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Three Gold-Bearing Prehispanic Ceramic Fragments from the Supía-Marmato Mining District, Rio Medio Cauca, Colombia

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Abstract

The alluvial environment of the Supía-Marmato mining district, in the Rio Medio Cauca region, Colombia, provided coarse and fine-grained gold that was used for prehispanic gold work and also fine-grained, gold-bearing sediments that were used for ceramic production. Three ceramic fragments, identified as Marrón Inciso—Quimbaya Clasico, were submitted for geochemical analysis in order to determine their elemental composition—the ICP (Inductively Coupled Plasma) data indicated: 2 - 8 ppm Ag; 91 - 367 ppm Au; 1 ppm Hg; 9 - 73 ppm Pt; 10 - 47 ppm Ni; 11 - 60 ppm Pb; and one sample contained 34,800 ppm Cu. The Rio Medio Cauca is a broad north-south zone that runs from Cauca Dept., in the south, to Medellin, Antioquia Dept., in the north. This region also hosts numerous mineral occurrences and mines such as Marmato (Au-Ag) and La Colosa (Au-Cu). We conclude that this is the first study to define and establish a link between the metal content of prehispanic ceramics and Au, Ag, Cu, and Pt occurrences in Colombia.

Keywords

Gold, ICP, Prehispanic, Ceramics, Rio Medio Cauca

1. Introduction

During 2011-2012, geoarchaeological field studies were carried out in the Supía-Marmato mining district, Rio Medio Cauca, which is north of Manizales, Colombia (Bermúdez et al., 2012) (**Figure 1**). This area hosts numerous small-scale gold-silver mines, lead-zinc, copper, and coal occurrences, and the more well-known Marmato Au-Ag underground mine (Mariquita New Granada Mining y Cia, 1869; Fetzer, 1938; Mutis, 1983;

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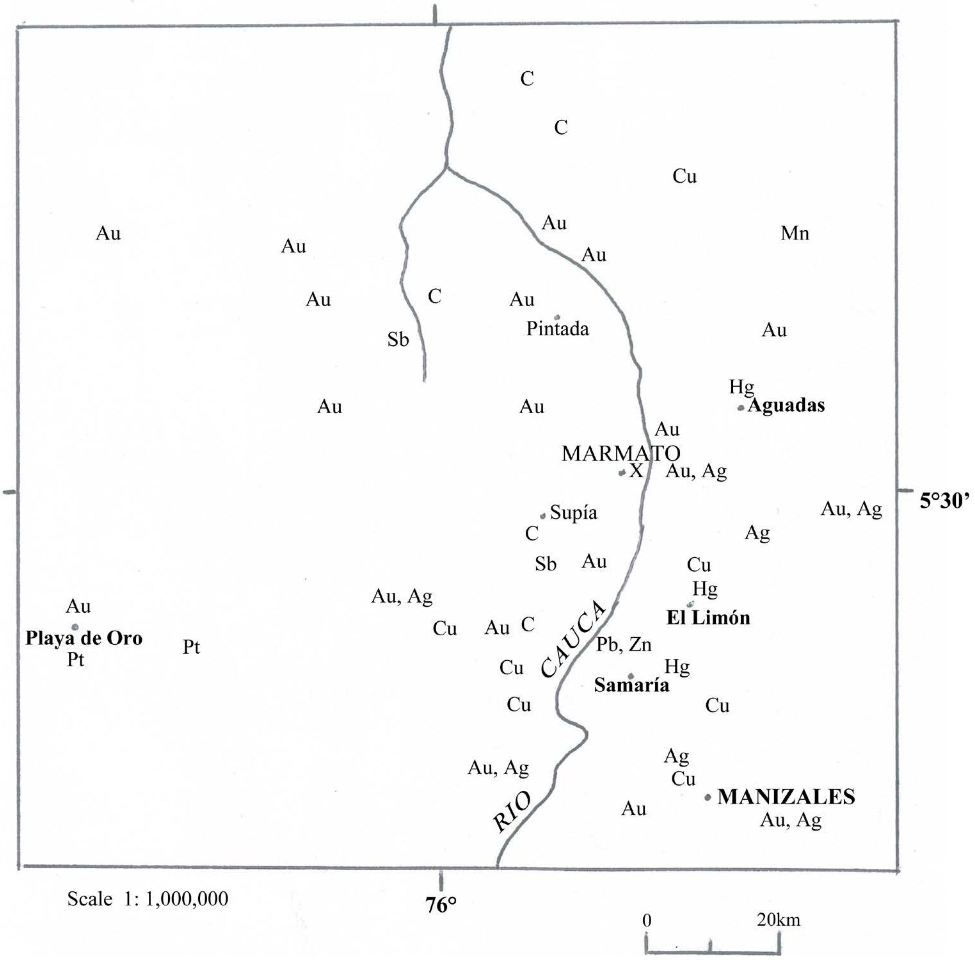


Figure 1. Generalized map of mineral occurrences in the Supía-Marmato mining district, Rio Medio Cauca, Colombia (Mejia et al., 1986). Au—gold; Ag—silver; Cu—copper; C—coal; Mn—manganese; Hg—mercury (*azogue*); Sb—antimony; Pb—lead; Pt—platinum; Zn—zinc; X—Hacienda La Moraga archaeological site.

Rodriguez & Pernet, 1983; Mejia et al., 1986; Mendoza, 2011; Brooks, 2014). There are also native mercury and cinnabar (the ore of mercury) occurrences near Aguadas, El Limon, and Samaría (**Figure 1**). Colombia's most well-known mercury mine, Mina La (Nueva) Esperanza, near Aranzazu, Caldas Dept., produced mercury until the 1960s (Brooks, 2014). These occurrences may have provided native mercury, or mercury retorted from cinnabar, which was used for prehispanic small-scale gold mining (Brooks et al., 2011) as well as blood-red cinnabar which was an important pigment that was widely used in the ancient Andes (Petersen, 1970/2010; Truhan et al., 2005; Brooks et al., 2008).

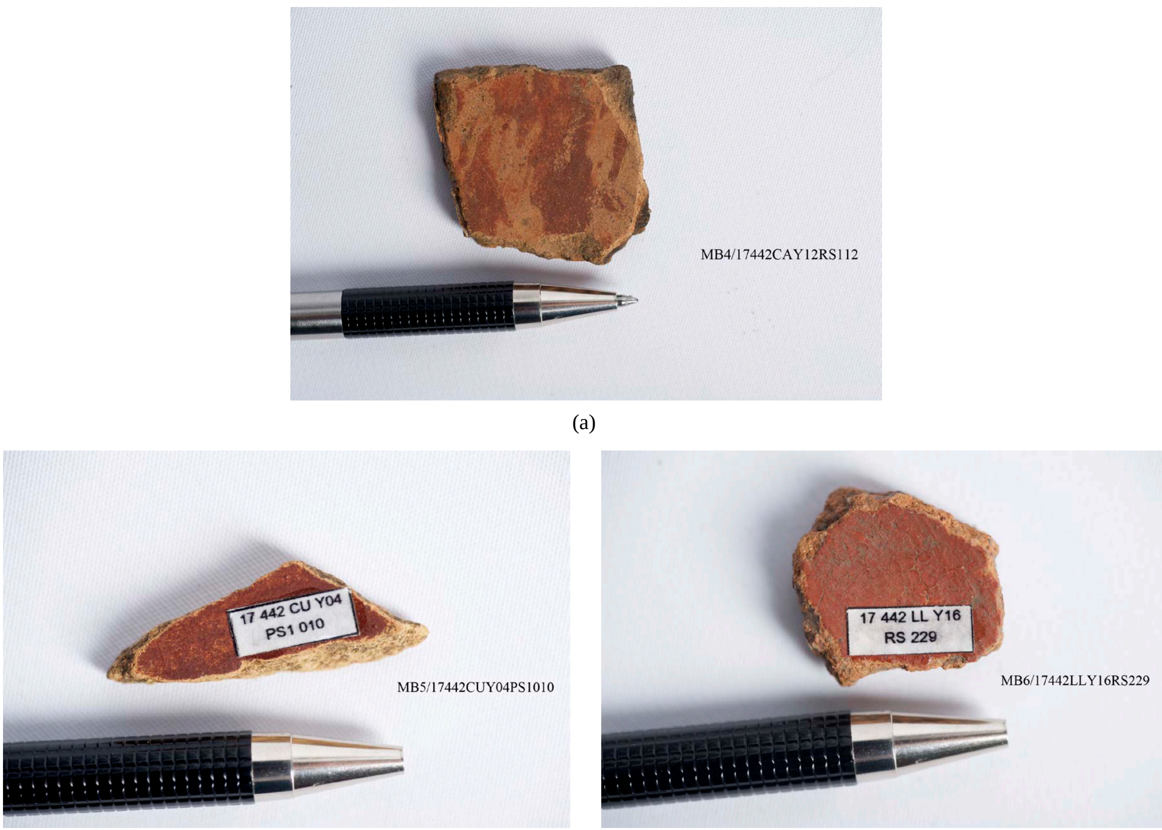
The Medio Cauca is also the locus of the Quimbaya culture whose prehispanic goldwork is highly artistic and technically developed. An hourglass-shaped ceramic furnace (29 cm high, 24 - 28 cm across), interpreted to have been used for smelting gold, was also found in the Medio Cauca (Bruhns, 1970). More than one hundred gold artifacts from the Medio Cauca, referred to as the Quimbaya Treasure, were studied to obtain archaeometric and metallurgical information using a variety of analytical methods (Perea et al., 2013).

There are a number of large scale mines in the region that include: Marmato (Au-Ag) as well as Carla Gran (Au-Ag) (Gran Colombia Gold Corp., Toronto, Ontario, Canada), El Piña (Au-Ag) (Angel Gold Corp., Vancouver, British Columbia, Canada), Frontino (Au-Ag-Zn) (Icon Exploration Inc., Vancouver, British Columbia, Canada), and Mineros Nacionales (Au-Ag) (Gran Colombia Gold Corp., Toronto, Ontario, Canada) (Howell International, 2014). The Medio Cauca is being explored for porphyry gold and gold-copper occurrences and hosts La Colosa (AngloGold Ashanti, Johannesburg, South Africa), a recent discovery that is estimated to contain 12.9 Moz of gold (Infomine, 2014), La Cumbre (Batero Gold Corp., Vancouver, British Columbia, Canada), and

Yarumalito (Colombian Mines Corp., Vancouver, British Columbia, Canada) gold-copper porphyries. Because of the abundant mineral occurrences in the region and their historical importance to Colombia's mineral economy, reconnaissance geologic mapping of the area was done in the 1900s (Scheib, 1919) and more recently, the relationship between tectonism, Late Miocene calc-alkaline volcanism, and epithermal Au-Ag deposits in the Medio Cauca has been documented (Borrero et al., 2013). This present investigation shows that the Medio Cauca alluvial material, which is essentially a stream-sediment sample that was also used for prehispanic ceramic production, reflects the mineral occurrences of the region.

During geoarchaeological field studies in the region, more than 100 prehispanic sites were documented and material excavated included 717 ceramic fragments, 113 micro-ceramic fragments, 75 lithics, and a *naringuera* or nose adornment. Three of the ceramic fragments (**Figure 2**) were thin-sectioned for petrographic description (**Figure 3**) and were also submitted for Inductively Coupled Plasma (ICP) analysis (**Table 1**) to determine elemental composition of the ceramics (Brooks et al., 2013). ICP is a reliable analytical technique that is widely used in minerals exploration and provides a wealth of elemental data on rock and metal samples.

Field studies at Hacienda La Moraga (**Figure 1**) documented 3 petroglyphs as well as 5 rock retention walls that are 1 - 1.5 m high and are constructed of poorly-sorted, 20 - 50 cm rounded-to-subangular boulders. The artefacts and rock walls, which have been variously described as *muros*, *vallados y canales*, collectively indicate prehispanic—to Colonial occupation and exploitation of gold-bearing alluvial deposits in the region (Bermúdez et al., 2012) (**Figure 4**). *Muros* or rock walls are found elsewhere in the Andes as are several distinctive styles of rock walls (*aparajos y muros*) that are used in ancient Perú (Larco Hoyle, 2001). An ancient rock retention wall (*muralla pircada*) that was used as a dam against debris flows (*huaycos*) was mapped in northern Perú (Brooks et al., 2005); however, none of those structures were related to alluvial gold mining. The rock walls (*muros*, *vallados y canales*) at Hacienda La Moraga are comparable in size and construction to rock walls found in small-scale gold mining areas in Tadó, Dept. Chocó, Colombia (Meyer, 1941; Restrepo Uribe, 2014) and small-



(a)

(b) (c)

Figure 2. Ceramic fragments from the Hacienda La Moraga archaeological site, Rio Medio Cauca, Colombia, original field number indicated in brackets.

Table 1. Inductively Coupled Plasma (ICP) analyses of scrapes from the worked surface of a *placa*; prehispanic ceramic fragments; and a *naringuera* from the Hacienda La Moraga archaeological site, Rio Medio Cauca, Colombia.

	MB1	MB2	MB3	MB4	MB5	MB6	MBm
Ag	0	0	0	8	2	4	130
Al	189,400	71,900	110,500	61,700	102,100	46,200	51
As	1	5	5	8	6	6	101
Au	4	3	19	367	122	91	173
B	6	5	7	10	24	11	8
Ba	28	36	33	103	239	643	7
Be	0	0	0	0	1	1	0
Bi	0	0	0	0	0	0	345
Ca	473	2630	3840	5510	10,400	12,300	46
Cd	0	0	0	0	0	0	1
Ce	20	20	20	20	20	20	20
Co	<1	3	106	62	16	13	32
Cr	460	2150	5370	192	34	54	1
Cu	2	459	10,900	34,800	46	170	988,988
Dy	1	0	1	0	0	0	3
Er	0	0	45	5	1	0	0
Eu	0	0	1	0	0	0	0
Fe	3420	5010	5070	29,700	31,300	26,600	633
Ga	2	1	70	68	24	21	4
Gd	1	0	15	15	7	3	0
Ge	0	0	0	0	0	0	0
Hf	0	0	0	1	0	0	0
Hg	1	1	0	0	1	1	3
Ho	0	0	0	0	0	0	0
In	0	0	0	0	0	0	19
Ir	0	0	0	0	0	0	35
K	45	34	300	3960	3170	19,600	0
La	0	0	0	0	0	0	0
Li	28	20	45	1	11	3	0
Lu	0	0	0	0	0	0	2
Mg	80	6520	8910	1360	2390	3680	10
Mn	37	65	67	194	245	201	1
Mo	0	0	2	1	0	0	0
Na	2190	145	175	8540	4830	14,700	62
Nb	1	0	0	3	19	9	8

Continued

Nd	0	0	0	0	2	1	0
Ni	1	44	51	10	13	47	163
Os	0	0	0	0	0	0	4
P	1	159	185	294	301	1140	113
Pb	5	8	10	50	16	11	937
Pd	1	0	0	0	0	0	189
Pr	0	0	0	0	0	0	0
Pt	0	0	0	0	9	73	59
Rb	0	0	0	0	2	7	0
Re	0	0	0	0	0	0	0
Rh	0	0	0	0	0	1	1
Ru	0	0	0	0	0	1	14
S	230	152	99	593	537	129	554
Sb	23	20	9	2	6	2	105
Sc	0	0	1	2	1	0	0
Se	1	1	0	0	1	0	76
Si	264,200	208,700	248,300	1,558,000	221,500	185,100	9300
Sm	0	0	0	0	0	0	0
Sn	0	0	0	0	0	0	19
Sr	4	3	4	87	19	113	1
Ta	0	0	0	0	0	0	0
Tb	0	0	0	0	0	0	0
Te	0	2	2	10	6	5	28
Th	1	0	3	17	17	17	1
Ti	8660	1430	7400	9520	9370	2930	30
Tl	0	0	0	4	4	0	0
Tm	0	0	0	0	0	0	3
U	1	2	4	15	1	9	0
V	18	7	7	122	159	69	9
W	0	0	1	1	3	0	12
Y	0	0	0	0	0	0	0
Yb	0	0	0	0	0	0	0
Zn	27	28	20	59	56	78	63
Zr	610	90	130	100	200	70	20

MB1 [17442CUY17PS1005]—scrape from a *placa* (lower grinding stone); MB2 [17442ECY06RS006a]—scrape from a *placa*; MB3 [17442ECY06RS006b]—scrape from a *placa*; MB4 [17442CAY12RS112]—ceramic fragment; MB5 [17442CUY04PS1010]—ceramic fragment; MB6 [17442LLY16RS229]—ceramic fragment; MBm—*naringuera* or Cu-Au nose adornment. Original field number given in brackets. Inductively Coupled Plasma (ICP) analysis, in parts per million (ppm), by American Assay Laboratories, Sparks, NV.

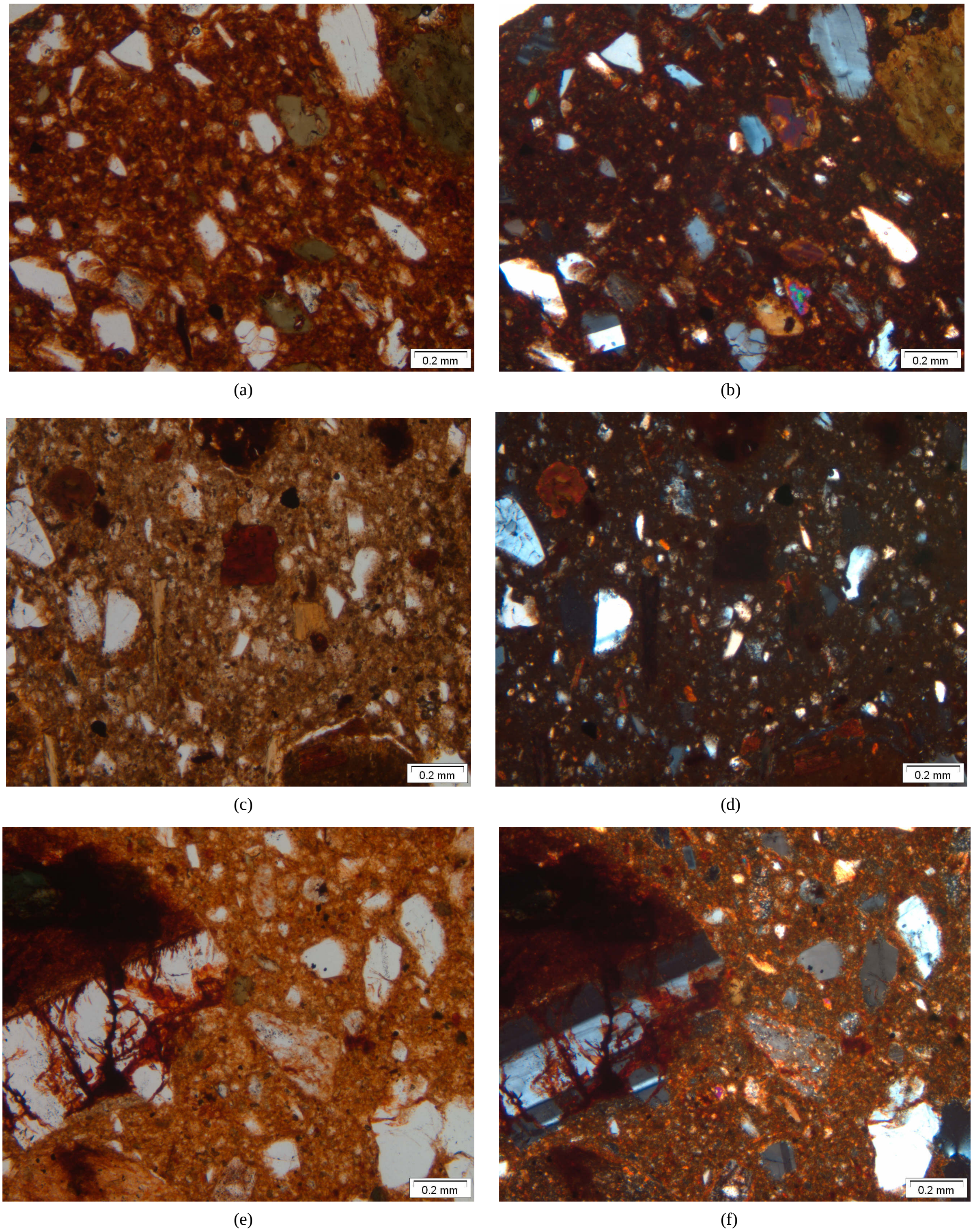


Figure 3. Thin-section photomicrographs of gold-bearing ceramic fragments from the Hacienda La Moraga archaeological site, Rio Medio Cauca, Colombia. Thin-sections prepared by Applied Petrographic Services, Greensburg, PA. (a), (b) MB4 [17442CAY12RS112]: thin-section photomicrograph of gold-bearing ceramic fragments from Rio Medio Cauca, Colombia: (a) plain light, (b) crossed nicols; (c), (d) MB5 [17442CUY04PS1010]: thin-section photomicrograph of gold-bearing ceramic fragments from Rio Medio Cauca, Colombia: (c) plain light, (d) crossed nicols; (e), (f) MB6 [17442LLY16RS229]: thin-section photomicrograph of gold-bearing ceramic fragments from Rio Medio Cauca, Colombia: (e) plain light, (f) crossed nicols.

Figure 4. One of several rock retention walls or *muros* at the Hacienda La Moraga archaeological site, Rio Medio Cauca, Colombia. During Colonial gold mining, the rocks were removed from the streams and stacked so as to more easily access and process the fine-grained gold-bearing sediments. Similar *muros* can be seen in the small-scale gold mining area of Tadó, Dept. Chocó, Colombia (Restrepo Uribe, 2014; Silva Herrera, 2010).

scale mining areas elsewhere in the Andes (Petersen, 1970/2010)—these types of retention walls (*muros*) are constructed from boulders taken from the streams before mining begins. These walls are specific to small-scale gold mining in the region and their presence is a guide to Colonial gold mining sites.

The ceramic styles at the site have been identified as Marrón Inciso—Tardío (Espinosa & Duque, 1993; Uribe, 2007) or Quimbaya Clásico and date to the first centuries of the Christian era. This permits the interpretation that the La Moraga site correlates to other documented prehispanic sites in the region. The find of a Quimbaya gold furnace (Bruhns, 1970) and studies of ceramics and goldwork (Uribe, 2007) in the Medio Cauca also support this correlation. *Placas* or the flat stone bases of several grinding tools (**Figure 5**) at the site were used for ancient ore treatment; and the petroglyphs were also interpreted as prehispanic.

2. Ceramic Sample Descriptions

Based on relative chronology, the three ceramic fragments are described as Marrón Inciso or Quimbaya Clásico and the petrography of each of the ceramic fragments is given below. Thin-section photomicrographs of the samples are shown on **Figure 3** and the ICP analyses are presented on **Table 1**. The original field number is provided within brackets.

MB4 [17442LLY16RS229]—photomicrograph of a ceramic fragment of a very fine-grained anthropogenic "dirty sandstone" with Fe cement; composed of subangular non-volcanic quartz (~0.2 mm), twinned plagioclase, zoned sanidine, and mafics that include magnetite, oxidized biotite, biotite rimmed with Fe, pleochroic grains (pyroxene) and subangular volcanic lithic fragments. Most grains are 0.1 - 0.2 mm; however, the lithic fragments are typically larger. The presence of biotite and the subangular grains suggests little transport of the sediments; however, stream action in the alluvial environment has resulted in a well-sorted fabric. The presence of the mafic grains and the lithics suggests an intermediate composition volcanic source. Quartz in the sample is not resorbed which indicates a non-volcanic origin. The sample contains 8 ppm Ag; 367 ppm Au; 34800 ppm Cu; and 50 ppm Pb; however, there is no visible gold in the ceramic fragment nor in the thin-section. The gold is likely micron-sized and may be disseminated in the dark matrix or in the volcanic lithic fragments.

MB5 [17442CUY04PS1010]—photomicrograph of a ceramic fragment of very fine-grained, poorly-sorted anthropogenic "dirty sandstone" with minor Fe cement; composed mainly of subangular non-volcanic quartz (~0.2 mm), resorbed or volcanic quartz, plagioclase, zoned sanidine, magnetite, oxidized and unoxidized biotite, pleochroic grains that may be pyroxene and rounded volcanic lithic fragments with biotite. Most grains are 0.1 - 0.2 mm; however, the lithic fragments are larger. The presence of biotite, other mafic minerals, and the subangular grains suggests little transport. The presence of biotite in the matrix and in the lithic fragments indicates a

Figure 5. Worked surface of a grinding stone, or *placa*, at the Hacienda La Moraga archaeological site, Rio Medio Cauca, Colombia.

nearby, intermediate composition volcanic source. Some of the quartz grains show the resorbed, vermicular texture typical of volcanic quartz. The sample contains 2 ppm Ag; 122 ppm Au; 46 ppm Cu; 1 ppm Hg; 16 ppm Pb, and 9 ppm Pt. There is no visible gold in the ceramic fragment nor in the thin-section and the gold is considered to be detrital, micron-sized, and disseminated in the dark matrix.

MB6 [17442CAY12RS112]—photomicrograph of a ceramic fragment of very fine-grained, poorly-sorted, angular to subrounded anthropogenic "dirty sandstone" with only minor Fe stain; ~1 mm twinned plagioclase grain, twinned plagioclase, minor rounded quartz; pleochroic (pyroxene?) grains; and fine-grained volcanic lithic fragments. With the exception of the quartz, this sample also appears to contain mainly volcanic material from a nearby source. The sample contains 4 ppm Ag; 91 ppm Au; 170 ppm Cu; 1 ppm Hg; 11 ppm Pb, and 73 ppm Pt and there is no visible gold in the sample.

3. Platinum Sources

Platinum artifacts and gold artifacts with platinum nodules are well-known in Colombia's regional archaeologic record (Bergsoe, 1937; Scott & Bray, 1980, 1994) and the association of platinum in alluvial gold deposits in Ecuador has also been described (Petersen, 1970/2010; Scott & Bray, 1980; Gemuts et al., 1992; Craddock, 2000). Platinum, with rare earth elements or REEs, is common in the gold-bearing alluvial deposits in Dept. Chocó (Meyer, 1941), for example at Playa del Oro, in western Colombia (**Figure 1**). This platinum-gold association points to an alluvial source for the platinum nodules found in many of the gold artifacts. In Dept. Chocó, a 900 g platinum nugget was found near Valle Chocó, a 520 g nugget was found near Istamina, and platinum is also known in the gold-bearing alluvial deposits in Bolivia, Chile, Ecuador, and Perú (Petersen, 1970/2010).

Two of the three ceramic samples for this study contain platinum. Geologically, platinum is more commonly associated with ultramafic rocks than intermediate composition volcanic rocks such as those found in the Medio Cauca; however, the platinum may be sourced from ultramafic rocks known near Marmato (Robert Carrington, Colombian Mines Corp., oral commun., 1 March 2015). Both platinum and palladium are produced as byproducts from copper ores at Cerro de Pasco, Perú (Petersen, 1970/2010). And, the ICP analysis of a copper-gold *naringuera* from this study indicates 59 ppm Pt (**Table 1**, sample MBm) which suggests that the platinum was a component of the copper ore used to make the *naringuera* and was not intentionally added.

Therefore, given: 1) the presence of ultramafic rocks in the Medio Cauca; and 2) the presence of copper occurrences in the Medio Cauca (**Figure 1**)—then these occurrences may indicate sources for the platinum found in the samples for this study and in the regional archaeological record.

4. Other Samples

Placas—Scrapes were taken with a glass slide of worked *placa* surfaces to interpret their use for mineral grinding or food preparation (**Figure 5**). The scrapes contained no silver, 3 - 19 ppm gold, 2 - 10,900 ppm copper, 1 ppm mercury, 5 - 10 ppm lead, and no platinum. The wear of the *placa* and the overall high metal content, especially gold and copper are consistent with use of the *placas* for ancient ore grinding (**Figure 5** and **Table 1**).

Naringuera—A portion of a ~2 cm *naringuera*, or ring-like nose adornment, was also submitted for ICP analysis (**Figure 6**). This artifact was mainly copper (988,988 ppm), and also contained 173 ppm gold and 130 ppm silver; other metals included 3 ppm mercury, 937 ppm lead, and 59 ppm platinum (**Table 1**). In comparison, XRF (non-destructive x-ray fluorescence analyses reported in percent) data on several *naringueras* from the region indicate similarly high copper content (98%), variable gold (0.5% - 37%) and silver (0.5% - 67%) content, and platinum (1% - 1.5%) was detected in two *naringueras* (Rodriguez, 2007, [Table 5.2]). Spectrographic data on a lip adornment from Piura, Perú indicates: silver >10%, gold >10%, copper 1% - 10%, and platinum <0.01% (Petersen, 1970/2010).

5. Discussion

Porosity, color, compositional or chemical analysis, and hand-sample characteristics are standard tools in the description of ceramic material and petrographic examination of ceramics is an established tool in archaeology (Orton et al., 1993; Meeks, 2000; Ixer et al., 2014). Chemical analysis, commonly atomic absorption spectrophototometry, neutron activation analysis, or X-ray fluorescence, has been shown to be useful in establishing provenance or source of the ceramic material (Orton et al., 1993). Common sources of ceramic precursor material may include: 1) alluvial sand and clay derived primarily from degradation of bedrock sources, and 2) clay derived from host rock that has been altered by hot, rising, mineralizing fluids related to igneous intrusions.

In exploration geology, it is common to sample and chemically analyze stream-sediments in order to characterize the mineral endowment of an area to be used as a guide for continued exploration for mineral deposits–for example, only a few flakes of gold in a *batea*, or wooden prospecting pan, concentrated from stream sediments may be sufficient to guide future exploration for gold targets in tropical jungle terrain (Brooks et al., 1995).

Therefore, ceramics composed of alluvial material may be considered, geologically, as stream-sediment samples and similarly, analyzed geochemically (ICP) in order to better define and interpret the mineral endowment in the source terrain of the ceramic material. For example, the Ca content of ancient, cuneiform clay tablets has proved useful in grouping the origin of the tablets in relation to the local bedrock geology in specific regions in Turkey (Uchida et al., 2015).

Our research integrates: 1) classic identification of ceramic style in a well-studied mineral district of Colombia; 2) thin-section examination of prehispanic ceramic material; 3) ICP chemical analysis of the ceramics; and 4) the geology and mineral occurrences of the source terrain. These data all help better understand the technolo

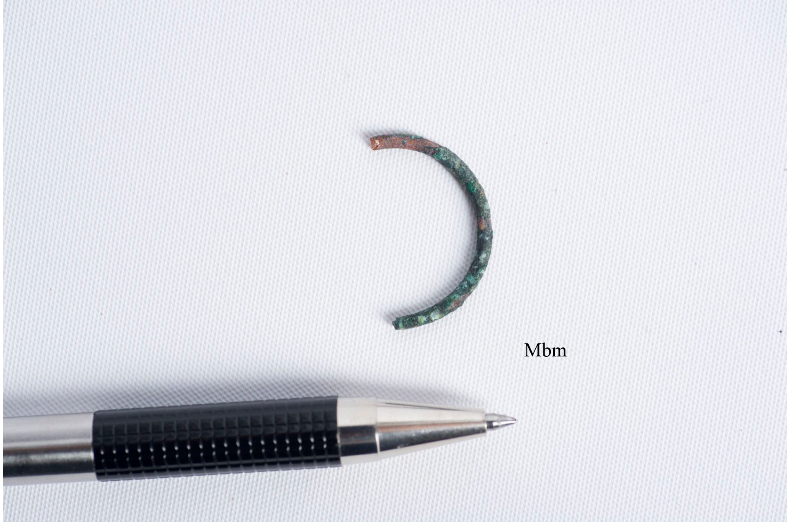


Figure 6. *Naringuera*, or copper-gold-silver nose adornment, from the Hacienda La Moraga archaeological site, Rio Medio Cauca, Colombia. ICP analysis given on **Table 1** (sample MBm).

gy used, the ceramic source material that was exploited, and the mineral resources that were available and used by ancient artisans in the Medio Cauca. With continued application of these parameters, it may become useful to identify the geochemical characteristics of ceramics from a certain region that may help to establish trade patterns. However, since there were only three samples used for this initial study and because this is the first report to tackle the geochemical descriptions of Medio Cauca ceramics, there remains much more sampling and analytical work to be done in order to establish a useful database. However, these initial results establish the presence of gold, silver, copper, lead, and especially platinum as metallic components of Medio Cauca prehispanic ceramics.

6. Conclusion

This research indicates that: 1) the gold-bearing alluvial material weathered from veins and mineral occurrences in the region such as Marmato provides the primary material used by the prehispanic craftsmen and producers of the metallic artifacts; and 2) the gold-bearing alluvial material, essentially a stream-sediment sample, was also used for ceramic production. This provides a spatial link between the regional geology and mineral occurrences in the region to prehispanic ceramic production and, for the first time, uses ICP to help expand prehispanic ceramic descriptions as well as the knowledge of ancient-to-Colonial mineral resource exploitation in the Rio Medio Cauca, Colombia.

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