KEYWORDS: ***Rock art – Production – Intensity of intervention – Spatial distribution – Chile***

REGIONAL TRENDS IN ROCK ART PRODUCTION ACROSS ANDEAN FOOTHILL VALLEYS OF NORTH-CENTRAL CHILE

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Abstract. Considering rock art as the result of human labour in a region, we discuss how the intensity of rock art intervention can be used as a proxy for understanding the human use of space in valleys of north-central Chile. This region has a long sequence of rock art production, ranging from the beginning of the late Holocene until the 18th century. Our results show variability in rock art intervention during this period, with two outstanding moments: the initial appearance of rock art and the intensification of its production after 1000 CE. Both points in time are related to major transformations in the social dynamics and use of space by its inhabitants.

Introduction

The regional distribution of the archaeological record has been used to understand different aspects of the social life of past communities (e.g. Willey 1953; Clarke 1977; Hodder and Orton 1979; Binford 1982; Ashmore 2002; David and Thomas 2008). In the case of rock art, its distribution has been discussed within the conformation of regional identities, the production of landscapes and the construction of social networks (e.g. Santos-Estévez 2008; Gallardo et al. 2012; McDonald and Veth 2012; Pastor 2012; Hampson 2015). These approaches have focused mainly on revealing how the visual aspects of rock art were articulated with human behaviours and social meanings, which is consistent with the primacy of representational perspectives for understanding this manifestation of the past (Jones and Cochrane 2018).

However, rock art does not refer solely and exclusively to the visual. This material record results from a spatially localised social practice that reveals a process of work and energy investment, resulting in an effective modification of space (Fiore 1996, 2018, 2020; Bednarik 1998; Valenzuela 2017; Ivanovic 2019; Troncoso 2022). This perspective allows us to address how labour investment is deployed in a specific region across time, evaluating its spatial and temporal trends considering the logics of occupation of the territory by human communities. In particular, the labour investment involved in the elaboration of rock art can be evaluated across time, allowing us to qualify and compare the *intensity of rock intervention* on a regional scale. The *intensity of rock intervention* is understood as the relative amount of work that communities invest in producing rock art per unit of time. It is relevant for understanding how the unequal distribution of rock marking within a territory varies in relation to the sociohistorical processes and ways of dwelling (Belardi and Goñi 2006; Fiore 2006; Goñi et al. 2019; Romero-Villanueva et al. 2020).

In this work, we explore how the variation in the spatial production of rock art over 5000 years in north-central Chile accounts for different production intensities in the territory. For this, we studied an assemblage of rock art distributed in the Combarbalá (~ 31° S) and Choapa (~ 32° S) river basins; dated from the beginning of the late Holocene to colonial times (Troncoso et al. 2008, 2017; Arenas 2011; Troncoso 2022) (Fig. 1). This rock art was initially manufactured by mobile hunter-gatherer communities and later by sedentary farmers, which towards the middle of the sixteenth century were impacted by the colonial dynamics of the Spanish Empire.

Our results show variability in the intensity of rock art production across time as well as in its territorial distribution. This variation is consistent with the changes in landscape use and preferences for residential spaces. In this way, the presence, absence and frequency of rock art are significant data to understand the relationships that communities established with their inhabited space through the act of marking images on rocks (e.g. Fiore 1996; Goñi et al. 2019; Re and Belardi 2019; Romero Villanueva et al. 2020). These approaches, in turn, allow us to consider rock art as a proxy-data record for evaluating the intensity of occupation through time and space, as other studies have done with sets of radiocarbon dates, deposition rates and artefact assemblages (i.e. lithics, archaeofauna and ceramics), among others (Rick 1987; Espinosa et al. 2013; Méndez et al. 2015; Barberena et al. 2017; Rademaker and Moore 2018).

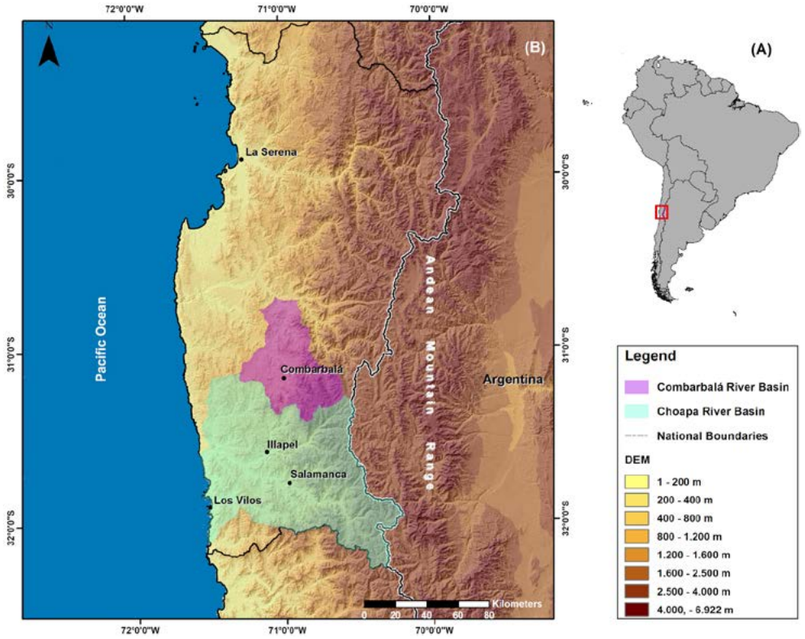

Figure 1. *Map of the study area showing the river basins under study.*

Evaluating production intensity through rock art

All human action varies significantly across space; therefore, evaluating its variability has been widely discussed in archaeology. For this, two analytical perspectives have been addressed: the recurrence with which these practices occur in space (intensity) and the kind of activities and their distribution (spatial variability). Multiple indicators have been used to address these aspects, ranging from furnishing residential spaces to the distribution and frequency of absolute dates from archaeological sites across a region (Chatters 1987; Seymour 2009; Williams 2012). In this context and as indicated by Rademaker and Moore (2018), the amount of material culture and its dispersion in a territory are indicators of the intensity of activities a group develops.

The relationship between rock art production and its spatiotemporal variability has been the basis of multiple investigations, although generally emphasising the frequency and visual heterogeneity of the images (e.g. Gallardo et al. 2012; Hampson 2015). In turn, other studies have focused on evaluating the relationship between the rate of rock art production and the occupation of a territory from biogeographic and communicative perspectives. For this purpose, rock art sites in a territory and their variability over time have been quantified. Thus, the frequency and variability of motifs are interpreted as indicators of the intensity or frequency of the flow of information and communication in the territory and, therefore, are associated with an increase or reduction in the occupational intensity of the space (McDonald and Veth 2011; Goñi et al. 2019; Romero et al. 2020).

As a result of the above, some studies have proposed that spatially circumscribed spaces with large carrying capacity present high occupational intensity associated with higher frequency and variability of rock art, reflecting an intense demarcation related to territorial competition. Likewise, a lower intensity of rock art spatial demarcation is associated with less occupied spaces (Barberena 2013). A high frequency of motifs, alongside the frequency of lithic artefacts and environmental access restrictions, has been interpreted as intensive seasonal use of specific areas in the context of population convergence (Belardi and Goñi 2006).

Although these studies provide a way to address the relationship between the occupation of a territory and the presence of rock art, they emphasise its visual character and communicative role, attributes that are relevant for niche formation (Belardi et al. 2016; Bird and Bird 2019; Lemke 2021). However, the intensity of rock art production and its relationship with space occupation as work investment indicators has not been much studied. Beyond its visual content, rock art is the result of a social practice that involves the application of energy and human work discontinuously across space (Fiore 1996, 2006, 2018). Labour investment in rock art unfolds through operational chains of production of instruments and motifs (Fiore 1996; Bednarik 1998; Méndez 2008; Fiore and Acevedo 2016; Valenzuela 2017). Additionally, this labour investment is reflected in space through a differential distribution of marked rocks, techniques and images that compose the studied archaeological record.

Following Fiore (1996), we understand rock art production intensity as the amount of work applied in a particular space and over a specific period. This work is deployed based on a production rate that can vary within a region and ultimately be comparable in

Figure 2. *Examples of different environments in the study area: (A) coastal landscape (0 – c. 200 m.a.s.l.), (B) coastal plains (c. 200 – 800 masl), (C) river valley (c. 800–1500 m.a.s.l.), (D) Andean mountain range (above 1500 m.a.s.l.).*

the long term. For this author (Fiore 1996, Fiore and Acevedo 2016), some aspects to consider in rock art labour are: (i) the availability and characteristics of the affected rocks, (ii) the availability and access to raw materials (e.g. lithic tools and pigments), (iii) the technological strategy (e.g. curated or expedient), (iv) the complexity of the techniques, (v) the simplicity and size of the motifs, and (vi) the number of motifs and their variability. However, as recognised by Fiore (1996), many of these attributes are difficult to evaluate in the archaeological record due to their low visibility or the difficulty of establishing systematic quantitative comparisons.

However, a feasible aspect to address at the regional level is the *intensity of rock intervention*. This concept refers to the magnitude of intervention in generating rock art. Such an intervention is directly related to the amount of labour and, therefore, is associated with the intensity of production. In turn, the intensity of rock intervention is affected by the recurrence with which rock markings occur in a territory and, therefore, with the use of space by human groups. In addition, the intensity of rock intervention could vary based on the intervention generated by other social practices in the environment and, therefore, could change over time.

Three analytical levels can be used to evaluate the *intensity of rock intervention* in a region (Fiore 1996, 2008, 2018). The first level refers to the frequency of rock art sites. This corresponds to the number of places marked in a territory. As an eminently discontinuous spatial record, an uneven distribution indicates a concentration of rock marking practices, work and energy in particular places, as opposed to spaces where this does not occur (Dunnell 1992). The second level corresponds to the number of rocks marked at each archaeological site. This level is complemented by the previous one and refers to the intensity of marking between different rock art sites. In this regard, rock art sites are concentrations of intervened rocks that are spatially finite and have limits defined by the absence of rock markings at a distance greater than 200 m from the last observed evidence. Although this measure is an arbitrary value, it is based on the spatial characteristics of local rock art sites (intra-site organisation and spatial distribution). Finally, the third level corresponds to the number of rock marking events and how they are associated with the labour invested in their manufacture (e.g. size, techniques, rock hardness and tools) and operational chain (Fiore 1996, 2006; Méndez 2008; Valenzuela 2017). Broadly, these events correspond to motifs, but on many occasions, as in the case of rock paintings, shapes have vanished and cannot be recognised, but paint traces can be digitally identified and quantified. Although the third level provides the finest resolution regarding the investment of labour in rock art manufacturing (Fiore 1996, 2008), it is not an approach that is feasible at a regional scale due to the large amount of work and time involved.

Study area: characteristics of the occupation and regional rock art

In this work, we evaluate the *intensity of intervention* associated with the creation of rock art in the Choapa and Combarbalá river basins (~31°– 32° S; north-central Chile) by quantifying the number of sites and blocks bearing rock art by past communities (Fig. 1). Additionally, the frequency of motifs is evaluated on this same scale. However, given the high number of affected rocks and the variability in their conservation, their quantification is considered a minimum number of observed figures without considering the multiple technical and material attributes suggested by Fiore (1996, 2008).

North-central Chile is an appropriate area for a diachronic comparison of rock art due to the high profusion of this type of evidence, which has been the subject of systematic research over the last two decades (Jackson et al. 2002; Troncoso 2022). This area

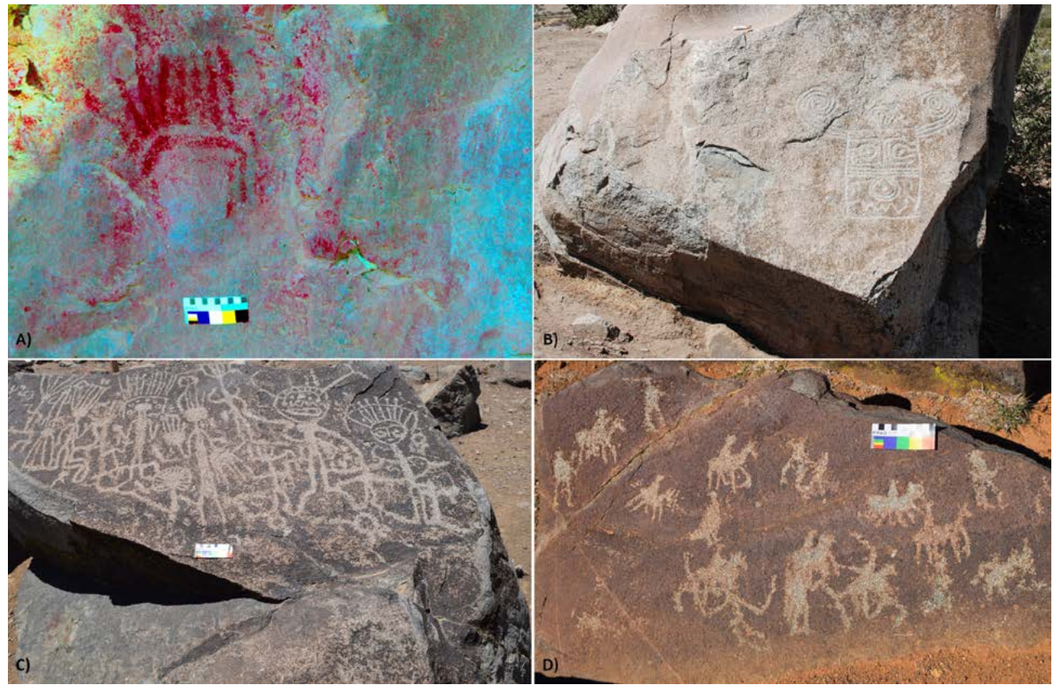

Figure 3. *Examples of rock art traditions from north-central Chile: (A) rock paintings (site Pintura de Pama, digital image enhanced with D-Stretch, channel LRE); (B) deep petroglyphs (site Mincha); (C) shallow petroglyphs (site Rincón de Las Chilcas-1); (D) colonial petroglyphs (site El Colihue).*

is characterised by a semiarid environment and is located south of the Atacama Desert (Romero 1985). It shows a marked west-east altitudinal gradient; within <100 km, it includes the Pacific coastline, river valleys (c. 900–1400 m.a.s.l.) and the Andean Mountain range (1500 to 5000 m.a.s.l.) (Fig. 2). Human groups widely occupied this territory, with archaeological evidence dating as early as c. 13 000 years ago and continuously occupied it until colonial times (18th century) (Méndez 2013; Méndez et al. 2015; Gayó et al. 2019). Human occupations became concentrated in valleys during the last 2000 years (Méndez and Jackson 2008; Troncoso et al. 2016; Grasset et al. 2021). These valleys provide the potential for agricultural development and have geomorphological characteristics that create important heterogeneity within the territory (Fig. 2).

Local communities have carried out rock art production for the last 5000 years. Three major rock manufacturing traditions have been suggested. The chronology for each assemblage is based on the combination of multiple lines of evidence, including the comparison of rock art motifs with other material media, the spatial association of rock art with stratigraphic deposits bearing anthropogenic remains, as well as superpositions between images (Moya et al. 2016; Troncoso et al. 2017, 2018, Troncoso 2022). The first tradition corresponds to paintings made by mobile hunter-gatherers, and it is characterised by nonfigurative motifs. Direct radiocarbon dates obtained from charcoal-made paintings indicate ages of the first half of the late Holocene (Moya et al. 2016; Troncoso et al. 2017; Troncoso 2022). These results are coherent with other evidence, such as the use of similar motifs in rock art and decorated bone tools (Bravo et al. 2019) and the recurrent presence of pigments and rock painting in late Holocene hunter-gatherer sites (Troncoso 2022; Troncoso et al. 2008, 2017). These paintings are infrequent and mainly red, although some rock art is black (Fig. 3A). Regarding pigments, red paints were made from iron oxides, and black paints were made from charcoal and manganese oxides; however, there is little clarity on the binders (Moya et al. 2016; Moya-Cañoles 2021).

The second tradition is deep petroglyphs manufactured by mobile groups. These petroglyphs mostly depict nonfigurative motifs and heads with large headdresses (Fig. 3B). This tradition extends between 500–1000 CE. This chronology is based on the superposition of deep petroglyphs over rock paintings, as well as visual resemblances between rock art motifs and the decoration of pottery dated to this period (Troncoso et al. 2008; Troncoso 2022). Technologically, they are characterised by deep grooves created by repetitive scraping and pecking along the same lines. This implies that each motif requires a substantial labour investment and temporal redundancy, a choice that privileged the re-marking of motives instead of intervening in new

rocks (Vergara and Troncoso 2015).

Finally, the third tradition is shallow petroglyphs. These petroglyphs are associated with agricultural communities dating between 1000–1550 CE and are mainly of nonfigurative, anthropomorphous and zoomorphic motifs. These are iconographically different from the previous assemblage (Fig. 3C) (Troncoso et al. 2008; Troncoso 2022). The chronology of this assemblage is based on the visual resemblance (motifs and symmetry patterns) between rock art, pottery and decorated bone tools. Also, rock art superpositions show shallow petroglyphs over rock paintings (assemblage 1) and over deep petroglyphs (assemblage 2) (Troncoso 2022).

The groups responsible for this assemblage, known in the archaeological literature as the Chilean Diaguita culture, had contact with the Spanish Empire during the 16th century. This interaction resulted in a transformation of this rock art tradition, for example, in the incorporation of visual references typical of the colonial world, such as Christian crosses, scenes of humans riding on quadrupeds (equestrian ensemble *sensu* González and Recalde 2021), priests and elements of Western writing (Martínez 2009; Arenas 2011; Troncoso et al. 2018) (Fig. 3D). Hence, this third tradition may be divided into late pre-Hispanic and colonial subtypes. It relies on delineating figures with shallow grooves associated with rapid weathering zone removal, and unlike the previous tradition, there is no re-marking and deepening of the motifs. This has led to the suggestion that the latter subtype focused more on decorating rocks with multiple motifs rather than repeatedly working over earlier specimens (Vergara and Troncoso 2015). For operational purposes, the latter subtype is called colonial petroglyphs. The colonial subtype only includes images associated with this period in the colonial Andes to provide better chronological control of post-Hispanic contact rock art in our region. As a result, we have excluded from our analysis more recent rupestrian manifestations associated with Republican times (at least 19th and 20th centuries), such as mule drivers' petroglyphs (Podestá et al. 2006).

The history of rock art production in this region suggests a sequence of assemblages replacing one another through time. Although this may come as a rigid scheme, we have no evidence supporting the coexistence of different assemblages of rock art in the region. This situation contrasts with the results obtained from other areas of north-central Chile; for instance, the Limarí and Elqui rivers basins, where a longer-term hunter-gatherer rock painting tradition extends from the beginning of late Holocene until colonial times (Troncoso et al. 2018; Troncoso 2022). This situation can be the result of two aspects: the lower intensity/recurrence of rock art production in our study and/or differences in the historical trajectories of pre-Hispanic communities in the Choapa/Combarbalá area in comparison to other areas of north-central Chile (Méndez and Jackson 2004; Troncoso and Pavlovic 2013; Troncoso 2022).

Material and methods

The Choapa and Combarbalá basins are among the most prolific regions in Chile in terms of rock art. This territory has been intensively investigated in recent decades, framed by scientific research and cultural resource management projects, which have produced extensive data. As a result of the above, 278 rock art sites and 3194 marked blocks have been recognised, resulting from the survey of a total area larger than 260 km² (Choapa 200 km²; Combarbalá 60 km²). Quantification was performed at the site and block level for each of these assemblages, and subsequently, their spatial frequency was evaluated in two dimensions. The north-south (NS) dimension compared the two basins under study: Choapa and Combarbalá. The east-west (EW) dimension evaluated the frequencies and distribution by comparing the coast and interior among different altitude ranges. This variability was analysed for each rock art assemblage to discuss the continuities and changes that occur across time and the variations in the intensity of rock intervention in the region.

A rock art intervention ratio was calculated considering the number of modified rocks and marking events for each assemblage and the time range represented by each set using a rate of 100 years (see also Fiore 2006). This range (in years) was determined based on the chronology associated with each assemblage established in the regional literature, which combines absolute and relative dating methods (Mostny and Niemeyer 1983; Troncoso et al. 2008; Troncoso et al. 2017; Troncoso 2022). Although limited because of the chronological assignment of rock art itself and because it assumes a stable rock marking rate across time, this procedure serves as a comparative resource based on the concept that the archaeological record corresponds to an average of human activities in space (Lucas 2008).

Results

Table 1 summarises the total number of sites and blocks and the minimum number of recognised events for each rock art assemblage in the area. Given that marked sites, blocks and the minimum number of events increase in time, there is a problem regarding the comparability between assemblages. As such, the main aspect affecting our results is the taphonomy of rock art, particularly rock paintings (Bednarik 1994). Although a certain degree of loss of rock painting can be assumed, it does not significantly affect our result. First, the study area's large size and the research plan's characteristics minimise differences resulting from research bias and taphonomy and allow the observation of changes in the frequency of the different traditions. Second, quantifying paint traces (eye-direct or digitally enhanced-identified) allows us to recover many highly damaged rock paintings. Finally, the number of rock art sites is a solid expression of the human

Rock art tradition		Combarbalá	Choapa	Total
Rock paintings (2000 years)	Sites	4 (1/15 km²)	1 (1/200 km²)	5 (1/43.4 km²)
	Rocks marked	5 (0.25/100 years) (1/12 km²)	1 (0.05/100 years) (1/200 km²)	6 (0.3/100 years) (1/43.3 km²)
	MNE	34 (1.7/100 years)	13 (0.65/100 years)	47 (2.3/100 years)
Deep petroglyphs (500 years)	Sites	0 (0/km²)	3 (1/66.6 km²)	3 (1/86.6 km²)
	Rocks marked	0 (0/ years) (0/km²)	4 (0.8/100 years) (1/50 km²)	4 (0.8/100 years) (1/50 km²)
	MNE	0 (0/100 years)	11 (2.2/100 years)	11 (2.2/100 years)
Shallow petroglyphs (550 years)	Sites	33 (1/1.8 km²)	240 (1/0.8 km²)	273 (1/0.95 km²)
	Rocks marked	657 (119.4 /100 years) (10.9/km²)	2378 (432.3 /100 years) (11.8/km²)	3035 (551.8/100 years) (11.6/km²)
	MNE	2628 (477.8 /100 years)	11890 (2161.8/100 years)	14518 (2639.6/100 years)
Colonial petroglyphs (250 years)	Sites	9 (1/6 km²)	33 (1/6.1 km²)	42 (1/5.9 km²)
	Rocks marked	142 (5.68/100 years) (2.36/km²)	83 (3.32/100 years) (0.45/km²)	235 (9.4 /100 years) (1.1/km²)
	MNE	426 (170.4/100 years)	249 (99.6/100 years)	675 (270/100 years)

Table 1. *Quantifying rock intervention by rock art tradition (MNE = minimum number of events) in relation to years and square kilometres.*

intervention in a territory, reducing the impact of taphonomic problems associated with the endurance of each marking event, and increasing the probabilities of recognising regional trends. In our case, the notable differences observed between the rock art assemblages strengthen the study and reflect the historical evolution of rock art production and transformations by human communities in north-central Chile.

Tradition 1: rock paintings

Rock paintings made by mobile hunter-gatherer communities of the late Holocene occur at a low frequency in the region (Fig. 4A). Considering the entire area surveyed, there is one site every 43.4 km². However, this tradition has a slightly higher representation in the Combarbalá area, both at the block and site levels. For Combarbalá, there is one site with paintings every 15 km², while for Choapa, there is one every 200 km². In terms of the altitudinal gradient WE, the paintings are located between 800 and 1200 m.a.s.l., suggesting spatial selectivity (Fig. 5).

Similarly, intervened blocks and the minimum number of recognised events are scarce. Considering that the chronology associated with the paintings in the area extends between 2000 BCE and the beginning of the Christian era (Troncoso 2022), an interval of 2000 years was considered for this assemblage. Based on this time span, the regional rate of rock intervention and painting events was very low (Table 1). Given the early age of this tradition and the friability of the paintings (compared with petroglyphs), an accentuated taphonomic loss is undeniable.

As seen from the data, although the intensity of painting is quite low, the difference between basins is significant. Given that the environmental conditions are similar between the two, we discard differential preservation. Likewise, given that neighbour basins to the north show more rock painting sites using similar methodologies (Troncoso 2022), the differences shown here are not considered a research bias.

Tradition 2: deep petroglyphs

Like rock paintings, this tradition has very low representation. It was only recognised in the Choapa basin (Fig. 4B). Compared with the previous tradition, its frequency is slightly higher in sites and affected blocks (Table 1). When considering the surveyed areas, there is one site every 86.6 km. However, considering only the Choapa basin, a site with deep petroglyphs is recorded every 66.6 km². These manifestations are placed in areas below 1000 m.a.s.l., which indicates a spatial difference from that for paintings (Fig. 5). As in the previous tradition, not only are sites scarce, but the number of affected rocks and identified marking events are also low.

Considering that a chronology between 500–1000 CE has been proposed for this tradition, an interval of 500 years was assigned to it. As such, the rock art intervention rate per area is very low (Table 1).

As in the case of paintings, we consider these results to be significant and that the low frequencies reported are not the product of a research bias. The recording methods used at the regional level are the same and have consistently yielded promising results in recognising blocks. Additionally, the technical nature of deep petroglyphs indicates repeated marking over the same motifs, which would lead to more intense motifs, but fewer marked blocks across time (Vergara

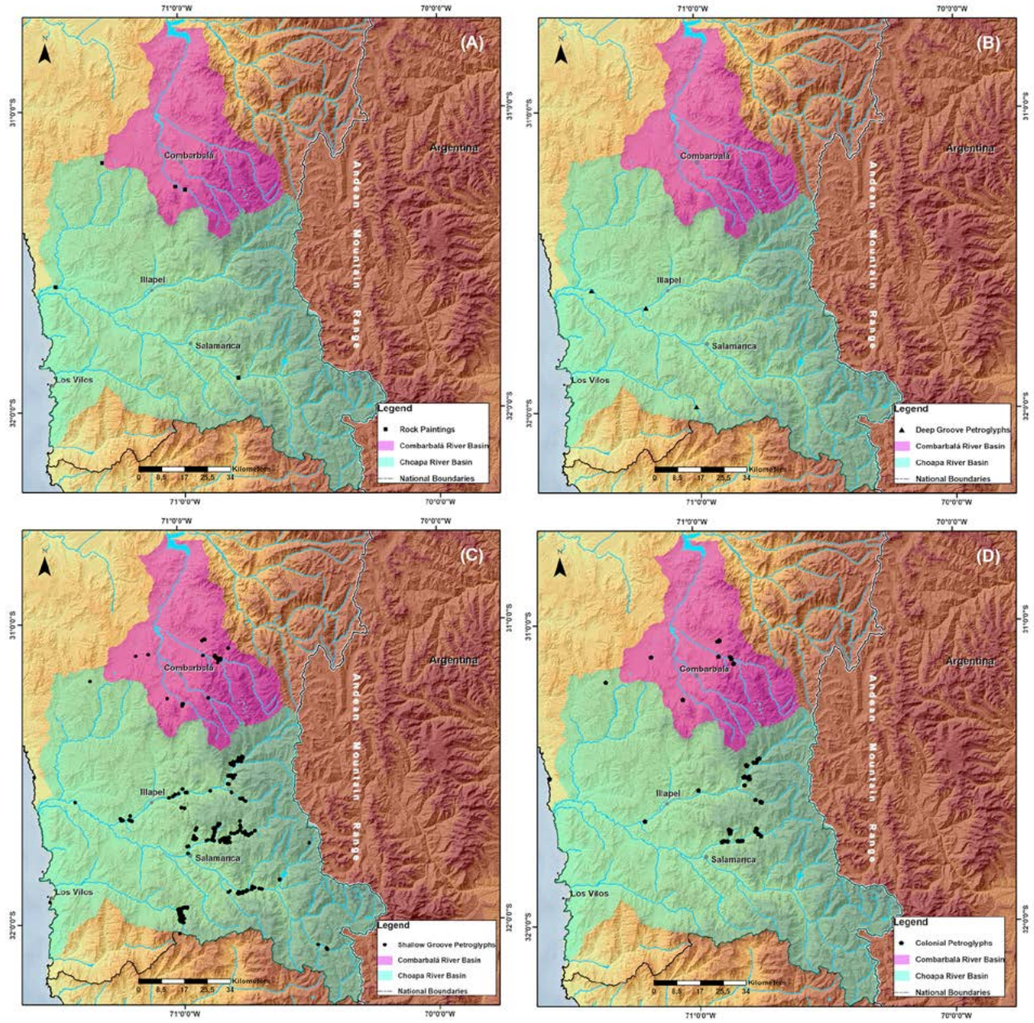

Figure 4. *Regional distribution of rock art sites: (A) rock paintings; (B) deep petroglyphs; (C) shallow petroglyphs; (D) colonial petroglyphs (site El Colihue).*

and Troncoso 2015).

Tradition 3a: shallow petroglyphs

This tradition is the most recurrent in the entire region. There is high representativeness at the level of sites and blocks, showing an apparent intensification in marking the territory (Table 1) (Fig. 4C). This intensification is observed when evaluating the relationship between sites and the area surveyed, with a rock art site every 0.95 km^2. At the basin scale, there is a higher frequency of sites in Choapa (1 site every 0.8 km^2) than in Combarbalá (1 site every 1.8 km^2). However, when considering only marked blocks, the difference in frequency is not as marked (Table 1).

At the site scale, there is an average of 11.6 marked blocks. This is common throughout the study area because, in both basins, small sites that contain between 1 and 20 marked blocks are dominant (87.9% sites in Choapa and 89.4% in Combarbalá). In Choapa, the most extensive site has 160 block interventions (Los Mellizos); in Combarbalá, the most extensive site has 289 interventions (Loma de López). This suggests variability in the intensity of rock art production in the region. Concerning previous traditions, there is an apparent increase in the minimum number of marking events in both areas, without particular trends for each basin.

The sites and blocks are concentrated between 300–2000 m.a.s.l. (95%), with a greater presence between 800 and 1200 m.a.s.l. (62.5%). Very low frequencies are observed in the middle and lower courses of these watersheds (0–800 m.a.s.l.) as well as in the mountain ranges

(above 2000 m.a.s.l.) (Fig. 5). The two most extensive sites in both basins are located between 800–1200 m.a.s.l. This trend differs from what occurs with the deep petroglyph tradition. Likewise, it indicates an expansion of rock art production at the regional level, extending beyond 1200 m.a.s.l. to 3200 m.a.s.l. When comparing this altitudinal distribution, no major differences are observed between the Combarbalá and Choapa basins.

Zooming in at each of the basins shows, in the case of Choapa, that these petroglyphs are more recurrent in valleys such as Illapel than in the Chalinga or Mauro, with the area surveyed in each being similar. In the case of Combarbalá, the Cogotí valley has a higher frequency of petroglyphs than Pama, with similar survey areas (Fig. 6). These trends are relevant because the Illapel and Cogotí valleys are spaces characterised by high agricultural productivity within their respective hydrographic watersheds and where a concentration of Diaguita residential occupations is recognised (Iribarren 1973; Castillo 1991; Troncoso 1999; Méndez et al. 2009).

Considering the chronology associated with this rock art tradition (1000–1550 CE), an interval of 550 years was assigned to evaluate its rate of rock intervention. There is a noticeable increase in the rate of rock art production relative to previous assemblages (Table 1). Additionally, there is no spatial coexistence with manifestations of the two previous traditions.

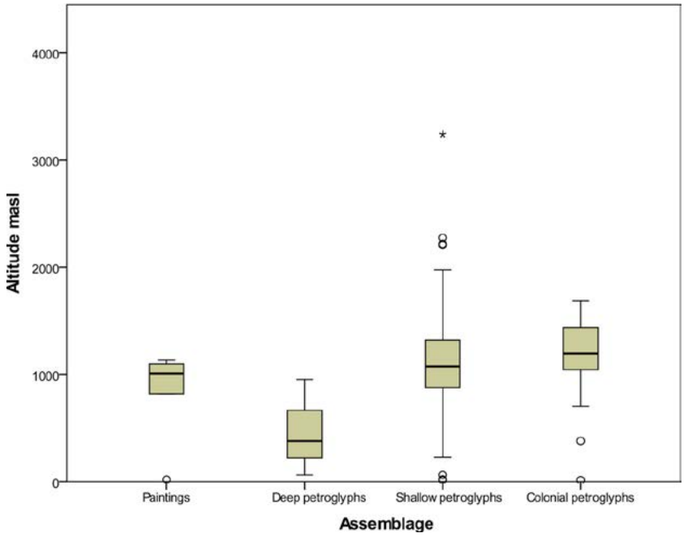

Figure 5. *Altitude distribution for each rock art tradition in north-central Chile.*

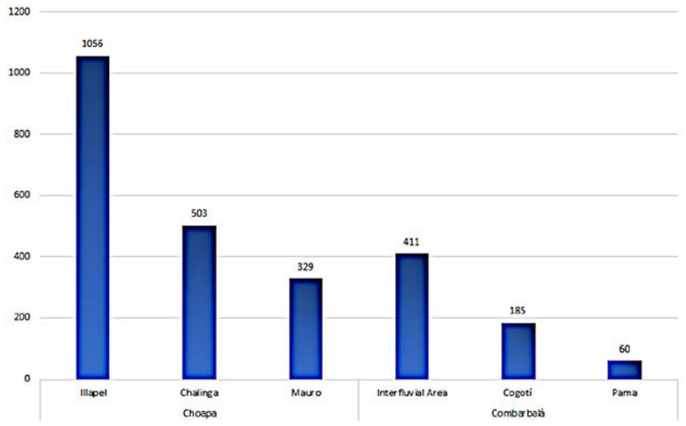

Figure 6. *Frequency of shallow petroglyphs (Tradition 3a) across valleys of north-central Chile.*

Tradition 3b: colonial petroglyphs

Petroglyphs that date to colonial times constitute the second-most frequent assemblage. At the site level, these are mostly concentrated in the Choapa basin, although when considering the surveyed area, their densities are similar (one site every 6.1 km^2 in Choapa and one every 6 km^2 in Combarbalá). Blocks are more frequent in Combarbalá, 2.36 blocks per km^2 than the 0.45 blocks per km^2 recorded in Choapa (Table 1) (Fig. 4D).

This greater frequency in Combarbalá is also supported by the higher number of blocks affected per site (e.g. 70 blocks in El Coligue and 52 in Loma de López); while in Choapa, the most extensive site has only 16 blocks with colonial inscriptions. Regardless of the above, one aspect to highlight is that all these sites were previously marked by the pre-Hispanic Diaguita; therefore, the petroglyphs of the colonial era are indicative of a purposeful marking of previously marked spaces. This tradition shares technical aspects and spatial distribution with the previous tradition but is different regarding the motifs represented. Additionally, the petroglyphs of the colonial era do not share space with paintings or deep petroglyphs.

The reduction in sites and blocks marked during colonial times is linked to a decrease in the altitude range of rock art because these are absent in spaces above 1800 m.a.s.l. Although sites below 800 m.a.s.l. are recorded, the blocks and colonial sites are concentrated between 800–1600 m.a.s.l., coinciding with the range for pre-Hispanic shallow petroglyphs (Fig. 5). When evaluating the distribution, it is interesting to note that

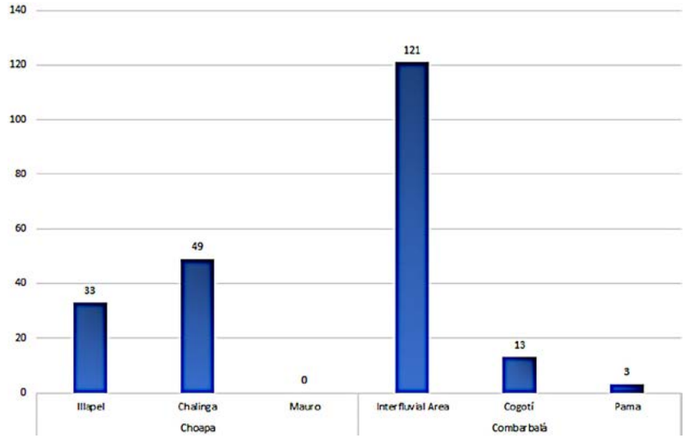

Figure 7. *Frequency of colonial petroglyphs (Tradition 3b) across valleys of north-central Chile.*

in the Choapa basin, colonial rock art is concentrated in the Chalinga valley and not in the Illapel valley, which is evidenced in a greater number of sites and rocks marked per site. In Combarbalá, this tradition is concentrated in interfluvial areas as in previous times, but the number of rocks marked decrease in Cogotí (Fig. 7). Although both areas were occupied as indicated by rock art, they are spaces that were minorly inhabited by the Diaguita during pre-Hispanic times, as opposed to their concentration in the Cogotí and Illapel valleys mentioned above.

Finally, considering the extension of the colonial period between 1550 CE until approximately 1800 CE (250 years), we recognise a drastic reduction in the production rate in contrast to that of the immediately previous tradition (Table 1); however, the rate remains higher than that of rock art production of mobile groups.

Discussion

Rock art production was a recurring and long-term activity in north-central Chile. It spanned from at least the beginning of the late Holocene by mobile hunter-gatherer groups until the mid-sixteenth century by agricultural communities subject to the rule of the Spanish Empire. This long sequence exhibits significant technical variations and differences in spatial distribution and variations in the frequency and recurrence of marking rocks. These differences can be evaluated as a marker of the intensity of rock intervention in their environment, comparing their rates over time. In particular, the records from the Choapa and Combarbalá basins show significant changes in this intervention rate that are related to the forms of land use and, therefore, serve as a proxy to understand this process.

Results obtained show a marked increase in rock art production in association with the appearance of the Diaguita culture at approximately 1000 CE. This increase is sudden and coincides with important changes in the socio-economic dynamics of the region, as these communities are the first agrarian sedentary groups (Troncoso 1999; Méndez and Jackson 2008; Alfonso-Durruty et al. 2017). These results show a marked difference in the intensity of production between mobile (traditions 1 and 2) and farmers groups (traditions 3a and 3b). This is evidenced not only in a greater number of sites and blocks but also in a larger altitudinal range of the latter: from the sea to the high mountain range. The areas with the most rock art coincide with concentrations of residential and productive spaces (800–1700 m.a.s.l.), as observed, for example, in the Cogotí and Illapel valleys. The enhanced intensity of rock art production and, therefore, greatest environmental modifications by these communities went hand in hand with a significant increase in the archaeological signature at the regional level. This is expressed by a greater number of radiocarbon ages, which have been interpreted as indicating an increase in population (Gayó et al. 2019).

The recurrence with which the Diaguita communities produced rock art was also projected after the contact with the Spanish Empire. A decrease in the performance of these practices by local communities has been recognised as a result of the violence and demise of indigenous populations as well as the control exerted by the crown over local traditional practices across the southern Andes (Martínez 2009; Arenas 2011; González and Recalde 2021). We know little about the spatial trends associated with this process; however, our study reveals two interesting aspects. First, although a reduction in production is recognised, rock art continued to be recurrent, indicating its relevance as a social practice for these communities. Second, this reduction co-occurs with a decrease in marking at the altitudinal level, indicating a decrease in the range of social action of these communities tied to the control of the Spanish crown. In turn, petroglyph production served as a resource for articulating the groups with their past, using and demarcating ancestral spaces previously occupied by the Diaguita (Troncoso et al. 2018). In this context, it is relevant that these petroglyphs are not concentrated in the most productive agricultural spaces, as was the case in pre-Hispanic times, but in areas with a lower productive yield. Investing in such spaces was consistent with colonial logic, as the most productive land was used for dwelling and activities by the Spanish crown, displacing traditional practices towards marginal spaces as an act of repression. Behind these transformations, indigenous communities deployed rock art as a resilient memory process against the Spanish colony.

In contrast to this situation, mobile groups employed little spatial intervention through rock art. This is expressed not only in the low frequency of marked sites and blocks but also in the fact that the marking acts are temporally distant, in contrast to what is observed for the Diaguita and colonial petroglyphs. At the regional level, there is no apparent concentration of rock art for these communities, except for their location in inland spaces and, in the case of paintings, at an altitude close to 1000 m.a.s.l. By the beginning of the late Holocene, redundant and sustained human occupation has been recorded in many spaces of north-central Chile, unlike in previous times (Méndez et al. 2015; Pino et al. 2018). On the one hand, the interior spaces had repeated occupations, both in the open air and caves (Villalón 2015; Grasset et al. 2021).

On the other hand, the coast has abundant shell middens that indicate a transition towards high residential mobility along the coastline at specific bays (Méndez and Jackson 2006). These trends suggest greater pressure on the space, where more people coexisted in the same territory, the context under which rock art began. Although this stage is associated with a low-intensity rate of rock marking, the novelty suggests the articulation of little-explored social aspects within the region. In fact, at this same time, shell mounds began to be built on the coast, another space demarcation behaviour indicative of greater occupation (Méndez and Nuevo-Delaunay 2021).

Although there are no noticeable differences in the spatial trends between the northern and southern areas, there are more sites and blocks with paintings in Combarbalá than in Choapa. This finding is consistent with a broader social process associated with an intensification of painting practices throughout north-central Chile. Our studies in the Limarí river basin, immediately north of Combarbalá, show an even greater number of sites and blocks with paintings than the two areas studied herein (Troncoso 2022). This suggests a declining pattern in painting, with a north-south arrangement across the region. These differences go hand in hand with other modifications in the archaeological record, such as a decrease in the frequency of manufactured bedrock mortars along the same spatial axis (Pino et al. 2018).

Our results reveal two major points in the evolution of rock art. First is the appearance of rock art as a form of spatial intervention that occurred at the beginning of the late Holocene. Second, there was an intensification of this activity after 1000 CE with the appearance of sedentary farmers. Both phenomena seem to be strongly related to changes on a broader scale. At the beginning of the late Holocene, a significant demographic increase was associated with marked changes in local communities' spatial, behavioural and material patterns (Méndez et al. 2015). This process has been interpreted as releasing a bottleneck resulting from the constraints produced by millennial droughts during the middle Holocene (Maldonado and Villagrán 2006; Barberena et al. 2017). Coincidentally, the beginning of the marking of space occurred in a context of demographic increase and was possibly mediated by a greater interaction between groups coexisting in the same territory.

A second inflection in rock art production development is associated with forming the first sedentary and agricultural communities in the region. This coincides with a significant change in lifeways, mobility dynamics and spatial patterns, as well as with the distributional trends of radiocarbon dates in the region, indicating consolidation and demographic enhancement since 700 CE with a peak between 950 and 1450 CE (Gayó et al. 2019). The two moments of inflection in rock art production (i.e. its appearance and its intensification on a large scale) coincide with two population changes that involved the reconfiguration of the ways of relating to spaces, the resources within spaces, and neighbouring communities. The results obtained show coherence in the long term between the intensity of the marking of spaces, as expressed by rock art, and the occupation of the territory and variability in the forms of use of space-based on altitude. This variability is also observed in the three main rock art traditions described herein, which do not share space at the site and block levels, suggesting a differential distributional logic at a smaller scale, an aspect that has been recognised in another research (Troncoso 2022).

Conclusions

As Fiore (1996, 2020) indicated, rock art production involves the deployment of time, energy and labour. These attributes allow the use of the archaeological record as a proxy to address the intensity of production and intervention of space, as the number of sites and marked rocks are the direct results of human actions and indicators of furnishing space for inhabitation. As indicated by Fiore (1996, 2020), the labour costs of producing rock art involve several factors, such as operational chains, difficulty accessing raw materials and time invested in production. However, from our perspective, broader indicators such as those used in this article constitute an input to address production processes from a regional scale and provide a large dataset to analyse it from spatial and temporal perspectives.

In the case presented, meaningful trends indicate differential rates of rock intervention across time. There is a marked contrast between the form, type and intensity of art associated with mobile hunter-gatherer groups and sedentary agricultural groups. Furthermore, a contraction of this process was observed in association with the colonial-repressive practices established by the Spanish crown in the sixteenth century.

Our analysis recognised two crucial peaks: the initial appearance of rock art in the region and its subsequent popularisation with the Diaguita culture. Both are consistent with population dynamics changes, as

independent studies suggested. The initial appearance of rock art was contemporaneous with the release of a possible regional demographic bottleneck (Barberena et al. 2017) and with other forms of spatial demarcation, such as the appearance of bedrock mortars and shell mounds in some bays (Pino et al. 2018; Méndez and Nuevo-Delaunay 2021). Rock art intensification towards 1000 CE occurred alongside the consolidation of an agrarian and sedentary way of life that involved a vital landscape modification, including the creation of fields for crops and channels for water circulation (Troncoso et al. 2016).

Finally, an aspect that seems essential to address from these results is that unlike other material records, such as pottery, lithics or dates, the rate of marking of a territory is a direct indicator of the process of furnishing the space and of human transformations of the territory. This process of conditioning a space is related to the intensity of rock art production and technology. As we have seen in this case, while the Diaguita shallow petroglyphs are characterised by an extensive intervention of the space-based on surface engravings, earlier deep petroglyphs were based on intensive and repeated interventions over the same motifs. Therefore, it is necessary to continue exploring strategies to understand and evaluate the intensity of rock art production, considering that the technological orientations of the different material expressions involve different work processes. In this context, an approach like the one presented here constitutes an alternative to address this variability. Although taphonomic processes always produce some noise in rock art research, the use of a regional perspective, the improvement of digital technologies and an approach centred on the act of making rather than on motifs allows the reduction of biases in comparative studies of different technological rock art assemblages. In our case, the heterogeneous trends recognised in the intensity of rock art production in north-central Chile shed light on the differences in human occupation and anthropogenic impact upon the territory. Through studies such as this one, it is possible to broaden the range of questions about rock art, addressing the representational and semantic problem by considering aspects that allow it to be integrated as another indicator in understanding social, economic and historical processes.

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