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METALOGENIA

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**DIFFERENT STYLES OF PGE-Ni-Cu MINERALIZATION IN THE
LUANGA COMPLEX, CARAJÁS, BRAZIL: A MEETING OF MAGMATIC
AND HYDROTHERMAL PROCESSES**

Cesar Ferreira Filho ¹, Vinicius A. Souza ²; Paulo I. Brito ²; Elianne E. Conde ²

¹ *Instituto de Geociências, Universidade de Brasília, Brasília, cesarf@unb.br*

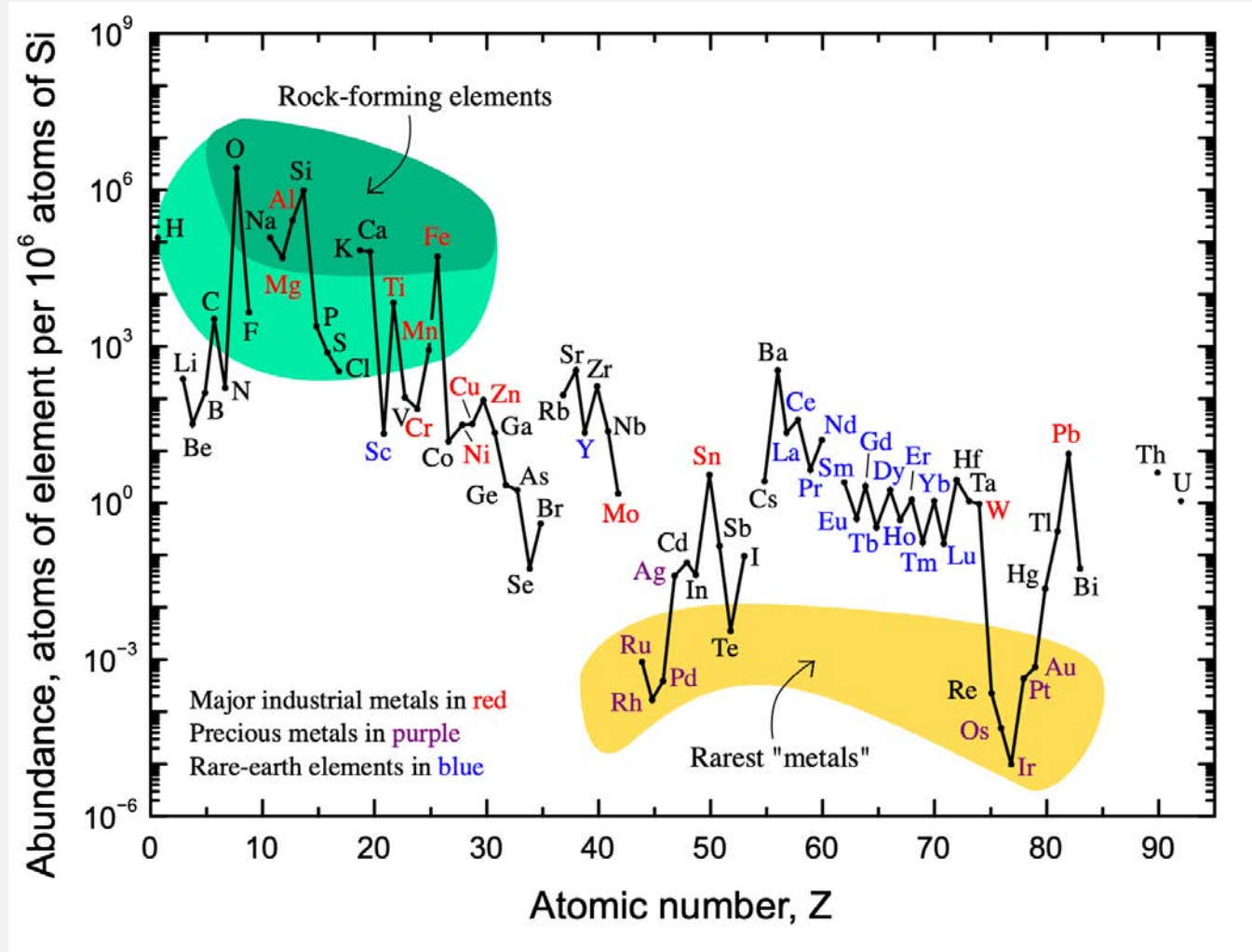
² *Bravo Mining Corp., Rio de Janeiro, RJ, Brasil.*



Economic PGE deposits (i.e., PGE are the main commodity) are rare. The bulk of PGE production and resources come from stratiform horizons located within 03 large layered intrusions.

PGE Geochemistry

- PGE are highly siderophile elements (iron-loving) that were concentrated in the Earth's core, leading to their very low abundance in the mantle (few ppb) and crust.
- The origin of economic PGE deposits with few ppm of contained PGE thus demands a highly efficient process (4-5 orders of magnitude).



PGE Metallogenesis

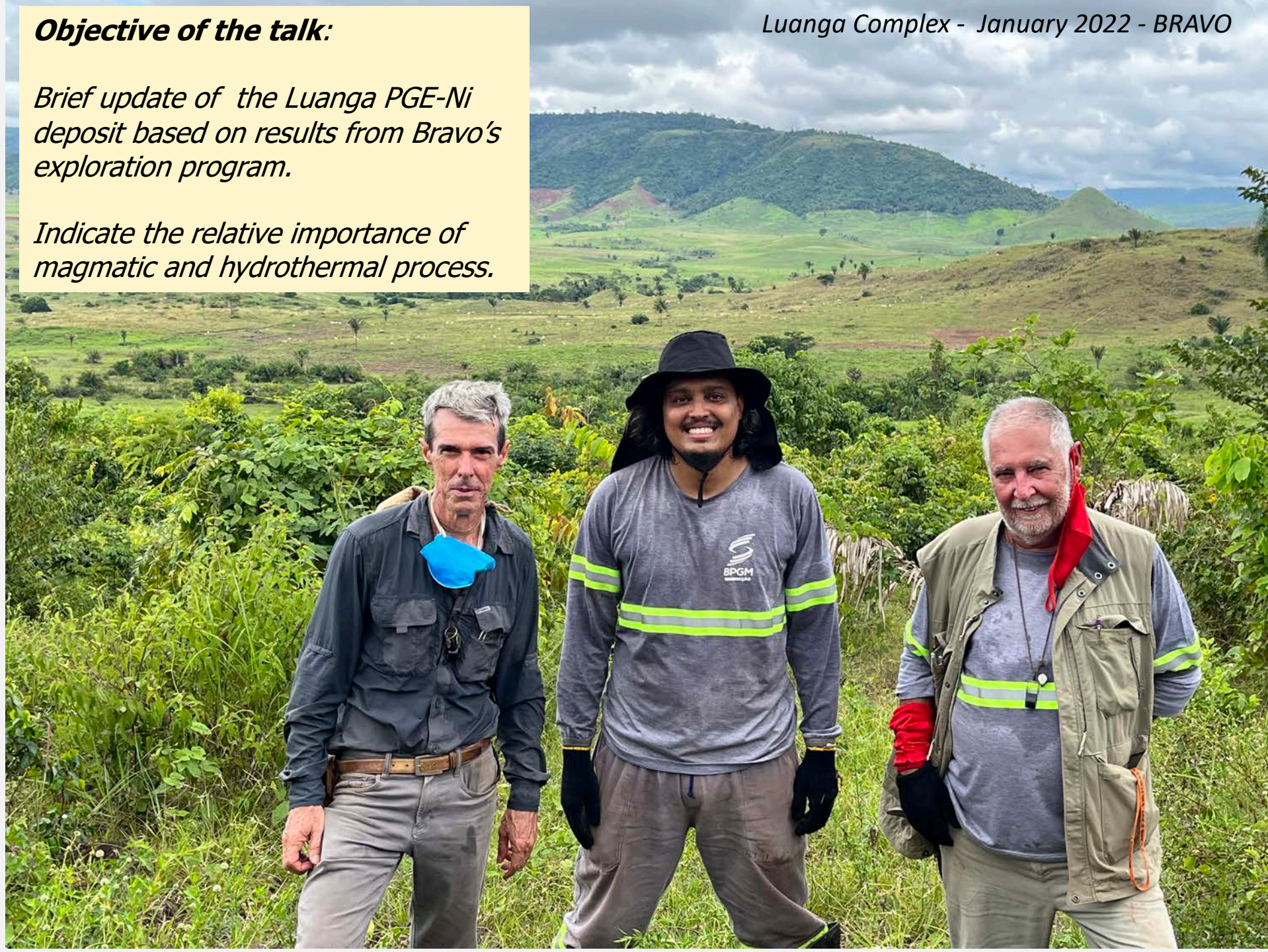
- The origin of PGE deposits is widely accepted as magmatic and commonly considered to result from the segregation of an immiscible sulfide liquid from mafic-ultramafic magmas. However, considerable evidence exists to show that PGM may precipitate directly from silicate magmas, as suggested for some chromitite-associated PGE deposits.
- The role of post-magmatic hydrothermal fluids is not relevant for the origin of stratiform PGE deposits, which is consistent with their location in layered intrusions without significant hydrothermal alteration processes.



Objective of the talk:

Brief update of the Luanga PGE-Ni deposit based on results from Bravo's exploration program.

Indicate the relative importance of magmatic and hydrothermal process.



The Luanga deposit is the largest PGE-Ni resource in Latin America

2021-2025 BRAVO Mining. A new phase of exploration and development of the Luanga PGE-Ni deposit. 431 drillholes and 107,516 m (BRAVO + VALE), 45 trenches. MRE (Bravo Release - February 2025; NI43-101 Technical report available in BRAVO's website on April 2nd, 2025):

Measured + Indicated
 158 Mt at 0.98 g/t Pd, 0.62 g/t Pt, 0.09 g/t Rh, 0.05 g/t Au, 0.12% Ni.
 8.85 Moz of 3PGE+Au.

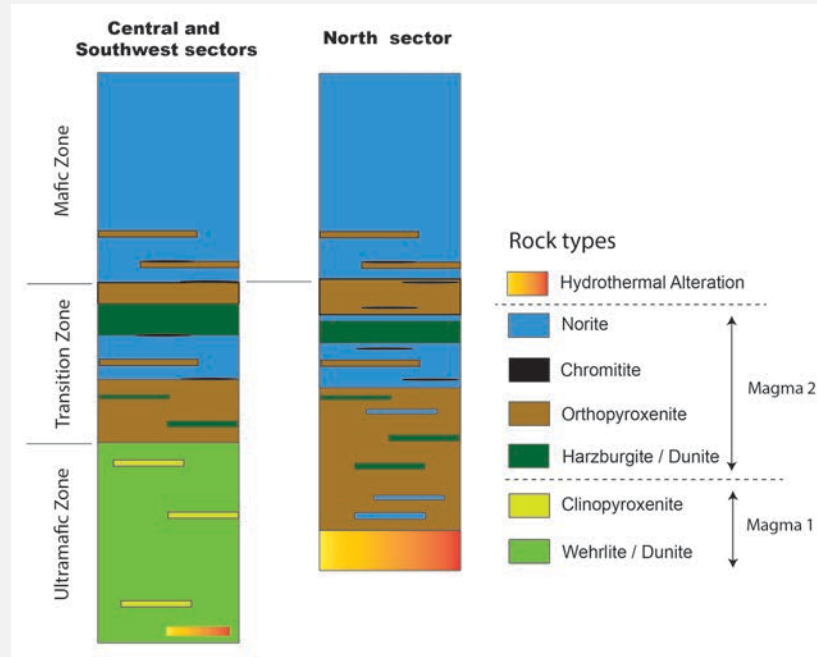
Resource Classification	Weathering	Average Grades and Contained Metal Estimates												
		Tonnes	PdEq ¹		Pd		Pt		Rh		Au		Ni	
		Mt	g/t	Oz	g/t	Oz	g/t	Oz	g/t	Oz	g/t	Oz	%	Tonnes
Measured	Oxide	4	1.51	197	0.90	117	0.88	115	0.12	15	0.05	7	—	—
	High talc	—	—	—	—	—	—	—	—	—	—	—	—	—
	Fresh Rock	32	2.06	2,144	0.97	1,009	0.67	694	0.08	88	0.04	46	0.11	35,282
	Total	36	2.00	2,340	0.96	1,126	0.69	809	0.09	104	0.04	53	0.10	35,282
Indicated	Oxide	6	1.51	314	0.97	200	0.73	151	0.11	23	0.04	9	—	—
	High talc	2	1.83	146	1.12	89	0.54	43	0.08	6	0.11	9	0.13	3,160
	Fresh Rock	113	2.09	7,599	0.99	3,583	0.59	2,133	0.09	318	0.05	193	0.14	156,406
	Total	122	2.06	8,058	0.99	3,872	0.59	2,326	0.09	348	0.05	210	0.13	159,566
Measured + Indicated	Oxide	10	1.51	510	0.94	317	0.79	266	0.11	38	0.04	15	—	—
	High talc	2	1.83	146	1.12	89	0.54	43	0.08	6	0.11	9	0.13	3,160
	Fresh Rock	145	2.08	9,743	0.98	4,592	0.60	2,827	0.09	407	0.05	239	0.13	191,688
	Total	158	2.04	10,399	0.98	4,998	0.62	3,135	0.09	451	0.05	262	0.12	194,848
Inferred	Oxide	3	1.57	130	0.88	73	1.04	86	0.13	11	0.05	4	—	—
	High talc	0.1	1.76	5	1.08	3	0.53	2	0.07	0	0.10	0	0.14	133
	Fresh Rock	75	2.02	4,878	0.97	2,344	0.58	1,389	0.08	191	0.05	123	0.13	97,586
	Total	78	2.01	5,013	0.97	2,421	0.59	1,476	0.08	202	0.05	128	0.13	97,719

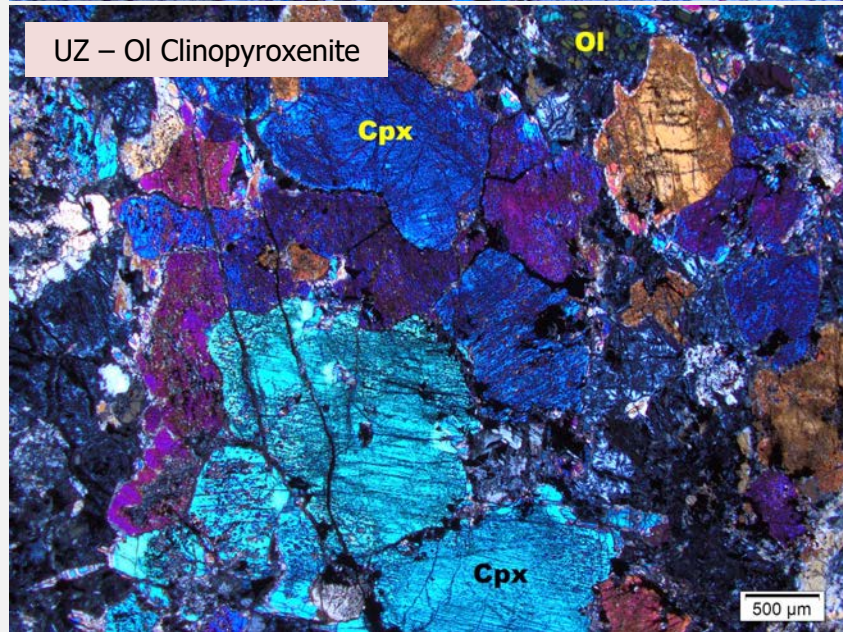
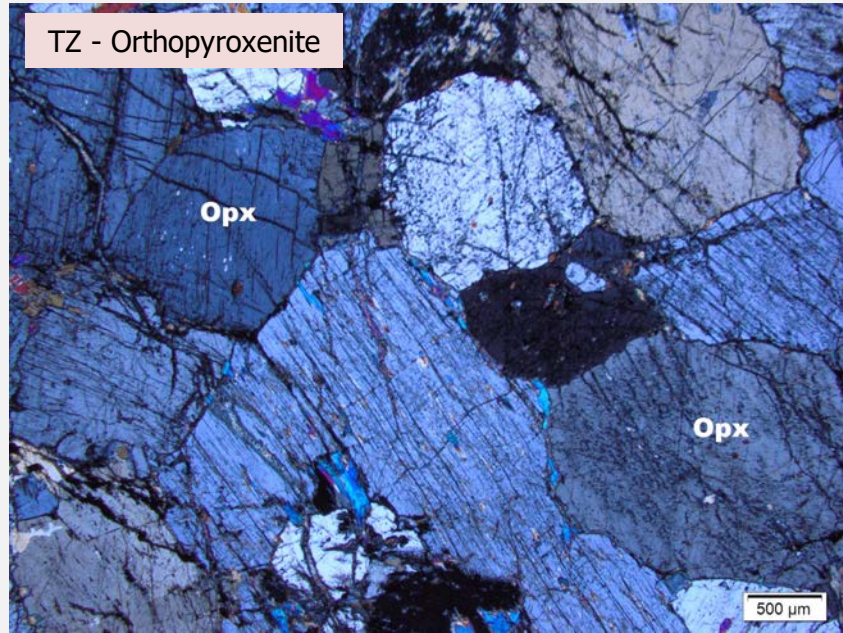
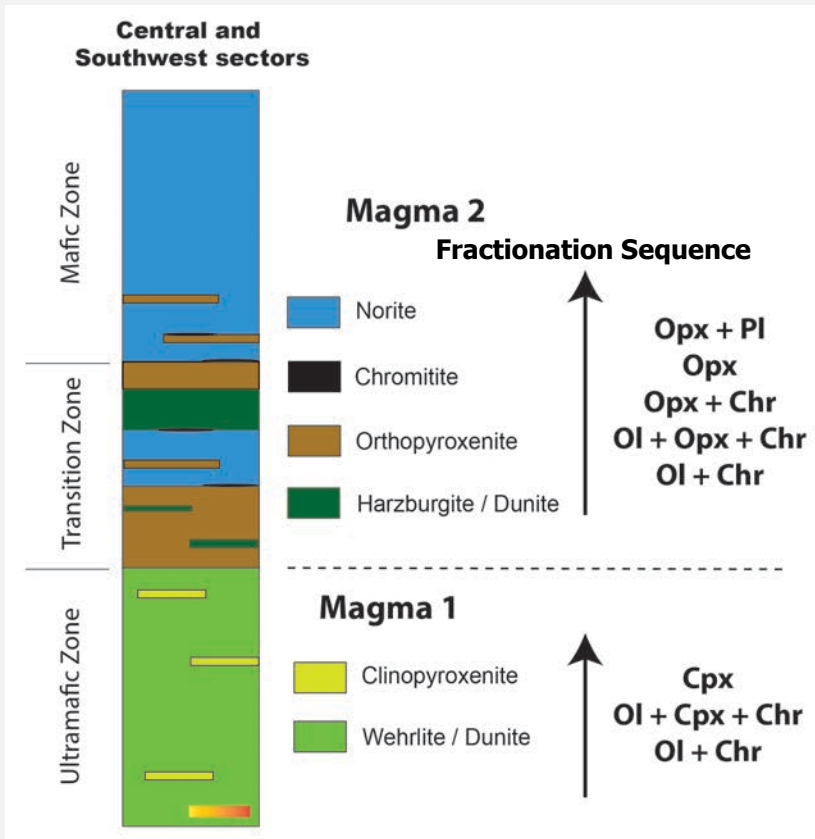
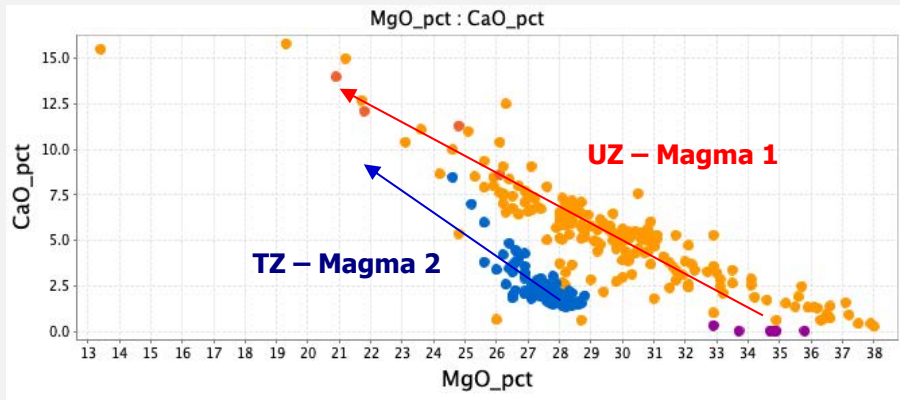
Table 1: MRE Declaration at a Cut-off of 0.5g/t PdEq^{1*}

Reviewed Geology and Stratigraphy of the Luanga Complex

1. Ultramafic Zone

The UZ is now recognized as a petrologically distinct unit that follows a different fractionation trend. The UZ occurs as a coherent eastern layered zone just at the southern and central sectors, extending as an irregular zone crosscutting country rocks to the east of the Luanga Complex. The UZ is interpreted as a distinct magmatic input (Magma 1) just partially connected to the TZ and MZ of the Luanga Complex (Magma 2).



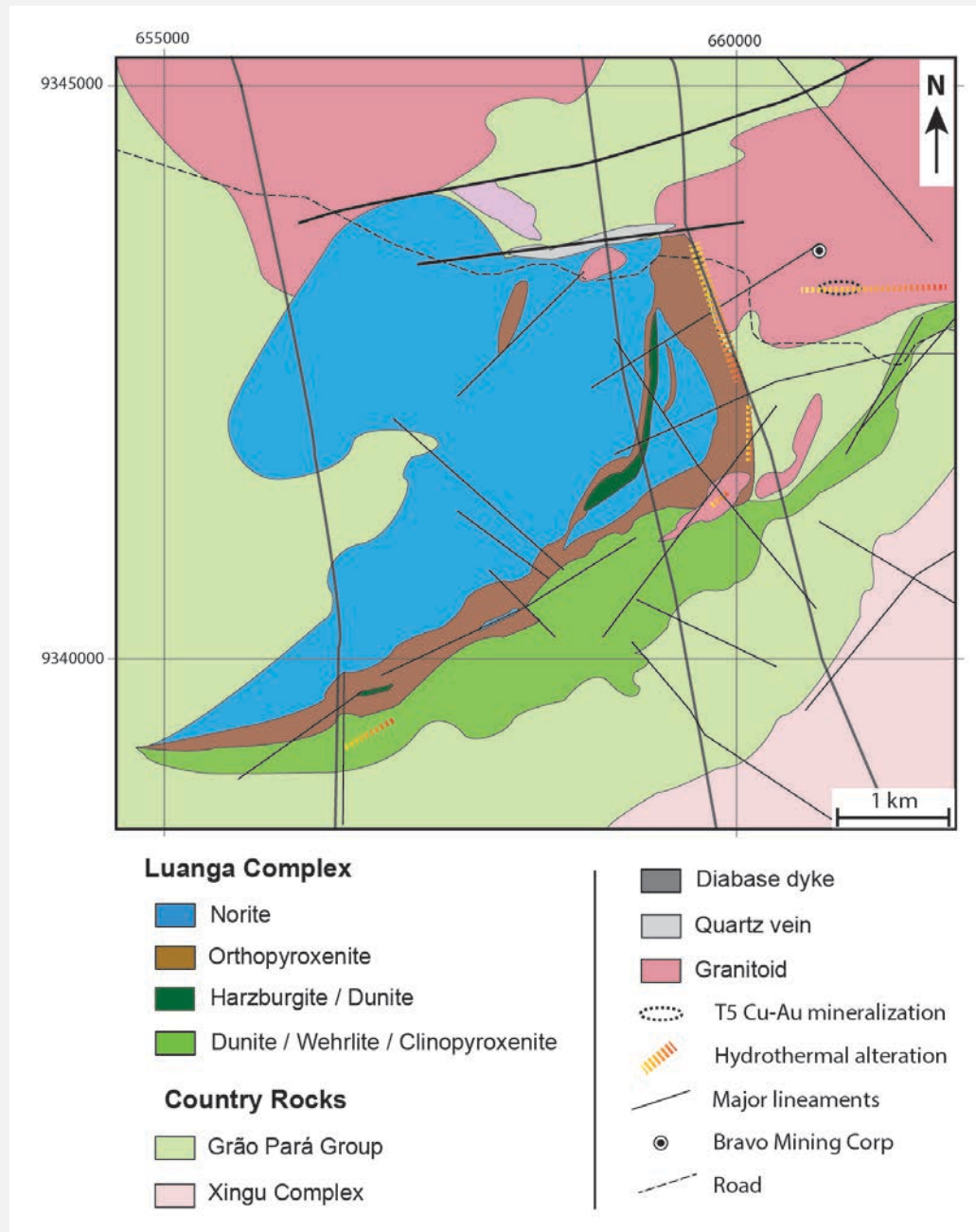
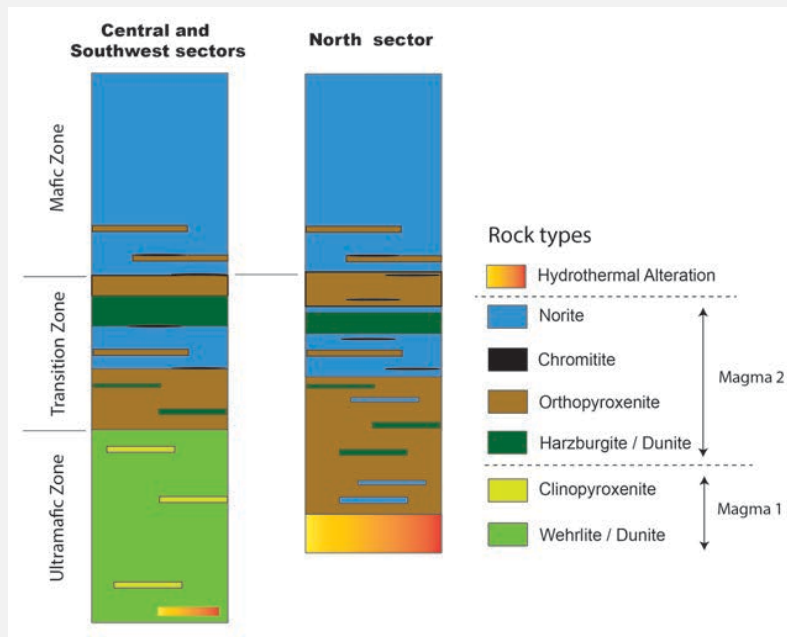


Reviewed Geology and Stratigraphy of the Luanga Complex

2. Hydrothermal Alteration

In addition to previously known heterogeneous widespread alteration that largely preserves primary textures and compositions, robust domains of metasomatic rocks that belong to the regional hydrothermal system linked to IOCG type and associated deposits in Carajás were recognized.

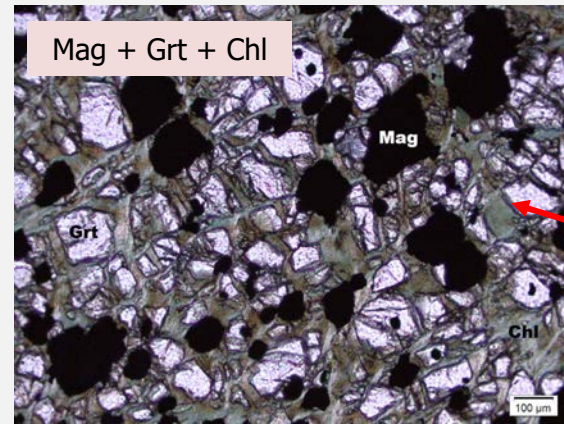
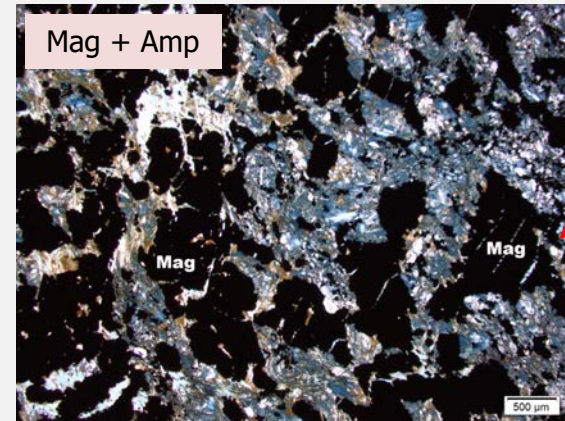
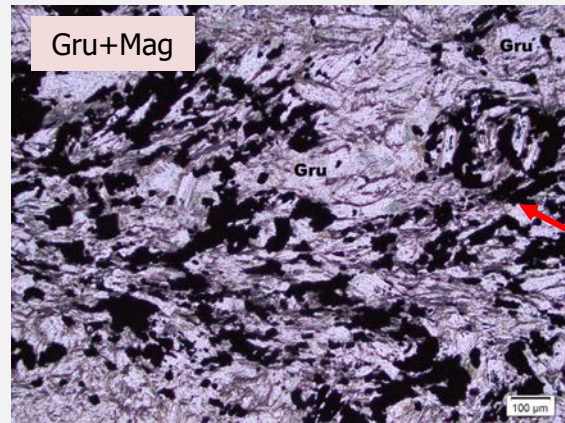
Metasomatic rocks are associated with crosscutting fault structures that partially disrupt the magmatic stratigraphy and the extension of the complex.



2. Hydrothermal Alteration

Metasomatic rocks include amphibolite, rocks consisting of variable proportions of amphibole-garnet-biotite-magnetite, banded iron formations and biotite associated with variable proportion of scapolite, tourmaline and amphiboles.

These hydrothermal alteration zones result from variable but predominantly Fe-Ca-K metasomatism.



Reviewed PGE-Ni mineralization

Results from the extensive drilling program developed by BRAVO Mining for MRE indicate a wide ~8 km long PGE-Ni mineralized envelope consisting of 6 different styles of mineralization in the Luanga Complex.

- Main Sulfide Zone (MSZ)
- Low sulfide Zone (LSZ)
- Chromite-associated Zone (Chr-PGE)
- Sulfide Zone (SZ)
- Ni-Rh Sulfide Zone (Ni-Rh)
- MASU

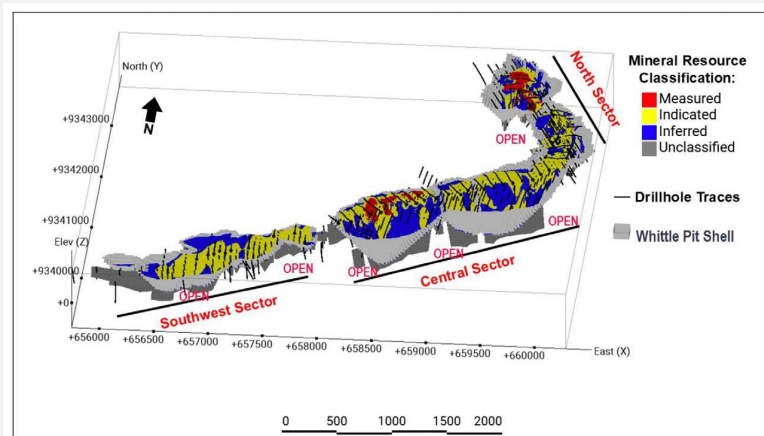
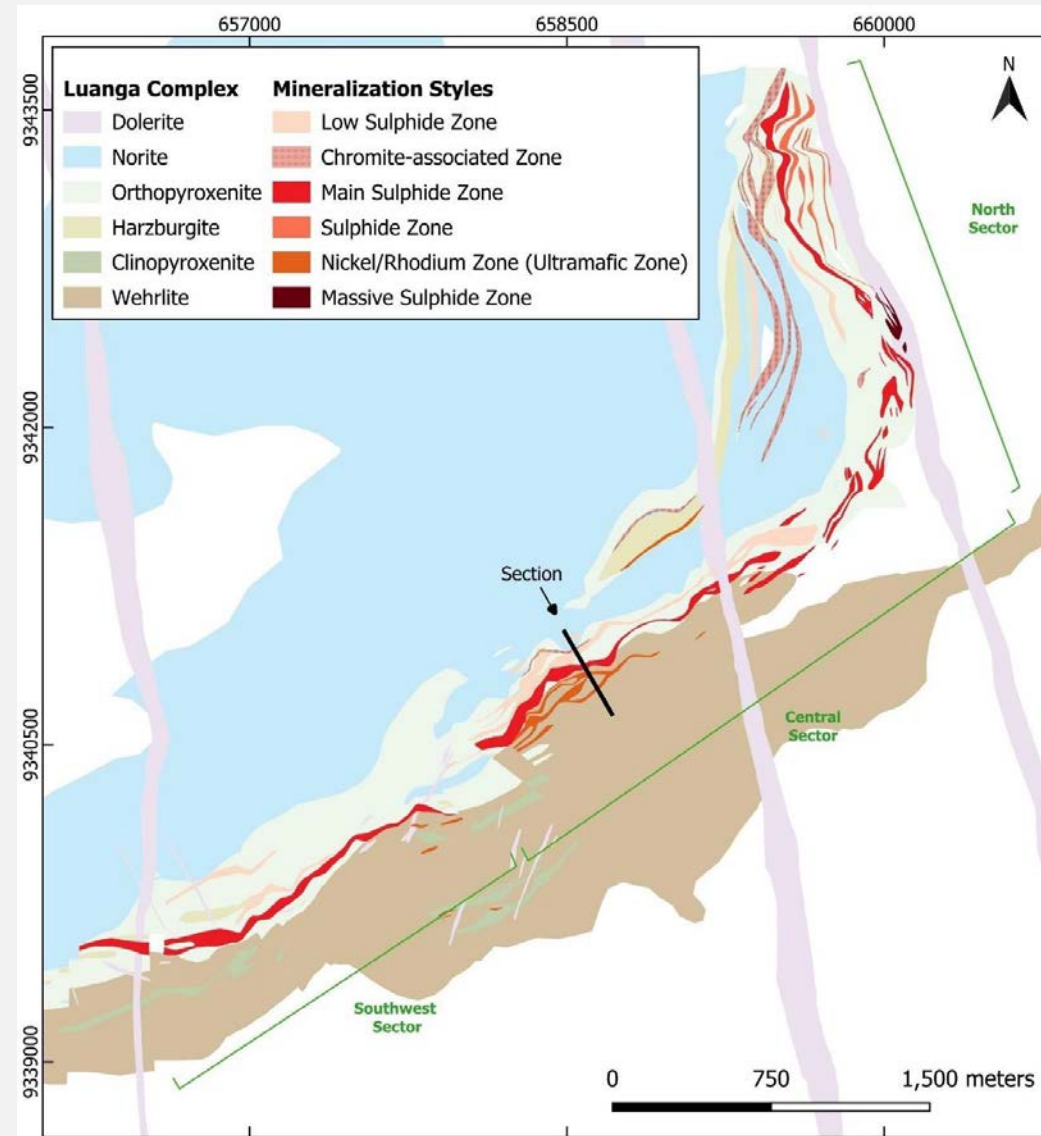


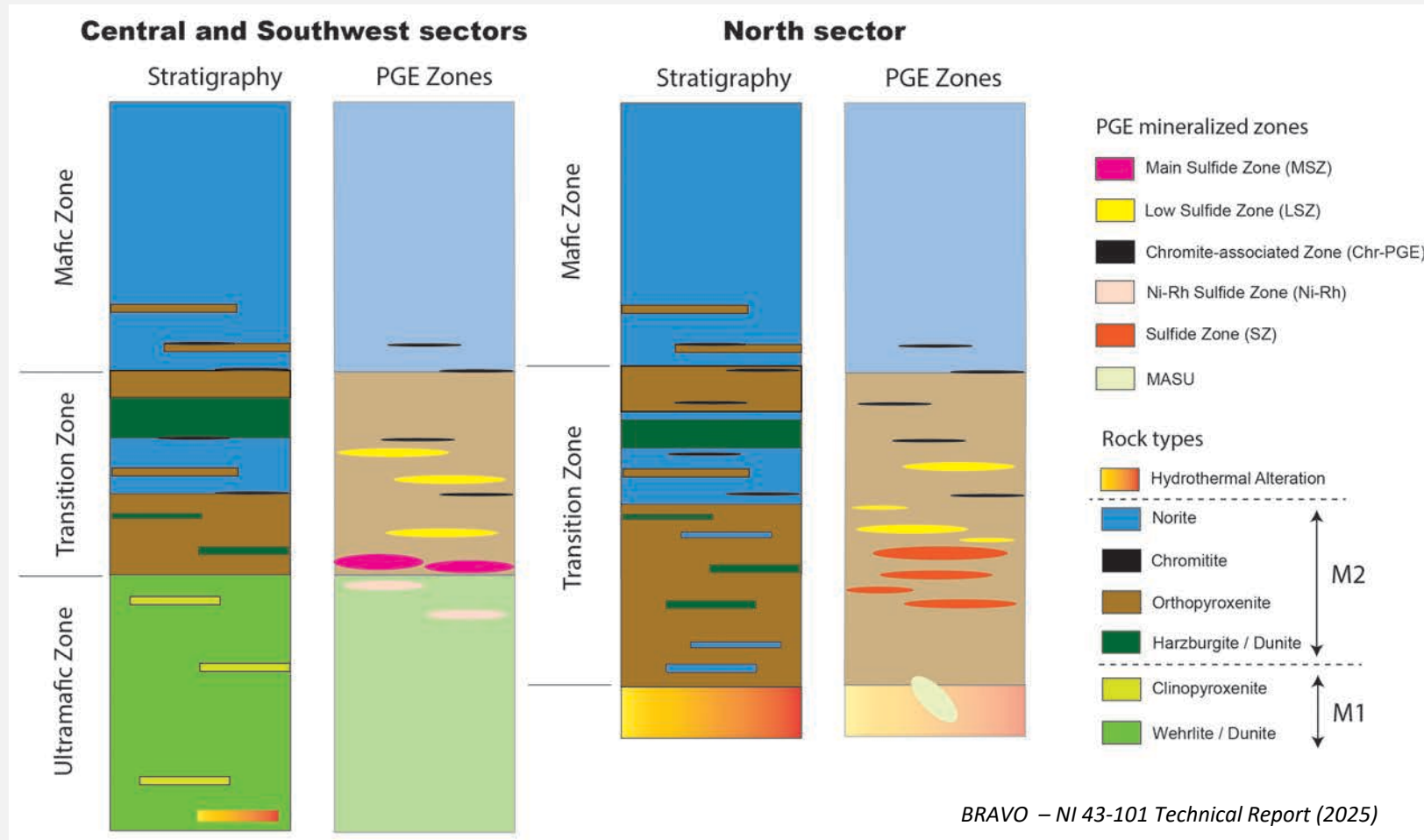
Figure 3: Oblique View of Luanga 2025 MRE within Constraining pit shell, showing resource classification distribution over 8.1km of Strike.



Reviewed PGE-Ni mineralization

Different styles of PGE-Ni mineralization are recognized by their host rocks, ore petrography and chemical composition. They are located within specific domains of the magmatic stratigraphy.

Except for the MASU, the different styles of PGE-Ni mineralization occur as stratabound layers or lenses that largely preserve primary magmatic textures and compositions, indicating a magmatic origin. These include stratabound DIS sulfide zones and chromitite-hosted ore.



Styles of PGE-Ni mineralization of the Luanga deposit

PGE-Ni mineralization	Sectors	Stratigraphy	Geology and Petrography	Chemical Composition
Main Sulfide Zone (MSZ)	Central and Southwest	Lower portion of the TZ at the contact with the UZ.	Stratabound DIS sulfides (1-5%) with variable thickness (up to 50 m) hosted by orthopyroxenite and minor harzburgite. Sulfide blebs interstitial to cumulus Opx-Ol. Po-Pn and minor Ccp. Pn (25-50% of sulfide fraction) occurs as fine-grained crystals with rare exsolutions within Po.	Very high Ni (10-20%) and Pt-Pd (up to 200 ppm) tenors, variable very high Ni/Cu (~10), Pt/Pd < 0.5, and Pd/Rh < 0.05.
Low Sulfide Zone (LSZ)	All sectors	Discontinuous stratabound lenses distributed throughout the stratigraphy of the TZ.	Several lenses of variable thickness (up to 200 m) hosted by orthopyroxenite, and minor harzburgite. No significant amounts of sulfides. PGE mineralized lenses occurs in Ol-Opx cumulates without any distinctive feature from barren cumulates.	Very low Ni-Cu contents, Pt-Pd contents < 1-2 ppm, and Pt/Pd ~ 1.0-2.0. Pt-Pd show moderate to strong positive correlation.
Chromite-associated Zone (Chr-PGE)	All sectors	Irregular chromitite pods or Chr-rich zones located predominantly at the upper portion of the TZ and lower portion of the MZ.	Chromitite pods consist of fine-grained cumulus Chr commonly with abundant inclusions and/or atoll texture. Hosted within harzburgite, orthopyroxene or norite.	Very low Ni-Cu contents, high Pt/Pd ratio (~4.0), and Rh/Pt ~0.3.
Ni-Rh Sulfide Zone (Ni-Rh)	Central and Southwest	Lenses located in the UZ of the Central and Southwest sectors.	Sulfide-bearing lenses (up to 25%) with variable thickness (up to 40 m). Hosted by interlayered wehrlite and dunite, and minor clinopyroxenite. DIS to net-textured sulfides consisting of Po (~60-70%), Pn (~30-40%) and minor Ccp. Pn occurs as medium-grained crystals (1-2 mm) with very rare Pn exsolutions within Po.	Pt/Pd < 0.5; Rh/Pd ~0.20. Higher % of sulfides and lower Pt-Pd contents than the MSZ, suggest relatively lower Pt-Pd tenors. Modal % of Pn (~30-40%) indicates very high Ni tenor (~10) and Ni/Cu (~8).
Sulfide Zone (SZ)	North sector	N-S trending zones of DIS sulfides. Stratigraphic correlation with the Central and Southwest sector is hampered by intense tectonism and alteration.	Folded or faulted stratabound bodies of DIS fine-grained sulfides (1-5%) with variable thickness (up to 40 m). Hosted by orthopyroxenite and minor harzburgite. Layered mafic-ultramafic sequence are crosscut by granitoids at depth. Pervasively altered rocks with poorly preserved primary textures. Consist mainly of fine-grained aggregates of sulfides (Po-Pn and minor Ccp) interstitial to pseudomorphs of Opx.	Low Pt/Pd (commonly < 0.5, but up to 1.0) and variable Ni contents. Weak positive correlation between Pd-Ni and Pd-Rh possibly results from variably altered sulfides.
MASU	North sector	Robust intercept of MASU (DDH22-LU047) within a hydrothermal alteration zone at the western border of the North sector.	Host rocks and the footwall sequence consist of hydrothermal rocks with variable proportions of Amp-Grt-Bt-Mag. Sulfide-bearing orthopyroxenite and interlayered norite occur in adjacent drill holes. Sulfides consist of Po (~80-90%) and Pn (~10-20%) with local Ccp-rich domains. Amp-Bt-Qz-Mag-Bt are enclosed within MASU, with common sulfide-Amp intergrowths. Pn occurs mainly associated with Po as fine-grained crystals or exsolutions.	Variable contents of Ni-Cu-PGE, with Ni>Cu and Pd>Pt. Weak correlation between metals (Ni-Cu-Pt-Pd-Rh). Contents of Ni (< 6.0%), Pd (< 6.0 ppm), Pt (< 2.5 ppm) and Rh (0.2 ppm) indicate lower tenors than those indicated to the MSZ.

Partially modified from BRAVO – NI 43-101 Technical Report (2025)

Main Sulfide Zone (MSZ)

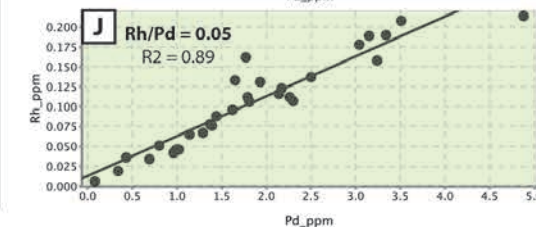
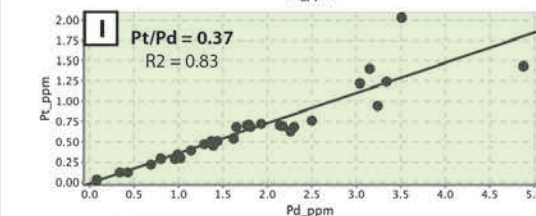
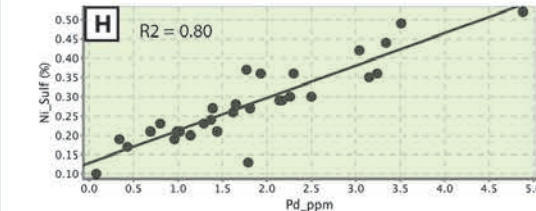
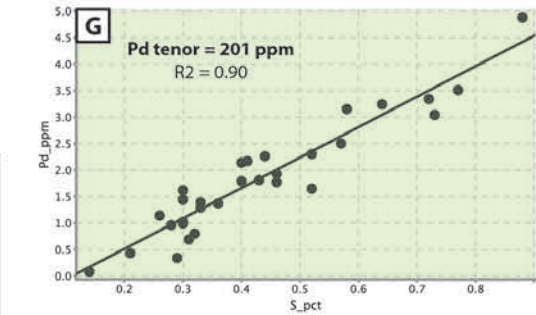
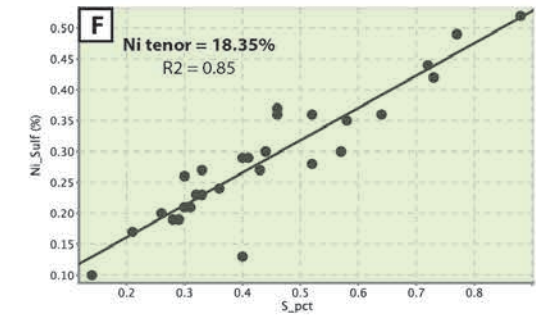
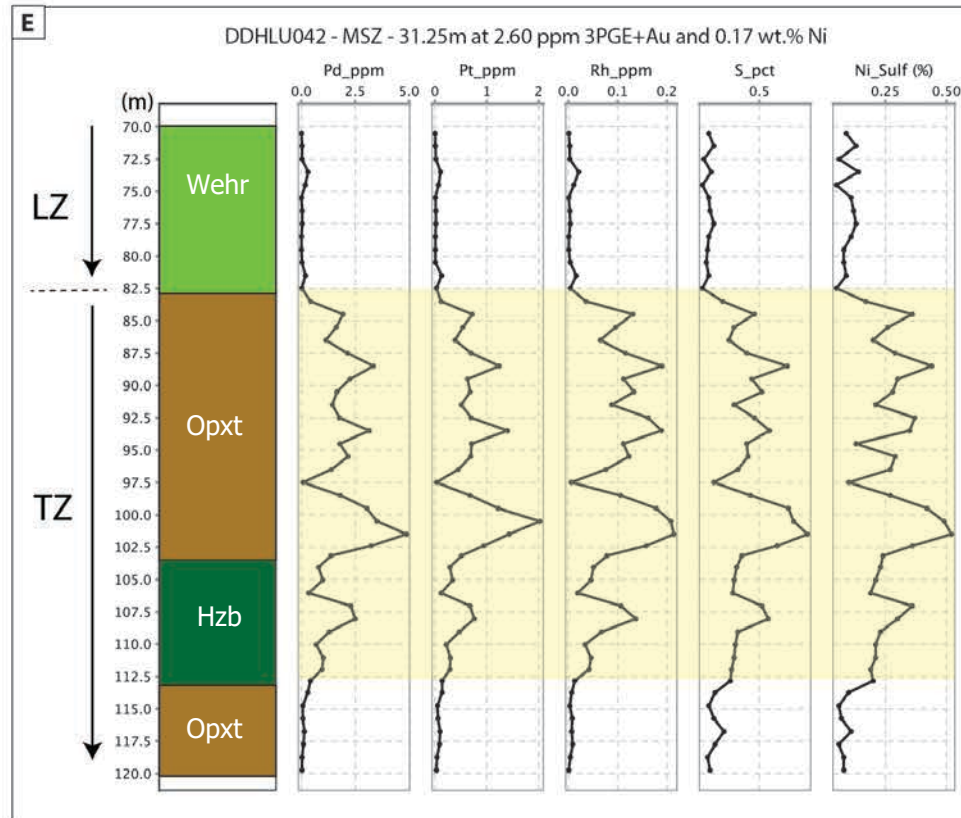
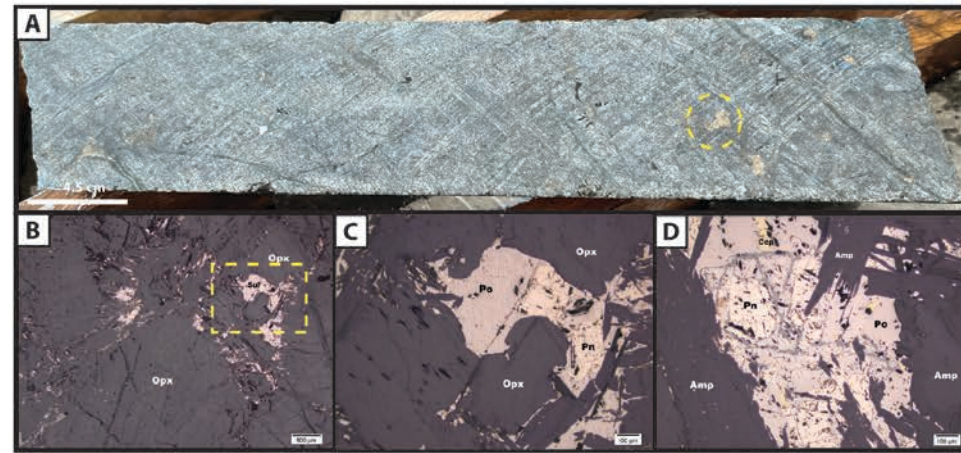
- ~ 6 km long zone of stratabound DIS sulfides (1-5%) with variable thickness (up to 50 m) hosted by orthopyroxenite and minor harzburgite in the lower portion of the TZ at the contact with the UZ.

- DIS sulfide blebs interstitial to Opx and Ol. Po+Pn and minor Ccp. Pn (25-50% of the sulfide fraction) occurs as fine-grained crystals with rare exsolutions within Po.

- Very High Ni tenors (10-20%)

- Very PGE tenors (up to 200 ppm)

- Ni/Cu ratio ~10



Ni-Rh Sulfide Zone (Ni-Rh)

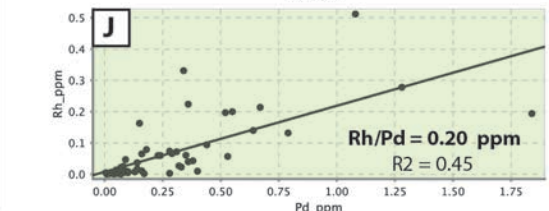
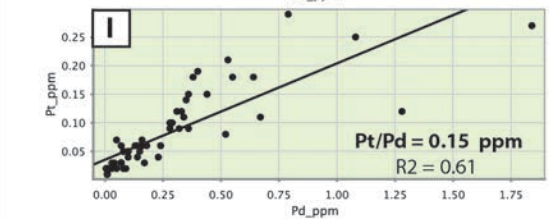
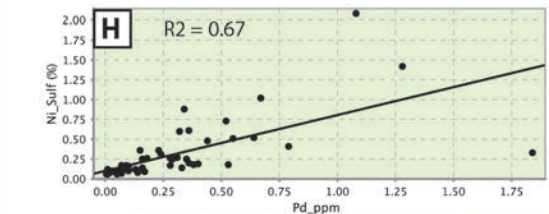
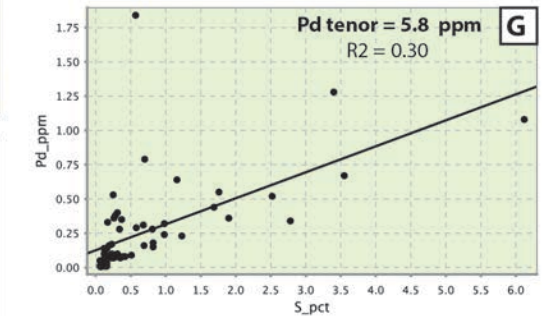
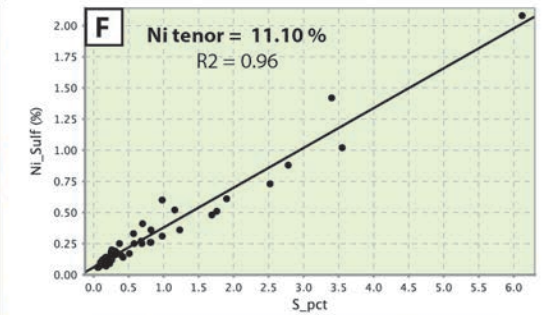
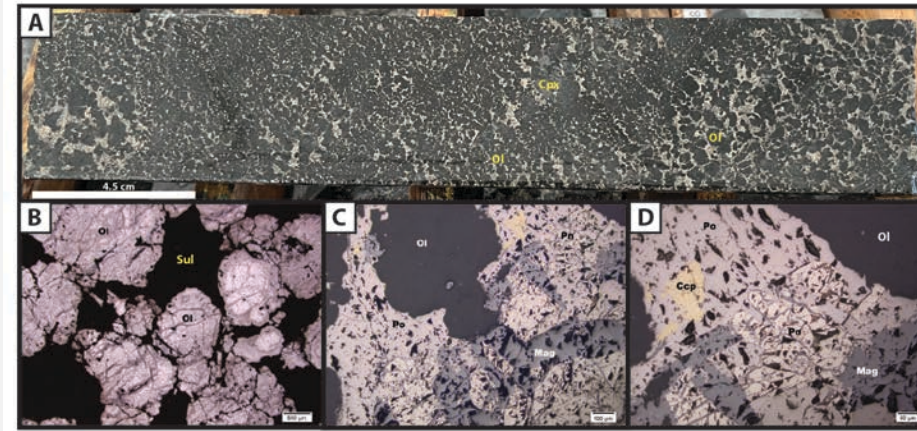
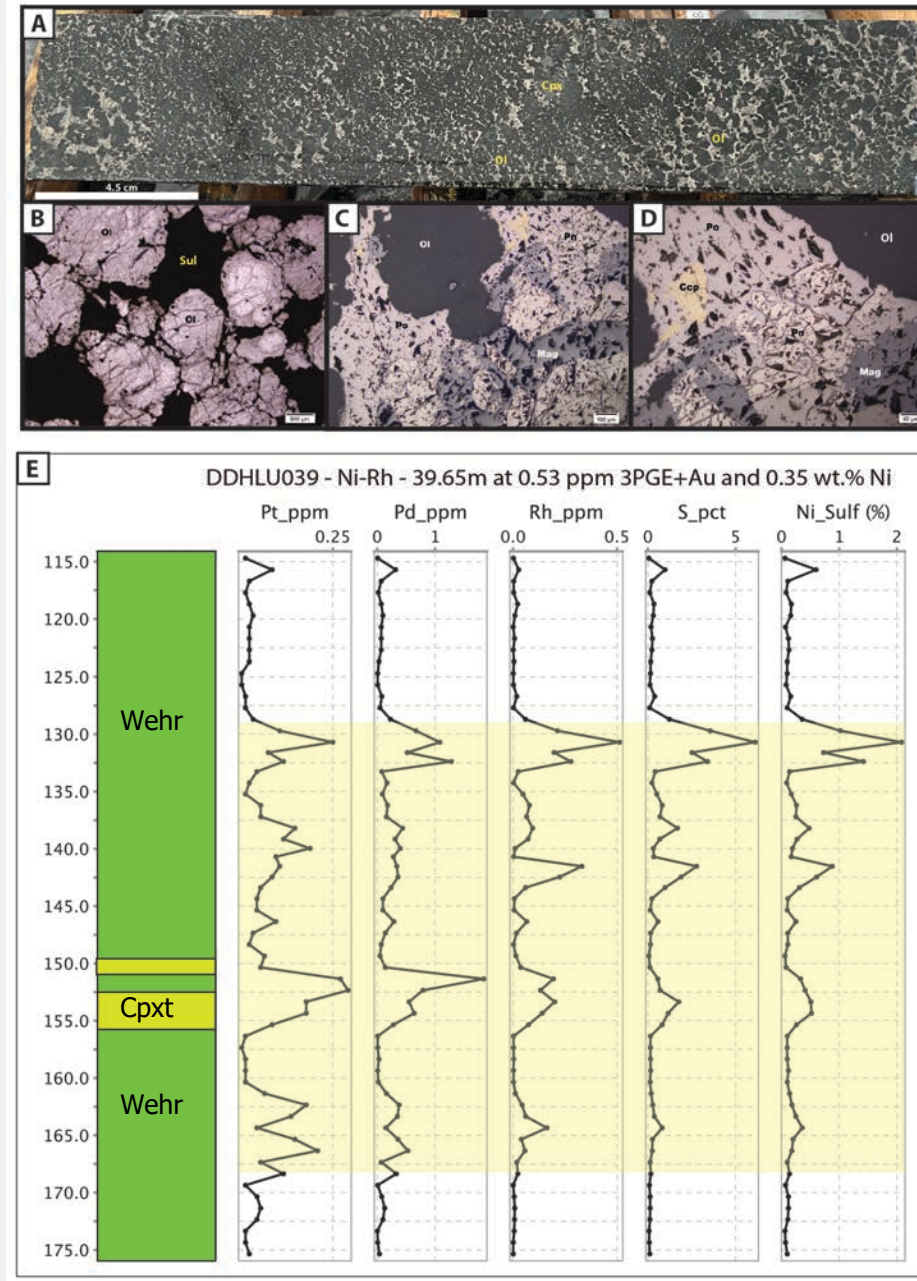
- Sulfide-bearing lenses (up to 25%) with variable thickness (up to 40 m) hosted by interlayered wehrlite and dunite, and minor clinopyroxenite of the UZ.

- DIS to net-textured sulfides consisting of Po (~60-70%), Pn (~30-40%) and minor Ccp. Pn occurs as medium-grained crystals (1-2 mm) with very rare Pn exsolutions within Po.

- Higher % of sulfides and lower Pt-Pd contents than the MSZ result in relatively lower PGE tenors (< 10 ppm).

- High Ni tenors ~ 10 wt.% and Ni/Cu ratio ~ 8.

- Pt/Pd < 0.5 and distinctively high Rh/Pd ratio (~ 0.20)



Massive Sulfide Zone (MASU)

BRAVO – News Release – 2022

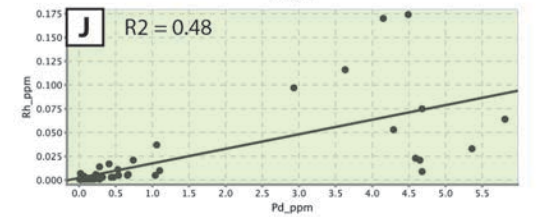
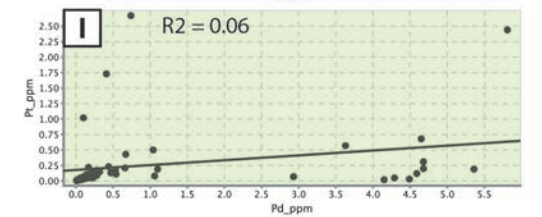
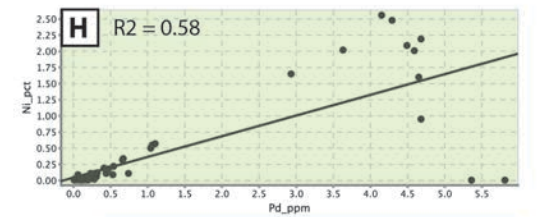
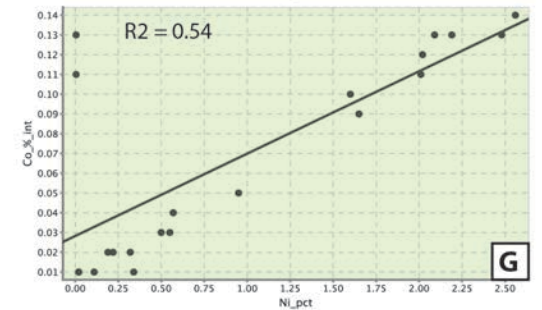
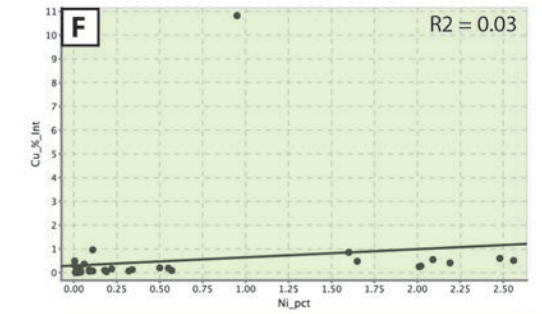
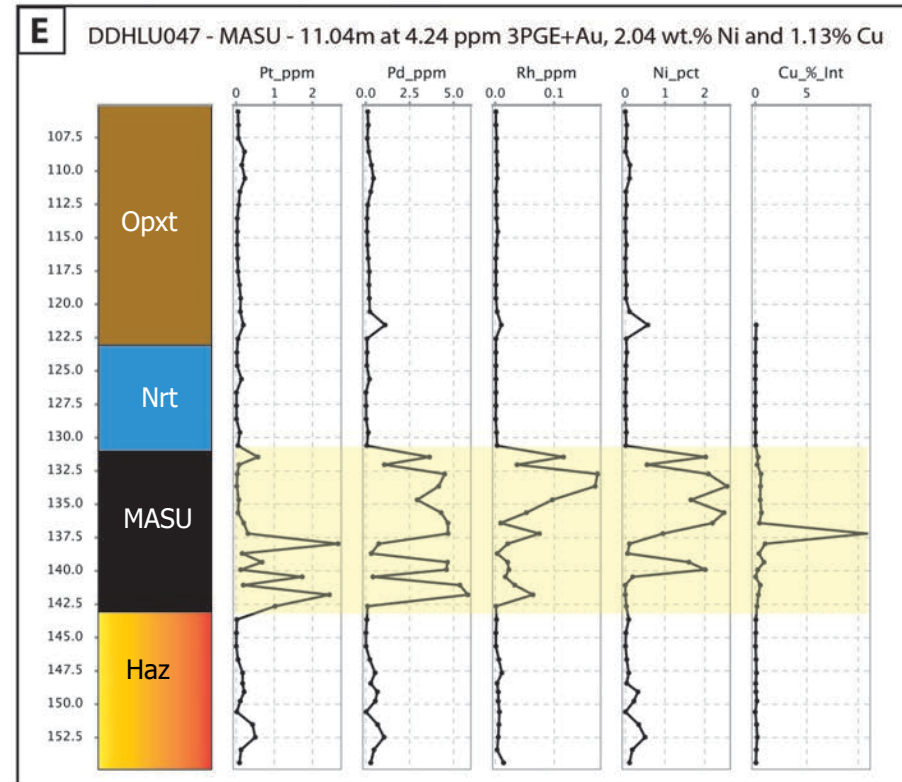
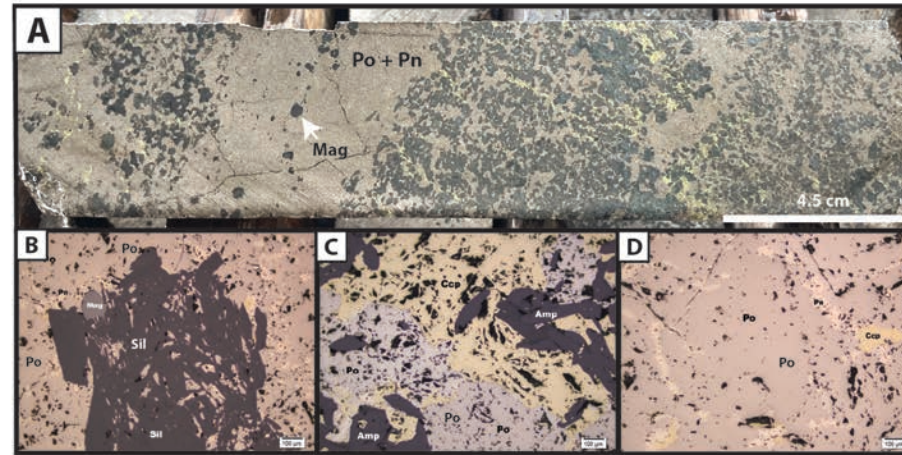
HOLE-ID	From (m)	To (m)	Thickness (m)	Pd (g/t)	Pt (g/t)	Rh (g/t)	Au (g/t)	PGM + Au (g/t)	Cu (%)	Ni (%) (Sulphide)	Type
DDH22LU047	131.11	142.15	11.04	3.56	0.57	0.07	0.04	4.24	1.23	2.04	FR



MASU

Robust irregular domain of MASU to semi-MASU ore located within a hydrothermal alteration zone at the western border of the North sector.

- Sulfides consist of Po (~80-90%) and Pn (~10-20%) with local Ccp-rich domains. Amp-Bt-Qz-Mag-Bt are enclosed within MASU, with common sulfide-Amp intergrowths. Pn occurs mainly associated with Po as fine-grained crystals or exsolutions.
- Higher % of sulfides and lower Pt-Pd contents than the MSZ result in relatively lower PGE tenors.
- Moderate Ni (~3 wt.%), Pt (~1-3 ppm) and Pd (~4-5 ppm) tenors.
- Decoupling of Pt-Pd with highly variable Pt/Pd ratios.
- Decoupling of Ni-Cu at variable scales. High Cu intercepts (up to 10.8%) have average Pt-Pd contents.



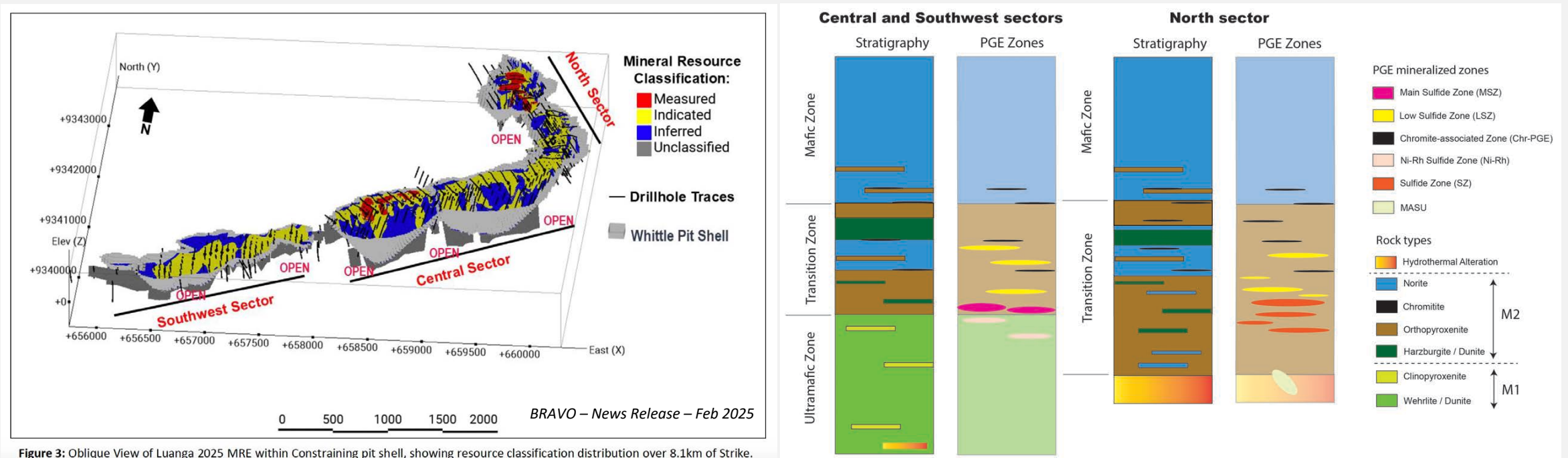
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Summary:

Results from the extensive drilling program developed by BRAVO Mining for MRE indicate a ~8 km long and ~500 m wide PGE-Ni mineralized envelope consisting of 6 different styles of mineralization in the Luanga Complex.

Except for the MASU, the different styles of PGE-Ni mineralization largely preserve primary magmatic textures and compositions, indicating a magmatic origin. These include several stratabound zones of DIS sulfide zones and chromitite-hosted ore.

The MASU mineralization is interpreted as resulting from remobilization and concentration of magmatic sulfides within robust Fe-Ca-K hydrothermal alteration zones. Decoupling of metals (Ni-Cu-Pt-Pd) in the MASU may help to understand the distribution of PGE in hydrothermal Cu-Au-Ni deposits in Carajás.



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