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Tuesday, March 30, 2004

Electron Spin Resonance and the Controlled Use of Fire

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In 1984, C. K. Brain and co-workers found a deposit of bones in Member 3 at Swartkrans Cave that appeared to have been heated. Subsequently he compared their physical characteristics to modern burnt bone. Histological results suggested that the heating temperatures experienced by the bones had been similar to those in campfires, and well above the temperatures experienced in naturally-occurring grass fires. If confirmed, this would place the earliest controlled use of fire at well over one million years ago. Heating organic and inorganic materials produces free radicals that can be detected by electron spin resonance (ESR). This technique has been used to look at heated flint, for example. The type of free radicals formed depends on the heating temperatures, with higher temperatures resulting in simpler radicals. Thus we decided to re-examine some of the Swartkrans bones to see if ESR could serve as a paleothermometer. Preliminary results confirm that the bones fall into three general categories: unheated, slightly heated, and calcined. The presence of manganese in the fossils makes comparisons with modern heated bone difficult, but there is some evidence that the manganese ESR signal depends on temperature, which would then provide a second measure of the degree of heating. Further experiments with bones of different ages and from different sites would be helpful.