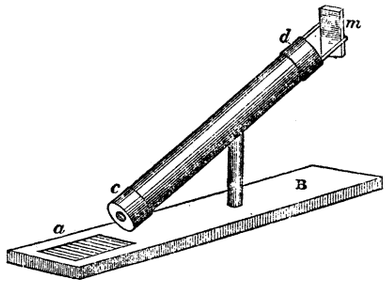
Classics of Science: Nicol Prisms

The inventor of the instrument for analyzing polarized light here describes his invention. Although transparent green tourmaline and Iceland spar are now very rare minerals, the other form of Nicol's apparatus, using reflecting mirrors as the source and analyzer of the polarized ray, may be made and used in the laboratory.

MANUAL OF MINERALOGY: Or the Natural History of the Mineral Kingdom, by James Nicol, F.R.S.E., F.G.S. Edinburgh: MDCCCXLIX (1849).



NICOL'S INSTRUMENT, using mirrors to produce a ray of polarized light. The illustration is from Nicol's book, and the construction of the instrument is described in the accompanying quotation

Polarization of Light

Intimately connected with this property [optical axes of crystals] is that of the polarization of light, which, being more easily and precisely observable than double refraction, is of higher value as a mineralogical character. By this term is meant a peculiar modification which a ray of light undergoes, in consequence of which its capability of being transmitted or reflected towards particular sides is either wholly or partially destroyed. Thus, if from a transparent prism of tourmaline (the green varieties are the best) two thin plates are cut parallel to its axis, they will transmit light, as well as the prism itself, when they are placed above each other, with the chief axis of both in the same direction. But when the one slip of tourmaline is turned at right angles to the other, either no light at all or very little is transmitted, and the plates consequently appear black. Hence in passing through the first slip the rays of light have acquired a peculiar property, which renders them incapable of being transmitted through the second, except in a parallel position, and are hence said to be polarized. The same property is acquired by a ray of light when reflected, at an angle of 35½ degrees (or angle of incidence 54½ degrees), from a plate of glass, one side of which is blackened, or from some other non-metallic body. When such a ray falls on a second similar mirror at an equal angle, but so that the plane of reflection in the second is at right angles to that in the first, it is no longer reflected, but wholly absorbed. When, on the other hand, the planes of reflection are parallel, the ray is wholly and at any intermediate angle partially reflected. A ray of light polarized by reflection is also rendered incapable of transmission through a tourmaline slip in one position, which, however, is at right angles to that in which a ray polarized by passing through another slip is not transmitted. A prism, half an inch thick, of clove-brown rock crystal, acts in the same manner as the tourmaline, but its crystallographic chief axis must be held at a right angle to the former.

The Polariscope

In order to observe the polarization of light, a very simple instrument will be found useful. At one end of a horizontal board B a black mirror *a* is fixed. In the middle is a pillar to which a tube *cd* is fastened, with its axis directed to the mirror at an angle of 35½ degrees. On the lower end is a cover *c*, with a small hole in the center, and at the upper end another cover with a small black mirror attached to it by two arms as in the figure, and also at an angle of 35½ degrees. With this instrument the mirror *d* can be so placed in relation to *a*, that the planes of reflection shall have any desirable inclination to exhibit the simple polarization of light. Its use in determining the polarizing properties of minerals depends on the following principles.

The Extraordinary Ray

As just stated, polarization may be produced either by reflection or transmission. Thus, when light falls on a glass plate, at the proper angle, part of it is reflected, part transmitted, but both portions polarized, the former in a plane parallel to the plane of incidence, the latter in a direction normal to this plane, or the two rays of light are polarized at right angles to each other. Though tourmaline, as an hexagonal or rhombohedric mineral, possesses double refraction, yet when cut as above mentioned, of a proper thickness, it only transmits the extraordinary ray E, polarized parallel to the basis OR. A slip of this mineral may therefore be used in place of the mirror *m*, and another also in place of *a*, as in the experiment lately mentioned. Whenever double refraction takes place, the two rays, O and E, are polarized at right angles to each other; O in a plane parallel, E in one normal, to the optic chief section of the surface of incidence. A simple proof of this is obtained by fixing a rhomb of calc-spar over the hole in *c* now placed on the upper end of the tube, and allowing the light to pass through it and be reflected at *a*. Two images of the opening *c* will be seen, and on turning *c* it will be observed that the maximum intensity of the image from O corresponds with the minimum from E, and the reverse. When, however, a ray of light passes through a crystal in the direction of an optic axis, the polarization of the light disappears along with the double refraction, the ray acting like common light.

James Nicol was born August 12, 1810, in Peeblesshire, Scotland, and died April 8, 1879, at Aberdeen. He went to the University of Edinburgh in 1825, studied geology under Jameson, and continued his studies at the Universities of Bonn and Berlin. In 1844 he published "Guide to the Geology of Scotland." He became professor of Geology in Queen's College, Cork, in 1849, and professor of natural history in the University of Aberdeen in 1853. The "Manual" from which our description of his instrument is taken, was published when he was 39 years old.

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ARCHÆOLOGY

Hundred Maya Skeletons

A hundred skeletons and 2,500 records of the size and other physical characteristics of living modern Maya Indians of Yucatan brought back to the Peabody Museum at Harvard by Dr. and Mrs. G. D. Williams may give an insight into the kind of people who erected great cities and developed a culture in America long before the coming of Columbus.

During an anthropometric survey of the Mexican state of Yucatan, Dr. Williams obtained information on 2,000 adults and 500 children of the descendants of the ancient Maya and also secured for scientific study the skeletons of a hundred present day Mayas. Metabolic tests were included in the studies. The expedition that was in the field for eight months was under the auspices of the Bureau of International Research of Harvard University and Radcliffe College.

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Distances of the nearer stars are found by a triangulation process similar to that used by surveyors.