Manganese dioxide staining on hominid crania from Sterkfontein and Swartkrans: possible associations with lichen

J.F. Thackeray[a*], F. Sénégas[a] and G. Laden[b]

HOMINID CRANIA FROM STERKFONTEIN, Swartkrans and other sites in the Cradle of Humankind World Heritage Site are sometimes associated with small spots of manganese dioxide, generally less than 5 mm in diameter. The source of manganese is probably the local Malmani dolomite in cave formations, having been leached out in chemical reactions associated with slightly acidic water, and redeposited on bone or stone surfaces, especially on durable chert outcrops. Here we report the mean size of MnO_2 spots on four hominid crania, and compare them with the mean size of MnO_2 'blotches' on flat surfaces of chert exposed on the hillsides in the vicinity of the cave sites, where lichen has been seen growing in discontinous thalli.

Four hominid crania were included in this exploratory study: Sts 71, representing *Australopithecus africanus* from Sterkfontein; SK 48 and SK 83, both representing *Australopithecus robustus* from Swartkrans; and SK 27, representing a species of early *Homo,* also from Swartkrans. The maximum diameter of MnO_2 spots was measured in millimetres using Mitutoyo digital callipers. For purposes of this study, specific spots with a maximum diameter of less than or equal to 5 mm were measured. Larger spots tend to merge and are thus considered to be discrete entities.

The mean values and standard deviations were as follows:

Sts 71 mean diameter: 1.668 ± 0.618 mm (n = 25)

SK 48 mean diameter: 1.332 ± 0.663 mm (n = 25)

SK 83 mean diameter: 1.665 ± 0.589 mm (n = 25)

SK 27 mean diameter: 2.017 ± 1.018 mm (n = 25).

The mean diameter of MnO_2 spots, taking all four hominid crania together, was 1.671 ± 0.781 mm. This is not significantly different from the mean spot diameter of 1.841 ± 1.109 mm in the case of MnO_2 staining on chert surfaces adjacent to the caves. Of particular interest is the fact that lichen can be seen growing in discontinuous thalli on the same chert surfaces, and often (but not always) appeared to be growing particularly well in moist, shaded environments in and around solution cavities.

There are clearly optimal conditions for the growth of lichen near cave entrances. Lichen does not grow where light is too limited within a cave, and it does not flourish where conditions are excessively hot and dry outside the cave. The optimal conditions appear to relate to cool moist conditions where lichen is exposed to some degree of light.

Under the right conditions of light and moisture, lichen grows on surfaces of bone as well as on tree bark in cave settings. At sites such as Sterkfontein, Swartkrans and Kromdraai, the spotty, discontinuous distribution of young lichen thalli appears to be analogous to the spotty distribution of MnO_2 on at least some hominid crania.

Notably, lichen takes up minerals in the course of growth and development. A hypothesis that we present here is that MnO_2 spots on mineralized bone from sites such as Sterkfontein, Swartkrans and Kromdraai may be associated, at least in part, with lichen growth on bone surfaces during the relatively short period before a cranium is covered by sediment, and during the time when the bone is still exposed to air to allow lichen growth under appropriate conditions.

If this hypothesis is correct, it may be useful for assessing the microenvironmental conditions to which bone was exposed before being covered by sediment, and before the sediment was transformed into breccia. Furthermore, if our proposal is valid, it may offer the potential to facilitate the dating of hominid fossils, using an oxide of manganese if not manganese itself, since it would relate to a biological process over a very limited period of time, possibly only a few decades, prior to the bone being covered by sediment, thus preventing further growth of lichen.

We recommend that the hypothesis be given attention, especially in the context of the recent technique that has been developed to remove MnO_2 chemically from bone.[1]

This work was supported by grants from the National Research Foundation (GUN 2065329) and from the University of Minnesota.

1. Cukrowska E.M., McCarthy T.S., Pole S., Backwell L. and Steininger C. (2005). The chemical removal of manganese dioxide coatings from fossil bones from the Cradle of Humankind, South Africa. *S. Afr. J. Sci.* **101**, 00–00.

[a]Transvaal Museum, P.O. Box 413, Pretoria 0001, South Africa.
[b]Department of Anthropology, University of Minnesota, 395 Hubert H. Humphrey Center, 301-19th Ave. S, Minneapolis, MN 55455, U.S.A.
*Author for correspondence.
E-mail: mrsples@global.co.za