

THE CONSTRUCTION OF A GEOLOGIC MODEL

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THE PROCESS of building a model of a given portion of the earth's surface showing the relation between the topography and the structure of the underlying geologic formations is four-fold. First, an original is made of wood, cardboard and clay; second, a mold is made from the original; third, a plaster cast is made from the mold; fourth, the cast is painted to indicate outcrops, roads and streams.

The usefulness of models as teaching equipment in geology has been well demonstrated by the fact that most of the larger and better equipped schools are supplied with complete series of models which illustrate geologic and topographic features and phenomena in a manner easily grasped by the student. A chart or diagram which has two dimensions is more explanatory than the written text, and a model is better yet, because its three dimensions leave nothing to the imagination.

It is possible for the teacher to build models to fit his needs, and although the details of construction may differ with different types of models, the principles of construction are the same in all cases. It is hoped that this brief outline of the construction of one particular type of geologic model may be of value in serving as a guide to other persons interested in the preparation of models for teaching and museum purposes.

A geologic model was built by the writer during the summer of 1928 in the laboratories of the Department of Museum Methods of the University of Iowa under the direction of Professor Homer R. Dill. It represents the surface topographic features, the areal and subsurface distribution of the different geologic formations and the relations between the topography and the rocks in an area ten miles square in one of the most interesting and well-known parts of the Arbuckle Mountains of southern Oklahoma. This area includes all of T. 2 S., R. 2 E. and parts of adjacent townships. In it are such places as the Washita River gorge, the East Timbered Hills, Turner Falls, Price's Falls, White Mound, the famous fossil-collecting ground, the Arbuckle and Daugherty anticlines, Vine dome, and the towns of Daugherty and Springer.

A horizontal scale of 1/26400 or 2.4 inches to the mile was chosen, which made the model about two feet square. The vertical scale was made five times greater than the horizontal scale to overcome the effect of foreshortening produced by viewing the model from above, and to emphasize the different topographic and geologic features.

In building a model of this kind, in addition to the material needed for the actual construction, it is necessary to have a topographic and a geologic map of the area chosen.

The process of construction is four-fold. The first operation is to build the original model representing the topographic surface; the second part of the work consists of making a mold of the original; third, one or more casts are made from this mold; fourth, the surface and sides of each model are painted to represent surface and subsurface arrangement of formations and to show the streams and the works of man.

In building the original model, the topographic map used must be en-

larged or reduced to the scale of the model, if it has not already the same scale. A portion of the Ardmore quadrangle of the United States Geological Survey was enlarged the proper amount in building the Arbuckle model, by using a projecting device similar to a magic lantern. Enlarging can be done with a pantograph or by photography.

After preparing a topographic map of suitable scale, the next step is to trace the pattern or patterns made by each individual contour line on a separate sheet of cardboard. These patterns are cut out by perforating along the line with a sewing machine. The thread is removed from the needle and the cardboard is not clamped down as in sewing cloth. In this manner, much more rapid progress is made than is possible by cutting along the lines with scissors or knife. After perforating it is an easy matter to tear away the unwanted portion. A layer of cardboard is prepared to correspond with each contour line. The layers are assembled on a base of two-inch white pine two feet square, by gluing each to the one beneath it with hot carpenter's glue and nailing it to the base with shingle nails. At this stage, the model has the appearance of a series of stair steps, and to smooth up the surface and put in the minor details, modelling clay is used. The last step is to elevate the model by building up the bottom of the base until its under surface represents the sea-level as computed from the vertical scale. The vertical scale of the model depends entirely upon the thickness of the cardboard layers, and can be determined only approximately until the completion of the original model.

In making a mold of the original model, a frame is built of one- by four-inch white pine to fit the outside of the model and to extend above it to receive the plaster when the mold is cast. It is hinged at three corners and fastened with a hasp and staple at the fourth. Small bevelled wooden cleats are nailed to the inside of the frame in such positions as to provide keys for the accurate replacement of the frame around the mold in future operations. The frame is then given two coats of shellac to prevent warping from absorbed moisture. After the shellac is dry, the frame is placed in position around the model so that the upper edge is level, and any cracks between the two are sealed with modelling clay. If reinforcing rods are placed in the mold, they are prepared at this time. To be sure that no iron is exposed at the surface, all points on the rods which touch the model must be held up by building supports of plaster on the rods themselves.

In mixing plaster of Paris, a quantity of water slightly exceeding the volume of plaster required is placed in a pan, and into it is shaken dry plaster until it is even with the top of the water. After allowing the mixture to stand a few seconds to assure complete absorption of water by the dry plaster, the excess of water is poured off and the mixture is stirred. It is then ready to pour. It is not poured all at once, however, but enough plaster is poured to cover the surface of the model with a thin layer, and this is blown thoroughly into all depressions and corners to prevent the formation of air bubbles. Whether the blowing is done by lung power or by another method, it must be done rapidly. Then, after placing the reinforcements in place, the remainder of the plaster is poured. The plaster will set in half an hour, but to minimize danger of breakage the mold should not be touched for several hours. Then the model, frame and mold are inverted, the frame removed, and the model lifted off the mold. The mold is allowed to dry until it no longer feels moist to the touch.

This will take several days. When dry, a coat of thin shellac is applied to the surface.

To make a cast from the mold, a process similar to that of making the mold is followed. The frame is placed around the mold, the cleats fitting into their proper positions, and the surface of the mold and the sides of the frame are greased with a thin coat of separator, which is prepared by melting a tallow candle and adding kerosene. After applying the separator, the excess is wiped off with a soft cloth. If too much is used, a mealy surface texture will result; and if too little is applied, it is impossible to remove the cast from the mold without breaking one or the other. Before mixing the plaster, a piece of burlap for reinforcing is prepared by soaking it in water, and four large stove bolts are placed at hand. Then the plaster is mixed as before, the first thin layer is poured, the bubbles are blown out, the burlap is dipped in plaster and placed on this layer, and the remainder of the plaster is poured. In order to reduce the weight of the cast, the base is partly hollowed by removing some of the plaster as soon as it has set to a thick consistency. At the same time the heads of the bolts are imbedded in the corners with about an inch protruding from the plaster for the purpose of fastening the model to a base, and the plaster is allowed to set completely. After several hours the frame is removed, and the cast is taken from the mold. If the two do not come apart readily, rapping the mold with a light mallet may assist in separating them. If this does not succeed, the mold and the cast are placed on edge and water is poured along the crack between them, and they are pried gently apart with a short blunt knife. This is repeated on the other three sides with a continual supply of water until a portion begins to separate. Water enters and with a little more prying the mold and cast come completely apart. The cast is allowed to dry thoroughly and is given a coat of thin shellac. Additional casts may be made from the same mold as long as it remains in good condition.

The model is completed by painting it to represent formations and faults, and the features shown on topographic maps. The section lines are drawn in pencil on the plaster surface by reference to the topographic map, and the lines of contact between geologic formations are sketched with reference to these from the geologic map. In sketching the contact lines a first-hand knowledge of the area is an advantage, because the characteristics of each formation must be kept in mind in order to place the banded outcrops in their proper relation to the topographic features. In the Arbuckle model, for instance, the series of rounded hills which marks the outcrop of the resistant Viola limestone was recognized as such before the contact lines were sketched in. A geologic cross-section indicating the underground relations of the rocks is sketched on each side of the model.

The model is painted with artist's oil colors. The color scheme used on the geologic map should be followed as closely as possible and made subdued in value, not to detract from geological interest. If the geologic map is not a colored one, the formations, both on the surface and on the cross-sections, are painted colors in keeping with those used by the United States Geological Survey for the different divisions of geologic time. Faults which cut the rocks in the area are sketched in relation to the contact lines and painted a medium grey. Black is too prominent to fit in with most color schemes. Streams are painted in their proper positions

in a light blue in accordance with conventional symbols. Roads, railroads, township lines, towns, and names of towns and of streams are painted over the outcrops in a lighter grey than that used for faults. A legend is prepared giving the location of the area, the date of construction, the name of the maker, the horizontal and vertical scales, the names of all geologic formations and the colors which represent them. It is made the length of the model and about five inches wide to give ample room for the numerous blocks of color indicating formations. A base of two-inch white pine is prepared which extends an inch beyond the model on three sides and about six inches on the fourth side to accommodate the legend. The model should be oriented with respect to the legend so that north is at the top, and is secured to the base with the bolts set in the cast for that purpose.