Exploration discovery in Papua New Guinea

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July 2014
Plate tectonic setting of Papua New Guinea
Porgera transfer structure
Styles of magmatic arc Cu-Au
Styles of magmatic arc Cu-Au mineralisation
History of Prospecting in PAPUA NEW GUINEA
Locations Discussed
Sudest Island
Misima Island

Placer production
3.7M oz Au 18.4 M oz Ag
To WW1
83,000 alluvial Au
100,000 oz lode
Woodlark
Modern era
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
Pliocene volcanism
Nauti diatreme
Edie Creek

Lode mining
1931-62, 88,000oz Au
1927 and onto the BDG
Bulolo Gold Dredging

2.1 M oz Au @ 0.15 g/t Au
1932-65
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
Styles of magmatic arc Cu-Au mineralisation
Kainantu- Bilimoia
Bilimoia

1.77M oz Au @ 22g/t Au
Noel Stagg Mt Victor about 1958…

Photo Duncan Dow
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
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
Wafi
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
- Diatremite Complex
- Wafi Porphyry (at depth)
- Faults

Distribution of Surface Alteration Mineralogy in the Wafi River Prospect Area (After Leach & Ercog 1990)
Common Alteration Mineralogy in Hydrothermal Systems

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

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 - diaspor; Ep - epidote; Fsp - feldspar;
Ga - garnet; Hal - halloysite; Heu - heulandite;
I - illite; I-Sm - illite-smectite; K - kaolinite;
Lau - laumonite; 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

- **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**

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

**Corbett**
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

* Resource inventory available on the Harmony website
Elevated metal grades due to acid overprint on porphyry
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
Lihir Luise volcano

Side looking radar and off shore seismic
Trigger for porphyry – epithermal transition

- Crackle breccia: 1-2 g/t Au
- Fractured porphyry: min. 1-3 g/t Au, 5 g/t at contact
- Shear: 12 g/t Au
- Quartz vein: 12 g/t Au
- 0.5-1 g/t Au
- 1-2 g/t Au
- 1-3 g/t Au
- 1.6 g/t Au

14 g/t Au
Series of cross sections

Minifie Drill Sections

South

Drill Section 9300 part only
biotite-anhydrite cut by banded chalcedony veins

Drill Section 9500 E part only
pyritization with sheeted quartz-pyrite + anhydrite veins

Drill Section 9775 E part only
top of anhydrite seal
intense quartz veined zone

North

opal veins overprint K-feldspar

rock type change
WILD DOG PROSPECT
Papua New Guinea Structure

- Crystal tuff
- Andesite porphyry (intrusive)
- Reef with dip established
- Interpreted reef
Tolukuma gold mine
Porphyry Cu-Au

X Yandera
X Mt Bini
X Ok Tedi
X Frieda
X Plesumi
X Panguna
Panguna discovery
1964

From Blake and Miezitis 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
Yandera
Yandera – geology

163 Mt @ 0.5 Cu equ
BMR 1960’s

From Dow 2010
Frieda-Nena

[Map and images related to Frieda-Nena geological features and mining activities]
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

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 Robertson, 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