Exploration potential of the Jervois mineral field

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Introduction

The Jervois Copper-Silver-Gold Project is located ~380 km by road to the northeast of Alice Springs in the Northern Territory (**Figure 1**). Geologically, the project lies within the eastern Arunta Region and is on the southern margin of Northern Australian Craton.

In 2015, KGL Resources Limited (KGL) began a systematic approach to exploration aimed to significantly improve the Project's mineral resource base. The primary goal of the program was to define and expand the major known deposits (Reward and Bellbird) into mineral resources with a JORC classification that would support robust prefeasibility and feasibility studies. While developing the two major deposits, there was a secondary focus on the exploration of less-drilled targets, which led to the discovery and delineation of Rockface, one of the project's largest and highest grade resources discovered to date.

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Figure 1. Location of Jervois Copper-Silver-Gold Project.

The main tools used by KGL during the past five years to refine the exploration targeting process have been a combination of multi-method geophysical surveys and the identification of important structural controls over the mineralisation. Application of these methods resulted in the recognition of the target horizons and the locus of mineralisation itself. The cumulative knowledge gained from many metres of drilling and the generation of geological models has led to the detection of other highgrade targets within the Jervois and greater Unca Creek tenement.

Five years of drilling by KGL has necessarily been focused on a small portion of the known targets at Jervois in order to bring these more advanced prospects (Reward, Bellbird and Rockface) up to Indicated Resource classification whereby, under the JORC code, they can be potentially converted to Ore Reserves by the application of appropriate modifying factors, such as mine designs, process recoveries and economic analysis. Now that this has been achieved, KGL aims to explore the whole, vast and substantial potential of the Jervois and Unca Creek mineral tenements.

A number of promising prospects have already been discovered at Jervois and Unca Creek (**Figure 2**). Some of these targets are drill-ready, particularly the ones that lie on the famous and large-scale Jervois J-fold. Some of the other targets require additional surface exploration work, such as geological mapping, geochemical sampling, RAB drilling, and geophysical surveys, in order to develop well-defined drill targets.

This report sets out to summarise the basis for this exciting program of exploration.

History of KGL Resources at Jervois

In early 2011, KGL purchased Jinka Minerals and its assets from Reward Minerals Limited. The Jervois project lies within Exploration Licence 25429 (38 km²) and includes three mineral licences (ML30180, ML30182 and ML30829). The current in-house geological and management teams commenced the systematic exploration and project development at Jervois in 2015. Since then, KGL has achieved important milestones as summarised in **Figure 3**.

The culmination of the past five years of concerted geological work has been the improved Mineral Resource Estimate, which was published in September 2020 (KGL 2020). Importantly for ongoing mining and development studies, the mineral resource now has the majority of the copper metal (68%) reporting in the JORC Indicated category (**Table 1**). The prefeasibility study was published in December 2020 and, based on its positive outcome, the KGL board of directors has now approved progress to a full feasibility study.

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Geology overview

Mineralisation/target horizon

The known major mineral deposits at Jervois (Rockface, Reward and Bellbird) are generally stratabound and hosted within the rocks that form the distinctive, km-scale J-fold. These rocks are typically garnet-chlorite-magnetite schist, which includes thin lateral variations to quartz tourmaline, banded epidotes, and calc-silicates. Mineralised lodes are subvertical at Reward and Bellbird, and steeply dip at $\sim 80^{\circ}$ north at Rockface. At the Rockface deposit, mineralisation is typically massive chalcopyrite-pyrite breccia in magnetitebearing quartzite. This chalcopyrite-pyrite-magnetite breccia is also common at Reward and Bellbird; however, these deposits additionally feature galena-sphalerite boudins generally associated with local skarn-like calc-silicates. The boundaries of the mineralised zones can vary greatly from wide (80–100 m), patchy, disseminated zones of low-grade sulfides to sharp contacts against high-grade semi-massive sulfides. These central zones of massive sulfides have been identified as higher-grade domains in which the primary copper mineralisation has been remobilised by later structural reworking.

Structural control on mineralisation

During the last four years, the KGL geology team has greatly improved the understanding of the controls of mineralisation and disposition of the mineralised lodes. KGL now recognises two main styles of mineralisation and alteration/metamorphic mineral assemblages:



Figure 2. Outcrop of Jervois and Unca Creek tenements, featuring the major and minor prospects.



Jervois Project.

Table 1. Jervois Mineral Resource Estimate (Taylor 2020, KGL 2020).

Resource		Material		Grade		Metal		
Deposit	Category	(Mt)	Copper (%)	Silver (g/t)	Gold † (g/t)	Copper (kt)	Silver (Moz)	Gold † (koz)
	Indicated	7.03	2.05	42.30	0.48	144.00	9.60	107.60
Reward (2020)*	Inferred	4.26	1.38	23.70	0.16	58.70	3.20	22.10
	Total	11.28	1.80	35.30	0.36	202.60	12.80	129.70
	Indicated	2.45	3.54	19.80	0.25	86.80	1.56	20.03
Rockface (2020)*	Inferred	0.84	2.07	15.60	0.18	17.50	0.42	4.96
	Total	3.29	3.17	18.70	0.23	104.20	1.98	24.73
	Indicated	1.67	3.17	18.42	0.22	52.80	0.98	11.78
Bellbird (2020)*	Inferred	2.83	1.78	12.89	0.10	50.30	1.17	9.08
	Total	4.49	2.30	15.00	0.15	103.10	2.17	21.66
Total Reward,	Indicated	11.15	2.55	33.78	0.39	283.60	12.14	139.41
Rockface, Bellbird	Inferred	7.93	1.60	18.98	0.14	126.50	4.79	36.14
	Total	19.07	2.15	27.60	0.29	410.00	16.94	175.70
D	Indicated	0.50	0.99	64.00		5.10	1.06	
Reward South	Inferred	1.40	0.81	78.00		11.10	3.44	
2013	Total	1.90	0.86	74.20		16.20	4.50	
	Indicated	11.65	2.48	35.08		288.70	13.20	139.41
Total Jervois	Inferred	9.33	1.48	27.84		137.60	8.23	36.14
	Total	20.97	2.03	31.82		426.20	21.44	175.70

*cut-off grades: 0.5% Cu above 200 m RL, 1% Cu below 200 m RL; 200 m RL is ±150 m below surface and considered to be the depth limit for potential open pit mining; resource estimates do not include Reward South † the 2015 resource estimate for Reward South had a deposit wide cut-off grade of 0.3% Cu and did not include gold

- 1. lower tenor, primary syn-depositional or stratabound disseminated sulfides
- 2. higher grade, structurally-controlled shoots, representing remobilised stratabound syngenetic mineralisation, possibly related to a late regional intrusion-related mineralising event.

Higher grade mineralised shoots are the result of reworked and remobilised primary stratabound base metals during deformation. During late-stage deformation, regional-scale granite intrusions likely provided the heat and fluids that remobilised copper from primary (stratabound) units into structural traps, such as anticlinal fold hinges. The structural framework for this is supported by research of the Northern Territory Geological Survey (NTGS; eg McGloin *et al* 2019 and Weisheit *et al* 2019). The shoots are observed as massive or semi-massive sulfide-magnetite veins and chalcopyrite-rich brecciated veins (**Figure 4**).

The improved geological model, upon which the new resource update is based, widens opportunities to target higher grade extensions and repetitions within favourable host rocks and structures in areas adjacent to known deposits and in other prospects at Jervois and the surrounding Unca Creek tenement.

Geophysics

Geophysics has been a critical tool in target generation at Jervois and will continue to play an important role in refining the prospectivity of the larger-scale Jervois mineral field. At a prospect-scale, the significance of its use is clearly demonstrated by the success of down-hole electromagnetics (DHEM). DHEM has been instrumental in defining drilling targets at Rockface and Reward. Clearly, downhole EM will continue as a vitally useful tool to be used in conjunction with drilling. This has already proven to be the case at Reward South Silver where DHEM conductors have corresponded with the discovery highgrade silver and base metals mineralisation and provided valuable directions for future follow-up drilling.

It should be noted that electrical and electromagnetic geophysical methods are highly applicable at Jervois due to the nature of the target minerals and the lack of a conductive overburden, which causes so many difficulties in other parts of Australia.

At a larger scale of survey, induced polarisation (IP) and resistivity surveys have delineated several drill targets at Reward, Rockface and Bellbird. Drilling of one of these resistivity targets at Reward South Silver has resulted in the recent discovery of high-grade silver, lead, and copper mineralisation. Other equally promising resistivity anomalies remain to be drilled.

At the regional scale, aeromagnetic and gravity surveys are instrumental in defining the tectonic structural trends and prospective lithological formations. The Jervois J-fold is well defined by magnetics and gravity anomalies. Of particular note is the residual gravity inversion image (**Figure 5**) showing a north-western extension of the Jervois J-fold (Scarp trend). The J-fold now becomes a U-structure (or U-fold), and this information greatly enhances the prospectivity of the Jervois mineral field.

In January 2021, a comprehensive review of over 60 years' worth of geophysical surveys was undertaken. These surveys³ include IP, airborne EM, fixed loop EM, aeromagnetics, airborne radiometrics, SAM MMR/EM, gravity, ground magnetics, DHMMR, MT, and DHEM (Hine 2021). This work has signposted many untested or poorly-tested geophysical anomalies (**Figure 6**) that will need to be followed up, either by drilling or more detailed geophysics prior to drilling. Many of the anomalies relate to the J-fold and many more extend into the Unca Creek Exploration Licence.

³ EM = Electromagnetics, SAM MMR/EM = sub-audio magnetics magnetometric resistivity/electromagnetics, DHMMR = downhole magnetometric resistivity, MT = magnetotellurics, DHEM = downhole electromagnetics



Figure 4. Massive sulfide-magnetite breccia in drill core.

Association with deep crustal structures

One of the distinctive and prospective features of the Jervois mineral field is its large size. As has already been noted, the Jervois J-fold is a large-scale fold that hosts a number of significant mineral deposits. These deposits have been recognised to be generally stratabound and have probably accumulated from exhalative mineralised fluids in an ancient, fault-bounded basin. It is postulated that the nearby crustal-scale Jervois Fault, which abuts and truncates the mineralised J-fold to the west, has been a significant driver of the formation of the Jervois mineral deposits. Recent studies by company geologists and the NTGS have unravelled the tectonic, structural and metamorphic history of the Jervois area (Weisheit *et al* 2019). Important for the understanding of the economic geology was the recognition of remobilisation of the original stratabound copper sulfides (along with lead, zinc, gold, silver and iron minerals) into structural traps, principally the hinges of isoclinal folds, which has resulted in a considerable metal grade enhancement.

It is generally understood that world-class mineral deposits are usually associated with large-scale tectonic features, such as the Jervois Fault, that act as a plumbing system for mineralising fluids. Orogenic processes,



Figure 5. Residual gravity inversion model covering the Jervois and Unca Creek tenements (blue boxes), featuring current Indicated and Inferred copper resources (in red), and selected prospects and copper occurrences (yellow dots).

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commencing with basin formation and ending in major folding episodes and regional metamorphism, provided the heat to drive the mineralising system. The close association of the Jervois mineral field with long-lived, crustal scale structures is an important positive element to be taken into account when assessing the prospectivity of the Jervois and Unca Creek mineral tenements.

Case study: High-grade copper discovery at Rockface

Prior to September 2015, Rockface was considered to be a second-tier copper prospect and had been underexplored

compared to the main Jervois copper deposits of Marshall/ Reward and Bellbird. Rockface is located within the same prospective stratum of rocks hosting the other Jervois copper deposits, ie a structural position very favourable for mineralisation. Despite this, the pre-2015 mineral resource comprised only a small, low-grade copper deposit defined by limited and shallow drilling.

Two geophysical surveys, one in 1965 by McPhar and the other in 2000 by MIM Exploration, demonstrated a good IP response over Rockface, as well as over Marshall/ Reward and Bellbird, but this only led to some shallow drilling at Rockface in 2013 using a track-mounted rig.



Figure 6. Major geophysical target zones and geophysical anomalies of the J-fold, coloured according to rank (hotter colours = higher rank). Superimposed on aeromagnetic total magnetic intensity map.

Steep terrain made the drilling difficult, and the results were disappointing.

The turning point in the Rockface story came in June 2015 with the Orion 3D IP and resistivity geophysical survey (3DIP), which was only the second such survey undertaken in Australia at the time. The 3DIP survey extended over the Rockface and Bellbird prospects; it used a survey geometry which ensured there was no bias towards any particular orientation of mineralisation, which is important for structurally complex targets like Rockface. The Orion 3DIP system offered KGL the ability to resolve targets well below the depth of the existing drilling; it subsequently identified several good anomalies. The strongest coincident chargeability and conductivity anomaly was observed at Rockface where it extended from the surface to the limit of the survey sensitivity at ~400 m depth.

Combining the 3DIP results with recent work from the NTGS and CSIRO, which focused on the style, timing and structural controls of the mineralisation at Jervois, gave KGL the confidence to return to Rockface and test a target zone 120 m below the previously deepest hole. Diamond drillhole KJCD171 was completed in September 2015 and intersected 14 m of massive magnetite, along with veined and disseminated chalcopyrite copper mineralisation, at a vertical depth 270 m. KJCD171 was the discovery hole of high-grade copper mineralisation at Rockface (KGL 2015).

It was noticed that the style of mineralisation intersected in KJCD171 appeared similar to the style observed at the northern end of the Reward deposit. In earlier work, this style of copper mineralisation had responded very well to downhole electromagnetic methods (DHEM). This led to a DHEM survey of KJCD171, which identified three good conductor targets.

In February 2016, two follow-up diamond drillholes, KJCD182 and KJCD183, intercepted high-grade copper mineralisation (KGL 2016a, b). These holes were subsequently surveyed using DHEM, which better defined the initial conductors and detected additional conductor plates that again formed the basis for further drilling (**Figure 7**). Some examples of the high-grade copper results from this drilling are:

- KJCD183: 11.7 m estimated true width at 3.34% Cu, 370 m below surface
- KJCD195: 7.5 m estimated true width at 8.76% Cu, 478 m below surface (KGL 2016c)

Over a period of 4 years and several campaigns, a total of 80 holes for 37 948 m were completed at Rockface, which have defined a new, structurally-controlled, highgrade copper deposit. Several iterations of mineral resource estimation have been carried out. The most recent estimate was carried out by independent consultants, Mining Associates Limited and forms part of the mineral resources underpinning the ongoing prefeasibility study (**Table 2**).

Highly prospective targets

The vast majority of the exploration effort and all of the known mineral resources at Jervois are associated with the famous J-fold. The J-fold is large in scale and has a known strikelength of ~10.5 km; it extends to at least 700 m below surface



Figure 7. Resource block model at Rockface showing conductor plates and the drillholes that were surveys to identify them. The chargeability at 0 m is projected below the model to show the chargeability high that coincides with the modelled mineralised envelope (mauve).

and is still open at depth (Figure 8). Drill-defined mineral deposits are located within only 3.5 km (~33%) of the J-fold strike-length; the remainder of the prospective structure has been only sparsely drill-tested or not drilled at all.

Whilst all of the known mineral deposits at Jervois are open at depth and/or along strike, the exploration team has recognised a number of highly prospective and entirely new and untested targets that have been prioritised for drilling during the next phase of exploration.

Unca Creek and continuity at depth

Since KGL's main focus has been on delineating mineral resources at Jervois, no follow-up drilling has been done on the larger Unca Creek tenement with its known copper prospects since the tenement acquisition in 2018. As seen in Figure 9, the strike line of the target horizon extends further north into the Unca Creek tenement, where several copper discoveries have already been made by previous companies (KGL 2017). In 2013, Natural Resources Exploration (NRE) drilled 19 holes in the Unca Creek region, with intercepts over 0.5% Cu (1 m interval samples) in 13 of those holes. The best intercepts from this drilling included:

- NRE 020: 8 m at 1.5% Cu from 39 m (Pioneer)
- NRE 003: 9 m at 2.6% Cu from 144 m (Becana)

Detailed ground gravity surveys at 25 m and 50 m line-spacing were carried out in early 2017 to cover the entire Jervois and Unca Creek areas. The resulting density inversion models show a good spatial correlation between the areas of higher densities and the location of the ironstones, both in outcrop and in drill core (Figure 5). These density inversion models show continuation of favourable host rocks in several zones: along the northern strike-line of the J-fold (Becana, Pioneer); in a northwestern extension along Bellbird (Scarp trend); and along a larger secondary F2 structure outside of the main J-fold. All of these continuations have mapped copper occurrences at the surface within both the Jervois and Unca Creek tenements; these are to be investigated further with follow-up work in 2021 with detailed mapping, soil sampling, geophysical surveys and drilling.

In 1991 and 1995, Poseidon Limited conducted Questem airborne EM surveys covering all of Jervois EL and most of Unca Creek EL. Figure 10 shows the location of Questem anomalies picked by Mitre Geophysics from survey 'Area 1', which covers most of the Jervois project and much of Unca Creek. Of particular note are the strong EM responses at Hamburger Hill in the Unca Creek tenement. Hamburger Hill also exhibits a strong radiometric anomaly (Figure 11).

	Cut off > 1% Cu	Category	Mt	Cu %	Ag g/t	Au g/t	Cu kt	Ag Moz	Au koz
	UG	Indicated	2.45	3.54	19.8	0.25	86.8	1.56	20.03
		Inferred	0.84	2.07	15.6	0.18	17.5	0.42	4.96
	Total		3.29	3.17	18.7	0.23	104.2	1.98	24.73

Table 2. Mineral Resource estimate at Rockface (Taylor 2020, KGL 2020).



Figure 8. Jervois J-fold synform featuring Indicated and Inferred copper resources and prospects. Yellow dashed lines mark the structural trends observed in the deposits; green dashed areas highlight exploration potential at depth from selected prospects and copper occurrences at surface along the 'J'.

Bellbird South

The Bellbird South prospect is located less than 1 km southeast of Bellbird Main and 1 km west of Rockface (**Figure 8**, **9**). The prospect was a target for exploration in the 1980s by MIM Exploration, with IP surveys and numerous costeans. The IP surveys over Bellbird South identified several potential targets; limited shallow drilling by KGL and Jinka Minerals confirmed disseminated copper mineralisation, but this was never followed up with deeper drilling.

During 2016 and 2017, KGL completed 3DIP and MT resistivity surveys and inversion models, which were more

advanced and higher resolution than the surveys carried out by MIM Exploration. The new geophysical models identified coincident gravity highs (relatively dense rocks) and low resistivity (relatively conductive rocks), some of which had been drilled systematically elsewhere at Jervois and proved to host significant resources (eg Rockface). Other prospective geophysical features were coincident magnetic-high anomalies (broadly associated with magnetite alteration) and high IP chargeability, which taken together at Jervois, is interpreted to be an indicator for high-grade massive copper-sulfide and magnetite breccia-style mineralisation (**Figure 12**).



Figure 9. Simplified geological map of Jervois Range (the Jervois and Unca Creek tenements), highlighting several copper occurrences and prospects and significant structures, including the Jervois Fault, the J-fold synform, felsic and mafic intrusions and F2 and F3 folds (after Weisheit *et al* 2019).

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The highest grade copper intercept for the Jervois Project was drilled at the deeper part of the Bellbird East lode: 1 m at 34.4% Cu and 436 g/t Ag from 358 m, mainly bornite (KJCD358: KGL 2019; **Figure 13**). Preliminary interpretation is that that vein represents a feeder zone to the wider mineralised area above it, or possibly to a yet to be discovered zone of mineralisation at depth. The deeper, southern part of the Bellbird Main lode showed high-grade copper intercepts that are open to the south (KJCD354X, 8 m at 5% Cu from 437 m). Gravity, IP and magnetic anomalies also appear to continue in the southern direction. The combined geological and geophysical evidence for massive sulfide mineralisation is encouraging. Given that Bellbird South sits between the Rockface and Bellbird deposits, there is a good chance of discovering another significant deposit in this region.

Reward South

Reward South (formerly named Green Parrot) is a silvercopper-lead-zinc deposit situated to the south of the main Reward deposits (**Figure 8**, 9). Advanced IP and gravity



Figure 10. Mitre Geophysics' anomaly picks (black dots) from the Area 1 Questem survey results including coverage of Unca Creek Exploration Licence. Strong EM anomalies at Hamburger Hill warrant detailed investigation. Questem Area 5 provides more coverage of the eastern part of Unca Creek, although the review has not yet included anomaly picking. The southern section of Unca Creek has not been covered by airborne EM. Airborne EM flight lines shown as purple lines.



Figure 11. 1999 MIM Exploration's UTS radiometrics data at 50 m linespacing. The mineralised J-fold trend is clearly a focus of potassium (K), uranium (U) and thorium (Th). Note the strong response at Hamburger Hill.



Figure 12. Long section of the Rockface and Bellbird South area. The section displays a gravity inversion model and IP resistivity isolines. It also shows the delineated Rockface resource, which coincides with gravity highs/resistivity lows. The prospective Bellbird South area is highlighted showing similar geophysical anomalies.

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surveys have been carried out over Reward South and defined coincident gravity and resistivity anomalies; however, unlike at Reward and Rockface, the anomalies are not centred over the currently drill-defined mineral resource. As shown in **Figure 14**, the anomalies are offset approximately 100 m to the east of the Reward South Lode.

These coincident geophysical anomalies are currently undrilled and are hypothesised to be the signature of high-grade copper mineralisation similar to that found at Rockface. Testing of this anomaly is currently a high priority for the next round of exploration drilling at Jervois.

The future

The outlook for major discovery and resource extensions at the Jervois Project is bright. Despite the significant amounts of drilling KGL has done in the past five years,



Figure 13. Photograph of a 1 m piece of core, comprised of mostly massive bornite.



Figure 14. Plan view of Reward and Reward South, highlighting low-resistivity isolines that overlap with proposed pit outlines.

there are still many underexplored targets to investigate. The main portion of the drilling to date has been focused on defining the resources for the three main prospects at the top of the Project Development Pyramid (**Figure 15**). This has left the remainder of the pyramid as highly prospective exploration potential.

Each of the unexplored targets on the pyramid represents untapped potential. The goal of KGL is make significant discoveries of copper and other metals at each thereby elevating these targets up towards the apex of the pyramid. Some examples of areas that have not yet been adequately drill tested are the Bellbird North – Scarp Trend – Crowes Nest, Pioneer, Reward North, Reward Silver Strike, Eagle, Hamburger Hill, Eagle, Eastern Side, Wards, Scrubby Hill W, and Anaconda. Achieving this goal will necessarily draw on the recent experience and knowledge the company and the exploration team have gained from drilling and defining the advanced Jervois deposits. This knowledge, combined with the high quality geophysical and geological datasets, will allow the design of precisely targeted drilling programs to maximise the chances of exploration success.

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Figure 15. KGL Project Development Pyramid.

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