AUSTRALIAN
# RESEARCH
INDEPENDENT INVESTMENT RESEARCH

# PolarX Limited (ASX: PXX)

January 2018

INDEPENDENT
INVESTMENT RESEARCH

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# Contents

INDEPENDENT INVESTMENT RESEARCH

# PolarX Limited (ASX: PXX)

# Initiation - January 2018

**Note**: This report is based on information provided by the company as at January 17, 2018.

| Investment Profile - Post Merger Pro-Forma | |
|---|---|
| Share Price - 17 January 2018 | A$0.11 |
| Issued Capital: | |
| Ordinary Shares | 238.9m |
| Options (Total) | 5.35m |
| Options (In the Money) | 4.00m |
| Fully Diluted | 244.2m |
| Market Capitalisation | $26.3m |
| 12 month L/H | A$0.065/$0.195 |
| Cash and Liquid Investments | A$3.51 m |
| Cash on Option Conversion | A$0.286 m |

| Board and Management |
|---|
| Mr Mark Bojanjac: Executive Chairman |
| Dr Frazer Tabeart: Managing Director |
| Dr Jason Berton: Executive Director |
| Mr Bob Boaz: Non-Executive Director |
| Mr Ian Cunningham: CFO/Company Secretary |
| Mitchell River Group: Technical Services |
| Millrock Resources: Exploration & Logistic Services |

| Major Shareholders | |
|---|---|
| HSBC Custody Nominees | 13.42% |
| Millrock Resources | 10.74% |
| JP Morgan Nominees | 9.27% |
| Orogen Investments (Dr Jason Berton) | 5.71% |
| Top 20 | 66.91% |
| Board/Management/Mitchell River Group | 17% |

**Price Chart**


Senior Analyst – Mark Gordon



## LOOKING FOR GIANTS

PolarX Limited ("PolarX" or "the Company") is actively exploring its 80% to 100% owned Alaska Range Project ("Alaska Range" or "the Project") in south-central Alaska. Work to date has delineated two deposits; the Zackly skarn and the high grade Caribou Dome sedimentary copper deposit, with Zackly having a historical resource estimate of 1.5Mt @ 2.9% Cu and 4.5g/t Au, and Caribou Dome a JORC 2012-compliant resource of 2.8Mt @ 3.1% Cu.

Mineralisation at both of these prospects is open at depth and along strike, and the Company is pursuing a strategy of proving up resources that will have a grade/tonnage combination to justify standalone mining operations, whilst also exploring the rest of the tenements.

Exploration to date over the Project as a whole has highlighted an almost continuous zone of copper anomalism over a NE trending strike length of ~35km, with several individual priority prospects also being recognised. These prospects represent a number of mineralisation styles, including porphyry Cu-Au-Mo, intrusion related gold ("IRGS") and sedimentary hosted copper, with exploration results from all of these undrilled prospects highlighting the potential for each to host a major deposit.

## KEY POINTS

**Highly prospective properties:** The consolidation of the previously separately owned Caribou Dome and Stellar Projects has resulted in a project with high prospectivity for a number of deposit styles (with this highlighted by the results of exploration), and two prospects with demonstrated resources.

**Open resources:** The identified deposits, namely Zackly and Caribou Dome are open along strike and at depth, and thus with significant room for resource expansion; in addition early stage exploration has identified along strike targets of the same mineralisation styles.

**Compelling targets:** Exploration has also highlighted a number of other targets, with these prospective for, and exploration results returning typical signatures of porphyry Cu-Au-Mo and IRGS mineralisation amongst others; these are styles of mineralisation that commonly occur in world class deposits and that are found in the mineral belts of Alaska and the neighbouring British Columbia - this highlights the potential for a company making discovery.

**Ready access to infrastructure:** The project is centred ~110km east of the town of Cantwell, situated on the George Parks Highway, and with grid power and a rail siding; and is readily accessible via the Denali Highway, which runs east from Cantwell immediately to the south of the Project.

**Attractive mining destination**: Alaska is an attractive and well regarded mining destination, ranking 14th globally and 5th in the United States in the 2016 Fraser Institute survey – the state is home to a number of metal mines, as well as coal and a large oil and gas industry.

**Strong management and technical team:** The Company has management, technical personnel and partners with extensive experience in the junior resources sector (and in the case of Millrock Resources, extensive Alaskan experience) and a proven history of technical success and delivering value to shareholders; in addition key personnel and related partners hold ~17% of the Company, thus aligning their interests with those of other shareholders.

**Active exploration programmes:** Although the Company is currently limiting exploration activities to May-October due to snow, exploration activities during this period are continuous, with work including significant drilling; there is the possibility to extend activities, particularly drilling, to year round.

**Leveraged to exploration success:** With an EV of ~A$23 million, the Company has a value towards the lower end of its peers, and is well leveraged to positive exploration news with the potential to return significant value to shareholders.

# SWOT ANALYSIS

## Strengths

- **High quality project:** This is the key strength of PolarX, with the Alaska Range Project demonstrating high prospectivity for mineralisation styles that have a history of occurring in world class deposits, and delineated mineralisation that is still open at the drilled deposits.
- **High grade mineralisation at Caribou Dome:** Mineralisation at Caribou Dome is at of grades and widths that could potentially support mining; the historical resource estimate at Zackly indicates a similar situation, however this will be confirmed (or otherwise) by the upcoming resource estimation, with some of the more recent drill results being of slightly lower grade but over thicker intersections.
- **Experienced people with skin in the game:** Company personnel have significant experience and success in the junior resources sector, and also have significant holdings in PolarX - good management is essential to the success of a resources junior.
- **Well regarded jurisdiction:** Alaska is a well regarded and mature mining jurisdiction, with a long history of successful mining operations.
- **Simple, state-based permitting:** Given that the Project is located over state, and not federal mining claims, permitting of exploration activities requires the approval of only one state based agency, and the permitting of any future operation will again be state based (with an exception being if there is any impact on wetlands, in which case permitting will need to include the federal Army Corps of Engineers).
- **Close to infrastructure:** The Project is centred within 110km of Cantwell and major transport infrastructure, and is readily accessible (outside of winter) by the Denali Highway; however the Project will be accessible all year round should the Company fund snow ploughing of the Denali Highway during winter.
- **100% ownership of Stellar:** The Company holds 100% of the Stellar claims, which host the Zackly, Mars and Moonwalk prospects.
- **Earn-in terms, Caribou Dome:** Although the total costs for the Caribou Dome earn-in is in the order of US$11 million, US$8 million is spread over an eight year period, with ~US$3 million due at the end of the ninth year.

## Weaknesses

- **Location:** Being located in a mountainous area of Alaska and being subject to relatively severe winters will mean that any future operation will be reasonably expensive; this also applies to exploration with this largely limited to six months of the year at the moment; however drilling activities can be carried out during winter but this will entail significant additional cost.
- **Funding:** As of September 30, 2017 PolarX had A$3.51 million in cash (including a A$1.33 million prepayment with Millrock); given the planned exploration programmes and past expenditure there will be the requirement to go to the market in 2018.
- **Earn-in terms:** The Caribou Dome agreement is an all or nothing deal; there is no staged earn-in, and thus if the Company pulls out early it will retain no equity; however this does not affect the 100% owned Stellar claims, on which activities will be concentrated over the next one to two years.

## Opportunities

- **Resource expansion:** This is the key opportunity at Zackly and Caribou Dome, with mineralisation being open along strike and at depth.
- **Drilling success:** This applies to the other key, untested prospects, with a number of these now drill ready; given the mineralisation styles these have very large, Tier 1 size potential.

## Threats

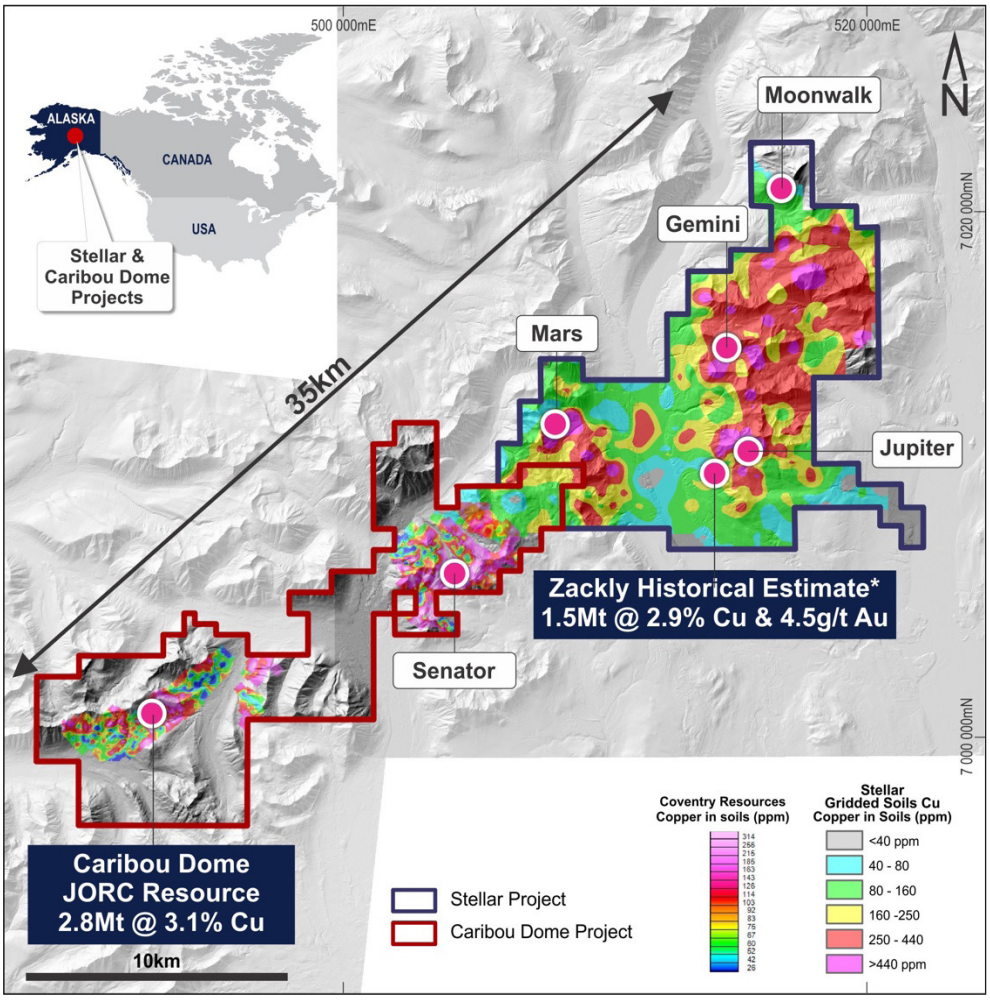
- **Lack of drilling success:** This is self explanatory, and is a key threat for any junior explorer.
- **Resources not stacking up:** This applies to the strategy of a relatively early start-up at Zackly and Caribou Dome, with resources needing to be able to support a relatively expensive operation.
- **Markets and metals prices:** A key perennial threat facing juniors are falls in the stock and metals markets, particularly when it comes to having to raise funds in a bad market – this will also impact with investors selling down the more risky juniors before other less risky investments.

# OVERVIEW

## STRATEGY AND PROJECT OVERVIEW

- PolarX's activities are focussed on the 203km$^2$ Alaska Range Project, which comprises two highly prospective contiguous projects, namely Stellar (117km$^2$) and Caribou Dome (86km$^2$), located in the Central Alaskan Ranges (Figures 1 and 2).
- The consolidation of the two projects has been completed by PolarX; previously they were held by separate parties, and PolarX has staked a number of additional claims to add to the previously acquired areas.
- The combined Project includes 35km of strike of geology that soil sampling shows to be almost continuously anomalous for copper, with gaps generally due to areas of cover, including braided streams (Figure 1).
- Two prospects, Zackly and Caribou Dome, have extensive drilling and historical (Zackly) and JORC 2012-compliant (Caribou Dome) resources from surface, with other prospects showing excellent potential for a major discovery.
- The Company's strategy is, should feasible resources be delineated, to work towards the early development of Zackly and Caribou, whilst in parallel exploring the other key prospects which offer the potential for a company making discovery.

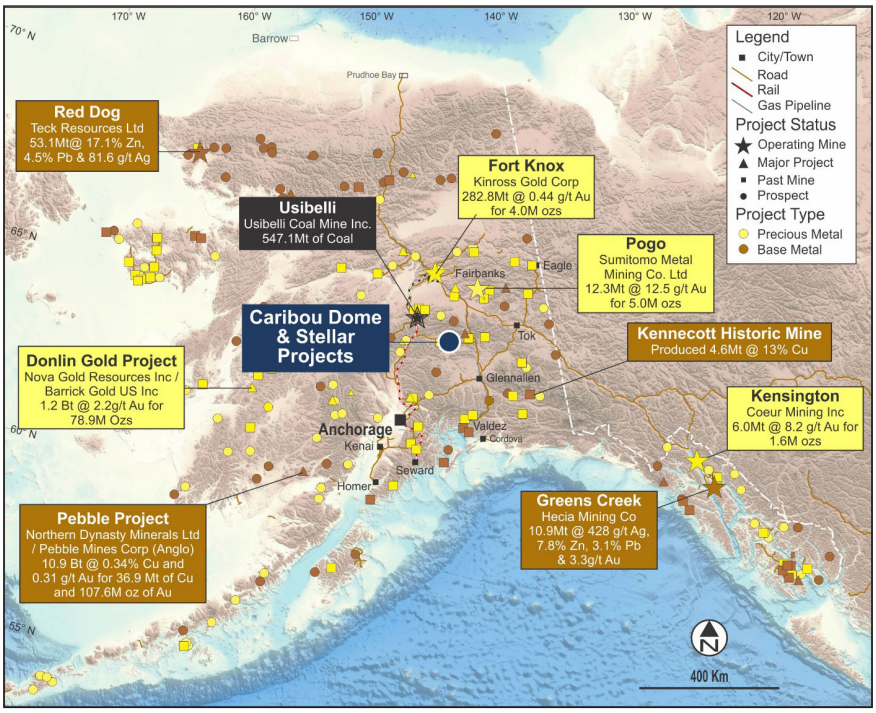
**Figure 1: Project location map**




Source: PolarX

- The identified prospects exhibit several styles of mineralisation:
  - Skarn copper-gold (Zackly)
  - Porphyry copper-gold-molybdenum (Mars, Jupiter, Gemini)
  - Intrusive-related gold ("IRGS", Moonwalk), and,
  - Sediment-hosted, or "Kennecott" style copper (Caribou Dome, Senator).

**Figure 2: Major Alaskan mineral deposits**




Source: PolarX

## FINANCIAL POSITION

- As of September 30, 2017, PolarX had cash of A$3.51 million - this included an A$1.33 held by Millrock as part of prepayments for exploration.
- Over the twelve months to September 30, 2017, PolarX raised A$5.495 million through the placement of 274.75 million shares at A$0.02/share pre-consolidation - these were later subject to a 1 for 5 consolidation.
- Over the same period PolarX spent A$3.345 million on exploration and A$1.107 million on staff and administration costs; the exploration expenditure includes prepayments to Millrock.

# ALASKA RANGE PROJECT, ALASKA

## LOCATION AND TENURE

- The Alaska Range Project is located in the Alaska Range of south-eastern Alaska, centred approximately 460km by road from Anchorage (Figures 1 and 2).
- Access is via State Highway 4 from Anchorage to Cantwell (340km, the nearest town), then east via the Denali Highway, which runs to the south of the tenements (85-140km).
- The Denali Highway is mainly good quality gravel, and is maintained during May-October, with access to the site being by up to 20km of 4WD tracks from the Denali Highway.
- Power and rail are also available at Cantwell, with the rail being connected to the year-round port at Seward.
- The Project comprises 44 x 40 acre and 303 x 160 acre unpatented Alaska State mining claims, for a total area of 50,240 acres, or 203.3km$^2$ (Figure 1), with all in good standing.
- The claims have been acquired at four separate times and under various agreements.
- Caribou Dome includes two groups of claims:
  - 97 claims totaling 10,240 acres (this includes 53 x 160 acre and 44 x 40 acre claims) in which PolarX is earning 80%, as announced to the market in November 2014, and,
  - 69 x 160 acre claims staked by PolarX and 90% owned, as announced in January 2015.
- Likewise Stellar includes two group of claims, however all are 100% held:
  - 111 x 160 acre claims acquired through the acquisition of Vista Minerals in July 2017, and,
  - 70 x 160 acre claims subsequently staked in August 2017.

## EARN-IN AND ACQUISITION AGREEMENTS

### Caribou Dome Earn-in

- As announced to the market on November 5, 2014, PolarX is earning up to 80% of 10,240 acres of the Caribou Dome Project through the now completed acquisition of 100% of the issued shares of unlisted Australian company Aldevco Pty Ltd ("Aldevco").
- The consideration for the acquisition was 60 million shares (pre-1 for 5 consolidation).
- At the time of the acquisition, Aldevco had an agreement with Canadian Hatcher Resources Inc. ("Hatcher") to earn 80% of Caribou Dome under the following terms:
  - (i) Payment to Hatcher of US$75,000, being part reimbursement of expenses incurred by Hatcher in relation to its evaluation and exploration activities on the Project during 2014,
  - (ii) Maintaining the claims at the Project in good standing, including making annual claim rental payments and ensuring minimum expenditure commitments are met,
  - (iii) Whichever comes first of either expending a total of US$9,000,000 on the Project (with required expenditure detailed in (iv) and (v) below) or completing a feasibility study on the Project by 6 June 2023 (unless the Earn-in deadline of 6 June 2023 is extended) - completion of a feasibility study prior to the US$9,000,000 expenditure commitment being reached terminates the expenditure commitment,
  - (iv) Expending a minimum of US$100,000 on the Project for each of the 12 month periods ending 1 September 2015, 2016 and 2017,
  - (v) Expending a minimum of US$2,000,000 (inclusive of payments in (iv) above) in each of the periods (a) 2 September 2014 to 1 September 2017; (b) 2 September 2017 to 1 September 2020; and (c) 2 September 2020 to 6 June 2023 (unless the Earn-in deadline of 6 June 2023 is extended), and,
  - (vi) Making annual payments (due on June 6 of each year, and totalling US$1.96 million over 9 payments) to the underlying vendors of the Project, who are not related parties of Hatcher or Aldevco, being US$20,000 in 2015, US$30,000 in 2016, US$50,000 in 2017, $100,000 in each of 2018 to 2022, and US$1,360,000 on the earn in deadline of June 6, 2023.
- Subject to the earn-in being complete, Hatcher will retain 10% with 10% being held by SV Metals LP.
- A 5% NSR royalty will be retained by the underlying owner, C-D development Corporation, with this being able to be purchased for US$1 million for each 1%.

### Stellar Acquisition

- PolarX acquired 100% of 111 claim blocks through the merger with Vista Minerals Pty Ltd ("Vista"), an unlisted Australian Company, with PolarX being the remaining entity.
- Vista had acquired the claims from TSX-V listed Millrock Resources Inc. ("Millrock"), with Millrock being issued ~28% of Vista, as consideration for the acquisition.
- The merger consideration for the shares of Vista was ~92 million PolarX shares (post consolidation basis), with 25.6 million of these shares going to Millrock.
- The merger was carried out in conjunction with an A$5.5 million placement, following which Millrock retained a 10.74% stake in PolarX.
- Terms of Vista's acquisition of Stellar also included:
  - Vista will pay USD $1m cash to Millrock if a JORC Indicated Resource of 1Moz contained Au or more is delineated,
  - Vista will pay USD $2m cash to Millrock if a JORC Indicated resource of 1Mt or more of contained copper (or copper equivalent) metal is delineated,
  - 45 claim blocks covering the Zackly, Moonwalk, Mars and Gemini prospects, are subject to a royalty payable to Altius Minerals:
  - a) 2% gross value royalty on all uranium produced,
  - b) 2% net smelter return royalty on gold, silver, platinum, palladium and rhodium,
  - c) 1% net smelter return royalty on all other metals,
  - All Stellar claim blocks are subject to a royalty payable to Millrock:
  - a) 1% gross value royalty on all uranium produced,
  - b) 1% net smelter royalty on all other metals,

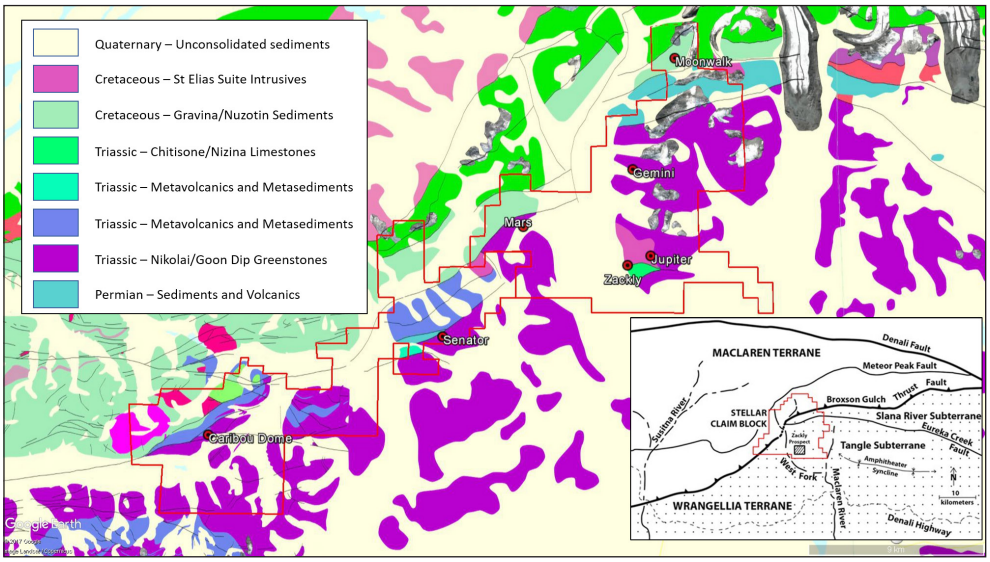
- Advanced royalty payments to Millrock must commence on the second anniversary of executing the Sale and Purchase Agreement, and every anniversary thereafter up to the fifth anniversary of production commencing. The initial payment will be USD $20,000 in April 2019 escalating by $5,000 per year. Payments are deductible from future royalty payments.

- Millrock will provide technical services to PolarX at the latter's discretion.

## REGIONAL GEOLOGY

- Figure 3 presents the regional geology, tenements, key prospects and structural framework (inset) of the Alaska Range Project.

**Figure 3: Alaska Range Project geology, tenements and prospects**



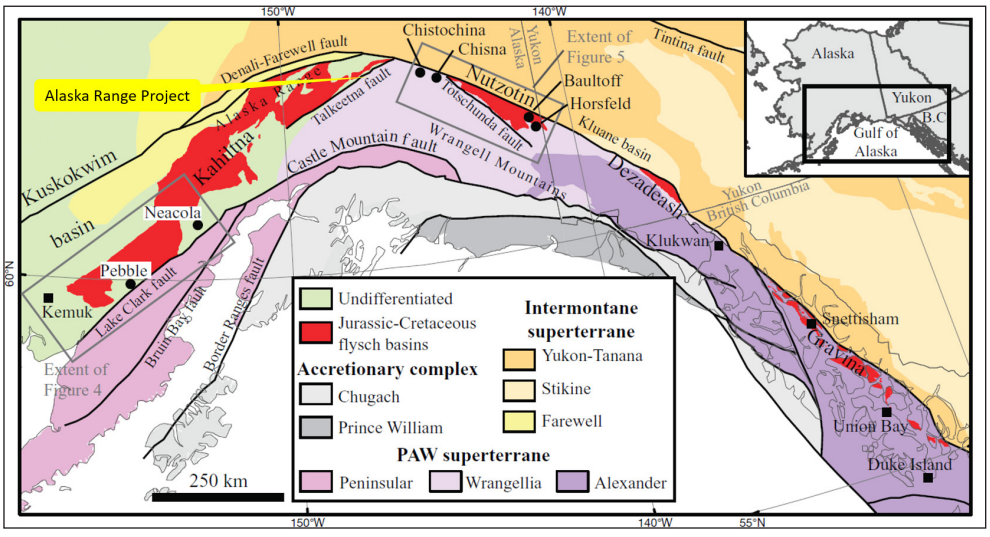

Source: PolarX, USGS, Google Earth

- The Project lies along and largely to the south of the north-dipping thrust faulted boundary between the Wrangellia and McLaren Terranes, two of a number of accretionary blocks that comprise the bulk of the geology of southern Alaska - units include Upper Paleozoic (Permian) to Cretaceous sediments and volcanics, intruded by Cretaceous calc-alkaline to alkalic intrusives.

- These terranes represent island arc complexes that accreted to the North American continent during the Cretaceous, with the Denali-Farewell Fault (to the north) representing the current day suture between the continental Intermontane Superterrane to the north, and the Peninsula-Wrangellia-Alexander ("PAW") Superterrane, which comprises the accreted arc complexes, to the south (Figure 4).

- This also shows the identified porphyry deposits in the PAW Superterrane (discussed later), and highlights the prospective location of the Project within the belt

**Figure 4: Accreted terranes and known porphyry deposits**




Source: Goldfarb et al, Economic Geology V108, pp405-419

- Within the Wrangellia Terrane, the dominant block is the Tangle Subterrane, however a small sliver of the Slana River Subterrane is present in the north-east of the Project to the south of the Moonwalk prospect.
- Key units in the Tangle Subterrane include the basal Triassic Nikolai/Goon Group Greenstones, which are largely composed of basaltic lava flows, with these being overlain by Triassic sediments and volcanics, including limestones, siltstones (argillites), tuffaceous sediments and some andesitic lavas (Figure 3).
- The "Zackly" limestone, which is interpreted as being an equivalent to the Chitistone Limestone (which hosts the Kennecott deposit), hosts the Zackly skarn mineralisation, and occurs within the Nikolai Greenstone.
- Regionally the Slana River Subterrane includes the older arc-related Permian Slana Spur and Station Creek Formations and the Tetelna Volcanics.
- The Mclaran Terrane to the north is dominated by Cretaceous and undifferentated Mesozoic metasediments and metavolcanics, which are interpreted as largely flysch in origin.
- Units have been metamorphosed to greenschist facies, and also strongly folded, with the strike of the sediments and sub-parallel thrusts being ENE within the Project area.
- Outcropping intrusives include Cretaceous calc-alkaline rocks of the St Elias Suite - these may represent the interpreted intrusive source for earlier Zackly skarn mineralisation, which is also interpreted as being overprinted by a later event caused by younger, buried intrusives.

## MINERALISATION

- The Project is prospective for, and has demonstrated occurrences of a number of styles of mineralisation, including:
  - Cu-Au Skarn - this is present at the Zackly prospect, where historical and current work has been targeted at the skarn mineralisation, hosted at the top of a limestone, shown in Figure 3 as the Chitistone Limestone,
  - Porphyry Cu-Au-Mo - Although no porphyry mineralisation has yet been drilled, a number of prospects, including Mars, Zackly, Gemini and Jupiter are prospective porphyry targets, with early stage exploration highlighting signatures typically associated with this style of mineralisation,
  - Tintina-style Au IRGS - IRGSs are a recently recognised/differentiated style of mineralisation associated with post-orgenic intrusives - a number of major deposits are located within the Tintina belt of Alaska and British Columbia, with the Moonwalk prospect being considered one.
  - Kennecott/Sedex Cu - mineralisation at Caribou Dome is of this style, with Senator also being interpreted as similar - this is hosted within the sediments immediately overlying the Nikolai Greenstone, and is also referred to as "Basaltic Copper" style mineralisation by the USGS.

## KEY PROSPECTS

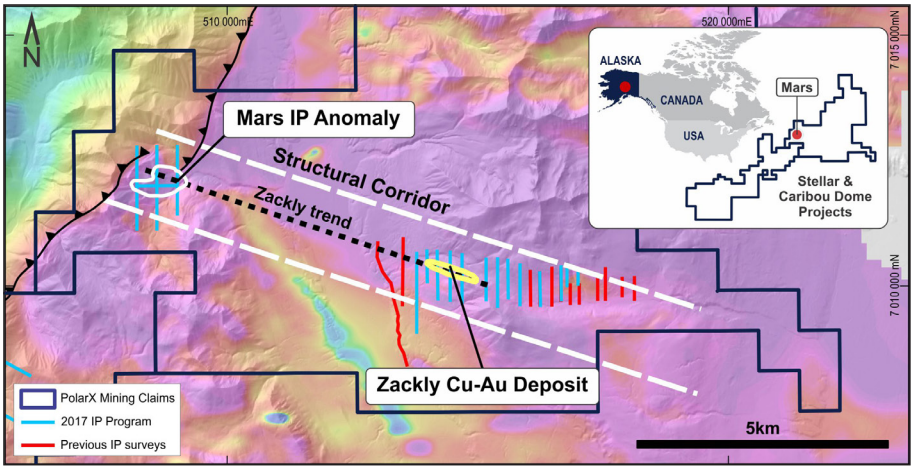
### Zackly-Mars, Gemini, Jupiter

#### Geology and Mineralisation

- The Zackly and Mars prospects occur along a ~7km long ESE trending structural corridor, that is interpreted to contain a number of porphyry Cu-Au targets (Figure 5), with the dominant lithologies belonging to the Nikolai Greenstone, with an outcropping diorite at Zackly (Figure 3); significant areas of the trend are covered by Quaternary sediments including braided streams.
- Skarn mineralisation at Zackly occurs as a number of lenses over a strike length of 4-5km (Figure 6), with the main skarn (for which historical resources of 1.5Mt @ 2.9% Cu and 4.5g/t Au have been estimated) having a strike length of ~800m and an average width of ~3m (with a range from 0.5m to 10m) - mineralisation has been intersected to a depth of 250m below surface and is still open at depth and along strike - this is located at the western end of the drilled skarns.

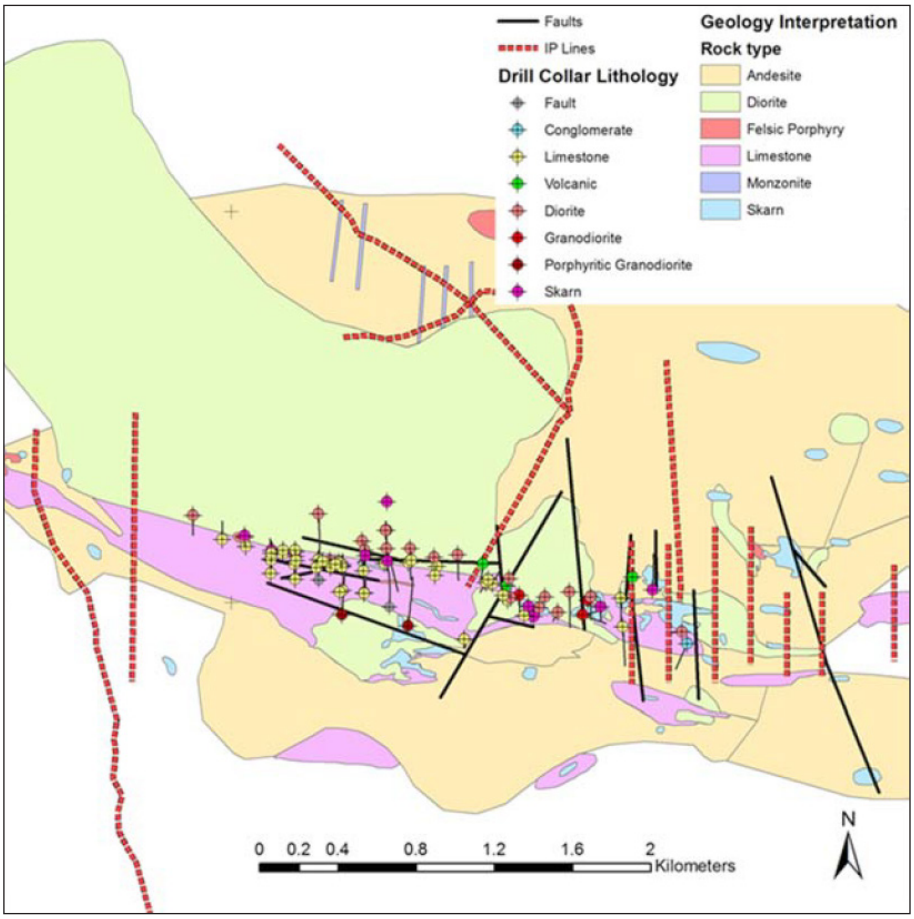
- The mineralisation, which has a general east-west strike and subvertical dip is hosted at the faulted top of a limestone (interpreted as being equivalent to the Chitistone Limestone), adjacent to a diorite intrusive - mineralisation is strongest adjacent to the faulted top of the limestone (Figure 7).
- Work reported by the Company suggests that the bulk of mineralisation may be at least partly due to a later buried intrusive, overprinting earlier phases of mineralisation caused by the exposed diorite adjacent to the skarn (Figure 7) - this later intrusive is also a porphyry copper-gold target.
- The outcropping diorite has been dated at around 126 Ma, significantly older than porphyry hosting intrusions in Alaska that typically have ages of 115Ma to 105Ma and 100Ma to 90Ma.

**Figure 5: Zackly trend**




Source: PolarX

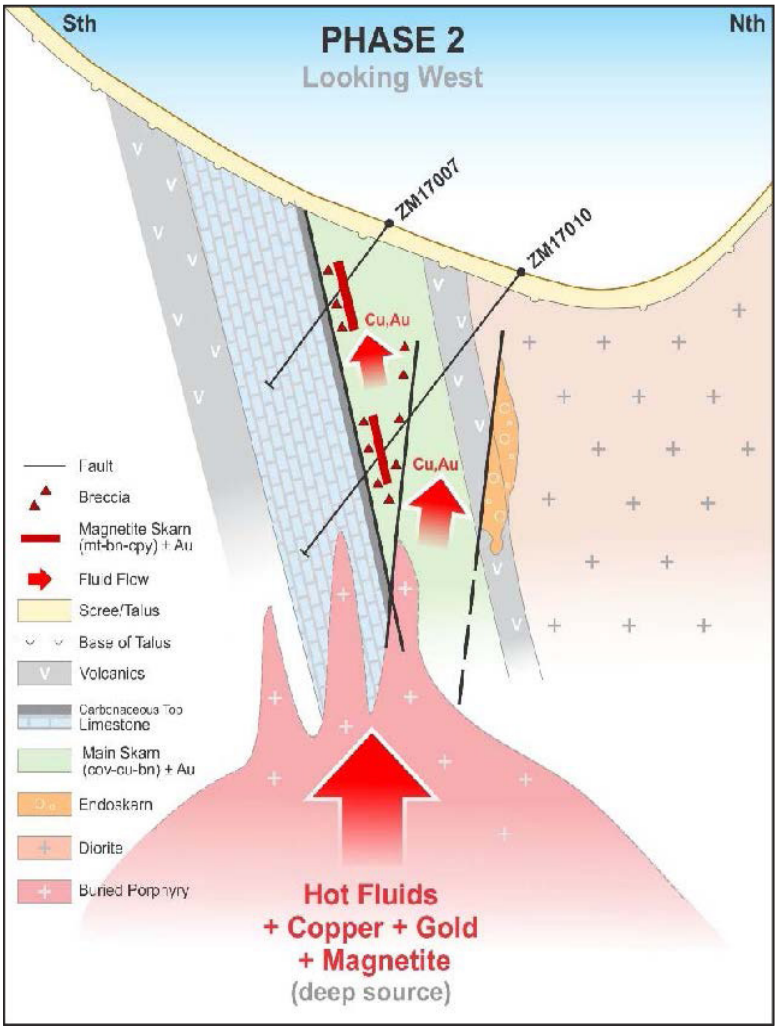
**Figure 6: Zackly geology and historical work**




Source: PolarX

- In addition, the geochemical signature at Jupiter may reflect an underlying porphyry related to the Zackly skarn - the 2km x 1km soil anomaly has exceptional values of up to 3,850ppm Cu and 0.78g/t Au.
- Although no drilling has been completed at Mars, geochemical sampling has identified rock chip and soil Cu, Au and Mo geochemical anomalism coincident with magnetic anomalies, with the >250ppm Cu in soil geochemical anomaly being some 2,000m x 1,500m in size, within which is a >120ppb Au in soil geochemical anomaly and up to 7.4% Cu and 1.8 g/t Au in rock-chip samples from thin veins and fractures at surface.
- Induced polarisation ("IP") surveying completed by PolarX in 2017 resulted in an anomaly coincident with the geochemical anomalism (Figure 8).
- This combination of geophysical and geochemical anomalies is that typically associated with porphyry Cu-Au systems, with modelling of the results suggesting that the top of the system may be a relatively shallow ~100m to 150m below surface.

**Figure 7: Interpreted mineralisation model - Zackly.**



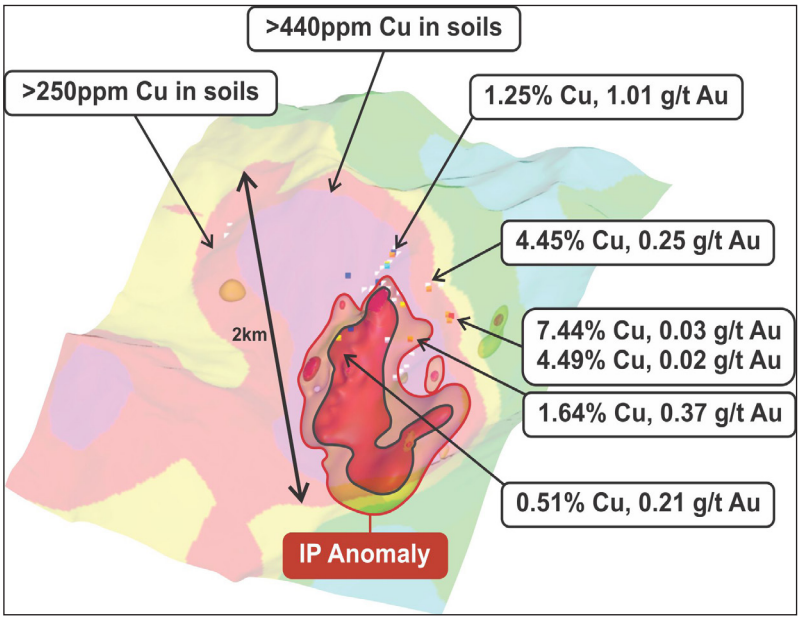

Source: PolarX

### Historical Work

- Prior to Millrock's acquisition of the Project in 2010, exploration was largely targeted at Zackly, which was originally identified in 1964, with initial exploration commencing in 1979 by the Resource Association of Alaska ("RAA") in JV with UNC Teton Exploration Drilling Inc.
- Exploration continued sporadically under various parties until 1995, with activities including geological mapping, geochemical sampling, ground geophysics (magnetics, EM, VLF and IP) and drilling, including diamond core ("DD"), percussion and reverse circulation ("RC").
- Five drilling campaigns (99 holes for 9,595m of core and 3,419m percussion/RC) were completed between 1981 and 1994, which were used in historical resource estimates, the latest of which was 1.5Mt @ 2.9% Cu and 4.5g/t Au - a summary of work completed is shown in Figure 6.

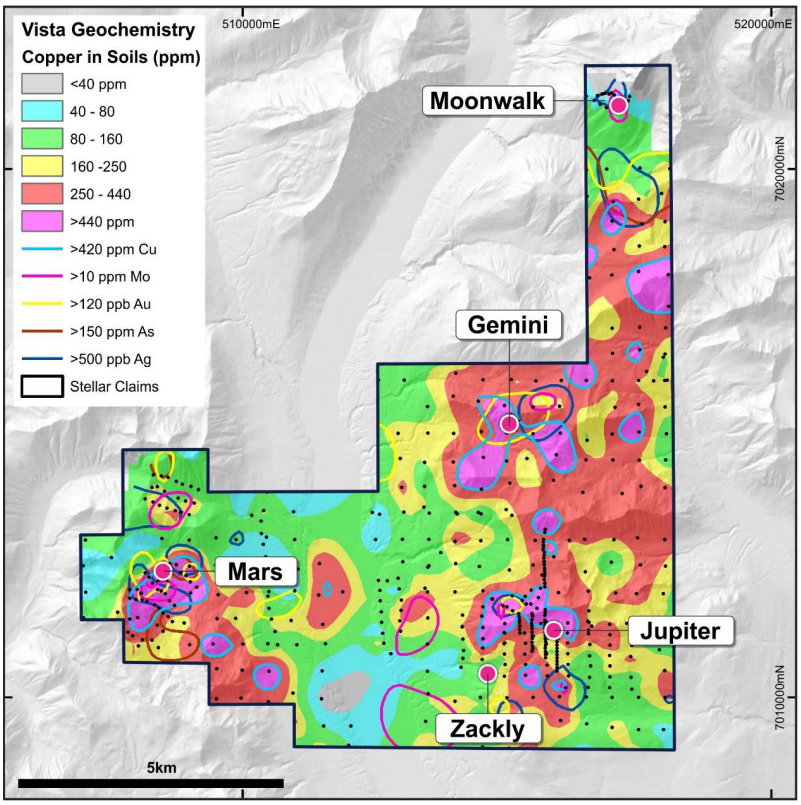
- Better results from the historic drilling included:
  - 19.51m @ 4.4% Cu, 14.26g/t Au, 88.93g/t Ag from 164.59m (Z-04-81, core)
  - 7.92m @ 2.07% Cu, 2.55g/t Au, 17.78g/t Ag from 171.30m (Z-02-81, core)
- However, some of the historical drilling suffered from poor core recovery, and hence results are considered unreliable for those holes affected - this also affects the historical resource estimates, which are considered unreliable.
- Early work at Mars (then called MEX) included geochemical sampling, geological mapping, and ground and airborne geophysics.
- Work by Millrock largely included geological mapping and geochemical sampling, with this covering the entire block, including the Mars prospect amongst others (Figures 8 and 9) - Mars returned rock chips of up to 7.4% Cu and 1.8g/t Au.

**Figure 8: Mars geochemistry and IP**




Source: PolarX

**Figure 9: Stellar soil sampling results**



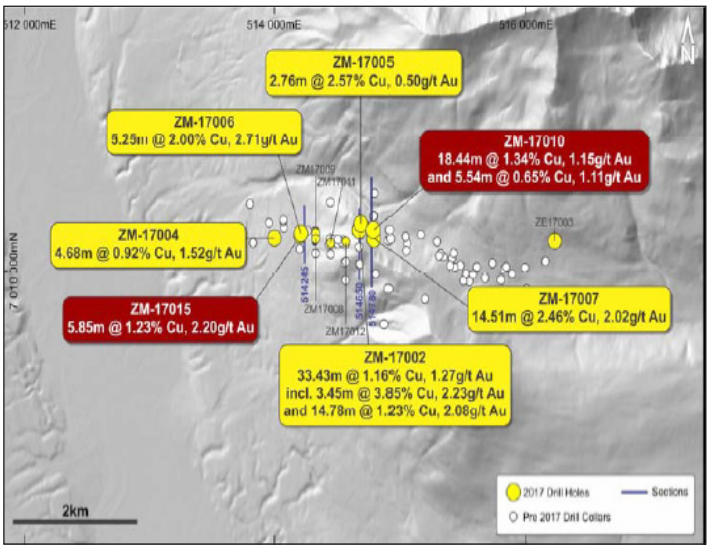

Source: PolarX

- This work defined a number of other prospects (as discussed earlier) with coincident multi-element geochemical anomalies, including Gemini and Jupiter (porphyry Cu-Au signatures), as well as highlighting Moonwalk (IRGS signature), which was discovered in 1982 by RAA.
- Work by Vista in 2016 included IP surveying over Zackly and Mars (red lines in Figure 5) - these areas, both to the east and west of the drilled mineralisation are largely untested by drilling, and provide compelling drill targets.

### Work By PolarX

- Work to date by PolarX has included an IP survey over Mars and Zackly (blue lines in Figure 5) and a diamond drilling programme (13 holes for 2021.53m) - 11 holes targeted the main skarn, with one each being drilled to the west and east (Figure 10)

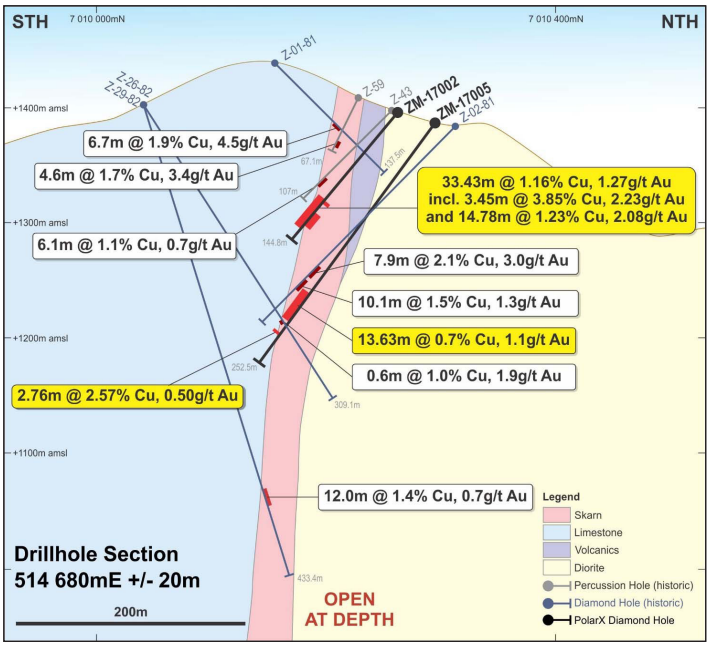
**Figure 10: PolarX drilling - Zackly - shown significant results**




Source: PolarX

- The drilling has largely been designed to confirm the results of historical drilling and provide reliable data for a planned initial JORC 2012-compliant Mineral Resource Estimate ("MRE").
- Better results from this drilling include:
  - 14.78m @ 1.23% Cu and 2.08g/t Au from 112.63m (hole ZM-17002), in a broader intercept of 33.43m @ 1.16% Cu and 1.27g/t Au from 98.27m (Figures 10 and 11), and,
  - 20.41m @ 2.10% Cu and 1.66g/t Au from 28.96m in hole ZM-17007 (Figure 10).

**Figure 11: Zackly cross section 514680mE, looking west**




Source: PolarX

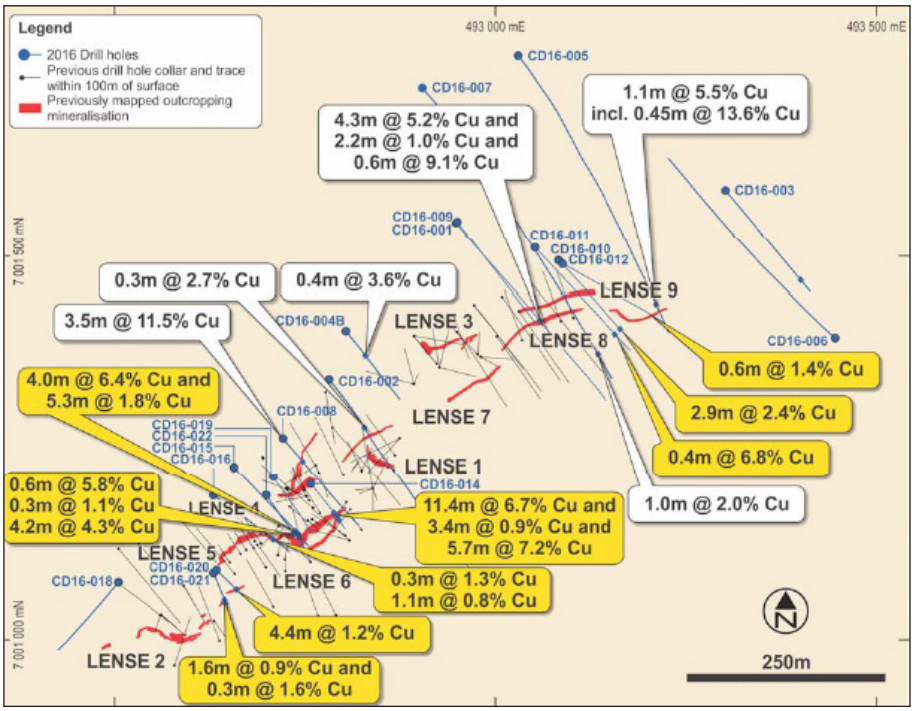
- The Company notes that, and as can be seen on the section above, the PolarX drilling has generally returned broader intercepts than those in holes being twinned, however we note that the grades are generally slightly lower - this may be due to different criteria being applied to sampling and reporting of mineralisation between the different drilling programmes.
- As mentioned previously the IP survey delivered a chargeability anomaly coincident with the geochemical and magnetics anomalies at Mars, highlighting a compelling porphyry target.

## Caribou Dome - Senator

### Geology and Mineralisation

- Caribou Dome is a stratiform sulphide deposit, hosted in the basal units of the Triassic metamorphosed volcanic/sediment succession conformably overlying the Nikolai Greenstone.
- Mineralisation is in the form of a number of (nine identified to date) sub-vertically dipping lenses up to ~10m thick over a strike length of around 800m (Figures 12 and 13), with these open along strike and at depth - mineralisation has been intersected to ~250m below surface.
- Prospective stratigraphy has been recognised for a strike length of ~15km from Caribou Dome in the south-west to Senator in the north-east (Figures 1 and 15), with this following the upper contact of the Nikolai Greenstone.

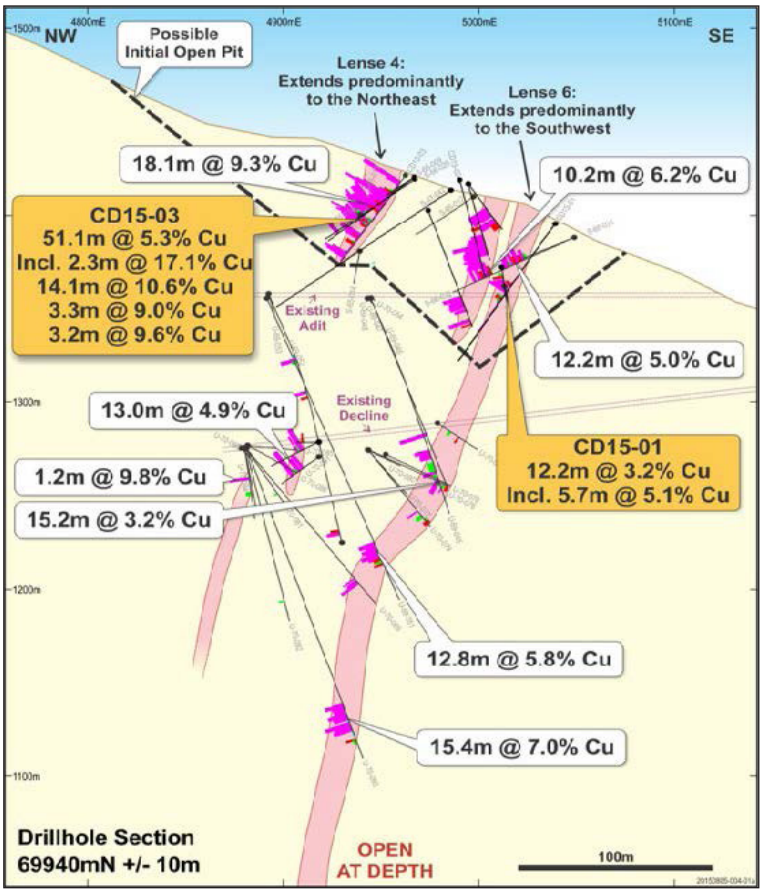
**Figure 12; Caribou Dome plan showing mineralisation and drilling**




Source: PolarX

- Mineralisation, which is interpreted as being syngenetic, or else being formed soon after deposition, has been deformed, thus resulting in the complex structure.
- The mineralisation is largely composed of fine grained pyrite and chalcopyrite, and is considered by the USGS as "Basalt Copper" or "Kennecott" style mineralisation (with the Kennecott deposit being hosted in a similar stratigraphic position).
- Kennecott (location shown in Figure 2) produced some 4Mt of ore at a very high grade of 13% Cu from 1911 to 1938.

**Figure 13: Caribou Dome cross section 69940mN looking NE**




Source: PolarX

## Resources

- As announced to the market on April 5, 2017, PolarX has estimated a JORC 2012-compliant MRE for Caribou Dome as presented in Table 1 - this remains open along strike and down dip.
- Using a lower cut of 2% Cu (instead of the 0.5% Cu as presented in Table 1) results in a MRE of 1.6Mt @ 4.6% Cu for 72,000t contained copper.

**Table 1: Caribou Dome JORC 2012-compliant MRE - 0.5% Cu lower cut**

| Caribou Dome JORC 2012-compliant MRE - 0.5% Cu lower cut | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Open Cut (>1300m RL) | | Underground (<1300m RL) | | Total | | |
| Category | Tonnes | Grade Cu (%) | Tonnes | Grade Cu (%) | Tonnes | Grade Cu (%) | Contained Cu (t) |
| Measured | 495,000 | 3.6 | 74,000 | 3.7 | 569,000 | 3.6 | 21,000 |
| Indicated | 480,000 | 2.2 | 113,000 | 2.3 | 593,000 | 2.2 | 13,000 |
| Inferred | 655,000 | 3.1 | 979,000 | 3.3 | 1,634,000 | 3.2 | 52,000 |
| **Total** | **1,630,000** | **3.0** | **1,166,000** | **3.2** | **2,796,000** | **3.1** | **86,000** |

Source: PolarX

## Historic Work

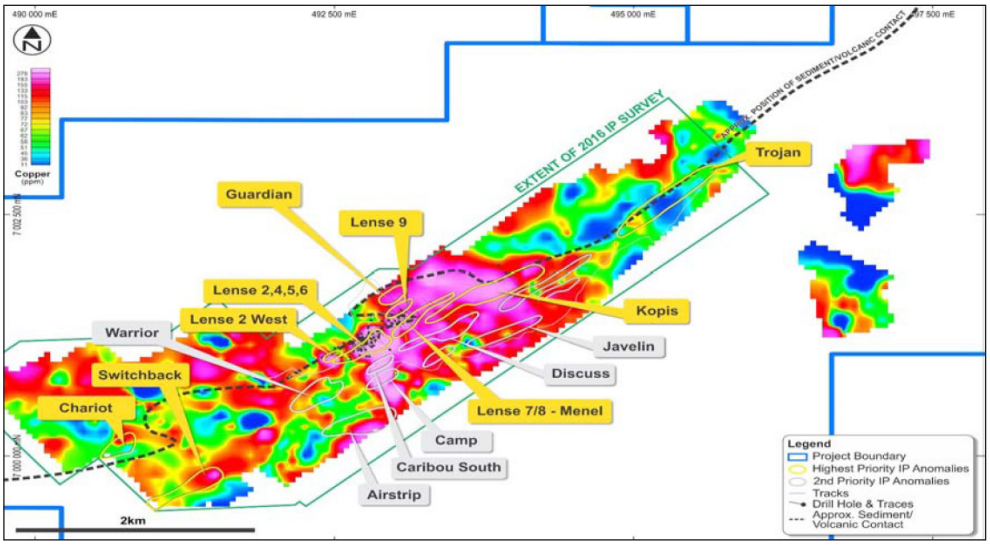
- Copper occurrences were first noted in the Clearwater Mountains area in 1963 during mapping and sampling by state agencies.
- This was followed by the commencement of private, helicopter supported exploration in the same year, with comprehensive exploration activities continuing up until 1970 - this was largely concentrated on lenses 4, 5 and 6 with the view to developing a high grade, underground copper mine.
- This work included surface mapping, geochemical sampling, trenching and drilling.
- Some of the drilling was carried out from underground, with two declines/inclines being dug specifically for this purpose:
  - A 1,400', 0.5% grade (to allow water to flow out) adit was dug in 1967, and,
  - A 1,706', 15% spiral decline was dug in 1970 - both targeted the main 6 lens.

- The drilling included 6,024m of diamond drilling from both the surface (43 holes) and underground (49 holes), and 3,282m of underground percussion drilling.
- Results of this drilling included the following very high grade intersections:
  - 18.1m @ 9.34% Cu, and,
  - 18.4m @ 6.25% Cu.
- The work highlighted the complexity of the mineralisation, and also recognised metallurgical issues with fine grained chalcopyrite mineralisation - recent work by PolarX however has been positive, with this partly due to significant advances in the metallurgical treatment of fine grained mineralisation since the 1970's.
- Little work was carried out subsequent to 1971, with this including some metallurgical testwork and limited drilling - for the majority of the time subsequent to 1970 work programmes have been those sufficient to maintain the tenements.

**Work by PolarX**

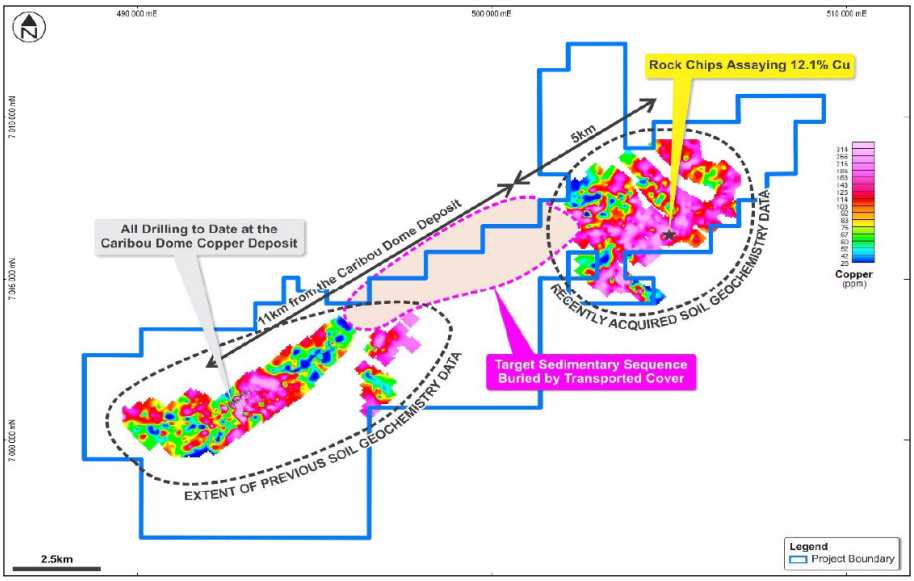
- Since acquiring the Project in 2014, work by PolarX has included:
  - A 28 hole, 4,300m diamond drill programme in 2015,
  - A 22 hole, 6,520m diamond drill programme in 2016, with the drilling programmes used in the initial MRE (as discussed earlier), and also to collect metallurgical samples,
  - Soil sampling over Caribou Dome and the newly defined Senator prospect, and,
  - IP surveying over 7km of strike at Caribou Dome.
- This work was completed in the 2015 and 2016 field seasons; in 2017 the focus moved to Stellar as discussed earlier.
- This work has highlighted the potential of Caribou Dome and Senator, with the drilling defining new zones of mineralisation (including shallow, potentially open pittable mineralisation, which was the subject of a preliminary scoping study ("PSS") - this considered the potential for an open pit targeting the 60% of the mineralisation that occurs in the top 150m, with a conceptual pit outline shown in Figure 13.
- Work also defined additional drill targets, including coincident IP and soil geochemical anomalies at Caribou Dome, and the prospective corridor between Caribou Dome and Senator (Figures 14 and 15) - sampling at Senator returned rock chip assays up to 12.1% Cu within a coherent 5km long soil Cu anomaly (Figure 15).
- Metallurgical testwork, completed in late 2015/early 2016 returning very encouraging results, including recoveries of >95% Cu from rougher flotation tests and concentrate grades of up to 24.5% from cleaner tests.

**Figure 14: Caribou Dome soils and IP, highlighting co-incident anomalies**




Source: PolarX

**Figure 15: Caribou Dome soils - Caribou Dome deposit in south-west, Senator in north-east**




Source: PolarX

## Moonwalk

### Geology and Mineralisation

- Moonwalk, which is located in the north-east of the Project, is located over an area that includes Permian metasediments of the Slana Subterrane intruded by an altered granodiorite.
- This occurs in a complex area of thrust faulting, just south of the major flexure in the Denali Fault.
- Geochemical sampling has returned anomalous Au, As, Bi, Sb, W and Zn, an assemblage more reminiscent of an IRGS rather than a Cu-Au porphyry, with a 1km x 1km Au-As-W soil anomaly.
- Two lines of grab sampling along ridges returned average grades of 1.1g/t Au over a 140m long ridge and 0.55/g/t Au over an 85m long ridge.

### Historic Work

- The prospect was discovered by RAA in 1982,with subsequent work including rock chip sampling and VLF-EM surveying, which identified conductors coincident with mapped thrust faults.
- The next work was carried out by Millrock in 2010-2012 - this again included geochemical (rock chip and soil) sampling, with this identifying a granodiorite ridge with anomalous Au, As, Bi, Sb and Zn, with locally anomalous to ore grade gold samples.

## PLANNED ACTIVITIES

- PolarX is looking towards a comprehensive exploration and evaluation programme for the Alaska Range Project, with work planned on all main targets in the 2018 May to October field season.
- This will incorporate aspects required for development studies for Zackly and Caribou Dome; this includes environmental monitoring/baseline programmes, which are already underway.
- Detailed programme planning will take place during the northern winter, with field activities commencing with camp and access preparation in April.
- Metallurgical testwork, including initial work for Zackly and ongoing work for Caribou Dome is planned for the northern winter.

## PEERS

- PolarX is one of a number of explorers and developers looking at poly-metallic resources, with these shown in Table 2, which also includes producers.
- This has been sorted on undiluted enterprise value, highlighting the upside potential of the Alaska Range Project and the Company.

- We have calculated the copper equivalent ("CuEq") grade using current metal prices and exchange rates - this does not take into account expected or actual metallurgical recoveries.
- We would expect uplift in value with increasing resources and exploration/drilling success - the Company has an EV at the lower end of its peers.

**Table 2: PolarX peers**

**Table 6: PolarX peers**

| Company | Project | EV Undiluted (A$m) | Equity Resource (Kt) | CuEq Grade (%) | Deposit/ Target Style | Project stage | Metals (all resources) |
|---|---|---|---|---|---|---|---|
| Terramin | Angas, Tala Hamza | $282.4 | 54,158 | 2.72% | Various | FS - Hamza C & M - Angas | Zn, Pb |
| Auralia Metals | Hera, Nymagee | $225.4 | 2,933 | 4.64% | Cobar | Hera - Production Nymagee - FS | Cu, Pb, Zn, Ag, Au |
| Red River Resources | Thalanga | $139.8 | 5,569 | 6.28% | VMS | Production | Cu, Pb, Zn, Ag, Au |
| Nzuri Copper | Kalongwe | $106.3 | 11,459 | 3.12% | Copperbelt | Feasibilty | Cu, Co |
| Peel Mining | Mallee Bull | $92.1 | 3,380 | 2.75% | Cobar | Drilling, Resource Expansion | Cu, Pb, Zn, Ag, Au |
| KGL Resources | Jervois | $75.7 | 30,500 | 1.50% | VMS | Resource Drilling | Cu, Pb, Zn, Ag |
| Heron Resources | Woodlawn | $52.4 | 18,100 | 4.09% | VMS | Development | Cu, Pb, Zn, Ag, Au |
| Venturex Resources | Sulphur Springs | $50.6 | 23,955 | 3.46% | VMS | Feasibility | Cu, Pb, Zn, Ag, Au |
| Orion Gold | PCM | $43.3 | 9,350 | 3.33% | VMS | Pre-Feasibility | Cu, Zn |
| Altona Mining | Little Eva | $41.4 | 290,000 | 0.60% | IOCG | DFS | Cu, Au |
| Talisman Mining | Springfield | $41.0 | 315 | 10.37% | VMS | Development | Cu, Au |
| Ironbark | Citronen | $36.1 | 70,800 | 2.64% | Sedex | Feasibility | Zn, Cu, Pb |
| Rex Minerals | Hillside | $32.4 | 337,800 | 0.59% | IOCG | Permitting | Cu, Au, Fe |
| Hot Chili | Productora | $29.2 | 363,600 | 0.33% | Porphyry | DFS | Cu, Au, Mo |
| KBL Mining | Mineral Hill | $28.0 | 17,455 | 2.77% | Epithermal | In Receivership | Cu, Pb, Zn, Ag, Au |
| PolarX | Alaska Range | $22.8 | 2,240 | 3.10% | Sedex, Skarn, Porphyry | Exploration, Drilling | Cu, Au |
| Metalicity | Admiral Bay | $19.1 | 170,000 | 3.17% | MVT | Scoping | Zn, Pb, Ag |
| PNX Metals | Hayes Creek | $10.6 | 4,076 | 4.64% | VMS | Feasibility | Cu, Pb, Zn, Ag, Au |
| Alta Zinc | Gorno | $9.6 | 3,300 | 3.04% | MVT | Development Studies | Pb, Zn, Ag |
| White Rock | Mt Carrington Red Mountain | $7.8 | 16,700 | 3.98% | MVT | Exploration | Cu, Pb, Zn, Ag, Au |
| Overland Resources | Yukon | $6.4 | 12,560 | 2.84% | Sedex | Feasibility | Zn, Pb |

Source: IRESS, Company Reports, IIR analysis

## CAPITAL STRUCTURE

- PolarX currently has 238,897,103 fully paid ordinary shares on issue, and 5,346,200 options with expiry dates ranging from June 30, 2018 to September 9, 2020.
- Of these, 4 million options are in the money with an exercise price of A$0.0715; other exercise prices range from A$0.12 to A$0.23.
- The largest shareholder is HSBC Custody Nominees at 13.42%, with Millrock Resources holding 10.74%.
- Directors and Management currently hold 8.98%; this increases to over 17% when related party holdings, including the Mitchell River Group, are included.
- There are 805 shareholders, with the top 20 holding 66.91%.

## RISKS

- **Exploration:** This is a key risk for any explorer, however the positive results of work to date, both historical and by PolarX outside of Zackly and Caribou Dome have partly mitigated this.

- **Resource:** This is a key risk at both Zackly and Caribou Dome, where the Company is looking at a potential operation - resources will need to be able to support, given the location, a relatively expensive operation.
- **Location and climate:** Any potential operation may be comparatively high cost, given the harsh winter climate and location.
- **Funding:** This is a perennial issue for junior explorers; and PolarX will probably need to go to the market in 2018.
- **Markets:** Although relatively buoyant at the moment, markets can turn on a dime and funding for juniors can dry up very quickly.

## BOARD AND MANAGEMENT

- **Mr Mark Bojanjac – Executive Chairman:** Mark is a Chartered Accountant with more than 25 years' direct experience in developing resource companies. He was a founding director of Gilt-Edged Mining Limited which discovered one of Australia's highest grade gold mines and managing director of an unlisted public company which successfully developed and financed a 2.4Moz gold resource in Mongolia. He was previously CEO of Adamus Resources Limited, where he oversaw its advancement from an early stage exploration project through definitive feasibility studies and managed the debt and equity financing to build its successful Ghanaian gold mine. He is currently also a Non-Executive Director of Geopacific Resources Limited and of Kula Gold Limited, which are developing a copper mine in Cambodia and a gold mine in PNG respectively.
- **Dr Frazer Tabeart – Managing Director:** Frazer is a geologist with 30 years international experience in exploration and project development, with a strong technical background in porphyry copper-gold systems in SE Asia, SW Pacific, the American Cordillera and central and northern Asia. After spending 16 years with WMC Resources and managing exploration portfolios in the Philippines, Mongolia and Africa, he left to join the Mitchell River Group. He has served on ASX-listed Company Boards at Executive level over the past 10 years. He is a Director and Principal at Mitchell River Group (see below), and current Managing Director of African Energy Resources Limited and Non-Executive Director at Arrow Minerals Limited.
- **Dr Jason Berton – Executive Director:** Jason is a geologist with more than 16 years' mining and exploration experience including working for Homestake, Barrick and BHP Billiton and SRK Consulting. Jason has also previously spent two years in private equity investment and four years as Managing Director of ASX-listed Estrella Resources. Jason holds two Degrees, a Bachelor of Economics and a Bachelor of Science (Hons) plus a PhD in Structural Geology, all from Macquarie University.
- **Mr Bob Boaz – Non-Executive Director:** Bob graduated with honours from McMaster University of Hamilton, Ontario with a Bachelor of Arts in Economics and has a Masters Degree in Economics from York University in Toronto. He is a highly respected financial and economic strategist in Canadian bond and equity markets with experience related to equity research, portfolio management, institutional sales and investment banking. Mr Boaz has more than 20 years' experience in the finance industry, most recently as Managing Director, Investment Banking with Raymond James Ltd and Vice-President, Head of Research and in-house portfolio strategist for Dundee Securities Corporation. He is currently President & CEO of Aura Silver Resources Inc.
- **Mr Ian Cunningham - CFO/Company Secretary:** Ian is a Chartered Accountant and Chartered Secretary with a Bachelor of Commerce degree and Bachelor of Laws degree from the University of Western Australia. He also holds a Graduate Diploma in Applied Corporate Governance from the Governance Institute of Australia and a Graduate Diploma of Applied Finance and Investment from the Securities Institute of Australia. Mr. Cunningham has 15 years' experience in the resources industry in executive and senior management roles, including with Adamus Resources Ltd, during which time Adamus developed the Nzema Gold Mine (Ghana) before merging with Endeavour Mining Corporation.
- **Mitchell River Group - Technical Services:** Mitchell River Group is a privately owned project generation and resource management and development group providing technical, commercial and management services to multiple ASX-listed companies. Current clients include ASX-listed African Energy Resources, Anova Metals, Exterra Resources and EVE Investments. MRG has been engaged to provide commercial and

technical management of its Alaskan projects, including data management, resource modelling and estimation, management of feasibility studies and management of US permitting.

- **Millrock Resources Inc. - Exploration and Logistic Services:** Millrock is a 10.8% shareholder of PolarX and provides on-ground exploration logistics under PolarX management at cost +10%. Based in Anchorage, Alaska, USA and TSX-V listed, Millrock has 20+ years Alaskan exploration experience as a focussed project generator. Millrock's presence provides immediate in country and on-ground experience combined with incentive as a major shareholder.

# BACKGROUND - ALASKA

## General

- Alaska, which is the largest state in the US ranks 48th in terms of population (~750,000) and last in terms of population density.
- The capital city is Juneau, with the largest city being Anchorage, with a population of ~300,000; Fairbanks (with a population of ~100,000) is Alaska's second largest city and 190km as the crow flies north of the Project.
- Alaska has a strong mining background and well-developed mining industry, and in 2016 was ranked 14th globally and 5th in the US in the Fraser Institute survey.
- This is supported by well-developed transport infrastructure including road and rail.
- Given the size of the state and population density there is no state wide power grid, however the populated areas from Fairbanks south to Anchorage are served by the interconnected "railbelt" grid, which services a large part of the Alaskan population.
- Natural gas supplies ~50% of Alaska's electricity generation, hydro ~25% and petroleum liquids and coal the majority of the rest - petroleum liquids generation is prevalent in regional communities which have no grid access.
- The nearest power station to the Alaska Range Project is a 30MW coal fired facility at Healy, some 60km north of Cantwell and located on the "railbelt" grid - this is also on the main George Parks highway and railroad, connecting Seward and Anchorage in the south to Fairbanks in the north.

## Mining

- Alaska has a long history of mining, with Russian explorers mining placer gold in the early 1800's, with both placer and hard rock mining continuing and growing after the US purchase of the territory in 1867.
- Large placer discoveries and operations included Nome (discovered in 1899, and with over 5Moz produced) and Fairbanks (discovered in 1902, and with over 6Moz produced).
- Closer to the Project is the Valdez Creek Mine, with alluvial gold first being discovered in 1903 - Valdez Creek was operated by Cambior from 1984 to 1995, producing some 459,162oz of gold at up to 75,000oz annually, making it North America's largest placer operation in 1992.
- Modern hard rock gold operations include Fort Knox (7Moz Au, operated by Kinross) and Pogo (3Moz Au, operated by Sumitomo) - these large mines are both within 200km of Alaska Range.
- Other major discoveries and operations include Teck's Red Dog zinc deposit, one of the largest zinc mines in the world and located above the Arctic Circle in NW Alaska, and the Pebble Cu-Au-Mo porphyry deposit, located 320km SW of Anchorage, which is currently being permitted.
- Pebble, which is owned by Northern Dynasty Minerals, contains some 107Moz Au, 81Blbs Cu, 5.6Blbs Mo and 514Moz of Ag in a resource of 10Bt at a 0.3% CuEq cut-off.
- Another significant project is the permitting stage Donlin Gold Project, 50:50 owned by Novagold Resources and Barrick Gold Corporation - with resources of over 39Moz and plans to produce over 1.1Mozpa over a 27 year mine life, this is one of the largest advanced gold projects globally.
- Alaska has a well-developed coal industry, with coal first being mined in the state in 1855, and has a large oil producing industry, being one of the top crude producing states in the US.

### Mining Tenements

- Alaska's mining and exploration permitting regime is transparent, however rigorous - permitting and approval of work programmes can involve up to twelve federal and state agencies, depending upon the complexity of the activities, however in the case of PolarX requires approvals from one state agency only.
- Claims are based on 160 acre (and sometimes 40 acre) parcels for hard rock "lode" mineralisation, and 20 acre placer claims.
- Claims are unpatented, meaning that ownership still resides with the federal or state governments (all of the Project claims are with the state authorities, and not the federal Bureau of Land Management "BLM", thus making permitting of any operation potentially simpler than otherwise).
- As long as the annual rental and expenditure requirements are kept up claims can be held in perpetuity - rentals range from US$140 per 160 acre claim for years 1 to 5, US$280 for years 6 to 10, and US$680 thereafter.
- The minimum expenditure (referred to as "annual labour" is US$100/claim.
- As for most jurisdictions globally, approval of mining operations can include a number of federal and state agencies, an environmental impact assessment ("EIA") and stakeholder engagement; in the case of PolarX, given that the Project is on state claims, only state approvals may be necessary - the only federal input would be from the Army Corps of Engineers should the Project impact wetlands.

## BACKGROUND - DEPOSIT STYLES - A BRIEF OVERVIEW

- The styles of mineralisation being explored for by PolarX are well understood, and are widespread globally, in addition they are major sources of the sought for metals.

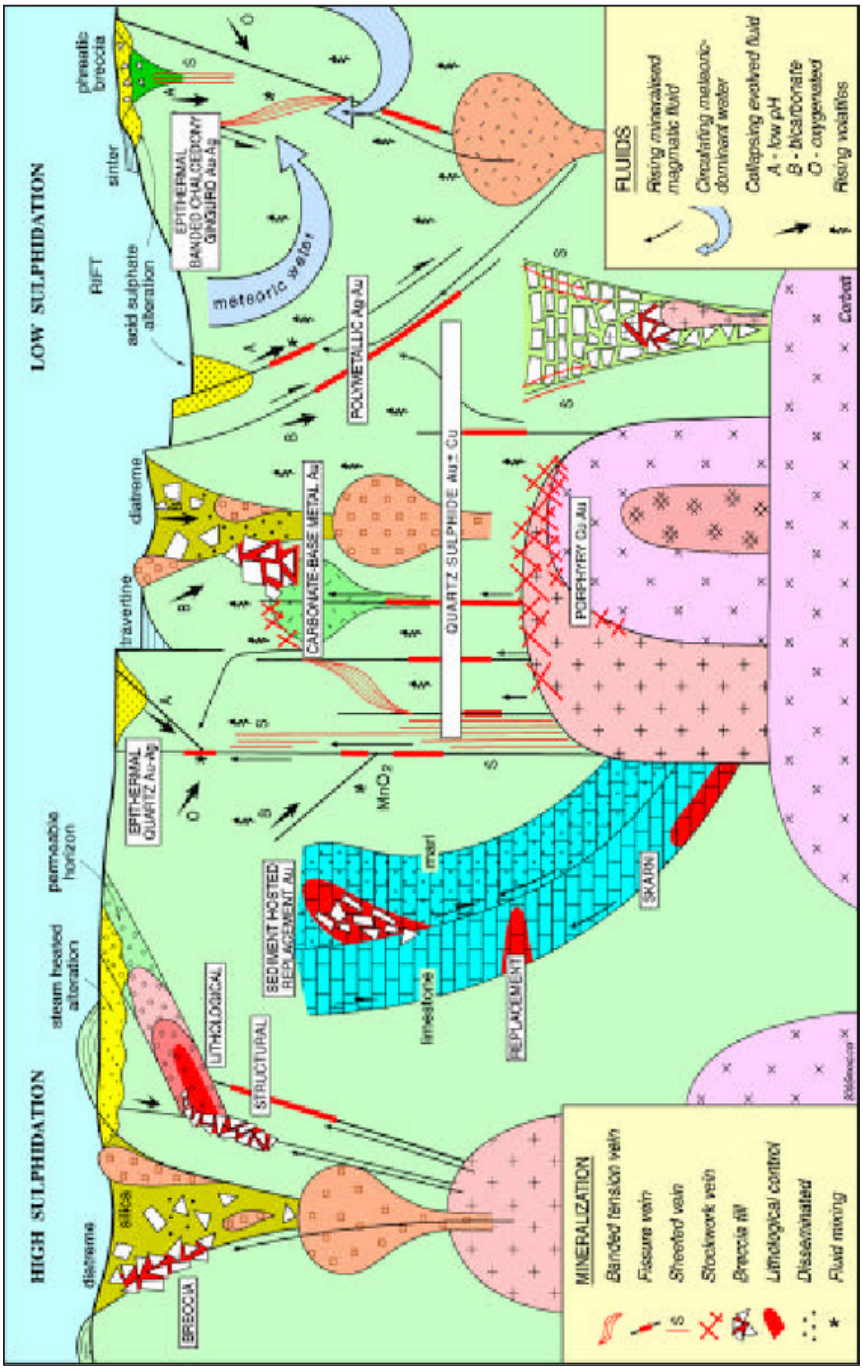
### Porphyry and Porphyry-Related Cu-Au-Mo

**Geology**

- Porphyry copper deposits are the main source of copper globally, and are found in numerous regions, including North, Central and South America, SE Asia and Oceania and Mongolia amongst others.
- They form at convergent plate margins - these include island arc settings (e.g. the Philippines, Indonesia) and continental margins (e.g. the current South American western continental margin and the historical North American plate margin in Alaska, Figure 4).
- Copper production from the world's largest producer, Chile, is largely from porphyry copper deposits, as is that from Peru and the US, both major global copper producers.
- Molybdenum and gold are major by-products, again with Chile, the US and Peru being major producers.
- Although the primary ore is generally low grade, with a mean copper grade of ~0.5%, and gold grades ranging from 0.05g/t to ~1g/t, this is more than made up by size, with many containing 100's of millions to billions of tonnes of mineralisation.
- The key copper minerals are chalcopyrite and bornite, with mineralisation generally being disseminated and in stockwork vein zones - in the continental margin porphyries (such as those in South America) mineralisation commonly forms a shell to a barren core or a cupola over the top of the high-level, sub-volcanic porphyry intrusions.
- Notable examples include Pebble (Alaska, 10Bt), Chuquicamata (Chile) and Grasberg (Irian Jaya).
- Magmatic arc porphyry deposits are related to a number of other mineralisation styles, including gold-copper skarns, epithermal gold and mesothermal base metal carbonate vein gold - the relationship between these mineralisation styles is shown conceptually in Figure 16.
- Skarns, with an example being Zackly, are formed by the alteration of reactive rocks, such as limestone and marl with metal and volatile rich fluids emanating from an intrusive (Figure 16) - common metals include copper, gold, tungsten tin, lead, zinc and iron, with the metal types dependent on those enriched in the source intrusive.

- Skarns commonly exhibit metal zonation and numerous mineralising events - these include prograde and retrograde skarns, with the former due to alteration by the original hot fluids, and the latter due to alteration by cooling fluids during the waning of the hydrothermal system.
- As discussed earlier, the Zackly skarn is interpreted as being at least partly related to a buried porphyry intrusive, with the possibility that this is overprinting an earlier skarn related to the older, outcropping diorite.
- Major global skarn deposits include Ertsberg in Irian Jaya, paragenetically related to the nearby Grasberg porphyry copper deposit, and Ok Tedi, again with skarn mineralisation related to the adjacent porphyry mineralisation - skarn also forms within the porphyritic intrusives (endoskarn).
- These major deposits show a clear relationship between skarns and porphyries - another example includes the Cadia complex in New South Wales, Australia.

**Figure 16: Conceptual model - magmatic arc related mineralisation styles**




Source: Corbett and Leach, various publications

## Exploration

- Porphyry copper deposits have distinctive geochemical and geophysical signatures, which are exhibited by the targets with the Alaska Range Project.

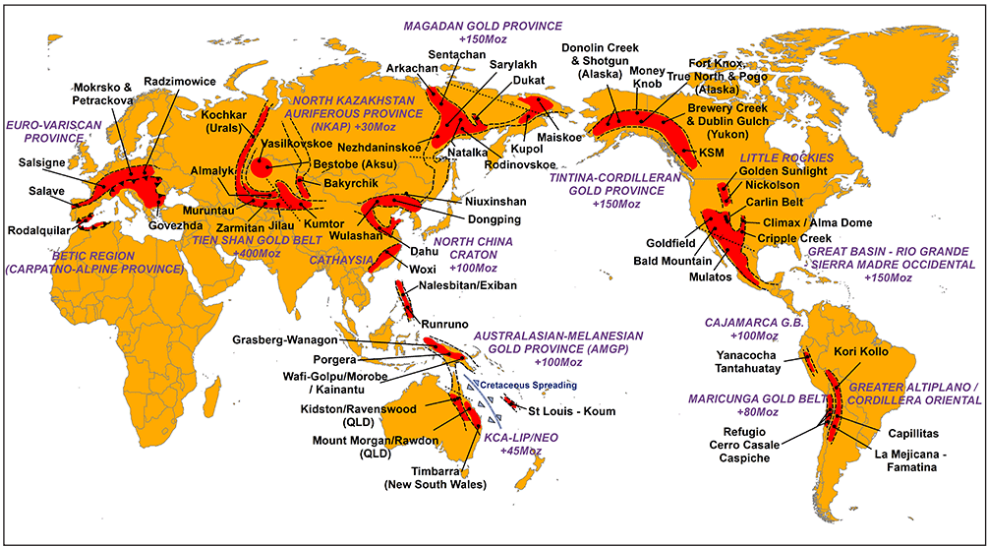
- Zoned geochemical signatures include a core of copper +- gold+- molybdenum, with this grading out to possibly lead or zinc on the peripheries.
- Other pathfinder elements commonly include tin, bismuth arsenic and antimony, with these also showing zonation.
- The two major geophysical tools are magnetics and IP (chargeability) - they are often (but not always) characterized by a bulls eye magnetic anomaly, due to the presence of a core of magnetite-rich potassic alteration, surrounded by an annular low, due to the magnetite destructive propylitic and phyllic zones - this will particularly show up where the porphyry has intruded into magnetic rocks, such as basalts and andesites.
- One of the features of particularly the phyllic alteration zone is large quantities disseminated pyrite, which provides a perfect target for IP chargeability surveying.
- Geologically, porphyries are associated with distinctive alteration styles in the wallrocks, which can be recognised in outcrop.
- In skarns metal associations include proximal base metal, grading through precious metal to distal Pb-Zn-Ag veining - the metals present will depend upon the skarn style.
- Typical geophysical tools include magnetics (skarns, due to the presence of magnetite, can be highly magnetic) and EM, due to the common presence of massive sulphides.

## Intrusion Related Gold Systems

### Geology

- IRGS deposits span a gamut of mineralisation styles, however are all associated with post orogenic intrusives, largely situated along the continental side of a convergent plate margin, as is seen in the Tintina Belt in Alaska and British Columbia (Figures 17 and 18).
- The mineralisation style was first postulated in 1999, with steady advances in the understanding subsequent to this.

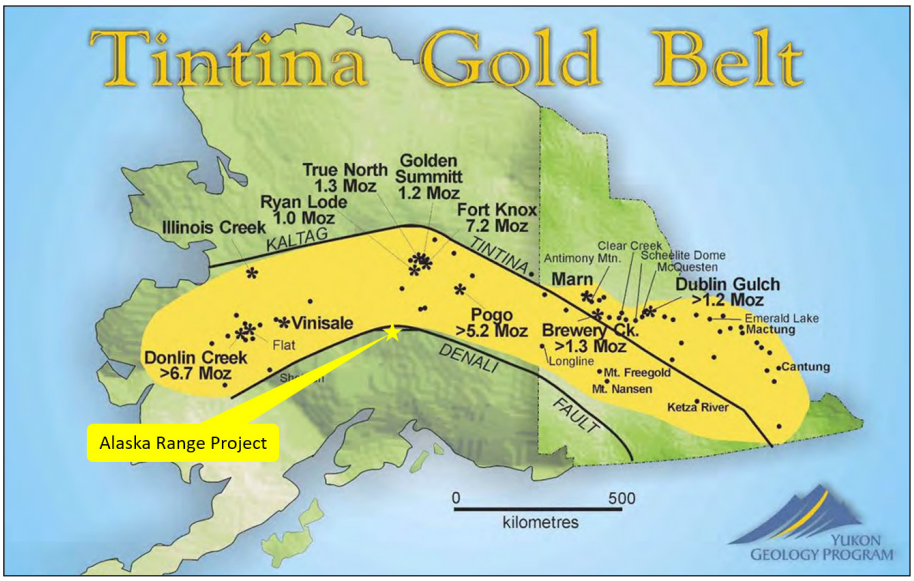
**Figure 17: Global distribution of IRGS belts**




Source: Adapted Lang and Baker (2001)

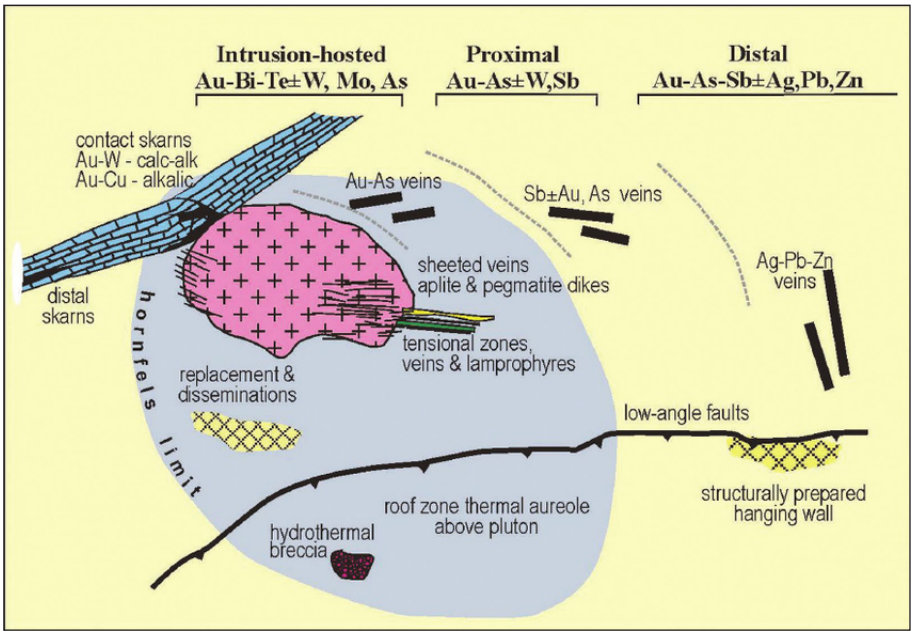
- Figure 19 shows the styles of mineralisation within the IGRS grouping - mineralisation forms over a wide depth range, from <1km to >8km, with one of the most common form of mineralisation being low sulphide sheeted veins within the host intrusion, with the intrusive event and mineralisation largely being contemporaneous.
- These styles are also associated with other broad mineralisation groupings, including orogenic gold, with which IRGS systems are often confused.
- Differentiating features are tectonic setting (post orogenic vs orogenic), location of mineralisation within and around the cupola of the host intrusions and geochemical signatures and zonation; in addition, IRGS mineralisation is generally related to smaller intrusive bodies including stocks - they are not related to batholiths as is commonly the case with orogenic gold deposits.
- Geochemically the deposits lack significant copper, and also there is concentric mineral zoning due to a sharp geothermal gradient around the causative intrusion.

**Figure 18: Tintina Gold Belt and deposits**




Source: Adapted from Anchor Resources presentation

**Figure 19: IRGS deposit styles**




Source: Adapted from Hart (2002)

### Exploration

- Key exploration tools, in addition to geological mapping of the well developed alteration zones, include geochemistry and sometimes geophysics.
- Geochemical signatures are shown in Figure 19 with these similar to the Au-As-Bi-Sb-W-Zn anomalism seen at Moonwalk.
- The key geophysical tool, in areas of cover and buried intrusives, includes magnetics to recognise various intrusive phases - electrical methods are generally inconclusive given the lack of sulphides.

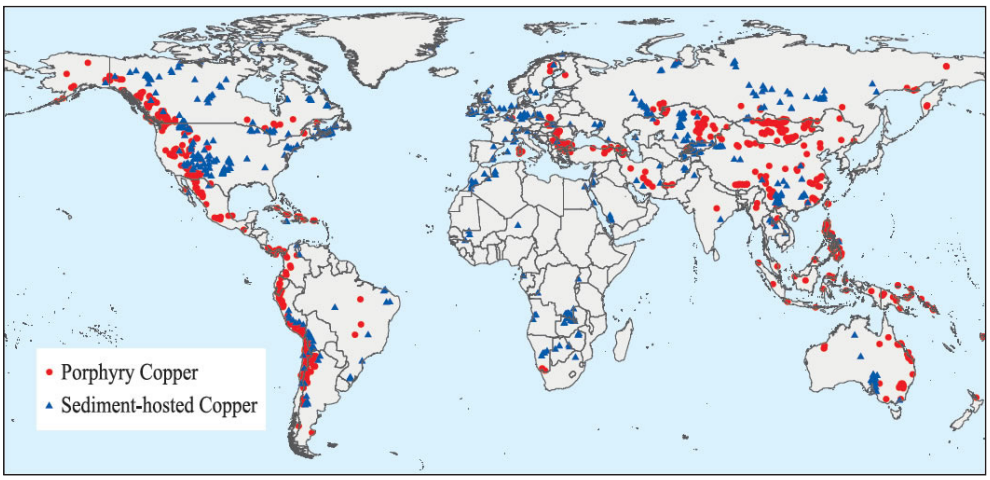
## Sediment Hosted Copper

### Geology

- Like IRGS systems, sediment hosted copper mineralisation includes a broad gamut of mineralisation styles.
- However key discriminants include the stratiform or stratabound nature of mineralisation, and as the name suggests, an association with sediments.

- Major examples include the Kupferscheifer in Western and Central Europe and the major deposits of the Central African Copperbelt, historically the world's largest producer of copper - Figure 20 shows the global distribution of both sediment hosted and porphyry copper deposits.

**Figure 20: Global copper deposits**




Source: Geology.com

- The majority of these formed during diagenesis, with oxidised copper bearing basinal brines being reduced by the reaction with reduced (pyritic, carbonaceous or calcareous) sediments to form the copper minerals, including primary chalcocite, bornite and chalcopyrite.
- Alaskan examples, which are also termed "Kennecott style" or "basalt copper" deposits include Kennecott, which, as mentioned previously produced ~4Mt of ore at 13% Cu.
- However, also as mentioned earlier, it has been suggested that mineralisation at Kennecott is reasonably late, with structurally controlled fluids reacting with the limestone to form the mineralisation, which includes structural and solution breccias.
- Other North American examples include the Keeneenaw and Porcupine districts of Michigan.
- One interpretation of the mineralisation at Caribou Dome, as discussed earlier, is that the mineralisation is syngenetic, being formed by the direct precipitation of copper sulphides in a euxinic environment, with the source of the copper being from the basalts of the Nikolai Greenstone.

**Exploration**

- Given the stratabound nature of mineralisation one of the main exploration tools is geology, and mapping out the target stratigraphy.
- This has been demonstrated at Caribou Dome/Senator, as has geophysics (IP) and geochemistry.
- Secondary and trace element geochemistry depends on the deposit, source rocks and fluid chemistry, but can include cobalt (Central African Copperbelt amongst others), precious metals, vanadium and molybdenum.

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