

# XRT technology ushers in a new era in diamond recovery

The spectacular success of TOMRA X-ray transmission (XRT) technology at the Karowe diamond mine of TSX-listed Lucara Diamond Corp in Botswana has led to more and more diamond mines electing to install TOMRA's sorters in their processing facilities. The XRT technology provides a single-stage alternative to traditional concentration and recovery techniques used in the diamond mining industry and is particularly effective in preventing the breakage of large diamonds during processing operations, a problem which has bedevilled the industry for years.

Although XRT technology goes back several decades in applications such as recycling, its use in the diamond mining industry is much more recent with TOMRA Sorting Mining, the mining arm of TOMRA's Sorting Division, having only started development of its machines for diamond recovery in 2005. A pilot XRT unit was installed at Gem Diamonds' Letšeng mine in Lesotho in 2011, where it worked successfully

The TOMRA XRT machines installed at Karowe (photo: Lucara).



A view of Lucara's Karowe mine in the Orapa Kimberlite Field of Botswana. The tall building in the centre of the photo houses the XRT sorters (photo: Lucara).

Below: TOMRA and Karowe personnel in the XRT section of the Karowe processing plant (photo: Lucara).

for several months. The breakthrough, however, was the installation of the technology at Karowe in 2015.

TOMRA's XRT machines at Karowe were commissioned in April 2015 as part of a major plant upgrade designed to address the changing characteristics of the orebody as open-pit

mining progressed, most notably the increasing density of the material at depth which was resulting in a higher DMS yield to the recovery plant. The upgrade also provided the opportunity to install a large diamond recovery circuit, a priority for Lucara given that Karowe – which mines the AK6 kimberlite – was proving to be a far bigger producer of large, high value diamonds than was originally anticipated.

"After extensive test work which saw several tons of Karowe ore being shipped to TOMRA's facilities in Germany, we were able to demonstrate to Lucara that the use of our XRT technology would deliver a significantly lower percentage yield in a single pass in the plus 8 mm fractions and proved that it was possible to replace both DMS and Final Recovery with a single stage, at the same time also providing 100 % detection of every diamond in the feed," says Geoffrey Madderson, Diamond Segment Manager at TOMRA Sorting Mining. "As a result, we were awarded a contract to install six of our COM Series XRT 1D belt sorters at Karowe to replace DMS technology in the +8 mm size range, with each unit able to treat up to 150 tons per hour (tph) at over 8 000 hours per year."

The XRT machines installed deal with three size fractions. The largest size fraction is processed through a Large Diamond Recovery (LDR) XRT machine, able to recover diamonds in excess of 1 000 carats. The +14-32 mm fraction is processed through two coarse XRT machines, and the finer +8-14 mm fraction is processed through two middles XRT machines.



The sixth machine is used in an audit role.

All XRT concentrate is directed to a high security 'Red Area' directly below the XRT machines, and into separate, individual sorting glove boxes, where hand sorting takes place.

Madderson says that the advantages of the XRT technology include its compact footprint and lower operating costs, as well as the fact that there is no need to further process the concentrate from the sorters before final hand sorting. Capacities are impressive with the latest generation units being capable of handling up to 420 tph.

The XRT sorters work on the principle of identifying the carbon signature (atomic

Some of the large diamonds recovered by the XRT sorters at Karowe (photo: Lucara).





The Renard mine of Stornaway in Quebec, Canada, is the first diamond mine in the world with LDR in its primary flowsheet (photo: Stornaway).

number) of diamonds. They reliably detect all diamonds including coated, low luminescent and Type II diamonds which can prove problematic for other recovery methods and they greatly reduce the incidence of diamond breakage as they minimise the exposure of diamond-bearing ore to comminution processes which can result in diamonds being damaged.

The XRT machines at Karowe have proved to be a huge success, the high point being a single week in November 2015 which saw the recovery (in the LDR unit) of the second biggest diamond ever to be unearthed by a diamond-mining operation, the 1 109-carat *Lesedi la Rona*, as well as the 813-carat *Constellation*. The *Lesedi la Rona* is still in Lucara's possession but the company announced in May last year that the *Constellation* had been sold for US\$63 million, a new record for a rough gem.

Following on from the initial installation, Lucara is now in the process of more than doubling the number of TOMRA XRT sorters at Karowe, with three separate projects currently underway and due for commissioning later this year. The first is the Mega Diamond Recovery (MDR) facility, which is being installed post the primary crusher and which will allow diamonds up to several thousand carats to be recovered. The second is a sub-middles XRT project. This is targeting the recovery of diamonds between 4 mm and 8 mm and will enable the scale of high-cost DMS operations at Karowe to be further reduced. The third project will see a further two units being installed to audit material between 4 mm and 20 mm.

"The success of our technology at Karowe has led to huge interest from other diamond miners and indeed a surge in sales," comments Madderson. "The amazing outcome we've had

at Karowe is due to the confluence of a number of factors, including a dynamic client receptive to the introduction of new technology, as well as the characteristics of the orebody, most notably the high yielding ore, the very coarse size/frequency distribution and the presence of a very significant population of large, high value diamonds in the AK6 kimberlite."

The applications of TOMRA's XRT technology are not confined to kimberlite material and the sorters have proved very effective in alluvial operations, a case in point being the Lulo mine in Angola operated by ASX-listed Lucapa Diamonds. A single TOMRA machine was installed there in the final quarter of last year. Forming part of a new coarse recovery stream, it processes material between 18 and 55 mm

in size and allows the recovery of individual diamonds of up to 1 100 carats. It has already proved its worth with Lucapa announcing in February this year that it had been responsible for the recovery of a 227-carat stone, Angola's second biggest diamond on record.

"The recovery of the 227-carat diamond through the new XRT circuit ... vindicates our investment in this large-diamond recovery technology, which will have more than paid for itself with the recovery of this one stone alone," commented Stephen Wetherall, Lucapa's MD, at the time of the announcement.

Elsewhere in Africa, two TOMRA XRT machines have been delivered to the Kao mine of Storm Mountain Diamonds in Lesotho, one is currently being installed at Letšeng, while a further two have been supplied to an alluvial operation in Sierra Leone.

Outside of Africa, the technology has been selected for Lipari's Braúna mine in Brazil, reputedly the first kimberlite mine in South America, and for two Canadian kimberlite projects. One is the newly commissioned Renard mine of TSX-listed Stornaway in Quebec, which is the first diamond mine in the world with LDR in its primary flowsheet (treating +19 mm-45 mm material), while the second is the Star-Orion South project in Saskatchewan of Shore Gold, also listed on the TSX.

In a recent update on Star-Orion, Shore Gold reported that some 2,8 tonnes of AG milled product had been shipped to TOMRA in Germany for diamond recovery testwork using the TOMRA dual energy X-ray transmission (DEXRT) full-scale sorter. "The results of the test showed that XRT is viable as a replacement, for +8 mm fractions, for dense media separation in the re-design of the process plant,

potentially reducing capital costs of the plant, and simplifying the overall flowsheet, leading to reduced operating costs and a smaller environmental footprint," says Shore in its update. "TOMRA engineers are currently developing XRT sorters for use in final recovery, with a proposed capability of recovering diamonds down to +2 mm from DMS concentrate."

Madderson stresses that TOMRA Sorting Mining is not simply a supplier of equipment. "Every system we install – although it is based on our standard sorters – is designed around the needs of the customer with the aim of providing a customised process solution that is consistent with the characteristics of the ore to be treated and the operational requirements of the project or mine," he says. "We are always closely involved with the commissioning of our machines and, beyond that, we can assist with their ongoing operation. We have a full service agreement in place with Karowe, for example, which ensures that the XRT machines are kept

in peak condition and run reliably and, by the end of this year, we expect to have 20 full-time employees on the mine.

"So, to sum up, we see ourselves as a solutions provider to the mining industry dedicated to partnering with our customers to provide them with the ability to extract maximum value from their orebodies. XRT is the main thrust of our offering in the diamond mining field but we also have available a range of other sensors which can also be very effective in concentration and final recovery. Using these technologies and, in particular XRT, mines now have a very viable alternative to the conventional systems that have traditionally been used to process diamond-bearing ores."

Report by Arthur Tassell



The 227-carat diamond recovered by a TOMRA XRT sorter at Lucapa's Lulo mine in Angola (photo: Lucapa Diamonds).

## TOMRA celebrates 45 years in business

TOMRA, which is celebrating its 45th anniversary this year, was started in a small shed in Asker, Norway, by two brothers, Petter and Tore Planke, who had developed – at the request of a local grocer – an automated machine that could quickly and easily take back used, empty bottles for recycling.

Today the company is a diversified group which in 2015 had revenues of Euro 650 million. It is headquartered in Norway and is listed on the Oslo Stock

Exchange but has operations around the world, including factories located in Slovakia, the USA, The Netherlands, Germany and Belgium. The company reinvests 8 % of its revenues in research and development and around 20 % of its 2 600-strong global workforce is engaged in R&D.

TOMRA operates in two business areas – Collection Solutions (reverse vending and material recovery) and Sorting Solutions (recycling, food sorting and

mining). Mining is the smallest part of its Sorting Solutions division but is regarded as having high potential.

Although our article here has focused on TOMRA's XRT sorters, the company offers a full mining sensor portfolio comprising electromagnetic, near-infrared spectrometry (NIR), colour and laser reflection/fluorescence sensors.

TOMRA's mining business is headquartered in Hamburg, Germany, but the South African subsidiary has played a lead role in driving its expansion into mining and in developing the XRT technology. ■

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