

though Regulus was shining through the dark limb of Venus, if one judged the size of the dark side from the apparent size of the brightness of the luminous hemisphere. This, of course, is a very well-known phenomenon.

Roger Hosfeld, a member of my party, using one of the Madrid Observatory telescopes through the kindness of the director, R. Carrasco, was able to obtain a long series of photographs from which the changing relative positions of Venus and Regulus (with corresponding times) can be obtained. The timing of this occultation serves as an important reference point in the theory of the orbital motion of Venus.

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Paleolithic Paint

Abstract. Discovery of hematite and kaolinite in excavations of late paleolithic occupation sites at Les Eyzies (Dordogne), France, raises anew the question of the nature of the paint used by paleolithic people. Hematite as a pigment source is widely documented, but the presence of kaolinite imported into prehistoric sites poses problems. The suggestion is made that white clay might have been used as an "extender pigment" to mix with colors such as that derived from hematite.

Archaeologic excavations under the direction of H. L. Movius Jr., exposed late paleolithic occupation levels in the Abri Pataud at Les Eyzies (Dordogne), France, during the summer of 1958 (1). Several thousand stone and bone implements, much animal bone, and some human skeletal material was found. In addition, some carving on stone came from the Périgordian Final level and some rock which may have been painted was found in this level as well as in the overlying Proto-Magdalenian level. We are here concerned with the discovery of earth materials which may have formed part of a paleolithic paint palette.

Examples of what the archeologist terms "red ochre" were found in each of the two main cultural horizons. These are small, earthy chunks 2 to 3 cm in maximum dimension. Field examination showed them to be hematite (Fe_2O_3), and x-ray analysis of one showed the hematite to be essentially pure. The chunks had been "used," for each was artificially shaped by abrasion which produced relatively flat, intersecting facets. Similar objects were reported earlier from the nearby Grotte de Font-

de-Gaume and other sites (2). The abrasion is recorded in fine, nearly parallel scratches on the flattened faces. These marks are absent along the narrow ridges separating the abraded faces.

No earthy hematite occurs in the limestone cliffs near the abri, or in the stream deposits of the neighboring Vézère River. Such hematite does occur however, in association with clays of Tertiary age described below.

That the hematite was used as a pigment source is an unproved but not unwarranted suggestion and has been advanced by others for similar finds (2, 3). We are, however, on more tenuous, albeit more tantalizing grounds, when we consider the significance of fist-sized lumps of unctious clay found in deposits of Périgordian Final age of the Abri Pataud. This material is not characteristic of the limestone rubble fill of the shelter, nor is there any known occurrence of pockets of such material in the Cretaceous limestone in which the abri has formed. X-ray analysis shows the material to be the clay mineral kaolinite, a material that could only have been brought into the site by man from some outside source.

Several occurrences of clay are known in the general vicinity of the site, and at least two of these are commercially exploited today. These clays represent the weathering, during the Tertiary, of Cretaceous limestone. They occur in large masses, perhaps in sinkholes, in the uplands flanking the Vézère River valley where the site is situated. Brindley and Comer (4) report both kaolinite and halloysite clays from the Les Eyzies deposits, and x-ray examination of samples I collected reveals the same assemblage.

Why was the clay imported into the abri? It was clearly not for use in pottery making, a technical art which then lay several thousand years in the future. Could it have been used by a local artist? For instance, modeling in clay is known from the paleolithic stations of Tuc d'Audoubert and Montespan (Ariège), France. No clay modeling, however, has yet been reported from the Abri Pataud.

Is it possible that the clay was in some way connected with painting? If so, then it might have been used as a white pigment. White is rare in the surviving paleolithic art of western Europe, although it has been suggested that kaolinite was used as a white pigment in some of the later European paintings (5) and in the prehistoric paintings of Africa (6; 7, p. 250).

Another possibility exists, namely, that the kaolinite was used to mix with colored pigments. Thus the kaolinite could have been used for what is known in the

paint industry as an "extending pigment." An extending pigment should have a low opacity, and the index of refraction of kaolinite (1.560 to 1.570) allows it to meet this requirement. In fact, kaolinite has been used as an extending pigment in modern paint manufacture.

As far as I know, the nature of the vehicle for paleolithic paint is still unknown. It is most generally held that pigments were mixed with animal fats (3, 8). No analyses are available to test this or any other hypothesis. There is some ethnographic evidence, however, that Bushmen used animal fat (7, p. 251; 9) as well as the latex-like sap of some plants (9) as a vehicle for pigment, and urine, milk, blood, and honey also have been suggested (9). Strangely enough, common water has not been suggested as a vehicle.

We do not know whether the occupants of the Abri Pataud used clay in painting. Nevertheless, the presence of clay in the cultural horizons of the abri reminds us that as yet we know very little concerning the technical side of prehistoric painting. We are quite obviously in need of organic and inorganic chemical analyses as well as mineralogical analyses of paleolithic paint.

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References and Notes

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