FIELD WORK IN PHYSIOGRAPHY.

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It is my purpose in this paper to treat in a very restricted way a subject full of opportunities.

Until an orderly plan of field work is evolved from the present chaos of ideas, and a schedule, sufficiently broad to be adapted to the varying conditions and environments of secondary schools throughout the country is agreed upon, it will be well for the teacher to study out for himself what the possibilities of his region best offer, then to so plan his work as to bring out the best there is in it, and to correlate it in scientific harmony with the efforts of his co-workers.

The tendency is to place the elementary study of earth science early in the high school course. This plan has many good reasons for its maintenance, but personally, I advocate having some of the work late in the course, or having an advanced course offered as an elective in the fourth year. It is with fourth year pupils that I have been privileged to work, and I doubt if my plan would, unmodified, be practicable with younger pupils.

The possibilities of a region, then, is the keynote of the plan which, if followed in specialties from term to term, will in a few years result in the accumulation of much valuable data, which must be carefully preserved, and may finally be arranged into a syllabus of information from which maps of the topography, areal and economic geology, water supply, and general physiographic features of the district may be constructed by the careful student who has obtained a broad grasp of the subject. Such work, if properly begun and systematically, even though slowly, advanced by the persevering teacher, will in time bring forth results that will bear the stamp of true value when the growth of his department is reckoned with.

Recognizing that the subject of topographic map-making offers a wide diversity of interesting work in and about Sioux City, I have taken that up as a special adjunct to the year's work. The necessary equipment is not elaborate. An aneroid barometer, a

compass, a hand level, a ten-foot pole, a hundred feet of measuring tape, note books with coördinate ruling, protractors, and pencils complete the field equipment. If two sets of the first three instruments are available, two independent parties may work at once and thereby the practice be extended to all members of the class more rapidly.

The barometer should be of good grade, compensated for temperature, and capable of recording a change in elevation of five feet. Its face should have a movable rim graduated in feet so that the readings may be made directly and the instrument set at a known elevation whenever desirable. It should not be much larger than a watch, so as to be conveniently carried in the vest pocket. Such an aneroid costs about \$20 and is also quite essential to a physics laboratory. An excellent form of compass is the "Geologist's," made of aluminum, with a base four inches square, the edges of which are bevelled and graduated, two of them for a tangent scale and the other two with scales of eighths and tenths of an inch. The base is provided with spirit levels and folding sights, one of which carried a reflector. There is also a screw and lever for setting and releasing the needle, and the graduated circle is movable so as to be adjusted for magnetic variation. The face is also provided with a clinometer with separate graduated semicircle. The cost is about \$20. The Abney form of hand level, with a clinometer for giving angles of elevation is a very satisfactory instrument. Its retail cost is about \$13.50.

A map made with the above equipment accompanies this article. (Fig. 1.)

In order that the pupils may at the outset become familiar with the plan and purpose of a topographic map the maps of Folios 1, 2 and 3 of the Topographic Atlas of the U. S. (Physiographic Types) are studied, and for purposes of class discussion I have prepared lantern slides of all the maps in the series. Profiles of roads and streams, cross sections, generalized topography of portions of each map, represented in color, and other exercises of a similar nature based on these maps are required of the pupils.

The field work must necessarily begin early in the fall term, perhaps before each pupil understands the full meaning of the

work, and is carried on contemporaneously with the study. Exercises in making profiles up and down several streets or suburban roads come first. (These would hardly be profitable in a flat country.) I make it a point to conduct a *small* part—say of four or five of the aptest boys in the class at first—and acquaint them with the methods of work, subsequently giving each one of them charge of a party or of a division of the work.

Fig. 1.

This work is then continued by various assignments so made that the work of each party is checked up by the work of others, and is extended to profiles and cross-sections of all the surface features so that little detail is omitted. When pupils begin such work independently, if in the city, the instructor can have at hand as a check on their results the city engineer's grades for street intersections. One field exercise a week for each pupil, occupy-

ing three to five hours, during six weeks, planned as outlined, will be found to be ample time for a large quantity of work, and will furnish material for indoor work for the remainder of the term.

It is not the intention to have each pupil perform all parts of the work, but it is the intention to have him be able to interpret the work of every other pupil so that if called upon he may continue a piece of work or explain its application. After all the important elevations in the desired area have been obtained, and the location and direction of the drainage features noted, the same are placed upon base maps. (County or city maps upon a sufficiently large scale may usually be obtained so that each pupil may have a copy, or else a tracing may be made from which any number of positive prints may be taken.) Then the sketching of the topography begins. This is conveniently done in small sections on a large scale, on base maps drawn on the coördinate paper in the note books, showing the observed elevations at the proper stations. Some pupils will be found not to have the desired art of expressing topography by means of contour lines, and it will be difficult for such to acquire it in the limited time, but this work will find its devotees as well as the more monotonous parts of the work have done. Finally, if any two or more of the completed areas adjoin, they can be given to certain pupils to join up and reduce, letting the pupils go into the field to inspect doubtful points if necessary.

If such a plan as this is followed, it should not be a matter of discouragement if only a few blocks in the vicinity of the school building are mapped in one season, or a portion of a public park, or the vicinity of a water supply reservoir, provided the start is made and what is done is done with painstaking.

An especially valuable subject for topographic work is a region in which there are frequent outcroppings or exposures of rock. When the study is begun of the geology, nothing is of greater value in connection with the geological mapping than a good topographic map having a small contour interval.

Not having stood the test of extended use, the plan may be found to have certain disadvantages, but essentially, in its incep-

tion, it builds for the future—a long way in the future—and every teacher will recognize that at least it is destined to relieve him of the monotony of an oft repeated course, and will incidentally afford him a chance to shape some practical, original work.

A NEW AND CHEAP FORM OF AUXANOMETER.

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It is very much more interesting and instructive, in elementary courses in botany, to observe periodicity of growth in plants than merely to demonstrate, by means of a lever, what every one knows already, namely, that plants grow. It is sounder pedagogically to do such experiments quantitatively, since, when so performed, they mean very much more in training. It is for this reason that attempts have been made to construct a cheap form of auxanometer by attaching a recording cylinder to the minute-hand spindle of an ordinary clock. It is obvious, however, that the centering of a cylinder, and its vertical adjustment without lateral movement, are by no means easy of accomplishment. A cylinder is very likely to revolve irregularly unless made with very great care, a process which involves turning and centering on a lathe, and skilful mechanical adjustment to the clock. I have to confess to failure in this direction, except after a too great expenditure of time and labor. Happily, however, this experience has led me to devise a very cheap and accurate mechanism which accomplishes the end desired, and this at a very small cost of money, time or skill. This is done by substituting for a revolving cylinder, a lever, which is jogged once an hour by an arm moved by the minute-spindle of a seventy-five cent clock.

As will be seen by the illustration the lever bearing the record is fixed on a horizontal axis, and stands vertically upward, held against a block by means of a thread, reeved through a wire pulley, drawn sufficiently taut by means of an attached weight. This weight must be heavy enough to draw back the record lever to the block when it has been displaced from the vertical, say from