

# GEOLOGY OF THE “ROUND MOUNTAIN” GOLD MINE IN NEVADA, UNITED STATES OF AMERICA, AND POTENTIAL FOR EXPLORATION OF SIMILAR DEPOSITS IN THE ANDES

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## SYNOPSIS

*Round Mountain* is one of the world's largest volcanic rock-hosted gold deposits, of the disseminated, low-sulfidation epithermal type. This article offers a brief version of the mine's more relevant issues and some comments on the exploration of similar deposits in the Andean Cordillera. *Round Mountain's* reserves amount to more than 500 tons of metallic gold. Permeable pyroclastics bound by impermeable rocks host mineralization and alteration. Mineralizing fluids migrated along concentric and radial fractures related to a caldera. Mineralization and alteration processes took significantly less than 500,000 years. Case studies in Quaternary to upper Tertiary volcanic edifices in the Colombian, Ecuadorian and Peruvian Andes contain disseminated gold mineralization in porous-permeable pyroclasts bound by impermeable lavas and/or welded tuffs.

## KEY WORDS:

Andes, Caldera, Colombia, Ecuador, Galeras volcano, gold, hydrothermal alteration, Guagua-Pichincha volcano, Hilaló volcano, hydrothermal ore deposit, leaching, low sulfidation, mineral exploration, Nevada, Nevado del Ruiz volcano, ore deposit, Perú, precious metal, pyroclastic rock, Quaternary, Round Mountain, tuff, United States of America, volcanic rock.

## MAIN BODY

*Round Mountain* is one of the world's largest volcanic rock-hosted gold deposits. It is located in the Basin and Range geological province of the south-western United States of America, between the towns of Tonopa and Austin, Nevada. Some authors consider the mine to be a typical epithermal low sulfidation deposit. It has been mined since 1905, and its reserves amount to more than 500 tons of metallic gold.

Gold content at this deposit is in the order of ten parts per billion, and the lowest economic concentration is 0.2799 gAu/ton. Miocene, porous and permeable tuffs (aquifers) bounded by impermeable welded tuffs and crystalline basement (aquitards) host mineralization. Concentric fractures related to caldera margins and radial fractures of the same caldera served as routes for mineralized fluid flow; hydrothermal alteration and mineralization extends outward from these thin mineralized fractures along the porous, permeable tuffs limited by impermeable units in a “sandwich” fashion (Figs. 1, 2). Fig. 3 presents a typical low-sulfidation epithermal gold deposit model; note the way in which mineralization and alteration extend along favorable, permeable layers to produce disseminated precious metal concentration. Round Mountain is one of the best examples of this type of mineralization.

Alteration types are propylitic, phyllic, silicification and argillization, and there is no direct relationship between ore grade and alteration. Based on radiometric dating, all mineralization and alteration at *Round Mountain* lasted between 50,000 and 500,000 years; it is thought to have taken considerably less than 500,000 years to form (HENRY et al [1997]). Establishing average gold grade in this type of deposits requires detailed studies, since grade may vary up to four orders of magnitude within 10 centimeters. Occasional gold nuggets (some of which weigh over one pound) are found along intersection of main fractures and are sought with metal detectors.

The mine uses novel, re-usable heap leaching pads.

Colombia, Ecuador and Perú have a reasonable potential for gold deposits hosted in volcanic strata such as those present at *Round Mountain*. Repetitive explosive composite volcanic activity in southern Colombia has exposed numerous mineralized tuffs and ash layers. Galeras Volcano, one of the best studied in the region, expels 0.5 kg of gold per day to the atmosphere in its fumaroles, and is probably depositing more than 0.06 kg Au/day in the volcanic edifice (GOFF et al [1994]). If such rates remain constant, a moderately sized gold deposit (more than 200 tons of contained gold) may form in only 10,000 years. If an equivalent amount is left behind in porous volcanic rocks, a short lapse of hydrothermal activity may produce deposits such as *Round Mountain*. These observations do not take into account moments of great activity and explosive vulcanism, when fumarolic activity increases and several type of hydrothermal breccia are formed.

Nevado del Ruiz, in the axis of the Colombian Central Cordillera, is another Quaternary volcanic system studied by the author. It contains important epithermal gold dissemination associated with tuff layers limited by andesite lava aquicludes. Mineralization is conditioned to more than eight porous, permeable, pumice-rich pyroclastic layers. The system is of the high sulfidation type, since alunite conforms a large portion of the matrix in breccias and mineralized tuffs.

Ecuador also has numerous recent volcanic edifices, that are well exposed by lateral explosions. Several volcanoes in the Interandean Graben, such as Hilaló and Guagua-Pichincha are open to the west due to preferential collapse of volcanic edifices in that direction, where unidirectional wind regimes tend to erode away the ash and other components. Cerro Bravo and Nevado del Ruiz volcanoes in Colombia display clear evidence of lateral explosions.

Large extensions of Eocene to Oligocene volcanic rocks outcrop in the Peruvian Andes. They are older, display more erosion than their counterpart in the Northern Andes, and in some cases offer ideal conditions for entrapment of precious metals in *Round Mountain* style. Numerous high explosivity rhyolitic events, intercalated with pyroclastic, cineritic and welded tuff events produced monotonous sequences of porous and non-porous volcanic rocks.

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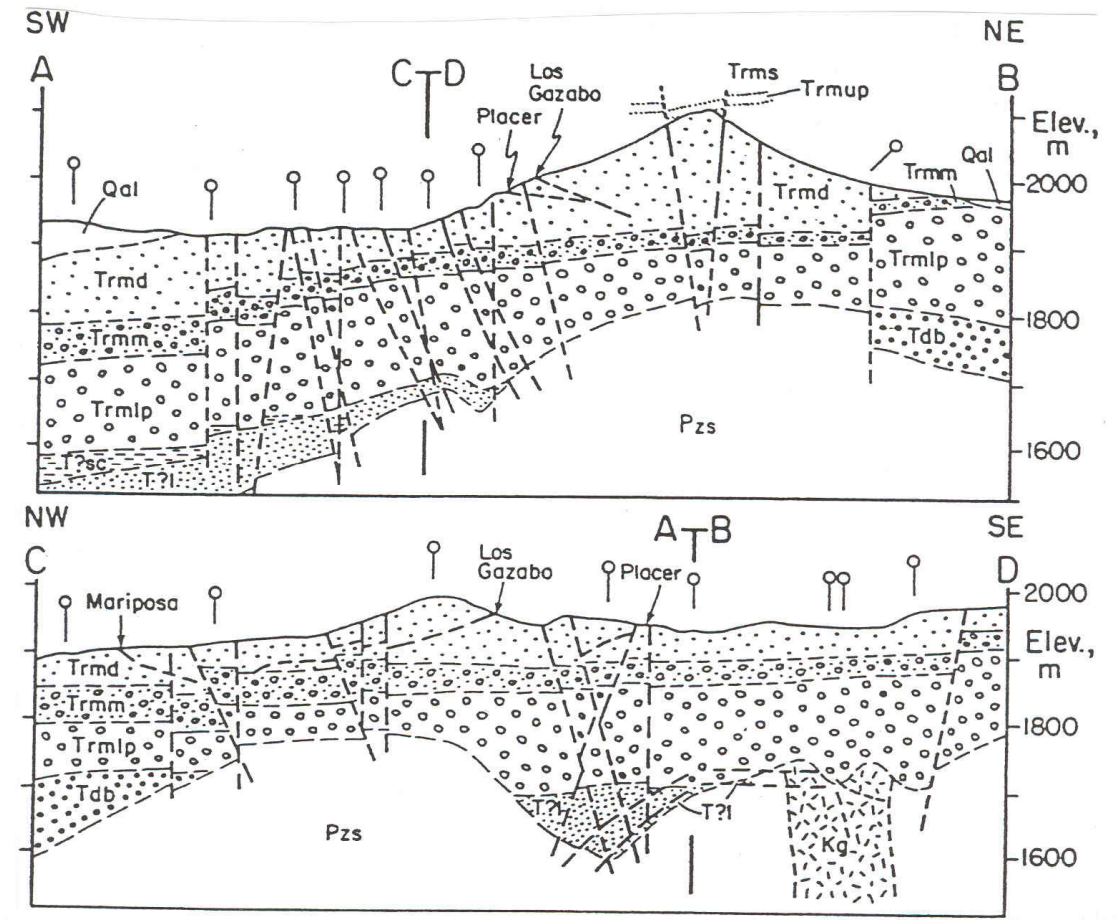
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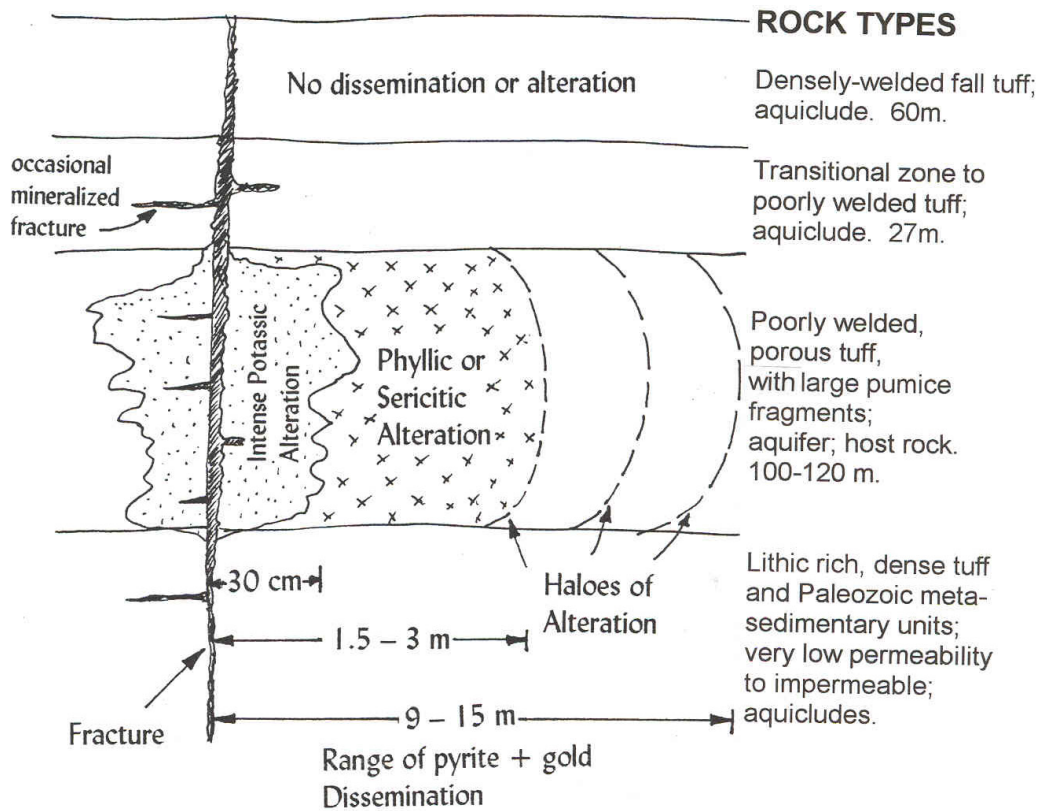
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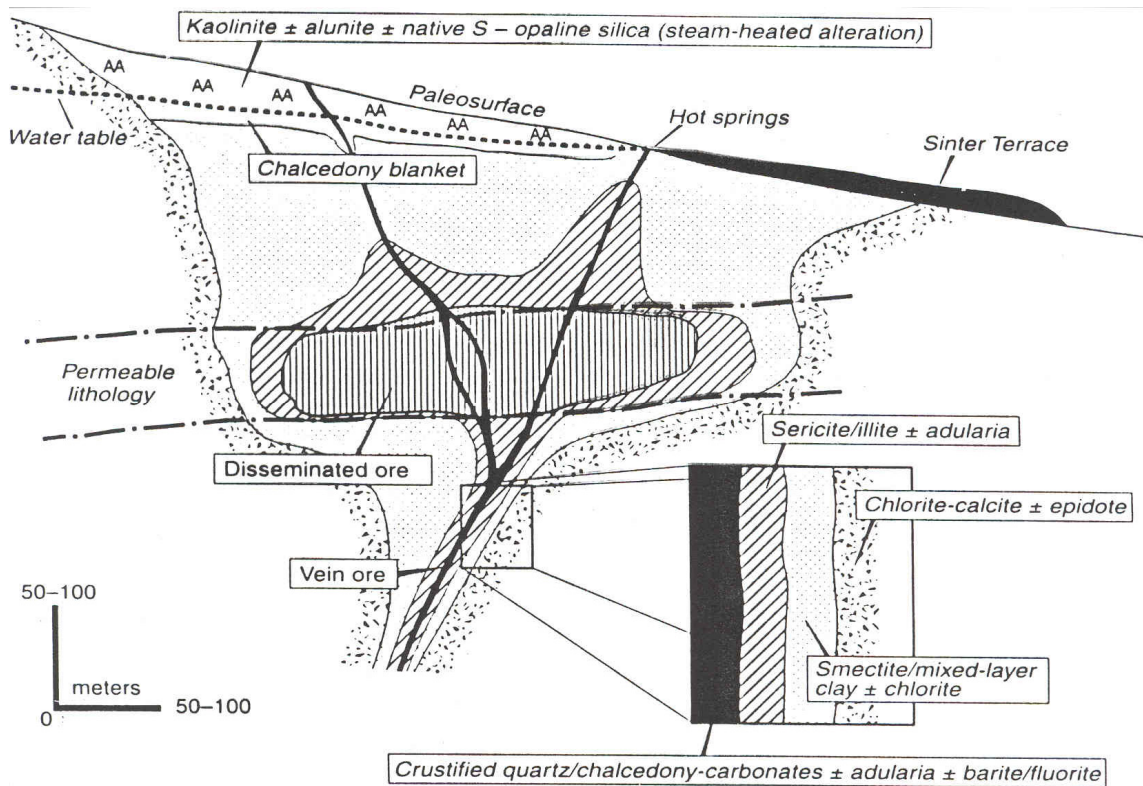
**Fig. 1 Cross sections through the *Round Mountain* deposit.**

Trmlp is a non-welded tuff limited by welded tuffs above and impermeable crystalline basement below. It hosts a large portion of the mine's ore. Thin fractures served as feeders for mineralization that spread out along permeable beds. (From SANDER et al [1990])



**Fig. 2 Ranges of alteration in different types of rock at the Round Mountain mine.**

Hydrothermal fluids migrated along thin fractures and away from them along permeable tuffs to produce alteration and gold dissemination. Pyrite and precious metals mineralization is found up to fifteen meters away from individual fractures. Note that Trmlp from Fig.1 is the poorly welded porous tuff. (LOBO-GUERRERO [2001])



**Fig. 3 Generalized schematic section of alteration patterns in a low-sulfidation epithermal system.** Note widening of alteration and mineralization that takes place along favorable host rock lithology. The *Round Mountain* case is one of the best examples of this feature. The section shows variations along depth, typical hydrothermal alteration including distribution of sinter, advanced argillic alteration (AA), alteration produced by hot springs, and silicification associated with water table. Geological variations in specific deposits offer multiple deviations from this model. (Modified from HEDENQUIST et al [2000])