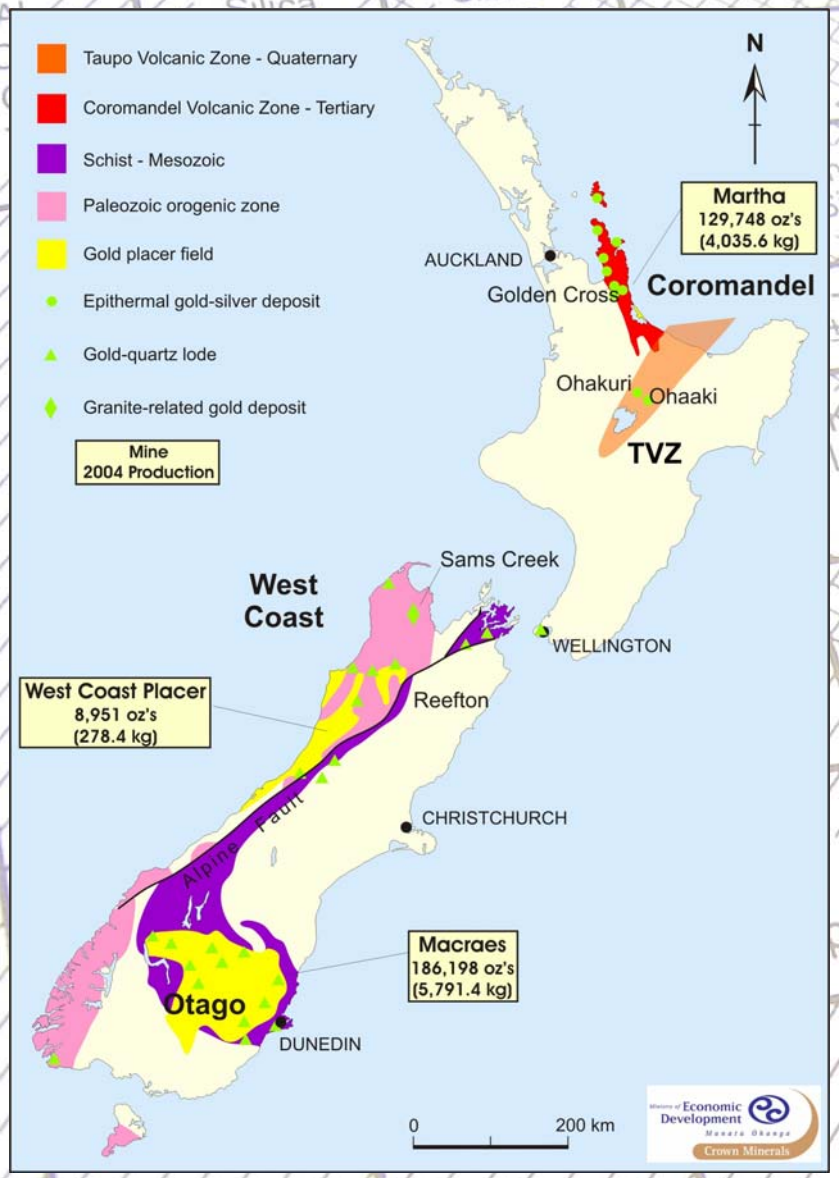
Terry Leach and Gold in New Zealand – Turning Concepts into Targets

P Grieve

Terry Leach Symposium

17 October 2008

Gold provinces of New Zealand



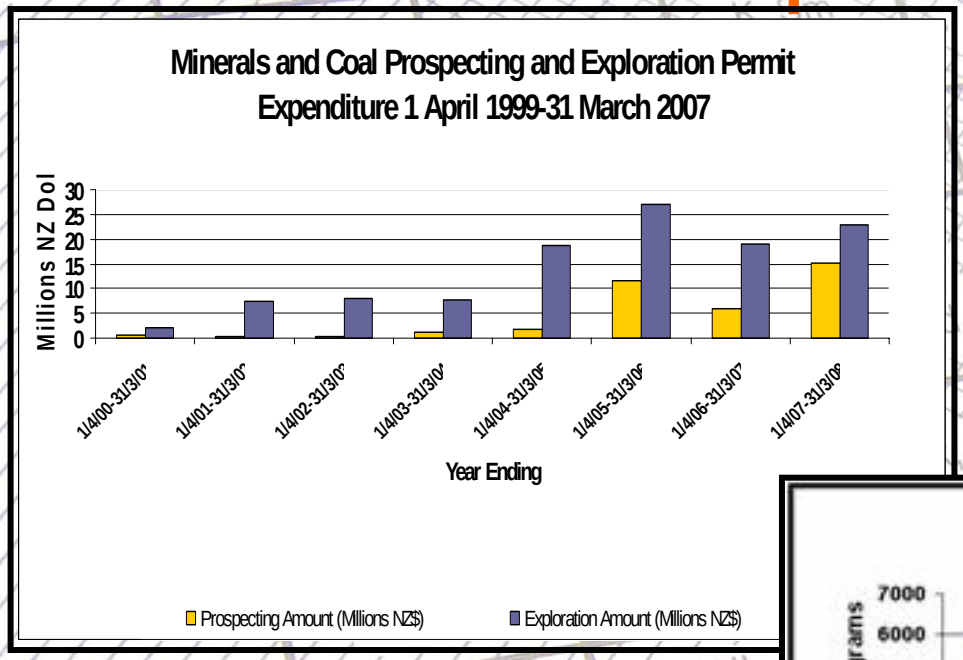
Past and present gold production in New Zealand has been from four main geological environments:

- Mesothermal quartz lodes in Paleozoic metagreywacke
- Mesothermal quartz lodes in Mesozoic schist
- Epithermal quartz lodes in Cenozoic volcanic rocks,

and

- Placer deposits in Cenozoic gravel and sand

New Zealand Gold Production and Exploration Expenditure



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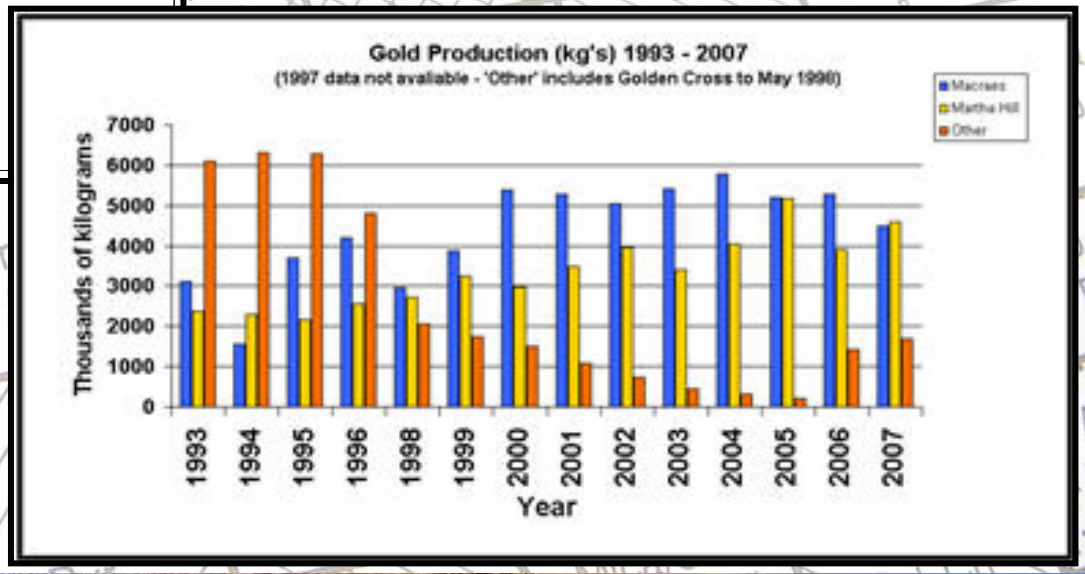

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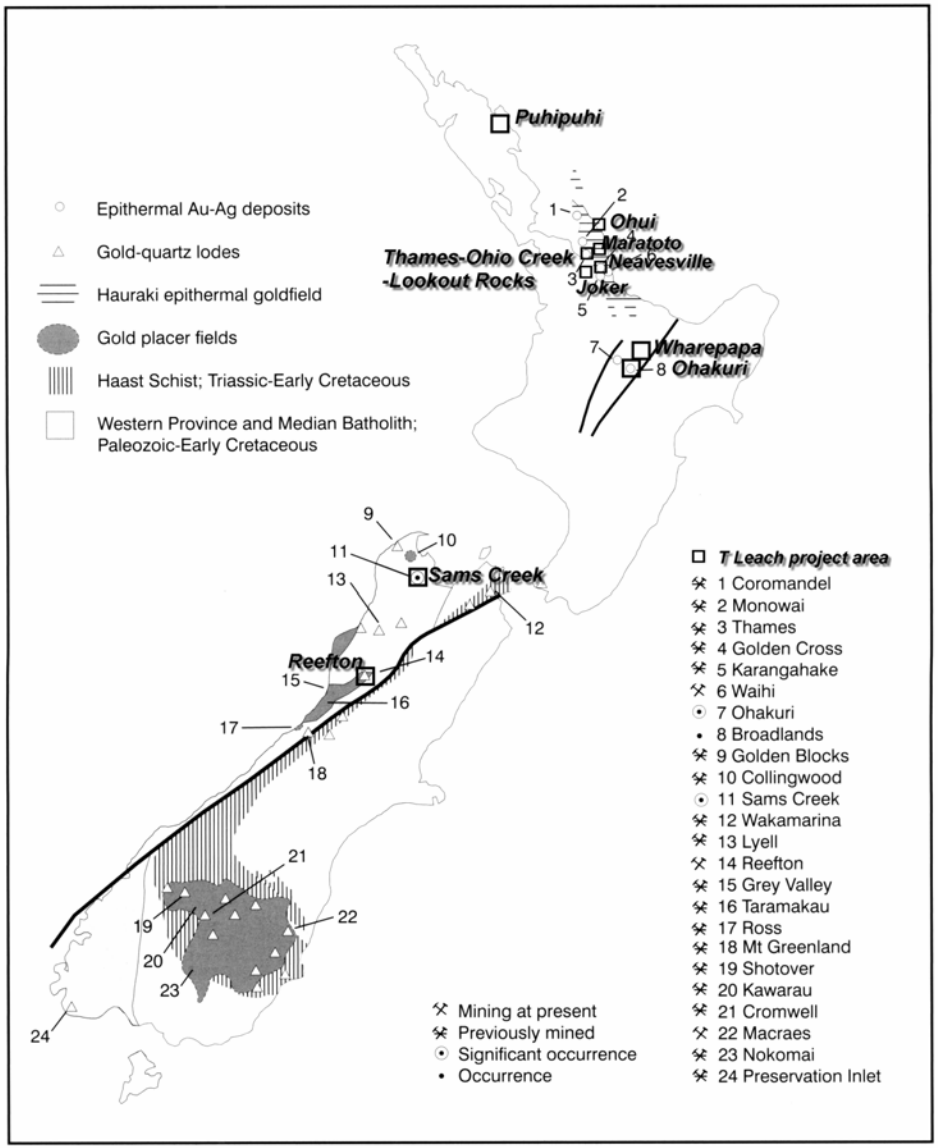
Selected projects reviewed by Terry Leach



Northland – Puhipuhi

Hauraki Goldfield – Joker

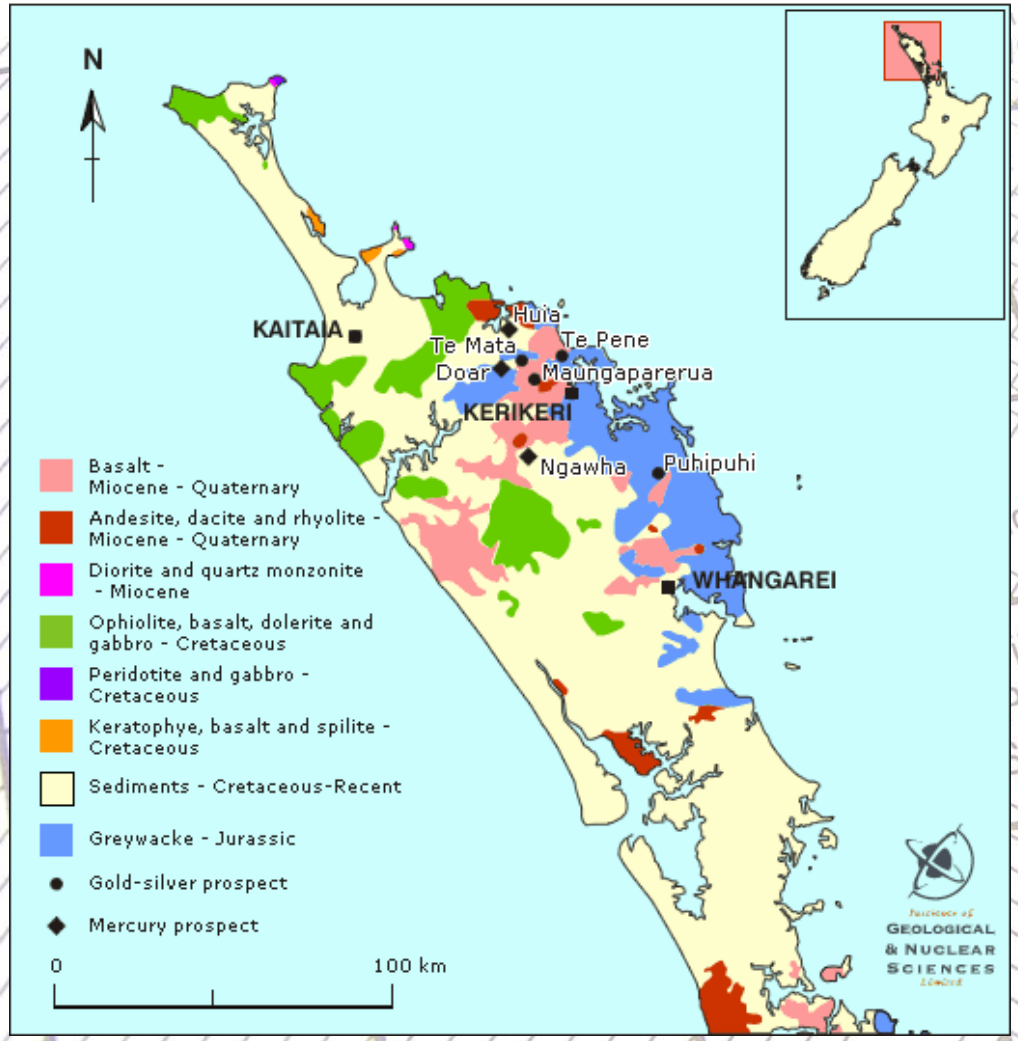
Taupo Volcanic Zone – Ohakuri

NW Nelson – Sams Creek

Reefton Goldfield

Northland - epithermal

New Zealand gold prospects - Northland



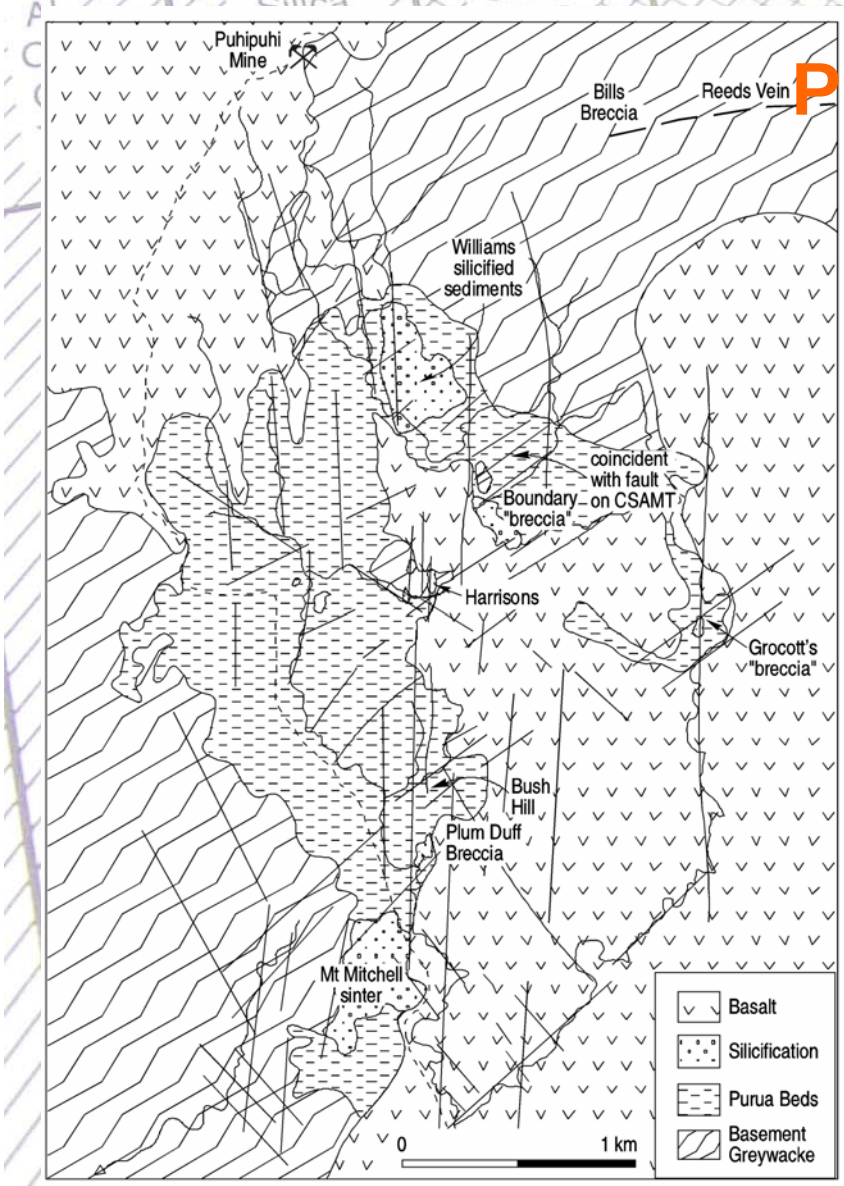
Puhipuhi

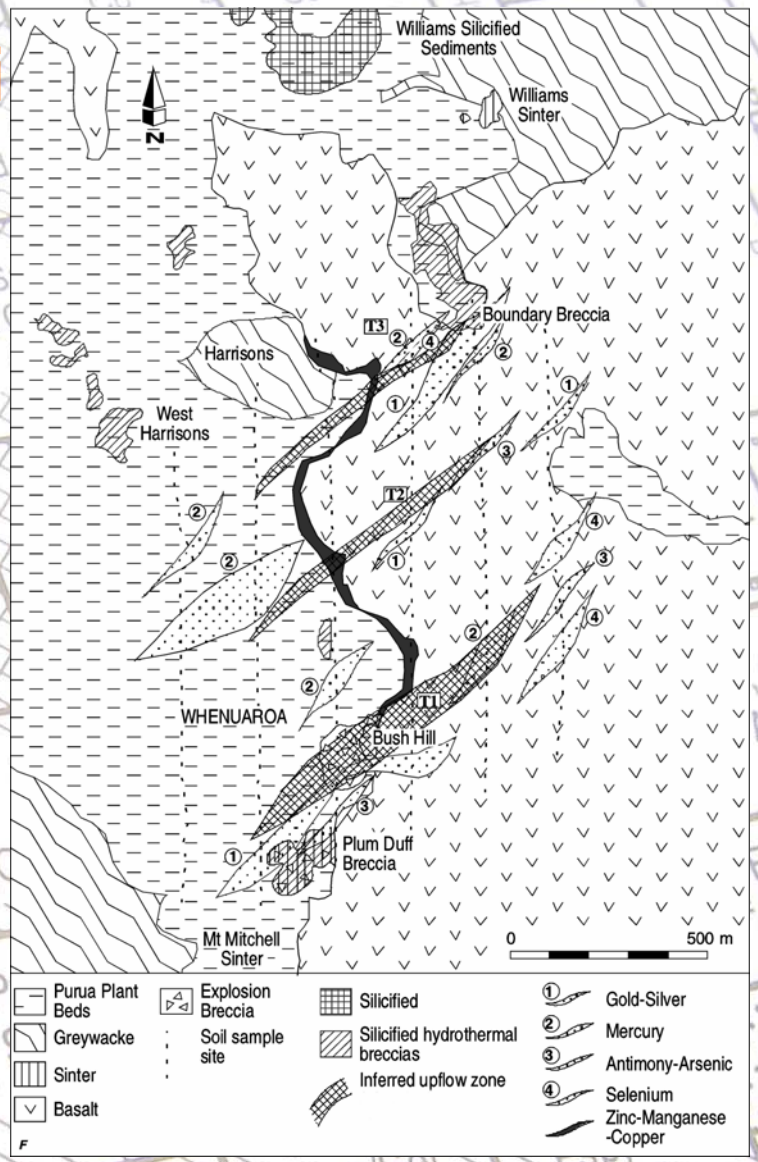
Exposure of collapsed sinter sheet and hydrothermal eruption blocks at Plum Duff, Puhipuhi, Northland (Christie and Brathwaite 2003)

Puhipuhi is a well preserved sinter/breccia hydrothermal system hosted in greywacke and lake sediments overlain by <5 Ma basalts related to a NS graben.

The conceptual model invokes N-S structural control to the emplacement of a high level felsic intrusion at depth and upflow of mineralising fluids within NE trending dilational structures beneath the Bush Hill area.

Puhipuhi


Puhipuhi Mine
Bills Breccia
Reeds Vein
Williams silicified sediments
coincident with fault on CSAMT
Boundary breccia
Harrisons
Grocott's "breccia"
Bush Hill
Plum Duff Breccia
Mt Mitchell sinter
Basalt
Silicification
Purua Beds
Basement Greywacke
0
1 km


Williams Silicified Sediments
Williams Sinter
N
Boundary Breccia
Harrisons
West Harrisons
T3
T2
T1
WHENUAROA
Bush Hill
Plum Duff Breccia
Mt Mitchell Sinter
0
500 m
Purua Plant Beds
Greywacke
Sinter
Basalt
Explosion Breccia
Soil sample site
Silicified
Silicified hydrothermal breccias
Inferred upflow zone
Gold-Silver
Mercury
Antimony-Arsenic
Selenium
Zinc-Manganese -Copper

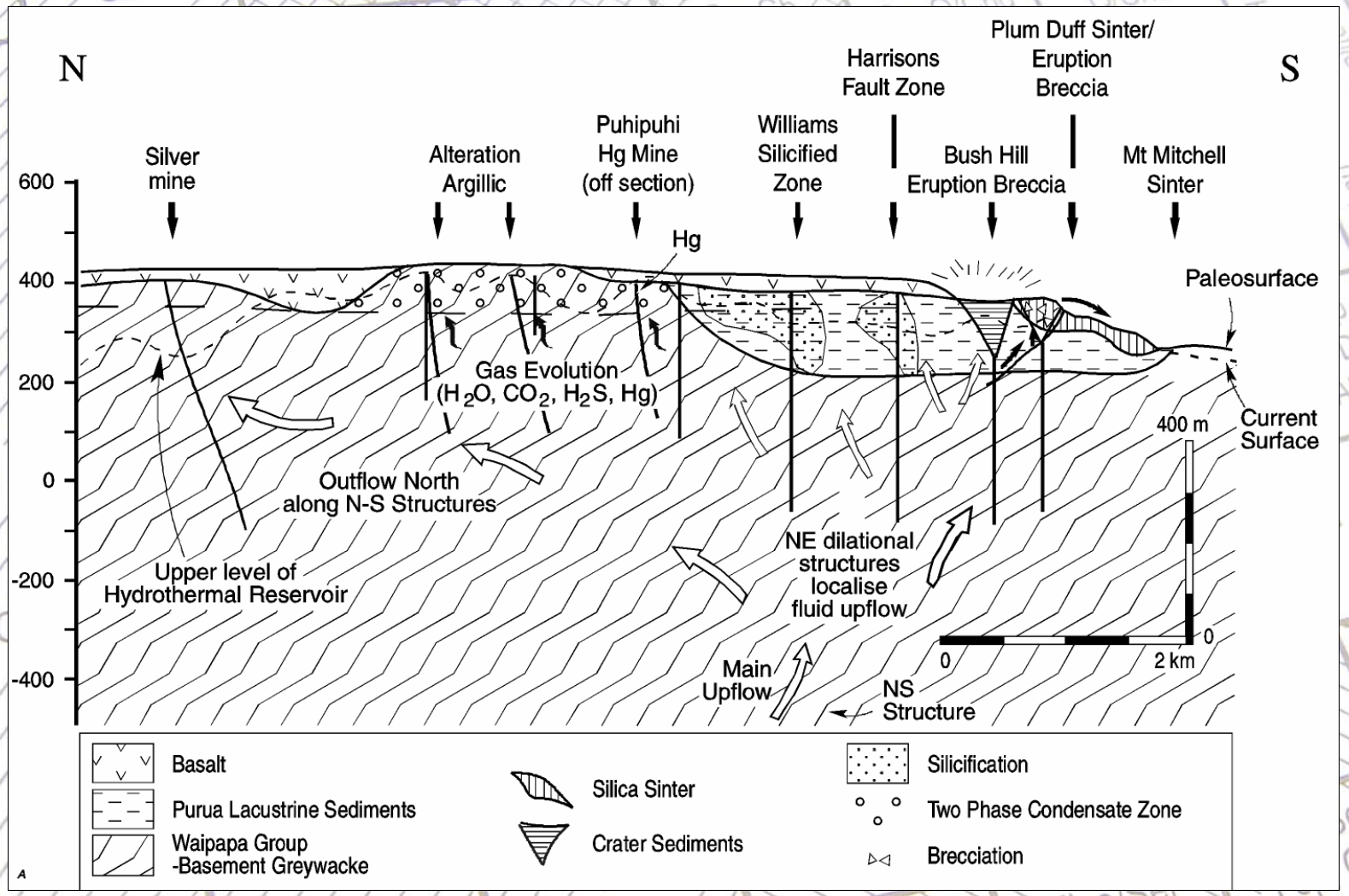
Puhipuhi

Block of silicified hydrothermal eruption breccia containing large fragments of laminated sinter sheet at Plum Duff, Puhipuhi, Northland. (Christie and Brathwaite 2003)

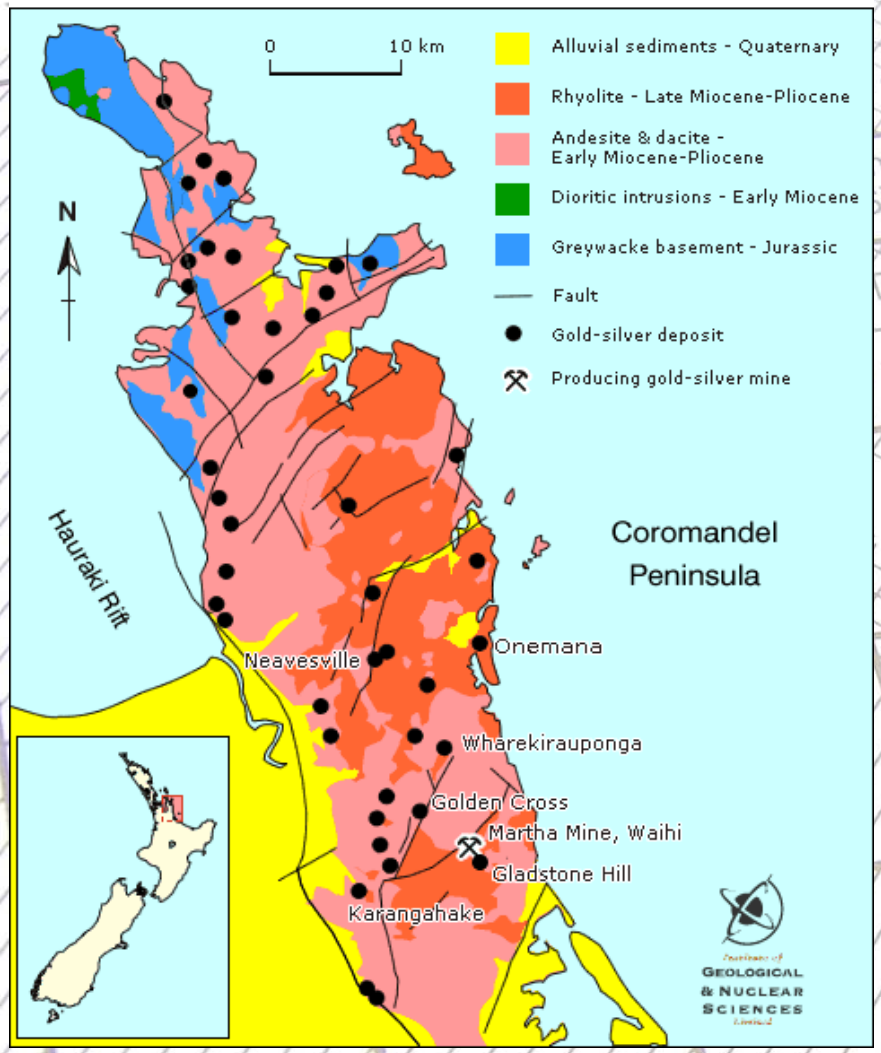
A progression of mineralisation and alteration styles from south to north is recognised from: the Mt Mitchell sinter, through brecciated sinter at Plum Duff, to open space breccia/veins in filled with quartz pseudomorphing bladed stibnite at Bush Hill, and argillic alteration further north. Outflow is evident to the south as sinter deposits.

Exploration of the inferred targets is yet to be undertaken.

Puhipuhi


N
S
Silver mine
Alteration Argillic
Puhipuhi Hg Mine (off section)
Williams Silicified Zone
Harrisons Fault Zone
Plum Duff Sinter/ Eruption Breccia
Bush Hill Eruption Breccia
Mt Mitchell Sinter
Hg
Paleosurface
Current Surface
600
400
200
0
-200
-400
Gas Evolution (H_2O, CO_2, H_2S, Hg)
Outflow North along N-S Structures
Upper level of Hydrothermal Reservoir
NE dilational structures localise fluid upflow
Main Upflow
NS Structure
400 m
0
2 km
Basalt
Purua Lacustrine Sediments
Waipapa Group -Basement Greywacke
Silica Sinter
Crater Sediments
Silicification
Two Phase Condensate Zone
Brecciation

Hauraki Goldfield – epithermal-porphyry



Terry's contribution included work on :

Neavesville

Waitekauri

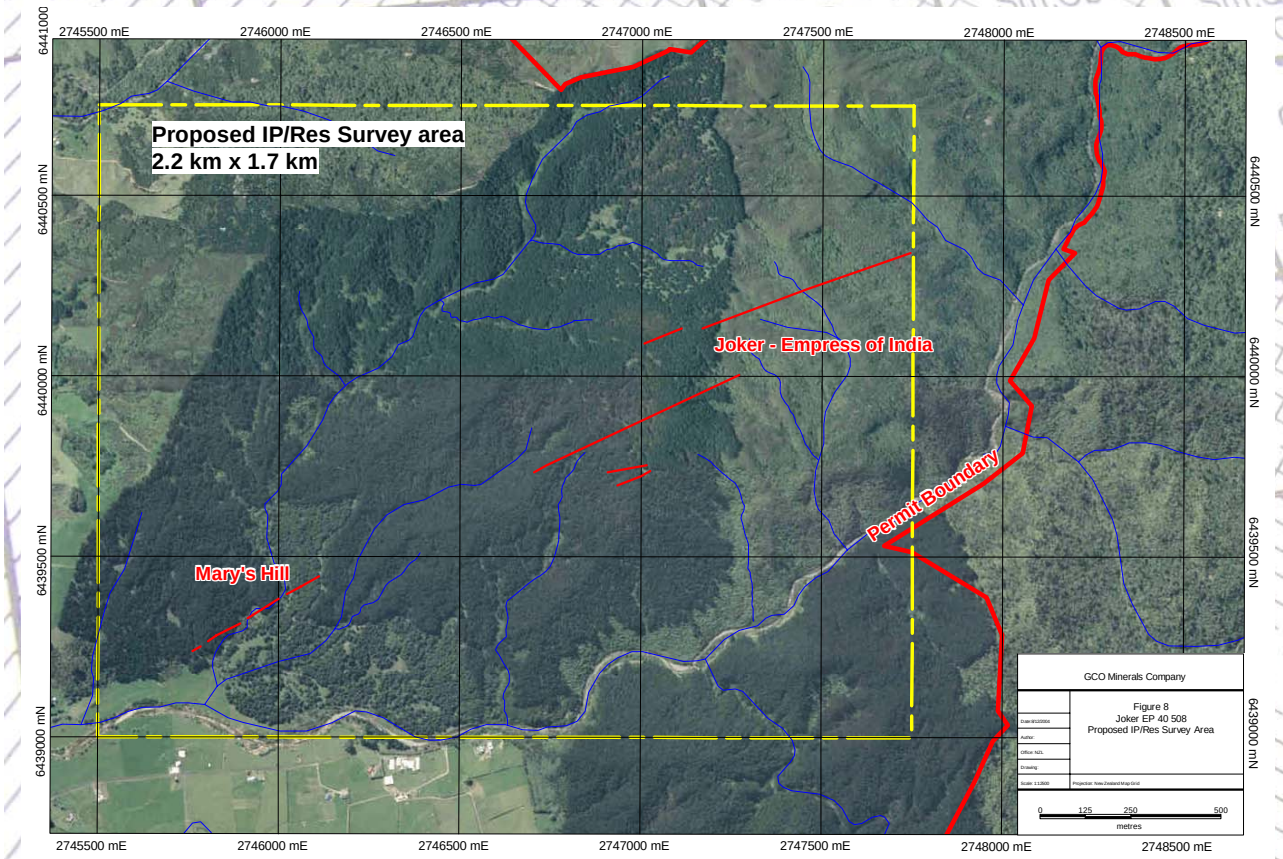
Ohui

Joker

Look Out Rocks

Maratoto Valley

Joker

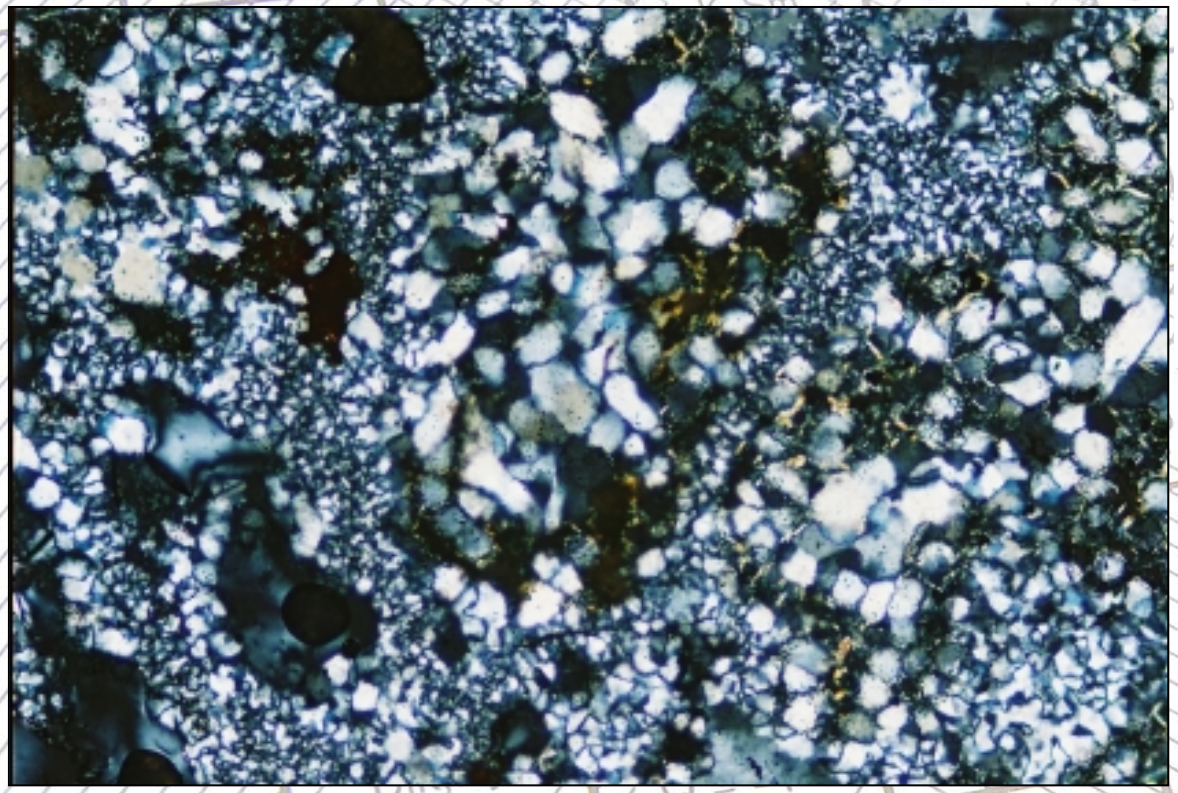


Joker comprises a set of historically worked epithermal low sulphidation style veins on the eastern margin of the Hauraki Goldfield

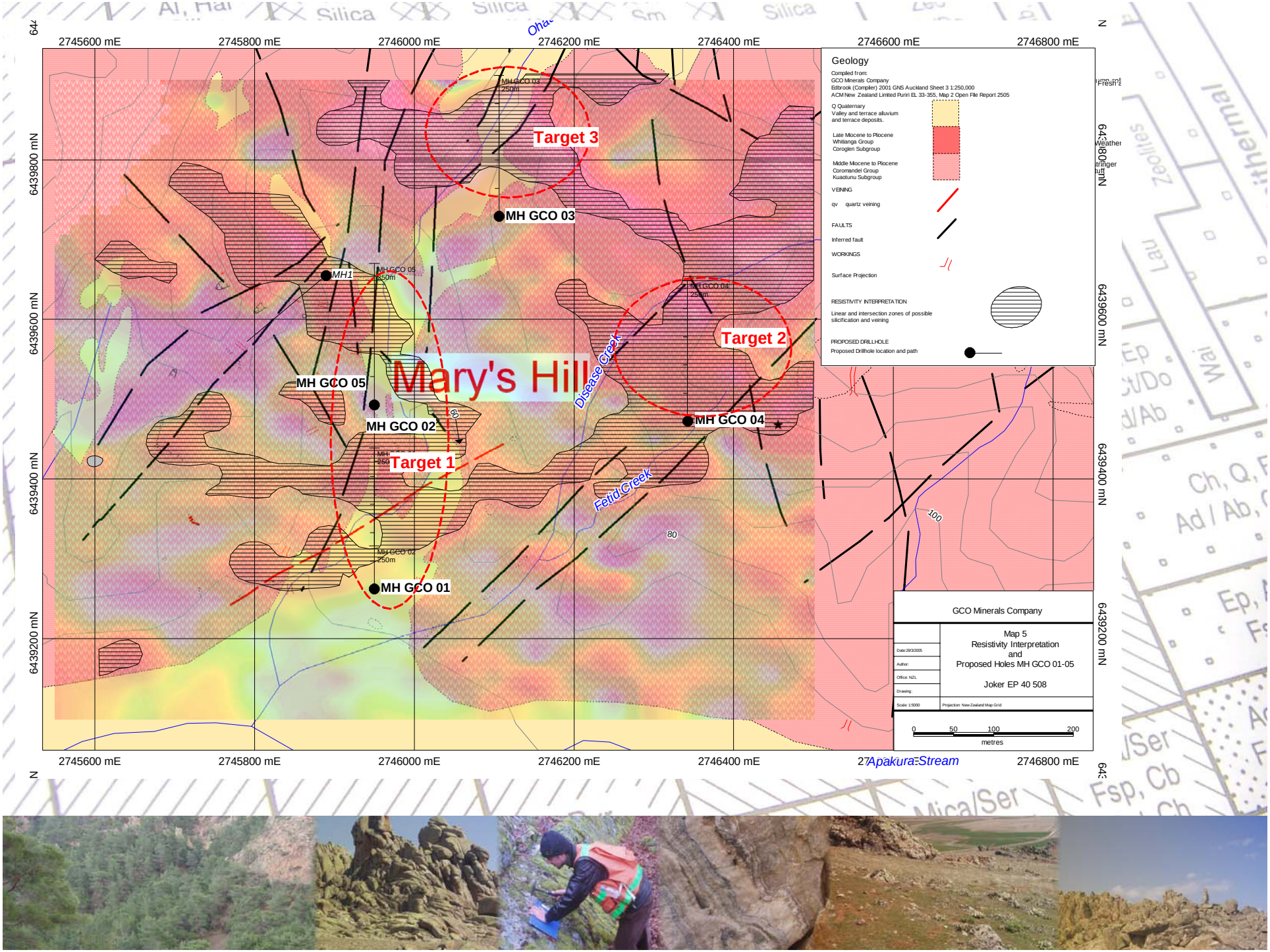
TML: 'The vein samples from this suite are characteristic of the low sulphidation veins formed at very shallow epithermal levels in the Thames Goldfield. The presence of illitic clay rather than adularia, which occurs in the eastern Coromandel goldfields, is a reflection of the less felsic, andesite calc-alkaline environment in which the Thames hydrothermal systems developed."

Recent drilling by Underworld Resources returned results up to 9 m at 1.05 ppm Au.

Joker



TML Plate 2, 10005 : Globular vughs lined by quartz and overgrown by illitic clay are inferred to have been gas bubbles. These are incorporated into a very fine grained quartz vein that exhibits relict colloform banding indicative of re-crystallisation from an original amorphous silica . Field of view is 1.3 mm. XPL


2745600 mE
2745800 mE
2746000 mE
2746200 mE
2746400 mE
2746600 mE
2746800 mE
6439800 mN
6439600 mN
6439400 mN
6439200 mN
Target 3
Target 2
Target 1
Mary's Hill
MH GCO 03
MH GCO 05
MH GCO 02
MH GCO 04
MH GCO 01
MH1
Disease Creek
Feild Creek
Apakura Stream
Geology
Compiled from:
GCO Minerals Company
Edbrook (Compiler) 2001 GNS Auckland Sheet 3 1:250,000
ACM New Zealand Limited Puriri EL 33-355, Map 2 Open File Report 2505
Q Quaternary
Valley and terrace alluvium and terrace deposits.
Late Miocene to Pliocene
Whitianga Group
Coroglen Subgroup
Middle Miocene to Pliocene
Coromandel Group
Kuaotunu Subgroup
VEINING
qv quartz veining
FAULTS
Inferred fault
WORKINGS
Surface Projection
RESISTIVITY INTERPRETATION
Linear and intersection zones of possible silicification and veining
PROPOSED DRILLHOLE
Proposed Drillhole location and path
GCO Minerals Company
Map 5
Resistivity Interpretation
and
Proposed Holes MH GCO 01-05
Joker EP 40 508
Date: 29/3/2005
Author:
Office: NZL
Drawing:
Scale: 1:5000
Projection: New Zealand Map Grid
0
50
100
200
metres

Ohakuri – Taupo Volcanic Zone

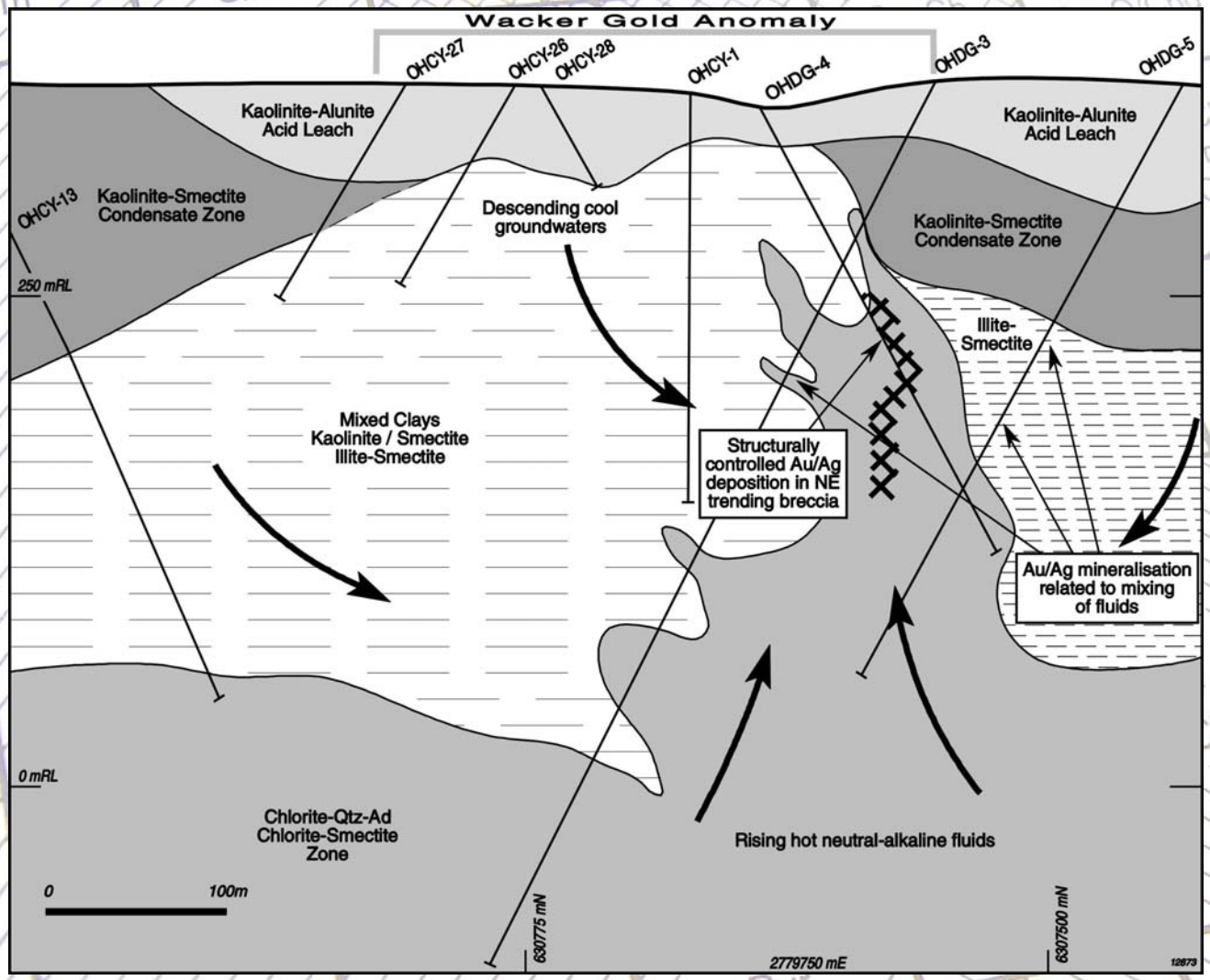
Ohakuri – Taupo Volcanic Zone

Two modes of gold deposition were recognised at Ohakuri:

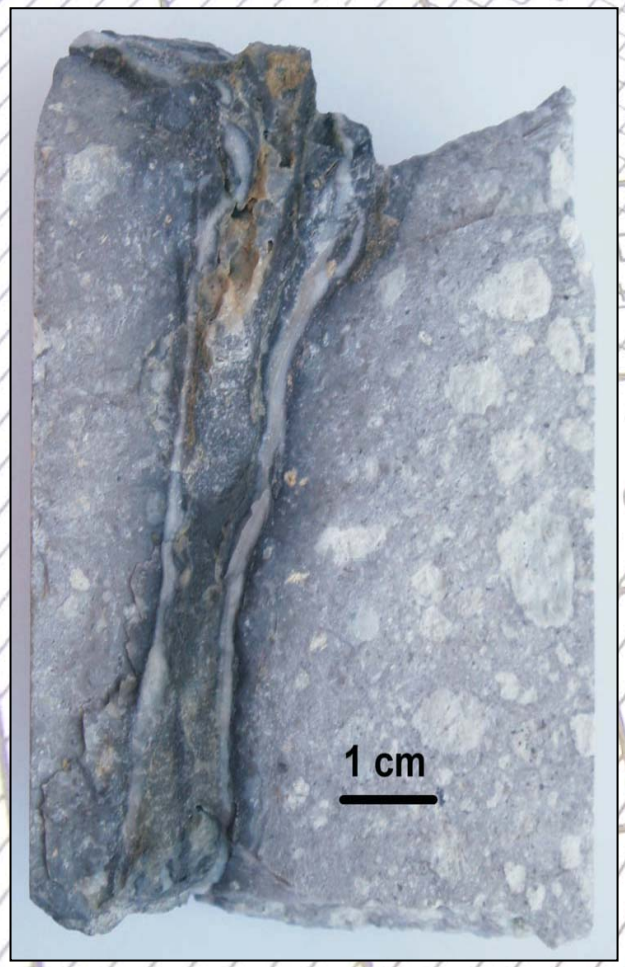
1. Mineralisation associated with thin (<20 mm) weakly banded quartz-sulphide veins which account for higher grades (up to 45 g/t Au in selected vein samples) and,

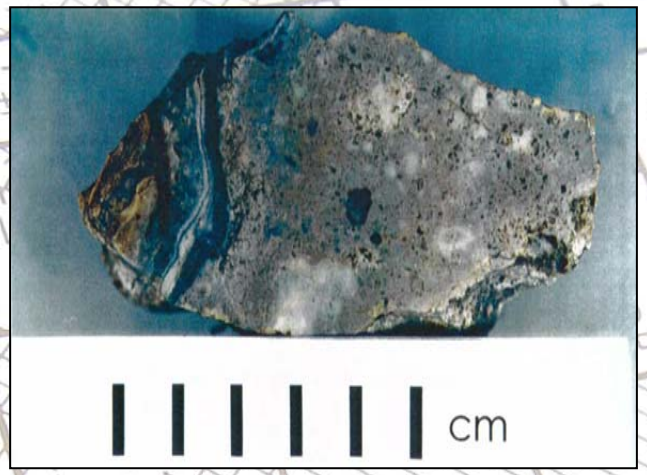
2. Mineralisation associated with mixing of cool near surface acid waters with deeper chloride waters accounts for lower grade, disseminated mineralisation (e.g. 100 m @ 0.33 g/t Au in hole OHDG-5).

Ohakuri – Taupo Volcanic Zone



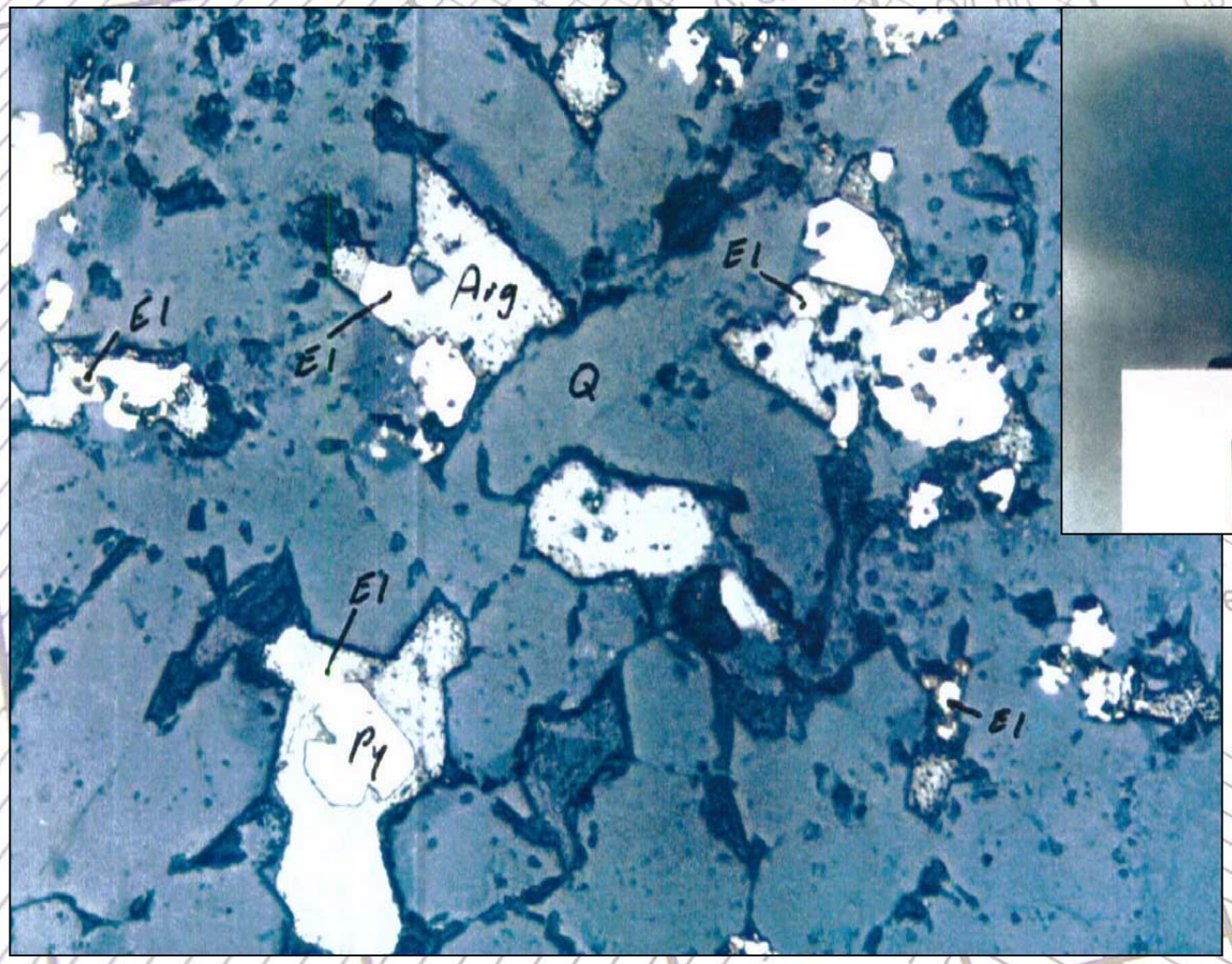
Ohakuri – Taupo Volcanic Zone





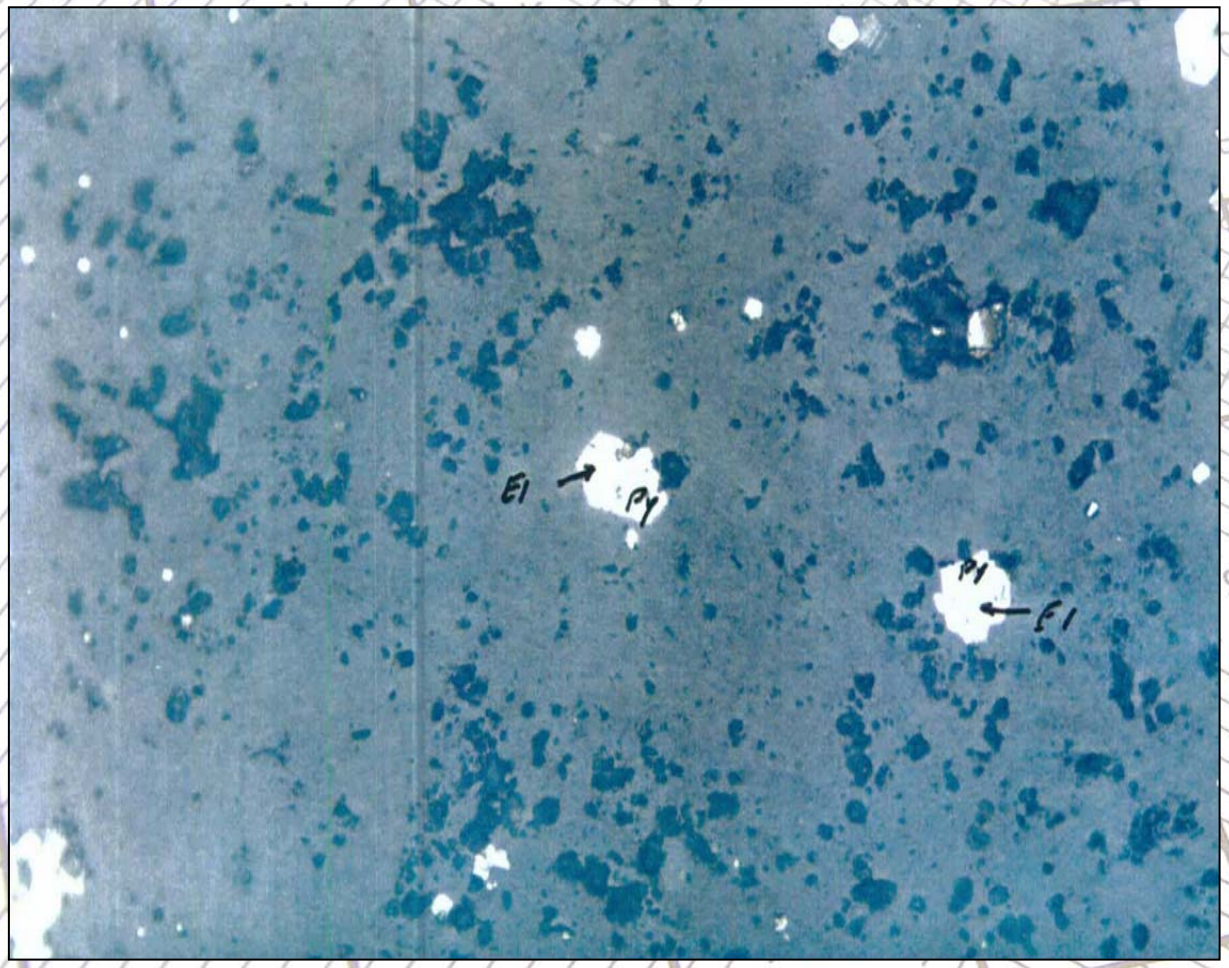
Colloform banded quartz fissure vein in drill core - OHCY-8 @ 171 m depth. The 10 cm sample interval assayed 45 ppm Au.

Ohakuri – Taupo Volcanic Zone



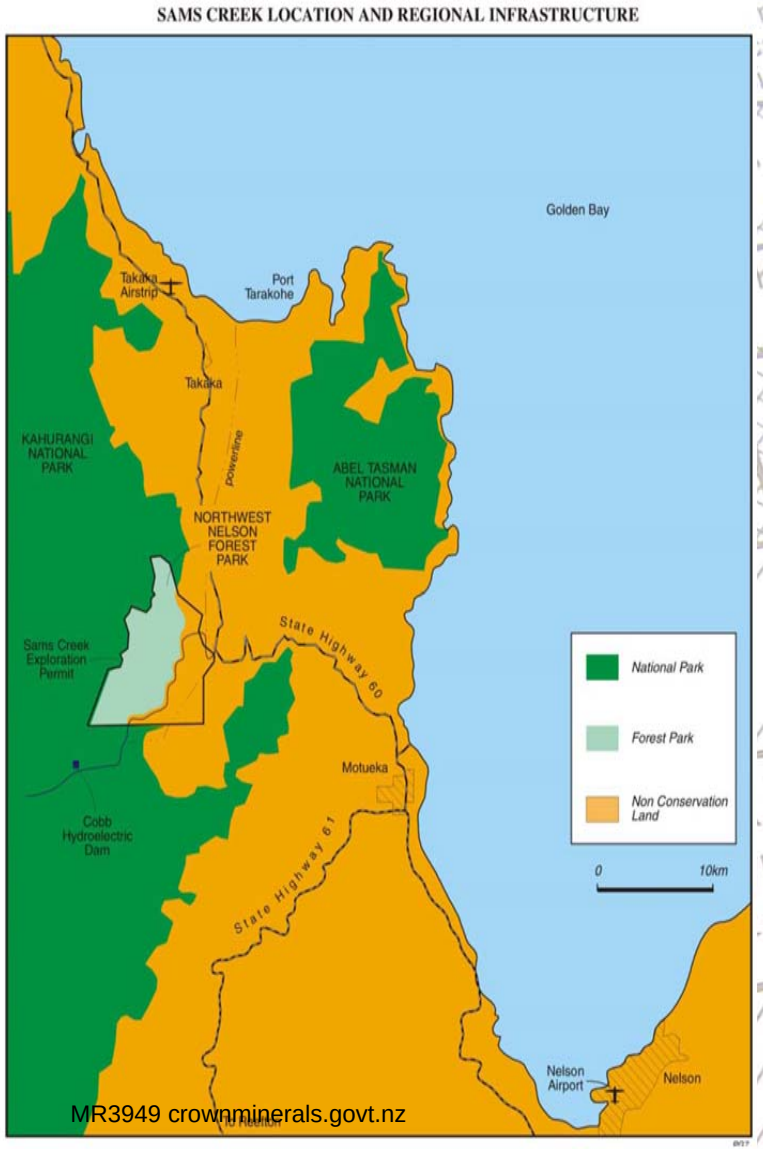
B0804; OH4 @ 117.1 m depth. Pyrite overgrown by argentite and electrum infilling open cavities in quartz-adularia vein. Field of view 0.6 mm

Ohakuri – Taupo Volcanic Zone



B0805; OH6 @134.3 m. Mixing zone mineralisation: 4-6 micron electrum inclusions in pyrite in quartz+/- adularia crackle brecciation of tuff. Field of view 0.3 mm (XPL).

Sams Creek - porphyry

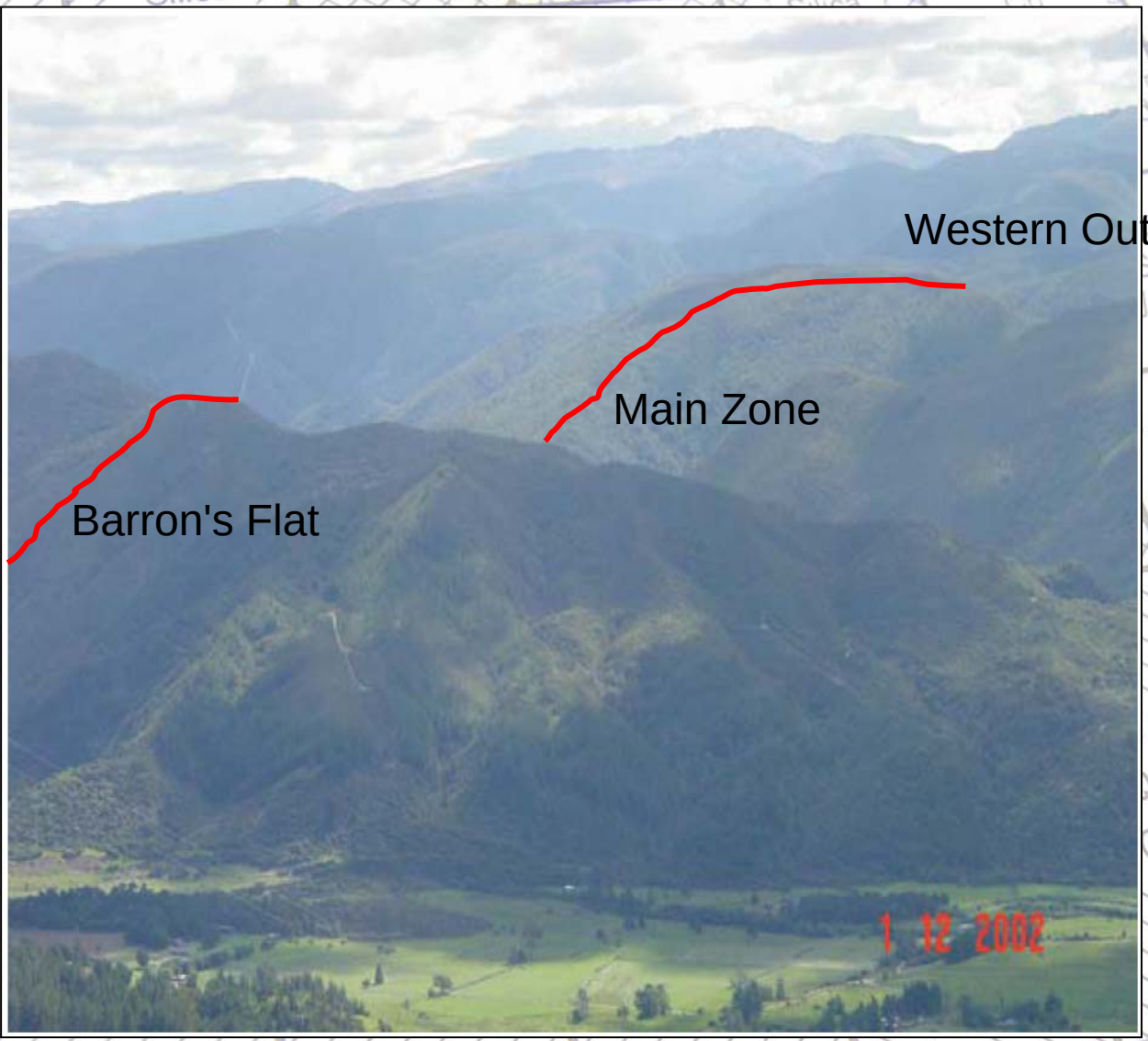


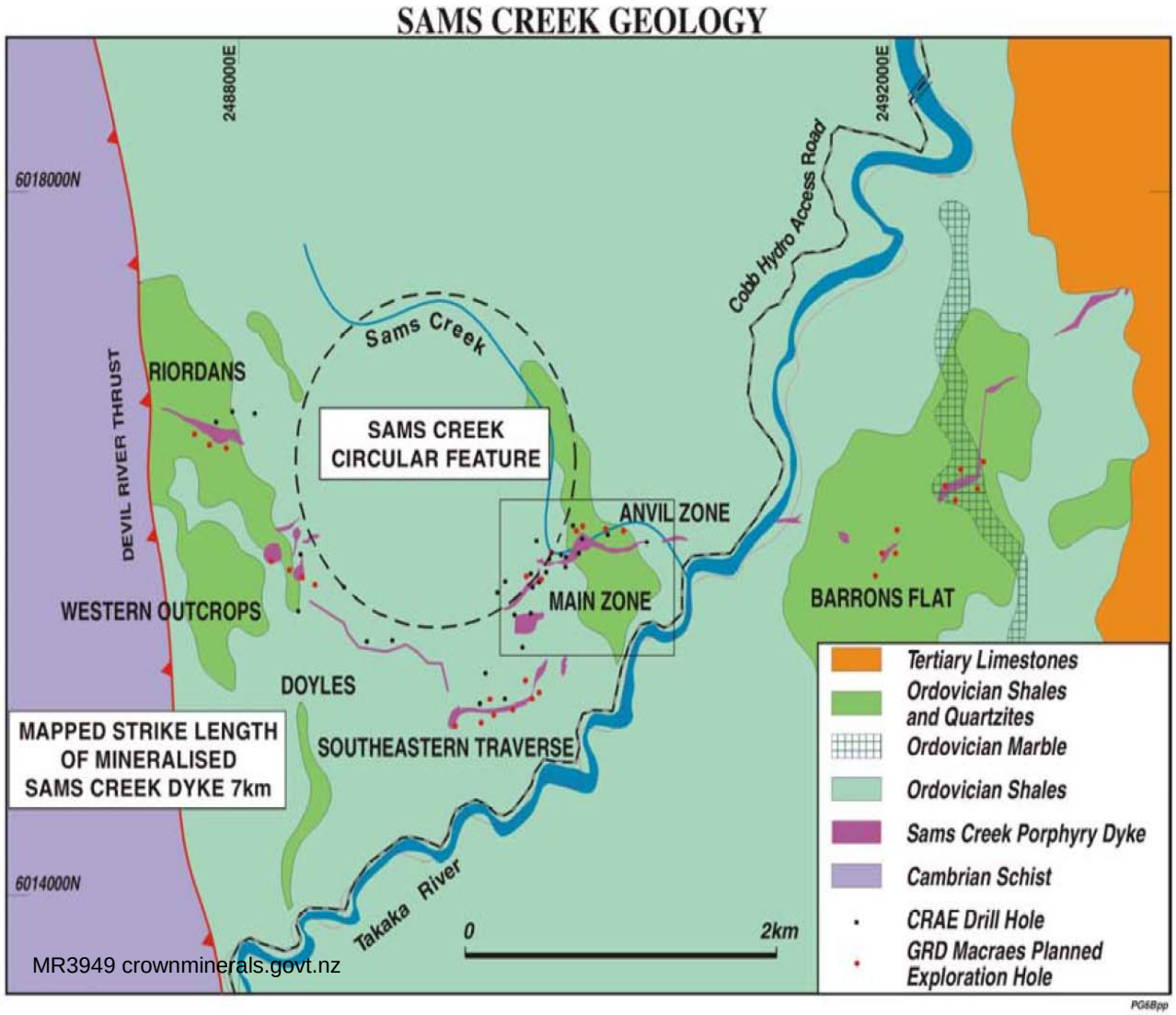
The Sams Creek porphyry is a 7 km long mineralised dyke with an average thickness of 20 m. CRAE drilled 42 holes to define a resource at the Main Zone.

Based on a geological model developed in conjunction with Terry Leach and Greg Corbett a 6 hole drill programme over the summer of 2002-2003 resulted in an increased resource estimate for the Main Zone of 13.50 Mt at 1.78 ppm Au for 0.77Moz Au. Intersections included 144 metres grading 1.53 g/t in SCDDH44, 48 metres grading 2.62 g/t in SCDDH45 and 38 metres grading 3.19 g/t in SCDDH48.

OceanaGold (2008) consider the mineralised dyke to be a small part of a much larger pluton related alteration and mineralisation system.

Sams Creek





MR3949 crownminerals.govt.nz

Sams Creek

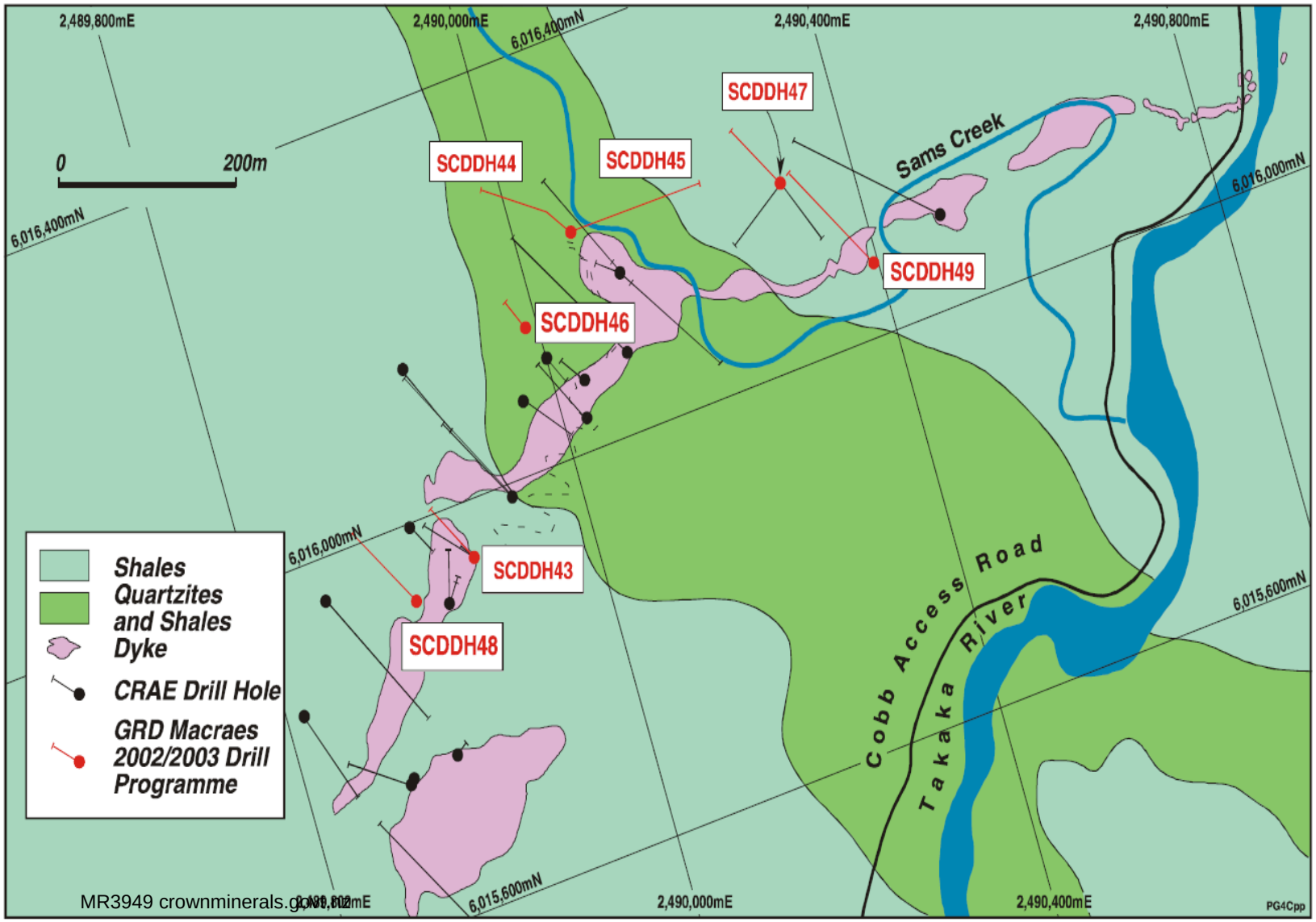
Mineralisation style is porphyry related quartz-sulphide, similar to many magmatic arc gold occurrences. It was recognised that gold mineralisation is related to sheeted quartz-pyrite-arsenopyrite veins hosted within a Triassic peralkaline granite dyke and related lamprophyre dykes which were emplaced into low grade Ordovician meta-sedimentary host rocks.

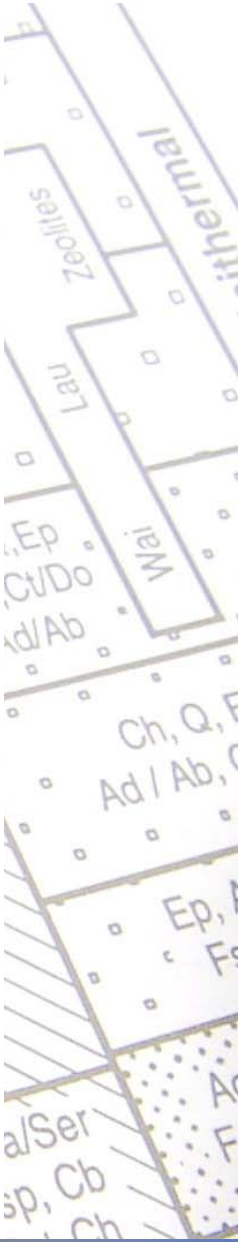
Sams Creek

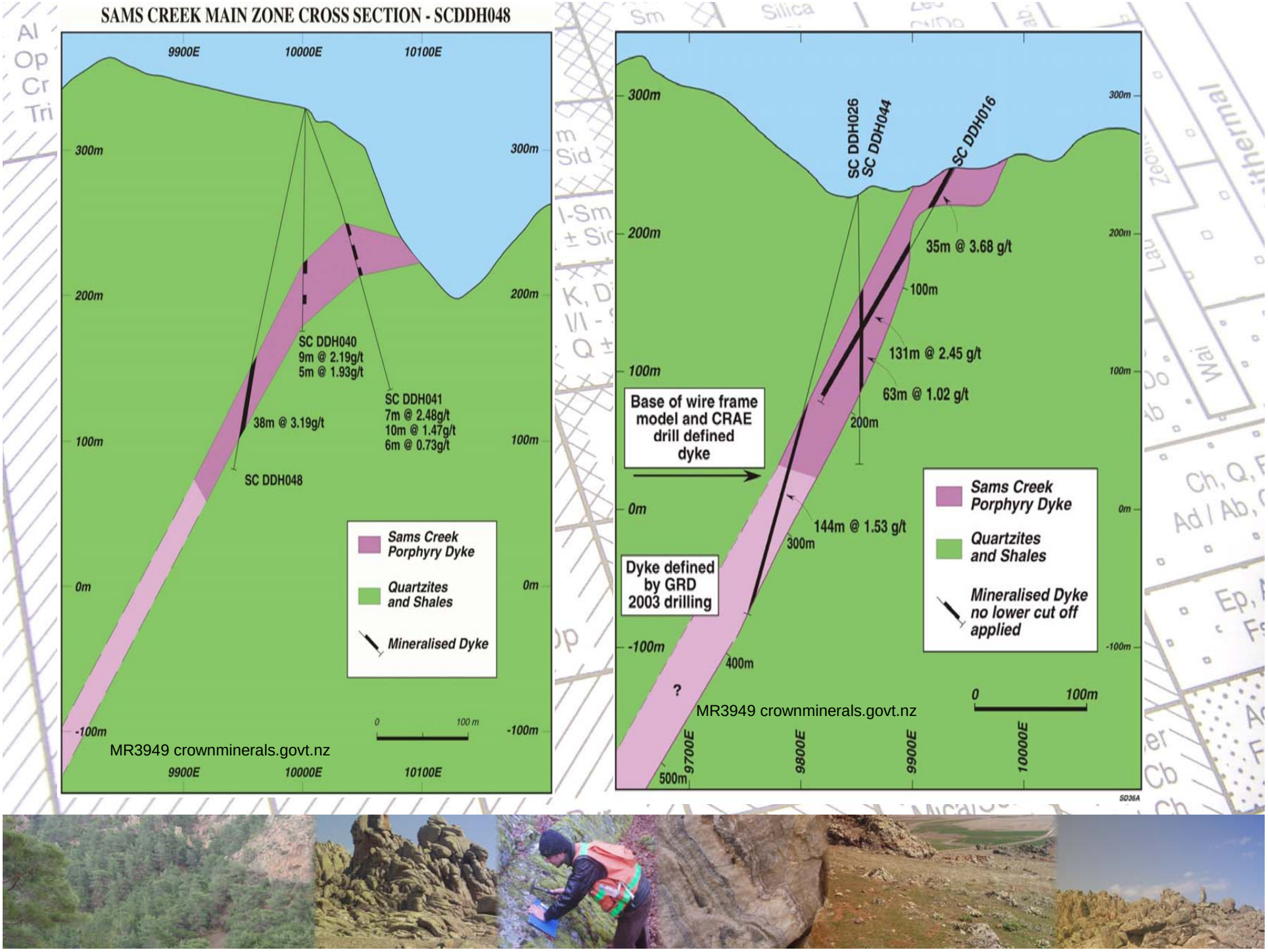
Barren quartz +/- carbonate veins

Mineralised qtz+py+aspy+gold veinlets

SAMS CREEK MAIN ZONE PLAN

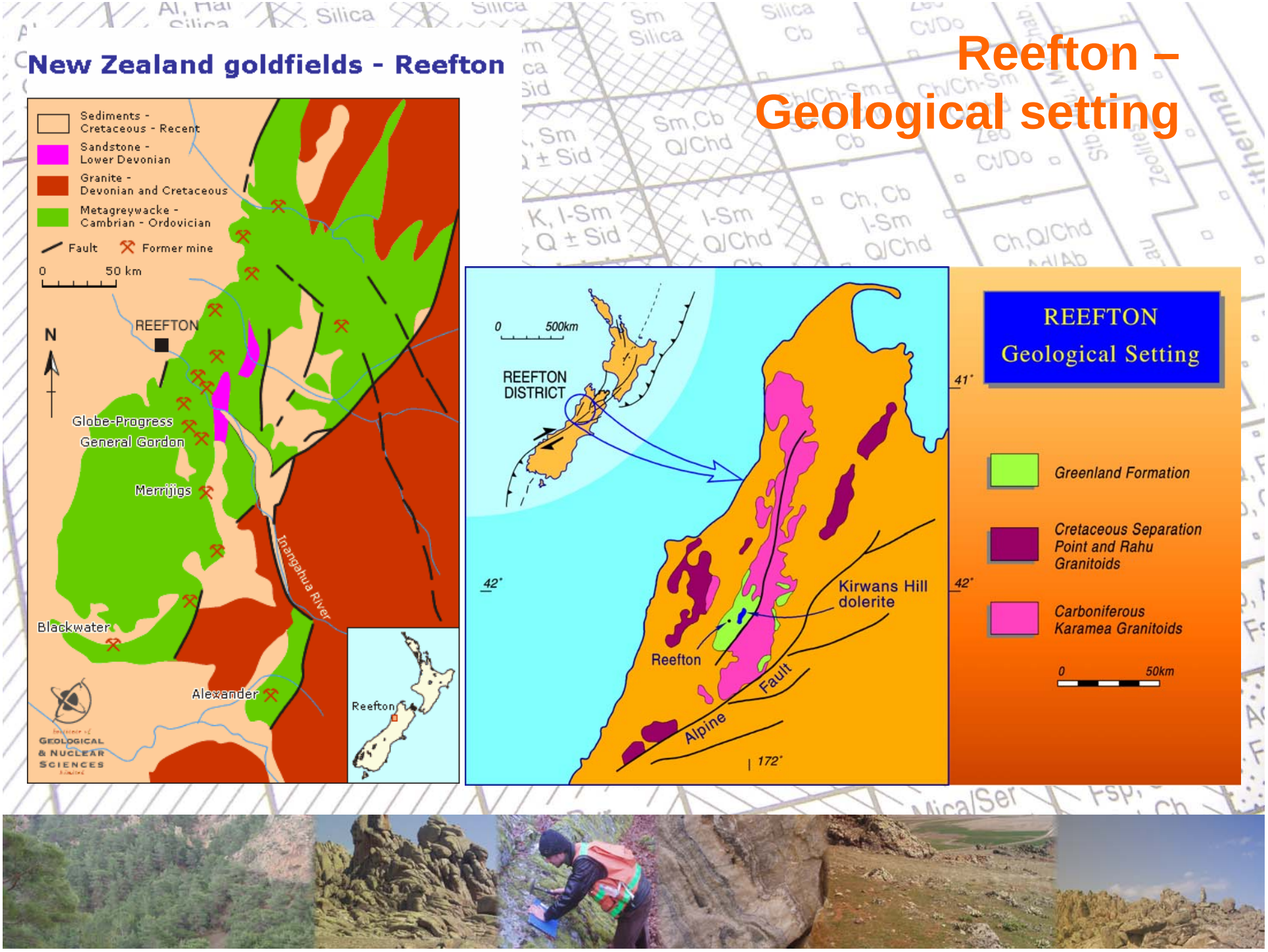





SAMS CREEK MAIN ZONE CROSS SECTION - SCDDH048
9900E
10000E
10100E
300m
200m
100m
0m
-100m
SC DDH040
9m @ 2.19g/t
5m @ 1.93g/t
SC DDH041
7m @ 2.48g/t
10m @ 1.47g/t
6m @ 0.73g/t
38m @ 3.19g/t
SC DDH048
Sams Creek Porphyry Dyke
Quartzites and Shales
Mineralised Dyke
0
100 m
MR3949 crownminerals.govt.nz
SC DDH026
SC DDH044
SC DDH016
35m @ 3.68 g/t
131m @ 2.45 g/t
63m @ 1.02 g/t
144m @ 1.53 g/t
Base of wire frame model and CRAE drill defined dyke
Dyke defined by GRD 2003 drilling
Sams Creek Porphyry Dyke
Quartzites and Shales
Mineralised Dyke no lower cut off applied
0
100m
MR3949 crownminerals.govt.nz
9700E
9800E
9900E
10000E
500m
400m
300m
?
SD36A

Sams Creek

Reefton – Geological setting



Reefton

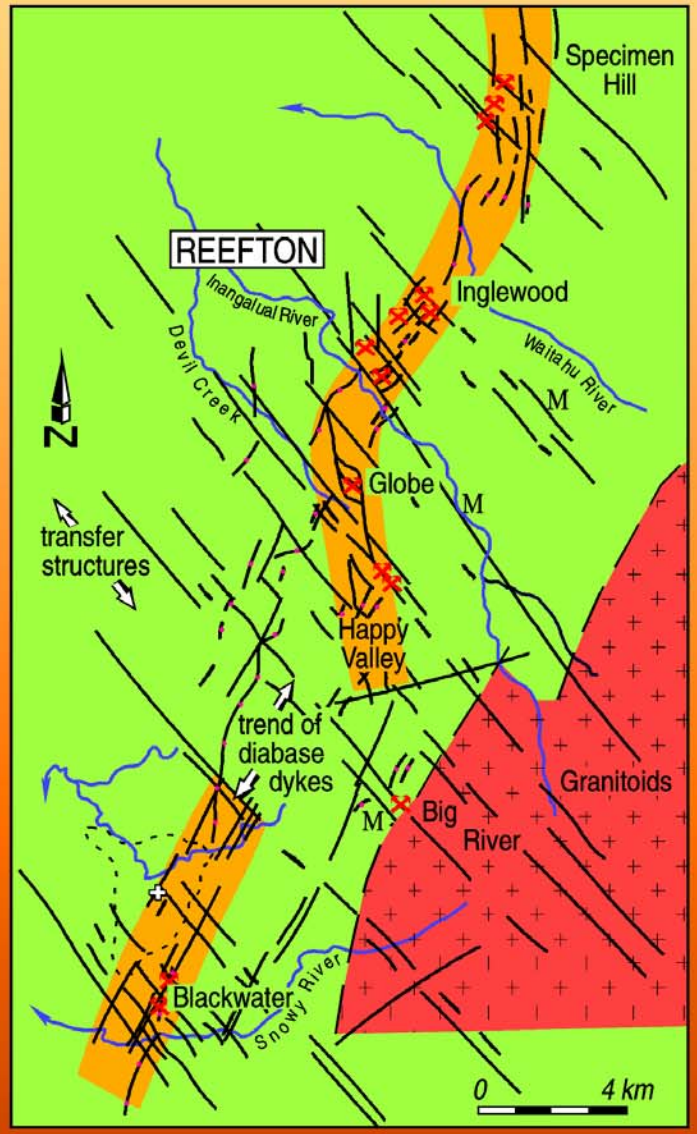
Leach *et al* (1997) proposed a geological model for the Reefton Goldfield which linked the gold mineralisation to a magmatic source.

Mineralised structures within the Paleozoic metasedimentary host rocks (Greenland Group) are developed on:

1. F1 folds which have acted as conduits for mineralizing fluids,
2. at major jogs formed by sinistral strike-slip movement along F1 fold segments or,
3. at smaller jog sites along strike

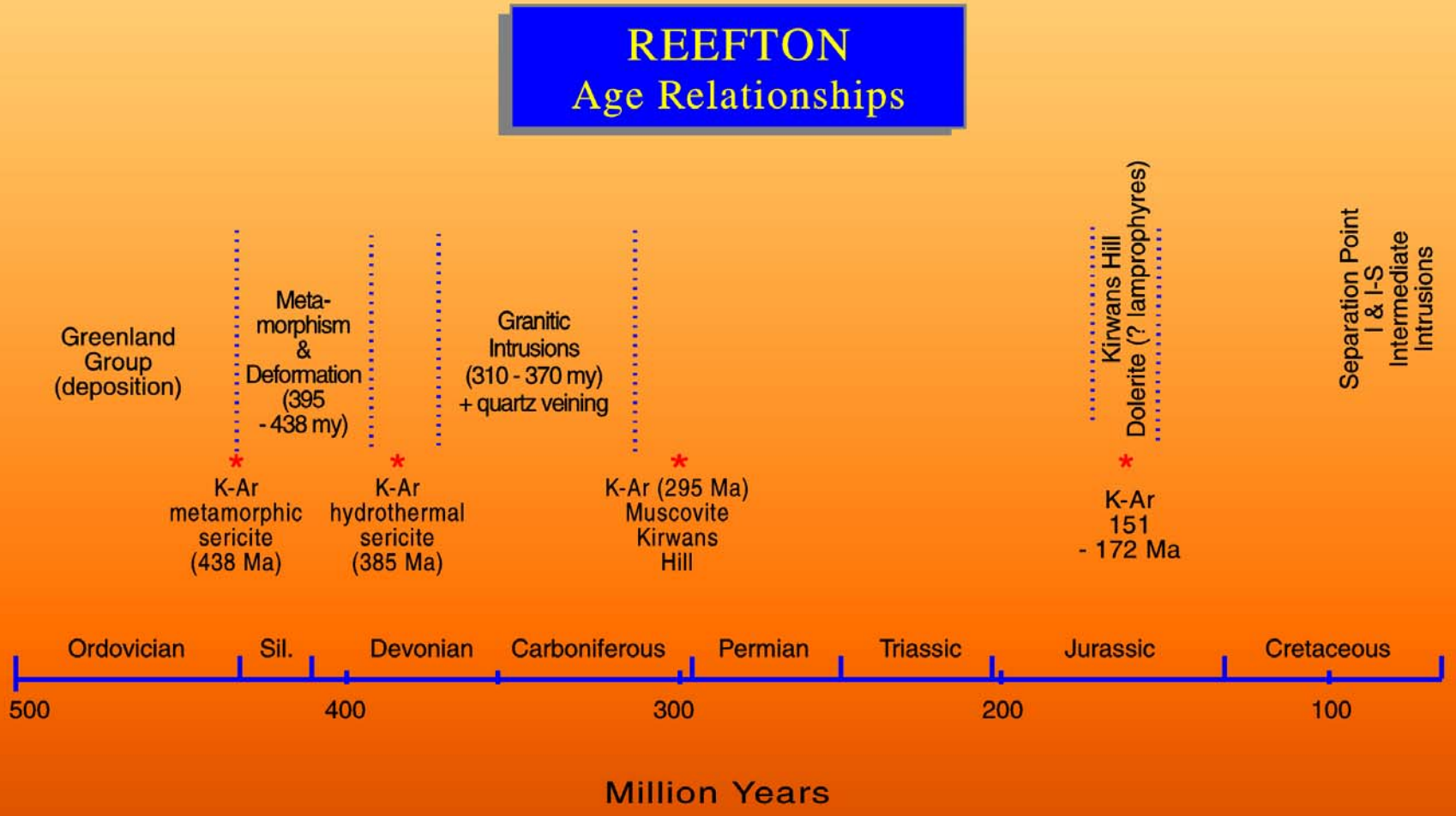
Younger dolerites and Carboniferous granitoids are known to intrude the Greenland Group and are inferred to be the sources of magmatic fluids occupying these structures

REEFTON
Transfer Structures and Setting of F1 fold closures



- *Structure from topography*
- M — *Coincident structure from topography and aeromagnetic data*
- *Aeromagnetic anomaly*
- *Mine*
- *Regions of F1 closures and shears*

REEFTON
Age Relationships



REEFTON Paragenetic Sequence

		Metamorphism and Deformation	Quartz Lodes	Mafic Dykes	Mineralization		
					Quartz-Fe/As-Sulphides	Carbonate + Base Metals	Shearing + Clays
Alteration-Gangue	Quartz	– – – –		?			
	Albite		–				
	Chlorite				– – – –	– – – –	
	Sericite/Mica				– – – –	– – – –	–
	Dolomite		– – –		– –		
	Siderite	– –				– – –	
	Illitic Clay					– –	
Ore Phase	Pyrite	– – – –	– – – –				
	As - Pyrite					– – –	
	Arsenopyrite	– – – –	– – – –			– –	
	Molybdenite		– – – –				
	Chalcopyrite		– – – –			– – –	
	Sphalerite					– – –	
	Galena					– – –	
	Pb-Sulphosalts					– – –	
	Stibnite					– – –	
Gold	Au - Arsenopyrite				– – –		
	Au - Pyrite						–?–
	Native Gold					–?–	– – – –

Reefton

Quartz veins formed after the peak of metamorphism and possibly related to the emplacement of the Carboniferous granites. This was followed by a sequence of vein deposition and wallrock alteration as follows:

1. polyphasal quartz-As/Fe-suphides
2. carbonate-stibnite±trace base metal sulphides and Bi-sulphosalts
3. illitic clay/sericite-chlorite.

Leach et al, 1997 likened the above sequence to that encountered in many South-West pacific intrusion related gold systems (Corbett and Leach, 1998).

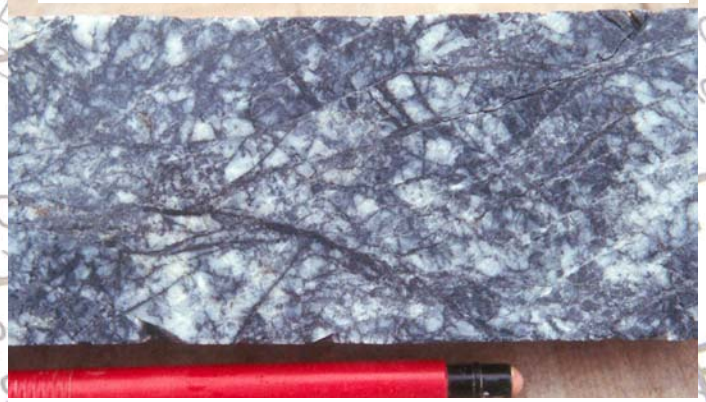
OceanaGold (2008) describe the mineralisation as located along a locally complex N-S trending structural corridor within and between the thermal aureoles of two granites. The goldfield shows a strong bimodal distribution of mineralisation, dominated by a large number of small, high-grade quartz vein-associated gold deposits; and apparently fewer large, disseminated sulfide-associated gold deposits.

Mining commenced in Oct 2007 at 65000 oz per annum.

Reefton

Ribbon quartz vein with gold on plane of ribbon

Ribbon quartz vein and gold – Blackwater mine



Brecciated quartz vein and arsenopyrite

Terry's ongoing legacy…the Ph/T alteration card…