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Supplement of

Recent revisions of phosphate rock reserves and resources: a critique

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Figure 1.

Major elements of USGS mineral resource classification based on McKelvey's resource box, excluding the reserve base and inferred reserve base. Adapted from: USGS and USBM, 1980.

>>>> Decreasing degree of geologic assurance >>>>					
	IDENTIFIED RESOURCES			UNDISCOVERED RESOURCES	
	Measured	Indicated	Inferred	Probability range	
				Hypothetical	Speculative
Decreasing economic feasibility <<<<	ECONOMIC	<i>Reserves</i>		<i>Hypothetical</i>	<i>Speculative</i>
	MARGINALLY ECONOMIC	<i>Marginal Reserves (not part of reserves)</i>		<i>Resources (undiscovered)</i>	<i>Resources (undiscovered)</i>
	SUB-ECONOMIC	<i>Demonstrated Subeconomic Resources</i>			
	OTHER OCCURENCES	<i>Other PR occurences (not part of the resources)</i>			

Figure 2.

Reserve base and inferred reserve base under the USGS classification. Adapted from: USGS and USBM, 1980.

>>>> Decreasing degree of geologic assurance >>>>						
	IDENTIFIED RESOURCES			UNDISCOVERED RESOURCES		
	Demonstrated		Inferred	Probability range		
	Measured	Indicated		Hypothetical	Speculative	
<<<< decreasing economic viability <<<<	ECONOMIC	<i>Reserve</i>		<i>Inferred Reserve Base</i>	<i>Hypothetical Resources (undiscovered)</i>	<i>Speculative Resources (undiscovered)</i>
	MARGINALLY ECONOMIC					
	SUB-ECONOMIC	<i>Demonstrated Subeconomic Resources (not part of reserve base)</i>		<i>Inferred Subeconomic resources</i>		
OTHER OCCURENCES		<i>Other PR occurences (not part of the resources)</i>				

Figure 3.

General relationship between Exploration Results, Mineral Ore resources and Ore reserves under JORC classification. Source: JORC, 2012 edition (JORC, 2012).

JORC style codes use seven main definitions, being: (i) Mineral Resources; (ii) Inferred Mineral Resources; (iii) Indicated Mineral Resources; (iv) Measured Mineral Resources; (v) Ore Reserves; (vi) Probable Ore Reserves; (vii) Proved Ore Reserves. Exploration Results may also be reported under JORC.

Mineral Resources may be inferred, indicated or measured. Ore Reserves are a subset of Mineral Resources and are reported as extractable material. Modifying factors are considerations which are used to convert Mineral Resources to Ore Reserves (see arrow in overview below). Mineral resources may be converted to either Proved Ore Reserves or Probable Ore Reserves depending on uncertainties relating to some or all of the modifying factors, (JORC, 2012, p. 8). See broken arrow below.

Exploration results include data generated by mineral exploration programs that might be of use to investors but do not form part of a declaration of Mineral Resources or Ore Reserves. The reporting of such information is common in the early stages of exploration when the quantity of data available is generally not sufficient to allow any reasonable estimates of Mineral Resources (JORC, 2012).

The aggregate of JORC indicated and measured resources and JORC measured and proved ore reserves are comparable to USGS' reserves and Australian EDR (Lambert et al. 2012).

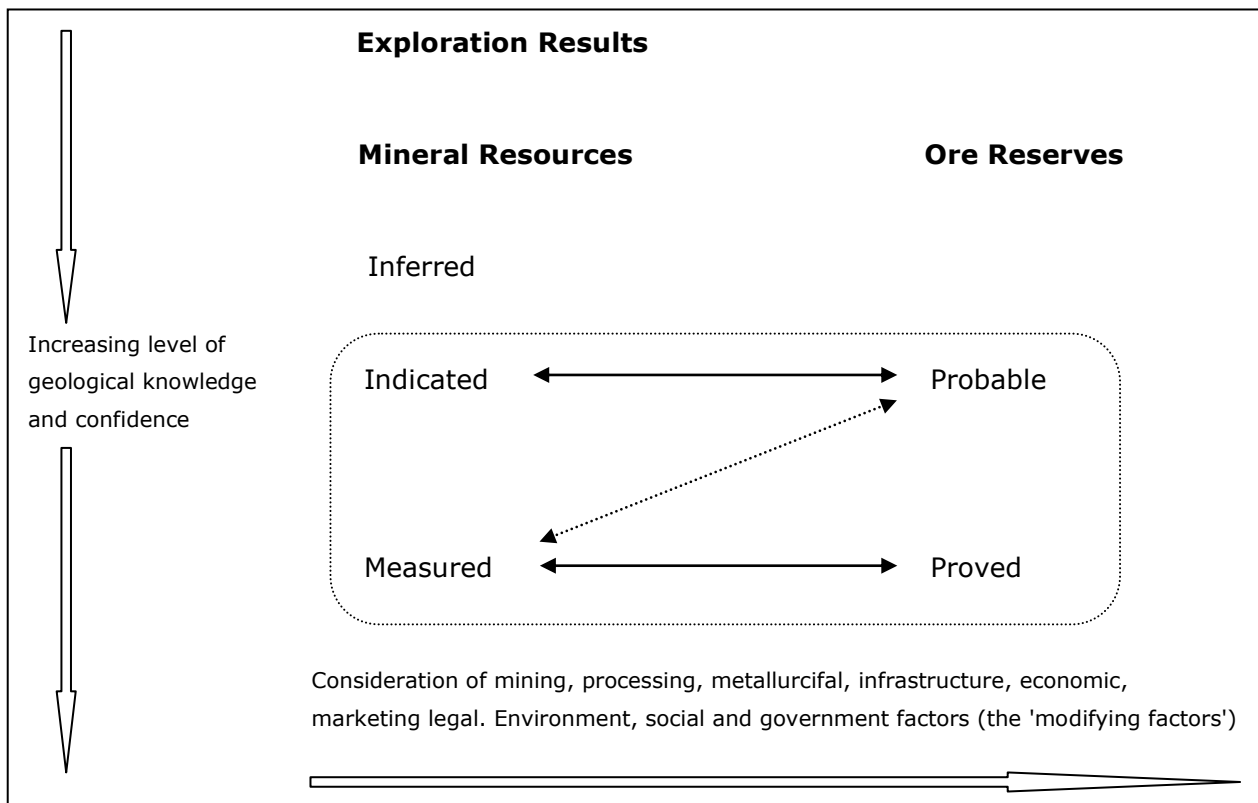


Figure 4.

JORC proved and probable ore reserves and JORC measured and indicated resources mapped to USGS classification, based on McKelvey's resource box. Source: Lambert et al., 2012.

>>>> Decreasing degree of geologic assurance >>>>

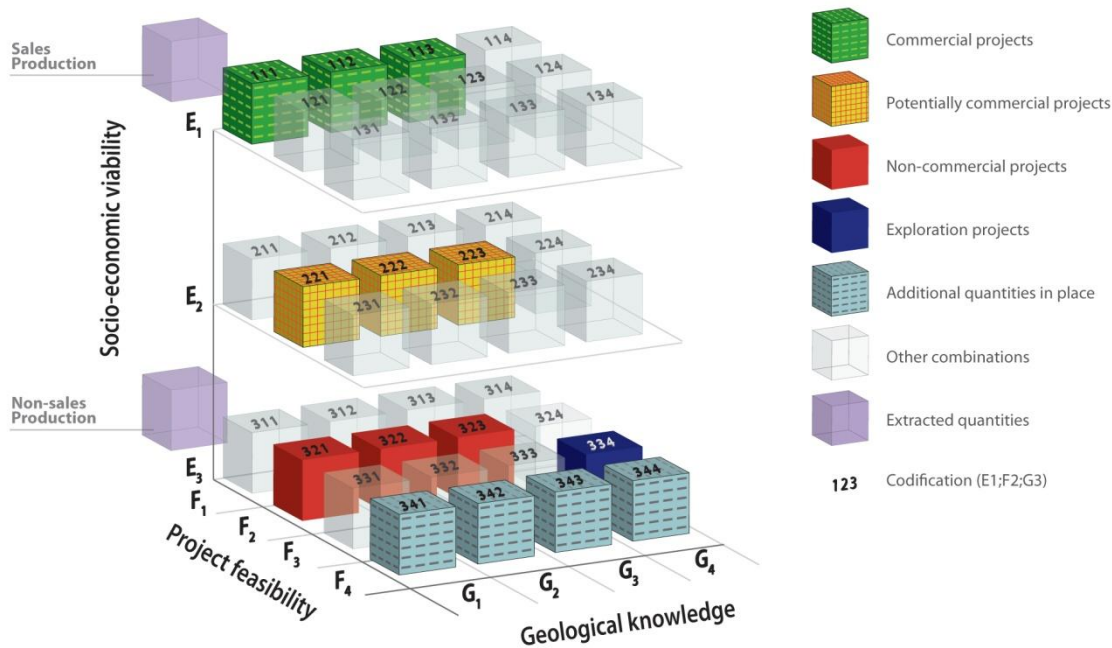
Decreasing economic feasibility <<<<

	IDENTIFIED RESOURCES			UNDISCOVERED RESOURCES	
	Demonstrated		Inferred	Probability range	
	Measured	Indicated		Hypothetical	Speculative
ECONOMIC	<i>JORC proved ore reserves</i>	<i>JORC probable ore reserves</i>			
	<i>JORC measured resources</i>	<i>JORC indicated resources</i>			
MARGINALLY ECONOMIC					
SUB-ECONOMIC					
OTHER OCCURENCES					

Figure 5.

Overview UNFC classification. Source: UNFC, 2010.

The UNFC classification consists of a three dimensional numerical system containing three axes: (i) Geological knowledge; (ii) Project feasibility and (iii) Socio-economic viability.



Cubes 111 and 112 score the highest in terms of economic feasibility, project feasibility and geological knowledge. Cubes 111 and 112 are comparable to JORC proved and probable reserves (see figures 3 and 4).

Cubes 221 and 222 are positioned somewhat lower on the viability and feasibility axes and are comparable with JORC measured and indicated resources (figure 4). Taken together, cubes 111, 112, 221 and 222 are comparable with USGS reserves (figure 1) or Australian EDR (Economic Demonstrated Resources). Cube 223 is comparable with JORC inferred economic resources of USGS inferred reserves (which are not part of the reserves under USGS terminology).

Cubes 321, 322 and 323 (non commercial projects) are comparable with JORC demonstrated subeconomic and inferred subeconomic resources, or USGS demonstrated and inferred subeconomic and marginally economic resources (see: figure 1).

Cube 334 (exploration results) is designed specifically to report exploration results, in a manner similar to JORC exploration results.

Cubes 341, 342, 343 and 344 represent deposits which are not deemed potentially economic in the foreseeable future. These categories are comparable to USGS' other occurrences (USGS and USBM, 1980; see figure 1) and suitable for reporting sub resource deposits at various stages of geological knowledge.

Source for mapping: Lambert et al. 2012

Figure 6.

Overview of PR ore and borehole distances. Source: OCP annual statement for the year 2000 (OCP, 2000)

EXPLORATION GRID					
ORE DEPOSIT AREA	< 500 m	500-1000 m	1000-2000 m	> 2000 m	TOTAL
Ouled Abdoun	8.06	9.13	2.89	17.27	37.35
Gantour	6.55	2.92	5.12	16.50	31.09
Meskala	2.18	-	0.77	13.00	1.95
Boucrâa	0.44	0.33	0.30	0.04	1.11
Total	17.23	12.38	9.08	46.81	85.50

Unit: billions of cubic meters