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SIMILARITY RECOGNITION AND INTERPRETATION OF TYPICAL GRAPHIC SYMBOLS IN DAMAIDI ROCK ART

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ABSTRACT

The rock art of Damaidi is a system of graphical symbols created by various northern nomadic peoples and tribes in the region. This study focuses on three typical graphic symbols frequently appearing in Damaidi

rock art: “”, “”, and “”. These symbols function similarly to oracle bone script in terms of pictographs and ideographs. By integrating computer pattern recognition technology with traditional methods in the study of rock art, the similarity recognition between typical rock art symbols and oracle bone script forms can break through the limitations of traditional interpretation, providing a new medium for the interpretation of rock art. This study also considers different rock arts with similar graphic symbols and their historical contexts to identify and interpret rock art symbols, exploring new methods and theories for rock art research. Furthermore, it aims to scientifically determine whether rock art symbols might represent an early form in the development of Chinese characters, providing evidence and clues for the study of the origins of Chinese civilization.

KEYWORDS

Damaidi Rock Art, Typical Graphic Symbols, Similarity Recognition, Interpretation

Before the invention of writing, rock art was the earliest evidence of human imagination and artistic creation, constituting a part of human heritage with the most universal significance (Emanuel, 2019). The rock art of Damaidi is a system of graphical symbols created by various northern nomadic peoples and tribes in the region. According to expert estimates and comprehensive dating, the early Damaidi rock art dates back to the mid to late Neolithic period. Damaidi is located in the desert of Zhongwei, Ningxia. To the west lies the vast Tengger Desert, while to the east, it forms a striking geographical contrast with the Helan Mountains. The Yellow River, making a turn here, flows northward alongside the Helan Mountains. Although the Damaidi rock art is related to the Helan Mountain rock art, it also constitutes an independent and unique rock art group.

Geographically, Damaidi is a basin-like mountainous area. From the late Neolithic period to the Bronze Age, this enclosed valley region had a humid climate with abundant water and lush vegetation. This environment was conducive to both hunters, who could easily catch

animals, and nomads, who could graze cattle, sheep, dogs, and horses. It was a paradise for many northern nomadic peoples and tribes, who created a large number of rock art pieces here.

1. ORIGINS OF THE STUDY

Digital humanities represent the intersection and integration of humanities and technology theories and methods. Applying digital humanities to the inheritance and protection of rock art can undoubtedly open up a new path for its preservation and study. In this field, South Africa and Sweden have been at the forefront. South Africa boasts the world's largest rock art cultural heritage database, the South African Rock Art Digital Archive. The establishment of the Swedish Rock Art Research Archive has made the Scandinavian Peninsula the core area for rock art research in Western Europe. Under the impetus of digital recognition technology, rock art research has ushered in different developmental directions and broader possibilities, one of which is the

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They have successfully recorded and identified some rock art images that are difficult to recognize with the naked eye using digital automatic recognition technology, achieving remarkable results. In China, it was not until 2016 that scholars in the field of pattern recognition and image processing proposed an algorithm based on bilateral filtering to enhance colored images of rock art, marking the initial attempts at the digital recognition of rock art images.

Since the discovery of a large number of rock art graphic symbols, there has been ongoing debate about whether these symbols represent the pictorial stage of the origin of Chinese characters. Due to the limitations of technology and human resources, research on rock art graphic symbols has been confined to case studies and has not yet expanded into large-scale, comprehensive systematic research. As noted by the renowned rock art expert Robert G. Bednarik, "We can only play the role of humans in our current society; we cannot comprehend the conceptual world of people thousands of years ago—even though this is all archaeology" (Robert and Bednarik, 2016). The goal of this research is to use digital recognition to find clues to the relationship between rock art graphic symbols and the heritage of Chinese characters, while also revealing the mysteries of the origin and evolution of Chinese characters.

Additionally, while there has been substantial research on the interpretation and elucidation of rock art content, there has been relatively little study on the interpretation and elucidation of individual symbols in rock art. Understanding the interpretation and elucidation of rock art can provide insights into the social life of primitive humans. The 21st-century information technology has brought tremendous transformation and vitality to various fields. Introducing image comparison and recognition technology from the computer field into the study of rock art will bring new discoveries to the interpretation of rock art content and symbols. Among the graphic symbols created by the nomadic peoples of Damaidi, one can still feel the rhythms of nature, history, knowledge, and life today. Sunlight and water in the natural world are indispensable conditions for the survival and reproduction of life, and these were most perceived by the ancestors. Livestock and hunting were the most basic ways of life, and the tools used by the ancestors played an important role. The perception of nature and the desire for food led to the frequent appearance of symbols representing the sun, water, and essential tools in the Damaidi rock art.

The three symbols "☉", "☁", and "☪" are frequently seen in Damaidi rock art. These symbols are typical and representative of the graphic symbols in the rock art.

2. GRAPHIC SYMBOLS OF NOMADIC PETROGLYPHS IN DAMAIDI

The Damaidi rock art is widely distributed across numerous mountain ridges and cliffs, resembling waves surging and crashing, with an unbroken array of fascinating rock art pieces of various sizes. These artworks often extend for hundreds to nearly a thousand meters in length. In densely concentrated areas, almost every rock bears rock art, and many of these artworks overlap or break into each other. The sheer number, vast scale, rich content, and dense distribution of these rock art zones are truly exceptional. These graphic symbols in the rock art reflect the cultural memory of the nomadic peoples, vividly portraying the prehistoric populations' reflections on the real world and their imaginations of the unknown, among other aspects of their spiritual outlook (Wei et al., 2023).

The Damaidi rock art contains a vast number of pictographic and abstract symbols. Although their phonetic functions are not yet understood, research has shown that these symbols already possess functions of pictographs, ideographs, and associative compounds, which are similar to those of the early oracle bone script in Chinese characters. Thus, it can be said that the symbols in Damaidi rock art exhibit some characteristics of the pictographic Chinese characters.

While studying and interpreting the graphic symbols of Damaidi rock art, comparing them with oracle bone script may yield unexpected results. Traditional methods of interpreting rock art are often limited by subjective assumptions, thus requiring an objective medium. Oracle bone script, known to be the oldest form of Chinese writing dating back about four thousand years, retains clear traces of its original pictographic nature,

making it closer to pictures and suitable as a reference for studying rock art symbols.

Through recognition technology and similarity calculations, if the rock art symbols show a high degree of similarity to oracle bone script and are frequently and consistently used in certain contexts to represent specific meanings, these symbols can be termed as rock art graphic-character symbols. (Shu et al., 2022). There are some typical graphic symbols in Damaidi rock art that often form a system with other rock art images. Interpreting these symbols is of great significance for unraveling the mysteries of rock art.

To date, the ancient form of Chinese characters known as oracle bone script, like the world's oldest discovered scripts such as Egyptian hieroglyphs and Sumerian cuneiform, has not revealed any earlier origins in its evolutionary process. The Chinese language and characters, which the Chinese nation has consistently used, inherited the characteristics of oracle bone script. Based on basic Chinese characters primarily pictographic, they evolved towards compound characters and developed associative compounds, ideographs, and phonograms. Before the emergence of oracle bone script, what did human civilization rely on to record and express information during the pictographic symbol stage?

Academically, it is widely believed that the early period of Damaidi rock art roughly corresponds to the mid to late Neolithic period to the Bronze Age, just before the emergence of oracle bone script. This period fills the gap in the pictorial form of writing that preceded oracle bone script. The introduction of the digital humanities concept has undoubtedly brought new prospects to the comparative recognition research between rock art symbols and oracle bone script. Computer pattern recognition technology overcomes the subjective limitations of comparative recognition, making the interpretation of rock art symbols more objective.

3. PATHWAYS FOR RECOGNIZING THE SIMILARITY BETWEEN ROCK ART SYMBOLS AND ORACLE BONE SCRIPT

In the current research on rock art, interpreting the meanings of abstract rock art symbols remains a challenging issue. Finding similar rock art symbols in different sites is a time-consuming and labor-intensive task. Introducing database construction and computer comparison recognition algorithms into rock art research is a new attempt. Due to the long-term natural damage to rock art, computers have difficulty recognizing specific information from rock art photographs. However, archaeological line drawings can use simple lines to depict the shapes and structural features of rock art, so this paper uses archaeological line drawings of rock art as the object for similarity recognition.

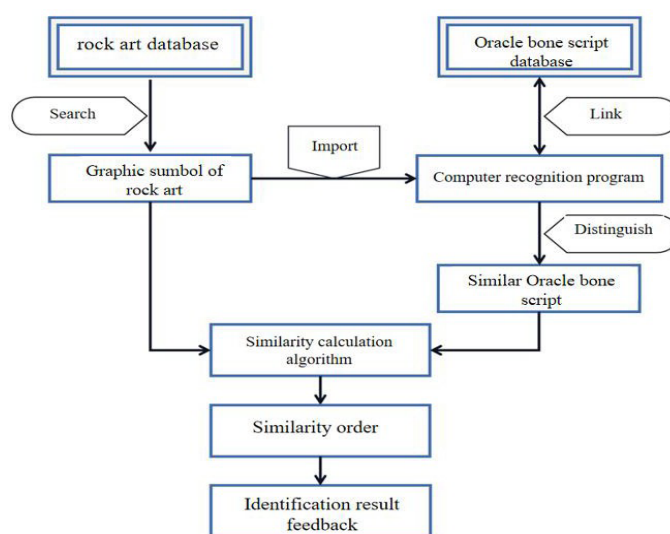


Figure 1: Roadmap for similarity recognition

Image recognition technology and image similarity comparison technology have been approaching maturity. Using these technologies to compare and identify abstract rock art symbols with oracle bone script can reveal the oracle bone script characters most similar to the rock art symbols. Oracle bone script is the oldest known Chinese writing system, and each character has a corresponding modern Chinese character. Chinese characters originated from pictographs or are based on pictographs, and each character has a unique interpretation. These interpretations can be used as a basis for deciphering rock art symbols. By integrating different rock art sites with similar symbols and considering their historical contexts, we can judge and interpret the Damaidi rock art symbols. The comparison between Damaidi rock art symbols and oracle bone script characters is shown in Figure 1.

3.1 Roadmap Introduction

Obviously, the first step is to establish a rock art database and oracle bone script database. This is the premise and basis for the comparison and recognition. On this basis, the contents and functions of these database will be further expanded and the original data materials will be retained. The Helan Mountain Petroglyph Database already includes clear images, line drawings, as well as relevant data and information such as the collection sites, the staged production methods and the collectors of the Helan Mountain rock art and the Damaidi rock art in the north of Helan mountain. In addition, searching and filtering functions have been added to the database, covering a variety of topics such as rock paintings of people riding, rock paintings of human faces, animal rock paintings, rock paintings of production and life, and rock painting symbols. The database of ancient scripts was established to include recognised oracle bones. These oracle bones include all variant glyphs of each glyph. To ensure the accuracy of the glyphs, these glyphs will be recorded in the form of original topographies to avoid distortion of the glyphs. In addition, a sub-glyph database will be set up in the database to facilitate users to retrieve a specific character and all its variant glyphs at one time. These expansions and improvements will make the rock art database and the oracle bone script database an important tool for researchers to compare and identify symbols. The establishment of these databases will not only help in the in-depth study of petroglyphs and oracle bones, but also provide researchers with more references and resources.

The second is that graphic symbols of rock art are retrieved from the rock art database, and then imported into comparison and recognition program in the computer. Similar graphic symbols of rock art in different pictures of rock art usually present the characteristics of untidy arrangement, inconsistent size and inconsistent direction. To cope with these problems, commonly used image feature extraction algorithms include SIFT algorithm, SURF algorithm, FAST algorithm and ORB algorithm. In this study, ORB-based image feature extraction algorithm is used, which is able to extract local features of petroglyph images and has invariance to the size, scale scaling and rotation of the pictures. With the ORB-based image feature extraction algorithm, the number of petroglyph images containing similar symbols can be counted, and their frequency of occurrence can subsequently be analysed for researchers' reference. Such an analysis can reveal the importance and universality of different rock painting graphic symbols in rock painting art, and provide support for further research on the cultural meanings, production backgrounds and evolutionary trends of rock painting graphic symbols.

The third is to find pictures of oracle bone glyphs with similar characteristics in the oracle bone database. These pictures will be used for similarity calculation with the imported pictures of petroglyph symbols. The similarity calculation procedure uses five traditional methods for comparing pictures in the computer field, including aHash, dHash, pHash, and Three histogram algorithm and Histogram algorithm for single channel. These five algorithms have different principles and generate different similarity results. In order to produce more accurate results, the weighted average of these five algorithms is used as the overall similarity metric by assigning different weights to the algorithms and the results are sorted in descending order. Ultimately, the comparative identification results and similarity calculations were fed back to the researchers in order to explore the relationship between graphic symbols in rock paintings and the origin of Chinese characters. Through this analysis, more in-depth understanding of the connection between the two and references for researchers can be provided.

3.2 Introduction to the Use of Algorithms

The first point to note is the recognition algorithm.

ORB (Oriented FAST and Rotated BRIEF) algorithm is a computer vision algorithm for image feature extraction and description. It combines the advantages of FAST (Features from Accelerated Segment Test) keypoint detection algorithm and BRIEF (Binary Robust Independent Elementary Features) descriptor subalgorithm, and improvements have been made. Firstly, the ORB algorithm uses the FAST algorithm to detect keypoints in an image. The FAST algorithm is an efficient corner detection algorithm that finds corner points with significant variations by performing a fast feature detection on the brightness of the pixel points. Compared to other corner point detection algorithms, FAST algorithm is faster and suitable for real-time applications. Next, the ORB algorithm describes the detected keypoints by means of the BRIEF descriptor, a binary feature descriptor algorithm that works by selecting a set of binarised pixel pairs in the region around the keypoints and encoding them as a binary string. This binary descriptor has the characteristics of fast computation and efficient storage.

The BRIEF algorithm is more sensitive to scale, rotation and illumination changes in the image, therefore to improve the robustness and reliability of the ORB algorithm, it introduces rotation and scale invariance. The ORB algorithm uses the angular information of the keypoints to rotate the pixels around the keypoints in order to make the descriptors invariant to rotation changes. In addition, the ORB algorithm employs a pyramidal scale space to deal with the scale changes of images, which improves the robustness of the algorithm.

In the symbol recognition task, a database of rock art symbols is first constructed, which contains images of different symbols and the corresponding labels. Then, for the rock art symbol images to be recognised, their feature descriptors are first extracted using the ORB algorithm and recorded. Next, the symbols that are most similar to the features of the symbol images to be recognised are found by feature matching with the symbol images in the database. Finally, the symbols are classified and recognised based on the matching results.

To summarise, the ORB algorithm extracts feature information from rock art images by using the FAST keypoint detector and the BRIEF descriptor, and introduces rotational invariance to enhance the robustness of the algorithm. By matching the features with the symbol images in the database, the ORB algorithm can achieve the automated recognition of petroglyph symbols, providing a powerful tool for petroglyph research and conservation.

The second point to note is similarity matching algorithm.

Hash Algorithm: Arbitrary length binary values obtained by the hash algorithm are mapped to shorter fixed length binary values, i.e., hash values. Hash algorithm is a function that can convert almost any digital file into a string of numbers and letters constitute a seemingly garbled string to the picture. A fingerprint in the format of such a string is generated based on the image, the more similar the fingerprints of the two pictures are, the more similar the two pictures are. Mean hash is essentially a comparison of colours; perceptual hash is essentially a comparison of frequencies due to the DCT operation; difference hash is essentially a gradient based perceptual hash algorithm.

Histogram Algorithm: The histogram algorithm groups the pixel values in an image according to a certain range and counts the proportion of each pixel value to form a histogram. When calculating the histogram, the pixel values can be divided into several intervals. For example, the grey value 0~255 is divided into 10 intervals etc, and the number of pixels contained in each interval is the height of the interval. By comparing the histograms of two images, the degree of difference between them can be calculated. The single-channel histogram algorithm groups the pixel values of an image according to the grey values and counts the proportion of each grey value to form a grey histogram. It works well for the similarity calculation of black and white images. The three-channel histogram algorithm is to group the three colour channels of a colour image according to the grey values, count the proportion of each grey

value in each colour channel, and form a three-channel histogram. It can better reflect the colour information in the colour image.

The similarity obtained from the hash algorithm and the histogram algorithm is evaluated in a comprehensive manner. Different weights are given to the two algorithms according to practical needs, and then the weighted average is calculated to get the final similarity score. The comprehensive similarity assessment takes into account the contributions of the hash algorithm and the histogram algorithm in similarity matching, giving a more comprehensive and accurate similarity measurement result for the comparison between the rock art symbols and the oracle bones.

4. RECOGNITION AND INTERPRETATION OF THE SYMBOLS “” AND “”

In prehistoric times, the sun, just as it does today, shone upon the earth, providing life to all things. To ancient people, the sun was a radiant, illuminating entity that could light up everything and was personified as a deity. The sun brought them light and energy, making it an inseparable part of their lives. Typically, the sun was depicted as a round entity, unlike the moon, which changes shape. When depicting the sun, a circle was often drawn—sometimes solid, sometimes hollow, and sometimes with rays. This veneration of the sun led to the frequent appearance of the circular symbol with a dot, “”, in Damaidi rock art, making it one of the most representative and typical symbols.

Using the common rock art symbol “” from Damaidi as an example, we apply recognition algorithms to find the most similar oracle bone script characters, followed by similarity calculations. The results are then sorted in descending order of similarity. The findings are presented in Table 1.

In the Damaidi rock art, there are many symbols similar to “”. Here, we only present the similarity calculation results for “”. The symbol “” in Damaidi rock art closely resembles the sun in reality, making it more appropriate to refer to it as the “sun” symbol.

We compare the rock art symbol “sun” with the oracle bone script character “日” (rì). The comparison reveals a high degree of similarity. The symbol “sun” frequently appears in Damaidi rock art, indicating its representative significance.

The character “日” (rì) is a common Chinese character, first appearing during the Shang Dynasty. In ancient times, there was no term for “sun”; “日” itself represented the sun. The alternation of day and night is a natural phenomenon caused by the Earth’s rotation, a fact well known to modern people. Although ancient people did not understand the reason for day and night changes, they were aware of the sun rising in the east and setting in the west. Many characters with the radical “日” are related to the

sun or time, such as 时 (time), 晖 (brightness), 景 (scenery), 晴 (sunny), 明 (bright), 暗 (dark), 晦 (nightfall), 旦 (dawn), 暮 (dusk), 昏 (twilight), 晓 (dawn), 春 (spring), and 晨 (morning). “日” is one of the earliest pictographs, representing the sun.

Figure 2 shows the evolution of the character “日” from a pictographic image to an abstract character symbol.

Whether it is the rock art symbol “日” or the different forms of the character “日” during its evolution in Chinese script, their striking similarity indicates that ancient human thought was rich with primitive graphic cultural information.

In the Damaidi rock art, the symbol “” also frequently appears as an independent figure. The “” symbol in Damaidi rock art closely resembles the shape of flowing water in reality, making it more appropriate to refer to it as “water.” Water has played a crucial role in the evolution of life. Humans recognized the importance of water very early on, and in both ancient Eastern and Western materialistic views, water was considered a fundamental element.

In Table 2, the rock art symbol “” is compared with oracle bone script characters. The similarity calculations are conducted and ranked in descending order of similarity. The weighted average of the similarity scores from five different algorithms is calculated, with weights assigned based on the characteristics of each algorithm. The results are shown in Table 2.

Through calculations, the Damaidi rock art symbol “” and the

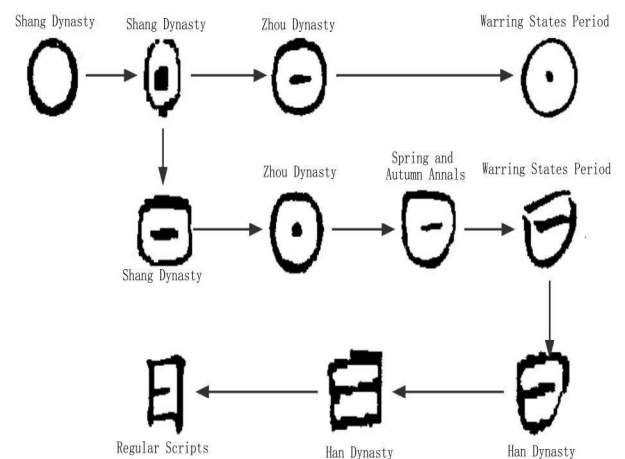


Figure 2: The Evolution of the Character “日” (Li, 2013)

Table 1: Recognition and Similarity Calculation Results for Symbol “”^{1,2}

Graphic symbols of rock art	Oracle bone script	Origin of oracle bone script	Similarity ranking	Oracle bone script correspond to Chinese character
		合 27338	1	日
		合 27548	2	日
		合 33694	3	日

Table 2: Recognition and Similarity Calculation Results for Symbol “”

Graphic symbols of rock art	Oracle bone script	Origin of oracle bone script	Similarity ranking	Oracle bone script correspond to Chinese character
		合 20615	1	水
		合 22288	2	水
		合 33356	3	水

oracle bone script character “” have a high degree of similarity. As an ideographic symbol, the “water” symbol in rock art and the oracle bone script “水” both exhibit the earliest characteristics of pictographs. These symbols were frequently used in fixed contexts and were widely recognized by ancient peoples.

Ancient humans, based on their reverence for water, regarded it as the indispensable source of life for all living things on earth. They used rock art symbols to record the use of water in daily life and production activities, making it a graphical imprint before the advent of written language.

5. RECOGNITION AND INTERPRETATION OF THE SYMBOL “”

The primitive tribes and nomadic peoples living in Damaidi primarily engaged in hunting and animal husbandry, both of which depended on animals. The Damaidi rock art features many depictions of wild animals and domesticated livestock, with sheep being the most frequently depicted animal. Sheep were the most common food and sacrificial item for ancient people, serving as the primary resources for production and daily life for the nomadic peoples. Sheep became central to the lives of ancient people.

Any of the sheep rock art images are accompanied by the symbol “”. Given the specific nature of rock art creation, the appearance of the “” symbol is unlikely to be a coincidence. The renowned British iconographer E. H. Gombrich once said in his book “The Sense of Order”: “Nothing is more fascinating than mysterious symbols whose meanings have been forgotten. Who can explain the wisdom of the ancients contained in these incredible shapes and forms?” (Gombrich.2000)

By comparing the vertical hook-like symbol “” in rock art with oracle bone script characters and calculating their similarity, the results are ranked in descending order of similarity. The findings are presented in Table 3.

As seen in Table 3, the oracle bone script character with the highest similarity is “”, followed by “”, and then “”. All three oracle bone script characters correspond to the modern Chinese character “”. According to the modern Chinese dictionary, “” is pronounced jué in modern Chinese and means “hook” or “vertical hook”. In the “Shuowen Jiezi”, it is defined as “逆者謂之。象形。凡之屬皆从。讀若槩。衢月切。” (Xu,1963) “” is a tool with a hook. Considering the historical context of the rock art, the rock art symbol similar to “”, “”, can be interpreted as a vertical hook-like herding tool. Herding tools can be used to tame or drive animals. Whether this interpretation is reasonable should be analyzed based on the actual content of the rock art.

The “” symbol appears in rock art with simple compositions. The first three rock art pieces in Figure 3 are very similar, each consisting of two sheep and a vertical hook-like symbol. These can be interpreted as follows: the two sheep represent a flock, and the tool symbol indicates the use of a tool. Although there are no humans depicted in the scene, the tools were used by ancient people. Therefore, these three rock art pieces depict scenes of humans taming or driving a flock of sheep. In the lower right corner of Figure 3, the rock art depicts a different animal instead of sheep. Although the exact species of the animal is unknown, the vertical hook-like symbol is still present near the animal’s tail. Even though this symbol is a horizontally flipped version of “”, it still depicts the action of driving or taming the animal.

Table 3: Recognition and Similarity Calculation Results for Symbol “”³

Graphic symbols of rock art	Oracle bone script	Origin of oracle bone script	Similarity ranking	Oracle bone script correspond to Chinese character
		合 9669 白	1	
		懷 1636	2	
		合 17612	3	

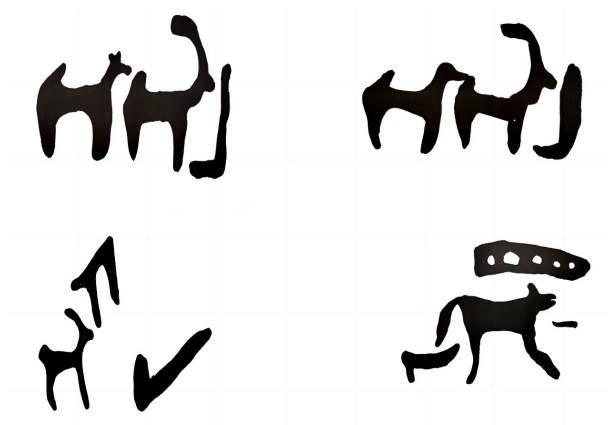


Figure 3: Rock Art Depictions of “J” and Animals



Figure 4: “J” Rock Art



Figure 5: “Nomadic Style” Rock Art and Modern Herding Scene

In Figure 4, Both rock art pieces are composed of a human, sheep, and a vertical hook-like symbol. In the left side of Figure 4, the human and the rotated vertical hook tool appear on the left, with two sheep facing the human, as if the person is taming the sheep. In the right side of Figure 4, a vertical hook tool is depicted between the human on the left and the sheep on the right, with the sheep facing away from the human, depicting the act of driving the sheep. The human is the user of the tool, and their interaction with the tool shows its purposeful use. The combination of humans, sheep, and the vertical hook-like symbol makes the interpretation of the “J” rock art symbol as a herding tool more reasonable.

The “J” shaped rock art symbol also appears in large-scale rock art. In the lower half of the rock art in Figure 5, a person is depicted riding a horse with sheep following behind. In the upper half of the rock art, the person is shown holding a horizontally flipped vertical hook-like tool symbol, seemingly driving the sheep. The overall scene depicted in the rock art suggests that the vertical hook-like symbol is undoubtedly a herding tool, consistent with previous interpretations. The person rides a horse leading the lead sheep forward, with a companion holding the tool driving the sheep from behind. This scene closely resembles familiar herding activities. As a metaphysical symbol system, it embodies human spirit and will, serving as a way for people to produce and understand the world extensively (Bai and Yang, 2023). It is through the ancient ancestors' carvings on rocks that we can experience their colorful herding life and rich nomadic culture.

Other “J” rock art symbols will not be displayed one by one. Through the example analyses, it is evident that interpreting “J” as a tool in

its rock art scenes is highly appropriate. This interpretation strongly supports the notion that “J” is a vertical hook-like herding tool.

6. CONCLUSION

The frequent appearance of typical rock art symbols in Damaidi rock art most accurately reflects the geographical environment of the nomadic peoples. Their worship of nature and human reproduction is the most basic and direct expression of their life. In ancient societies, the occurrence of wind, rain, thunder, and lightning was seen as divine punishment, while the appearance of the sun symbolized a day of stability. The ancient people's respect for the sun is represented by the symbol “☉”. The symbol “☼” reflects the ancient people's need for water, an indispensable natural resource for humanity. Tools were also essential in the daily life and production of ancient people. Whether the symbol “J” represented a tool for slaughtering or a tool used by nomadic peoples for herding, it is faithfully recorded on the rocks of Damaidi.

Using computer pattern recognition technology to compare rock art symbols with oracle bone script is feasible, but the results cannot directly serve as the basis for determining the meanings of rock art symbols. While there is a high degree of similarity between rock art symbols and oracle bone script, concluding that the rock art symbols “☉”, “☼”, and “J” correspond to the modern Chinese characters “日”, “水”, and “J” still requires further evidence.

Undoubtedly, the combination of computer pattern recognition technology with traditional methods in comparing typical rock art symbols with oracle bone script increases the scientific accuracy of

rock art interpretation. This approach represents the latest methods and trends in rock art research and provides a potential insight into the origins of Chinese characters. If it can be scientifically confirmed that rock art symbols are one of the possible early forms of Chinese writing, this research will significantly contribute to the study of the early origins of civilization in China and the world.

ANNOTATION

Note 1: “合”, from the Collection of Oracle and Bone scripts edited by Guo Moruo, Beijing: Zhonghua Book Company, 1978-1983 edition.

Note 2: The numbers in the column of Oracle Origin are from the Dictionary of Common Characters of Oracle and Bone scripts, edited by Liu Zhao and Feng Kejian, Beijing: Zhonghua Book Company, 2019 edition.

Note 3: “懷”, from Writings on Oracle and Bone scripts Collected by White's, written by Xu Jinxiong, Royal Ontario Museum, Canada.

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