# SMALL MINES

# THE PITFALLS

# SUCCESS OR FAILURE

**Bob McNeil – march 2023**

Small mines are defined here as those with initial annual planned production of less than 40,000 ozs gold or equivalent

# WHAT I WILL COVER

- I will cover five examples – coverage of each example has to be somewhat superficial, each could be a presentation on its own.
- Initially I describe Peko Mines NL experience in the 1960's. It started as one small mine with perhaps 2/3 years reserves and grew to 4 mines in about 13 years/then 5 in 16 years. I was an employee.
- Then I follow on with four mines developed 1990's to 2010's by companies I /my partners formed, listed on the ASX and TSX-V
- Two in PNG between 1993 and 2005 – one by Macmin in JV with Union Mining – Wapolu - and one by New Guinea Gold - Sinivit
- Then one in Queensland in 2006 by Macmin Silver -Twin Hills
- And one in Tasmania in 2016 by Torque Mining in JV with BCD or Beaconsfield Mines –Stormont.

# Tennant Creek, 1955 - 1972

- Tennant Creek deposits are pipe like, flattened pipes or tabloid bodies of magnetite, quartz, and sulphides – copper, gold, bismuth, selenium, and lead – mines are underground. Oxidation is between 70 and 100m depth. Often no surface expression.
- The Peko Mines NL Board in the late 1950's decided that for the company to survive and prosper cash flow from Peko Mine itself would be diverted to exploration and further development
- The Peko orebody was greatly expanded between 1958 and 1965
- Orlando discovered in 1959/production commenced in 1962.
- Ivanhoe discovered in 1962/production commenced in 1965
- Juno discovered in 1964/production commenced in 1966
- Warrego discovered in 1962, shaft sinking commenced in 1968 and production in 1972.

# Tennant Creek Problems

- **Tennant Creek was a very high cost environment**. It was remote, with few amenities.
- Peko copper concentrates trucked in bags to Alice Springs – 315 miles- then by the old Ghan railway to Maree/Port Pirie. Then shipped to Japan. Very costly - 20% of mine costs.
- Water was initially in short supply – had to be trucked in. Dams built later. Diesel power supplied on site.
- Infrastructure including housing and accommodation for all workers, was supplied, very costly to build/ service.
- Bitumen roads and power transmission lines were built to Orlando and Ivanhoe
- The power plant at Peko provided power to Orlando and Ivanhoe

# Peko Mine

Original oxidised outcrop at Peko – some gold values, no copper


Peko Mine c1970 .. the Iron Stone Outcrop

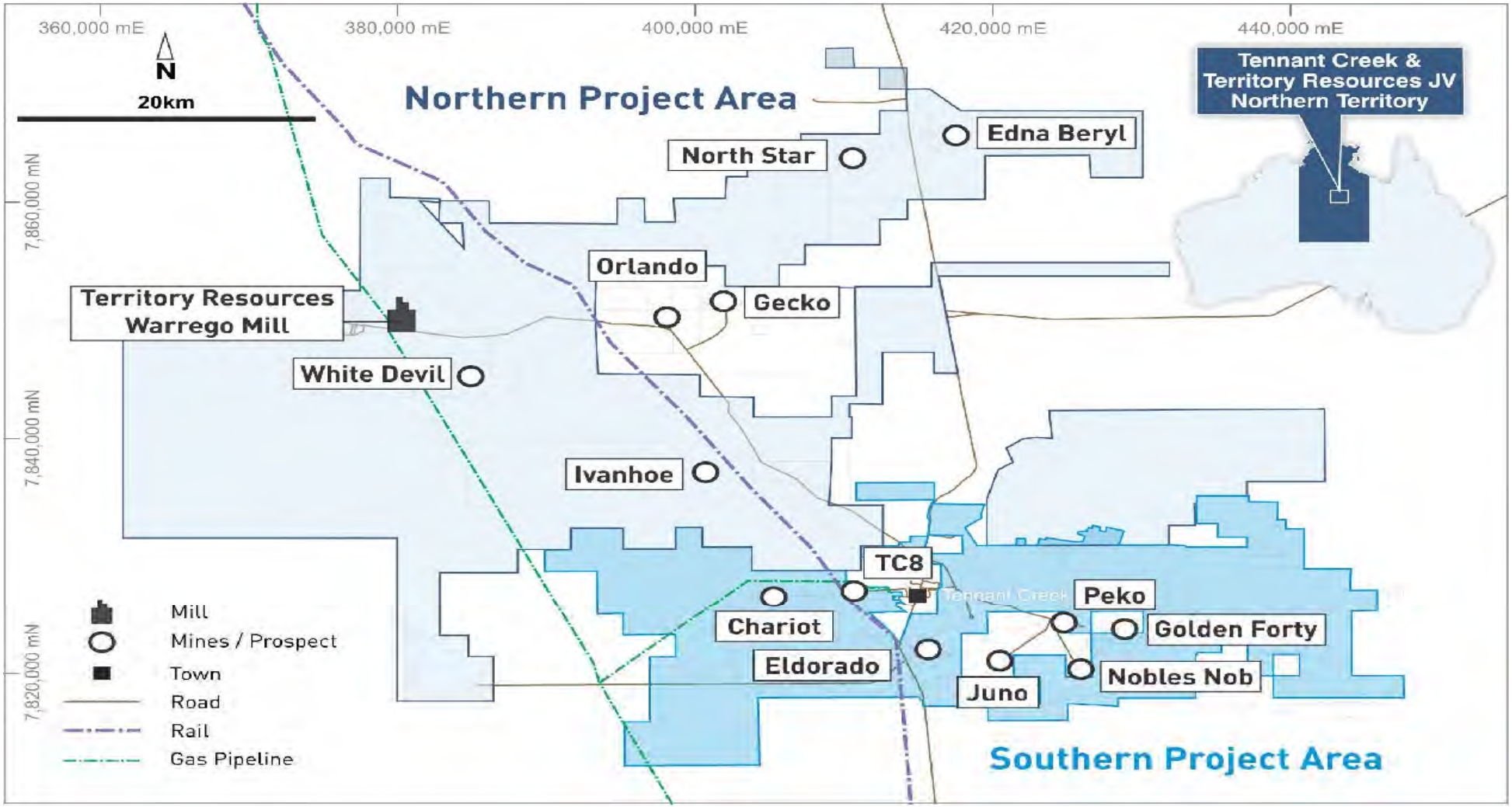
# PEKO MINE

- The Peko mine outcrop was  located in 1934. A company was formed after the war for gold as Peko Gold Mines NL– production was treated at the Government battery.
- Drilling in 1950's revealed copper below the near surface **secondary** gold at about 70m depth – oxidised zone then enriched zone.
- Peko Mines NL was then established as a copper/gold miner in May 1954 and in 1954/55 year milled 23,692 tons at a grade of 7.62% copper and 4.28 dwts gold (6.65g/t). Copper price 29 cents/lb.
- At this time nothing was known about the primary ore at depth and Reserves were less then 100,000 tons.
- In 1955/56 - 51,000 tons milled at 8.54% copper plus 7g/t gold - record copper price US 37 cents/lb – then max at 41 cents/lb. This was a major boost to Peko's finances

- **Set back** -in late 1958 copper price dropped to US 25 cents/lb and the Copper Bounty($70/refined ton of copper) was needed to prevent negative cash flow.
- In 1959 however, throughput was increased to 100,000 tons and profitability restored.
- Exploration by 1959 had shown the copper deposit was much more substantial than earlier known.
- Production by 1963 had increased to 165,000 tons, with reduced copper grade 4% and 6g/t gold.
- Production continued to increase and sealed long term success.
- **Peko mine between 1954 and 1975 produced 3,160,000t at 3.5 g/t Au, 4.0% Cu, 0.2% Bi -produced 355,000 ozs Au, 118,884 t Cu and 7,350 t Bi.**

# Peko Mine establishment -1963

# Between 1959 and 1964 four new orebodies were discovered - Orlando, Ivanhoe, Juno and Warrego



# Orlando Mine

- Old workings plus magnetic anomaly. Shaft sinking at Orlando commenced in 1959, based on intersections in two drill holes only – the Peko Board took a major risk at Orlando.
- Decision was lucky as original holes intersected separate small pods – main orebody did not commence for a further 50m depth below initial holes, and was later defined by U/G drilling.
- Production commenced in August 1962 on a reserve of 150,000t at 11dwt (17g/t) Au (82,000 ozs) and 1.5% Cu
- Ore was trucked to Peko on new sealed road and processed on new circuit. Power transmission line built from Peko to Orlando
- Orlando largely built with surplus equipment from Peko Mine
- **Orlando 1962-1973; production 322,060t at 11.5 g/t Au, 0.1% Bi, 1.8% Cu – metal produced - 119,078 ozs Au; 320 t Bi; 4,852 t Cu**

# Ivanhoe mine

- This was a magnetic anomaly – no outcrop – drilling commenced in 1961 – all before wireline was introduced
- Shaft sinking commenced in August 1963 and production in May 1965 at rate of 40,000t /annum
- Mine decision was made on reserve of 240,000t at 5% Cu and 4 dwts/t Au (6.2g/t) – dilution was a problem
- Ore was trucked to Peko on same road as Orlando ore, free gold extracted, then copper as part of Peko float circuit. Power transmission line from Peko
- **Ivanhoe 1965-1972; production 316,000t at 4.0% Cu, 5.0g/t Au – metal production 9000t Cu; 51,000 ozs Au**

# Juno Mine

- No outcrop, low order magnetic anomaly – between Eldorado and Nobles Nob
- Initial 3 holes, 2 by National Lead and 1 by Peko all deviated up to 50 degrees and missed target. The Juno magnetic anomaly was very nearly abandoned.
- Detailed and difficult mapping (very little outcrop) then defined the cleavage direction - allowed drill hole to be designed to drill parallel to cleavage.
- Initial intersections October 1964 were 12m at 167g/t Au and 1.3% Bi; 15.5m at 286 g/t Au. Mineralisation occurred between 550 to 800 feet vertical depth
- Shaft sinking commenced July 1965 - decision made on initial reserve of 30,000 tons at 109g/t Au, 0.8% Bi, 0.4% Cu and 1oz/t Ag. Ore trucked to Peko mine
- **Juno 1967-1977; production 454,938 at 59 g/t Au, 0.6% Bi – metal produced 862,982 ozs Au and 2,293t Bi plus copper and selenium**
- **LUCK** – Discovery hole deviated 20m from target. Later found target point was barren ironstone, if this had been intersected Juno may not have been developed.

# Warrego Mine

- No outcrop – magnetic anomaly. Initial intersection , May 1962, 23m at 3.92% Cu and 3.0g/t Au
- Initial ore reserves in 1985 were 3.1mt at 2.6% Cu and 1.9g/t Au. Not considered economic
- Surface drilling continued from 1961 to 1969. Sufficient ore proved to justify shaft sinking 1968. Production commenced in 1972, initially treated at Peko until processing plant erected at Warrego. Smelter construction near site was disaster.
- Small gold orebody defined U/G drilling August 1972 – 50m crosscut intersected 2000g/t Au over the 50m - ultimately 135,000 ozs at 35g/t produced over 4 months.
- **Warrego 1972-1980, production 4,944,000t at 7.6 g/t Au 0.3% Bi 2.0% Cu – metal produced 1,208,064 ozs Au, 12,000t Bi and 91,500t. Cu.**

# Peko's Success

- It took **13 years** for the company Peko Mines NL, then Peko Wallsend, to become a significant mining company. Peko, Juno, Warrego all became modest sized mines.
- Cash flow from the new mines commenced in 1962, 1965, 1967 and 1972
- **Critical to success was the early exploration success at Peko Mine itself – locating substantial primary Cu/Au mineralisation.**
- **Use of Peko Mine cash flow to finance exploration.**
- **Luck**
- **High grades and high metal prices at critical times.**

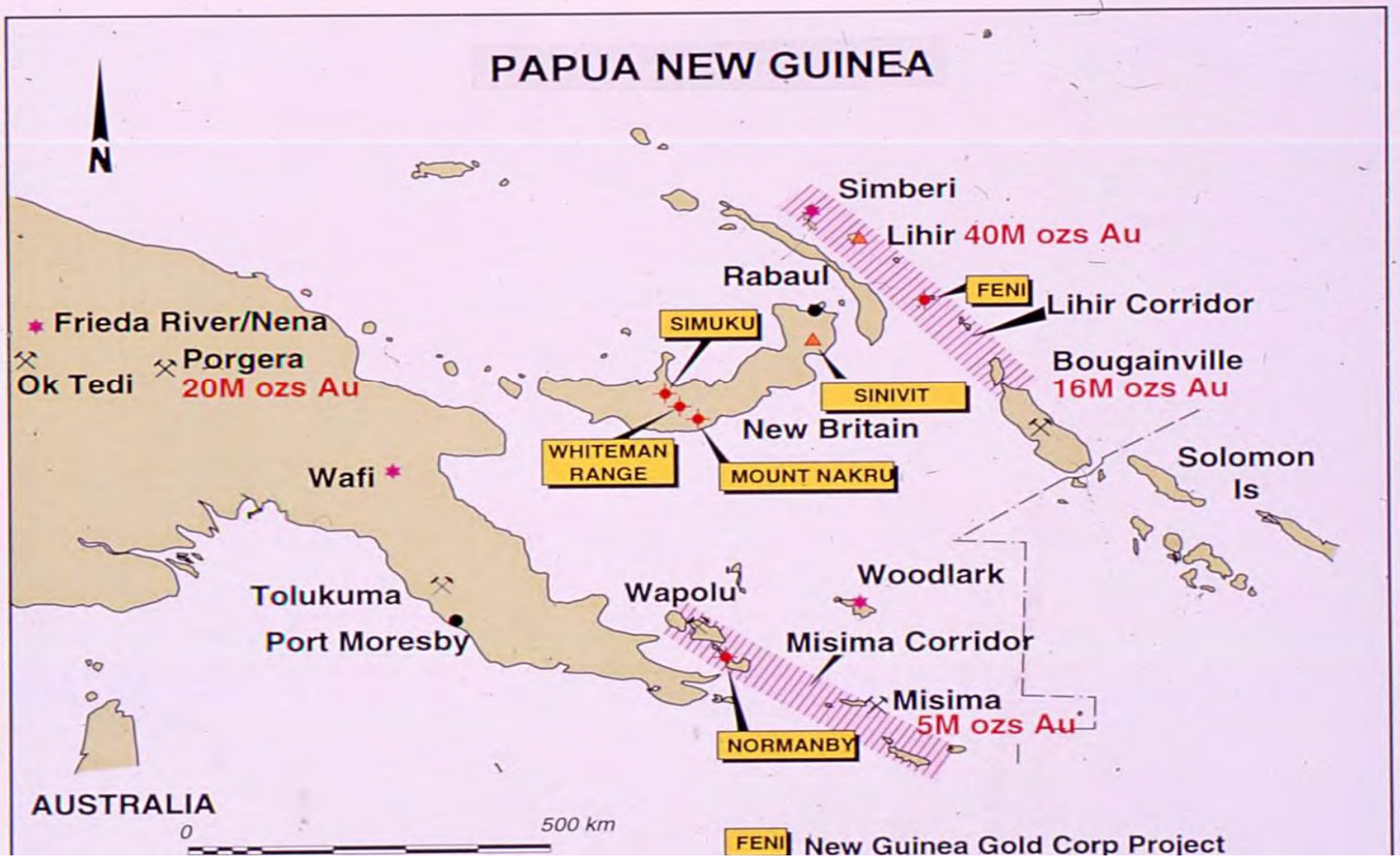
# Peko's success

- **Success outside Peko Mine itself – additional mines found and developed**
- Lack of environmental and other regulations helped considerably to allow quick development – not available today
- Peko base was used as a central processing and logistic hub reducing capital and running costs for Orlando, Ivanhoe and Juno – Warrego which came much later was largely self sufficient
- The Peko Board took many risky decisions to allow quick development after only a few positive drill holes
- Some decisions in later years were even disastrous.

# Other significant Tennant Creek Mines

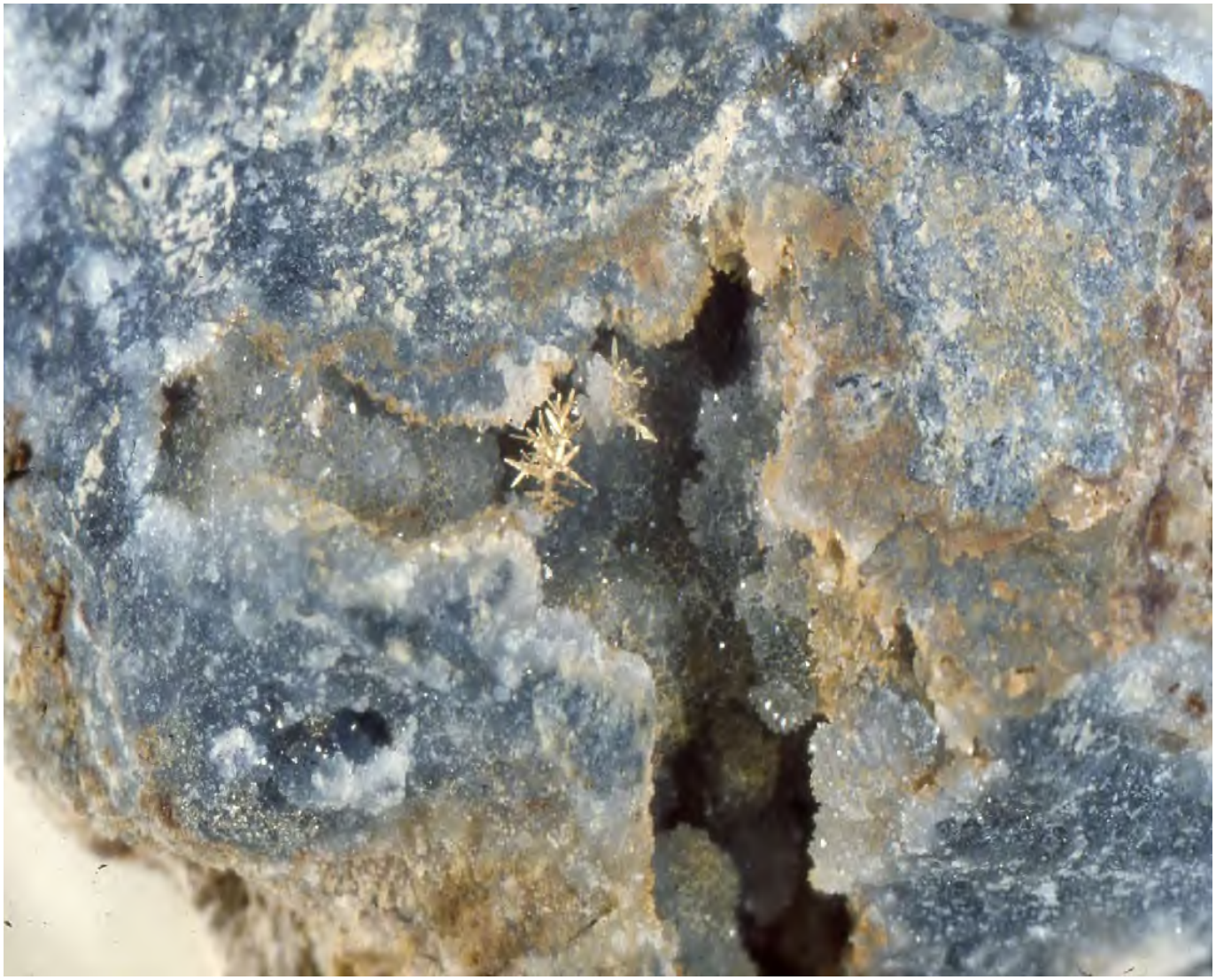
- **Orlando East** 1994-1997; 411,300t at 4.8 g/t Au 1.5% Cu - 63,474 ounces Au, 6,170 tonnes Cu
- **Gecko 1973-1997;** 2,320,000 1.3 g/t Au 4.1% Cu 96,968 ounces 93,300 tonnes
- Nobles Nob 1949-1975; 2,138,156t at 16.5 g/t Au - 1,134,282 ounces Au.
- White Devil 1987-1999; 1,600,000 at 14.7 g/t Au - 756,197 ozs Au

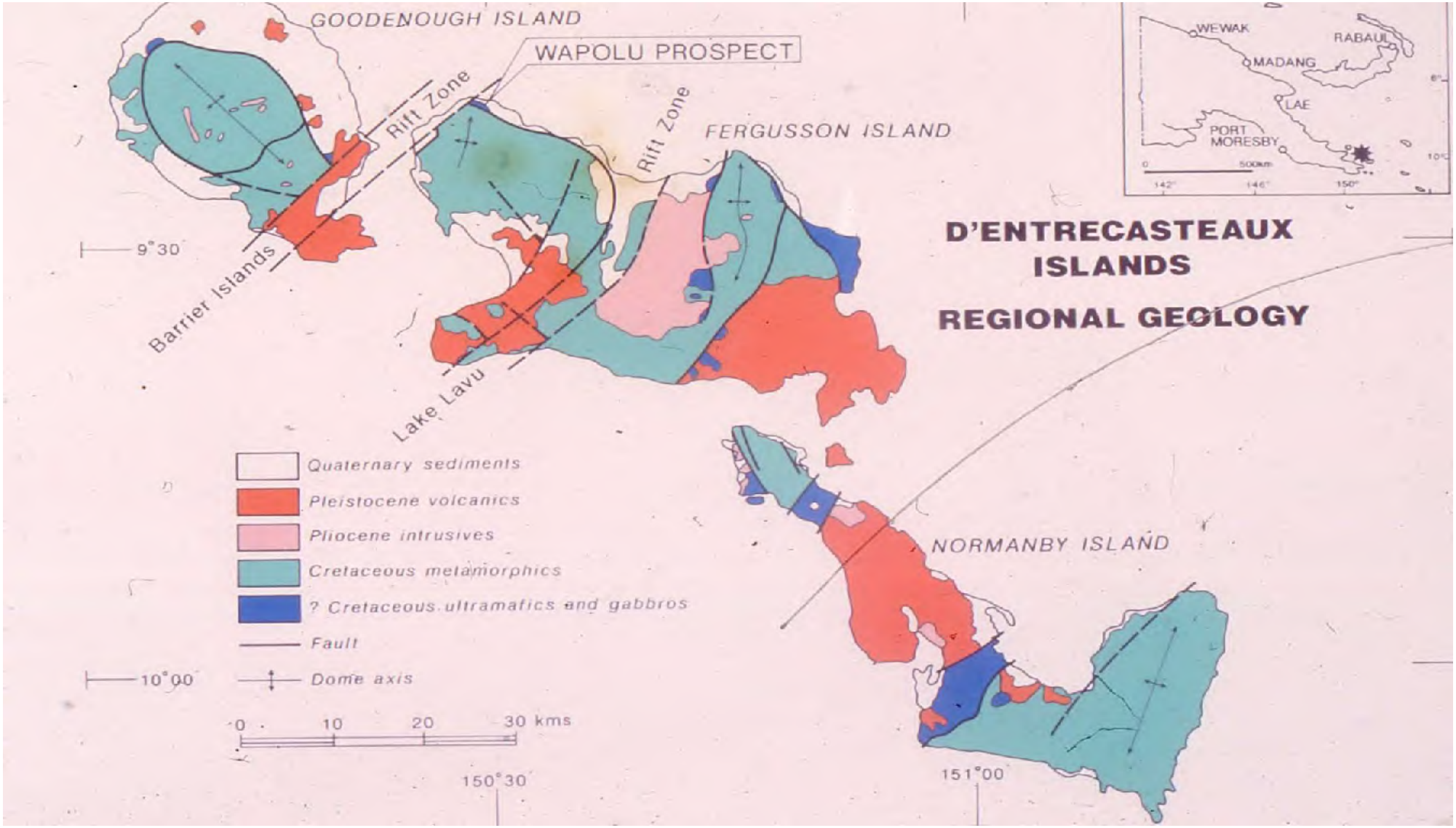
# Wapolu Gold Mine



# Wapolu Gold Mine – Union Mining/Macmin JV

- Gold discovered by Exxon/Esso exploration in 1983.No earlier workings on site. Visible gold at site. $10m spent by Exxon and City Resources in 1980's
- Macmin NL acquired property 1992, JV with Union Mining 1993 – Union to provide all mine capital for 51% interest and was Operator.
- Morgans required decision mine Wapolu before sponsoring Macmin float.
- Two mineralised bodies, near surface, thickness 7 and 9 m. Mineralisation hosted in decollement zone, chaotic talus breccia and ultramafic rocks on side of uplifted granitic dome. Ultramafic rocks and breccia matrix host highest grades.
- Resource at cut off of 0.5g/t gold – 13.5mt at 1.2g/t gold – 520,000 ozs gold. Resource at cut off 1g/t - 5.3mt at 1.9g/t – 320,000 ozs gold.
- **Decision to mine based on probable reserve 1.9mt at 2.4g/t, cut off 1.2 g/t – 140,000ozs. Capex AUD$ 14m, 3.5 year production.**




GOODENOUGH ISLAND
WAPOLU PROSPECT
Rift Zone
Rift Zone
FERGUSSON ISLAND
Barrier Islands
Lake Lavu
NORMANBY ISLAND
WEWAK
RABAUL
MADANG
LAE
PORT MORESBY
D'ENTRECASTEAUX ISLANDS
REGIONAL GEOLOGY
Quaternary sediments
Pleistocene volcanics
Pliocene intrusives
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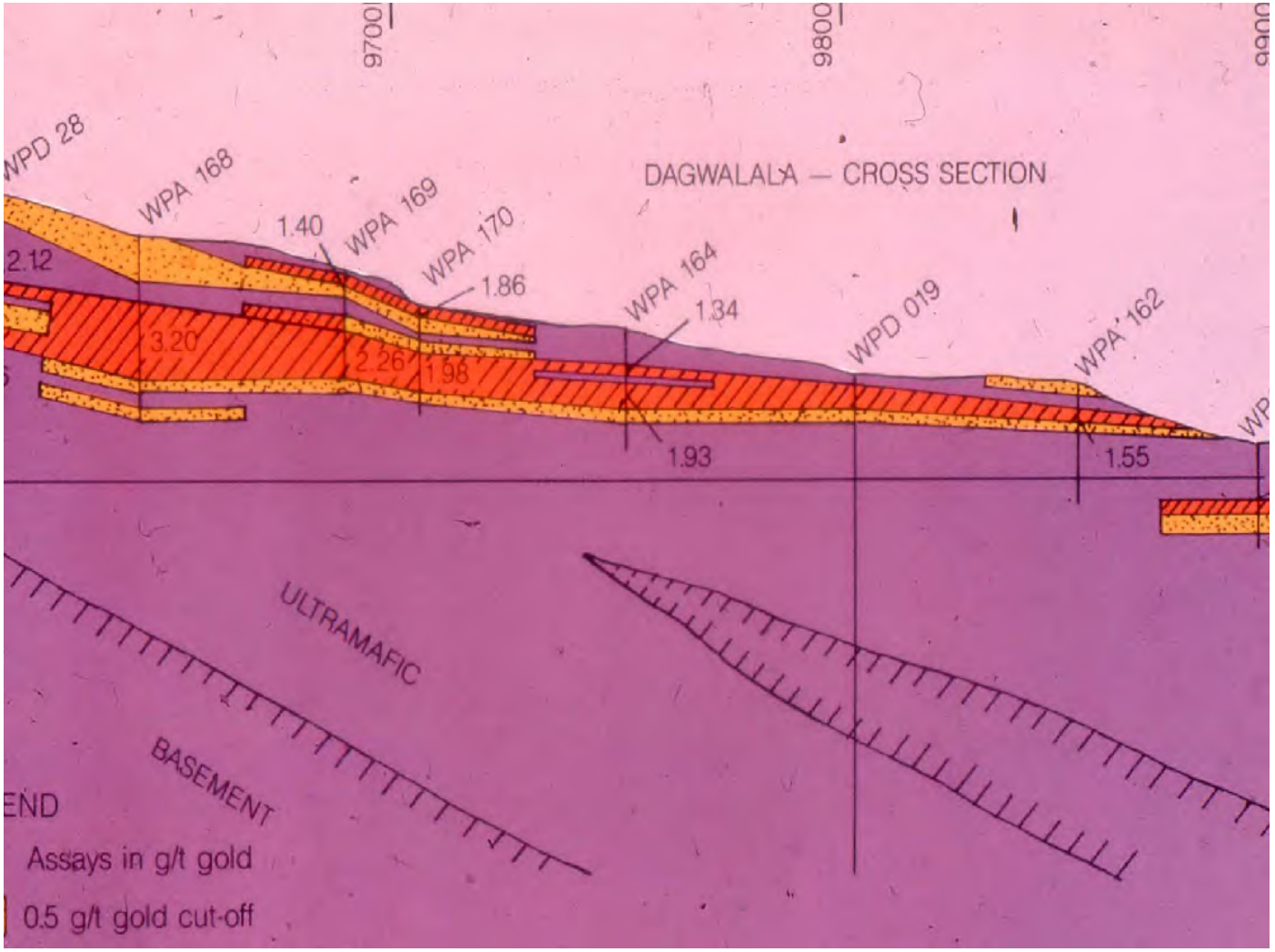
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DAGWALALA — CROSS SECTION
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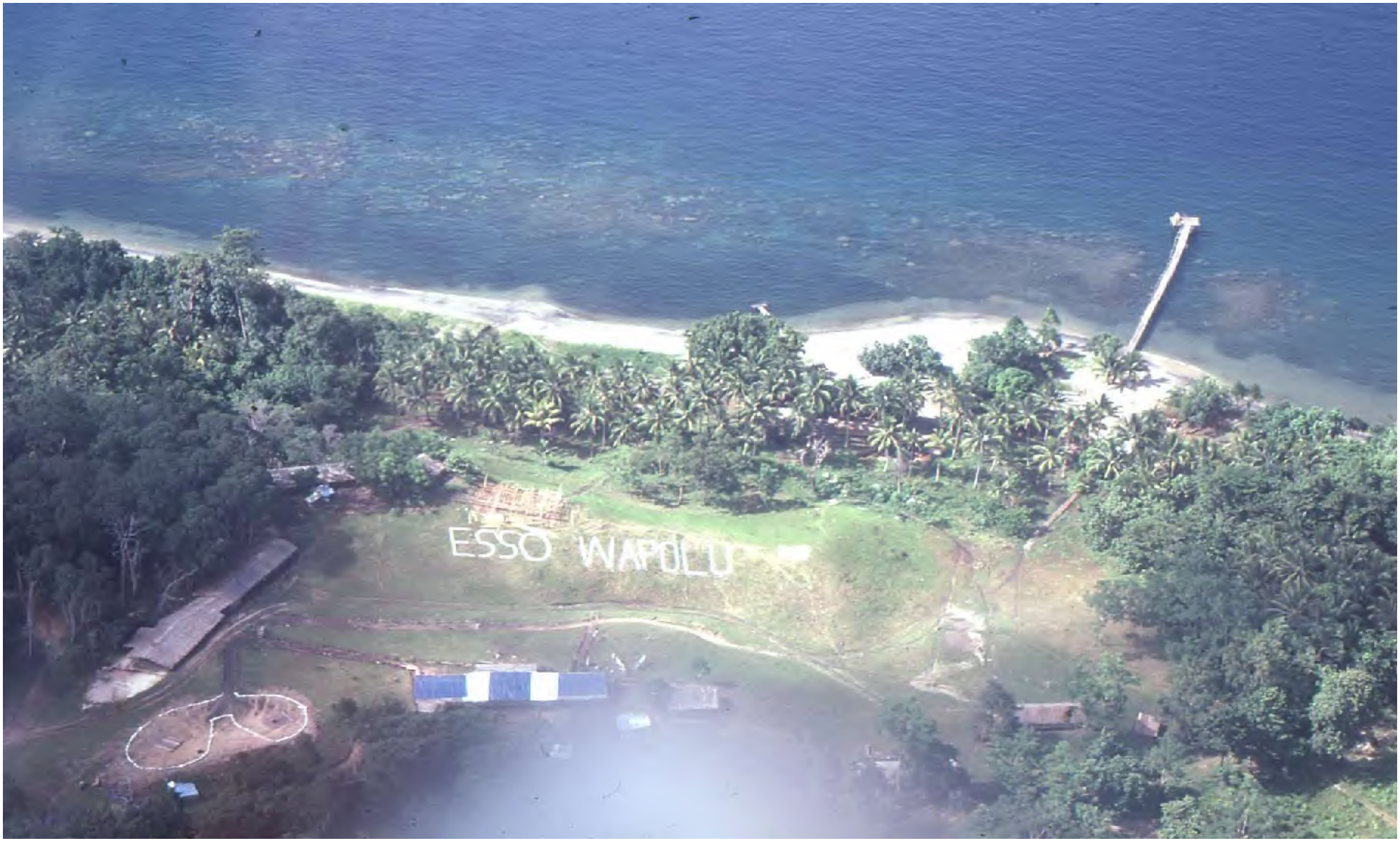
ULTRAMAFIC
BASEMENT
END
Assays in g/t gold
0.5 g/t gold cut-off

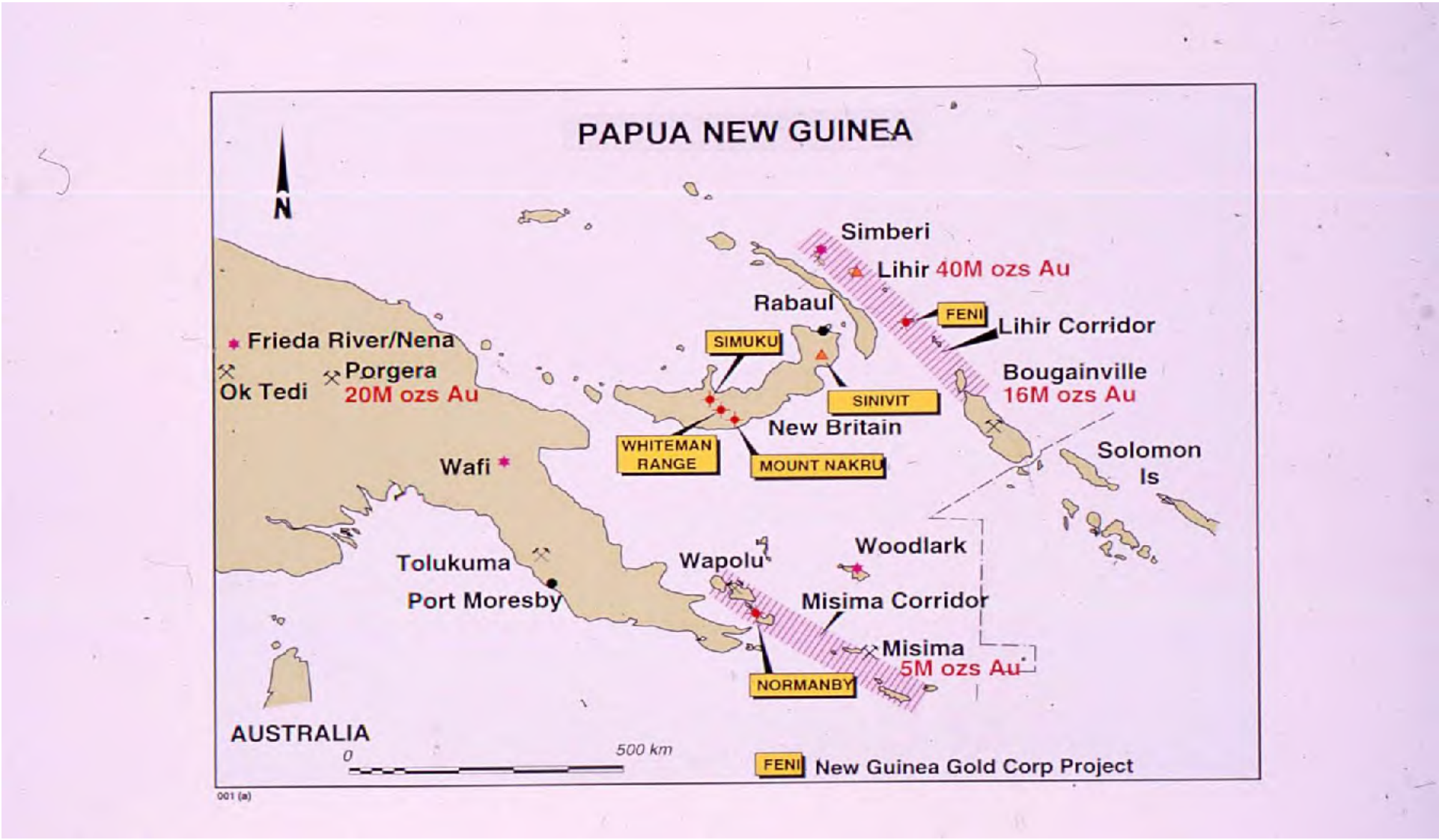
- Metallurgy suggested 90% recovery could be achieved by combined CIL and Heap Leaching
- Clay fines – a problem – removed and treated by CIL, course fraction up to 12mm heap leached, fraction greater the 12mm re-crushed, resized and heap leached.
- Tailings discharged into dams along coastal plain
- Waste all free digging – 50% of ore required ripping, minor blasting only. 1mt/year to be moved
- 3.5 year mine life current reserves, operating surplus AUD$11/t or $5.5M/ annum
- Adjacent to the sea – good access in that respect. Wharf and Jetty needed to allow Australia – Lae vessels to be able to call plus airstrip needed. Nearest centre Alotau.


ESSO WAPOLU

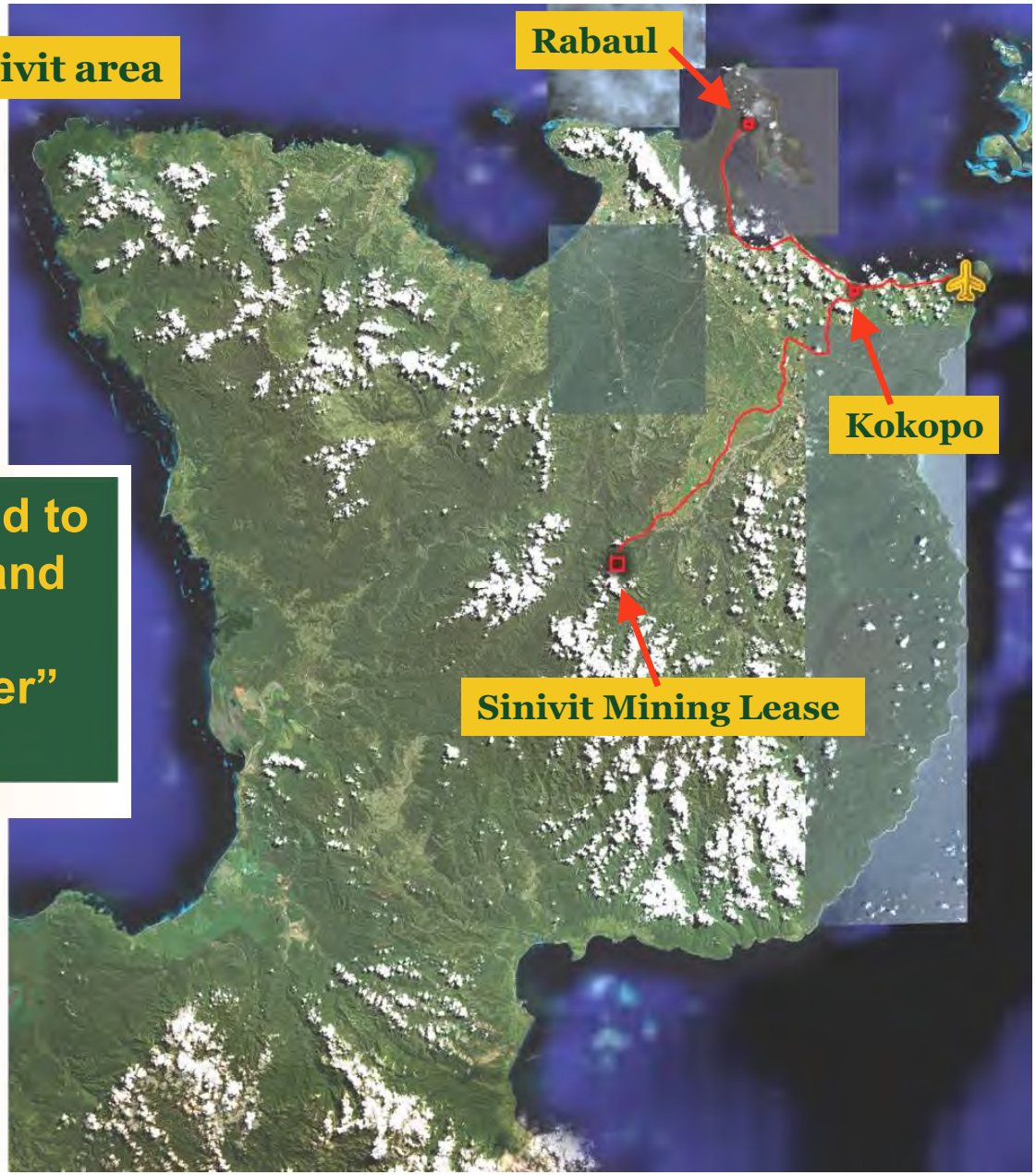
# WAPOLU – WHY IT WAS NOT A SUCCESS

- Main reason was massive dilution. After a year Macmin noted that grade achieved over a period was only 1.7g/t – near breakeven. Independent review blamed poor supervision of mining at night resulted in 30% dilution. JV was acrimonious and Macmin sold out to Union at cost.
- **Other contributing factors were**;
- Logistics were costly; Wapolu was remote and difficult to access; Emergency repairs for breakdowns– needed a lot of spares on site; Excavator breakdowns prevented production levels being achieved; Tailings ponds required more attention than planned. At one stage only one excavator was operating on site for multiple tasks. **Operating cost thus higher than forecast**
- 3-4 year mine life is very short if problems emerge or additional capital required. Difficult to hire competent Mine Manager.
- Capital not all raised initially – Union attempted to develop on the cheap.
- **Resources not converted to reserves. New resources not defined which was necessary for profitable operation in the long term**
- Wapolu neutral financially for Macmin but must have been negative for Union due to capital supplied**.**

# Sinivit Gold Mine East New Britain



## Image of Rabaul – Sinivit area

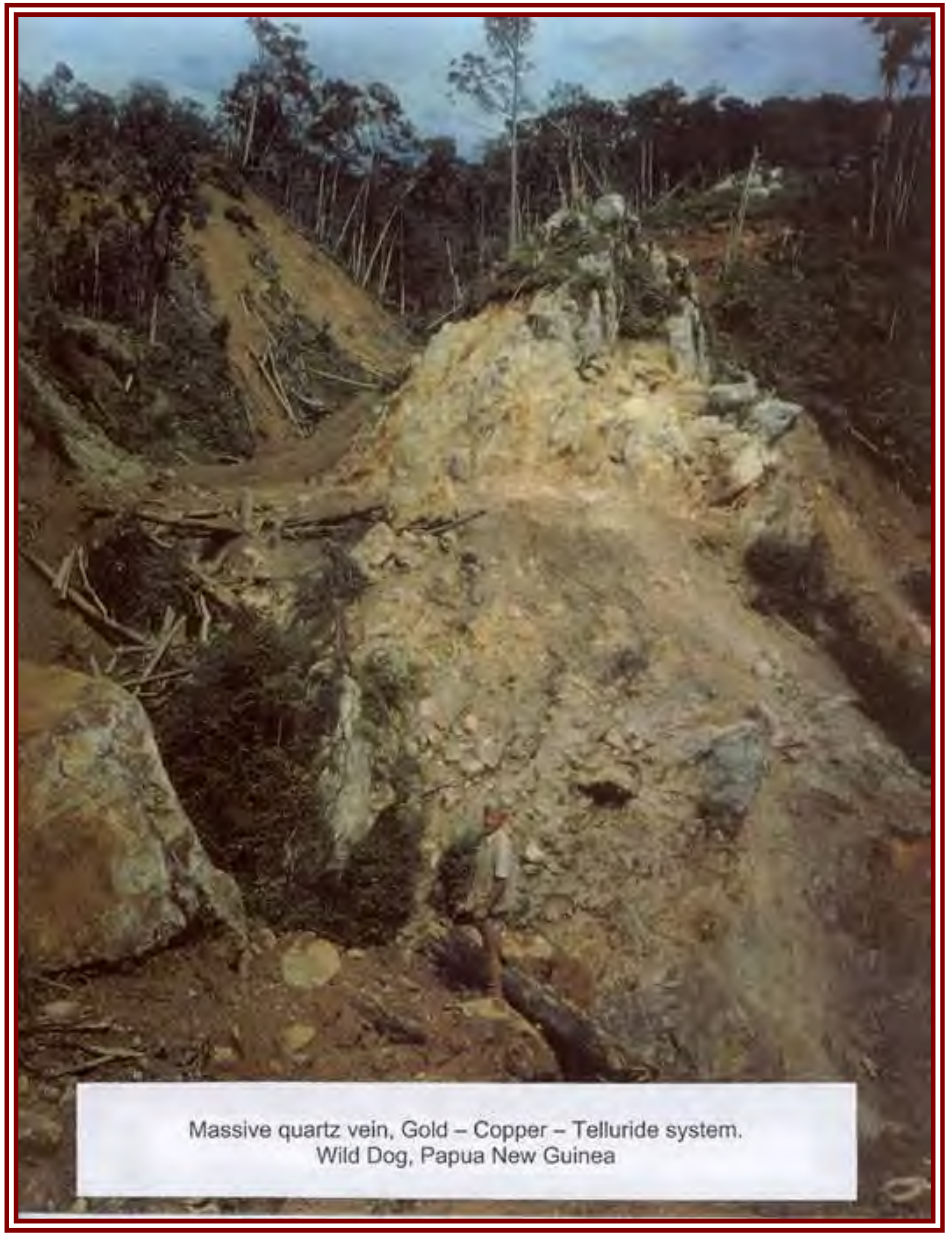



**Sinivit is connected to Kokopo, Rabaul and the airport by an "all weather" road.**

# Sinivit Gold Mine

Discovered by Exxon/Esso in July 1983 – initially named Wild Dog. 60kms SW of Rabaul in Baining Mts

Sinivit was a series of gold, telluride, copper structural zones/ vein system. Up until 1992 it was explored by Exxon, City Resources, Highlands Pacific. System masked by 600m wide zone of quartz veined hydrothermal clay alteration. System has both high and low sulphidation characteristics with potential for major copper gold system at depth.

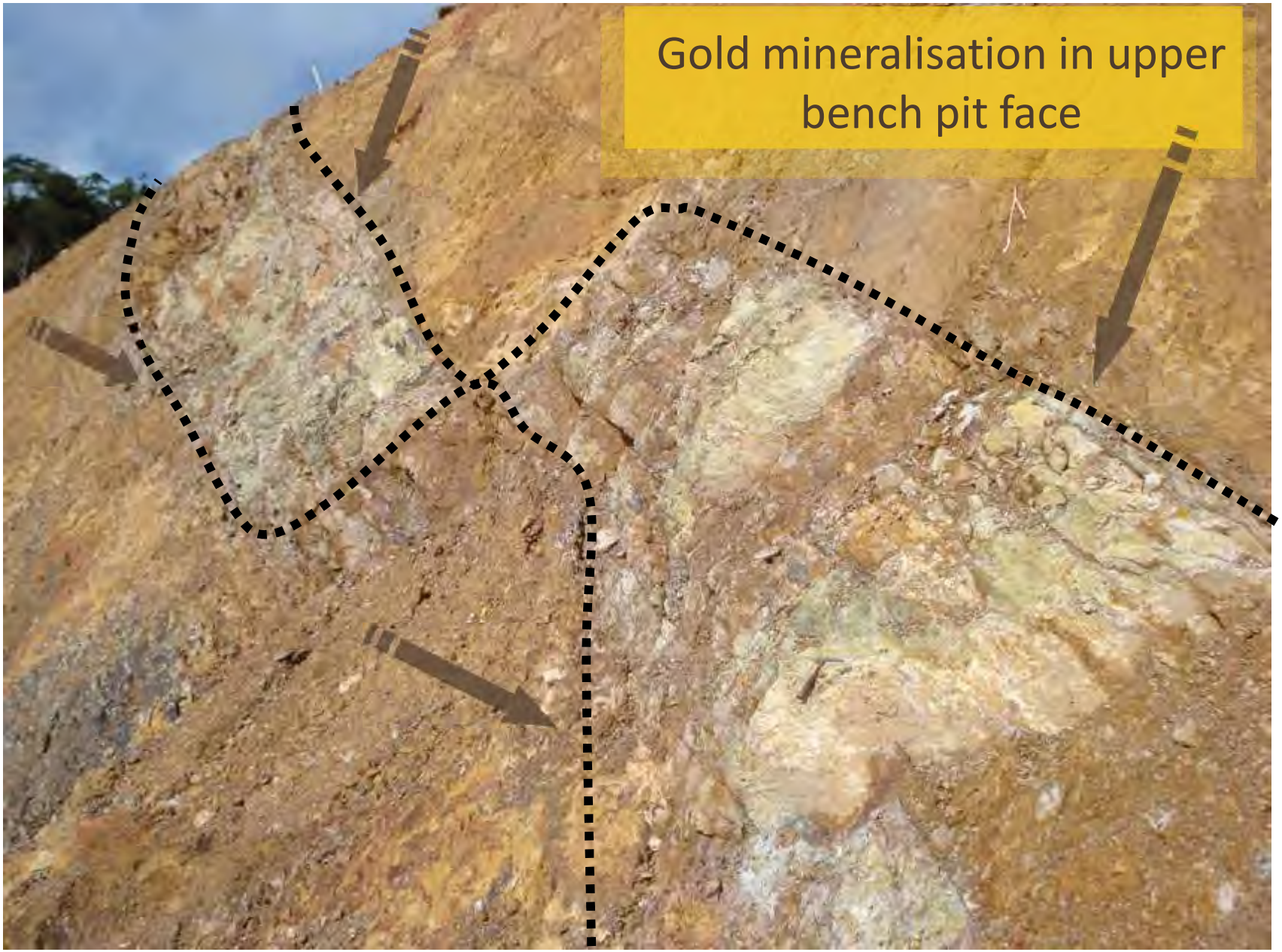


Massive quartz vein, Gold – Copper – Telluride system.
Wild Dog, Papua New Guinea

- Macmin 90% interest acquired in 1995, subsequently spun out to New Guinea Gold, a TSX- V listed company.
- Gravel road constructed to site in 1995.
- Ausenco completed a feasibility study in 1995 but development curtailed due to low gold prices. In 2005 feasibility updated and development commenced in 2007.
- Decision to mine influenced by broker support in Vancouver – NGG needed to reinvent itself after 10 years to survive – did so by spinning off other PNG properties and focussing on cash flow from and further development of Sinivit.
- Development commenced with capital partly raised. Further capital raised by selling other assets – but all proposed capital not raised

- Decision to mine made on Indicated Oxide Resources of 306,000t at 5.3g/t Au for 52,000 ozs Au.
- Sulphide resources were 310,000t at 7.7g/t Au for 77,000 ozs but not included in original mine plan – longer term potential.
- Open pit mining; waste: ore ratio 3-1, gold 88% cyanide soluble, crushed to 100% -10mm - 70 % recoverable, processed in vats followed by heaps on top of vats. Vat becomes the pregnant pond. Projected gold production was 5000 ozs /quarter.
- Exploration Target of gold/copper/telluride/silver mineralisation below oxide mineralization, - 1 million ozs gold equivalent. Exploration to be financed from cash flow with development to follow.

- To December 2010, 2.5 years gold production 19500 ozs. Earth moving more than 2 million tonnes stripping and vat construction. Production averaged 2000 ozs /quarter against forecast 5000ozs/quarter
- Closed early 2014 – total production about 45,000 ozs – recovery ultimately plus 70% but only after months/ years leaching time.
- Grade achieved about 4.5g/t (cut grade in feasibility)
- Should have been closed by 2012 but some leaching continued until 2014.
- No surplus funds for exploration.


Gold mineralisation in upper bench pit face

# Heap V3 – 27,000 tonne heap built on top of Vat 3

## Flat Type Vat Cover

## Open Type Vat Cover

Pouring Gold Dore

## Why Sinivit was not successful

- Gold production rate was only 40% of forecast production.
- Instead of a 2.5 year mining/ 4 year processing operation , operation took 6.5 years.
- Rain – severely restricted production, needed covered crushing facilities; rain also resulted in many unscheduled delays in all aspects of earth moving.
- Topography not adequately assessed - required extensive earth moving to build vats/heaps
- Vat/heap leaching, although ultimately achieving recoveries, **was very slow**, delaying gold production and cash flow.

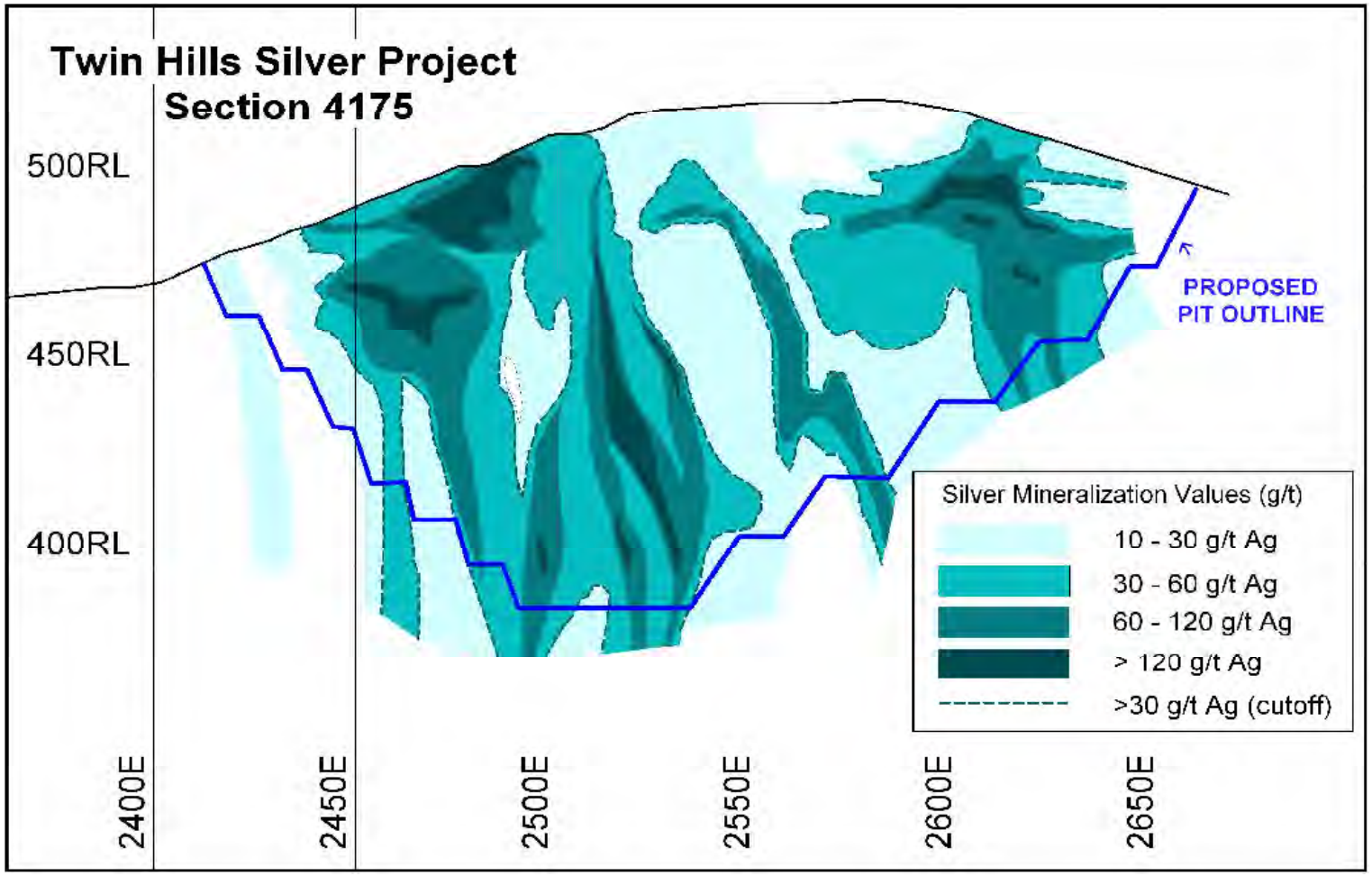
View of Rain from Office

- Undercapitalised partly due to pressure from NGG's broker in Vancouver to go into production.
- Inadequate mining equipment which prolonged mining.
- Dispute with earth moving contractor caused six months delay.
- Surplus cash not achieved preventing exploration potential being defined.
- Ultimate success always depended on defining additional resources and extending mining to high sulphide zones with production of copper and tellurium in addition to gold.

# Twin Hills Silver Mine

**Excellent access, Topography favorable for benched quarry.**

# Longer term production reliant on processing lower grades or depth extensions of mineralisation



# Twin Hills Silver Mine

- 2.5m ozs/year initial production. Projected cash cost AUD$7 to $8.50, silver price AUD$15 to $16. Planned increase to 4.0m ozs/year.
- Reserve – **31m ozs silver equivalent,** Resources 56m ozs silver equivalent
- Open Pit mine, drill and blast – high grade ore to crusher, lower grade ore to stockpile.
- Crushing, agglomerating and stacking – three stage crushing to -4mm. Heap leach. Silver dissolved in weak cyanide solution, then to pregnant pond. 70% recovery forecast.
- Silver extracted from pregnant liquor by electro-winning to produce a silver powder, dried, sold “as is” or refined.
- Silver recovery from heaps ultimately achieved forecast recovery, 70%, instead of 2 months took about a year.

# Twin Hills mine layout

# View of mine – open pit – in early 2008

**Preparing base of heap – covered in plastic, then sand with drainage piping, finally ore as a heap**

**First layer of course ore on heap – this assisted drainage - electrowinning shed in background**

**Dumping finely crushed ore on heap pad using rubber tracked vehicle to prevent damage to liner**

**Completed heap with sprinklers spraying cyanide solution. Cyanide dissolves silver in crushed rock, liquid containing silver extracted from base of heap, flowed into pregnant pond and silver is extracted by electrowinning as silver dore.**

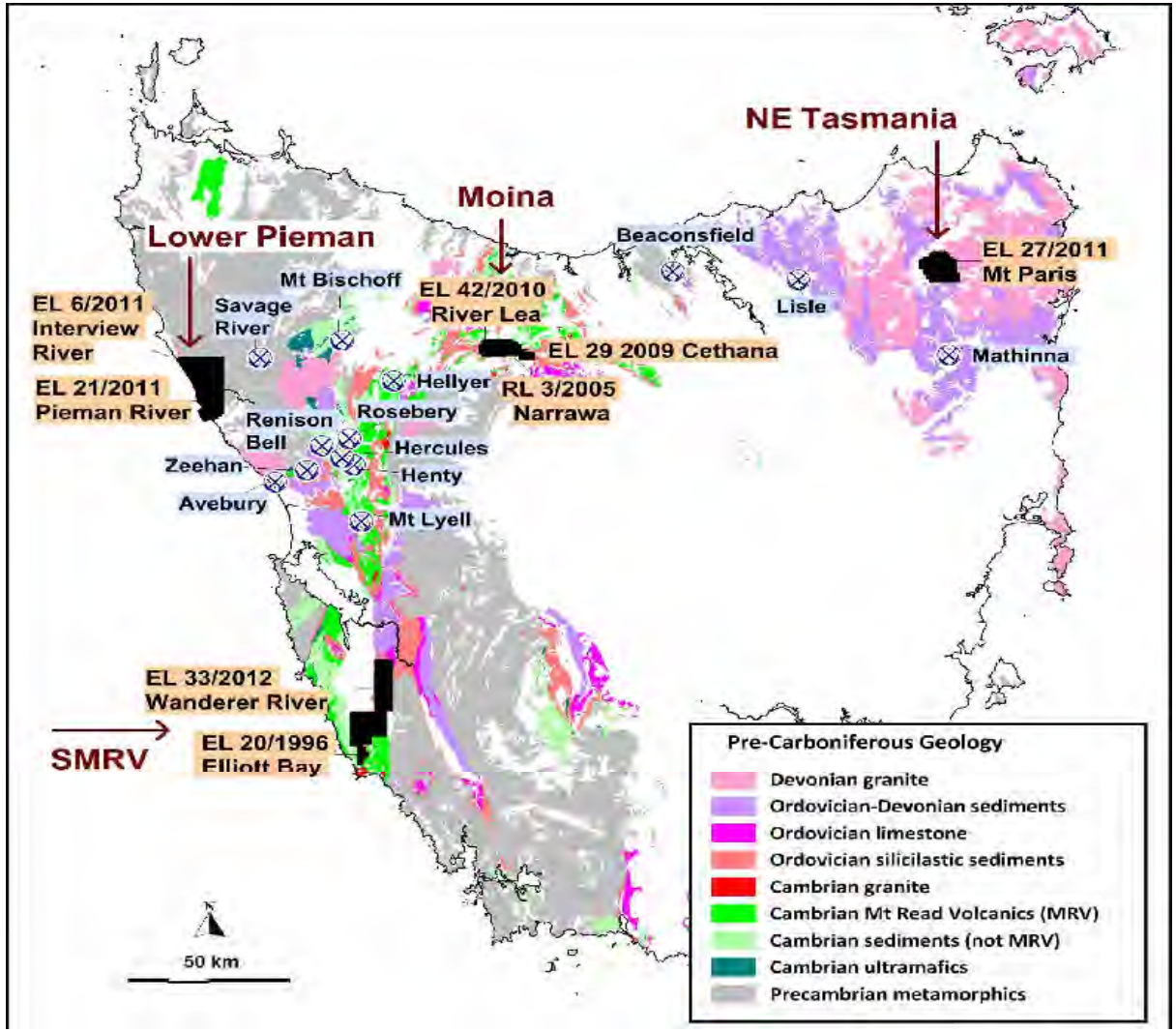
# Electrowinning circuit

# Demise of Macmin Silver

- Silver production in first 9 months of 2008 was 1.0m ozs.
- Crushing circuit had not performed to specifications. Electrowinning plant was only extracting 50% silver in leachate. Remaining silver had to be recycled through heaps
- To achieve 2.5M ozs silver/annum, increasing to 4m ozs **required additional capital being raised in late 2008,** to double the crushing capacity and add Merrill Crowe plant to recover remaining silver in leachate.
- When the GFC occurred this finance faded away.
- GFC crisis, silver dropped to AUD$10/oz. Cash cost was AUD$ 14.50/oz – project was losing money.

- Macmin had $4M in cash and silver,  with continuing production the company could survive perhaps four months. Consensus was low silver prices could last for many months.
- Independent directors, company secretary favoured Administration to pay off debts.
- Within three months, AUD $ fell to 50 cents US, silver spiked to over AUD$20/oz – if we had continued production, we would still be in business.
- The global financial crisis was the main cause of the demise of the Twin Hills Mine and Macmin Silver Ltd. Administration was combination of bad luck/timing/judgement – and don't believe all the so-called financial experts – they were wrong.

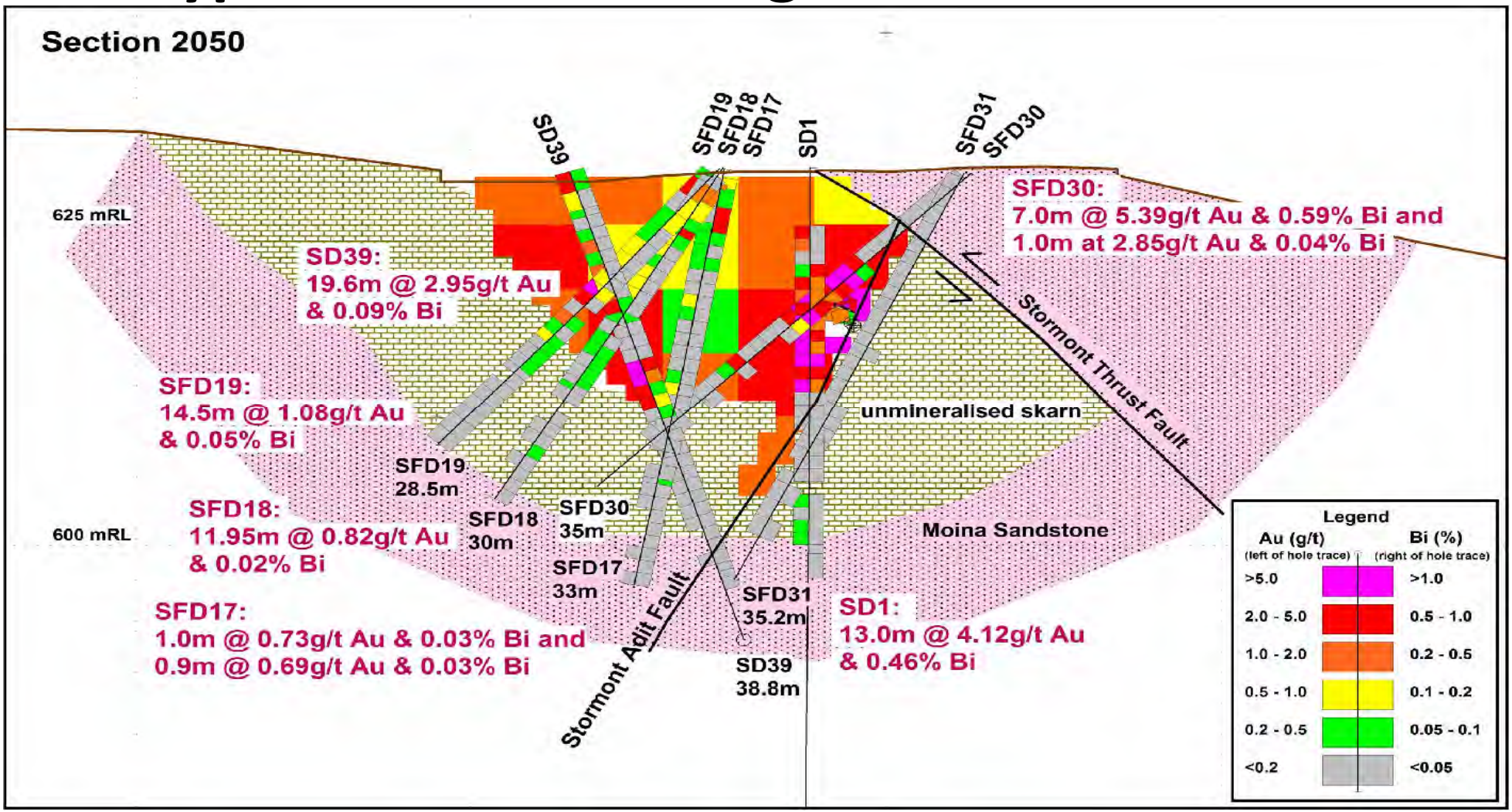
# Stormont Gold Mine – Moina, Tasmania



# Stormont Gold Mine – Moina, Tasmania

- Stormont is/was a gold bismuth, skarn type deposit near Moina in North/central Tasmania. It was worked as a small mine in the 1930's
- Frontier Resources spun off Torque Mining in 2012 to acquire Frontier's Tasmanian projects – raised $1 million in seed capital
- A 50/50 joint venture with BCD Resources – Beaconsfield Mines – with BCD as operator, was completed in October 2012 for the Stormont lease.
- Torque would provide a small Indicated Resource - 150,800t at 2.89g/t gold for 14,011 ozs gold - BCD would fund feasibility, initial capital, provide its processing facilities at Beaconsfield and advance Torque $500,000 at commencement of production.
- J/V undertaken by Torque to attempt make the IPO successful/ provide finance for exploration. BCD needed cash flow to fund Queensland development and provide use for their milling facilities.
- The attempt to list on ASX in January 2013 failed –poor market conditions

# Typical section through Stormont



## Feasibility prepared by BCD

- Reserve 74,400t at 4.64g/t gold, 1.5g/t cut off for 11,100ozs; BCD had mill and tailings facility.
- Recovery 91%/88%; 10% dilution grade 0.7g/t gold.
- Truck ore 140kms to Beaconsfield $24/t; no crushing on site;
- Processing $31/t; breakeven to mill from site 1.2g/t gold
- Waste to ore 2.5 to 1; three months mining, five months processing. Very short operation.
- Total production cost estimated $782/oz gold; gold price $1450; net cash flow $5.8m.

- BCD entered administration January 2015 owing Torque $125,000. In addition to Stormont, BCD had been developing a gold project in Queensland – was this funded partly from Stormont cash flow?
- Administration resulted in no financial reconciliation or chance to dispute many additional charges compared to feasibility.
- BCD charged JV **50%** increase in admin costs; processing cost of **$50/t** as against feasibility cost of **$31/t, 61%** increase; recovery was **83%** as against 91% in tests and **88%** in feasibility;
- Milled grade was **2.8g/t** as against reserve grade of **4.6g/t** – **60%** dilution; mobile crusher required on site – extra $5/t.
- Discrepancy of 3000t ore as weighed at site to that milled.
- BCD had no gold stripping at Beaconsfield – carbon shipped to Perth, then dore refined in Sydney. Gold shipped on carbon, gold stripped, gold remaining on carbon, gold refined did not balance.
- 1410 ozs gold, $2.2m missing. No investigation.

# Comments on Stormont

- Stormont illustrates problem with 50/50 Joint venture and short mine period, if trust/good will ceases and Operator enters administration.
- Feasibility study produced by BCD a fantasy.
- BCD never justified the **61% increase** in processing (through their own mill); major increases in administration charges; discrepancy of the 3000t of ore between site and mill; absence of reconciliation from gold on carbon to refined gold – **difference of 1410 ozs**.
- **Wrong mining method** –deposit not suitable for bulk mining. Selective mining needed. **60% ore dilution**, BCD failed grade control; blast pattern was too wide, mining poorly supervised by Mine Manager.
- Blast pattern, same for ore and waste, resulted in large blocks of silicious ore required secondary breakage/additional cost of a mobile crusher
- The Project Manager spent less than 50% of time on site.

# Why do Junior exploration companies attempt to develop small mines

- After 5/10 years  as a listed company markets/investors tend to lose interest in a junior if immediate success is not obvious.
- Often from a companies sponsoring broker's point of view, to remain viable the company needs to somehow reinvent itself –so there is pressure!
- One way to do this is to proceed to development – even if prudence tells you that the deposit in question is not ideal for immediate development
- Consequently development often commences without all capital raised – or unable to raise all capital!
- Long term viability dependant on defining additional reserves to add to mine life. All my examples initially had very short mine lives.
- Historical example of Peko's success actually took 7 to13 years
- Succeeded because initial Peko Mine had success in enlarging its reserves and maintained continued positive cash flow which allowed new mine exploration success.

# What a small mine usually needs for success

- Luck.
- Medium/high metal grades; favorable metal prices.
- Successful exploration during mining to increase mine life.
- Realistic feasibility study – mining method, recovery, processing, capital raising.
- Access to further funds in event of unforeseen problems - which will occur
- Favorable location; favorable and on time regulation; favorable market conditions.
- Competent mine manager.
- Good JV relations, viable JV partner.