Blasting for maximum effect

In the second article in this edition dealing with open-pit mining, *Mining Mirror* visited Samancor's Buffelsfontein Chrome Mine to find out about an innovative blasting technique that reduces costs and delivers an improved product. Charles Butler, Andru Mining's site manager at Buffelsfontein, explained how he applied this technique to provide Samancor with a superior product.

Charles Butler stands next to a chrome ore stockpile. The even breaking qualities of the power deck blasting system give a relatively uniform lump size creating a more marketable product.

To the west of Brits is Samancor's Buffelsfontein Chrome Mine. Here the mining contractor, Andru Mining, is busy both with mining and rehabilitation work. There are four sites where the contractor is working at present. The Buffelsfontein Eastern Pit is undergoing rehabilitation at present while the Buffelsfontein Western Pit is being mined. There is a site at the Elandskraal Chrome Mine to the west of the Buffelsfontein operation, which has been mined out, where Andru Mining will be carrying out rehabilitation.

Butler has had a wide gamut of mining experience, having joined Andru Mining from Alpha Cement's limestone quarry at Ulco. At this mine, he was responsible for environmental control and mine planning among a host of other tasks. It was at this mine that he first started using the 'power-deck' blasting technique.

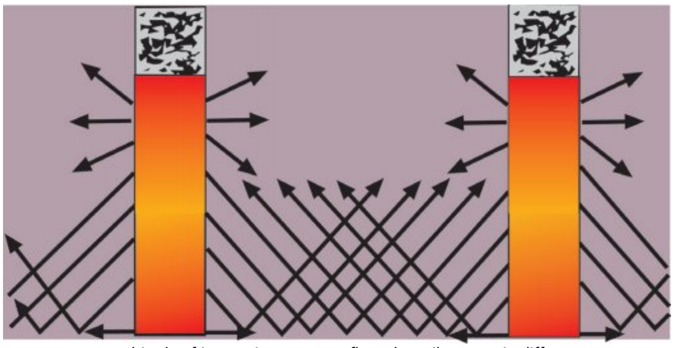
The geology of the Buffelsfontein Mine is highly complex explains Butler, and is one the most challenging mining operations he has had to manage. However, some two years ago, Butler got to know of a novel type of blasting technique while he was still at Ulco, This technique hinged around creating an open area or 'power deck' at the bottom of the blasthole using a device called a 'tulip plug'. When he carried out his first blast using tulip plugs about two years ago, he found the results were most encouraging. Butler continued to work with the local agent, Blast Analysis Africa cc, to refine this blasting technique.

How the technique works is that the tulip plug is placed at a set distance from the bottom of a blasthole and covered with a layer of drill cuttings. In early applications of this technique, the US-based designers of this system used to lower the plug down the hole to the desired point using a string. Today, a simpler method using a dowel rod attached to the underside of the tulip plug is employed. This automatically gives the correct spacing between the plug and the bottom of the hole. The plug creates a 'power-deck' or void filled with either air of water, at the bottom of the blasthole.

The explosive is loaded into the hole, on top of the plug, in the conventional manner, though the amount of stemming might be increased. When the explosive is detonated, the blast follows the route of least resistance, very much on the same

An excavator cleans the top of the MG2 reef. The use of tulip plugs means that the overburden can be removed cleanly without disturbing the underlying chrome ore. To clean the top of the reef, the excavator operator uses the back of the bucket to ensure the chrome ore remains in situ.

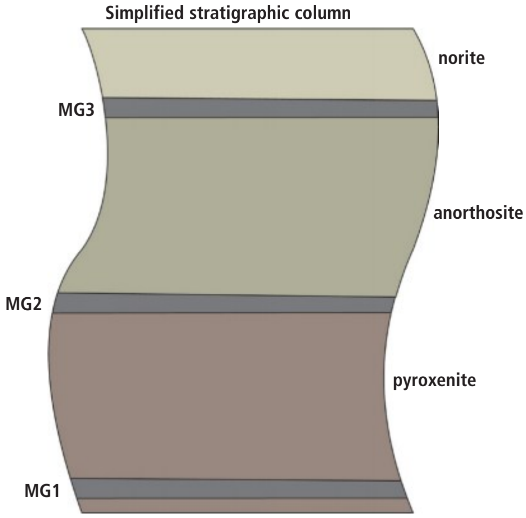
Wave interaction among neighbouring blastholes with bottom power decking



A multitude of interaction among reflected tensile waves in different mass areas and shock waves originated by detonation.

The floor level is established at the bottom of the blasthole and not at the bottom of the explosive column. A much lower powder factor is used in conjunction with the tulip plugs. This reduces the amount of fines and increases the proportion of lumpy ore. Other designs such as spacing and burdens, timing and explosive characteristics for a given rock type remain unchanged.

Simplified stratigraphic column



not to scale

principle as a bullet leaving the barrel of a gun.

In conventional blasting, the force is all directed upwards. This has the effect that the floor tends to be cratered and uneven and there is a higher proportion of oversize rocks in the stemming area and more fines in the body of the blast.

With the power-deck system, the blast is channelled downwards as the plug is forced down the void to the bottom of the hole. When the blast reaches the bottom of the hole, the force has nowhere to dissipate but sideways. The junction of the planes at the bottom a blast hole naturally form the weakest point in this cylindrical space. The fracture that occurs at this point, tends to create an even shearing plane that follows the deepest extent of the various blastholes.

In conventional blasting, the majority of the shock waves are compressive. The blast travelling downwards also creates tensile shock waves that are reflected off the fracture plane at the bottom of the hole. These travel back into the block of ground that is being blasted. When the tensile waves travel back through the rock they combine with compressive shock waves to form a highly efficient rock breaking force.

Tensile waves create a higher degree of destructive force in the rock mass, since rock has less resistance to tension than to compression.

The use of tensile shock waves breaks the rock into evenly sized particles. In conventional blasting, the force of the blast is greatest next to the hole and dissipates as the blast travels further from the hole. This results in fines being created close to the blastholes and larger rocks in the area in between the blast holes. With the power-deck system, the break is more even throughout the broken material. This also means that the average size of the blasted rocks can be varied by the simple expedient of moving blastholes nearer or further apart.

As the power-deck type blast creates an even floor that follows the deepest extent of the blastholes, the need for extra drilling (sub-drilling) below the bottom of the bench is eliminated. In ore blasting, the amount of dilution is reduced. This blasting system can also be used in holes that are filled with water.

At the mine, looking at blasted muckpiles, it was apparent that the fragmentation had improved and the cast (throw) was also better. The broken rock had formed a looser pile that was easier to load. The smoother floor created by the blast also helped to speed up the loading process.

Though the designer of the system recommends no sub-drilling, Butler still tends to use a little sub-drilling for any toe that might be picked up. Importantly, there is a saving on the amount of explosive that would have gone into the sub-drill area as well as the amount that would have gone into the power-deck or space under the plug. In addition the stemming is increased. In all Butler estimates that he saves about 10% to 15% on explosives in the waste blast and 40 to 50% in the ore blast. “That is very significant for any open-pit operation,” says Butler.

The transition of this blasting technique to chrome has been successful. Here Butler sounds a caution.

“As with all things if you want a successful blast, you have to supervise this technique carefully. However, the concept is an excellent one, and I have been pleased with the results,” concludes Butler. ■

Photographs: Andrew Lanham

Softer layers make harder mining

At Buffelsfontein, the chrome reef occurs in three horizons. The shallowest is the MG3 reef with the MG2 and MG1 reefs occurring at successively deeper levels. The reef dips at anything between 16° and 20°. The mine design dictates that the reef is excavated until a 35m highwall is reached. The MG1 is the reef that contains the most significant value. Differences in hardness in the various rock layers makes mining more challenging.

Between the surface and the uppermost MG3 reef is mainly norite. This waste layer is very hard and has even harder boulders encased within it. These large boulders have a weathered layer a few centimetres thick encasing them. This weathered layer tends to lead the blast energy around the rock rather than through it. These large rocks create difficulty for the loading and hauling equipment, though Butler points out that if Andru were not using the power-deck blasting system, this problem would be exacerbated.

Between the MG3 and the MG2, the rock is anorthosite that is very hard. Between the MG2 and the MG1 is also a hard pyroxenite.

The mining sequence is as follows: The norite is blasted and stripped. The more friable MG3 reef is then excavated. Thereafter Andru drills through the anorthosite layer, through the MG2. The same burdens are used for all these rock types, though Butler points out that the tulip plugs tend to eliminate any dilution of the MG2 reef.

Andru drills through the pyroxenite to the top of the MG1 reef, the pyroxenite is blasted, using the tulip plug system, and stripped . Finally, the MG1 is blasted using the tulip plug system, and mined.