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Leading the next boom? Competitive Eastern Limb platinum supply

J.E. MCGILL
Colorado School of Mines and CSIR

Introduction

Primary production of PGE globally is geographically restricted to South Africa—Bushveld Complex (77%); Russia—Noril'sk and alluvial producers (13%); and collectively USA—Stillwater; Zimbabwe—Great Dyke; and Canada—Lac de Iles (10%). Seventy-seven per cent of the world's PGEs are supplied from mining operations in South Africa's Bushveld Complex (Johnson Matthey, 2010). The Bushveld Complex has geographically distinct western and eastern portions. Historically, the majority of supply has come from the western limb due to the favourable platinum grade distribution, geographical proximity to existing water, power, and transport infrastructure and human resource availability from the nearby Gauteng Province. Through resource depletion and increased mining depth in the west, an alternative supply for these metals is now required. Producers must secure capital investment to develop these resources in order to continue to maintain historical production levels as well as market share, despite substantial preproduction lead times. Shareholders also require competitive returns on their investments. Meanwhile, competing for economic rents is the South African government whose key objective is to ensure that historically disadvantaged groups also benefit directly from the resources sector. While long-run global demand trends for PGEs remain positive, it is also anticipated that platinum supply will peak around 2014/2015 whereafter a supply gap could result in a shortfall by 2029 (Black, 2009, and Johnson Matthey, 2010). This gap would need to be satisfied through either primary production, or recycling. Extraction of PGEs is without doubt required for the foreseeable future; replacement resources and associated investment are thus required. A strategic choice is therefore available to South African PGE producing firms. The western and eastern limbs are geographically 300 km apart and exhibit distinct differences. As mining on the western limb gets deeper, and consequently more expensive, will operations on the eastern limb be able to provide South African PGEs more competitively?

Assessment

Mining currently predominantly occurs on the western limb. Several core conditions would need to be satisfied to establish the viability of replacement of western limb resources with eastern limb reserves:

- Sufficient eastern limb resources exist, which support a progression of projects (or supply pipeline) in different stages of development promoting the mineral resource value chain (exploration through feasibility to production stage projects).
- The application of cost-effective mining methods to safely extract the eastern limb Bushveld deposit.
- A favourable long-run economic environment exists such that economically competitive PGE production from the eastern limb is supported.
- Sufficient infrastructural resources are available or planned.
- Sector participants have the ability to satisfy the South African government's socio-political agenda.

Data for this study was obtained entirely from sources within the public domain, and supplemented through an online survey distributed to mining industry role players.

Supply pipeline

Of the 31 current operations only a third are located on the eastern limb (Table I). The data indicate that a healthy platinum production pipeline exists in South Africa. The total number of projects overall has increased slightly between 2006 (during the commodity boom) and 2010 (post global economic downturn) but a shift in distribution has occurred (Table II). More exploration, advanced exploration and prefeasibility stage projects are prevalent (most started in 2008-2009) and fewer late-stage projects. Three feasibility stage projects were deferred until PGE price recoveries occurred. Also, the majority of exploration and development projects are located on the eastern limb. This evidence underpins the importance of the eastern limb in the future of PGE production in South Africa.

Mining methods

A distinct difference exists between how the geographic landscape affects deposit access, and mine development, on the western versus eastern limbs. In the west, underground reef horizons are mostly accessed through shaft systems from surface, whereas in the east the escarpment edge facilitates decline access. The majority of near surface resources have been exploited on the western limb. Future development requires deeper, down-dip extensions. The

Table I
Current (2010) operating status of Bushveld PGE operations

Current operations	Total (2010)	Western Limb	North Limb	Eastern Limb
Open	30	19	1	10
Closed/suspended	1	0		1

Table II
The number of projects in South Africa per development phase

Development phase	Total projects (2006)	Total projects (2010)	West	North[a]	East
Initial exploration	18	20	6	5	9
Advanced expl.	13	17	6	4	7
Prefeasibility	7	9	2	5	2
Feasibility	9	6	0	1	5
Construction	6	3	2	0	1
Sum	53	55	16	15	24

a The northern limb focuses on exploitation of the shallower Platreef. Platreef is not present on the western or eastern limbs. Northern limb project data has been only included for completeness.

near-term eastern limb resources are shallower and simpler to develop without complex and expensive shaft requirements. Therefore the east limb is favourable for new mine developments.

Mine development can not proceed without cognizance of related safety issues. Over the past 21 years, the number of fatalities across all mining sectors in South Africa has decreased significantly, with the largest reduction coming from the gold sector (Figure 1).

However, with the growing production pressures on PGM producers, concerns exist that the incident rate for fatal accidents could potentially rise. This concern appears warranted given the upward trend in platinum related fatalities from 1998 to 2004 (Figure 2).

The root causes of mine fatalities vary greatly, with the greatest proportion being attributed to falls of ground and powered haulage (Figure 3). Ironically, this mirrors fatality trends found in both the US and Canada. Two fatality classes of particular significance to South Africa are inundation by material (water, sand, mud) and those that are attributed to unknown causes. These two classifications account for 7% and 6% of the total, respectively. An example of an unknown cause includes instances where individuals are found deceased in situations that suggest criminal, rather than work-related, causes. The data does not support either an increase or decrease in frequency of these classifications but not withstanding should become the motivation for further investigation.

Currently there are 19 western limb operations, and 11 eastern limb operations. On the western limb 38% of fatalities were due to fall of ground, and 19% to powered haulage, while on the eastern limb 41% of fatalities were due to fall of ground, and 12% to powered haulage. The fewer number of operations and the shallower average mining depth on the eastern limb compared to the western limb contributes to the resultant lower accident rates but fall-of-ground rates are slightly higher on the eastern limb. This should be recognized and new operations should pay particular attention to the fatality classification through correct rock support standards and implementation.

An audit of the principal mining method on each operating Bushveld mine was conducted using public domain sources (Table III). Of the Bushveld operations, 24% are predominantly mechanized or conventional, and 52% of mines have adopted the hybrid approach. Of the six newest mines (three on each limb) two are surface operations, one employs bord and pillar, and three comprise hybrid mining methods. It would therefore appear that

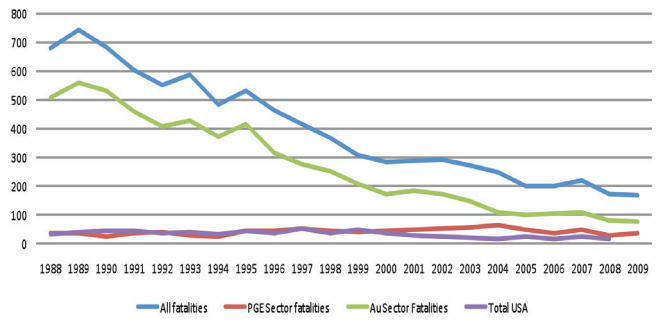

Figure 1. Comparison of all South African fatalities, gold and platinum sectors and total underground fatalities for the USA (1988–2009, (2008 for USA)) (Data source: DMR and MHSA)

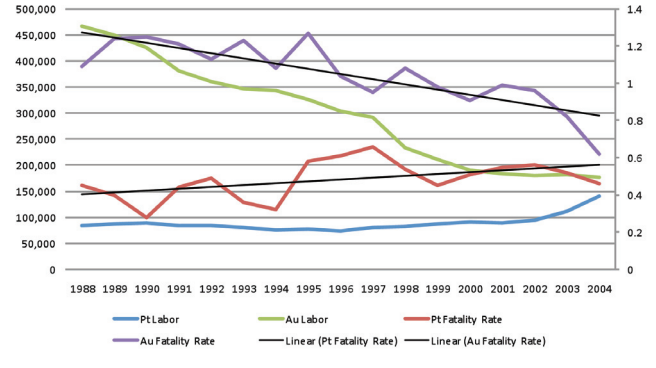

Figure 2. Comparison of gold and platinum sector labour and fatality rates (per 1000 people at work) (1988–2004) (Data source: DMR)

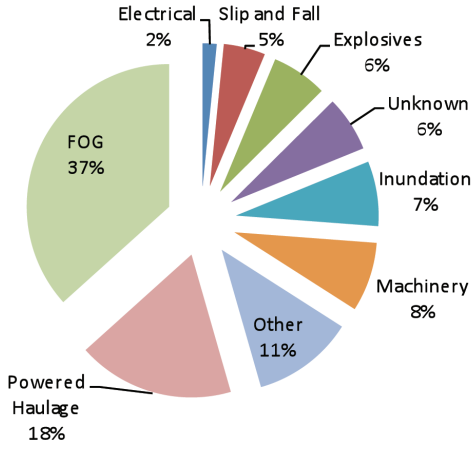

Figure 3. Distribution of occupational fatalities by accident class on all RSA platinum mines (2005–2010) N=191 (Data source: DMR)

Table III
Principle PGE mining methods as of 2010 (Data source: company websites and expert opinion discussions)

	Mining method	Total underground	West	East
Surface	Open-pit operation		2	0
Underground	Mechanized – bord and pillar using ultra low profile machinery	24%	3	4
	Hybrid – mechanized tramming using load haul dumpers (LHDs) and conveyors, and conventional stope mining	52%	10	5
	Conventional – hand drilled and blasted material removed from stope via box-holes using scrapers and transported via rail hoppers	24%	3	2

South African PGE mine development supports the hybrid approach which accommodates the 'best of both worlds'. Hybrid mining methods take advantage of faster and safer mechanized development, as well as the low dilution factors and higher shaft head grades that conventional stoping provides.

Individual mines will often mechanize specific elements of their operations, including individual production or development areas, components of their unit operations, and specialized activities related to such things as maintenance, mine plant operations, and hoisting/material storage and haulage. As such, this often makes it difficult to accurately assess and categorize the degree of mechanization of any given mine.

Economic aspects

The global economic environment exhibits significant variability. Commodity price trends and forecasts, and currency fluctuations can all impact producer viability. The relationship between the price of platinum and the other PGEs is important as high platinum prices support substitution by cheaper PGEs (Figure 4).

Plotting the nominal prices of all the PGEs from July 1992 through to July 2010 reveals that rhodium exhibited a run-up before prices peaked at $9,553/oz in mid-2008, followed by a sharp decline. Removing the volatile rhodium series provided a second, more realistic, view of the relationship between the nominal prices of the other four PGEs (Figure 5), to support why substitution can be a demand driver for PGEs.

South African PGE producers earn their revenues in United States dollar (USD). This currency is converted to South Africa rand (ZAR) to fund local operating expenses. The relationship between the USD and ZAR therefore becomes important for producers. A strong USD (weak ZAR) will increase the local purchasing power of producers. They will receive more rand for every dollar sold and can fund both operating and capital projects. A weak USD (strong ZAR) will decrease the local purchasing power of producers. They will receive less rand for every dollar sold, having to curtail rand denominated expenditures and delay capital projects. A weaker USD-ZAR exchange rate therefore requires higher commodity prices to offset exchange losses. Undue volatility in the exchange-rate relationship makes long-term planning and forecasting uncertain. The ZAR significantly depreciated relative to the USD in 2001–2002 and 2008–2009, while in 2006 the local price of platinum, in rand terms, was not high enough to justify the high capital costs to start production, especially underground, on several projects delaying production development (Gerbino, 2006). The present 2010 sentiment is that the currency remains volatile and overvalued (OECDa, 2010).

Ninety per cent of global PGE tonnage supply is generated by just two countries: South African and Russia. South African PGE production has steadily increased over the past 30 years to its current level of 150 tons per year (Figure 6). Three main phases of increasing production rates are: 1981–1993 (apartheid era), 1993–2001 (post-apartheid growth), and 2001–2007 (significant commodity demand fuelled by global growth).

While overall South African production has increased overtime, the distribution of market share between the tier one producers has shifted. The policy requirement to use mineral reserves, rather than hold onto them, has allowed a variety of participants to enter the sector, underpinning the redistribution (Figure 7). Anglo Platinum's contribution was consistently around 50% until 2003 where the impact of redistribution through joint ventures and new entrants, as a result of legislative transformation, is clear. Impala Platinum and Lonmin market shares converge around 22%

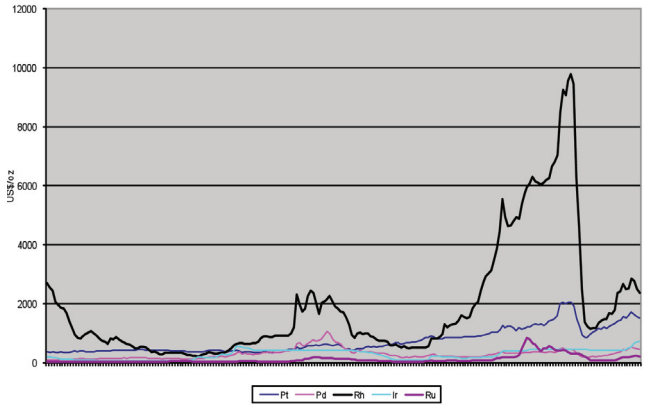

Figure 4. Variation in nominal PGEs spot price from July 1992 till July 2010 in USD/troy oz (Data source: Johnson Matthey)

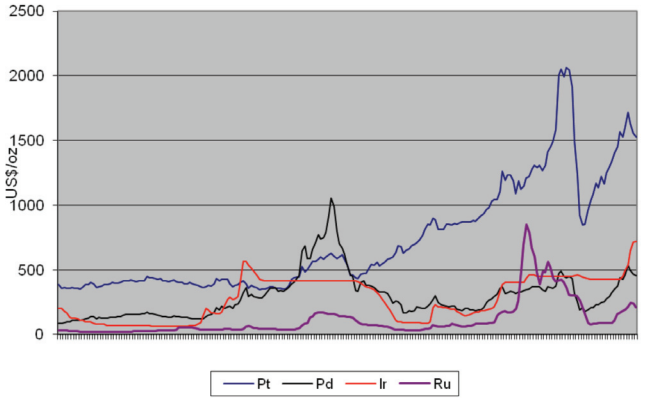

Figure 5. Variation in nominal PGEs (excluding rhodium) spot price from July 1992 till July 2010 in USD/troy oz (Data source: Johnson Matthey)

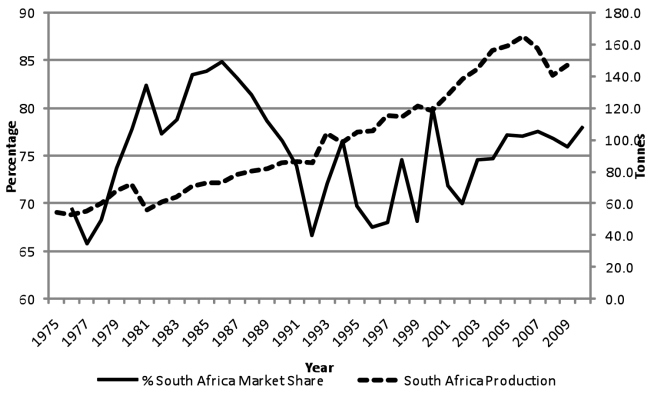

Figure 6. South African PGE production and associated market share (1975–2009) (Data source: Johnson Matthey and Raw Materials Group)

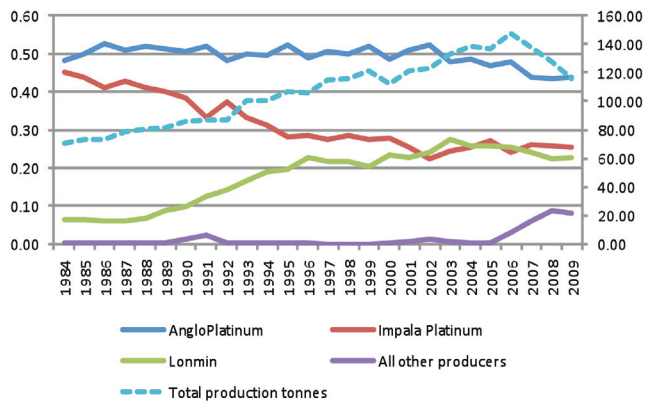

Figure 7. Market share of South African producers (left axis) with redistribution of production share to JV managed partners evident, and total production tonnes (right axis).(Data source: Raw Materials Group)

each. In 1996 and 2003 merger attempts between Impala and Lonmin were overturned by competition authorities.

Public policy framework and other potential constraints

No geographic or commodity specific allowances or initiatives exist within South African mining legislation specifically for PGE operations. Therefore in a macro sense no preference exists for operations to be established on either the western or eastern limbs. All operators must demonstrate legislative compliance, and any future changes in issues of nationalization will affect all mines equally. Sixty-five per cent of survey respondents consider nationalization to be a complete deal breaker for PGE growth opportunities. One respondent reiterated this as: '(The) PGM industry is vital for SA's future economic prospects. Nationalization is not an option'. Concern over possible nationalization has negatively affected South Africa's rankings as determined by Frasers and Behr Dolbear. Ramifications of nationalization by the South Africa government could have far-reaching consequences if not logically and empirically assessed. Besides the legislation framework that all exploration, development and mine operations must adhere to, certain overriding considerations exist that could adversely affect development of eastern limb production capacity. These include the road infrastructure, power capacity and water supply. Various initiatives are in place within each of these categories, all intent on facilitating improvements to each.

Conclusion

Competitiveness within the mining sector is of particular importance for South Africa, which is well endowed with mineral reserves—as publically emphasized by the recent Citibank study. Natural competitiveness is obtained by an operation's ability to sustain low production costs; whereas apparent competitiveness is defined as both 'natural (true) competitiveness, which is based solely on natural costs, and the effects of public policy' (Tilton, 1992). Potential therefore exists for mineral resources to contribute to the economic wellbeing of developing economies such as South Africa. If maintaining competitiveness can contribute to ongoing economic development, especially where favourable public policy and/or institutions limit development of resource curse type symptoms, then the impact from maintaining competitiveness, of the South African platinum mining sector, could be significant for long-term economic development.

On the eastern limb an opportunity exists to consider the area more holistically compared to the piecemeal approach of areas such as the Witwatersrand and Western Bushveld. Large tenement areas are core platforms for future development, especially with contiguous blocks of ground that are along dip. With careful planning a large holistic mine area is possible that best considers optimal mine layout and mining methods. What is suggested is that a similar consideration is possible on the eastern limb were a 'modern mining complex' can be carefully planned taking into full consideration of producer economics, resulting in a set mining method and associated optimal mine design. In addition, up front infrastructure planning for road systems, power supply, and smelter facilities can all be achieved.

Through the analysis of the criteria it is deemed reasonable that the eastern limb can become a competitive PGE producer, but in the current South African political and global economic environment this will not be without challenges.

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Jeannette E. McGill

Competency Area Manager, CSIR - Centre for Mining Innovation

Jeannette spent the formative years of her career as an Anglovaal bursar in the Northern Cape iron-ore fields. She then worked in exploration and production for both Anglovaal and AngloGold on the Welkom, and West Wits, Goldfields. During this time she became only the 2nd woman in the Free State to be issued an underground blasting ticket. Applied work in geological modelling, mine design, and extensive small-scale deposit evaluation, for the CSIR expanded her skill-set. She completed projects, and accompanied the DMR, in Ghana and Mali prior to embarking on further studies at the Colorado School of Mines, USA. Jeannette also has experience in technical and financial valuation for royalty financing transactions from the International Royalty Corporation (now Royal Gold), Denver, USA. She is currently leading a CSIR research group focused on novel mining methods, and about to defend her PhD thesis.