

Geological controls on gold mineralisation at Spring Hill: New insights

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Regional geological framework

The Spring Hill gold deposit is located within the Paleoproterozoic Pine Creek Orogen of northern Australia, an important metallogenic province of the North Australian Craton. The region hosts numerous gold, uranium and base-metal deposits, and has been an important focus of mining and exploration since the late nineteenth century, including the historic Pine Creek Goldfield (Ahmad *et al* 2009, Ahmad and Hollis 2013).

The orogen comprises a succession of sedimentary and volcanic rocks deposited in a marine basin between approximately 1.88 and 1.86 Ga. These rocks were subsequently deformed during regional tectonothermal events related to continental assembly between about 1.87 and 1.85 Ga, producing large-scale folds, faults, and shear zones that strongly control the distribution of mineralisation (Ahmad *et al* 2009).

Stratigraphically, the Pine Creek Orogen is dominated by sedimentary units of the Cosmo Supergroup, including the South Alligator Group and Finniss River Group (Figure 1). These successions consist mainly of turbiditic sandstones, siltstones, mudstones, and volcanoclastic sediments deposited in a submarine basin environment (Ahmad *et al* 2009, Ahmad and Hollis 2013).

During deformation, the sedimentary sequences were folded and metamorphosed to greenschist facies. Intrusion of granitoids associated with the Cullen Batholith contributed to the regional thermal regime and may have influenced hydrothermal fluid pathways. Gold deposits in the region commonly occur near granitoid intrusions or along major shear zones where structural complexity created favourable sites for quartz-vein emplacement and gold mineralisation (Sener 2004; Blewett *et al* 2010).

Local geological setting

The Spring Hill gold deposit lies approximately 200 km southeast of Darwin and about 25 km northwest of Pine Creek within the central domain of the Pine Creek Orogen (Figure 2). The deposit occurs within folded Palaeoproterozoic metasedimentary rocks belonging primarily to the Mount Bonnie Formation of the South Alligator Group (Northern Territory Geological Survey 1999, Sener 2004).

The stratigraphic succession in the Spring Hill area includes several formations representing different depositional environments within the Palaeoproterozoic basin. The oldest units exposed locally occur within the core of the Spring Hill Anticline and include carbonaceous siltstones, mudstones, ironstones, and cherts belonging to the Koolpin Formation (Northern Territory Geological Survey 1999).

Overlying the Koolpin Formation is the Gerowie Tuff, a sequence of volcanoclastic sediments consisting of siltstones, cherts, and tuffaceous units deposited during a period of volcanic activity within the basin (Figure 1). The Gerowie Tuff is overlain by the Mount Bonnie Formation, which hosts the majority of the gold mineralisation at Spring Hill (Northern Territory Geological Survey 1999). Younger sedimentary rocks of the Burrell Creek Formation overlie the Mount Bonnie Formation in parts of the local stratigraphy.

The Mount Bonnie Formation consists predominantly of interbedded greywacke, siltstone, shale, and minor chert or iron-formation horizons deposited in a turbiditic submarine environment (Sener 2004). The unit is estimated to reach a thickness of approximately 500–700 m within the Spring

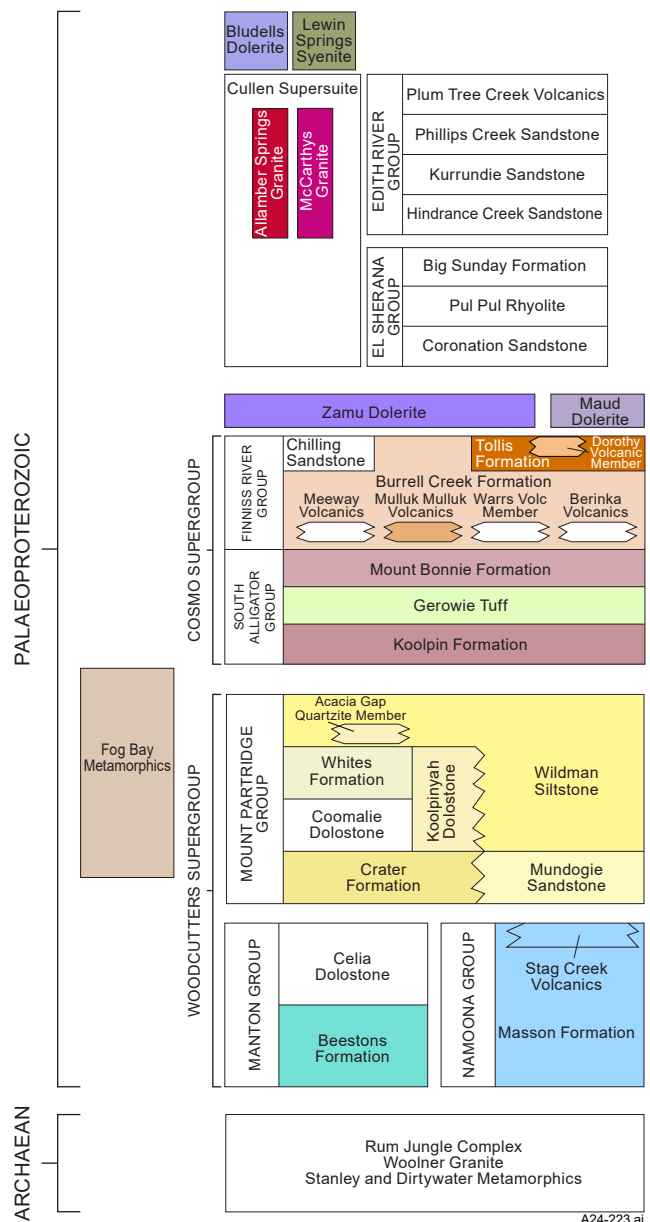


Figure 1. Regional stratigraphy of the Pine Creek Orogen.

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Hill area. These rocks were subsequently metamorphosed to greenschist facies during regional deformation and display well-developed foliation and cleavage.

The dominant structural feature within the deposit area is the Spring Hill Anticline, a regional fold structure plunging to the southeast (Figure 3). The anticline forms part of a series of northwest-trending folds produced during compressional deformation of the Pine Creek basin sediments (Northern Territory Geological Survey 1999,

Sener 2004). The fold geometry is complex, with steeply dipping limbs and locally asymmetric geometries.

A local deposit stratigraphy has been developed that breaks down the Mount Bonnie Formation locally into a succession of graded sedimentary units alternating between coarser-grained dominant greywacke with smaller packages of siltstones, mudstones, and minor cherts and tuffaceous horizons that grade into dominant siltstone and mudstone packages with minor greywacke and cherts. The sequence

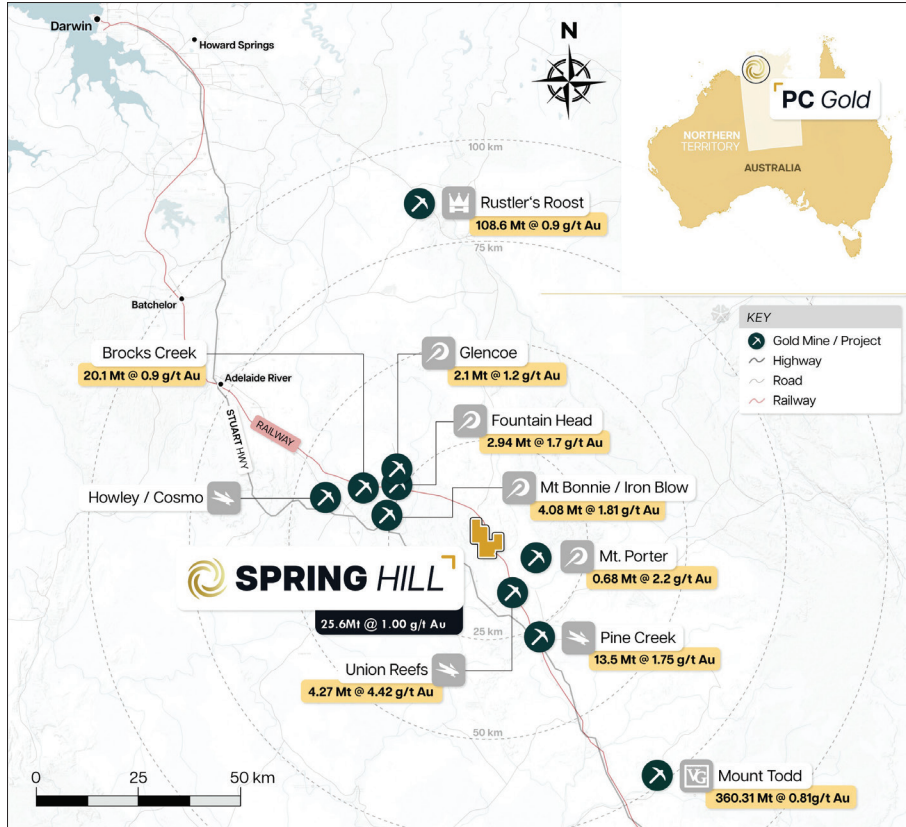


Figure 2. Location of the Spring Hill Project.

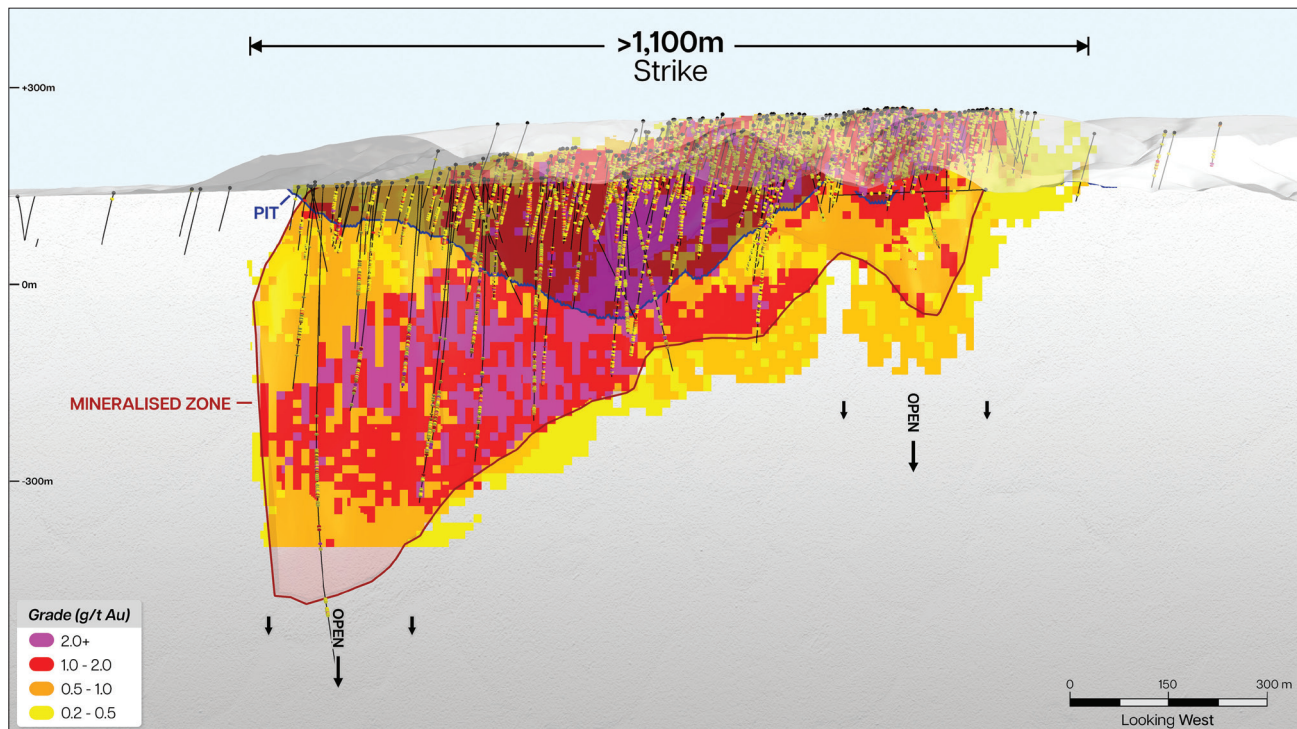


Figure 3. Long section view of Spring Hill block model showing the plunge of mineralisation to the south.

as currently interpreted comprises the Cover Greywacke unit, Upper Pelite, Middle Greywacke, Middle Pelite, Lower Greywacke and Lower Pelite. The delineation of these local stratigraphic units has enabled a litho-structural model to be developed that captures the main Spring Hill Anticline geometry (Figure 4, 6).

The Spring Hill deposit lies within a structural corridor associated with the Pine Creek Shear Zone, a major northwest-trending strike-slip fault system extending across the Pine Creek goldfield (Ahmad *et al* 2009). Reactivation of this shear zone during successive deformation events likely played an important role in controlling hydrothermal fluid migration and the localisation of gold mineralisation.

Mineralisation style and structural controls

Gold mineralisation at Spring Hill occurs predominantly within quartz vein systems hosted by metasedimentary rocks of the Mount Bonnie Formation. Mineralisation is structurally controlled and is associated with fold hinge zones, shear zones, and extensional fractures developed during deformation.

A new observation is that contacts between local stratigraphic units have been identified as a favourable position for higher gold grades (Figure 5). The favourable stratigraphic units and contacts between units plunge with the main anticline approximately 45° to the south, suggesting that plunging higher-grade shoots are possible. The intersection of favourable stratigraphic horizons with the main mineralisation trend of 346° appears to play a local control on higher-grade gold mineralisation, particularly in the Hong Kong – Macau Zone.

Two principal mineralised systems have been recognised within the Spring Hill deposit: the Hong Kong – Macau sheeted vein system and the historic Main–Middle–East lode system (Northern Territory Geological Survey 1999). These zones consist of arrays of quartz veins, sheeted vein systems, and vein-breccia structures developed within the folded sedimentary sequence (Figure 4).

The Hong Kong – Macau Zone sheeted quartz vein system consists of numerous subparallel veins. Individual veins range from a few millimetres to approximately 0.5 m in thickness and occur at densities of up to several veins per metre in highly mineralised zones. These mineralised zones occur in clusters within structurally dilatational zones developed during deformation of the host sequence. The vein system extends for approximately 1 km along strike and has a width of approximately 100 m (Northern Territory Geological Survey 1999).

In contrast, the historic mining area contains several discrete lodes referred to as the Main, Middle, and East lodes. These lodes consist of quartz veins typically ~0.4 to 1.5 m in width and contain sulfide minerals including pyrite, arsenopyrite, and minor galena. Historical mining focused on the oxidised portions of these lodes, where reported grades averaged approximately 30 g/t Au (Northern Territory Geological Survey 1999).

Gold occurs both as free gold within quartz veins and as microscopic inclusions within sulfide minerals. Coarse visible gold is locally present and contributes to a pronounced nugget effect observed in some drill samples (Figure 7).

Hydrothermal alteration associated with mineralisation includes quartz, carbonate, sericite (phengitic white mica),

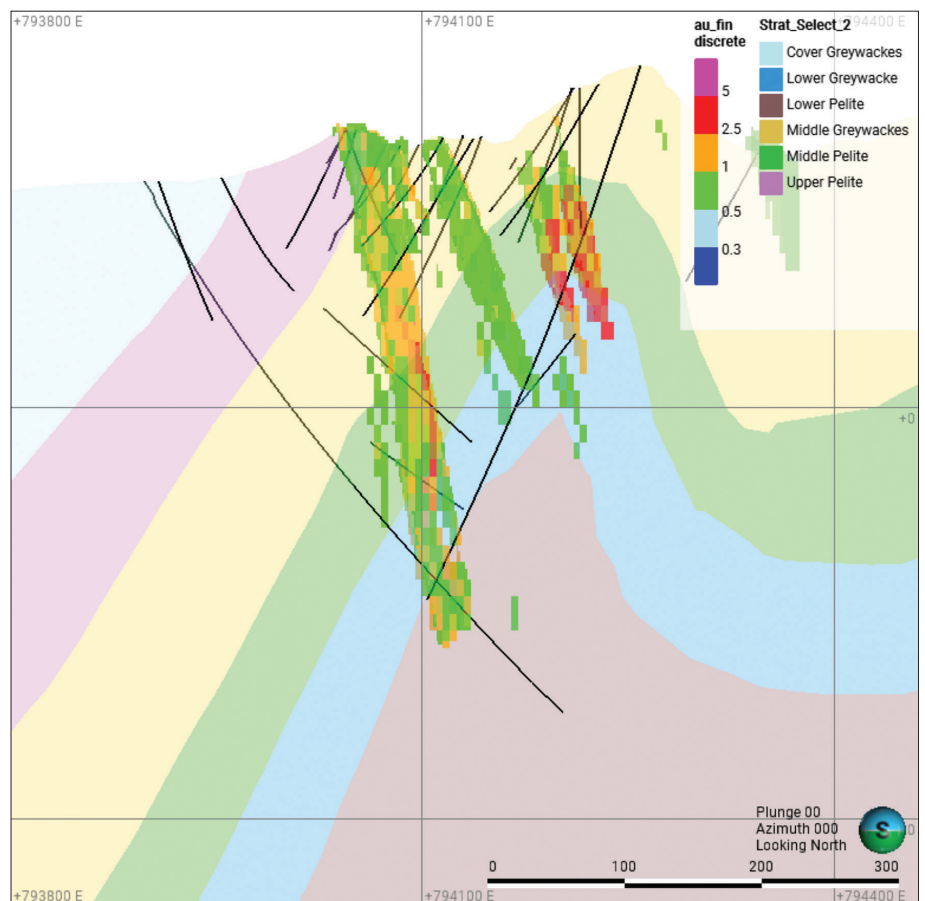


Figure 4. Cross-section through Spring Hill showing the local stratigraphy, anticlinal geometry and higher grades within specific stratigraphic horizons. Hong Kong sheeted veins sit on the western limb of the anticline and the Main Zone is in the centre.

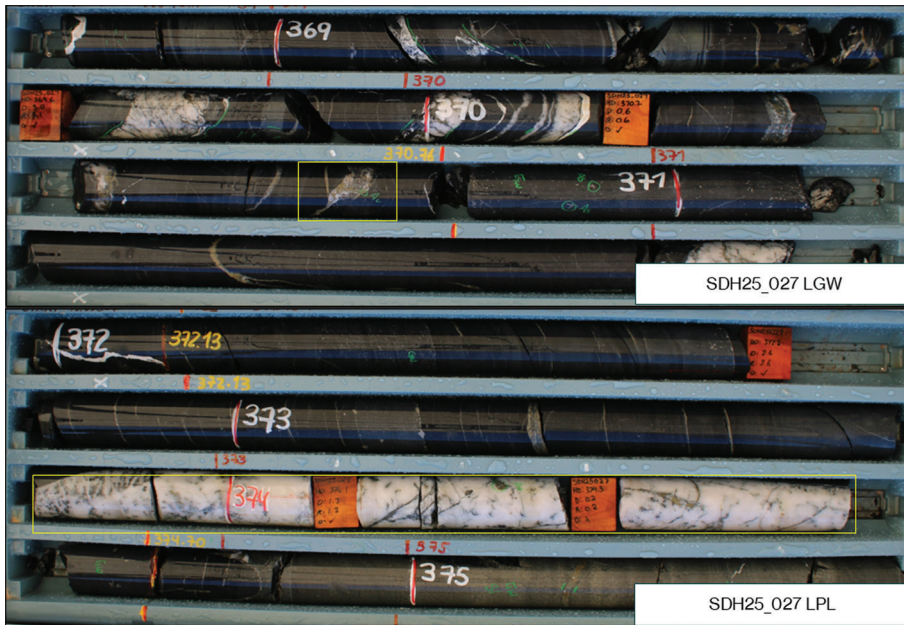


Figure 5. Diamond drill core showing quartz vein mineralisation style at the contact between Lower Greywacke and Lower Pelite stratigraphic units.

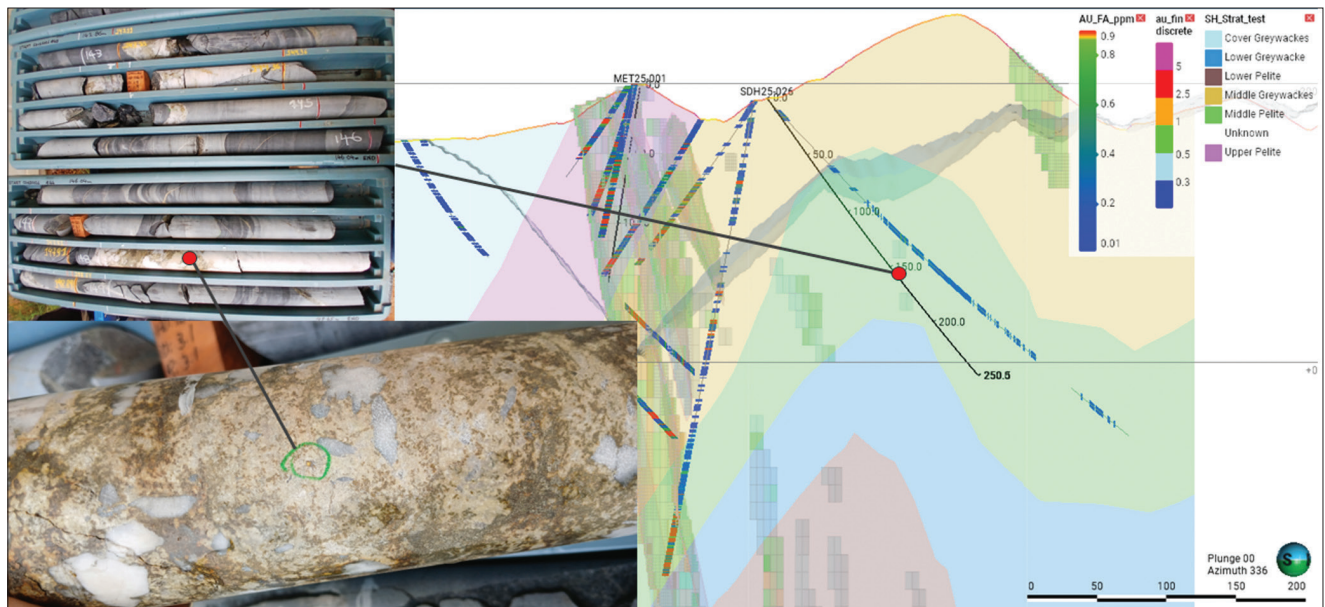


Figure 6. Visible gold located in the fold hinge in the Main Zone southern extension.



Figure 7. Left and right, visible gold in magnetic hematite-altered siltstone.

chlorite, and albite alteration of the host metasedimentary rocks. These alteration assemblages are typical of orogenic gold systems formed under greenschist facies conditions (Sener 2004, Blewett *et al* 2010).

Recent drilling programs including NTGS co-funded diamond drill hole 22HK008P have confirmed that the sheeted vein system extends to depths greater than 600 m below surface within the Spring Hill Anticline.

Recent exploration and development

Exploration work conducted since listing has focused on three principal objectives: 1) resource definition drilling within the Hong Kong – Macau Zone; 2) step-out drilling to identify extensions of known mineralisation; 3) testing of regional exploration targets within the broader structural corridor associated with the Spring Hill Anticline and Pine Creek Shear Zone.

Resource definition

Recent drilling programs have targeted the Hong Kong – Macau Zone, which contains 86% of the currently defined mineral resource of 821,000 oz Au (PC Gold 2025). Infill

drilling within this zone aims to improve geological confidence and upgrade portions of the resource from inferred to indicated classification. These programs involve both reverse-circulation and diamond drilling designed to refine the geometry of the sheeted vein system and evaluate the continuity of mineralisation along strike and at depth.

Drilling results confirm the geometry and geology of the Hong Kong sheeted vein system as described above.

Southern extension of the Main Zone

Exploration drilling has targeted extensions of the historic Main Zone south of the previously defined mineral resource. Step-out drilling along the southern margin of the deposit has identified significant new zones of mineralisation associated with structural extensions of the Main Zone (Figure 6).

Drillhole SDH25-026 intersected 14.9 m at 3.84 g/t Au from a depth of 143 m, including a high-grade interval of 0.96 m at 30.6 g/t Au. These intersections demonstrate that mineralisation continues approximately 100 m southward beyond the limit of the existing resource estimate and demonstrate that the Main Zone structure extends further along strike than previously recognised.

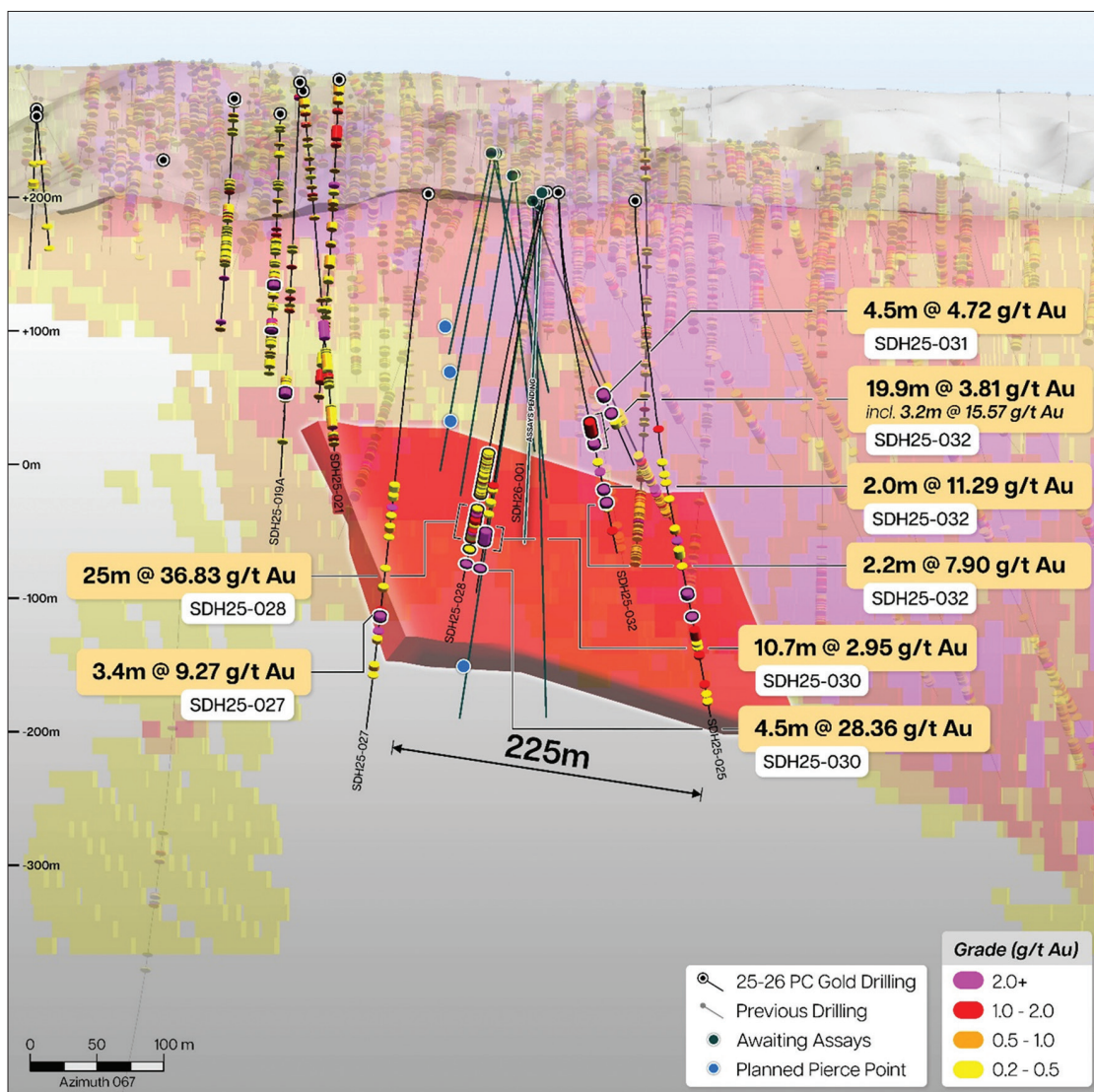


Figure 8. Oblique view looking at the recently interpreted Link Zone with significant gold intercepts.

The discovery of mineralisation along the southern extension significantly increases the prospective strike length of the deposit and provides additional targets for further drilling programs.

Discovery of the Link Zone

One of the most significant recent discoveries at Spring Hill is the identification of the Link Zone, a new mineralised structure interpreted as a cross-cutting structure connecting the Hong Kong Zone with the Macau Zone (**Figure 8**). The Link Zone contains intersections of significantly high grade, with a standout intercept of 25 m @ 36.83 g/t Au in SDH25-028 (**Figure 8**).

Geological interpretation suggests that the Link Zone developed within a structurally complex area of the Spring Hill Anticline where multiple geological features intersect. The Hong Kong and Macau zones trend 346°, cross-cutting the local stratigraphy. The Link Zone is interpreted as the intersection of the Hong Kong trend with favourable stratigraphy, closer to the centre of the main Spring Hill Anticline. These intersections may have created ideal conditions for hydrothermal fluid flow, fracturing and gold deposition.

Drilling results from the Link Zone include several significant mineralised intervals containing quartz veins with associated sulfide minerals such as pyrite and arsenopyrite. Locally pervasive magnetic hematite is observed commonly with visible gold in the finer-grained siltstone and mudstone units (**Figure 7**). Within the coarser greywackes, mineralisation is more commonly associated with quartz veining and brecciation with lesser amounts of magnetic hematite inside the quartz veins and breccias.

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