

COMPOSITION OF PERUVIAN NATIVE GOLD¹

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Abstract. Gravimetric analyses of Peruvian placer gold, obtained in the form of irregular grains, showed a gold content exceeding 90% with silver as the other major component. Iron was found as a frequent minor component and may be in the form of either disseminated hematite or magnetite. These specimens did not have weighable amounts of copper. It is suggested that iron occurs in Peruvian placer gold in higher proportion than in native gold from other regions of South America.

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Fire assay has been and still is the method customarily employed for the quantitative testing of native gold found in Peru. Though very satisfactory from a commercial standpoint, this method is not so from a scientific standpoint because no determinations are made of small proportions of individual base metals that may be contained in the gold. The only previous quantitative wet analyses of specimens of Peruvian native gold are apparently those reported by Antonio Raimoni (Petersen 1970). The results of these analyses are listed in table 1. Whether all the specimens were placer gold is uncertain.

The specimens were collected by Dr. Georg Petersen of Lima and sent to the author for analysis by Professor Heather Lechtman of the Massachusetts Institute of Technology. All specimens contained over 90% gold, the average being 93.5%. This is close to the average of 92.8% for Raimoni's specimens in table 1, in spite of the differences in the distribution and range of gold content for the two sets of specimens.

The silica content of the Rio Sandio specimen (No. 1) of table 2 was mainly due to quartz grains imbedded in the surface and trapped in the crevices of this specimen. In contrast to specimens in

TABLE 1
*Raimoni's analyses of specimens of Peruvian native gold**

No.	Locality	% composition by weight				
		Au	Ag	Cu	Fe	Total
1	Challuma	97.30	2.40	0.03	0.05	99.78
2	Ccapac-Orcco	97.10	1.80	0.04	0.80	99.74
3	Quimsamayo	96.46	2.50	0.04	0.30	99.30
4	Ninamahua	89.20	4.80	6.50	—	100.50
5	Pallasca	84.30	8.40	7.60	—	100.30

*Not certain that all specimens were placer gold (Petersen, 1970).

The results of gravimetric analyses by the author of specimens of Peruvian placer gold in the form of irregular grains are shown in table 2. See Caley and Shank (1968) for details of the methods.

table 1, the placer gold specimens did not contain weighable amounts of copper. The most unexpected result of these new analyses is the presence of iron in excess of 1% in four of the specimens (table 2). In table 1 the Quimsamayo specimen (No. 3) percentage of iron is equal to the percentage of silver and in the Nina-

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TABLE 2
Caley's chemical analyses of specimens of Peruvian native gold

No.	Locality	Weight (g)	% composition by weight			
			Au	Ag	Fe	Total
1	Rio Sandia	0.7235	93.34	3.95	0.79	99.96**
2	Vetasmayo	0.3960	90.45	6.42	2.54	99.41
3	Llamillami*	0.1660	94.9	2.1	2.1	99.1
4	San Juan*	0.0697	98.0	0.6	1.1	99.7
5	Ancoccala*	0.0363	90.9	7.5	1.3	99.7

*The results for No. 3 to 5 are to one decimal place because of the small amount of material available for analysis.

**Including 1.88% SiO₂.

mahua specimen it is almost double that of the silver. In view of the chemical activity of iron it was probably not present as metal, as is conventionally listed in the table, but as oxide. The low totals of the analyses of the Ccapac-Orcoo and Quimsamayo specimens (table 1) strongly indicate the presence of undetermined oxygen, and this could only have been attached to the iron. If the percentages of iron in table 2 are calculated as the two possible oxides, then the totals of the analyses are as shown in table 3. These totals tend to indicate that the iron was in the form of Fe₃O₄ (magnetite) rather than Fe₂O₃ (hematite). The transitory appearance of fine black specks during the dissolution of the Vetasmayo (table 2) also tends to indicate magnetite. Because no iron oxide was superficially visible on the surfaces of the specimens, it probably was contained within them, in all likelihood as disseminated particles. Whether this entrapped oxide was hematite, magnetite, or both, is uncertain from the experimental evidence, though magnetite seems more likely.

The occurrence of iron as a usual component of the native gold of Peru is also shown by the results of semi-quantitative spectrographic analyses done in the laboratory of the Cerro de Pasco Corporation of Oroya, Peru (Petersen 1970). Iron was reported to be present in two of these specimens as a minor component (1%-10%), and in the other five as strong traces (0.1%-1.0%). Here again it is very probable that this iron was

actually present as oxide. The only other metals besides silver found in all seven specimens were copper and lead. Copper was reported to be present in five of the specimens as strong traces, and in the other two as weak traces (0.10%-0.10%). Lead was present in all specimens as very weak traces (less than 0.01%). Silicon was reported to be present as strong traces in three specimens.

TABLE 3
Calculated percentage of oxides when the iron is calculated as oxide

Oxide form	Specimen iron calculated as oxide				
	1	2	3	4	5
Fe ₂ O ₃					
calc. %	1.13	3.62	3.0	1.6	1.9
Total %	100.30	100.50	100.0	100.2	100.3
Fe ₃ O ₄					
calc. %	1.10	3.51	2.9	1.5	1.8
Total %	100.27	100.38	99.9	100.1	100.2

The occurrence of iron in native gold is not peculiar to the Peruvian region of South America. Iron has been reported in 4 out of 7 analyses of gold from Bolivia in proportions ranging from a trace to 0.35%, in 3 out of 4 analyses of gold from Chile in proportions ranging from 0.09% to 0.23%, and in 2 out of 4 analyses of gold from Argentina, as 0.33% and 0.43% (Rivet and Arsandaux 1946). The analytical data available at present

shows that iron occurs in Peruvian native gold more often and in higher proportion than in the native gold from other regions of South America.

LITERATURE CITED

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