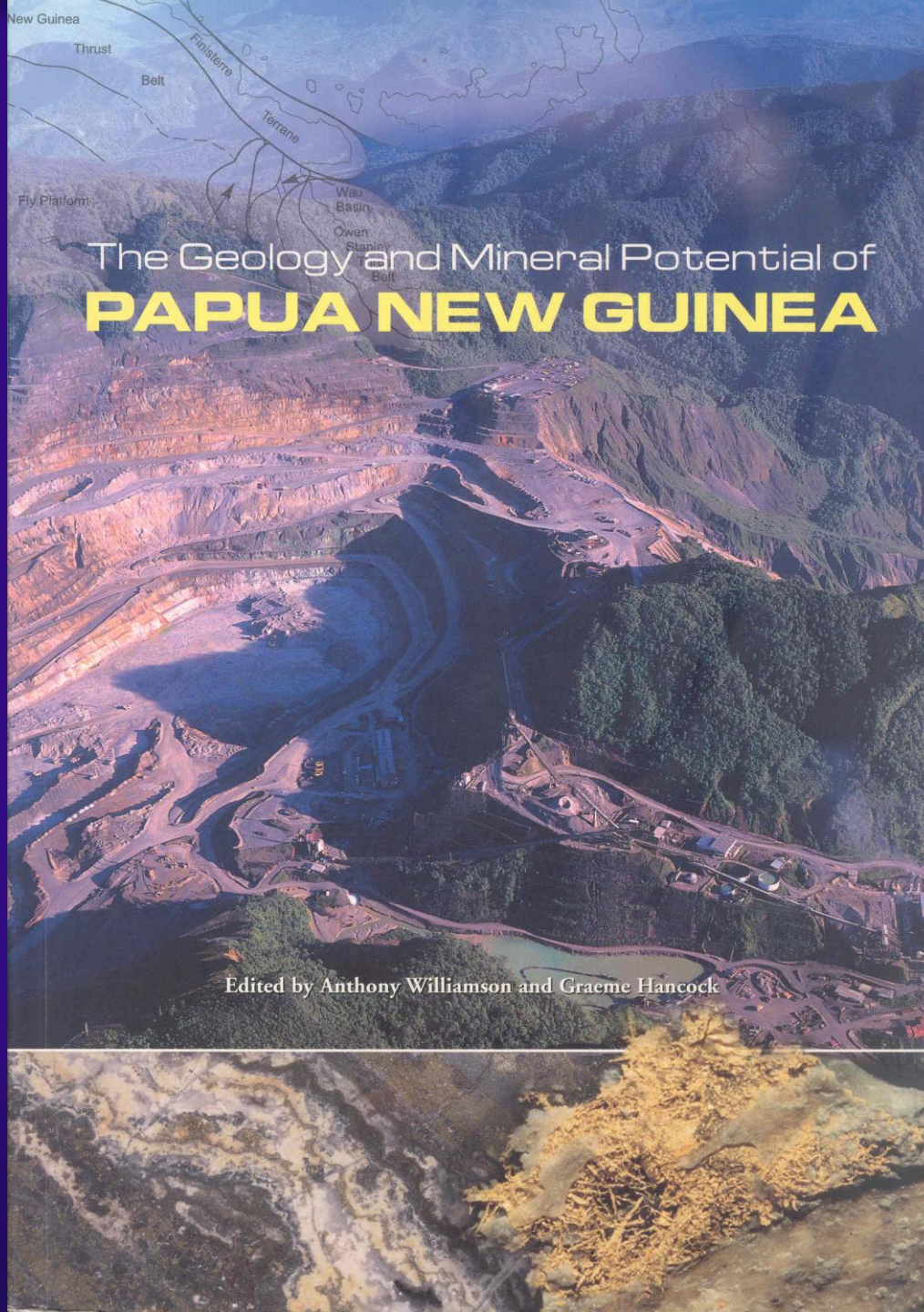


Exploration discovery in Papua New Guinea



Greg Corbett
Corbett and Menzies Consulting
July 2014

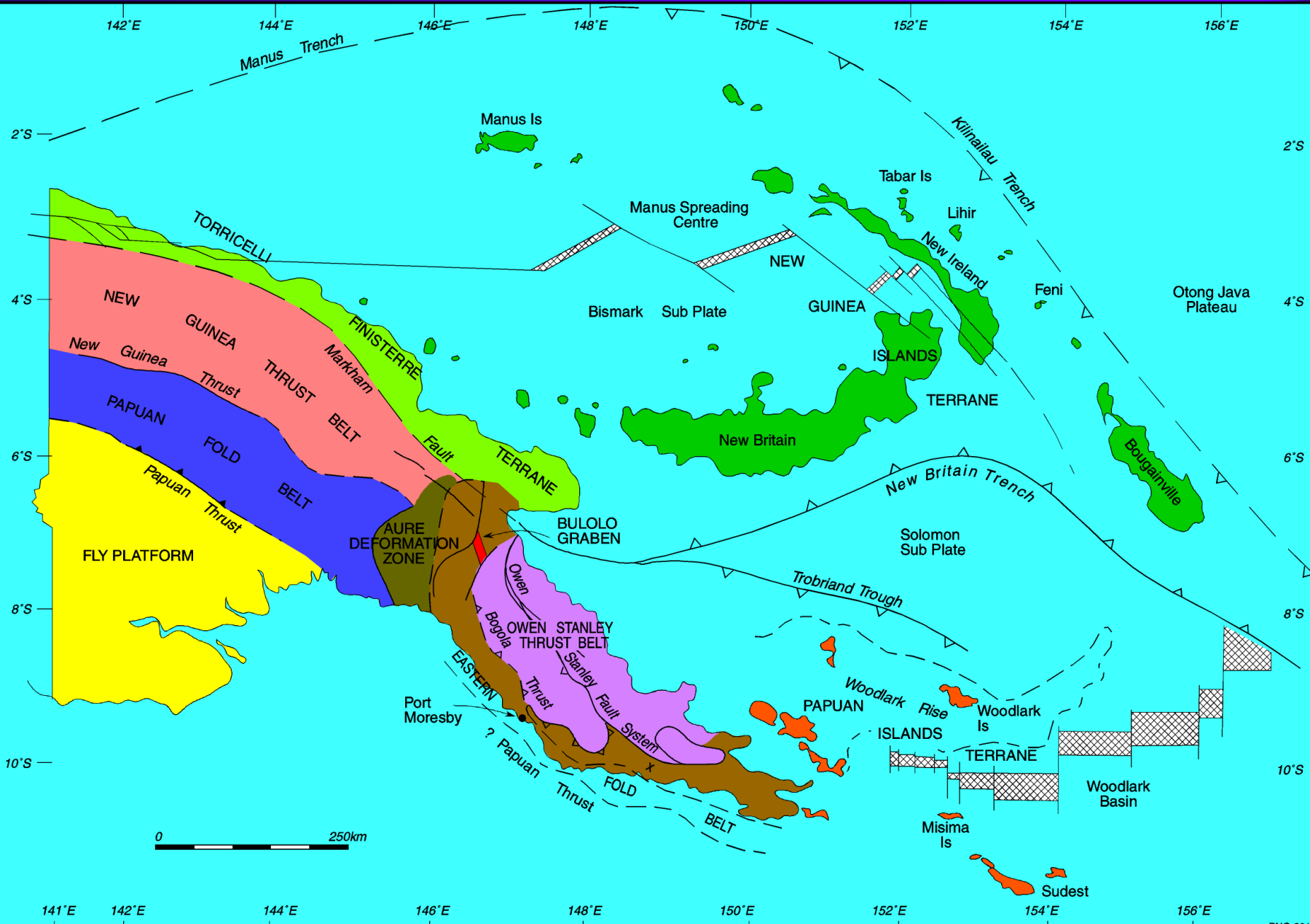
2005

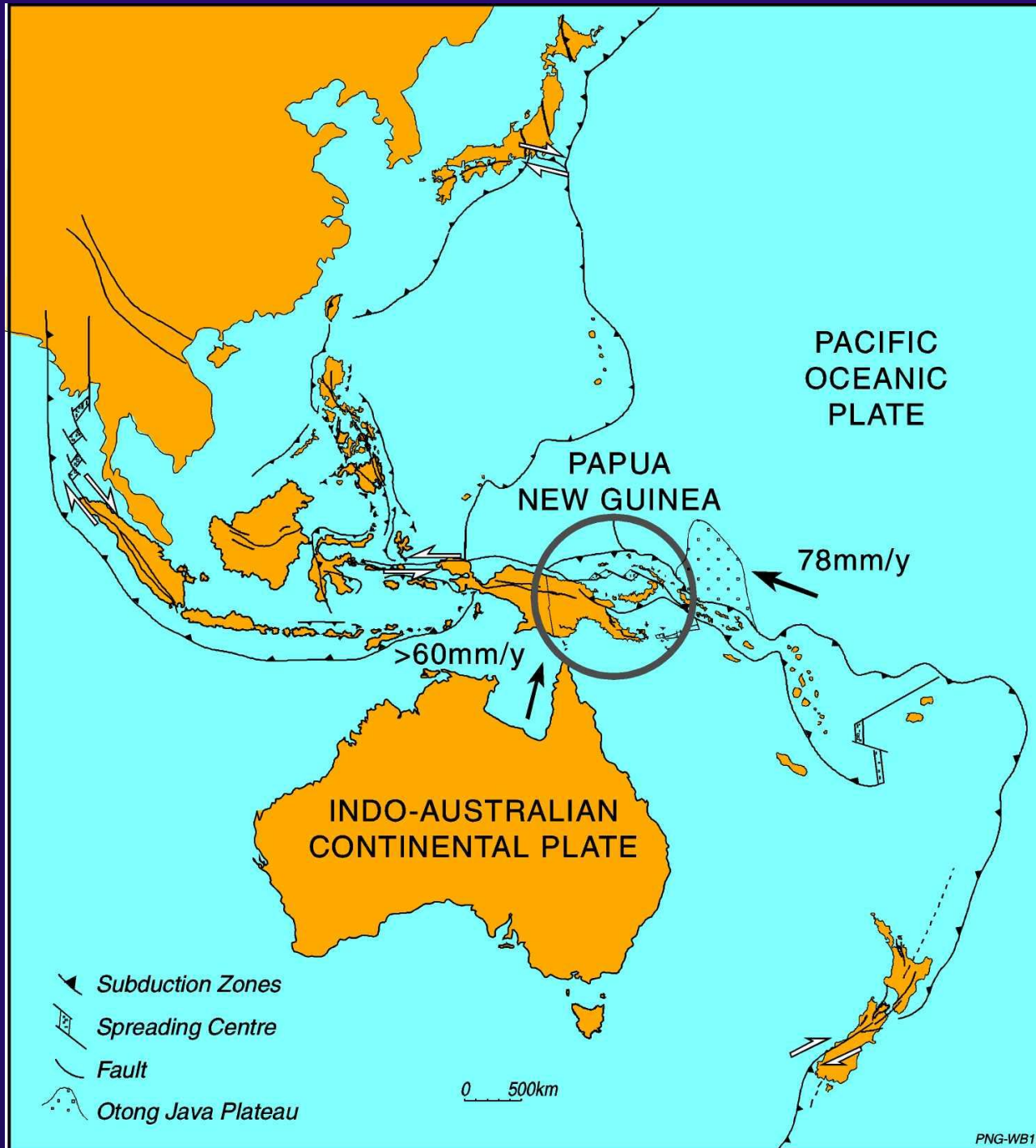


The Geology and Mineral Potential of
PAPUA NEW GUINEA

Edited by Anthony Williamson and Graeme Hancock

Tectonic elements of Papua New Guinea





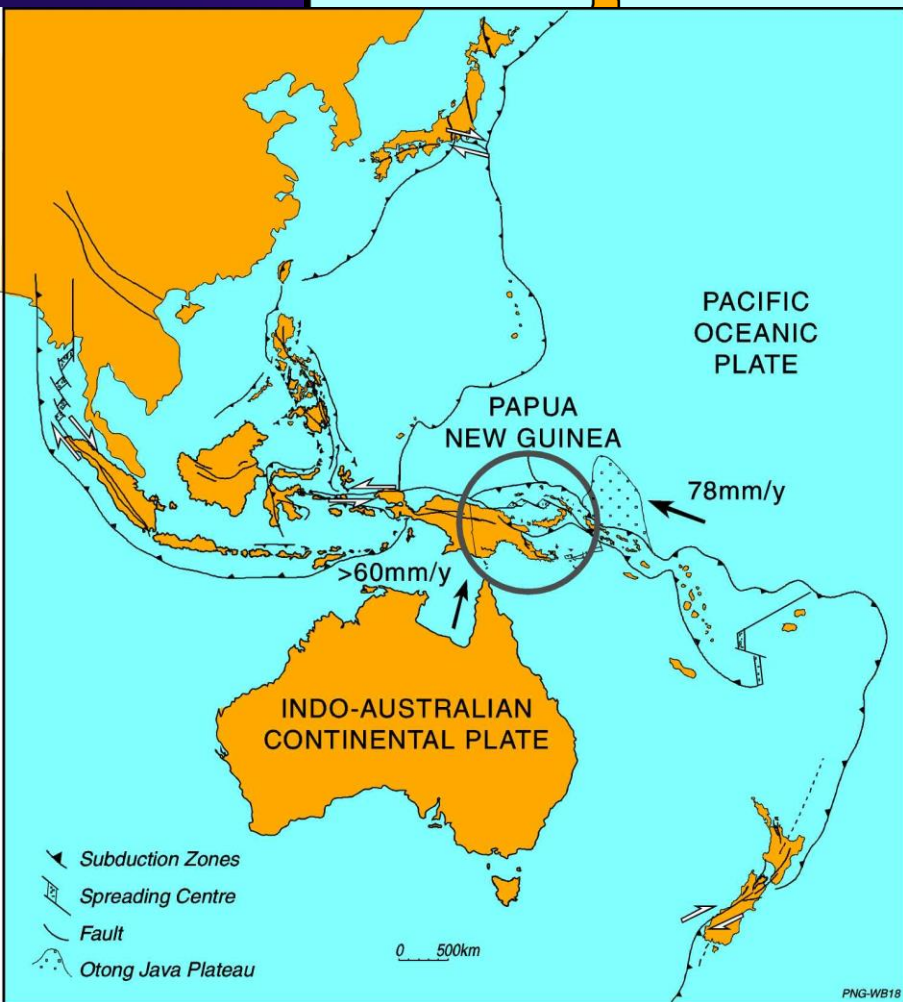
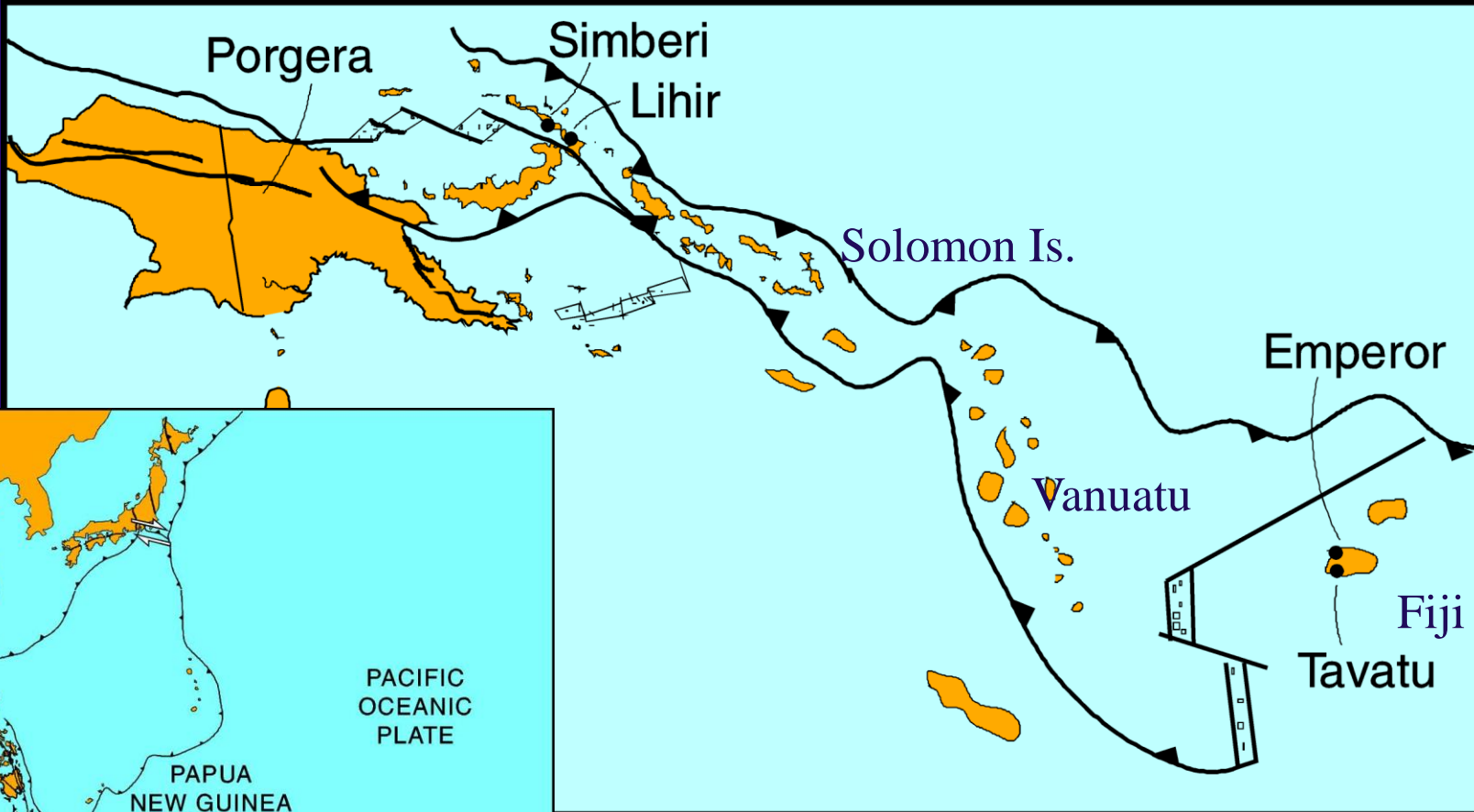
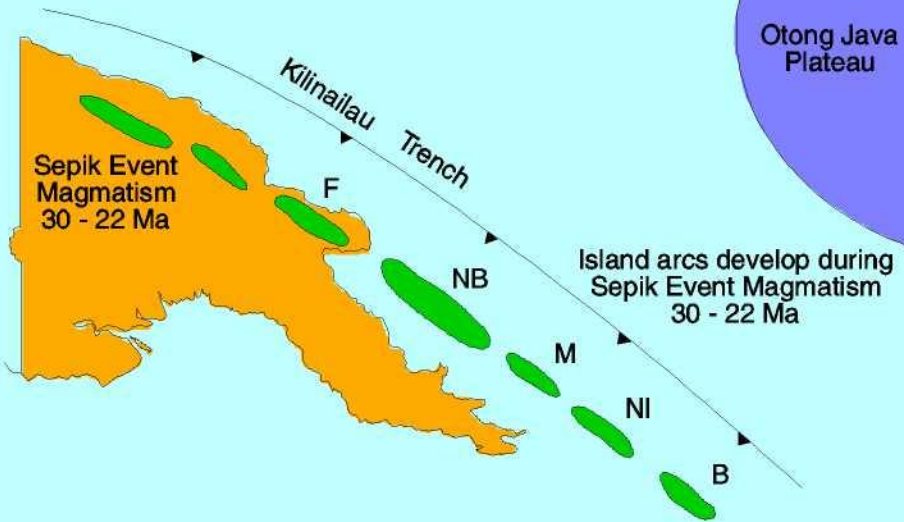
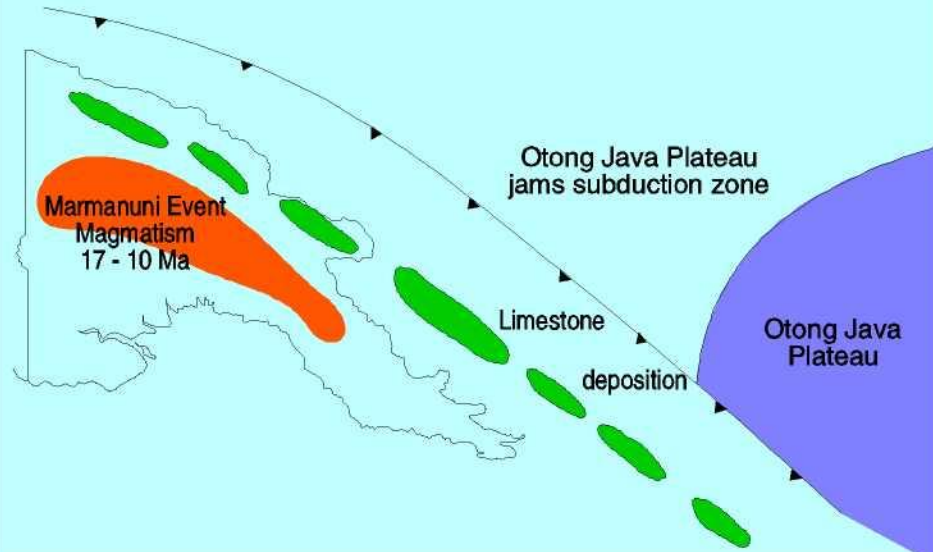


Plate tectonic
setting of Papua
New Guinea

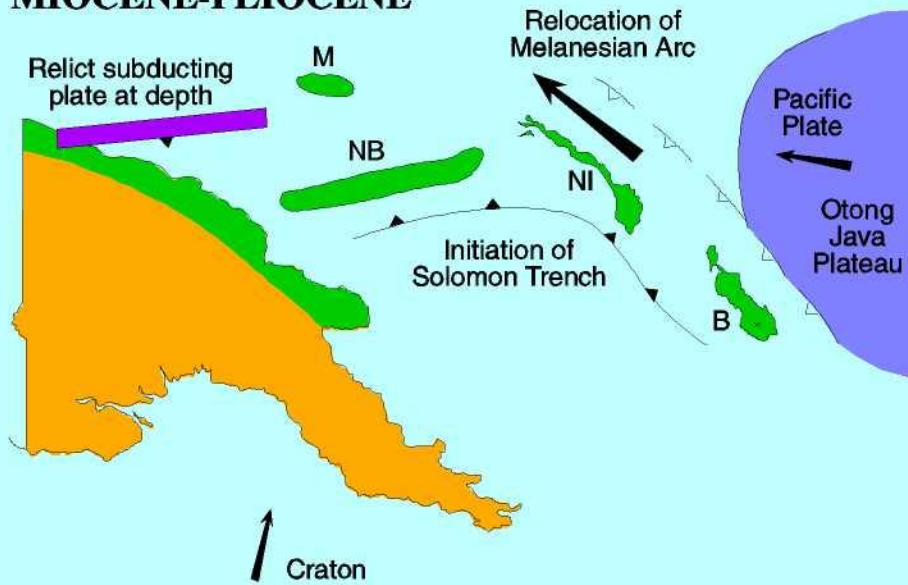
OLIGOCENE



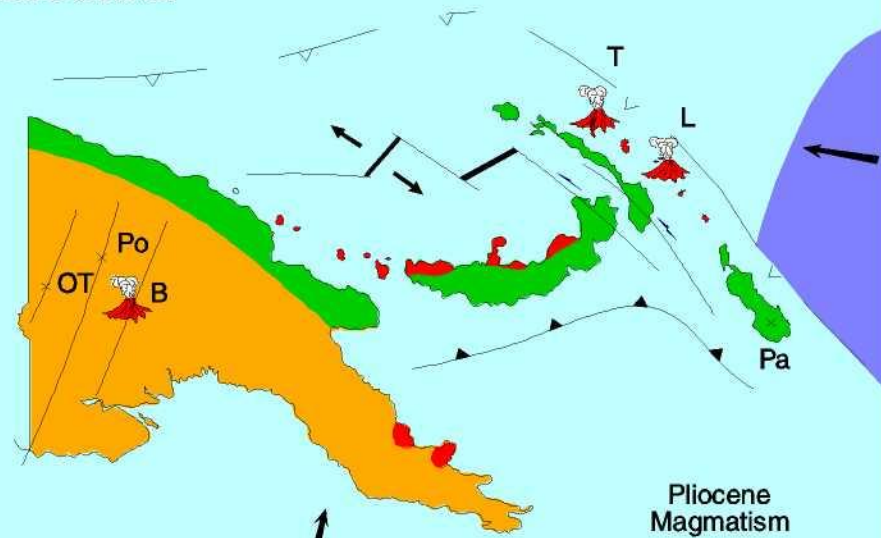
MIOCENE



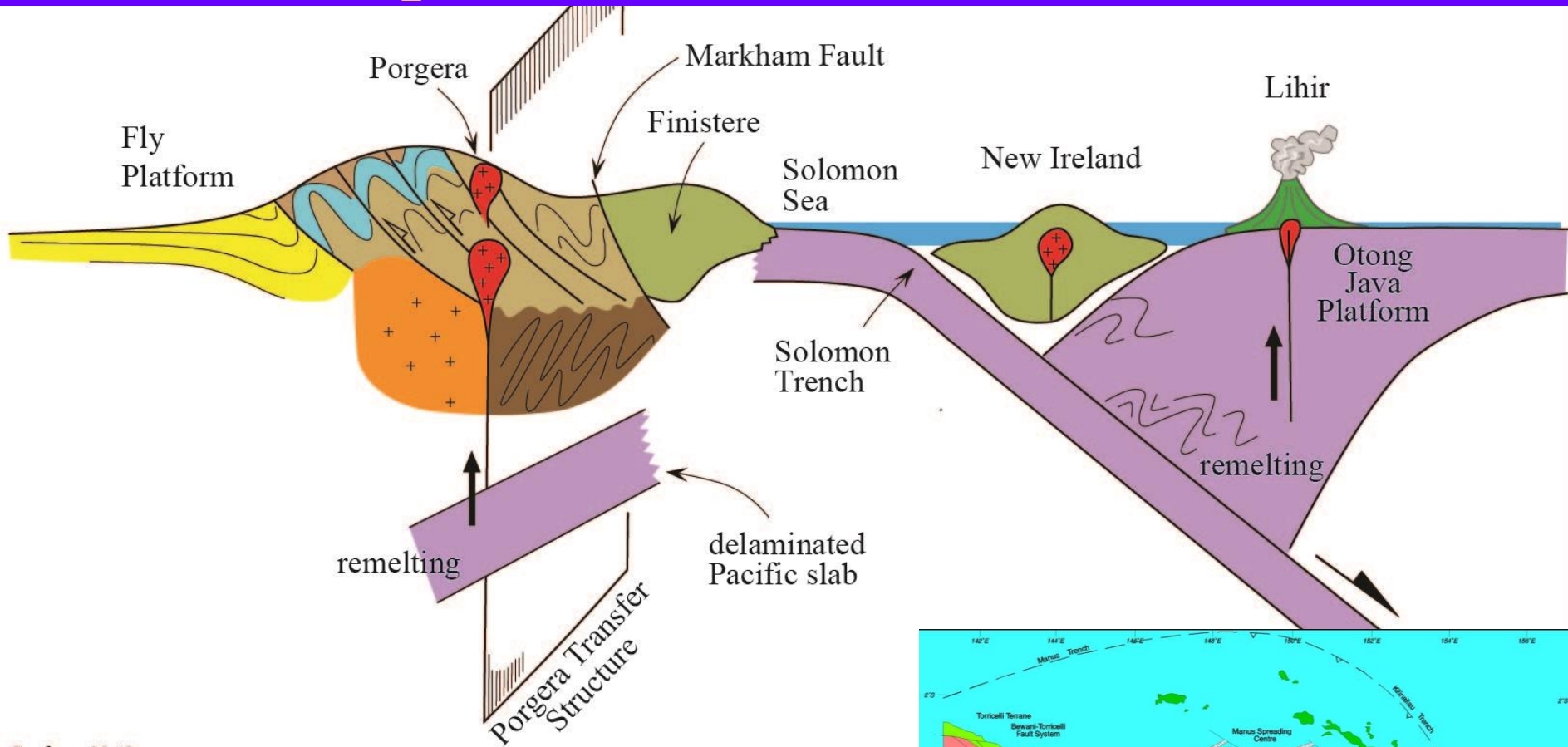
MIOCENE-PLIOCENE



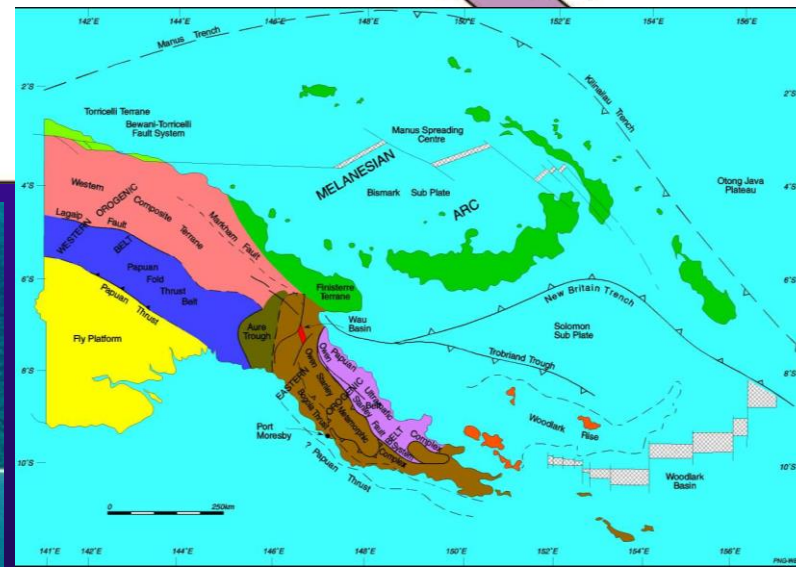
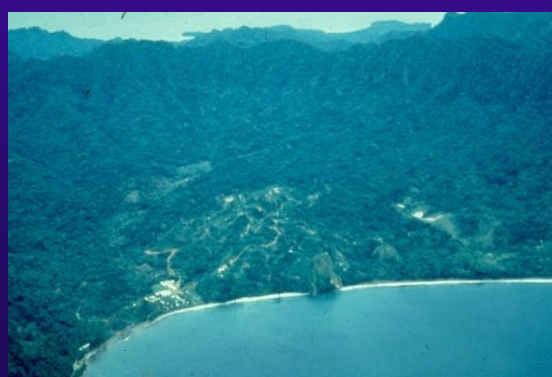
PLIOCENE



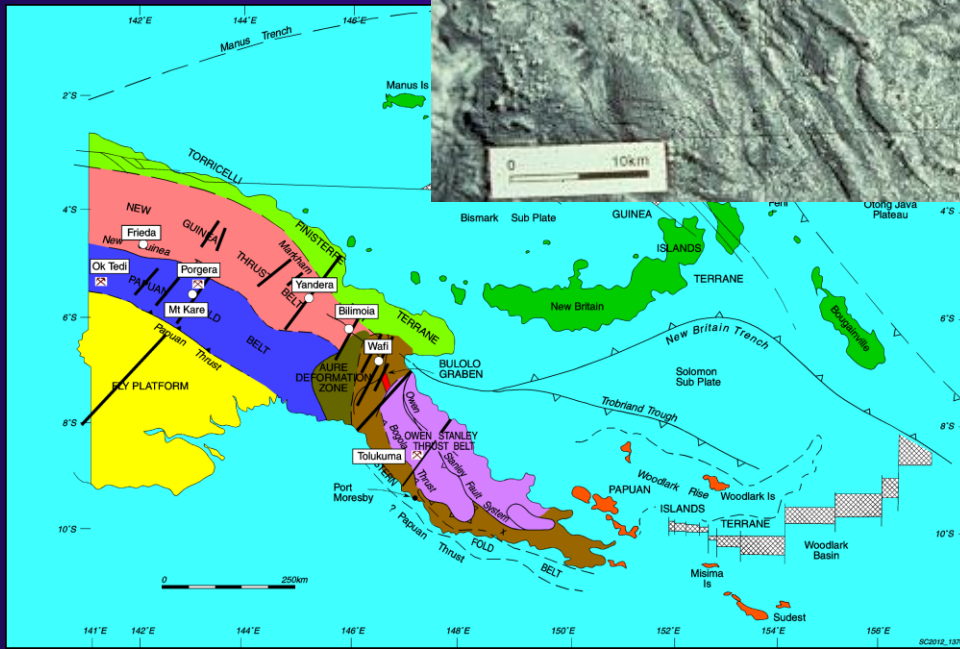
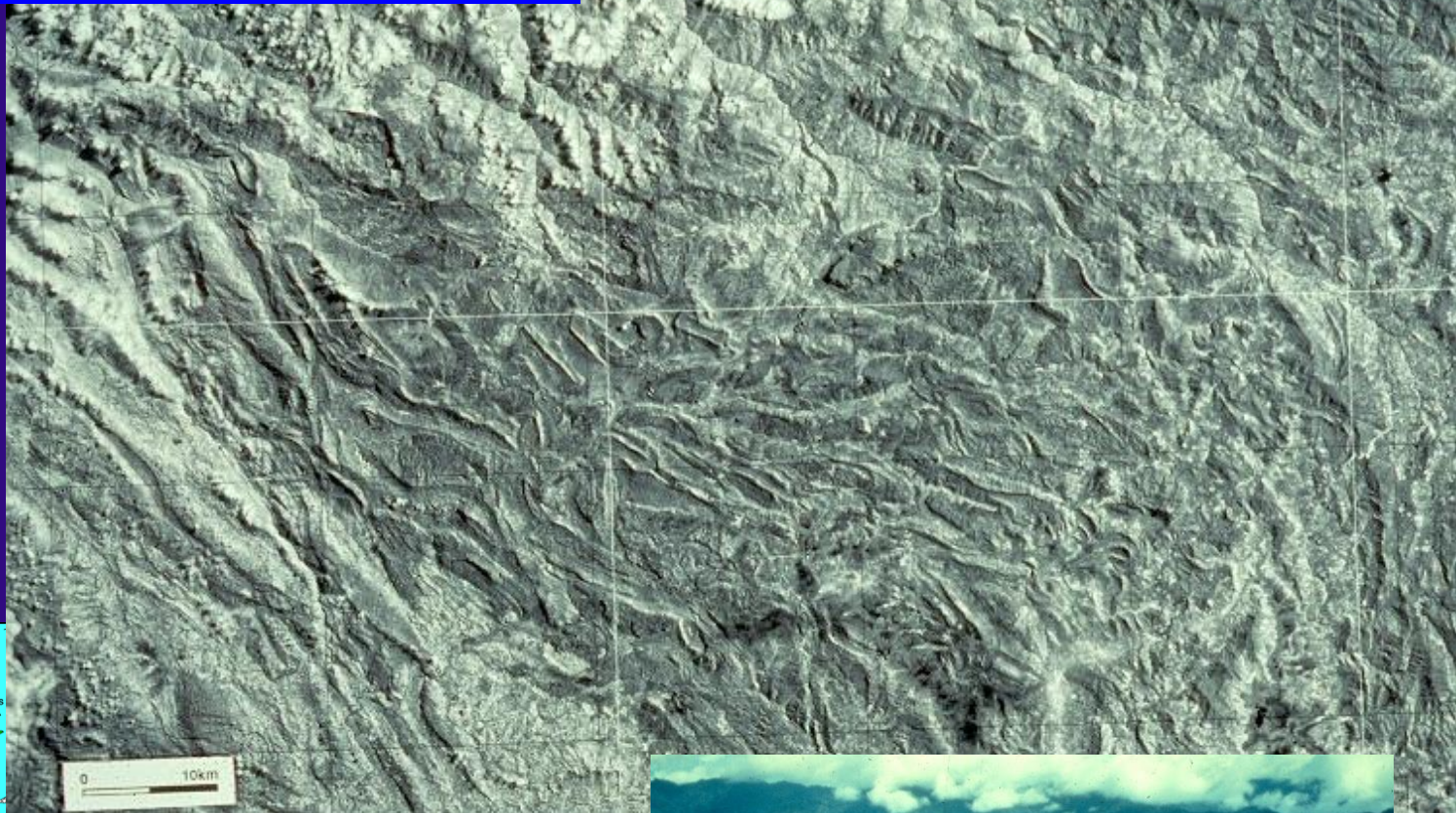
Papua New Guinea tectonics



Corbett 1343



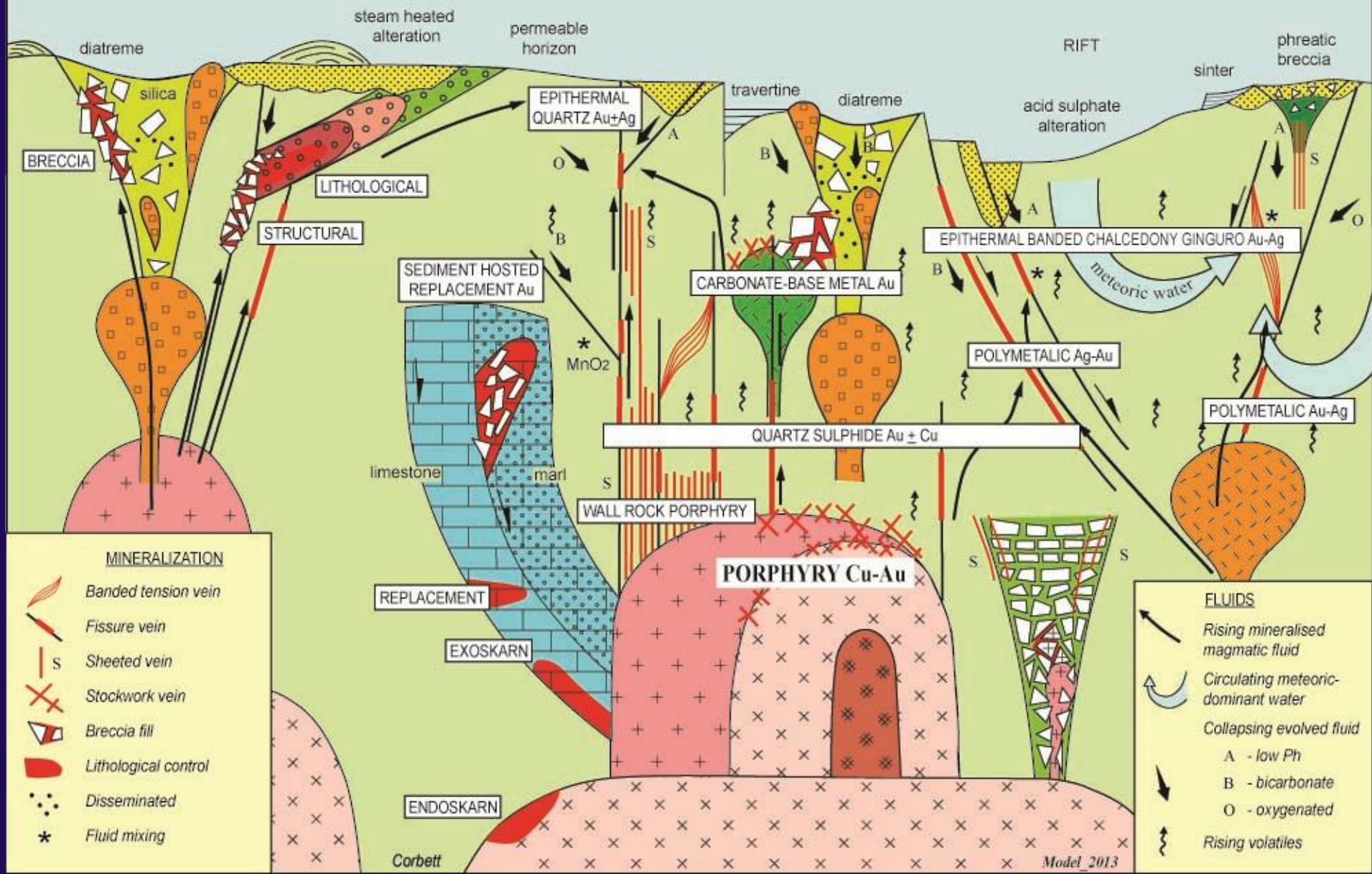
Porgera transfer structure



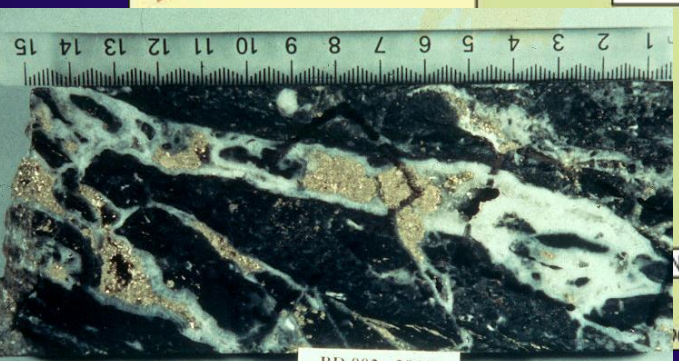
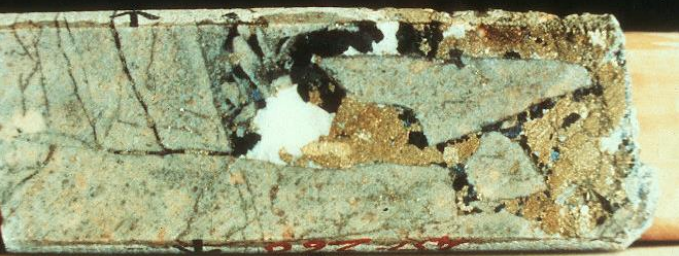
Styles of magmatic arc Cu-Au

HIGH SULPHIDATION EPITHERMAL Au

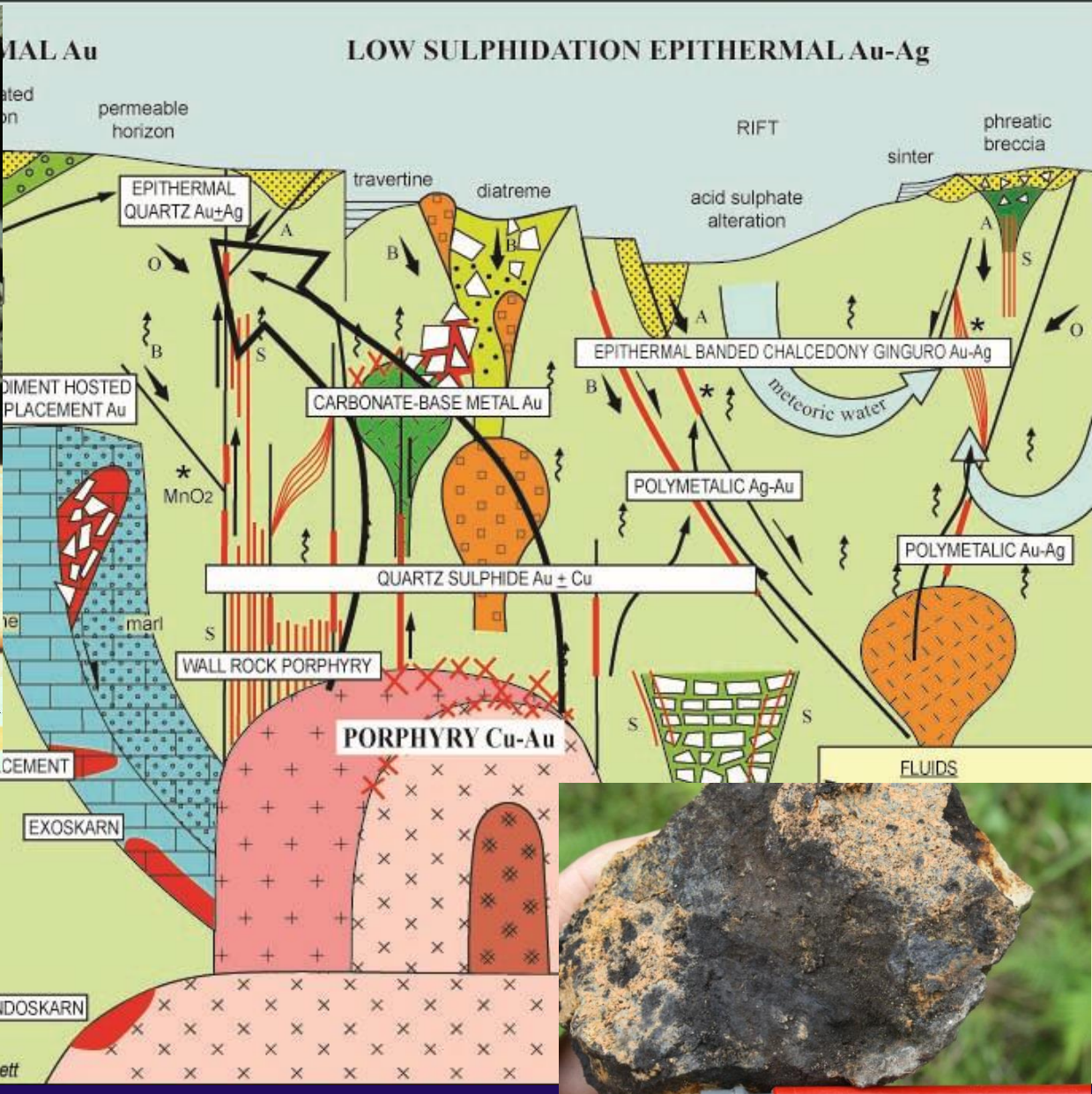
LOW SULPHIDATION EPITHERMAL Au-Ag



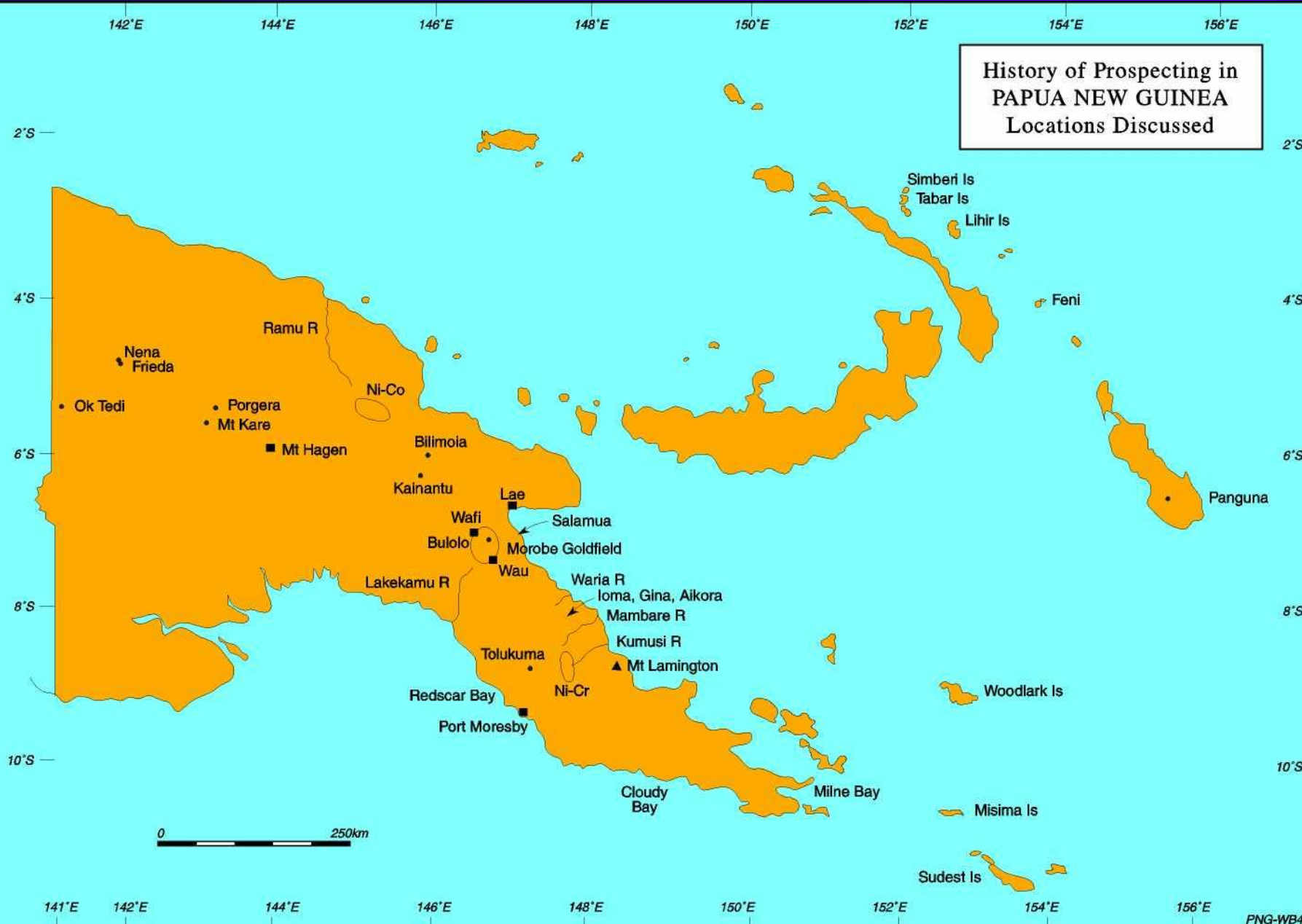
Styles of magmatic arc Cu-Au mineralisation



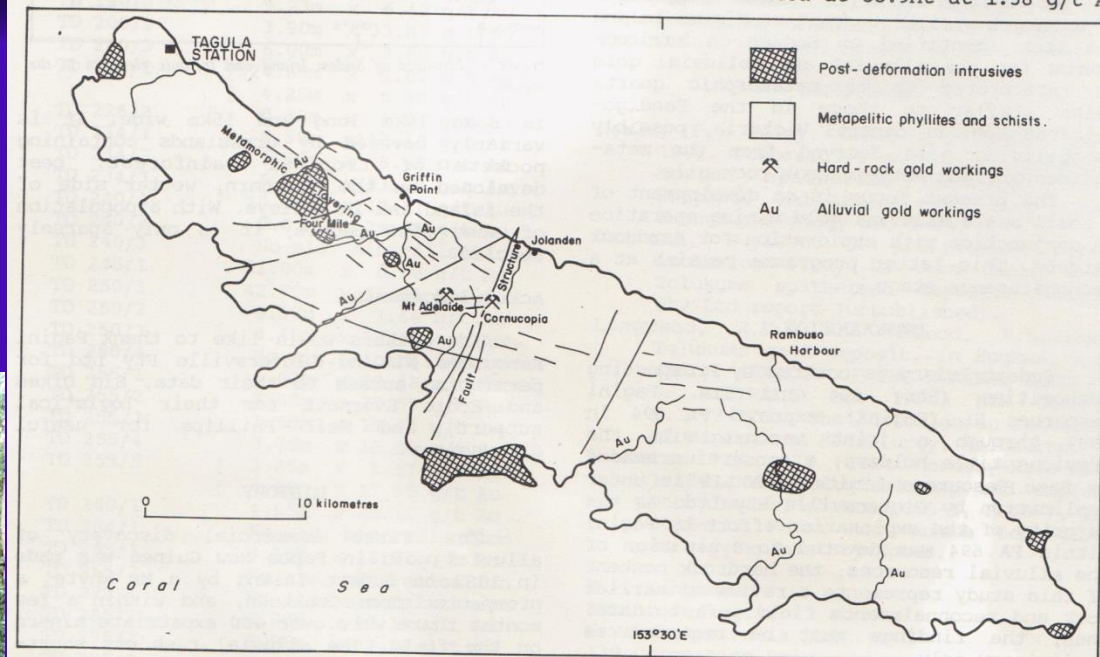
BD 002 - 208.9



History of Prospecting in
PAPUA NEW GUINEA
Locations Discussed

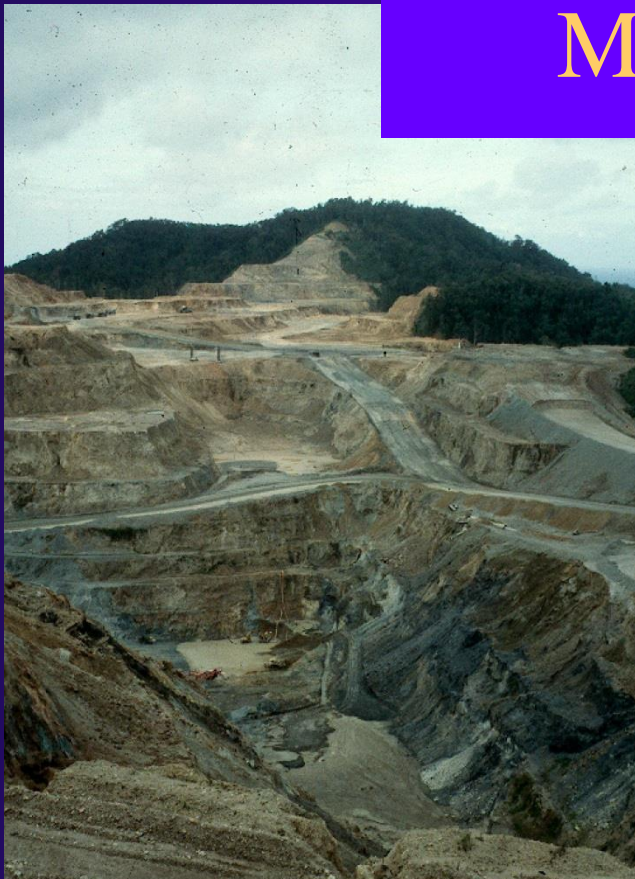


Sudest Island

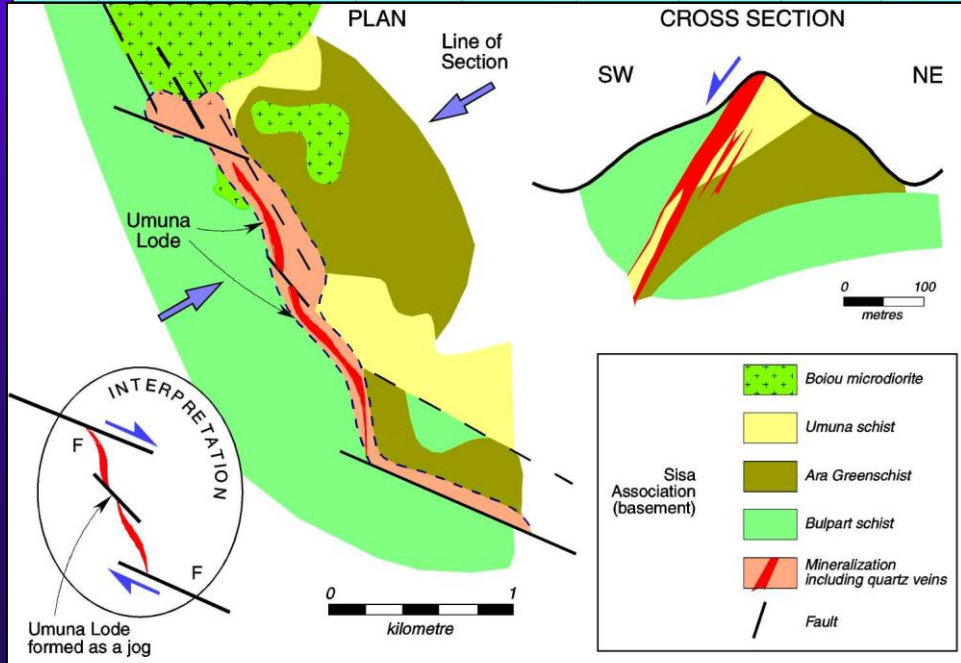
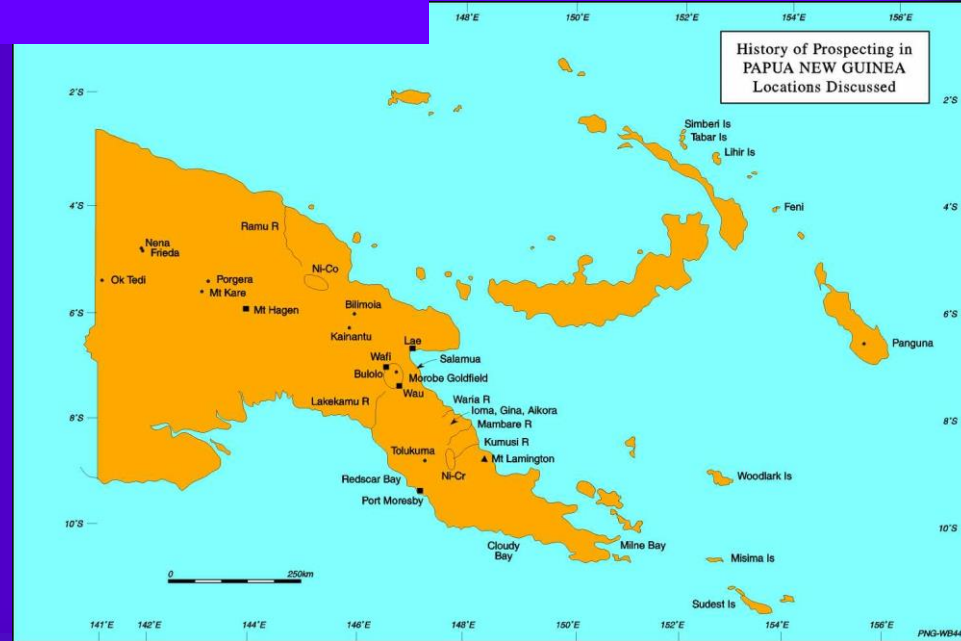


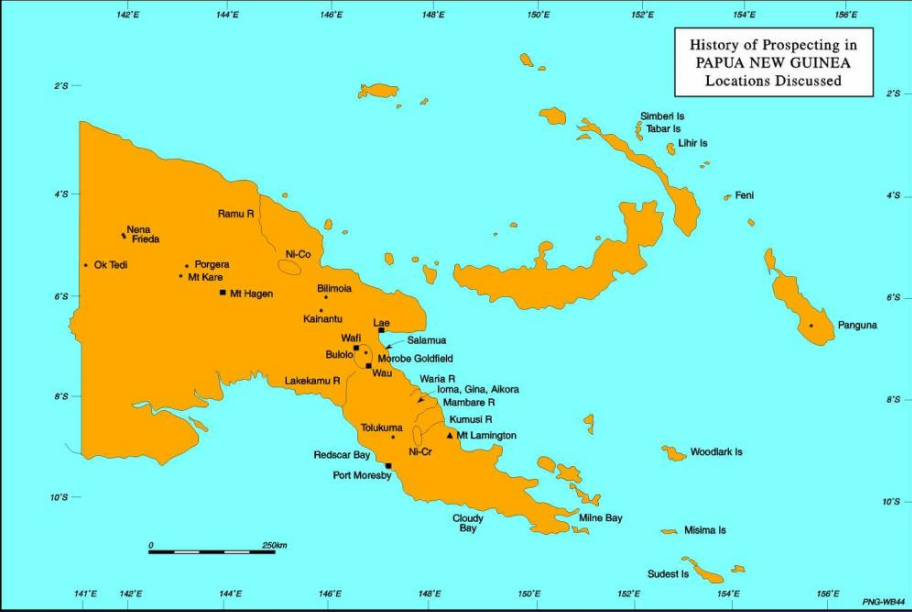
Misima Island

200,000 oz Au to 1911

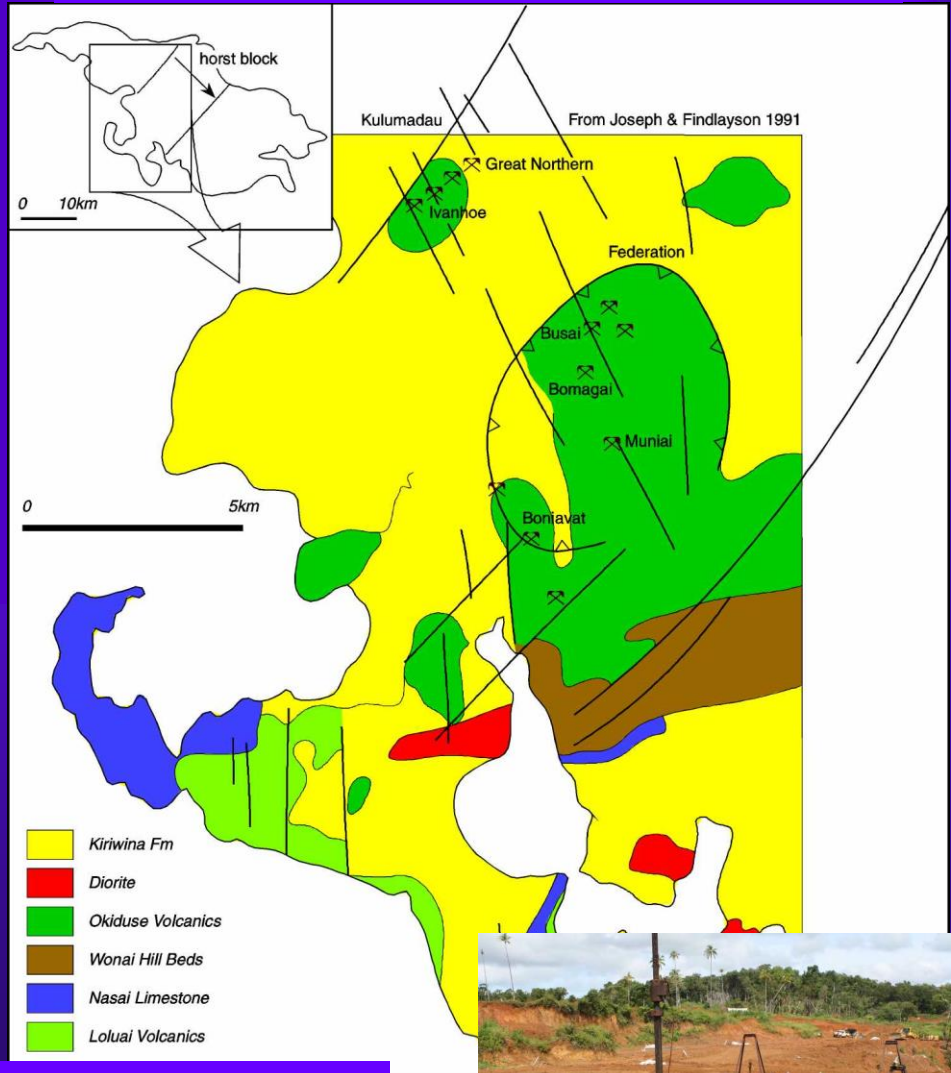


Placer production
3.7M oz Au 18.4 M oz Ag





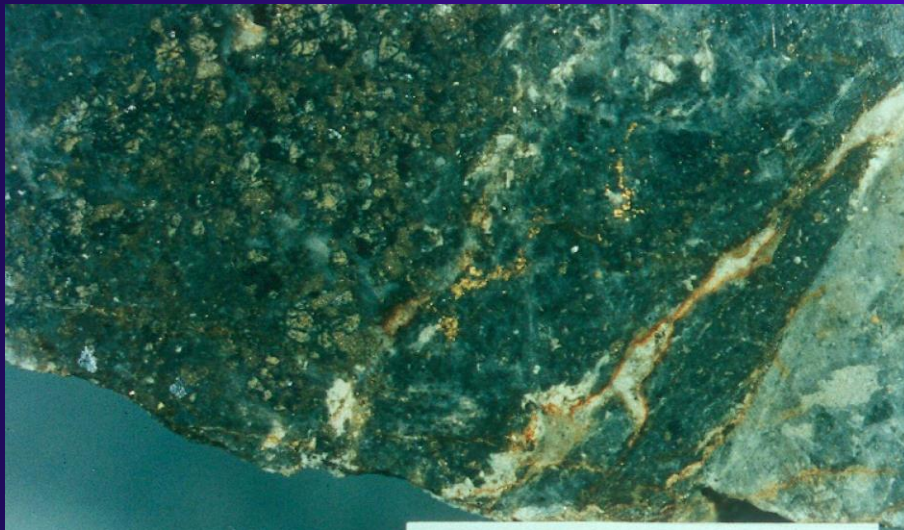
Woodlark Is



To WW1
83,000 alluvial Au
100,000 oz lode



Woodlark Modern era



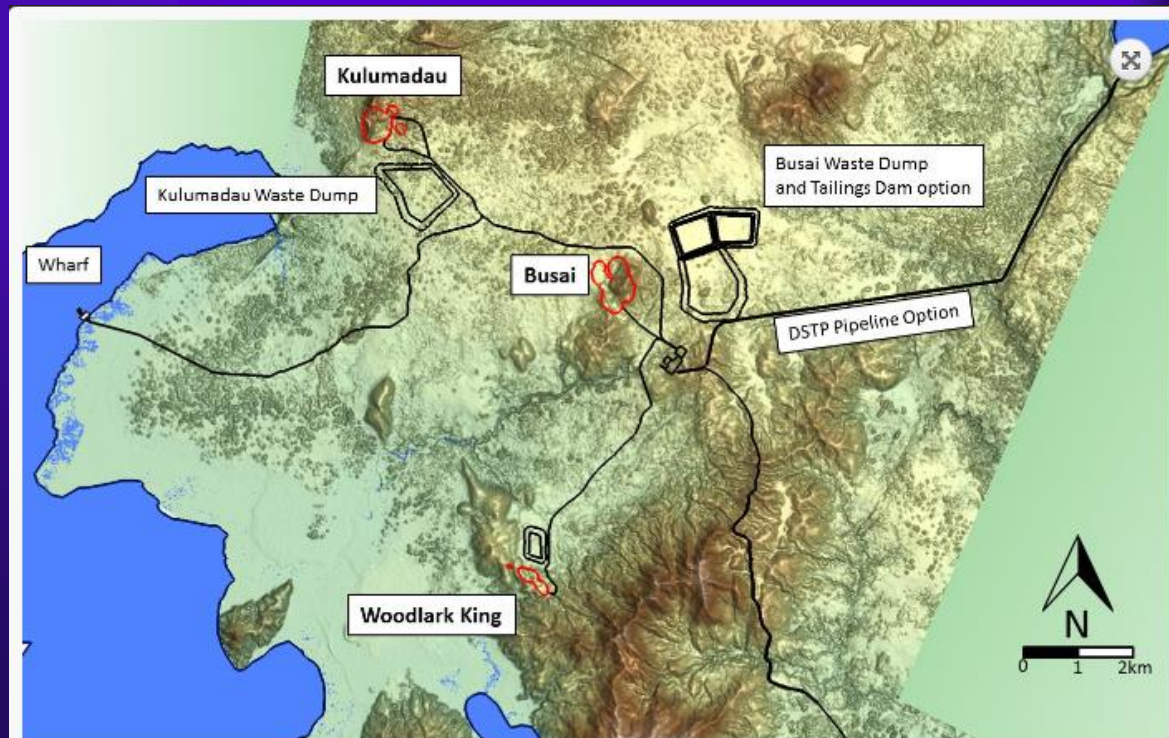
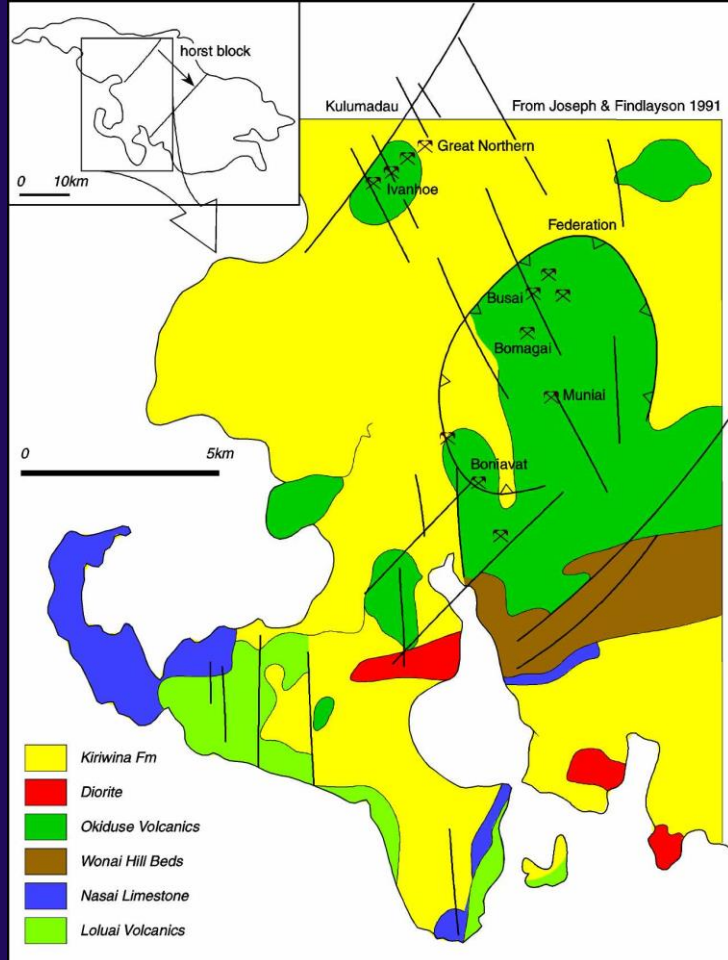
91 BSD 013 - 62.0



Kula Gold planned mining

Reserves 45.1Mt @ 1.5g/t Au for
2.1M oz Au

Proven and probable resource
11Mt @ 2.2g/t Au for 0.766M oz Au



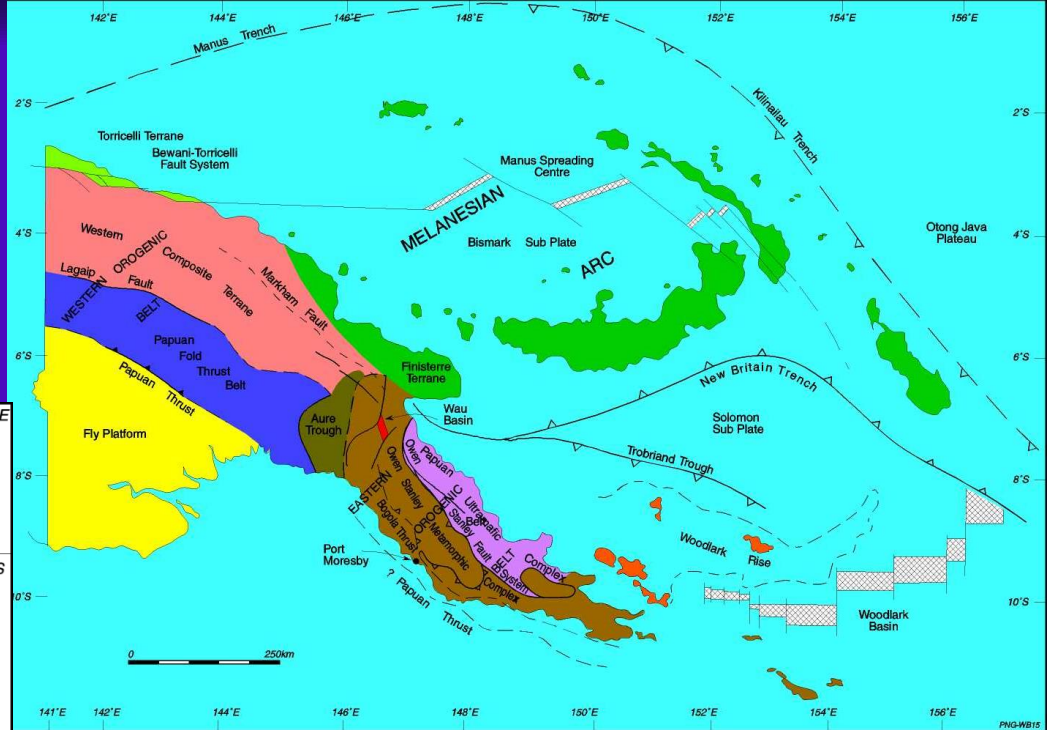
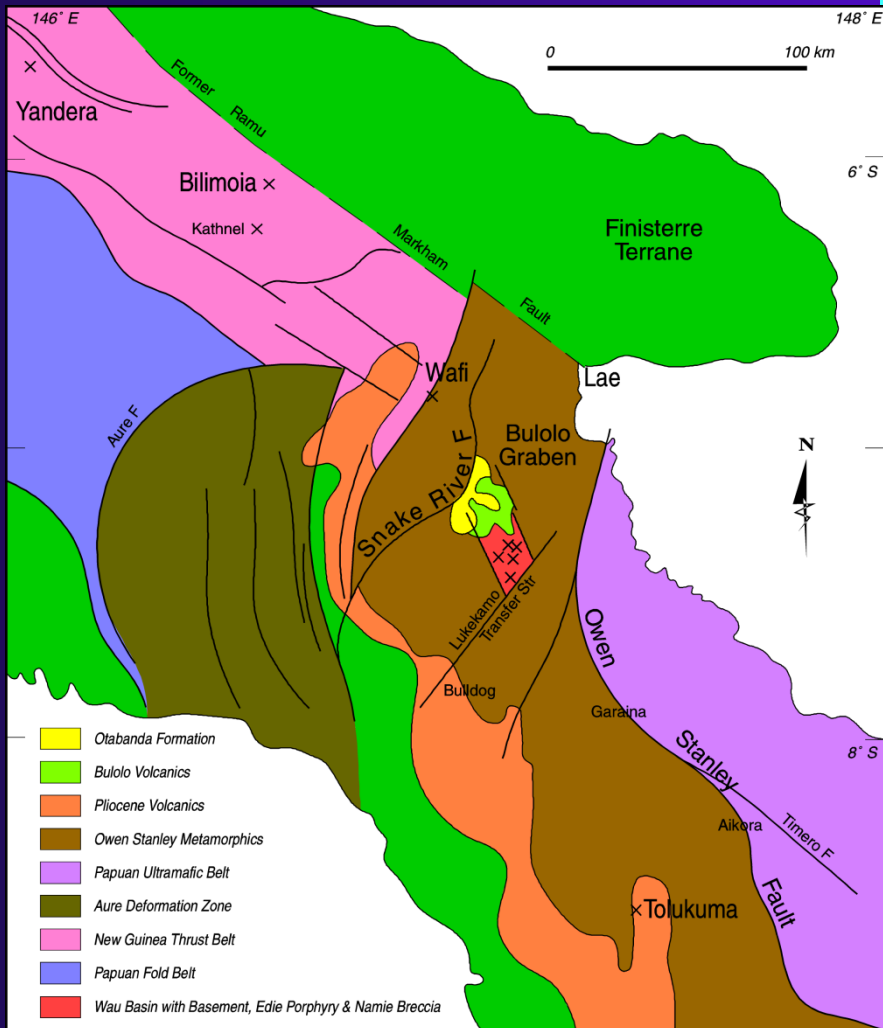
Morobe goldfield



Carriers

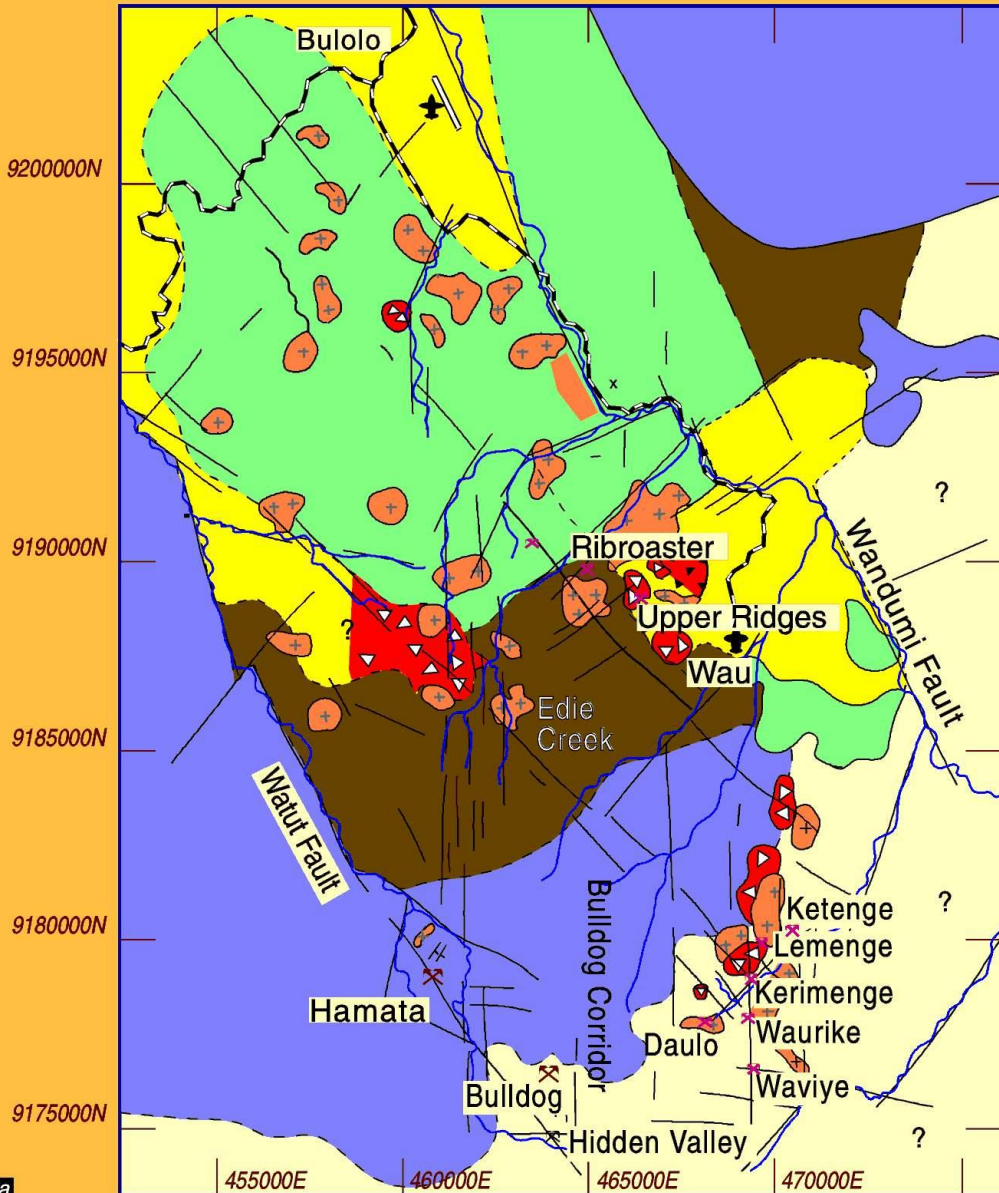


Morobe goldfield



BULOLO GRABEN

Geology



- Otibanda Formation*
- Bulolo Volcanics*
- +
+
+ *Edie Porphyry*
- ▲
▲
▲ *Diatreme breccia*
- Morobe Granodiorite*
- Kaindi Phyllite*

0 10 km

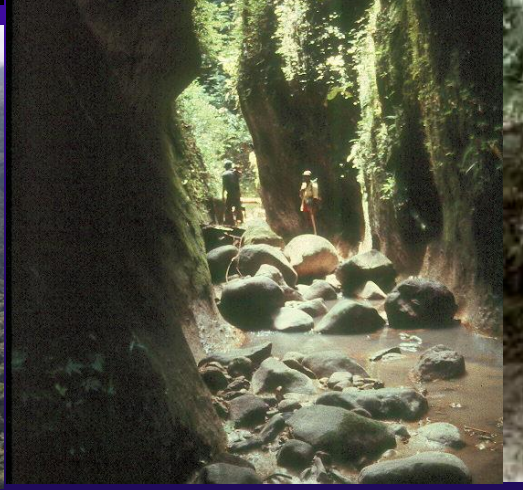
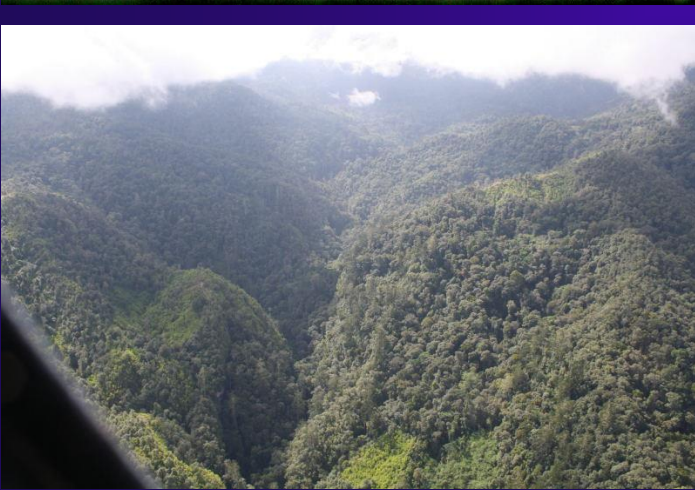


Pliocene volcanism





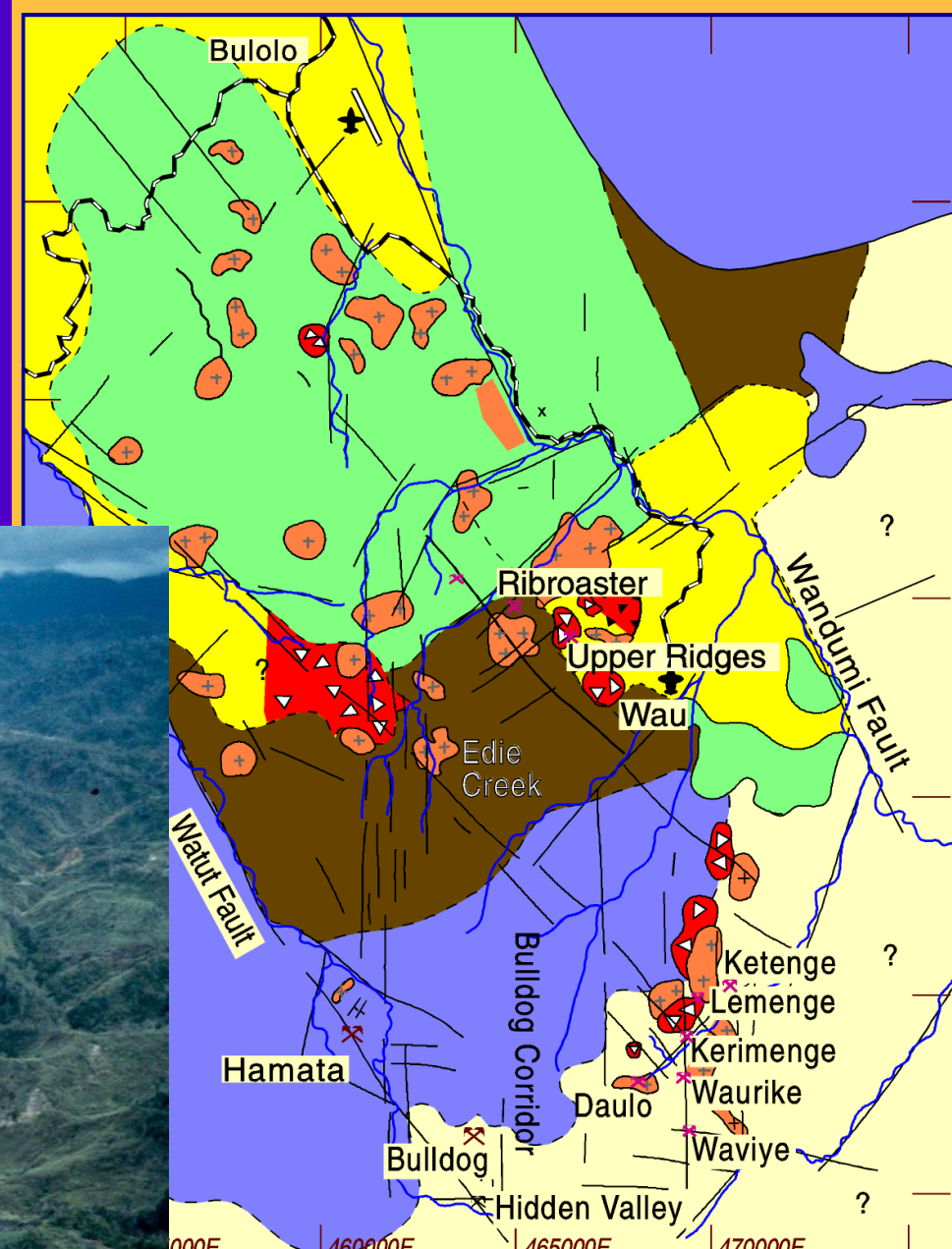
Nauti diatreme



Wau



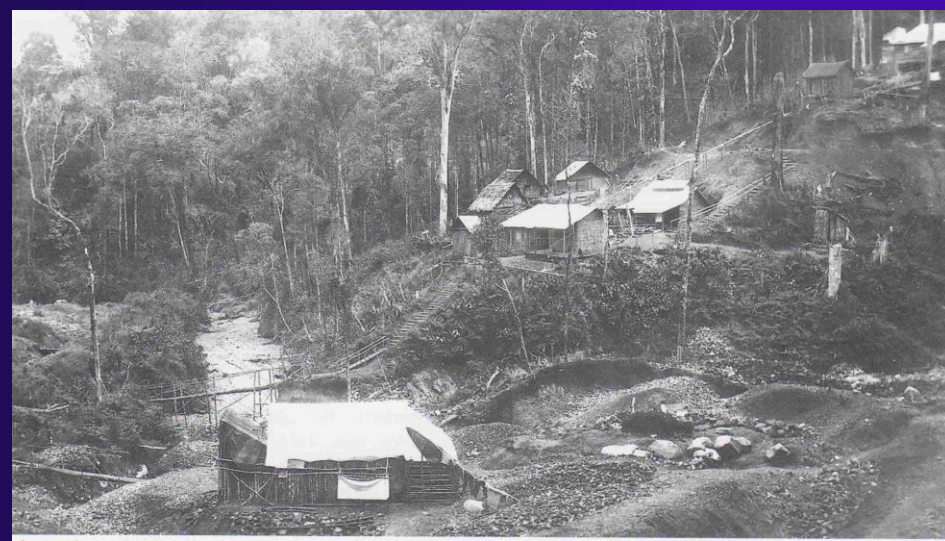
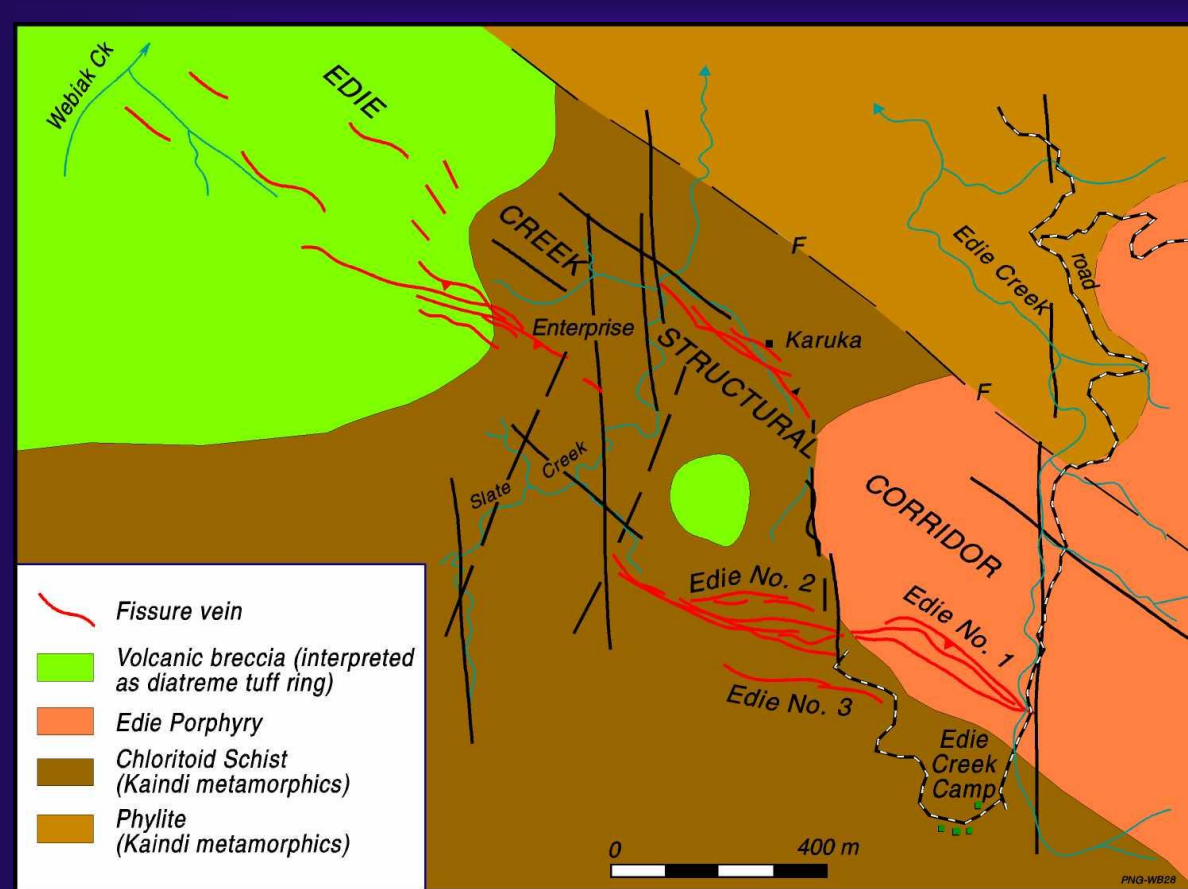
Edie Creek



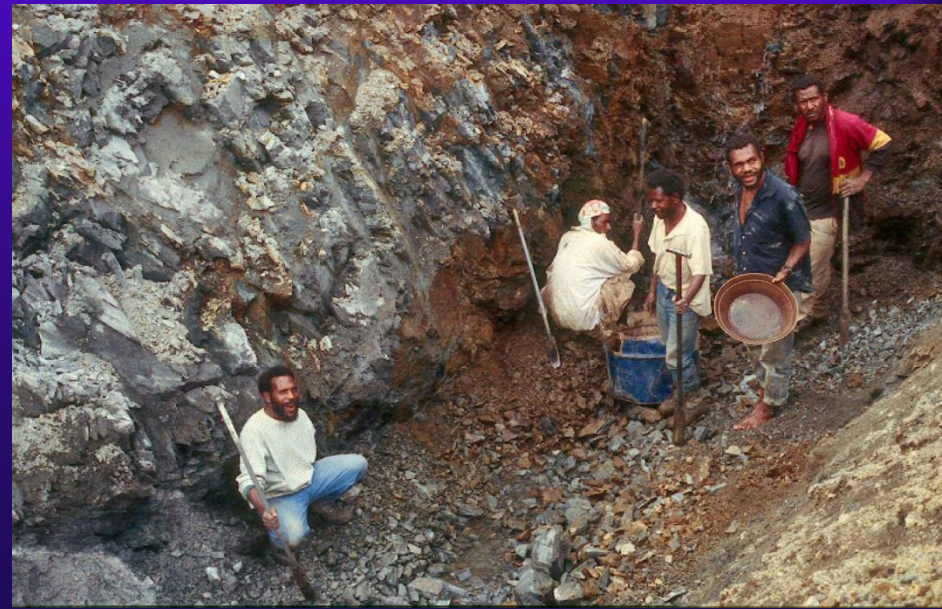
Edie Creek



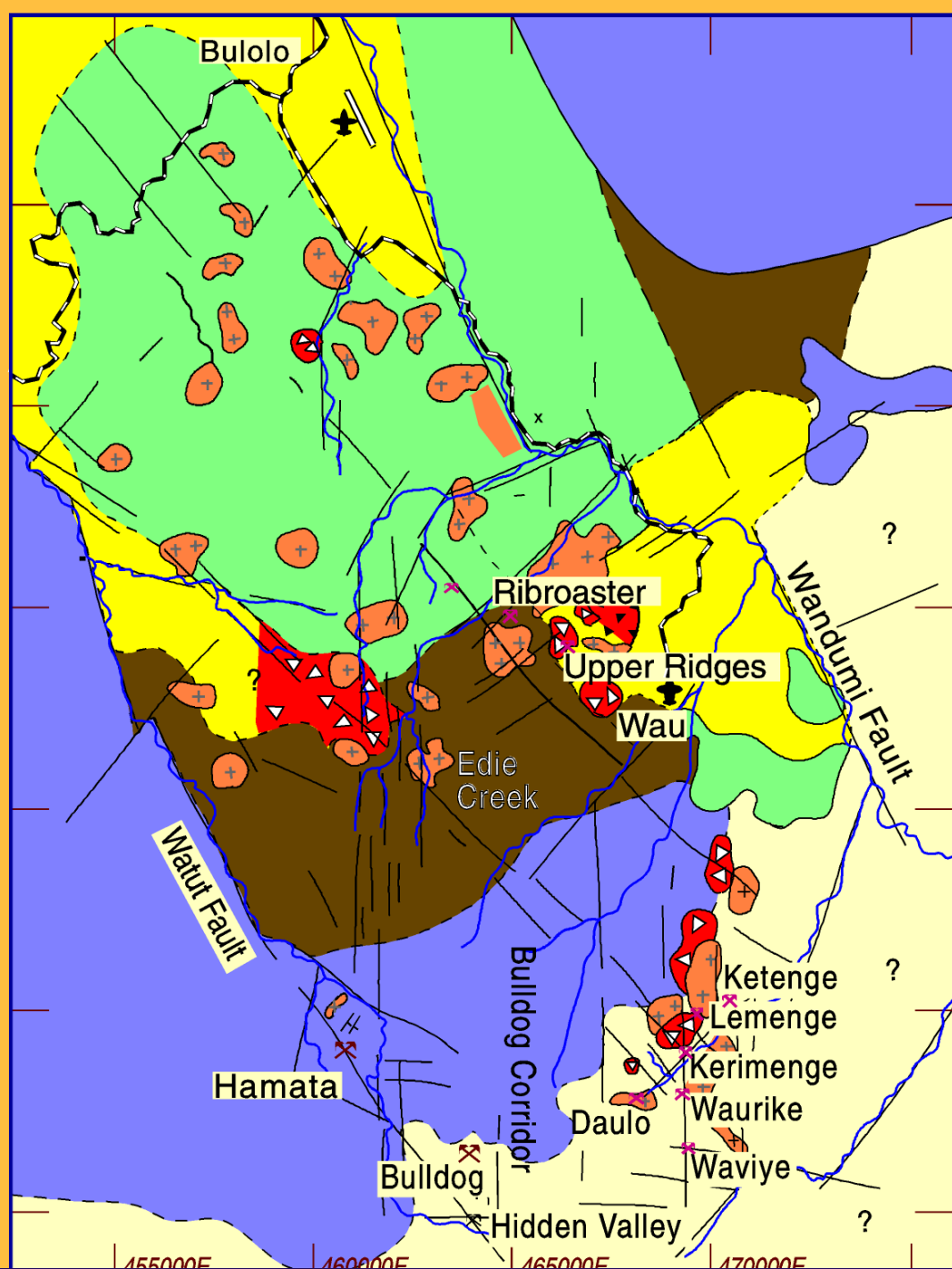
Lode mining
1931-62, 88,000oz Au

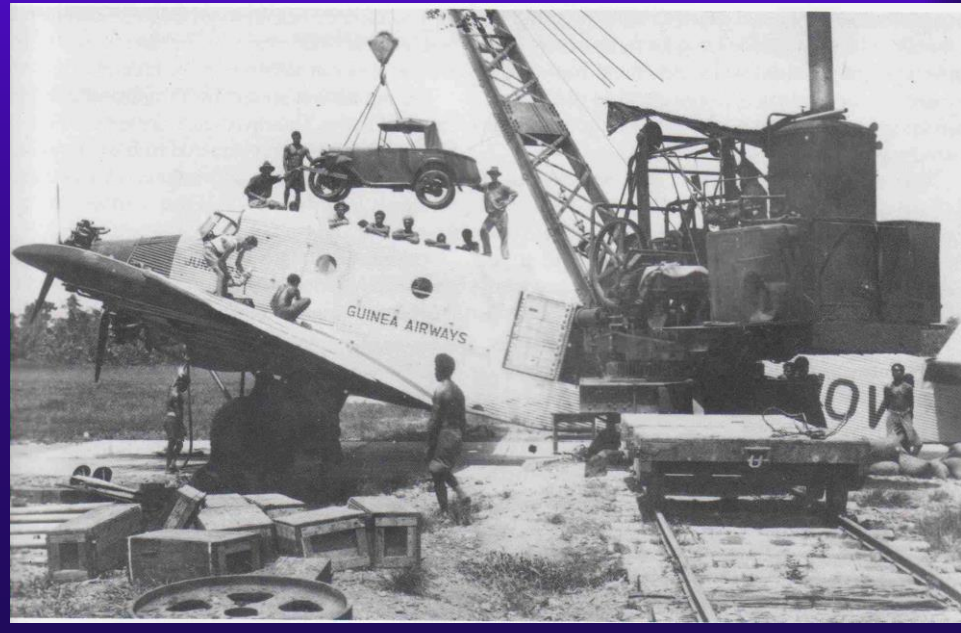
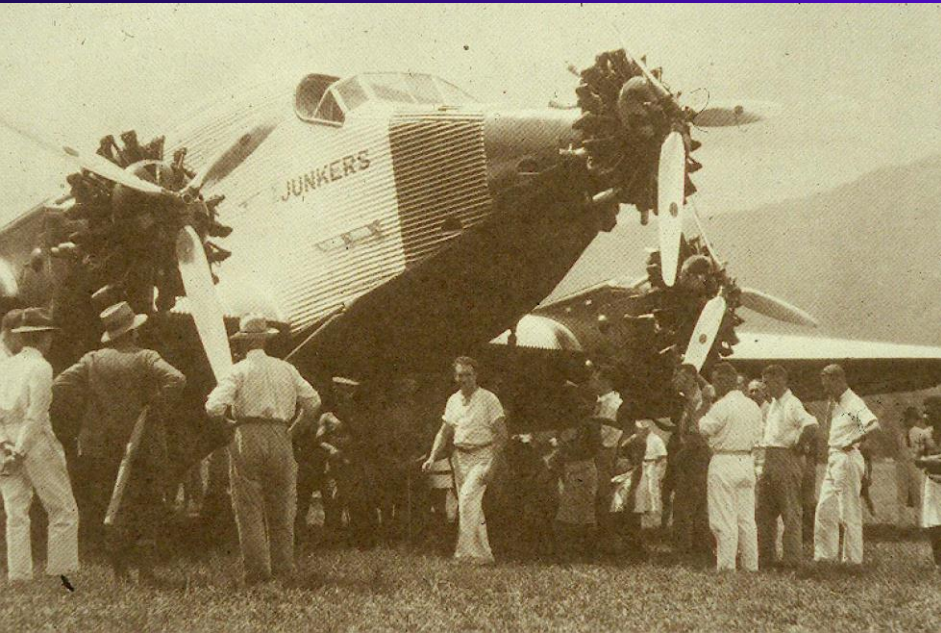
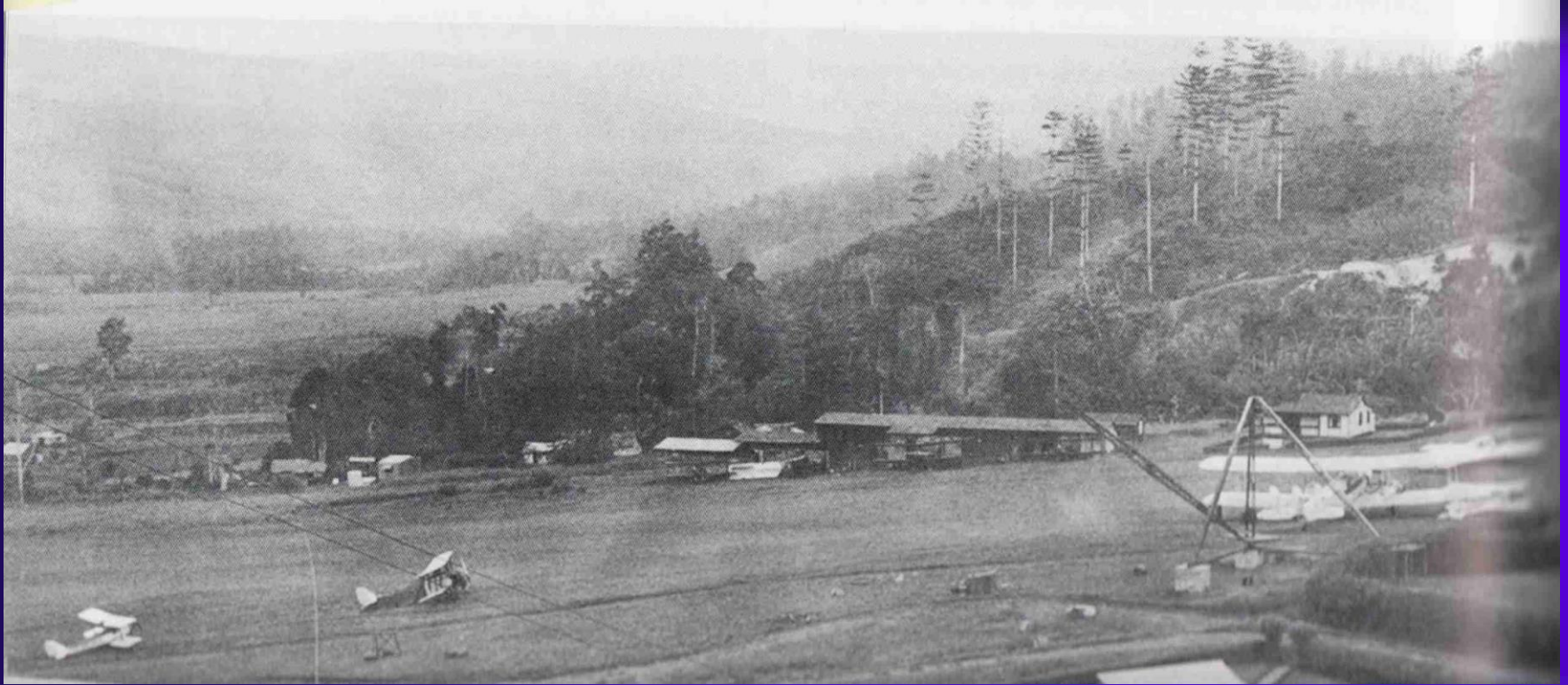


Edie Creek



1927 and onto the BDG





Bulolo Gold Dredging

2.1 M oz Au @ 0.15 g/t Au
1932-65



Dredge 5

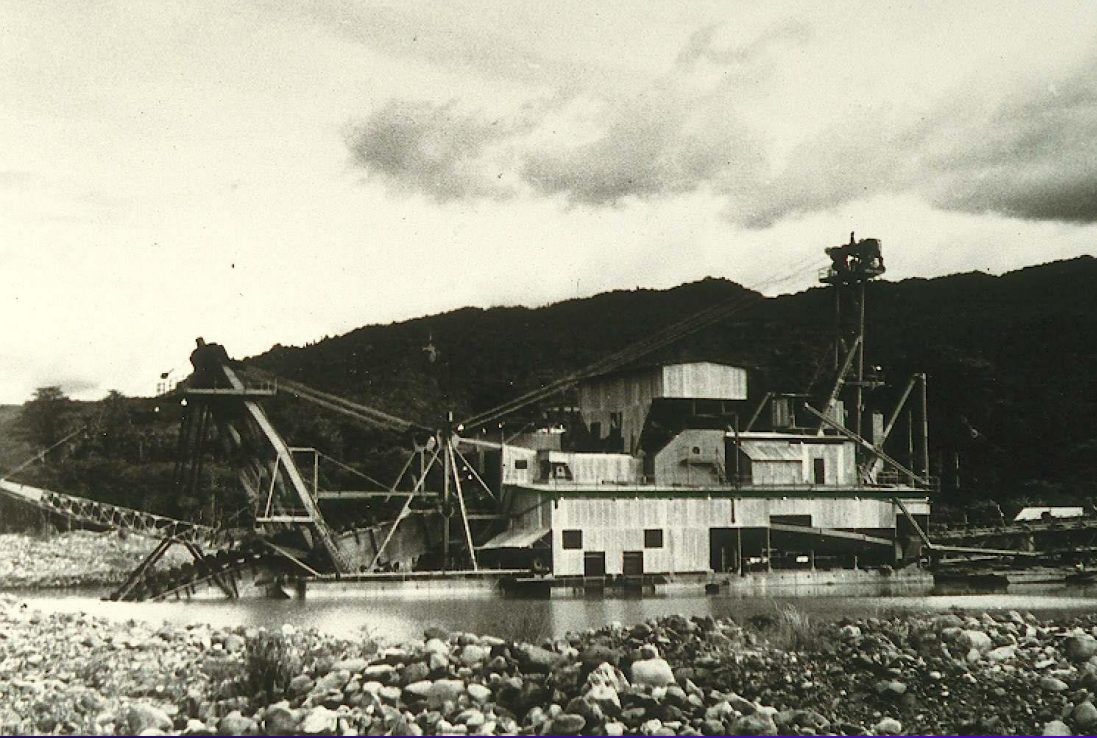


Illustration 1

Bulolo Gold Dredger upside down in eighty feet of water.



Illustration 8

End of the first operation. The dredger at rest on the bilge and superstructure with the pond pumped dry.

Wau-Namie-Ribroaster



About 1 M oz Au
1923-90



Morobe goldfield



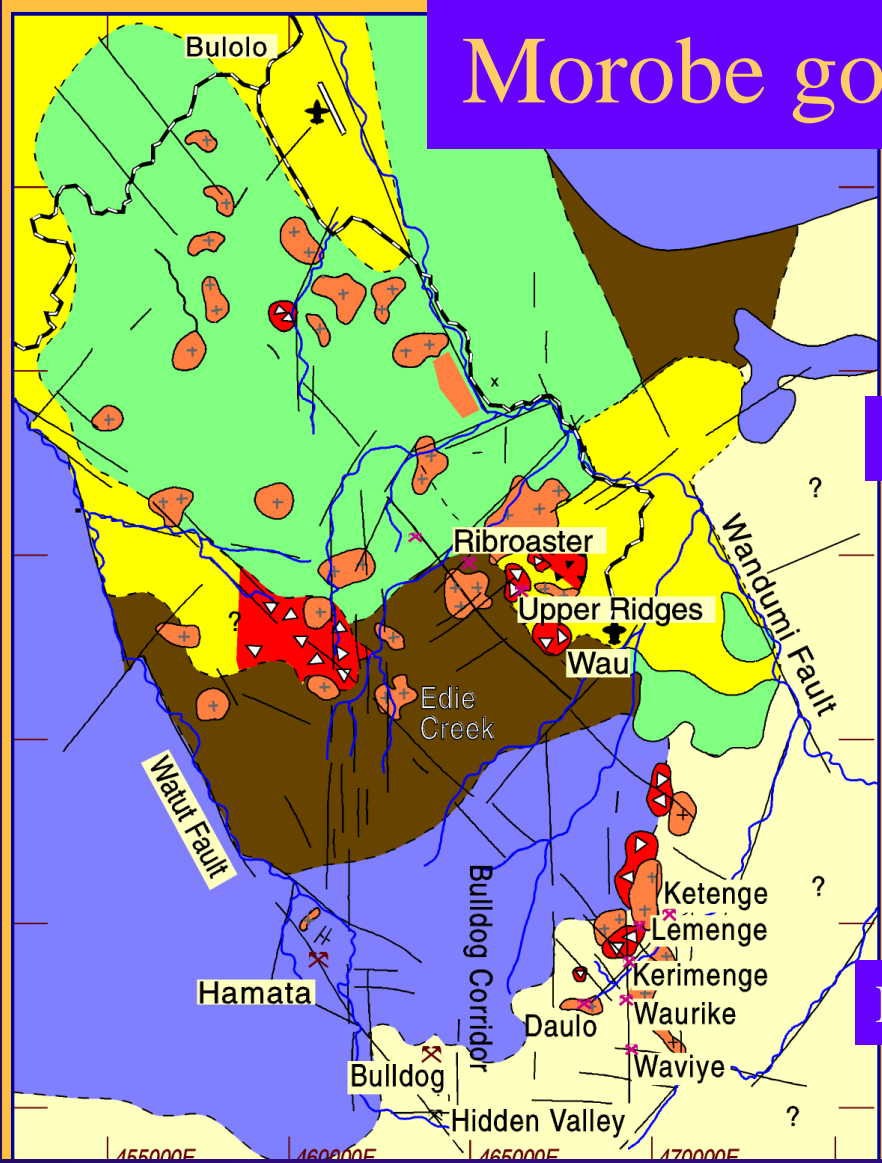
Hidden Valley

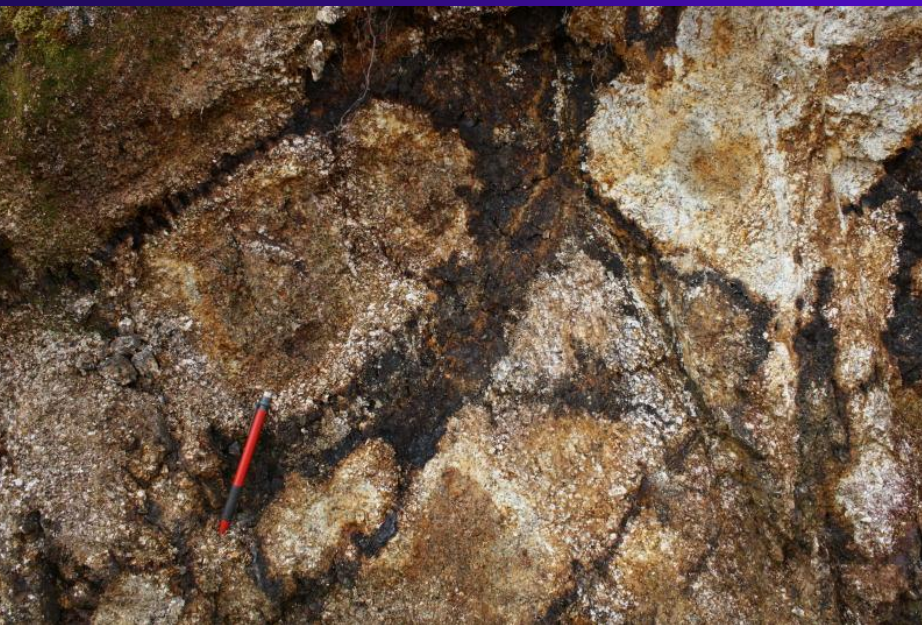
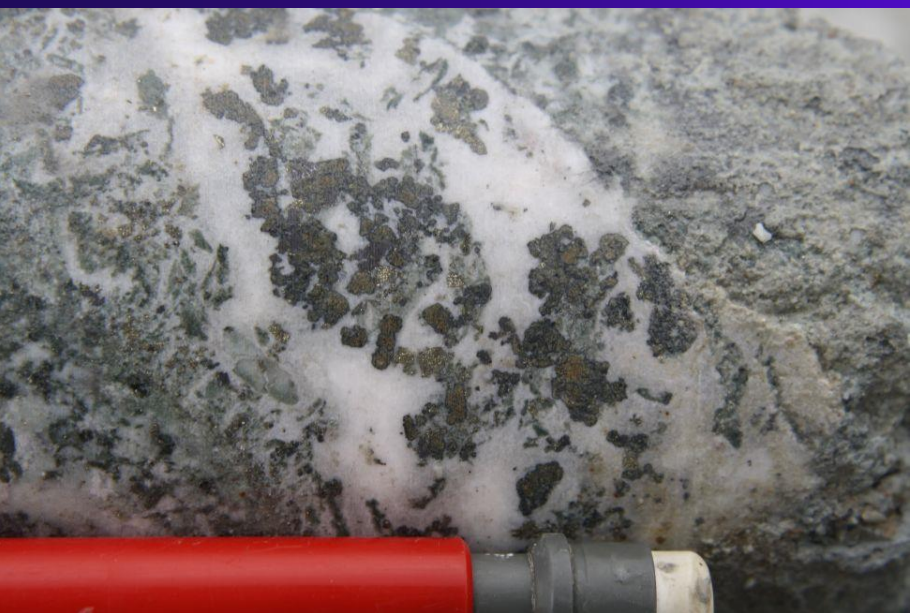


Hamata

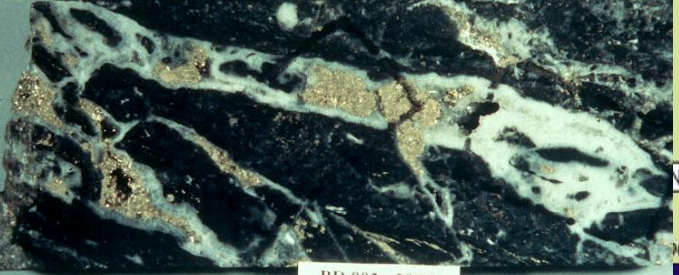
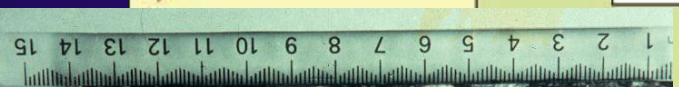
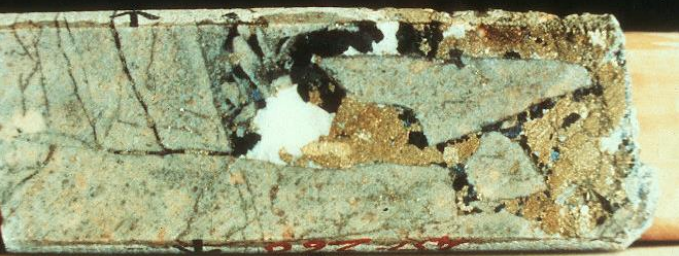


Kerimenge

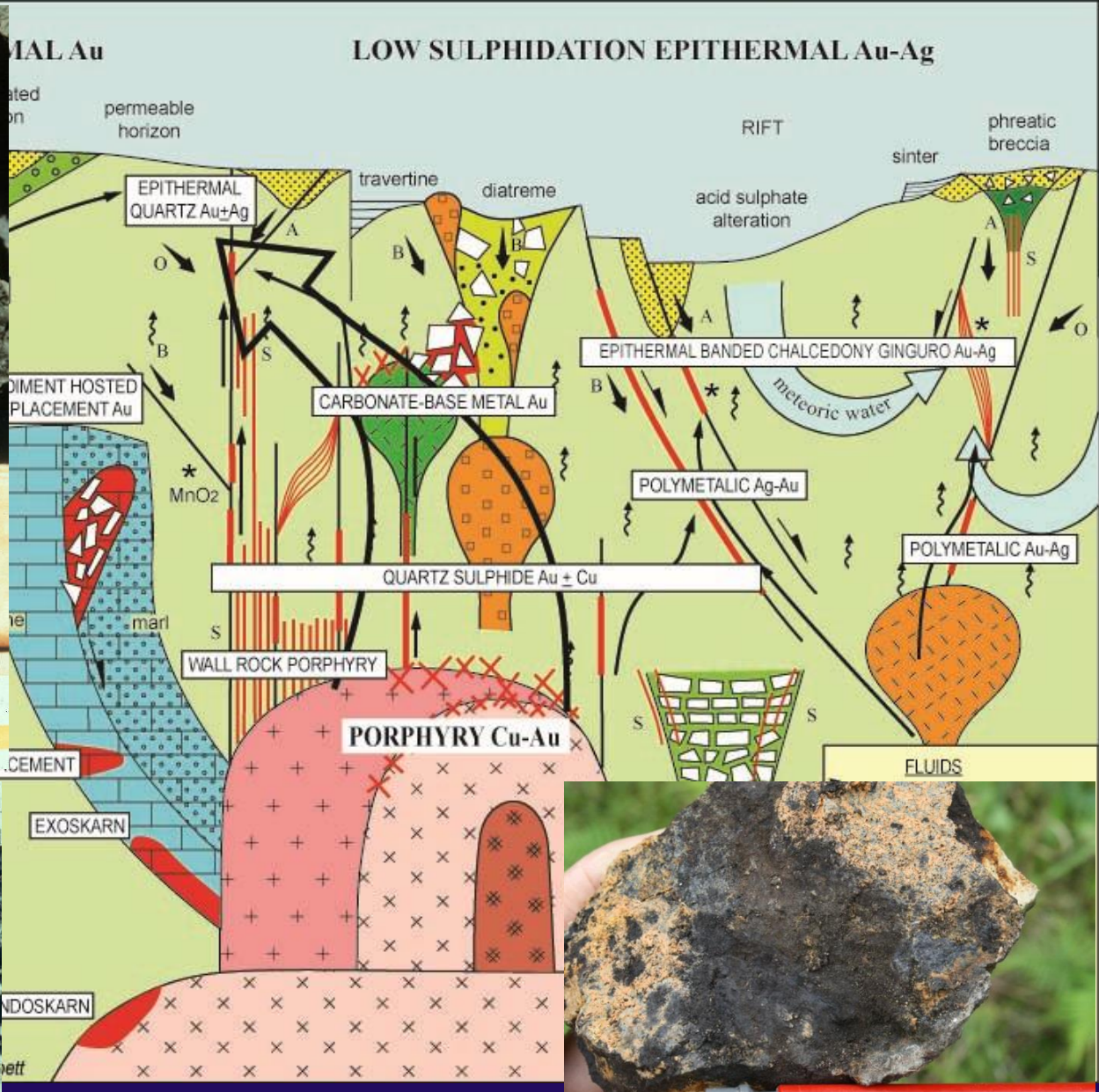




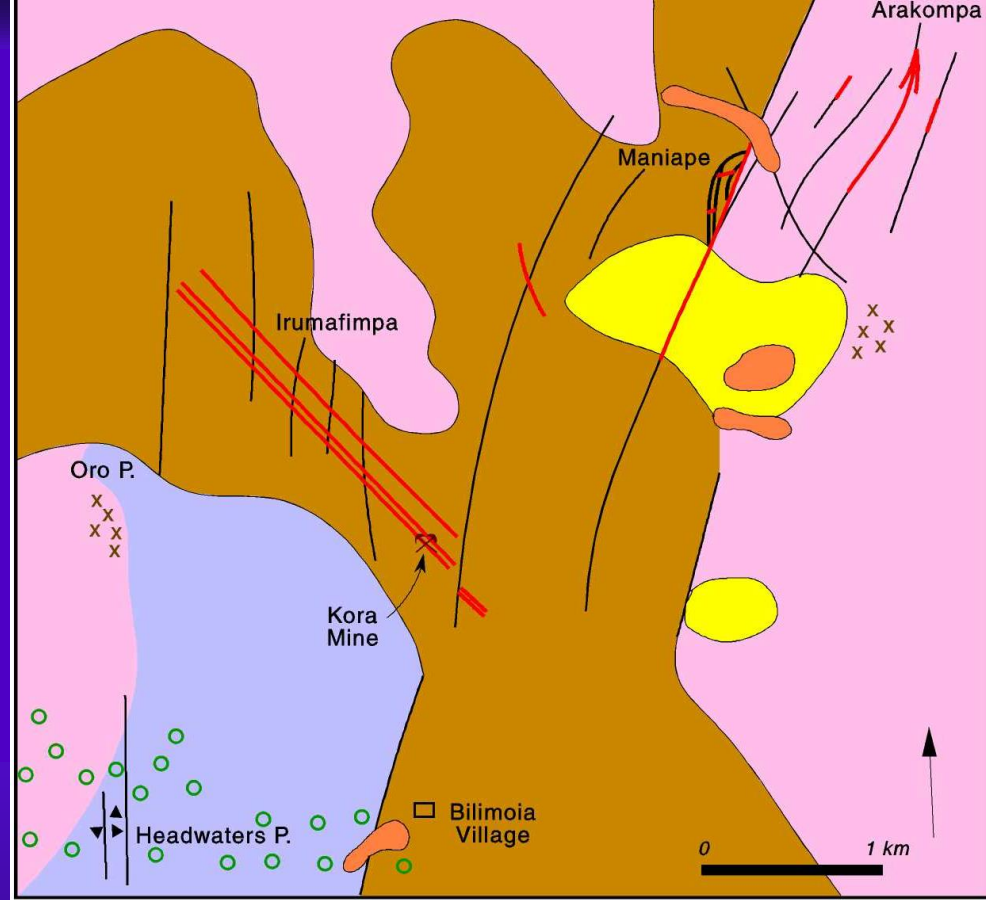
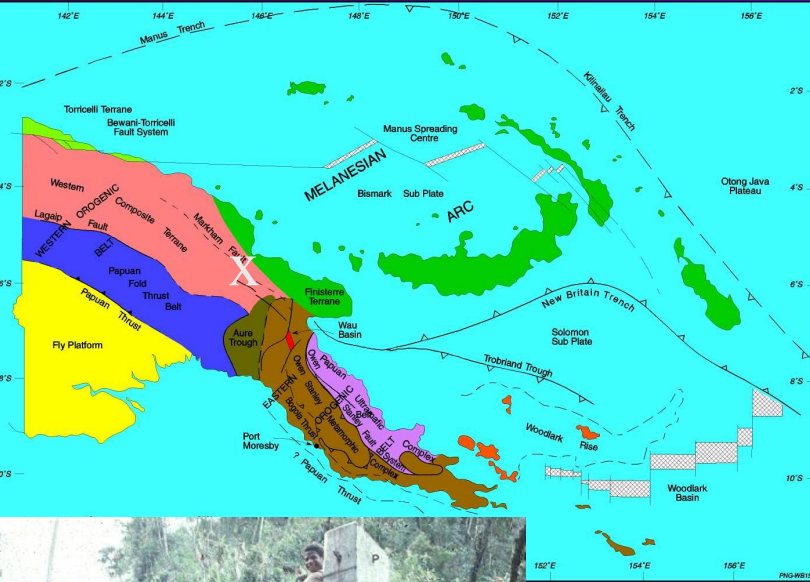
Styles of magmatic arc Cu-Au mineralisation



BD 002 - 208.9



Kainantu- Bilimoia



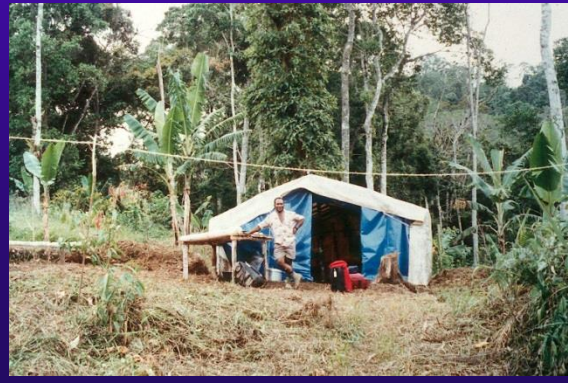
X
X
X

Porphyry Cu-Au occurrence

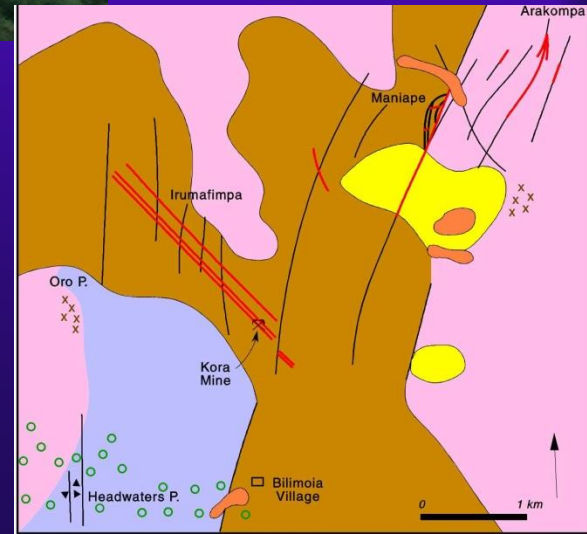
Bilimoia

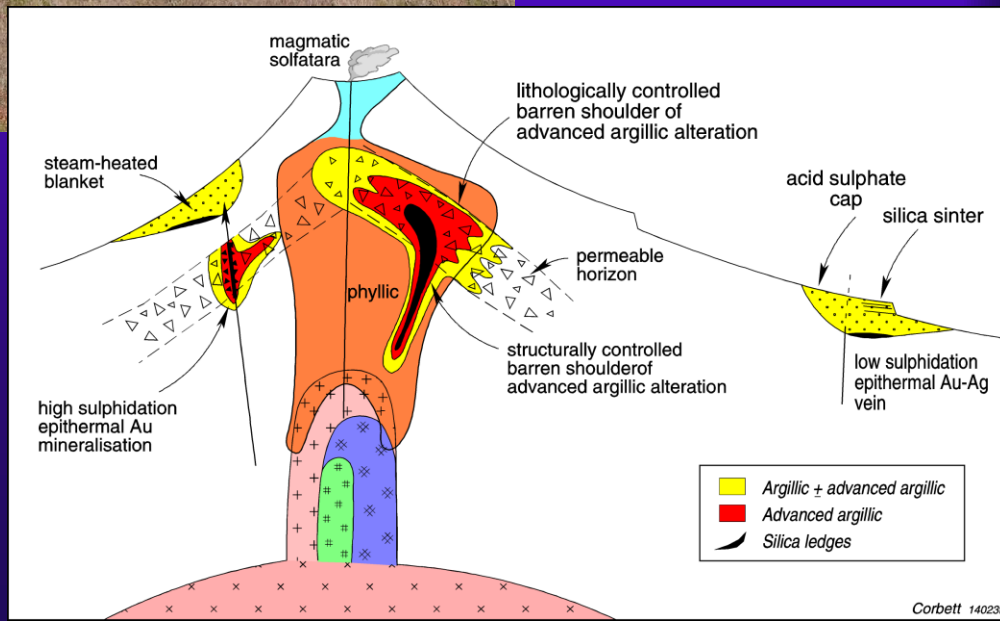


View



1.77M oz Au @ 22g/t Au



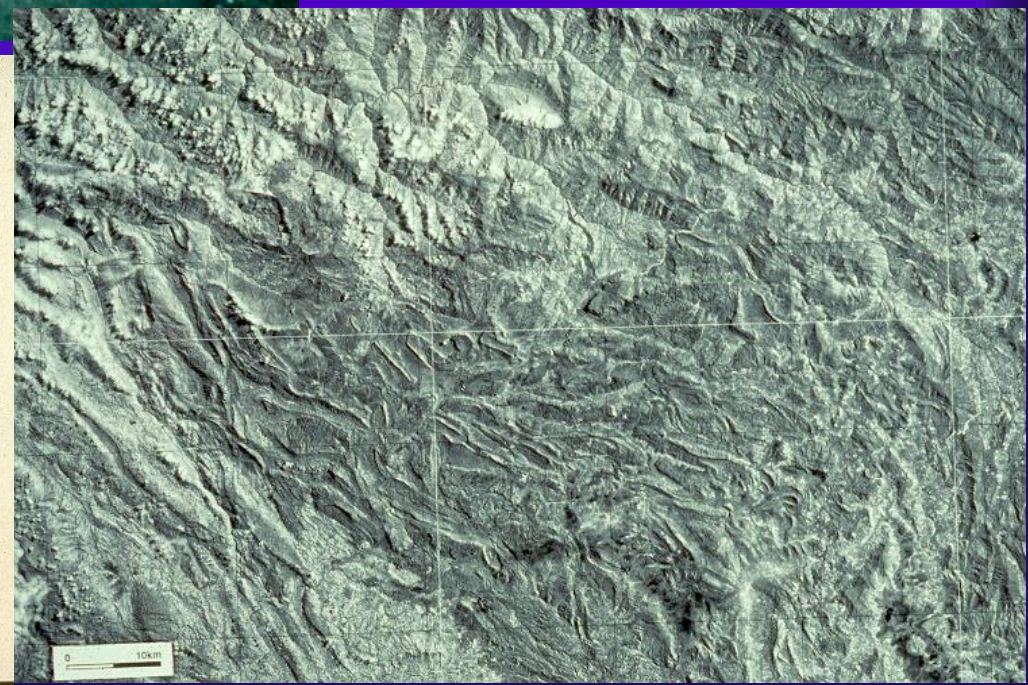
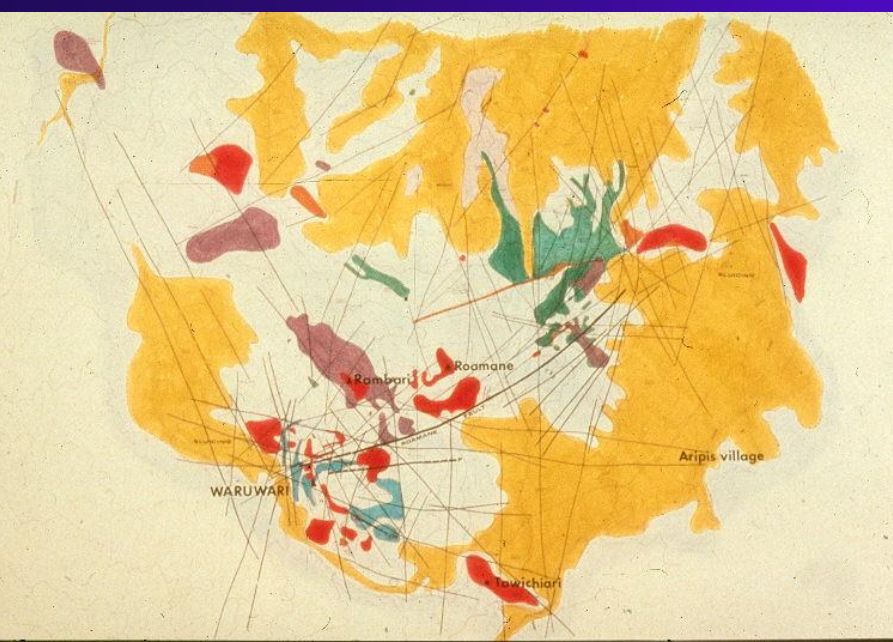
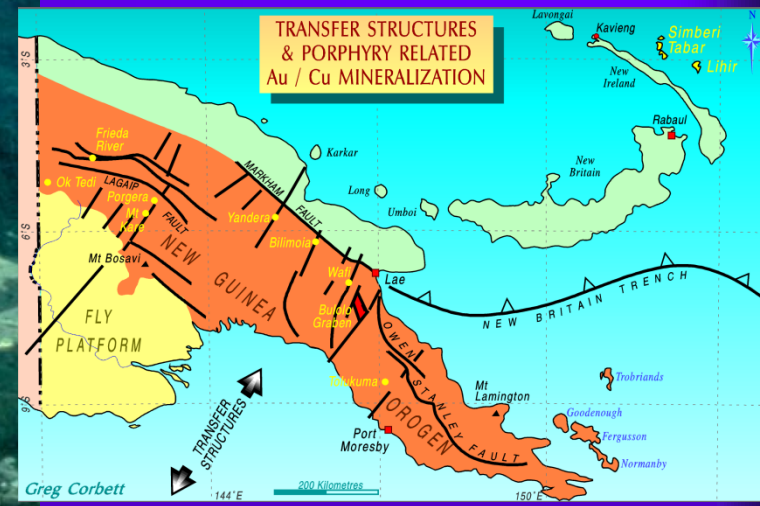


Noel Stagg Mt Victor about 1958...

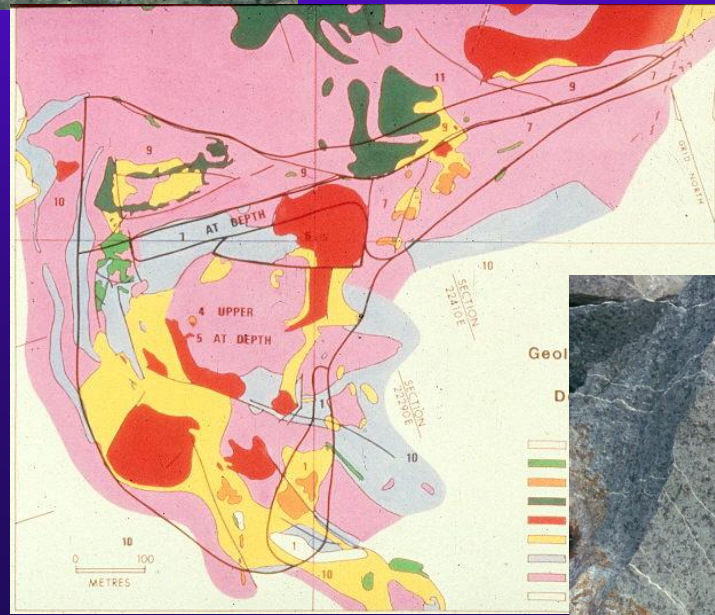
Photo Duncan Dow



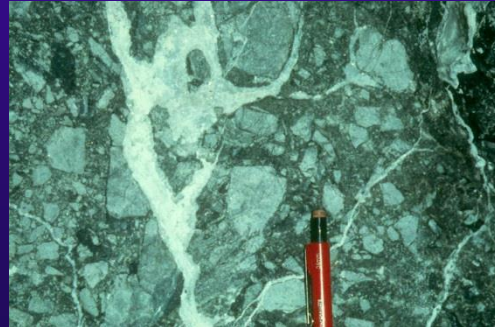
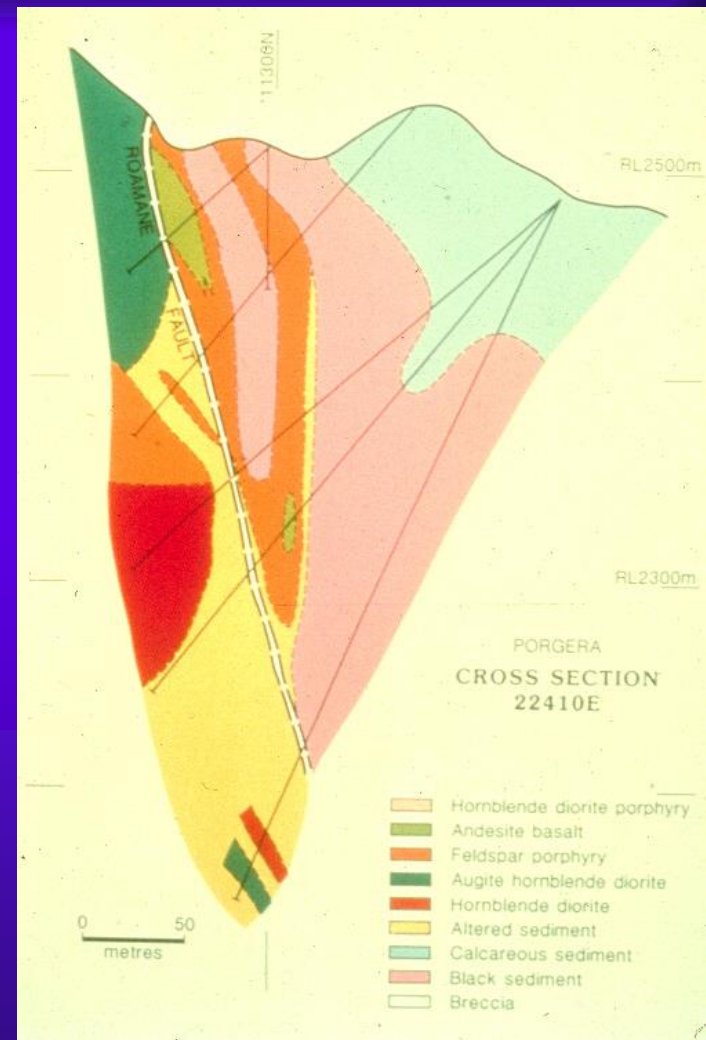
Porgera



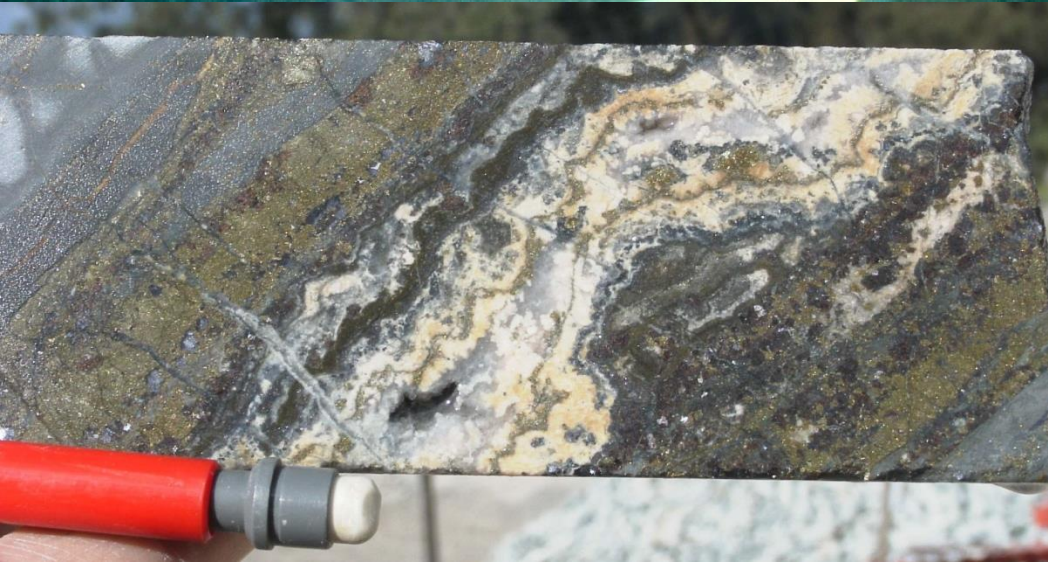
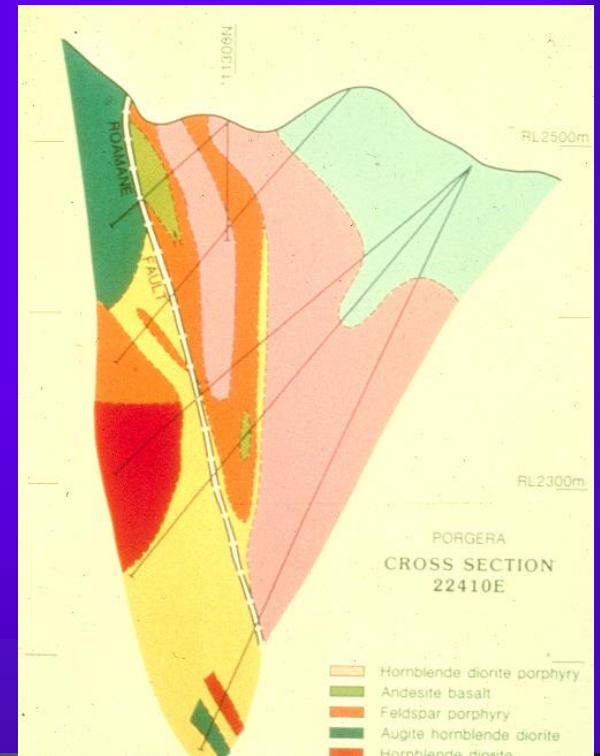
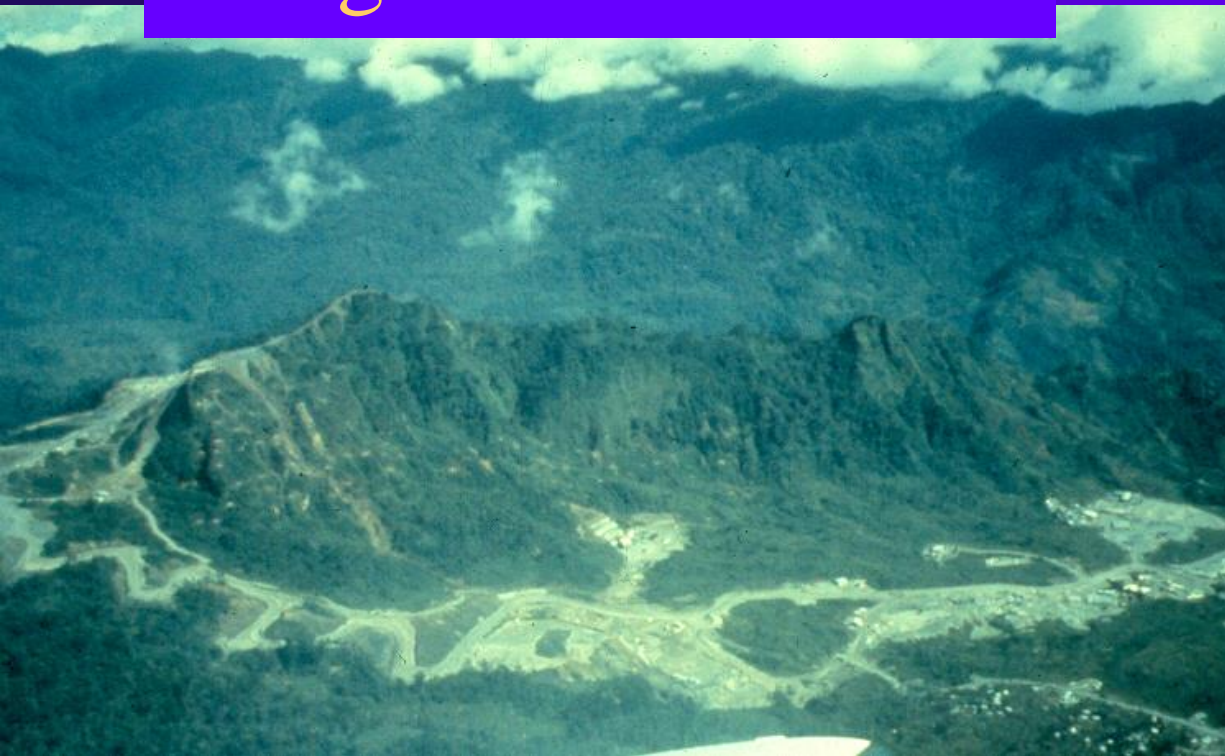
Porgera 1980



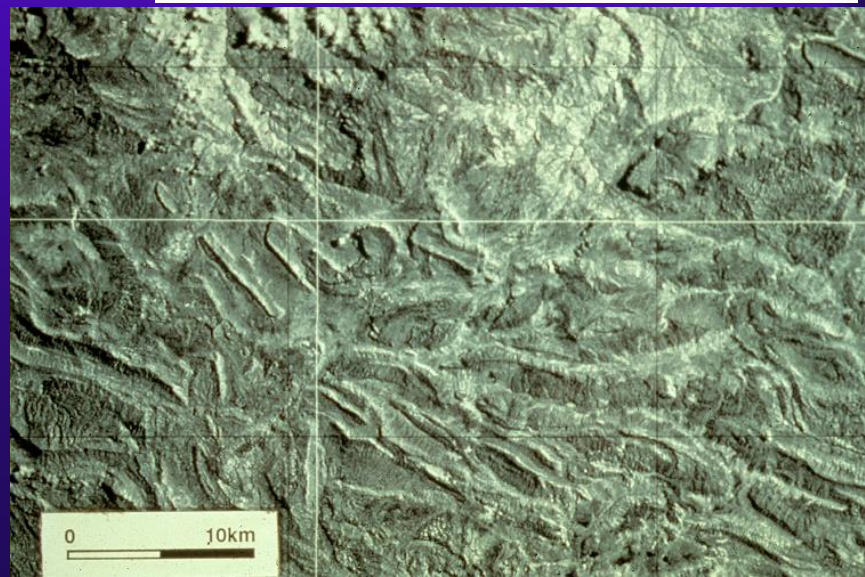
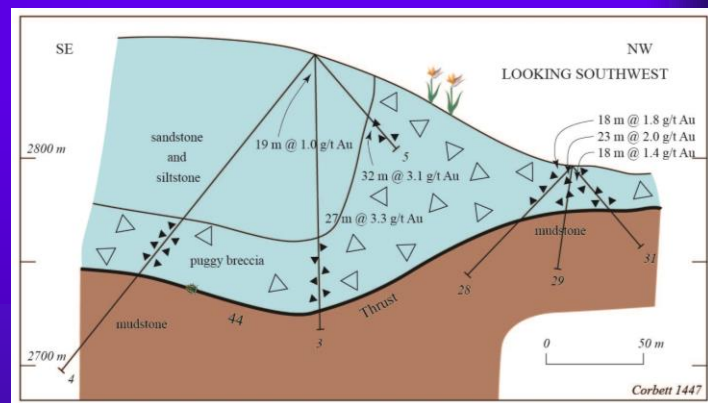
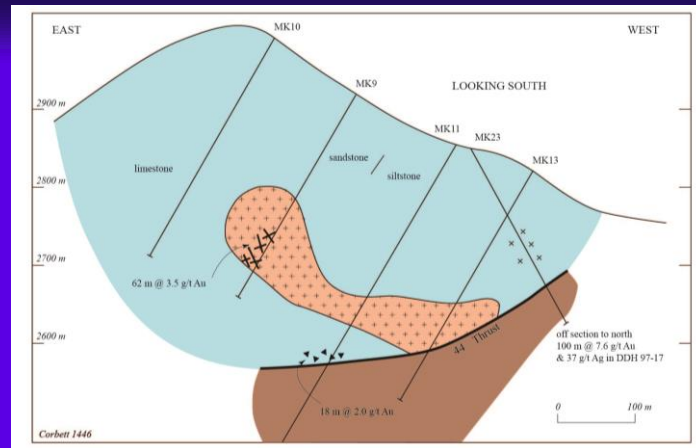
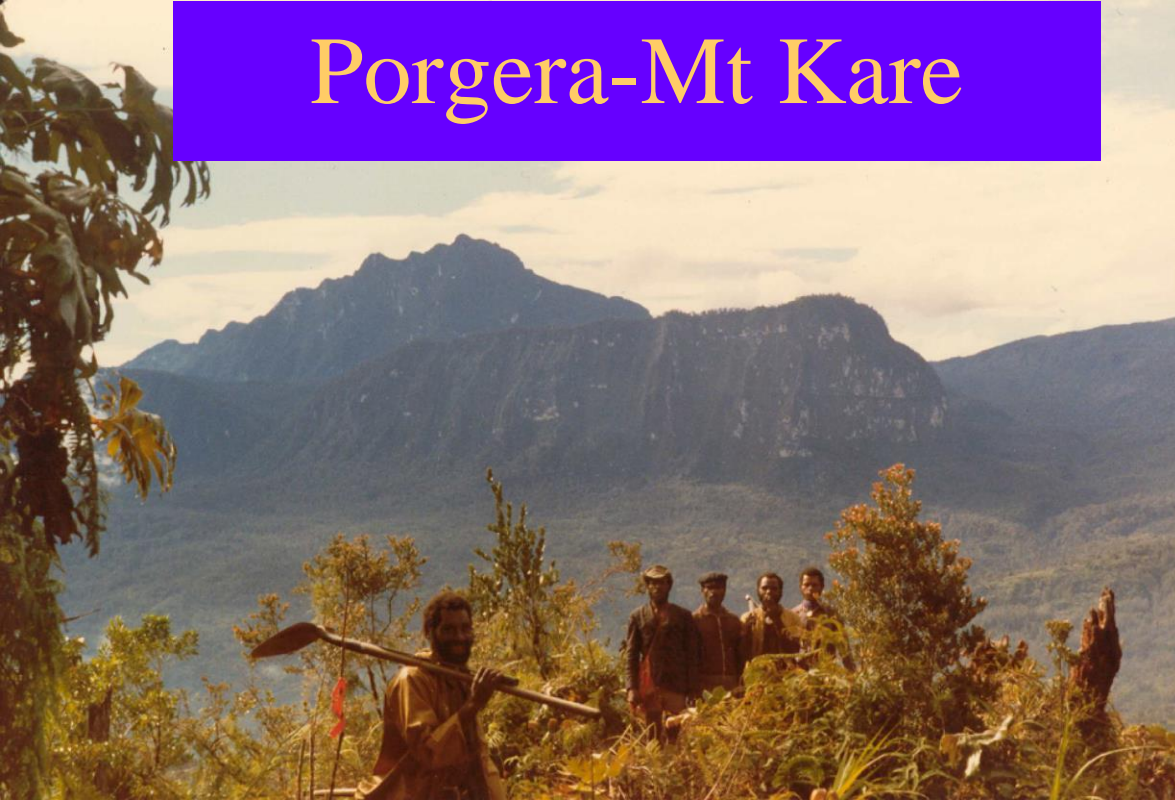
Porgera Zone VII



Porgera - two events



Porgera-Mt Kare



Mt Kare





Mt Kare – supergene Au

25.5 million t @
2.2/t Au and 29g/t Ag
1.8 M oz Au
0.29M oz production



Porgera

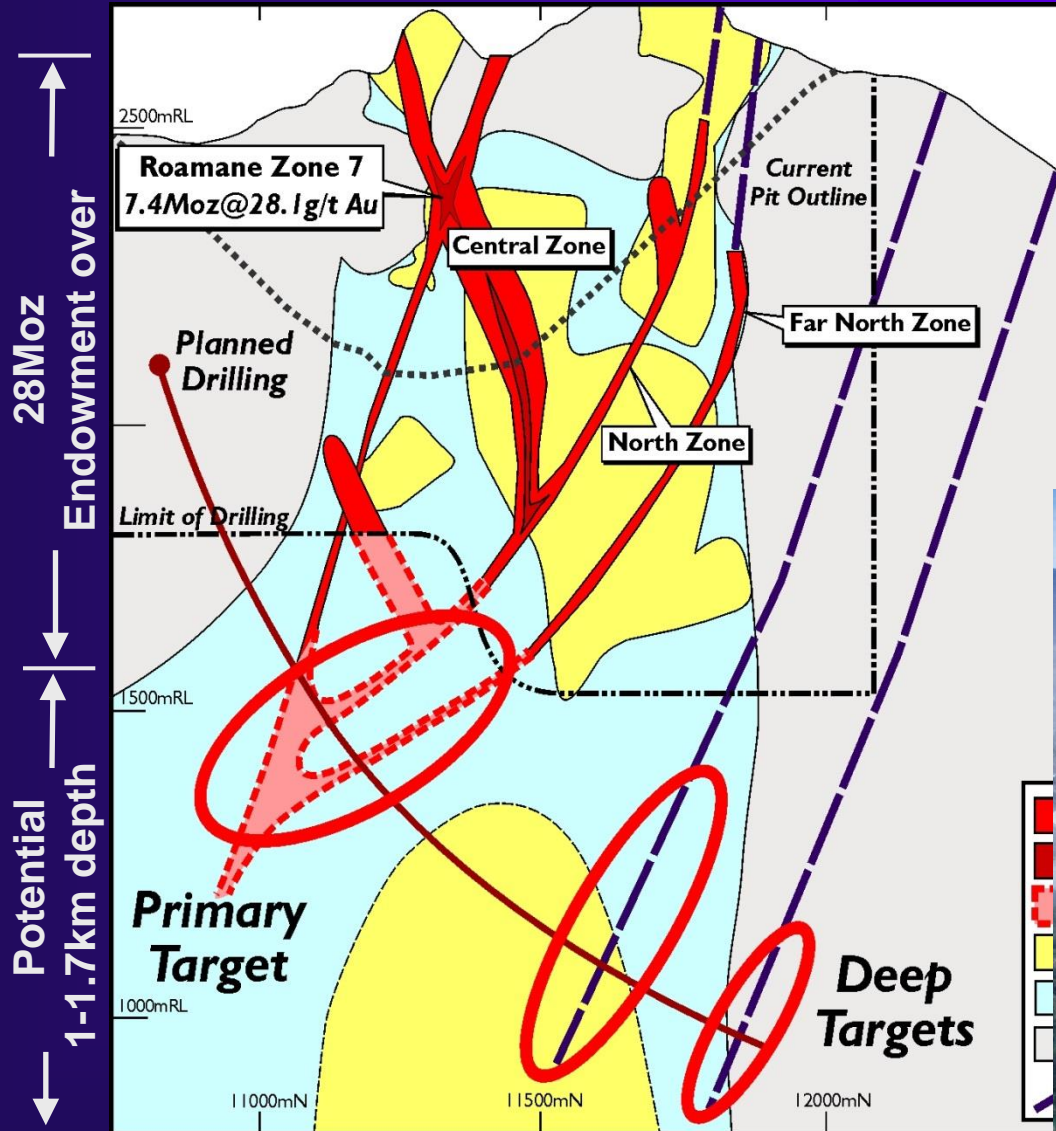
1980



2005



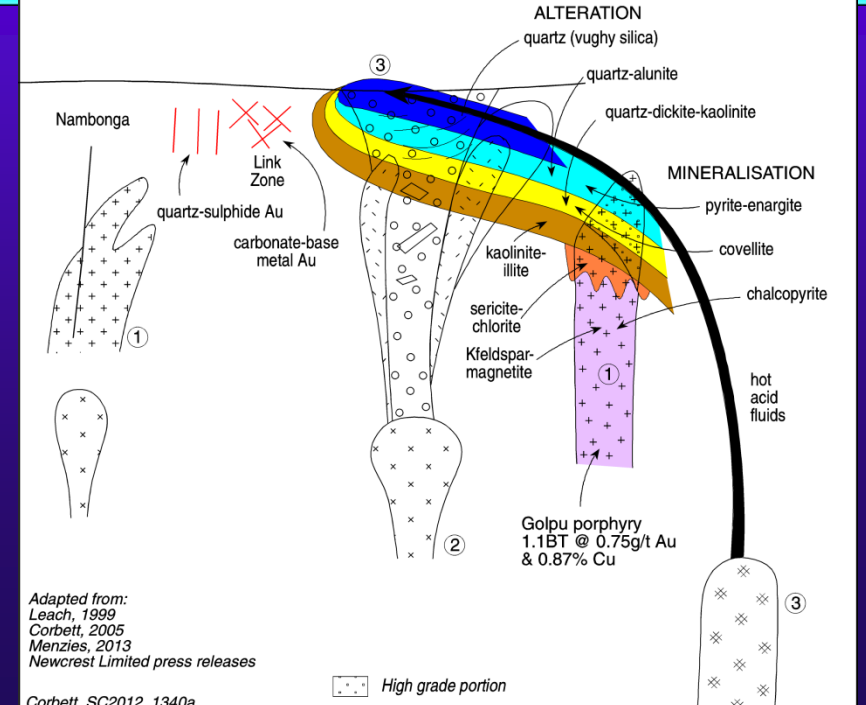
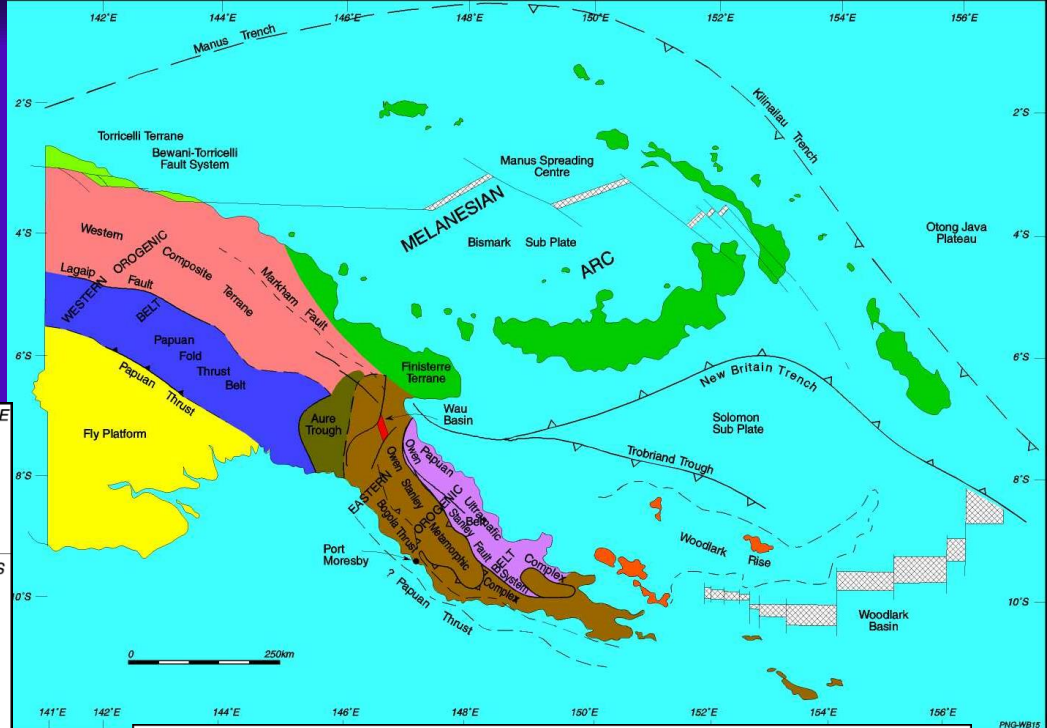
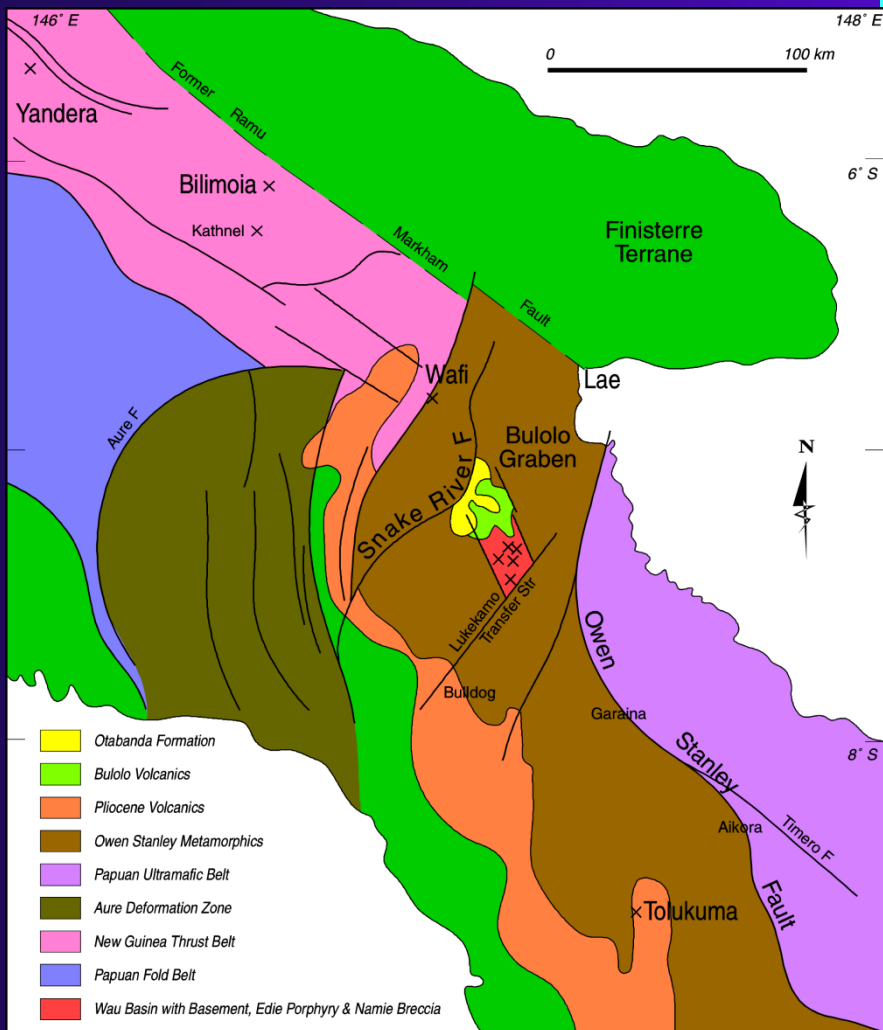
1990-2003 – 12.22M oz Au 2.23M oz Ag
2006 reserves 77.26Mt @ 3.79g/t Au (9.4M oz)
2013 production of 17.3M oz and reserves of 6.2M oz



Porgera 1980



Wafi

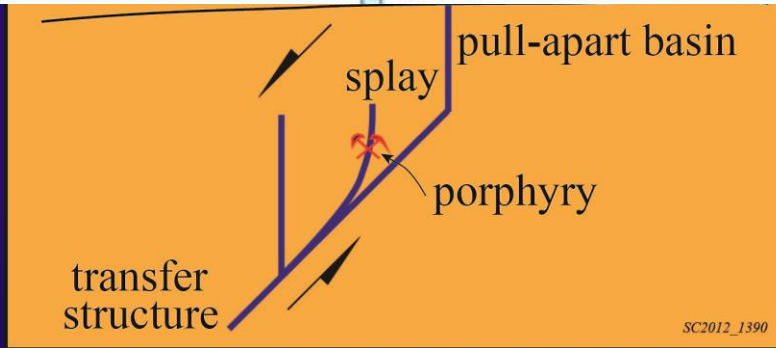
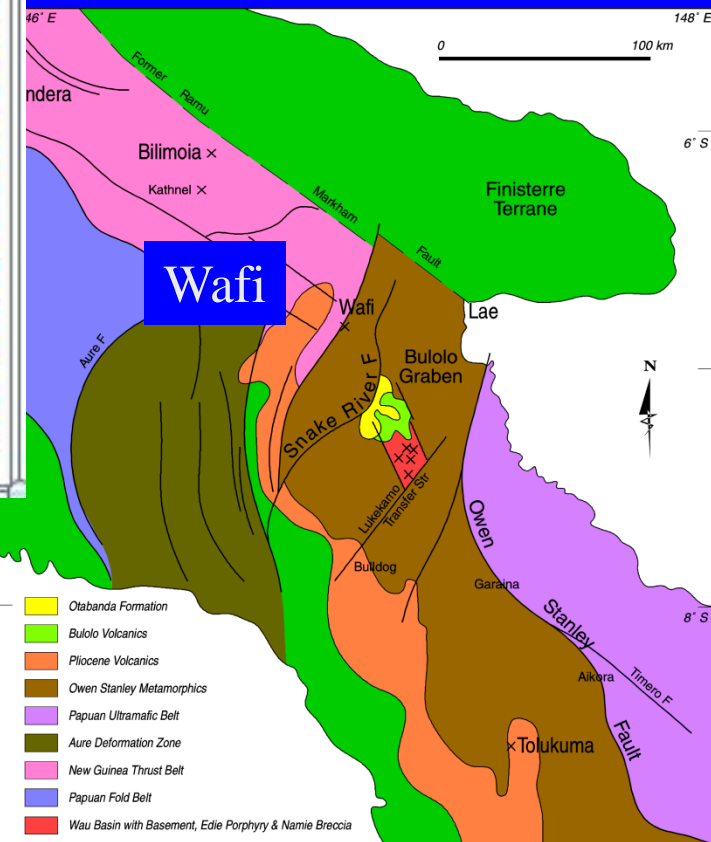
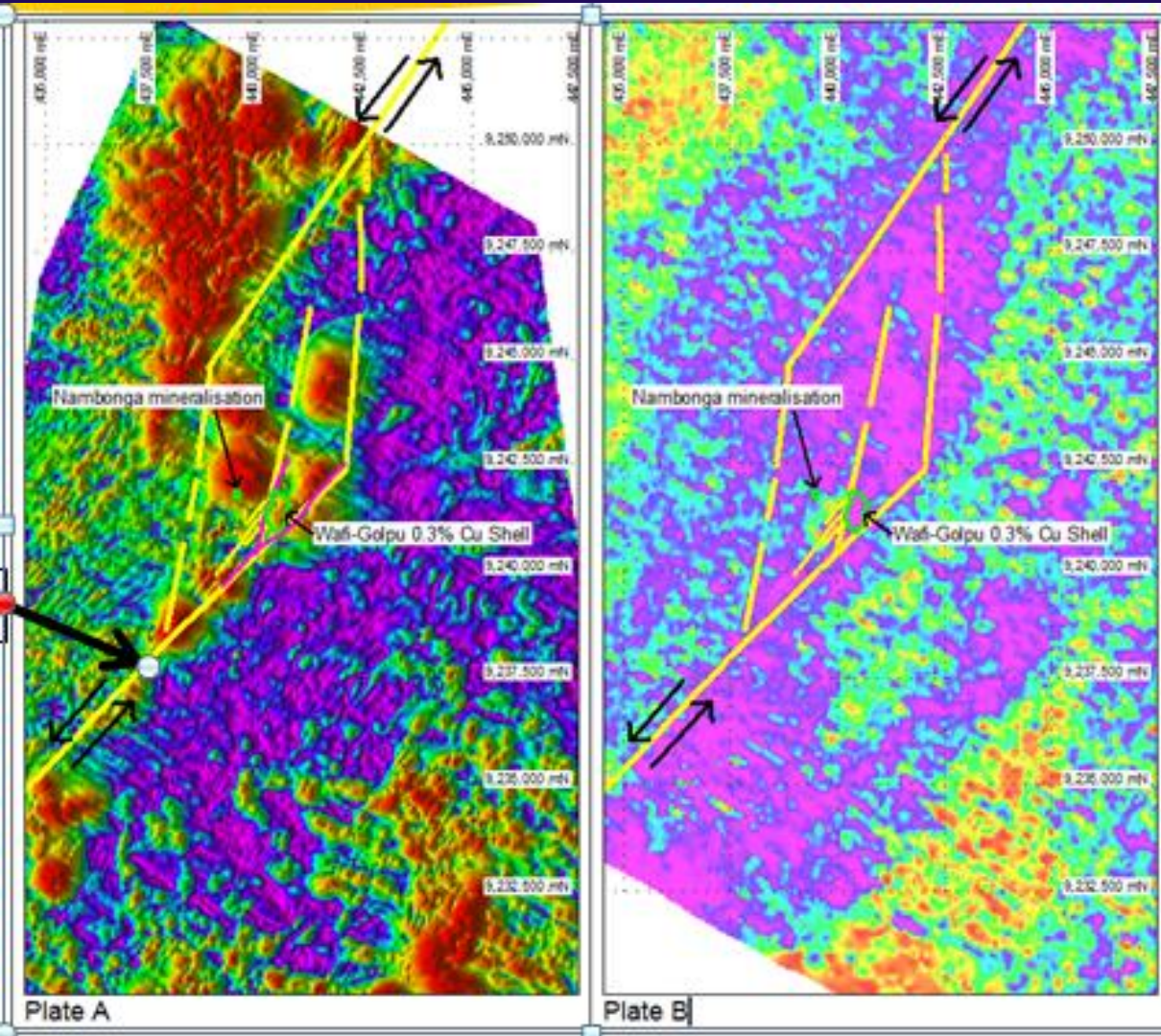


Adapted from:
 Leach, 1999
 Corbett, 2005
 Menzies, 2013
 Newcrest Limited press releases

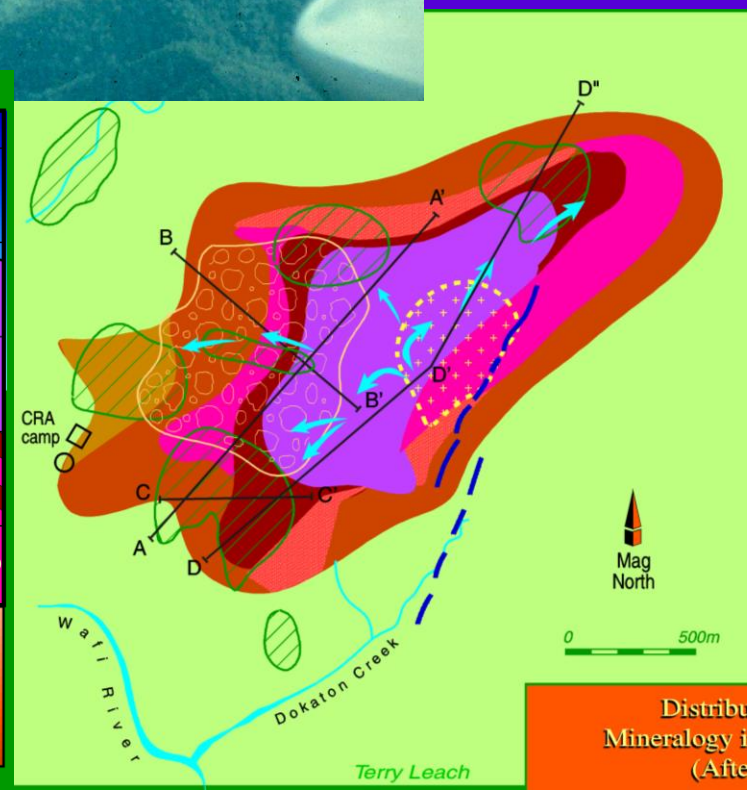
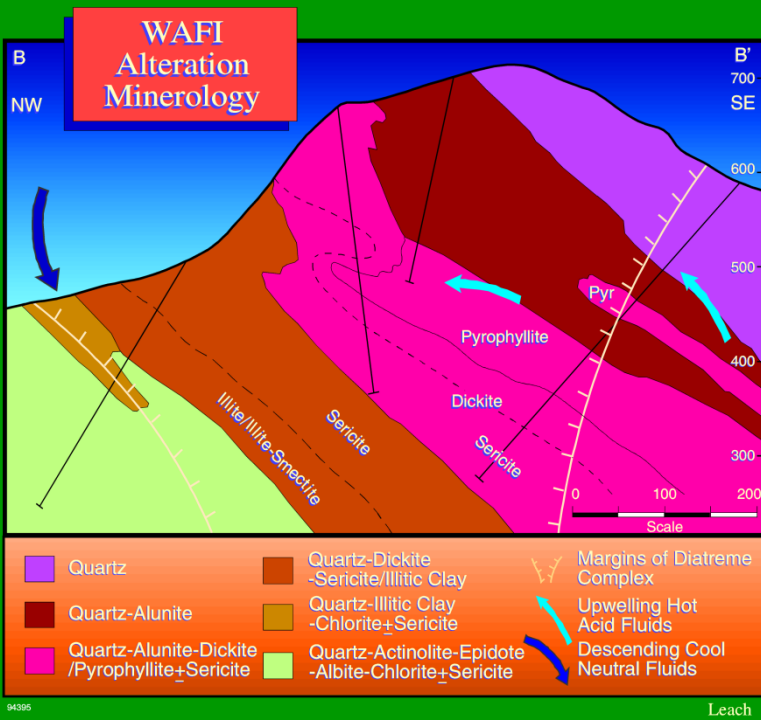
Corbett SC2012_1340a

Golpu porphyry localised by splay in pull-apart basin array

Data to left from Menzies 2013



Wafi



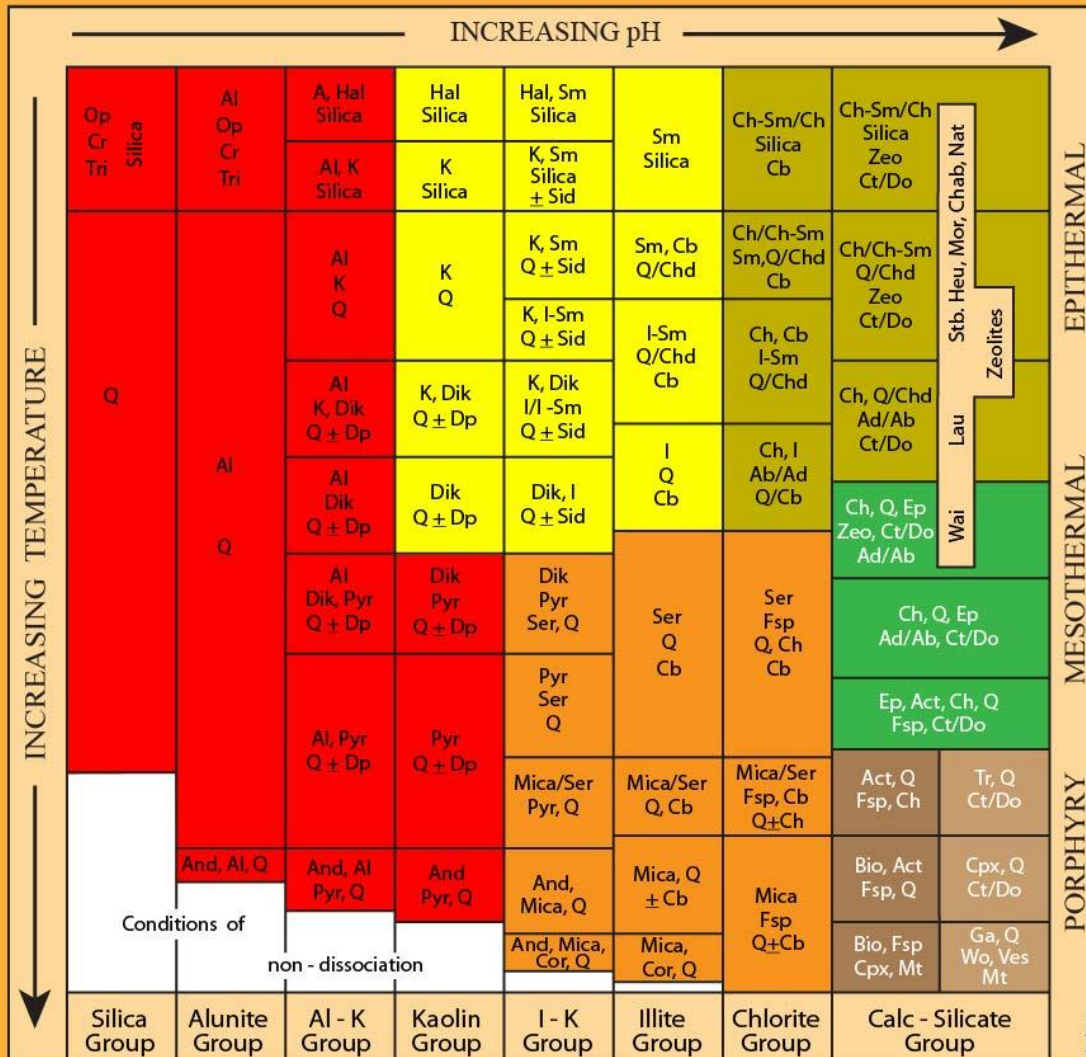
Alteration Assemblages

- Quartz
- Quartz - Alunite
- Quartz - Alunite - Dickite ± Pyrophyllite
- Quartz - Dickite - Kaolinite + Pyrophyllite
- Quartz - Dickite - Kaolinite - Sericite/Illite
- Quartz - Illitic Clay + Chlorite ± Sericite
- Quartz - Actinolite - Epidote - Chlorite ± Sericite
- > 1 g/t Au in soil
- Postulated Flow of Hot Acid Fluids
- Diatreme Complex
- Wafi Porphyry (at depth)
- Faults

Distribution of Surface Alteration Mineralogy in the Wafi River Prospect Area (After Leach & Erceg 1990)

Terry Leach pH vs temperature figure

Common Alteration Mineralogy in Hydrothermal Systems



- Potassic
- Skarn
- Inner Propylitic
- Phyllic
- Outer Propylitic
- Advanced Argillic
- Argillic

Ab - albite; Act - actinolite; Ad - adularia;
 Al - alunite; And - andalusite; Bio - biotite;
 Cb - carbonate; (Ca, Mg, Mn, Fe); Ch - chlorite;
 Chab - chabazite; Chd - chalcedony;
 Ch-Sm - chlorite-smectite; Cor - corundum;
 Cpz - clinopyroxene; Cr - cristobalite;
 Ct - calcite; Do - dolomite; Dik - dickite;
 Dp - diaspore; Ep - epidote; Fsp - feldspar;
 Ga - garnet; Hal - halloysite; Heu - heulandite;
 I - illite; I-Sm - illite-smectite; K - kaolinite;
 Lau - laumontite; Mt - magnetite;
 Mor - mordenite; Nat - natrolite; Op - opaline silica;
 Pyr - pyrophyllite; Q - quartz; Ser - sericite;
 Sid - siderite; Sm - smectite; Stb - stibnite;
 Tr - tremolite; Tri - tridymite;
 Ves - vesuvianite; Wai - wairakite;
 Wo - wollastonite; Zeo - zeolite.

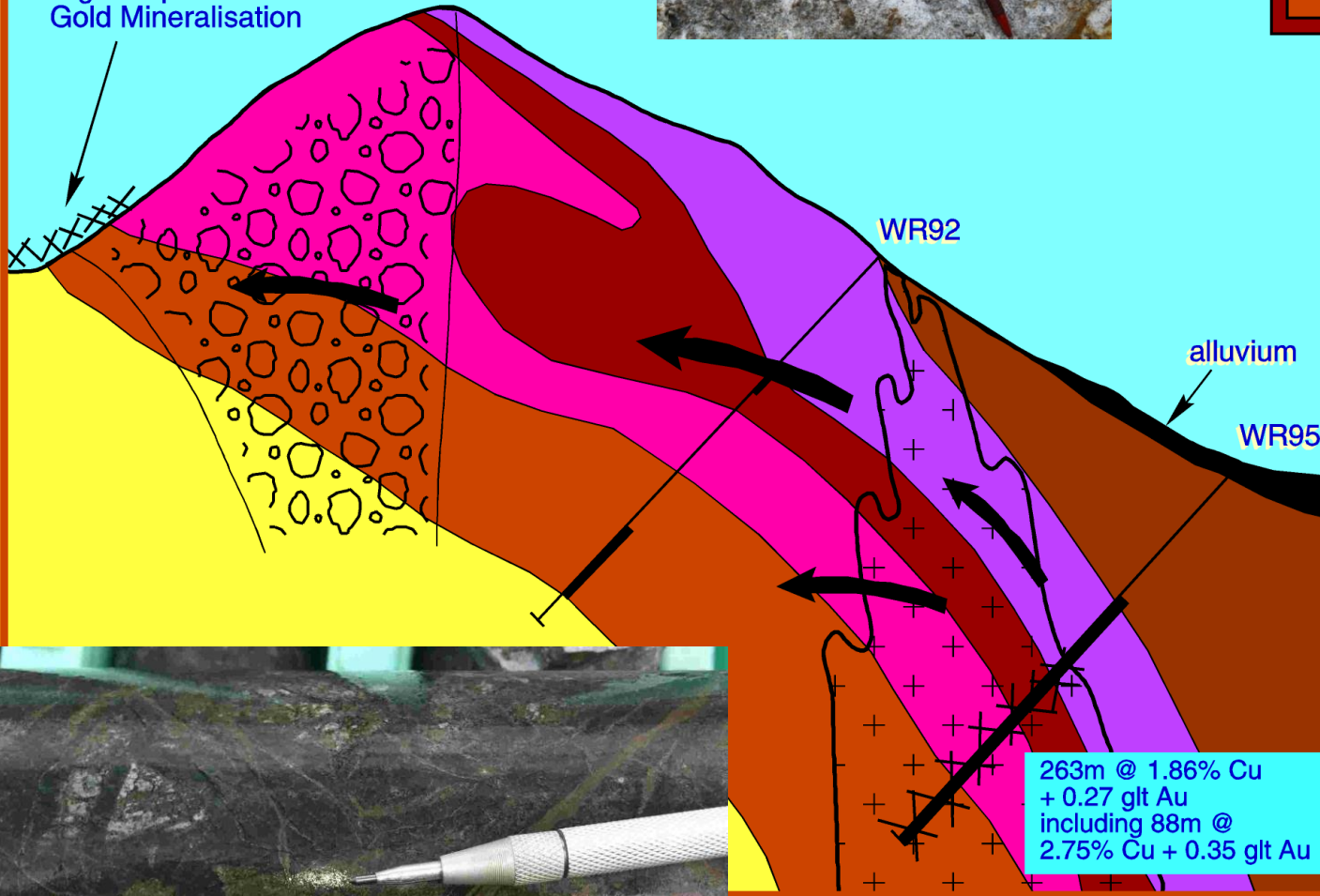
WAFI

Setting of the Rafferty's Porphyry

WEST

Zone B & C
High Sulphidation
Gold Mineralisation

EAST



drill hole with >0.1% Cu

stockwork veining

+ Porphyry

Diatreme breccia

SIMPLIFIED ALTERATION

Quartz

Quartz-alunite

Quartz-pyrophyllite

Quartz dickite/kaolinite sericite

Quartz illitic clay

0 200m

263m @ 1.86% Cu
+ 0.27 g/t Au
including 88m @
2.75% Cu + 0.35 g/t Au



Wafi about 2003



Western Zone
(not currently in
resource)

Diatreme

Golpu Porphyry*

163 Mt @ 1.1% Cu, 0.57 g/t Au, 132 ppm Mo
3.9B lb Cu, 47M lb Mo **2.96 Moz Au**

Wafi Au Resource*

- 1 g/t grade shell (Blue)
- 2.5 g/t grade shell (Yellow)

110Mt @ 1.85 g/t for **6.51 Moz Au**

Link Zone

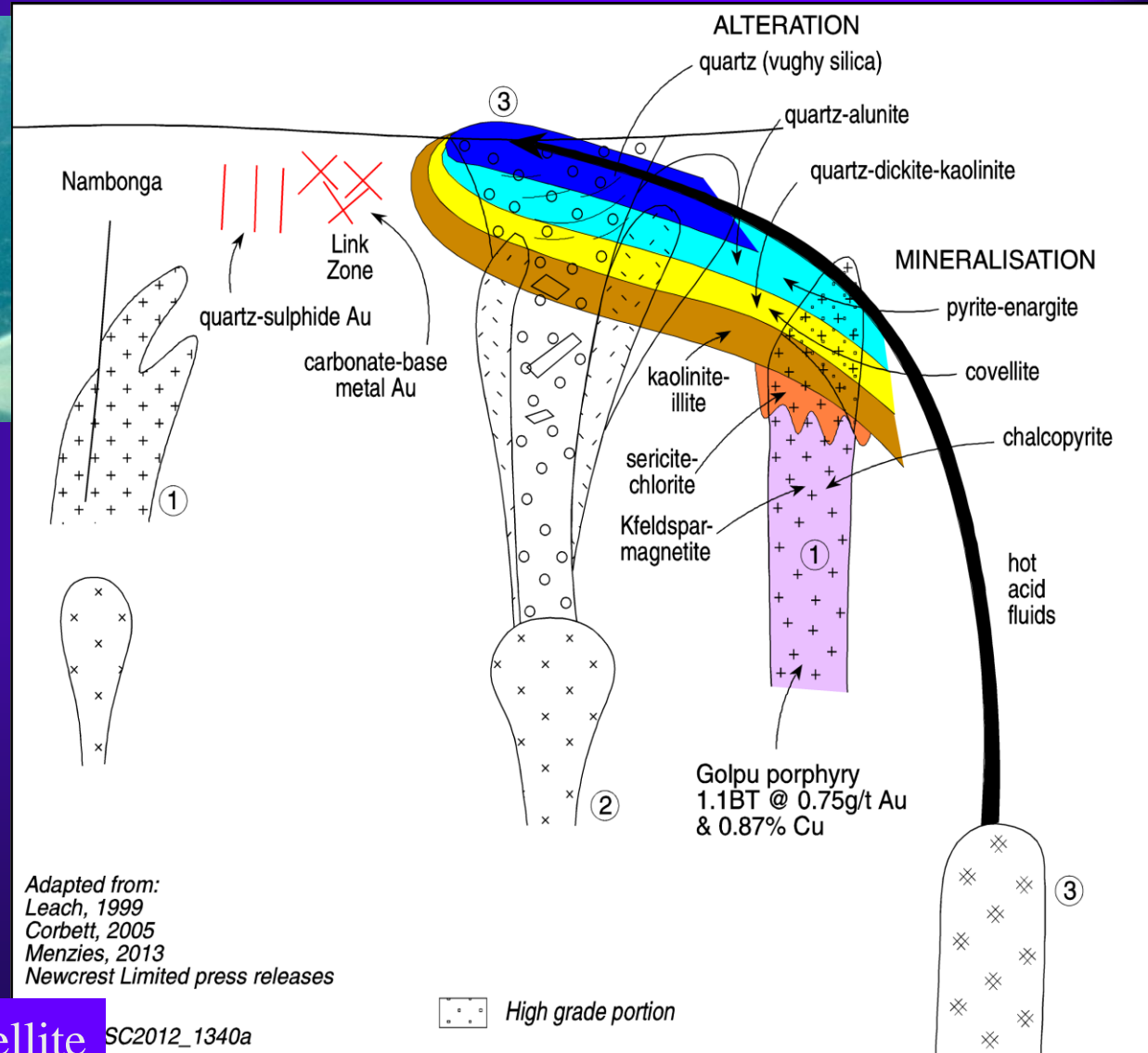
4.8 Mt @ 8.4 g/t
for **1.3 Moz Au**

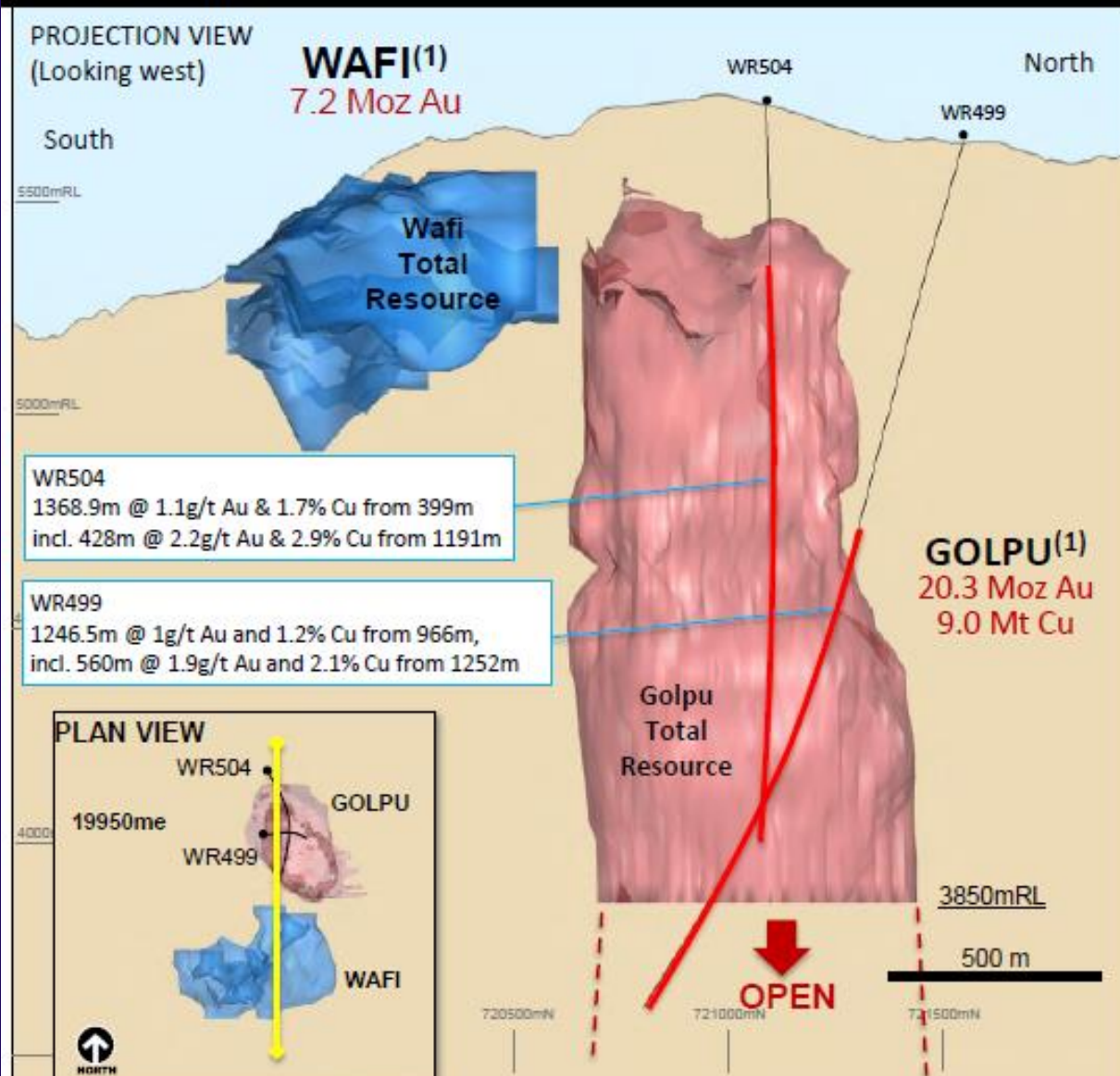
Range = 81 Azimuth 356

0 100 200 300 400

* Resource inventory available on the Harmony website

Elevated metal grades due to acid overprint on porphyry





- WR5041 (west to east)

1 369m @ 1.1g/t Au and 1.7% Cu from 399m, including 428m @ 2.2g/t Au and 2.9% Cu from 1 191m

- confirmed fault structure controlling higher grade blocks

- WR499 (north to south)

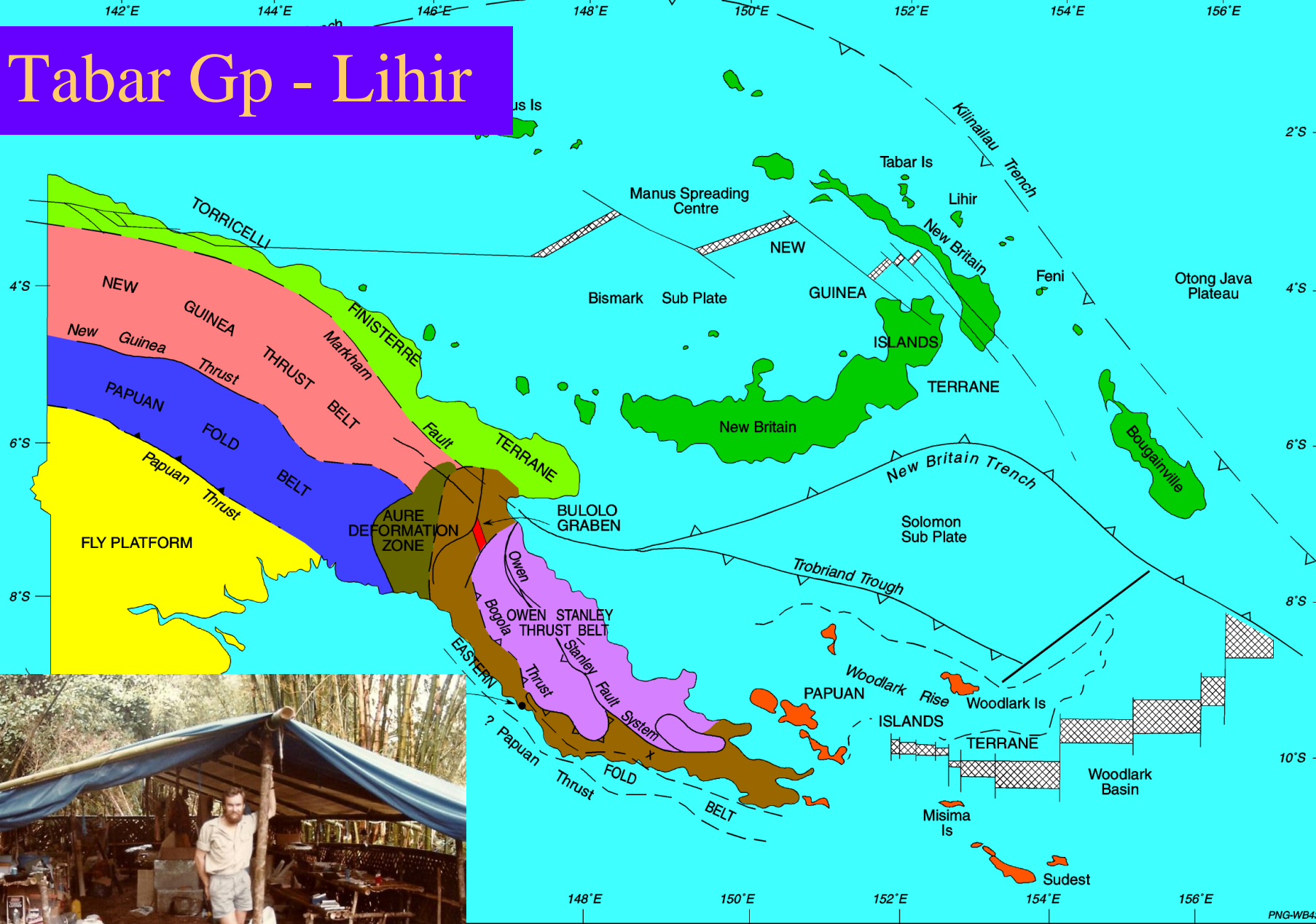
1 247m @ 1.0g/t Au and 1.2% Cu from 966m, including 560m @ 1.9g/t Au and 2.1% Cu from 1 252m

- confirmed northern margin
- demonstrated continuity of mineralisation below the current resource

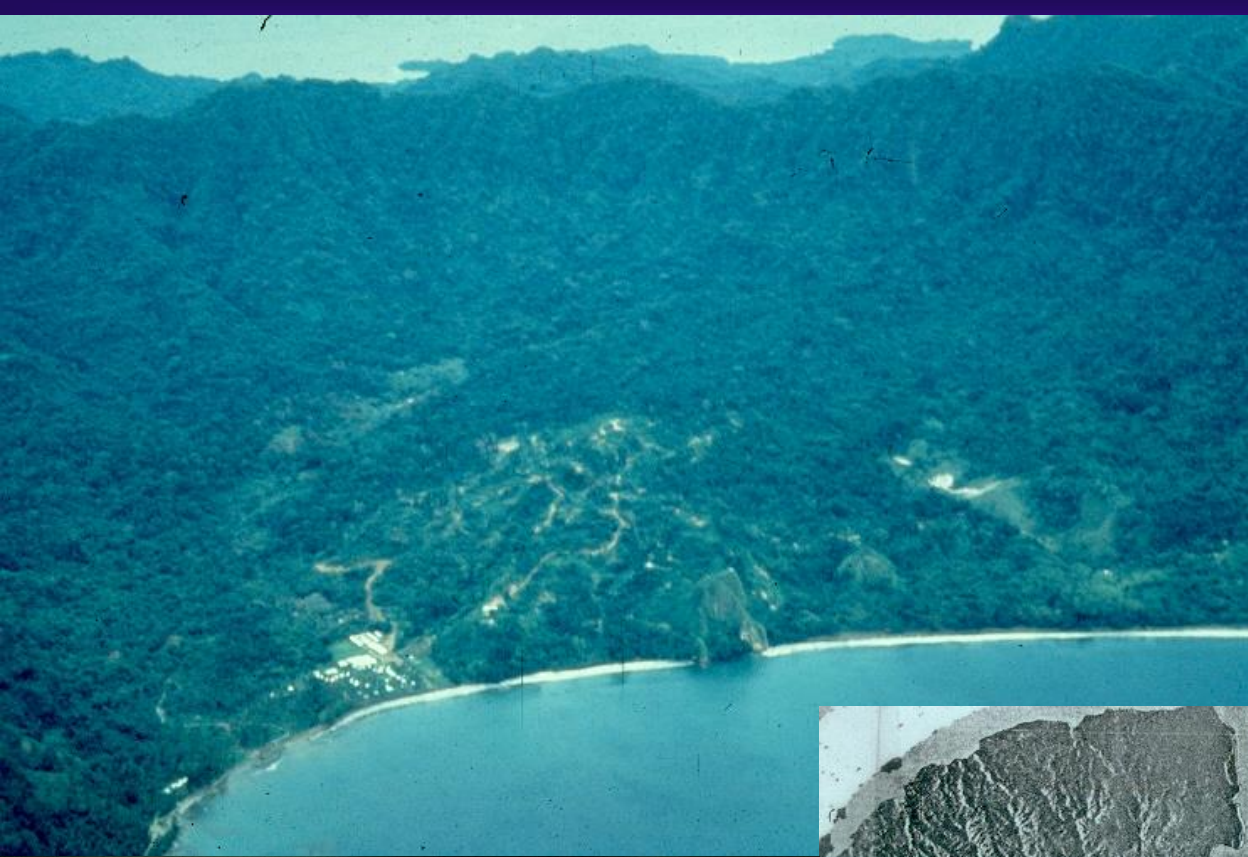
From Harmony Press release
14 March 2014

- WR499* – 1 247m @ 1.0g/t Au and 1.2% Cu from 966m, including 560m @ 1.9g/t Au and 2.1% Cu from 1 252m;
- WR504 – 1 369m @ 1.1g/t Au and 1.7% Cu from 399m, including 428m @ 2.2g/t Au and 2.9% Cu from 1 191m

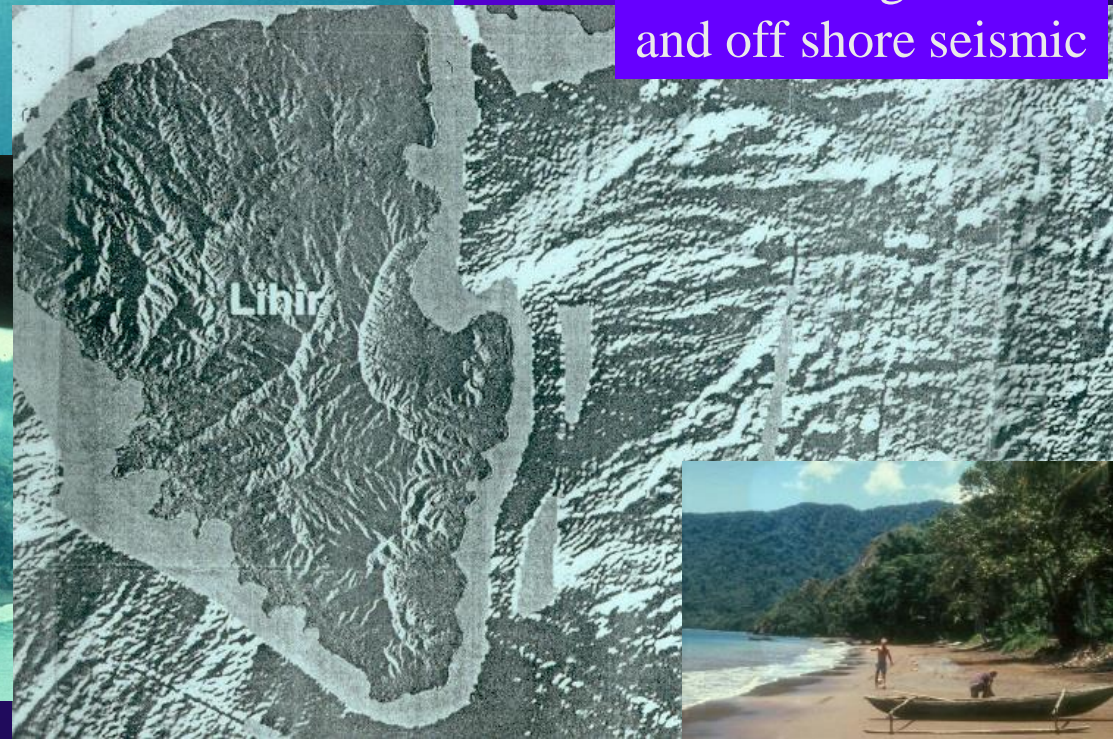
Tabar Gp - Lihir



Lihir Luise volcano

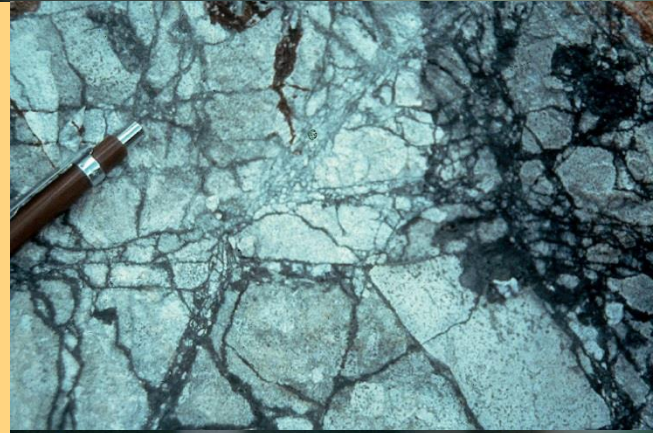
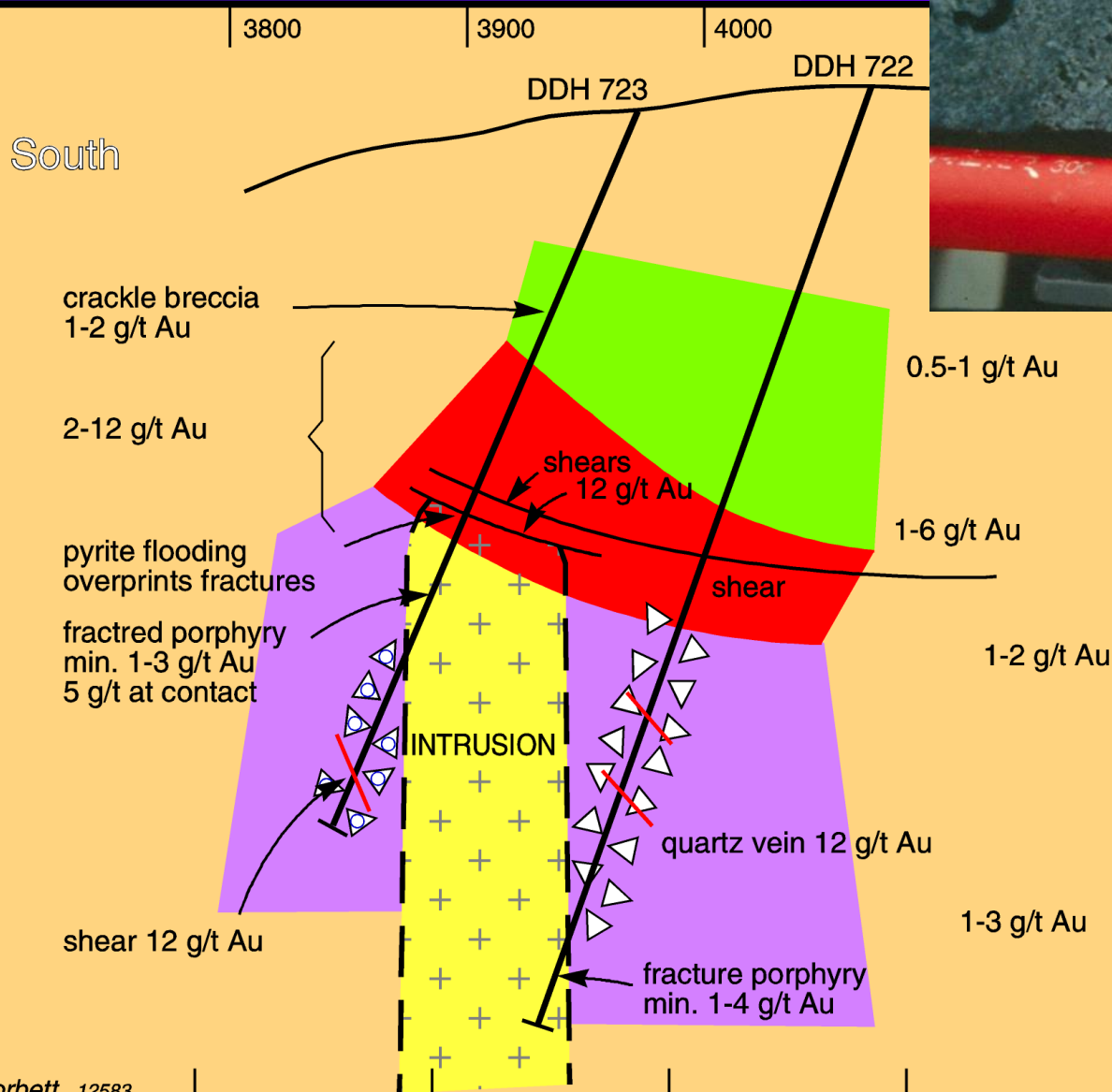


Side looking radar
and off shore seismic

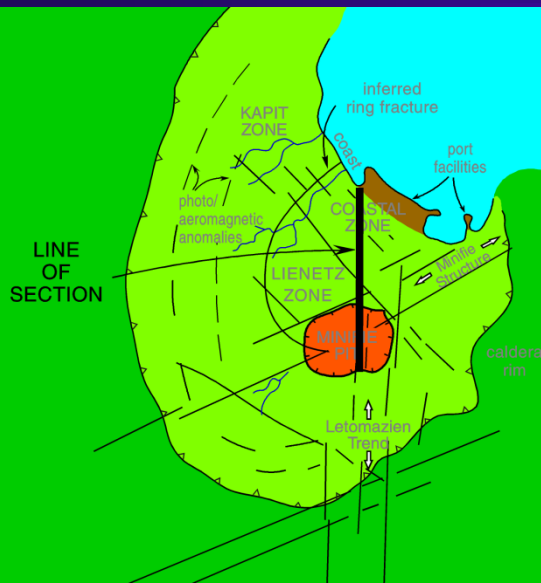


Trigger for porphyry – epithermal transition

14g/t Au



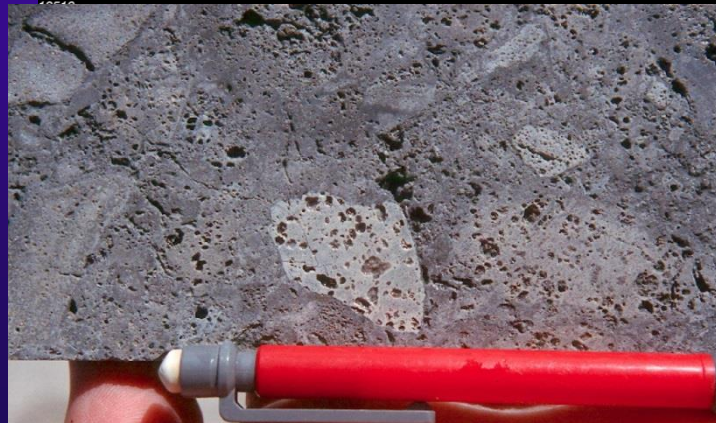
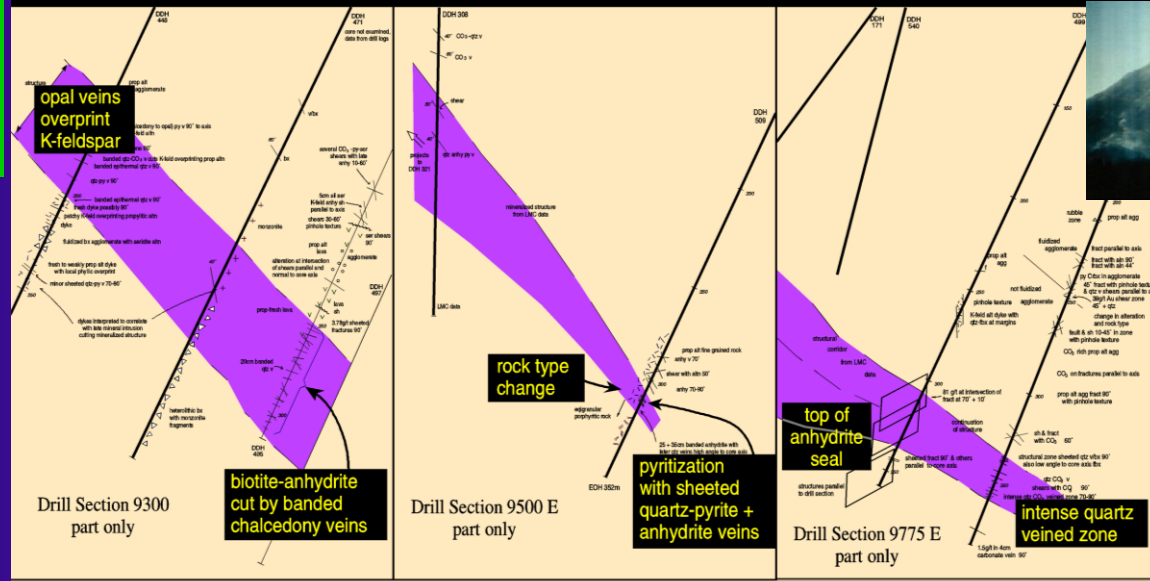
Series of cross sections

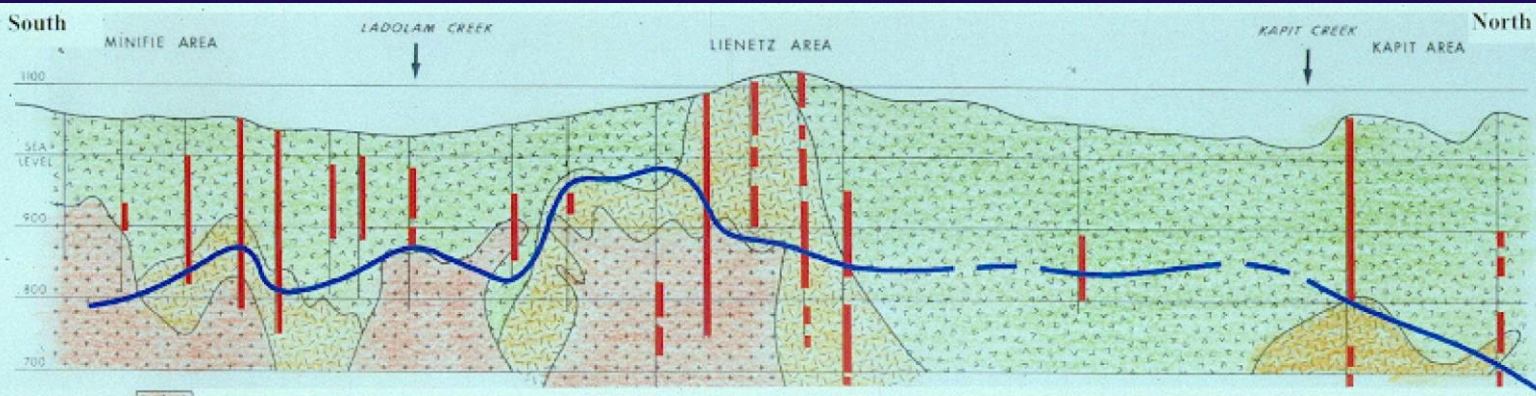







Minifie Drill Sections

South

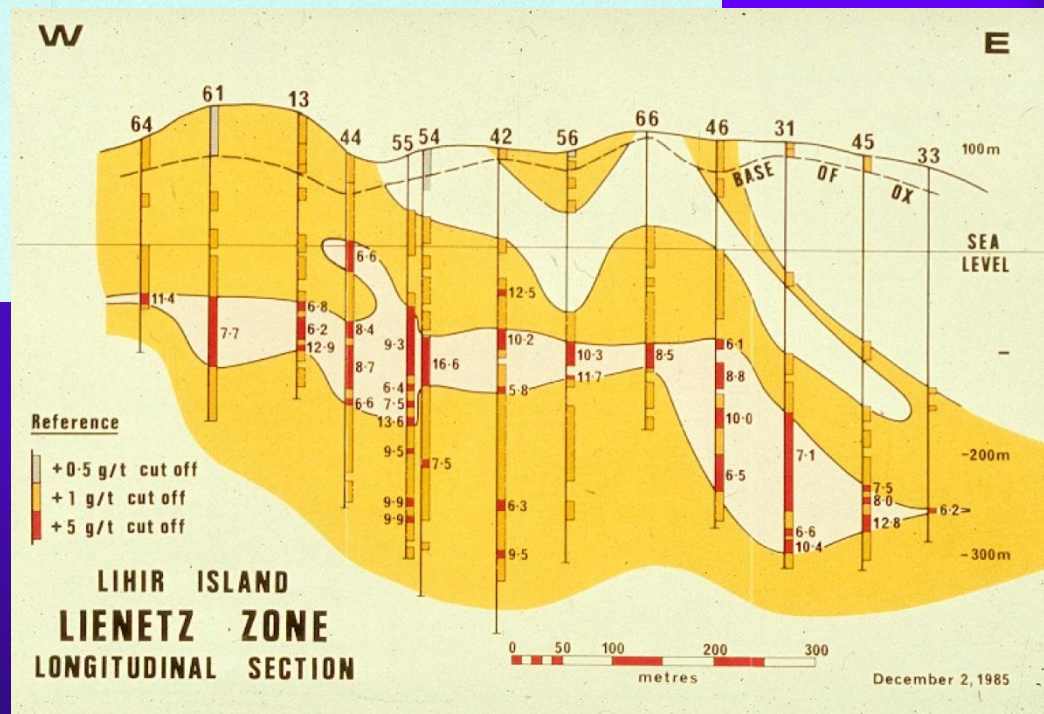
North



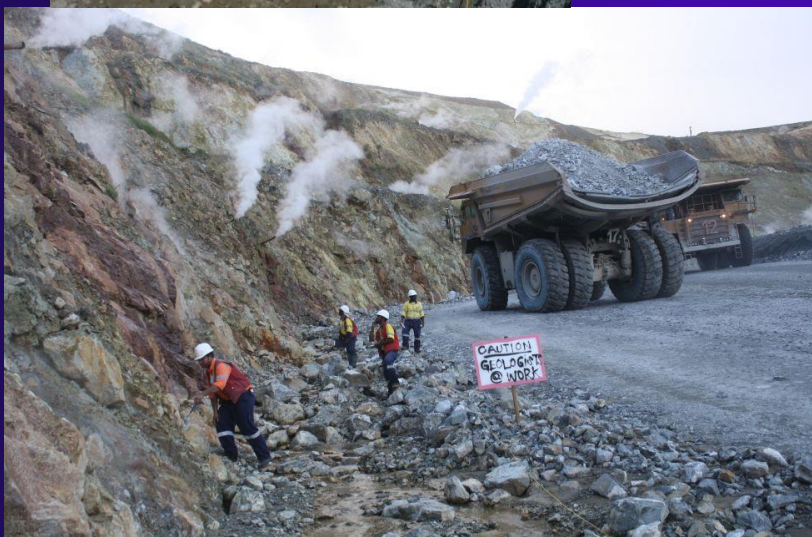


-  Equigranular monzonites
-  Undifferentiated porphyries
-  Undifferentiated lavas & pyroclastics
-  > 1.0 g/t Au
-  Top of anhydrite seal

0 500m



Lihir, pit 2006-10



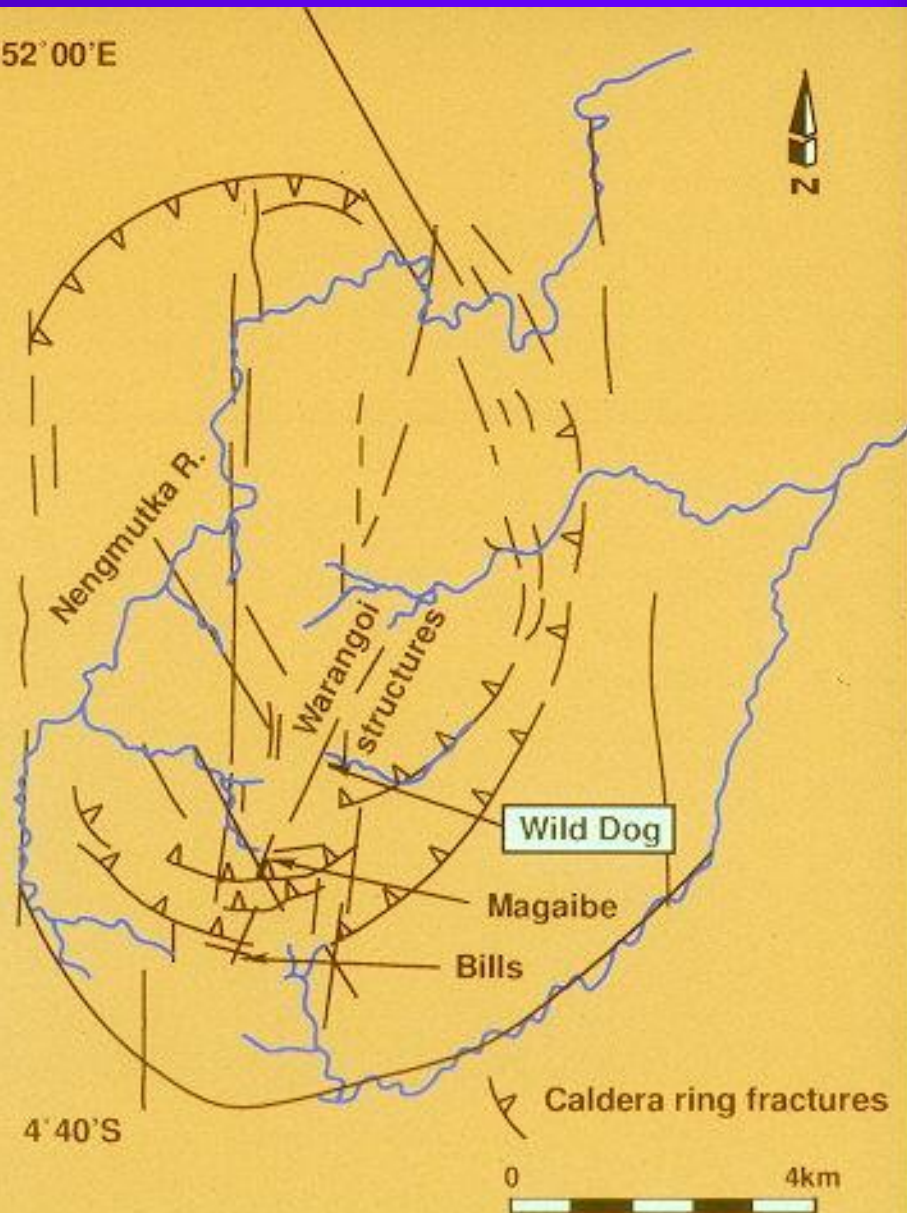
WILD DOG PROSPECT

Geological Setting

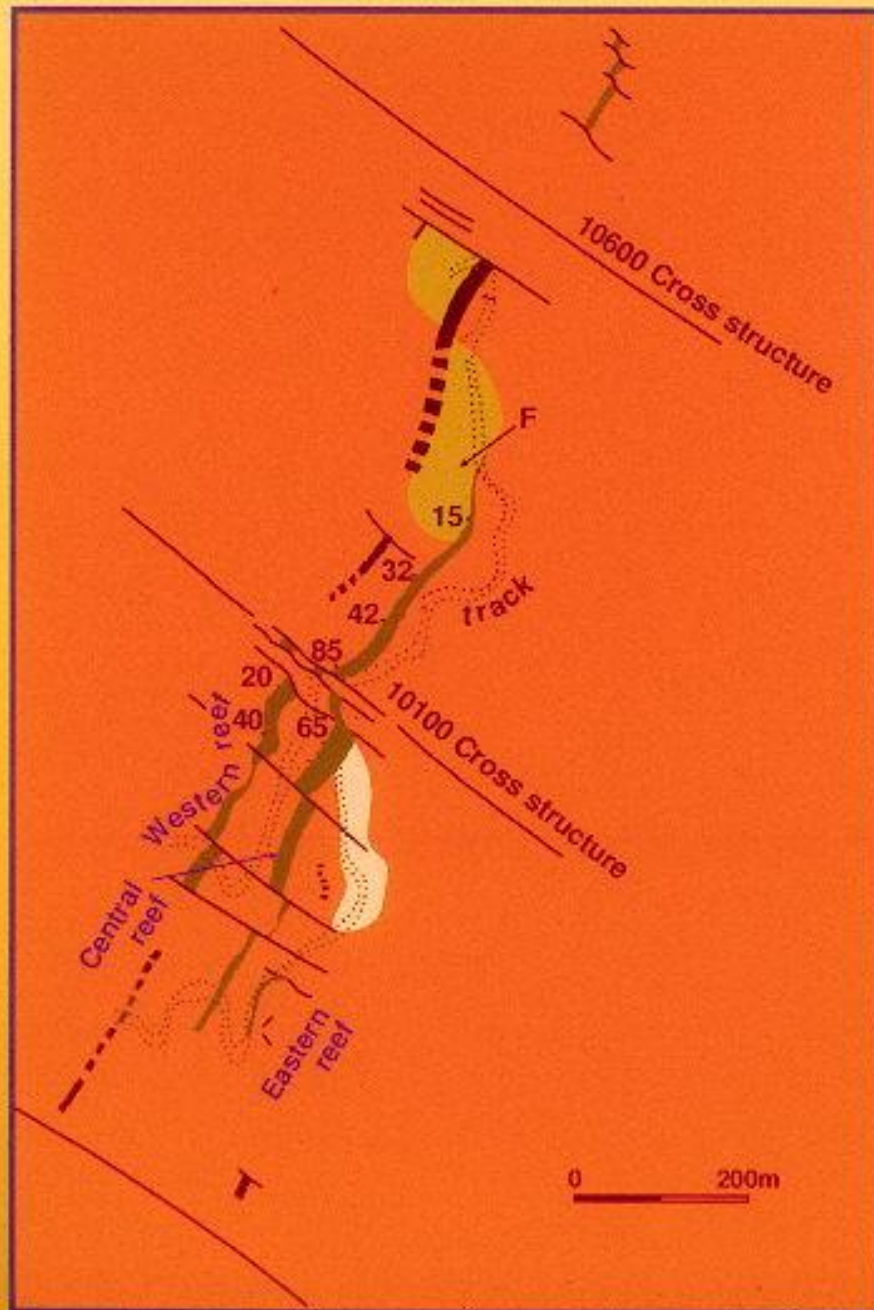






20
depth to mantle in km
from Weibenge 1973.

152° 00' E

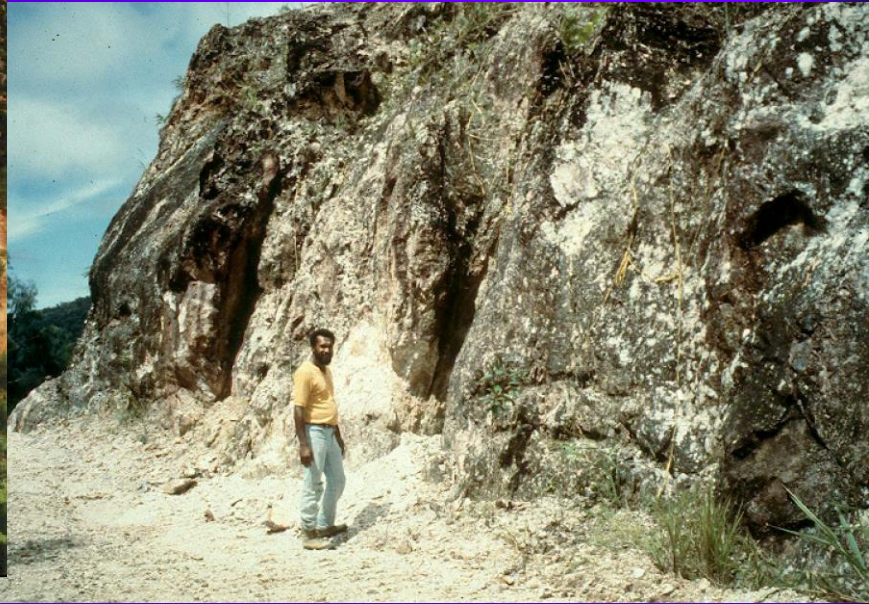


WILD DOG PROSPECT Papua New Guinea Structure

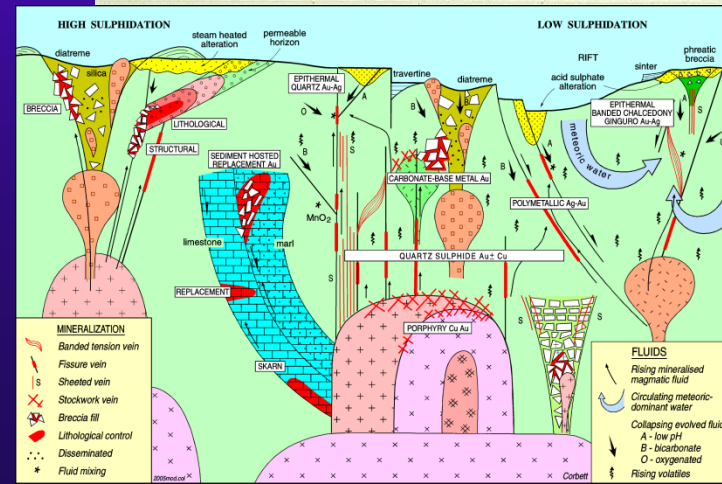
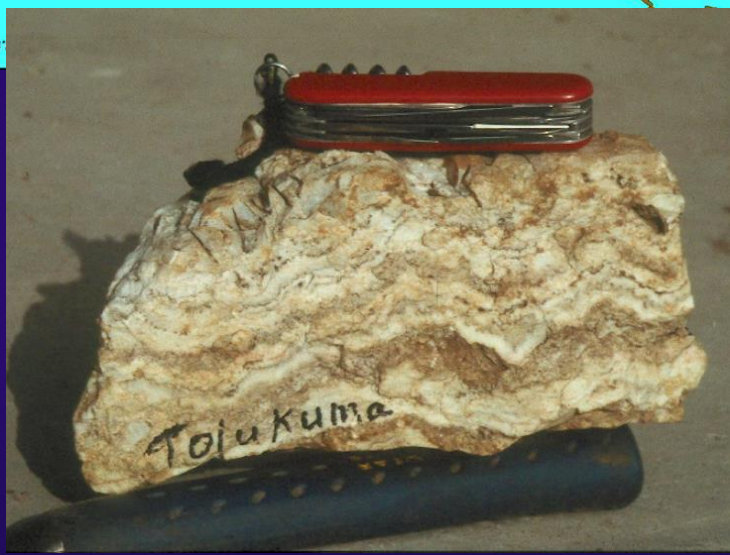
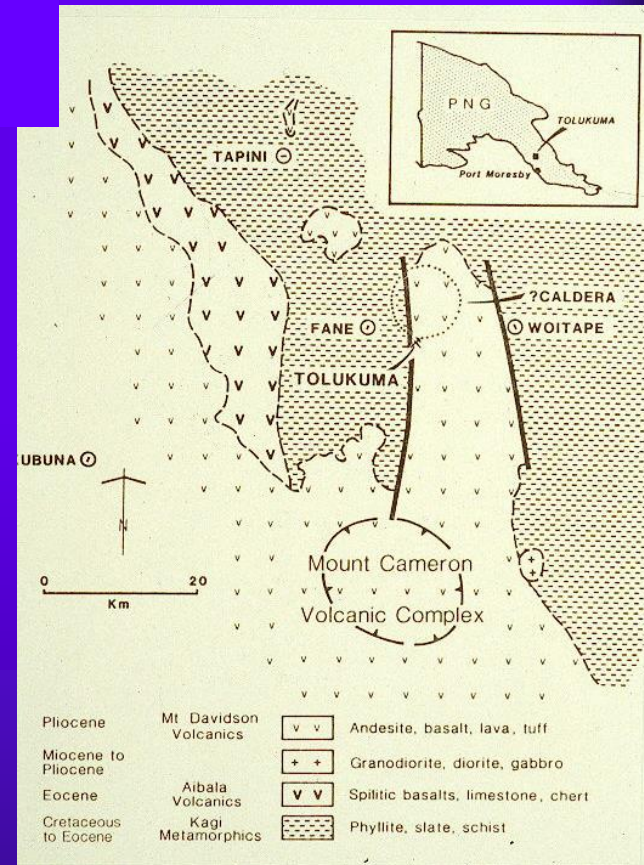


-  Crystal tuff
-  Andesite porphyry (intrusive)
-  Reef with dip established
-  Interpreted reef

Wild Dog



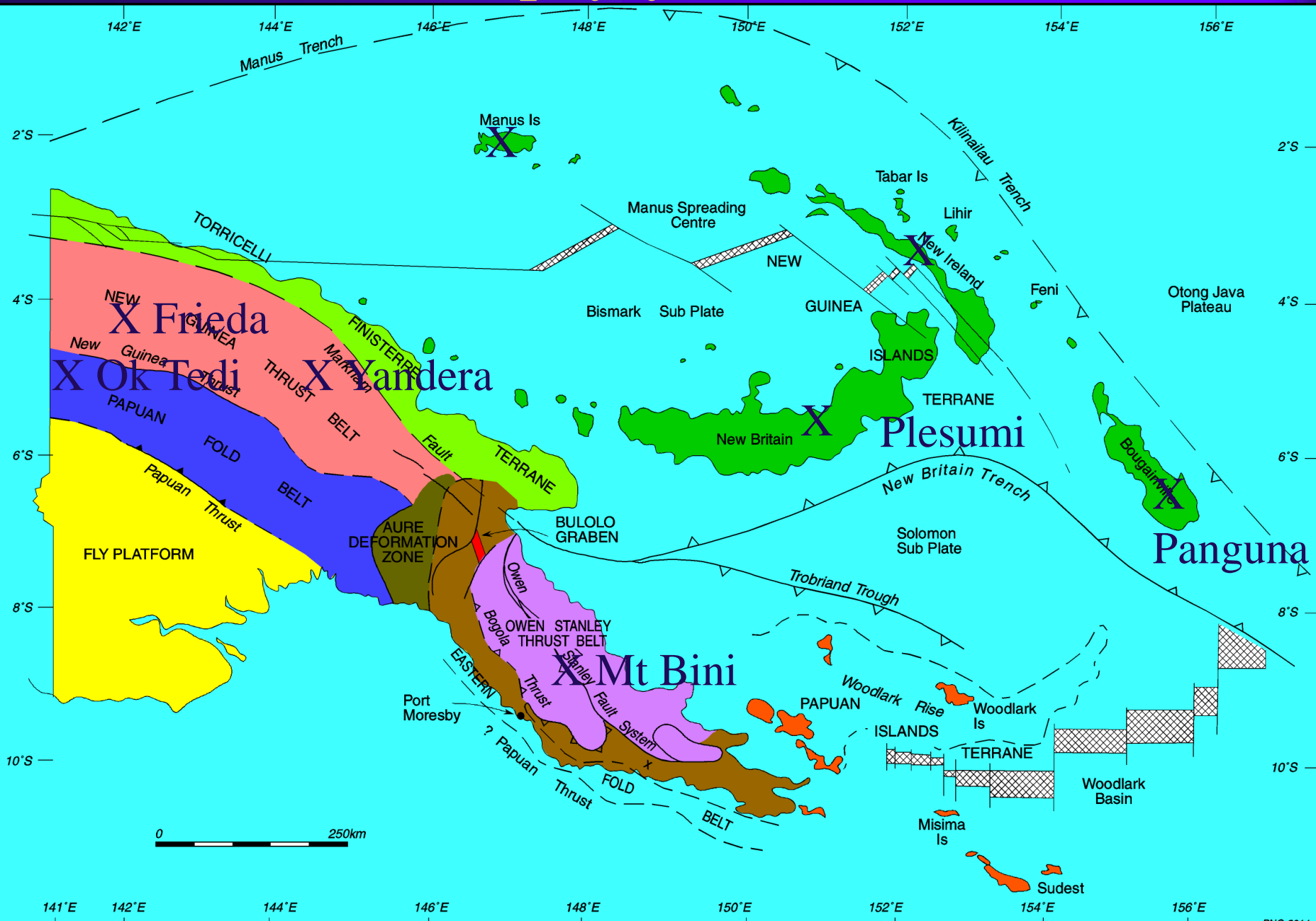
Tolukuma gold mine



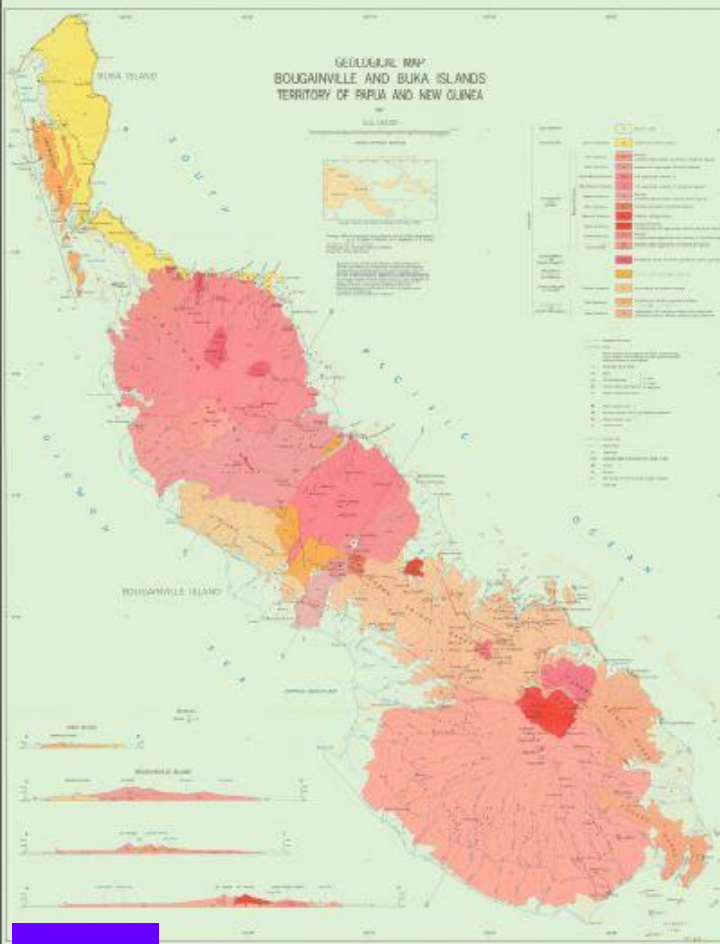
Tolukuma



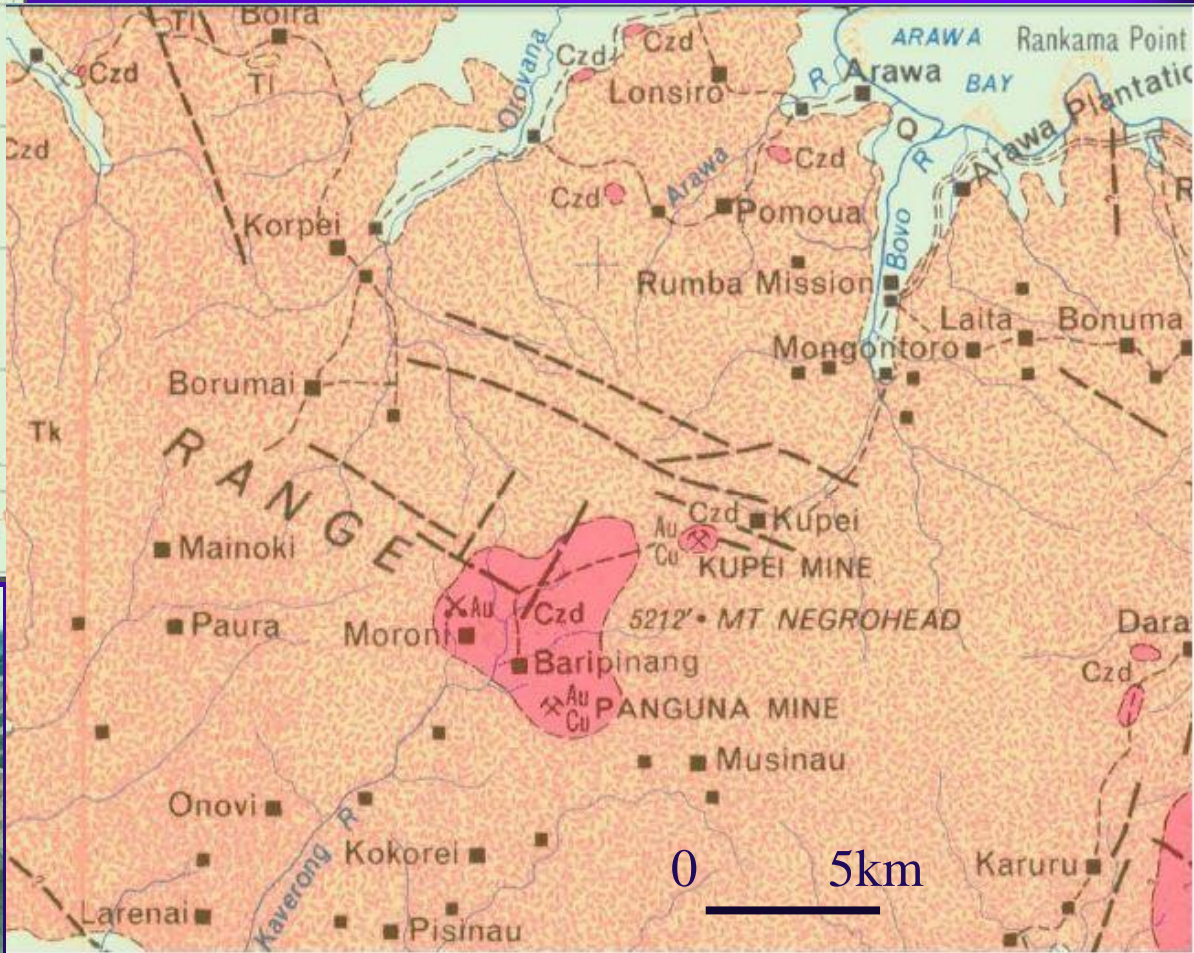
Porphyry Cu-Au



Panguna discovery 1964

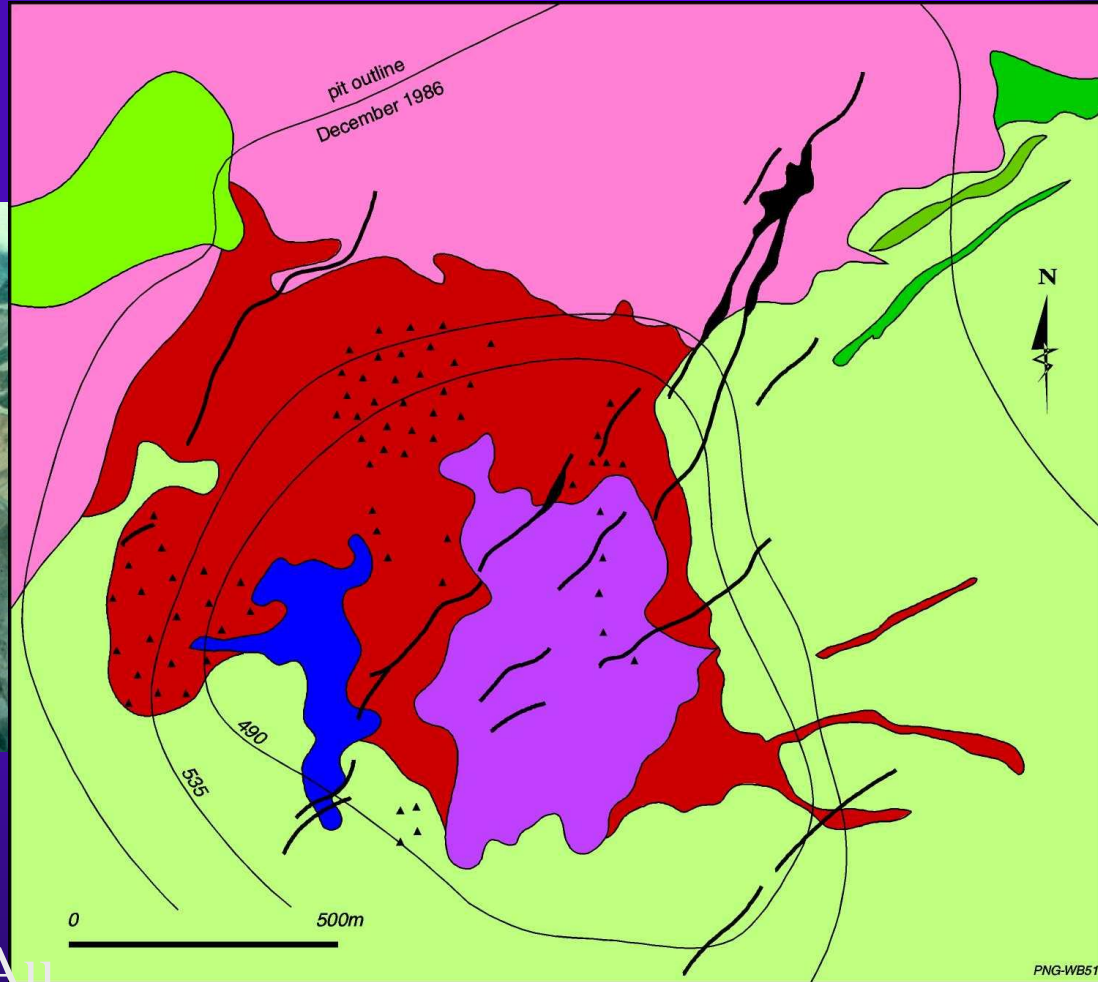


1984




From Blake and Mieztis 1967

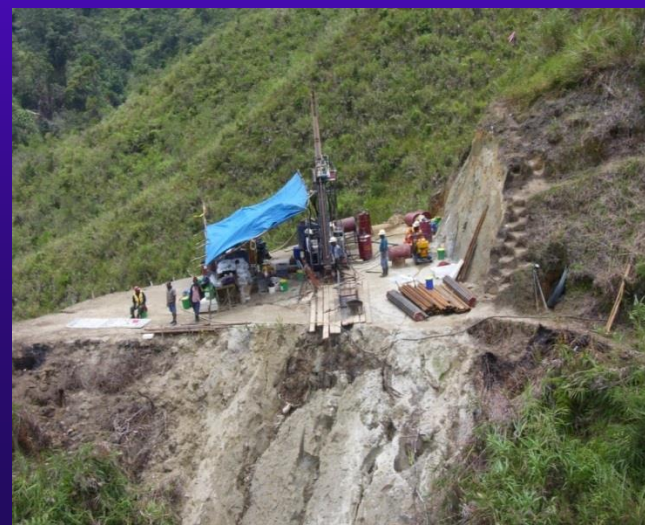
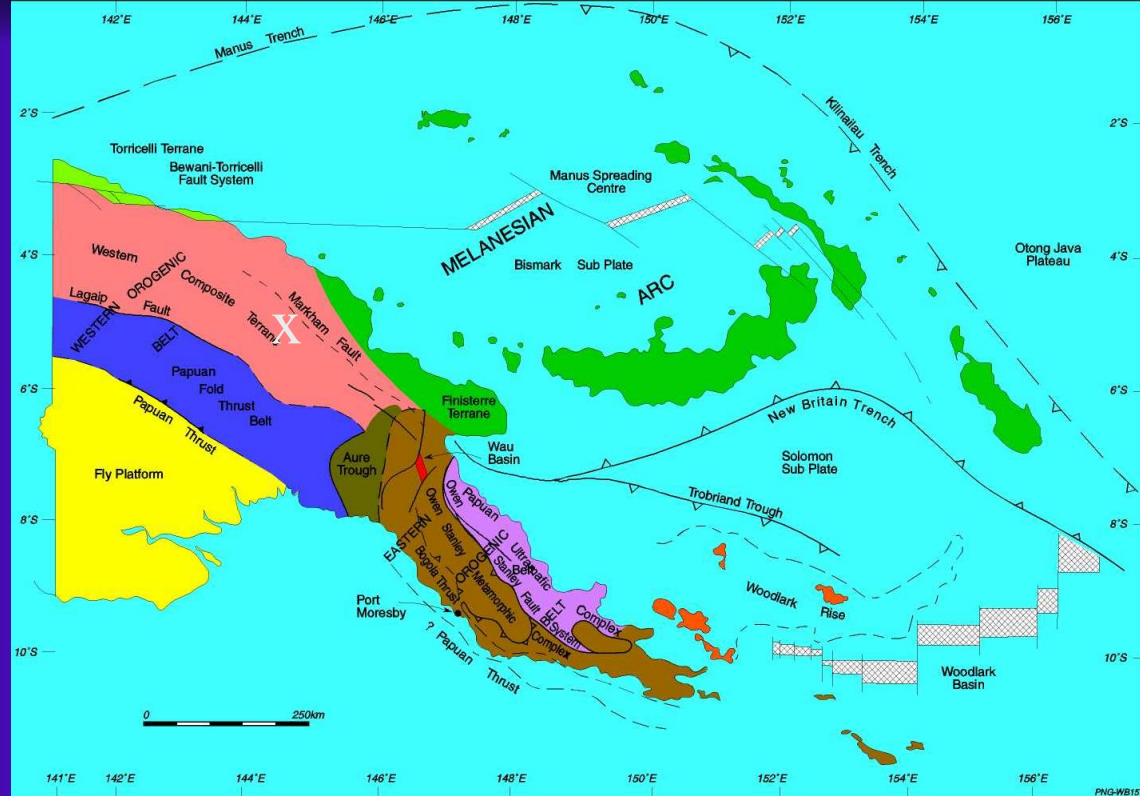
Porphyry Cu-Au – Panguna



In 1972
944 Mt @ 0.48% Cu, 0.56 g/t Au
To 1988 produced
3 Mt Cu, 9.6 M oz Au

- | | |
|--|---|
|  Nautango Andesite |  Biotite Granodiorite |
|  Biuro Granodiorite |  Biotite Diorite |
|  Breccia |  Kawerong Quartz Diorite |
|  Pebble dyke |  Panguna Andesite |

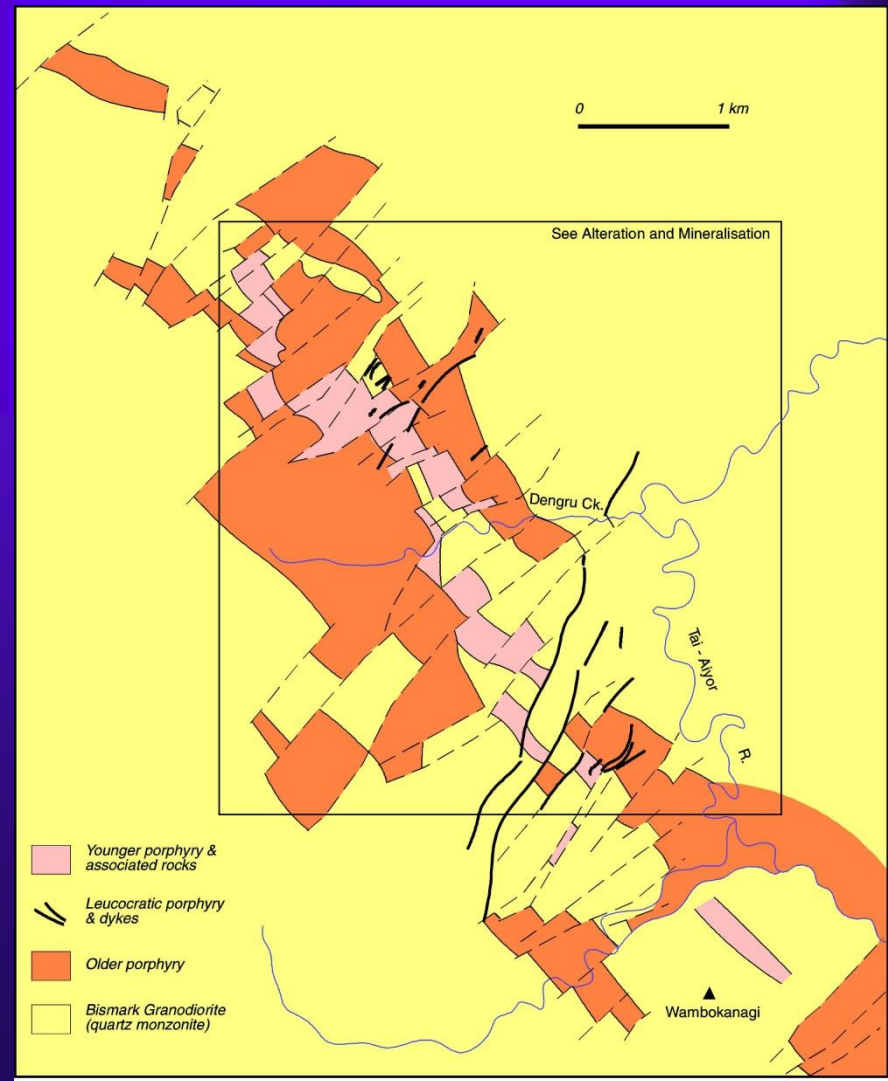
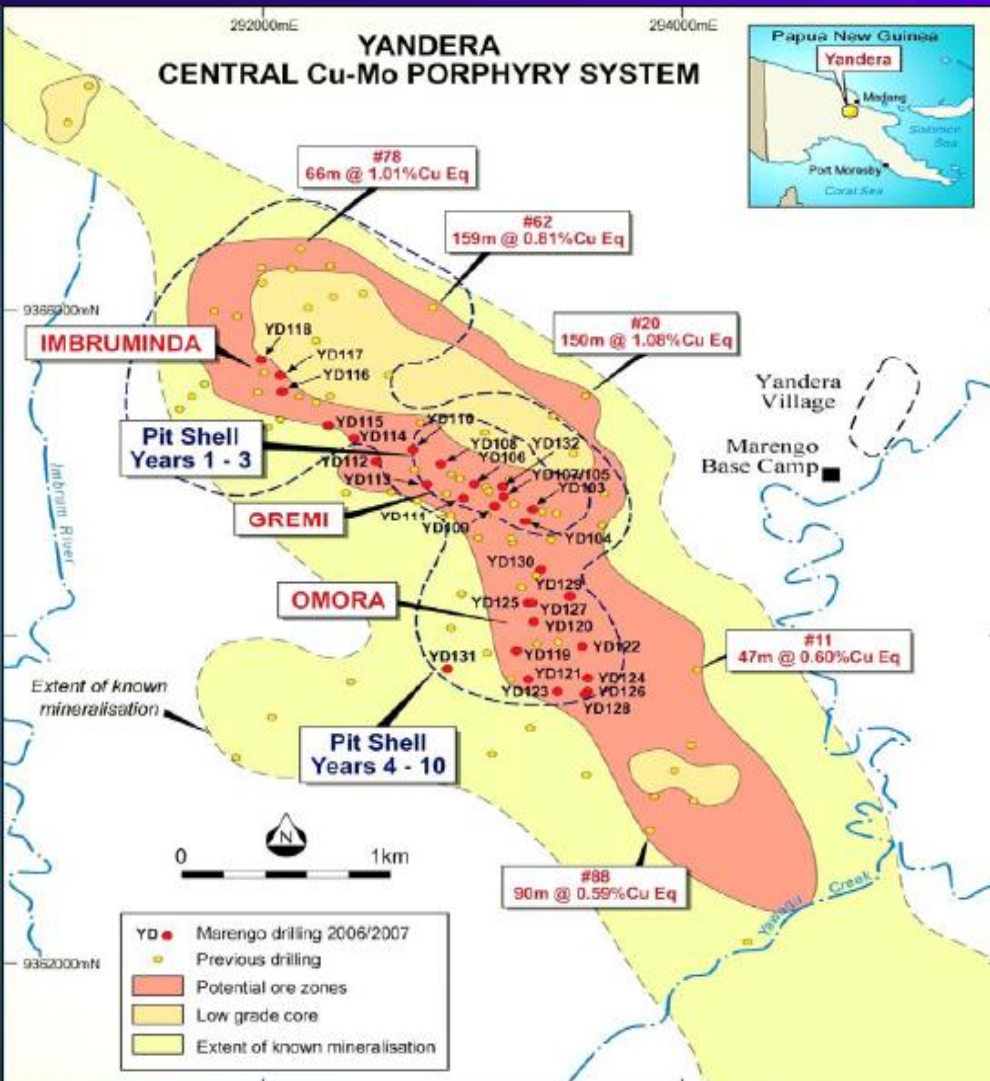
Yandera



PNG-WB15

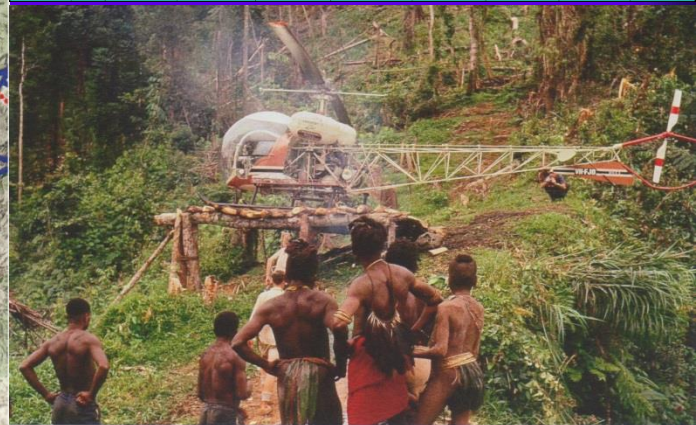
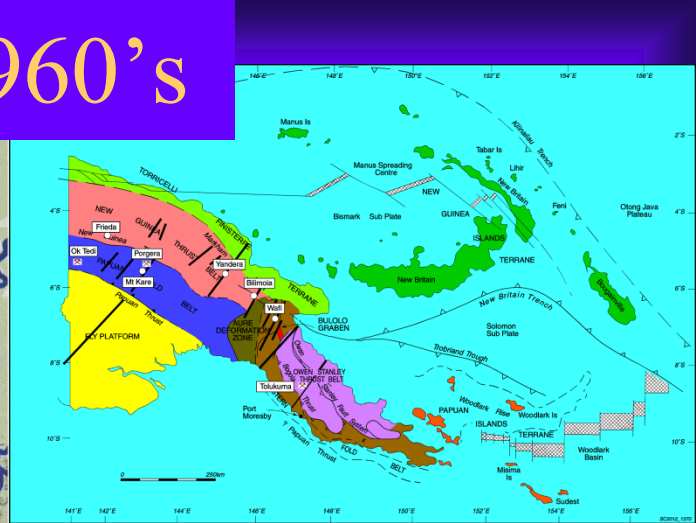
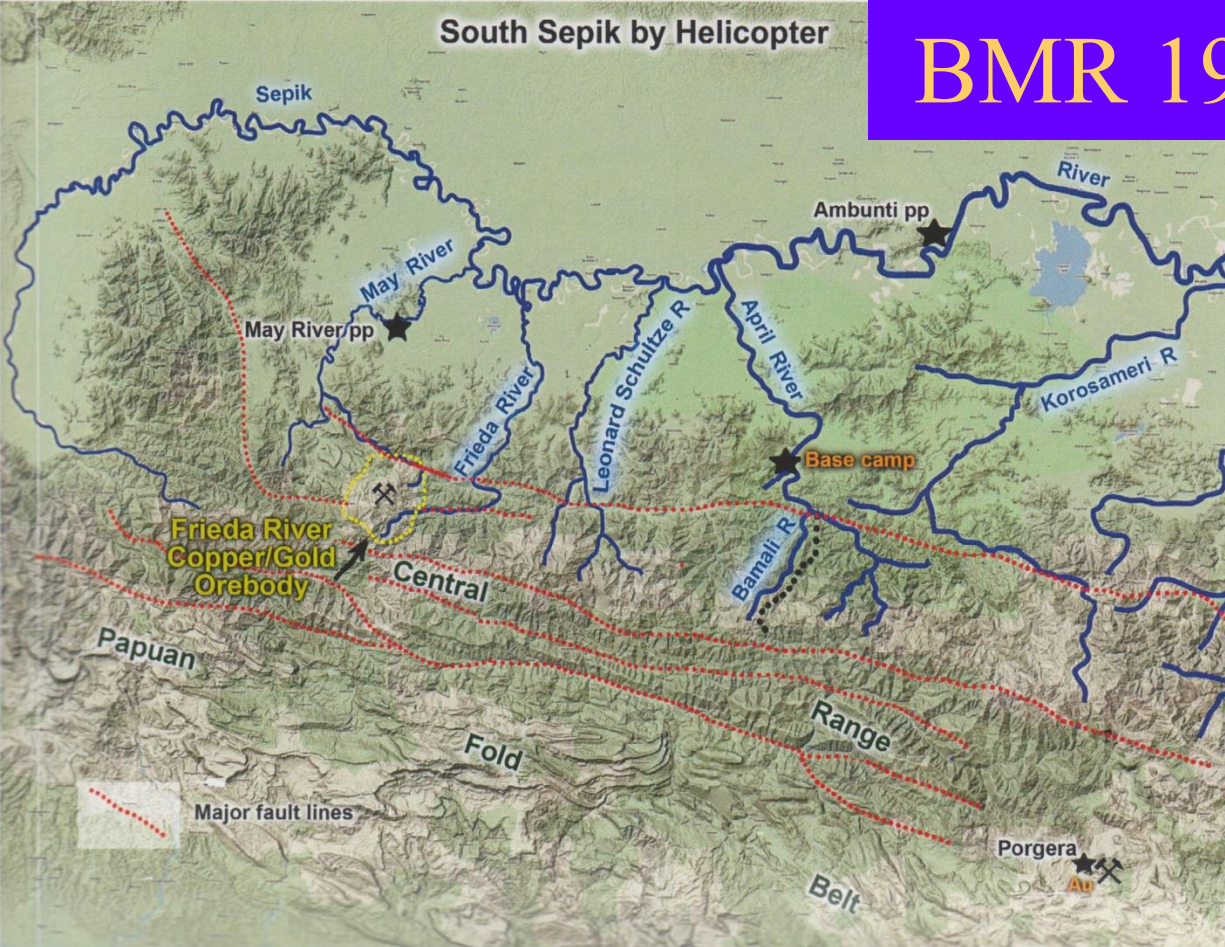
Yandera – geology

163 Mt @ 0.5 Cu equ



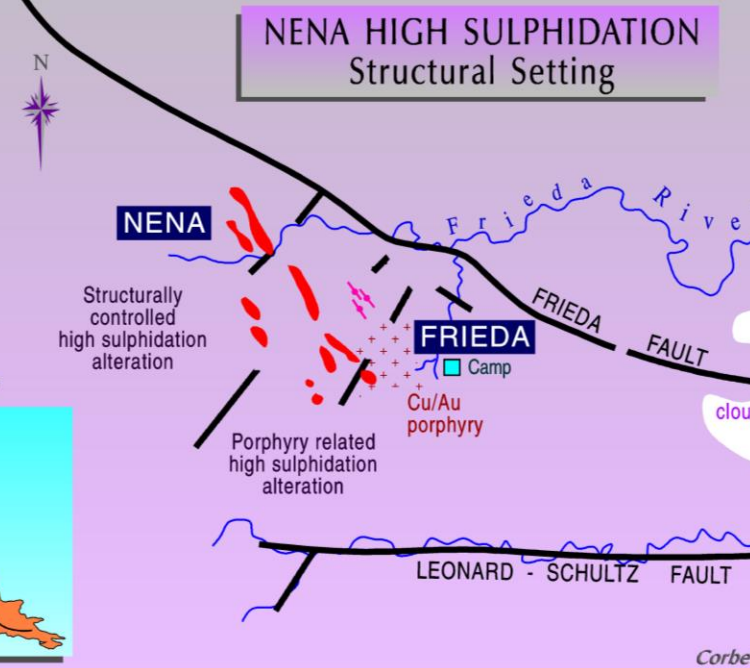
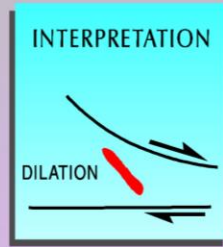
South Sepik by Helicopter

BMR 1960's



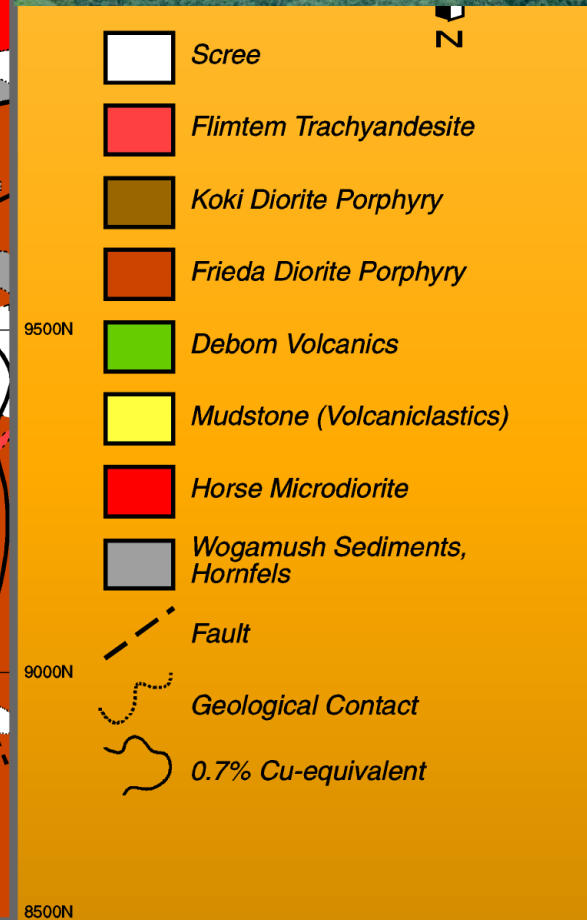
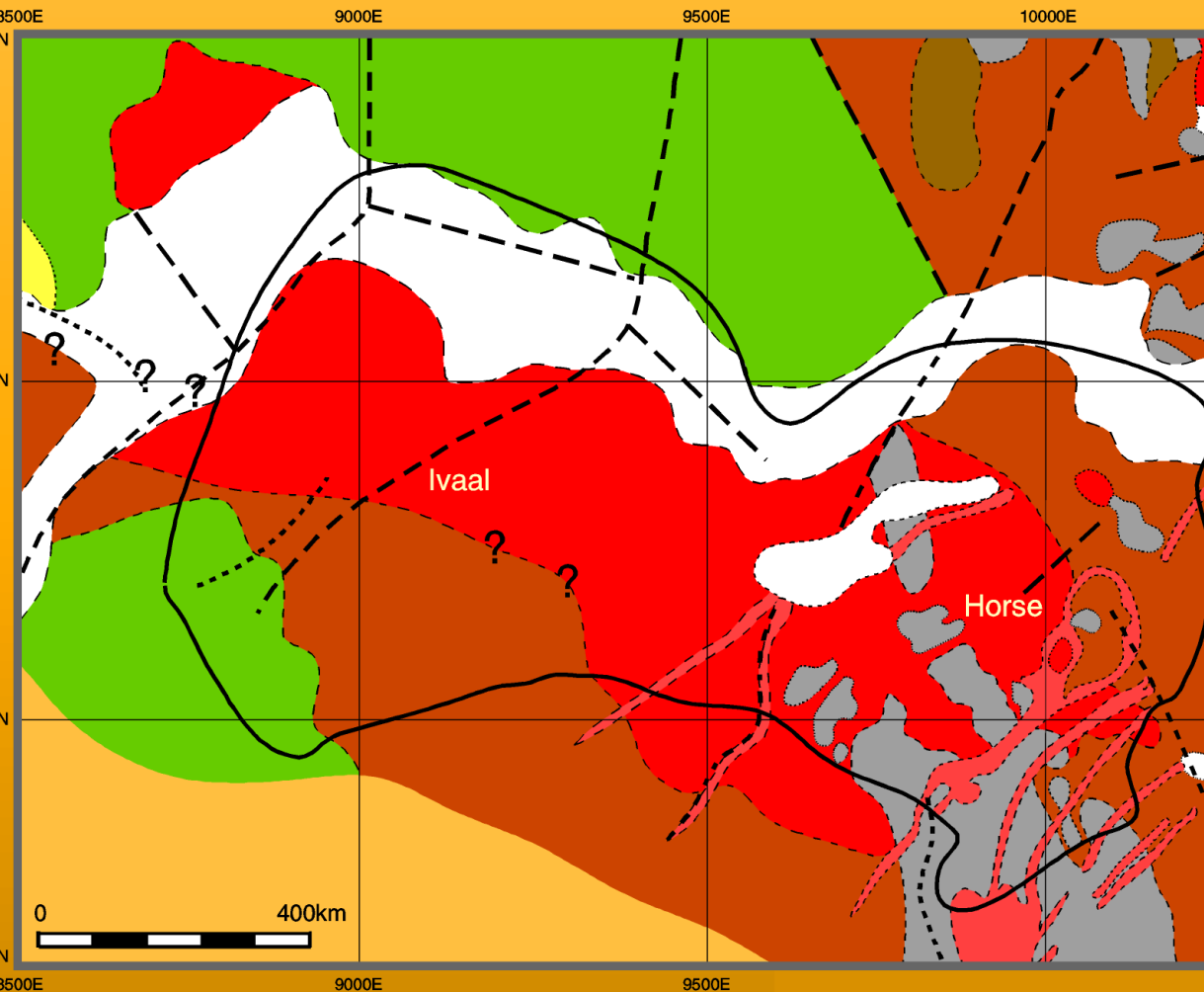
From Dow 2010

Frieda-Nena



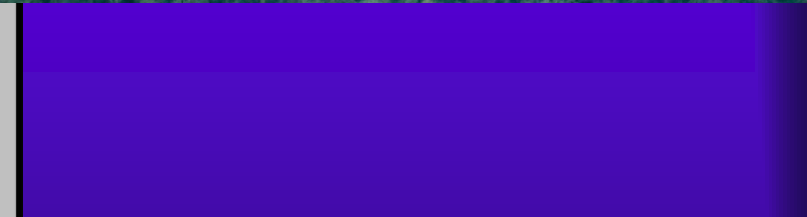
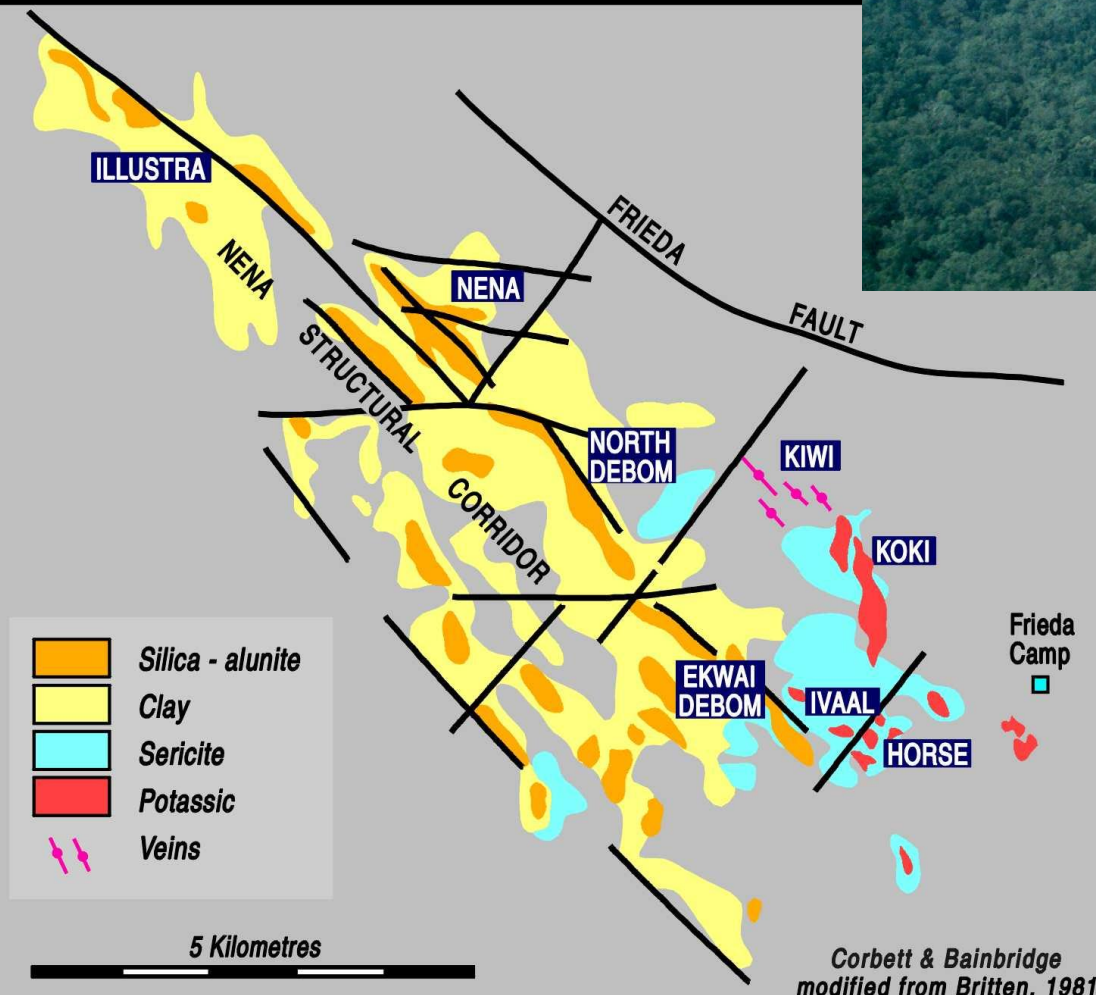
Horse-Ivaal Geology

1 Bt @ 0.5% Cu, 0.3 g/t Au



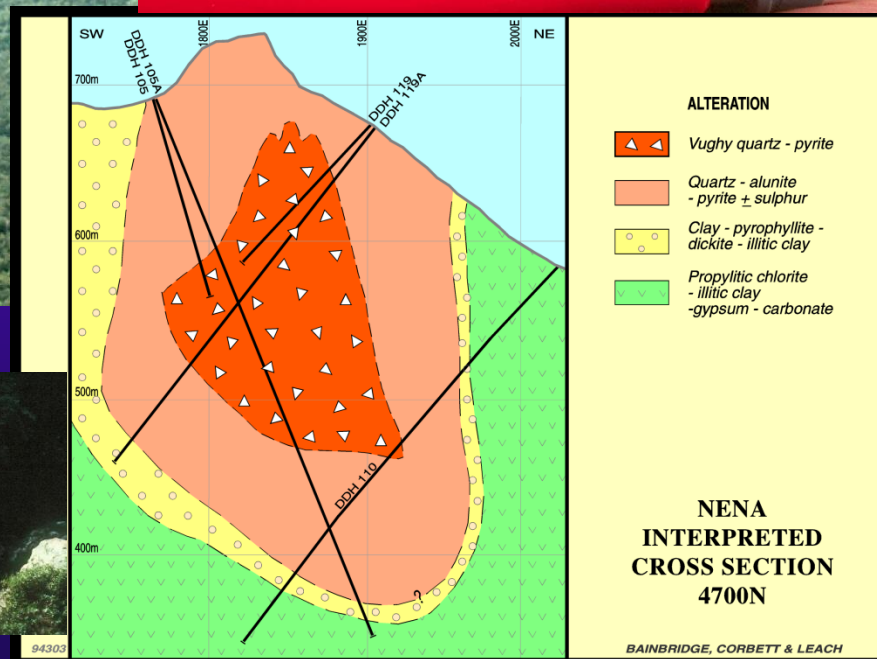
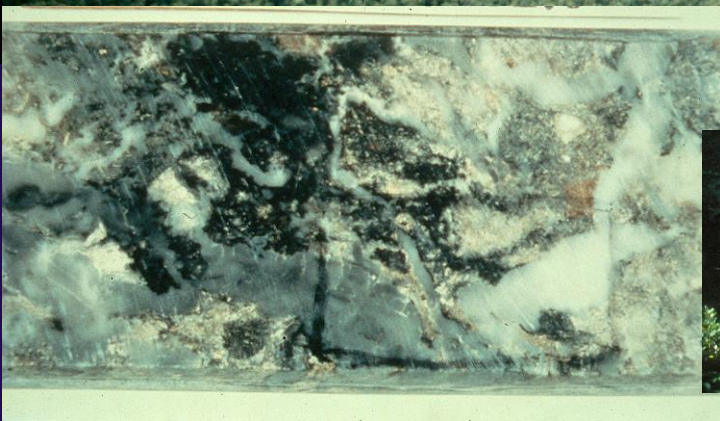
Ekwai Debom

Advanced argillic alteration

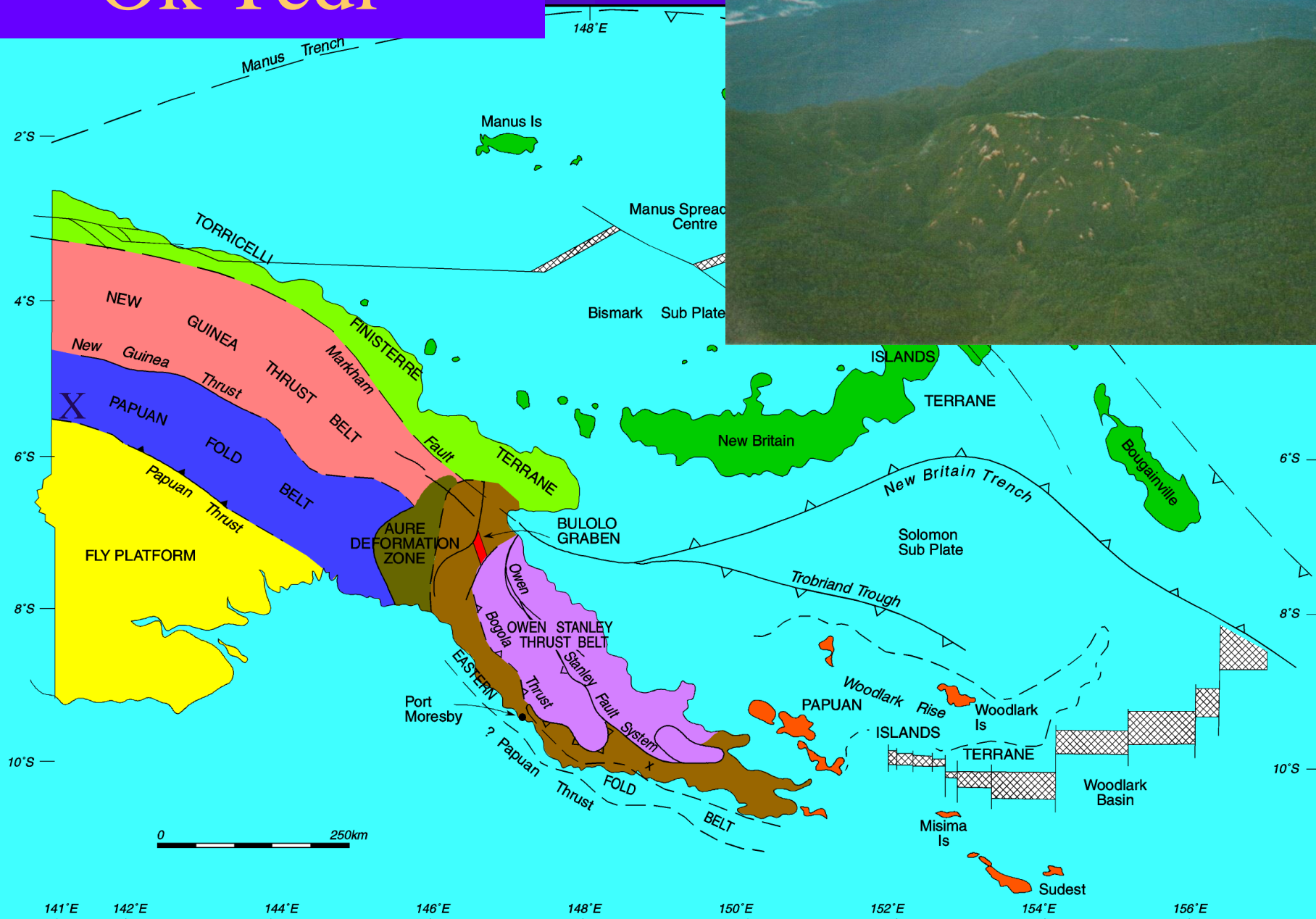


Nena high sulphidation epithermal Cu-Au

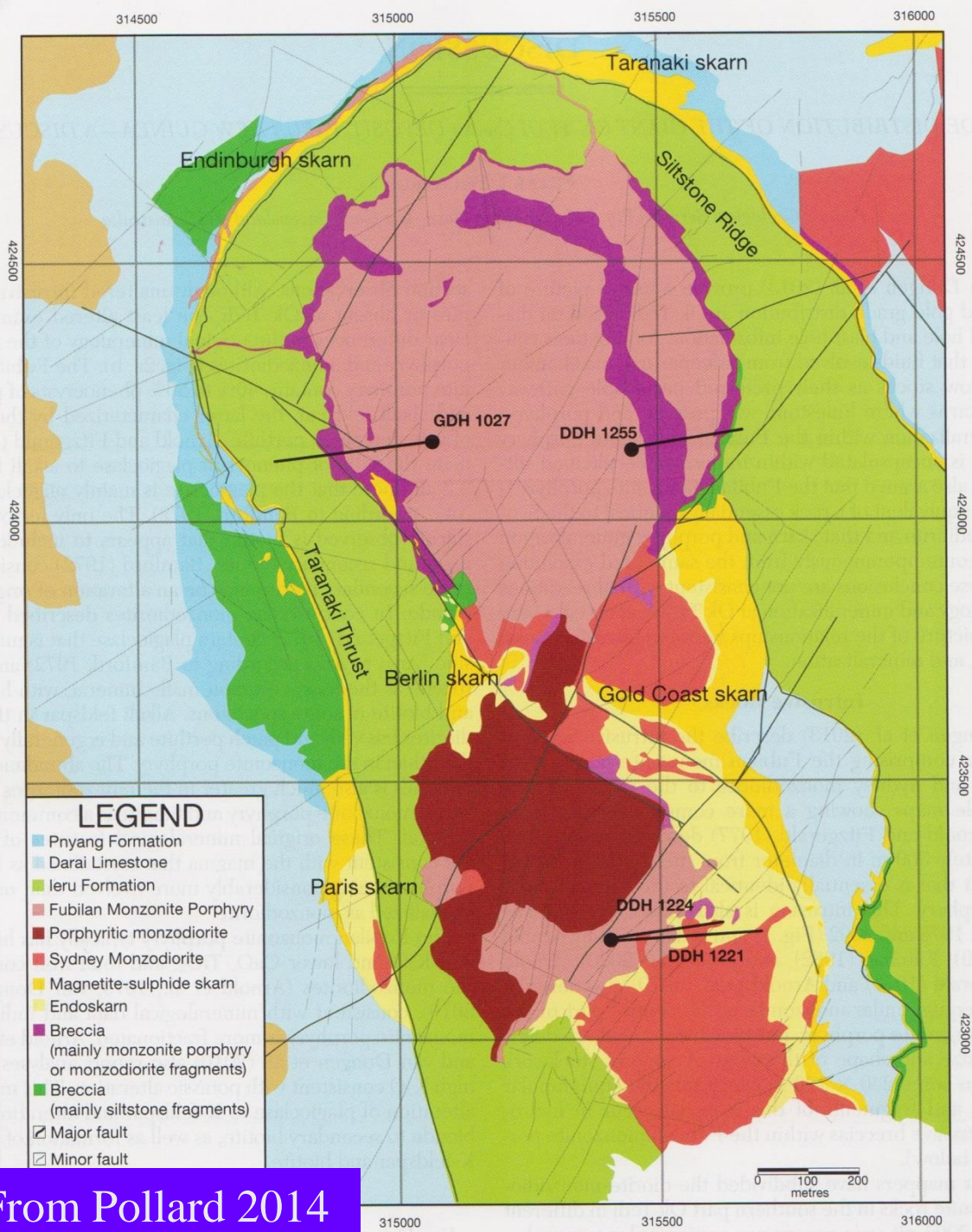
18 Mt @ 0.1% Cu, 1.4 g/t Au
51 Mt @ 2.2% Cu, 0.6 g/t Au



Ok Tedi



Ok Tedi

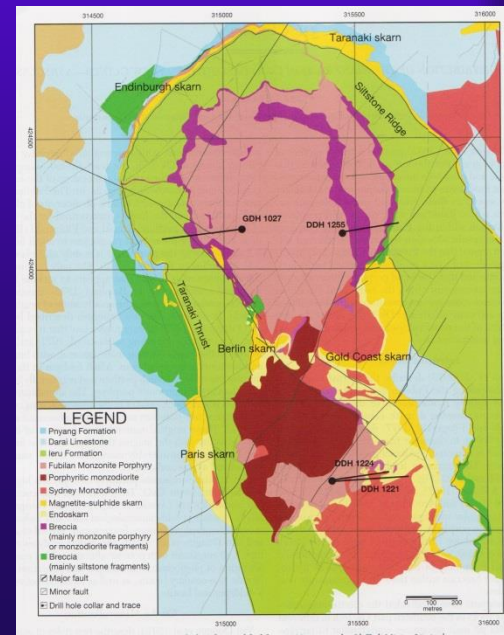
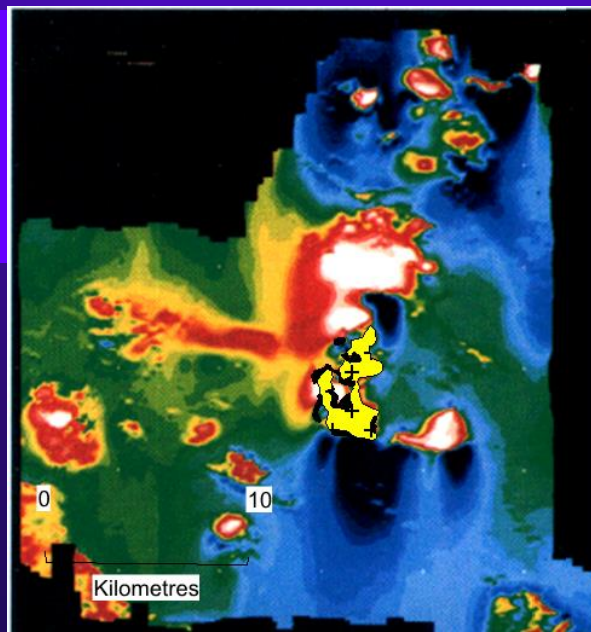


From Pollard 2014

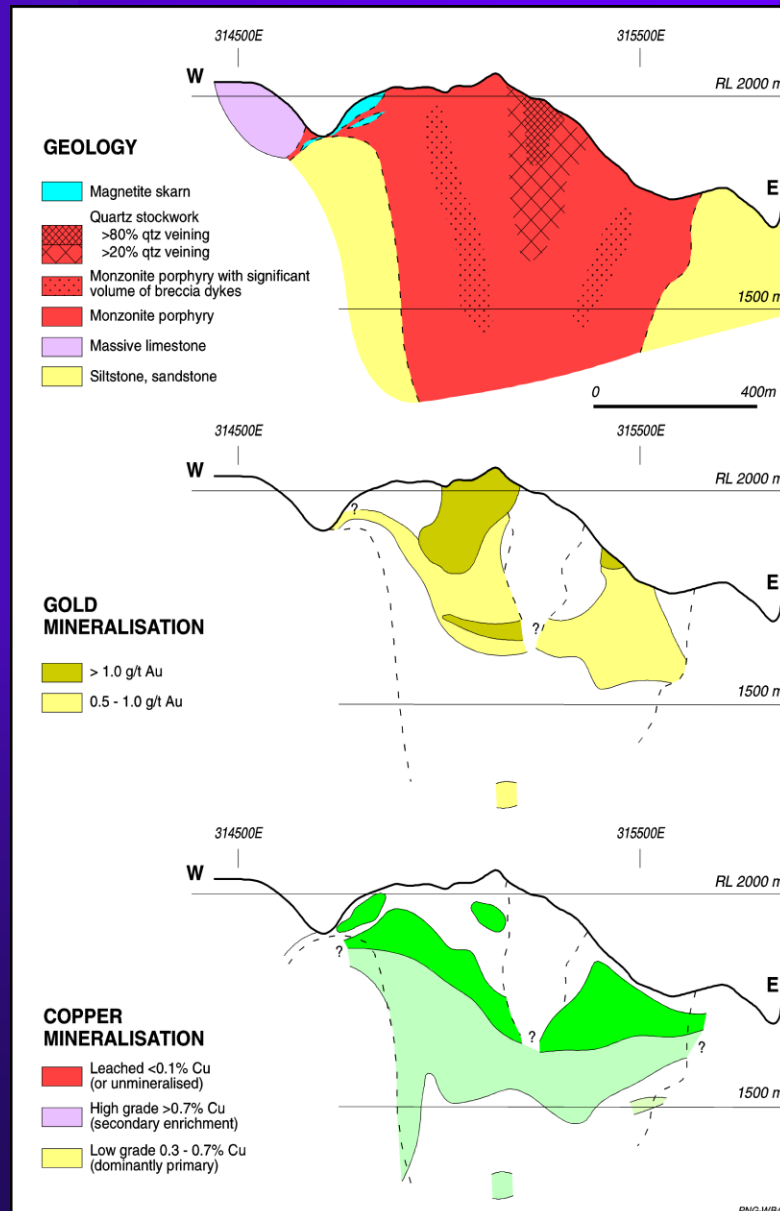
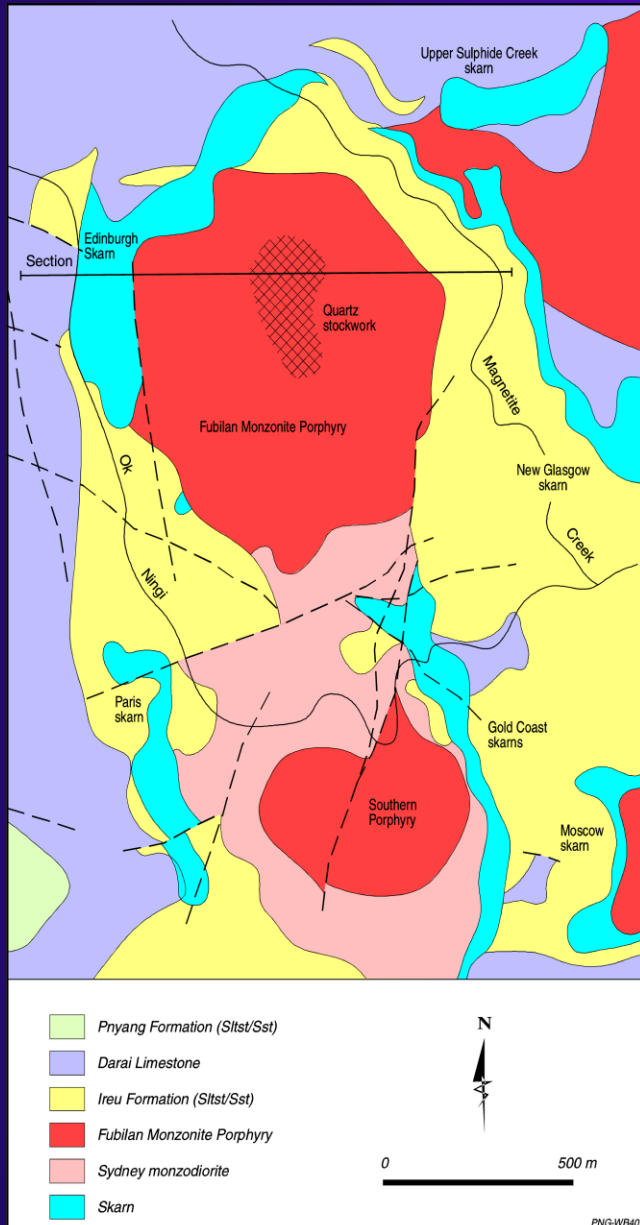


Since 1984 produced
 3.8 Mt Cu, 10.6 M oz Au
 13 M oz Ag

Ok Tedi – porphyry Cu-Au
 and skarn – RTP magnetics
 Irvin and Robertston, 1987



Ok Tedi – Porphyry Cu Au



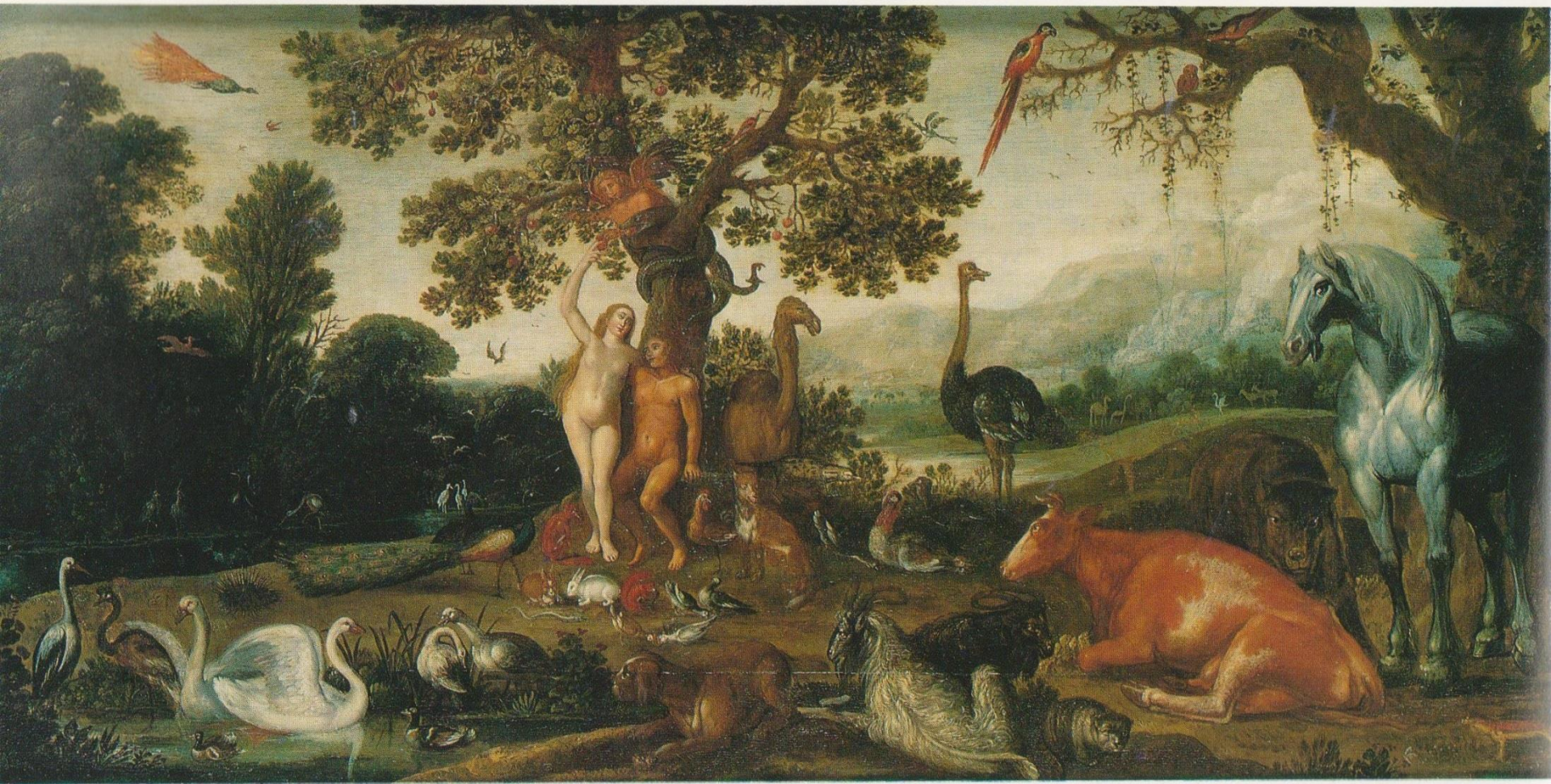
Au cap
2.87 g/t

0.7% Cu
0.6 g/t Au
0.11% Mo

Papua New Guinea discovery

- ◆ Early prospectors – panning alluvial to lodes
- ◆ Government patrol officers and geological mapping – Frieda, Ramu Ni, Porgera, Ok Tedi, Panguna, Tolukuma
- ◆ Float – Ok Tedi, Frieda, Tolukuma, Yandera, Bilimoia, Hamata
- ◆ Modern methods (geochemistry) – Hidden Valley, Wafi, Kerimenge, Mt Kare, Wild Dog
- ◆ Concepts – Panguna, Golpu, Lihir,
- ◆ Prospect beyond the discovery outcrop – Zone VII, Minifie, Bilimoia
- ◆ Geological models for the new millenia

Circa 1635



From Rickwood 1990

Thank you



Tectonic elements of Papua New Guinea

