although it does not interfere with its use outside of an east or a west window. The improvements suggested by experience have been incorporated in the design given. To save space unnecessary descriptions of details have been omitted; the intelligent teacher will see how to adapt the construction to the material he has at hand.

GEOGRAPHICAL EXPERIMENTS ON EROSION.

BY WILLIAM H. SNYDER.

The forces of nature are so slow in their action that it is very difficult, particularly for the elementary student, to realize that the surface features of the earth are largely due to the action of disintegration and erosion. If this is really to be pressed home, illustrative experiments showing at least the production of some of these surface forms seem almost a necessity. For some time it has been the effort of the writer to arrange experiments of this kind and at last this effort seems to have met with a fair amount of success. The difficulties are that the results must be accomplished with a considerable amount of quickness and that the forces and the materials used must simulate to a large extent those which are found in nature. If the experiments take too long, interest wanes, and if the forms produced are not distinct and fairly like those found upon the earth's surface, the point of the experiment is lost.

If the right relations between the force of the eroding agent and the material to be eroded can be maintained, then the minute features in the laboratory model can in a small amount of time be made to imitate the gigantic features which have been produced by nature in a great amount of time. Of course with the ordinary material obtainable in the laboratory this approximation is far from close, but such is the fate of experiments in many other branches of science besides physical geography.

Perhaps the most difficult thing to get is a suitable eroding apparatus. The writer has tried many different schemes, but all

of these except one have been unsuccessful. The falling water must be uniformly spread, the drops must be small, there must be little variation at different times in the size of these drops and the amount of water falling on the model must never be sufficient to cause any but the tiniest streams. The apparatus used consists, in the present stage of its development, of two parts, the nozzle and the spreader. The nozzle is a brass tube about a quarter of an inch in diameter made so that it can be screwed to the end of

an ordinary garden hose. The end is then plugged with a piece of brass which has been bored with the smallest size of drill and the end of this hole thinly soldered over and a hole the size of a small cambric needle punched in the solder. The end of the nozzle which screws onto the hose has in it a wire filter in order to keep out all sediments. This nozzle must be made with great care, for it is necessary that a very fine but continuous stream of water shall be maintained. Finally the nozzle must be attached to a pipe where there is a good head of water so that there will be force enough to prevent the small orifice from becoming obstructed.

The spreader consists of a piece of very thin sheet copper about three inches wide and seven inches long, one end of which has been folded over in the form of truncated cone—at the truncated end slightly bent in and roughened with a fine file. This end is then bent up a little, about 30 degrees, and the rest of the strip rounded in so as to form a trough which can carry away the surplus water that escapes from the nozzle.

The nozzle is placed within the spreader so that its stream plays upon the slightly bent-in edge of the cone. The water will arch over in front of the spreader in the form of a very fine mist, which if the spreader is rightly made, will fall uniformly over a surface two or three feet square. The height of the fall and the force of impact can be regulated by the angle at which the end of the spreader is bent up. Some little care will be needed in the adjustment of the nozzle and spreader so as to get the best results, but this is by no means a difficult task. Nothing but a fine mist must be allowed to fall upon the model and this must fall uniformly.

For holding the model the writer has used a rather tight wooden tray one and three-fourths feet square and four inches deep. One side of the tray has holes bored in it at different heights above the bottom. By opening or closing these holes different water levels can be made, thus simulating a rise or fall of the land during the period of erosion. The tray is placed in a slightly inclined position in front of the spreader, the side in which are the holes being the lowest.

To get the best results the materials of which the erosion model is to be made must vary in size and shape of grains, specific gravity, strength of adhesion, solubility and color. As yet not as many different inexpensive materials as desirable have been hit upon for building up the model. A sufficient number, however, for producing the simpler forms have been found. The size of the grains can be determined by using sieves of different sized mesh. The writer uses sieves of 12, 20 and 24 meshes to the inch. The materials are carefully sifted over each other in the tray, the layers being made of the thickness desired and placed in the order desired.

The materials thus far experimented with have been sand, coal

dust, ground brimstone, bone meal, moulders' clay, two sizes of pulverized pumice, chalk and salt. These are named in about the order of difficulty of erosion. Any grain which will not pass through the largest sieve mentioned above cannot be used to advantage.

The brimstone, when properly ground (the writer uses an old hashing machine), is about the best for the erodable hard layer. The bone meal has one great advantage in that, being an organic substance, it can be dyed any color with ordinary aniline dyes. Thus its layers can be made to stand out distinctly. The moulders' clay is very fine but rather tenacious, thus making somewhat subdued relief. The pumice is easily eroded. The salt is the soluble material. All these differ from each other in color and can thus be easily traced in the deposition formations. If the materials are sifted in layers one above the other leaving a vacant space toward the side of the tray in which are the holes and the lower of these holes is plugged, the erosion of plains and the accompanying deposition phenomena can be easily shown. Current action can be produced by causing a small stream to flow from a pipe into the quiet water bordering the model. The action of waves can be simulated by causing a plunger attached to some clock-work or an interested boy to move up and down in this quiet water. In a model produced as above described a geographically inclined friend of mine found nearly thirty characteristic surface features, thus showing plainly its usefulness for illustrative purposes.

Sufficient experiments have not yet been made for determining the best method of showing erosion in folded strata. The method, however, which seems to be most successful is to build up a rough model of the structure which it is desired to imitate and, having covered this with a flexible waterproof cloth and carefully sifted the layers of material onto the cloth, to subject this to the action of the eroding apparatus. The relief cannot, of course, be greatly exaggerated, but this is no disadvantage. Although there is no crushing or breaking of the layers, yet here, as usually in nature, the layers upon the prominences are thinner and therefore more easily eroded than those in the depressions. This is due to the sliding of the material as it falls from the sieve.

Of course the production of the more complex mountain features cannot be simulated.

All, then, that is needed for the illustrative production of a number of the physiographic features of the earth, is the above described simple apparatus, a basement where water can be allowed to run or a sillcock in the school yard, and sufficient water pressure to keep a constant stream. This kind of work can be performed where it is inexpedient to take classes on excursions. Although in many ways it is not as valuable as the excursion, yet in some ways it is more valuable, as here the action is seen in its entirety, whereas in the excursion only the finished product or a phase of the formative action is seen. Photographs taken at different stages in the production of the model are very instructive for reference but the formation of the model itself is the essential thing. The great need is to show the pupils that surface features can be produced in the way in which they are taught that they are produced. Seeing is believing.

HOW TO MAKE A LANTERN SLIDE CAMERA.

BY W. F. WATSON.

Professor of Chemistry and Biology, Furman University.

Lantern slides are easily made by the "contact method" with quite limited appliances. Even the tyro, with the ordinary photographic equipments, can by careful work obtain quite good results. Working in the dark-room, a negative is put into the printing frame and an ordinary lantern-slide dry plate, $3\frac{1}{4} \times 4$, is placed upon it in the desired position, with the films in contact. The process is similar to that of making the ordinary print on sensitized paper. When properly adjusted the frame holding the plates is exposed to the light for a suitable time; then the exposed plate is removed and developed like an ordinary negative.

The range of work which can be done by the contact method is necessarily limited. The positive obtained must correspond in size with the negative. Any enlargement or reduction by this method is absolutely impossible. Consequently the operator who has used plates of various sizes for photographic work is fre-