A TILTING BLACKBOARD FOR GEOLOGIC INSTRUCTION

PERSONS accustomed to geologic profiles and structure sections can readily imagine them tilted this way or that on the blackboard or on paper. In other words, they can readily imagine the horizontal of the drawing to be something other than the horizontal of the blackboard or the paper. Beginning students find this difficult, and some help is desirable in introducing the general concept of tilting to classes in geology.

In my classroom is a light, auxiliary blackboard about 18 inches high and 48 inches long. The writing surface is of special blackboard paint on very dense, thin wallboard made of wood fiber compacted under unusually great pressure. A frame of fir, of $\frac{7}{8}$ by $2\frac{1}{2}$ inch cross-section, gives adequate stiffness to the whole. Rubber-covered nails, driven into the back of the fir frame, protect the permanent, main blackboard. Both ends of a slack cord are attached to screw-eyes in the upper edge of the frame. The cord is passed over two hooks in the upper molding of the permanent blackboard. By sliding the cord over the hooks the auxiliary blackboard may be hung horizontally or may be tilted either way.

The simplest and yet the most valuable use to which I have put it is in explaining unconformities. The auxiliary blackboard is placed so its long axis is horizontal, and half a dozen horizontal lines are drawn on it to represent the deposition of some horizontal strata. Then the board is tilted and erasure above a new horizontal line represents erosion to a new horizontal surface that bevels the tilted strata. Addition of a new set of horizontal strata gives an angular unconformity. Overlaps, both transgressive and regressive, may be illustrated readily. A cross-section of a lake may be tilted, bringing wave-made features above the water on one side of the lake and submerging them on the other side.

The auxiliary blackboard is also convenient on quiz days. The first question or two may be written on the blackboard in the office beforehand. As soon as the paper is distributed and the blackboard hung up the students can get to work. There is no delay while the instructor writes the questions.

It happened that our university carpenter shop had suitable scrap material, so the cost to my department was nil. I judge that new material would cost a dollar or at the most two dollars.

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SPECIAL ARTICLES

EVAPORATION, TRANSPIRATION AND OXYGEN CONSUMPTION BY ROOTS[1]

EARLIER experiments by one of us showed that, other factors being equal, the rate of oxygen absorption by roots might be less when the shoot is in light than when it is in shade or darkness.[2] The experiments here summarized support the earlier conclusion and suggest certain possible causes for exceptions.

In the present experiments the most important conditions were the following, namely, the plants were in distilled water during the tests, but were kept otherwise in a normal culture solution, and the shoots were either in dense shade, or darkness, or were directly exposed to sunlight. The temperature of the solution was fairly constant. The evaporating power of the air was determined with white and black atmometers. The oxygen determinations were made with the Thompson-Miller apparatus and by the Winkler method. The plants used were cuttings of willow (*Salix laevigata* Bebb, from Stanford University, and *S. exigua* Nuttall, from San Diego). The experiments were carried out in the summer at Stanford University. The leading results can be briefly presented, as follows:

When the shoots were kept in dense shade, or darkness, for one hour, as from 8 to 9, or from 9 to 10 A. M., and immediately thereafter placed in direct sunlight for one hour, the consumption of oxygen by the root was usually less during the period of light.

The evaporating power of the air was always greater during the light period, but it varied from day to day. Especially the ratio of black to white atmometer readings (B/W) were found to range from 1.5 to 1.9, which was in part the result of haziness, from whatever cause, often obtaining in early morning. Although further work must be done to surely establish the relation, it was apparent from the experiments that a high ratio would be expected to be coincident with low oxygen consumption of the roots, other factors being equal, and that the converse would be expected with a low ratio. This, it will be seen, is merely a means of defining in a certain way the light-oxygen-consumption relation of the root.

Quite as important a factor is that of the temperature of the culture. When the temperature was low, as about 16° C., the oxygen consumption was also low, whatever the light conditions may have been. But the converse did not appear to follow necessarily.

[1] The investigation was carried out in part with the aid of a grant from the National Research Council.

[2] SCIENCE, n. s., 75: 1934, 108, 1932. *Plant Physiology,* 4: 673, 1932.