Chapter 14
Culture, Environmental Adaptation or Specific Problem Solving? On Convergence and Innovation Dynamics Related to Techniques Used for Stone Heat Treatment

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Abstract Heat treatment of stone for tool knapping may have been one of the oldest documented transformative techniques of materials. It has been interpreted as shedding light on the technical behavior of past humans, on their time- or resource-management and even on their cognitive capacities. Its earliest invention likely dates to the African Middle Stone Age, but prominent examples are also known from more recent periods on all other continents. In all of these contexts, stone was heated with specific techniques, applying specific parameters, and in many cases these vary between regions. Differences may be interpreted as technical responses to specific problems, as adaptations to environmental factors like climate, or alternatively as more or less random markers of cultural identity. This chapter will consider these possibilities by comparing the techniques and parameters applied during heat treatment in five different archaeological contexts: the earliest known cases from Southern Africa; the European Upper Paleolithic Solutrean culture; the European Mesolithic Beuronien culture; the European Neolithic Chassey culture; and the recent North-American Paleo-Indian period. During these five periods, stone was transformed for purposes that may be interpreted as being similar yet slightly different. The stones themselves were of different nature and strong variability of the used heating parameters can be observed. In the end of this chapter, I will discuss observations on the dynamics of invention, reinvention and technical convergences.

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Introduction

Heat treatment of stone for tool knapping may well be one of the oldest documented transformative techniques of materials. Its invention in the southern African Middle Stone Age (MSA) (Brown et al. 2009) marks a turning point in the cultural evolution of modern humans because stone knappers no longer accepted the properties of available resources, but began to deliberately transform them. Heat treatment is also known from later periods such as the European Upper Paleolithic and Mesolithic (Bordes 1969; Tiffagom 1998; Eriksen 2006), the American Paleo-Indian period (Crabtree and Butler 1964; Wilke et al. 1991) and the European Neolithic (Binder 1984; Léa 2005). It has been interpreted as being a proxy for many archaeological concepts: modern behaviors (Sealy 2009), complex cognition (Wadley 2013), high technical skill (Inizan and Tixier 2001) or non-shared specialized craftsmanship (Léa et al. 2012). The underlying assumption is that heat treatment requires an important investment in terms of cognition, resources and time. This assumption, in turn, is based on interpretations of the actions performed and choices made during the heating process: the heating technique and procedure. Unfortunately, such heating techniques cannot be easily reconstructed from material evidence. This has been possible in the past at sites that preserved intact heating structures (for an example see: Shippee 1963) but evidence of this kind is fairly rare in the archaeological record (Schmidt 2016). In most cases, heating techniques must be understood by reading a set of proxies specific to a particular heating environment or procedure. This has recently been attempted for four chrono-cultural contexts: the southern African MSA (see for example:

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Schmidt et al. 2015b), the European Upper Paleolithic Solutrean (Schmidt and Morala 2018), the Mesolithic Beuronian of southern Germany (Schmidt et al. 2017b) and the French Neolithic Chassey culture (Schmidt et al. 2013a). These contexts together allow us to appreciate a first picture of the technical solutions to heating stone at different periods and in different natural environments.

The obvious question arising from these first datasets is whether these techniques were similar (either completely, or partially—i.e. containing at least similar elements). The potential implications of similarities observed in a priori unrelated contexts could be of potential importance for understanding the mechanisms of original invention, but also of potentially independent reinvention (see for example: Tennie et al. 2017). Reinvention implies the possibility for partial or full independent convergence that, if observed in two archaeological contexts, raises questions about the role of cultural transmission in explaining similarities (see also, Shennan 2020). In other words, are similar technical behaviors across some or all contexts the result of cultural transmission? Or did similarities arise in the absence of cultural transmission? How may we envision that such independent convergence happen? One potential answer lies in the responses to specific natural environments, another in the predictability of individual reaction to specific technical problems. This chapter will examine these questions by comparing the parameters of some of the archaeologically documented heating techniques. Another possibility to investigate these questions would be to rely on descriptions of ethnographic observations of heat treatment (see for example: Hester 1972; Mandeville 1973), but most reports are short and imprecise in terms of the preformed actions, heating environments, even the nature of the stones that were heated. This discussion will therefore only take into account the archaeological contexts for which explicit material evidence on at least some aspects of the used heating technique is available.

Expectations and competing hypotheses: At first glance, there are two possible explanations of the heat treatment-related patterns observed across contexts: Heating techniques may be [1] culturally transmitted from one context to another, or [2] independently (re-)invented at different places and times. In the first case, transmission, we would expect to observe a relation between techniques used at different times in confined regions. Such a relation might be the absence of change over time, but also gradual not immediately reversible change (local evolution). However, the search for such a relation only allows to make a negative argument: a relation between contexts would neither exclude transmission nor reinvention, but the absence of a relation would plead against transmission. If reinvention had been at play, the question becomes: can we observe independent convergence in heating techniques? The absence of any convergence will most likely lead to the conclusion that it is impossible to explain invention dynamics by external factors. If we can observe (at least partial) convergence, we can try to investigate the mechanisms driving the invention and adaptation of techniques.

The Southern African Middle and Later Stone Age

Archaeologists have only recently discovered the antiquity of heat treatment of silcrete (a relatively coarse-grained pedogenic silica rock) in the archaeological record of South Africa's Cape region. The discovery by Brown et al. (2009) that some artefacts were heat-treated in c. 164 ka old deposits at the site of Pinnacle Point showed for the first time that MSA hunter-gatherers intentionally transformed some of their raw materials with fire. The authors also found that at c. 71 ka, almost all silcrete artefacts had been knapped after being heated, suggesting an important role of heat treatment in local technology. Other datasets from the MSA (Schmidt et al. 2015b; Delagnes et al. 2016) and the Later Stone Age (LSA) (Porraz et al. 2016) also revealed more than 80% of all silcrete to be heat-treated. Hence, heat treatment was used as a standard procedure, applied to all or almost all silcrete before knapping in the MSA and LSA of Africa's Cape region.

The heating technique used for these thermal treatments, and the investment in time and resources they require, have also been the subject of intensive debates, initiating a discussion about technical complexity and cognitive capacity (Brown and Marean 2010; Schmidt et al. 2013b, 2015a; Wadley 2013; Wadley and Prinsloo 2014). For example, if silcrete heat treatment was a time and resource consuming process as suggested by some authors (Brown et al. 2009; Brown and Marean 2010; Wadley 2013; Wadley and Prinsloo 2014), it must have considerably slowed down the lithic reduction sequence and most likely also altered raw material and resource provisioning strategies. This would have a significant impact on the selective context that made such investment worthwhile. However a mineralogical and crystallographic analysis of the transformations taking place in Cape silcrete during heat treatment (Schmidt et al. 2013b) showed that the material itself does not require a specially slow heating procedure, but can be heat-treated in the embers of an open air fire. The temperatures experienced by rocks heated in embers were described as scattering between 350 and 500°C (Schmidt et al. 2015b, 2017b), not imposing the risk of excessive heat fracturing in silcrete. The finding of such great heat tolerance of cape silcrete implied that a specially built heating environment creating slow heating rates (like a sand-bath, see for example: Brown et al. 2009) was not necessary in the MSA. However, this model was challenged by Wadley and Prinsloo (2014) who found in an experimental study that many of their samples heated in open air fires showed signs of heat-induced failure. On this basis, they argued for the necessity of a sand-bath to successfully heat-treat silcrete. A new element in this debate emerged from a study of c. 63–80 ka old artefacts from the Diepkloof Rockshelter. The discovery of a previously undescribed residue indicated that silcrete was indeed heat-treated in open fires during this period (Schmidt et al. 2015b). The residue is an organic wood-tar strictly associated with surfaces that correspond to the outer limits of the silcrete blocks at the time of their heat treatment. It was deposited on the silcrete surface by dry distillation of plant exudations and contains micrometre-sized charcoal inclusions, indicating that it formed in the reducing conditions of a pile of glowing embers (Schmidt et al. 2016a). A second argument in favour of such a fast heating technique came from the finding that up to 10% of the heat-treated lithics from Diepkloof show signs of heat-induced fracturing in a fire after which they were still knapped (Schmidt et al. 2015b). Such heat-induced failure only occurs at high temperatures and fast heating rates and is practically absent when silcrete is heated in a sand-bath (Schmidt et al. 2013b; Schmidt 2014; Wadley and Prinsloo 2014). Since this initial discovery, tempering residue and heat-induced fractures after which knapping continued have been identified in numerous other South African MSA and LSA sites (Delagnes et al. 2016; Porraz et al. 2016; Schmidt and Mackay 2016; Schmidt 2019) and today, it seems to be a secure assertion that at least most of the heat-treated silcrete in MSA and LSA assemblages was heated using a fast and expedient heating technique that relied on the use of open-air fires, perhaps regular domestic fires.

The European Upper Paleolithic Solutrean

The c. 22–18 ka old Solutrean is the oldest European context to have yielded proof of intentional heat treatment of rocks for stone knapping (Bordes 1967, 1969). In this context, relatively fine-grained silica rocks like flint and chert (henceforth only called chert) were heated. In contrast to the African MSA and LSA evidence, Solutrean heat treatment was not universally applied to a large range of artefact types. The artefact class best recognized as being knapped from heat-treated chert comprises the so-called laurel-leaf points or *feuilles de laurier*. Several examples from south-western France (Bordes 1969) and Spain (Tiffagom 1998) document thermal treatment as part of the later stages of the reduction sequence associated with the production of these bifacial points. The production of some of these artefacts also involved a final step of pressure knapping (Aubry et al. 1998). The strict association between pressure flaking and heat treatment in the Solutrean has recently been questioned by a study of the unique Solutrean laurel-leaf points of Volgu (Schmidt et al. 2018). These relatively largest and most skillfully crafted laurel leaf-points known today were not modified by heat, yet some of them benefited of a final step of pressure retouch. Still, the finely crafted laurel-leaf points of the Solutrean document a high technical skill of the knappers of this period and heat treatment was part of this skillset in at least some cases.

Also, the Solutrean was for long considered the oldest culture where heat treatment was practiced (Tiffagom 1998; Inizan and Tixier 2001) before Brown et al. (2009) found the African silcrete evidence. However, together with the Siberian Dyuktai culture (Flenniken 1987), the Solutrean still appears to have yielded the earliest evidences of heat treatment of chert. Such finer-grained silica rocks need to be heated with a procedure that involves relatively low temperature, slow heating rates (Schmidt et al. 2011, 2012) and thus larger investment in time and resources (Schmidt et al. 2016b). This was already noticed by the first experimenters attempting to heat-treat chert (Crabtree and Butler 1964) and the theory of sand-bath heating was used to interpret the heating technique used in the Solutrean (Inizan and Tixier 2001). The technique actually used for heat treatment in the Solutrean was recently investigated by Schmidt and Morala (2018). The authors used a technique based on near infrared spectroscopy (Schmidt et al. 2013a) to investigate the heating temperatures experienced by 44 laurel-leaf points from the Laugerie-Haute site. The underlying assumption behind these analyses was that different heating environments and procedures produce different temperatures. If the pieces had been heated in an open fire, the effective heating temperatures measured in different artefacts could be expected to scatter within a large interval of temperatures, as the embers of open fires were found to produce a wide range of different temperatures (see for example: Bentsen 2013). If, however, Solutrean heat treatment instigators had used a dedicated heating environment like a sand-bath, these temperatures can be expected to fall into a narrower range and be generally lower. The study found that most of the analyzed laurel-leaf points were heat-treated with temperatures between 250 and 300°C, a minor part of the samples between 200 and 250°C and only four samples were heat-treated slightly but insignificantly above 300°C (Schmidt and Morala 2018). The only way such reproducibility of similar heating temperatures can be achieved is by a standardized technique that allows the reproduction of similar conditions during successive heating cycles. A sand-bath or similar underground heating structures allows one to heat-treat stone with a range of temperatures from 200 to 400°C and fairly good standardization (Mandeville and Flenniken 1974; Griffiths et al. 1987; Eriksen 1997; Brown et al. 2009) and therefore appears to be a valid working hypothesis explaining the observed pattern. As it stands, the Solutrean data rule out the possibility of heat treatment in open-air fires and point in the direction of indirect, perhaps underground, heating.

The Mesolithic Beuronian

The Early Mesolithic of south-western Germany, the so-called Beuronian (9600–7100 BC), is yet another period that yielded evidence of stone heat treatment. Its material leftovers are found in the Swabian Jura region, a ~200 km long and ~70 km wide limestone plateau of Jurassic age in south-western Germany. It was a period of important transformations in the way people lived, in their subsistence and in the stone tools they produced. Typical lithic artefacts for this period are small triangular or rectangular microliths that were used as hafted implements on wooden projectiles. The majority of the Beuronian lithic assemblage is made from local chert of Jurassic age, an opaque white and slightly rough-looking chert. Part of this chert was heat-treated prior to tool production (Hahn 1998). Several works explored Beuronian heat treatment, providing the first insights into its relative prevalence in different assemblages (Eriksen 2006), and investigating possibly applied heating techniques experimentally (Eriksen 1997). Some of these studies found that Jurassic chert was particularly heat resistant (Eriksen 1997) and hypothesized a low-investment, cost- and time-effective heating technique, relying on the active part of above-ground fires for this period. A recent study (Schmidt et al. 2017b) on the Beuronian site Helga-Abri investigated the heating environment with the same near-infrared-based technique described above. The authors estimated the heating temperatures of all artefacts that were found to be heat-treated to fall in a relatively large temperature interval, ranging from 350 to 500°C. These temperatures lie significantly above the temperatures determined for other heat-treated archaeological assemblages, namely the Solutrean assemblage described above. The degree of standardization allowed by the Beuronian technique also seems to be considerably lower. The Beuronian temperature ranges of ±75°C are statistically broader than the ±~30°C of the Solutrean (Schmidt and Morala 2018). Standardized heating techniques, such as sand-baths or earth-ovens, are unlikely to produce such great scattering of heating temperatures, precluding the hypothesis of their use in the Mesolithic of south-western Germany. Thus, the study found no indication of a specific heating environment or oven-like structure that would allow to produce, control and maintain a well-calibrated range of heating temperatures in the stones. On the contrary, using open-air fires for heat treatment can be expected to produce a wider range of heating temperatures when the stones are placed at different parts of the embers or ashes and temperatures as high as 550°C have been attained with this technique experimentally (Schmidt et al. 2015b). Schmidt et al. (2017b) conclude in their study that the observed pattern can be reasonably well explained by the hypothesis that Jurassic chert was heat-treated in the above-ground part of camp-fires. This would put the Mesolithic evidence and the African silcrete data on the same page, both documenting the use of fast, expedient and rather opportunistic techniques.

The Neolithic Chassey Culture

The Neolithic Chassey culture of southern France (4100–3500 BC) also documents heat treatment of chert. The treatment was systematically used for producing pressure-flaked bladelets (Léa 2005). It may even have been the reason for the widespread use of a particular type of chert from the French Vaucluse region that can be found at sites in all of southern France, Tuscany (Italy) and Catalonia (Spain). The Chassey reduction sequence included heat treatment of large volumes of this chert shaped into pre-cores (preforms) that attained up to 7 cm in diameter. The discovery of lithic production sites in the Vaucluse region, where these large preforms were heat-treated, shows that the treatment was conducted by specialists who did not seem to have shared their know-how (Léa 2004). Heating large volumes of this chert must be considered a difficult task, as it has to my knowledge not yet been possible to experimentally heat-treat such large preforms of this particular chert in 'actualistic' conditions without thermal fracturing (overheating). Unlike for the African data on silcrete heat treatment, such heat-induced fracturing would render the Neolithic chert preforms useless for further pressure-reduction. One of the reasons for this failure to reproduce Chassey heat treatment is that most of the parameters applied during heating remained unknown until recently. In response to this, two studies aimed at determining the heating temperatures experienced by Chassey artefacts. On experiment used the above described near-infrared analyses (Schmidt et al. 2013a) and the other investigated the pressure in fluid inclusions within heat-treated chert (Milot et al. 2017). Both studies found average heating temperatures between 200 and 250°C for the analyzed flakes and a precision of heating temperatures of

±∼25°C. It thus appears that heat treatment in the Neolithic Chassey culture was an even better calibrated process than in the Solutrean (i.e. producing a slightly narrower interval, and generally lower temperatures). It allowed to produce and re-produce these temperatures in chert during successive heating cycles (Schmidt et al. 2013a; Milot et al. 2017). Similar to the Solutrean, this may be understood as yet another augment for underground heating using sand-baths or similar structures. However, it should be emphasized that, as for the Solutrean, there has not been any other data indicating such a technique in the Neolithic so far. During this period, witnessing a steadily increasing technical know-how and fire-related skills (e.g. the mastering of ceramic firing), it appears prudent to await more detailed data on the techniques used for stone heat treatment before final conclusions can be drawn. At our current state of knowledge, it can only be stated that this technique, similarly to the Solutrean, aimed at producing good temperature control and standardization and that the data support underground heating.

The Paleo-Indian Evidence for Underground Heating

The perhaps most detailed description of an archaeological structure used for heat treatment was made by Shippee (1963). He interpreted an undated feature found in North America as a fire-pit used for heat treatment of chert. He described a ∼45 cm-deep pit containing an infill of chert, sediment and ashes. The pit contained at its base a bed of ashes. Chert cores and flakes were placed on top of the ashes. The pit was backfilled with sediment and limestone boulders on top of the chert. This isolated and undated dataset provides a small window onto the North American heat treatment evidence and unambiguously documents the used of underground structures in this context. Although this data is of a very different nature than the above explained examples from Europe and Africa, it can nonetheless be compared with the latter. Similar underground heating techniques have successfully been used to heat-treat fine grained silica rocks like chert in heating experiments (see for example: Mandeville and Flenniken 1974). During these experiments it was noted that the indirect heating in the sand environment allowed good temperature control and slow heating rates. It appears therefore likely that such a technique would allow to produce similar patterns in heated stones as the ones recorded from Solutrean and Chassey artefacts. This indicates that the heat treatment technique used in all three contexts was similar or at least contained similar elements.

Similarities, Dissimilarities, Convergence?

The data detailed above are not all of the same kind, in some cases being precise heating temperatures, in others direct or indirect evidence of heating environments. This is unfortunate and results from the different suitability of silcrete and chert for analysis with analytical techniques (e.g. silcrete is too opaque for the infrared-based method for temperature reconstruction described above). It is nonetheless possible to compare different contexts in terms of the heating environment used (either directly in fires or indirectly in underground or oven-like structures). All heating techniques discussed above are compared in Table 14.1. In summary, two of the above described contexts yielded evidence of stone heat treatment using the above-ground part of fires (the African MSA to LSA and the German Mesolithic) whereas the other three contexts yielded evidence for indirect heat treatment, perhaps in underground structures.

Can cultural transmission explain this pattern? One way of examining this question is by comparing the three techniques throughout the European sequence, from the Solutrean to the Neolithic Chassey culture, where direct or indirect population contact (necessary for cultural transmission) may at least be tentatively assumed. It is not suggested here that there was any type of cultural continuity across the three European contexts. Comparing them will not likely answer the question of whether heat treatment techniques were directly transmitted from one of those contexts to another (for example, heat treatment was not even practiced during the Magdalenian period that separates the Solutrean

Table 14.1 Comparison between the five heat treatment bearing contexts discussed in this chapter. The early date under 'Approx. age/duration' corresponds to the earliest published age for heat treatment within the context and the second date to the end of the context

Context	Approx. age/duration	Heating temp.	Heating environment
MSA/LSA	164–∼12 ka	∼350–500°C	Open-air fires
Solutrean	22–18 ka	∼250–300°C	Indirect heating. Underground?
Beuronian	9600–7100 BC	∼350–500°C	Open-air fires
Chassey	4100–3500 BC	∼200–250°C	Indirect heating. Underground? Ceramic kiln?
Paleo-Indian	Undated holocene	Probably ∼200–350°C	Underground heating

and the Mesolithic Beuronian in time; also, there might have been important population turnovers between contexts). However, if such a comparison were to be made and if it would result in the observation of continuity, it might be argued that there were some, not yet understood indirect mechanisms of transmission or perhaps a collective memory of techniques (e.g. via other similar but more regularly practiced fire-based techniques; such as bleeding over of cooking styles). The testing conditions for a relation between contexts would be satisfied if the heating technique practiced in Europe was invariable, or if shifts from one technique to another were gradual, or perhaps if we could observe irreversible changes from one heating technique to another. Neither of these was the case in Europe: the rather well-standardized indirect heating technique of the Solutrean was replaced by an opportunistic camp fire-based technique in the Mesolithic that had no apparent similarities. The following Neolithic yielded evidence for even higher standardization and control that were most likely only possible by indirect heating. Thus, the European data do not provide arguments for the transmission of technical knowledge related to heat treatment. However, again, this sequence is not ideal to test for such transmission. Can the obvious problems of the European sequence be overcome by seeking for transmission in other contexts? The MSA to LSA sequence of Africa's Cape region provides an alternative dataset. There, no archaeological evidence of underground heating has ever been brought forward and, from at least 70 ka (Schmidt and Högberg 2018) to about 20 ka (Porraz et al. 2016), silcrete appears to have been invariably heated in open-air fires. And so, in this case, cultural transmission is a possible scenario. However, this would be in contrast to technological changes in other domains (see also Will and Mackay 2020) and probably also population turnovers during this period. In all non-African cases, heat treatment appears to have been an independent (re-) invention.

The similarities between some of these independently invented heating techniques must then be termed independent convergence. It can be expected that at least some traits of these heating techniques result from inherent processes, necessities or structures within the heat-treating groups (i.e. they were not chosen arbitrarily). For example, building a heating environment that allows temperature control and slow heating rates is cost-intensive (Brown and Marean 2010; Schmidt et al. 2016b) and its re-invention in three distant contexts most likely followed some underlying reasoning. If this was the case, by what factors can the partial convergences be explained and what might have been the reasons for choosing one technique or another?

One possibility is to explain convergence in heating techniques by environmental factors such as climate or the availability of wood fuel. However, such factors are very different in southern Africa during the MSA and central Europe during the Mesolithic, both contexts that documented heat treatment in open-air fires. The same is true for the three contexts that documented underground heating: such techniques are more resource-consuming (Brown and Marean 2010), so that one might expected to find fuel-efficient open-air fires in the arid Last Glacial Maximum (at the time of the Solutrean) and more fuel-consuming underground structures in the temperate and more humid Mesolithic. The contrary was the case. Thus, external factors related to climate cannot explain the observed pattern. Another approach to explaining these convergences comes from understanding the heated rocks themselves. In all three contexts that documented underground heat treatment and good temperature control, it was fine-grained silica rocks like chert that were heated. Such rocks typically have ideal heating temperatures between 200 and 350°C (Schmidt et al. 2012, 2013c, 2017a). Most become even less well suited for stone knapping after heating above these temperatures (see for example: Inizan et al. 1976; Terradas and Gibaja 2001). A similar statement can be made for the speed these rocks can be heated with. If heating rates are too fast, chert may overheat and become un-knappable (Schmidt 2014). Thus, finer-grained silica rocks require slow and low-temperature heating and one way of producing such conditions is by setting up a heating environment (Schmidt et al. 2016b) that relies on indirect, perhaps underground, heating. Other rocks like silcrete do not pose the same problem. Silcrete heated in Africa's Cape region did not require particularly slow or low-temperature heating conditions (Schmidt et al. 2013b). It is therefore not surprising that this context documents the use of above-ground fires for heat treatment. The same is true for the Jurassic chert heat-treated in open-air fires in the German Mesolithic. As detailed above, this chert is unusually heat resistant, not failing when heated rapidly in open fires (Eriksen 1997). The dichotomy between slow indirect- and fast direct-heating may thus be the result of specific problem solving of different groups with access to different types of rock. In other words, it was no coincidence that chert that is susceptible to overheating was carefully heated in unrelated contexts in dissimilar natural environments. This was rather the specific responses to similar technical problems posed by similar materials. It was also no coincidence that more heat-tolerant rocks like silcrete and the Beuronian Jurassic chert were heated in open-air fires because, in the absence of constraints in terms of temperature or heating rate, knappers chose the simplest and most efficient technical solution. Thus, oriented problem solving and the intention not to complicate techniques when it is not necessary appears to provide the best explanation of the partial convergence in techniques used for stone heat treatment in different parts of the world.

Outlook

These observations result in obvious questions about other contexts that document heat treatment of similar types of stone. An ideal case study would be the comparison between silcrete heat treatment in Africa's Cape region and Australia. Both regions are rich in silcrete types that have previously been described as being similar in terms of genesis, mineralogy and structure (see for example: Summerfield 1983). Heat treatment was part of silcrete reduction sequences since at least 25 ka in Australia (Hanckel 1985; Schmidt and Hiscock 2019) and even longer in Africa's Cape region (Brown et al. 2009). Contact or cultural transmission can be confidently ruled out in these two distant contexts.

Where the requirements in terms of heating temperature or heating speed of Australian and southern African silcrete the same? Was the technical response of knappers the same or, in other words, did early Australians heat-treat silcrete in the same way as knappers in Africa? The comparison between both continents would provide ideal conditions to investigate the mechanisms and dynamics of inventions, cultural differentiation and oriented problem solving.

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