

LASER-SCANNER SURVEY AT KONG-E YĀR ‘ALĪVAND. RESEARCH OF THE IRANIAN-ITALIAN JOINT EXPEDITION IN KŪZESTĀN*

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Abstract: Between 2008 and 2010, the Iranian-Italian Joint Expedition in Kūzestān conducted research in the area of the modern city of Īḍa under the co-direction of the authors of this paper. The aim of the expedition was to acquire new data on the Parthian rock reliefs recognised up to now at Kong-e Azdar, Kong-e Yār ‘Alīvand and Kong-e Kamālvand by applying the most up-to-date technologies, namely the GPS survey and laser scanning. Indeed, despite the several studies conducted on these works, several aspects, such as the chronology of the represented scenes, their evolution and carving techniques, still need to be clarified.

A preliminary elaboration of the data acquired at Kong-e Yār ‘Alīvand allowed us to create a digital 3D model of the sculpted surface consisting of 2,467,745 points. The surface analysis conducted on this digital support revealed traces of an inscription on the upper part of the sculpted scene, which has been deeply eroded and was never reported in previous surveys, and still undetected iconographic details, which shed new light on the sculpted scene, usually interpreted as an investiture.

Key words: rock reliefs, Kong-e Yār ‘Alīvand, Kūzestān.

When I met Professor David Sellwood for the last time in 2006, in Florence, he was preparing a revision of a particular series of Parthian “provincial” issues with Alberto Simonetta. We spent almost the whole day looking at ruler portraits through magnifying lenses and, on that occasion, I asked him for his opinion on a project that I was at that time just starting to think about. My intention was to conduct field research in the area

* Acknowledgements: all pictures are courtesy of the “Iranian-Italian Joint Expedition in Khuzestan,” held by the Centro Ricerche Archeologiche e Scavi di Torino per il Medio Oriente e l’Asia and the Iranian Center for Archaeological Research.

of the city of Izeh (ancient Mal-e Mir), where several Parthian rock carvings are located, with the aim of acquiring new information and data on their method of manufacture and interpretation. Needless to say, he warmly encouraged me to proceed and kindly gave me precious suggestions on the scientific relevance of these sculptural works. That research started in 2008, with the first campaign of the Iranian-Italian Joint Expedition in Khuzestan, and is still ongoing under the co-direction of myself – the corresponding author – and Jafar Mehr Kian.¹ We would like to honour Professor Sellwood by presenting some of the results of the research conducted at Hung-e Yar-i Alivand, where traces of an inscription unnoticed by previous surveys and new iconographic details have been detected on the surface of a well-known Parthian rock carving.

The Parthian carvings located in the area of the modern city of Izeh belong to the so-called group of rock carvings of ancient Elymais.² These works are of particular importance for two main reasons: they constitute the most outstanding group of carvings in Parthian Iran, and their individual characteristics set them apart from other sculptural works found in other regions of the Parthian empire. The carvings dated to the AD centuries appear particularly uniform because of their composition (in which an absolute hieratic frontality of the figures prevails), the choice of iconographic themes (such as scenes celebrating the sovereign, the homage of dignitaries or investiture scenes), and some figurative details (such as the clothing).

However, some carvings are not well understood because of their poor state of preservation, while their method of manufacture and interpretation have never been focused on in recent studies. Indeed, despite the research being carried out by traditional methods, some aspects regarding their iconography, style and carving technique still need to be clarified, for the available documentation is limited to photographs or drawings which, even when of superior quality, do not allow for more in-depth examination.

Our project aimed to acquire new data on these carvings by means of modern technologies and methods, including architectural survey techniques: namely laser scanning and 3D modelling. This technology produces complex information by 3D digital models that are faithful and measurable representations of real objects. Given that 3D models of the carvings might be constructed on a scale of 1 : 1 (both graphically and in a digital medium), previously undetected details might be subjected to analysis. These observations are the result of objective measurements, verifiable by other observers using the same data: for this reason, the 3D surface analysis offers promise of considerable advance in the study of ancient sculptural works, while 3D digital models are innovative means for documenting and sharing both raw and elaborated data.

Three rock carvings in the area of Izeh, dated to the Parthian period, have been selected for this analysis, namely at Hung-e Yar-i Alivand, Hung-e Azhdar and Hung-e Kamalvand. The relief at Hung-e Azhdar is, for several reasons, the most important of them from the historical point of view: indeed, it shows a scene of homage or investiture

¹ The expedition operates within the framework of a Memorandum of Understanding signed by the Centro Ricerche Archeologiche e Scavi di Torino per il Medio Oriente e l'Asia and the Iranian Center for Archaeological Research. Other Institutions involved in the project are the University of Turin, Politecnico di Torino, and the Ayapir Cultural Heritage NGO.

² At present, 14 Parthian monuments are known to us in the region of Elymais (Mehr Kian 1997, 67–72; Mehr Kian 2011, 293–298).

that has been related to the conquest of Elymais by Mithradates I.³ The data acquired and elaborated after our laser-scanner acquisition revealed that the scene showing a bearded horseman in profile (often identified as Mithradates I himself) proceeding toward four standing men in a frontal position and lined-up in a paratactic manner, which can be seen there (on the surface of a huge boulder), was executed at two times: its right half, in which the standing men are represented, was re-sculpted in the first decades of the 2nd century AD, having been added to the left half (that of the horseman), which can be dated to the half of the 1st century BC.⁴ In any case, the carving appears to have been commissioned and re-sculpted by local rulers, and not by the famous Parthian king.

In the same area, two other rock carvings reveal stylistic and iconographic analogies with the four Hung-e Azhdar standing men: one is located at Hung-e Kamalvand, on the southern slope of a gorge giving access to the highlands of the Bakthiari mountains, and the other at Hung-e Yar-i Alivand, on the mountain slope that follows the modern road leading to the valley of Hung-e Azhdar.

The relief at Hung-e Yar-i Alivand is particularly damaged because of surface erosion: it is indeed completely exposed to wind and rainwater, having been sculpted at about 2 m from ground level on a vertical cliff oriented approximately north-southward.⁵ It represents two standing men in a frontal position, paratactically placed side-by-side and dressed in the characteristic Parthian belted (?) tunics and trousers, perhaps with a cloak.⁶ Their feet are in profile and slightly turned down. The man on the right has his left hand at his hip, perhaps on the hilt of a sword – almost completely disappeared – and holds an object – usually interpreted as a ring – in his lowered right hand. The man on the left mirrors that on the right, with his right hand on his hip: he seems to hold an object that is interpreted by some scholars as a flask;⁷ his left hand seems to be at his chest. The scene is interpreted as an investiture, in which the right man is investing the left man with his authority,⁸ and is dated, quite unanimously, to the 2nd century AD.⁹ However, one of the most interesting problems related to the Hung-e Yar-i Alivand carving is the debated presence of an inscription below the lower frame of the sculpted surface, under the feet of the two standing men, which allowed the Hungarian scholar J. Harmatta to identify the figure on the left as a god (Ahura Mazda) presenting a diadem to a local ruler (Kamnaskires VI), on the right.¹⁰

The purpose of our survey was to verify, in the first instance, the presence of this debated inscription. The laser-scanner acquisition was accurately planned before the fieldwork was started and then performed using a high-resolution instrument based on the triangulation principle. This traditional survey technique, which is also the basis of

³ Von Gall 1969–1970, 301–302; de Waele 1975, 60; Vanden Berghe 1983, 120–121; Vanden Berghe/Schippmann 1985, 32–38; Kawami 1987, 209–213; Mathiesen 1992, 119–121; Invernizzi 1998, 219–259.

⁴ Messina and Mehr Kian 2010, 31–45; Messina/Mehr Kian 2011, 215–231.

⁵ The rock carving is located at 31°56'12.47"N and 49°50'24.90"E, according to the WGS84 coordinates system.

⁶ Hinz 1963, 169–170, pl. 57; de Waele 1975, 65–66, note 4; Vanden Berghe 1983, 48; Vanden Berghe/Schippmann 1985, 40–41, fig. 2, pl. 7; Kawami 1987, no. 51; Mathiesen 1992, 123–124.

⁷ Vanden Berghe/Schippmann 1985, 41.

⁸ Hinz 1963, 170; Vanden Berghe/Schippmann 1985, 41; Kawami 1987, 127.

⁹ Mathiesen 1992, 124 and selected bibliography.

¹⁰ Harmatta 1984, 174–175.

other metric survey techniques such as photogrammetry, allows very high accuracy (less than 0.2 mm) and resolution (1 point every sq mm). The instrument selected is a third-generation handyscan, a laser scanner device that fixes the coordinate system directly on the object, allowing the acquisition phase also in critical field conditions. Markers have to be placed randomly on the object's surface at a distance of no more than 5 cm from each other, in order to allow the scanner to recognise its position in a 3D model: these are reflective circular targets, with a diameter of about 5 mm, that can be removed after acquisition. The surveyed surfaces may be subdivided into small portions in order to fit the memory capacity of the laptop used for recording data.

The handyscan seems particularly suited to the acquisition of the irregular surface often characterising rock carvings. The natural, and generally irregular, conformation of a carved rock requires careful detection, because of the presence of blind angles or protruding parts that could hinder the objective measurement and analysis of the sculpting depth. The handyscan is moved like a brush, at about 10–15 cm from the acquired surface, and it follows the natural conformation or irregular surface of a rock carving perfectly, avoiding the problems of blind angles or loss of information in post-processing. Each of the acquired sectors overlaps adjacent sectors by about 10%, in order to guarantee the stability of the geometry of the whole object and an average of 1 point every 2 mm, with an estimated accuracy of 0.15 mm.

The 3D model provides a geometric description and in many cases this is not sufficient to allow a correct interpretation of both semantic and geometric contents. To overcome this limit, high-resolution true colour images may be acquired and oriented in a photogrammetric way on the 3D laser scanner model to allow a correct mapping of the images on the 3D model itself.

At the end of the data treatment many instruments of analysis were produced in order to provide various information: realistic 3D models, true orthophotos and solid images. While 3D realistic models and orthophotos are well-known products, solid images are a new investigation instrument realised thanks to the integration of laser scanner and photogrammetry: they are high-resolution digital RGB files (perspective and non-orthorectified) integrated by a numerical matrix of the same resolution and providing tridimensional data of the scanned surface, in which all the pixels contain x, y and z coordinates. In this way, experts may obtain sections, profiles and points in order to verify their hypothesis and to outline new investigation strategies. The use of controlled lighting conditions, infrared or macro photography for the carving at Hung-e Yar-i Alivand was initially taken into consideration for verifying the data acquired by laser scanning; however, the preliminary results of raking light and infrared photography, showing a very faint relief, left us doubtful of achieving a good result, and discouraged us from pursuing those techniques, notwithstanding their reliability, because of the poor state of preservation of the sculpted surface.

Acquisition by laser scanning at Hung-e Yar-i Alivand was conducted in March 2009 and lasted two days. The 2.2 sq m sculpted surface was divided into nine squared sectors, each of 60 × 60 cm. About 3,000 markers were placed on the surface for the laser tracker and completely removed after acquisition. Even the rock below the carving's lower frame, under the feet of the standing men, was acquired down to ground level, with the purpose of verifying the presence of an inscription. Each sector was separately scanned

and the instrument was handled at about 15–20 cm from the rock surface: several frames were acquired as digital files at the highest resolution (1.95 mm), and an overlap band was saved between adjacent sectors, with a tolerance of 10%. The scanner never touched the surface during the operation. The acquisition of several sectors was repeated when the relevant acquired frames needed to be completed or integrated.

Images with a digital photogrammetric camera were also acquired in order to update the information provided by the laser scanning: several frames were photographed twice, at a distance of 5.3 and 1.3 m (for details) and the used lens was calibrated before the image acquisition in order to bypass radial and tangential geometric distortions.

The vertices were located on the ground by a traditional topographic method, while 15 control points, placed on the sculpted surface, were located by a total station, in order to define a georeferenced network. This allowed us to relate the numerical and tridimensional nature of the acquired information to a known reference system. The accuracy of the grid was verified by triangulation of each vertex, and intersections of the control points were measured from two vertices. Some of the markers (less than 0.1% of those placed on the sculpted surface) were surveyed by using a total station from two different stations, whose coordinates were surveyed by using a GNSS static positioning. The coordinates of the total station points were estimated with an accuracy of 1 mm, but the survey scheme adopted for the markers – namely forward intersection from known points – provided an accuracy of less than 0.5 mm for the markers and less than 1 mm for the global coordinate system.

The frames acquired at Hung-e Yar-i Alivand were elaborated in the laboratory of the Politecnico di Torino, and allowed us to create a 3D digital model of the rock carving consisting of 2,467,745 points, with an accuracy of approximately 0.2 mm. The images acquired by the digital photogrammetric camera were elaborated to obtain digital orthophotos and solid images of the scanned surfaces. Software was created for the analysis of these data: the user can follow lines, locate points, define areas on the image and recover metric information.¹¹

All the elaborated files – the 3D models, orthophotos and solid images – were merged on a single digital platform, and precise and objective measurements of the sculpted surfaces were taken in a virtual three-dimensional space. Given that the numerical and three-dimensional nature of the acquired information, namely the point cloud, is related to a known reference system, the anomalies evidenced by the software basic tools (progressive sections, distances, angles, areas and volumes) are nothing but the graphic rendering of equations, whose result can be mathematically verified at any time. Consequently, the detected anomalies cannot be ascribed to the subjective interpretation of anyone observing the 3D model and/or using the software tools, but rather to the objective situation of the carving and/or the conformation of the rock.

The preliminary elaboration of the data acquired at Hung-e Yar-i Alivand demonstrated that there is no inscription below the carving's lower frame, under the feet of the standing men. If this inscription existed, it has now completely disappeared. The 3D model rather revealed traces of a previously unreported inscription on the upper part of the sculpted scene, between the heads of the standing men: this is invisible to the naked

¹¹ Bornaz/Rinaudo 2004, 514–519.

eye as it has been deeply eroded, and only scant traces of some letters became detectable in the grey-scale post-processed 3D frame of the carving.

It is an Elymaean inscription in Aramaic of the south Mesopotamian group, arranged on two lines, which can be read as follows:¹²

line 1. [.] 'š(m)b(p)[.](n/k)[...]

line 2. br k[.](n/k)[..]k[...]

These can be translated as:

line 1. [...]

line 2. son of [...]

The letters are typologically similar to those that compose the much clearer inscription already recognised on the rock carving at Hung-e Kamalvand, which appears to be read as “Phraates, the priest, son of Kabneshkir” and has been dated, by comparison with similar inscriptions on the carvings at Tang-e Sarwak, to the end of the 1st/beginning of the 2nd cent. AD.¹³ As far as palaeography is concerned, the letters of the Hung-e Yar-i Alivand inscription appear to be of the same type and, if the date proposed for the former is accepted, it seems possible to date the Hung-e Yar-i Alivand carving to the same period, for it was surely sculpted when the letters were incised on the surface between the men’s heads. In the second line of the Hung-e Yar-i Alivand inscription, after the word “son (of),” one could be tempted to read the dynastic name “Kbnshyr,” in the light of the Hung-e Kamalvand inscription; however, only two letters out of six – or seven (?) – are clear, and this name – that of the father or ancestor of one of the standing men – remains obscure. In any case, the scene composition, arranged on two paratactic figures with an inscription running on the top of it, and the type of the inscription itself, which is a statement made by “someone, son of someone,” appear quite similar to those on the Hung-e Kamalvand carving. It is generally assumed that this carving depicts an investiture:¹⁴ it shows a man, on the right, wearing a belted tunic and trousers, pouring liquid (probably water) from a small jug, flask or pitcher held in his right hand, and standing in front of a horseman proceeding toward him. It is also assumed that the inscription refers to the horseman and claims his royal descent, while the standing figure remains unidentified; however, the possibility that the inscription refers to the standing man cannot be completely ruled out. In any case, if this scene represents an investiture, it must be placed in a religious context, because of the reference to a priest made in the inscription and the action of pouring liquid made by the standing man. According to T.S. Kawami, who also considers the religious milieu, this relief may depict a member of the Kamnaskirid dynasty who retained some power, perhaps religious, rather than political, in the region.¹⁵

The religious milieu already attested for the Hung-e Kamalvand carving could help in the interpretation of the Hung-e Yar-i Alivand sculpted scene, especially in the light of the observations that can be made on the 3D model and post-processed false-colour image obtained after our laser scanner acquisition. Indeed, the preliminary surface analysis

¹² Moriggi 2011, 109.

¹³ W. Hinz translated the Hung-e Kamalvand inscription and proposed dating it to c. AD 100 (Hinz 1963, 171–172).

¹⁴ Mathiesen 1992, 122–123 and selected bibliography.

¹⁵ Kawami, 1987, 72–73.

revealed first of all that the left hand of the left figure is undoubtedly at his chest (his arm being folded), that no flasks are clearly detectable in his right hand, which seems indeed to rest on his hip (maybe on the hilt of a sword, like the mirroring figure), and that the object held in the right man's right hand appears oblong in shape rather than circular. This said, it seems improbable that the right man holds a ring, which should appear circular, and even that the left man is receiving it, for his left arm is folded. The oblong shape of the object held by the right man is closer to that of the small vessel held by the left figure sculpted at Hung-e Kamalvand, and even the arm gesture is similar, the hand being lowered to pour liquid from the vessel. On the basis of these observations, it seems that the scenes at Hung-e Yar-i Alivand and Hung-e Kamalvand have been sculpted following the same composition scheme: this is based on two paratactic figures (one of which is identified by an inscription on the top), of whom the figure on the right makes a symbolic gesture – of purification (?) – in front of the figure on the left (a standing man at Hung-e Yar-i Alivand, a rider at Hung-e Kamalvand). Furthermore, the head of the left man at Hung-e Yar-i Alivand seems surrounded by a kind of halo, which could be interpreted as either what remains of curly hair or else a crown of rays (judging by the points that can still be seen beside the figure's left ear): if the latter interpretation is valid, the left man could be even identified as a sun god or – more probably – a deified person. It must be admitted, however, that this hypothesis cannot be definitively demonstrated, for the left figure's head is deeply eroded, especially on the top. In any case, the analogies between the two carvings outlined above, if considered correct, lead us to assume that both represent a scene of homage rather than an investiture; a homage paid, in a religious milieu, by a high-ranking personage, perhaps a sovereign (who is always represented on the right), to a figure majestically standing in front of him (and always on the left), which can be defined as an ancestor, possibly deified, of his own dynasty: the line of descent is indeed traced in both inscriptions by the occurrence of the word “son (of).”

The religious nature of the Elymaean rock carvings in fact also seems to be confirmed by the discovery, in front of the sculpted boulder at Hung-e Azhdar, of a cult place, far older than the Parthian relief sculpted, in two times, onto its surface, where particular objects (most of all arrowheads) were offered close to a platform in undressed stones, laid at the feet of the boulder itself.¹⁶

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¹⁶ Messina/Mehr Kian 2011, 215–231.

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Fig. 1. The Area of Izeh in modern day Khuzestan (south-western Iran)



Fig. 2. Location of the Hung-e Yar-i Alivand rock carving



Fig. 3. The rock carving at Hung-e Yar-i Alivand



Fig. 4. Hung-e Yar-i Alivand. Acquisition of the rock carving by handyscan



Fig. 5. 3D model of the Hung-e Yar-i Alivand carving

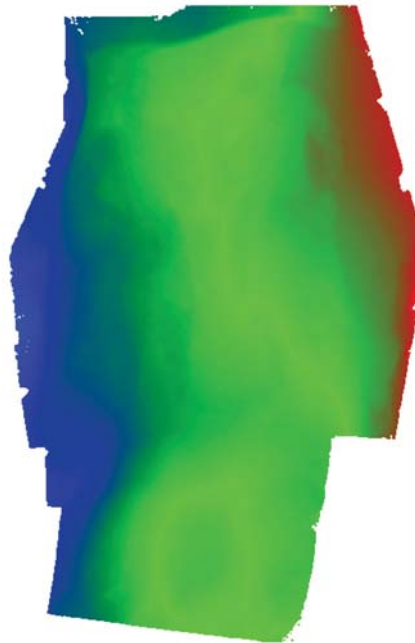


Fig. 6. False-color image Hung-e Yar-i Alivand carving. Chromatic nuances correspond to different sculpting depth

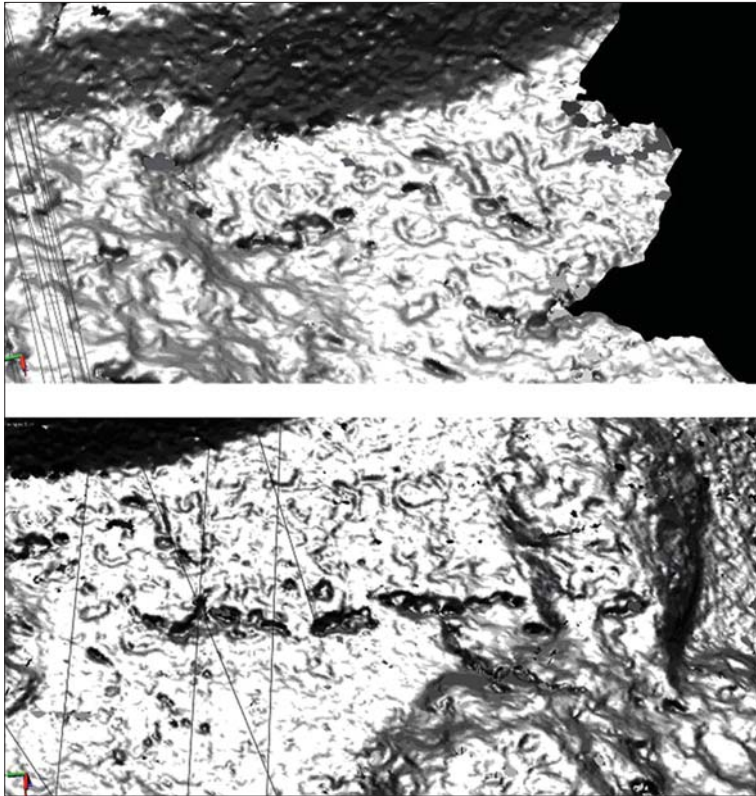


Fig. 7. Grey-scale 3D model of the Hung-e Yar-i Alivand Parthian carving. Detail of the inscription in the upper part of the sculpted scene