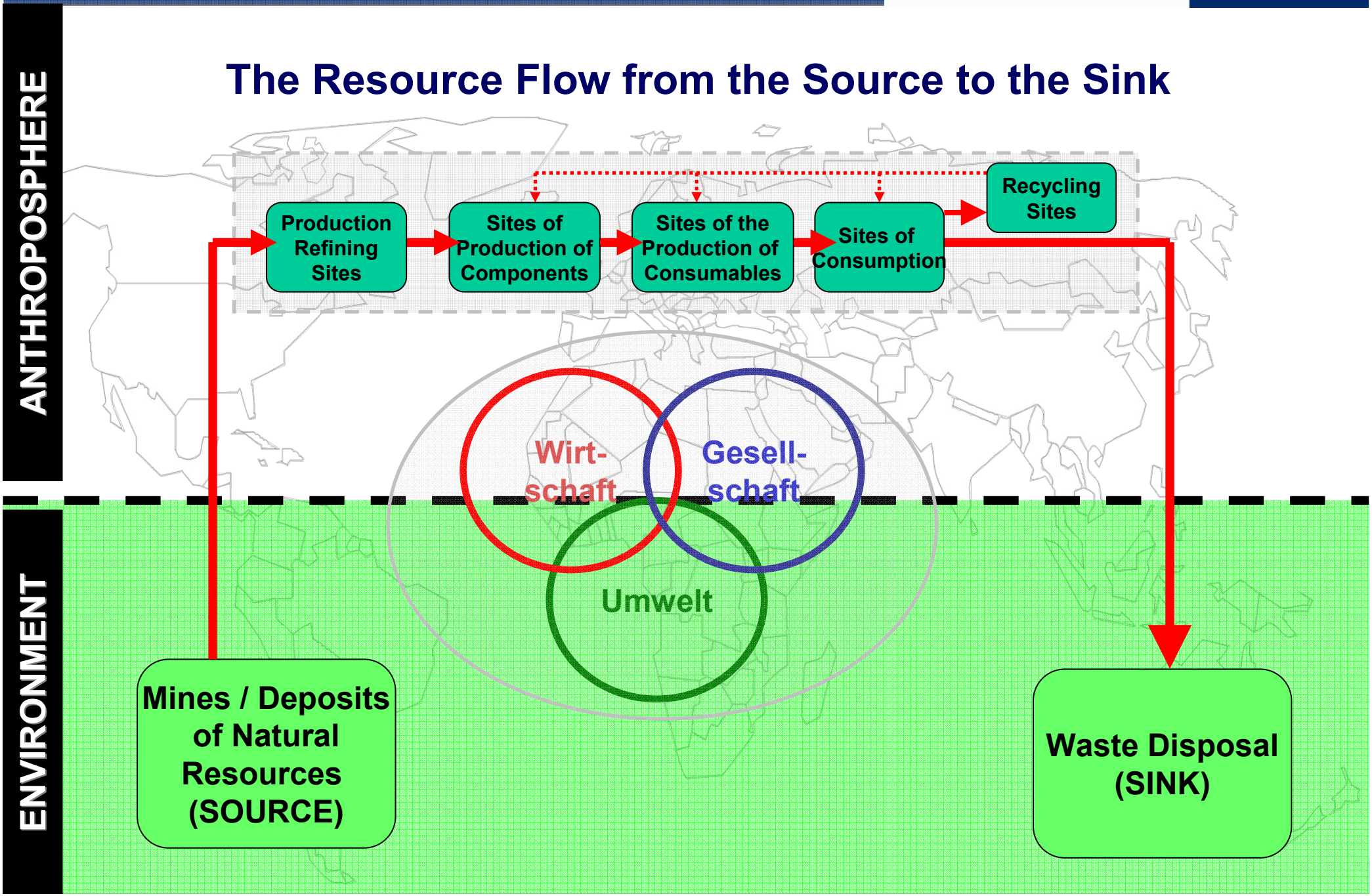

Innovative Technologies and Strategic Resources

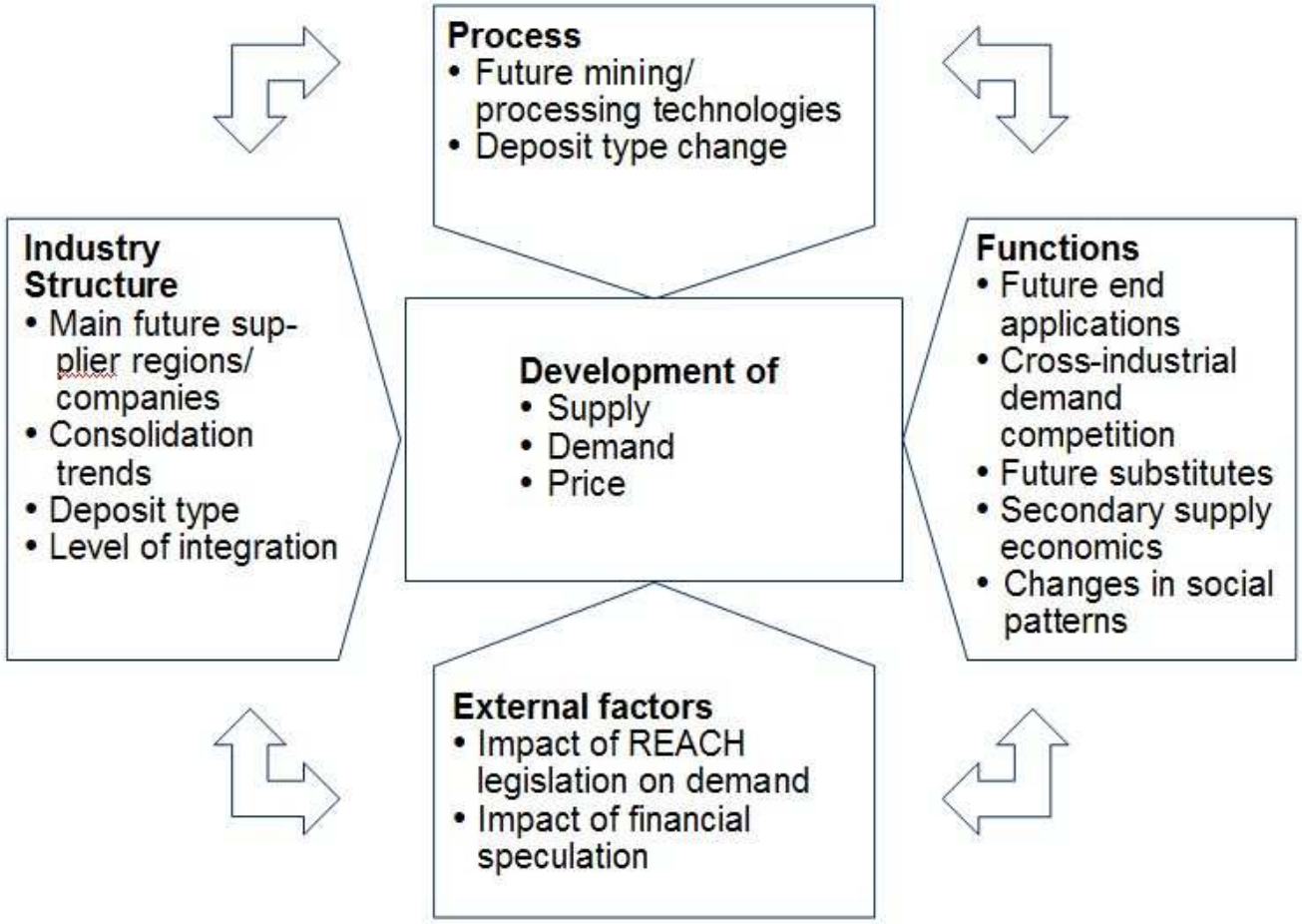
ANTHROPOSPHERE

The Resource Flow from the Source to the Sink



ENVIRONMENT

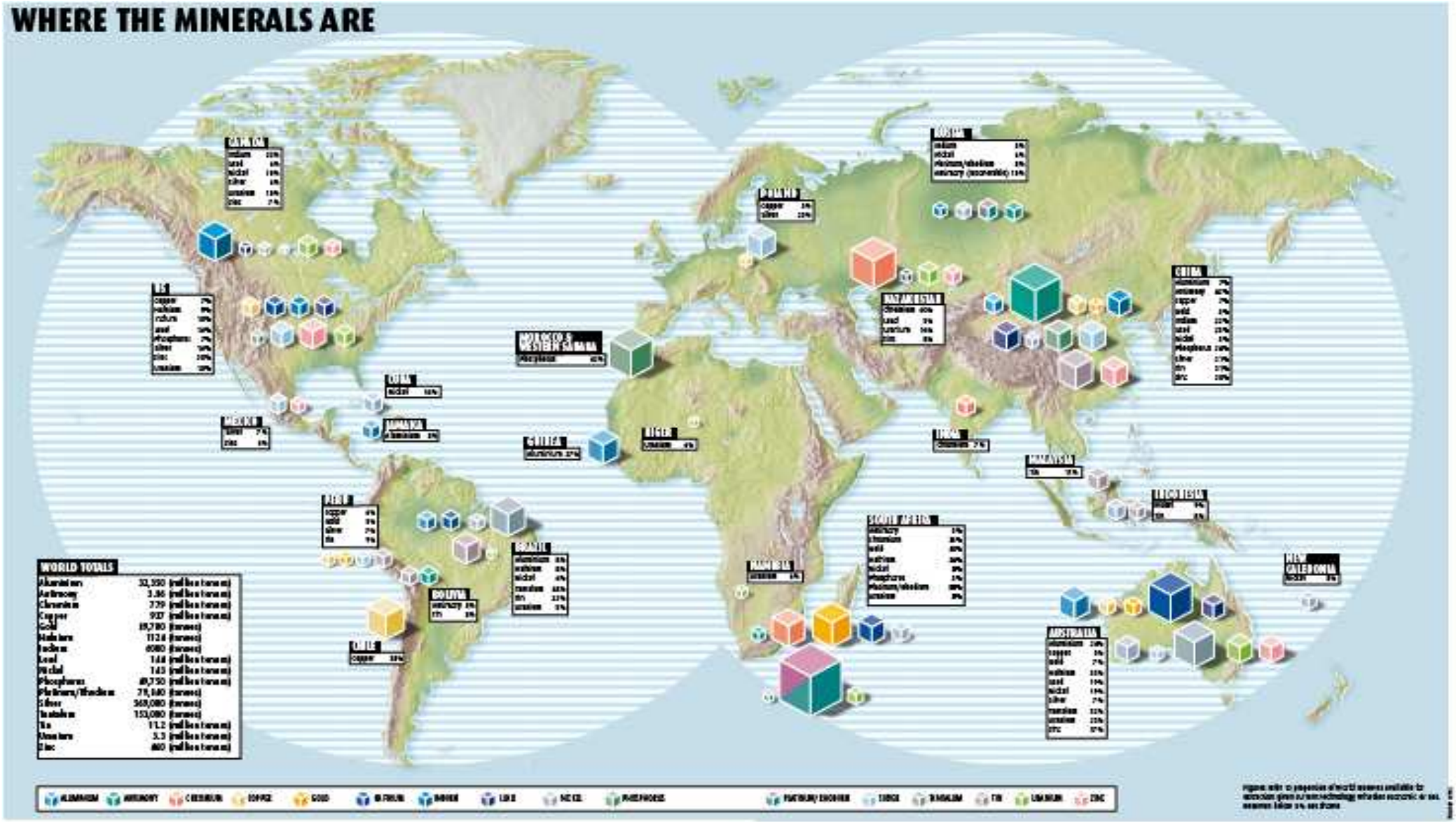
Overlaying industry structure to gain transparency on key drivers of metal markets economics and identify cluster of similar economic behavior



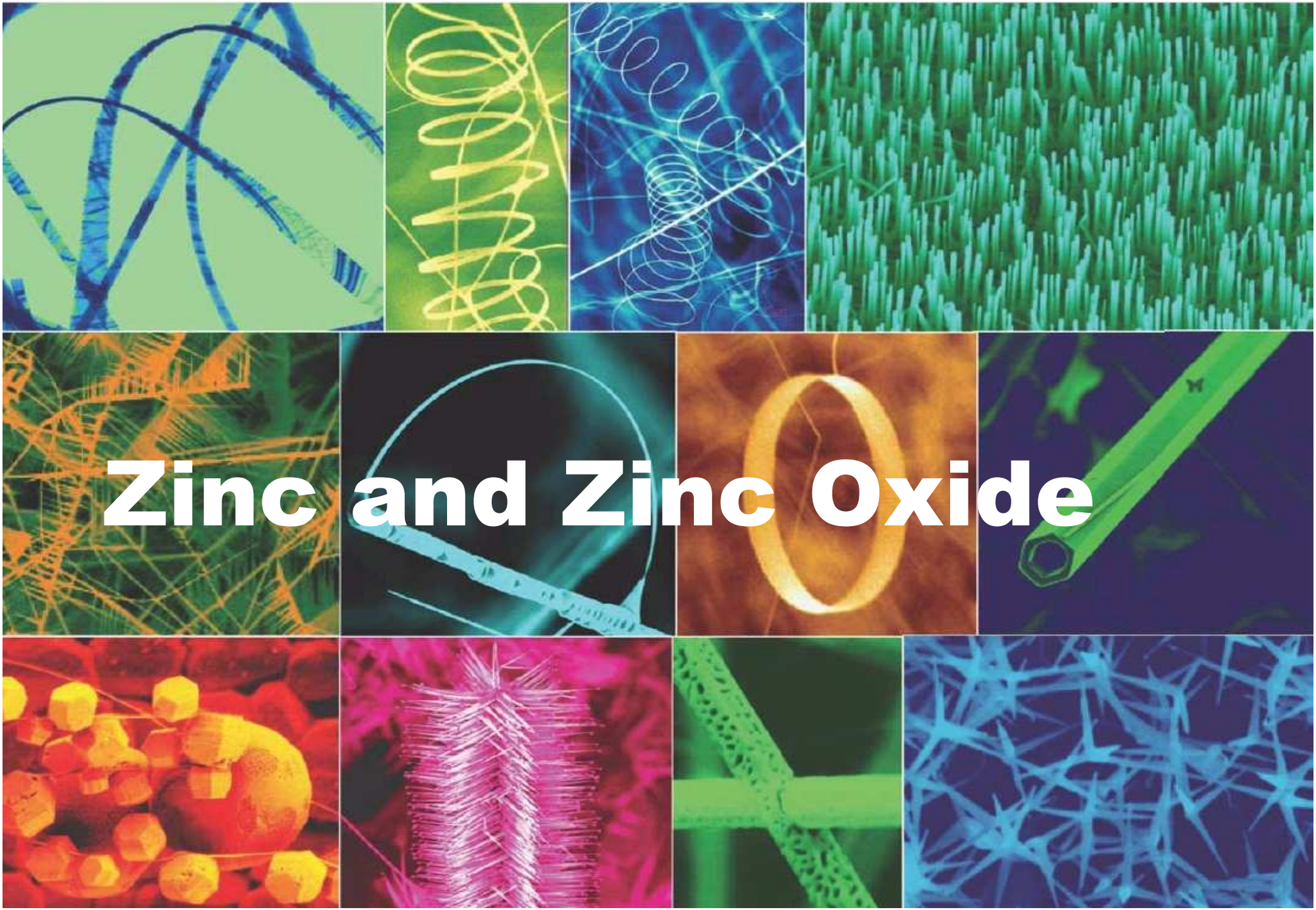
Source: Porter, various sources

We are using up minerals at an alarming rate. How long before they run out, asks David Cohen (New Scientist, 2007)

source: New Scientist / May 26, 2007


WHERE THE MINERALS ARE
WORLD TOTALS

Risks and Potentials of Strategic Metals


Zinc and Zinc Oxide

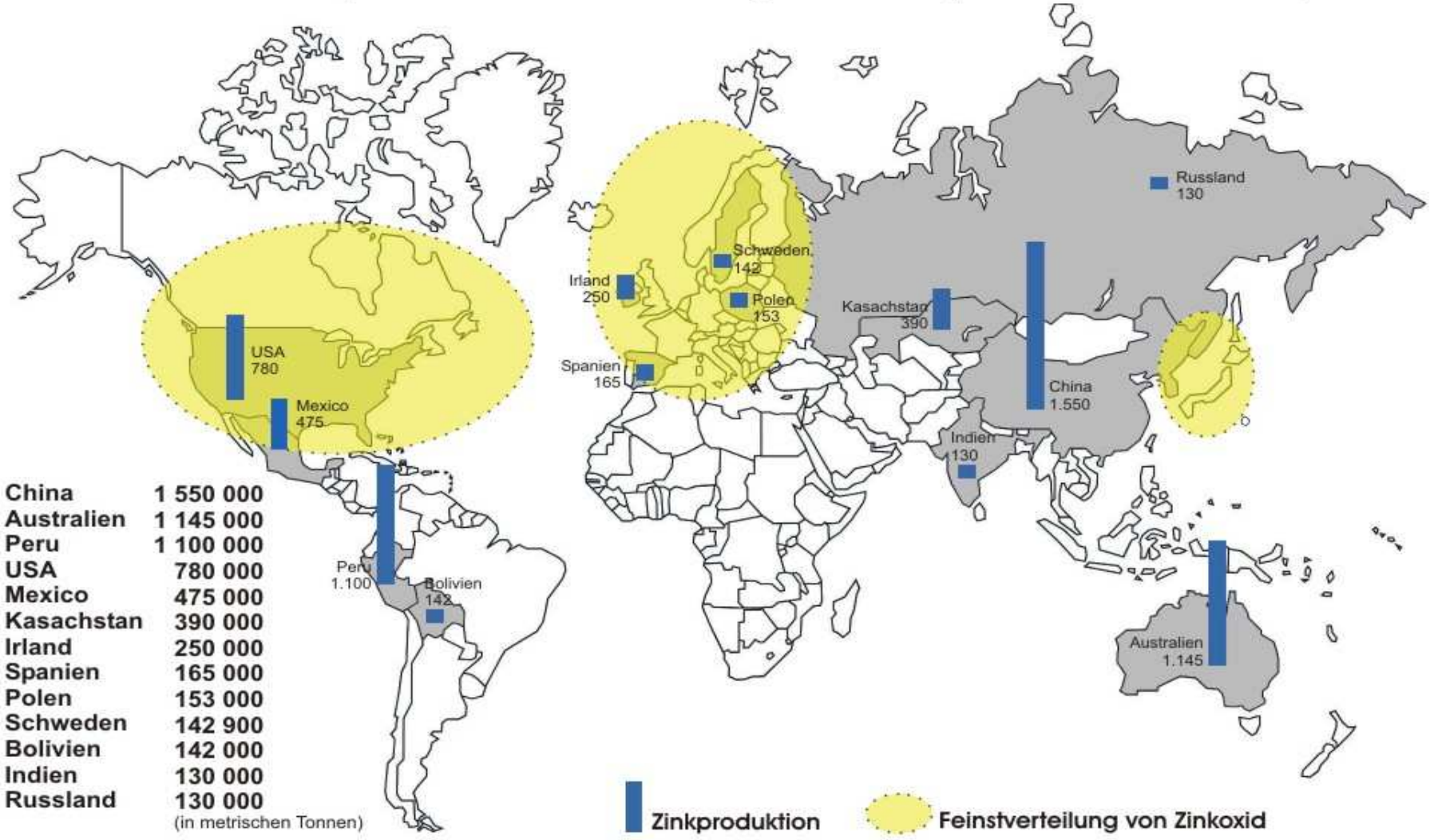
Applications

HIER IST ZINK IN SEINEM ELEMENT:

Im Automobilbau zeigt Zink die ganze Vielfalt seiner Anwendungsmöglichkeiten. Nahezu überall ist der Werkstoff im Einsatz. Oftmals sogar an Stellen, an denen man ihn gar nicht vermutet.

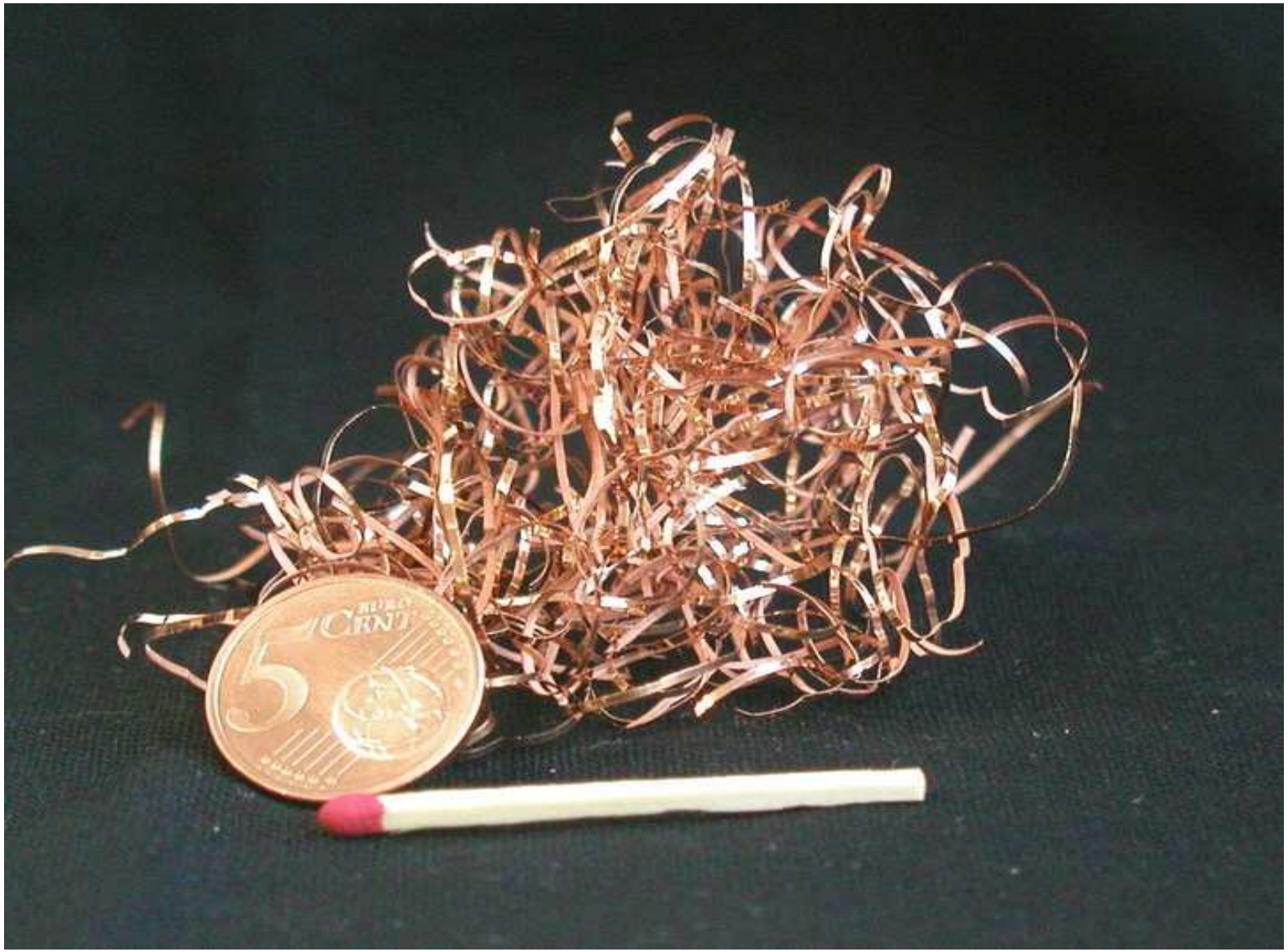
1. Scheinwerfer (Gehäuse)
2. Kühlergrill
3. Symbole und Embleme
4. Elektronische Baugruppen (Airbagsensoren)
5. Pumpengehäuse
6. Lüftungsklappen
7. Instrumenteinfassung
8. Pedale
9. Teile des Türöffnungssystems
10. Innenausstattung (z. B. Aschenbecher)
11. Autositz (Baugruppen)
12. Gurt (Baugruppen)
13. Vulkanisator im Gummi
14. Tankabdeckung
15. Heckleuchte (Gehäuse)
16. Zierleiste, Heck
17. Verschlussmechanismus
18. Antenne
19. Dachkomponenten
20. Sonnendach (Einfassung)
21. Fensterheber (Gehäuse, Mechanismus)
22. Innenspiegel (Gehäuse)
23. Lenksäule
24. Schließzylinder (Diebstahlsicherung)
25. Radio/RF/CD-Player/GPS/Navigation (Rahmen)
26. Außenspiegel (Gehäuse)
27. Kindersicherung
28. Scheibenwischanlage (Wischarm)
29. Scheibenwischanlage (Motorengehäuse)

Weltweite Zinkproduktion und Feinstverteilung von Zinkoxid (in Tausend Tonnen - 2002)

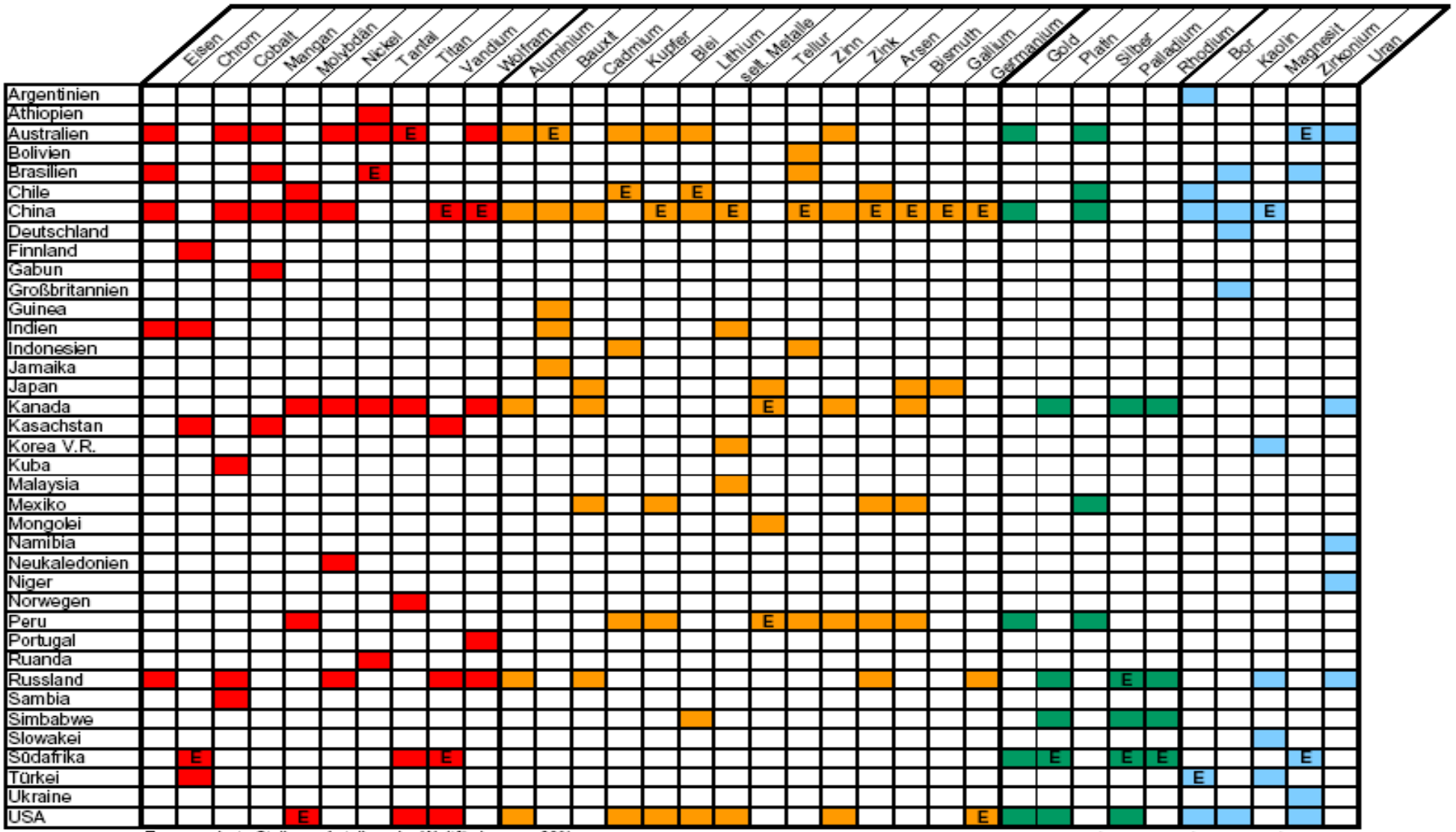


China	1 550 000
Australien	1 145 000
Peru	1 100 000
USA	780 000
Mexico	475 000
Kasachstan	390 000
Irland	250 000
Spanien	165 000
Polen	153 000
Schweden	142 900
Bolivien	142 000
Indien	130 000
Russland	130 000

(in metrischen Tonnen)

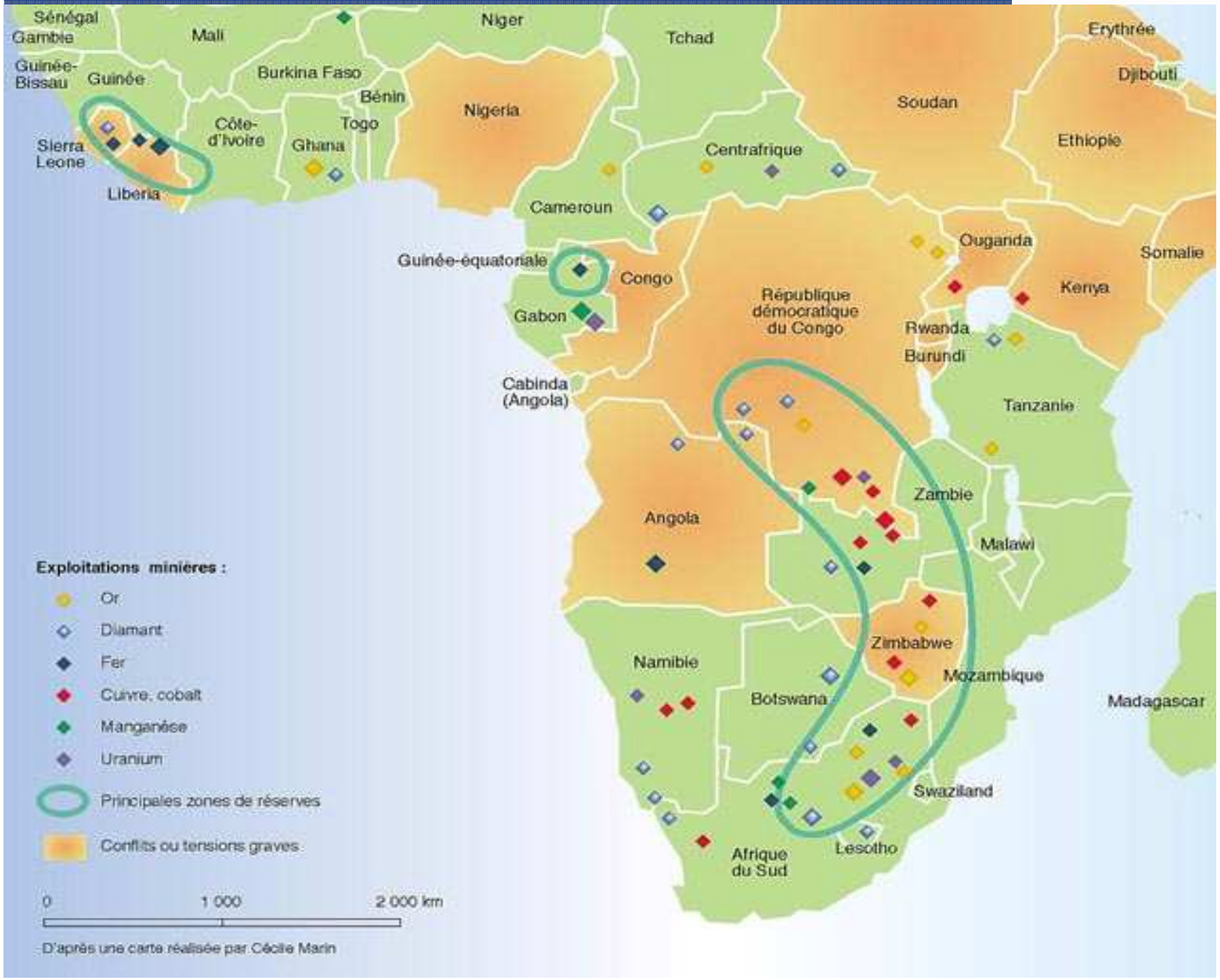


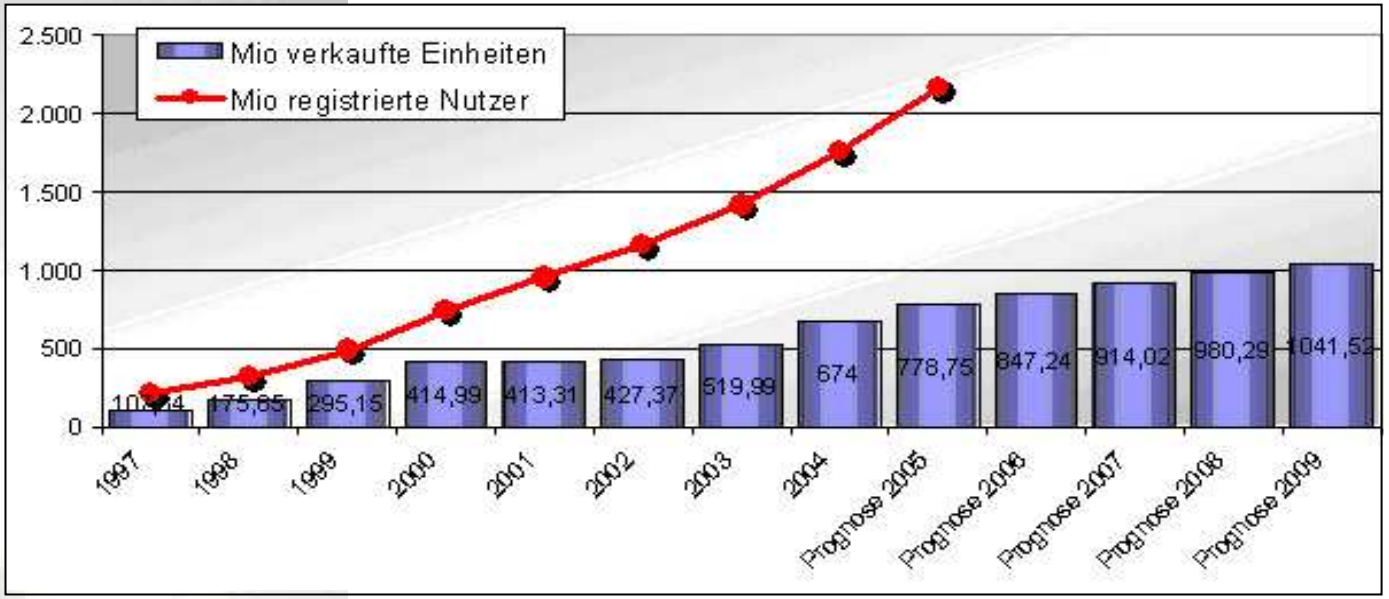
NASA image of **Escondida Mine in Chile**,
taken by ASTER on April 23, 2000.
Originally from http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=4492



E = exponierte Stellung, Anteil an der Weltförderung >30%

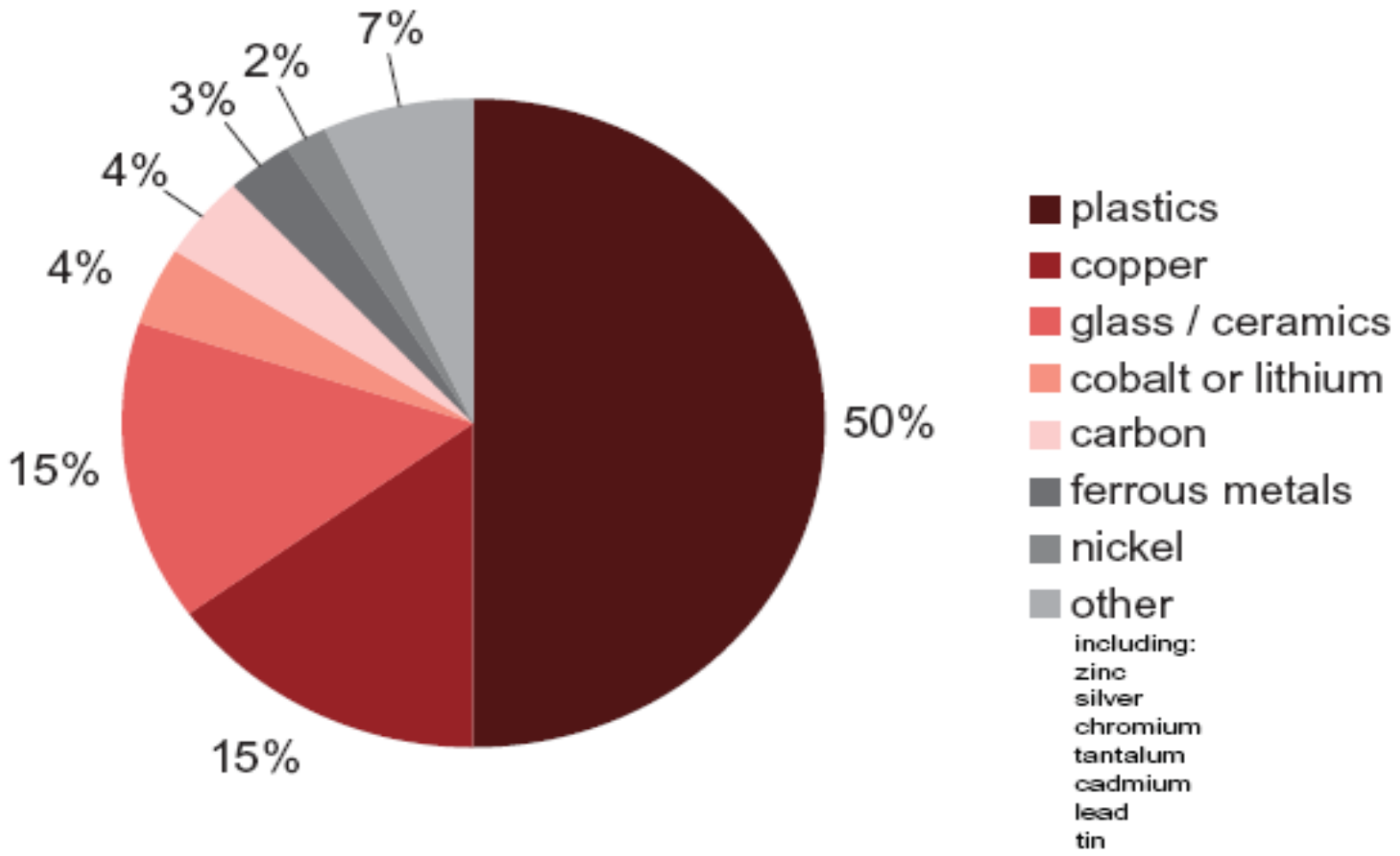
Förderanteile nach Welt-Bergbau-Daten 2007


Sénégal
Gambie
Mali
Niger
Tchad
Erythrée
Guinée-Bissau
Guinée
Burkina Faso
Bénin
Nigeria
Soudan
Djibouti
Sierra Leone
Côte-d'Ivoire
Togo
Ghana
Centrafrique
Ethiopie
Liberia
Cameroun
Ouganda
Somalie
Guinée-équatoriale
Congo
Kenya
Gabon
République démocratique du Congo
Rwanda
Burundi
Cabinda (Angola)
Tanzanie
Zambie
Angola
Malawi
Zimbabwe
Namibie
Mozambique
Botswana
Madagascar
Swaziland
Lesotho
Afrique du Sud
Exploitations minières :
Or
Diamant
Fer
Cuivre, cobalt
Manganèse
Uranium
Principales zones de réserves
Conflits ou tensions graves
0
1 000
2 000 km
D'après une carte réalisée par Cécile Marin



Purchased Mobile Phones between 1997 and 2009 (Estimation) and registered Users from 1997 bis 2005

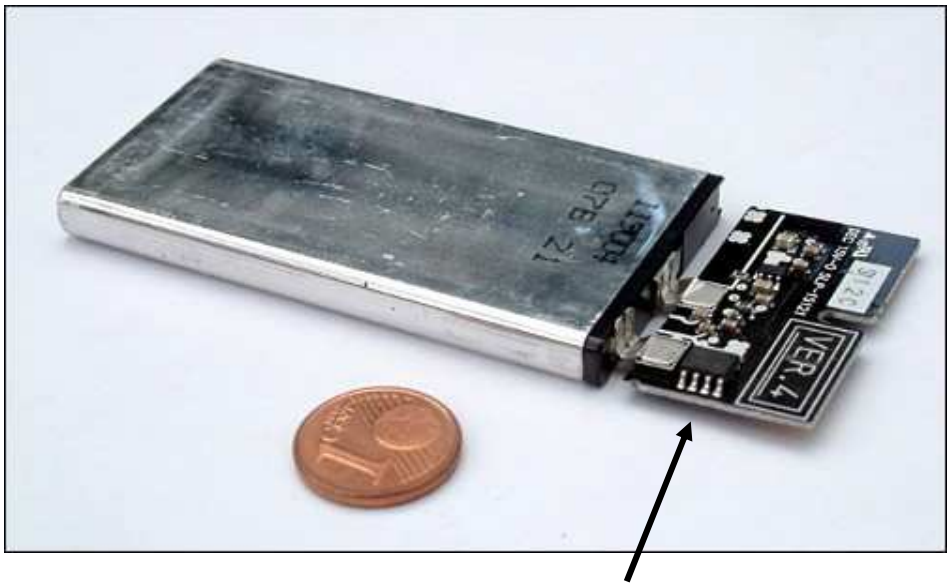
(after Gartner 2005 and International Telecommunication Union 2006)



Average cell phone composition (data source: UNEP 2006; graphics : I. Oswald)

Setup of a Li-polymer accumulator

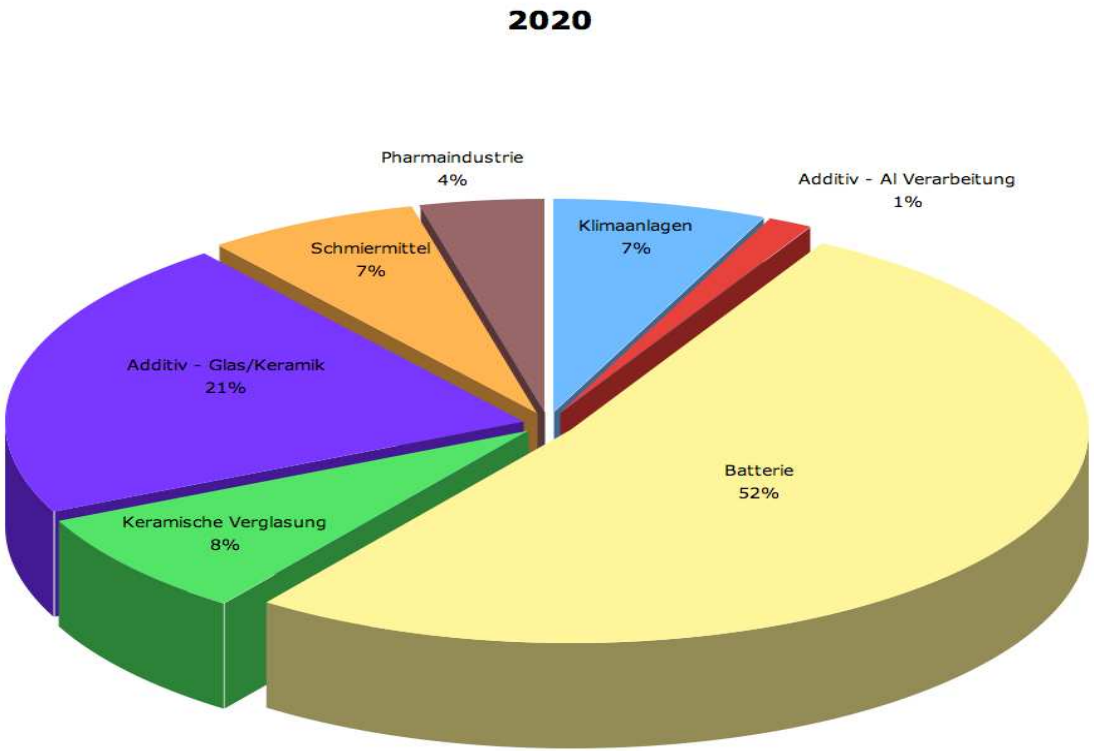
Mobile phone accumulator after removement of the plastic housing.

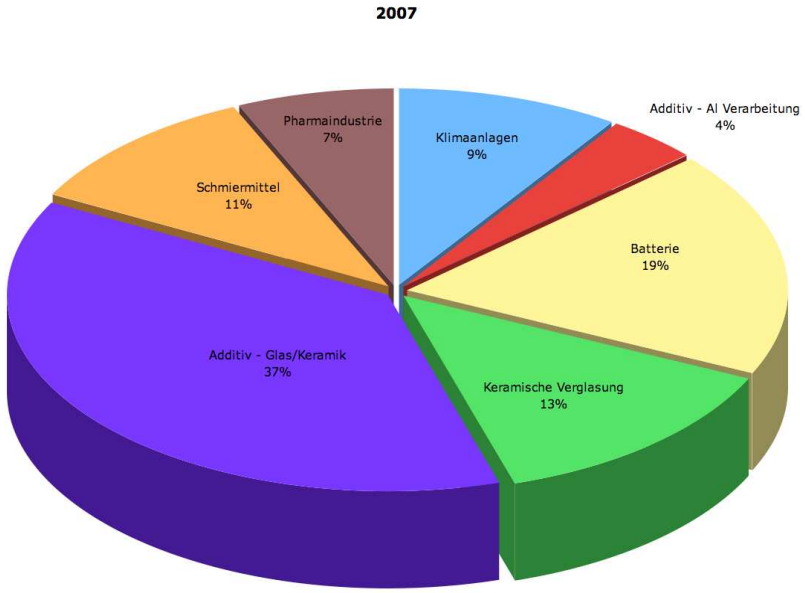


Electrical security switch against overload.

unfolded accumulator.

Because of the electrolyte design as (welled (gequollen) Li-Ions containing) polymer the outer shape can have almost any form. The foils are coated with the electrode material. The energy density is even higher than the one of the Li-Ion accumulator.





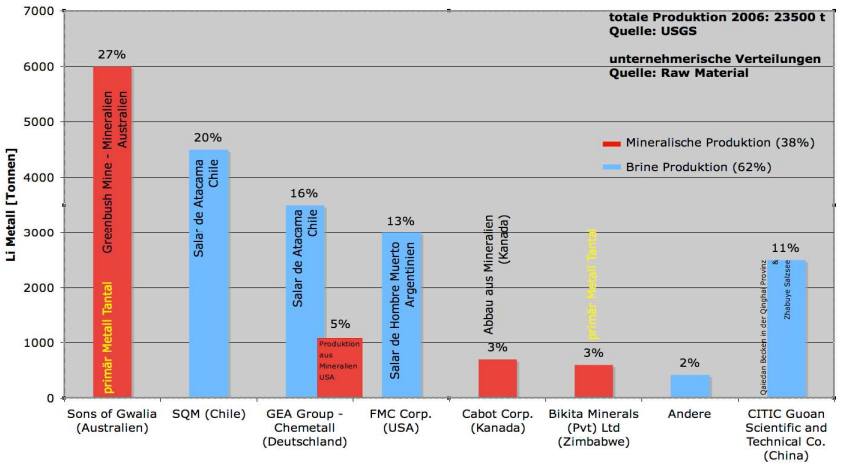
Q: Lithium Supply & Markets 2009 IM Conference 2009

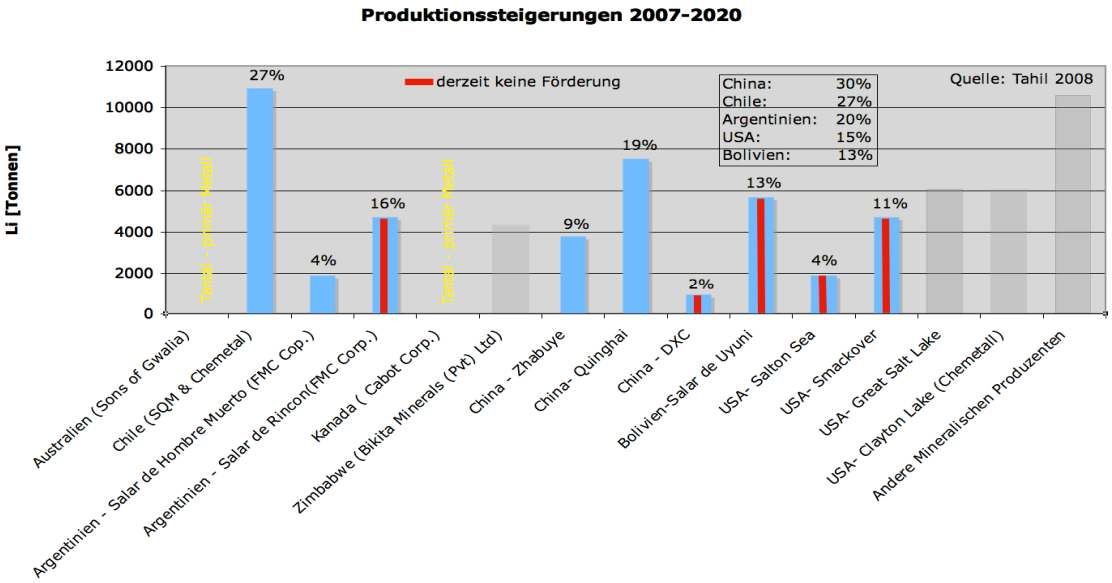
Driving Force for Lithium Demand: Lithium Batteries

- Growth of application in automotive industry
- Storage of energy in regenerative energy technologies
- Additional growth of lithium ion batteries in the range of 7% per

Criticality of Lithium

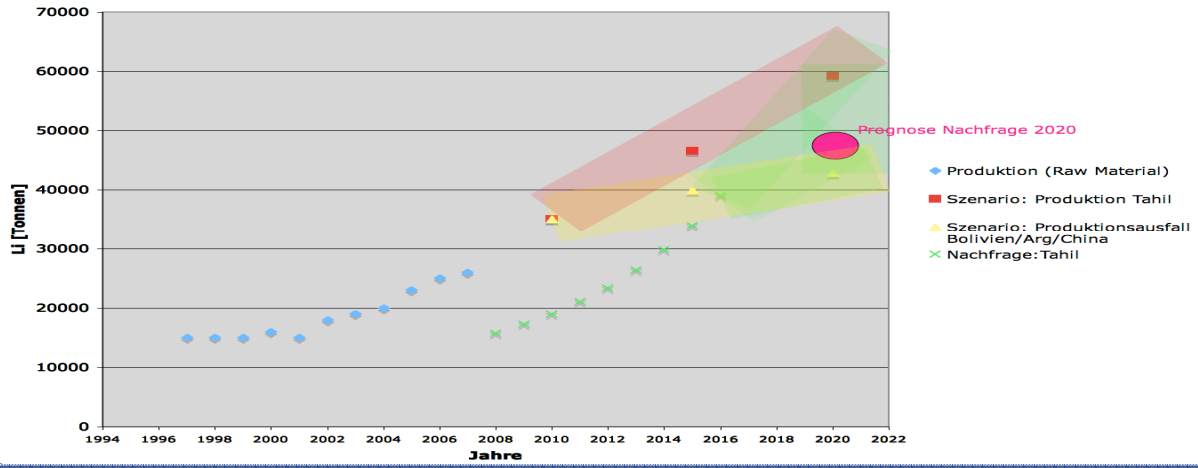
Reliability of production in Bolivia / China / Salar de Rincon?





Summary: Cost Risks and Scarcity

- Deposits are highly comcentrated (Political influences!)
- Growth depends on the potential of the deposits (Investment!)
- Speculation
- Dependence on other metals



This minicomputer was the first internationally successful IT-product

Quelle: http://www.tink.ch/schweiz/new/article/2007/06/18/innovation-des-letzten-jahrhunderts/

Functional Metals in a Computers

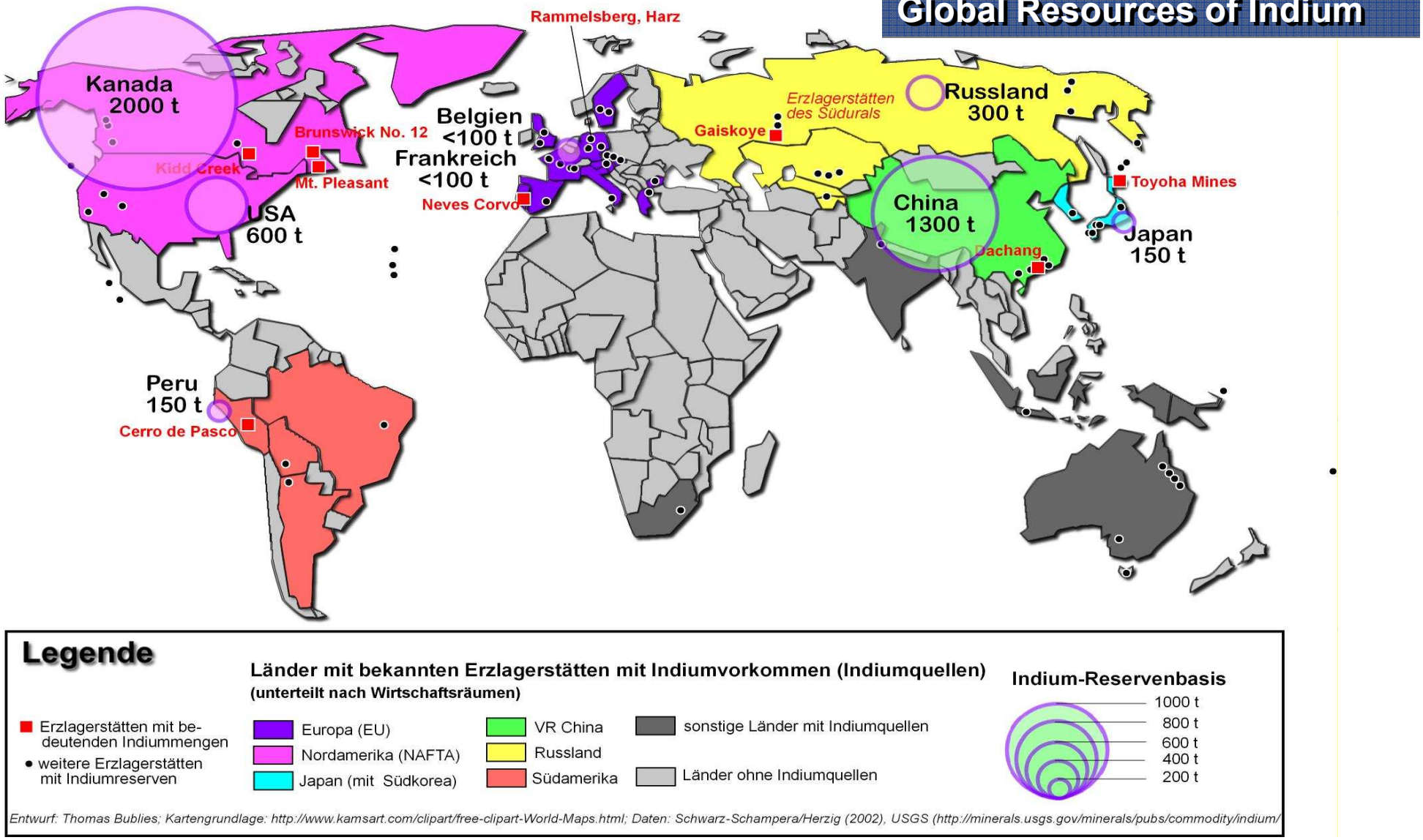
Material	% Weight
Silica	24,8803
Plastics	22,9907
Iron	20,4712
Aluminium	14,1723
Copper	6,9287
Lead	6,2988
Zinc	2,2046
Tin	1,0078
Nickel	0,8503
Barium	0,0315
Manganese	0,0315
Silver	0,0189
Beryllium	0,0157
Cobalt	0,0157
Tantalum	0,0157
Titanium	0,0157
Antimony	0,0094
Cadmium	0,0094

Material	% Weight
Bismuth	0,0063
Chromium	0,0063
Mercury	0,0022
Germanium	0,0016
Gold	0,0016
Indium	0,0016
Ruthenium	0,0016
Selemium	0,0016
Arsenic	0,0013
Gallium	0,0013
Palladium	0,0003
Europium	0,0002
Niobium	0,0002
Vanadium	0,0002
Yttrium	0,0002
Platinum	Trace
Rhodium	Trace
Terbium	Trace

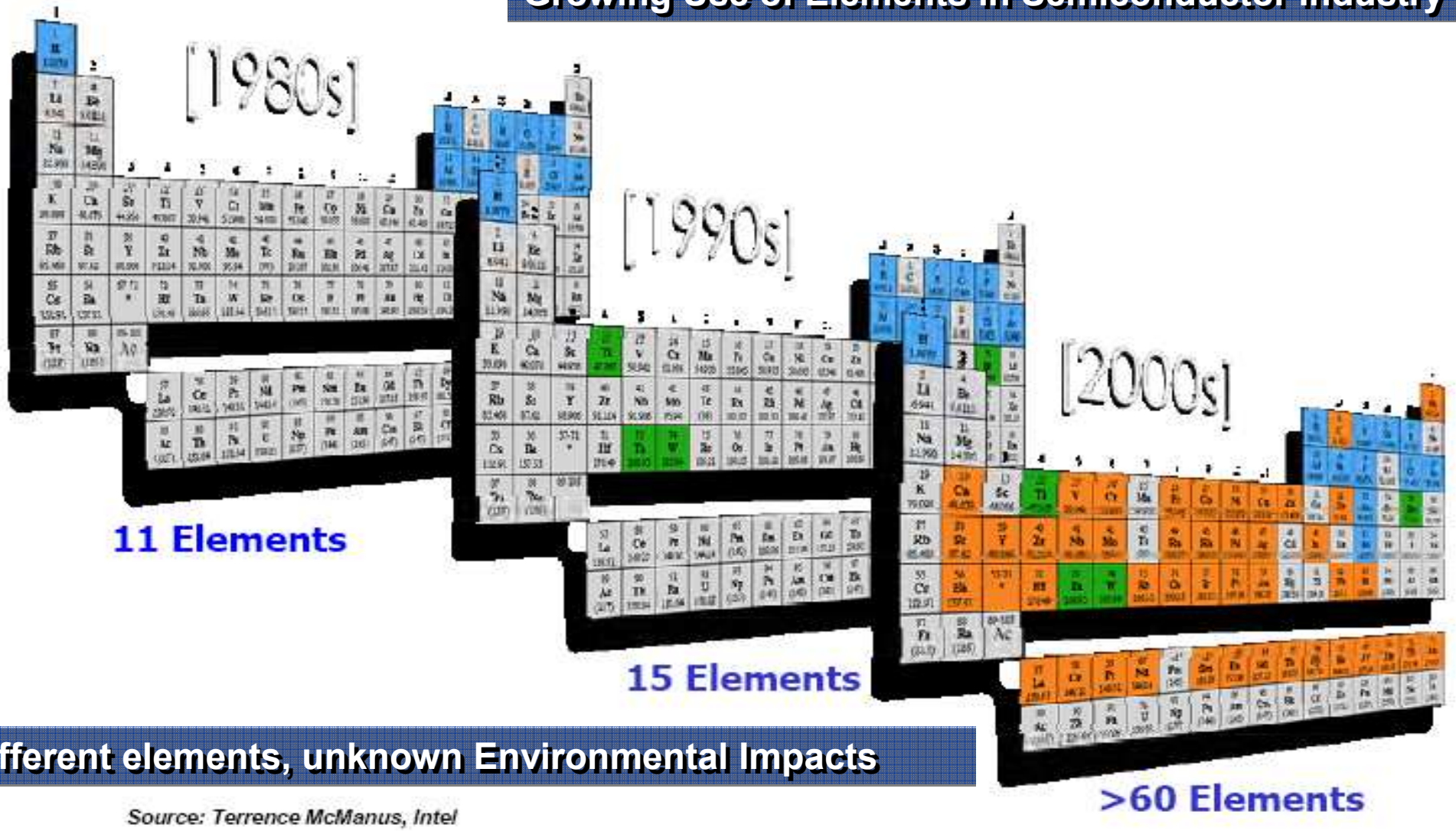
Indium

- Doped indium-tin-oxide (ITO) is transparent and exhibits a nearly metallic conductivity
- ITO is a perfect functional material for LCDs as well as for solar cells (CIS technology)
- Using sol-gel-synthesis technologies large thin layes can be deposited on different substrates

Global Resources of Indium



Growing Use of Elements in Semiconductor Industry



Different elements, unknown Environmental Impacts

Source: Terrence McManus, Intel


For the production of one computer we need:
• 240 kilograms o fossil fuels
• 22 kilograms synthetic chemical compounds
• 1500 liters of (grey) water
> all together at least 1´800 kg raw materials, i.e. resources!

HIGH-TECH TRASH

Will your discarded TV or computer end up in a ditch in Ghana?

64

Reported international e-waste shipments from industrialized economies to developing countries (data source and graphics: see caption)

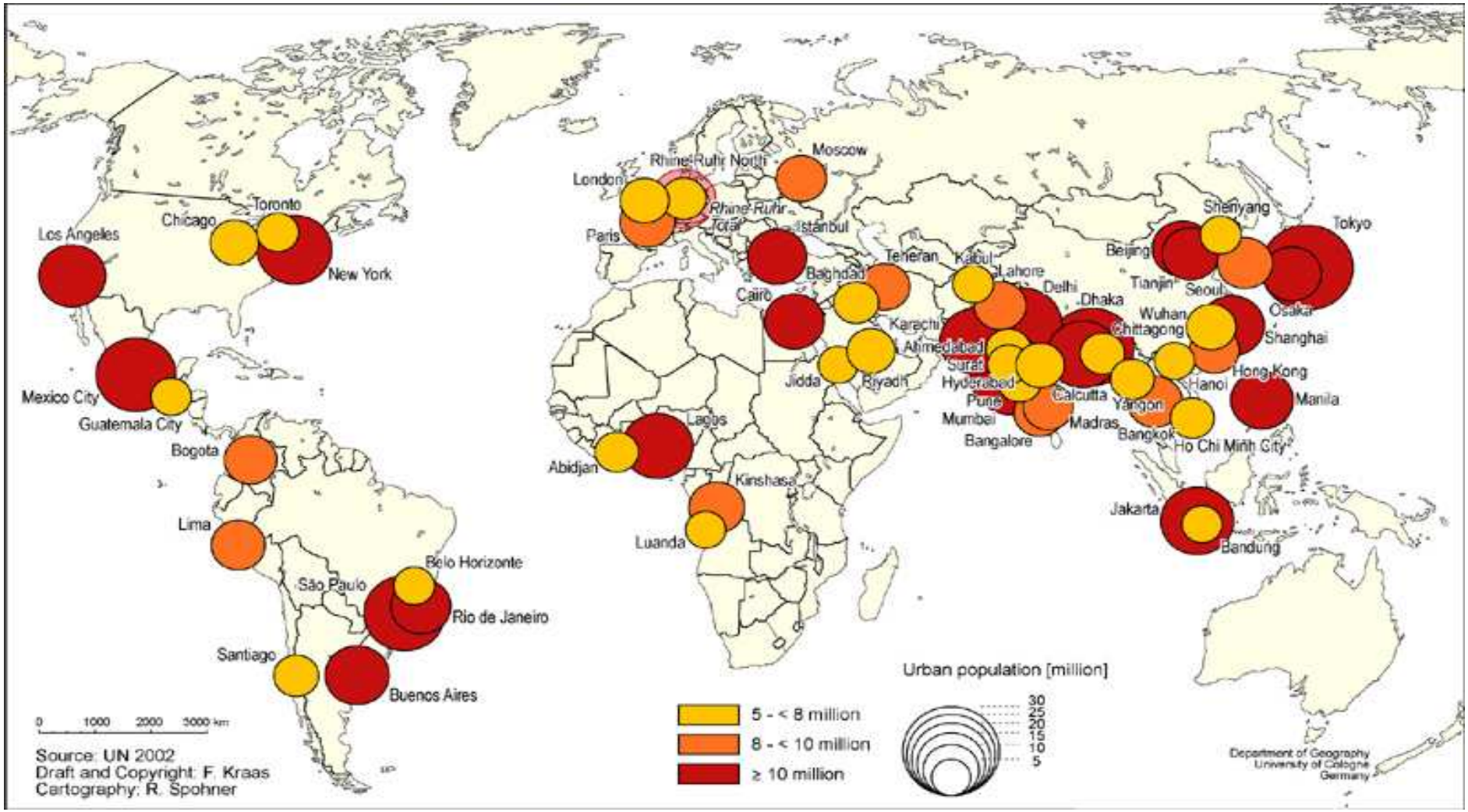
Fruits of Labour

Mexico-City - 150 years ago . . .

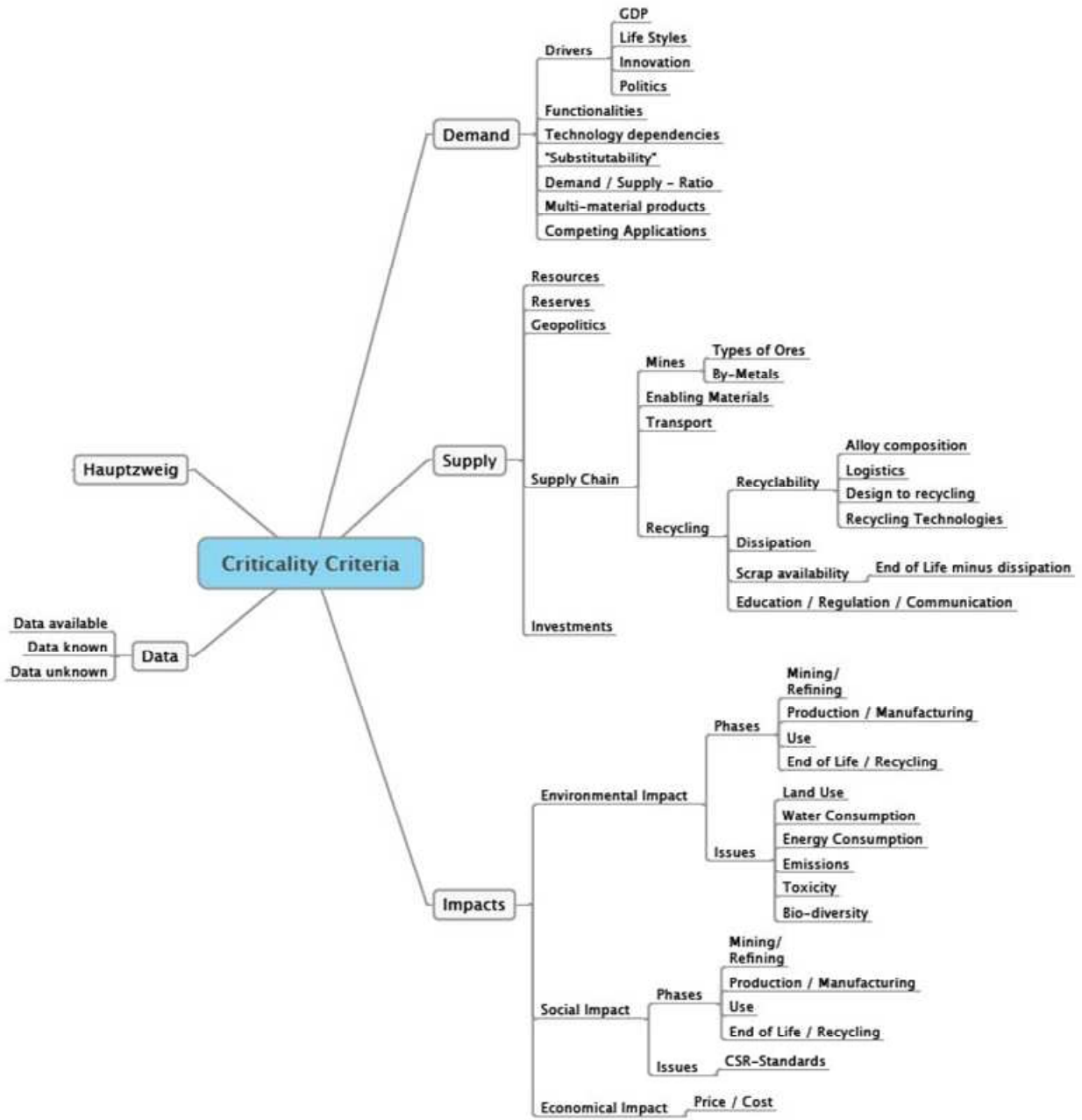
. . . and today

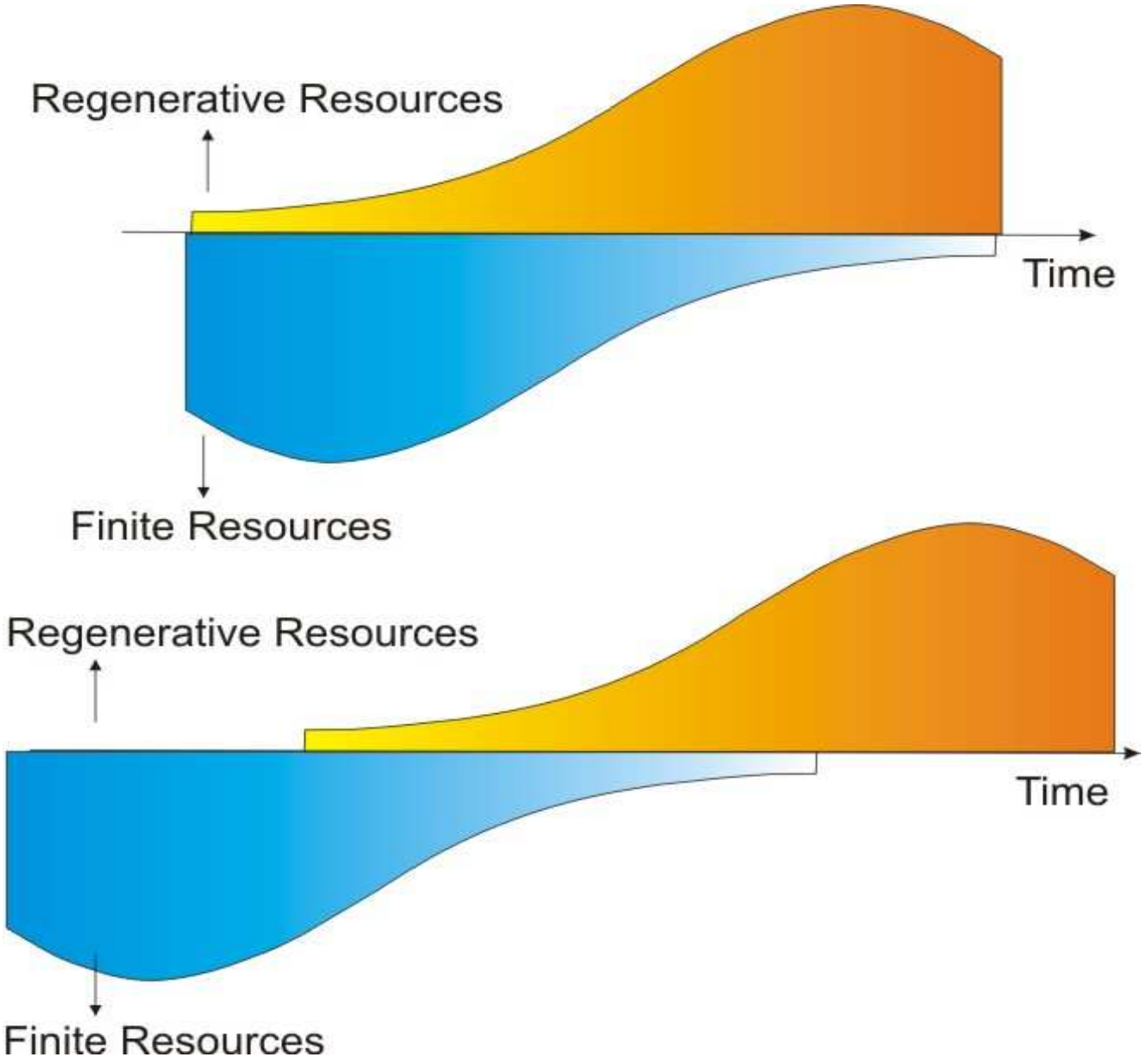
http://upload.wikimedia.org/wikipedia/commons/a/ac/Mexiko_City_von_oben.jpg

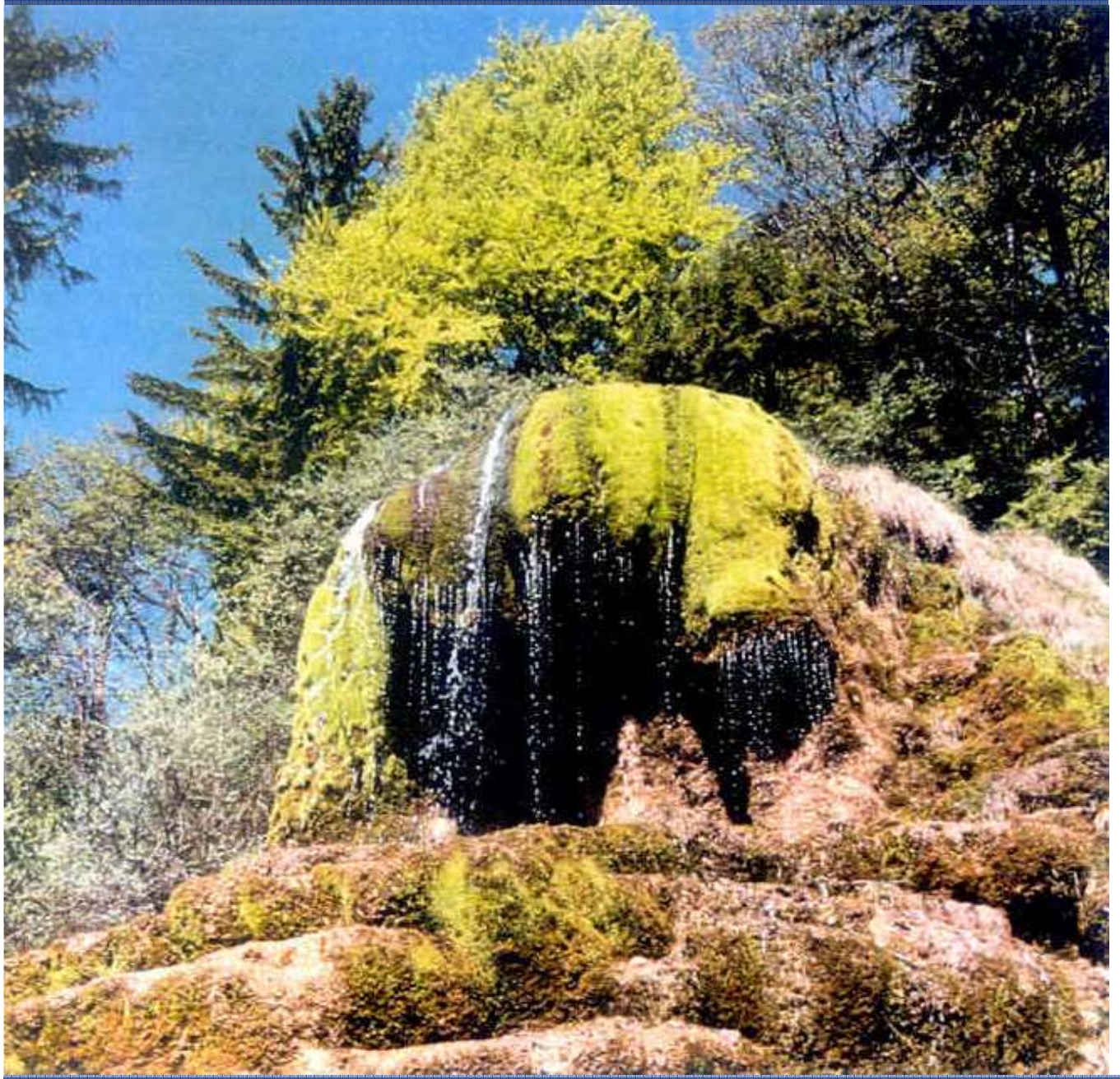
Megacities



Source: http://blogs.tnr.com/tnr/blogs/environmentandenergy/megacities.jpg


Criticality Criteria
Hauptzweig
Demand
Drivers
GDP
Life Styles
Innovation
Politics
Functionalities
Technology dependencies
"Substitutability"
Demand / Supply - Ratio
Multi-material products
Competing Applications
Supply
Resources
Reserves
Geopolitics
Supply Chain
Mines
Types of Ores
By-Metals
Enabling Materials
Transport
Recycling
Recyclability
Alloy composition
Logistics
Design to recycling
Recycling Technologies
Dissipation
Scrap availability
End of Life minus dissipation
Education / Regulation / Communication
Investments
Data
Data available
Data known
Data unknown
Impacts
Environmental Impact
Phases
Mining/ Refining
Production / Manufacturing
Use
End of Life / Recycling
Issues
Land Use
Water Consumption
Energy Consumption
Emissions
Toxicity
Bio-diversity
Social Impact
Phases
Mining/ Refining
Production / Manufacturing
Use
End of Life / Recycling
Issues
CSR-Standards
Economical Impact
Price / Cost


Regenerative Resources
Time
Finite Resources
Regenerative Resources
Time
Finite Resources



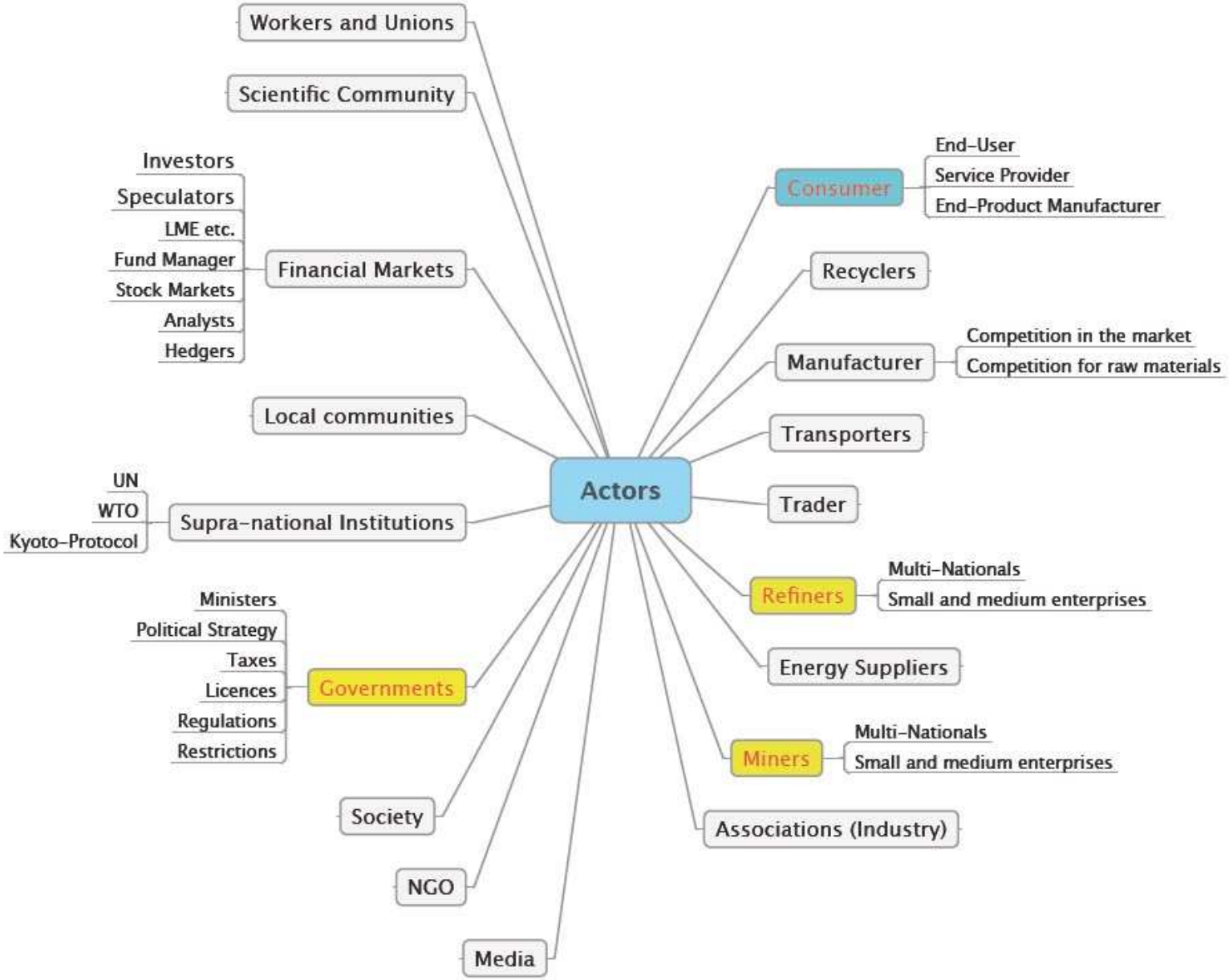
Acknowledgements

R. Diessenbacher
Co-workers of the
Chair of Materials Science
As well as of the
Environmental Science Center

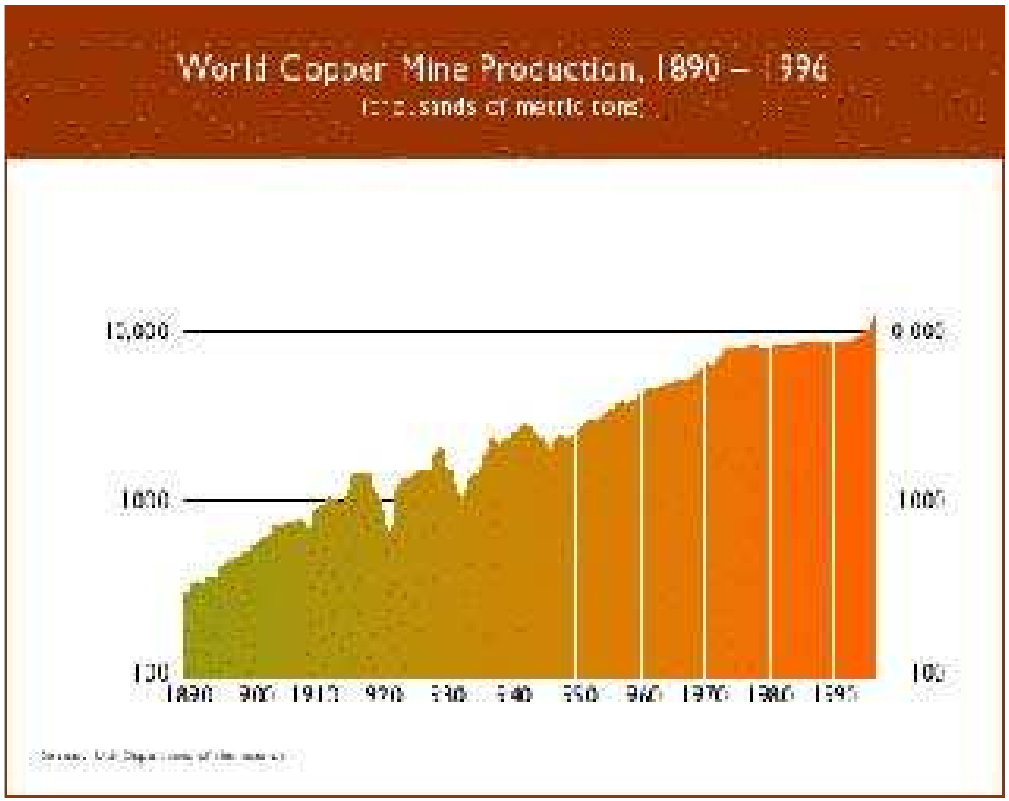
Students in
• Physics
• Materials Science
• Geography

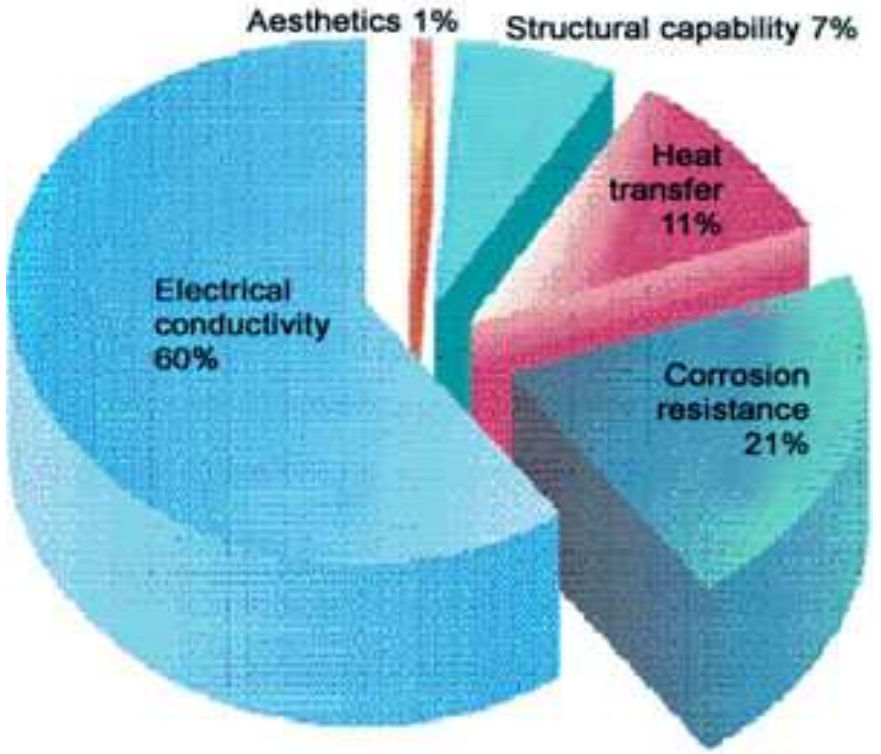
Bildquelle: Armin Reller


unter
2,8%
Geschätzter Anteil am weltweiten Klimagasausstoß im Jahr 2004
179%
Zunahme der Emissionen von 1970 bis 2004
mehr als 40%
Zukünftige Entwicklung ohne Klimaschutzanstrengungen


Actors
Workers and Unions
Scientific Community
Financial Markets
Investors
Speculators
LME etc.
Fund Manager
Stock Markets
Analysts
Hedgers
Local communities
Supra-national Institutions
UN
WTO
Kyoto-Protocol
Governments
Ministers
Political Strategy
Taxes
Licences
Regulations
Restrictions
Society
NGO
Media
Consumer
End-User
Service Provider
End-Product Manufacturer
Recyclers
Manufacturer
Competition in the market
Competition for raw materials
Transporters
Trader
Refiners
Multi-Nationals
Small and medium enterprises
Energy Suppliers
Miners
Multi-Nationals
Small and medium enterprises
Associations (Industry)

Copper mine in Nevada





Principal reasons using copper