# Lantern project update – realising opportunity through the use of numeric exploration technology

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## Overview

Kirkland Lake Gold Limited (KL) continues to grow beyond being a mid-tier gold miner, with its record 723 477 oz of gold production during 2018 from high performing, low cost mines in Canada (Macassa) and Australia (Fosterville) (Kirkland Lake Gold Ltd 2019). The future growth of KL is supported by district-scale exploration potential in both countries. Within the Northern Territory, KL holds 56 mineral titles over 150 km$^2$ and 27 exploration titles (in joint venture with PNX Metals Limited) over 1420 km$^2$, all in the historically prolific gold producing area of the Pine Creek Orogen (**Figure 1**).

## Lantern Gold Deposit update

The Lantern deposit is located within the Cosmo-Howley antiform, down sequence of the Koolpin Formation-hosted Cosmo Gold Mine, which was mined as an open pit (1989–1994) and underground operation (2010–2016). The Lantern metasedimentary rocks are hosted in more structurally complex, deformed Koolpin Formation metasedimentary rocks between the Zamu and Phantom dolerite sills. Amphibolite grade metamorphic assemblages of chlorite–biotite–amphibole–quartz–garnet–cordierite–tourmaline–carbonate +/- pyrite–pyrrhotite–arsenopyrite form intense multiphase alteration. Mineralisation occurs in sandier metagreywacke beds and in selected quartz-carbonate veins. Gold grades tend to be higher in areas of more structural complexity with a preference towards Fe-rich sedimentary rocks.

Over the last year, KL commenced exploration development comprising eight additional underground drill sites, three cross cuts and three ore drives into Lantern mineralisation. With this additional diamond drilling information and *in-situ* access to the mineralised lodes, KL geologists have further opportunity to investigate the complexities of some of the higher grade mineralisation within Lantern deposit.

## Technology and Innovation

KL's investment in existing and emerging technologies has enabled the company to work with multiple suppliers to further understand and delineate the Lantern resource. The NExT project (Numeric Exploration Technologies) was founded in May 2018 as a means to drive technology-assisted exploration and project definition in the Northern Territory, enabling higher quality geological interpretations and resource models than previously possible. The project has three key components:

- quick, accurate and consistent data acquisition
- effective communication and information accessibility
- mineralisation understanding and exploration targeting.

Key projects during 2018 focussed on quick and accurate data acquisition; two major study areas were drill core logging and underground face mapping.

## Drill core logging data acquisition

Existing drill core logging practices comprise recording protolith lithology, rock alteration, sulfide mineralisation and vein characteristics. A geotechnical interval log (recovery, RQD, hardness, strength, weathering, fracture count and structural sets count) is also completed on every hole. On selected drillholes, a geotechnical defect orientation log is completed where fractures are characterised by orientation, type, roughness, alteration infill and thickness. Specific gravity measurements are performed on selected holes.

KL's aim for the drill core logging project was to assess the viability of geochemical and mineralogical data collection technologies and evaluate their suitability for delineation of Lantern geological features pertinent to resource estimation. Discriminating the controls on higher grade gold mineralisation is of specific focus. Technologies applied in the project included:

- portable XRF (pXRF) niche sampling
- portable ASD (Halo) hyperspectral mineralogical niche sampling
- portable (pXRF) pulp scanning
- magnetic susceptibility niche sampling
- Orexplore tomographic X-ray attenuation
- Minalyze continuous XRF (cXRF) analysis
- NTGS HyLogger™ short wave infrared (SWIR) and thermal infrared (TIR) analysis
- Corescan continuous SWIR analysis.

A niche sampling study comprised ~1400 point samples across four drillholes. Sample measurements were taken using pXRF, Halo, and a magnetic susceptibility meter; samples were selected to characterise alteration, veining and faulting. Four representative diamond drillholes were scanned using the NTGS HyLogger and analysed by Rocksearch Australia. One drillhole was also sent to Perth for Corescan and Minalyze analysis. In a separate study, intervals from 10 Lantern drillholes were also scanned using Minalyze and Corescan in an attempt to understand local geochemical and mineralogical variability using continuous scanning technology.

All technologies showed that there was adequate mineralogical and geochemical variation within Lantern metasediments to differentiate the major lithological units. HyLogger, Corescan and Minalyze also provided high quality core photos which have potential to be used for machine learning and automated logging purposes. Continuous multi-element cXRF geochemical scans produced by Orexplore and Minalyze allow variability to be mapped at niche sample intervals not previously understood. While both suppliers are working to rectify

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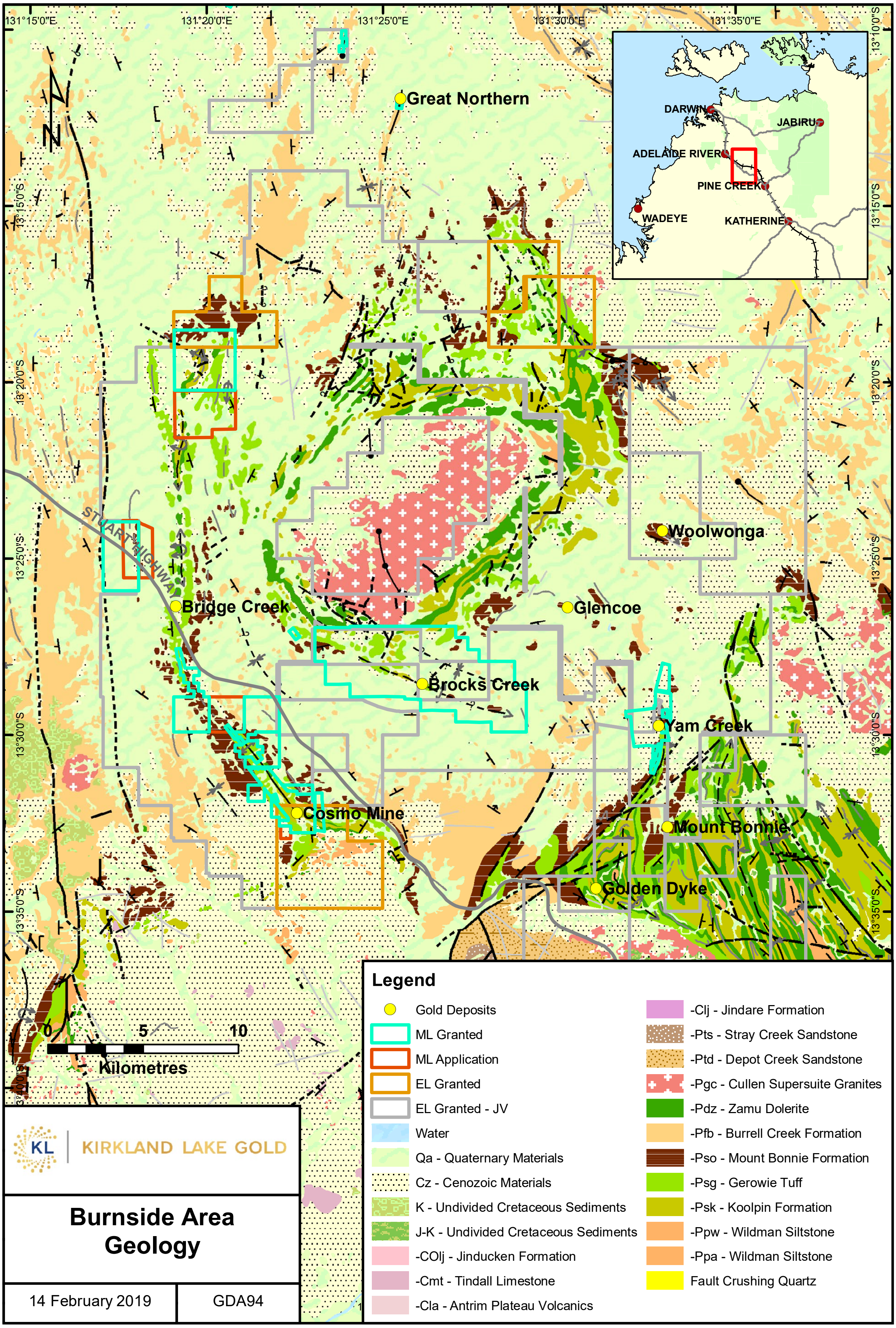


**Figure 1**. Burnside geology map (S Suy, KL, pers comm 2019) showing regional geology, tenement information and historical mines. The Lantern project is located at Cosmo Mine (lower left).

minor scanning artefacts, the geochemical data provided appears to be suitable for the application of calculated lithology algorithms. Corescan and HyLogger both provide hyperspectral data for mineral identification with the former able to illustrate 2D mineral relationships. The 0.5 mm precision SWIR data provided by Corescan is suitable for mineral mapping; however, it is limited in its infrared analysis range due to the abundance of anhydrous silicate minerals in Lantern's ore bearing metasediment units. While slightly lower resolution (8 mm scan intervals), the additional TIR analysis provided by HyLogger can identify the presence of many anhydrous silicate minerals observed in Lantern.

Orexplore, Minalyze, and Corescan also provide the user with the opportunity to collect geotechnical information. Orexplore allows user-defined two point defect orientation measurement using its Insight software. Minalyze has commercially-ready drill core RQD measurements and a structural defect picking interface under development. Research at the University of Tasmania has investigated the feasibility of automating geotechnical defect picking using Corescan data (Harraden *et al* 2017). At this stage, Minalyze is the only supplier that has attempted to quantify specific gravity from drill core; it has also worked on using multielement data to generate a gold-index as proxy for assaying to locate presence of gold in core without traditional core-destructive lab analyses.

## Underground face mapping data acquisition

Existing underground face mapping practices comprised a hand drawn face map with an accompanying high resolution photograph. Chip sampling data was recorded on the face map and manually registered later using Surpac software. This process took 15 to 30 minutes at the face and an additional 15 minutes data entry and registration on surface.

KL's aim for the underground face mapping project was to collect more meaningful and higher resolution face mapping data with reduced time required to collect and register maps and images. The resultant data needed to be suitable for machine learning and automation. For this project, results from a previous trial at Fosterville Gold Mine were evaluated and potential suppliers selected accordingly. Within the Lantern development, two technologies were evaluated against existing practises:

- I-Site laser scanner (Maptek)
- CR Kennedy RTC360 laser scanner.

Maptek (I-Site) and CR Kennedy (RTC360) demonstrated their 3D photo-imagery laser scanners within the Lantern mine development. Both technologies were able to complete 3D registered scans in a time effective manner. The RTC360 was the fastest scanner and was able to capture an image of the development backs where I-Site was limited due to the placement of the LED light. The RTC360 was also lighter weight and easier to set up for scanning due to a purpose built tripod. Although the I-Site system did not come with its own tripod, it is built to integrate with existing site survey equipment. I-Site was able to capture a better quality image, primarily due to a stronger light source, and provided additional laser intensity data, which assisted geological interpretation. Both suppliers provided stand-alone software to manipulate the point cloud data, and both datasets could be imported into Surpac; however, the file sizes were generally too large to utilise effectively. Maptek Point Studio software was more user intuitive and efficient, with features such as automated defect mapping and additional software modules to support underground mapping/wireframing using drillhole data and existing geological interpretations.

## Future Directions

Given the success of the NExT project to date, KL's goal is to work with selected semi to fully commercialised suppliers to develop products that are beneficial and effective for its Australian and Canadian operations and exploration projects. The focus of the drill core logging data acquisition project has moved to data validation of continuous scanning technologies (QXRD, petrology, wet-lab geochemistry) so that a site-based trial can be established. Given the importance but time consuming nature of geotechnical data collection, KL will work with suppliers to further develop and semi-automate geotechnical logging. Machine learning and cloud-based interfaces will be evaluated in an attempt to better categorise, validate and communicate logging and mapping information that enables offsite accessibility.

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