SAIMM ZIMBABWE BRANCH CONFERENCE

Tuesday 19 July, 2011

Venue: Zimbabwe School of Mines

Bulawayo - Zimbabwe

Dyke Chrome Mining Mechanization

Opportunities and Dilemmas

Presented By: S. Kalenjeka

MINING SYSTEMS MANAGER

ZIMASCO (Pvt.) Ltd.

SINOSTEEL

INDEX

- GEOLOGICAL SETTING
- HISTORY OF CHROME MINING
- THE BURNING PLATFORM
- THE DILEMMA
- PREVIOUS MECHANISATION ATTEMPTS
- OPPORTUNITIES

CHROME GEOLOGY - ZIMBABWE

Types of Chrome Deposits

- Podiform – Off the Dyke, at Shurugwi, Valley & Mashava, Mberengwa
- Stratiform – on Great Dyke

Podiform Deposits

- Normally ultramafic sequences in altered serpentine and talc schists
- Over 100 known orebodies in the Selukwe Ultramafic Complex,
- Ranging in thickness from 2 to 25 m and in length from 5 to 1000 m, up to 1100 m deep.
- Current Zimasco operations at Valley, Peak, Railway Block and Ironton mines.

CHROME GEOLOGY - ZIMBABWE

Stratiform Deposits

- Linear intrusion of mafic and ultramafic rocks cutting across the Zimbabwe Craton
- In serpentine and harzburgite
- 3 to 11km wide and 550km long from Snake's Head in the north to Zezani mission in the south.
- at least 12 known chromite seams
- 8 to 26cm seam thickness
- Current Zimasco operations around Mutorashanga, Ngezi, Lalapanzi and South of Shurugwi

ZIMASCO HISTORY OF CHROME MINING

Early History

- Claims pegged at Peak in 1904, Railway Block in 1905, Mutorashanga in 1917
- Ore first railed 1906 from Peak Mine and exported 1907
- 1906 – 1965 Ore was exported as raw chrome
- 1965 – Furnace 1 acquired from Windsor Chrome
- 1984 – Furnace 6 commissioned.

Ore Supply to Kwekwe for 6 Furnaces

- Podiforms supplied 41,000 tpm (85%)
- Dyke Mines supplied 7,000 tpm
- Currently Podiforms supply 13,300 tpm, (29%)
- Efficiencies – 14 tonnes/man/mth
- Currently Dyke supplies 33,200 tpm
- Efficiencies – 4 tonnes/man/mth

THE BURNING PLATFORM

Ore Supply to Kwekwe

- Current installed capacity 600,000 tpa
- At Peak production smelter consumed 85% Podiform; 15% Dyke
- Current smelter consumption 29% Podiform; 71% Dyke
- Planned expansion to 1,109,000 tpa by 2015
- By 2016 Ore Supply will be 7% Podiform; 93% Dyke

Future Dyke Mining

- Currently 7 mechanised surface mines producing up to 28,000 tpm
- This tonnage to be replaced by Dyke UG mines
- Future smelter ore supply will be 100% from the Dyke UG

THE DILEMMA

The Dilemma

- 154 Dyke UG mines at current capacity of 600 tpm required
- Not feasible to operate 154 UG mines on the Dyke

Challenges

- Unavailability of skilled manpower
- Scarcity of labour willing to perform manual tasks
- Mining and social infrastructure
- Spatial complexity of operations
- Safety and Environmental requirements

OPPORTUNITIES

Resource

- **Abundant chromite resource on the Great Dyke**
- **Zimbabwe's resource estimated at 12% of world chromite resource**

Zimasco identified the need to establish 5,000 tpm Dyke UG mines

- **In 2010 Zimasco commissioned TWP Projects of South Africa to carry out "Mechanisation Conceptual Study"**
- **Results of study so far not conclusive**
- **Costs derived from study not sustainable at current market prices**
- **Use TWP Study to "Define level of mechanisation"**

PREVIOUS MECHANISATION ATTEMPTS

Previous mechanisation attempts using mainly coal-based technology

- 1960's – Vanad Mine Coal Cutter Trials
- 1987 – Joy Coal Cutter Studies
- 1990–1994 Roadheader ET110 plus Joy 14CM5 Continuous Miner
- 1994–1999 Trackless mining – Skidsteer trials at Darwendale &Ngezi

Results

- ALL THESE TRIALS WERE NOT CONCLUSIVE
- THERE WAS NO URGENT NEED TO ARRIVE AT A SOLUTION

CURRENT MECHANISATION STRATEGIES

Concept	• Based on mechanisation concept study by TWP Projects of South Africa • Optimise mining methods to increase production to at least 5000 tpm through mechanisation
Mining Options	• Option 1 - extract and hoist chrome only; leave stoping and development waste underground • Option 2 – extract and hoist both chrome and waste and separate these through a washing plant on surface

SELECTION OF MINING METHOD

Criteria for selection

- Safety;
- Width of orebody or seam thickness;
- Dip of orebody/seam;
- Geotechnical properties;
- Productivity (economies of scale);
- Practicality (Fit for Purpose).
- Operating Cost (Opex) requirements
- Capital Expenditure (Capex) requirements

MECHANIZED MINING OPTIONS

Mining methods

- Scraper Mining – Conventional Breast Stoping;
- Scraper Mining – with waste cast blasting
- Diamond Wire Cutting;
- Mechanised Longhole Blasting;
- Mechanised LP Hybrid Mining Method – Low Profile (LP) equipment;
- Mechanised XLP Mining Method - Extra Low Profile (XLP) equipment.

PROPOSED MECHANISATION OPTIONS

Scraper Mining	• Rocker shovels with bottom discharge hoppers • 37kW scraper winches • 6 tonne battery locomotives and • Utility/Personnel carrier to each level
Scraper Mining with Waste Cast Blasting	• Same as above but; • With waste cast blasting into the back of the stope
Mechanised Longhole Stoping	• Low Profile mobile equipment. • Mobile Drill Rigs for development & stope drilling and support • Longholes drilled & blasted downdip at15m along strike. • LHD's load from the bottom drive and tram to the strike conveyor which feeds the Decline Conveyor

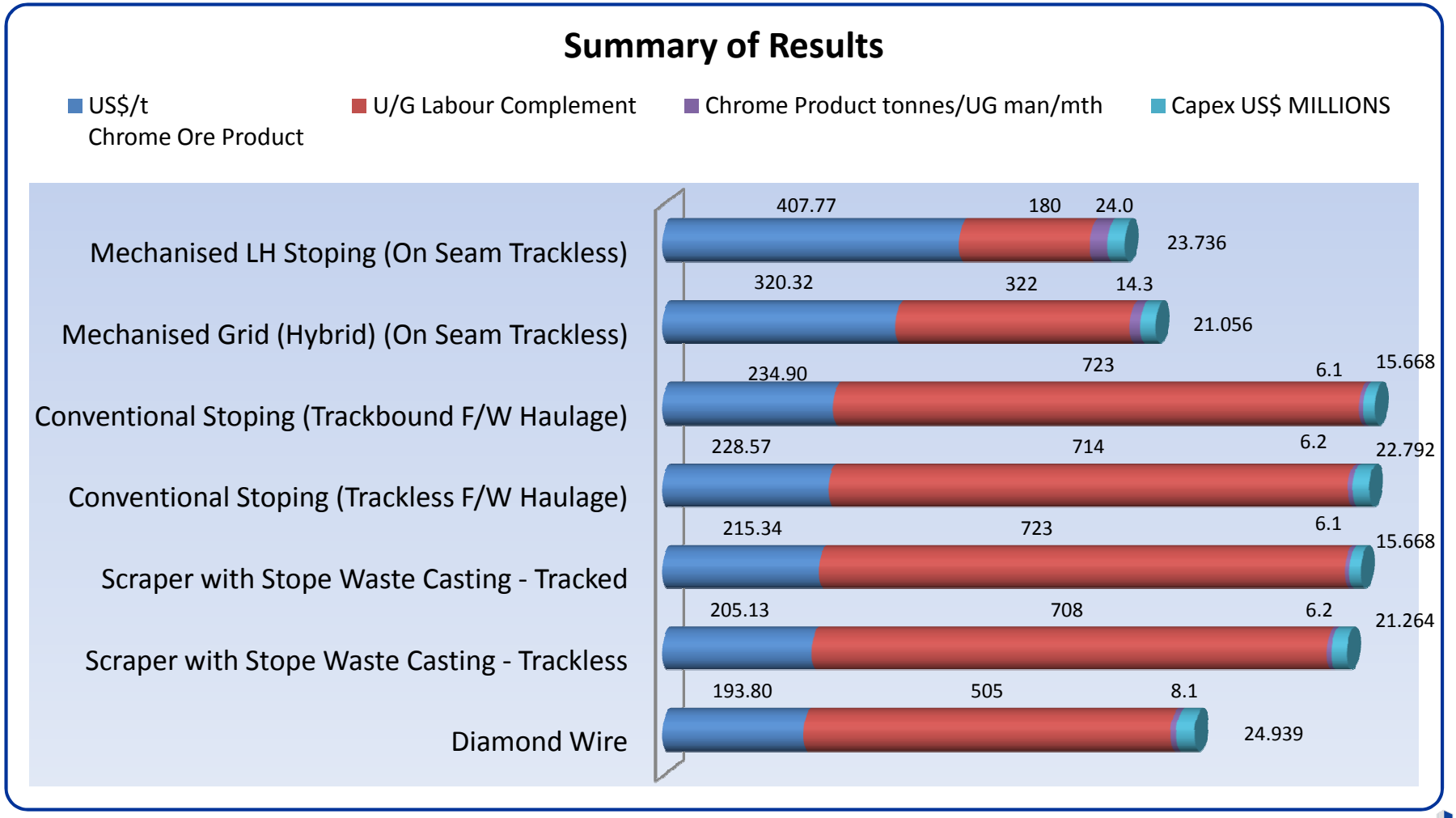
PROPOSED MECHANISATION OPTIONS (CONT.)

Diamond Wire Cutting	• Not a widely used method except in dimension stone industry • Involves removal of the seam with minimal associated waste dilution using a top and bottom diamond wire cut
Mechanised Hybrid Grid Mining	• Development Drill Rigs, conventional jackhammers for stoping • LHD machines for cleaning in drives • 37kW scraper winches for stope cleaning. • Mechanised Stope support drilling & roofbolt installation
Mechanized XLP (Extra Low Profile)	• XLP stope drilling • XLP dozer • XLP Bolter • All other equipment same as in Mechanised Hybrid

SUMMARY OF RESULTS

Method	US$/t Chrome Ore Product	U/G Labour Complement	Chrome Product tonnes/UG man/mth	Capex US$ MILLIONS
Diamond Wire	193.80	505	8.1	24.939
Scraper with Stope Waste Casting - Trackless	205.13	708	6.2	21.264
Scraper with Stope Waste Casting - Tracked	215.34	723	6.1	15.668
Conventional Stoping (Trackless F/W Haulage)	228.57	714	6.2	22.792
Conventional Stoping (Trackbound F/W Haulage)	234.90	723	6.1	15.668
Mechanised Grid (Hybrid) (On Seam Trackless)	320.32	322	14.3	21.056
Mechanised LH Stoping (On Seam Trackless)	407.77	180	24.0	23.736

SUMMARY OF RESULTS



CONCLUSION

Work in Progress

- Current mechanisation options do not look attractive, given the current market prices.
- Semi mechanised option being pursued

THANK YOU

ROADHEADER – EICKHOFF ET110

CONTINUOUS MINER JOY 14CM SERIES

UNILOADER – CASE 1840 SKID STEER

Wrong machine, a Uniloader/Skidsteer. Could not manage steep dips

Shafts had to be mined on apparent dip.

Excessive wear on tyres.

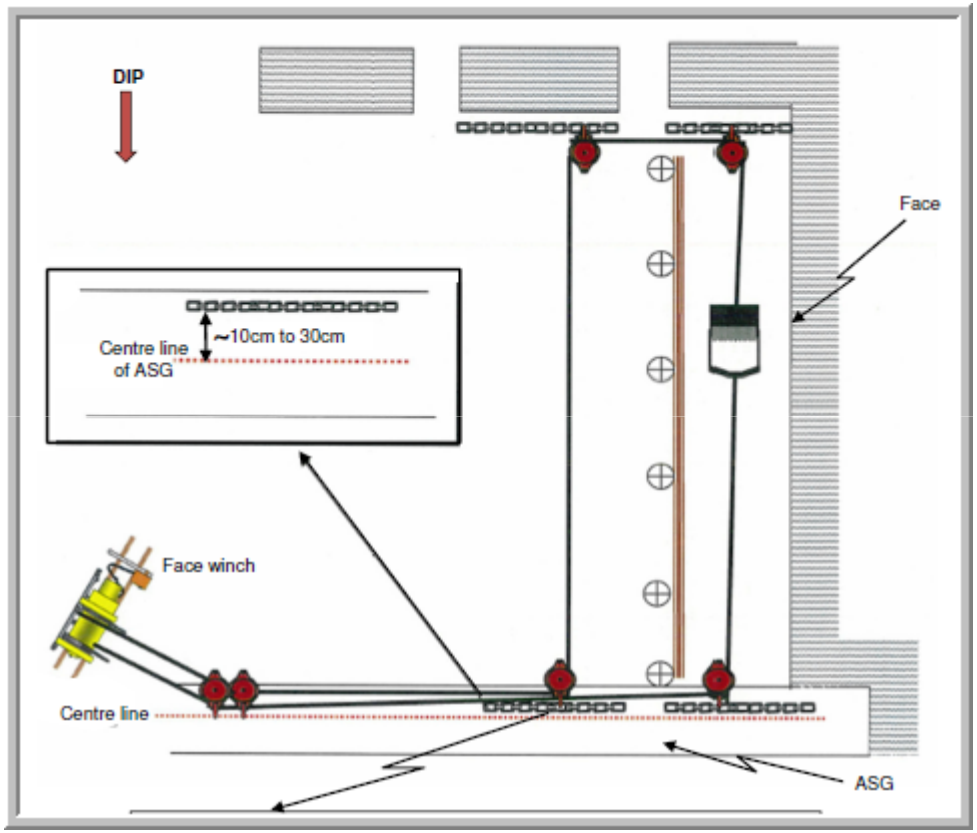
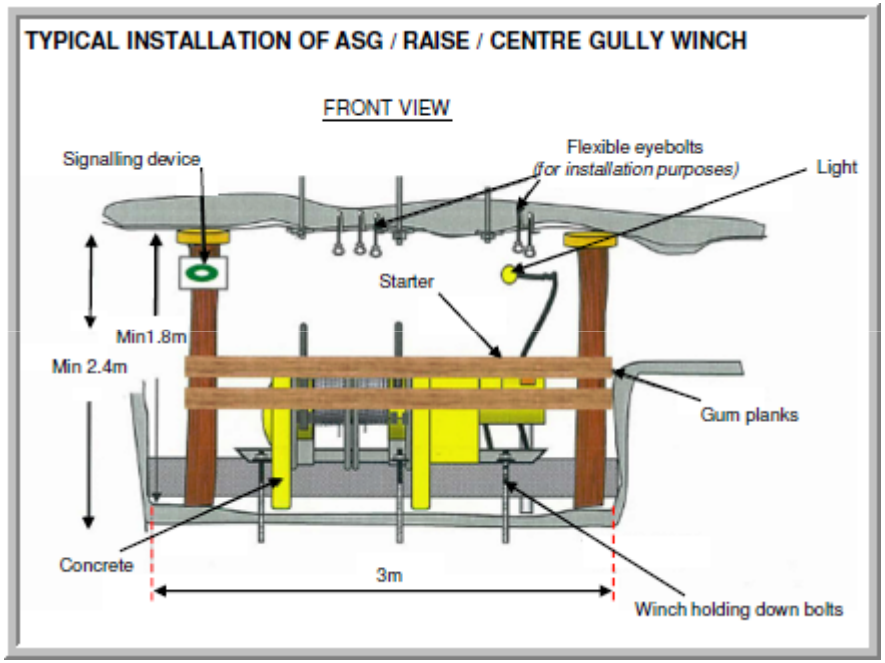
Tyres had to be dressed with chains.

In January 2000, the shafts were equipped with hoists and rail.

XLP Equipment

XLP DOZER

XLP DRILL RIG

XLP BOLTER

Scraper Winch