



**COLORADO**SCHOOL OF **MINES**



**COMPETITIVE PLATINUM–GROUP–METAL (PGM)  
SUPPLY FROM THE EASTERN LIMB, BUSHVELD  
COMPLEX: GEOLOGICAL, MINING, AND MINERAL  
ECONOMIC ASPECTS**

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# ACKNOWLEDGEMENTS

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- ▶ Mr. VISHNU PILLAY  
(EXECUTIVE HEAD: JV'S – Anglo Platinum)
- ▶ ACADEMIC ADVISORS  
Prof. Murray Hitzman (Economic Geology); Dr. Hugh Miller (Mining Engineering); Prof. Rodderick Eggert (Mineral Economics).

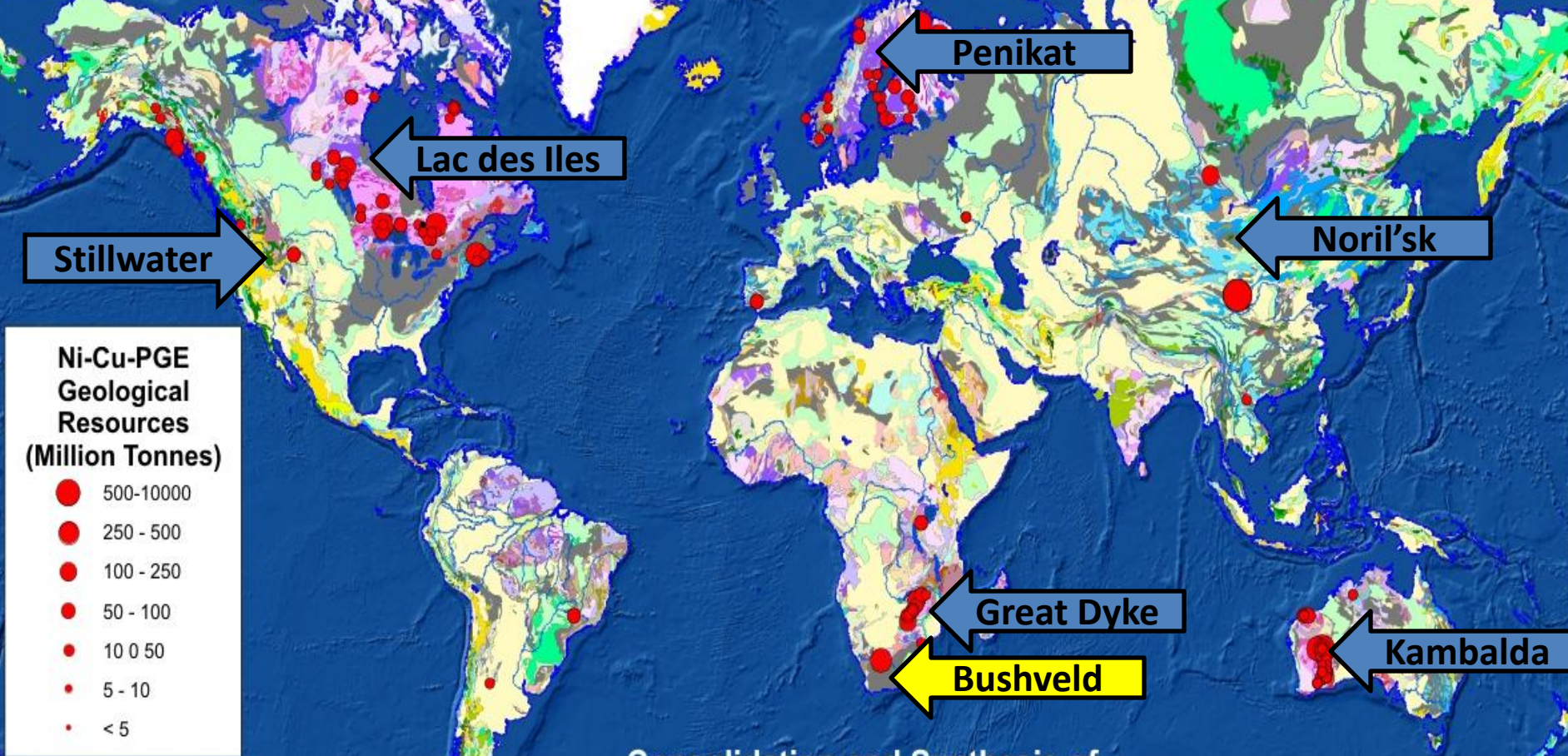
An analysis of South African PGM production potential to prolong global

Can the Eastern Limb, Bushveld Complex, be considered, by investors, in preference to the Western Limb?





# MAJOR Ni-Cu-PGE DEPOSITS OF THE WORLD



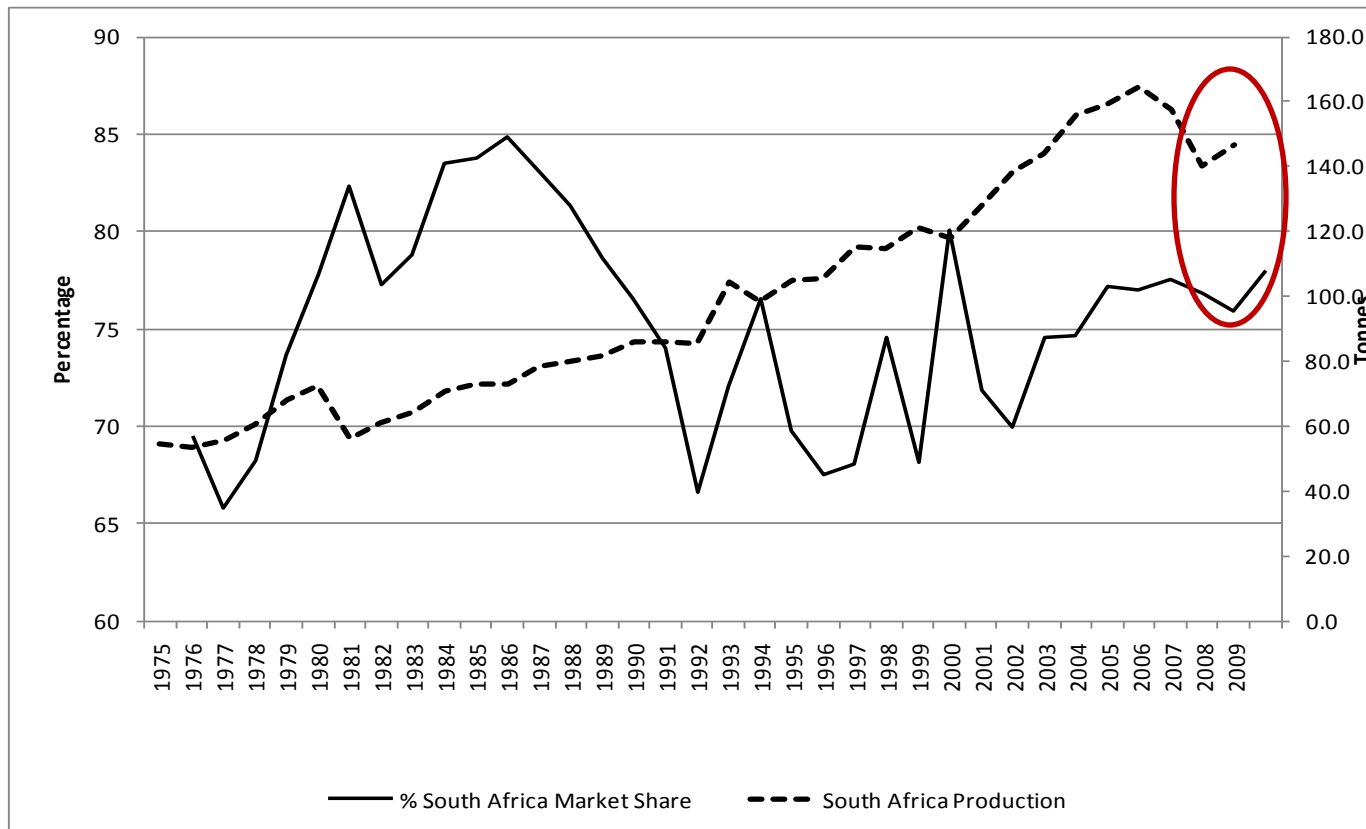
Consolidation and Synthesis of  
Mineral Deposits Knowledge

<http://gsc.nrcan.gc.ca/mindep/>

# The Bushveld Complex

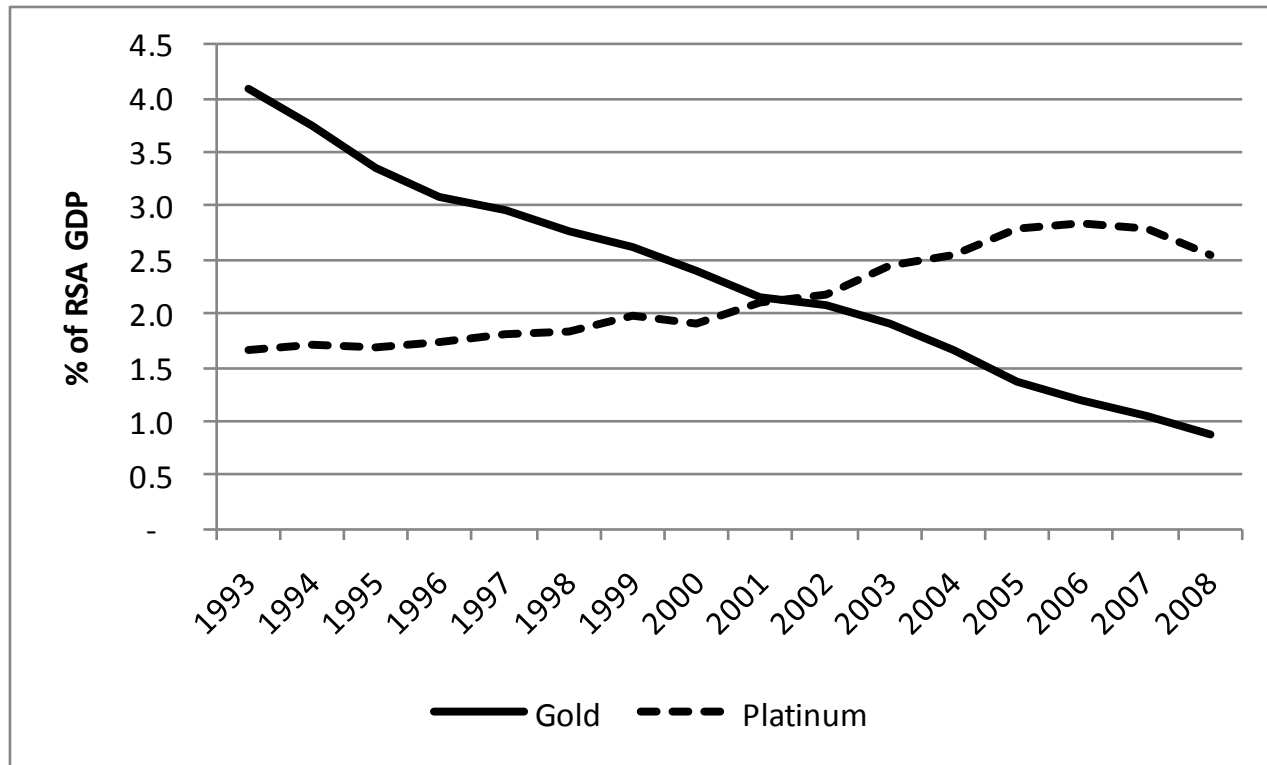
- ▶ Two distinct geographical portions: western and eastern limbs
- ▶ Main mineralized horizons: Merensky Reef and UG2
- ▶ (For the purposes of this discussion the northern limb and the Platreef is excluded)

# Total South African PGM production and associated market share (1975–2009)



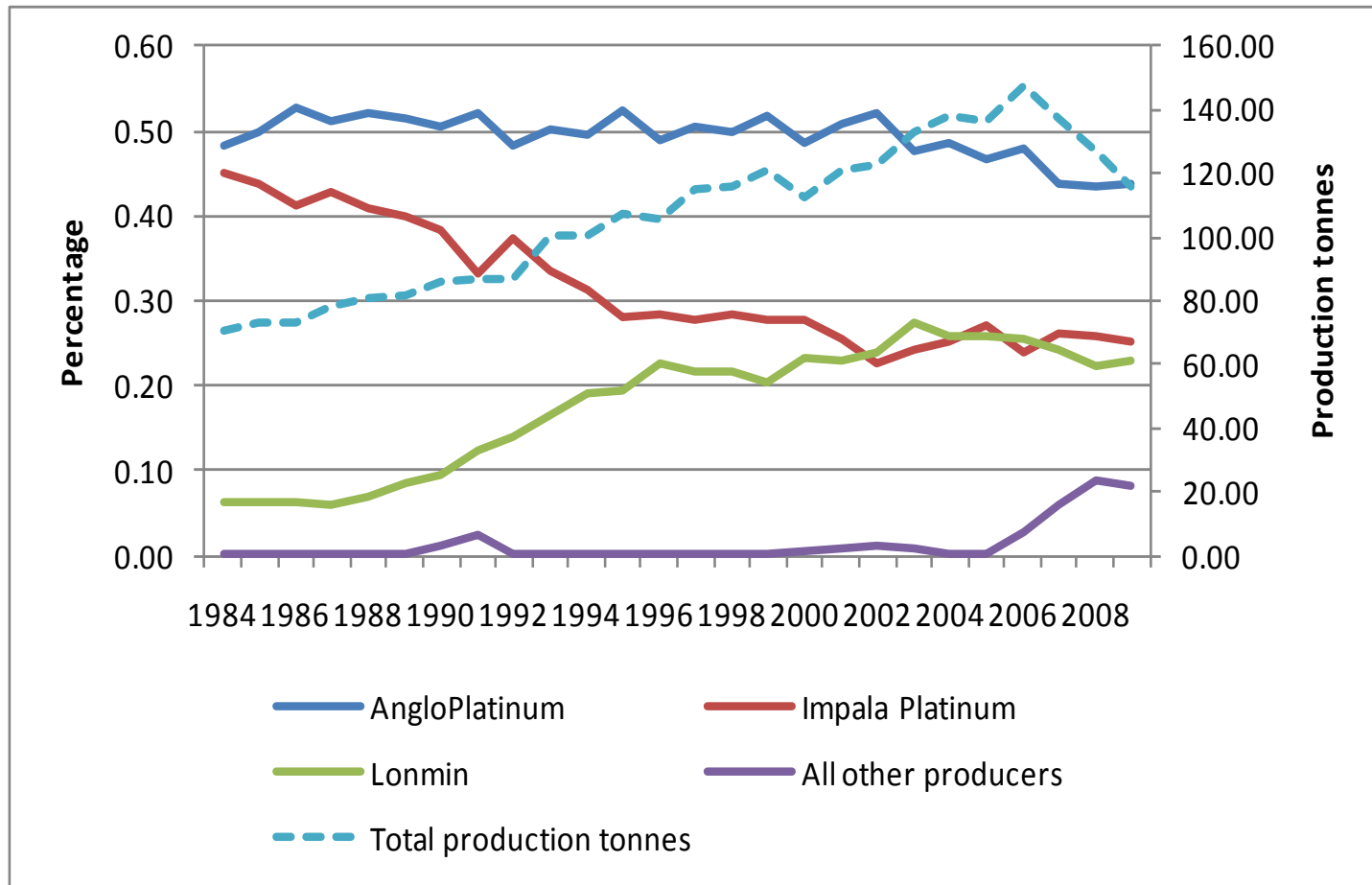
(Data source: Johnson Matthey, Raw Materials Group)

# Gold and PGM sector South African GDP contribution



(Data source: Chamber of Mines)

# Legislative impact on market share





# This work provides

**Integration of diverse data sources to provide a holistic, and strategic, view of the South African PGM landscape, with specific reference to the eastern limb, Bushveld Complex**

**There is an overall lack of cumulative studies, in the public domain, that strategically appraise the South African PGM production sector**

# Core conditions → underlying criteria

Mineral Economics



- Long-run demand/supply
- Economically competitive

Resource/Reserves



- Sufficient size and grade
- Supply-pipe line

Mining - related



- Largely mechanized, cost effective and safe

“Above-ground” risks



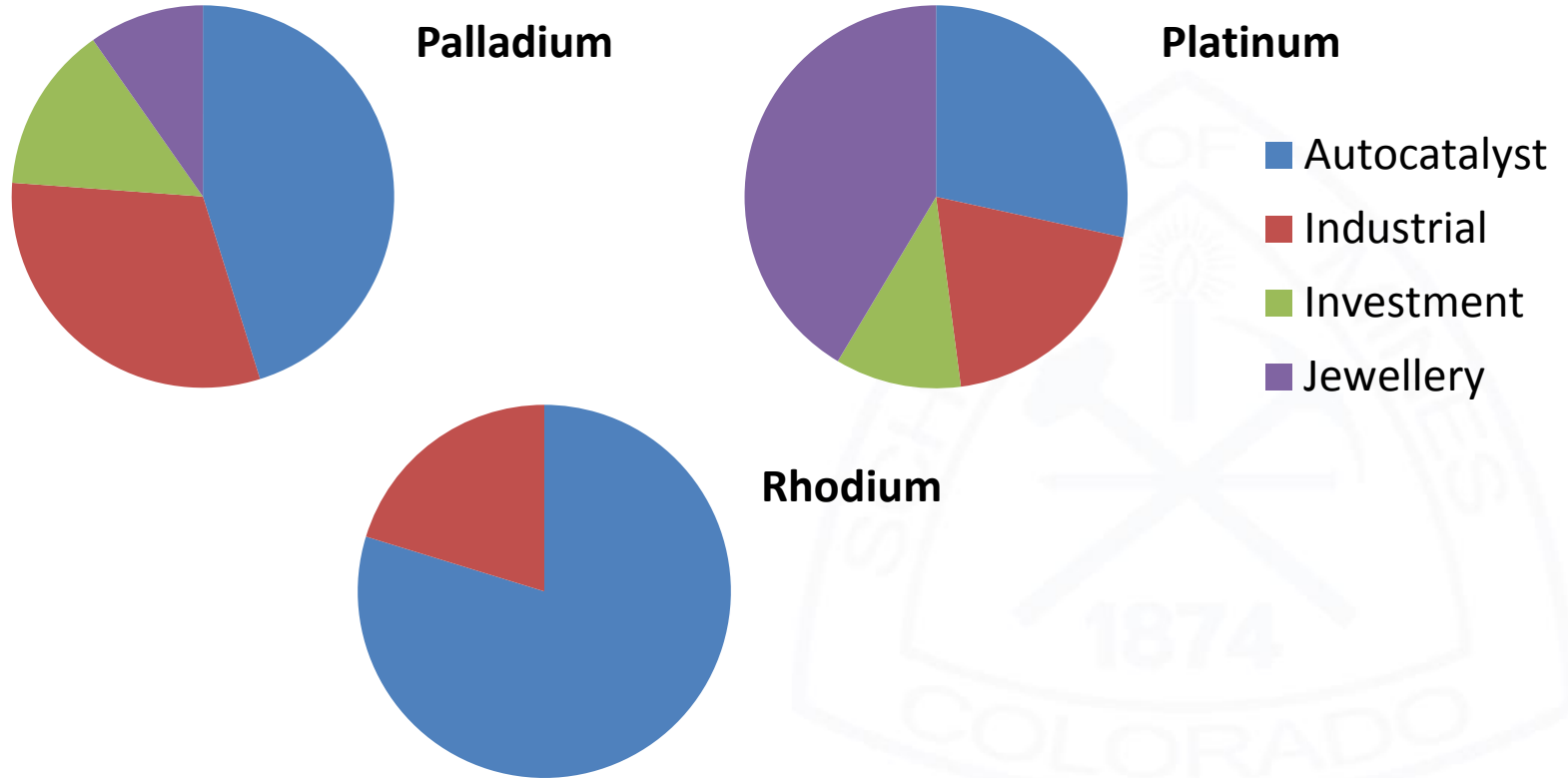
- Adequate water and power

# Criteria 1

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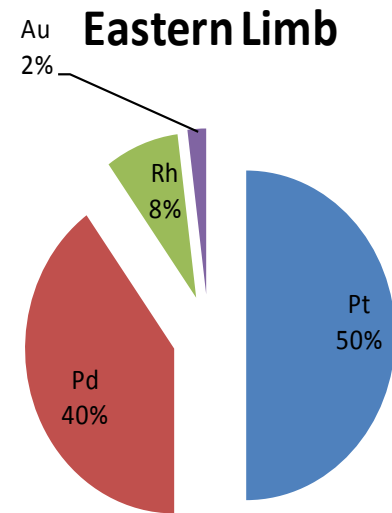
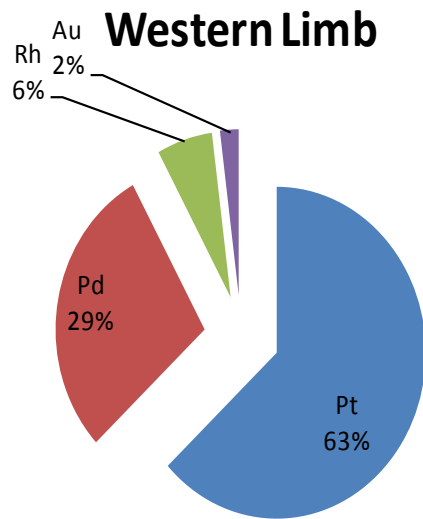
The long-run forecast of demand and supply dynamics underpin a continued need for PGM production

# Global PGM demand per use sector (2010)



(Data source: Johnson Matthey)

# Mineral basket comparison



# Long-run demand and supply trends

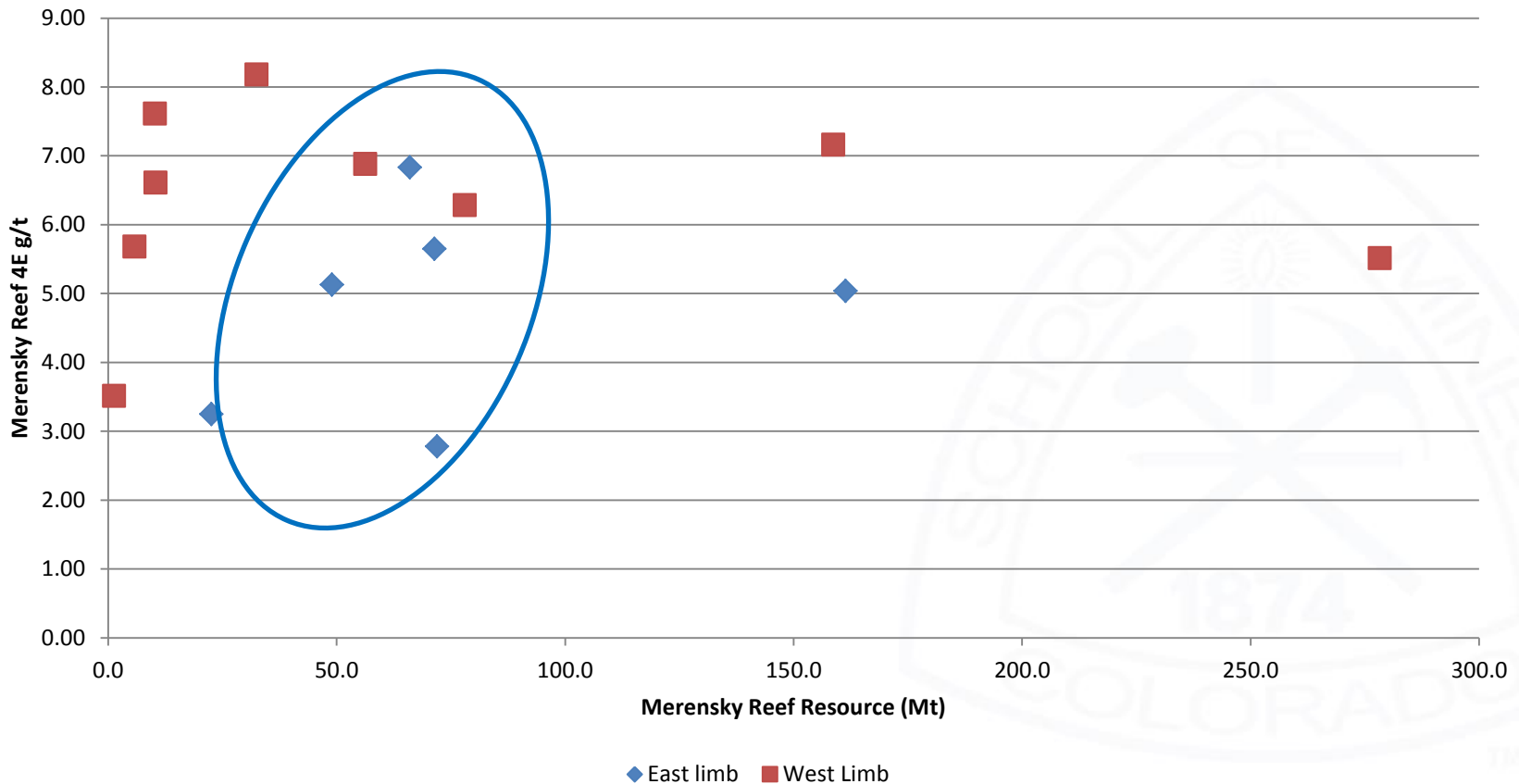
- ▶ Global demand for PGM's is forecast to be sustained – underpinned by auto catalyst and jewellery sector demand growth (especially from China)
- ▶ The world needs PGM's
- ▶ Can South Africa remain the number one global supplier?

# Criteria 2

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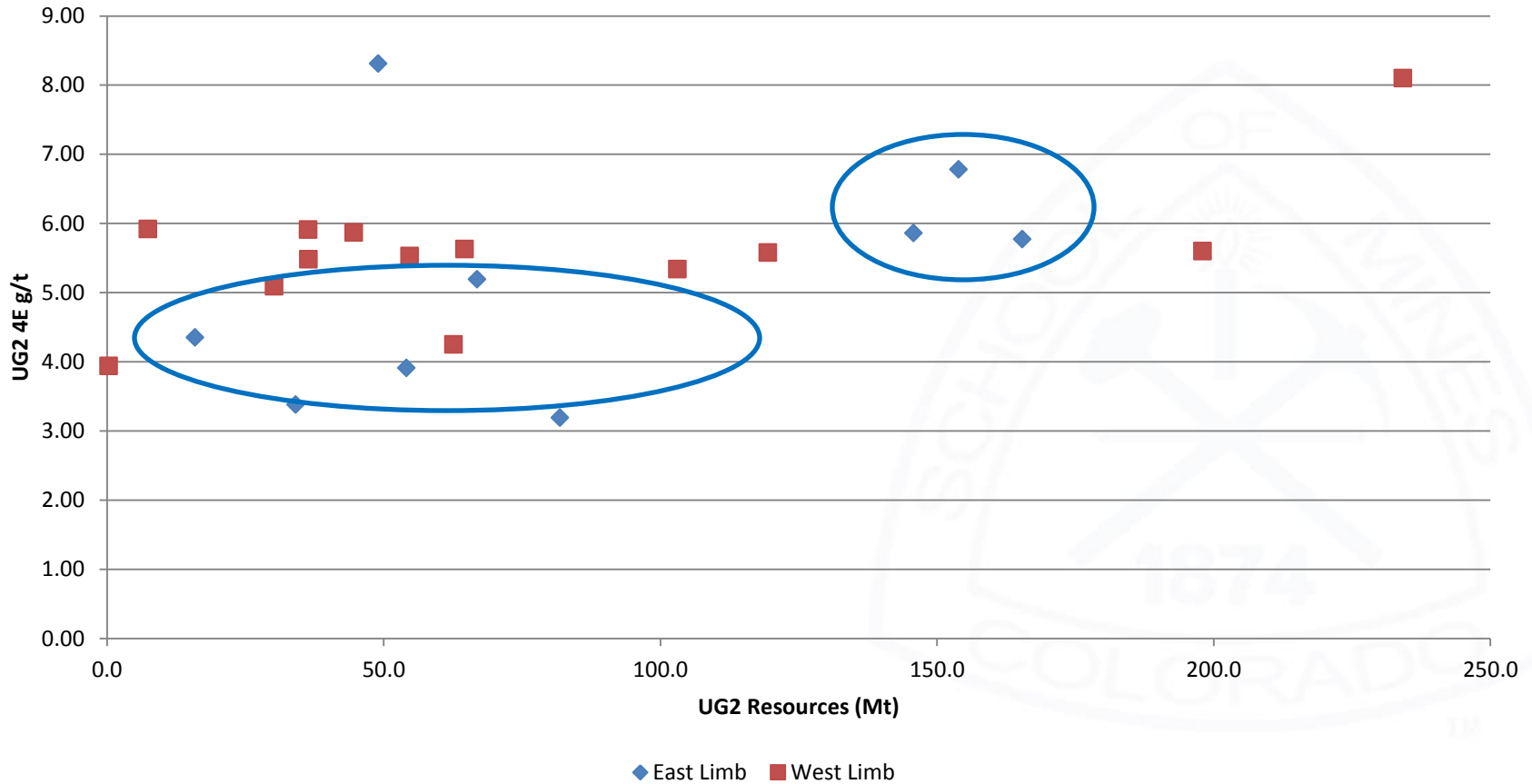
The eastern limb contains deposits of sufficient size, and grade, to support mineral production

# MR Resources versus grade





# UG2 Resource versus grade



# Criteria 3

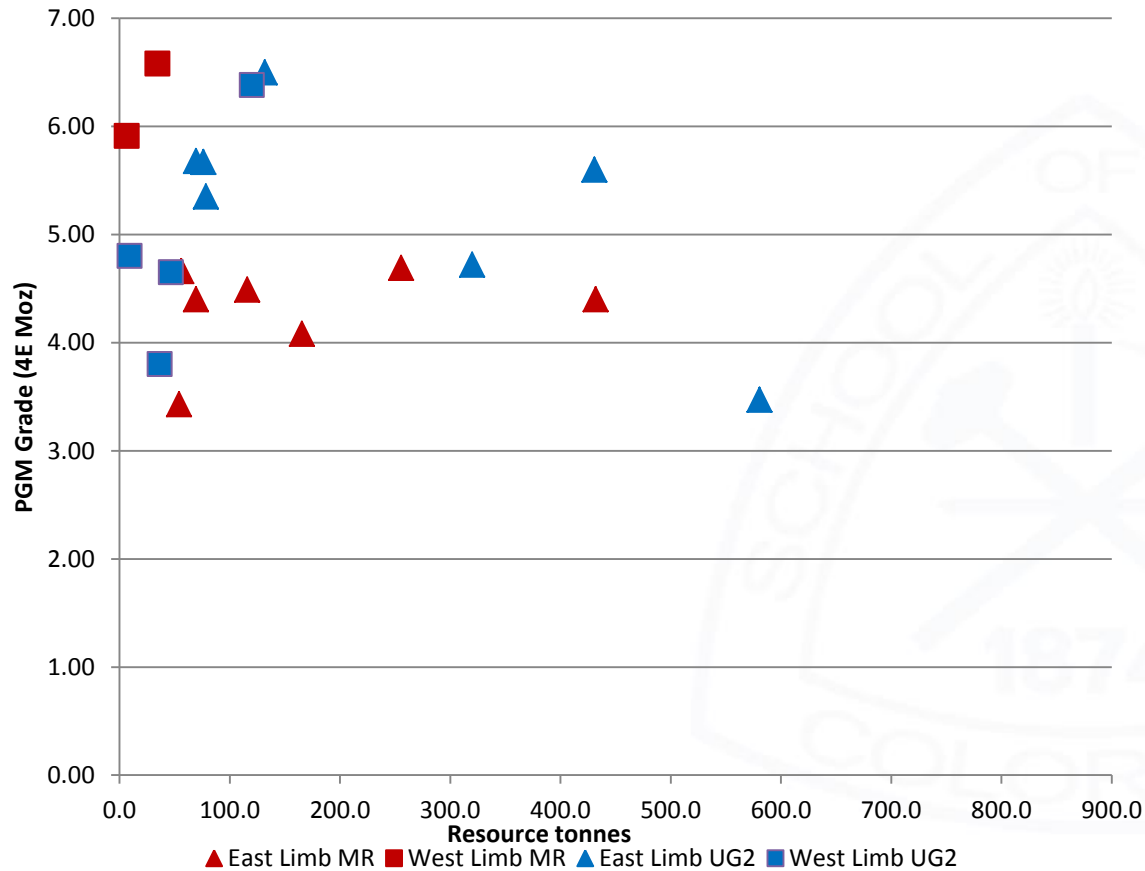
An eastern limb supply pipeline, comprising all phases of the mineral resource value chain is currently present

# PGM pipeline per development phase

Phase	Total (2006)*	Total (2010)*	West (2010)	East (2010)
Initial Expl.	18	20	6	9
Adv Expl.	13	17	6	7
Pre-Feasibility	7	9	2	2
Feasibility	9	6	0	5
Construction	6	3	2	1
SUM	53	55	16	24

\* Total includes North

# And pipeline resource tonnes



# Criteria 4

Initial mining of the eastern limb will be at shallow to intermediate depth facilitating largely mechanized operations that are cost effective and safe

# Conventional versus mechanized mining



# Principle choice of mining method

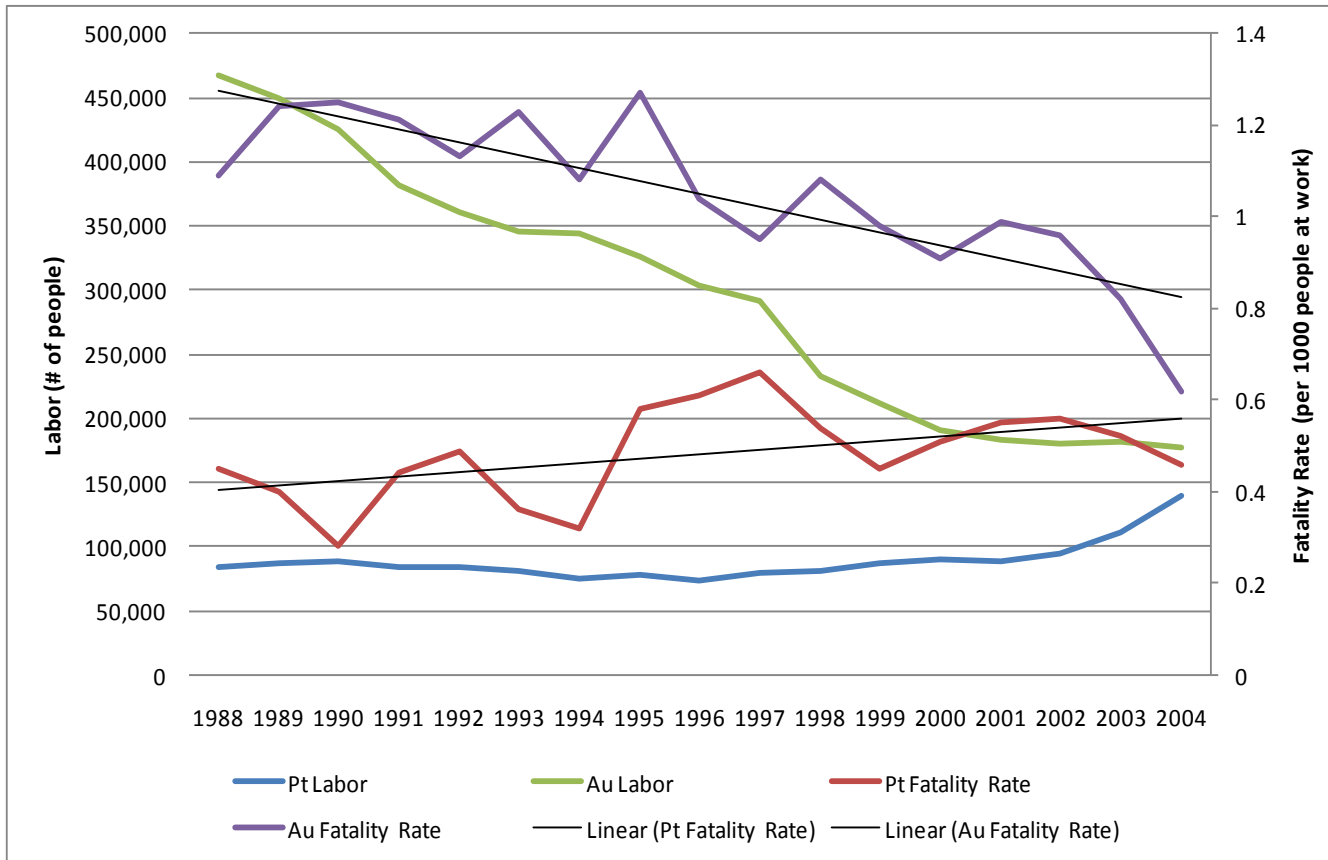
Mining method	Prevalence	West	East
Mechanized – Bord and Pillar; XLP	26%	3	4
Hybrid – Mechanized tramming, conventional stoping	48%	10	5
Conventional – longitudinal breast, with handheld rock drills, material removal via box-holes using scrapers, rail hoppers	26%	3	2

# Mining costs per method

	Direct mining costs (July 2010)		
Mining method	USD/m <sup>2</sup>	USD/tonne mined	USD/equiv reef oz
Conventional	643-357	50-92	857-1643
Hybrid	472-542	57-93	1114-1643
Mechanized	257-414	39-42	886-1000
Open-pit		9-14	357-428



# Mining safely



Western Limb – 1 fatality for 3.3 million tonnes broken

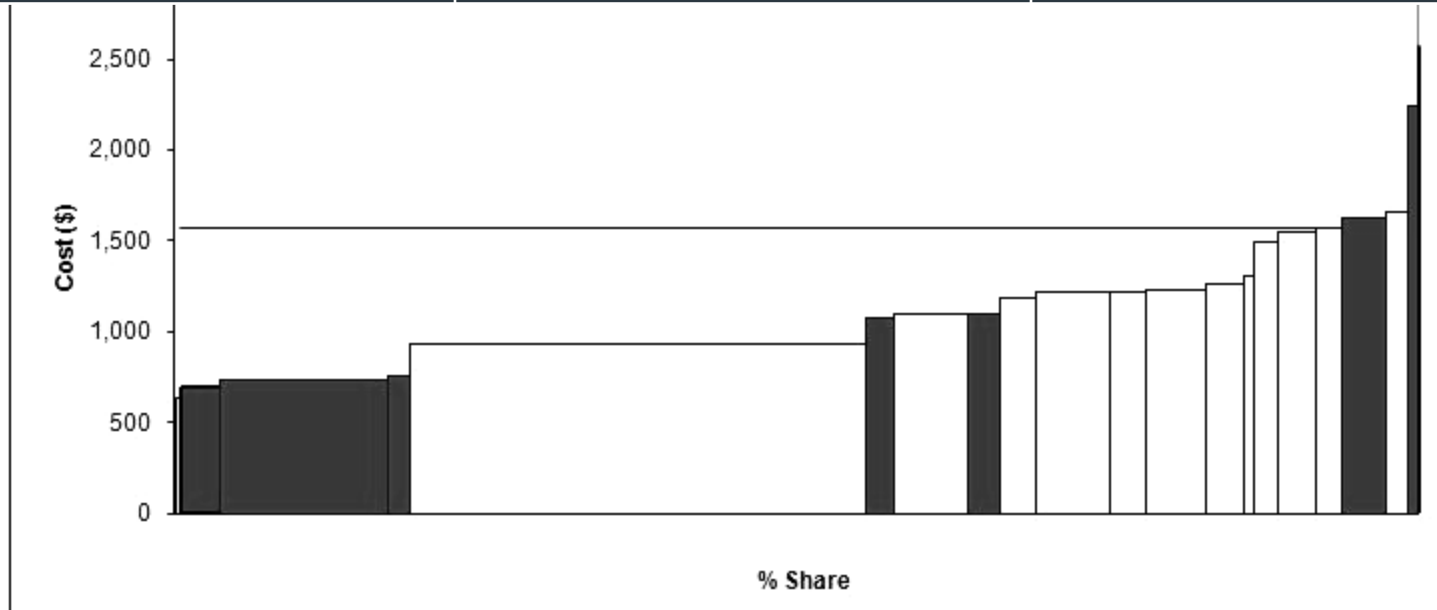
Eastern Limb – 1 fatality for 4 million tonnes broken

# Criteria 5

The production of PGM's on the eastern limb is economically competitive, relative to the continuation of western limb production

# Cumulative cash costs – existing operations

	West	East
Average (USD/oz)	1,264	1,355
Range (USD/oz)	638 – 1,661	696 – 2,575



# Criteria 6

Adequate power and water supply exists to support mine development on the eastern limb

# Western versus Eastern limb infrastructure



**WEST**



**EAST**

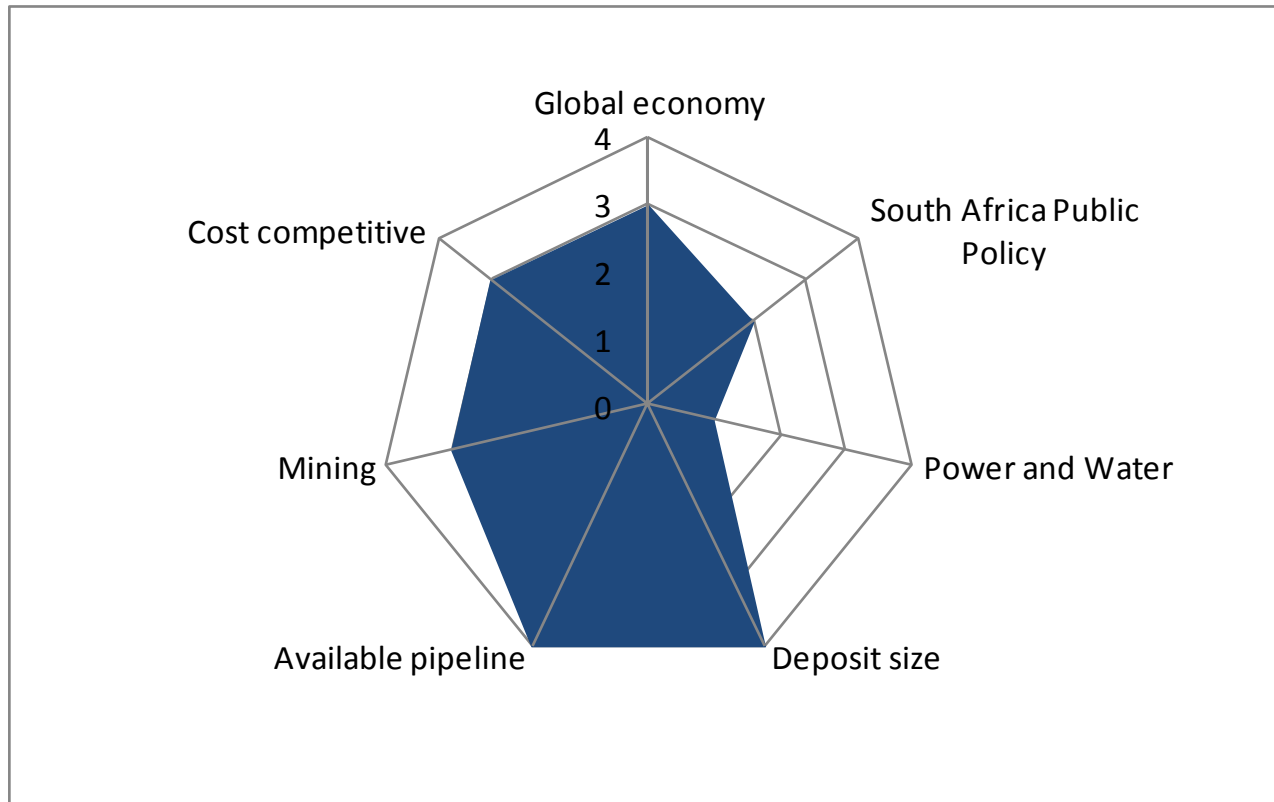
# Power and water supply

2009	West	East
Power (MJ/t ore)	524	346
Water (M <sup>3</sup> /t ore)	1.26	1.35

*Data Source: Mudd (2010)*

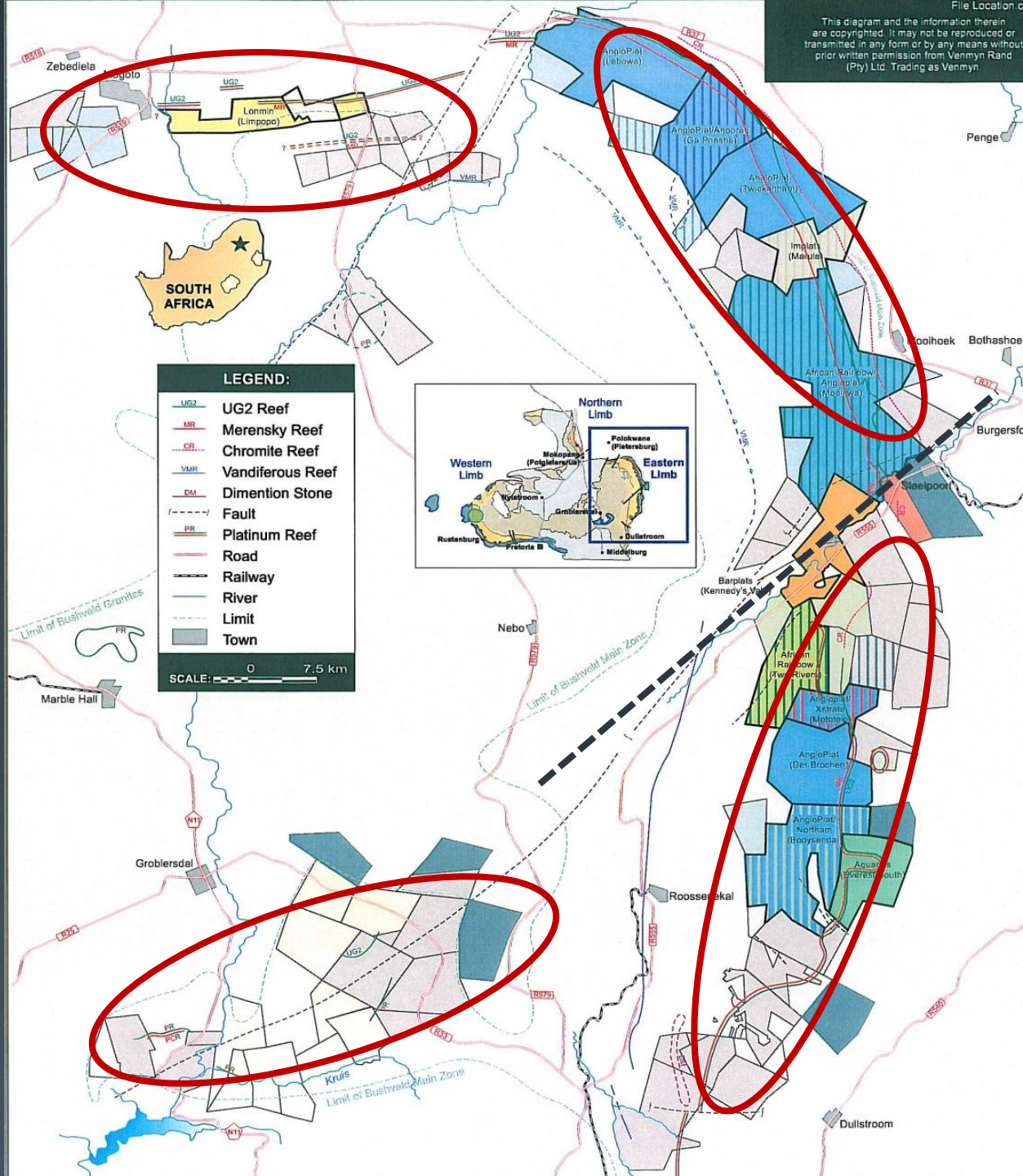
- Reality: Impact of global economic downturn has resulted in financing and development delays for: de Hoop Dam, Medupi power station
- With increased production there will be constraints

# Core conditions – cumulative impact




# Regional development prospects

- Four main “regions”
- Contiguous lease area synergies
- Especially for water and power supply delineation





HOME Multimedia



PLATINUM

### JV platinum profile poised for growth, says Anglo Platinum's Pillay

COMMENT EMAIL PRINT

By: Martin Cremer  
7th April 2011

JOHANNESBURG (miningweekly.com) – The contribution to production from joint ventures is expected to grow to as much as one million ounces a year, says new Anglo Platinum executive head of joint ventures **Vishnu Pillay**.

Currently, Anglo Platinum's joint venture operations contribute 30% of overall production, which Anglo Platinum expects to be 2.6-million ounces in 2011.

The former head of Gold Fields South Africa tells *Mining Weekly Online* in a video interview that the increased contribution from joint ventures is expected to arise out of increased levels of partnership with new entities, as well as with existing partners, who have the ability to sustain current levels of production and to grow within their existing properties.

"We want to consolidate and start growing the eastern limb through existing and new partnerships. We want to pull together our holdings at De Brochen, Twickenham and Gaphasha and to grow the industry.

"We're also working on collapsing the farm fences and realising value across them through co-operation," says Pillay.


Anglo Platinum has a number of properties on the eastern limb of the Bushveld Complex that are seen as being ripe for exploitation.

On the western limb, its most significant partnership is at the Bafokeng Rasimone mine, and opportunities include arriving at the best way of returning some of its mothballed shafts to production, including shafts 2 and 3 at Siphumelele, as well as optimising its pilling and sharing agreements with Aquarius.

"There are significantly greater opportunities for better exploitation of the platinum resources on both limbs of the Bushveld Complex," Pillay tells *Mining Weekly Online*.

While Anglo Platinum entered into several of its existing joint venture transactions in order to secure its licence to operate and obtain new-order mining rights, Pillay points out

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Anglo Platinum executive head joint ventures Vishnu Pillay talks to Mining Weekly Online's Martin Cremer about Anglo American group company's strategy on platinum partnerships. Camera work and editing: Darlene Cremer  
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*We want to consolidate and start growing the eastern limb through existing and new partnerships. We're also working on collapsing the farm fences and realising value across them through co-operation"*

*"Our strategy going forward is to consolidate the eastern limb of the Bushveld complex ... The consolidation will not just be through rights and properties, but also collaboration on the provision of services including health and training, and procurement, so that we have a critical sphere of influence on the eastern limb, which has still to be developed as comprehensively as the western limb (April 7, 2011).*

# Outcomes

- ▶ The most inhibiting production constraints are “above-ground” risks
- ▶ Great potential exists for regional planning and co-operation: contiguous lease area synergies, regional geological (pothole) investigations; also consider lessons from the western limb and Witwatersrand
- ▶ The eastern limb is considered moderately viable to produce PGM’s in preference to the western limb
- ▶ South Africa could remain globally competitive in the supply of PGM’s if the above ground risks are mitigated successfully



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**THANK YOU**

