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Geological Overview of the Urasar Cu-polymetallic mineralisation, Armenia.

Prepared for Hayasa Metals Inc.

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April 2025

Introduction

A linear belt of high-grade copper sulphide mineralisation occurring along the Yellow River fault zone in the Urasar District in Northern Armenia was mined by the French, the Soviets and others from the early 1900's onwards. The property is divided into two sections, the E-W trending Yellow River targets to the north-west and three targets to the south-east termed the Black River prospects.

The distribution of the massive sulphide lenses at Yellow River clearly reflects strong structural controls, is spatially associated with early Tertiary aged mafic to felsic intrusions and serpentinite and hosted by strongly altered folded and faulted Cretaceous aged meta-volcanic and meta-sedimentary stratigraphy.

Historical trenches, pits and adits, mostly relating to the Soviet period, extend along an WNW-ESE trending strike length of approximately 14km. Stronger copper mineralisation occurs to the west in the Chibukhlu / Yellow River area (Silica West, Oxide Basin, Copper Creek and Golden Vein prospects), and better grading gold mineralisation occurs to the east within the Black River prospects (Hanqakutak, Black River and Brick House).

The lateral extent of the mineralised zone, the geological features of the individual targets and metallogenic patterns indicate that the Urasar prospects probably correspond to a 'Mineral District' style deposit cluster. This model implies that the individual targets are likely to relate to a 'single deep seated' productive magmatic source which through fractionation over an extended period (typically 1-3 million years) produced successively more silicic and precious metal rich differentiates the development locations of which typically migrate in a linear trend. For instance, at Urasar more mafic – copper rich differentiates are prominent to the west and younger silicic (dacitic) intrusions dominate are prominent to the east where fetter grading gold mineralisation occurs.

The nature of the mineralisation and the mineralisation controls at Urasar have been assigned to a variety of geological interpretations and mineralisation styles. The early Russian geological reports emphasise stratigraphic controls and suggest an association between the copper mineralisation and steeply dipping faults. The Soviet reports commonly refer to secondary quartzites. More recent interpretations (aka. Luis Artega and L.J.Karr) have inferred a shallowly dipping thrust fault setting for the mineralisation having invoked published regional scale tectonic models.

In 2024 Hayasa Metals drilled a series of diamond drill holes in the Oxide Basin, Copper Creek, Golden Vein and Black River targets with disappointing results. None of the holes drilled intersected the high-grade Cu mineralisation evident in the historical data, in outcrop exposures and mine dump samples. A key objective of this study has been to verify whether the 2024 drill holes a) adequately tested the Urasar targets and b) if not why.

The initial conclusion is that the holes drilled did not test the obvious high-grade mineralisation at either the Yellow or Black River targets. And the reason why includes a) the program was guided initially by incorrectly located IP geophysical data, b) the drill hole planning did not include a compilation of the Soviet adit and drill hole data, c) questionable assumptions regarding geological controls and d) regulations that hindered the drill program design (i.e., not drilling in close proximity to water courses).

Project data base

The legacy data sets include good quality Soviet data provided as geological plans, adit geological and Cu assay data and fragmented drill hole data. The adit plans highlight where the better grading (>1.0% grading up to +5% Cu) massive sulphide mineralisation occurs in the Golden Vein area and the distribution of the adits at Copper Creek provide a good indication of where the mineralisation occurs in these areas. It is significant that the adit data highlights high grade copper mineralisation over a +100m vertical interval focussed along the contact of the serpentinite dykes against the metavolcanics. Analytical and geological log data located for 14 of the Soviet drill holes at Yellow River is now available in the company's data set. The key message to be gained from the Soviet drill hole and adit data sets is that the high (multi percent) grade copper mineralisation extends over large areas and perhaps over a significant depth interval but that it is not continuous. However, drilling in the right areas will greatly enhance the probability of a drill programs success.

In the Black River Zone high sulphidation style mineralisation crosscut by younger low and intermediate sulphidation epithermal veining is spatially associated with flow banded dacite porphyry dykes. The Russian plans and sections depict the adits and drill hole locations at Hanqakutak (not included within the Urasar Lease area) and Black River superimposed on geological maps, but the retrieved data lacks any references to the Cu, Ag, Au grades. The Soviet reporting suggests that the principal objective of the Black River and Hanqakutak exploration was for sulphur. The Soviet plans and sections indicate that they drilled 22 holes at Black River, 13 holes at Hanqakutak and at as many as 17 holes into the Yellow River targets. Google imagery also depicts extensive trenching by the Soviets throughout the Urasar area for which the scanned data files include analytical data but without any co-ordinate reference.

Hayasa Metals conducted a large soil grid (100x200m) across the lease block area totalling 1571 samples (appendix I) including best Au Ag Cu Mo grades of 633ppm, 5.1ppm, 496ppm and 28ppm respectively. In addition, Hayasa has compiled a rock database of 297 samples (Appendix II) including channel outcrop rock chip, subcrop, float and mine dump samples a data set that includes better values of 12.5g/t Au, 99.1ppm Ag and 15.2% Cu. In addition, Hayasa Metals conducted a project wide ground magnetic survey and 3 IP lines. Limited reporting and mapping by Hayasa consultants was also provided.

Geological Setting of the Mineralisation

There are both similarities and significant differences between the Yellow and Black River deposits. In both areas the mineralisation is intrusion driven, relates to subvertical fault

structures and, from a rock alteration perspective, the deposits in both area exhibit evidence of weak potassic and strong propylitic alteration, strong sericitization and intense clay / acid sulphate alteration. The key differences between the two areas are perhaps the level or exposure and the nature of the intrusive facies where mafic intrusions dominate at Yellow River and silicic intrusions dominate in the Black River area. The nature of the intrusions is similarly reflected in the geochemical signature of the two areas, Yellow River prospects being on average Cu-Mo-As dominant versus the Black River prospects are characterised by Au-Ag-Pb-Zn (see Appendix I & II). Structurally the Yellow River targets are aligned along a broad E-W trending structural corridor while the Black River targets within what appears to be an ESE-WNW trending structural splay.

Figure 3 depicts the complex geological framework of the Urasar setting. The central feature of the geological map is a major E-W trending fault to the north of the Yellow River marked by the emplacement of a laterally extensive ribbon of serpentinite (mapped as ultrabasic dykes) and a common deviation of streams to the west along the interpreted fault zone. The serpentinites and the rock alteration and mineralisation along the Yellow River ends to the east where the Black River fault splays begin, while the Yellow River fault continues eastwards through to the Big Copper zone. Where the SE trending Black River fault splays intersect the Yellow River trend the interbedded carbonate metasediments and phyllites are intensely fractured, faulted and tightly folded with subvertical fold limbs, but further east the carbonate metasediments are flat lying and are intruded by narrow dioritic sills and dykes.

Along the **Yellow River trend**, the serpentinite hosting fault zone demarcates the boundary between thick sequence of weakly altered basement phyllites to the north juxtaposed against Cretaceous aged, folded metasediments and (younger?) volcanics to the south. It is notable that the strong iron staining along the N-S running streams ends abruptly above the serpentinite outcrops. The Soviet geologists mapped an anticlinal fold hinge zone along the Yellow River and infer that 'strongly altered metasediment and volcanics' hosting the copper mineralisation, dip at plus 45 degrees to the north, and that the southern limb dips at a similar angle to the south. Though minor rock alteration and apparently mineralisation occurs to the south of the Yellow River, it is the northern limb of the folded sediments between the Yellow River and the serpentinite dykes where the most intense alteration (figure 4) and better grading mineralisation is localised associated with multiple E-W trending fault structures (up to 30m wide) and multiple dioritic dykes and sills (figure 5). The magnetic highs along the Yellow River trend (figure 4) are assumed to reflect underlying [causative] intrusions.

The **Black River deposits** are an enigma. At Hanqakutak and Black River highly pyritic mineralisation and intense acid sulphate alteration is spatially associated with flow banded dacitic porphyries and locally fluidised volcanic breccias, perhaps mafic marine volcanics, that cannot be readily assigned to typical breccia facies groupings other than perhaps hyaloclastites. The Soviet deposit reporting notes E-W trending lens like silica / pyrite bodies at Black River extending over 200m laterally and to similar depths and dipping 55-56° to the south. The Soviet discussion on the Hanqakutak Zone is incoherent but emphasises very intense clay alteration, shallowly dipping structures and conglomeratic (?) units. The Brick House mineralisation is different again characterised by what appears to be a NE-SW trending sericite/clay altered structure crosscut by wide spaced and apparently narrow NW-SE trending low and intermediate sulphidation epithermal veins. The Hayasa drill hole at Brick house also intersected a continuous interval of flow banded dacitic porphyry an aspect that is not recognisable in outcrop.

The intensity of the clay alteration along the Yellow and Black River trends which is unusual in many respects may relate to the devitrification of volcanic glass. Though no pillow basalts have been recognised, it is readily evident that most of the recognisable volcanic intercepts are basaltic-andesites in composition and typically the intense clay alteration occurs over intervals of brecciated basaltic andesite. The intense white sticky clays noted at Hanqakutak and Black River deposits presumably relates to devitrification in a marine depositional setting.

Viewed from a Mineral District perspective, the field observations, soil and rock geochemistry and the logged geological features support the contention that the Urasar deposit cluster system initiated towards the west and the focus areas of the hydrothermal alteration and mineralisation associated with the silicic intrusions migrated eastwards over time terminating with the low sulphidation vein system at Brick House. In most complexes the location of the better grading and largest concentration of mineralisation lies within the 60-80% window (distance wise) along the chain of deposits which in a temporal sense equates to the period when silicic intrusions are being differentiated. If applicable to Urasar the Mineral District concept would highlight the Hanqakutak-Black River area as the most prospective zone for a discovery. That is a big if, but worth considering.

Figure 4 illustrates the spatial relationships between the serpentinites and the E-W trending belt of intrusions (magnetic highs) with the belt of acid alteration in the Yellow River area and that this serpentinite / alteration zone relationship is does not extend eastwards into the Black River area where the belt of acid alteration deviates to the SE. The underlain analytical signal image in figure 4 illustrates the Yellow River prospects are associated with a string magnetic highs as opposed to the Black River targets which correlate spatially with subtle magnetic highs (silicic intrusions) within a wedge of weaker magnetism (metasediments).

YELLOW RIVER PROSPECTS (Figures 6-9)
As noted above the Yellow River targets are hosted by intensely sericitized Cretaceous aged marine sediments (quartzites, siltstones and sandstones), which the Soviet literature infers are overlain by Eocene aged volcanics and are spatially associated with series of intrusions including serpentinite, diorite and quartz porphyries which are undoubtedly Tertiary aged. The Hayasa drill logs (this study) note that the volcanic lithologies include an upper unit of andesitic tuffs overlying andesitic lavas (with carbonate filled vesicles).

Field evidence concurs that the metasediments and volcanics generally dip to towards the north, locally dipping to the NE or NW, but questions whether the localised tectonic brecciation of these units supports the contention of a shallowly dipping thrust fault rather than attributing the localised brecciation to the a) subvertical E-W and NS trending fault structures or b) hyaloclastites.

Yellow River mineralisation developed within a broad E-W trending structural zone marked by multiple shears and dykes, and where lens shaped zones of better grading mineralisation could relate to cross cutting N-S trending structures that drainages my follow. It is also likely that the broad zone of clay and sericite alteration (and subsequent silicification – referred to as secondary quartzite in the soviet reports) relates in part to endogenous basaltic-andesite domes emplaced in a marine environment (hence the widespread brecciation, intense retrograde alteration through devitrification and subsequent silicification) within a down dropped graben like structure that formed along the anticlinal fold axis, a feature which might

explain the preservation of a wedge of volcanics and the juxtaposition of the altered volcanics against weakly altered phyllites, metasediments and volcanics on the northern and southern margins of the alteration zone.

The individual targets along the Yellow River appear to be pinch and swell structures presumably in response to cross cutting fault structures. Having compiled the Soviet underground workings and adit sample assays, it is readily evident that the Hayasa 2024 drill holes did not target the areas where the Soviet underground workings are located (figure 6).

Rock Alteration is known to extend over a strike length of 5km at Yellow River and over widths of between 350-450m. Obvious indications of mining or exploration activity along the Yellow River trend has been concentrated over less than 15% of the belt of alteration which extends for several kilometres further to the west. Sericitic alteration is the dominant alteration facies noted on outcrop, however in the Hayasa drill holes, propylitic alteration dominates with evidence of weak potassic (patchy K-spar with trace biotite and magnetite). The potassic alteration suggest that the mineralisation relates to underlying intrusions, a conclusion that would fit with the magnetic features along the Yellow and Black River zones. The intensity of the drain back acid alteration along E-W trending structures (granular silica and granular clay with quartz-alunite-clay and pyrophyllite) is indicative of a hot and relatively powerful hydrothermal system at play.

As noted above the Yellow River targets coincide with a string of magnetic highs which look suspiciously like intrusive signatures perhaps quartz diorite bodies. IP survey lines 1 & 2 which transect the Oxide Basin and Copper Creek targets (figure 9) depict chargeable features to the north and resistive features to the south. The sectional plots depict apparent steeply dipping fault off sets which would fit with the graben or half graben concept. The assumption is that the chargeable features relate to the serpentinites and underlying intrusions, the resistive features to metasediments. Often the principal zone of interest lies at the where the limits where high (pyrite) related chargeability and stronger (silica) related resistivity intersect, but in this instance the IP Lines are located some distance from the principal areas of interest.

N351_Silica West – Rock and soils sampling indicate that appreciable Cu-Mo grades along the Yellow River trend extends westwards from the Oxide Basin across the West Silica Zone and perhaps even further. Steam float in the area includes skarn, equigranular and slightly porphyritic diorite (i.e., relatively deep emplacement levels), hornfelsed metasediments, serpentinite and gossan with minor veining. The area has not been mapped but should be considered as a future target area.

N352_Oxide Basin – Lacking usable Soviet adit analytical data it is not possible to assess the potential for high grade copper mineralisation across the of the Oxide Basin area. However, it is the area with the better outcropping geology where subvertical E-W trending diorite dykes and an NNE-SSW trending quartz diorite dyke with silicified margins are evident combined with multiple E-W trending fault structures. The single Hayasa Metals drill hole in the area (UDD-004) which targeted the southern (outer) margin of the potential mineralised zone intersected highly brecciated (hyaloclastic) mafic volcanics, prior to drilling to andesitic volcanics, a series of diorites and basaltic andesite volcanics at the end of the hole. The porphyries exhibit evidence of weak potassic (kf-mt) overprinting chlorite-epidote propylitic alteration, minor sulphide, quartz, gypsum and late carbonate veining. Weak advanced argillic alteration is also noted including pyrophyllite which undoubtedly relate to drain back acid along structures.

N353_Copper Creek – This area has been extensively worked. Soviet plans depict more than 1.5km of underground workings and at least 6 drill holes, including drill hole RUD-001 which intersected high grade copper at the end of the drill (39m @ 0.7% Cu incl. 8m @ 2.2% Cu). The adit sample data has yet to be located and plotted, but the adit workings and drill hole results suggest that copper mineralisation extends over a minimum strike length of 350m and over a vertical interval of 330m. In lieu of physical evidence of the mineralisation the assumption is that the massive sulphide lenses are stacked, with a high probability that mineralisation is replacement in style within north dipping receptive / reactive breccia horizons within the metavolcanic / sedimentary package. The evidence to date indicates that better copper grades are likely focussed towards the north – adjacent to the serpentinite dyke.

N354_Golden Vein – Similar to the Copper Creek area, extensive underground workings estimated at +1.5km combined length extend over an area measuring 450x x 300m. The copper sampling data from the adit plans depict discontinuous intervals of >1% copper occur over a lens shaped zone measuring 325m in strike by 125m across the 1840m level. In lieu of any drill information within the mineralised zone (note we do have the Soviet drill logs – but in Russian and clearly lacking any detail), it can be assumed that the mineralisation controls at both Copper area and Golden vein are similar. Gold and silver in rock data for both areas include values of up to 12ppm Au and plus 20ppm Ag – samples that were collected from dumps and drainage outcrops. The Hayasa drill holes despite being located outside of the principal zones of interest provide some valuable information including the presence of potassic alteration, and multiple vein types which include rare pink quartz veins (silica replacement after actinolite?), and epithermal veins such as quartz-carbonate veins (+/- sphalerite and galena), white and sugary quartz vein types. This data indicates that the hydrothermal system extended over a considerable time frame during which significant uplift and erosion occurred.

BLACK RIVER PROSPECTS (figures 8-10)

The belt of rock alteration along the Black River trends NW-SE, extends over a width of up to 500m and over strike distance of more than 5km marked by acid alteration and elevated Au-Cu-Pb-Zn-As 'in soil' values. Flow banded dacite porphyritic intrusion breccias (i.e. high-level energetic intrusions) are a feature common to each of the mineralised target areas along this belt. Soviet exploration aimed specifically to identifying sulphur concentrations with no attention paid to gold, silver or copper. Subsequent exploration reviewed the Hanqakutak for copper. The Soviet maps depict multiple trenches, pits, adits and drill holes at Hanqakutak and Black River though it is not clear if all holes were drilled. Analytical results and drill logs have yet to be located and included in the Hayasa data bases. More recently Hayasa identified epithermal veining at Brick House, but the long intervals between Brick House and Black River and NW of Hanqakutak open for future investigation.

N355_Hanqakutak – Soviet exploration at Hanqakutak includes extensive trenching, 3 adits (+200m), and drilled a minimum of 13 shallow vertical drill holes (RHD- holes in this data compilation) adjacent adit 1 at the base of the hill. The Soviet target description emphases sticky white clays associated with a narrow E-W trending lens of silicification at the base of the hill. Later studies (2007-2008) apparently identified several additional silicified structures, work which notes that the silicification developed on the downthrown side of the Black River Fault, and that the silicified structures apparently dip shallowly to the south (15°). The Molibdeny Ashkharh" LLC report (2008) concludes that the breccias in the area relate to hydrothermal processes but does not elaborate further.

Soviet trenching in the area suggests that the target area is rhomb shaped covering an area of approximately 700m x 450m and is exposed over a vertical range of 200m bound to the NE by andesitic volcanics and metasediments and to the SW by diorite. Historical reports note results from adits of 1.5m @ 6.32% Cu and 12m @ 1.82% Cu and subsequent rock and dump sampling by Hayasa identified significant gold values including 4 samples better than 1g/t Au ranging up to 12.5g/t Au with a 0.41g/t Au located at an elevation 160m above the Soviet adits.

This is a sizable target across which the soil sample data depicts an Au-Cu-As mineralised core rimmed by elevated Mo-Pb-Zn, i.e., that the mineralisation is zoned (hot core to cool margin) aspects that are indicative of deposit style which is intrusion driven and probably not related solely to structures. Soviet reporting notes the white sticky clay material, which is evident in the adit dumps, clays that could conceivably relate to volcanic glass devitrification in a similar fashion to the assumptions made at Yellow River. The initial impression from outcrop evidence (this study) including rock flour matrix breccias and late mineral mafic dykes is that Hanqakutak may relate to a relatively large phreatic breccia body with an underlying dacitic porphyry.

N356 Black River – The mineralisation controls at Black River (the deposit) which trends NW-SE are open to a variety of interpretations. Soviet geology mapping and deposit notes record several E-W trending lenses of silicification (plus pyrite) measuring up to 220m x 50m extending to depths to up to 300m and dipping to the south at angle of between 55-65 degrees. (figure 12) and highlights a dacite porphyry dyke that Hayasa drill hole UDD-007 unwittingly drilled along. The second Hayasa hole (UDD-009) also drilled towards the SE intersected a thick sequence of basaltic andesitic and andesitic volcanics, including broad intervals of hyaloclasite, and cut across a series of broad NE trending fault zones that are visible in access road outcrops.

In outcrop the most intense silicification (massive and vuggy silica) is noted towards the northern end of the target area which according to the Soviet plan extends across the across the Black River towards Hanqakutak. Whether these to targets are linked remains to be determined. However intense acid alteration – predominantly sericitization, silicification and silica-clay alteration facies extends towards the SE, the southern limit to which is undefined. Propylitised volcanics and dacite porphyry float marks the north-eastern limit to the belt of alteration.

The dacite porphyry drilled in hole UDD-07 is an unusual flow banded intrusion breccia with large-resorbed quartz eyes that hosts silicified, sulphide and mafic volcanic clasts. The clast density suggests that this intrusion is not a phreatomagmatic breccia (i.e. is not an obvious component of a phreatic breccia complex) and the alteration / mineralisation features of the clast component suggests that the dacitic porphyry was emplaced at a late stage.

The soviets drilled at least 13 vertical holes at Black River into the target concentrated towards the north on approximately 30m spacings but to unknown depths. Three of the holes included on the sections are known to have been terminated at depths of between 150 & 230m. No geological of analytical data has been compiled to date for any of the holes, but it can be assumed that the Soviets only analysed for sulphur. Hayasa has located some drill hole analytical data but correlating which assays relate to which holes, remains to be determined.
A geological interpretation for the Black River prospect remains elusive, however it is possible that the NW-SE belt of acid rock alteration relates to volcanic glass devitrification within a fissure style eruptive centre (in a similar fashion to the Yellow River Zone), while the

silicification is a gold mineralised epithermal structure related hydrothermal leakage from the Hanqakutak system.

N357_Brick House – Located 2km south-east of Black River, Hayasa identified a series on NW-SE trending low and intermediate quartz veins that cross-cut what appears to be a SW-NE trending zone of intense sericitization, silica-clay and clay-silica alteration. An intermediate sulphidation quartz vein with intense clay altered selvages sampled by Hayasa returned 0.46g/t Au, 58ppm Ag, 1.01% Cu, 7.9% Pb, 17.2% Zn with elevated As, Sb and Cd.

OTHER TARGET

N358_Big Copper – Located 1km NE or Black River soil sample results identify a Cu-Pb-Zn (Mo) anomaly measuring approximately 1,000m x 500m the source of which has not been adequately explained. The Big Copper zone is apparently localised along an eastern extension of the Yellow River Fault correlates with a large magnetic feature which is assumed to relate to very weak porphyry style body that remains to be identified in outcrop. Rock samples in this zone are identified as andesitic intrusions but maybe volcanic.

From an interpretation view point it is possible that the Big Copper zone equates to a Yellow River style porphyry which has not been emplaced into the fissure style mafic volcanics (i.e., no hyaloclastites or devitrification).

Concluding comments and drill planning

The current project review has gone some way towards a) compiling the historical data and b) identified several aspects of the geological controls, including a possible fissure style eruption complex along a [half] graben style fault zone that traces the E-W trending Yellow River prior to deviating to the south-east in the Black River area. It can be assumed that the Cu-Mo mineralisation to the west and Au-Ag-Mo mineralisation to the east are components or products of a single deep seated productive magma chamber which probably also sourced the mafic volcanics, diorite dykes, the serpentinite and the mineralisation.

The Hayasa Metals 2024 drilling clearly did not test the mineralisation potential of the Yellow or Black River targets principal reasons being the holes drilled at Copper Creek, Golden Vein and Oxide basin tested the southern outer margin of the copper mineralised zones evident in the historical data sets.

In consultation with the Hayasa Matals team and guided by the historical data it is recommended that Hayasa conduct further drilling with a focus on the northern half of the alteration belt at Oxide Creek, Copper Creek and Golden vein with a series of holes that are inclined steeply to the south. The reason for inclining the holes to the south initially takes into account the northern dip to the reactive volcanics and sediments, however if these holes are successful in intersecting high grade copper additional holes should perhaps be inclined steeply to the north to tests for feeder structures which based ion IP chargeability pseudo sections appear to be inclined steeply to the south or subvertical and may channel up / along the margin of the serpentinite at depth (figures 13 & 14). Of course these are optimistic representations of what could occur within the Yellow River deposits, but it is not unreasonable to a) assume that the mineralisation extends to depth (as per Soviet hole RUD-001), and b) assume that the silicification will be laterally continuous down dip – following the receptive / reactive volcanic & sedimentary units which may relate spatially to hyaloclastites. It is unknown at this time whether the hyaloclastites acted as aquicludes or receptive units for silicification.

A single hole has been planned for the Black River deposit (figure 15) and a second hole is under consideration. Constrained by the lease boundary and proximity to the creek, the hole planning options are limited. Taking into account that the Soviets inferred that the silica / mineralised lenses dip to the south drilling from the south is perhaps the most prudent option – the objective in this instance is to assess the gold / silver potential of the area with a view to determining just how much effort should be directed towards including the Hanqakutak and Hanqakutak West within the company's land package.