KEYWORDS: ***Rock art – Economy – Production sequence – Operative chains – Technology***

THE ECONOMIC SIDE OF ROCK ART: CONCEPTS ON THE PRODUCTION OF VISUAL IMAGES

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Abstract. This paper focuses on the analysis of the economic aspects of rock art production. Such analysis is based on a theoretical perspective that widens the narrow association between art and ideology and centres on the economic processes that occur within art creation. These are analysed by studying the organisation of work processes in art production. The paper proposes a production sequence model constituted by three operative chains, and provides criteria to analyse each of its stages. It discusses possible interpretations of this model in terms of labour investment, stressing that such investment was not always guided by optimal (cost-minimising) choices. It is argued that assessment of the labour invested in rock art production can shed light on the reasons behind raw materials, techniques and bedrock-space selection. The paper also includes some brief examples from Patagonia and north-western Argentina which illustrate the potential of these concepts when applied to rock art research.

Introduction: the materiality of rock art

The main aim of this paper is to discuss theoretical concepts which focus on the economic aspects of rock art production.[1] Numerous aspects of rock art have been the focus of detailed analyses and have constituted the main viewpoint of entire theoretical frameworks. These include the study of: (a) its visual aspects (elements, motifs, plastic composition, display etc.); (b) its techniques (extractive and additive); (c) its functions (e.g. art for art's sake, sympathetic magic, initiation rites, semiotic communication, caravan traffic signs, territorial delimitations, stylistic and identity markers etc.); (d) its spatial distribution within a site, and of sites within a landscape; (e) its temporality (e.g. chronology and diachronic continuity and changes of different features); and (f) its taphonomy, management and conservation (see syntheses in Ucko and Rosenfeld 1967; Bahn and Vertut 1988; Bednarik 2001; Whitley 2001, among others). Yet the analyses and interpretations of rock art have usually been oriented towards the symbolic, ideological and social contents of images and sites. This stems from a rationale that splits activities into economic, political or ideological (e.g. 'artistic activities are ideological', 'subsistence activities are economic' etc.) and avoids recognising that any human activity involves simultaneously all these aspects. As a consequence, art is frequently — and often implicitly — associated with the ideological realm of society, and is therefore set aside from another fundamental realm of society, i.e. economy (García Canclini 1986; Alvarez and Fiore 1993; Wolff 1993; Fiore 1996).

This happens within theoretical frameworks that are essentially concerned with the mental aspects of human activities and therefore see rock art (and any kind of art) as an expression of these, i.e. as a projection from the mind to the image (see discussion in Davis 1986). But the straight association between art and ideology also happens in materialist approaches, such as some applications of the Marxist theoretical perspective, which conceive art as a superstructural phenomenon determined by an economic structure. Art is thus conceived primarily as an ideological — reflected or inverted — representation of reality, which masks the actual social structure and justifies its contradictions and inequalities in order to reproduce such structure (Zis 1987). Therefore, in spite of this materialist framework, art is again considered mainly as an ideological expression, while its economic aspects are basically contextual: hunter-gatherer, agricultural or industrial activities influence art creation in different manners, while art is mainly regarded as an expression of these

1 A previous version of this paper was presented at the NEWS International Rock Art Congress (1995, Torino), and published in the congress proceedings (Fiore 1999a). This paper offers an updated account of the ideas presented in that version.

contextual influences. Economic conditions are thus placed *around* art but not *in* it (Fiore 2002).

This paper proposes that art's economic factors are not just a determining external structure: the material existence of rock art depends on the economic processes involved in its very production (Leroi-Gourhan 1976). Rock art's economic factors entail the interplay of productive forces and social relations of production (Godelier 1976). *Productive forces* include *people* who work (individuals of a certain age, gender, social roles, personal skills etc.) and their *labour investment* (including the energy, time, physical force, manual dexterity, knowledge, mental attention, skilled visual perception, affection etc. involved during the work process). *Social relations of production* involve the ways in which people engage themselves in the work process and how this process is organised (who produces rock art, in which circumstances —domestic, ceremonial, public, private etc. — who teaches and who learns how to make and interpret rock art images etc.). It is clear that productive forces and social relations of production have a different level of archaeological visibility, the former being usually easier to identify than the latter, especially in pre-Historic hunter-gatherer contexts which lack several clear indicators about the way in which rock art production was organised.

Productive forces and social relations of production are implied in — though not reducible to — the technological aspects of rock art creation. They are required to manage materials (tools, paint, bedrock) through the manipulation of techniques and of knowledge to use them. Interestingly, the technology of rock art has often been regarded as a neutral means applied to achieve a more meaningful end (the image), but not as meaningful or symbolic in itself. Again, this can be traced back to the rationale mentioned above: in this case, technology is narrowly tied to economy, while its ideological contents are often neglected. Yet, several ethnographic and some archaeological studies have shown that technology can bear numerous cultural values which go beyond its practical-mechanical functions and which deeply influence its development (Pfaffenberger 1992). These values include the sacred nature and the aesthetic aspects of the materials involved in rock art production (landscape, bedrock, pigments etc.). Thus, the selection of a particular kind of pigment may not respond exclusively to its availability, but may be related to the sacred nature of its quarry or to the symbolic meaning of its colour. Moreover, as Bégouën pointed out when referring to sympathetic magic, 'it was the act of painting or engraving itself which had been the essential act of the sympathetic rites' (Ucko and Rosenfeld 1967: 135). Art images are often deeply meaningful; art technology can be meaningful too.

Consequently, while rock art images are not reducible to their ideological factors because they also entail economic factors, the technology of rock art is not reducible to economy, since it also involves ideology. This perspective aims to avoid the confusion between *empirical data* (rock art images, rock art technology) and *factors* inherent to any kind of activity (ideology and economy): these factors are constitutive of any set of cultural products, including rock art.

Rock art's production sequence: a general model

Rock art's *production sequence* is conceived here as a model integrated by three *chaînes opératoires*[2] or *operative chains*: one related to the production of artefacts, one related to the production of paint, and one related to the production of the images themselves (see Chart 1). The distinction between these chains is based on three main groups of material evidence that are involved with rock art's existence: artefacts, paint and images. A fourth type of material is the bedrock, which entails an intentional selection and sometimes a preparation stage, but these tasks have been included in chain number 3 (image production) because the material creation of the images cannot be actually detached from their bedrock. Each chain includes two or more *stages*, and, in turn, each stage includes one or more *operations* (see below), which can be done just once or repeatedly.

The actual rock art production sequences involved the interrelation and overlap of *stages* from these different chains. Thus, engraving sequences required the interaction of only two chains (artefacts and images), while painting sequences involved the interaction of the three chains (artefacts, paint and images). Although these chains will be presented separately for analytical purposes, it is important to stress that some stages of different chains were obviously superimposed in practice, i.e. in the same act of paint preparation, the *manufacture* stage of the paint chain and the *use* stage of the artefacts chain are happening simultaneously, because they are inextricably linked. The identification of stages from different chains which, in practice, overlap in a particular task is in itself an interesting indicator of the behavioural complexity involved in this type of artistic production, and can help to recognise the degree of labour investment during the work process.

Operative chains include the following stages: resource procurement, product manufacture (using the resources previously gathered), product maintenance (retouching its shape by adding/removing materials to keep its form and function) and/or product recycling (transforming its shape and/or materials to change the product into another product) (Leroi-Gourhan 1953–1955; Pelegrin et al. 1988). It should be noted that manufacture and production are not used as synonyms here, since the former is a particular stage

2 From now on, '*chaîne opératoire*' will be translated into English as *operative chain* for language coherence.

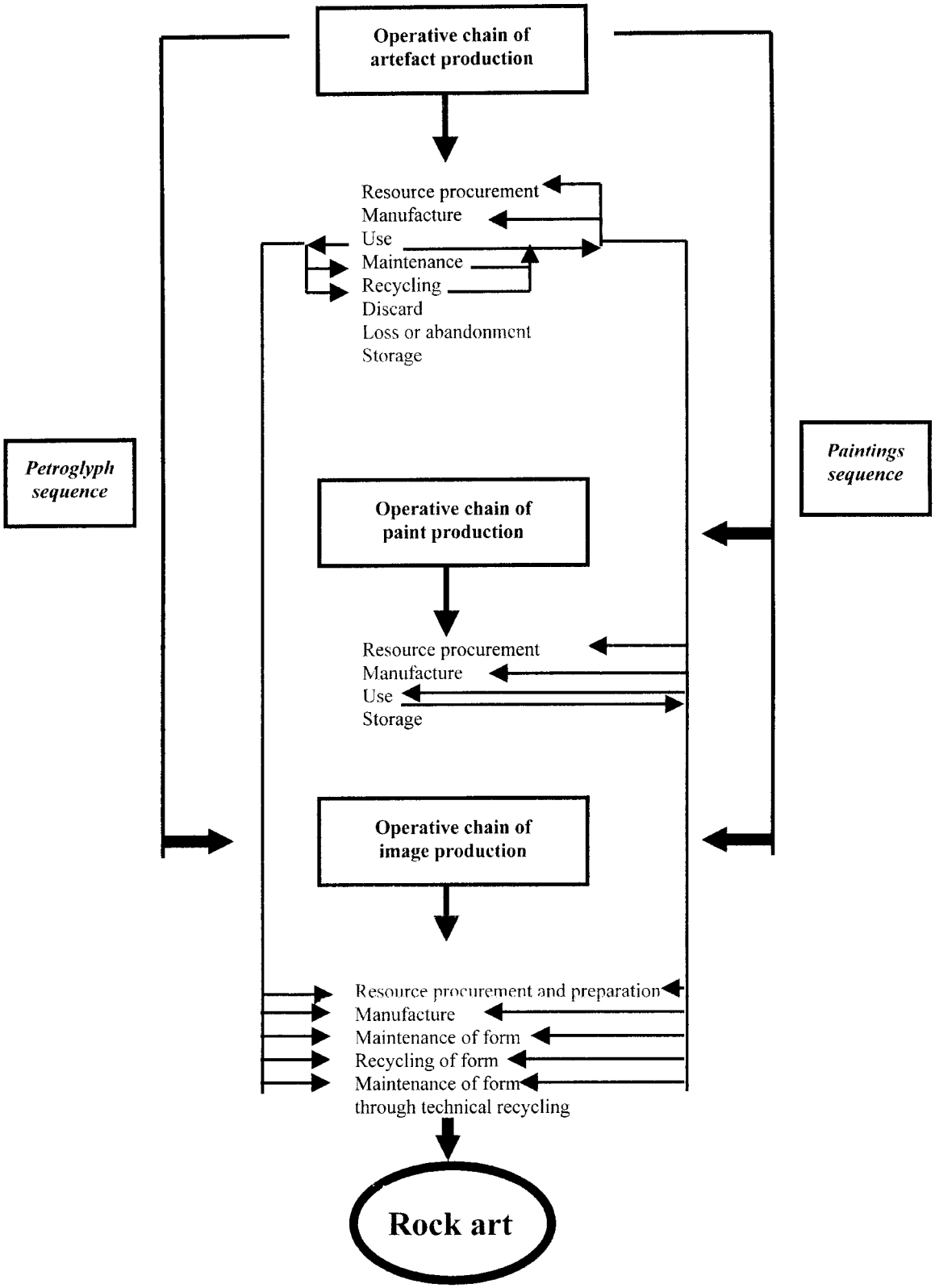

Chart 1. *Flow model. Rock art production sequences of engravings and paintings: relations between stages of the different operative chains.*

of the operative chain, while the latter covers the whole work process throughout the entire chain.

This concept shows clear similarities to Schiffer's flow model of an artefact's trajectory in the systemic context and the archaeological context (1972). Yet the French concept involves not only a chain of several stages, but also the existence of *operations* in each stage. These can be related to Piaget's notion of operations (Piaget 1971), which involve the physical manipulation of objects and the mental construction of notions involved in such manipulation. The notion of operation is therefore not restricted to a

mental realm, because it also entails bodily practice. Thus, operations involve simultaneously mental and practical knowledge, both of which are embodied in technical gestures. Such theoretical perspective sheds light on the cognitive aspects (rational, perceptual and affective) involved in any kind of object manipulation and production, which already has a well-established academic tradition in archaeology (e.g. Wynn 1981; Mithen 1996 etc.). In rock art analysis, the existence of a sequence of three stages — production, maintenance and recycling — has been proposed by Aschero (1983/85, 1988). The model presented here owes him an important part of its methodological basis.

Unravelling the operative chains involved in rock art production entails the identification of technical procedures used in its creation, and also allows for the identification of the economic aspects necessary to develop this work process. Operative chains involve a certain labour investment, which is influenced by a number of factors:

(a) Abundance or scarcity of bedrocks, which can influence the way in which they are valued (scarce bedrocks and/or specific types of bedrocks may be more valuable for a social group which is interested in making rock art on/in them).
(b) Bedrock accessibility or inaccessibility, which requires less or more energy to reach them and work in them.
(c) Bedrock hardness and texture: the harder the bedrock, the harder it is to engrave it with lithic tools (involving more time and physical effort)[3]; conversely, the softer the bedrock, the easier it is to engrave it, although in this case the risk of image decay is usually higher, particularly in open-air bedrocks; coarse-grained and small-grained bedrocks can have similar effects on the conservation of pigment particles of paint (Rosenfeld 1988; Bednarik 1994) and may also have been a factor taken into account by the producers, if image durability was indeed a relevant factor within the cultural values of the producing group.
(d) Raw materials availability to make engraving and painting tools: the greater the raw material availability, the least effort in the procurement stage of the tool production operative chain; conversely, a low raw material availability would involve a higher effort in time and energy during its procurement. In turn, this would indicate a specific interest producing rock art at a specific site in spite of its distance to the lithic quarries or to other sources of materials to make the tools.
(e) Pigment availability to make paint and availability of substances to make binders (when these are necessary): the same logics apply here, since the choice of most available pigments (or binders) usually indicates a lower labour investment than the choice of specifically selected pigments from distant quarries. As noted above, this not only depends on these economic variables, but also on the ideological-symbolic values given to pigment, pigment quarries, binding materials etc.
(f) The expedient versus curated nature (Binford 1979) of the engraving and painting tools: the former usually entail a lower labour investment than the latter.

From an epistemological point of view, the assessment of these economic aspects is particularly relevant to rock art research since they provide means to propose predictive hypotheses with testable expectations, which can be verified in the archaeological record (Bednarik 2001). Different hypothetical productive scenarios can be modelled by considering the economic factors mentioned above, and then the actual patterns found in rock art production of a certain site or region can be measured against the model. This helps transcend description, since the economic aspects of rock art can be used to analyse the dynamics of human actions behind its production.

It should be clear that the rationale behind this perspective is to assess these economic factors not only in terms of cost-benefit logics, since maximisation is a possible option but not a general law of human behaviour (Winterhalder and Smith 1981). Rather, the assessment of rock art's economic factors is considered here as a manner to determine the degree of labour investment involved in rock art production by analysing to what extent the tendencies found in an actual case veer from the optimal modelled expectations. This, in turn, can shed light on the reasons why it was important for a social group to make such investment, particularly when it *does not* reduce material costs in terms of time, energy, raw materials or skilled labour[4]. Finding out that time, energy, matter and skill were not 'saved' but rather 'spent' indicates a concrete interest in such spending: they help analyse the economic organisation behind rock art production, and may also help point to other non-economic factors involved, such as the political and ideological aspects of rock art creation, and/or to its relation with other spheres of activity such as

3 This difficulty varies with the degrees of technical skill and with the different engraving techniques (Alvarez and Fiore 1995; Bednarik 1998).

4 It is often easier to recognise specific intentions to produce art in a certain manner when evidence escapes from optimisation logics, because it shows defined patterns which are not accountable by a material cost-benefit rationale, and may thus reflect the symbolic value of a rare pigment, the geo-political relevance of marking an inaccessible site, the demonstration of power by spending high amounts of skilled labour in the production of specific images etc. These indicate other priorities of the producing society, which are in fact other forms of 'return' from the initial labour investment. Yet, symbolic, political and affective values can also be included *within* optimal choices, and this should not be neglected in spite of their lower archaeological visibility.

subsistence or religion (Fiore 1996).

Three chains with numerous outcomes: from model to practice

Tools and techniques are clearly essential to the production of rock art. Direct observation of the macroscopic traces left on the motifs by the technical gestures used to make them indicates that rock art images have been produced by several types of artefacts used according to the different techniques of painting and of engraving. Yet, in many cases, the artefacts remain almost unknown. Therefore, the *operative chain of artefact production* is quite difficult to reconstruct.

An example of this problem is the study of nine painted and engraved sites in the Pilcaniyeu region, North Patagonia (Argentina). A total of 35 258 lithic artefacts (including tools, flakes and microflakes) have been found in five of these sites (Boschín 2000; Alvarez 1999). Among these, only one artefact was macroscopically identified as an engraving 'chisel' (a tool with an elongated shape and a rounded tip), while no painting artefacts were found (Boschín and Nacuzzi 1980). This situation was paradoxical, given the great number of images produced in most of the sites, which would have required the use of a number of tools. To put this case study in a broader context, a systematic bibliographical search of rock art sites showed that from 146 Patagonian sites (including the ones mentioned above), only three artefacts have been identified by the papers' authors as engraving tools (Fiore 1996/1998) and five artefacts as painting tools (Onetto 1991). Three hypotheses (Fiore 1999b) could account for this potential 'absence of evidence': (1) it could be related to a sampling problem; (2) it could be related to a problem of archaeological formation processes, both natural and cultural; and (3) it could be related to a problem of archaeological identification of the artefacts.

The sampling problem hypothesis can be evaluated by assessing the number of artefacts found in the sites and the size and volume of the excavations or surveys. Given the great number of artefacts found in the sites and the extensive excavations carried out in them, the artefact samples of the five Nordpatagonian sites can be considered representative of the local tool kits (Alvarez 1999). This also applies to at least part of the 146 Patagonian sites mentioned above; in turn, this suggests that sampling problems may not be the core issue in the identification of rock art tools.

The second hypothesis can be partially related to cultural formation processes of the archaeological record, in particular, ancient social behaviour. Several factors could have led to a reduction artefacts' disposal: their *curated technology* (Binford 1979), their hafting (Alvarez 1999), their multifunctional purpose (idem), or their social value due to the task that they were used for (Fiore 1999b). The first two cases entail a high labour investment, the third one implies a high economic value given to multifunctional tools, while the fourth case involves an ideological significance of a tool according to its use context, and hence implies certain social relations of production established between rock art producers and certain tools. Yet in all these cases, the artefacts should have been discarded, lost or abandoned, and at least some of them should appear among the archaeological remains.

This second hypothesis also includes the natural formation processes of the archaeological record. According to their raw materials and to the tasks for which they were used, painting and engraving artefacts have different chances of archaeological preservation and identification. Some of the artefacts known to be used in paint preparation and images manufacture are: lithic mortars for pounding or grinding mineral pigments; bone artefacts which offer surfaces that can be used as an 'artist's palette' (Aschero 1983/85); hollow bones through which to spit paint; and brushes and rods made of vegetal or animal fibres to apply paint (Onetto 1991). Finding the most perishable of these artefacts depends a great deal on the site's taphonomic conditions: soil pH, sedimentary moisture, trampling etc. (Bednarik 1994). But their identification and functional attribution can sometimes be easier, because paint residues can remain attached to the artefacts' surface and can be identified macroscopically, microscopically and/or chemically (e.g. Rial and Barbosa 1983/85; Wainwright et al. 2001).

In the case of engraving artefacts, their raw material has to be harder than the bedrock in order to extract a portion of its surface. Therefore, in many cases it is expected that they will be lithic tools, whose preservation does not depend so directly on the site's taphonomic conditions. Yet, in spite of their potential durability, they are difficult to identify.

This leads us to the third hypothesis, which concerns the possibility of a failure in the archaeological identification of the artefacts (mainly those used to make engravings and other petroglyphs, for the reasons stated above). This third hypothesis suggests that maybe the artefacts used to produce the engravings are among the archaeological materials that have already been *found*, but they have not been properly *identified*.

The criteria to identify engraving tools have usually been morphological and macroscopic. Some researchers have inferred the shape of the artefacts needed to produce engravings by observing the traces left by them on the bedrock (e.g. Gradin 1979; Boschín and Nacuzzi 1980; Delluc and Delluc 1978; Maynard 1977; Podestá 1988). The expected tool types usually include chisels and burins, though pointed flakes have also been mentioned. Yet, in order to be corroborated as diagnostic, these macroscopic morphological criteria need to be reinforced by independent lines of evidence. This can be provided by two separate but interrelated methodologies: experimentation and

Figure 1. *Engraved (pecked) anthropomorphous figure and circles. Santa Maria valley (Catmarca, North-West area, Argentina)*

microscopic studies. Indeed, experimental analyses which replicate the production of engravings have shown that the required tools may be neither chisels nor burins but just sharp flakes and, in the case of percussion petroglyphs, hammerstones (Bard and Busby 1974; Alvarez and Fiore 1995; Bednarik 1998). The use of such tools depends, among other factors, on the kind of bedrock and on the engraving techniques used: bedrocks with hardness below 5 in Mohs scale can be easily engraved with sharp and/or pointed flakes (Alvarez and Fiore 1995). This clearly broadens the scope of expected tool types to be identified within specific archaeological assemblages, and adds new morphological criteria that help make a preliminary macroscopic identification. Yet, the confirmation that a certain archaeological tool has been used in an engraving task requires microscopic analyses (Semenov 1964; Bednarik 1998, 2001). Observations of experimental and archaeological tools with optical microscopes and SEM have helped identify a series of micowear traces left on the points and edges of the engraving tools which are distinctive of percussion, scraping and incision techniques (Allain 1979; d'Errico and Sacchi 1995; Bednarik 1998; 2001; Alvarez et al. 2001). These tools include not only chisels but also flakes and cobbles.

Thus, experiments and microscopy show that not all engraving (or other petroglyph) tools were necessarily curated artefacts: in certain cases, expedient artefacts were also useful for this task. These cases entail less labour investment in tool production. Yet, labour investment in engraved rock art production also depends on the size of the motifs, types of technique and bedrock hardness, and therefore requires a specific contextual assessment in each case study.

The *operative chain of paint production* also concerns specific work processes and the manipulation of certain resources to produce different colours of paint. The *raw materials* needed to *manufacture* paint are pigments, which act as the *colorant* (these are usually of mineral nature although organic substances have also been used). These can be detected by x-ray diffraction, FTIR or SEM-EDX, among other techniques (Rial and Barbosa 1983/85; Couraud 1988; Clottes 1993). Analyses of paint samples from five Patagonian sites using x-ray diffraction, FTIR and polarising microscopy indicate the use of haematite, goethite, maghemite, green earth (celadonite or glauconite) and manganese oxide black (pyrolusite), among other components. Gypsum has also been identified, both as a component of the samples and as an accretion (e.g. Wainwright et al. 2001). These minerals are available in different portions of the Patagonian landscape and their exploitation would not have required a high labour investment. Yet it has been noted that in some sectors of the Cardiel-Strobel region the use of paint was not favoured (while engravings were preferred) when pigment quarries were distant (Belardi and Goñi 2006).

In some cases, an organic substance was used as a *binder* to fix the paint on the bedrock (e.g. blood, honey, beeswax, eggwhite or animal grease; see Dewdney and Kidd 1967 and Grant 1967 cited in Watchman 1993). Yet, experiments show that this does not always guarantee paint durability (Couraud 1988). Organic binders can be detected through gas chromatography and CG-EM, among other techniques (e.g. Clottes 1993). Analyses of Patagonian samples have usually shown an absence of binders (e.g. Wainwright et al. 2001), which may be related to their decay or to their lack of use during paint preparation.

The economic level in this chain can be inferred by analysing the availability of pigments and location of pigment quarries, the relative cost of their exploitation, and their technical requirements and labour investment during their extraction and paint manufacture.

Both the *manufacture* and *use* stages of this chain involve the *use* of artefacts produced through the *operative chain of artefact production*, and also overlap with the *manufacture* stage of the *operative chain of image production*.

The *operative chain of image production* involves a series of painting and engraving techniques which are used on a bedrock (Figs 1, 2 and 3; Fig. 2 is on the front cover), and which are almost exclusive of this kind of work (portable art and body decoration sometimes share variants of some of these techniques).

As noted above, this operative chain overlaps with the artefact production chain and — if images are painted — with the paint production chain. Hence, the raw materials used in this chain are provided through the development of one or both of those chains. The *resource procurement* stage in this operative chain is thus focused on the selection of the space in which the images will be created, both at an intra-site level (panel) and at an inter-site level (site). Included in this stage is not only the selection of space in which to produce and display the images, but also the occasional task of *bedrock preparation*. This can be done through several devices, such as, for example, applying a coat of gypsum (Aschero 1983/85).

Regarding space selection, at an inter-site level the choice of sites to paint or engrave necessarily leaves out other sites: the study of the whole set of available bedrocks and not just the ones which display rock art images is an invaluable approach to unveil the decisions behind their selection[5] (Bradley et al. 1994). This approach can shed light on the ideological-symbolic and economic aspects of bedrock selection. The ease versus difficulty to reach a site and to move inside it, its sheltering conditions for protecting both people and rock art, its orientation (regarding sunlight, wind, cardinal points etc.), and its visibility conditions (towards and from the site, towards and from the rock art) are spatial aspects which can simultaneously have symbolic and economic implications: a certain cardinal orientation may have been chosen for its mythical meaning and/or due to the protection it offers from the weather (e.g. Leroi-Gourhan 1968; Aschero 1988; Bahn and Vertut 1988; Fiore 1996). Rock art can be thus involved in the creation of cultural landscapes and territorial boundaries due to both ideological and economic factors operating behind its spatial distribution (e.g. Conkey 1984; Schaafsma 1985; Llamazares 1989). As noted above, the archaeological discrimination between ideological and economic aspects is easier when the former show patterns which are unattainable to economic reasons. Their coincidence in a single spatial pattern may lower the archaeological visibility of ideological aspects when the pattern can be explained for economic reasons, but it does not necessarily imply that only economic reasons were behind certain spatial choices.

At an intra-site level, the association between certain motifs and certain bedrock features (holes, crevasses, dark areas, well-illuminated areas etc.) indicates that their plastic composition and their potential ideological contents were not spatially constructed at random. Moreover, the use of specific portions of the bedrock may show that special features like niches or fissures were as meaningful as the images themselves (e.g. Leroi-Gourhan 1968; Casamiquela 1968; González 1974; Gradin et al. 1977; Llamazares 1989; Ouzman 1998). This may indicate that space was as meaningful as the images themselves. Also, the fact that not only the easily reached portions of the bedrock were used to produce rock art (e.g. Aschero 1988; Balbín and Moure Romanillo 1982), but also that almost-unreachable panels were used as a canvas, show that labour investment was not always minimised. Moreover, such high labour investment may have been part of the message jointly conveyed by the images and their costly spatial location: the time, energy and skilled work invested in such production may have been signs of economic power.

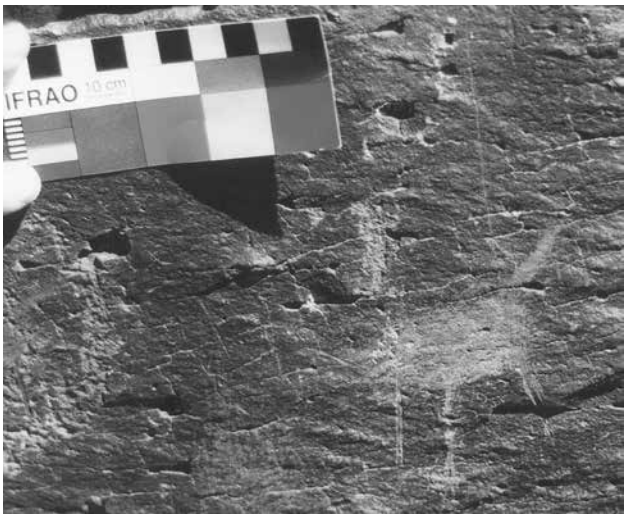

Figure 3. *Engraved (scraped and incised) zoomorph ('guanaco'). Bi Aike, northern shore of Santa Cruz River (Santa Cruz, Patagonia, Argentina). (Fig. 2 is on the front cover.)*

Regarding the *manufacture* stage, rock art images are usually done either by painting and engraving techniques, used independently or combined (Figs 4 and 5; Fig. 4 is on the back cover) [6]. All engraving techniques are extractive and involve '... a mark made by removing material from a rock surface ...' (Flood 1987: 92; Maynard 1977; Rosenfeld 1988). Several engraving techniques have been described by different authors, sometimes resulting in the same technique being named with different terms (Fiore 1996/98). The more frequently mentioned are incision, scraping, pecking/pounding and drilling. These techniques have been defined from observation of certain features, including groove width, groove depth, groove section, groove continuity or discontinuity, and traces (striations and pits) left by the engraving tool inside the motifs and on the bedrock (e.g. Sujo Volsky 1975; Maynard 1977; Flood 1987; Podestá 1988; Delluc and Delluc 1978; Fossati et al. 1990; Bednarik 1998; see further details in Fiore 1996/1998).

Experiments done with lithic tools on North Pa-

5 Whether spatial patterns are found or not, they should always be assessed in terms of the possibility that some rock art images may have disappeared due to taphonomic factors and/or to human agents (e.g. vandalism).

6 Other techniques have also been reported, yet they are less frequent and will not be treated in this paper.

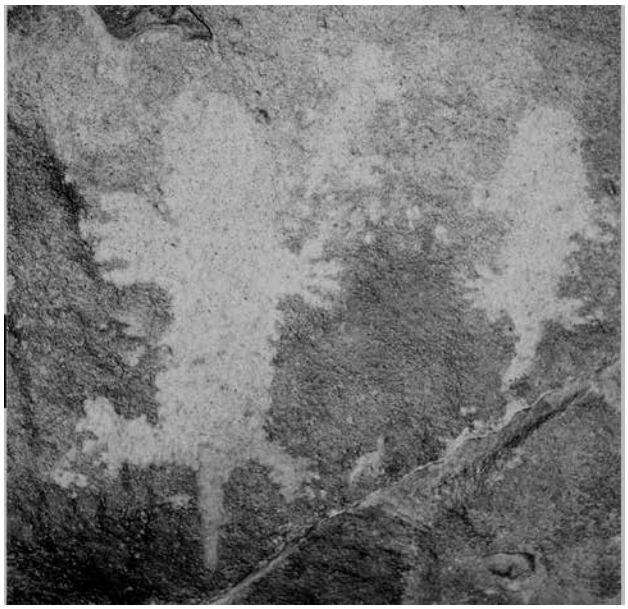

Figure 5. *Engraved (pecked) 'matuastos'. Uli, Cardiel-Strobel region (Patagonia, Argentina). (Fig. 4 is on back cover.)*

tagonian tuff of 3–4 hardness in Mohs scale show that each engraving technique leaves diagnostic macroscopic traces (Alvarez and Fiore 1995):

(a) *Incision* involves the use of the edge or point of a tool (which as noted above can be a flake and is not necessarily a chisel or a burin) which are positioned parallel to the direction of movement and is moved unidirectionally or bidirectionally; it leaves a groove with a narrow V-shape (though it can leave U-shaped grooves in harder bedrocks).

(b) *Scraping* involves the use of a tool's edge which is positioned transversal to the direction of movement and is moved unidirectionally or bidirectionally; if the edge is short, it leaves a slightly wider groove than incision with a concave shape, if the edge is long, it leaves not a groove but an entire homogenous surface which is clearly distinguishable from the bedrock's irregular surface.

(c) *Pecking* involves hitting the rock surface directly with one tool (direct percussion) or with two artefacts (indirect percussion, using a chisel and a hammer; these usually offer greater control of the impact and hence on the motif's design); this technique leaves small shallow pits with a softly concave shape on the bedrock.

(d) *Drilling* involves a rotational movement of the artefact to make a round hole on the bedrock with very well-defined limits and a wide concave shape.

These experimental results are quite coherent with the macroscopic features quoted above from the bibliography and thus help their validation as relevant diagnostic criteria. In terms of labour investment, these experiments on North Patagonia tuff bedrocks show that in rocks of hardness 3–4 in Mohs scale, all techniques are relatively similar in terms of time investment and number of blows/strokes. Preliminary experiments using three techniques (incision, scraping and direct pecking) on dolerite (Santa María Valley, north-western Argentina) and basalt (Cardiel-Strobel region, southern Patagonia) indicate that when bedrocks are harder:

(1) *Pecking*: (a) is more effective for bedrock removal in terms of time (though not necessarily in terms of number of blows/strokes) in bedrocks with hardness of 5, (b) sometimes entails fragmentation of the tool, (c) is the most effective technique when engraving bedrock with hardness of 6;

(2) *Incision*: (a) consumes more time than pecking to produce the same number of blows/strokes in bedrock with hardness of 5, (b) the active edge or point is rapidly blunted in bedrock of 5, and thus requires tool maintenance or tool change, (c) can achieve the same visual contrast and more shape control than pecking in bedrock with hardness of 5, (d) is not an efficient technique to engrave bedrock with hardness of 6.

(3) *Scraping*: (a) consumes more time than pecking to produce the same number of blows/strokes in bedrock with hardness of 5, (b) generates a lower visual contrast than pecking in bedrock with hardness of 5, (c) is not an efficient technique to engrave bedrock with hardness of 6.

These observations suggest that some technical choices may have been related to bedrock hardness in order to minimise time and/or energy investment or to reduce tool-damage. This seems to have been the case in the petroglyphs from Santa María Valley, which were all produced through pecking on dolerite bedrocks with hardness of 6 (Fiore 1997; see Fig. 1). Yet, in other cases technical choices do not always reflect an optimisation interest: in regions such as the Cardiel-Strobel region and the northern shore of Santa Cruz river region (southern Patagonia), certain motifs, like the 'guanacos' (*Lama guanicoe*) were produced by a combination of scraping and incision (Belardi and Goñi 2006; Ferraro and Molinari 2006; and pers. obs.; see Fig. 3, compare to Fig. 2, front cover). The use of these techniques — which are more time-consuming and less frequent in the region — to represent these animals — which were a crucial staple of Patagonian hunter-gatherers — clearly indicates that labour investment in their production was not considered an unaffordable 'cost' but rather as a sensible expense. Such investment may have even constituted a powerful material aspect of the symbolic message conveyed by these motifs.

The *manufacture* stage also involves painted motifs. As noted above, this requires a specific operative chain to produce paint. Paint is then used in the operative chain of image production when it is applied through different techniques, including hand-painting, brush-painting, rod-painting and stencil-painting. These

techniques can be used to produce positive or negative paintings, which can be monochrome, bichrome or polychrome (e.g. Leroi-Gourhan 1968; Clottes 1993). The assessment of the labour investment implied by each technique will not be explored here due to space reasons. Suffice it to say that it should include variables such as resource availability, and time and technical skill requirements. Experiments have shown that these variables are in fact identifiable in many archaeological records (Lorblanchet 1991).

An interesting example of differential technical skill investment has been found by Carden, who has analysed 32 sites in the Central Plateau of Santa Cruz province (southern Patagonia), among which 27 contain negative hands. Of these, one site shows two small hands (which due to their size are clearly of children): one is a negative red hand outlined in ochre, the other one is a negative hand outlined in ochre, framed in a black oval which in turn has also been framed in ochre and has been sprinkled with white paint (Carden 2007). These two hand negatives are technically the most complex of the region (ibid.) and suggest that labour was specially invested in the representation of children's hands, which hints towards their social significance within the group. They also suggest a possible social relation of production established between children and adults, since the former may have been helped by the latter to produce these complex designs.

Combinations of different kinds of engraving techniques, of painting techniques, and of painting and engraving techniques have been observed (Llamazares 1982; Podestá 1988), although the latter are not frequent in Patagonia. In fact, a systematic survey of published Patagonian rock art shows that out of 489 sites[7], 347 (71%) are painted, 109 (22%) are engraved, while only 33 (7%) show combinations of painting and engraving techniques (Fiore 2006). This is particularly interesting since paintings are more frequent in spite of potential taphonomic problems that can affect their conservation (Rosenfeld 1988; Bednarik 1994), which suggests that this proportion seems not entirely attributable to sampling problems. The fact that most sites show images made with only one kind of technique may have to do with economic aspects such as regional availability of raw materials (e.g. pigments to produce paint) or bedrock hardness (which can foster or discourage engraving production). However, other factors may have also played an important part in these technical choices. The production of paintings and engravings seems not to have started at the same time: relative dates indicate that painted images were produced from 9320 ± 80 BP onwards (Gradin et al. 1977) while engraved motifs[8] were produced at least from 2526 ± 80 BP onwards (Ceballos and Peronja 1983). This may partly explain their considerable quantitative difference. Yet, at a broad spatial scale, paintings and engravings appear throughout Patagonia with a similar spatial distribution (although engravings do not reach beyond Santa Cruz river, in its very southern portion). One reason for the speedy spatial distribution of engravings in a shorter period of time is that engraving techniques might have been more expedient due to the fewer operational chains required to produce them (when the bedrock presented a suitable hardness) and to the more durable quality of the resulting images. But other relative dates show that paintings kept being produced even when engravings were already in use (see details in Fiore 2006). Thus, technical choices were not only related to cost-minimising economic factors (such as expedience, durability or pigment-quarry distance): other perceptual and affective factors which escape economic rationality such as colour, texture and contrast with bedrock, may also have influenced the choice for a certain technique.

The manufacture stage does not entail that all rock art in a site was produced simultaneously, since sites were revisited and new motifs were produced. Indicators of these different manufacture moments include superimpositions, differential pigment weathering and different engraving patina tones, although their degree of temporal resolution and reliability is quite variable (Aschero 1988; Bednarik 2001). These different manufacture moments refer to the initial production of a motif, and should not be confused with the maintenance and recycling stages.

The *maintenance* stage of this operative chain can occur when a motif has been damaged in any way and the same technique is used to restore its original shape, or when a motif is 'retouched' as part of its re-use throughout the group's social life (e.g. in daily or seasonal rituals). This stage is difficult to recognise archaeologically from macroscopic observations, because maintenance with the same technique may leave no diagnostic traces. However, a painted motif with different degrees of conservation, or an engraved motif with portions with different patinae, may be useful maintenance indicators (although selective weathering should firstly be assessed to reject taphonomic causes).

The *recycling* stage can be recognised when new elements are added the motif's original shape, or when the motif has later been included as part of a new one, either by the same technique or by a different one. Superimpositions of different paint colours, of different engraving techniques and of different patinae are useful macroscopic recycling indicators. Mineral pigment analysis and AMS dating (e.g. Rial and Barbosa 1983/1985; Clottes et al. 1990) can also help

7 The currently known number of rock art sites in Patagonia is higher.

8 Engravings of lines called 'basal markings' have been found in Epullán Grande Cave (northern Patagonia) beneath sediments with a relative date of 9970 ± 100 BP (Crivelli and Fernández 1996). The chronological relevance of this important case has been discussed in detail elsewhere (Fiore 2006).

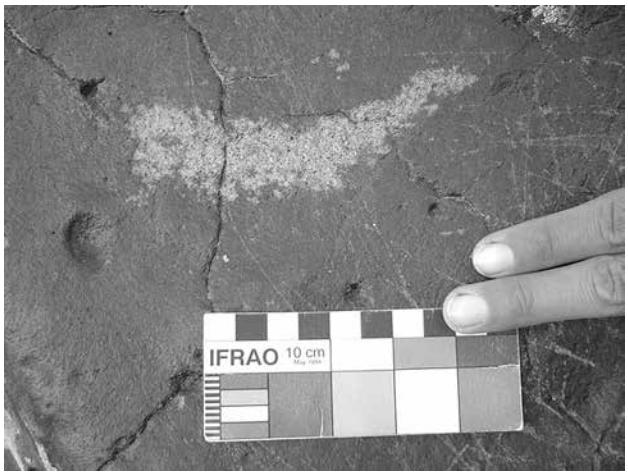

Figure 6. *Engraved 'guanaco' produced by scraping and incision, recycled through pecking. Uli, Cardiel-Strobel region (Patagonia, Argentina). Photograph by Anahí Re.*

detect maintenance or recycling cases. An interesting recycling case has been identified in the site Paredon Lanfré, Manso river (central Patagonia): a painted 'guanaco' motif has been recycled into a 'horse' (which was introduced to South America by the Europeans; Bellelli et al. 2005). In this case, such recycling suggests a symbolic reconfiguration of the social world of the Patagonian natives.

Extremely few cases show a combination of *maintenance of a motif's form through technical recycling*. Examples of this are an engraved three digit-footprint motif at Abrigo de Pilcaniyeu (northern Patagonia), which suffered partial damage and was recycled through painting (Llamazares 1982); and a scraped and incised 'guanaco' at Uli (Cardiel-Strobel region, southern Patagonia) that has been recycled through pecking (unpubl. pers. records; Fig. 6). These cases suggest the existence of different rates of change between form and technique in rock art motifs: while motif form is being maintained and thus shows a slower rate of change, new techniques are used and thus show a faster rate of change[9]. Again, this can be attributed to economic causes, e.g. changes in technique may respond to differential labour investment — and/or to ideological causes — *both* the technique and shape of a motif can involve symbolic implications that may have influenced their continuity or discontinuity in time. Yet, a motif's shape usually carries more meaning than its technique: this would account for its continuity in time in spite of its different material expressions.

Final comments: breaking dichotomies

The material creation of rock art involves production sequences of different degrees of complexity, depending on the materials, techniques and designs involved. The three different operative chains proposed in this paper have been separated for analytical purposes, but some of their steps overlapped in practice. Facing a painted image with these concepts implies that the act of applying paint on a bedrock to produce a motif was one stage — use of artefact — of the *operative chain of artefact production*; the last stage — use of paint — of the *operative chain of paint production*; and the first stage — manufacture — of the *operative chain of image production*. The actual combination of *stages* of these different *operative chains* defines a concrete *production sequence*.

The artefact production and pigment production chains have the potential to link rock art on the bedrock with production remains on the site. They also involve off-site activities, because procurement of raw materials usually happens elsewhere; hence, they help integrate the site with its landscape and to focus on ancient people's regional practices.

Following the manufacture, maintenance and recycling steps that each motif underwent during the operative chain of image production can be a useful approach to unveiling production tendencies in a site (e.g. motif/technique associations, types of motifs selected for recycling etc.). This can also be a relevant methodological tool to make inter-site comparisons: recurrences in the production tendencies at contemporaneous sites can show regional productive trends.

The perspective that underlies this approach favours a break with the theoretical conception that stems from the Cartesian mind/body dichotomy and thus splits material culture into only-ideological or only-economic objects. It favours instead the notion that both economy and ideology are aspects of any cultural product. Rock art is no exception.

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9 The opposite — technical continuities and motif changes through time (and space) — is obviously possible and indeed quite frequent in Patagonia (Fiore 2006).

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REFERENCES

Allain, J. 1979. L'industrie lithique et osseeuse de Lascaux. In A. Leroi-Gourhan and J. Allain (eds), *Lascaux inconnu*, pp. 87–106. XIIe Suplément à Gallia Préhistoire. CNRS, Paris.

Alvarez, M. 1999. La producción de artefactos líticos en el sudoeste de Río Negro. *Relaciones de la Sociedad Argentina de Antropología* 24: 257–276.

Alvarez, M. and D. Fiore 1993. La arqueología como ciencia social: apuntes para un enfoque teórico - epistemológico. *Boletín de Antropología Americana* 27: 21–38.

Alvarez, M. and D. Fiore 1995. Recreando imágenes: diseño de experimentación acerca de las técnicas y los artefactos para realizar grabados de arte rupestre. *Cuadernos del Instituto Nacional de Antropología* 16: 215–240.

Alvarez, M., D. Fiore, E. Favret and R. Castillo Guerra 2001. The use of lithic artefacts for making rock art engravings: observation and analysis of use-wear traces in experimental tools through optical microscopy and SEM. *Journal of Archaeological Science* 28: 457–464.

Aschero, C. 1983/85. Pinturas rupestres en asentamientos cazadores-recolectores. Dos casos de análisis aplicando difracción de rayos X. *Cuadernos del Instituto Nacional de Antropología* 10: 291–306.

Aschero, C. 1988. Pinturas rupestres, actividades y recursos naturales, un encuadre arqueológico. In H. Yacobaccio (ed.), *Arqueología Contemporánea Argentina*, pp. 109–142. Búsqueda, Buenos Aires.

Bahn, P. and J. Vertut 1988. *Images of the Ice Age*. Windward, England.

Balbín, R. and A. Moure Romanillo 1982. El panel principal de la cueva de Tito Bustillo. *Acta Praehistorica* 1: 47–96.

Bard, J. and C. Busby 1974. The manufacture of a petroglyph: a replicative experiment. *Contributions of the archaeological research facility (Berkeley): Four Great Basin Petroglyph Studies* 20: 83–101.

Bednarik, R. G. 1994. A taphonomy of palaeoart. *Antiquity* 68: 68–74.

Bednarik, R. G. 1998. The technology of petroglyphs. *Rock Art Research* 15: 23–35.

Bednarik, R. G. 2001. *Rock art science. The scientific study of palaeoart* (2nd edn 2007). Brepols, Turnhout.

Belardi, J. and R. Goñi 2006. Representaciones rupestres y convergencia poblacional durante momentos tardíos en Santa Cruz (Patagonia argentina). El caso de la meseta del Strobel. In D. Fiore and M. M Podestá (eds.), *Tramas en la piedra. Producción y usos del arte rupestre*, pp. 85–94. WAC, AINA and SAA, Buenos Aires.

Bellelli, C., V. Scheinsohn, M. Podestá, M. Carballido and P. Fernández 2005. Arqueología, arte rupestre y turismo. Comarca Andina del Paralelo 42. *Argentina, Estudios y Perspectivas en Turismo*. 14: 22–50.

Binford, L. 1979. Organization and formation processes: looking at curated technologies. *Journal of Anthropological Research* 35(3): 255–273.

Boschín, M. T. 2000. Sociedades cazadoras del Area Pilcaniyeu: elementos para un análisis territorial. *Mundo Ameghiniano* 4: 1–75.

Boschín, M. T. and L. Nacuzzi 1980. Investigaciones arqueológicas en al Abrigo de Pilcaniyeu, Río Negro. *Sapiens* 4: 123–129.

Bradley, R., F. Criado Boado and R. Fabregas Valcarce 1994. Rock art research as landscape archaeology: a pilot study in Galicia, north-west Spain. *World Archaeology* 25(3): 374–390.

Carden, N. 2007. Estudio del arte rupestre de la Meseta Central Patagónica (área de los zanjones Blanco y Rojo), provincia de Santa Cruz. Unpubl. PhD thesis, Facultad de Ciencias Naturales y Museo, UNLP.

Casamiquela, R. 1968. Novedades interpretativas con relación a nuevos yacimientos con grabados rupestres del norte de la Patagonia. *Actas XXXVII Congreso Internacional de Americanistas* 3: 375–395.

Ceballos, R. and A. Peronja 1983. Informe preliminar sobre el arte rupestre de la Cueva Visconti, provincia de Río Negro. *Relaciones de la Sociedad Argentina de Antropología* 15: 109–119.

Clottes, J. 1993. Paint analyses from several Magdalenian caves in the Ariège region of France. *Journal of Archaeological Science* 20: 223–235.

Clottes, J., M. Menu and P. Walter 1990. New light on the Niaux paintings. *Rock Art Research* 7: 21–27.

Conkey, M. 1984. To find ourselves: art and social geography of prehistoric hunter-gatherers. In C. Shire (ed.), *Past and present in hunter-gatherer studies*, pp. 253–276. Academic Press, New York.

Couraud, C. 1988. Pigments utilises en prehistoire: provenance, preparation, modes d'utilisation. *L'Anthropologie* 92: 17–28.

Crivelli, E. and M. Fernández 1996. Palaeoindian bedrock petroglyphs at Epullán Grande Cave. *Rock Art Research* 13: 124–128.

Davis, W. 1986. The origins of image making. *Current Anthropology* 27: 193–215.

Delluc, B. and G. Delluc 1978. Les manifestations graphiques Aurignaciennes. *Gallia Préhistoire* 21: 213–438.

d'Errico, F. and D. Sacchi 1995. Approche technologique des pétroglyphes, premiers résultats et perspectives de recherches. Les pétroglyples de Tamgaly. *Bulletin of the Asia Institute* 9: 167–207.

Ferraro, L. and R. Molinari 2006. Uso y valoración de las altas mesetas santacruceñas a partir del estudio del arte rupestre. Lago Strobel (Argentina). In D. Fiore and M. M Podestá (eds), *Tramas en la piedra. Producción y usos del arte rupestre*, pp. 95–102. WAC, AINA and SAA, Buenos Aires.

Fiore, D. 1996. El arte rupestre como producto complejo de procesos económicos e ideológicos: una propuesta de análisis. *Espacio, Tiempo y Forma*, Serie I, Prehistoria y Arqueología 9: 239–259.

Fiore, D. 1996/1998. Técnicas y artefactos para realizar grabados rupestres. Una investigación bibliográfica. *Palimpsesto* 5: 208–222.

Fiore, D. 1997. Analysis of Ampajango rock art, Santa María, Argentina: an approach to the structure of its design and the technology of its production. Unpubl. MA. thesis, University of London, UCL Institute of Archaeology, London.

Fiore, D. 1999a. The economic side of rock art. A contribution to another analytical approach. *Proceedings of the 1995 NEWS International Rock Art Congress*, Torino, CD-

ROM.

Fiore, D. 1999b. Cuestiones teórico-metodológicas e implicaciones arqueológicas en la identificación de artefactos utilizados en la producción de grabados rupestres. Hacia una arqueología del arte. *Relaciones de la Sociedad Argentina de Antropología* 24: 277–291.

Fiore, D. 2002. Body painting in Tierra del Fuego. The power of images in the uttermost part of the world. Unpubl. PhD thesis, University of London, UCL Institute of Archaeology, London.

Fiore, D. 2006. Poblamiento de imágenes: arte rupestre y colonización de la Patagonia. Variabilidad y ritmos de cambio en tiempo y espacio. In D. Fiore and M. M Podestá (eds), *Tramas en la piedra. Producción y usos del arte rupestre*, pp. 43–62. WAC, AINA and SAA, Buenos Aires.

Flood, J. 1987. Rock art of the Koolburra Plateau, north Queensland. *Rock Art Research* 4: 91–126.

Fossati, A., L. Jaffe and M. Simões de Abreu 1990. *Rupestrian archaeology. techniques and terminology*. Ricerche Archeologiche 1(I), Cooperativa Archeologica Le Orme dell´Uomo, Val Camonica.

Garcia Canclini, N. 1986. *La producción simbólica. Teoría y método en sociología del arte*. Siglo XXI, Mexico.

Godelier, M. 1976. *Antropología y Economía*. Anagrama, Barcelona.

Gonzalez, A. R. 1974. *Arte, estructura e ideología*. Nueva Visión, Buenos Aires.

Gradin, C. 1979. Los grabados de la Angostura de Gaiman (Prov. de Chubut). *Miscelánea de Arte Rupestre de la República Argentina* 1: 151–171.

Gradin, C., C. Aschero and A. Aguerre 1977. Investigaciones arqueológicas en la Cueva de las Manos (Alto Río Pinturas, Santa Cruz). *Relaciones de la Sociedad Argentina de Antropología* 10: 101–170.

Leroi-Gourhan, A. 1953–1955. *Evolution et techniques*. Albin Michel, Paris.

Leroi-Gourhan, A. 1968. *The art of prehistoric man in western Europe*. Thames and Hudson, London.

Leroi-Gourhan, A. 1976. Sur les aspects socio-économiques de l´art paléolithique. *L´autre et l´ailleurs*. Hommages à Roger Bastide, pp. 164–168. Berger-Levrault, Paris.

Llamazares, A. M. 1982. Arte rupestre del Abrigo de Pilcaniyeu, Provincia de Río Negro. *Relaciones de la Sociedad Argentina de Antropología* 14: 103–120.

Llamazares, A. M. 1989. El estilo 'pisadas' en la Patagonia Argentina. Análisis de su formulación y algunos datos sobre una posible modalidad septentrional. *SIARB Boletín* 3: 48–56.

Lorblanchet, M. 1991. Spitting images: replicating the spotted horses at Pech Merle. *Archaeology* 44: 24–31.

Maynard, L. 1977. Classification and terminology in Australian rock art. In P. Ucko (ed.), *Form in indigenous art*, pp. 387–402. Australian Institute of Aboriginal Studies, Canberra.

Mithen, S. 1996. The origin of art. Natural signs, mental modularity and visual symbolism. In H. Maschner (ed.), *Darwinian archaeologies*, pp. 197–217. Plenum Press, New York.

Onetto, M. 1991. Propuesta para la integración del Arte Rupestre dentro del sistema de comportamiento de los cazadores-recolectores del Valle de Piedra Parada. Curso medio del Río Chubut. In M. I. Hernández Llosas, M. Podestá, S. Renard de Coquet (eds), *El arte_rupestre en la Argentina contemporánea*, pp. 123–131. FECIC-SAA, Buenos Aires.

Ouzman, S. 1998. Towards a mindscape of landscape as expression of world understanding. In C. Chippindale and P. Taçon (eds), *The archaeology of rock art*, pp. 31–41. Cambridge University Press, Cambridge.

Pelegrin, J., P. Bodu and C. Karlin 1988. 'Chaînes opératoires': un outil pour le préhistorien. *Technologie préhistorique. Notes et Monographies Techniques* 25: 55–62.

Pfaffenberger, B. 1992. Social anthropology of technology. *Annual Review of Anthropology* 21: 491–516.

Piaget, J. 1971. *Biology and knowledge: an essay on the relations between organic regulations and cognitive processes*. Edinburgh University Press, Edinburgh.

Podestá, M. M. 1988. Soportes y tecnología de grabados rupestres. Paper presented at IX Congreso Nacional de Arqueología Argentina, Buenos Aires.

Rial, G. and C. Barbosa 1983/85. Análisis mineralógico por Difracción de Rayos X de muestras de pinturas del sitio Inca Cueva-4 (Depart. Humahuaca, Prov. de Jujuy). *Cuadernos del Instituto Nacional de Antropología* 10: 307–311.

Rosenfeld, A. 1988. *Rock art conservation in Australia*. Special Australian Heritage Publication Series 2, Canberra.

Schaafsma, P. 1985. Form, content and function: theory and method in North American rock art studies. *Advances in Archaeological Method and Theory* 8: 237–277.

Schiffer, M. 1972. Archaeological context and systemic context. *American Antiquity* 37: 156–165.

Semenov, S. 1964. *Prehistoric technology*. Moonraker Press, Wiltshire.

Sujo Volsky, J. 1975. *El estudio del arte rupestre en Venezuela*. Instituto de Investigaciones Históricas, Universidad Católica Andrés Bello, Caracas.

Ucko, P. and A. Rosenfeld 1967. *Palaeolithic cave art*. World University Library, London.

Wainwright, I., K. Helwig, D. Rolandi, C. Aschero, C. Gradin, M. Podestá, M. Onetto and C. Bellelli 2001. Identification of pigments from rock paintings sites in Argentina. *L´art avant l´histoire. 10es. Journées d´etudes de la section Francaise*, pp. 15–24. Paris.

Watchman, A. 1993. Perspectives and potentials for absolute dating prehistoric paintings. *Antiquity* 67: 58–65.

Whitley, D. (ed.) 2001. *Handbook of rock art research*. AltaMira Press, Walnut Creek, CA.

Winterhalder, B. and E. Smith (eds) 1981. *Hunter-gatherer foraging strategies. Ethnographic and archaeological analyses*. The University of Chicago Press, Chicago.

Wolff, J. 1993. *The social production of art*. Macmillan, London.

Wynn, T. 1981. The intelligence of Oldowan hominids. *Journal of Human Evolution.* 10: 529–541.

Zis, A. 1987. *Fundamentos de la estética marxista*. Raduga, Moscow.

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