

John Chadwick went into Mongolia's Gobi Desert to see progress at Oyu Tolgoi's #2 sinking, and he reports on advances in sinking and equipping shafts elsewhere

One of the great shafts of the world is currently being developed at one of the largest current developing mine projects, Oyu Tolgoi in Mongolia's Gobi Desert. Andre Zeelie, a man with decades of shaft sinking experience, is Oyu Tolgoi's Deputy Director – Mining. He believes that "Mongolia will become a world leader in underground mining because the latest technologies are being developed here."

In January, 2008, and at a depth of 1,385 m, Redpath completed sinking the deepest and largest diameter mine shaft in Mongolia, OT's Shaft #1 (seen on this page). The shaft is 6.7 m in diameter, concrete lined, and from it lateral development and construction of the Hugo North Lift 1 Block Cave is now underway. That work includes 45km of pre-production development, and over 145km of total development. Redpath is the principal mining and construction contractor.

RUC Cementation is raise boring two ventilation shafts near Shaft #1. A successful breakthrough of the pilot hole for the first lift of the raise (from the 512-m level to surface) and commencement of the pilot hole for the second lift of the raise (from the 1,300-m level to the 512-m level) were completed in the third quarter of 2010. Completion of the ventilation raise will increase ventilation capacity at the 1,300-m level and allow for the introduction of two additional underground

development crews and equipment, expected in the third quarter of 2011.

RUC Cementation is using a Strata 950 raise drilling machine its accuracy, within 30 mm on the first holing, comes from the use of Mincon's Rotary Vertical Drilling System (RVDS). This tool continuously self surveys and corrects itself to the vertical. The RVDS tool will always try to establish a vertical line by internal computers and survey systems that send a message to the jacking pads giving side pressure, when required, to re-align the hole. The Strata 950 is one of the most powerful raise borers in the world, built specifically for underground raise boring of holes up to 6 m in diameter over 1,000 m of depth.

The design and engineering of the Shaft #2 headframe has been finalised. Construction of a 97-m-tall (approximately 31-storey), reinforced-concrete headframe for Shaft #2 is progressing to plan. The structure for the Shaft #2 conveyor tunnel is complete, as is the ventilation plenum structure (air intake capacity 150 m³/s).

The most modern shafts

Shaft #2 provides for substantially all movement of personnel, materials, equipment and services for the mine. It also provides about a third of the total ore hoisting capacity of the mine and serves as a primary ventilation intake.

It is to be a 10 m diameter concrete-lined shaft fully equipped with steel sets on 6 m centres. The sinking platform for Shaft #2 is on site and Redpath is expected to begin sinking around August 2011, with a planned final depth of 1,335 metres below surface, with a loading station at the 1,195-m level. It will be the main service shaft for the underground Hugo North block-cave mine. Shaft #2 also will be used as the initial production shaft to hoist the Hugo North ore to the surface.

The underground development from Shaft #1 is expected to connect with the bottom of Shaft #2 in early 2013 and production from the first lift of the Hugo North block-cave mine is scheduled to commence in 2015.

The purpose of Shaft #1 is to allow resource characterisation and mine development, and to provide initial ventilation. Shaft #2 will provide service access to the underground mine for crews, equipment, installed materials and



REDPATH 1



Preparation for sinking platform installation at Oyu Tolgoi #2 (Top) and installation of the platform (Bottom)

consumables. It will also provide intake ventilation air and allow for initial production of more 28,600 t/d.

Two more shafts are to be sunk. Shaft #3 will allow production to be raised to of 55,600 t/d of ore and provide more ventilation; Shaft #4 will be for hoisting development ore and exhaust ventilation.

Shaft #2's 97 m high concrete headframe, will, as Zeelie describes it, "be a beacon across the Gobi." Six floors high it will certainly be seen for long distances across the desert. It will be equipped with two main hoists (ore and service) and one auxiliary hoist. Concrete-lined, it will be equipped with steel sets, cables and service pipes. There will be seven compartments, two for the main cage and counterweight, one each for the two 60-t capacity skips, one for the auxiliary cage and two for utility service pipes and cables. The utility service pipes will include, for instance, four 152 mm diameter and two 203 mm diameter slick lines for delivering shotcrete, etc.

The main cage will carry 150 people underground and at dimensions of 9.5 m x 5 m x 12 m high, the large Sandvik LH517 LHDs will be able to drive into and off the cage for transport up and down the shaft with just their buckets removed. Similarly cement mixers will be able to drive from the batch plants into the cage to deliver product underground for the 120 km of paved haul roads that will be established for the Hugo North mine.

This will be the highest suspended mass of any hoist system in the world, Zeelie explains, beating its nearest rivals by a long way – Impala #17 (South Africa), suspended mass 258 t and payload 33 t; Konkola #17 in Zambia, suspended mass 242 t and payload 33 t; and one of Mosaic's shafts in Canada, suspended mass 238 t, and payload 45.5 t.

The conveyor gallery for ore transfer to the concentrator and skip unloading are particularly innovative. Rather than the conventional skip unloading in the headframe, these skips will be unloaded at 20 m below the shaft collar. The skips will unload via a feeder system directly onto the conveyor belt. The conveyor system will be suspended from the roof of the conveyor gallery to allow LHDs to move back and forth below it for clean up.

Preliminary sub-surface work at Shaft #2 began in mid-2007 and, as planned, paused for winter in mid-December. It then paused for longer while the Oyu Tolgoi project awaited the approved Investment Agreement to begin full-scale construction. Progress to date has included completing the concrete headframe to 14 m below grade and extending the conveyor gallery and ventilation system.

Composite concrete/steel headframe construction started from shaft collar with steel erection, followed by jump formed concrete. Sinking steel and equipment are being installed concurrently. Next, the sinking tower structural and internal steelwork will be complete to 46.5 m, ready for pre-commissioning and rope-up. The shaft foundations have been designed to withstand earthquakes and the headframe to cope with wind speeds up to 200 km/h.

Rope-up and shaft sinking plant final commissioning will be done at completion of the head frame. Composite concrete/steel construction to 46.6 m will be done during winter; completion of the head frame is expected by mid July 2011.

Once the headframe tower structure is complete, installation of permanent hoist and related equipment will progress above 46.5 m.

Shaft sinking will use precision drilling and blasting, which will mean no rock bolting should be required. A Brokk robotic shotcreter will be employed. The Brokk 440 can also be equipped with a loading bucket, a drill and a material handler to install pipes.

Zeelie is also keen to replace cactus grab or clamshell-type grab mucking with mini excavators lowered down the shaft. This he explains means less people can move the same amount of muck as the conventional system. This shaft will use a Caterpillar 314D excavator. This is a small 14 t hydraulic excavator featuring a compact radius, making it ideal for work in restricted spaces. Its reduced tail swing improves overall safety, while the new tool control system enables machines to be very quickly adjusted to a wide variety of jobs.

To further aid speed and productivity an automatic boom and swing function prioritises the oil flow and pressure to where it is most needed – giving the impression that the machine automatically selects the best mode based on joystick control.

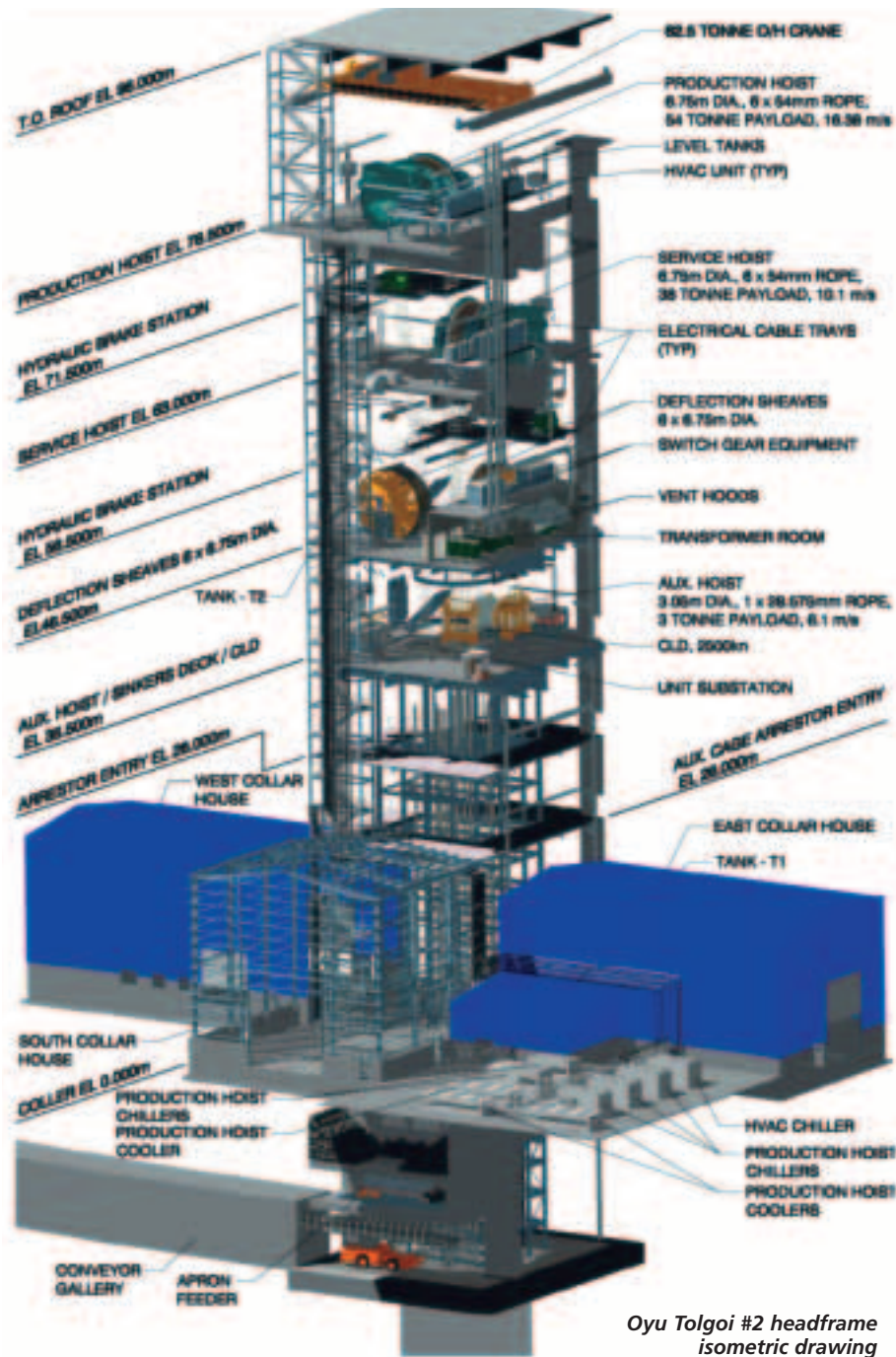
Operator comfort is enhanced via high visibility and large cab, which is sealed and pressurised to keep dust out and clean air in. All operator controls are designed easy reach, smooth, low-effort operation and the siding door system allows easy operator access, even in tight quarters.

Hepburn Engineering is supplying a new 2,790 mm single drum two-rope Blair service hoist to Shaft #1. The 1,305 kW hoist will greatly improve underground access with a 13-t maximum payload, and a

REDPATH 2

Oyu Tolgoi main production and service hoist

	Production	Service
Diameter	6.75 m	6.75 m
Number of ropes	six	six
Payload	60 t	38 t
Production rate	28,600 t/d	N/A
Hoist speed	16.4 m/s	10 m/s
Rope diameter	54 mm	54 mm
Suspended mass	449 t	404 t



Oyu Tolgoi #2 headframe isometric drawing

maximum speed of 10m/s. The new service hoist will feature advanced AC Drive and control technology – the Hepburn Hoist Manager software – and will have the capability for fully automated operation. Hepburn has also supplied an electrical

upgrade to the #2 sinking hoist.

Other news from the company is its new remote hoist access solution, HOIST CARE, which includes comprehensive remote diagnostic technical support. This is achieved using a secure link over the internet from

Hepburn's hoisting specialists to ensure the hoisting systems top operational effectiveness. This allows the specialists access to the hoist controllers (PLC), Hoist Manager and Hoist Reporter without exposing any of the core hoist control elements to the internet. It has been carefully designed and configured to satisfy the critical safety issues inherent in mine hoisting. Hoist Reporter uses web technology to provide immediate production reporting to mine management desktops.

Hepburn has also added to its range of shaft sinking winches. It recently two 36,300 kg sinking winches which are currently being installed in Mullan, Idaho, USA. These two winches are similar to the over 30 Hepburn units with either 45,000 or 68,000 kg line pull rating except that the 36,300 kg winch can be fully disassembled for underground installation. When disassembled, these winches can be lowered down a vertical shaft with dimensions limited to a maximum of 1.83 m, and a maximum component weight of 15 t.

And in Africa...

In one of Zambia's biggest underground developments for decades, Murray & Roberts Cementation has secured the development phase contract at Konkola North for the East Decline system and ramps to access the orebody. The Konkola North copper project is a 50:50 joint venture between African Rainbow Minerals (ARM) and Vale, situated near the town of Chililabombwe in the north of the Copperbelt province, and is adjacent to the border with the DRC and north of the existing Konkola Copper Mine (KCM).

The scope of Cementation's work comprises some 2,100 m of conveyor belt ramp development, 4,000 m of access ramp development and 12,900 m of footwall and ore drives. In addition, raise drilling will be done for a total of about 550 m to accommodate service ways, air ways, dams and silos. These raise drilled holes will be at varying diameters.

Previously, the Konkola North orebody was developed between 1953 and 1959 by others, following which the mine was exploited for a period of some two years. Thereafter it was closed due to the poor economic climate at the time.

DRILLCON



DRATS two refurbished hoists at Great Basin Gold's Burnstone gold mine

Konkola North is a continuous orebody and consists of two distinct, the South and East, Limbs. The orebody strikes generally in a northeast to southwest direction and dips between 15° and 77° in a southerly direction. The mineralisation associated with the tabular orebody occurs along an extensive strike length, with a true thickness range of 3 to 15 m in the currently planned areas and up to 18.6 m in the high grade, deeper regions.

Access to the East Limb will be via the new East Declines which will be sunk from surface to the 75 and 100 m levels. On the 100 m level footwall drives will be developed on strike for the top access of the three ramp systems to access the orebody down to 250 m level in phase one of the project. A set of three conveyor declines with transfer silos will be developed during this phase.

In the final configuration, ore and waste handling from underground will be by means of permanent conveyors and the East Limb material will report to either the concentrator on surface or waste stockpiles.

Development will start in February 2011 from the portal access, and the operation will be executed using mechanised mining equipment consisting of twin boom drill jumbos, bolter rigs for support, LHDs, 40 t mine trucks, emulsion explosive chargers and purpose fit utility vehicles.

Total mine capital expenditure, in July 2010 terms, on the Konkola North development was estimated at \$380 million. Construction commenced in August 2010 with commissioning of the concentrator plant expected 27 months later and the mine is planned to reach full production in 2015.

The expected life of mine of Konkola North is 28 years. A further three-year exploration programme to evaluate area "A", which has

potential to double the output to 100,000 t/y of copper in concentrate is in progress. Initially, the South and East Limb mines will be developed, after which the deeper, higher grade and wider reef areas will be mined. The Vale/ARM joint venture has completed 86,000 m of exploration drilling and defined 300 Mt at an average grade of 2.57% total Cu.

The mine's throughput design is 2.5 Mt/y of ore at an average mill head grade of 2.3% Cu, yielding 45,000 t of contained copper in concentrate to be toll smelted in Zambia.

New and old hoists

ABB is currently supplying two complete mine hoist system to LKAB's Malmberget iron ore

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mine (*IM*, August 2010), in northern Sweden. The first mine hoist, ordered from ABB in November 2007, is under installation/commissioning and is planned to be in operation at any time. The second hoist is planned to be put into production during 2013.

The two mine hoist systems are identical. ABB's scope of supply includes both mechanical and electrical equipment, such as pulley and shaft, brake system, skips, measuring pockets, System 800xA control system, motors, drive system ACS 6000 SD, installation as well as commissioning.

Both will be used to transport ore from the new main haulage level, M1250, which is currently under construction at Malmberget. Both hoists will help LKAB increase its overall output and productivity to meet increasing demand from the world market.

ABB has a long history of cooperation with LKAB, and has worked with LKAB on numerous projects. In April this year ABB received an order to supply a new complete mine hoist, including mechanical and electrical parts, to LKAB's Kiruna mine.

"It is a great honour for ABB to have won LKAB's trust again to deliver the second mine hoist to its mine in Malmberget", says Mikael Grage, Head of Underground Mining within

ABB Business unit Minerals. "We are committed to providing the comprehensive solutions they need to continue their capacity expansion, and optimize overall productivity of the mine well into the future."

Meanwhile, subsidiary ABB South Africa has acquired the mine hoist related business of local manufacturer, Coilmech. ABB South Africa will add the business to its process automation portfolio for customers in the mining sector.

"This acquisition forms part of ABB's strategy to support the mining sector with local manufacturing and demonstrates our commitment to the local market," says Carlos Pone, CEO of ABB South Africa. "Current and future customers will benefit greatly from ABB's electrical and mechanical integration capabilities, as well as from ongoing improvements in quality and performance arising from ABB's far-reaching research and development efforts."

ABB South Africa will expand distribution of these solutions through its India, Middle East and Africa (IMA) regional distribution channels and increase the product range. The business will also benefit from ABB South Africa's black economic empowerment (BBBEE) credentials. Coilmech employs approximately 30 people and has transferred to ABB South Africa's new head office,

logistics and manufacturing premises at Longmeadow, Johannesburg.

Burnstone's hoists

DRA Technical Services (DRATS), the specialist South African winder engineering company, has handed over two refurbished hoists to Great Basin Gold's Burnstone gold mine near Balfour, South Africa (*IM*, March 2010, pp45-49). The project not only reduced the amount of capex the client required for the hoists but also enabled it to bring the project to an earlier completion date.

The project saw the units, an 1,800 kW 4.27 m double drum man winder and a 4,88 m double drum rock winder driven by two 1,343 kW motors, undergo a full mechanical refurbishment, replacing all wear components as well as providing modern brakes and hydraulics. All of the rotating machines including motors and generators were completely rebuilt, being rewound to class F insulation standards in the process and new, state-of-the-art electronic speed control and protection equipment was supplied and installed.

The man winder will hoist a 5.25 t payload, in a 7 t cage on a depth of wind of 500 m. The rock winder features a 12.5 t payload, a skip mass of 9.38 t and a depth of wind of 490 m. One of the unique features of the

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Burnstone's rock hoist motor at M&C

project is the incorporation of a fibre optic bell signalling system. Designed and built by DRATS, the system is a first for the mining industry anywhere in the world.

Says Graham Du Plessis, Managing Director of DRATS, "It made economic sense to the client to refurbish the winder units rather than opt for new ones. From a cost perspective, in this particular case, the refurbished winders offered a 50% saving compared to the cost of new winders while at the same time providing a delivery period of about half that of new machines. This project took about nine months to complete from contract signing to completion of winder refurbishment.

"In their refurbished state, the winders will operate as new and according to the mining industry's strict safety requirements. This despite the man winder tracing its origins back to the 1930s where it operated at the now defunct Okiep copper mine. The rock winder was sourced from Zambia and was originally built in 1954. The refurbishment and modernisation of these units will extend their operating lifespans another 30 years." According to Du Plessis, while the electrical equipment in a winder has a finite lifespan,



due to eventual obsolescence, overall, a winder can be used almost indefinitely. He cites the example of the oldest continuously operating winder in South Africa, at the Hercules shaft at ERPM in Boksburg, which was in use at its original location for 91 years until the mine was closed.

"It has been a policy of many local mining companies to re-use secondhand winders wherever possible," adds Du Plessis. "DRA

Technical Services is fully equipped to handle any type of winder project whether it be for new units or refurbished ones and has handled some of the biggest winder installations in Africa."

Marthinusen & Coutts (M&C) successfully completed the repair of both the rock winder and the man winder rotating machines comprising drive motors and generators on this. Contracted by DRATS, the work was done on a phased program schedule and after

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In 2008 Timberland provided a mobile mine rescue vehicle to Huainan Coal in China and believes it "is one of the first ever mobile rescue units in the country. The system includes a personnel rated mine rescue hoist mounted on a flat-bed truck with a boom and bullet style rescue cage. The truck is easily moved from shaft to shaft to allow the rescue system to be used at multiple sites"

completion, the rebuilt rotating machines were stored by M&C until the site could accept delivery for installation.

M&C has a close working relationship with DRATS and this contributed to the overall success of the contract. All the work was undertaken at M&C's Cleveland ISO 9001:2000 accredited workshops. Installation was done by one of the well-known winder supply companies, but M&C was responsible for verifying the air gaps, brush and brush arm settings and ensuring that dowelling was correct on the installations.

The complete rock hoist drive comprises two motors, one MG set drive motor and two generators. During the repair process, where relevant, technology on components was upgraded to ensure reliable performance once installed. Repair work to the two 1,343 kW rock hoist motors and the two 933 kW generators included rewinds on both the armatures and field frames.

Work on the 2,107 kW MG set drive motor included a design change from a 3,300 V hairpin winding to a 11,000 V set diamond winding on the stator. This was done to accommodate the mine power supply. It was necessary to manufacture a new stator core at M&C's Cleveland facility to complete this design change and the stator as well as the rotor was rewound.

The man hoist machines included a 1,750 kW generator which had its armature and field frame rewound and a 1,865 kW winder motor which received an overhaul of the armature and field frame. During testing it was discovered that the 1,343 kW MG set drive motor had developed 'hot spots' and to eliminate this, a complete restack of the stator core was done. The rotor was also rewound.

Hoist brakes

Twiflex has launched a larger, enhanced version of its highly successful VMS2/SP safety brake, aimed specifically at the demanding mine hoist market. In common with the VMS-2, the VMS3/SPS is a spring applied, hydraulic released safety brake, but offers faster operation and superior performance, delivering

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The Twiflex VMS3/SPS safety brake design integrates small size pistons for quicker reaction times, coupled with an improved drainage system and a reduced retraction pressure of 160 bar (depending on rating). In addition, the status of the VMS3/SPS braking system can be linked to a PLC to provide a signal for brake on/off and indicate when the brake pads need to be replaced

a maximum static braking force of 300 kN (with 1 mm air gap), and 230 kN (with 3 mm air gap) of dynamic braking force, with the added benefit of infinite fatigue life. The mine-ready, robust design of the VMS3/SPS is characterised by a strengthened, longer housing which integrates additional springs for improved braking force. Totally sealed for corrosion and dust protection, the new design offers users the set-up and maintenance advantages of tamper proof pad/air-gap adjustment, the facility for external pad retraction, on-site torque adjustment and a 'Park-Off' facility for achieving fast seal changes without the requirement for special tools.

In the past 18 months, Twiflex has supplied the VMS3/SPS units to Davy Markham for use on two major gold projects. The Westwood mine located near Rouyn-Noranda, Quebec, Canada is using the VMS3/SPS's on its 5.5 m double drum service hoist and the 6.4 m double drum production hoist. On the service hoist four off brakes are used on the fixed drum and two off brakes on the clutched drum giving a total of 3,988 KNm torque. On the production hoist five off brakes are used on each drum giving a total of 7,728 KNm torque.

The Lalor mine is located in the Snow Lake region, Manitoba, Canada where the VMS3/SPS brakes are being used on the 4.3 m service hoist (eight off brakes) and 4.9 m production hoist (seven off brakes). **IM**

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