



AURUS MINING

From Signal to Target

Exploration geochemistry, sampling design and anomaly decisions

WP19 | EXPLORE

MINING | INFRASTRUCTURE | ENGINEERING | ENVIRONMENT

OUR POSITION

Exploration geochemistry under deep weathering cover works when teams build a chain of evidence. Start with regolith landform mapping and an orientation survey that proves the right sampling medium for the local dispersion model. Use fit for purpose analytical methods with explicit QA and compositional checks. Rank anomalies with multi element evidence, then

EVIDENCE FIRST | DECISIONS MADE EXPLICIT | DELIVERY CONDITIONS STATED

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Executive summary

WP19 frames deep weathering cover as the controlling variable in exploration geochemistry. Thick regolith is widespread in the tropical to subtropical belt between 40°N and 40°S and is commonly lateritic, with clay rich saprolite capped by iron and or aluminium enriched horizons formed under seasonally humid climates. The paper treats this cover as both a filter and a generator of signal. In relict and erosional terrains, surface and near surface geochemistry can work, but it is generally ineffective in most depositional regimes, where transported overburden breaks the link between surface chemistry and buried mineralisation. A documented exception is calcrete gold, where anomalies can penetrate 5 to 10 m of cover and pedogenic carbonate becomes the preferred sampling medium when present.

Sources: WP19-01, WP19-02, WP19-03, WP19-04

The method sequence begins before sampling. Regolith landform mapping is an essential first step because it enables a dispersion model, which then indicates the most appropriate sample medium and improves interpretation discipline. Mapping combines remote sensing and airborne radiometrics with field checking, but remote sensing only indicates surface materials and becomes a poor indicator of underlying regolith where transported or basin cover dominates. Where cover matters, preliminary drilling or deep pitting becomes essential to select sample media and interpret results. The paper flags a frequent failure mode: ferruginous lateritic residuum is a valuable medium but can be confused with low value sedimentary units, so accurate logging of profile units and boundaries is a technical task, not an administrative one.

Sources: WP19-07, WP19-08, WP19-09

Sampling design and anomaly decisions depend on how weathering redistributes elements. In lateritic weathering of lode gold, dispersion of gold is limited except in

upper horizons; leaching and depletion commonly affect the top 1 to 3 m with enrichment below, and if lateritic residuum is eroded the target dimensions collapse toward the bedrock target, changing required sampling density. Environment controls surface expression, from rainforest leaching that suppresses surface signals but strengthens drainage anomalies, to arid terrains where enrichment can extend to surface. Where gold itself is depleted, pathfinders such as As, Sb, W, Cu and Bi can provide a better expression than gold. For VHMS or base metals, lateritic residuum halos can be extensive and multi element, while truncated profiles without gossan may leave little trace.

Sources: WP19-10, WP19-11, WP19-13, WP19-14

The analytical chain of evidence is explicit. Fire assay remains the reference determination for gold in geochemical work, with published procedures specifying fusion charge masses and detection limits. Multi element pathfinder coverage is commonly achieved with an aqua regia super trace ICP MS or ICP AES schedule suited to sulphides and labile phases, while four acid digestion approaches total dissolution and is preferred where resistate minerals matter; method selection follows the deposit model and regolith setting, not a default menu. Portable XRF enters as field triage only: it screens base metals and pathfinders for rapid decisions, but it cannot determine gold at exploration concentrations, so it prioritises samples for laboratory fire assay and ICP MS rather than replacing them. Anomaly ranking then uses multi element, dispersion model informed judgement and integrates into follow up planning because residual anomalies can be broader and more findable than the primary lode.

Sources: WP19-20, WP19-21, WP19-22, WP19-23

At a glance

Six evidence markers establish the scale, threshold or decision condition carried into the chapters that follow.

40°N to 40°S

LATITUDINAL BELT WHERE THICK REGOLITH COVER IS ESPECIALLY CHARACTERISTIC, WITH A

Source: WP19-01

5 to 10 m

DOCUMENTED CALCRETE GOLD ANOMALY PENETRATION THROUGH COVER, SUPPORTING PEDOGENIC

Source: WP19-04

Top 1 to 3 m

TYPICAL ZONE OF GOLD LEACHING AND DEPLETION IN LATERITIC RESIDUUM, WITH

Source: WP19-10

Top 10 to 40 m

POSSIBLE SAPROLITE ZONE OF STRONG GOLD LEACHING AND DEPLETION IN ARID REGIONS

Source: WP19-12

0.002 ppm Au

LOWER DETECTION LIMIT FOR ALS AU-AA21 (30 G) AND AU-AA22 (50 G) FIRE ASSAY

Source: WP19-20

Bi 0.001 ppm; W 0.

REPRESENTATIVE SUPER TRACE PATHFINDER DETECTION LIMITS ON ALS ME-MS41L AQUA

Source: WP19-21

Method and boundaries

This paper is a bounded synthesis of registered public evidence. Source identifiers remain visible so that each quantitative or framework statement can be traced to its dossier row.

INTENDED READERS

- Exploration managers accountable for target pipelines under cover
- Field geologists and geochemists designing orientation surveys, sampling media and QA QC
- Data and GIS practitioners integrating compositional geochemistry with regolith maps, geophysics and drill planning

READING METHOD

- Read each chapter opener as a decision frame.
- Use the three section exhibits as working review instruments.
- Return to the evidence ledger before reusing any number or requirement.

BOUNDARIES

- Rows about termite mound geochemistry are supported at title and abstract or metadata level only, so the paper states qualitative findings and avoids numeric excavation depths or correlation coefficients. [WP19-16 to WP19-19]
- The calcrete gold anomaly penetration figure is carried through the archived Butt paper which cites Lintern 2002, but the Lintern primary is not separately archived, so it is treated as a carrier citation. [WP19-04]
- S&P budget, discovery and lead time figures are secondary capture transcriptions and are used as macro context only, not as method validation or performance evidence. [WP19-05, WP19-06, WP19-28]
- Portable XRF is treated qualitatively as triage only; no precision, error or quantitative capability claims are made. [WP19-23]
- Analytical detection limits and method codes are drawn from a single published commercial laboratory schedule and are framed as a representative benchmark, not an industry universal. [WP19-20, WP19-21]

PUBLICATION DISCIPLINE

- No client identity or company-age claim is published.
- No Aurus delivery result is inferred from public guidance.
- Dated forecasts retain their institution and vintage.

01

SIGNAL UNDER WEATHERING COVER

The geochemical signal

Deep tropical to subtropical weathering creates thick regolith and lateritic profiles that can either amplify or suppress ore related geochemical expression. This chapter frames the signal problem as a regolith controlled dispersion question, then sets the non

40°N to 40°S rego

LATITUDE BELT WHERE THICK REGOLITH COVER IS CHARACTERISTIC, ESPECIALLY OVER PREC | WP19-01

5 to 10 m

DOCUMENTED COVER THICKNESS THAT CALCRETE GOLD ANOMALIES CAN PENETRATE (ARCHIVED | WP19-04

Top 1 to 3 m

TYPICAL NEAR SURFACE LEACHING AND DEPLETION INTERVAL FOR GOLD IN LATERITIC RES | WP19-10

1.1 1.1 Cover, regimes, and what fails

Thick regolith cover is common across the tropical to subtropical belt between 40°N and 40°S, and it is especially extensive over Precambrian shields and adjacent basins. In many of these terrains, residual regolith evolves into lateritic profiles with clay rich saprolite and an iron or aluminium enriched horizon that may be patchy or partly eroded. Those profiles span long time windows, from Palaeozoic to present, with widespread late Mesozoic to early Tertiary deep weathering documented in South America, Africa and Australia. The practical consequence is that the geochemical signal is rarely a simple projection of bedrock into topsoil. The signal reflects profile architecture, landscape stability, and the boundary between residual and transported cover.

WP19-01, WP19-02

Surface and near surface geochemical techniques generally work in relict and erosional terrains but they are generally ineffective in most depositional regimes. That statement is not a warning against geochemistry. It is a warning against treating transported cover as a transparent filter. Butt notes that there are very few instances where significant anomalies in transported overburden can be reliably related to underlying mineralisation, even with special analytical techniques. The chain of evidence starts by classifying the regime and then selecting a sample medium that actually connects to mineralisation. Where a programme cannot establish that connection, it should treat any apparent anomaly as a hypothesis that needs physical validation. Under cover, that validation often begins with regolith observation, not with extra statistics.

WP19-03

DECISION INSTRUMENT

Decision framework: classify the regime before interpreting surface anomalies

Use this to decide whether a surface anomaly is interpretable as a mineralisation proxy or should be treated as a weak hypothesis until validated by regolith work.

TEST	EVIDENCE READING	DECISION RESPONSE
Residual or erosional terrain present	Surface and near surface geochemistry is generally effective in these regimes.	Proceed with surface sampling, but interpret against profile architecture and landscape stability.
Depositional regime dominates	Surface geochemistry is generally ineffective in most depositional regimes; reliable linkage to mineralisation is rare.	Defer anomaly claims until the programme establishes a physical connection to basement, typically via regolith characterisation.
Lateritic profile evident	Lateritic residual regolith commonly includes clay rich saprolite and iron or aluminium enriched horizons, sometimes eroded.	Treat each horizon as a distinct geochemical medium; avoid mixing materials that represent different dispersion histories.
Tropical to subtropical belt context	Thick regolith cover is characteristic between 40°N and 40°S and is extensive over shields and basins.	Assume cover is a first order control until mapping and field checks show otherwise.

Sources: WP19-01, WP19-02, WP19-03

1.2 1.2 Lateritic gold dispersion and the near surface target

In lateritic weathering of lode gold, Butt describes little gold dispersion except in the upper horizons. Within lateritic residuum, leaching and depletion typically occur in the top 1 to 3 m, with enrichment below. That pattern changes the exploration target. Instead of a narrow bedrock feature, the near surface expression can become broad and multi element, and it can sit at specific depths within the profile rather than at the surface. If lateritic residuum is preserved, that broadened dispersion can help reconnaissance because it produces a larger, more findable target. If the residuum has been eroded, the target in saprolite becomes similar in dimensions to the bedrock target. The sampling density decision changes accordingly, because the exploration problem shifts from finding a broad halo to resolving a narrow feature.

WP19-10, WP19-24

Climate and groundwater chemistry can suppress surface gold even where mineralisation exists. Butt contrasts rainforest and arid settings. In rainforest, stronger leaching lowers the surface expression but produces widespread drainage anomalies. In arid terrains, enrichment in lateritic residuum can continue to the surface, which makes surface sampling more direct. Butt also notes a distinct arid case where acid, saline groundwaters drive strong leaching and depletion of gold through the top 10 to 40 m of saprolite, with absolute supergene enrichment below. The supergene zone may matter to resources, but it commonly shows no greater dispersion target than the underlying lode. These settings require the programme to separate the question of enrichment from the question of dispersion footprint, because they do not always scale together.

WP19-11, WP19-12

DECISION INSTRUMENT

Decision framework: anticipate the gold signal from regolith and climate setting

Use this to decide whether to hunt for a broad near surface halo, a narrow saprolite target, or a pathfinder proxy when gold is depleted.

TEST	EVIDENCE READING	DECISION RESPONSE
Lateritic residuum preserved	Leaching and depletion in the top 1 to 3 m with enrichment below can create a broad multi element near surface target.	Design sampling to resolve a broad halo and to separate shallow depleted material from enriched residuum.
Lateritic residuum eroded	Saprolite target dimensions can revert toward bedrock target dimensions.	Increase sampling density or move to more targeted sampling, because the footprint may narrow.
Rainforest setting	Stronger leaching lowers surface expression but gives widespread drainage anomalies.	Expect weaker soil response; consider drainage focused media where appropriate and interpret soil cautiously.
Arid setting with lateritic residuum	Gold enrichment can continue to the surface, improving accessibility to surface sampling.	Treat surface residuum as a primary medium, while still controlling for horizon mixing.
Arid setting with acid, saline groundwater	Gold can be depleted through the top 10 to 40 m of saprolite with supergene enrichment below; dispersion may not broaden.	Do not assume a large surface footprint; plan for proxies and for physical testing where depletion is likely.

Sources: WP19-10, WP19-11, WP19-12

1.3 1.3 Pathfinder logic and anomaly meaning

When gold is depleted or weakly expressed at surface, Butt points to pathfinder elements as the practical signal carriers. In these settings, the appropriate pathfinders for gold include As, Sb, W, Cu and Bi. Where the depleted zone outcrops or sits beneath transported cover and no pedogenic carbonate is present, pathfinders can express mineralisation better than gold itself. This is not a licence to chase any multi element noise. The chain of evidence still requires a dispersion model that explains why the elements should co locate and why the sample medium should contain them. The purpose of pathfinders is to recover interpretability where gold becomes a poor tracer, and to keep follow up decisions grounded in mineral system chemistry rather than in single element thresholds.

WP19-13, WP19-25

For VHMS and related base metal targets, Butt describes how lateritic residuum can carry an extensive dispersion halo defined by Cu, Zn and Au and by Bi, As, Sb and Sn. He also warns that saprolite may show little widespread dispersion halo, so a truncated profile without a gossan may leave little trace of mineralisation. This contrast matters for anomaly ranking. A programme can rank a lateritic residuum anomaly higher when the element suite matches the expected halo and the regolith setting supports preservation. Conversely, a weak saprolite signal does not automatically de risk a target if the profile is truncated. Ranking should therefore integrate the regolith architecture with the element suite, and it should recognise where absence of evidence is expected under the dispersion model.

WP19-14, WP19-25

DECISION INSTRUMENT

Decision framework: use pathfinder suites, not single element thresholds

Use this to decide whether an anomaly is chemically credible given the deposit model and the regolith setting.

TEST	EVIDENCE READING	DECISION RESPONSE
Gold target with depleted surface gold	As, Sb, W, Cu, Bi can express mineralisation better than gold where depletion affects gold response.	Rank anomalies by coherence of the pathfinder suite and by regolith context, not by gold alone.
Transported cover without pedogenic carbonate	Where the depleted zone subcrops beneath transported cover and no pedogenic carbonate is present, pathfinders improve expression.	Shift anomaly criteria to pathfinder patterns and validate with regolith characterisation.
VHMS or base metal target in lateritic residuum	Lateritic residuum halo can include Bi, As, Sb, Sn in addition to Cu, Zn, Au.	Treat multi element halos in lateritic residuum as meaningful where the profile is preserved.
Truncated profile or saprolite without gossan	Saprolite may show little widespread dispersion; truncated profiles can leave little trace.	Do not downrank solely on weak saprolite geochemistry; require regolith logging evidence before excluding targets.
Anomaly ranking approach	Anomaly ranking is a multi element, dispersion model informed judgement.	Document the model assumption behind each ranked anomaly and the medium that carries the signal.

Sources: WP19-13, WP19-14, WP19-25

02

ORIENTATION AS RISK CONTROL

Orientation before scale

A disciplined sequence starts with regolith landform mapping, then field characterisation by drilling or deep pitting, then sample medium selection and pathfinder led analysis interpreted against dispersion models. This chapter frames orientation as the step

Sequence of 5 step

DOCTRINE SEQUENCE: MAPPING, DRILLING OR DEEP PITTING, MEDIUM SELECTION, PATHFI | WP19-27

Remote sensing and

REMOTE SENSING INDICATES SURFACE MATERIALS ONLY AND IS POOR FOR UNDERLYING REG | WP19-08

15.7 years

AVERAGE DISCOVERY TO PRODUCTION LEAD TIME ACROSS 127 MINES STARTING PRODUCTION | WP19-06

2.1 2.1 The method sequence, stated plainly

Butt states a method sequence that functions as doctrine in covered terrains. It starts with regolith landform mapping, then field characterisation by drilling or deep pitting, which is essential under transported cover. Only after that work does the programme select the sample medium, driven by the regolith model. It then applies pathfinder led multi element analysis and interprets the results against dispersion models validated by local orientation and case studies. The doctrine also contains a negative rule. Generic templates applied without this sequence fail in depositional regimes. The central editorial point is that orientation is not a small pilot run of a preferred template. Orientation is where the programme tests whether its chosen medium can carry an ore related signal and whether the planned analytical approach can discriminate background from dispersion in the actual regolith setting.

WP19-27, WP19-03

Regolith landform maps are not a cartographic deliverable. Butt calls them an essential first step because they let the programme model ore related element dispersion. That modelling supports two downstream decisions: it indicates the most appropriate sample medium and it assists interpretation of the resulting data. The mapping workflow combines remote sensing and field checking, and Butt notes that remote sensing indicates surface materials only and becomes a poor indicator of underlying regolith under transported or basin cover. Airborne electromagnetic systems can map regolith thickness, palaeochannels and an outline stratigraphy in three dimensions. Taken together, those points set a clear orientation task list. The programme must map what it can see, then test what it cannot see, and only then design the sampling grid. Skipping that progression forces interpretation to carry uncertainty that fieldwork could have resolved early.

WP19-07, WP19-08

DECISION INSTRUMENT

Decision framework: pass or fail gates for an orientation survey

Use this to decide when a project can scale a geochemical survey and when it must return to regolith work.

TEST	EVIDENCE READING	DECISION RESPONSE
Gate 1: regolith landform map completed	Regolith landform mapping is an essential first step; it enables dispersion modelling and medium selection.	Do not scale sampling until the map supports a defensible dispersion model.
Gate 2: transported cover assessed	Remote sensing indicates surface materials only and is a poor indicator under transported or basin cover.	Require field checking and, where needed, subsurface testing before interpreting surface geochemistry.
Gate 3: 3D context established	Airborne EM can map regolith thickness, palaeochannels and outline stratigraphy in three dimensions.	Use 3D cover architecture to constrain where a medium can plausibly carry an anomaly.
Gate 4: medium chosen from model	Sample medium selection is driven by the regolith model, not by default templates.	Record the model basis for the medium and the expected element suite.
Gate 5: interpretation model stated	Multi element analysis is interpreted against dispersion models validated by local orientation and case studies.	Document assumptions and validation observations before ranking anomalies for follow up.

Sources: WP19-07, WP19-08, WP19-27

2.2 2.2 Orientation drilling and profile logging as evidence

Butt makes the fieldwork requirement explicit. Preliminary fieldwork should include drilling or deep pitting, and this becomes essential where transported cover is present. The reason is operational. Under cover, the programme cannot choose a meaningful sampling medium without seeing the profile units and boundaries that connect surface materials to the deeper regolith. Butt also notes a common failure mode. Ferruginous lateritic residuum is an important sample medium, yet it is readily confused with sedimentary units of little sampling value. Accurate logging of profile units and boundaries is therefore critical, and he warns against delegating that task to inexperienced geologists. In practice, this means orientation drilling does not serve only to measure cover thickness. It also validates that the material being sampled represents the intended horizon and dispersion process. Without that validation, a survey can generate precise numbers that describe the wrong medium.

WP19-09, WP19-07

Generalised dispersion and exploration models can guide early design because lateritic landscapes show genetic similarity across climatic zones. Butt notes that these generalised models can predict the broad geochemical expression of mineralisation and guide sampling strategies even where little prior information exists. He also draws a boundary around what generalisation can do. Finer, region and commodity specific dispersion detail requires local orientation and case studies. This distinction should shape how a programme records orientation outcomes. The purpose is not to prove the textbook model true. The purpose is to identify where local controls change the expected element suite, the horizon that carries the signal, or the footprint size. Those are the variables that later drive sampling density, analytical method, and anomaly ranking. If orientation fails to resolve them, the scaled survey will carry the uncertainty forward into every decision stage.

WP19-26, WP19-27

DECISION INSTRUMENT

Decision framework: profile evidence needed to trust a sample medium

Use this to decide whether surface materials are being sampled as intended or whether the programme must return to regolith characterisation.

TEST	EVIDENCE READING	DECISION RESPONSE
Transported cover suspected	Drilling or deep pitting is essential where transported cover exists.	Collect subsurface evidence before selecting a surface medium as a proxy for mineralisation.
Lateritic residuum targeted	Ferruginous lateritic residuum is important but can be confused with sedimentary units of little sampling value.	Require logged boundaries and material descriptions that separate residuum from sediments.
Logging responsibility assigned	Accurate logging is critical and is too often delegated to inexperienced geologists.	Assign experienced logging oversight and document decisions on horizon picking.
Using generalised models	Genetic similarity supports generalised dispersion and exploration models.	Start with the general model, but treat it as a hypothesis pending local checks.
Need local detail	Finer dispersion detail requires local orientation and case studies.	Scale only after orientation defines the local horizon, element suite, and footprint expectations.

Sources: WP19-09, WP19-26

2.3 Why discipline matters in a constrained discovery market

S&P Global Market Intelligence reports that global gold exploration budget fell about 7% to roughly US\$5.55 billion in 2024, with grassroots spending around 19% of the gold total, down from about 50% in the mid 1990s. Across 2020 to 2024, only six major gold discoveries were made, with about 27 million ounces total, and none in 2023 to 2024. It also reports that the average new deposit size has fallen to about 4.4 million ounces over the recent five years versus about 7.7 million ounces in the prior decade. These figures do not prove any method choice. They frame the cost of weak method discipline. When fewer discoveries occur and fewer dollars fund early stage work, the tolerance for surveys that do not connect sampling media to regolith processes becomes low. Orientation becomes a control on wasted follow up, not an academic preference.

WP19-05

S&P also reports that discovery to production lead time averaged 15.7 years across 127 mines with production starts from 2002 to 2023, with a range of 6 to 32 years. It rises to 17.9 years for mines started 2020 to 2023 versus 12.7 years fifteen years earlier, and almost 12 of those years are spent in discovery, exploration and studies. This time structure changes how early decisions compound. A reconnaissance programme that selects the wrong medium or the wrong digestion can lose a field season, but the deeper cost is that it can force later teams to backfill missing evidence. Butt's sequence offers a way to push uncertainty reduction forward in time. It cannot shorten permitting or construction, but it can reduce the probability that early geochemistry sends the team into the wrong follow up cycle. Under long lead times, that matters as much as any single anomaly.

WP19-06, WP19-28

DECISION INSTRUMENT

Decision framework: treat orientation as schedule and capital protection

Use this to justify orientation effort when budgets and timelines constrain the number of shots on goal.

TEST	EVIDENCE READING	DECISION RESPONSE
Grassroots funding constrained	Grassroots is about 19% of the gold total, down from about 50% in the mid 1990s.	Prioritise early design correctness because fewer grassroots programmes can absorb rework.
Discoveries scarce	Only six major gold discoveries across 2020 to 2024 and none in 2023 to 2024.	Avoid generic templates; require evidence that the medium can carry a signal in the local regolith setting.
Deposits smaller on average	Average new deposit size about 4.4 million oz vs about 7.7 million oz prior decade.	Increase focus on subtle, model consistent multi element signals rather than relying on large single element contrasts.
Long lead times	Discovery to production averages 15.7 years; almost 12 years in discovery, exploration and studies.	Front load uncertainty reduction via mapping, profile evidence, and orientation validated dispersion models.
Sequence discipline	Butt's sequence explicitly orders mapping, drilling or deep pitting, medium choice, multi element analysis, model based interpretation.	Use the sequence as a gate before scaling sampling density or committing to drilling.

Sources: WP19-05, WP19-06, WP19-28, WP19-27

03

CHOOSE MEDIA THAT CAN CARRY THE STORY

Sampling media and support

Sampling media decisions start with regolith landform mapping and subsurface profile evidence. Lateritic residuum, saprolite, pedogenic carbonate, and biological constructs such as termite mounds can each carry distinct signals, while analytical choices must

Pedogenic carb

CALCRETE GOLD ANOMALIES CAN PENETRATE 5 TO 10 M OF COVER; PREFERRED MEDIUM IN | WP19-04

Termite mounds

ESTABLISHED WEST AFRICAN SURFACE MEDIUM WHERE TERMITES BRING SUBSOIL FROM DEPT | WP19-16

Golden Grove halo

LATERITIC RESIDUUM HALO DEFINED BY BI, AS, SB, SN PLUS CU, ZN, AU FOR VHMS; SA | WP19-14

3.1 3.1 Lateritic residuum and saprolite are not interchangeable

Butt treats lateritic residuum as a primary medium when it is correctly identified and preserved. In lode gold terrains, he describes a pattern of limited dispersion except in upper horizons, with leaching and depletion typically in the top 1 to 3 m and enrichment below. That profile can create a broad multi element near surface target. However, if the lateritic residuum is eroded, the target in saprolite becomes similar in dimensions to the bedrock target. The exploration implication is direct. The same commodity and same mineralisation style can require different sampling densities depending on which part of the profile survives. Programmes that sample “soil” without separating residuum from saprolite risk diluting the signal with material that either has been depleted or never carried the ore related dispersion. A defensible medium choice therefore starts with profile logging and horizon picking, not with a default grid.

WP19-10, WP19-09

For VHMS and base metal targets, Butt provides a caution that reinforces the medium distinction. At Golden Grove, lateritic residuum carries an extensive dispersion halo defined by Bi, As, Sb and Sn in addition to Cu, Zn and Au. In contrast, he notes little widespread dispersion halo in saprolite. A truncated profile without a gossan may therefore leave little trace of mineralisation. This contrast should change how a team treats negative results. A weak saprolite response does not carry the same meaning as a weak lateritic residuum response, because the medium may not be capable of carrying the halo. The chain of evidence must include a statement of which profile unit was sampled and why that unit should contain the halo. Without that statement, anomaly ranking becomes a contest of thresholds rather than an evaluation of dispersion plausibility.

WP19-14, WP19-25

DECISION INSTRUMENT

Decision framework: select between lateritic residuum and saprolite media

Use this to decide which regolith unit can plausibly carry the target element suite and how to treat negative results.

TEST	EVIDENCE READING	DECISION RESPONSE
Lateritic residuum present and correctly identified	Lateritic residuum can host broad multi element targets for gold; it can host extensive halos for VHMS style targets.	Prefer residuum sampling where preserved; document horizon criteria and avoid mixing with other units.
Residuum eroded or absent	Saprolite targets can narrow toward bedrock dimensions for gold; saprolite can show little widespread halo for some base metal targets.	Tighten sampling density expectations and treat weak saprolite signals cautiously.
VHMS target without gossan and profile truncated	Truncated profiles may leave little trace in saprolite.	Do not exclude targets solely on saprolite geochemistry; require regolith evidence before ranking down.
Gold in lateritic profile	Leaching and depletion often occurs in the top 1 to 3 m with enrichment below.	Separate shallow depleted material from deeper enriched residuum during sampling and interpretation.
Anomaly ranking rule	Ranking is multi element and dispersion model informed, not a single element threshold.	Tie each anomaly to a stated model of which unit carries which elements and why.

Sources: WP19-10, WP19-14, WP19-25

3.2 3.2 Calcrete and termite mounds as special purpose media

Butt records a documented exception to the general ineffectiveness of surface methods in depositional regimes. Gold anomalies in calcrete, meaning pedogenic carbonate, can penetrate 5 to 10 m of cover. He describes pedogenic carbonate as the preferred sample medium in residual soils or where cover is less than 10 m thick, while noting that concentrations and contrasts are low, targets are small, and the method usually applies to gold only. This framing matters because it constrains how the medium should be used. Calcrete sampling is not a general substitute for profile work. It is a special purpose option when the cover thickness and carbonate development match the conditions under which a signal can traverse cover. A programme that uses calcrete should state these preconditions explicitly, then use orientation to confirm the presence and continuity of pedogenic carbonate before scaling a grid.

WP19-04, WP19-03

Termite mound sampling is presented in the literature as an established surface exploration medium in parts of West Africa. The stated mechanism is that mound building termites bring subsoil up from depth as they forage toward the water table, so mound material integrates deeper regolith than ordinary surface soil. That integration can carry a geochemical signal of mineralisation beneath shallow transported cover and complex regolith. A classic demonstration reports that gold is concentrated in termite mound material relative to surrounding soil over a gold anomaly in Kalahari sand. The method also generalises beyond gold, with studies reporting use for chromite and for rare earth element prospecting, and it has been combined with high resolution airborne geophysics as a reconnaissance medium over concealed terrain. The evidence in this dossier supports qualitative applicability, not numeric depth claims or correlation coefficients. The practical decision is whether mound material plausibly samples below a disturbed surface horizon in the local setting.

WP19-16, WP19-17, WP19-19, WP19-18

DECISION INSTRUMENT

Decision framework: when to deploy calcrete or termite mound sampling

Use this to decide whether these media add information beyond conventional soil and regolith unit sampling.

TEST	EVIDENCE READING	DECISION RESPONSE
Pedogenic carbonate present	Calcrete gold anomalies can penetrate 5 to 10 m; preferred where cover is less than 10 m thick in residual soils.	Use calcrete as a targeted medium for gold where preconditions are met and orientation confirms carbonate continuity.
Expect low contrast targets	Calcrete contrasts can be low and targets small, usually gold only.	Design tighter quality controls on sample selection and interpret anomalies as subtle signals requiring follow up.
Complex regolith with shallow transported cover	Termite mounds integrate deeper regolith than ordinary surface soil and can carry a signal beneath shallow cover.	Trial mound sampling where surface soil is likely to be decoupled from deeper regolith; document mound selection criteria.
Need proof of concept for gold	Gold concentration in termite mound material relative to surrounding soil reported over a gold anomaly in Kalahari sand.	Use a local orientation comparison of mound versus soil as an evidence check before scaling.
Multi commodity reconnaissance intent	Termite mound materials reported as tools for chromite and rare earth element prospecting and used with airborne geophysics over concealed terrain.	Consider mounds for early screening across commodities, but keep claims qualitative unless local calibration supports more.

Sources: WP19-04, WP19-16, WP19-17, WP19-18

3.3 Analytical support choices follow the medium and model

Analytical method selection is target dependent, and the dossier sets a clear rule. Aqua regia is a partial digestion, near total for sulphides and labile phases, and it suits pathfinder soil and sediment surveys because it dissolves sulphides and releases weakly bound elements. In the referenced ALS schedule, the ME MS41L aqua regia super trace approach uses about 0.5 g sample digested in 75% aqua regia in a graphite block, and it reports low detection limits for pathfinders such as Bi and W at 0.001 ppm and Sb at 0.005 ppm. Four acid digestion approaches total dissolution and becomes preferred where resistate or refractory hosts must be reported, including Ni, Co, Cr, Sn and W in resistant minerals. But reinforces the principle that the choice is made from the deposit model and regolith setting, not by default. In practice, this means the programme should document why its digestion matches the expected host phases in the chosen medium.

WP19-21, WP19-22

Gold determination remains a special case because it requires a reference method when decisions progress toward drilling. The ALS schedule describes fire assay with lead collection fusion as the reference determination for gold in geochemistry. Au AA21 uses a 30 g fusion charge with a lower detection limit of 0.002 ppm Au and an upper limit of 1 ppm before over range reruns. Au AA22 uses a 50 g charge with the same 0.002 ppm detection limit. The paper should treat these as representative published benchmarks, not as universal performance. They provide a practical design anchor when a programme needs to reconcile low level reconnaissance results with follow up sampling. They also clarify the division of labour for field screening tools. Portable XRF reads suites of base metals and pathfinders rapidly for non destructive screening and survey levelling, but it cannot determine gold at exploration concentrations, so it triages targets and prioritises samples for laboratory fire assay and ICP MS rather than replacing them. This keeps the chain of evidence coherent from field decisions to lab confirmed assays.

WP19-20, WP19-23

DECISION INSTRUMENT

Decision framework: pair digestion and detection strategy to the deposit model

Use this to decide which laboratory methods and field screening tools support the chosen sample medium and element suite.

TEST	EVIDENCE READING	DECISION RESPONSE
Pathfinder soil or sediment survey	Aqua regia dissolves sulphides and releases weakly bound elements; suited to pathfinder surveys.	Select an aqua regia ICP method when labile and sulphide hosted pathfinders are central to the model.
Need resistate element reporting	Four acid digestion approaches total dissolution; preferred for Ni, Co, Cr, Sn, W in resistant minerals.	Select four acid digestion when the deposit model expects resistate or refractory hosts to control the signal.
Gold confirmation required	Fire assay is the reference determination; Au AA21 30 g and Au AA22 50 g both list 0.002 ppm lower detection limits.	Use fire assay for gold decision points and for confirmation of any gold anomalism indicated by proxies.
Field triage and levelling	Portable XRF reads base metals and pathfinders for rapid screening; it cannot determine gold at exploration concentrations.	Use pXRF to triage and prioritise, then send selected samples for lab ICP and fire assay.
Selection principle	Choice is made from the deposit model and regolith setting, not by default.	Document the model assumption behind each method choice and the expected host phase in the sampled horizon.

Sources: WP19-21, WP19-22, WP19-20, WP19-23



04

EXECUTE THE SURVEY AS AN EVIDENCE SYSTEM

Field design and custody

Field design converts a regolith model into an executable sampling plan and an interpretable dataset. The chain of evidence depends on mapping, correct horizon identification, target dependent analytical choices, and disciplined anomaly ranking based on multi

30 g and 50 g

REPRESENTATIVE FIRE ASSAY FUSION CHARGES IN ALS METHODS AU AA21 AND AU AA22; | WP19-20

Bi and W 0.001

ppm

REPRESENTATIVE REPORTABLE DETECTION LIMITS FOR PATHFINDERS IN ALS ME MS41L AQUA | WP19-21

pXRF for triage,

PORTABLE XRF SUPPORTS RAPID SCREENING AND SURVEY LEVELLING FOR BASE METALS AND | WP19-23

4.1 4.1 Sampling design starts from dispersion geometry

Sampling design should be an explicit translation of dispersion geometry into spacing and medium rules. Butt notes that residual regolith can be in place, and secondary dispersion can produce targets broader than the primary mineralisation itself. A residual near surface anomaly can therefore be a larger, more findable target than the lode. This is the opportunity that offsets the challenge of cover. The same text also sets a constraint. If lateritic residuum is eroded, the saprolite target becomes similar in dimensions to the bedrock target. That shifts the spacing decision from finding a broad halo to resolving a narrow feature. Design should therefore begin with a statement of the expected footprint size in the selected horizon, derived from the regolith model and validated by orientation observations. This statement can then control whether the programme uses wide reconnaissance spacing, tighter infill, or targeted transects, without forcing the data to answer a question the spacing cannot resolve.

WP19-24, WP19-10

The design must also address the failure of generic templates in depositional regimes. Butt states that regolith landform mapping should come first, followed by field characterisation by drilling or deep pitting, then medium selection from the regolith model, then pathfinder led multi element analysis interpreted against dispersion models validated by local orientation and case studies. This sequence is not a narrative preference. It is an engineering logic for survey design. Mapping and profile evidence define where a medium can plausibly carry a signal. Multi element analysis then supplies the chemical discrimination needed to rank anomalies. Under transported cover, remote sensing is limited to surface materials, so the design should include the field checks that confirm what the sampling grid is actually sampling. If the programme cannot show that sampled material is the intended horizon, the later statistical processing will only produce precise artefacts. A sound design therefore records the mapping units, the horizon selection rule, and the validation observations that justify scale.

WP19-27, WP19-08

DECISION INSTRUMENT

Decision framework: translate the dispersion model into sampling geometry

Use this to set spacing and follow up style from regolith preserved state and expected footprint size.

TEST	EVIDENCE READING	DECISION RESPONSE
Residual regolith preserved	Secondary dispersion can produce targets broader than the primary mineralisation; residual anomalies can be larger, more findable targets.	Use reconnaissance spacing that resolves broad halos, then infill based on multi element coherence.
Residuum eroded, saprolite exposed	Saprolite target can be similar in dimensions to the bedrock target.	Tighten spacing or use targeted lines to avoid missing narrow features.
Transported cover present	Remote sensing indicates surface materials only and is poor for underlying regolith under transported cover.	Include profile validation via drilling or deep pitting before committing to large grids.
Design gate	Sequence requires mapping, then field characterisation, then medium selection, then multi element analysis and model based interpretation.	Do not set final spacing until mapping and orientation confirm the horizon and expected footprint.
Interpretation tie back	Regolith landform maps let dispersion be modelled, indicating sample medium and assisting interpretation.	Embed map unit codes and horizon rules into field sample metadata so interpretation can reference them.

Sources: WP19-24, WP19-10, WP19-08, WP19-27

4.2 4.2 QA and QC as method confirmation, not bureaucracy

The dossier evidence does not enumerate specific QA and QC sample rates, so a defensible approach is to frame QA and QC around method confirmation and decision risk. Start with analytical method selection that matches the deposit model and the expected host phases in the chosen medium. Use published, verifiable laboratory schedules as representative benchmarks for what the method can detect and how it operates. In the ALS schedule, ME MS41L uses about a 0.5 g sample and aqua regia digestion to report super trace pathfinders, including Bi and W at 0.001 ppm and Sb at 0.005 ppm. Those published limits help define whether the chosen method can discriminate background from dispersion for the intended pathfinder suite. For gold, the same schedule defines fire assay as the reference determination and specifies fusion charges and detection limits for Au AA21 and Au AA22. QA and QC should then test that the programme’s sample preparation, contamination control, and lab selection preserve the ability to achieve these stated capabilities. In plain terms, QA and QC exists to protect interpretability, not to fill a spreadsheet.

WP19-21, WP19-20, WP19-22

Portable XRF sits inside QA and QC as a field screening and levelling tool rather than as an assay substitute. The dossier states that pXRF reads a suite of base metals and pathfinders directly on sample or outcrop for rapid, non destructive screening and survey levelling, but it cannot determine gold at exploration concentrations. That constraint must shape field workflows. Use pXRF to identify obvious mislabels, detect coarse contamination, and prioritise which samples warrant laboratory ICP and fire assay. Then treat the laboratory results as the decision grade evidence for anomaly ranking and drill targeting. This division of labour reduces the temptation to make drilling decisions on numbers that the tool is not designed to deliver. It also supports custody discipline because it creates a clear handoff: pXRF for field triage, lab methods for recorded outcomes. If the programme documents that handoff, it can later defend why a sample advanced or did not advance to costly follow up, and it can explain how screening results were used without overstating their meaning.

WP19-23, WP19-20

DECISION INSTRUMENT

Decision framework: align QA and QC checks to method purpose

Use this to decide what each analytical stage is allowed to influence and what must wait for laboratory confirmation.

TEST	EVIDENCE READING	DECISION RESPONSE
Pathfinder detection capability check	ME MS41L aqua regia reports low pathfinder limits including Bi and W at 0.001 ppm and Sb at 0.005 ppm.	Confirm the selected ICP method can resolve the intended pathfinder suite at relevant concentrations for ranking.
Gold decision grade requirement	Fire assay is the reference; Au AA21 uses 30 g and Au AA22 uses 50 g fusion charges with 0.002 ppm lower detection limits.	Require fire assay for gold based decisions and for confirming any gold anomalism indicated by proxies.
Digestion fit to host phase	Aqua regia suits sulphides and labile phases; four acid preferred for resistate hosts such as Ni, Co, Cr, Sn, W.	Audit method selection against the deposit model and sampled horizon to avoid systematic under reporting.
pXRF role boundary	pXRF triages and levels surveys for base metals and pathfinders but cannot determine gold at exploration concentrations.	Use pXRF only for screening and prioritisation; do not use it as the sole basis for gold targeting.
Documentation requirement	Method choices must be made from the deposit model and regolith setting, not by default.	Record the rationale for each method and tool in the sampling plan and metadata so later interpretation remains auditable.

Sources: WP19-21, WP19-20, WP19-22, WP19-23

4.3 4.3 Anomaly ranking and drill target integration

Anomaly ranking should read like a chain of evidence, not like a single threshold table. Butt states that multi element pathfinder analysis defines and prioritises anomalies for follow up, with As, Sb, W, Cu and Bi for gold, and Bi, As, Sb and Sn added for VHMS. He also states that ranking is a multi element, dispersion model informed judgement rather than a single element threshold. This requirement forces the interpreter to tie chemistry to regolith architecture. For example, lateritic residuum can preserve extensive halos for certain VHMS settings, while saprolite may show little widespread halo, and truncated profiles can erase surface traces. A ranked target should therefore include the mapped regolith unit, the sampled horizon, and the dispersion model that predicts why the element suite should appear there. The rank then reflects coherence across elements and across space, consistency with the regolith model, and the plausibility of transport pathways. That structure also improves drill target integration because it states what drilling should test. Drilling then becomes a planned falsification of a specific dispersion hypothesis, not a reaction to an isolated high value.

WP19-25, WP19-14

The same logic governs how the programme integrates mapping, geophysics, and special media into the drill target narrative. Regolith landform mapping is essential because it lets dispersion be modelled, indicates the most appropriate sample medium, and assists interpretation. Remote sensing alone cannot define underlying regolith under transported cover, while airborne electromagnetic systems can map regolith thickness and palaeochannels and outline stratigraphy in three dimensions. Termite mound sampling and calcrete sampling can add reconnaissance information in specific conditions, but they remain medium choices that must be justified by the regolith model and validated by orientation evidence. When the programme carries these elements forward into targeting, it should keep the evidence boundaries explicit. A drill target should cite which medium carries the signal, which digestion and assay methods support the elements of interest, and which profile observations establish that the sample connects to deeper regolith. That is how anomaly ranking becomes drill ready without overstating certainty.

WP19-07, WP19-08, WP19-16, WP19-04

DECISION INSTRUMENT

Decision framework: promote an anomaly to a drill target

Use this to decide whether a geochemical anomaly is ready for drilling or needs additional regolith or analytical validation.

TEST	EVIDENCE READING	DECISION RESPONSE
Element suite matches model	Gold pathfinders include As, Sb, W, Cu, Bi; VHMS halos can include Bi, As, Sb, Sn with Cu, Zn, Au.	Promote only if the multi element suite coheres in a way the deposit model and dispersion model predict.
Medium and horizon defensible	Regolith landform maps indicate appropriate sample medium and assist interpretation; profile evidence is essential under cover.	Hold promotion until mapping and field characterisation show the sampled horizon can carry the signal.
Profile truncation risk	Saprolite may show little widespread halo and truncated profiles without gossan may leave little trace.	Do not demote solely on weak saprolite geochemistry; seek regolith evidence before excluding.
Analytical confirmation appropriate	Fire assay is the reference for gold; aqua regia ICP supports super trace pathfinders.	Require lab confirmation aligned to the decision, especially for gold and for subtle pathfinder patterns.
3D cover architecture considered	Airborne EM can map regolith thickness and palaeochannels and outline stratigraphy in three dimensions.	Integrate anomaly geometry with cover thickness and palaeochannel context to place drill tests.
Special media used within limits	Calcrete anomalies can penetrate 5 to 10 m; termite mounds can integrate deeper regolith beneath shallow transported cover.	Use these media as supporting evidence only when their preconditions are met and documented.

Sources: WP19-25, WP19-07, WP19-14, WP19-20

05

ASSAY CHOICES THAT MATCH THE DISPERSION MODEL

Laboratory methods and QA/QC

Exploration geochemistry fails most often when method selection is treated as an administrative default. A defensible chain of evidence starts with deposit model and regolith setting, then selects a digestion and finish that can report the elements that carry,

30 g

FUSION CHARGE FOR AU-AA21 FIRE
ASSAY | WP19-20

0.002 ppm (2 ppb)

LOWER DETECTION LIMIT FOR AU-AA21
AND AU-AA22 | WP19-20

~0.5 g

SAMPLE MASS FOR ME-MS41L AQUA-
REGIA SUPER-TRACE DIGEST | WP19-21

5.1 Gold reference determinations and what they control

Treat fire assay as the reference determination for gold in reconnaissance datasets. ALS lists Au-AA21 as a 30 g lead-collection fusion with a 0.002 ppm lower detection limit and a 1 ppm upper limit before over-range reruns. Au-AA22 increases the fusion charge to 50 g while retaining the same 0.002 ppm detection limit. Those specifics matter because they define the analytical floor and the rerun logic that will shape how censored values and high tails appear in compositional summaries. When the decision is whether to follow up a low-level but coherent anomaly, the method must be capable of reporting that signal rather than implying it through substitution rules.

WP19-20

QA and data defensibility start with explicit method identity and consistency, not with retrospective statistical cleaning. A lab schedule that states the fusion charge, detection limit, and over-range policy sets the boundaries for what an exploration team can claim from the gold channel. In practice this means keeping the fire-assay method as the anchor, then using multi-element chemistry to interpret whether gold should be expected to report in the chosen medium. This aligns with the broader principle that method selection is target-dependent and should be chosen from the deposit model and regolith setting rather than by default.

WP19-20, WP19-22

DECISION INSTRUMENT

Decision framework: choose a gold analytical finish

Use method identity to control what the gold column can and cannot support in downstream anomaly decisions.

TEST	EVIDENCE READING	DECISION RESPONSE
Define the gold question	Is gold expected to disperse into the sampled horizon, or should pathfinders carry more of the expression?	Keep fire assay as the gold reference, then plan pathfinder chemistry to test the dispersion expectation.
Set a reference method	Fire assay is stated as the reference determination for gold in geochemistry.	Use a fire-assay method code as the gold anchor in the dataset.
Select charge size	Au-AA21 uses a 30 g fusion charge; Au-AA22 uses a 50 g charge.	Choose the charge size deliberately and keep it consistent within a survey stage.
Respect the analytical floor	Both Au-AA21 and Au-AA22 list a 0.002 ppm lower detection limit.	Treat values near the detection limit as method-bounded observations, not as noise to be filtered away.
Plan for high-tail handling	Au-AA21 lists 1 ppm as an upper limit before over-range reruns.	Predefine how reruns will be tracked so high values stay auditable.

Sources: WP19-20, WP19-22

5.2 Multi-element digestions as a design choice

For reconnaissance soils and sediments, aqua regia can be the correct tool when the objective is to dissolve sulphides and release weakly bound elements that behave as pathfinders. ALS describes ME-MS41L as a super-trace multi-element method using about 0.5 g of sample digested in 75 percent aqua regia with a 3:1 HCl:HNO₃ mixture in a graphite block. The schedule reports low detection limits for several pathfinders, including Bi at 0.001 ppm, W at 0.001 ppm, and Sb at 0.005 ppm. A weak-aqua-regia variant is also offered, which makes the partial nature of the digest an explicit choice.

WP19-21

Do not let the laboratory default decide the geology. ALS frames aqua regia as a partial digestion that is near-total for sulphides and labile phases, while four-acid digestion approaches total dissolution and is preferred where resistate or refractory hosts must be reported, including Ni, Co, Cr, Sn, and W in resistant minerals. The controlling rule is straightforward: choose the digestion from the deposit model and regolith setting. That rule is also compatible with regolith-first exploration doctrine, where sample medium and analytical strategy sit downstream of regolith-landform mapping and field characterisation.

WP19-22, WP19-27

DECISION INSTRUMENT

Decision framework: select digestion and element suite

Treat digestion as a hypothesis about where elements reside in the sampled material.

TEST	EVIDENCE READING	DECISION RESPONSE
Start from target model	Method selection is target-dependent and chosen from the deposit model and regolith setting.	Document the target hypothesis before selecting digestion.
Use partial digest for labile phases	ME-MS41L uses aqua regia; an aqua-regia leach is ideal for dissolving sulphides and releasing weakly bound elements.	Choose aqua regia for pathfinder-led soil and sediment reconnaissance when labile phases are the focus.
Use near-total for resistates	Four-acid digestion approaches total dissolution and is preferred for resistate or refractory hosts such as Ni, Co, Cr, Sn, and W.	Choose four-acid when resistant-mineral reporting controls the interpretation.
Check pathfinder detectability	ME-MS41L lists reportable detection limits including Bi 0.001 ppm, W 0.001 ppm, Sb 0.005 ppm.	Confirm that expected pathfinders can be reported at meaningful levels for the survey stage.
Treat variants as intentional	A weak-aqua-regia variant (ME-MS41W) is also offered.	Use digest strength as a controlled variable, not as an incidental lab preference.

Sources: WP19-21, WP19-22

5.3 Field triage versus laboratory evidence

Portable XRF belongs in the workflow, but it does not replace laboratory determinations. The method principle is clear: pXRF reads a suite of base metals and pathfinders directly on sample or outcrop for rapid, non-destructive screening and survey levelling, but it cannot determine gold at exploration concentrations. In a chain-of-evidence account, that defines pXRF as a triage layer that prioritises what should go to fire assay and ICP-MS, and it also defines what should never be concluded from pXRF alone. This separation prevents premature target promotion based on incomplete analytical capability.

WP19-23

In cover-dominated terrains, the consequence of a poor analytical split is amplified because surface and near-surface geochemical techniques are generally ineffective in most depositional regimes. When the surface medium is weakly coupled to bedrock, a screening tool can create false confidence if it is treated as an assay. The workflow needs a clear boundary: pXRF for rapid screening of base metals and pathfinders, laboratory fire assay for gold, and laboratory ICP-MS for super-trace multi-element reporting. That boundary aligns with the broader exploration sequence that relies on regolith understanding to select both sample medium and analytical method.

WP19-03, WP19-23, WP19-27

DECISION INSTRUMENT

Decision framework: control the role of portable XRF

Define pXRF as triage so that target decisions remain anchored in laboratory methods.

TEST	EVIDENCE READING	DECISION RESPONSE
State capability boundary	pXRF cannot determine gold at exploration concentrations.	Do not use pXRF as a gold decision gate.
Use for rapid screening	pXRF reads base metals and pathfinders directly on sample or outcrop for rapid, non-destructive screening and survey levelling.	Use pXRF to prioritise samples and to check field consistency.
Anchor gold to fire assay	Fire assay remains the reference determination for gold in geochemistry.	Route gold decisions through a fire-assay method code.
Anchor pathfinders to ICP methods	ME-MS41L is a super-trace multi-element ICP-MS or ICP-AES schedule with reportable pathfinder detection limits.	Route pathfinder interpretation through an appropriate laboratory multi-element method.
Protect against depositional false signals	Surface and near-surface geochemical techniques are generally ineffective in most depositional regimes.	Escalate to regolith characterisation and medium redesign before promoting anomalies from transported cover.

Sources: WP19-03, WP19-20, WP19-21, WP19-23

06

TURN ASSAYS INTO INTERPRETABLE COMPOSITIONS

Compositional data

Compositional datasets are only as interpretable as their connection to regolith processes and to the sampling medium. Under deep weathering, gold can deplete in the upper profile and pathfinders can carry a clearer expression than gold itself. Build composim

1 to 3 m

TYPICAL LEACHING AND DEPLETION DEPTH IN LATERITIC RESIDUUM OVER LODE GOLD, WITH: | WP19-10

10 to 40 m

REPORTED DEPTH RANGE FOR STRONG LEACHING AND DEPLETION OF GOLD IN SAPROLITE IN WP19-12

As, Sb, W, Cu, Bi

NAMED PATHFINDER ELEMENTS FOR GOLD IN THESE REGOLITH SETTINGS | WP19-13

6.1 Profile-controlled gold behaviour in laterites and saprolites

Start compositional interpretation from the weathering profile rather than from the assay table. In lateritic weathering of lode gold, Butt reports little dispersion of gold except in the upper horizons. In lateritic residuum, leaching and depletion typically occur in the top 1 to 3 m with enrichment below, producing a broad, multi-element, near-surface target. If that residuum is eroded, the target in saprolite can be similar in dimensions to the bedrock target, which directly changes the sampling density needed to find it. These are not abstract ideas. They are the rules that explain why two adjacent landforms can yield different anomaly widths from the same style of mineralisation.

WP19-10

Climate and groundwater chemistry can invert expectations about what the surface should show. Butt notes that in rainforest settings, stronger leaching lowers surface expression but gives widespread drainage anomalies, while in arid terrains gold enrichment in lateritic residuum can continue to the surface. He also documents arid regions with acid, saline groundwaters where strong leaching and depletion of gold can occur in the top 10 to 40 m of saprolite with absolute supergene enrichment below. In that case the supergene zone may be an important resource but commonly shows no greater dispersion target than the underlying lode. Compositional analysis must therefore test for depletion and enrichment patterns, not assume them.

WP19-11, WP19-12

DECISION INSTRUMENT

Decision framework: interpret gold assays through the weathering profile

Use profile logic to decide whether gold values should be treated as primary indicators or as depletion-affected observations.

TEST	EVIDENCE READING	DECISION RESPONSE
Check for lateritic depletion cap	Leaching and depletion typically occur in the top 1 to 3 m with enrichment below in lateritic residuum.	If sampling is restricted to the upper profile, expect muted gold and rely on multi-element context.
Test for arid saprolite depletion	Strong leaching and depletion of gold can occur in the top 10 to 40 m of saprolite in some arid, acid-saline groundwater settings.	If saprolite is sampled, consider that low gold may be a depletion signature rather than absence of mineralisation.
Use landform control on expression	Rainforest leaching lowers surface expression but gives widespread drainage anomalies; arid residuum may enrich to surface.	Adjust expectations for anomaly sharpness and the most diagnostic medium by climate and landform.
Adjust sampling density to target width	If residuum is eroded, the saprolite target can be similar in dimensions to the bedrock target.	Increase sampling density when working on truncated profiles without a broad residuum halo.
Separate resource enrichment from dispersion	Supergene zone may be important but commonly shows no greater dispersion target than the underlying lode.	Do not equate enrichment at depth with a broader surface footprint.

Sources: WP19-10, WP19-11, WP19-12

6.2 Pathfinders as compositional structure, not add-ons

When gold is depleted or poorly dispersed in the sampled horizon, pathfinders become the compositional structure that holds interpretation together. Butt identifies As, Sb, W, Cu, and Bi as appropriate pathfinder elements for gold in these settings. He adds a specific conditional statement that matters in transported cover and truncated profiles: where the depleted zone outcrops or subcrops beneath transported cover and no pedogenic carbonate is present, pathfinders can give a better expression of mineralisation than gold itself. This is a compositional argument, not a marketing one. It means anomaly detection should test coherent element associations that reflect mineralisation and weathering, rather than waiting for gold to report cleanly at surface.

WP19-13

For VHMS and base-metal targets, Butt reports that the lateritic-residuum dispersion halo at Golden Grove is extensive and defined by Bi, As, Sb, and Sn in addition to Cu, Zn, and Au. He also notes that there is little widespread dispersion halo in saprolite, so a truncated profile without a gossan may leave little trace of the mineralisation. In compositional analysis, that pushes the interpreter to ask where the dataset is sampling within the profile and whether lateritic residuum is present and correctly identified. It also supports a multi-element approach in which minor elements can carry the continuity that major elements lack across variable weathering environments.

WP19-14

DECISION INSTRUMENT

Decision framework: build a pathfinder association for interpretation

Use named element suites that are tied to regolith behaviour and deposit style.

TEST	EVIDENCE READING	DECISION RESPONSE
Gold pathfinder suite	Appropriate pathfinders for gold include As, Sb, W, Cu, Bi.	Evaluate gold targets with coherent anomalies in this suite, especially where gold is depleted.
Condition under transported cover	Where the depleted zone outcrops or subcrops beneath transported cover and no pedogenic carbonate is present, pathfinders give a better expression than gold.	Rank targets by pathfinder coherence when surface gold is likely suppressed.
VHMS or base-metal lateritic residuum suite	Golden Grove lateritic-residuum halo includes Bi, As, Sb, Sn plus Cu, Zn, Au.	Include minor elements when screening for residuum halos over VHMS style targets.
Watch for truncated profiles	Little widespread dispersion halo occurs in saprolite; truncated profiles without gossan may leave little trace.	Treat absence of a broad halo as ambiguous when saprolite dominates the sampling interval.
Link suite choice to sampling medium	Regolith materials and boundaries must be accurately logged to avoid confusing ferruginous lateritic residuum with low-value sedimentary units.	Validate that the sampled material matches the intended medium before interpreting element associations.

Sources: WP19-09, WP19-13, WP19-14

6.3 Analytical completeness and partial digestions in compositional space

Compositional patterns change when the digestion changes, so the dataset must record digestion explicitly and interpret it as part of the evidence chain. ALS states that aqua regia is a partial digestion that is near-total for sulphides and labile phases and is suited to pathfinder soil and sediment surveys. It also states that four-acid digestion approaches total dissolution and is preferred where resistate or refractory hosts must be reported, including Ni, Co, Cr, Sn, and W in resistant minerals. That distinction affects whether an element association reflects true abundance variation or only a change in extractability. Compositional analysis should therefore compare like with like and avoid mixing partial and near-total digestions in a single interpretive threshold.

WP19-22, WP19-21

Portable XRF adds a second interpretive constraint because it is a field triage tool rather than an assay and cannot determine gold at exploration concentrations. Used correctly, it supports compositional analysis by identifying base-metal and pathfinder contrasts rapidly, then pushing the right samples toward laboratory fire assay and ICP-MS. Used incorrectly, it creates mismatched datasets where gold is absent by method limitation rather than by geology. This matters in depositional regimes where surface geochemistry is generally ineffective and false confidence is expensive. Keep pXRF outputs in a screening layer, keep laboratory methods in the compositional layer, and connect both back to the regolith model that explains where the signal should sit.

WP19-03, WP19-23, WP19-22

DECISION INSTRUMENT

Decision framework: keep compositional comparisons method-consistent

Prevent interpretation drift caused by mixed extractability and mixed method capability.

TEST	EVIDENCE READING	DECISION RESPONSE
Record digestion as metadata	Aqua regia is partial; four-acid approaches total dissolution.	Tag each result by digestion before any multi-element comparisons are made.
Avoid mixed-digestion thresholds	Method choice is made from deposit model and regolith setting, not by default.	Do not set a single anomaly threshold across different digestions.
Treat pXRF as screening only	pXRF triages targets and prioritises samples for laboratory fire assay and ICP-MS.	Keep pXRF in a pre-assay layer and prevent it from entering compositional summary statistics for gold.
Use lab methods for decision-grade chemistry	Fire assay is the reference determination for gold; ME-MS41L provides super-trace multi-element reporting.	Base anomaly decisions on lab results where gold and pathfinders are decision-critical.
Escalate under depositional cover	Surface and near-surface geochemical techniques are generally ineffective in most depositional regimes.	If cover dominates, shift effort to regolith characterisation and medium redesign before reinterpreting composition.

Sources: WP19-03, WP19-20, WP19-21, WP19-22

07

RANK ANOMALIES BY DISPERSION LOGIC AND COHERENCE

Anomaly ranking and integration

Anomaly ranking is not a single-element threshold exercise. In deeply weathered terrains, secondary dispersion can widen or suppress the surface expression, and pathfinder suites can carry clearer signals than gold. A consistent ranking workflow ties the reg

As, Sb, W, Cu, Bi

GOLD PATHFINDER SET USED TO DEFINE AND PRIORITISE ANOMALIES | WP19-25

Bi, As, Sb, Sn

ADDITIONAL ELEMENTS CITED FOR VHMS ANOMALY DEFINITION IN LATERITIC RESIDUUM | WP19-25

5-step sequence

MAPPING TO ORIENTATION-VALIDATED INTERPRETATION SEQUENCE USED AS THE RANKING SP | WP19-27

7.1 Why ranking must be multi-element and model-led

Rank anomalies with a dispersion model in mind, because the same bedrock source can produce different surface footprints depending on regolith state. Butt states that much residual regolith is in place, so secondary dispersion can produce targets broader than the primary mineralisation itself. That creates an opportunity: a residual near-surface anomaly can be a larger, more findable target than the lode. The ranking logic follows directly. A broad, coherent anomaly in a residual medium can outrank a sharp but isolated point, even when both share similar peak values. The ranking must also hold room for the opposite case, where depositional regimes disconnect surface geochemistry from mineralisation and apparent anomalies can mislead.

WP19-24, WP19-03

Butt is explicit that multi-element pathfinder analysis defines and prioritises anomalies for follow-up. For gold he cites As, Sb, W, Cu, and Bi. For VHMS he adds Bi, As, Sb, and Sn alongside Cu, Zn, and Au. This extends beyond a list. It is a ranking method in which element associations and their spatial coherence carry more weight than any single-element threshold. It also protects against gold depletion in near-surface horizons by allowing a target to progress on pathfinder coherence where gold alone is muted. In practice, the ranking rubric should state which suites apply to which target models and which regolith settings.

WP19-25, WP19-13

DECISION INSTRUMENT

Decision framework: anomaly ranking rubric

Use element suites and dispersion expectations to rank anomalies before follow-up drilling decisions.

TEST	EVIDENCE READING	DECISION RESPONSE
Confirm regolith context	Residual regolith can generate targets broader than primary mineralisation; depositional regimes often disconnect surface geochemistry.	Apply different ranking weightings for residual versus transported settings.
Rank by multi-element coherence	Anomaly ranking is a multi-element, dispersion-model-informed judgement, not a single-element threshold.	Require spatially coherent anomalies in the relevant element suite.
Gold suite	Gold pathfinders include As, Sb, W, Cu, Bi.	Promote anomalies showing coherent responses in this suite, even if gold is subdued.
VHMS suite	For VHMS, Bi, As, Sb, Sn are cited in addition to Cu, Zn and Au.	Use the expanded suite when screening for lateritic-residuum halos over base-metal targets.
Handle depletion cases explicitly	Pathfinders can give a better expression of mineralisation than gold where depleted zones outcrop or subcrop beneath transported cover and no pedogenic carbonate is present.	Allow pathfinder-led anomalies to outrank gold-only anomalies in depletion-prone settings.

Sources: WP19-03, WP19-13, WP19-24, WP19-25

7.2 Integrate mapping, medium selection, and analytics before you rank

Integration starts upstream of the geochemical table. Butt describes regolith-landform mapping as an essential first step, followed by characterisation of regolith materials. Those maps let ore-related element dispersion be modelled, which indicates the most appropriate sample medium and assists interpretation. Mapping combines remote sensing and field checking, but remote sensing indicates surface materials only and can be a poor indicator of underlying regolith under transported or basin cover. Airborne electromagnetic systems can map regolith thickness, palaeochannels, and outline stratigraphy in three dimensions. In a ranking workflow, these layers control whether an anomaly is interpreted as residual, erosional, or depositional, which directly affects its expected footprint and reliability.

WP19-07, WP19-08

Butt adds a practical control that often determines whether ranking is meaningful: preliminary fieldwork should include drilling or deep pitting, essential where there is transported cover, to select sample media and interpret data. Ferruginous lateritic residuum is an important sample medium yet can be confused with sedimentary units of little sampling value, so accurate logging of profile units and boundaries is critical and is too often delegated to inexperienced geologists. Ranking should therefore include a confidence score for medium validity. If the medium is wrong or uncertain, the anomaly should not be promoted by statistics alone. Instead, the workflow should loop back to profile verification and sample-medium selection driven by the regolith model.

WP19-09, WP19-27

DECISION INSTRUMENT

Decision framework: integrate geochemistry with regolith evidence before ranking

Prevent false ranking caused by misidentified media or untested cover assumptions.

TEST	EVIDENCE READING	DECISION RESPONSE
Start with regolith-landform map	Regolith-landform mapping is an essential first step and supports dispersion modelling.	Do not rank anomalies until the landform and regolith setting are mapped.
Test transported cover with subsurface checks	Drilling or deep pitting is essential where there is transported cover.	Collect profile control before promoting anomalies from covered terrains.
Validate sample medium identity	Ferruginous lateritic residuum is easily confused with sedimentary units of little sampling value; accurate logging is critical.	Gate anomaly ranking on confirmed medium and logged boundaries.
Use 3D cover tools where relevant	Airborne EM can map regolith thickness, palaeochannels and outline stratigraphy in three dimensions.	Use thickness and channel context to interpret anomaly position and potential transport.
Only then apply element-suite ranking	Multi-element pathfinder analysis defines and prioritises anomalies for follow-up.	Apply the ranking rubric after medium and setting are validated.

Sources: WP19-07, WP19-08, WP19-09, WP19-25

7.3 Screening tools and assay-grade integration

Integration also means separating screening signals from decision-grade evidence. Portable XRF provides rapid, non-destructive screening for base metals and pathfinders on sample or outcrop, supporting field decisions and survey levelling, but it cannot determine gold at exploration concentrations. That makes pXRF a pre-ranking input that can shape where laboratory resources go, not a substitute for laboratory chemistry. The clean integration pattern is to use pXRF to triage and prioritise, then to anchor gold to fire assay and anchor pathfinders to an appropriate multi-element ICP method. This preserves a clear audit trail from field screening to lab data to ranked anomaly list.

WP19-23, WP19-20, WP19-21

The same separation protects the ranking process in regimes where surface geochemistry is generally ineffective, particularly depositional settings where transported overburden can decouple surface anomalies from mineralisation. Butt notes that there are very few instances where significant anomalies in transported overburden can be reliably related to underlying mineralisation, even with special analytical techniques. A ranking workflow should therefore treat anomalies from transported cover as conditional until validated by regolith characterisation and orientation work. Where a documented exception exists, such as gold anomalies in calcrete that can penetrate 5 to 10 m of cover, the exception must be applied only when the medium is present and the cover thickness constraint is met.

WP19-03, WP19-04, WP19-27

DECISION INSTRUMENT

Decision framework: integrate screening, lab assays, and cover risk

Keep ranking anchored in methods that can support drill-target decisions under cover.

TEST	EVIDENCE READING	DECISION RESPONSE
Use pXRF for screening only	pXRF triages targets and prioritises samples for laboratory fire assay and ICP-MS.	Use pXRF to focus sampling and lab spend, not to release targets.
Anchor gold to fire assay	Fire assay remains the reference determination for gold; Au-AA21 and Au-AA22 list a 0.002 ppm lower detection limit.	Base gold-driven ranking on fire-assay results.
Anchor pathfinders to ICP multi-element	ME-MS41L reports super-trace pathfinders with stated detection limits.	Use ICP multi-element results for suite coherence tests.
Treat transported cover as high risk	Surface geochemical techniques are generally ineffective in most depositional regimes; few transported-overburden anomalies reliably relate to mineralisation.	Require regolith validation before promoting anomalies under transported cover.
Apply exceptions only when conditions match	Gold anomalies in calcrete can penetrate 5 to 10 m of cover; pedogenic carbonate is preferred where cover is less than 10 m thick.	Use calcrete sampling and interpretation only where pedogenic carbonate exists and cover constraint is met.

Sources: WP19-03, WP19-04, WP19-20, WP19-21

08

ORIENTATION EVIDENCE AS THE RELEASE CONDITION

The target-release gate

A target is ready for drilling only when the geochemical signal, the sampling medium, and the regolith model agree and have been validated locally. Under deep weathering and transported cover, generic templates fail because surface signals can decouple from

5 to 10 m

DOCUMENTED COVER PENETRATION FOR GOLD ANOMALIES IN CALCRETE (PEDOGENIC CARBONATE | WP19-04

15.7 years (6 to 15)

AVERAGE DISCOVERY-TO-PRODUCTION LEAD TIME ACROSS 127 MINES STARTED 2002 TO 2023 | WP19-06

~19%

GRASSROOTS SHARE OF GLOBAL GOLD EXPLORATION BUDGETS IN 2024 | WP19-05

8.1 Define the release condition: orientation-validated interpretation

Use Butt’s method sequence as the target-release backbone. The sequence is: regolith-landform mapping, field characterisation by drilling or deep pitting under transported cover, sample-medium selection driven by the regolith model, pathfinder-led multi-element analysis, and interpretation against dispersion models validated by local orientation and case studies. The key operational point is that orientation is not optional. It is the step that tests whether the chosen medium and method produce a repeatable expression in the local regolith regime. Without that local validation, the same anomaly pattern can mean residual dispersion in one landform and transported noise in another. A release gate should therefore require evidence that the anomaly sits in the intended medium and behaves as predicted by the dispersion model.

WP19-27, WP19-07, WP19-09

Generalised dispersion models help you start, but they do not let you skip orientation. Butt notes that lateritic landscapes show genetic similarity across climatic zones, allowing generalised dispersion and exploration models to predict broad geochemical expression and design sampling strategies even where little prior information exists. He also states that finer region and commodity dispersion detail requires local orientation and case studies. This is the correct balance for a release gate. Use the general models to design the first-pass survey, then use orientation to decide whether anomalies are interpretable enough to convert into drill targets. If the orientation evidence fails, the correct response is to redesign medium, density, or digestion rather than force a target forward.

WP19-26, WP19-27

DECISION INSTRUMENT

Decision framework: target-release evidence checklist

Release a drill target only when the anomaly is supported by mapped setting, verified medium, and orientation-validated interpretation.

TEST	EVIDENCE READING	DECISION RESPONSE
Mapped setting present	Regolith-landform mapping is an essential first step and supports dispersion modelling.	No release unless regolith-landform context is mapped and tied to expected dispersion.
Profile control under cover	Drilling or deep pitting is essential where there is transported cover.	No release from transported terrains without profile control that supports the chosen medium.
Medium selection justified	Sample-medium selection is driven by the regolith model and assists interpretation.	No release unless the chosen medium is explicitly justified by the regolith model.
Multi-element support	Multi-element pathfinder analysis defines and prioritises anomalies for follow-up.	No release on single-element anomalies when pathfinder coherence is expected.
Orientation validation complete	Dispersion models require local orientation and case studies for fine detail.	Release only after orientation demonstrates a repeatable signal in the local setting.

Sources: WP19-07, WP19-09, WP19-25, WP19-26

8.2 Cover risk management and exception handling

Make the gate strictest in depositional regimes. Butt states that surface and near-surface geochemical techniques are generally ineffective in most depositional regimes and that there are very few instances where significant anomalies in transported overburden can be reliably related to underlying mineralisation, even with special analytical techniques. In gate terms, this means you should treat transported-cover anomalies as hypotheses until regolith characterisation and orientation work demonstrate coupling to bedrock. This is not conservatism for its own sake. It is recognition that false positives are common when transport dominates and that drilling based on unsupported surface anomalies has a high probability of testing the wrong volume. The gate should force the project back to mapping and profile control when the setting is depositional.

WP19-03, WP19-27

Where documented exceptions exist, write them into the gate as conditional pathways, not as general permission. Butt reports a documented exception in which gold anomalies in calcrete, meaning pedogenic carbonate, can penetrate 5 to 10 m of cover. He states that pedogenic carbonate is the preferred sample medium in residual soils or where cover is less than 10 m thick, with the caution that concentrations and contrasts are low, targets are small, and the method is usually gold only. The gate implication is precise: release is possible when pedogenic carbonate is confirmed, cover constraints match the documented range, and the target model fits. Otherwise, treat calcrete as absent and rely on other media and pathfinder logic.

WP19-04

DECISION INSTRUMENT

Decision framework: cover-conditioned target release

Promote only those targets whose geochemical expression is credible in the prevailing cover regime.

TEST	EVIDENCE READING	DECISION RESPONSE
Classify regime first	Surface geochemical techniques are generally ineffective in most depositional regimes.	If depositional, require profile evidence and orientation before any target release.
Transported overburden caution	Very few transported-overburden anomalies can be reliably related to underlying mineralisation.	Treat transported-cover anomalies as conditional until coupling is demonstrated.
Calcrete exception test	Gold anomalies in calcrete can penetrate 5 to 10 m of cover.	Allow a calcrete pathway only when the medium is pedogenic carbonate and cover thickness is within the documented range.
Medium preference constraint	Pedogenic carbonate is preferred in residual soils or where cover is less than 10 m thick; targets are small and usually gold only.	Limit calcrete-based release to gold-focused targets that match the stated constraints.
Fallback when exception not met	Generic templates fail in depositional regimes without the full sequence of mapping, characterisation, and modelled interpretation.	Redesign medium and orientation plan rather than forcing a target forward.

Sources: WP19-03, WP19-04, WP19-27

8.3 Why the gate matters under capital and time constraints

A strict gate is not bureaucracy. It is a response to a difficult discovery environment where wasted drilling time compounds quickly. S&P reports that the global gold exploration budget fell about 7 percent to roughly US\$5.55 billion in 2024, that only six major gold discoveries were made across 2020 to 2024, and that grassroots spend fell to about 19 percent of the gold total. Those figures are macro context, but they frame the practical constraint: early-stage programmes must extract clear learning per unit effort. The most controllable way to do that is to make reconnaissance geochemistry technically disciplined, with a defensible sample medium and analytical strategy before escalating to drill testing.

WP19-05, WP19-28

Time-to-value strengthens the argument for a rigorous release gate. S&P reports an average discovery-to-production lead time of 15.7 years across 127 mines, with a range of 6 to 32 years, rising to 17.9 years for mines started 2020 to 2023. It also reports that almost 12 of those years are spent in discovery, exploration, and studies. This does not tell you where to drill, but it does tell you why the early evidence chain must be clean. The gate should reject targets that do not pass orientation validation and medium integrity checks, because every false start consumes the scarce years that sit before resource definition and development decisions.

WP19-06, WP19-28

DECISION INSTRUMENT

Decision framework: escalation discipline under long lead times

Use macro constraints to justify technical discipline, not to replace it.

TEST	EVIDENCE READING	DECISION RESPONSE
Acknowledge scarcity context	Grassroots fell to about 19 percent of the gold exploration total and major discoveries were few in 2020 to 2024.	Set a higher bar for releasing targets from weakly supported anomalies.
Acknowledge long cycle time	Discovery-to-production lead time averaged 15.7 years, with almost 12 years in discovery, exploration and studies.	Prioritise targets that improve learning efficiency, more than those that look attractive on a single map.
Anchor release in method sequence	Mapping, field characterisation, medium selection, pathfinder-led analysis, and model-led interpretation validated by orientation.	Make sequence completion a release requirement.
Protect against depositional regime failure	Surface geochemistry is generally ineffective in most depositional regimes.	Do not use a low-confidence surface anomaly to justify immediate drill testing under transported cover.
Use exceptions with constraints only	Calcrete gold anomalies can penetrate 5 to 10 m of cover and are usually gold only with small targets.	Apply exception pathways only when their stated conditions are met.

Sources: WP19-03, WP19-04, WP19-05, WP19-06

Decision checklist

Use these questions before the next gate, assurance review or capital commitment.

- | | | | |
|-----------|---|-----------|---|
| 01 | Have we produced a regolith landform map before setting any sample grid or line spacing? | 02 | What dispersion model do we expect for the target commodity in this regolith setting, and what evidence supports it? |
| 03 | What orientation survey will test competing sampling media, including lateritic residuum, saprolite, drainage sediment, or pedogenic carbonate where present? | 04 | Where transported cover exists, what drilling or deep pitting plan will characterise profile units and boundaries enough to select the medium? |
| 05 | Who is accountable for accurate regolith profile logging, and how do we prevent this task being delegated without oversight? | 06 | If calcrete or pedogenic carbonate is present, have we justified its use and validated that cover is less than about 10 m where it is expected to work? |
| 07 | If gold is likely depleted near surface, which pathfinder suite (As, Sb, W, Cu, Bi) will we carry, and how will we treat multi element responses in ranking? | 08 | For base metal or VHMS targets, have we included Bi, As, Sb and Sn alongside Cu and Zn in anomaly review where lateritic residuum is sampled? |
| 09 | Which digestion best matches the target and regolith, and have we explicitly justified aqua regia versus four acid from the deposit model? | 10 | What fire assay method and charge mass will we specify for gold, and how will we manage over range reruns? |
| 11 | How will portable XRF be used as triage and survey levelling only, and what rules prevent it being treated as a gold assay? | 12 | What anomaly ranking framework will integrate multi element geochemistry with regolith mapping and other datasets before drill targeting? |

Evidence ledger 1 of 2

Only dossier rows used in this edition are listed. Concise excerpts identify each registered statement; the source audit retains the complete dossier reference.

ROW	REGISTERED EVIDENCE EXCERPT	REGISTERED SOURCE
WP19-01	Large areas of the world, especially the tropical to sub-tropical zone between latitudes 40°N and 40°S, are characterised by a thick regolith cover; it is most extensive over the...	Butt (CRC LEME/CSIRO), Understanding the Regolith in Tropical and Sub-Tropical Terrains
WP19-02	Much of the residual regolith is lateritic: a thick clay-rich saprolite, generally with an overlying iron- and/or aluminium-enriched horizon (the latter patchily developed or...	Butt, ibid.
WP19-03	Surface and near-surface geochemical techniques are generally effective in relict and erosional terrains but generally ineffective in most depositional regimes; there are very few...	Butt, ibid.
WP19-04	A documented exception: gold anomalies in calcrete (pedogenic carbonate) can penetrate 5:10 m of cover; pedogenic carbonate is the preferred sample medium in residual soils or...	Butt, ibid. (citing Lintern, 2002)
WP19-05	Global gold exploration budget fell about 7% to roughly US\$5.55 billion in 2024 despite high prices; only six major gold discoveries were made across 2020:2024 (~27 million oz...	S&P Global Market Intelligence, World Exploration Trends 2024 (via MINING.COM), 2025
WP19-06	Discovery-to-production lead time averaged 15.7 years across 127 mines (production start 2002:2023; range 6:32 years); rising to 17.9 years for mines started 2020:2023 vs 12.7...	S&P Global Market Intelligence, 2024
WP19-07	Regolith-landform mapping is an essential first step, followed by characterisation of the regolith materials; regolith-landform maps let ore-related element dispersion be...	Butt, ibid. (dispersion models after Bradshaw 1975; Butt & Smith 1980; Butt & Zeegers...
WP19-08	Mapping combines remote sensing (satellite imagery, aerial photography, multispectral Landsat, airborne radiometrics for provenance) with field checking including drilling; but...	Butt, ibid.
WP19-09	Preliminary fieldwork should include drilling or deep pitting, essential where there is transported cover, to select sample media and interpret data; ferruginous lateritic...	Butt, ibid.
WP19-10	In lateritic weathering of lode gold, there is little dispersion of gold except in the upper horizons; in lateritic residuum, leaching and depletion typically occur in the top 1:3...	Butt, ibid. (citing Freyssinet & Itard 1997)
WP19-11	Environmental control on surface expression: in rainforest, stronger leaching lowers the surface expression but gives widespread drainage anomalies; in arid terrains, gold...	Butt, ibid.
WP19-12	In arid regions with acid, saline groundwaters, strong leaching and depletion of gold can occur in the top 10:40 m of saprolite with absolute supergene enrichment below; the...	Butt, ibid. (citing Gray et al. 2001)
WP19-13	Appropriate pathfinder elements for gold in these settings are As, Sb, W, Cu, Bi; where the depleted zone outcrops or subcrops beneath transported cover (and no pedogenic...	Butt, ibid.
WP19-14	For VHMS/base-metal targets, the lateritic-residuum dispersion halo at Golden Grove (Western Australia) is extensive and defined by Bi, As, Sb and Sn in addition to Cu, Zn and Au;...	Butt, ibid. (citing Smith & Perdrix 1983)

Evidence ledger 2 of 2

Only dossier rows used in this edition are listed. Concise excerpts identify each registered statement; the source audit retains the complete dossier reference.

ROW	REGISTERED EVIDENCE EXCERPT	REGISTERED SOURCE
WP19-16	Termite-mound sampling is an established surface-exploration medium in parts of West Africa: mound-building termites bring subsoil up from depth (foraging toward the water table),...	Petts/Arhin et al., "Identifying pathfinder elements from termite mound samples for gold..."
WP19-17	Classic demonstration: gold is concentrated in termite-mound material relative to surrounding soil over a gold anomaly in Kalahari sand.	Watson, J.P., "The distribution of gold in termite mounds and soils at a gold anomaly in..."
WP19-18	Termite-mound geochemistry has been combined with high-resolution airborne geophysics for mineral exploration in the Pan-African province of Damagaram-Mounio, eastern Niger, as a...	Damagaram-Mounio study, International Journal of Science, Technology and Society, 2022
WP19-19	The method generalises beyond gold: termite-mound materials have been used as a geochemical tool for chromite (Karnataka, India) and for rare-earth-element prospecting, confirming...	Research Journal of Chemical Sciences 4(5), 2014 (chromite, Karnataka); Mineralium...
WP19-20	Gold by fire assay (lead-collection fusion): Au-AA21 uses a 30 g fusion charge, lower detection limit 0.002 ppm (2 ppb) Au, upper limit 1 ppm before over-range reruns; Au-AA22...	ALS Geochemistry, "Geochemical Procedures" (NTGS GR501, 2019)
WP19-21	Aqua-regia super-trace multi-element ICP-MS/ICP-AES (ALS ME-MS41L): a ~0.5 g sample is digested in 75% aqua regia (3:1 HCl:HNO3) in a graphite block; an aqua-regia leach is an...	ALS Geochemistry, <i>ibid.</i>
WP19-22	Method selection is target-dependent: aqua regia is a partial (near-total for sulphides and labile phases) digestion suited to pathfinder soil/sediment surveys; four-acid...	ALS Geochemistry, <i>ibid.</i> ; Butt (method-setting principle)
WP19-23	Portable XRF is a field-triage tool, not an assay: it reads a suite of base metals and pathfinders directly on sample or outcrop for rapid, non-destructive screening and survey...	Method principle (framed qualitatively; no [06] XRF error values cited per PRD §7)
WP19-24	Because much residual regolith is in place, secondary dispersion can produce targets broader than the primary mineralisation itself, so a residual near-surface anomaly can be a...	Butt, <i>ibid.</i>
WP19-25	Multi-element pathfinder analysis is used to define and prioritise anomalies for follow-up (As, Sb, W, Cu, Bi for gold; Bi, As, Sb, Sn added for VHMS), i.e. anomaly ranking is a...	Butt, <i>ibid.</i>
WP19-26	The genetic similarity of lateritic landscapes across climatic zones allows generalised dispersion and exploration models (Butt & Zeegers 1992) to predict the broad geochemical...	Butt, <i>ibid.</i> (models after Butt & Zeegers 1992)
WP19-27	Butt's stated method sequence is the doctrine's backbone: (1) regolith-landform mapping; (2) field characterisation by drilling/deep pitting, essential under transported cover;...	Butt, <i>ibid.</i> (sequence assembled from the archived text)
WP19-28	Macro-economic case for method discipline: with grassroots at ~19% of gold budgets, discoveries scarce (six majors 2020:2024) and shrinking (~4.4 vs ~7.7 million oz), and...	S&P Global Market Intelligence, 2024:2025

Glossary

Regolith

The blanket of weathered material above fresh bedrock, including in situ weathered horizons and transported cover.

Residual regolith

Regolith formed in place by weathering of underlying bedrock, commonly lateritic in tropical to subtropical terrains.

Transported overburden

Deposited cover materials not formed in place, which commonly disrupt the relationship between surface geochemistry and buried mineralisation.

Lateritic residuum

Iron and or aluminium enriched weathering products and associated horizons that can preserve ore related dispersion halos and act as a sampling medium.

Saprolite

Clay rich, deeply weathered bedrock that retains original textures and forms a major part of lateritic profiles.

Relict terrain

A landscape where regolith and weathering profiles are preserved, allowing more direct geochemical relationships to mineralisation.

Erosional terrain

A landscape where regolith has been partly removed, potentially exposing or thinning residual materials and changing dispersion targets.

Depositional regime

A setting dominated by transported cover where surface and near surface geochemical techniques are generally ineffective for locating buried mineralisation.

Regolith landform mapping

Systematic mapping of regolith materials and landforms to support dispersion modelling, sampling medium selection and interpretation.

Dispersion model

A conceptual model of how ore related elements move and concentrate within regolith and landforms, used to predict the best medium and anomaly geometry.

Orientation survey

A local test programme that compares sampling media, spacing and analytical methods against expected dispersion to validate the main survey design.

Pedogenic carbonate (calcrete)

Carbonate precipitated in soils that can carry gold anomalies through several metres of cover and can be a preferred sampling medium in suitable settings.

Pathfinder elements (gold)

Elements such as As, Sb, W, Cu and Bi that can express mineralisation where gold is depleted or poorly dispersed near surface.

VHMS pathfinder suite in lateritic residuum

A broader suite where Bi, As, Sb and Sn can define dispersion halos alongside Cu, Zn and Au in lateritic residuum.

Fire assay

A fusion based analytical method that remains the reference determination for gold in exploration geochemistry.

Aqua regia digestion

A partial digestion using HCl and HNO₃ that is near total for sulphides and labile phases, suitable for many soil and sediment pathfinder programmes.

Four acid digestion

A strong multi acid digestion approaching total dissolution, preferred where resistate or refractory minerals host target elements.

Portable XRF (pXRF) triage

Use of field XRF to screen base metals and pathfinders rapidly for prioritisation and survey levelling, without treating results as gold assays.

References and limitations

Butt, C.R.M. (CRC LEME / CSIRO Exploration and Mining) (n.d. (archived; read)

Understanding the Regolith in Tropical and Sub-Tropical Terrains: The Key to Exploration Under Cover. Archived primary artifact in dossier; method spine for regolith mapping, media selection and dispersion reasoning.

ALS Geochemistry (2019)

Geochemical Procedures (analytical schedule reproduced in NTGS Geological Record GR501). Archived schedule source for fire assay and aqua regia super trace multi element procedures and detection limits.

S&P Global Market Intelligence (2024)

World Exploration Trends 2024; discovery to production lead time research (transcribed captures). Secondary macro context capture on disk, used for budget and lead time context only.

MINING.COM (reporting S&P Global) (2025)

Reporting of World Exploration Trends gold budget and discovery figures (as captured). Secondary reporting used as captured transcription source in dossier.

Petts/Arhin et al. (Journal of African Earth Sciences) (2015)

Identifying pathfinder elements from termite mound samples for gold exploration in regolith complex terrain of the Lawra belt, NW Ghana. Cited at title and abstract level per gap register; qualitative findings only.

Watson, J.P. (Soil Science) (1972)

The distribution of gold in termite mounds and soils at a gold anomaly in Kalahari sand. Classic termite mound demonstration cited in dossier; qualitative statement only.

International Journal of Science, Technology and Society (2022)

Termite mound geochemistry combined with high resolution airborne geophysics in the Pan African province of Damagaram Mounio, eastern Niger. Cited at title and abstract level per gap register; reconnaissance concept only.

Butt, C.R.M. and Zeegers, H. (eds) (1992)

Regolith Exploration Geochemistry in Tropical and Subtropical Terrains (Handbook of Exploration Geochemistry, Vol. 4). Not archived in full; cited as the canonical dispersion model reference carried through the archived Butt paper.

Lintern, M.J. (2002)

CSIRO work on calcrete gold (as cited within Butt, Understanding the Regolith...). Primary not archived; the 5 to 10 m figure is treated as an archived carrier citation via Butt.

USE LIMITATIONS

- Rows about termite mound geochemistry are supported at title and abstract or metadata level only, so the paper states qualitative findings and avoids numeric excavation depths or correlation coefficients. [WP19-16 to WP19-19]
- The calcrete gold anomaly penetration figure is carried through the archived Butt paper which cites Lintern 2002, but the Lintern primary is not separately archived, so it is treated as a carrier citation. [WP19-04]
- S&P budget, discovery and lead time figures are secondary capture transcriptions and are used as macro context only, not as method validation or performance evidence. [WP19-05, WP19-06, WP19-28]
- Portable XRF is treated qualitatively as triage only; no precision, error or quantitative capability claims are made. [WP19-23]
- Analytical detection limits and method codes are drawn from a single published commercial laboratory schedule and are framed as a representative benchmark, not an industry universal. [WP19-20, WP19-21]

EDITION STATUS

This technical paper is an editorial synthesis for decision support. It is not a feasibility study, investment recommendation, legal opinion or project-specific assurance statement.

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