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Geological Overview of the Vardenis porphyry & epithermal mineralisation, Armenia.
Prepared for Hayasa Metals Inc.

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Introduction

Situated at the northwestern end of an Oligocene to Miocene porphyry copper belt that extends from Pakistan to Armenia, the Vardenis property encompasses a significant area of hydrothermal alteration measuring >7km x >5km, hosted in Eocene to Miocene volcanics (Doyle 2023).

The land package held by Hayasa Minerals is extensive (figure 1), of which the northern half is apparently of greatest interest hosting five recognised prospect areas with potential for additional targets concealed under recent basaltic andesite flows and tuffs. The five recognised prospect areas were defined through soil sampling by previous exploration programs (including Dundee Precious Metals Ltd, 2014-2017). The Dundee exploration program identified both epithermal and porphyry potential within the project area, the former at higher altitudes which they drill tested with limited success and the latter at somewhat lower altitudes. Porphyries exposed at lower altitudes suggests that porphyries are the likely source for the epithermal mineralisation. Allot depends on age relationships between the different mineralisation styles, but typically within a single district the epithermal mineralisation postdates porphyry development that is to say that when a district goes epithermal (DGE) the porphyries typically cease to develop and the remaining portion of the intrusion related hydrothermal mineralisation rises to higher levels and form vein style systems that are often associated with phreatic breccias bodies. Extensive tectonic dislocation during district formation is more likely to develop epithermal dominant systems associated with high level domal intrusions, while tectonic stability during the critical phases of mineralisation development typically results in porphyry dominant districts. Most mineral districts include elements of both mineralisation styles, in which case the exploration objective at Vardenis is to determine where the economic mineralisation potential lies, is it the porphyry or the epithermal styles of mineralisation. The Dundee exploration program clearly determined that the epithermal mineralisation styles represented greatest potential and drilled the obvious Artsiv vein target with limited success prior to determining that the jurisdiction was no longer a high priority in their target portfolio.

In 2024 Hayasa conversely focused on the porphyry potential and scout drilled what were considered the two most viable porphyry targets the findings which are discussed in these notes. The objective of this brief (5 day) field review of the Vardenis project and the Hayasa drill holes was to determine whether the targets which the best potential have been drilled and if so, did the scout holes drilled in 2024 provide an adequate test of the Rasmik (also labelled Razmik SE on some plans) and Rasmik NW zones. These notes focus in on the core of the Vardenis lease block (figure 1), with greater attention given to the porphyry components.

Appendices I-V summarise the geochemical, geophysical and mineralogical data sets and Appendix VI focusses on the Soviet Target area.

Project data and reporting

Given the brief field component of the site visit, these notes draw heavily on the technical geological report for the project (Doyle 2023) and notes by Luis Arteaga (2023-2024).

The majority of the projects geochemical data was generated by Dundee Precious Metals Ltd. (2014-2017) including 3440 soil samples on variable 200m, 100m and 50m grid spacings 1658 rock samples and 24 stream sediment samples in addition to 1245 drill core samples from 7 shallow drill holes. Scanned images of the Soviet plans and logs which relate principally to the Soviet Target plans depict 4 short adits, 16 drill holes, 67 pits and hundreds of metres of trenching with most of the Soviet work focused on what this study interprets to be the margin of the intense advanced argillic altered lithocap. Analytical data for the soviet work is incomplete, limited to assays for 5 of the drill holes,

Hayasa has since added 148 drill core samples from 2 drill holes and analyses for 85 rock samples. Dundee also conducted SPECTRAL studies on rock samples to which Fremont added an additional 722 sample records the results from which are illustrated in the Artega report (2024), included as a figure 6 and the processed data is presented as Appendix V.

Hayasa also conducted ground magnetic and IP surveys, providing levelled data sets against which the geochemical and geological data can be referenced. (Appendix IV).

Geological mapping (see figures 2-5) includes Soviet data (1960's), the Dundee interpretative plan (2017) and subsequent lithology and alteration mapping by Artega (2023-2024). The scanned Soviet pans supplied include several useful plans showing pit, adit and drill hole locations and drill logs for some of the holes with partial Cu & Mo assays.

Project Geology

The regional setting of the Vardeins project is described in some detail in the Doyle (2023) report. In summary, Vardenis is situated within the South Armenian tectonic block which lies to the south of the Tethyan suture where serpentinites (i.e. at Urasar) mark the closure of the Tethys Sea and the suture between the Eurasian and the Arabian Plates.

The closure of the Tethys Sea entailed the subduction of >2700km of oceanic crust, but at a relatively slow rate, both to the north under the Eurasian Platform and to the south under a remnant of the Gondwana Plate. The tectonic map shown illustrated as figure 12 in the Doyle (2023) report is probably incorrect, tomography having demonstrated that the subduction zone to the south dips to the SW (Meldrum, 2015) across what is now Iran. Magmatic activity during this period was minimal due to the low subduction rates (less than 4 cm/year) on both sides of the Tethys Sea. Magmatism in the region and southwards into Iran only began with the onset of collisional tectonics in the early Tertiary, with the fold belt and magmatic activity to the south divided into two volcanic arcs wrapping around several Tethys micro plates including the large Lut Block. Within the project area marine condition persisted through to the Mid Eocene followed by volcanism that is estimated to have initiated at approximately 47.8Ma, as noted by Doyle (2023).

Very recent volcanics cover much of the area, beneath which creek outcrops expose extensive structural dislocation with intense sericite – clay altered structures that may have related to the initial phase of collisional tectonics which resulted in a) folding of the Cretaceous and older

basement metasediments (88-70Ma) and b) at a much late stage the development of productive magmas the resulted in the Vardenis deposit cluster (approx.. 41Ma). Deep seated compression combined with shallow crustal extension continues through to the present evidenced by very young post mineral volcanism that characterises the core of the Vardenis property includes volcanic necks and thick valley filling basaltic andesite lava flows and andesitic pyroclastics. Note that the large centrally located ground magnetic analytical signal high is perhaps a reflection of the magnetic ash relating to the youngest volcanic events and less likely to be a true indicator of porphyry deposit related or basement magnetic effects (see figure 2). This probability is readily evident in the 1 & 2 Vertical Derivative plots (see Appendix IV).

The deposit cluster at Vardenis which is comprised of a series of both epithermal (higher altitude) and porphyry (lower altitude) systems trending NW-SE (i.e., arc normal orientated) hosted by early tertiary volcanics and sediments and underlying Cretaceous aged basement.

The NW trending fault (referred to in this study as the Soviet Fault) is a key feature of the Soviet geological plan (1961) subdividing the deposit cluster into exposed porphyry related centres to the SW investigated by Hayasa in 2024, and epithermal mineralisation / lithocaps to the NE including the Artsiv East target. The assumption that could be drawn is that the Soviet Fault is perhaps a NE dipping normal fault structure on the southern margin of a down thrown graben structure the northern margin to which could correspond to the NW trending stream course to the north of the Artsiv. (i.e., that the Soviet and Artsiv targets lie within a down thrown preserved portion of the district).

The current study which incorporates the Soviet data combined with interpretative logs for the Hayasa drill holes and rock samples collected along field traverses, in addition to the Dundee, Fremont and Hayasa data sets notes that acid alteration to the south of the Soviet Fault is characterised widespread white mica and montmorillonite in the ASD (analytical spectral device) data with pyrophyllite along structures (i.e., deep), whereas along the Soviet Fault and to the NE alunite and silica are the dominant minerals (i.e., higher level lithocap remnant). The NW trending 'Soviet Fault' has been transposed onto the plans provided in Appendix II, III & IV for reference, but it should be noted that other major NW and NE trending structures (or structural zones) which are apparent in the data remain to be defined through field mapping. Clearly, structure is an important geological control and a key feature that is largely absent from the post-Soviet geological plans viewed.

The Soviet Target lithocap between the Razmik porphyry and Artsiv epithermal belts has been largely ignored since the early 1960's following extensive trenching, adit exploration and drilling by the Soviets. With hindsight given the findings of the Dundee and Hayasa drilling, this study ranks the Soviet target as the highest ranked target in the deposit cluster. The Soviet analytical data includes the strongest and longest intercepts of both copper and molybdenum encountered to date at Vardenis which is a clear plus, even though the results we have in hand only relate to the western argillised periphery to the silica dominant acid sulphate lithocap. Based on the more recent surface sampling the Soviet analyses apparently low ball the actual values.

Lithologies

The summarised historical and more recent data notes that andesitic to basaltic andesitic volcanics and metasediments dominate as the host rocks for the mineralisation underlying post mineral volcanics. The logging data highlight dioritic dykes and sills to the south of the Soviet

Fault, a feature which concurs with the Soviet mapping and the ASD data combined with the interpretative drill logs. This data further identifies the Razmik target as a zone with weak potassic alteration over printing propylitic, and the Razmik NW target as a zone where acid alteration is more intense and widespread, while the Soviet Target is identified as a well preserved lithocap setting with silica alunite, jarosite and dickite as key identifying minerals indicative of a relatively high level of exposure. Advanced argillic alteration forms to depths of less than 2km through the interaction between oxygenated ground water and rising sulphur rich hydrothermal fluids and gasses. During deposit cluster formation significant uplift and erosion occurs (up to 4km) resulting in acid alteration overprint of earlier formed porphyry systems. This is assumed to be the case at Vardenis.

Discriminating intrusive lithologies from volcanics is a difficult task due to intense rock alteration, however the fine grained porphyritic character of most samples viewed suggest that volcanic predominate across the project area and the presence of common quartz eyes in the altered rocks to the north of the Soviet Fault suggest that quartz andesites are preserved to the north of the fault and that andesites / basaltic andesites are dominant to the SW. The large coherent body of porphyritic microdiorite depicted on the southern side of the Soviet Fault is questioned on textural detail and it is notable that the Hayasa drill holes into what is mapped as fine grained diorite include what are interpreted to be a significant volcanic component with minor sedimentary intervals interspersed with dykes and sills.

At the northern limit of the Soviet Target (higher altitude) phreatic breccias are noted and several samples of hydrothermal breccias are also recorded. To the north at Artsiv, Dundee mapping highlights dacitic porphyries that probably equate to high level domes.

Alteration

Rock alteration facies mapped, noted in the rock sample ASD data and in the interpretative (QL) drill hole and surface sample logs denote widespread white mica (sericite) and montmorillonite across the project area, chlorite and carbonate as key features of the Razmik Target to the south of the Soviet Fault and topaz, jarosite, alunite and silica indicative of a higher level of exposure in a strongly acidic lithocap environment on the northern side of the fault.

If the typical sequence of mineral districts development is assumed it appears probable that the Razmik target is an ‘early’ component of the district followed by Razmik NW and finally the Soviet lithocap and Artsiv epithermal alteration formed over an extended period of uplift and erosion. Structurally controlled high temperature acid alteration over printing potassic / propylitic alteration at Razmik certainly suggests a significant component of uplift and erosion, and there is a distinct possibility that acid alteration over printed on the ‘Razmik porphyry’ targets, relates in part to repeated vertical displacement across the Soviet Fault Zone through to a late stage in the district development.

Mineralisation

The mineralisation at Vardenis is structurally controlled and intrusion driven. The regional setting of the deposit cluster is recognised to be a tectonic collisional zone, but that at shallow crustal levels the structural setting was extensional – perhaps relating to a NW-SE trending graben crosscut by NE-SW orientated structures that are largely concealed by recent volcanics. Previous workers have recognised both porphyry Cu-Mo and high to intermediate sulphidation epithermal mineralisation styles which are adequately documented by Doyle (2023) and Artega (2024).

Drilling by Dundee along the Artsiv epithermal trend intersected several short intervals notably 2m @ 9.62 g/t Au, 263ppm Ag & 4,472ppm As, the strong arsenic indicative of a high sulphidation epithermal structure. The Soviet drilling (Soviet target) intercepts include maximum intervals of 2.9m @ 0.77% & 2.0m 0.55% Cu and molybdenum assays of up to 1000ppm over 1m intervals. However, the Soviet drilling sample data that has been located do not relate to the principal Soviet target area where rock values range up to 11,000ppm Mo and 26,100ppm Cu. The rock sample and soil results for this area question the validity of the Soviet assays.

The calculated maximum and mean values for subsets of the soil and rock analyses (Appendices II &III) identify the Razmik target as the better porphyry Cu-Mo target (in soil values), while the rock and soil results combined focus attention on the Soviet target as a combined porphyry / epithermal system, Artsiv West as the better high sulphidation target and Artsiv East as a promising intermediate sulphidation target and the probable fluid source for the Artsiv West mineralisation. Other peripheral targets at Vardeins include the Hasbi and Arthuk targets to the east and the Getikvahq and Snake targets to the south, none of which are focal targets in this compilation.

Porphyry targets

The Artega (2024) report highlighted the Razmik (also labelled Razmik SE on some plans) and Razmik NW areas as the better porphyry targets based primarily on the 'in soil' copper and molybdenum results as well as the recognition of 'B' and 'D' family porphyry veining styles in outcrop. The subsequent drilling intersected weakly developed quartz-sulphide (Mo-Cu) veining and sulphide veins with serictised halos and potassic alteration in both areas confirming the Artega observations. The tenor of the mineralisation in the drill holes and intensity of the veining are not indicative of proximity to economic porphyry mineralisation. In addition, anhydrite veining is noted at depth at Razmik NW (VARD-01) and lower temperature gypsum and calcite occurs as fracture fillings over the final 150m of the Razmik SE drill hole (VARD-02). The Razmik SE drill hole terminated in propylitised basaltic volcanics. At Razmik NW a significant component of late polymetallic sulphide veining is also evident (sphalerite – galena) which is inferred to be an over print veining style related to the margin to the Soviet target.

The crosscutting vein styles display a sequence of early quartz veining, followed by quartz-sulphide veining, pyrite dominant sulphide veins, and finally late-stage fracture filling gypsum, anhydrite and carbonate. Pink quartz veining is noted at Razmik NW – a vein style that often results from the replacement of early actinolite veins by silica, and trace magnetite veining was noted at Razmik SE, vein styles that typically relate to deeper seated, early-stage porphyries.

The inference from the holes drilled is that both holes drilled out of the mineralised zones at depth (i.e. both holes drilled away from the better mineralised zones) indicating perhaps that the Soviet Fault Zone (assumed to dip to the NE) marked by strong iron oxides in outcrop (at Razmik) could be the source for the porphyry mineralisation. The suggestion that additional porphyry potential may lie under the recent volcanic flows between these two targets is questioned by the IP data, data that identified strong combined resistivity and chargeability readings to depth at Razmik NW and weaker resistivity and low chargeability at Razmik. The drilling broadly confirmed the IP Results.

Soviet – lithocap target

Soil and rock data across the Soviet target combined with field observations defines a sizable anomaly measuring approximately 1,000m x 600m trending NW-SE coincident with the central

ridge line (Appendix VI) across the Soviet target. The available plans indicate that the Soviet exploration focussed on the zone of intense sericite-clay alteration flanking the western side of the silica rich lithocap that this study identifies as the 'Soviet Target'. In effect the Soviet program focussed on the argillic halo to the intrusive system which is assumed to underly the silica lithocap. The broad intervals of anomalous Cu and Mo intersected in the Soviet holes closest to the silica lithocap supports the contention that better grades are likely to occur beneath the lithocap to the north-east.

Only the northern most of the IP lines are truly relevant to the Soviet target, and the E-W orientation of the survey lines provides an imperfect representation of the data across what is apparently a NW-SE trending structural control. In hindsight NE-SW IP line orientations would have been optimal for the Vardenis project area. In section IP line P10 depicts a NE dipping resistivity / chargeability boundary which suggests that the causative body dips in this direction however the 3D IP plans depict a subvertical chargeability feature under the silica lithocap flanked by stronger resistivity features.

The majority of the rock samples from the Soviet Target area (RGEOL_QL see Appendix I) are affected by intense silica-alunite-clay alteration overprinting former sericite-illite, some have clear evidence of pyrophyllite as well. Most of the samples have relict porphyritic textures, some with small quartz eyes which are inferred to be quartz-andesitic volcanics. Only two of the samples are interpreted to be intrusives and rock samples from the northern limit of the target area includes phreatic breccias (altered rock flour matrix) and hydrothermal breccia (iron oxide-silica matrix). Phreatic breccias typically relate to high level, often gold endowed porphyry systems that were emplaced at less than 1.5km depth. Three sulphide samples from an adit along the Soviet Fault Zone host disseminated chalcopyrite-pyrite with minor chalcocite, one of which is logged as a melanocratic fine grained feldspar porphyry with relict chlorite and leucoxene, may be intrusive.

The Soviet Target rock samples produced many of the strongest Mo-Cu Ag and gold results recorded to date at Vardenis. The majority of the rock samples from the area grade >10ppm Mo ranging up to 1100ppm, with samples grading up to 1.3g/t Au and 582ppm Ag and 2.6% Cu. Though some of these samples are undoubtedly float or sub-crop samples it is very likely that the samples are locally sourced.

DISCUSSION

The current review of the Vardenis data combined with a short field visit broadly agrees with many of the pervious consultant's comments but the conclusions regarding the perceived target ranking differs. While it is clear, in terms of 'outcrop' geology that the alteration and mineralisation at Razmik and Razmik NW is porphyry related, weak potassic alteration intensities in the holes drilled combined with weakly developed disseminated sulphides and a paucity of quartz-magnetite veining dampens enthusiasm for these targets. Conversely this study considers that the 'Soviet Target' (sometimes referred to as the Molybdenum anomaly) which has been largely ignored by previous workers is potentially the most significant intrusion driven target, the available results from which fully supports exploration drilling.

In addition, though not a focal issue for this study or earlier studies by Hayasa, it is recommended that the mineralisation potential along the Soviet Fault be investigated in greater detail and that the Artsiv East and Archuk (also labelled Arthuk on some plans) targets be mapped in detail – both areas exhibiting potential for epithermal mineralisation which remain to be evaluated and drilled.

In broad geological terms, this investigation interprets a NW-SE trending graben as the principal structural control at Vardenis (figure , where deeper early stage and weakly mineralised porphyry Cu-Mo mineralisation outcrops on the SW flank of the graben and the Soviet and Artsiv lithocaps with and epithermal mineralisation overlying concealed intrusion driven mineralisation lies to the NE within and along the graben bounding faults. Based on this interpretation the Soviet (molybdenum) Target is considered the area with the greatest potential for a discovery, and it is recommended that Hayasa consider drilling a series of inclined holes across the Soviet Target ridge line (figure 7). Accounting for the apparent NE dip to the resistivity and chargeability features along the IP line P10 it is suggested that the initial holes be collared on the NE side of the target and inclined to the SW. The Soviet holes that we have results for indicate that mineralisation adjacent to the Soviet Target extends through to at least 250m vertical and the IP chargeability feature coincident with the silica lithocap is projected to at least -300m – both aspects indicating that that planning holes to at least 500m depth is justified. Based on results, drilling additional exploratory holes from the SW inclined to the east, vertical holes along the ridge line and at least one drill holes collared within the outcropping phreatic breccia at the northern limit of exposure angled to the south to may then be considered (figure 8).