Porphyry Exploration in the Americas

2D Synthetic and field resistivity data modeling

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Workshop on Exploration Undercover
August 15, 2013

Kemess North – Case Study

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Results shown courtesy of:

Northgate Minerals Corporation

Objectives

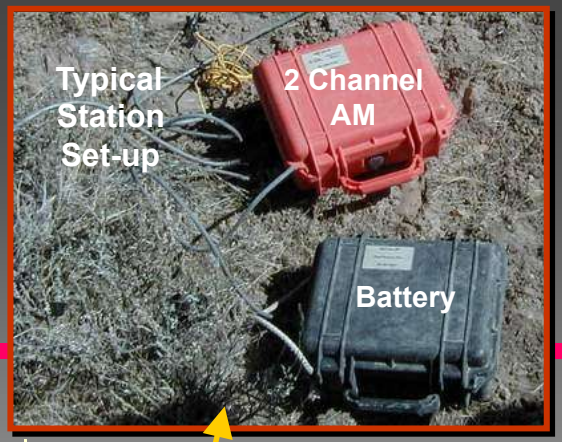
- Demonstrate the use of physical properties and synthetic model tests to survey design and planning

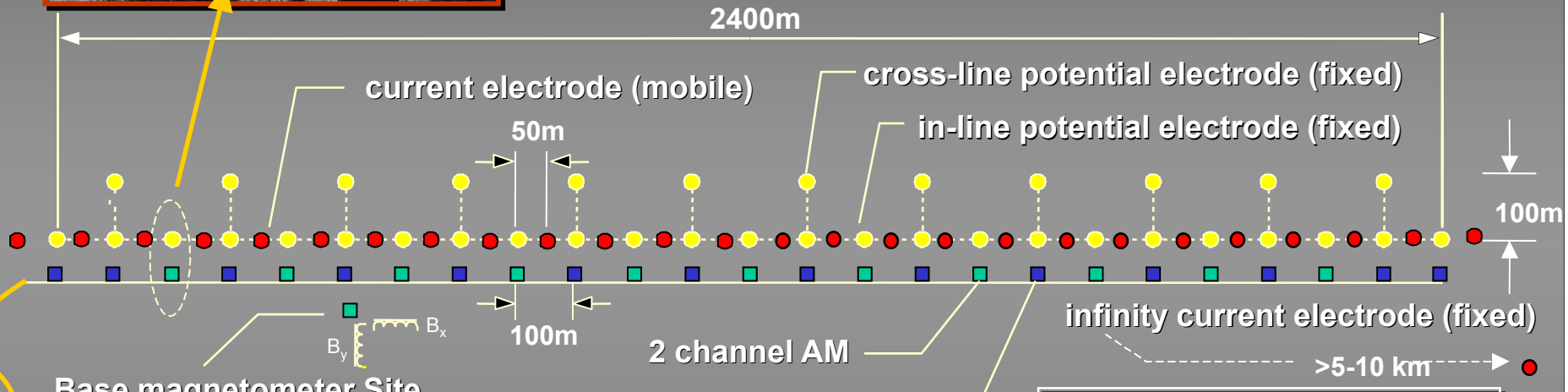
- Show Results from Titan 24 Survey at Kemess, Northern BC

Kemess North Case Study

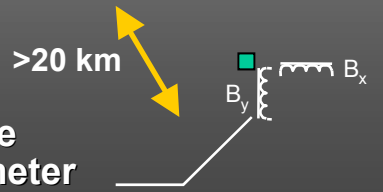
- Survey design based on initial synthetic model testing using physical property estimates from previous geophysical surveys (useful approach)
- Final results agreed with initial synthetic models (proof of concept)
- Drilling of Titan DC/IP targets led directly to new discovery of “Ora” and “Altus” Zones at Kemess North

Titan-24 Distributed Acquisition System



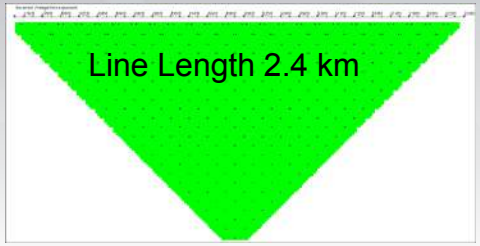


Line Length - 2400 m
24 E_x 100m dipoles
12 E_y 100m dipoles
25 current stations
2 B_x/B_y magnetometer sites



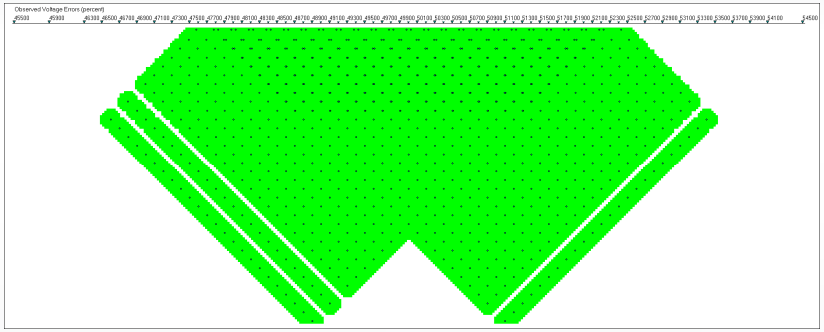
This slide presents a schematic of the typical Titan DCIP & MT configuration in the field – with 24 in-line dipoles, 12 cross-line dipoles and current injections in-between receiver stations. For the dcip, each currebt injection, spanning 10,20 or more cycles, is recorded in each acquisition module (AM), at the end, the “event” is harvested back to the recording truck along a LAN. The data are then qc’d by the operator before a decision is made to proceed to the next current injection or to repeat. A Titan spread typically takes a day to undertake, starting with the set-up, andthe dcip acquisition in the day-time, followed by the mt acquisition at night. The entire data record is then brought to the processing office in camp, and the final results are available the following day to determine whether the line can be moved or repeated. This process is repeated until all the lines are completed.

Titan single spread

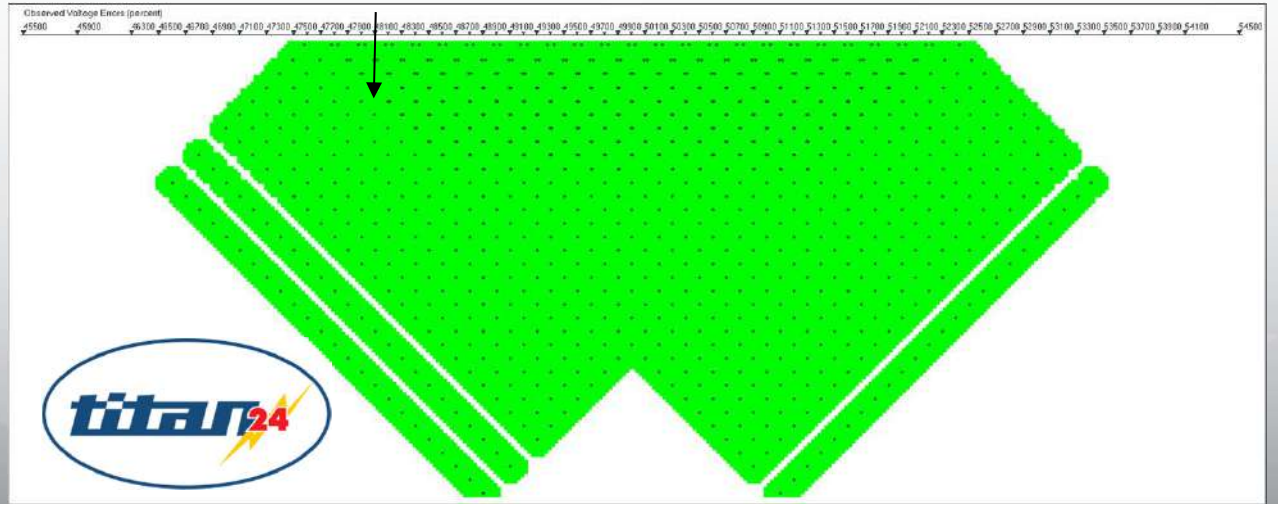


Standard Titan spread
N=0.5 to 23.5, a= 100m

Titan extensions - extra injection points beyond ends of line



Larger receiver dipoles (150 m or 200 m)
plus current extensions has provided DC and IP information to 900 metres.



Extensions are added to provide depth coverage under the ends of the lines which improves the accuracy of the model at the edges – minimize geometrical edge effects

Survey Objectives

- *Find more ore*

- *Kemess North mineralization is a typical Copper-Gold Porphyry Target, occurring at the surface in the favourable Takla volcanic host rocks.*

- *However, Kemess stratigraphy becomes progressively buried and block-faulted below 300 m to 600 m thick, younger Hazleton Volcanic and talus cover, and intruded by post-mineralization Black Lake intrusives.*

- *Challenges include rugged topography and contact issues due to talus, and snow cover.*

Original Deposit, Kemess North outcrops, but block faulting has dropped the mineralization to depth as you go northeast
Tough terrain – poor ground contact due to talus and snow cover

Survey Objectives

- *The Titan-24 DAS surveys were proposed based on their deep penetration and multi-parameter capability, with emphasis on detecting the primary mineralization using IP and providing additional alteration and geologic mapping using DC + MT resistivity.*

- *Titan field surveys were preceded by a 2D synthetic modeling study to determine optimal array parameters (dipole size) and detection limits/sensitivity of the proposed survey.*

IP is the main parameter for detecting the mineralization – resistivity for structural control and mapping

Procedures:

- *Create 2D synthetic DCIP model for the Kemess Deposit, using pole-dipole data (1991) or physical property estimates and sketch geologic section.*

- *Calculate synthetic 2D DC & IP data for Titan lines across*
  - *deposit (approx. 5 km survey line - Assume 100m dipoles, with 2 x end-on 2.4km Titan Spreads), and also for*
  - *"Barren" geologic model (for comparison).*

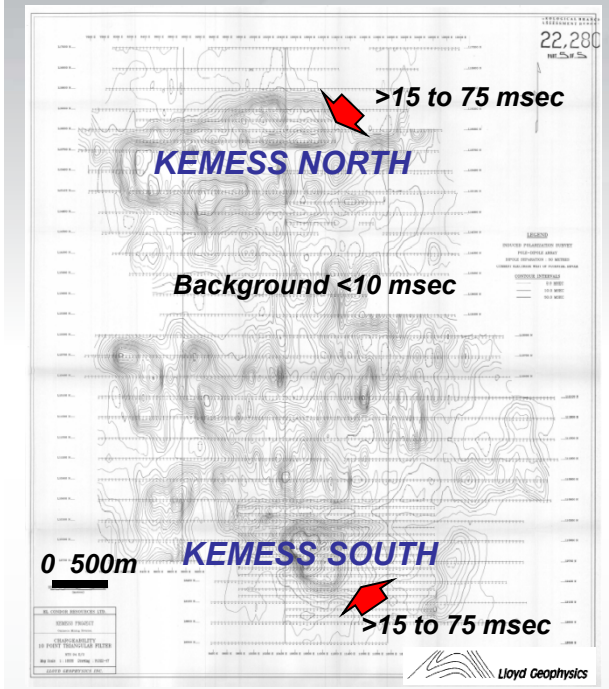
- *Create 2D resistivity and chargeability inversion models.*

- *Compare Inversion Results with original Geologic Model to evaluate accuracy and capability of Titan to resolve Buried Kemess-style Porphyry Copper Deposits.*

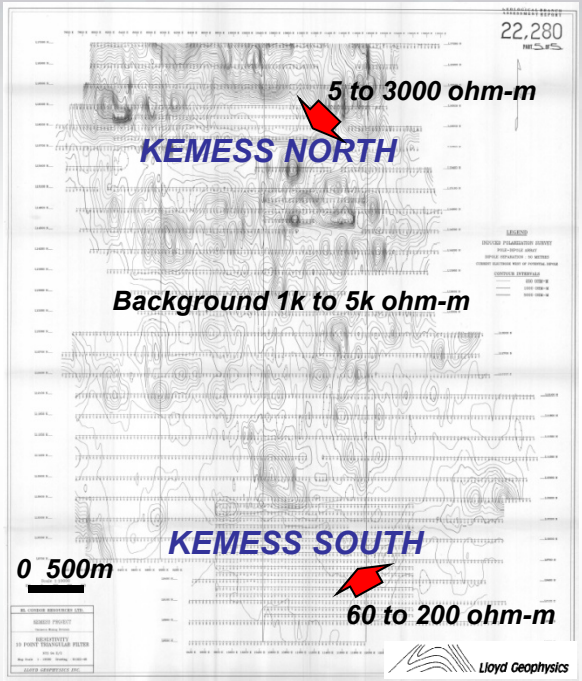
Now I describe the procedure that we employed for the synthetic model analysis
2 models are created – 1 for barren geology, one including the mineralization – the reason we do this is for sensitivity analysis to establish the degree to which we can detect and delineate the mineralization
Forward modeling to create the 2D systhetic data –.
Invert these synthetic data to understand how accurate and resolvable the deposit mineralization is. Error floor – 5%

Legacy geophysical data (1991) to estimate Physical Properties

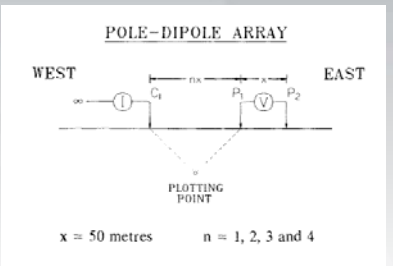
TOTAL CHARGEABILITY PLAN



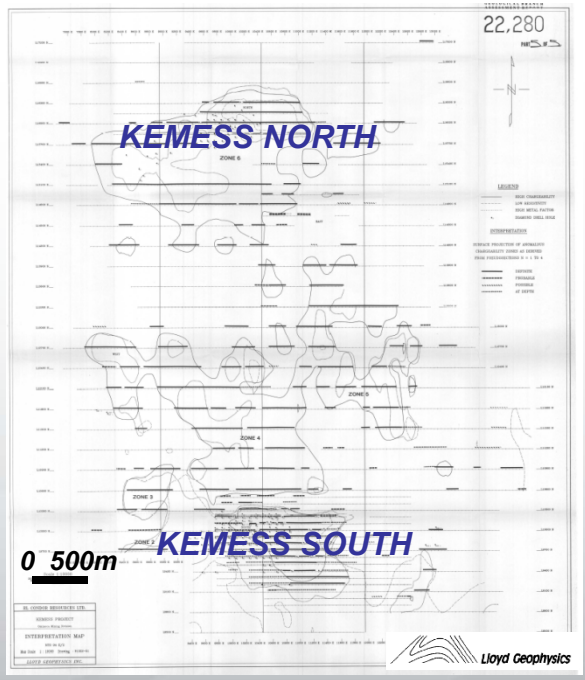
DC APPARENT RESISTIVITY PLAN



TDIP Pole-dipole Array (A=50m / N=1-6)



DC/IP INTERPRETATION PLAN



A total of 201 kilometres of IP data was collected during this time. Approximately 60% of the property showed a strong IP (chargeability) response. This response has been interpreted to indicate the presence of a significant sulphide system.

Extensive drilling of a portion of this large sulphide system has led to the discovery of the Kemess South and Kemess North deposits.

Whilst geophysics did not lead to the original discovery of the Kemess deposits, the application of geophysics in outlining the interpreted sulphide system and in support of the drilling programme was of significant value.

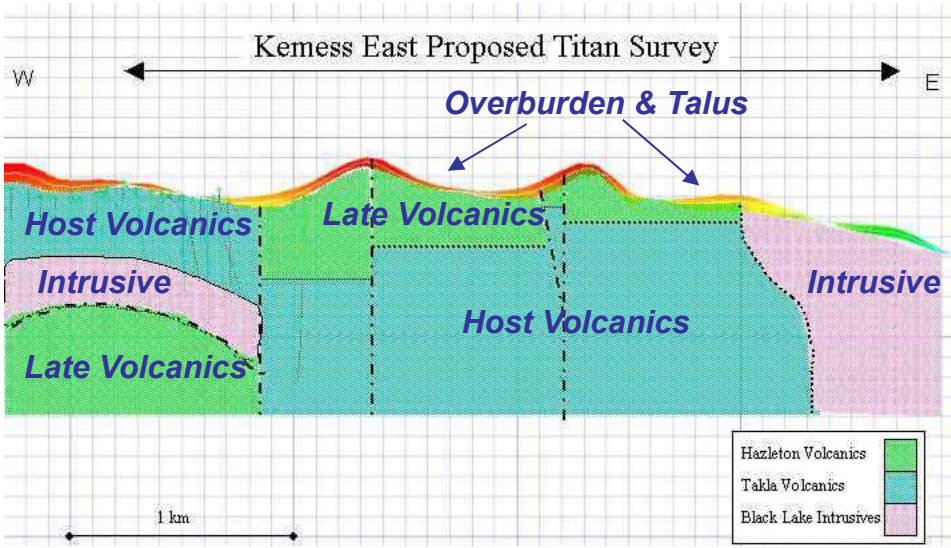
Results from: AN ASSESSMENT REPORT ON AN INDUCED POLARIZATION SURVEY ON THE KEMESS PROPERTY

Results shown courtesy of Northgate Minerals

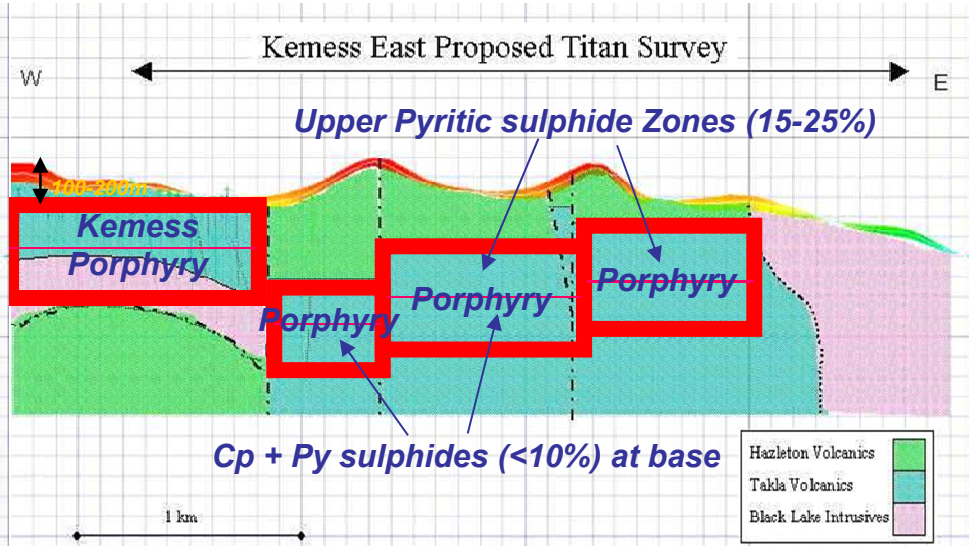
Legacy data acquired in early 1990's includes conventional IP – 50 m dipole spacing – over known mineralization in the near surface

These data were used to establish the physical properties for the model study.

"Barren" Geologic Model



"Mineralized" Geologic Model



Unit	Resistivity	Chargeability
1. Hazelton volcanics (late)	1 000 ohm-m	7 mrad
2. Takla volcanics (host)	300 ohm-m	10 mrad
3. Black Lake Intrusive (late)	5000 ohm-m	1 mrad
4. Overburden	200 ohm-m	0.5 mrad

*** Note, Res & IP values estimated from 1991 pldp survey**

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4. Overburden	200 ohm-m	0.5 mrad
5. Pyrite Cap	100 ohm-m	50 mrad
6. Cu-Py Ore	50 ohm-m	30 mrad

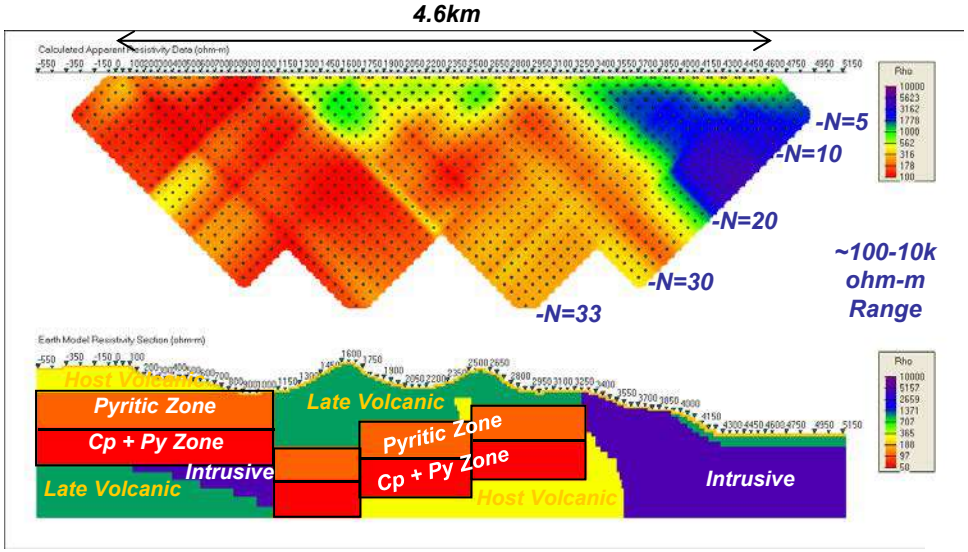
These are the two models generated for the barren and mineralized cases.
Good contrast betwent he host and mineralized zones.

KEMESS NORTH PORPHYRY COPPER – DC RESISTIVITY MODEL

2d DC Resistivity Forward Model

(Titan Pole-dipole Array – A=100m / N=0.5-32.5)

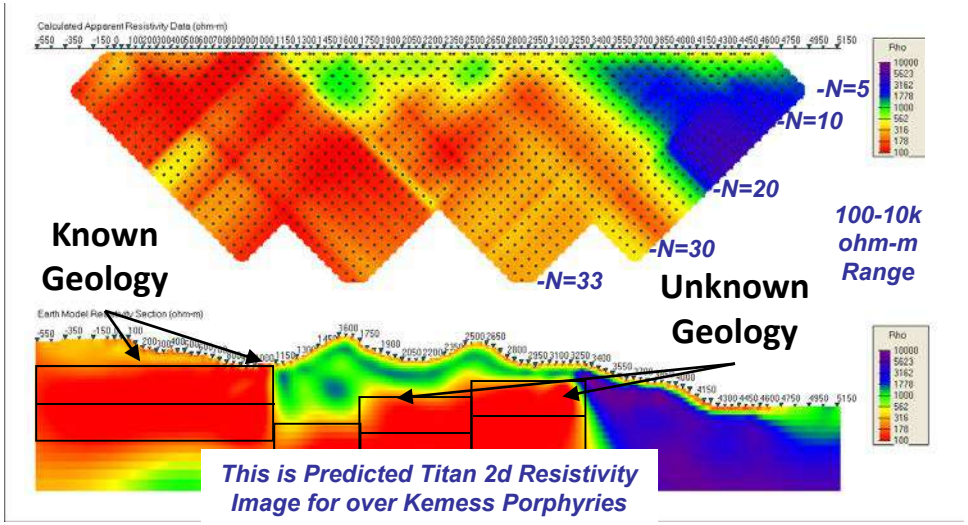
Calculated Response from Geologic Model Below - used as data for 2d Inversion Bottom



2D DC Resistivity Inversion

(Titan Pole-dipole Array – A=100m / N=0.5-32.5)

Calculated Response from 2d Inversion Model Below – using data from 2d Forward Above



Notice:

a) Similarity between Fwd & Inverse Models, but Cu vs. Py Zones Not Differentiated,

b) Moderate contrasts in Fwd Data, but Targets Well Resolved in 2d

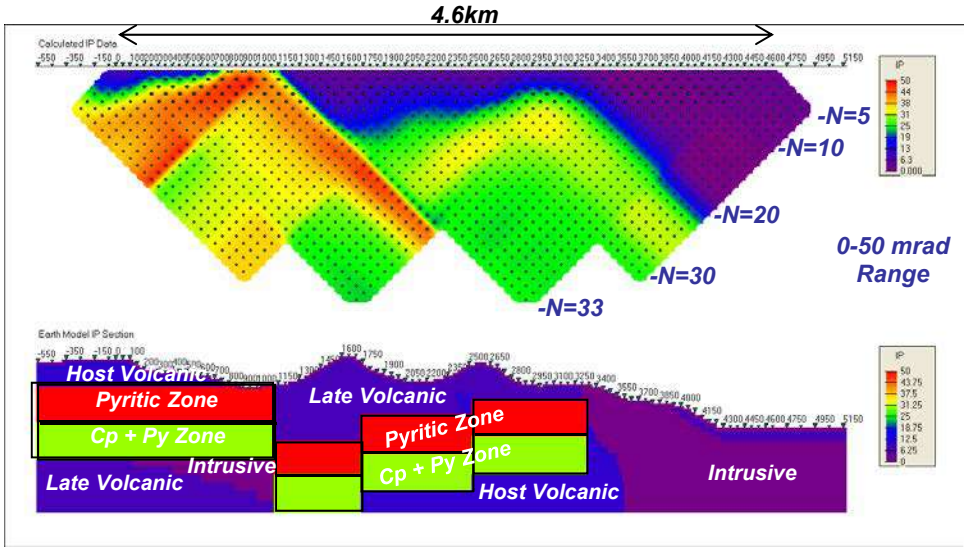
Forward data in pseudosection format on top with the model.
On the bottom, the inversion model and the inversion response in pseudosection format – you can see that the data has been recovered very well
But you can see that there is no clear discrimination betweent eh cap and economic mineralization

KEMESS NORTH PORPHYRY COPPER – CHARGEABILITY MODEL

2d Chargeability Forward Model

(Titan Pole-dipole Array – A=100m / N=0.5-32.5)

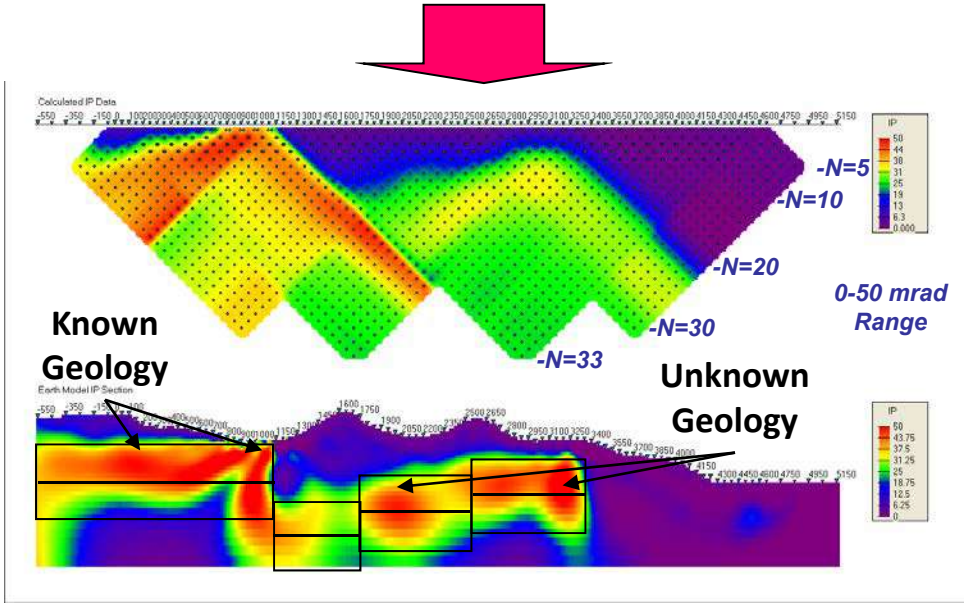
Calculated Response from Geologic Model Below - used as data for 2d Inversion Bottom



2D Chargeability Inversion

(Titan Pole-dipole Array – A=100m / N=0.5-32.5)

Calculated Response from 2d Inversion Model Below – using data from 2d Forward Above



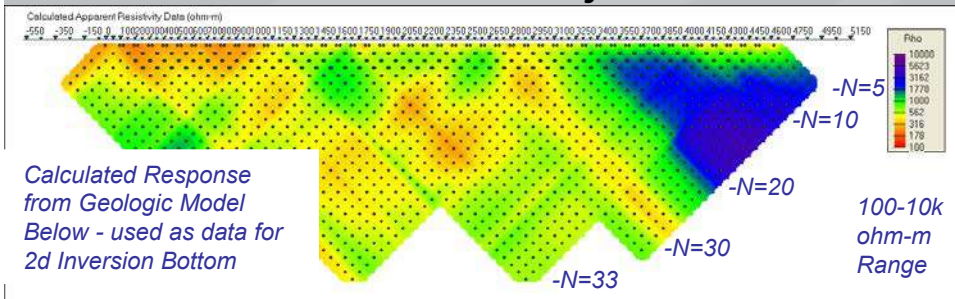
Notice:
a) similarity between Fwd & inverse models, but Cu vs. Py zones not differentiated,
b) moderate contrasts in fwd data, but targets well resolved in 2d

Same for chargeability – pyrite zone has been well-resolved, copper zone not so much

Used a DC reference model

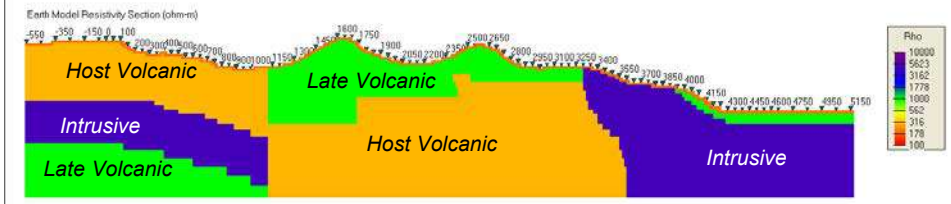
Barren vs. Mineralized - resistivity

BARREN - 2D DC Resistivity Forward Model

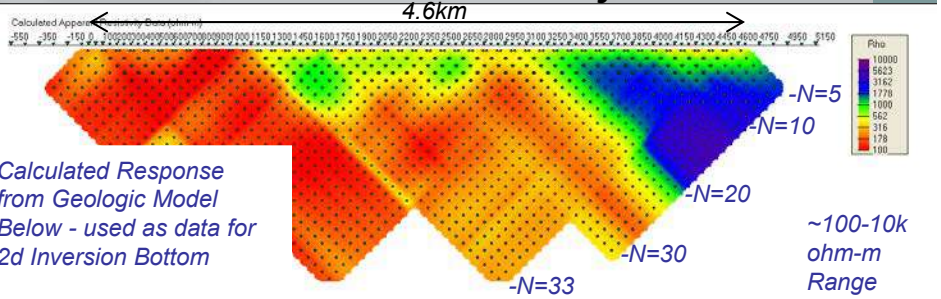


Calculated Response from Geologic Model Below - used as data for 2d Inversion Bottom

100-10k ohm-m Range

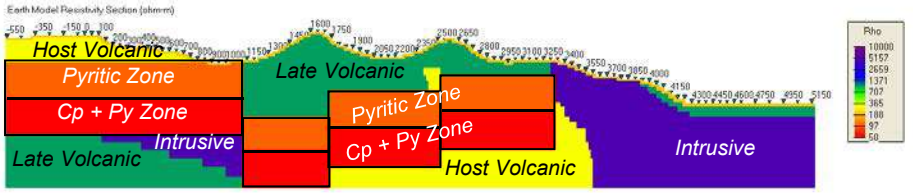


MINERALIZED - 2D DC Resistivity Forward Model



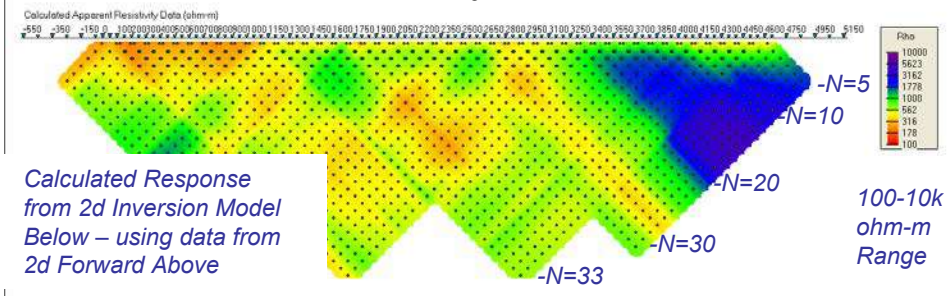
Calculated Response from Geologic Model Below - used as data for 2d Inversion Bottom

~100-10k ohm-m Range



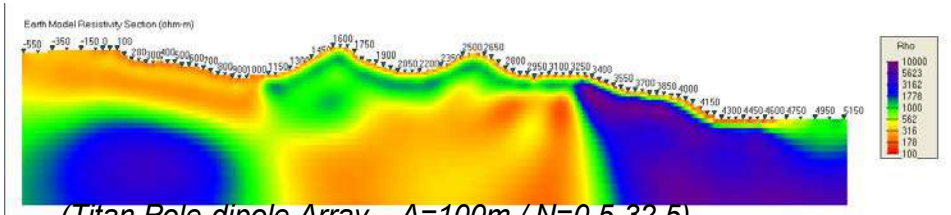
- Excellent Similarity between Fwd & Inverse Models
- Marked Difference between Barren & Mineralized

2D DC Resistivity Inversion



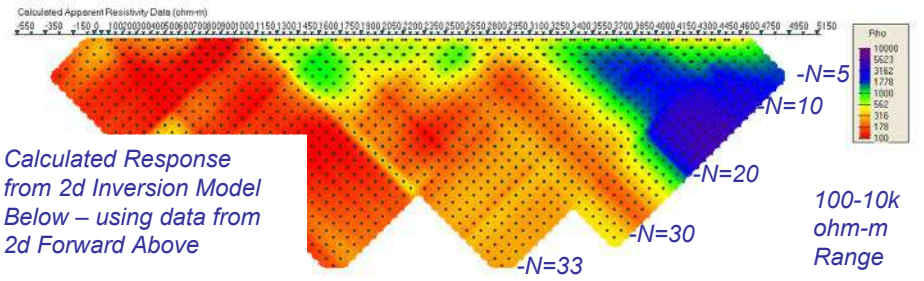
Calculated Response from 2d Inversion Model Below – using data from 2d Forward Above

100-10k ohm-m Range



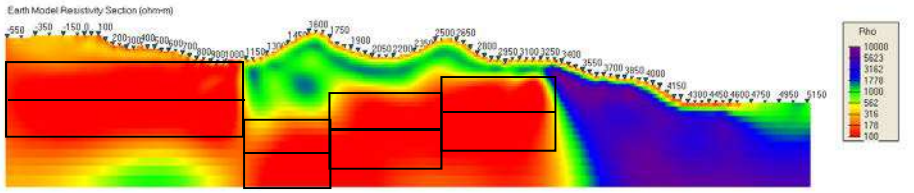
(Titan Pole-dipole Array – A=100m / N=0.5-32.5)

2D DC Resistivity Inversion



Calculated Response from 2d Inversion Model Below – using data from 2d Forward Above

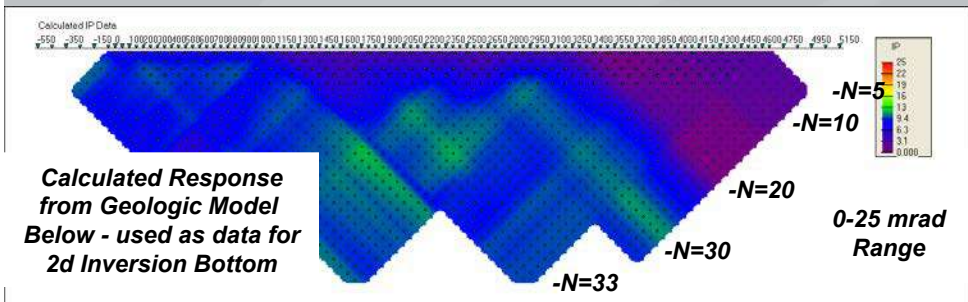
100-10k ohm-m Range



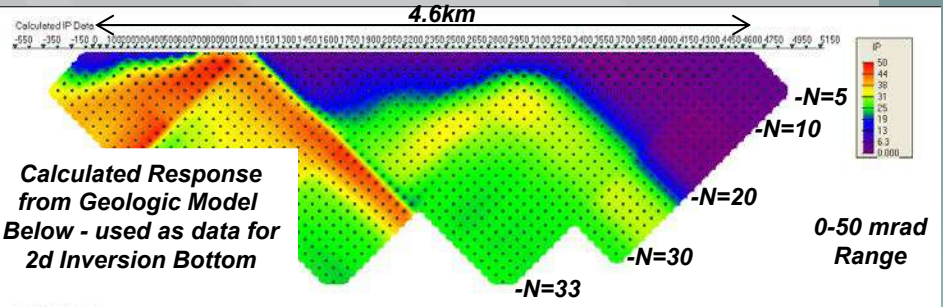
Here are the two resisivity results together indicating that the proposed survey design is sensitive to the mineralization and is a very viable approach to mappign the porphyry systems.

Barren vs. Mineralized - chargeability

BARREN - 2D Chargeability Forward Model

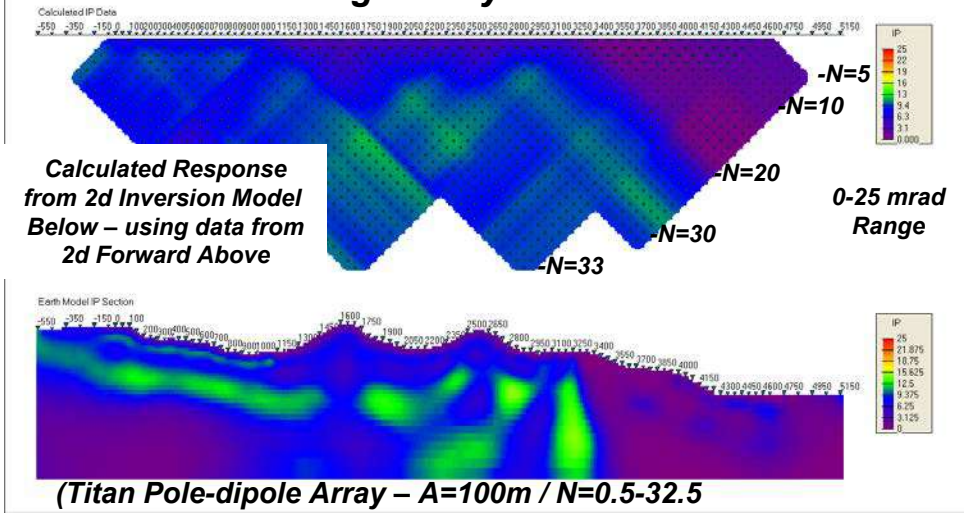


MINERALIZED - 2D Chargeability Forward Model

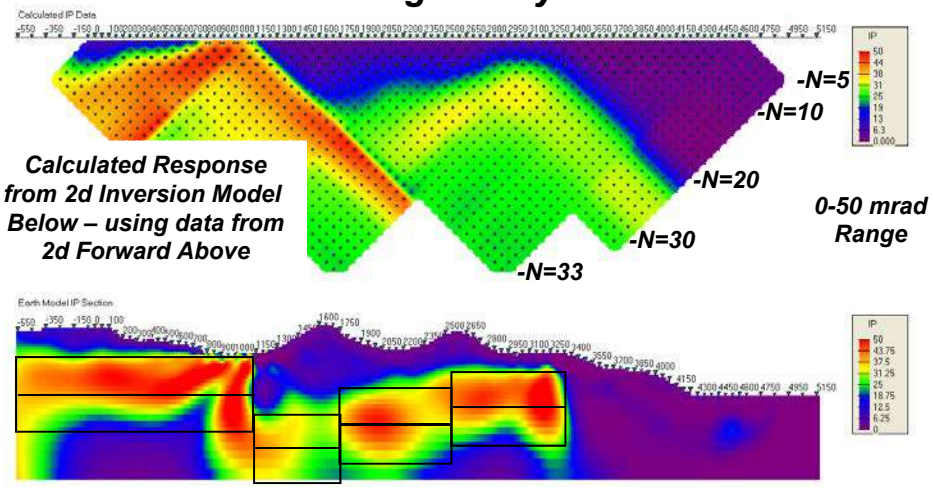


- Excellent Similarity between Fwd & Inverse Models
- Marked Difference between Barren & Mineralized

2D Chargeability Inversion



2D Chargeability Inversion



Same for IP

Synthetic Modeling Summary

- *Proposed 2D Titan survey will require 2 separate 2.4 km receiver spreads, with 200m overlap, and 600m-1km current extensions – Total length 4.2km with a=100m, n=0.5-33.5 separations.*

- *Titan surveys should be able to penetrate and resolve Porphyry bodies below 300-600m of Takla volcanic cover.*

- *Titan results should be able to image top and possibly bottom of Porphyry mineralization, but may not be able to distinguish between Pyrite-only and Cp+Py Phase in Ore zones at depth.*

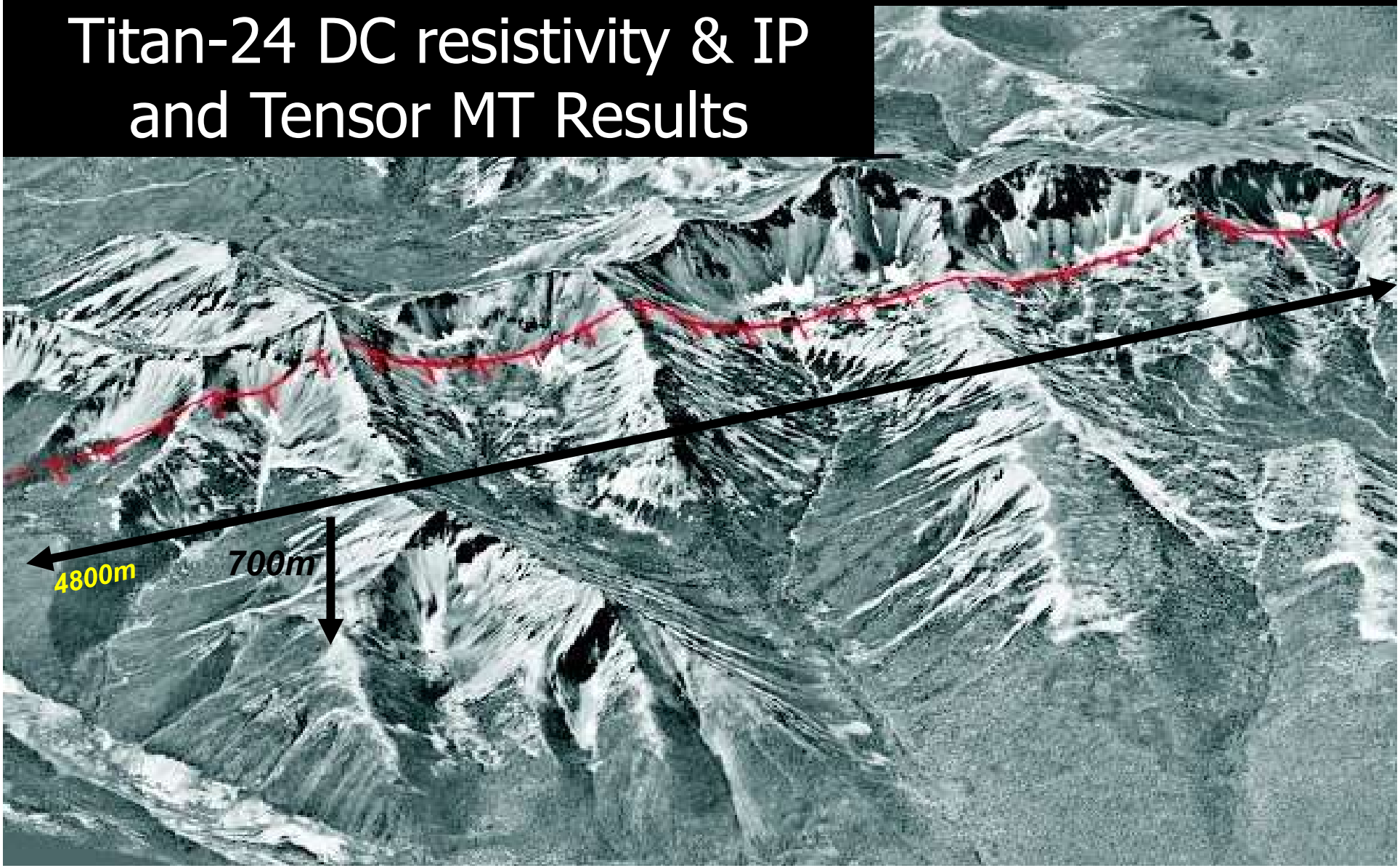
- *The results show that chargeability model could be a primary data for interpretation because it shows a higher resolution due to stronger contrasts, when compared with resistivity.*

- *DC resistivity image will nevertheless assist in mapping alteration & structure – Titan MT will provide additional support and improved resolution.*

- *2D Titan DCIP survey imaging could be improved by using 3d Inversion tools (better image along NS strike) - provided 3 or more lines are surveyed (300-400m spaced) .*

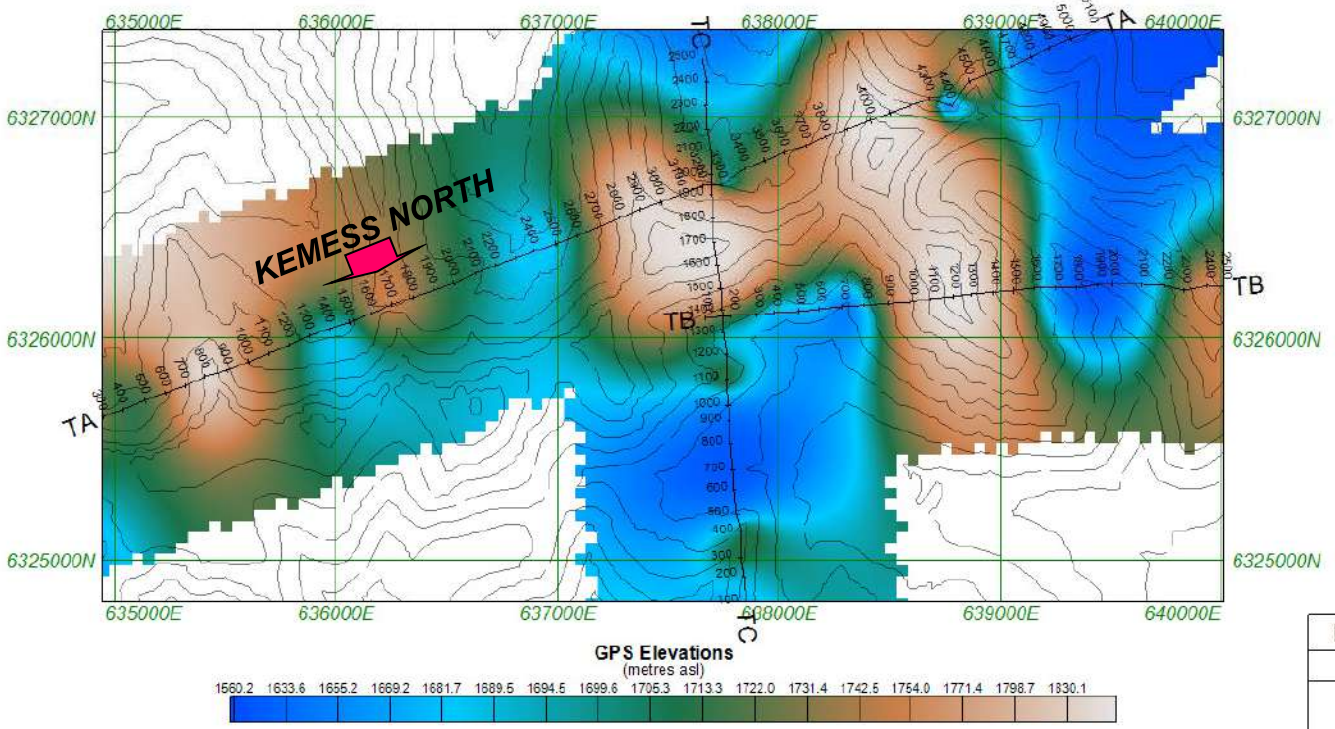
Case History: Kemess North

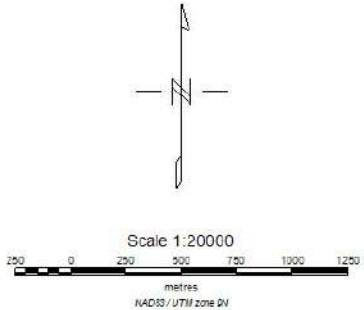
Titan-24 DC resistivity & IP
and Tensor MT Results



This is where the survey was completed – looking from the SE – single line, 4.2 km in length

TITAN LINE LOCATION MAP





GPS Elevations
(metres asl)

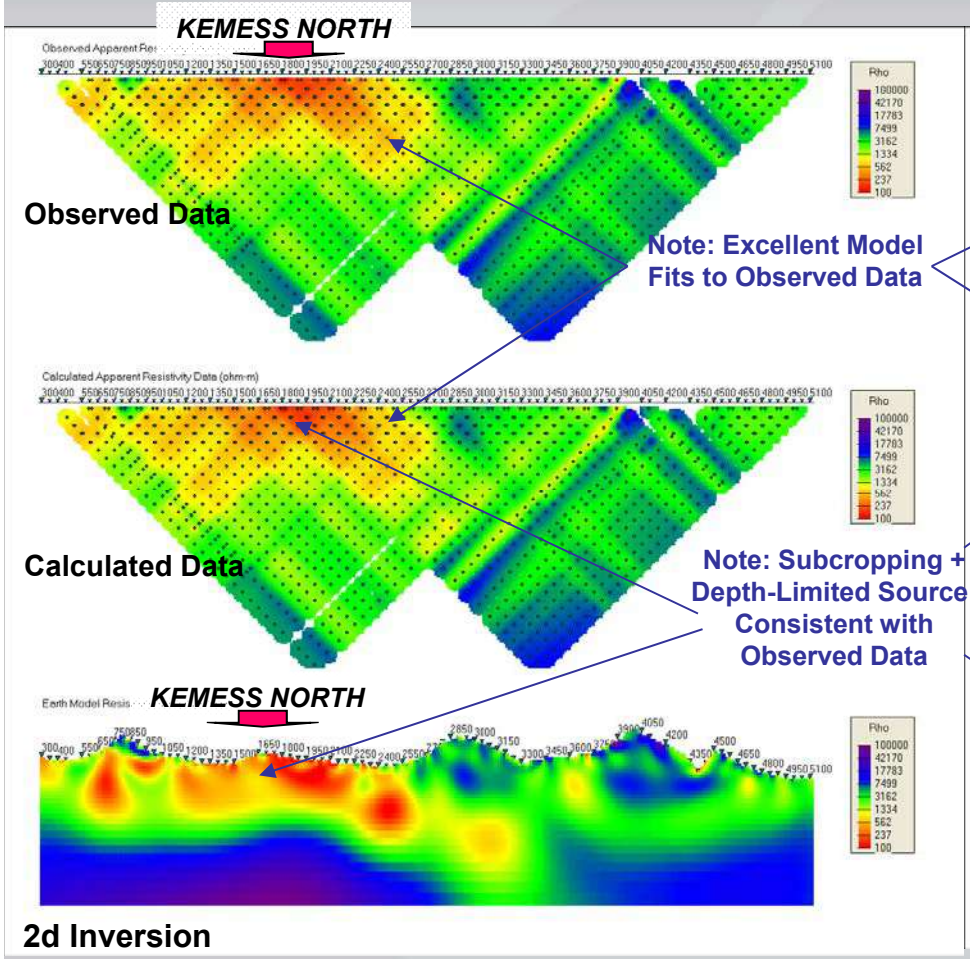
1560.2 1633.6 1655.2 1669.2 1681.7 1689.5 1694.5 1699.6 1705.3 1713.3 1722.0 1731.4 1742.5 1754.0 1771.4 1798.7 1830.1

NORTHGATE MINERALS CORPORATION
KEMESS NORTH PROJECT
TITAN DISTRIBUTED ACQUISITION MT & DCIP SURVEYS TITAN LINE LOCATION MAP August, 2006
QUANTEC GEOSCIENCE LTD.

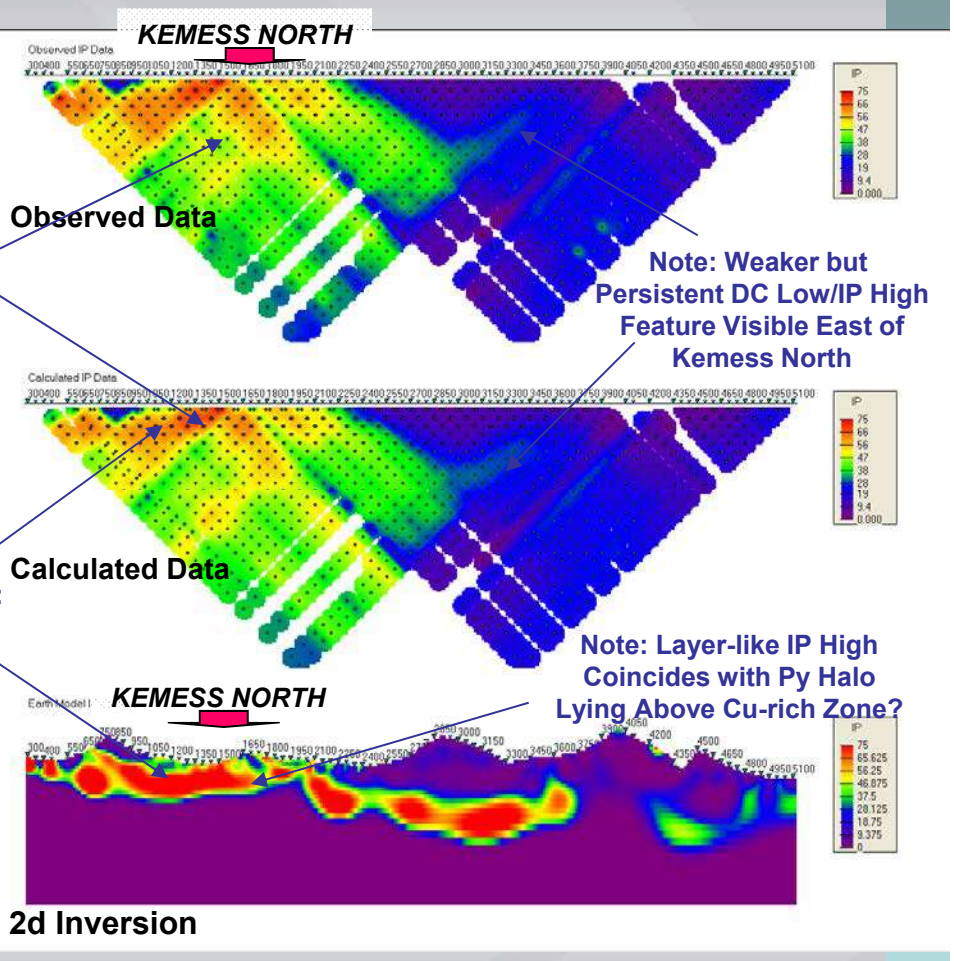
This is a plan map of the three lines that we will be discussing as completed with TITAN 24. More lines were recorded.

Line TA – 2D DCIP Inversion Results

Line TA Sp1+2 - Smooth UBC 2d DC Resistivity
(using 5% error floor w 15x error misfits removed)



Line TA Sp1+2 - Smooth UBC 2d IP Chargeability
(using 3.0mrad error floor w 15x error misfits removed



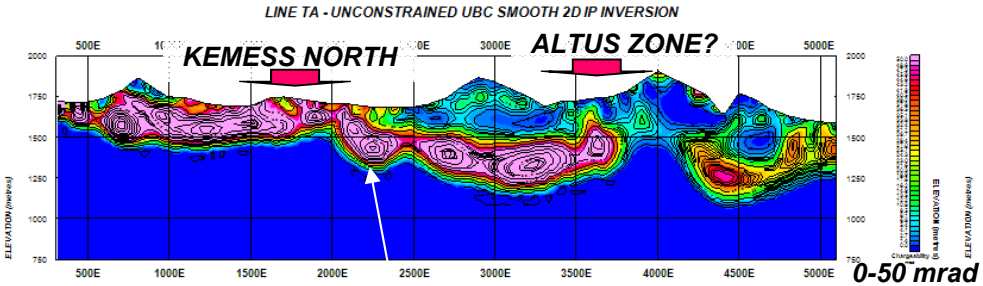
0 500m

View Looking Northwest

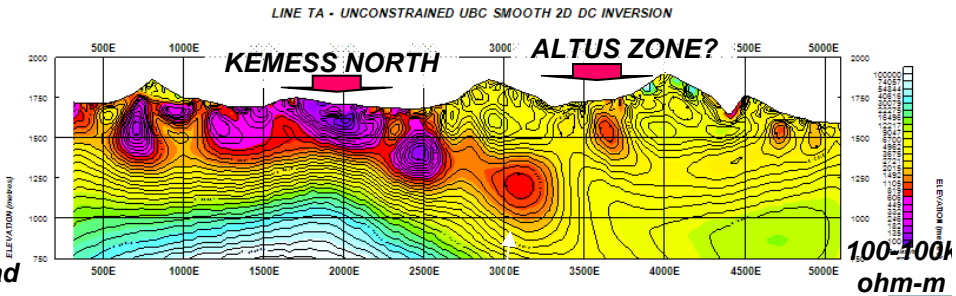
This is the actual data in pseudosection format and inversion below along the long NE trending TA line. Resistivity on left and IP on right. Even without inversion, we can see several geologic points of interest. Kemess North mineralization at surface is clearly mapped with the limited depth extent. Unknown potential mineralization to depth at the northeast is clearly mapped, and furthre potential target at greater depth and the far NE. Chargeability response is depth limited and may only be representing the pyritic cap. DC referenced chargeability model.

Line TA – 2D Multiparameter Inversions

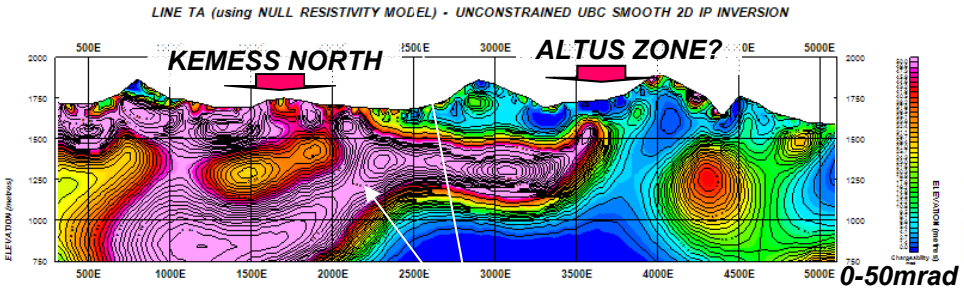
2d Smooth Chargeability
(Titan Pole-dipole Array – A=100m / N=0.5-32.5)



2d Smooth DC Resistivity
(Titan Pole-dipole Array – A=100m / N=0.5-32.5)

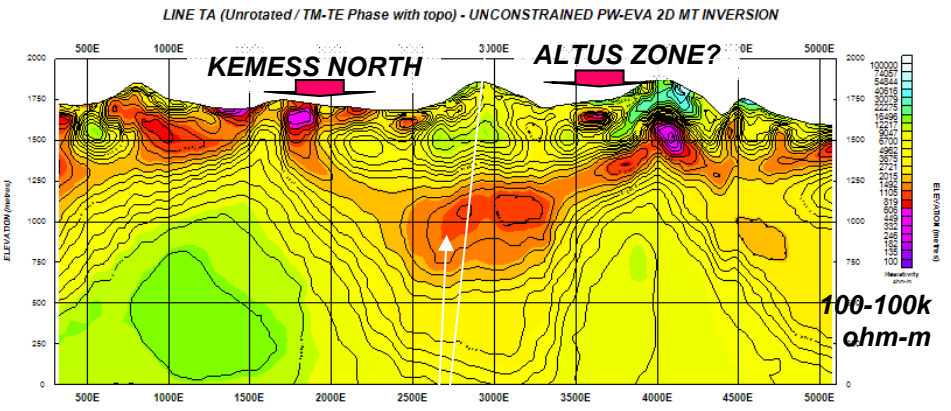


2d Smooth IP (Null Resistivity Reference Model)
(Titan Pole-dipole Array – A=100m / N=0.5-32.5)

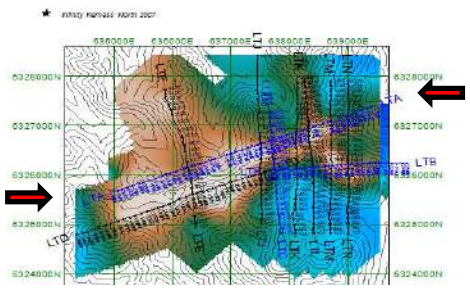


Note: Deeper Vertical Extent of "Null Res" vs. Default IP Model

2d PW MT Resistivity (Topo-Corrected TM-TE Phase)
(Titan Tensor MT Array – A=100m / f=0.1-10,000Hz)



Note: Graben-like Deep Resistivity Low Structure , i.e. Alteration System?



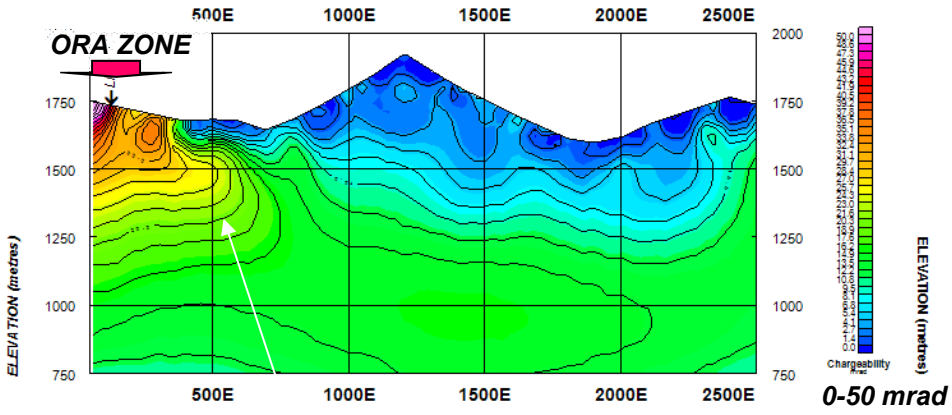
View Looking Northwest

0 500m

Note the clear fault offset between the Kemess Noth zone and the previously unknown Altus zone at depth – no surface expression. The resistivity model on the bottom left uses a HHS (null) reference model and shows additionl chargeability at depth which could represent copper mineralization zones at great depth. IT is important to run several IP inversion models to remove any bias in the results caused by the initial model. At right si the resistivity – DC at top and MT at bottom. MT sees to a depth of 1.5 km, and indicates a graben-like structure which may reflect alteration.

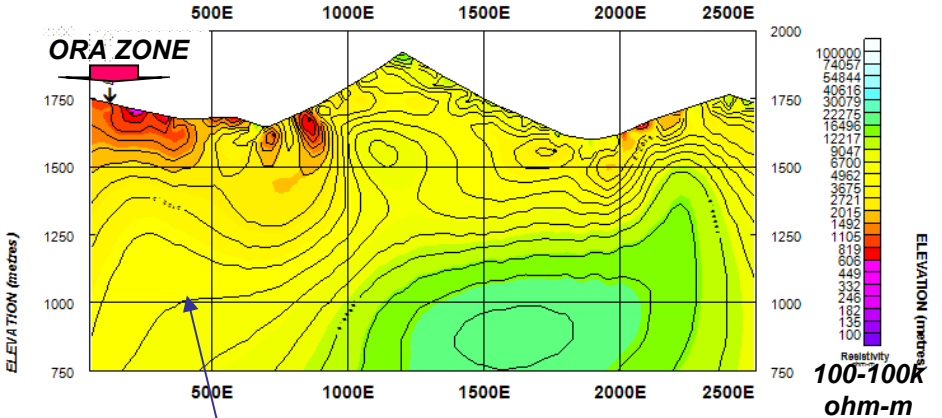
Line TB – 2D Multiparameter Inversions

LINE TB - UNCONSTRAINED UBC SMOOTH 2D IP INVERSION



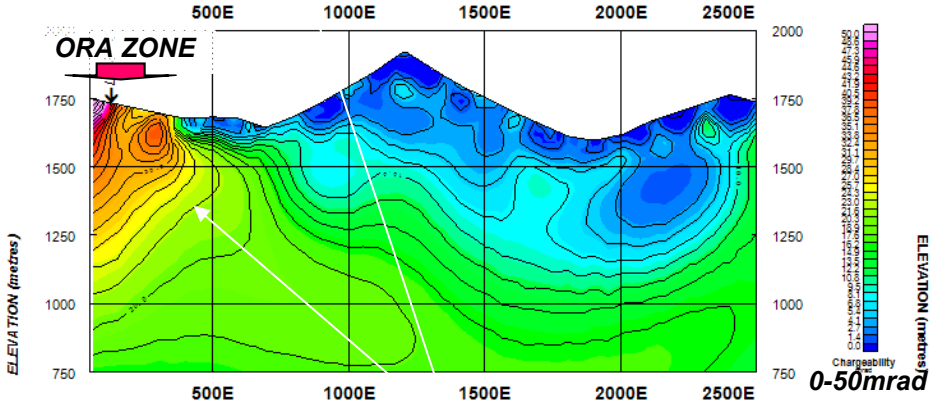
0-50 mrad

LINE TB - UNCONSTRAINED UBC SMOOTH 2D DC INVERSION



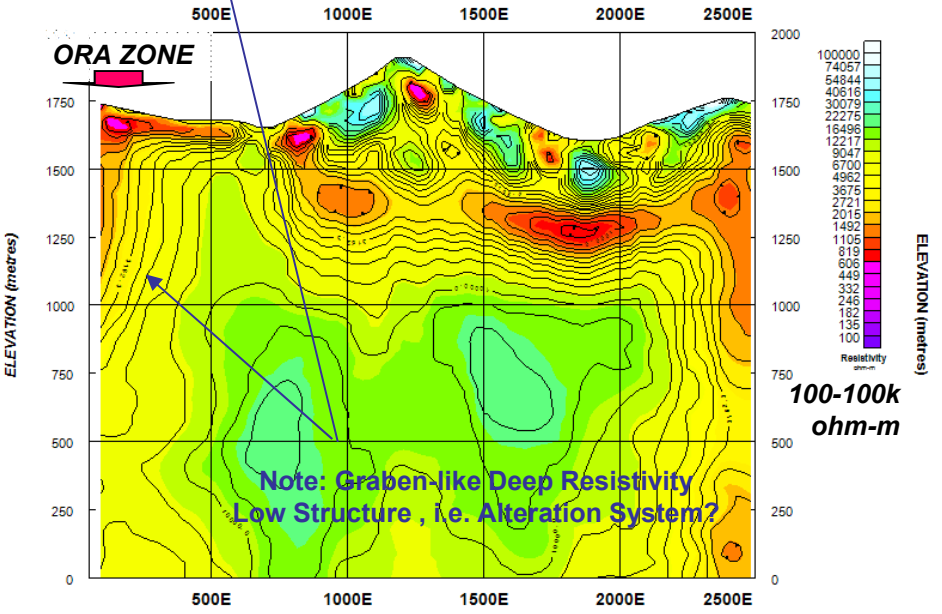
100-100k ohm-m

LINE TB (using NULL RESISTIVITY MODEL) - UNCONSTRAINED UBC SMOOTH 2D IP I



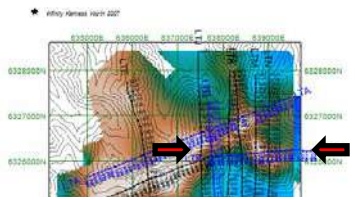
0-50mrad

LINE TB (Unrotated / TM-TE Phase Model with topo) - UNCONSTRAINED PW 2D MT INVI



100-100k ohm-m

Note Similarity Between "Null Res" vs. Default IP Model

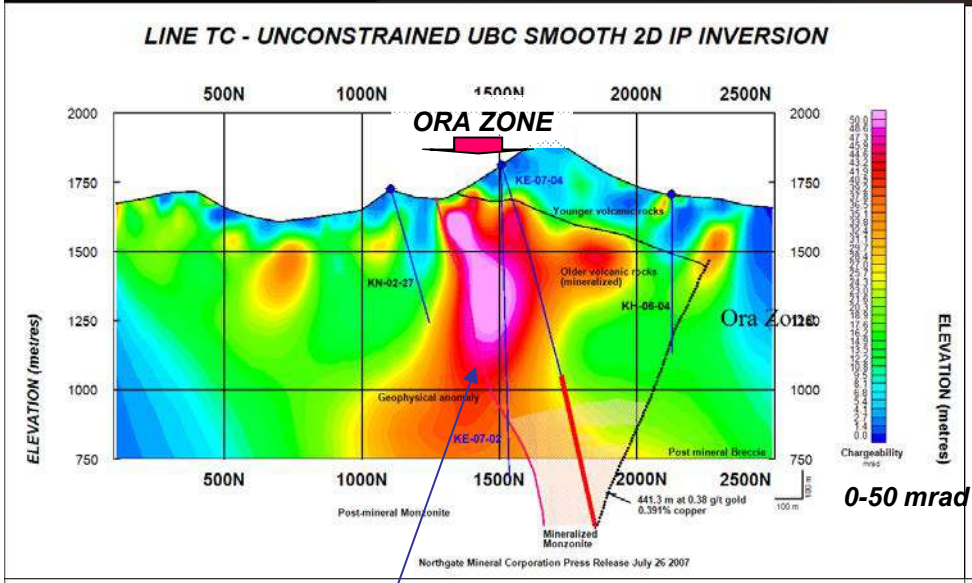


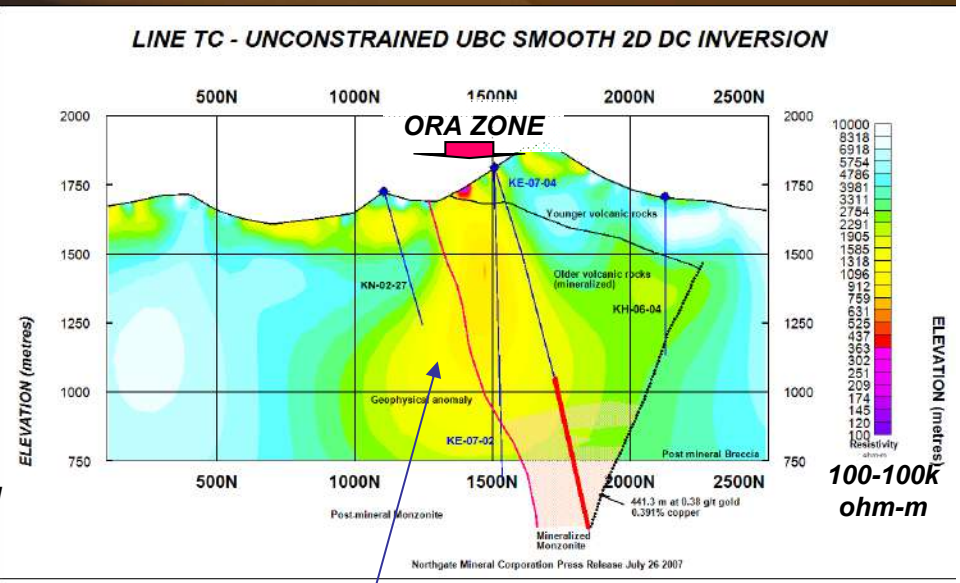
0 500m

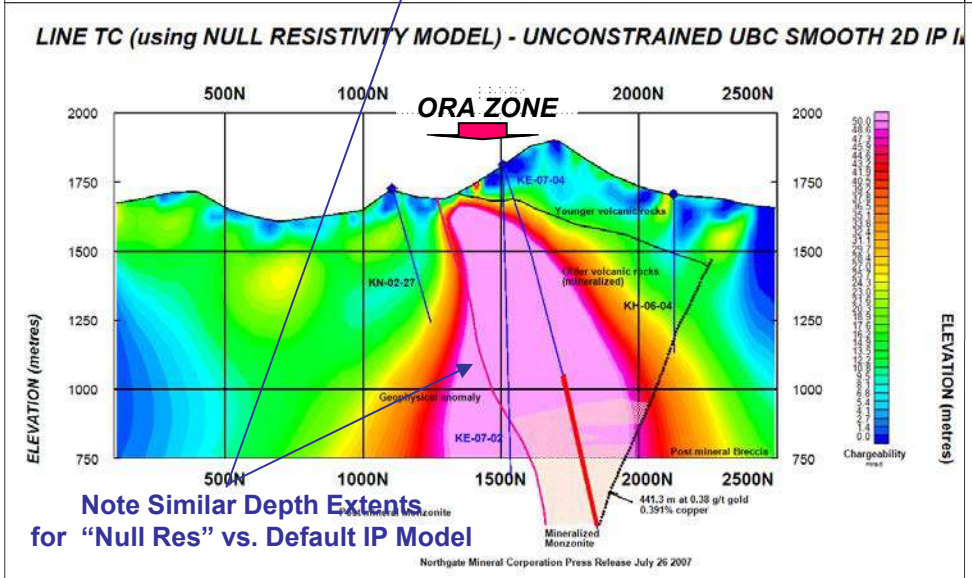
View Looking North

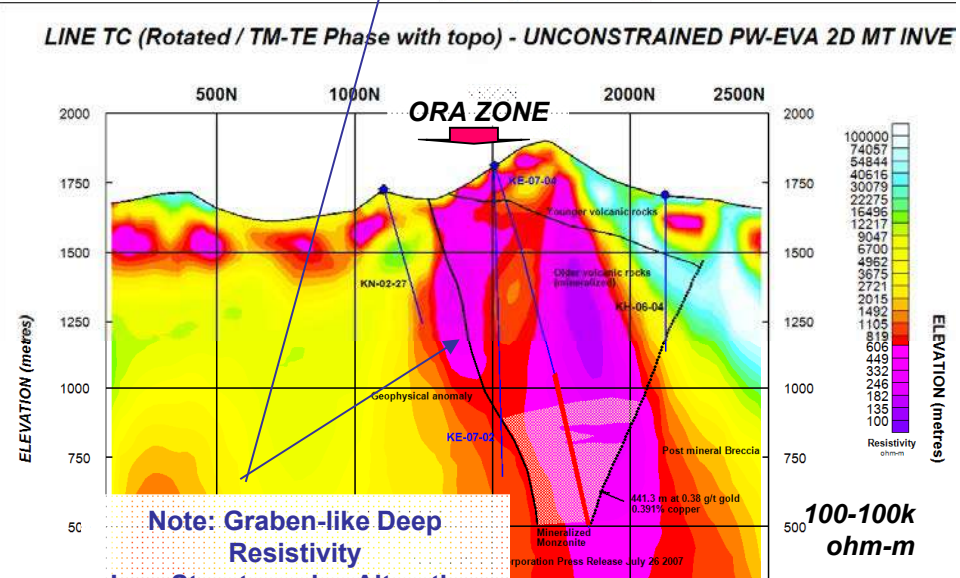
Moving to another line, this east-west line show very similar IP model using the two different startign models. Highly conductive, high chargeable zone at the west is the Ora zone MT shows the same graben-like structure on the previous line.

Line TC – 2D Multi-parameter Inversions + DDH Results







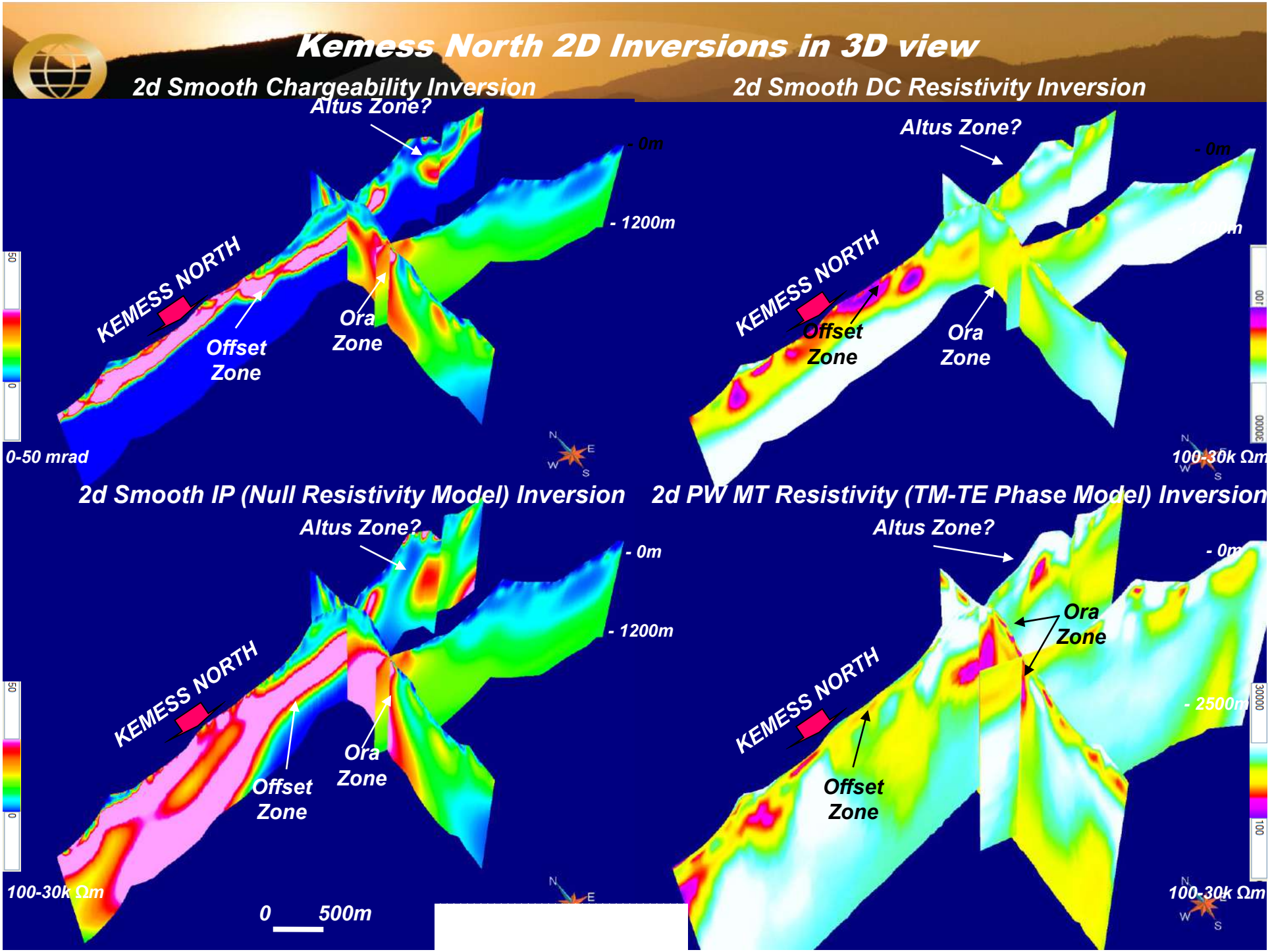


0 500m

View Looking West

Now we are looking at a N-S line which intersects the TB line at the end. So we are crossing the Ora zone directly. The null resistiity IP model show a depth extent to the anomaly, and the MT confirms this depth extension.

Kemess North 2D Inversions in 3D view



Putting these three lines together. Ora zone, Offset zone, Altus Zone

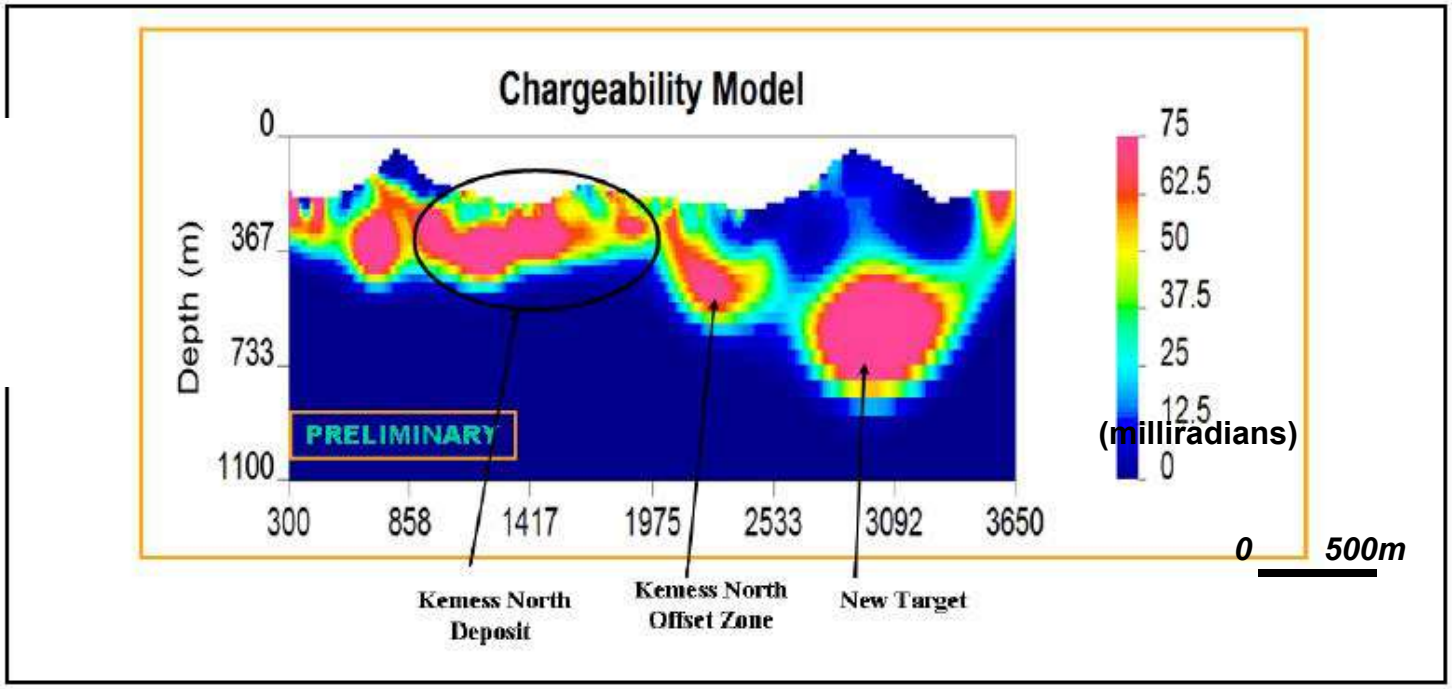
Northgate Minerals Corporation

KEMESS CLAIMS EXPLORATION RESULTS

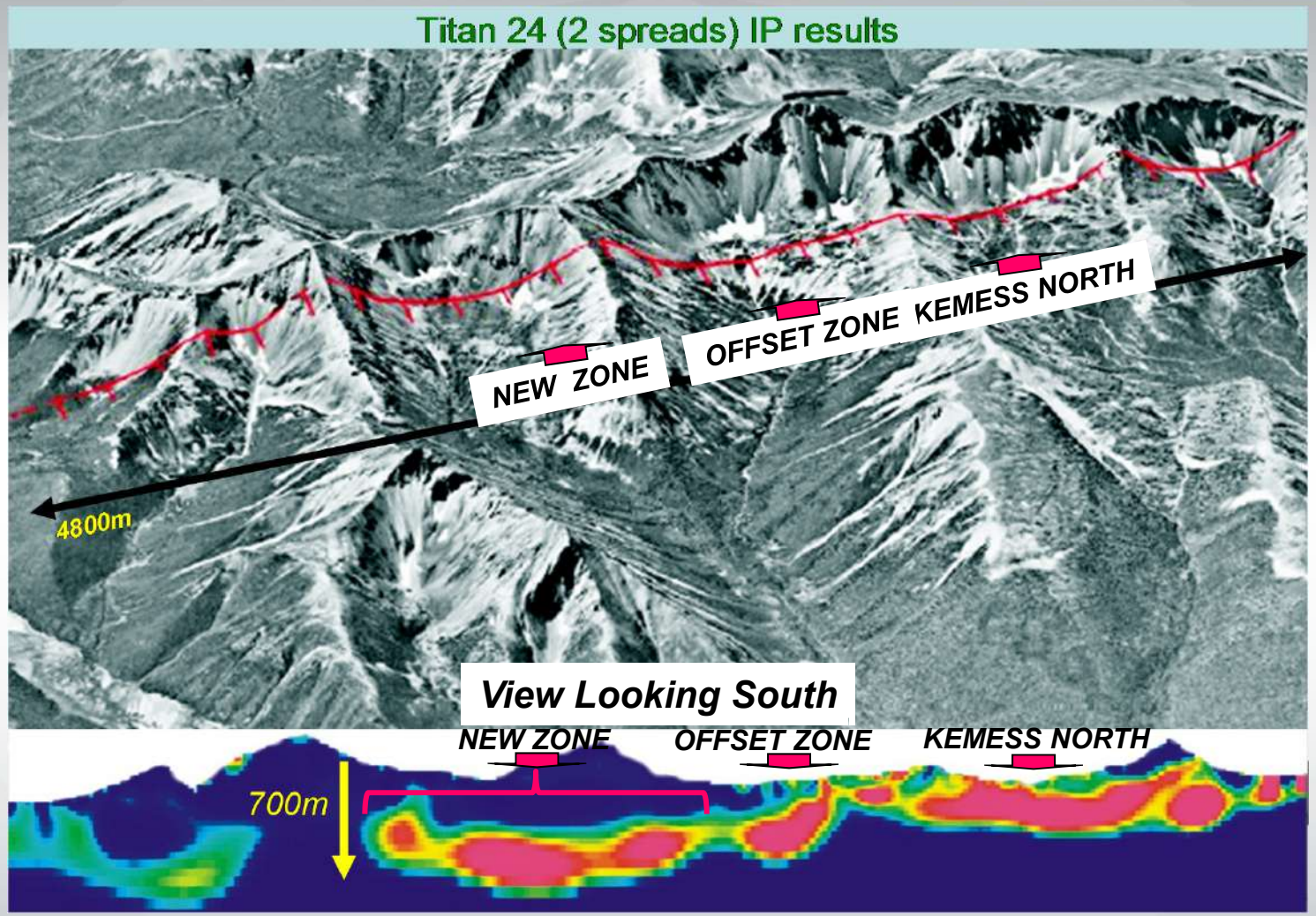
During the summer exploration season, a deep penetrating IP survey was conducted in the area surrounding the Kemess North deposit. This survey outlined several previously unknown exploration targets which are shown in pink in Figure 2. Northgate plans to drill several diamond drill holes to test the largest of these targets to the east of Kemess North during November, prior to the end of the 2006 exploration season. While the large target to the east of Kemess North Offset looks to be quite deep on the section view provided, the proposed drill holes will be collared at much lower elevations to the north and south of the plane of the section. Assay results from these holes are expected towards the end of December.

Figure 2: Kemess North Area (Vertical, North Looking, Longitudinal Section)

TITAN-24 2D CHARGEABILITY INVERSION
(from Pole-Dipole Array DCIP Survey - a=100m / n=0.5 to 32.5)



Kemess North



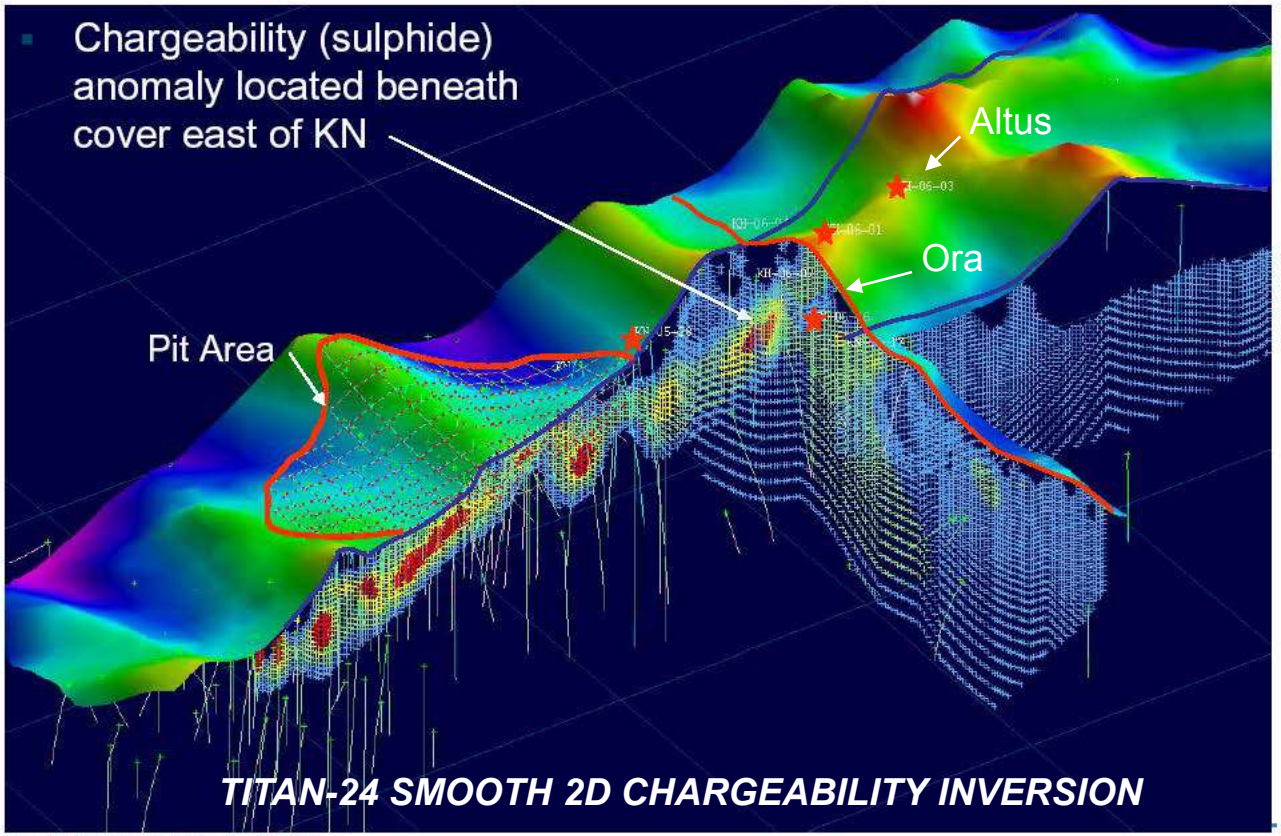
TITAN-24 2D CHARGEABILITY INVERSION

(from Pole-Dipole Array DCIP Survey - a=100m / n=0.5 to 32.5)

From Northgate Minerals Press Release March-2007

Kemess Camp Exploration

Isometric View of Kemess North Region



May 3, 2007 Board of Directors Meeting

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View Looking North

From Northgate Minerals Press Release May-2007

Northgate Minerals Corporation

News Release

TSX NGX AMEX NXG

Q2 07

NORTHGATE REPORTS STRONG QUARTERLY CASH FLOW OF $43.7 MILLION
A THIRD LARGE GOLD-COPPER PORPHYRY SYSTEM DISCOVERED AT KEMESS

VANCOUVER, July 26, 2007 – (All figures in US dollars except where noted) – Northgate Minerals Corporation (TSX: NGX; AMEX: NXG) today reported cash flow from operations of $43,685,000 or $0.17 per diluted common share and net earnings of $8,647,000 or $0.03 per diluted common share for the second quarter of 2007.

SECOND QUARTER HIGHLIGHTS

- Production of 65,999 ounces of gold and 14.8 million pounds of copper
- Net cash cost of production of $35 per ounce of gold
- Exploration drilling on targets identified in a deep penetrating induced polarization (IP) survey in 2006 has discovered two new zones of mineralization east of the Kemess North deposit
  - » Ora Zone: Hole KH-07-04 returned 441 metres (m) of 0.38 grams per metric tonne (g/t) gold and 0.39% copper
  - » Altus Zone: Holes KH-07-03 and KH-07-05 returned 155 m and 128 m, respectively, averaging 0.23 g/t gold and 0.3% copper

Ken Stowe, President and CEO, stated, "The discovery of another large mineralized system in the Kemess camp is very exciting. Equally important is the success of the Titan© deep penetrating IP survey technique, which has proven itself to be an excellent predictive tool for spotting drill holes on the Kemess property in areas where there is no surface expression of mineralization. Over the next two months, we plan to follow up with further drilling of the Ora and Altus zones while conducting additional IP surveys at both Kemess North and Kemess South. From a financial

Findings

- ***Field surveys corroborated our initial 2-D DC synthetic modeling studies, plus the discovery of new mineralized zones.***
- ***Initial inversion results suggest that deeper Cu-rich zone is not differentiated from shallower Pyrite Halo – the use of Null-Conductivity IP model proposes deeper chargeability signature consistent with Cu-zone.***
- ***Kemess North and Ora signatures coincide with Resistivity Low /IP High features – consistent with previous geophysics.***
- ***Mineralized zones defined below >350m cover, extending to >1km – confirmed by drilling of deepest mineralization in Kemess camp, Cu-Au at 855-1296m***

Findings

- ***Mineralized zones also indicated to subcrop (Ora), but remained previously undetected/hidden below talus cover – proves shallow to deep resolution capability of Titan DAS surveys.***

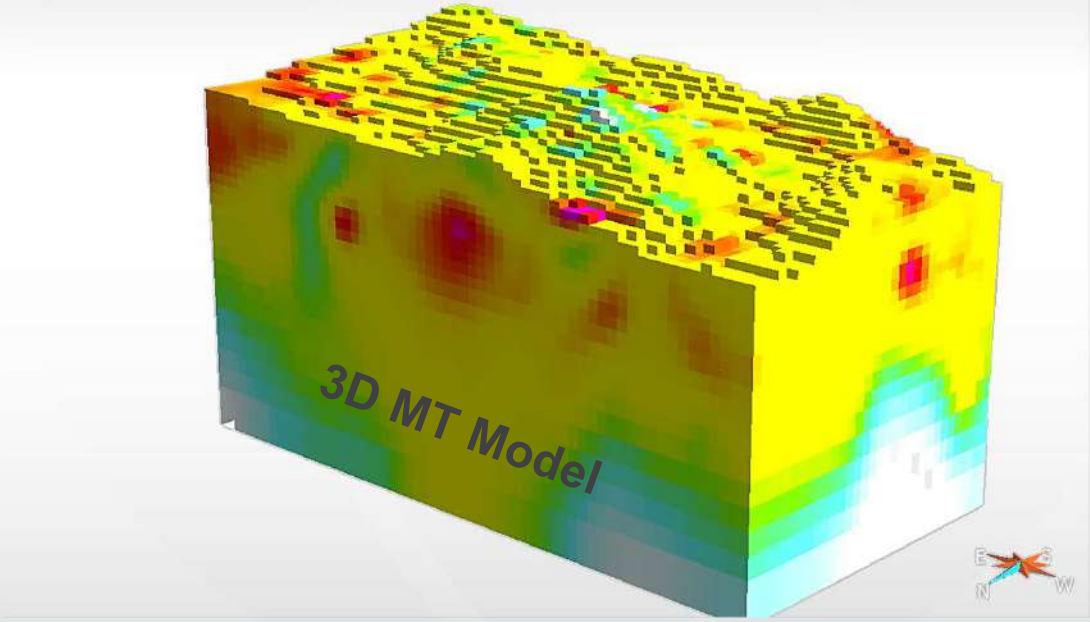
- ***Deeper DC + MT Resistivity Low signatures suggest source is deeply rooted hydrothermal clay-chlorite alteration system.***

- ***More detailed coverage recommended (e.g. Orion 3D survey), supported by 3D inversion, to better determine geometry and potential continuity between Kemess North and Ora-Altus zones, as well as nature of apparent deeply altered/mineralized system.***

Kemess Summary

- ***Availability of Physical Property Data (from previous geophysics) Critical for Success of Synthetic Model Study.***
- ***Although Titan Survey Results Led to New Discovery adjacent to Kemess North, Arguably Success is Attributed to Strategically Designed Survey.***
- ***However, Knowledge Gained from Synthetic Modeling Provided Confidence in Capability of Geophysics to Be Successfully Applied in These Areas.***
- ***Titan Surveys Able to Prove that Mineralized System Extended >1.5km Beyond Previously Known.***

Delineation of a Porphyry Copper-Gold system using ORION 3D DCIP- MT and CSAMT surveys-Case history, the Santa Cecilia Deposit, Chile

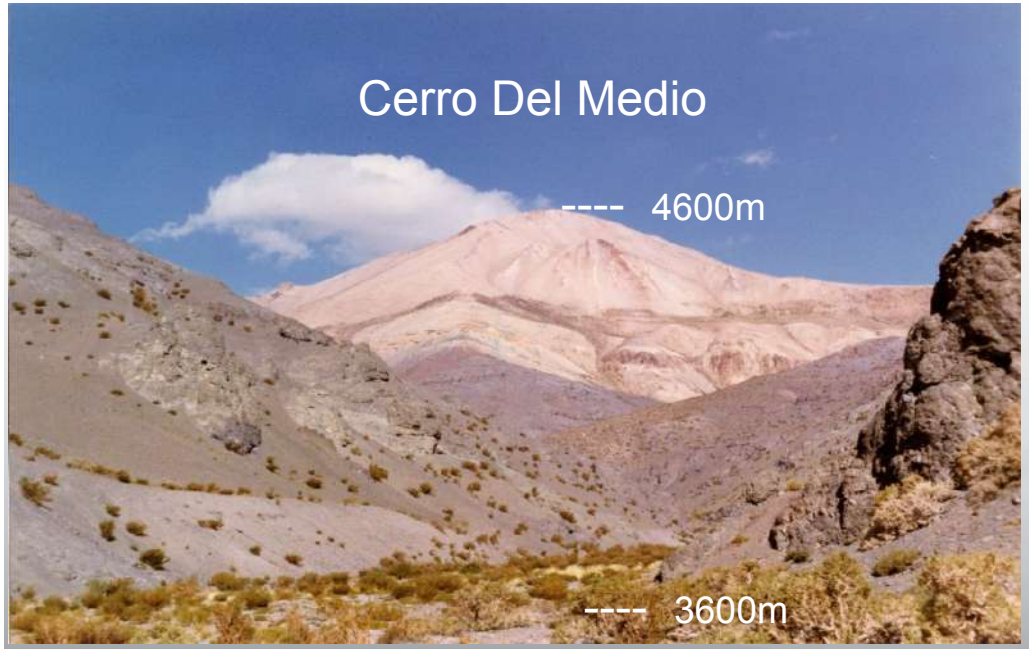


Nasreddine Bournas(1) and David Thomson (2)*
(1) Quantec Geoscience, (2) Cerro Grande Mining Corporation

KEGS-PDAC Symposium, Toronto March 2nd 2013

Introduction

- Location, High Western Cordillera, Maricunga Belt.
- Intensive Hydrothermal alteration
- Magnetic, CSAMT and ORION 3D DCIP/MT



SC project area is located in the High Western Cordillera of Chile's "3rd Region" within the Maricunga Mining Belt.

Intensive Hydrothermal alteration with Cu-Au-Ag mineralization occurs within an area of ≈ 10 km² at elevations of 3600 to 4600m ASL.

CSAMT and ORION 3D DCIP/MT results are presented and discussed

History

- 1983- Helicopter-borne reconnaissance by M. Hernandez and D. Thomson.
- 1984-1990- Anglo American Chile
- 2009- Ground magnetic survey
- 2010- CSAMT and Mobile Metal Ion (MMI)
- 2011-2012- CSAMT coverage and drilling
- 2012- QUANTEC ORION 3D DCIP/MT

Regional settings

- Maricunga Mining Belt (Mining District).
- Folded Formations of Upper Triassic Caspiche
- Oligocene to Lower Miocene Aguas Blancas and Rio Nevado Formations
- Porphyry intrusives, diorites and Qz-diorites & alteration zones

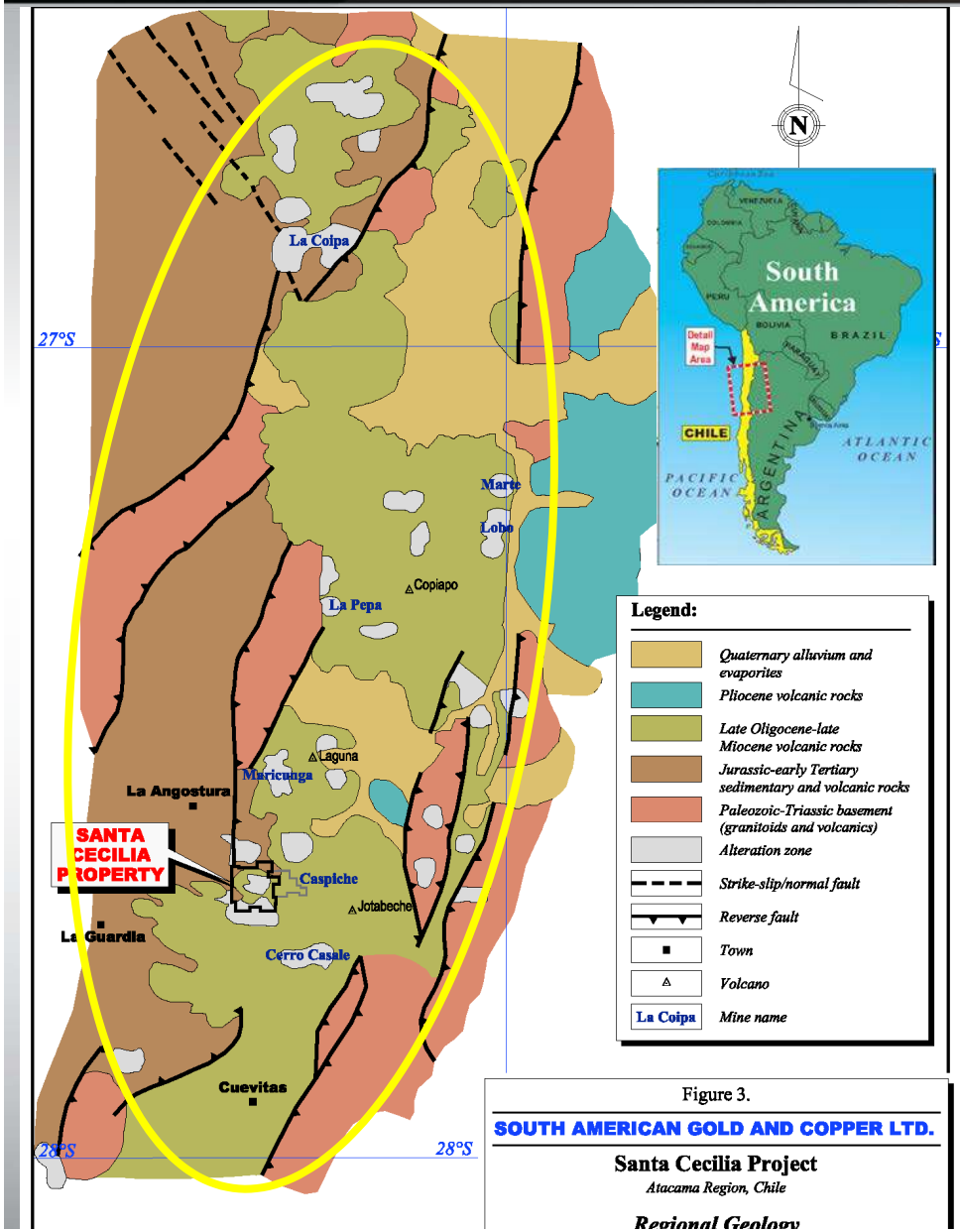


Figure 3.

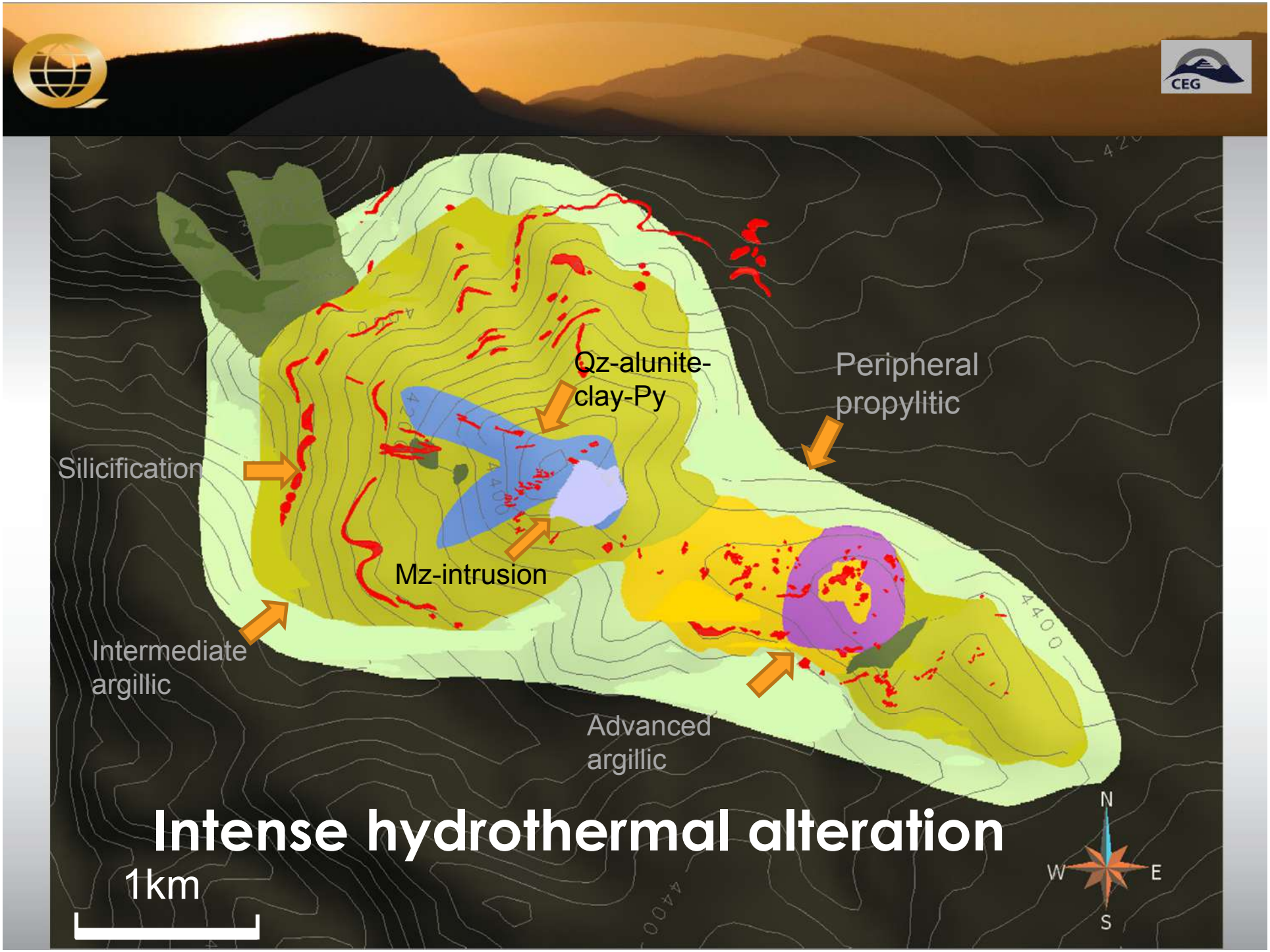
SOUTH AMERICAN GOLD AND COPPER LTD.

Santa Cecilia Project

Atacama Region, Chile

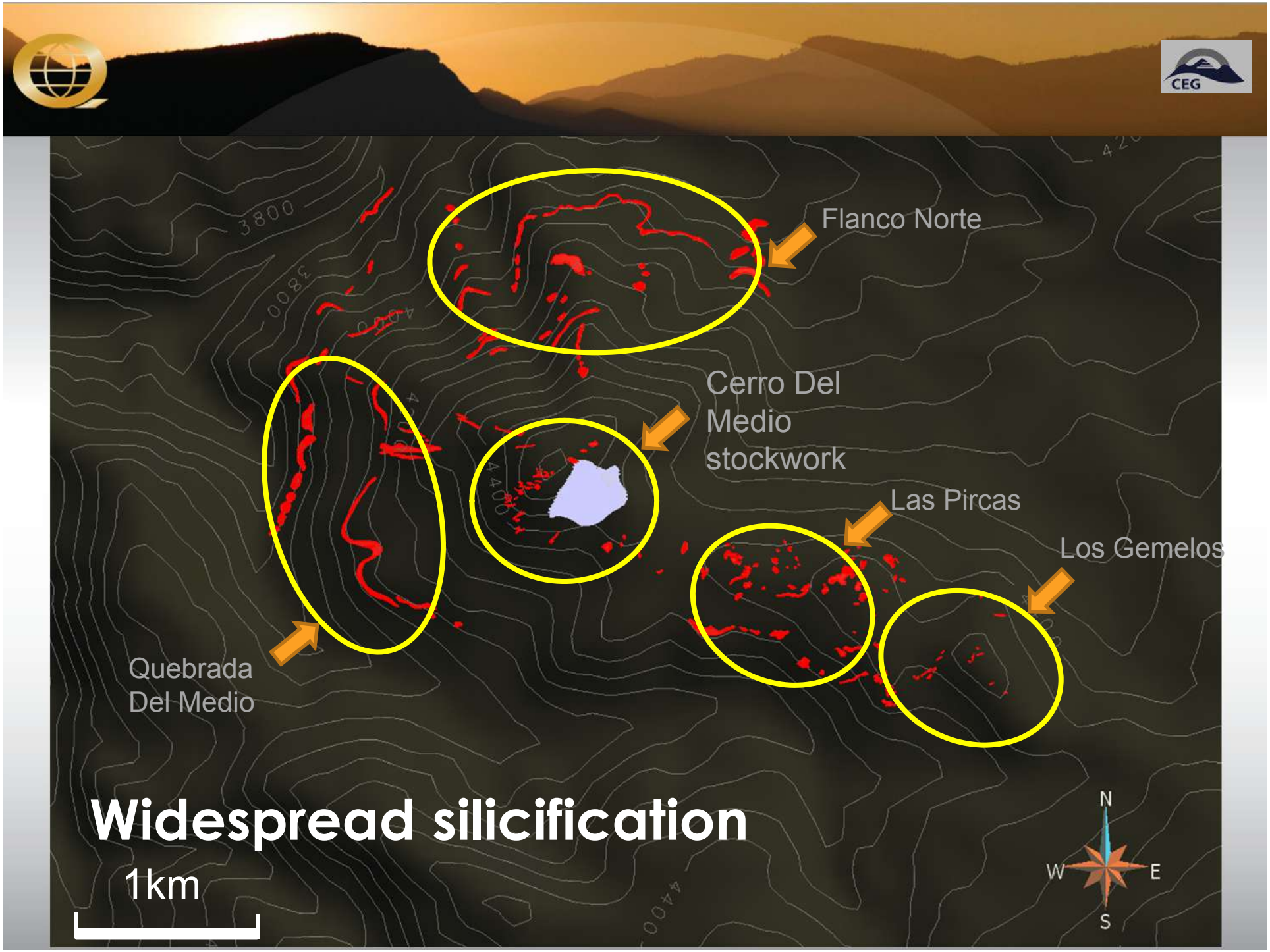
Regional Geology

On regional scale SC lies within the Maricunga Belt (Mining District).
Basement rocks are Folded Formations of Upper Triassic Caspiche (volcanics and sediments) unconformably overlain by Oligocene to Lower Miocene Aguas Blancas and Rio Nevado Formations (Volcano-sedimentary rocks).
Mineralization is found in Porphyry intrusives, diorites and Qz-diorites located in alteration zones.

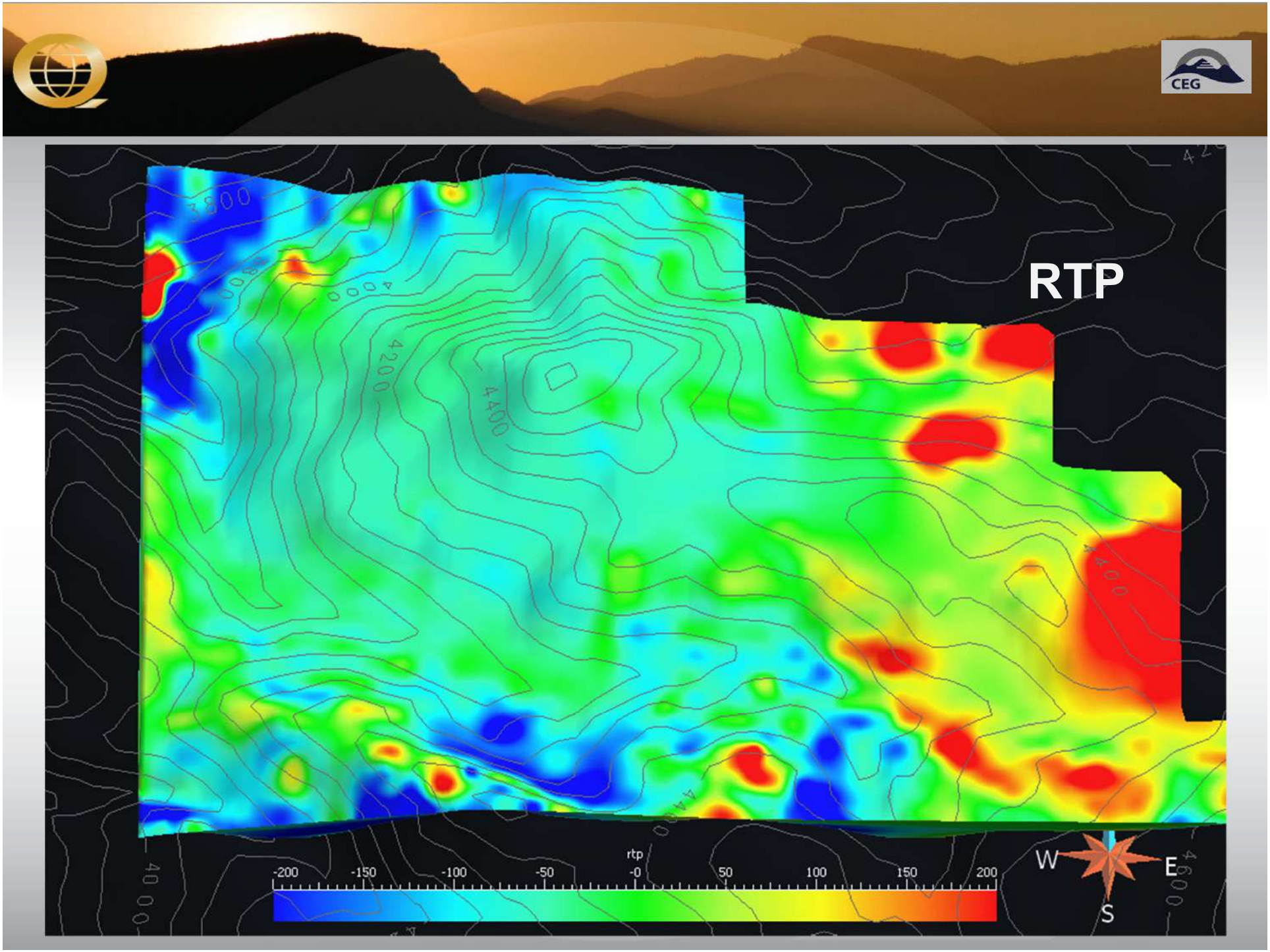


Intense hydrothermal alteration

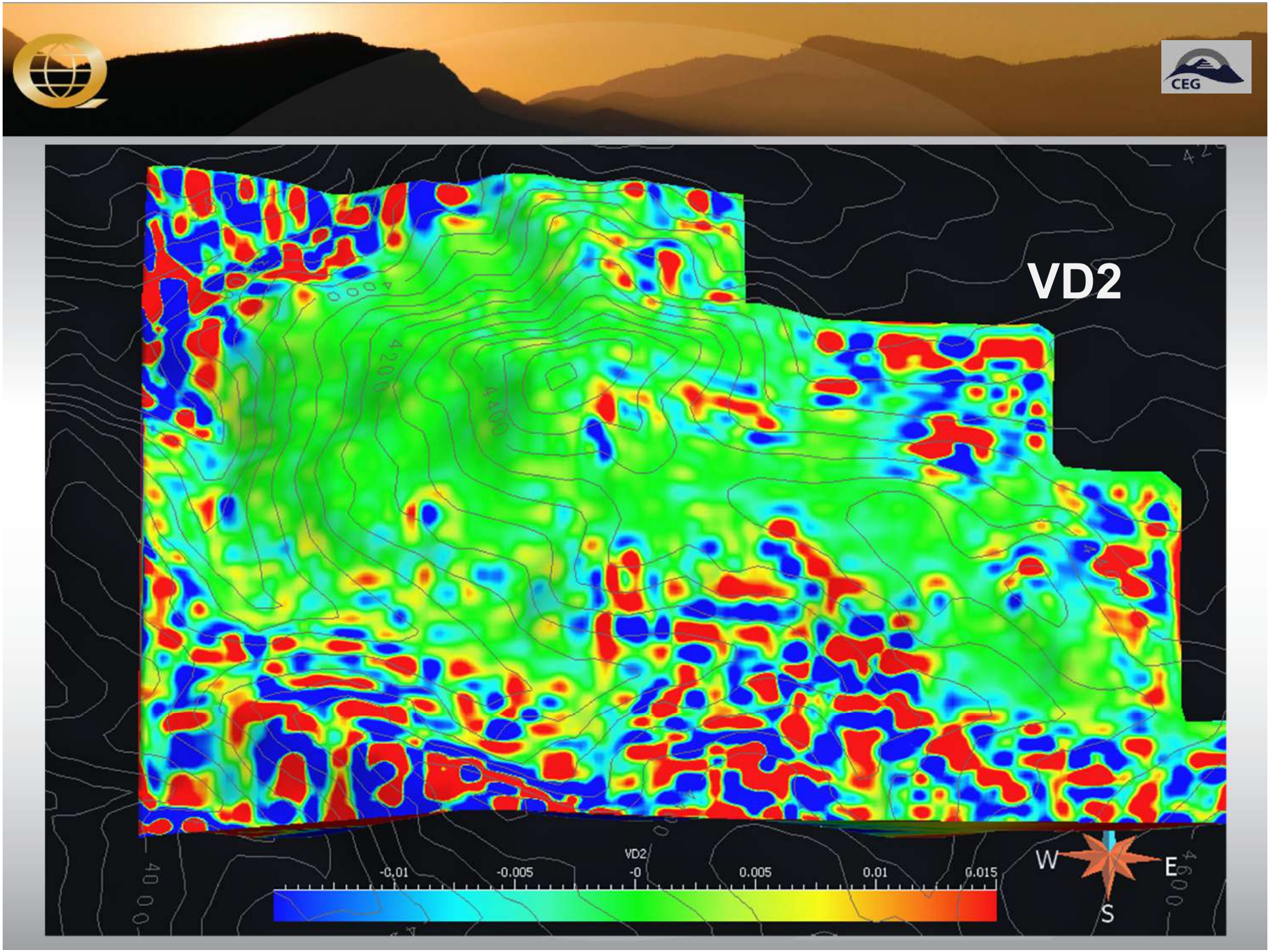
Intense hydrothermal alteration, which has affected all rocks at Santa Cecilia, comprises a peripheral propylitic zone with an inner shell of quartz-alunite-sericite-chlorite, clay-pyrite. Intensity is indicative of mineralization that includes stockwork intrusives, porphyry-type intrusives and silicified structures. Alteration is 3km wide and centered on Cerro Del Medio, and extends along the ridge to the ESE where it narrows to approximately one kilometre.


Flanco Norte
Cerro Del Medio stockwork
Las Pircas
Los Gemelos
Quebrada Del Medio
Widespread silicification
1km
N
W
E
S

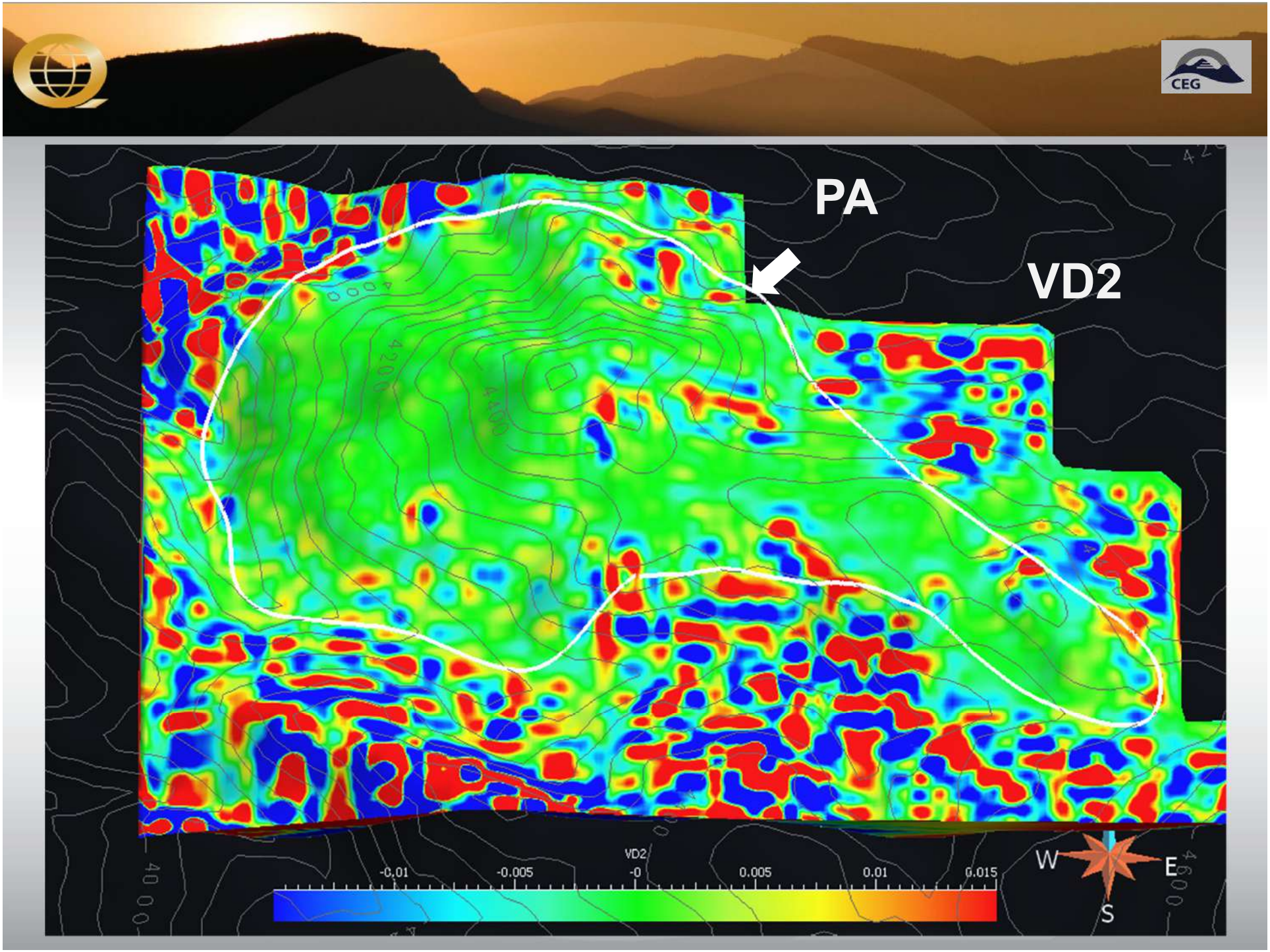
There is a widespread silicification associated with argillic alteration, disseminated sulphides, pyrite and alunite. Main mineralization includes gold, silver, and copper in Stockworks and siliceous veins associated with Qz-diorite and microdiorite including pyrite, chalcopyrite within altered breccias.


RTP
3800
4000
4200
4400
4600
rtp
-200
-150
-100
-50
-0
50
100
150
200
W
E
S

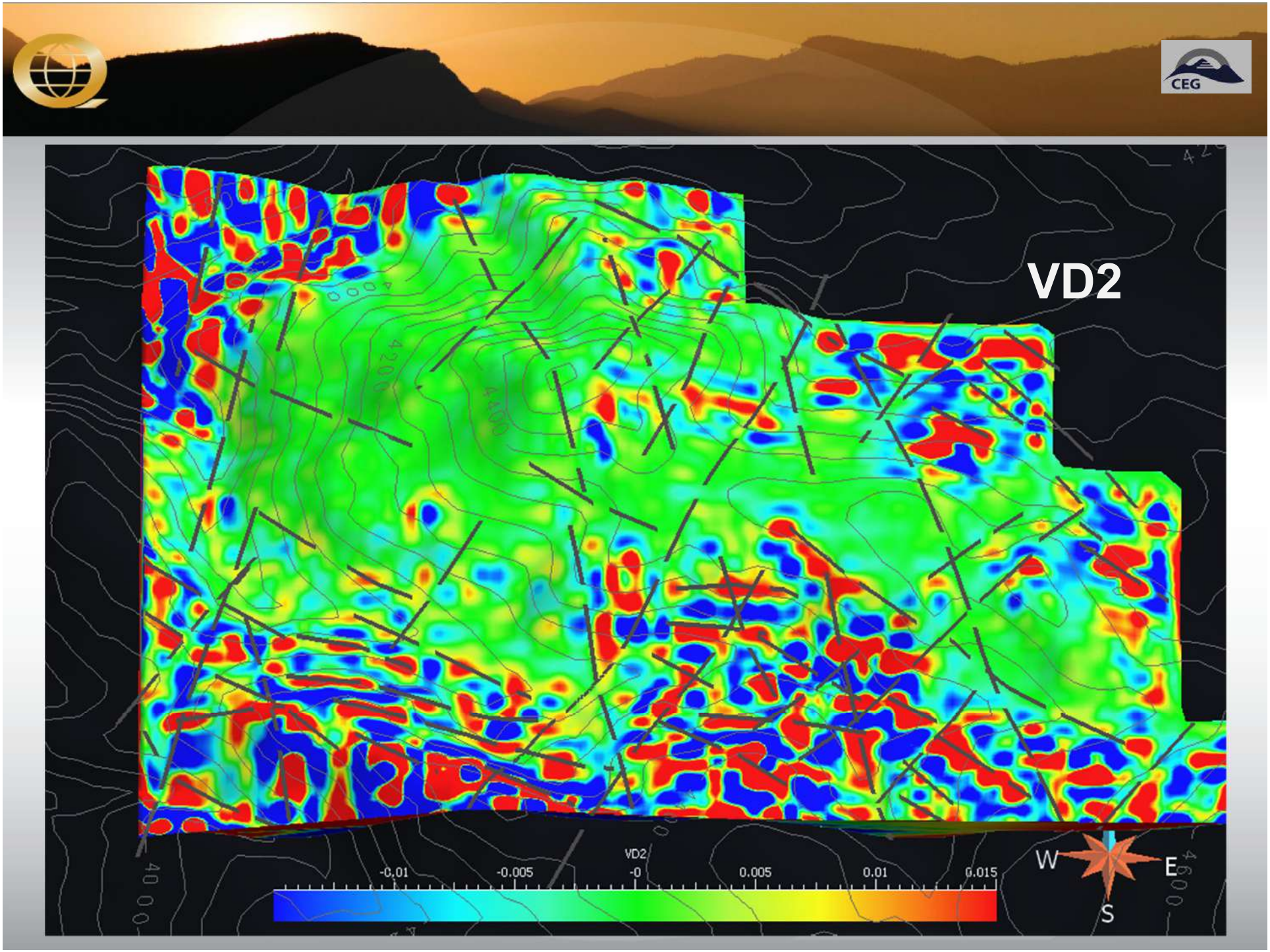
A detailed ground magnetic survey with east west traverse lines of 100 meters apart was run by Quantec over the entire SC altered zone in 2009. The RTP image draped on the topography, shows a broad circular feature of low-magnetic relief closely outlining the SC alteration zone probably reflecting magnetite destruction. The strong short wavelength lineament observed in the SE coincides with diorites and microdiorites.


VD2
VD2
-0.01
-0.005
-0
0.005
0.01
0.015
W
E
S

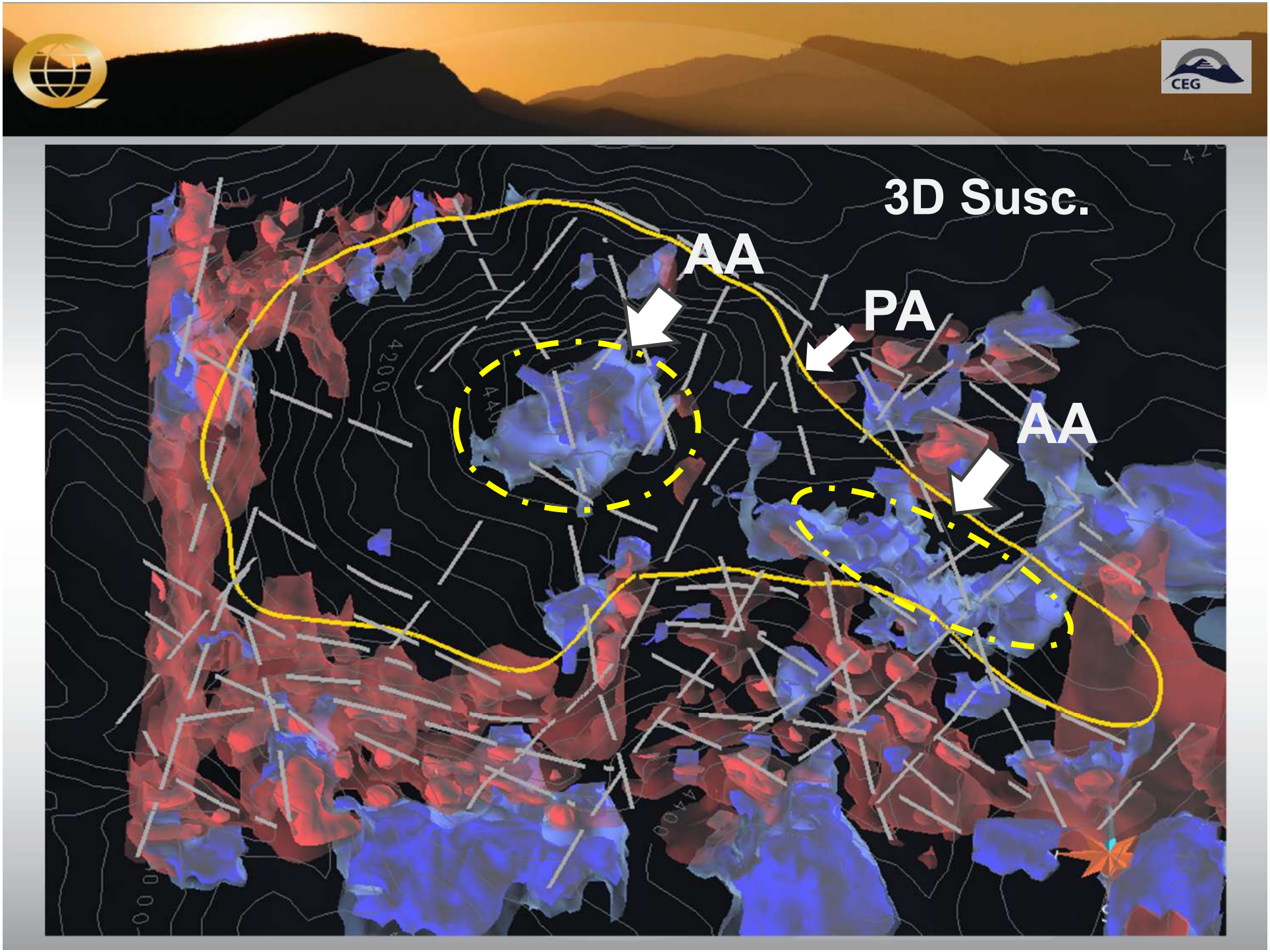
Enhanced filtering technique such as the 2nd VD, better highlights the near-surface feature and particularly provides with a precise delineation of the altered zone the response of which is very well market by the low-gradient area as shown in this slide.


PA
VD2
VD2
-0.01
-0.005
-0
0.005
0.01
0.015
W
E
S

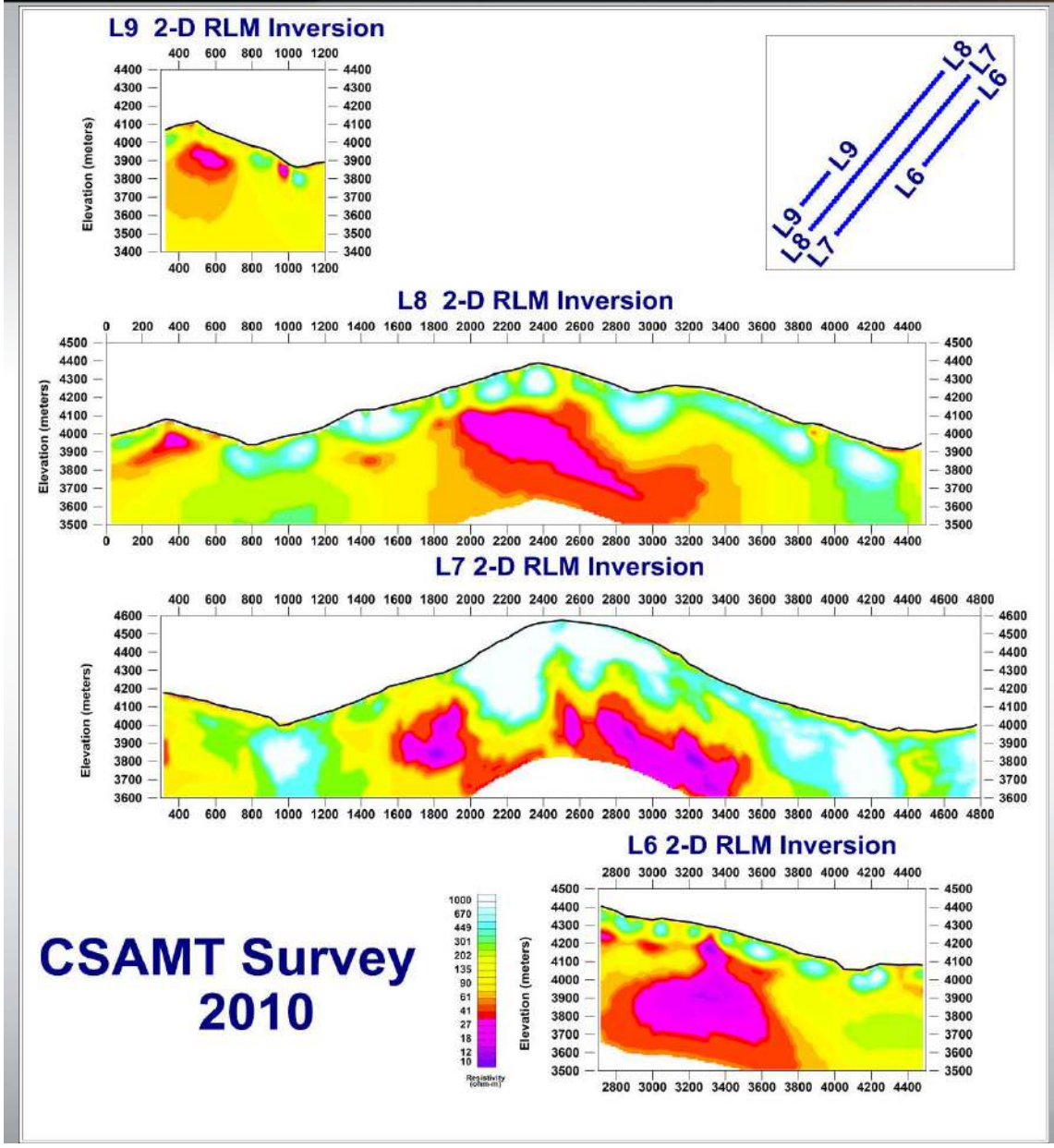
The transition between low and high gradient area marks the outline of the Peripheral alteration zone.


VD2
VD2
-0.01
-0.005
-0
0.005
0.01
0.015
W
E
S

In addition, the magnetic interpretation suggests that the areas has been subjected to several faulting systems (NW, NE).

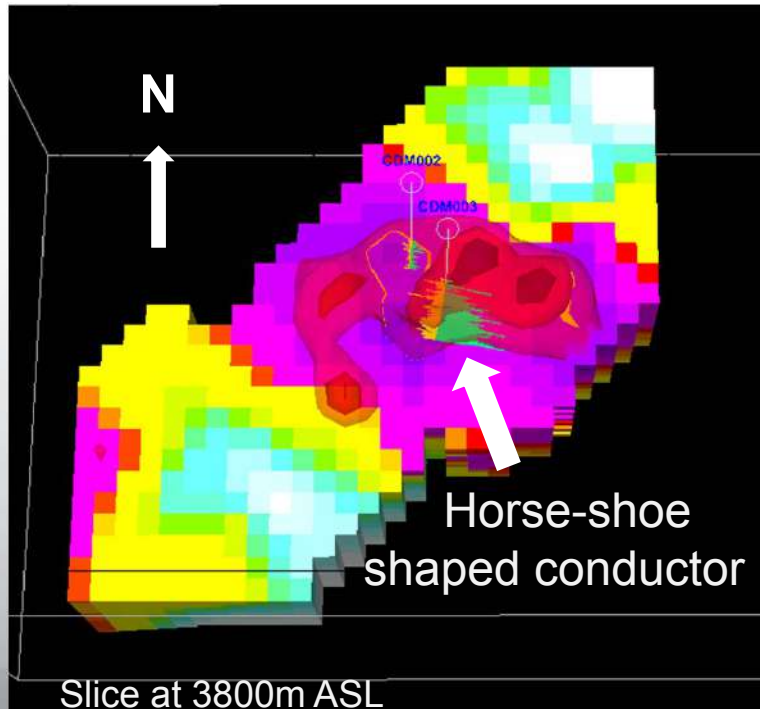

3D Susc.
AA
PA
AA

Blue= low mag susceptibility and red= high mag susceptibility. The blue areas appear to be indicative of advanced alteration due to destruction of magnetite.



CSAMT

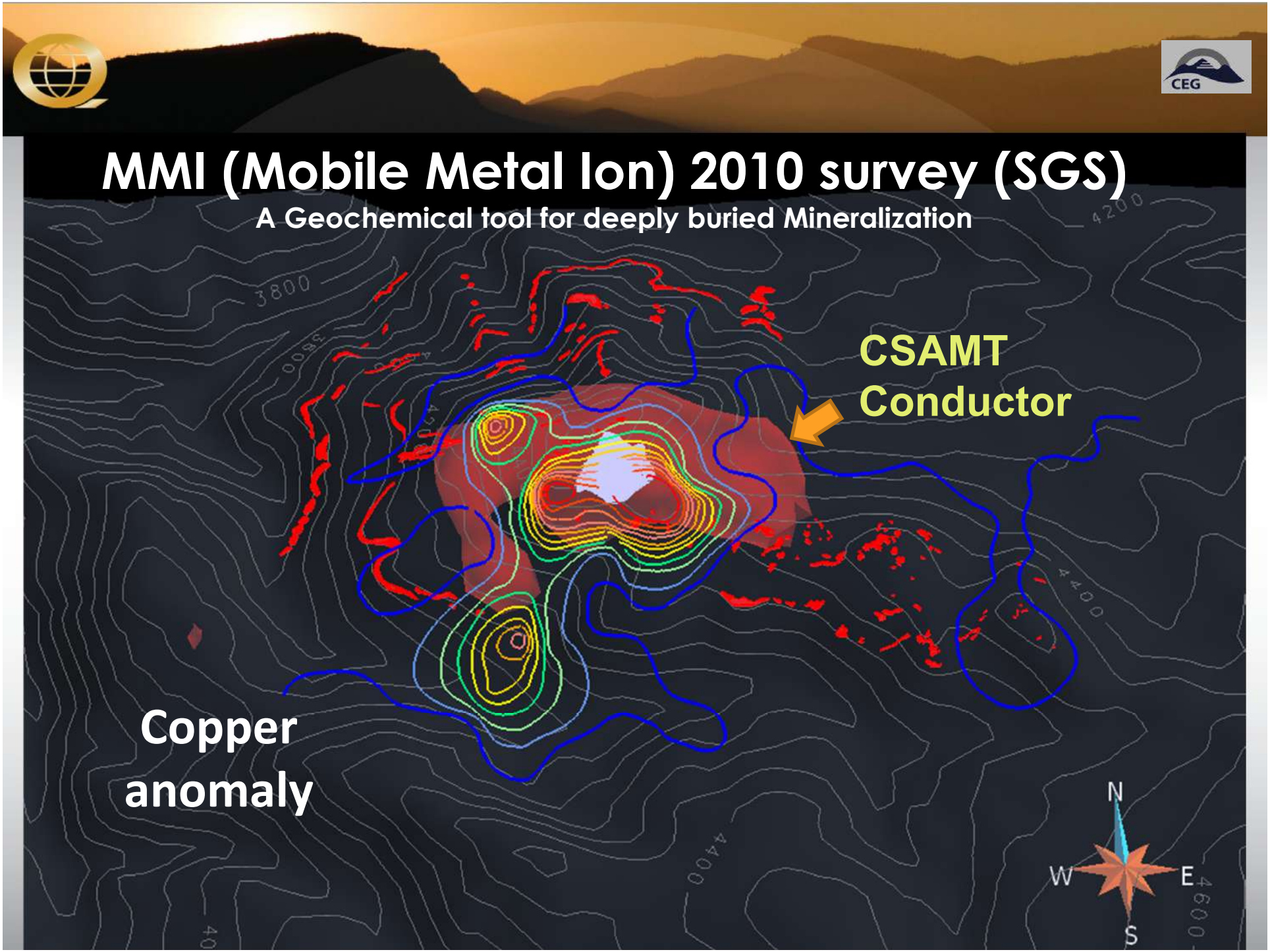
- Source dipole (3.5 km length)
- Current =2-13 A
- Acq. Bandwidth= 2-9000 Hz
- Inv. Bandwidth=24-9000 Hz
- Bostick depth ≈ 750m



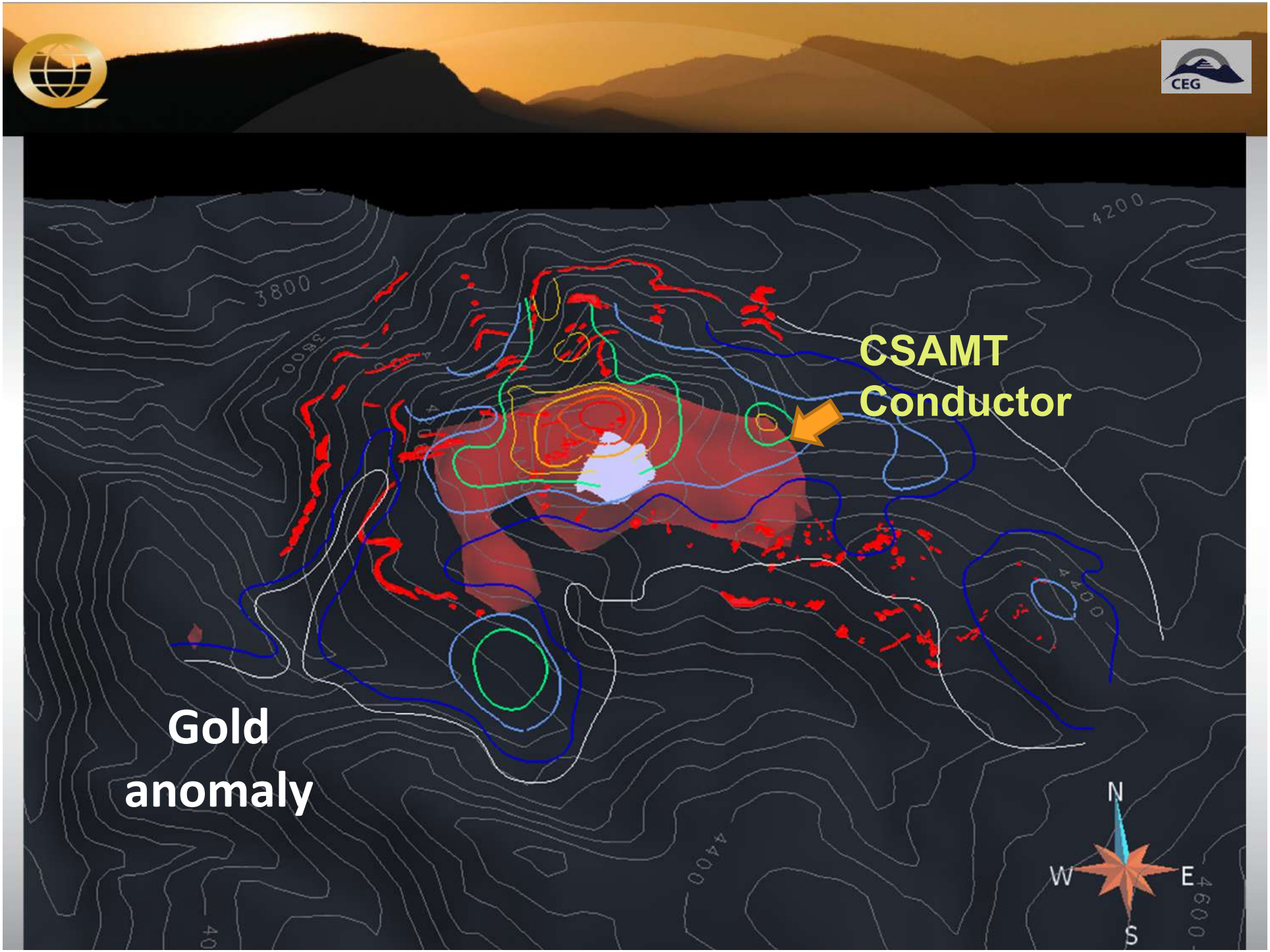
A CSAMT was conducted in 2010 to test the MMI anomalies and to detect anomalous zones associated with mineralization and alteration.
This slide shows the 2D MT inversion results along the CSAMT lines.

MMI (Mobile Metal Ion) 2010 survey (SGS)

A Geochemical tool for deeply buried Mineralization



Following the successful results of the Mobile Metal Ion (MMI) survey over the nearby Caspiche Mine, a MMI survey was carried out over the SC property by SGS. This slide shows the strong Cu-geochemical anomaly, occurring in coincidence with the CSAMT conductor


CSAMT
Conductor
Gold
anomaly
N
W
E
S
3800
4200
4400
4600

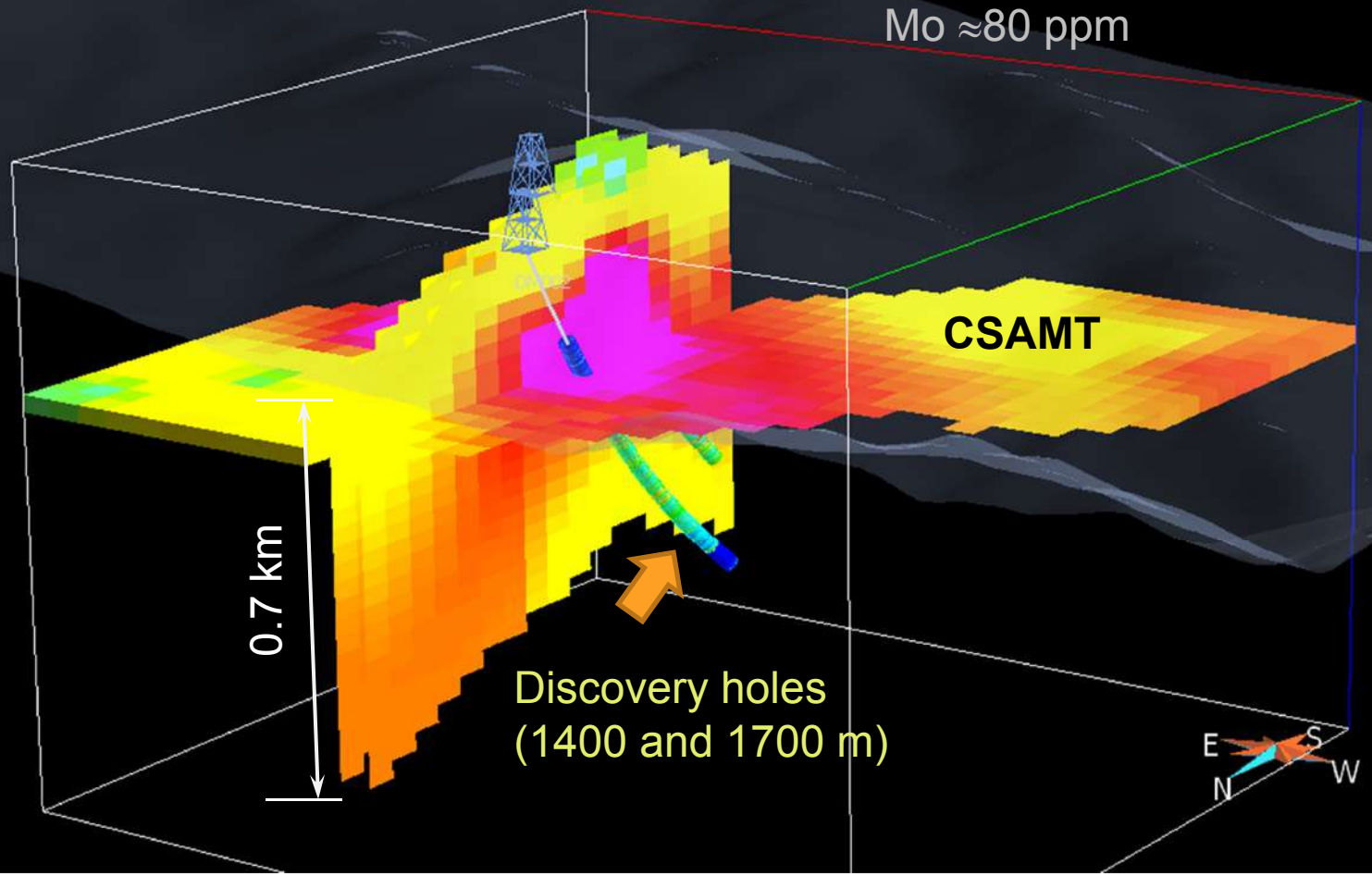
Discovery holes (2011)

Mineralization over 1000m

Au≈0.2 g/t

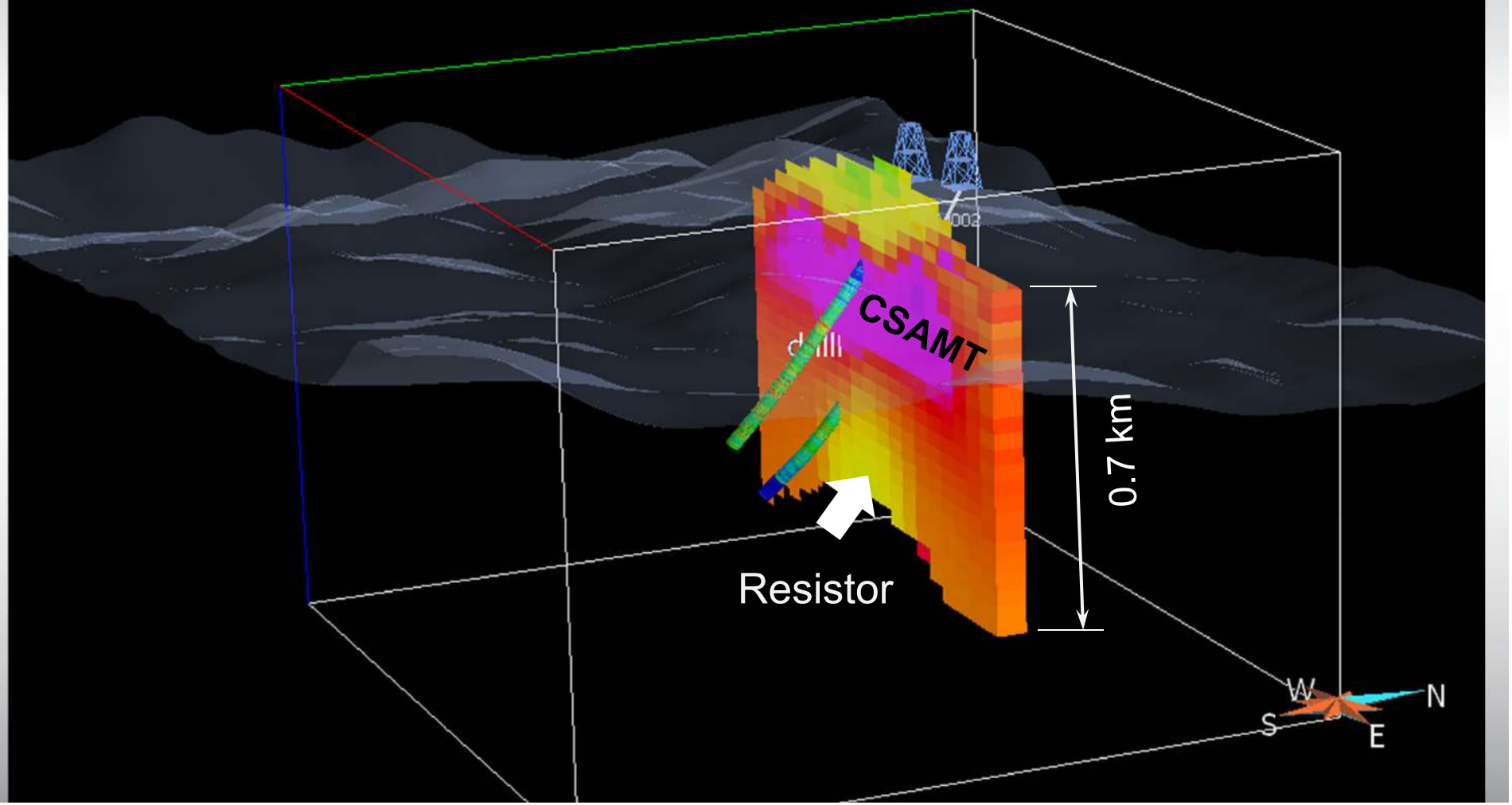
Cu≈0.25%

Mo ≈80 ppm



In 2011 two deep holes have been drilled by CEG to test the CSAMT and the MMI anomalies (CDM03=1400m and CDM02=1700m) . Both holes were successful and intercepted Cu-Au and Ag mineralization which is still persistent down to level 2800 ASL.

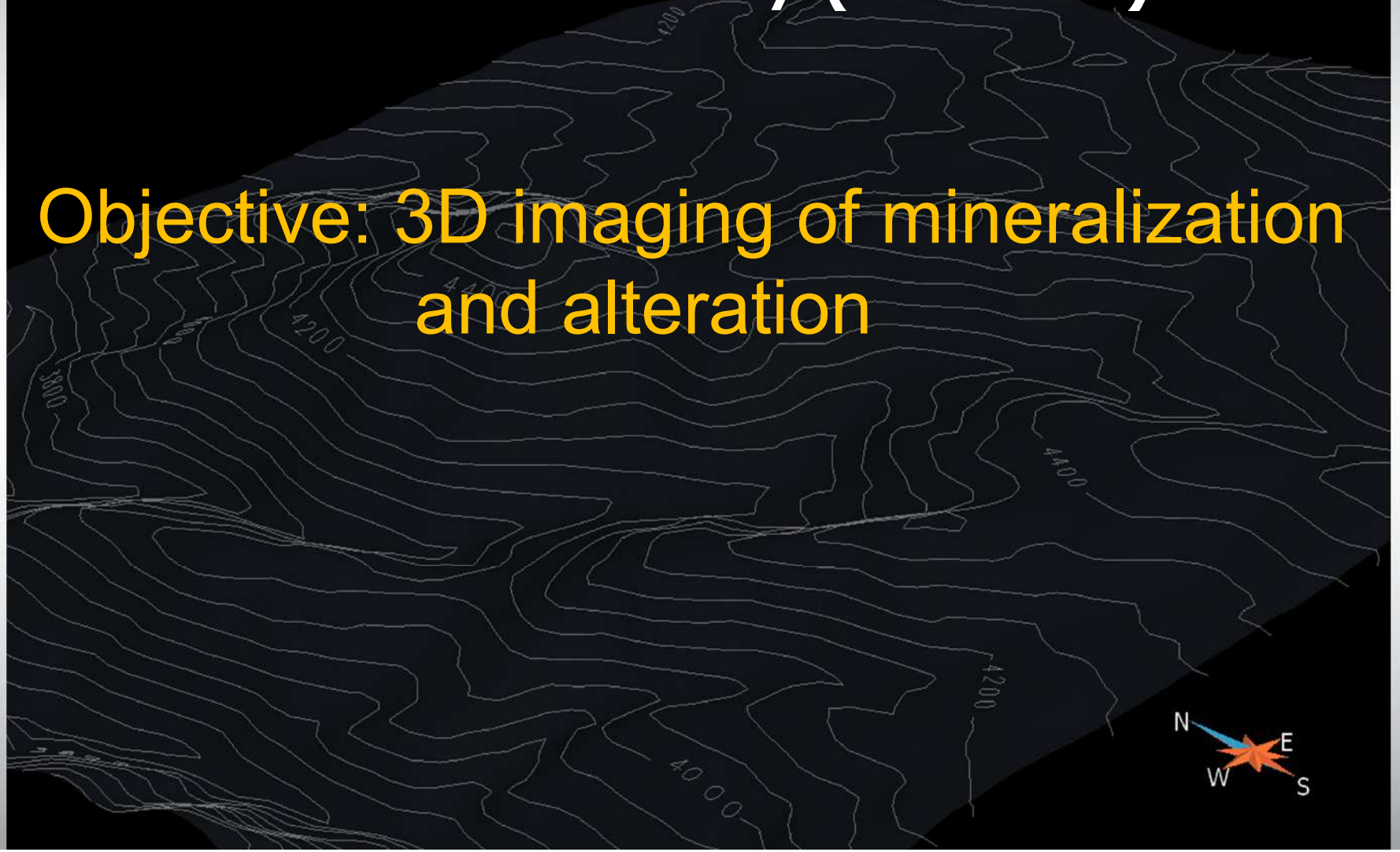
Drill testing the CSAMT conductor



A CSAMT section looking NW. It highlights a flat lying conductor with limited depth extension. The deep part of the CSAMT model section does not however, support the DH results.

ORION 3D Survey (Fall 2012)

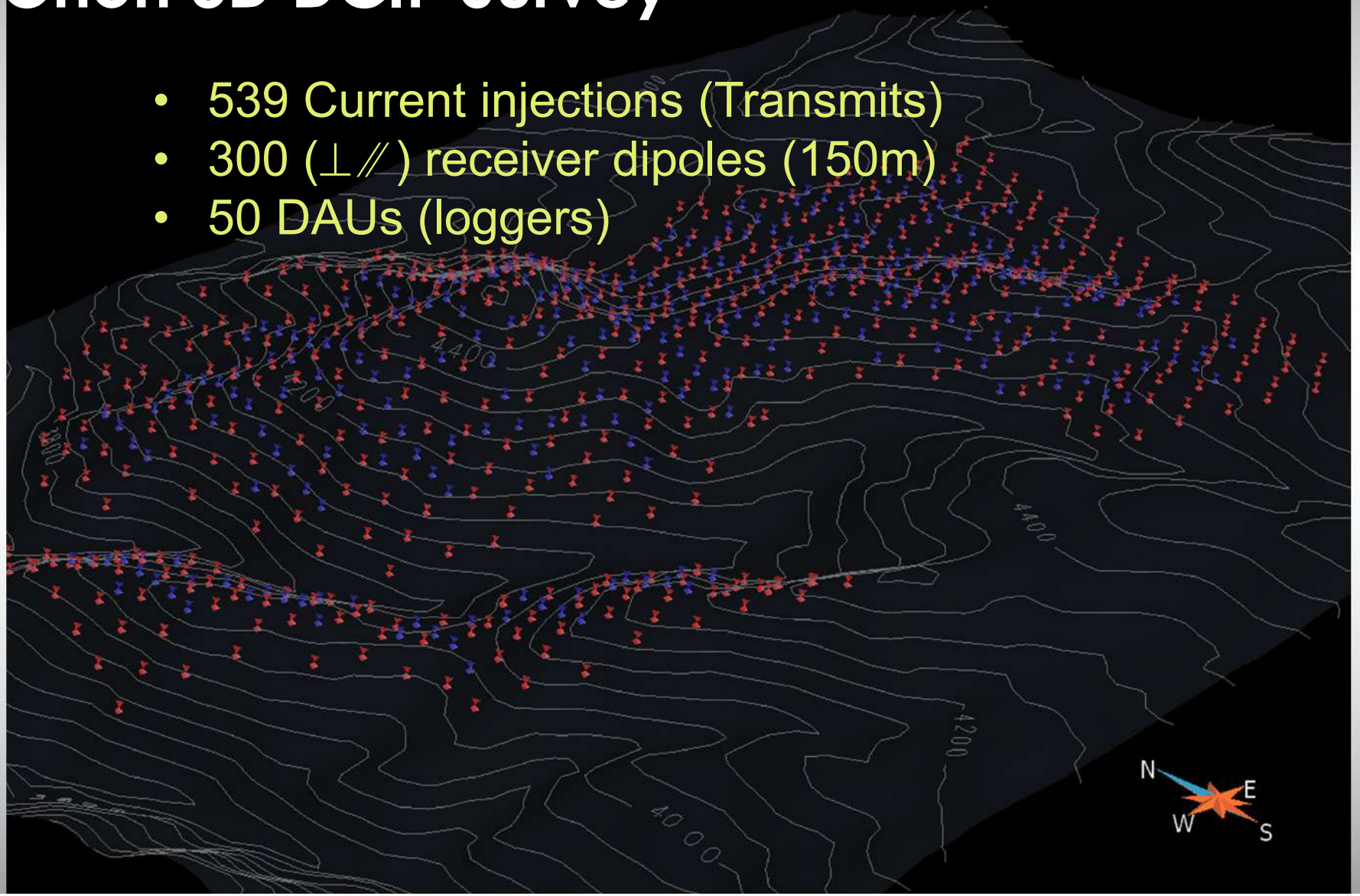
Objective: 3D imaging of mineralization and alteration



In Fall 2012 an Orion 3D survey was carried out by Quantec covering the SC alteration zone with the objective of 3D imaging and investigating of deep-seated mineralization and alteration.

Orion 3D DCIP Survey

- 539 Current injections (Transmits)
- 300 (⊥⫽) receiver dipoles (150m)
- 50 DAUs (loggers)

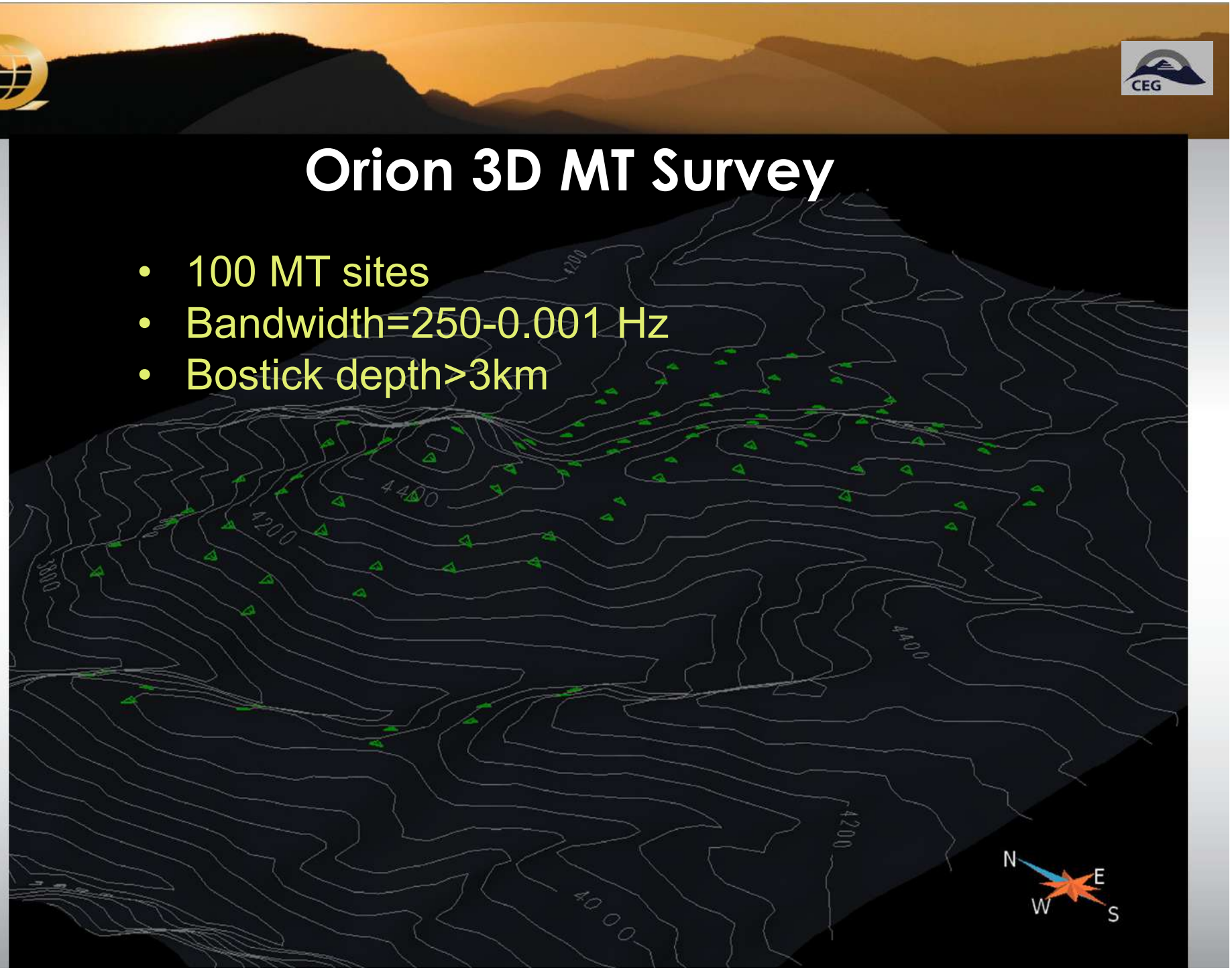


539 current injections and 300 receiver dipoles were deployed along with loggers that collect the data from neighbouring dipoles

Remove the current ext.

Orion 3D MT Survey

- 100 MT sites
- Bandwidth=250-0.001 Hz
- Bostick depth>3km

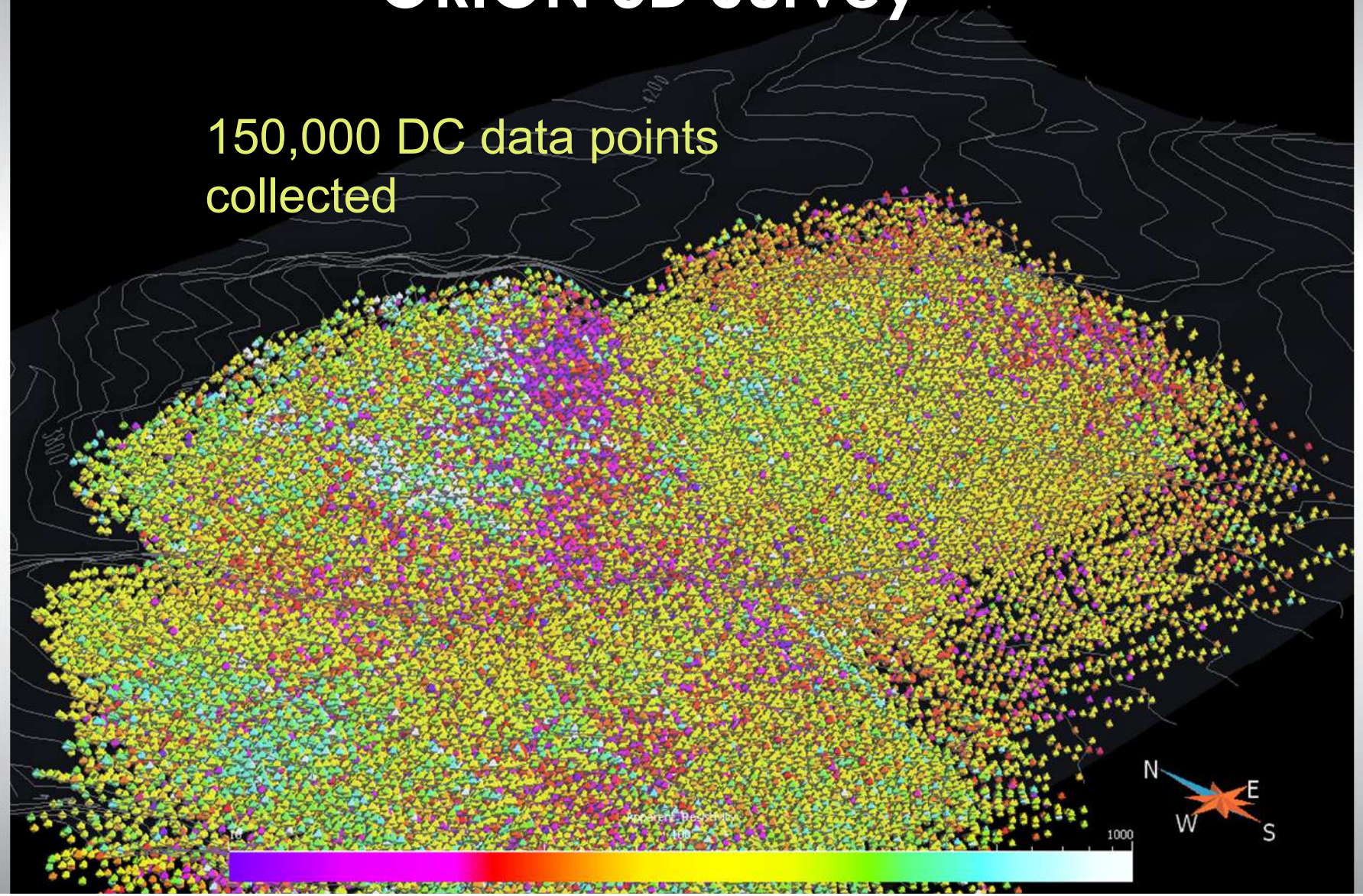


539 current injections and 300 receiver dipoles were deployed along with loggers that collect the data from neighbouring dipoles

Remove the current ext.

ORION 3D Survey

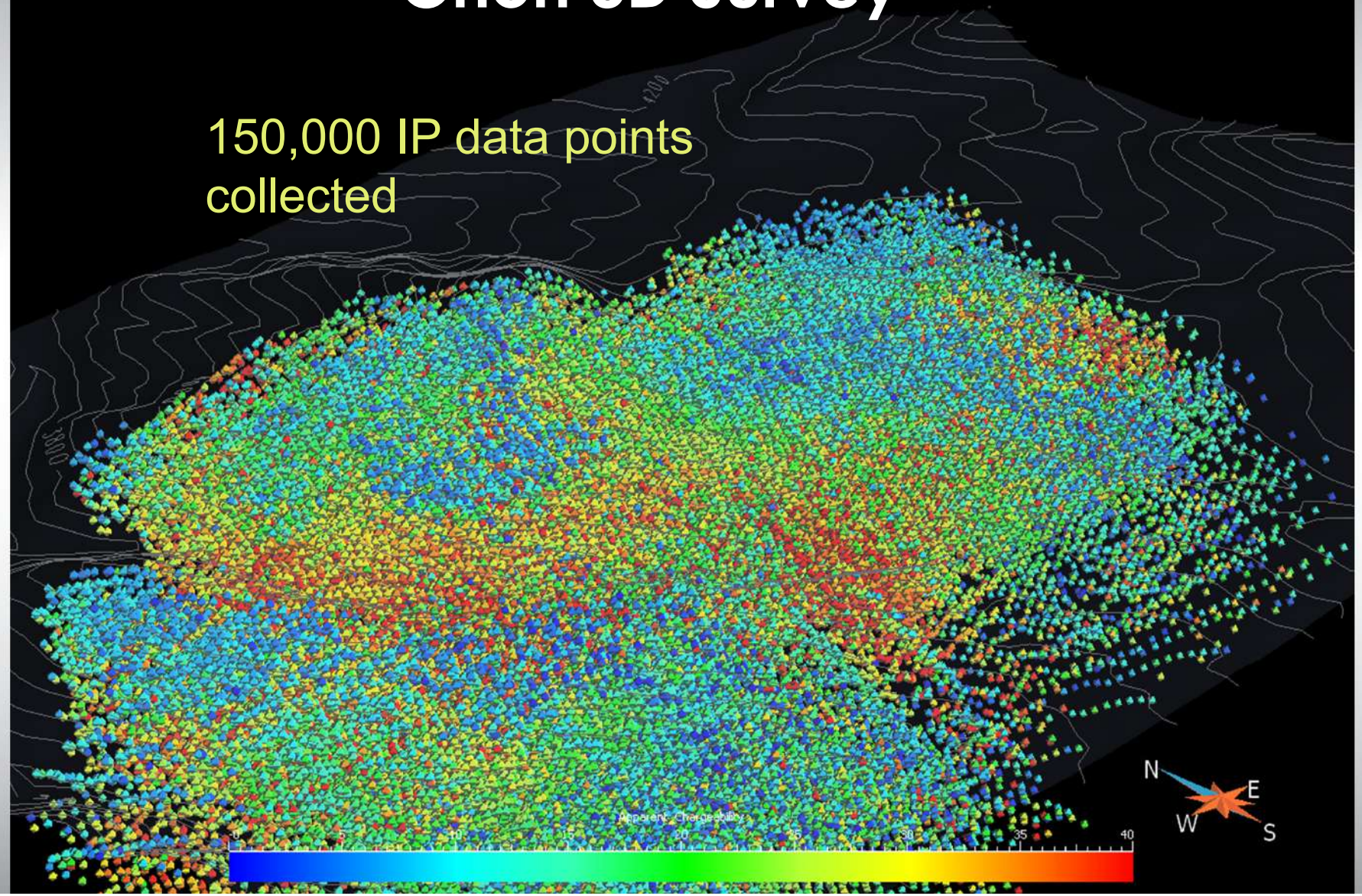
150,000 DC data points collected



Pseudo-plot of apparent resistivity data

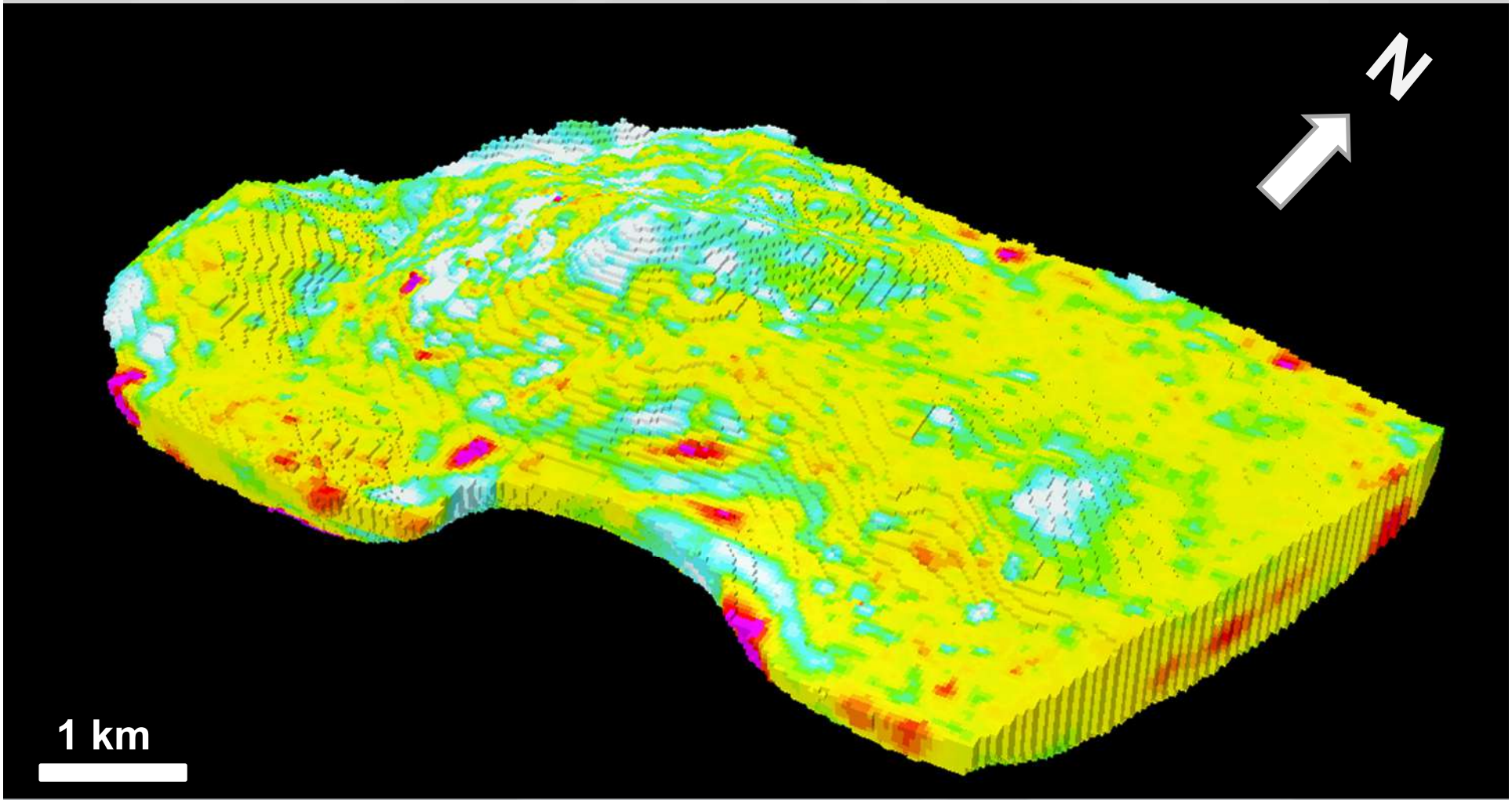
Orion 3D Survey

150,000 IP data points collected



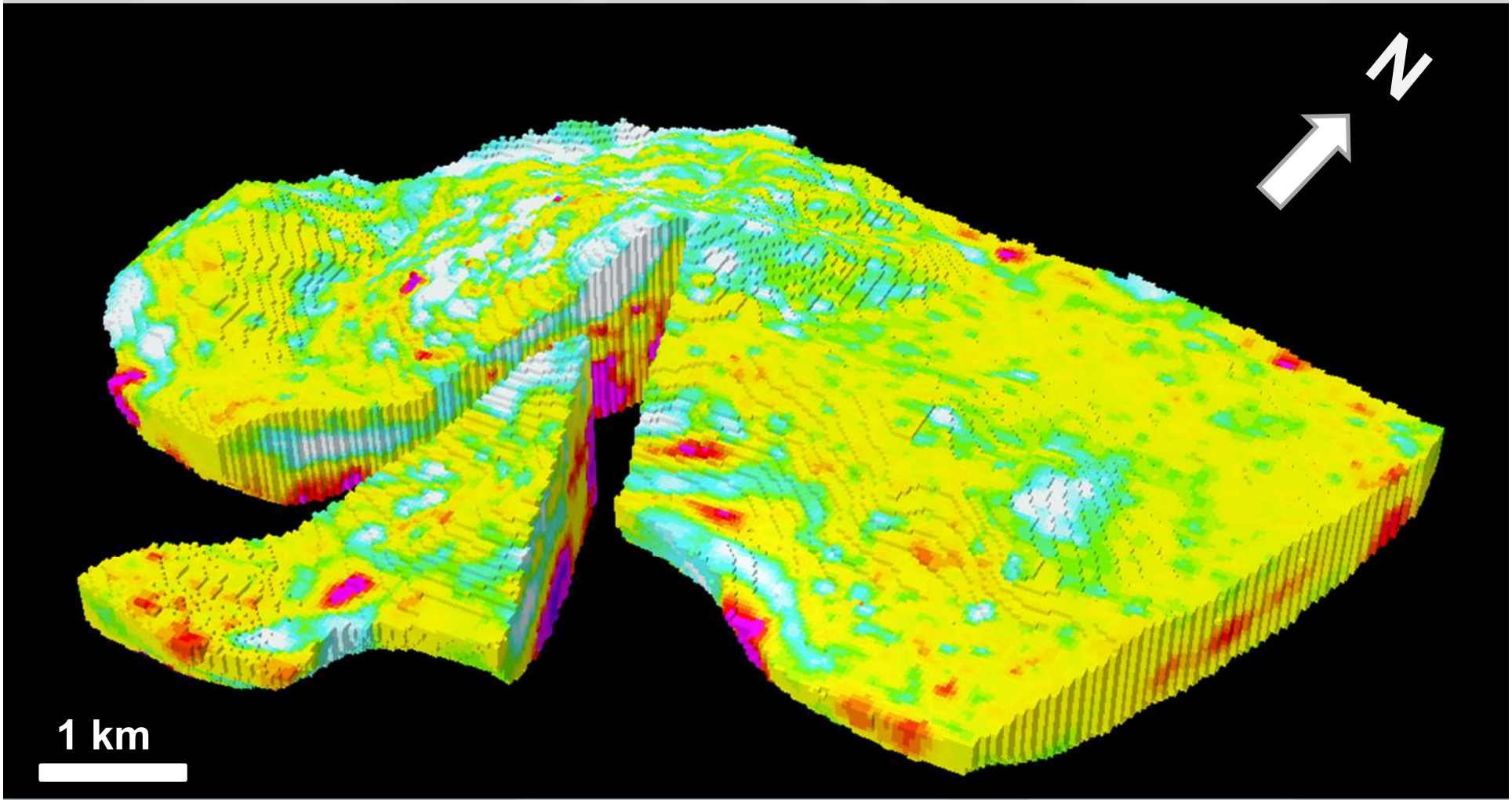
Pseudo-plot of apparent chargeability data

3D DC Resistivity Model

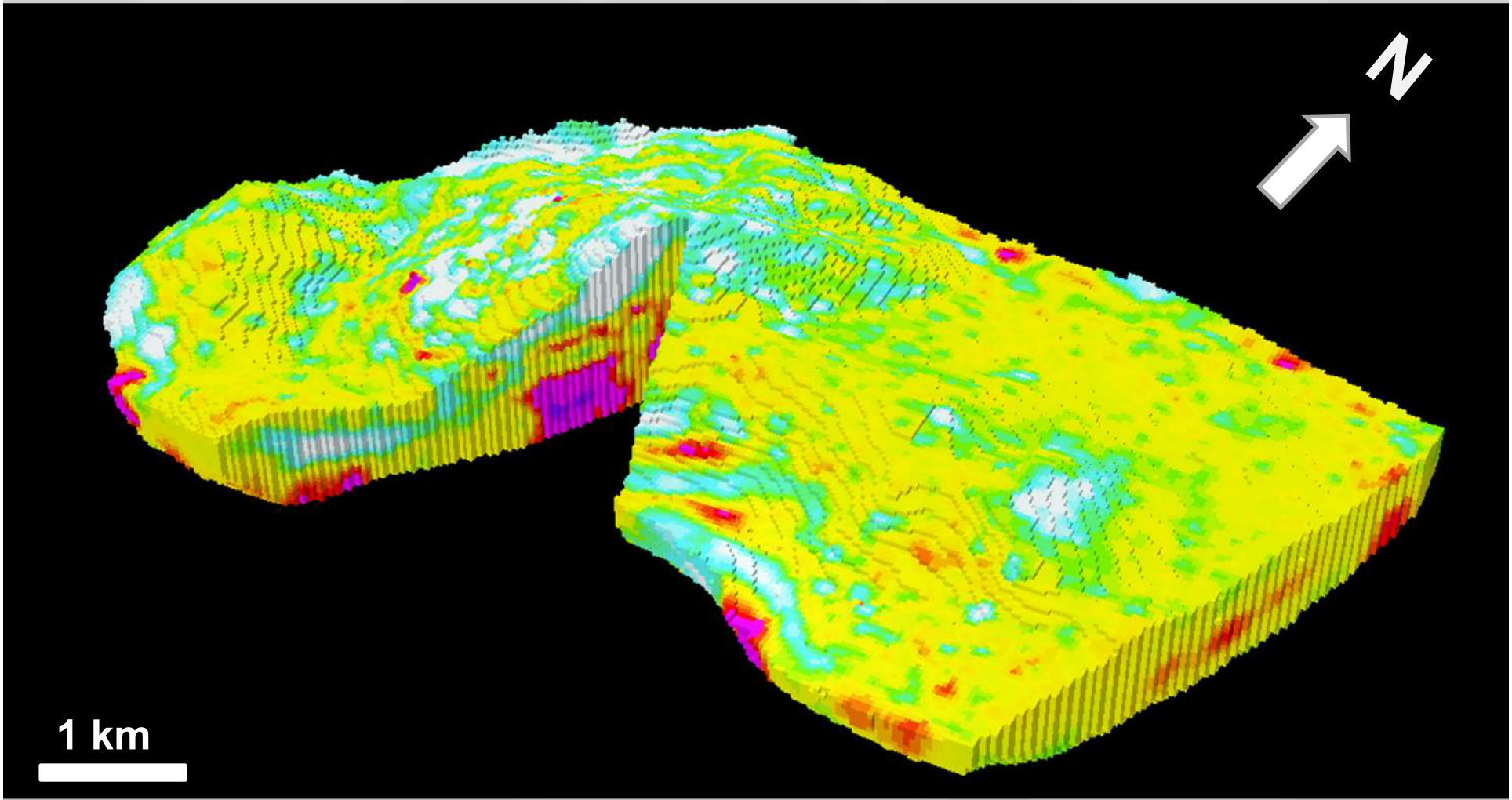


A sensitivity analysis has been applied to the Model data to determine the areas of confidence (areas that are sensitive to the survey).
Show the model with sensitivity

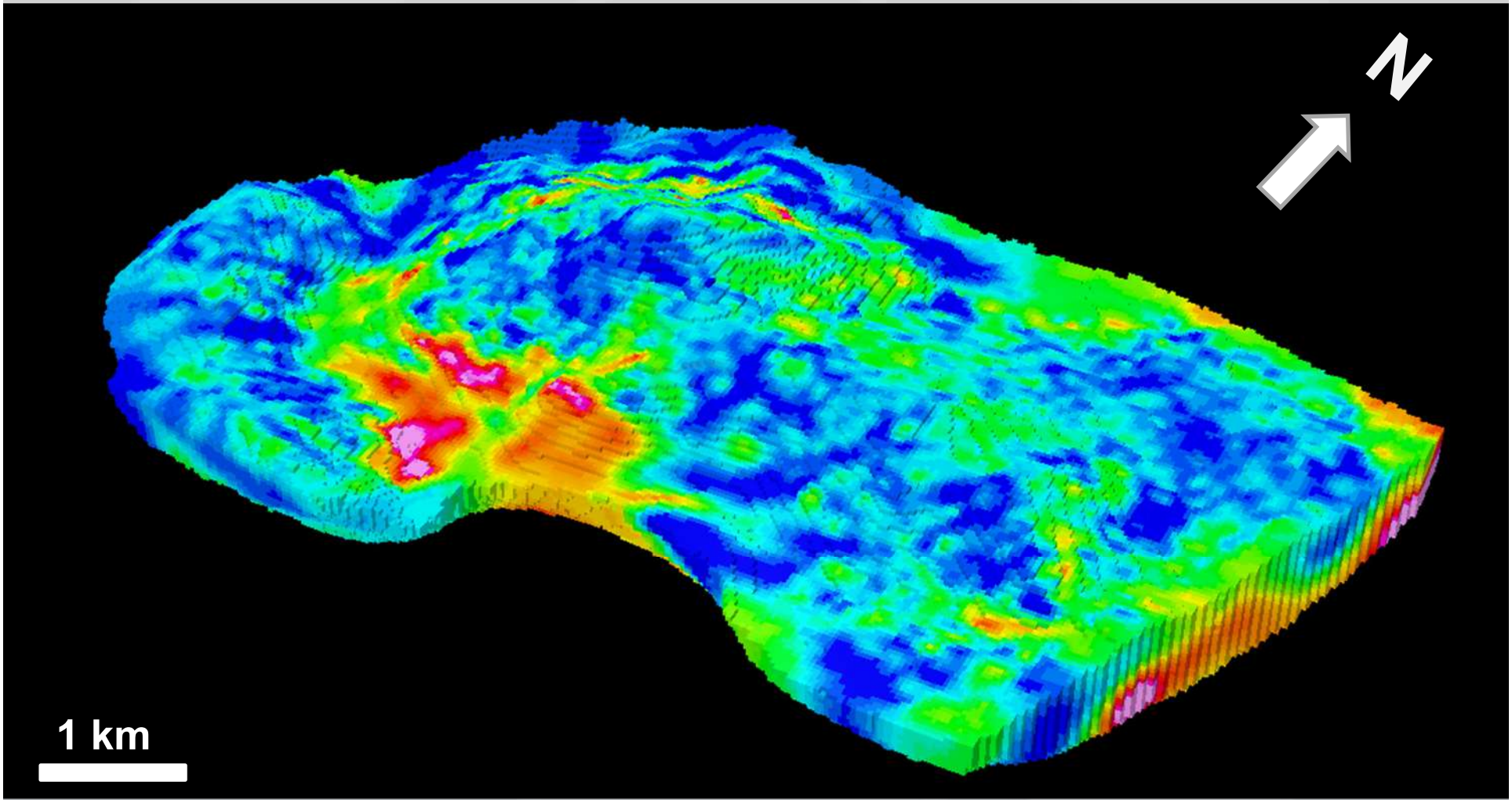
3D DC Resistivity Model



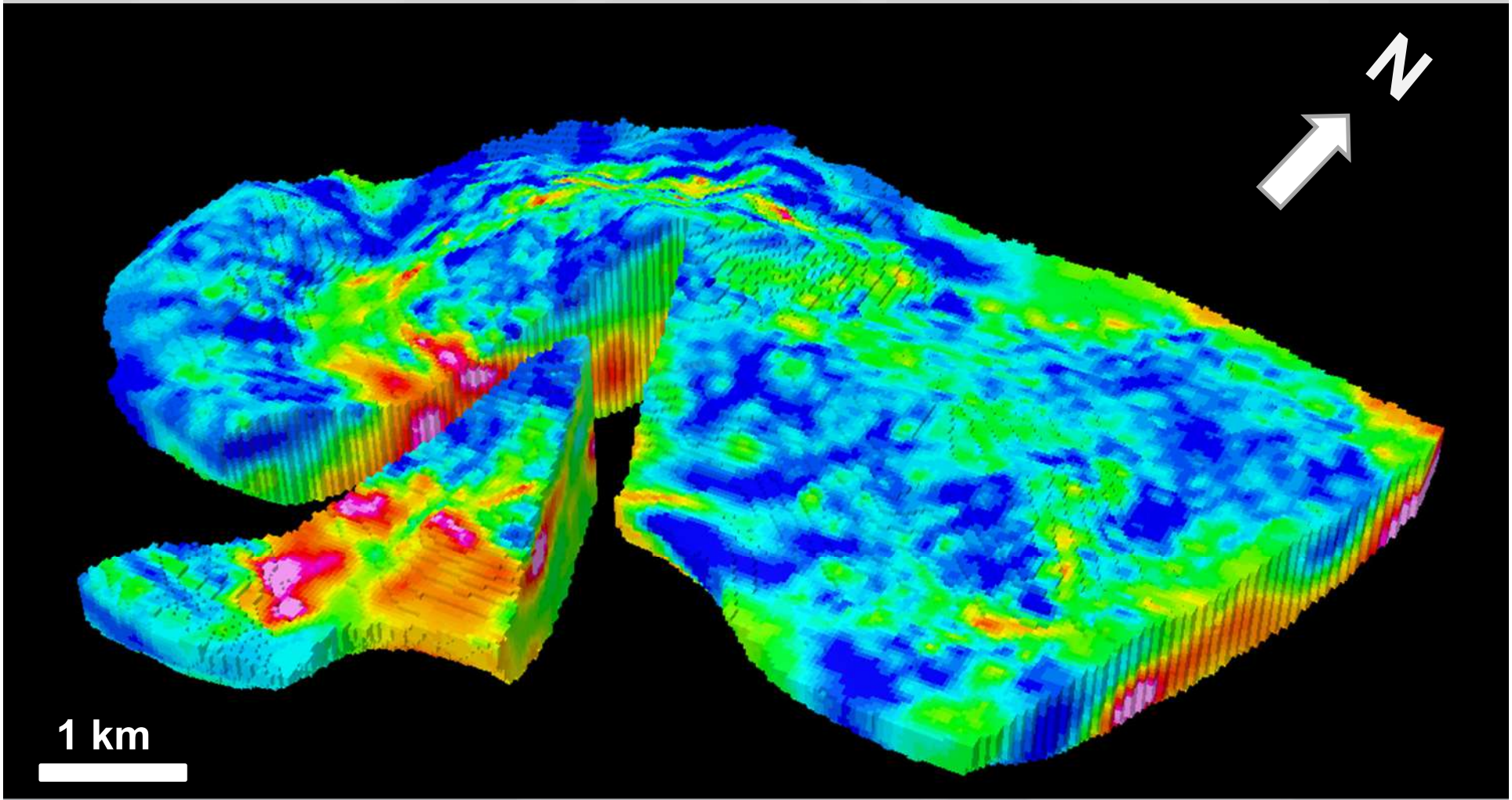
3D DC Resistivity Model



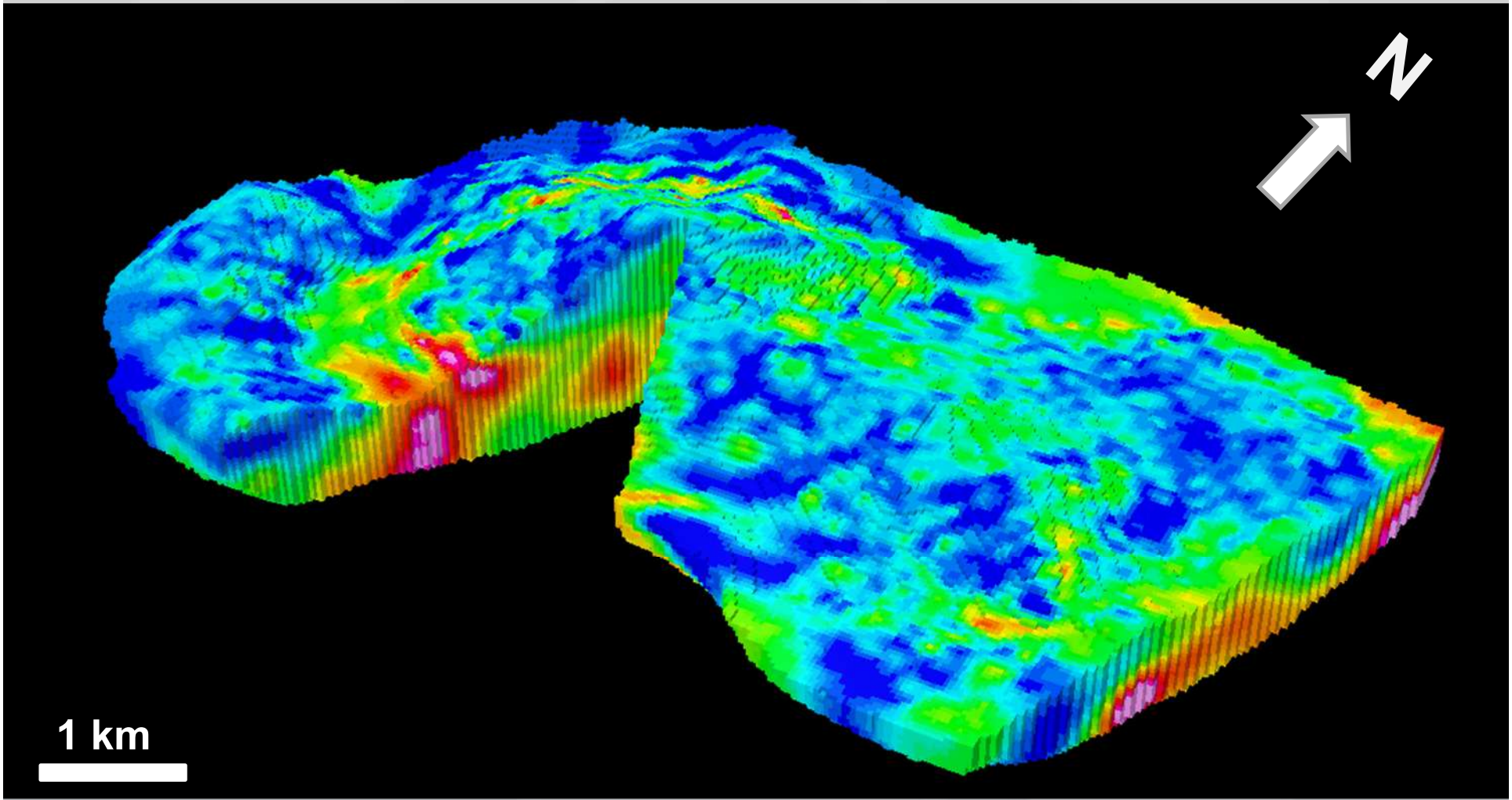
3D IP Model

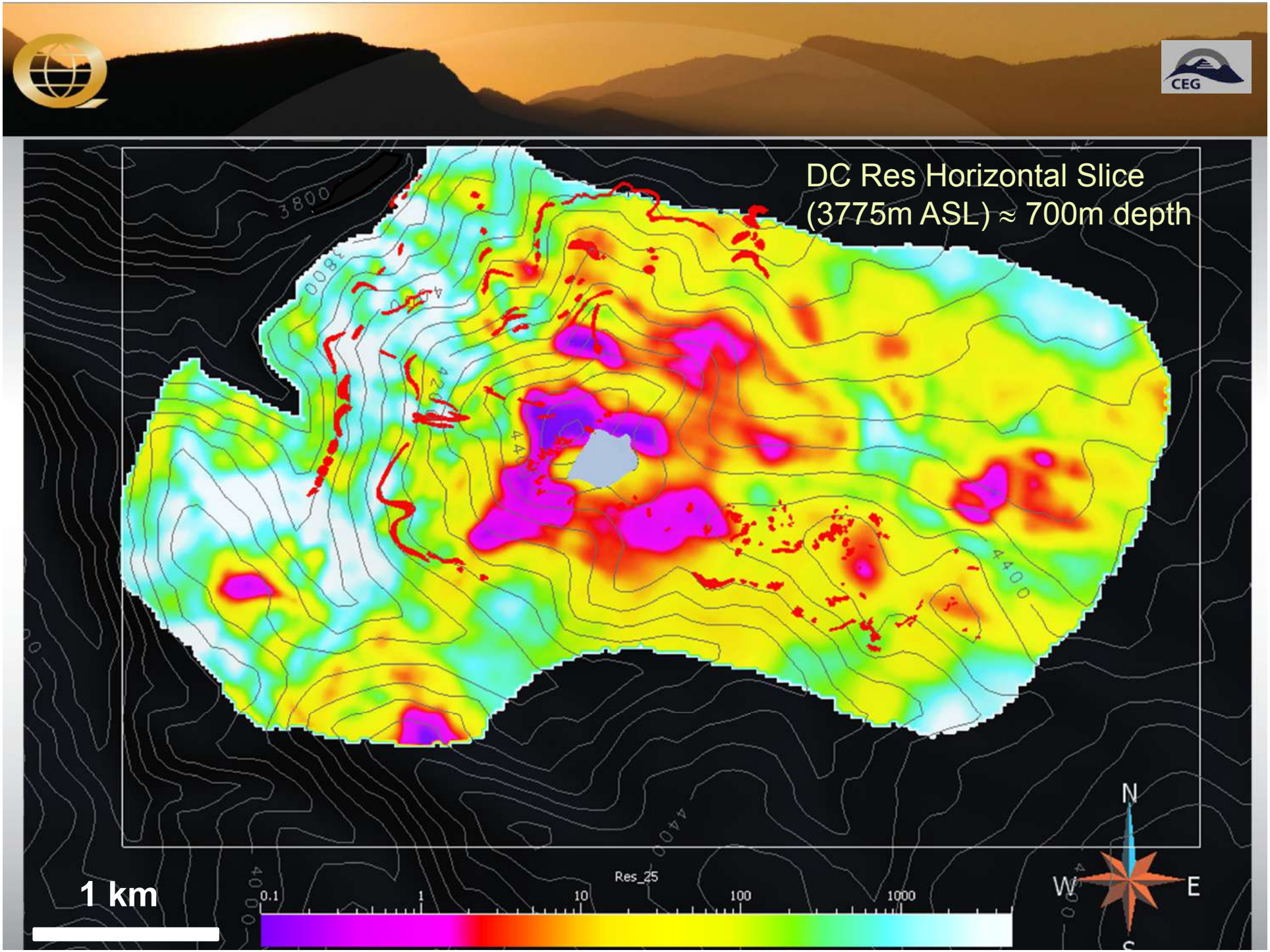


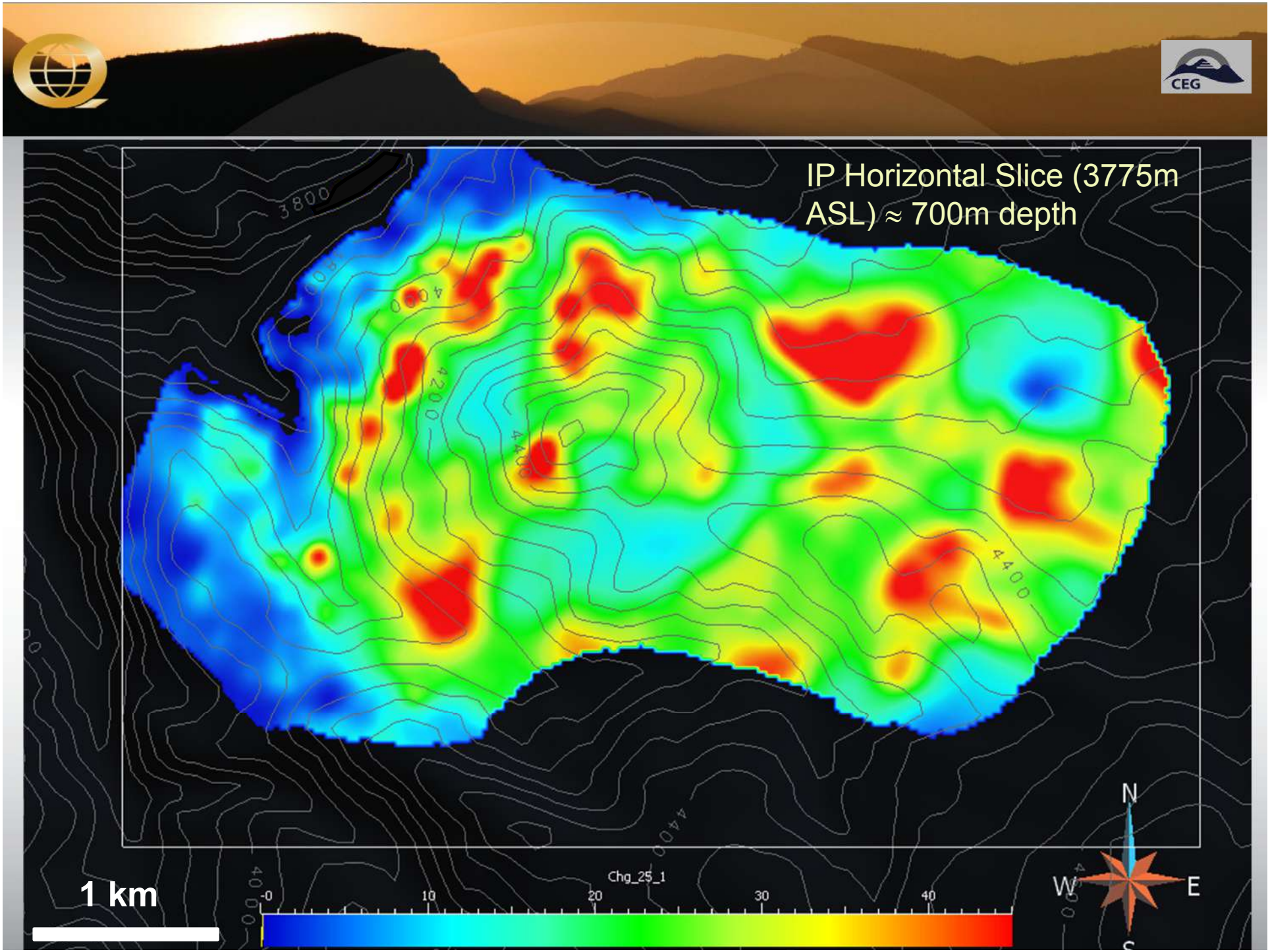
3D IP Model

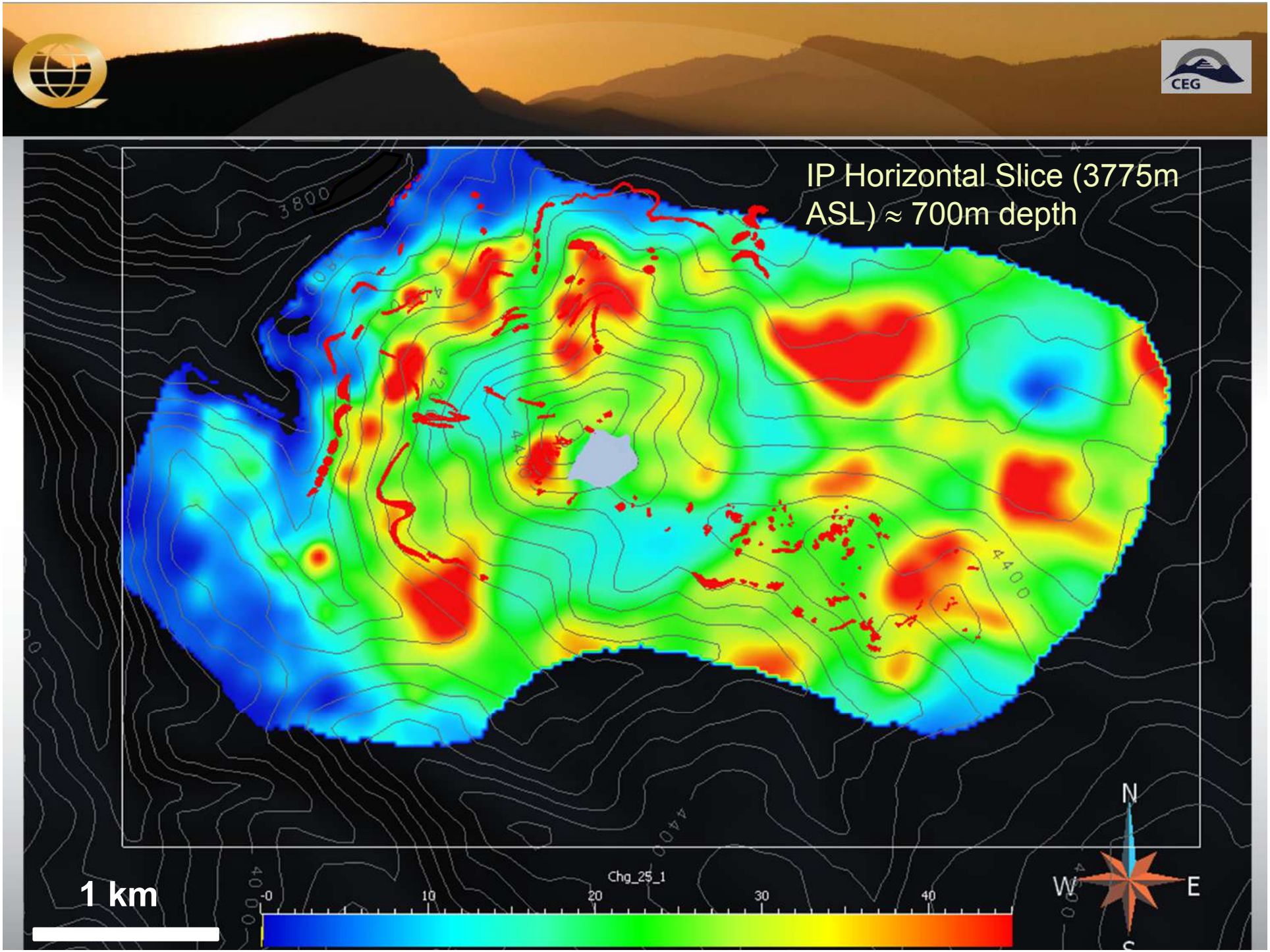


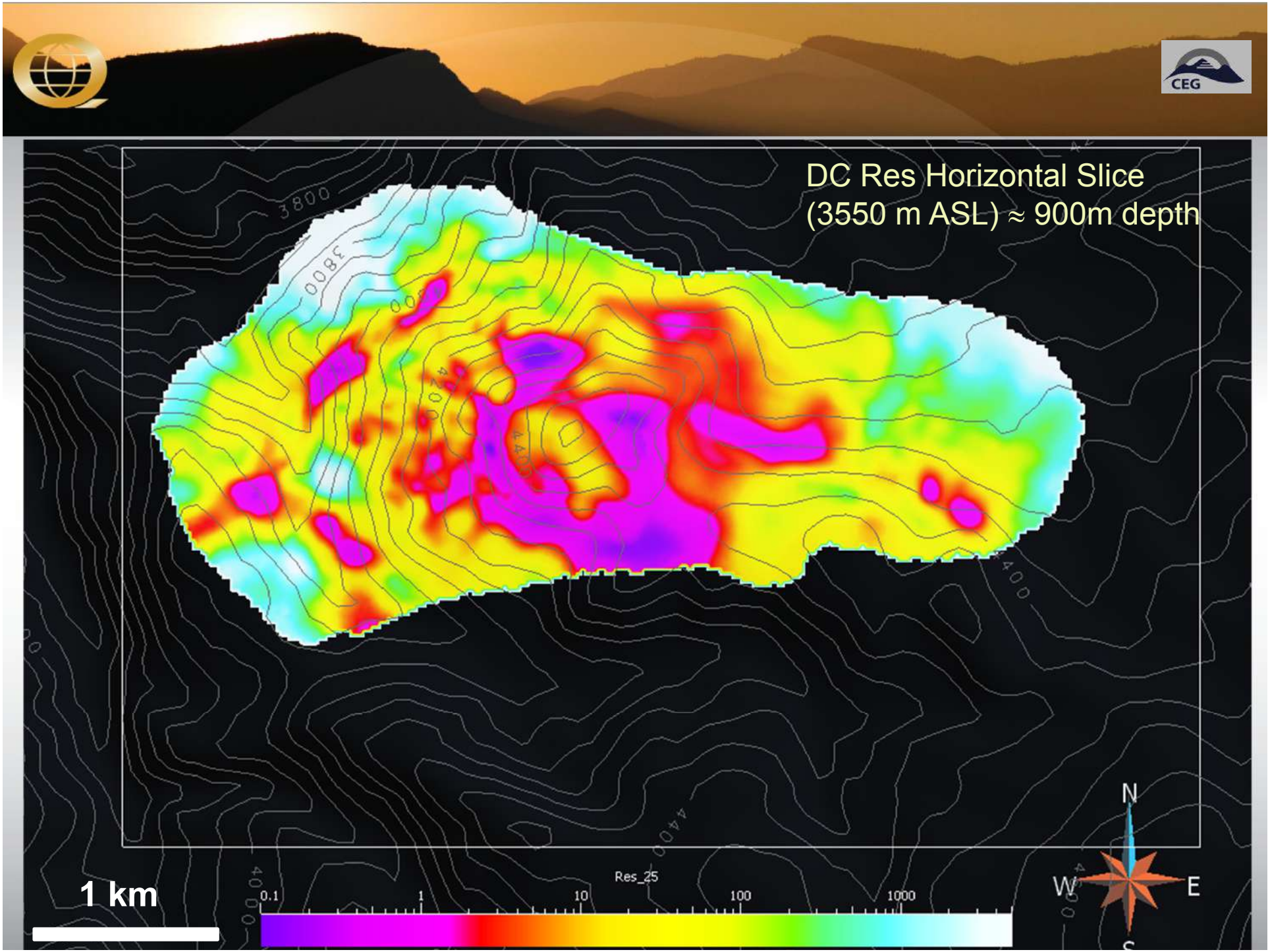
3D IP Model

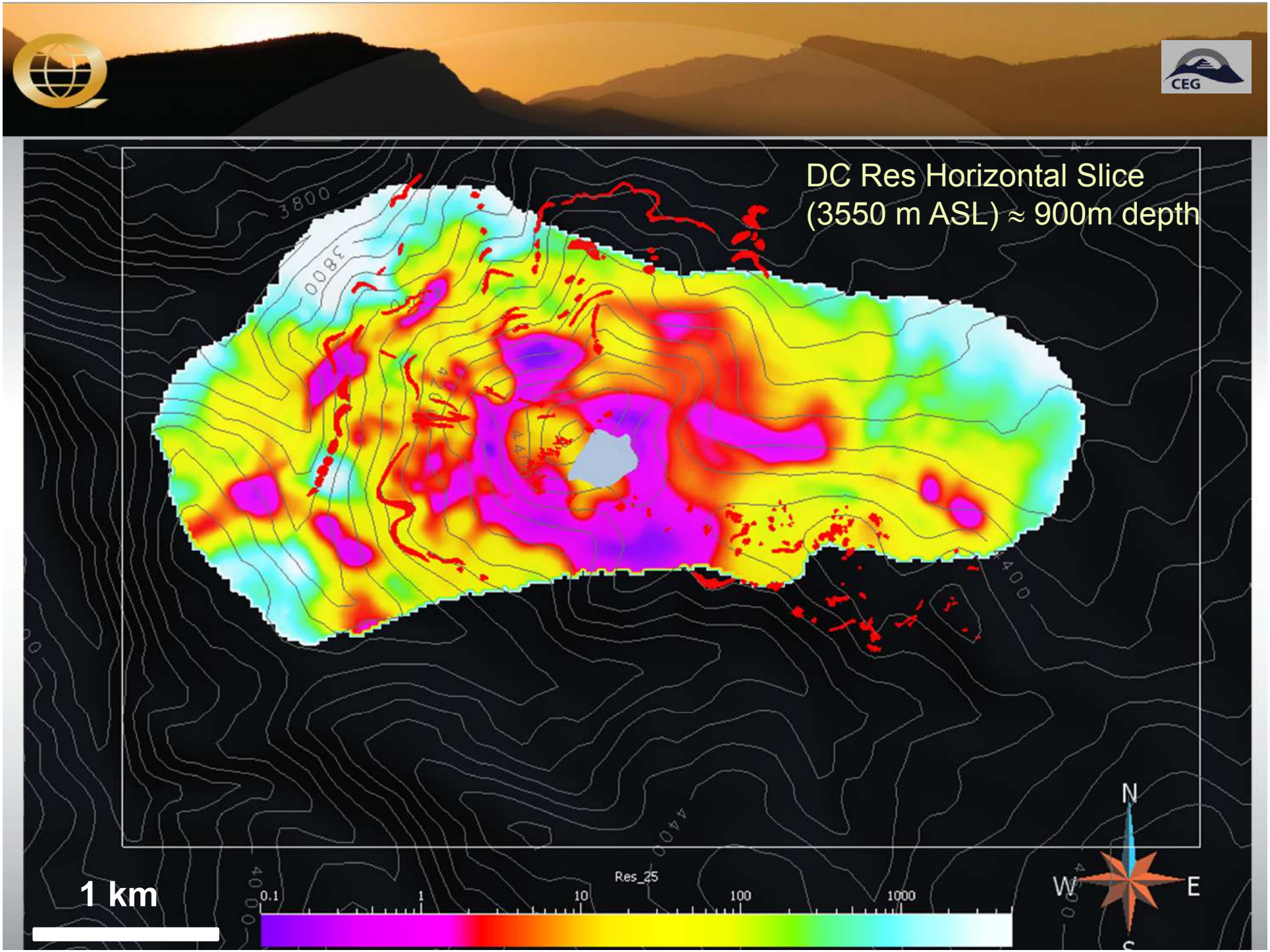


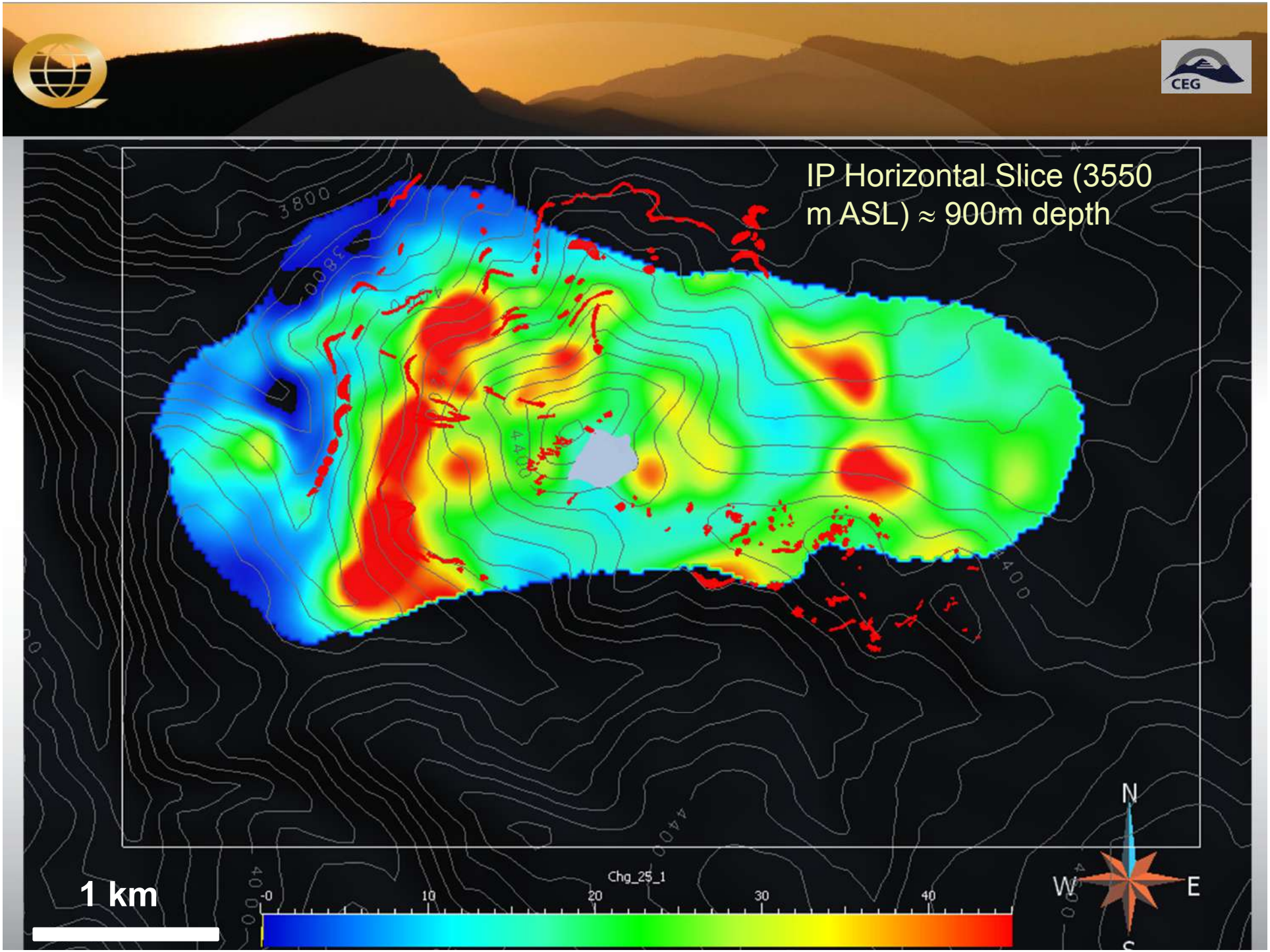

DC Res Horizontal Slice
(3775m ASL) ≈ 700m depth
3800
4000
4200
4400
Res_25
0.1
1
10
100
1000
1 km
N
W
E
S

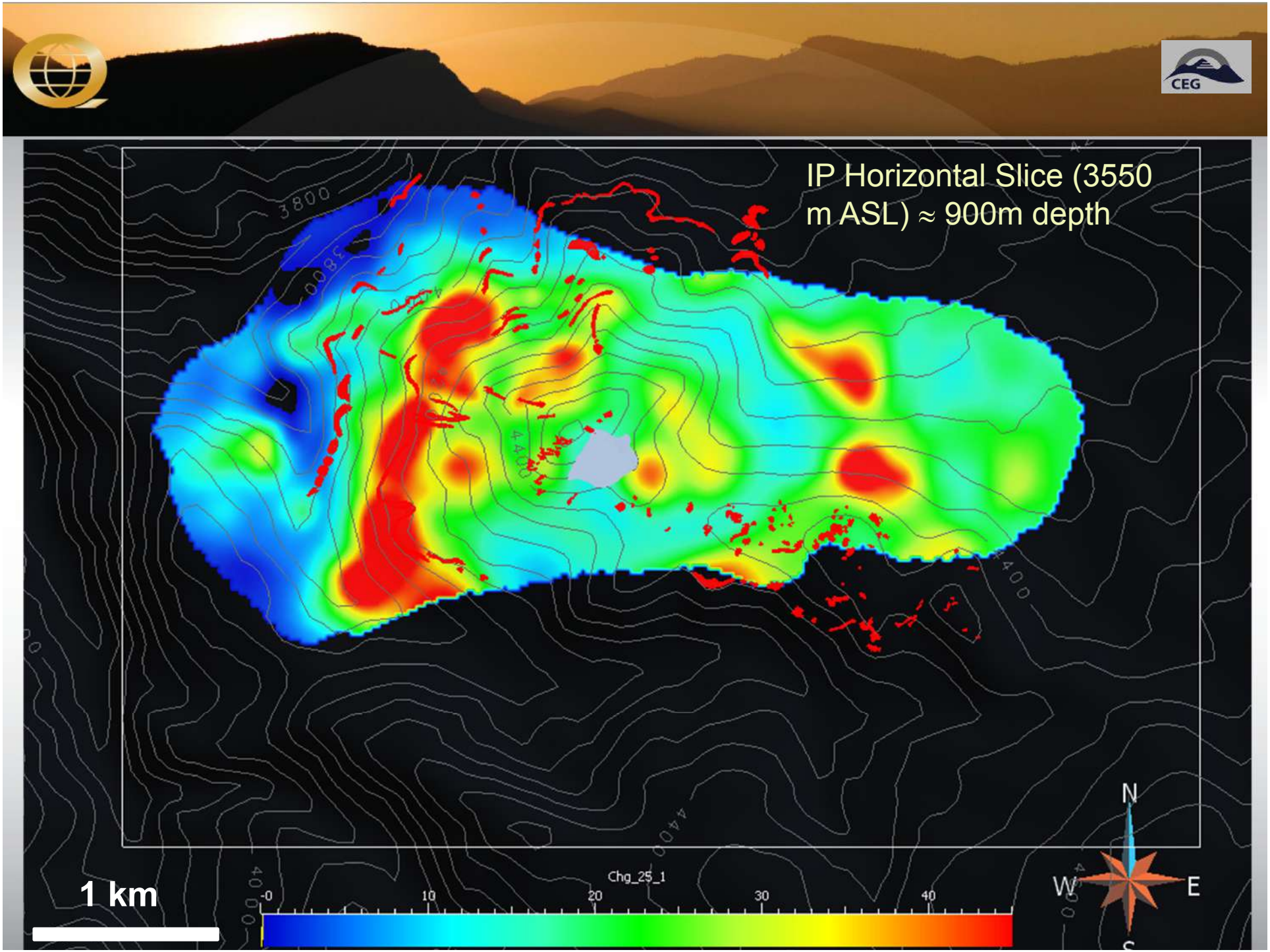

IP Horizontal Slice (3775m ASL) ≈ 700m depth
3800
4000
4200
4400
4400
4400
1 km
Chg_25_1
-0
10
20
30
40
N
W
E

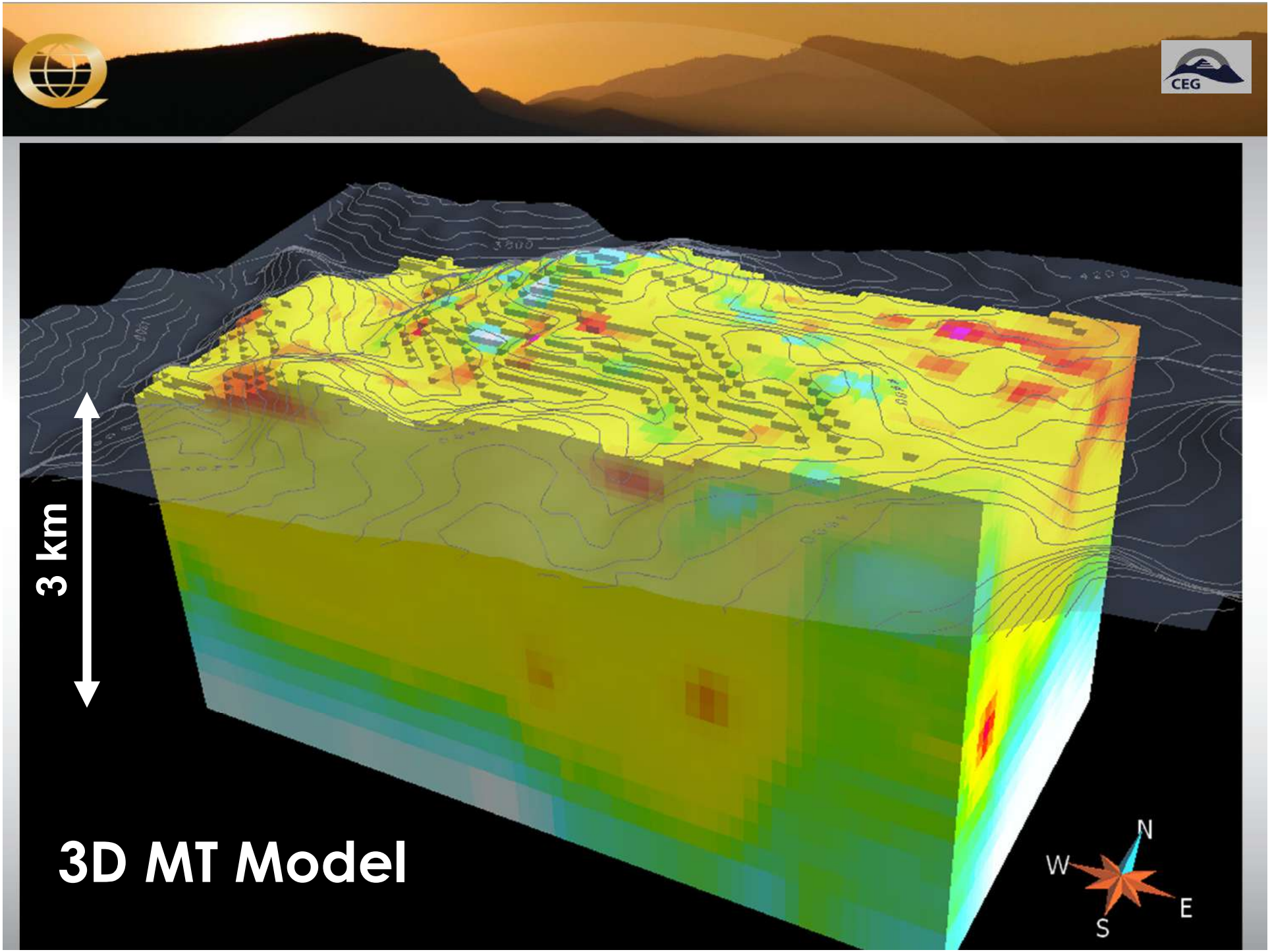

IP Horizontal Slice (3775m ASL) ≈ 700m depth
3800
4200
4400
4400
4400
Chg_25_1
-0
10
20
30
40
1 km
N
W
E


DC Res Horizontal Slice
(3550 m ASL) ≈ 900m depth
3800
4000
4400
1 km
Res_25
0.1
1
10
100
1000
N
W
E


DC Res Horizontal Slice
(3550 m ASL) ≈ 900m depth
3800
4000
4400
1 km
Res_25
0.1
1
10
100
1000
N
W
E

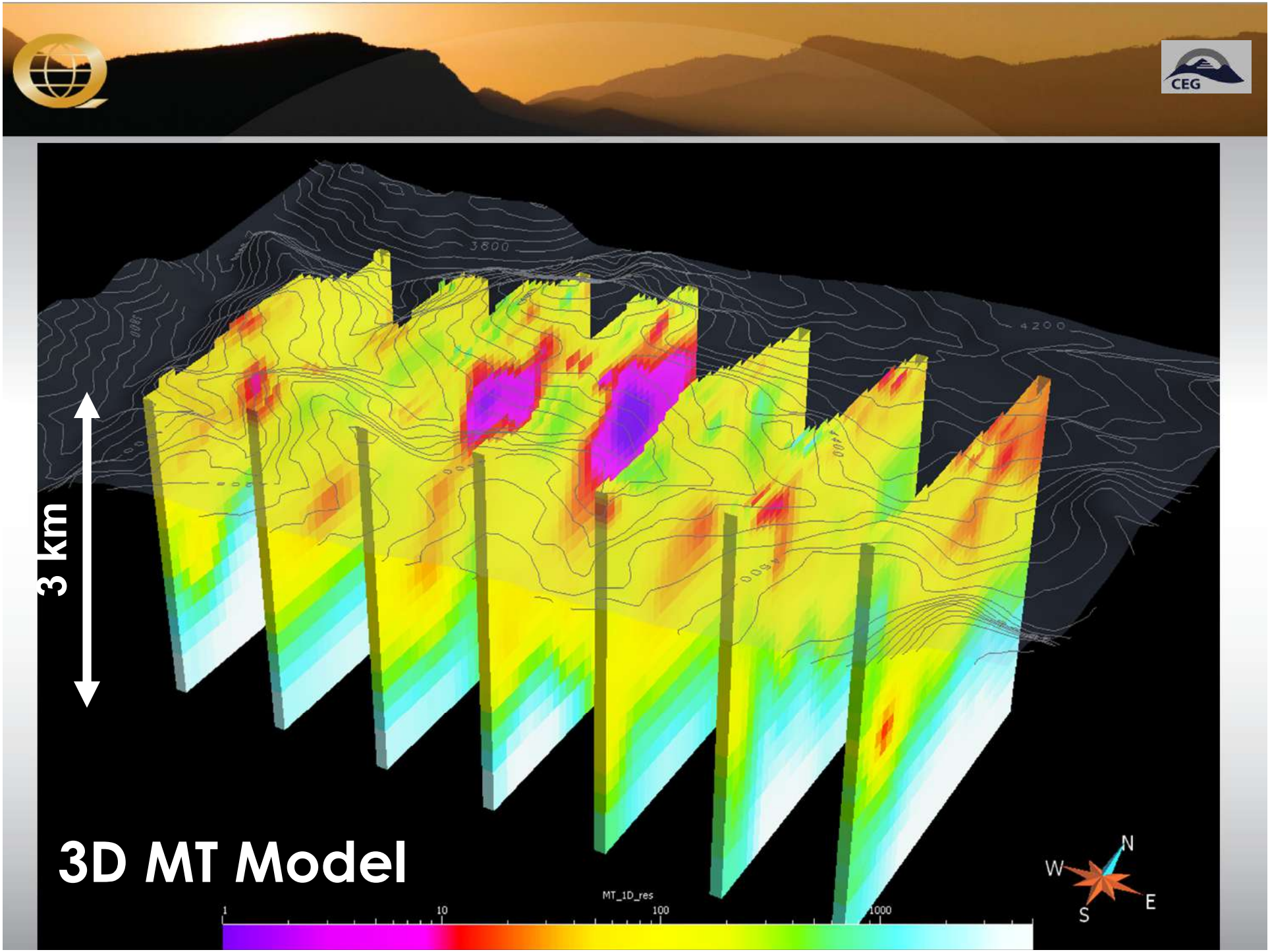

IP Horizontal Slice (3550 m ASL) ≈ 900m depth
3800
4000
4400
1 km
Chg_25_1
-0
10
20
30
40
N
W
E


IP Horizontal Slice (3550 m ASL) ≈ 900m depth
3800
4000
4400
1 km
Chg_25_1
-0
10
20
30
40
N
W
E

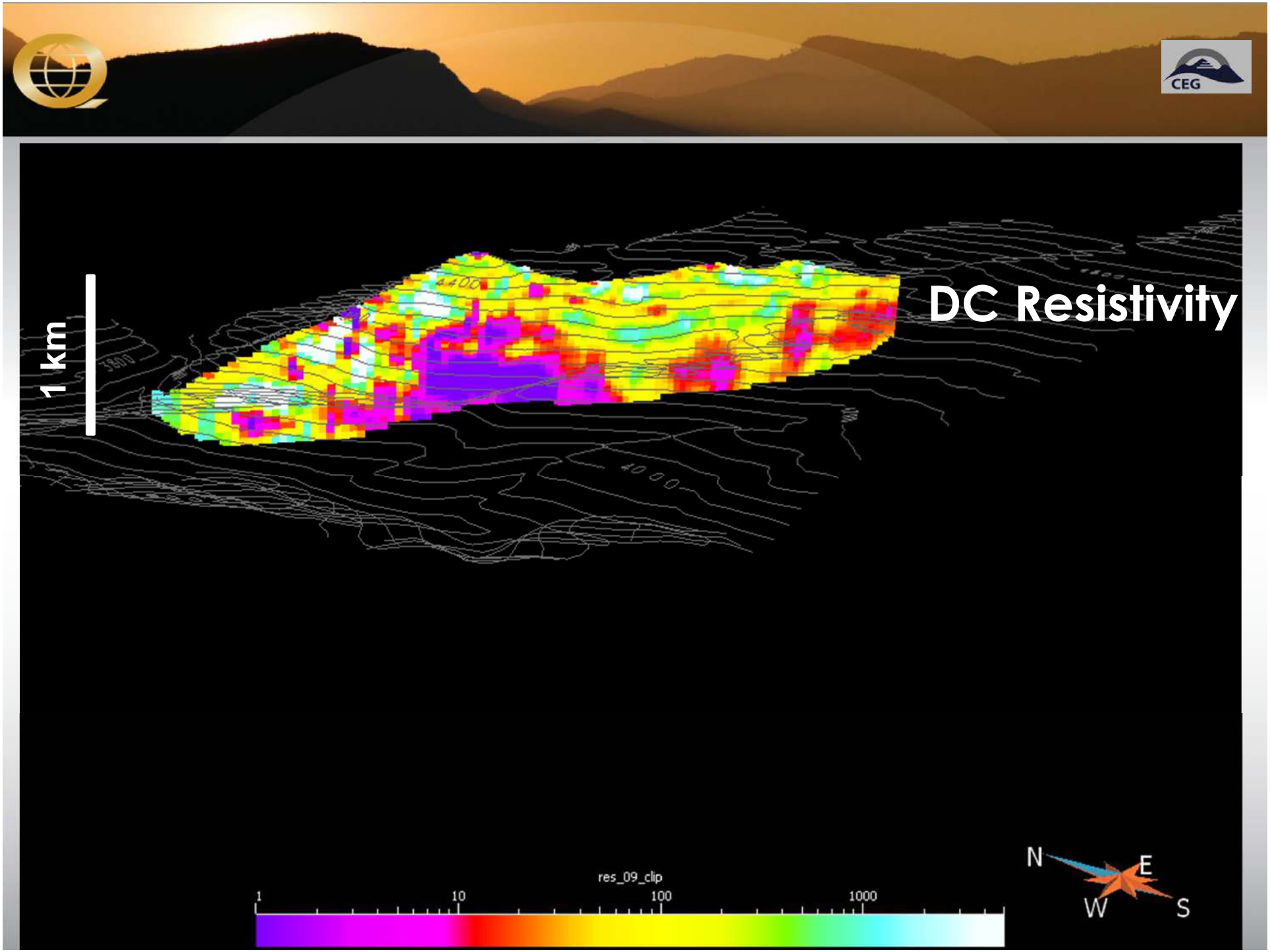


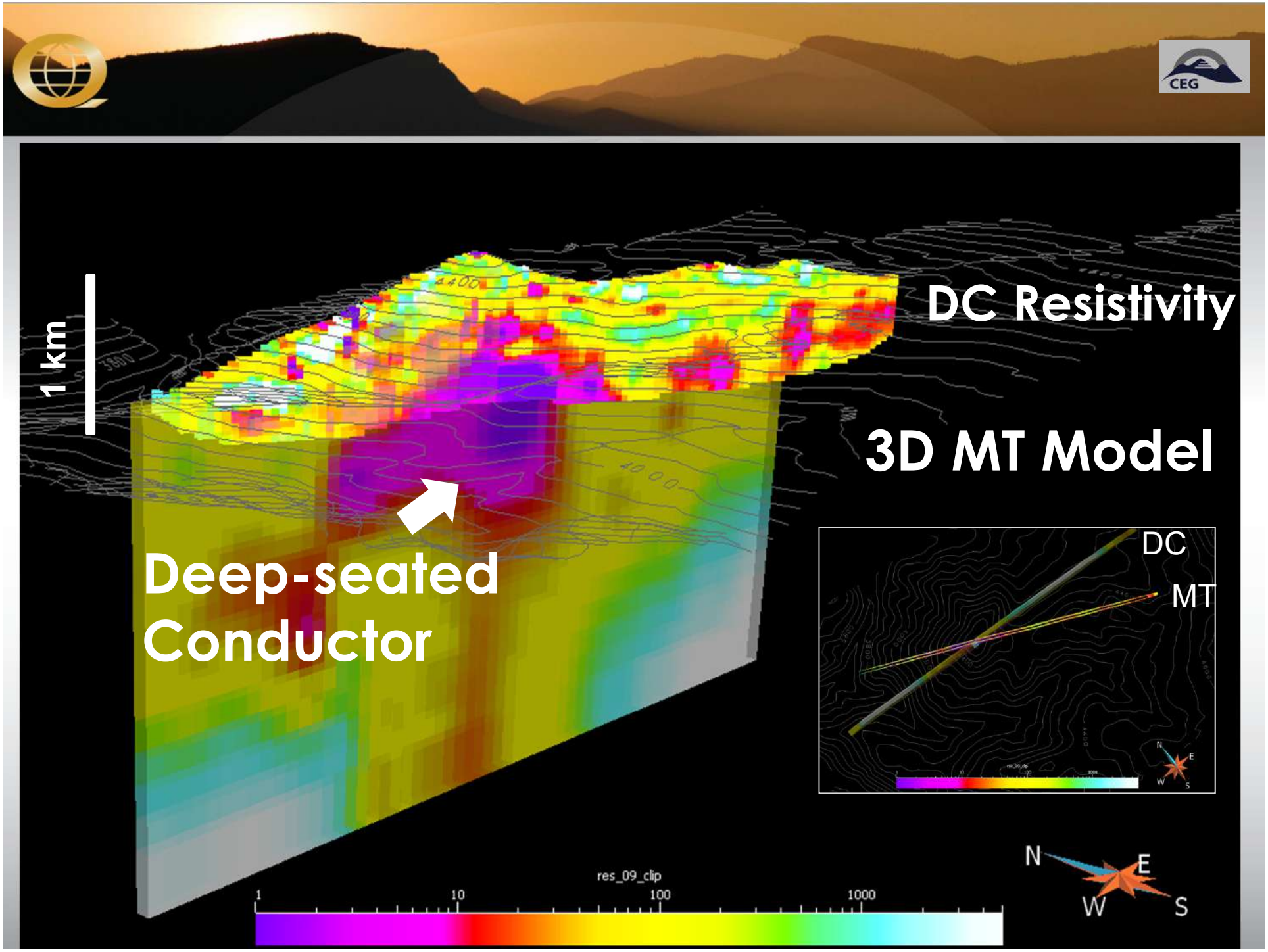
3D MT Model

3D MT inversion code (WS and Egbert)
using half space and 1D models and topo.
, 15 freq. 250Hz-1000 s. 99 sites

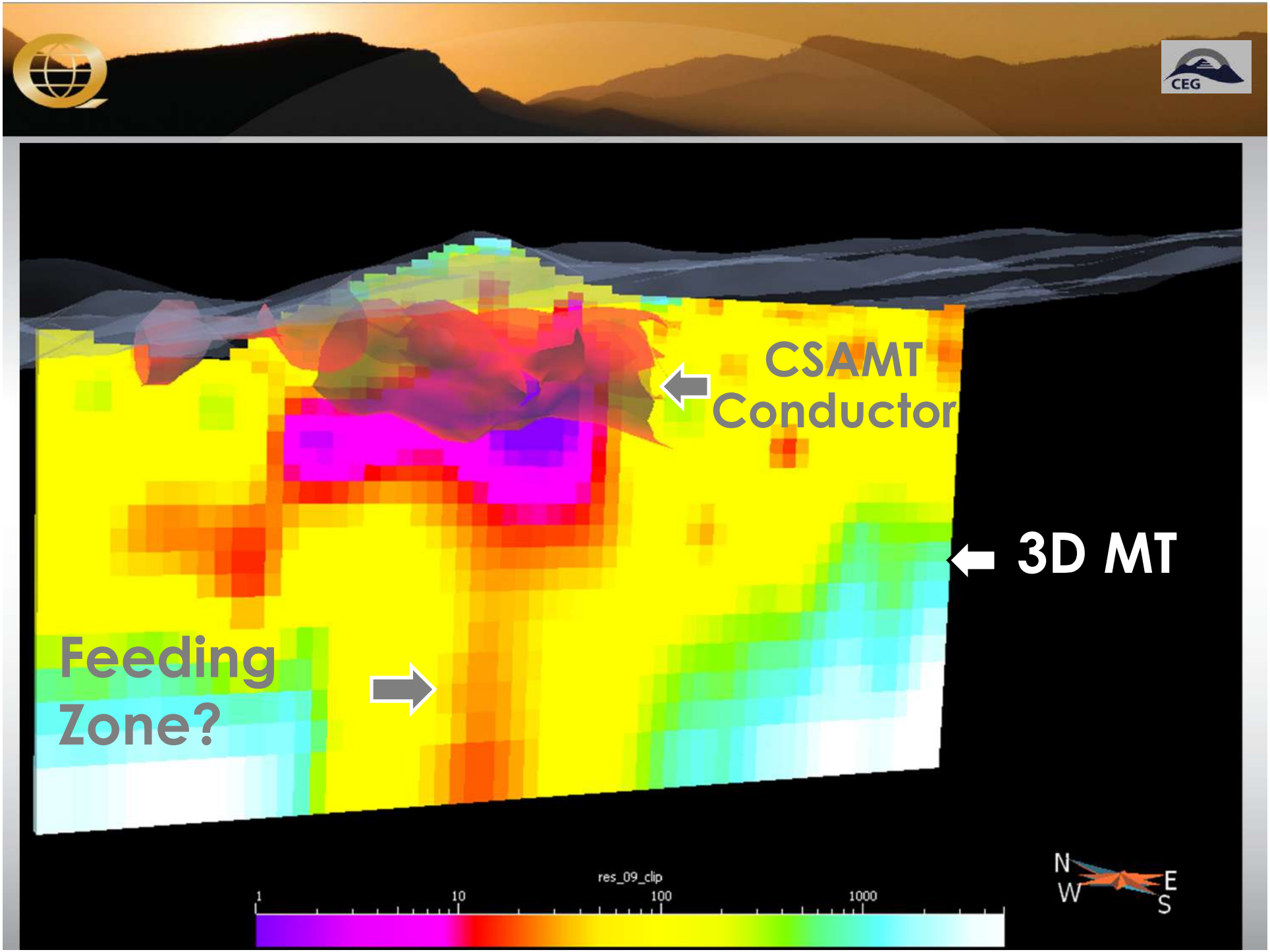

3800
4200
3 km
3D MT Model
MT_1D_res
1
10
100
1000
N
W
E
S

3D MT vertical slices

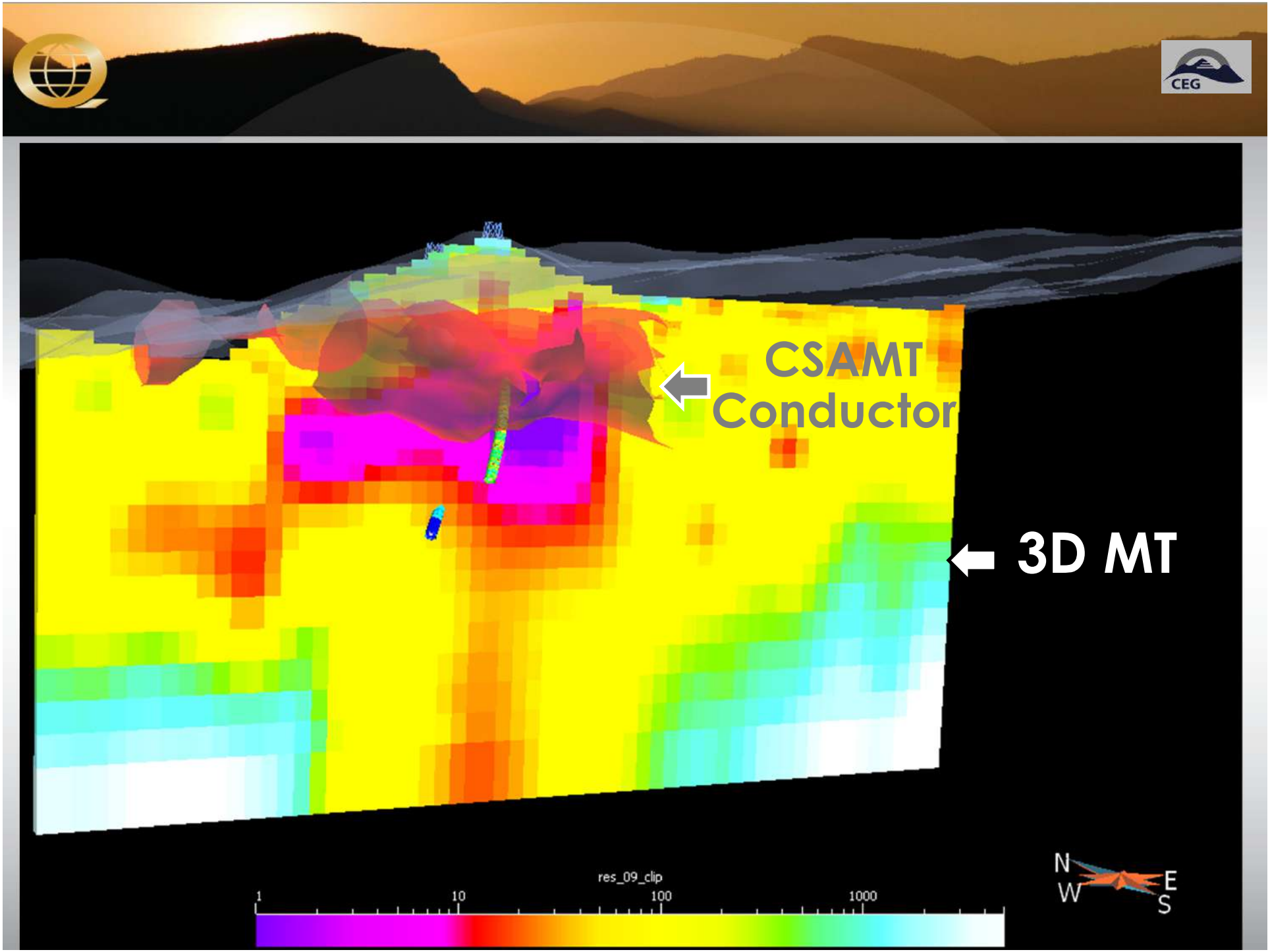

DC Resistivity
1 km
4400
4000
res_09_clip
1
10
100
1000
N
E
W
S

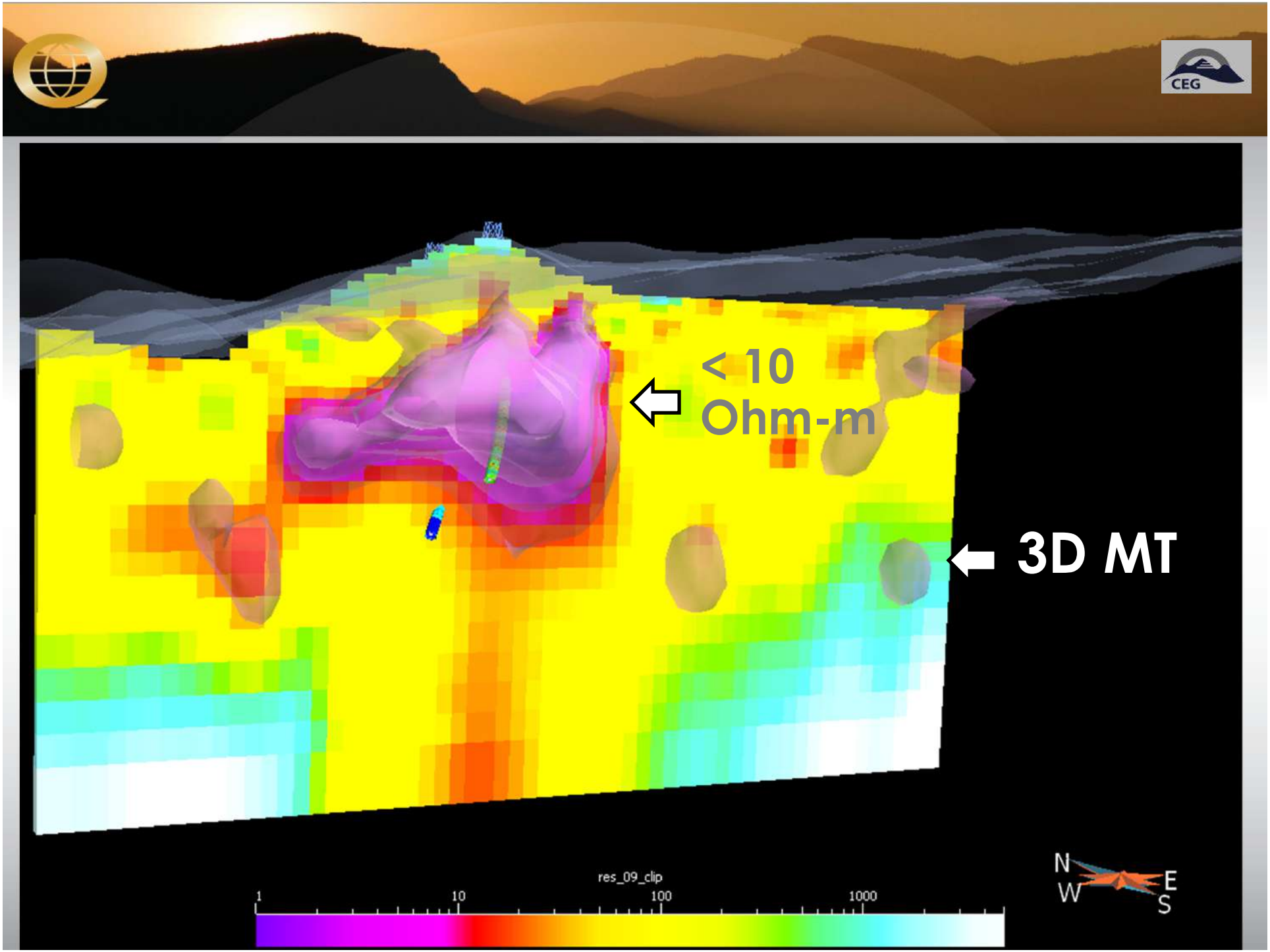

1 km
DC Resistivity
3D MT Model
Deep-seated
Conductor
DC
MT
N
E
W
S
res_09_clip
1
10
100
1000

The MT model suggests a down-dip extension of the conductive zone

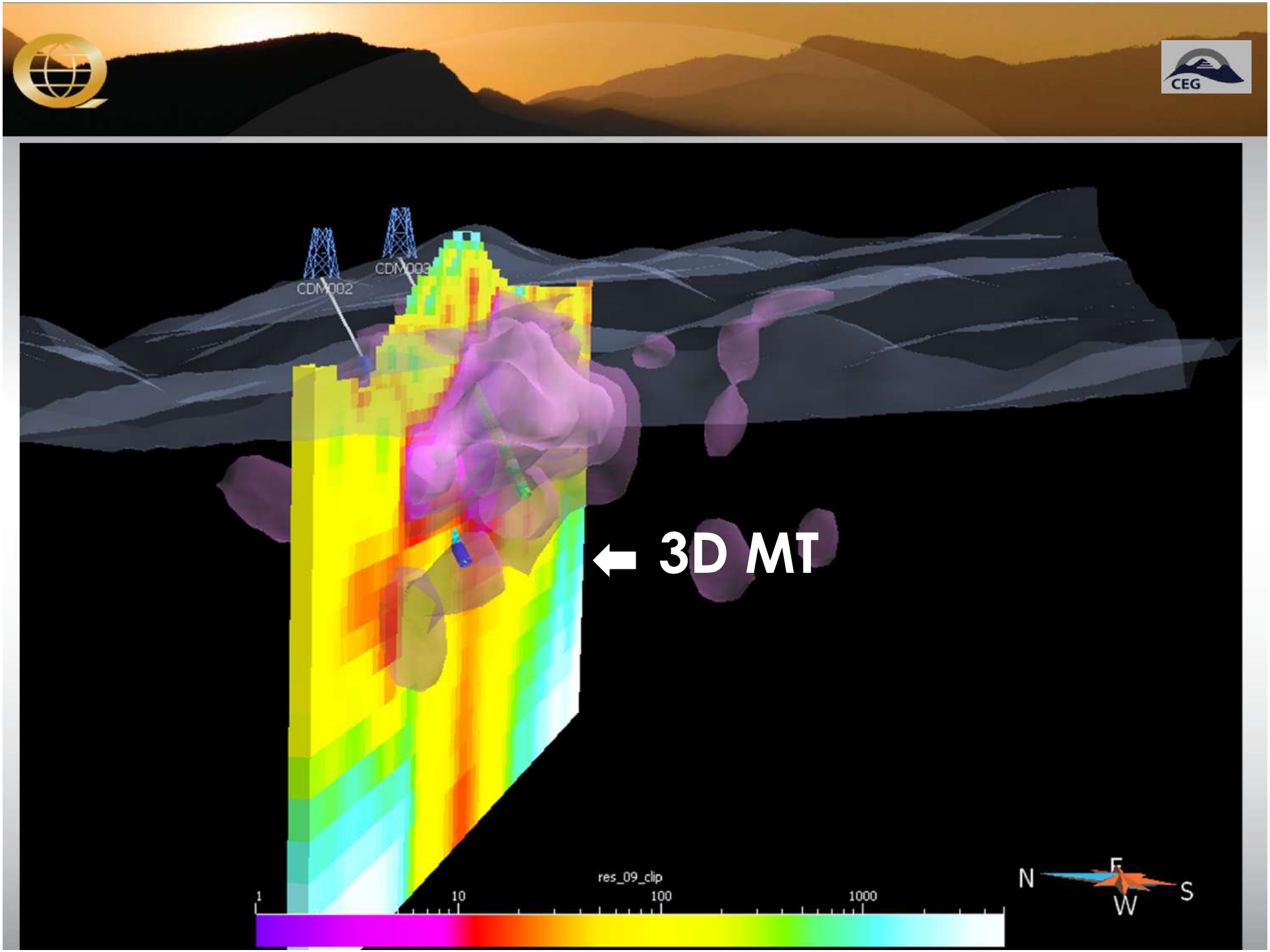

CSAMT
Conductor
3D MT
Feeding
Zone?
res_09_clip
1
10
100
1000
N
W
E
S

The CSAMT conductors appears as of limited depth extension
The MT suggests a vertical conductive zone featuring a possible feeding zone


CSAMT
Conductor
3D MT
res_09_clip
1
10
100
1000
N
W
E
S

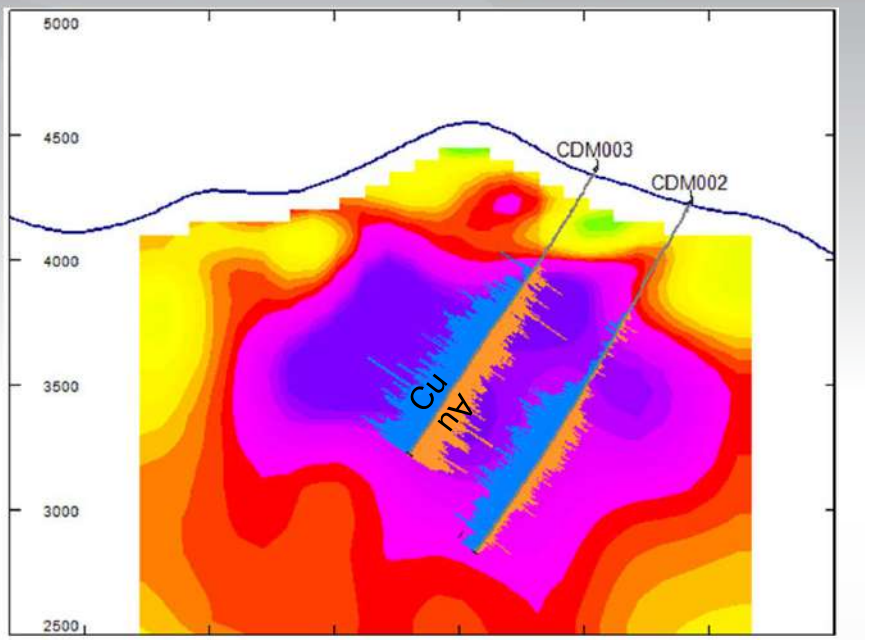

< 10
Ohm-m
3D MT
res_09_clip
1
10
100
1000
N
W
E
S

MT isosurfaces of < 10 Ohm-m

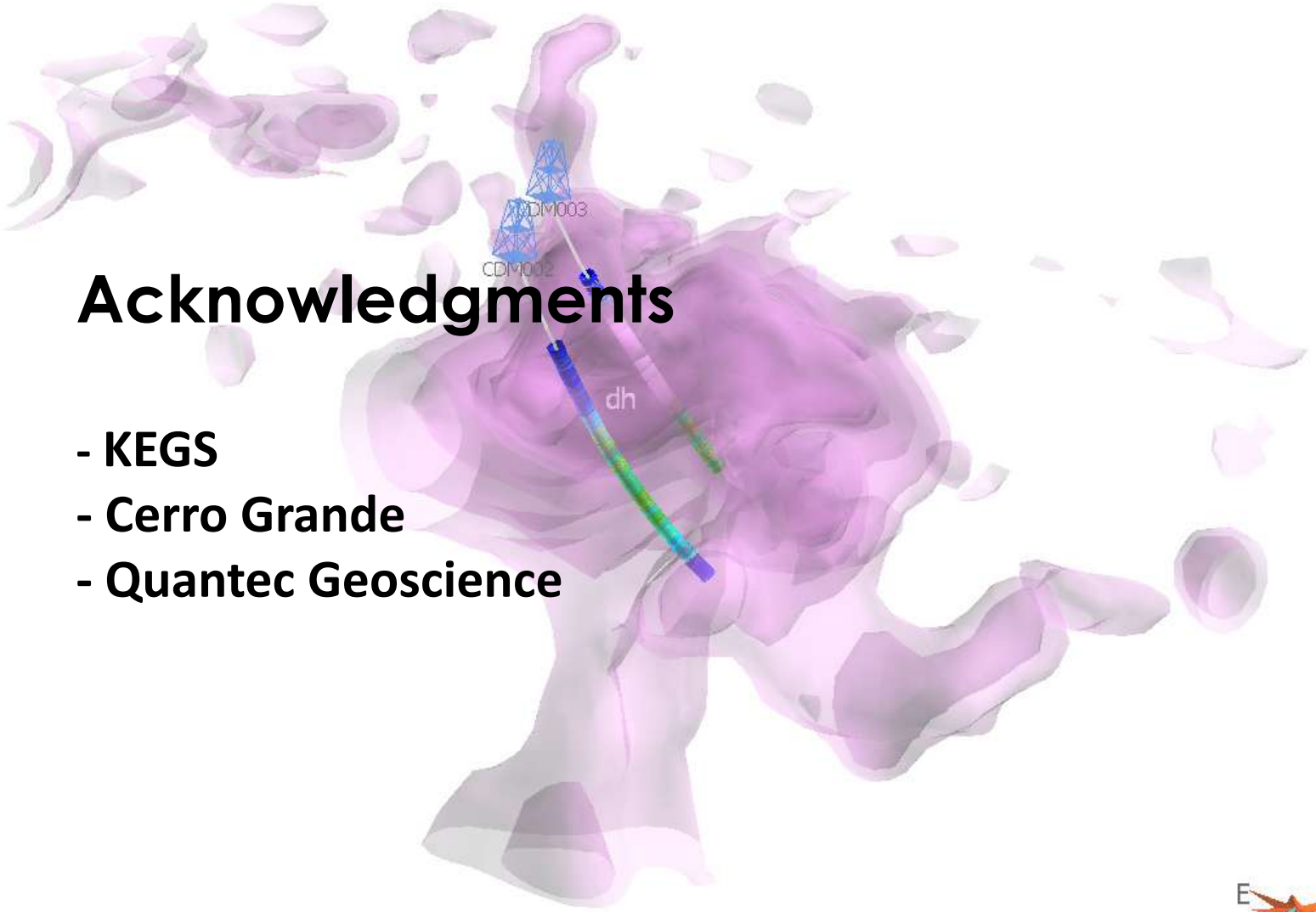

CDM002
CDM003
← 3D MT
res_09_clip
1
10
100
1000
N
E
S
W

Conclusions

- Accurate delineation of the outer alteration with the magnetic data.
- Strong CSAMT conductor in coincidence with MMI anomalies.



- Accurate delineation of alteration and stockwork intrusives (up to 1km) with the ORION 3D DCIP
- Significant conductive zone, increasing the size and depth extension of the alteration zone and related mineralization to depth of 2km in the down dip direction with the ORION 3D MT



Acknowledgments

- KEGS
- Cerro Grande
- Quantec Geoscience

Quantec Geoscience

THANK YOU

QUESTIONS?

Northgate Minerals Corporation