Hog Ranch gold property, northwestern Nevada: age and genetic relation of hydrothermal mineralization to coeval peralkaline silicic and associated basaltic magmatism

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HOG RANCH GOLD PROPERTY, NORTHWESTERN NEVADA: AGE AND GENETIC RELATION OF HYDROTHERMAL MINERALIZATION TO COEVAL PERALKALINE SILICIC AND ASSOCIATED BASALTIC MAGMATISM

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The Hog Ranch property, located approximately 35 miles north of Gerlach in northwestern Nevada (fig. 1), is a low-grade bulk-mineable gold deposit hosted largely by silicified rhyolite. Western Goldfields, the present operator, has announced reserves of approximately five m.t. of heap-leachable ore averaging about 0.8 oz/ton Au with a stripping ratio of 2.5:1 (Anonomous, 1986). The property is presently (October, 1986) in production. The purpose of this paper is to present radiometric ages for the host rocks and for hypogene alunite formed during the hydrothermal event and to discuss the relation of mineralization to highly evolved peralkaline silicic volcanic rocks that probably represent the early magmatic activity of an incipient caldera system and to mafic magmas and rocks that are inferred to have been present at depth.

GEOLOGIC SETTING

The peralkaline rhyolite that hosts the Hog Ranch deposit is part of a large field of high-silica peralkaline rhyolite of middle Miocene age that extends over an area of roughly 1,500 square miles in northern Washoe and westernmost Humboldt Counties, Nevada (Bonham, 1969; D. C. Noble, unpub. data). Many of the rhyolites in the region are aphyric, and most of the remainder contain less than 10 percent phenocrysts of sanidine and quartz. Vapor-phase and/or groundmass sodic amphibole can be found in some samples, showing that some, and probably all, of the rhyolites are slightly peralkaline (comenditic), as are other rhyolitic tuffs and lavas of middle Miocene age in the region (Noble and others, 1968; 1970; Korringa, 1973). The obsidians are highly evolved chemically, and have very low concentrations of such elements as Sr, Ba, Eu, Co, and Mg (Noble and others, 1979).

The rhyolites (Cañon Rhyolite of Bonham, 1969) interfinger with closely associated petrographically and chemically similar nonwelded to densely welded tuffs of air-fall, ash-flow and surge origin as well as with reworked tuffs and tuffaceous sedimentary rocks. The rhyolites typically possess well-developed flow foliation and ramp structures, and many distinct vent areas can be recognized from the flowage patterns (cf. Korringa, 1973). Field relations (e.g., Park, 1983) suggest that some, and perhaps most, of the rhyolites are air-fall (agglutinate) and perhaps ash-flow tuffs that have densely welded and undergone secondary fluid flowage after deposition.

The Hog Ranch property is located on the southern portion of a donut-shaped body of flow-banded peralkaline rhyolite that surrounds and interfingers with a sequence of bedded and nonwelded rhyolite tuffs. This feature, mapped by Bonham (1969), is very obvious on aerial photographs and even on satellite images. A number of vent areas, defined by concentric flow patterns (ramp structures) (cf. Korringa, 1973), define a NE-SW elongated oval vent zone about 10 by 15 miles in diameter. Cottonwood Creek flows through the central part of this zone, and we herein

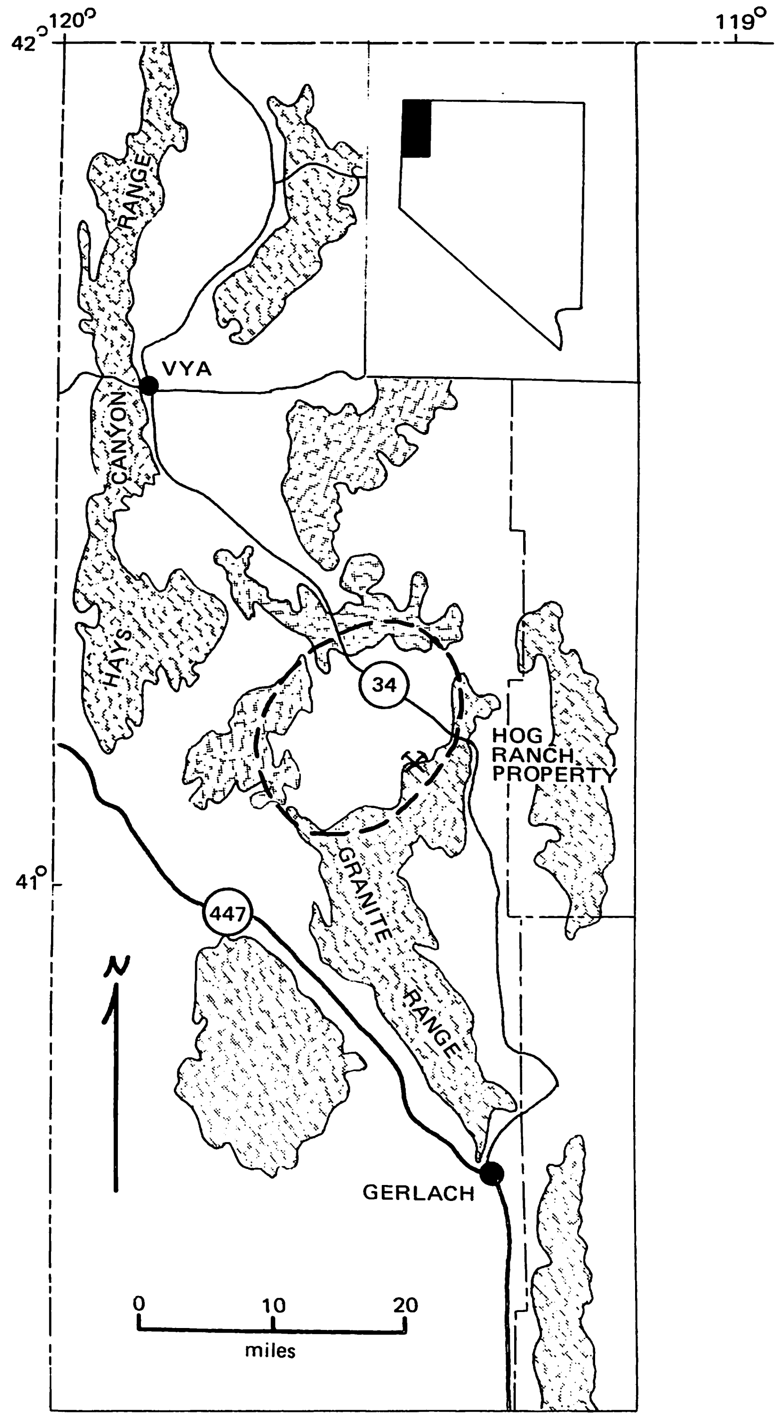

FIGURE 1. Map showing location of Hog Ranch property. Heavy dashed line indicates approximate location of inferred incipient ring structure and arcuate fissure-vent system.

term this volcanic feature the Cottonwood Creek volcanic center. Although some workers have suggested that the Cottonwood Creek center is a collapse caldera, no outflow sheet is associated with it. A more likely possibility is that it represents a "failed" caldera system, with "precursor" magmas having erupted from a number of vents located along a ring-fracture system, but with no large-volume ash-flow eruption or major caldera collapse. The highly differentiated peralkaline rhyolites would reflect the most highly differentiated portion of the magma system as do, for example, the highly evolved subalkaline rhyolites of Glass Mountain of the Long Valley caldera system (Noble and others, 1972, 1979; Metz and Mahood, 1985).

HYDROTHERMAL ALTERATION AND MINERAL DEPOSITS

Within the area of the Hog Ranch deposit the peralkaline rhyolites, including tuffs and dense rhyolite of pyroclastic and/or flow origin—have been pervasively hydrothermally altered (D. S. Harvey, unpub. data). Rocks exposed on the surface in the outer parts of the district have been strongly opalized and in many places in the central part of the altered and mineralized area have been converted largely to kaolinite. Resistant ledges of chalcedony and zones containing coarse-grained hypogene alunite or smectite clay are present within the zone of kaolinitic alteration. At depth the kaolinite zone is underlain by rocks containing hydrothermal adularia. Gold values are largely found, and are highest, in the more intensely silicified (chalcedony) rocks. Geological reconstruction of the land surface at the time of hydrothermal activity and the vertical zonation pattern of the alteration suggest that mineralization took place within a few hundred meters of the surface.

AGE OF HOST ROCKS AND MINERALIZATION

Although the host rocks in the immediate vicinity of the deposit are pervasively silicified, and contain no mineral that can be dated by K-Ar methods, we have obtained an age of 15.1 ± 0.4 m.y. on a specimen of nonhydrated obsidian (HOG-MOB) from the same sequence of peralkaline rhyolite exposed 2.5 miles northeast of the deposit. In addition, an age of 15.5 ± 0.4 m.y. (recalculated using presently accepted constants) was reported by Noble and others (1970, specimen NN-21B-NG) for a specimen of lithologically identical peralkaline rhyolite obsidian collected about 12 miles west-southwest of the property. We have also obtained an age of 15.2 ± 0.4 m.y. on coarse-grained hypogene alunite (HR-56) from within the area of hydrothermal alteration about one mile west of the deposit. This age is within the limits of analytical uncertainty of the radiometric ages obtained on the two specimens of rhyolite obsidian.

DISCUSSION AND CONCLUSIONS

Gold mineralization at the Hog Ranch property is closely associated both spatially and temporally with large-scale peralkaline silicic volcanism, and with a probable major ring-fracture system. Although peralkaline rhyolites commonly contain high concentrations of uranium (e.g., Stuart and others, 1983) or are closely associated with uranium mineralization (e.g., Roper and Wallace, 1981), a genetic association with gold has not been generally recognized. However, the peralkaline rhyolites of the northwestern Basin and Range province belong to a bimodal suite that includes voluminous basalt (Steens Basalt and voluminous correlative lavas in northwestern Nevada; Noble and others, 1970; Hart and Carlson, 1985). Basalts of the Columbia River Basalt Group, which are of very similar age, composition, and tectonic setting to the correlatives of the Steens Basalt in northwestern Nevada, have a relatively high (0.5 to 11 ppb, median 3.2 ppb) gold concentration (Gottfried, Rowe, and Tilling, 1972), a feature that appears to be common in continental basalts. Moreover, there is some suggestion that gold contents increase during the differentiation of continental tholeiitic magmas (Gottfried, Rowe, and Tilling, 1972). Iron-rich andesite (icelandite) and ferrodacite differentiates are present at the McDermitt caldera complex (Wallace and others, 1980), and similar intermediate to silicic lavas appear to be present between High Rock Canyon and Summit Lake in westernmost Humboldt County, Nevada. We speculate that the gold of the Hog Ranch property may have been derived from basaltic or derivative iron-rich intermediate magmas and/or rocks that were present at depth when the Cottonwood Creek magmatic-hydrothermal system was active. A similar source may have provided the gold for the relatively gold-rich deposits of the National district (Vikre, 1985) and the Sleeper Mine in northwestern Nevada, which also were formed at about the same time as the widespread Columbia River-Steens episode of basaltic and basalt-related magmatic activity.

SAMPLE DESCRIPTIONS

1. *HOG-MOB* K-Ar
Peralkaline rhyolite obsidian (41°10.3′N,119°24.7′W; Butte Spring 7.5′ quad.; Washoe Co., NV); float block from concentration of nonhydrated glass blocks weathering from glassy zone of peralkaline rhyolite. *Analytical data:* K_2O = 4.73 wt. %; $^{40}Ar^*$ = 1.03568×10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar^*$ = 87.8%. *Collected by:* D. C. Noble.
(whole rock) 15.1 ± 0.4 m.y.

2. *HR-56* K-Ar
Coarse-grained hydrothermal alunite (41°08.8′N, 119°28.8′W; Butte Spring 7.5′ quad.; Washoe Co., NV) from hydrothermally silicified peralkaline rhyolite. *Analytical data:* K_2O = 10.76 wt. %; $^{40}Ar^*$ = 2.3663×10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar^*$ = 52.9%. *Collected by:* D. S. Harvey.
(alunite) 15.2 ± 0.4 m.y.

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