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METALLOGENIC STUDY OF THE GEORGETOWN, FORSAYTH AND GILBERTON REGIONS, NORTH QUEENSLAND

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Terra Search Pty Ltd Report TS 2019/025

Townsville,
January 2019

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1.0 SUMMARY

A new metallogenic database, GIS and interpretation have been developed for the Georgetown region as part of the Queensland Government Future Resources Program. The Georgetown region lies in the western part of the Forsayth Subprovince of the Proterozoic Etheridge Province of the North Australian Craton. The region has had a long history of mining, particularly gold, with over 1000 mines, prospects and mineral occurrences identified within the study area, including Kidston, one of Australias largest historical gold producers (144 tonnes).

This study has built on the previous metallogenic study of Tate et al. (1987), supplemented with an exhaustive review of published company reports and communications, field inspection of 160 historical mines and mineral occurrences, collection of numerous observations and samples for radiometric dating, rock identification and studies of hydrothermal alteration, quartz textures and multi-element geochemistry. The ultimate aim of the study is to improve the understanding of the various styles of mineralisation throughout the region and provide a comprehensive digital data set for referencing and to stimulate exploration.

Geology in the Georgetown region is dominated by Proterozoic age granitic and metamorphic rocks. These basement rocks have been intruded by three phases of intrusives in the Silurian, Permo-Carboniferous and Permian. A prominent north-south striking belt of Permo-Carboniferous felsic volcanics (Newcastle Range) lies within the study area. Most of the deposits researched and examined in the field were found to fall into one of three categories, Plutonic, Intrusion Related or Epithermal.

The **Plutonic** style deposits are Early Devonian in age and form a north-south trending corridor 35km wide and 140km long that incorporates the gold deposits of the three historical mining centres of Georgetown, Forsayth and Gilberton. The deposits are mainly shear-hosted lodes in east to south-east trending faults. At each of the three centres there is a distinct zonation outward from hypozonal to mesozonal and epizonal level of emplacement and geochemically from Bi-Te to Pb-Zn-Cu to As-Sb. This is interpreted as syn- to late-deformational mineralisation localised in active structures above stocks that emanate from an underlying Silurian – Early Devonian batholith.

The **Intrusion-Related** deposits have Early Permian and Early Carboniferous groups with two possible Late Carboniferous examples (Mt Turner, Log Creek). All the deposits are polymetallic with prominent Te-Bi and As-Sb signatures. The Early Carboniferous deposits in the Kidston region are Au-rich mesozonal hydrothermal breccias whereas the deposits west of Georgetown are Early Permian-Late Carboniferous Au>Ag lode deposits (Electric light, Cumberland Mine, Beverley, Double Z) or Ag>Au epizonal-mesozonal lodes, stockworks and breccia deposits (Ironhurst, Phyllis May, Mt Turner, Bald Mountain).

All the **Epithermal** deposits have rhyolites related to or of the same age as mineralisation so the boundary between epithermal per se and intrusion related epizonal is not clear. This separation is currently based on presence of chalcedony and boiling textures in Epithermal versus fine comb quartz only in Intrusion-related epizonal deposits, but both types have similar chemistry with significant tellurium and silver often greater than gold.

The mineral deposits of the Georgetown region were divided into 55 camps based on a common origin. Understanding of the camp features, timing relationships and zoning patterns produces a model of the mineralised hydrothermal system that allows prediction of favourable mineralised sites and an evaluation of the exploration potential. Although the Georgetown, Forsayth and Gilberton regions host numerous deposits covering a range of mineralisation styles, the region has still suffered from a lack of modern, focussed and thorough exploration. Detailed studies around existing deposits aimed at understanding the metal zonation, structural controls on shoots and metallurgical studies on sulphide ores aim to unlock new resources and advance the discovery of new deposits.

2.0 INTRODUCTION

A new metallogenic database, GIS and interpretation have been developed for the Georgetown region as part of the Queensland Government Future Resources Program. The Georgetown 'region' as used here covers a contiguous area approximately 150 x 100km over the Etheridge, Gilberton and Oaks (Kidston) Goldfields and the Einasleigh Mineral District, as well as the adjacent Woolgar Goldfield, but not the Croydon Goldfield. The overall emphasis has been on elucidating the metallogeny or genetic classification of the gold deposits rather than the base metal, Uranium and Sn-W-Ta-Nb deposits (Figure 1).

The new metallogenic database and GIS has built on the previous metallogenic study of Tate et al., (1987) supplemented with an exhaustive review of published company reports and communications and collection of numerous observations and samples for rock and hydrothermal alteration identification, , quartz textures, multi-element geochemistry and radiometric dating. The ultimate aim of the study is to improve the understanding of the various styles of mineralisation throughout the region and provide a comprehensive digital data set to stimulate exploration.

The provision of confidential data for review and interpretation but not release, has been a critical part of the overall effort and thanks are due to major supporters: ActiveX Ltd, Bushman Resources, JKO Mining and affiliated companies, Laneway Resources, Strategic Minerals, and nearly all the other active players in the region who have contributed data, samples, friendly advice, discussion and cups of tea.

The synthesis of the data focuses on comparing similar characteristics and relationships between adjacent mines and mineral occurrences to determine if they have a common origin. The area defined by such a group of occurrences is defined as a *metallogenic camp* and is interpreted as a coherent *hydrothermal system or lode system* that may include multiple mineral occurrences and commodities, as long as they have a consistent origin (Tate, 1987). The understanding of the camp features, timing relationships and zoning patterns produces a data-driven four-dimensional model of the mineralised hydrothermal system that allows prediction of favourable mineralised sites and an evaluation of the exploration potential.

The summary of data, features and classification for each camp is a sheet in the metallogenic database and each camp is represented in typical versions of the map with mineral occurrence (MINOCC) points; structure, dike and lode lines; symbols for open pit, lodes or veins; and a polygon outlining the camp that is color-coded for class and has a symbol for mineralisation style (Figure 2). Other broad fields in the database cover location, overall classification, endowment, geology, mineralisation, exploration and references (example of camp datasheet inserted in Table 2.1).

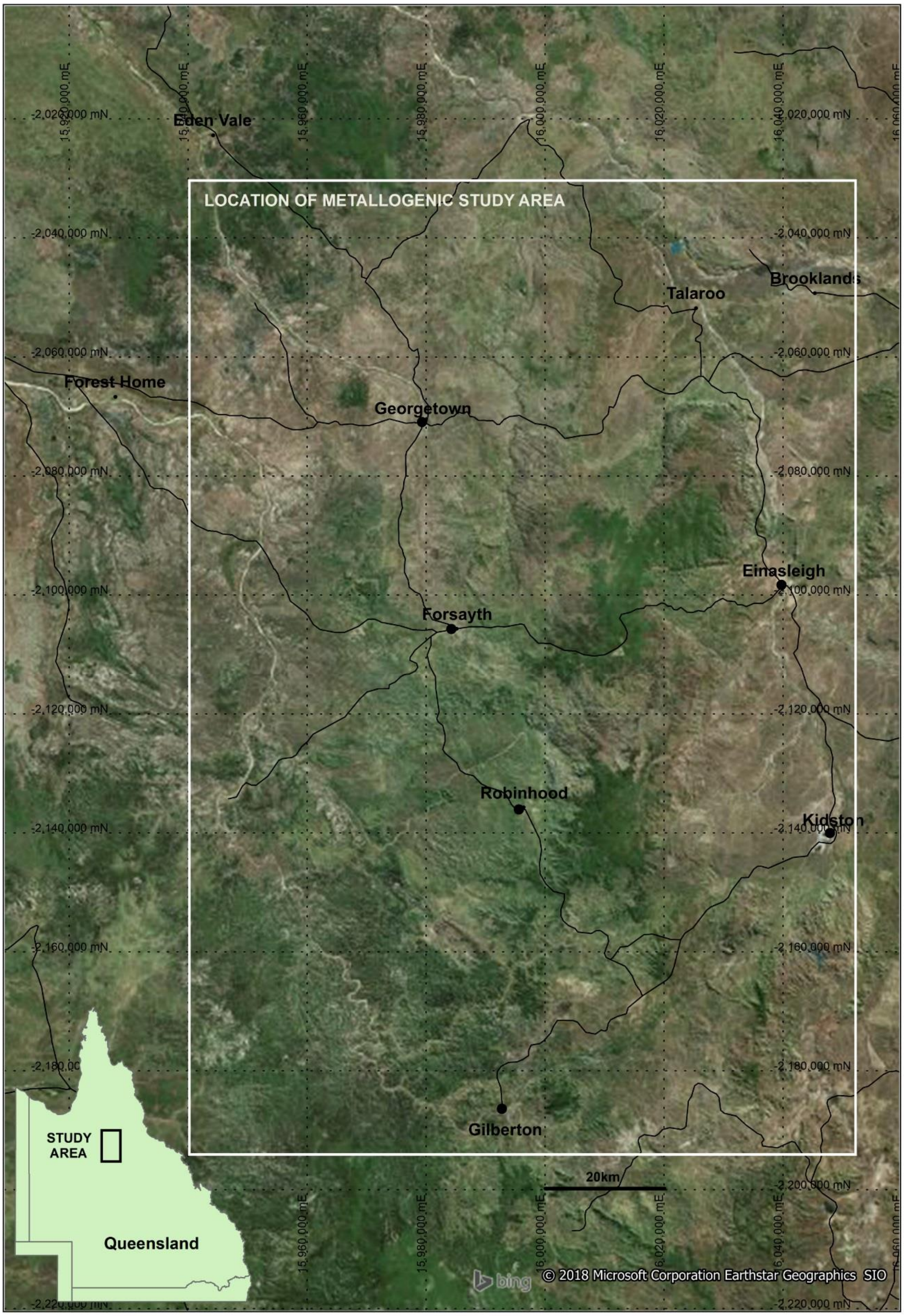

FIGURE 1 : Map showing approximate boundary of the Georgetown Metallogenic Study area.

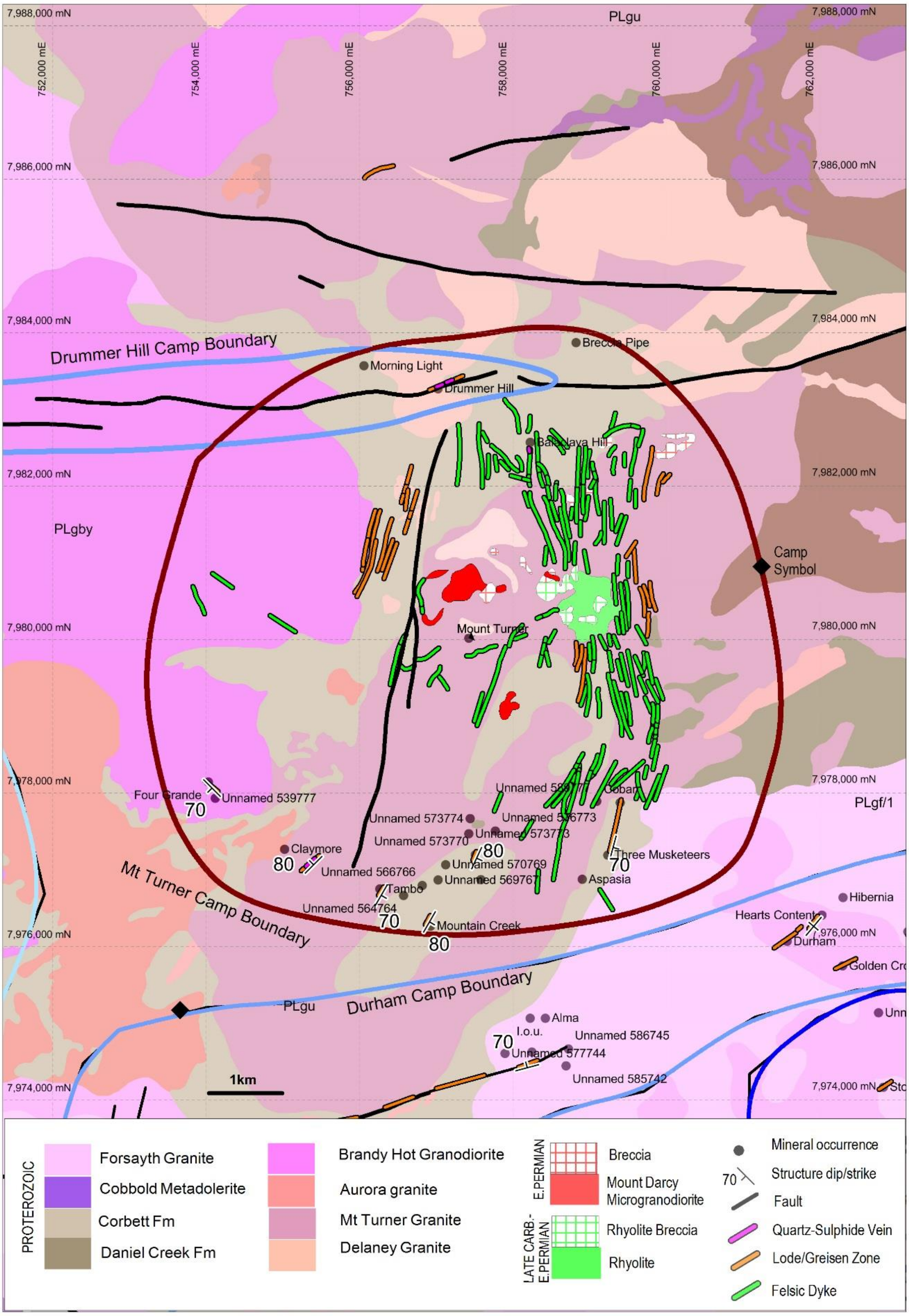

Figure 2: Mount Turner Camp. Example of GIS data available for the Georgetown Metallogenic Study area i.e. geology, structure, dyke – lode – vein orientations, mineral occurrence locations, etc.

Table 2.1 : Example of Camp Data Sheet.

CAMP	Georgetown
CLASS ALL	PNLMP
EPOCH	EDEV?
Related Intrusion	none
Mineralisation Style	LD, VN
QUARTZ ZONE	PLM
METAL ZONE	Pb
Size class (endowment)	465
Mining Method	Shafts
Production: Metal	Wexford (69kg), Melbourne Exhibition (13kg), Ancient Briton (11kg), City of Dunedin (5kg).
Periods of Production	Historical bullion production: Ancient Briton, 1880-1902, (16.96kg); Better Luck, 1877-1913, (93.56kg); Chance 1885-1891 (4.07kg); City of Sydney, 1879-1899, (26.14kg); Gladstone, 1889-1906, (1.18kg); Glencoe 1889-1891, (1.18 kg), Harp of Erin, 1881-1904, (7.62kg); Melbourne Exhibition 1880-1891, (19.84kg); North Star, 1879-1895, (287.8kg); Overland Telegraph, 1880-1913, (24.03kg); Owens, 1894-1899, 93.09kg); Coolgardie 1879-1899 (73.2kg); St. George 1877-1915 (154.84kg); Papa, 1894-1896, (94.69kg); Paxo, 1883-1894, (2.35kg); Golden Horseshoe (22kg); Spero Meliora 1878-1903, (106.55kg).
commodities mined	Copper, lead, silver
Current status	
Tenement Holder	EPM15146 Central Goldmines, EPM17589 JKO Mining P/L, EPM18699 Alice Queen Ltd
Deposit Names	Glencoe, Melbourne Exhibition, Diamond Jubilee, Coolgardie, Ancient Briton, Blind, Papa, Overland Telegraph, Wexford, St George, Golden Horseshoe, Lighthouse, Chance, Lady Mary Gully, Rob Lowe, Gladstone, Delaney River, Spring Creek, Better Luck, Owens Reef, Spero Meliora, Lady Maria
CHEM CLASS	SAT
METAL ZONE	Pb
GEOCHEMICAL ENRICHMENT SIGNATURE	Te Au Pb Ag As Zn Sb Bi Cu
Host 1	Forsayth Granite & Lighthouse Granite
Host Description	Grey, foliated coarse porphyritic, biotite rich granite & muscovite, biotite, leucogranite.
Host 1 Age	Mid Proterozoic (1465 +/-20my)
Regional Structure	Camp overlaps regional scale N-S Delaney Fault.
Mineralisation Age	
Deposit form	Quartz veins hosted in shear zones
Deposit Orientation	Generally north to northeasterly strikes, subvertical or moderate and rarely shallow westerly dips.
ore minerals	Pyrite, sphalerite, galena, chalcopyrite
ore texture	Mainly occurs as sulphides interstitial to euhedral buck quartz crystals. To a lesser extent sulphides can occur as part of a late stage breccia cement. Veins generally <10cm thick.
gangue minerals	Quartz, calcite
TYPICAL VEIN CHARACTERISTICS	Medium euhedral buck quartz, cut by later shearing +/- late fine comb veins and spider veins
BUCK & INFILL C to F	BmLf
QUARTZ ZONE	PLM
gold fineness	900 at Spero Meliora
alteration minerals	Silica, light green sericite, chlorite. Potassic alteration noted in Wexford pit.
alteration facies	Phyllic (K-spar stable)
Related Intrusion Name	No rhyolite (Permo-carb) dykes observed nearby
Intrusive Age	
COMMENTS	At the Papa mine, vein occupies fault contact between Forsayth Granite & Metasediment. Veins often fractured and recrystallised by later shearing. Gold fineness unusually high for this style of camp. Sphalerite relatively common in fresh ore. Gold fineness unusually high for this style of camp (Reported 900 fine at Spero Meliora mine). Separated from Titania camp because of high sulphide content and different vein strikes.
Exploration	1984, Midapa Pty Ltd evaluated many of the historical workings in the Forsayth & Georgetown district. Selected mines were mapped &sampled ATP3406M CR 13817. 1985, Castlegold exploration & drilling EPM3908, CR21453. 1990, Castlegold conducted drilling at Wexford & St George, ATP8787, CR21333. 1992-1997, Union Mining NL mapping, costeaning and drilling at numerous historical mines around Georgetown , CR24579, CR24758, CR25609, CR27781.
100K sheet	Georgetown 7661 & Forrest Home 7561
AMG North	7975000.00
AMG East	770000.00
Latitude	-18.30
Longitude	143.56
Last update	27-5-2017
REFERENCES	(1) 1978; GSQ Report Series #100, I. Withnall, Mines description, geology, production CR55605. (2) 1939; QGMJ 40:363,402-407 Mining proposal, minor production (3) 1935; QGMJ 36:276-278 (4) 1932; QGMJ 33:331(a) St. George, brief report on mining. (5) 1900; GSQ Publ 151 Mines description, production, geology (6) (7) Bain, J.H.C., 1987; BMR newsletter #6, p14 sericite dating. (8) ATP/EPM 479, 649, 1111, 2159, 3908, 4093, 4346, 8787. (9) 1993-97 extensive mapping and sampling of Georgetown & Forsayth district historical mines CR24579, CR24758, CR25609, CR27781.

3.0 GEORGETOWN MINE ENDOWMENTS AND HISTORICAL GOLD PRODUCTION

Figure 3 shows the gold endowment for each camp in the Georgetown region. The production, remaining resources and style of deposit are listed in Table 3.1. Interestingly, the three mineralisation styles identified in this study (Plutonic, Intrusion Related, Epithermal) are represented in the top three deposits by endowment (Table 11.1). By far the biggest producer in the region was the Kidston gold mine which operated from 1985 to 2001 and produced 145 tonnes of gold and an overall endowment in excess of 5Moz (158 tonnes) (Figure 3).

After Kidston, of the eleven other camps that have an endowment greater than 1 tonne of gold metal, seven are Early Devonian Plutonic lode or vein style deposits, two are Early Permian intrusion- related epi-mesozonal vein or stockwork deposits and two are epithermal deposits (Table 3.1). The Woolgar mesozonal and epithermal (Lost World) deposits which are separated spatially and temporally have the second and third largest endowment (37.3 & 21.9 tonnes respectively) but only a comparatively small production history (979.94 kg from the mesozonal deposits only; Denaro et al., 2001).

The Agate Creek epithermal deposit currently hosts the fourth largest mineral endowment in the Georgetown region (15,985 kg Au) and is the best example of gold mineralisation related to Early Permian volcanism. The mineralisation occurs as veins, stockwork and breccia hosted in rhyolite sills dated at 285Ma that cut Silurian (Robin Hood) granodiorite and Proterozoic metasediment.

The Mount Hogan gold mine was the largest single producer in the Gilberton area (2530 kg). The high grade and flat-lying nature of the veins enabled Eltin Mining to construct a mill at Mount Hogan and extract 67,700 ounces of gold from two open cuts between 1992 and 1994. The Marquis (120kg?), Josephine (266.5 kg) and Jubilee Plunger (555 kg) gold mines (Forsayth) are three other Early Devonian, Plutonic style lode deposits with flat-lying veins.

The Cumberland Mine is the biggest individual, historical producer close to Georgetown, producing 1581 kg gold at an average grade of over an ounce /tonne (Jack, 1886). The deposit is hosted along a northeast striking Early Devonian structure similar to the other deposits in the Camp. However, unlike the other deposits (Plutonic epizonal) the mineralisation is related to Permian dykes. Mine records show that the shape of the ore shoots were complex, controlled by jogs in the host structure and overprinting of early quartz vein material by gold- bearing sulphides. The mine reached a maximum depth of 310m and was only mined along strike for around 400m, and although the lode was recorded to have pinched out at depth the host structure was still present (Cameron, 1909).

The Electric Light (1325 kg) and Red Dam (2997 kg) gold deposits were mined by Deutsch -Rohstoff in 2011. Pits were only excavated to the base of oxidation (10 – 15 metres) as test work showed the fresh sulphide ores to be refractory and contain high levels of arsenic. Significant high grade (>10 g/t) resources still exist below the level of oxidation. Further metallurgical studies of the sulphide ore are warranted to determine if modern processing and treatment methods can successfully recover the gold from what is currently thought to be refractory ore. Additional drilling at depth and along strike may also assist with metal zonation patterns within the mineralised structure to determine if less refractory ores are present.

Based on population estimates and uncertain production reports by the Mining Warden, Withnall (1981) approximated that 4000 kg of alluvial gold was produced from the Gilberton region between 1869-1873 and 1876-1881. More recent alluvial production from the immediate area around Gilberton by Portman Ltd (1985-1987) was reported as 112 kg. Sandhurst Mining extracted 100kg of alluvial gold from the Percy and Gilbert Rivers between 1987 and 1989. Alluvial gold has been mined sporadically at Western Creek, 20 km NW of Forsayth by ERO Georgetown Gold Operations P/L and at Mosquito Creek, 10kms west of Forsayth.

Table 3.1 : Georgetown region, summary of mine production history, metal endowment, style and age of mineralisation.

CAMP	Size class (endowment) kg gold only	Production: Metal (kg fine gold)	Product ion Grade g/t Au	Gold Resources	Minz. Environment	Age	Minz. Style
Kidston	157833	126234	1.80		IM	ECARB	BX,VN
Woolgar Mesozonal	37227	23.1	30.6	18.4 Mt at 2 g/t	PLM	EDEV	LD
Woolgar Epithermal	21887			21.85 Mt @ 0.97 g/t	EPB	EPERM?	VN, SW
Agate Creek	15985	61.29	11.20	17 Mt @ 0.94 g/t	EPB	EPERM	VN, SW,DS
Gilberton Alluvials	4000 ?					RECENT	
Red Dam	2997	300	10.00	151,370t @ 19.8 g/t	PLE	LCARB/EDEV?	LD
Mt Hogan	2700	2530	5.20	137,000t @ 5.51 g/t	PLM	EDEV	VN
Durham	2200	1863.70	45.26		PLM	EDEV?	LD, VN
Cumberland Mine	1900	1581.50	37.37		IM	EPERM	LD
Electric Light	1325	260.90		51,000 ozs, 1586 kg	IE	EPERM	SW, BX
Queenslander	1420	1271.10	36.00		PLM	EDEV?	LD
International	1150	1150			PLH	EDEV	LD
Big Wonder	1030	925.20			PLM	EDEV?	VN
Gilberton	925	831.80	46.70		PLM	EDEV?	LD VN SW BX
Big Reef	820	806.40	32.80		PLM	EDEV?	VN
Havelock	645	579.40	44.30		PLM	EDEV	LD
Titania	535	479.90	35.50		PLH	EDEV?	LD, VN
Percyvale	500	446.50	31.10		PLE	EDEV	LD
Georgetown	465	98.00			PLM	EDEV?	LD, VN
Beverley	460	75		170,903 t @ 5.2 g/t	IE	ECARB?	BX, SW
Goldsmiths	420	379.90	21.97		PLH	EDEV?	LD, VN
Four Gees	285	16.80	53.70	8700 tonnes @ 5.3 g/t	PLH	EDEV?	VN, LD
Carbon Copy	250	226.90	24.70		PLE	EPERM?/ EDEV?	LD
Drummer Hill	190	14.20			PLM	EDEV	LD
The Drum	175	157.60	24.10		PLE	EDEV?	LD, VN
Lane Creek	143	128.20	30.55		PLM	EDEV?	LD, VN
Dry Hash	142	127.80	18.15		PLM	EDEV	LD, VN
Marquis	120	88.90	12.67		PLH	EDEV?	LD, VN, BX
Monte Cristo	77	69.40	22.07		PLM	EDEV?	LD
Jubilee Plunger	63	23.20	6.80		PLM	EDEV	LD
Western Ck	51	True Blue (43.7), Tunnel (4.46), Liberator (Rosie?) (8.27)	55.20		PLH	EDEV?	VN, LD
Mountain Maid	46	41.20	110.00		IH	EPERM/EDEV	VN
Ironhurst	44	0	15.00		IE-M	EPERM	BX, VN, SW
Percy Queen	36	16	40.00	10,000 t @ 5 g/t	EPB	EPERM	SW VN
Christmas Hill	30	27.40	136.40		IM	ECARB	LD, BX
Glenrowan	26	22.90			PLH	EDEV?	LD
Robinhood West	26	0			IM	EPERM	LD, SW
Mt Moran	23	32.29	25.80		PLM	EDEV?	VN
Dairy Maid	21	38.20	125.50		IH	EDEV?	VN
New Moon- Mosquito	7	5.50	90.00		PLM	EDEV?	LD
Long Gully	5.88	5.88	32.80	6531 kg Au	PLM	EDEV?	LD
Mt Turner	3	2.50			IM	EPERM/LCARB	BX, LD, SW
Bald Mountain	0	0			IE	EPERM	SW, BX
Black Knob	0	0			PLH	EDEV?	VN, BX
Double Z	0	0			IE	EPERM? /EDEV?	LD, BX
Evening Star	0	0.8674 tons @ 65% WO3; 0.4285tons @ 50% Bi			IH	MPROT?	VN
Greenhills	0	0			IE	EPERM?	BX, VN
Huonfels	0	0			IM	EPERM?	LD, VN, BX
Log Creek	0	0			IE-M	LCARB	LD
Long Lode	0	0			PLM	EDEV?	LD
Mt Borium	0	0			IE-M	ECARB	BX
Mt Clark	0	0			IE-M	EPERM?	BX, LD
Mt McDonald	0	0			EPB	EPERM/LCARB?	BX
Phyllis May	0	0			IM	EPERM	SW

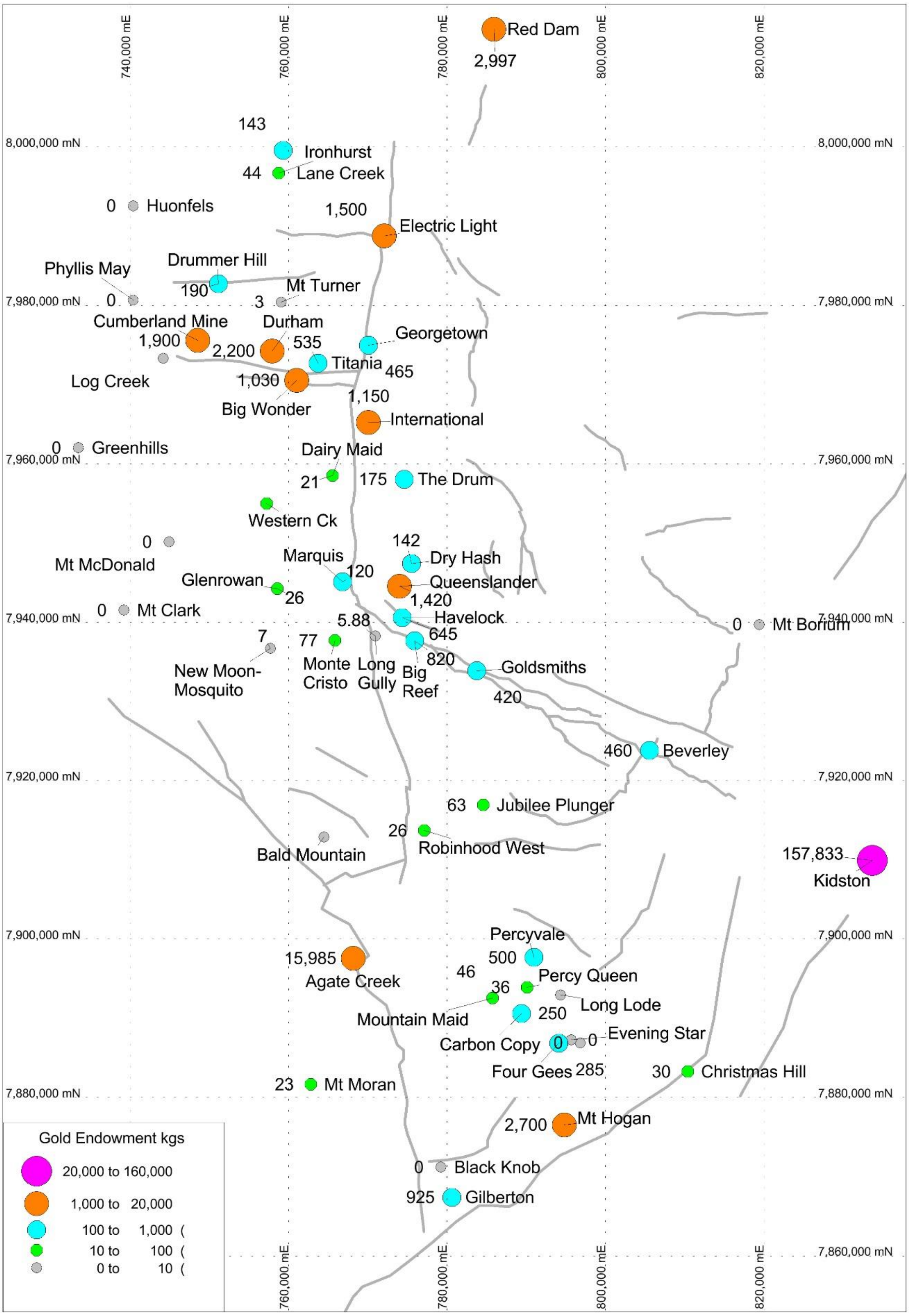

Figure 3 : Map of Georgetown, Forsayth and Gilberton region showing location of historical gold mines and gold endowments.

4.0 GEOLOGY

The Georgetown region lies in the western part of the Forsayth Subprovince of the Proterozoic Etheridge Province of the North Australian Craton (Jell, 2013). Proterozoic rocks were extensively intruded by Silurian to Early Devonian granitoid batholiths of the Pama Igneous Association and dominantly felsic Carboniferous to early Permian intrusive and extrusive complexes of the Kennedy Igneous Association. Parts of the region, particularly in the north-west and south-west, are covered by Jurassic to Cretaceous clastic sedimentary rocks and Cainozoic sediments and (locally) basalts (Figures 4 & 5).

4.1 PROTEROZOIC METAMORPHIC AND INTRUSIVE ROCKS

Proterozoic rocks are dominated by the Paleoproterozoic Etheridge Group. The Etheridge Group includes compositionally diverse metamorphic rocks, subdivided into numerous individual units – Einasleigh Metamorphics, Cassidy Creek Metamorphics, Juntala Metamorphics, Bernecker Creek Formation, the Robertson River Subgroup (Daniel Creek Formation, Dead Horse Metabasalt, Corbett and Lane Creek formations), Upper Etheridge Group (Towneley, Hellman and Candlow formations, Lungdon River Mudstone) (Withnall, 1984; Bain and Draper, 1997; Jell, 2013).

The Einasleigh Metamorphics, dominant in the south and east of the region, are characterised by layered biotite and calc-silicate gneisses, with common amphibolites and migmatites. The Juntala Metamorphics, composed of mica schists (locally graphitic) and minor quartzites, grade into and are faulted against the Einasleigh Metamorphics in the south of the region. The Cassidy Creek Metamorphics, compositionally similar to the Juntala Metamorphics, are structurally juxtaposed against the Einasleigh Metamorphics in the east of the region (north-east of Einasleigh). The Bernecker Creek Formation consists predominantly of calcareous to dolomitic fine-grained sandstones, siltstones and mudstones, grading to the east into calcareous mica schists and quartzites with calc-silicate minerals and finally - calc-silicate gneisses, compositionally similar to parts of the Einasleigh Metamorphics into which the Bernecker Creek Formation proably grades.

The Robertson River Subgroup is mostly composed of originally fine-grained meta-sediments (calcareous siltstones, calcareous or carbonaceous mudstones, minor sandstones), interlayered with dominant meta-basalts with common pillow-lava textures in the Dead Horse Metabasalt. The stratigraphically higher Upper Etheridge Group is dominated by siltstones and mudstones (locally calcareous or carbonaceous), minor sandstones and rare thin limestones. The Langdon River Mudstone, the uppermost unit of the Etheridge Group, consists of laminated carbonaceous pyritic mudstones.

Depositional age of the Etheridge Group is constrained by U-Pb geochronology of magmatic and detrital zirons. The lower part of the Etheridge Group (including the Einasleigh Metamorphics, the Bernecker Creek Formation and the Robertson River Subgroup) was deposited between 1700 and 1660 Ma (Jell, 2013). The minimum age of the top of the Etheridge Group is constrained at ~1630 Ma by the maximum depositional ages (U-Pb on detrital zircons, Neumann and Kositcin, 2011) of the Langdon River Mudstone (1629 ± 12 Ma) and the Langlovale Group (1625 ± 5 Ma), which unconformably overlies the Etheridge Group along the western margin of the Etheridge Province (Withnall, 1984; Jell, 2013).

The Etheridge Group was intruded by extensive Mesoproterozoic predominantly S-type granitoids, mostly forming the Forsayth Batholith. The main individual plutons include the Aurora, Delaney, Forsayth, Goldsmiths, Mount Turner, Bowler Creek, Mistletoe, Ropewalk, Welfern, Mywyn, Mount Hogan and Lighthouse granites, the Forest Home and Talbot Creek trondhjemites and the Brandy Hot Granodiorite. U-Pb zircon geochronology indicates the major emplacement age of the Mesoproterozoic granitoids across the region at ~1550-1560 Ma (Black and Withnall, 1993; Bain and Draper, 1997; Neumann and Kositcin, 2011; Jell, 2013). The presence in the region of relatively common zircon cores in zoned magmatic zircons from Mesoproterozoic and Palaeozoic granites and sedimentary rocks with measured ages of ~1580 Ma (Murgulov et al., 2007; Kositcin and Bultitude, 2015; Kositcin et al., 2015) indicates an earlier event of magma emplacement or partial melting.

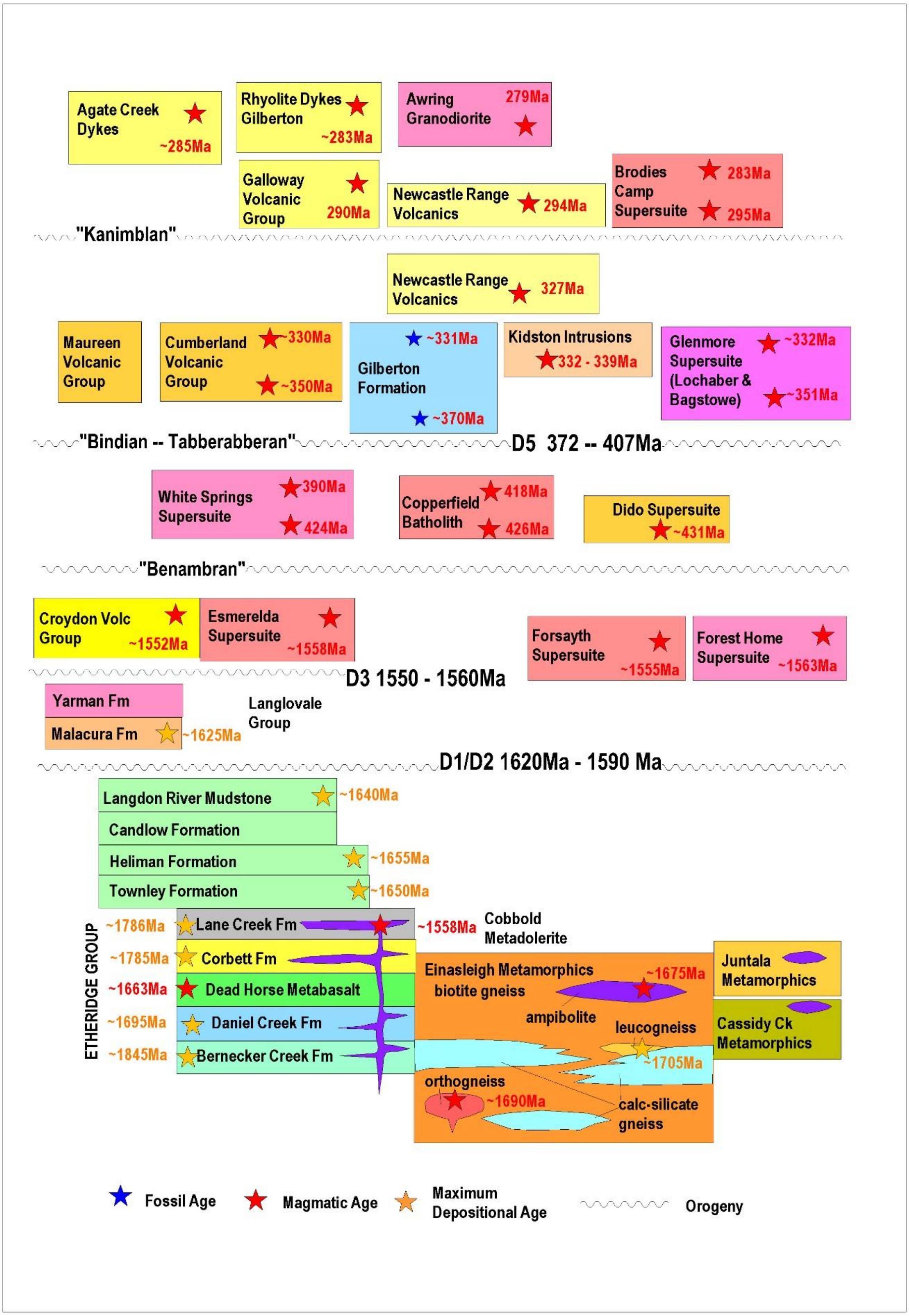

Figure 4: Georgetown Region stratigraphic column, modified from Jell, 2013.

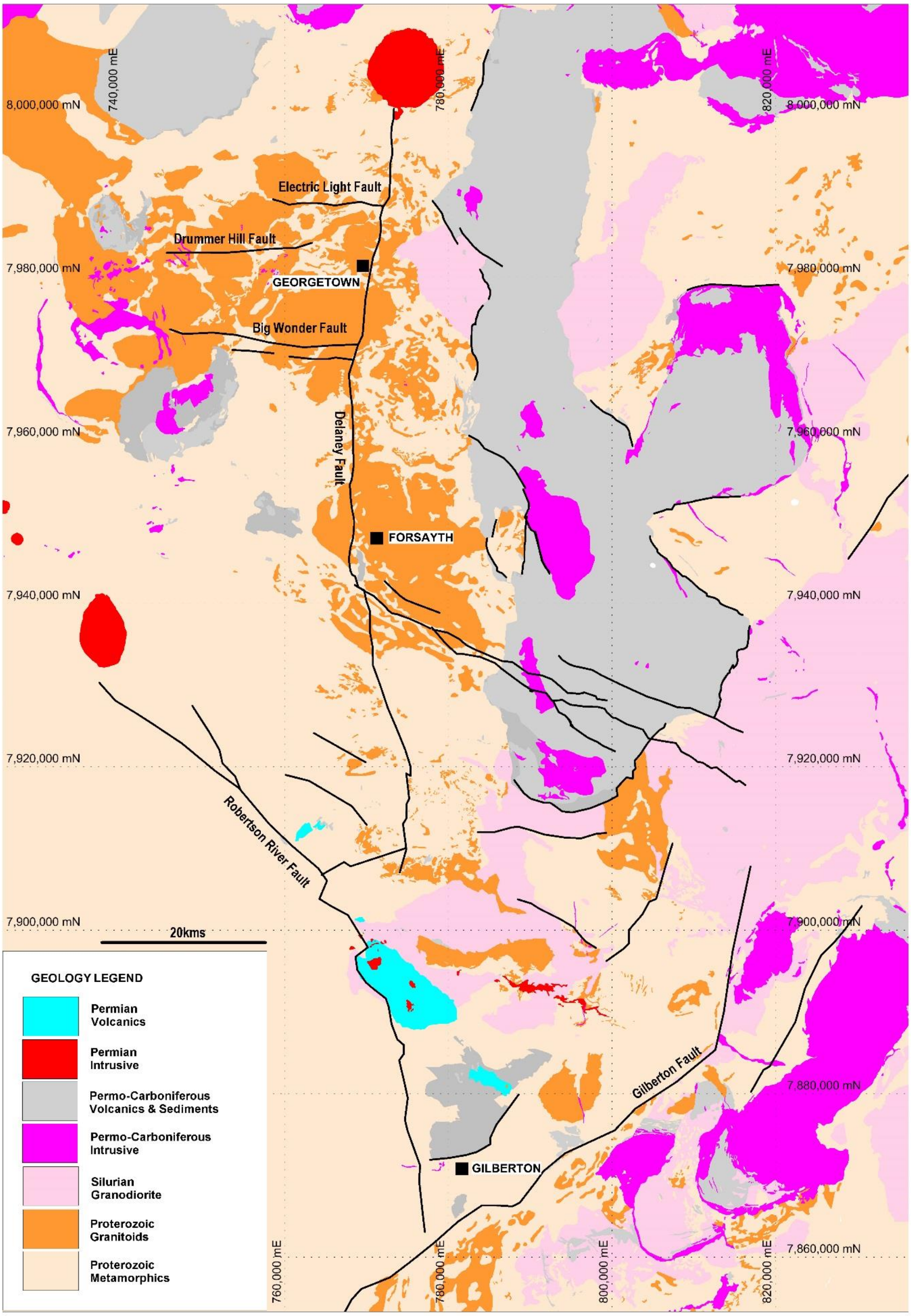

Figure 5 : Simplified geology of the Georgetown region with major structures only.

The Georgetown region experienced multiple phases of regional metamorphism and deformation in the Proterozoic. Metamorphic grades in the Etheridge Group generally increase from the west to the east and range from the lower greenschist to granulite facies. The main regional high-grade metamorphic and deformational event affecting the region accompanied the emplacement of the Mesoproterozoic granitoids (~1550-1560 Ma), but one or two older deformational events pre-dated the magmatism in the period between 1590 and 1620 Ma (Jell, 2013).

4.2 SILURIAN – DEVONIAN INTRUSIVE ROCKS

Extensive plutonic dominantly I-type granitoids of the Siluro-Devonian Pama Igneous Association were emplaced across the Georgetown region, particularly in the south (Figure 5). They include the Copperfield Batholith (including the Oak River Granodiorite), Dumbano, Dido, Glenmore, Ingham, Robin Hood, Tate and White Springs batholiths. The granitoids are also geochemically subdivided into the White Springs, Dido and Mount Webster supersuites (Bain and Draper, 1997; Jell, 2013). Batholiths are mostly elongated to the north-east. The granitoids have significant compositional variations, both between and within supersuites, ranging from gabbros (rare) and diorites to granites with >75% SiO_2. They are mostly unfractionated, with primary oxidation state varying from oxidised to moderately reduced.

U-Pb zircon geochronology for plutons of the Pama Igneous Association in the Georgetown region (summarised in Table 2.1) and other parts of the Etheridge Province (discussed in Bain and Draper, 1997 and Jell, 2013) indicates the dominant magmatic emplacement age in the middle to late Silurian, between 418 Ma and 435 Ma. This is consistent with U-Pb zircon geochronology from numerous samples of Cainozoic stream sediments in the Etheridge Province (Murgulov et al., 2007) and Devonian sedimentary rocks from the adjacent Mossman Orogen (Jell, 2013; Kositcin and Bultitude, 2015; Kositcin et al., 2015), indicating the common presence of a major detrital zircon population with the same range of measured ages.

Historic Rb-Sr whole rock and mineral geochronology obtained from several plutons of the Pama Igneous Association in the region recorded ages in the range of 385 - 425 Ma (Richards et al., 1966; Black, 1973). Older measured ages overlap age estimates obtained from U-Pb zircon geochronology, while the younger Devonian ages have been subsequently interpreted as spurious (Bain and Draper, 1997; Jell, 2013). K-Ar geochronology (summarised in Table 4.1) recorded apparent ages between 370 Ma and 415 Ma. To date, Devonian magmatic ages have not been recorded by robust U-Pb zircon geochronology from any larger plutons of the Pama Igneous Association in the Georgetown region. However, magmatic crystallisation age of 377.2 ± 2.0 Ma (Table 2.1 – from Cross et al., in prep.), estimated for a population of 26 zircon grains from a quartz-feldspar porphyry dyke from the West 24 prospect (part of the Lineament camp) confirmed that at least minor intrusive magmatism occurred in the region in the Late Devonian. Similar magmatic ages, although rare in north-east Queensland, have also been recorded for a granite intersected by a drill hole 225 km south-west of Georgetown (382.1 ± 2.9 Ma; Carson et al., 2011) and plutons of the Mt Formantine Supersuite in the Hodgkinson Province, ~300 km to the north-west (378.8 ± 2.7 Ma and 376.0 ± 3.0 Ma; Kositcin et al., 2015a, b). Widespread Early to Middle Devonian plutonic magmatism (between 390 Ma and 410 Ma) of the Pama Igneous Association has been documented in the adjacent regions to the north (the Cape York Peninsula Batholith) and south-west (the Reedy Springs and Lolworth batholiths in the Charters Towers Province).

Recorded Devonian Rb-Sr and K-Ar ages from intrusive rocks of the Pama Igneous Association in the Georgetown region thus probably reflect re-setting of the Rb-Sr and K-Ar isotopic systems by the same Devonian regional thermal event which produced large-scale plutonic magmatism in other parts of north-east Queensland.

Table 4.1: Radiometric Ages on Palaeozoic rock units (upper section) and mineralisation related intrusions (lower section).

UNIT	EPOCH	Age*[Ma]	Error +/- [Ma]	Brief Description	Method	Mineral	Reference
Awring Granodiorite	EPERM	279.2	2.7	granodiorite	U-Pb	zircon	KOSITCIN, N., et al., 2016
Brodies Gap Rhyolite	EPERM	283.2	3.2	Ignimbrite	U-Pb	Zircon	GSQ/GA archive
Scardons Volcanic Group	LCARB	289	2	Tuff	U-Pb	Zircon	GSQ/GA archive
Galloway Volcanics	LCARB	290	3	Dacite	U-Pb	Zircon	GSQ/GA archive
Brodies Gap Rhyolite	LCARB	294.5	2.1	Rhyolite	U-Pb	zircon	KOSITCIN, N., et al., 2017
unnamed	LCARB	308	3	Ignimbrite	U-Pb	Zircon	GSQ/GA archive
Bousey Rhyolite/2b	ECARB	323.4	3.5	Obsidian	U-Pb	Zircon	GSQ/GA archive
Gilberton Formation	ECARB	335		Sandstone	U-Pb	Zircon	GSQ/GA archive
Lochaber Ring Complex (near Kidston)	ECARB	337.9	2.6	Lochaber Diorite	U-Pb	Zircon	Murgulov & others, 2009
Lochaber Ring Complex (near Kidston)	ECARB	350.7	1.3	Black Cap Diorite	U-Pb	Zircon	Murgulov & others, 2009
White Springs Granodiorite/1	EDEV/SIL	370		Granodiorite	K-Ar	biotite	GSQ/GA archive
Robin Hood Granodiorite host at CC	EPERM/SIL?	322.1	7.4	F.G. Bt Granodiorite	K-Ar	biotite	Morrison, Cody & Todd, this report
Robin Hood Granodiorite	EDEV/SIL	380		Granite	K-Ar	Biotite	GSQ/GA archive
SDg/g-Reedy Springs Batholith	EDEV/SIL	390		Granodiorite	K-Ar	biotite	GSQ/GA archive
Dumbano Granite/1	EDEV/SIL	390		Adamellite	K-Ar	biotite	GSQ/GA archive
White Springs Granodiorite/1	EDEV/SIL	408		Granodiorite	K-Ar	Muscovite	GSQ/GA archive
Dido Tonalite	EDEV/SIL	385		Granodiorite	K-Ar	biotite	GSQ/GA archive
Dido Tonalite	EDEV/SIL	410		Granodiorite	K-Ar	biotite	GSQ/GA archive
Dido Tonalite	EDEV/SIL	410		Granodiorite	K-Ar	hornblende	GSQ/GA archive
Dido Tonalite	EDEV/SIL	415		Granodiorite	K-Ar	hornblende	GSQ/GA archive
Dido Tonalite	SIL	431	7	Tonalite	U-Pb	Zircon	GSQ/GA archive
Oak River granodiorite (Kidston host)	SIL	417.7	2.2	Granodiorite	U-Pb	Zircon	Murgulov & others, 2009
Dumbano Granite	SIL	421	8	Granite	U-Pb	Zircon	GSQ/GA archive
White Springs Granodiorite	SIL	424	11	Granodiorite	U-Pb	Zircon	GSQ/GA archive
Zig-Zag dyke - Sherwood	EPERM	284.5		rhyolite dike	U-Pb	zircon	CROSS, A.J et al., in prep.
Sherwood - rhyolite sill	EPERM	284.9		rhyolite sill	U-Pb	zircon	CROSS, A.J et al., in prep.
Bald Mountain	EPERM	286	2	Phase 1 porphyry	U-Pb	Zircon	Nethery, 2009
Bald Mountain	EPERM	283	2	Phase 3 rhyolite dyke	U-Pb	Zircon	Nethery, 2009
Lineament Central 50	LDEV?	377		quartz feldspar porphyry dyke	U-Pb	zircon	CROSS, A.J et al., in prep.
Kidston	ECARB	335.7	4.2	Median dyke	U-Pb	Zircon	Murgulov & others, 2009
Lochaber Ring Complex (near Kidston)	ECARB	337.9	2.6	Lochaber Diorite	U-Pb	Zircon	Murgulov & others, 2009
Lochaber Ring Complex (near Kidston)	ECARB	350.7	1.3	Black Cap Diorite	U-Pb	Zircon	Murgulov & others, 2009
Oak River Granodiorite host near Kidston	SIL	417.7	2.2	Oak River Granodiorite	U-Pb	Zircon	Murgulov & others, 2009
Kidston	ECARB	~332		Syn, post minz. dykes	U-Pb	Zircon	Perkins & Kennedy, 1998
Gilberton - Homeward Bound	EPERM	~281		rhyolite dyke alt/mineralised	U-Pb	zircon	JAV GM GSQ samples 2018
Gilberton - Mountain Maid	EPERM	~284		rhyolite dyke alt/mineralised	U-Pb	zircon	JAV GM GSQ samples 2016
Gilberton - Percy Queen	EPERM	~283		Rhyolite dyke alt/mineralised	U-Pb	zircon	JAV GM GSQ samples 2017

4.3 LATE DEVONIAN TO EARLY CARBONIFEROUS SEDIMENTARY ROCKS

Mostly undeformed clastic sedimentary rocks of the Gilberton Formation (Withnall et al., 1980) occur near Gilberton and in several isolated outcrops in the Georgetown region (Figure 5). They unconformably overlie low-grade metamorphic rocks of the Etheridge Group and are locally overlain by the early Permian Agate Creek Volcanic Group. The formation is dominated by poorly sorted fluvial sandstones and polymictic conglomerates, with minor mudstones and sandstones. Its preserved stratigraphic thickness is estimated to commonly range from 100 m to 500 m. The age of the formation is biostratigraphically constrained to the Late Devonian (Frasnian) at the base to early Carboniferous (Visean) at the top (Withnall et al., 1980; Bain and Draper, 1997). The formation is commonly tilted and locally cut by high-angle faults, some of which are intruded by rhyolitic dykes.

The existing radiometric ages for the geological units in the Georgetown region have been augmented by recent ages from various sources on intrusions that are associated with the mineral deposits (Table 4.1). An additional 17 samples of mineralised intrusions have been submitted U-Pb zircon dating and the results are awaited. The dating reinforces the established broad epoch subdivision and highlights the likely justifiable separation between early Permian, late Carboniferous and early Carboniferous mineralising events. The most interesting feature is the recognition that dikes related to mineralisation in the Gilberton District are part of the early Permian Agate Creek suite rather than early Carboniferous Kidston-Lochaber suite as had been anticipated.

Although there are no new zircon U-Pb ages on the Silurian intrusive suites the available ages do reinforce the Silurian as the emplacement age and the early Devonian as a regional tectonic-hydrothermal overprint that has reset biotite and hornblende K-Ar and Rb-Sr ages. This is a feature of the Pama Province granitoids throughout north Queensland and is a key support for the idea that the extensive Early Devonian gold mineralisation is not directly related to the host granitoids either in Georgetown or Charters Towers.

Broad-scale structural controls are evident in the distribution of the camps relative to the regional geology and structure (Figure 6). The first is the apparent restriction of the early Devonian camps to an approximately 20km wide corridor adjacent to the western margin of the Newcastle Range Volcanic Group and a coincidence with the exposures of the Mesoproterozoic granitoids. The Newcastle Range Volcanic Group does not obscure this mineralisation in the east as the NNW-trending boundary clearly extends in the same direction in the basement south of the Newcastle Range and east of Percyvale and Mt Hogan.

Within this corridor the Early Devonian lodes follow east-trending structures like the Drummer Hill and Big Wonder Faults at Georgetown and the ESE-trending Big Reef structure at Forsayth. The Big Reef structure can be traced as a series of faults and lodes for 40km from Greenhills in the NW to Kidston in the SE. The deposits along this structural corridor range in age from Permian to Early Devonian and represent many mineralisation classes and styles. Maybe such structural corridors can be considered long-lived, crustal-scale channel-ways for magma and fluids. A similar ESE-trending corridor extending from Agate Creek to north of Christmas Hill localises the Percyvale dike swarm, but cuts across the more E-trending Early Devonian lodes in the Percyvale area.

The NE-trending Gilberton Fault is drawn as the southern boundary of the Gilberton District, but does not clearly localise mineralisation. Extensions of the Gilberton Fault and a series of parallel faults seem to bound the Silurian intrusions east of the Newcastle Range and probably control the orientation of the Lochaber Bagstowe Complex across the Gilberton Fault from Kidston, but do not influence the Kidston mineralisation (Morrison, 2007).

The N-trending Delaney Fault cuts through the Early Devonian mineralised corridors, may in part limit their distribution, does have some sub-parallel veins in the Georgetown camp and is cut by several Early Permian plugs with mineralisation (Figure 5). It is not as significant a mineralised structure as Big Reef and Big Wonder and may represent a hinge fault formed by evacuation of the magma-chamber that fed the Newcastle Range Volcanics in the Carboniferous.

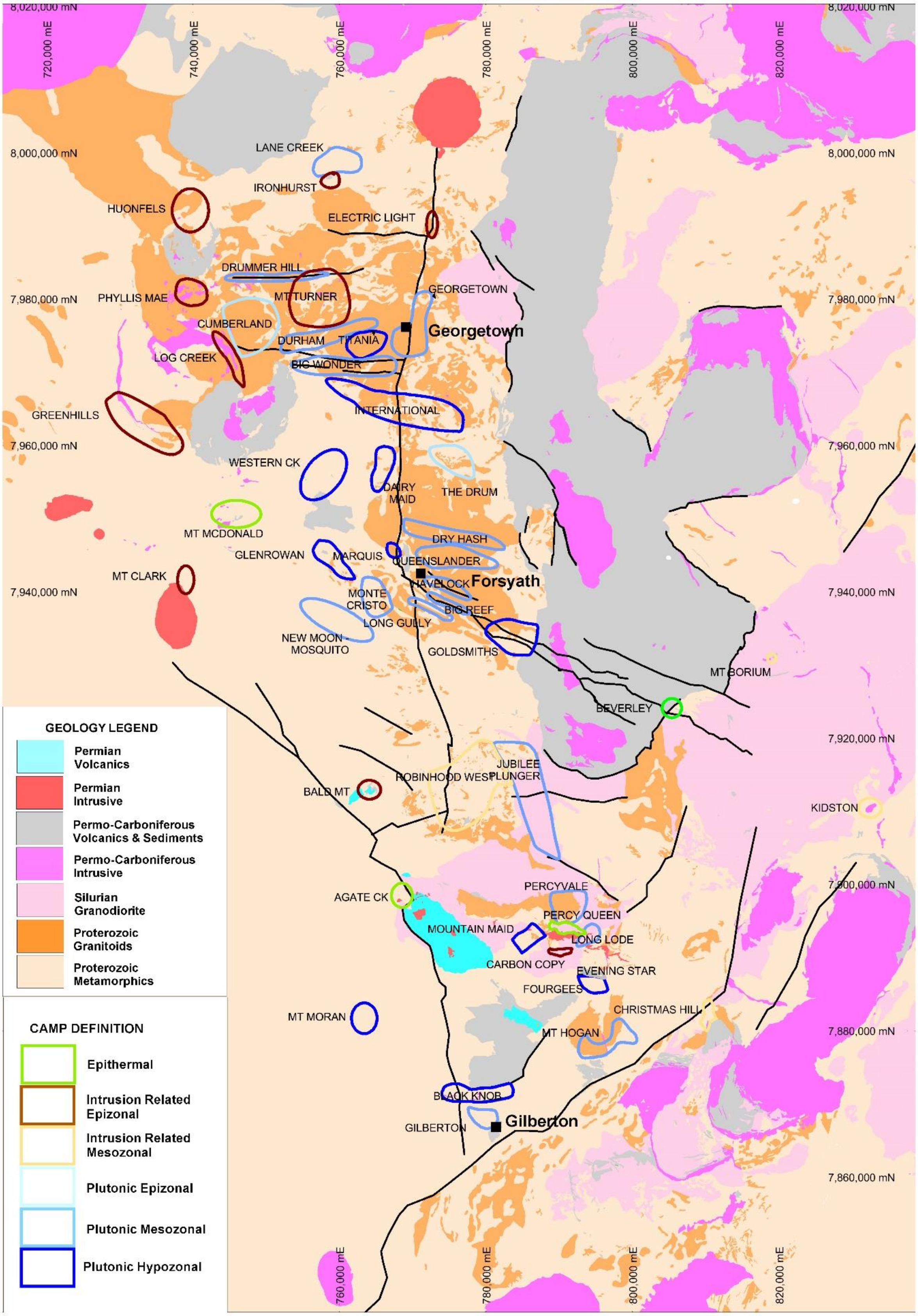

Figure 6 : Metallogenic camps plotted on the broad scale geology and structure.

4.4 PERMO – CARBONIFEROUS INTRUSIVE AND EXTRUSIVE ROCKS

Permo-Carboniferous age intrusive and extrusive rocks are widespread throughout the Georgetown, Forsayth and Gilberton regions and some of the major mineral deposits have direct links to this phase of magmatism, e.g. Kidston and Agate Creek. The bulk of the Permo-Carboniferous volcanic rocks are hosted in the Newcastle Range Volcanic Group which forms a northerly trending zone of preserved cauldron collapse structures 100 km long and 20 km wide (Figure 6). The Newcastle Range Volcanic Group is dominated by rhyolitic ignimbrite, lava and tuff with rocks of intermediate to basaltic compositon making up only a minor component (Champion & Bultitude, 2013). The oval shaped Lochaber and Bagstowe intrusive complexes lie 30 km south of the Newcastle Range and are composed of biotite to hornblende-biotite granite, microgranite and rhyolite and represent more deeply eroded equivalents of the Newcastle Range Volcanic Group. Rhyolite dyke swarms are common throughout the region and typically possess a northerly or northwesterly trend, parallel to the main regional structures (Figure 6).

Dates of the Permo-Carboniferous intrusives range from ~345 Ma to 280 Ma, although magmatism appears to have been intermittent, with discrete Carboniferous (345-335 Ma) and Permian (~290-280 Ma) episodes and very few dates between 320 Ma and 290 Ma (Withnall et al., 1997).

Two isolated volcanic centres composed mainly of rhyolitic to dacitic igimbrite lie 30 kilometres northwest and southwest of Georgetown respectively. The volcanics belong to the Carboniferous Cumberland Range Volcanic Group. Mineralisation in the Huonfels Camp is spatially and probably temporally related to a swarm of rhyolite dykes emanating from the northern volcanic centre (See Section 9.7). Numerous, scattered, porphyritic micrograpite and microgranodiorite intrusives of late Carboniferous to early Permian age, crop out within and between the two volcanics centres and also at the nearby Mount Turner i.e. Mount Sircom and Mount Darcy Microgranodiorites and the Prestwood Microgranite (Table 6.1) (See Section 9.6). Disseminated and breccia style porphyry copper – gold mineralisation at the Phyllis Mae, Log Creek and Mount Turner Camps are related to these relatively young intrusives (Figure 6).

The Agate Creek volcanic centre is located on the Robertson River Fault, 30 km north of Gilberton and consists of a northwest elongate oval shaped block of Permian age, intrusive, volcanic and volcaniclastic rocks, 12 km long and 6 km wide. The volcanic sequence is up to 1000 m thick and is composed of crystal-lithic rhyolite ignimbrite and basaltic andesite with abundant agate filled amugdules, capped by arenite and rudite derived from the erosion of the underlying volcanic units (see Section 9.8). Mineralisation at the Sherwood gold deposit is partly hosted in rhyolite dykes and sills of the Agate Creek Volcanic Group that have been dated as early Permian (Tables 4.1 and 6.1).

5.0 THE METALLOGENIC DATABASE AND GIS

This study resulted in the division of all known mineral deposits in the Georgetown district into 55 metallogenic camps. A summary of the characteristics and classification of each camp is tabulated in the metallogenic database (Appendix 1). This new database is an expansion of the database originally prepared by Tate, 1987. A detailed digital map of the study region that contains geology, structure, dykes, veins, mine and deposit locations, camp boundaries and mineralisation styles was prepared as part of this study and can be accessed from the Queensland Geological Survey website.

One hundred and forty-seven historical mines and deposits were visited during the study. Notes on the nature of the geology, structure, mineralisation and alteration were made and samples collected for determination of quartz textures, age dating and trace element geochemistry. A summary of this data is provided as tables in this report and in the accompanying database.

General Classification Scheme

Overall, we have found the most useful features for classification of the camps is the overall environment of mineralisation, age represented as epoch, the quartz textures for depth of formation, multi-element geochemistry for class and the presence or absence of related intrusions.

- plutonic clan (intrusion-hosted but not intrusion-related) with Au-base metals;
- IRGS (Intrusion-Related Gold Systems) clan with genetic links to intrusions and magmatic-hydrothermal fluids and typical Au- Bi-Te polymetallic (Pb Zn Cu As Sb) geochemistry;
- the epithermal clan (formed near surface with little or no magmatic input), with Au-Ag ± Te, As-Sb, base metals.

The **related intrusion** is any intrusive body that is demonstrably genetically related to the mineralisation. The best evidence is where dikes or plugs host mineralisation and alteration and occupy the same hydrothermal system, structure or area as the mineralisation. In addition, radiometric dating demonstrates dikes and alteration/mineralisation are of the same epoch. The best examples are in porphyry systems like the Kidston breccia pipe where dikes are pre, syn- and post mineralisation and are demonstrably the cause of the hydrothermal breccia that is the main host to mineralisation and where multiple radiometric ages are all 335 ± 5Ma (Morrison, 2007).

In many examples there are intrusions in the same area and orientation as the mineralised structure, but the exact relations are unclear. In these cases, we use the texture of the quartz and the geochemical signature to evaluate intrusion involvement in the hydrothermal system. Typical examples are in the Percyvale District where a significant Permian dike swarm traverses the area with Early Devonian shear-hosted mineralisation. In most outcrops the dikes are seen to cut the shear and to not be mineralised, but in some cases, there are mineralised dikes and clasts of mineralised dike in the shear and fine comb quartz veins with Ag>Au geochemistry that is typical of the Permian dike mineralisation e.g. Carbon Copy.

In the camps where there are no intrusions that are demonstrably genetically related to the mineralisation, there may still be granitoids that host the mineralisation. In previous interpretations by others this may be taken to mean the mineralisation is magmatic, but in this study it is necessary to demonstrate age, quartz-type or chemical evidence that support a magmatic link. In the Georgetown region, the Meso-Proterozoic granites have related Sn-W-Nb-Ta mineralisation in pegmatites and are the most common host to the Devonian and younger gold mineralisation, but they have no genetically related gold mineralisation. Similarly, the Silurian granitoids host Devonian and younger mineralisation, but there is no demonstrated Silurian mineralisation.

6.0 AGES AND EPOCHS OF MINERALISATION

Twenty-seven new K-Ar ages have been completed on alteration minerals from deposits and combined with recent ages obtained by GSQ and published mineralisation and rock ages to interpret mineralising epochs in the Georgetown region (Table 6.1).

There are four Palaeozoic mineralised epochs interpreted from the radiometric dating in the Georgetown region (Figure 7):

1. **Early Devonian (EDEV) epoch** spans 418-370 Ma and includes most of the historic and recent gold producers in the Georgetown – Forsayth –Percyvale-Mt Hogan districts that have been linked to the Silurian granitoids historically but have no direct evidence of causative intrusive bodies.
2. **Early Carboniferous (ECARB) epoch** spans 350-320 Ma and includes scattered occurrences on the east side of the Newcastle Range that are demonstrably genetically linked to intrusions that are age equivalent to the early phases of the Newcastle Range and at least in part represent sub-volcanic complexes that may have been part of the same magmatic event (e.g. Lochaber-Bagstowe Complex linked to the Kidston deposit).
3. **Late Carboniferous (LCARB) epoch** spans 320-290 Ma and includes scattered occurrences near the Carboniferous-Permian volcanic complexes west of Georgetown and locally around the Newcastle Range. These complexes can contain units that span from early Carboniferous (~350 Ma) and into early Permian <290 Ma), but there seems to be three separate mineralised epochs here. The late Carboniferous deposits are intrusion-related (e.g., Mt Turner) and epithermal (Log Creek) and are associated with dikes and plugs that are sub-volcanic phases of those complexes.
4. **Early Permian (EPERM) epoch** spans 287-270 Ma and includes intrusion-related Ag-Cu (Phyllis May) and epithermal Ag-Au (Agate Creek) deposits associated with sub-volcanic intrusions in and near the volcanic complexes west and north of Georgetown and in a SE trending belt along the Robertson Fault from Greenhills to Gilberton.

A notable feature in the Georgetown region is the lack of mineralisation and spatially and genetically related to the Silurian granitoids (Figure 8) of the White Springs and Dido Supersuites of the Pama Igneous Association (Bultitude, Champion & Hutton, 2013). There has been confusion historically about the age of these supersuites with most historic Rb-Sr and K-Ar ages reporting in the Early Devonian, but more recent U-Pb zircon ages in the Silurian (430-420 Ma). This is typified by the Dido Tonalite giving 431 Ma by U-Pb zircon, 410 Ma on K-Ar biotite and 415 Ma on K-Ar hornblende (Table 4.1). This age difference is a general feature noted throughout the Pama Igneous Association, particularly at Charters Towers and ascribed to an Early Devonian tectonic-hydrothermal event overprinting the Silurian granitoids. A notable feature at Charters Towers is that there is pluton-level porphyry Cu-Mo mineralisation in the Silurian granitoids there but not so far seen at Georgetown (Morrison et al., 2016). This might be explained by the generally more felsic un-fractionated I-type granitoids at Georgetown compared with more mafic and fractionated granitoids at Charters Towers. However, in both provinces there is substantial gold mineralisation of similar character in the Early Devonian tectonic-hydrothermal event even though there are no demonstrably linked intrusions.

Table 6.1 : List of radiometric age dates for samples of alteration and mineralisation collected from mineral deposits in the Georgetown Region.

CAMP	Prospect	EPOCH	Age*[Ma]	Error +/- [Ma]	Brief Description	Method	Mineral	Reference
Mt Maid	Mountain Maid RH002	EPERM	268.5	6.2	rhyolite dyke complete sericite alt.	K-Ar	sericite	Morrison, Cody & Todd, 2017
Cumberland Mine	Cumberland #4	EPERM	275.0	6.3	green sericite altered rhyolite	K-Ar	sericite	Morrison, Cody & Todd, 2017 (this report)
Robin Hood West	Delaney	EPERM	276.8	6.4	pale green sericite in qtz fs in dyke cut by qtz-sf vn	K-Ar	sericite	Morrison, Cody & Todd, 2017 (this report)
Ironhurst	Ironhurst IH1	EPERM	278.4	6.4	oxide shears in qtz-ser altered breccia in porphyry	K-Ar	sericite	Morrison, Cody & Todd, 2017 (this report)
Mt Maid	Homeward Bound	EPERM	~281 Ma		rhyolite dyke altered & mineralised	U-Pb	zircon	JAV GM GSQ samples 2018
Percy Queen	Gilberton - Percy Queen	EPERM	~283		rhyolite dyke altered & mineralised	U-Pb	zircon	JAV GM GSQ samples 2017
Bald Mt	Bald Mountain	EPERM	283	2	Phase 3 rhyolite dyke	U-Pb	Zircon	Nethery, 2009
Electric Light	Electric Light	EPERM	~283 Ma		Ore in rhyolite - sulphides, Au	Ar-Ar	K-spar	G. Lister and M. Foster (unpub)
Mt Maid	Gilberton - Mountain Maid	EPERM	~284		rhyolite dyke altered & mineralised	U-Pb	zircon	JAV GM GSQ samples 2016
	Wallabadah	EPERM	284.5	<2	Alteration related to sulphides	Ar-Ar	Sericite	Gold Anomaly Ltd 2010
Agate Creek	Zig-Zag dyke - Sherwood	EPERM	284.5		rhyolite dyke	U-Pb	zircon	CROSS, A.J et al., in prep.
Agate Creek	Sherwood - rhyolite sill	EPERM	284.9		rhyolite sill	U-Pb	zircon	CROSS, A.J et al., in prep.
Einasleigh	Bloodwood Knoll	EPERM	285.2	6.6	Fe ox on silvery ms altered metaseds	K-Ar	sericite	Morrison, Cody & Todd, 2017
Bald Mt	Bald Mountain	EPERM	286	2	Phase 1 porphyry	U-Pb	Zircon	Nethery, 2009
Phyllis May	Mt Darcy Volcanic breccia	EPERM	286.7	6.6	brain rock strong sericite alteration	K-Ar	sericite	Morrison, Cody & Todd, 2017
Mt Turner	Mt Turner	EPERM	289.4	1.3	molydbenite-quartz vein in rhyolite	Re-Os	Mo	R.Creaser (unpub)
Log Creek	Log Creek 2 kspar	LCARB	251.6	5.8	bt+/-hn feldspar quartz porphyry crowded	K-Ar	K feldspar	Morrison, Cody & Todd, 2017 this report
Log Creek	Log Creek 1 ser, alt qtz porph	LCARB	292.1	6.7	pale green sericite altered porphyry	K-Ar	sericite	Morrison, Cody & Todd, 2017 this report
Brody's Camp	Brodies camp	LCARB	299.0		qtz - Moly vein	Re-Os	Mo	R.Creaser (unpub)
Mt Turner	Mountain Ck Claymore #1	LCARB	310.8	7.2	c.g. granite ser/plag kf unaltered	K-Ar	sericite	Morrison, Cody & Todd, 2017
Red Dam	Red Dam RD1026 186m	LCARB	313.0	7.2	green sericite altd m.g. granite some alteration biotite?	K-Ar	sericite	Morrison, Cody & Todd, 2017 this report
Ellendale	Ellendale	LCARB	316.0	7.3	grey-gn sericite-biotite/chlorite in granite porphyry	K-Ar	sericite	Morrison, Cody & Todd, 2017 this report
Kidston	Kidston	ECARB	321	15	Sericite alteration near veins	sericite	K-Ar	Bain et al 1988
Carbon Copy	Robin Hood Granodiorite	?	322.1	7.4	f.g. biotite granodiorite	K-Ar	biotite	Morrison, Cody & Todd, 2017
Mt Borium	Boriums Whisper	ECARB	325.3	7.5	strong sericite in c g granite	K-Ar	sericite	Morrison, Cody & Todd, 2017
Kidston	Kidston	ECARB	~332		Sericite alteration, mineralisation	Ar-Ar	Sericite	Perkins & Kennedy, 1998
Kidston	Kidston	ECARB	~332		Syn, post mineralisation dykes	U-Pb	Zircon	Perkins & Kennedy, 1998
Kidston	Kidston	ECARB	335.7	4.2	Median dyke	U-Pb	Zircon	Murgulov & others, 2009
Christmas Hill	Christmas Hill	ECARB	336.6	7.7	oxide silver sericite bx granite	K-Ar	sericite	Morrison, Cody & Todd, 2017
Kidston	Lochaber Ring Complex (near Kidston)	ECARB	337.9	2.6	Lochaber Diorite	U-Pb	Zircon	Murgulov & others, 2009
Kidston	Kidston	ECARB	339.5		molybdenite in early laminar qtz vein	Re-Os	Mo	R.Creaser (unpub)
Kidston	Kidston	ECARB	339.7		molybdenite in early laminar qtz vein	Re-Os	Mo	R.Creaser (unpub)
Electric Light	Electric Light EL 1000 17-21m	ECARB	346.5	8.0	Fe ox shears in sericite alt granite	K-Ar	sericite	Morrison, Cody & Todd, 2017 this report
Kidston	Lochaber Ring Complex (near Kidston)	ECARB	350.7	1.3	Black Cap Diorite	U-Pb	Zircon	Murgulov & others, 2009
Drummer Hill	Rocky Reward	EDEV?	372.1	8.6	Dolerite, sericite-qtz alteration & qv	K-Ar	sericite	Morrison, Cody & Todd, 2017 this report
Drummer Hill	Lineament	LDEV?	377		quartz feldspar porphyry dyke	U-Pb	zircon	CROSS, A.J et al 2017.
Big Vein South	LRD0203 Core 125.3-125.6m	EDEV?	377.1	8.7	gn-gy sericite altered meta-sandstone qsv	K-Ar	sericite	Morrison, Cody & Todd, 2017 this report
Big Vein Sth	LRD0235 Core 68.4-68.8m	EDEV?	377.8	8.7	partial sericite selvage, qz vn in gte	K-Ar	sericite	Morrison, Cody & Todd, 2017
Monte Cristo	Pigs Eye, 0.39g	EDEV?	378.7	8.7	qz-sf vns in sericite altered sheared metasediment	K-Ar	sericite	Morrison, Cody & Todd, 2017 this report
Mt Maid	Homeward Bound	EDEV?	388.1	8.9	strong green sericite in granodiorite	K-Ar	sericite	Morrison, Cody & Todd, 2017
International	Black Diamond	EDEV	389.1	8.9	sericite in shear zone in dolerite	K-Ar	sericite	Morrison, Cody & Todd, 2017
Mountain Maid	Mountain Maid sericite	EDEV	391.4	9.0	green sericite selvage on buck qtz vn in m.g granite	K-Ar	sericite	Morrison, Cody & Todd, 2017 this report
Mt Hogan	Welcome MHR220 & 221	EDEV	392.5	9.0	sericite alteration	K-Ar	sericite	Morrison, Cody & Todd, 2017
Jubilee Plunger	Lady Mary	EDEV	397.5	9.2	flaky silver sericite in bx granite	K-Ar	sericite	Morrison, Cody & Todd, 2017
Mt Hogan	General Gordon	EDEV	397.7	9.1	sericite alteration	K-Ar	sericite	Morrison, Cody & Todd, 2017
Georgetown	Wexford	EDEV	398	3	Sericite alteration near veins	sericite	K-Ar	Bain et al 1988
Mt Hogan	Mt Hogan	EDEV	400	4	Sericite alteration near veins	K-Ar	sericite	Bain et al 1988
Havelock	Havelock	EDEV	404.7	9.3	qtz vein margin sericite alt. granite	K-Ar	sericite	Morrison, Cody & Todd, 2017
Jubilee plunger	Jubilee plunger	EDEV	407	6	Sericite alteration near veins	sericite	Rb-Sr	Bain et al 1988
Queenslander	Queenslander	EDEV	418	2	Sericite alteration near veins	K-Ar	sericite	Bain et al 1988
Dry Hash	Dry Hash	EDEV	419	2	Sericite alteration near veins	sericite	K-Ar	Bain et al 1988
International	International	EDEV	426	5	Sericite alteration near veins	sericite	K-Ar	Bain et al 1988
Glenrowan	Glenrowan	EDEV	444.6	10.2	qtz-sf veins in silky sericite-qtz altered metasediment	K-Ar	sericite	Morrison, Cody & Todd, 2017 this report
Kidston	Oak River Granodiorite host near Kidston	SIL	417.7	2.2	Oak River Granodiorite	U-Pb	Zircon	Murgulov & others, 2009

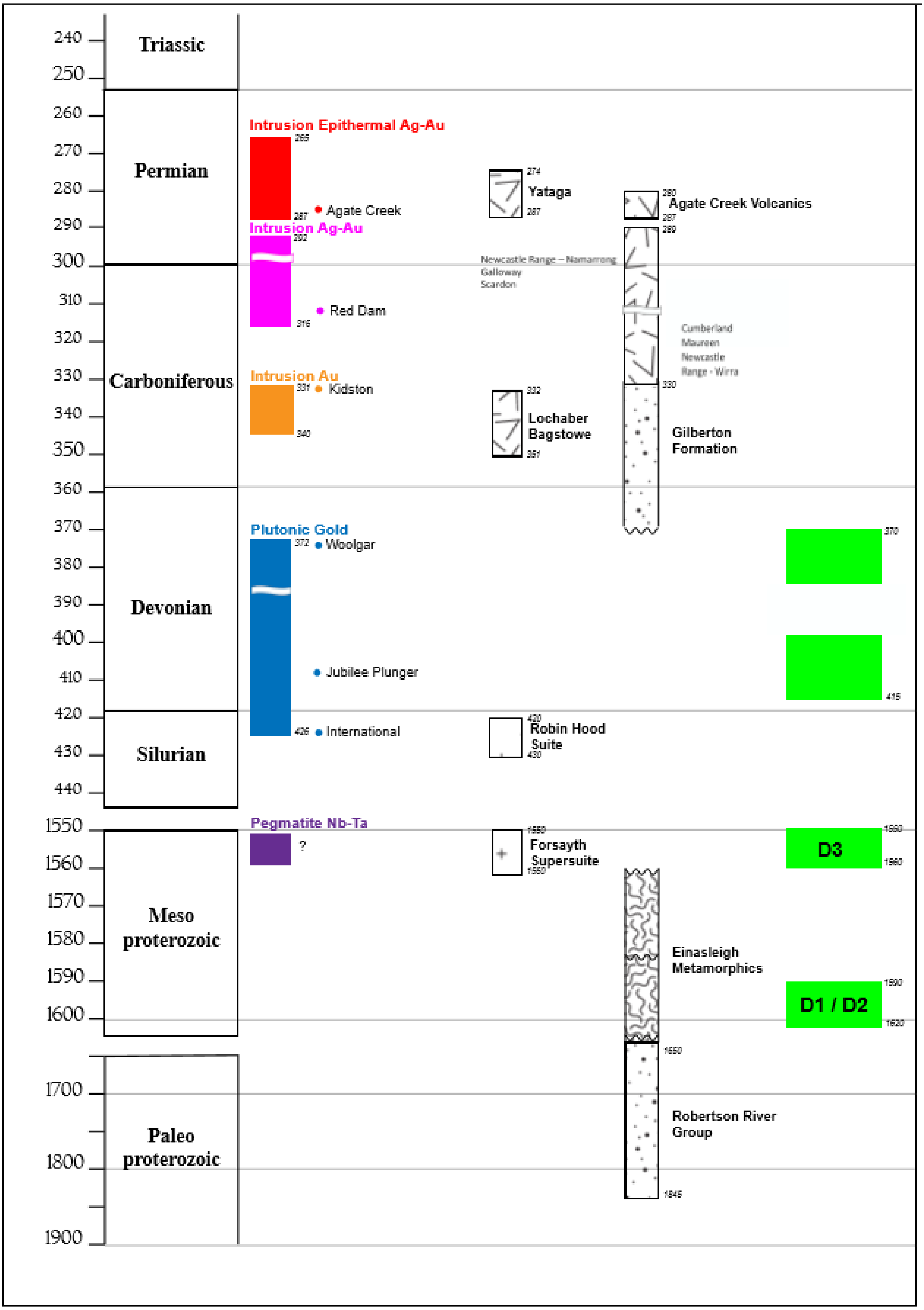

FIGURE 7 : Geological time scale showing age of major rock groups found in the Georgetown Region, timing of orogenic events and mineralisation epochs.

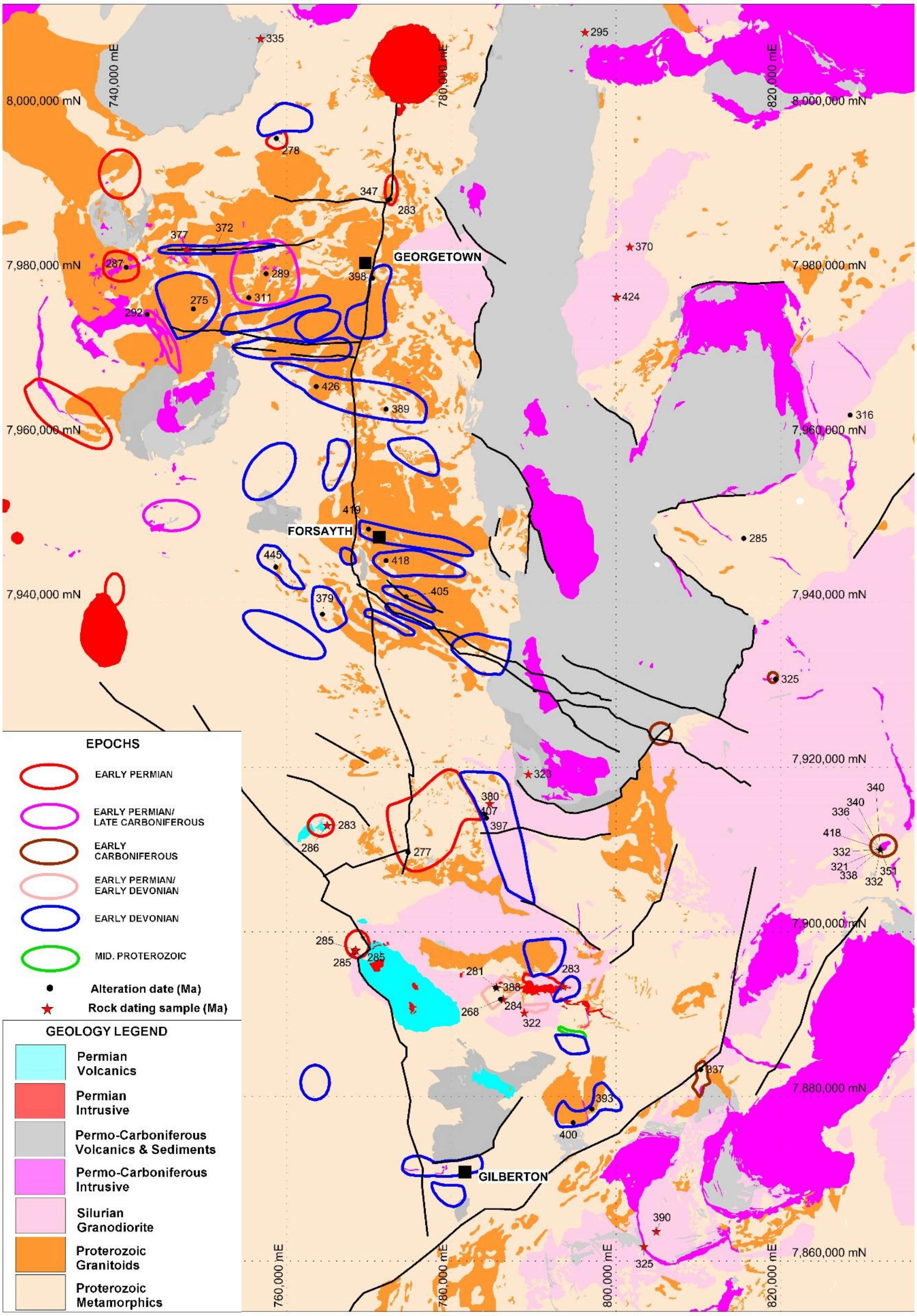

Figure 8 : Camps color-coded for mineralising epoch with actual ages at sample points.

7.0 MINERALISATION STYLE AND DEPTH CLASSIFICATION BASED ON QUARTZ TEXTURES

Most mineral deposits in the Georgetown region possess quartz as a gangue to mineralisation. The morphology and texture of quartz are a good indicator of the conditions under which the quartz and associated mineralisation was formed. When used in combination with the geologic setting, trace element geochemistry and age determinations, quartz textures can help determine the style of deposit and the relative depth of formation (Dowling & Morrison, 1990).

One hundred and thirty-three historical mines in the Georgetown, Forsayth and Gilberton districts were visited and sampled as part of the current project and were augmented by hundreds of samples from Gilberton collected by Jose Veracruz, together with samples and photos provided by company collaborators. The samples have been used to identify quartz textures and textural assemblages using the scheme of Dowling & Morrison (1990) (Table 7.1 & 7.2) and to update the previous interpretation in the Georgetown region by Tate et al. (1987).

TABLE 7.1: Quartz texture Classification Scheme (Dowling & Morrison, 1990).

CLASS	GRAIN SIZE	INTERNAL VARIABILITY	GRAIN FORM	CRYSTAL PACKING	PREFERRED GRAIN ORIENTATION (relative to substrate)
1. Buck					
(a) Anhedral	Variable	High	Anhedral	Tight	None
(b) Euhedral	Variable	High	Prismatic	Tight	Random
2. Fiber	Variable	Low	Fibrous	Tight	Orthogonal
3. Comb					
(a) Coarse	Coarse	Low	Prismatic	Moderate	Prismatic
(b) Medium	Medium	Low	Prismatic	Moderate	Prismatic
(c) Fine	Fine	Low	Prismatic	Open	Prismatic
4. Banded					
(a) Crustiform	Variable	Low	Variable	Tight	Orthogonal
(b) Colloform	Variable	Low	Variable	Tight	Orthogonal
(e) Cockade	Variable	Low	Radial	Tight	Orthogonal
5. Saccharoidal	Variable	Low	Anhedral	Moderate	None
6. Laminated	Variable	Low	Anhedral	Tight	Parallel
7. Ribbon [1]					
8. Stylolite[1]					
9. Spider					
(a) Comb	Fine	Low	Prismatic	Moderate	Orthogonal
(b) Phantom	Fine	Low	Mimics Host	Tight	Mimics Host
10. Breccia					
(a) Infill	Variable	High	Prismatic	Variable	Variable
(b) Aggregate	Variable	High	Anhedral	Variable	Variable
11. Replacement	Variable	Low	Mimics Host	Mimics Host	Mimics Host

[1] Ribbon and stylolite textures are an integral part of the classification scheme; however, they do not consist of a new generation of quartz. Their features are dependent on the host and it is not appropriate to summarise the variable features of the host quartz in this table.

Many of the quartz textures listed in Table 7.1 were observed in ore from the historical mines, particularly Class 1(b) and 3. Euhedral buck quartz is a common early quartz phase found in many of the mineral deposits investigated and consists of tightly packed, interlocking prismatic crystals with no or little open space (Plate 1). Comb quartz was the most common quartz texture found during the study and was observed in almost all deposits visited (Plate 2). Close examination of samples often revealed a complex history with multiple generations of quartz formation. Samples from some deposits possessed over five events of quartz development, with each event exhibiting a different texture (Plate 3).

As many deposits in the Etheridge Province are hosted in faults, deformation of early quartz phases by later shearing was often observed. The most common deformation textures found were recrystallization of veins forming saccharoidal quartz, brecciation and development of stylolites and spider veins (Plate 4).

During field inspection and sampling of each site, records of quartz textures, deformation textures, their order of formation and relative abundance were made. To help group the deposits, codes were assigned to each textural style. Each deposit was then assigned a list of codes based on the quartz textures identified. This allowed classification of each deposit according to their mineralising environment as outlined in Table 7.2. Results showed that based on the quartz textures all the deposits investigated could be divided into three mineralising environments, Plutonic, Intrusion-Related and Epithermal and also assigned a relative depth of formation - hypozonal, mesozonal and epizonal.

Table 7.2: Proportions of quartz textural types for the four Major gold mineralising environments recognised in North Queensland (Dowling & Morrison, 1990).

	ENVIRONMENT			
Textural Type	**Epithermal**	**Porphyry**	**Plutonic**	**Slate belt**
1 Buck				
(a) Anhedral	--	--	--	****
(b) Euhedral	--	*	****	--
2 Fiber	--	--	--	**
3 Comb				
(a) Coarse	**	*	***	**
(b) Medium	**	**	**	--
(c) Fine	****	****	**	--
4 Banded				
(a) Crustiform	****	**	--	--
(b) Colloform	****	--	--	--
(c) Cockade	*	*	*	--
5 Saccharoidal	*	*	--	--
6 Laminated	--	*	--	--
7 Ribbon	--	--	**	****
8 Stylolite	--	--	**	***
9 Spider veinlet				
(a) Comb	**	*	**	**
(b) Phantom	--	--	*	***
10 Breccia				
(a) Infill	****	*	**	***
(b) Aggregate	--	--	**	**
11 Replacement	***	*	*	*

PLATE 1: Coarse euhedral buck quartz vein texture consisting of tightly packed crystals of variable size and orientation with little open space. Sample from the Aurora Mine, International Camp (Georgetown). Sample #231606; 0.15 g/t Au, 1.3 g/t Ag.

PLATE 2: Quartz vein composed of clear to white, zoned, medium to coarse euhedral crystals growing perpendicular to vein walls giving a “comb” like appearance. Specimen of ore from the Stonewall Jackson Mine, International Camp (Georgetown). Sample #231603; 1.21 g/t Au, 7.53 g/t Ag.

PLATE 3. Polymict matrix support breccia with a complex history of formation. At least four phases of pre-breccia and post-breccia quartz veining of variable texture. Fine, dark coloured, silica – pyrite breccia cement. Specimen of ore from the Cumberland Mine, Georgetown (Sample #231594; 4.46 g/t Au, 24.3 g/t Ag).

PLATE 4: Sample of mineralised quartz vein material showing brecciated and recrystallised buck quartz cut by thin, irregular stylolites (black lines) and late fine, clear comb quartz cutting all earlier events. Specimen from the Trafalgar Mine, Queenslander Camp, Forsayth (Sample #231422; 1.24 g/t Au, 30.7 Ag).

In the Etheridge Province, the main quartz textures observed for each mineralising environment were:

Plutonic: quartz textures are typified by tightly packed coarse euhedral buck quartz, often brecciated or recrystallised by deformation, development of stylolites and spider veins. Late, fine to medium comb quartz as veins or breccia infill may overprint all earlier events.

Intrusion-Related deposits: quartz textures are generally finer grained than the Plutonic category. Textures generally consist of fine to medium euhedral buck or comb quartz in veins, stockwork or breccia. Early quartz phases are often cut by later fine comb quartz. Deformation textures such as recrystallization of quartz and stylolites can be present but are rare.

Epithermal quartz textures consist of fine comb and chalcedony that maybe colloform and crustiform banded.

7.1 QUARTZ TEXTURES OF PLUTONIC DEPOSITS

Quartz textures indicative of the Plutonic mineralising environment were the most common textural types found in the mineral deposits of the Georgetown, Forsayth & Gilberton regions. Of the 133 deposits and prospects visited 101 could be classified as Plutonic. The Plutonic deposits are often hosted in steep dipping shears or lodes cutting Proterozoic granite and metamorphic rocks. The lodes can be of significant size i.e. kilometres in length and 10’s of metres in width e.g. Long Gully line of workings (Forsayth), Big Wonder & Drummer Hill Faults (Georgetown). However, individual quartz veins tend to be irregular or lenticular in shape and rarely exceed 50cm in thickness and 20 metres in length. The nature of the quartz veins is related to the irregular development of tensional zones during fault movement, brittleness of host rocks and deformation by later fault movement (Plate 5 & 6).

PLATE 5: Steep dipping lenticular mineralised quartz body hosted in sheared Forsayth Granite (Mountaineer Mine, Forsayth). Sample 231425; 62.5 g/t Au, 15.15 g/t Ag.

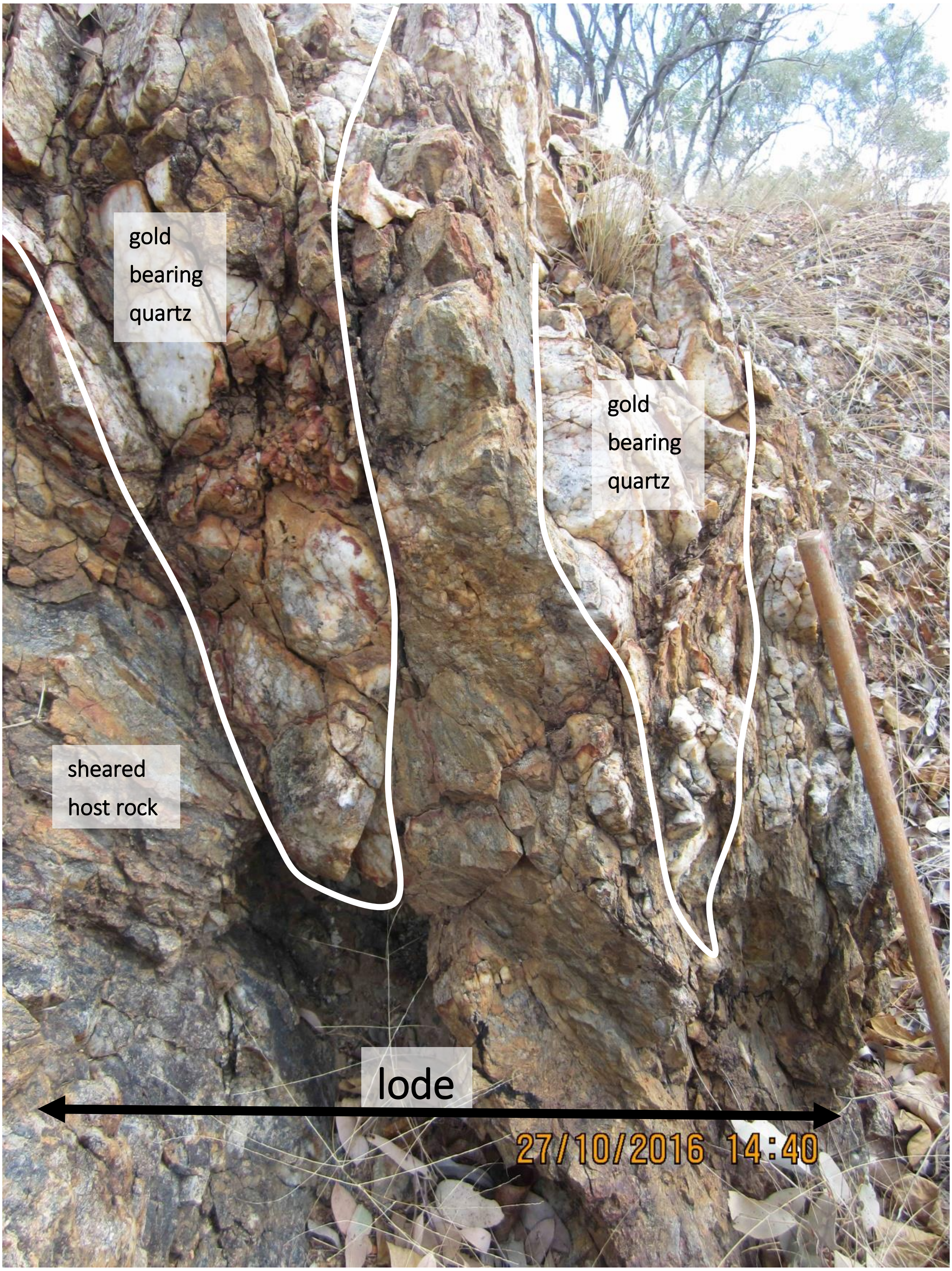

PLATE 6: Lenticular quartz bodies hosted in steep dipping lode, typical of the hypozonal and mesozonal deposits found around Georgetown and Forsayth (Harp of Erin pit, 2kms south of Georgetown). Sample 231579; 0.12 g/t Au, 7.33 g/t Ag.

The early, coarse euhedral buck quartz phase found in many of the deposits is nearly always recrystallised by later shearing and brecciation producing an equigranular texture of anhedral grains obliterating or masking original quartz textures. The deformation of early quartz often leads to breccia and veins infilled by finer comb quartz, and development of spider veinlets and stylolites (Plate 4). The later phases of quartz are often accompanied by sulphides that are usually responsible for gold and base metal mineralisation. The quartz is commonly observed as multiple crosscutting events, with each event exhibiting different textures. The later quartz phases tend to be finer grained, indicative of a shallower depth of formation than earlier quartz phases. Breccia developed within the lodes rarely possess a ductile fabric and is dominated by brittle textures.

Close examination of the quartz textures showed that the deposits falling into the Plutonic environment could be subdivided further into hypozonal, mesozonal and epizonal by using the grain size (coarse, medium, fine) of the various quartz phases (Plates 7 – 10).

PLATE 7: Tightly packed, coarse euhedral buck quartz with little open space (Plutonic hypozonal). Specimen of quartz vein ore from the Josephine Mine, Percyvale (Sample# 231316; 9.59 g/t Au, 183 g/t Ag).

PLATE 8: Tightly packed coarse, growth zoned, euhedral quartz crystals with little open space. Ore vein sample from Mountain Maid, Plutonic hypozonal (Sample #231302; 1.62 g/t Au, 41.3 g/t Ag).

PLATE 9: Early medium grained euhedral buck quartz, fractured, brecciated and recrystallised with open space filled by pyrite, chalcopyrite and galena. ore from Mount Hogan, Plutonic Mesozonal (Sample #231331; 336 g/t Au, 498 g/t Ag).

PLATE 10: Early medium, white euhedral buck quartz fractured and cut by fine, clear quartz spider veinlets and minor stylolites. Disseminated sulphide mineralisation introduced along late fractures. Typical of textures found in the central Georgetown and Forsayth districts. Sample of vein ore from Hawkins Hill, Georgetown. Plutonic Mesozonal. (Sample #231560; 24.9 g/t Au, 16.55 g/t Ag).

7.2 QUARTZ TEXTURES OF INTRUSION RELATED DEPOSITS

Quartz textures indicative of the Intrusion Related environment are generally finer grained than the Plutonic category. Textures commonly found are fine to medium euhedral comb quartz in veins, stockwork or breccia. Early quartz phases are often cut by later fine comb quartz (Plates 11 – 14). Like the Plutonic deposits, Intrusion Related deposits can also be subdivided into mesozonal and epizonal categories based on the nature of the mineralisation and fineness of the quartz textures. The deposits are often hosted in Permo-Carboniferous age intrusives or have a spatial association with them, e.g., Mt Turner, Electric Light, Cumberland, Kidston, Log Creek, Mt McDonald, Huonfels.

In contrast to the Plutonic deposits, the Intrusion Related deposits occur as: a) hydrothermal breccia pipes, e.g., Kidston, Bald Mountain, Mount Turner, Ironhurst; b) as fracture, veinlet, disseminated and stockwork style mineralisation in and adjacent to Permo-Carboniferous porphyry intrusives, e.g., Phyllis Mae, Christmas Hill, Log Creek, Mt Turner, Mount Borium and, c) broad, linear zones of breccia cemented by a hydrothermal matrix, often incorporating clasts of Permo-Carboniferous porphyries, e.g., Beverley Mine, Huonfels, Electric Light.

PLATE 11: Vugy, medium comb quartz infill of brecciated granite and schist. Euhedral quartz crystals are zoned, not deformed and cores to Vugs filled with limonite after sulphides. Eastern Bar Prospect, Robin Hood Station. Intrusion Related Mesozonal (Sample #231503; 0.03 g/t Au, 179.0 g/t Ag).

PLATE 12: Brecciated granite cemented by fine comb quartz. Note euhedral quartz terminations in Vugs. Delaney Prospect, Robin Hood Station. Intrusion Related Mesozonal (Sample #231512; 0.26 g/t Au, 13.05 g/t Ag).

PLATE 13: Early phase of brecciation cemented by fine, black silica-pyrite cut by a stockwork of clear to white, fine comb quartz. Rhyolite breccia ore from Electric Light. Intrusion Related Epizonal (Sample #231509; 70.9 g/t Au, 50.6 g/t Ag).

PLATE 14: Polymictic breccia composed of clasts of porphyry and schist in a silicified rock flour matrix cut by numerous generations of very fine quartz. Sample of mineralisation from the Beverley Mine, Einasleigh. Intrusion Related Epizonal (Sample #231522; 0.82 g/t Au, 0.44 g/t Ag).

In some deposits, particularly those hosted along major structures, overlapping Plutonic and Intrusive Related style quartz textures and mineralisation have been observed e.g. Rocky Reward, Electric Light, Cumberland (Georgetown), Mountain Maid (Percyvale) and Big Jack (Forsayth) (Plate 15). This can cause problems when attempting to classify deposits based on quartz textures and geochemistry. In cases like this care is required when collecting samples of quartz or mineralisation to understand the various textural and genetic relationships.

PLATE 15: White euhedral buck quartz brecciated and cut by stylolites (bottom of photo). Cemented by dark fine, silica-pyrite matrix that is cut by very fine, clear to white comb quartz. Example of Plutonic style quartz later cut by Intrusion Related style quartz. Ore from Big Jack Mine, Long Gully, Forsayth (Sample #231445; 1.42 g/t Au, 14.15 g/t Ag).

7.3 QUARTZ TEXTURES OF EPITHERMAL DEPOSITS

Quartz textures indicative of the Epithermal mineralising environment were the least common textural types found in the mineral deposits of the Georgetown, Forsayth & Gilberton regions. Of the 133 deposits and prospects visited, only eight could be classified as epithermal, e.g. Sherwood (Agate Creek), Woolgar and Percy Queen (Percyvale). Epithermal quartz textures identified consisted of colloform and crustiform banded chalcedony and very fine comb in stockwork or as breccia infill (Plates 16 - 17). All the deposits recognised had a close association with Permian age volcanics.

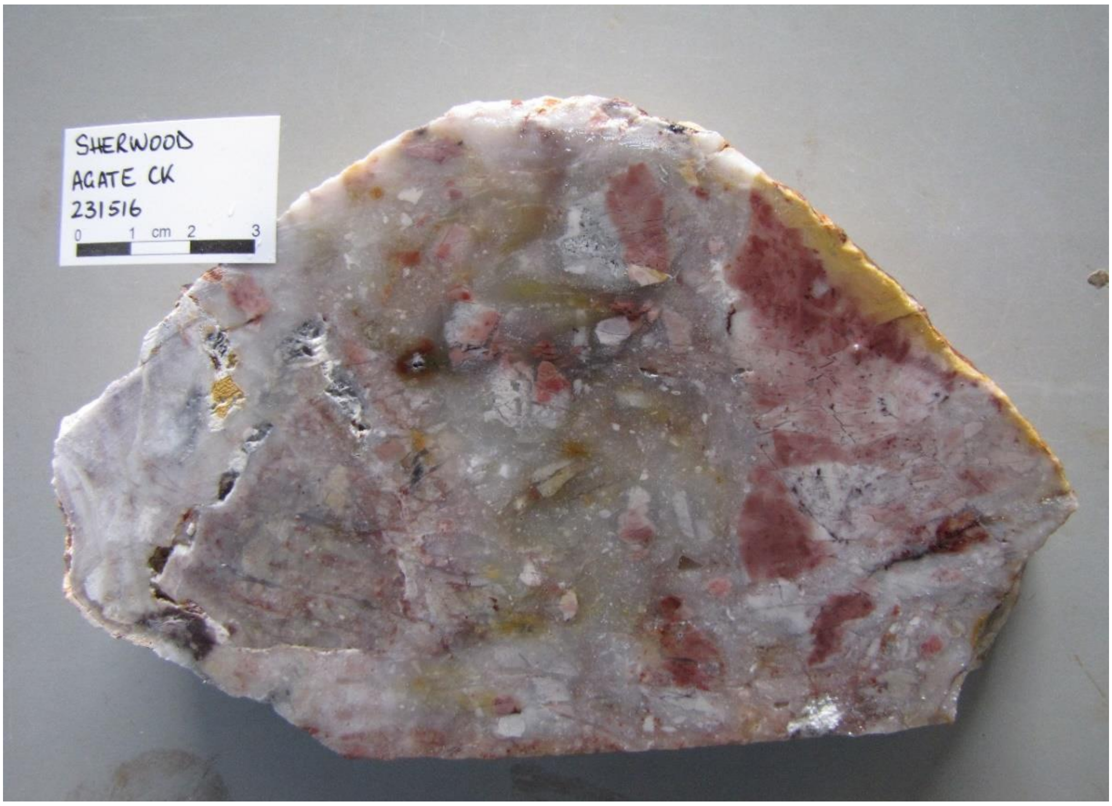

PLATE 16: Polymictic breccia composed mostly of rhyolite angular clasts cemented by cryptocrystalline quartz. Cut by later fine veinlets of clear quartz. Hydrothermal breccia from Sherwood, Agate Creek, Forsayth (Sample #231516; +100 g/t Au, 42 g/t Ag).

PLATE 17: Brecciated rhyolite cemented by very fine comb quartz and fine silica-pyrite (darker patches). Hydrothermal breccia from Percy Queen, Percyvale (Sample #231307; 11.3g/t Au, 151 g/t Ag).

7.4 QUARTZ TEXTURE ASSEMBLAGES AND CAMP DEFINITION

Codes were defined for each quartz textural variety and deformation feature (See Table 7.3). Individual deposits were assigned a sequence of codes based on the assemblage of quartz textures observed at the deposit in order of abundance. Mineral deposits with similar quartz texture codes, occurring in the same area were grouped into camps. In total, 54 camps were defined in the Georgetown, Forsayth and Gilberton region (See Table 7.4 & Figure 6). Of the 54 metallogenic camps defined, 33 fall into the Plutonic mineralising environment category, 16 fall in the Intrusion Related category with five camps designated as Epithermal.

TABLE 7.3: List of quartz textures and corresponding codes used to classify each camp.

CAMP QUARTZ TEXTURE CODES	
A	Saccharoidal quartz
Bf	Fine euhedral buck +/- recrystallisation
Bm	Medium euhedral buck +/- recrystallisation
Bc	Coarse euhedral buck +/- recrystallisation
C	Coarse comb, cockade
D	Deformation of early phase quartz by shearing tectonic brecciation, producing saccharoidal and anhedral recrystallised grains stylolites, spider veins & stockworks
F	Fine comb, cockade
K	Stockwork comb and saccharoidal quartz
Lf	late fine comb quartz overprint or infill
Lm	late medium comb quartz overprint or infill
Lc	late coarse comb quartz overprint or infill
M	Medium comb, cockade
O	Chalcedony +/- colloform, crustiform silica
P	Very fine crystalline to saccharoidal quartz-pyrite
S	Stylolites and/or Spider veinlets
X	Hydrothermal Breccia
Z	Zoned crystals

In general, the Plutonic camps form a linear NNW trending core of deposits through the district (Figure 9). The main mining centres of Georgetown and Forsayth are dominated by Plutonic Hypozonal and Mesozonal style deposits. With the Plutonic Epizonal, Intrusion- Related and Epithermal style camps clustered around the edges, particularly west of Georgetown around the Cumberland Range volcanic complex. This relationship suggests there may be a shallowing trend in quartz textures and mineralisation styles away from the Plutonic camp centres.

TABLE 7.4: Classification of Mine Camps by Quartz Texture. See Table 7.3 for codes.

CAMP	TYPICAL VEIN CHARACTERISTICS	VEIN TEXTURE CODES	CAMP QTZ CODE	BUCK & INFILL
Agate Creek	fine comb, chalcedony	FCM, CH +/- CR, CO	FO	FO
Mt McDonald	Chalcedony & fine comb quartz veins and breccia infill.	BX, FCM, CH	XFO	FO
NC Range	Fine-med. comb, chalcedony, colloform banded, crustiform	F-MCM, CH +/- CR, CO	FO	FO
Percy Queen	Fine comb qtz +/- CH, SP.	FCM	FOS	FO
Woolgar Epithermal	chalcedonic, bladed, crustiform-colloform, fine crystalline	CH, CO, CR, SAC, FCM	FO	FO
Beverley	fine comb, chalcedony	FCM, CH, CR	FO	FO
Double Zed	Silicified rock brecciated, recrystallised cut by fine silica-pyrite spider veins, stylolites and late fine comb quartz. Minor medium buck euhedral quartz,	MEB, BX, REC, FCM	FP	FP
Bald Mountain	Fine comb veins and breccia cement	FCM, BX	XF	FX
Cumberland Mine	Silica-pyrite infill and late fine comb quartz veins, zoned crystals	BX, FCM, Z	XPFZ	FZ
Electric Light	Fine qtz-pyrite in breccia. Cut by fine white comb qtz veins, STX, SP veins	BX, FCM, SP, K	XFSK	FDF
Greenhills	Fine comb	FCM	F	F
Huonfels	Fine comb, zoned crystals	FCM, Z	FZ	FZ
Ironhurst Bx	fine comb quartz veins and breccia infill, zoned crystals	BX, FCM, Z	XFZ	FZ
Log Ck	fine comb	FCM	F	F
Mt Clark	fine comb quartz veins and breccia	FCM, BX	XF	FX
Mt Turner	fine comb	FCM+/- STY	FS	F
Phyllis May	fine comb	FCM	F	F
Christmas Hill	Med comb qtz bx fill, barren; mineralised clay shears minor fine comb qtz	F-MCM, BX	MX	MX
Kidston	Fine - med. comb quartz cementing breccia and in late stage sheeted vein ore. Minor early saccharoidal quartz (Mo) stockwork	K, BX, F-MCM	AXL	F-M(A)
Mt Borium	fine comb	FCM	F	F
Robinhood West	Fine-medium comb quartz, +/- breccia, spider veins	F-MCM +/- BX, SP	FXS	F-MD
Carbon Copy	Early fine euhedral buck, brecciated, late fine comb quartz infill	FEB, BX, FCM	BfXL	BfLf
Red Dam	Fine comb quartz, recrystallised, saccharoidal +/- s'work, bx, spider veins	FE, SACC +/- STX, BX,SP	FD	BfD
The Drum	Fine euhedral buck, recrystallised	FEB, REC	BfD	BfD
Cumberland Camp	Fine euhedral buck qtz, recrystallised cut by fine comb qtz and spider veins	FEB, REC +/- FCM, SP	BfDL	BfLf
Percyvale	Multiple phases of med-fine comb qtz, medium-fine buck, often recrystallised +/- BX, SP, STY	F-MCM, REC, FCM +/- BX, SP, STY	FDL	f-mBLf
Drummer Hill	Medium buck, euhedral quartz, cut by late fine comb qtz +/- stockwork, bx, chalcedony, spider veins	MB, FCM +/- STX, CH, BX, SP, SACC	BmDL	BmLf
Dry Hash	Med. euhedral buck, cut by late fine comb quartz and spider veinlets	MEB, FCM, SP	BmSL	BmLf
Durham	Med. Euhedral buck cut by later fine-med. Comb +/- BX, SP, STY	MEB +/- FCM, BX, SP	BmDL	BmLf
Georgetown	Med euhedral buck qtz, cut by later shearing, late fine comb veins and SP	MEB, REC, FCM, BX, SP	BmDL	BmLf
Gilberton	Med euhedral buck quartz, brecciated, recrystallised +/- fine comb qtz	MEB, REC +/- FCM, BX	BmDL	BmLf-m
Havelock	Medium euhedral buck, recrystallised, late fine comb +/- chalcedony	MEB, REC, FCM +/- CH	BmDL	BmLf
Jubilee Plunger	Med. euhedral buck, recrystallised, cut by later fine comb and bx	MEB, REC, FCM +/- BX	BmDL	BmLf
Lane Creek	Med euhedral buck, bx, cemented by fine comb qtz and silica-pyrite	MEB, BX, FCM	BmXFP	BmLf
Long Gully	Early medium euhedral buck, sheared, recrystallised, brecciated, with late fine comb and silica-pyrite infill	MEB, REC, BX, FCM, STY	BmDPL	BmLf
Long Lode	Medium comb qtz, bx, recryst with spider veins, STY and late fine comb qtz	MCM BX REC FCM SP STY	MDL	BmLf
Monte Cristo	Med. euhedral buck, med-fine comb quartz +/- REC, STY	MEB, FCM, STY	BmFD	BmLf-m
Mt Hogan	Med euhedral buck quartz, recrystallised, late fine - medium comb quartz	MEB, REC +/- M-FCM	BmDL	BmLf-m
Mt Moran	Medium euhedral Buck, recrystallised.	EB, REC	BD	BmD?
New Moon- Mosquito	Med. euhedral buck, recrystallised & cut by late fine-med. comb quartz	MEB, REC, FCM	BmDL	BmLf-m
Queenslander	Med euhedral buck & fine comb quartz, bx, spider veins, sugary qtz & STY	MEB FCM BX SP SAC STY	BmDL	BmLf
Big Reef	Medium euhedral buck, recrystallised, stylolites, late fine comb	MEB, REC, STY, FCM	BmDL	BmLf
Big Wonder	Med. comb crystals. Fractured and recrystallised by later shearing.	MCM, BX, REC	MD	BmD
Woolgar mesozonal	Med euhedral buck brecciated spider veins stylolites late fine comb-sulfide	MEB, REC, BX, SP, FCM	BmDL	BmLf
Black Knob	Coarse euhedral buck quartz, brecciated with fine - medium comb infill +/- recrystallised, spider, chalcedony veinlets	CEB, BX, MCM +/-REC, CH, SP	BcDLO	BcLf-m
Four Gees	Coarse euhedral buck quartz, zoned, brecciated, recrystallised, spider veins	CEB, Z, REC +/-SP	BcZD	BcD
Glenrowan	Coarse euhedral buck, recrystallised & cut by stylolites, fine-med. Comb quartz +/- spider veins & bx	CEB, REC, STY, F-MCM +/- SP, BX	BcDL	BcLf-m
Goldsmiths	Coarse euhedral buck, fine comb, recrystallised +/- breccia	CEB, FCM, REC +/- BX	BcFD	BcLf
Marquis	Coarse euhedral buck, recrystallised & late fine comb quartz	CEB, REC, FCM, BX, SP	BcDL	BcLf
Titania	Coarse euhedral buck and comb quartz, cut by later shearing	CEB, REC, BX, SP SACC	BcFD	BcD
Western Ck	Coarse euhedral buck and med-fine comb	CEB, M-FCM	BcM	BcLf-m
International	Coarse euhedral buck , recrystallised and cut by med-fine comb, breccia, stylolites and spider veins	CEB +/- REC, M-FCM, SP, BX, STY	BcDL	BcLf
Mt Maid	Coarse comb qtz, zoned, infill sulphide, minor barren fine comb in rhyolite	CCM, Z	CZ	CZ
Dairy Maid	Coarse comb quartz, zoned crystals infill sulphide maybe pods in deformed buck but this is minor	CCM, Z	CZ	CZ

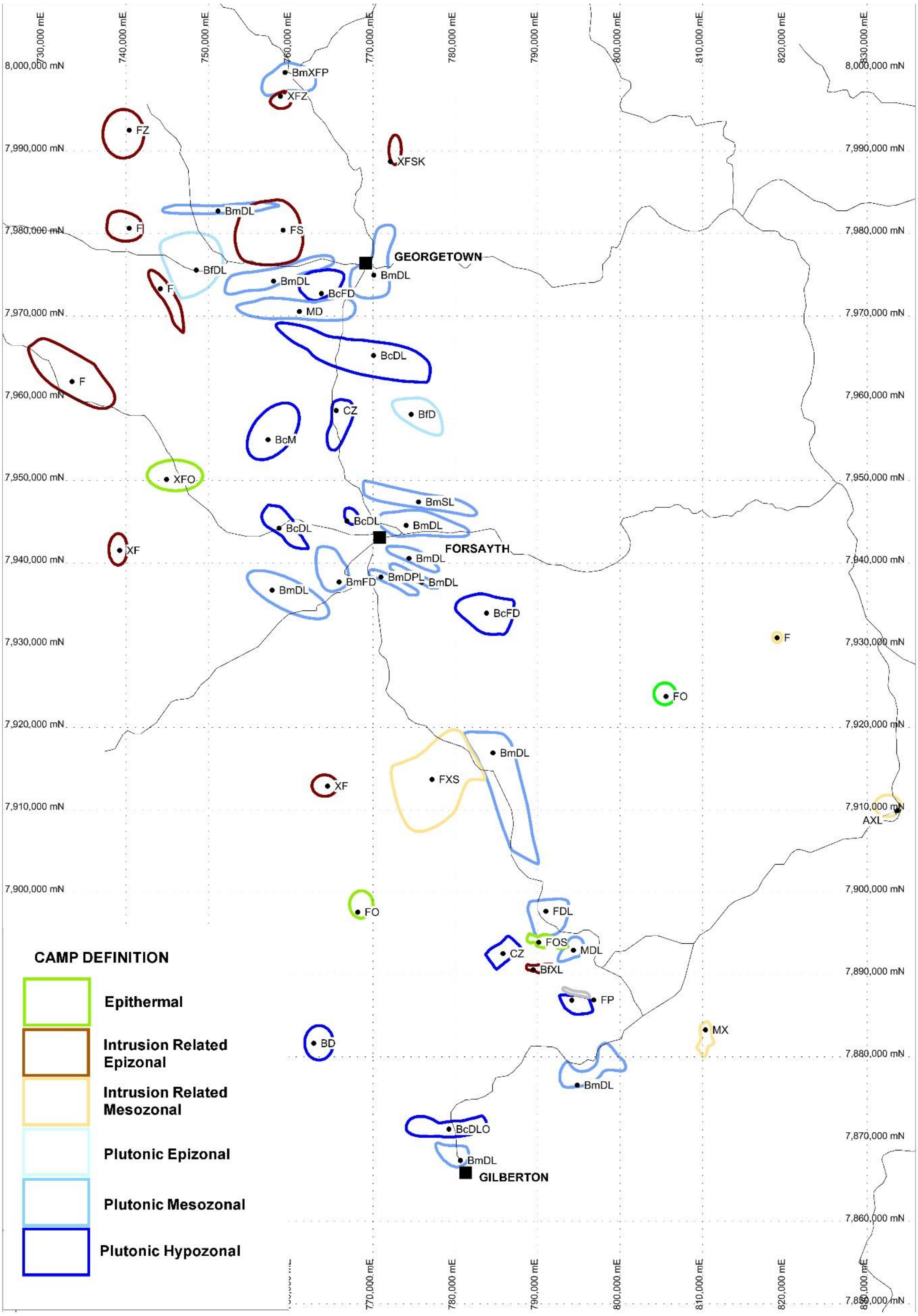

FIGURE 9 : Metallogenic camps coloured by mineralising environment based on quartz texture.

8.0 MULTI-ELEMENT GEOCHEMISTRY

Multi-element geochemical data from 203 prospects in 54 camps for the Georgetown region have been interpreted to classify the hydrothermal systems and to establish internal geochemical zoning patterns for all the main represented classes of hydrothermal deposits.

The data was sourced from the most recent geochemical database for the region held by the GSQ and derived mainly from the compilations by TerraSearch (pre-2014) and Map-to-Mine (2016). This has been augmented with company supplied confidential data from a number of major projects (Agate Creek, Gilberton, Kidston, Woolgar) and from numerous prospects with additional data or a more comprehensive suite of elements. The interpretation of this data is supplied as part of the project, but the raw data is not.

In this project rock chip and drill-hole data have been used in preference to soil and stream data to establish true templates of the hydrothermal systems and zoning models without the complexities of differential transport of elements by surficial processes. Diagnostic metal associations and zoning patterns can be recognised in residual soils and the stream sediments can be useful guides to system location using pathfinder elements. Some of the case histories presented here include interpretation of this data.

While much of the modern data analysed using ICP methods include up to 51 elements that can be used for rock type and alteration classification, the suite used here is for the metallic elements that are commonly concentrated in magmatic-hydrothermal systems. The overall classification scheme is based on a 12-element suite (Au-Ag, As-Sb, Cu-Pb-Zn, Bi-Te, Mo-W-Sn ± Ba, Hg, Mn and Se) that has proven useful for both deposit classification and geochemical zoning. The classification is determined from the relative enrichment of the elements, estimated as the average element concentration in a sample suite divided by the corresponding average concentration values for the dominant host rock (Tables 8.1 and 8.2). The elements are then listed in the order of relative enrichment and tabulated for comparison with the existing general classification scheme for north Queensland (Tables 8.3, 8.4 and 8.5) which tags the major hydrothermal system classes and alteration zones by geochemical association and inferred spatial proximity to a causative intrusion.

8.1 METHODOLOGY OF MULTI-ELEMENT GEOCHEMISTRY INTERPRETATION

The methodology that has been adopted for multi-metal data interpretation is as follows:

- Extract data for the selected 12-16 elements used for system classification and geochemical zonation interpretation from a prospect geochemical database.
- For each element, sort the data and replace the results below detection limit by average crustal abundance for the appropriate host rock type. This is generally granite for Georgetown region.
- Define populations by prospect within the camp and for the camp overall and calculate an average of the raw values for each population.
- Normalise the average for each population by host rock type (e.g., granite) to obtain the relative enrichment of each element for the population (Table 8.1).
- List relative enrichments in orders of magnitude signifying enrichment >**1000** bold; 100-1000 normal and *100-10* in italics.
- Compare with the general metal zoning chart used to define system class (Table 8.5).

Table 8.1: Average crustal abundance of selected metallic elements typical of felsic magmatic-hydrothermal systems (selected from Levinson, 1974)

Element	Earth's crust	Ultra mafic	Basalt	Grano diorite	Granite	Shale	Lime stone	Soil	River water[1]
Ag	0.07	0.06	0.1	0.07	0.04	0.05	1	0.1	0.3
As	1.8	1	2	2	1.5	15	2.5	1-50	2
Au	0.004	0.005	0.004	0.004	0.004	0.004	0.005	-	0.002
Ba	425	2	250	500	600	700	100	100-3000	10
Bi	0.17	0.02	0.15	0.12	0.1	0.18	-	-	-
Cu	55	10	100	30	10	50	15	2-100	7
Hg	0.08	-	0.08	0.08	0.08	0.5	0.05	0.03	0.007
Mn	950	1300	2200	1200	500	850	1100	850	7
Mo	1.5	0.3	1	1	2	3	1	2	1
Pb	12.5	0.1	5	15	20	20	8	2-200	3
Sb	0.2	0.1	0.2	0.2	0.2	1	-	5	1
Se	0.05	-	0.05	-	0.05	0.6	0.08	0.2	0.2
Sn	2	0.5	1	2	3	4	4	10	-
Te	0.001	0.001	0.001	0.001	0.001	0.01	-	-	-
W	1.5	0.5	1	2	2	2	0.5	-	0.03
Zn	70	50	100	60	40	100	25	10-300	20

Working through an example below shows how the interpretations were typically made (Table 8.2):

- The average value for each element analysed (column #2) is divided by background value for the particular lithology involved, in this case granodiorite (column #3). The result is the enrichment factor (column #4).
- The enrichment in this example is: Au Ag Pb Bi As Cu *Te Zn*, where the elements are listed in the order of decreasing enrichment.
- In this example, Au is associated with strongly elevated Ag, Pb, Bi, which indicates a magmatic system with a moderate fractionation (Bi>Te). Strong fractionation would have higher base metals enrichment.
- Bi ± Te rich suggests an intermediate intrusive source, like granodiorite.
- Ag-Pb-As imply a distal zone is being sampled at surface, based on the general zoning model (Table 8.5).
- Overall, this sample suite could represent a relatively mafic magmatic hydrothermal system emplaced at a deep porphyry level. This is consistent with known geology and presence of euhedral buck quartz veins and granitic vein dikes in this occurrence.

Table 8.2: A typical interpretation using the methodology outlined above based on a dataset of rock chip samples where n=238, there is no data for Ba Sn W and all the values are in ppm.

	average	granod	enrich
Ag	8.71	0.04	217
As	102.93	1.5	68
Au	1.97	0.004	491
Ba	0.00	500	0
Bi	17.16	0.1	171
Cu	338.63	10	33
Mo	3.89	2	1
Pb	3504.27	20	175
Sb	2.10	0.2	10
Sn	0.00	2	0
Te	0.09	0.01	8
W	0.00	2	0
Zn	462.66	60	7

Enrichment **Au Ag Pb Bi** (As Cu) ± Te Zn

8.2 INTERPRETATION OF GEORGETOWN MULTI-ELEMENT GEOCHEMICAL DATA

The multi-element data interpretation for 56 systems has been tabulated (Table 8.3) and a classification scheme built on the element class has been established (Table 8.4). The aim was to distinguish the different genetic clans of mineralisation and establish the level of current exposure in the zoned systems.

In the Georgetown region, the main interest is in the geochemical distinction between what have been called Early Devonian granite-hosted plutonic lodes like those in Georgetown and Forsayth districts; the early Carboniferous IRGS like Kidston; the early Permian IRGS systems like Phyllis May; and the early Permian epithermal systems like Agate Creek.

The geochemical classification scheme was built from the enrichment suite by designating some key element ratios (Table 8.4). In the code list the Au/Ag ratio, the Bi/Te ratio and the position of As-Sb versus Pb-Zn-Cu are mainly diagnostic of the system type, whereas the relative position in the enrichment table of As Sb Cu Pb Zn Mo W are indicative of the level (metal zone) in the system.

High Te and Bi are key indicators of magmatic-hydrothermal systems overall and also vary systematically, with Te dominant in mafic systems and Bi dominant in felsic systems. The Bi/Te ratio thus progressively increases going from mafic to felsic intrusion-related systems (Table 8.5). Plutonic and Epithermal systems have much lower or absent Bi and Te so they are mid-range or weak in the enrichment list. As-Sb are more consistently high in the enrichment list than base metals for plutonic and epithermal systems whereas base metals are more prominent in IRGS.

The CHEM classification (Table 8.3) is determined by listing the three dominant elements from the enrichment suite. The level in the system or ZONE (Table 8.3) is labelled using the style of mineralisation (Plutonic = P, IRGS = I, Epithermal = E) and a code representing the important metal ratios from Table 8.4. The CLASS code is a generalisation of the CHEM codes based on Au – Ag ratios and Te-Bi levels (Table 8.3 and 8.4).

Table 8.3: Classification of camps in the Georgetown region based on interpretation of enrichment ratios of hydrothermal metallic elements.

Camp	Prospect	CLASS	ZONE	CHEM	Geochemical Enrichment Signature
Mt Moran	Mt Moran	AM	PZ	AGZ	Au Ag Zn Pb Cu
Woolgar Big Vein	Woolgar Big Vein South	ASM	PS	ASP	**Au** Ag Cd As Pb *Sb Zn Cu Bi W*
Robin Hood West	Robin Hood West	GB	IP	BGP	Bi Ag Pb Te As Cu Au
Bald Mountain	Bald Mountain	GST	IS	GTS	*Ag Te As Bi Se Au Pb*
Huonfels	Huonfels	GST	IS	GTS	Ag Te As Au Sb Pb Cu Bi
Ironhurst	Ironhurst	GST	IS	GST	As Ag Te Pb Sb Bi Au Cu Zn
Log Creek	Log Creek	GST	IS	GSB	Ag Au As Sb Bi Te Pb
Mt Clark	Mt Clark	GST	IS	SBG	As Bi Ag Au *Sb Pb Cu*
Mt Mcdonald	Mt Mcdonald	GST	IS	NGS	Sb Ag As Te Au Zn Bi Cu
Percy Queen	Percy Queen	GST	IS	GTS	**Ag Au** Te Bi As Sb Pb *Cu Se Mo*
Woolgar Epithermals	Woolgar (Lost World)	GST	IN	TNG	Te Bi Sb Ag Au *As*
Agate Creek	Agate Creek	SAT	ES	AST	Au *As Sb Ag Te*
Black Knob	Black Knob	SAT	IS	TSC	**Te As Cu** Ag Sb Au In Bi Se *Hg Mo*
Cumberland	Cumberland Camp	SAT	IS	ASB	**Au As** Bi Ag *Sb Te Pb Zn*
Cumberland	Cumberland Mine	SAT	IS	SGT	**As** Ag Au Te Cu *Sb Pb*
Dairymaid	Dairymaid	SAT	IN	GNT	**Ag** Sb Te As Pb *Zn Au Bi Cu*
Double Z	Double Z	SAT	IC	TAC	**Te Au Ag** Cu Mo *Pb As Se Bi Sb*
Durham	Durham	SAT	PS	SAT	As Au Te Ag Pb Sb Zn
Electric Light	Electric Light	SAT	IS	TAS	**Te Au** As Pb Ag *Sb Bi Cu Zn*
Georgetown	Georgetown	SAT	PP	TAP	Te Au Pb Ag As Zn Sb Bi Cu
Glenrowan	Glenrowan	SAT	PS	SAC	As Au Cu Te Ag Pb Bi Zn
Goldsmiths	Goldsmiths	SAT	PN	TNA	**Te Sb** As Au Mo Bi *Ag Pb*
International	International	SAT	IS	AST	Au Ag As Te Bi Pb Zn Sb Cu
Jubilee Plunger	Jubilee Plunger	SAT	IS	ASB	**Au Ag As** Sb *Pb Bi Te Cu*
Lane Creek	Lane Creek	SAT	PP	ATP	Au Te Ag Pb Sb *Bi As Cu*
Long Gully	Long Gully	SAT	IS	STG	As Sb Te Ag Au Bi Cu W
Monte Cristo	Monte Cristo	SAT	IS	ATS	**Au Te** As Ag Pb Sb *Bi Cu*
New Moon Mosquito	New Moon Mosquito	SAT	PS	ASP	Au Ag As Pb Sb Te Cu Bi Zn
Red Dam	Red Dam	SAT	IS	TSA	**Te As Sb Au** Ag Bi *Cu Pb Sn*
Titania	Titania	SAT	PP	SAT	**Au As** Te Pb *Zn Ag Cu Sb*
Beverley	Beverley	TB	IN	TAN	Te Au Bi Ag Sb *As W*
Big Reef	Big Reef	TB	IP	ATC	**Au Te** Ag *Bi Cu W*
Big Wonder	Big Wonder	TB	IC	TAP	**Te Bi** Au Ag Pb *Cu As Zn Sb*
Carbon Copy	Carbon Copy	TB	IP	TGP	**Te Bi Ag Pb** Cu Se Au Sb *Zn W Mo As Cd Hg*
Christmas Hill	Christmas Hill	TB	IS	AST	Te As Au *Bi Ag Se Sb*
Drummer Hill	Drummer Hill	TB	IS	STA	**As** Te Au Bi Sb Ag *Pb U Zn*
Dry Hash	Dry Hash	TB	IP	PAB	**Pb Au** Ag Bi Te *Cu Sb As Zn*
Evening Star	Evening Star	TB	IP	BWA	**Bi Te** W Au Ag Pb Se Sb *Cd Mo As Cu Hg*
Four Gees	Four Gees	TB	IP	BAP	**Bi Te Au** Ag Pb W Cu *Sb Se Cd As Hg Mo*
Gilberton	Gilberton	TB	IN	TAN	**Te** Au Bi Se Ag *Sb As Pb Hg Cd*
Greenhills	Greenhills	TB	IP	TAP	**Te** Au Bi Pb U Ag *As Sb Cu*
Havelock	Havelock	TB	IC	BAC	Bi Au Te Ag Cu Pb Sb W
Kidston	Kidston	TB	IP	BAP	**Au Bi Te** Ag Pb Zn Cu As Mo W F
Long Lode	Long Lode	TB	IP	TAP	**Te** Au Bi Pb Ag Cu *Se Sb As Cd*
Marquis	Marquis	TB	IS	ATS	**Au Te** Ag Bi As *Pb Cu*
Mountain Maid	Mountain Maid	TB	IC	TAC	**Te Bi Au** Ag Cu As Pb Sb *Cd Se Mo Zn*
Mountain Maid	Mountain Maid (HWB)	TB	IS	BGS	**Bi Te Ag As** Sb Pb Au Cd Cu *Se Mo Zn U W*
Mt Borium	Mt Borium	TB	IS	TSP	**Te** Au Ag Bi *As Pb Mo Sb*
Mt Hogan	Mt Hogan	TB	IP	TAP	**Te Au Bi** Ag *Pb Sb Se As Cu Cd*
Mt Turner	Mt Turner	TB	IS	TSA	**Te As** Bi Au Ag Sb *Pb Zn Cu*
Percyville	Percyville	TB	IC	ATC	**Au Te Ag** Bi Cu Sb Cd *As Pb Se W*
Phyllis May	Phyllis May	TB	IC	TCN	Te Bi Cu Sb As Ag Au Mo
Queenslander	Queenslander	TB	PP	ATP	Au Te Ag Pb As Bi Cu Zn
The Drum	The Drum	TB	IP	ATP	Au Te Ag Pb Bi Cu Sb Zn
Western Creek	Western Creek	TB	IS	TAS	Te Au Ag Bi U As Pb

Table 8.4: Code set of element ratios used in the classification scheme and CHEM code groups sorted into CLASS.

CODE	ZONE/RATIO
A	Au> Ag
B	Bi>Te or Bi only
C	Cu dominant base metal
G	Ag>Au
I	Intrusion -Related
L	base metals Pb Zn Cu
N	Sb>As
O	Mo >W
P	Pb dominant base metal
R	Te-Bi minor (orogenic?)
S	As>Sb
T	Te>Bi or Te only
W	W>Mo
Z	Zn dominant base metal

Au>Ag, As, Te	**Bi-Te rich**	**Ag>Au**
SAT	**TB**	**GST**
AST	BAC	GSB
ATP	BAP	GST
ASP	BAS	GTS
ATS	BGS	SBG
	BWA	
SAC	PAB	**GB**
SAT		BGP
STA	ATC	GNT
STG	ATP	
SGT	ATS	**GM**
		NGP
TAC	TAB	NGS
TAP	TAC	
TAS	TAN	
TNA	TAP	
TSA	TAS	
TSC	TCN	
	TGP	
ASM	TSA	
ASB	TSP	

The CLASS scheme has three main groups and a minor group that represent fundamentally different genetic systems of mineralisation (Figure 10):

- The TB group has Te and Bi as the dominant elements in the enrichment suite more or less independent of what else is in the enrichment suite and independent of Te/Bi ratio. This is the predominant group in the Georgetown region and covers the majority of IRGS, many of the plutonic camps and even some of the epithermal deposits (Table 8.3). The Te-Bi class is generally interpreted as of magmatic origin and is typical of IRGS elsewhere in north Queensland (Morrison 2014, Morrison et al 2016). ***The implication for Georgetown is that not only the IRGS, but the epithermal deposits and most of the plutonic deposits that don't have mappable related intrusions still have a magmatic fluid contribution.***
- The SAT group has Au>Ag, As-Sb prominent and Te prominent but without Bi. This is a common group in Georgetown region and represents the distal parts of some of the IRGS and plutonic deposits. The Au-As-(Te) association is generally interpreted as typical of epithermal and orogenic gold deposits especially where the Te is relatively subdued (e.g. Hodgkinson Province deposits-Morrison & Lisitsin, 2017). ***The implication for Georgetown is that there is no ready distinction between IRGS plutonic and possible orogenic deposits based on the geochemical model alone.***
- The GST group has Ag>Au; As-Sb prominent and Te-Bi universally present but not prominent. This chemistry uniquely represents the group of Permian Intrusion-Related Deposits in the area NW-W & SW of Georgetown. This group is not generally recognised elsewhere but its characteristics fit Intrusion-Related Mineral Systems with Ag dominant over gold.
- The ASM group has Au>Ag, prominent base metals (Pb, Zn, Cu) and common As-Sb without Bi, Te. This is typical of pluton-hosted orogenic deposits such as Charters Towers.

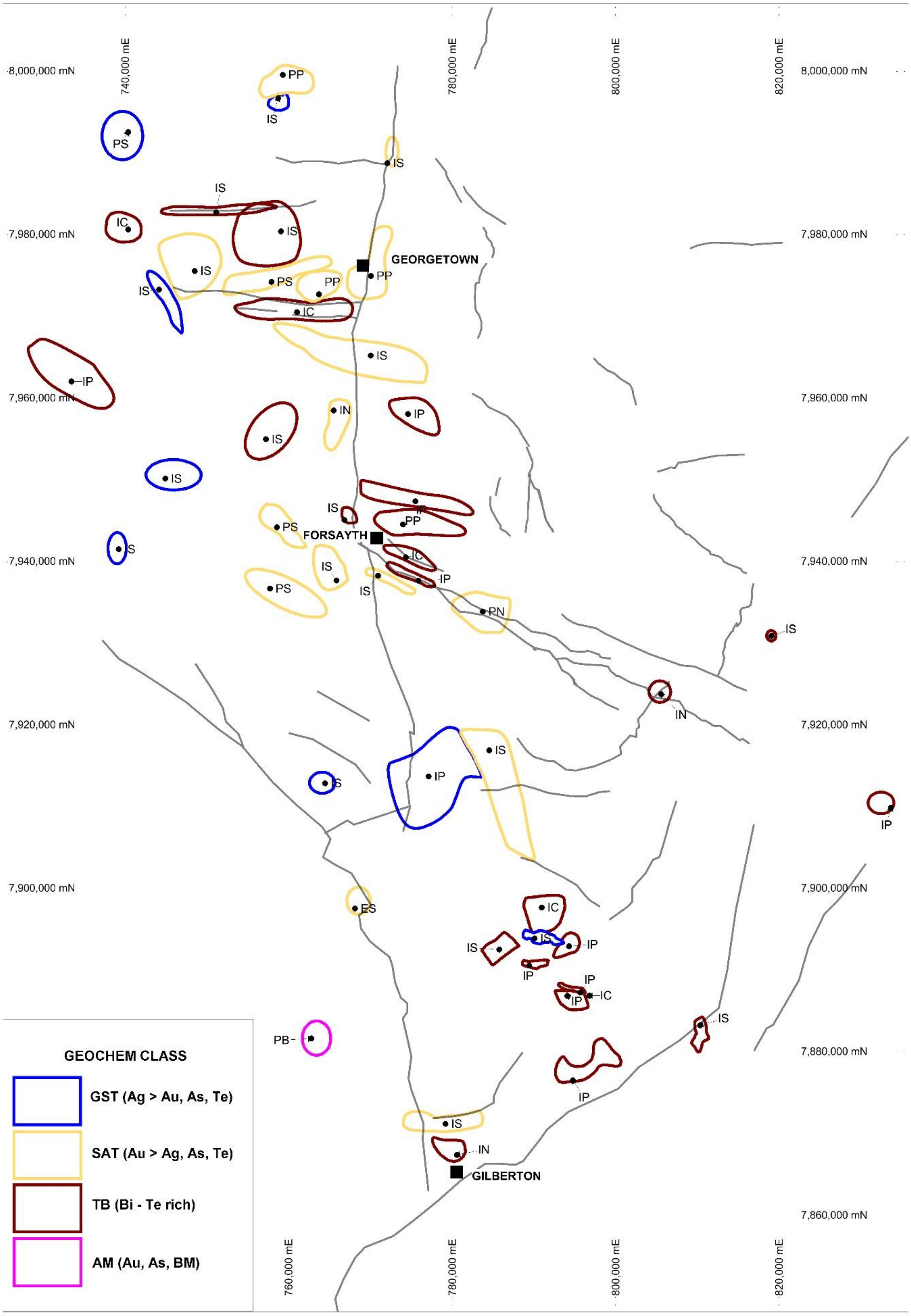

Figure 10 : Camps coloured by Geochemical Class labelled with the metal zone for each camp.

The classes within the IRGS clan relate to level of emplacement and/or the composition of the related intrusion, so there is a distinction of Bi-rich felsic intrusive systems from Te-rich mafic intrusive systems, and those more enriched in As-Sb compared with base metals in the plutonic IRGS group (Table 8.5).

8.3 GEOCHEMICAL ZONATION PATTERNS

The geochemical zoning template (Table 8.5) was constructed during a major project on eastern Australia Intrusion-Related Mineral Systems (IRMS) undertaken by Gregg Morrison and Phil Blevin in 1994-1997 as AMIRA Project P425. The template identifies variations in metal zoning patterns for IRMS emplaced mainly at the porphyry level and related to intrusions of different magmatic geochemistry and evolution. It is based on more than one hundred examples from north Queensland which were then compared with international examples considered typical of the magma chemistry spectrum. A feature of Table 8.5 is the consistent overall pattern of metal zones that allows the classification to include five standard metal zones that can be used in place of the local metal suite. The table also allows the subtle differences between system types to be identified with key elements and element assemblages. For example, the position of maximum gold concentration in relation to a causative intrusion varies systematically from nearest to the intrusion (the core) in mafic systems to progressively more distal in felsic systems. This is shown by the shading in Table 8.5 and illustrated by Figure 11. In addition, Bi and Te that are demonstrated consistently as key indicators of magmatic-hydrothermal systems also vary systematically, with Te dominant in mafic systems and Bi dominant in felsic systems. The Bi/Te ratio thus progressively increases going from mafic to felsic systems.

Table 8.5: Zoning models for porphyry-level magmatic hydrothermal systems in north Queensland and their relationships to the spectrum of magma types (Morrison & Blevin, 1997).

CLASSIFICATION AND ZONING PATTERNS FOR PORPHYRY RELATED HYDROTHERMAL SYSTEMS						
METAL ASSOCIATION CLASSIFICATION	Au	Cu-Au	Cu-Mo	Mo-W-Bi	Sn-W	Sn-B
Example Eastern Australia	Fifield	Goonumbla	Mount Leyshon	Kidston	Herberton	Cooktown
Example World	Marciunga Chile	British Columbia	Bingham	Climax	Erzgebirge	NE Tasmania
IGNEOUS CHARACTERISTICS						
CHEMICALTYPE; FRACTIONATION; REDOX	M, U-F, O	M, U-F, SO-O	I, U-F, O	I, F, O-R	I, F, R	S, F, R
IGNEOUS ROCK TYPE ON QAP	DI-QD-TN	DI-MZD-MZ-QMZ	DI-GD-MZG	QMZ-MZG-SYG	MZG-SYG-AFG	SYG-QSY-ASY
METAL ZONING						
MARGINAL	Hg, S	Ca	Ca	F U	F Ba Se Hg U	F
DISTAL (As)	As (Au)	Au As Sb	(As Sb Au)	(As Ag Sb Au)	As (Au)	As
DISTAL (BM)	Pb Zn Ag Sb (Au)	Pb Zn Ag Au (Cu Mo Te)	Pb Zn Ag (Au Bi)	Zn Cu Pb Bi Au	Pb Ag Zn	An Pb Ag
PROXIMAL (BM)	Au Cu Mo (Ag As)	Cu (Zn)	Cu Au Ag (Bi Te)	Cu (Au Bi Te)	Cu Mo Bi	Cu Bi Mo (W)
CORE	Au Te (Pt)	Cu Au (Te)	Cu Mo	W Mo Bi	Sn W	Sn B (W)

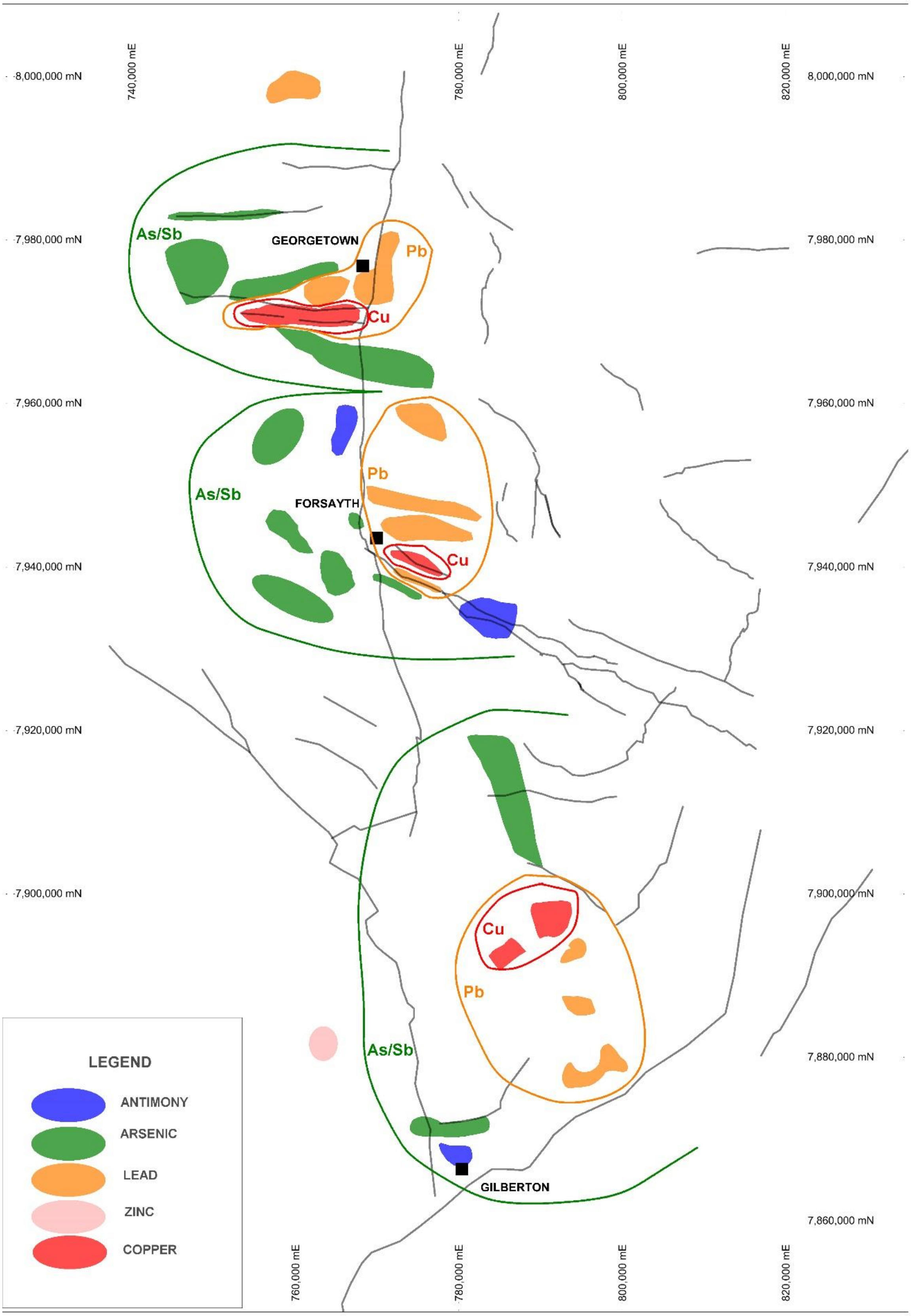

FIGURE 11 : Map showing Georgetown metallogenic camps coloured by most enriched base metal including arsenic and antimony. Note copper rich cores enveloped by lead and a peripheral arsenic and antimony zone. Gold occurs throughout all camps but is more often found associated with lead.

In the Georgetown region, the majority of IRMS fall in one of three groups characterised by Cu-Au, Cu-Mo or Mo-W-Bi metal association in the core element zone (Table 8.3). However, almost all of them have been targeted for gold, rather than base metals as the economic commodity, so they fall into the more specific category of intrusion related gold systems (IRGS). This makes the zoning models valuable because the Au-rich part of the systems may not be exposed at surface, which, if misunderstood could have discouraged historical gold exploration. As a consequence, our metallogenic work has targeted identification of IRMS systems and the geochemical data search has tried to classify and develop zoning models for these systems, so they can be ranked in terms of likely position of the best gold in relation to current surface exposures.

9.0 DEPOSIT MODELS

Examples of the different deposit styles encountered in the Georgetown region are described, focussing on the nature of the quartz textures, geochemical signature of the mineralisation and the temporal and spatial relationship with any nearby intrusives.

9.1 MOUNT HOGAN FLAT PLUTONIC LODE

The Mount Hogan gold-base metal-uranium deposit is the largest historical gold producer in the Gilberton district at 2530 kg. The deposit is located 18kms northeast of Gilberton and is hosted in the Proterozoic age Mount Hogan Granite (Figures 1 & 6). The granite pluton is an irregular horseshoe shape in outcrop, 7kms in diameter and has intruded Proterozoic rocks of the Robertson River Subgroup (Figure 12). The granite is composed of grey (fresh) to pink (altered), medium to coarse grained, equigranular, sparsely porphyritic, biotite adamellite. Northern outcrops of the granite appear to be a less fractionated (more mafic) phase of the intrusion. Permo-Carboniferous rhyolite and andesite dykes have been mapped immediately north of the Mount Hogan gold deposit (O'Rourke & Bennel, 1977). Drilling at Mt Hogan suggests the southern contact between granite and the surrounding metasediment is near vertical.

Gold mineralisation is concentrated around the south-eastern margin of the Mt Hogan Granite and consists of a set of stacked, shallow, southwest dipping (15-20˚) quartz - sulphide veins. The veins are composed of medium grained, euhedral buck quartz crystals that have been brecciated and recrystallised by later movement of the veins structures. Cores of the veins are often filled with sulphide (Plate 18). The lenticular veins are enveloped by an alteration halo of sericite (proximal), chlorite and epidote (distal) and appear to have developed in tensional openings produced by north-easterly thrusting. Continued movement along structures after vein formation has deformed and folded some veins (Plates 19 and 20). Individual veins reach up to 60cm in thickness but are generally thinner (10 – 20cm).

The alteration and by inference the quartz veins and shear zone are Devonian age (~400 Ma), based on K-Ar radiometric dating on sericite. The nature of the mineralisation and host structures indicates the deposit is plutonic meso-hypozonal in style, the high bismuth and tellurium values point to the mineralising fluids having an intrusive source component however there is no clear genetic link to Permo-Carboniferous age rhyolite and basalt dikes in the general area.

O'Rourke and Bennell (1977) suggested there is primary uranium mineralisation as uraninite associated with the sericite alteration and the gold-base metal sulphide bearing quartz veins and in the fluorite veins that cut the rhyolite and basalt dikes. Secondary uranium, mainly torbernite is dispersed in the alteration zones and host rocks over a wide area at surface. The Horseshoe Hill uranium occurrence is in quartz stockwork and fractures in the Mt Hogan Granite. Drilling by Bondi Mining (Newcrest JV) in 2008, returned a best intercept of 7m @ 0.38% U_3O_8 (drill hole 79HHPDH1) with a metal enrichment of U Sb As Zn Ag Mo W (Pb Cu). The implication is the same as at Mt Hogan Mine with the primary uranium mineralisation being part of the gold event.

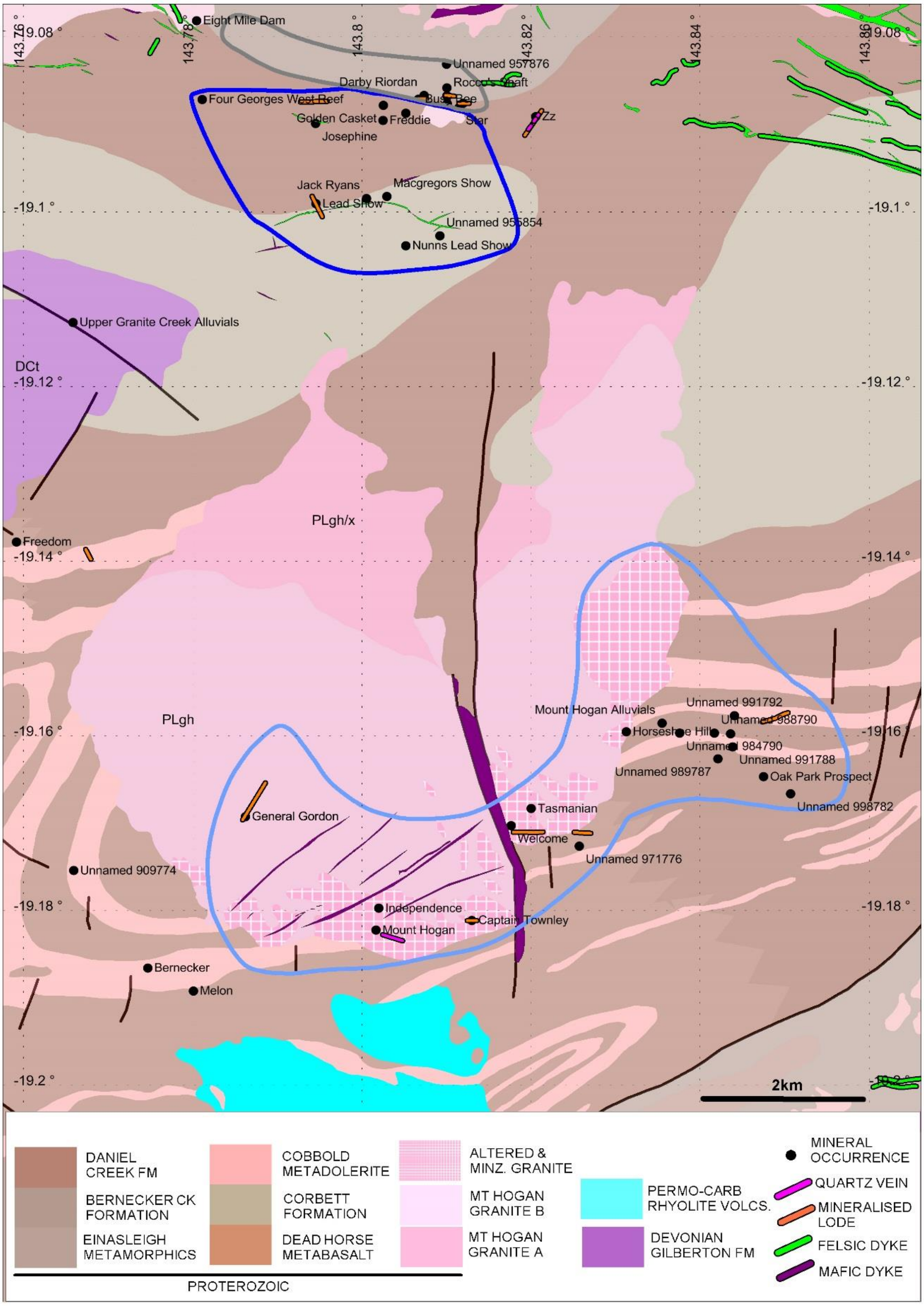

FIGURE 12 : Mount Hogan geology showing horseshoe shaped Proterozoic age granite with early more mafic phase to north and more fractionated phase in south. This figure shows the distribution of shallow dipping, auriferous sheeted vein sets localised around the south-eastern margin of the Mt Hogan Granite.

PLATE 18 : Photo of typical high grade Mount Hogan vein ore. Recrystallised and brecciated coarse comb quartz with infill of chlorite, pyrite, pyrrhotite & chalcopyrite. Sample 231331; 336 g/t Au, 498 g/t Ag, 1.315% Cu, 876 g/t Bi, with anomalous Pb and As.

PLATE 19: Photo of mineralised quartz vein in north wall of the main Mount Hogan open cut. Shows shallow plunge of structure, sense of movement of thrust forming the lode of sheared and brecciated granite and opening up tension gashes filled with quartz and sulphides.

PLATE 20 : Close up photo of Mount Hogan high grade quartz vein exposed in Mount Hogan open cut. Photo shows recrystallised euhedral, buck quartz vein containing sulphide tension veins and quartz - sericite alteration selvage, typical of the gold bearing veins found at Mount Hogan.

The style of mineralisation as stacked/en echelon quartz veins with prominent sericitic alteration envelopes in a 70m thick zone of partly mylonitic granite and quartz is typical of occurrences such as the Josephine mine and Mountain Maid prospect (Percyvale), Jubilee Plunger (Robin Hood), Marquis near Forsayth, Mt Clark and many occurrences at Croydon. The partly mylonitic form of the host structure implies meso-hypozonal conditions and is consistent with the quartz character and comparison with Devonian orogenic deposits in the province. Mt Hogan alteration has been dated at 400 Ma at the mine and at 398 Ma at the General Gordon vein deposit so this is internally consistent. The multi-element geochemical signature of prospects in the Mt Hogan camp is Te Au Ag Bi Pb and this is consistent across the gold prospects in the camp and similar to numerous camps along the eastern margin of the Etheridge-Gilberton fields such as Percyvale, Goldsmiths, Queenslander and Lighthouse.

9.2 PLUTONIC LODE DEPOSITS

The Forsayth and Georgetown districts are well known for their lode or quartz reef style gold deposits. The deposits lie along steeply dipping well defined regional scale faults or their subsidiary structures hosted in Proterozoic granite and metasediment (Figures 6 and 9). A greater proportion of deposits are hosted in granite which appears to deform in a more brittle manner and develop much more open space for mineral deposition compared to the metamorphic rocks where fault movement tends to be absorbed through ductile deformation. Structures like the WNW striking Big Reef – Goldsmiths Fault, Black Jack line of workings and Havelock Fault which lie south of Forsayth and the east-west striking Drummer Hill, Big Wonder and Golden Bar Faults near Georgetown range from 5 to 25 kilometres in length. All these structures are mineralised intermittently along their entire length.

The multiple phases of shearing, brecciation and quartz ± sulphide mineralisation along the faults attest to the long history of movement and annealing along these structures. Zones of weakly mineralised sheared rock or lodes typically occur at regular intervals along the structures. Within the lodes, narrower (<2m) shoots of higher grade quartz ± sulphides have been targeted by the historical miners. In some deposits the shoots are well defined and have not been disrupted too much by later movement along the controlling structure, allowing miners to follow the shoots continuously for hundreds of metres underground e.g. International and Big Reef (Figure 13). However, in some deposits mineralised shoots have been brecciated by later movement along the faults diluting the high-grade material with lower grade wall rocks.

Most of the lode style gold occurrences in the Georgetown and Forsayth districts contain tightly packed, coarse to medium grained, buck quartz typical of Plutonic hypozonal or mesozonal deposits. However, many deposits show multiple events of brecciation and cementation and replacement by silica and sulphides and it is often the later, finer grained (higher level?) phases that are gold bearing (Plates 4, 10 and 15).

Inspection of numerous deposits in the field has shown that like the preferred granite host, early quartz reef development and silicification along the structures has provided extra preparation of the rocks providing potential for more sites of brittle deformation and formation of open space. Later phases of mineralisation in the lodes and shoots can be subtle. Outcropping, buck quartz reefs can be quickly passed off as barren but when smooth wet surfaces, preferably cut with a rock saw, are closely inspected, late stage, fine grained phases of often clear coloured quartz and sulphides can often be found (Plate 21).

Examination of the trace element geochemistry for the Plutonic style lode deposits shows that the occurrences in the cores of the districts are enriched in bismuth and tellurium whereas the peripheral deposits tend to be more silver and arsenic dominant (Figures 10-11). This zonation, observed at both Georgetown and Forsayth suggests the centre of the districts maybe closer to a magmatic fluid source and the peripheral deposits more distal.

PLATE 21 : Photograph of sample of ore from Hawkins Hill, Durham Camp, Georgetown. Insert shows rough, coarsely crystalline, buck quartz with little textural variation on fresh rock sample compared to the same specimen cut with a diamond saw producing a polished face revealing a complex, multi-phase history of quartz and sulphide development along fractures and in veins.

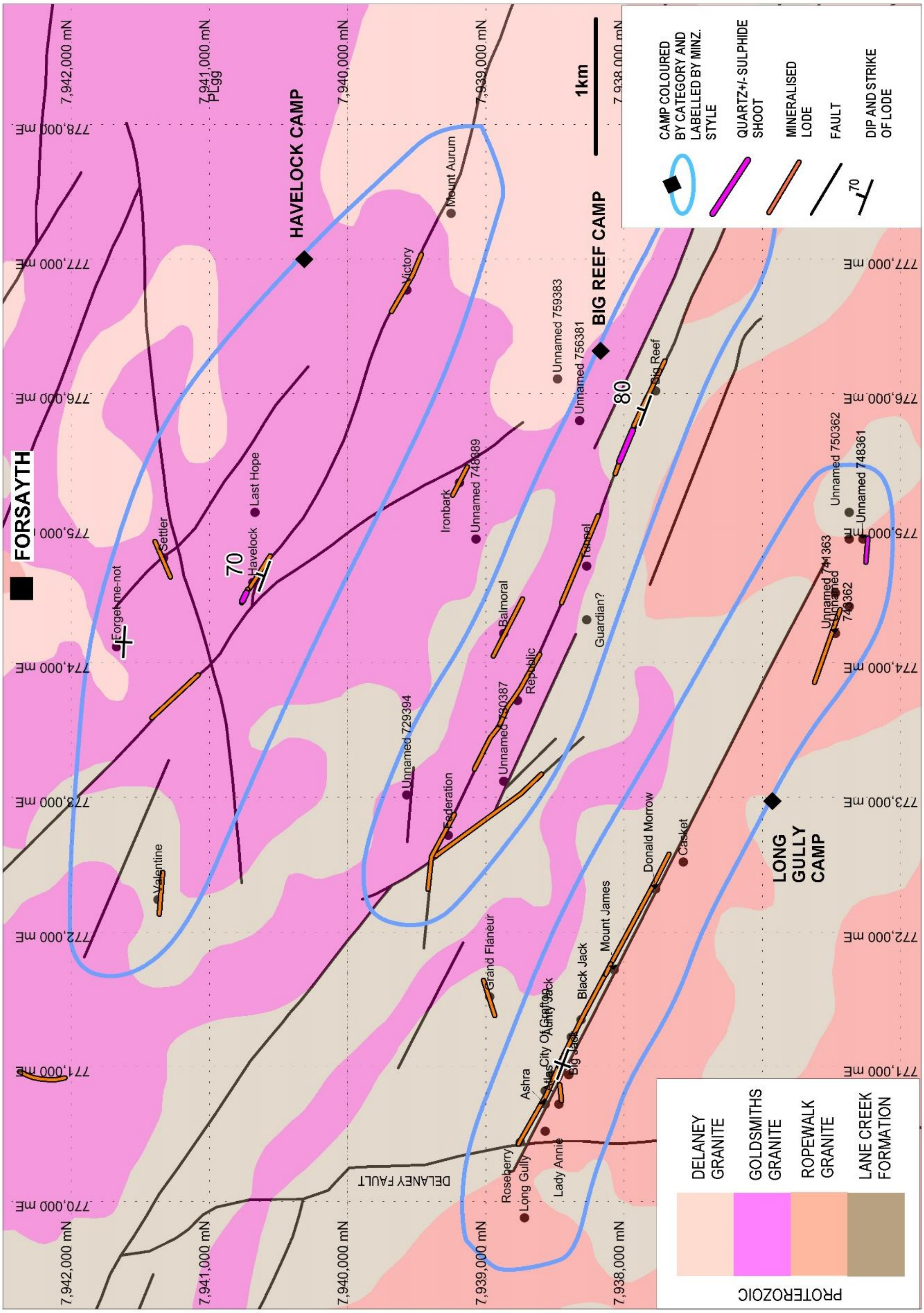

Figure 13 : Map of major Devonian Plutonic Lode style camps near Forsayth. Shows major northwest trending structures that host mineralised lodes at intervals along their length. In places higher grade quartz-sulphide shoots are present within the lodes.

9.3 GILBERTON DISTRICT

Basement rocks in the Gilberton District consist of variably deformed Proterozoic age metasediment of the Bernecker Creek, Daniel Creek and Corbett Formations and basic metavolcanics of the Dead Horse Metabasalt Member (Etheridge Group) (Figures 4 and 6). The sedimentary units are composed of mudstone, siltstone and sandstone grading into slate, phyllite, schist and gneiss. Numerous, extensive sills and dykes of Proterozoic age metadolerite and metagabbro (Cobbold Metadolerite) often 10's to 100's metres thick, have intruded the metasedimentary units. The regional scale NE striking Gilberton Fault marks the southeastern boundary of rocks of the Etheridge Group against amphibolite grade biotite gneiss of the Early Proterozoic Einasleigh Metamorphics (Figures 14-15).

Northeast of Gilberton in the Mount Hogan and Percyvale areas mid-late Proterozoic granite (Mt Hogan & Digger Creek granite) and Siluro-Devonian granodiorite (Robin Hood Granodiorite) batholiths have intruded the basement rocks. Throughout the district, irregular dykes and stocks of ENE trending Permo-Carboniferous age rhyolite intrude the Proterozoic and Devonian rock units (Figure 16).

Mineralisation in the Gilberton and Black Knob camps typically consist of gold bearing quartz veins and silicified breccia, with minor disseminated pyrite in the quartz, hosted along single or sets of narrow (<2m) steeply dipping shears. The mineralised shears generally parallel the regional foliation but in some deposits cut oblique to the layering e.g. Commissioner Hill and Oratava (Figure 14). Comstock, the largest of the known gold deposits at Gilberton, consists of a broad, linear, northeast striking, steep northwest dipping zone of breccia, cemented and replaced by buck quartz, iron carbonate, magnetite and pyrite. Deposits partially hosted in metadolerite commonly possess iron carbonate (siderite?) as part of the infill and alteration products e.g. Comstock, Caledonia, Macedonia (Plates 22-23).

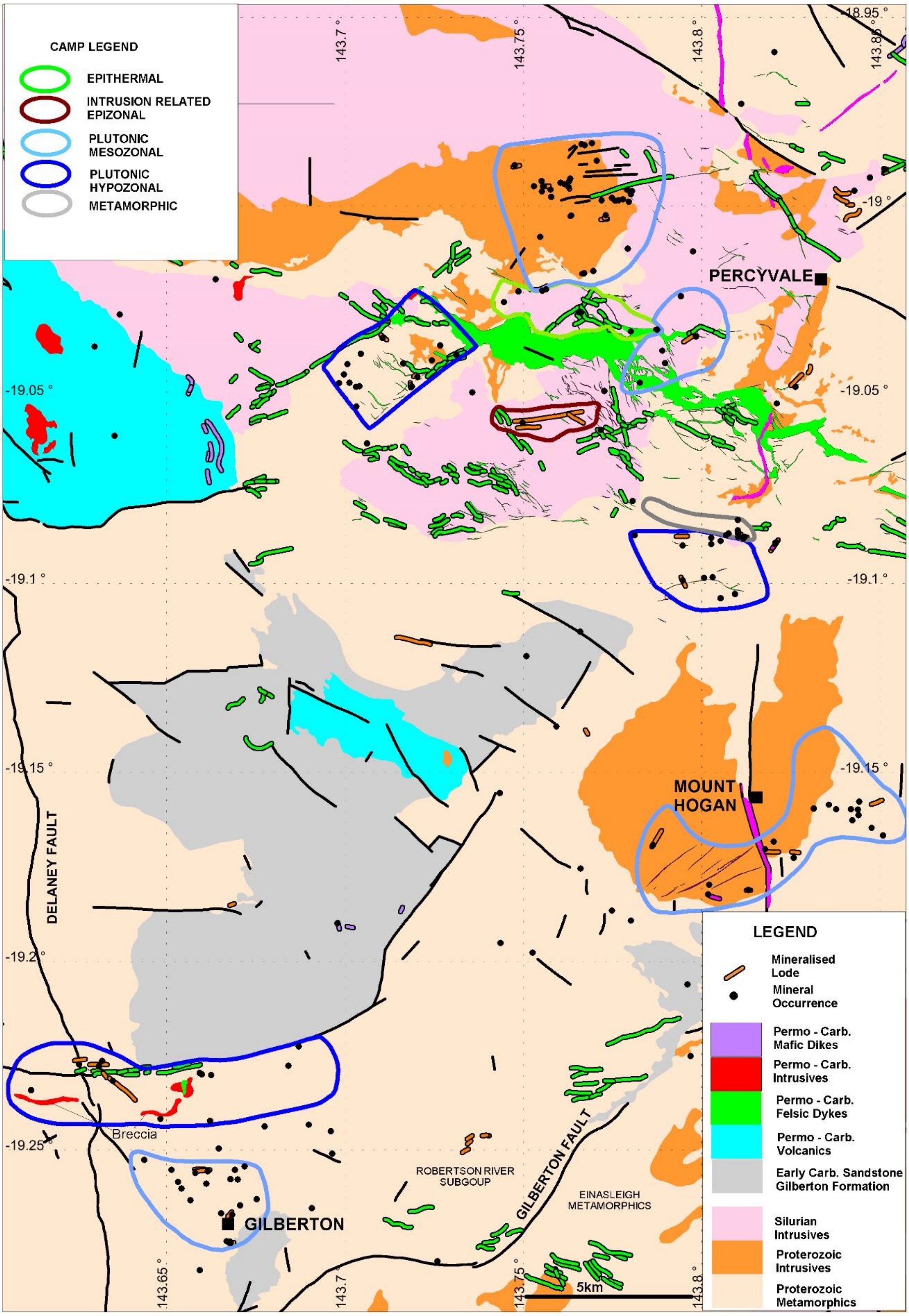

FIGURE 14 : Gilberton District simplified geology showing metallogenic camps, mineral occurrences and major structures.

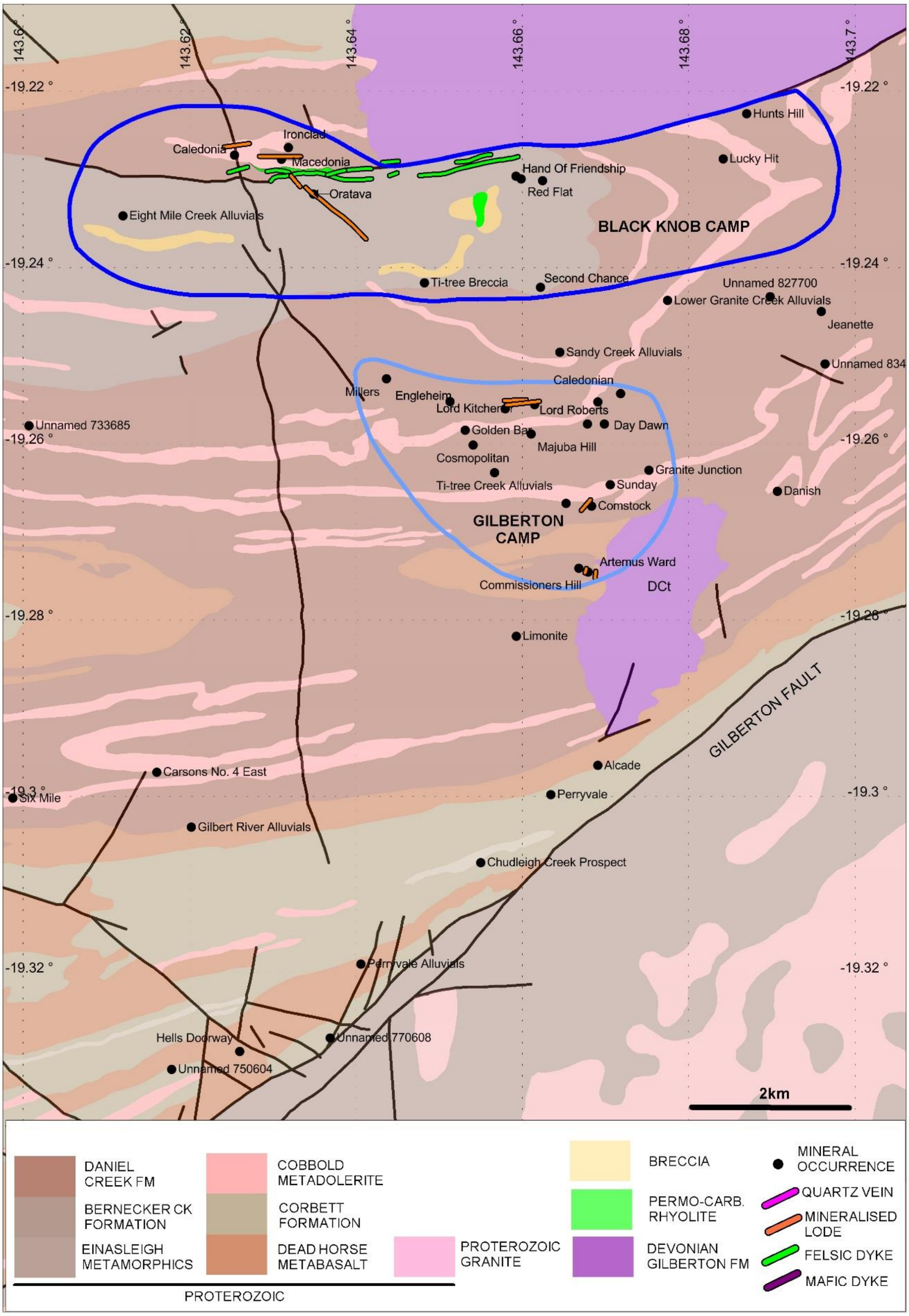

Figure 15 : Gilberton and Black Knob Camps geology. Shows location of the mineral occurrences and orientation of major lodes and location of regional scale faults.

Quartz textures in the mineralised structures often reflect multiple episodes of fault movement. Early quartz phases are typically medium grained, white euhedral buck that have been brecciated and recrystallised with finer quartz and sulphide cross-cutting, infilling and/or replacing more fractured portions of the early vein material (Plate 24). At the Caledonia prospect early white, euhedral buck quartz has been brecciated and cemented by colloform-banded and moss textured quartz and siderite (Plate 23). This indicates that the early plutonic style mineralisation has been overprinted by an epithermal event that could be related to the Permo-Carboniferous age rhyolite dyke that parallels the Macedonia lode, 100m to the south (Figure 15). Early phases of coarse and medium euhedral quartz crystals were observed at the Lord Kitchener and Caledonia workings (Plate 25).

In the northern camps of the Gilberton district, two main styles of veining were observed: (i) south to southwest shallow dipping, coarse to medium grained, euhedral buck quartz sometimes cut by finer comb quartz, often lightly brecciated and infilled with sulphide minerals such as pyrite, chalcopyrite, galena, and minor sphalerite (e.g., Mt Hogan, Josephine, Homeward Bound, Mountain Maid), and (ii): E-W trending, steeply dipping sericite-altered and variably silicified rhyolite breccias overprinted by thin (1-3mm) quartz stockwork veins composed of fine comb quartz and ultrafine sulphides (e.g., Percy Queen, Percy West, ZZ) (Plates 17, 26, 27 & 28) (Figure 16). Textural characteristics of the euhedral buck quartz suggest a hypozonal to mesozonal plutonic environment whereas the quartz textures in the rhyolite breccia and stockwork indicate an intrusive epizonal environment of formation.

Geochemical sampling throughout the Gilberton district, including the Mount Hogan and Percyvale areas identified geochemical zonation at the camp and deposit scale. Extensive multi-element assaying by Activex Ltd (2015 – 2017) has identified distinctive signatures (Figure 17). Most samples collected from known mineral occurrences are enriched in tellurium and bismuth indicating a magmatic input to the mineralising solutions. The Devonian age plutonic style, mesozonal to hypozonal deposits are typically enriched in copper and lead whereas Permian age epizonal IRGS deposits have a characteristic arsenic- antimony signature. Understanding these geochemical variations is important when designing exploration programmes that target specific styles or ages of mineralisation and interpretation of results.

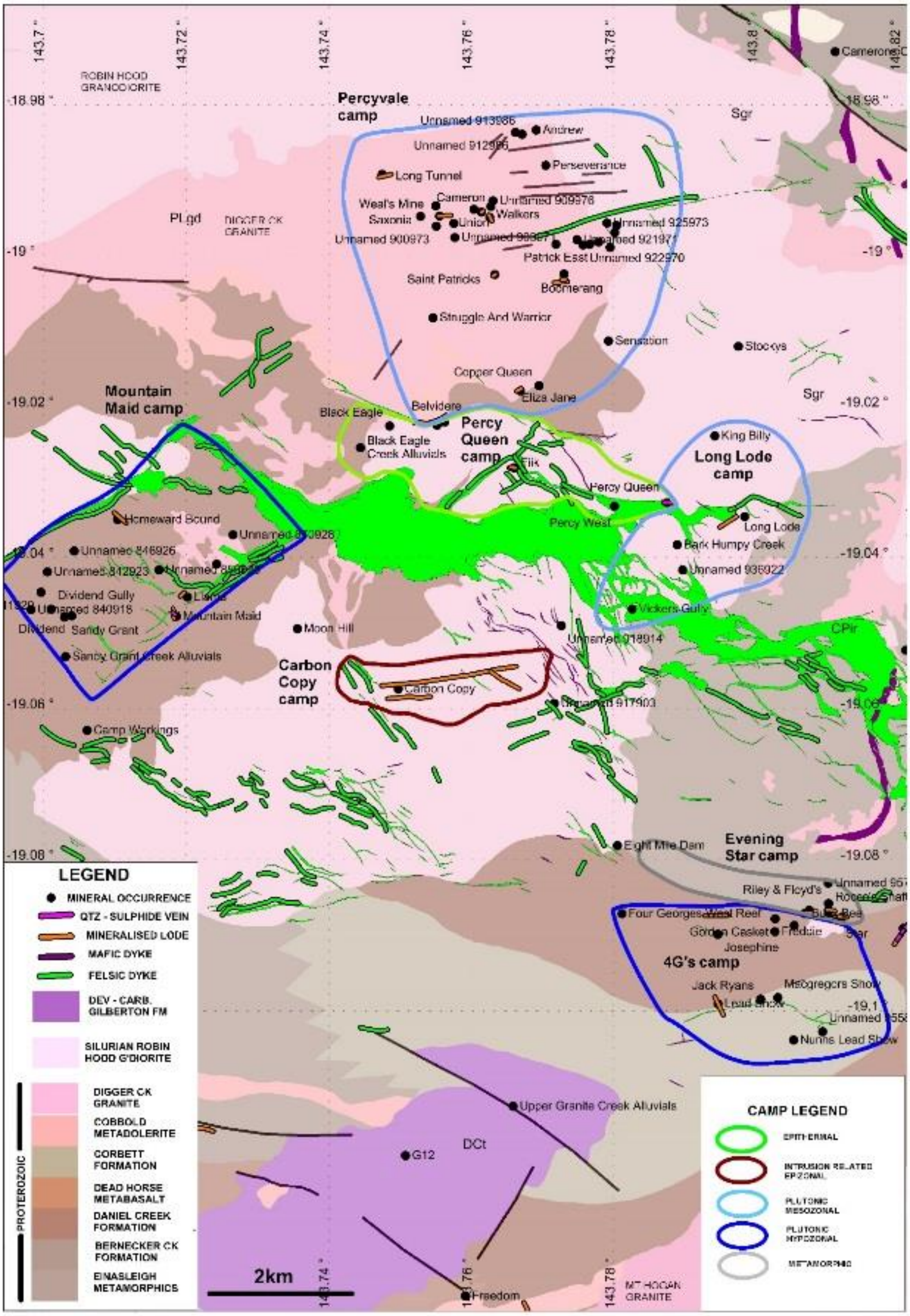

Figure 16 : Geology of the Percyvale area showing camps and mineral occurrences. Note the abundant westerly trending swarm of mainly Permo-Carboniferous rhyolite dykes passing through the centre of the metallogenic camps.

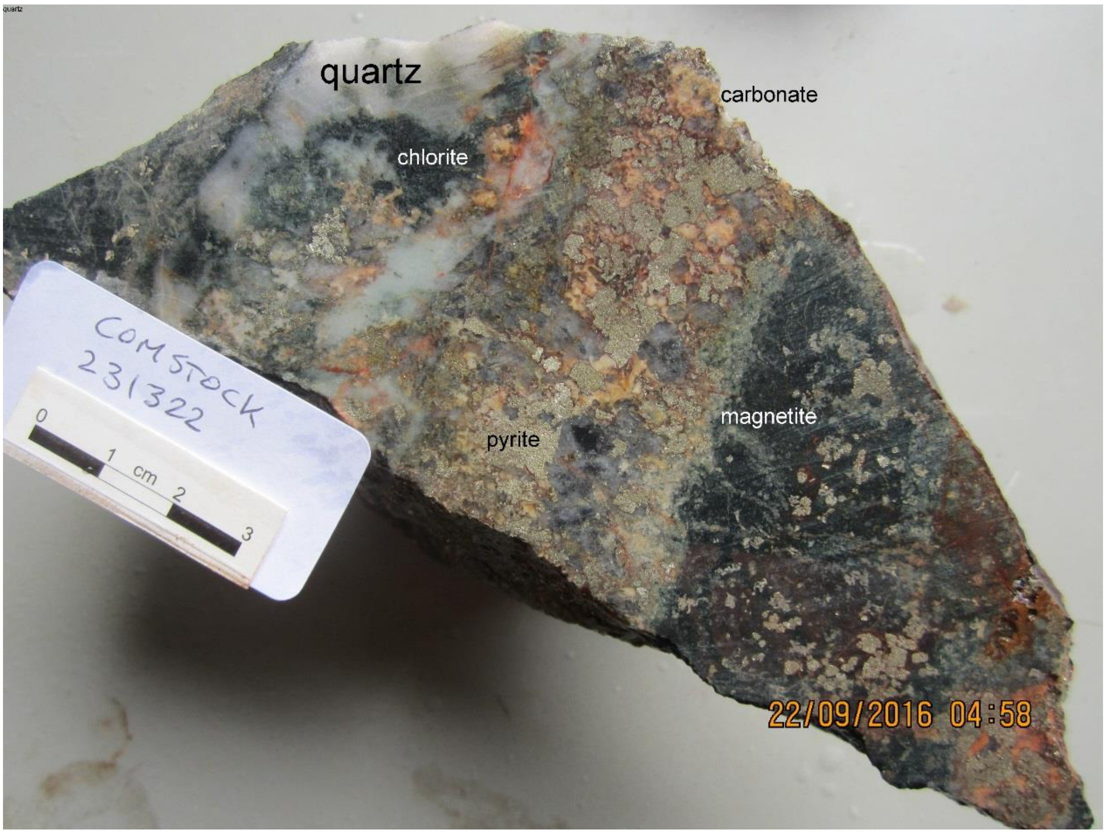

PLATE 22 : Comstock gold mine ore. Brecciated metadolerite cemented and replaced by quartz, iron carbonate, chlorite, pyrite and magnetite (5.67 g/t Au, 2.67 g/t Ag).

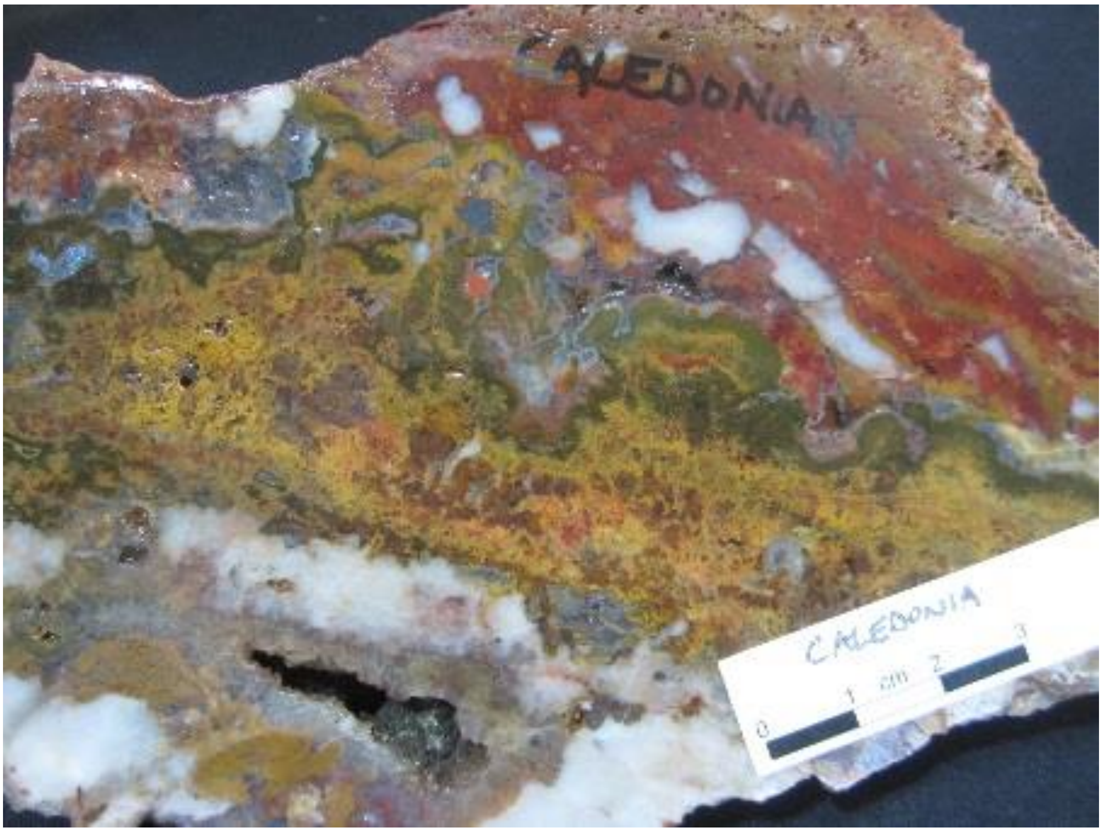

PLATE 23: Sample from the Caledonia workings, Gilberton. Shows brecciated early, white, tightly packed, euhedral buck quartz (Plutonic style) cemented by clear, comb textured quartz, colloform banded and in places moss textured chalcedonic silica and siderite (Epithermal style).

PLATE 24: Gold ore from Commissioners Hill. Brecciated early white medium grained buck quartz, recrystallised, replaced and cemented by finer grey quartz and pyrite. Gold mineralisation is related to the late phase of quartz and sulphides. Sample 231323; 2.67 g/t Au, 8.11 g/t Ag.

PLATE 25: Specimen from Caledonia Workings, Gilberton, showing early phase of large quartz crystals growing into Vugs. Vugs were filled with siderite now removed by weathering.

PLATE 26 : Sample from the Josephine gold mine, Four Gees Camp, Percyvale area. Euhedral buck quartz, fractured, brecciated, recrystallised and cemented by pyrite and chalcopyrite (Sample 231317, 48.7 g/t Au, 825 g/t Ag, 4.27% Cu, 1260 g/t Bi).

PLATE 27 : Sample from Homeward Bound gold mine, Mountain Maid Camp, Percyvale area. White, medium grained, tightly packed, euhedral buck quartz, cut by stylolites and weakly brecciated and infilled by iron carbonate, pyrite, chalcopyrite and galena (Sample #231305, 3.02 g/t Au, 78.9 g/t Ag, 126 g/t Bi).

PLATE 28 : Outcrop photo from Percy Queen mine, Four Gees Camp, Percyvale area. Rhyolite dyke cut by quartz stockwork and vuggy breccia with clasts rimmed by fine-grained comb textured quartz (Sample #231307; 11.3g/t Au, 151 g/t Ag).

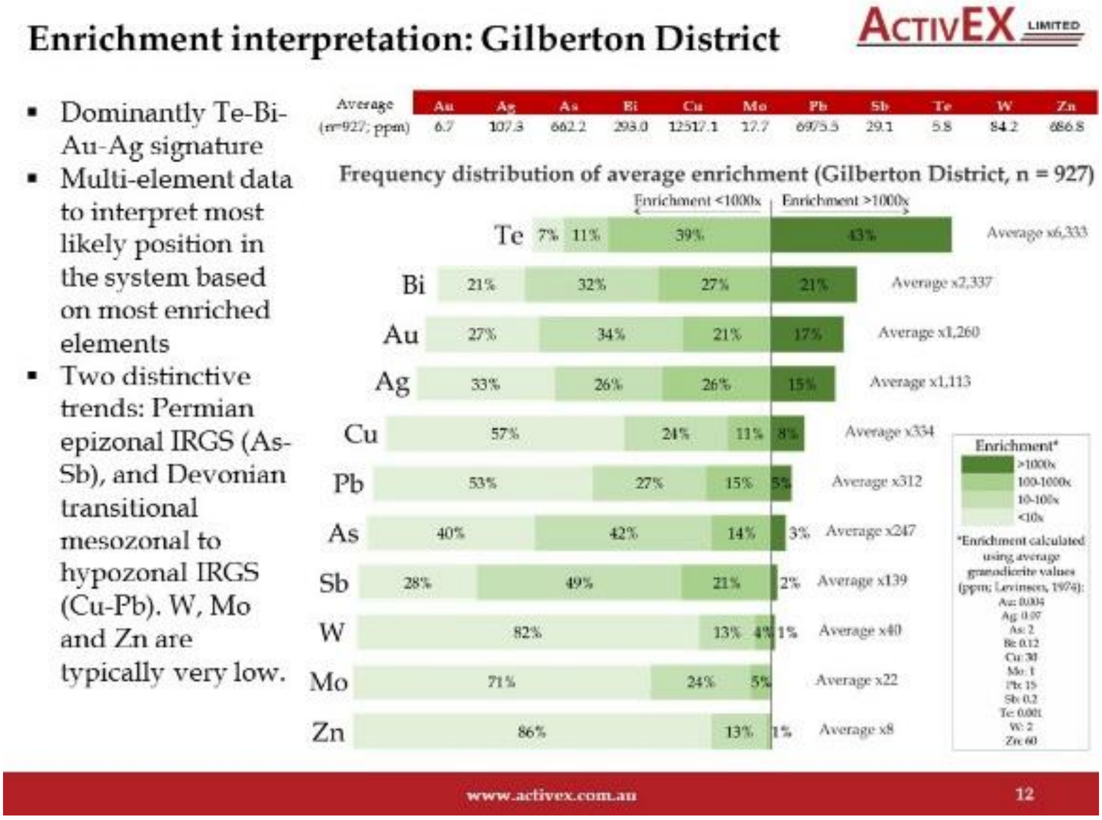

Figure 17 : Statistical analysis of multi-element data from Gilberton mineral occurrences (927 samples). Graph shows levels of enrichment compared to average background values (Sourced from Activex Ltd)

9.5 KIDSTON INTRUSIVE RELATED MESOZONAL BRECCIA HOSTED GOLD DEPOSIT

The Kidston gold mine is located 280 km NW of Townsville and 40 km south of Einasleigh. Between 1985 and 2001, 109 Mt of ore were treated and around five million ounces (158 tonnes) of gold recovered (Figures 1 and 6). The deposit lies along the northwest trend of a rhyolite dyke swarm that emanates from the Lochaber Ring Complex 5 km to the south and extends to the Newcastle Range Volcanics 25 km to the northwest (Figure 18). Radiometric dating of granite at the Lochaber Ring Complex, volcanics in the Newcastle Range and pre and post mineralisation dykes at Kidston all return an early Carboniferous age (330-335 Ma) (Murgulov et al., 2009). The dyke swarm is coincident with a regional gravity low extending to the Lochaber Ring Complex suggesting the area is underlain at depth by an early Carboniferous batholith.

Gold mineralisation occurs within a large ovoid shaped breccia pipe 1100 m by 900 m at surface and at least 1300 m deep. The margins of the pipe dip steeply inward resembling a funnel. The breccia pipe is hosted in Proterozoic age migmatite of the Einasleigh Metamorphics. The pipe straddles the contact between granodiorite and banded biotite gneiss-amphibolite phases. Numerous pre-breccia and post breccia dykes and stocks of rhyolite, some restricted to within the margins of the breccia pipe have been mapped at surface and defined at depth by drilling (Figures 19-20). These host lithologies can be traced in the breccia mass through the pipe. In general, the breccia grades from more intensely milled, rounded clasts in a rock flour matrix at the core of the pipe to less milled, blocky breccia composed of angular clasts in a clast support fabric and open space matrix around the margins and at higher levels in the pipe. Zones of breccia within the pipe dominated by rhyolite clasts reflect the location of dykes and stocks prior to pipe formation.

Mineralisation consists of medium-grained comb quartz, carbonate and base metal sulphides as sheeted veins, breccia infill and replacement (Plates 29, 30a-b). Gold occurs as inclusions within the sulphides. Data from fluid inclusions indicates the pipe was formed around 3.5 km from surface (Baker & Andrew, 1991). This implies that the space required for the main breccia body to form must have been through magma withdrawal. A later stage of magma withdrawal was also probably responsible for collapse or sagging of the breccia pipe that produced bowl shaped extensional sheeted vein sets and opened fractures for intrusion of rhyolite porphyry sills cutting the main breccia. The main episode of gold mineralisation was related to this late stage collapse of the pipe (Figure 21).

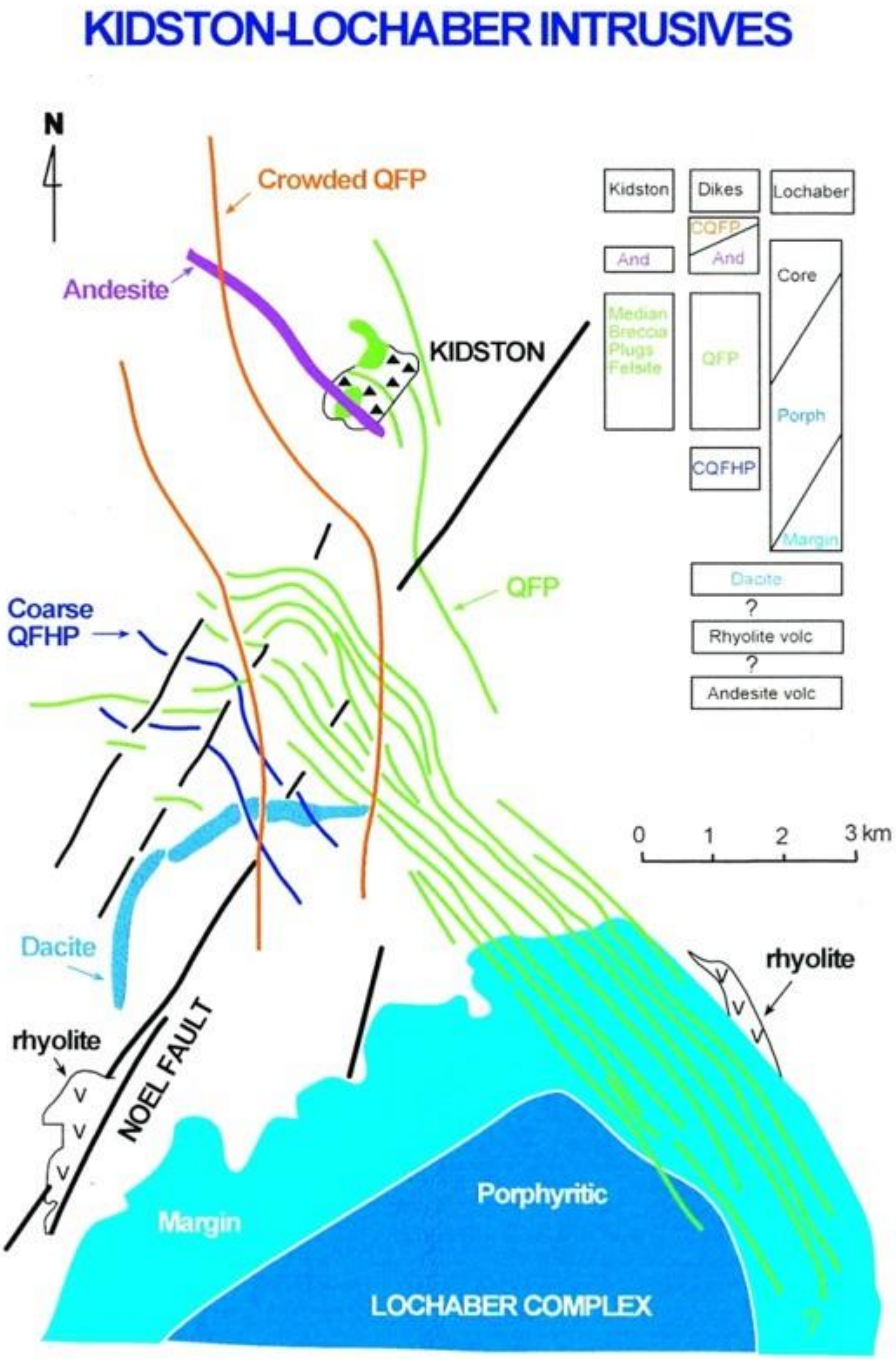

FIGURE 18 : Kidston gold deposit regional geology map showing location along northerly trending rhyolite dyke swarm emanating from the Permo-Carboniferous Lochaber-Bagstowe intrusive complex.

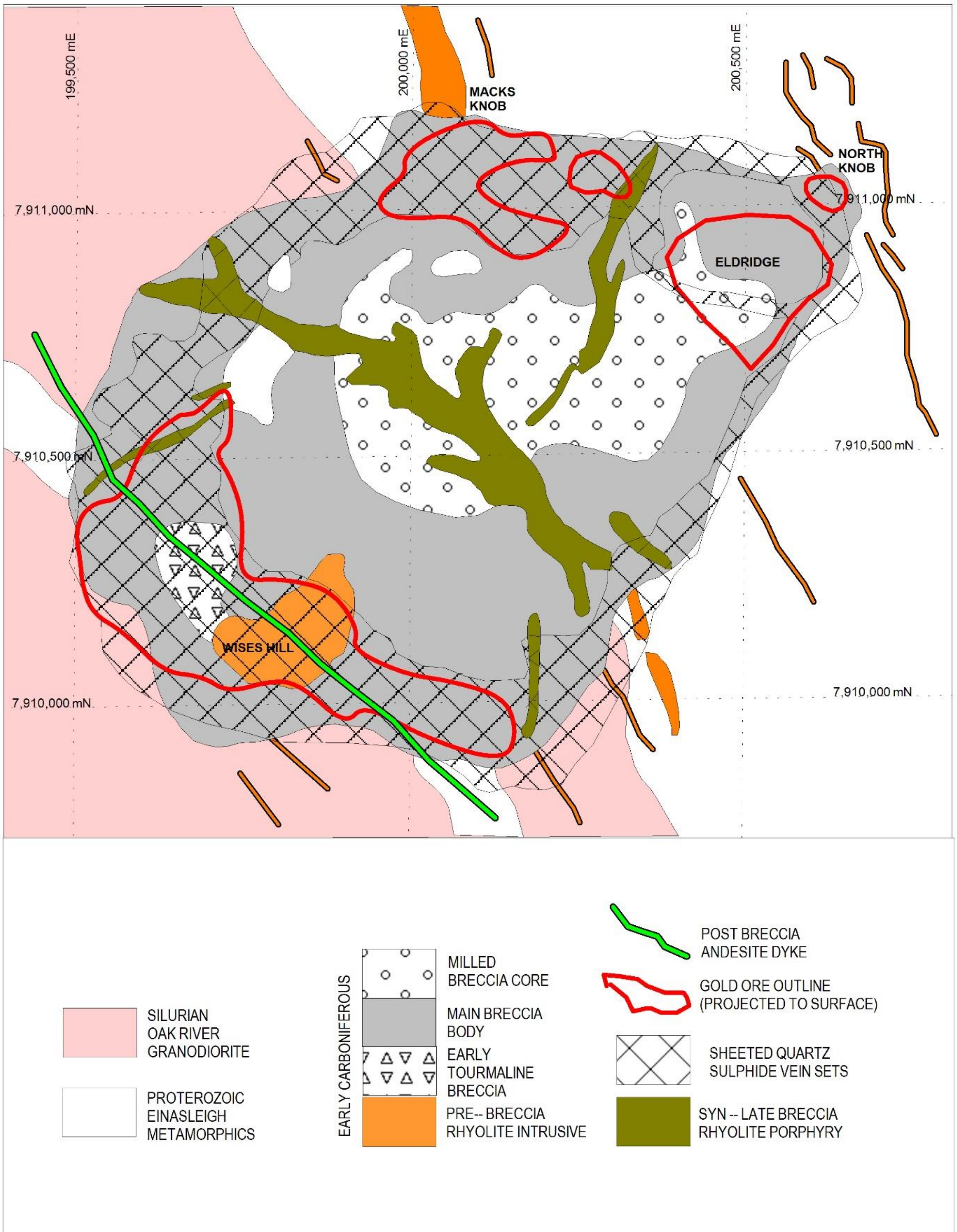

FIGURE 19 : Surface geology of the Kidston breccia pipe showing outline of pipe margin and differentiation of pre-breccia and post-breccia phases of mineralisation and intrusion (modified from Morrison 2007, Baker & Andrews, 1991).

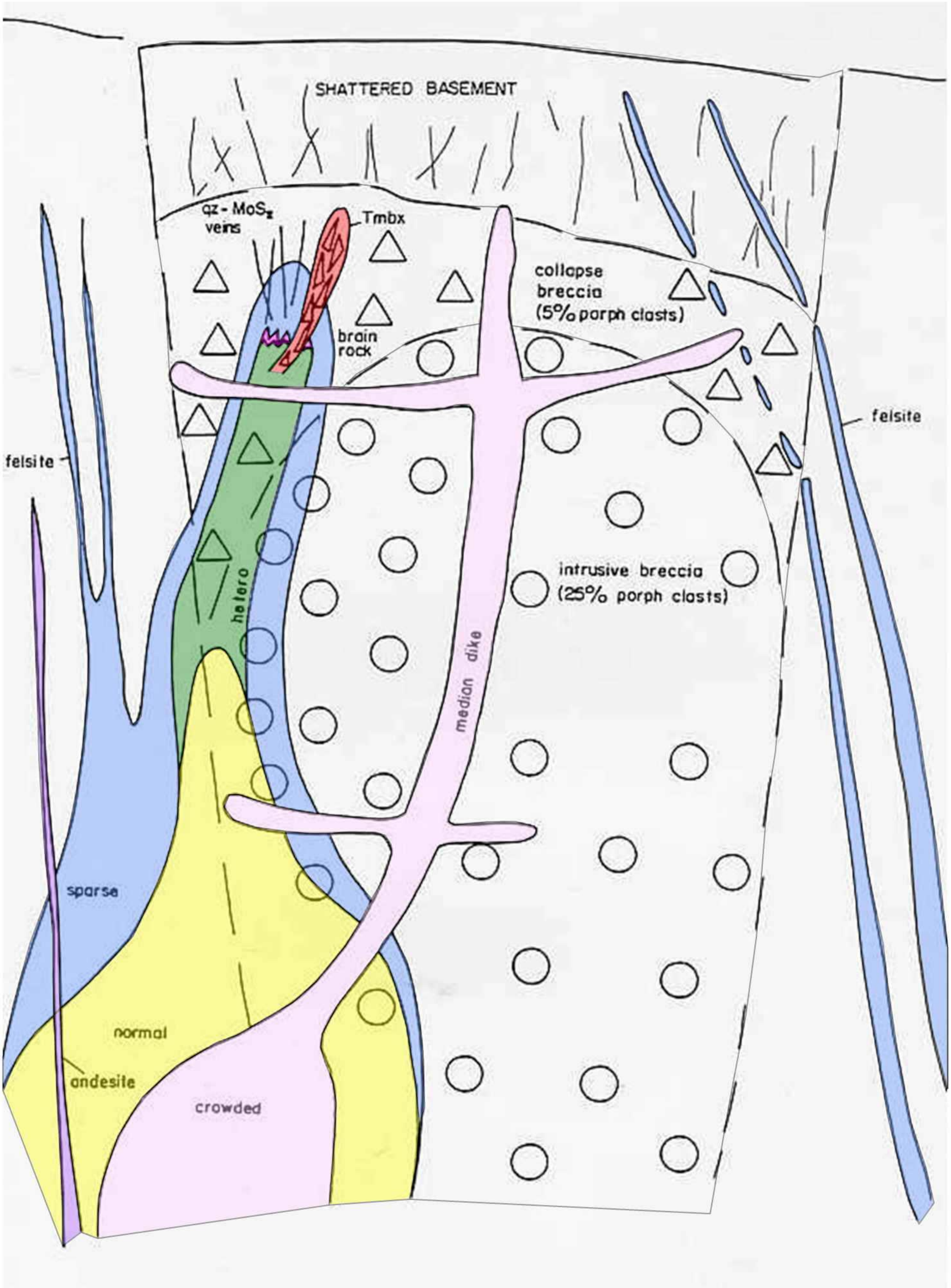

FIGURE 20 : Kidston Gold deposit. Schematic section showing different intrusive phases and breccia types within the pipe. Interpretation based on open cut mapping and deep diamond drill core logs.

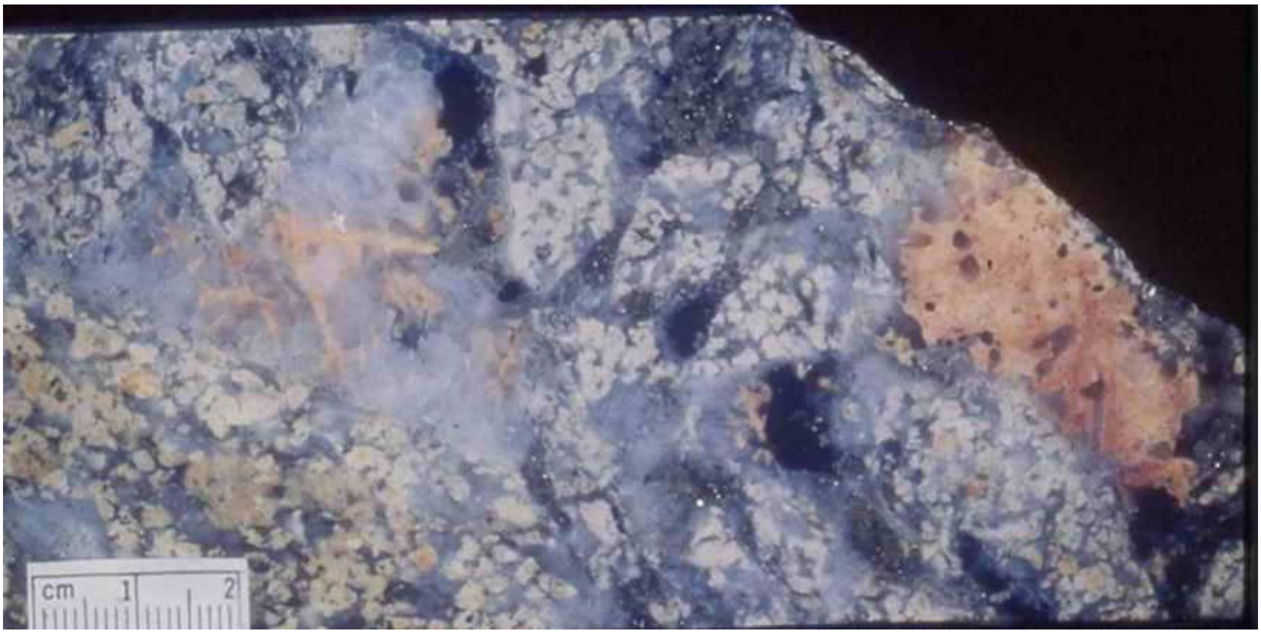

PLATE 29 : Kidston breccia ore showing stubby, medium grained, comb textured quartz crystals lining Vugs with later carbonate, pyrite and base metal sulphide filling Vug cores.

An early phase of quartz-molybdenite and quartz-magnetite stockworking and quartz-tourmaline breccia hosted in a porphyritic rhyolite stock was brecciated by the main pipe forming event and preserved as clasts in the southwest section of the pipe. Biotite and K-feldspar alteration was associated with this phase of mineralisation. Detailed studies on alteration and mineralisation has shown a complex zonation both laterally and vertically within the breccia pipe (Morrison et al, 1996; Morrison & Seed, 1993). Generally, the main breccia body and zones of sheeted veining possess a pervasive phyllic (quartz-sericite-pyrite-carbonate+/-chlorite) style of alteration. In deeper levels of the pipe an earlier biotite-epidote-magnetite-potassium feldspar is typically overprinted by the phyllic alteration assemblage.

A study of metal zoning at Kidston shows that apart from the gold and base metal sulphides in steep dipping sheeted veins overlapping the margin of the pipe at surface the core of the pipe at surface is barren (Figure 21). Under the barren zone lies a 200-250 m thick gold-base metal sulphide-pyrrhotite zone consisting of sheeted vein and secondary breccia infill mineralisation, then a zone of pyrrhotite-dominated (lesser base metal sulphides) cavity infill, and a lower sheeted vein zone hosting pyrrhotite, base metal sulphides, molybdenite, fluorite, native bismuth, tennantite, wolframite and scheelite. This zoning pattern is typical of a polymetallic porphyry system with a molybdenum core and is thought to reflect increasing temperature with depth (Morrison et al., 1996).

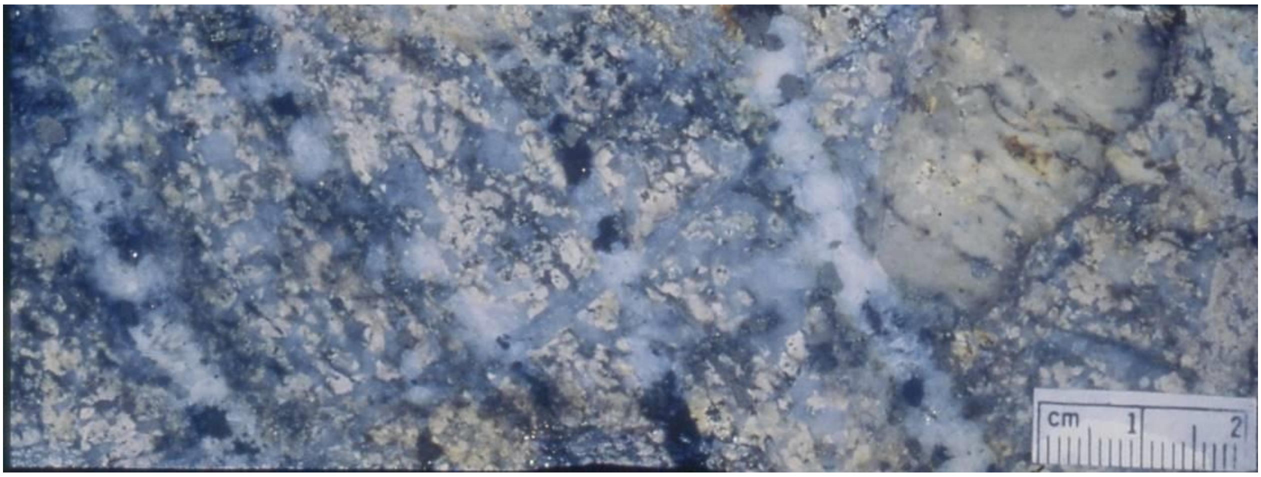

PLATE 30a : Kidston sheeted vein gold mineralisation. Similar quartz, carbonate, sulphide infill as breccia matrix. Believed to have formed simultaneously with the late stage breccia mineralisation during magma withdrawal and collapse/sagging of the breccia pipe.

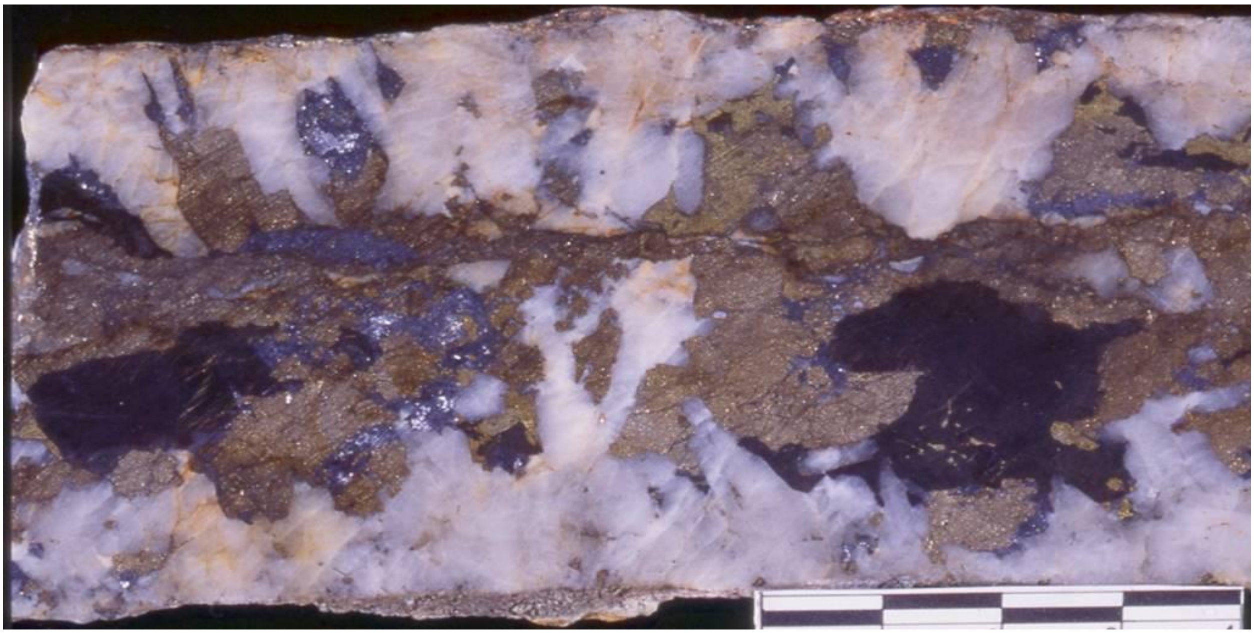

PLATE 30b : Kidston sheeted vein gold mineralisation. Close up of vein, showing medium grained, comb textured quartz crystals lining vein margin with later iron carbonate, pyrite and base metal sulphide filling vein cores.

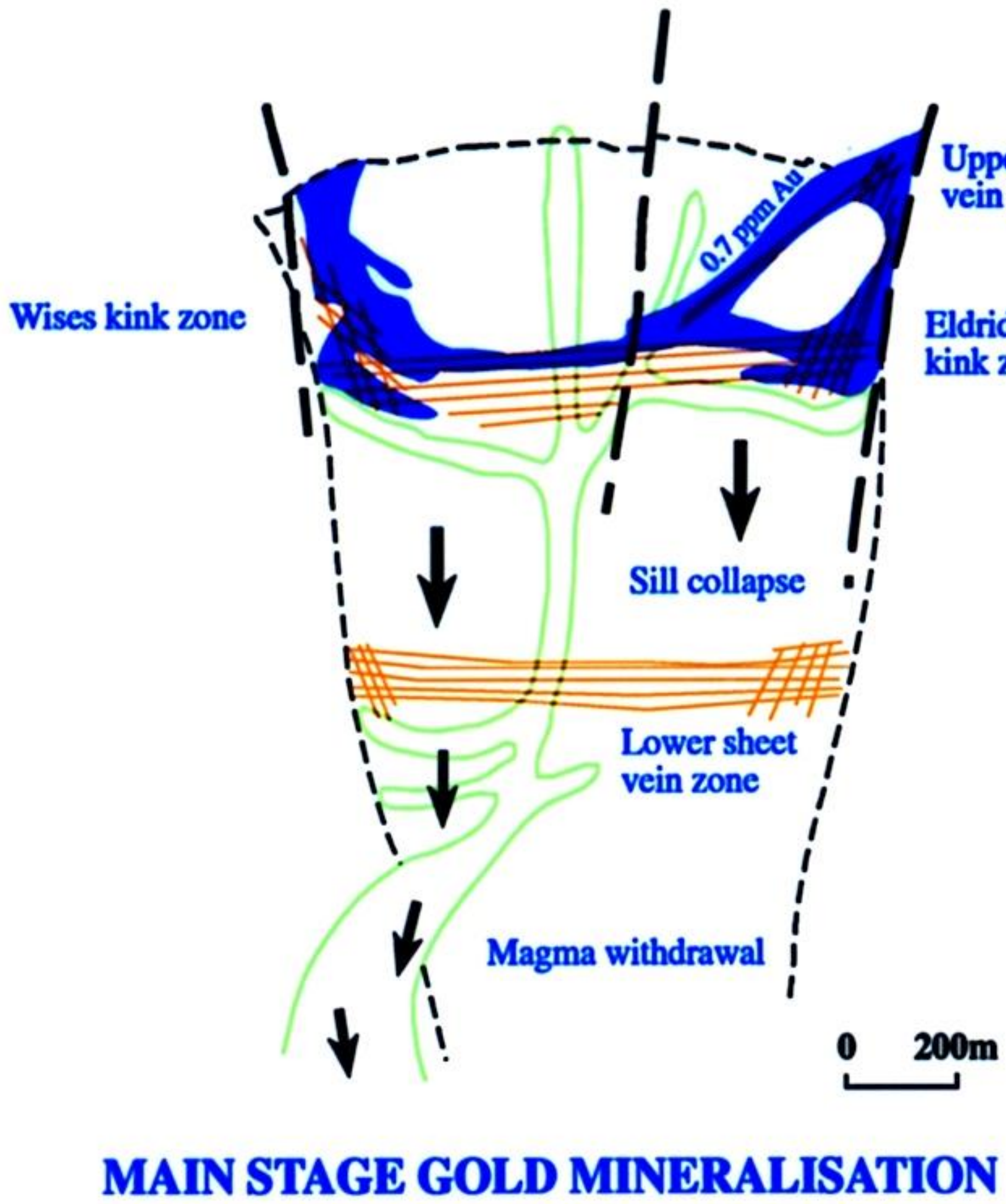

FIGURE 21 : Kidston Gold deposit. Schematic cross section showing location of ore, mineralised sheeted vein sets and syn-mineralisation rhyolite porphyry within the breccia pipe. Higher grade gold mineralisation is hosted in sheeted vein sets and breccia between the roof of the pipe and a post-breccia sill, with >3 g/t gold shoots located at vein intersections (Eldridge and Wises kink zones). Main stage gold mineralisation is hosted in collapse breccia and sheeted veins related to magma withdrawal.

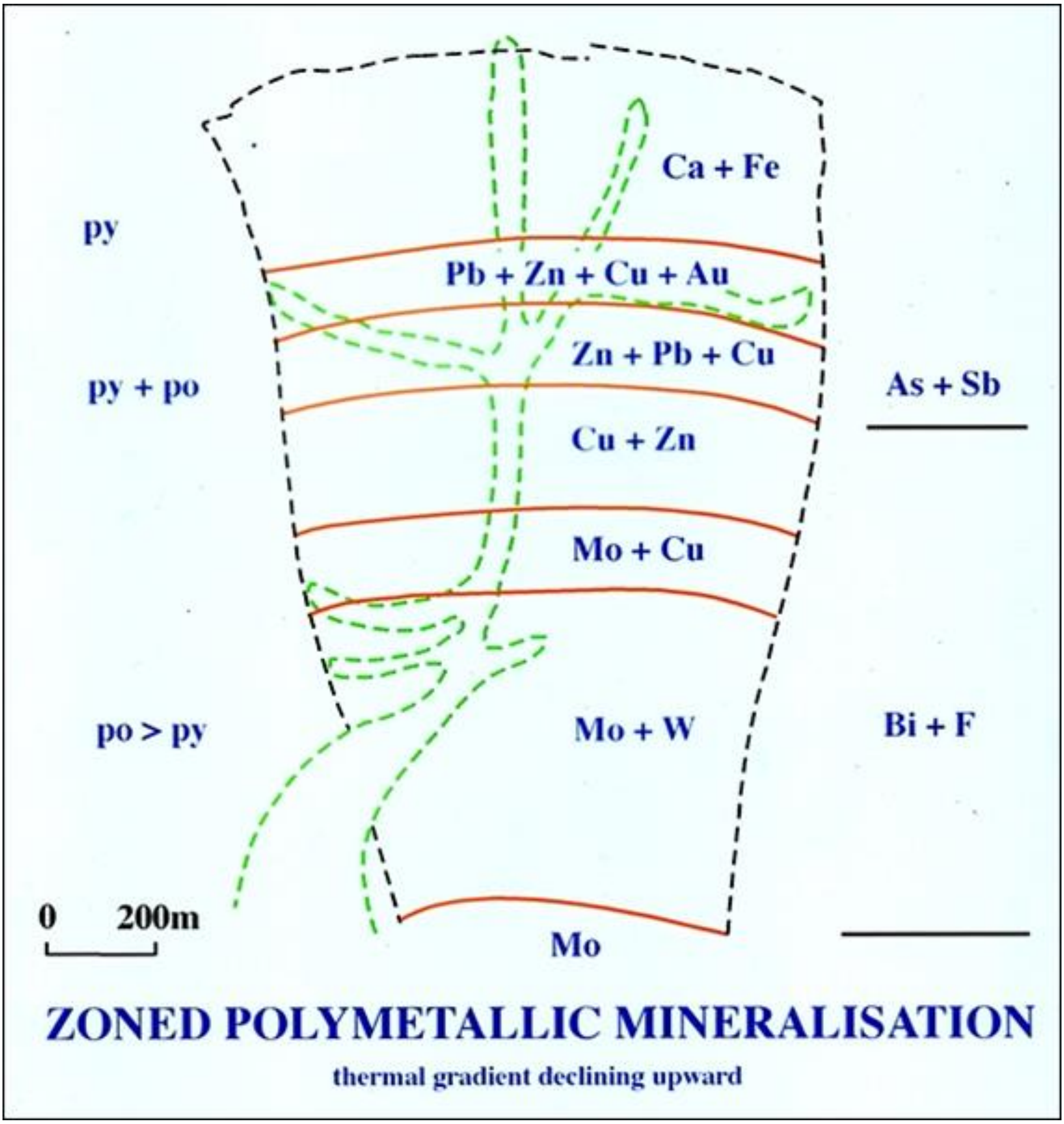

FIGURE 22 : Kidston Gold Deposit. Diagrammatic section through breccia pipe showing metal zonation reflecting upward decreasing temperature. Grades from a W-Mo-Bi system at the base through to gold and base metal rich veining and breccia infill at the top of the pipe.

9.6 MOUNT TURNER

The Mount Turner intrusive complex is located 11 km NW of Georgetown and consists of multiple phases of rhyolite to microgranodiorite dykes, stocks and associated breccia, hosted in Proterozoic Forsayth Granite and metasediment of the Lane Creek Formation (Figures 6 and 22). The intrusive complex has been described as a porphyry Cu-Mo system with zoned polymetallic mineralisation (Baker & Horton, 1982). There is an early rhyolite phase of intrusion consisting of a central plug, a swarm of greisen-altered dikes and local breccias and copper mineralisation. A later phase of granodiorite plugs have Cu-Mo mineralised breccias and peripheral veins that zone from copper in the core through a barren pyrite zone to distal As-Pb-Zn-Ag-Au veins that were the main focus of historic mining (Plates 31-32).

The system was explored in the 1970’s porphyry Cu boom for the Cu-Mo potential in the potassic alteration zone immediately around the intrusions, but found disappointing in terms of grade. Exploration in the 1980’s and 1990’s focussed on the potential for gold mineralisation in the peripheral base metal zones using a model from the Kidston Mine that has the best Au with Zn and Pb (Georgees et al., 1996, CR28415). Although good gold assays were obtained and the association with As-Pb-Zn-Cu was well established the continuity and spacing of the host veins and lodes was disappointing and the project lapsed when Kidston Gold Mines exploration was wound up about the time of closure of the Kidston mine.

A review of the historic data and addition of radiometric dating and interpretation of multi-element geochemistry allows an interpretation of the mineralised system. The Mt Turner mineralised area is a 6 km diameter magmatic-hydrothermal system with an early NNE-trending rhyolite dike swarm with potassic and sericitic alteration and Cu mineralisation. A second phase of intrusion is a widespread set of micro-granodiorite plugs with local dykes and breccias and potassic-sericitic alteration that coincide with all the significant prospects with Cu-Mo and As-Pb-Zn-Cu-Ag-Au veins.

The multi-element geochemistry demonstrates that the deposits are all part of the same system with an As-Bi-Te-Au-Ag-Cu-Pb-Zn signature and an inbuilt zoning pattern from Cu-Mo to Cu-As-Sb-Au-Bi to Pb-Zn-Ag-(Au) that is characteristic of the Permo-Carboniferous porphyry systems in the district and distinct from the nearby Early Devonian structure localised Drummer Hill Mine that has an As-Au-Ag-Pb signature.

There are three new radiometric ages from this mineralised complex that also bear on the mineral evolution (Table 4.1). The Rocky Reward Mine, on the same structure as the Drummer Hill Mine, returned a K-Ar age of 372 Ma from sericite alteration and is interpreted as part of the Early Devonian (~400 Ma) mineralisation event with a partial Carboniferous-Permian alteration overprint. The alteration at the Claymore deposit in the Four Grande area is 311 Ma (late Carboniferous) but the deposit is interpreted as part of the polymetallic mineralisation event and therefore more likely early Permian. The molybdenite at Mt Turner proper is 289.4 Ma which is early Permian and therefore consistent with the model from drilling by Kidston Gold Mines that the Cu-Mo mineralisation is related to the Mt Darcy Micro-granodiorite suite. Although the paragenetic relations between the rhyolite system and the granodiorite system seem well established, interpretation of the latest dating results is not entirely clear.

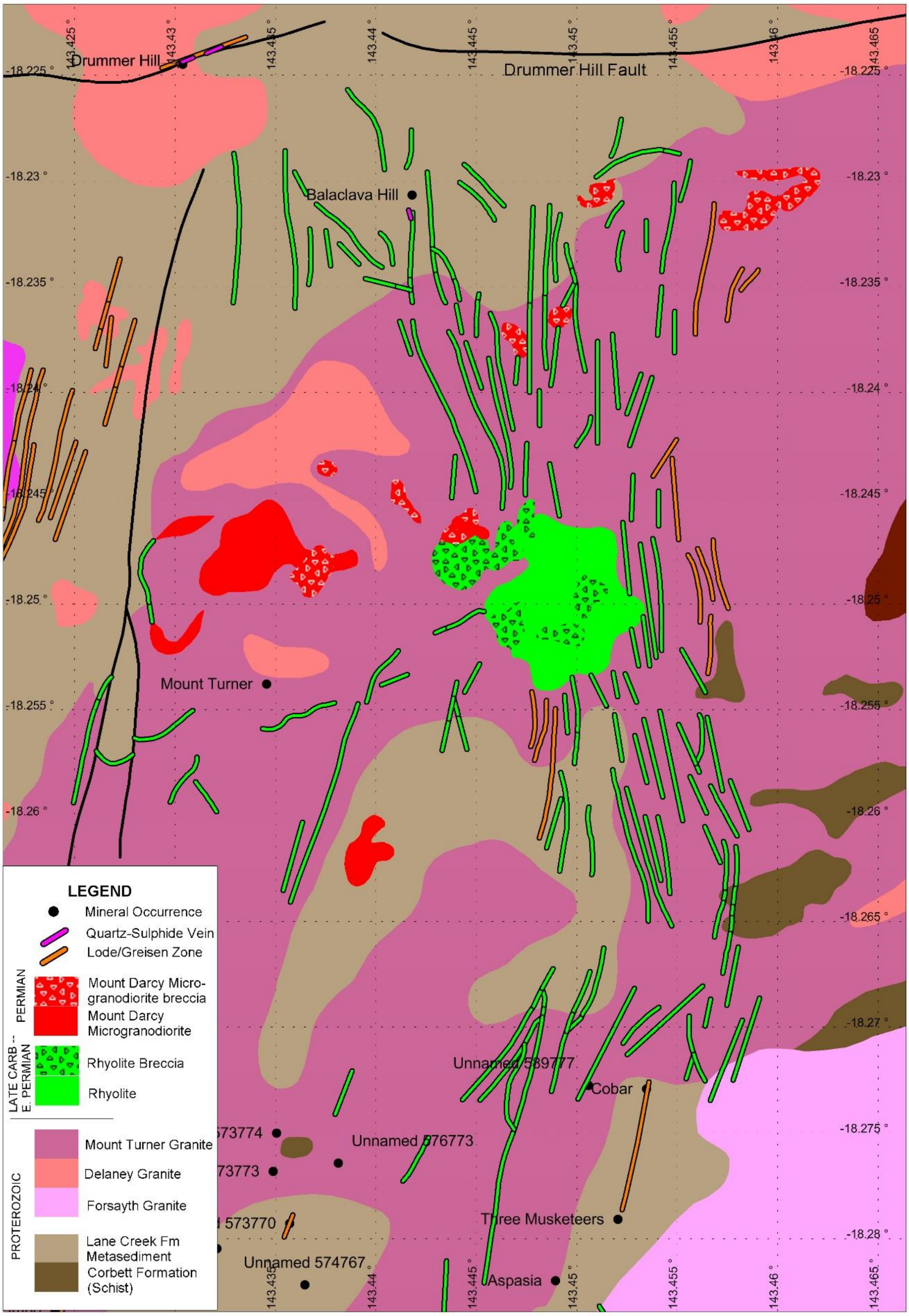

Figure 23 : Mount Turner geology map showing relationship of Permo-Carboniferous intrusives, breccia bodies, related dykes swarms and structurally controlled greisen zones.

PLATE 31 : Brecciated Mt Turner Granite. Clasts intensely replaced by quartz and sericite and cemented by fine quartz and limonite after sulphides.

PLATE 32 : Mount Turner. Quartz-sericite "greisen" lode material from Three Musketeers mine composed of fine comb quartz stockwork with late sphalerite, arsenopyrite, galena infill. Numerous north-south striking greisen lodes have been mapped emanating from the Mount Turner intrusive complex.

9.7 HUONFELS, INTRUSION RELATED EPIZONAL LODE AG – AU PROSPECT

The Huonfels prospect is located 33 km NW of Georgetown and is hosted in Proterozoic metasediments (Lane Creek Formation) and porphyritic biotite granite (Forsayth Granite) and Carboniferous rhyolite intrusions (Huonfels Rhyolite Member, Dismal Creek Dacite) (Figure 6). The prospect lies between the Permo-Carboniferous Dismal Creek and Maureen volcanic centres. Mineralisation at Huonfels is related to a northerly trending zone of steeply dipping, anastomosing faults 4.5 km long and up to 1 km wide. Irregular and discontinuous zones (up to 20 m wide) of ferruginous and silicified breccia and quartz veining are localised along the structures (Figure 24; Plate 33). Quartz veins rarely exceed 20 cm in width and like the breccia infill are composed of medium to fine grained euhedral quartz crystals and less commonly chalcedony (Plate 34). Rocks adjacent to the mineralised structures are often intensely replaced by quartz, sericite and iron carbonate. Pyrite, galena and arsenopyrite are commonly disseminated throughout the silicified rocks and as late stage breccia infill.

From 1985 to 1990 CRA conducted rock chip sampling, mapping, trenching, geophysics surveys and drilling over the Huonfels Prospect. Drilling confirmed the broad zone of faulting that marks a contact between metasediment (east) and granite (west). Numerous dykes and intrusions of rhyolite, often brecciated and altered were mapped on surface. The best intercept in drilling was 6m @ 2.56 g/t Au and 527 g/t Ag (RC85KA4). Examination of multi-element geochemistry from Huonfels shows that silver is much more enriched than gold, arsenic and antimony is dominant over base metals and tellurium is significantly enriched. The structural setting, nature of the mineralised quartz and geochemical signature all point to Huonfels being a distal, epizonal intrusion-related lode style deposit. The geochemical signature is similar to other nearby Permian and Carboniferous intrusion-related deposits such as Phyllis May, Log Creek and Ironhurst that also have enrichment of silver over gold.

No dating has been completed on the intrusions or alteration at Huonfels. It is inferred that Huonfels is early Permian as it is part of the same intrusion and mineralisation suite as Ironhurst on which there is a sericite K-Ar date of 278 Ma and the Mt Darcy Micro-granodiorite where there is a sericite K-Ar age of 285 Ma (Table 4.1, Figures 6 & 8).

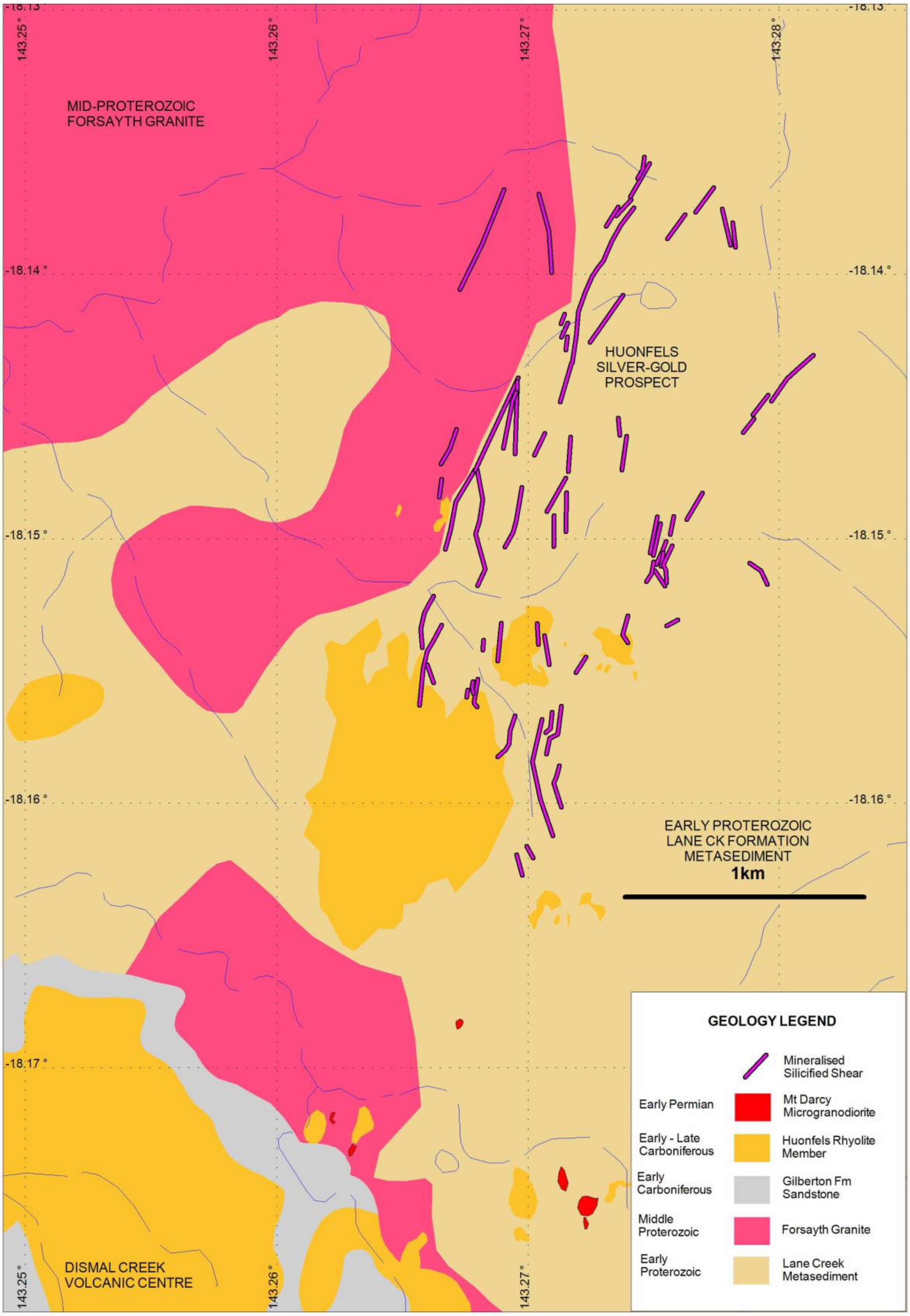

Figure 24: Geology of the Huonfels Prospect, Georgetown.

PLATE 33 : Typical outcrop of mineralised veins and silicified breccia localised along a northerly trending structure at the Huonfels Prospect, Georgetown.

PLATE 34 : Huonfels Prospect, Georgetown. Medium grained euhedral, zoned, comb quartz rimming breccia clasts. Cores of breccia Vugs filled with iron carbonate and sulphides (now oxidised to limonite). Sample 231570, 0.18 ppm Au, 50.6 ppm Ag, 639 ppm As, 254 ppm Sb.

9.8 AGATE CREEK EPITHERMAL GOLD DEPOSIT

The Agate Creek gold deposit is located 340 km west of Townsville, 45 km south of Forsayth and 65 km west of the Kidston gold mine (Figures 1 and 6). The main part of the deposit, known as Sherwood contains the bulk of the defined gold resources (4.39 Mt @ 1.47 g/t for 207,000 ounces). Gold resources at Sherwood West have been calculated at 4.78 Mt @ 1.25 g/t for 194,000 oz using a 0.5 g/t cut-off (Renison Consolidated Annual Report, 2012).

The Agate Creek Camp lies adjacent to the regional scale Robertson Fault Zone and off the northwest end of the Agate Creek Volcanic Complex. The basement rocks are Proterozoic metasediment, composed of mudstone, sandstone, phyllite, quartzite and meta-basalt. The metamorphic rocks have been intruded by Siluro-Devonian age Robin Hood Granodiorite and by early Permian rhyolitic and andesitic dykes and stocks that are related to the Agate Creek Volcanic Complex. The volcanic complex is largely fault bound and consists of andesitic lavas, rhyolitic tuff and ignimbrite. Jurassic Hampstead Sandstone consisting of basal conglomerate and quartzose sandstone forms plateau-like outliers capping the older rocks (Figure 25).

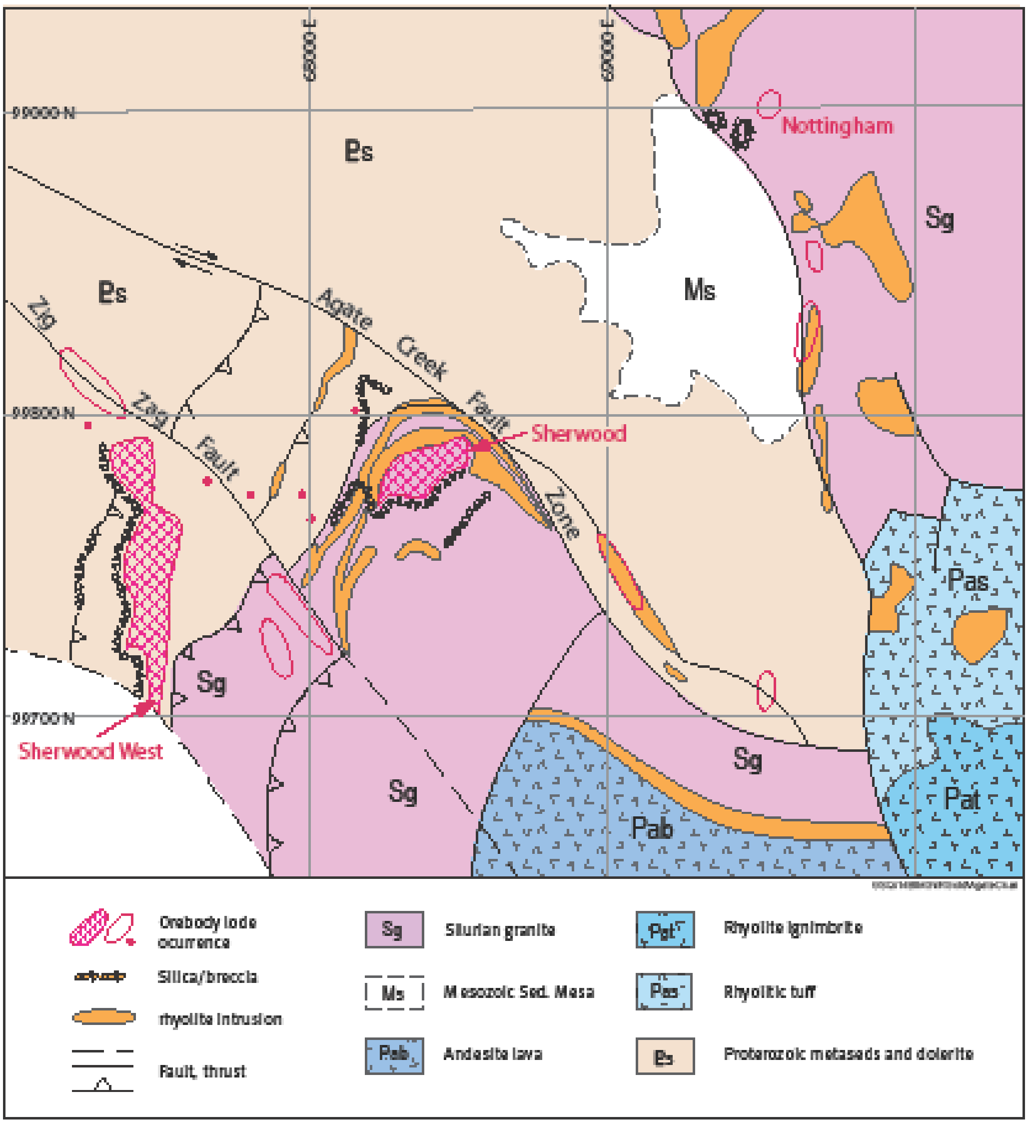

Figure 25: Simplified geology map of the Agate Creek Camp showing the relationship of the deposits to the geology and structure.

The mineralisation at the main Sherwood deposit is best developed in breccias and vein networks hosted in shallow dipping rhyolite dykes that occupy shallow SE-dipping thrust faults in the granodiorite. Thrust faults also separate the granodiorite from the metamorphic rocks throughout the prospect area and there are series of N & NW-trending steep normal faults that bound and disrupt the mineralised zones (Figures 25 & 26). Mineralisation is characterised by irregular swarms of narrow colloform-banded chalcedonic veins which grade into breccias and stockwork vein zones (Plates 16 and 35). They have a geochemical signature (Au As Sb Ag Te) which is typical of distal epithermal mineralisation with a possible link to andesitic intrusions indicated by the Te enrichment. Rhyolite dykes associated with mineralisation have returned U-Pb zircon ages of 285 Ma (Early Permian) (Cross et al, in prep.) and are interpreted as part of the adjacent Agate Creek Volcanic Complex.

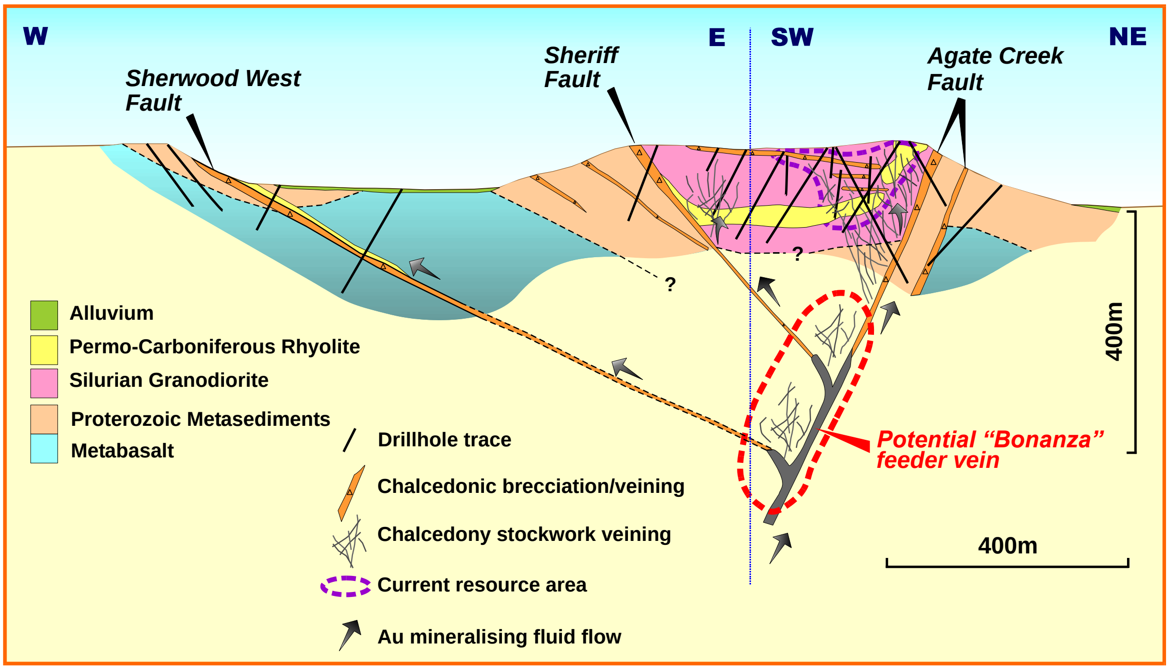

Figure 26 : Model cross-section through the main deposits with an interpreted link to a bonanza feeder zone (Renison Consolidated Annual Report, 2012).

At the Sherwood West resource, gold mineralisation is localised along a north-striking fault, that dips 30° to 45° East. The Sherwood West Fault hosts a zone of chalcedonic veins and breccia 5 to 10 m thick, hosted in metasediment. Permian rhyolite and quartz-feldspar porphyry dykes that have intruded along the fault are also mineralised. This mineralisation overall and the ore controls are very similar to the Sherwood deposit.

The epithermal mineralisation at Agate Creek is part of a group of similar deposits localised in a Permian NW-SE rectilinear fault network occupied by dikes and volcanic complexes (Figure 3). The known deposits have been interpreted as linked to each by a series of dikes in faults and to emanate from a bonanza zone lying on a major fault (Figure 26). Drilling in the Agate Creek Fault Zone which was the interpreted feeder demonstrated mostly post-mineralisation movement Modelling of the alteration zoning by company consultants suggest the feeder zone may be SE of the known mineralisation.

PLATE 35. Sherwood Prospect, Agate Creek. Multiple phase fine comb and chalcedonic quartz stockwork cutting silicified and sericite altered rhyolite. Sample 231517; 5.63 g/t Au, 0.83 g/t Ag.

10.0 OVERALL METALLOGENIC CLASSIFICATION

All the **epithermal** deposits have rhyolites related to or of the same age as mineralisation so the boundary between epithermal per se and intrusion-related epizonal is not clear (Table 10.1). This separation is currently based on presence of chalcedony and boiling textures in Epithermal versus fine comb quartz only in intrusion-related epizonal deposits, but both types have similar chemistry notably Te significant and Ag>Au most common. The implication is that the epithermal deposits are part of the Intrusion-Related Epizonal system and predominantly of Permian age (Figures 27-28).

The **Intrusion-Related deposits** have early Permian and early Carboniferous groups with two possible late Carboniferous examples (Mt Turner, Log Creek). All the deposits are polymetallic, with prominent Te-Bi and As-Sb and are mesozonal to epizonal. The early Carboniferous deposits in the Kidston region are Au-rich mesozonal hydrothermal breccias, whereas the deposits west of Georgetown are early Permian – late Carboniferous Au>Ag lode deposits (Electric light, Cumberland Mine, Beverley, Double Z) or Ag>Au epizonal-mesozonal lodes, stockworks and breccia deposits (Ironhurst, Phyllis May, Mt Turner, Bald Mountain) (Figures 27-29).

The **Plutonic** deposits are those in which there is no demonstrated spatial or temporal link to intrusions. These deposits are Early Devonian shear-hosted lodes that may have steep or shallow dipping orientation and be extensive on kilometre scale along the structure. There are three districts - Georgetown, Forsayth and Gilberton, each with a distinct Au>Ag, Bi-Te, As-Sb, base metal signature and zoning on kilometre-scale in both quartz textures and metal geochemistry (Figure 27 and 30).

CAMP	EPOCH	CLASS ALL	Related Intrusion	Mineralisation Style	QUARTZ ZONE	METAL ZONE	CHEM CLASS
Agate Creek	EPERM	ERWES	rhyolite	VN,SW,DS	EPB	As	SAT
Bald Mountain	EPERM	IRWES	rhyolite	SW,BX	IE	As	GST
Beverley	ECARB?	IRXEN	rhyolite	BX, SW	IE	Sb	TB
Big Reef	EDEV?	PNLMP	none	VN	PLM	Pb	TB
Big Wonder	EDEV?	PNLMC	none	VN	PLM	Cu	TB
Black Knob	EDEV?	PRLHS	rhyolite	VN, BX	PLH	As	SAT
Carbon Copy	EPERM?/EDEV?	IRLEP	rhyolite	LD	IE	Pb	TB
Christmas Hill	ECARB	IRLMS	rhyolite, monzonite	LD,BX	IM	As	TB
Cumberland Camp	EDEV?	PNLMS	none	LD, VN	PLE	As	SAT
Cumberland Mine	EPERM	IYLMS	rhyodacite	LD	IM	As	SAT
Dairy Maid	EDEV?	PNVHN	none	VN	IH	Sb	SAT
Double Z	EPERM?/EDEV?	IRLEC	rhyolite	LD,BX	IE	Cu	SAT
Drummer Hill	EDEV	PDLMS	rhyodacite?	LD	PLM	As	TB
Dry Hash	EDEV	PNLMP	none	LD, VN	PLM	Pb	TB
Durham	EDEV?	PNLMS	none	LD, VN	PLM	As	SAT
Electric Light	EPERM	IRWES	rhyolite	SW, BX	IE	As	SAT
Evening Star	MPROT?	IPVHP	pegmatite	VN	IH	Pb	TB
Four Gees	EDEV?	PNLHP	none?	VN, LD	PLH	Pb	TB
Georgetown	EDEV?	PNLMP	none	LD, VN	PLM	Pb	SAT
Gilberton	EDEV?	PNLMN	none	LD,VN,SW, BX	PLM	Sb	TB
Glenrowan	EDEV?	PNLHS	rhyolite?	LD	PLH	As	SAT
Goldsmiths	EDEV?	PNLHN	none	LD, VN	PLH	Sb	SAT
Greenhills	EPERM?	IRXEP	rhyolite	BX, VN	IE	Pb	TB
Havelock	EDEV	PNLMC	none	LD	PLM	Cu	TB
Huonfels	EPERM?	IDLMS	granodiorite	LD, VN,BX	IM	As	GST
International	EDEV	PNLHS	none	LD	PLH	As	SAT
Ironhurst	EPERM	IRXES	rhyolite	BX, VN, SW	IE	As	GST
Jubilee Plunger	EDEV	PNLMS	none	LD	PLM	As	SAT
Kidston	ECARB	IYXMP	rhyodacite	BX,VN	IM	Pb	TB
Lane Creek	EDEV?	PNLMP	none	LD, VN	PLM	Pb	SAT
Log Creek	LCARB	IGLES	granite	LD	IE	As	GST
Long Gully	EDEV?	PNLMS	none	LD	PLM	As	SAT
Long Lode	EDEV?	PNLMP	none	LD	PLM	Pb	TB
Marquis	EDEV?	PNLHS	none	LD,VN, BX	PLH	As	TB
Monte Cristo	EDEV?	PNLMS	rhyolite?	LD	PLM	As	SAT
Mountain Maid	EPERM/EDEV	PNVHS	rhyolite?	VN	IH	As	TB
Mountain Maid HWBW	EPERM/EDEV	IRLEC	rhyolite	LD	IE	Cu	TB
Mt Borium	ECARB	IYXES	rhyodacite	BX	IE	As	TB
Mt Clark	EPERM?	IRXES	rhyolite	BX, LD	IE	As	GST
Mt Hogan	EDEV	PNVMP	basalt?	VN	PLM	Pb	TB
Mt McDonald	EPERM?/LCARB?	EYXES	rhyodacite	BX	EPB	As	GST
Mt Moran	EDEV?	PNVMZ	none	VN	PLM	Zn	AM
Mt Turner	EPERM/LCARB	IDLMS	granodiorite, rhyolite	BX, LD, SW	IM	As	TB
New Moon- Mosquito	EDEV?	PNLMS	none	LD	PLM	As	SAT
Percy Queen	EPERM	ERWES	rhyolite	SW VN	EPB	As	GST
Percyvale	EDEV	PNLEC	rhyolite?	LD	PLE	Cu	TB
Phyllis May	EPERM	IDWMC	granodiorite	SW	IM	Cu	TB
Queenslander	EDEV?	PNLMP	none	LD	PLM	Pb	TB
Red Dam	LCARB/EDEV?	PNLES	none	LD	PLE	As	SAT
Robinhood West	EPERM	IRLMP	rhyolite, diorite	LD, SW	IM	Pb	GB
The Drum	EDEV?	PNLEP	none	LD, VN	PLE	Pb	TB
Titania	EDEV?	PNLHP	none	LD, VN	PLH	Pb	SAT
Western Ck	EDEV?	PNVHS	rhyolite?	VN, LD	PLH	As	TB
Woolgar Epithermal	EPERM?	ERVEN	rhyolite, rhyodacite and andesite	VN, SW	EPB	Sb	GST
Woolgar mesozonal	EDEV	PNLMS	none	LD	PLM	As	ASM

Table 10.1 : Summary classification for each metallogenic camp defined in the Georgetown region.

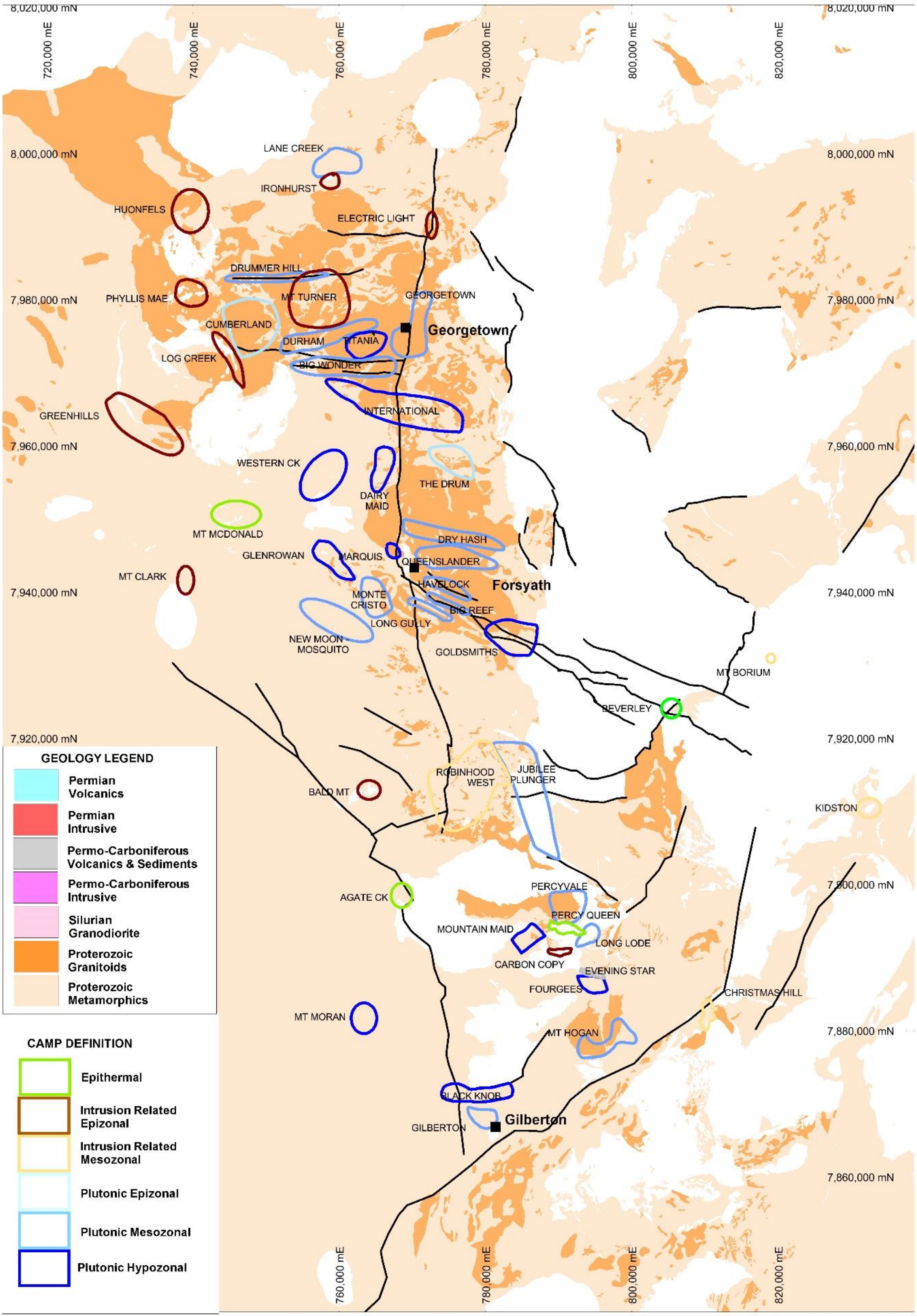

Figure 27: Proterozoic geology with all metallogenic camps.

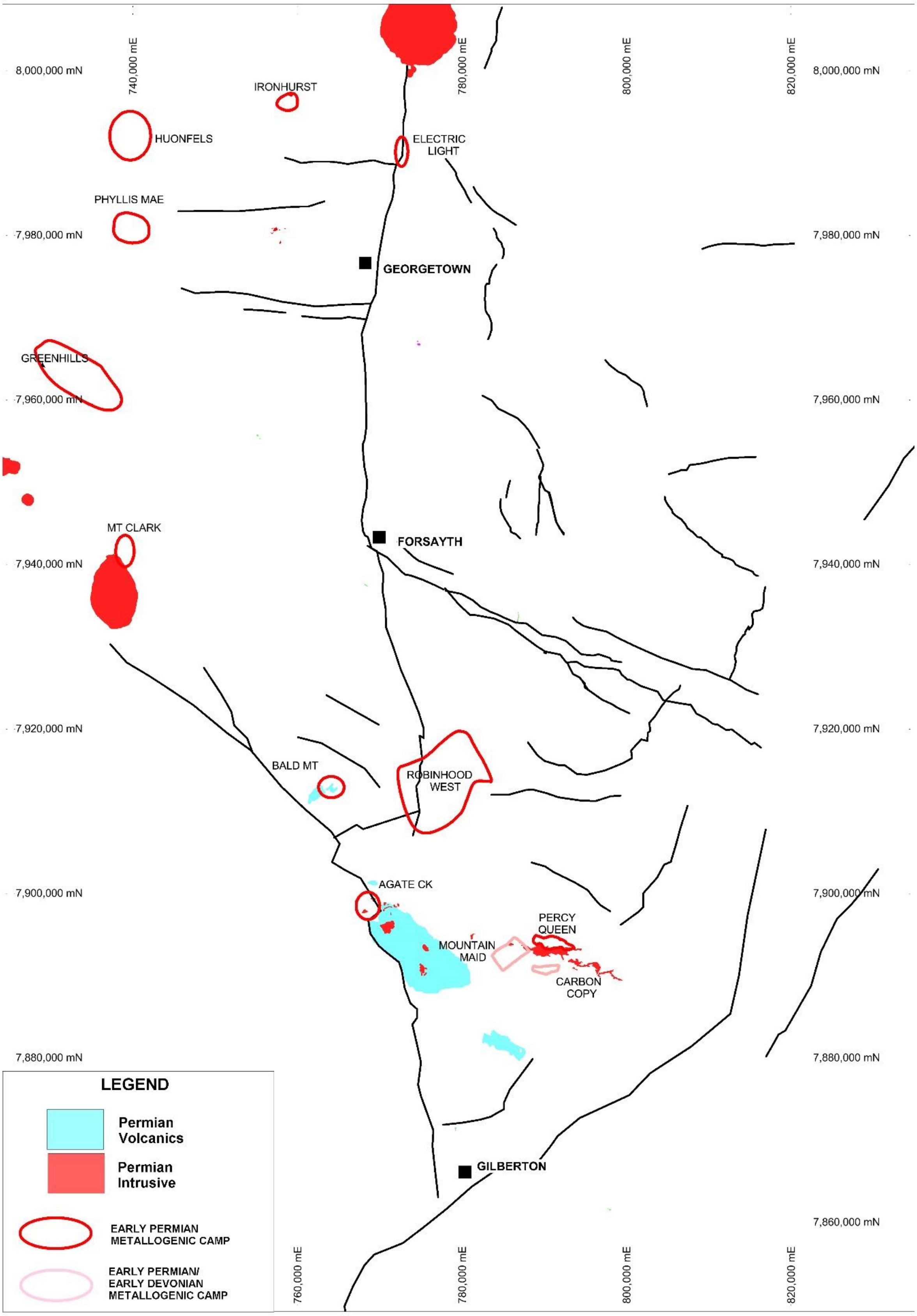

Figure 28: Permian geology, with Permian metallogenic camps.

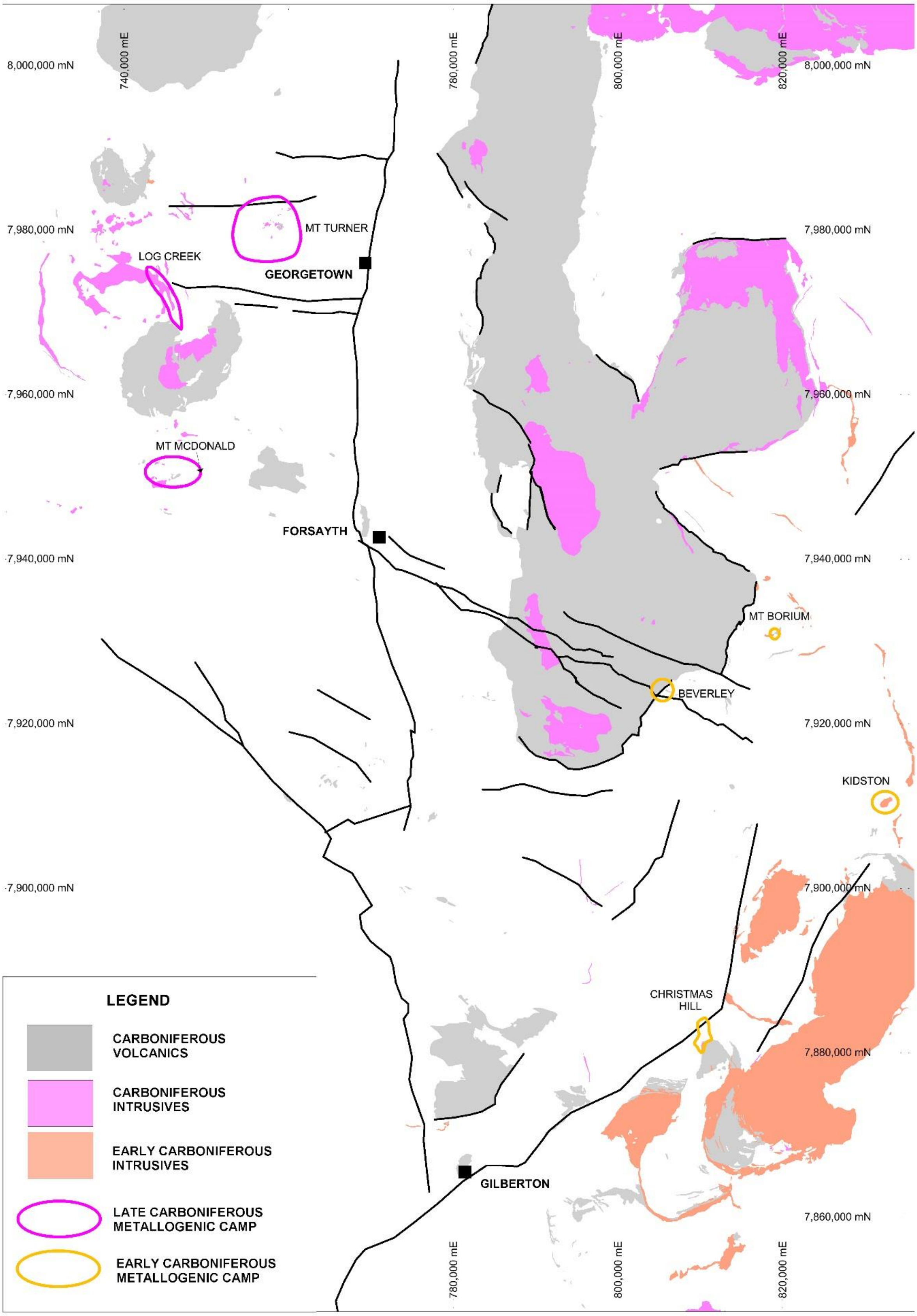

Figure 29: Carboniferous geology, with Carboniferous metallogenic camps.

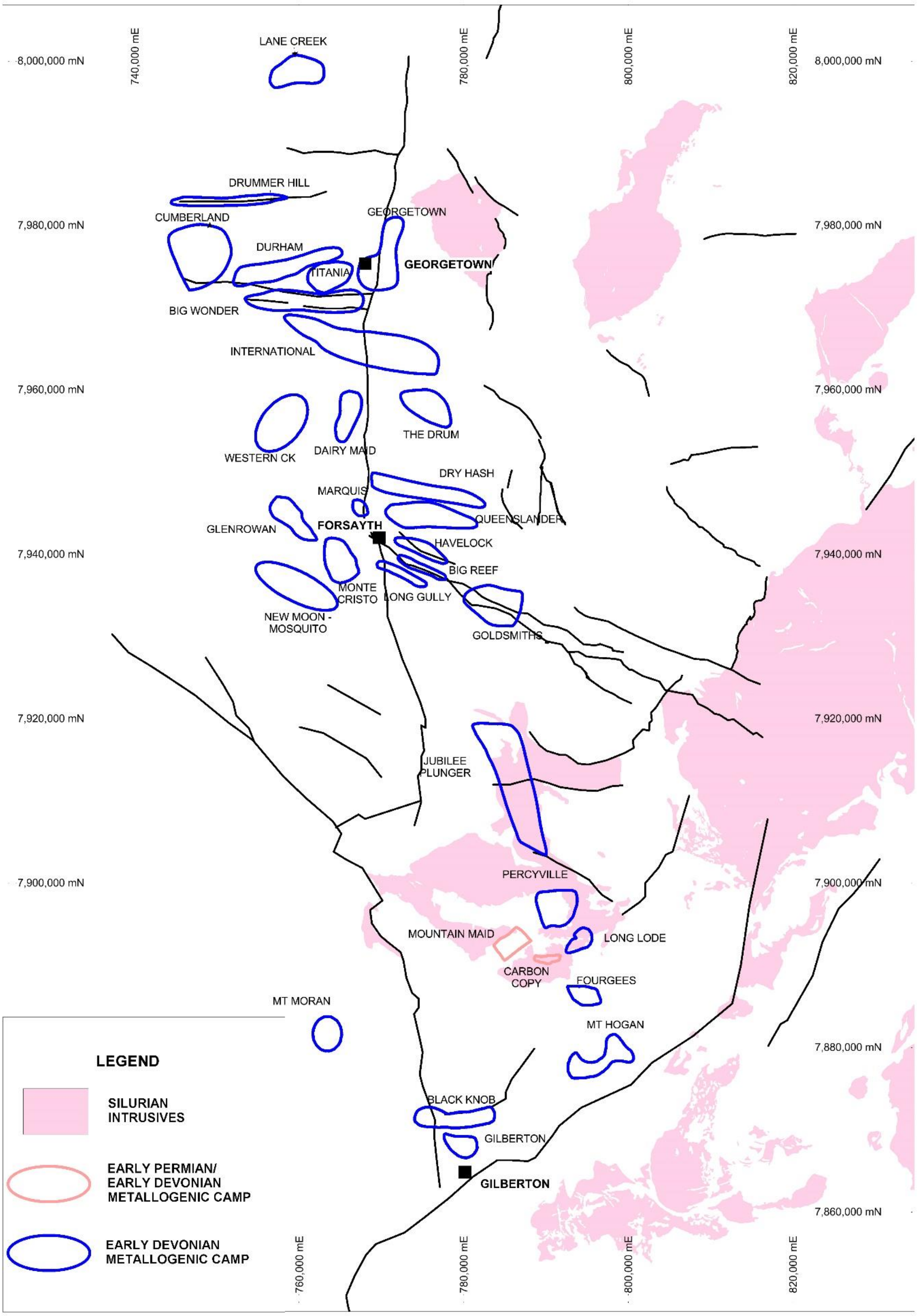

Figure 30: Silurian geology, with Early Devonian metallogenic camps.

11.0 CONCEPTUAL MODEL

The observed features, structural controls, related intrusions, quartz textures and metal geochemistry have been used to classify the deposits and to build models of the hydrothermal systems responsible for the mineralisation as a conceptual guide for exploration.

In the Georgetown region there are two main conceptual models: porphyry-epithermal that applies to the Carboniferous and Permian Intrusion-related deposits and the Plutonic model that applies to the Early Devonian lode gold deposits (Figure 31).

The epithermal-porphyry system is dominated by magmatic fluid that emanates from porphyry plugs and dikes at mesozonal to epizonal-level and interacts with ground-water at shallow levels. There are two variants of the epithermal deposits in the Georgetown region those with boiling textures-chalcedony, crustiform and colloform banding and bladed textures and those with fine crystalline textures only that have been referred to as epizonal IRGS. The field distinction is quite valid but in both variants there are rhyolitic dikes related to the mineralisation and anomalous Bi and Te that suggests that all the deposits have a magmatic link and that the boiling zone variant is just a shallower level variant of the epizonal IRGS.

The plutonic deposits are those formed at mesozonal to hypozonal level above stocks that emanate from an inferred batholith during deformation (Figure 31). There is no direct physical evidence of intrusion involvement, but the textures of the quartz suggest the hypo-mesozonal level of emplacement and the multi-element geochemistry with prominent Te-Bi suggest magmatic fluid is involved in the mineralisation. The best mechanism for this is to form the deposits under moderate confining pressure due to deformation loading, but to uplift the area above the batholith with buoyant forces during batholith emplacement. In this case there is a combination of fluid derived by contact metamorphic dewatering in the aureole of the pluton and local magmatic fluid emanating from the stocks.

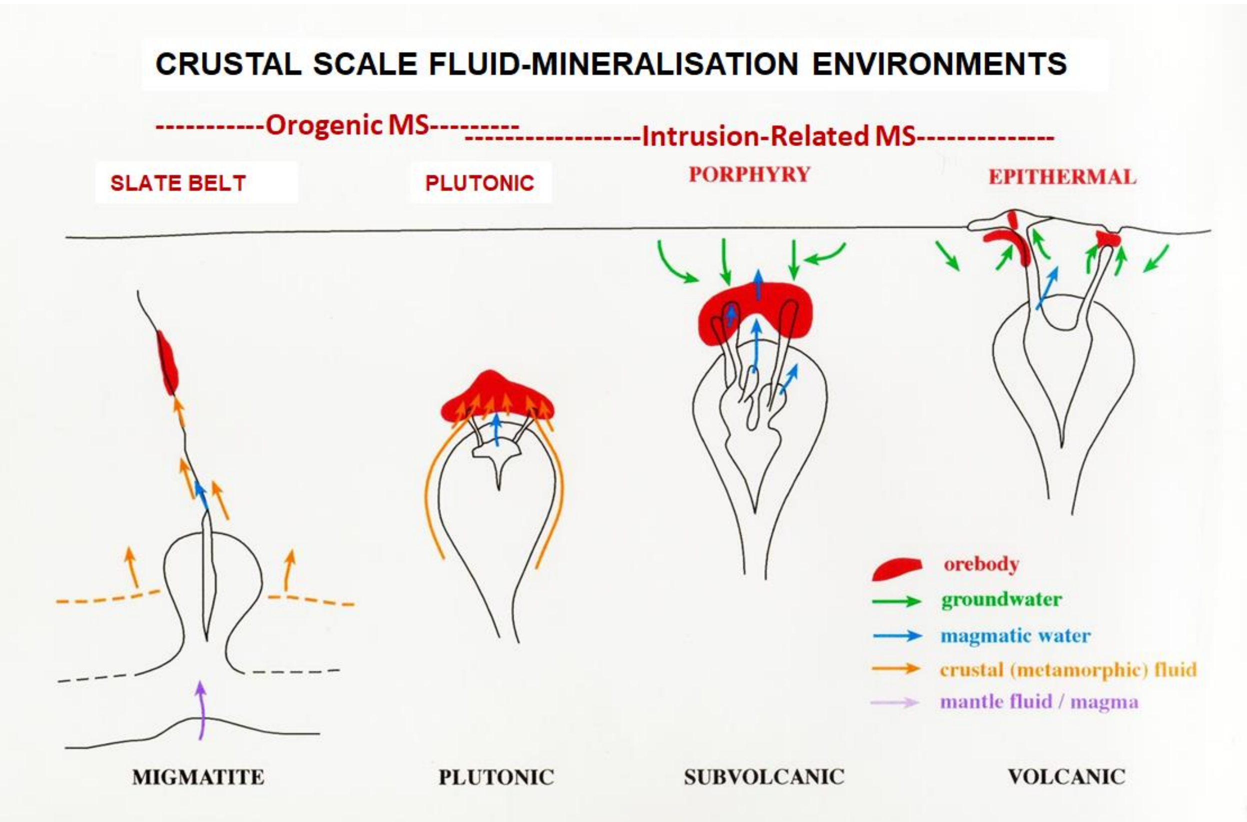

Figure 31: Conceptual model of fluid regimes for the plutonic and porphyry-epithermal deposits compared with the metamorphic fluid model generally envisaged for orogenic deposits.

The Plutonic deposits in the current Georgetown model have previously been referred to as orogenic deposits because they are lodes formed in active shear zones during regional deformation and dewatering and without direct involvement of intrusions. This is a valid descriptive model, but it does not account for the Te-Bi geochemical signature of the deposits that is interpreted as magmatic. The Te-Bi geochemical signature is most prominent in the centres of the metal zoning pattern and less prominent in the peripheral As zone in the Georgetown region deposits and in the Early Devonian deposits at Woolgar and Charters Towers that are also interpreted to have formed in a peripheral part of the zoning pattern. The overall interpretation is that there is a more magmatic signature in the deepest and most central of the districts than at shallower and more peripheral positions where the contact metamorphic fluid is more prominent.

12.0 GEORGETOWN EXPLORATION POTENTIAL

The Kidston gold deposit was the biggest producer in the region (>5 Moz) and is closely related to early Carboniferous sub-volcanic intrusives and mineralisation is hosted in a large (1 km in diameter) hydrothermal breccia pipe cut by sheeted veins. Many other intrusion-related gold (IRG) deposits lie marginal to and show genetic ties to the Carboniferous Newcastle Range Volcanics and Lochaber and Bagstowe Igneous complexes, e.g. Christmas Hill, Mount Borium and Beverley.

Strategic Minerals Corporation NL have been exploring the Woolgar area since 1986 and through their persistence have managed to identify a significant resource. Extensive drilling has enabled a detailed understanding of the geochemical zonation within the deposits. This has proved important not just for vectoring towards the gold zones but also because the base metal-rich portions of the deposit have more favourable metallurgy than the zones rich in arsenic. Historical treatment records have shown this phenomena to be applicable to other mine camps around Georgetown and Forsayth where galena bearing gold ores were reportedly easier to process than sphalerite and chalcopyrite ores, e.g. Durham, Queenslander, Nil Desperandum, Havelock (Cameron, 1909). Applying this metal zoning technique to other camps in the Georgetown region may uncover ores that were previously thought to be refractory.

The Mount Hogan gold mine was the largest single producer in the Gilberton area (2530 kg). Mineralisation consists of a series of shallow dipping, stacked veins hosted in Proterozoic granite. Alteration at Mt Hogan has been dated at 400 Ma (Early Devonian) and the deposit is classed as Plutonic Mesothermal vein style. The high-grade and flat-lying nature of the veins enabled Eltin Mining to construct a mill at Mount Hogan and extract 67,700 ounces of gold from two open cuts between 1992 and 1994. Alteration and veining has been mapped outside of the mine area and has been subject to limited drilling with some success. The Marquis (~120 kg), Josephine (266.5 kg) and Jubilee Plunger (555 kg) gold mines (Forsayth) are three other Early Devonian, Plutonic style lode deposits with flat-lying veins which, like Mount Hogan, also warrant further exploration to better understand the controlling structures and identify mineralisation peripheral to the mine area.

The Cumberland Mine is the biggest individual historical producer close to Georgetown, producing 1581 kg gold at an average grade of over an ounce /tonne (Jack, 1886). The deposit is hosted along a northeast striking Early Devonian structure, similar to the other deposits in the camp. However, unlike the other deposits (Plutonic epizonal) in the camp, the mineralisation here is related to Permian dykes. Mine records show that the shape of the ore shoots was complex, controlled by jogs in the host structure and overprinting of early quartz vein material by gold-bearing sulphides. The mine reached a maximum depth of 310 m and was only mined along strike for around 400 m and, although the lode was recorded to have pinched out at depth, the host structure was still present (Cameron, 1909). The nature of the ore suggest that other shoots probably exist along the controlling structure but this has not been tested. Like the Cumberland Mine many other lode deposits in the Georgetown area are in dire need of modern exploration.

A cluster of >1 t (gold endowment) Early Devonian lode-style camps lie immediately south and west of Georgetown (Big Wonder, Durham, International, Figure 3). Many of the deposits within these camps lie along major (20 km long) E-W trending structures, e.g. Big Wonder Fault, Golden Bar Fault. Development of the mineralised lodes, veins and shoots occur at intervals along the entire length of these structures however, many have not been drill tested or mined below the level of oxidation.

Three large, Permo-Carboniferous porphyry systems, Phyllis-May, Mount Turner and Huonfels, with anomalous gold, silver, base metal and molybdenum signatures, lie west of Georgetown. The camps all possess extensive alteration systems developed in and around porphyry complexes. Mineralisation primarily occurs as disseminated sulphides, but also occurs in fracture zones, veins, stockworks and breccia. To date, exploration has identified lode and linear zones of breccia hosting high silver and lead values (Three Musketeers, Cobar, Huonfels) with low grades of copper, gold and molybdenum. Some of the high-grade silver prospects explored in the 1980’s should be reassessed as potential silver deposits.

The Agate Creek epithermal deposit (15,985 kg Au resource) is the best example of gold mineralisation related to early Permian volcanism. The mineralisation occurs as veins, stockwork and breccia hosted in rhyolite sills dated at 285 Ma that cut Silurian (Robin Hood) granodiorite and Proterozoic metasediments. The younger volcanic rocks appear to be a more favourable host due to their brittle nature, similar to that observed at the Electric Light and Cumberland mines. Like Kidston, gold mineralisation at Agate Creek shows a close genetic link to Permo-Carboniferous intrusions, and should be included in any exploration strategy applied to the Georgetown region.

Although the Georgetown area is best known for its gold mining history, during the 1970’s significant efforts were made exploring for uranium. Only one significant deposit was identified (Maureen) located in the far north of the study area (Hurtig et al., 2014).

Many of the Devonian age Plutonic lode deposits had base metal sulphides associated with the gold ore, but rarely was the galena and chalcopyrite in sufficient concentrations to be worth treating. Some mines did however report small amounts of lead production, e.g. Dry Hash, Queenslander, International and Monte Cristo Camps.

Alluvial tin, tungsten, tantalum and bismuth have been mined historically at a few locations near Percyvale Station and in the Grants Gully area near Western Creek. The minerals are understood to be shedding from Meso-Proterozoic pegmatites hosted in the metamorphics (Withnall, 1981) and can be found within the pegmatites as well in these areas.

Although the Georgetown, Forsayth and Gilberton regions host numerous deposits covering a range of mineralisation styles, the region has still suffered from a lack of modern, focussed and thorough exploration. Detailed studies around existing deposits aimed at understanding the metal zonation, structural controls on shoots and metallurgical studies on sulphide ores will unlock new resources and advance the discovery of new deposits.

13.0 CONCLUSIONS

The overall metallogenic model for the Georgetown region has three main components:

- The **Early Devonian Plutonic Gold** group forms a distinct corridor extending ~35 km west of the Newcastle Range and ~140 km from the younger cover in the north to the Gilberton Fault in the south. This corridor hosts the main group of gold deposits mined historically in three main centres at Georgetown, Forsayth and Gilberton. The deposits are mainly shear-hosted lodes in E and ESE trending faults. At each of the three centres there are distinct zones outward from hypozonal to mesozonal and epizonal level of emplacement and from geochemically from Bi-Te to Pb-Zn-Cu to As-Sb. This is interpreted as syn- to late-deformational mineralisation localised in active structures above stocks that emanate from an underlying Silurian – Early Devonian batholith.
- The **Early Carboniferous Intrusion-Related Gold** group is scattered occurrences in the Einasleigh Metamorphics along the eastern side of the Newcastle Range. The main occurrences, including the 5 Moz Kidston gold deposit, are mesozonal-epizonal hydrothermal breccias and vein networks related to rhyolite plugs and dikes in the now exposed sub-volcanic periphery of the Newcastle Range Volcanics. The deposits have a distinct polymetallic geochemical signature with the best Au in As or Pb zones and a core of Mo-W. These are typical north Queensland IRGS with the same igneous- chemical signature as the Red Dome and Mungana deposits at Chillagoe.
- The **Early Permian Intrusion-related and Epithermal Ag-Au** group is in two distinct corridors adjacent to the Early Devonian corridor. One corridor NW of Georgetown extends NE from the Robertson Fault through the Phyllis May and Red Dam prospects towards Chillagoe and the other extends SE along the Robertson Fault from Greenhills prospect through the Agate Creek deposit to the Gilberton Fault. The deposits are Ag-rich polymetallic stockwork and breccia deposits centred on dioritic plugs as at Phyllis May and Ag-Au epithermal deposits associated with rhyolitic dikes adjacent to the volcanic centre as at Agate Creek. In several deposits including Mt Turner and Log creek there is also Au-Ag mineralisation associated with late Carboniferous sub-volcanic intrusions peripheral to the volcanic complexes. The distinctive intrusive and volcanic centres localised along the early Permian trans-tensional corridors have long been a target both here and around Mt Leyshon in Charters Towers.

The gold deposits are the predominant feature of the region but there are also: Paleo-Proterozoic (?) base metal deposits in Einasleigh Metamorphics, for which we obtained an early Permian age that is difficult to explain; U-Mo-F deposits in the basal sedimentary portion of the early Carboniferous volcanic complexes; and the Nb-Ta ± Li-W-Sn deposits mainly in Meso-Proterozoic pegmatites.

The most notable feature of the mining and exploration work in the region is the dearth of drilling, particularly into the sulfide lodes beneath the shallow oxide Au deposits in the recent mines. The metallurgical problems of the As-rich sulfide ores is appreciated, but the Pb-Zn zone in these deposits has better Au grade and better metallurgy as has been demonstrated in the resource definition in Big Reef South at Woolgar and in the recent sampling in the Gilberton District. The shallow dipping gold lodes at Mt Hogan and Jubilee Plunger have likewise only been tested at shallow level so the true extent of the mineralisation is not defined.

The IRGS deposits like Kidston and Mt Turner are distinctly metal-zoned systems, with the gold confined to a base metal zone beneath a gold-poor As zone. The known systems defined previously from hydrothermal features but only explored in the As zone like Beverley, Mt Borium or Ironhurst are thus of interest.

There are million ounce resources in both the early Permian (?) epithermal and Early Devonian mesothermal lodes in the Woolgar Inlier 60 km SW of Gilberton. The now established metallogenic link of these deposits to the Georgetown Inlier demonstrates the potential beneath the Mesozoic cover in this region.

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