

# Quantitative method on study of Mani heaps: the case study on color analysis of Mani heaps in Dingqing county, Tibet

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## Research article

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# Abstract

A Mani heap, as an important religious art, is piled up by hundreds of stones or slates carved with a lot of information about religion, culture, history, art and lifestyle of Tibetans. Mani heaps are scattered almost everywhere in Tibet and also become a significant way to understand Tibet and Tibetans. However, the study on Mani heaps appears relatively limited in scope so far not only in Tibet or even in the Himalaya area. In most of the existing studies, qualitative research is the main method to describe or explain Mani heaps which leads to subjective tendencies in somewhere. In this paper, we propose a quantitative method by digital processing the colors of 70 images of Mani heaps in Dingqing county. Compared with the previous related studies, the results are more accurate to reflect the color features of Mani heaps in Dingqing county. More importantly, this quantitative, digital processing way may become an effective research method to apply, verify, underpin or challenge the study on Mani heaps in Tibet or other Himalaya areas.

## Introduction

A Mani heap is a kind of altar mainly made of hundreds of stones and slates carved with Avalokiteśvara's six syllable mantra, excerpts from Buddhist sūtra texts, Buddhist deities, various Buddhist patterns, or portraits of religious figures used by Tibetans to perform pray and blessing ceremonies. In Tibetan area, Mani heaps are scattered almost everywhere in monasteries, beside villages, crossing, along paths, on mountains or rivers, and next to other scared places. Not like other types of religious Tibetan art, such as Thangka, murals, temple buildings, having rigid religious regulation in themes, forms and working process, Mani heaps have different colors and shapes that are made by local craftsmen who have more freedom and creativity in producing. Figure 1 shows the biggest Mani heap called Naicham in Dingqing county. this Mani heaps covers an area about 350 square meters, piled up with tens of thousands of different stone carvings by several generations of Tibetan.

### Ethics approval and consent to participate

Besi "Wind Horse" prayer flag[2], "tsa-tsas"[3], pagoda or any combination of these, offering a unique artistic landscape. Figure 2 shows a Mani heap decorated with "Wind Horse" prayer flags. In a sense, Mani heaps in Tibet constitute an essential component of the Tibet tradition, the religion, cultural heritage and the rural landscape. Religious, culture, history, lifestyles, and technology, as well as the diversity of Tibetan's anonymous aesthetic preference, are imprinted in the Mani heaps and their surrounding landscape. des the various carvings in Mani stones and the different shapes and sizes, Mani heaps are surrounded by the prayer wheel[1],

However, the study on Mani heaps appears relatively limited in scope. Mani heaps are considered to be the most popular yet least studied type of religious art in Tibet or even in the Himalaya area. "Despite being an integral part of the Himalayan landscape these monuments have not retained the attention of many Tibetologists. In fact, the scholarly literature devoted to the subject is surprisingly sparse" (Yannick Laurent 2017:231).

In the limited available literatures of Mani heaps, the qualitative approach is mainly employed to describe and illustrate them. Through the methods of interview, participatory and empirical observations, these studies help us to understand Mani heaps as a whole, especially on their characteristics, classification, formation and value. (Feng XH, Xiang JC, 2016) It's worth noting that the majority studies are mainly on the level of phenomenal introduction, narration and character analysis, and many of them are repetitive and not profound. (Feng XH, Xiang JC, 2016)

Obviously, only using the qualitative approach on the study of Mani heaps is not enough, especially considering the large number and wide scope of Mani heaps in Tibet. So, the quantitative and technical approach are tried to employ to investigate the color characteristic on Mani heaps of Dingqing county in Tibet in this paper. The research collected the data of 70 Mani heaps in Dingqing county by field investigation and image photographed, then digitally processed these data to extract the color features and quantified them to figure out the proportion of different color features in Mani heaps, finally analyzed the overall color feature preference of the 70 Mani heaps and based on the results to discuss the relationship between the color characteristic and environment, culture, religion of Mani heaps in Dingqing county. Based on this case study, the aim is that the quantitative nature of the results will eventually verify, underpin or challenge the qualitative observation made by previous studies, and more importantly, to conduct a new research perspective for the Mani heaps study.

## Background

### 1) Observations on Mani heaps by previous studies

Although Mani heaps were described by early traveling scholars in the Himalaya[4], (G.Tucci,1994) and widely photographed in the tourist literature, the scholarly literature on Mani heaps is amazing sparse. There have been only 25 scholarly literatures about Mani heaps in Chinese and 6 in English since 2019. Because of the geographically restricted, the Chinese researchers mainly focused on the Mani stones or heaps in Tibet. the first research paper was published under the title "*A Elementary Introduction to Carving on Mani Stone in Tibet*" in 1985. (Han SL, 1985) Since then, several researchers from different academic backgrounds (e.g. anthropologists, sociologists, geographers, historians, archaeologists and architects) have studied different aspects of the Mani heaps. These studies generally fall in three broad categories:

1. Studies on causes of the formation of Mani heaps. Almost every researcher has recognized the close relationship between the belief and the formation of Mani heaps. they believed the formation of Mani heaps originated from the original nature worship and animistic concept in Tibetan areas (Dun ZM, 2014, Suo NJ, 2019, Lin L,2005), and pointed out that the primitive people in Tibet believed every mountain had a god and they piled up stones to heaps for worship which are called "Laze"[5], (Dun ZM, 2014,Gesangyixi, 2011) and with the origination of Bon and the introduction of Buddhism and integration development of the two, the stone heaps gradually evolved into Mani heaps. (Mao JZ, 1987)

2. Studies on the form and function of Mani heaps. Most research on the form of Mani heaps has been concentrated on introducing the engraved content on stones of Mani heaps and briefly classified them into several types, such as texts (including Avalokitesvara's six syllable mantra and excerpts from sutra texts), portraits of religious figures (including Buddha, Bodhisattva, deities, eminent monks), religious symbols (including stupa, auspicious patterns and other symbols) and mundane images. Figure 3 shows the Mani stone carved with abundant religion elements, and figure 4 shows a dog carved on the Mani stone. As for the studies on Mani heaps' function, it is widely believed that Mani heaps are built mainly as religious altars (Buddhism and Bon), and also some of them have been used for landmark, landslide warning, signpost and so on. (Lin L,2005)
3. Studies of the value of Mani heaps. Mani heaps have very high value in research on religion, history, culture and art of Tibet. Firstly, as a kind of folk art, the Mani stone carving art has the significance of promoting social harmony, social enlightenment and psychological counseling. (Lv CX,2009) Secondly, as a kind of cultural heritage, Mani heaps provide a wealth of material for the study of Tibetan history, religion, culture and the relationship between Tibetan and Han. (Luo SKZ, 2010, Song WZ, 2012)

In general, these scholarly literatures in Chinese are principally using the method by introducing or describing a certain issue, which can help us to have an overall idea about Mani heaps of Tibet, but it may also make the discussed issues in these literature repetitive and recapitulative. (Feng XH, Xiang JC, 2016) Comparatively, in the few published literatures in English, the scholars' research is more creative and profound in some respect. Johannes T. Weidinger was interested in the Mani stone-walls in Nepal areas where mountain hazards such as torrent, debris flow and snow avalanche occur. By carefully observing the location of these structures and their geographical environment, he believed the Mani-walls erected not only to motivate by religious thinking and faith, but also to serve as indicators, silent witnesses and even to protect settlements and farmland from hazards (Weidinger,2002). John Ardussi, devoted to the Mani walls of Bhutan, defined the Mani walls as communication medium in the service of a religious and political project in his two specific articles (Ardussi 2004, 2006). According to John Ardussi, the appropriation of these monuments as public media began around the seventeenth century when religious hierarchs used stone inscriptions to promote and reaffirm religious values and secular law. Anthropologist Monia Chies has taken an active interest in the greatest Mani wall in the world—the Gyanak Mani in Qinghai, west China. Although the paper is mainly an account of ethnographic records which aims to highlight temporary cultural responses to the earthquake in 2010, the description about the place making process and geography of Gyanak Mani provide a well understanding about Mani heaps (Monia 2014). Yannick Laurent analyzed the unique corpus and text information on four Mani stone inscriptions from Spiti in Nepal and found out their content with full of historic information “stressed the importance of epigraphic documentation for the study of Tibet and the Himalayas and raises question about the nature and function of inscribed Mani stones.” He believed that “the study of stone inscriptions offers a vibrant testimony to lesser known aspects of Tibetan and Himalayan history.” (Yannick,2017)

It's worth noting that there is also a scientific paper by geologists and environmental scientists, which seems the administrative evidence for Weidinger's research by lichenometry. In this paper, the growth rate of *Rhizocarpon geographicum*, a lichen found on Mani walls in the Langtang Valley in Nepal was studied as a potential dating technique to confirm the age of Mani walls, which verified the hypothesis of Weidinger's view that the Mani walls were constructed as landslide warnings. It seems the first paper by using geological research method on Mani heaps' study. (Emmerman, S.H. et al. 2016) Although the result of this study appears relatively limited in scope, (Yannick, 2017) its analysis still not only offers a very useful complement to the traditional ethnographic fieldwork in Mani heaps, but also provides a transdisciplinary research perspective for us to study these monuments.

## **2) The need for a more quantitative approach to the case study of Mani heaps in Tibet**

Actually, exploring more in-depth research to Mani heaps in Tibet is not so easy, especially only using the qualitative empirical observations. The reason for this may be in two aspects, one is that the widespread Mani heaps and their dynamic styles make the complete collection of research data become difficult. Mani heaps are scattered over almost everywhere in Tibet and most of them are changing and growing all the time because the new carved Mani stones are being deposited on the top of heaps constantly with the Tibetan's praying. The other is that the extensive mass foundation and unplanned design for Mani heaps make the exploration become complex, especially based on qualitative empirical observations. A Mani heap is less likely finished by individual, its formation and growth is accumulated by different people including craftsmen, monks, donors, even villagers for years even centuries. Figure 5 shows a man is carving mantra on a Mani stone who is one of the craftsmen in Dingqing County. The long-time efforts from different participants make the Mani heaps amassed abundant information from the historic, social and religious circumstances and folk wisdom throughout years or centuries.

Therefore, only using the methods of interview and observation for research seemed insufficient, as Yannick Laurent said, "local informants interviewed in this regard, however, often presented differing views". (Yannick Laurent 2017) it is necessary to carry out multidisciplinary study and extend the research methods from other disciplines in studying (Feng XH, Xiang JC 2016). Given the qualitative empirical observation used in previous research, more quantitative approach should be considered or employed in the future study process. Obviously, the quantitative approach could be more objectivity, clarity and persuasion than qualitative method especially in analyzing the features, relationship and variation of the quantity. In view of the great number, the constant variation and the accumulated information of Mani heaps, emphasizing the combination of qualitative and quantitative approach to analyze Mani heaps seems more beneficial and in-depth.

Besides the quantitative approach, the 'case study' is also necessary for the in-depth study of Mani heaps, which the Six paper in English provide a useful reference. All these paper are focused on one aspect of Mani heaps, such as function, inscriptions, in specific locations, which make us have insight into the Mani heaps in these places. As we known, Tibet is so vast in territory that the number of Mani heaps is much large than the number of neighbor countries, like Bhutan, Nepal. Studies that analyze the

characteristics of Mani heaps from one place in a micro-cosmic view may give us a fresh perspective for Mani heaps research in Tibet.

In short, using more than one research method of different disciplines is more important to the in-depth research of Mani heaps in Tibet. The review of previous studies also demonstrates that the quantitative analysis of Mani heaps' characteristics has not yet been conducted in Tibet. Even internationally, few studies incorporate both quantitative study and case study in the analysis of Mani heaps.

In this paper, the research selects the color feature of Mani heap in Dingqing county as a study sample for better understanding of the relation between the color of Mani heaps and area. Compared with previous studies, the study is based on a lot of high resolution data of collected by field work about Mani heaps, and obtained the results through the data processing, and the method employed is the combination of quantitative analysis and qualitative analysis. Figure 6 shows the research areas in previous study in English and in this paper. Figure 7 shows the data collection of Mani heaps in Tibet from 2016-2019. More importantly, the study tries to propose a methodological framework that best adapts to the study of Mani heaps in Tibet.

### **3) A brief overview of Dingqing County**

The differences between the Mani heaps in Dingqing county and those in other areas of Tibet must be identified. Dingqing county is located in the east of the Tibetan Autonomous Region of Changdu. Figure 8 shows the geographical location of Dingqing county. Dingqing county also has long history and culture. In the folklore of Dingqing county, the ancient Khyung tribe moved from the west Zhang Zhung to the east, then the Khyungpo settled down in Dingqing area, where they spread their Bon[6] culture. In the 7<sup>th</sup> century, after the Buddhist introduced into Tibet from India, the competition between Bon and Buddhist become more and more intensive and lasted for more than 1300 years' struggle, the sphere of influence of Bon religion was dissipated and the turf in Tibet was almost disappeared except Dingqing county because of the special culture reasons and geographical location.(Cai TR, 2006) After more than 2000 years of development, Dingqing County has been gradually formed a characteristic tradition of Bon culture and now become one of the most concentrated Bon monasteries and believers in Tibetan areas of China and formed a very stable Bon culture circle.

Mani heaps are also very special in Dingqing county, as Ma LH said, "Tibet is the only place in world where the people are so keen to build Mani heaps, and in Tibet is Changdu city, and in Changdu is Dingqing county. We have never seen any other places where Tibetans like Dingqing have the passion for building Mani heaps." (Ma LH 1995) the distribution of Mani heaps is almost covered about 80% of Dingqing area and also is the densest area in Tibet. Figure 9 shows the shape of Dingqing county and the geographical distribution of Mani heaps in this place. Therefore, Mani heaps are such a common sight in Dingqing area that can be indirectly reflected the culture, religious, folk art and so on and studying the Mani heaps in this area may provide a micro sample for the deep research for other places of Tibet.

### **4) The Colors of Mani heaps**

“Color, as one of the most important dimensions of vision, plays a key role in place identity and people’s experience in the environment.” (Yang MH:2020) Colors of various buildings, structures and landscapes in one place or an area could not only provide both information and pleasure, but also, perhaps most importantly, communicate a cultural identity bound in history and tradition. As for Tibet, because of the influence of natural environment and the cultural and religious tradition, people tend to choose the high-saturated and purity colors, mainly blue, green, red, yellow, white and black to decorate their buildings, landscapes, costume, and artworks. (Shu JY.2013)

The main colors of Mani heaps are also about the six colors. However, Mani heaps is not like other religious art in Tibet, such as Tangka, murals, temple buildings, which need to observe the strict rules on coloring. On the basis of maintaining the basic rules and requirement of Buddhist painting, the craftsmen also have some freedom to follow their own aesthetic design to make the color of Mani heaps present visual harmony. (Luo SKZ, 2010) Accordingly, Relative freedom in producing make the prevailing color and the display order of six colors be quite different as for being affected by the different area, culture, religion and aesthetic. Figure 10 shows the different color on Mani heaps in different area. Therefore, in this paper, colors’ feature of Mani heaps in Dingqing county are investigated by analyzing the collected photo data, and through the color analysis and information visualization, the results show the aesthetic in color directly of the contemporary people living there, and reflect the relationship between the color characteristics on Mani heaps and cultural and religious tradition in Dingqing county.

## Methods

### Data collection and analysis

The color features of the Mani heaps are closely related to its function, environment, geographical distribution and local humanistic and religious factors. The analysis of the color proportion of Mani heaps can provide quantitative basis for the study of Mani stone heap history, culture and religion. In this paper, the image data of 70 Mani heaps in Dingqing, Tibet are collected by camera and the images are of high resolution and low noise, which can meet the requirements of data processing.

Considering the limited color quantity of Mani heaps and the complexity of its image data, the conventional image segmentation and extraction algorithm is difficult to effectively process the collected Mani heaps images. In order to obtain the color features of the Mani heaps, as shown in Figure 11, this paper divides and preprocesses the images of Mani heaps, and extracts the main color parts of Mani heaps respectively by Photoshop, so as to avoid the influence of photographing methods, environmental interference, external pollution and other factors on the color features of Mani heaps

Based on the image segmentation preprocessing result of the Mani stone pile, the color gamut space analysis of the Mani stone pile is carried out. This paper extracts the RGB three-channel color of the collected Mani heaps image, and obtains the color distribution of the Mani heaps sample in the RGB space by the the OpenCV library, as shown in Figure 11. And through the color gamut analysis of the

overall sample of the Mani heaps, the main colors of the Mani heaps are: red, black, green, yellow, blue, white, and gold.

In order to facilitate the feature comparison of the main colors of Mani heaps and simplify the data analysis process, combined with the color gamut space analysis of the Mani heaps, this paper converts the RGB image of Mani heaps from RGB space to HSV space. And the HSV threshold range of the main colors of the Mani stone pile is: white ([0,0,221] [180,30,255]), black ([0,0,0] [180,255,46]), red ([156,43, 46] [188,255,255]), green ([35,43,46] [77,255,255]), blue ([100,43,46][124,255,255]) yellow ([26,43,46] [34,255,255]), gold ([43,245,215] [53,255,245]). Figure 12 shows the RGB spatial distribution of the Mani heap in Figure 11.

According to the HSV threshold range of the main colors of the Mani heaps, this paper extracts the color features of the main colors of the Mani heaps, and performs data processing and analysis. The average percentage of the main colors of the Mani stone pile is shown in the figure 13.

## Results And Discussion

Obviously, the analysis results indicate that red, blue and yellow are three main colors painted on Mani heaps in Dingqing county. In comparison with the qualitative observation about color made by previous studies, the results may verify, underpin or challenge from these aspects:

1. Red is the most common color on Mani heaps in Dingqing county, followed by yellow and blue, and the proportion of yellow is slightly more than blue. It is clearly shows that the Tibetans choose the three colors as their main color is affected by their religion. As we known, Dingqing county is not only the center of Bon religion, but also have other sects of Buddhism in here. In previous study, the researchers believe that in the belief of original Bon religion, the white, red and blue is used to represent heaven, man's world and earth respectively. (Yue Y,2013) So the white, red and blue are the top three colors to the original Bon religion. However, after the Buddhism entered Tibet, the top three colors are white, red and yellow in the belief of Buddhism. (Wang KG, 2011, Xu B, 2015) Compared the main colors of the two religion, red is retained as the primary color which is shared by Bon and Buddhism, meanwhile, yellow is absorbed from Buddhism belief, and blue is persisted by people in Dingqing county because of their dominant religion—Bon religion in this place.
2. Black is the fourth most popular color. This analysis result is very interesting. Through the interviews with Bon monks and local Bon believers in Dingqing county, they believe that black is not a holy color, and very resent that Buddhists call their religion as black religion. However, some literatures show that black is the holy color in the original Bon religion. (Xu B, 2015, XiaZ. ZXJZ,2000) the reason may be that black is regarded as evil and inauspicious in Buddhism, and as the Buddhism introduced to Tibet, the Buddhists used it to describe the Bon believers in order to squash them. After the long time fight between these two religion and accompanied by the decline of Bon, the Bon

monks and believers also accept that black is not a holy color. whereas, even if the black is not an unwelcomed color, the people unconsciously follow the signification of black in the original Bon to apply it on Mani heaps.

3. White is less than black. No doubt white is the holy color both in Bon and Buddhism, and according to the introduction from previous study, the white is brushed on the Mani stones as the background color before painted other colors (Wang D,2018). However, from the proportion of white on Mani heaps in Dingqing county, this painting process has not been fully used. This analysis result is quite different from the previous research results, and further research is needed.
4. Gold and yellow are distinguished in this color analysis. Gold does not account for much, which may be related to the high price of gold pigments, or may be the color that gold can only be used by dignitaries. Usually, only famous ashtrays and important temples are use gold to decorate their roofs. Therefore, the folk craftsmen are more discreet when painting on Mani heaps.
5. Green has the least proportion. This may be related to the growth of green grass around the Mani heaps, too much green application on Mani heaps is not easy to make the Mani heaps stand out from its surroundings.

## Conclusions

In this article, a quantitative, digital process to analysis the colors order on Mani heaps in a county is proposed. This new process provides several objective evidence that are short of when using the traditional process, which involves the subjectivity of observers and local interviewers. The related previous researches in China are still not deep enough which only rely on the investigation and interview, although these methods are very important for the study of Mani heaps in Tibet. Through the digital processing for 70 images of Mani heaps, this paper is clearly present the ratio of colors on Mani heaps in Dingqing county. And also compared the data analysis results with previous studies, this paper verifies, underpin or challenge some conclusions made by previous studies. So this paper is of great significance for next similar studies, both in theory an in practice.

There are also some limitations in this paper. Firstly, the study only provides visualized and quantitative evidence that the basic colors are used on the Mani heaps in Ding Qing county and it does not confirm whether the selection of color was the results of conscious and well-planned actions or more spontaneous actions. Future studies could take a more interdisciplinary approach by combining data visualization analysis with cultural history and socio-geographical studies to better support the examined arguments.

Secondly, the study examines the color of Mani heaps in Ding Qing county, which is at the microscale; thus, its scope is limited. So, there is now a need for undated systematic study on the Mani heaps of the whole Tibet that, ideally, should be guided by a framework of state-of-the-art methods in multiscale surveying, documentation and environment analysis. Such study would ideally not only limit itself to the

documentation of studying on the Mani heap, but should further expand into translating the analytical findings of the Mani heaps into contemporary design strategies for digital visualizing the Mani heaps.

## Declarations

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### Authors' contributions

ZJP was involved in the sample analysis, interpretation and writing part of manuscript. HS was a major contributor in the data collected, sample analysis, writing part of manuscript and revision. DP, FYZ and JY were involved in the initial concept of the experiments and data processed in this paper. All authors read and approved the final manuscript.

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### Competing interests

The authors declare that they have no competing interests.

### Availability of data and materials

Not applicable

### Ethics approval and consent to participate

The paper presented is the work made by our independent research. All data cited in the paper were from publicly available datasets and published literatures. In addition to the content of particular reference, this paper does not contain any work that has been published or written by any other individual or group. Individuals, who have made important contributions to the study of this paper, have been clearly demonstrated in the acknowledgements.

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## Figures



**Figure 1**

The Naicham Mani heap in Dingqing county



Figure 2

Mani heap hanged with "Wind Horse" prayer flags in Dingqing county



Figure 3

A Mani stone caved with Bodhisattva, stupa, candlestick for the Buddha, fish symbols and so on.



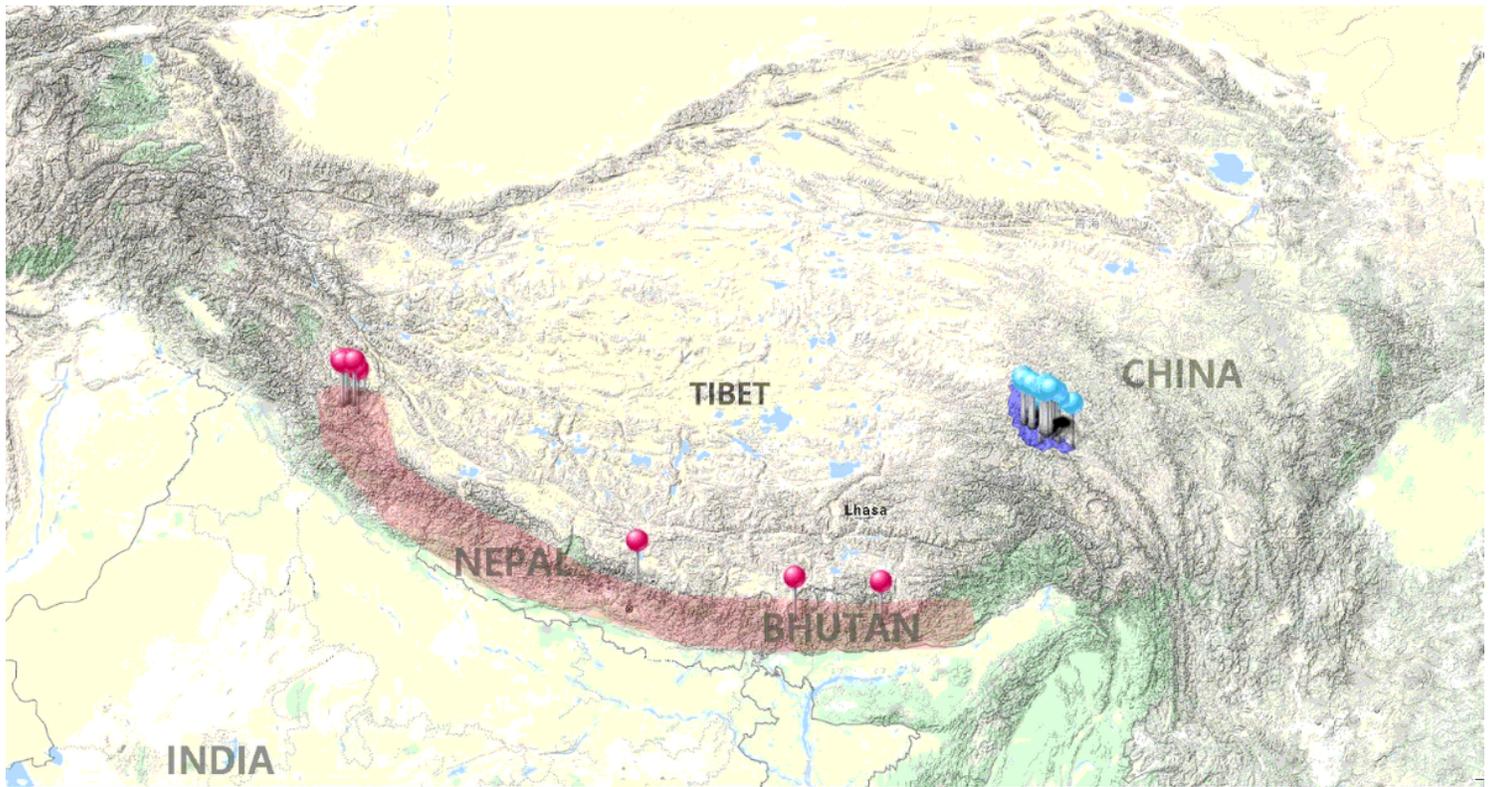
Figure 4

A Mani stone caved with mantra, a dog and a candlestick for the Buddha.



**Figure 5**

A Craftsman is carving and coloring mantra on a Mani stone in Dingqing county, Tibet.



**Figure 6**

The red points are the research places in the previous studies in English, the blue points are the research areas in this paper. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

Form of Data Collection					
	Picture	360 degree panorama image	vedio	Aerial photo	Interviewee
number	58517	1733	5h43min	96	84

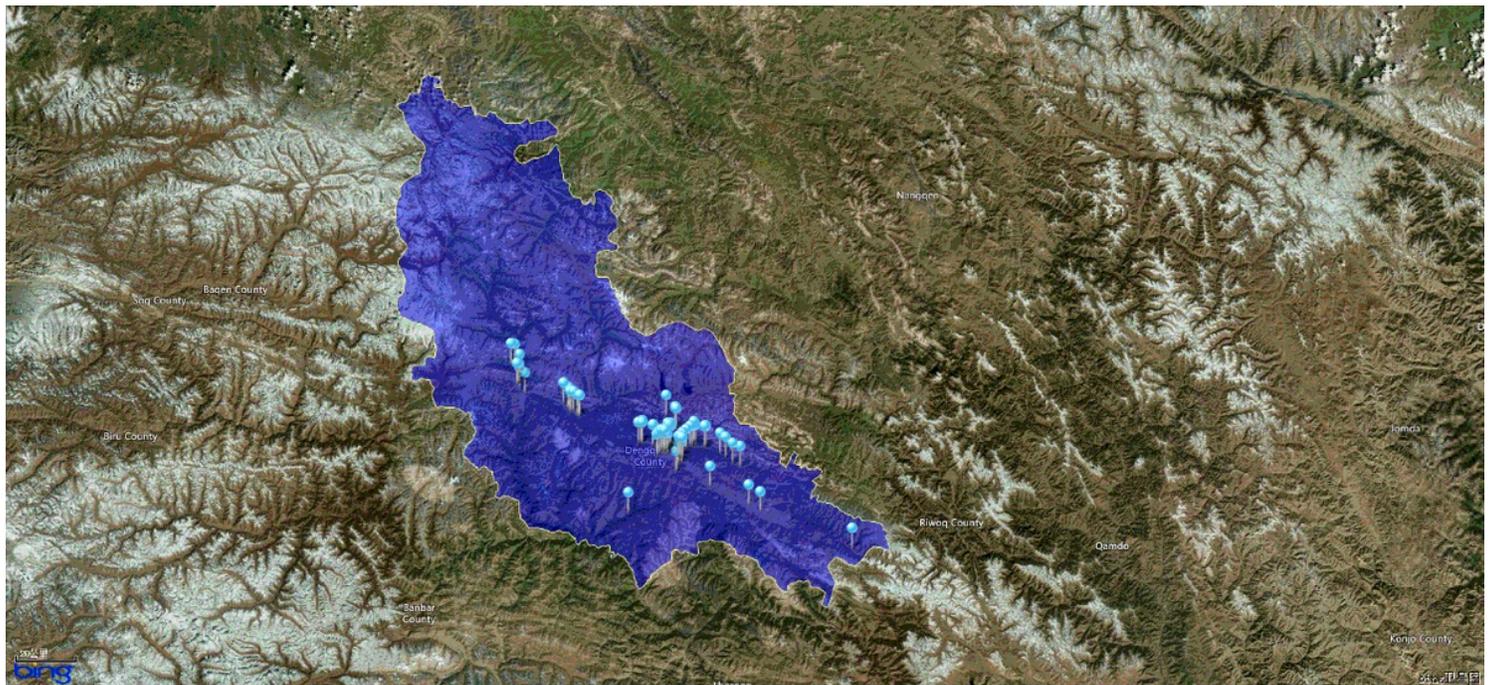
**Figure 7**

the total amount of data collection of field trips in Tibet from 2016 to 2019.



**Figure 8**

the geographical location of Dingqing county on the map Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.



**Figure 9**

the blue shape is the Dingqing county's shape on map and the points shows the geographical distribution of Mani heaps in this place. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.



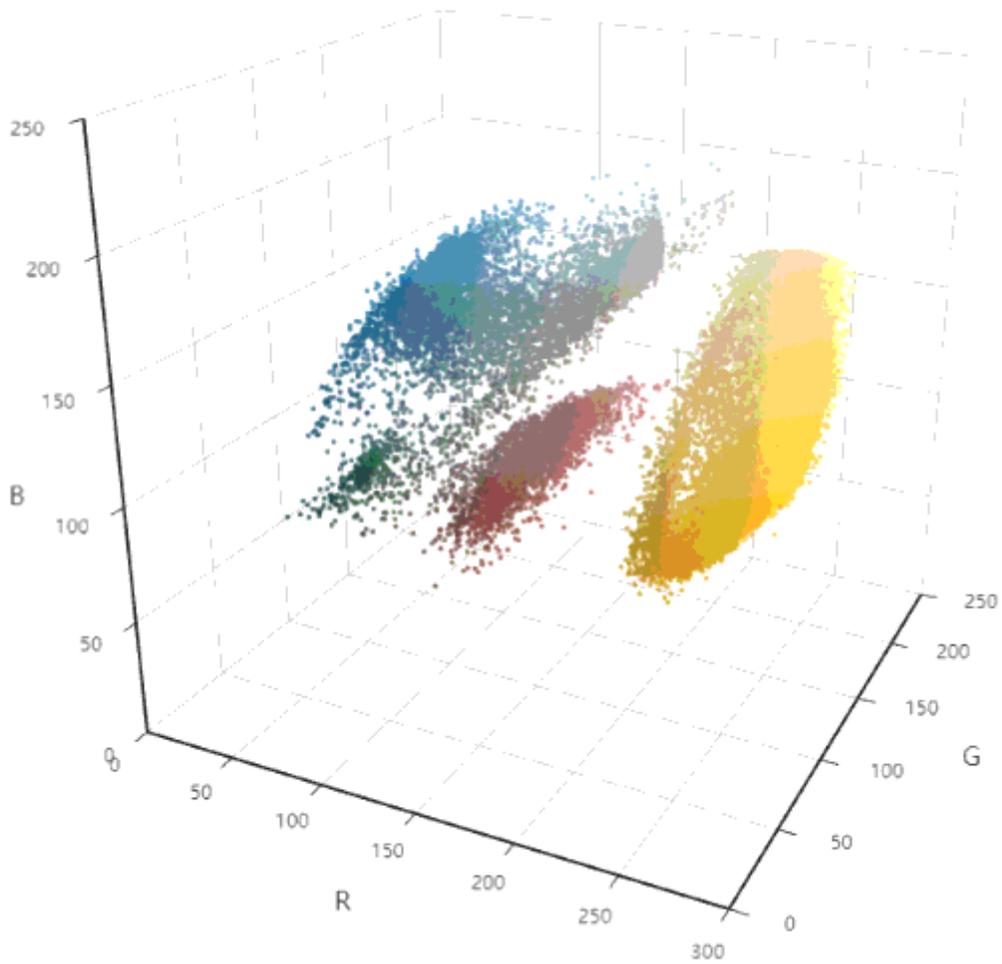
**Figure 10**

Left: the Mani heap in Nangqian county of Yushu, Qinghai; Right: the Mani heap in Leiwuqi county of Changdu, Tibet



**Figure 11**

Main color segmentation preprocessing of Mani heaps image.



**Figure 12**

RGB spatial distribution of Mani heaps samples.

# 环形图

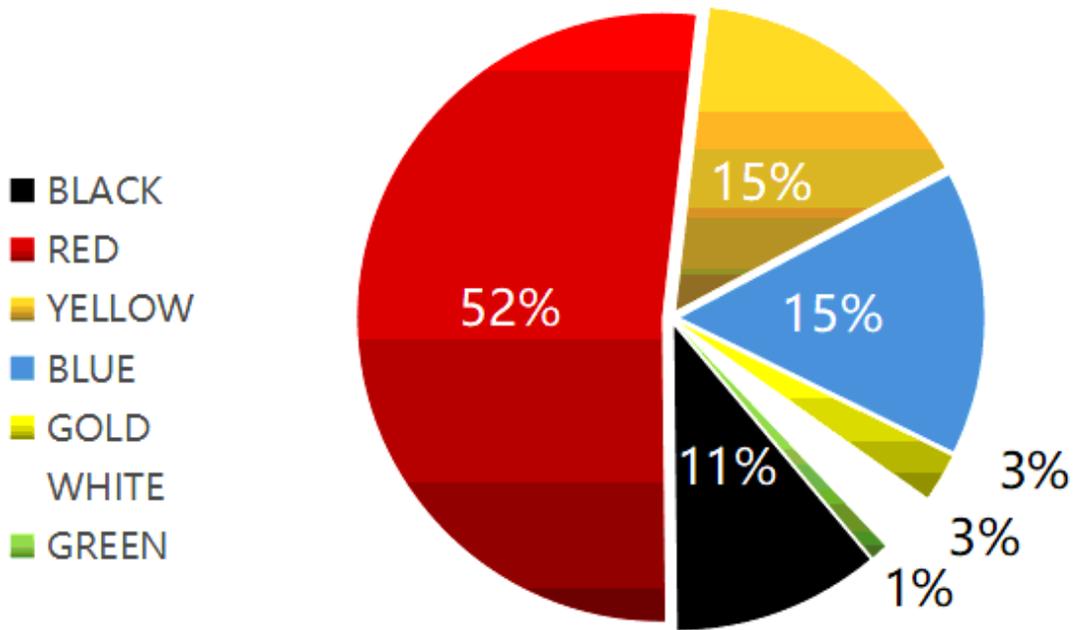


Figure 13

Analysis chart of main colors of Mani heaps