



*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	
			Inferred	Probability range	
	Measured	Indicated		Hypothetical	Speculative
ECONOMIC	Reserves		<i>Inferred reserves (not part of reserves)</i>	<i>Hypothetical Resources</i>	<i>Speculative Resources</i>
MARGINALLY ECONOMIC	<i>Marginal Reserves (not part of reserves)</i>		<i>Inferred marginal reserves (not part of reserves)</i>	<i>(undiscovered)</i>	<i>(undiscovered)</i>
SUB-ECONOMIC	<i>Demonstrated Subeconomic Resources</i>		<i>Inferred subeconomic resources</i>		
OTHER OCCURRENCES	<i>Other PR occurrences (not part of the resources)</i>				

Decreasing economic feasibility <<<<<

**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
ECONOMIC		<i>Reserve</i>		<i>Inferred Reserve Base</i>	<i>Hypothetical Resources</i>	<i>Speculative Resources</i>
MARGINALLY ECONOMIC		<i>Base</i>		<i>(not part of reserve base)</i>	<i>(undiscovered)</i>	<i>(undiscovered)</i>
SUB-ECONOMIC		<i>Demonstrated Subeconomic Resources (not part of reserve base)</i>		<i>Inferred Subeconomic resources</i>		
OTHER OCCURRENCES		<i>Other PR occurrences (not part of the resources)</i>				

decreasing economic viability <<<<

**Figure 3.**

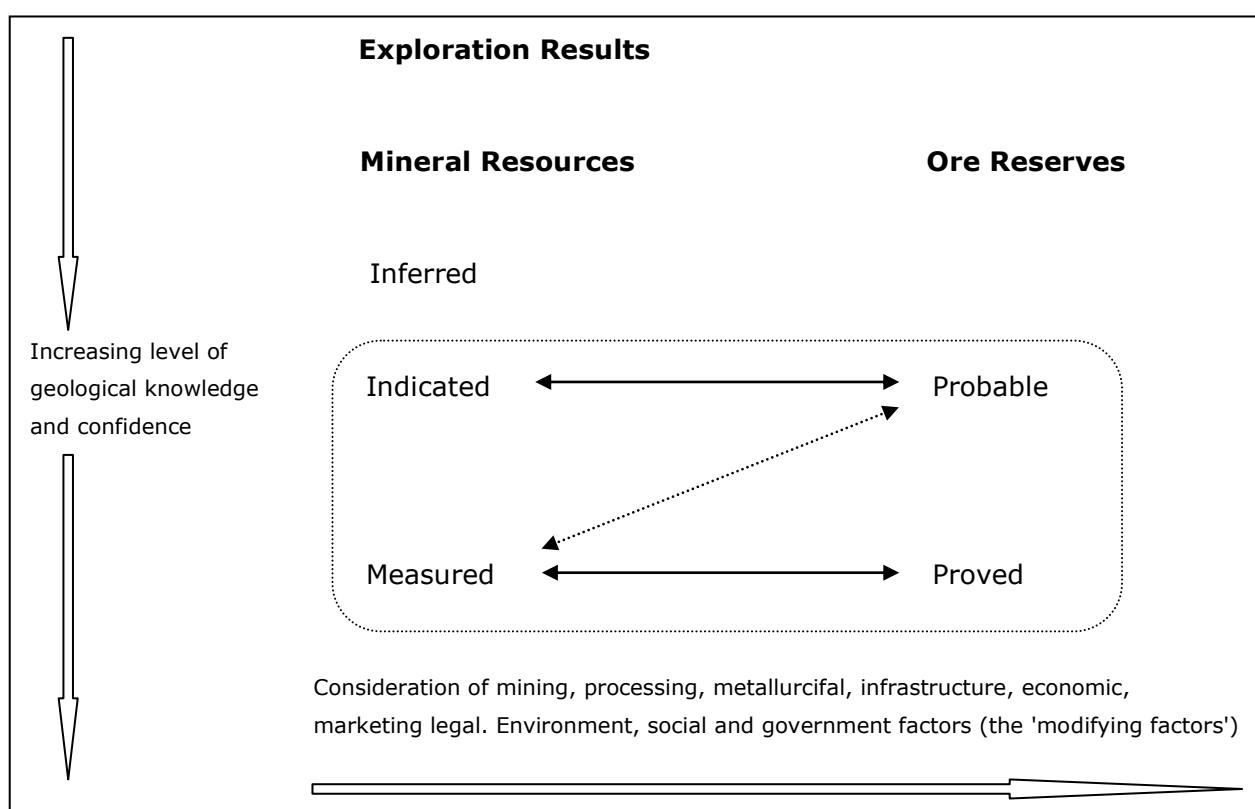
General relationship between Exploration Results, Mineral Ore resources and Ore reserves under JORC classification. Source: JORC, 2012 edition (JORC, 2012).

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 >>>>

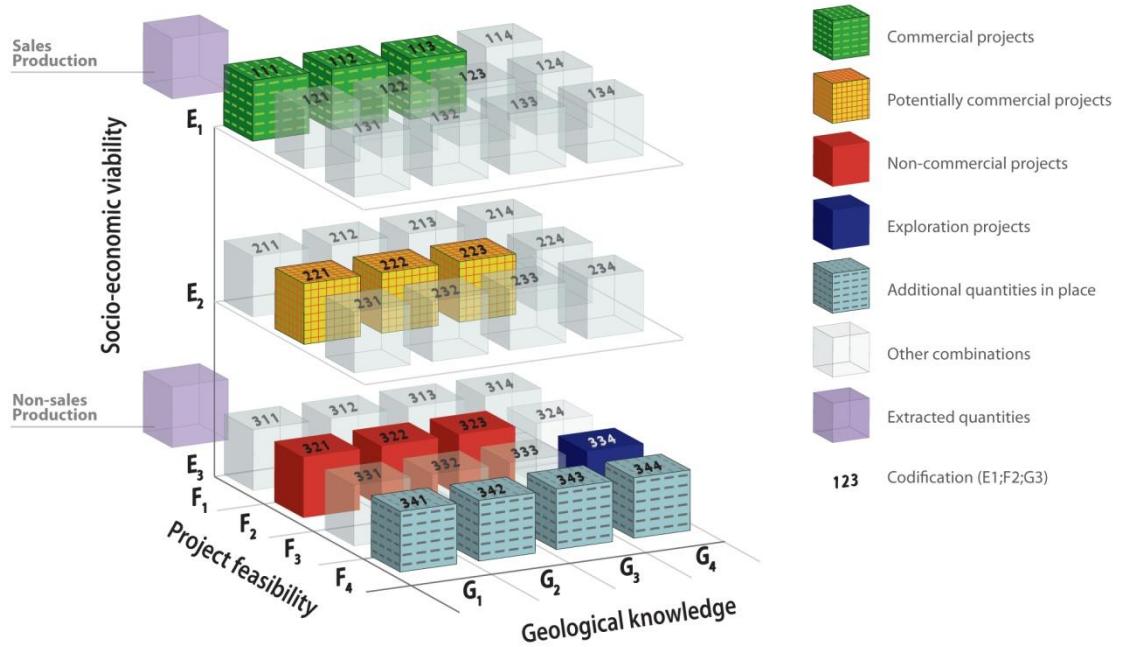
	IDENTIFIED RESOURCES			UNDISCOVERED RESOURCES	
	Demonstrated		Inferred	Probability range	
	Measured	Indicated		Hypothetical	Speculative
ECONOMIC	<i>JORC proved ore reserves</i>	<i>JORC probable ore reserves</i>	Inferred		
	<i>JORC measured resources</i>	<i>JORC indicated resources</i>			
MARGINALLY ECONOMIC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

Decreasing economic feasibility <<<<

**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 (UGSG 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)

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

Unit: billions of cubic meters