

Use of converted waves at Middlekraal mine

Target

The challenge of imaging a shallow target (500-1000m depth) is the long wavelength due to high P velocity field.

Since many years seismic surveys have been successfully used in Western and Eastern Bushveld to estimate the ore volume in place, plan mine works and get a valuable estimate of the mine in term of SAMREC certification.

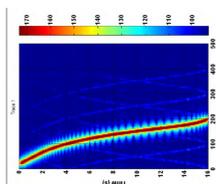
All surveys were using P waves. Some attempt were made to use S converted waves at target level but were not concluding.

The analysis of raw VP was always showing a linear signal at some 4200m/s especially in down dip direction whereas the refracted P wave was 6000 to 6500 m/s.

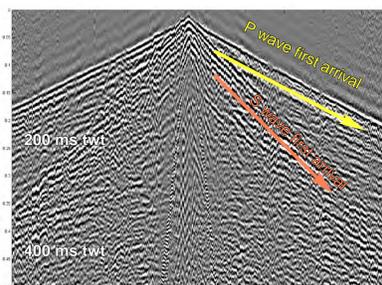
Seismic acquisition trials

In 2007, a 2D seismic line was recorded at ZAF3218 start of operation in Middelkraal (Western Bushveld). It was made of 280 channels at 20 m receiver interval. Every trace was made of x6 10Hz geophones laid in 1 m radius circle pattern.

The source was a N65 60000lbs vibrator with a 30-200 Hz 16s sweep at 50% drive level.



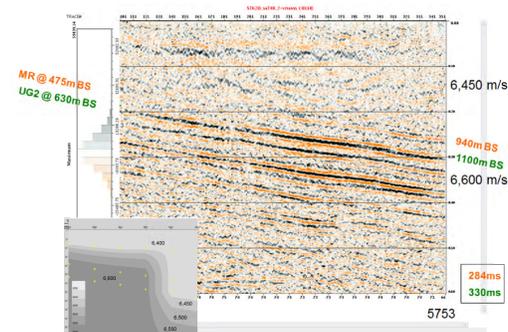
FT diagram for the DPG pilot with Middelkraal sweep



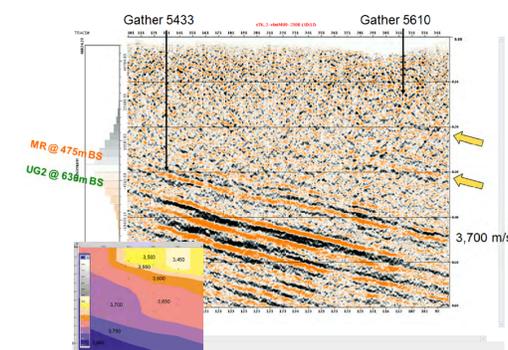
Raw VP display with P & S first arrivals

Processing

A first stack was first performed using a hard rock velocities law commonly used in Bushveld (5000-6500m/s). Merensky reef is visible at 940m BS and UG2 at 1100m BS East of the section.

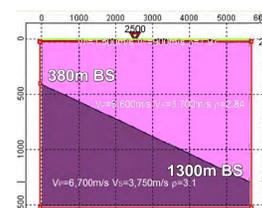


A second stack was then made using a conventional sedimentary rocks velocity law (2000-4500m/s). It was then really surprising to have reflectors appearing even if of lower frequency content.



Immediately came the idea that it was some converted wave trend. Question was then what type of wave can stack at such velocity of 3700 m/s?

Elastic modelling was done with Tesseral soft using a simple model with WZ and a flat dipping ore body (right). Different wave trends are observed, some easy to understand, other still questionable. Simulation was done with and without GR (strip right).



The reflections matching with the 3700 m/s is a PSSP mode with strong conversion from P to S then S to P at the base of the weathered layer. The MR reef is much more visible on PSSP section below were a P/S ratio of 0.6 has been applied to the PSSP section for comparison with the PPPP one..

