Gold and base metal deposits of the Abu Marawat Concession, Egypt

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Abu Marawat Concession (AMC)

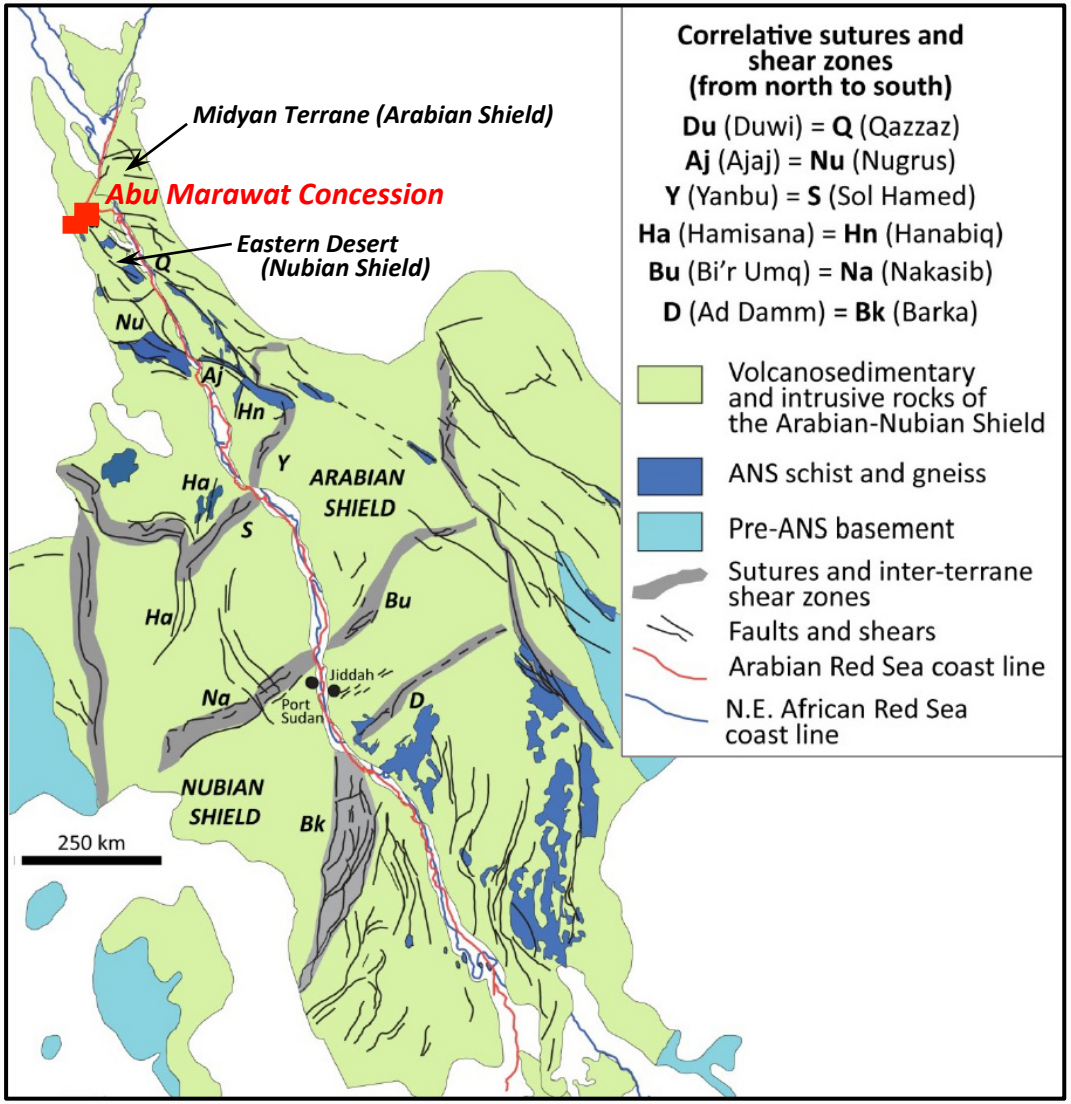
Who and where we are

- Formerly Alexander Nubia
- AMC granted in 2007, and now covers 738.8 km^2
- Egyptian Central Eastern Desert
- Located between Qena and Safaga

Exploration & mining history

- Ancient mining dates back 4,500 years to Old Kingdom
- British mining: *c.* 1904-08
- Minex exploration: late 80's
- PGM exploration: 1990's
- AAN: 2008 - present

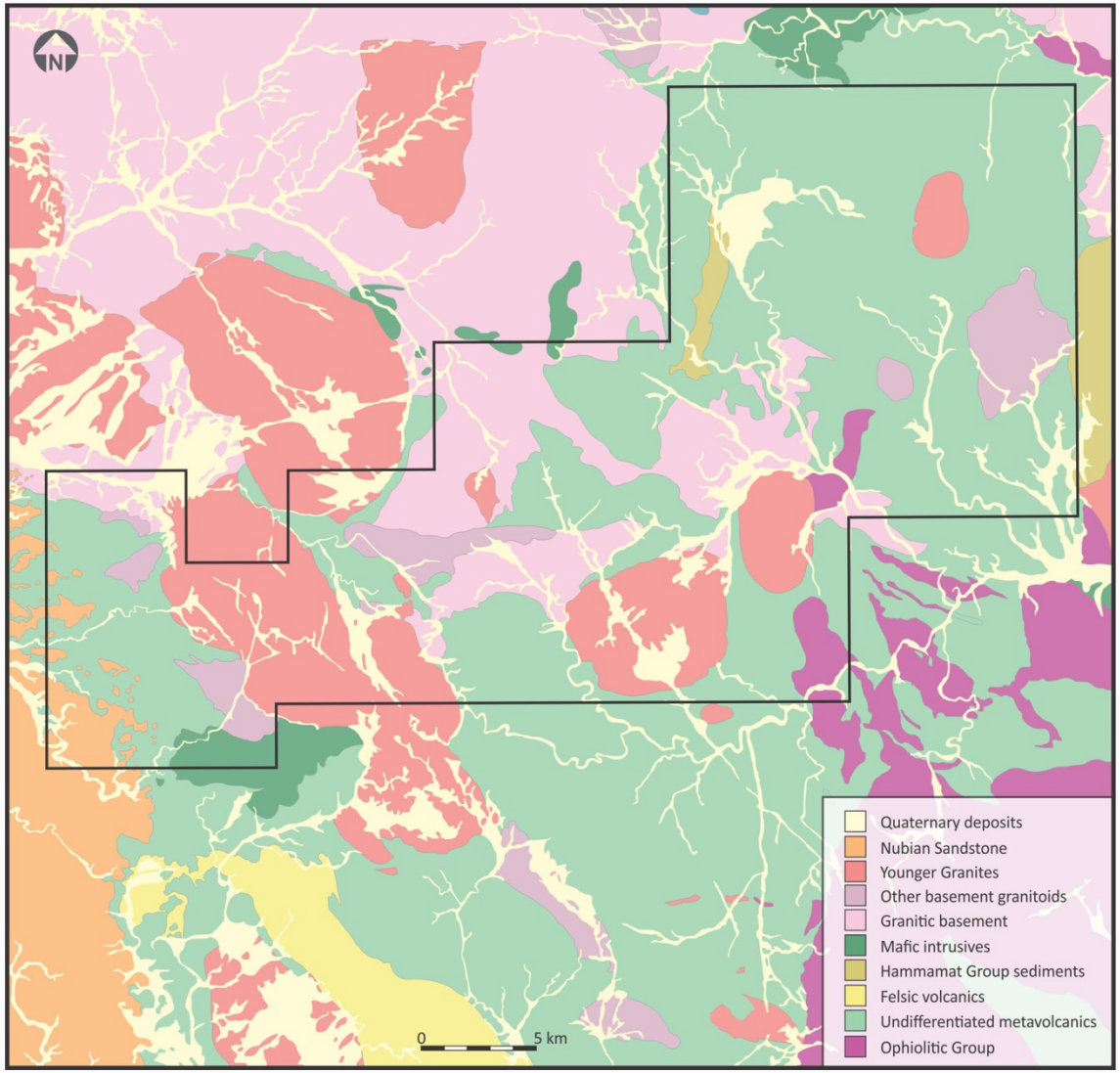
Regional setting in the ANS



Modified from Johnson (2016): Mineralization in a Neoproterozoic accretionary orogen

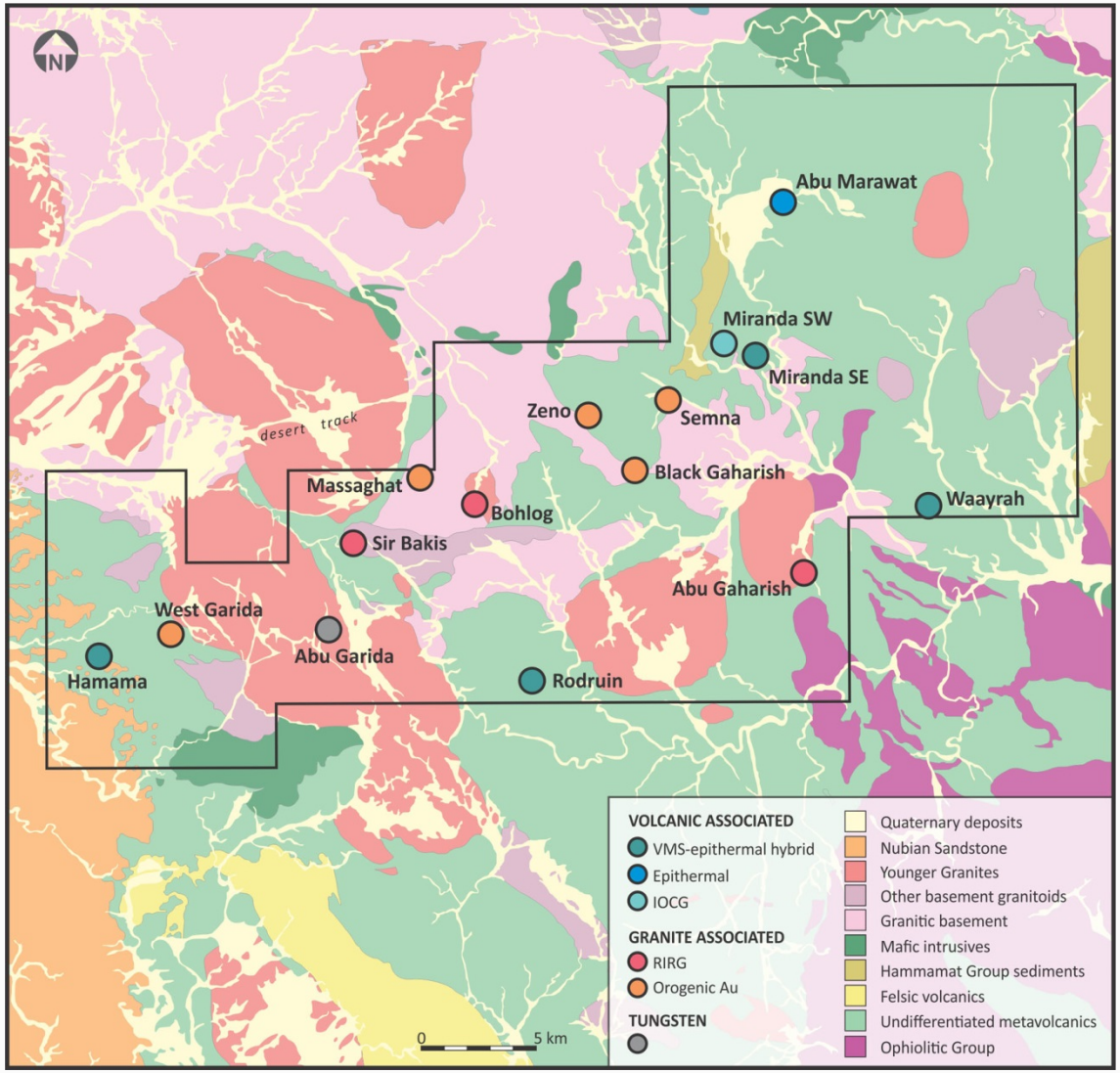
- AMC located in northern part of the ANS
- Series of Neoproterozoic accreted island arcs
- Arc boundaries preserved as ophiolites ± melange
- ANS composed of juvenile crust, *c.* 620-870 Ma in age
- Eastern Desert / Midyan terranes *c.* 810-720 Ma
- Late post-orogenic granites, *c.* 570 Ma in AMC
- Mineralisation types: VMS, orogenic Au, IR Au, Cu-Au porphyry, IOCG, BIF, REE-Nb-Ta-U, Sn-W, Cr, PGM

Geology of the AMC



- Felsic to intermediate arc volcanics, volcaniclastic sediments
- Ultramafics – wedges of ophiolitic oceanic crust
- Basement orogenic “grey granites”(Gd-To-Di)
- Pan-African orogeny – generation of juvenile crust, accretion of arcs, crustal shortening
- Post-orogenic evolved, pink “Younger Granites” *c*. 570 Ma
- Late clastic sedimentary package (Hammamat)

Gold mineralisation styles within the AMC



Volcanic associated gold

- Carbonate-hosted VMS-epithermal hybrid
- Abu Marawat-Miranda SW epithermal-IOCG corridor

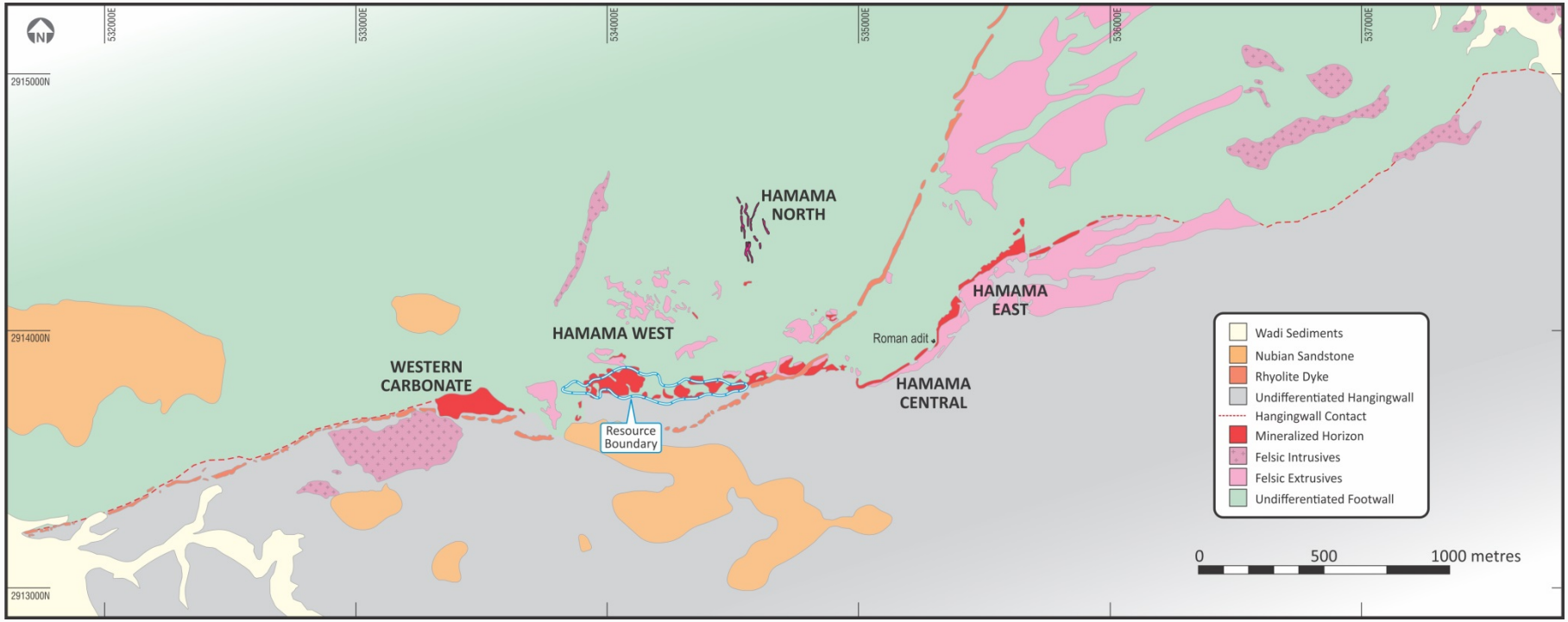
Granite associated gold

- Orogenic / lode Au possibly associated with RIRG systems
- RIRG style mineralization located on margins of, and surrounding late, evolved W(-Sn-Mo?)-bearing pink granites

Mineralisation styles within the AMC

Deposit Style	Commodity	Examples
Carbonate-hosted VMS-epithermal hybrid	Au-Zn-Ag (-Pb-Cu)	**Hamama, Rodruin**, Waayrah, Miranda SE
Epithermal	Au-Ag (-Zn-Cu-Te)	**Abu Marawat**
IOCG	Cu-Au	Miranda SW, Hamama North
Orogenic Au (lode gold 1)	Au (±Cu)	***Semna***, Zeno, Black Gaharish
Orogenic Au (lode gold 2)	Au, Ag (±Cu-Te?)	***Sir Bakis (Main Vein)***, Zeno, West Garida
RIRG Au	Au-W-Bi (±Cu?)	Abu Gaharish, Bohlog, Sir Bakis (sheeted vein swarm)
Granite association	W; F; U; REE-Nb-Ta	***Abu Garida*** (W), Garida granite (fluorite), Eradiya granite (U), Kab Amira granite (Nb-Ta)
Ultramafic association	Talc, Cr Au	Wadi Sagia, Abu Gaharish (south)

Hamama - VMS mineralisation?



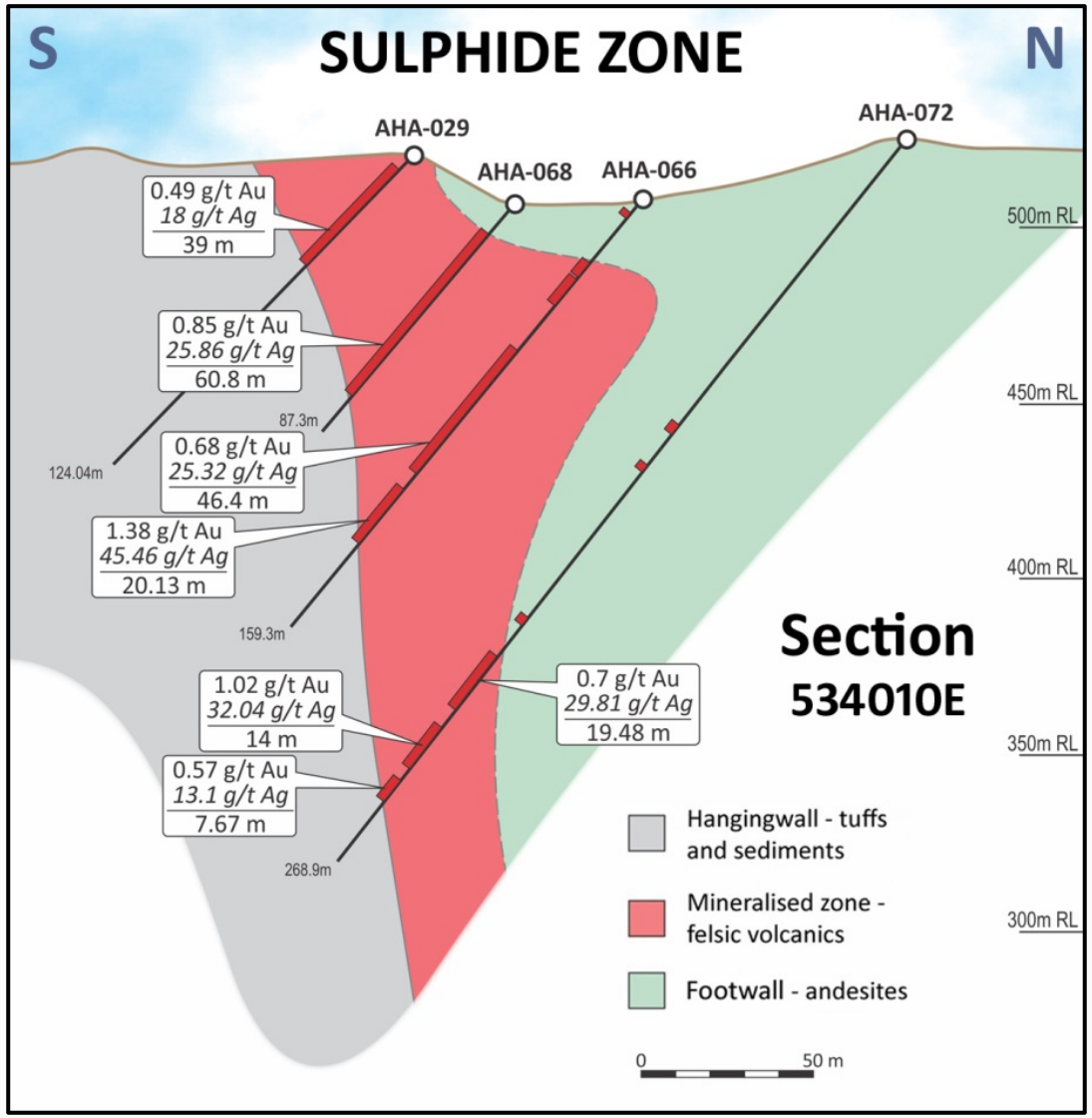
- Stratabound Au-Ag-Zn (Cu-Pb) mineralisation in silica-carbonate-barite rock (SCBR)
- Syn-volcanic faulting, local thickening of mineralised zone
- Mineralisation at distinctive

- Footwall: intensely altered tuffs / flows with disseminated pyrite and stringer Zn mineralization
- Intense crb alteration in min zone
- Hangingwall: Ash/lapilli tuffs, jasper, BIFs, pyritic mudstones

Hamama - epithermal mineralisation?

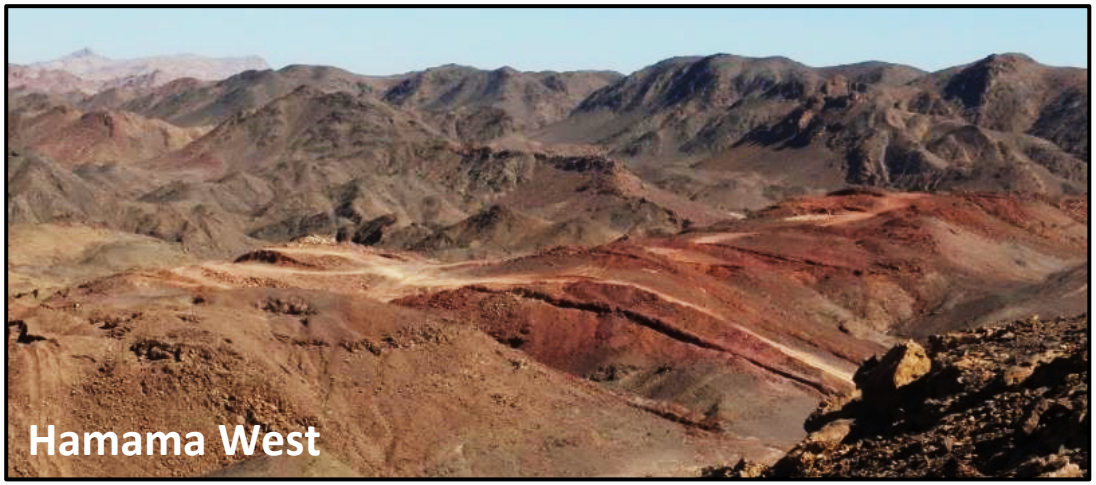
- Au-Ag-Zn (Cu-Pb) mineralisation hosted in SCBR
- Sulphide occurs as as veins, stringers, blebs and disseminations, no massive
- Sulphide content typically <30%, no massive sulphide
- Crustiform/colloform qtz-crb-slf veins throughout SCBR rock, and into footwall
- Brecciated veins - boiling/explosive activity (low pressure?)
- Drusy cavities immediately below h/wall contact – possibly emergent?
- As, Sb, Bi, Cd, Hg geochem signature
- Distinctive welded tuff/ignimbrite unit immediately above h/wall contact – subaerial environment?

Hamama - VMS-epithermal hybrid



- Hamama is a transitional VMS-epithermal hybrid deposit, formed in a very shallow water to possibly emergent arc environment
- Clearly a VMS deposit on a macro scale, but distinctive epithermal ore textures
- Low-temperature acid magmatic hydrothermal system - Zn-rich, Cu-poor
- Mineralisation hosted in a replacive carbonate unit – ophiolite link?
- High Mg content - ophiolite link?

Hamama - VMS-epithermal hybrid

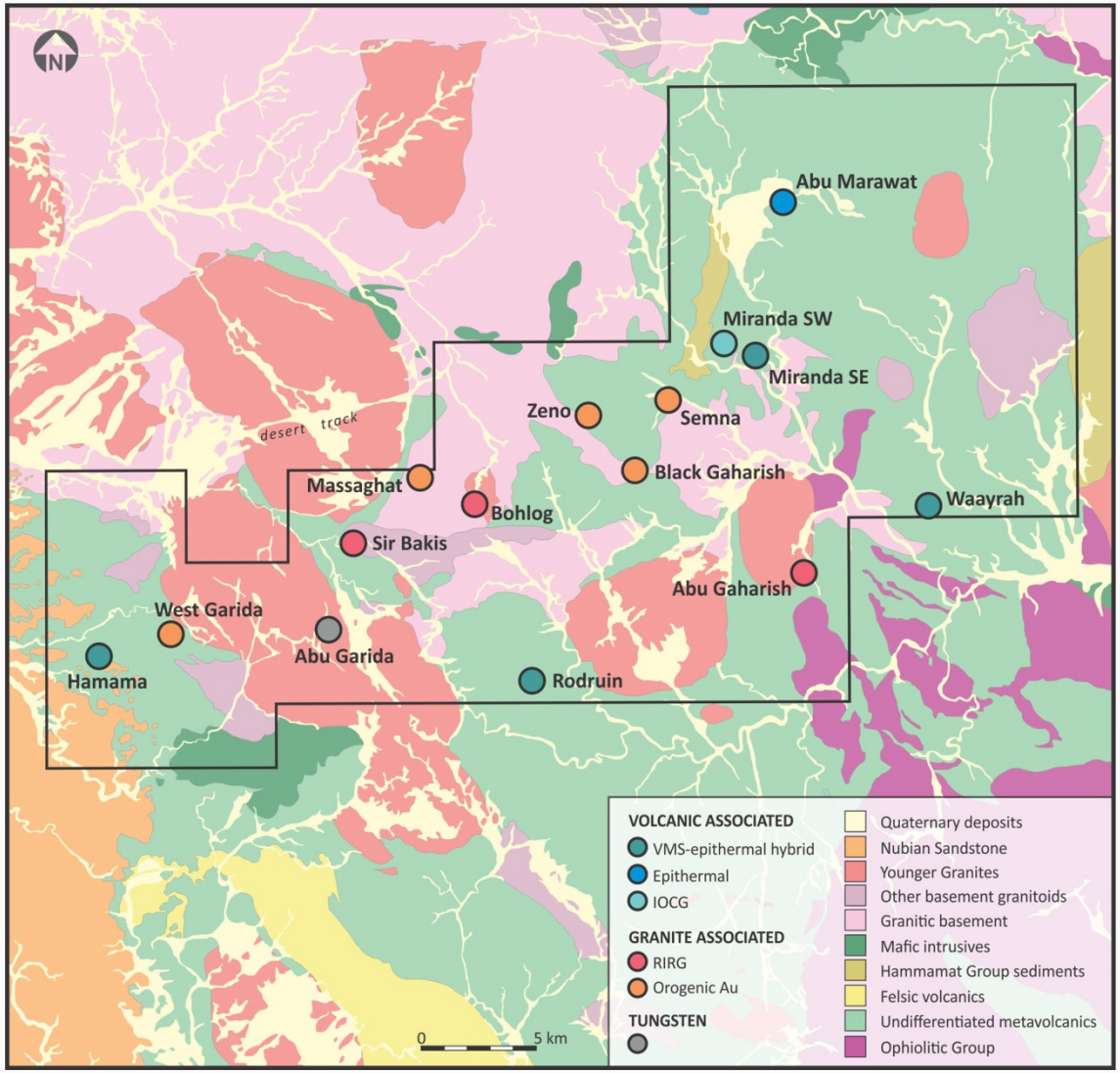

Hamama West

- Red gossan (high sulphide content) – restricted to Hamama West

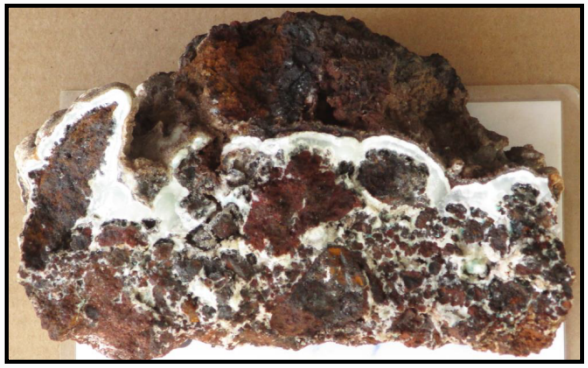

Hamama East road cutting

- Dark brown gossan (manganiferous carbonates) – Hamama East and Central

Other VMS-epithermal hybrid targets



Waayrah



- Manganiferous Zn-Au-Ag-Cu gossans
- 24.6% Zn, 16.4 g/t Au
- GPR targets

Miranda SE

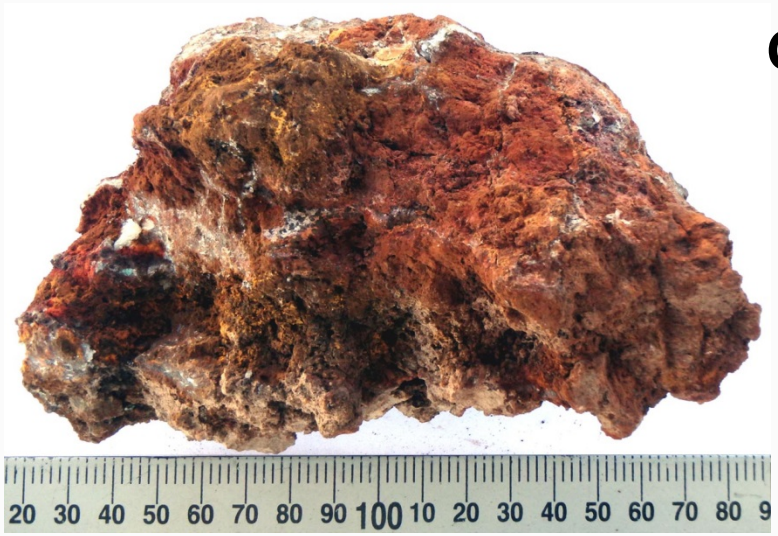
- Strong GPR target
- 7.3 g/t Au, 2.42% Pb, 1.38% Zn, 1.85 % Cu

Rodruin: December 2017

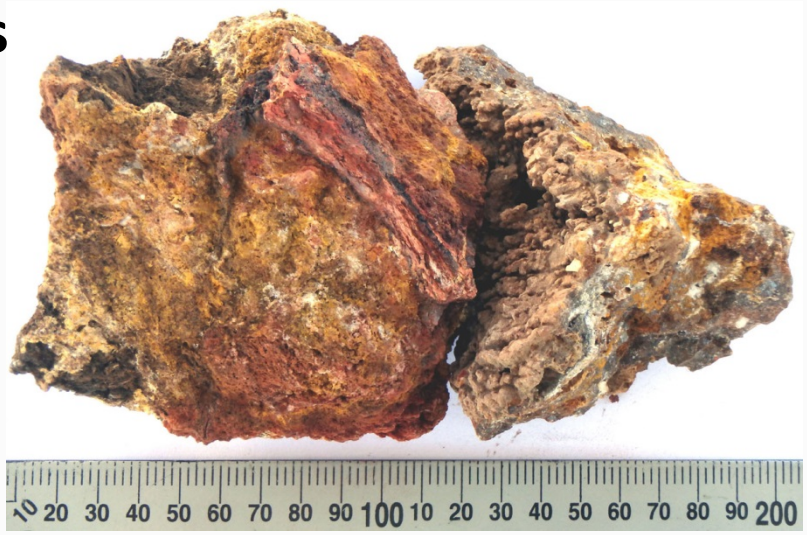
Rodruin - VMS-epithermal hybrid

Rodruin - VMS-epithermal hybrid

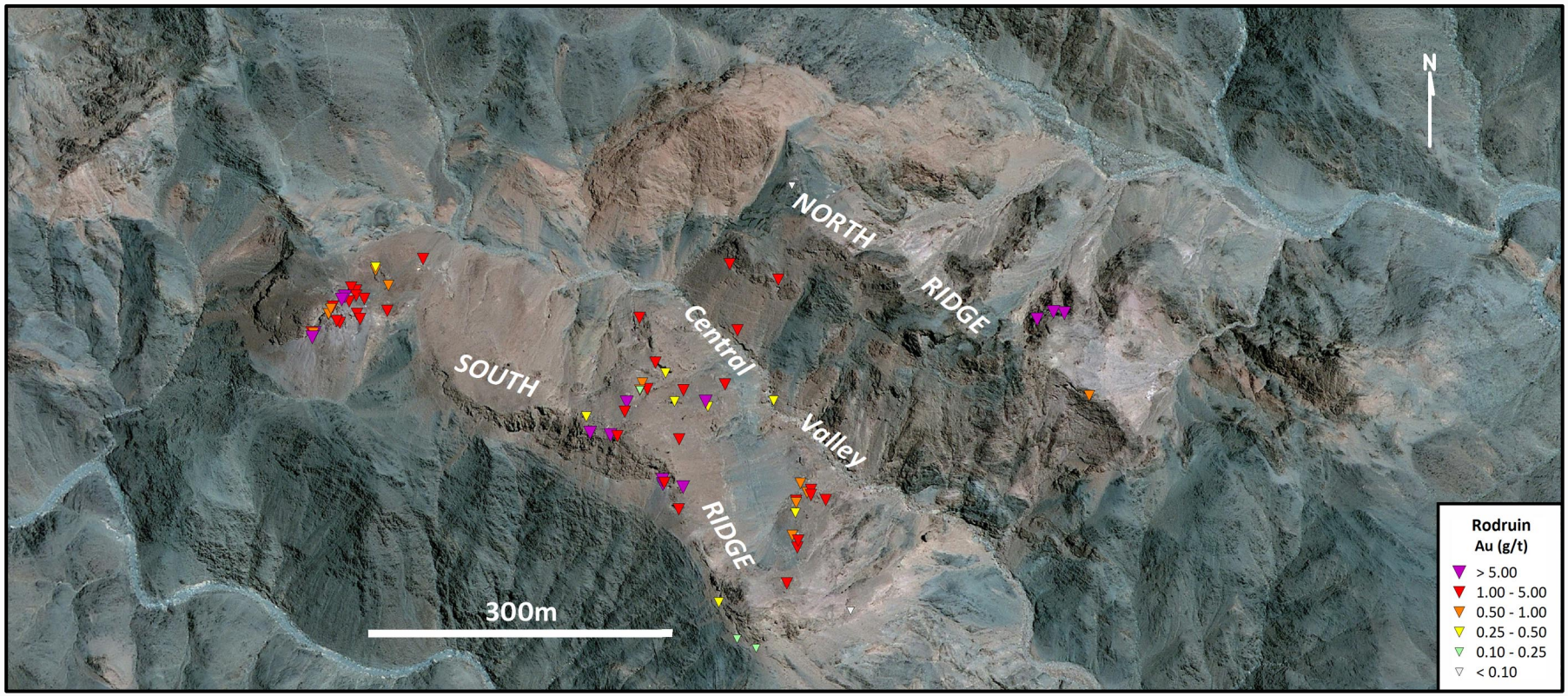
Gossan



Gossanous carbonate

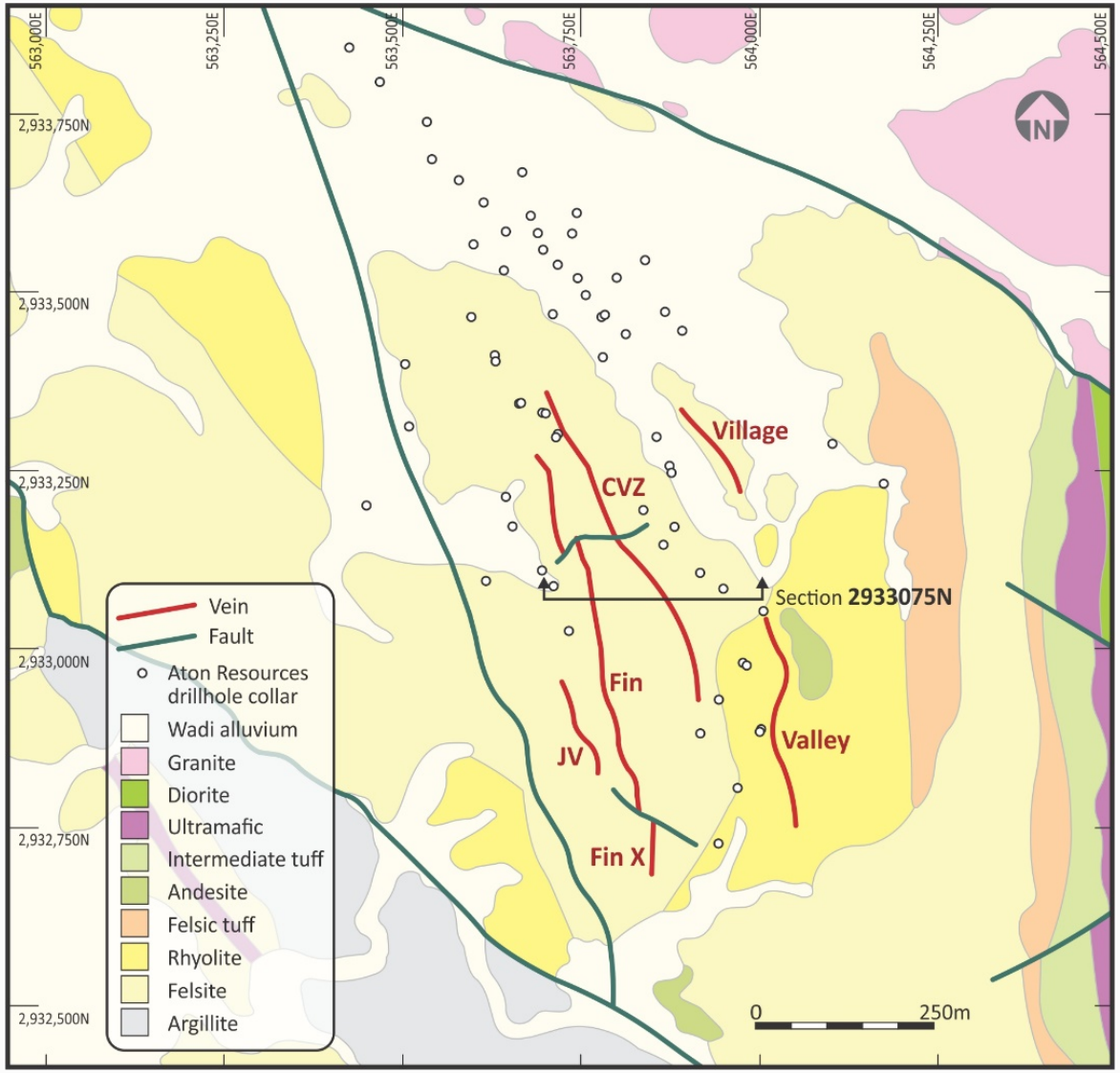


Rodruin - VMS-epithermal hybrid



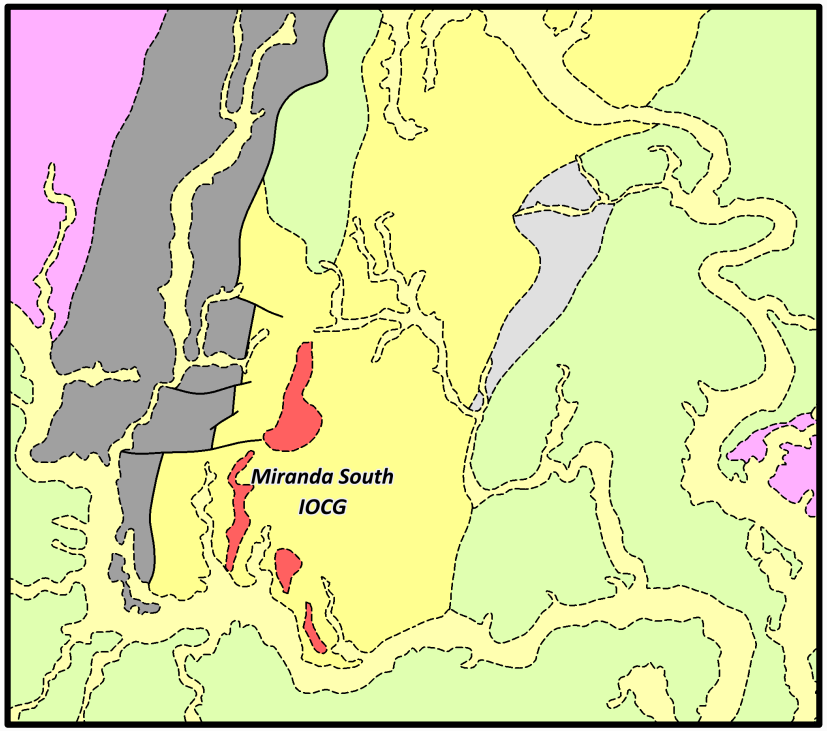
- High-grade shear hosted Au-Ag-Zn mineralisation (up to >300 g/t Au), associated with red gossanous sheared qtz-pyr veins, visible Au and Ag
- Mineralisation distributed over a wide area, hemimorphite-rich gossans
- Mineralisation hosted in a sequence of carbonate altered felsic tuffs
- Structurally complex, vertical foliation, folding, possibly overturned?

Abu Marawat – epithermal veins



- Abu Marawat only significant example
- Linear sub-vertical *en echelon* quartz lenses
- Hosted in deformed rhyolites and rhyolitic tuffs
- Saccharoidal qtz-pyr-Zn-Cu sulphide veins; Au-Ag tellurides
- Strong phyllic (qtz-ser-pyr) alteration
- Deposit in fault bounded block: suture zone to E, major strike-slip fault to S

Miranda SW/Hamama North – IOCG veins

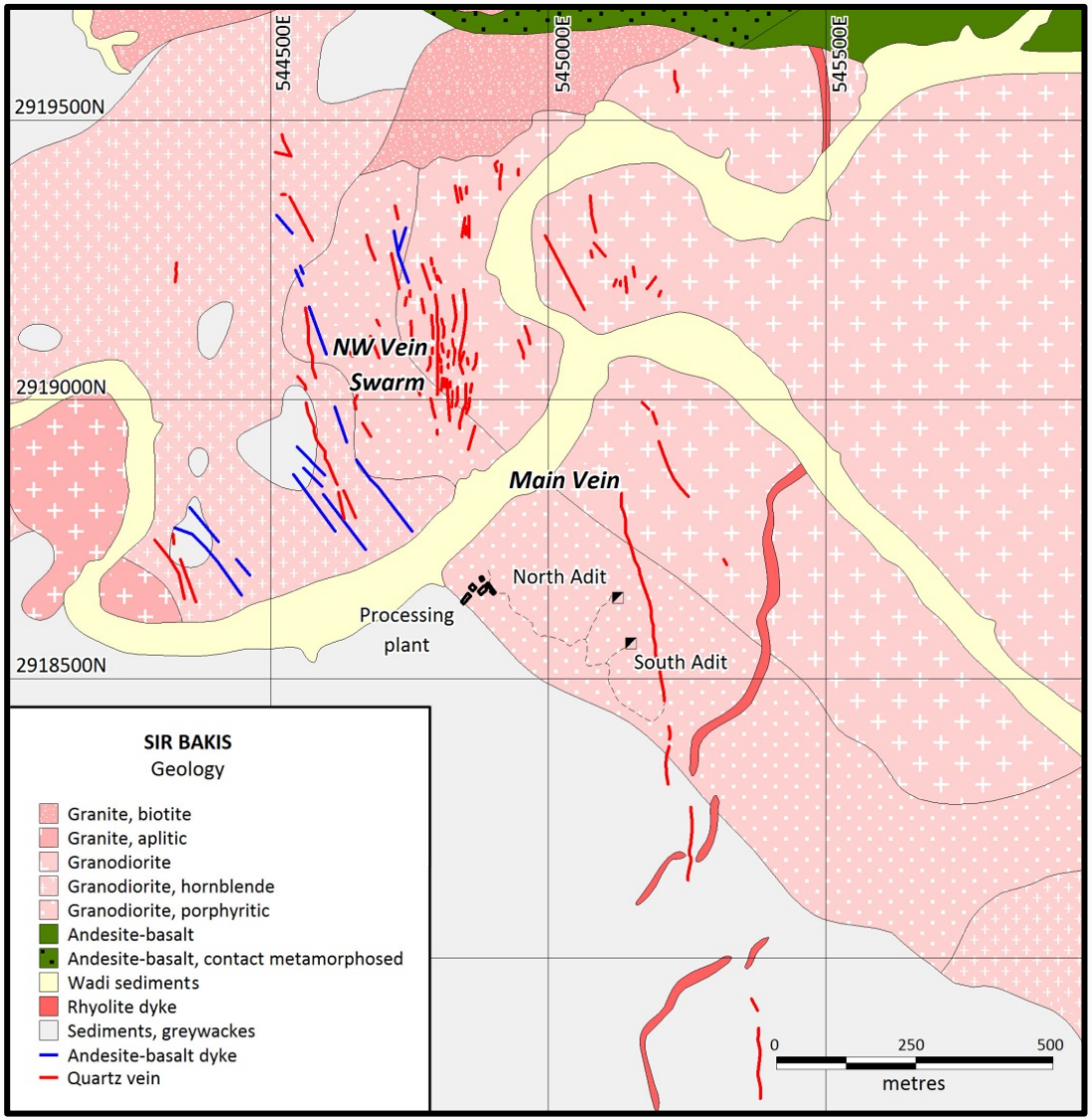


- Vertical veins (Hamama North) or conformable replacements (Miranda SW) in arc volcanics
- Simple mineralogy: qtz-hem-mag-pyr
- Cu-Au at Miranda South only, Fe only in Hamama area
- Hypersaline epithermal systems – source/origin of fluids is unclear

Orogenic / lode gold 1 – Shear

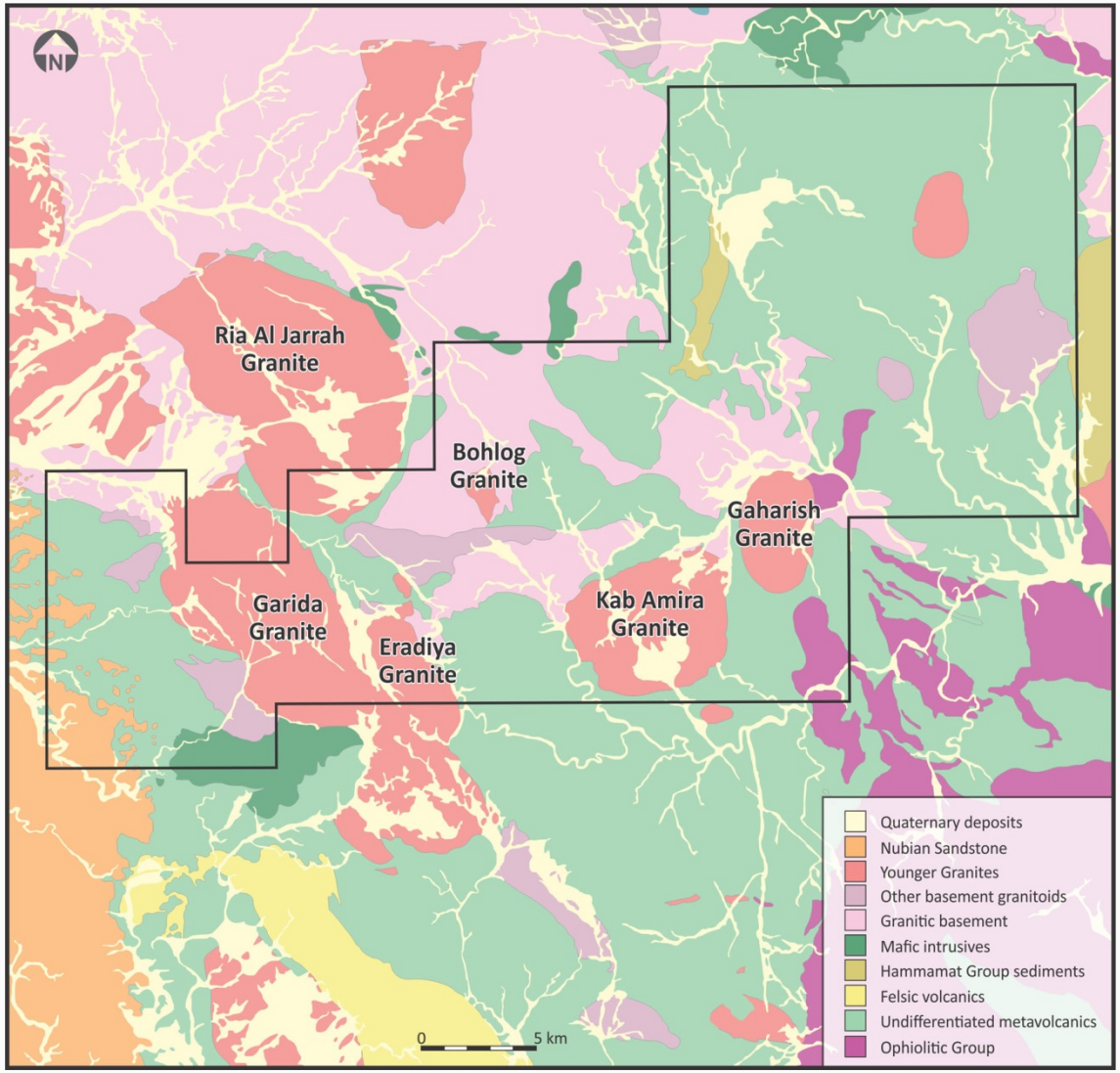
- Sheared host rock with/without sheared quartz, grade confined to shears – not in massive qtz veins
- Hosted by older “grey granites” and arc volcanics
- Low sulphide content, no other metals (Cu at Semna), limited alteration
- Fairly deep emplacement, associated with main orogenic stage?

Orogenic / lode gold 2 – Passive



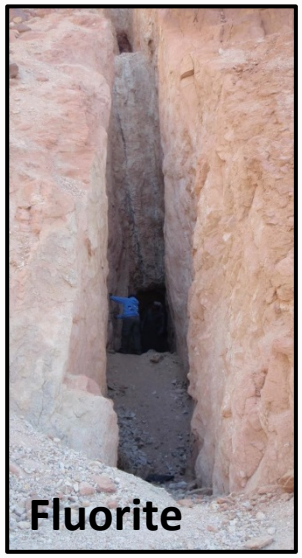
- Several mineralising events
- Veins are vertical to horizontal
- Single veins (Sir Bakis Main Vein) or clusters (Zeno)
- Low-sulphide qtz veins ±crb-chl
- Minor Cu, Pb, Zn (Te?)
- Textures: massive, w/ drusy cavities, not crustiform
- Limited alteration halo
- Some affected by contact metamorphism
- Crustal relaxation – late in orogenic cycle

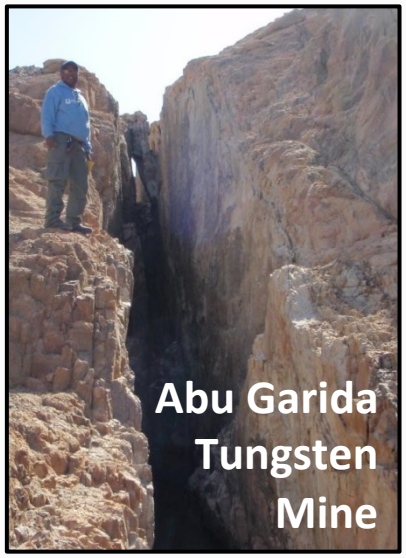
Younger Granites - distribution



- Younger Granites ("pink" or Gattarian) – late, post-orogenic alkalic evolved suite of granites
- Occur throughout ANS, young towards the north, ~570 Ma in AMC
- Associated with Sn-W-Mo, RE-Ta-Nb mineralisation
- Also RIRG association?
- Garida granite: W, F
- Eradiya granite: U
- Kab Amira: Ta-Nb
- Abu Gaharish/Bohlog: RIRG Au

Granite related mineralisation (other)



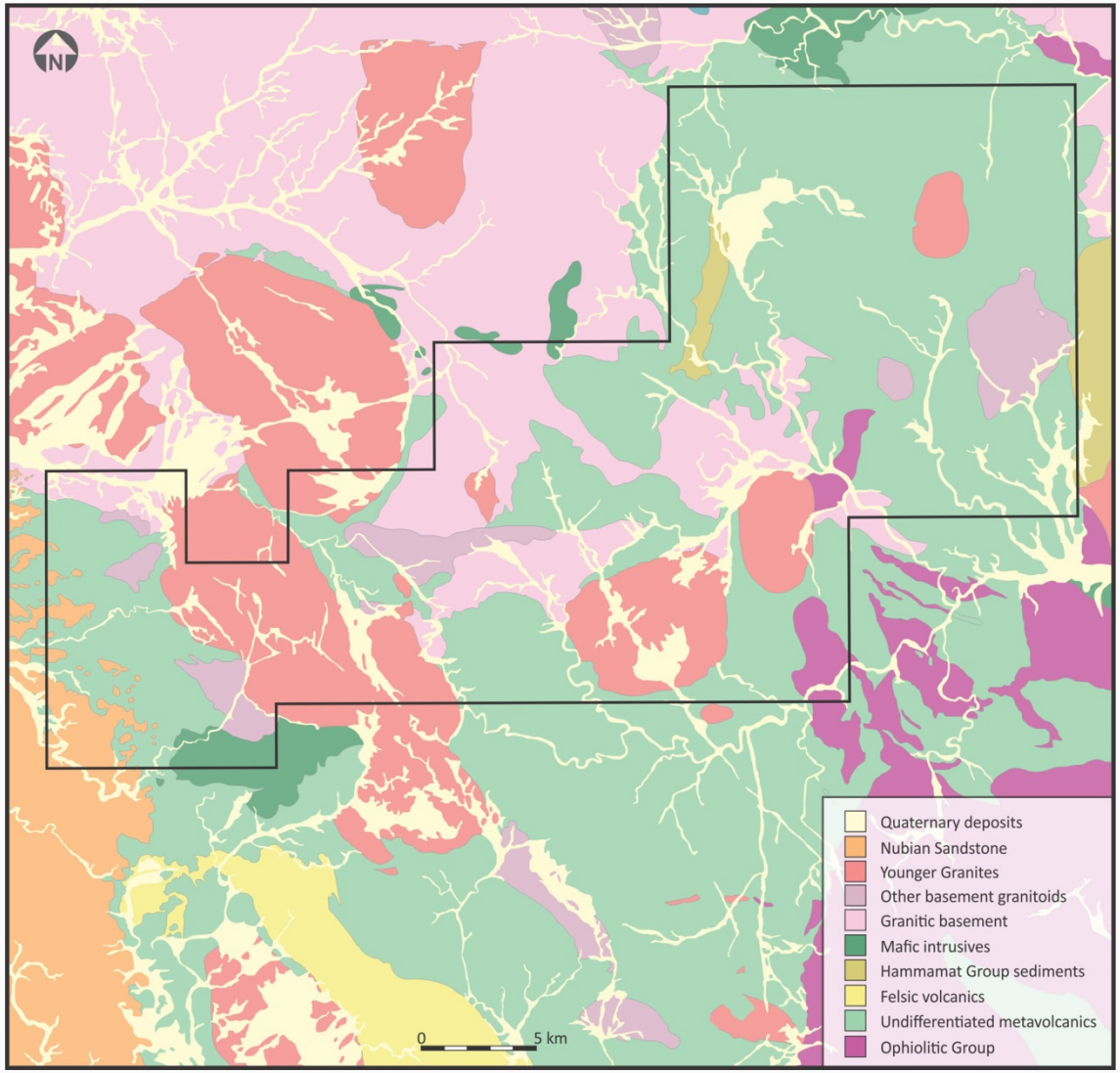


- Associated with evolved post-orogenic Younger Granites
- Eradiya Granite: W-quartz-muscovite (±Cu) veins and fluorite veins
- Eradiya Granite: U mineralisation occurs within fracture system
- Kab Amira Granite: Disseminated Nb-Ta mineralisation

Intrusion-related RIRG gold

- Associated with small, polyphase Younger Granite plutons (eg. Abu Gaharish, Bohlog?)
- Hosted in late pink granites, on their margins or immediately in adjacent country rock
- Low sulphide quartz veins
- Clusters of sub-parallel, often shallow dipping veins, stockwork zones (eg. Bohlog)
- Structurally controlled ladder vein systems (eg. Abu Gaharish)
- Sheeted vein swarm (Sir Bakis)
- Anomalous W, Bi, As, Cu, Pb
- Late/post intrusive activity, post orogenic Younger Granites

Ultramafic association



- Southeast of AMC:
- Mineralisation in ophiolitic ultramafics includes:
  - chromite lenses;
  - Cu-Ni-Co sulphides;
  - asbestos, magnesite and talc

- Within AMC:
- Talc deposits (Wadi Sagia)
- Au in dolomite-quartz-fuchsite veins (Abu Gaharish South)