Mapping of Australia's National Mineral Resources Classification System to the UNFC-2009

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Introductory remarks

- Mineral resources are an important component of the Australia's current and future wealth
  - Government policies require a strategic (long term) perspective of what is likely to be available for mining
- Like most other countries with significant mining sectors Australia maintains a national inventory of its mineral stocks

Introductory remarks

- It is necessary to map the various classification and reporting systems for mineral and energy resources to a common base to
  - Clarify similarities/differences between the systems
  - Enable comparisons between countries' inventories and better estimates of total world stocks
- This should be done by mapping the various national classifications/reporting systems in current use to UNFC-2009

Introductory remarks

- This presentation summarises Australia's national classification system for identified mineral resources
- Describes how data from company reports on individual Australian mineral deposits are aggregated into coarser categories for national mineral resource reporting
- Maps the Australian national mineral resources reporting system to the UNFC-2009
- Compares Australia's system with those of some other countries
- Puts a case for major mining nations map their national reporting with UNFC and consider providing information on resources likely to be available in short, medium and long time scales

History of Australia's national mineral resource system

- In 1975, Australia adopted with minor changes the McKelvey resource classification system
  - Used for national and international reporting by the then US Bureau of Mines and USGS
- We do not routinely assess undiscovered resources

Australia's National Resource Classification System

Cumulative Production	INDENTIFIED RESOURCES			UNDISCOVERED RESOURCES	
	Demonstrated		Inferred	Probability Range	
	Measured	Indicated		Hypothetical	Speculative
ECONOMIC	Reserves		Inferred Reserves		
MARGINALLY ECONOMIC	Marginal Reserves		Inferred Marginal Reserves		
SUBECONOMIC	Demonstrated Subeconomic Resources		Inferred Subeconomic Resources		
Other Occurrences	Includes nonconventional and low-grade materials				

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Decreasing degree of geological assurance

Decreasing degree of economic feasibility

		IDENTIFIED RESOURCES	
		DEMONSTRATED	INFERRED
		Measured / Indicated	
ECONOMIC		Economic Demonstrated Resources (EDR)	
SUBECONOMIC	PARAMARGINAL		
	SUBMARGINAL		

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Australia's 'EDR' was copied after USGS's 'Reserves' and both are defined by the labels on the respective diagrams:

- 'Economic' and 'Demonstrated', except that
- The term 'Reserves' was replaced by 'Resources' for Australia to avoid confusion with the much more restrictive JORC term 'Reserves' as used in Australia.

The relationships of JORC and GA resource categories is discussed in the following slides

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Estimating Australia's National Mineral Resources

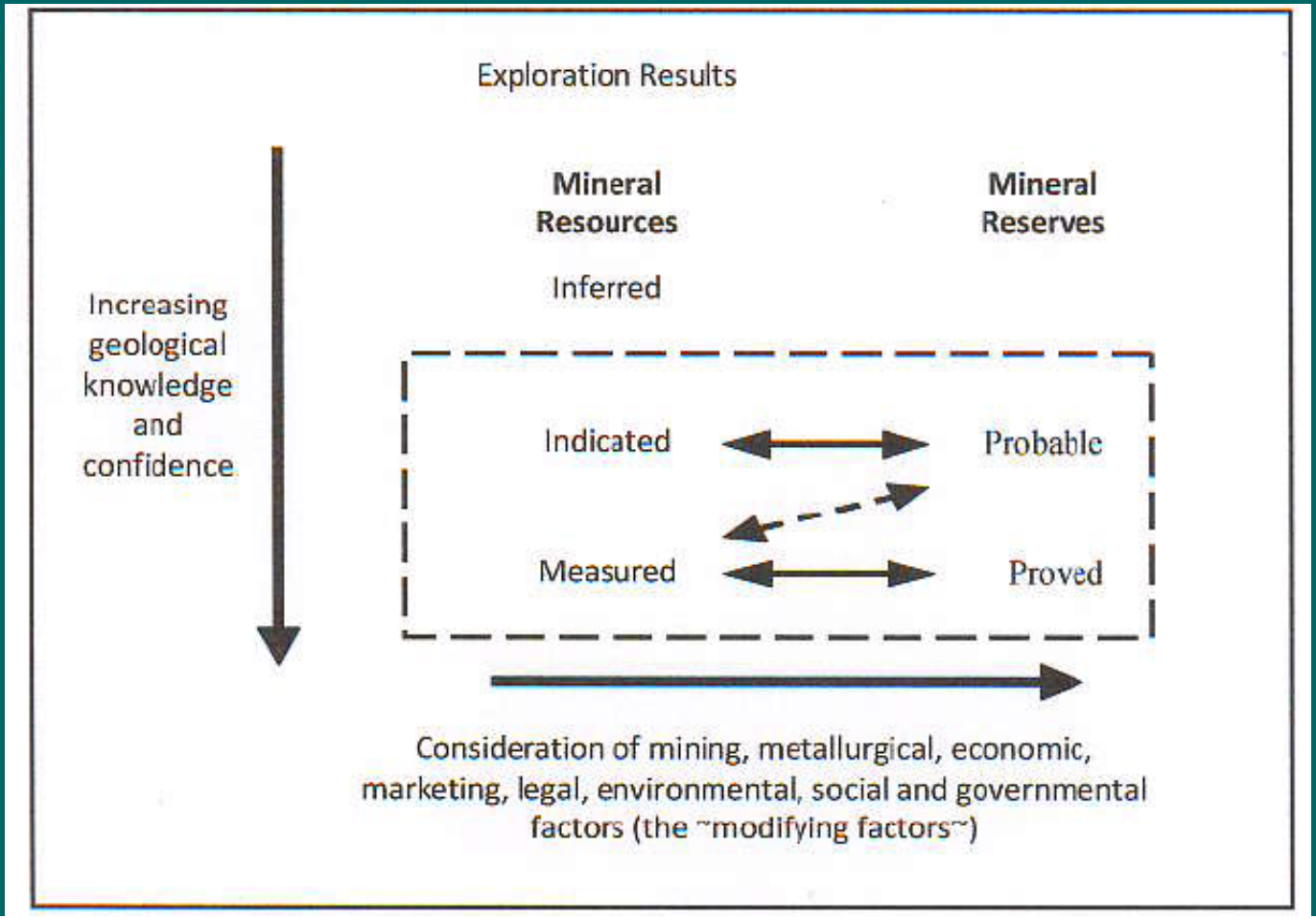
- **Not feasible for a government agency to conduct individual resource assessments for all mineral deposits because of:**
  - **Lack of access to sensitive data on economic viability of deposits**
  - **Limited staff resources**
- **Therefore national reporting needs to based on company reporting on individual deposits**

Commercial mineral resource reporting in Australia

- Companies listed on the Australian Securities Exchange (ASX) are required to report publicly on Ore Reserves and Mineral Resources under their control, using the Joint Ore Reserves Committee (JORC) Code (http://www.jorc.org/)
  - JORC 'Resources' must have "reasonable prospects for economic extraction" in the foreseeable future
  - JORC Reserves provide commercial (relatively short term) view of what is to be mined

Commercial mineral resource reporting in Australia

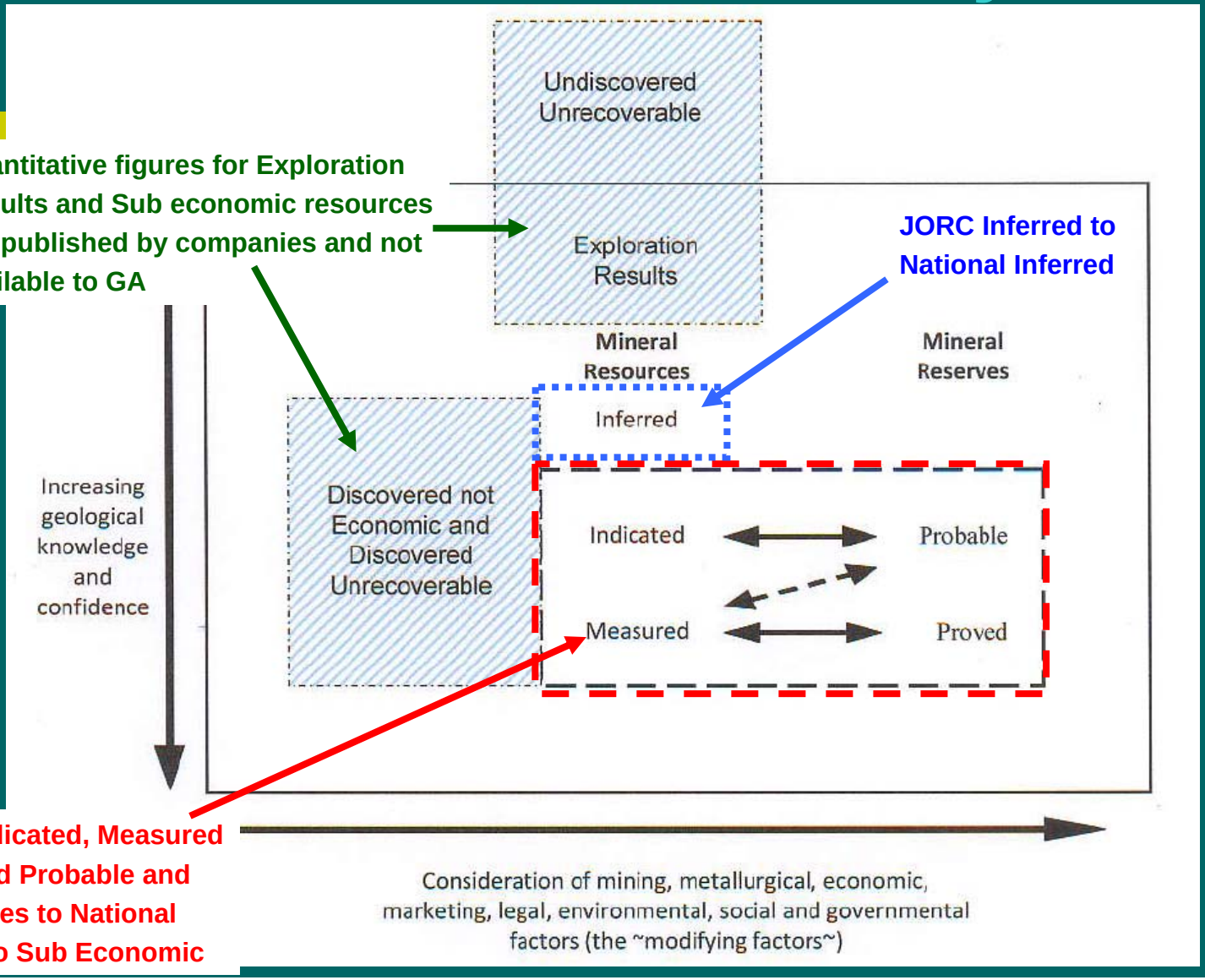
The JORC Template



From company reports to national inventory

- Reserve and Resource data reported for individual deposits by mining companies are compiled in Geoscience Australia's national mineral resources database
- These data provide the basis for the national assessment of Australia's mineral resources
- The JORC categories available for compilation of national resources are shown in the following slide

From company reports to national inventory



Quantitative figures for Exploration Results and Sub economic resources not published by companies and not available to GA

JORC Inferred to National Inferred

Most JORC Indicated, Measured Resources and Probable and Proved Reserves to National EDR – some to Sub Economic

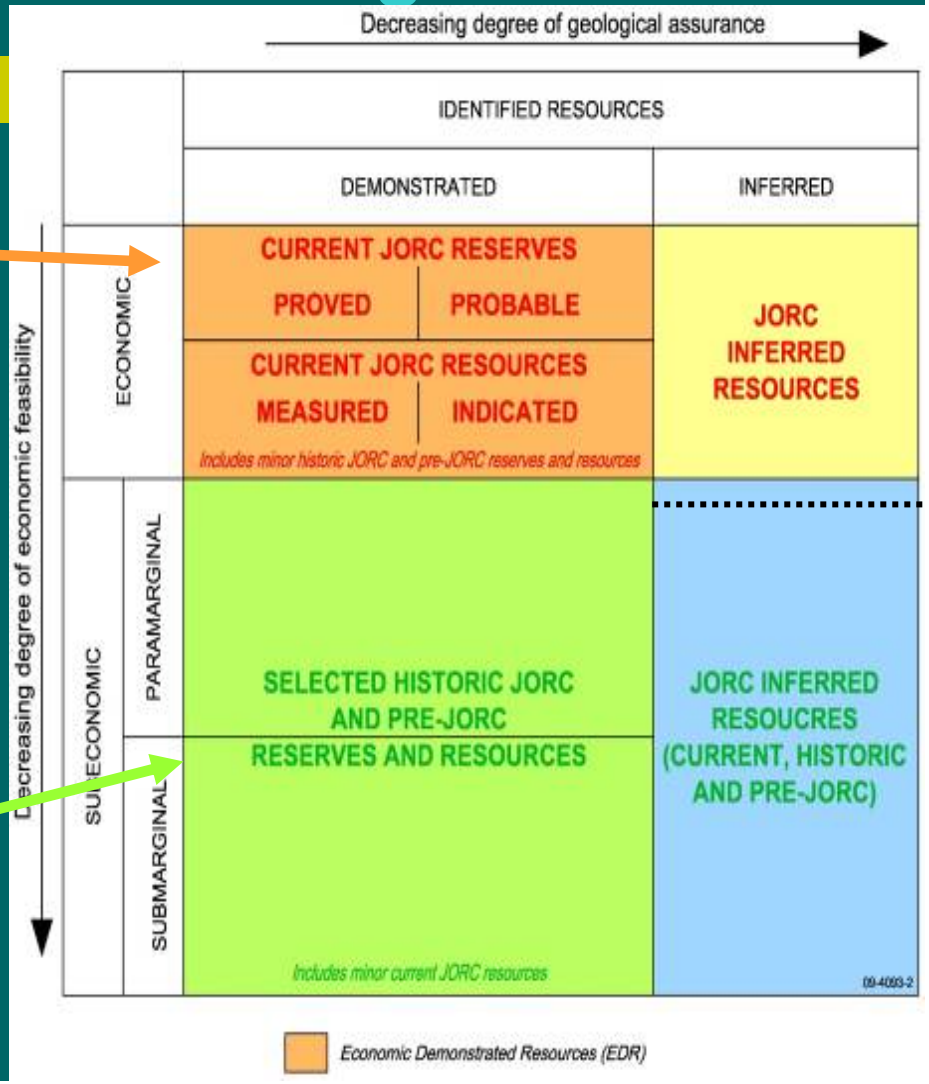
From company reports to national inventory

- JORC categories are aggregated into a smaller number of coarser categories in the national system
- These coarser categories provide a longer term (~25 year) perspective of what is likely to be available for mining
- More appropriate for forming long term planning for government policy
- As defined under the JORC code, a ‘resource’ in Australia’s national system must also have a reasonable prospect for becoming economic in the foreseeable future

Correlation of Australia's National Resource Classification system with JORC Code categories

In the national inventory, the highest category is 'Economic Demonstrated Resources' (EDR)

- EDR = 'Proved Reserves' + 'Probable Reserves' + 'Measured Resources' + 'Indicated Resources'
  - 'Subeconomic' Resources mainly from old reports but include some from current company reports



From company reports to national inventory

- As part of the compilation and aggregation of reported company resources into Australia's national resource system
  - Published company resource figures (historic and current) are continually reviewed and if necessary, moved out of EDR and downgraded to subeconomic categories

National minerals inventories: Not a precise science

- Estimating the total amount of each commodity likely to be available for mining in the long term is not a precise science
  - JORC ‘Reserves’, will in general all be mined, but they only provide a short term view of what is likely to be available for mining
  - Most current JORC ‘Measured’ and ‘Indicated’ Resources are likely to be mined
  - Some current JORC ‘Inferred’ and ‘Subeconomic’ Resources will also be mined
  - New discoveries (including extensions to known deposits) will add to the resource inventory

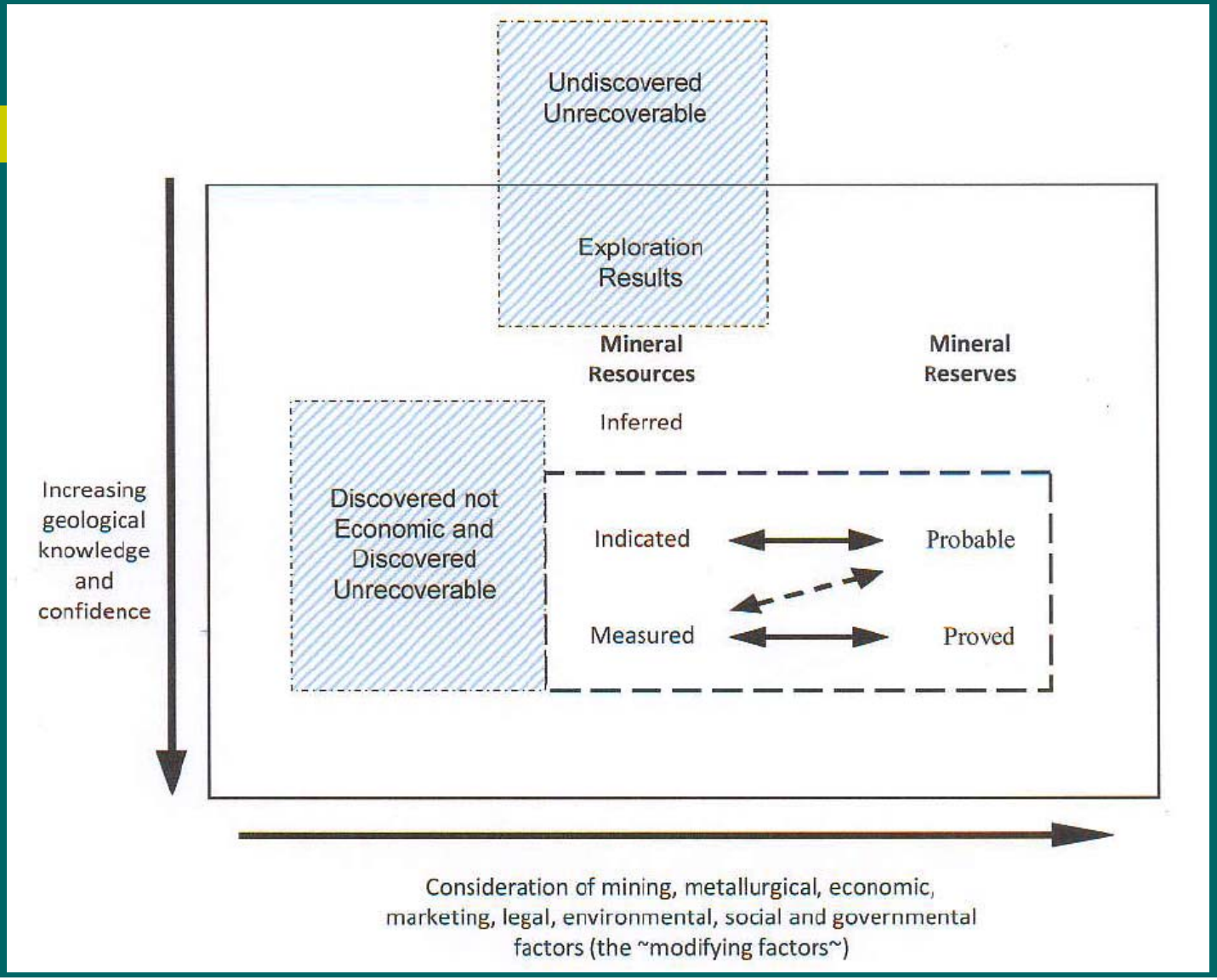
EDR: key indicator for development of long term government policy

- EDR considered to provide a reasonable and objective indication of what is **likely to be available for mining in the *longer term***
  - In an increasingly globalised world, the development of individual deposits will depend on how they compare with competing deposits elsewhere
  - The relative quality of deposits is important in determining when and whether they will be mined

Correlation of Australia's national system with UNFC-2009

- The CRIRSCO mineral resource template is the international equivalent of the JORC Code resource categories and
- The economic parameters of the CRIRSCO/JORC resource categories are illustrated in the following slides

Correlation of Australia's national system with UNFC-2009



High level mapping of JORC code/CRIRSCO scheme to UNFC-2009

Total commodity initially in place	Production	Sales Production / Non-sales Production	Categories		
		Class	E	F	G
	Future recovery by commercial development projects of mining operations	Mineral Reserves	1	1	1,2,3
	Potential future recovery by contingent development projects or mining operations	Mineral Resources	2	2	1,2,3
		Discovered Not Economic	3	2	1,2,3
	Discovered Unrecoverable		3	4	1,2,3
	Potential future recovery by successful exploration activities	Exploration Results	3	3	4
	Undiscovered Unrecoverable		3	4	4

Sub-class level mapping of JORC code/CRIRSCO scheme to UNFC-2009

UNFC Classes defined by categories and sub-categories						
Total commodity initially in place	Extracted	Sales Production				
		Non-sales Production				
	Class		Sub-class	Categories		
				E	F	G
	Known Deposit	Commercial Projects	On Production	1	1.1	1, 2, 3
			Approved for Development	1	1.2	1, 2, 3
			Justified for Development	1	1.3	1, 2, 3
		Potentially Commercial Projects	Development Pending	2[10]	2.1	1, 2, 3
			Development On Hold	2	2.2	1, 2, 3
		Non-Commercial Projects	Development Unclarified	3.2	2.2	1, 2, 3
			Development Not Viable	3.3	2.3	1, 2, 3
		Additional quantities in place		3.3	4	1, 2, 3
	Potential Deposit	Exploration Projects	[No sub-classes defined][11]	3.2	3	4
		Additional quantities in place		3.3	4	4

CRIRSCO/JORC RESERVES

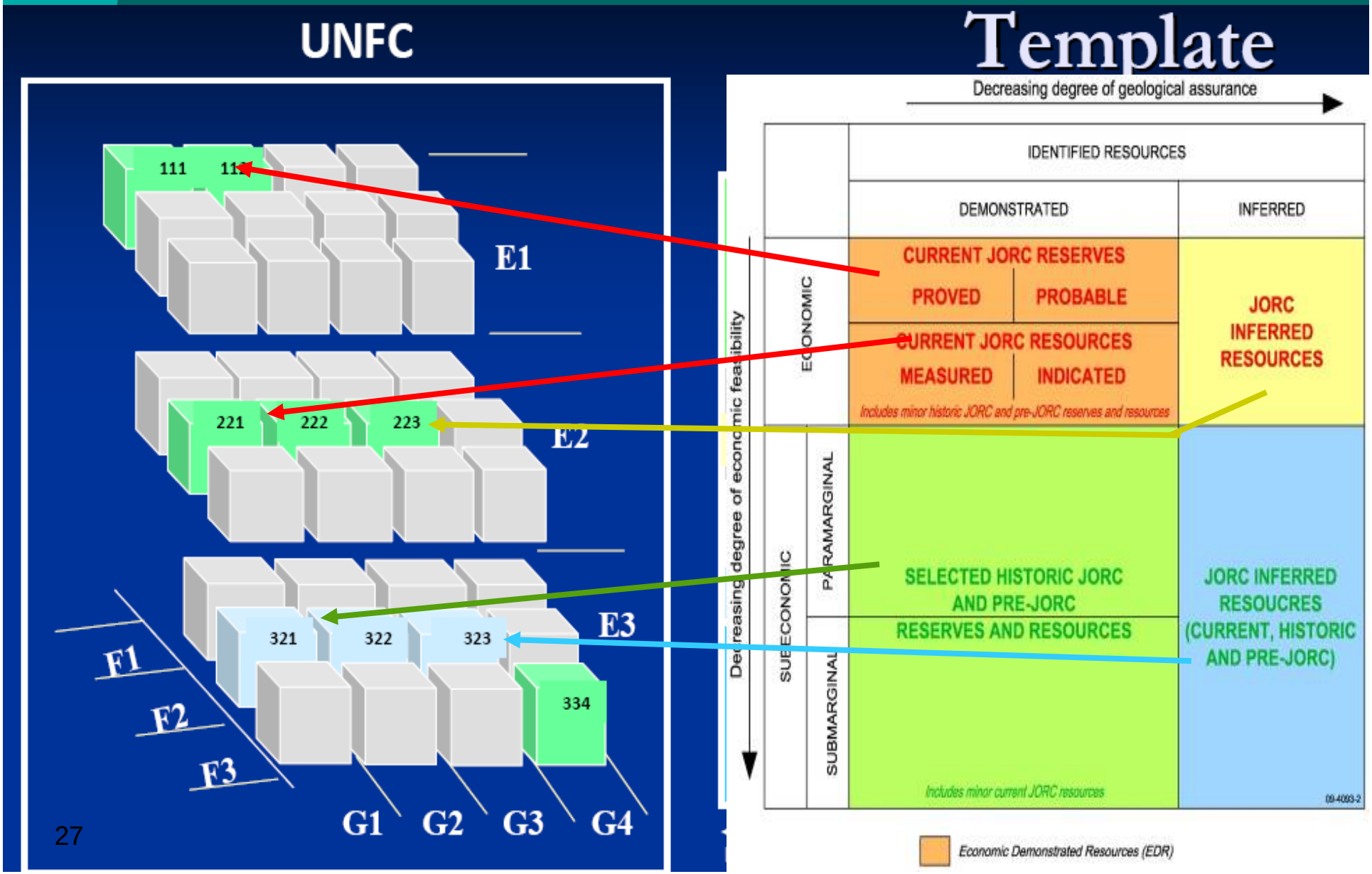
CRIRSCO/JORC RESOURCES

NOT ECONOMIC AND NOT PART OF CRIRSCO/JORC TEMPLATE

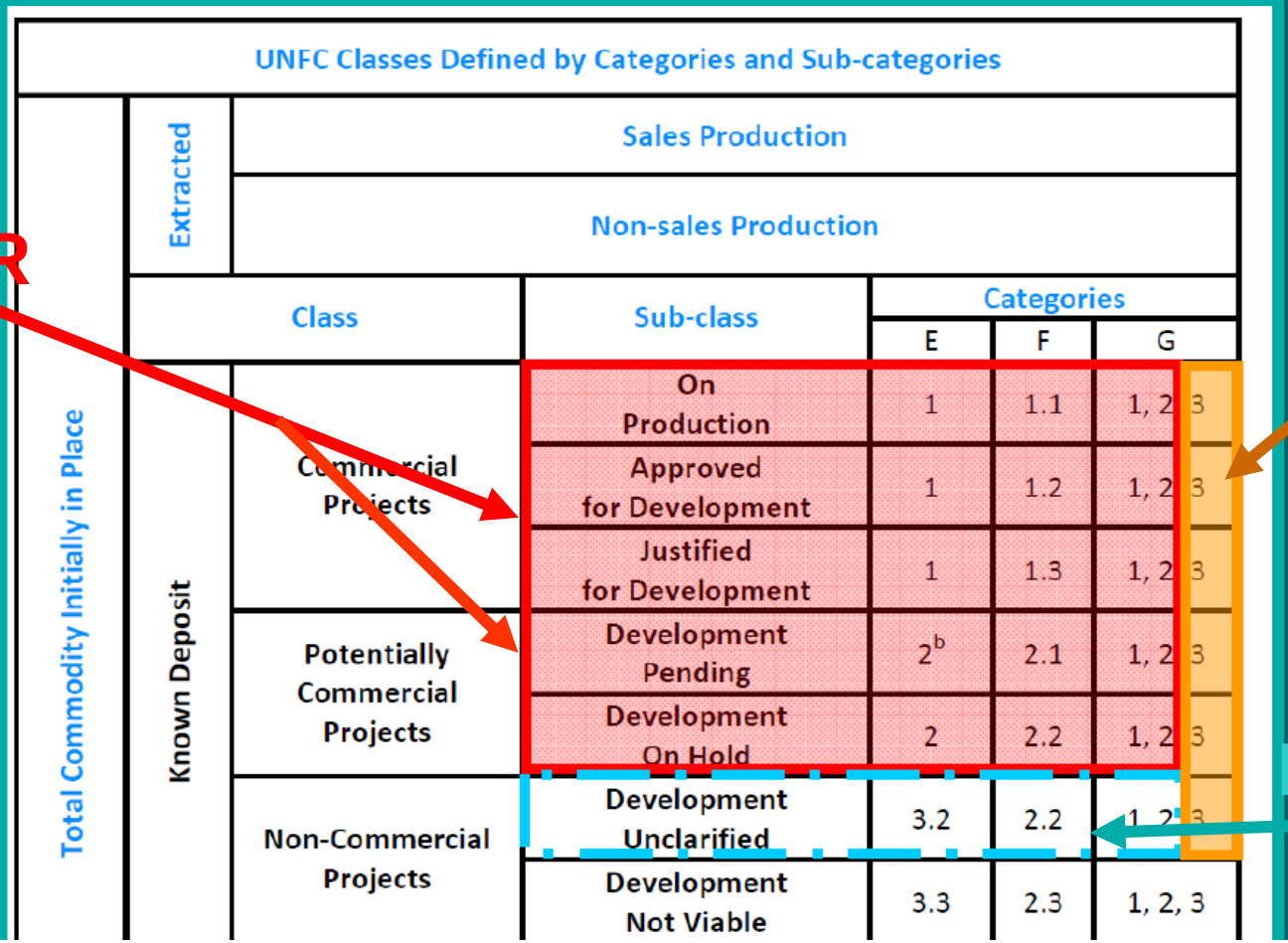
Correlation of Australia's national system with UNFC-2009

The correlation of Australia's national mineral resource classification with UNFC 2009 follows that of the JORC/CRIRSCO's mapping with UNFC – as shown in the following slides

Correlation of Australia's national system with UNFC-2009



Correlation of Australia's national system with UNFC-2009



EDR

Inferred

Paramarginal, Submarginal

UNFC as universal template

- The United Nations Framework Classification (UNFC 2009) is a universal template to which all other systems can be mapped
  - Industry, financial, national and international resource reporting systems are being, and hopefully will be, mapped to UNFC
    - To clarify the similarities and differences between systems in use around the world
- Many countries already have mandated commercial reporting systems
  - These countries will not adopt the UNFC
  - Other countries may choose to use the UNFC

What do some other countries report?

- USGS publishes “Reserves”
  - Comparable with EDR for most commodities
    = UNFC classes: “Commercial projects” + “Possibly Commercial Projects”
- Canada publishes Reserves (JORC equivalent) in operating mines
  = UNFC Sub-class: “Commercial projects on Production”
    - Very short term perspective on national resources
  - Except for U (equivalent to EDR)

Challenges due to different objectives in national and commercial reporting

- Commercial reporting focus on immediate/medium term financial returns, versus
- Need for government policies to assess longer term availability of mineral resources to support a national minerals industry
- Conflicting views even between companies with long-life large deposits and small miners with small deposits needing discoveries in immediate future to survive
- Further challenges with “promotional” reporting of resources by small companies in search of ‘good news’ to maintain shareholder interest.

Greater granularity of national reporting

- Australia is trialling further subdivision of EDR to:
  - Provide information on what is likely to be available in short, intermediate and longer time frames
    - Useful additional information for all interested parties
  - The sub-divisions of EDR being trialled reflect different levels of assurance of production
  - These can readily be mapped to the UNFC
    - Could be accepted through UNFC as international practice for national and international reporting

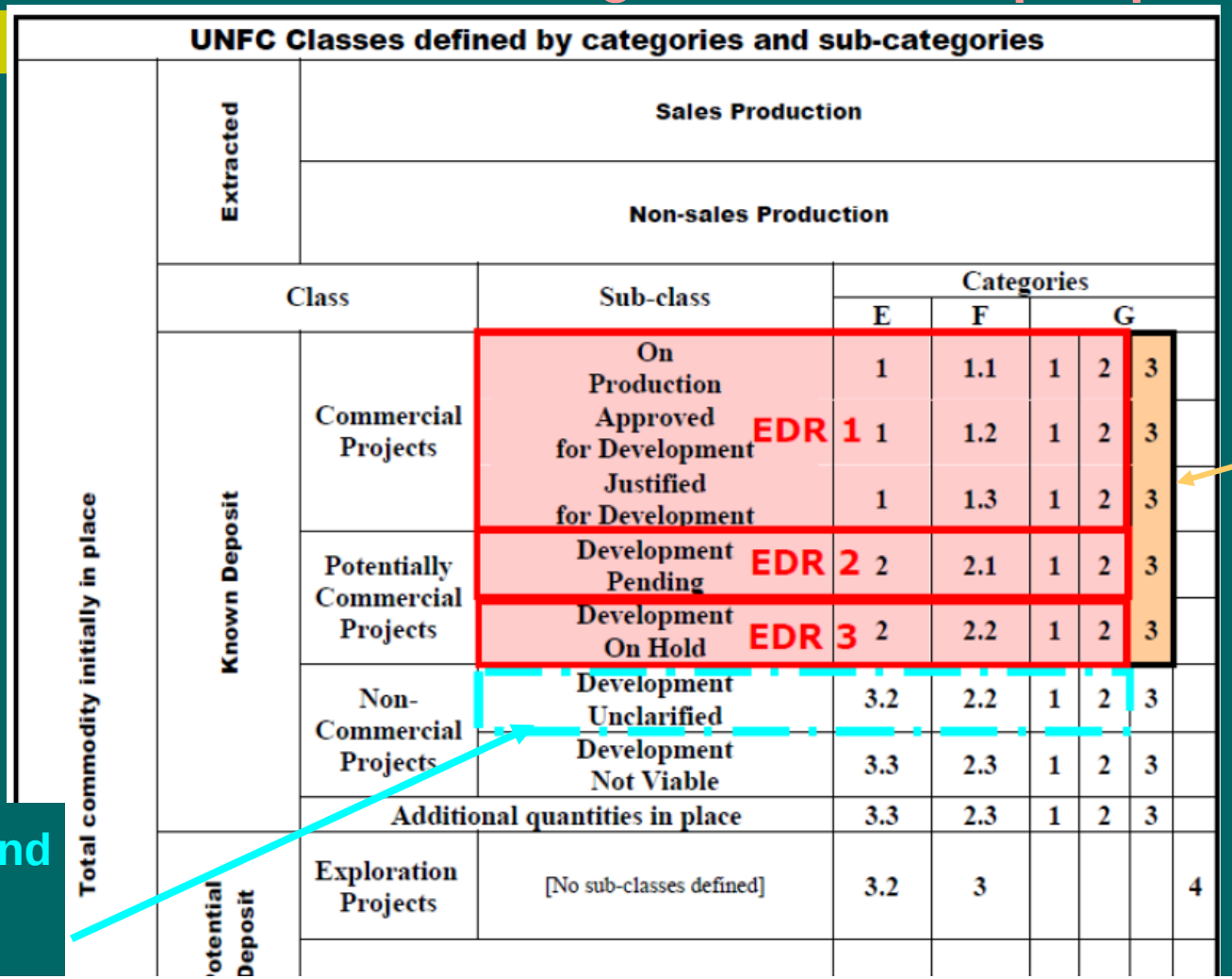
Greater granularity of national reporting

- **Short Term Economic Resources (“EDR 1”)** = Proven and Probable Ore Reserves (as defined under the JORC Code) [Note that Geoscience Australia already publishes this category in *Australia’s Identified Mineral Resources* as JORC Reserves]
- **Potential Medium Term Economic Resources (“EDR 2”)** = Measured and Indicated Mineral Resources in existing mines and undeveloped deposits which have had a positive feasibility study
- **Potential Long Term Economic Resources “EDR 3”** = Measured and Indicated Mineral Resources in deposits where their grade and tonnage characteristics are judged to be similar to deposits being mined elsewhere, but no positive feasibility study

Total EDR = sum of EDR1 + EDR2 + EDR3

EDR subdivisions mapped to UNFC-2009

➔ Short, intermediate and long term national perspectives



UNFC Classes defined by categories and sub-categories									
Total commodity initially in place	Extracted	Sales Production							
		Non-sales Production							
	Class		Sub-class	Categories E	F	G			
	Known Deposit	Commercial Projects	On Production	1	1.1	1	2	3	
			Approved for Development EDR 1	1	1.2	1	2	3	
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			Development Not Viable	3.3	2.3	1	2	3	
		Additional quantities in place		3.3	2.3	1	2	3	
	Potential Deposit	Exploration Projects	[No sub-classes defined]	3.2	3				4

Inferred Resources

Paramarginal and Submarginal Resources

Concluding Comments

- Australia's national mineral resource system is populated by data reported by mining companies for individual mineral deposits according to the JORC code/CRIRSCO scheme
- CRIRSCO have already mapped their resource categories onto the UNFC 2009
- Geoscience Australia has used CRIRSCO's (JORC code) mapping to correlate its broader (coarser) national categories with the UNFC 2009

Concluding Comments

- Because of limitations in staff and lack of access to confidential company data, it is not feasible for a government agency such as Geoscience Australia to convert company resource data to UNFC 2009 in more detail for individual deposits
- However, Geoscience Australia is currently investigating the possibility of subdividing its national EDR category

END

Australia’s identified mineral resources

- Australia’s resource stocks for all major and several minor mineral commodities are quantified in the annual online publication by Geoscience Australia (GA) : *Australia’s Identified Mineral Resources*: http://www.australianminesatlas.gov.au/aimr/index.jsp

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AUSTRALIA'S IDENTIFIED MINERAL RESOURCES 2010

Table 1. Australia's resources of major minerals and world figures as at December 2009.

COMMODITY	UNIT	AUSTRALIA							WORLD	
		Demonstrated Resources			Inferred Resources (a)	Accessible EDR (b)	JORC Reserves (% of AEDR) (c)	Mine Production 2009 (d)	Economic Resources (e)	Mine Production 2009 (f)
		Economic (EDR)	Subeconomic							
			Para-marginal	Sub-marginal						
Antimony	kt Sb	61	17	24	226	61	42 (69%)	0.2[i]	2100	187
Bauxite	Gt	6.2	0.2	1.4	0.93	5.4	2.4 (44%)	0.065	27	0.201[n]
Black coal										
in situ	Gt	60.7	3.3	9.2	125.2					
recoverable	Gt	43.8	1.8	5.9	78.2	43.7	14.2[g] (33%)	0.445	669[ii]	5.8[ii][j]
Brown coal										
in situ	Gt	41.2	43.5	18.1	112.4					
recoverable	Gt	37.1	39.1	16.3	101.2	32.1	4.7[g] (15%)	0.068[ii]	148[ii]	0.88[ii]
Cadmium	kt Cd	60.8	10.0	10.2	0.3	60.8	51.3 (84%)	0.46**	490	19.9[m]
Cobalt	kt Co	1363	269	241	1471	1363	293 (22%)	4.63[k]	6467	60.13
Copper	Mt Cu	80.4	4.5	1.0	38.4	80.4	23.2 (29%)	0.853	596	15.8
Chromium	kt Cr	0	0	0	3455	0	0	46.3[y]	>97 500	[z]
Diamond										
gem & near gem	Mc	104.8	41.7	0	15.3	104.8	85.5 (82%)	5.3	n.a.	96
industrial	Mc	109.1	43.4	0	16	109.1	89 (82%)	5.5	594	63
Fluorine	Mt F		0.5	0	0.4	0	0	0	117[ll]	2.6
Gold	t Au	7399	1495	120	4431	7270	3548 (48%)	223	47 00	2350
Iron ore	Gt	28.0	0.3	1.9	33.5	37.9	12.3 (44%)	0.394	168	2.3
Lead	Mt Pb	30.8	4.8	0.3	19.1	30.8	11 (35%)	0.57	85	4
Lithium	kt Li	607	0	0.1	37	607	58 (9.5%)	[m]	9927	18[m]
Magnesite	Mt $MgCO_3$	330	22	35	826	330	37.5 (11%)	0.345[o]	7980	17.32[m]
Manganese ore	Mt	181	23	167	134	181	146 (81%)	4.45	1420	31
Mineral sands										
Ilmenite	Mt	200.4	30.2	0.03	127.1	167.3	27.7 (17%)	1.534	1252	9.1
Rutile	Mt	22.7	7.0	0.06	31.3	19.4	5.0 (26%)	0.280	46	0.5[m]
Zircon	Mt	40.0	10.3	0.07	34.3	33.6	8.9 (26%)	0.476	87.7	1.19
Molybdenum	kt Mo	276	905	5	263	276	220 (80%)	0	8700	200
Nickel	Mt Ni	24.0	3.0	1.9	21.2	24.0	4.7 (20%)	0.165	68.6	1.4
Niobium	kt Nb	115	15	0	543	115	0	[p]	2900	62
Phosphate rock	Mt	248.6	1014	0	1295	248.6	81.6 (33%)	[q]	16 000	158
PGE (Pt, Pd, Os, Ir, Ru, Rh)	t metal	5.2	132.3	35.3	145.3	0.9	0.12 (13%)	0.726	71 000	373
Rare earths (REO & Y_2O_3)	Mt	1.65	0.37	34.48	24.56	1.65	0	0	95	1.33
Shale oil	GL	0	213	2074	1272[r]	0	0	0	763 139[s]	1.165[t]
Silver	kt Ag	70.3	11.9	2.9	33.7	70.3	26 (37%)	1.63	438	21.2
Tantalum	kt Ta	51	15	0.2	31	51	19 (37%)	0.022[u]	116	0.62
Thorium	kt Th	0	75.7[w]	0	409.0[v]	0	0	0	n.a.	n.a.
Tin	kt Sn	176	63	27	395	176	47 (27%)	5.63	5660	332
Tungsten	kt W	195.5	0.8	1.4	204	195.5	40.3 (20.6%)	0.0036	2995	58
Uranium	kt U	1223	11	3	567	1115	307 (27%)	7.985	2577[ww]	50.772[x]
Vanadium	kt V	2673	8629	1279	5117	2673	1172 (44%)	0	15 673	54
Zinc	Mt Zn	58.4	4.2	1.0	21.8	58.4	19.6 (33%)	1.29	235	11.1

Available through Australian mines atlas

www.australianminesatlas.gov.au

Australian Government

australian atlas of minerals resources, mines & processing centres

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Information about Mineral Resources

Read in-depth information about **Gold, Bauxite, Iron Ore, Copper** and other major mineral commodities in the annual Australia's Identified Mineral Resources report.

View Fact Sheets and Rock Files about some of Australia's key metals and minerals in our **Education** section. Also available is Minerals Downunder - a student resource with information about **Gold, Copper, Silver, Mineral Sands** and **Iron**, as well as interactive quizzes.

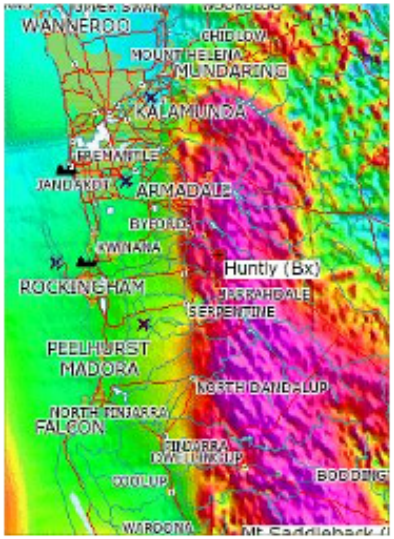
- **Australia's Identified Mineral Resources**
- **Mineral Fact Sheets**
- **Mineral Rock Files**
- **Minerals Downunder**
- **Geoprovince-Scale Assessment of Mineral Potential**

History of the Minerals Industry

View a history of the minerals industry in Australia in Google Earth and read about its role in Australia's economic development.

- **History of the Minerals Industry in Australia**

Your Feedback



Airborne Magnetics image of Darling Range Bauxite - www.australianminesatlas.gov.au

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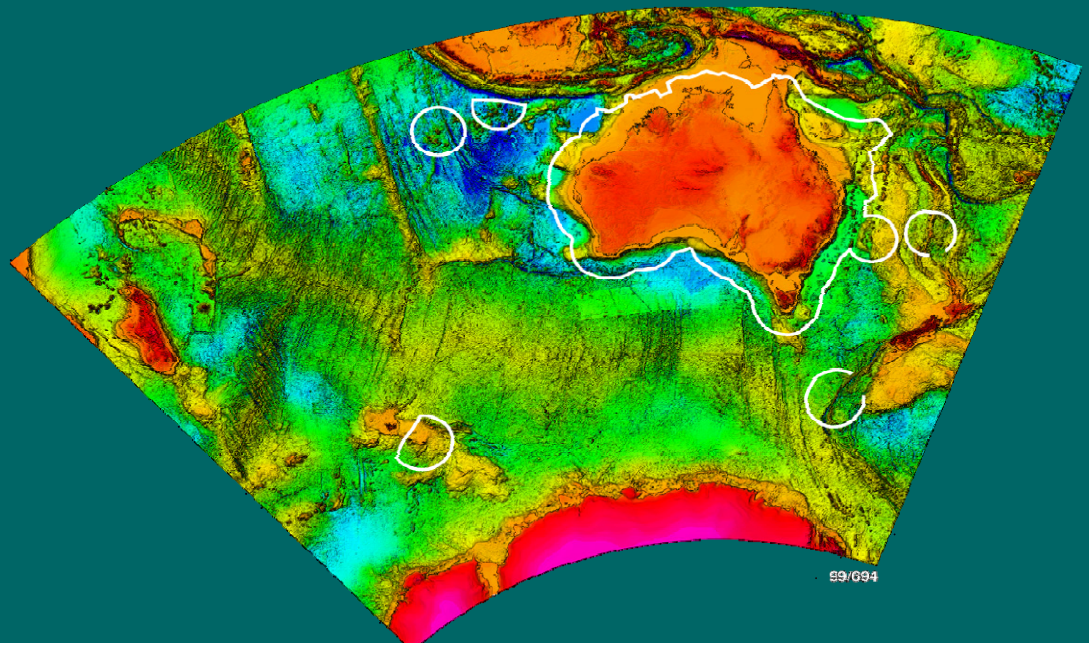

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    - Including many international leaders in their fields
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