Amulsar, Armenia:
An IOCG chameleon?

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ABSTRACT

Lydian International's flagship gold project, Amulsar, in the south of Armenia, is a low grade, high tonnage gold deposit with a current total combined CIM compliant resource of 4.1 million ounces gold and is currently open in all directions. The deposit lies within silicified host rocks along the crest of a 2800m high mountain ridge and the silicified rocks are underlain by, and partly interleaved with, a large volume of highly visible pale clay-altered volcanogenic rocks dominated by porphyritic andesite. A number of small plutons and subvolcanic intrusives lie just to the west of the alteration system, and contain currently sub-economic galena-chalcopyrite veins.

Amulsar is a true 'greenfields' discovery. Although the alteration had been mapped in early Soviet times for a silica resource, and later Soviet exploration had been carried out for silica, gold was not reported until a reconnaissance trip by Lydian geologists in 2005 recognised the potential for epithermal-style gold mineralisation in rocks beside the highway.

Multiple panels of clay-altered porphyritic andesite are interleaved throughout the silicified upper volcanosedimentary sequence and these panels have complex fold geometries. The origin of most of the andesite panels is probably intrusive, but the interleaving is also at least partly structural. Prior to mineralisation several generations of thrusts had produced a large dissected fault-fold structure. Subsequent deformation, possibly dextral wrenching, produced structures that overprinted and refolded the older structures. An abundance of both systematic and non-systematic faults and linking fractures accommodated the resultant geometrical incompatibilities associated with the refolding, and it is these brittle structures that host mineralisation. Later oblique normal faults further segmented the system.

Gold, hematite, and silica occur within fractures, narrow oxide-filled breccia zones, and a few larger hydrothermal breccia zones. The alteration history at Amulsar is complex, reflecting the complex structural history. The early alteration patterns have elements of high to medium sulfidation models (silica±alunite and argillic alteration). However, the very strong hematite-silica alteration that accompanies gold deposition, and the high statistical association of Fe, Cu, Au, As, Sb, Bi, and Pb gives the deposit a strong IOCG signature for the Au, rather than either 'epithermal' or 'orogenic' models, although the epithermal alteration may be associated with polymetallic deposits elsewhere in the area.

Introduction

Figure 1: View south from Artavasdes toward Arshak at Amulsar.

Amulsar, in the south of Armenia is 100% owned by TSX-listed Lydian International Ltd (LYD). The project is a low grade, high tonnage gold deposit with a total combined CIM compliant resource of 4.1 million ounces gold comprising, 52.4 Mt at 1.05 g/t gold (1.77 million ounces) of Measured category resources, 18.1 Mt at 1.02 g/t gold (0.59 million ounces) of Indicated category resources and 58.0 Mt at 0.93 g/t gold (1.73 million ounces) of Inferred category resources. It lies along an elongate north-south ridge rising up to 750 metres above the adjacent valleys (figure 1 and 2). It is a true 'grassroots' gold discovery with no known recorded occurrence of gold in the area until Lydian's exploration rock-chip samples returned plus 1g/t gold results in 2006.

Gold occurs in iron-stained fracture networks, faults, and narrow oxide-filled breccia zones in silica-altered rocks. Quartz veins are few and not apparently associated with gold. These proximal gold host rocks overprint, and are surrounded by, extensive zones of silicification and advanced argillic alteration, forming km-scale bleached and iron-stained rocks, which were the initial mineralisation signals identified in the discovery (and visible from the nearby regional highway).

The Amulsar gold deposit does not appear to fall into any simple deposit type classification. It has both epithermal signatures as well as low temperature, low sulphur IOCG signatures (Barton 2000, Kreiner and Barton, 2011). The very strong degree of syntectonic structural control also provides a hint of orogenic (*sensu stricto*) signature.

The broad silica and argillic alteration, and the local presence of alunite, meant that initial exploration focussed on a high sulphidation epithermal model. As drilling progressed however, it became apparent that the main mineralized volumes at Amulsar are zones of strong structural complexity, and of high iron oxide content, relative to the simple structure and pale alteration of the surrounding rocks. Multiple bands of argillically altered rock are interleaved within the silicified units and the resultant packages are variably tilted and folded. Moreover, there is evidence of a significant pre-history to gold deposition including probable silicification of the volcanic protolith of some of the volcanosedimentary mass-flow units.

Extensive mapping and 3D modelling has resolved much of the geometry of the system but also raised questions about the relative timing of the main alteration packages relative to mineralisation and to each other. This paper outlines the discovery and resource definition history, and provides a preliminary model for the gold mineralization and its structural controls.

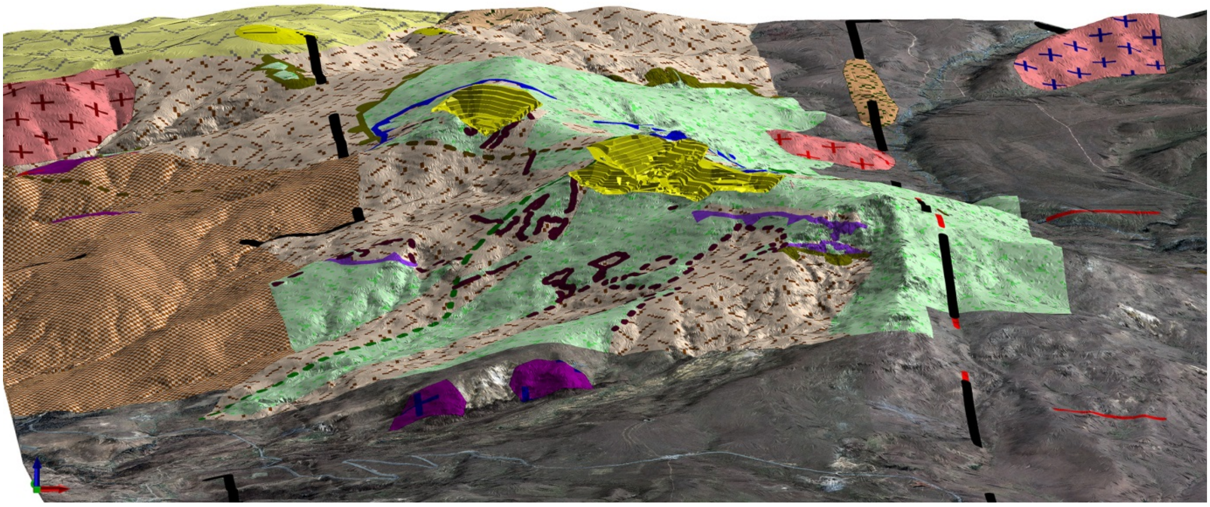

Figure 2: View of Amulsar looking NNE, with current geology and initial pit plan overlain on 3D view of Ikonos imagery. Switchbacks in the main highway over the pass in the Amulsar ridge are visible at the bottom of the image. The map legend is shown in figure 6.

LOCATION AND INFRASTRUCTURE

Armenia is a land locked former Soviet Republic located in the southern Caucasus region. It shares a border with Iran in the south, Turkey in the west and Georgia and Azerbaijan in the north and east. Geologically, Armenia forms a small segment of the Mesozoic to Tertiary age Tethyan metallogenic belt.

The Amulsar deposit is located in central Armenia some 170km by sealed road and 6km by unsealed track to the southeast of the capital Yerevan. The licence area straddles the boundary between Vayots-Dzor and Syunik provinces and takes in part of the main highway south from Yerevan. A high-tensile power line, gas pipeline and fibre-optic cable all transect the licence area.

Armenia gained its independence from the Soviet Union in 1991. From a geopolitical risk perspective it is currently ranked 105 (out of 176) on Transparency Internationals Corruption Perception Index ahead of Russia and neighbouring Azerbaijan and Iran but behind its neighbours Georgia and Turkey (source Transparency International, 2012). Armenia fought a war with Azerbaijan from 1988 to 1994 over the disputed territory of Nagorno Karabakh. A ceasefire brokered by the Russians was signed in May 1994 and peace talks are currently administered by the joint Russian, US and French led OSCE Minsk Group.

Armenia has good and navigable mining and environmental laws and the government is actively seeking to attract foreign investment but like many transition economies it has some reform and administrative challenges. Political goodwill is a necessary prerequisite and Lydian's view is that this starts at ground level with local community engagement and support. Lydian attempts to mitigate geopolitical risk by employing world's best practice in environmental management and social engagement

DISCOVERY

Armenia was known during Soviet times for Mid-Tertiary age copper-molybdenum and to a lesser extent, gold deposits. Lydian's geologists recognised the potential of Armenia to host gold deposits similar in style and age to those hosted in the better known and similar age arc-orogenic rocks of neighbouring Turkey. Amulsar was discovered during a reconnaissance field trip by Lydian geologists in 2005. The discovery was made simply by recognising an extensive road-side alteration assemblage whilst driving along the main road approximately 170km south of the capital Yerevan. Some days later, on return to the capital, the team resolved to register a local company and place an exploration license over the occurrence.

Grab samples of silica-barite and silica-kaolin altered rocks collected from road-side and nearby outcrops returned very low levels of gold but were later deemed significantly anomalous in bismuth (up to 600ppm), tellurium (up to 18ppm) and antimony (up to 195ppm) to imply proximity of a possibly gold-mineralised epithermal system.

The Amulsar exploration license was granted to Lydian's local subsidiary, Geoteam CJSC, in March 2006.

The first significant gold results were returned from grab rock-chip samples of silicified haematite-alunite-barite bearing breccia in July of 2006. Soil sampling, trenching, rock-chip channel sampling and shallow pitting was then conducted before an initial scout drilling program in the summer of 2007. Best results from this program were DDA-004, 53m @ 2.6g/t gold, and DDA-003, 51m @ 1.0g/t gold. A maiden CIM compliant resource of 1Moz in Inferred category was reported in March 2009. Ground magnetics, IP and radiometric (K,U,Th) surveys were also completed and further drilling and resource updates were estimated throughout the years 2010 to 2013. The latest CIM-compliant resource statement comprises 52.4 Mt at 1.05 g/t Au (1.77 million ounces) of Measured category resources, 18.1 Mt at 1.02 g/t Au (0.59 million ounces) of Indicated category resources and 58.0 Mt at 0.93 g/t Au (1.73 million ounces) of Inferred category resources. A Feasibility Study for an open-pit Heap Leach style operation was released in September of 2012. The key outcomes highlighted an NPV of $646m at 5% discount rate and an IRR of 27.7% (at $1,200/oz gold).

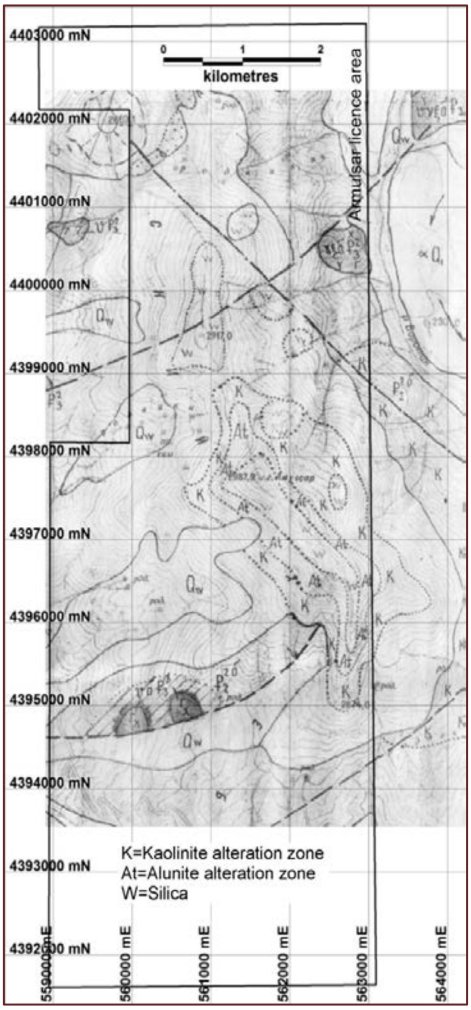

Figure 3: Reproduction of early 1980's Soviet Map at Amulsar showing mapped alteration zonation

The Amulsar gold deposit is a true "grass-roots" gold discovery given that, until gold was returned from Lydian's grab rock-chip samples in 2006, there was no known recorded occurrence of gold in the area. Geological work at Amulsar during Soviet times (1936-1937 and 1946) was focussed on testing the projects potential to host a silica resource. This work concluded that the alunite content of the silica was too high (up to 25%) and that as such the project was of no interest as a source of quality silica. Further work aimed at researching the silica potential at Amulsar was conducted in the early 1960's. This work identified the silica as being metasomatic in origin and developed due to the replacement of intermediate composition volcanic rocks (known regionally as the Amulsar Suite). Some 300m of tunnelling and 640m^3 of trenching are recorded as having been completed during this time. 13 tonnes of bulk sample were collected and sent for analysis and on the basis of this work it was concluded that the silica was of sufficient quality for the production of low-grade glasses only. Research work by the Soviet Expedition continued at Amulsar during the period 1979 to 1982. This work was focussed principally on understanding and mapping the alteration zonation across the area (see Figure 3). Silica reserves at Amulsar were never entered into the Republic of Armenia State Balance and there had been no further exploration or research work conducted in the area since 1982 (source Soviet Expedition documentation).

In the north of the licence area two small uranium prospects were discovered by the Soviet Expedition in 1951. They conducted limited tunnelling and drilling on the occurrences but concluded that the mineralisation was related to minor intrusions and was too low-grade and localised to be of economic interest (source Soviet Expedition documentation).

RESOURCE AND DEVELOPMENT

History

The first CIM compliant inferred category resource estimate at Amulsar was completed in April 2009. The resource estimate comprised combined diamond and RC drilling completed during the 2007 and 2008 drilling seasons and totalled 31.0Mt @ 1.0 g/t gold for 1.0 Mozs gold. This resource was updated after further drilling in April 2010 to a total of 49.60 Mt @ 0.90 g/t gold for 1.43 Mozs gold in the inferred category. The 2010 drilling program at Amulsar was focussed on infill drilling to upgrade the resource to higher categories. The resource estimate completed at the end of the drilling season delineated a CIM compliant resource of 32 Mt @ 1.1g/t gold for 1.1 Mozs in the Indicated category and 48.3 Mt @ 0.9 g/t Au for 1.4 Mozs in the Inferred category.

The first mineral reserves at Amulsar are reported in the Amulsar Feasibility Study (3rd of September 2012) and are based on the drilling completed up to and through the 2011 drill season and on a mineral resource estimate completed in February of 2012. The mineral resource estimate was updated to 36.5 Mt @ 1.00 g/t Au for 1.1 Mozs in the Measured category, 32.2 Mt @ 0.95 /t Au for 0.9 Mozs in the Indicated category and 35.5 Mt @ 0.9 g/t Au for 1.0 Mozs contained in the Inferred category. The February 2012 estimate contained significant silver credits. At a 0.4g/t cut-off value, the silver resource totalled: 36.5 Mt @ 3.82 g/t Ag for 4.5 Mozs in the Measured category; 32.2 Mt @ 3.84 g/t Ag for 4.0 Mozs in Indicated category; and 35.5 Mt @ 4.01 g/t Ag for 4.5 Mozs in the Inferred category. Figures 4 and 5 show the historic growth of the resource estimates.

Mining of the Amulsar gold deposit is planned to be accomplished by conventional open pit, truck and shovel mining methods. Mineral reserves, comprised of Proven and Probable, were estimated within the pit geometry determined by the floating cone algorithm (independently verified by Whittle optimization). The final pit design is based on the shell generated by the US$ 900/oz cone. The mineral reserves in Amulsar, at 0.3 g/t cut-off totalled: 51.1 Mt @ 0.8 g/t Au and 3.37 g/t Ag for 1.3 Mozs Au and 5.5 Mozs Ag in the Proven category; and 37.1 Mt @ 0.7 g/t Au and 3.43 g/t Ag for 1.0 Mozs Au and 4.1 Mozs Ag in the Probable category.

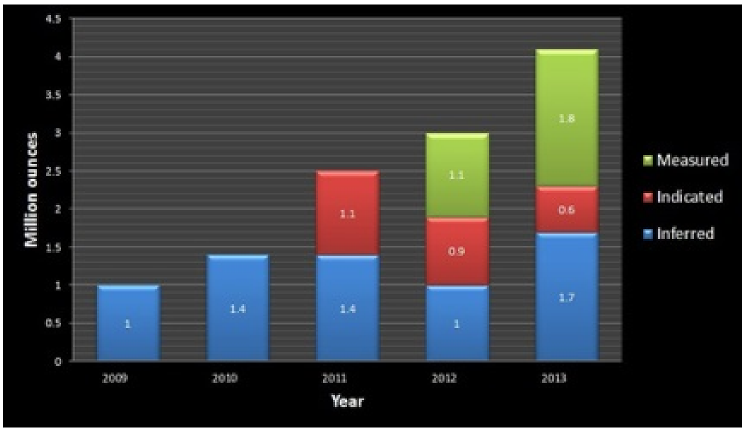

Figure 4: Amulsar resource growth since the first published estimate

Current Resource

The current CIM compliant mineral resources at Amulsar are estimated at:

- Measured: 52.4 Mt at 1.05 g/t Au 4.19 g/t Ag, for 1.77 Mozs Au and 7.0.Mozs Ag;
- Indicated: 18.1 Mt at 1.02 g/ Au and 3.25 g/t Ag for 0.59 Mozs Au and 1.9 Mozs Ag;
- Inferred: 58.0 Mt at 0.93 g/t Au and 2.8 g/t Ag for 1.7 Mozs Au and 5.3 Mozs Ag .

This updated mineral resource estimate is based on a total of 1,154 combined RC and diamond drill-holes and about 360m of saw-cut channel samples collected in the course of exploration work undertaken between 2007 and 2012. Gold grades were estimated using multiple indicator kriging (MIK).

The Amulsar resource remains open in all directions.

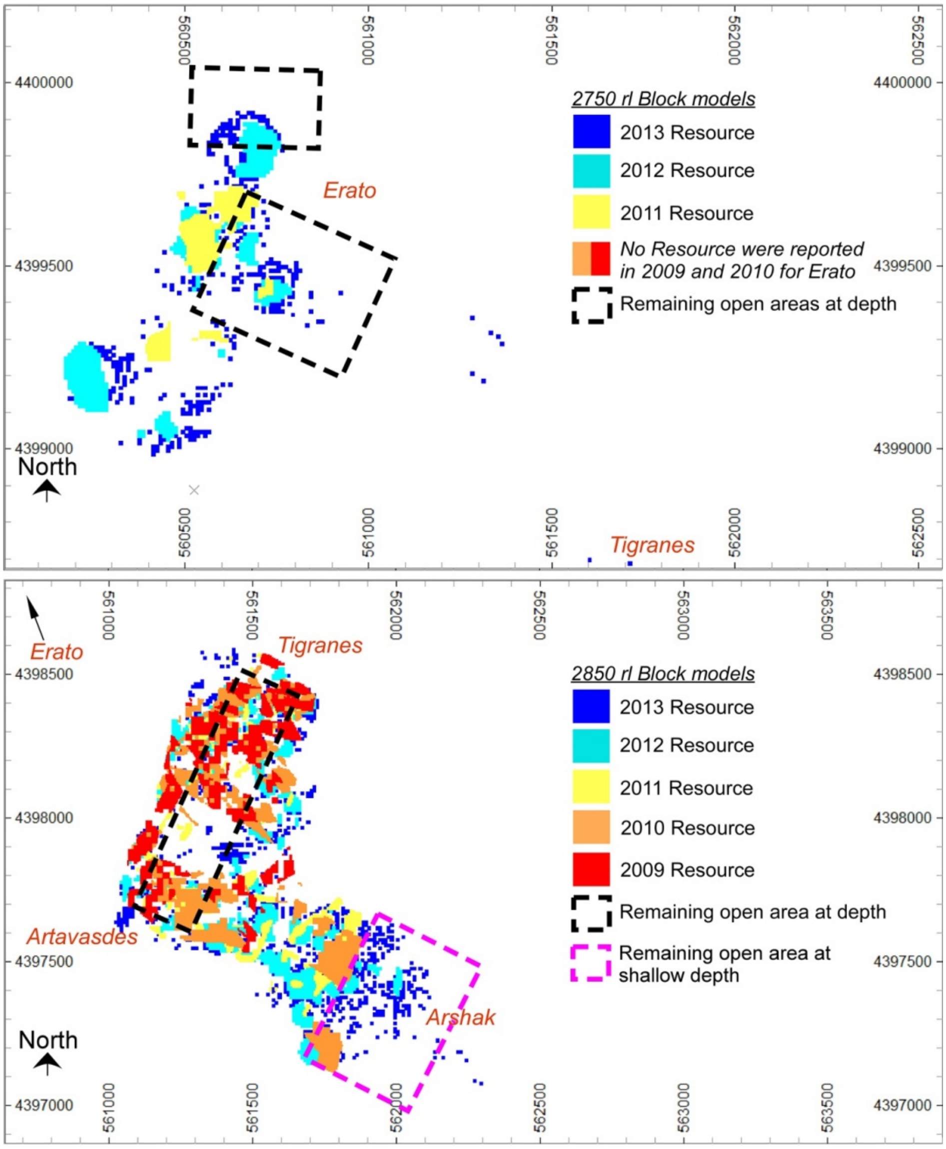

Figure 5: Plan views of resource increase since 2009: Top: Erato (2750 rl); Bottom: Tigranes-Artavasdes-Arshak (2850 rl)

GEOLOGY

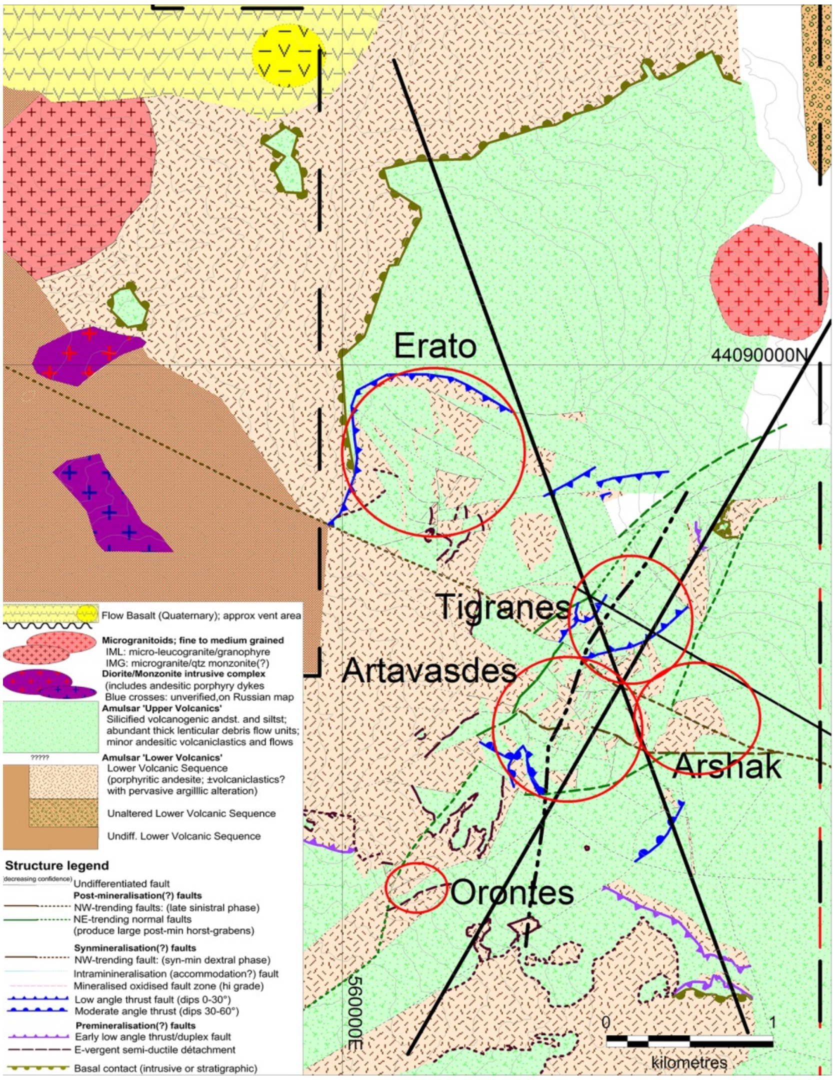

Figure 6: Geological map of Amulsar and location of selected cross-sections (heavy black lines). The dashed section line is the oblique section of Figure 9. The red circles show the location of the main mineralised zones (labelled). The thick dashed lines are licence boundaries.

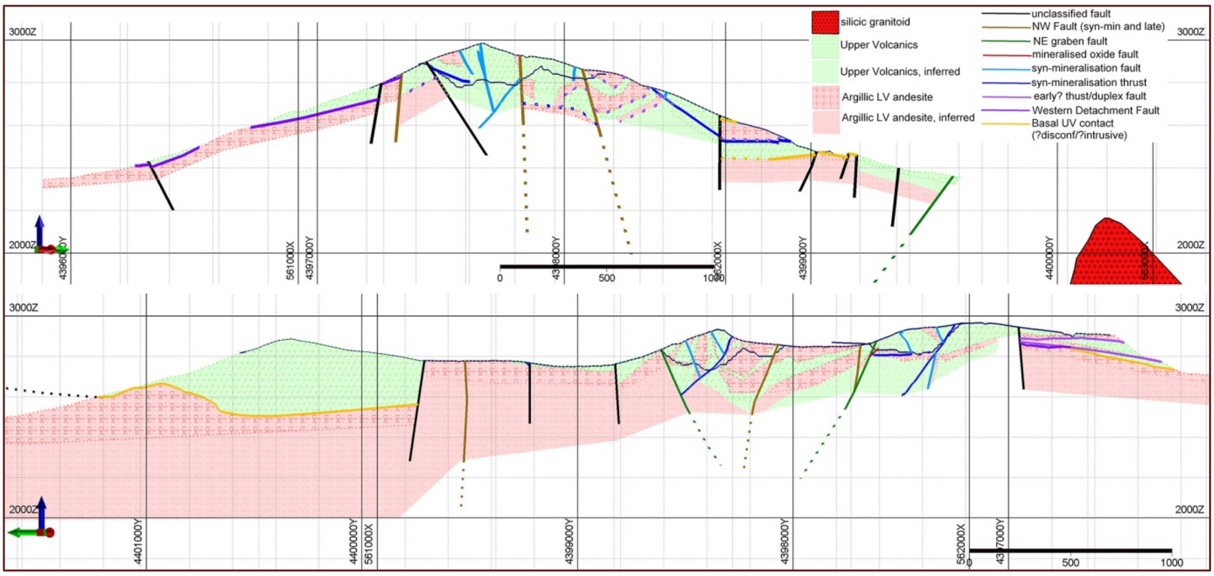

Figure 7: Selected sections (section lines shown in previous figure): Top: Section trending 030 through Artavasdes and Tigranes; Bottom: Long section trending 140

General features

Regionally, Amulsar lies within a very thick package of Palaeogene volcanosedimentary rocks. Locally, those flanking Amulsar, consist of multiple fining-upward cycles of volcanogenic conglomerate and mass flow breccia fining up to volcanogenic and marly mudstone and, locally, thin calcilutite limestone. Andesitic to dacitic volcanic and volcaniclastic units are sparsely interspersed low in the stratigraphy, but increase in frequency as higher stratigraphic levels are exposed on the flanks of the Amulsar ridge. The structure of these peripheral rocks is very simple; the strata are subhorizontal to gently dipping, with little internal structure except where cut by steep faults.

The geology within the ~1000m high, ~5km long, north-northwest trending ridge that hosts Amulsar is anomalous. Apart from the mineralisation and complex alteration system described below, there is a complexity of structure that is not seen elsewhere in the subregion, and an anomalous cluster of small plutonic and subvolcanic intrusives (possibly of two different ages) flank the deposit. Furthermore, the background volcanosedimentary host units, while broadly similar to those at lower structural, and perhaps stratigraphic, levels contain a much greater component of lenticular mass flow deposits relative to those rocks. That is, there is a strong indication (strongly masked by the alteration and structure), that Amulsar evolved from a localised volcanogenic edifice which, at some time in its history, had an associated subvolcanic core.

Throughout the mineralised area, multiple, strata-parallel panels of strong white-cream clay alteration (20-100m thick), dominated by porphyritic andesite, are interleaved with the silicified volcanosedimentary host rocks (figures 6,7,8). The silicified rocks and these argillic panels, only occur above a stratiform/structural level called here the ‘basal contact’. Below that level, the clay altered rocks persist to below present drilling depths. The rocks immediately below the contact are dominantly the same as the porphyritic andesite in the panels above (although locally coarse clastic protoliths appear), and distally the clay alteration merges into stratified and unaltered rocks. There is some question about how much of the interleaving of the argillic panels is primary sill intrusion (the andesite is dominated by intrusive textures), and how much of it is structural imbrication (low angle faults are common). Sparse occurrences of fragmental rocks in some argillic panels may indicate derivation from lower levels).

The strong stratiform control on the location of the base of the silicic volcanosedimentary rocks has given rise to the map definition of Upper Volcanics and Lower Volcanics. Thus the division into Upper Volcanics and Lower Volcanics in local terminology is based on alteration and structural position, rather than on actual statigraphic criteria, although it has been argued that the ‘basal contact’ may be a disconformity.

Small plutons and subvolcanic intrusives occur around the periphery of the mineralised zone. These fall into two classes: a suite of slightly altered magnetite-bearing intermediate rocks (diorite; monzonite; hornblende-porphyritic andesite); and a fresh medium, to fine-grained, silicic suite (micro-leucogranite; granite to quartz monzonite).

Quaternary to Recent volcanics occur throughout the region and at Amulsar a volcanic vent at the northeastern margin of the Amulsar licence has erupted a single thick basalt flow through the prospective rocks and locally concealed them.

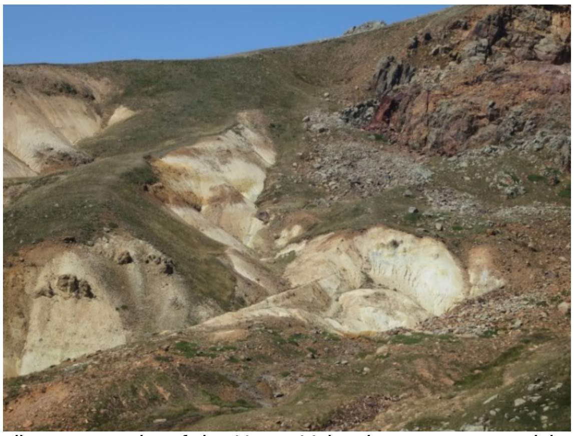

Figure 8: Siliceous volcanosedimentary rocks of the Upper Volcanic sequence overlying argillically altered rocks of the Lower Volcanic sequence. Here the contact is a low angle fault (shown in figure 11).

Rock types

Upper Volcanics (UV): Sparsely bedded volcanogenic conglomerate (figure 9a), feldspathic sandstone and minor siltstone are interbedded with abundant thin and thick lenticular mass wasting (debris flow) units; minor andesitic flow volcanics and volcanogenic/volcaniclastic breccia (figure 9b). Debris flow units are dominated by pebble and cobble breccia with sparse large boulder components. Significantly, clasts in some of the mass-flow breccias appear to have been silicified prior to deposition.

Lower Volcanics (LV): The strong argillic alteration strongly masks the protolith of these rocks, but the dominant rock type seen is feldspar-porphyritic andesite, generally without any flow alignment or other flow characteristics (figure 9c). A few examples also contain hornblende phenocrysts (figure 9d). These rocks are most likely dominantly subvolcanic intrusives. Locally they contain silicic volcanic fragments (xenoliths?). Minor pebble to cobble fragmental rocks and indeterminate rock types also occur, as well as minor feldspar-amphibole porphyritic andesite and a single reported occurrence in drill core of amphibole-magnetite andesite.

Local intrusive suites: Two different intrusive suites occur within or adjacent to the licence area: small, radiometrically hot, fresh-looking silicic plutons (micro-leucogranite; quartz monzonite); and an extensive suite of slightly altered, quartz-poor, intermediate plutons and subvolcanic dykes (diorite, monzonite porphyritic andesite) that are characteristically magnetite-bearing. The latter are in contact only with argillically altered rocks of the Lower Volcanics; whereas one of the fresh silicic plutons is surrounded by Upper Volcanics. Some of the dykes have similar porphyritic textures to the clay-altered intrusive andesite within the Upper Volcanics, although any connection has not been established at this point.

Figure 9: Representative rock types of the mineralised zone: a. Polymictic conglomerate fining upwards to laminated sandstone with small basal loading structures in the overlying next conglomerate (Artavasdes); b. Polymictic matrix-supported breccia (primary or reworked volcaniclastic; North Tigranes); c. Strongly altered feldspar-phyric andesite (west of Artavasdes); d. moderately altered feldspar-hornblende porphyritic andesite (core, Artavasdes).

Structure

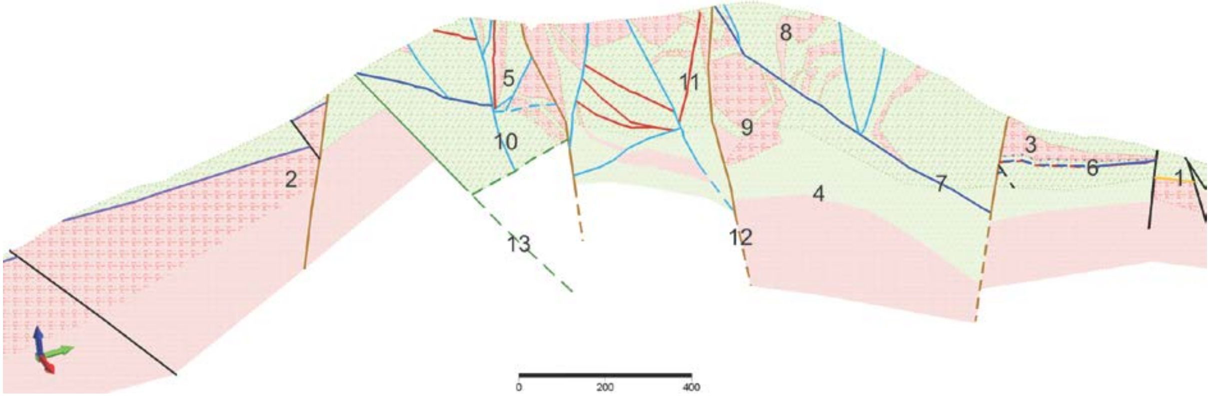

Figure 10. Tilted profile across Tigranes and Artavasdes (view looking down at 32° toward WNW). The tilt optimises the down-plunge view on the folds (9) in the footwall of the low angle thrust (7). Note that with the wide variation in plunge across the main faults, no single section is a profile plane for all of the folds, and all other folds are distorted, or appear unfolded, in this view. Numbers are examples of structures referenced within brackets in the text. See figure 7 for hatch and colour legend.

Amulsar is a centre of high complexity within a regionally simple structure. However, within the mountain ridge system, where the main alteration systems occur, the structural complexity increases markedly and locally dips become steep and overturned. At least four different sets of structure (shears, folds, and faults) produce the final geometry, with increasingly brittle response in the younger structures.

The most prominent post-mineralisation structures are a NE-trending set of normal faults that cross the ridge obliquely and subdivide it into a series of horst-graben blocks that expose the mineralisation in the graben blocks (Structure 13 in figure 10). A slightly younger sinistral reworking of an older NW-trending set of faults locally offsets these graben faults (12), and is the youngest of the main fault events.

On the margins of the map area, the structure is very simple; Strata are subhorizontal to gently dipping, and the silica-altered rock units consistently overly the argillically altered rocks. On the eastern side, the contact between the lower argillic rocks and the silicic rocks above occurs at an undeformed stratigraphic contact (1). This stratiform contact, described in the previous section, will be referred to as the 'basal contact', although its nature is currently under review. It also appears at the same general structural/stratigraphic level at both the southern and northern ends of the Amulsar ridge.

On the western side of the ridge, the lowest contact seen is a west-tilted, low angle semi-ductile fault zone (2), with steeply dipping, locally folded, silicified rocks overlying the argillic rocks (figure 11a). A cm-spaced cleavage is developed in some units within 20m above the fault. The sense of vergence indicated by the overturned beds and cleavage relationship is to the northeast. Termed 'western detachment' fault in this discussion, it is most likely an early northeast-vergent thrust. This structure partially wraps over the central horst block between Tigranes and Erato so predates some of the subsequent deformation. A narrow east-dipping mylonitic zone, with vague east-vergent kinematics, occurs on the eastern flank of the ridge and may be the same structure on the opposite limb.

The structural complexity increases towards the mineralised zones along the ridge. On the eastern and southern margins, one or two subhorizontal sheets of clay-altered andesite are stacked at intervals above the 'basal' contact (3). In some instances, the bases of these sheets appear to be faults (figure 11b), in others the nature of the contact is ambiguous and may be intrusive.

In the south and southeast, the thick lower andesite slabs, and the 'basal' contact, arch into a gentle antiform (4) before a transition across faults into the highly complex central folded zone (Fig.12). Within the complex zone, the andesitic slabs are more numerous and thinner. The overall pattern appears to be a footwall synform below a southeast?-vergent thrust, and one possibility for the formation of the multiple thin panels in the complex zone is that they are the result of duplexing during this major thrust event.

Although mineralisation occurs within the 'complex zone' in the core of this large apparent fold structure, it is the further complexity produced by the refolding of this already folded structure that creates the final host structure. Gold mineralisation is intimately associated with the variably oriented accommodation faults (10, 11) and the large volume of fractured mineralised rock that links them. These fractures are really just small scale accommodation structures that allow local deformation associated with the folding.

The folds in the thin andesite panels related to these host accommodation structures have steep E-W trending axial planes and widely varying plunge (8, 9) (reflecting their orientation in the earlier fold structure). They show marked plunge changes across a set of large northeast dipping spoon-shaped thrusts (7). The syn-mineralisation thrust at 7 appears to correlate with a thrust flat that emerges at the surface as a thin mylonite zone at 6. This mylonite has southwest vergence, consistent with the inferred vergence of the thrusts, and lies at the top of a syn-mineralisation silica-hematite breccia that partly overprints the mylonite.

Mineralisation lies within ~800m either side of a prominent steeply dipping NW-trending fault (12) that transects the deposit. It is likely that all of the syn-mineralisation structures (6,7,8,9,10,11) are linked, and occur within a general zone of dextral transpression about 1.6 km wide, around this central fault.

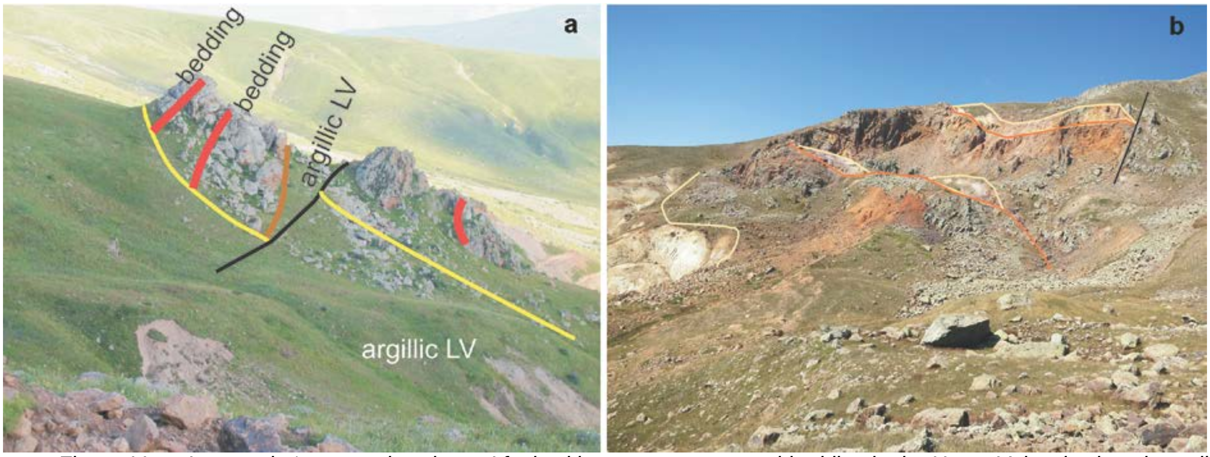

Figure 11: a. Low angle 'western detachment' fault with steep to overturned bedding in the Upper Volcanics hangingwall. The contact with argillic rocks in the hangingwall (brown line) may be the stratiform 'basal contact' seen elsewhere. b. Stacked subhorizontal argillic andesite panels (outlined) at the southern end of the long section shown in figure 5). The lowermost contact is the laterally continuous 'basal contact'. The panels are parallel to local strata and the base of each of the upper panels appears to be a fault. (The top contact is shown in figure 8).

Figure 12. a. Part of section trending 120 through Tigranes showing the apparent underthrusting and folding of the thick argillic sheets beneath the complex zone. Legend as for Figure 7. b: Cartoon showing the inferred large structure (asymmetric breached fold or thrust) with younger faulting removed.

Alteration and Geochemistry

All map units are overprinted by strong alteration, but the alteration mostly reflects the local rock type. Silicification dominates the volcanosedimentary rocks, whereas white argillic alteration (and local relict phyllic alteration) dominate a number of discrete, strata-parallel, porphyritic andesite panels interleaved within the silicic rocks. Three general styles of alteration and one of supergene overprinting are observed;

1) strong silicification, mostly but not exclusively confined to the uppermost parts of Amulsar, preferentially developed in volcaniclastic/clastic rocks. In the andesite porphyry, this style of alteration is restricted to discrete sub-vertical channels up to several metres wide, and local sheets also up to several metres thick, below volcaniclastics;

2) strong advanced argillic alteration (clay-quartz ± hematite, rare alunite), locally overprinting phyllic alteration (sericite-quartz-pyrite), mostly found in the andesite porphyries and locally in the volcaniclastic units where the clay alteration overprints the silicification;

3) the main gold stage of hematite-gold and other metals, as fracture- and fault-infill (figure 13), rare cataclasite and ferruginous mylonite, and matrix to breccias, all of which almost exclusively overprint 1) and 2); and

4) supergene goethite and limonite, affecting the hematite-rich rocks, forming abundant leisegang rings, and local porous, somewhat gossanous material, replacing hematite. Some Quaternary poorly consolidated conglomerates have limonite matrix; these may have been shed from exposed ore.

Figure 13. Typical hematite-matrix mosaic breccia veins, carrying good gold grades (Erato), These features show evidence for the commencement of high energy hydraulically-driven clast transport. They overprint the already hydrothermally brecciated and silica-cemented Upper Volcanics, and a generation of silica alteration is associated with the hematite. Late limonite overprints locally.

Au fire assays and ICP-AES analyses (30 elements) were performed on halved core pulps and RC samples, at the ALS laboratory in Romania. Limited 4-acid digest ICPMS data (50 elements) constrain the validity of low detection elements in the ICP-AES data, and consequently Be, Cd, Hg, Ni and W were omitted from further consideration, and Bi, Co, Mg, Na and Ti were treated with caution, due to the abundance of samples recording below detection limit values.

Styles 1) and 2) are associated with km-scale enrichments in K, S, and (inferred) Si, at the expense of Ca, ?Na, and other alkali earths (Fig. 14). In the envisaged scenario, the widespread K-S-Si alteration would represent distal, earlier circulation of basinal and/or magmatic fluids, with these elements being precipitated on a cooling path.

Style 3), gold mineralization, is associated with enrichments in Fe, Cu and a suite of other metals (As, Zn, Mo, ?Bi, Sb, Pb; Fig. 13). These correlations, along with the relatively poor local correlation with sulphur, are consistent with an IOCG association akin to the recorded low-temperature variants with surrounding advanced argillic alteration in Chile (Kreiner & Barton, 2011). Additional factors are a) bulk addition of iron, i.e. not simply using iron previously available from pyrite, b) the presence of hematite-matrix, high grade breccias, c) the local presence of hypogene, low S copper minerals (chalcocite, cuprite) on the edge of the gold resource at the interface of the hematite with the surrounding clay+phyllic or silica-rich alteration, and d) the situation of Amulsar within a broadly easterly trending belt of Eocene to Miocene felsic to intermediate intrusions, of ages probably similar to those of mineralization. We have not determined the effects of supergene weathering on gold grades, but the continuity of grade with depth, to well below the weathering level, suggests only a minor impact. Hematite is ubiquitous throughout whereas iron hydroxides are restricted to approximately 200m below the ground surface.

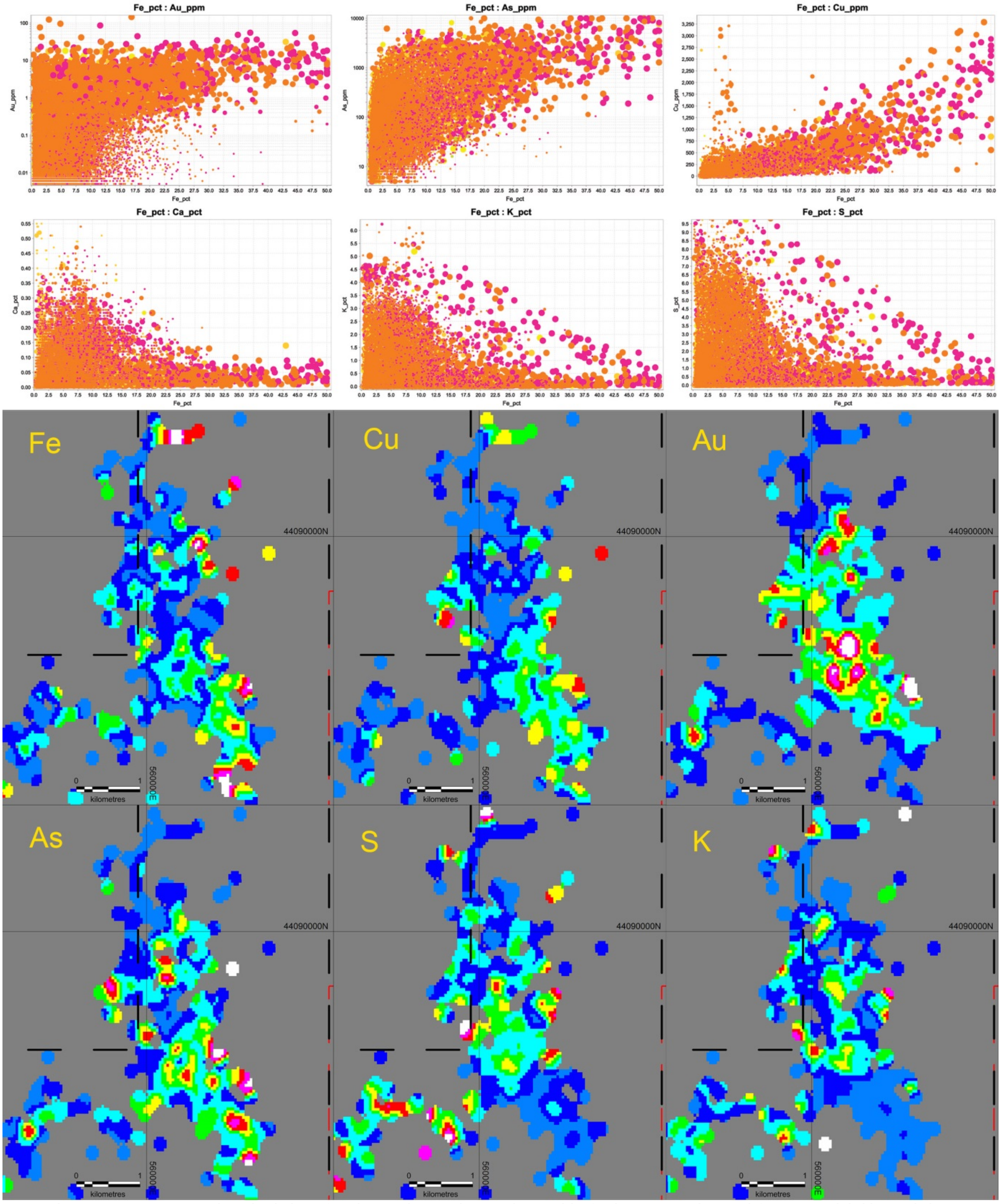

Figure 14. Top: Geochemical data for the main ore hosts, hematitic fault zone rocks and fractures (pink), and the Upper Volcanics (orange and yellows). Fe, Cu, Au and As are well correlated (dot size relates to gold grade in all figures); whereas correlations of these elements with Ca, S and K are poor, reflecting the distal breakdown of feldspar with phyllic alteration, cut by the IOCG ore association. Bottom: spatial plots of the distribution of the key elements around Amulsar, which emphasises the IOCG-type correlation and the spatial separation of the K-S (argillic and phyllic) alteration from the gold suite. The thick dashed lines are licence boundaries.

DISCUSSION

Amulsar was an opportunistic discovery. Lydian geologists had essentially style-correlated and extended the magmatic and orogenic arc from neighbouring Turkey and assumed that the country as a whole would be prospective for copper and gold mineralisation. Geological work was accompanied by a thorough geopolitical and risk analysis and on the basis of both deemed prospectivity and risk assessment a decision was made to conduct a reconnaissance field trip.

Amulsar was identified from the road-side by its extensive halo of silica-clay-iron oxide alteration. Basic pathfinder geochemistry (elevated bismuth, tellurium and antimony) then added the confidence required for initial investment, the registration of a local company and license acquisition over the area.

Amulsar has an unexpectedly complex local structural evolution given the structural simplicity of the subregional geology. It is an on-going challenge to integrate the equally complex alteration paragenesis into that history, particularly in the absence of unambiguous geochronology data. Preliminary geochronology results on illite in the clay-altered porphyritic andesite give mid-Eocene signatures, reset in the early Oligocene but these data are still being refined and interpreted. It is clear that the mineralisation, with its IOCG-like signature, occurred syntectonically during a late deformation event (dextral wrenching?). However, at least two substantial deformation events preceded the mineralisation stage, and at least one stage of silicification post-dates the earliest of these. (The cleavage in the 'western detachment' is disrupted and healed by silica±?adularia). Furthermore, the presence of previously silicified clasts in some of the mass-flow breccia units indicates a stage of silicification in the protolith of these Upper Volcanics units.

Integration of the timing of the local magmatic rocks into the stratigraphic and deformation history is also problematic, as most of those that are unaltered occur outside the licence area and have not been mapped or studied in detail. It is worth noting that Amulsar has been a local focus of deeply derived magmatism over a considerable period of time. A crude east-west belt passing through Amulsar contains numerous small plutons of two separate suites, large subvolcanic dykes, and an isolated Recent basalt volcanic vent. Old Soviet maps assign an Oligocene age to the plutons that contain the fresh-looking silicic microgranite and quartz monzonite. It is likely that the suite of diorite-monzonite plutons and large subvolcanic dykes that locally host polymetallic veins is older than this age. At this point we can only speculate on the relative timing of the altered porphyritic andesite within the mineralised area at Amulsar. It is possible that they are broadly coeval with the polymetallic mineralisation.

Amulsar is a chameleon; discovery was opportunistic and straight forward but identifying the nature of the deposit has proved elusive, and evolving exploration strategies focussed on finding Amulsar look-alikes will have had to adapt as the underlying system becomes understood. The Amulsar gold deposit doesn't fall into any simple deposit type classification; however it is most analogous (world-wide) to Chilean low temperature, low sulphur iron-oxide-Cu-Au systems, and is clearly syntectonic.

If the Amulsar discovery is to teach us anything, it is that simple vigilant road-side reconnaissance is effective, that it should never be assumed highly visible and easily accessed alteration occurrences have been fully tested and that anomalies in simple gold pathfinder elements require attention. The Amulsar discovery reminds us that quickly securing tenure, even over potentially unmineralised alteration systems, is one of the cheapest and lowest risk aspects of the exploration process; but also one of the most valuable.

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