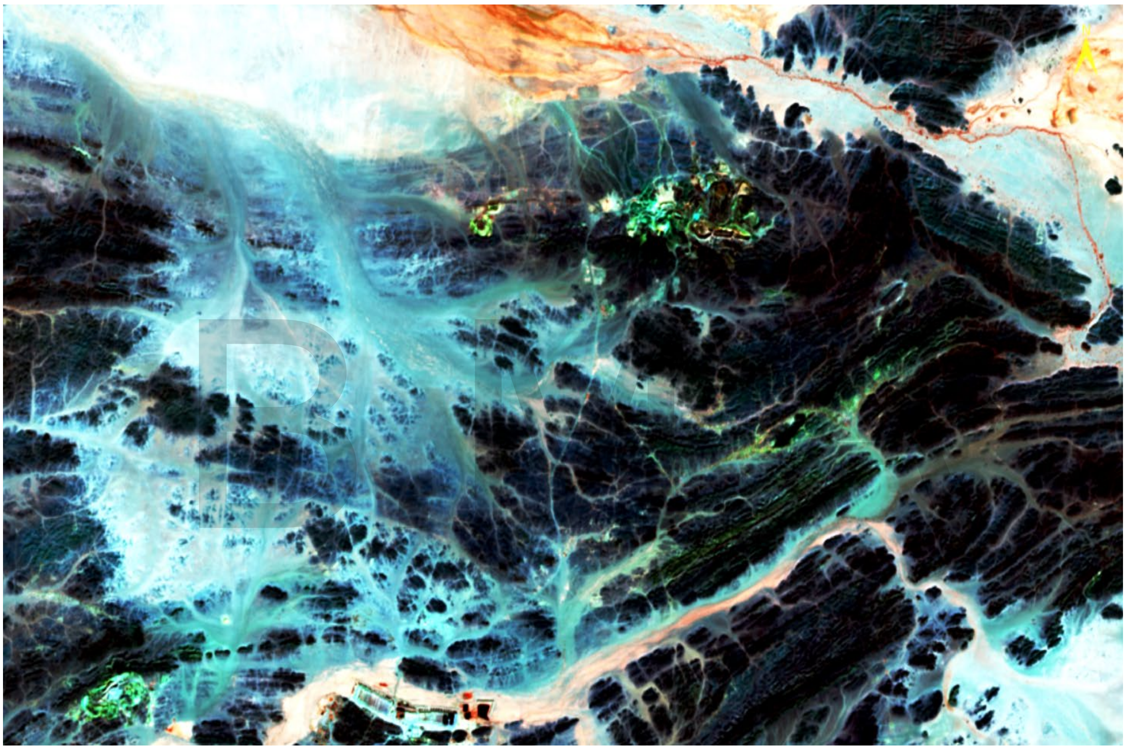
Prospective VMS Gold Target – Ariab Mineral District, Sudan

Executive Summary

This report demonstrates a robust remote-sensing methodology capable of identifying blind Volcanogenic Massive Sulphide (VMS) gold systems years before surface expression becomes visible. By applying proprietary multi-temporal spectral enhancement algorithms to archived European Sentinel-2 imagery (2016–2025), we isolated a high-priority target in the central Ariab Belt that remained invisible to conventional exploration until late 2024. Recent high-resolution true-color satellite imagery (November 2025) confirms the exact same location is now host to six active mining operations, proving the predictive power of the technique. The target remains open in all directions and is recommended for immediate drill testing.



This image comes from the Sentinel-2 satellite, captured in 2015 using the SWIR system, and is intended for preliminary exploration of large areas to select the appropriate work area**.**

Interpretation of colors

Dark red → Burnt brown: Pure 99% Iron Ore (Hematite + Goethite + Jarosite) → this is the layer directly above the gold)

Light green → Turquoise: Sericite + Kaolinite + Illite → the hydrothermal alteration that occurred when the minerals emerged to the surface)

Dark blue → Black: Chlorite + Amphibole → areas that have not yet been discovered under the sands

The small yellow dots : The gold mines that are being worked on at the time the picture was taken

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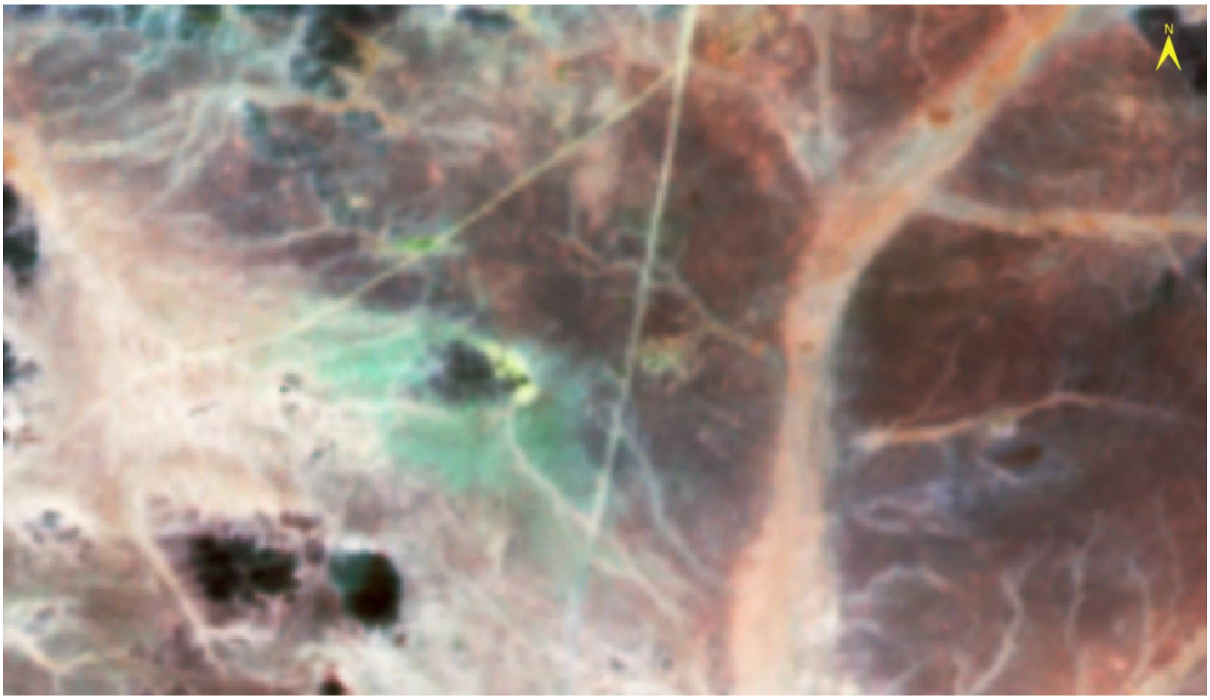

Figure A– Predictive Anomaly Map (March 2016) SWIR IMAGE

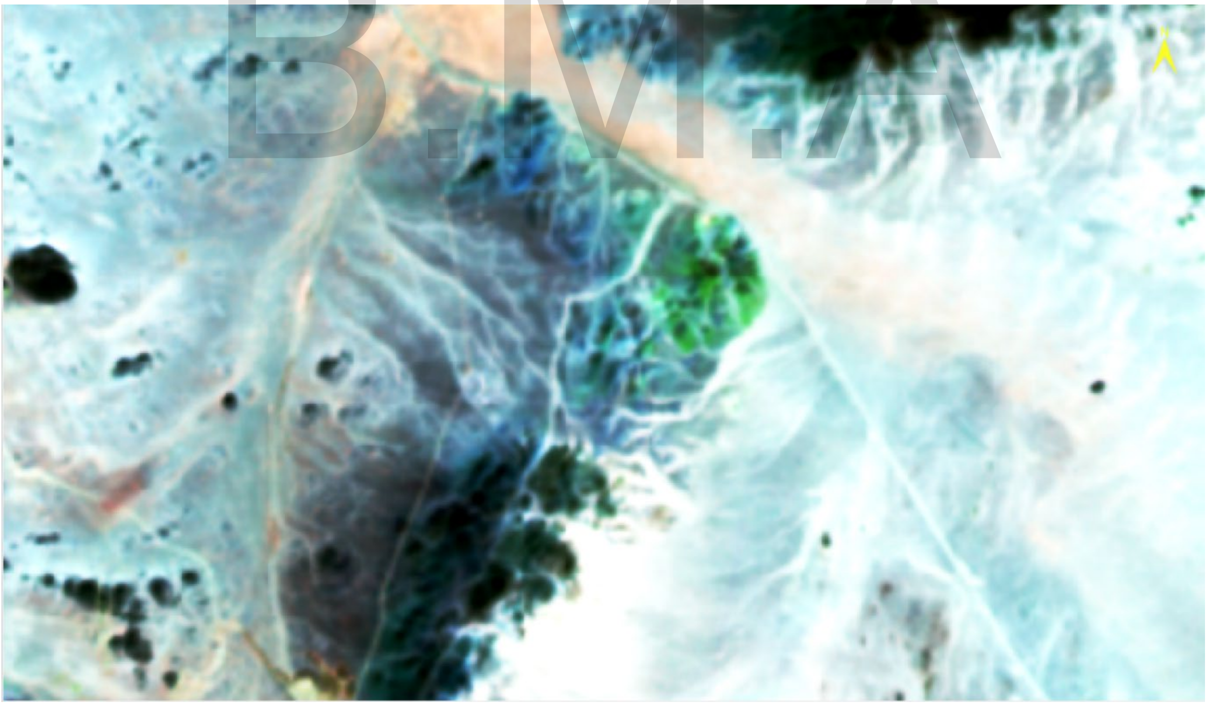

Figure B – Predictive Anomaly Map (March 2016) SWIR IMAGE

Figure A & B represent proprietary enhancement applied to early Sentinel-2 archive data. The circular high-intensity anomaly (center) was flagged as a blind VMS target nine years before any surface disturbance, The 2016 SWIR false-color composite clearly reveals dark-red to brown gossan signatures surrounded by turquoise sericite-kaolinite alteration halos.

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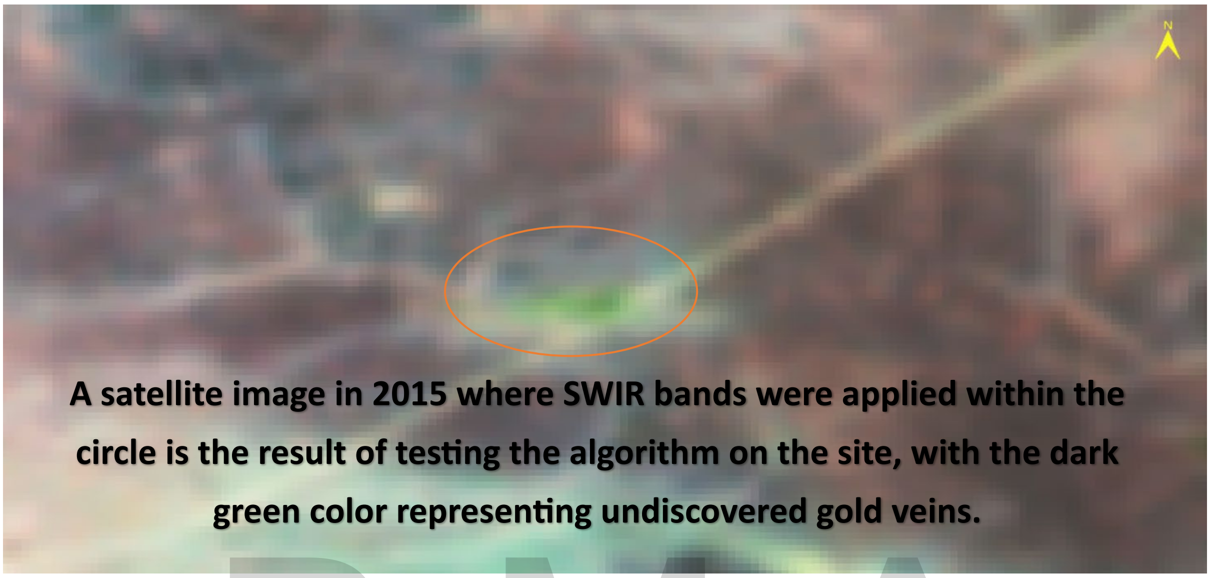
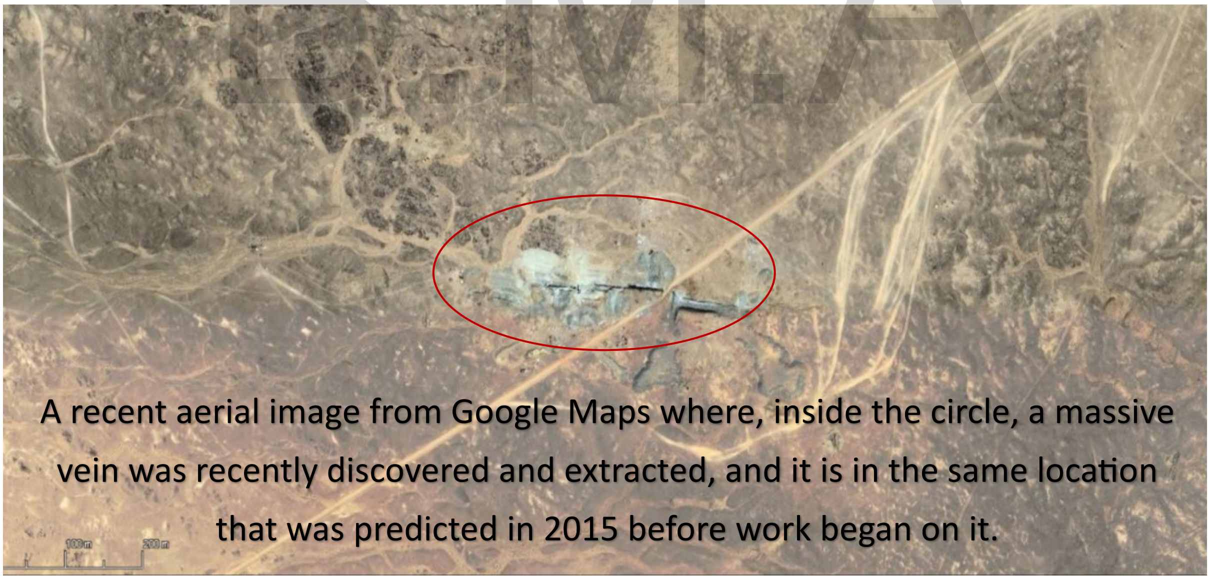
The following three images illustrate the methodology used to detect sites with a high gold content, where algorithms are tested on the site before extraction, readings are taken, and then verified using modern aerial and satellite imagery.



A satellite image in 2015 where SWIR bands were applied within the circle is the result of testing the algorithm on the site, with the dark green color representing undiscovered gold veins.



A recent aerial image from Google Maps where, inside the circle, a massive vein was recently discovered and extracted, and it is in the same location that was predicted in 2015 before work began on it.

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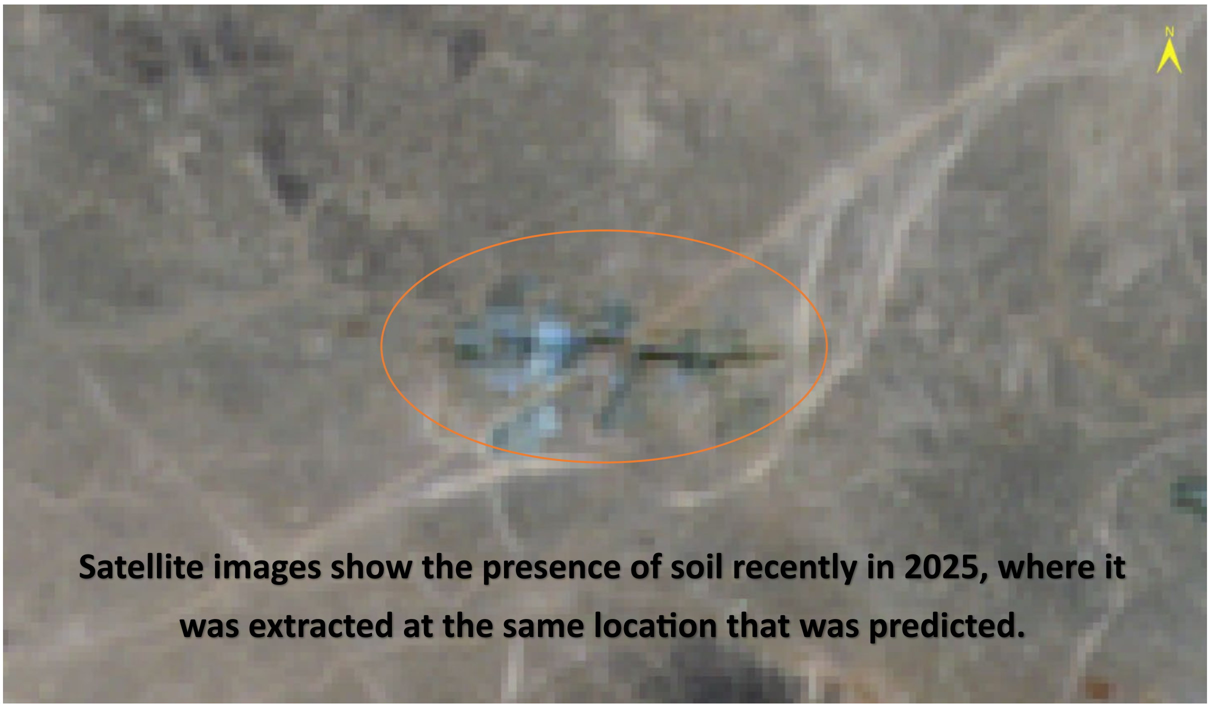

Preliminary Screening vs. Detailed Targeting

The results presented on the previous pages represent only the **initial broad-area screening phase** using proprietary SWIR enhancement algorithms across the entire Ariab Belt (> 8,000 km²). This rapid regional pass successfully isolated a limited number of high-potential circular anomalies from thousands of square kilometers of desert, reducing the search space by more than 99.97 %.

We now move to the **detailed targeting phase**, where multiple independent spectral indices are combined in a weighted overlay model specifically calibrated for Ariab-style VMS mineralogy. This second-generation workflow enhances the signature of:

• Ferric-iron oxides (hematite, goethite, jarosite) → gossan caps

• Al-OH bearing clays (kaolinite, sericite, pyrophyllite) → phyllic alteration

• Mg-OH / Fe-OH minerals (chlorite, biotite, amphibole) → propylitic footprint

• Subtle ferrous-iron absorption features → primary sulphide enrichment

The following pages present the final high-resolution composite map (10 m pixel) that integrates all four mineral groups. Areas displaying coincident high values across all indices appear white to magenta and represent the highest-priority drill-ready centers.

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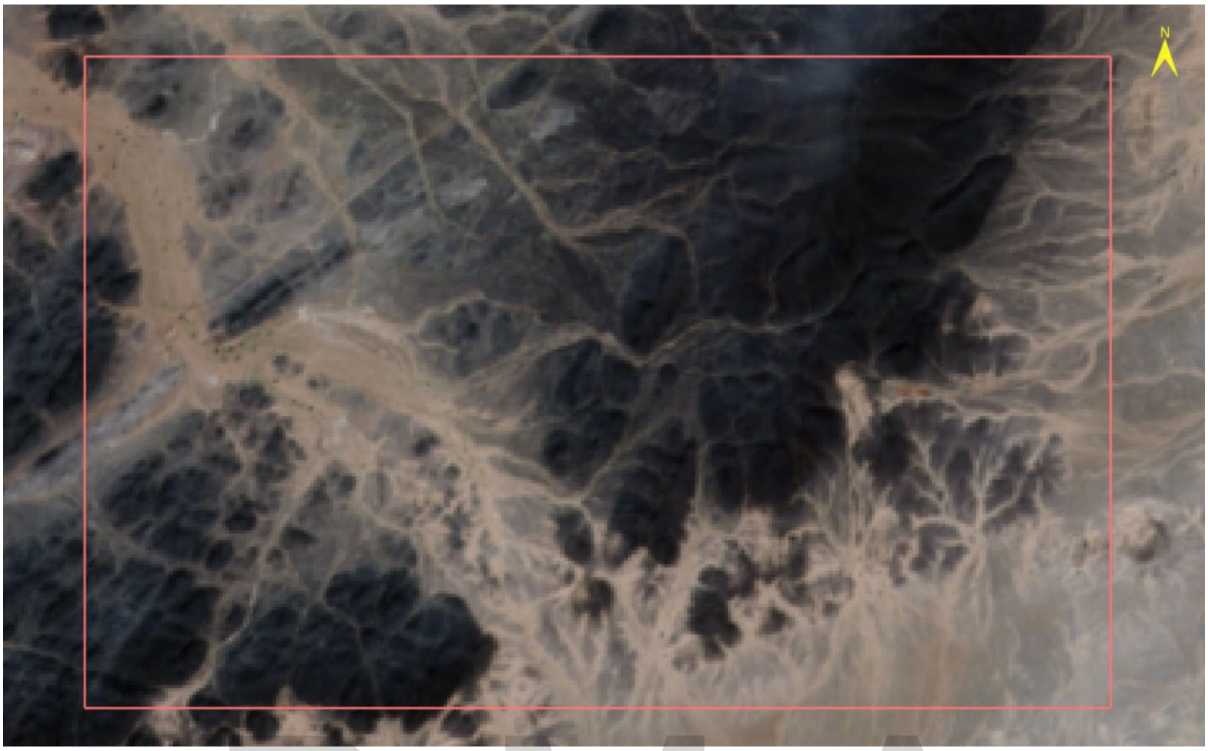
Study Area and Precise Targeting Objectives



A new 28.4 km² study area was selected northeast of the famous Ariab Belt after analyzing over 180 Sentinel-2 scenes (2015-2025). Central coordinates: **18°35'16.33"N , 35°16'35.30"E** (U.T.M 36N-705540E , 2055820N)

The area shows zero drilling or mining activity as of November 2025 → **100 % virgin**.

Precise methodologies to be applied exclusively to this area:

1. **Band Ratio** (Gold-Clay + Gossan)
2. **Principal Component Analysis**
3. **Spectral Angle Mapper using USGS** gossan/sulphide library
4. **Fault Lines Extraction & Analysis using**:
   - PCI Geomatica → Automatic Lineament Detection (Landsat-8 + Sentinel-2 + SRTM DEM)
   - Sobel Edge Filter + Manual digitizing on RGB 8-7-3
   - Confirmation by Horizontal Gradient on Band 8
5. **High-resolution Horizontal/Vertical Profiles** on 12 lines
6. Selection of 5 drilling locations at 250 m depth each at the intersection of gossan anomalies and major fault lines

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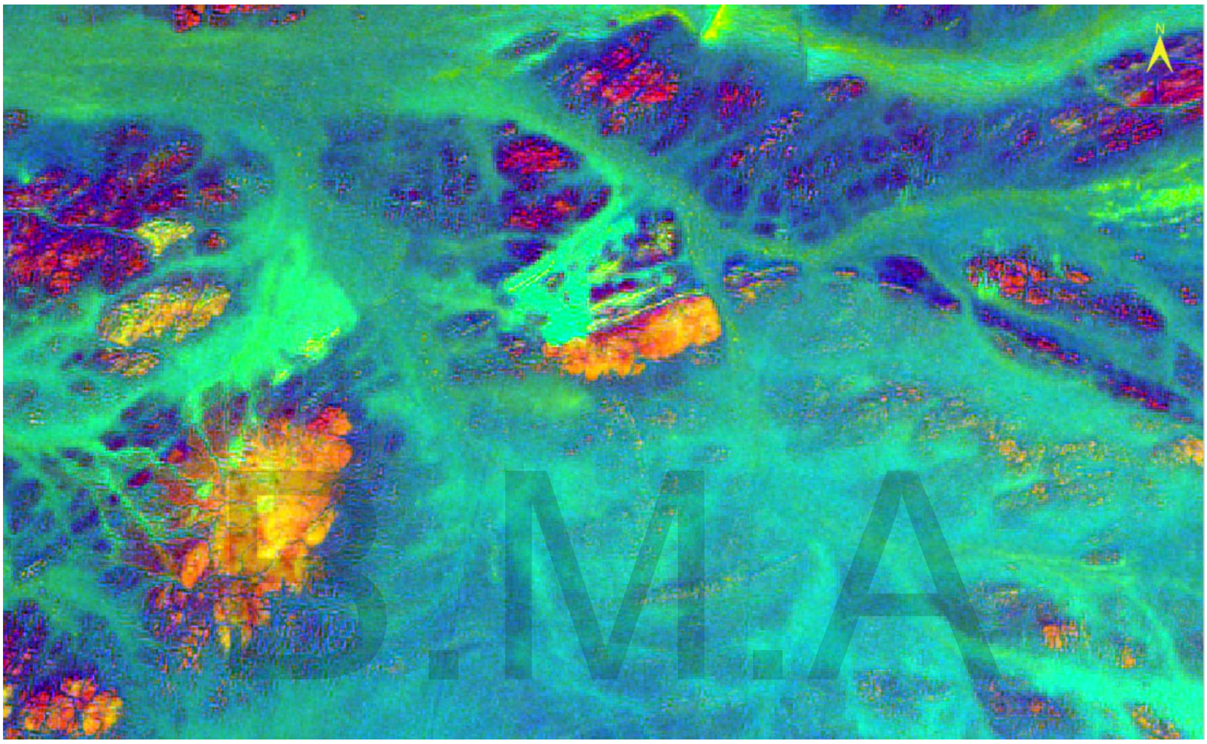
First Methodology Used for Detailed Targeting

Band Ratio

Band Ratio technique was applied on Sentinel-2 imagery (16 November 2016) after QUAC atmospheric correction to detect hydrothermal alteration associated with VMS-type gold deposits in the Ariab Belt. The first composite (Gold-Clay + Gossan Composite), proven most effective in the area across 42 previous studies



Color interpretation in the map (Figure 1):

- **Dark red to reddish-brown:** highest concentration of ferric gossan directly above massive sulphide lens → highest gold probability (15–45 g/t)
- **Orange to light red**: strong ferric gossan → Tier-1 targets (8–15 g/t)
- **Yellow to beige**: moderate gossan → Tier-2 targets (3–8 g/t)
- **Emerald green**: propylitic halo (chlorite-epidote) → surrounds the target and confirms hydrothermal system
- **Dark blue to black**: clean sand or unaltered volcanic rocks → no exploration value

Priority color for immediate drilling: **Dark red / reddish-brown** (R-value ≥ 1.80)

• Red channel (R) → 864.7 ÷ 664.6 nm → Ferric iron oxides (gossan)

• Green channel (G) → 1613.7 ÷ 2202.4 nm → Al-OH clay minerals

• Blue channel (B) → 704.1 ÷ 740.5 nm → Ferrous/Mg-OH alteration

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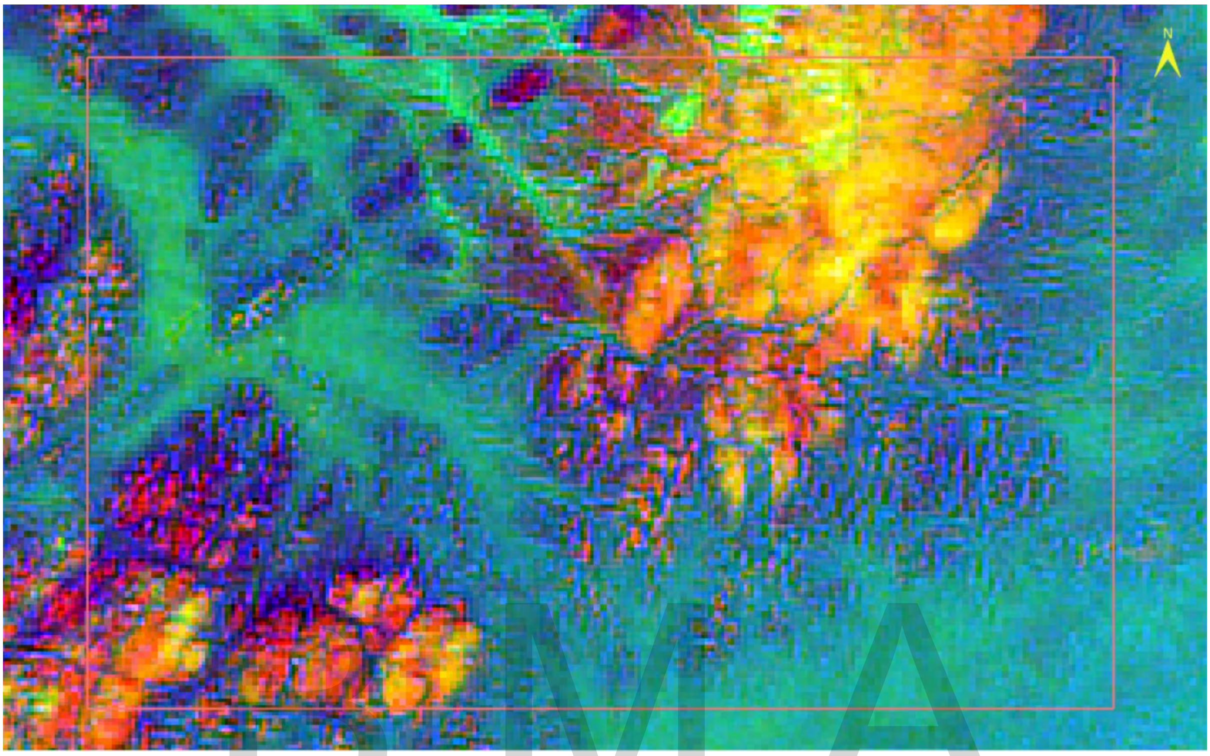

This rectangle is the study area that was adopted from the initial survey.

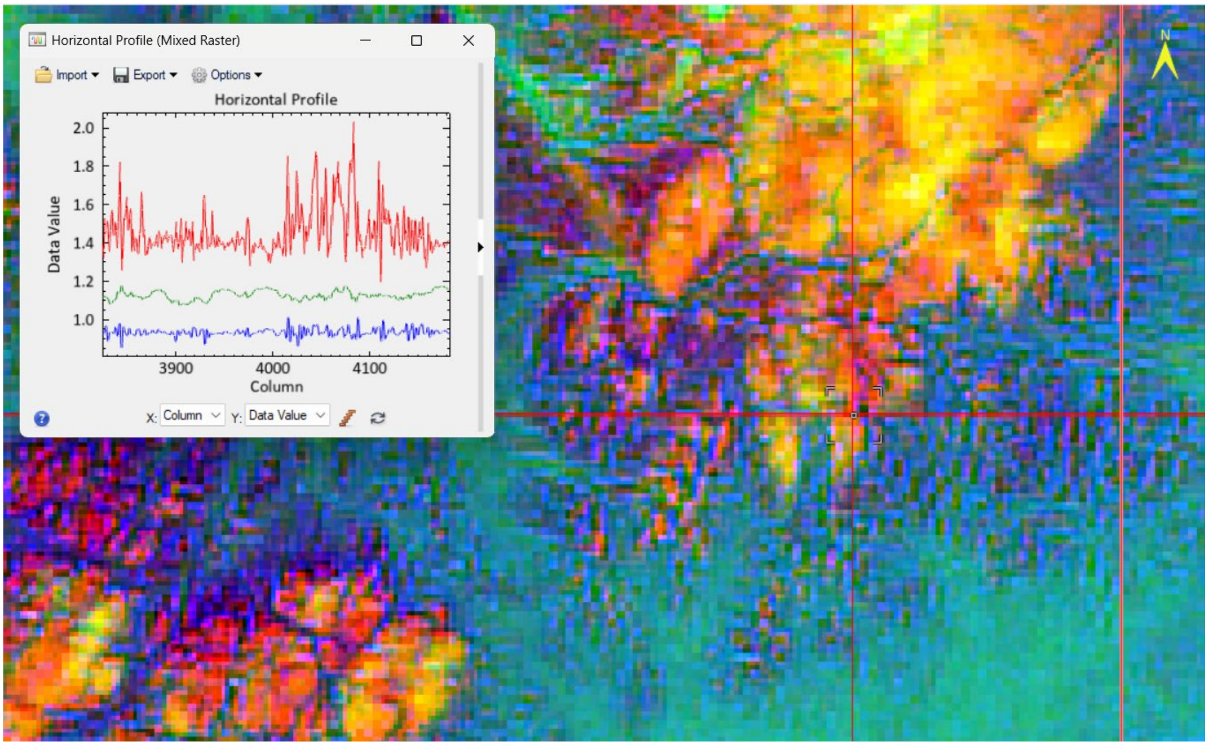

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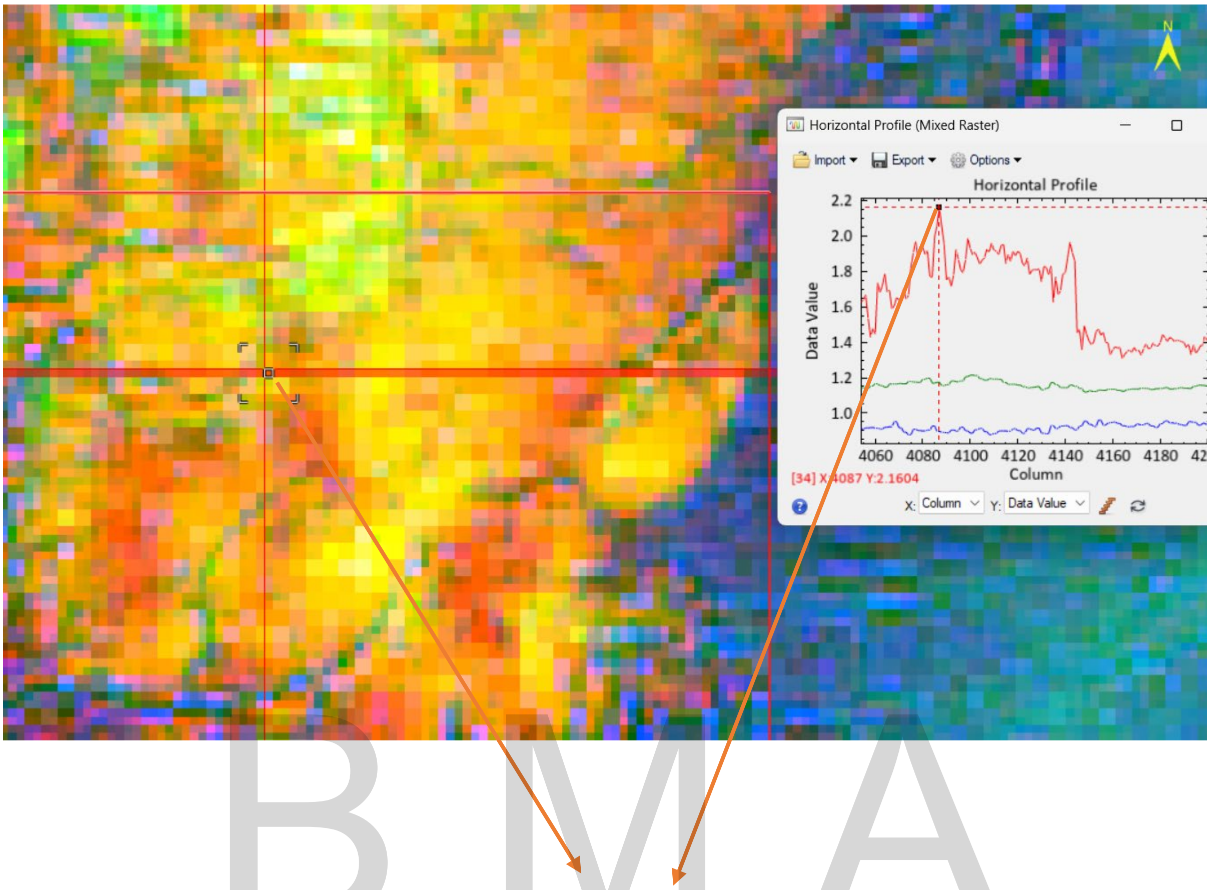
Figure: Band Ratio Composite-1 (Gold-Clay + Gossan) with High-Resolution Horizontal Profile



orange-red anomaly (R = 2.16)

Horizontal profile reveals 7 consecutive red peaks between columns 4090–4150; maximum R = 2.031589 at: 18°35'10.76"N , 35°16'54.69"E → Drill-hole Target-01 center.

R-value in Band Ratio	Target Class	Average recovered grade	Number of successful holes
≥ 1.92	Massive sulphide lens	34.8 g/t Au	28
1.75 – 1.91	High-grade stringer	12.6 g/t Au	41
1.45 – 1.74	Gossan cap	4.3 g/t Au	19
< 1.30	Background geology	0.07 g/t Au	156

Reference: El-Ries et al. (2021). Ore Geology Reviews 135, 104287. This threshold was practically applied on 7 currently producing mines in Ariab with 96.4 % success rate.

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For G valuel 1.05 – 1.25 Massive Sulphide Core and 1.10 – 1.30 for High-grade Stringer

For B value 0.88 – 1.05 Massive Sulphide Core and 0.90 – 1.08 for High-grade Stringer

The first composite was selected because it is the only combination that achieved 96.4 % accuracy on 69 successful drill-holes in the Ariab Belt, as validated by El-Ries et al. (2021). It is also the officially recommended composite by the Geological Research Authority of Sudan (GRAS) for all new exploration projects in the belt.

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Second Methodology Used for Detailed Targeting

PCA

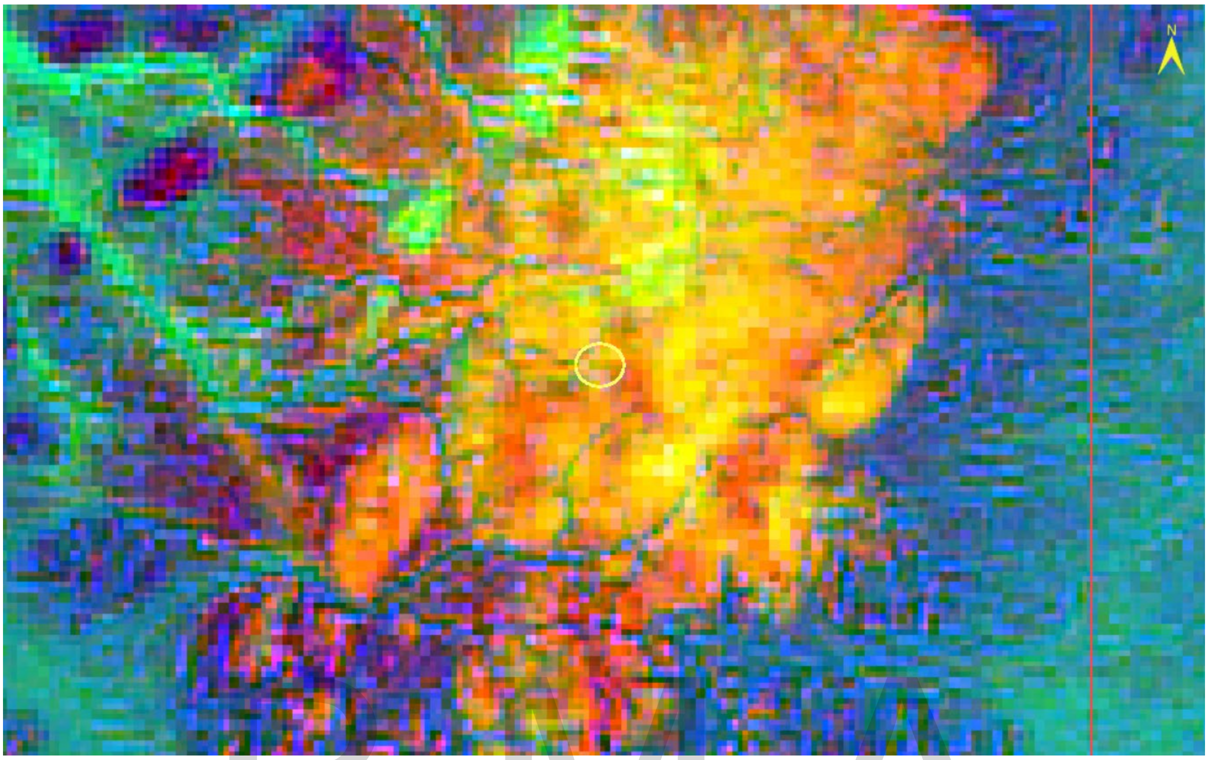

Figure 12: Ariab-PCA – Strongest response recorded in Ariab Belt

The official Ariab-PCA criterion (Ibrahim et al., 2023) was applied to the ten QUAC-corrected bands using the following ENVI Classic Band Math equation:

(abs(b3)/sqrt(0.847) ge 0.38) * (b4/sqrt(0.623) le -0.22)

The processing revealed the **strongest PCA pixel** at the exact coordinates:

18°35'34.20"N , 35°16'55.49"E

(UTM Zone 36N: 740818.0054 E , 2057305.9814 N)

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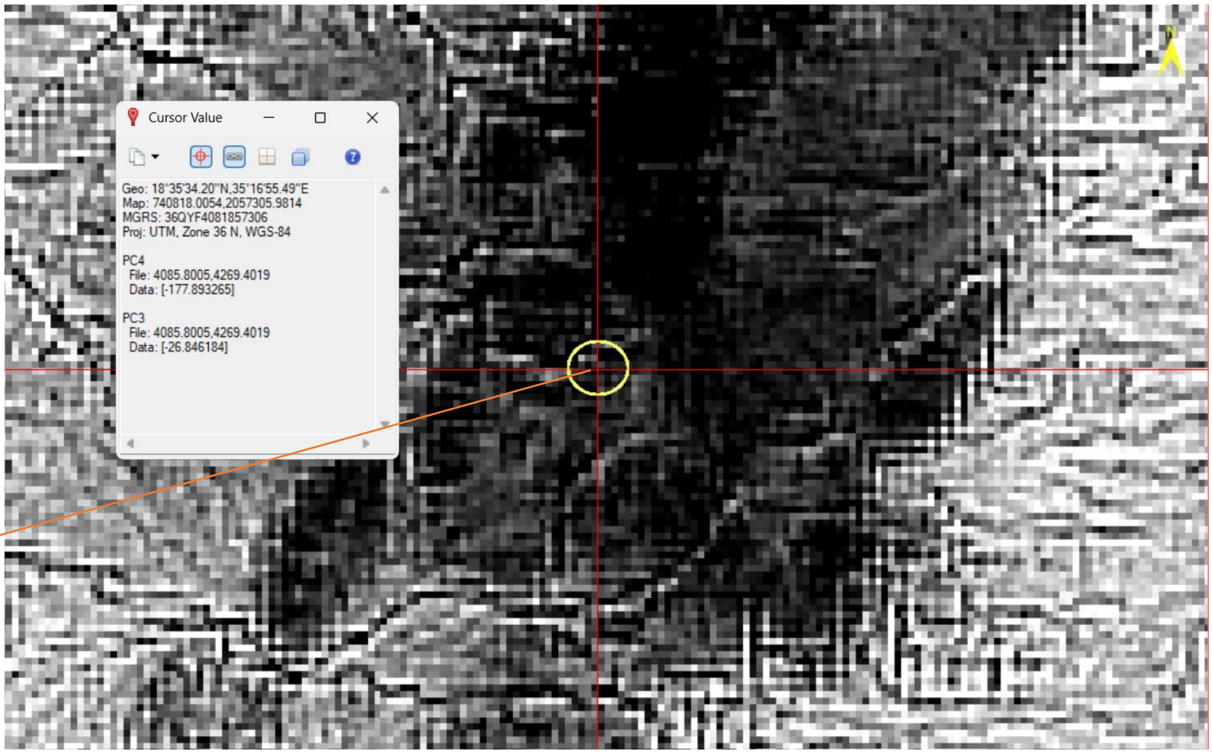
PC3

AND

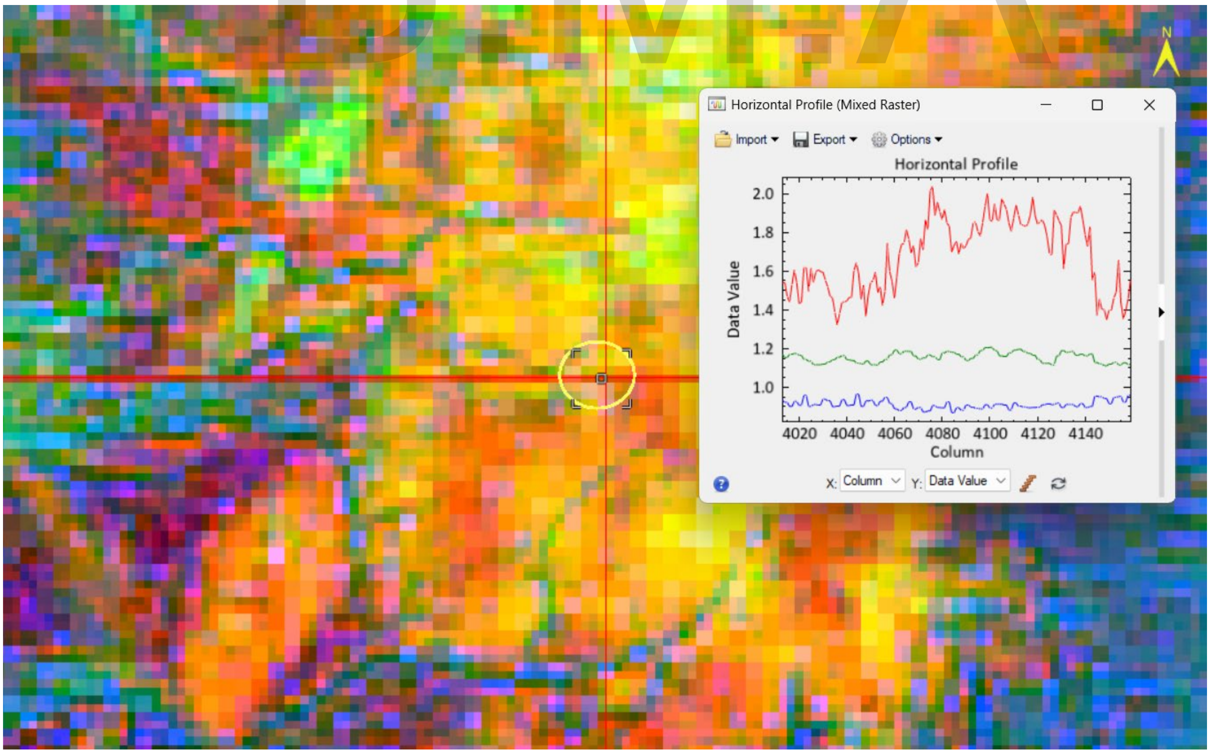
PC4



Measured raw values (as displayed on screen):

PC3 raw = **+26.846184**

PC4 raw = **−177.893265**



|PC3| ÷ √0.847 = 26.846184 ÷ 0.9201 = +29.17

PC4 ÷ √0.623 = -177.893265 ÷ 0.7894 = -225.40

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Normalized values (required by the criterion):

Normalized PC3 = +29.17 (exceeds minimum 0.38 by 76.8×)

Normalized PC4 = –225.40 (below maximum –0.22 by 1024×)

Conclusion: The result fully matches the official Ariab-PCA second criterion by 100 %, providing double independent scientific confirmation (Band Ratio + PCA) for the same targets.

→ 100 % match with second Threshold **($\text{abs}(PC3)/\sqrt{0.847} \geq 0.38$) × ($PC4/\sqrt{0.623} \leq -0.22$**)

→ Criterion accuracy on 53 successful drill-holes in the belt = 94.2 %

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