Age of mineralization at the Cailloma and Orcopampa Silver districts southern Peru

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AGE OF MINERALIZATION AT THE CAILLOMA AND ORCOPAMPA SILVER DISTRICTS, SOUTHERN PERU

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Cailloma and Orcopampa, two major producing epithermal silver districts, are located in the high plateau province of southern Peru, approximately 150 km north and northwest, respectively, of the city of Arequipa (fig. 1). The veins of the Cailloma district have been worked essentially continuously for more than 100 years, and mining operations are presently under the control of a subsidiary of Mauricio Hochschild y Cia. Ltda. S.A. Modern operations in the Orcopampa district have been carried out since 1965 by Cia. de Minas Buenaventura S.A. Total production at Cailloma and Orcompampa are, respectively, approximately 100 million and 50 million ounces of silver.

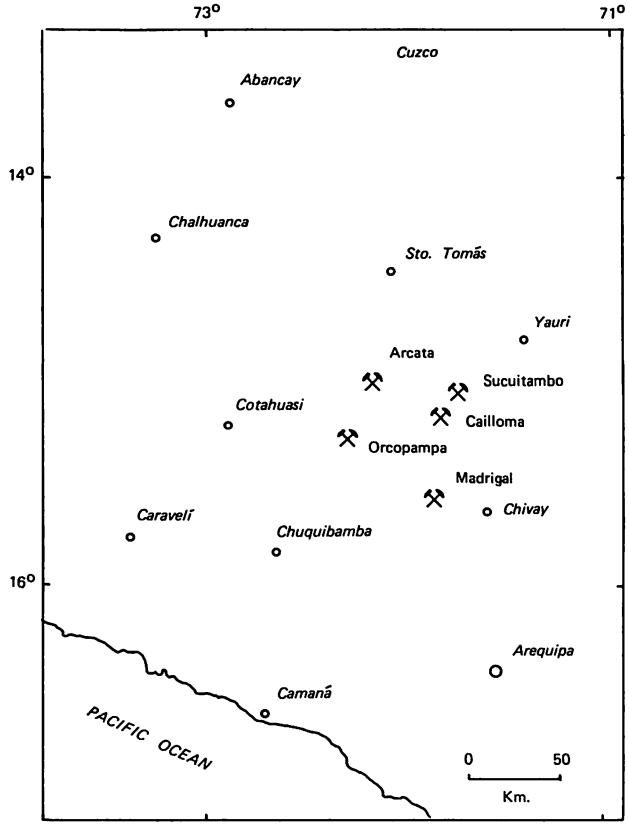

FIGURE 1. Map showing location of Cailloma and Orcopampa silver districts, southern Peru.

GEOLOGICAL SETTING AND MINERAL DEPOSITS

The geology and ore deposits of the districts have been described by Stephan (1974), Arenas Figueroa (1975), Fornari and Vilca Neyar (1979), and Hackbarth and Petersen (1984). Additional unpublished work on the districts has been done by company geologists, Ulrich Petersen, and D. C. Noble.

Both districts contain classic epithermal silver veins. Very significant gold values were present in the upper levels of the San Cristobal vein, the most important structure at Cailloma, and ores with major gold values have recently been discovered in the Calera vein at Orcopampa. At Cailloma silver occurs in a variety of silver sulfosalt minerals and in tetrahedrite, whereas at Orcopampa silver occurs almost entirely in tetrahedrite. Gangue minerals are mainly quartz, manganese silicates and carbonates, and calcite. At Cailloma the veins exhibit evidence of repeated tectonic movement during mineralization. The vein material at Orcopampa possesses textures suggestive of repeated hydrothermal brecciation.

The veins at Cailloma are hosted by lavas, breccias, and associated pyroclastic and epiclastic strata of intermediate composition that are probably of late Oligocene or early Miocene age. Mineralization may be genetically related to magmatic activity reflected at the surface by hydrothermally altered silicic dikes that cut the intermediate rocks and predate the vein systems. At Orcopampa the veins are hosted largely by rhyolitic ash-flow tuffs that have been dated at 19.5 m.y. (Noble and others, 1974). Directly east of the district in the Cordillera Shila, these tuffs are overlain by voluminous intermediate lavas that may conceal their source areas.

Wall rocks adjacent to the veins of both districts have been subject to locally strong potassium metasomatism that produced rocks rich in adularia, which has been used to date the hydrothermal activity.

RADIOMETRIC DATING

The hydrothermal activity at the two districts has been dated at about 16 to 17.5 m.y. For Orcopampa we have obtained a single age of 17.0 ± 0.5 m.y. on an impure concentrate of fine-grained hydrothermal adularia from sample ORCO-K, which consists of altered rhyolitic tuff collected adjacent to the Manto vein. Better control is available for Cailloma. Two ages of 17.1 ± 0.7 and 16.3 ± 0.5 m.y. were obtained on impure concentrates of hydrothermal adularia from samples FDEM-2 and CAI-22, which were collected from two of the altered pre-mineral dikes adjacent to major veins. In addition, we have obtained an age of 15.8 ± 0.5 m.y. on pure vein adularia from the San Cristobal vein.

DISCUSSION

Cailloma and Orcopampa are the oldest of the many epithermal precious-metal districts that have been dated in Peru, with mineralization shortly postdating the Quechua 1 pulse of compressive deformation (McKee and Noble, 1982; Megard and others, 1984). Other dated precious-metal districts in southern Peru are about 11.5 m.y. old (Sucuitambo; Peterson and others, 1983) or younger (E. H. McKee and D. C. Noble, unpub. data), although other districts, for example Madrigal and San Juan de Lucanas (Bellido and de Montreuil, 1972), may be of similar age to Cailloma and Orcopampa.

Constants used in calculating the ages are: $\lambda_\beta = 4.962 \times 10^{-10}$ yr^{-1}; $\lambda_{\epsilon+\epsilon'} = 0.581 \times 10^{-10}$ yr^{-1}; and $^{40}K/K = 1.167 \times 10^{-2}$.

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SAMPLE DESCRIPTIONS

1. *ORCO-K* K-Ar
Rhyolitic ash-flow tuff (adjacent to Manto vein, Orcopampa district, Peru). *Analytical data:* K_2O = 6.31, 6.35, 6.36, 6.37%; $^{40}Ar^*$ = 1.563×10^{-10} moles/gm; $^{40}Ar^*$ = 40%. *Comments:* Hydrothermally altered rock consists of fine-grained aggregate of adularia, quartz, and sericite. Sample dated was modified whole-rock material in which the amount of adularia had been slightly increased by magnetic and heavy-liquid methods.
(impure adularia) 17.0 ± 0.5 m.y.

2. *FDEM-2* K-Ar
Dacite (15°10'40"S,71°51'30"W; adjacent to Flor del Mundo segment of San Cristobal vein, Cailloma district, Peru). *Analytical data:* K_2O = 4.96, 4.97, 4.99, 5.00%; $^{40}Ar^*$ = 1.232×10^{-10} moles/gm; $^{40}Ar^*$ = 29%. *Comments:* Hydrothermally altered rock consists largely of a fine-grained aggregate of quartz, adularia, and sericite. Sample dated was modified whole-rock material.
(impure adularia) 17.1 ± 0.7 m.y.

3. *CAI-22* K-Ar
Dacite (15°10'50"S,71°51'00"W; adjacent to Bateas vein, Cailloma district, Peru). *Analytical data:* K_2O = 12.14, 12.24%; $^{40}Ar^*$ = 2.868×10^{-10} moles/gm; $^{40}Ar^*$ = 54%. *Comments:* Hydrothermally altered rock consists largely of a fine-grained aggregate of adularial, quartz, and sericite. Sample dated was modified whole-rock material.
(impure adularia) 16.3 ± 0.5 m.y.

4. *ADU-SL-10B* K-Ar
Vein adularia (10th level San Cristobal vein, Cailloma district, Peru.) *Analytical data:* K_2O = 15.01%; $^{40}Ar^*$ = 3.436×10^{-10} moles/gm; $^{40}Ar^*$ = 52%.
(adularia) 15.8 ± 0.5 m.y.

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