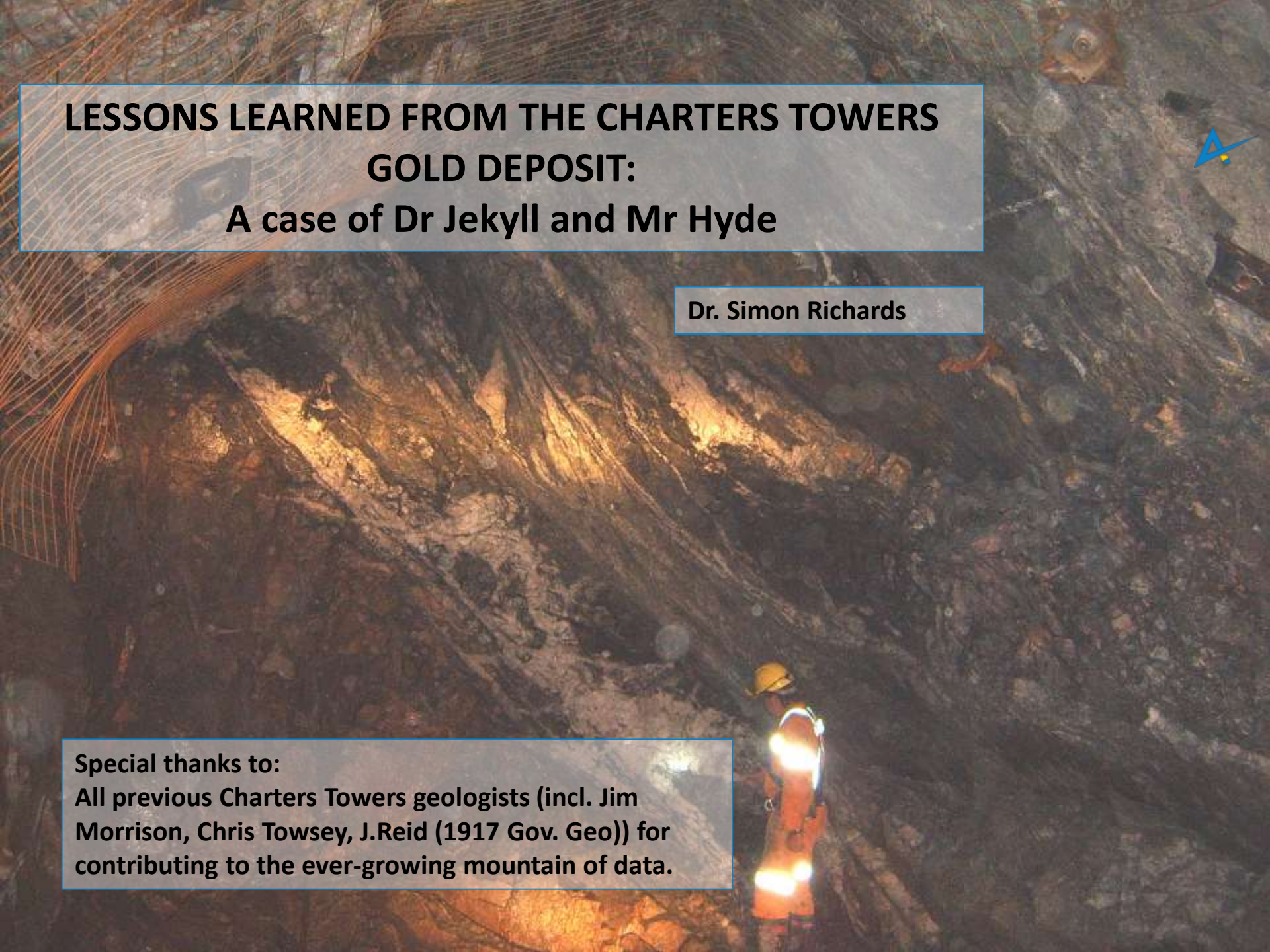
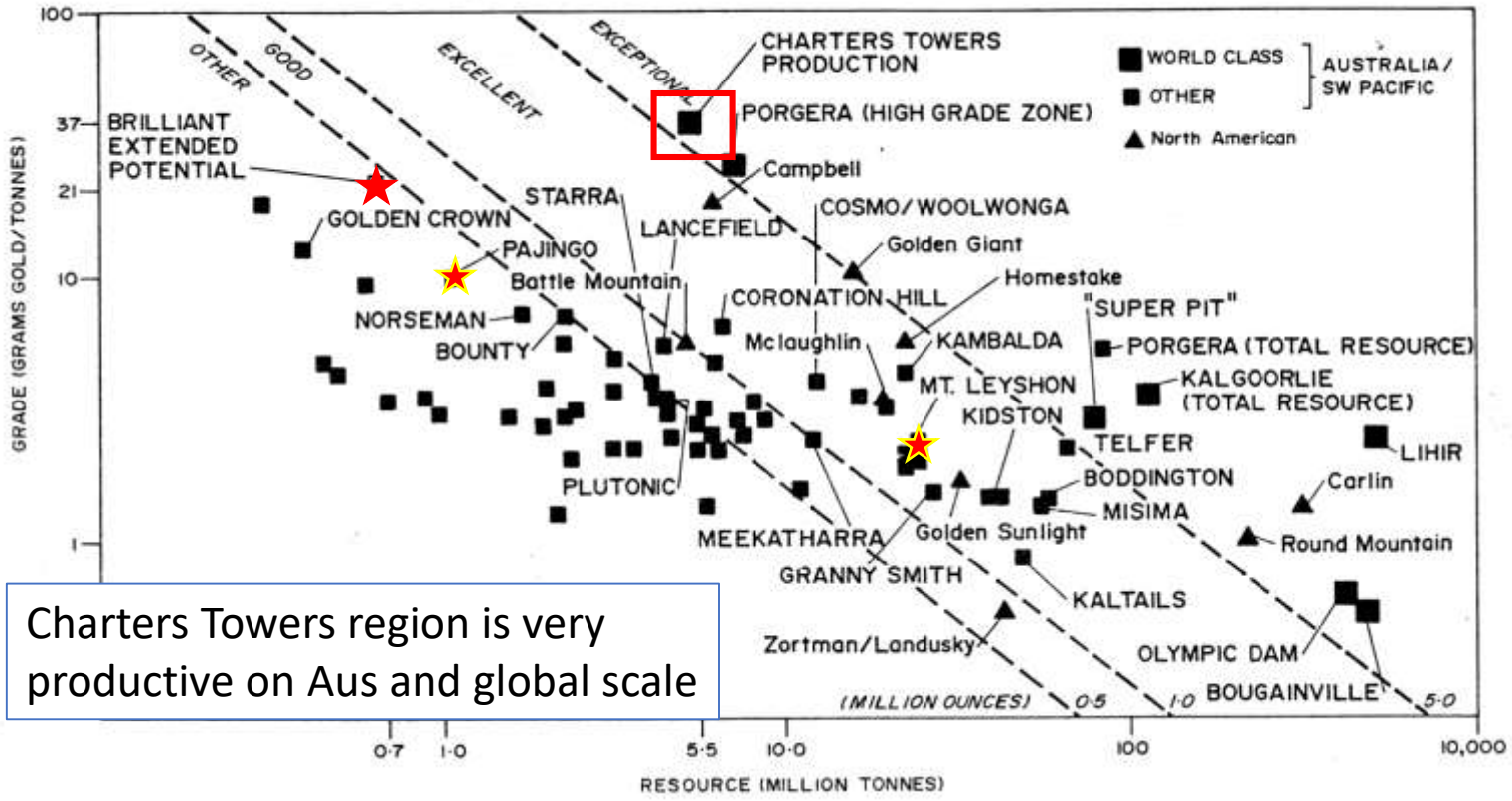
LESSONS LEARNED FROM THE CHARTERS TOWERS GOLD DEPOSIT:
A case of Dr Jekyll and Mr Hyde

Dr. Simon Richards



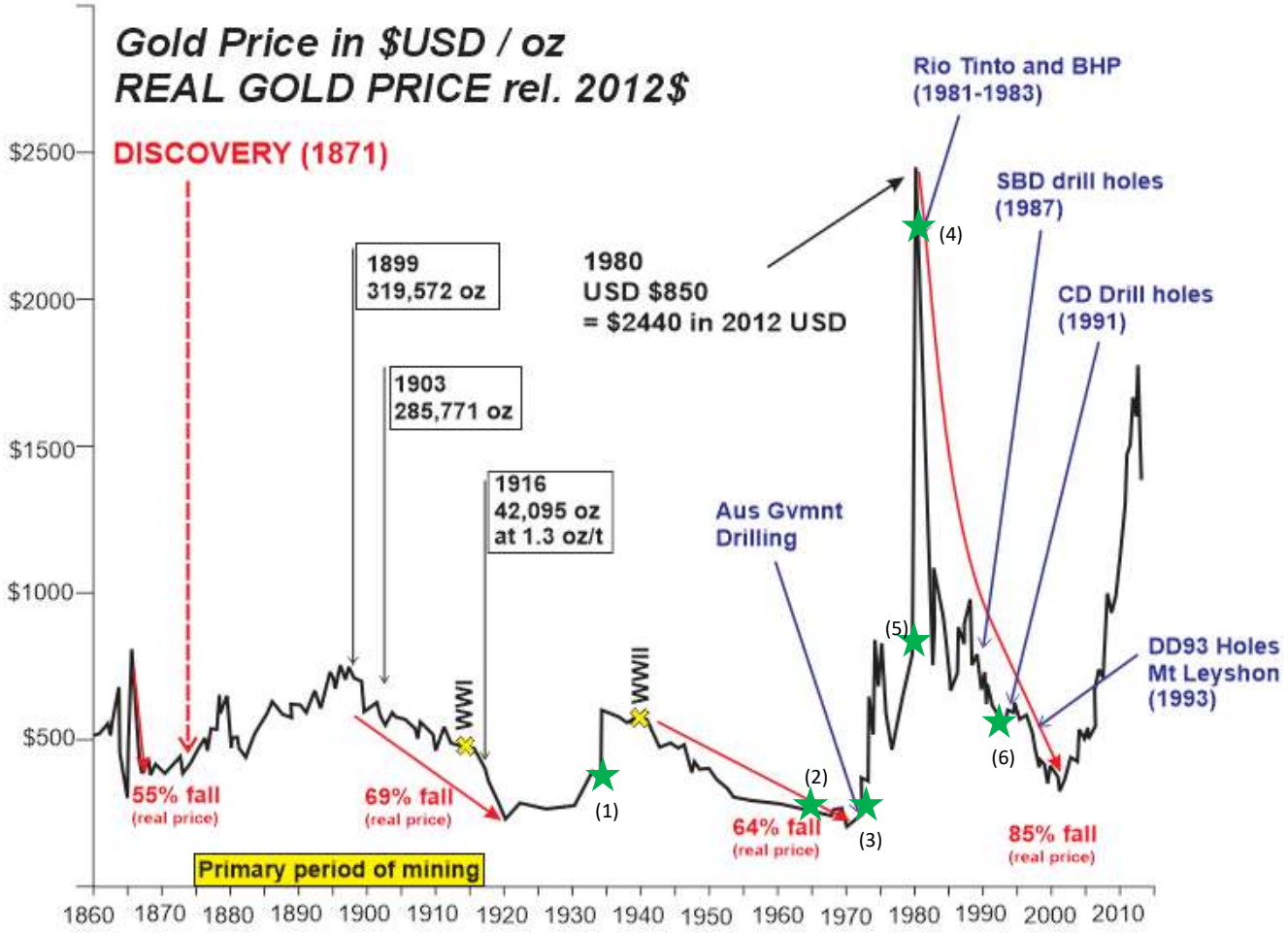
Special thanks to:
All previous Charters Towers geologists (incl. Jim Morrison, Chris Towsey, J.Reid (1917 Gov. Geo)) for contributing to the ever-growing mountain of data.

What makes Charters Towers so interesting/inviting?
Approximately 6.8 Million ounces of gold since 1871



Charters Towers region is very productive on Aus and global scale

Recent attempts to revive mining/discovery at Charters Towers



History of exploration partly governed by gold price.

Most drilling in central occurred between 1980 and 1993 during massive downward slide in gold price.

Lack of knowledge about deposit.

Extremely high development costs per ounce of gold returned.

★1) Gold Mines of Australia
★2) Mines Exploration ltd
★3) AOG Minerals
★4) Homestake-BHP (BD Drill holes)

★5) CRA
★6) Normandy-Mt Leyshon

OUTLINE

1) “**Orogenic” style** of mineralisation in Charters Towers – characteristics of the fracture hosted gold deposit

2) Historical mining - A brief history of mining in Charters Towers from a **project termination** perspective.

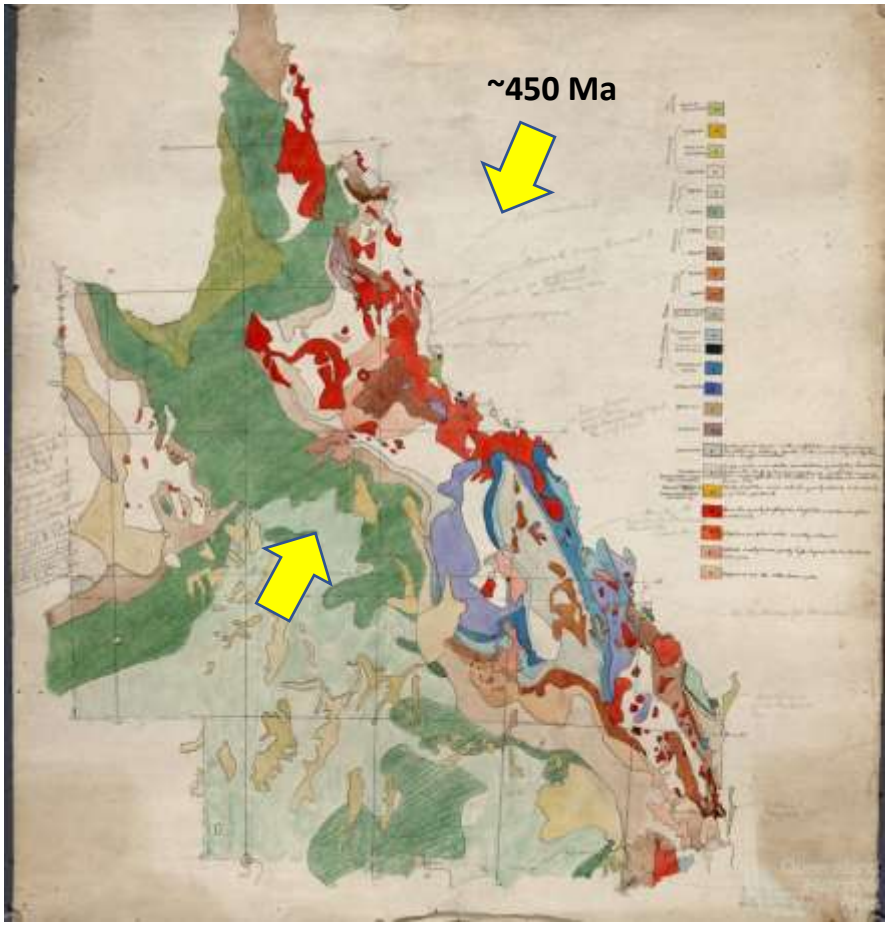
3) Recent history of exploration,

The problem with drilling – not understanding deposit style

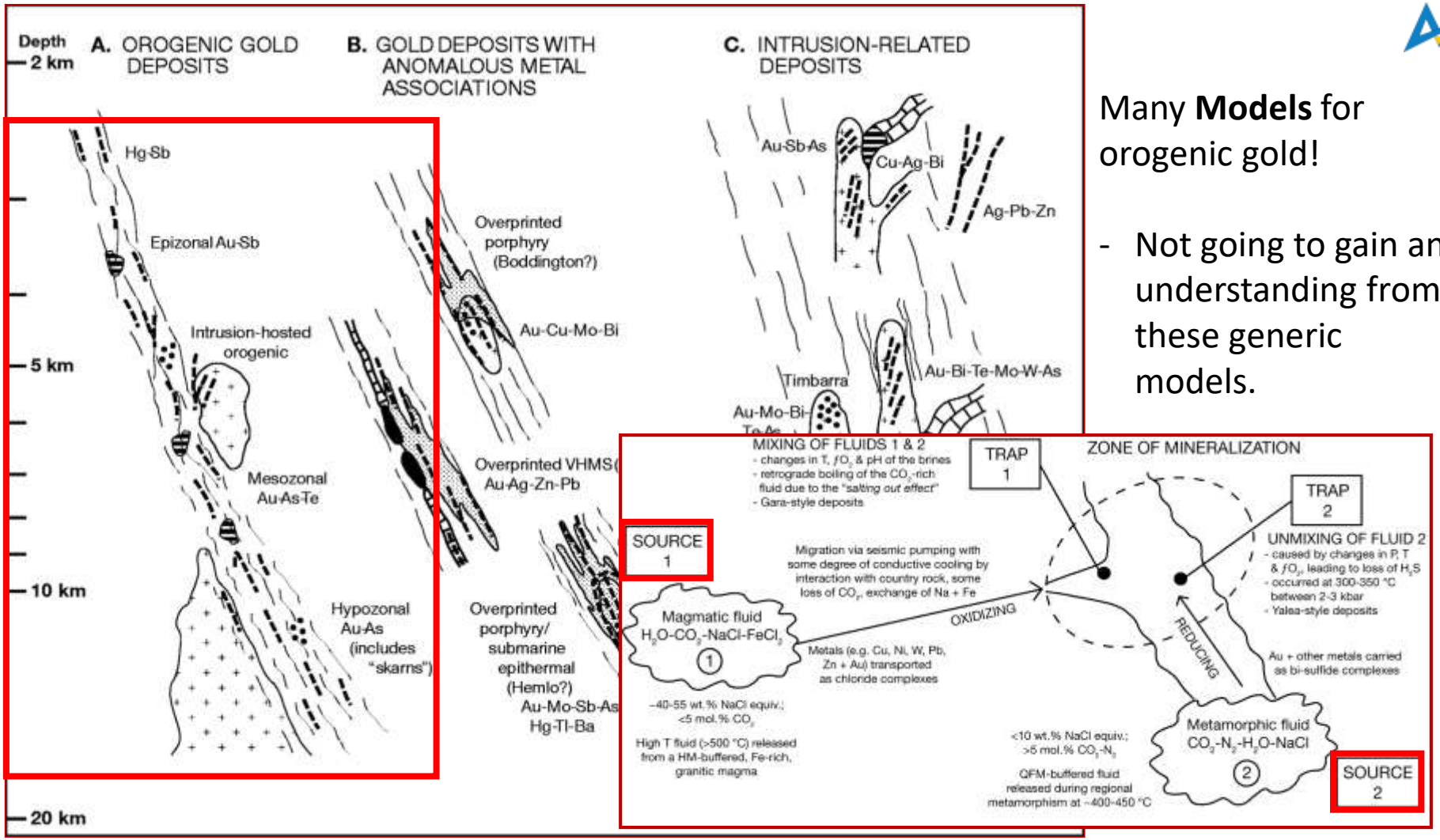
4) A change in approach is required

Smart geophysics to save time and money

1) Large-scale - What is an orogenic gold deposit?



Gold is hosted within fractures formed in granite at ca.450-480Ma.

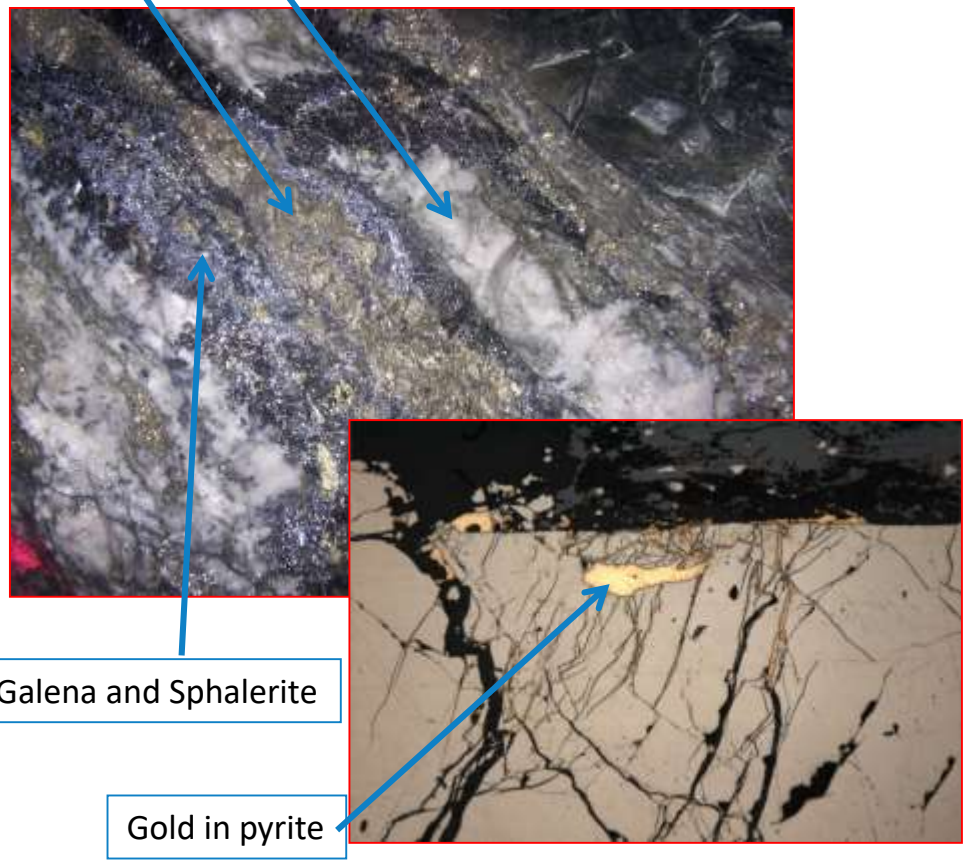


Many **Models** for orogenic gold!

- Not going to gain an understanding from these generic models.

Goldfarb et al al 2005 Econ Geol 100yr Ann

Charters Towers deposit characteristics

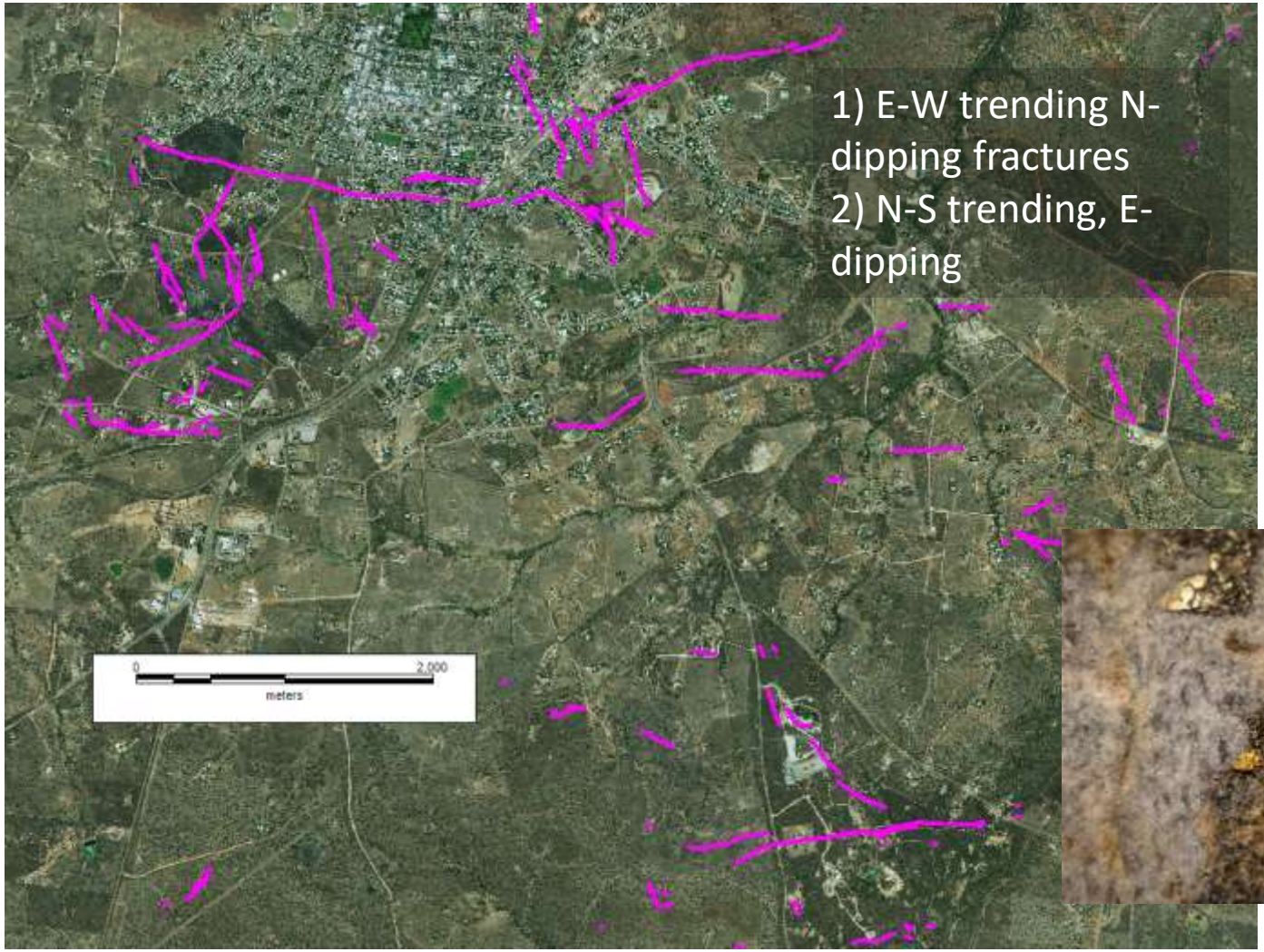


Charters Towers contains Narrow Vein, fracture-hosted gold mineralisation.

High gold but with only minor amounts of lead and silver with unusually low arsenic and low copper

Gold occurs as free gold contained along grain boundaries (some gold contained within sulfides)

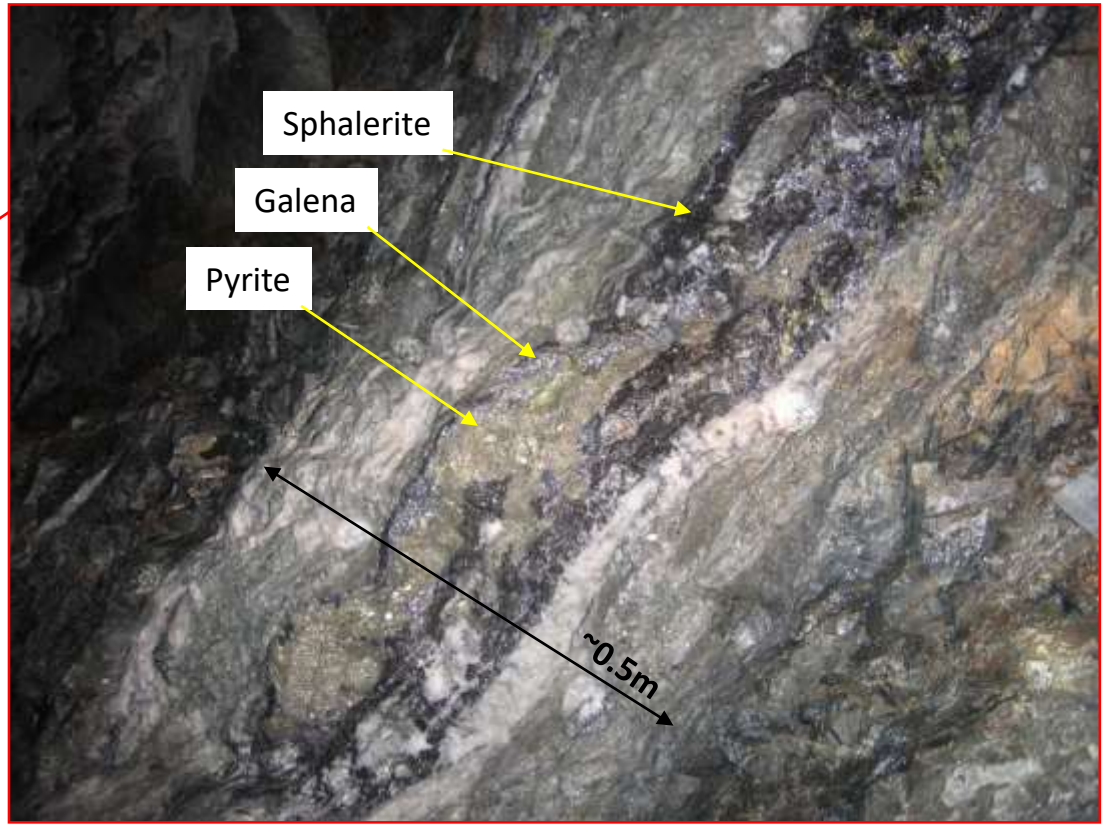
Gold is found in fractures displaying very small amounts of crustal displacement. This is unlike shear-hosted gold deposits of Africa and Western Australia which are associated with large, crustal scale shears and secondary faults.



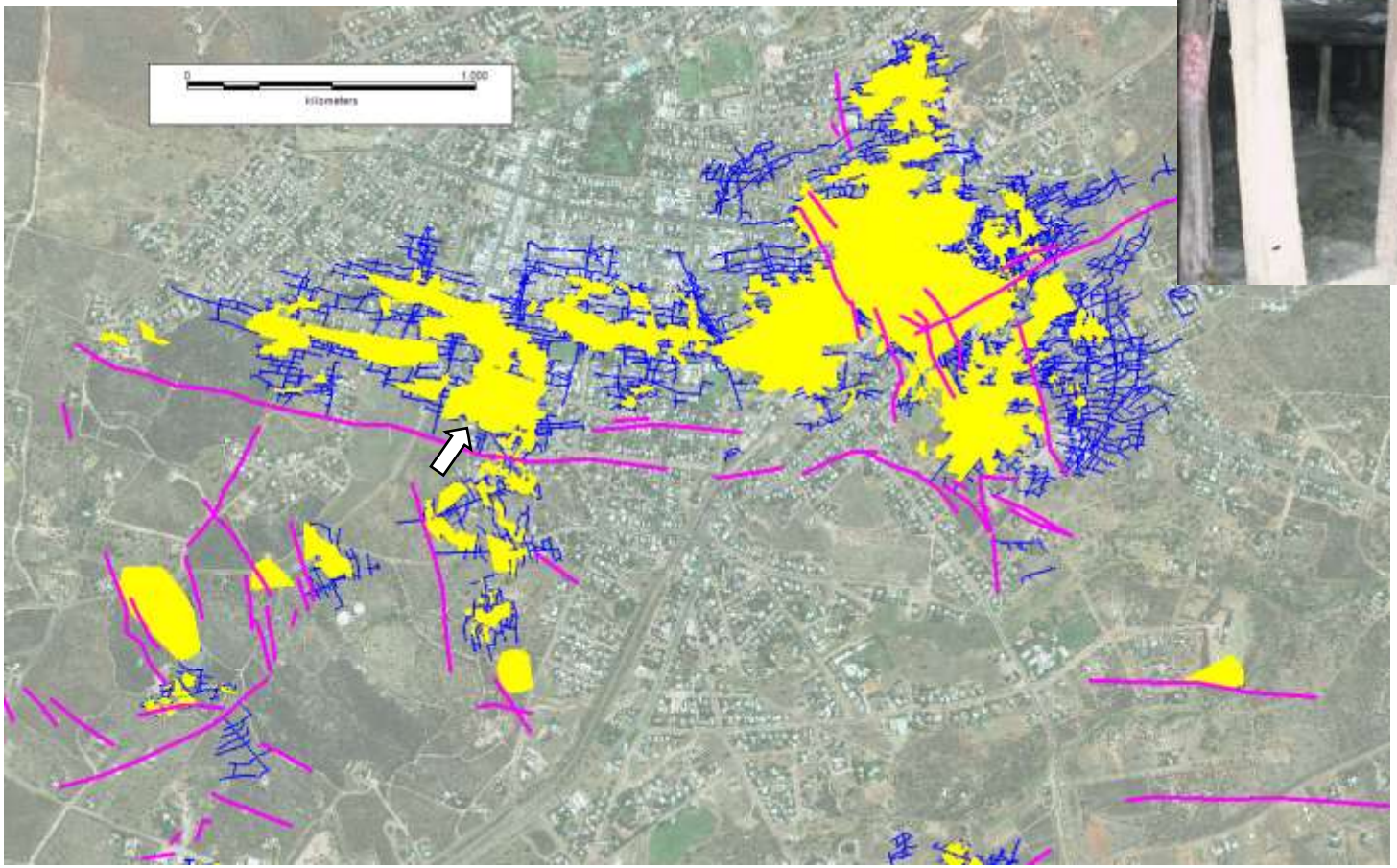
Fractures in the Charters Towers area (Based on data from Reid 1917)

Most veins in the "Central" area are not exposed at the surface


Altered host rocks
Altered host rocks


Sphalerite
Galena
Pyrite
~0.5m

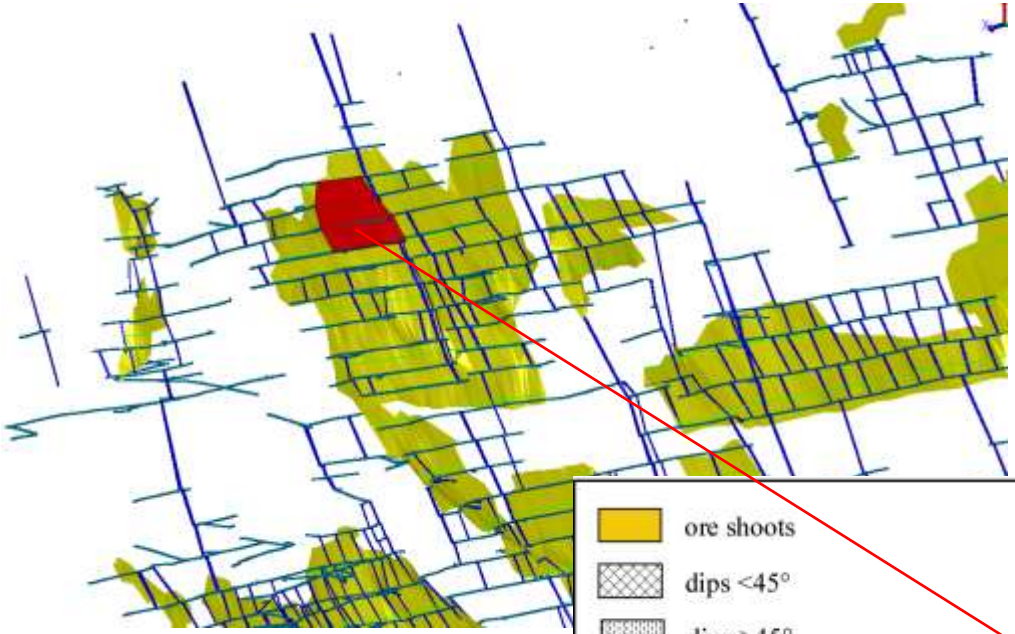
Mineralisation occurs as discontinuous pods or lenses within fractures.



Surface expression of fractures

Development (drives, underlies etc)

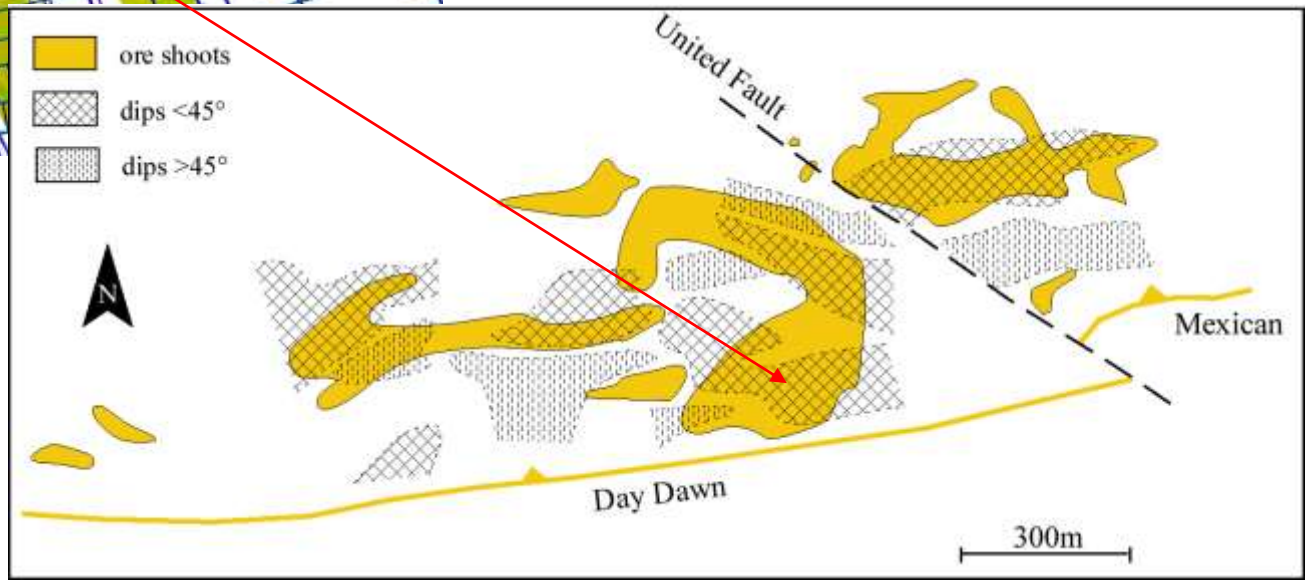
Stopes (Pre 1918)



Thick, high-grade "POD" of mineralisation on the Mills Day Dawn.

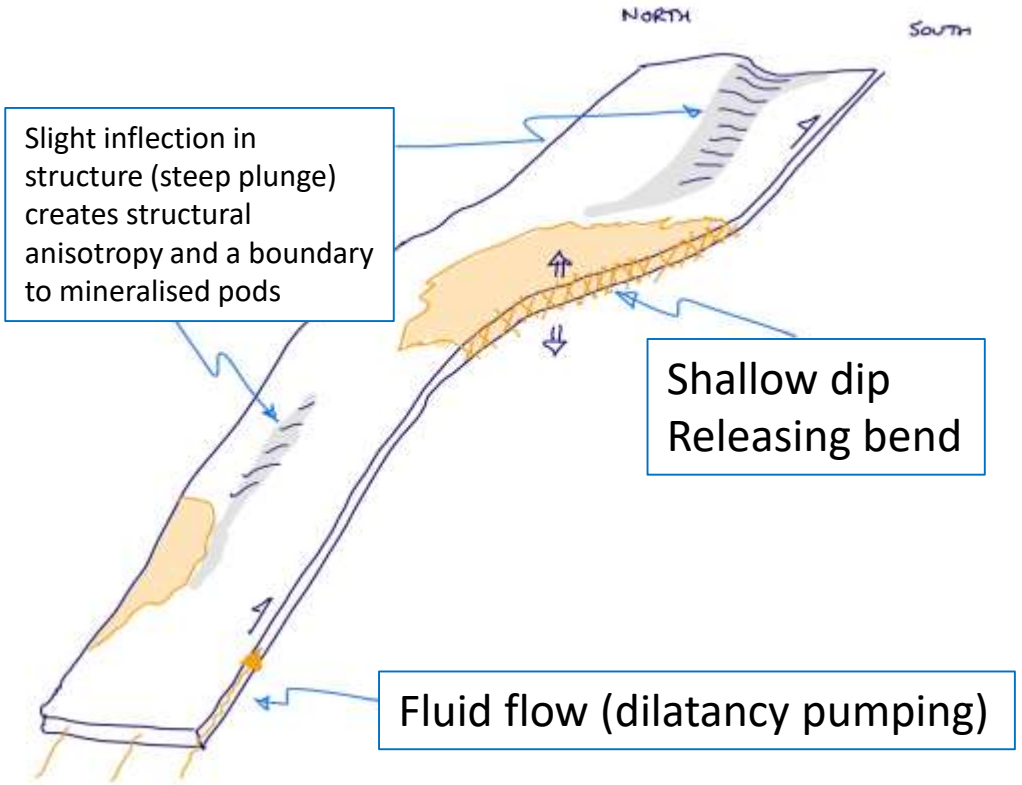
- "50 foot" thick ore body on No 6 Level
- Only 20m down-dip extent before narrowing to 10 ft.

Modified after Peters (1990)



Brilliant extended (2200ft level)

Easy targeting technique – look for structural inflections?



Defining structural inflections requires a large amount of precise, structurally-oriented diamond drilling

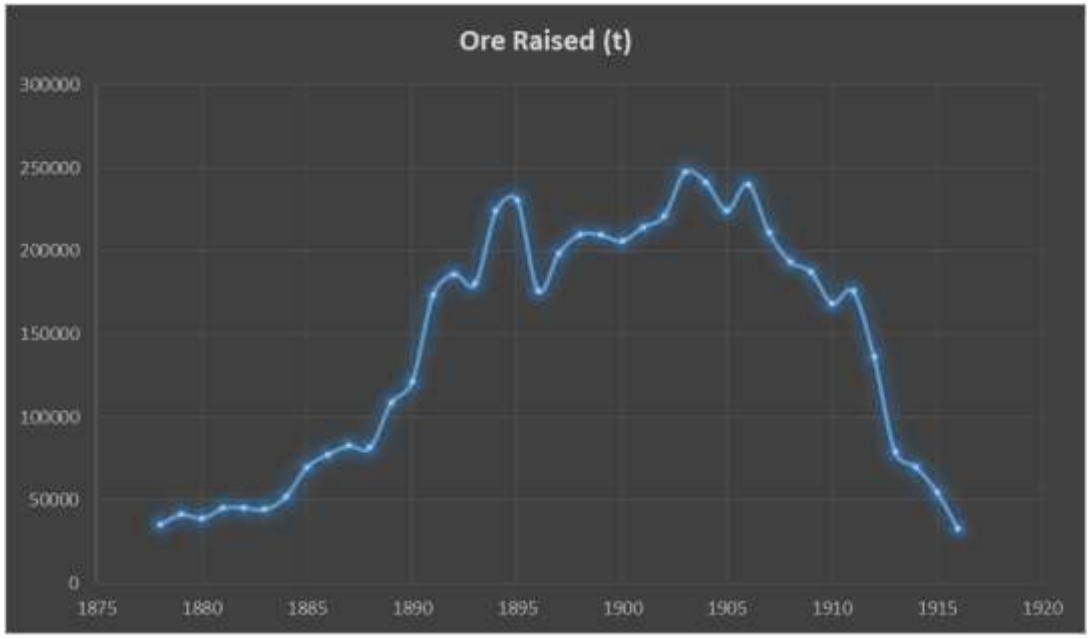
2) A review of historical mining at Charters Towers?

Learning from the past to better plan for the future

Why did large-scale mining and discovery come to an end in Charters Towers?

- Field operated from ca. 1871 – 1916 with very little production since this time.

- Citigold has been the main producer from Charters Towers since 1916. Over the ca. 15 years of operation has produced 100,000 ounces with 57,000 ounces of production from the Warrior mine since ca. 2005.

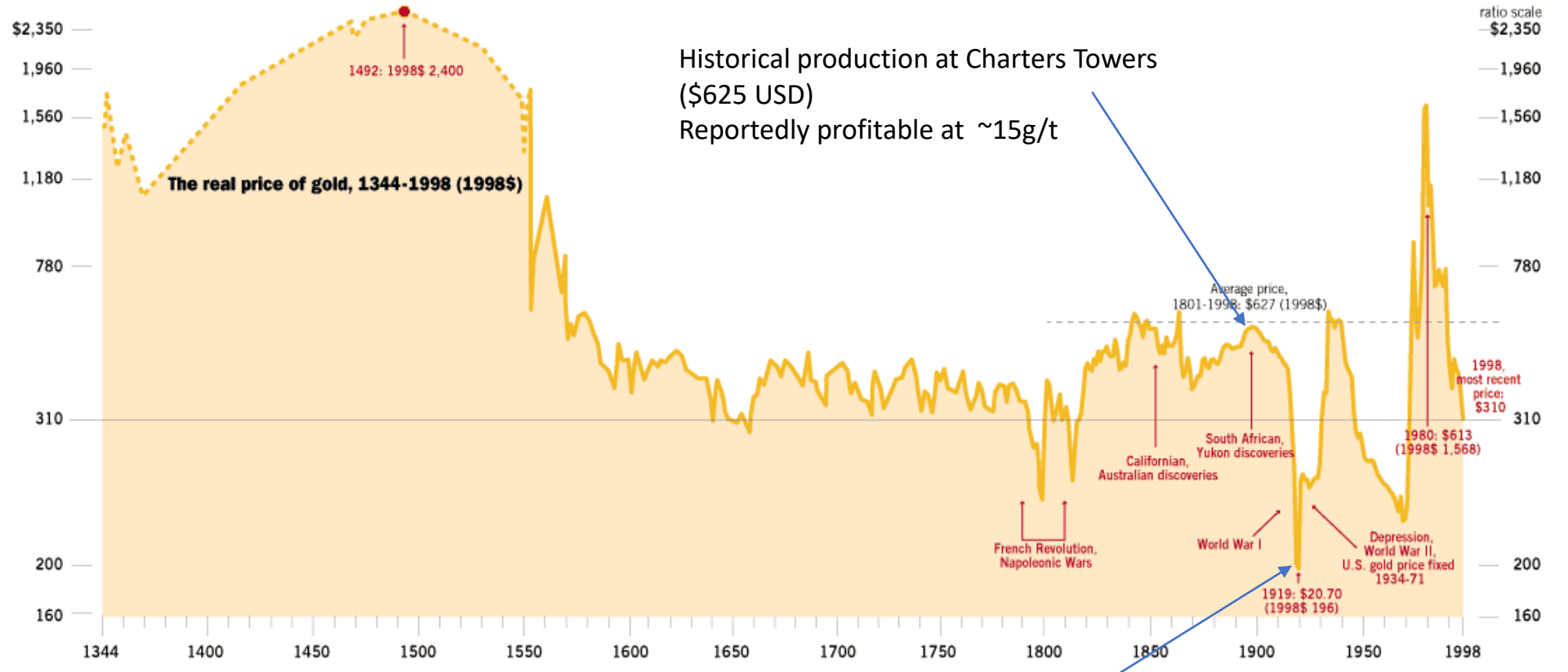


Loss of production after ca.1910

Two main causes?

1) Decreasing grade (?)
2) Decreasing discovery (?)

Price of Gold a major contribution

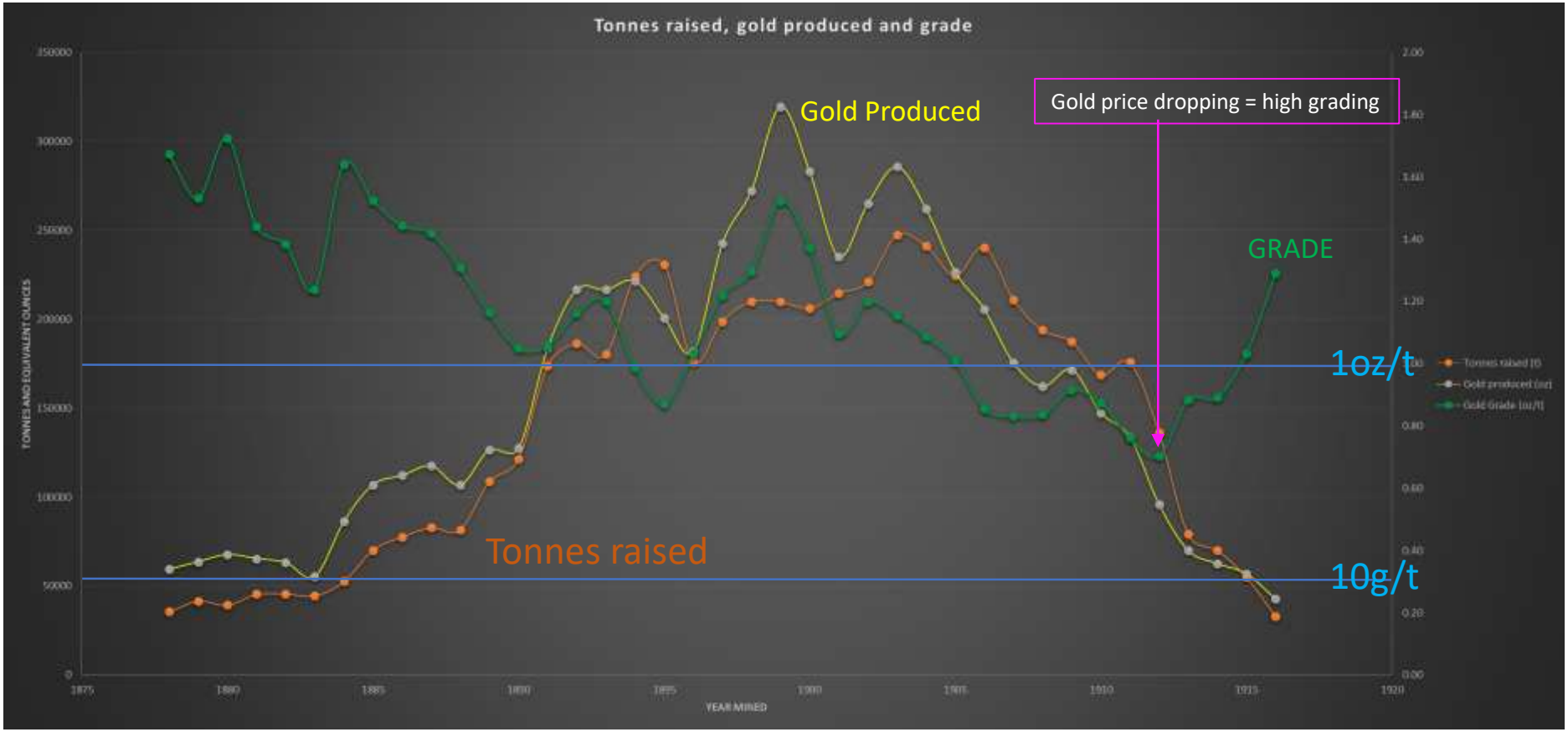


Historical production at Charters Towers
($625 USD)
Reportedly profitable at ~15g/t

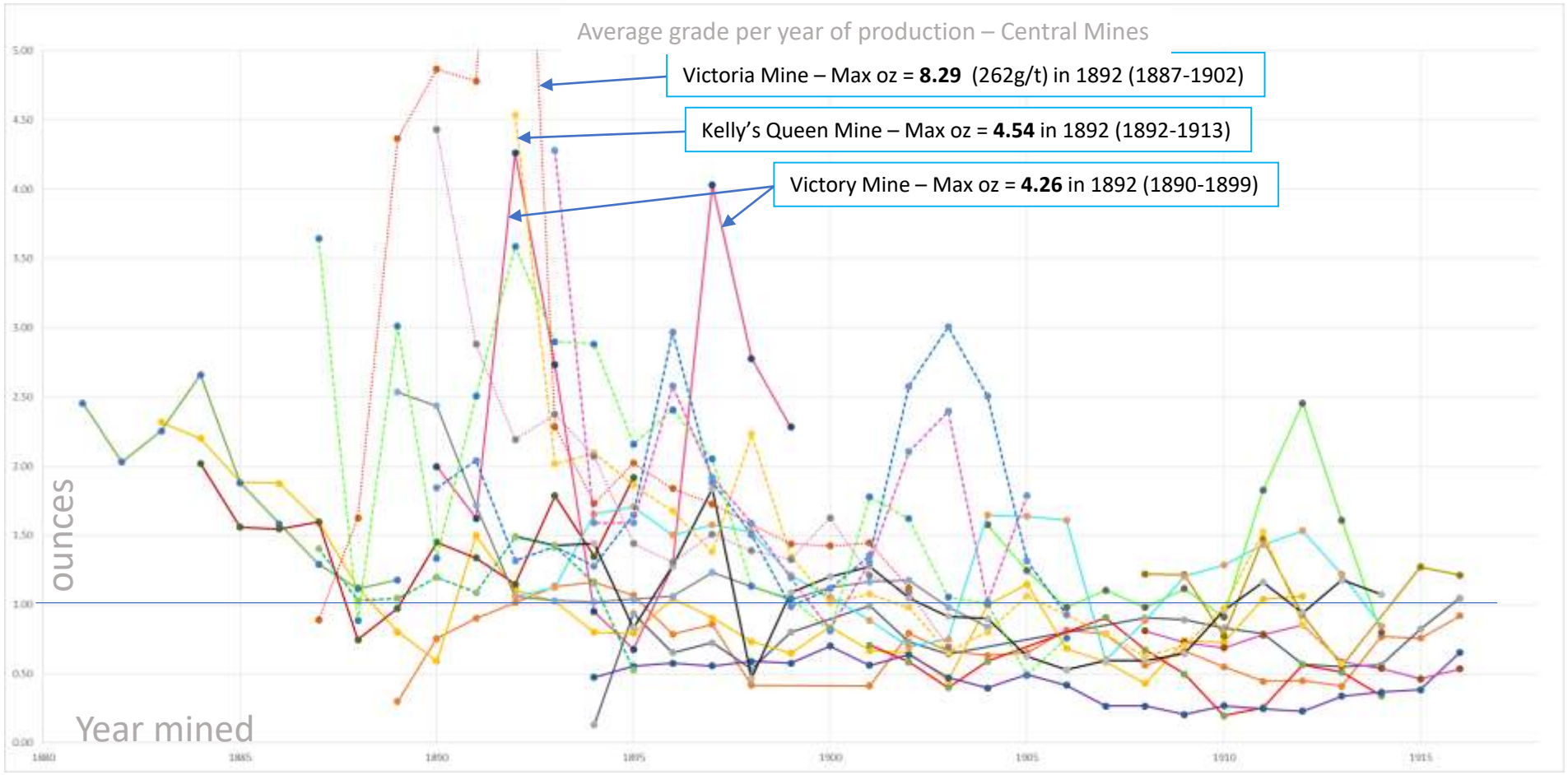
Most CT projects came to an end
Equiv to $196 USD in 1998
In order to be profitable, mining must be over 45g/t

Gold production versus Grade – 1871-1917 (data from J.Reid 1917)

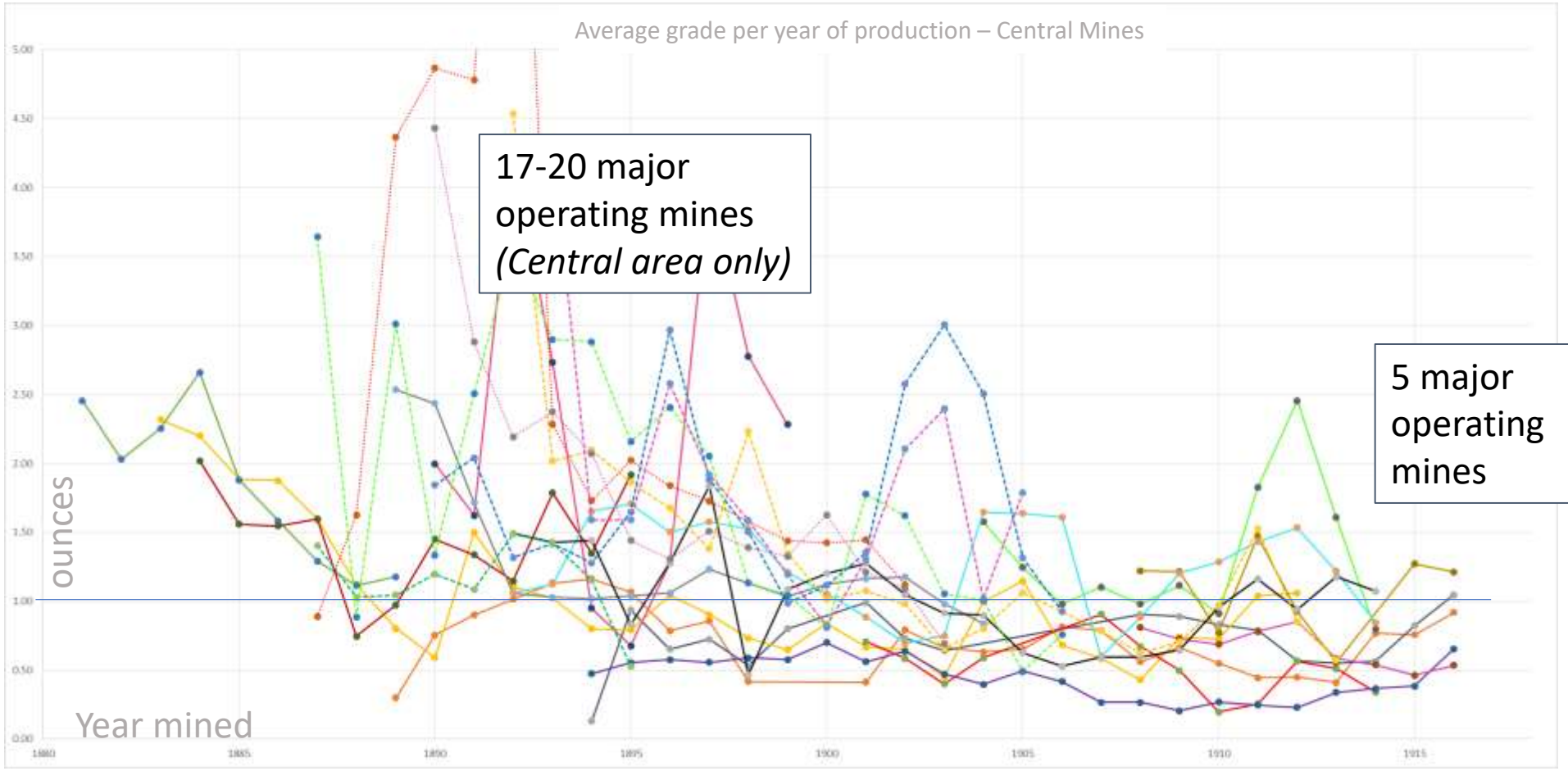
All mines CT



Performance of individual mines – central area only



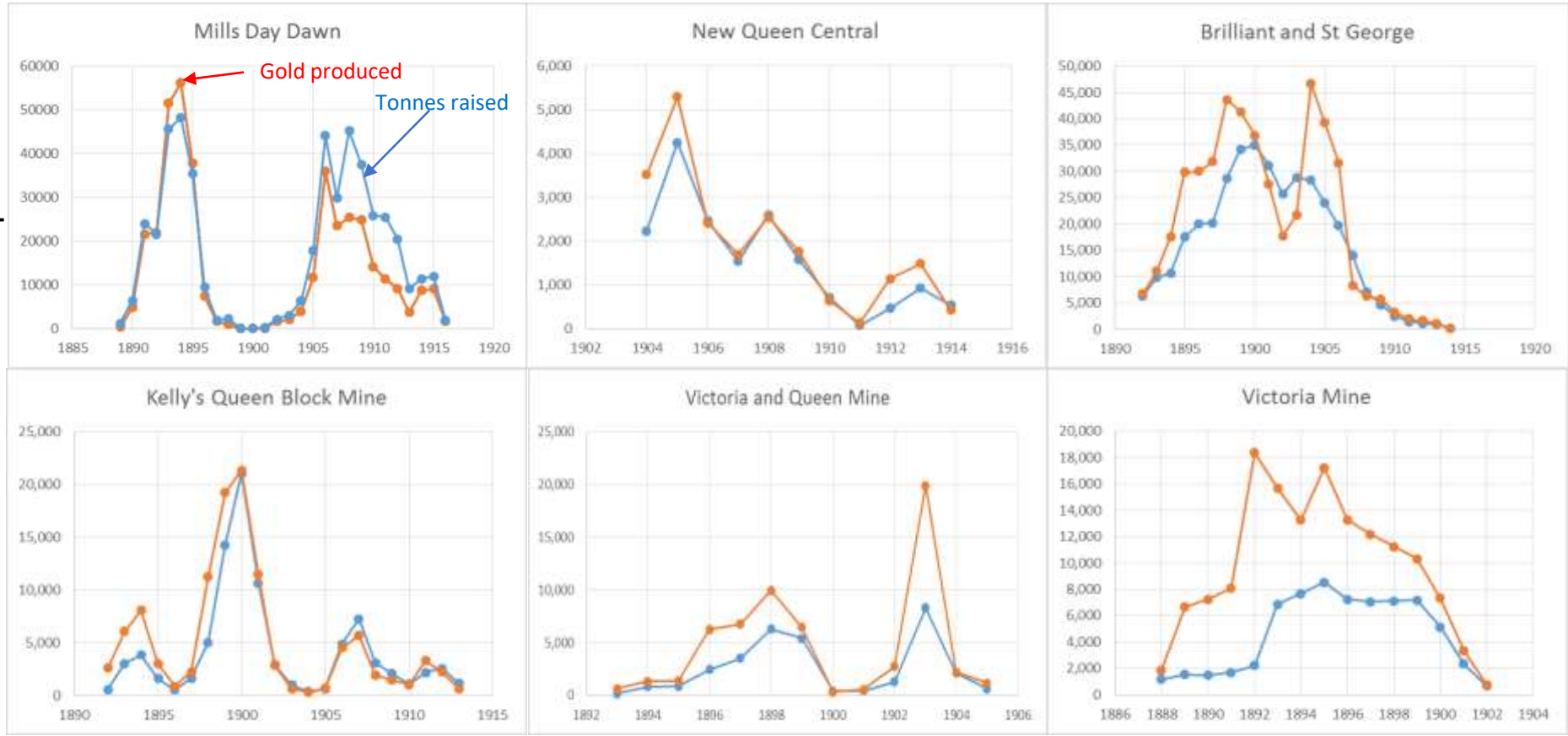
Performance of individual mines

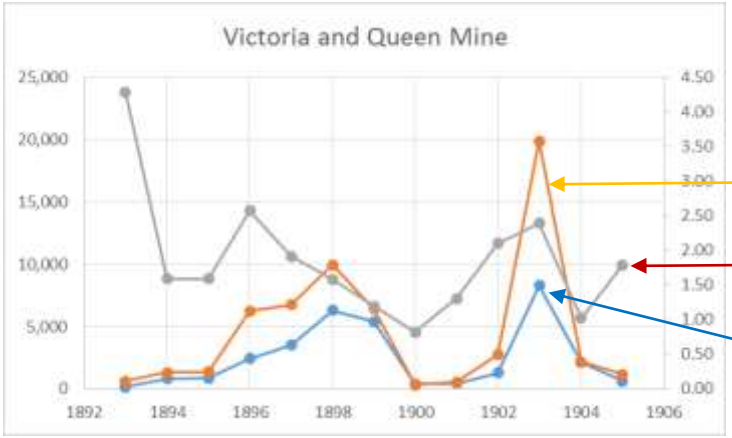


Production from an exploration perspective – why was production so variable?

Production tonnes and ounces reflect variability in the nature of the ore zones / ore shoots!

Tonnes raised and ounces produced





Tonnes

Grade

Gold produced

Grade

Variability in the tonnes raised reflects the "Poddy" nature of the deposit.

AVERAGE tonnes produced from each cycle based on data from 25 mines is 108,000t.

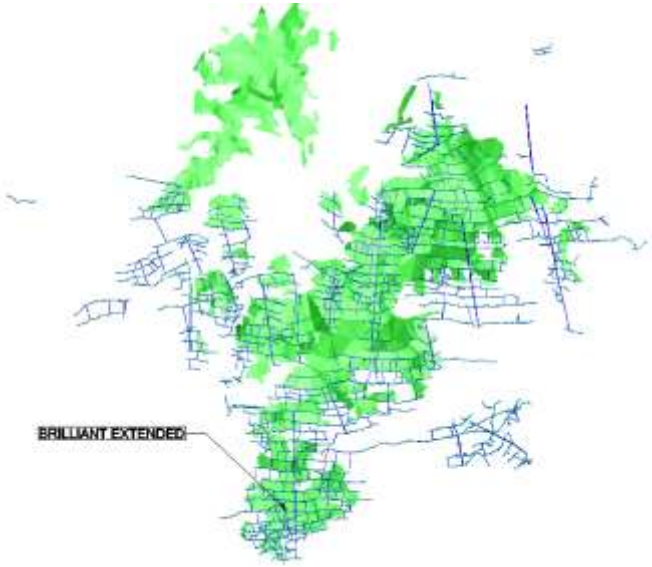
Exploration strategy is for 100,000t *and*, production should be expecting numerous pods at around 100,000t.

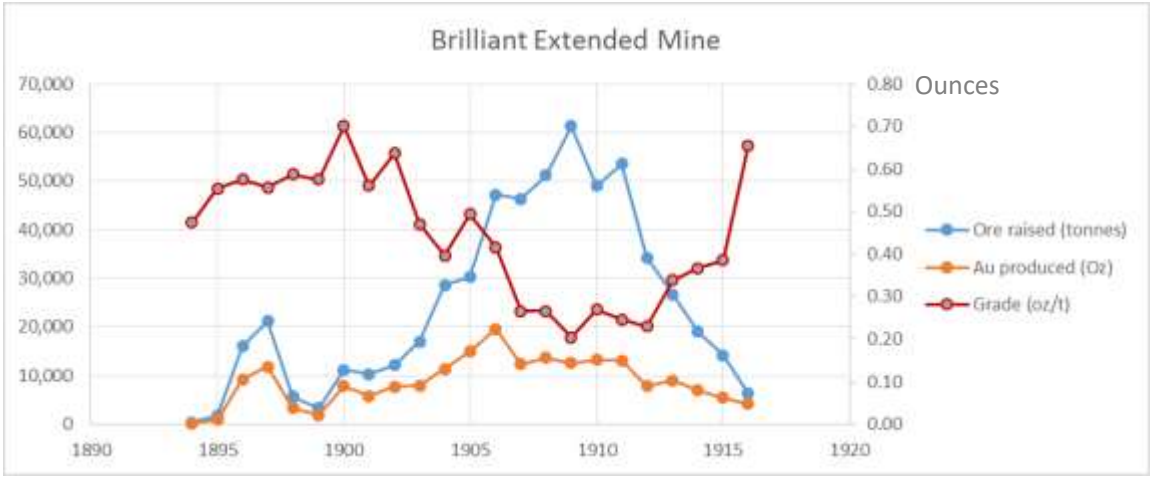
Another Cause? Decreasing gold with depth

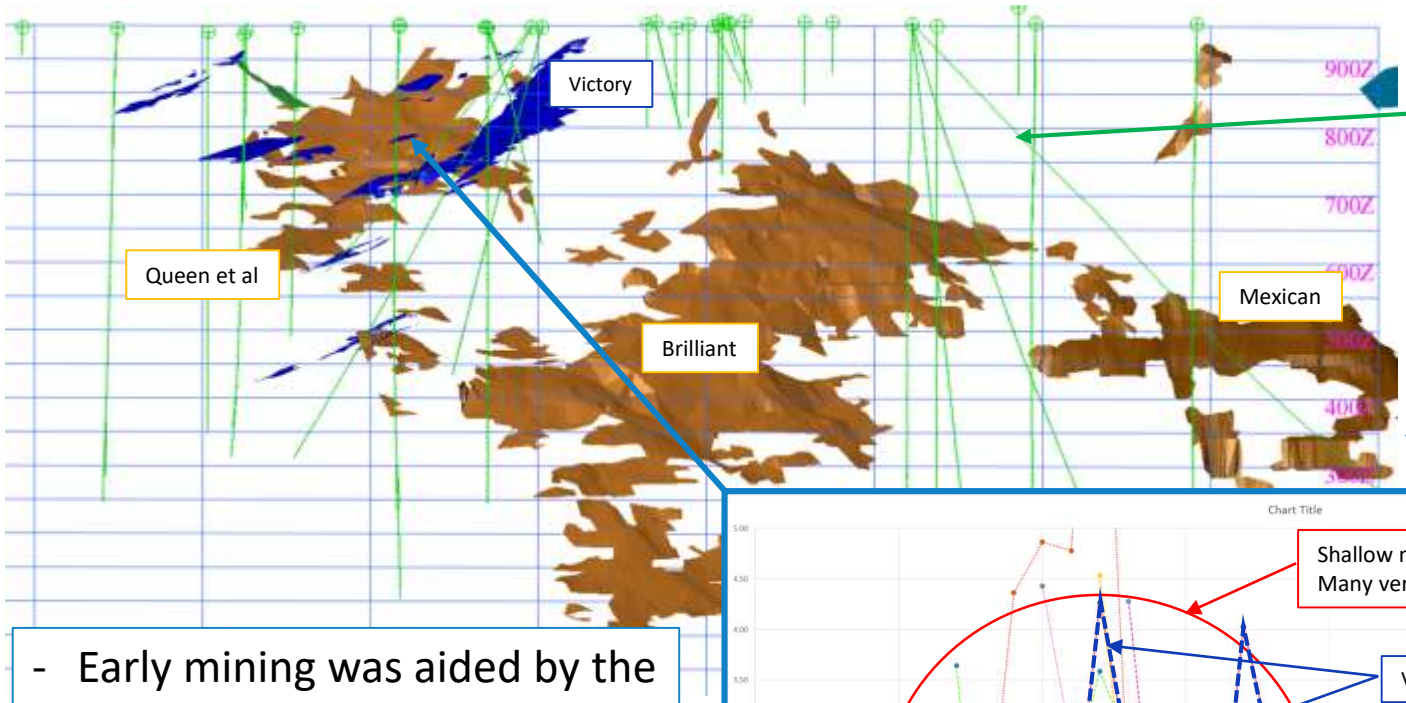
Reports of decreasing gold grade with depth are (somewhat) unsubstantiated, however, the Brilliant extended mine produced gold at grades of less than 10 g/t and with an average grade of approximately 13.5 g/t Au.

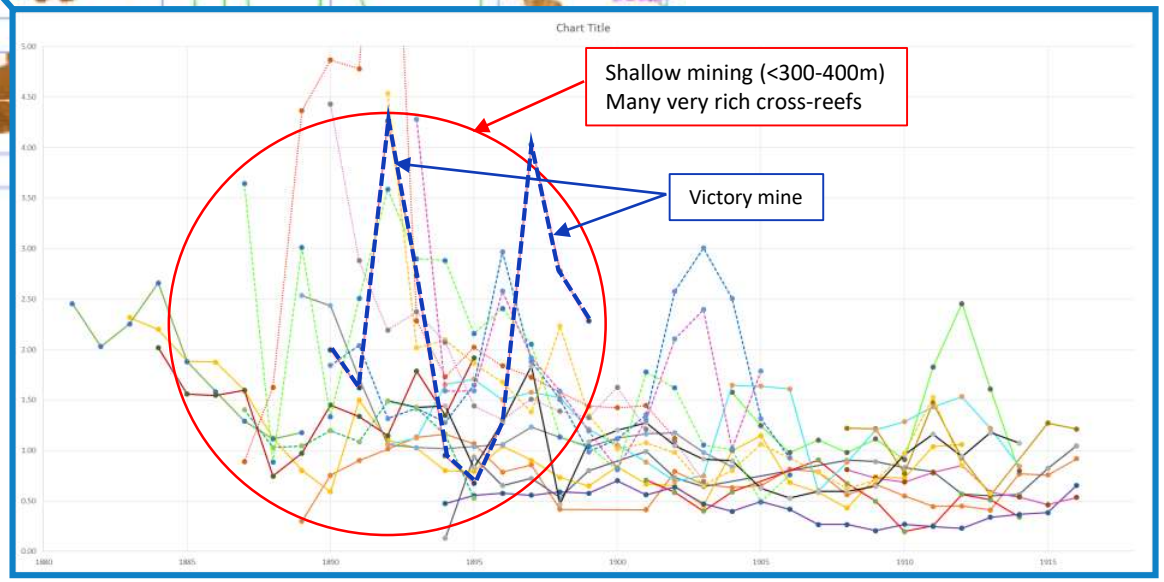
Gold production was buffered by the high tonnes of production.

Both Reid (1917) and Connolly (1935) show average grades diminishing to 17g/t gold with a m.g/t estimate of 12.8 at 900m depth.









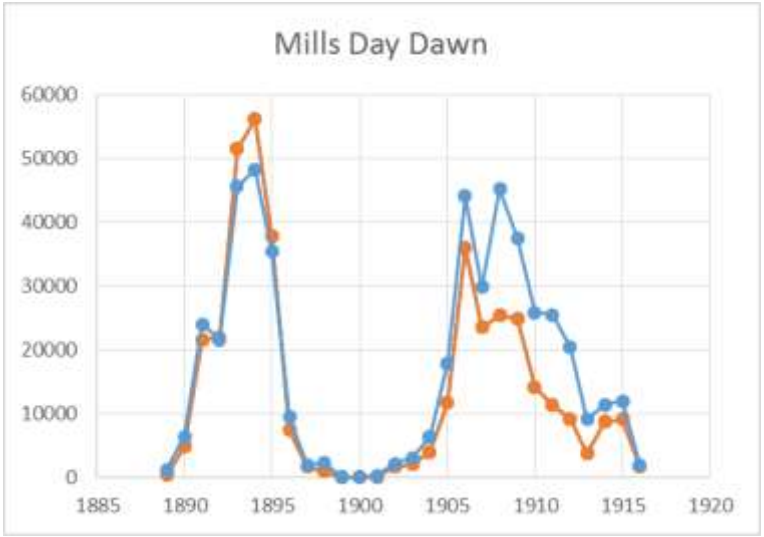
- Early mining was aided by the presence of many shallow cross-reefs
- Below ~500m, these cross reefs are not as common (?)
- Lack of drilling/exploration therefore cannot be confirmed

Why Stop Mining ?

Mining ceased not because of a lack of mineralisation, but due to a combination of factors:

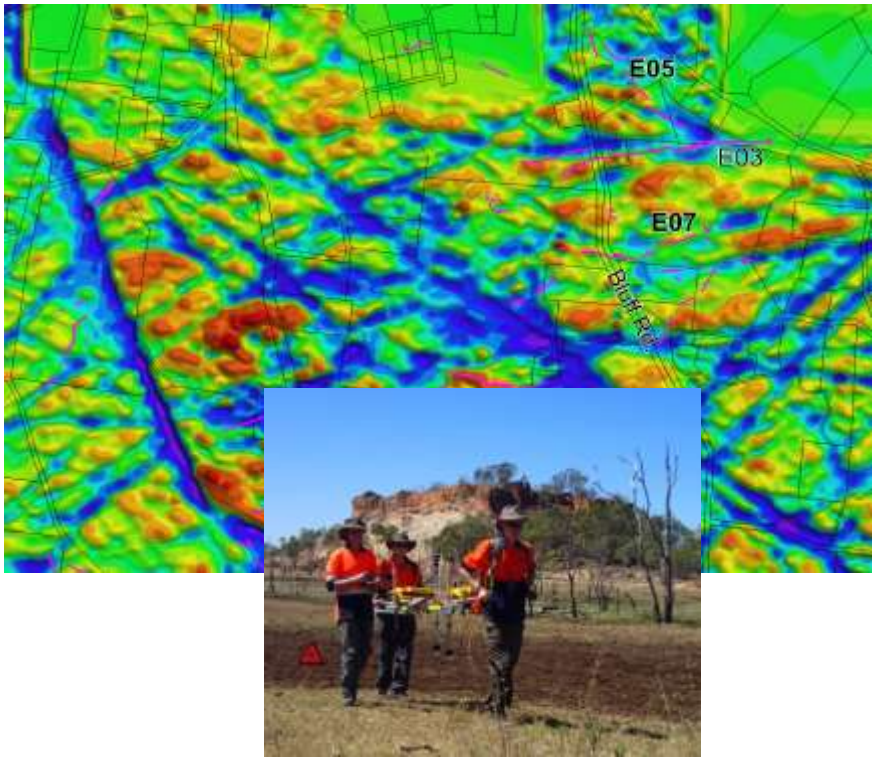
1) Decreasing gold price
2) Poor ventilation,
3) High monetary inflation,
4) Increased wages that doubled in 1914,
5) Commandeering of coal stockpiles by the Navy for the First World War,
6) Inability to raise funds for gold mining pre- and during wartime,
7) Lack of retained capital due to a policy of paying high monthly dividends from profits and
8) Accumulated water inflow as high-cost mines closed and their water load passed to remaining operating mines. At the end of the goldfield life, mines were hoisting five tons of water by bailing for each ton of ore.

Ultimately, it was the style of Charters Towers Mineralisation, combined with other factors that led to the termination of Mining in Charters Towers



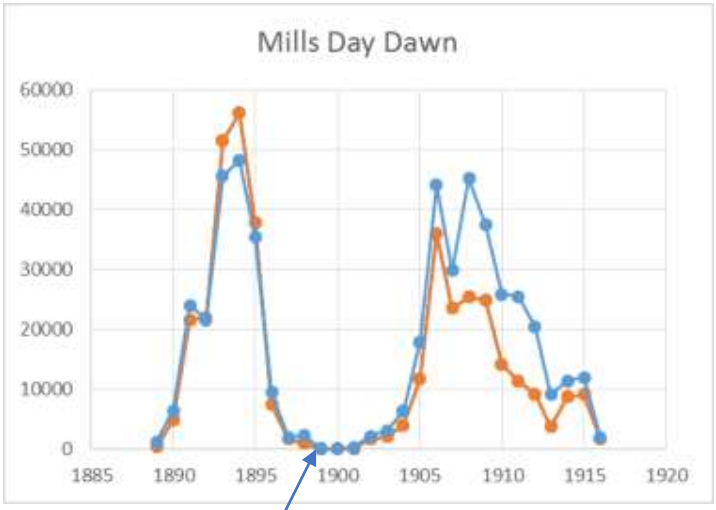
3) “Recent” exploration and the attempt to uncover hidden reserves

Learning from the (recent) past to better plan for the future

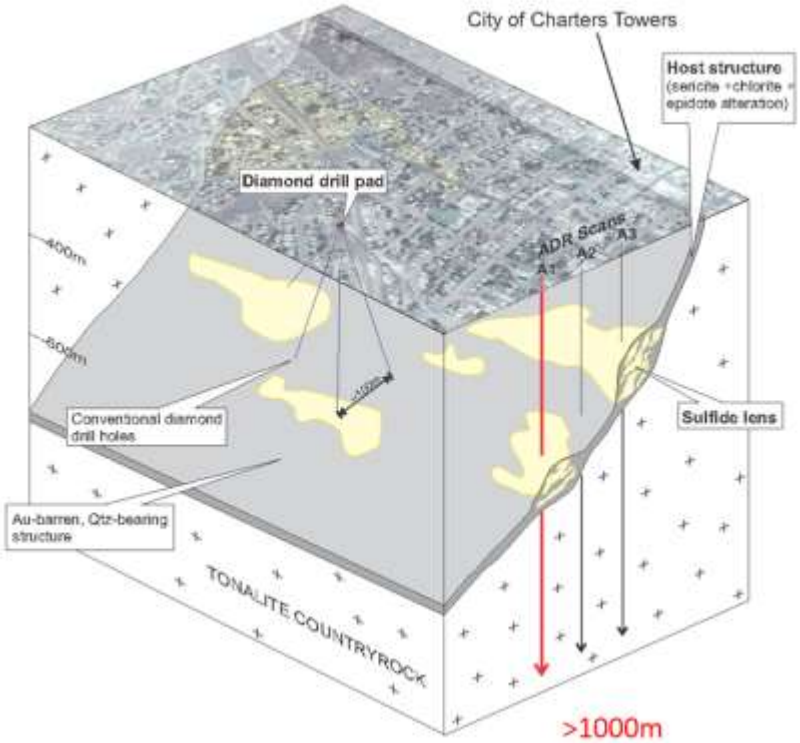


Smart exploration and “pod” definition

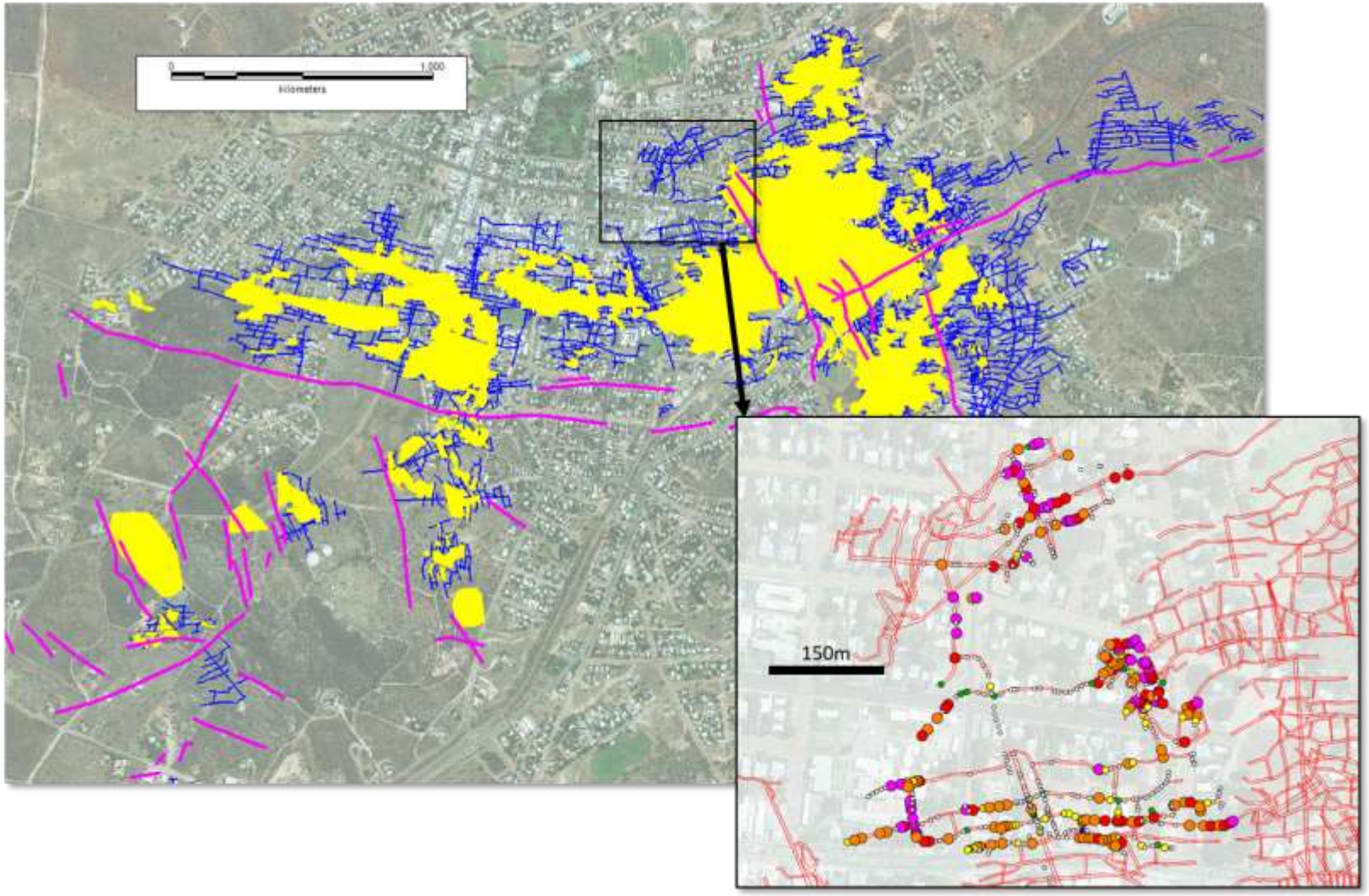
The need to quickly define pods of mineralisation

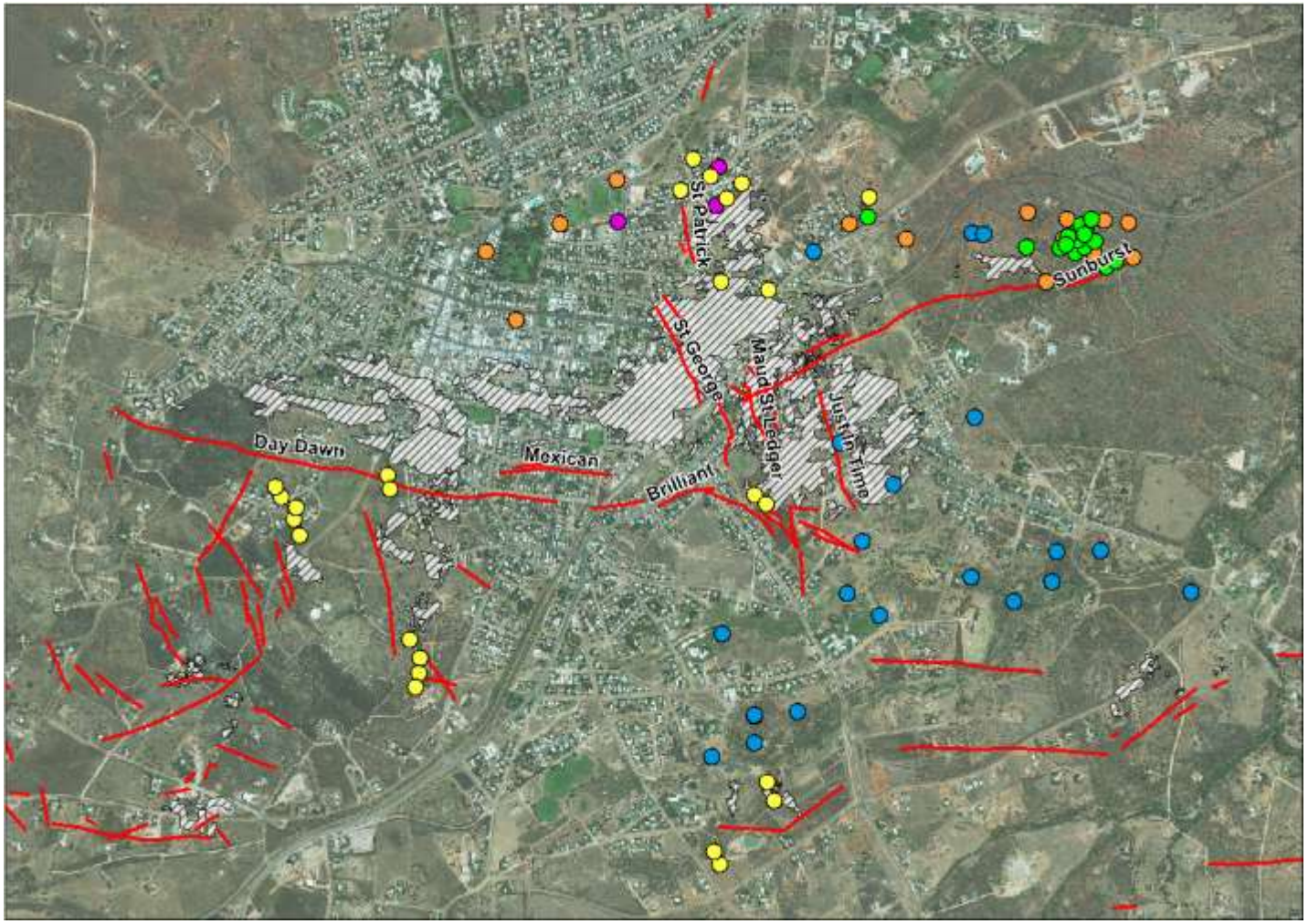


Minimise “delay” by having a pipeline of well-defined pods of mineralisation.



Drilling ineffective, costly, time consuming and “Hit & Miss”


0
1,000
kilometers
150m



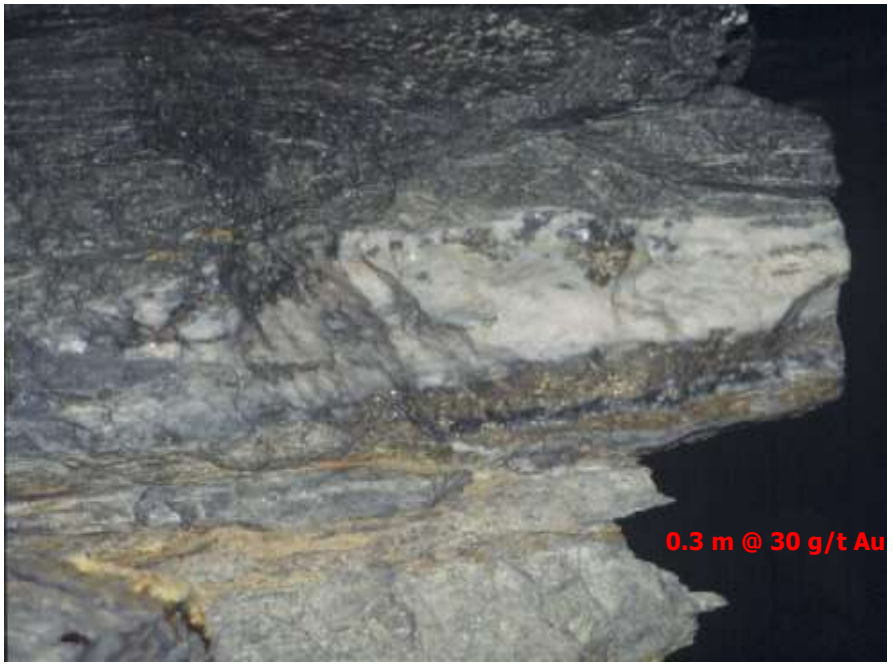
SPARSE DRILLING*

Probability of missing any significant lode is high BUT, some high grade results were obtained in drill core including 15cm @ 858 grams Au in diamond hole DD93QF5.

* each point on the map is 40m diameter!

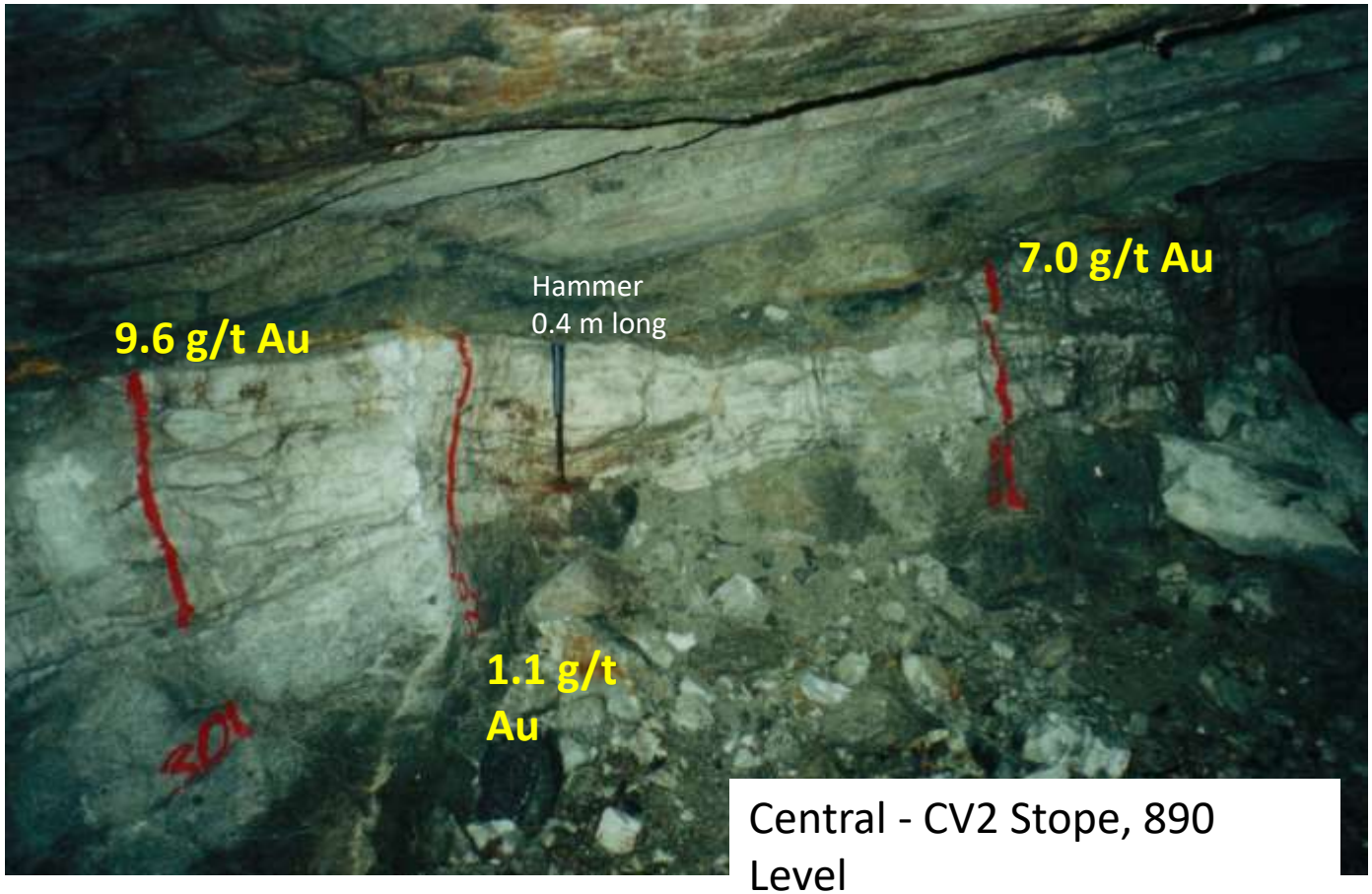
Variability in grade on a small scale

Charters Towers auriferous reef, C15 (CV2) stopes:
Low grade section.



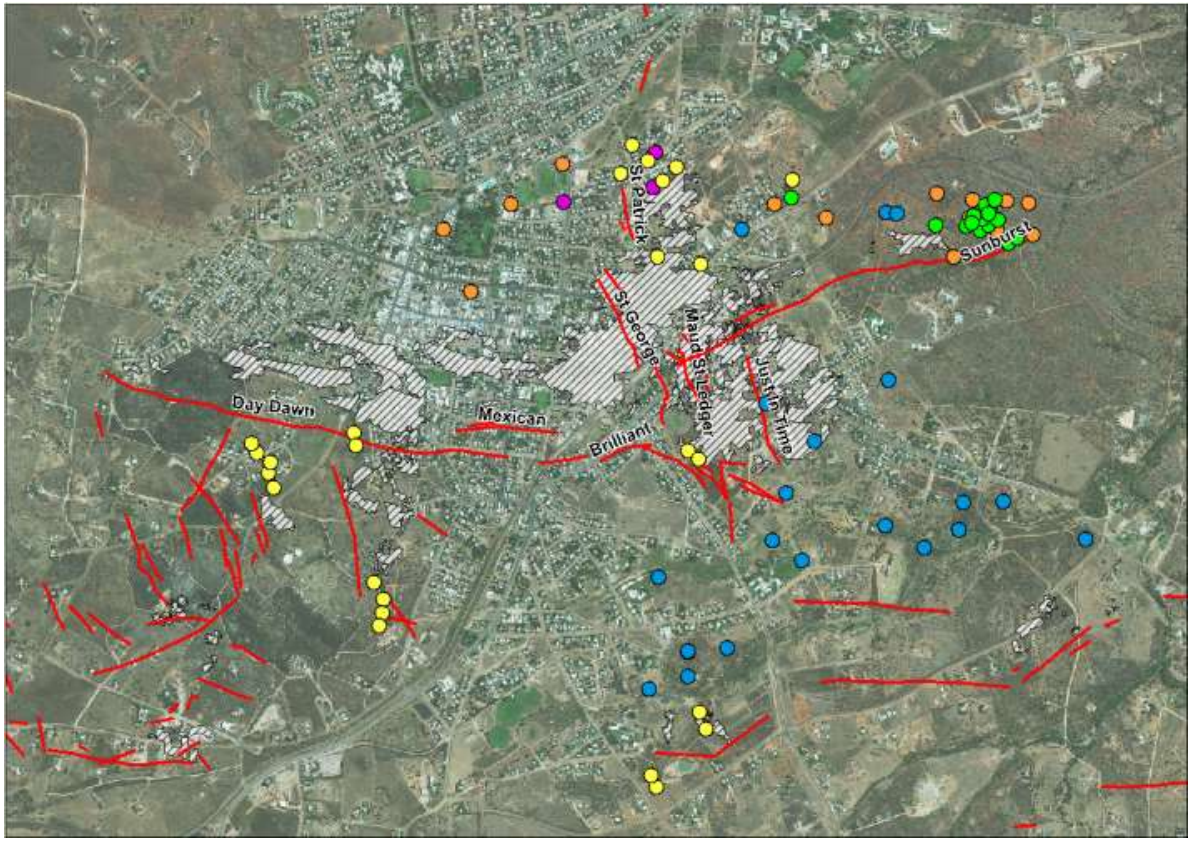
Charters Towers auriferous reef, C15 (CV2) stopes

Drilling is extremely hit and miss historical data does show, however, that persistence is key



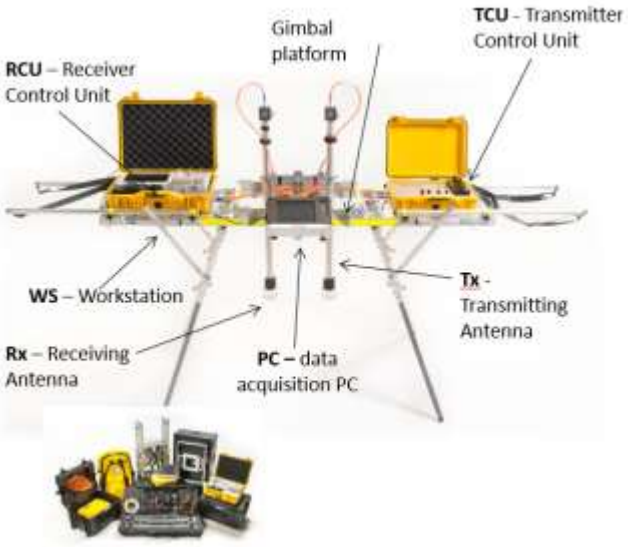
Central - CV2 Stope, 890 Level

Lack of knowledge about the deposit meant that modern exploration companies failed to discover hidden wealth



Historical (pre-Citigold) drilling at Charters Towers

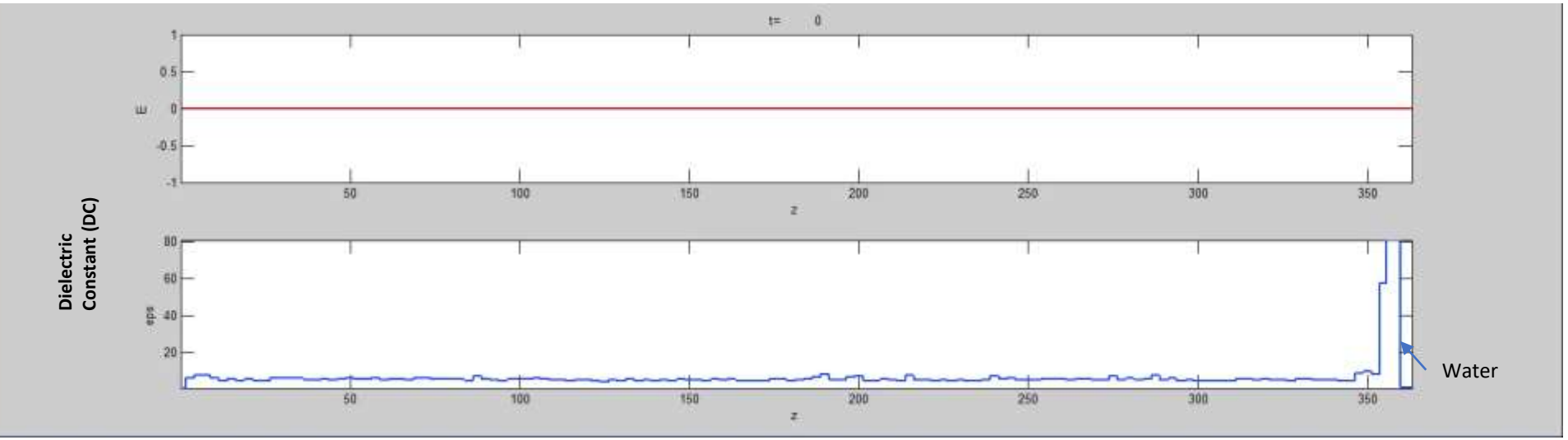
- Scattered
- Misinformed
- Did not understand deposit style
- No historical drilling to manage statistically
- Limited funding/cost of drilling
- Variable gold price

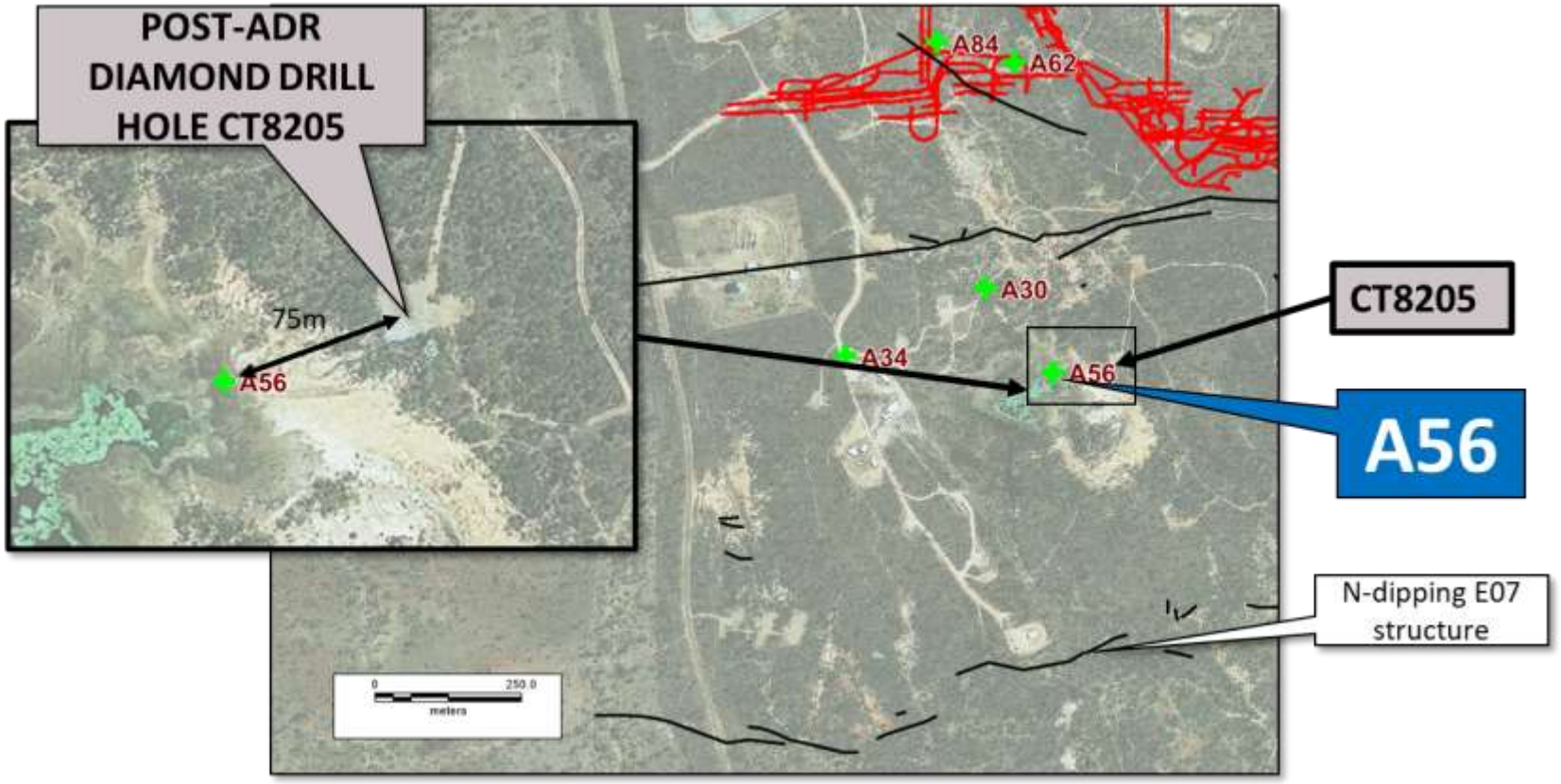


A smart approach to pinpointing mineralisation

- **ELECTRIC FIELD ANIMATED IN TOP GRAPH**
  - **WE OBSERVE PULSE TRAVELING DOWN (LEFT TO RIGHT)**
  - **SMALL IRREGULARITIES IN DC CAUSE BACKSCATTER**
  - **BIG REFLECTION AT JUMP IN DC - PROPAGATES BACK TO SURFACE**

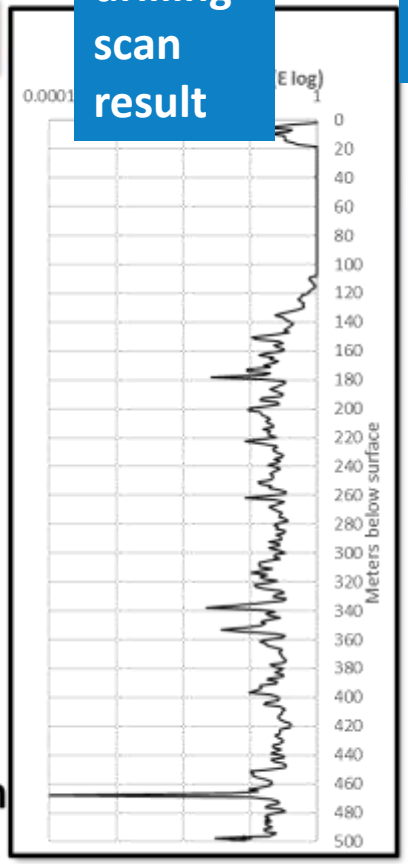
Lab measured DC of Charters Towers Rocks (CSIRO)
Granite av; 3 samples = 7.99 @ 1Mhz
Pyrite ore; 1sample = 73.63 @ 1Mhz




POST-ADR
DIAMOND DRILL
HOLE CT8205
75m
A56
A84
A62
A30
A34
A56
CT8205
A56
N-dipping E07
structure
0
250.0
meters

ADR A56

Pre-drilling scan result



-467.91m

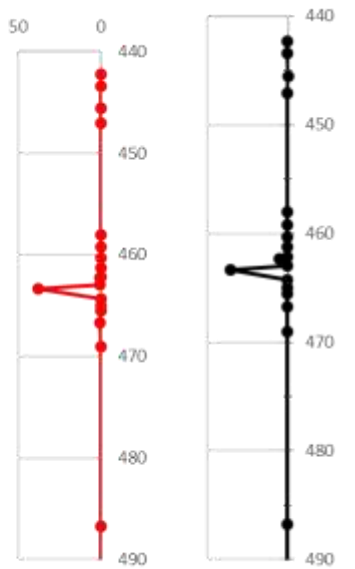
Anomaly testing drill core

Assay results

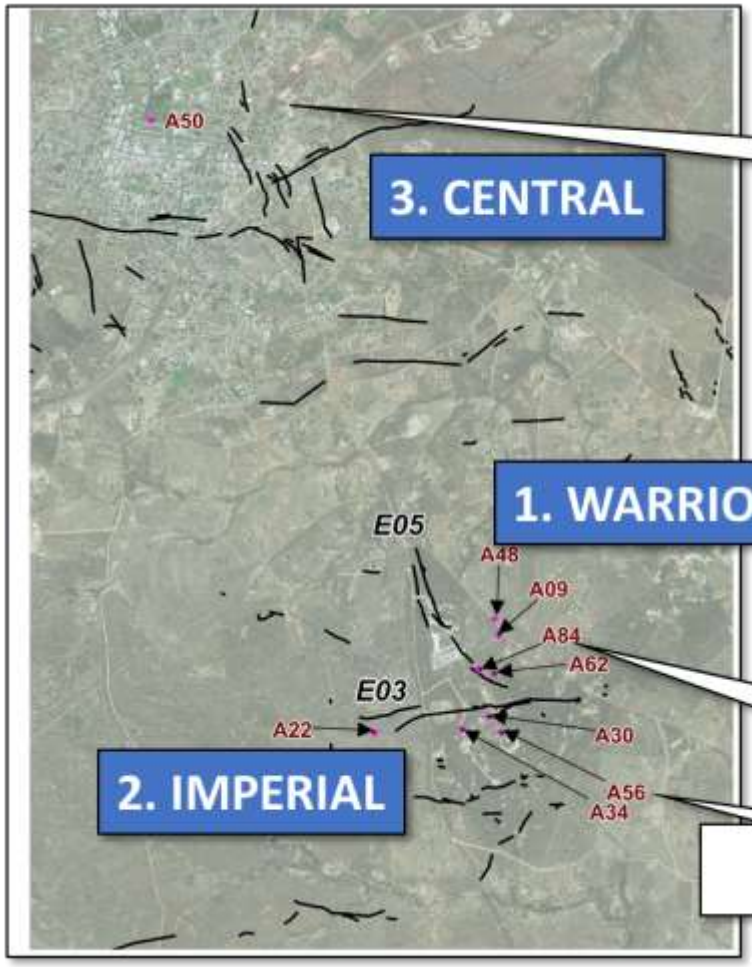
~40cm thick intercept at **-463m**

CT8205 assay results

37.9 g/t Au | **7200ppm Pb**



ADR Trial scans



A63 targeting C05 – Brilliant East

A84 and A62 targeting N-dipping **E03** structure

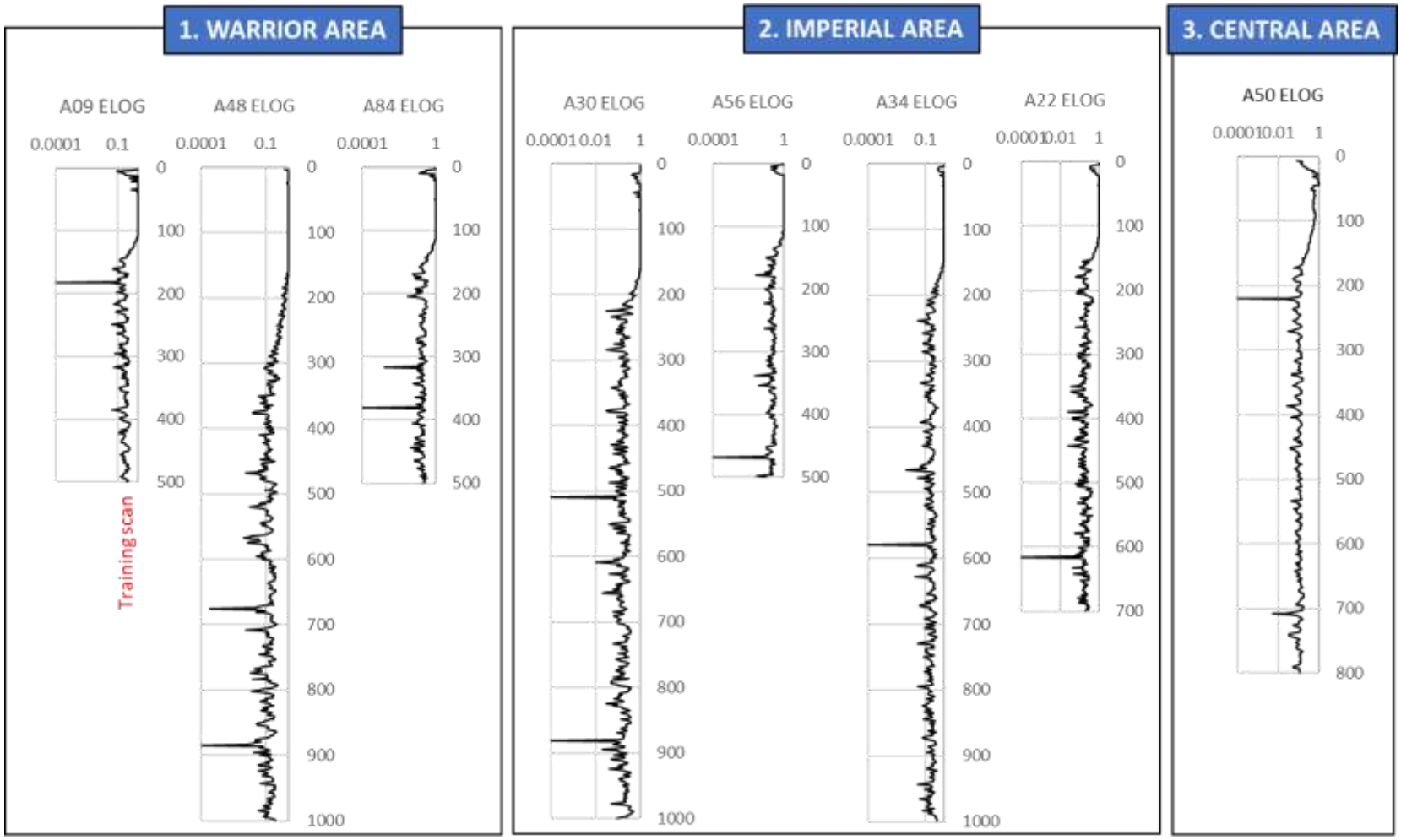
A30, **A56**, A34 and A22 targeting NE-dipping **E07** structure

ADR SCAN LOCATION SELECTION

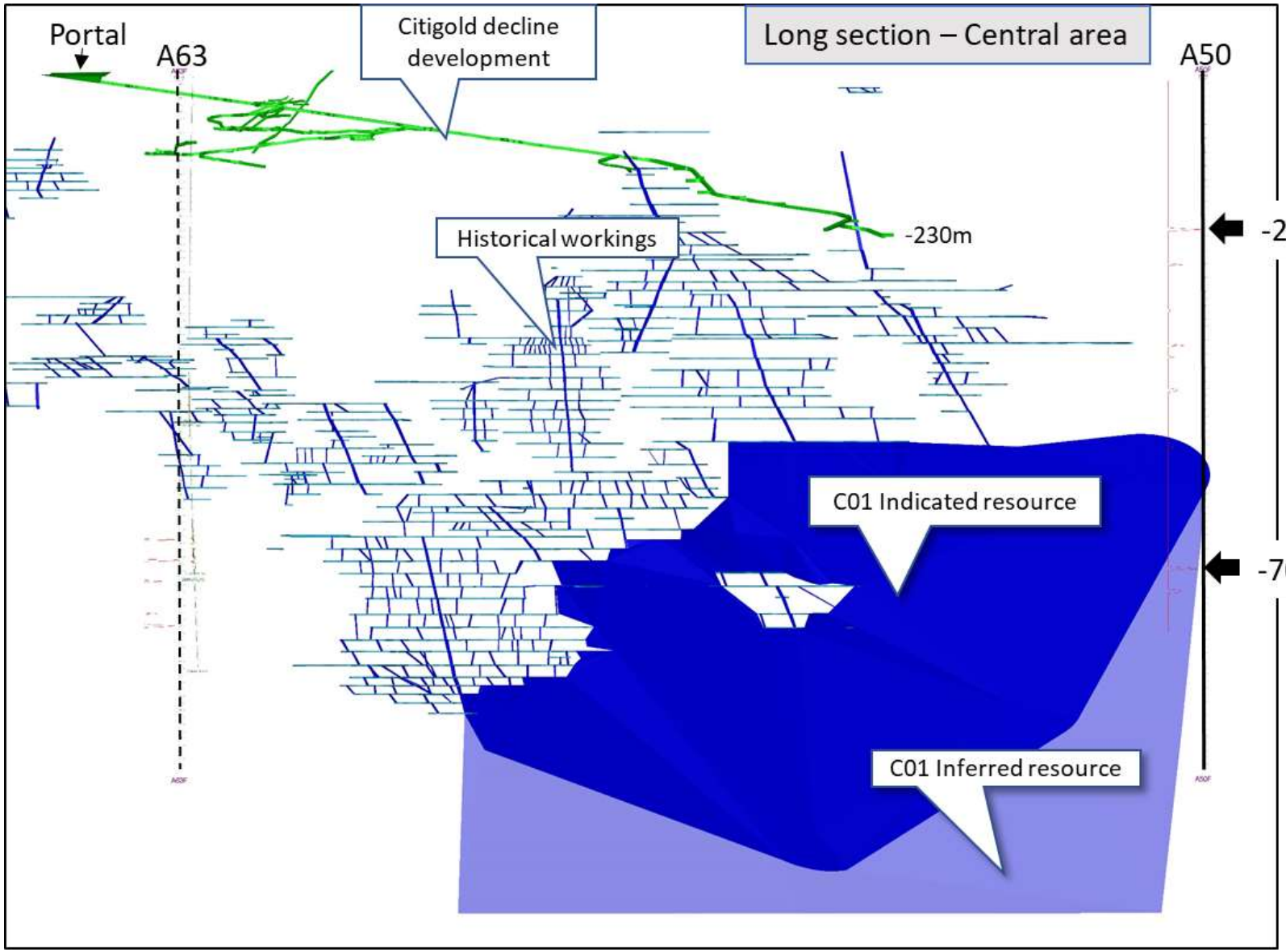
A84 – WARRIOR

A56 – IMPERIAL

A63 – CENTRAL

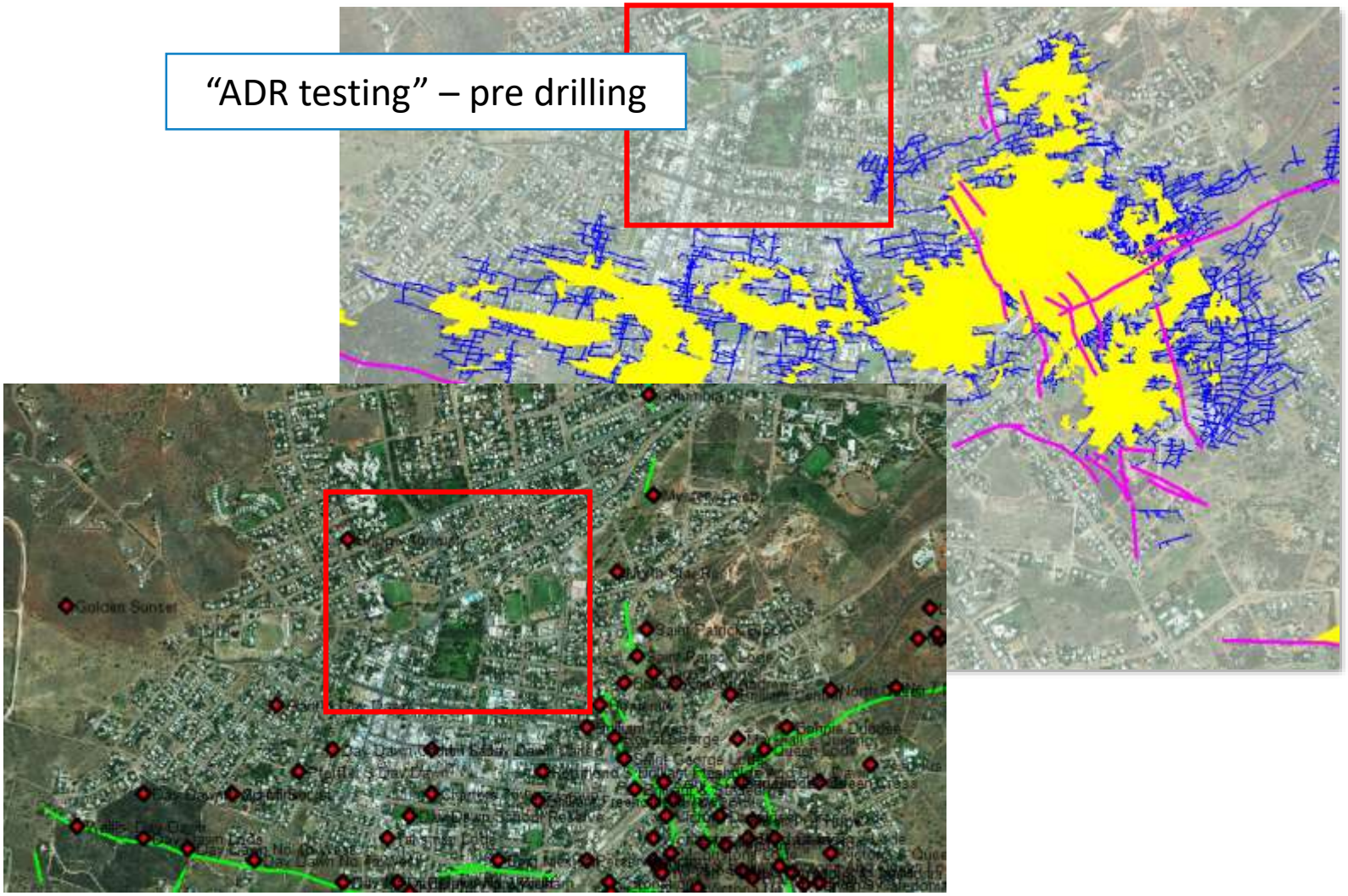

1. WARRIOR AREA
A09 ELOG
A48 ELOG
A84 ELOG
Training scan
2. IMPERIAL AREA
A30 ELOG
A56 ELOG
A34 ELOG
A22 ELOG
3. CENTRAL AREA
A50 ELOG

A realistic way to define resources for future drilling

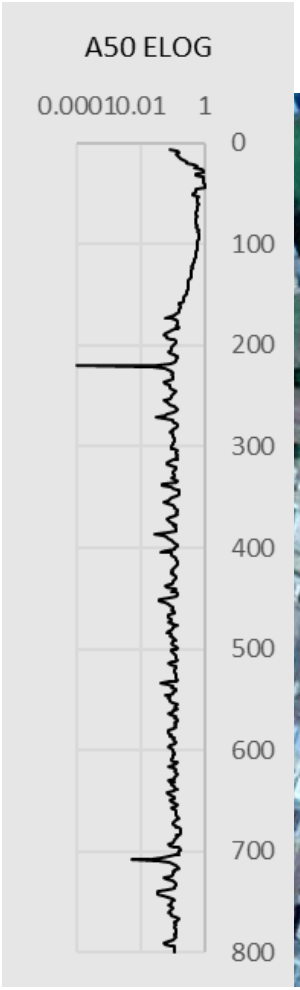


ADR SCAN ARRAY – an example

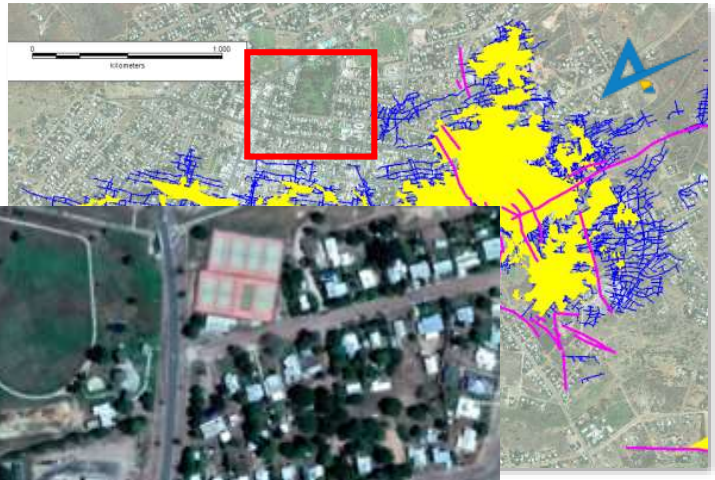
"ADR testing" – pre drilling



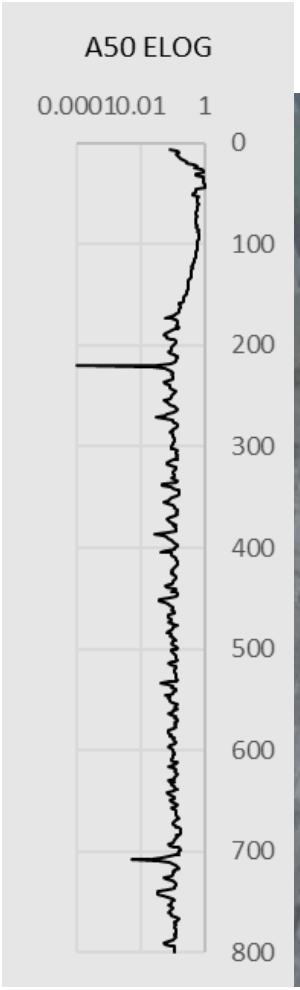
A50 results



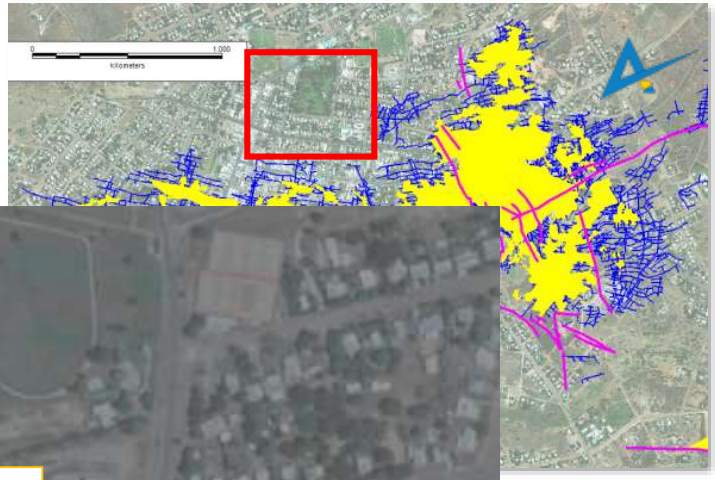
"ADR testing" – pre drilling
EXAMPLE GRID PLAN

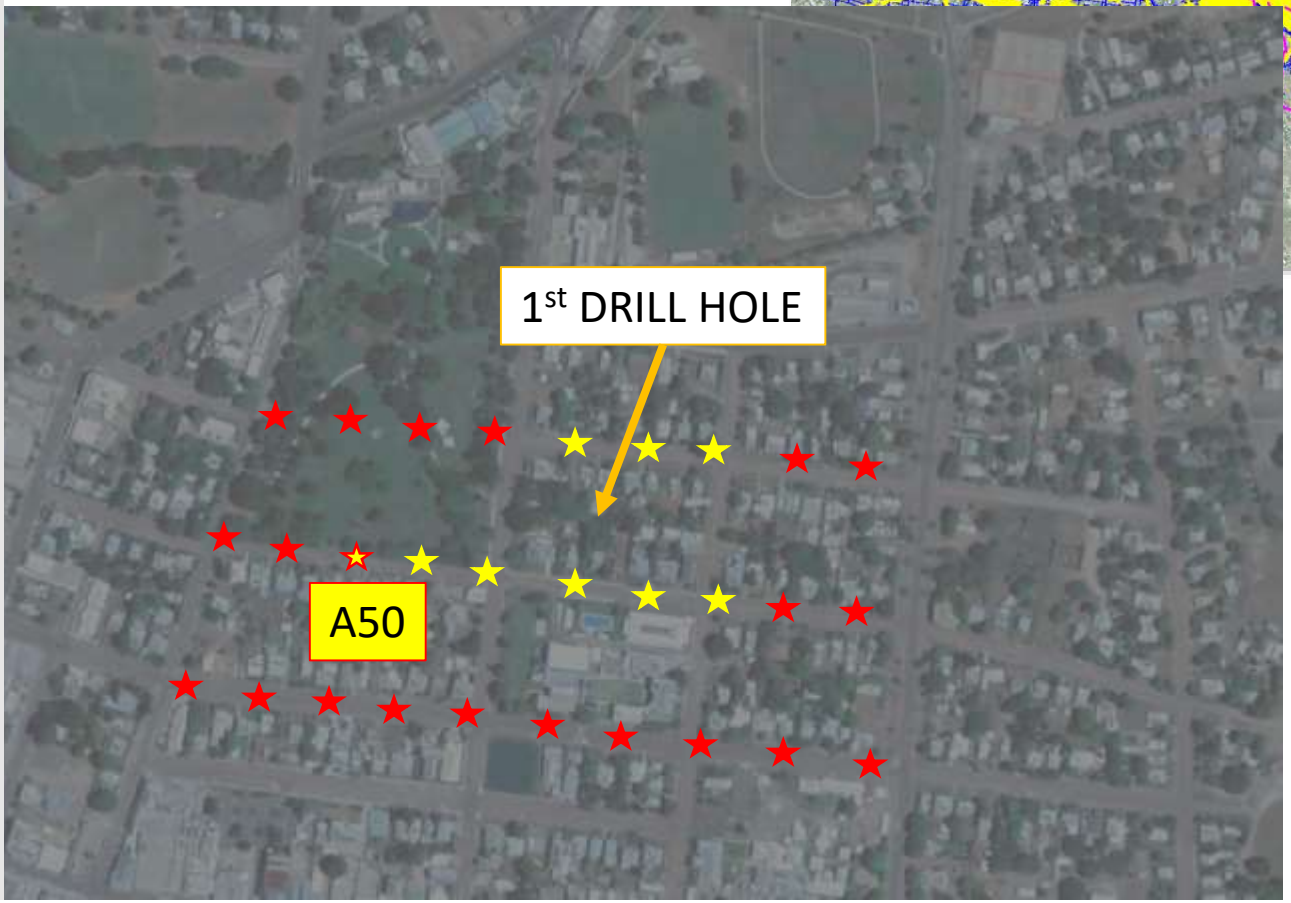


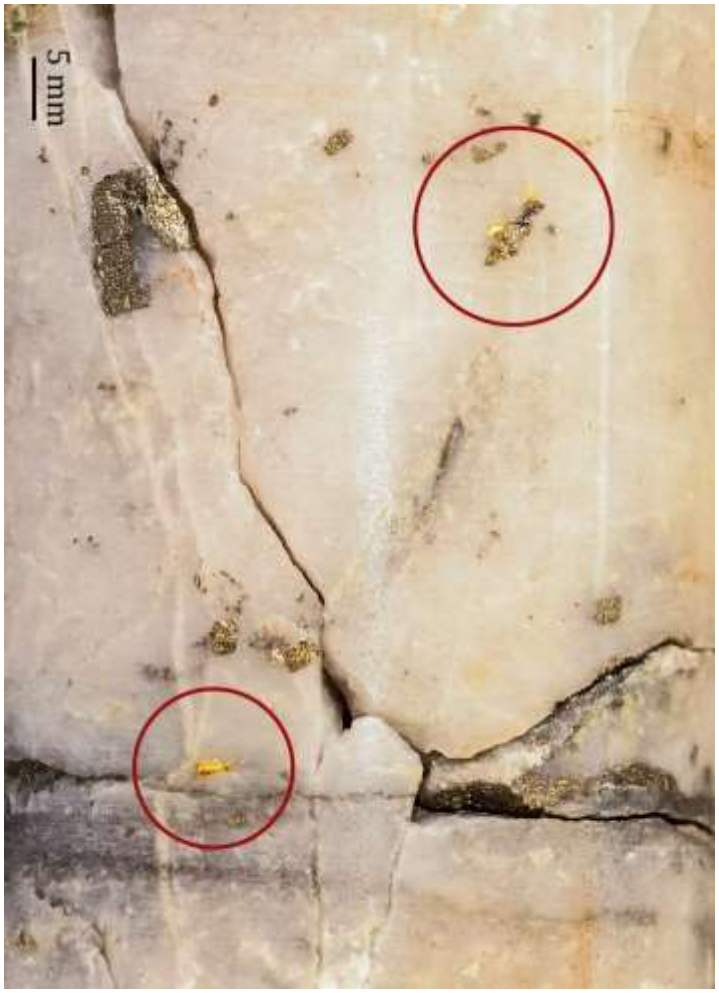
A50 results



"ADR testing" – pre drilling
EXAMPLE GRID PLAN







CONCLUSIONS

Will Charters Towers be revived as a high-grade gold producing mine? **YES**

HOW

1) **Pre-define area of drilling using new technologies that save time and money**

2) **Smart drilling and drill hole spacing to define 100,000 oz "PODS" of mineralisation**

3) **Generate a Pipeline of mineralised pods and plan the mine around these**

4) **Explore and "open up" areas surrounding the central mine where mineralisation is proven but un- /under- explored using modern techniques**