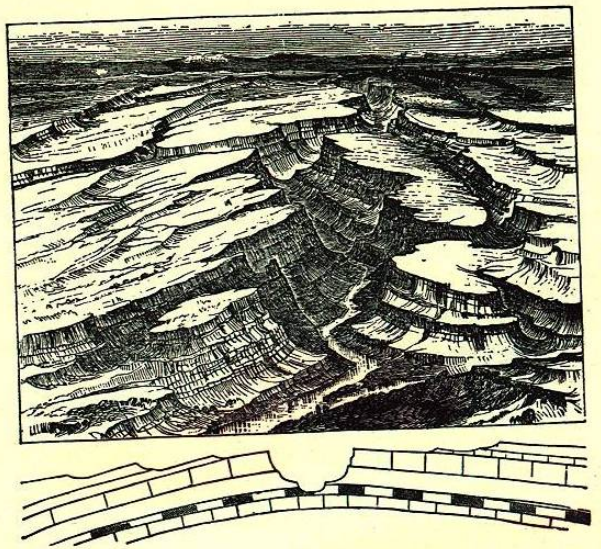
lets, some of which have no outlets; and a careful comparison with the first model shows not only that many of the minor branches have been obliterated or greatly modified, but also that one of the largest tributaries has been diverted near its junction with the main stream and forced to add its waters to those of a smaller tributary, finally reaching the main stream at a point considerably below its original confluence. The diversion of the streams will often cause them to flow over ledges or ridges of solid rock, giving rise to waterfalls, which are wanting in the unglaciated landscape. Eventually, however, the streams, by deepening their channels, will drain all the standing water, and obliterate the cascades; and their altered courses, with remnants of drift upon the hills, will alone remain to tell of this crisis in their history.

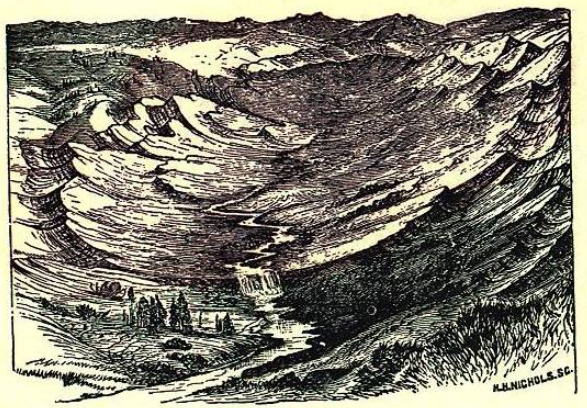
We pass now to a series of six models (**11–16**) illustrating the influence of volcanic phenomena upon the topography, the illustration embracing the entire life-history, or development and decay, of two volcanoes. The first model (**11**) represents a flat country with slightly incised drainage lines having a general east to west course. Volcanic activity commences near the sources of the streams (**12**), a cinder cone (green color) is formed and a stream of lava flows southward and occupies the valley of the southern stream, damming back its waters and forming two lakes. In the third model (**13**) these lakes have been drained by the erosive action of the stream flowing from them along the edge of the lava. But a more recent flood of lava, having a general southwesterly course, has invaded this stream at a

lower point, intercepting its main tributary and damming it back until its waters discharge over the low water-parting into the northern stream. Two small lakelets are also formed at the confluence of the two lava streams in the northern valley. Two flows of lava have also invaded the northern valley, slightly impounding its waters. In the fourth model (**14**) this crater is represented as extinct and holding a lakelet; and all but one of the lakes formed by its flows have been drained. Meanwhile, however, a second cone has arisen in the eastern part of the field, and from this new center of volcanic activity lava has spread widely over the surrounding country, obstructing the northern stream and obliterating the large lake formerly existing between the two cones. In the fifth model (**15**) this second crater is also extinct, both cinder cones are largely wasted by erosion, and in the older one the central core or plug, the volcanic "neck" begins to appear. The lakes are all drained; but the flows of solid, resistant lava are still almost intact, although the streams which border them are steadily gnawing at their edges. In the last model (**16**) the cinder cones have wholly disappeared, the protruding necks alone remain to mark their sites, and the lateral erosion of the streams has greatly narrowed the sheets of lava, which, although formed in the valleys, now rise abruptly above the surrounding country.

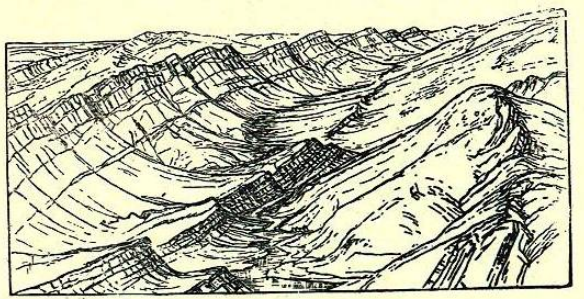
The next series embraces the two models on the left side of the south window These are intended especially to show the normal relations of erosion to anticlinal and synclinal folds, and may be regarded as especially typical of a large area of mountainous country in middle



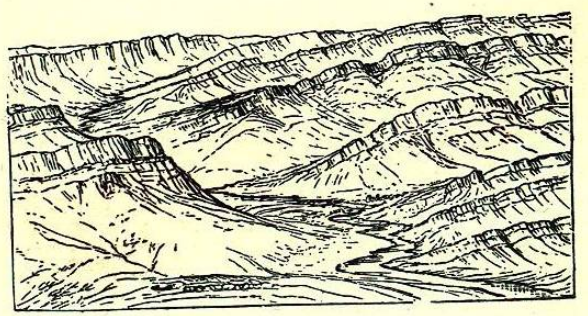
An anticlinal valley, with section.



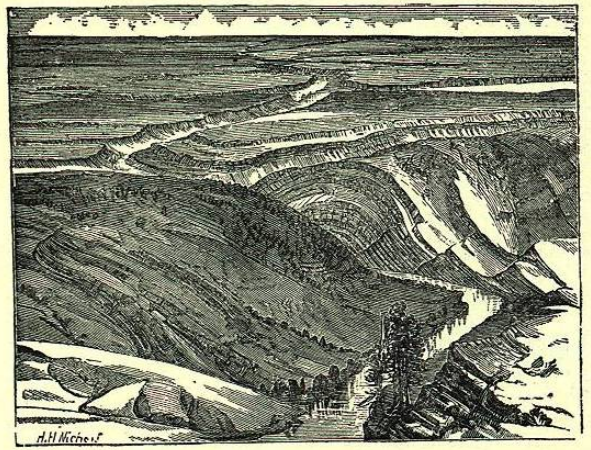
A synclinal valley.



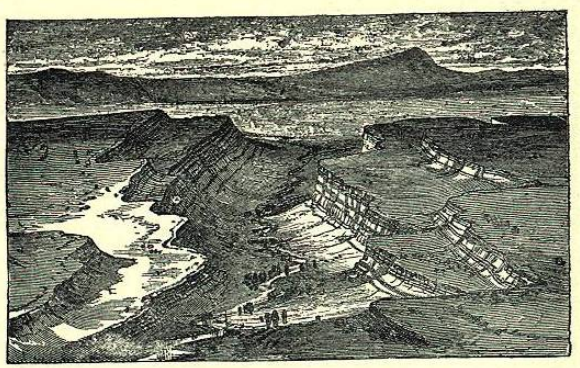
A monoclinal valley.



An anaclinal valley.



A diaclinal valley.



A cataclinal valley.

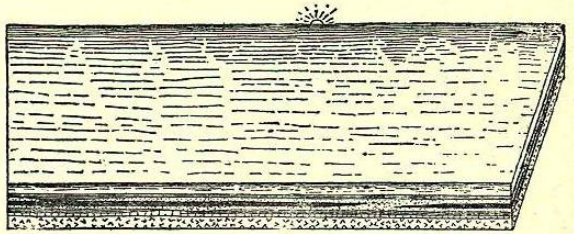
Pennsylvania. The lower model is purely ideal, representing the strata as bent into a series of sharp parallel folds without having suffered erosion. The agreement between the geology and topography is perfect, each ridge corresponding to an anticline and each valley to a syncline. Now the rocks on the crest of the anticline have been stretched and broken, while those forming the trough of the syncline have been compressed and made more resistant; and since the anticline is also more elevated and more exposed to erosion, it follows that it will usually be worn down more rapidly than the syncline. And if the upper strata are underlain by softer rocks, as soon as the former are worn through on the anticline the erosion will proceed still more rapidly, the crests of the anticlines being very generally replaced by narrow valleys, as shown in the upper model, in which the valleys are about equally divided between the synclinal valleys due to the original folding of the strata and the anticlinal valleys due to subsequent erosion. The synclinal or structural valleys would, in many cases, be without outlets, but for the transverse notching of the ridges by the streams; and it will be observed that in several instances the anticline is now more deeply eroded than the adjacent syncline, foretelling a time when the synclinal valleys will have disappeared and the relations of topography to geology be completely reversed or transposed, — anticlinal valleys and synclinal ridges.

The next series includes the two models on the right side of the south window. It expresses still another relation of topography to geology. The lower model represents a great mountain uplift, the combined product

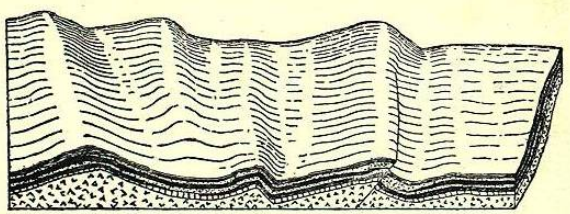
of gigantic faults and flexures, and entirely unmodified by erosion. It shows what the subterranean agencies would have produced if the superficial agencies had, meanwhile, been at rest. The upper model shows the same uplift modified by erosion; and in the river which cuts directly across the uplift or mountain range, we have evidence not only that the erosion was in progress during the uplifting, but also that the river is older than the uplift, and that the elevation of the mountain took place so slowly that the river was able to keep pace with it and preserve its course. The horizontal and sloping terraces afford a clue to the stratigraphy of the uplift.

The next pair of models, on the left side of the middle window, is intended especially to illustrate the capture by one stream of part of the drainage area of another stream. Two streams are represented, one flowing north and the other south, their basins or drainage areas being distinguished by the different colors. The headwaters of the northward-flowing stream, as shown in the lower model, have much the greatest fall and erosive power, and in their backward gnawing they eventually capture, as shown in the upper model, the first two branches of the southward-flowing stream. The sluggish character of the latter is seen in the fact that, after being deprived of a good part of its headwaters, it is no longer able to sweep away the detritus brought down by its lateral branches, which clogs the valley and forms shallow ponds of standing water.

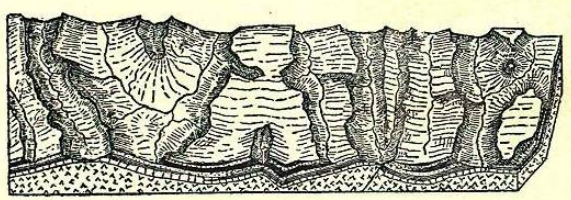
The pair of models on the right side of the middle window is another illustration of the same general character and purpose; one tributary of a main stream steal-



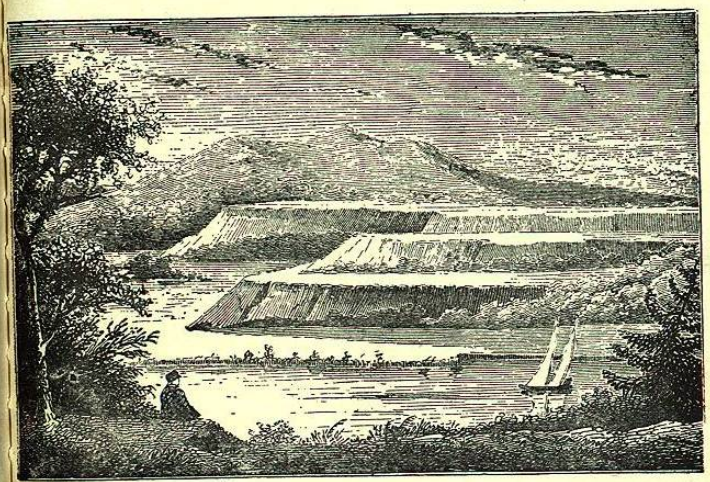
Newly-deposited strata enclosing a seam of coal.



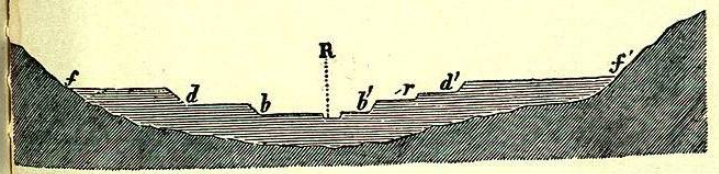
The same, subsequent to upheaval and prior to denudation.



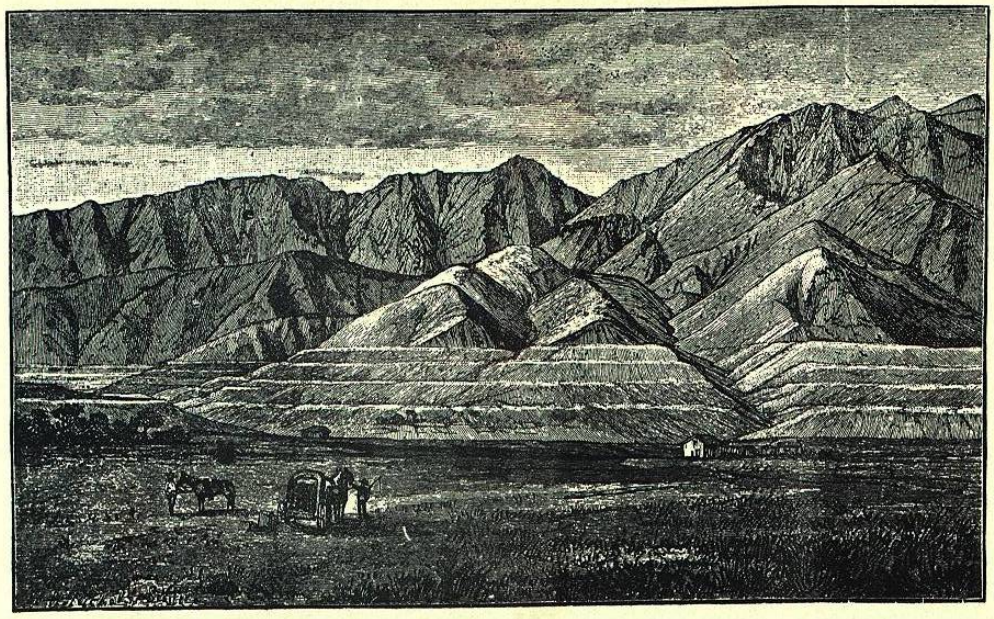
The same subsequent to denudation.



Terraces on the Connecticut River, south of Hanover, N. H. (Dana.)



Section of a valley with its terraces completed. (Dana.)



Terraces or elevated shore-lines of Lake Bonneville, near Wellsville, Utah, showing a contrast between littoral and subaerial topography.

ing water from another tributary. The lower model should be observed first, and then compared with the upper model, noticing the increased extent of the yellow tint and the diminished extent of the gray. In the next pair of models, on the left side of the north window, the same general story is told again. The left hand model shows a large stream and several brooks flowing into a lake; the large stream having commenced to form a delta. In the other model one of the brooks has succeeded in capturing all the upper part of the large stream, which below the scene of the piracy has become relatively insignificant, and delta-deposits have become more general along the coast.

The three models in the passage way to Room A illustrate the river terraces so characteristic of the valleys running south from the retreating front of the great ice-sheet. The first model of the series shows the valley before the ice age. The enormous floods of water resulting from the melting of the ice washed down vast amounts of sand and gravel which were deposited in the valleys, filling them up in some cases to a depth of several hundred feet, as shown in the second model.

These accumulations dammed the mouths and impounded the waters of tributary valleys, which were not swept by the glacial torrents. After the ice-sheet had passed away and the streams had regained their normal dimensions and were no longer overloaded with detritus, they began to clear out their channels; and the progress which they have made in this work is recorded in the successive terraces which rise, step-like, on either side of the valley to the hight of the glacial flood-plain, as shown

in the third model. The terraces below the highest are simply remnants of later and still later flood-plains down to the lowest, which is the modern flood-plain of the river.

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