

## **World Archaeological Congress 4**

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## **Symposium: WORLD ARCHAEOLOGY OF GOLD**

### *Abstract Package*

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The contributions are more clearly defined in topic in that all are concerned with various aspects of the technical history and scientific study of gold production and goldworking. Included, there are two papers on gold mining, two on the refining of gold, two on goldworking and one each on the more general and diverse topics of the technical considerations of the aesthetics of goldwork and on the fingerprinting of gold sources by trace element analysis. The latter paper should prove especially important as the research represents one of the more important breakthroughs in the provenancing of metals in antiquity generally.

This has provided a very balanced framework within which it should be possible to generate debate on a wide range of topics connected with gold. Thus the potential is there to attract an audience with a diverse interests to discuss these topics both generally and more specifically applied to the history of gold mining and working within southern Africa.

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***Trace element study by LA-ICP-MS of gold from southern African archaeological sites***

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Gold is frequently found in 2nd millennium AD archaeological assemblages in southern Africa. Gold was used exclusively for personal adornment and insignia, and most of it has been recovered from excavations of elite burials. The famous gold jewellery and ornamental objects from 10th to 13th century AD Mapungubwe and 13th to 15th century AD Great Zimbabwe have been studied non-destructively and described as the products of typically African fabrication technology (Oddy, 1983, 1984). Metallographic investigation has shown that the fabrication techniques were identical to those used for fabricating similar copper items. Evidence for gold processing is widespread, but excavations at only two sites, Great Zimbabwe and the 16th century AD site of Thulamela in the Kruger National Park, have produced indigenous ceramic sherds which have been used as gold melting crucibles and have adhering glassy slag containing gold droplets (Küsel, 1992; Verhoef & Küsel, 1992).

More recently, the archaeological focus has been on the trace element chemistry of gold from these sites, which is the subject of ongoing research in collaboration with Anglo American Research Laboratories (Grigorova *et al.*, in press). Over a hundred individual gold objects from four sites (Mapungubwe, Bosutswe, Great Zimbabwe, Thulamela) have been analysed by laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS), their trace element profiles grouped, and compared with each other and available comparative source material. The samples from any one site could be grouped into relatively few groups, with some groups but not all in common between individual sites. This pointed to various distinct geological sources of the gold, with minimal mixing of material from discrete sources. The relatively high levels of platinum group metals were characteristic of southern African gold, uncommon in material from elsewhere tested at Anglo American Research Laboratories.

Given the likelihood of some degree of mixture, and the paucity of well provenanced historical alluvial samples it is unlikely that trace element sourcing will be able to identify distinct archaeological sources. Ongoing research is directed at attempting to define regional comparative signatures in order to distinguish archaeological material derived from the various geological provinces of southern Africa.

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***The surface enhancement and refining of gold by cementation: an overview***

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The treatment of gold alloys with chemicals in the solid state to enhance their appearance has a long history extending from the earliest Chalcolithic period through to the present day.

Basically, salts containing the three main acidic ions, sulphate, nitrate or chloride were applied in poultices to the surface of the gold alloy to be treated in a variety of inert media, typically clay, and gently heated. This was followed by further heating and pickling to remove the metal salts that had formed leaving a rather porous surface of pure gold. Normally the metal was then uniformly burnished to give a shiny surface, however, some cultures, notably in South America, used differential treatments to produce distinctive patterns of contrasting surface colours and textures.

Chemically there was little difference between the treatments used to enhance the surfaces and those used to remove the other metals from the bulk of the gold in refining processes. The stimulus for the application of parting by cementation seems to have been the introduction of coinage shortly before the mid first millennium BC. For this, gold of guaranteed weight and purity was necessary. This prerequisite encouraged the application of cementation to parting and the first successful parting processes were almost certainly development by the Lydians at Sardis in the early 6th century BC.

Cementation processes continued to be used in Europe and elsewhere for gold refining until well into the post Medieval period, and solid state enhancement processes are still described in recent textbooks on jewellery making.

***Melting and refining of Gold in Egypt and beyond***

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Egypt, and in particular its southern part well into Nubia, was famous for its gold deposits throughout history. A faint representation of this reached our times when the grave of Tut-ankh-amen was found, unlooted. Despite this incredible wealth of archaeological gold objects, and a substantial body of ancient gold mining sites in Nubia, very little is known about the actual means of hot working of gold in ancient Egypt. Here, the results of a scientific investigation of a few melting sherds from the New Kingdom are given, contrasting similar sherds from a significantly later (2nd/3rd

c AD) site in Sri Lanka. The results of thin section microscopy of crucible slag and technical ceramic, and the metallography of individual finds together with ICP-MS trace element data of sets of gold foils are given. The possible evidence for the refining of gold on these sherds, together with the trace element pattern of related gold foils is presented and discussed in view of the broader technological and artefactual context.

***Gold and silver in Ancient Egypt; aesthetics considerations***

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Precious metals - gold, silver and electrum - came into use in the ancient Egypt during in the Predynastic Period (ca. 4500 - ca. 3100 BC), but to judge from archaeological remains and ancient texts from the historical periods that followed, gold was invariably the more common of the two metals, and until perhaps the time of the New Kingdom (ca. 1550 - ca. 1070 BC) silver was considered to be the more valuable in pure monetary terms. On various occasions, the ancient metalworker or his patron chose to combine gold and silver in the manufacture of an Egyptian objet de vertu: a jewel, a vessel, a royal coffin. An overview of the instances and the ways that gold and silver were used together in ancient Egypt can perhaps provide insights into values assigned to these metals in ancient times that are independent of monetary considerations, residing rather in aesthetic or symbolic systems of thought.

***The laboratory reconstruction of some Etruscan and Greek goldworks***

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A recent Senior Fulbright research project at the Metropolitan Museum of Art in New York considered that stylistic configuration of some goldworks was in part a consequence of technical factors. Following observation by microscope of selected goldworks from the Museum's Greek and Roman collection, samples were made replicating artefacts by means of goldsmithing skills based on typical technology of the same era.

Laboratory reconstructions and the making of copies test assumptions and theoretical strategies of working by the ancient goldsmith.

Series of drawings were made of selected artefacts depicting possible sequence of assemblage and these were also used as maps for the SEM observations and photography. The EDS elemental analyses of artefacts and samples identifying surface and subsurface alloys was integral to the research and discussions. Using the SEM, markings and structures indicating manufacture of the decorative components were observed and photographed. Visual information on surfaces can reveal sequence of assemblage and identify goldworking methods.

Constructing goldworks by diffusion bonding with copper salt results in a copper enriched surface. Composition changes to alloys as a result of the application of copper during the heat joining process became major issues for reconsideration. The relevance of flux as a reduction agent of copper oxide on heat joined gold alloy became a major consideration as the interference of copper oxide on surfaces proved quite problematic during ongoing joining campaigns. An accumulation of copper on some samples suggests there could have been a conscious depleting of surfaces as the final sequence of manufacture.

### ***Exploitation of gold in the Iron Age of France***

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In the Limousin and in the north-east of Dordogne, there are several hundreds of very ancient gold mines, worked in opencast from outcropping veins, then deepened in underground works through the centuries. Recent archaeological research has enabled us to trace them back to the Iron Age, some sites to the 5th and 4th centuries BC, others to the 3rd century BC, and the largest sites to the 2nd and 1st centuries BC. The study now under way has already produced significant data on the mining techniques used (opencast and underground works, wood propping, drainage), on the ore treatment practices (crushing, roasting, grinding, washing) and on the daily life of the miners (dwelling areas near mining excavations). The future of these researches will concern necessary and complementary studies about the pumping system, the ore washing area, the refining of gold, etc., the quantification of the gold production and a deeper approach on the life at the mine and in the mining districts, providing thereby a better knowledge of the Iron Age in Limousin.

### ***Some aspects of history and metallurgy of gold in ancient India***

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Gold has attracted the attention of mankind throughout the world since time immemorial. India was no exception in this regard. Gold has extensively been referred to in the earliest Sanskrit text Rgveda and other Vedic and Classical Sanskrit texts of the later period. An attempt has been made to trace out the antiquity of gold through these literary evidences. There are a large number of Sanskrit names for gold, which give interesting information on the history of gold in ancient India. Some of the Sanskrit names for gold would be discussed.

Ants' gold has been referred to in classical Sanskrit literature Mahabharata, and also in Classical Greek literature. An attempt has been made to analyse the source and nature of this gold in ancient India. Further, the coloured gold in ancient India is also discussed.

The paper also describes the various sources of gold and the methods used for its extraction and refining in ancient India.

***The influence of central Andean metallurgy in the highlands of southern Colombia.***

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In the archaeological record of the southern highlands of Colombia and northern Ecuador there are evidences from around AD 500 of a highly developed and complex metallurgical tradition. Several schemes have been proposed with relation to the cultural areas and periods of this region but there are still many doubts as to the pre-Hispanic history and the extent of the influences exerted by the highly developed Andean cultures that flourished to the south of it. This paper is an advance of a research conducted on a sample of nearly 2,000 gold, gold-copper alloy and copper objects from this area, most of which belong to the collection of the Museo del Oro in Bogota, Colombia. The research puts forward a new classification of styles and identifies iconographic and technological trends. The goldwork of this area (Nariño – Carchi) is quite different from the rest of the styles of south-western Colombia and shows remarkable similarities with contemporary cultures in northern Peru and Ecuador. Those similarities are analysed and interpreted and a hypothesis is proposed in connection with the relation between the two areas.

***Early manifestations of Tairona goldwork***

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This paper deals with the early manifestations of the Tairona archaeological region, located in the Sierra Nevada de Santa Marta in the Caribbean coast in Colombia. Determination of the characteristic elements of this group has been carried out on the metal collection from the Gold Museum of Bogotá, Colombia, and also on known Tairona pieces housed in other international museums.

Iconographical, metallurgical, and C14 analyses, are used to describe the development of this goldwork. More or less 70% of the total collection in the Gold Museum has been identified as Tairona. Since this group involves many representations, I choose only one theme to illustrate the development of this goldwork - bird pendants. The manufacture, finishing treatments, etc. will be described, supported with dates obtained from the clay and charcoal cores of some pieces cast with the lost wax process. A taxonomic identification of the birds represented on the gold or tumbaga pendants has also been done.

***The Uraba gold style and its significance in the introduction of metallurgy to central America***

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This paper discusses a gold style found in the Uraba region, situated in the Caribbean plains of Colombia, close to Panama. This style is represented by a group of pieces with a strong stylistic affinity and certain technological traits. This goldwork shows close relations with other styles from the north and centre of Colombia (Quimbaya, Zenu and Tairona) and from Panama (Inicial, International and Openwork styles) and Costa Rica (from the Central Highlands and Atlantic Watershed), with which it forms a single metallurgical province. Work by Warwick Bray, Richard G Cooke, Michael J, Snarkis and others in Panama and Costa Rica, and by Clemencia Plazas, Ana Maria Falchetti and me in Colombia, has demonstrated these ancient connections, in the first centuries AD, between Colombia and Central America. This paper proposes that the Uraba style played a key role in the introduction of metallurgy from Colombia to Central America based on the comparative study of shapes, technology and chronology of the involved styles. The research is done in the collection of the Museo del Oro (Gold Museum) of Colombia, which has around 500 pieces of the Uraba style.

***The transformation of the seed: an approach to the symbolism of gold, ritual offerings and trade among the Uwa of central Colombia and related communities.***

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This paper explores some possible interpretations with reference to the symbolism of gold, and its relationship with the meaning of ritual offerings and of trade. It focuses on the analysis of mythology and ethnographic data, complemented with archaeological and historical information, with reference to the Uwa, Chibcha-speaking communities who live in the eastern mountain range of Colombia.

Some general propositions are established through the study of a particular system of beliefs and its social and ritual expressions, in a historical context. The methodology and the lines of interpretation followed can be extended to other indigenous communities, and they are applied here mainly to peoples who inhabited or are still living in northern South America and lower Central America.

Some underlying basic concepts are then established, such as the "transformation of the seed" in the Universe, nature and society, as the basis of the continuity of fertility and life. In this context, the offerings of gold and related materials are seen as "seeds" that "germinate" symbolically, and through which humans propitiate the continuity of life. In the same order, through trade, the symbolic properties of gold and various other goods, which are associated with cosmological concepts, are symbolically

"mixed", distributed and balanced, in order to reach the equilibrium in the relationships between different social groups.

***The development of Pre-Inca metal production and traditions based upon technical studies of excavated objects from the North Coast of Peru***

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The major archaeological sites of Sipán (Moche IV and V, AD 450-700) and Batán Grande (Sicán, AD 700-1470) are within the same ecological zone of the Northern Coast of Peru. While these cultures had potential access to the same local natural resources of geological ore deposits and native gold, each culture produced and used metal objects in diverse ways and with marked preferences. This presentation will present an overview of recent archaeometallurgical research for the Sicán culture as well as outline fundamental differences in the two metallurgical traditions.

For the Moche and Sicán cultures, social differentiation and elite status can be inferred based upon the quantity, quality, typology and technology of metal objects excavated from burials. However, past exploitation of metal resources and metallurgical properties cannot be readily interpreted without technical studies. Archaeometallurgical studies for the Sicán Archaeological Project (Directed by Prof. I Shimada, Southern Illinois University) have been undertaken at MASCA, (University of Pennsylvania), Peabody Museum (Harvard University), Dept. of Chemistry (University of Michigan), Pontificia Universidad Católica del Perú and the Institute of Archaeology, UCL. A total of 4 M.Sc. reports and 3 B.Sc. dissertations at the Institute of Archaeology have utilised metal samples from the excavations of the Sicán Archaeological Project. This unpublished M.Sc. research has been based upon technical studies and fieldwork and the B.Sc. research has concentrated upon conservation aspects of the precious metal alloys. Various alloy compositions including gold, silver, copper and arsenic have been studied.

Objectives of the metallurgical and conservation studies of the alloy objects include the characterisation of metallurgical traditions and trade as well as preservation and presentation of the metal objects on display.