The discovery of a buried siliceous hot spring deposit beneath the Omui Mine: Implications to the evolution of a complex low sulfidation epithermal deposit in Omu, Hokkaido, Japan

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Gold Mining in Japan

Japan's tectonic setting

Affected by the interaction of 4 tectonic plates: Eurasian Plate, North American Plate (Okhotsk Microplate), Pacific Plate and Philippine Sea Plate

A product of complex tectonic processes since the Paleozoic which involves subduction, accretion, metamorphism, igneous activity, back-arc spreading and arc-arc collision (Wakita, 2013)

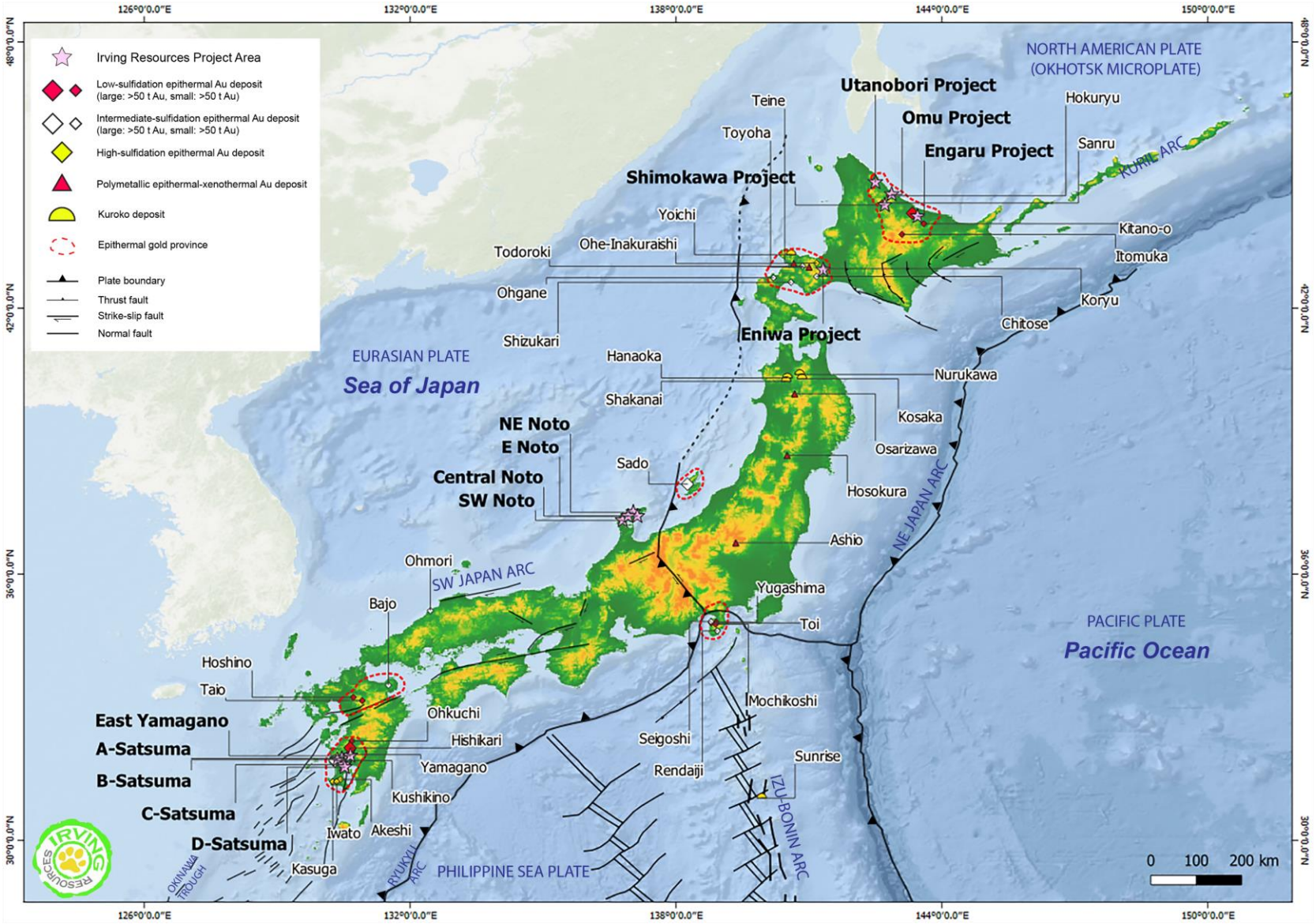
Epithermal gold deposits

The principal source of gold in Japan (Izawa and Watanabe, 2001)

- Low-sulfidation epithermal systems are associated with extensional settings that control bimodal basaltic-rhyolitic volcanism (Garwin et al., 2005)

The Hishikari Mine

- A world class deposit with exceptionally high gold grade (high grade with 20 grams of gold per ton, or about five times the average)
- Discovered in Kagoshima Prefecture in 1981
- Has produced 254.2 tons of gold (as of the end of March 2021) since it opened in 1985. (Sumitomo Metal Mining Co. Ltd., 2021)



Modified from Garwin et al. (2005)

The Company

Irving Resources Inc.

A Canadian-based mineral exploration company with a focus on gold in Japan.

Incorporated a 100% owned subsidiary named Irving Resources Japan GK in May 2016, which enables the Company to hold mining and exploration projects in Japan.

Newmont Corporation and Sumitomo Corporation are stakeholders in the company. Irving also holds a Joint Exploration Agreement with JOGMEC.

Has as a unique strategy to explore for and mine high-silica, high-grade epithermal gold and silver veins (suitable for use as smelter flux in the many operating base metal smelters throughout Japan)

Our projects

Hokkaido

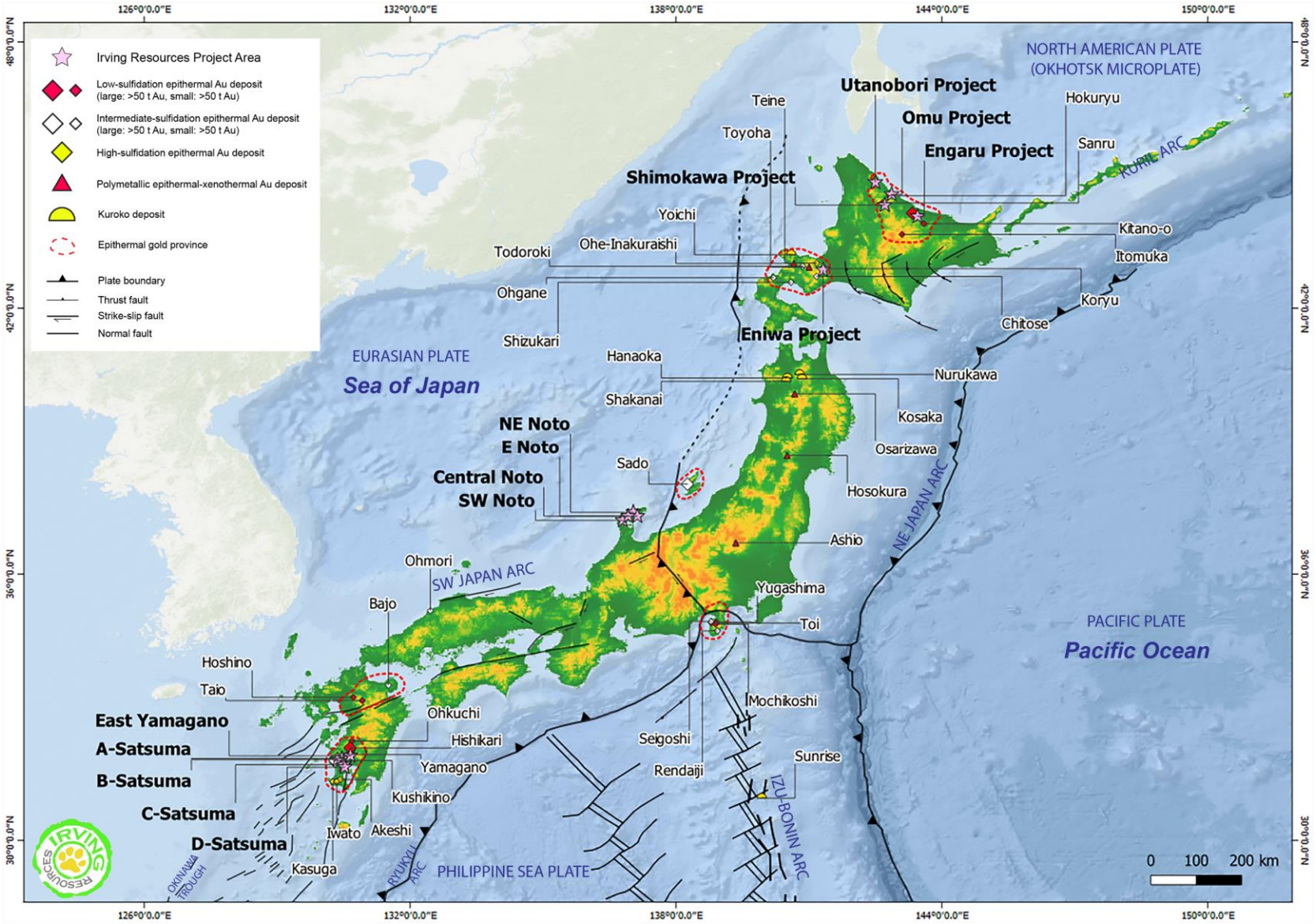
- Omu
- Utanobori
- Shimokawa
- Engaru
- Eniwa

Honshu

- Noto

Kyushu

- Yamagano
- Satsuma A, B, C, D



Modified from Garwin et al. (2005)

Kitami Metallogenic Province

Epithermal Mineralization

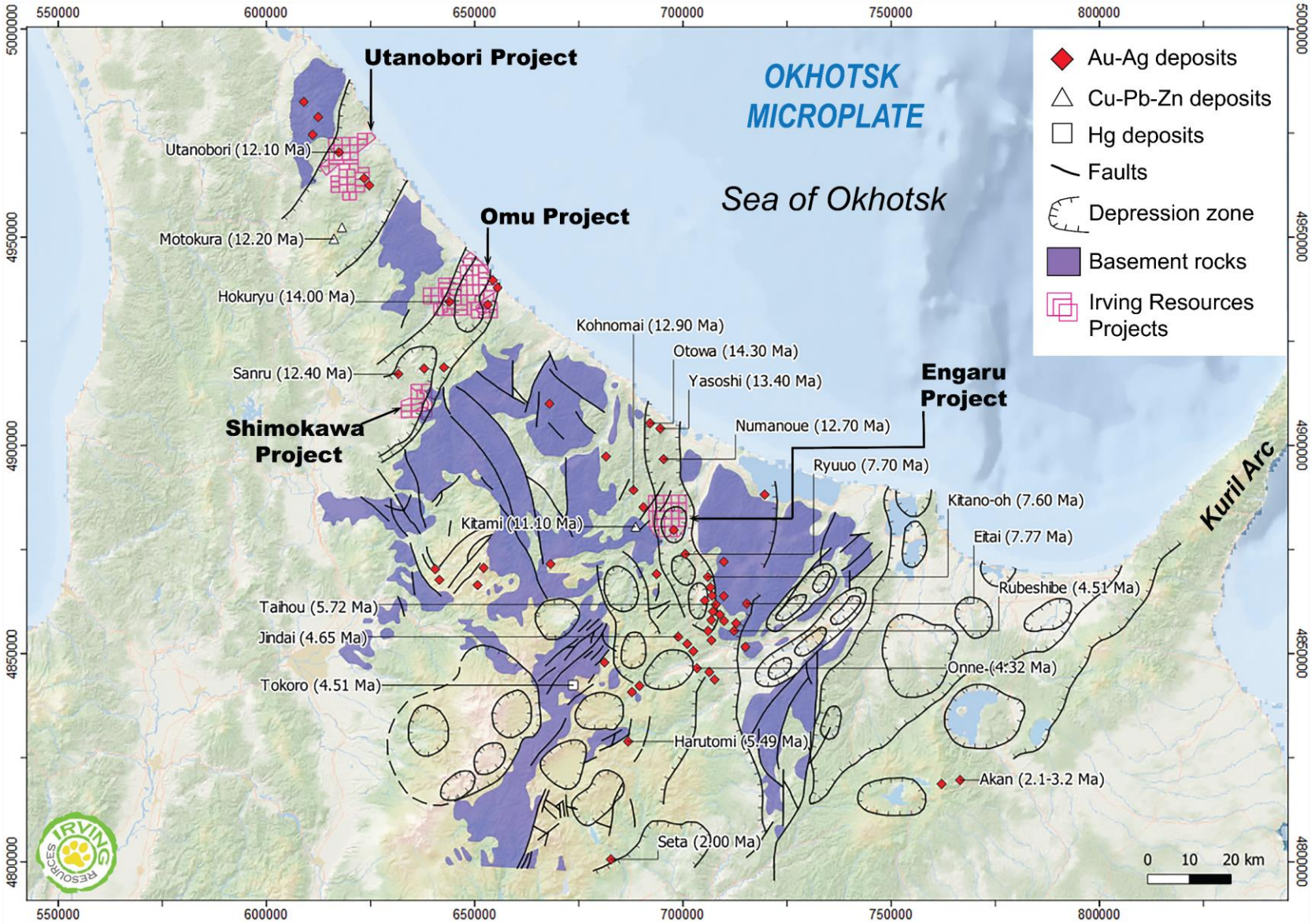
Bark-arc extension occurred during the middle to late Miocene (Kimura and Tamaki, 1986) and volcanism migrated from northwest to southeast from 14Ma to 6Ma (Watanabe, 1995; Watanabe, 1996)

- Hydrothermal activity was closely associated with felsic volcanism and resulted in the formation of low sulfidation epithermal deposits
- Ore deposits occur in and around the grabens (Ishihara et al., 2000)

Historic precious metal production yielded a total of ~2.9 Moz Au and ~44.7 Moz Ag, (Watanabe, 1995) with minor base metal and mercury production (Maeda, 1997)

The Kohnomai Mine

- 3rd largest Au producer in Japan (73.181t Au, 1243t Ag)
- Discovered in 1915, operating in 1917 until 1973
- More than 10 epithermal Au-Ag veins (1-10m thick, one vein extends up to 2.5km)
- Located in the western part of Monbetsu-Kamishihoro graben (Ishihara et al., 2000; Kondoh et al., 1967)



Modified from Ishihara (1998)

The Omu Project

The company's lead project is the Omu Project located in the town of Omu on Japan's northern island of Hokkaido.

The project is comprised of the 2.98 km^2 Omui mining license and 56 prospecting licenses covering an additional 171.38 km^2.

Geology

Omui Prospect

Elevation: ~150-220m asl

Includes the Old Omui Mine, which produced 0.34t Au and 8.5t Ag (8000t of ore at a grade of 15-20 g/t Au, 400-500g/t from the Honpi vein (Honko area) from 1925 to 1928 (Jones and Lu, 1995)

Hokuryu Prospect

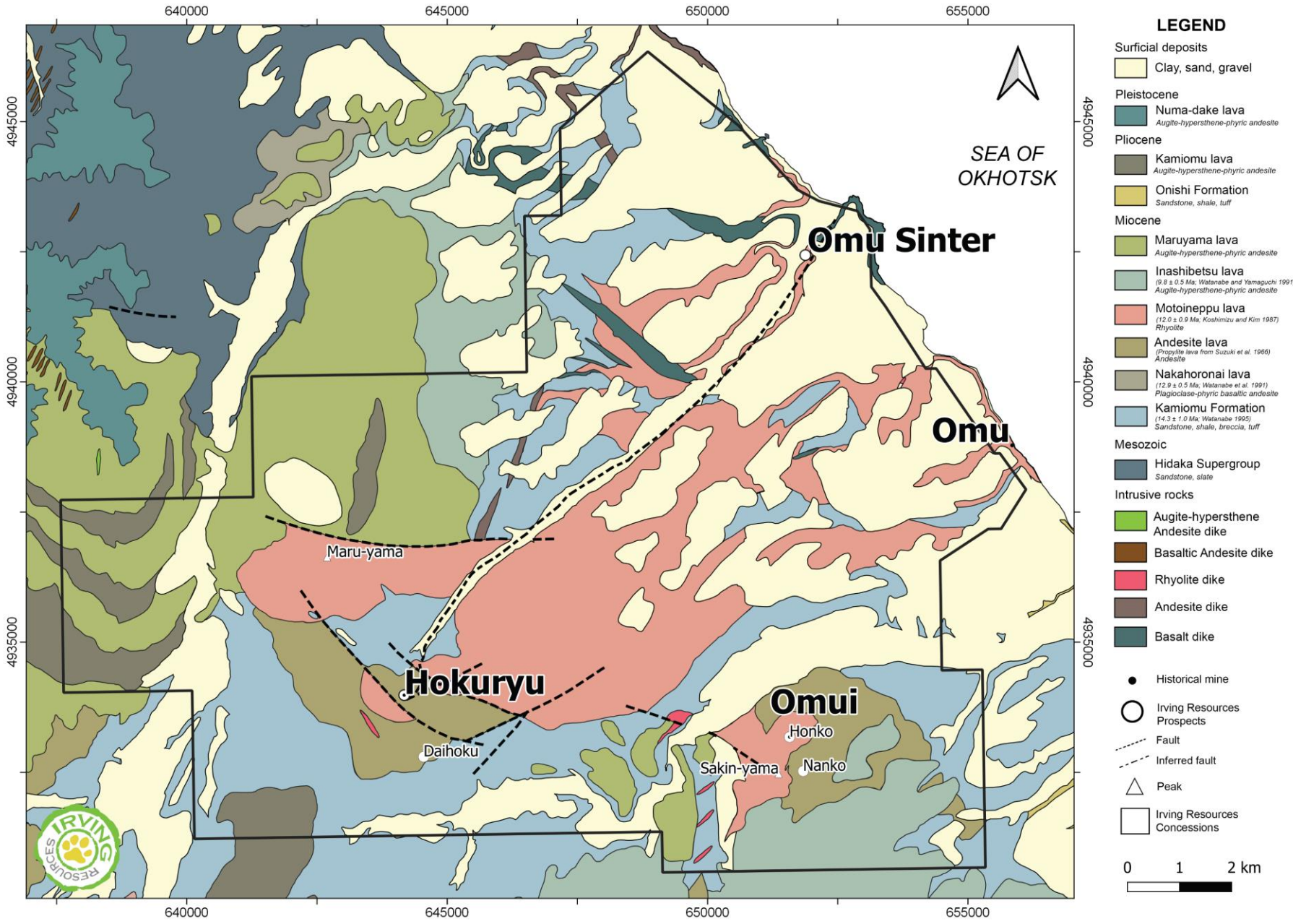
Elevation: ~150-485m asl

Includes the old Hokuryu Mine, which produced 2.2t Au and 11.8t Ag (300 kt of ore at a grade of 7.4 g/t Au, 32.4 g/t Ag) from 1928-1943 (Geological Society of Japan, 1980; Watanabe, 1995)

Omu Sinter Prospect

Elevation: ~10-35m asl

Au-bearing sinter discovered by Irving staff during district reconnaissance in 2016



Geologic map updated from company's geologic mapping and drilling results. Modified from Suzuki et al. (1966) and Zeeck et al. (2021)

Gravity Survey

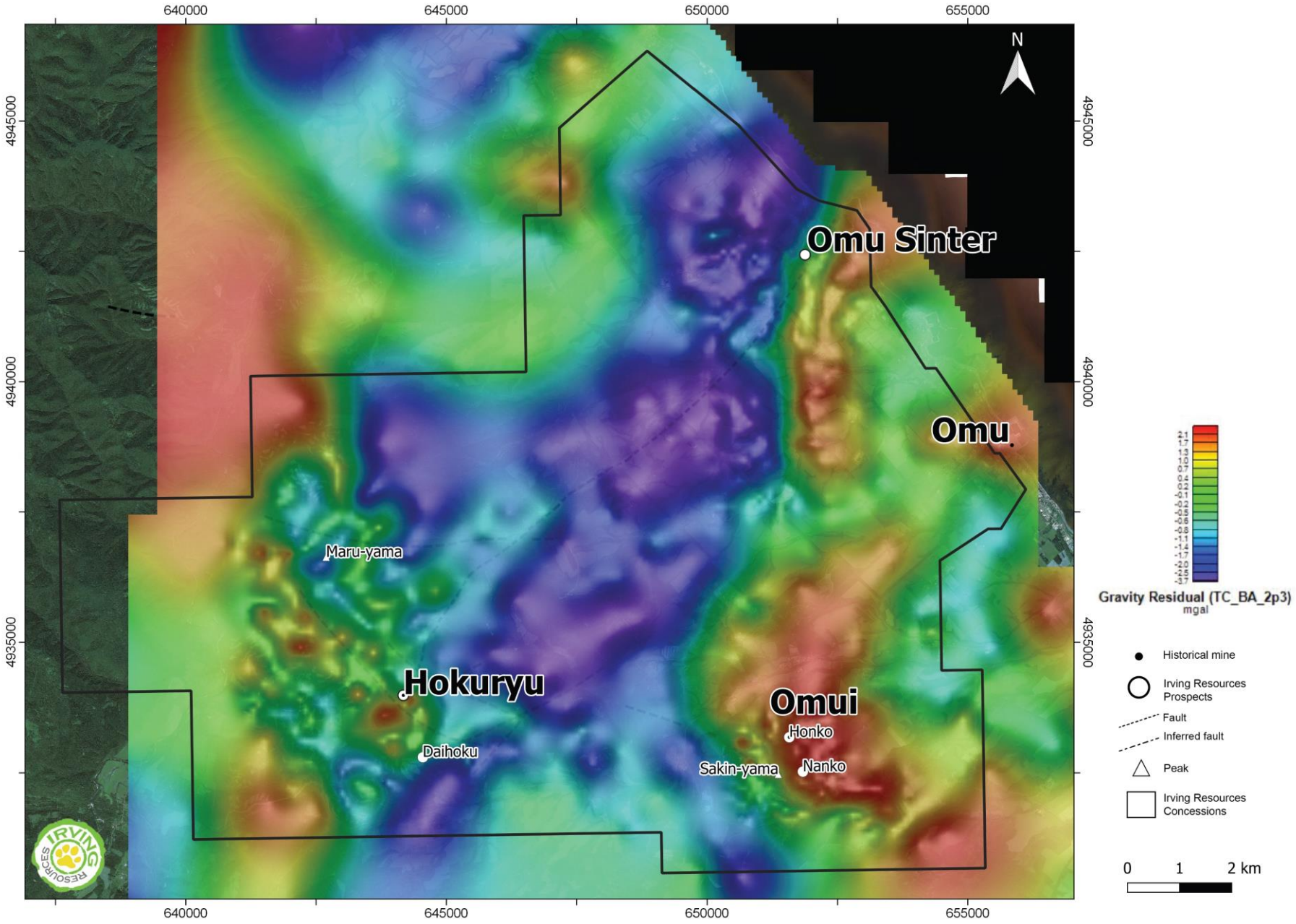
Graben-bounding structures

3 prospects sit atop or on the edges of gravity highs

- Reflect shallowly buried dense basement rocks

Bouguer gravity horizontal gradient clearly highlights graben-bounding structures

- NE-trending gravity low extending across the area reflecting a graben filled with low density volcanic rocks
- Omui and Omu Sinter are connected along faults defining the eastern margin of the graben
- Hokuryu sits astride faults defining the western margin



Geologic map updated from company's geologic mapping and drilling results. Modified from Suzuki et al. (1966) and Zeeck et al. (2021)

The Omui Mine

The Omui Mine is a registered mine of a low sulfidation epithermal gold deposit situated within the Omu Project, northern Hokkaido. It includes the historical Omui Mine (Honko), the Sakinyama placer deposit, and the Nanko prospect which features a complex epithermal vein - hydrothermal breccia system.

The Historical Mine

Placer mining and discovery

Historical small-scale prospecting and placer mining activities started in the 1890s.

An outcropping gold-bearing vein was later discovered by local prospectors and was named the Honpi vein in Honko.

In 1920, Mr. Mitsuo Tachibana carried out drill testing and opened an upper tunnel and a 30m shaft.

Underground mine development

In 1925, Fujita Mining Co. developed a small mine focused on the Honpi vein which consisted of a 100 m deep vertical shaft from which four main levels and two sublevels branched out.

Until its closure in 1928, the mine produced 0.34 t Au and 8.5 t Ag (8000 t of ore at a grade of 15-20 g/t Au, 400-500 g/t Ag from the Honpi vein).

Discovery of other veins

In 1932, hanging wall veins No. 2 , 3 and 4 were discovered in the northeast by Mr. Hitoshi Suduo and Mr. Ootakara Shinya.

Ore (average grade of 30g/t) was sold to the Ikutahara Mine.

After that, mining rights were transferred to different individuals or mining/drilling companies until 1984.

The historical Omui Mine

Omui Mine workers and ore piled for shipping

Timeline of exploration activities

2016

- **Rock chip sampling**
  121 samples

2017

- **Rock chip sampling**
  248 samples
- **Soil sampling**
  1722 samples
- **Gravity survey**
  753 stations
- **Drone magnetics survey**
  173 km

2018

- **Rock chip sampling**
  4 samples
- **Drone LIDAR survey**
  3.13 km^2
- **Drone magnetics survey**

2019

- **Rock chip sampling**
  50 samples
- **Trenching**
  747.56m
- **CSAMT survey**
- **Gravity survey**
- **Diamond drilling (Phase 1)**
  10 holes, 2257.8 m

2020

- **Diamond drilling (Phase 2)**
  9 holes, 4277.12m

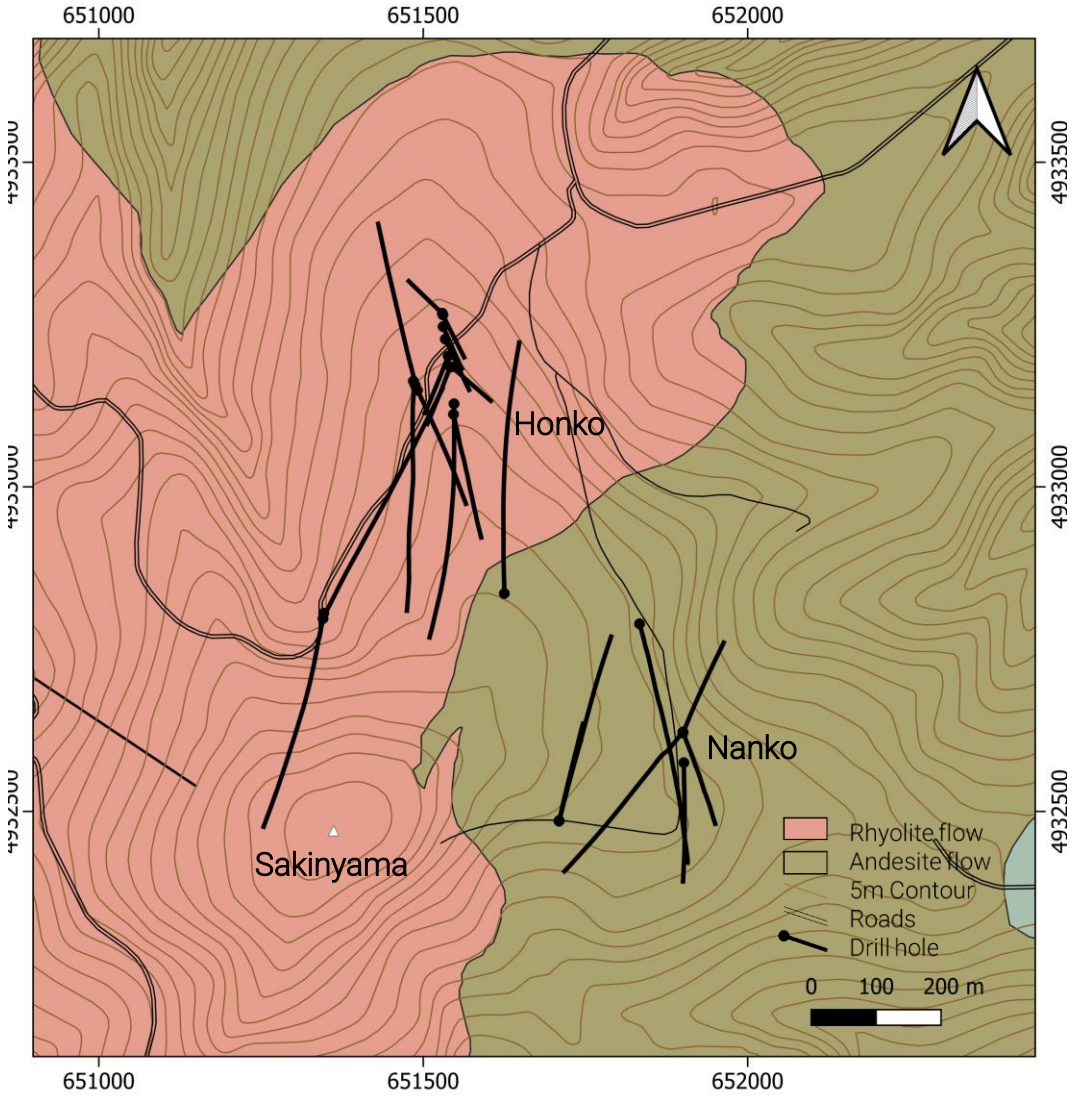
2021

- **Rock chip sampling**
  13 samples
- **Soil sampling**
  626 samples
- **Diamond drilling (Phase 3)**
  2 holes, 759.80m

2022

- **Diamond drilling (Phase 4)**
  2 holes, 1306.45m
- **Rock chip sampling**
  316 samples
- **Trenching**
  488.70m
- **CSAMT survey**

Geology



Host Rock

Features a complex epithermal vein - hydrothermal breccia system hosted in rhyolitic to andesitic volcaniclastic sequences of the Miocene Motoineppu Lava and Propylite Lava, respectively

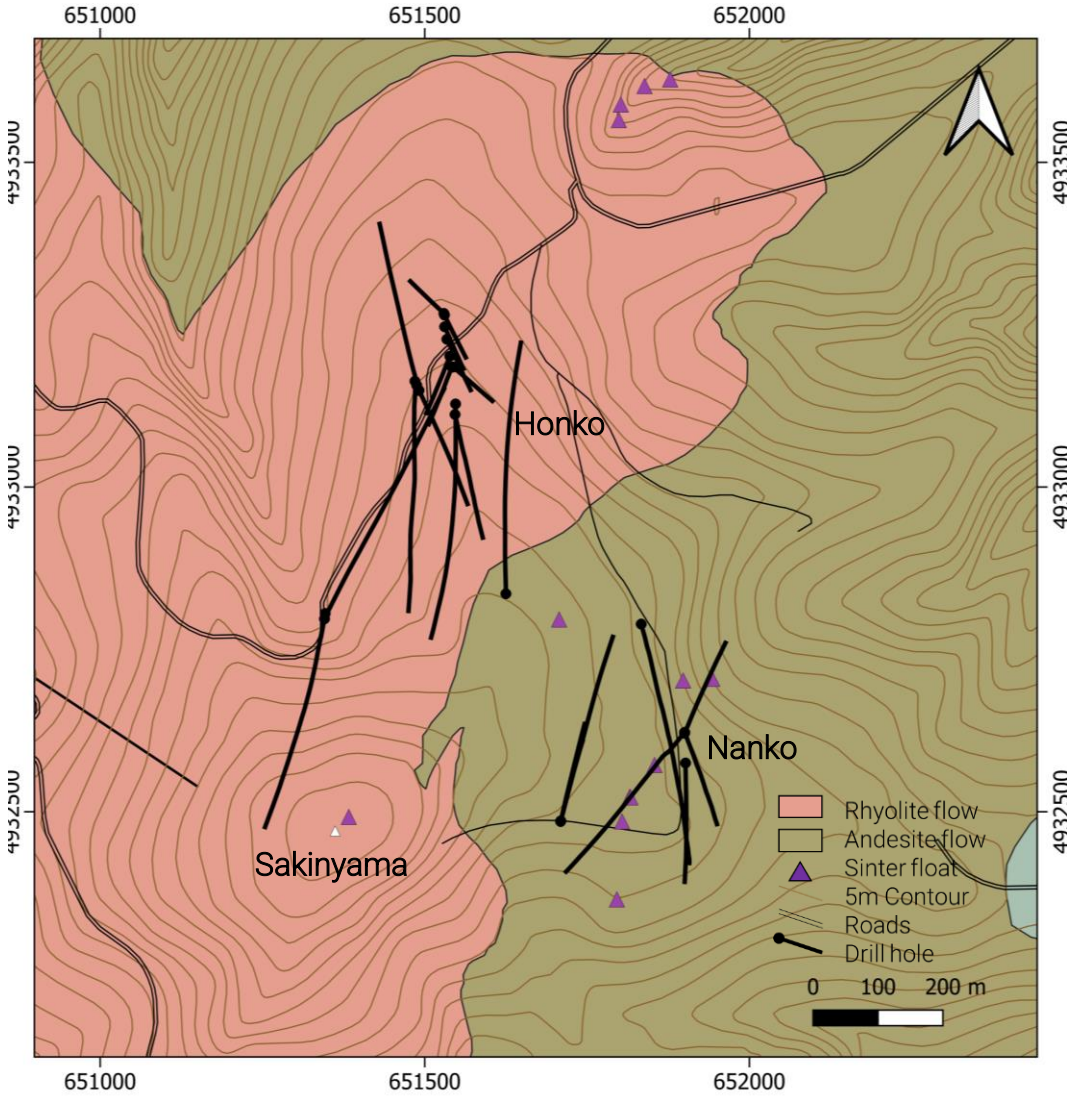
Veins

8 reported east trending veins in Honko (dipping 80°N) and 2 veins in Nanko

Pit excavated by local prospector, Mr. Masaru Nanjo, exposing the high grade ore veins (2 or more mineralized vein over a span of 6m)

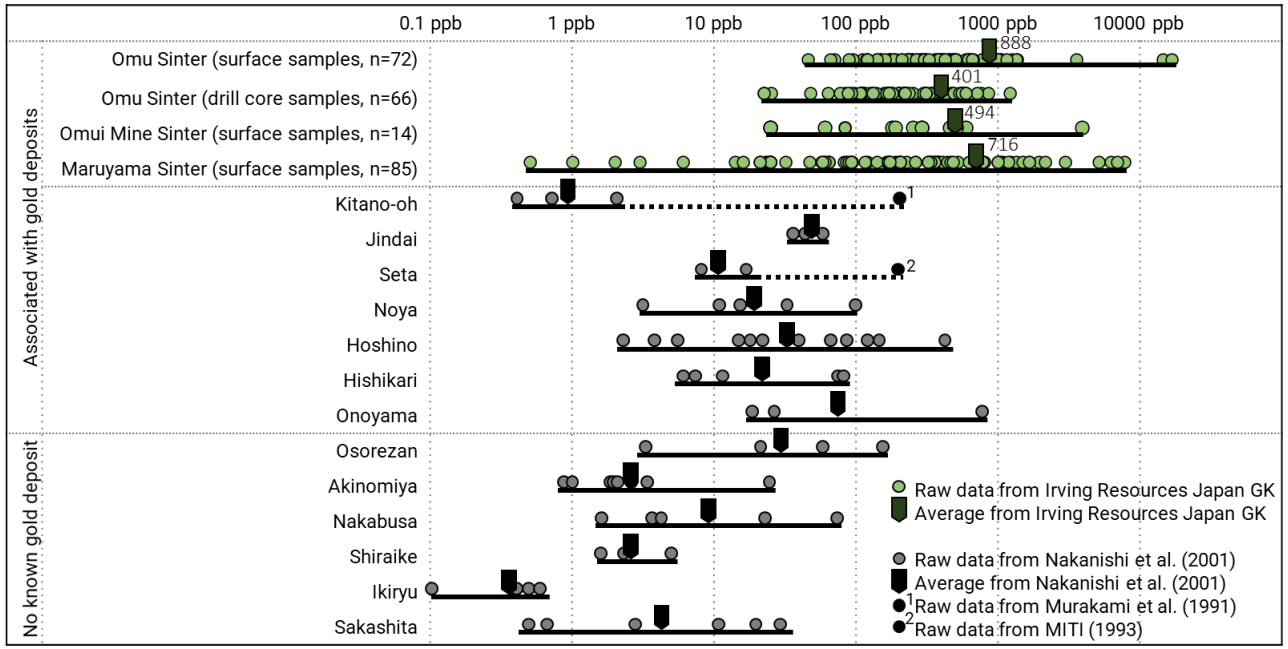
Honpi-style vein breccia containing ginguro

Geology

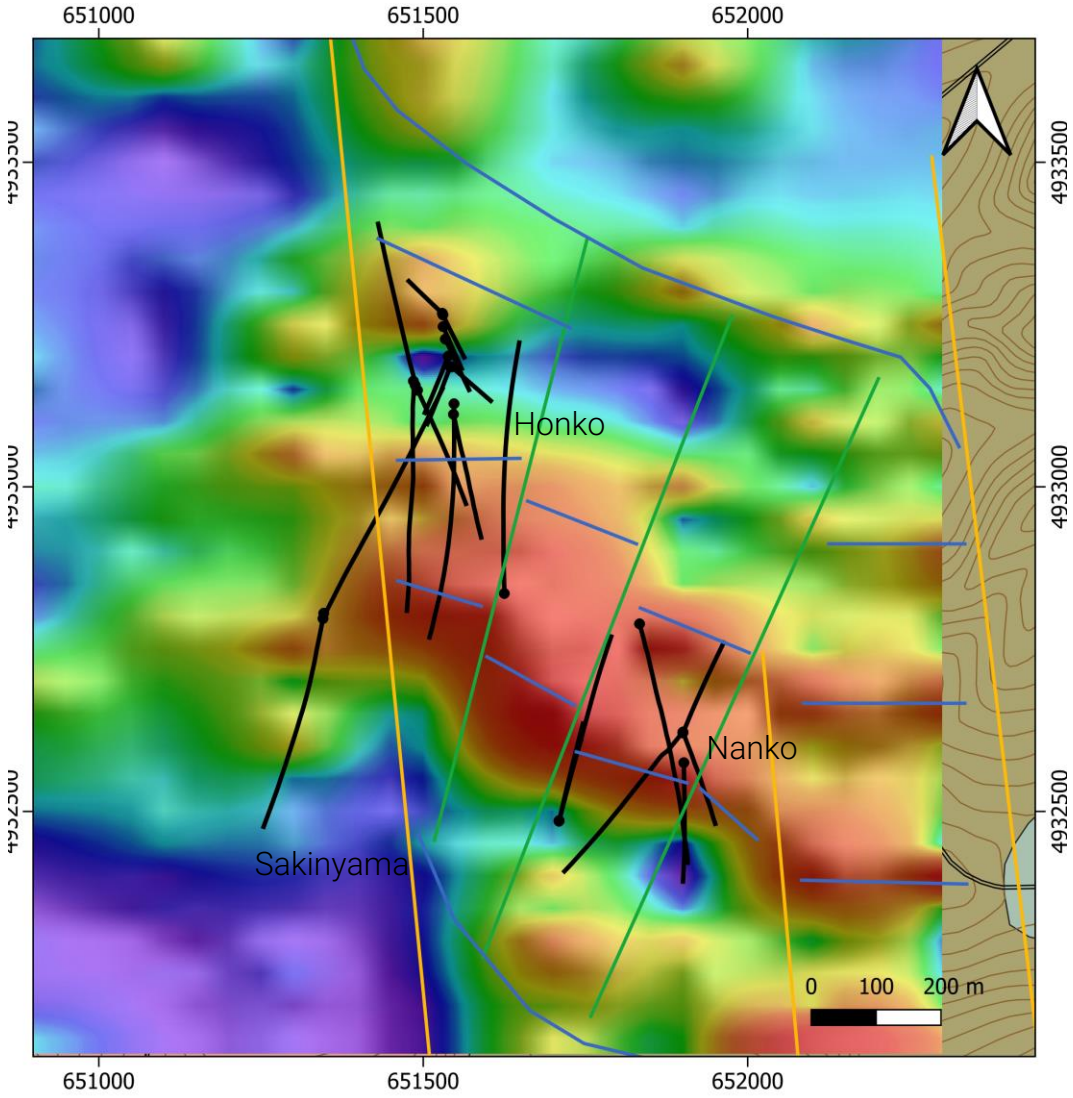


Sinter Occurrences

Silica sinter floats were mapped along a steep cliff about 500m north of Honko and around Nanko road.



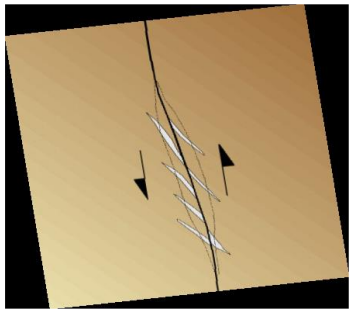
Structural Interpretation: A Pull-Apart Basin

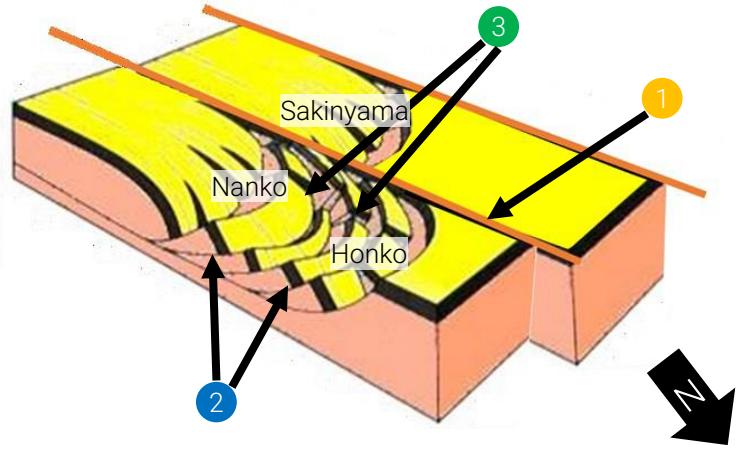


1. Sinistral strike slip
   - steep sidewall faults bounding the basin (NNW-SSE)
   - western-bounding fault interpreted as potential limit to mineralization
   - eastern-bounding fault interpreted further to the east as new gravity and soil geochemistry data show the system may extend to the SE

2. Dip-slip normal
   - steep, south-dipping listric extensional faults (WNW-ESE)
   - hosts ginguro-bearing quartz veins that are commonly brecciated by post-vein fault movement

3. Dextral strike slip
   - accommodation faults at a high angle to normal faults (NE-SW)
   - may have displaced listric extensional faults and related veins
   - may be strike slip with antithetic movement with respect to bounding fault





2019-2022 Omui Drilling Programs

The 2019-2020 drilling programs at Honko and Nanko aimed to determine the extent of the shallow epithermal mineralization reported by historical data and to test several deeper drilling targets delineated by controlled-source audio-frequency magnetotelluric (CSAMT) survey. The follow-up drilling during the 2021-2022 drilling programs at Honko led to the discovery of a buried siliceous hot spring deposit and the extension of a high-grade carbonate-quartz vein mineralization at depth.

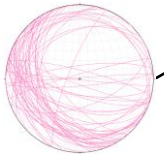
Host Rock

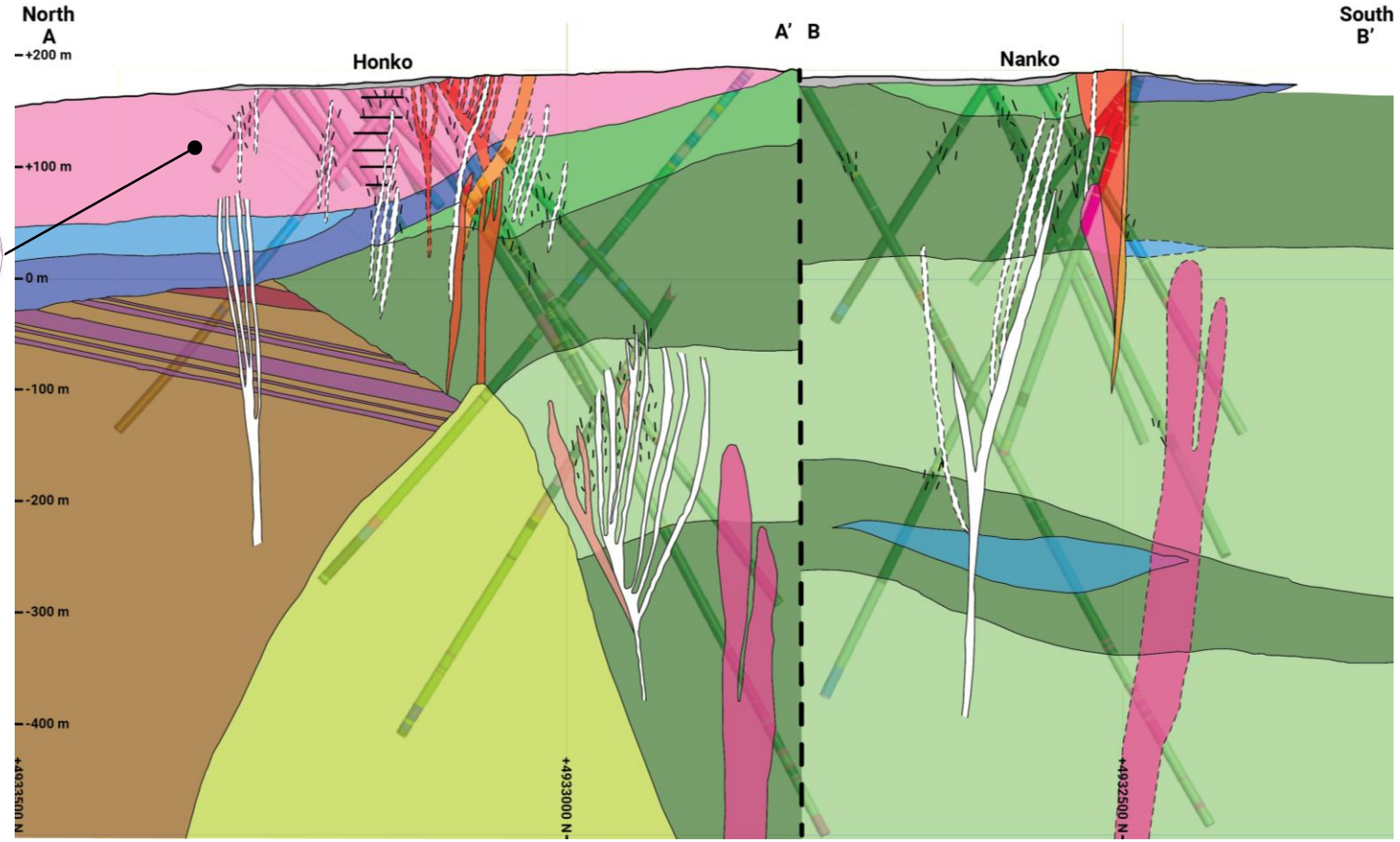
Motoineppu Lava

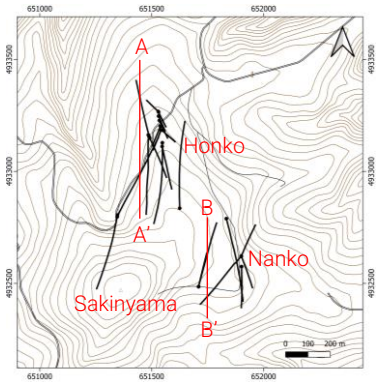
Composed of flowbanded quartz eye rhyolite flows, rhyolitic tuff and lapilli tuff

Intersected only in Honko (deeper erosional level in Nanko)

Flowbanding generally strikes NW and gently dips to the SW







Host Rock

Propylite Lava

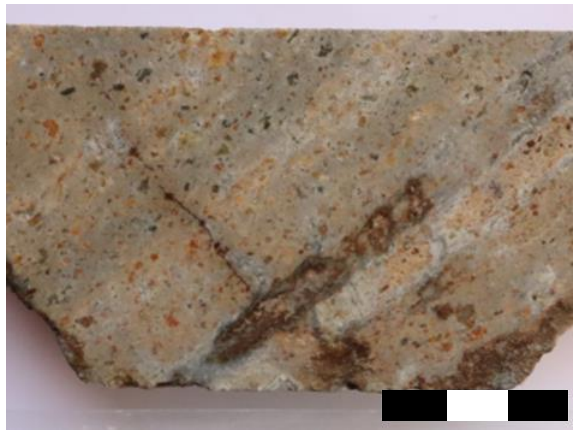
Composed of porphyritic and flowbanded andesite flows and andesitic tuff and lapilli tuff.

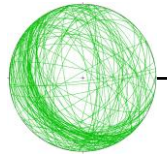
Possibly includes an andesitic intrusive body intercepted beneath Honko (not enough data to determine if pre-mineralization or post-mineralization)

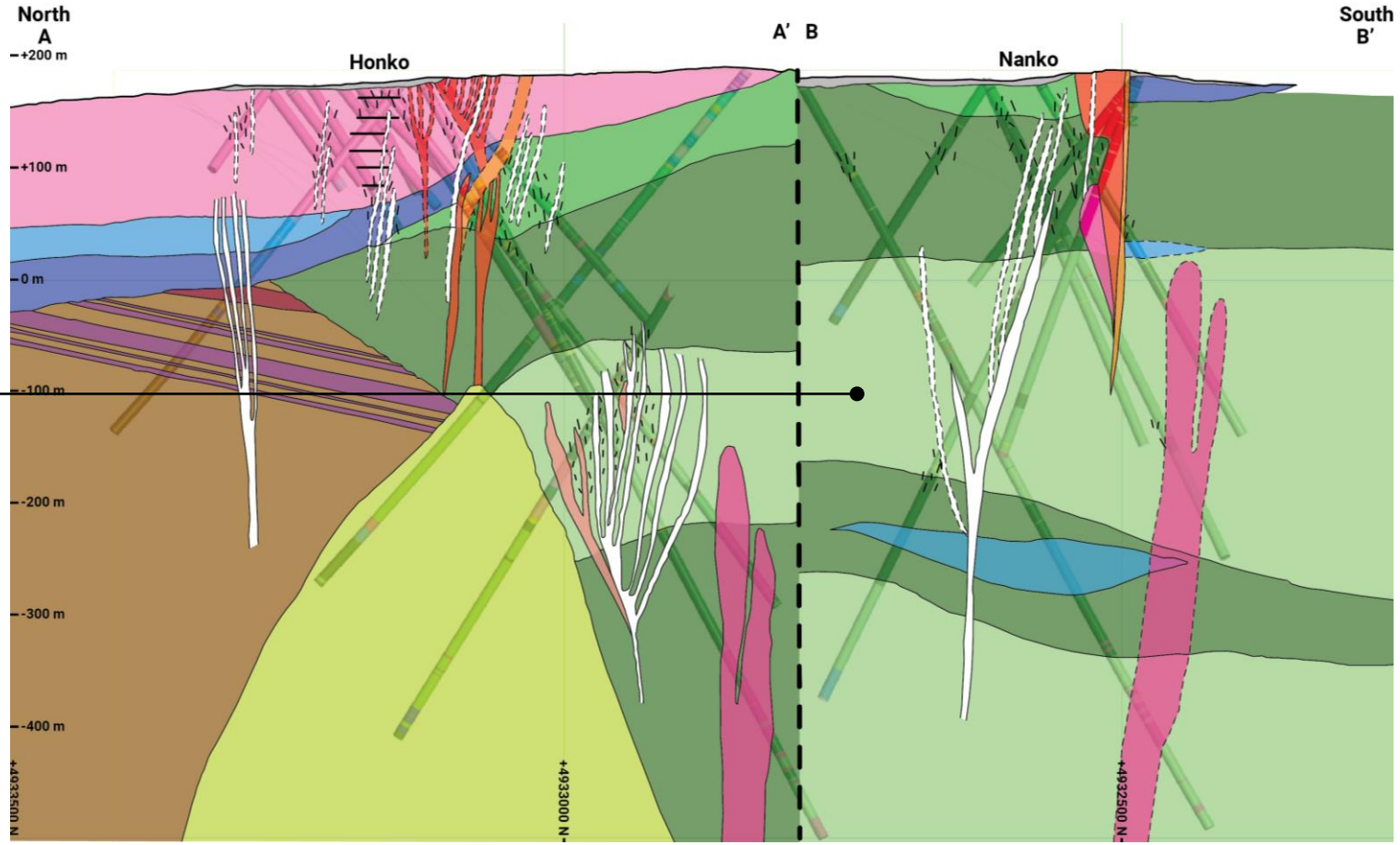
Intersected underneath rhyolite flows in Honko

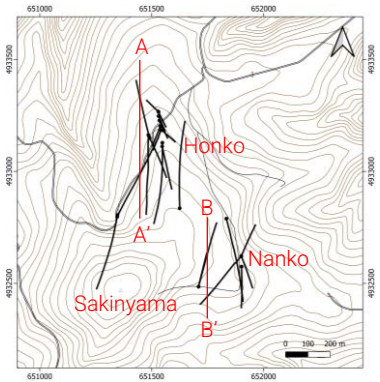
Intersected underneath alluvium in Nanko (deeper erosional level in Nanko)

Flowbanding generally strikes NW and gently dips to the SW









LEGEND

- Alluvium
- Quartz eye and rhyolitic tuff
- Bedded volcaniclastic rocks
- Volcaniclastic rocks
- Andesitic tuff
- Porphyritic andesite
- Flowbanded andesite
- Andesitic intrusive
- Breccia
- Sedimentary rocks
- Upper silica sinter horizon
- Lower silica sinter horizon
- Silica matrix breccia
- Carbonate matrix breccia
- Fault/shear zone
- Vein
- Stockwork zone
- Underground mine workings

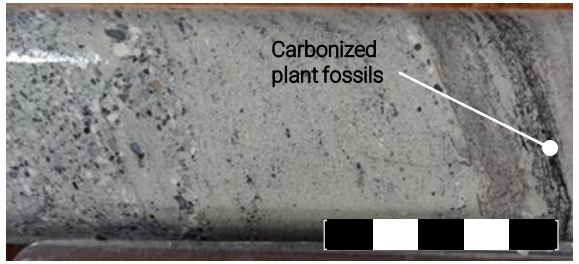
Host Rock

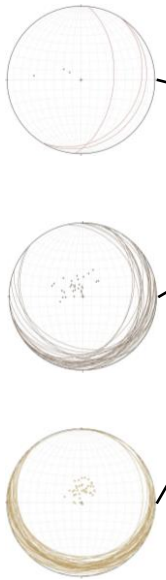
Kamiomu Formation

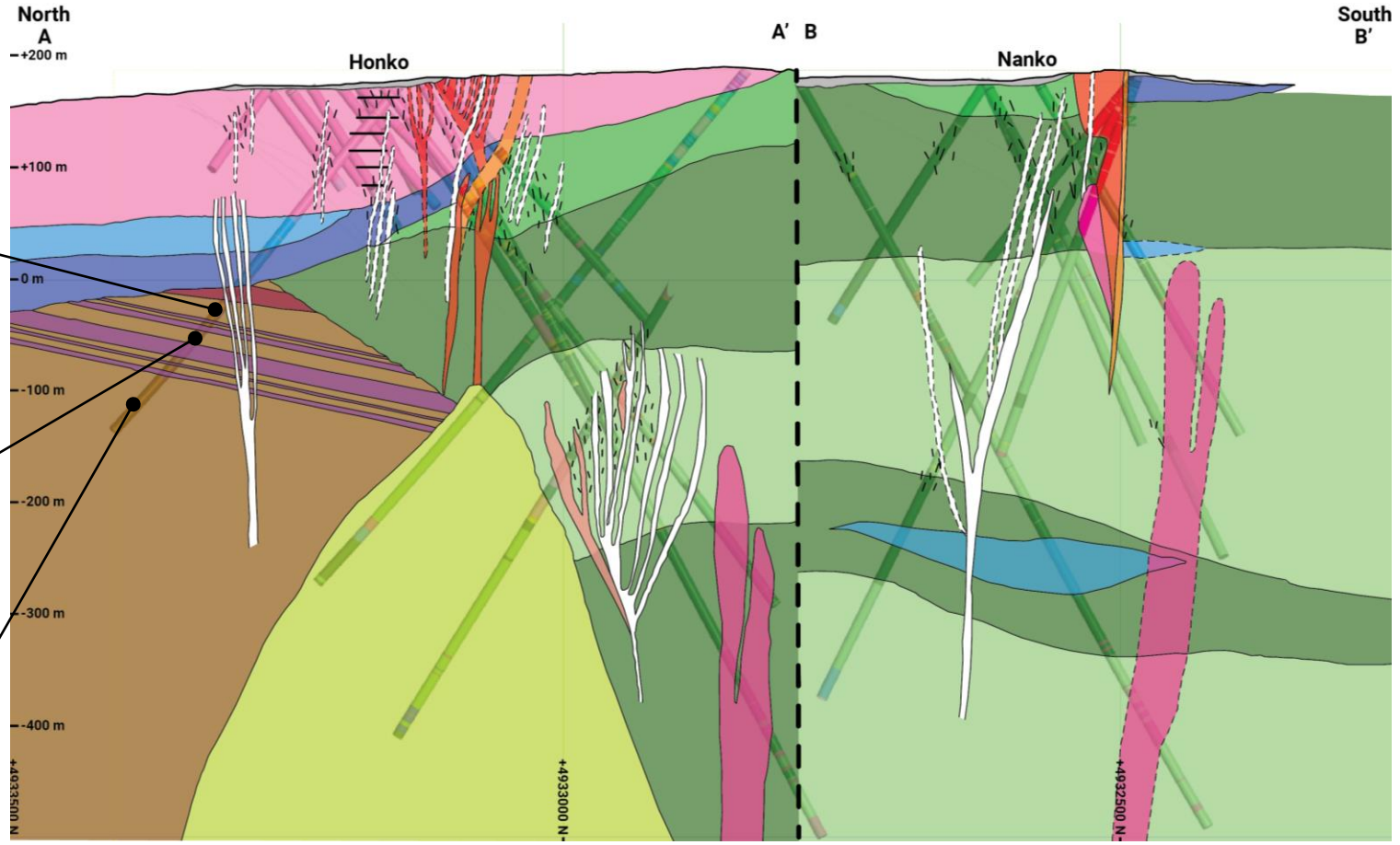
Composed of bedded mudstones, sandstones and conglomerate

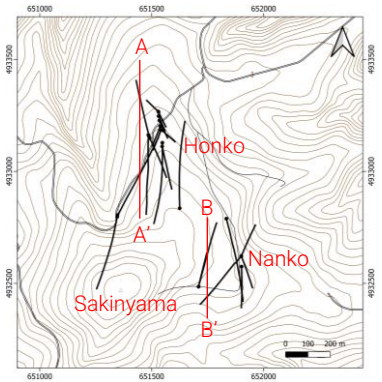
Contains carbonized plant fragments indicating terrestrial origin

Beds at the top strike NNE and dips gently SE, then shifts orientation towards the bottom striking E-W and dipping S









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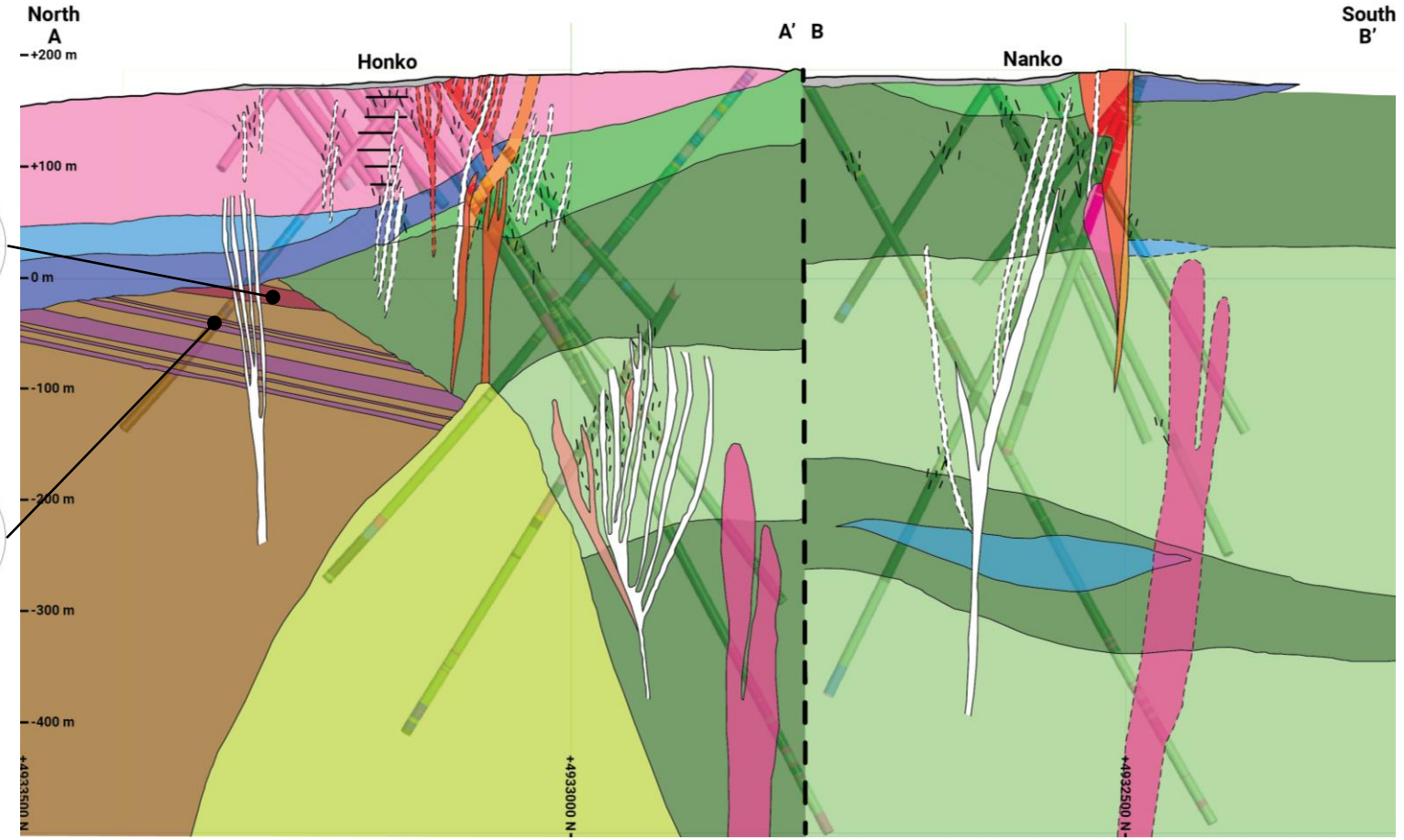
Host Rock

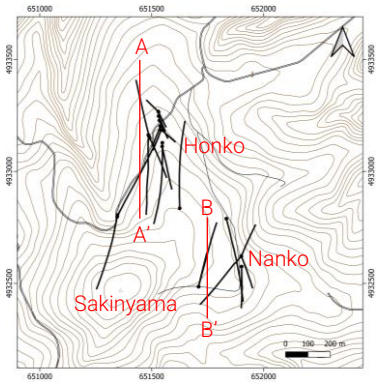
Silica Sinter Horizons

At least 2 silica sinter horizons with different orientations were found intercalated with the sedimentary sequences of the Kamiomu Formation (represent at least 2 paleosurfaces)

Finely laminated and composed of dark gray, light gray to bluish white silica, with abundant pyrite along the laminations (0.016 ppm to 3.55 ppm Au with an average of 0.59 ppm Au)

Fibrous to fine columnar siliceous structures which grew orthogonal to the sinter laminations interpreted as fossilized algal matter are present





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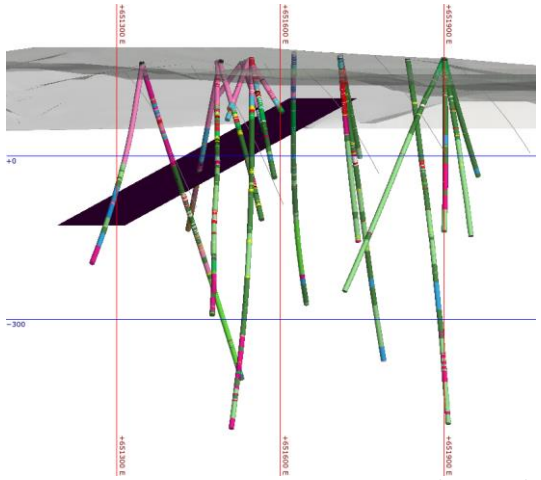
Silica Sinter Horizons

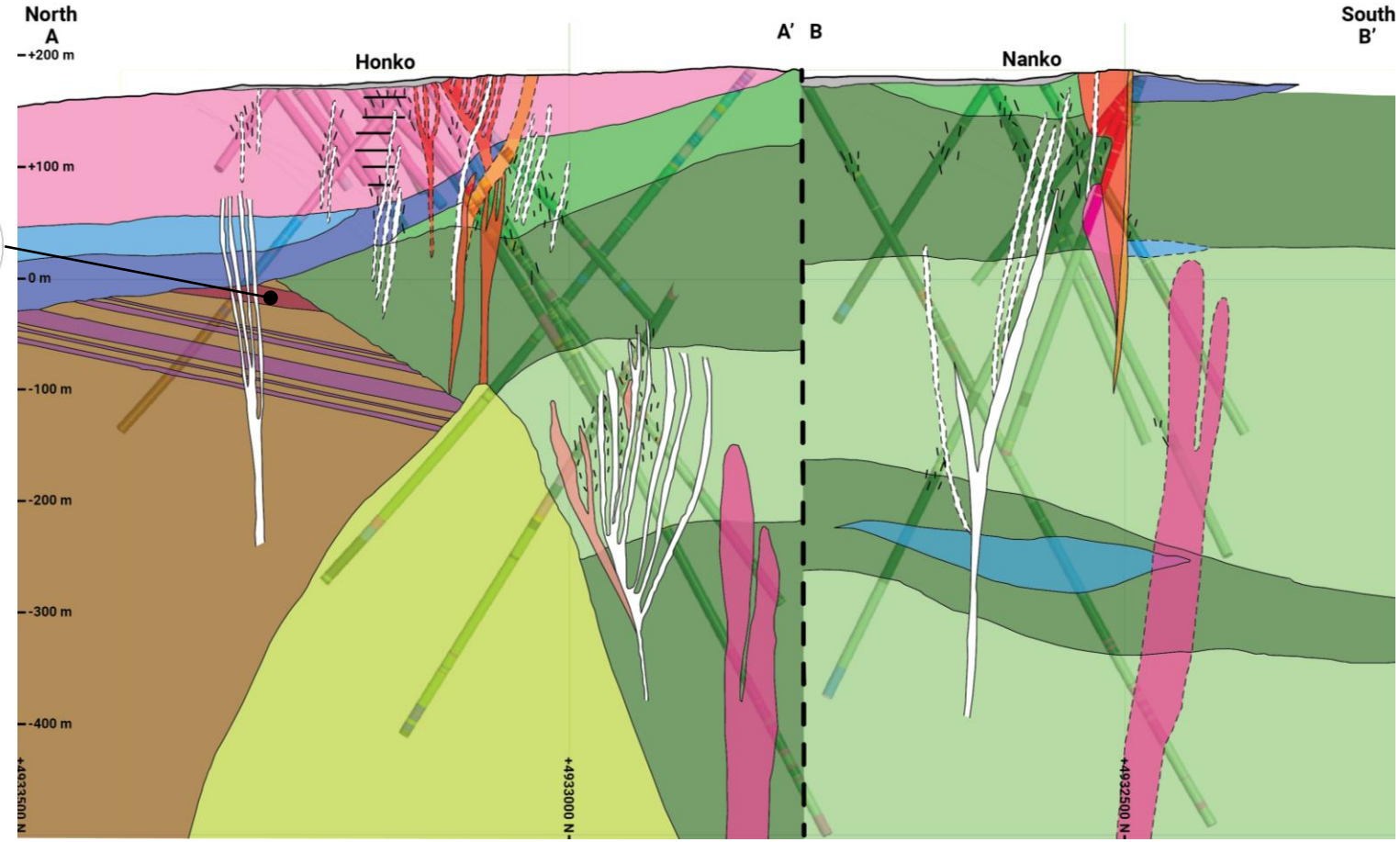
Upper silica horizon:

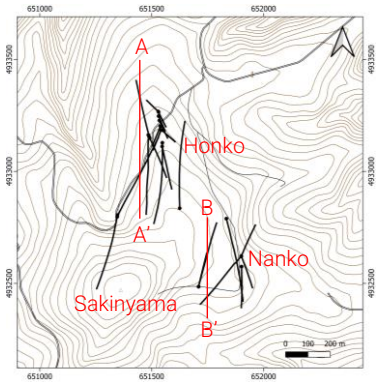
Dark gray massive to laminated from 236.20 m to 254.70 m drill depth

Strikes NNW and dips 24° to 32° WSW



Looking North





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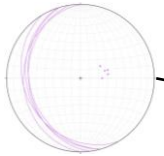
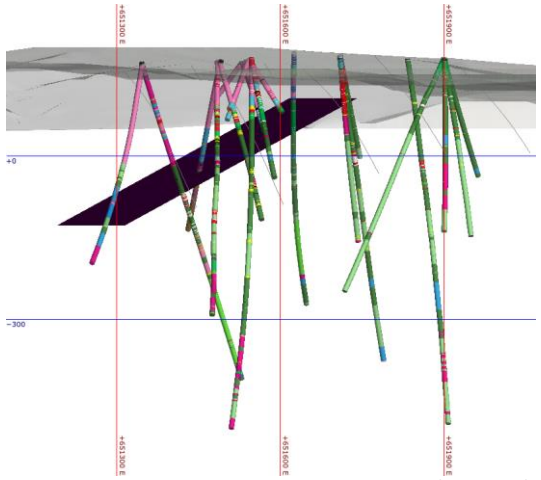
Silica Sinter Horizons

Upper silica horizon:

	Au ppm	Ag ppm	As ppm	Hg ppm	Sb ppm
Ave	0.89	8.25	263.49	5.52	115.77
Min	0.22	2.70	58.00	1.30	41.80
Max	3.55	29.30	892.00	24.60	239.00





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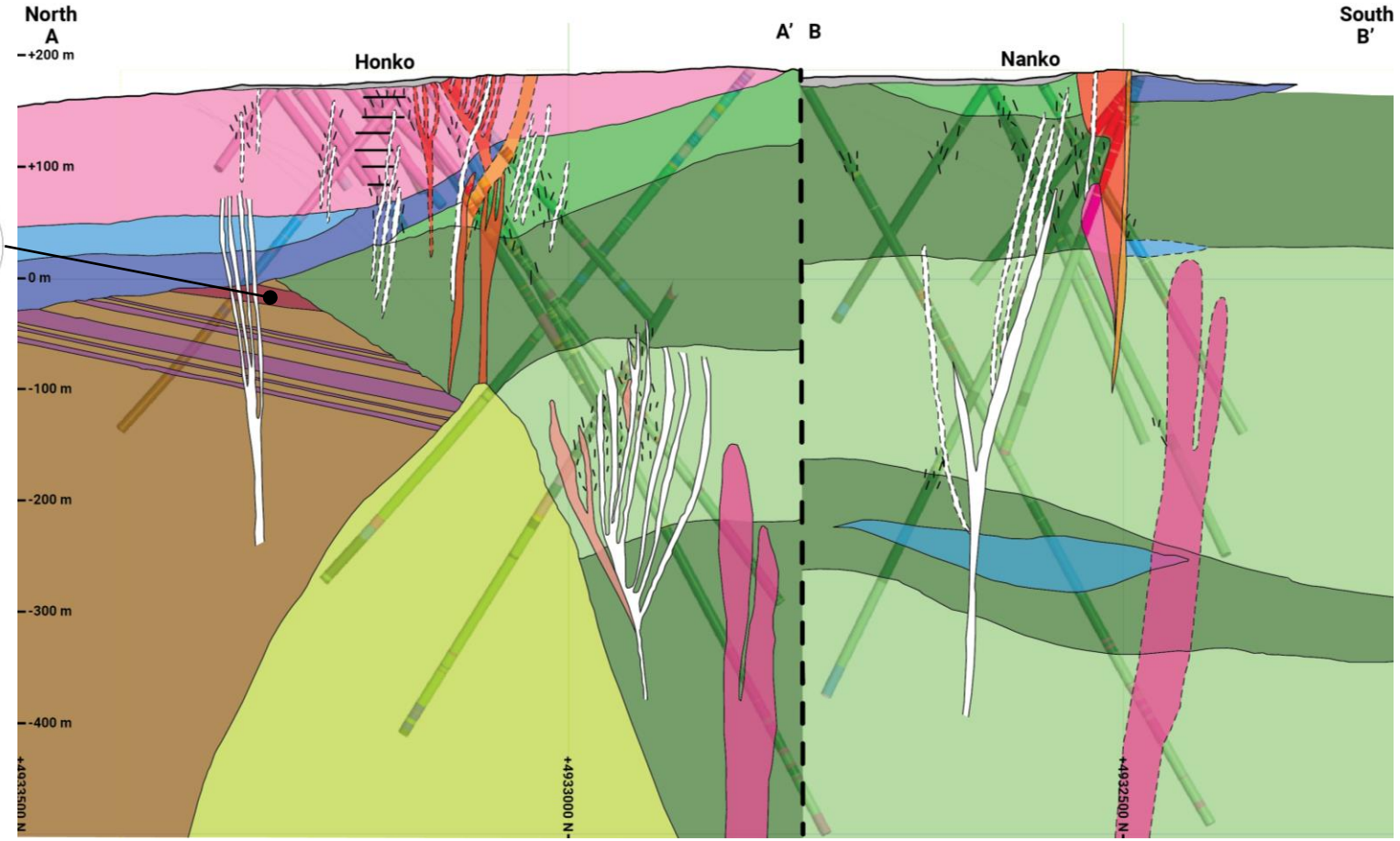

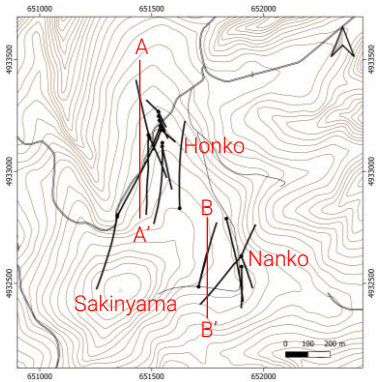

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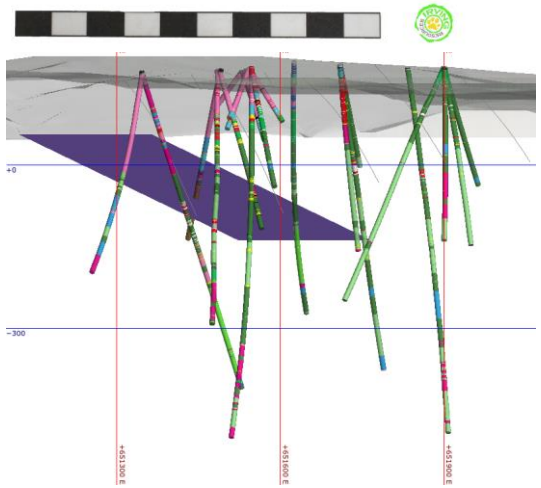
Host Rock

Silica Sinter Horizons

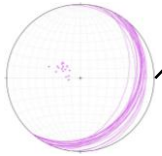
Lower silica horizon:

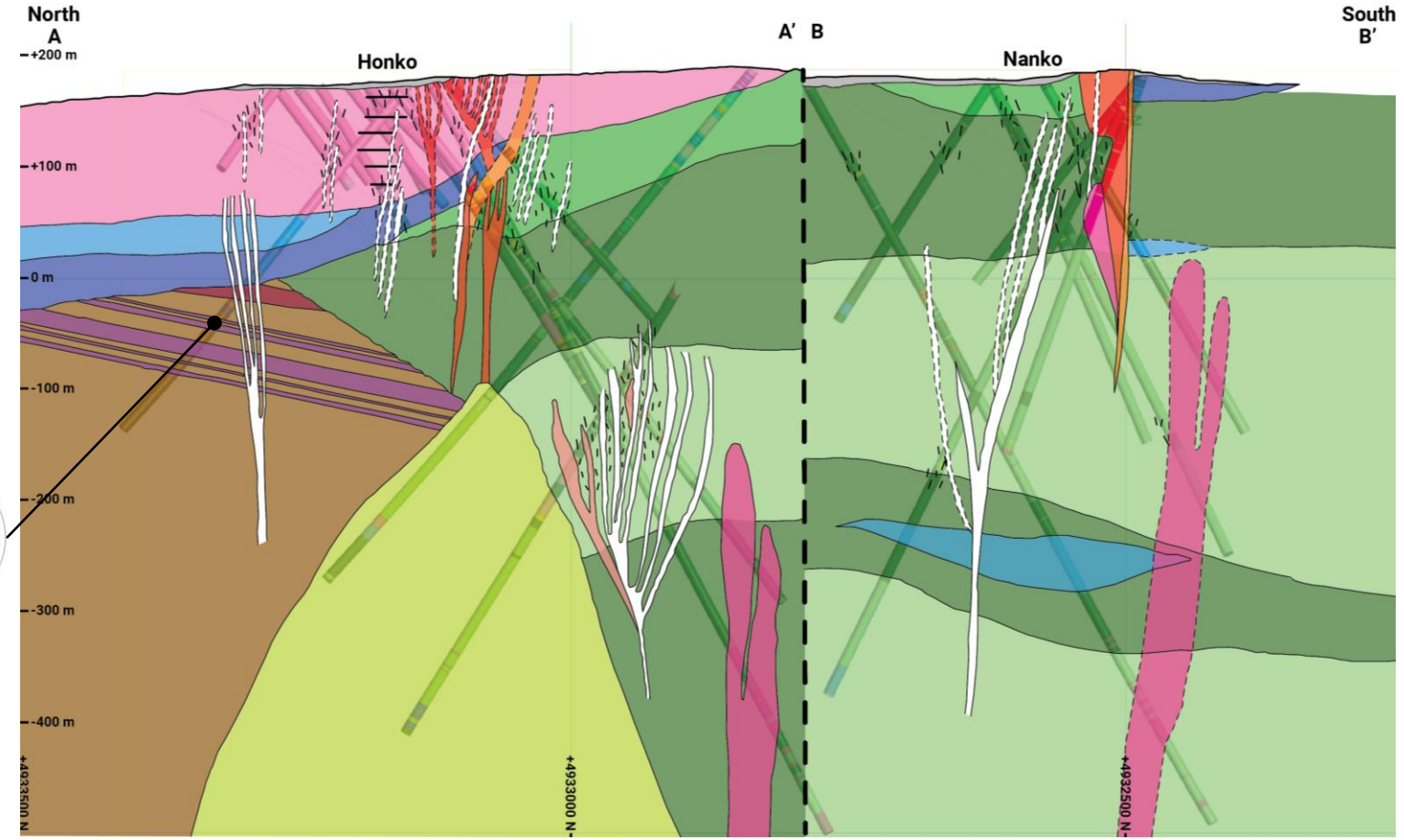
Multiple layers of bluish white to dark gray laminated silica sinter intercalated with silicified clastic rocks from 279.27 m to 342.27 m drill depth

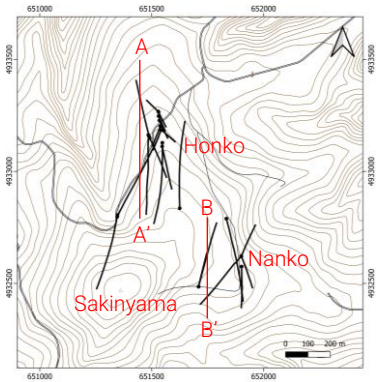
Strikes NNE and dips 13° to 37° SE



Looking North







LEGEND

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- Quartz eye and rhyolitic tuff
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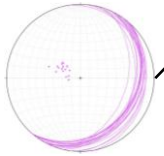
- Volcaniclastic rocks
- Andesitic tuff
- Porphyritic andesite
- Flowbanded andesite
- Andesitic intrusive
- Breccia
- Sedimentary rocks
- Upper silica sinter horizon
- Lower silica sinter horizon
- Silica matrix breccia
- Carbonate matrix breccia
- Fault/shear zone
- Vein
- Stockwork zone
- Underground mine workings

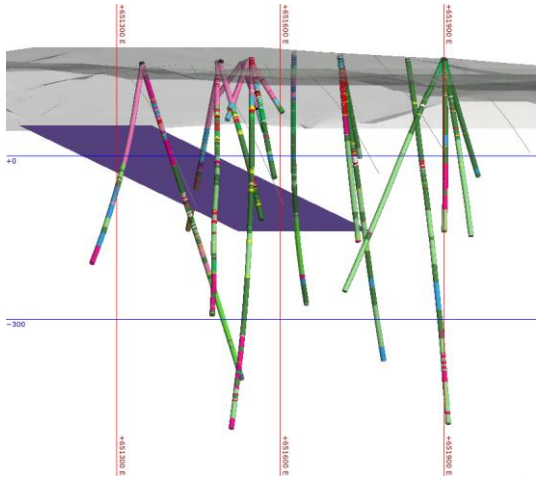
Host Rock

Silica Sinter Horizons

Lower silica horizon:

	Au ppm	Ag ppm	As ppm	Hg ppm	Sb ppm
Ave	0.37	3.41	224.43	2.01	135.56
Min	0.02	0.51	17.40	0.18	44.90
Max	1.80	14.10	1390.00	13.75	342.00





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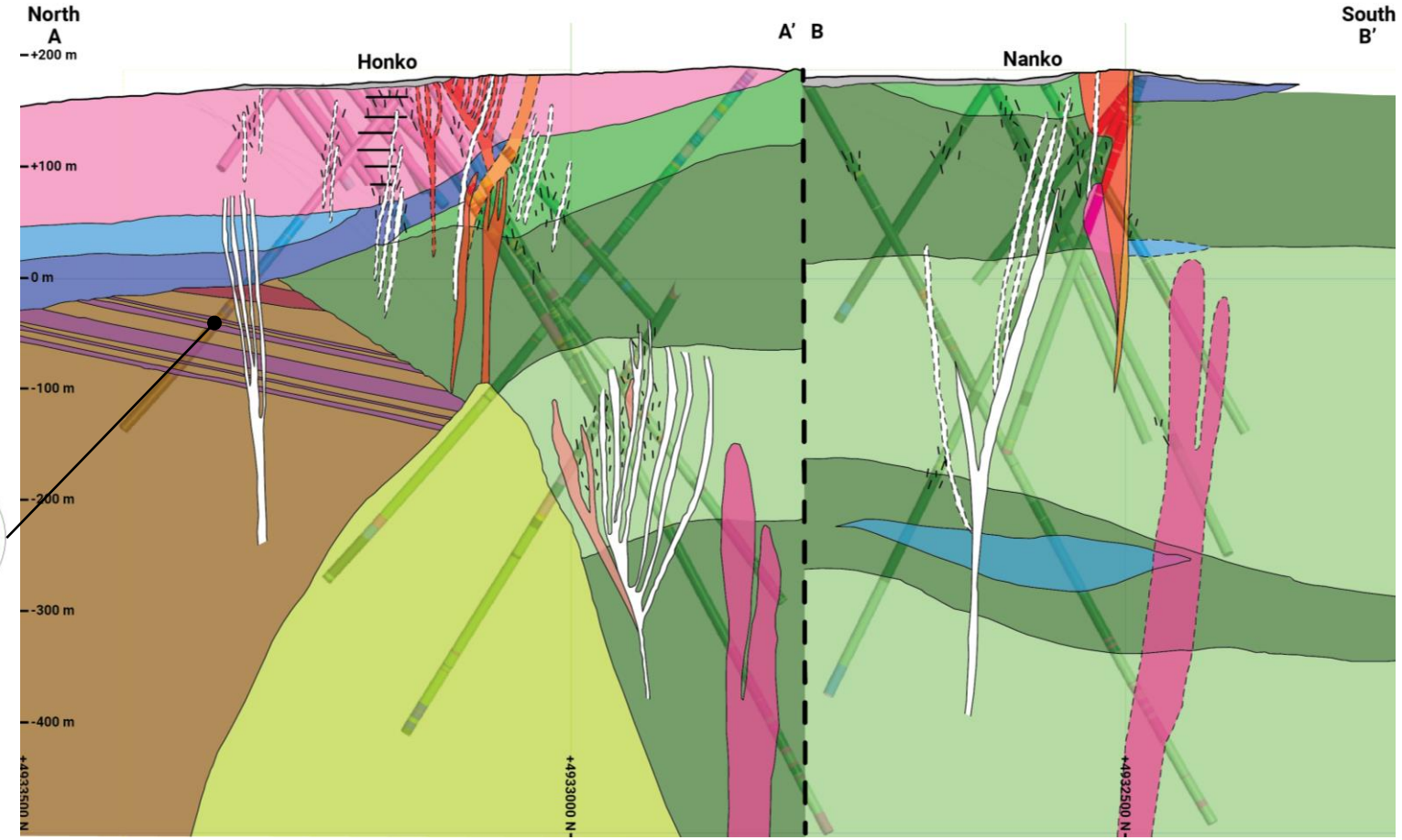

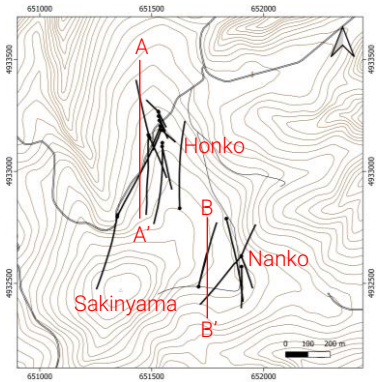

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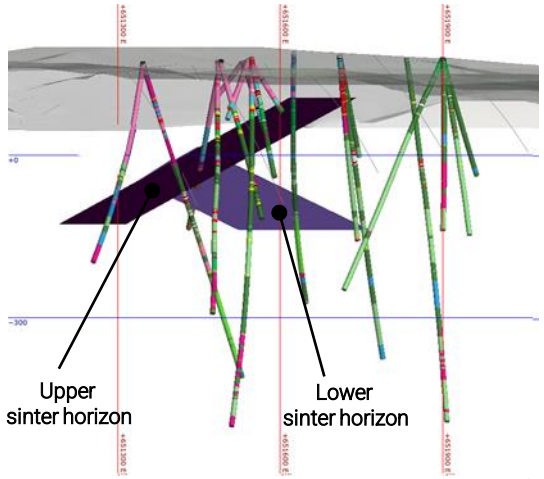
Host Rock

Silica Sinter Horizons

The configuration of the upper and lower sinter horizons indicates:

- The upper sinter horizon is the later paleosurface of the two.
- The western extent of the lower sinter horizon is eroded upon the deposition of the upper sinter horizon
- The eastern extents of both silica sinter horizons might still be preserved towards the east



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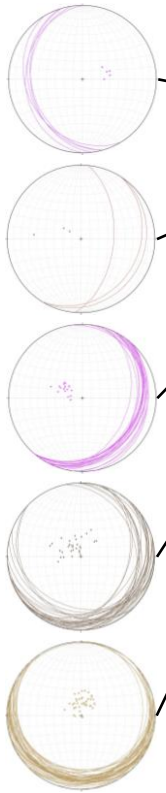

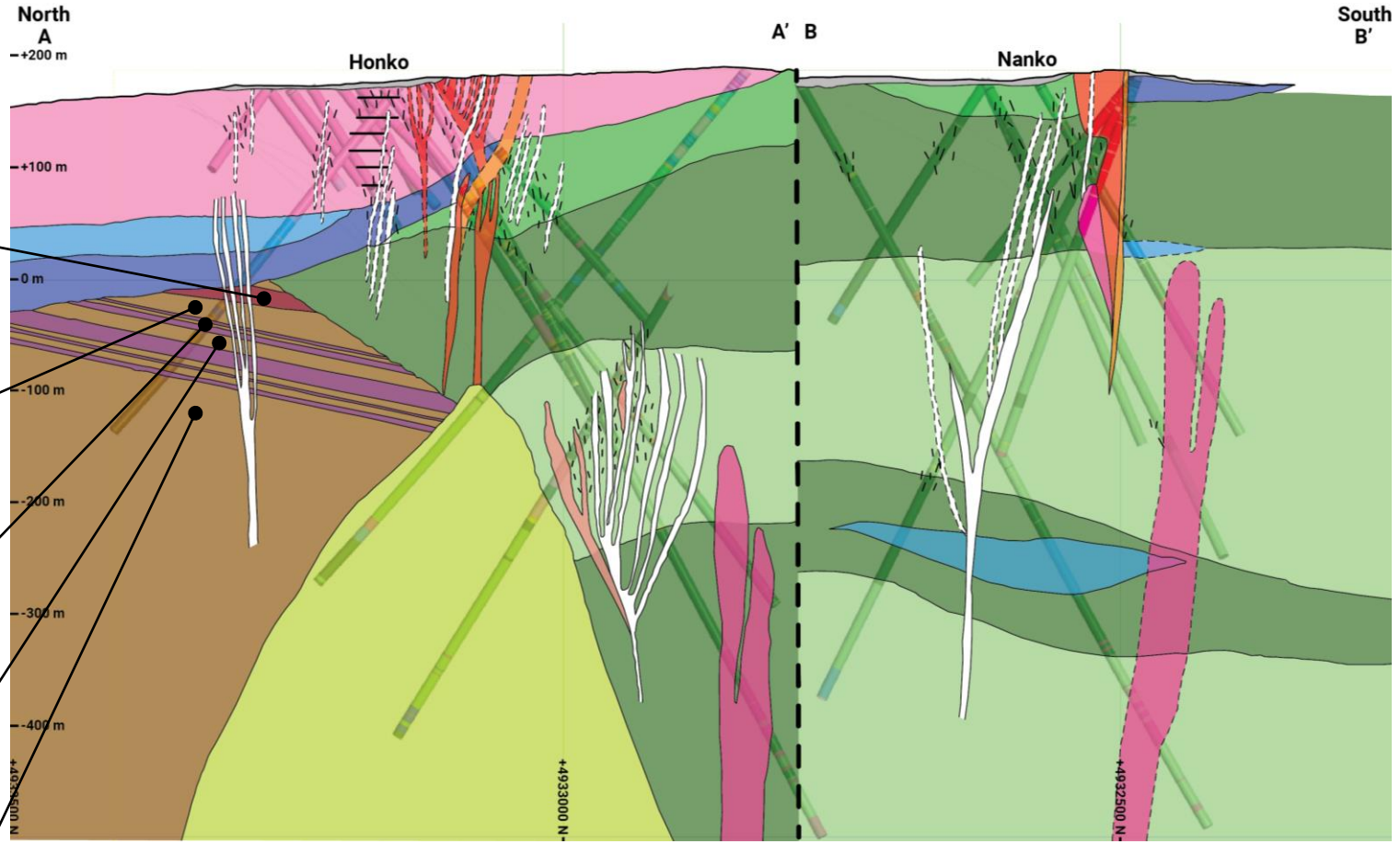

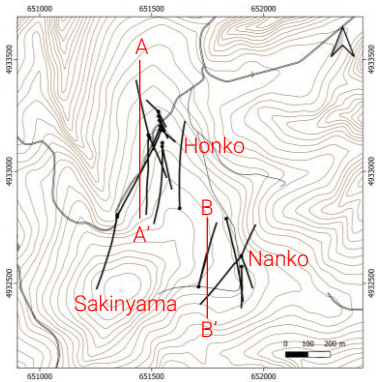

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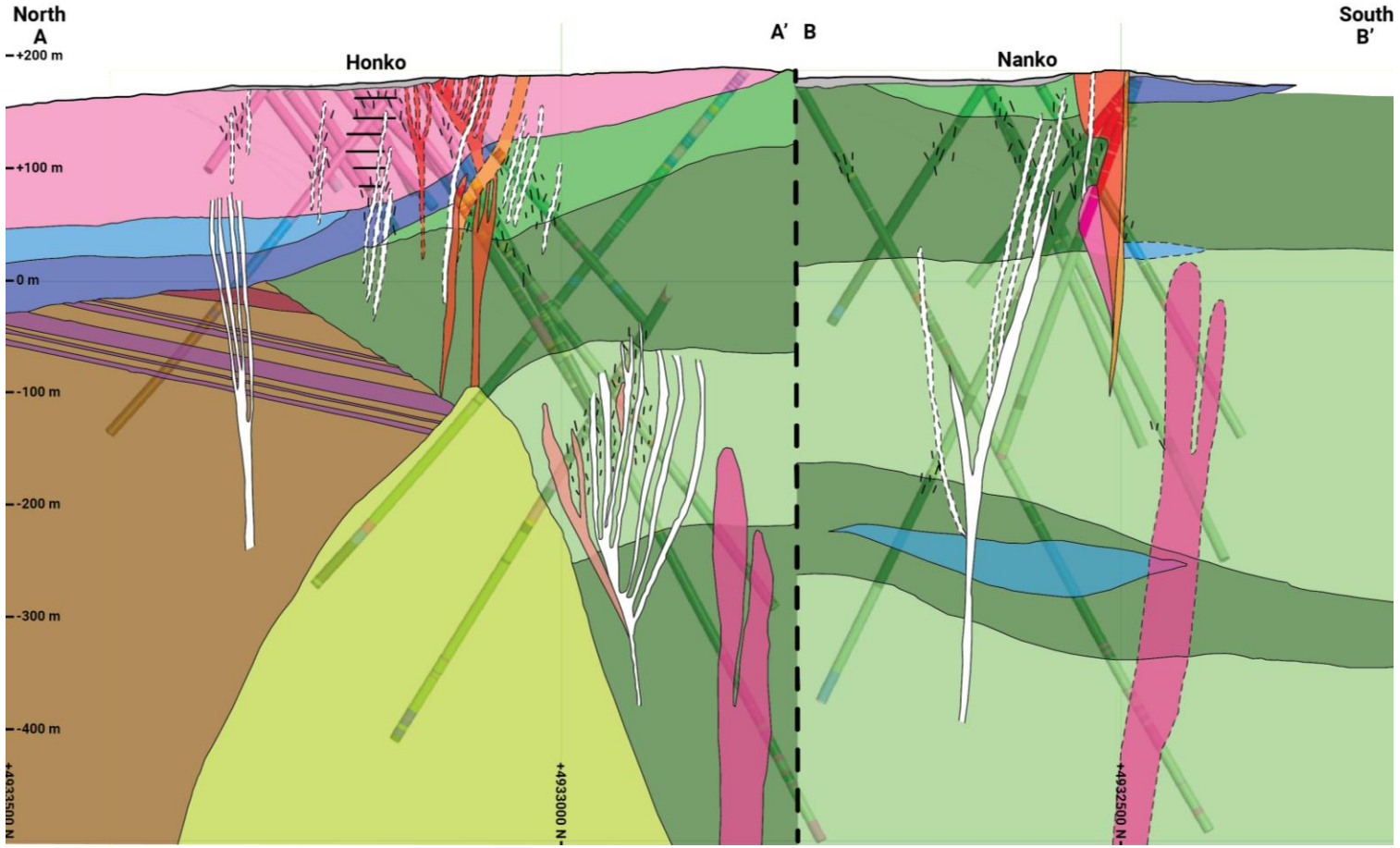
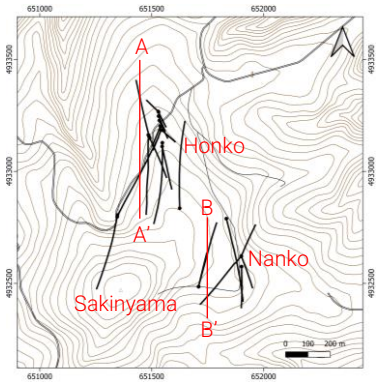
Mineralization

Silica Matrix Breccia

Honpi style vein breccias contain elongated crustiform to massive quartz vein fragments surrounded by dark gray to brownish white silica. Ginguro and electrum are found in both the quartz vein clasts and silica matrix





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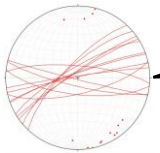
Mineralization

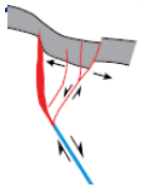
Silica Matrix Breccia

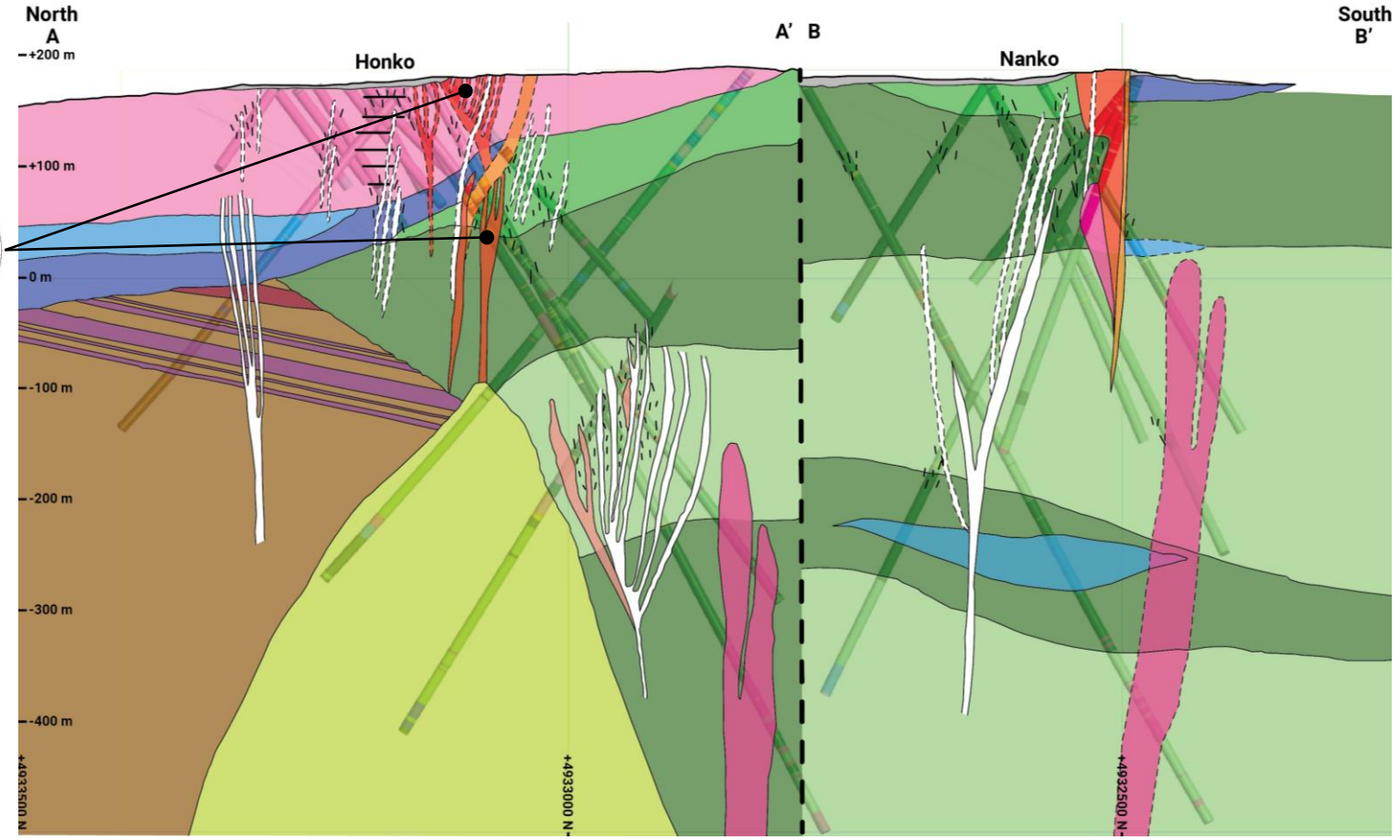
Honpi style vein breccias contain elongated crustiform to massive quartz vein fragments surrounded by dark gray to brownish white silica. Ginguro and electrum are found in both the quartz vein clasts and silica matrix.

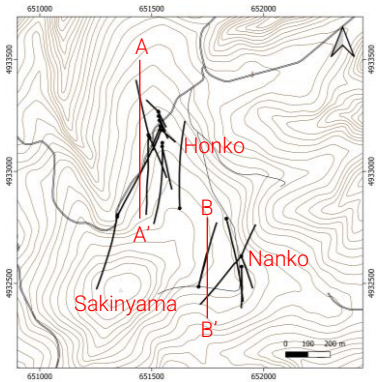
At Honko, shallow steeply dipping vein breccias are oriented ENE to E-W mostly dipping to the N

1.00 ppm Au, 34.40 ppm Ag









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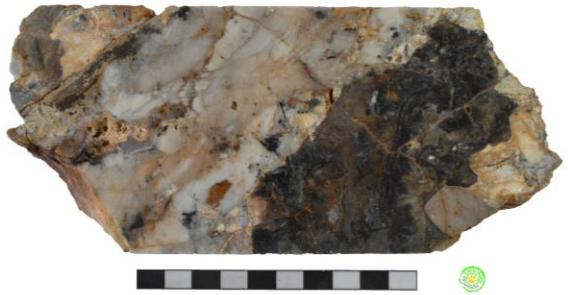
Mineralization

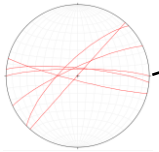
Silica Matrix Breccia

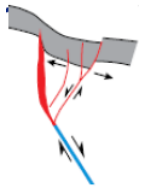
Honpi style vein breccias contain elongated crustiform to massive quartz vein fragments surrounded by dark gray to brownish white silica. Ginguro and electrum are found in both the quartz vein clasts and silica matrix.

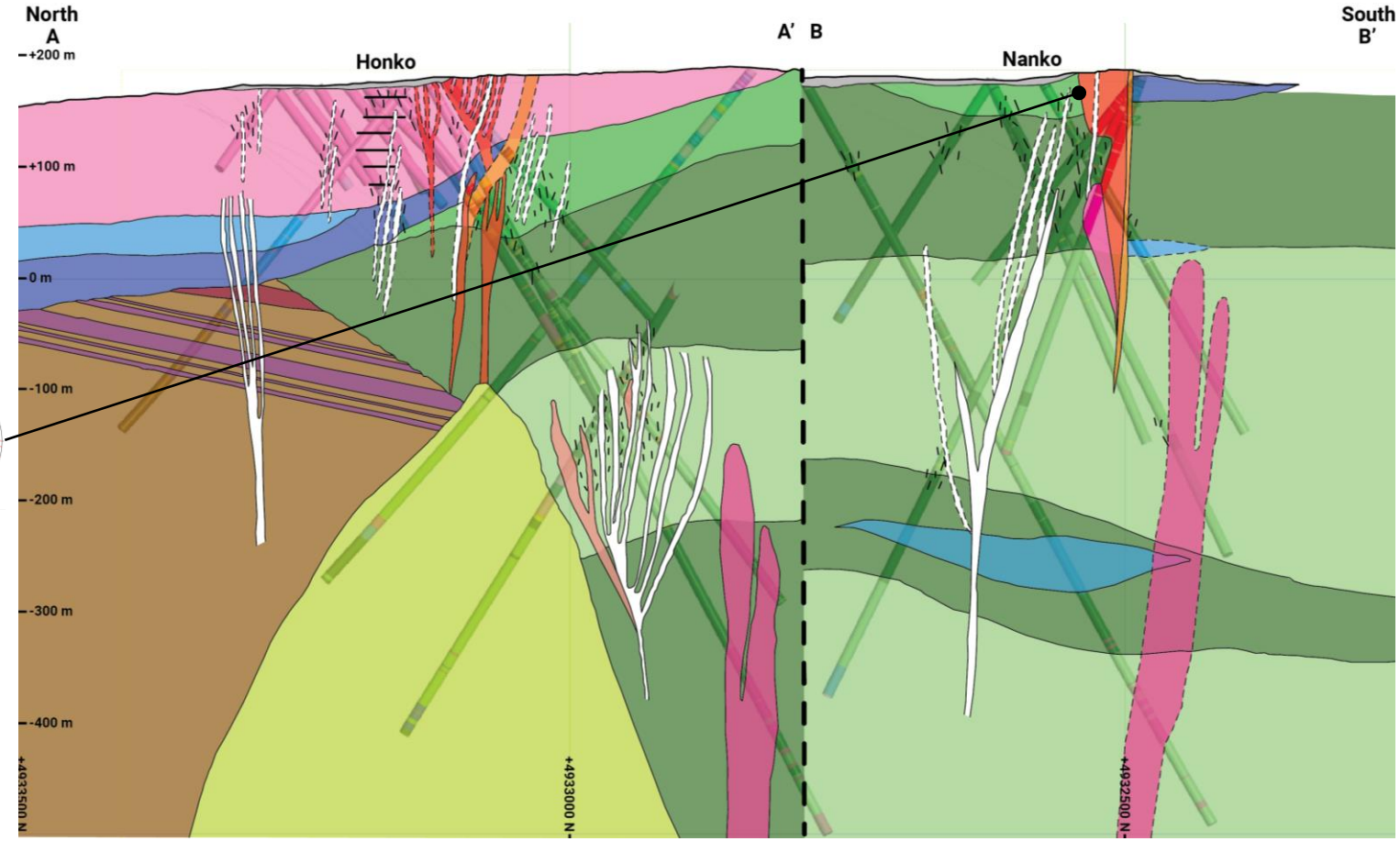
At Nanko, the steeply dipping vein breccias are also oriented ENE to E-W mostly dipping to the N

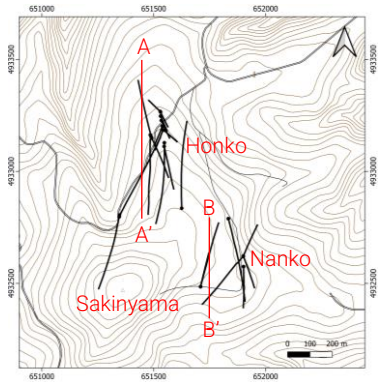


20.50 ppm Au, 572.00 ppm Ag









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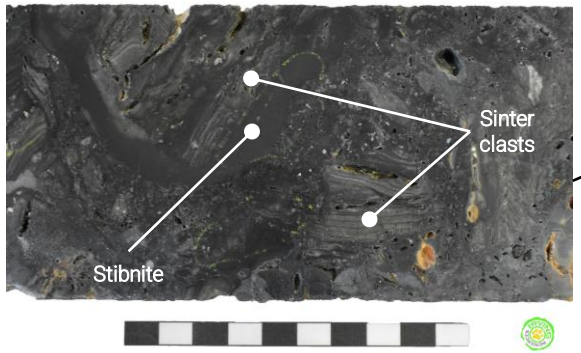
Mineralization

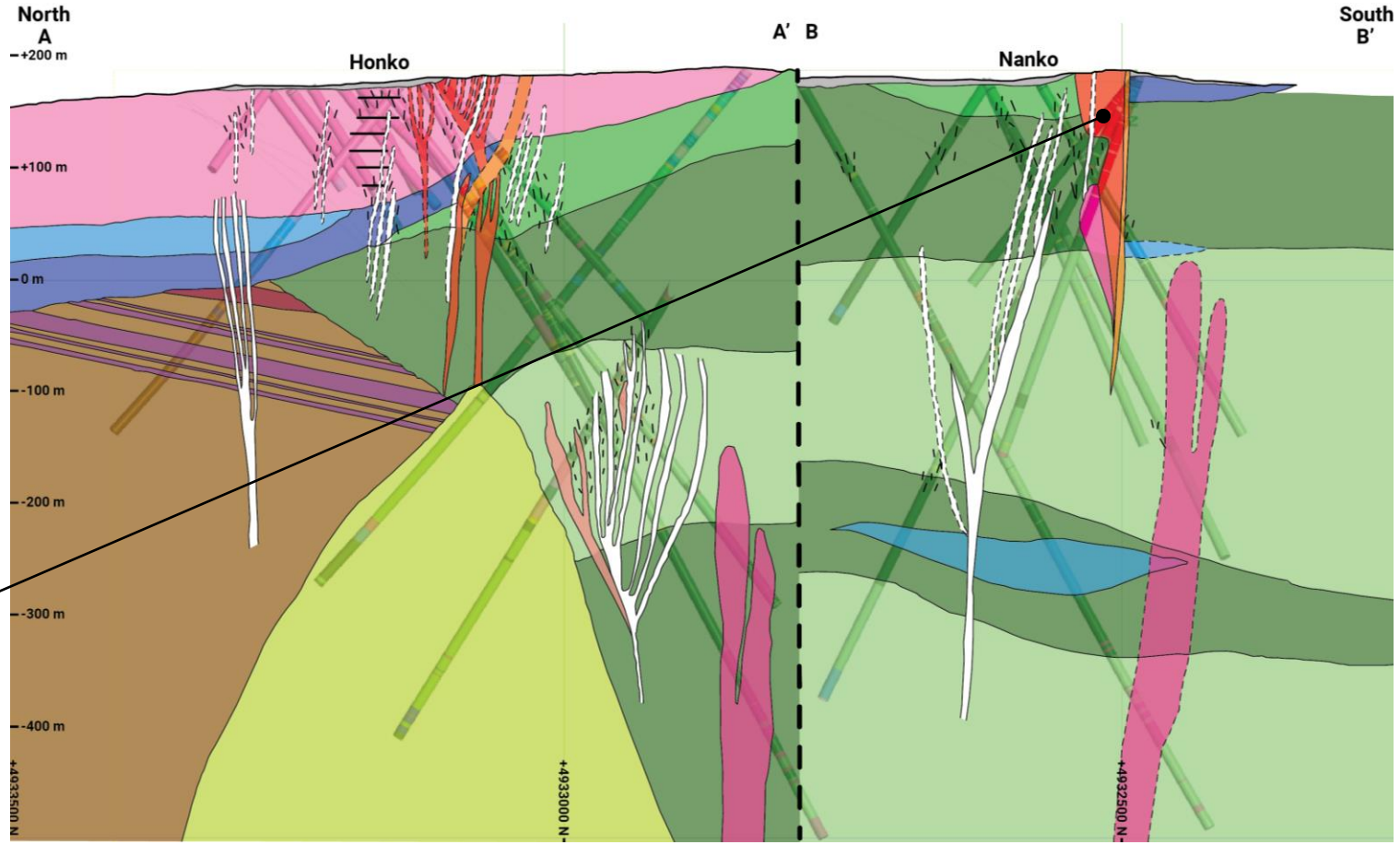
Silica Matrix Breccia

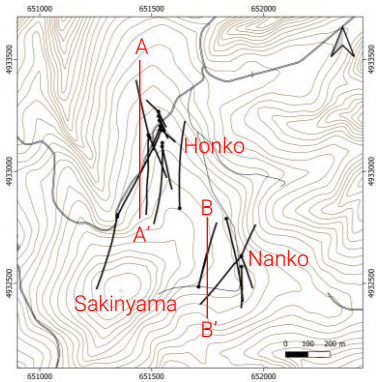
Other silica matrix breccias contain silicified host rock clasts and silica sinter clasts.

Some intervals contain elevated Sb content (more than 10000ppm Sb) aside from Au and Ag (up to 56.1ppm Au, 1435ppm Ag)



4.96 ppm Au, 30.80 ppm Ag, 4110.00 ppm Sb





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Mineralization

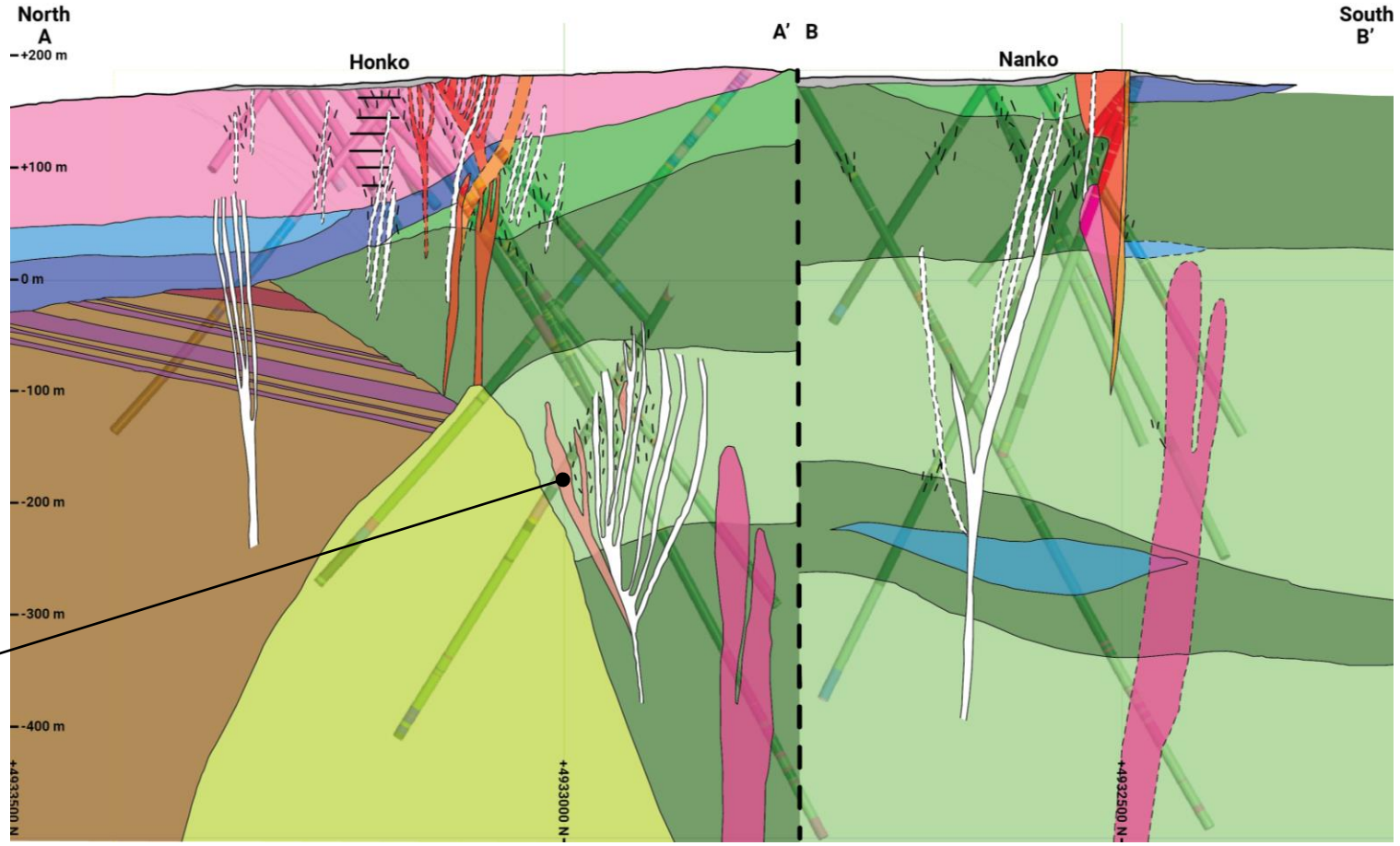
Carbonate Matrix Breccia

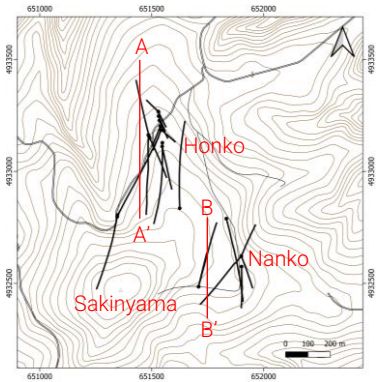
Intersected at depth in holes 19OMI-010 and 22OMI-001.

Contained chlorite-carbonate altered andesitic host rock clasts, surrounded by white calcite matrix.(up to 9.17ppm Au, 137ppm Ag)

Sometimes partially replaced by silica

3.59 ppm Au, 27.80 ppm Ag





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Mineralization

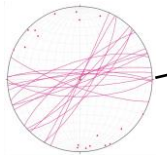
Quartz Veins - Crustiform

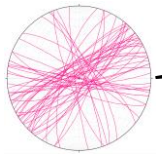
White-brown to white-gray crustiform veins often crosscut dark gray quartz veins and early silica matrix breccias.

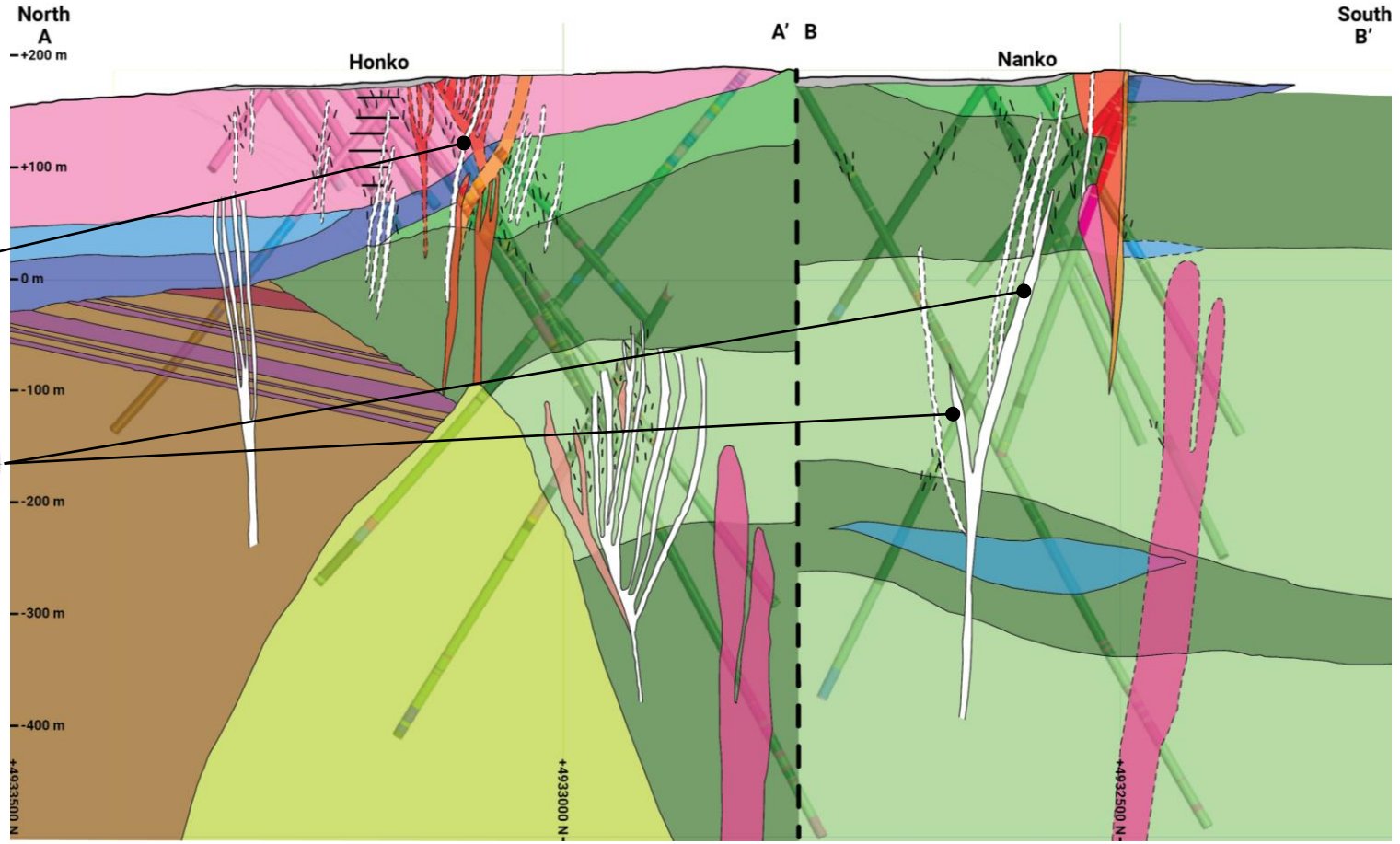
At Honko and Nanko, steeply dipping crustiform veins strike NE to E-W but dip direction varies.

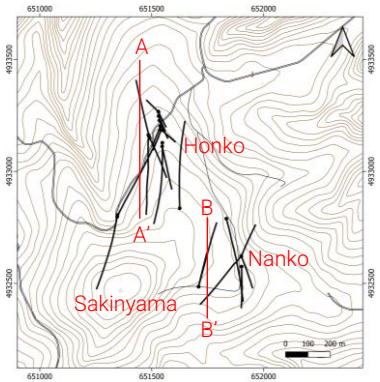
12.65 ppm Au, 104.00 ppm Ag

5.34 ppm Au, 46.70 ppm Ag









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Mineralization

Quartz Veins – Lattice Bladed

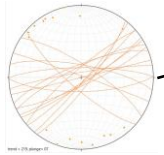
White-brown lattice bladed veins often crosscut dark gray quartz veins and early silica matrix breccias.

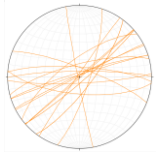
Lattice bladed quartz veins sometimes occur as bands within crustiform quartz veins.

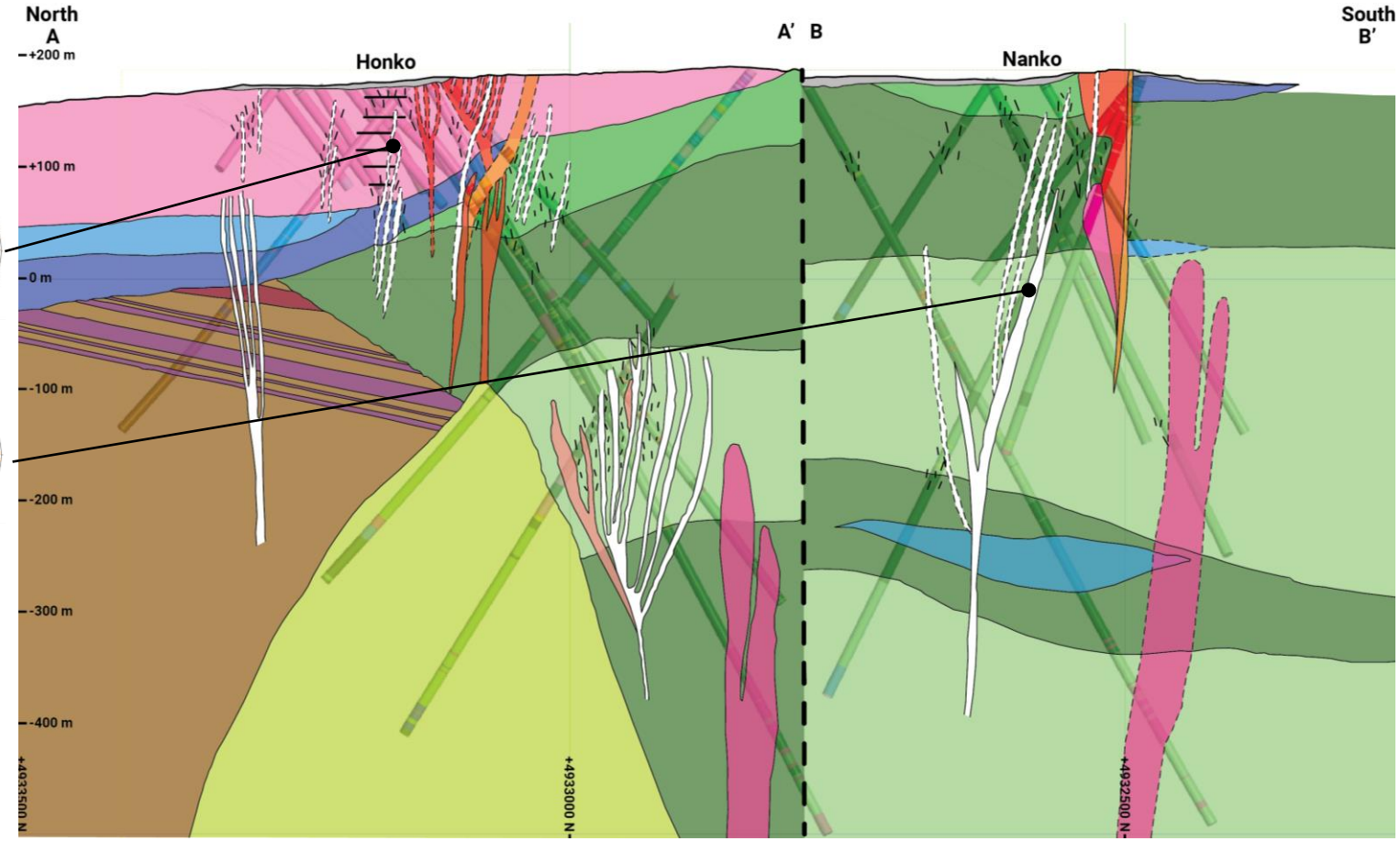
At Honko and Nanko, steeply dipping lattice bladed veins strike NE to E-W but dip direction varies.

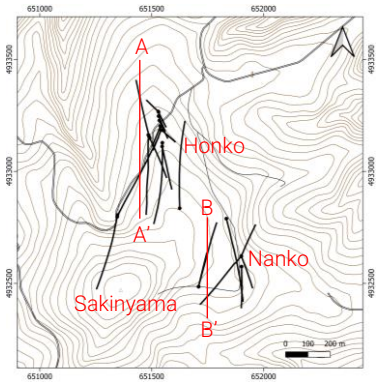
10.90 ppm Au, 72.90 ppm Ag

4.18 ppm Au, 80.50 ppm Ag









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Mineralization

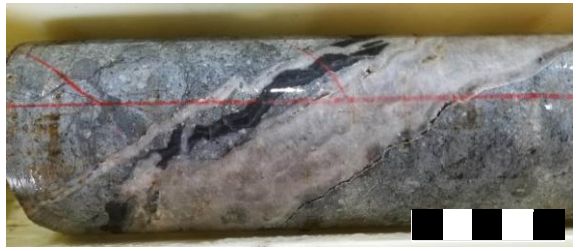
Quartz Veins - Massive

Early dark gray to brown-black massive quartz veins are crosscut by later sugary white massive quartz veins.

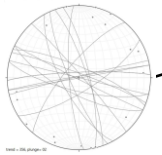
At Honko, massive veins generally strike to the NW.

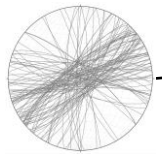
At Nanko, massive veins generally strike to the NE.

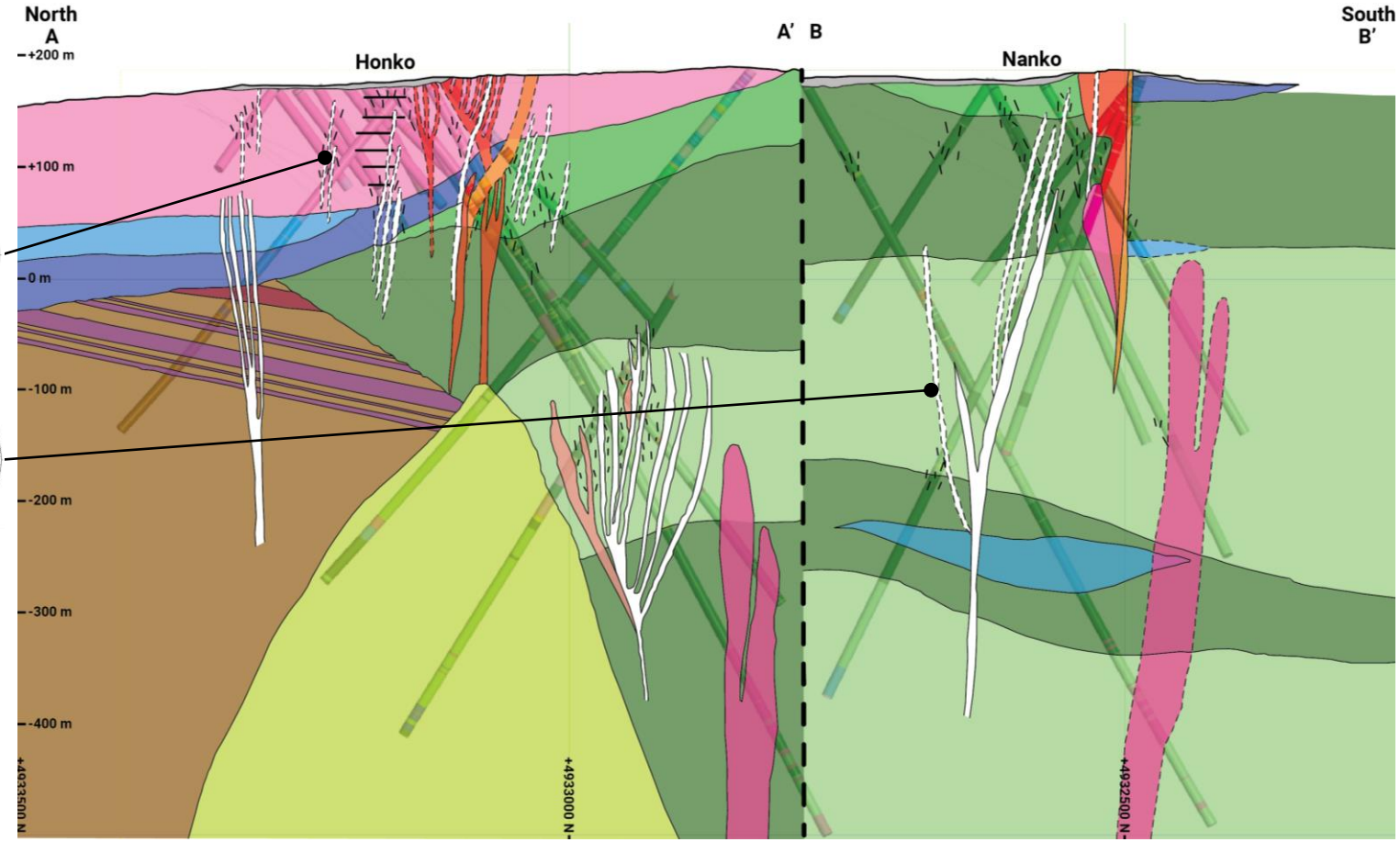
0.309 ppm Au, 49.80 ppm Ag

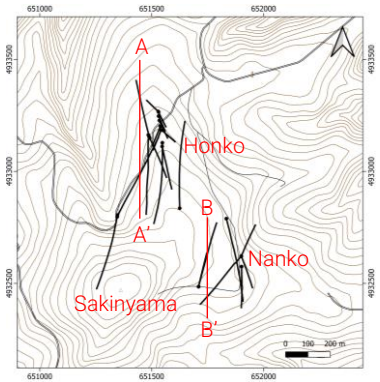


0.221 ppm Au, 18.85 ppm Ag









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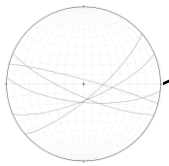
Mineralization

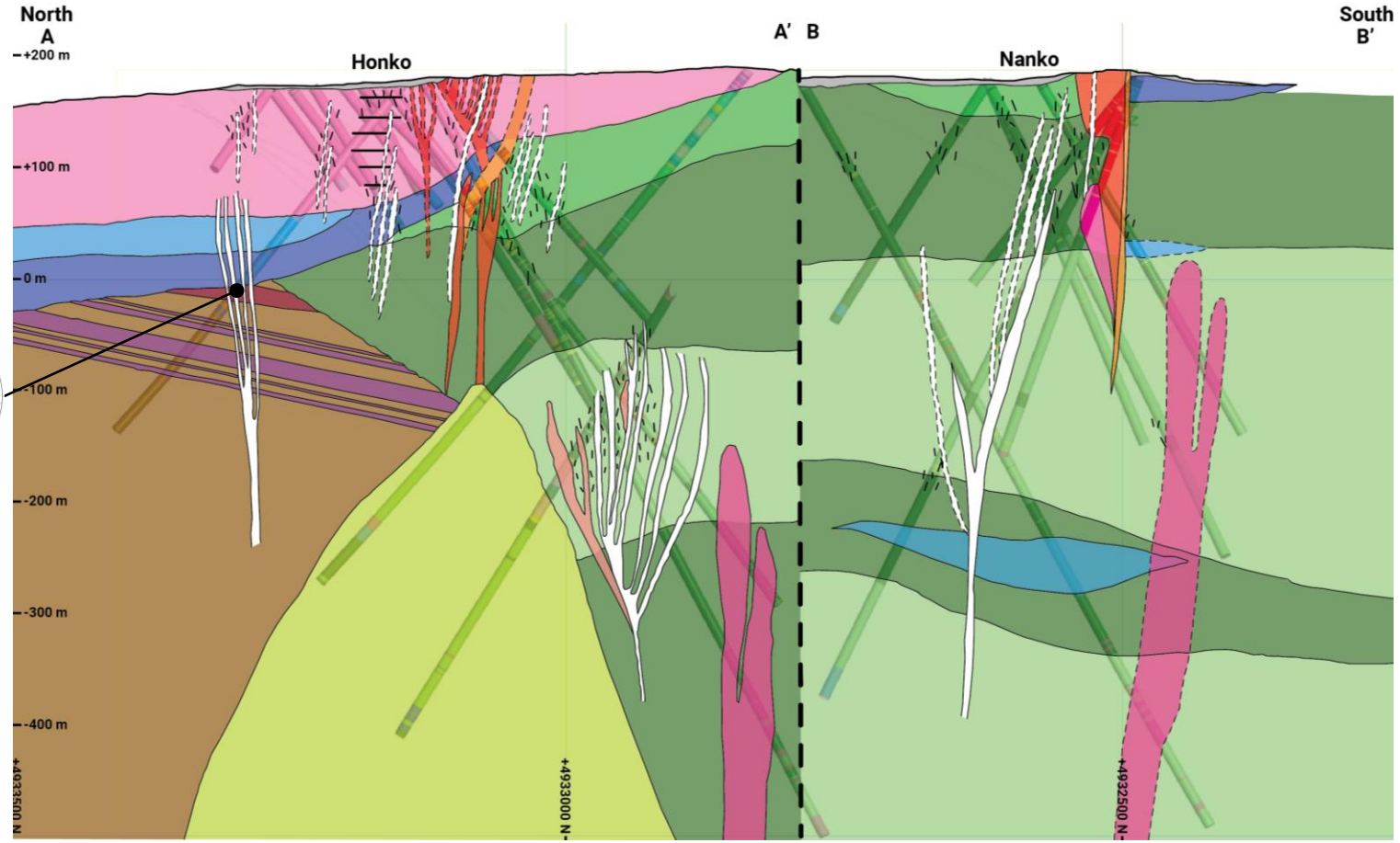
Quartz Veins Crosscutting Sinter Horizon

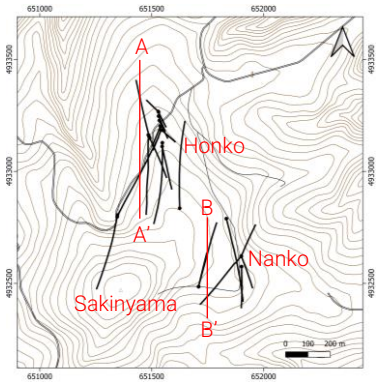
White massive quartz veins crosscut the buried upper silica sinter horizon intersected in hole 21OMI-002.

These veins strike approximately E-W and dominantly dips steeply to the S

0.345 ppm Au, 5.38 ppm Ag







LEGEND

- Alluvium
- Quartz eye and rhyolitic tuff
- Bedded volcaniclastic rocks
- Volcaniclastic rocks
- Andesitic tuff
- Porphyritic andesite
- Flowbanded andesite
- Andesitic intrusive
- Breccia
- Sedimentary rocks
- Upper silica sinter horizon
- Lower silica sinter horizon
- Silica matrix breccia
- Carbonate matrix breccia
- Fault/shear zone
- Vein
- Stockwork zone
- Underground mine workings

Mineralization

Carbonate-Quartz Veins

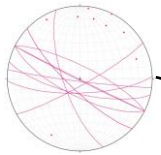
Intercepted at depth in holes 19OMI-010 and 22OMI-001

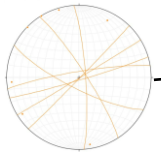
Composed of crustiform, lattice bladed and massive carbonate veins, some partially replaced by silica.

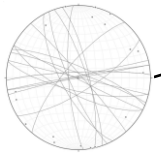
Crustiform veins are generally dipping SW while lattice bladed and massive veins have different orientations.

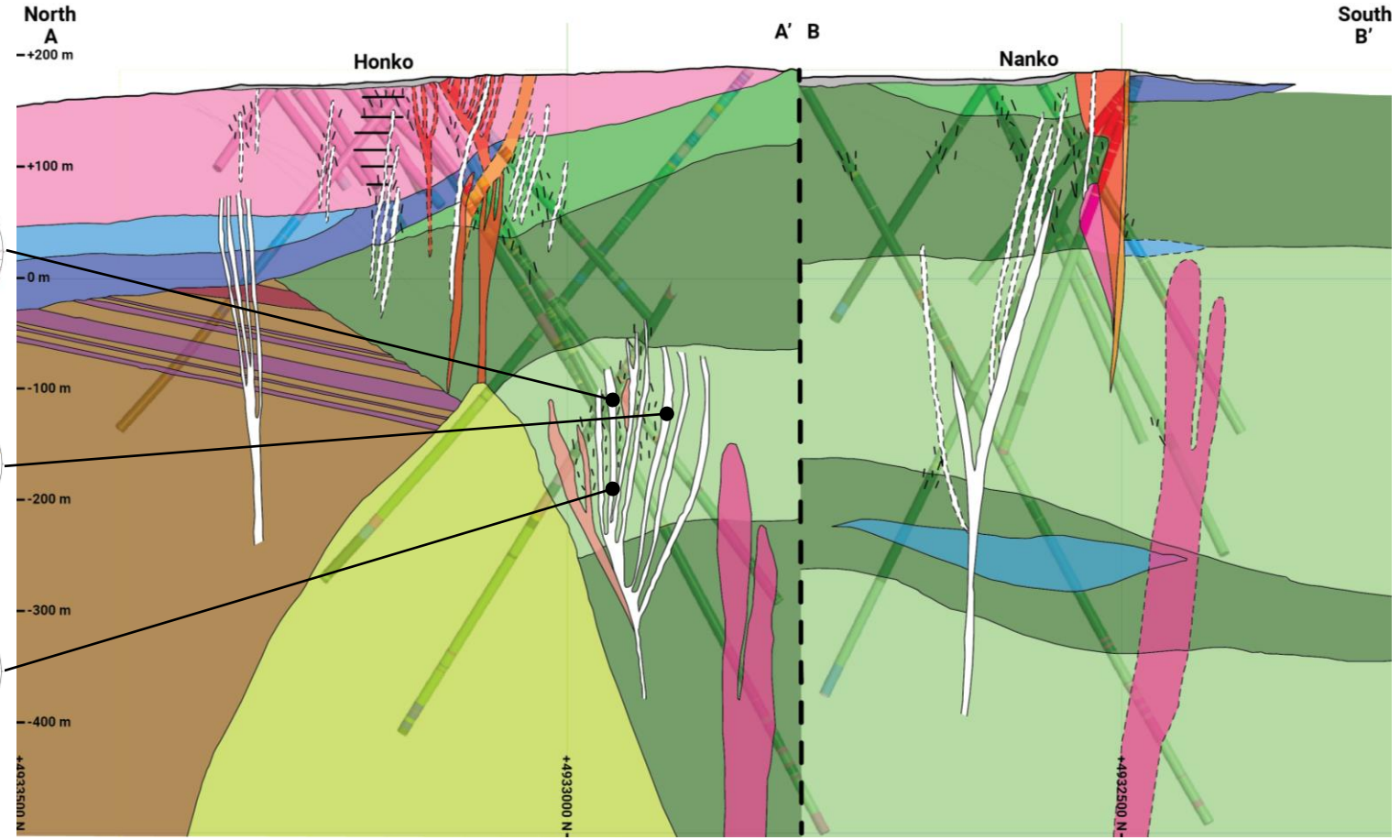
3.59 ppm Au, 27.8 ppm Ag

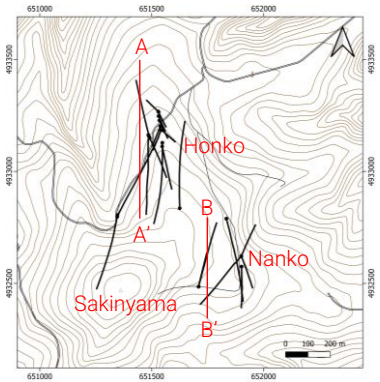
7.55 ppm Au, 155 ppm Ag











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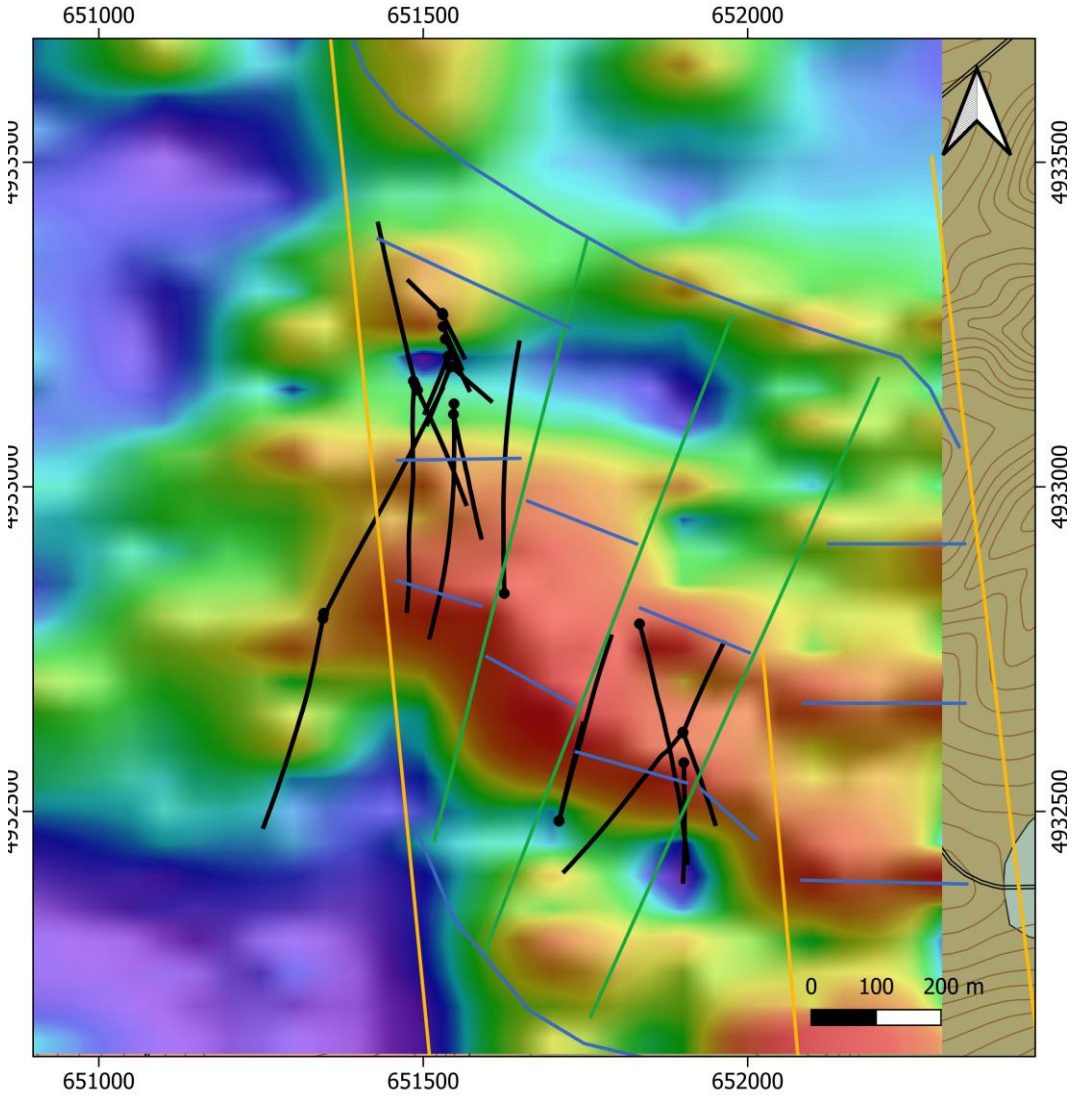
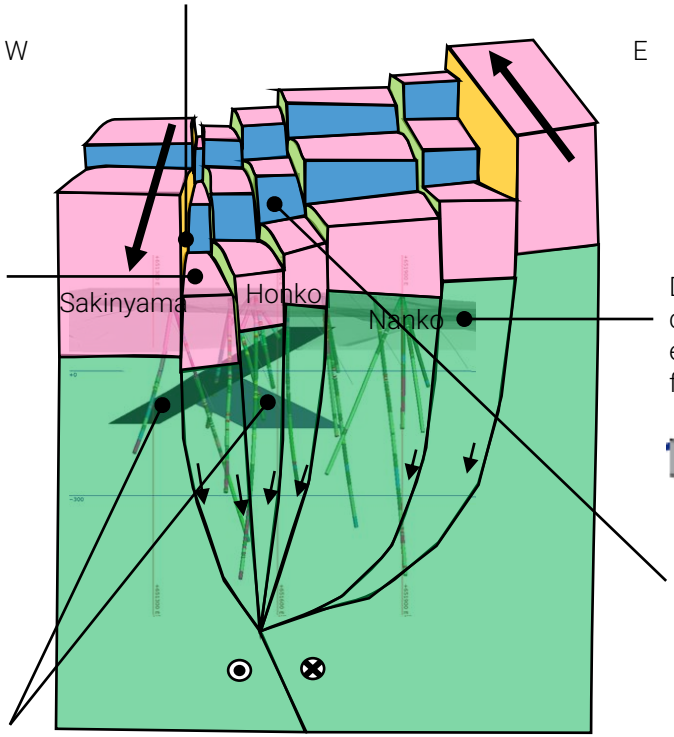
Geological Model



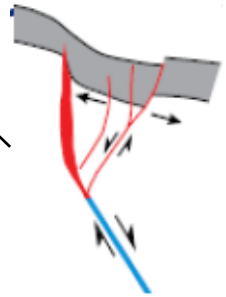
Sinistral fault at the west potentially the limit for mineralization (barren drill hole in Sakinyama)



Downthrown blocks towards the SW explain the SW dip of the rhyolite and andesite flows

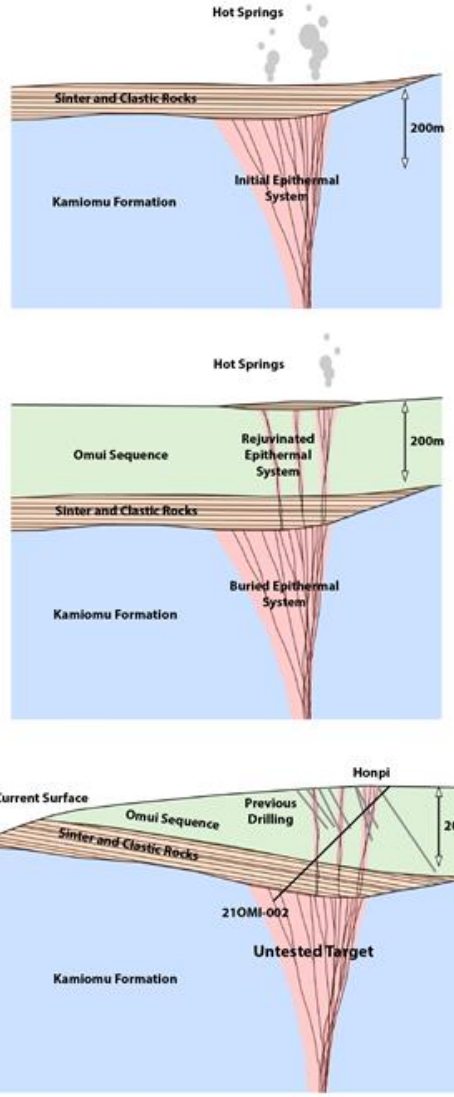
Deeper erosion at Nanko compared to Honko exposing the andesitic flows at Nanko

Two sinter horizons below Honko represent two paleosurfaces. Sinter horizons towards the east of west-bounding sinistral fault were preserved, however, were possibly displaced by structures related to the pull apart basin.



Tilted fault blocks due to S-dipping dip-slip faults are ideal structures for epithermal vein formation

Geological Model

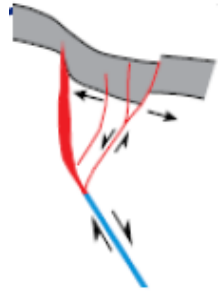


Buried siliceous hot spring deposit

- Indicates an early Miocene age for the initial hydrothermal system contemporaneous with the deposition of the sedimentary sequences of the Kamiomu Formation
- Indicates the discharge of hot near-neutral pH, amorphous silica-saturated fluids in a relatively quiet environment, with temperatures conducive for high T algal matter growth
- Indicates at least 2 paleosurfaces and significant tectonic tilting after the deposition of the lower sinter horizon
- Suggests an association with an early precious metal mineralization due to the significant occurrence of pyrite and the sinter's elevated gold content (and other epithermal pathfinder elements)

Quartz veins cutting across the upper sinter horizon, sinter clasts in silica matrix breccias

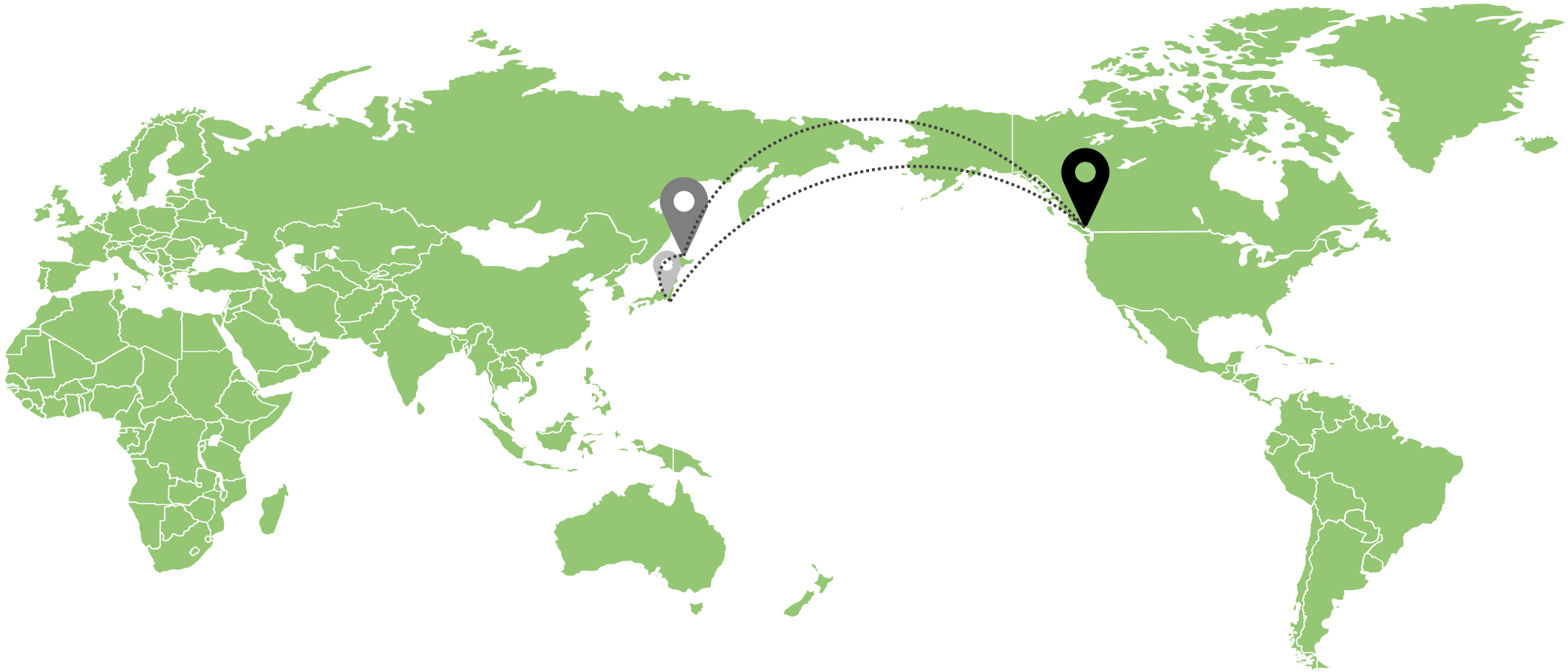
- Indicates the formation of a rejuvenated hydrothermal system contemporaneous or after the emplacement of middle Miocene andesitic to rhyolitic flows of the Propylite Lava and Motoineppu Lava
- Possibly using the same feeder system as the older hot spring system corresponding with the buried silica sinters.
- Veins best develop in dilation zones within or adjacent to structures, consistent with a pull-apart basin model



New avenues for exploration

- High-grade veins were discovered beneath silica sinter outcrops in Omu Sinter prospect and in other analogous epithermal (e.g. Fruta del Norte, Chile and McLaughlin, USA).


Thank you.



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