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A Simple Recipe to Unravel Veladero Mine Mineralization Controls, Argentina

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The Veladero mine, a 50/50 joint venture operation between Barrick Gold and Shandong Gold, is in the Andean Cordillera in Argentina. It is a large open-pit, heap-leach Au-Ag mine in San Juan province that started production in 2005 and has recovered approximately 8.2 million ounces of gold and 16.6 Moz of silver from approximately 319 million tonnes (Mt) of ore averaging 1.09 g/t Au and 14.9 g/t Ag as of December 31, 2017.

The deposit is situated at the El Indio Gold Belt, a 120- by 25-km north-trending corridor composed of a Permian basement and characterized by Miocene volcanic and intrusive rocks with associated epithermal deposits.

Veladero is a high-sulphidation epithermal deposit hosted by volcanic breccias, tuffs, and volcaniclastic sediments. Hydrothermal alteration shows a typical silicified core grading outward into advanced argillic, argillic, and propylitic alteration haloes.

In order to expand the brownfield exploration of the epithermal deposit, a new series of studies were completed in the 3.5-kilometer-long NNW-striking mineralized zone that comprise three orebodies: Amable (mined out) in the south, Cuatro Esquinas in the centre, and Filo Federico in the north.

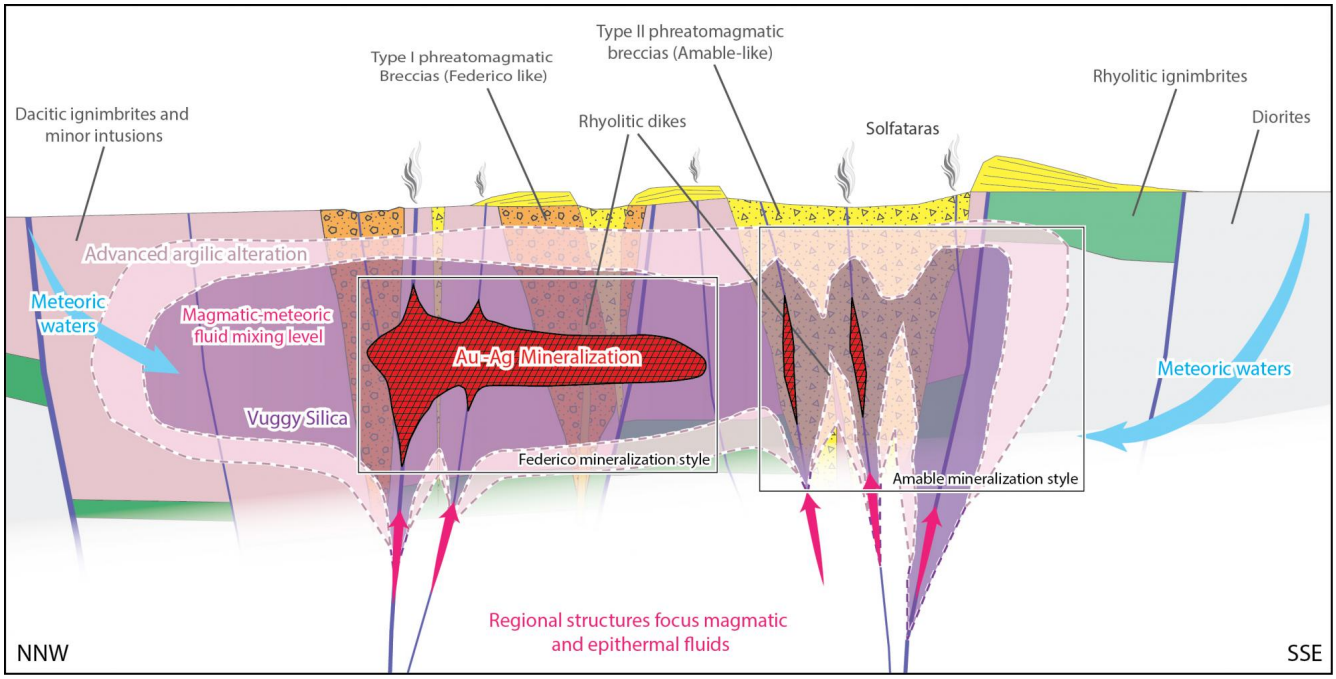
The studies comprise open-pit mapping and logging of 189,585 meters of drill cores and RC cuttings to make detailed geologic, structural, alteration, and mineralization descriptions that were compiled along 70 east-west cross sections, 3 km long and with a 50-meter separation. In addition to these geologic cross sections, a systematic study of the hydrothermal alterations was carried out along the same east-west sections, but with a 200-meter separation. The alteration was characterized with portable TerraSpec with measurements every 10 meters and confirmed by X-ray diffraction and petrographic studies.

The Veladero mine general NNW-striking structural corridor of the epithermal mineralization is reflecting the influence of combined stratigraphic and structural controls, with strong influence of a premineralization intermediate-composition volcanic depocenter that was affected by pre- to synmineralization faulting, intrusions, and two overlapped maar-diatreme complexes (Type I and II phreatomagmatic breccias) that increase permeability for different high-sulphidation events, represented by two main silica flooding pulses.

Circulation of hydrothermal fluids (alteration and silica injections) in Federico is favored by the lithological control of the volcaniclastic sequence (mainly ignimbrites and phreatomagmatic breccias) present in the NNW-striking depocenter (Federico mineralization style). In Amable, alteration and mineralization areas are aligned with N-S and NE directions, evidencing greater structural control (Amable mineralization style).

Au and Ag concentrate in NNW-striking subhorizonal level inclined 15° east, with 300 to 400 meters of vertical development (3,900 to 4,400 m altitude). WNW and N-S fault intersections seem to control the source of the fluids, inferred to the South (Amable) and East (Zorro fault) of Veladero mine, as evidenced by high-temperature minerals: dickite, pyrophyllite, and topaz. This favors the presence of high-grade feeders vectoring towards those sectors.

The geologic model, together with data interpretation, provides ideas to improve exploration and recommendations to increase understanding of the Veladero mine geology and mineralization.


Type II phreatomagmatic breccias (Amable-like)
Type I phreatomagmatic Breccias (Federico like)
Rhyolitic ignimbrites
Dacitic ignimbrites and minor intusions
Rhyolitic dikes
Solfataras
Diorites
Advanced argilic alteration
Meteoric waters
Magmatic-meteoric fluid mixing level
Au-Ag Mineralization
Meteoric waters
Vuggy Silica
Federico mineralization style
Amable mineralization style
Regional structures focus magmatic and epithermal fluids
NNW
SSE