Bakkie of the SKIES

STORY BY SEAN WOODS

High-tech gyroplane reinvigorates the science of airborne geophysics

It sounds contradictory, but exploration of the ground we stand on – digging for precious metals, trying to locate hidden faultlines in Earth's crust, or establishing the optimum way to fertilise farmland – is often best accomplished from the air. But to do the job properly, you need a robust aerial platform able to fly low and slow, with a superhero-like capacity to see right through solid objects.

Until now, that's been hard to accomplish, anywhere. That's why it's especially pleasing that a solution has been found right here in South Africa. The Kriek IIB gyrocopter carries a high-tech payload that allows it to penetrate the ground to depths of up to 15 km, giving geologists a detailed, accurate picture of what's hidden from view. Amazingly, it's relatively inexpensive, too. The quality of its captured data is so high, and its operational costs so low, that it's already attracted serious attention from big mining concerns in Australia, Canada and Asia.

Forget that it looks look like a hangover from aviation's pioneering days. This tough, purpose-built "bakkie of the skies" is decidedly modern, incorporating the very latest in gyrocopter technology.

The brainchild of Wagtail Aviation gyro guru Johan von Ludwig, the Kriek (its name comes from the Afrikaans for cricket) is a real toughie. It's capable of taking the punishment of rough-field operations squarely on the chin. Von Ludwig elaborates: "Its robust, deep floating undercarriage allows it to land and take off on runways littered with bricks. Those are our specs. Basically, where you can drive a bakkie, you can take off and land."

Von Ludwig had long been working on a tractor-configured gyro (in which, unlike most modern designs, the prop up front pulls the fuselage forward rather than pushing it from behind). But it took a Popular Mechanics article to really kick-start the project.

Dr Laurent Ameglio from EXIGE – a company specialising in conducting geophysics surveys, mainly for mineral and natural resource exploration – read in PM about the joint venture between Von Ludwig and Alto Air's Gerhard Jacobs. Our August 2008 article "Sky watchers" told how the collaboration between Von Ludwig and Jacobs, called Airwatch, was using gyrocopters as aerial surveillance platforms to fight crime. It also spoke of the technological breakthroughs Von Ludwig had achieved to bring their squadron of gyros up to military spec.

"It had always been a vision of mine to use something that flew low and slow without requiring a runway," recalls Ameglio. "When I read about what these guys were doing, I immediately knew they were the ones to contact."

He wasn't disappointed. In no time this like-minded trio set up a new company, GyroLAG, with EXIGE taking care of the geophysics surveys and all related electronic equipment, and Airwatch concentrating on aviation operations.

AERIAL PROSPECTORS

Using fixed-wing aircraft or helicopters to perform aerial geophysics surveys is the established way of doing things. However, both options present serious drawbacks. For starters, aircraft fly too high and too fast to accumulate quality data. Helicopters – apart from having to "hang" on their rotor blades when moving forward slowly (something they were never really designed for) – cost an absolute fortune to operate.

There's also the logistical hassle of transporting and storing aviation fuel in remote locations. And, of course, planes need a runway. "The bottom line," says Ameglio, "is that mines typically spend millions sinking exploratory drills in their search for deposits. Traditional aerial maps have too low a resolution."

The Kriek can take off and land in a ploughed field if need be. It runs on regular unleaded automotive fuel. And its overall running costs are a fraction of that of either aircraft or helicopters. But, most importantly, it can fly low and slow. "In airborne geophysics, when you fly slowly you get higher-resolution data," explains Ameglio. "And, the closer to the ground you are, the higher the concentration of measurements become." To put this into perspective, The Kriek can capture a detailed measurement every metre. A typical fixed-wing equivalent manages only one in seven.

BUILT FOR THE JOB

The Kriek is the only commercially certified gyrocopter in the world that Von Ludwig's aware of. It has attributes that make it ideal for the job: robust tricycle undercarriage, tractor configuration, proven rotor head with large aluminium rotor blades and a fine-tuned, purpose-built rotor mast.

In rough terrain operations, you can't beat a tractor-configured gyro. That's because, as the propeller is up front, stones and the like can't get flung into it by the wheels during take-off or landing. Says Von Ludwig: "To date we've flown about 620 hours without experiencing any damage to the prop. Unfortunately, the same can't be said for pusher props. We've found that anything from 12 to 100 flying hours can damage them significantly, which means they require servicing – a job that can take

Main: GyroLAG's Kriek IIB gyrocopter busy conducting an aerial geophysics survey in the Barberton area for the International Continental Scientific Drilling programme (ICDP). Right: The portable gamma-ray spectrometer, housed inside the Kriek's cockpit, comprises a large caesium iodide crystal that detects natural radiation emitted from the ground. Middle: Dr Laurent Ameglio preps the onboard instrumentation before take-off. Far right: The Kriek was specifically designed to handle remote, rough-field operations.

Above: After conducting successful tests on their "technology demonstrator", Airwatch will soon be fitting Krieks out with light machine guns and state-of-the-art comms. Top: The Kriek can also be used to assist in large-scale precision farming. Below: Two flux-gate magnetometers are used to detect ferrous metals and measure the earth's magnetic field.

the gyro out of action for up to two days."

Another big advantage: improved yaw stability. Because thrust is applied from a much greater distance to the fuselage's rear vertical surfaces than with pusher configurations, the longer momentum arm makes for a much more stable flyer. You'll appreciate this when you're wanting to flying in accurate straight lines 100 metres apart, as low as 40 metres above ground. "The whole feeling of the machine is of one that's much heavier than it actually is," explains Von Ludwig. "This makes it significantly less influenced by the wind."

As most flying occurs in the same zone used by large birds such as guinea fowl, plovers and pigeons, bird strikes are a common occupational hazard. With a tractor configuration, the unfortunate victim disintegrates in the propeller.

When flying low level, the last thing you need is to be swayed by the elements. Von Ludwig's proven rotor head design, built to military specifications, has undergone a total of five updates, and boasts more than 1 500 flying hours without showing any hint of failure. Structurally tested to handle 20 tons in the horizontal axis and 10 tons in the vertical axis (way beyond the standard industry norms), it can handle large rotor blades almost 11 metres long – a feat not possible in a recreational gyro.

Apart from providing serious lift, which, in turn, improves efficiency, the increased inertia brought about by these blades provides the Kriek with impressive stability. It's largely indifferent to the turbulence, mainly caused by midday thermals, that upsets delicate onboard sensors. "Conventional aircraft used in geophysics mostly fly morning or afternoon," says Von Ludwig. "We're different; we can fly all day."

Because the onboard geophysics instrumentation is so sensitive, vibrations in the fuselage have to be kept to a minimum. To achieve this, a lot of thought went into the rotor mast's design. What Von Ludwig did was put all its components under tension, before gluing them together in sequence. Effectively, what he did was tune the frequency generated by the mast to ensure that virtually no vibrations ended up being transmitted into the structure.

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CRYSTAL EYE IN THE SKY

The main components of the Kriek's delicate payload are two flux-gate magnetometers fixed on the end of the booms protruding out from each side of its fuselage, a portable gamma-ray spectrometer housed inside the cockpit and a simple notebook computer used as a digital acquisition system.

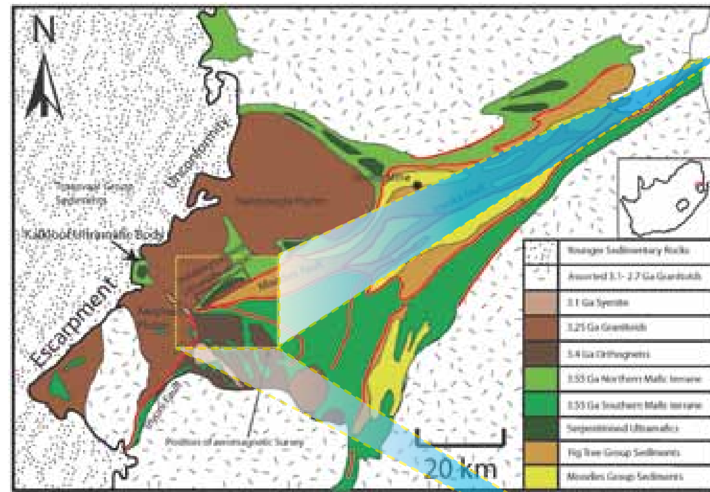
The flux-gate magnetometers are used to detect ferrous metals and measure the Earth's magnetic field. They can extrapolate their findings down to depths of 15 km. Inside the spectrometer, a large Caesium iodide (CsI) crystal detects the natural radiation emitted from the ground. This radiation, when passed through the crystal, causes it to vibrate and emit light. Each specific sliver of the light spectrum emitted can in turn be measured, and its source identified.

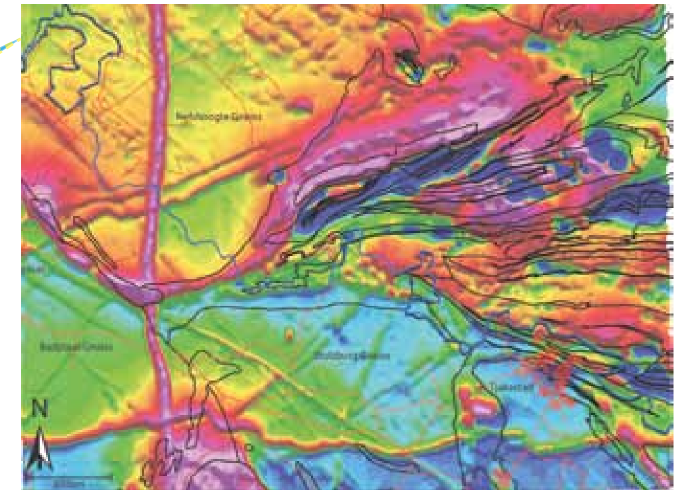
Data from both instruments is captured simultaneously and, after much number-crunching, Ameglio and his colleagues can interpret their findings. "By enhancing certain signals we can locate and map specific mineral deposits such as coal, copper, gold, oil or diamonds," he says. "This not only helps mines determine what sites are best suited for drilling, but also what areas are best avoided."

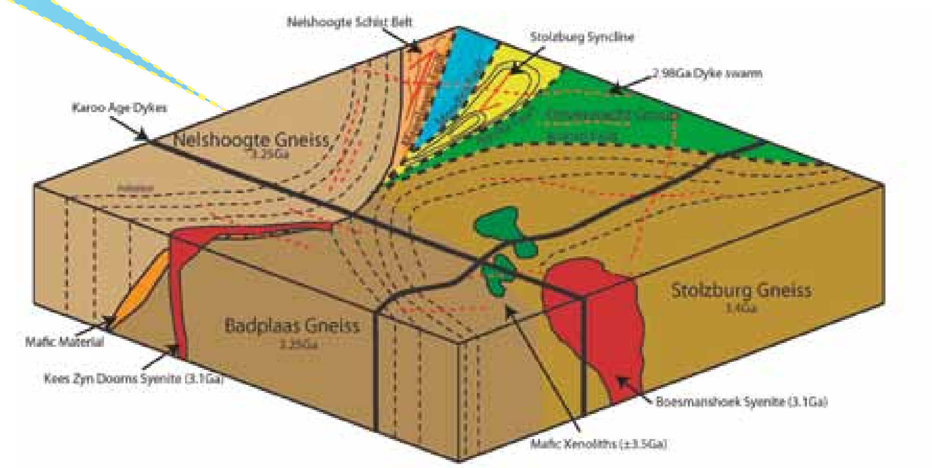
A perfect example of identifying where not to drill was the survey conducted in the Barberton Greenstone Belt in Mpumalanga for the International Continental Scientific Drilling programme (ICDP), an area home to some of the oldest rock on the planet. The ICDP's plan is to drill a core 10 km deep to reconstruct the environments at or near the surface where life first emerged and subsequently evolved. The drilling phase alone should take 10 years, and the entire project is expected to run for 15. Needless to say, it's a massive concern, involving an investment of millions of dollars.

GyroLAG's survey identified a number of hidden fault lines beneath the surface that previous ICDP exploratory efforts had missed, causing it to re-evaluate where to set up shop. "Because they need to drill away from any faults to get proper data, the site where they initially wanted to locate their operation would have been a disaster," explains Ameglio.

But it doesn't stop at identifying mineral deposits and hidden fault lines. They can also assist in large-scale precision farming operations, he says. This is a practice popular in Australia, and something that South Africa is slowly waking up to. "By measuring the potassium and water levels in the soil, we can advise farmers where best to apply fertiliser or where they're over watering to help them increase their yields."







EXIGE's survey of the Barberton Greenstone Belt in Mpumalanga for the International Continental Scientific Drilling programme is a perfect example of what this company can do. Top left: A geological overview (survey area outlined in yellow). Top right: A total magnetic intensity map of the surveyed area with geology (black lines) over imposed. Below: A 3D geological interpretation of the survey's findings.

MULTIFACETED FLYER

Work is already underway on producing gyros for two other applications. Jacobs believes its potential uses are almost limitless. "The way we see it, it's all about marrying our gyro technology and expertise with real-world applications."

For example, the stable flight characteristics and heavy load capacity of the Kriek make it an ideal platform for distributing sterilised codling moths (an agricultural pest of note) over large citrus plantations. "At the moment quadbikes are used to release them, but the sheer volumes and large areas involved make this impractical," says Jacobs. "We are busy building four aircraft for this programme and expect to have them in the field by the end of the year."

Predictably, there has been interest from the security establishment. Plans are afoot to kit out the Kriek with lightweight machine guns and state-of-the-art comms to provide cost-efficient support to troops deployed in the field. Enthusiastic support has been shown by a number of African countries. "We used an alternative fuselage as a technology demonstrator because it was available," says Jacobs. "Kitted out with cameras for target acquisition and a high-frequency, wide-bandwidth data link capable of transmitting live video feed to the ground, it works incredibly well. Once we have more Krieks available we'll be using these."

Airwatch's production facility at Wonderboom Airport, north of Pretoria, is working flat out to supply the machines the company desperately requires. "Our target is to produce 20 to 30 units over the next six months," says Jacobs. "All of them will be absorbed into our current operations."

To find out more, visit *www.alto-air.com* and *www.wagtail.co.za*. **PM**