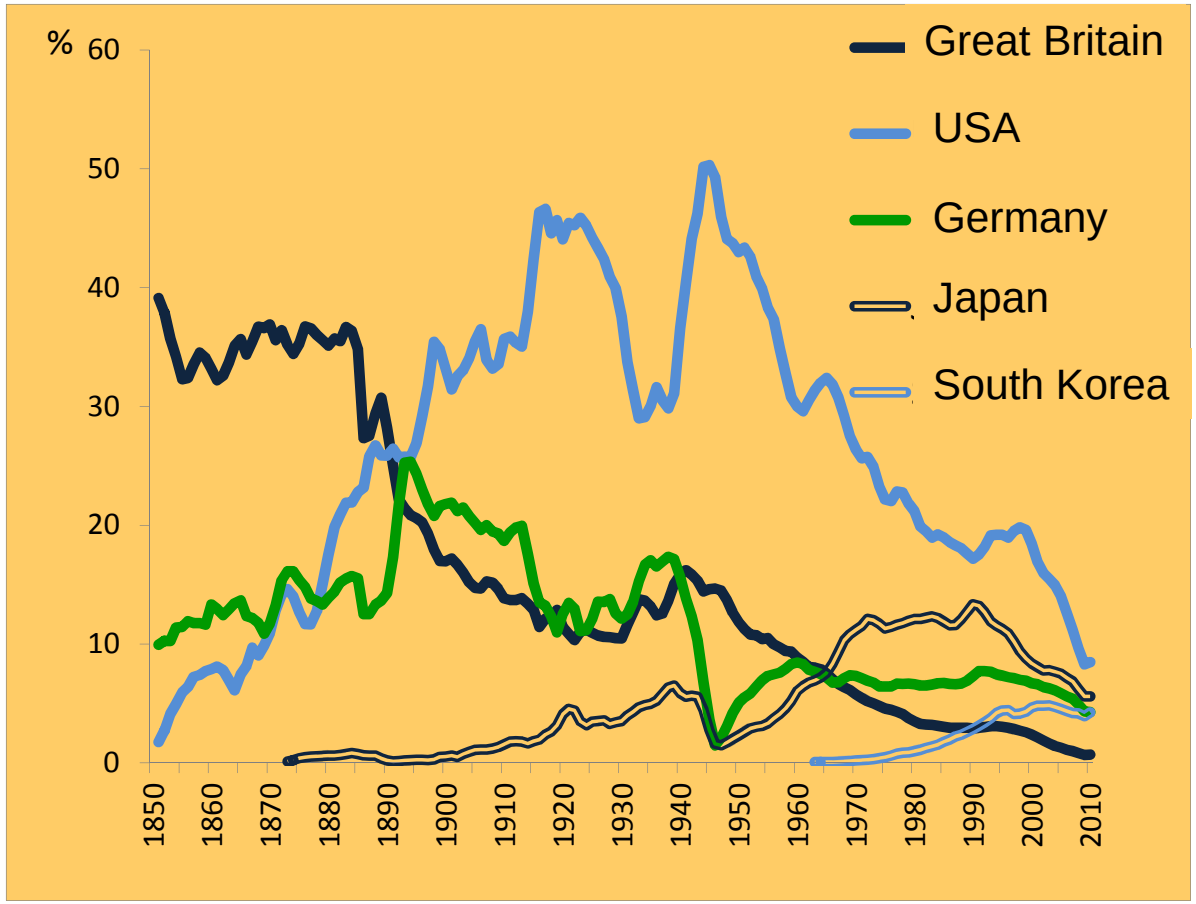
Share of global demand



Average share of demand of the BRIC states of global demand for aluminium, steel, copper, zinc and tin

University of Bonn, M. Stürmer, study commissioned and funded by DERA, 2012

Share of global demand



Average share of demand of Industrialised Nations of global demand for aluminium, steel, copper, zinc and tin

University of Bonn, M. Stürmer, study commissioned and funded by DERA, 2012

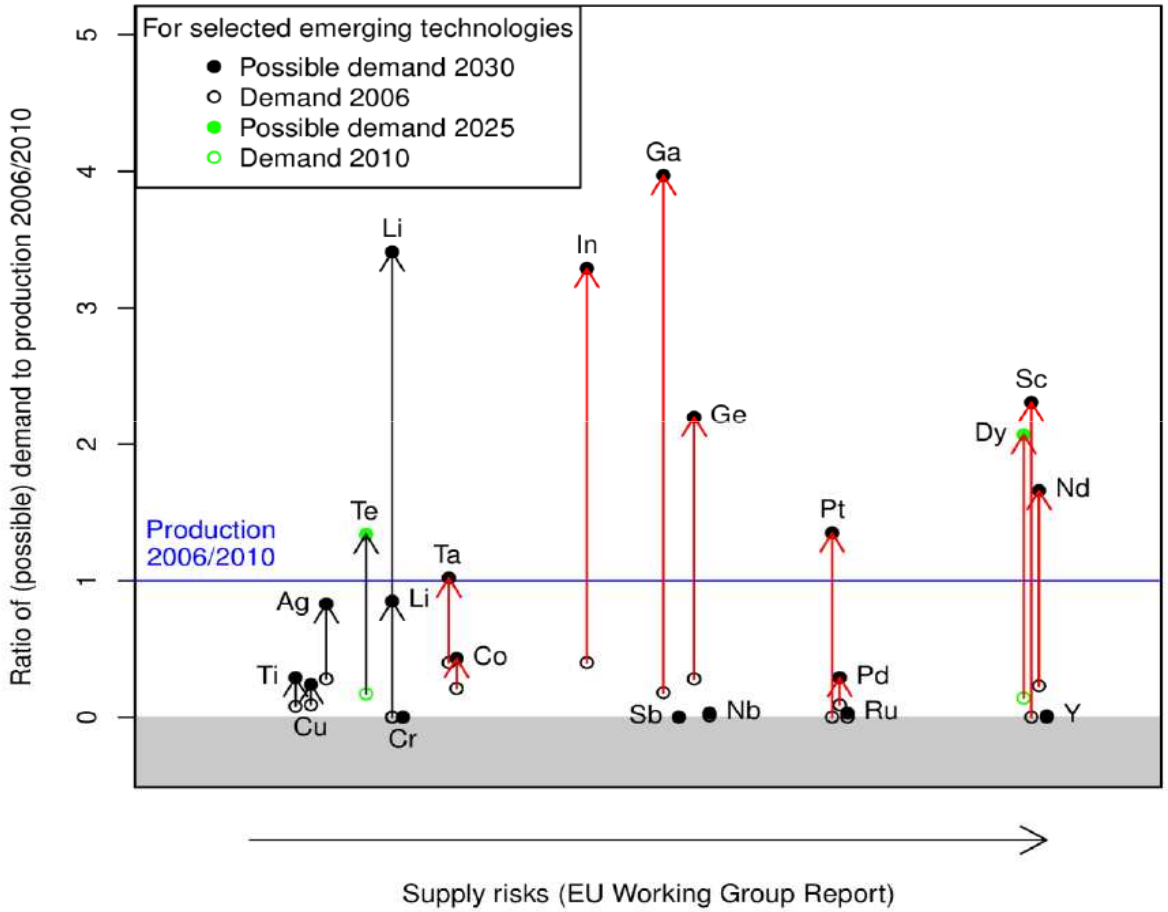
Outlook demand: Emerging technologies

Raw material	2006*	2030*	Emerging Technology
Gallium	0,18	3,97	Thin layer photovoltaics, IC, WLED
Indium	0,40	3,29	Displays, Thin layer photovoltaics
Scandium	low	2,31	SOFC Fuel cells, Al-alloys
Germanium	0,28	2,20	Fibre optic cable, IR optical technology
Neodym	0,23	1,66	Permanent magnets, laser technology
Platinum	low	1,35	Fuel cells, catalysts
Tantalum	0,40	1,02	Micro capacitors, medical technology
Silver	0,28	0,83	RFID, lead free solders
Tin	0,57	0,71	Lead free solders, transparent electrodes
Cobalt	0,21	0,43	Lithium ion batteries, synthetic fuels
Palladium	0,09	0,29	Catalysts, seawater desalination

Share of global production in 2006 compared to global demand in 2030 for the relevant technology Source: Fraunhofer-Institut für System- und Innovationsforschung, Institut für Zukunftsstudien und Technologiebewertung (2009); * Recalculated by BGR with new data (2009)

Future Demand - The influence of emerging technologies: Breakthrough difficult to predict

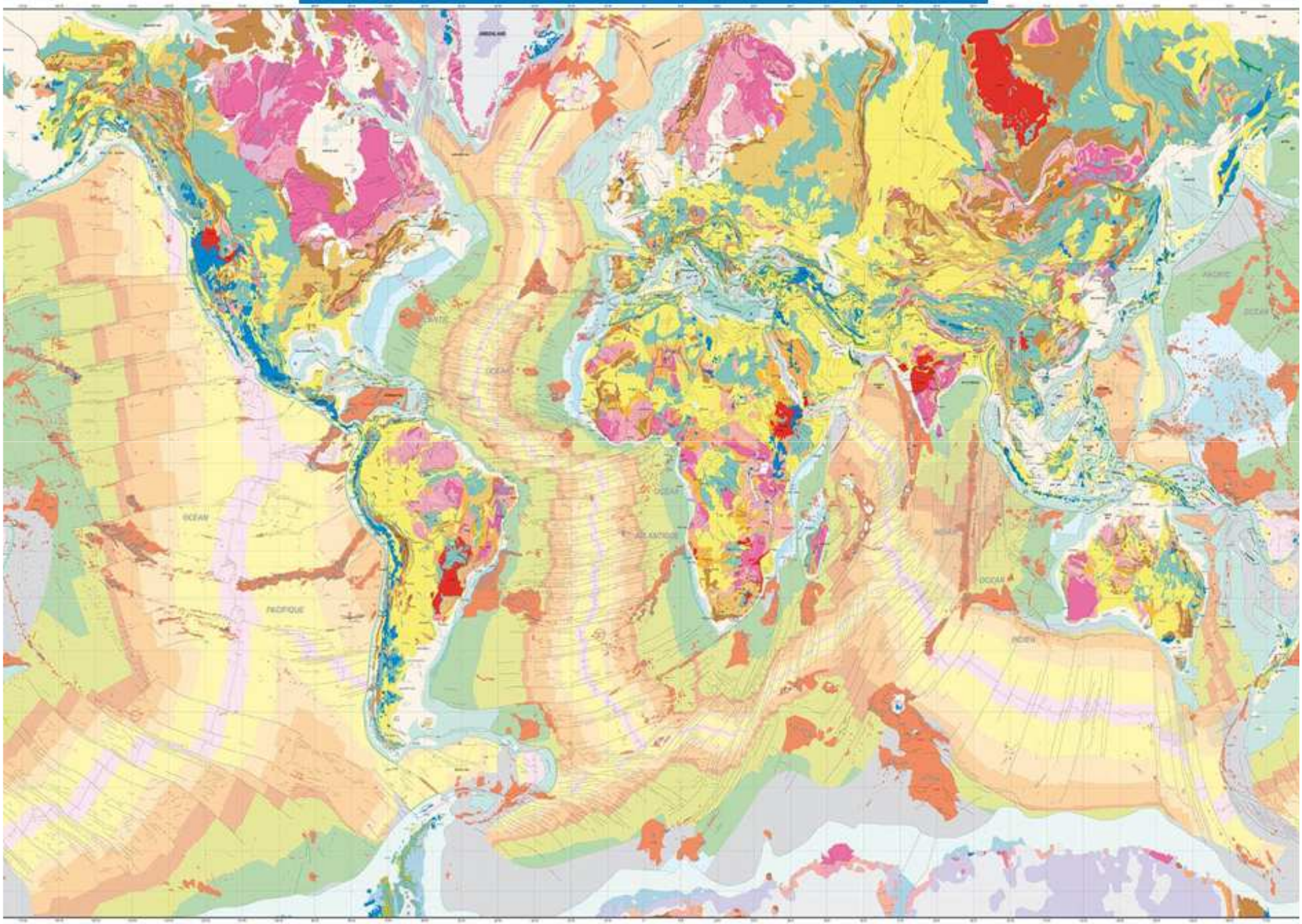
Expected increases in demand for selected raw materials in correlation to current supply and corresponding supply risks



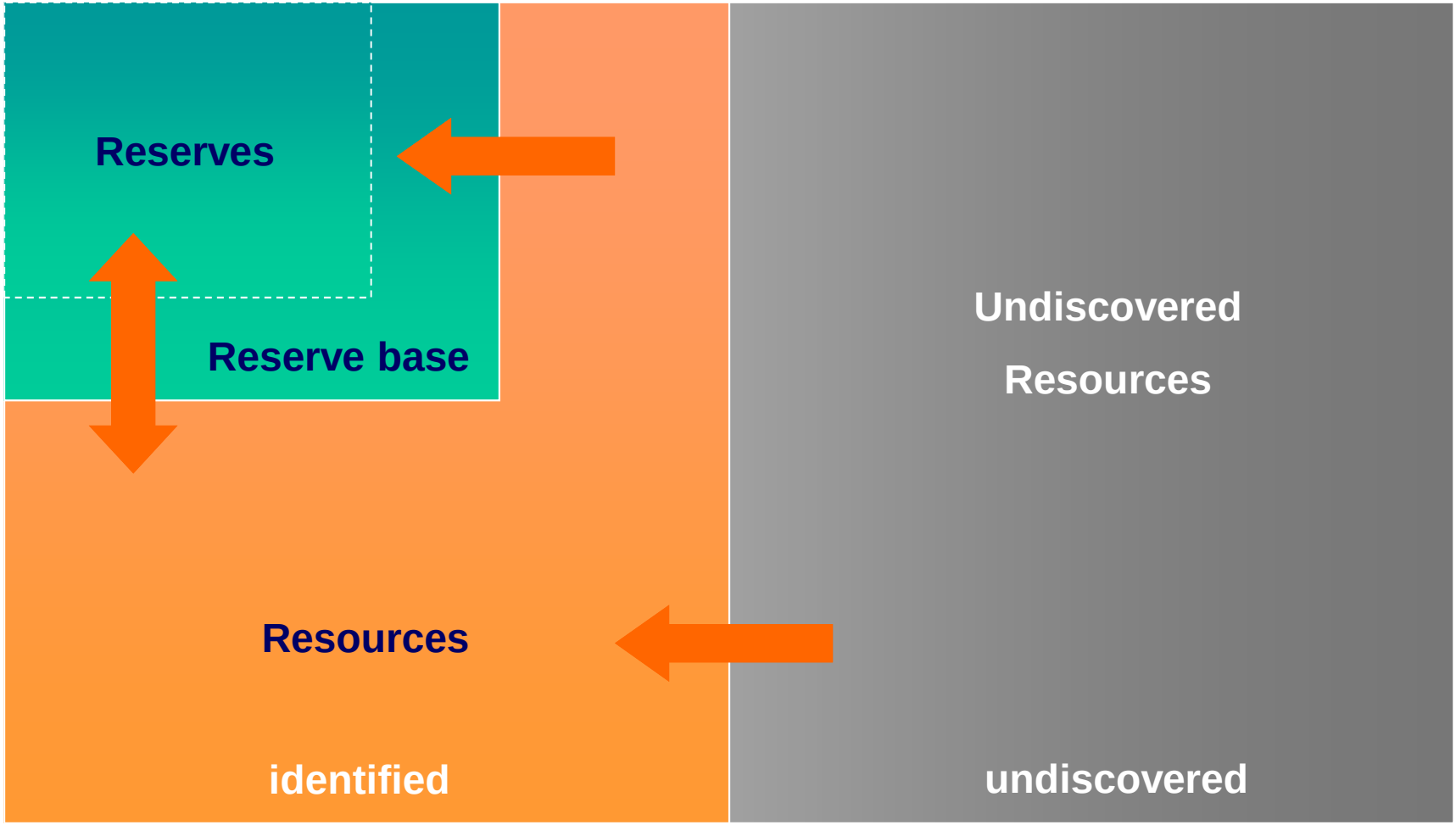
(source: Tercero Espinoza: „The role of emerging technologies in a rapidly changing demand for mineral raw materials“, Polinares WP2

Future Supply

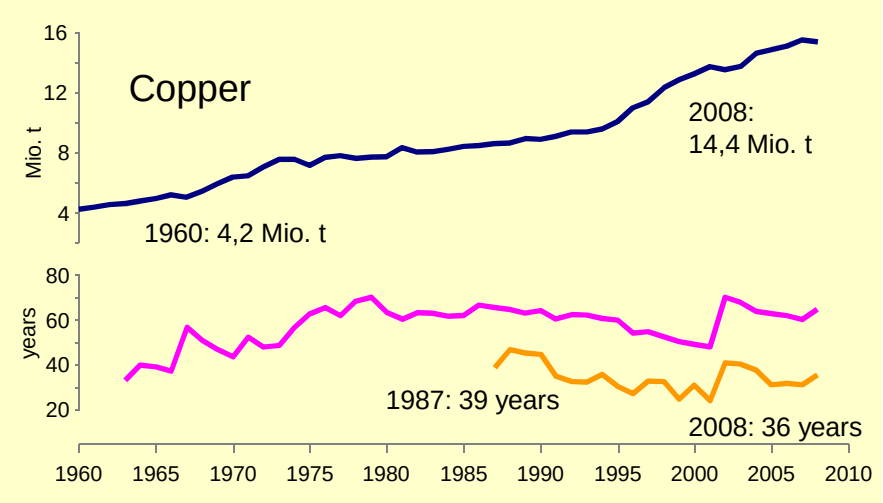
Commission for the Geological Map of the World

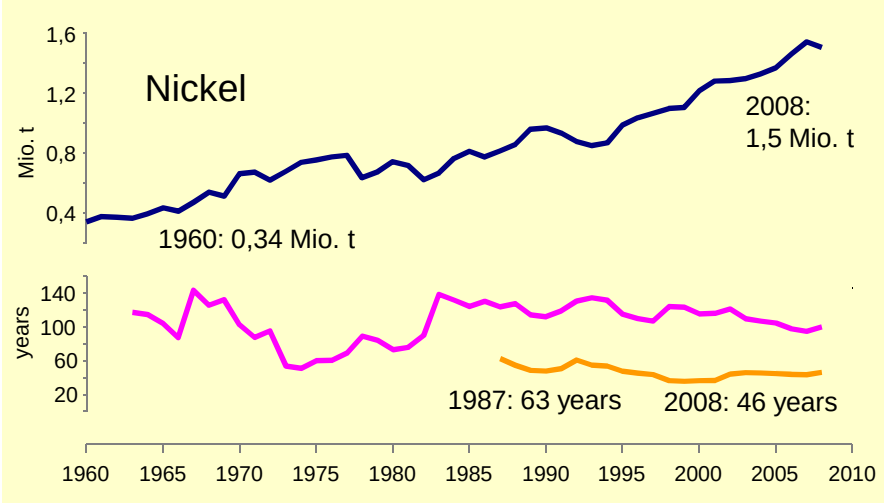


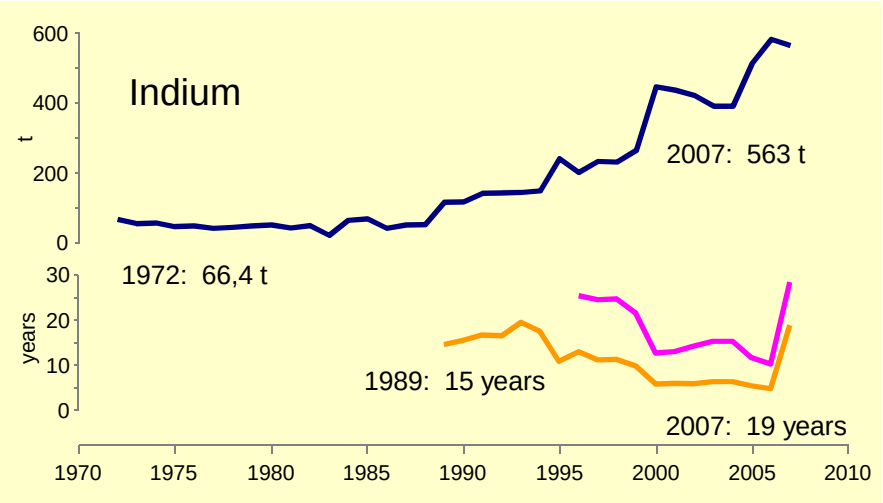
Global reserves and resources – a dynamic system

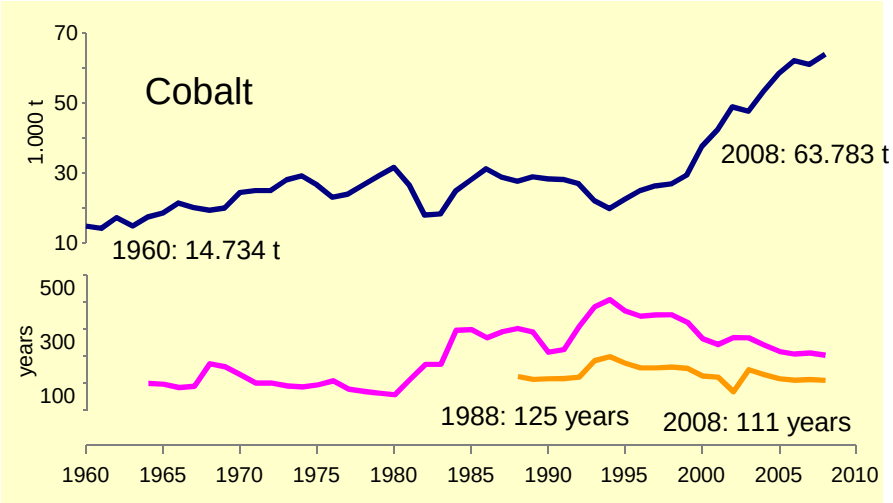


Static lifetime of reserves and resources – a dynamic system









Source: USGS, BGR database, 2009

Static lifetime of reserve base
Static lifetime of reserves
Mine production (Indium: refined production)

Deutsche Rohstoffagentur
Bundesanstalt für Geowissenschaften und Rohstoffe

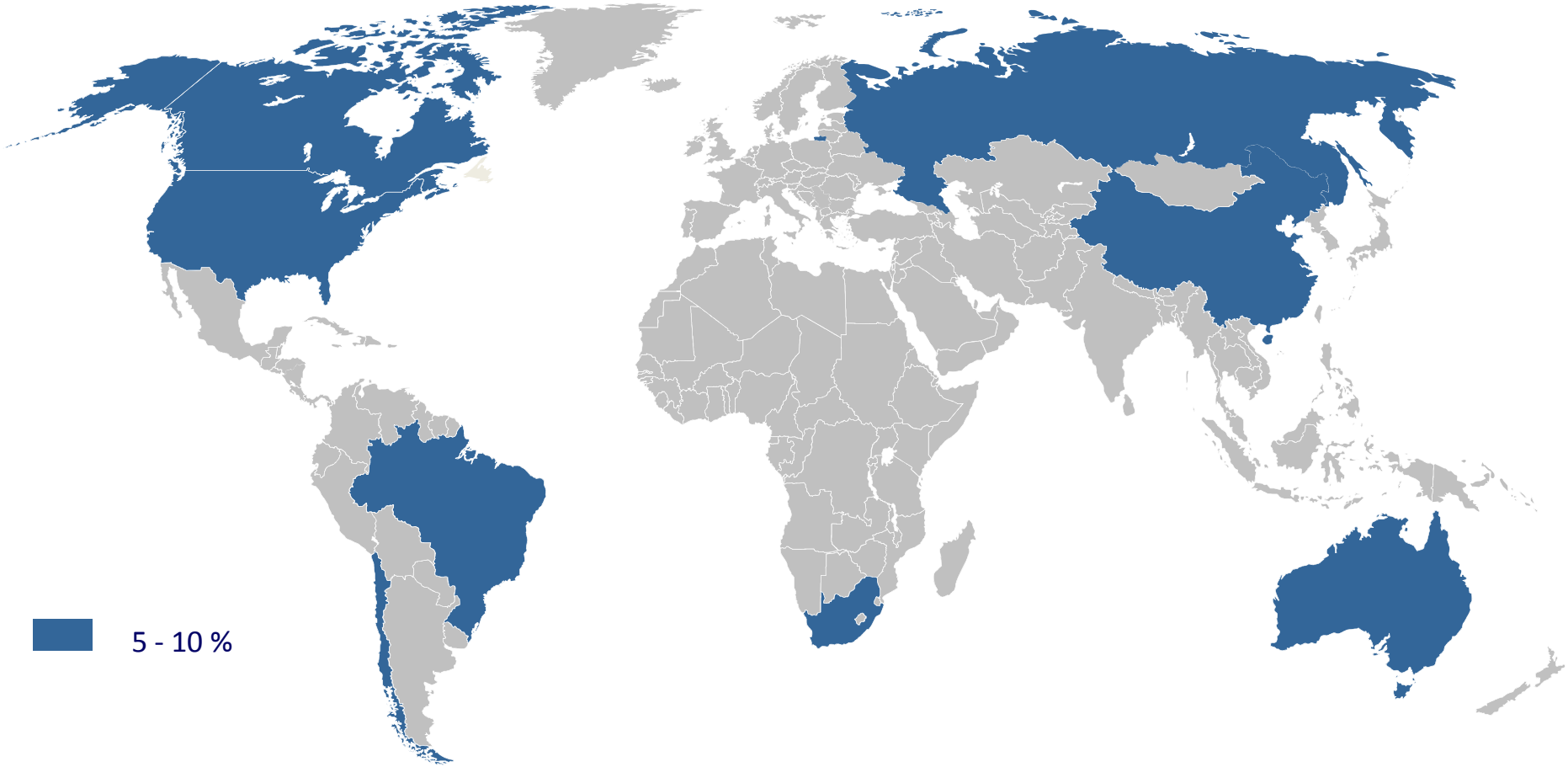
Global supply – What are the major mining countries?

fotalia

Major mining countries of the world

Major mining countries in the world* by value

Share of global mine production >5 %, countries represent ca. 50-55 % of the total value



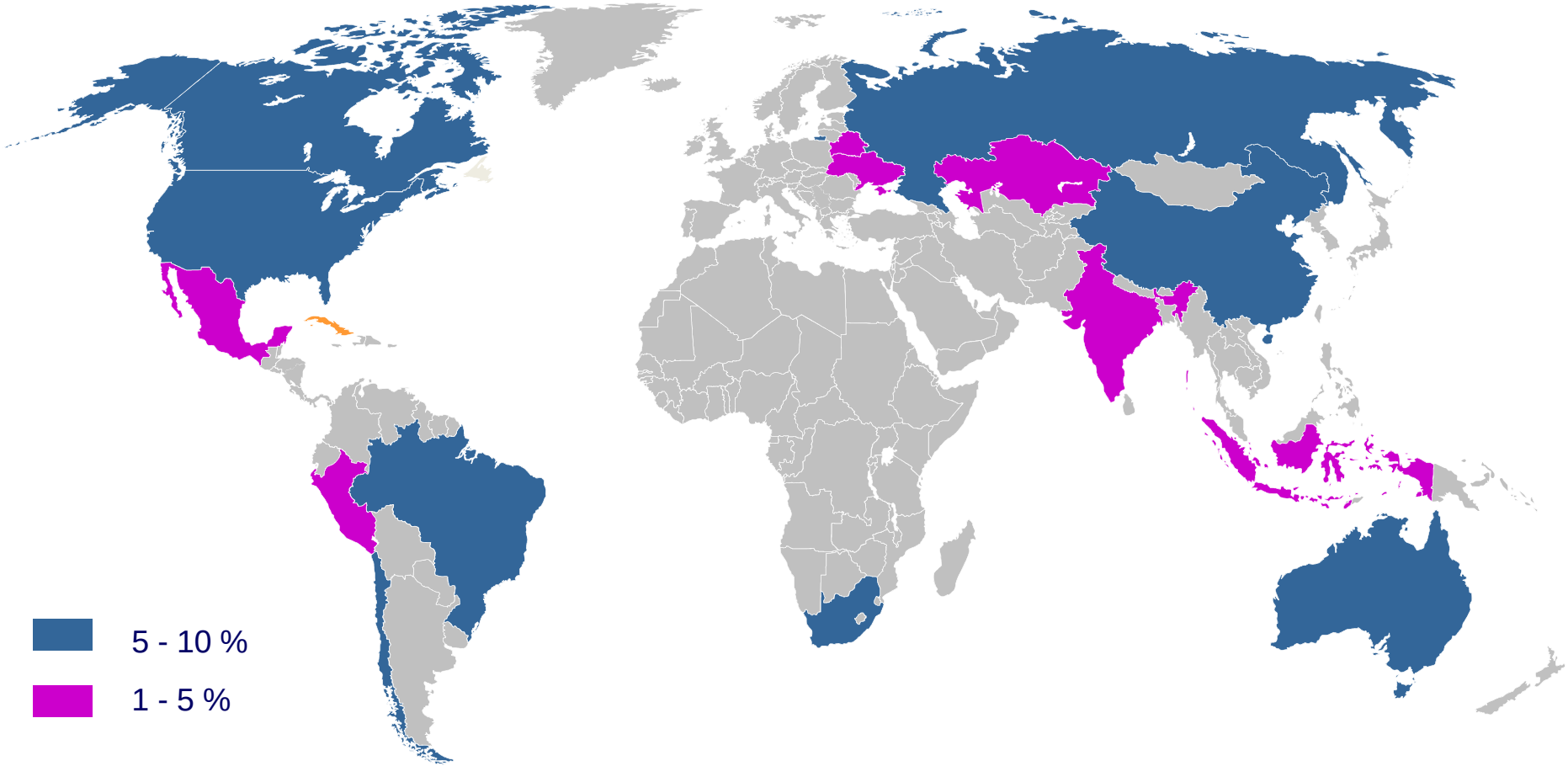
* Metals, diamonds, zircon, P, K2O, B, Li, incl. U

Data source: Raw Materials Group Stockholm, Mines Value 2008, 75 % coverage

Major mining countries of the world

Major mining countries in the world* by value

Share of global mine production >1 %, countries represent ca. 60-65 % of the total value



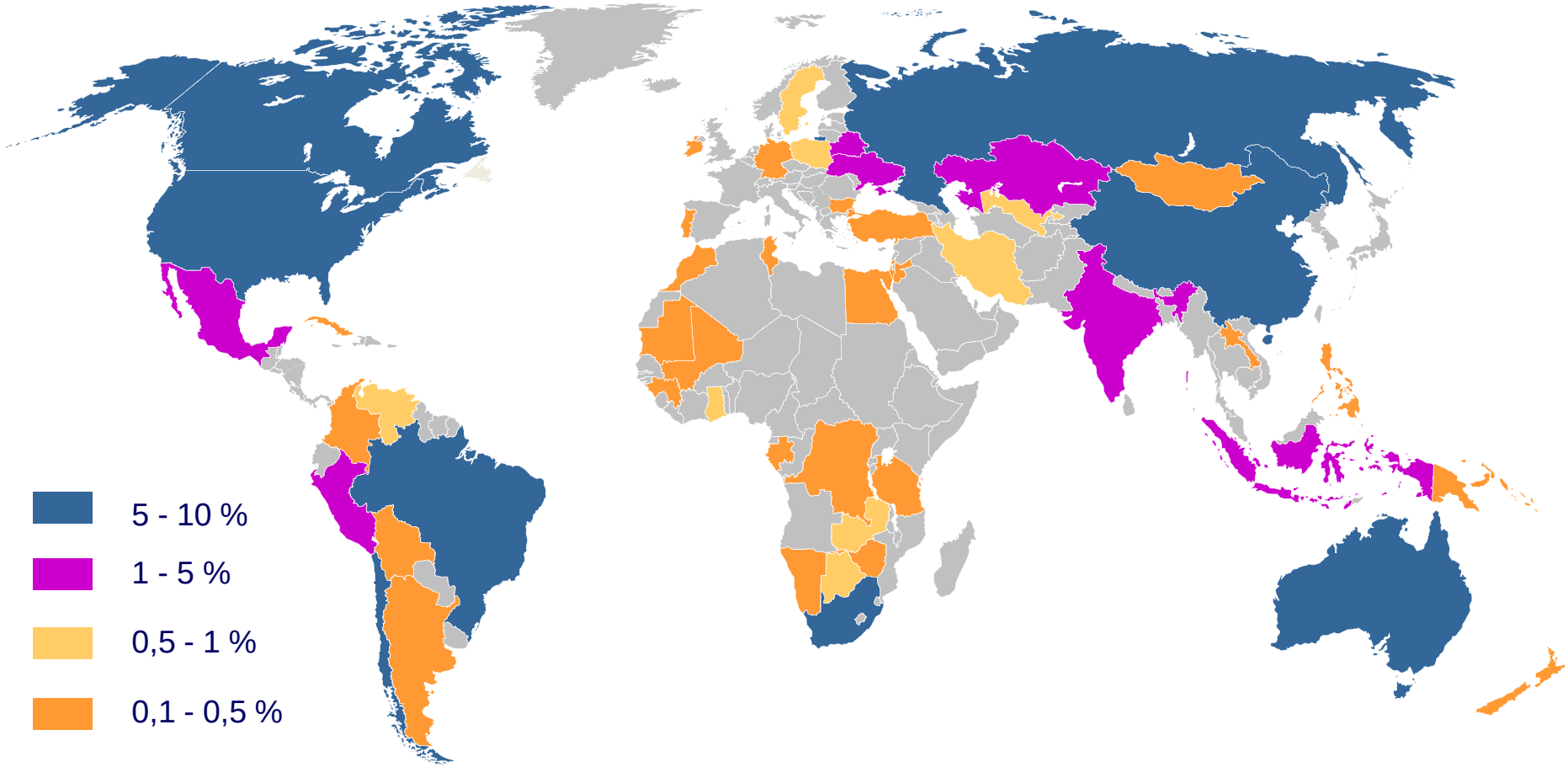
* Metalle, Diamanten, Zirkon, P, K2O, B, Li, inkl. U

RMG Mines Value 2008, 75 % Datenerfassung

Major mining countries of the world

Major mining countries in the world* by value

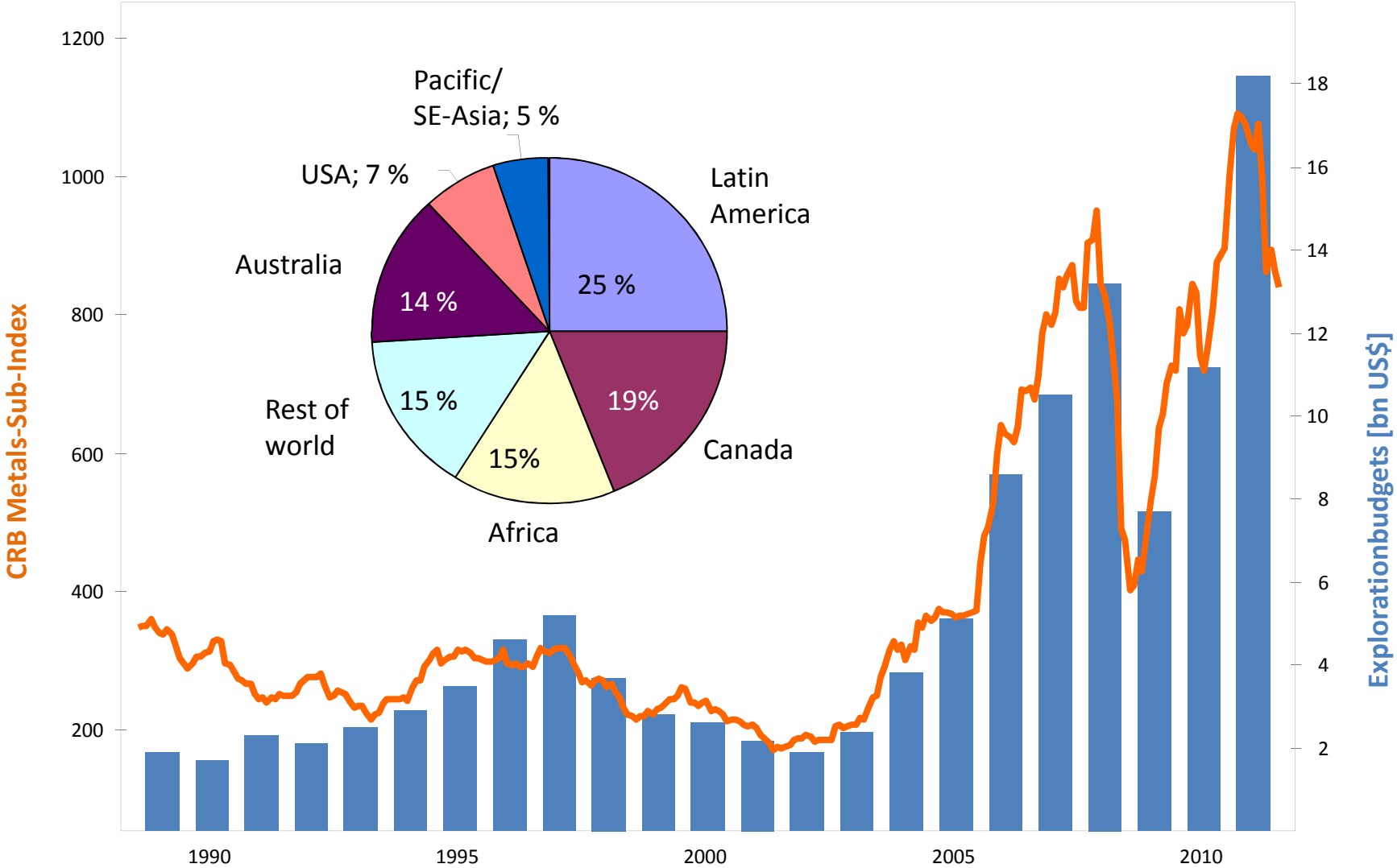
Share of global mine production >0,1 %, countries represent ca. 80-85 % of the total value



* Metalle, Diamanten, Zirkon, P, K2O, B, Li, inkl. U

RMG Mines Value 2008, 75 % Datenerfassung

Gloabal exploration budgets and CRB-Metals-Sub-Index

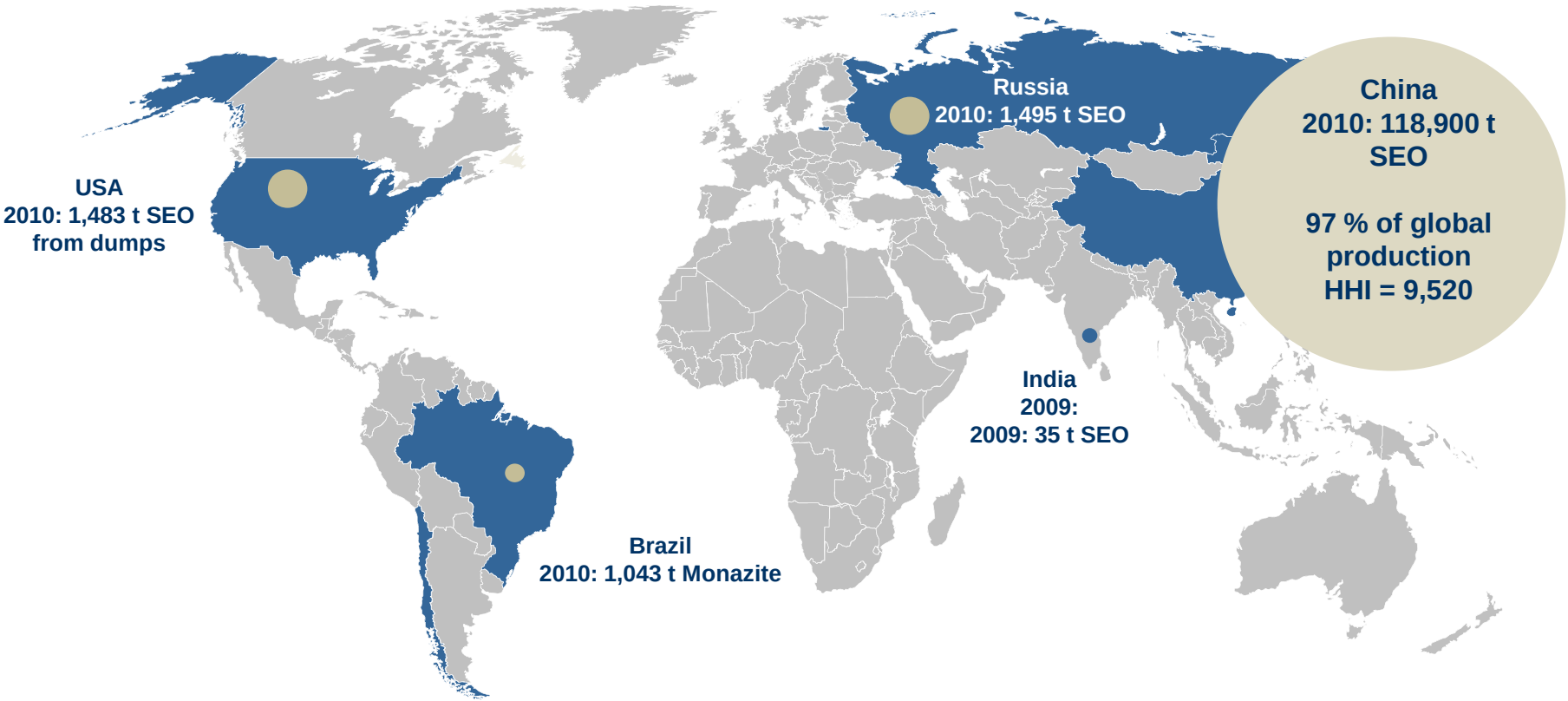


Data Source: Metals Economics Group (MEG), CRB

Which raw materials are critical?

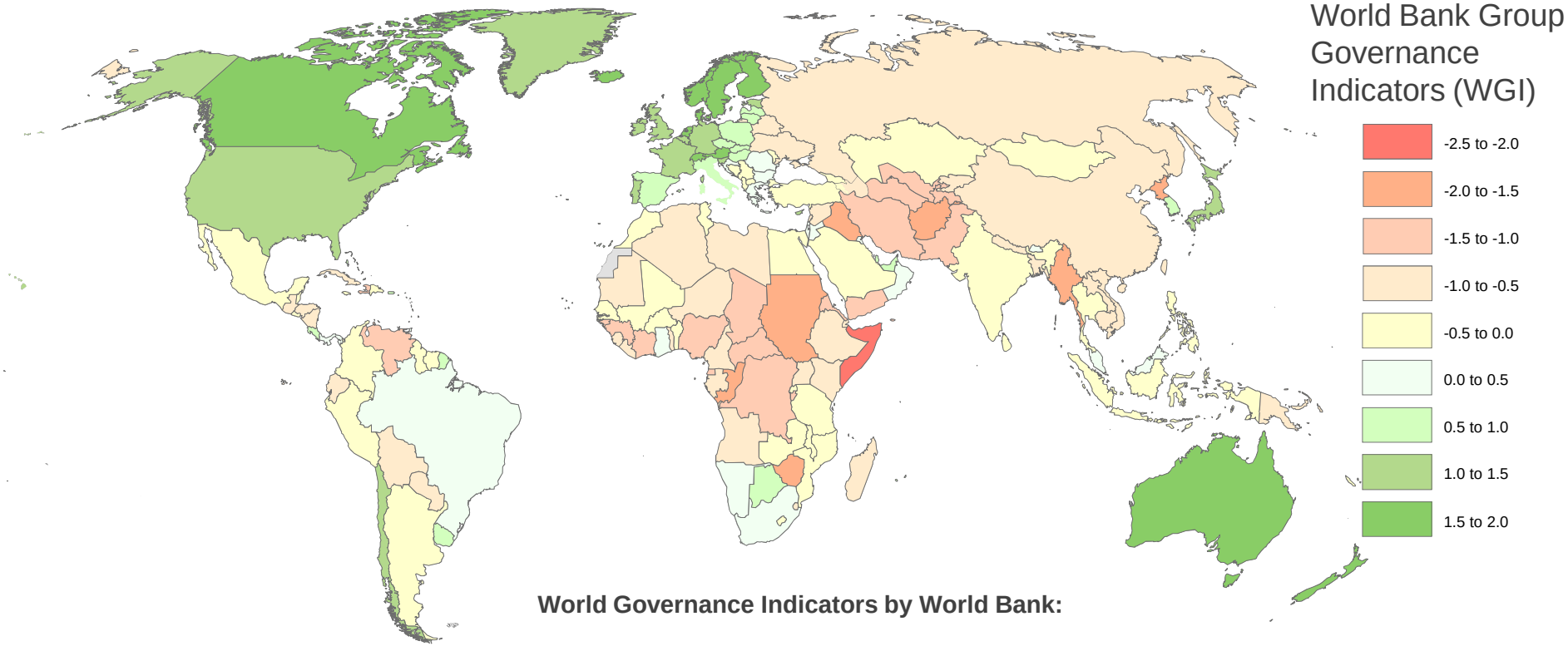
Methodology: Global concentration of supply (Herfindahl-Hirschman-Index, HHI)

Rare Earths: Global concentration of mine production



DERA Risk Assessment for Mineral Supply

Methodology: Weighted country risk (GLR) by World Governance Indicators

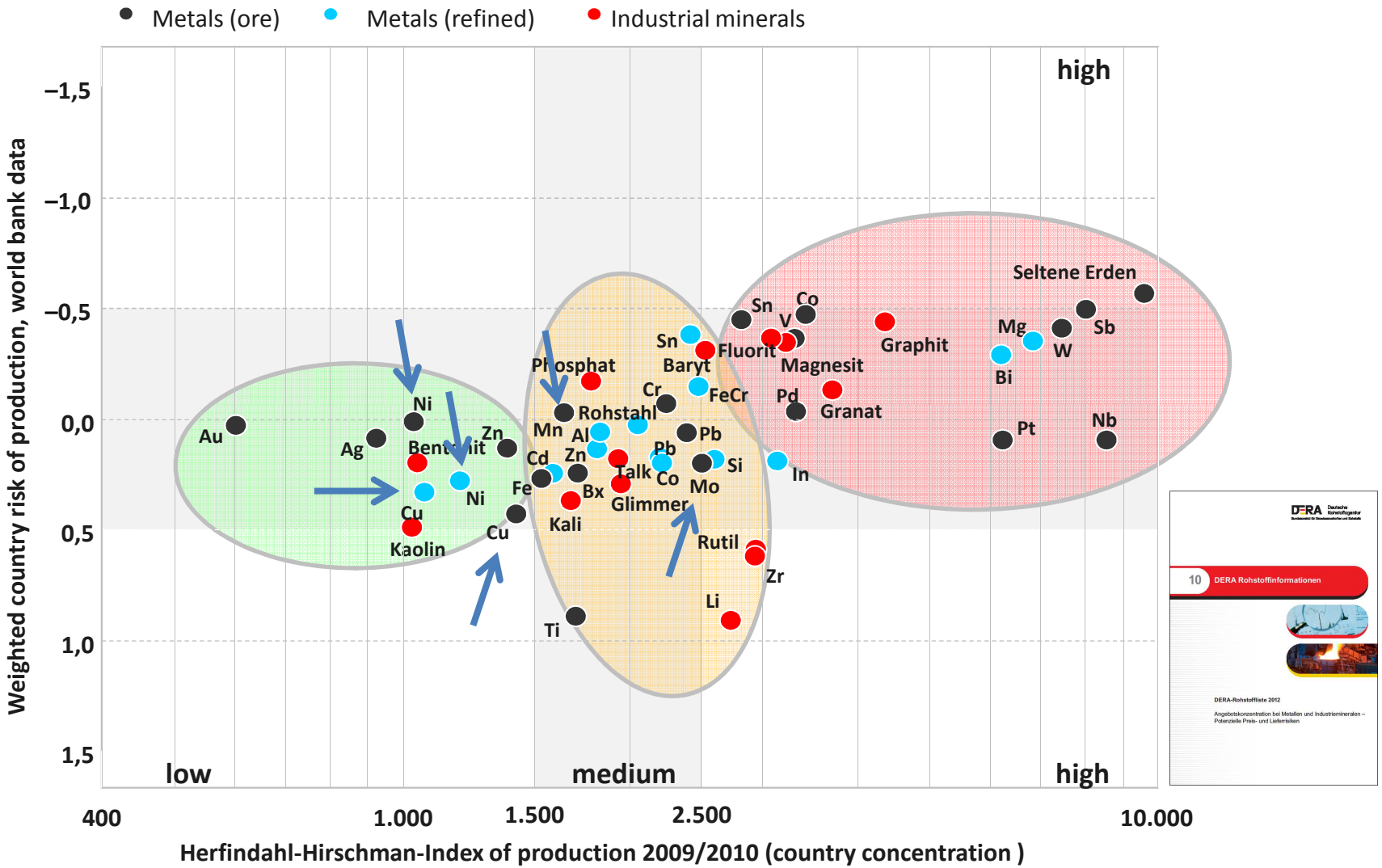


World Governance Indicators by World Bank:

- Control of Corruption
- Voice and Accountability
- Political Stability and Absence of Violence
- Government Effectiveness
- Regulatory Quality
- Rule of Law

World Bank Group, 2010.
Worldwide Governance Indicators (WGI).
http://info.worldbank.org/governance/wgi/index.asp.

DERA study on critical raw materials – Highlight Cu, Ni, Mn, Mo



Resources Policy 34 (2009) 161–175

Contents lists available at ScienceDirect

Resources Policy

journal homepage: www.elsevier.com/locate/resourpol

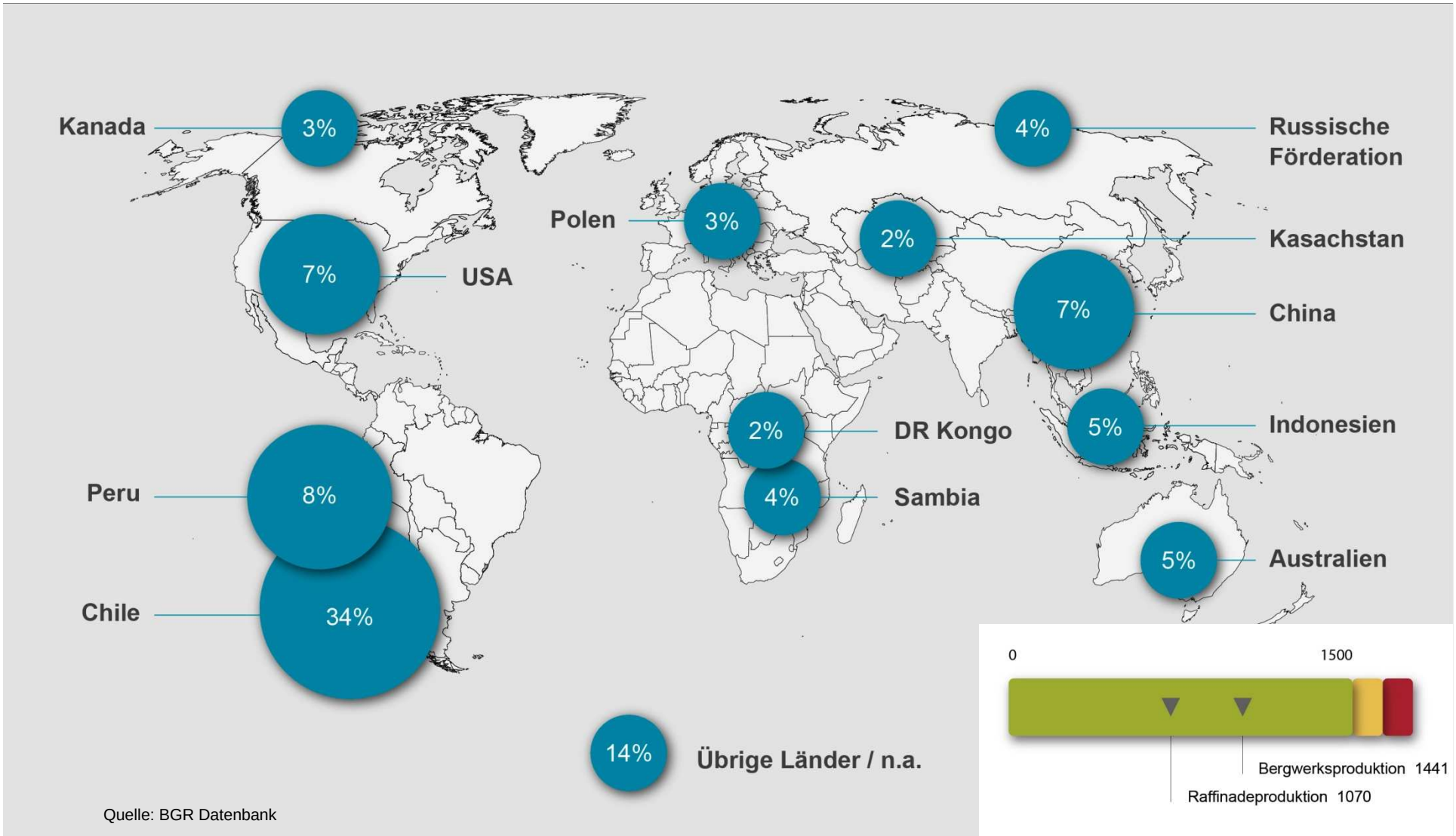
Assessing the long-term supply risks for mineral raw materials—a combined evaluation of past and future trends

Dirk Rosenau-Tornow [a], Peter Buchholz [b,*], Axel Riemann [a], Markus Wagner [b]

[a] *Volkswagen AG, Group Research, Environmental Affairs Product, Letter Box 1774, 38436 Wolfsburg, Germany*
[b] *Federal Institute for Geosciences and Natural Resources (BGR), Section Mineral Economics, Stilleweg 2, 30655 Hannover, Germany*

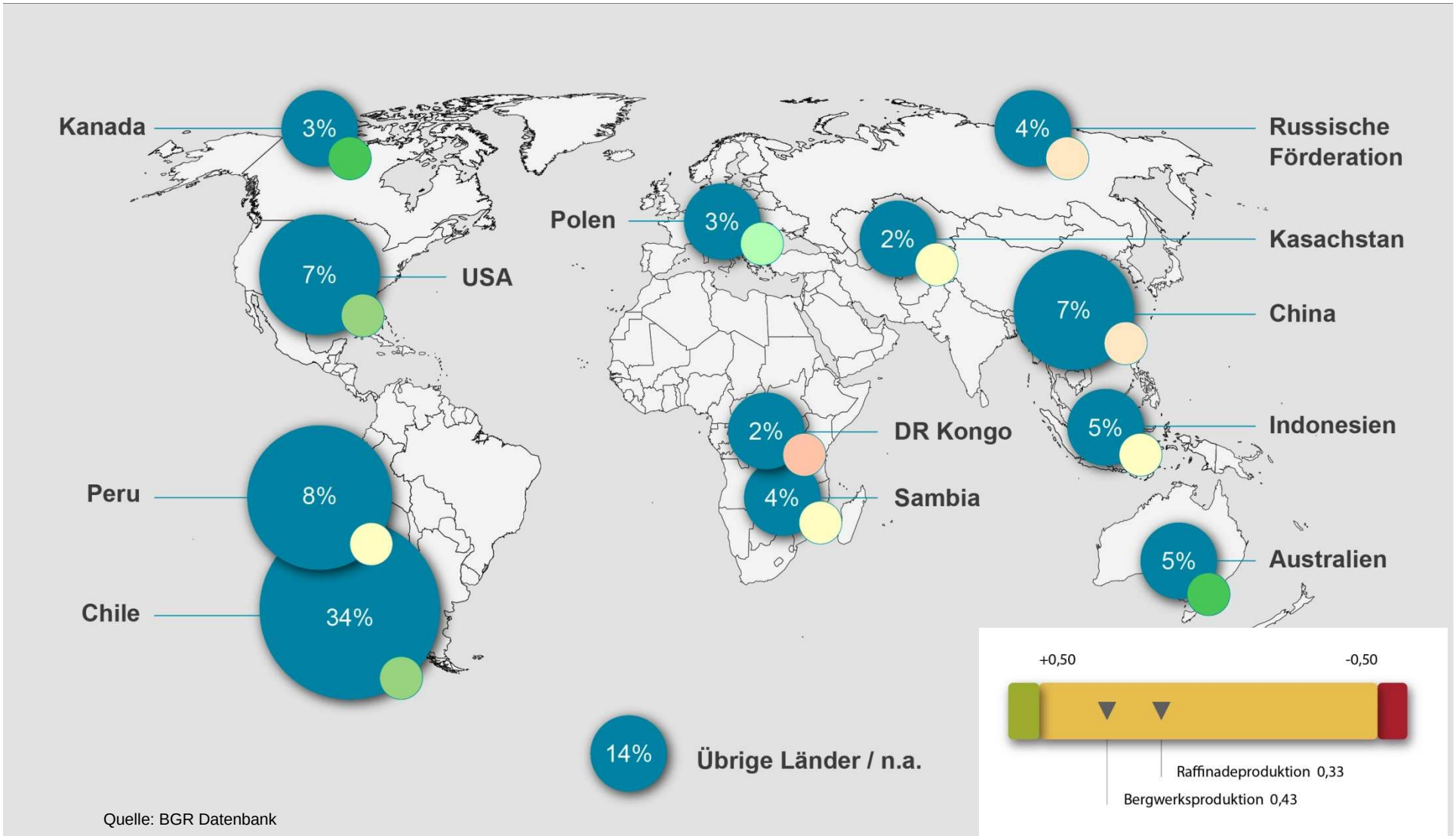
Outlook for copper

Copper mine production 2010



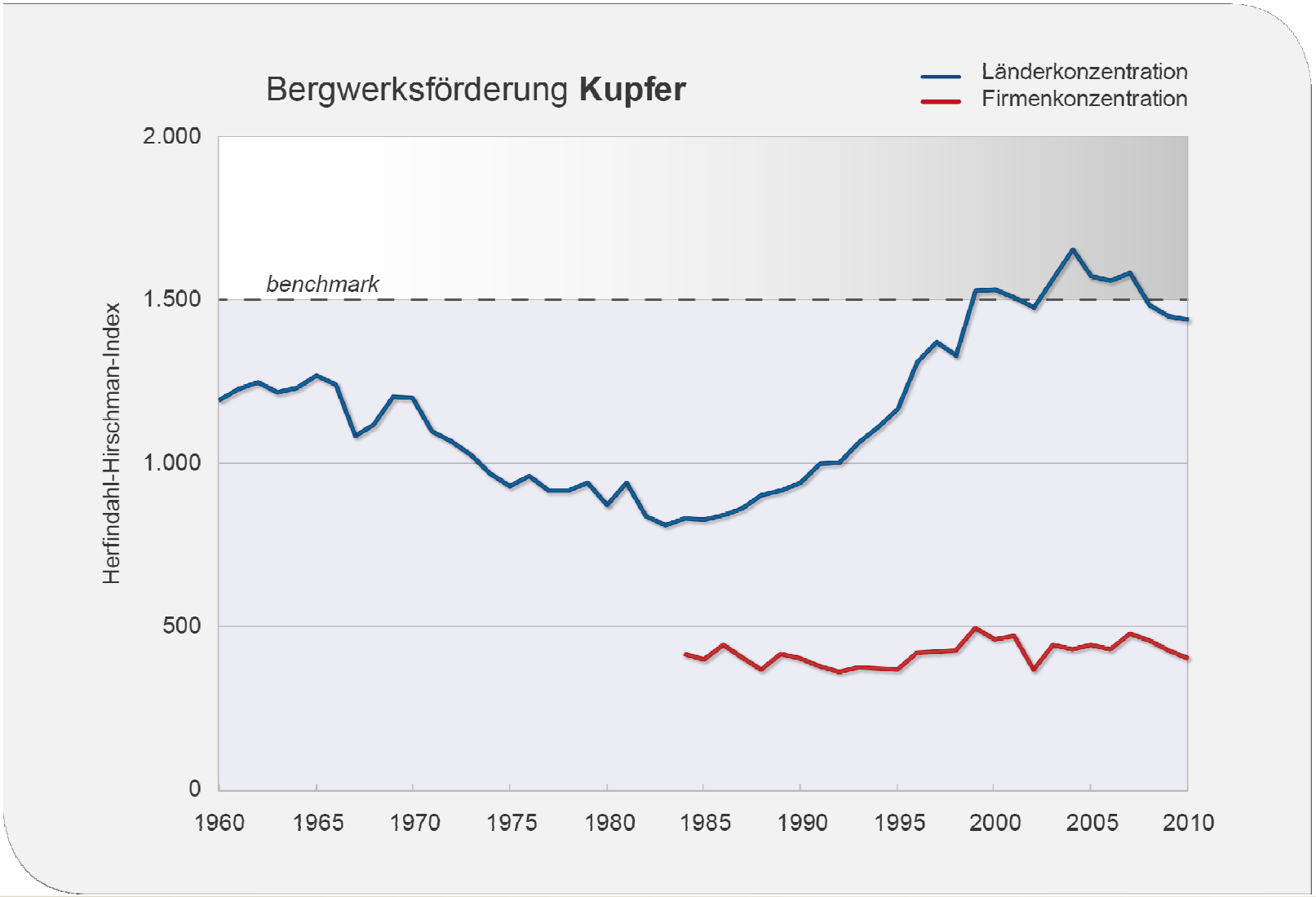
Quelle: BGR Datenbank

Copper mine production 2010 and country risk

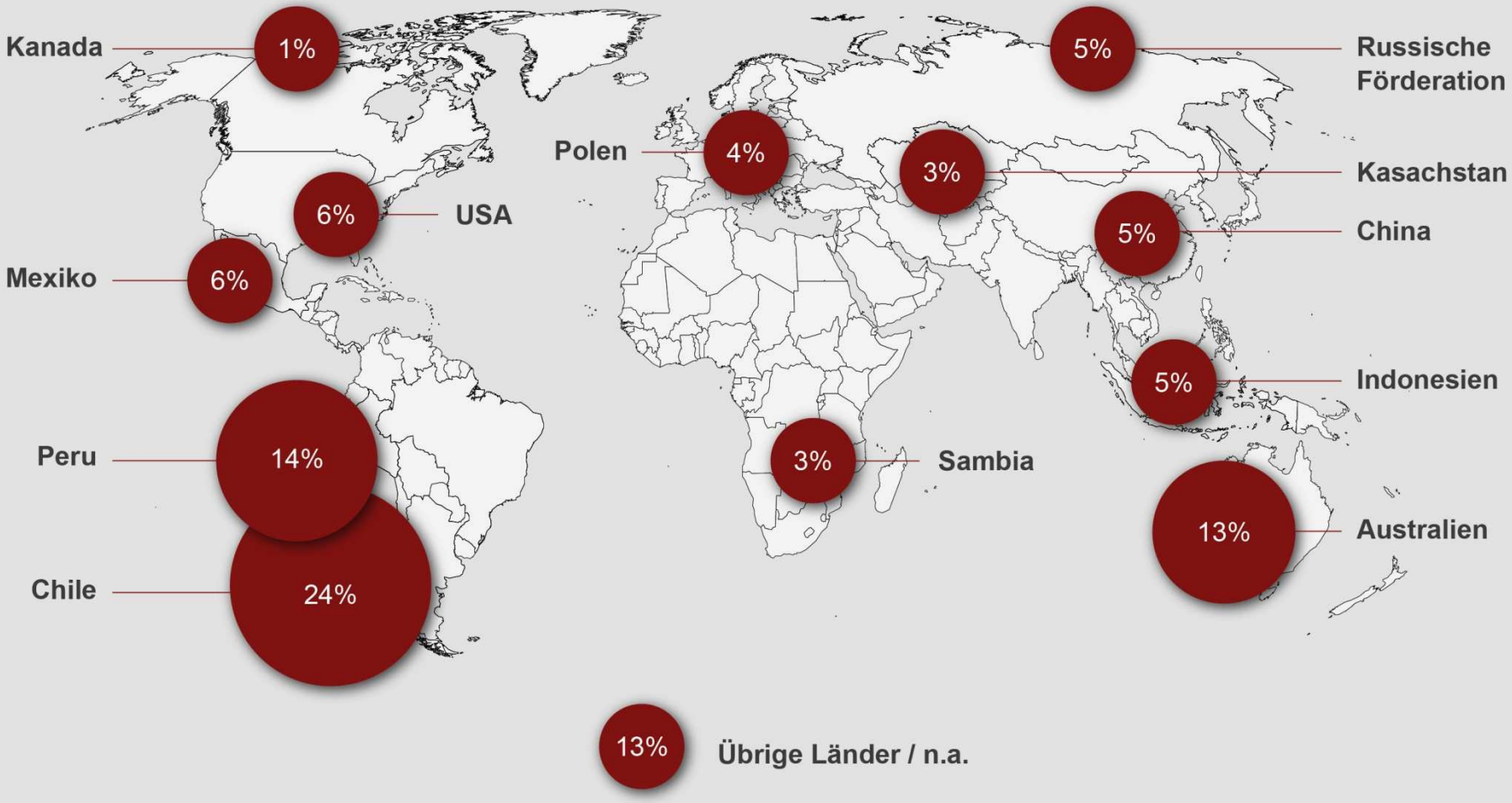


Quelle: BGR Datenbank

Country and company concentration of copper mine production

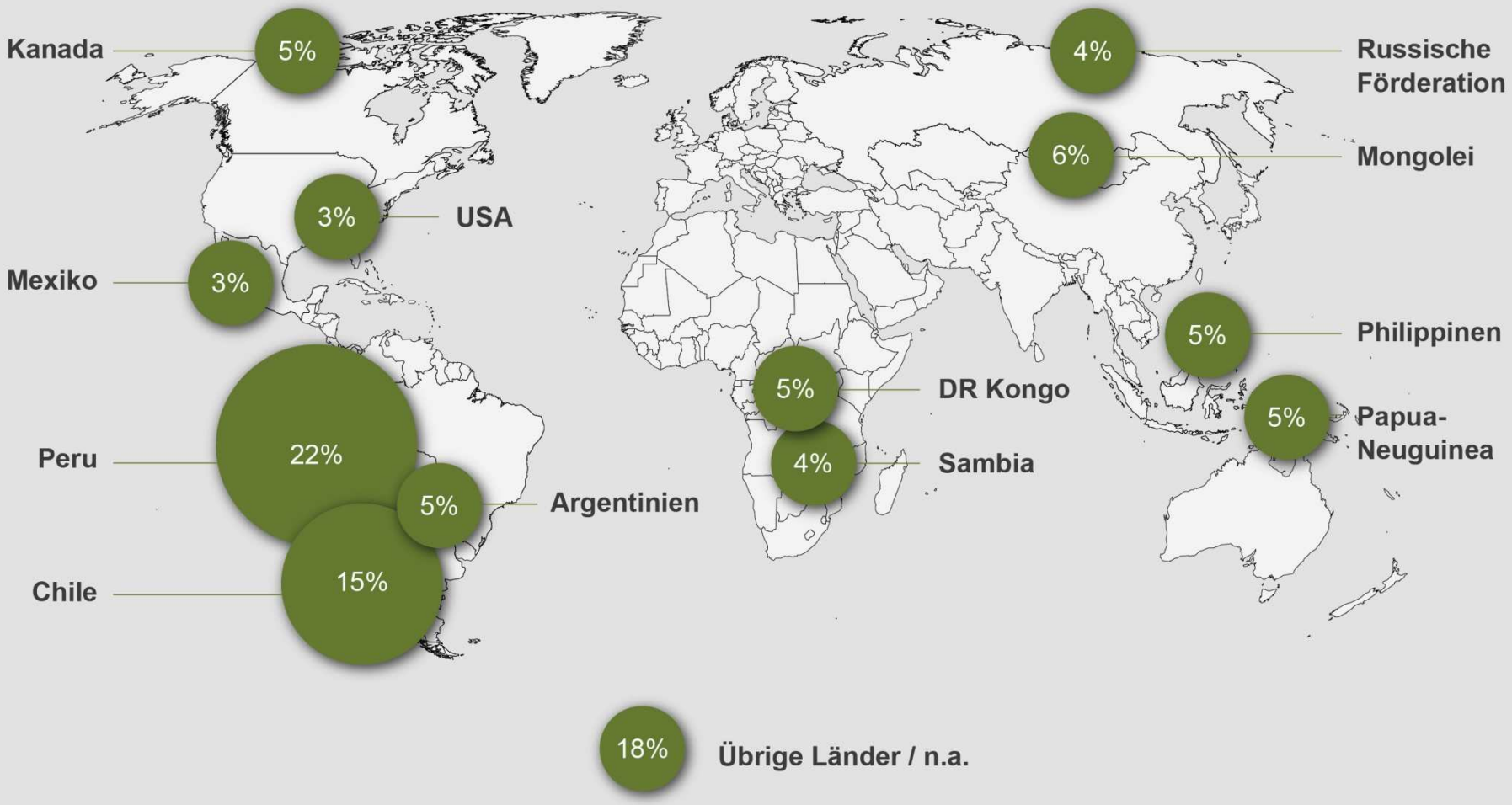


Distribution of copper reserves 2010



Quelle: USGS

Future Production – annual mine capacity until 2017



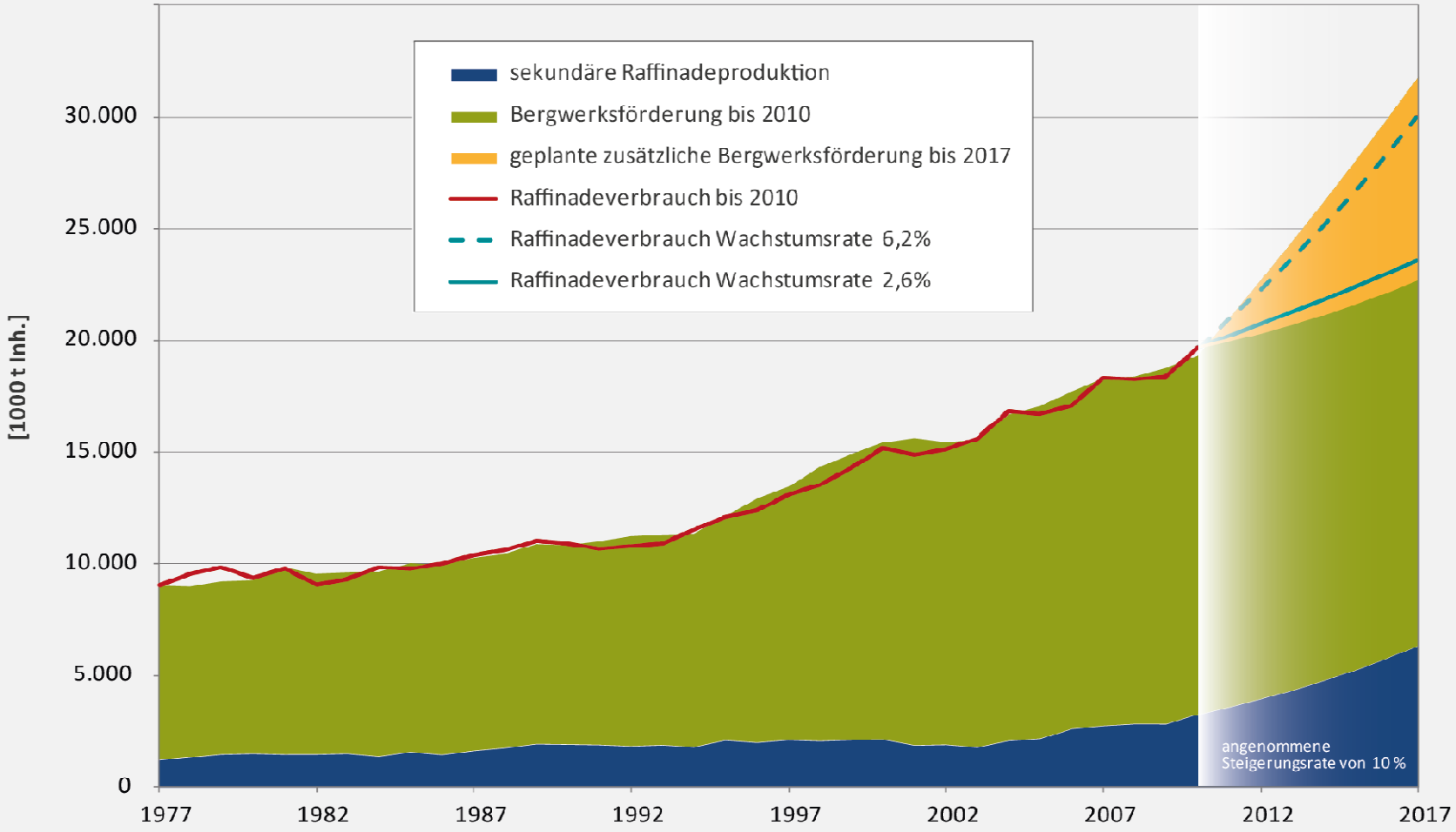
Data source: Metals Economic Group

The ten largest cooper projects (total, all cooper projects until 2017: 9.6 Mt Cu)

Name	Firma	Land	Status	Typ	Erwartete Jahresförderkapazität [1.000 t Cu]	Reserven & Ressourcen [Mio. t Inh.]	Erwarteter Produktionsbeginn	Betriebskosten [US$/lb]
Resolution	Rio Tinto	USA	Feasibility	UG	500	23,9	2021	k. A.
Oyu Tolgoi	Rio Tinto	Mongolei	im Bau	OP	450	31,5	2013	0,45
Tampakan	Xstrata	Philippinen	Feasibility	OP	450	15,1	2019	0,46
Congo Mines and Infrastructure Construction*	China Railway Engineering	DR Kongo	Feasibility		400	6,8	2013	k. A.
El Pachon	Xstrata	Argentinien	Feasibility	OP	400	15,5	2016	0,50
Las Bambas	Xstrata	Peru	im Bau	OP/ UG	400	10,5	2014	0,60
Golpu	Newcrest Mining	Papua-Neuguinea	Prefeasibility	UG	330	k. A.	2019	k. A.
Pebble	Northern Dynasty Minerals/ Anglo American	USA	Prefeasibility	OP/ UG	307	32,4	2019	-0,11
Frieda River	Xstrata	Papua-Neuguinea	Feasibility	OP	304	12,8	2017	0,43
La Granja	Rio Tinto	Peru	Prefeasibility	OP	300	18,4	2017	0,47

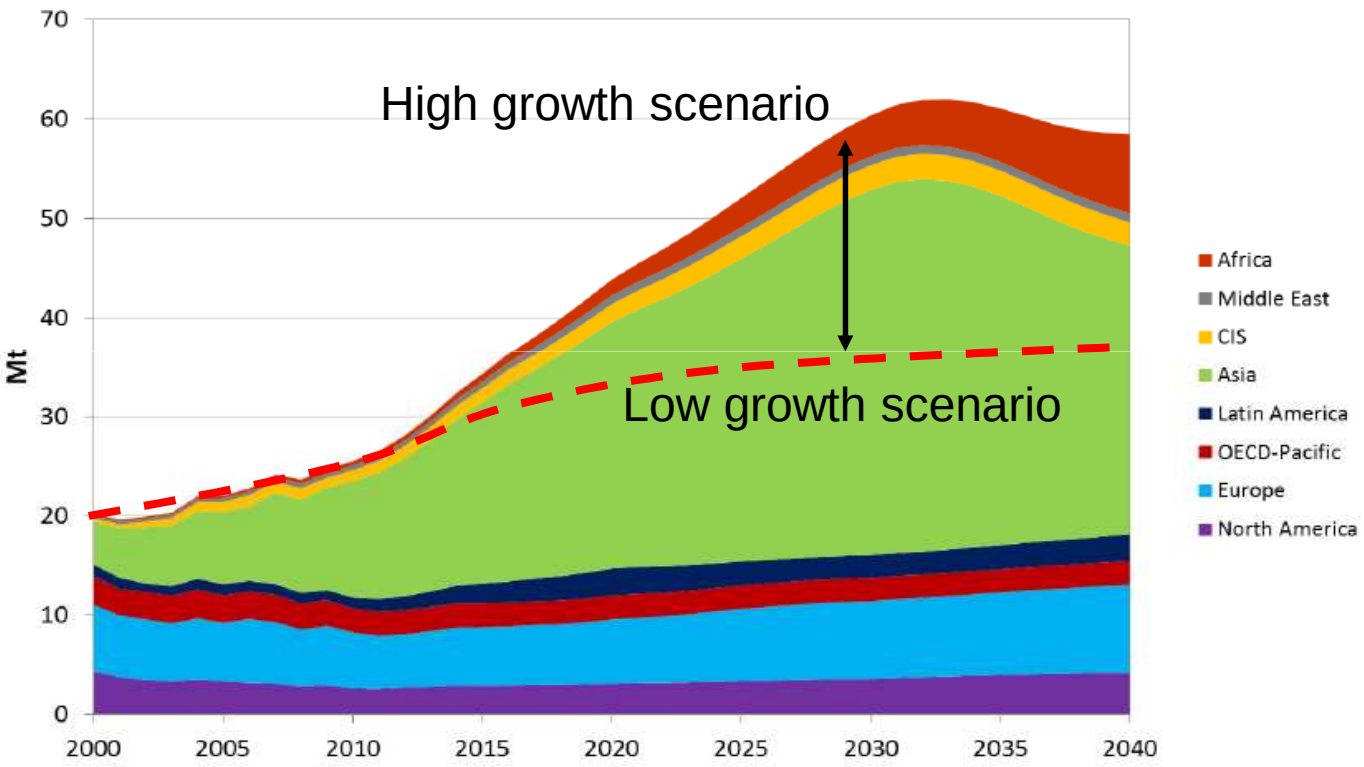
* Dikuluwe- und Mashamba-Konzession

Expected future supply for copper until 2017



Future Demand – Industrialisation: Asia as a driver

Demand for copper per world region
(low/high growth scenario, by ENERDATA)



(source: Keramidas, Kitous, Griffin: „Future availability and demand for oil gas and key minerals“, Polinares WP2

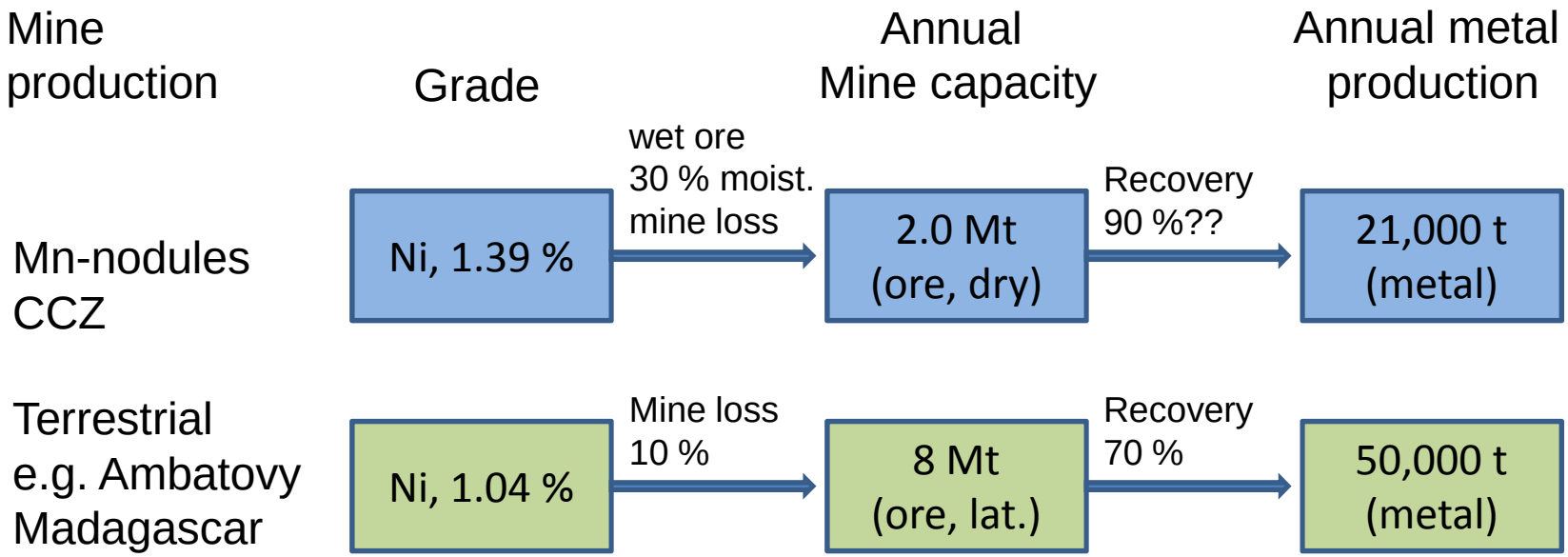
Terrestrial and marine mining - some thoughts

Copper, simple estimate (dimensions)

Mine Production (One mine)	Grade		Annual Mine capacity		Annual metal production
Mn-nodules CCZ	Cu, 1.18 %	wet ore 30 % moist. mine loss →	2.0 Mt* (ore, dry)	Recovery 90 %?? →	21,000 t (metal)
Terrestrial e.g. Las Bambas, Peru	Cu, 0.5 %	Mine loss 10 % →	100 Mt (ore)	Recovery 90 % →	405,000 t (metal)

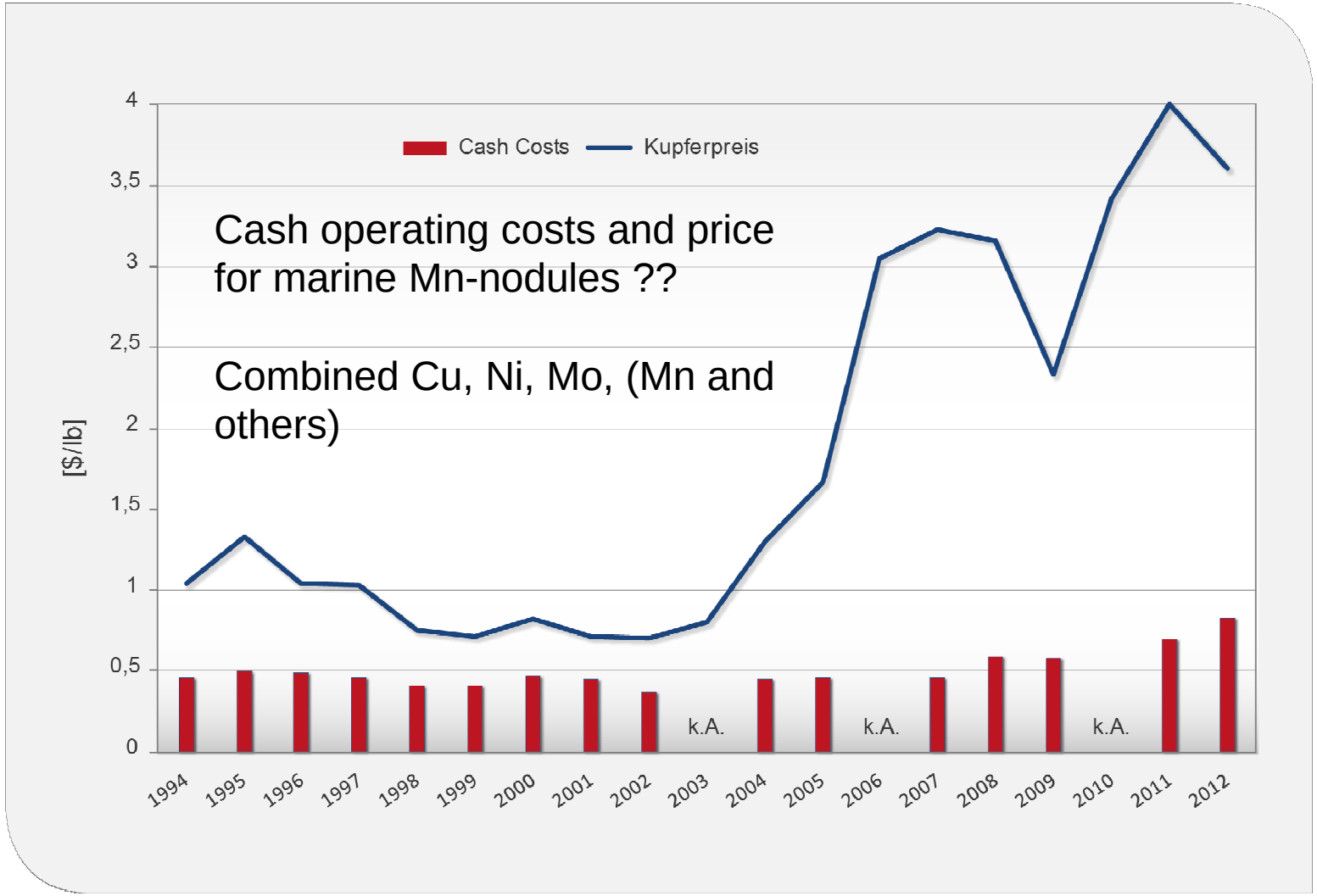
*marine: range 1.5-4.0 Mt annual mine capacity, International Seabed Authority, Hein et al, 2013 and others

Nickel, simple estimate (dimensions)



*marine: range 1.5-4.0 Mt annual mine capacity, International Seabed Authority, Hein et al, 2013 and others

Average cash costs for copper (terrestrial)



Future Ocean, Kiel Marine Sciences
March 20, 2013

World metal production and future demands

Peter Buchholz, Ulrike Dorner

German Mineral Resources Agency at the

Federal Institute for Geosciences and Natural Resources (BGR), Berlin, Germany