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CARTOGRAPHY IN BENAHOARE: AN ORIENTATED MAP OF THE CANARY ISLAND OF LA PALMA IN AN ANCIENT PETROGLYPH

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ABSTRACT

The Canary island of La Palma (ancient Benahoare) is one the richest island territory of the world in rock art manifestations (Martín Rodríguez and Pais Pais, 1996); there are dozens of petroglyph stations in a territory of only 700 km^2. These groups of petroglyphs, carved in a delicate way by picking or lining techniques, often are representations of geometric forms (spirals, concentric circles, meanders, etc.) of great beauty. If their number were not enough to illustrate the importance that they had for the former aboriginal settlers of the island, the situation and orientation of some of them would confirm the ritual significance that these artistic manifestations must have had for them. Across the island, important rock art stations such as "El Verde" (discovered in 1982 and named originally "El Cementerio", Pais Pais and Herrera García, 2007) can be found. A beautiful phenomenon of light and shadow can be observed there, illuminating the petroglyphs on site during sunset at the summer solstice. This and other phenomenology located elsewhere in the island show the close relationship between Benahoare's rock art and astronomy.

An especially puzzling petroglyph can be found in a place named Monte Braulio on the westernmost coast of the island (see Figure 1 a). This is one of the biggest single glyphs found in La Palma and it is nearly isolated. The petroglyph was carved on an inconspicuous almost horizontal lava platform that occupies an approximate surface of 3 m^2. Our hypothesis is that it represents the world known to the inhabitants of the island. A metric and morphologic analysis of the petroglyph allows stressing the idea that we are facing a map of Benahoare, as imagined in the mind of its ancient inhabitants in a similar way as other prehistoric 'maps' discovered so far (Harley and Woodward, 1987). The 'map', which is perfectly orientated according to the cardinal points, is completed by another smaller spiral-shaped petroglyph (perhaps a solar representation) located at the map's east side (and therefore on the region of the horizon where sunrise happens). Both the map and the additional glyph are composed of a set of grooves, small channels and cup-marks, which could have been used for sympathetic magic rituals in order to call for rain, a major important necessity for the islanders in a territory where fountains were nearly absent.

If we are correct, this will be one of the best examples of emic maps ever produced before the development of modern cartography.

KEYWORDS: La Palma island, prehistoric cartography, map, archeoastronomy.

1. INTRODUCTION. BENAHOARE'S ROCK ART

Most of the archaeological research on the island of La Palma has been focused on the indigenous rock art. Since the first studies of Van de Valle de Cervellón in 1752 about "Cueva de Belmaco" (Villa de Mazo), the research has been marked by isolated or continuous projects that have accomplished a substantial definition on the matter. To the first references like the ones on Villa de Mazo, or A. Jiménez de Cisneros (1923:28-30) that presented, among other things, the Lybic-Berber inscriptions in Tajodeque (Caldera de Taburiente, El Paso), the recent work by J. Pais Pais (1993, 1996a, 1999) besides a group of people associated to the "Benahorita" Archaeological Museum can be included as well. In this long research journey several scholars have taken part such as P. Hernández Benítez (1955), Luis Diego Cuscoy (1955), Telesforo Bravo (1960), M. Hernández Pérez (1981), E. Martín Rodríguez (1984, 1990, 1996), and J. F. Navarro Mederos (1990), among others. Furthermore, even after 50 years of research, there are still discoveries of new stations of remarkable size, such as Fuente del Colmenero (Garafía), Barranquito de Silva-La Castellana (Garafía), Las Grajas (Los Llanos de Aridane), Chaco Canyon (Vaquero & Malville, 2014; MAA 2014) etc.

La Palma has a large number of rock art manifestations of the indigenous population (largely known as Benahoara, as gathered in old chronicles) belonging to the period in which the culture was developed, lasting at least 1500 years, allowing a rich variety of stone carvings preserved today with a remarkable complexity and which meaning still eludes us due to the fact that they belong to a lost culture in which intangible aspects and diachronic content are present. However, it is possible to consider that the motives behind their execution come from various circumstances: political and social relationships, religious expressions, land distribution, wars, natural catastrophes, etc.

In general lines, the rock art in La Palma is organized in four types, without prejudice to the theme or technique used to their elaboration: geometric engravings, alphabetic inscriptions, figurative naviforms and cruciforms, and the group of channels and large and small cup-marks. The techniques used in their elaboration are essentially two: percussion (or picketing), both continuous and discrete, and incision. The carvings are mostly realized in basaltic rocks, with different hardness and consistency, and the material used as a tool to cut the stone is mostly basalt, gabbro, obsidian or silex.

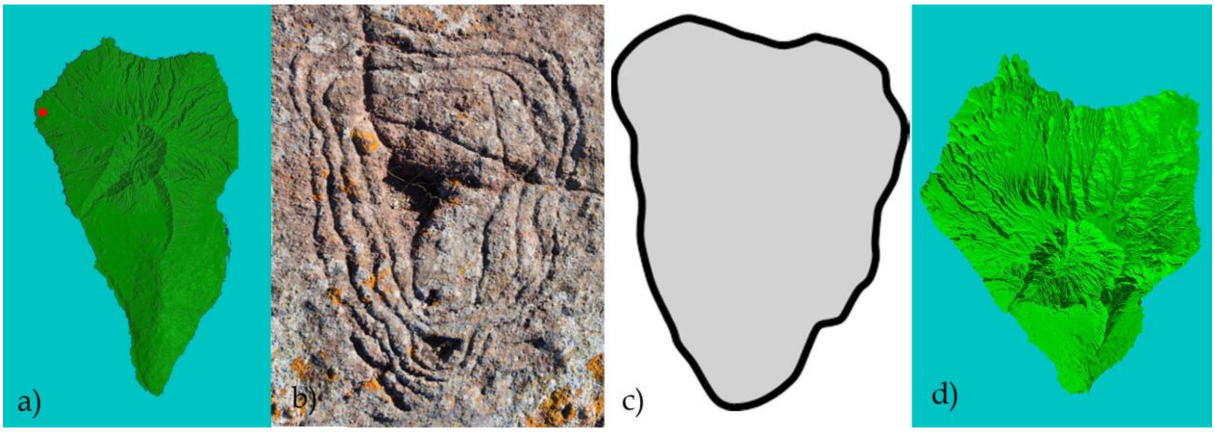

Figure 1. a) Digital Terrain Model (DTM) of La Palma (red point is the location of petroglyph), b) carving with cardinal orientation, c) carbon copy of the contour, and d) perspective view of La Palma (overlapped with DTM)

It is most likely that the meaning of the rock carvings made by the Benahoara can never be completely ascertained. The motivations are likely due to from a wide range of facts (Martín Rodríguez and Pais Pais, 1996). Water, being one of the most decisive variables, is fairly possible to englobe the most relevant cult. As a matter of fact, there is a close spatial relation between rock art and long-lasting water springs that are associated to carvings, cup-marks, basins and small channels. The rain was the only chance for the pastures to grow and a need for the life of animals and humans, thus rogatives are a possibility. The link between carvings and water is also present in the "cabocos" (natural cave settlements), in the lower course of the stems or in the cliffs. The carving under study in the present work appears to be under the same circumstances as the others. Nevertheless, it presents particular factors that remark its undoubted exceptionality, while the structure, technique, cultural and natural environment and location are closely related with the geometrical motifs: spirals, concentric circles, cup-marks and small channels. Is it bizarre to think that it is indeed a special representation for the local community?

2. MONTAÑA DE BRAULIO'S PETROGLYPH: A WORLD MAP OF THE ISLAND OF LA PALMA

The petroglyph under study stands out from the hundreds of rock art stations located across La Palma island due its size and isolation. The shape is ovoidal (roughly 1.34 x 1.05 m) and it is engraved in the outcrop of a lava vein (very grainy basalt) located in the westernmost area of the island (see Figure 1 b). The motif is composed by four concentric and two radial channels and completed by two cup-marks located in the eastern side at approximately 0.5 m and with a diameter of 10-12 cm as that of the sun shape spiral placed approximately 2 meters away in the same direction.

Several issues must be considered apart from size and location, when comparing this rock art example with other examples in the island. First, the apparent roughness compared with the delicate lines of the motifs made with different techniques found in various places. Second, the mixture of channels, hollows and cup-marks is rare amongst the typical rock art stations of the island. Finally, the overall asymmetry of the main motif leads us to think that this is possibly not accidental. Therefore, it is the shape that is suggested in this motif, arguably similar, if not substantially identical, to the island of La Palma, what is at the basis of our analysis (see Figure 1a).

2.1. *Morphological analysis*

The analysis starts by comparing the outline of the image of the main motif (the carbon copy) with an image of the Digital Terrain Model (DTM, it built from the Spanish -IGN- and Canary topographic database using Triangular Irregular Network -TIN-). A shot of this model as it had been taken a few dozen meters above the Roque de los Muchachos peak (the highest of the island) with a fisheye lens shows the island as a composition taken from the highest points of the island, all this in the same cardinal orientation (Figure 1d).

Certainly, the similarities are remarkable, although on first sight, a sharper shape is missing at the south of the island, an area that was formed that was form during the last volcanic event in 1677. However, this difference may be explained in a simpler manner, this is the different point of view in which the projections have been taken. In case of the DTM, the point of view would be in an infinitely distant point above the island, while for the author of the carving, with the goal of represent the reality (actually his reality, the edge of his world) the point of view would have been in the highest peaks of La Caldera de Taburiente (Roque Palmero, Roque de los Muchachos and/or Pico de las Nieves). The fact of having the point of view closer to the Earth makes the perspective of the shoreline to be deformed.[1]

Although the carving is basic and imprecise, simple shore structures such as big bays and capes can be easily detected; note that the definition of these structures is eyeballed from distances between 8 to 30 km. Figure 2 shows the definition of these structures on the DTM and the motif, in which only the inflection points that shape the concavities and convexities have been marked. It is easy to notice the eminent coincidence between bays and capes in both images. This would confirm the objective of representing the shoreline with a noteworthy realism.

The other elements of the petroglyph can be split into two groups, internal and external. Two types of elements can be observed inside the rock carving. One of them is composed by a group of concentric lines, simulating a series of concentric channels that have some affinity to the most external one, the assumed shoreline. Although it has a remarkable similitude with modern topographic representations, such as contour lines or isohypses, this should not be interpreted as such. It is more reasonable to assume a more common use, such as the distribution of any liquid that may drop from the external side. Or even acts in a spiritual aspect at the same time, embracing the centre of the motif, like in several all other circular shape carvings spread across the island. In this case, this would be something as spectacular as La Caldera de Taburiente, the dominant topographic feature of the whole island. It is not absurd to think about the supreme importance that this orographic element would have had in the Benahoara's life.

The next type of features corresponds to the big central basin (already discussed), two smaller ones to the east and another two to the south. There are also two small channels with radial characteristics. The first one goes from the central cavity to the north, while the second goes from the central cavity to the East side of the shore, which would correspond with the great bay of Santa Cruz. It looks like as it was important that the distribution of the liquid reached directly the first of these channels. Can equivalent topographic elements be related to these new interior elements on the 'map'? (see Figure 3).

[1] This deformation, produced by the effect of perspective, has endured for all ancient cartography until the end of the 19th century. This can be noticed just by looking at maps of La Palma made by Leonardo Torriani (1592), Pedro Agustín del Castillo (1686), M. Bonne (1779), Tomás López (1780), Leopold Buch (1814) or Francisco de Coello (1849) among others. Some of them can be seen in the map collection of the Instituto Geográfico Nacional of Spain (http://www.ign.es/web/catalogo-cartoteca/)

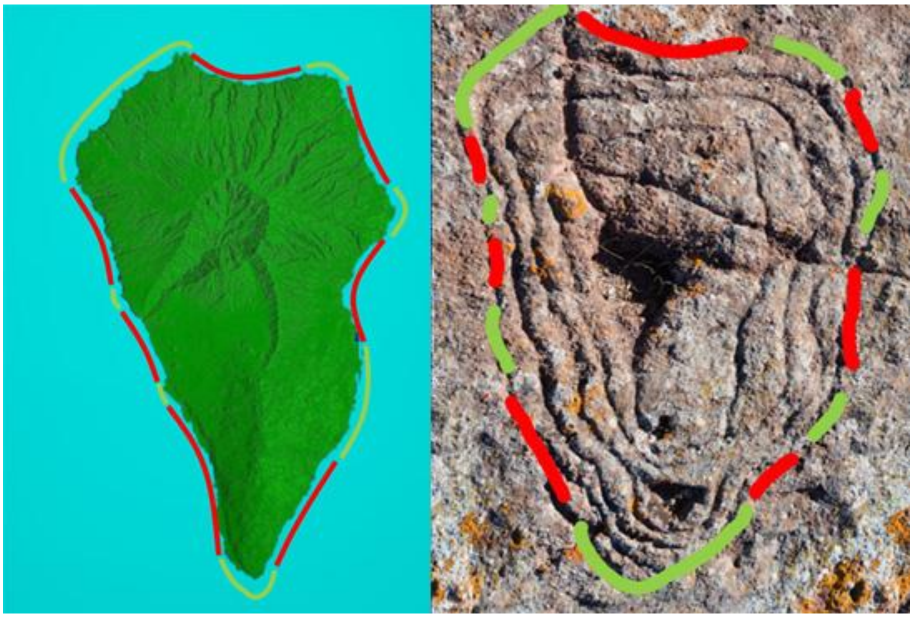

Figure 2. Bays (in red) and capes (in green) in the island of La Palma and the carving in Montaña de Braulio.

There are four hydrographic dominant elements (Figure 3). A permanent water course quoted in the Cronicles of the conquest appears in the centre of the island (Abreu Galindo, 1848). This is river Taburiente (Fig 3-2), which collects water from the la Caldera and discarges in Tazacorte, in the west coast. Second, Barranco del Agua (Fig 3-1) discharges in the village of San Andres at the northeast of the Island, collecting the waters of the precipices at the foot of the watershed between Pico de la Cruz and Piedra Llana in the bor-ders of the Caldera. The third one, Barranco de las Nieves (Fig 3-3) is formed by the waters from Barranco Hondo and barranco de La Hortelana, at the base of Pico de las Nieves and Punta de los Roques, place where the watershed at the south rim of the Caldera does begin.

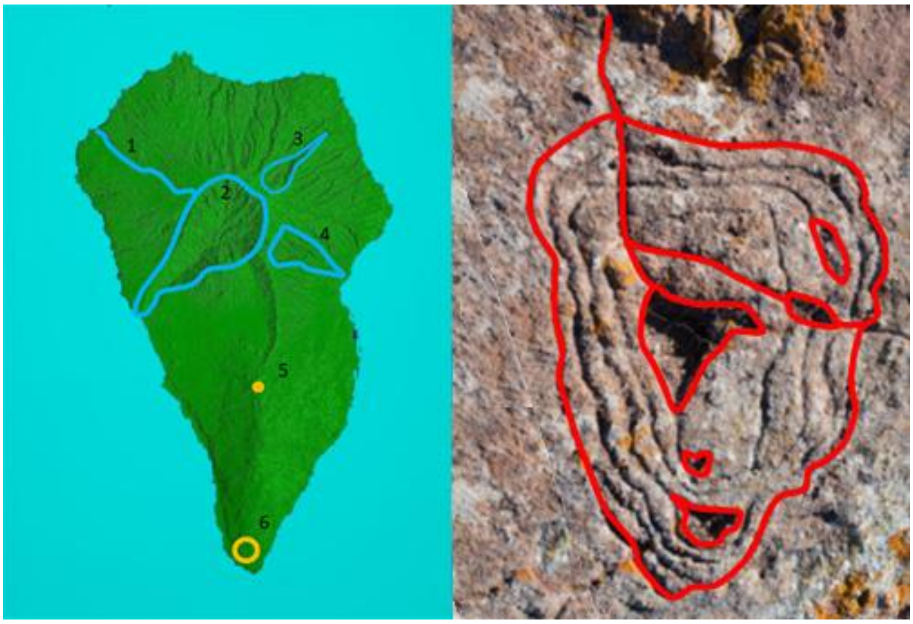

Figure 3. Left, relevant orographic and hydrological elements in the Island; right hollow in the carving.

These three 'rivers' or watersheds would correspond to the three holes in the rock carving, both by location and relative size. At the north, the radial channel that takes a northern direction would match the biggest ravine of the island, excluding the one leaving from the Caldera itself, Barranco de Izcagua (Fig 3-1). It is born at the base of Roque de los Muchachos and discharges at Costa de Hiscaguan. It does not possess any relevant tributary in its almost 12 km of length, meaning that the amount of water is highly dependent on the climatology. As a matter of fact, in all northwest of the island, only in the ravines of Izcagua and Garome turn out to be nearly permanent flows of waters associated with the rainy season (Pais Pais, 1996). This might also be the reason why a second channel directly connects the east side (the bay of Santa Cruz) with Barranco de Izcagua; This might indicate the interest of the Benahoara that the water which eventually goes into the island circulates to the northwest, where the water is scarcer; by this way all island hydric sources would be connected virtually and ritually.

There are two additional features at the south of the motif, a couple of cup-marks (Figure 3), a small one in the south-central area and a bigger one further south. The first one is connected to the alleged Caldera through a small channel, which could indicate the end of the watershed of Cumbre Nueva, the chain of volcanos forming the backbone of this part of the island. The second cavity is not connected to the channel system, and could be related to the big crater of Volcan de San Antonio (Fig 3-5), a prominent landmark in the island because of its size and depth in comparison to others volcanoes of the island. The main reason for its representation could be related not to the orographic element per se, but to the existence of four fountains located at its base, quoted in the chronicles when they mention 'Tagragito', the thermal waters (origin of place named today as Fuentecaliente). They used to flow close to the present beach of Echentive and were engulfed in 1677 by the volcano of Fuentecaliente (Fig 3-6).

Externally to the 'map' engraving, at the easter side, there are two additional cup-marks, a small channel that joints one of them with the main motif, and a spiral carving composed by four concentrically circles which has often been identified as solar, or at least astral, motives in the rock art of la Palma.

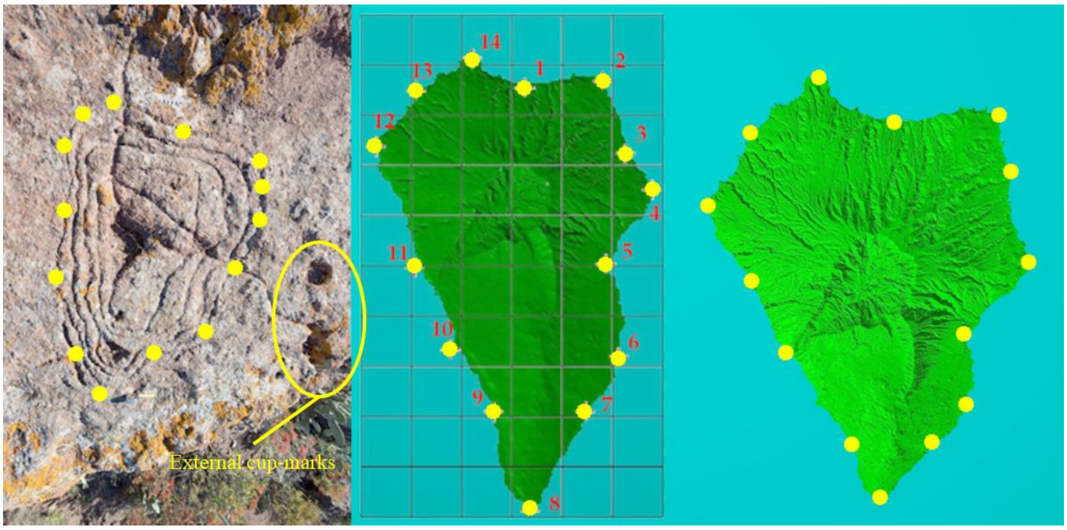

Figure 4. The 14 counterparts in the petroglyph, the Island (DTM) and its perspective.

2.2. Metric analysis

A second set of analysis will allow to determinate the metric goodness of fitness of the rock carving. This serves to quantify how close the shape of the glyph is when compared to the shape of what is supposed to be represented. To achieve this, the reality and the perception of the author of the glyph will be compared with the motif; this perception can be approximated by the perspective of the island. It must be clarified that although cartographic techniques are going to be used to determinate the distortions between this counterpart points, the objective is not to quantify the deformations cartographically. Two reasons justify this impossibility: the first is that it is impossible to expect metric characteristics in the representations since there is no evidence that the technique used to measure was something else than simple howk-eye estimations of the possible distances. The second is the lack of certainty in the identification of the reference points used to calculate the affinity computations. Therefore, the estimation of those interpreted inflexion points in both images in Figure 4 will have to be considered as an approximate approach.

Our reality will be defined by the representation of the island of La Palma in UTM projection in the Zone 28 (ETRS89) and its correspondent grid. It will be assumed that the deformations produced by the use of this grid is delimited by a scale factor of 1.009 (for the most western extreme) and that the meridian convergence is between -1º20´and -1º25´. The first deformation (10 mm/km) is negligible. In the second case, the value of the convergence can be corrected to the orientation obtained, to be compared with the goodness of the fit of the rock carving.

The coordinates of the reference points on the motif were obtained from an image of 4016 x 6016 pixels, using the left bottom corner as reference point. Although these coordinates are provided with an accuracy of 1 pixel, the estimation of the precision has been taken in the order of magnitude of 50 pixels, like an image of the model (perspective) (6000 x 4000 pixels). These data are presented in Table 1.

Table 1. Coordinates of the counterpart points.

Point Id	Pixel coordinates in carving		Pixel coordinates in perspective		UTM coordinates in La Palma (m)	
	x	y	x	y	X	Y
1	2066	4517	2800	3456	221272	3192789
2	2966	4187	3712	3528	228999	3193448
3	2957	3920	3832	3040	231294	3186188
4	2984	3509	3984	2216	233911	3182576
5	2681	2991	3408	1568	229329	3175202
6	2318	2277	3440	928	230611	3165930
7	1769	1992	3112	584	227287	3160535
8	1100	1536	2648	104	221781	3150647
9	827	2010	2400	576	218161	3160479
10	644	2871	1808	1408	213880	3166679
11	731	3629	1512	2056	210294	3174888
12	734	4376	1112	2720	206447	3186892
13	856	4733	1496	3376	210476	3192502
14	1298	4895	2104	3864	216052	3195707

In order to assert the similarity between the three groups of reference points, and therefore of the contours of the island of the three representations, we use an affine transformation (with 6 parameters, two translations of the axes-X_0,Y_0-, two rotations of the ones-α_X,α_Y–, and two scale factors of the ones too - k_X,k_Y-) between the 14 points of the shore (outline) of La Palma, that are easy enough identifiable in all the representations. By doing so, the 6 parameters can be estimated by the method of least squares between each pair of coordinates. These results are presented in Table 2, along with the standard deviations and the root mean square generated in the adjust.

Table 2. Transformation parameters

Transformation / Parameters	Rock carving-La Palma		Perspective -La Palma		Rock carving- Perspective	
X_0	-97887 ± 9412 m		-36264 ± 10295 m		1248 ± 100 px	
Y_0	-221266 ± 9412 m		-263720 ± 10295 m		1588 ±100 px	
α_X	-345.6 º± 2.7º		-355.8º ± 2.8º		-348.8 ± 3.3º	
α_Y	-341.3º ± 2.2º		-356.7º ± 2.2º		-345.7 ± 2.7º	
k_X	9.8 ± 0.5		9.4 ± 0.5		1.05 ± 0.06	
k_Y	13.1 ± 0.5		11.9 ± 0.4		1.13 ± 0.05	
Standard deviation	1712 m	153 px	1753 m	167 px	203 px	187 px
r.m.s.	2422 m	216 px	2479 m	236 px	288 px	265 px

On the other hand, this table presents the twisting angles of each of the axis. The lack of orientation in the carving image used to determinate the parameters of the transformation must be considered; the image is positioned in the same way as the picture was taken and roughly matches the real orientation of the island. The first operation will be to eliminate this lack of orientation in the image. This will be achieved by using a lava outcrop represented in the motif, as the real orientation is known to be 73º approximately. Therefore, a rotation of 17º degrees in clockwise direction is required, which allows to determine the new rotation on the X and Y axis: α_X= 2.6º y α_Y=-358.3º, and the mean, α= 0.5º. This value represents the rotation (estimated from the adjustment of 14 points) of the carving. Since the convergence was in the order of γ =−1.5º, the position of the carving with respect to the geodesic north (equal to the astronomic one for practical effects) would have placed our 'map' with respect of the cardinal points with a drift of 1º, smaller than the error of 2.4º provided by the adjustment.

These results allow us to confirm that the rock carving was indeed realized in the same relative position as the island. Therefore, it is perfectly orientated, indeed an excellent achievement.

On the other hand, Table 2 also shows the comparison between the dimensions of the carving and reality. This shows two different scales, 1:27.500 in the X direction and 1:36.300 in the Y direction (the dimensions of the carving are 1.05 x 1.34 m). Because of the order of magnitude of the errors is around 2.5 km, if the scale were 1:30.000 (average and rounded), the error in the representation would be around 8 cm, so to speak between 6 and 7.5% of its dimensions. The relation-ship between both factors provides a flattening value of 0.79, very similar to the one found in the perspective 0.85 that shows a marked similarity between the perspective of the island and the carving; indeed, another interesting outcome that is validated by the minor values in the standard deviation and r.m.s. Finally, it is worth mentioning that the translation in the axis has no cartographical validity, as each image has its own reference system and different units.

3. CONCLUSIONS

The main objective of this study is to confirm the hypothesis of the similarities between the carving under analysis and the vision of the island of La Palma as seen from the highest of its peaks. The glyph was carved with a high precision in morphology, metrics and orientation. In this way, the contour of the carving could be considered as a representation of La Palma, that is, a perfectly orientated map and with all the main contours of bays and capes thoroughly represented. The errors detected are in the order of magnitude of a few kilometres, a stunning achievement for a representation most likely made by estimation and eyeballed.

Several elements were found inside the rock carving, supporting this morphological similitude, the grooves and small channels, that seems to simulate some of the most remarkable topographical features of the island: the three main permanent water courses that chroniclers and historians mention in the chronicles of the conquest, including the great Barranco de Izcagua and the two volcanic craters associated to Cumbre Vieja and San Antonio, elements which describe the orography and hydrography significantly well. Therefore, carved in stone, there is a precise representation of the world inhabited by the *Benahoara*, which would be perfectly defined and known. This is the reason why it is proposed to include the motif into the category of mappiforms, understanding this motif as a representation (map) of the island.

But, what are the reasons to elaborate this map? What are the motives to sculpt it in rock? These questions will lead us to others that are the explanation of the outside elements to the main carving. From the four elements previously described, two of them have a simple explanation which also would explain the reason of the map. These two elements are the external cup-mark and the small channel (on a higher than the main glyph) connected to the main motif, as if some liquid such as water or milk were to be poured and dispersed throughout the island by means of the concentric circles surrounding the big hollow. It looks like this was used as a sympathetic magic device calling for something of great importance to the Benahoara: water, either in the form of rain or like clouds full of humidity.

Although scarce, a few examples support the existence of maps in Prehistory: the bulls paints in the cave of Laxcaux (France, c. 15000 BP), representing in this case the region of Taurus (Rappenglück, 1997), the wall paint in Čatal Hüyuk (south of Turkey, c. 6500 BC) with the representation of the first registered volcanic eruption (Schmitt et al, 2014);[2], the landscape painted in a ceramic of Tepe Gawra (Irak, c. 6000 BC; Tobler, 1950), the map of Bedolina (Valcamonica, Lombardy, Northern Italy; Arcà, 2004) and the eskimo insular maps from the Hudson Bay (Raisz, 1985) and Micronesian of the Marshall islands scheme considered as navigations charts (Thrower 2008:5).

The map presented here verifies the definition of Harley and Woodward (1987), as well as the conditions proposed by Delano (1987), as it is a spatial representation of the shore of the island. Besides it includes different orographic and hydrographic elements that are quite appropriated cartographically speaking. They are appropriated for the assumed used of the whole diagram for the spread the water (or any other liquid) along the entire island. It also looks as if the complete design has been simultaneously done, although this is difficult to quantify, fact that endorses the cartographic consideration of the carving. Indeed, it is also a way of communication, in the sense that it allows the user of the map to communicate with someone (maybe the deities?) a message: the need of water. And this could be the explanation for the other two external elements: the cup-mark and the (sun-shaped?) spiral, located at the East in presumable relation-ship to the location of the equinoctial sunrises. For a number of different reasons, these could have held some importance, as in other island of the archipelago, especially Gran Canaria (Belmonte, 2015). As a matter of fact, the local population of La Palma was able to create a geographical representation of their surroundings with a depurated technique that uses the local tradition of rock art to perform a true representation of their world: Benahoare.

[2] http://www.sci-news.com/archaeology/science-catalhoyuk-map-mural-volcanic-eruption-01681.html

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