

# Exploration for Giant High Sulfidation Epithermal Gold Deposits in the Chilean – Argentine Andes.

Presented by: Stephen Nano



#### Acknowledgements

Many thanks to Professor Rick Valenta, Director WH Bryan Mining Geology Research Centre and the Queensland Exploration Council for the invitation to present today



Sustainable Minerals Institute

I would like acknowledge Newcrest Mining Ltd and Mirasol Resources Ltd for consent to present materials in today's presentation





I would also like to thank the team at Global Ore Discovery Consulting who have provided key technical and marketing supporting to Mirasol Resources Ltd since inception and for the Global Ore team's help in preparing today's presentation





#### ntroduction

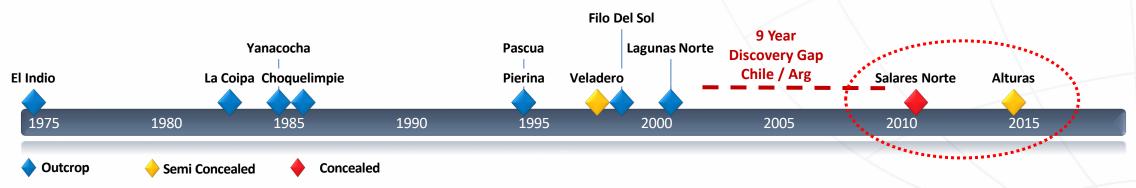
#### **Presentation focus**

- On the on-going exploration for giant High Sulfidation Epithermal (HSE) Gold deposits in the Chile Argentine Andes
  - Provide a synopsis of the exploration signatures
  - Exploration process and results-to-date from a Joint Venture (JV) partnership between a TSX-V listed junior company Mirasol Resources Ltd (MRZ) and Newcrest Mining Ltd (NCM)

#### **Underlying themes**

- A combination of the following factors has contributed to a renewed exploration cycle of discovery semi-concealed to concealed HSE Gold deposits in what is traditionally considered a mature exploration terrain
  - 1. Improved exploration deposit models
  - 2. Application of newer exploration technology
  - 3. Change in risk appetite from management and investors that provides access funding for high-risk high-reward exploration

#### **HSE-G Discovery Timeline – First Deposit in Each District (Peru, Chile, Argentina)**

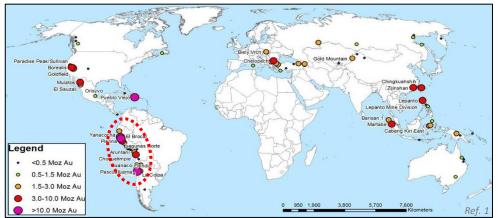


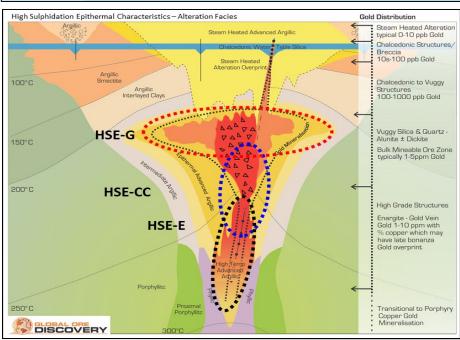




## Global HSE Deposits: Geography and Scale

#### Global Distribution – High Sulfidation Epithermal (HSE) Deposits





- 5 50 Moz gold bulk-mineable oxide High Sulfidation Epithermal Gold (HSE-G) deposits are clustered in the Mio-Pliocene Arc of Chile, Argentina and Peru
- Giant deposits form in near paleo-surface environment (hundreds of metres from surface) as opposed to HSE covellite – chalcosite – enagrite (HSE-CC) or epithermal gold enargite (HSE-E) vein systems or gold systems formed in telescoping or prograde overprinting in porphyry copper gold systems
- Deep oxidation is a critical factor in deposit economics for bulk mineable HSE-G deposits
- Located in challenging environments, high altitude (4000-5000m), seasonal access
- → Slow, high cost exploration
- → Need large-scale, high value deposits to be economically viable
- → Recent trend of discovery of semi-concealed to 100% concealed deposits

			Elevation	Surface	Discovery	Production	R and R	Production + R and R	
Mine	Country	<b>HSE Class</b>	(m)	Expression	Year	(Moz AuEq)	(MozAuEq)	(Moz AuEq) Ref. 2	
El Indio	Chile	HSE-E	4,000	Outcropping	1975	5.7		5.7	
Tambo	Chile	HSE-G	4,000	Outcropping	1982	1.5		1.5	
La Coipa	Chile	HSE-G	4,100	Outcropping	1983	7.6	0.69	8.29	
Yanacocha	Peru	HSE-G	3,950	Outcropping	1985	36.2	11.3	47.5	
Choquelimpie	Chile	HSE-G	4,860	Outcropping	1986	2.2		2.2	
Pierina	Peru	HSE-G	4,000	Outcropping	1995	8.2		8.2	
Pascua	Chile/Arg.	HSE-G	5,000	Outcropping	1995		21.3	21.3	
Veladero	Argentina	HSE-G	4,200	Semi-Concealed	1998	7.1	10.9	18	
Filo Del Sol	Chile/Arg.	HSE-CC	5,000	Outcropping	1999		9.2	9.2	
Lagunas Norte	Peru	HSE-G	4,100	Outcropping	2001	9.1	5.7	14.8	
Puren - La Coipa	Chile	HSE-G	4,300	Concealed	2002	1.5		1.5	
Salares Norte	Chile	HSE-G	4,250	Concealed	2011		4.6	4.6	
Alturas	Chile	HSE-G	4,800	Semi-Concealed	2015		8.9	8.9	



## $\mathcal{J}$

#### La Coipa District; Puren Deposit – Catalyst for New Cycle of Exploration for Chilean HSE Precious Metal Deposits





Concealed

- 2002-04 Discovery of the Puren deposit (1.5 Moz Au eq.) in the La Copia district after 19 years production and exploration
- 100% concealed beneath +100-150m "barren" steam heated alteration cap
- Watershed discovery
- → New exploration knowledge and technologies applied
- → Team and knowledge disseminated through the industry
- This success facilitated funding and management support for a new wave of exploration for concealed HSE-G deposits in Chile / Argentina
- 9 year discovery gap until Salares Norte in 2011
   25 Mt at 4.76 g/t Au and 53.1 g/t Ag
   for 3.91 Moz Au, 43.66 Moz Ag
- 6 years exploration discovery cycle for Gold Fields
- First significant deposit discovered North of the Maricunga belt





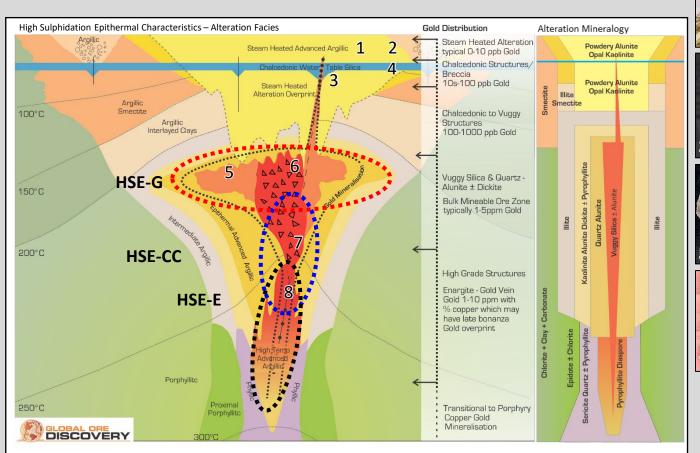
Outcrop

Semi Concealed

# High Sulphidation Epithermal Deposits Regional Controls, Deposits Characteristics and Exploration Signatures



## High Sulphidation Epithermal Characteristics -



ightarrow 6.2 to 13.1 Ma "brackets" the formation of giant Mio-Pliocene age HSE-G and HSE-E deposits in Chile and Argentina ightarrow Geochron.

















Steam Heated Zone 1,2 Atlas Project, Chile

Water Table Silica 3,4 La Coipa, Chile

HSE-G Vuggy Silica / Breccia 5 La Coipa, Chile 6 El Indio District Chile

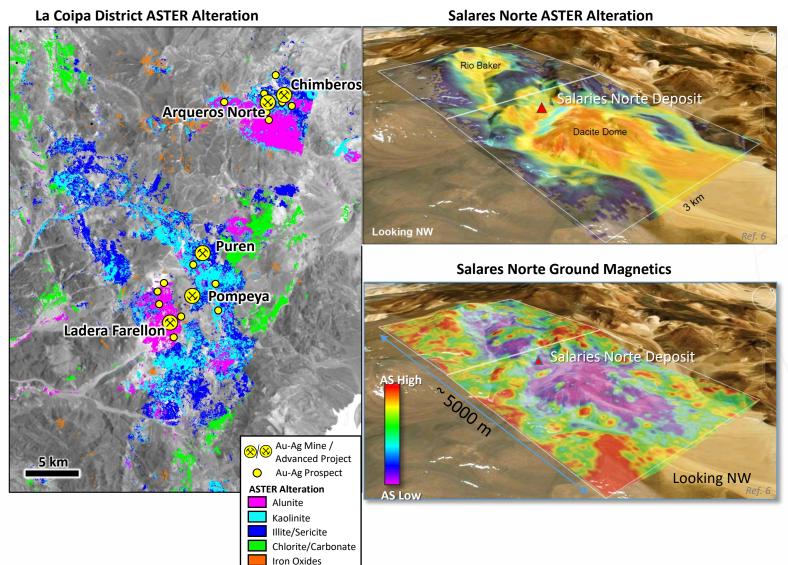
HSE-CC Covellite Chalcosite 7 Agua Rica, Argentina

HSE-C Enargite Zone 8 El Indio District Chile





## District Scale: HSE Characteristics - Alteration

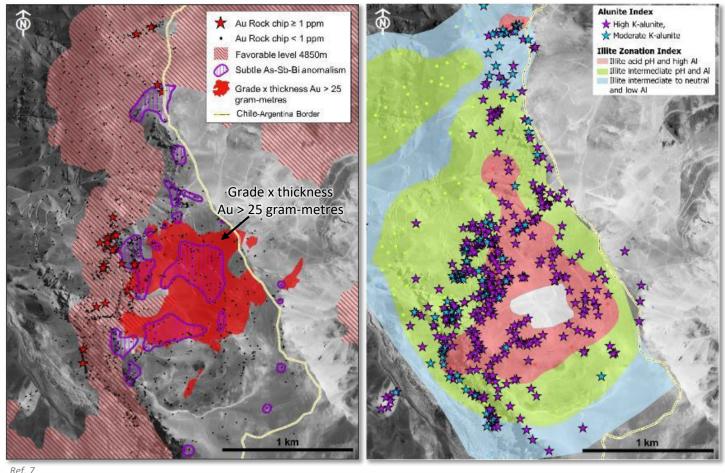


- In the steam-heated zone, above the water table, often see coalesced or composite alteration cells form district scale alteration centres covering tens of square kms
  - La Coipa 235 sq kms
  - Salares Norte → 33 (50) sq kms
  - Altazor → 70 sq kms?
- Dominated by Advanced Argillic Steam heated Alteration kaolinite > alunite - cristobalite and localised areas of jarosite or native sulfur → "sea of white powdery rock"
- Extensive development of opaline to chalcedonic silica replacement at the water table – regional scale over tens of square kms.
- The challenge is to effectively evaluate these enormous alteration systems and vector towards concealed deposits that are typically significantly less than a square km in size
- → District scale exploration toolkit includes
- High resolution magnetics to map the extents of the alteration system and potentially large-scale structural feeders
- ASTER / WorldView3 image processing and remote mineral occurrence and abundance mapping to vector toward fluid flow centres at a district scale



## Prospect Scale - HSE Characteristics - Geology, Alteration Mineralogy and Soil Geochemistry

#### Alturas: Soil - low Detection Limit Geochem, Spectral Geology PSM / ASD Zoning



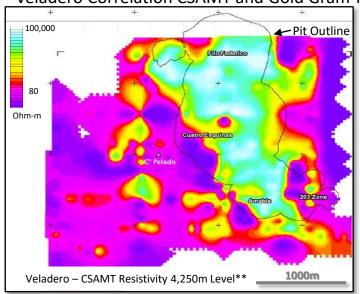
- Careful geological mapping (int. alteration texturally destructive / differentiation of Breccia types)
  - paleo-water table silica blanket
  - multiphase phreatic and hydrothermal brecciation
  - differenced andesitic to dacitic dome complexes
  - Presence of pyroclastic in sequence
  - structures and zones of silicification (alunite, Jarosite, gypsum) that could indicate fluid conduits
- Systematic alteration vectoring with Corescan or handheld infra-red spectrometers
  - alteration facies mapping
  - mineral composition variation
  - mineral crystallinity
  - → Alteration facies / infer fluid chemistry / temperature vectors
- Trace element soil and Rock chip geochemistry with multi-acid digest ultra low detection limit Au-Ag / As-Sb-Pb-Te-Bi

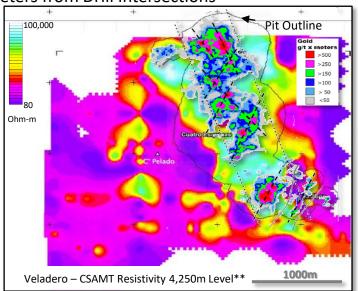




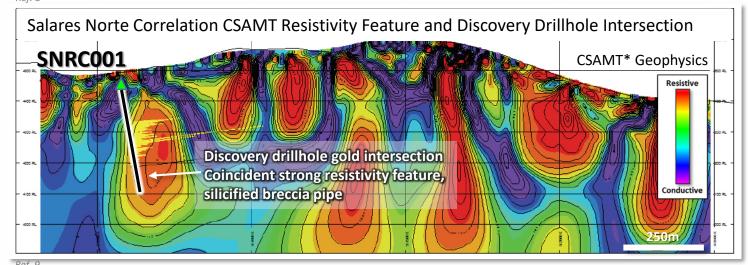
### Target Scale – Geophysical Signature: CSAMT Resistivity Geophysics

#### Veladero Correlation CSAMT and Gold Gram-Meters from Drill Intersections





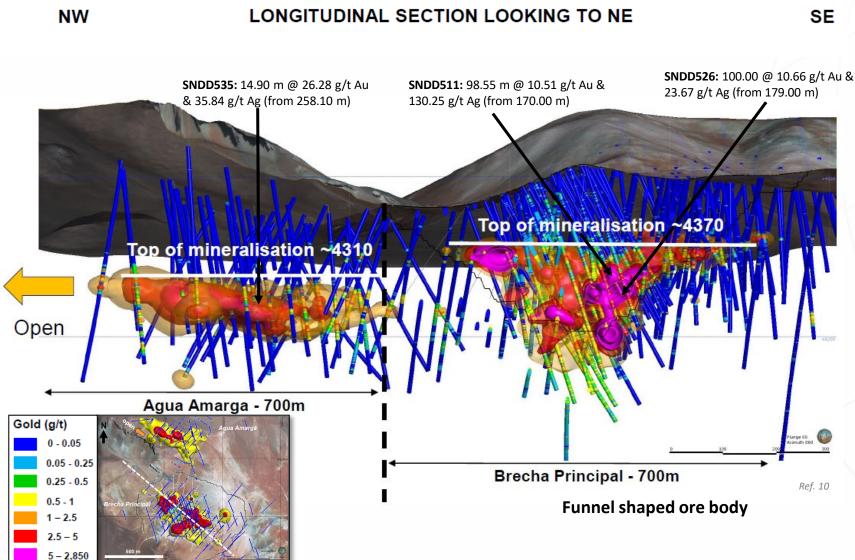
Ref. 8



- A range of electrical geophysical tools have valid application in HSE-G search however CSAMT is a preferred tool for covered oxidised HSE-G exploration
- Strong correlation between economic concentrations of gold mineralisation and residual (vuggy) silica +/hydrothermal silica accumulations → CSAMT resistivity response in 10,000 – >50,000 Ohm-m range
- Example 1: CSAMT resistivity plan view depth slice Barrick Gold, Veladero gold mine; total endowment 18 Moz gold
- Example 2 CSAMT resistivity section, Gold Fields Salares Notre discovery hole
- Strong resistivity anomaly correlates to the residual and introduce hydrothermal silica in the Salares Norte Breccia beneath 150-200m of gold "barren" steam-heated cap.
- Note that there are a number of resistivity anomalies in this section → they're not all orebodies!



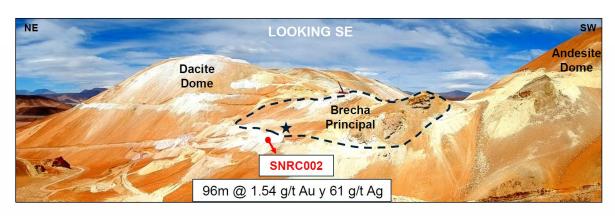
## Deposit Scale - HSE Characteristics - Morphology



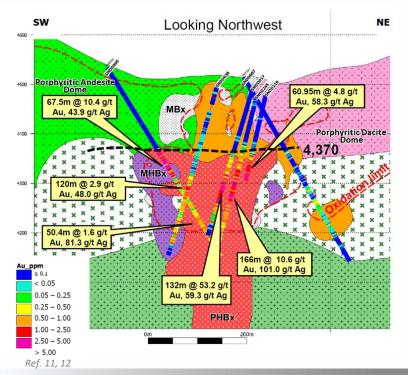
- 150 250m thick gold-barren (0 50ppb) steam heated and advanced argillic alteration cap, concealing Salares Norte and Agua Amarga goldsilver deposits.
- Erratic, ppb level gold-silver leakage overlying Salares Norte orebody → this is what we're looking for in soils and surface rock-chip sampling
- Flat-top to mineralisation represents paleo-water table, post depositional structural displacement Agua Amarga vs Salares Norte breccia
- Funnel or "carrot" shaped breccia pipe reflected in shape of CSAMT resistivity anomaly
- Flat-lying tabular zone Agua Amarga zone is mineralisation hosted in stratabound vuggy silica zone
- "Uber" gold grades over long intervals seen within the Salares Norte breccia pipe are a key factor in deposit economics



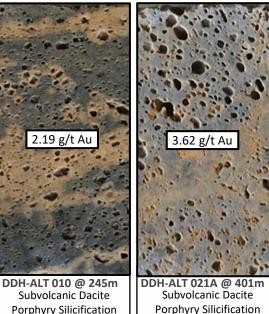
## Deposit and Drill Intersection Scale: HSE Characteristics - Morphology



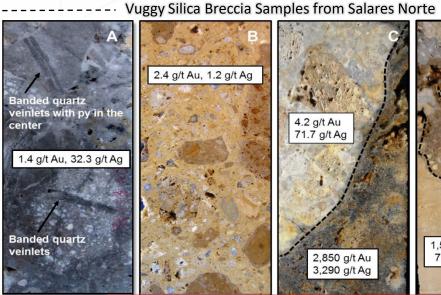
- Pre-mineral andesite and dacite domes (differentiation of Magma)
- Steam-heated phreatic hydrothermal breccia
- ppb level gold at surface (maximum rock chip of 53 ppb)
- Brecciation "necks-down" above the water table → smaller footprint at surface than at depth
- Note development of cone of oxidation following the breccia body
- Residual vuggy silica gold mineralisation typically introduced post development of vuggy silica texture
- Multiple hydrothermal / mineralising events evident in the breccia, including late stage "Uber" gold event with banded colloidal silica



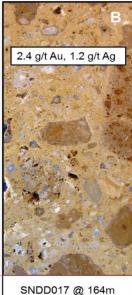
Vuggy Silica (not from Salares Norte)



overprinting residual atz overprinting residual qtz



SNDD005 @ 388m Unoxidised polymictic breccia; clasts with porphyry-style veinlets



Oxidised Polymictic breccia (PBX)



cutting PBX.

1,520 g/t Au 706 g/t Ag SNDD017 @ 234m Creamy silica & visible

gold (VG) in PBX

#### HSE-G Summary: Exploration Checklist

HSE-G Exploration Checklist	Salares Norte	Alturas	
District scale advanced argillic alteration steam heated with opal alunite, Jarosite, native sulfur	✓	✓	
Mio-Pliocene alt/mineralization age within 5 to 12 Ma Fertile window of giant HSE-G deposits	✓	✓	
Differentiated volcanic complex – andesitic → dacitic (rhyolitic) dome field + pyroclatics	✓	✓	
Large scale phreatic / hydrothermal multi-phase breccia complex	✓	✓	
Zoned alteration mineral vectors evident in soils / outcrop	✓	$\checkmark$	
Anomalous zoned soil geochemistry (As, Sb, Pb, Zn, Bi, Hg)	✓	✓	
Anomalous Au/Ag in rock chip and soil Geochem > 50 ppb Au → suggest fertile	✓	✓	
Large scale highly resistive features in electrical geophysics (CSAMT > 10,000 Ohm-m)	✓	✓	
Broad intersections of 0.5 to 1 g/t Au in breccia vuggy silicia	✓	✓	
Evidence of intense oxidation: surface and drillhole	✓	✓	
Drill evidence of bonanza grade phase mineralization	✓	×	

Salares Norte Indicated and Inferred Resources: 25 Mt at 4.76 g/t Au and 53.1 g/t Ag for 3.91 Moz Au, 43.66 Moz Ag

- In development phase first gold production 2023
- "Uber" grade mineralisation event key to deposit economics

**Alturas** Inferred Resources: 261 Mt at 1.06 g/t for 8.9 Moz of Au

 On-going exploration to find high-grade gold "kicker" or larger contained ounces to meet deposit economics threshold



## Mirasol Exploration Concepts and Newcrest Joint Venture Partnerships



#### Mirasol Resources Ltd



- TSX-V Mirasol Resources (MRZ) listed in 2005 gold, copper, silver explorer
- Market Cap. ~CAD\$27m, 54 million shares on issue, ~CAD\$18m treasury
- Operates under hybrid project generator joint venture, self-drill model
- Throughout it's history, has used leading-edge geoscience to target generate and explore
   → build an extensive portfolio of district scale gold-copper-silver projects
- Track record for industry leading joint ventured deals with major miners
- Initial focus on low sulfidation epithermal in Santa Cruz providence, Argentina
- Today, focussed on Chile and Argentina in epithermal and porphyry exploration
- In 2012, Discover under joint venture Joaquin silver/gold deposit 49% sold to Coeur Mining in 2012 for US\$ 60M
- Discovery of Virginia silver project with initial 2014 NI 43-101 resource at approx. 15 M Oz Ag at approx. 300 g/t











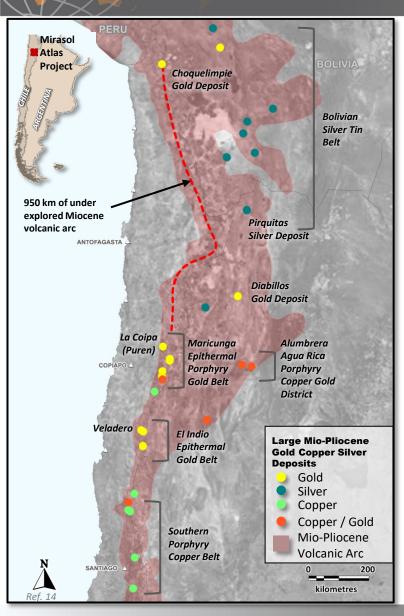








#### Mirasol Resources: Mio-Pliocene Arc Program - Chile



Technical opportunity in 2010 → Mirasol began HSE-G exploration Chile – Arg Mio-Pliocene

- Last giant HSE discovery in Chile / Argentina was Veladero in 1998
- 950km of potentially prospective Mio-Pliocene arc from La Coipa → Choquelimpie
- New exploration knowledge and exploration technologies for covered HSE
- → Discovery of a giant bulk-mineable oxide HSE deposit
- → Mirasol embarked on four seasons of Mio-Pliocene HSE project gen. and recon. 2009/10 and 2015-18
- → 20 projects, 113,000 Ha, 11 high-level HSE systems (9 porphyry copper-gold and/or porphyry gold targets)

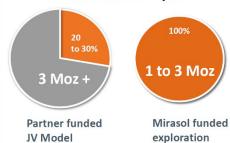
Challenges for a junior exploring for HSE in Chile / Argentina

- high altitude (3800m 5500m elevation) / isolated / short exploration season / social licence
- → slow, high cost exploration

Project generation - Joint Venture model

- Mirasol balanced exploration strategy diversified sovereign risk / geography / deposit class
- High end geoscience / early stage exploration → district scale opportunities
- JV model to access capital and operating capacity of mid-tiers and majors
- 2014 2019 ~CAD\$40m JV partner in-ground spend and CAD\$3m in option payments

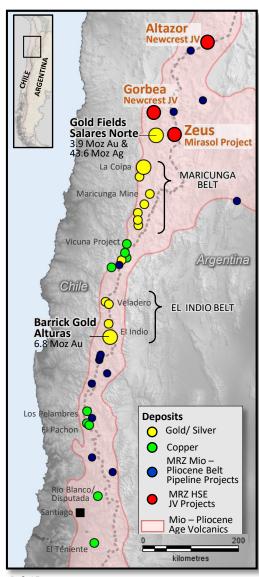
#### Mirasol Retained Project

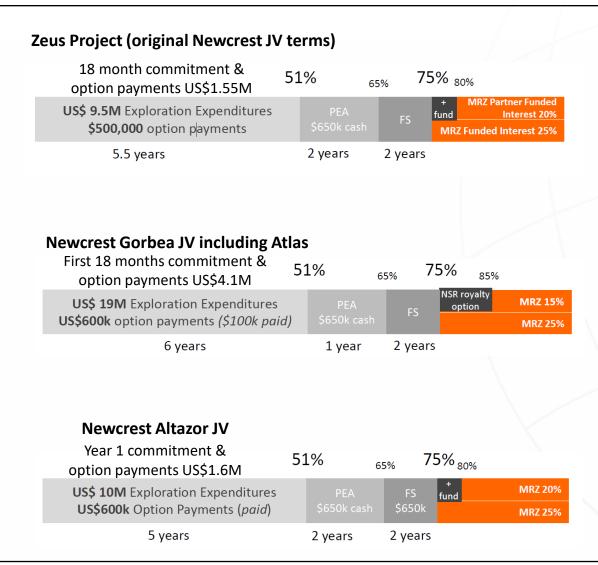


- → Apply Joint Venture model share equity for high-risk high-cost high-reward targets
- → 30% project equity funded to production of a 3 5 M Oz deposit is significant value creation for investors
- → Self-fund lower risk, lower cost target exploration



## Mirasol Resources: Partnering with Newcrest Mining for HSE-G Exploration





Zeus was staked by Mirasol in 2017
Mirasol surface exploration: Mapping, Streams,
Rock chip sampling, PIMA alteration modelling
Newcrest JV: February 2018 - December 2018
Summary: ~US\$900k incl. opt.
Corescan soils and alteration, geology, CSAMT

→ Priority drill target defined - didn't meet NCM
target criteria – NCM exited without drill testing

Gorbea package was staked by Mirasol in 2010:
Mirasol surface exploration, electrical geophysics
and initial drill test at Titan project
Yamana JV: March 2015 - April 2018
Summary: +US\$ 8.58M incl. opt.
→ Drilled 11,640m with best intersection

- 114 m @ 1.07 g/t Au in oxide HSE breccia

  → Newcrest JV: December 2018 → Active JV

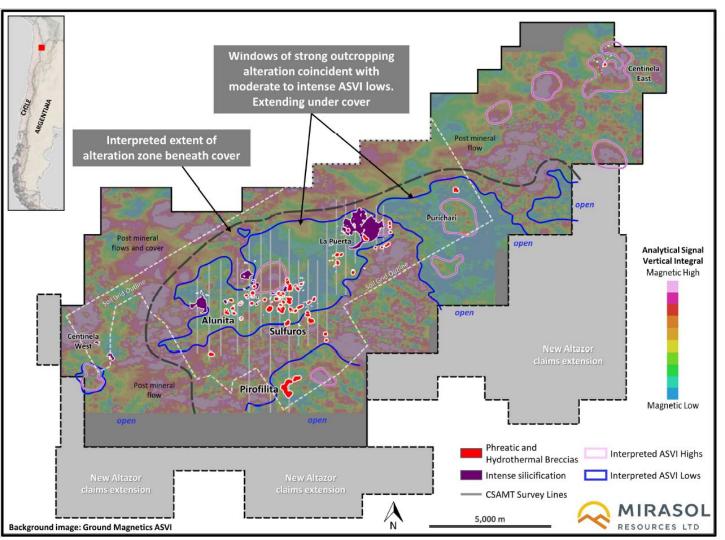
  drilling in progress
- Altazor was staked by Mirasol in 2017
  Mirasol surface exploration: Mapping, Streams,
  Rock chip sampling, PIMA alteration modelling

  → Newcrest JV: November 2017 → Active JV
  Corescan soils, alteration, geology, CSAMT
  First phase of drilling planned 2020





#### Mirasol / Newcrest JV - Altazor Holes Pending Results

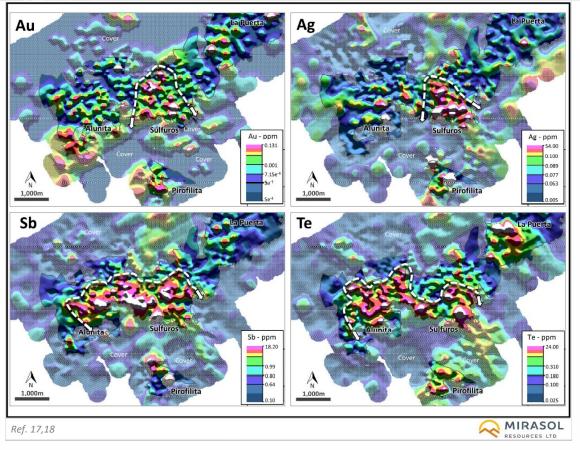


- Mirasol completed initial mapping, stream sediment sampling, rock chip sampling, PIMA alteration modelling
- → Confirm large scale gold bearing HSE breccia system preserved at steam-heated level
- → Geochron dating of hydrothermal alunite 7.3 7.8Ma within bracket for giant HSE systems in Chile / Argentina
- First season of joint venture exploration operated by mirasol included systematic Corescan + low detection limit geochemistry on soils, further geological mapping, detailed ground magnetic survey and initial CSAMT survey
- → Defined 75 sq. km alteration system open, new claims staked
- Large scale alteration assemblage / mineral composition / soil and rock chip vectoring consistent with large HSE system
- Multiple, high-intensity CSAMT resistivity features consistent with signatures of multiple Salares Norte scale breccia targets
- → Newcrest built a Chilean field and land access team and in-country infrastructure and is managing and operating the exploration and social licence process
- → Drilling planned for Spring / Summer 2020

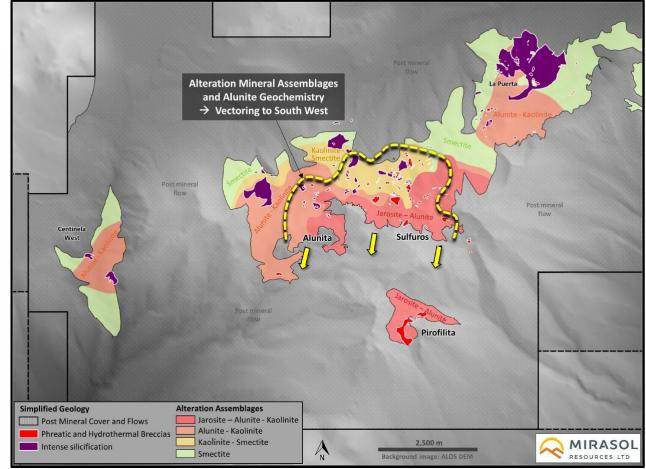




## Mirasol / Newcrest JV Altazor Soil Survey and Low Detection Multi-Element Assays



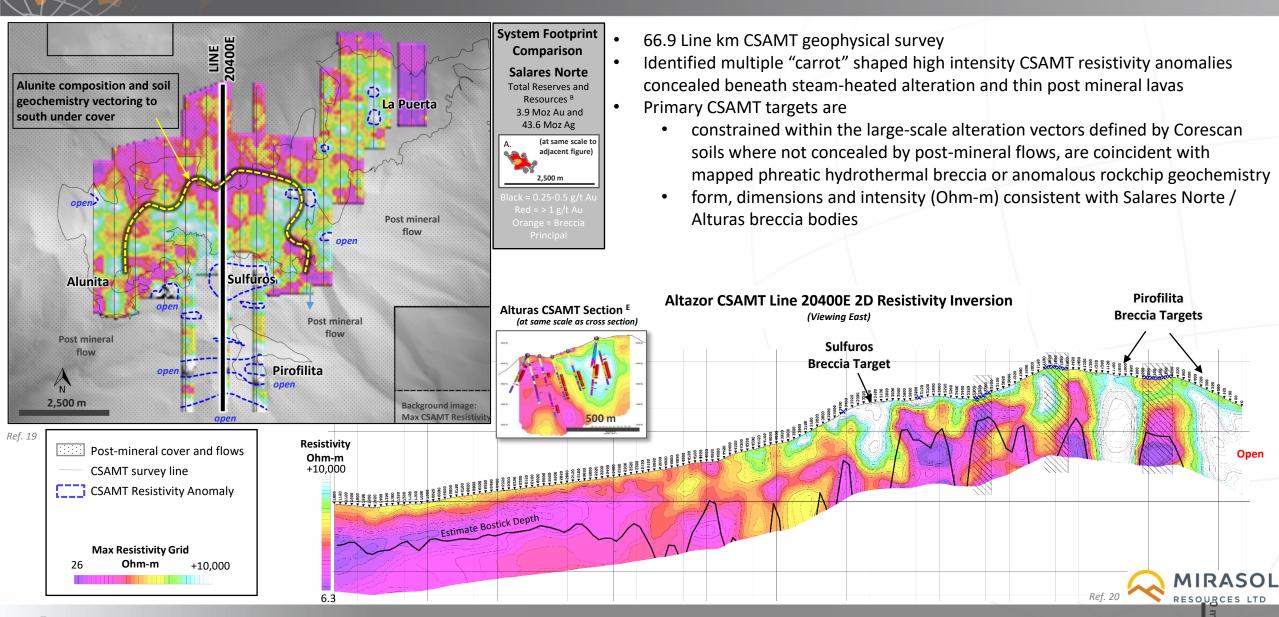
- 2,030 sample, 85 sq. km soil survey with multi-element 4-acid digest low detection limit MS finish
- Defined a large-scale, zoned multi-element (Au, Ag, Sb, As, Te) anomaly vectoring toward covered geophysical anomalies to southeast
- Peak Au to 0.131 ppm, Ag to 54 ppm, Sb to 18.2 pm, Te to 24 ppm



- Corescan hyperspectral mineralogical analysis of soil samples
- Defined large-scale advanced argillic alteration facies vectors
- Alunite compositional zoning vector south with soils towards high intensity covered CSAMT resistivity anomalies



#### Altazor CSAMT Geophysical Survey



21

#### In Conclusion

HSE Checklist	Salares Norte	Alturas	Zeus	Atlas	Altazor
District scale advanced argillic alteration system with Alunite, Jarosite, native sulfur	✓	✓	✓	✓	✓
Mio-Pliocene alteration/mineralization age within 5 to 12 Ma "giants window"	✓	✓	?	similar age to La Coipa	✓
Differentiated volcanic complex – andesitic → dacitic (rhyolitic) dome field	✓	✓	✓	✓	✓
Large scale phreatic / hydrothermal multi-phase breccia complex	✓	✓	✓	✓	<b>√</b>
Zoned alteration vectors evident in soils / outcrop	✓	✓	✓	✓	✓
Anomalous zoned soil geochem As, Sb, Pb (Zn, Bi, Hg)	✓	$\checkmark$	✓	$\checkmark$	✓
Anomalous Au/Ag in rock chip and soil Geochem > 50 ppb Au → may be patchy and a distraction	✓	✓	✓	✓	✓
Large scale highly resistive features in electrical geophysics (CSAMT > 10,000 Ohm-m)	✓	✓	Not detected in CSAMT	Strong resistors in IP	<b>/</b>
Broad drill intersections of 0.5 to 1 g/t Au in breccia vuggy silicia	✓	✓	No drilling	✓	No drilling
Evidence of bonanza grade phase mineralization in drilling	✓	×	No drilling	Not Yet	No drilling

New Cycle HSE – G discovery in Chile and Argentina:

- 2002 → Puren Deposit 1.5 Moz Aueq
- 2011 → Salares Norte Gold Fields 3.9 Moz Au
- 2015 → Alturas Barrick 8.9Moz Au
- 2020 → Newcrest / Mirasol ????

#### Driven by;

- Improved Deposit Models
- Application of new exploration technologies
- Management and investors fund long lee time high risk / reward exploration

Mirasol Resources (Junior) has been able to participate in this by;

- High-end geoscience and field exploration
- North American style Joint Venture model For and exploration (discovery) partnership with major gold producer Newcrest Mining







#### References

- 1. Modified from Gold Fields pg 7: M. Combes, Salares Norte Project 10 April 2019
- 2. Modified from Gold Fields pg 8: M. Combes, Salares Norte Project 10 April 2019
- 3. Modified from Mirasol Resources pg 3: Characteristics of High Sulphidation Epithermal Gold Deposits of the Mio-Pliocene Age Volcanic Belt, Chile and Argentina, 2018
- 4. Modified from Gold Fields pg 7: Francisco (Chico) Azevedo, Nathan Brewer, Diego Huete Verdugo, Alex Santos, Lisseth Roncal de Santos, Regina Baumgartner, Alex Trueman and Andrew Foley, 2015. The Discovery and Geology of the Salares Norte Epithermal Gold-Silver Deposit, Northern Chile, NewGenGold 2015
- Modified from Gold Fields pg 8: M. Combes, Salares Norte Project 10 April 2019
   Barrick Alturas NewGen Gold presenation November 2017
- 6. Modified from Gold Fields pg10: Nathan Brewer, Francisco Azevedo, Diego Huete Verdugo, Teresa Guevara, Fernando Rojas, Juanita Rodriguez Melo, Christian Lagos, Claudio Cerda, Constanza Moreno, Regina Baumgartner, Alex Trueman and Andrew Foley, The Discovery and Geology of the Salares Norte Epithermal Gold-Silver Deposit, 2017
- 7. Northern Chile, AME ROUNDUP January 2017
- 8. Gold Fields Mineral Resources and Mineral Reserve Supplement to the Integrated Annual Review, 31 December 2015
- 9. Modified from Gold Fields pg20: Nathan Brewer, Francisco Azevedo, Diego Huete Verdugo, Teresa Guevara, Fernando Rojas, Juanita Rodriguez Melo, Christian Lagos, Claudio Cerda, Constanza Moreno, Regina Baumgartner, Alex Trueman and Andrew Foley, 2017. The Discovery and Geology of the Salares Norte Epithermal Gold-Silver Deposit, Northern Chile, AME ROUNDUP January 2017
- 10. Azevedo, F., Brewer, N., Santos, A., Huete Verdugo, D., Baumgartner, R., Roncal, L., Trueman, A. & Foley, A. (2015). The discovery and geology of the Salares Norte epithermal gold-silver deposit, northern Chile. In NewGenGold 2015 (p145-157). Perth, Australia.
- 11. Modified from Gold Fields pg 11/12: Francisco (Chico) Azevedo, Nathan Brewer, Diego Huete Verdugo, Alex Santos, Lisseth Roncal de Santos, Regina Baumgartner, Alex Trueman and Andrew Foley, 2015. The Discovery and Geology of the Salares Norte Epithermal Gold-Silver Deposit, Northern Chile, NewGenGold 2015
- 12. Figures modified from Gold Fields, Azevedo et.al 2015 pg 14
- 13. Modified from Geology and Mineralization of the Veladero Gold Deposit, San Juan Province, Argentina. Geological Society of Nevada Symposium May 18, 2005
- 14. Modified from Gold Fields pg20: Nathan Brewer, Francisco Azevedo, Diego Huete Verdugo, Teresa Guevara, Fernando Rojas, Juanita Rodriguez Melo, Christian Lagos, Claudio Cerda, Constanza Moreno, Regina Baumgartner, Alex Trueman and Andrew Foley, 2017. The Discovery and Geology of the Salares Norte Epithermal Gold-Silver Deposit, Northern Chile, AME ROUNDUP January 2017
- 15. Nathan Brewer, Francisco Azevedo, Diego Huete Verdugo, Teresa Guevara, Fernando Rojas, Juanita Rodriguez Melo, Christian Lagos, Claudio Cerda, Constanza Moreno, Regina, Baumgartner, Alex Trueman and Andrew Foley, 2017. The Discovery and Geology of the Salares Norte Epithermal Gold-Silver Deposit, Northern Chile, pg18, AME ROUNDUPJanuary 2017
- 16 20. Mirasol News Releases; Altazor Project 2017 2019 http://mirasolresources.com/category/active-jv/altazor/

