40. THERMO-FACTS VS. ARTIFACTS: AN EXPERIMENTAL STUDY OF THE MALPAIS INDUSTRY

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The Malpais "Industry" of the deserts centering around the lower Colorado River has presented a difficult theoretical problem ever since it was first described by Malcolm J. Rogers (1939). Some archaeologists, mainly in oral discussion, have questioned whether the Malpais specimens were really produced by the hand of man. Others, tentatively accepting Malpais as a cultural product, have raised the question of whether Malpais is evidence for a <u>pre</u> "early lithic" occupation in North America, or whether despite its crudity, it represents a relatively late culture (Willey and Phillips, 1955, p. 734).

These questions have mainly been caused by the facts that Malpais specimens are: 1) extremely crude in appearance; 2) exclusively surface finds of questionable human association and age. The crudity of the Malpais materials led Rogers (1939, p. 22) himself to state:

> Realizing that archaeologists are sometimes led into improper interpretations through the enthusiasm engendered by a personal discovery, the writer wishes to state that he finds the formulating of a cultural pattern from hand choppers, primary flakes, and a few retouched flakes as difficult to accept as will the critical reader. If some precursor of homo sapiens were involved, the problem would be simplified; but that any type of modern man could exist with such a primitive working equipment is difficult to believe.

The Malpais specimens illustrated by Rogers (1939, pl. 3-5), unimpressive as they are, are probably among the best-looking ones collected. Only a very small proportion of the Malpais specimens that the writer has seen or personally collected in the lower Colorado River valley have any even half-way convincing evidence of human use. There is a total absence of such distinguishing artifacts as blades, projectile points, or grinding tools. In fact, Malpais seems distinguishable by what is absent as much as by what is present.

Many of the specimens bear a remarkable resemblance to the Old World eoliths and also to the "pseudo-eoliths" manufactured by European archaeologists simulating geological processes (for a review and bibliography of the eolith question, see Boule et Vallois, 1952, pp. 98-105).

Unlike the European eoliths, however, Malpais materials occur on flat expanses of desert pavement and the surface locations of some Malpais sites make it difficult to dismiss all of these crude lithic materials as products of stream and gravel action. Although the lithic specimens called Malpais are often widely scattered over the desert gravels, this is not always the case. Sometimes they occur by the hundreds in concentrations of a few meters diameter in the midst of an expanse of otherwise undifferentiated desert pavement. Such desert pavements consist of the same gravels as the Malpais specimens, but lack their sharply fractured surfaces. These are the desert areas which are characteristically located well above surfaces ever reached by flash floods or other moving water. In short, it is extremely difficult to explain the origin of some of these sites in terms of water and gravel action. If this situation is to be empirically verified, however, detailed reports are needed on a number of such sites by both archaeologists and geologists.

Since I could not, to my own satisfaction, account for the origin of all the Malpais specimens in terms of geological causation, I was faced with either tentatively accepting some of the Malpais materials as evidence of a legitimate stone industry or finding some previously unconsidered origin for the specimens.

Such an origin was suggested to me by Arnold R. Pilling, fellow graduate student in the Department of Anthropology at Berkeley. His idea was that the Malpais materials might be the result of fracturing produced by aboriginal man through the dropping of hot stones into water for stone-boiling purposes. Another possible factor involving heat was the aboriginal practice in southern California and the Southwest of roasting mescal in stone lined pits.[1]

In order to test Pilling's hypothesis, I obtained information on the heat-producing abilities of various kinds of fires from Dr. R. Keith Arnold, U. S. Forest Service Experiment Station, Berkeley, and from Mr. Ralph Fenner, consulting forester to the same station. Arnold and Fenner have both been conducting experiments on the subject. Arnold reported that either a forest fire or an ordinary wood-burning campfire is easily capable of heating stones equivalent in size to those of the desert gravels to a temperature of 1000 degrees Fahrenheit, if they are on the ground underneath the fire. Fenner supplied the additional information that in a brush fire an extremely concentrated pile of brush (such as a rat's nest), can likewise heat such cobbles to 1000 degrees F. However, he ruled the possibility out that a grass fire would be able to do so.

After obtaining the above information, the following experiment was conducted. Seventeen Malpais specimens of jasper and chalcedony from UCAS site Yuma 27 (Arizona) were placed in an electric laboratory oven which had been heated to a temperature of 500 degrees F. (because an electric oven rises in temperature very slowly compared to an ordinary wood fire, the oven was pre-heated to simulate better the conditions of an actual fire.) After approximately 20 minutes, the oven reached a temperature of 1000 degrees F. It was held at this temperature for 2 hours. The oven was then permitted to cool to 900 degrees F. and was opened. It was found that the 17 specimens had fractured into 54 fragments plus a number of minute chips. The fragments and chips thus produced by the experiment appeared to resemble the original specimens in shape, though, of course, they were smaller. The fragments were then reheated to 1000 degrees F. (from 900 degrees F.), individually removed and quickly plunged into a kettle of water at room temperature.

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[1]The experiments by Blackwelder (1927, p. 138) indicate that diurnal changes in temperature can be dismissed as a significant factor in rock fracturing.

No significant additional fracturing or flaking was produced by the water immersion, even though the stones were red-hot when dropped into the water.

Thus the experiment suggests that stone boiling is not an essential step in the heat-fracturing of rock.

A number of additional oven-runs have since been made, using Malpais specimens from the same site and producing more than 600 fragments. The laboratory procedure has been the same as outlined, except that the oven has been permitted to cool to 500 degrees F. before removing the specimens; and the water immersion step has been eliminated. These subsequent runs have made it evident that Malpais-like fractures are not produced as frequently as the results of the initial experiment indicated. Oven-produced surfaces on the Malpais specimens tend to have less chipping along the edges and the fragments as a whole tend to be less conchoidal in their appearance. Although the fragments were not examined microscopically, additional differences should be observable microscopically. While the original Malpais specimens sometimes exhibit bulbs of percussion, none of the oven-run Malpais specimens thermally fractured in such a way as to produce a new bulb of percussion.

It should be noted, however, that this was not the case with a non-Malpais rock of obsidian. This was subjected to identical laboratory treatment. The obsidian produced several chips with bulbs of percussion. By reconstructing the rock from its component chips, it was possible to determine that every bulb of percussion was the direct result of percussive blows. These blows had been struck with an iron hammer when the rock was broken off of its parent obsidian mass. In other words, the heat fractures, in producing bulbs of percussion, were apparently following lines of stress set up by previous percussive action. Whether such lines of stress could be built up by natural percussive forces was not determined, but seems probable.

In summary, thermal fracturing has failed to reproduce some of the characteristics which typify Malpais specimens. <u>If</u> the experiments adequately simulated the conditions of an actual fire, and <u>if</u> certain of the sites bearing Malpais lithic materials should prove to be unexplainable on a geological basis; then it seems likely that we will be faced with the conclusion that a certain proportion of the Malpais lithic materials are evidence of a legitimate stone industry.

There are two "if's" in the above statement and both can be resolved only by competent fieldwork and reports. First is the question of whether the laboratory oven adequately simulates the actual conditions of a real fire set at an actual site with local fuels. If fieldworkers could find it feasible to set campfires at Malpais sites and report the fracturing results, the first "if" undoubtedly could be resolved. The second "if" is the question of whether or not the occasional concentrations of Malpais lithic materials can be explained on a geological basis alone. It seems unlikely; but in order to be certain, detailed studies of a number of such concentrations by archaeological-geological teams are needed.

The Malpais materials present a problem of dating as well as one of origin. It may be useful to summarize here the present status of the dating problem.

One of Malcolm Roger's arguments (1939, pp. 19-29) for the antiquity of the Malpais materials is that they are invariably coated with a layer of accumulated iron or manganese oxide. This coating is commonly called "desert varnish" and generally is most noticeable on the exposed surfaces of desert rocks. The speed at which it accumulates has been a subject of controversy and it now appears that local conditions considerably affect the rate of accumulation. In the course of the writer's archaeological survey work, desert varnish, or a coating identical in appearance to it,[1] was discovered on the exposed surfaces and exposed broken edges of potsherds and a pottery vessel found in the desert west of Yuma (Harner, 1953, p. 5). In view of this information, caution should be exercised in utilizing desert varnish as an indicator of considerable antiquity in the lower Colorado River region.

The nondescript nature of Malpais and the necessity of having a statistically adequate sample of specimens considerably complicate attempts at dating it. This is one of the problems involved in attempting to equate Malpais with the artifacts of the Ventana Cave volcanic debris layer (dated pre-8000 B. C.; Haury, 1950, figs. 116, 117). Rogers apparently felt that this correlation could be made (Haury, 1950, table 12). However, careful reading of the Ventana report leaves the suggestion that the question is still open.

Rogers also recommended (1939, p. 21) assigning the Tule Springs, Nevada, site (now dated "older than 23,800" years; Libby, 1954, p. 740) to Malpais on the basis of some "oxidized, silicified limestone" specimens which were not found in situ. The one chip found in situ at Tule Springs is of obsidian (Simpson, 1933, pp. 8-9). [Recent research at the site has not revealed any more chips in situ (personal conversation with M. R. Harrington, August 31, 1955).] However, Rogers had reported, "Either chert, silicified limestone, or some metamorphic phase of the same were exclusively" [italics mine] the materials of which the Malpais specimens were composed in that area of Nevada.

In conclusion, the results of the experiments suggest that although fire-cracked rocks may have sometimes been mistaken for Malpais specimens, fire-fracturing cannot reproduce all of the characteristics found on some Malpais specimens. In addition, fellow researchers should be cautioned that the Malpais lithic materials, whatever their origin and age, cannot be satisfactorily recognized (let alone dated) without a sample of at least several hundred specimens. Such specimens must be virtually unmixed with other lithic assemblages, because the Malpais materials are essentially indistinguishable from much of the waste chipping that normally occurs in lithic industries.

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1 Identified as iron oxide by Professor Norman E.A. Hinds, Department of Geological Sciences, University of California, Berkeley.

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