The Rockface copper discovery at Jervois

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Introduction

The *Jervois Project*, owned 100% by KGL Resources Limited (KGL), lies 250 km northeast of Alice Springs in the Northern Territory. Access is via the Plenty Highway, which passes within 15 km of the project, and then by the Lucy Creek Station Road.

Jervois is the largest base metals deposit in the eastern Arunta Region, and comprises over ten prospects with mineral resources of varying size and grade. In July 2015, KGL announced a Mineral Resource of 30.5 Mt containing 327 000 t of copper, 22.6 Moz of silver and a growing inventory of lead and zinc that is now a combined 190 000 t. A prefeasibility study was completed in December 2015 based on a 2.2 Mtpa flotation plant producing copper and lead-zinc concentrate to be transported by road and rail to the port of Darwin.

There has been a renewed focus on exploration during 2016 with the aim of increasing both the size and grade of the Jervois resource with particular emphasis on the recently discovered high-grade *Rockface* Prospect. Rockface is located along strike to the southeast of the *Bellbird* resource. It was discovered through a review and re-interpretation of previous exploration with the benefit of recent research by the Northern Territory Geological Survey (NTGS) and Commonwealth Scientific and Industrial Research Organisation (CSIRO), and a follow-up Orion 3D induced polarisation (3DIP) survey. Initial investigative work suggests the style of mineralisation at Rockface is different to the existing resources at *Reward*, Bellbird and *Green Parrot*. The discovery has led to modification of our conceptual models and targeting factors; these new insights have re-invigorated exploration and highlighted the increased potential of the Jervois project.

Jervois Project geology

Jervois is hosted by the Bonya Metamorphics (Reno *et al* 2015) of the Aileron Province: a sequence of Palaeoproterozoic sedimentary rocks in the Arunta Region that formed part of the North Australian Craton prior to 1700 Ma (Scrimgeour 2013). The Bonya Metamorphics is a high-temperature, low-pressure package of metasedimentary rocks with protoliths interpreted to be equivalent to the lower Strangways Metamorphics (Reno *et al* 2015). Metasedimentary successions in the Aileron Province were deposited within the interval 1860–1740 Ma; the majority of the magmatism occurred in the interval 1820–1700 Ma (Scrimgeour 2013).

At Jervois, the Bonya Metamorphics is dominated by quartz-muscovite schist derived from metamorphosed siltstone and mudstone (**Figure 1**). The schist is interbedded with fine- to medium-grained beds of meta-sandstone that typically vary in thickness from 1 cm to 30 cm, although thicker beds and lenses of meta-sandstone have been mapped at the surface. Within the fine-grained schistose beds, there are broad belts with distinctive andalusite porphyroblasts that give the rock a knotted appearance. Beds of marble and calc-silicate rock occur throughout the Jervois project area, though with poor strike continuity due to flattening and attenuation during deformation. While minor in extent, narrow beds of finely bedded quartz-tourmaline and fine- to coarse-grained volcanic/volcaniclastic rocks of rhyolitic composition have been mapped. The Jervois sequence is intruded by several phases of pegmatite and an amphibolite rock interpreted to correlate with the Attutra Metagabbro (ca 1786 Ma). The Bonya Metamorphics is unconformably overlain by Neoproterozoic–Palaeozoic-aged sediments of the Georgina Basin that form a prominent ridge on the western edge of the project area.

Three main deformation events have been identified at Jervois. Although not well preserved, D_1 is interpreted to be large westward closing recumbent folds. The dominant structural fabric seen throughout the Jervois area is sub-parallel to bedding and is interpreted to have formed during D_2 in an east–west, possibly transpressional regime. Isoclinal folding during D_2 may have resulted in repetitions of the mineralised horizons exemplified by the parallel sulfide lenses at Reward and *Reward East*. D_3 led to the refolding of the D_2 isoclinal folds and foliation, resulting in the formation of the characteristic 'J-shaped' Jervois Range. Much of the western limb of the Jervois Range has been faulted off against the Jervois Fault Zone (**Figure 1**).

Mineralisation

Previous exploration companies have variously described the mineralisation at Jervois as volcanic massive sulfide, iron oxide copper-gold, skarn and Broken Hill-type. Recent work by the NTGS has indicated that there is syngenetic, sediment-hosted and volcanic-associated mineralisation that formed ca 1790 Ma (McGloin and Weisheit 2015).

Copper-silver and lead-zinc sulfide mineralisation is primarily contained within two main lenses at both *Marshall-Reward* and Bellbird with smaller lenses at Green Parrot, Bellbird North and *Cox's Find*. The lenses are steeply dipping and stratabound within a trend that extends for at least 14 km within the 'J-shaped' Jervois Range. The Marshall-Reward and Bellbird deposits are copper-silver rich and hosted by psammite and pelitic schist with minor meta-carbonate. Green Parrot and Bellbird North are smaller, lead-zinc rich deposits hosted by units of meta-carbonate within pelitic schist.

In copper-rich lenses, chalcopyrite is the main sulfide with minor pyrite, galena and sphalerite. Chalcopyrite can be disseminated, veined, semi-massive and massive over intervals of up to one metre. When disseminated, the chalcopyrite mineralisation follows bedding planes that

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coincide with the pervasive D_2 foliation; the mineralisation is also folded about F_2 folds. Remobilisation of the chalcopyrite into low pressure zones along fractures, crenulations and folds is evident at various scales. At Reward, there is a prominent gossanous hill that is underlain by a thick, rheologically competent unit of psammite with pelitic schist wrapped around the margins. Copper mineralisation is hosted by contact shears but also by brittle fractures within the psammite, forming an open stockwork. Sulfide lenses have alteration halos extending up to 100 m into the hanging wall and footwall. The regionally abundant quartz-muscovite-andalusite schist is altered to a proximal assemblage containing variable amounts of silica, garnet, chlorite, biotite and magnetite.

Lead-zinc rich sulfide lenses at Reward, Green Parrot and Bellbird North comprise galena and sphalerite, with minor chalcopyrite; they are mostly associated with units of meta-carbonate. The sulfides can be semi-massive or massive and coarse-grained, grading into meta-carbonate and calc-silicate rock with disseminated sulfide. Contacts between the mineralised meta-carbonate/calc-silicate and the unmineralised meta-pelite country rock can be sharp. Proximal to sulfide mineralisation, the meta-carbonate units are altered to an assemblage containing garnet, clinopyroxene (diopside), epidote and magnetite.

Rockface discovery

The Rockface Prospect is located 1.2 km southeast of the Bellbird deposit at the southern closure of a large D_3 fold that forms the J-shaped Jervois Range. Prior to 2013, KGL's exploration was focused on the two main copper resources at Bellbird and Marshall-Reward. The presence of several smaller prospects and copper occurrences along a trend

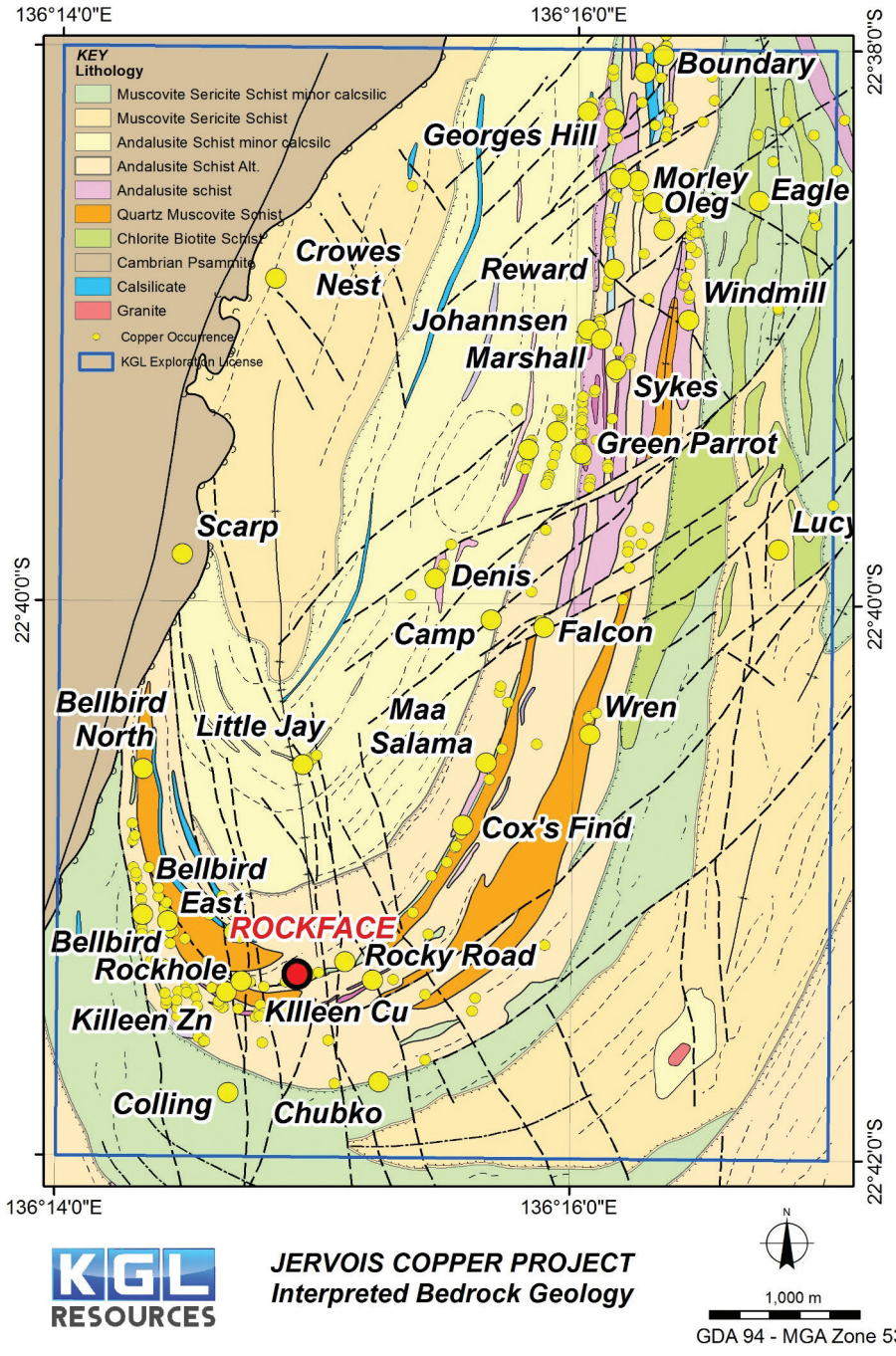

Figure 1. Jervois geological map.

between Bellbird and Marshall-Reward (including the Cox's Find and Rockface Prospects) supports the interpretation that the mineralisation is stratabound and extends over a strike length of 14 km.

A compilation of historic data and additional field mapping in 2013 led to an increased interest in the Rockface Prospect. Historical induced polarisation (IP) surveys were conducted over much of the Jervois area, including Rockface, by McPhar in 1965 and Mount Isa Mines Limited ('MIM') in 2000; these surveys demonstrated a good IP response over the known deposits of Bellbird and Marshall-Reward. Both surveys also recorded an IP response over the Rockface area. A simultaneous 3D inversion of the MIM data significantly improved the quality of the results. This prompted a small RC drilling program at the *Rockhole* prospect 400 m west of Rockface where reconnaissance mapping located abundant malachite exposed in a small working at the same stratigraphic level as Rockface. RC hole KJC035 intersected an encouraging 24 m at 1.47% Cu from 160 m, but further drilling was hampered by the steep terrain. In late 2013, a track-mounted diamond drill rig was used to test for extensions to the mineralisation between Rockhole and Rockface but returned disappointing results. In 2014, a track-mounted RC rig was used for in-fill drilling of previous shallow drilling at Rockface to generate an Inferred Resource.

The drilling completed by KGL in 2013–14, supplemented with historical drilling undertaken by MIM and Reward Minerals, enabled the estimation of a maiden Inferred Resource of 0.7 Mt at 0.82% Cu containing 6000 t of copper. The relatively low grade of this initial resource meant that subsequent drilling was focused on other areas of higher grade mineralisation at Bellbird, Marshall-Reward and Green Parrot. While the area remained prospective due in part to its structural setting, it required some further refinement of targeting before a return to drilling could be justified.

The key factor in the discovery of the high-grade sulfide resource at Rockface was an Orion 3DIP survey conducted in June 2015, the second such survey undertaken in Australia (**Figure 2**). This survey extended over the Bellbird resource in order to help characterise and calibrate the responses from a known deposit. The primary target areas for this survey were extensions both north and south of the existing Bellbird, Bellbird East and Bellbird North mineralisation. This included the Rockface-Rockhole prospects where poorly defined chargeability anomalies were previously generated by a MIM Distributed Acquisition System (MIMDAS) survey.

The Orion 3DIP system offered KGL the ability to see well below the depth of the existing drilling and provided high resolution data to optimise drill targeting. In addition, it was unbiased by survey geometry, an important feature in areas of complex deformation history.

The 3DIP survey identified several good anomalies including the known Bellbird Resource, but the strongest coincident chargeability and conductivity anomaly was observed below the Rockface Prospect, extending from surface to the limit of the survey at approximately 400 m depth (**Figure 2**). Combining these geophysical survey results with recent work by the NTGS and the CSIRO on the style, timing and structural controls of mineralisation at Jervois, gave KGL the confidence to return to Rockface and test an area 120 m below what was previously the deepest hole. RC/diamond hole KJCD171 was drilled in September 2015 to test the Rockface IP anomaly, intersecting 14 m

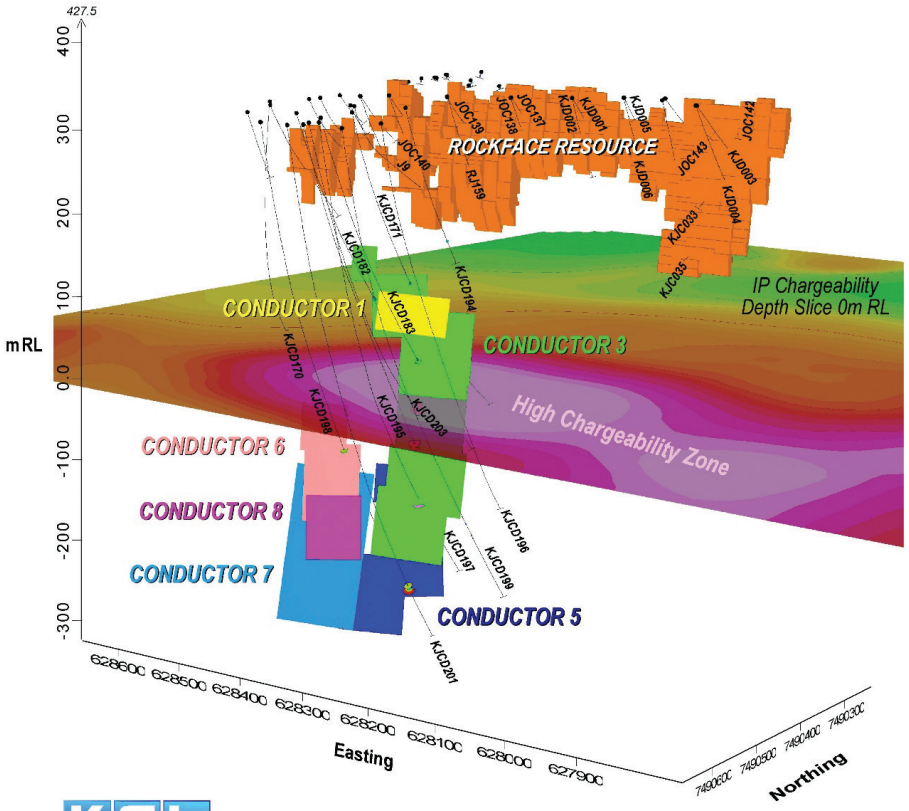

Figure 2. Rockface Prospect DHEM conductors and IP chargeability perspective view (looking southeast).

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Jervois Copper Project
Rockface-Rockhole Prospect

of massive magnetite with veined and disseminated chalcopyrite. The hole was drilled below the current resource boundary and intersected mineralisation at a vertical depth of approximately 270 m. KJCD171 is effectively the discovery hole of the high-grade mineralisation that has remained the focus of exploration over the past 12 months.

Best results from KJCD171 included:

- 13 m at 2.14% Cu, 12.5 g/t Ag, 0.1 g/t Au from 255 m
- 2 m at 2.83% Cu, 10.8 g/t Ag, 0.05 g/t Au from 278 m.

The style of mineralisation encountered in KJCD171 appears very similar to the high grade magnetite/chalcopyrite mineralisation observed at the northern end of the Reward deposit that has responded very well to downhole electromagnetics (DHEM). A DHEM survey was subsequently undertaken on KJCD171 to help delineate the extent of the intersected sulfide mineralisation and to identify off-hole conductors that may represent additional lenses of high-grade mineralisation. Modelling of the DHEM by Newexco Services Pty Ltd identified three good conductors, all of which are part of what is now Conductor 3 (KJCD171 had pierced the top corner of Conductor 3). Subsequent drilling in February 2016 targeted these three conductors with holes KJCD182 and KJCD183, both intercepting additional high-grade mineralisation (**Table 1**). Given its early success in identifying zones of high-grade mineralisation, DHEM has continued to be used to target subsequent drilling, leading to the discovery of further zones of high-grade copper mineralisation.

Exploration to date in the Rockface area has determined that only high-grade copper mineralisation and little else responds to DHEM. With each DHEM survey, the dimensions and orientation of all the conductors are further refined, often becoming more complex in shape; however, this additional resolution helps to optimise drillhole targeting.

Drilling now extends approximately 650 m below the outcropping mineralisation at Rockface. A trend of increasing grades of copper, silver and gold with depth can be observed in **Table 1**. Also of note is the relatively high density of the mineralisation due to a combination of massive/semi-massive magnetite and chalcopyrite.

Rockface Prospect geology and mineralisation

Following the completion of diamond hole KJCD171 to test the 3DIP anomaly at Rockface, it was clear that a new style of sulfide mineralisation had been discovered in the Jervois project. The mineralogy and texture of the sulfide lenses are different to anything intersected at the existing resources at Marshall-Reward, Bellbird and Green Parrot, with the possible exception of deeper parts of the northern end of Reward. Of particular significance is that the copper grade is comparable with the historical higher grade intersections elsewhere at Jervois.

Rockface forms a prominent ridge of lateritised ferruginous schist that is flanked by knotted andalusite schist with minor quartz veins and intruded by narrow pegmatite dykes. The ferruginous schist contains small occurrences of malachite. The ridge extends west to the Rockhole prospect, and then northwest following the western fold limb where it forms one of several mineralised trends that parallel and then merge with the Bellbird mineralised trend. Despite its close proximity, Rockface is not a direct extension of the Bellbird deposit but may be on a related fault splay.

Rockface is located at the southern closure of the D_3 Jervois fold, close to the axial plane. D_2 foliation is well developed and parallel to bedding but has been crenulated by the D_3 axial planer foliation creating a steeply plunging lineation. Axial planer faults are interpreted to cause minor offsets of the mineralised ferruginous schist. There is also evidence for bedding parallel faults that propagate along weak zones and climb across more competent units during D_3 folding. Differences in the footwall lithologies at Rockface and Rockhole 400 m west are likely to be caused by these faults: Rockface has andalusite schist in the footwall while Rockhole has quartz-muscovite schist of possible volcanic origin.

High-grade copper mineralisation is hosted by lenses of massive magnetite-chlorite that plunge steeply parallel to the D_2–D_3 intersection lineation (**Figure 3**). Individual lenses are up to 23 m wide by 100 m long and extend for up to 350 m down plunge. Collectively the mineralised magnetite-chlorite lenses extend to a vertical depth in excess of 650 m and are still open; however, none of the

Table 1. Significant results from Rockface drilling since Sept 2015.

Hole ID	Interval	ETW (m)	RL (m)	SG (t/m^3)
KJCD171	13 m at 2.14% Cu, 12.5 g/t Ag, 0.10 g/t Au from 255 m 2 m at 2.83% Cu, 10.8 g/t Ag, 0.05 g/t Au from 278 m	10.0 1.5	140.6 121.5	4.33 2.95
KJCD182	9 m at 2.91% Cu, 17.6 g/t Ag, 0.2 g/t Au from 284 m 6 m at 1.6% Cu, 9.3 g/t Ag, 0.16 g/t Au from 296 m	6.6 4.4	118.3 108.7	3.65 4.46
KJCD183	16 m at 3.34% Cu, 16.7 g/t Ag, 0.17 g/t Au from 362 m	11.7	46.6	3.84
KJCD203	28 m at 5.08% Cu, 22.4 g/t Ag, 0.22 g/t Au from 435 m Incl. 14 m at 8.89% Cu, 38.5 g/t Ag, 0.38 g/t Au from 436 m	23.2 11.6	-13.5 -14.2	4.02 4.28
KJCD195	10.5 m at 8.76% Cu, 42.9 g/t Ag, 0.51 g/t Au from 478.4 m 5.1 m at 2.66% Cu, 13.8 g/t Ag, 0.27 g/t Au from 513.6 m	7.5 3.7	-58.6 -87.0	4.42 3.38
KJCD198	5.95 m at 4.94% Cu, 25.9 g/t Ag, 0.45 g/t Au from 449.85 m	4.0	-61.4	3.90
KJCD197	9.4 m at 11.53% Cu, 56.6 g/t Ag, 0.87 g/t Au from 535.4 m 8.9 m at 1.00% Cu, 7.3 g/t Ag, 0.09 g/t Au from 544.8 m 15 m at 7.11% Cu, 29.4 g/t Ag, 0.89 g/t Au from 558 m	6.6 6.2 10.5	-133.2 -141.3 -152.2	4.03 3.94 3.59
KJCD201	10.05 m at 8.99% Cu, 45.5 g/t Ag, 0.6 g/t Au from 645.65 m	7.5	-243	3.90

ETW – Estimated True Width. RL – Height above mean sea level at the start of the interval. SG – Specific Gravity (density).

high-grade lenses extend to surface which is why they were only discovered in 2015.

The main sulfide mineral, chalcopyrite with minor pyrite, forms veins and stringers within the fractured massive magnetite-chlorite rock. In high-grade areas, the veins coalesce to form semi-massive to massive sulfide. Boundaries with the unmineralised country rock can be sharp.

Alteration extends up to 100 m into the hanging wall and footwall of the mineralised magnetite-chlorite lenses (**Figure 4**). Unmineralised andalusite schist and quartz-muscovite schist typically contain low amounts of garnet, chlorite and biotite. Proximal to base metals mineralisation, these minerals form variable alteration assemblages that include garnet-chlorite schist and biotite-chlorite-garnet schist. The first indication of alteration in pelitic rocks is weakly disseminated garnet or traces of garnet along foliation planes. Garnet content commonly increases with proximity to mineralisation and is accompanied by an

Figure 3. Diamond drill core from KJCD201 (circa 655 m).

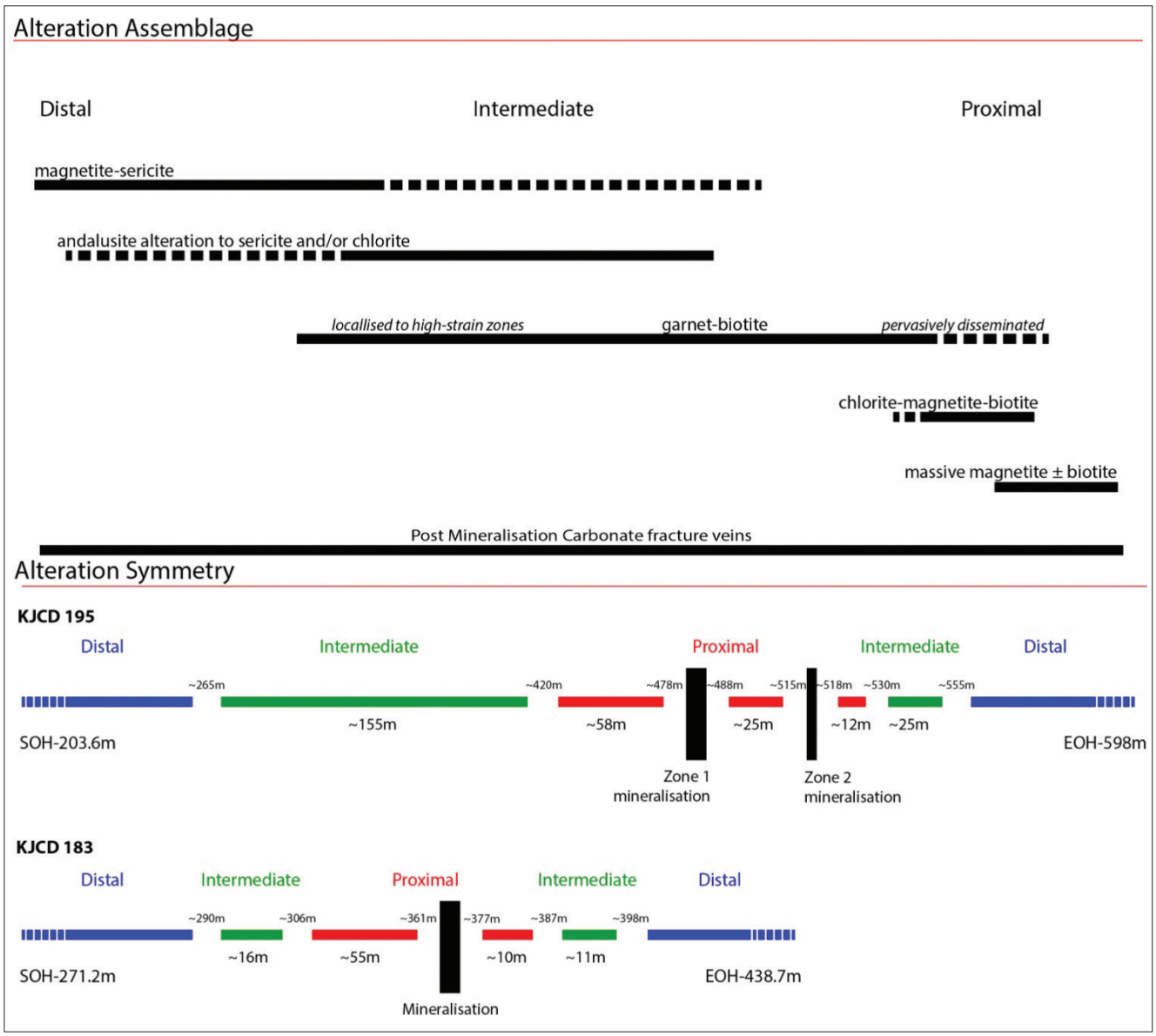

Figure 4. Rockface alteration (Crowe 2016).

increase in biotite and chlorite/chloritoid causing the rock to darken in colour. Metamorphic andalusite porphyroblasts become more diffuse and are gradually replaced by biotite and chlorite. Garnet contents can increase to over 50% of the rock, with individual crystals up to 1 cm across. The alteration assemblage at Rockface can also include tourmaline, axinite, and serpentinite (chrysotile). The origin of the chrysotile is not known but could be replacement of an unknown prograde mafic mineral.

The Rockface mineralisation has features different to the known Reward and Bellbird resources that do not fit easily into a syngenetic model. The steeply plunging shoot geometry and the fracture-fill textures of the sulfide within the magnetite-chlorite host suggest mineralisation was late in the deformation history.

The future at the Jervois Project

The discovery of the high-grade sulfide mineralisation at Rockface is a significant milestone in the long history of exploration at the Jervois project.

KGL will recommence drilling at Rockface in March 2017 using DHEM surveying again as an effective targeting technology. The program will test the new eastern conductors for additional high-grade mineralisation while extending the strike of the Rockface mineralisation to the east. A second objective is to better define the extent of mineralisation and to in-fill where required in support a mineral resource update; this will be the first update since discovery of the Rockface high-grade mineralisation. The results will enable preliminary work to commence on assessing mining and processing options, as well as guide future drilling to further upgrade the mineral resources at Rockface. In addition, collaborative research is also planned to help resolve the timing of mineralisation and its impact on the established exploration models. Whatever the outcome, exploration at Jervois has entered a new and exciting phase.

Acknowledgements

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