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Abstract

Pachacamac was considered a sanctuary or oracle by several of the pre-Columbian Andean cultures. As a pilgrimage destination, the site was rich in archaeological artifacts and yielded also many well preserved textiles. Some of the objects found at Pachacamac are considered offerings by the pilgrims to their Gods, and the majority are assumed to be of nonlocal origin. Others are from the Ychsma people, who lived in Pachacamac and the nearby Rimac Valley during the last centuries before the conquest. We have investigated 10 pre-Columbian textile samples, which were supposedly excavated at the archaeological site of Pachacamac, Peru. The textiles from which the samples came today form part of the Ethnological Museum of Berlin. Nine of the ten textiles investigated in this study were collected by Wilhelm Gretzer (1907 museum entry) while the last one (textile V A 62696) was collected by von Diebitsch and entered the museum in 1925. The aim of this study was to, for the first time, investigate the origin of the pre-Columbian textiles' raw materials (mostly wool) by the application of strontium isotope analyses.

Investigaciones de procedencias de materias primas en textiles precolombinos de Pachacamac; Análisis de isótopos de estroncio

Resumen

Pachacamac fue considerado como un santuario u oráculo por varias de las culturas andinas precolombinas. Por ser un destino para peregrinos, se han encontrado muchos artefactos arqueológicos en el lugar, los que incluyen textiles conservados en buen estado. Algunos de los objetos encontrados en Pachacamac son considerados ofrendas a los dioses, hechas por los peregrinos, por lo que se supone que en su mayoría proceden de un origen no local. Otros son de la cultura Ychsma, una población residente en Pachacamac y el adyacente valle de Rimac durante los últimos siglos antes de la conquista. Hemos investigado 10 muestras de textiles precolombinas que supuestamente fueron excavadas en el yacimiento arqueológico de Pachacamac, Perú. Los textiles forman hoy parte del Museo Etnológico de Berlín. Nueve de los diez textiles investigados en este estudio fueron coleccionados por Wilhelm Gretzer (entrada en 1907) mientras que el último (textil VA 62696) fue coleccionado por von Diebitsch y entró en el museo en 1925. El objetivo de este estudio ha sido, por primera vez, investigar el origen de las materias primas de los textiles precolombinos (principalmente lana) mediante la aplicación de análisis de isótopos de estroncio.

Introduction

Wilhelm Gretzer was a German textile merchant, who lived and worked in Lima for 20 years around the turn of the 19th century. Gretzer collected preColumbian artifacts, a practice very much in vogue in the upper-class society of Lima

at the time. He sold around 40.000 artifacts to the Museum für Völkerkunde in Berlin, of which ca. 10.000 were textiles.

Gretzer acquired the artifacts either by excavating them himself or by buying them from local grave robbers. He was however meticulous and noted the locations from which the articles were excavated, but this information often provided

by the grave robbers can't be considered *always reliable*. Hence, the context in which these textiles were found should therefore be considered with care.

Pachacamac is a very important archaeological site situated ca. 45 km south of Lima. Until the Spanish conquest it had been a ritual place for several thousand years used by people of many different cultures from diverse geographical regions. Pachacamac was considered a kind of Sanctuary and/or Oracle and was for many cultures a pilgrim destination. The rich amount of artifacts retrieved from the site seems to point to the fact that many of these goods were offerings to the Gods. Hence, many of the pre-Columbian objects found in Pachacamac (including the textiles) were not locally produced, but instead had been brought by the pilgrims, probably from their place of origin. In order to investigate, where these textiles came from, textile archaeologists often rely on iconography and the techniques with which these textiles were made. Nevertheless, this type of information does not necessarily provide information on where the textiles' raw material came from. As pre-Columbian cultures are known for their long-distance trade, this study aims at investigating where the textiles' raw material might have come from.

The textiles investigated in this study are:

Fig.1,2,3,4. Shroudpatches, V A 56735, V A 57024, V A 56886, V A 56906.

4 of the analyzed textiles (V A 56735, V A 57024, V A 56886, V A 56906) are made by the Ychsma people. They lived in and around Pachacamac in the last centuries before the Spanish conquest. The textiles analyzed are parts of shrouds for wrapping the dead. The technique is slit and interlocked tapestry, the material is cotton. All 4 fragments have 2S warps, and the wefts are Z, 2Z or 2S – often mixed in the same textile.

The hairnet (V A 42669) is made on the central coast of Peru between AD 1200 – 1500. Likely in Pachacamac by the Ychsma or in Chancay on the coast, 80 km north of Lima (and so 120 km north of Pachacamac). It is made from 2S Furcreae Andina – a South American Agave sort and the technique is lark's head knotting.

The three textiles (V A 57540, V A 57793, V A 58040) are from the Lambayecke/Sican culture that flourished AD 900-1100. The center of this culture was on the northern coast of Peru around the contemporary city of Chiclayo, 770km north of Lima. They are woven in tapestry technique.

The first one (V A 57540) is a man's tunic (S cotton warps and wefts and Z camelid fiber wefts).

The second (V A 57793) is an unidentified fragment (2S and 2Z cotton warps and wefts of 2S and 2Z cotton and 2S

Fig. 5. Hairnet, V A 42669

camelid fiber) Notice the image of women spinning the camelid fiber on drop spindles.

The last one (V A 58040) is a fragment of a woman's hip cloth (warp 2S cotton, and weft 2S camelid fiber). The three dimensional plants are made in wrapping and looping techniques.

Fig.6. Man's tunic, V A 57540

Fig.7. Fragment, V A 57793

Fig.8. Fragment of a Woman's hipcloth, V A 58040

V A 56568 is a fragment of a Chimu textile – made between AD 1200-1450 on the northern coast of Peru. It's size and purpose is unsure – another fragment of the same textile was sold to the National Museum of Copenhagen in 1923. The fragment has 2Z cotton warps and 2S camelid fiber wefts.

The last of the analyzed textiles (V A 62696) is a provincial Inka man's tunic from AD 1450 – 1550. It has 2S cotton warps and 2S camelid fiber wefts. The basic pattern is made in tapestry with eccentric warps and rounded forms, which is rather seldom in preColumbian Peru and has so far only been found in the south of Peru. However the tunic is composed in a typical Inka way – with a diamond waist band and a step fret net yoke.

Strontium isotope analyses and baselines

Ericson (1985) was the first who proposed the idea of using the variations of the strontium isotopic ratios in archaeological materials and to relate these to the bedrock and soil characteristics of specific geological areas and thus to constrain their potential geographical origin. Since then, many studies of human and animal migration have been conducted on the base of archaeological bone tissue/skeletons (Price et al., 1998, Price et al., 2010, Knudson et al., 2005, Grupe et al., 1997, Montgomery et al., 2003, Evans et al., 2006, Price et al., 2011). The base for performing such tracing studies lies in the fact that strontium isotopic ratios ($^{87}\text{Sr}/^{86}\text{Sr}$) do not change within their pathway throughout the food chain (Graustein, 1989).

Furthermore, the age and the type of lithology of the bedrocks (magmatic, metamorphic and sedimentary rocks) on which respective soils are developed impose a control on the $^{87}\text{Sr}/^{86}\text{Sr}$ ratios of a particular geological area and thereby creating necessary variations in this signature which are measurable and traceable. However, studies have shown that the knowledge of the local bedrock is not always sufficient; hence there is the need to characterize the so-called bio-available strontium isotope composition of the targeted area. There are several ways to characterize such a bio-available signature: by bone tissue of small animals, by plants, by water and/or soil samples (Evans et al., 2010, Frei and Frei, 2011, Price et al., 2002). However, it should be noted that the spatial resolution of the bio-available $^{87}\text{Sr}/^{86}\text{Sr}$ ratios can be similar in different geographical areas, therefore setting limits to the discrimination between different areas with the same or very similar bio-available strontium characteristics.

Fig.9. Fragment, V A 56568

Fig.10. Man's tunic, V A 62696

Fig.11. Map of the South Peru depicting soil baseline sampling locations and mean radiogenic strontium isotope ratios, after Knudson et al., (2014), figure 3.

While the use of radiogenic strontium isotope values to investigate paleomobility is increasing in the Andes, there is still no good baseline coverage of the strontium isotope bio-availability ranges of the different areas. Peru is however, to date, one of the best areas investigated by this methodology, and efforts have been made by e.g. Knudson et al., (2014) to provide some baseline knowledge of the area. Knudson et al., (2014) collected and analyzed soil samples from different areas, mostly covering the southern part of Peru. Their study revealed a $^{87}\text{Sr}/^{86}\text{Sr}$ range from 0.702 to 0.719 (Fig. 1), the highest values coming from the Cusco area.

However, as the baseline for Peru is still incomplete, we have sampled the Pachacamac area to constrain the local strontium isotopic baseline. A total of six samples were collected by Dr. Jane Feltham covering the Pachacamac site. The strontium isotopic values of the soils collected in this study yielded a range from $^{87}\text{Sr}/^{86}\text{Sr} = 0.7062$ to 0.7083 . Similarly, the soils samples investigated by Knudson et al., (2014) from the area of Lima yielded a similar range of $^{87}\text{Sr}/^{86}\text{Sr} = 0.7065$ - 0.7077 . Based on these studies we propose a local baseline for the area of Pachacamac of $^{87}\text{Sr}/^{86}\text{Sr} \sim 0.706$ to 0.708 .

Pre-cleaning/decontamination of ancient textile samples

The sampling protocols for ancient textiles vary depending on whether the textiles have been dyed or not. In this case most of the textiles have been clearly dyed. Consequently, the samples followed a series of pre-cleaning processes to ensure the decontamination of the textiles' raw material previous to dissolution. The textile samples were washed 1N hydrochloric (HCl) acid and subsequently in 20% dilute cold hydrofluoric (HF) acid under ultrasonic treatment for 1 hour in a 7ml Teflon beaker (Savillex™). The samples were rinsed twice with 1 ml of deionized water (MilliQ™) in an ultrasonic bath between the acid washes. The respective acid washes were subsequently pipetted away from the textile samples and the remaining fiber samples were thereafter deeply rinsed (several times) with 1 ml of deionized water (MilliQ™) and dried.

In order to remove traces of dyestuff in the textiles, the rinsed textile fiber samples were emerged in 3 ml of 0.2M ammonium peroxodisulfate ($(\text{NH}_4)_2 \text{S}_2\text{O}_8$) (a strong oxidant, abbreviated as "APDS") on a hotplate (preferably at 130 °C)

Fig.12. Map of Pachacamac with indications (+) of where the soil samples were taken.

for c. 30 minutes. The residual textile fiber samples were once again deeply rinsed with 1 ml of deionized water (MilliQ™) several times and subsequently dried.

The final residual textile fibers were dissolved in a 1:1 mixture of 30% HNO₃ (Seastar™) and 30% H₂O₂ (Seastar™). The samples tended to decompose within 30 to 60 minutes. After decomposition the solutions were dried down on a hotplate at c. 80 °C.

Samples were taken up in a few drops of 3N HNO₃ and loaded on especially prepared, disposable pipette-tip columns containing 0.2 ml, intensively pre-cleaned mesh 50-100 SrSpec™ (Eichrome Inc./Tristchem) ion chromatographic resin. The elution recipe essentially followed that of Horwitz et al. (1992).

Strontium from the soil samples were separated according the analytical procedures and protocols described by Frei, and Sr fractions from these samples were measured on the same facility described below.

Thermal ionization mass spectrometry

The samples were dissolved in 2.5 µl of a Ta₂O₅-H₃PO₄-HF activator and subsequently loaded onto outgassed 99.98% single rhenium filaments. Samples were measured in a dynamic mode on a VG 54 Sector IT mass spectrometer (at the Danish Center for Isotope Geology, University of Copenhagen), at temperatures between 1300 and 1450 °C. The mass 88 ion beam was kept above 300 mV during an analytical run which consisted over a minimum of 6 blocks with 10 mass scan cycles each.

Strontium isotopes results

Table 1 presents the results of the strontium isotope analyses of the ten textiles investigated in this study. The results present a range of strontium isotopic values from ⁸⁷Sr/⁸⁶Sr = 0.7069 to 0.71209. When these values are compared with the local baseline range of Pachacamac which ranges from ⁸⁷Sr/⁸⁶Sr = 0.7062 to 0.7083, only one of the herein investigated textile samples fall within this range (56906). Table 1 depicts the values in bold black as the samples that have strontium isotope values that are nonlocal while the bold red value depicts the one that could be made of local raw material. This fact indicates as expected that the large majority of these textiles were made of nonlocal raw materials. Furthermore, the range of values indicates that the areas from which these raw materials came from are several. It should be however noted, that even though the textiles are made of nonlocal raw materials, they can still have been weaved at Pachacamac.

Table 1. Strontium isotope results from textiles from Pachacamac

Lab nr.	Museum nr.	⁸⁷ Sr/ ⁸⁶ Sr	abs. error
KF911	VA 42669	0.70908	0.00003
KF912	VA 58040 W	0.70971	0.00007
KF913	56906 3W	0.70690	0.00004
KF914	57793 3W	0.70930	0.00003
KF915	VA 56568 V W	0.71007	0.00004
KF922	VA 56886 BW	0.71088	0.00003
KF923	57540 WB	0.71057	0.00006
KF924	VA 56735 BW	0.71209	0.00004
KF925	VA 57024 BW	0.71177	0.00003
KF926	VA62696 V	0.71174	0.00003

W is wool, BW is cotton (*Baumwolle*)

Art historically these textiles belong to the following cultures:

- 1-4 Ychsma
- 5 Ychsma/ Chancay
- 6-8 Lambayeque
- 9 Chimú
- 10 Inka provincial

They all supposedly were excavated in Pachacamac.

Conclusions

The textiles analyzed within this study yielded in their majority (90 %) values that were nonlocal. Furthermore, the values yielded a somewhat large enough range which suggest that the materials originate from areas with different geological terrains and hence geographically different. The strontium isotopic values tend to all be above 0.709, values that as seen in the map by Knudson et al., (2014) seem to indicate that they came from inside the country, probably the mountains. This fits perfect for the camelid fibers. Cotton was not grown in the mountains, and as the strontium values of most of the cottons are too high for the areas south of Lima, the raw cotton must have grown further away, where the strontium values are higher, i.e. maybe on the northern coast or the far southern coast.

Only one of the Ychsma shrouds (fig. 1,2,3,4) is made from local cotton. The other 3, made in the same Ychsma style are woven in nonlocal cotton.

Further investigations are needed to enable further conclusions on the potential trading routes of textiles' raw materials of ancient preColumbian textiles. Nevertheless, our pilot study shows the potential of applying strontium isotope analyses to textiles in museum collections also from the preColumbian world.

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