more advanced than archaeologists have previously believed. He partially domesticated the red deer and initiated sizeable forest clearances.

In comparing old, middle-age and young soils on Exmoor K. Crabtree (University of Bristol) and E. Maltby (University of Exeter) estimated the developmental stage reached by a soil profile by measuring the rate of accumulation of organic matter over time. By this technique again a process can be calibrated from its inception to the present day; eventually absolute soil chronologies should be available which will allow refined measurement of the ecological stability and trend of individual soil environments as related to management and planning.

The problems which recur when attempts are made to interpret archaeological evidence in environmental terms were well exposed by D. A. Davidson (University College, Lampeter) and R. L. Jones (Lanchester Polytechnic) who examined the location and distribution of Neolithic chambered cairns in the Orkneys. A model for the island of Rousay evaluated seven environmental parameters of cairns: distance from coast, nature of coast, slope, soil drainage, rockiness, altitude and visibility from the mainland of Orkney. The sites generated were compared with the actual distribution of cairns and the best approximations were found to occur for (1) nearness to a beach coastline and (2) steepness of slope. W. Kirk (Queen's University, Belfast) criticised any rationalisation of the location of cairns since they were burial places and not settlement sites. But as Frances Lynch (University College of North Wales, Bangor) has argued (in *The Effect of Man on the Landscape: Highland Zone;* Council for British Archaeology Research Report II, in the press), prehistoric man may have been discriminating in the selection of both vantage points and viewpoints for burial as well as settlement A subtle blend of the defensive and the exhibitionist, and of the imitation of natural features, may sometimes be inferred.

Lunar eclipses and Danjon's law

from David W. Hughes

LUNAR eclipses occur when the Earth's shadow is cast over the full Moon. They have an average duration of 226 min, totality (full shadow) lasting about 103 min. Sixteen lunar eclipses occurred between 1965 and 1975; the exact time of occurrence depends on the relationship between the draconic (lunar nodal) month, the synodic (identical phase) month, the precession of the nodes of the orbit and the Earth–Moon–Sun geometry. In totality the Moon presents a fascinating spectacle—the contours of the seas and some of the craters are discernible, its hue is distinctly red and its brightness and colour vary from limb to centre creating the impression of a sphere as opposed to the flat disk of the normal full Moon.

The reddish glow is an interesting phenomenon. Rays of sunlight just grazing the edge of the Earth's globe must pass right through the thickest part of the atmosphere where they undergo refraction and are bent into the cone of shadow and fall upon the eclipsed Moon. The light also undergoes absorption due to Rayleigh scattering; the short wavelengths are attenuated much more than the long, leaving the remaining light red like sunsets on Earth. The spectrum of the light reflected from the eclipsed Moon and its variation across the disk can be explained by the absorption of light in the terrestrial ozone layer and can be used to give a concentration–height profile of ozone in the Earth's atmosphere.

In 1920 Danjon, a French astronomer, noticed a relationship between the phase of solar activity and the brightness of a lunar eclipse (*C. r. Acad. Sci. Paris,* **171**, 1127; 1920). This relationship is now known as Danjon's law and can be stated as follows: in the two years immediately after a solar activity minimum the shadow of the Earth during a lunar eclipse is very dark and has little colour. As the solar activity moves away from minimum the eclipsed Moon becomes brighter and redder until, during the seventh and eighth year after solar minimum the eclipsed Moon is at its brightest and is red, copper coloured or orange. The brightness curve then falls away very sharply to its minimum value. The maximum phase of the solar cycle passes unnoticed whereas the minimum phase is indicated by a sudden and considerable diminution in brightness and colour, this change forming a discontinuity.

To obtain this law Danjon had analysed eclipse records dating back to the time of Tycho Brahé. He subsequently used the law to estimate the times of solar minimum during the 17th, 18th, and 19th centuries, finding the general relationship that minima occurred in the years $1584.8+10.87n$ where n is an integer (*C. r. Acad. Sci. Paris,* **171**, 1207; 1920). Notice that the length of the solar cycle, 10.87 years as derived from lunar eclipses, is less than the currently used value of 11.2 years derived from sun spots.

Link, of the Institut d' Astrophysique, Paris, has reconsidered the underlying causes of the variations of lunar eclipse brightness described by Danjon's Law in a recent edition of *The Moon* (**11**, 137; 1974). He finds that the phenomenon behind the law is not the absorption of the light in the terrestrial atmosphere, as originally assumed by Danjon, but some light source other than the normal refracted solar illumination. The problem is to find this source. Vassy (*J. Sci. Mét.* **8**, 1; 1958) hypothesised that the cause is a scattering layer in the Earth's upper atmosphere produced by aerosols. The spatial density of these aerosols could be affected by the corpuscular radiation flux from the Sun and the variation in density caused by the sudden change in the heliographic latitudes of the source of this radiation after solar minimum. Link examines the possible implication of this hypothesis on the twilight and daytime sky as observed from Earth. Looking at two extremes of shadow density he finds the eclipse of January 18, 1954 to be a thousand times less luminous than that of September 26, 1950. To explain the bright eclipse by aerosol scattering requires an aerosol density such that the twilight brightness would be a hundred times more than observed. The luminance of the daylight sky too is far from that needed to explain Danjon's Law.

Another source of additional light is the luminescence of lunar surface materials. This could be caused by corpuscular radiation striking the Moon during the eclipse or it could be an afterglow from the period preceeding the eclipse. But recent laboratory examinations of lunar samples showed that the luminescence is much too low to explain the eclipse observations.

Two other facts must be borne in mind: first Fisher (*Smithson. Misc. Coll.,* **76**, No 9; 1924) found winter eclipses to be brighter than those occurring at other seasons and second, exceptions to Danjon's Law have occurred when very dark eclipses were seen after the eruption of the volcanoes Krakatoa (1883) and Katmai, Alaska (1913).

But we must return to Link's final conclusions; that a scattering layer in the upper atmosphere, or luminescence of the lunar surface—both caused by solar corpuscular radiation—describe qualitatively the general features of Danjon's law but are quantitatively completely unsatisfactory. So the cause of the relationship remains unknown.

Erratum

In the report "G-wizardry at Dallas" by John Faulkner (**253**, 231; 1975) the scalar coupling constant was printed in the penultimate paragraph as $\gtrsim 23$ instead of $\lesssim 23$. Also Colgate's institution is New Mexico Institute of Mining and Technology, not University of New Mexico as printed.