

# Silver-and-Gold Moche Artifacts from Loma Negra, Peru

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## INTRODUCTION

COMPOSITE SILVER-AND-GOLD ORNAMENTS are known from various cultures throughout the ancient world; no culture in the Americas, however, appears to have indulged a taste for this visual, and presumably symbolic, juxtaposition as frequently as the Moche of northern Peru (ca. A.D. 100–800) (Figure 1). The emergence of a large corpus of Moche metallic artifacts in the last three decades has allowed archaeologists as well as historians of art and technology to recognize the Moche culture as the source of some of the most sophisticated metalwork ever produced in ancient America.<sup>1</sup> The particularly rich collection of Moche metalwork from Loma Negra in The Metropolitan Museum of Art serves as a fine starting point for investigations into the technical ingenuity that the Moche applied to the manufacture of these composite precious-metal ornaments.

The exploitation of metal in Peru had its very modest beginnings in the Initial Period.<sup>2</sup> The Early Horizon that followed was a period of pan-Andean unity based in part on what may have been the propagation of a religious cult identified with Chavín de Huántar, a major archaeological site in the northern highlands of Peru. Metalwork was still relatively rare during this period, and the extant artifacts are almost exclusively of gold. While Early Horizon objects entirely of silver are almost unknown, there are a few Chavín silver-and-gold pieces. The subsequent Early Intermediate Period, which is characterized by the development of regional cultures, witnessed the rise of the Moche people and their innovative metalworking practices. During the Early Intermediate Period the frequency and size of gold objects increased dramatically, and silver as well as copper came into widespread use.<sup>3</sup>

The consistent exploitation of silver in ancient Peru has been traditionally associated with the Chimú, a north coast culture centered in the Moche Valley in the Late Intermediate Period, but this outdated per-

ception was based both on the misattribution of known artifacts and on the lack of metalwork dating to earlier periods. For example, many of the silver, or partly silver, objects formerly described as Chimú are now attributed to the Lambayeque culture (also called Sicán), which established itself in the valley of that name during the Middle Horizon. Other silver objects can be recognized as Vicús, a culture nearly contemporary to the Moche. Accidents of preservation and discovery can skew the archaeological record: in a review of the state of Peruvian archaeology in 1942

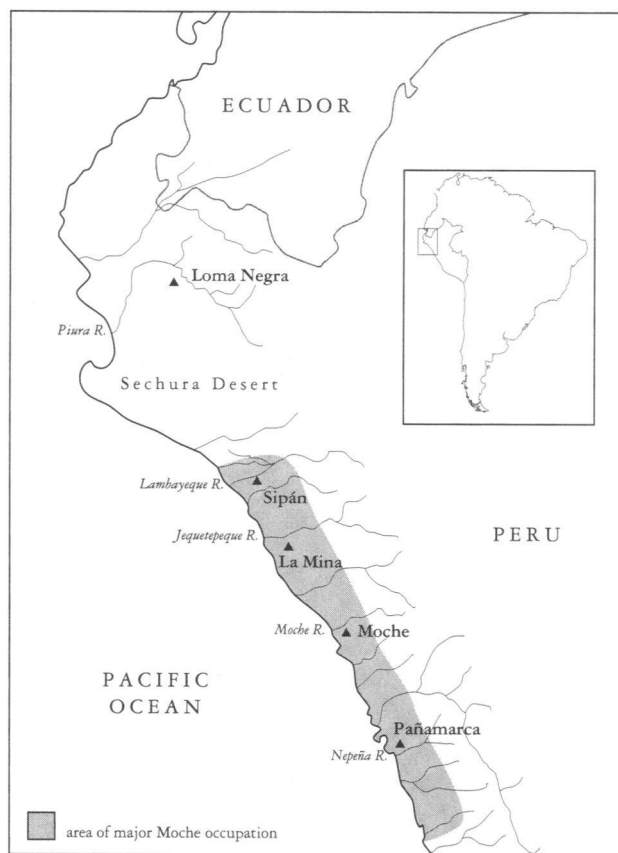


Figure 1. Map of northern Peru (courtesy of Adam Hart)

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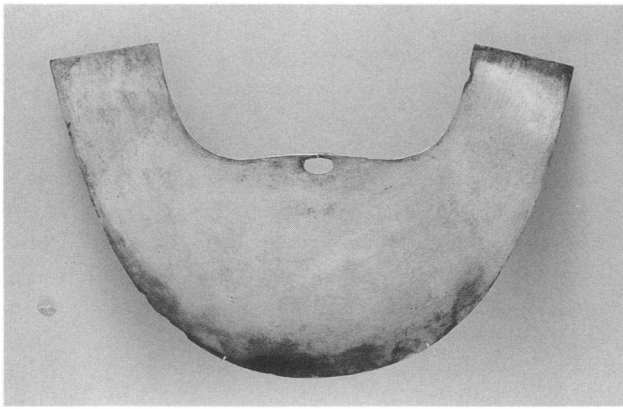


Figure 2. Nose ornament, Moche, from Loma Negra, Peru. Silver, W. 22 cm. The Metropolitan Museum of Art, The Michael C. Rockefeller Memorial Collection, Gift of Hugh Smith, by exchange, 1970, 1978.412.243

Alfred Kroeber wrote that contrary to popular opinion silver was used by the Moche but stated his belief that early silver was rare.<sup>4</sup> A few years later, in a chart summarizing the development of metallurgy in northern Peru, Samuel Lothrop described silver as present but rare in Chavín, Gallinazo, and Mochica (Moche) contexts.<sup>5</sup> As mentioned earlier, artifacts entirely of silver attributed to the Early Horizon Chavín culture are almost unknown, although there are a few examples of silver-and-gold composite pieces. Early Horizon metalworkers also used silver as an alloying metal: there are Chavín silver-based ternary alloys, where the three components are gold, silver and copper, which were used for solder,<sup>6</sup> and other man-made gold-based ternary alloys were employed for the fabrication of metal sheet.

Discoveries of the last forty years, having significantly increased the number of silver or partially silver artifacts that can be attributed to the Vicús and Moche cultures, demonstrate that the use of silver was so not uncommon in the Early Intermediate Period. An abundance of silver objects was recently found at a Moche site at Sipán.<sup>7</sup> In addition to the solid-silver-sheet nose ornaments from Loma Negra (see MMA 1978.412.243; Figure 2), a considerable number of artifacts from Loma Negra were made from silvered-copper sheet.<sup>8</sup> Again, one may mention the use by the Moche of ternary silver-based and intentionally alloyed ternary gold-based solders, as well as the intentional alloying of binary (gold-silver) alloys and ternary alloys (gold-silver-copper), the former for gilding copper substrates and the latter for use as sheet metal.

## LOMA NEGRA AND THE DISCOVERY OF MOCHE METALWORK

The first opportunity to observe the enormous productivity and high level of expertise achieved by Moche metalworkers came in the late 1960s when tomb robbers discovered and looted a rich burial site that came to be known as Loma Negra, in the Vicús region of the Piura Valley on the far north coast of Peru (Figure 1).<sup>9</sup> During the early 1960s this area had been the focus of widespread illegal digging, and study of the objects recovered, supplemented by information gathered in professional salvage operations, led to the recognition of the Vicús culture.<sup>10</sup> Indigenous to the Piura River valley, the Vicús culture has been dated to the first half of the Early Intermediate Period.<sup>11</sup> Hundreds of artifacts recovered in the Vicús region, however, are attributed to the Moche, a people who flourished in the fertile river valleys far to the south on the other side of the inhospitable Sechura Desert, from about A.D. 100 to 800. The intensive agricultural activity undertaken by the Moche supported a highly stratified society with widespread commercial contacts.<sup>12</sup> Still, the discovery of Moche artifacts on the north side of the desert, far from the Moche cultural sphere as it was then defined, raised many questions. The relationships between the local Vicús culture and this Moche "outpost," and between the Piura Valley sites and Moche culture as a whole, have been considered by various scholars, but much remains to be clarified.<sup>13</sup>

In the early 1970s a project to document the Loma Negra material was undertaken at the former Museum of Primitive Art in New York. At that time hundreds of objects attributed to Loma Negra were catalogued by Anne-Louise Schaffer, under the supervision of Julie Jones, at that time curator of Precolumbian Art.<sup>14</sup> Subsequently, the Museum of Primitive Art was closed, and in 1978 and 1979 its collections, along with the Loma Negra Archive, were transferred to the Metropolitan Museum, where they are now housed in its Department of the Arts of Africa, Oceania, and the Americas.

The objects included in the Loma Negra Archive are almost exclusively metal, and nearly all were fashioned from hammered sheet, rather than cast.<sup>15</sup> The large number of metal objects relative to ceramic finds was noted by Hans-Dietrich Disselhoff as typical of the Vicús region,<sup>16</sup> but subsequent discoveries suggest that this may not be the case. When the archive was assembled, relatively few examples of other Moche works of art in metal were known, and archaeologists and art historians were perplexed by the new finds.<sup>17</sup> Not only were there no obvious parallels for certain individual

objects or types of objects, the sheer number of metal finds from a single context was overwhelming and difficult to explain.<sup>18</sup> Scholars were uncertain as to what type of site Loma Negra could represent because extremely metal-rich individual burials in the Andean region were largely unpublished.

Recent excavations in the Lambayeque Valley at Sipán, and the discovery of a rich Moche tomb in the Jequetepeque Valley at a site called La Mina, are providing analogous finds in terms of typology, style, quality, quantity, methods of manufacture, and context.<sup>19</sup> In 1987 attention was drawn to a cluster of eroded adobe pyramids at Sipán known as Huaca Rajada, when a number of high-quality Moche artifacts began to appear on the Peruvian art market. At the site it was discovered that grave robbers had penetrated and looted part of the burial of a high-status Moche male. Under the direction of Walter Alva of the Bruning Museum in the town of Lambayeque, the site has been the focus of ongoing scientific excavations and other significant tombs have been discovered.<sup>20</sup>

One year after the looting of the Sipán burial, grave robbers located an isolated elite tomb about fifty miles to the south at La Mina, near the site of Pacatnamú in the Jequetepeque Valley.<sup>21</sup> While the tomb was subsequently located and a salvage excavation undertaken, nearly all the precious-metal artifacts and sumptuous ceramics had already been removed.<sup>22</sup> These new discoveries led to a reevaluation of the Loma Negra corpus, and in 1992 an exhibition entitled “Loma Negra—A Peruvian Lord’s Tomb” was presented in The Metropolitan Museum of Art.<sup>23</sup> Although their deposition context is lost, the Loma Negra artifacts can now be recognized as the grave goods of high-status

Moche individuals buried in the Piura Valley.<sup>24</sup> The colloquium/workshop “Andean Royal Tombs, Works of Art in Metal,” organized in conjunction with the exhibition, elicited further thought and discussion about Moche metalwork from Loma Negra, Sipán, and La Mina.

Between 1979 and 1987 approximately four hundred artifacts documented in the Loma Negra Archive entered the collections of the Metropolitan Museum.<sup>25</sup> Among these objects are a sizable group made from unalloyed copper, including “crescents”<sup>26</sup> and a variety of relief plaques. Most of the artifacts—including personal ornaments, small figures of animals (particularly insects and crustaceans), disk ornaments, anthropomorphic and zoomorphic standards, and numerous relief plaques in a great variety of shapes—were made from gilded- or silvered-copper sheet. There are also more than twenty objects or fragments of objects, including plain and embellished nose ornaments, earflares, and flat or three-dimensional ornaments for attachment to substrates of other metals, that were made from solid gold sheet. A group of gold nose ornaments and two small gold figures (Figure 3) that were probably not manufactured locally are also associated with the finds.<sup>27</sup>

There are also a number of silver objects, primarily nose ornaments (Figure 2), known from Loma Negra. It is, however, the artifacts that combine silver and gold components or silver and gold surfaces using a variety of mechanical and metallurgical processes that constitute the most striking finds from Loma Negra, Sipán, and La Mina. The composite objects from Loma Negra that combine gold and silver sheet rather than gilded or silvered surfaces are limited to nose ornaments and



Figure 3. Anthropomorphic figures, from Loma Negra, Peru. Gold, H. 3.8 and 4.2 cm. The Metropolitan Museum of Art, The Michael C. Rockefeller Memorial Collection, Bequest of Nelson A. Rockefeller, 1979.1979.206.1341,1342



Figure 4. Nose ornament, Moche, from Loma Negra, Peru. Silver and gold, W. 20.8 cm. The upper portion of this ornament is silver sheet; the lower *ajouré* relief band is gold. The Metropolitan Museum of Art, The Michael C. Rockefeller Memorial Collection, Bequest of Nelson A. Rockefeller, 1979.1979.206.1225

earflares (Figures 4–12), but additional types of artifacts that combine solid precious-metal sheets are known from Sipán and La Mina. Relative to the number of composite silver-and-gold objects of Moche manufacture, much effort went into developing methods used for combining the two metals. Several of these processes were already in use in Chavín times and many were employed simultaneously, if less frequently, by Vicús metalworkers; yet the innovative metallurgy of the Moche far exceeded the legacy they inherited, just as many of their technological innovations were not incorporated into the metalworking traditions of subsequent Andean cultures. Later Peruvian cultures continued to express an interest in the juxtaposition of gold and silver but none appears to have pursued this goal with the refinement and resourcefulness displayed by the Moche.

Two mechanical and three metallurgical methods were employed in the manufacture of composite works from Loma Negra in the Metropolitan Museum (see Appendix).<sup>28</sup> Three of these methods, and two additional ones, were observed on objects from Sipán. Most of these seven techniques appear to have been used in the manufacture of the objects from La Mina and possibly an eighth as well. Another method of combining gold and silver was used in the manufacture of an unprovenanced Moche nose ornament in the American Museum of Natural History, New York, and yet another method can be observed on an unprovenanced silver-and-gold figure of a llama in the Museo del Banco Wiese in Lima.<sup>29</sup> In some instances a combination of mechanical and metallurgical pro-

cesses were used on a single artifact.

The research presented here is based on detailed technical examinations of thirteen composite objects from Loma Negra in the Metropolitan Museum.<sup>30</sup> The work was carried out in conjunction with an ongoing study of the Loma Negra corpus currently under way in the Sherman Fairchild Center for Objects Conservation.<sup>31</sup> The project was begun by Ellen Howe, initially in preparation for the Loma Negra exhibition and the colloquium/workshop “Andean Royal Tombs, Works of Art in Metal.” Moreover, several unprovenanced Moche composite objects, and those attributed to other ancient Peruvian cultures, in the collections of the Metropolitan Museum, the American Museum of Natural History, New York, the National Museum of the American Indian, New York and Washington, D.C., and Dumbarton Oaks Research Library and Collections, Washington, D.C., were included in this investigation.

These objects, as well as two nose ornaments attributed to La Mina in a private collection, were examined under magnification and radiographed. Polished sections of joins were studied using a metallographic microscope, and elemental analysis of the sections and of microsamples were carried out using an energy-dispersive x-ray spectrometer attached to a scanning electron microscope (EDS/SEM).<sup>32</sup> Two of these sections were also analyzed using wave-dispersive x-ray spectroscopy (WDS) in conjunction with an electron microprobe.<sup>33</sup> In addition, a significant number of composite silver-and-gold objects from Sipán were examined under magnification.



Figure 5. Nose ornament, Moche, from Loma Negra, Peru. Silver and gold, W. 19.9 cm. The upper portion of this ornament is silver sheet; the lower relief band is gold. The Metropolitan Museum of Art, The Michael C. Rockefeller Memorial Collection, Bequest of Nelson A. Rockefeller, 1979, 1979.206.1228 (photo: author)



Figure 6. Reverse of silver-and-gold nose ornament in Figure 5, showing staples used for mechanical attachment (photo: author)

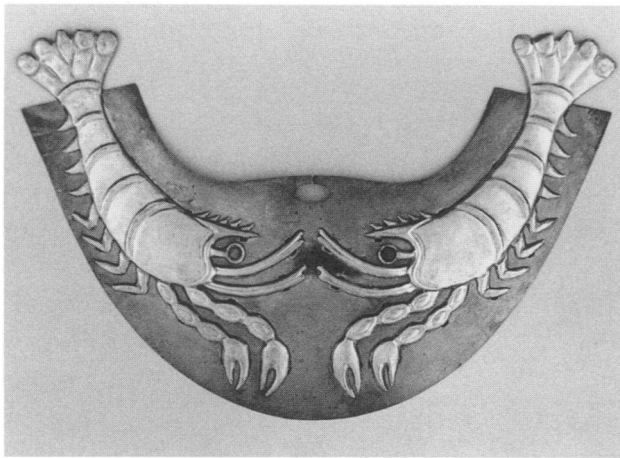


Figure 7. Nose ornament, Moche, from Loma Negra, Peru. Silver and gold, W. 18.7 cm. The ornament overall is silver sheet; the applied crayfish are gold. The Metropolitan Museum of Art, The Michael C. Rockefeller Memorial Collection, Bequest of Nelson A. Rockefeller, 1979, 1979.206.1236 (photo: author)



Figure 8. Reverse of silver-and-gold nose ornament in Figure 7, showing staples used for mechanical attachment (photo: author)

#### MECHANICAL JOINING METHODS

In ancient times metal joins were executed using mechanical, adhesive, or metallurgical methods. Mechanical joins are those where interlocking metal components are held in close physical proximity.<sup>34</sup> The largest number of composite silver-and-gold artifacts from Loma Negra were joined mechanically, which is consistent with the finds from the site as a whole, as mechanical joining was the predominant method used to assemble the approximately four hundred Loma Negra artifacts in the Metropolitan Museum fashioned from gold, silver, copper, silvered-copper, and gilded-copper sheet.<sup>35</sup> Mechanical joins are also found on composite silver-and-gold artifacts from Sipán<sup>36</sup> and La Mina.

I. The mechanical joins present on the Loma Negra objects generally rely on a series of rectangular tabs and slots; the tabs extend from the edges of one sheet of metal and are inserted into slots cut into a second sheet. For example, there are several nose ornaments made from hammered silver sheet with gold attachments. In one case a gold band with snails in low relief is joined in this manner to the bottom edge of the silver component (Figures 5, 6). In a second example the silver substrate is overlaid with two mirror-image gold crayfish in low relief (Figures 7, 8).

On all the composite nose ornaments in the Metropolitan Museum that were joined using mechanical means, the gold sheet was applied to or over the silver, but taken together with the objects of similar manu-



Figure 9. Pair of earflares, Moche, from Loma Negra, Peru. Silver and gold, Diam. 7.6 and 7.5 cm. The harpy eagles are sheet silver, the frontplates are gold; the backplates and the shafts are gilded copper. The Metropolitan Museum of Art, The Michael C. Rockefeller Memorial Collection, Bequest of Nelson A. Rockefeller, 1979, 1979.206.1245,1246



Figure 10. Pair of earflares, Moche, from Loma Negra, Peru. Silver and gold, Diam. 7.8 cm. The shafts, rims surrounding the frontals, and the warriors are gold sheet; the backplates of the frontals are silver; one third of the backplate on 1979.206.1241 is restored. The Metropolitan Museum of Art, The Michael C. Rockefeller Memorial Collection, Bequest of Nelson A. Rockefeller, 1979, 1979.206.1241,1242

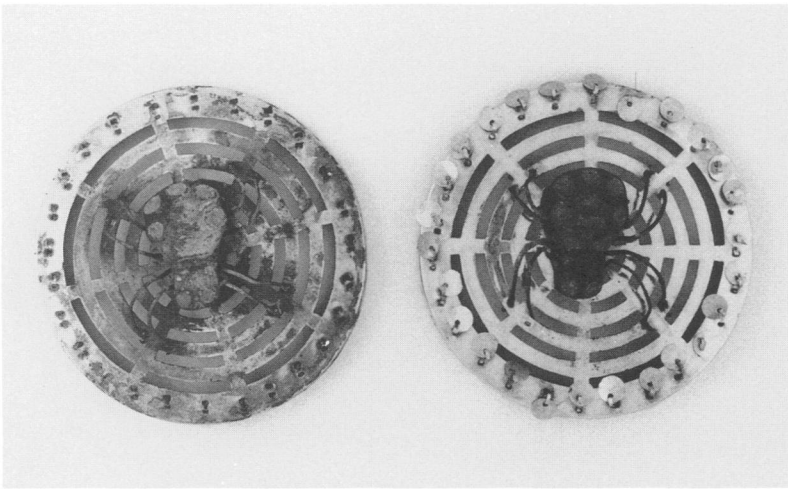


Figure 11. Pair of earflare frontals, Moche, from Loma Negra, Peru. Silver and gold, Diam. 8.4 cm. The spiders are silver sheet and wire; the webs and danglers are gold sheet. The Metropolitan Museum of Art, The Michael C. Rockefeller Memorial Collection, Bequest of Nelson A. Rockefeller, 1979, 1979.206.1240 (right), and National Museum of the American Indian, 24/3543 (left) (photo: author)

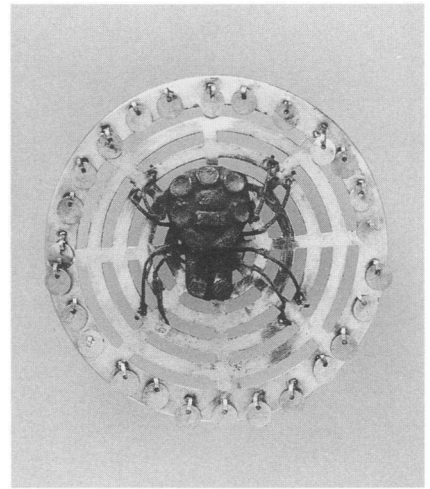


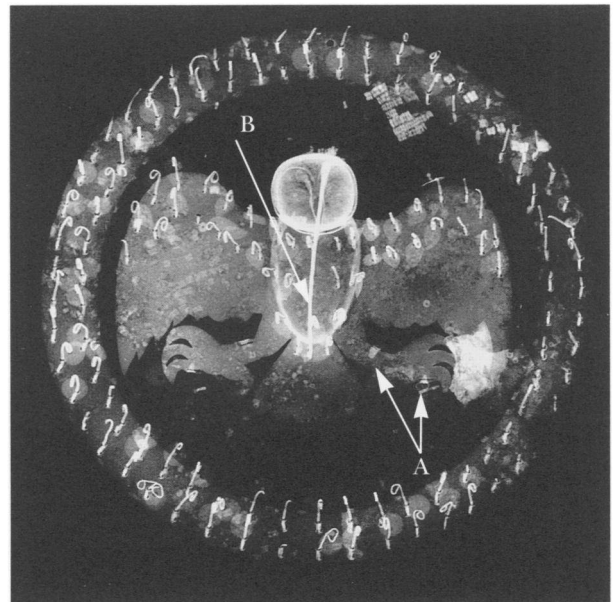
Figure 12. Earflare frontal shown at right in Figure 11. The Metropolitan Museum of Art, The Michael C. Rockefeller Memorial Collection, Bequest of Nelson A. Rockefeller, 1979, 1979.206.1240



Figure 13. Radiograph of silver-and-gold earflare frontal in Figure 12 (photo: author)

Figure 14. Disk ornament, Moche, from Loma Negra, Peru. Silvered- and gilded-copper sheet, Diam. 28.2 cm. The owl and the outer band are gilded-copper sheet; the backplate is silvered copper. The Metropolitan Museum of Art, Bequest of Jane Costello Goldberg, from the collection of Arnold I. Goldberg, 1986, 1987.394.56

Figure 15. Radiograph of silvered- and gilded-copper disk ornament in Figure 14, showing A) tabs attaching body of owl to backplate and B) attachment of rod supporting head (photo: author)



facture from other collections documented in the Loma Negra Archive, where silver was applied to gold, the nose ornaments demonstrate that for the Moche both gold and silver could function either as foreground or background. This flexibility can also be observed on the Loma Negra harpy eagle earflares (MMA 1979.206.1245,1246), each of which has a silver bird within a gold field (Figure 9),<sup>37</sup> and the warrior earflares (MMA 1979.206.1241,1242), where the metals used for image and ground are reversed (Figure 10), and on the large disk ornaments discussed below.

Mechanical joins were also used in the manufacture of the frontals from a pair of circular earflares divided between the Metropolitan Museum (MMA 1979.206.1240) and the National Museum of the American Indian (24/3543). Each frontal represents a silver spider in the center of a gold web (Figures 11, 12).<sup>38</sup> The spiders are three-dimensional, each having been formed from two raised sheets of silver that were pressure-fitted.<sup>39</sup> The legs are made from four round silver wires, each threaded through a pair of holes on opposite sides of the body (Figure 13). The wires were fitted into rectangular holes in the webs and flattened so as not to slip out, holding the spiders mechanically in place.

Silver-and-gold objects of Chavín manufacture are rare, and none is known to have used mechanical joining methods. Although Vicús composite objects are relatively common, mechanical joins are rare.<sup>40</sup>

II. The second Moche method of combining gold and silver is similar to the first insofar as it involves the assembly and mechanical attachment of metal sheets using tabs and wires. However, in this case the sheets are of copper with gilded or silvered surfaces. Close examination of Loma Negra artifacts in the Museum that were assembled from copper-sheet components has revealed that a considerable number use both gilded-copper and silvered-copper sheets.

Among these, the largest and the most impressive in terms of imagery are two disks that measure approximately twenty-six and twenty-eight centimeters in diameter. These disks, along with eight others from Loma Negra in the Metropolitan Museum are part of a cohesive but enigmatic group of objects found thus far only in the Vicús region. The disks have one or more hole(s) for suspension or attachment to a support, but their function is unknown.<sup>41</sup> As noted above, the use of gold and silver as both foreground and background characterizes the disks.

In the first case (MMA 1987.394.56) a background disk of "silvered" copper supports a gilded-copper owl assembled from several pieces of sheet (Figure 14).

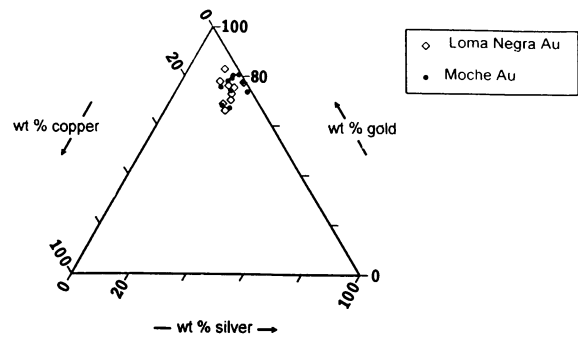


Figure 16. Ternary gold-silver-copper diagram plotting gold alloys from Loma Negra and other Moche contexts

Copper corrosion products that have migrated from the substrate obscure much of the disk's surfaces, but in radiographs it is possible to see that the wings lack the tabs that held the other parts of the body in place and would have flapped freely when the disk was moved (Figure 15). Its head, created entirely in the round, is mounted on a metal rod inserted into the body and attached to its inner surface and would have rotated from side to side. The outer edge of the disk is covered by a rim made from gilded-copper sheet. The



Figure 17. Disk ornament, Moche, from Loma Negra, Peru. Silvered- and gilded-copper sheet, Diam. 26.4 cm. The warrior, the "moon creature," and the outer band are silvered-copper sheet; the backplate is gilded copper. The Metropolitan Museum of Art, Bequest of Jane Costello Goldberg, from the collection of Arnold I. Goldberg, 1986, 1987.394.54



Figure 18. Staff head, Moche, from Loma Negra, Peru. Silvered- and gilded-copper sheet, H. 6.8 cm. The Metropolitan Museum of Art, The Michael C. Rockefeller Memorial Collection, Bequest of Nelson A. Rockefeller, 1979, 1979.206.1314

rim is anchored there with tabs and by the numerous flat gilded-copper wire strips\*<sup>42</sup> supporting gilded-copper dangles,\* which also would have swayed and jingled when the disk was moved. The gold surface layer examined in a section prepared from one of the attachment tabs on the owl contains 20.2 percent silver;<sup>43</sup> the ratio of gold to silver (ca. 4:1) is similar to that typically found in Moche ternary alloys (Figure 16).<sup>44</sup> The so-called silvered layer of the background contains 43.7 percent silver and 56.3 percent gold. Alloys of the same compositions prepared as standards indicate that the juxtaposed metals were relatively similar in color.<sup>45</sup>

The second disk (MMA 1987.394.54), which is embellished with shell-and-stone inlay, represents a warrior surmounted by a double-headed “moon creature” holding a prisoner by the hair in each of its jaws, all made from silvered-copper sheet\* and mounted with tabs onto a gilded-copper disk (Figure 17). Here the rim, held in place by tabs and dangle wires, has a silvered surface. There are no moving parts other than a multitude of silvered-copper dangles.\* With 25.8 percent silver, the ratio of gold to silver in the gilded layer of the background is lower (3:1) than found in the gold alloys typically used by the Moche; the silver-rich



Figure 19. Mask, Moche, from Loma Negra, Peru. Copper, silvered- and gilded copper, H. 20.2 cm. The mask is made of copper sheet; the eyes and teeth are gilded copper; the ring is silvered copper. The Metropolitan Museum of Art, Bequest of Jane Costello Goldberg, from the collection of Arnold I. Goldberg, 1986, 1987.394.68

Figure 20. Bead in the shape of a human head, Moche, from Sipán, Peru. Gold, silver, and lapis lazuli, H. 12.5 cm. The bead is made of gold sheet; the eyes are inlaid with silver sclerae and lapis-lazuli pupils. Lambayeque, Bruning Museum (photo from Alva and Donnán, *Royal Tombs*, fig. 23)

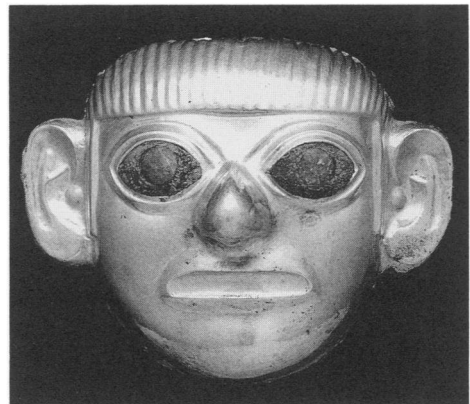






Figure 21. “Headless figure” ornament, Moche, from Sipán, Peru. Gilded-copper sheet and silver, H. 42.5 cm. The sheet is gilded copper and the finger and toenails are inlaid with silver. Lambayeque, Bruning Museum (photo from Alva and Donnan, *Royal Tombs*, fig. 66)

layer on the rim contains 44.5 percent gold.

In general, movement—be it tongues dangling from the jaws of foxes<sup>46</sup> or the rotating owl head and flapping wings described above, combined with the liberal use of dangles of every description—played an integral part in Moche metalwork. It seems that the ability of ancient Andean peoples to appreciate subtle differences in the gold–silver spectrum was more highly developed than ours,<sup>47</sup> but in the case of the two large gilded- and silvered-copper disks, the use of carefully chosen gold-and-silver alloys similar in color placed in close juxtaposition would have animated the surfaces and complemented the viewer’s perception of the physical movement and sound inherent in their construction.<sup>48</sup>

A third object constructed from mechanically joined gilded- and silvered-copper sheets is a staff head (MMA 1979.206.1314) (Figure 18).<sup>49</sup> From the surviving components it appears that a relatively thin sheet of silvered copper\* was hammered to form a cylinder and fitted onto a wooden staff. Attached to one end of the cylinder are two gilded-copper plaques\* worked in relief, each spanning one-half of its circumference. Copper nails held the plaques and sheet onto the wooden core.<sup>50</sup>

Thus far, this method of combining gold and silver has not been reported on objects from other Moche contexts, but closer examination of the material from Sipán and elsewhere may reveal their existence. This method appears not to have been popular with Vicús metalworkers.<sup>51</sup>

#### ADHESIVE JOINING METHODS

III. Moche metalwork characteristically had inlays of nonmetallic materials, such as shell and stone. The inlays were held in place with a natural resin bulked with an inorganic material to increase its viscosity (Figure 17).<sup>52</sup> This adhesive method of attachment was also used for metal inlays and can be seen on, for example, a Loma Negra copper mask (MMA 1987.394.68) with eyes and teeth of gilded copper\* (Figure 19). Although there are no known Loma Negra composite silver-and-gold examples, several objects from Sipán were made using this adhesive joining method. Frequently illustrated is one of several similar beads made from solid-gold sheet in the shape of a human head, whose eyes are inlaid with solid-silver scleras and lapis lazuli pupils (Figure 20). The silver inlays were cut or hammered to shape and adhered in place with resin. From Sipán there are also examples of gilded-copper sheet\* that was inlaid with solid-silver-sheet inlay (Figure 21).<sup>53</sup>

#### METALLURGICAL JOINING METHODS

Metallurgical joins are those that bond metal components on an atomic scale to form a continuous piece, sometimes with the addition of an intermediate metal layer. Such joins are effective due to the interdiffusion of metal atoms within the two joined components, and generally require the application of heat. Heather

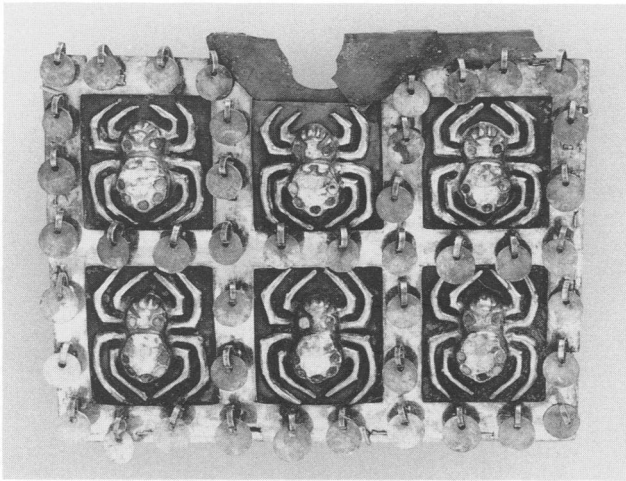


Figure 22. Nose ornament, Moche, from Loma Negra, Peru. Silver and gold, W. 8.6 cm. The spiders, the grid, and the danglers are gold sheet; the backplates are silver. The Metropolitan Museum of Art, The Michael C. Rockefeller Memorial Collection, Bequest of Nelson A. Rockefeller, 1979, 1979.206.1230

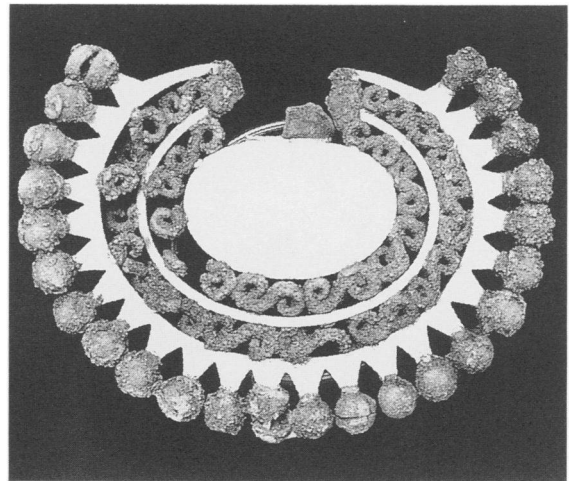


Figure 23. Nose ornament, Moche, from Sipán, Peru. Silver and gold, H. 4.0 cm. The gold components are made of sheet; they are soldered to silver wire and to hemispheres constructed from silver sheet. Lambayeque, Bruning Museum (photo from Alva and Donnan, *Royal Tombs*, fig. 223)



Figure 24. Effigy spoon, Chavín, from Chavín de Huántar(?), Peru, 400–200 B.C. Silver and gold, H. 11.1 cm. The figure and the spoon are constructed from gold sheets, the shell from two sheets of silver. Washington, D.C., Dumbarton Oaks B-440 (photo: Dumbarton Oaks Research Library and Collections)

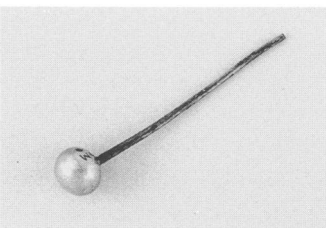


Figure 25. Pin, Chavín, from Chongoyape, Peru. Silver and gold, L. ca. 5.5 cm. The head of the pin consists of two gold sheet hemispheres mounted onto a silver shaft. Washington, D.C., National Museum of the American Indian 16/1971M (photo: author)

Lechtman suggests that metallurgical joining techniques, such as soldering and brazing, were important stimuli to the development of alloys in the central Andes.<sup>54</sup>

IV. The overall examination of the artifacts from Loma Negra in the Metropolitan Museum revealed few instances of solder.<sup>55</sup> A nose ornament representing spiders on a web (MMA 1979.206.1230) (Figure 22) is the only instance where solder was chosen to assemble silver and gold components.<sup>56</sup> By contrast, solder appears to have been used more frequently on composite silver-and-gold artifacts from Sipán (Figure 23). Solder may have been used to join silver and gold components on two objects of the Early Horizon: a Chavín spoon with a man blowing into a conch shell in Dumbarton Oaks (B-440) (Figure 24)<sup>57</sup> and a small Chavín pin in the National Museum of the American Indian (16/1971M) (Figure 25).<sup>58</sup> Solder is rarely observed on silver-and-gold artifacts attributed to the Vicús culture.

The Loma Negra composite nose ornament on which solder was used consists of six gold spiders in low relief, each placed on an individual silver backplate, which was joined to the reverse of a rectangular gold grid (Figures 22, 26). The solder is readily visible in radiographs of the ornament; fully fused, it is evident from strings of fine radiotransparent bubbles present in radiopaque zones seen near the outlines of the spiders (Figure 27). The joining of the backplates to the grid is less delicate and was ultimately a less successful

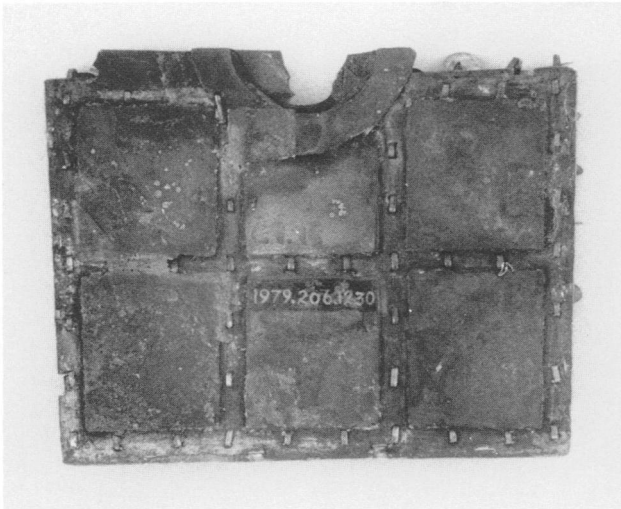


Figure 26. Reverse of silver-and-gold nose ornament in Figure 22 (photo: author)

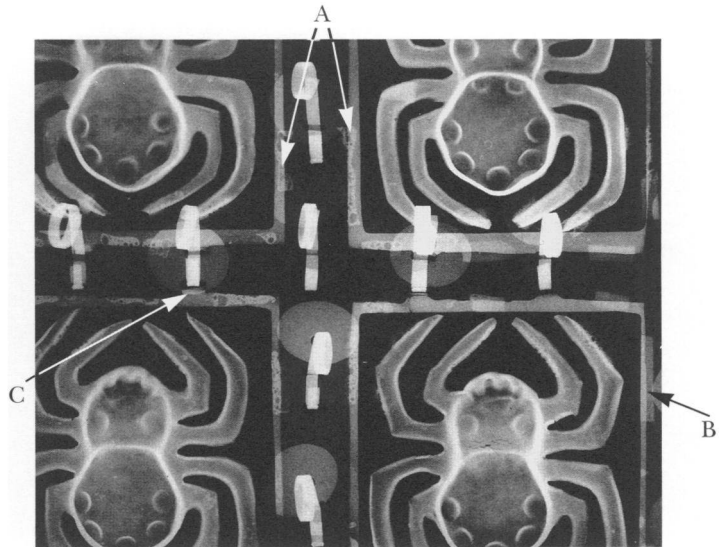


Figure 27. Radiograph of silver-and-gold nose ornament in Figure 22, to show A) fused solder; B) unfused pallion; C) location of a tab (now lost) and slot for attaching backplate onto grid (photo: author)



Figure 28. Warrior figure, Moche, from Loma Negra, Peru, Early Intermediate Period. Gilded copper sheet and shell(?), H. 12.0 cm. The Metropolitan Museum of Art, Gift of Jane Costello Goldberg, from the collection of Arnold I. Goldberg, 1981, 1981.450.32

operation. Occasional patches of porosity, indicating where melting occurred, are clearly visible in the radiographs, but in many cases large pallions—or rectangular pieces of unfused solder—can also be observed. In some cases the edges of the pallions are visible between the backplate and the grid.<sup>59</sup> Apparently the maker of this ornament was concerned that the joints might fail: four tabs, no longer extant, originally extended from the top and bottom of each plate and were slotted into the grid. Soldering supplemented by tabs was also noted on each of a pair of three-

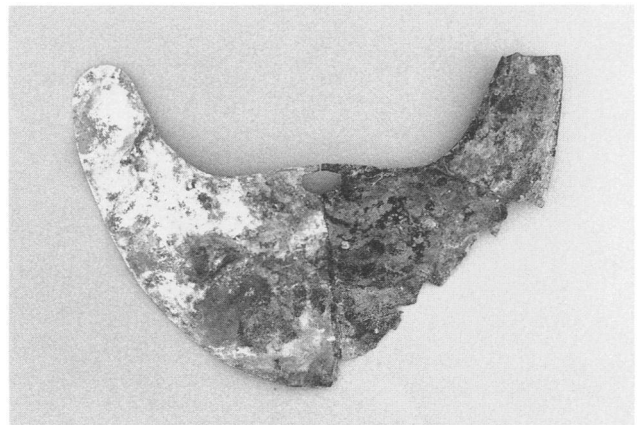


Figure 29. Nose ornament, Moche, from Loma Negra, Peru, Early Intermediate Period. Silver and gold, W. 14.0 cm. The proper right half is gold sheet, the proper left silver. The Metropolitan Museum of Art, The Michael C. Rockefeller Memorial Collection, Bequest of Nelson A. Rockefeller, 1979, 1979.206.1332 (photo: author)

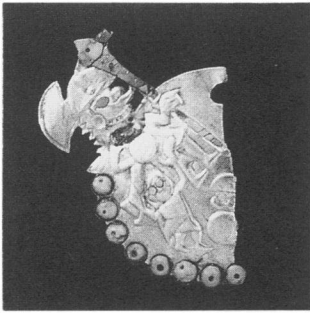


Figure 30. Nose ornament, Moche, from Sipán, Peru, Early Intermediate Period. Silver and gold, W. 8.5 cm. The proper right half is gold; only narrow strip of silver survives from proper left half. Lambayeque, Bruning Museum (photo from Alva and Donnan, *Royal Tombs*, fig. 160)

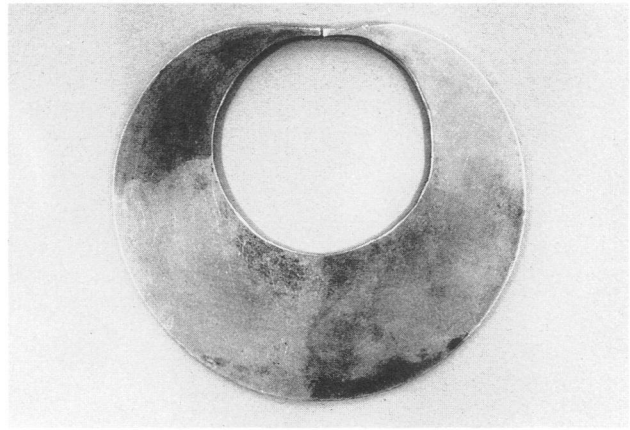


Figure 33. Nose ornament, Vicús, Peru, Early Intermediate Period. Silver and gold, W. 8.6 cm.; From the proper right, silver-and-gold sections alternate. New York, American Museum of Natural History, Department of Anthropology 41.2/8677 (photo: author)

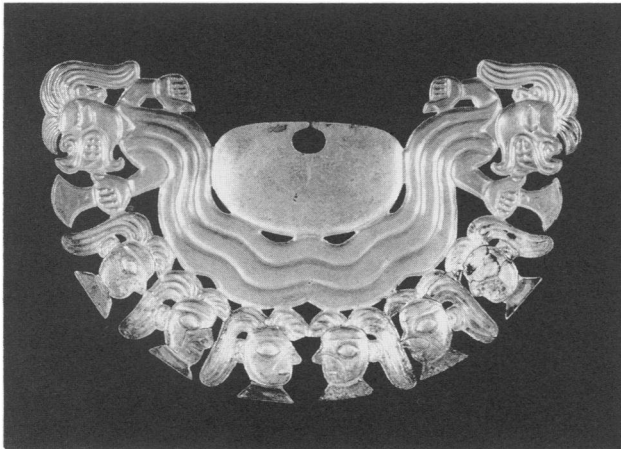


Figure 31. Nose ornament, Moche, from La Mina, Peru, Early Intermediate Period, Gold and silver, w. 13.3 cm. The upper oval section and warrior heads are silver sheet; the double headed serpent is gold. Private collection (photo: Diana Harvey)

dimensional warrior figures from Loma Negra (MMA 1981.450.31, 32) constructed from gilded-copper sheet\* (Figure 28).<sup>60</sup>

V. Another metallurgical join observed on Moche artifacts can be described as a hammer-welded lap joint. There is one hammer-welded nose ornament (MMA 1979.206.1332) from Loma Negra in the Metropolitan Museum (Figure 29) and at least one other documented in the Loma Negra Archive that was probably made in this manner.<sup>61</sup> Visual examinations carried out on the objects from Sipán indicate that the same technique was used in several cases (Figure 30). In terms of technical mastery and design the composite

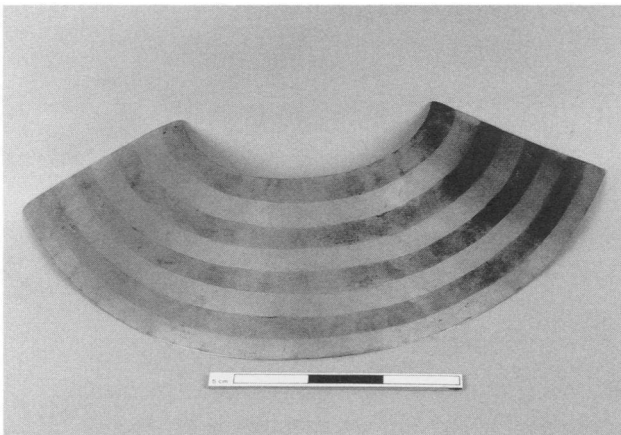


Figure 32. Pectoral, Chavín, Peru. Silver and gold, H. ca. 14.6 cm, max. W. 47.0 cm. From the top, silver-rich and gold-rich strips alternate. New York, American Museum of Natural History, Department of Anthropology 41.0/3706 (photo: Judy Levinson)

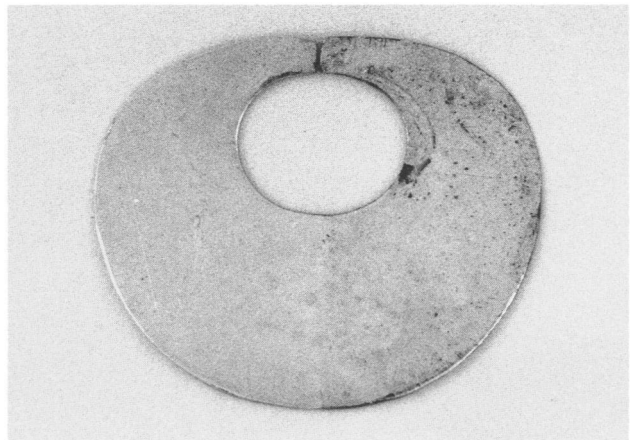


Figure 34. Nose ornament, Vicús, Peru. Silver and gold, W. 3.6 cm. The proper right section is gold sheet; the proper left silver. Washington, D.C., National Museum of the American Indian 15/894 (photo: author)

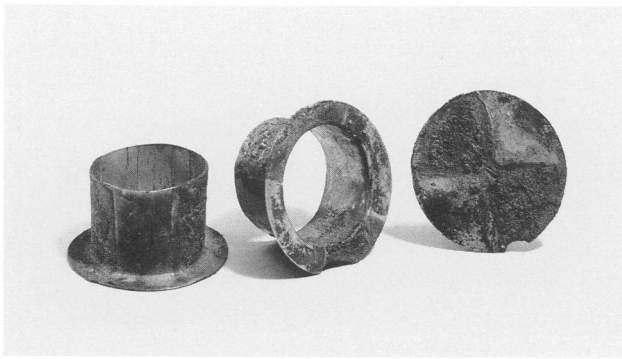


Figure 35. Pair of earflares, Moche, Peru. Silver and gold, Diam. of shafts 5.2–5.3 cm. Right: frontal with alternating pie-shaped sections of gold and silver sheet; center: left and center: shafts. The Metropolitan Museum of Art, The Michael C. Rockefeller Memorial Collection, Bequest of Nelson A. Rockefeller, 1979, 1979.206.1175–1177

silver-and-gold *ajouré* nose ornaments attributed to La Mina (Figure 31) represent some of the most sophisticated Moche artifacts on which this method was used.<sup>62</sup>

A hammer-welding technique was apparently also employed for the manufacture of two pectorals in the American Museum of Natural History (41.0/3706, 41.0/3707) (Figure 32) that are attributed to the Chavín culture,<sup>63</sup> as well as for Vicús nose ornaments in the same collection (41.2/8677) (Figure 33) and in the National Museum of the American Indian (15/894, 15/895) (Figure 34). In fact, hammer-welding seems to have been quite popular with Vicús metalworkers.<sup>64</sup> Because only one hammer-welded object from Loma Negra was available for technical study, objects attributed to other ancient Peruvian cultures were examined in order to determine the physical

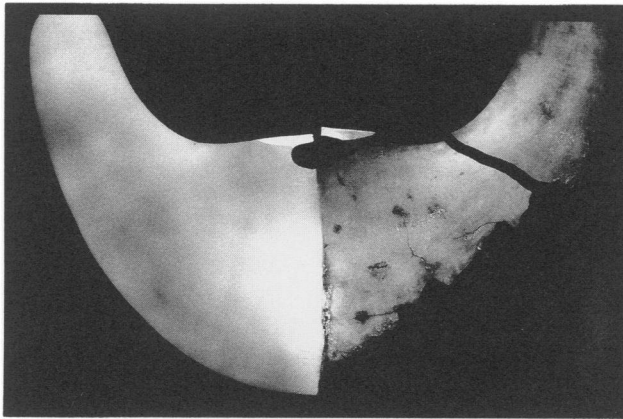


Figure 36. Radiograph of silver-and-gold nose ornament in Figure 29 (photo: author)

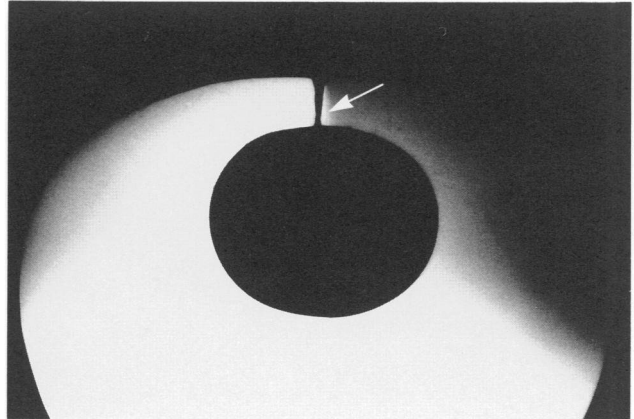


Figure 38. Detail of radiograph of silver-and-gold nose ornament in Figure 34; arrow indicates gold strip continuous with silver sheet component (photo: author)

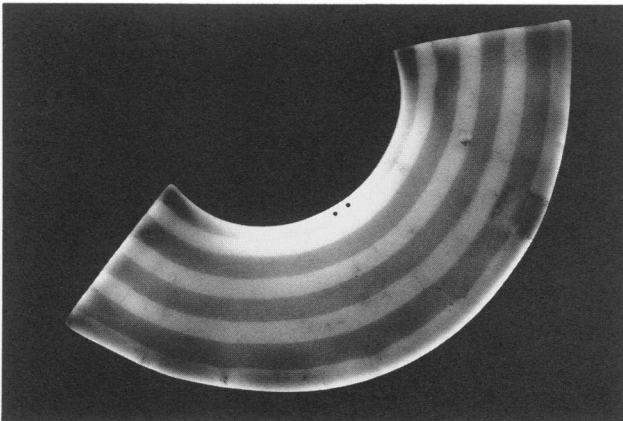


Figure 37. Radiograph of silver-and-gold pectoral from Figure 32 (photo: author)

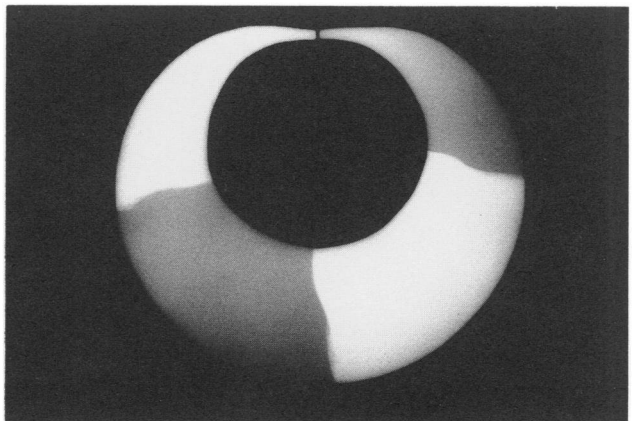


Figure 39. Radiograph of silver-and-gold nose ornament in Figure 33 (photo: author)

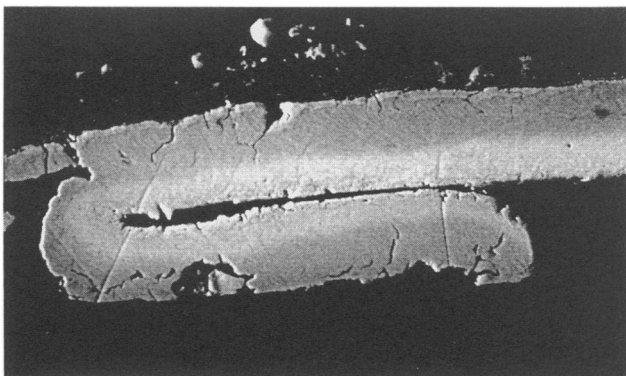


Figure 40. Polished section from hammer-welded join on silver-and-gold nose ornament in Figure 29, electron back-scattered photograph; the lighter area is gold sheet; the darker area is silver sheet (photo: Mark T. Wypyski)

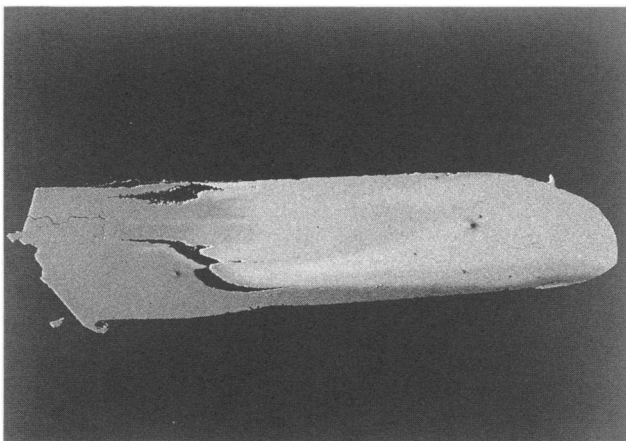


Figure 41. Polished section from hammer-welded join on silver-and-gold earflare in Figure 35, electron back-scattered image; lighter areas are gold; the darker areas are silver (photo: Mark T. Wypyski)

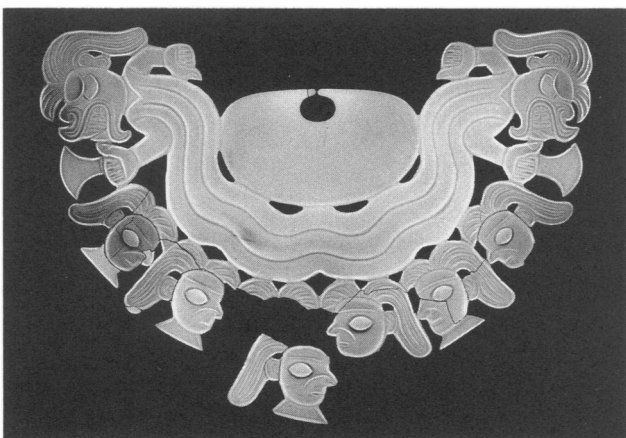


Figure 42. Radiograph of silver-and-gold nose ornament from Figure 31 (photo: author)

character of this type of join and to hypothesize how it was executed. In addition to the Vicús nose ornaments and Chavín pectorals, a pair of earflares in the Metropolitan Museum (MMA 1979.206.1175–1177) (Figure 35) attributed to the Moche culture and a pair of roundels in the American Museum of Natural History (41.2/6297) and a *tupu* in Dumbarton Oaks (B-472)<sup>65</sup> attributed to the Lambayeque culture were also examined.

A number of Vicús and Moche silver-and-gold composite nose ornaments were examined and radiographed at the Royal Ontario Museum in the mid-1970s in conjunction with a traveling exhibition of metal artifacts in the Museo Oro del Perú.<sup>66</sup> Tushingham, Franklin, and Toogood discounted soldering as a possible joining method and concluded that the ornaments had been welded without the introduction of a filler metal. In the radiographs they noted sharp junctures between the components and proposed that the joins had been executed, without overlapping the gold and silver sheets and without much hammering, through the action of heat. The authors also mentioned the presence of cracks along some of the joins but offered no explanation for their origin.

In radiographs of the Loma Negra and Vicús nose ornaments, the Moche earflares, the Lambayeque roundels and *tupu*, and the Chavín pectorals, the corresponding silver-and-gold components in each object exhibited drastically different opacities (Figures 36–39), such as had been observed by Tushingham, Franklin, and Toogood in objects of similar manufacture.<sup>67</sup> To confirm the supposition that these artifacts had been hammer-welded, metallographic sections were prepared from samples removed from joins on the Loma Negra nose ornament and from one of the Moche earflares. Pending further investigation, it appears that gold and silver sheets were assembled with slightly overlapped edges and alternately heated and hammered until adequate fusion occurred.

Certainly in viewing these sections (Figures 40, 41) it is obvious that the silver and gold components had been overlapped prior to joining. The metal sheets that were used for the Loma Negra nose ornament are quite thin, measuring about 0.2 millimeter near the join, while the metal at the join is nearly twice as thick. The Moche earflares are made from substantially thicker gold and silver sheets, the edges of which appear to have been beveled at the overlap, so that the joins are approximately the same thickness as the individual starting sheets. The abrupt junction between the gold and silver sheets, with their dramatically different radiopacities, tends to obscure features associated with the joins, but, in fact, a careful review of each

hammer weld in the radiographs reveals a narrow zone where the gold and silver sheets overlap. As a rule porosity, which is generally associated with melting, was not observed. The Chavín pectorals, the only exceptions, had isolated pores along the joins.

It is clear that the joins were annealed, because substantial interdiffusion of the gold and silver can be observed in the metal sections at relatively low magnifications; the distribution of the two metals on an atomic scale is confirmed with electron backscatter imaging and elemental dot mapping. On the section from the Moche earflare, in particular, long narrow peninsulas of gold penetrate the silver sheet on the other side of the join and vice versa, suggesting that the heating occurred repeatedly and in alternation with campaigns of hammering (Figure 41). Furthermore, there is evidence for considerable deformation by hammering, both at the joins and on the objects overall, subsequent to joining. The broad area of overlap between the gold and silver sheets of the Loma Negra nose ornament (Figure 40), for example, is due to extensive hammering at the joins, while the similarity in the pattern of hammer blows and changes in thickness in the gold and silver components, visible in the radiographs, also suggest that the final shaping and finishing were carried out after the components were joined (Figure 36). The joining of the gold and silver sheets prior to shaping the artifacts could also be established for both Vicús nose ornaments in the National Museum of the American Indian. In one case (15/894) (Figure 34), there is a vestigial strip of gold attached to the silver component, which indicates that the notch where the ornament was attached to the septum was cut and shaped after the two metals had been joined and hammered to form a slightly ovoid disk (Figure 38).

Cracks very close to the hammer-welded joins are visible in the radiographs. Their position parallel to the joins suggests that the cracks are due not to inadequate fusion but rather to subsequent stress to the join. In fact, the irregular black voids visible in the section from a join on one of the Moche earflares are cracks, also seen in section, that probably resulted when the flat band consisting of the four hammer-welded sections was hammered into a cylinder (Figure 41).

The radiographic images of the two hammer-welded La Mina nose ornaments are significantly different from those of the various other hammer-welded objects that were radiographed in this study and by Tushingham, Franklin, and Toogood. When taken with evidence acquired through other means of examination, these differences may point to a local variation in manufacture. For example, in correlating the radi-

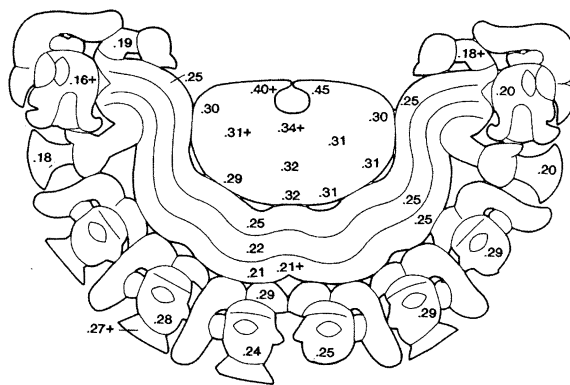


Figure 43. Drawing of silver-and-gold nose ornament in Figure 31, indicating sheet thicknesses (drawing by Barry Girsh)

ographic images of the hammer-welded ornaments, such as the nose ornament from Loma Negra (Figure 36), the Moche earflares, the Chavín pectorals (Figure 37), and the Vicús nose ornaments (Figures 38, 39), with measurements of sheet thicknesses, it is obvious that the corresponding silver and gold components were made from silver and gold sheets of similar thickness. However, the error of assuming that the lack of marked differences in the radiopacity of the different metal components means that an object was not hammer-welded is illustrated by a nose ornament attributed to La Mina (Figure 31). From top to bottom, the piece consists of an oval silver field, a gold serpent with two human heads, and a row of silver trophy heads. Whereas preliminary macroscopic examination of the ornament suggested that it had been made from gold and silver sheets joined by hammer-welding, this conclusion was at first discounted because the radiopacity is fairly consistent throughout the ornament except where changes in thickness were created by the repoussé and chasing, or on the edges, where it is obvious that the metal had been disproportionately thinned by hammering (Figure 42). The possibility that these ornaments had been made from gilded silver was briefly considered and rejected as being inconsistent with the radiographic evidence. Confirmed examples of gilded-silver Moche artifacts are extremely rare.<sup>68</sup>

Subsequent examination of broken edges within the silver component and of a metallographic sample removed from an exterior gold edge proved definitively that the ornament was made from solid-gold and solid-silver sheets. Detailed caliper measurements of numerous sites on the La Mina nose ornament (Figure



Figure 44. Nose ornament, Moche, from Loma Negra, Peru, Early Intermediate Period. Partially silvered gold sheet and silver sheet, W. 18.9 cm. The headband, the top edges of the feathers, the earflares, and the necklace are silvered gold; the nose ornament and danglers are silver sheet. The Metropolitan Museum of Art, The Michael C. Rockefeller Memorial Collection, Bequest of Nelson A. Rockefeller, 1979, 1979.206.1223



Figure 45. Band from nose ornament, Moche, from Loma Negra, Peru, Early Intermediate Period. Partially silvered gold sheet, W. 21.0 cm. The background fields are silvered gold; the birds and borders are gold. The Metropolitan Museum of Art, The Michael C. Rockefeller Memorial Collection, Bequest of Nelson A. Rockefeller, 1979, 1979.206.1226

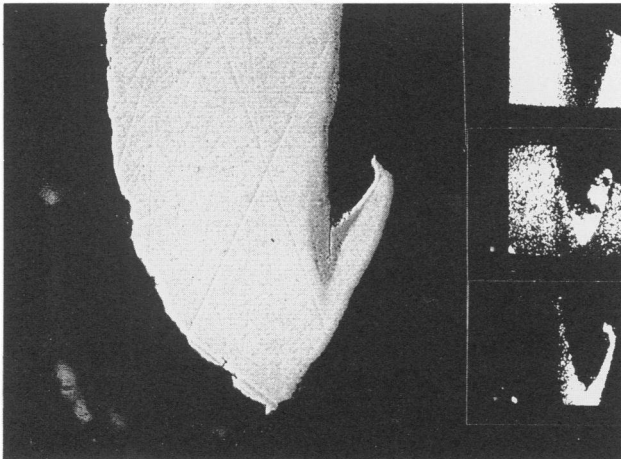


Figure 46. Polished section of silvered-gold sheet from nose ornament in Figure 44; left: electron backscattered image; right: elemental dot maps of (from top to bottom) gold, copper, and silver (photo: Mark T. Wypyski and author)

43), together with the radiographs and visual examination of the object and its section, suggest that it was hammer-welded from components of different thicknesses. The silver sheet near the join is consistently thicker than the corresponding gold sheet, which might account for the fortuitously homogeneous radiopacity visible in the radiographs. A similar relationship between the measured thicknesses of the gold and silver sheets and their relative radiopacities was observed in the examination of the second composite silver-and-gold nose ornament attributed to La Mina.

Close examination of two hammer-welded ornaments from La Mina (see Figure 31) suggests that the following sequence of steps was used in their manufacture. First, gold and silver sheets were joined by alternating heating and hammering. This was followed by the execution of the relief decoration. The metal along the joins was then selectively removed to create negative spaces and the ornament was trimmed. Hammering to finish the edges and the polishing were the final steps. Evidence that the joining of the two metals was a preliminary step can be seen along internal and external edges of the ornament, where lengths of silver sheet have narrow gold borders, and vice versa.

Analysis of the silver and gold components from the Loma Negra hammer-welded ornament indicated that both are debased.<sup>69</sup> The composition of the gold sheet—which contains 19.3 percent silver and 5.2 percent copper—is typical for the Loma Negra gold alloys, as well as Moche gold in general (see Figure 16). The silver sheet contains 6.6 percent gold and 4.4 percent copper. Unfortunately this nose ornament was the only Loma Negra hammer-welded join available for analysis, but in all instances where silver-sheet samples from hammer-welded composite silver-and-gold artifacts were analyzed, they were found to contain amounts of gold and copper equal to or greater than what was detected for the Loma Negra example. It is interesting to note that the silver used on composite objects that employ other metallurgical means of attachment, i.e., soldering or silvering, also contain considerable additions of gold and copper.



The silver used for metallurgical joining processes differs distinctly in composition from the alloys used for Loma Negra artifacts without metallurgical joins. In the six cases where analyses were carried out on objects made entirely of silver sheet or on silver components mechanically joined to gold sheet, three were quite pure (0.7–1.1 percent copper, with no gold detected). The other three were found to contain 2.0–3.6 percent copper with, in one case, an additional 1.3 percent gold (also see Appendix).

The location and composition of silver sources used by the Moche have not, as yet, been investigated, but it is obvious that pure silver was available. It also seems quite likely that the Moche added gold and copper to silver to produce alloys not known to occur in nature,<sup>70</sup> and that they chose specific natural and artificial alloys for different cultural or practical reasons. In the six instances where the silver was employed in the manufacture of objects that do not have metallurgical joins, one must assume that melting point or other working properties related to the application of heat were not factors in the choice of metal.

Whereas the color of gold is altered by the presence of even small amounts of additional metals, changes in the color or sheen of silver are optically less evident even as moderate amounts of copper and gold are added.<sup>71</sup> Therefore it is conceivable that color did not greatly affect the decisions concerning the alloying of the silver used for the Loma Negra hammer-welded nose ornament. The different degree or quality of polish attainable on different alloys may have been a factor, but this question has not been investigated. Although the reason for choosing (and probably preparing) the silver alloy is not clear, the metal must have had some combination of physical—including visual—and mechanical properties that made it suitable for combining with gold.

In most cases, the corresponding silver and gold components of the hammer-welded objects studied have relatively similar melting points; on the Loma Negra nose ornament the gold and silver components melt at 960° and 920°C, respectively. How melting point might relate to the diffusion coefficients of the two metals at elevated temperatures, and the role of concentration gradients associated with specific pairs of alloys, remain to be considered. Other properties, such as the two metals' relative malleabilities, that might have affected their ability to maintain adequate physical proximity during heating may also have played a role in choosing the alloys.<sup>72</sup>

In view of the multitude of variables, it is interesting to consider the two pectorals in the American Museum of Natural History attributed to the Chavín culture

(see Figure 32). Each pectoral consists of eight alternating gold and silver bands. Analysis of the bands indicates that they are all ternary alloys. The compositions of the artificially alloyed silver-rich bands on both ornaments are nearly identical, averaging about 54 percent silver, 39 percent gold, with the remainder copper. This alloy melts at about 950°C. The gold-rich bands on one of the pectorals (41.0/3706) average 67 percent gold, 20 percent silver, with the remainder copper,<sup>73</sup> which melts at approximately 880°C, while on the second piece (41.0/3707) the average composition of three of the gold-rich bands is 78 percent gold, 13 percent silver, with the remainder copper. The alloy melts at about 950°C, or at the same temperature as the alloy used for the silver-rich bands.<sup>74</sup> What is notable in the appearance of the pectorals is the similarity in the colors of the different alloys; the alternation of the bands is evident today because the silver-rich ones are tarnished; when viewing cleaned areas on the reverse of the pectorals or modern standards replicating the alloys used, one recognizes what great forethought and effort went into joining eight bands of metal that to our eyes are barely distinguishable visually.<sup>75</sup>

VI. There are two silvered-gold objects from Loma Negra in the Metropolitan Museum. The embellishment of Loma Negra objects through the application of silver onto a gold substrate was previously noted by Lapiner,<sup>76</sup> and by Lechtman, Erij, and Barry Jr.,<sup>77</sup> but this phenomenon is generally unreported for Peruvian artifacts.<sup>78</sup> As a rule, silvered gold is rare in all cultural contexts because, if for no other reason, gold is generally regarded as the more precious or high-status metal.<sup>79</sup> Silver coatings on gold artifacts from Sipán and La Mina have not been confirmed thus far.

The first of the two silvered-gold artifacts is a nose ornament (MMA 1979.206.1223) that represents the head of a man wearing a feathered headdress and several pieces of jewelry (Figure 44). Both the obverse and reverse surfaces are gold, but on the obverse certain details—the earflares, the necklace, the headband, and the top border of the feathers—are silvered. The nose is a separate, raised sheet of gold attached mechanically with tabs, and the man's nose ornament and the dangles were cut from a solid silver sheet. The ornament is inserted into the septum of the nose and the dangles are suspended from silver wires, which are rectangular in section.

The second silvered-gold artifact (MMA 1979.206.1226) is a flat, curved band divided into ten trapezoidal fields, each containing a bird shown in profile (Figure 45). The birds are executed in low relief and

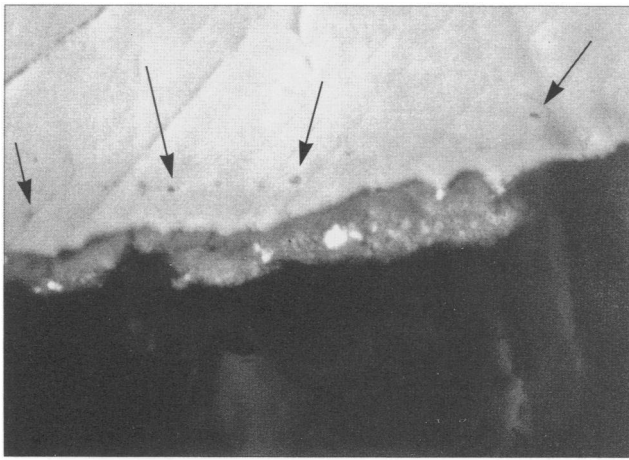


Figure 47. Polished section of silvered-gold sheet from nose ornament band in Figure 45, electron backscattered image; arrows indicate string of voids delineating interface between silver layer and gold substrate (photo: Mark T. Wypyski)

the fields are surrounded by raised borders. Once again only gold is visible on the surface of the reverse; on the obverse the birds and the borders are gold and the trapezoidal fields are silvered. Along the top edge are eleven small tabs that were used to attach the sheet to the upper half of a nose ornament, and when complete, the object would have been comparable in appearance to the snail nose ornament discussed earlier (see Figure 5).

Although visual examination and radiographic analysis were helpful in characterizing these ornaments, proof for their manufacture from partially silvered-gold sheet was obtained from the examination of polished sections. Viewed in section, the silver layers on the anthropomorphic nose ornament and the bird relief band are fairly irregular in thickness, averaging one and three microns, respectively. Scanning electron microscope elemental x-ray maps, electron backscatter images, and electron microprobe traces across the sections document the distribution of gold and silver (Figures 46–48). It is interesting to note a marked accumulation of silver in an angular irregularity on the surface of the gold in the section of the nose ornament (Figure 46).<sup>80</sup>

The structures observed in the etched metallographic sections indicate that in a later or final stage of manufacture, these artifacts were reheated sufficiently for the heavily cold-worked grains of the gold substrate to recrystallize and a certain degree of diffusion to occur. Unfortunately the silver coatings are far too thin for one to observe grain structure when using a conventional metallographic microscope, or other features that may be present.

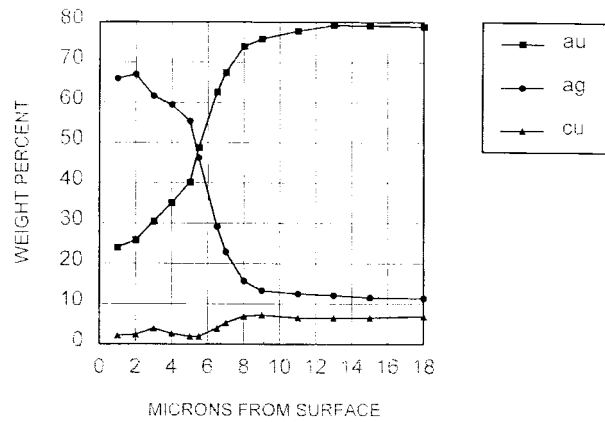


Figure 48. Electron microprobe analyses of silver, gold, and copper across section of silvered gold sheet from nose ornament in Figure 44

Electron microprobe line scans across the silver-gold interfaces carried out on both sections indicate that the zone of diffusion is quite broad, particularly in relation to the thickness of the silver layer. On the section from the anthropomorphic nose ornament, where the discrete silver layer averages three microns in thickness, diffusion of substantial amounts of silver into the gold substrate occurred to an approximate depth of eight microns (Figure 48).<sup>81</sup>

At this time it remains unclear how these silver coatings were applied. It is obvious that neither depletion plating, which was widely used in pre-conquest South America to gild and silver copper substrates, nor electrochemical replacement plating, the mechanism proposed by Lechtman for the gilding and silvering of copper sheet from Loma Negra, could have been used to produce silver layers on gold. Mechanical joining also seems unlikely.

In the manufacture of the bird-relief band it is possible to recognize the following steps: the relief detail was chased into a sheet of gold cut to approximate the final shape; the obverse was silvered and then the raised areas—the birds and the borders—were abraded to reveal the gold beneath; the band was then cut to its proper size and attached with tabs to its corresponding top half. Evidence for these steps can be found in radiographs (Figure 49) and in a careful examination of the band's silvered and unsilvered surfaces. The gold areas are somewhat less radiopaque than the silvered-gold areas, but because of its extreme thinness (ca. one micron) and the low atomic weight of silver relative to that of gold, the silver layer is not responsible for the increased radiopacity. Caliper mea-

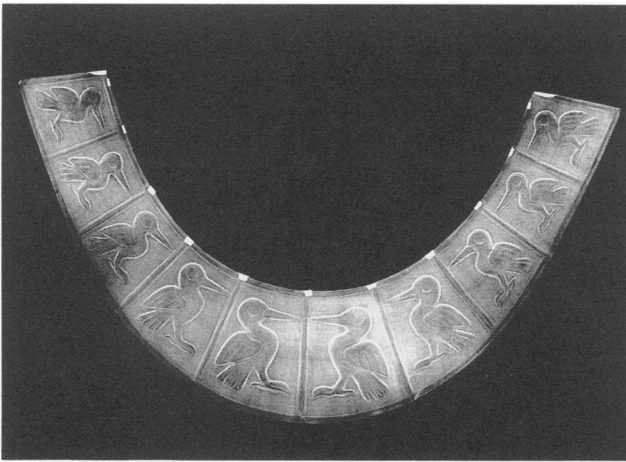


Figure 49. Radiograph of silvered-gold nose ornament band from Figure 45 (photo: author)

surements indicate that the silvered-gold sheet is thicker than the unsilvered sheet but by more than can be accounted for by the addition of one micron of silver. Some thinning of the raised areas, all of which are unsilvered gold, may be attributed to the chasing process, but other observations, including polishing scratches and small silver islands on the gold surfaces, suggest that the gold areas are thinner because they were abraded during the selective removal of patches of silver from an overall silver layer. Most convincing is the fact that the very top edge of the band and the tabs extending from it are silvered. If the silver layer had been applied locally, it is unlikely that a millimeter-wide strip adjacent to the gold border, or the tabs, would have been silvered; the presence of silver on the tabs implies that the layer had been applied to the entire obverse surface. Evidence of an overall application and selective removal of a silver layer on the anthropomorphic silvered-gold nose ornament was not observed.

An interesting and as yet unexplained phenomenon is the presence of mercury on the surface of the bird-relief band. Whereas mercury gilding, also called fire or amalgam gilding, was widely used in many ancient and historic Old World contexts, its use on objects from pre-conquest Peru has never been confirmed.<sup>82</sup> Amalgam silvering on gold is metallurgically possible, though it was rarely, if ever, carried out anywhere in the ancient world.<sup>83</sup> There are sources of elemental mercury in Peru, but it is not clear that they were exploited before the Spanish conquest.<sup>84</sup> However, the mineral cinnabar, a mercuric sulfide with the formula  $\text{HgS}_2$ , had widespread use as a pigment for painting

and during burial seems occasionally to have been sprinkled in powdered form on bodies of deceased individuals, or on the grave goods that accompanied them in death.<sup>85</sup>

In any event, as indicated by electron microprobe analysis of the section from the bird-relief band, mercury is present both in the rather spongy silver surface layer and concentrated in visually discrete structures on the surface itself, where minute specks of gold can be observed as well (Figure 50). Minimal amounts of mercury were detected in the gold substrate. In situ x-ray diffraction analysis of the surface of the band and elemental analysis of the section proved unsuccessful in identifying a mercury-containing compound.<sup>86</sup> Red pigment present on the surfaces of several pieces from Loma Negra has been identified as cinnabar, and it is possible that the mercury is due to the subsequent decay of cinnabar that had been sprinkled during burial onto the surface of the nose ornament to which this band belonged, or onto a neighboring object. The sublimation of cinnabar, which occurs at  $583^\circ\text{C}$ , would presumably leave a mercury residue on the surface; there is, however, nothing to suggest that the bird-relief band was heated after burial. Mercury independent of cinnabar was not detected on the silvered-gold nose ornament, nor on any other Moche object thus far analyzed.

VII. There is an unprovenanced Moche nose ornament in the American Museum of Natural History (41.2/8676) that was also made from partially silvered gold (Figure 51). In this case, because of the poor preservation of the silver layer, it is possible in many areas to observe the formerly silvered gold substrate and to gauge the thickness of the silver layer, which is significantly greater than those present on the two Loma Negra ornaments. The differences observed in both the macroscopic and radiographic features of the unprovenanced silvered-gold nose ornament on one hand and the two Loma Negra pieces described above point to the use of different working methods that led to a similar result.

It was noted above that the areas of silvered-gold sheet on the Loma Negra ornaments are slightly more radiopaque than gold areas, where it appears that a silver layer was intentionally abraded away. Exactly the opposite is true for the unprovenanced nose ornament, where the silvered-gold areas are considerably less radiopaque than the plain gold sheet (Figure 52). The unsilvered gold substrate is approximately 0.18 millimeter thick, while in the formerly silvered areas, where the silver has been lost due to corrosion and probably from a cleaning undertaken after the orna-

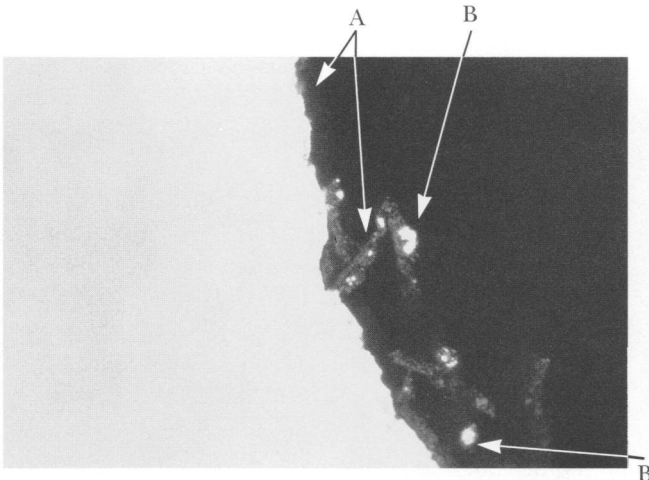


Figure 50. Electron back-scatter photograph of polished section of silvered-gold sheet from nose ornament band in Figure 45, showing A) mercury "crystals" and B) gold particles (photo: Mark T. Wypyski)



Figure 51. Nose ornament, Moche, Peru. Partially silvered gold sheet, W. 6.7 cm. Alternating swirls of unsilvered and silvered gold sheet. New York, American Museum of Natural History, Department of Anthropology 41.2/8670 (photo: author)

ment was retrieved from its burial place, the same gold sheet is an average of 0.15 millimeter thick. Intact silvered-gold areas are considerably thicker, measuring 0.24–0.25 millimeter. In this case it appears that the method of application involved the removal of gold from the surface before the application of the silver layer, rather than the application of an overall silver layer locally removed by abrasives. It is possible that the silver was applied as sheet and hammer-welded in place, or using a method related to the fusion and diffusion processes proposed by David Scott for the gild-

ing and silvering of some copper artifacts from Ecuador and Colombia.<sup>87</sup> In the absence of additional artifacts of this type that can be studied and analyzed in section, one must reserve all opinions.

VIII. There is a single example of precious metal inlays secured using metallurgical means that can be observed on one of a pair of silver-and-gold scepters from tomb 1 at Sipán. The substrate is the solid cast-silver shaft.<sup>88</sup> Gold has been inlaid in a series of spiraling channels cast and/or scored into two war clubs that

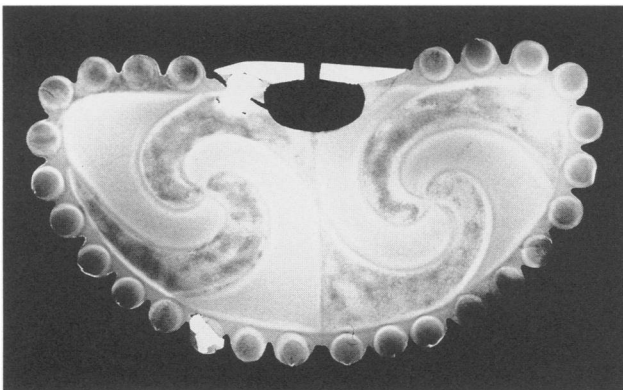
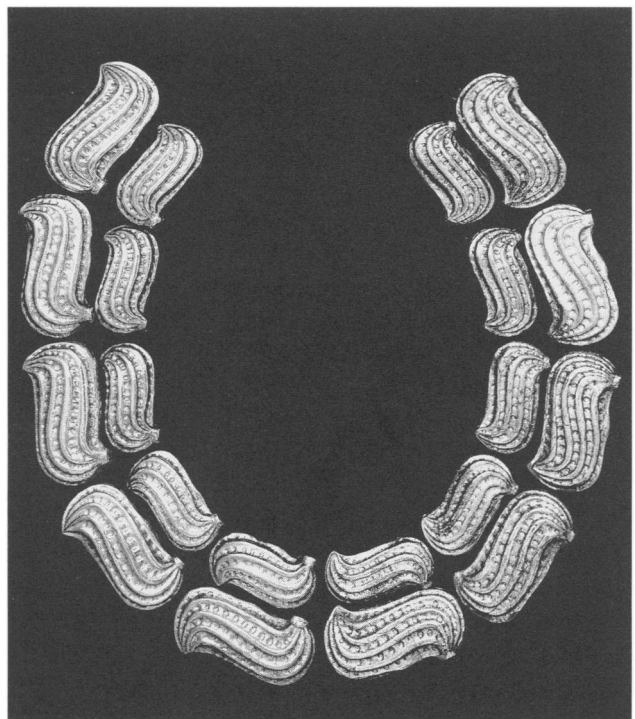


Figure 52. Radiograph of silvered-gold nose ornament in Figure 51. Areas of extreme radiopacity on border and below proper left nose prong correspond to ancient repairs. (photo: author)

Figure 53. Peanut bead necklace, Moche, Sipán, Peru. Silver and gold, L. of largest bead 9.0 cm. The five pairs on the proper right are gold; those on the left are silver. Lambayeque, Bruning Museum (photo from Alva and Donnan, *Royal Tombs*, fig. 96)



ornament the shaft. The surfaces of the gold inlays are globular and, for the most part, below the surface level of the silver substrate. In the few instances where the gold had been higher when first applied, it was smeared, apparently during manufacture, across the silver, so that the surfaces are now more or less flush. Minute amounts of gold were also applied to the convex silver surfaces of two “stones” shown in slings wrapped around the war clubs. In this case the gold does not appear globular, nor to have been set into a deep recess. It can be proposed that the gold inlay was applied in a semi-molten state, but a rigorous examination is necessary in order to discover the precise methods of application of both the gold inlays and overlays; the method used for the latter may be related to that used to apply silver to a gold surface on the unprovenanced nose ornament in the American Museum of Natural History described above and, in any case represents a rare, if small-scale, occurrence of gilded silver in Peru that predates the Lambayeque culture.

IX. One method for combining gold and silver used by the Moche seems, thus far, to be unique to La Mina. It appears on several similar gold zoomorphic trumpets, to which silver has been applied using two methods.<sup>89</sup> One method is inlay, probably of the first type, using an organic adhesive, described for the Sipán material, and the second appears to involve the fusion of silver strips onto the surface of the gold. A full examination of the trumpets would be necessary to determine the precise details of their manufacture.

## DISCUSSION

It is clear that the visual juxtaposition of silver and gold was highly significant to the Moche. In addition to the use of gold and silver within a single composite work, gold and silver objects themselves were sometimes arranged to express a specific, dualistic relationship between the two metals. In Sipán tomb 1, excavated by the Bruning Museum, three pairs of objects in gold and silver versions—ingots, backflaps, and *tumis*—were placed on the proper right and proper left sides, respectively, of the deceased.<sup>90</sup> A similar right-left arrangement of pairs of gold-and-silver backflaps and bells was found at Sipán in tomb 3, the burial of a man believed to have held a similar position in the Moche hierarchy, but in an earlier period.<sup>91</sup> This phenomenon is thus far known only from Sipán because evidence for this type of arrangement, should it exist, can

be ascertained only for artifacts obtained through excavation. The association of gold and silver with the right and left sides of the human body has also been observed on composite silver-and-gold objects, such as the famous peanut bead necklace from tomb 1 at Sipán (Figure 53) and on hammer-welded nose ornaments from Loma Negra (Figure 29) and Sipán,<sup>92</sup> and nose ornaments attributed to the Vicús culture (Figure 34).<sup>93</sup> Whereas the finds at Sipán suggest that in burial contexts at that site and/or for specific personages there was a symbolic association between gold and the right side of the human body, and silver with the left, compositionally most Moche composite objects are not bisected by a single vertical line of symmetry that separates two mirror-image fields of different color, nor are gold and silver limited to one side or the other of a central axis (see Figures 4, 5, 7, 9–11, 14, 17, 22, 31, 44, 45, 51).<sup>94</sup>

Viewed in terms of the effort and creativity that went into the manufacture of the composite artifacts discussed in this article, one might suggest that the interest of the Moche in the visual juxtaposition of gold and silver was unlimited. “Why juxtapose silver and gold on a single object?” “Why cover copper with a layer of gold?” “Why fashion an object of solid gold in one instance and the same object from gilt copper in another?” To these questions that Heather Lechtman posed while reflecting on the lectures presented at the colloquium/workshop “Andean Royal Tombs, Works of Art in Metal,”<sup>95</sup> one might add: Why devise so many methods of manufacture to create a specific visual effect? Are these sumptuous ornaments the work of a people for whom innovation, or variety, or the mastery of the physical world through the manipulation of raw matter, was a value of cultural significance? A preliminary examination of Vicús metalwork suggests that Vicús metalsmiths also depended on a considerable range of methods for combining gold and silver; perhaps this tendency or desire to juxtapose these metals embodies a specific level or quality of contact between the Moche and Vicús cultures; alternately, one might suggest that this technical and visual aesthetic is a development of the Early Intermediate Period in the north central Andes rather than a specifically Moche phenomenon. In considering this question one should look also to the composite silver-and-gold artifacts attributed to the problematic Friás culture, associated with a site of the same name in the highlands just northeast of Loma Negra and neighboring Vicús culture sites and thought to be contemporaneous in date.

Having adopted and developed these techniques, how did the Moche metalworker choose the method or methods that would be used in the manufacture of

a specific object? The evidence from the existing corpus of Moche metalwork suggests that there are regional variations in the types of objects executed in gold and silver, just as one observes that certain methods seem to be favored at one or another of the three main sites. What combination of various and interrelated factors, such as date of manufacture, local traditions, type and function of the artifact, social status of the owner, availability of resources, and working properties of materials, formed a preference for one manufacturing method over another? Our hope is that, with further study and thought, we might begin to assign cultural values to the different technological processes used to create these objects and thereby might explain a particular confluence of artifact and manufacture.

#### ACKNOWLEDGMENTS

I would like to thank James H. Frantz, conservator-in-charge of the Sherman Fairchild Center for Objects Conservation of the MMA, for his ongoing generous support of my research. I am indebted to Julie Jones, Department of the Arts of Africa, Oceania, and the Americas, MMA, and to Ellen G. Howe and Richard E. Stone of the Sherman Fairchild Center, for their time and expertise, which were essential for the formulation and execution of this research. Samantha Alderson, Sarah Nunberg, and Leesa Vere-Stevens all provided information about the Loma Negra material gleaned in the course of the examinations and conservation treatments they undertook during their internships at the Sherman Fairchild Center; George S. Wheeler carried out the open architecture x-ray diffraction analysis; and Mark T. Wypyski carried out numerous analyses for this research, offered his expertise in their interpretation, and provided electron back-scatter images and elemental dot maps. Lawrence Becker of the Worcester Art Museum and Heidi King of the Department of the Arts of Africa, Oceania and the

Americas, MMA, repeatedly offered useful commentary and advice. Heather Lechtman of the Center for Materials Research for Archaeology and Ethnography at MIT provided much encouragement as well as stimulating discussion about Loma Negra and Sipán. In addition I must acknowledge an enormous debt to Lechtman's writings, which have established a theoretical basis for much of the contemplation that went into this article. I am grateful to Craig Morris, Judith Levinson, and Barbara Conklin (formerly) of the American Museum of Natural History; to Nancy Rosoff, Scott Merritt, and Mary Mooney of the National Museum of the American Indian; and to Elizabeth H. Boone and the late Carol Callaway, both formerly of Dumbarton Oaks, for generously facilitating the examination and loan of Peruvian metalwork in their care. Richard Newman of the Museum of Fine Arts, Boston, carried out electron-microscopic analyses. Ulrike Bunte of the Linden-Museum Stuttgart, Staatliches Museum für Völkerkunde, was kind enough to examine the Moche mask and its documentation on a moment's notice. My thanks go also to Christopher B. Donnan of the Fowler Museum of Cultural History at the University of California at Los Angeles for providing access to the Moche Archive, for facilitating my examination of metalwork from Sipán, and for answering my many queries on Moche culture. I enjoyed Walter and Susanne Alva's hospitality during a 1993 visit to Lambayeque. Thanks to Robert Baines of the Royal Melbourne Institute of Technology, who carried out preliminary hammer-welding replication experiments. Thanks also to other colleagues at the MMA: Adam Hart of the Design Department, Joshua Lee of the Department of Arms and Armor, Silvia Centeno of the Sherman Fairchild Center, Barry Girsh, formerly of the Department of Egyptian Art, Ross Day, Jeanette Schnell, Peter Blank (formerly), Katie Dowling (formerly), James Downtin, and Donald Roberts of the Department of the Arts of Africa, Oceania and the Americas, and especially, Eileen Travell and Bruce J. Schwarz of the Photograph Studio, for their generous contributions.

# Appendix: Composite Silver-and-Gold Artifacts from Loma Negra in The Metropolitan Museum of Art

## *I. Mechanical joining of silver and gold sheets*

1979.206.1225  
Silver nose ornament with applied gold double-headed dragon  
W. 20.8 cm, H. 12.3 cm  
Not analyzed  
Figure 4

1979.206.1228  
Silver nose ornament with applied gold-relief band  
W. 19.9 cm, H. 12.6 cm  
Analysis of silver component: 99.0% Ag, 1.0% Cu  
Figures 5, 6

1979.206.1235 (not illustrated)  
Silver nose ornament with applied gold snakes and relief trophy head  
W. 9.1 cm, H. 7.1 cm  
Analysis of silver component: 95.1% Ag, 1.3% Au, 3.6% Cu

1979.206.1236  
Silver nose ornament with applied gold-relief crayfish  
W. 18.7 cm, H. 12.3 cm  
Analysis of silver component: 98.0% Ag, 2.0% Cu; of gold component: 76.3% Au, 17.0% Ag, 6.7% Cu  
Figures 7, 8

1979.206.1240  
(cf. National Museum of the American Indian 24/3543)  
Earflare frontal in form of silver spider on gold web  
Diam. 8.4 cm  
Analysis of silver component: 97.2% Ag, 2.8% Cu; of gold component: 70.3% Au, 16.7% Ag, 13.0% Cu  
Figures 11–13

1979.206.1241 (cf. 1979.206.1242)  
Gold earflare with gold warrior figure on silver backplate  
Diam. 7.8 cm, L. 8.1 cm  
Not analyzed  
Figure 10

1979.206.1242 (cf. 1979.206.1241)  
Gold earflare with gold warrior figure on silver backplate  
Diam. 7.8 cm, L. 8.1 cm  
Not analyzed  
Figure 10

1979.206.1245 (cf. 1979.206.1246)  
Gold earflare with silver harpy eagle appliqué (backplate and cylinder shaft of depletion-gilded ternary alloy)

Diam. 7.6 cm, L. 10.0 cm  
Not analyzed  
Figure 9

1979.206.1246 (cf. 1979.206.1245)  
Gold earflare with silver harpy eagle appliqué (backplate and cylinder shaft of depletion-gilded ternary alloy)  
Diam. 7.5 cm, L. 10.8 cm  
Analysis of gold component: 74% Au, 19% Ag, 7% Cu (Heather N. Lechtman, Antonieta Erlj, and Edward J. Barry Jr., who, in “New Perspectives on Moche Metallurgy; Techniques on Gilding Copper at Loma Negra, Northern Peru,” *American Antiquity* 47 [1982] p. 7)  
Figure 9

1979.206.1247 (not illustrated)  
Gold nose ornament frontal with stone inlays in form of Ai-Apec wearing a silver nose ornament  
W. 9.6 cm, H. 6.9 cm  
Analysis of gold component: 68.8% Au, 18.8% Ag, 12.4% Cu  
Illustrated in Alan Lapiner, *Pre-Columbian Art of South America* (New York, 1976) fig. 382

## *II. Mechanical joining of gilded- and silvered-copper sheets (selected examples)*

1979.206.1314  
Staff head  
H. 6.8 cm, Diam. 3.7 cm  
Not analyzed  
Figure 18

1987.394.54  
Warrior and “moon creature” disk  
Diam. 28.2 cm  
Analysis of gold surface layer (backplate): 74.2% Au, 25.8% Ag; of silver surface layer (rim): 44.5% Ag, 55.5% Au  
Figure 17

1987.394.56  
Owl disk  
Diam. 26.4 cm  
Analysis of gold surface layer (owl): 79.8% Au, 20.2% Ag; of silver surface layer (backplate): 43.7% Ag, 56.3% Au  
Figures 14, 15

## *III. Solid-gold and -silver sheets soldered with ternary alloy*

1979.206.1230  
Nose ornament in shape of a spiderweb  
W. 8.6 cm, H. 6.6 cm  
Analysis of silver component: 88.7% Ag, 6.1% Au, 5.2% Cu; of gold component: 66.0% Au, 13.1% Ag, 20.9% Cu; of solder: 52.8% Ag, 14.2% Au, 33.0% Cu  
Figures 22, 26, 27

#### IV. Hammer-welded gold and silver sheets

1979.206.1332

Nose ornament

W. 14.0 cm, H. 10.7 cm

Analysis of silver component: 89.0% Ag, 6.6% Au, 4.4% Cu;  
of gold component: 75.5% Au, 19.3% Ag, 5.2% Cu

Figures 29, 36

#### V. Partially silvered-gold sheet

1979.206.1223

Gold nose ornament in form of a man wearing a feathered  
headdress (wearing mechanically joined silver-sheet nose  
ornament)

W. 18.9 cm, H. 12.7 cm

Analysis of gold substrate: 78.0% Au, 13.3% Ag, 8.7% Cu; of  
silver surface layer: 71.6% Ag, 23.5% Au, 4.9% Ag

Figure 44

1979.206.1226

Gold-relief band from nose ornament

W. 21.0 cm, H. 12.0 cm

Analysis of gold substrate: 83.0% Au, 12.5% Ag, 4.5% Cu; of  
silver surface layer: 56.9% Ag, 38.0% Au, 5.1% Cu

Figures 45, 49

#### NOTES

1. See Heather N. Lechtman, "Traditions and Style in Central Andean Metalworking," in *The Beginning of the Use of Metals and Alloys*, Robert Maddin, ed. (Cambridge, Mass., 1988) pp. 344–378, esp. p. 349, and Heather N. Lechtman, "Andean Value Systems and the Development of Prehistoric Metallurgy," *Technology and Culture* 25 (1984) pp. 1–36, esp. p. 15.

2. The following periods of central Andean prehistory and northern Peruvian cultures are discussed in this article: Initial Period (ca. 1800–ca. 900 B.C.); Early Horizon (ca. 900–ca. 200 B.C.); Early Intermediate Period (ca. 200 B.C.–ca. A.D. 600); Middle Horizon (ca. A.D. 600–ca. 1000); Late Intermediate Period (ca. 1000–ca. 1475); Late Horizon (ca. 1475–1534). The dates defining these periods and cultures are under constant revision; those cited here are found in Richard W. Keatinge, preface in *Peruvian Prehistory*, Richard W. Keatinge, ed. (Cambridge, Mass., 1988) pp. xiii–xvii; for other recent chronologies, see Michael E. Moseley, *The Incas and Their Ancestors* (London, 1992) pp. 16–21; Heather N. Lechtman, "The Andean World," in *Andean Art at Dumbarton Oaks*, 2 vols., Elizabeth Hill Boone, ed. (Washington, D.C., 1996) I, pp. 15–32, esp. table 1; and Karen O. Bruhns, *Ancient South America* (Cambridge, Mass., 1994) pp. 7–14.

3. The development of copper metallurgy, and particularly systems for gilding and silvering copper surfaces, while beyond the scope of this article, was a major technological development of the Early Intermediate Period.

4. Alfred L. Kroeber, *Peruvian Archaeology in 1942* (New York, 1944) pp. 57, 127–128.

5. Samuel K. Lothrop, "Gold Artifacts of Chavín Style," *American Antiquity* 16 (1950–51) pp. 226–240, esp. p. 235. Lothrop also mentions a few specimens of poorly documented Early Horizon Paracas silver said to have been found by Tello at Cerro Colorado in southern Peru; see Samuel K. Lothrop, "Gold and Silver from Southern Peru and Bolivia," *Journal of the Royal Anthropological Institute of Great Britain and Ireland* 67 (1937) pp. 305–325, esp. p. 306. Lechtman, in "Traditions and Style," p. 235, suggests that the use of silver dates at least as far back as ca. 700 B.C., at the beginning of the Early Horizon. The Gallinazo culture dates to the early years of the Early Intermediate Period and was centered in the Virú Valley, south of the Moche valley.

6. See notes 57, 60 below.

7. Walter Alva and Christopher B. Donnan, *The Royal Tombs of Sipán* (Los Angeles, 1993) figs. 27, 33, 36, etc.

8. Representative gilded- and silvered-copper objects from Loma Negra were studied by Heather N. Lechtman, Antonieta Erljij, and Edward J. Barry Jr., who, in "New Perspectives on Moche Metallurgy: Techniques of Gilding Copper at Loma Negra, Northern Peru," *American Antiquity* 47 (1982) pp. 3–30, hypothesized the use of an electrochemical replacement plating method on all of the artifacts examined with the exception of a pair of earflares, see note 37 below; see also Heather N. Lechtman, "A Precolumbian Technique for Electrochemical Replacement Plating of Gold and Silver on Objects of Copper," *Journal of Metals* 31 (1979) pp. 154–160; idem, "Pre-Columbian Surface Metallurgy," *Scientific American* 250 (1984) pp. 56–63; idem, "Andean Value Systems," pp. 14–21. A number of the gilded-copper objects from Sipán have been described as depletion gilded; see Christian Eckmann, "Gilding Processes and Surface



Treatment of Gold-Silver-Copper Alloys from the Royal Tomb of Sipán," paper presented at the colloquium/workshop "Andean Royal Tombs, Works of Art in Metal," May 10, 1993, MMA. There were apparently no silvered-copper artifacts among those from Sipán examined by Eckmann.

9. Alan Lapiner, *Pre-Columbian Art of South America* (New York, 1976) pp. 113–115; Julie Jones, "Mochica Works of Art in Metal: A Review," in *Pre-Columbian Metallurgy of South America*, A Conference at Dumbarton Oaks, Oct. 18–19, 1975, Elizabeth P. Benson, ed. (Washington, D.C., 1979) pp. 53–104; Hans-Dietrich Disselhoff, "Metallschmuck aus der Loma Negra, Vicús (Nord-Peru)," *Antike Welt* 3 (1972) pp. 43–53.

10. Hans-Dietrich Disselhoff, *Vicús, Eine neu entdeckte altperuanische Kultur*, Monumenta Americana VII (Berlin, 1971); Hans Horkheimer, *Vicús, Exposición auspiciada por la Universidad Técnica de Piura* (Lima, 1965); idem, "Vicús, Ausdrucksformen einer neu aufgefundenen Kultur," *Archiv für Völkerkunde* 22 (1968) pp. 85–91.

11. Bruhns, *Ancient South America*, p. 13.

12. For a general introduction to Moche culture, see Alva and Donnan, *Royal Tombs*, pp. 13–25; Christopher B. Donnan, *Moche Art of Peru*, rev. ed. (Los Angeles, 1978). The dates cited here for the Moche culture are based on Donnan's work.

13. Horkheimer, *Vicús*; Disselhoff, "Metallschmuck"; Lechtman et al., "New Perspectives," pp. 3–7; Peter Kaulicke, "Moche, Vicús-Moche y el Mochica Temprano," *Bulletin de l'Institut Français d'Études Andines* 21 (1992) pp. 853–903; idem, "La Presencia mochica en el Alto Piura: problemática y propuestas," in *Moche: Propuestas y Perspectivas*, Actas del Primer Coloquio sobre la Cultura Moche, Trujillo, April 12–16, 1993, S. Uceda and E. Mujica, eds. (Lima, 1994) pp. 327–358; Bruhns, *Ancient South America*, pp. 327–358; Krzysztow Makowski, Christopher B. Donnan, Ivan Amaro Bullon, et al., *Vicús* (Lima, 1994).

14. Schaffer, a graduate student at the Institute of Fine Arts, New York University, was then an intern in the Museum of Primitive Art, New York.

15. See, for example, Lechtman, "Traditions and Style," p. 344. Based on the paucity of cast objects found at Sipán, a metal-rich Moche site in Lambayeque Valley discovered in 1987, this does not seem remarkable.

16. Disselhoff, "Metallschmuck," p. 46.

17. Jones, "Mochica."

18. Anne-Louise Schaffer, "Impressions in Metal: Reconstructing Burial Context at Loma Negra, Peru," in *Recent Studies in Andean Prehistory and Protohistory*, D. Peter Kvietok and Daniel H. Sandweiss, eds. (Ithaca, 1985) pp. 95–119.

19. To these examples of Andean burials of elite individuals one might add a tomb of the Lambayeque culture recently excavated at Huaca Loro; Isumi Shimada and Jo Ann Griffin, "Precious Metal Objects of the Middle Sicán," *Scientific American* 270 (1994) pp. 82–89.

20. Walter Alva, "Discovering the New World's Richest Unlooted Tomb," *National Geographic* 174 (1988) pp. 510–548; idem, "Splendors of the Moche: New Royal Tomb Unearthed," *National Geographic* 177 (1990) pp. 2–15; Alva and Donnan, *Royal Tombs*; Walter Alva, *Sipán* (Lima, 1994). Since the appearance of two full-length volumes describing the excavation of three major tombs, approximately ten more burials, far less rich in their contents, have been excavated at Huaca Rajada.

21. Christopher B. Donnan, "Splendors of the Moche: Masterworks of Art Reveal a Remarkable Pre-Inca World," *National Geographic* 177 (1990) pp. 17–33, esp. pp. 29–32; idem, "The Royal Moche Tomb at La Mina, Jequetepeque Valley," paper presented at "Andean Royal Tombs," MMA.

22. Some of the finds from this looted site are documented in the Moche Archive at the University of California at Los Angeles. A number of objects said to be from La Mina are illustrated in Christopher B. Donnan, "Oro en el arte moche," in *Oro del antiguo Perú*, Juan Antonio de Lavalle, ed. (Lima, 1993) pp. 119–193.

23. Julie Jones, "Loma Negra—A Peruvian Lord's Tomb," exh. pamphlet, Oct. 13, 1992–July 4, 1993, MMA (New York, 1992).

24. Julie Jones, "Welcome, and More on Loma Negra," paper presented at "Andean Royal Tombs," MMA.

25. The first portion of the Loma Negra corpus accessioned by the MMA came from the Museum of Primitive Art in 1979 as part of the Nelson A. Rockefeller Bequest. Loma Negra objects formerly in the Arnold I. Goldberg collection were donated to the MMA in several phases, starting in 1980. A number of Loma Negra artifacts are illustrated in Lapiner, *Pre-Columbian Art*, nos. 347, 349–355, 357–361, 363, 365–369, 376–382, 385–386, 388–397.

26. Crescent ornaments, which may be ceremonial axes, are known only from the Vicús region. Examples are illustrated in Disselhoff, "Metallschmuck," figs. 3–5, 8–10, 12, 15, 17, and in Lapiner, *Pre-Columbian Art*, nos. 347, 360, 361, 365.

27. Jones, "Welcome."

28. Nine additional composite objects or pairs of objects, and two components of gold that were used in composite constructions, all belonging to various private collections, were documented in the Loma Negra Archive in the early 1970s. Some composite silver-and-gold objects attributed to the Vicús culture in catalogues of the Museo Oro del Perú are now thought to have come from Loma Negra; see Miguel Mujica Gallo, *Catalogue Museo "Oro del Perú"* (Lima, 1970) e.g., nos. 16, 17. One Loma Negra composite silver-and-gold nose ornament in a private collection appears in Lapiner, *Pre-Columbian Art*, no. 397. See also note 61 below.

29. Illustrated in Daniel Levine, *L'Or des dieux, l'or des Andes*, exh. cat., Metz-Arsenal (Woippy, 1994) p. 41.

30. Deborah Schorsch, "Manufacturing Methods of Composite Gold and Silver Objects at Loma Negra," paper presented at "Andean Royal Tombs," MMA.

31. Ellen G. Howe, Deborah Schorsch, Mark T. Wypyski, Samantha Alderson, Sarah Nunberg, and Leesa Vere-Stevens, "Technical Overview of Loma Negra Metalwork," paper presented at "Andean Royal Tombs," MMA; Deborah Schorsch, Ellen G. Howe, and Mark T. Wypyski, "Moche Metalwork from Loma Negra, Manufacture and Aesthetics," *Boletín Museo del Oro* (forthcoming).

32. The analyses were carried out by Mark T. Wypyski on a Kevex model Delta IV energy-dispersive x-ray spectrometer with a modified Amray model 1000 (1600T) scanning electron microscope operating at a voltage of 30 kV. The data were quantified with Kevex software using MAGIC IV ZAF corrections for standardless analysis and are reported in relative weight percentages of elements detected.

33. The analyses were carried out by Richard Newman on a Cameca electron beam microprobe equipped with a Tracor-Northern 5502 energy-dispersive x-ray fluorescence system with stage automation at the Department of Earth and Planetary Sciences

of Harvard University. The microprobe was calibrated with gold, silver, copper, and cinnabar standards, and matrix corrections were carried out using ZAF (fundamental parameters) method.

34. Heather N. Lechtman and Arthur Steinberg, "Bronze Joining: A Study in Ancient Technology," in *Art and Technology: A Symposium on Classical Bronzes*, Suzannah Doeringer, David G. Mitten, and Arthur Steinberg, eds. (Cambridge, Mass., 1970) pp. 5–35. Mechanical joining processes are based on the production of metal components that can be hammered, crimped, bent, or tied in place, sometimes with the use of rivets, wires, and tabs. Two other possibilities exist: cast components can be designed so that they interlock after casting, or components can be cast together. Moche composite gold-and-silver artifacts were nearly always made from hammered rather than cast components, and only the first of the three mechanical methods outlined by Lechtman and Steinberg has been observed.

35. See Lechtman et al., "New Perspectives," p. 7, and Lechtman, "Traditions and Style," pp. 360–362. The entirely silver objects surviving from Loma Negra are simple nose ornaments whose manufacture did not require joining.

36. See Alva and Donnan, *Royal Tombs*, fig. 166.

37. The backplates of the frontals and the shafts are gilded-copper sheet, and the earflares are one of two pairs of objects from Loma Negra known to have depletion gilded components; Lechtman, "Andean Value Systems," fig. 5; Silvia A. Centeno and Deborah Schorsch, "The Characterization of Gold Layers on Copper Artifacts from the Piura Valley (Peru) in the Early Intermediate Period," in *Gilded Metals*, Terry Drayman Weisser, ed. (forthcoming).

38. The MMA earflare frontal, while it was still in the Museum of Primitive Art, was described by Lapiner (*Pre-Columbian Art*, no. 380) as having a silvered-gold web, a misperception that probably arose from the presence of a grayish sulfide tarnish on the gold surface.

39. Pressure-fitting is a mechanical joining method that involves preparing metal-sheet components that can be hammered to fit tightly together without tabs, wires, etc.

40. An exception is a nose ornament in the National Museum of the American Indian (15/901) composed of a gold bead on a silver wire.

41. Most of the other eight disks from Loma Negra in the MMA are made of gilded copper. Two examples are illustrated in Lapiner, *Pre-Columbian Art*, nos. 363, 366. A number of disk ornaments not documented in the Loma Negra Archive are found in the American Museum of Natural History.

42. Surface layers on components marked with an asterisk were not analyzed.

43. This and other analyses of silvered and gilded surfaces presumed to be applied by electrochemical deposition were normalized by the subtraction of copper, which, in such cases, would be present almost exclusively due to the migration of copper from the substrate during burial; see Centeno and Schorsch, "Oro y Plata."

44. The data plotted in Figure 16 derive from SEM analyses carried out at the MMA Sherman Fairchild Center for Objects Conservation and from published analyses that appear in Salvador Rovira, "Pre-Hispanic Goldwork from the Museo de América, Madrid: A New Set of Analysis," in *Archaeometry of Pre-Columbian Sites and Artifacts: Proceedings of a Symposium Organized by the UCLA Institute of Archaeology and the Getty Conservation Institute, Los Angeles, March 23–27, 1992*, David A. Scott and Pieter Meyers, eds. (Malibu, 1994) pp. 323–350, and in Kroeber, *Peruvian Archaeology*, p. 132. For these

and other analyses subsequently carried out at the Sherman Fairchild Center, see Schorsch et al., "Manufacture and Aesthetics."

45. See the Chavín pectorals discussed on page 125.

46. Jones, "Mochica," figs. 19, 20; Schorsch et al., "Manufacture and Aesthetics."

47. Heather Lechtman has written extensively about the significance of color in ancient Peruvian metalwork.

48. A similar effect, attained through the juxtaposition of plain and textured surfaces that have different reflective properties and therefore appear to be of slightly different colors, can be observed on a Loma Negra gilded-copper openwork disk, decorated with concentric bands of sea creatures (MMA 1987.384.46); Schorsch et al., "Manufacture and Aesthetics."

49. The metal is erroneously described as copper sheet in Lechtman et al., "New Perspectives," p. 6.

50. A sample of wood removed from the inside of this artifact provided a carbon-14 date of A.D. 295 ± 95 years; Lechtman et al., "New Perspectives," p. 5.

51. A mask in a private collection attributed to the Vicús culture is described as having been made from mirror-image gilded- and silvered-copper sheets joined with a metal "staple"; see Museum zu Allerheiligen, *Idole Masken Menschen: Frühe Kulturen, Alte Welt und Neue Welt*, exh. cat. (Schaffhausen, 1992) no. 5.18.

52. Attempts to identify natural resins used on artifacts from Loma Negra have thus far proved unsuccessful.

53. A method of inlay more familiar to students of Old World metallurgy appears much later and becomes widespread in Peru only in Inka times. In that case the metal to be inlaid is formed or cut to size and hammered into existing channels; see Julie Jones, *Art of Empire: The Inca of Peru*, exh. cat., Museum of Primitive Art (New York, 1964) fig. 38.

54. Heather N. Lechtman, "The Central Andes: Metallurgy without Iron," in *Coming of the Age of Iron*, Theodore Wertime and James D. Muhly, eds. (New Haven, 1980) pp. 267–334, esp. p. 286; Lechtman, "Traditions and Style," p. 360.

55. Howe et al., "Technical Overview"; of the hundreds examined, nine individual objects or pairs of objects were found to have been joined with solder. With the exception of the silver-and-gold composite nose ornament discussed here, these examples were made from gold or gilded-copper sheet. As used in this essay, the term soldering refers to high-temperature, or hard, soldering, which is generally referred to as brazing in the metallurgical industry; see Deborah Schorsch, "Copper Ewers of Early Dynastic and Old Kingdom Egypt—An Investigation of the Art of Smithing in Antiquity," *Mitteilungen des Deutschen Archäologischen Instituts Abteilung Kairo* 48 (1992) pp. 146–159, esp. p. 152.

56. Two composite nose ornaments not in the MMA that are known from photographs in the Loma Negra Archive are also likely to have been assembled with solder.

57. Solder was used to join some gold components to each other and may well also have been used for gold-to-silver joins; Lechtman, "Bimetallic Effigy Spoon" (cat. entry), in *Andean Art at Dumbarton Oaks I*, pp. 55–66.

58. Samuel K. Lothrop, "Gold Ornaments of Chavín Style from Peru," *American Antiquity* 6 (1940–41) pp. 250–262, esp. pp. 258–260, pl. xxc. Solder is not visible in the radiographs of the pin, neither on gold-to-gold or gold-to-silver joins. The joins may have

been produced by fusing, which is executed at elevated temperatures without the introduction of a filler metal.

59. Compare Lechtman, "Traditions and Style," p. 263.

60. A sample of the solder used to join one of the backplates to the web from the nose ornament was analyzed and found to contain 52.8% silver, 33.0% copper, and 14.2% gold. The composition of the solder used on the Loma Negra gilded-copper warrior figures is entirely different, containing 48.5% gold, 27.7% silver, and the remainder copper (Howe et al., "Technical Overview"). Copper-silver solders have also been noted on Moche gold objects (Lechtman et al., "New Perspectives," pp. 38–42), as has the use of both gold- and silver-based soldering alloys on Chavín gold (Lechtman, "The Central Andes," p. 286). At the present time there are too few analyses of Moche solders to compare with these data or to evaluate what combination of factors, aesthetic and practical, affected their formulation.

61. In addition, not included in the archive is a hammer-welded Loma Negra nose ornament in the American Museum of Natural History (41.2/6983).

62. Donnan, "Oro," figs. 127, 128, 130, 131.

63. These pectorals were formerly thought to be of the later Chimú period; Pliny E. Goddard, "Peruvian Gold of the Chimú Kingdom," *Natural History* 21 (1920) pp. 447–452.

64. See esp. Mujica Gallo, "Oro del Perú," nos. 3326, 3328–3330, 3332, 3353, 3359, 3420, 3431; A. D. Tushingham, Ursula M. Franklin, and Christopher Toogood, *Studies in Ancient Peruvian Metalworking, History, Art and Technology Monograph* 3 (Toronto, 1976) nos. 24, 32, 34, 42, 43; Makowski et al., *Vicús*, figs. 120, 466, 477.

65. Lechtman in *The Andean World*, pp. 207–210; a *tupu* is a pin used for securing clothing.

66. A. D. Tushingham, Kent C. Day, and Léo Rosshandler, *Gold for the Gods*, exh. cat., Royal Ontario Museum (Toronto, 1979); see Tushingham et al., *Ancient Peruvian Metalworking*, pp. 20–24.

67. Tushingham et al., *Ancient Peruvian Metalworking*, figs. 72, 74, 76.

68. One such example, a scepter from Sipán, is discussed on pages 128–129.

69. Objects were sampled on outer edges away from hammer-welded joints so that the analyses more or less reflect the metal as originally formulated and unaffected by diffusion that occurred at the joints.

70. Georg Peterson, *Minería y metalurgia en el antiguo Perú*, Arqueológicas, Publicaciones del Instituto de Investigaciones Antropologías 12 (Lima, 1970); Noel H. Gale and Zofia A. Stos-Gale, "Ancient Egyptian Silver," *Journal of Egyptian Archaeology* 67 (1981) pp. 103–115, esp. p. 114.

71. Ernst Drost and Jürgen Haußelt, "Uses of Gold in Jewellery," *Interdisciplinary Science Reviews* 17 (1992) pp. 271–280, fig. 1.

72. Preliminary hammer-welding replication experiments were undertaken by Robert Baines during his residency at the Sherman Fairchild Center.

73. This average is based on the analysis of three of the four gold-rich bands.

74. The fourth gold-rich band contains about 85% gold, which raises the melting point to approximately 975°C.

75. These pectorals are discussed by Lechtman in Benson, *Dumbarton Oaks*, p. 74 and no. 29.

76. Lapiner, *Pre-Columbian Art*, nos. 380, 393; see note 38.

77. Lechtman et al., "New Perspectives," p. 7; see also Lechtman, "Andean Value Systems," fig. 6.

78. The famous mask from Huaca de la Luna in the Linden-Museum Stuttgart Staatliches Museum für Völkerkunde (119–156) is described in a recent publication as partially silvered gold; Donnan, "Oro," p. 124. The piece had been previously published by other scholars as gilded and painted copper (e.g., Jones, "Mochica," p. 70), which was reconfirmed by Ulrike Bunte of the Linden-Museum, who recently examined the mask (Bunte, personal communication with author). Visual examination of a specific type of composite silver-and-gold Vicús nose ornaments indicates that they were partially silvered, but as yet no analyses have been undertaken. There is a partially silvered gold bowl, attributed to the Huari culture of the Middle Horizon, in the Museo Nacional de Arqueología, Antropología y Historia in Lima.

79. P. Andrew Lins, "A History of Metal Coatings on Metals Pre-1800 AD (unpublished manuscript, 1974; British Museum Department of Scientific Research Reference Library 669 [031]) p. 20, cites an unusual case of an oblong piece of gold wrapped in silver sheet from predynastic Egypt. Several authors have noted Chinese amalgam silvered bronzes that have a gold layer between the silver and the bronze. It has recently been suggested that the presence of a gold layer improves the adhesion of the silver; Kilian Anheuser, "An Investigation of Amalgam Gilding and Silvering on Metalwork" (Ph.D. diss., University of Oxford, 1996) p. 14.

80. The large patch of copper visible in the elemental dot map corresponds to the presence of copper corrosion products on the inner surfaces of the irregularity.

81. All microprobe analyses were carried out with a point beam. An area of approximately three microns in diameter generates the x-rays detected in a single analysis. Therefore, as most of the successive points analyzed are only 0.5–2.0 microns apart, there is considerable overlap.

82. V. P. Oehm, *Investigaciones sobre minería y metalurgia en el Perú prehispánico*, Bonner Amerikanische Studien 12 (Bonn, 1984) p. 47.

83. Lins, "Metal Coatings," p. 30; for mercury silvering on base metal substrates, see Susan La Niece, "Silvering," in *Metal Plating and Patination*, Susan La Niece and Paul T. Craddock, eds. (London, 1993) pp. 201–210; see also note 79 above.

84. Peterson, *Minería y Metalurgia*, pp. 55, 87.

85. In Moche burials traces of a red pigment that has not been analyzed are often found on the frontal bones and eye orbits of the deceased, and a unique case where the floor of a Moche tomb was covered with red pigment, also unidentified, was found in Sipán; Alva and Donnan, *Royal Tombs*, pp. 91, 215.

86. The scans were carried out on a Phillips 1710 open architecture diffractometer using copper radiation. No crystalline phases were detected.

87. David A. Scott, "Fusion Gilding and Foil Gilding in Pre-Hispanic Colombia and Ecuador," in *Pre-Columbian American Metallurgy*, Clemencia Plazas, ed. (Bogotá, 1985) pp. 307–326, and idem, "Gold and Silver Coatings over Copper: An Examination of Some Artefacts from Ecuador and Colombia," *Archaeometry* 28 (1986) pp. 33–50.

88. Alva and Donnan, *Royal Tombs*, pp. 96–100, figs. 101–104; solder was the means of attaching the gold scepter to the silver handle. It is unclear if the second scepter (Donnan, "Oro," fig. 117) also had gold inlay.

89. These trumpets are documented only in the Moche Archive (UCLA).

90. Alva and Donnan, *Royal Tombs*, pp. 221–223; *tumis* are a type of blade.

91. *Ibid.*, p. 221, figs. 230, 231.

92. For example, in tomb 2 at Sipán in the burial of a man who has been tentatively identified as a “Bird Priest,” a gold-and-silver nose ornament and a composite backflap were placed so that their gold and silver halves corresponded to the right and left sides of the deceased’s body; Alva and Donnan, *Royal Tombs*, pp. 148–160, 163–165, figs. 160 (left), 166.

93. Composite nose ornaments of this type are occasionally worn by

Moche and Vicús personages represented in clay vessels; see Lapiner, *Pre-Columbian Art*, nos. 445, 451; Christopher B. Donnan, *Ceramics of Ancient Peru* (Los Angeles, 1992) cat. no. 121.

94. Furthermore, adherence to strict right and left placements of gold and silver artifacts, respectively, around the body of the deceased in burials is not observed. A pair of nose ornaments, one of gold and the second of silver, was found one on top of the other on the right side of the deceased’s cranium, believed to be a “Warrior Priest,” in tomb 3 at Sipán; Alva, *Sipán*, figs. 72, 74.

95. Heather N. Lechtman, “Additional Perspectives on Moche Metallurgy,” paper presented at “Andean Royal Tombs,” MMA.