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**THERMAL ALTERATION OF QUARTZITE FROM SPANISH DIGGINGS,
WYOMING –
A PRE-HISTORIC QUARRY**

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ABSTRACT

Experiments indicate that the application of heat to silica material may have aided primitive man in the manufacture of chipped-stone implements. When quartzite from Spanish Diggings is heat treated, predictable color changes occur. Using Spanish Diggings material as a model, quartzite artifacts from the Hudson-Meng site were examined in an attempt to determine if this material was thermally altered.

Archaeologists are being confronted with the problem of identifying source areas of lithic material encountered during excavation. It is now recognized that lithic materials from some archaeological sites have been altered by heat treatment (Crabtree, 1972, p.5). This may require a revision of current ideas regarding importation and wide scale lithic trade networks. The possibility of heat treatment also requires that the archaeologists keep in mind not only what the material is like at the source area but also the possible alterations caused by heat.

This study was carried out on quartzite from Spanish Diggings, a large quarry site in Platte Co., Wyoming (NE¼; Sec. 1: T. 30N; R. 67W). The purpose was to determine what changes, if any, occurred when these quartzites were subject to heat treatment.

A random sample of quartzite was taken from the quarry area. Fifty samples were then sorted by color (with the aid of the Munsell color chart), grain size, and banding characteristics. The colors ranged from light-to-dark yellow-browns, light-to-dark grays, purples of various shades, blacks and olive greens.

Conditions under which heating experiments were conducted are as follows:

Heating

1. Rapid temperature increase: temperature was raised by 50°C increments and held approximately 1 hour, at each succeeding increment up to 600°C. (no measurement for weight loss was taken)

2. Gradual temperature increase: temperature was raised by 50°C increments and held approximately 24 hours at each succeeding increment up to 600°C. Specimens were weighed before and after heating to check weight loss.

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Cooling

1. Rapid cooling: specimens were subjected to room temperature at the end of the testing period.
2. Gradual cooling: specimens were left in the oven at the end of the testing period.

RESULTS

Color change was observed using both heating procedures and occurred consistently between 225° to 250°C. Light yellow browns (10 YR 6/4) altered to weak reds (10 YR 5/4); yellow browns (10 YR 5/4) altered to reds (10 R 5/6); grays (5 YR 6/2) altered to pink grays and olive (10 R 3/6) specimens altered to dark reds (10 R 3/6). Black specimens suffered no color change but lost the most weight. Purdy (1971) suggests that weight loss occurs as interstitial water is driven off. If this suggestion is correct, it appears that the black specimens selectively contain more water than other specimens.

It should be noted that brown specimens had a tendency to alter to red. This change in color apparently comes about when limonites and other ferric oxides which are present as impurities, are losing water and are being altered to ferrous oxides including hematite. There was no correlation between the amount of water lost and the color variations among the specimens.

Gradual temperature increase induced the same physical alterations as rapid temperature increase. Color alteration started along the thin edge of the specimens at 225°C; by 250°C alteration had reached the peak but the colors had a tendency to be blotched. Temperature from 250°C to 450°C had no observed structural or textural influence, but the blotchy colors tended to blend. No effects were apparent from 450° to 600°C.

The only other observed physical change was in luster. Externally this change was not very apparent. If a small flake was removed from a treated specimen however, it was observed that the area of conchoidal fracture had a much duller luster than the external surface. This was not true of flakes struck from untreated specimens. Thus if a facet of this original surface remains on a heat treated artifact, the change may be easily noted.

In the author's opinion, the material which was allowed to heat and cool slowly demonstrated the greatest flaking ease; the material had a tendency to fracture like glass rather than that of a rock aggregate; it was also noticed that flakes had a tendency to feather rather than step off. This flaking ease is probably due to the fact that the microcrystals had sufficient time to allow fusion of matrix material between grain particles. Rapid heating and cooling probably did not allow such fusion.

From the Hudson-Meng site, (25 miles NW of Crawford in Section 17 and 18; T. 33N; R 53 W) three quartzite artifacts were recovered from past

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excavation. HM-945 is a complete projectile point, light-red in color with dark banding and has Diggings textural characteristics (Witzel, 1973). The color is not represented by any unaltered quarry material collected. The only approximate color match with quarry material was with thermally altered specimens. This indicates that heat alteration may have occurred.

HM-1014, a brown, incomplete basal projectile point, shows Flint Hill textural characteristics (Witzel, 1973). Since brown specimens from the Diggings tended to turn red after head treatment, one would suspect a similar change with Flint Hill material. It would appear that no thermal alteration has taken place.

HM-166, a red basal projectile point, shows no characteristics of either Spanish Diggings or Flint Hill. Since no source area has been assigned, it is impossible to theorize any possible heat alteration.

CONCLUSION

The quartzite from Spanish Diggings suffered definite alteration when subjected to heat. The color which consistently changed between 225°C to 250°C could be readily predicted. These temperatures could easily be obtained by a campfire. Specimens altered by heat took on a distinct luster differing from the unaltered specimens from the source area. Findings give hope for determining whether quartzite artifacts in an archaeological site have been heat treated. They also require that archaeologists use caution in assigning source areas based on color alone.

REPRESENTATIVE SAMPLE OF COLOR CHANGES OBTAINED BY THERMAL ALTERATION (Munsul Color chart used)

- 115 5 YR 5/3 (Reddish Brown) to 10 R 4/4 (Weak Red)
- 123 7.5 YR 4/2 (Dark Brown) to 10 R 4/2 (Weak Red)
- 126 7.5 YR 7/1 (Light Gray) to 7.5 YR 7/2 (Pink Gray)
- 132 10 YR 6/4 (Light Yellow Brown) to 10 R 5/4 (Weak Red)
- 141 7.5 YR 5/6 (Strong Brown) to 10 R 3/6 (Dark Red)
- 145 5 Y 4/4 (Olive) to 10 R 3/6 (Dark Red)

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