Abstract: During the 2007 GRESLE, archaeological teams conducted in the northeast Montana region, particularly focusing on the 39PA2772 site. This study has elucidated several new facets of work, such as the utilization of various forms of energy on stone and the natural alternations of energy from one phase to another. Hence, this paper presents a detailed examination of the energy transformations that occur within the stone and energy out of the stone. The energy source and sink terms deal with chemical reactions which transform chemical energy into thermal energy. The energy accumulation is determined via the energy in and energy out differences, and the energy accumulation will give an idea of the change in temperature of the stone being heated. From the change in temperature, and the thermal conductivity of the stone, a temperature gradient can be determined. From the temperature gradient, the thermal stress and strain in the stone can be determined and a reasonable conclusion about whether the stone should explode or not will be determinable.

Introduction:
Understanding when habitual, controlled use of fire was to be ubiquitous in the behavioral repertoire of hominids opens a window to the emergence of crucial aspects of human adaptability. Fire gave early humans protection, it gave them a source of mobile, extraneous warmth allowing them to migrate into cooler climates, and it gave them a center point at which to gather. Evidence of controlled use of fire is suggested to date back further than 1 mya (Weiner et al. 1998:251). However, distinguishing naturally occurring fires from hearths is proving to be an archaeological enigma. Describing the formation processes in natural burn areas can assist in evaluating evidence of fire from archaeological sites. This poster examines patterns of thermal alteration and explores the physical processes behind their creation.

How does energy get into the stone?
By the Zeroth Law of Thermodynamics, heat will transfer from a warmer body to a cooler body until the temperature of the warmer body and the temperature of the cooler body are equal. The Zeroth Law of Thermodynamics is what accounts for energy into the stone and energy out of the stone. The energy source and sink terms deal with chemical reactions which transform chemical energy into thermal energy. The energy accumulation is determined via the energy in and energy out differences, and the energy accumulation will give an idea of the change in temperature of the stone being heated. From the change in temperature, and the thermal conductivity of the stone, a temperature gradient can be determined. From the temperature gradient, the thermal stress and strain in the stone can be determined and a reasonable conclusion about whether the stone should explode or not will be determinable.

Thermal Spalling:
In order to determine an internal temperature gradient, it was assumed that the temperature of the surface was constant and equal to the value of the fire. This was done in order to obtain suitable boundary conditions.

The ultimate stress, the stress at which failure occurs, of quartzite has been measured to be up to 280 megapascals (Incropera & Dewitt 2002). A possible value of thermally induced stress of 500 megapascals has been found during this lines analysis. In conclusion, it is possible for fracture of quartzite to occur if quartzite stone undergoes sufficient stress in shape, and one meter in diameter, is soaked in a hot forest fire.

Spatial Patterning:
Figure 1 above displays oxidized sediment patches and associated chipped stone on sites 48PA2772 and 48PA2776. When comparing this to spatial patterning of other archaeological sites, they appear to be similar. After time these features will go through the same depositional processes as hearths (Johnson 2003). Further discussion of oxidized sediment patches in relation to phantoms hearths is also investigated in greater detail in Koepsell 2007. Given the close, discrete nature of these patches and the burned material within them they could be interpreted as evidence of either a reoccupation site, or multiple unit camp site.

References:

Discussion:
Controlled use of fire was a huge technological innovation for humans (Bellomo 1993) and separating natural process from controlled habitual use is crucial to investigating the impacts of fire technology. Holistically researching the history of the environment aids in reconstructing interactions between archaeological material and naturally occurring fires: Analysis of materials that have undergone thermal alteration are not always the products of human activity (Buenger 2003). Spatial patterning between oxidized sediment patches show that they can leave distinct patches across the landscape. Thermal spalling and other alterations of material provide data on the frequency of naturally occurring fires and can aid in constructing a fire history of the landscape.