

A central collage of gambling-related items. In the center is a roulette wheel with numbers 0, 00, and 000. Surrounding it are several playing cards, including the Ace of Clubs, Ace of Spades, Ace of Hearts, and Ace of Diamonds. There are also several roulette chips in red and white, and two red dice. The background is dark green, suggesting a casino table.

Chancing One's Arm

Discovery of the Cadia Deposits, NSW

Dan Wood AO
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Applied Maths Dept, ANU
5 February 2021
CWEDG

A collection of playing cards, poker chips, and dice on a green felt background. The cards include the Ace of Clubs, Ace of Spades, Ace of Hearts, and Ace of Diamonds. The chips are in blue and white, red and white, and red. A red die is also visible. A yellow ring is draped over the cards and chips.

Content of Talk

History of Newcrest Mining

Cadia Hill Discovery

Cadia East Discovery

Ridgeway Discovery

Cadia Far East Discovery

Concluding Comment



**The key to discovery of the Cadia deposits is captured
in this quote by William Hazlitt, English essayist 1778-1830**

**“I’m not smart, but I like to observe.
Millions saw the apple fall,
but Newton was the one who asked why.”**



What is a Discovery in Mineral Exploration?

- a random & rare event
- a product of an often chaotic process
- which usually results from non-linear thinking

A 3D-rendered illustration of various gambling items. In the center is a roulette wheel with its characteristic numbered pockets in red, black, and green. Surrounding the wheel are several playing cards, including the Ace of Clubs, Ace of Hearts, and Ace of Diamonds. There are also numerous poker chips in blue and white, and red and white checkered chips. Two red dice are visible, one showing a six and the other a five. The entire scene is set against a dark green background, suggesting a casino table.

**Mineral Exploration is “the world’s
biggest and best gambling business”
(Slichter, 1960 Jackling Lecture)**



“An attractive feature of this gamble is that the players are free to rig the odds as favorably as possible” (Slichter, 1960)

Cadia Gamble Paid Off Handsomely, for Newcrest

"As the crow flies, the Newcrest Cadia Hill mine sits only 37kms across the ranges from deserted Ophir, which was the scene of the epoch-making gold rush of 1851. Indeed in that same year the first government geologist, Samuel Stutchbury, was inspecting the traces of copper at Cadia, just at the very time when he heard news that the first gold of Ophir had been found. Stutchbury rightly hurried over to Ophir. It was in 1992 that Newcrest found the first large gold-copper deposit at Cadia Hill. That new mine produces, each year, far more gold than all the diggings of New South Wales produced in that magical year of 1851."

Geoffrey Blainey, "The Rush That Never Ended", 2003

Mine boost to city economy



CWD 13-7-93

NEWCREST Manager of the Cadia project John Holliday said previous mining companies had not discovered the ore at Marrs Forest because they had not drilled for long enough, or spent enough money.

MINING in the Central West may soon be receiving an added boost with the development of a gold prospect at Marrs Forest near Cadia.

One of the largest mining companies in Australia, Newcrest Mining, is developing the site and has already spent about \$2 million on drilling to estimate the extent and grade of gold and copper ore.

Newcrest Manager of the Cadia

Project Mr John Holliday said the project was still in the exploration stage but if it did go ahead it would be one of the biggest mines in the State.

Mr Holliday said the Marrs Forest site had a long history of mining projects but that previous miners had never drilled for long enough to make the resource discovery.

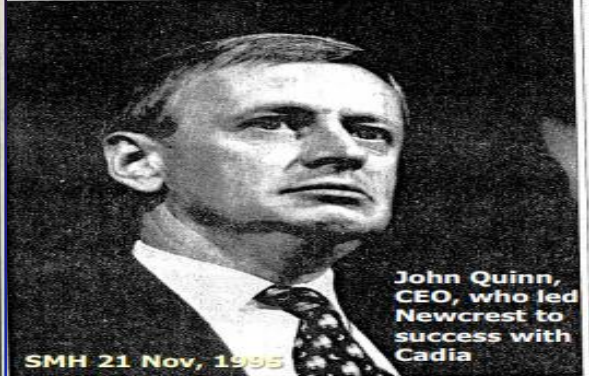
Newcrest company secretary Mr Peter Turnbull said the project was in such

early days that he would be 'shooting in the dark' to speculate on the employment-boost to the Orange economy which could result in the creation of about 150 jobs.

"These things need quite a lot of time to get going," Mr Turnbull said.

Newcrest has had mining interests in the Orange district since 1991 and has been investigating the Marrs Forest prospect for 12 months.

\$400m gold plan



John Quinn, CEO, who led Newcrest to success with Cadia

SMH 21 Nov, 1995

By BRUCE HEXTALL
Resources Writer

Newcrest Mining Ltd's \$400 million Cadia Hill copper-gold project is up for public scrutiny following the release of an environmental impact study on the proposal to exploit more than 50 billion worth of minerals near the NSW central west town of Orange.

The top ranking gold producer lodged the EIS - running to 2,000 pages and three volumes - with the NSW Government yesterday, claiming that it could bring Cadia Hill into production with minimal environmental damage.

"Newcrest believes the project can deliver major economic benefits to the local community and would have a multiple effect on the environment outside the project area," said Newcrest's chief executive officer and general manager of development, Mr Cameron Chamberlain.

Mr Chamberlain said Newcrest had recognised legitimate local concerns in its planning, assessing potential water supply volumes, identifying and managing waste and protecting the landscape.

The EIS, which will be subject to public scrutiny for 30 days, comes as the NSW Government is reviewing the environmental impact of a \$220 million Northparkes gold-copper mine.

Cadia, used in the gold recovery process, built up the Northparkes tailing dam and added thousands of cubic metres of waste this year, highlighting the environmental impacts of major resource developments.

Newcrest is distancing itself from this incident, saying that Cadia Hill's gold - contained in the 90,000 tonnes of copper concentrate produced annually - would not be affected and it leaves the mine site.

"In particular, people should know we do not intend using

esoxide," Mr Chamberlain said.

Newcrest discovered the large low-grade Cadia Hill resource in 1993. Managing director, Mr John Quinn, heralded the discovery as an "imaginative piece of work, by the company's exploration team and immediately urged further drilling to prove up its potential.

The date the company has spent \$20 million on exploration and completing feasibility studies.

The aim was to fast-track the project to capture the end of a peak in the copper price cycle and add significantly more ounces to Newcrest's gold production profile.

Final approvals are likely to be won by mid-98, allowing production to start in mid-99.

Over the latest 12-year mine life, Newcrest's gold production is expected to average 200,000 ounces, while 23,000 tonnes of copper metal will also be produced each year from the Cadia Hill concentrate.

\$440m to start new 'gold rush'



Early days ... gold mining at Cadia Hill near Orange

By RACHEL MORRIS
Political Reporter

THE State Government gave the go-ahead yesterday for a \$440 million gold mine at the site of Australia's first gold rush.

More than 140 years after prospectors first descended on the central tablelands beyond Cadia and nearby Lithgow, a major mining company has again struck gold in the same area.

Did the best-selling prospectors, their pickaxes and pans have been replaced by a mining giant that brings the latest technology and the promise of a much different dollar injection into the local community?

Work on the Cadia gold mine is set to start early next month - according to 1500 jobs with a new class of property for the Lithgow and Orange areas.

In a case of history repeating itself, Cadia and Lithgow were the sites of the country's first gold rush in the early 1850s before the precious metal was found in the famous fields of Ballarat and Bendigo.

The first rush lasted just 50 years but after four years of exploration, McQuay's found Newcrest Mining Ltd has found new deposits in the area.

Rich deposits of iron ore were mined between the two world wars and copper has been mined in the Cadia district continuously since the 1930s.

General Manager of Newcrest Mining, Robert Quinn, said the development was an important step for economic growth and represented an important link with the local community.

"It's an area rich in mining tradition and the central tablelands is an area rich in mining deposits," Mr Quinn said.

The Lithgow open cast mine is expected to have a life of 20 years and produce 1.6 million tonnes of gold and 1.2 million tonnes of copper over that time, including more than \$2 billion.

Operation costs will total \$100 million annually and each year the mine will generate 600 jobs in wages, goods and services for the region.

Premier Bob Carr said yesterday that the mine had been approved subject to 100 conditions which impose environmental standards on its operations.

Newcrest is also paying for the restoration of an 1850s engine house on the Cadia site for use as a visitor centre.

It will also fund the relocation of a museum, cemetery and several sites of Aboriginal significance to the area.

The Cadia decision will boost the mining industry of the NSW Government, which came under fire from the Opposition after it voted approval for the \$200 million Lithgow open cast mine to produce 1.6 million tonnes of



Garrett Halliday with Bob Carr in front of an 1850s engine shaft yesterday. Photo: Jeff Galloway

The Gamble

Newcrest was valued at <\$200 m

It spent \$38m to discover & prove up Cadia Hill

It borrowed \$400 m to build a \$440m mine

To recover very low grade Au & Cu in a mine the 'experts' expected to fail because of its size & grade

The 'experts' failed to understand:

The low grade Au-Cu deposit was really

A high grade Cu deposit with a low W:O ratio

Located adjacent to a city of 30,000 people

And a 4 hour drive west of Sydney

This is how the "odds were rigged"



Exploration and drillout crew outside the first site office

Cliff South, Paul Dugham, Dave Whiteley, Graham Rapley, Max Baker, Matt Nimmo, Foy Leckie, John Holliday, unknown, Anne Eastwood, unknown, Paul Wright.



Newcrest Story

Mid-1986: BHP Gold buys Browns Creek Mine

In 1986 Browns Ck Mine running out of ore

Big Cadia deposit at Cadia, NSW is possible ore source

March 1987: BHP Gold Mines (BHPG) formed

Newmont Australia (NMA) under corporate attack in 1990

December 1990: BHPG/NMA merge to form Newcrest



Big Cadia acquisition started in 1986
Completed in March 1991
This was key to Newcrest's Success

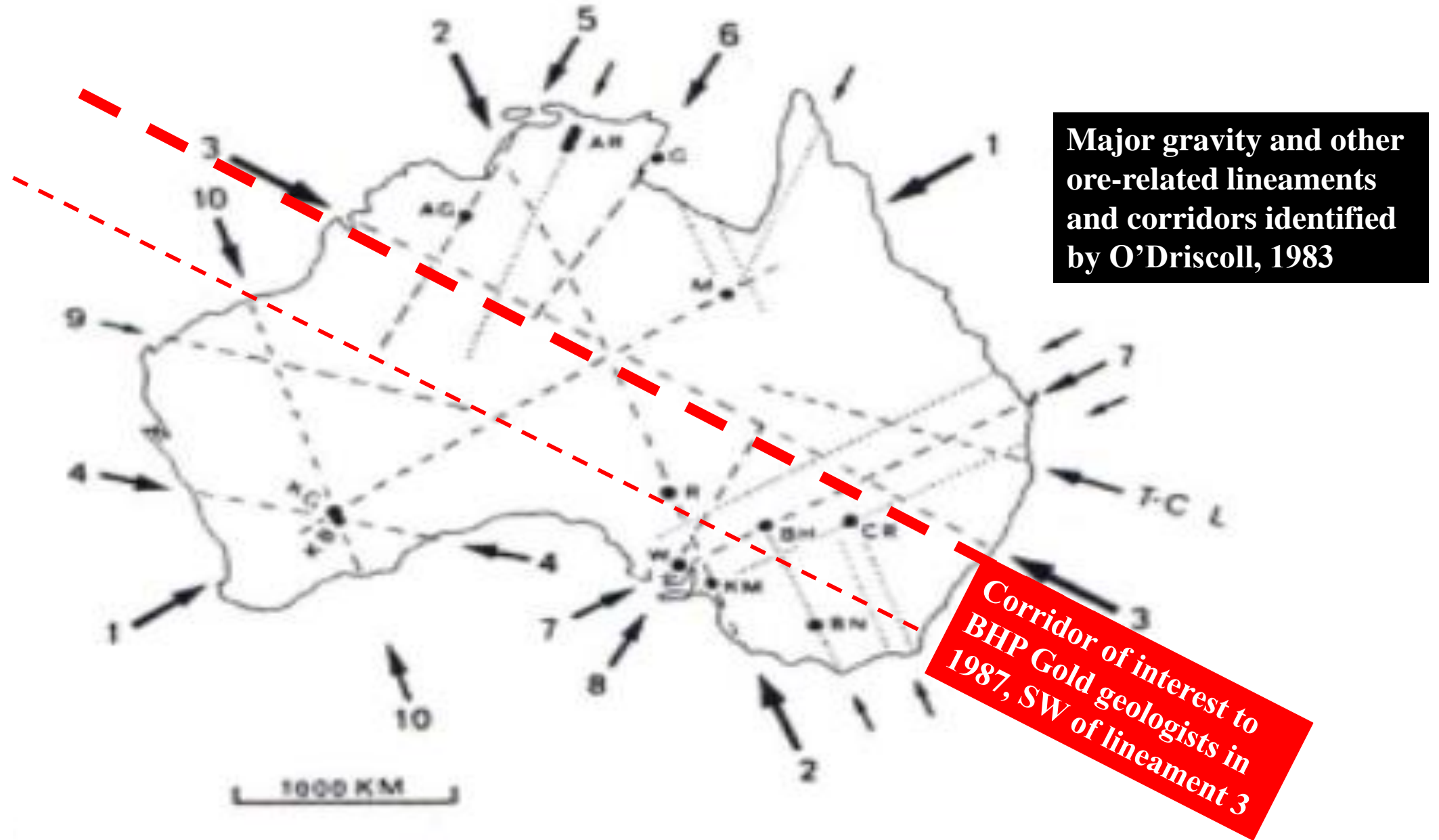
A central collage of gambling-related items. In the center is a roulette wheel with its numbers and pockets. Surrounding it are several playing cards, including the Ace of Clubs, Ace of Hearts, and Ace of Diamonds. There are also several roulette chips in blue and white, and red and white chips. Two red dice are also visible. The entire scene is set against a dark green background, suggesting a casino table.

Strategy Meeting, August 1991

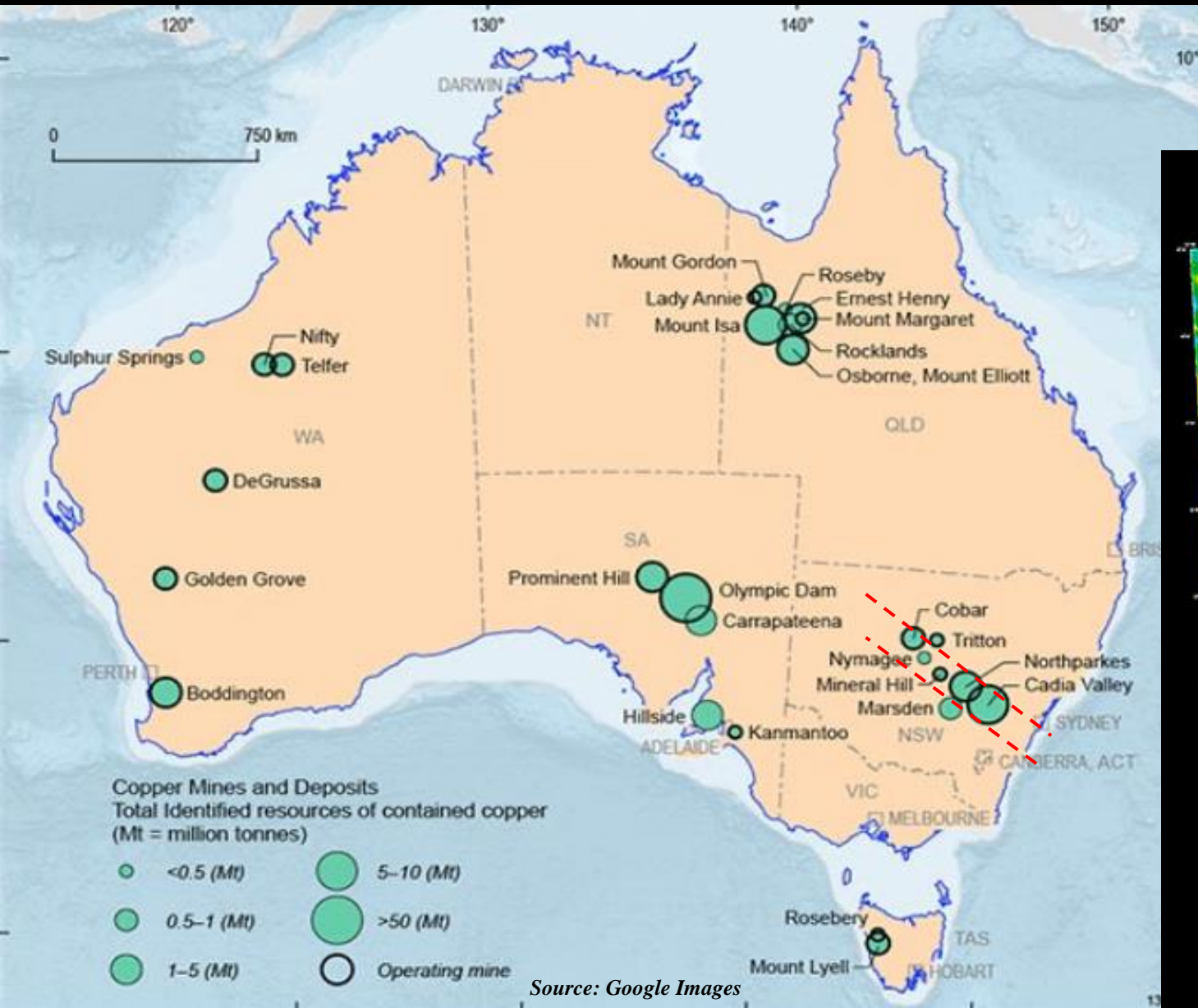
Exploration team told to discover
2 Moz Au in 3 years,
by late 1994

Otherwise we were out of business

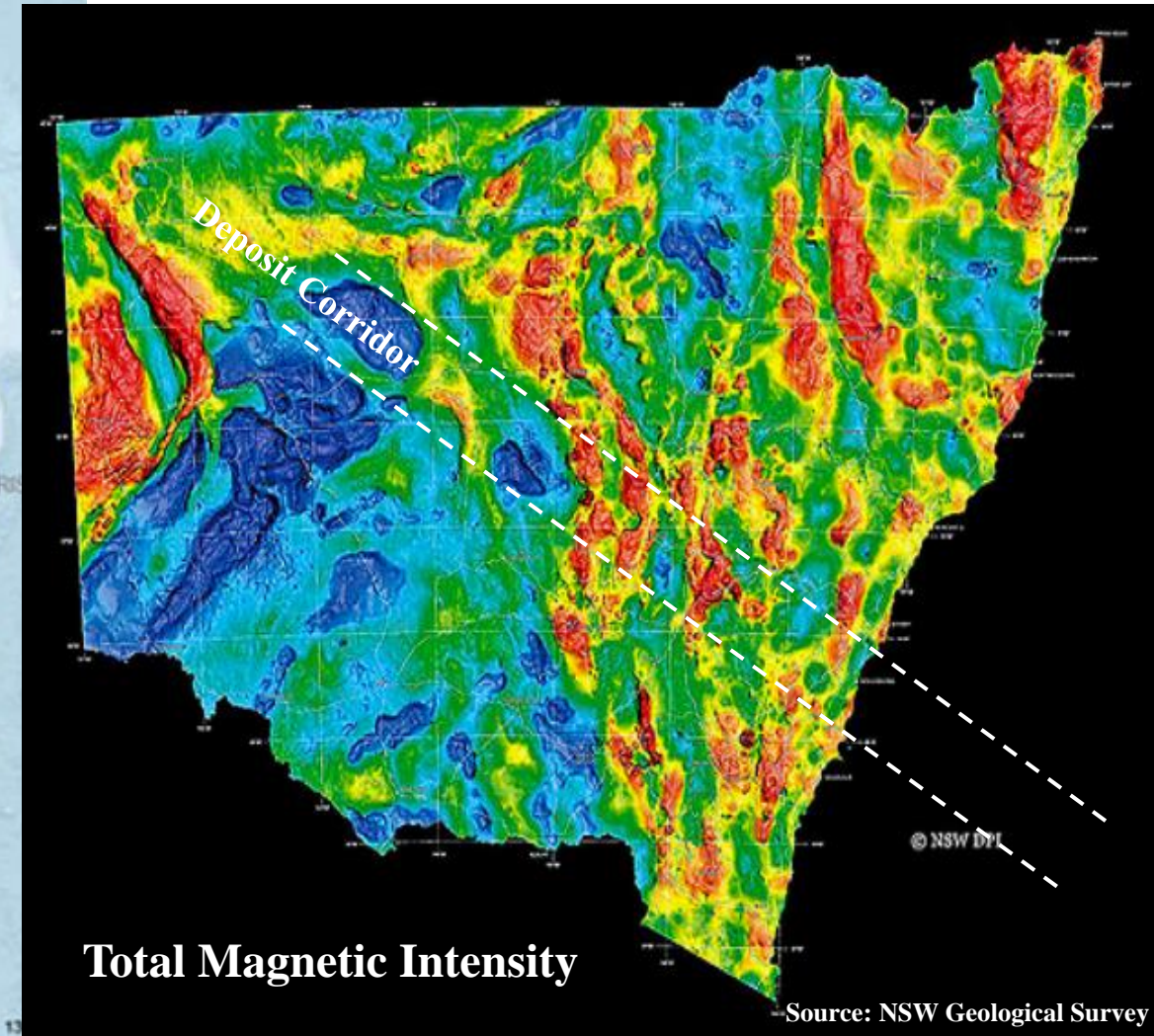
O'Driscoll's Metallogenic Road Map



Linears and Deposits in NSW

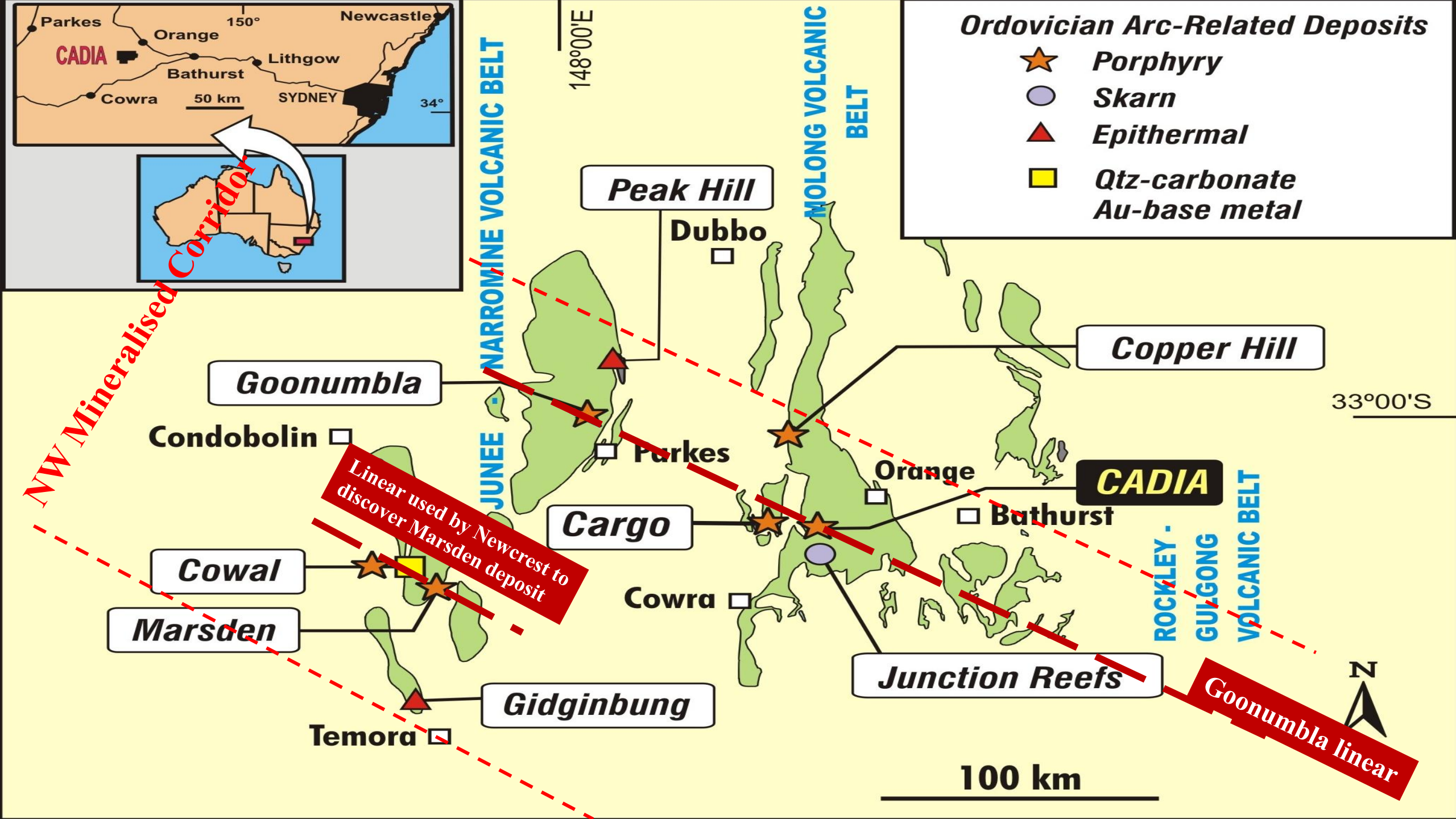


Source: Google Images

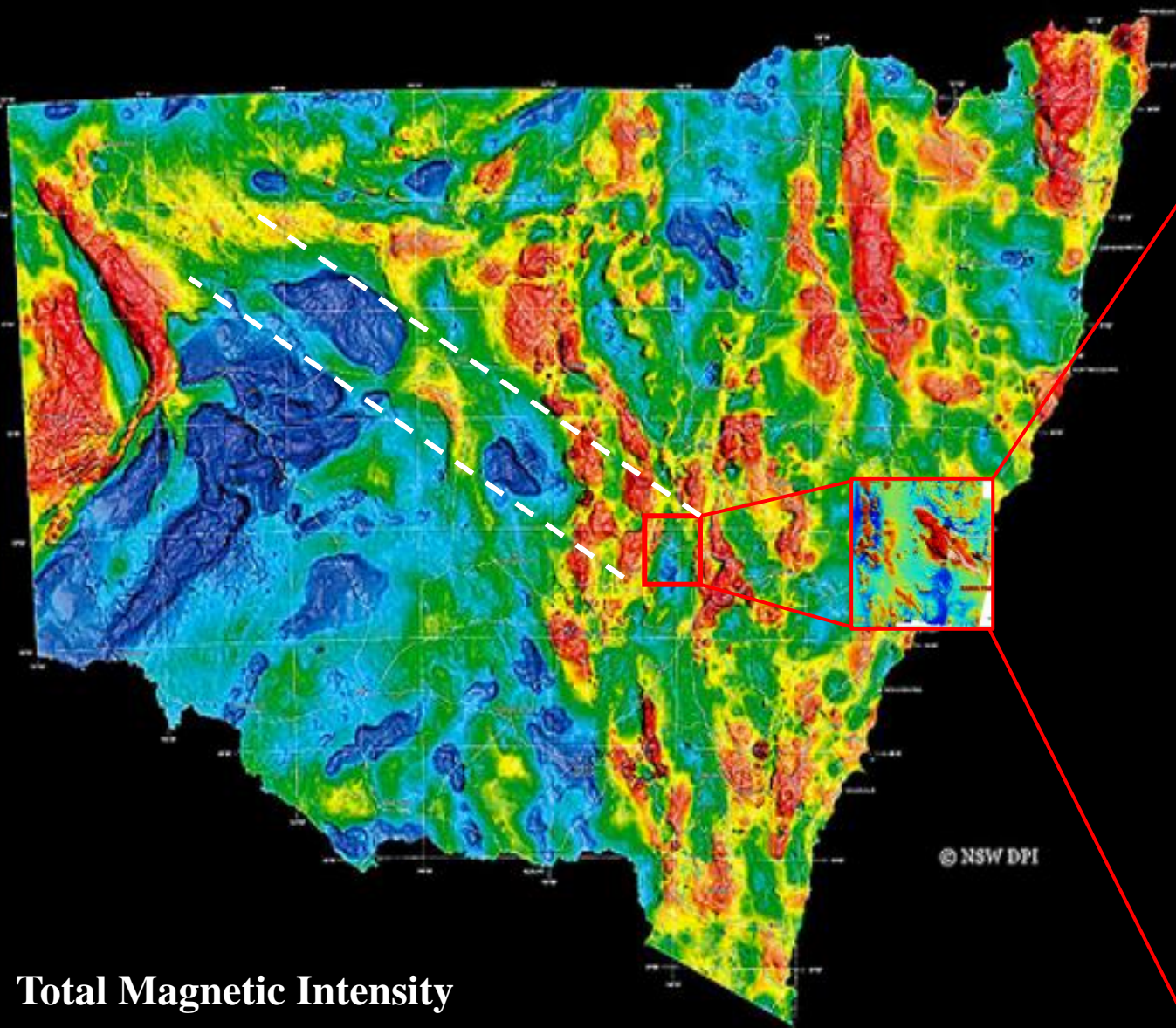


Total Magnetic Intensity

Source: NSW Geological Survey

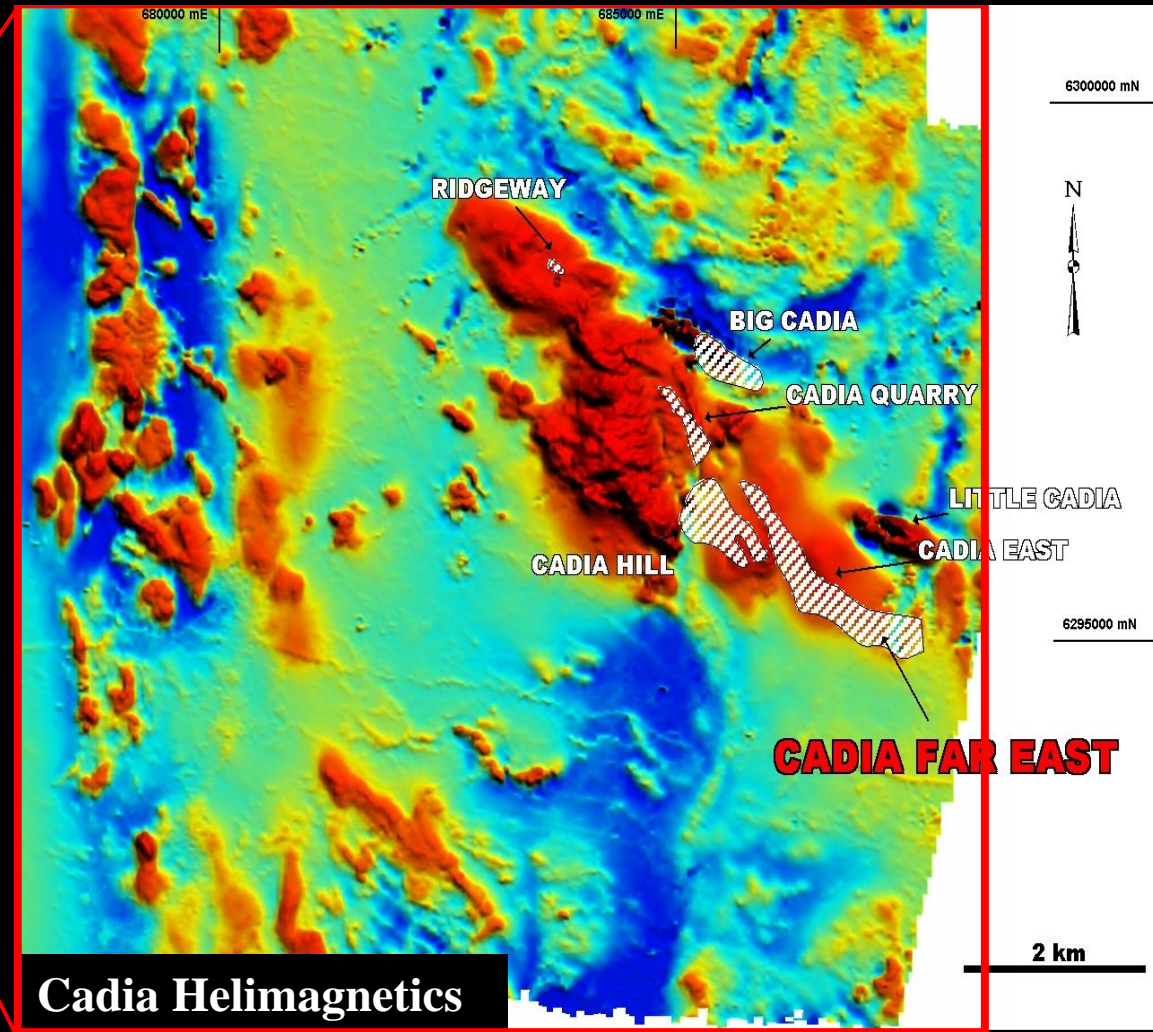


Regional and Detailed Aeromagnetics NSW/Cadia



Total Magnetic Intensity

Source: NSW Geological Survey



Cadia Helimagnetics

A central black rectangular box containing white text is superimposed on a background collage of casino-related items. The collage includes several playing cards (aces and tens of different suits), red and white striped poker chips, blue and white striped poker chips, and red dice. A roulette wheel is partially visible in the background, showing numbers and colored pockets. The items are arranged in a circular pattern around the central text box.

Discovery Timetable

Cadia Hill: March 1991 – September 1994

Cadia East: early 1993 – late 1995

Ridgeway: late 1994 – October 1997

Cadia Far East: August 1996 – 2001

A collage of casino-related items including playing cards (Ace of Clubs, Ace of Hearts, Ace of Diamonds), poker chips (red and white, blue and white), and a roulette wheel. A central black text box contains the following information:

Gold Added

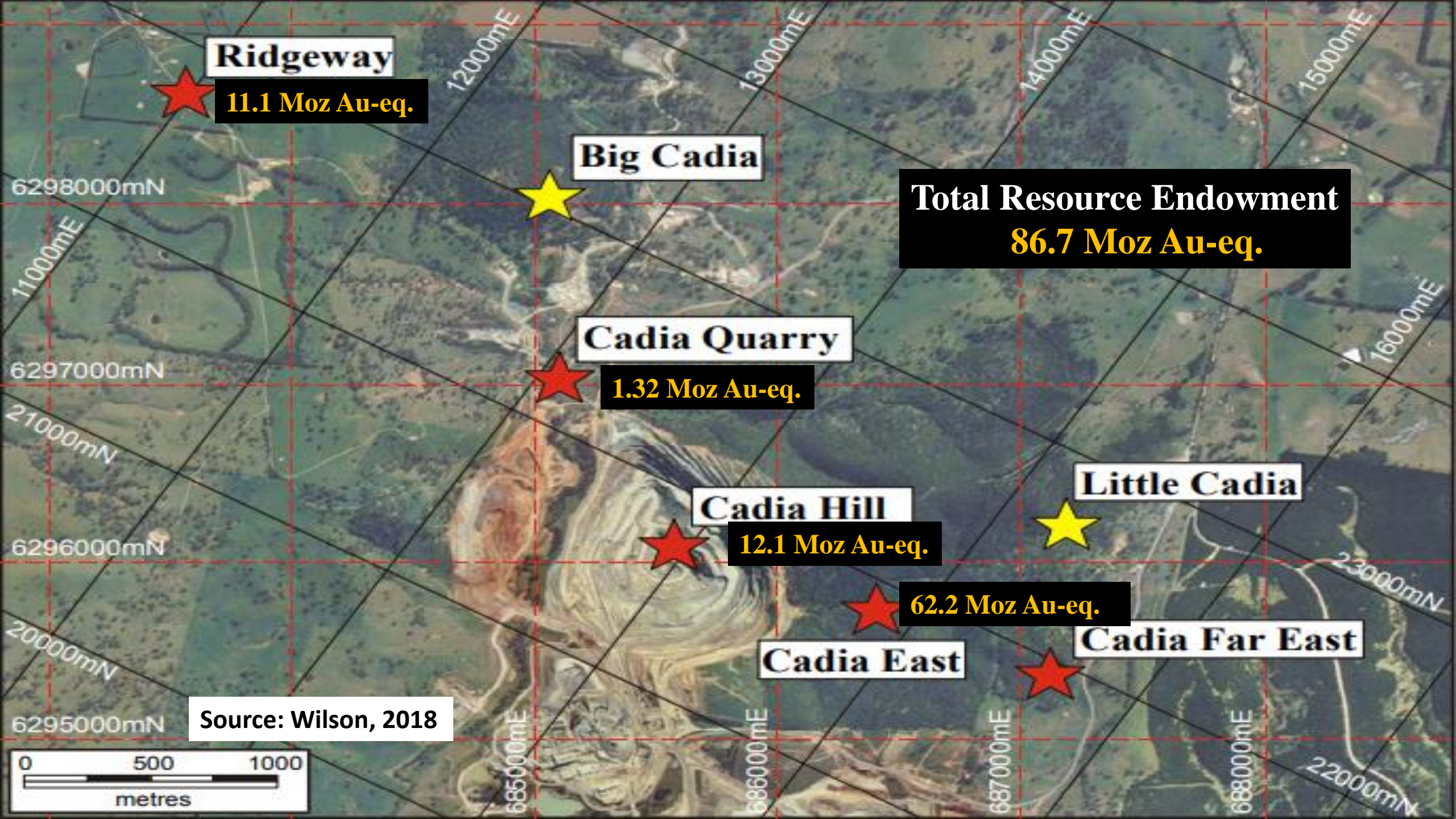
By February 1994 – 3.2 Moz
By September 1994 – 4.6 Moz
By April 1995 – 6.4 Moz
Target by end of 1994 – 2.0 Moz

By February 1994 – 3.2 Moz

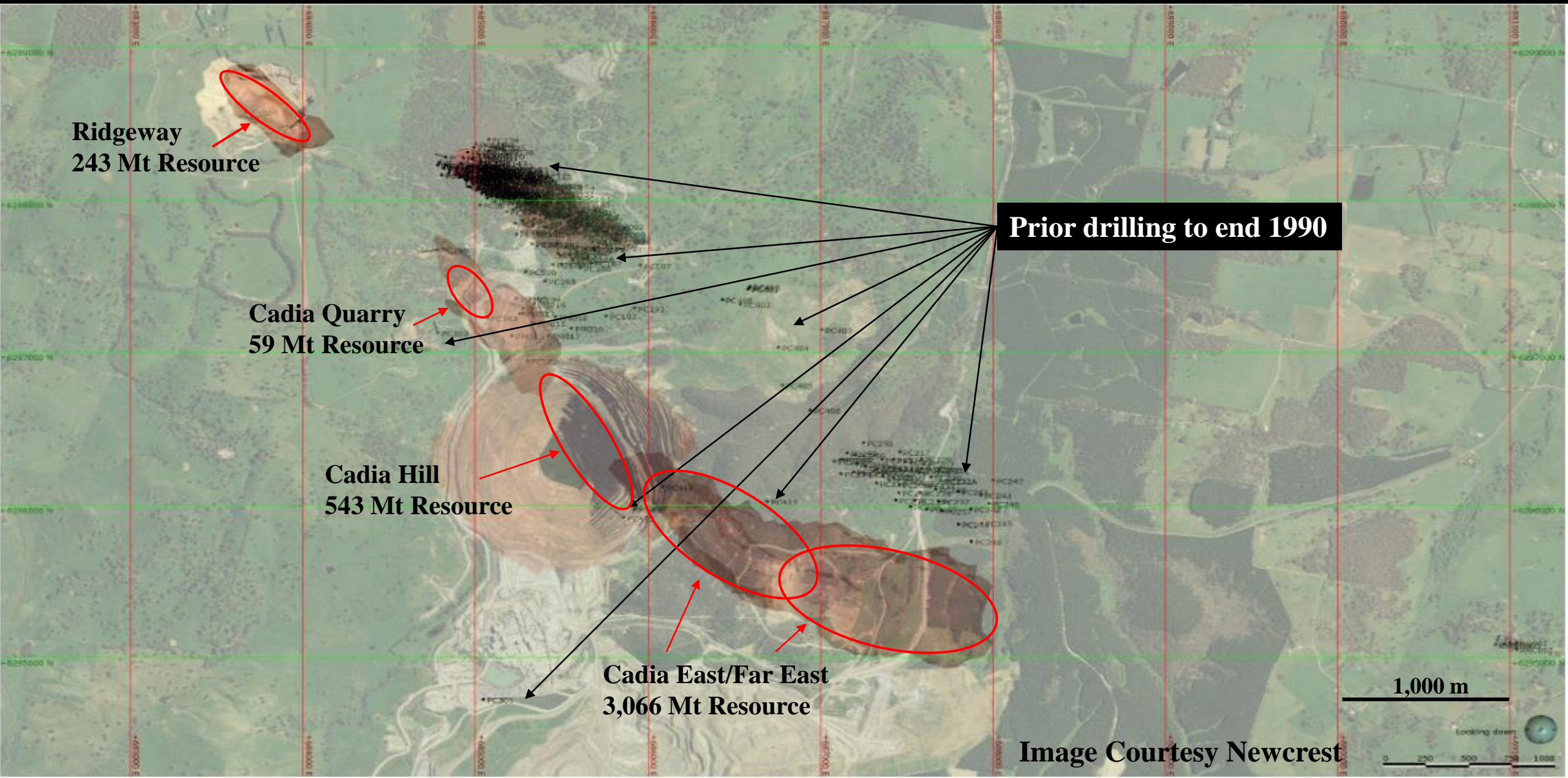
By September 1994 – 4.6 Moz

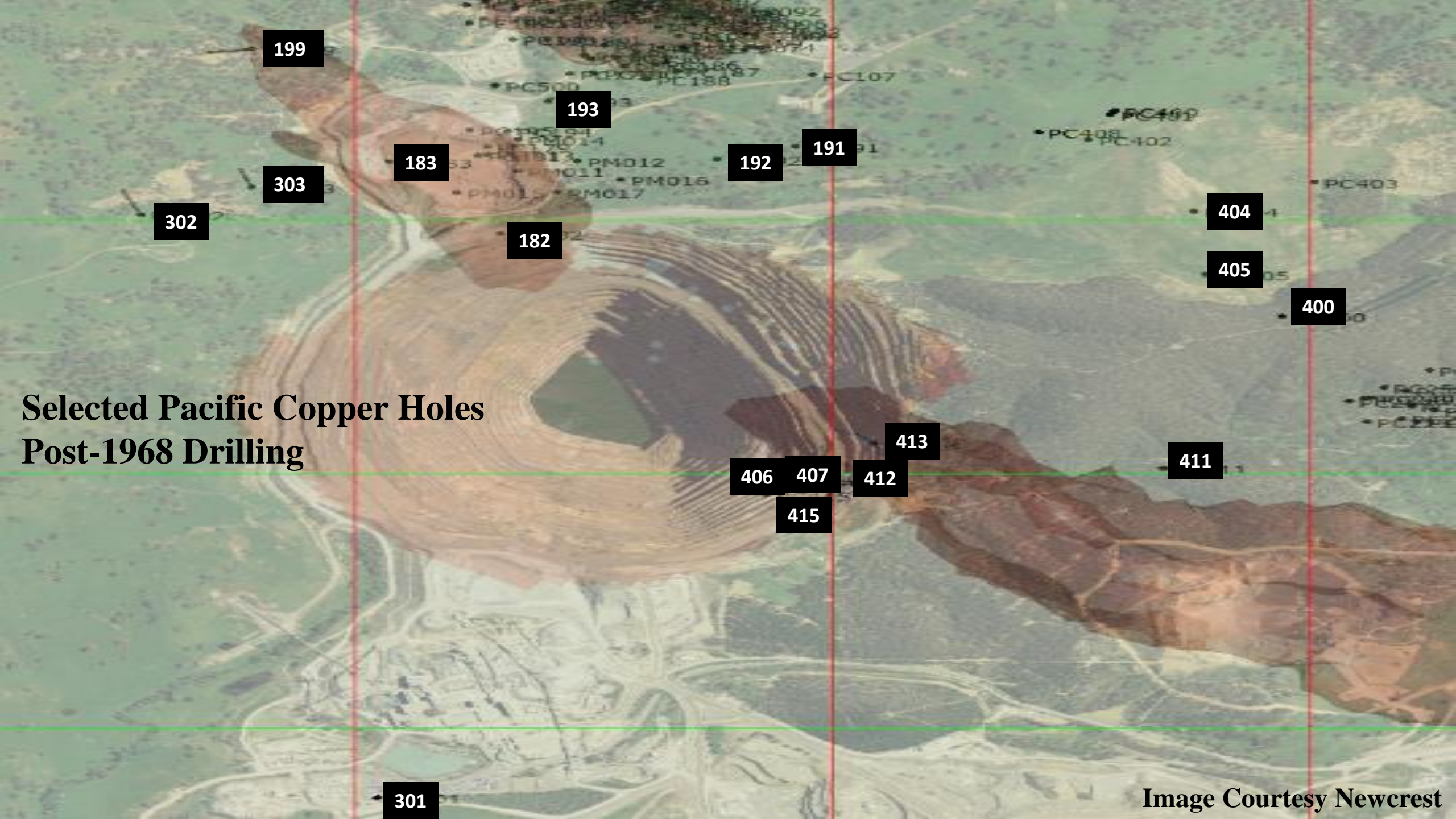
By April 1995 – 6.4 Moz

Target by end of 1994 – 2.0 Moz

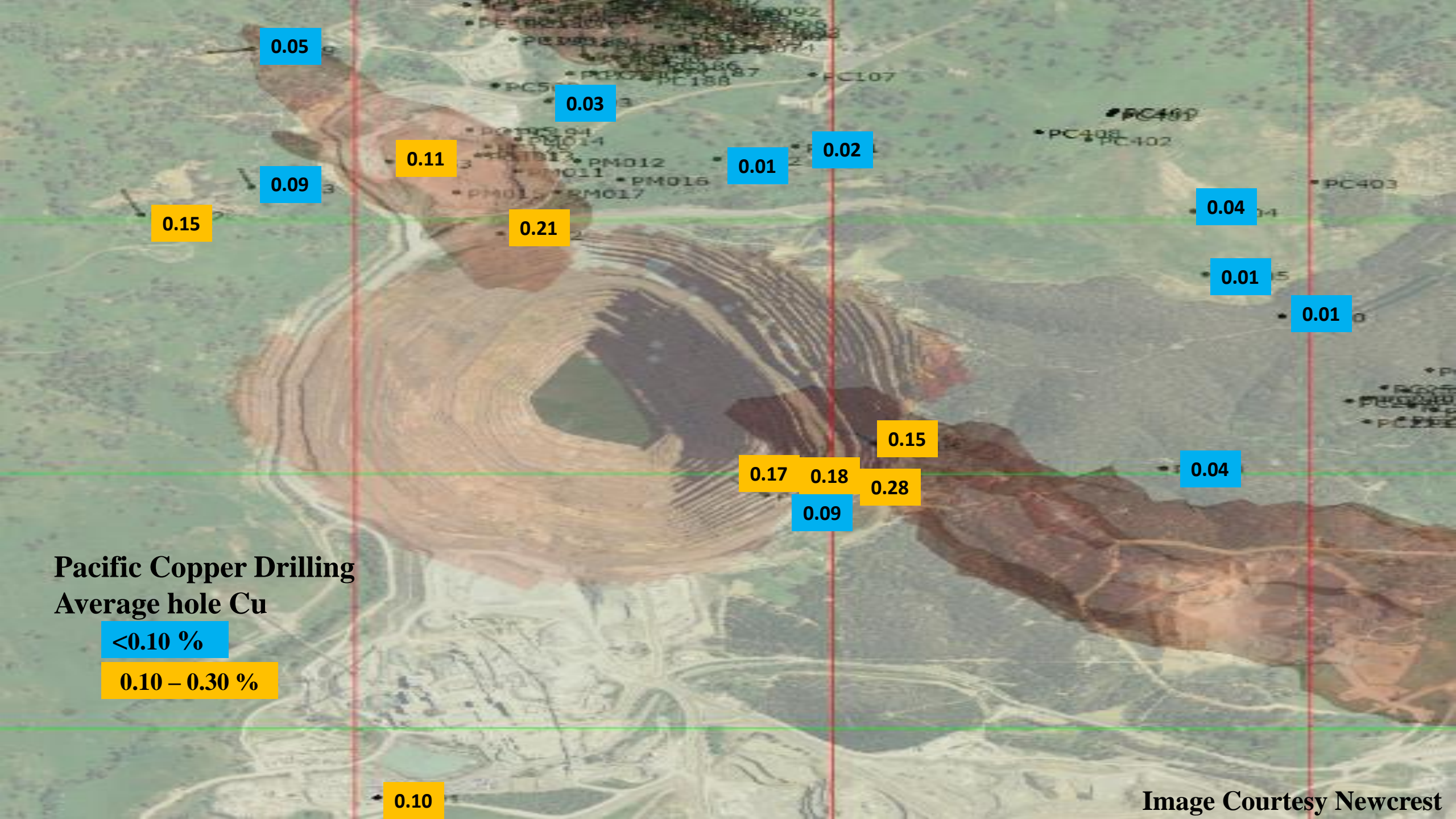


Drilling at Cadia Prior to Newcrest Discoveries





Selected Pacific Copper Holes Post-1968 Drilling





0.05

0.37

NA

0.07

0.15

NA

0.06

0.13

0

0.02

0.03

0.06

0.06

1.47

0.36

0.69

1.13

Pacific Copper drilling
Average hole Au

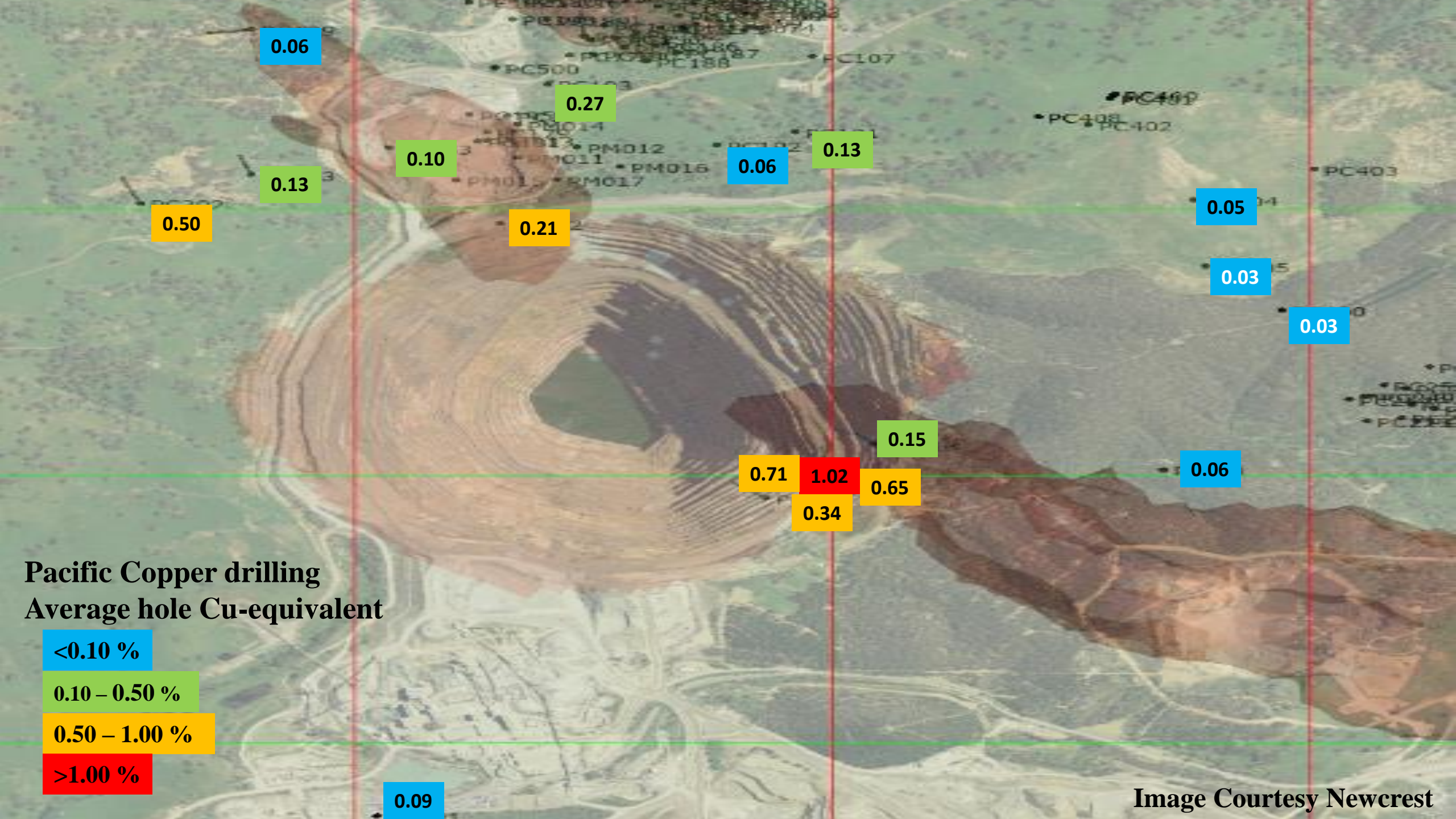
<0.10 g/t

0.10 – 1.00 g/t

>1.00 g/t

0.10

Image Courtesy Newcrest



0.06

0.27

0.13

0.10

0.06

0.13

0.50

0.21

0.05

0.03

0.03

0.15

0.71

1.02

0.65

0.06

0.34

**Pacific Copper drilling
Average hole Cu-equivalent**

<0.10 %

0.10 – 0.50 %

0.50 – 1.00 %

>1.00 %

0.09



Estimated Mineral Resources

Cadia Hill: 9.5 Moz Au & 0.88 Mt Cu

Ridgeway: 7.6 Moz Au & 1.1 Mt Cu

Cadia Quarry: 0.89 Moz Au & 0.24 Mt Cu

Cadia East/Far East: 38 Moz Au & 8.0 Mt Cu

A central collage of casino-related items. In the center is a roulette wheel with numbers 0, 00, and 000. Surrounding it are several playing cards, including the Ace of Spades, Ace of Clubs, Ace of Hearts, and Ace of Diamonds. There are also several red and white checkered chips, blue and white checkered chips, and two red dice. The entire scene is set against a dark green background.

“Rigging the Odds”

Don't Call it Gold Exploration



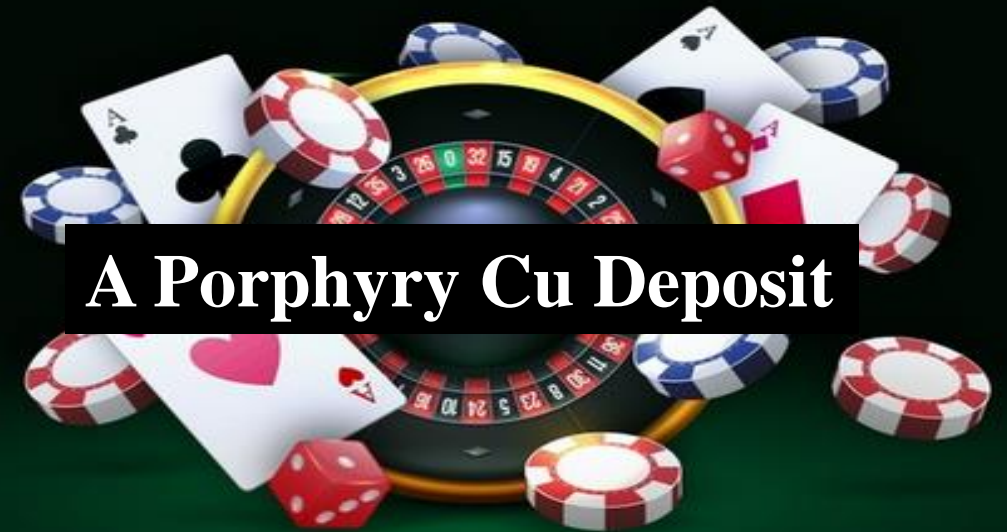
**For Newcrest Board
Target was Dollars**



This was \$20/t Rock



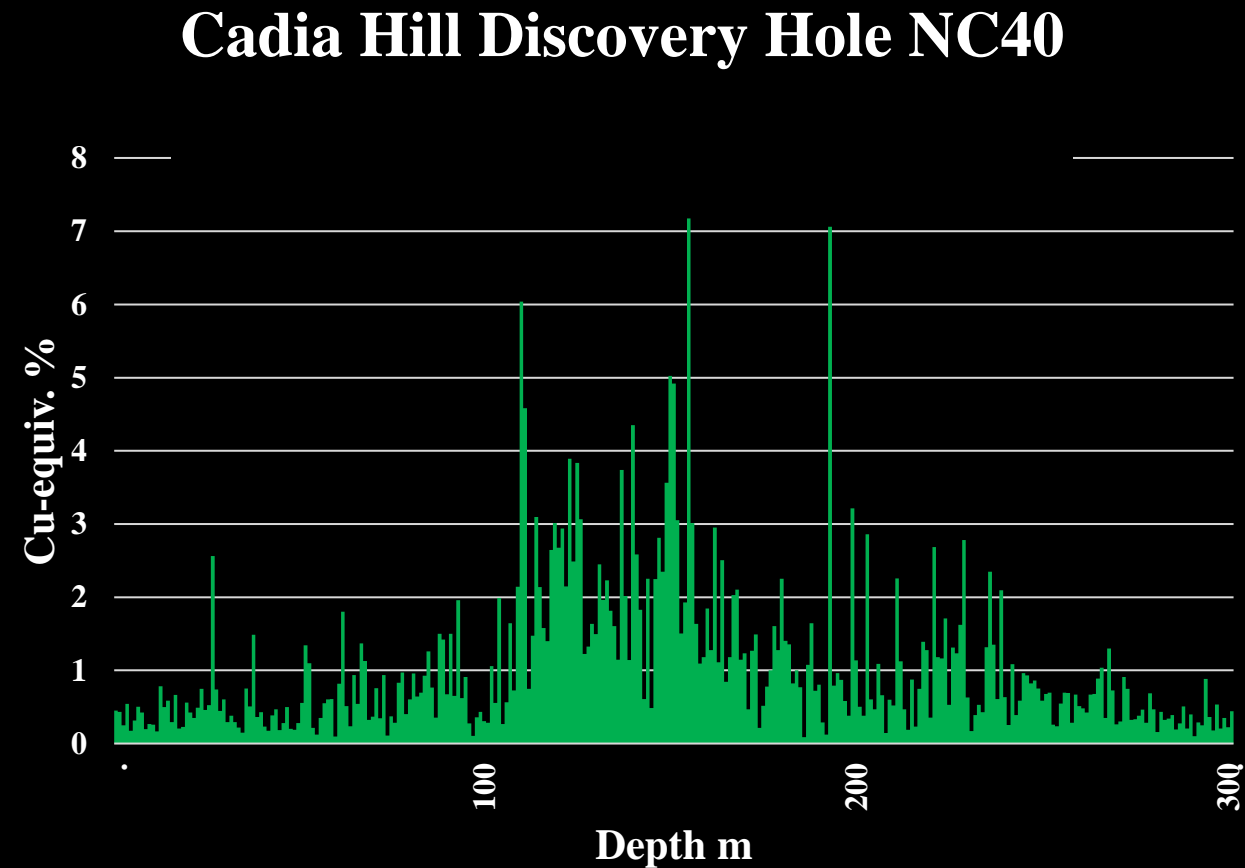
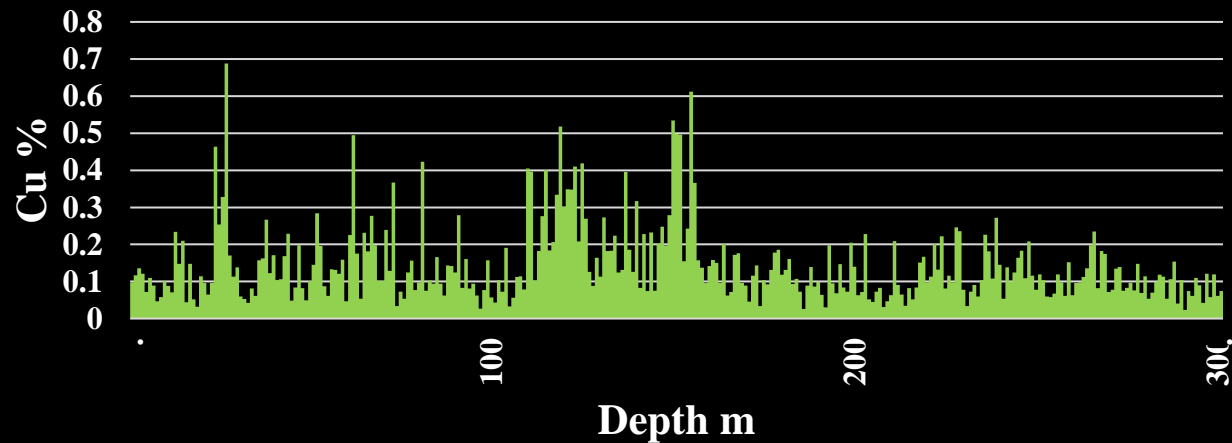
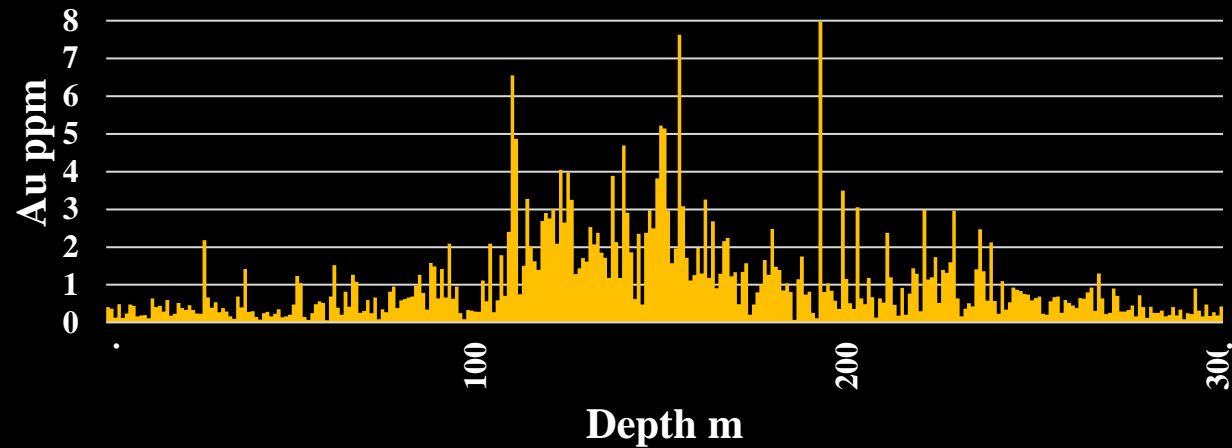
**For Mining Analysts
Target was Cu-equivalent**



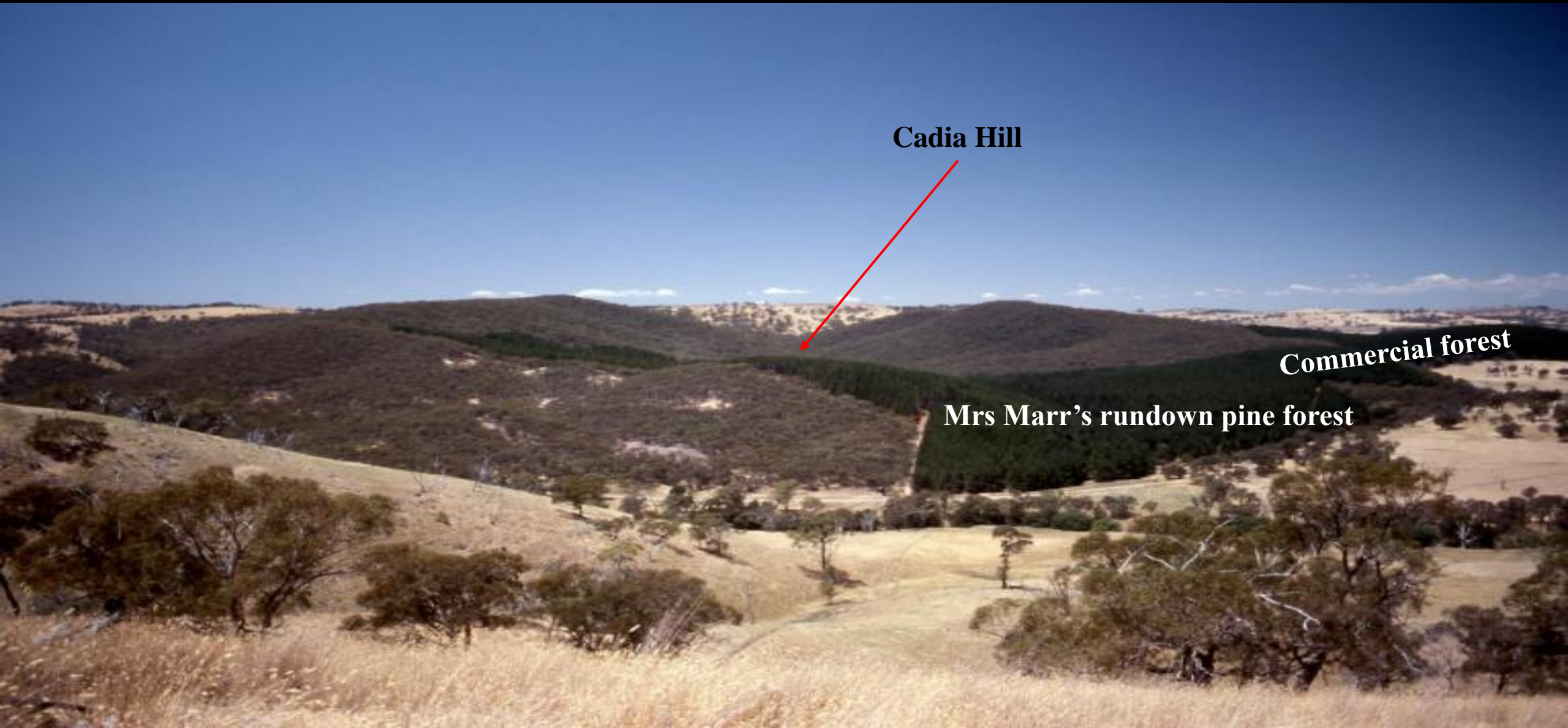
A Porphyry Cu Deposit

The Required Alchemy only needed a Formula

To add Au and Cu to make Cu-equivalent or Au-equivalent



Cadia Hill Deposit 1993



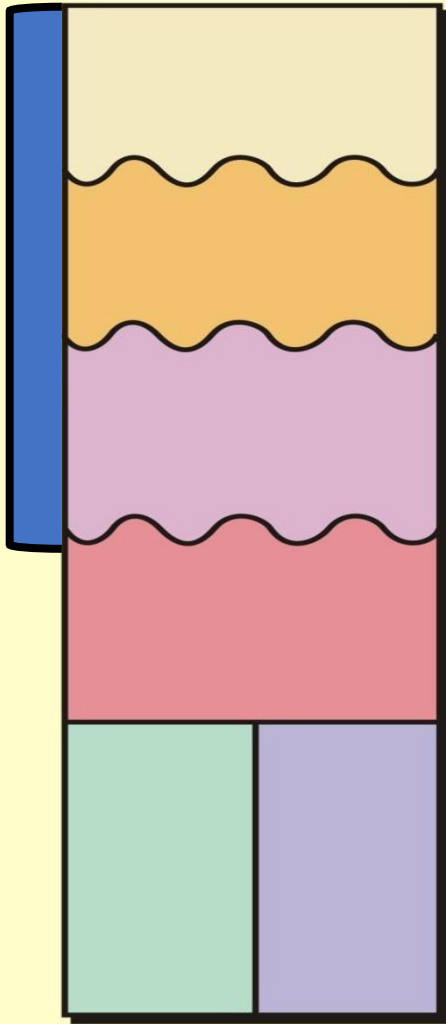
Cadia Hill

Commercial forest

Mrs Marr's rundown pine forest

Cadia District – Rock Units

Cover
Material



RECENT

soil, colluvium, alluvium.

Includes 10 cm of Loess

TERTIARY (11Ma)

basalt, trachyte, gravels.

EARLY - MID SILURIAN

Cadia Coach Shale
shale, sandstone, impure carbonates.

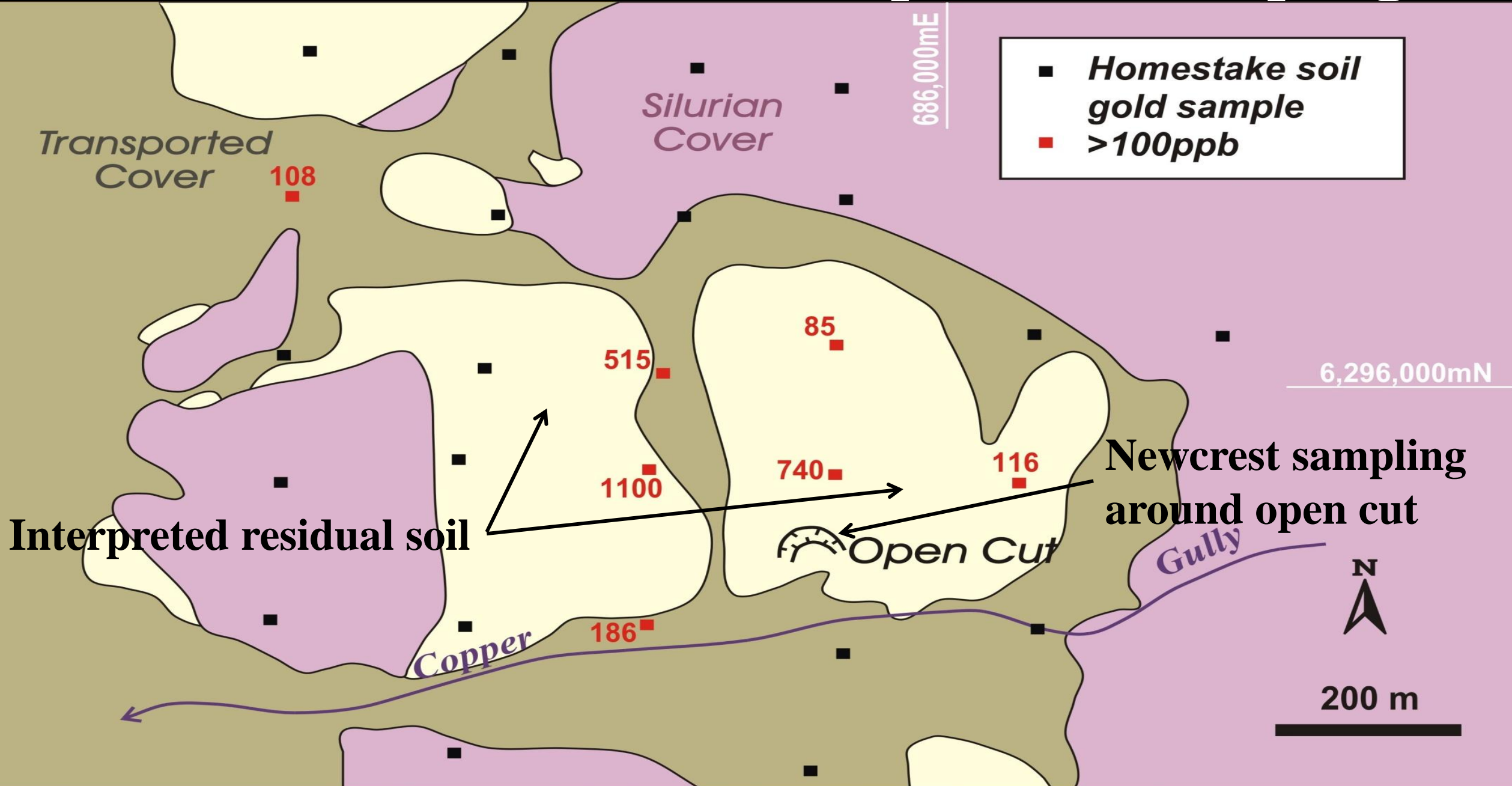
LATE ORDOVICIAN

Intrusives (435-440 Ma) **Age of Cadia Mineralisation**
monzonite, diorite.

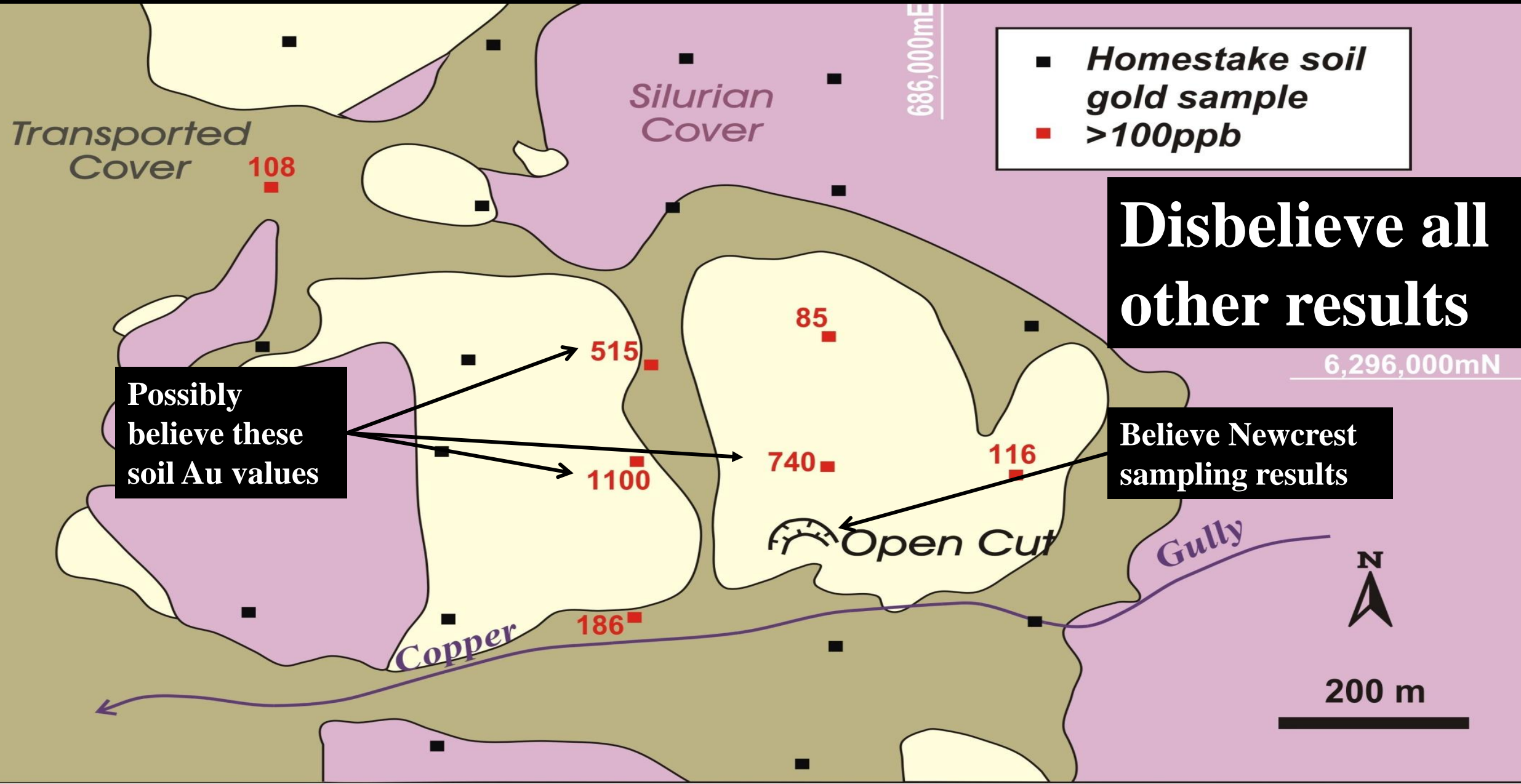
ORDOVICIAN

Forest Reefs Volcanics
volcaniclastics, lavas, sub-volc intrusives, limestone.
Weemalla Formation
sediments.

Cadia Hill: Cover material & prior soil sampling



This Meant



Old Cadia Hill Open Cut



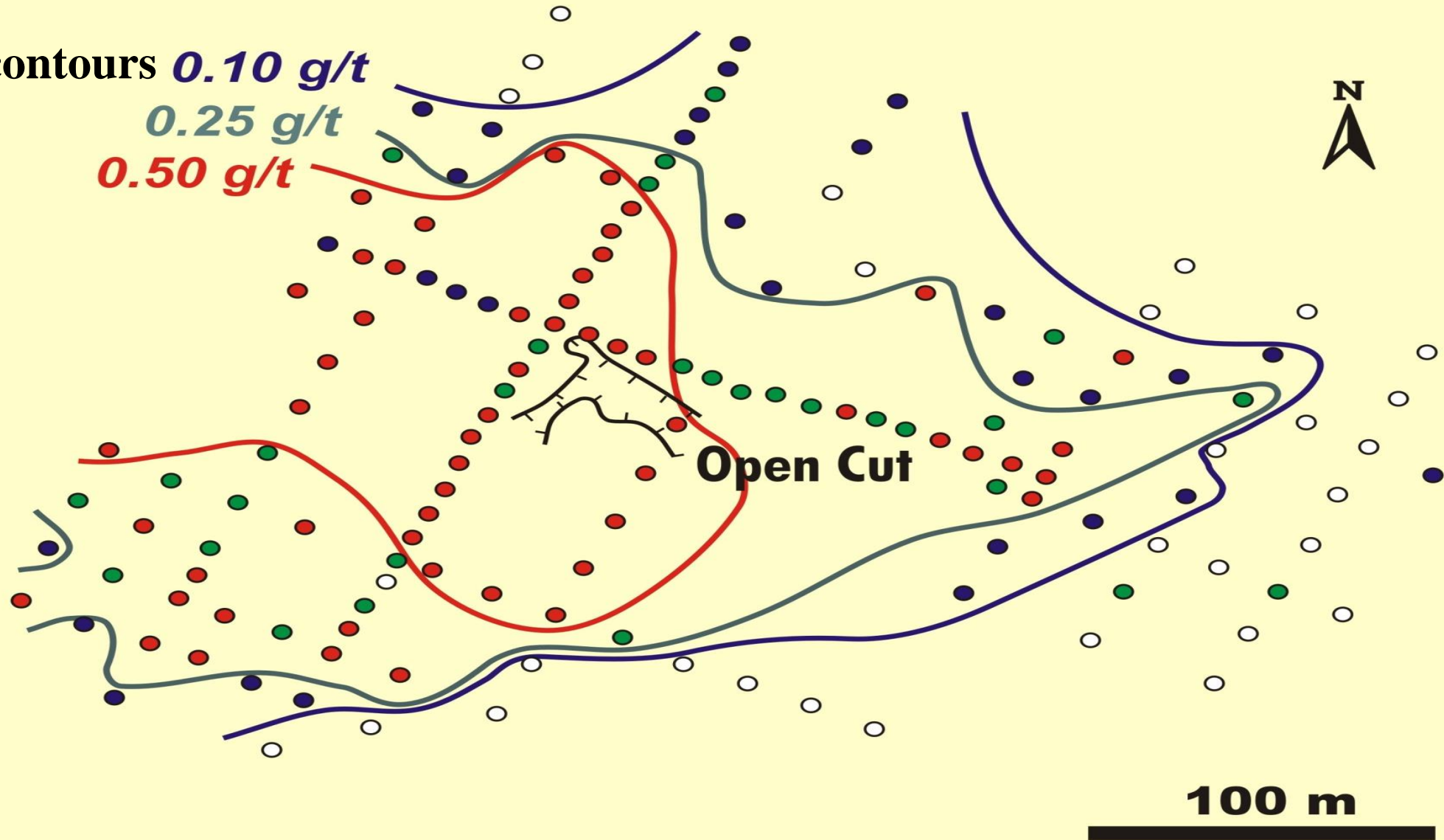
Newcrest Sampling of Pit Walls

- Cleaned and channel-sampled over 1m
- Recorded 89 m @ 1.1 g/t Au & 0.27 % Cu
- Showed Au-Cu-mineralised sheeted veins dipped ca. 45° SW with a NW strike



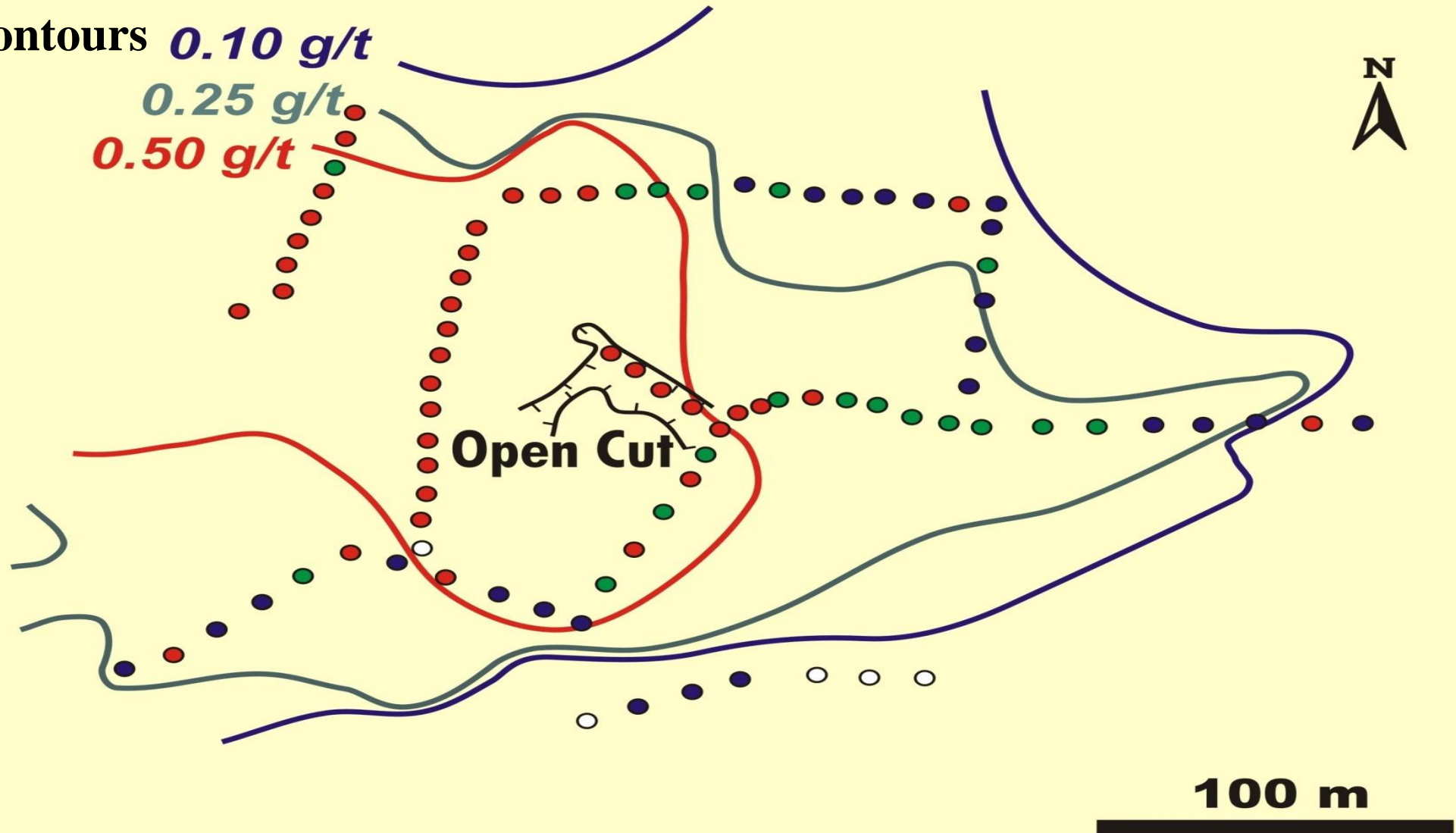
Previous soil Au results: old open cut area

Au value contours
0.10 g/t
0.25 g/t
0.50 g/t

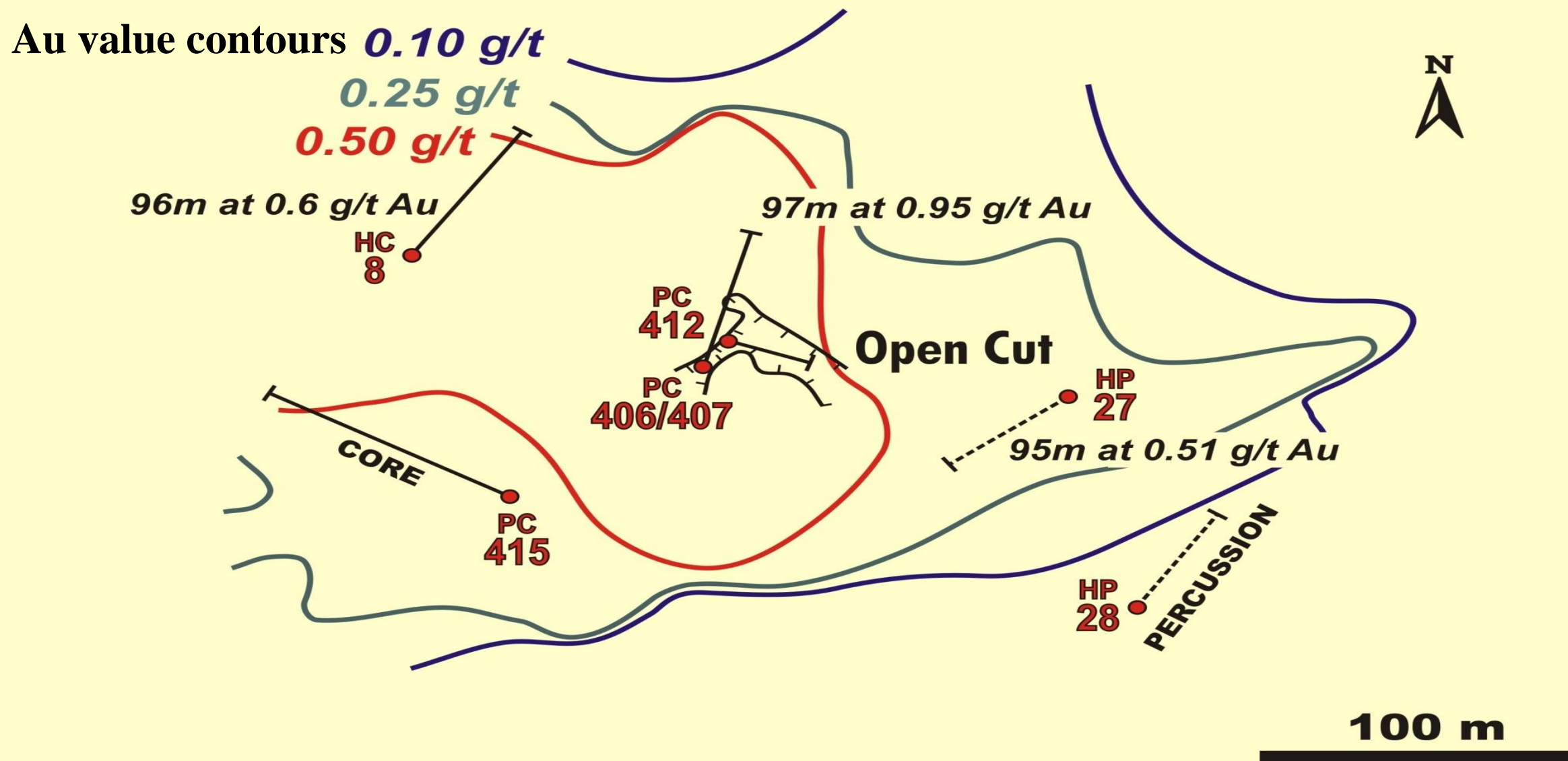


Previous RAB-drill results: old open cut area

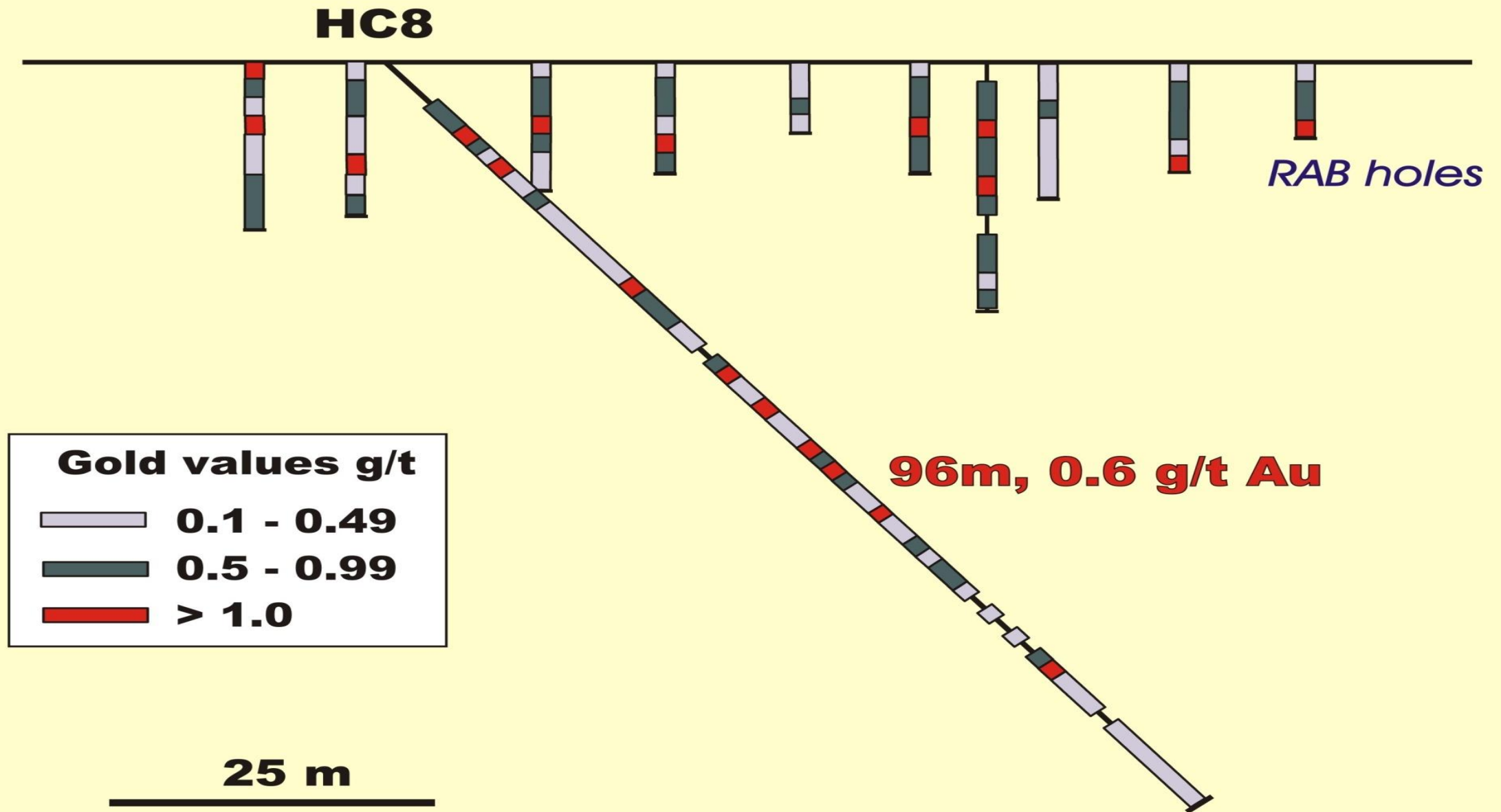
Au value contours
0.10 g/t
0.25 g/t
0.50 g/t



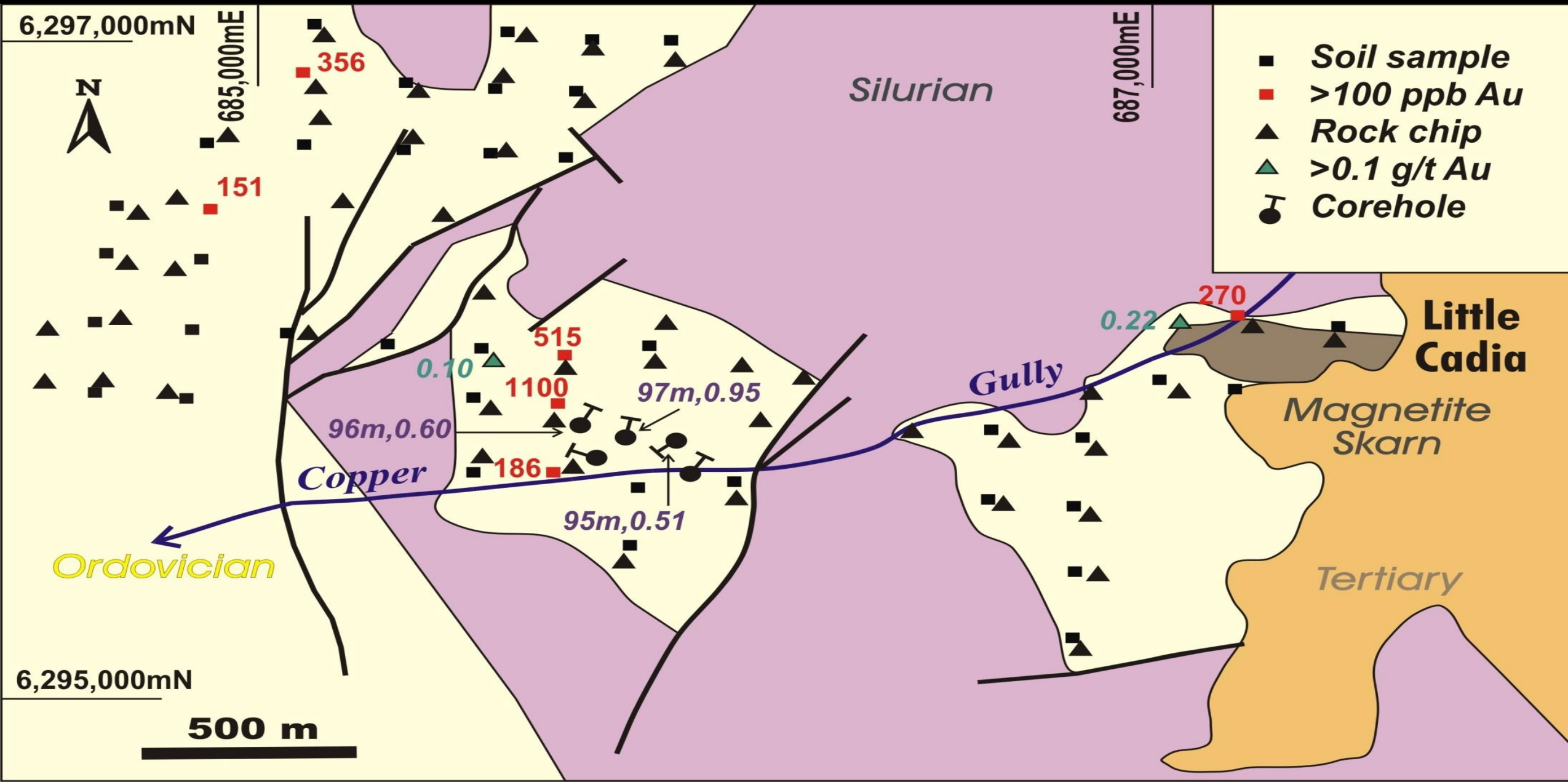
Previous Core & Percussion drilling results



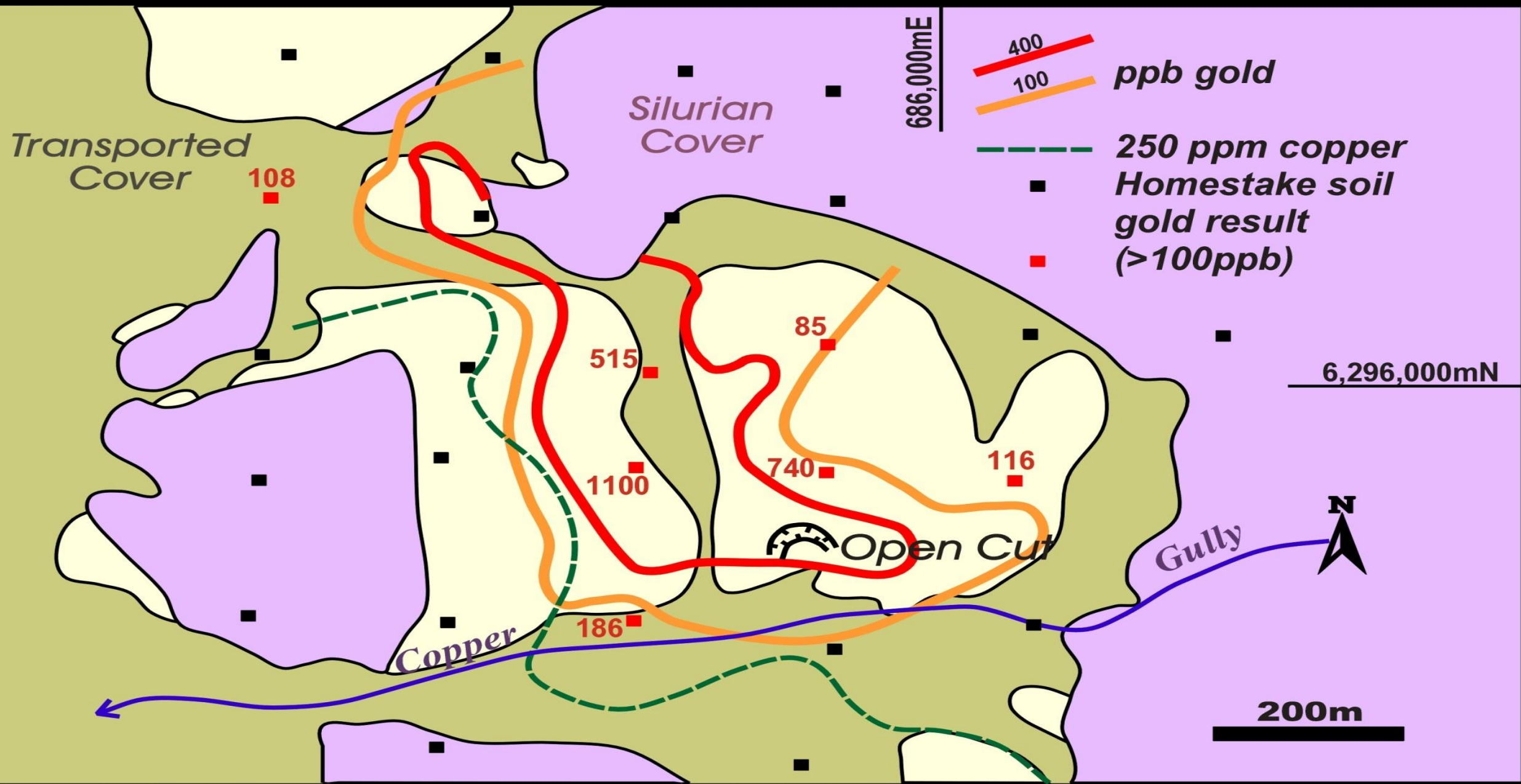
Core Hole HC8: Au results



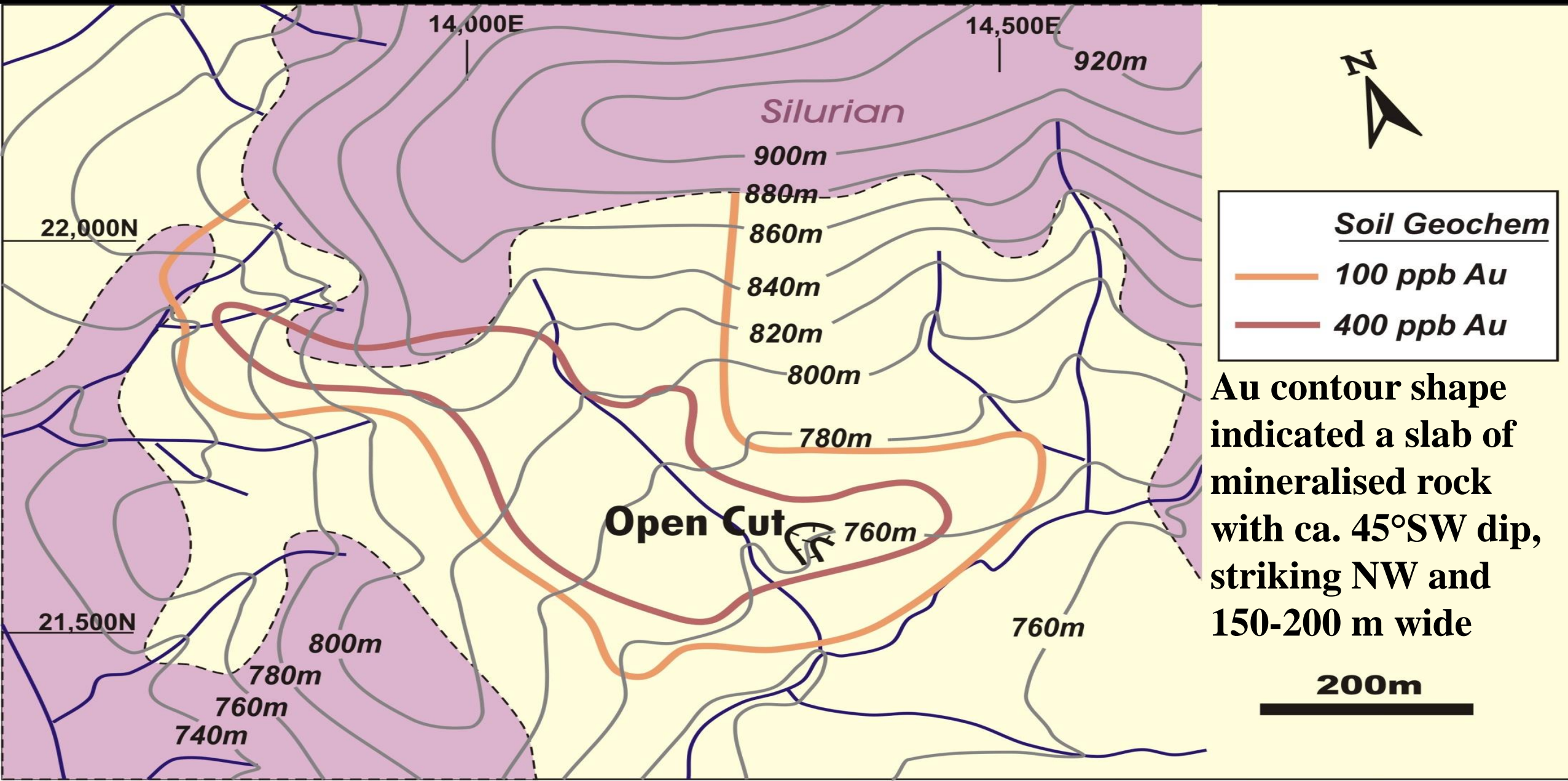
Pre-Newcrest Exploration Results: Cadia Hill



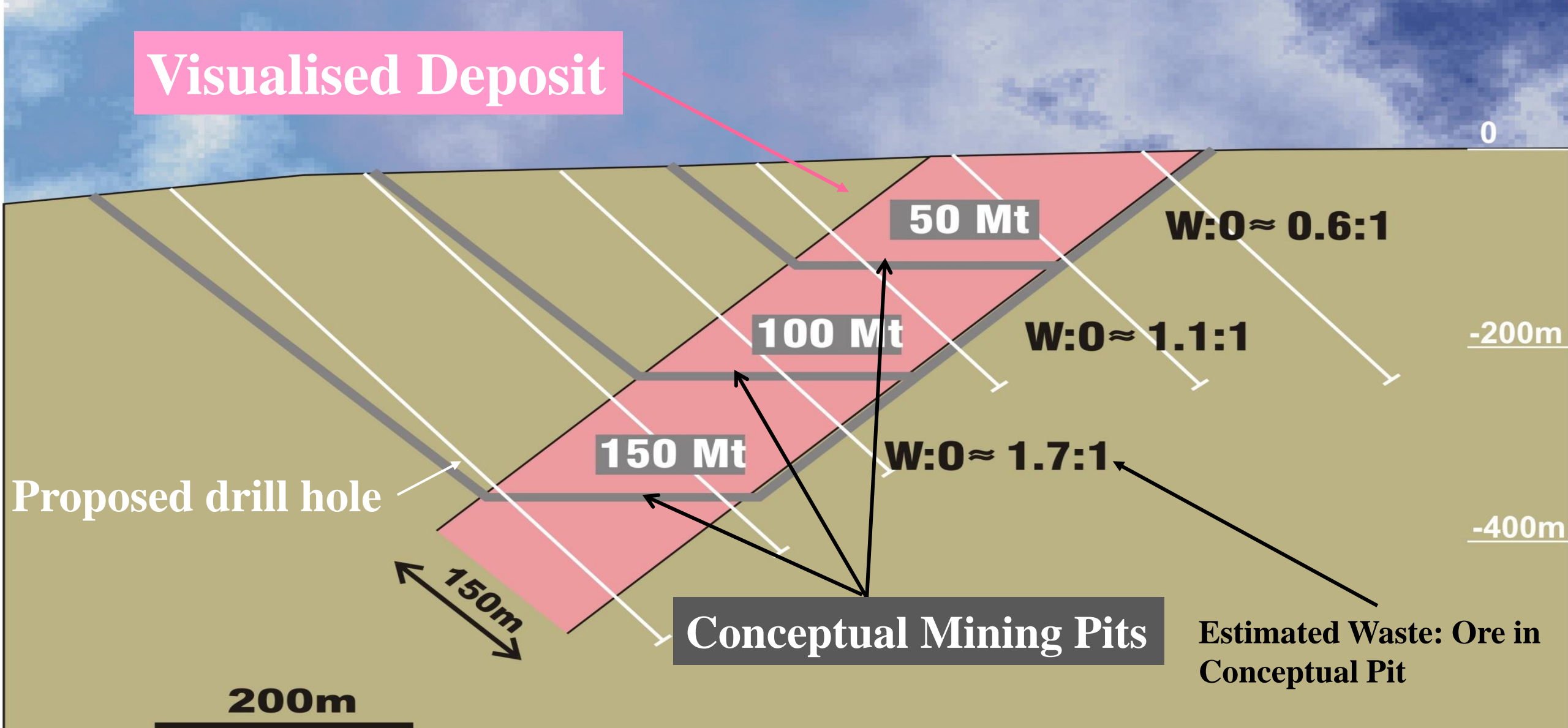
Newcrest Auger-Soil Sampling Results



Topography: crucial to interpreting results



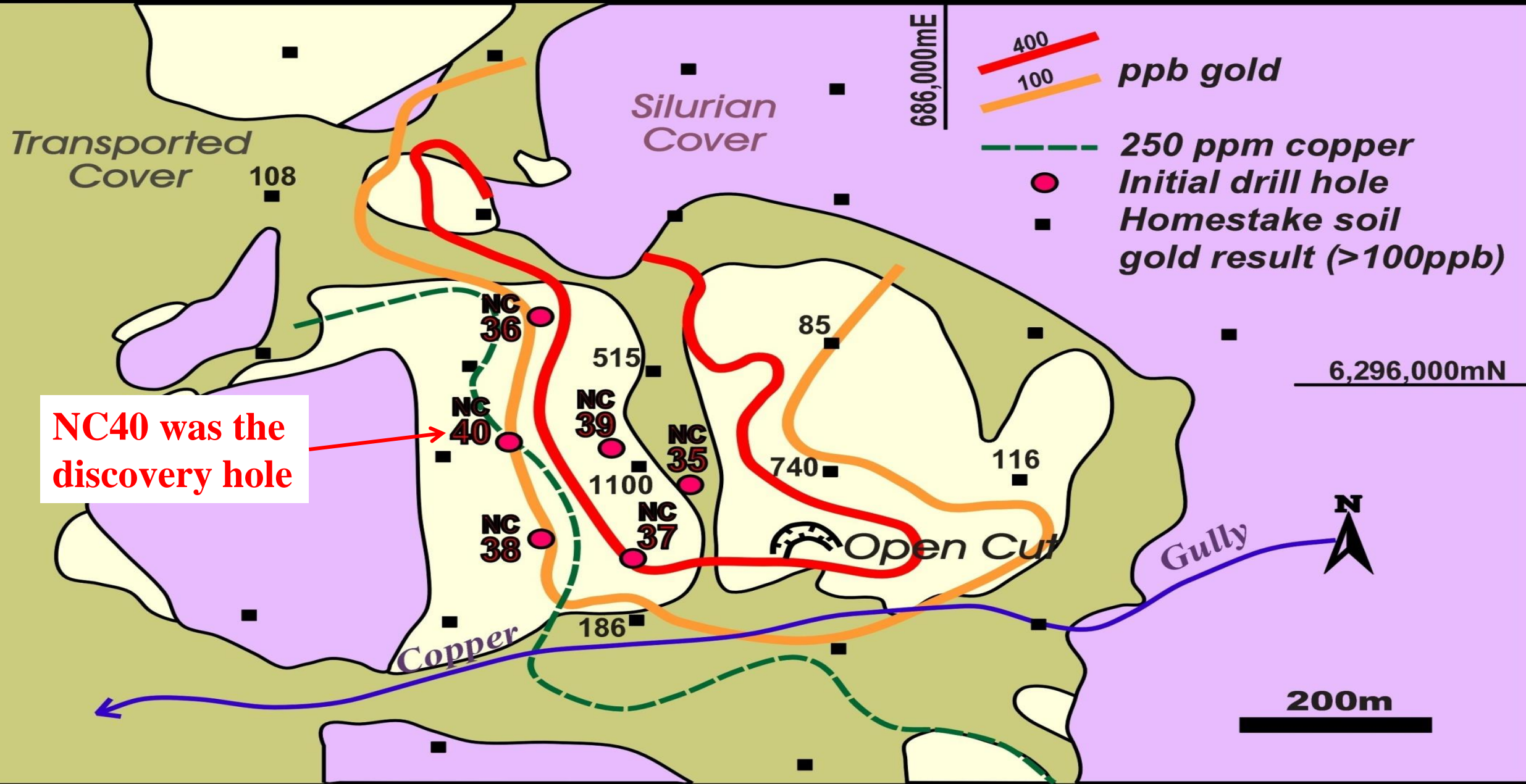
Deposit Drilling to Conceptual Mining Pit



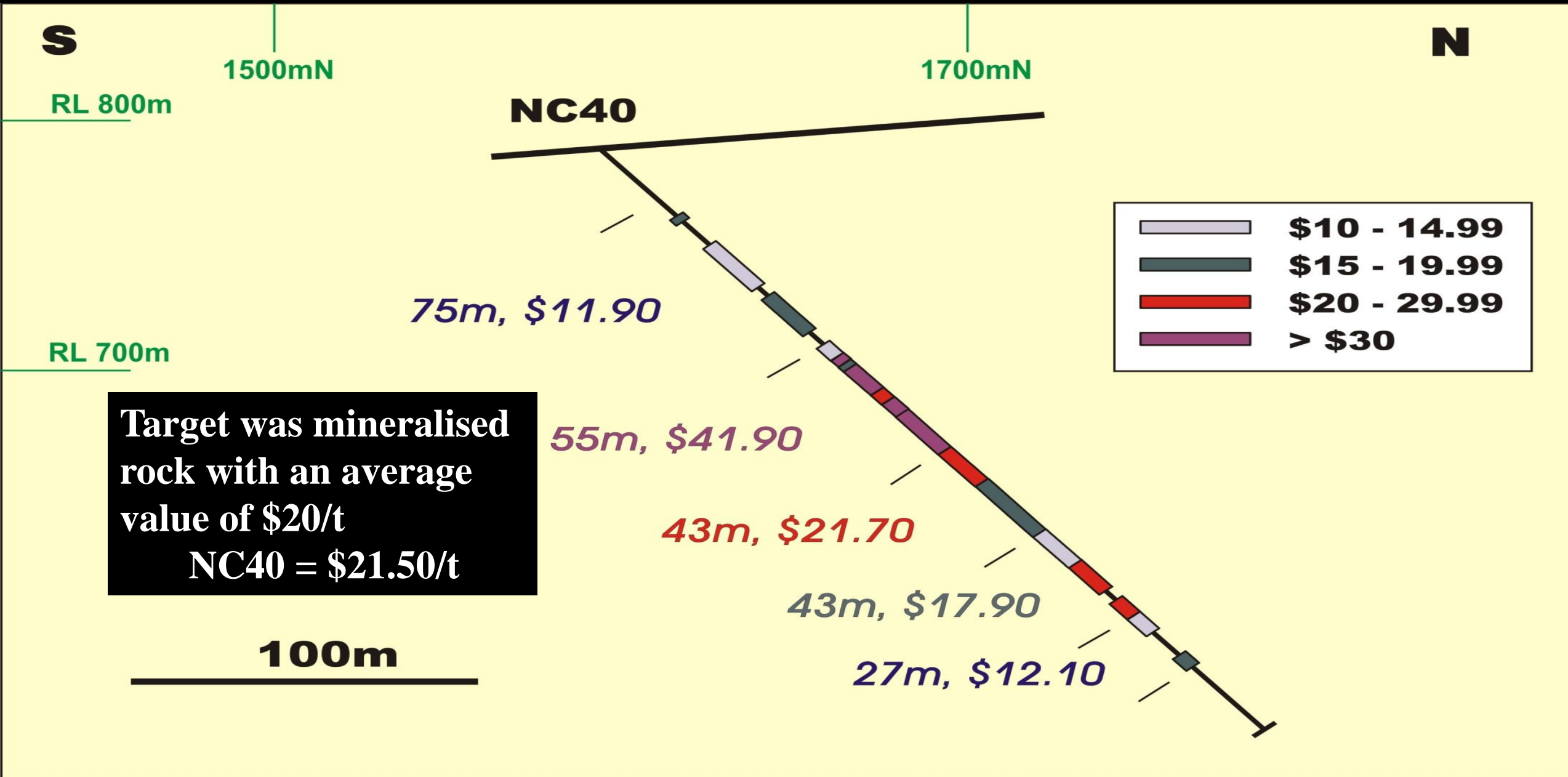
Newcrest Forest Logging prior to Drilling



First Six Holes drilled by Newcrest (NC35-40)



Discovery Hole estimated Metal Value

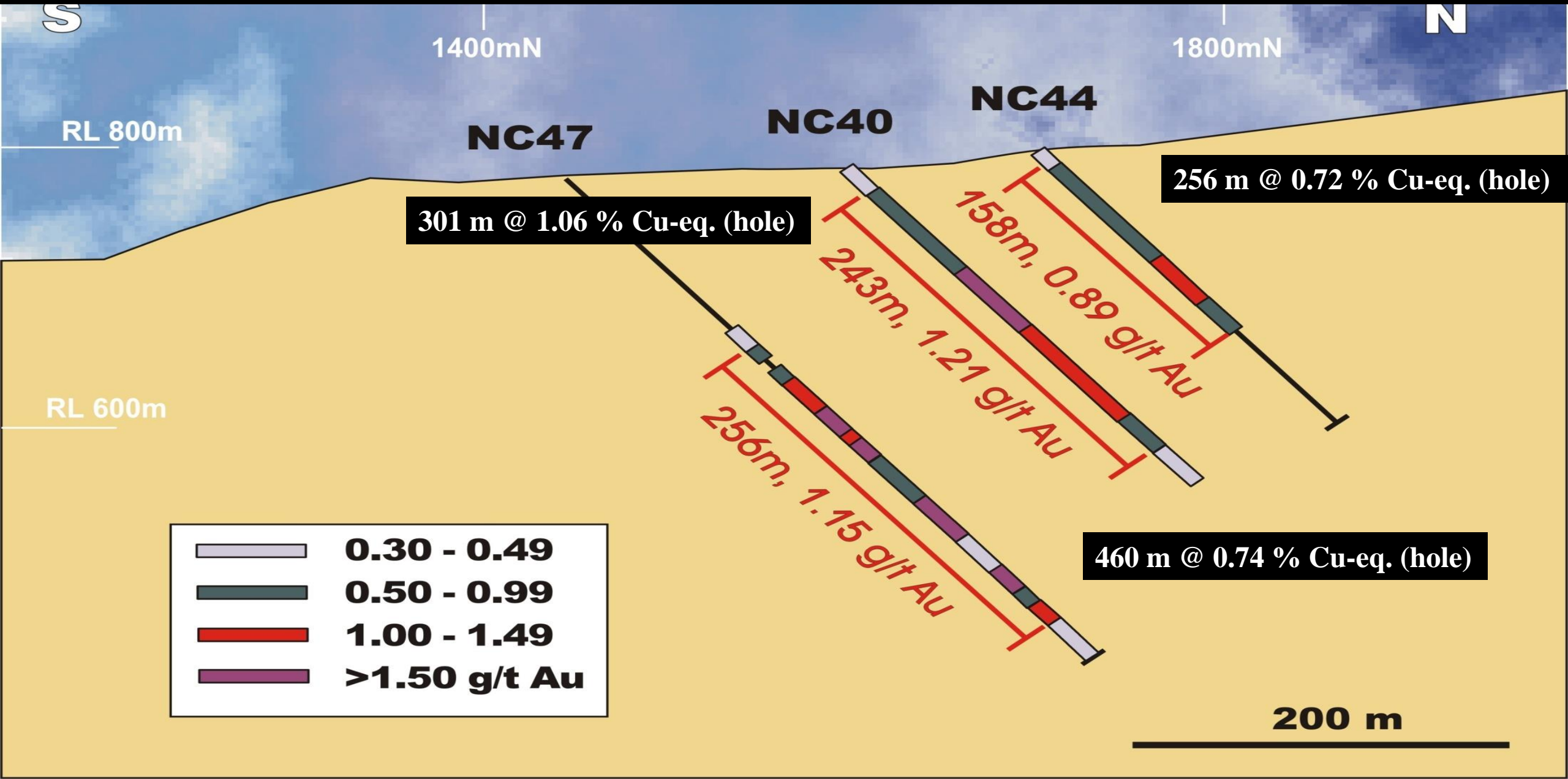


Cadia Hill sheeted-vein Au-Cu Ore: NC38

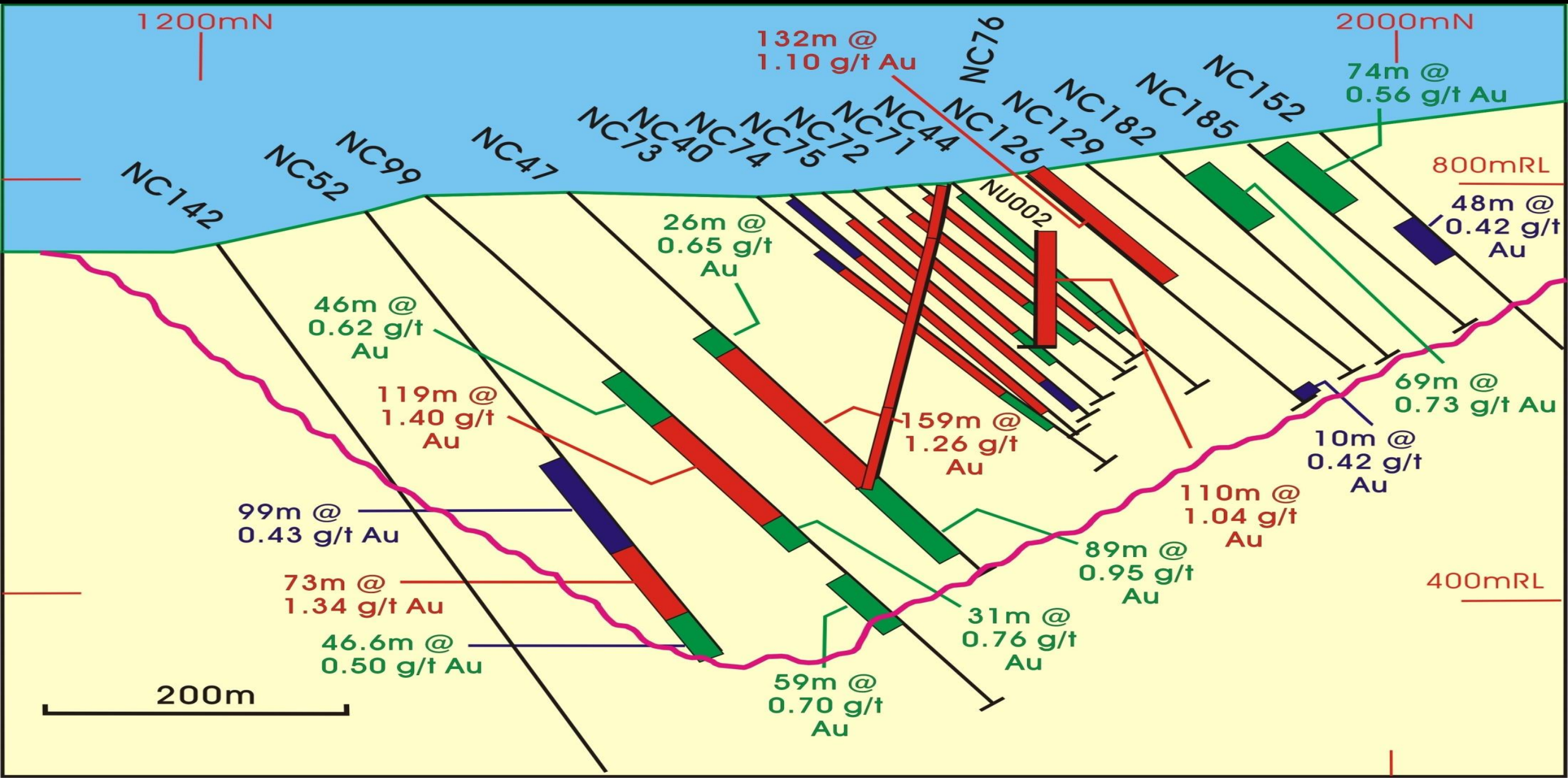


Average grade: 10 m @ 1.4 g/t Au & 0.13 % Cu = 1.36 % Cu-equivalent

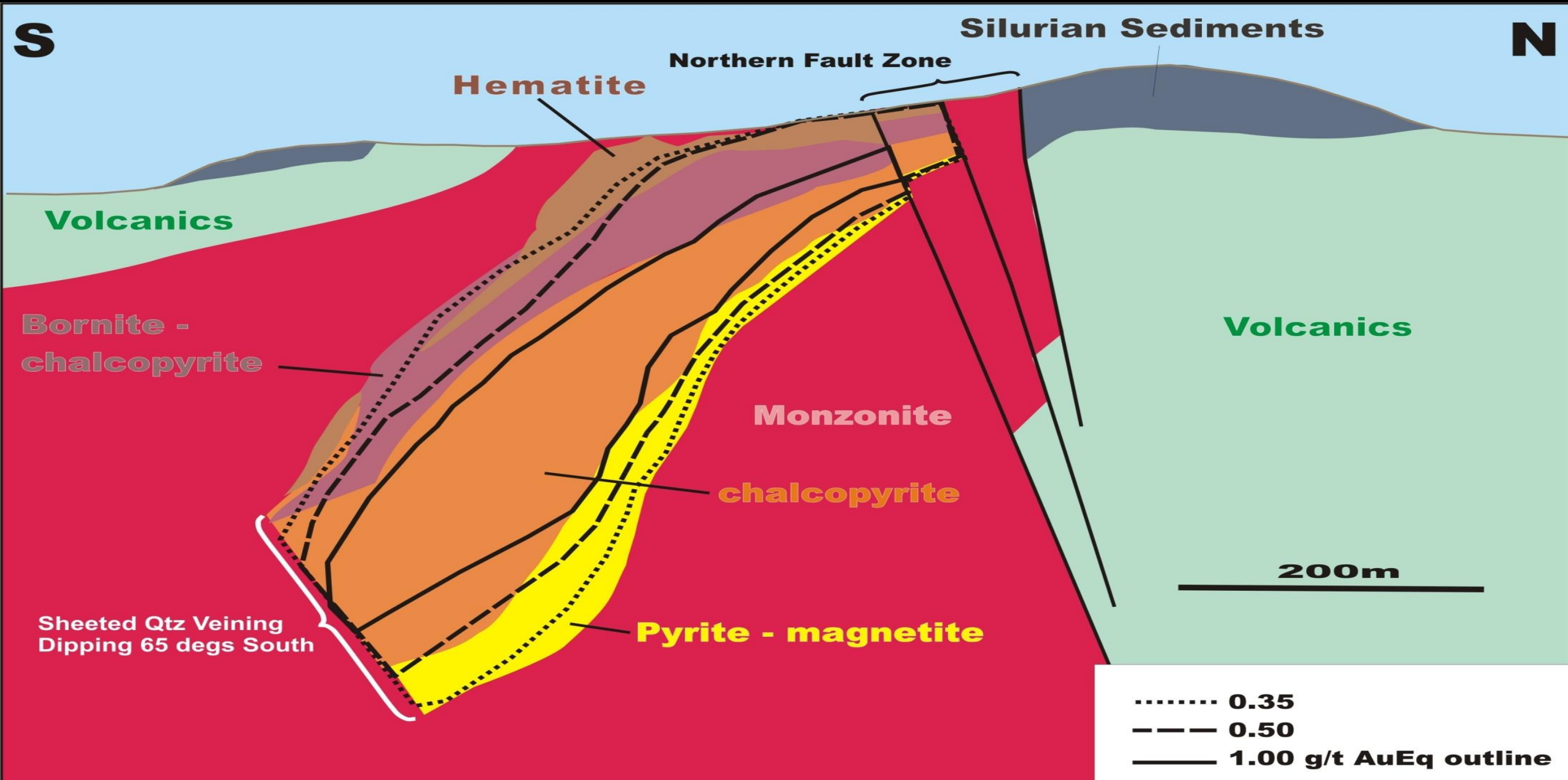
Cadia Hill Discovery Drill Section: 14,020E



Cadia Hill: Discovery Section Au & pit



Cadia Hill: Schematic Au-equivalent Section



Cadia Discovery & Feasibility Study Offices



**Metallurgist's & Engineers'
demountable office**

**Geologists' exploration office 1992-7
(later condemned)**

A central collage of casino-related items. In the center is a roulette wheel with numbers 0, 00, and 000. Surrounding it are several playing cards, including the Ace of Spades, Ace of Clubs, Ace of Hearts, and Ace of Diamonds. There are also several red and white checkered chips, blue and white checkered chips, and two red dice. A yellow ring is draped around the roulette wheel. The entire scene is set against a dark green background.

Discovery of Cadia East Deposit

-  Basalt
-  Cadia Coach Shale
-  Volcaniclastics
-  Cadia Hill Monzonite
-  Magnetite Skarn
-  Newcrest Diamond Hole

NC220

500 m

CE_DRILL.CDR
May 2001

**CADIA
HILL**

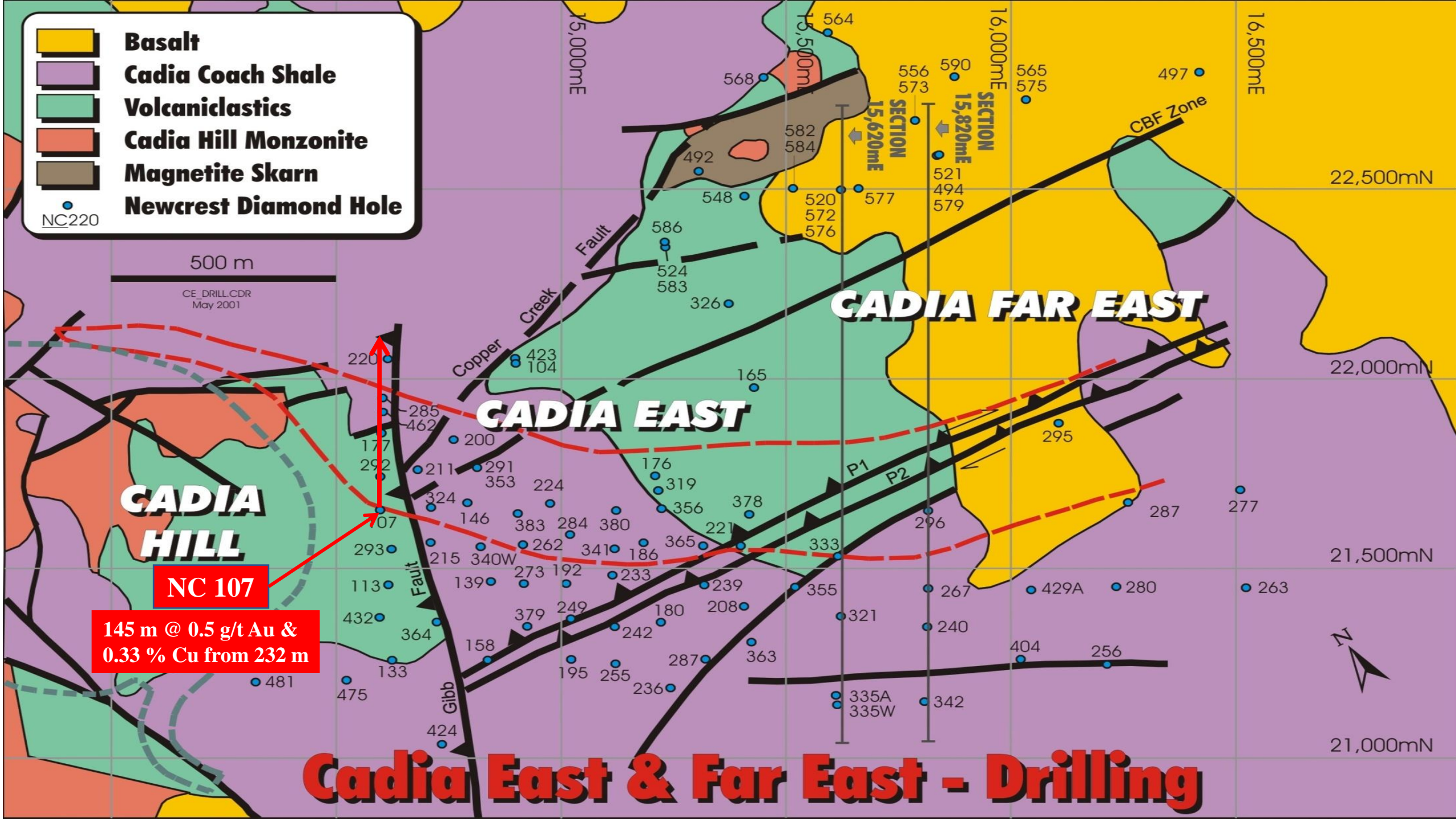
NC 107

**145 m @ 0.5 g/t Au &
0.33 % Cu from 232 m**

CADIA EAST

CADIA FAR EAST

Cadia East & Far East - Drilling

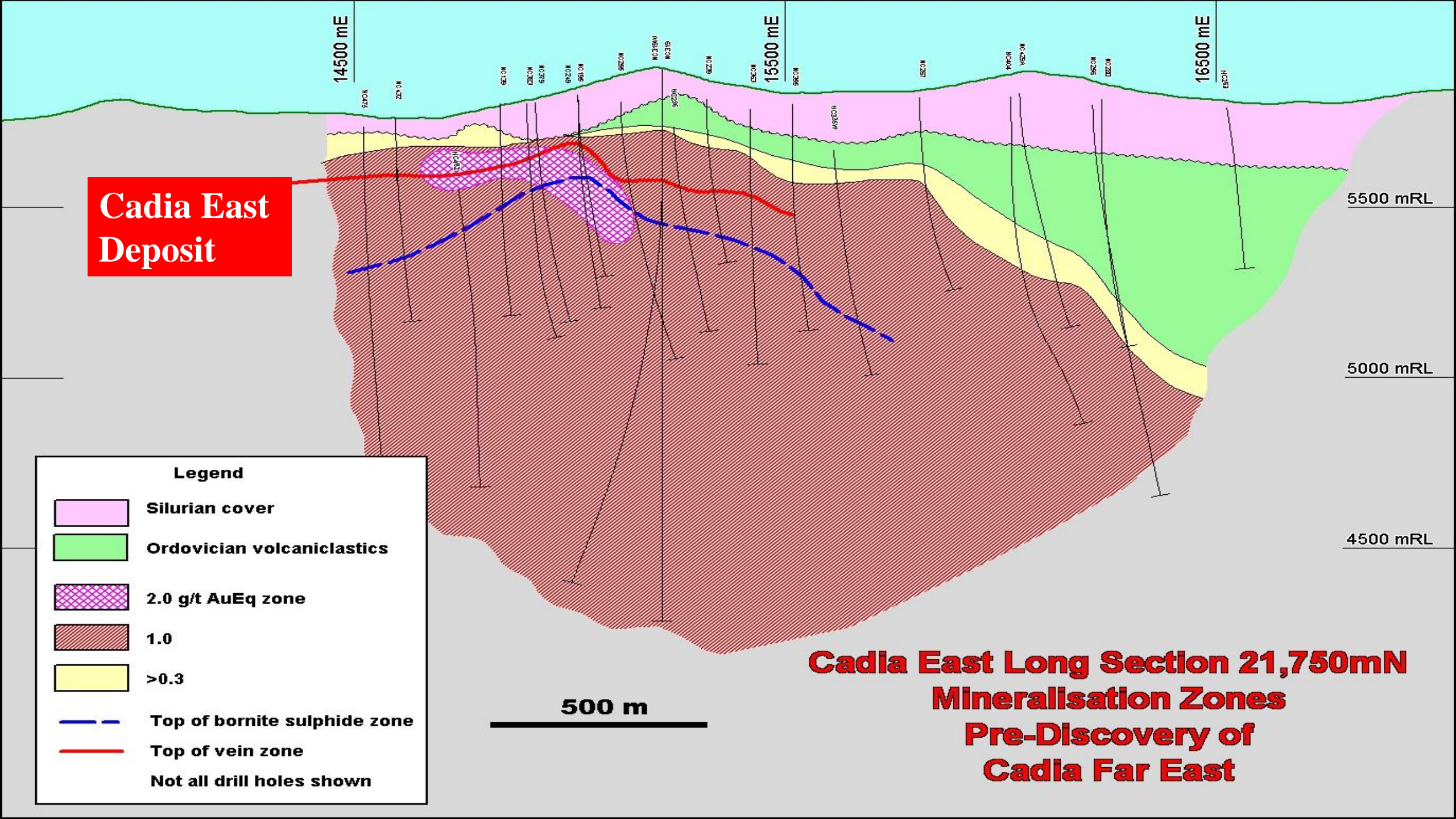


**Cadia East
Deposit**

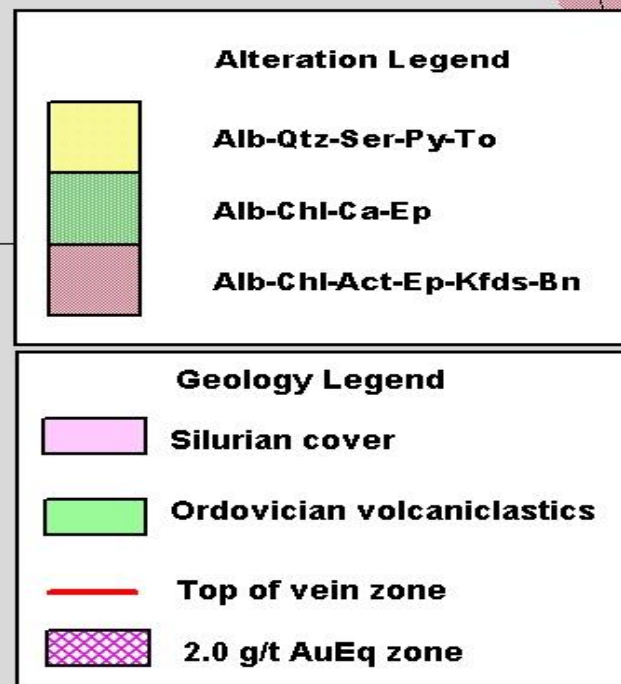


500 m

**Cadia East Long Section 21,750mN
Mineralisation Zones
Pre-Discovery of
Cadia Far East**

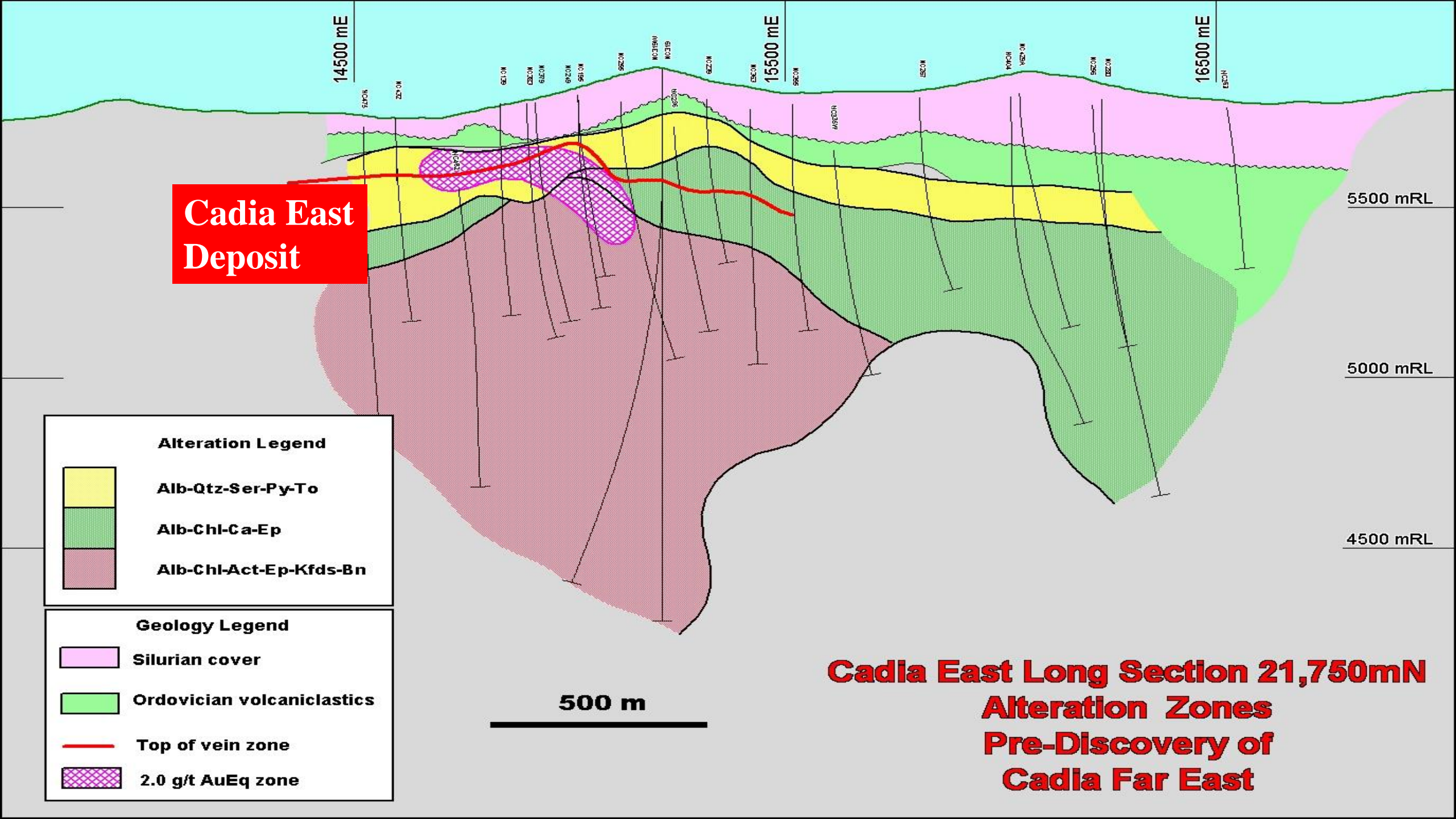


Cadia East Deposit



500 m

Cadia East Long Section 21,750mN
Alteration Zones
Pre-Discovery of
Cadia Far East



A central collage of casino-related items. In the center is a roulette wheel with numbers 0, 00, and 000. Surrounding it are several playing cards, including the Ace of Clubs, Ace of Hearts, and Ace of Diamonds. There are also several red and white checkered chips, blue and white checkered chips, and two red dice. The entire scene is set against a dark green background.

Mineral Resource
Inferred 1.9 Moz Au, late-1995



Cadia East

**Eventually 4.6 Moz Au & 1.1 Mt Cu
320 Mt @ 0.45 g/t Au & 0.36 % Cu
Potential Open Pit Deposit**



**Cadia Hill
Betting the Company
On Low Grade**



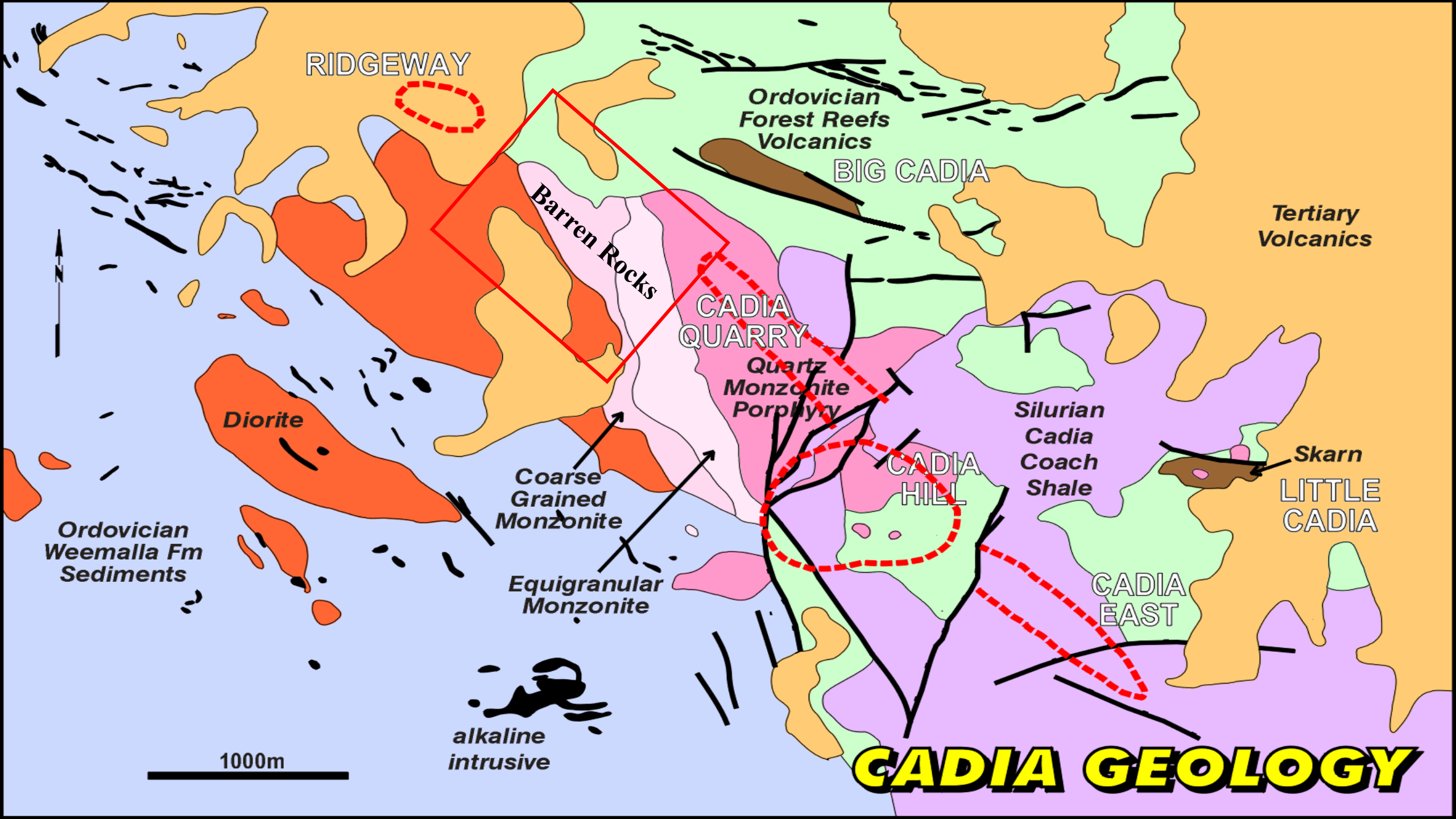
**Higher Grade
Would Help**



**Cadia East
Wouldn't add Grade**



**Search Re-directed
Under Basalt to NW**



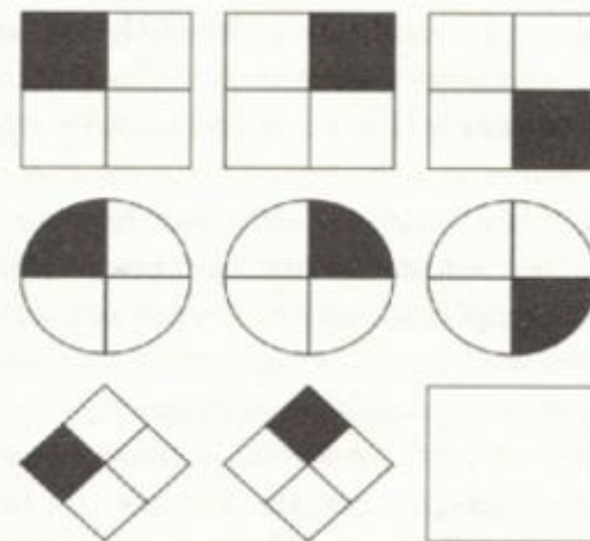


Pattern Recognition & Mineral Exploration?



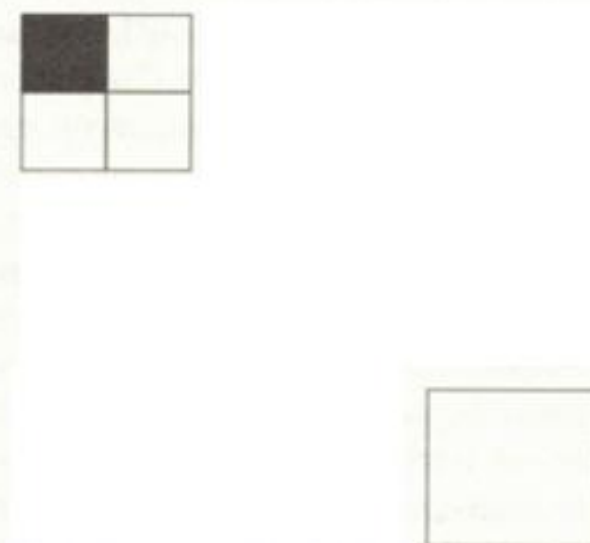
IQ Test

What pattern completes this quadrant?



Exploration

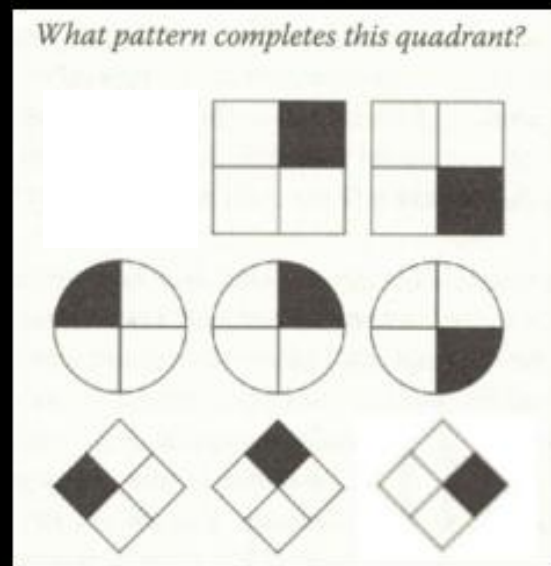
What pattern completes this quadrant?



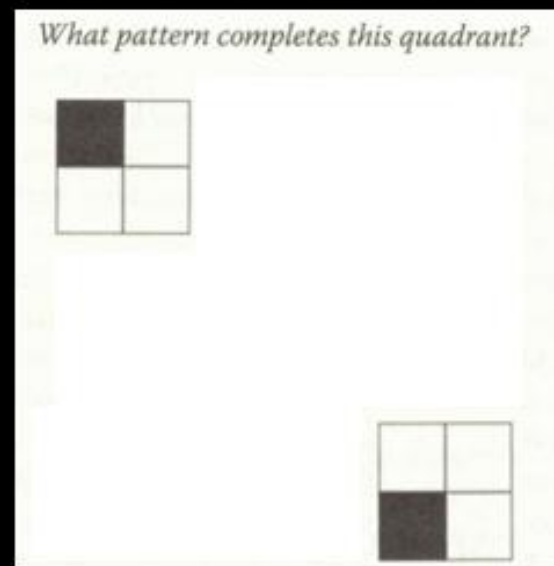


Exploration

Possibilities



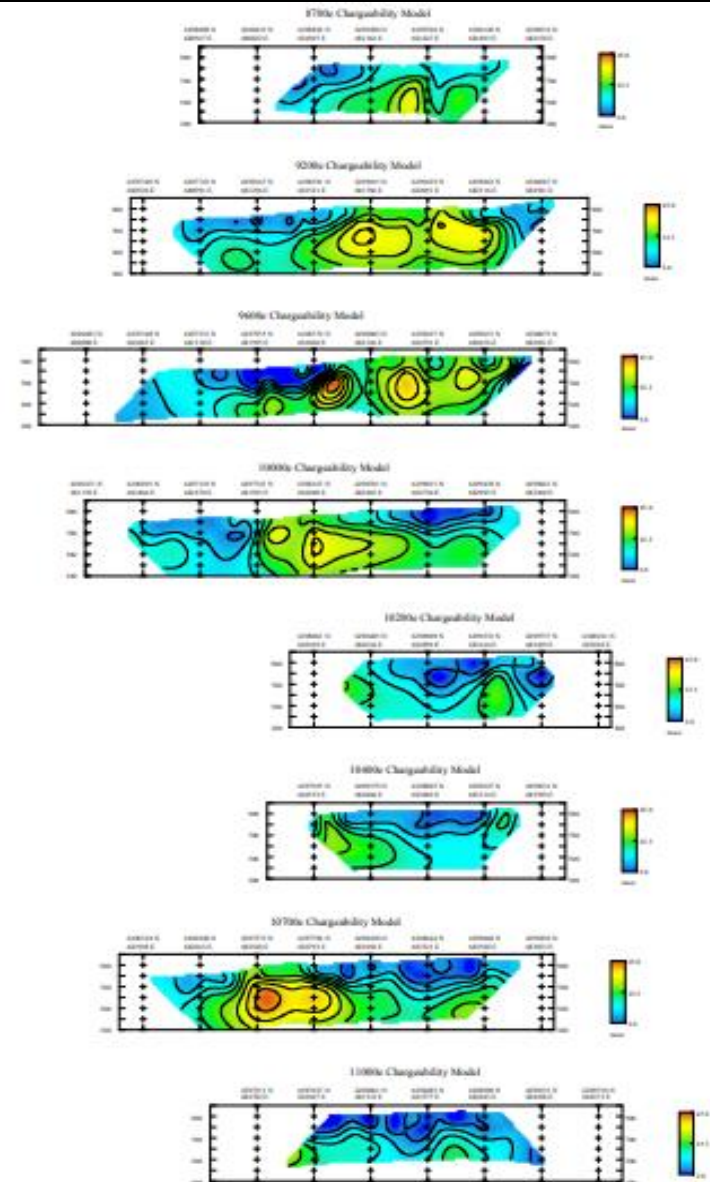
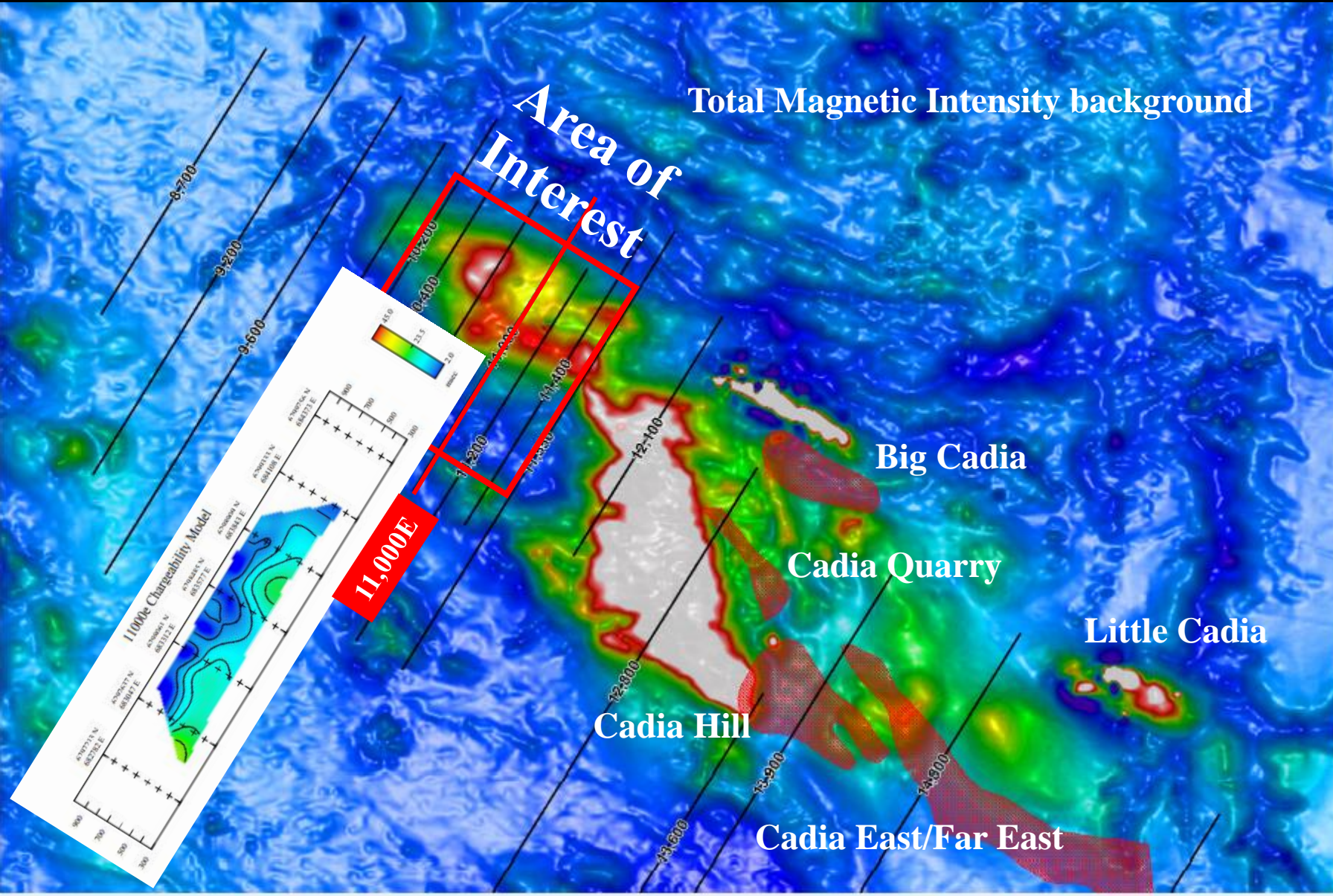
Goal



A vibrant collage of casino-themed elements. In the center is a roulette wheel with its characteristic numbered pockets in red, black, and green. Surrounding the wheel are several playing cards, including the Ace of Clubs, Ace of Hearts, and Ace of Diamonds. Scattered around are numerous poker chips in blue and white, and red and white. Two red dice are also visible. A thick yellow ring encircles the central roulette wheel. The entire composition is set against a dark green background, reminiscent of a casino table.

Discovery of Ridgeway Deposit

Cadia Valley Induced Polarisation Chargeability



CADIA - RIDGEWAY

LINE 11,000E

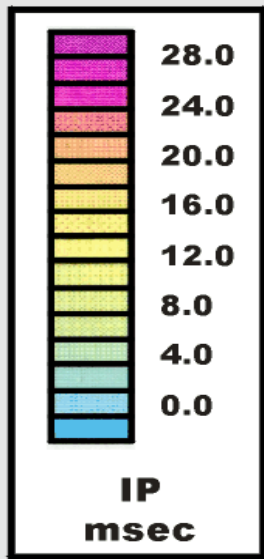
DIPOLE - DIPOLE PSEUDO SECTION

APPARENT CHARGEABILITY
(mSECS)

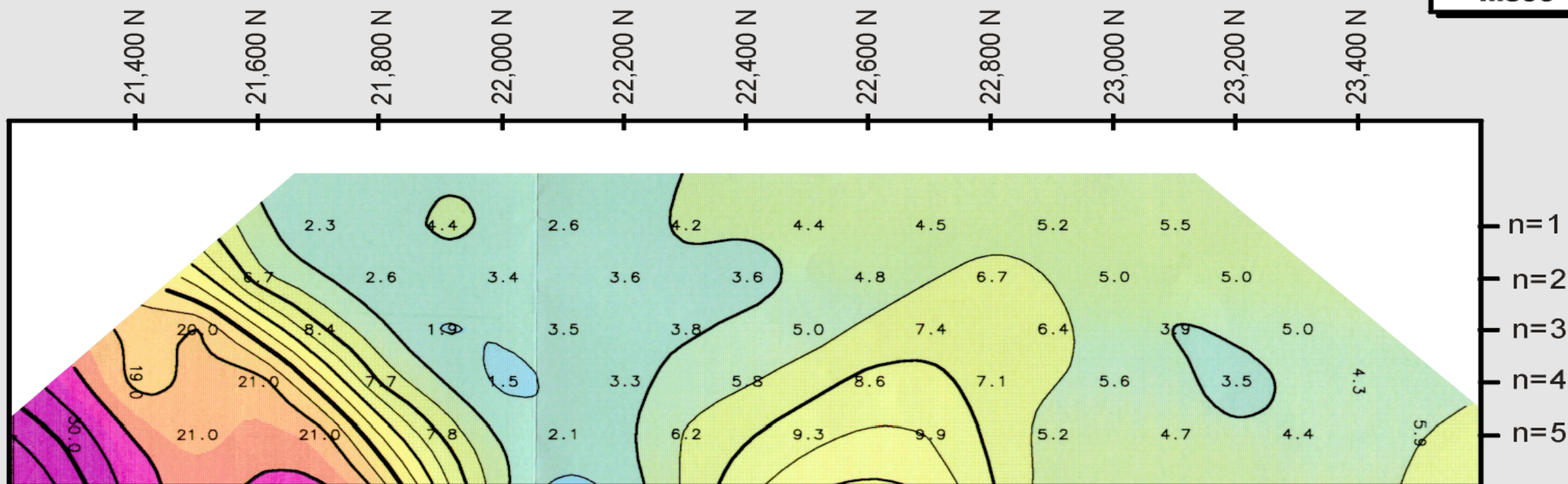
IP chargeability didn't detect the Ridgeway ore deposit which is located 500 m below surface.

The IP method used (200m dipole-dipole) could only detect to <400 m depth.

The IP chargeability detected pyrite in the alteration halo to the ore deposit.

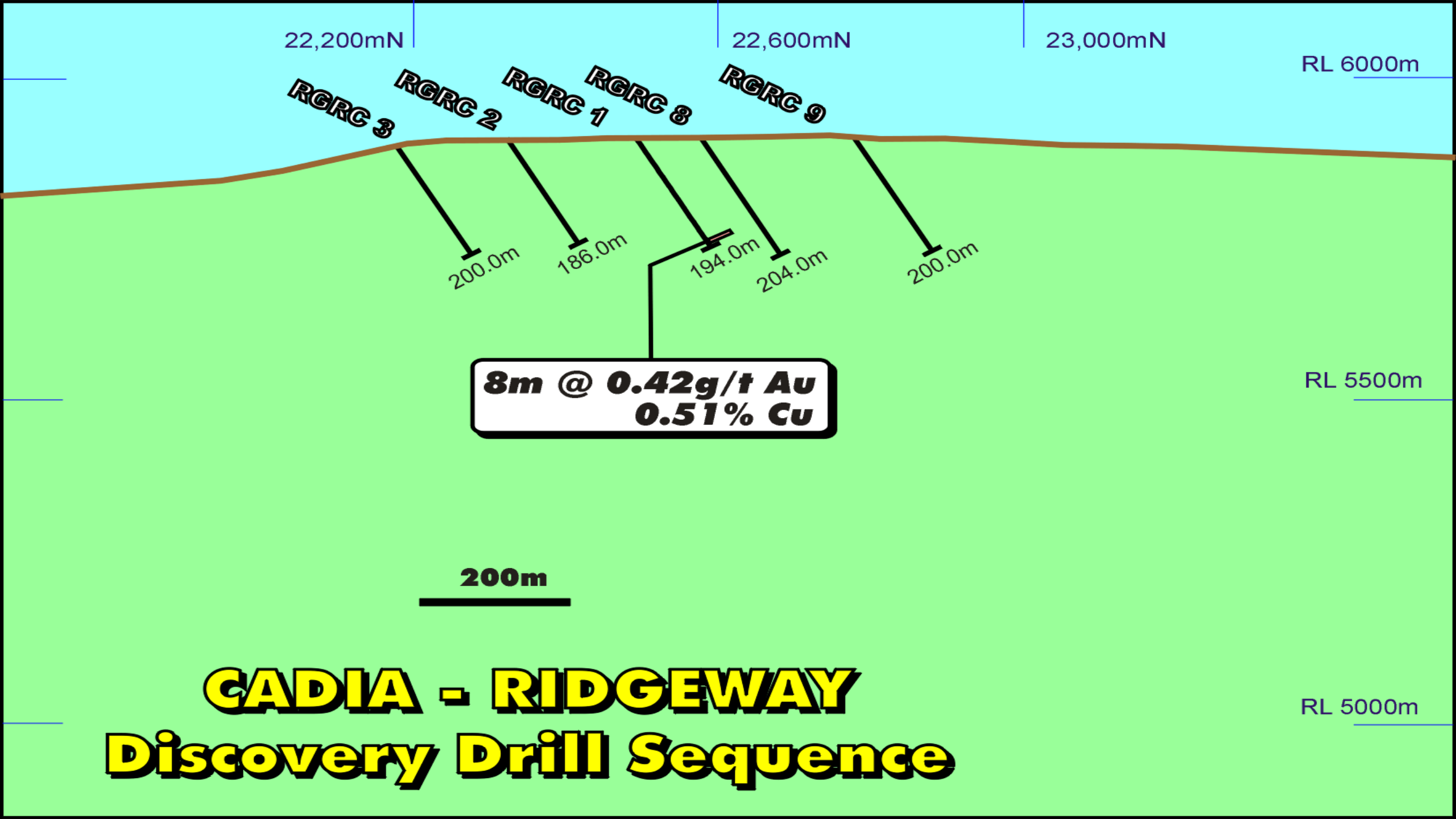


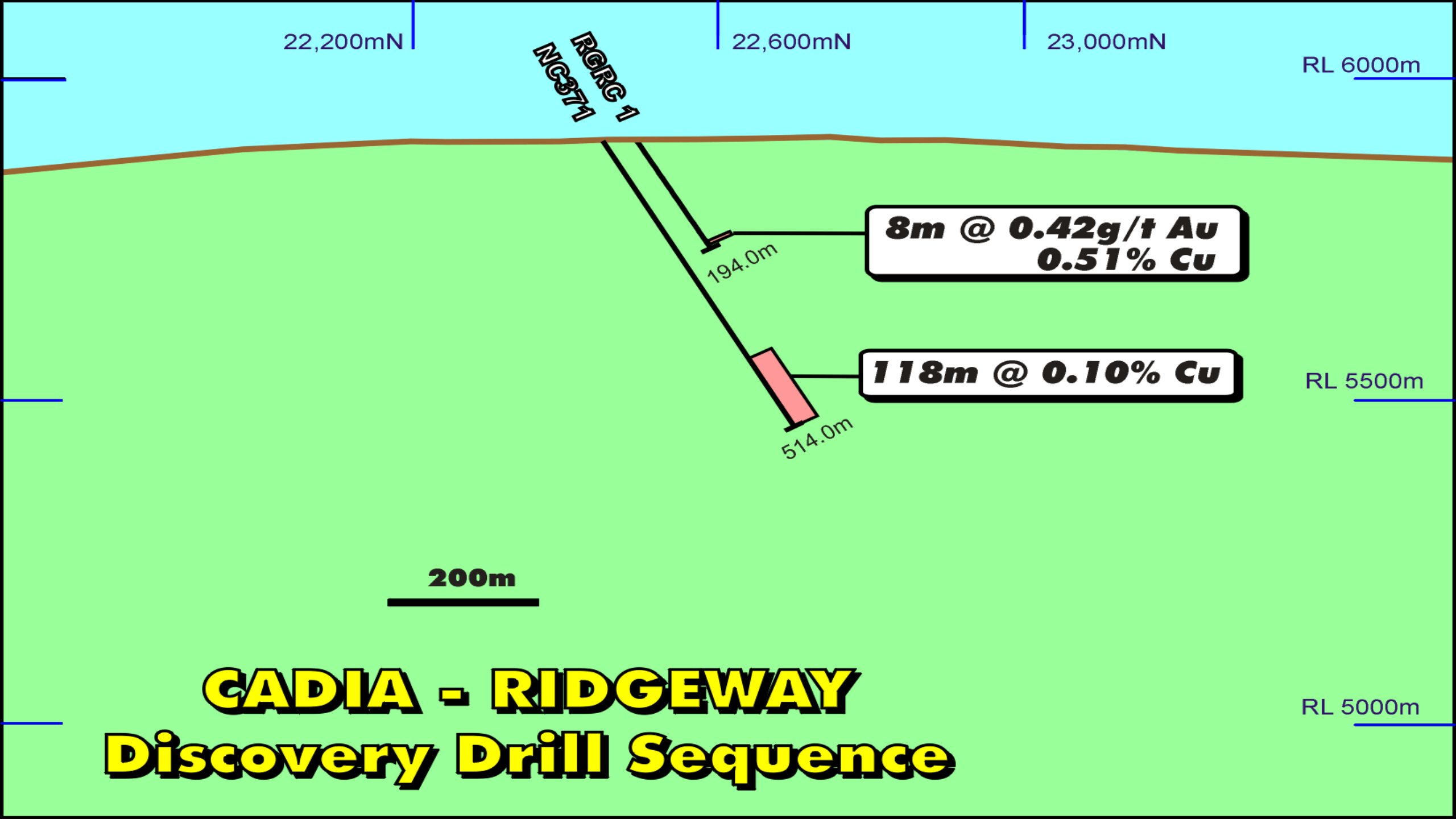
Ridgeway

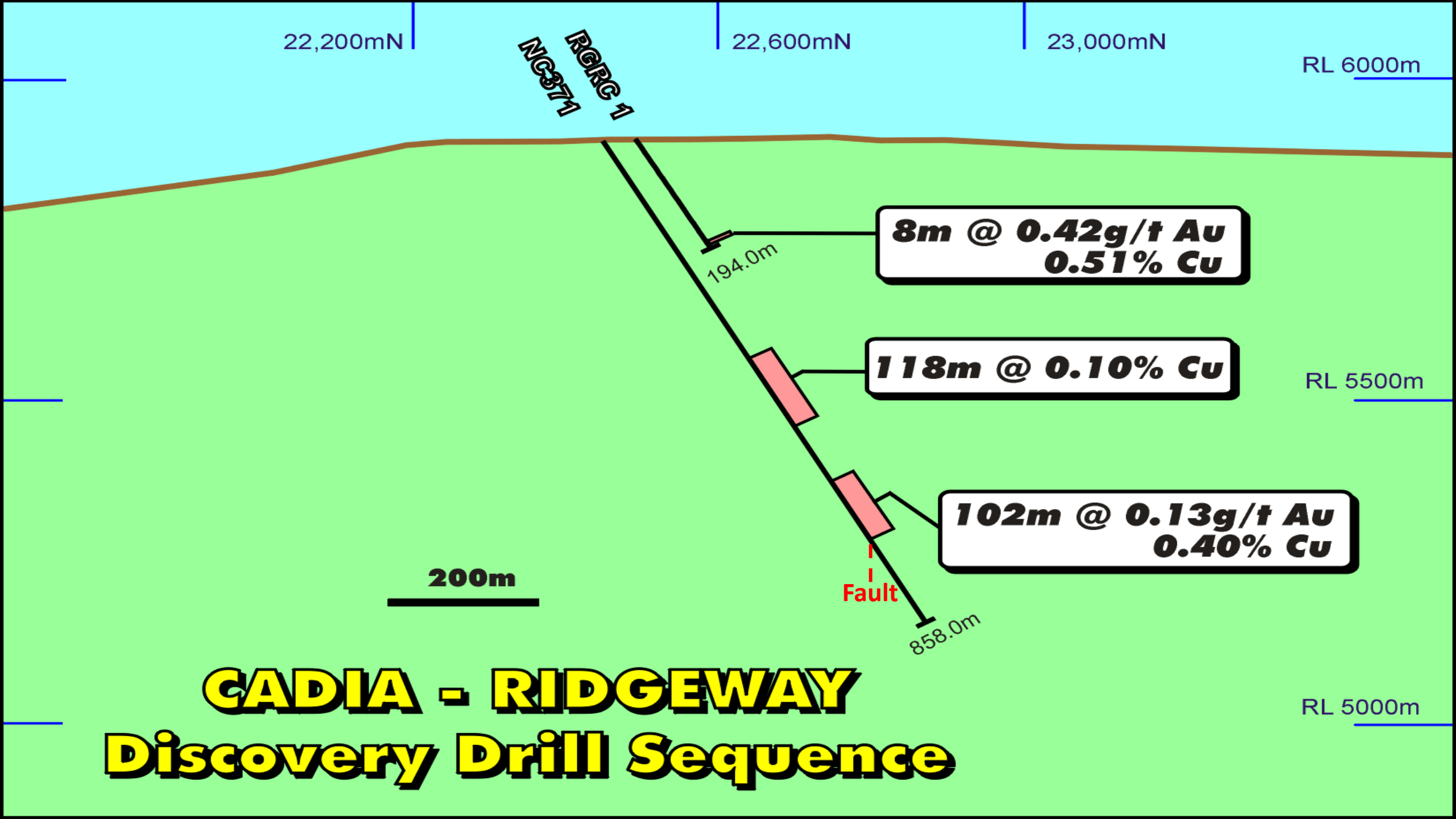


CONTOUR INTERVAL : 2mSECS

400 m





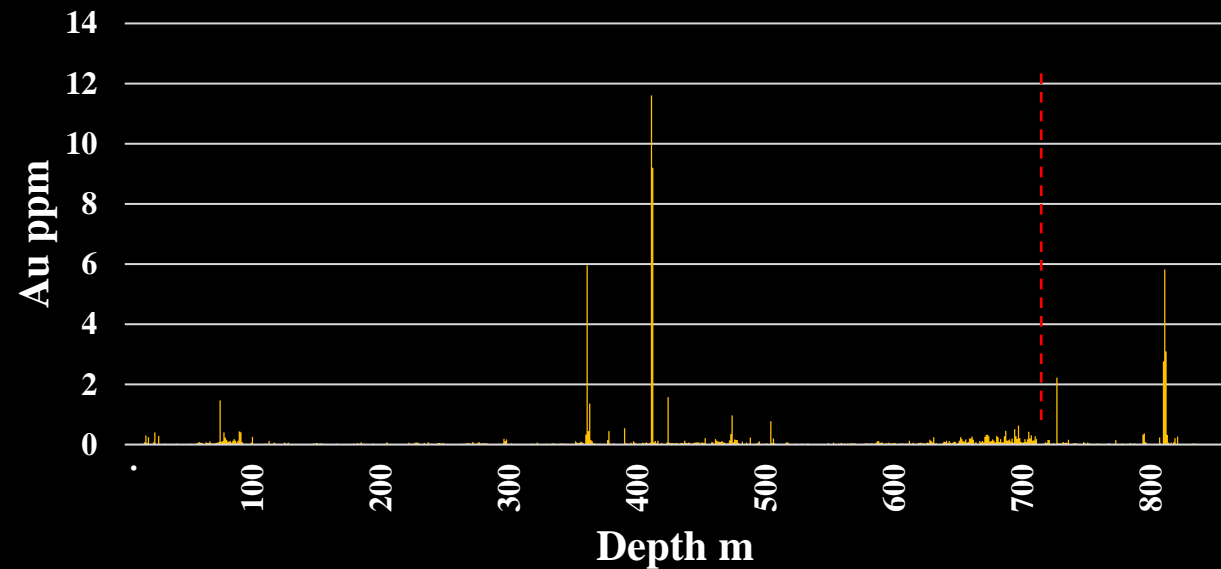
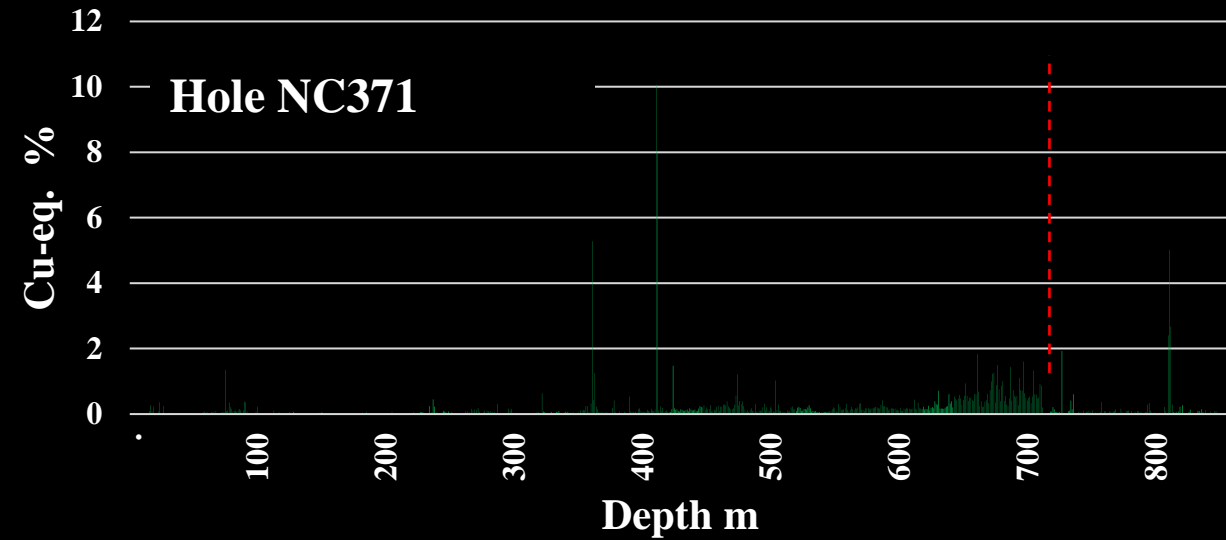
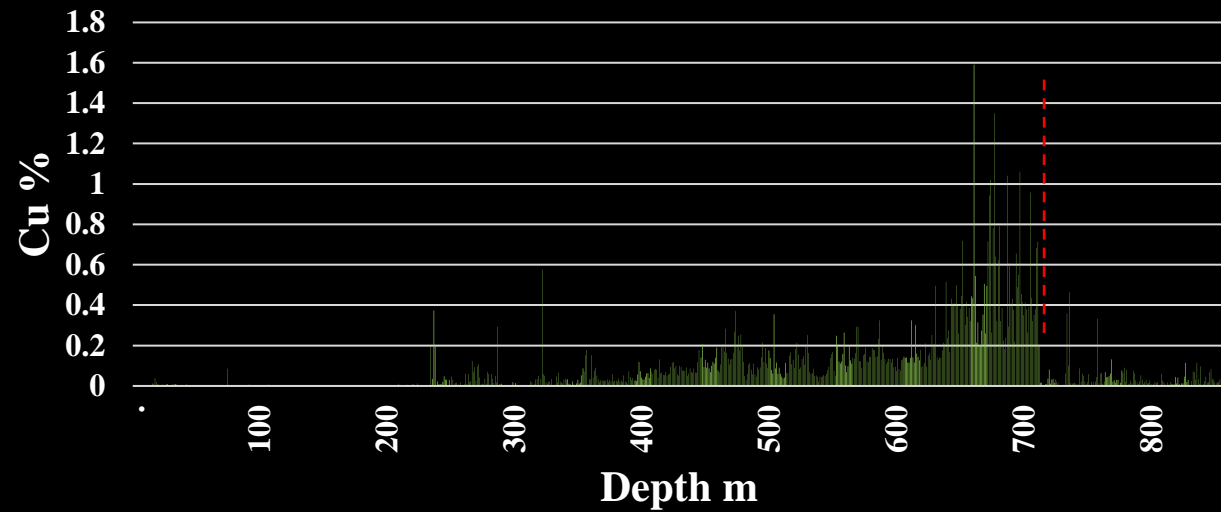




Decision Time

- **Negatives:** Deep intersection; low grade (0.4 % Cu); narrow (102 m)
- **Positives:** Encouraging alteration (red rock); improving grade
- **Intuition:** Drill additional holes

Intuition-supporting Evidence



Key elements

- Fault
- High Cu
- Au spikes

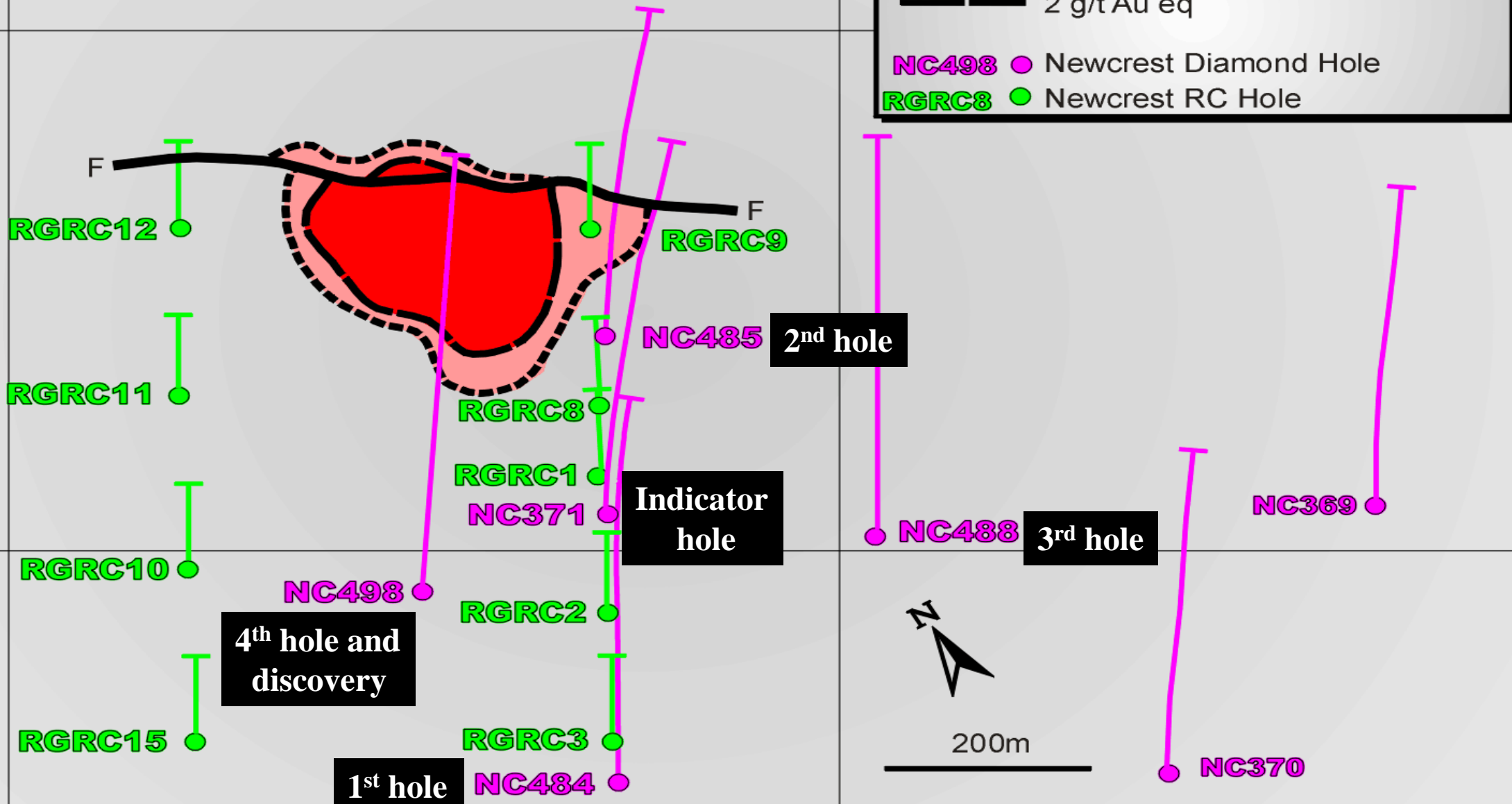
10,600mE

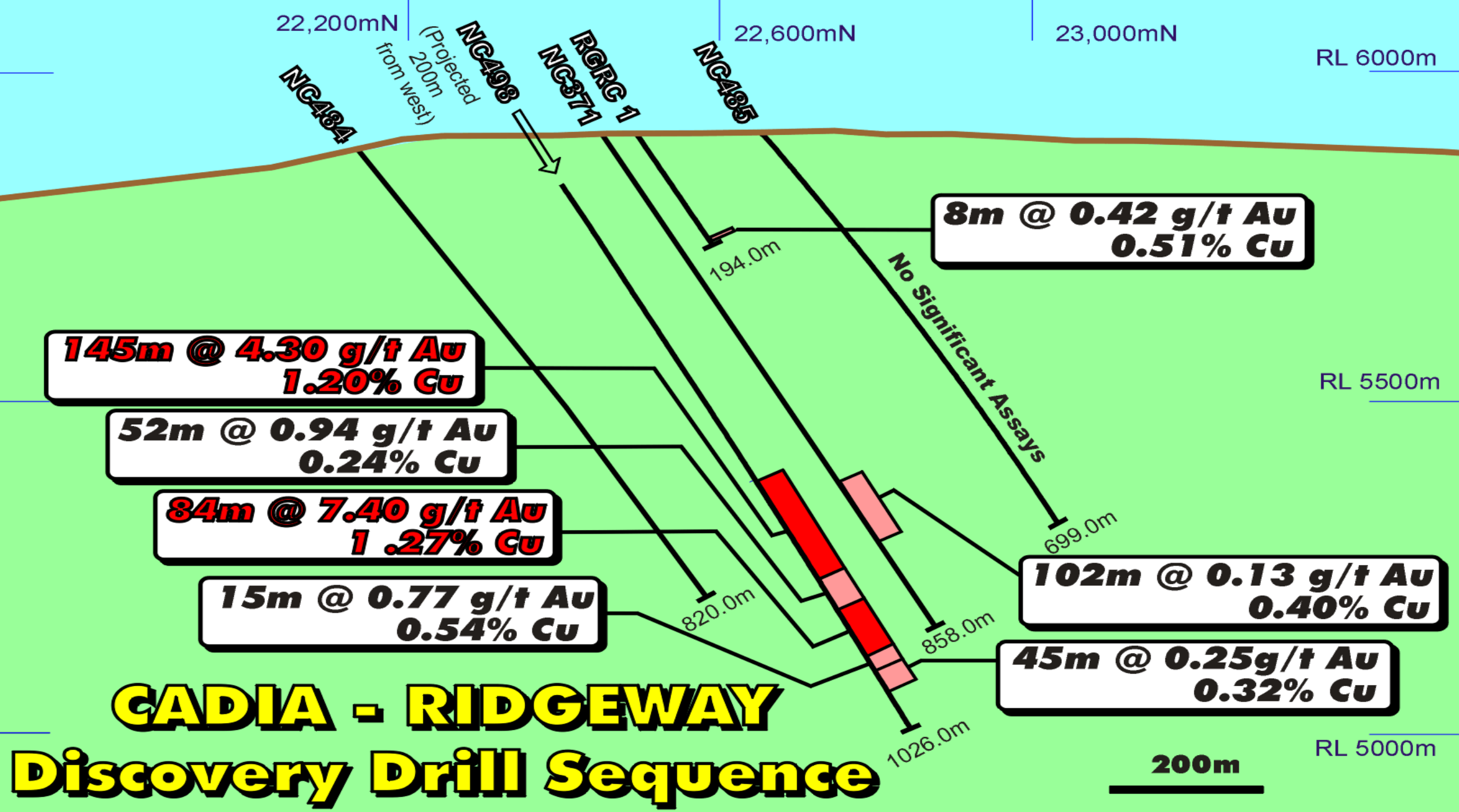
11,400mE

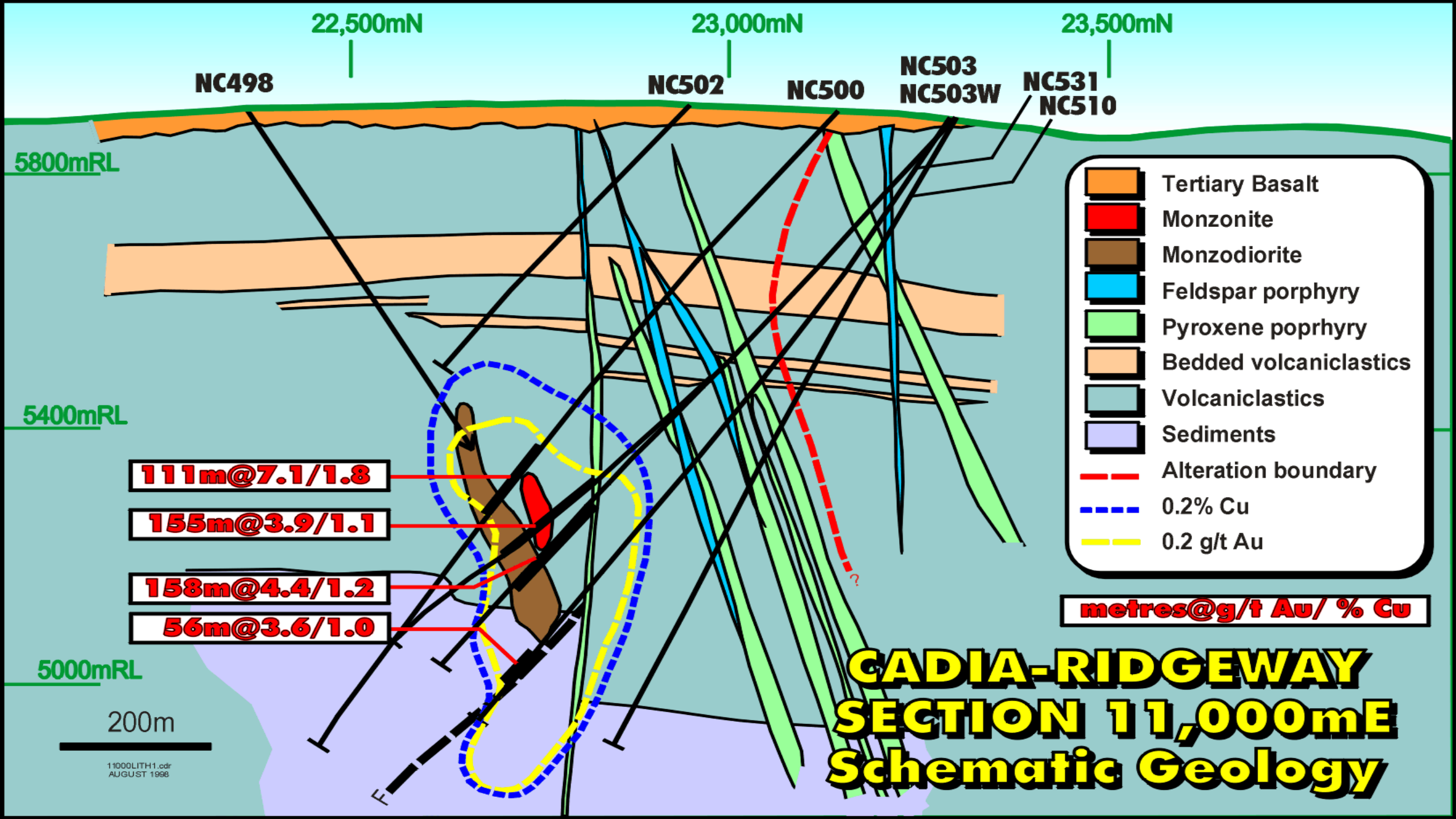
DISCOVERY DRILLING CADIA RIDGEWAY

23,000mN

22,400mN





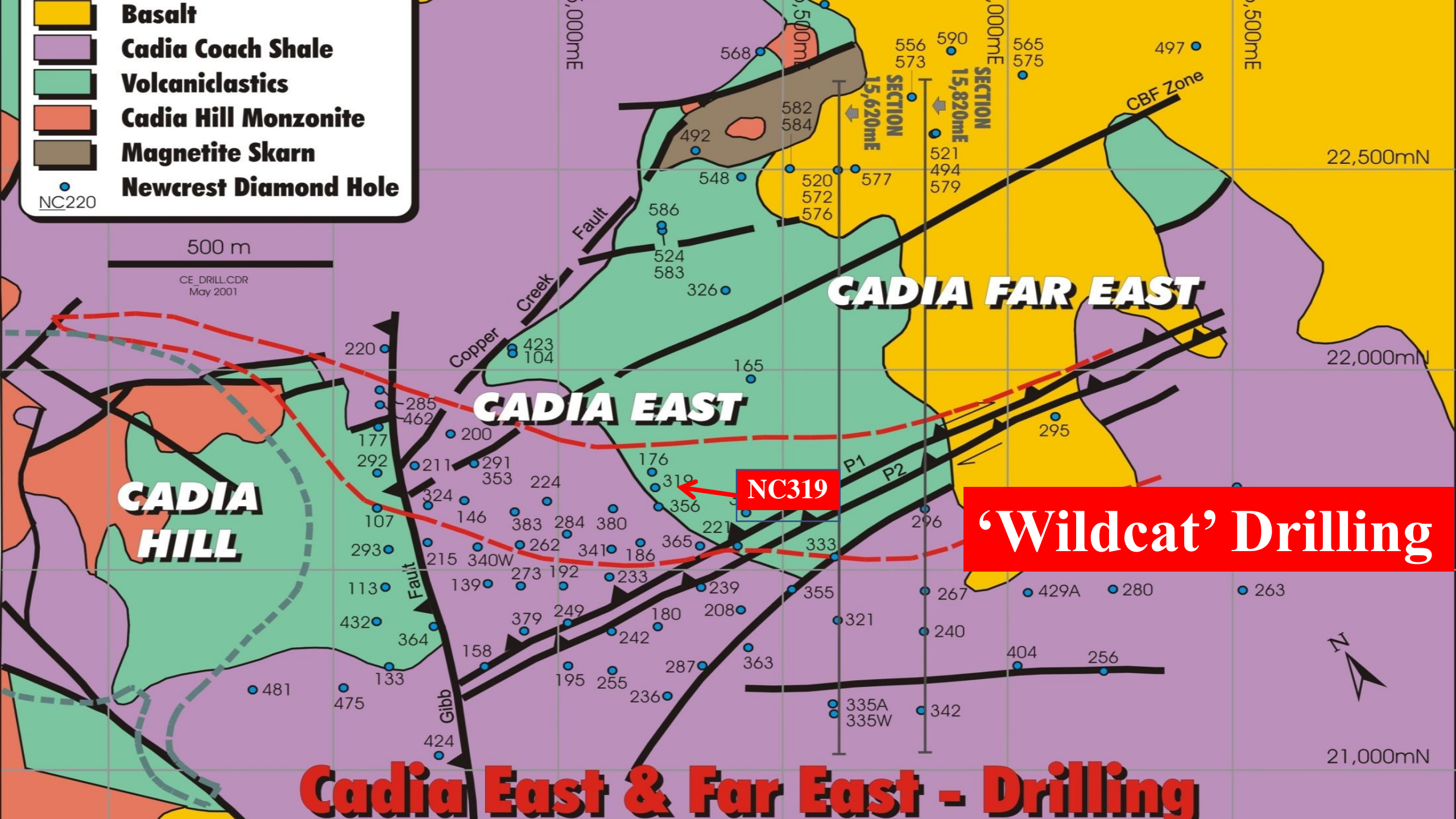


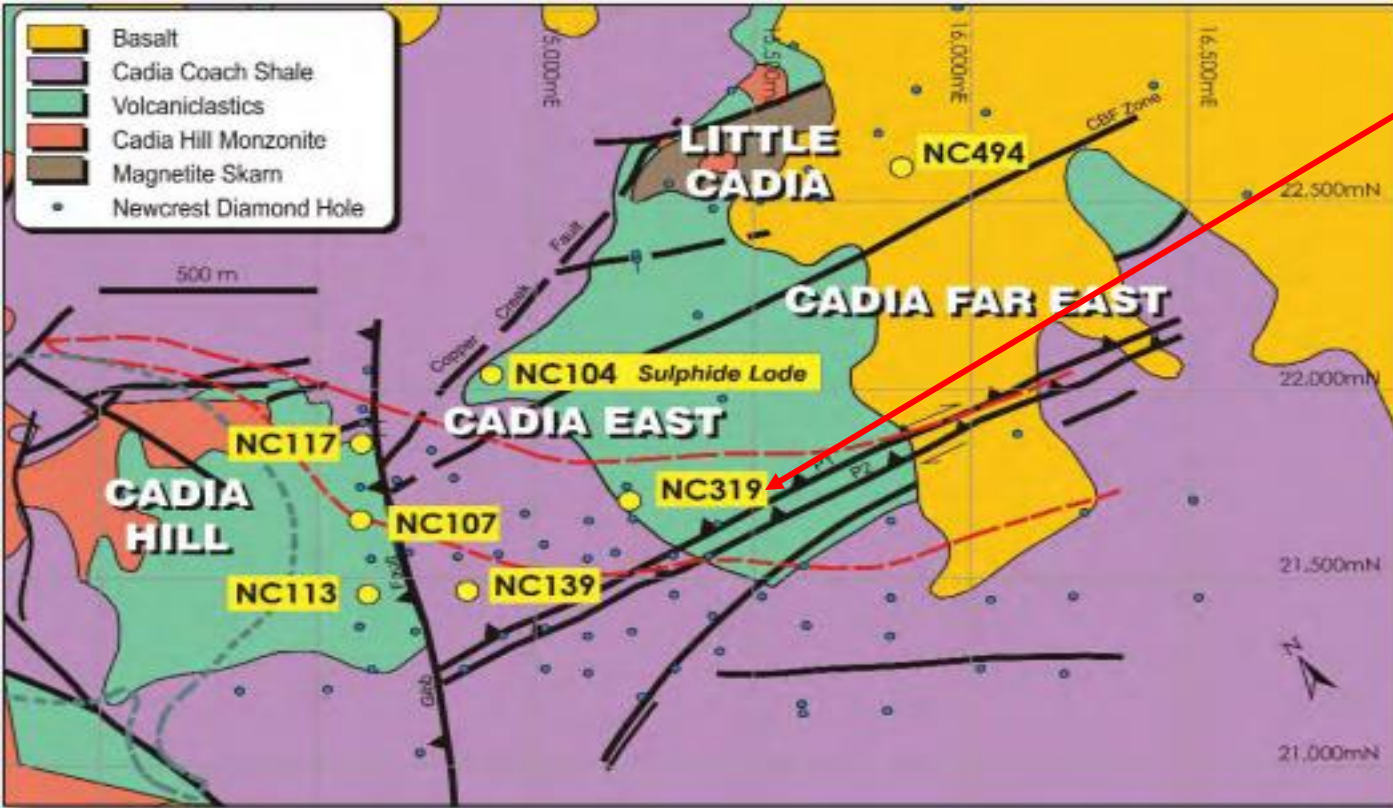


Ridgeway Cave Zone 2004

A central collage of casino-related items. In the center is a roulette wheel with numbers 0, 00, and 000. Surrounding it are several playing cards, including the Ace of Spades, Ace of Clubs, Ace of Hearts, and Ace of Diamonds. There are also several red and white checkered chips, blue and white checkered chips, and two red dice. The entire scene is set against a dark green background.

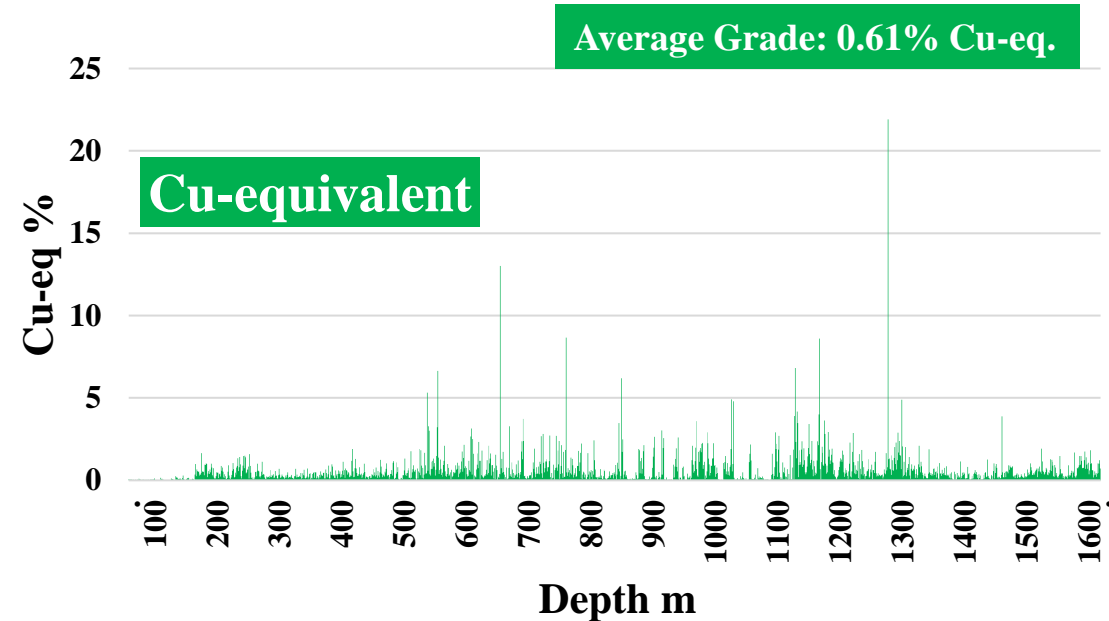
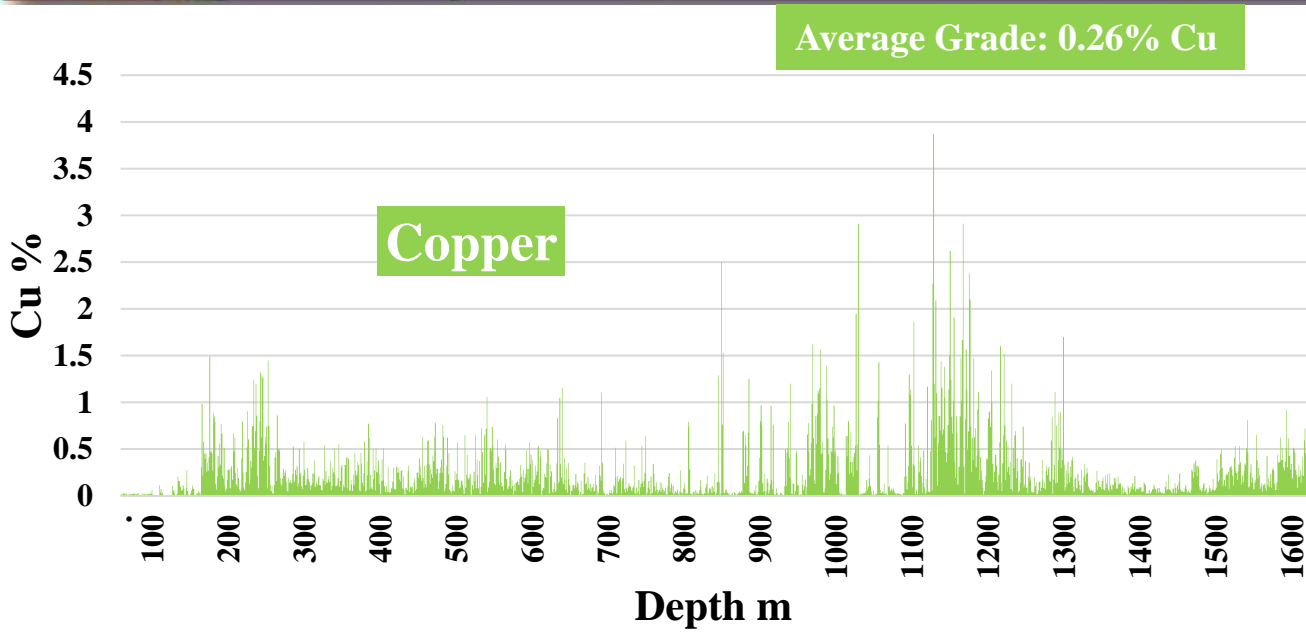
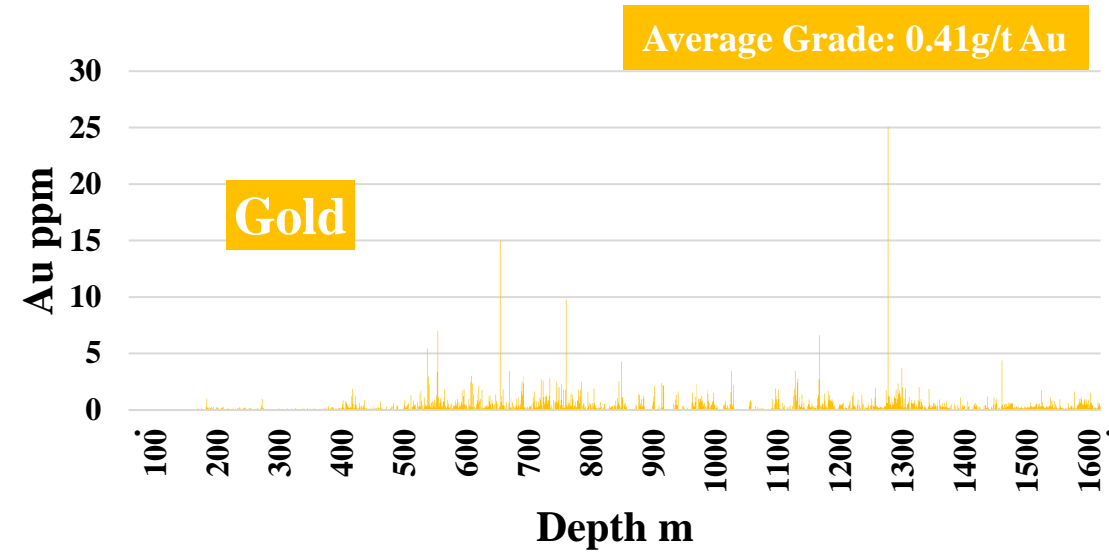
Discovery of Cadia Far East Deposit

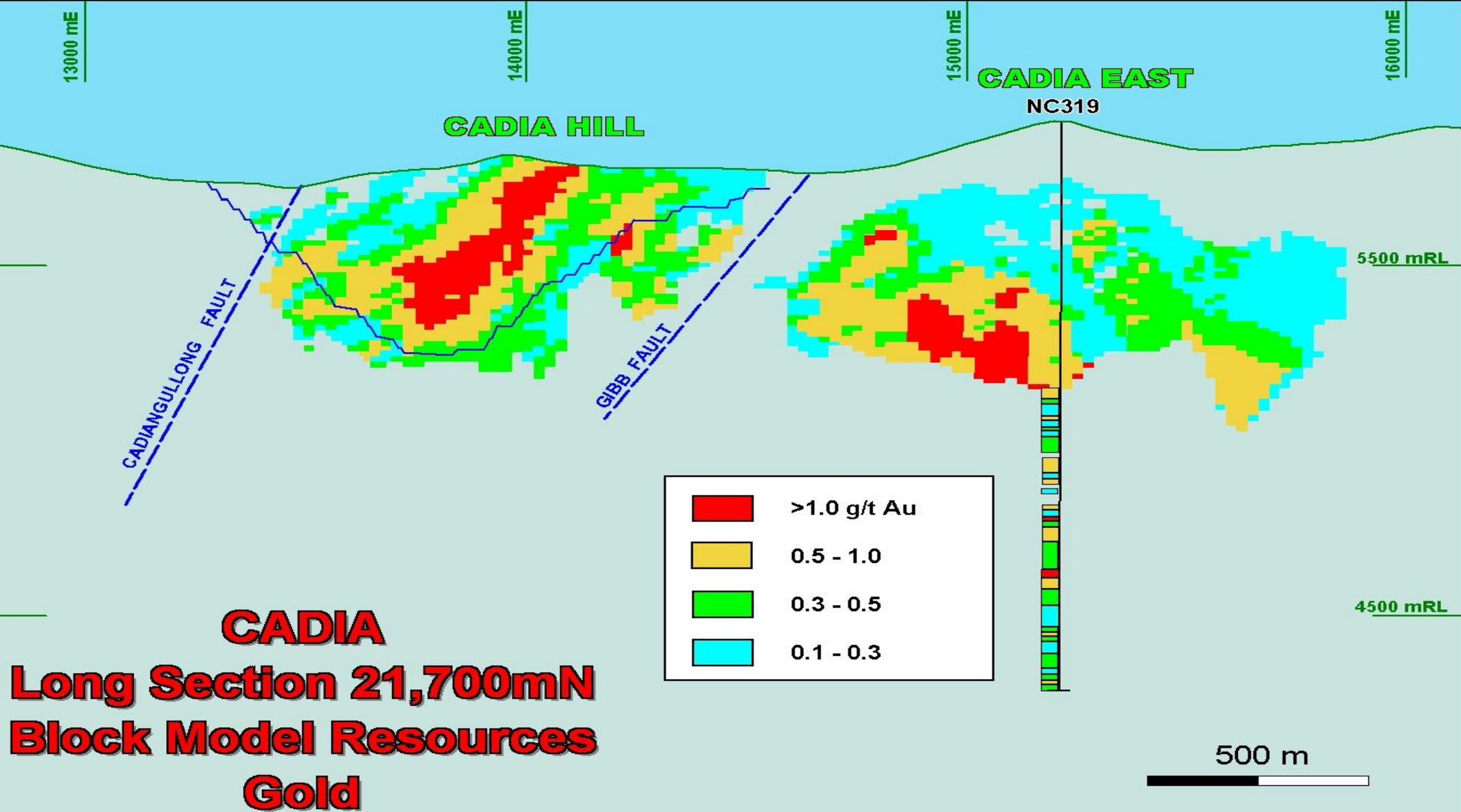


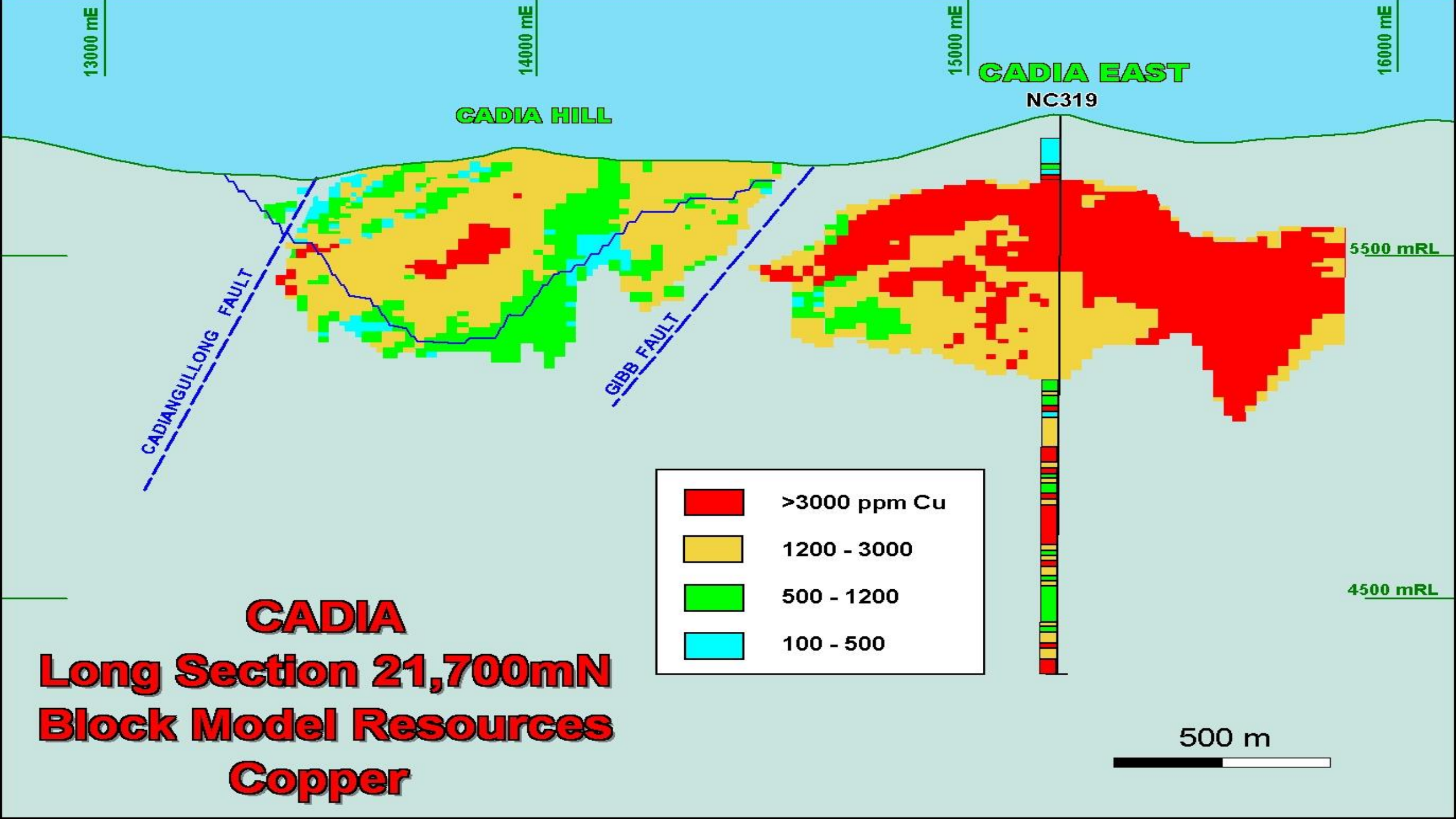


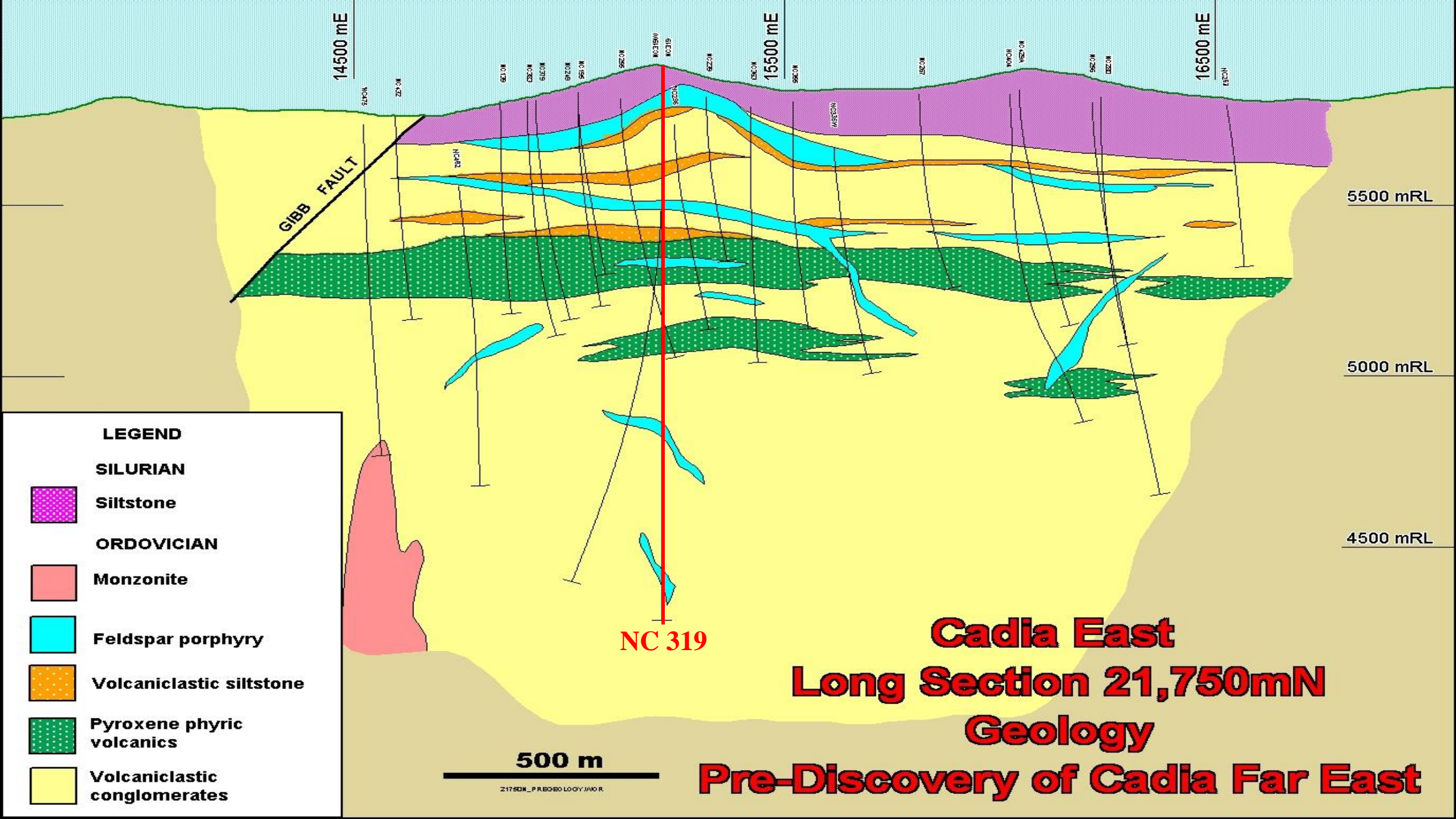
“Wildcat” Hole NC319

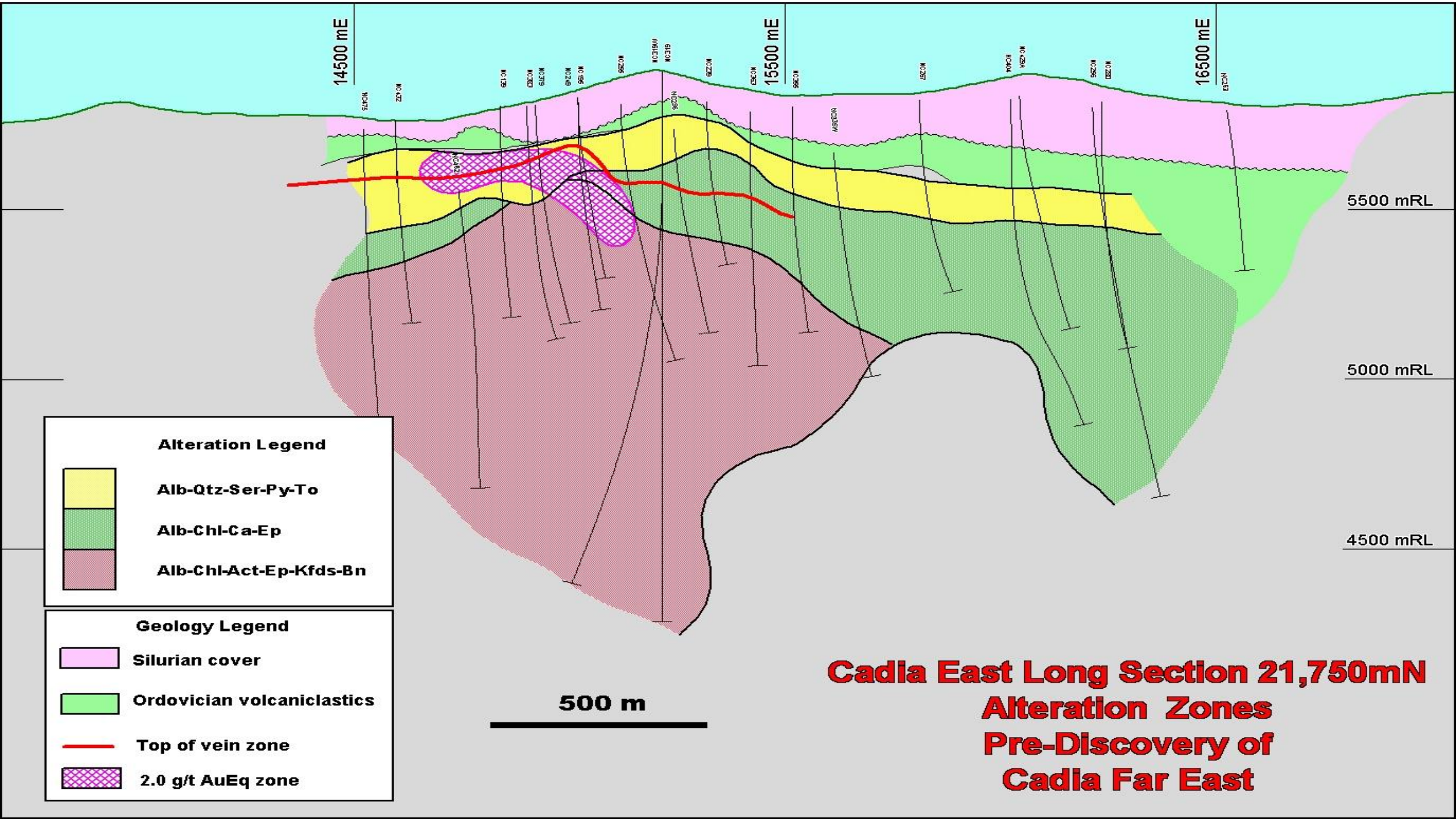
1,618 m @ 0.61 % Cu-equivalent



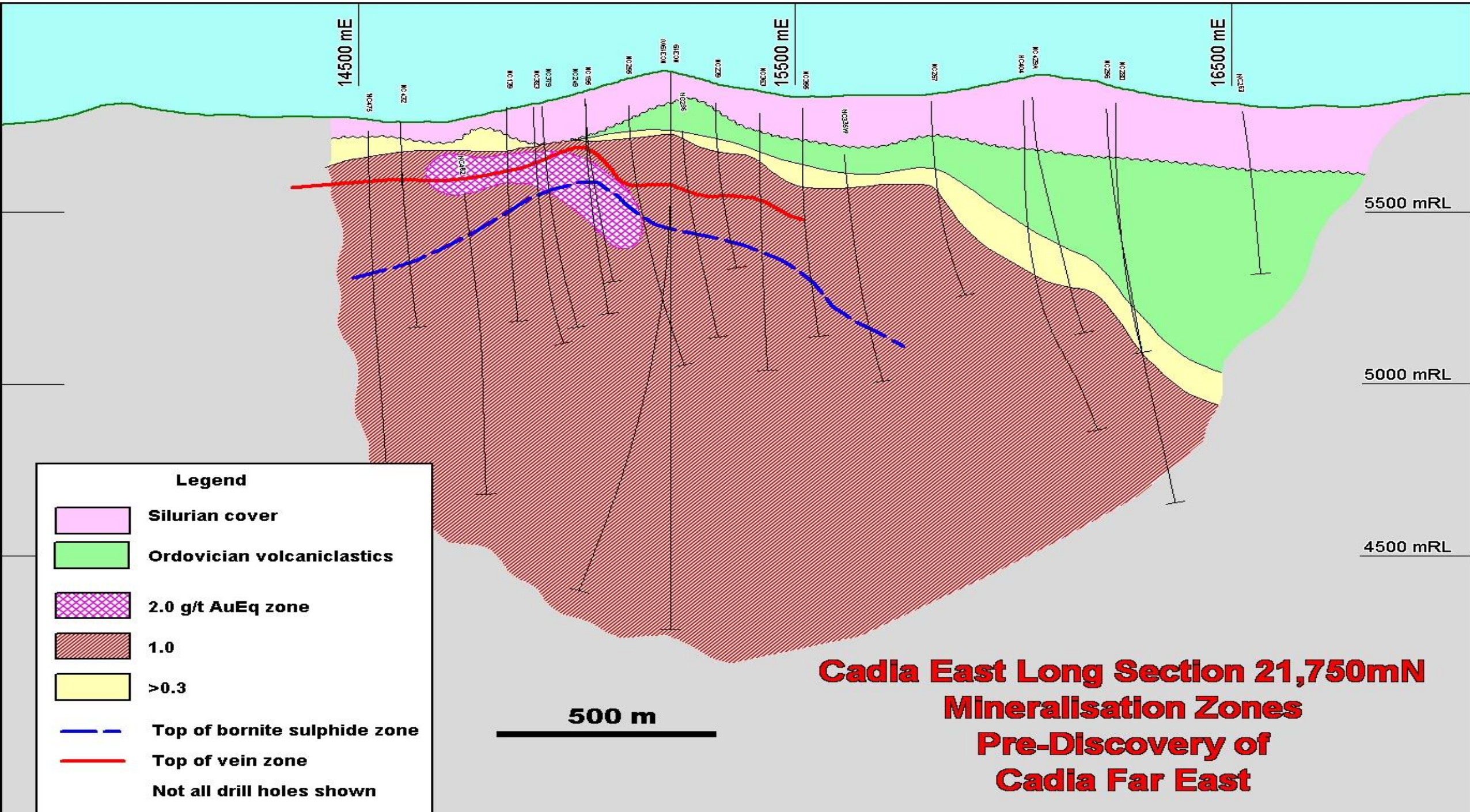


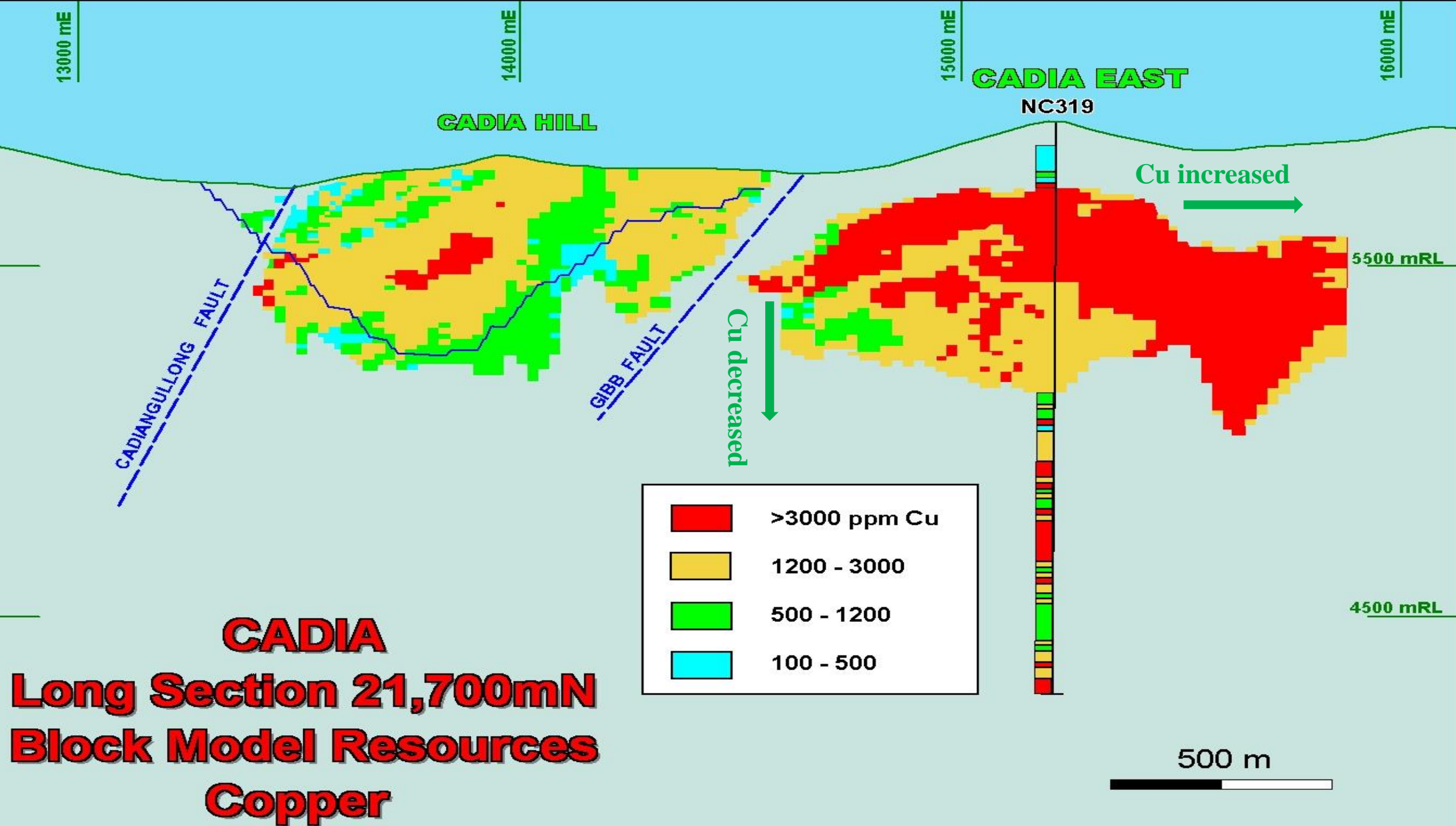




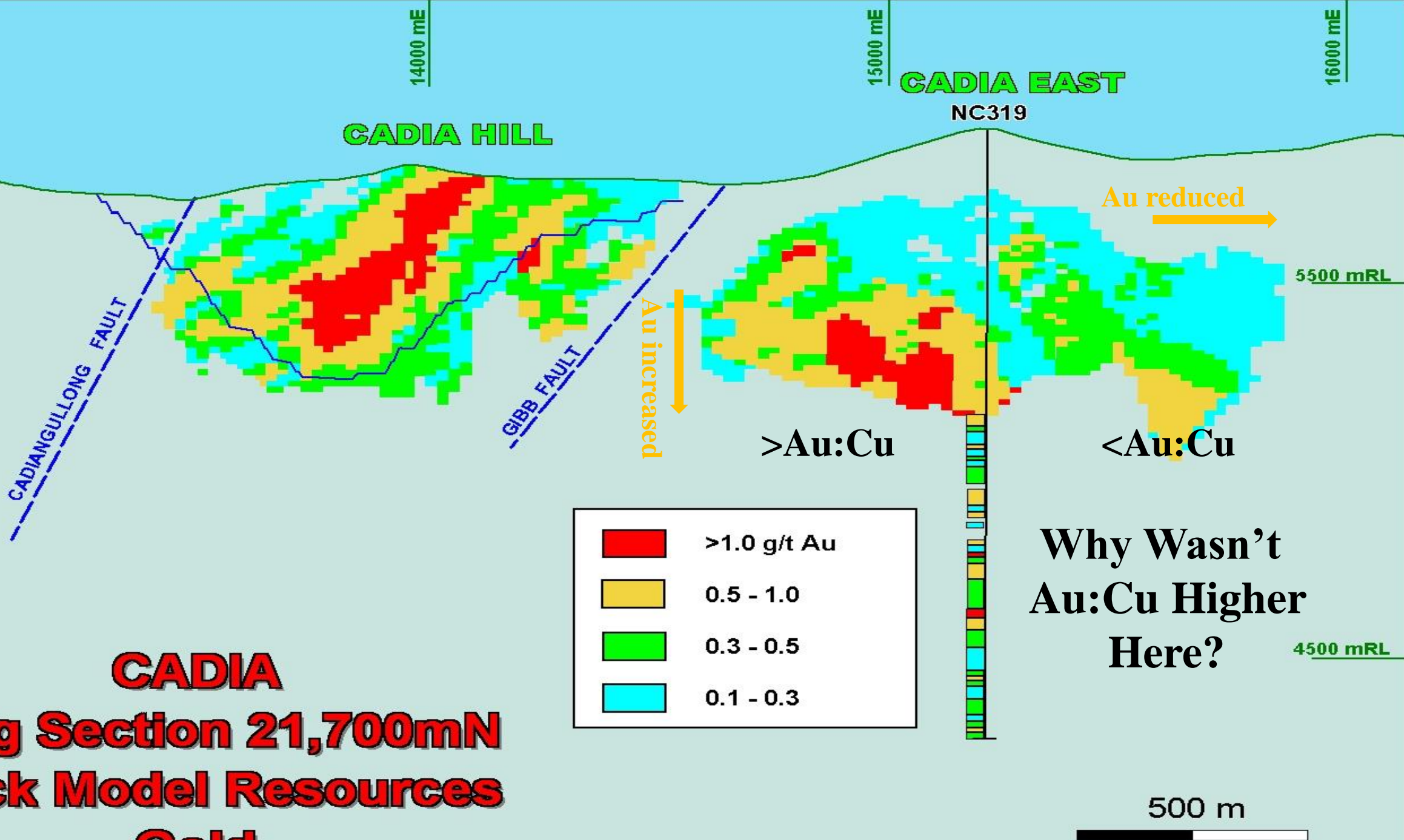


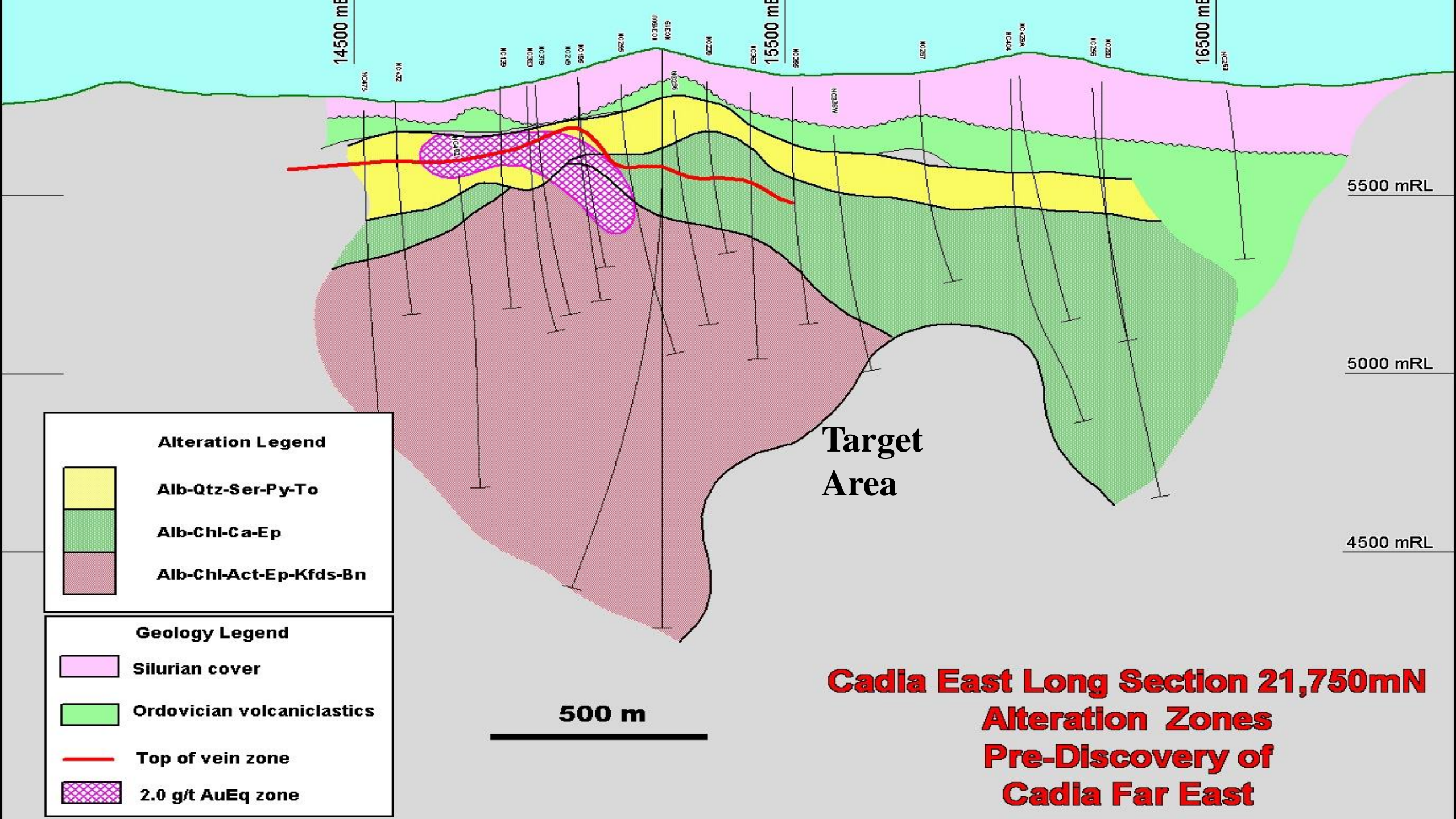
Cadia East Long Section 21,750mN
Alteration Zones
Pre-Discovery of
Cadia Far East

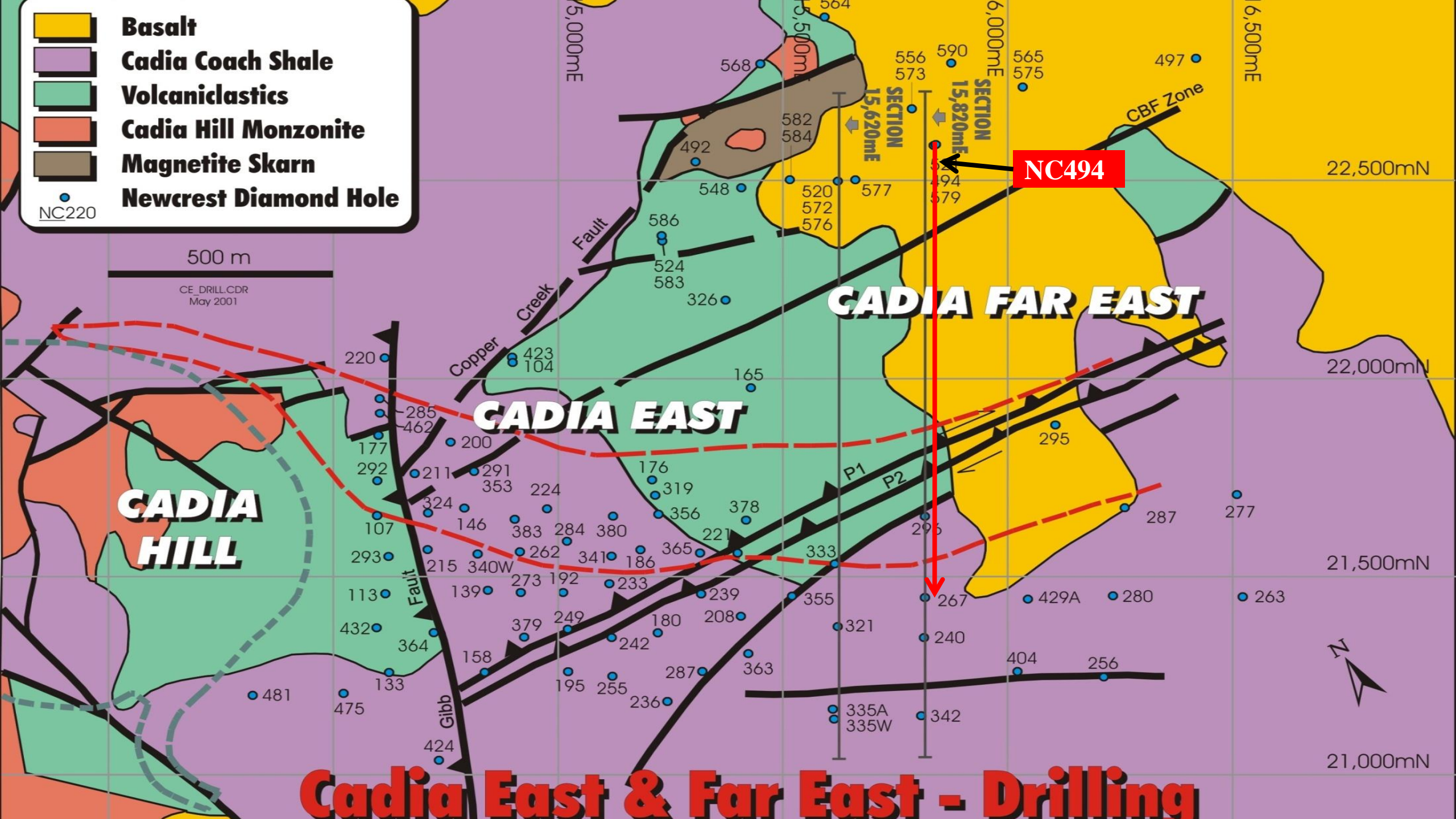


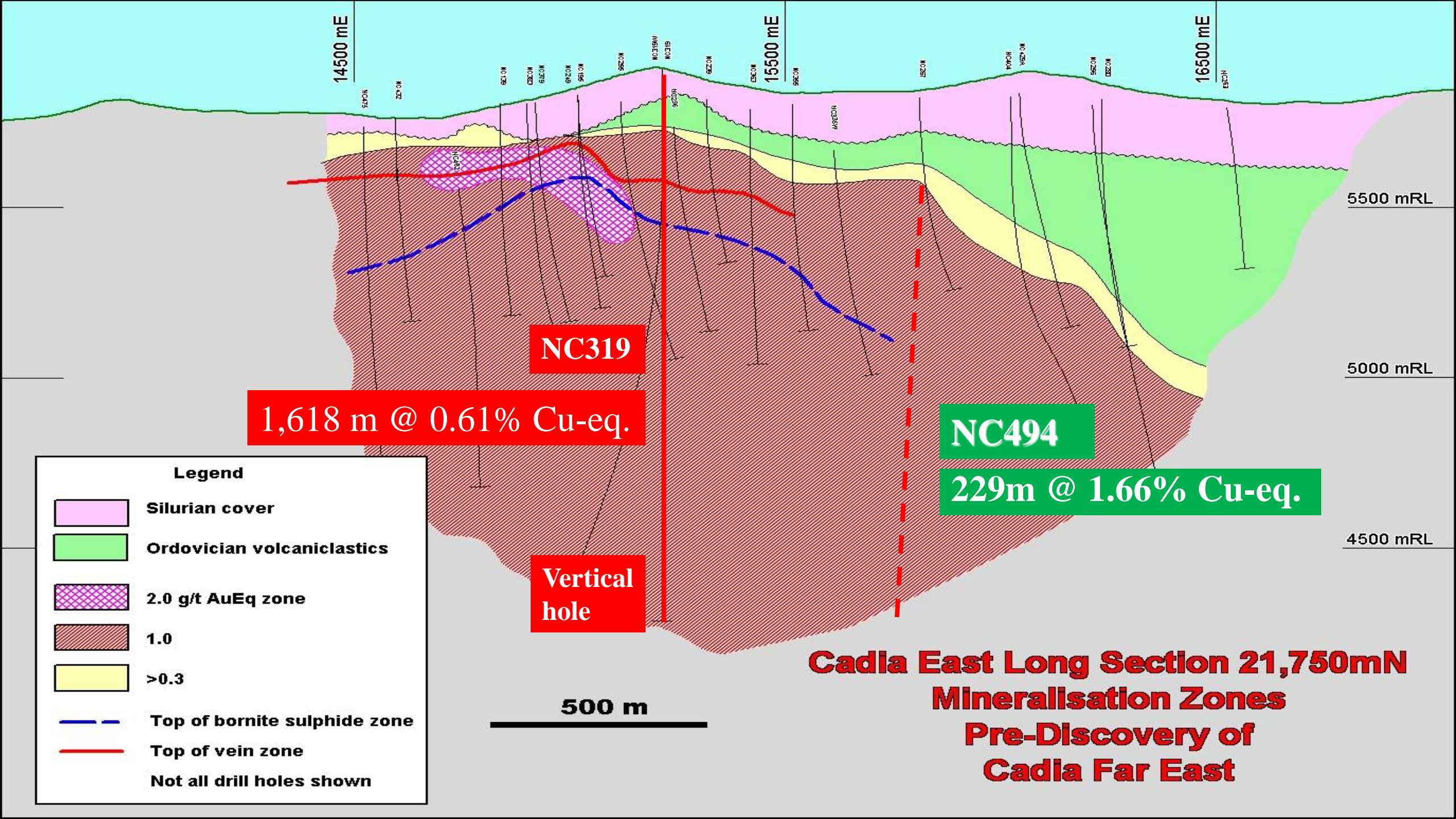


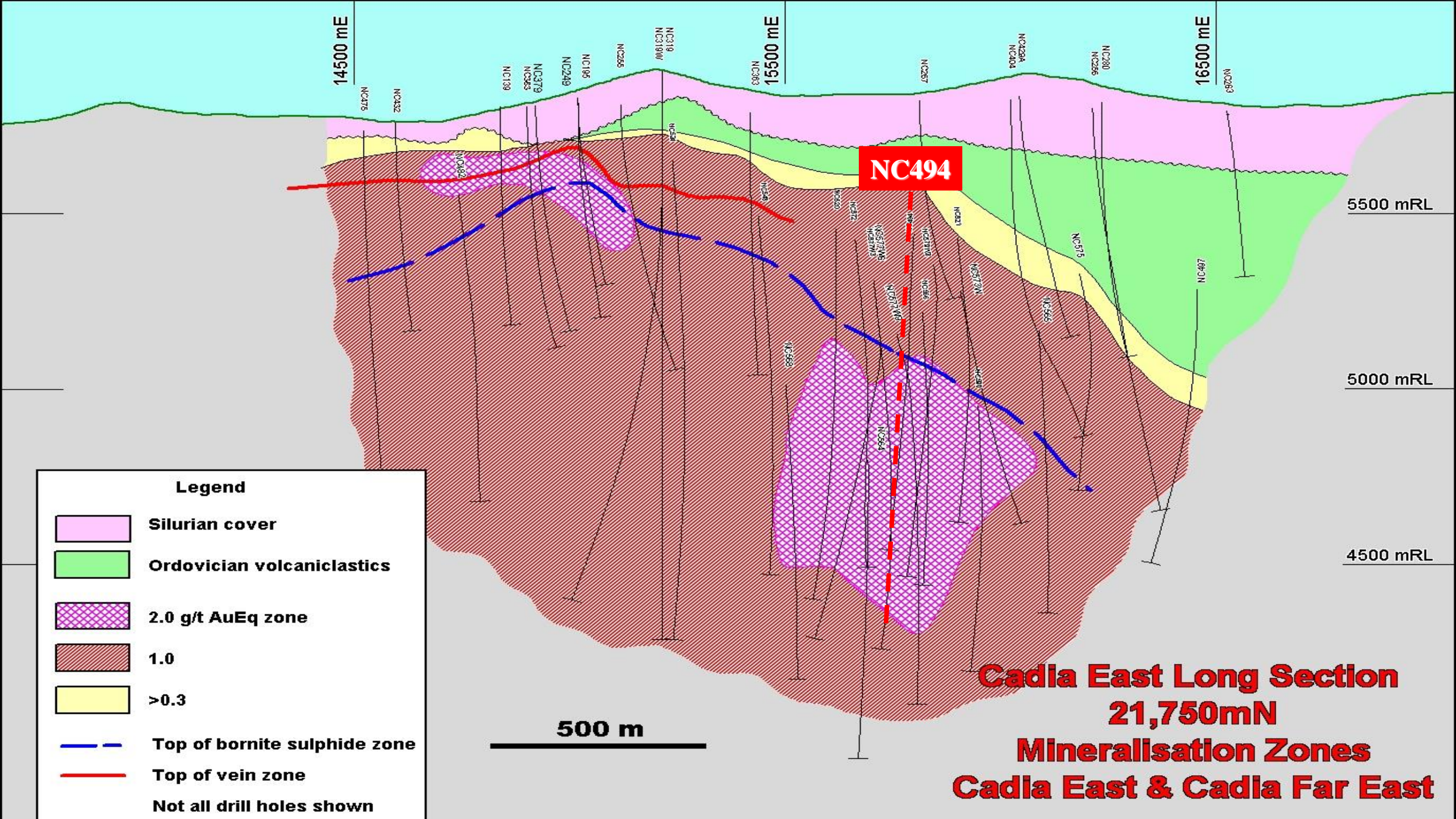
CADIA
Long Section 21,700mN
Block Model Resources
Gold

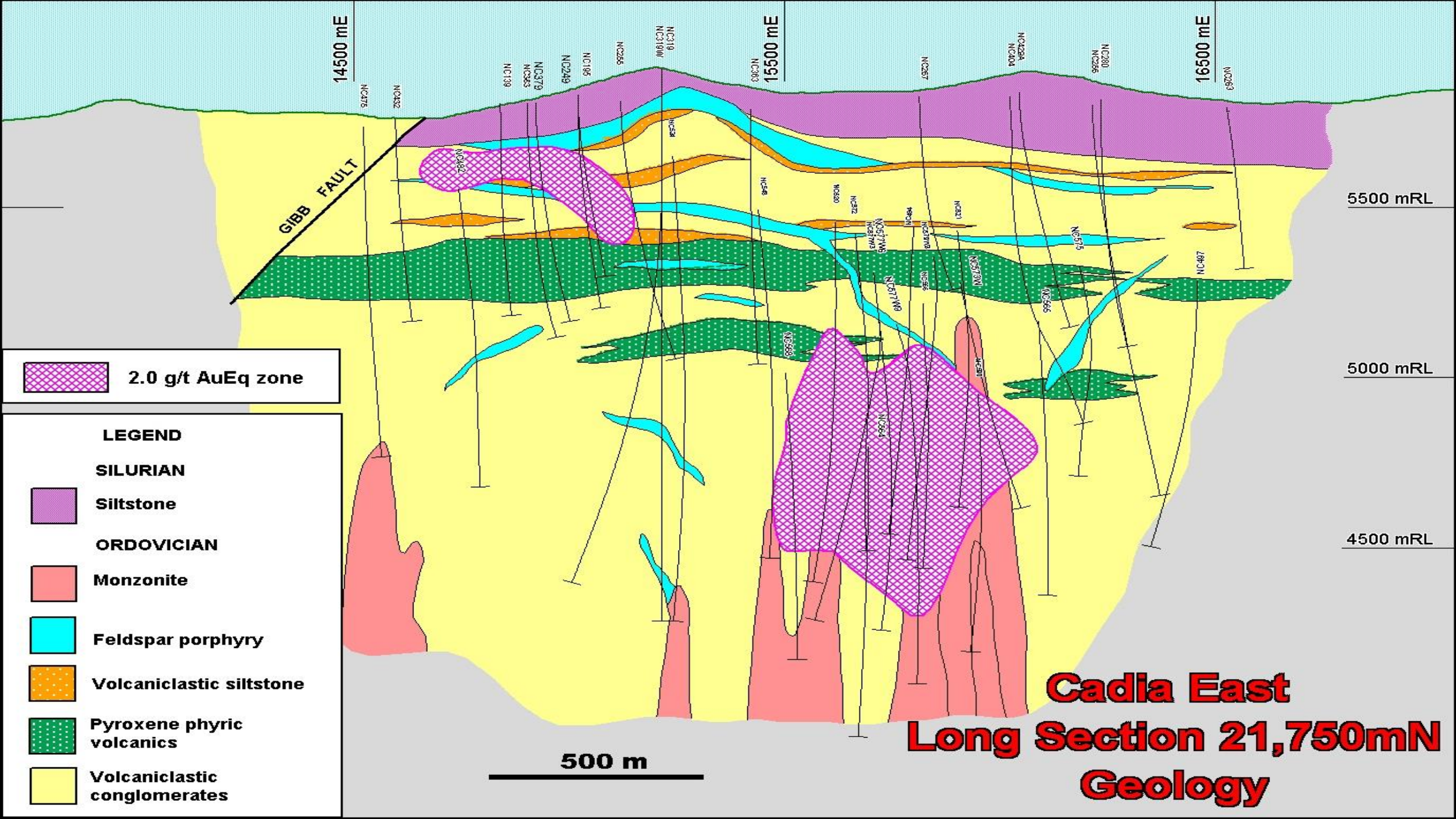












NW

SE

RIDGEWAY

CADIA QUARRY

CADIA HILL

CADIA EAST

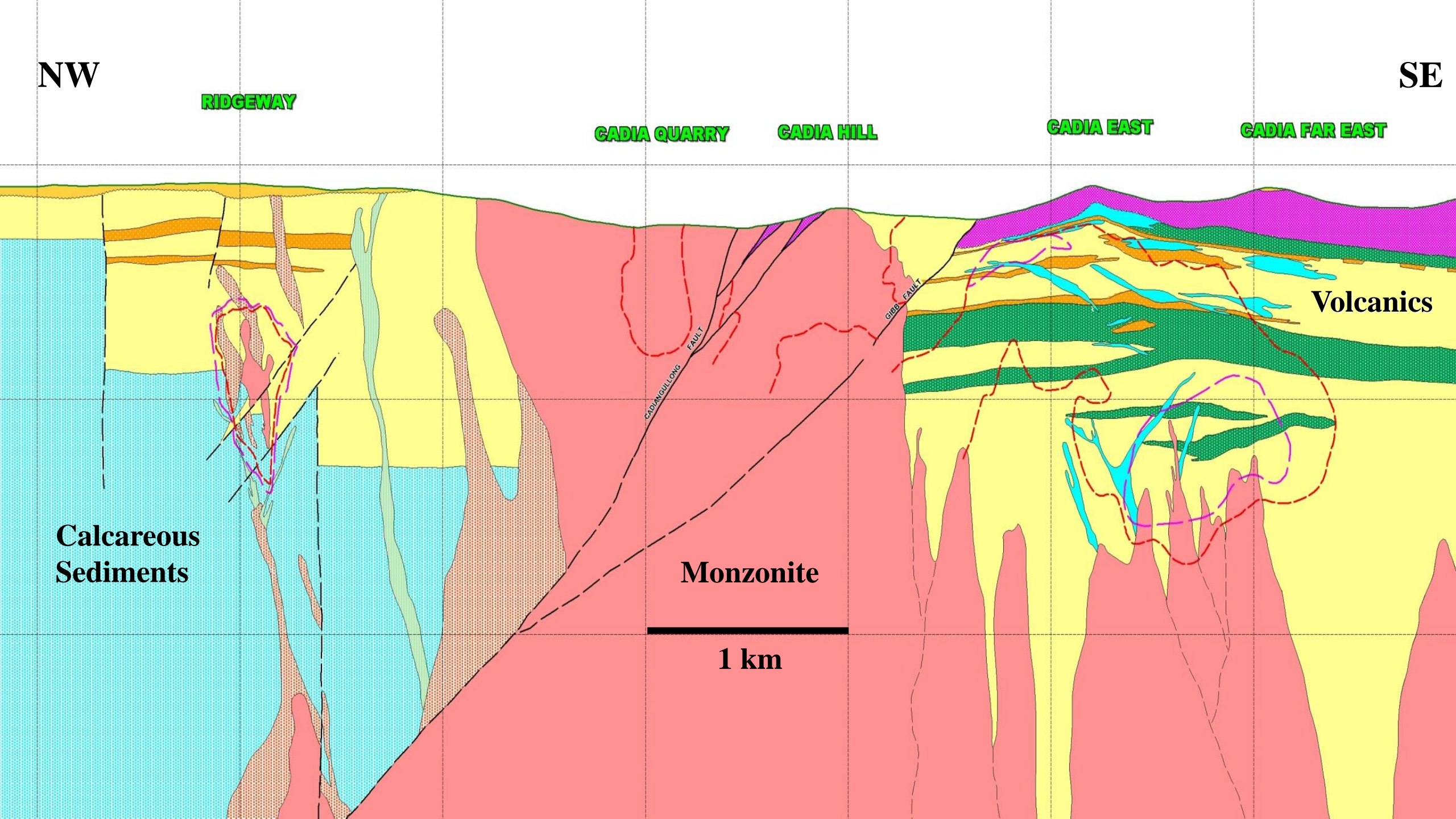
CADIA FAR EAST

Calcareous
Sediments

Monzonite

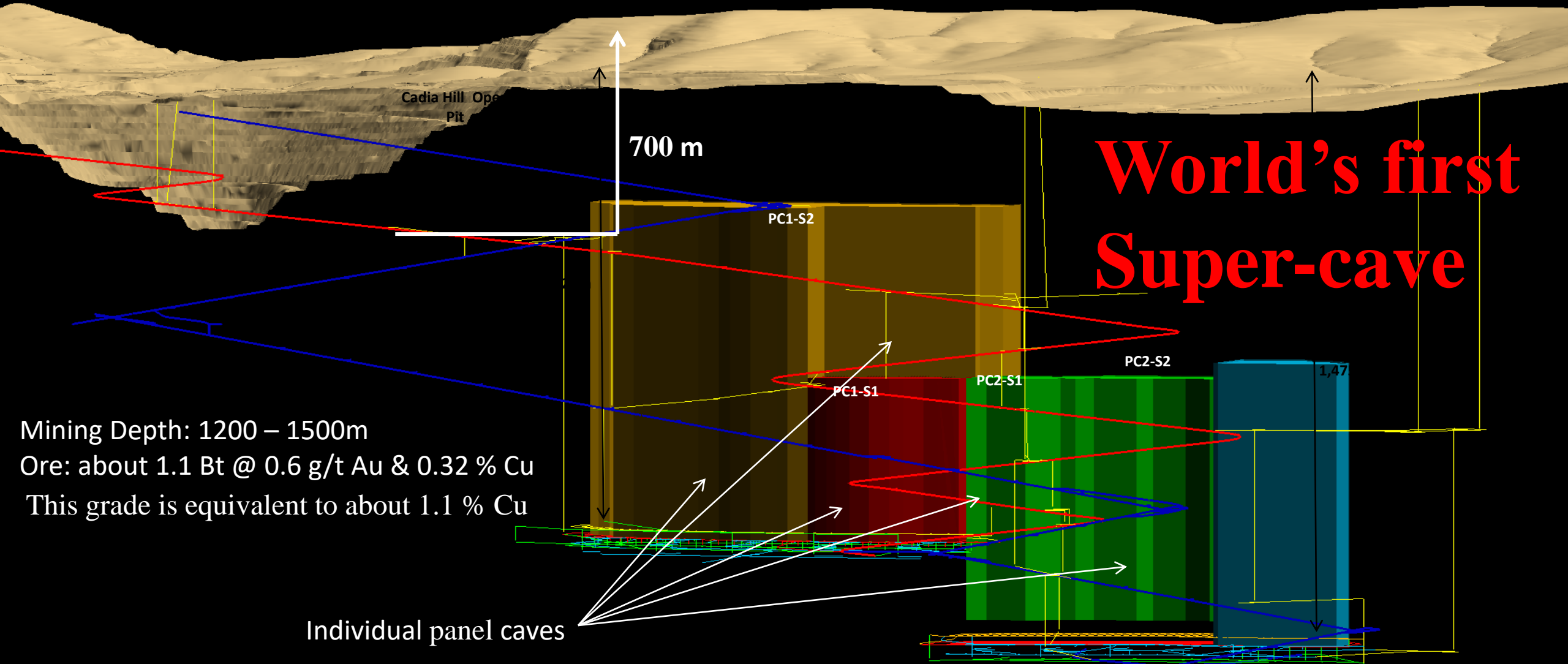
Volcanics

1 km



Cadia East Mine

(Image courtesy Newcrest Mining Limited)





Conclusion



**Newcrest's Gamble Succeeded
Because
It made its own luck
and
Rigged the Odds
by
Employing talented explorers
And Allowing them to explore**

A vibrant collage of casino-themed items arranged in a circular pattern. In the center is a roulette wheel with its characteristic numbered pockets in red, black, and green. Surrounding the wheel are several playing cards, including the Ace of Clubs, Ace of Hearts, and Ace of Diamonds. Interspersed among the cards are numerous poker chips in blue and white, and red and white. Two red dice are also visible, one near the top right and one near the bottom left. A thick, glowing yellow ring encircles the central roulette wheel. Overlaid on this entire composition is a black rectangular box containing the text "Thank You" in a white, serif font.

Thank You