

of the Wabash Drainage System," in this volume. The westward wall of ice along this Tippecanoe Gulf helps to explain the laking which was due to the obstruction of drainage toward the west.

Commenting on the theory proposed, Dr. C. R. Dryer mentioned that the Iroquois Beach in New York is thickly strewn with bowlders in much the same way as the Indiana belts mentioned.

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## AIDS IN TEACHING PHYSICAL GEOGRAPHY.

BY V. F. MARSTERS.



Harper's Ferry Sheet.

The past decade has witnessed a growing interest in and a corresponding advancement along rational lines in geography, now justly regarded as a technical science. One of the pertinent reasons for this is that the seeker after knowledge, long before the college is reached, is becoming cognizant of the fact that the mere accumulation of geographical facts does not constitute geographical knowledge in the scientific sense. To know *where* the Blue Ridge is, is simply memorizing a *fact*; to know *what* it is, and, still further, to find out for one's self something about the sequential history of this topographic feature, constitutes *real geographic knowledge*. The former calls for observation and the sole exer-

cise of memory; the latter demands that we not only accumulate facts, but that we seek a rational explanation of the facts observed. And just so far as we can see the relationships of the factors concerned in a geographical problem, and the role each has played in producing the observed results, to that degree have we gained real and useful scientific knowledge.

It was with this fundamental principle in mind that I have set about to prepare some geographical helps to attain this end. Any piece of apparatus such as a geological model, or map which properly expresses an evident relation between the geology or rock structure and the topography provides good material from which may be gained genuine geographical knowledge. Such material, however, is often in poor form and shape for laboratory use, and more often quite useless for lecture purposes, the scale being too small, or facts not well expressed. The material I describe below is intended primarily for use in lecture work. It consists of a lantern slide of a model representing a type of land form, and showing at once the relief of the land as well as the rock structure in two cross sections. With the picture of a model which brings out clearly the relations of structure to topography, and all the larger features of adjustment of drainage to structure, the lecturer can actually show up the facts as well as the arguments leading to his interpretation of the actual history of the land form discussed. Such details as could not be shown on ordinary maps may be clearly depicted by this method of illustration.

The data used in the construction of the illustrated model were gathered from the Geological Atlas sheets published by the United States Geological Survey. The area selected is that covered by the Harpers Ferry sheet. From the data therein contained, a model was constructed on the scale of one inch to the mile, vertical scale one inch to sixteen hundred feet.

The method used in the construction of the base may be aptly termed the contour method. The course of procedure was as follows: The topographic sheet was first enlarged to the desired scale. In the case of Harpers Ferry it was enlarged from two miles to the inch to one mile to the inch. The culture in addition to the topography was also transferred to the enlarged sheet and the whole traced on tracing cloth. The next step was to determine the vertical scale which would give the most expressive and yet close approach to the natural appearance of

the topography when combined with a given horizontal scale. In the illustration selected it was found that sixteen hundred feet to the vertical inch gave the most effective result. Inasmuch, then, as the contour interval used on the topographic sheet was one hundred feet, and we wished to adopt in the construction of the model the scale mentioned above, it follows that sixteen sheets of strawboard, one-sixteenth of an inch in thickness, placed one upon another, would provide the vertical scale desired. This determined, each contour, beginning with the lowest, was then traced on separate sheets of strawboard, carefully cut out, piled in their proper succession and location, and tacked to a well seasoned wooden base or platform. The model at this stage presented a terrace-like appearance. This objectionable feature so often seen on geographical models, was easily obliterated by covering the entire surface with a sheet of clay, taking care of course to preserve as much of the details of relief as was shown on the original map. A plaster negative was next made from the original and from it a final positive was prepared. After thorough drying, the surface was painted a dead white. The partings or the contacts between adjacent formations as indicated on the geologic sheets referred to above, were carefully plotted and drawn on the white surface, in well defined black lines, sufficiently broad to be clearly photographed on a scale small enough to be transferred to a lantern slide. Before taking this step, however, another addition was made to the model. Two cross sections expressing the structural geology, one from east to west and the other from north to south, the former located on the south end and the latter along the east side of the model, were prepared. The outline of the topography along the respective sections was also traced on each section and cut out. These sections were then fastened to the end and side of the model in their proper vertical position, so that the relief, partings and structure were correctly correlated. The model was then photographed in a tilted position so that both sections could be clearly seen and the relief at the same time well expressed by obtaining moderately strong light and shade. It is especially important that the lines of contact be clearly brought out, as they determine the limits of the formations to be subsequently colored. A slide was next made from the negative and sent with a copy of the Harpers Ferry Atlas sheet to a photographic artist, with instructions to color the slide, adopting of course, so far as might be feasible, the same scheme of colors as appear on the geologic sheets.



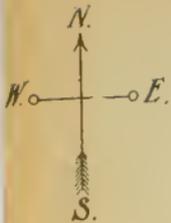


Fig A.

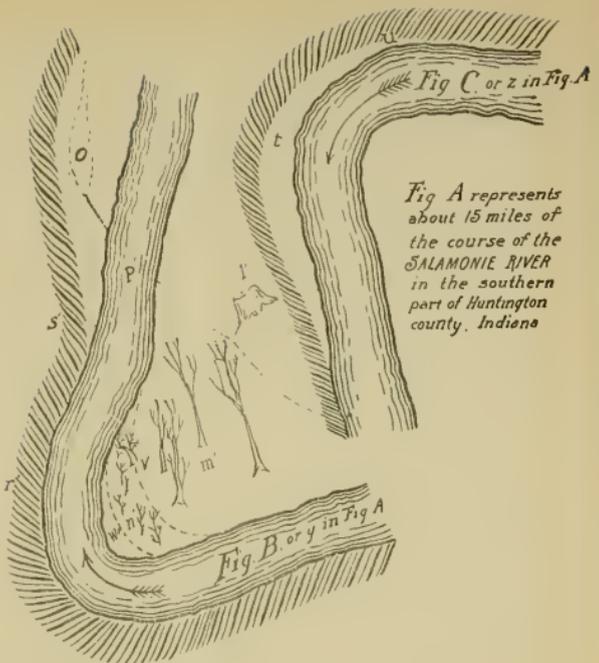
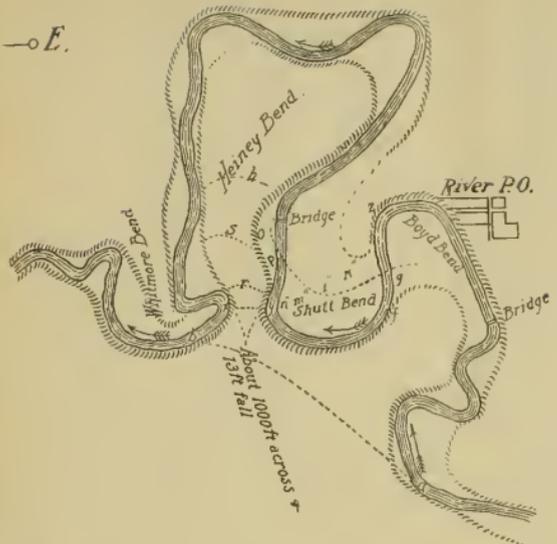


Fig A represents about 15 miles of the course of the SALAMONIE RIVER in the southern part of Huntington county, Indiana

 Bluffs  
 Present River Bed  
 Ancient or one bank of it.



From X<sup>67</sup> in Fig D. is contracted to about  $\frac{1}{3}$  what the Scale would make it. **Fig. D.**

In Fig D. the Scale is  $\frac{1}{16}$  in to 10 ft & in Figs B & C. it is approximately the Same.

Use.—In conclusion it should be said that a trial of the first slide made it evident that the use of such illustrations would materially increase the facilities for teaching geography and increase the educational value of the work accomplished. Such material may not only help the lecturer to avoid technical description of features usually not illustrated at all, when simplicity of treatment is demanded, but with this aid he is enabled to show his class or audience a mass of facts upon which he bases his interpretation of the phenomena discussed. By this means, the lecturer may even treat somewhat technical and involved problems so that they may be made easy to comprehend, and, most important of all, whatever geographical knowledge be absorbed, is properly attained through the exercise of observation, comparison and deduction. For just so far as the student subjects himself to such mental discipline, in the same degree does he acquire a scientific knowledge and the power of analysis that is lasting and of true educational value.

The picture attached below is a copy from the negative from which the lantern slide was prepared.\*

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## RIVER BENDS AND BLUFFS.

BY WM. M. HEINEY.

Bends and bluffs of rivers are interdependent. While under the universal river law of taking the course of least resistance, the embryonic bluff must first exist, the matured bluff is the product of the river's course. But, early the relation begins shifting, and the bend becomes the consequence of the bluff. Again, however, the bend batters down the bluff, so that the relations first attained are repeated.

The above propositions are verified by tracing the historical relation of the bluffs and bends in a very crooked section of about fifteen miles of the Salamonie River, found in the southern part of Huntington County, Indiana.

Fig. A represents the stream in its present course, with the bluffs and their connecting ridges, which define the territory over which the stream

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\*I will be glad to correspond with any person who desires to obtain copies of these slides for school or college collections. Others are being prepared.