BRIEF REPORT

Analysing the black pictograms of Takhte Chan, Pol-e Dokhtar, Iran

By SARA SADEGHI, MANIJEH HADIAN DEHKORDI, MORTEZA HESSARI and SAEED RAHIMI

The Takhte Chan pictograms are located in Takhte Chan Valley in Pol-e Dokhtar, a city in the southwest of Lorestan Province, Iran (Fig. 1). Takhte Chan Valley is at the base of the Kyalan mountain range, and the pictograms were made on large rock walls with the approximate height of 40 m extending continuously along the valley (Fig. 2). With time, a large part of the pictograms has faded or they have been exfolitated due to rain-caused sediments and human activities (such as lighting fire below the pictograms). Most importantly, the rock art has been damaged because the limestone bedrock is along the river. Takhte Chan pictograms include animal, human, and presumed tool motifs. Their main technique is painting, and most images were drawn flat. Since the pigments are black and no carbon has been detected, the presence of iron in the surface layer might be attributed to iron (II) oxide or magnetite, containing black pigment.

Since the imagery is simple and stylised, it seems that the paintings were made using fingers. The motifs are comparable to some others in other regions of Iran, such as at Arges Sofla, Hamadan (Beyk Mohammadi et al. 2012), Asbaqth, Yazd (Ayatizadeh 2014), Borujerd, Lorestan (Sabzi and Hemati Azandariyani 2020), Jorbat, North Khorasan (Rashidinejad et al. 2009) and Azandariyan, Malayer (Mohammadifar and Hemati Azandariyani 2014).

There are numerous archaeological sites within the region, settlements and multiple bridges over the Seymareh and Kashkan rivers. The authors' investigations in 2023 showed that the valley is still the sojourn for Pol-e Dokhtar nomads (of the Derikvand tribe). The approximate painted surface area of the site is 2.5 m × 5.5 m, 2.5 m above the ground, with 13 pictograms. All motifs face

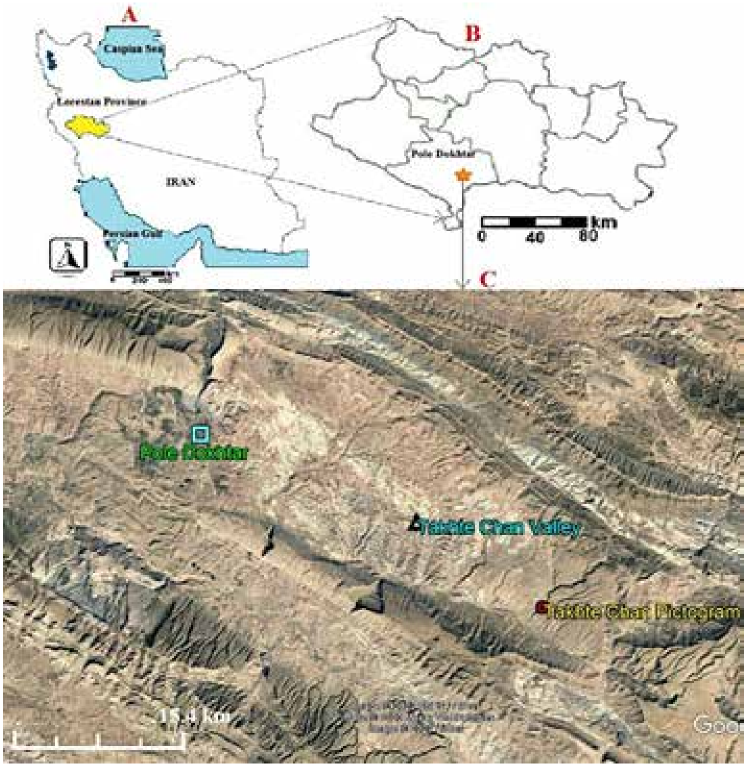

Figure 1. A: The location of Lorestan province on the map of Iran; B: map of Lorestan province and the Pol-e Dokhtar City location; C: the location of the paintings of Takhte Chan.

Figure 2. *The locations of the Takhte Chan pictograms.*

Figure 3. The motifs of the first rock, Takhte Chan pictograms.

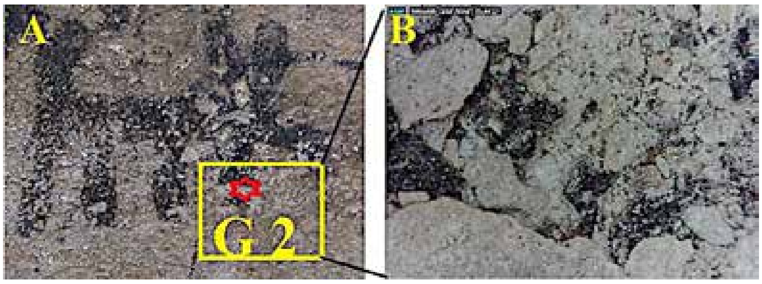

Figure 4. *A: Sampling location of black colour in Takhte Chan; B: microscopic image of black G2 sample.*

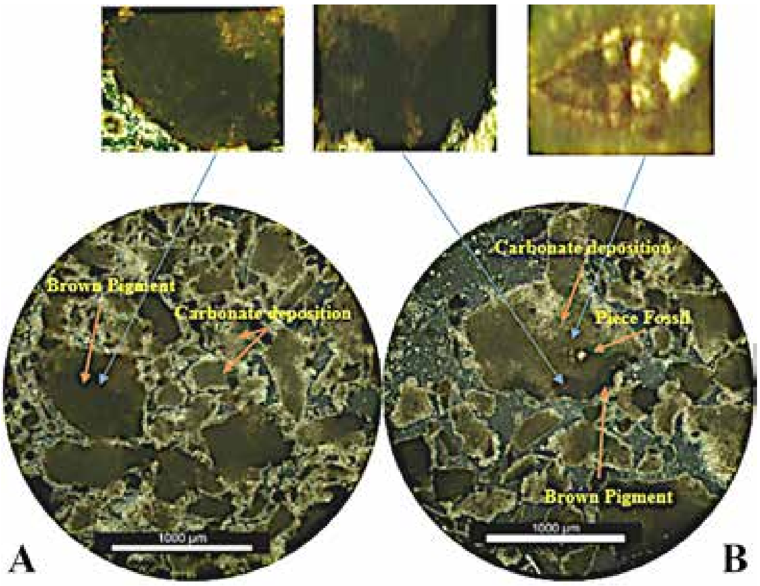

Figure 5. *A: Microscopic image of sample G-2, XPL light, 4× magnification, scattered pieces of carbonate with pigment; B: microscopic image of sample G-2, XPL light, 4× magnification, another view of the sample, scattered pieces of carbonate with pigment and fossil remains can be seen in the image.*

north (Fig. 3). The anatomy of these animals includes short, curled-back tails, pointy upward ears and all limbs. On the west side of the wall, an archer is shown frontally, apparently pulling the bowstring back and aiming at an animal motif. The animal is moving toward the left, and its horns are exaggeratedly stretching to the end of its body. The animal motif is much larger than the human.

Sampling methodology

At Takhte Chan, black paint was used in all the surviving 'scenes' and motifs. To understand what pigments were used to attain this black paint, specimens were sampled from the damaged ends of the pictograms (Fig. 4). Figure 4 depicts the sampling location and the microscopic image of the black colour. Gloves were worn to prevent contamination of the sample. Generally, sample collection focused on the lowest impact and gaining the most miniature samples. Samples were coded in this experiment.

Equipment and devices

Different equipment and methods were used to evaluate and identify the pigments. The thin section method was used to obtain the rock sample, and the samples were investigated using polarised light microscopy (PLM). A James Swift PLM was used for the study, and the magnification was 4×. The petrography experiments on sections and paint samples aimed to identify two major textural components: context texture and pigment. The experiments were conducted in Tehran's Petrography Lab of Preservation and Restoration of Historical-Cultural Monuments Research Center. Scanning electron microscopy with energy-dispersive x-ray spectroscopy (SEM-EDS) was adopted for point elemental analysis of samples. The SED-EDS device was a VEGA3 TESCAN device equipped with Sirius SD elemental analysis device. Fourier transform infrared spectroscopy (FT-IR) was employed to evaluate the main colours and complete previous experiments. The spectroscopy was performed using an FT-IR device (NICOLET 510P) and within the MIR wavelength.

Petrography

The petrography sample revealed that the main component of the sample was heterogeneous calcite. The sample was a cream-coloured mineral with small crystals which were light-cream under the microscope. A brown pigment was also observed due to calcareous deposits (Fig. 5a). The sample had sections of different sizes and dimensions, ranging from a few microns to 1 mm. Figure 5b shows a sample with fossil remnants, apparently of an insect found in the stone texture (Fig. 5b). Microscopic examination revealed that all pigments include iron oxide (i.e. haematite). The main mineral found in the samples was calcite.

SEM-EDS

The main components of the sample G2 were Ca and a small fraction of Mg in the stone layer. Si, Al and K are usually found in soils (Table 1). The distribution map shows that all elements are distributed among all zones, including the top surface. Although a small fraction of Fe was found in points B, C and D on the stone surface, their distribution map shows Fe at other points, which might be attributed to impurities. For the limestone, since the pigment was black and there was no sign of carbon, the presence of iron on the surface layer can be related to iron (II) oxide or magnetite. A significant amount of S was also found in the sample. Hence, the pigments used to paint the pictogram were a mineral compound composed of $Ca(Fe,Mg)Si_2O_6$ (Figs 6 and 7). Black iron oxide, called 'haematite',

Elt	W%			
	G2-A	G2-B	G2-C	G2-D
O	59.08	59.53	56.90	41.03
Na	-	1.65	1.58	1.19
Mg	3.83	2.27	2.34	3.07
Al	-	1.36	2.10	4.19
Si	2.36	2.59	3.06	6.92
Cl	-	0.93	1.04	1.11
K	-	0.28	0.22	0.77
Ca	34.73	31.12	32.29	40.95
Fe	-	0.27	0.46	0.76
S	-	22.17	11.02	17.36

Table 1. *Elemental analysis of specimen G2.*

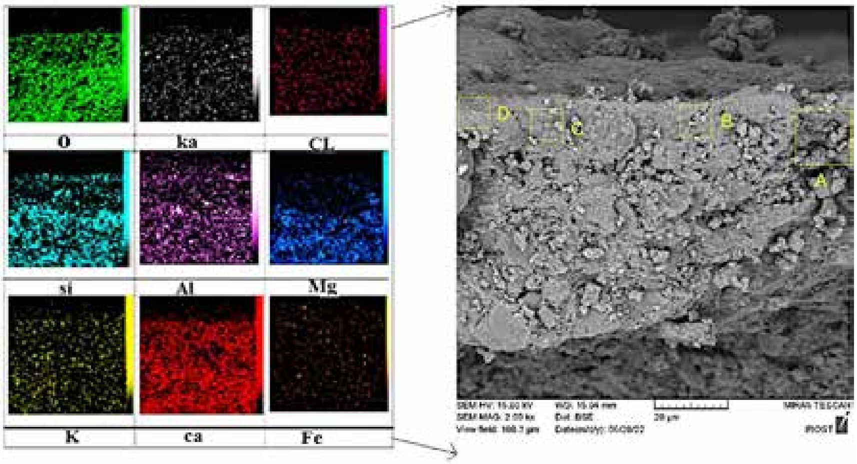

Figure 6. *SEM-EDS photomicrograph of the black paint specimen, Takhte Chan pictogram site, Pol-e Dokhtar, Lorestan*

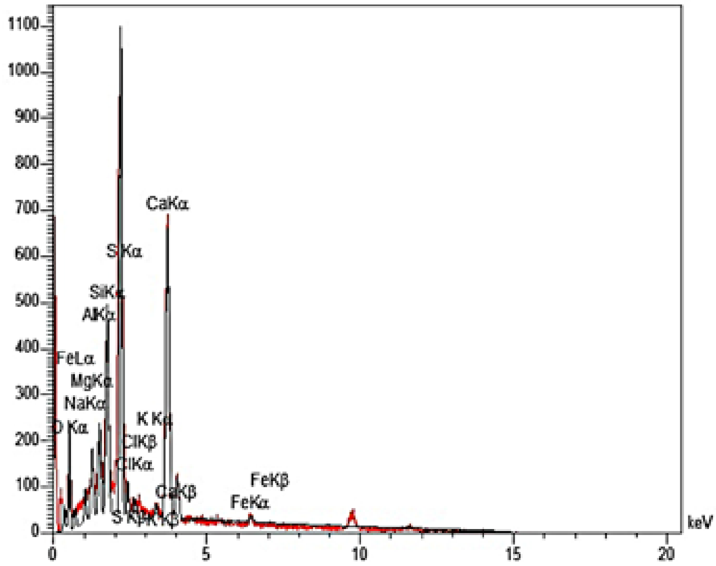

Figure 7. *Elemental analysis spectrum of the black sample in the colour pictures of Lorestan province by SEM-EDS method, identifier G2.*

has been used in the composition of some ancient black pigments. Jahri Neyshaburi (2004: 132) believes that the main components of the black compound are 85% chrome oxide, 10% manganese oxide and 5% magnesium silicate (Wolff 2005: 75).

FT-IR spectroscopy

Transparent tablets were made from samples using KBr under the pressure of 10 t. Then, the sample was subjected to spectroscopy using a Nicolet 510P FT-IR device in the range 450 to 4000 cm^{-1} through 32 scans of resolution 4. The results indicated that since the peak indices of iron oxide, appearing in the range of 460 to 520 cm^{-1}, were also found in the black pigment sample and since the petrography analysis verified that for some black pigment samples and the SEM-EDX analysis confirmed the same results, it can be concluded that haematite is probably found in the bedrock structure. The abundance of Fe element in elemental analysis results of the sample surface and the intensity of peaks related to iron oxide in FT-IR analysis indicate the presence of these compounds in the pigment. CO_3-based compounds were found in all samples. In addition to the almost certain relationship between CO_3 and $CaCO_3$ with peak indices at 712, 876, 1442, 1800 and 2517, the following situations can be considered.

According to SEM-EDX reports and petrography results confirming the presence of Mg and dolomite ($CaMg(CO_3)_2$) in the samples, it can be concluded that the peaks at 728, 882 and 1438 can be related to these compounds. However, the presence of magnesium carbonate ($MgCO_3$) is another possibility arising with the emergence of relevant peaks at 714, 744, 800-886, 1422-1484 and 3648. Based on FT-IR spectroscopy and lack of peaks in 711, and regarding petrography analysis, the calcium carbonate can be a non-crystal biogenic substance.

Spectral bands in 1618 and 1321 are related to regular vibrations of calcium oxalates, naturally found in limestone crusts such as whewellite and weddellite. Oxalates, often biologically weathered, are attributed to the oxalic acid secreted by lichens or fungi on a carbonate substrate (Bikiaris et al. 2000: 14). Calcium carbonate deposits as calcium oxalate. The deposit is black in the sample spectroscopy using the G2 code (Fig. 8). It was also reported that the hydrocarbons caused by industrial activities could be converted to produce oxalic acid. The low intensity of the relevant spectrum within bedrock spectroscopy confirms the result (Table 2).

Summary

Takhte Chan pictograms include animal, human and possibly tool motifs. The anthropomorphs are painted with thin lines and full-faced, and animals are painted in a standing and side-faced manner. Re-

Feature absorption band in FT-IR/(cm^{-1})	Identified compounds
1028, 512, 467	Iron oxide
2629, 2529, 1437, 881, 727	Carbonate compounds (dolomite & calcite)
3538, 3342, 1622, 1100	Sulfate compounds (probably gypsum & basanite)
1028, 781	Silica compounds (probably amorphous silica)
1313	Calcium oxalate

Table 2. *The elements identified in the black pigment sample G2 by the FT-IR method.*

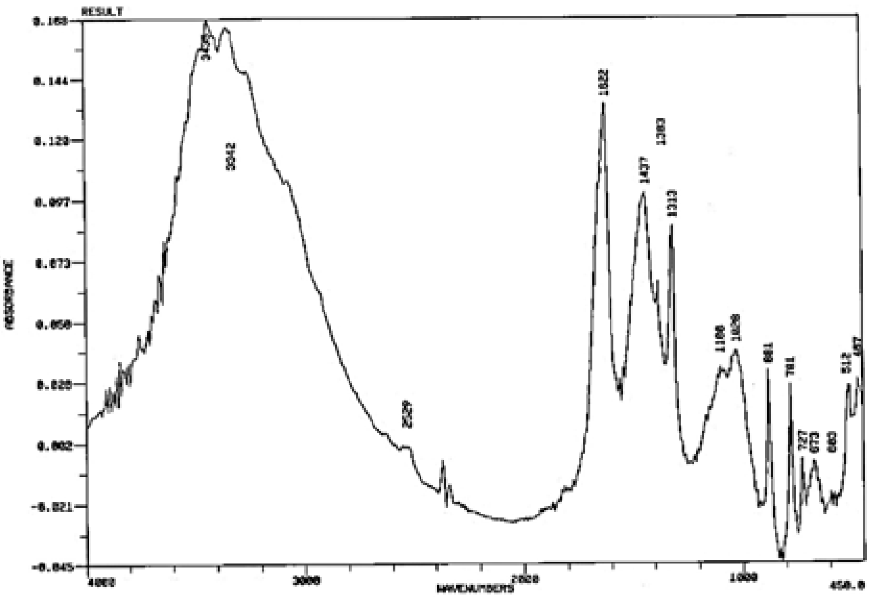

Figure 8. *FTIR spectrum of G2 sample with black pigment.*

garding their motifs, the images are similar to those found in the Zagros mountain range, such as those in Hamadan, Kurdistan and Kermanshah. The pictograms are all painted using a black colour on limestone walls. Based on the geographical characteristics of the Pol-e Dokhtar region, Takthe Chan Valley includes limestone and calcite-based minerals.

FT-IR spectroscopy and SEM-EDS analysis confirmed that the stones are calcite-based. An insignificant fraction of organic matter was identified in colours, and the pigments were made of iron oxide. The abundance of Fe in elemental analysis results of the sample surface and the intensity of peaks related to iron oxide in FT-IR analysis indicate the presence of these compounds in the pigment. CO_3-based compounds were found in all samples. Hence, FT-IR spectroscopy showed carbonate, sulphate, iron oxide, and oxalate compounds in most samples. Therefore, the pigments used for painting the pictograms are mineral compounds of $Ca(Fe,Mg)Si_2O_6$. Since the pigments were black and no carbon was found, the Fe element in the surface layer can be attributed to iron (II) oxide or magnetite. Their mineral structure is one of the main reasons they have been preserved over time because mineral colours are most resistant to destructive environmental factors.

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RAR 41-1440

RAR REVIEW

Rediscover the 'Earth': an evolving interpretative approach of palaeoart study

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Rock art in the landscape of motion, edited by PAWEL L. POLKOWSKI and FRANK FÖSTER. BAR International Series, Oxford; 183 pages, illustrated in colour, softcover, ISBN 978-1-4073-5989-2.

The possibly earliest known contemplation of rock art occurred at Cosquer Cave 19 000 years ago (Clottes et al. 1992), yet rock art recording began very late, e.g. in the 4th century CE in China (recorded in Li Daoyuan's *Shui jing zhu*[1]) and the 16th century CE in the rest of the world, mainly relating to Christian missionaries' activities in Latin America. Since the 17th century, with the global expansion of Europeans, written and graphic records have widely come out in Europe, the Americas, Africa and Australia, e.g. some early copies of the Backa rock art (Nordbladh 1981), and the records of the sites at Vallée des Merveilles, Newgrange, in the Yenisei Basin, or of Bushman people (Strahlenberg 1730; Bahn 1998). Roughly with the beginning of the 19th century, there appeared the first concern with rock art as a source of data for scholarly contemplation, manifested by deliberate endeavours to record not only what one thinks one sees on a panel, but also relative relationships, particularly of size and juxtaposition of motifs. This was probably only partly due to an appreciation that such relationships also need to be considered in interpretation. Developing attention to more objective observations can be seen in many people's works, e.g. Belzoni's expedition to the petroglyph sites on the upper Nile, Barth's fieldwork in Libya, Duveyrier's research of Saharan rock art (Duveyrier 1876) and Huang's visit[2] to the Xianzitan petroglyphs in southeast China (Huang 1935).

During the last decades of the 19th century, the emerging discipline of archaeology began to take a sustained interest in rock art. The principal tool for archaeologists is typology, classifying rock art motifs into various 'styles' based on their morphological features. This kind of 'stylistic studies' appeared first in Europe, then gradually spread to the rest of the world and persisted for nearly the entire 20th century, honed and refined by generations of archaeologists. However, since the 1970s, many new methods contributed by scientific disciplines have been introduced into the field of rock art study, including a wide range of physical and chemical analyses of rock art and rock art-related materials. Numerous approaches are being developed in the question of the age of rock art. Field microscopy of rock art has been developed for several purposes, including dating, petrography and technical analyses. Replication studies have been attempted at many sites around the world. The development of taphonomic logic and rigorously framed statistical approaches has greatly enriched researchers' arsenal.

A trend of upholding so-called objectivity has been rising in the discipline, resembling the concept of 'paradigm change' proposed by Thomas Kuhn (1970). However, this does not mean that every problem has been solved when people start to talk about 'science'. Despite all the objective means, subjective minds inevitably pre-designed research, which could be affected by many irrational factors. We have witnessed a fair number of disappointing cases of abusing scientific methods misled by the eagerness for quick success and instant benefits; we do not even need to cite any remote instance; just think of the recent debate of the Qiusang rock art dating (see Bednarik et al. 2022). Objectivity is not a synonym for truthfulness, and we are still trapped in subject-object dualism if we still perceive this issue as a single-choice question — in other words, the barrier between which needs to be broken through properly. Therefore, it was so inspiring to see that some colleagues took a step forward when we received the newly published *Rock art in the landscape of motion*, edited by Pawel L. Polkowski and Frank Föster. This volume has included nine research papers covering multiple topics as the proceedings of

1 The book title '*Shui jing zhu*' means '*Commentary on the waterways classic*', written by Li Daoyuan (469–527 CE), a geographer living in the northern Wei dynasty (386–557 CE). Based on *Shui jing* (*The waterways classic*), a geographic book compiled in the Three Kingdom's period (220–280 CE), Li added commentaries and finished his book some twenty times the size of the original.

2 This expedition was conducted in 1915 by Huang Zhongqin, a famous Chinese educator and revolutionary in the first half of the 20th century. It marked the beginning of academic interest in rock art in China.

a session of the 20th International Rock Art Congress IFRAO 2018 that took place in Valcamonica, Italy. Considering that all these discussions have demonstrated some significant aspects of the evolving paradigm mentioned above, we have enthusiastically accepted the invitation to review the volume from Prof. Robert G. Bednarik, the editor-in-chief of *Rock Art Research*.

The spillover effect of the developing landscape archaeology causes this change. The term 'landscape' came from the Dutch word *landschap* around the 1600s, used to indicate a type of linear perspective painting depicting natural scenery (Olwig 1993: 318), which visually reflects how people observed, comprehended, assessed and transferred the spaces they lived within (Cosgrove 1984: 27). This mindset also affected the European capitalists' understanding and interpretation of the unfamiliar scenery witnessed in remote colonies, then became a part of the inspiration in the design of gardens and courts in their lands (Hirsch 1995: 2). 'Landscape' as an academic concept occurred in Alexander von Humboldt's research of geography in the early years of the 19th century (Naveh and Lieberman 1984: 356). Since the 20th century, it has gradually become a core conception along with the development of human geography and, more importantly, its related studies have fostered landscape ecology in the 1960s, which focused on the theoretical integration of phytology and regional geography in its early stage of development, then turned to think of the spatial heterogeneity of different ecosystems since the 1980s. Probably in the meantime, some sociologists and anthropologists had also realised its significance, e.g. Sauer (1925) pointed out that the concept of landscape naturally contains human's cultural behaviours. The turning point occurred in the latter half of the century as a consequence of constant impact from the fields of humanities and social sciences, e.g. E. Husserl's phenomenology, M. Heidegger's existentialism, H. G. Gadamer's hermeneutics and P. Bourdieu's theory of practice, the connotation of landscape has been epically enriched and, for the first time, researchers feel that they might have been given a 'toolbox' to build the 'bridge' connecting subjective and objective worlds. Since then, people have paid more attention gradually to the discussion about human involvement in the construction of landscape, its semiotics, symbolism and structural characteristics as cultural carriers, rather than still as an only observable world image opposite to human vision (Morphy 1995). In this sense, the idea of landscape has led to an understanding of spatial network relationships of humanity's activities, i.e. every society in human history had its structures of landscapes (Thomas 2001: 173).

Archaeology is a discipline naturally concerning the issues about 'place' and 'space', such as the basic concept of 'site' and the spatial analysis in settlement archaeology. This tradition can even be traced back to Pitt Rivers's work in Cranborne Chase in the late 19th century (Pitt Rivers 1887). As a part of the trend mentioned above, the theorisation of landscape in archaeology progressed much more slowly. Since the last decades of the 20th century, researchers have gradually diverted their attention to the geographic background around sites; for instance, they began to talk about 'siteless' archaeology (Dunnell 1992) and off-site archaeology (Foley 1981). Simultaneously, post-processual archaeology rose by criticising the environmental determinism of processual archaeology. Cultural symbolism, individual practice, social cognition and power structures about landscape became crucial topics. The spaces where ancient people lived have been no longer perceived as only assemblages of natural resources but as mediums of social expression (McAnany 1995) or the cultural significance produced from the repeating social practice of individuals (Barrett 1991). Also, since the last decade of the 20th century, archaeologists have experimentally transplanted landscape theories into the field of rock art research (Bradley 1991; Bradley et al. 1994; Nash and Chippindale 2002; Chippindale and Nash 2004; Gillette et al. 2014). This process was also briefly reviewed in the section 'Theoretical landscapes, or landscape theorised' of the first paper of the volume, written by the two editors.

Furthermore, from a philosophical aspect, the real impetus propelling this transition is people's changing perception of artwork. As we know, it is one of the main topics that existentialism 'takes care of'[3], e.g. Martin Heidegger gave the first chapter of his collection *Holzwege* to the discussion about 'the origin of the work of art'. In Heidegger's philosophy, two concepts are the most fundamental: being-there (*Dasein*) and world (*Welt*). The world consists of all the beings that *Dasein* encountered in the 'aroundness' (*das Umhafte*). Heidegger called these beings *Dinge* (things), or in particular those encountered in taking care of *Zeug* (useful things or equipment) (Heidegger 1996: 64). As he proposed, a *Zeug* has two primary states in association with *Dasein*, following the law of contradiction: *Vorhandenheit* (ready-to-hand) or *Zuhandenheit* (present-at-hand). When a *Zeug* is *Vorhanden*, it is a static object in *Dasein*'s contemplation, i.e. it belongs to the 'aroundness' and keeps its distance from *Dasein*. On the contrary, it becomes *Zuhanden* during the utilisation because *Dasein* will no longer be aware of its existence but subconsciously feel as if it is a naturally extended part of his/herself when he/she uses it. In other words, useful things are either *Vorhanden* or *Zuhanden* associated with *Dasein*, but they cannot be both simultaneously. However, the case of work of art is quite different, for 'art, considered in its own nature, has nothing to do with the useful' — it is pure 'vision or intuition' and, an 'artistic intuition' is always 'lyrical intuition', derived from the impulsion of life

3 Here we use this phrase in the phenomenological sense. See sections 67–76 in Martin Heidegger's *Sein und Zeit* (*Being and time*) for more information about '*Besorge*' (taking care of things).

(Croce 1921: 11, 32). This peculiarity makes it neither completely *Vorhanden* nor *Zuhanden*. The truth is that it plays a *Zuhanden* role at the *Vorhanden* position, implying it belongs to *Dasein* and *Welt* synchronically, or perhaps, it is self-sufficient. Heidegger listed two essential traits that support the self-sufficiency of the 'work-being of a work': the setting up of a world and the setting forth of earth. 'Earth' (*Erde*) here can be considered as the 'signifier' of the external material part of the artwork on which the spiritual world is built, or the 'place' where the world emerges and withdraws, i.e. 'earth is that in which the arising of everything that arises is brought back — as, indeed, the very thing that it is — and sheltered' (Heidegger 2002: 21, 26). This is a more philosophical definition of the term 'landscape'. In the case of palaeoart, 'earth' refers to all the hidden information, such as belief systems, social organisation, lifestyle, economic structure, technological level, gender status and household.

Similarly, most of the papers in the mentioned volume focus on revealing the routes and relevant activities (e.g. trade, military affairs, pasture) hidden behind the spatial distribution of rock art sites. Rock art is visible, yet the 'earth'/'landscape' is hidden because they are no longer what they were, as Gernot Grube defined in the third paper of the volume, 'frozen gestures'; or as Heidegger stated, they are 'what we encountered; yet they themselves are what has been', and as what has been (*die Gewesenen*), they 'confront us within the realm of tradition and conservation' (Heidegger 2002: 20). In the phenomenological perspective, this change is the result of world-withdrawal and world-decay that occurred in the scale of Husserl's *inneren Zeit* (internal time). The well-known Italian art historian and critic Cesare Brandi used to describe this process as *tempo storico* (historical time) comprising two *momenti* (moments): the *durata* (duration) when the artist gave forms to the matter; the *attimo* (instant) when it is 'encountered' by the audience. Between the two moments, there is an *intervallo* (interval) representing the period from work fading out to re-entering the world of *Dasein* (Brandi 1992: 64). It is the *intervallo* that conceals the path to the 'earth' of works; thus the main task of rock art interpretation is to rebuild the connection between *durata* and *attimo* and to make the hidden truth or *realtà pura* (pure reality) 'flash at us' again, just like the authors of this volume did in their research. In this sense, the volume has displayed a thrilling and fascinating Heideggerian odyssey to rediscover the 'earth', i.e. the 'unconcealment of the work-being of the work'.

In recent years, related subjects like the psychology of iconicity and its decipherment, the distinction between mental and artistic representations, the relationships between ontogenic and phylogenic development of logic and symbolism, and the general utilisation of universals have received close attention. Undoubtedly, the most noticeable advances were the interpretation through scientific means, along with the significant achievements in palaeoart study and the attention to the constructs of the reality of early humans. Despite all this progress, the ultimate concern about the nature of rock art as 'work-being' always determines our attitude towards the discipline and keeps reshaping the basic epistemology and methodology - this is the most precious knowledge we can learn from this volume. Furthermore, it would also inspire us to ponder on the nature of the discipline in a more Heideggerian or Brandian style, i.e. the interpretation itself can be perceived as a *momento metodologico* (methodological moment) (Brandi 1979: 34) to reveal the truth of *In-der-Welt-sein* (being-in-the-world) through the work-being of the work of rock art, as a parallel approach with rock art science (objective), instead of the old ways of myth-making.

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RAR 41-1441

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