THE STORY OF SLATE

AND THE SLATE INDUSTRY

PRICE ONE DOLLAR

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STORAGE YARD AT THE PROCTOR QUARRY - CARDIFF, MD.

BY GEORGE BLEEKMAN AB AM

11-1809

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FOREWORD

The Story of Slate

THE story of slate has been written before, but always with a wealth of scientific terms and technical description which renders it impossible for the ordinary intellect to grasp. The writer claims no originality beyond his endeavor to describe the history, geology and chemistry of slate in language the average man can understand. The sources from which the information contained herein have been gathered are: the reports of the United States Geological Survey, Department of the Interior; by Prof. T. Nelson Dale, F. C. Eckel, W. F. Hillebrand, A. T. Coons and others; from the Encyclopaedia Brittanica and from personal observation and research.

The ages at which the earliest formation of slate are said to have begun are described respectively as Upper and Lower Silurian, Cambrian, Devonian, etc., The standard dictionaries define these ages as the Paleoloic period of the earth's formation, which in itself scarcely accomplishes more than add to the mystery. Further research tells us that the Paleoloic period was when coral formations began and invertebrae (without spine or backbone) were the denizens of the deep. The writer has classed these several ages as prehistoric, which is sufficiently simple for the ordinary person to comprehend. Many slates have an odor, which is described as "argillaceous." This means simply that the smell of clay is present in them. Good slates have a "semivitreous" ring, which in plain English means that when the slate is tapped gently with a hard substance, the sound is similar to that produced by striking a piece of china or thick glass. "Fissility" is another academic term which signifies capable of being separated into thin layers or leaves, while "cleavage" means the general direction in which the blocks of slate will split naturally.

While these technical words define precisely the several factors of slate, the simple words employed here will not always convey the exact shade of meaning, but rather the general sense, the

former being sacrificed to a degree in order that the meaning may be clearer to those whose education is not technical. The chemistry of slate has been largely omitted for the same reason.

The object of this little book is not to decry any slate on the market nor to unduly laud or praise the slate from any particular part of the globe, but to show the difference between the best roofing slate in the world and others of inferior quality.

Only the expert on slate as a rule, knows that any difference in quality exists. Yet it must be borne in mind that even the poorest quality is better and more lasting than any artificial roof can possibly be.

If the writer has succeeded in making clear some of the knotty problems, the object of his labor has been accomplished, and the public can understand something more of this great industry than can be learned from others works designed solely for the scientist and those learned in prehistoric lore. There may be errors due to the difficulty of simplifying the many academic words, but the work at least has been conscientiously done.

Part of the old Proctor quarry on Peach Bottom ridge, from which were quarried the first slates ever taken out in this country. The Proctor quarry was opened by Thomas Proctor in 1802, and furnished the dark blue-gray slate that was awarded the first prize at the Crystal Palace Exposition, London, Eng., in 1850, as the "BEST SLATE IN THE WORLD."

The Story of Slate

THE STORY OF SLATE

IN the ages past, primitive man was not interested in the history of slate and was supremely satisfied with the knowledge that it protected him from the inclemency of the weather. But the scientist arrived with a more mature civilization. He began to delve into the structural, mineralogical and chemical features of roofing slate. These factors are now well understood. Sedgwick, Sorby, Phillips, Tyndall, Daubree, Gosselet, Jannetaz and Becker are names associated closely with this research and complete analyses of the varied slates have been given to the world. These published treatises, however,, are all academic works and the descriptive words used are such that the ordinary man is bewildered with the technical terms. Shorn of this scientific description, roofing slate of the better class is by far the best and most serviceable protective roof that has ever been discovered since the world was young.

Papers of academic or technical nature have been published from time to time upon the slate production in America. Their circulation, however, has been limited to the few persons and societies scientifically interested in them and no effort has really been made to place the simple facts of this important branch of American industry before the general public.

There is, perhaps, no other line of business about which so little is known by persons aside from those financially or scientifically interested in it. That slate is simply slate, seems to be the impression of the average buyer. His information is limited to the one fact that slate does make a good roof, but he takes little or no account of the various grades of slates. He sometimes knows by experience that some slates are good, while others fade and discolor quickly, and break after a short period of exposure; but he probably does not know why they do so, and he has yet to learn how to distinguish the good and avoid the bad slate.

Slate is a rock of various colors formed from prehistoric clay—blue, purple, green, gray, black

or red—and of a peculiar texture by which it is easily split into thin plates or layers. Those who have studied its origin agree that it was originally a sediment or mud on the floors or bed of the ocean when the earth was without form and its surface was a waste of tumbling waters. This mud had been swept by the action of the waves from rocks and was afterwards compressed and hardened as the ages rolled by. It is an accepted fact that slate beds occur in about the same period of the earth's evolution as when coral reefs began to form.

These rocks, having been tilted from the original horizontal positions, probably through volcanic action, stretch across broad districts which arose to the earth's surface in crests and formed planes that to-day exist almost at right angles with their original horizontal positions. The result of the powerful forces that have accomplished this marvelous work are seen in the wavy contortions of the slate rock.

The relative commercial value of several slates is an index of their characteristics. Mathews, an acknowledged authority, has given these prices for slates 14 by 7 inches, three-sixteenths thick, per square (which means capable of covering 100 square feet of roof): PEACH BOTTOM, $4.85; Northampton County, Pa., $3.50; Lehigh County, Pa., $3.40-$3.95; Arvonia, Va., $3.60; unfading green, Vermont, $4.50.

The following prices per square for slates of the best quality, 16 by 8 inches, f. o. b., were obtained by Dr. Day from producers: PEACH BOTTOM, $6.35; Bangor, Pa., $5.75; Albion, Pa., $5; Pen Argyl, Pa., $4.75; Chapman, Pa., hard vein, $5.25; Slatington, Pa., $4.50 to $5; unfading green, Vermont, $4.50 to $5.25; sea green, Vermont, $3.50, Virginia, $5 to $5.50.

To-day although slate is a comparatively new factor in the commerce of the United States, the splendid quality of Peach Bottom slate has attracted attention throughout the civilized world.

This noted slate deposit derived its name from that of a small village a quarter of a mile west of the Susquehanna river and was formerly a port on the now disused canal which follows the stream.

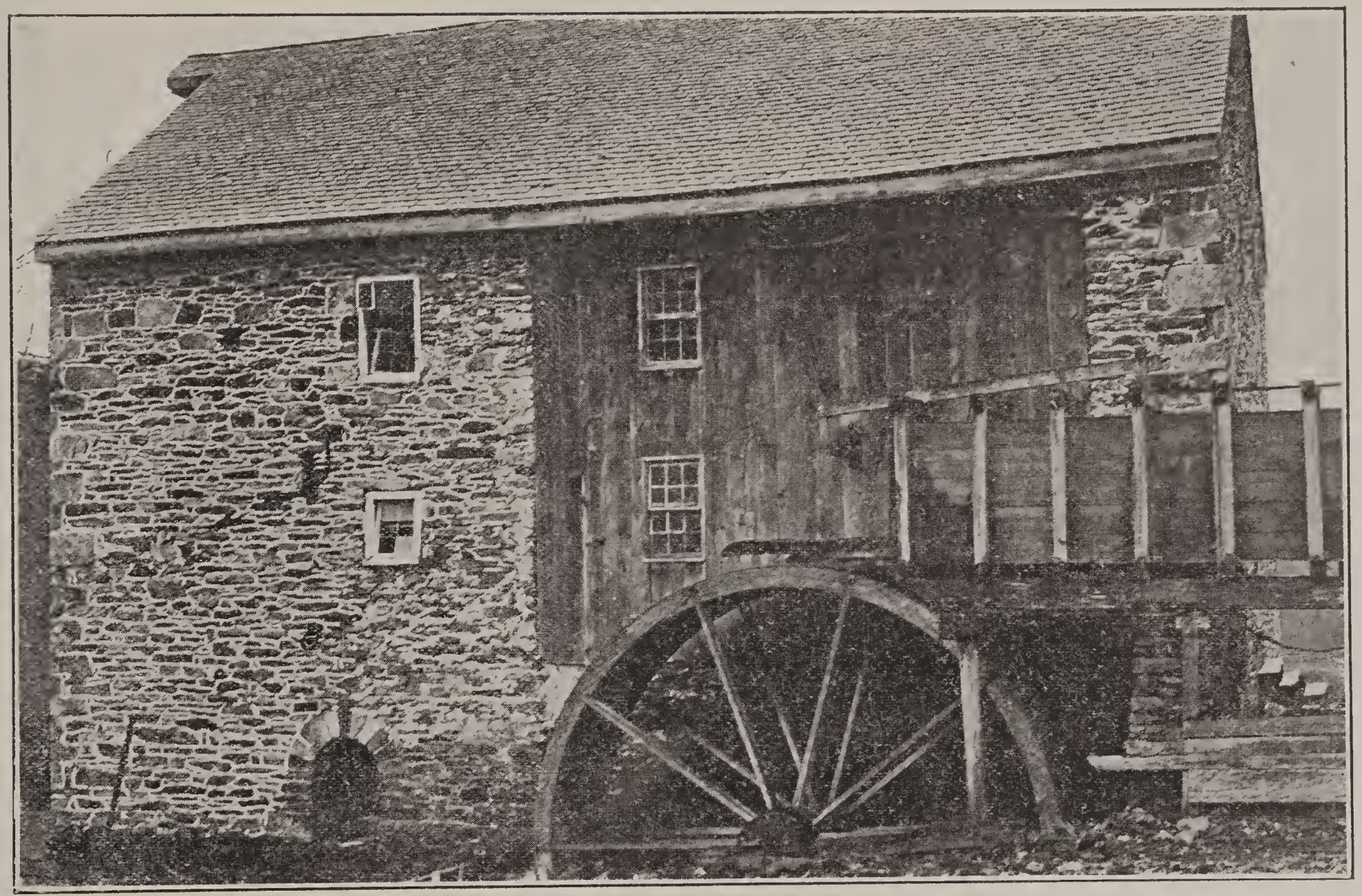
It is situated in York County, Pennsylvania, and extends to the Maryland line. The United States Geological Survey report, under the head of Slate Deposits and Slate Industry of the United States, compiled by T. Nelson Dale, goes thoroughly into the subject of Peach Bottom slate. He says in part: "Peach Bottom slate is a very dark gray, with a slightly bluish tinge. To the unaided eye its texture is minutely granular, crystalline with a lustrous surface and it does not discolor. The highly crystalline or glass-like character of the matrix and absence of carbonate indicate a very durable slate."

There are eleven quarries on the Peach Bottom ridge, of which, namely the Pennsylvania-Maryland, thirty-three acres, and the Proctor, (45) acres, the Henry twenty-three acres, together with a one-fourth interest in the (50) acre tract lying south of the Proctor properties and the (298) acre farm of the late Edward P. Stubbs, are under the direct control of J. G. Feist & Company, Bankers of Harrisburg, Pa., and their associates.

These are doubtless the most important of the slate quarries in the United States. Those on the other side of the Atlantic are also of great importance from an industrial viewpoint.

The Delabole quarries of Cornwall had acquired a goodly amount of importance as far back as the 16th century, while some of the old Welsh quarries date even further back into the dim past. But the slate industry, as a commercial factor belongs to the present time.

Among the largest and most valuable of the Welsh quarries are those of Llanberis, Penrhyn, Festinog and Dinorwic. There are also quarries in Cumberland, Westmoreland and Lancashire, the lake districts being especially noted for their rich green slates. Some of the western and midland districts of Scotland, mainly Argylshire, Dunbartonshire and Perthshire produce strong and durable slates, the largest quarry in the land of the Heather being at Ballachulish in Argylshire. The Scotch



Old Peach Bottom Mill, whose rough stone walls have borne the same roof of Peach Bottom slate for 130 years. The roof to-day is the same deep blue-gray color, and is as perfect after nearly a century and a half of exposure, as when it was laid atop the rafters, which, by the way, have been replaced more than once. The creaking old wheel has been stilled many years.

slates are chiefly blue in color, although thin beds of green slate are found in some of the districts. Good slates are also found in the south of Ireland particularly in the counties, Wicklow, Tipperary, Cork and Kerry, while on the continent of Europe slate is quarried in France, Belgium, Sweden, Norway, Germany, Austria and Italy.

METHODS OF TESTING SLATE

METHODS of testing the elasticity, absorption, fissility, and resistance of roofing slates have been in use for many years, and a number of more or less complete chemical analyses of slate have been published. In recent years, however, more exact methods of reaching these results have been devised. The best of these methods have here been brought together and several of them are of so simple a character as to be easily applied. This list of tests is largely compiled from Bottinger, Fresenius, Hutchins, Jannetaz, Merriam, Reverdin and de la Harpe, Sorby, Umlauft, and J. F. Williams. All offer valuable suggestions.

Sonorousness, or ringing musical sound—One of the first and most time-honored tests of roofing slate is to suspend a good-sized piece of the usual thinness and tap it with some hard object. If it possess the structure of a slate it will yield a clear, musical, ringing sound. A clay slate will be less sonorous or ringing than a mica slate, but mica slates with a large percentage of chlorite and possibly a little talc will be deficient in sonorousness. It is because of this property that at the quarries when refuse slates are thrown upon the dumps, the sound produced is not unlike that made by the smashing of a large quantity of crockery.

Cleavability, or the property of splitting smoothly and evenly—This test should be applied by an experienced workman. The block should be freshly quarried, unfrozen and moist. The chisel should be thin and about two inches wide. The cost of slate is closely related to the degree of its cleavability.

Cross fracture, or the property of splitting along the grain across the cleavage—(In the Pennsylvania-Maryland and Proctor Peach Bottom quarries, the electrically-driven saws largely take the place of the heavy chisel and mallet.) This is to determine the character of the "grain." This test should also be applied by an experienced hand to a large block several inches thick, with a stout chisel and a long-handled heavy mallet. Jannetaz has published a method for determining exactly the direction

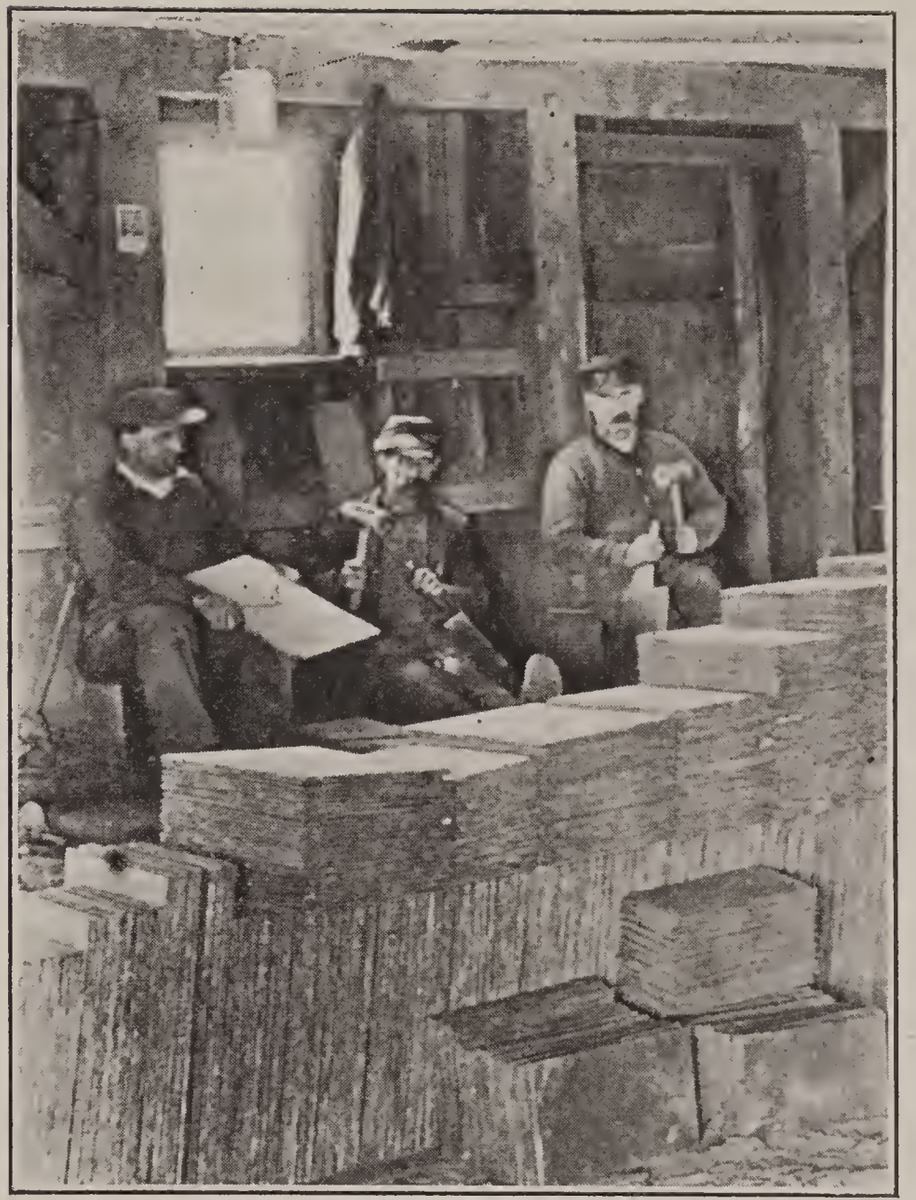
of the grain in slate when it is but obscurely shown on the cleavage surface. The slate is sawn in a direction parallel to its cleavage and one of the sawn surfaces is made exceedingly smooth and covered with an even and very thin coat of grease. The point of a red-hot platinum wire is applied to the slate opposite the centre of the greased surface. The greased area reached by the heat will, in cooling, leave an oval outline, the greatest length of which will show the direction of the grain, the heat having traveled more rapidly within the slate in the direction of the grain than in any other. He also made a disc of slate five inches in diameter, of ordinary thickness, with a central perforation or hole. This disc was fastened by the extremities of the diameter parallel to the grain and afterwards by that at right angles to the grain, and was made to vibrate by tapping the side of the perforation. The sound produced when the disc was fastened by the diameter at right angles to the grain was louder than when fastened by that parallel to it. In other words, the direction of the grain was that in which elasticity and vibration were greatest.

Character of cleavage surface—The cleavage surface should be examined with an ordinary magnifying glass. A superior slate should scale along the cleavage surface into very thin chips with translucent (almost glasslike) edges. If the grain is pronounced it will appear in fine lines. Ribbons, which are sometimes lines of weakness, should be noted. There is great difference in the smoothness of the surface in slates of different regions and smoothness is a desirable quality.

Color and discoloration—The color of the freshly-quarried slate should be noted and compared with that of pieces exposed for several years to the weather, either on a roof or on the quarry dumps, or with that at the top of the quarry close to the gravel, although this last comparison may not always be entirely conclusive. The value of the slates is affected by the extent of their discoloration, as it means the presence of some matter causing change, and naturally decay.

Presence of clay—This should be tested by breathing upon a fresh and clean piece of slate and

Trimming slate in the old way at the Proctor quarry at Cardiff, Maryland. This slow process has been the vogue for many years. The foot power knife has not yet reached Europe.



The splitters at work on Peach Bottom ridge. There is something humanly necessary in this slicing great blocks of slate into thin layers or leaves. No machinery has as yet been devised for this work.

observing whether there is any odor of earth or clay. The very best slate, such as Peach Bottom, will not emit any such odor.

Presence of marcasite—A slate containing crystals of a pale-yellow metallic mineral which, on exposure, decomposes, forming a yellow white film and rusty spots, is poor.

Strength—Merriam's method for testing the strength of slate is here described.

The pieces are supported in a horizontal position upon wooden knife-edges twenty-two inches apart, and these loads are placed upon another knife-edge halfway between the supports. The load is applied by means of sand running out of an orifice or hole in a box, at the uniform rate of seventy pounds per minute, and by the help of an electric attachment the flow is stopped at the instant the slate breaks. According to these tests, the measure of elasticity before the slate breaks in the best slates should range from 7,000 to 10,000 pounds. This is computed on the total weight borne by the slate reduced to the pressure per inch. Peach Bottom is about eight times as strong as any other Pennsylvania slate.

Merriam has also devised an impact test for determining the strength of slates. He lets a wooden ball weighing 15.7 ounces fall nine inches upon a piece of slate measuring six by seven and three-quarters inches by from 0.20 to 0.28 inches thick, and repeats the blows until the slate breaks. The foot pounds of work per pound of slate are then calculated from the weight and thickness of the slate and the number of blows.

Elasticity—Merriam finds certain Pennsylvania slates, when placed on supports twenty-two inches apart will bend from 0.270 to 0.313 inch before breaking. Certain blue-black slates in Eldorado County, Cal., when split seven to the inch and eighteen inches square and fastened solidly at the two ends are said to bend three inches in the centre without any sign of breaking.

Density or specific gravity—This is determined by weighing a piece of the slate in and out of

water and dividing its weight out by the difference between its weight in and out. All air should first be removed by boiling the piece of slate in distilled water.

Porosity (water-proof quality)—This is best determined by drying and weighing, then immersing for twenty-four hours and weighing again, in order to ascertain the percentage of water absorbed. Merriman takes a piece three by four inches, wih rough edges, dries it in an oven at 135 F. for twenty-four hours, cools to the normal temperature of room, weighs, and immerses it for twenty-four hours, and weighs again. His tests of Pennsylvania slates showed from 0.099 to 0.303 per cent. of absorption. Porosity is sometimes roughly estimated by immersing a roofing slate edgewise one-half in water and observing how far the water ascends on the dry part of the slate. In good slates it should rise but very little.

Hardness, or abrasion—Merriman has also devised a method of testing the relative hardness of slates by subjecting a piece of known weight to the action of a grindstone revolved 50 times, the slate being held against it by a lever, with a constant pressure of ten pounds. The loss of weight in the process is then determined.

Corrodibility—An important quality in roofing slates is their resistance to the acids of the atmosphere, particularly in cities, where gases increase their destructive power. Fresenius suggested testing the weathering qualities of a slate by immersing it for three days in dilute sulphurous acid in a closed vessel. At the end of that time poor slates are softened, broken up or easily fractured, while good ones preserve both their density and hardness.

In conclusion it must be remembered that the strongest and best slate stands highest in weathering and non-corrosive qualities. Chemical analyses give only imperfect results regarding these qualities, for from the view-point of the scientist, slate is a complex rock. The best test is that of time, such as is shown on the old Peach Bottom mill, where the slate roof has stood the test for more than 130 years and is still in excellent condition. The old Presbyterian Church at Peach Bottom, has been sur-

mounted by the same Peach Bottom slate roof for a century and the same slates had already been used on several other structures which had decayed before they were placed on the house of worship.

The foregoing tests are the principal ones used for the purpose of distinguishing good slates from those of inferior quality. There are still other tests for learning the degree of corrosion as influenced by the gases of a city, a railroad, etc.; and for the effect of heat and cold on slate. These tests are elaborate and complex and are unsatisfactory to the layman. Therefore they are omitted in this work.

Galleries showing great Slate Quarry at Port Dinorwic, North Wales, which has been worked for two hundred and fifty years, but only during the last century has the slate been quarried systematically. The galleries are each 75 feet high and 3,000 persons are employed in the quarry.

A NOTABLE WELSH QUARRY

PROBABLY the most important quarry in North Wales is the Dinorwic, which has been a fertile field of profit for more than two hundred and fifty years. This quarry is on the north flank of Mount Snowdon in the Llanberis pass. True, work in a systematic manner has been prosecuted only for about 150 years, during which period the quality, durability and strength of its slates have been heralded around the world. Indeed, until the Peach Bottom product reached England and won the first premium in the Crystal Palace Exposition as the "best slate in the world" the Dinorwic or Velinheli slates were considered superior to any others, and the name of the little Welsh seaport, whence they are shipped to London and from there to all quarters of the earth, became famous. Port Dinorwic on the Menai Straits, would be unknown but for the enormous slate industry carried on about six miles inland.

As shown in the accompanying engraving, the Dinorwic quarry consists of a series of galleries or terraces cut one above the other into the face of the Elidir mountain, receding like a giant's staircase from the floor of the quarry (which in places is below the water of Lake Padarn) to the top of the mountain. From the lowest gallery to the topmost the height is 1,800 feet, each terrace seventy-five feet in height. Viewed from a convenient eminence, one sees the great galleries rising one upon another in tiers to the very shoulder of the mountain. An interesting fact is that men are working in the same galleries to-day in which their fathers and grandfathers worked the same strata from thirty to sixty years ago.

And this stupendous work, this slicing away of a great mountain in shreds less than a quarter of an inch in thickness, has been progressing for centuries without improvement in methods. It is true, dynamite is used to loosen the slate, but the sledge, the crowbar, the dresser's knife, the splitter's chisel and hammer are the primitive tools with which this big hill is being taken piecemeal from the face of

the earth. The single improvement is a system of narrow gauge railway which facilitates the removal of debris and the carrying of the huge blocks to the sheds where they are split and trimmed. There is also a railway for carrying the finished slate down to Port Dinorwic for shipment.

On the continent and in the United States, the same primitive methods have also obtained until the advent into the Peach Bottom section of J. G. Feist & Company of Harrisburg, Pa., whose consulting engineer, George J. Atkins, at once discarded the time-worn methods which have been in vogue since the days of the crusaders, and introduced twentieth century machinery on Peach Bottom Ridge. Of the quarries in the vicinity of Delta, Penna., which is the centre of the Peach Bottom slate industry, the Pennsylvania-Maryland quarry was first equipped, and the hand of the Yankee necromancer who accomplishes things is shown both by the increased output of the quarry, and by the reduction in cost for bringing the slate from its original bed to the railroad.

There are other quarries on the ridge, but in them the ancient methods still prevail. The Pennsylvania-Maryland and the Proctor quarries alone are equipped with up-to-the-minute machinery. In everything, from hoisting the great quarried blocks, carrying them across the mouth of the pit on taut wires to tables, above which move multiple saws, electricity plays its part. Only the splitting is done by hand and the factor of waste is practically eliminated. In detail, the blocks of slate are carried from the bottom of the quarry and swung on a moving platform which brings the rough block to a table directly under a series of six saws, set at equal distances from each other and which quickly cut lengthwise through the block. Automatically the saws whirl backwards, the table moves forward to a point where six similar saws sweep transversely through the blocks and return to their station.

The blocks are now the required size and the table delivers them to the splitters who speedily cleave them to the required thickness. As each individual slate is separated from the block it is placed on a moving tramway or conveying belt and carried to the storage yard, where boys stack them up in squares ready for shipment. The new machinery, in addition to delivering perfectly cut blocks to

the splitter, eliminates the trimmer and very largely the factor of waste, as the entire block as it is taken from the quarry, except the rough and uneven edges, can be utilized for roofing slate. Instead of a loss of between seventy and eighty per cent. of the slate quarried, as under the old regime, scarcely ten per cent. reaches the scrap heap and this, too, is now used for scores of useful purposes.

Peach Bottom slate is invariably called for by the United States Government for roofs of all public buildings and where possible to obtain it, has been insisted upon by reason of its unchangeable color, elasticity and wearing qualities. The Pennsylvania and Baltimore and Ohio railroads also insist on Peach Bottom for similar reasons. When it is recalled that corrosive gases are more in evidence in the vicinity of railroad shops, roundhouses, etc., one can easily understand why none but the best roofing material can last for any long period without corrosion. The Peach Bottom district is comparatively small in area and the slates quarried there are of the general division called "mica" slates.

General view of the Dinorwic Slate Quarry, in Llanberis Pass, North Wales, showing Pekis Lake in the foreground, and Mount Snowden in the distance. This picture shows the galleries and approaches to the most important slate quarry in Europe, from which the best slates in the world have been taken until Peach Bottom Slate was discovered.

QUARRYING SLATES IN FRANCE

THE methods employed in working the slate deposits of France are as follows: The strata of fissile rock capable of being split into roofing slates are almost vertical, and it is vertically also that the work of quarrying them is pursued. There are two methods of mining the slate rock. The first of these is the open air method, in which, after the removal of the top bed , the slate, cut into easily handled blocks, is raised to the surface. In the second method, a shaft is sunk, in order to reach a slate of good quality, and then a chamber is excavated from which the blocks are raised to the surface in order to be split. Above the chamber there is left a certain thickness of slaty rock, which possesses great solidity, and the layers of which become as it were, long girders which form part of the side walls at their extreme ends. Under this vault, the excavation descends, while the blocks of slate are raised in a bucket which slides over cable stretched above the heads of the workmen. But since the roof of the vault, however carefully it may have been chiseled out at first, becomes weak in the long run, and since it is impossible to easily inspect it after the chamber has reached a great depth, blocks of stone have been known to fall with serious results. And, moreover, if inspection of the vault roof reveals displacements and fissures, the method of the miner is to desert the chamber, which will then become unworkable because of these cracks and threatened cave-ins. Such cave-ins have often extended to the surface and ruined the entire work as well as destroyed the hoisting machines installed upon the surface.

In the method of quarrying recently introduced, which it is believed is destined to completely revolutionize the industry in France, the work is performed in chambers, as before, but from the bottom upward. In the former method, it is the floor from which the slate is taken, while now it is the roof of the chamber that is worked. Successive layers of slate are cut from this by the workmen, who stand upon a platform suspended from the roof a part of which has been cut away. The slate, as

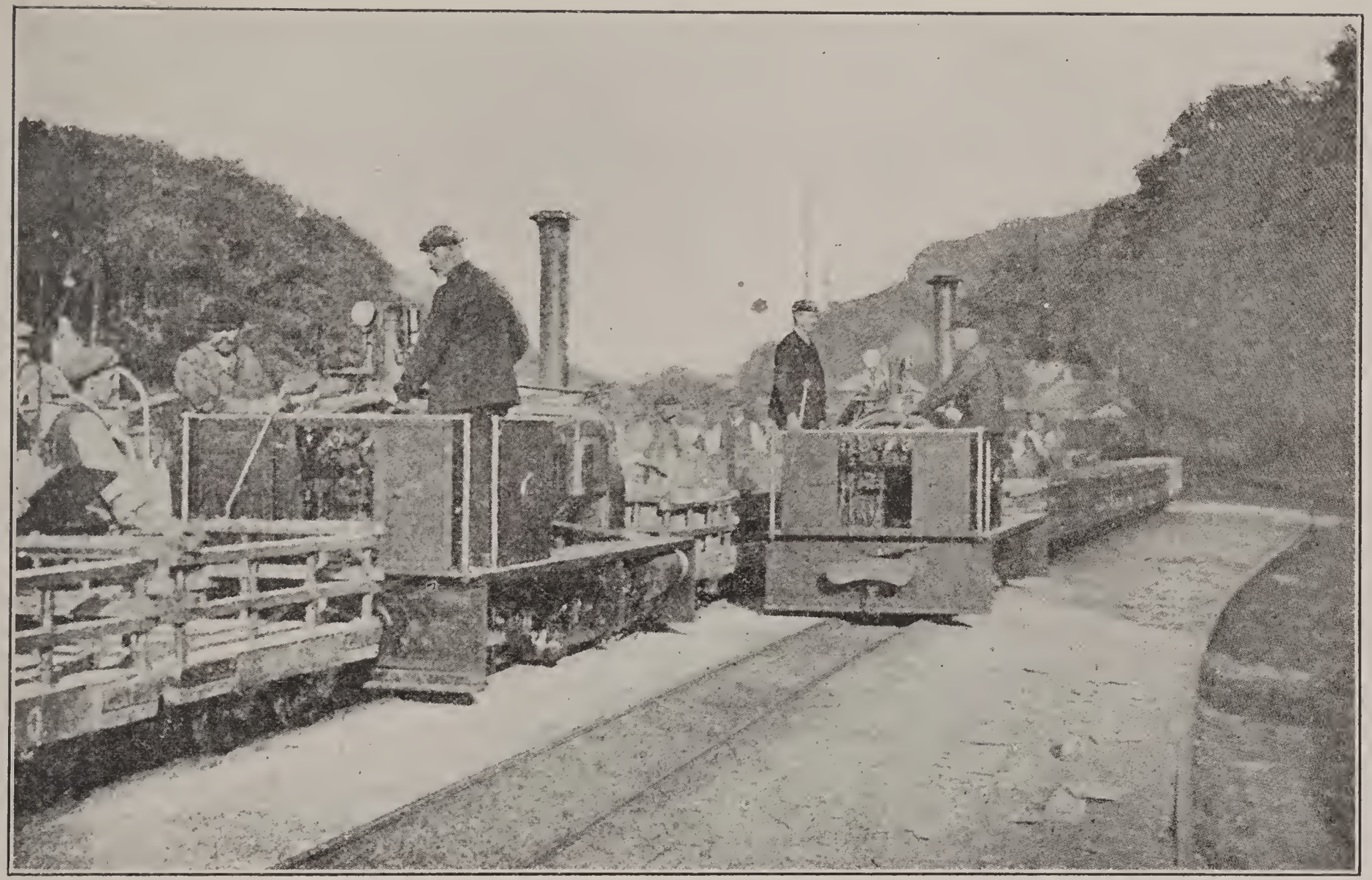
fast as it is quarried, is removed through horizontal galleries to the main vertical shaft, where it is immediately hoisted to the surface. The height of the chamber is kept always the same by building up the floor with waste material as fast as the roof is chiseled away. Thus, the waste material replaces the strata of rock as fast as they are removed from the ceiling, and the side walls have no tendency to fall in, on account of the extremely reduced height, which is by this method of working, kept always about the same.

A beginning is made by sinking a shaft to a depth of from 500 to 1,000 feet, outside of, but close to the wall of the vein that forms the plane of contact of the slate deposit—a chamber is opened at each working point and pushed toward the other side of the vein. Its width is at right angles with the cross-gallery that connects with the main gallery, and its length is a prolongation of it. In this way there is established a working chamber from six and a half to thirteen feet in height, according to the more or less resistant nature of the hard rock. The excavating naturally is done in horizontal lines. It it sometimes necessary to raise the waste material to the surface, whence it may afterwards be let down again for filling in; but the order observed in the work generally permits of its being emptied immediately into the chambers, the excavation of which is sufficiently advanced to allow the lower part to be filled in, in order that a stratum above may be taken out. The work is carried on therefore by cutting out the slate and afterward completely filling in the chamber thus made. In order to detach a block from the ceiling, workmen standing upon a footbridge or scaffolding hung from the roof of the chamber, cut in the entire length of the latter a cavity six feet in width by thirteen in height. This cavity is generally formed outside of the vein, and at its edge, starting from the working points, so as not to break the slate uselessly. It is then possible to drill blast-holes. A block of slate the entire width of the chamber is blasted out and falls upon the floor provided by the first work. The blocks, which are sometimes split into still smaller pieces are moved to the main vertical shaft and drawn to the surface.

After the first stratum or layer has been removed, work is begun on the second, and, after it is slightly advanced, there is excavated, outside of the vein, a new gallery which will end at the new ceiling, at a height of twenty-six feet above the original floor, and which is connected with the main shaft parallel to the vein. In this way, by means of this new system of galleries, it is possible to remove slate to the surface at the same time the waste material is being thrown into the bottom of the chamber in order to raise the floor by the thickness of one stratum. The waste material is distributed through the upper galleries, while the slate and rock that falls from the ceiling is shoveled into cars and carried through the lower galleries, the entire length of which is protected by timbering.

The quarrying (or more properly, mining) continues thus until, in ascending, the useless stratum of rock is reached. Moreover, when it is desired to work a vein of great thickness, it is preferred to divide the field of operation into two parts, by sinking the shaft toward the centre of the vein and opening chambers on each side.

Electric light has been adopted in many of the slate mines of the Angers region, and in addition, the Societe des Ardoisieres of Anjou, the inventor of this method of mining, has constructed and is regularly employing, for moving the blocks in the chambers, and loading them upon the cars, electric windlasses which a boy can operate and which have all the power desirable, while affording absolute security against accidental descents of the load.

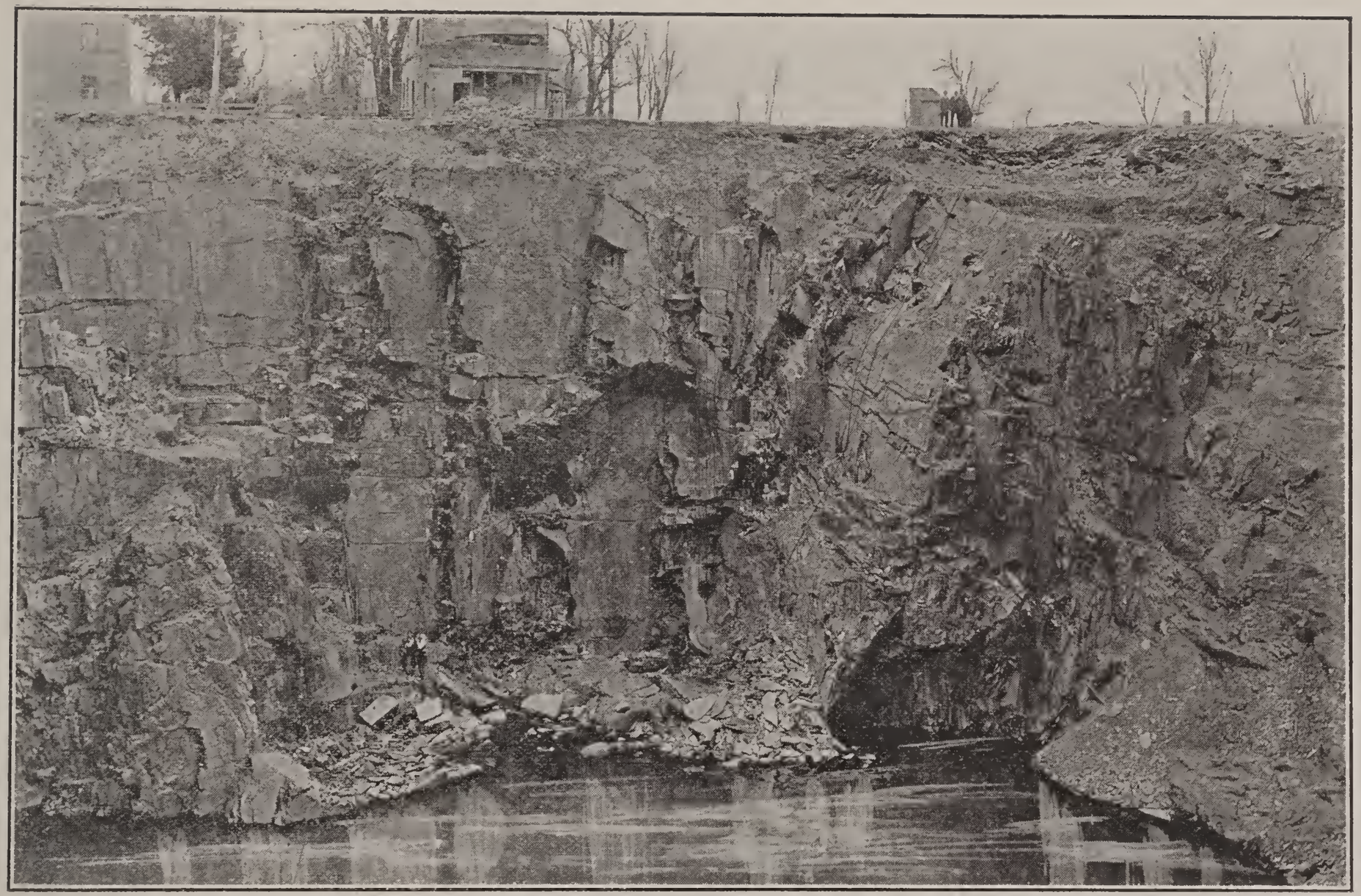


Portion of Quay at Port Dinorwic, North Wales, showing slates from Dinorwic Quarries to be loaded on L. & N. W. Railway's main line for transit. Port Dinorwic takes its name from the quarry, six miles inland from which the Dinorwic or Velinheli Slates are taken.

PEACH BOTTOM SLATES

THE village of Peach Bottom is in a triangular township of the same name, which is bounded by the Maryland line on the south, the river on the northeast, and in part by Muddy Creek on the northwest, and which forms the southeast corner of York County, Pa. The slate forms a belt and low ridge from one-fifth to one-half mile wide, which extends from a point about a mile northeast of the Susquehanna, in the town of Fulton, in Lancaster County, Pa., across the river and across Peach Bottom township in York County, and continues for about three miles in the same direction into the town of Cardiff, in Harford County, Md. Its total length is about ten miles, of which one mile lies in Lancaster County, Pa., one and one-half miles are submerged by the Susquehanna, four and one-half are in York County, Pa., and about three miles are in Harford County, Md. Most of the quarry population is congregated along one street, which follows the western foot of the ridge. The northeastern part of this street is Delta, Pa.; the southwestern is Cardiff, Md.

The slate belt has on its northwestern side a deposit of slate, lustrous and silky, resembling mica, in which at varied distances are imbedded hard semi-transparent stones similar to quartz. About midway between Delta and Bryansville this slate becomes harder through the fact that these flinty crystals become more frequent. According to the reports of the Second Pennsylvania Survey, similar fields of slaty substance recur on the southeastern side of the slate belt, and the whole formation leans or inclines toward nearby formations of grain-like surfaces, which occur on either side of it. There is a good exposure of slate on the east side of Slate Point, on the towpath along the Susquehanna. The slate here underlies about fifty feet of quartz (a hard flinty stone) which was formerly quarried for canal construction. A little farther east this is followed by deposits of coarse granite-like rock. This rock apparently continues into Lancaster County, for in looking across the Susquehanna from Slate Point, a considerable thickness of light-colored rock can be seen overlying the slates there.



A corner of the rich Pennsylvania-Maryland quarry on Peach Bottom ridge, showing the almost vertical slate formation that is the rule at Delta, Pa., where this profitable quarry is situated. The deep blue-gray slate from this quarry is greatly sought by architects and contractors who desire the unfading mica slates from Peach Bottom ridge.

The Story of Slate

The Delta and Cardiff quarries lie in three parallel lines and range from 75 to 120 feet across and up to 200 feet or more in depth, all of commercial roofing slate. The cleavage is uniformly vertical or nearly so, and there is usually a "big flat joint" sometimes from forty to sixty feet from the surface and including two to three feet of crushed slate, which is evidently the result of a secondary volcanic movement of the earth's surface. Commercial slate occurs below this joint. The "top" varies from forty to sixty-five feet and in places includes ten feet of slate in small fragments. The slate usually has along the planes toward the surface, a brown rim, called a "hem," from one to two inches wide. These hems represent simply the initial stage of weathering caused by the dripping and seeping through of water from the joints, of which process the final result is the red clay. The slate of the top has generally a red hue, and the whole belt is covered with red clay.

The slate districts of America are divided into two distinct classes which are known by the period of their formation as the Cambrian and Silurian, the meanings of which are defined in the foreword. The Cambrian deposits, from which the Peach Bottom are taken, are lower and older than the Silurian, from which are produced inferior slates.

As in all other lines of business there is some one make of goods which ranks higher in quality than all others in its line, so it is with the various kinds of slate, among which the genuine Peach Bottom ranks not only higher than any other American slate, but is regarded, by many prominent architects and builders, as the best slate in the world. This assertion is made because it is known to be a fact and authorities agree that such is the case.

The most satisfactory evidence regarding slate is the number of years of actual use. Such a test proves the most important fact about it, i. e., its durability. The genuine Peach Bottom slate has stood the test of 165 years constant, actual use; the first pieces made in 1734 being still in evidence and doing good service to-day. This is a test of nearly 100 years longer than to which any other American slate has been put and is the first reason for the assertion made of its being the best slate

in the world. In chemical analysis it far out-ranks other makes. In color (dark blue gray) it surpasses all others for it is positively unfading, and grows darker with age. It has none of the disfigurements that are characteristic of inferior slates, i. e., ribbons, and finally, it was awarded the highest premium over other slates by the London Crystal Palace Exhibition in 1850, as being the best slate in the world.

At the time of the Crystal Palace exposition, the Proctor quarry was in its infancy, while the Penrhyn and other quarries in North Wales had at that time been worked commercially for more than a century. Records show that slate was quarried in Wales a century before the first crusade and as far as authentic records exist, it was in that country that the desirability and usefulness of roofing slate was first discovered. It is said that some of the old Welsh castles—such as Carnarvon and Conway—were covered with this material. No doubt the better class of houses, situated in the neighborhood of slate beds were covered with slates obtained by rough surface digging or from blocks exposed by mountain streams and split by the action of the weather, long before the man of the stone age learned that slate could be sliced through the introduction of a wedge forced by the tap of a large stone. To-day the same method of splitting the slate exists, with the exception that a steel chisel and wooden mallet are substituted for the wedge of flint and the stone hammer.

Previous publications have instanced the roofing of the old Slate Ridge Presbyterian Church, near Delta, Pa., in 1805, with Peach Bottom slate, as being the first use of slate in America, while, as a matter of fact this slate had then been in constant use for seventy years on another building before it was placed on the House of Worship. The quarry from which the slate for this church was taken was owned by Thomas Proctor and opened by him commercially in a small way, at Cardiff, Md., in 1802. It is the same quarry owned and operated by the Proctor Slate Corporation to-day.

The early history of the use of slate in America is as follows: "Two brothers, William and James Reese, natives of Wales, took up land in 1725 under patent of the English Provincial Government,

in what is known as York County, Pa., and during the year 1734, when excavating for foundations for farm buildings, they discovered the slate rock from which they split the pieces necessary for roofing their out houses. This was the first use of slate in America (1734)." Those pieces are still in use, upon the property now belonging to Capt. David Jones, near Delta, Pa., and covering the seventh building upon which they have been placed. They show no disintegration or decay and still retain the strong, brilliant blue-black color for which this slate has become famous by the name of Peach Bottom. Numerous other instances are known of persons in this county following the example of the Reese brothers in using this slate for roofing purposes, during the years succeeding 1734, but it was not until 1785 that any effort was made to produce slate as a marketable commodity in America, when, during that year (1785) the first slate quarry for the sale of slate was opened by William Docker, in Peach Bottom Township, York County, Pa., and from that time dates the production of slate commercially; the name of the township (Peach Bottom) was then given to the slate.

The production of this slate steadily continued until 1846, when several operators of the slate quarries in Wales came to this region. With this added impetus the business became greatly broadened and increased. Among the newcomers was Capt. David Jones, who still resides upon his farm near Delta, Pa. Close to his residence, and on his farm is the place where the first slate used in America was discovered by the Reese brothers and the first quarry opened by William Docker. Mr. Roland Parry came to this region in 1847 and quarried this slate for several years returning to Wales about 1857. During the Crystal Palace Exhibition in London in 1850, Mr. Parry exhibited samples of Peach Bottom in competition with slate of other countries: "THE PEACH BOTTOM SLATE WAS AWARDED THE HIGHEST PREMIUM OVER ALL OTHERS AS BEING THE BEST SLATE IN THE WORLD."

The producers of Peach Bottom slate have always conducted their business in a quiet, conservative manner. Very little money has ever been expended in advertising, as they preferred their slate

This ravine on Peach Bottom ridge at the Pennsylvania-Maryland line, gives an idea of the size of slate blocks that are being quarried on the ridge. These larger blocks are best adapted for structural purposes. The fresh slates split to far better advantage where they have not been exposed to the weather for more than forty-eight hours.

should retain its high reputation through its own merits, rather than by self-praise through newspaper and other advertising mediums. This course was satisfactory until the introduction of imitations of their slate. It is because of its high merits that Peach Bottom is the only slate which is imitated and the imitation consists in simply naming and selling other slates as being Peach Bottom slate.

The imitations are known as the "Slatington Peach Bottom," "New Peach Bottom," "Lehigh Valley Peach Bottom," and "Peach Bottom of Lehigh Valley." The assumption of the name "Peach Bottom" is apparently for the purpose of deception. Instances are known of these imitations having been sold and substituted where the Peach Bottom was specified and desired. The careful contractor is not now easily misled by the imitations. Some of the producers of these imitations have made the misleading statement that their Peach Bottom slates were produced from one end of the same ridge from which the genuine Peach Bottom is taken; which is entirely false. The ridge from which the genuine Peach Bottom slate is taken, is situated in York County, Pa., and Harford County, Md., extending about three or four miles on either side of the Pennsylvania-Maryland line; the ridge from which the imitations are taken is nearly one hundred miles distant.

In its sales history, Peach Bottom slate is recorded as being used upon the highest class of buildings, a short list of which is appended. The United States Government has for a number of years recognized the high standard of the genuine Peach Bottom slate and the several Government Departments specify it when requiring slate for their buildings.

Along with other makes of slate, this slate has been subjected to all manner of tests by prominent geologists and scientists, and in every case has it surpassed its competitors in strength, color, durability as well as in chemical analysis and compression tests. It is a remarkable commentary upon the durability of Peach Bottom slate that all the old roofs of it still retain their remarkable color, and even the most experienced slater cannot tell from their appearance which is the oldest.

While it is true that the genuine Peach Bottom sells higher than other makes of slate, still, economically speaking, it is the cheapest slate on the market, for in it is combined all the highest qualities at a minimum of cost. The question of repairs, so important a factor in the use of inferior slates, does not need consideration when using Peach Bottom; THE FIRST COST WITH IT IS ALSO THE LAST COST.

By severe chemical tests for corrodibility, as well as by actual use, they have proven to be particularly serviceable upon such buildings as railroad shops, roundhouses, chemical laboratories, gas works, iron furnaces, and any buildings where fumes of gases and chemical elements abound. In the slate storage yards the pieces are kept in ricks on what is known as slate banks. They are not housed or stored in sheds, like inferior slates, as they are not affected by any extreme of temperature or by the elements.

Remarks from an article by Prof. Merriman, entitled "The Strength and Weathering Qualities of Roofing slates" read December 19th, 1894, and published by the American Society of Civil Engineers, includes the following:

"In splitting and dressing the roofing slate, it is always done so that the grain runs parallel to the longer side of the rectangle. This grain, although never so marked as that in the timber, has a similar effect upon the strength in directions. The strength and weathering qualities of slate or stone depend, not merely upon its chemical properties, but on the manner in which the grains are cemented together. For the determination of this, microscopic inspection is necessary." Peach Bottom slates have stood this severe test with excellent results.

In a letter by Geo. P. Merrill, Esq., (Curator of Department of Geology, Smithsonian Institution, Washington, D. C.) upon the above article, this well known authority says:

"Not to go too much into detail, it can be said, that in short, the clay slates pass by imperceptible gradations into crystalline (or glass-like) factors capable of being split into thin slices, and, further,

that so far as the writer's present experience goes, the more crystalline the rock is, other things being equal, the stronger, less absorptive and more durable it is. This is well exemplified in the Peach Bottom slates referred to in Prof. Merriman's paper. These are among the most highly crystallized of any of the cleavable slates that are used for roofing purposes. The microscope shows in them crystalizations which tend to give them great strength and elasticity. In the few cases in which the writer has been called upon to decide as to slates for roofs of public buildings, his decisions invariably have been based upon amount of crystalization as shown by the microscope, and the presence or absence of substances known to influence more or less rapid decay."

The value of Roofing Material is determined by a variety of considerations, amongst which the most important are, first cost, durability, appearance, resistance to fire and consequent influence on the cost of insurance, and the expense for maintenance or repairs. That there is a vast mass of false and misleading information prevalent on this point, even in the building trade, is evident, and in order to show at a glance what the actual facts are, we present the truth in a tabulated form, showing a comparative estimate between the leading materials used in the Roofing Trade.

The estimate is based on the square—100 square feet of surface—laid on roof complete, in the vicinity of Philadelphia or New York.

Material	First Cost.	Average Life.	Av. Cost per year.
Peach Bottom Slate,	$7.50	150 years	.05c
Tin,	5.50	20 years	.27.5c
Shingles,	4.30	12 years	.27.5c
Corrugated Iron,	5.10	10 years	.57.2c
Tin Shingles,	6.70	10 years	.67.2c
Copper,	30.00	40 years	.75.00

One of the picturesque bits of Cardiff, Md., is the "Owens Place," the homestead of the Owens family for half a century. The Owens place is a type of house of which many were built during the days of the Civil War. To-day the plastered walls and chimneys show the work of the passing years, yet the ruthless hand of time has touched but gently the Peach Bottom slate.

The Story of Slate

It will be readily seen that a Peach Bottom Slate roof is not alone the most durable, but when the original cost and average life are taken into consideration, it is five times cheaper than tin, seven times cheaper than shingles, eleven times cheaper than iron and fifteen times cheaper than copper.

Nor do these estimates take into account the expense of maintaining metal and wooden roofs. Tin and iron require frequent paint to prevent rust. Shingles require paint to prevent rot. Copper requires frequent soldering at the joints to keep the roof from leaking. A slate roof, when properly put on, is practically permanent and requires comparatively no repairs.

Among the notable buildings roofed with Peach Bottom slate, from all of which the same favorable reports have been gathered relative to wearing qualities, absence of repairs and unfading color, are:

U. S. Government Buildings, ... Pittsburg, Pa.
" " " ..... West Point, N. Y.
" " " ..... Brooklyn Navy Yard, N. Y.
" " " ..... Washington Navy Yard, D. C.
" " " ..... Annapolis Naval Academy.
" " " ..... Tybee Island, Ga.
" " " ..... Fort Point, Galveston, Tex.
" " " ..... Spokane Falls.
National Soldiers' Home, ... Danville, Ind.
Philadelphia Hospital for the Insane, ... Philadelphia, Pa.
Western Pennsylvania Penitentiary, ... Pittsburg, Pa.
" " Hospital, ... " "
Allegheny County Workhouse, ... " "
Warren Insane Asylum, ... Warren, "

Danville Insane Asylum,	Danville,	Pa.
Huntingdon Penitentiary,	Huntingdon,	"
City Market House,	Lancaster,	"
City Market House,	York,	"
Orphans' Home,	"	"
County Court House,	"	"
Maryland State Insane Asylum Buildings, (near)	Baltimore,	Md.
Maryland House of Refuge Buildings, (near)	"	"
Maryland House of Correction Buildings, (near)	"	"
Maryland State Penitentiary,	"	"
Maryland State Normal School,	"	"
Enoch Pratt Free Libraries,	"	"
Notre Dame Academy (near)	"	"
Johns Hopkins University Buildings,	"	"
Sheppard-Pratt Insane Asylum Buildings, (near)	"	"
B. & O. R. R. Grain Elevator,	"	"
Pennsylvania Railroad Grain Elevator,	"	"
Poole & Hunt's Foundries,	"	"
Gas Works,	"	"
Maryland State Insane Asylum Buildings,	Mt. Hope,	"
" Agricultural Buildings,	College Park,	"
New Jersey State Insane Asylum,	Morristown,	N. J.
State Hospital for Insane,	Poughkeepsie,	N. Y.

West Virginia Hospital for Insane, ... Clarkesburg, W. Va.
Lenox Library, ... New York City,
Carnegie Library, ... Allegheny, Pa.
York Collegiate Institute, ... York, Pa.
Ursuline College, ... Pittsburg, Pa.
Episcopal Home, ... Pittsburg, Pa.
Presbyterian Hospital Buildings, ... Philadelphia, Pa.
Kirkbride Hospital Buildings, ... " "
Pennsylvania Railroad, Broad Street Station, ... " "
" " Round House and Shops, ... Altoona, Pa.
" " Shops, ... Wall Station, Pa.
" " " ..... Mt. Royal, Md.
" " Freight Houses, ... Chicago, Ill.
" " Passenger Station, ... York, Pa.
" " " " ..... Trenton, N. J.
B. & O. R. R. Shops, ... Mt. Clair, Md.
Cambria Iron Companys Buildings, ... Johnstown, Pa.
Westinghouse Shops and Buildings, ... Wilmerding, Pa.
Billmeyer, Small Co.s Car Shops, ... York, Pa.
Gas Works, (Point Breeze), ... Philadelphia, Pa.
" " ..... Pittsburg, Pa.
" " ..... Newark, N. J.
" " (Metropolitan), ... New York.
" " ..... Boston, Mass.

Probably there is no more striking example of the indestructibility of Peach Bottom roofing slate than the roof which surmounts that rambling old landmark, the old Ramsey Tavern on Peach Bottom ridge. The slates are unbroken, their color has not faded and their weather resisting qualities are not impaired. The old Ramsey Tavern is a monument to the "BEST SLATE IN THE WORLD."

Prudential Insurance Company, Building, (general offices), ...Newark, N. J.
Residence, Geo. Vanderbilt, Esq., (Biltmore), ...Asheville, N. C.
" Wm. B. Astor, (Fifth Avenue).....New York.
" Hon. S. B. Elkins, ...Elkins, W. Va.
" E. C. Camp, Esq., ...Knoxville, Tenn.

OTHER PENNSYLVANIA SLATES

THE slates of Pennsylvania, aside from those of the southeastern part of York County, which are described under the heading "Peach Bottom" slate, occur in Northampton and Lehigh Counties in a strip from two to four miles wide, on the southern side of the Blue Mountain, extending from Delaware Water Gap to a point four miles west of Lehigh Gap, a distance of about thirty-two miles. The chief centres of the slate industry of Pennsylvania other than Peach Bottom Ridge, are at Bangor and Slatington.

On the southeast, forming a belt between Easton and Reading and beyond are the granite-like rocks of South Mountain, flanked and dotted over with strips of hard, flint-like stone and sandstone. Still farther northwest is a slightly hilly belt of roofing slates from six to eight miles wide. At one end these slates overlie the limestone, and at the other they dip under the Blue Mountain. The boundary between the slate formation and the limestone is roughly parallel to the general course of the Oneida and Medina boundary, but passes a little north of Nazareth.

The commercial slate, however, comprises but a few hundred feet. "Ribbons," or small beds of grit, measuring from a fraction of an inch to two feet in thickness, characterize this slate belt throughout. This grit consists mostly of more or less angular grains, together with scales of hard stony substances that interfere to some extent with rapid work in the several quarries. The corrosive carbonates are also present to a greater or less degree. Commercial slate is obtained along two belts. The upper and northerly one, known as the "soft vein," consists of beds of relatively soft slate, of sufficient thickness between the ribbons to furnish large slabs suitable for mill stock or roofing purposes. The lower or southerly belt, the "hard vein," consists of small beds of harder slate, separated by small ribbons which are not coarse enough to interfere with their use either as mill stock or roofing slate, but makes the slates more difficult to quarry and as a result more expensive to bring to the surface. The

Bangor, East Bangor, Pen Argyl, Danielsville, Slatington and Slatedale quarries are in the "soft vein" belt and the Belfast and Chapman are in the "hard vein."

In Northampton County the slate is dark gray, and to the unaided eye has a fine texture and a fine cleavage surface, but is almost without lustre. There is a gritty bed both at top and bottom which is regarded as the limit of the slate and the thickest bed of good slate is only nine feet thick, unlike Peach Bottom, which appears to be practically inexhaustible.

The product from the large beds is used for roofing, but that from ribboned beds in the largest quarry in this county goes into mill stock exclusively and is not unfading. There is also in Northampton County a six-foot bed of slate which is quite black, more so than any of the Lehigh County slates. It has to the unaided eye a somewhat fine texture and cleavage surface with a slight lustre.

The quarries at Pen Argyl are regarded as being near the bottom of the "soft vein" belt. One measures 650 feet long, 600 feet across and 300 feet in depth. It is a clay slate, the chemical analysis of which points to rapid decay. There is an exceptional bed, however, forty-four inches thick, of a dark, slightly greenish gray slate of superior quality. The chief product of this quarry, however, is a very dark-gray slate which, to the unaided eye, has a fine texture and a rough, almost lusterless surface. Only a portion of it can be used for roofing slate.

Some of the quarries at Pen Argyl show the passage of the black slate by weathering into a yellowish light brown, and even white shaly or flaky substance. The dumps afford specimens showing all gradations from black slate to white rock. In this connection it should be stated that in the "soft vein" quarries generally, judging from the dumps, the amount of iron and lime in the ribbon varies greatly. The slate flags which form the sidewalks in the village of Bangor wear along the ribbons more rapidly than along the slaty portions.

There is in this county a "hard vein" belt. The principal quarry measures from 700 to 800 feet long, and is about 200 feet wide and 300 feet deep. The largest bed, which, although containing very

Workmen clearing away the debris and ribboned slate in a quarry near Slatington, Pa., in order to reach a thick workable bed of valuable slate. This condition does not exist on the Peach Bottom ridge.

A remarkable fold of slate in a quarry near Slatington which shows a close "syncline" or trough-like, curled-up formation crossed by curved joints, over which are glacial deposits or "top."

small ribbons, can be used for roofing slate, measures sixteen feet. The number of ribbons exposed on the east-northeast wall, where the fold opens out, is 112, averaging a little over two per foot of slate.

The slate is very dark gray, but is crossed by frequent ribbons a trifle darker and measuring from one-eighth to one-half inch in width. To the unaided eye it has a fine texture, slightly rough and slightly lustrous surface.

The product of this hard vein was formerly used largely for flagging, posts, steps, etc., and because of its hardness had to be cut with diamond saws which operated horizontally. Owing to the competition of sandstone flagging and the high price of diamonds, this outlet is closed and the product now is used exclusively for roofing slate, for which, however, only selected material is available.

The slate quarries of Lehigh County all belong in the "soft vein" belt. The relation of the "soft vein" slate to the scaly formation of loose stone of similar formation is well exposed near Lehigh Gap, on the border of the county. On the eastern side of the gap the outcrop is a black flake of loose stone that, however, is capable of being split like slate which occurs in alternating thick and thin beds. The thick ones weather into shell-like fragments, while the thin ones break up into pencil-like pieces. A hundred feet south of the locality described a slaty cleavage predominates. Therefore, within a space of 200 feet the transition from a shale to a slate can be observed.

In weathering, the Lehigh slates undergo the same transformations as those of Northampton County. The black slate first passes into a soft, yellowish-brown rock, which later becomes nearly white clay, the "shale clay" of the fire-clay pits.

The slate quarries of Lehigh County are now confined to an area comprising about three square miles along Trout Creek and its tributaries. This stream empties into the Lehigh from the west at Slatington. The older quarries have reached a depth of about 300 feet.

The Slatington slate is a dark, bluish gray. After prolonged exposure this slate becomes at first

An unusual curled-up formation or syncline of sea-green slate at West Pawlet, Vermont. The slate within which is usually broken up and almost valueless, except for the smaller sizes of roofing slates.

Formation of slaty rock crossed by veins of quartz, (hard, flinty and semi-transparent rock), which appears at intervals in the green slate of New York and Vermont.

a lighter gray and finally various shades of cream and coffee color, but the rapidity and degree of discoloration differ in different beds. These slates are best adapted for blackboards and other indoor objects.

VERMONT

NEXT in importance from the viewpoint of commercial slate is Vermont, in which there are at least four distinct slate districts. The most easterly extends along the Connecticut River for more than two-thirds the length of the State. The slate is black or dark gray, and has been worked in Guilford, in Windham County, at the extreme southern end of the State, and also in Thetford, in Orange County, and at Waterford, in Caledonia County. The next district extends along the east flank of the Green Mountain range from the Canada line to about the middle of the State, and has been extensively worked at Northfield, in Washington County. The most important district, which furnishes the well-known "green" and "purple" slates, lies between the Taconic range and Lake Champlain, extending from the town of Sudbury, in Rutland County, southward to Rupert, in Bennington County, a distance of twenty-six miles. This belt also passes into Washington County, N. Y., where, however, it has thus far proved of less economic importance. The fourth is black slate, as yet undeveloped, and covering only from ten to twelve square miles in the town of Benson, in Rutland County, near Lake Champlain. Vermont slate, as a rule, contains but little carbonate, which indicates excellent wearing qualities. Records, however, show that the Peach Bottom slate of Pennsylvania possesses these qualities to a far greater extent.

The factor of waste is extremely large in quarrying Vermont slate and an important quarry near Montpelier is said to have been abandoned some years ago for this reason. This quarry was operated by means of three wide openings at intervals and communicating with each other by a ten-foot open cut, which also served as a drain. This waste may have been the result of the complex opening, as the slate appears to be essentially the same as that of the Northfield quarries, which are worked with a percentage of waste (between 70 and 80 per cent.) that is not excessive when it is recalled that the old fashioned methods of quarrying is the vogue.

It is Western Vermont that furnishes the green and purple roofing slate, while a commercial red slate is quarried near the boundary line between Vermont and New York. This bed continues into the last named state in the vicinity of Granville and Hampton. In some parts of Western Vermont two separate beds of slate, distinct both in color and quality twist around each other, sometimes one quality appearing on top and then the other. While this condition is at times puzzling, the relations of the two beds are more intricate in New York than in Vermont. The purple slates sometimes contain a few inches of dark-red slate. There is also some difference in the shade of the different beds of green in the same quarries, some being more green, others more gray. There are also differences in the amount of discoloration, produced by weathering in beds of the same locality. Although some quarries produce only the so-called "unfading green" and others only the "sea green," these differences appear not to belong to strata or deposits of different ages, but to occur at different points in strata of the same period.

The relations of the "sea green" and the "unfading green" are not at all clear. There is nothing as yet to show that the positions of these two varieties of slates are not identical. It seems probable that, at a point within two miles north of Poultney, a change in the sediments occurred, sufficient to account for the change in color and durability. Whether this alteration in composition is alone sufficient to account for the difference is uncertain. There may have been some change in the resistance to pressure which would account for more perfect cleavage at the south than at the north, or possibly, the greater abundance of grains of quartz, (hard, flinty stone), at the north may be responsible for the altered structure. With more lime deposited at the south and more quartz sand at the north, the whole difference may be traced back to changes in sediment. Even this demarcation between the fading and unfading green slate areas is not absolute, for fading green slates occur well within the unfading green area. The purple slates frequently have green ribbons—an inch or two in thickness, and such ribbons run into tows or planes of green spots. The ribboned slates are used for flagging.

Syncline or peculiar trough-like folding or curling up of a bed of black and gray banded slate at West Castleton, Vermont. This unusual formation shows the effect of the natural wearing away of the softer portions of the slate. This twisted, curled or trough-like effect is considered by many authorities to be a faulty formation that adds to the expense of quarrying. Such faults are not found on the Peach Bottom ridge.

The Story of Slate

In the unfading green-slate portion of the belt, about one and one-quarter miles north of Bomoseen and a little east of the lake, is an abandoned quarry where green slate which were made into slate pencils were obtained. The general substitution of paper tablets for school slates, however, has almost stopped the manufacture of slate pencils.

MAINE

THE slate region of Maine lies about in the centre of the State, in the southern part of Piscataquis County, south and southeast of Moosehead Lake and east and west of Sebec Lake, in the towns of Monson, Blanchard and Brownville. Commercial slate occurs also in the town of Forks, Somerset County. The portion of this belt now yielding commercial slate lies south of the central granite area of the State. The general structure of this belt is unknown.

Three quarries are in operation in the town of Monson. The slate is dark gray, but at the surface some of the beds have in bright sunlight a slightly purple hue, but is almost lustreless.

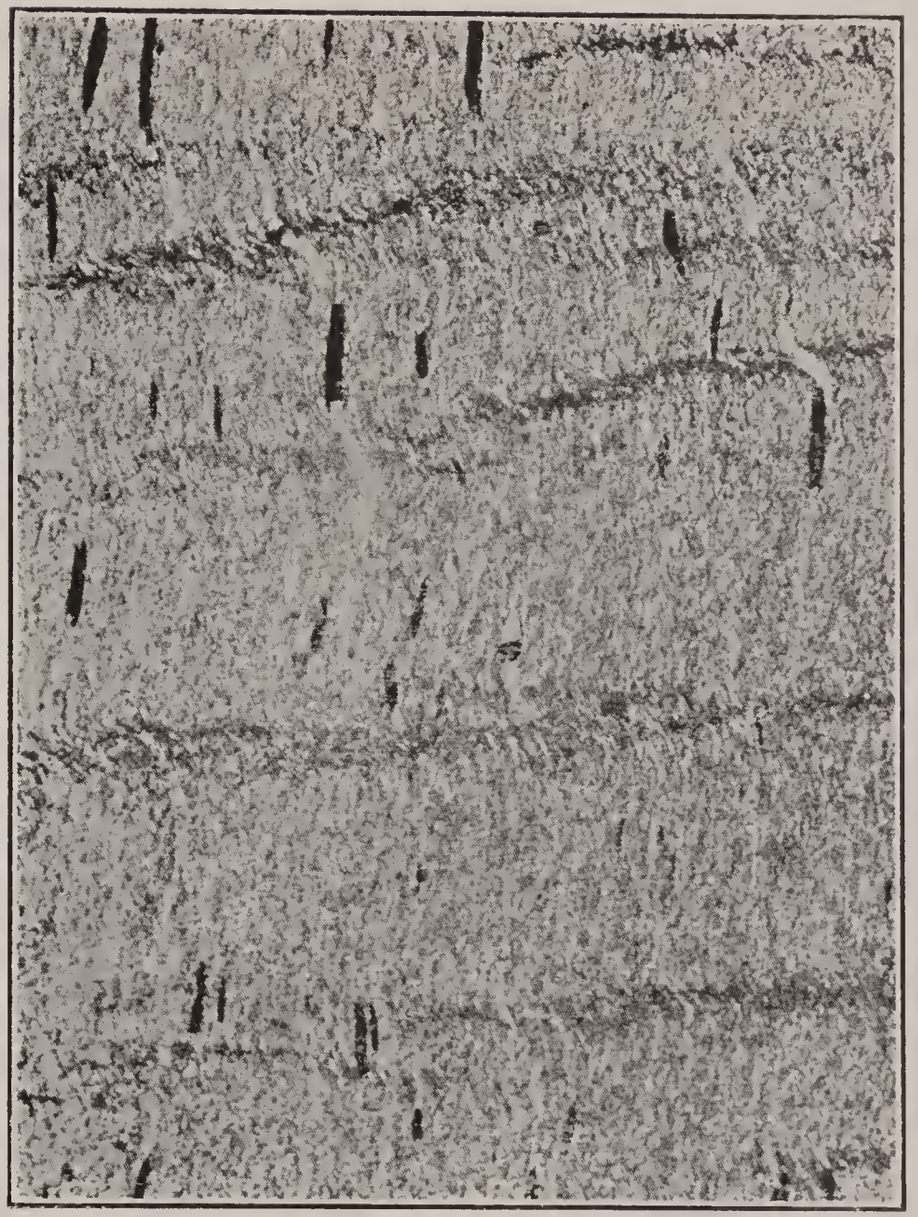
At another quarry, three and one-half miles from the village, there are about thirty feet of slate and interbedded flint exposed. The thickest bed of slate measures about eight feet. The slate is dark gray; to the unaided eye has a finer texture and finer cleavage surface than that of the first mentionel quarry, and also more lustre. At the third quarry a bed of black slate nine feet thick, with a bed of flint fifteen feet thick on its north side, and small alternating beds of hard stone and slate on its south side are exposed, the whole series measuring perhaps fifty feet. As only one bed of slate is worked, the percentage of waste at this quarry is comparatively small. It has some lustre. This slate is used both for roofing and mill stock and particularly for electric purposes.

There are two quarries at North Blanchard. the slate from these quarries is also a dark gray, with a slightly lustrous surface. Only one quarry is now in operation at Brownville, which lies less than a mile northeast of the station. Here are exposed forty-two beds of slate alternating with as many of flinty rock and measuring altogether 165 feet in thickness. The slate beds range from six inches to six feet, and the rock beds from six inches to five feet six inches. At an abandoned quarry in the same vicinity there are twenty-eight beds of slate alternating with an equal number of flinty rock, measuring in all 161 feet 6 inches. The slate beds range from one to nine feet and the rock from

four inches to twenty feet in thickness. The Brownville slate is highly crystalline, and is said to be one of the most valuable slate districts in the United States excepting Pennsylvania.

A slate prospect opened in Forks, Somerset County, is about eighteen miles west of the North Blanchard quarries, in the southwest corner of the town of Forks, the nearest railroad is the Somerset Railway extension at Mosquito Narrows, six miles distant. The slate is bluish black, of good texture and cleavage surface, with a lustre not so great as that of the Brownville slate. Neither the ledge nor the fragments, said to have been exposed fifteen years, show discoloration. This "Pleasant Pond" slate differs from the Monson slates in having a lustrous and smooth surface, and from the Brownville slate in having a little less lustre. It would prove suitable for roofing or mill stock purposes. Whether, like the other slates of the State of Maine, it is interbedded with hard flinty ribbons at frequent intervals, has not as yet been determined.

A ribboned slate from a quarry near Hatch Hill, in Whitehall, New York. Ribbons are seldom found in the best quality slates and are not of the same hardness as the marketable product.



A remarkable specimen of black roofing slate from a prominent quarry at Brownville, Maine. This fibrous formation is in the shape of long crystals and has a wavy, uneven surface.

MARYLAND

THE Peach Bottom slate of Cardiff, in Harford County, about thirty miles northeast of Baltimore, extends up into Pennsylvania, and has therefore been considered under a heading of its own, particular attention being paid to the rich Pennsylvania-Maryland and the old Proctor Quarries which are equipped with up-to-date machinery. Slate occurs also in Montgomery and Frederick Counties, about forty miles west of Baltimore and thirty-three miles northeast of Washington, where it has been prospected and quarried to a small extent. This slate belt, whatever may be its exact bounds, is well exposed at Ijamsville, on Bush Creek, and the Baltimore and Ohio Railroad in Frederick County. Between Ijamsville and a point two and one-half miles southwest of that place, it is at least one and one-half miles wide, and reappears west of Hyattstown, three and one-half miles farther south in Montgomery County. It passes between Sugarloaf Mountain and the village of Mount Ephraim on the west and Hyattstown and Barnesville on the east, its minimum length and width being about twelve and one and one-halfmiles respectively.

One-fourth mile west of Ijamsville station is an abandoned quarry of dark, slightly reddish-purple slate. Similar slate but interbedded with light green, occurs also several hundred feet east and north of the station. On Little Bennett Creek, about a half mile from Thurston, in Frederick County, is another quarry, operated twenty years ago but now abandoned. The slate is also dark purple, with light-green passages containing here and there a scaly, bright-green mineral, in which is a trace of copper. A piece of this slate that is said to have been on a roof many years shows some lightening of the color, owing chiefly to the growth of lichens, but the change is only superficial.

About 600 feet from this and one-half mile from Thurston is a recently opened quarry. Some of the slates on exposure develop dark spots, due to the organic change of some mineral.

VIRGINIA

IN reports to the legislature of Virginia, attention was called to the slate deposits east of the Blue Ridge in Buckingham, Fluvanna and Fauquier Counties. Slate also occurs in the Blue Ridge in Amherst County. This roofing slate makes its appearance on both sides of the James River. In Buckingham County the bed is largely exposed in the neighborhood of New Canton, on Slate River. This quarry was first opened to procure slate for roofing the Capitol, but little further use has been made of it.

Slate River empties into the James about forty miles west-northwest of Richmond and fifty-two miles northeast of Lynchburg. The width of the formation north of the James extends from a point one-half mile west of Bremo Bluff to a small creek entering the James to the southeast. South of the James its eastern boundary lies about 3,000 feet west of the toll bridge opposite Bremo Bluff, and its western boundary is roughly one-fourth mile east of the Virginia Mills, on Slate River. There is in this vicinity a forty foot bed of slate.

The general structure of the belt in which the commercial slate beds lie, judging from the railroad cuttings between New Canton and Slate River, appears to consist of minor folds. The commercial slate itself appears to occupy a belt two-fifths of a mile wide along Hunt's Creek, which is a tributary of Slate River. At Arvonia the river's course is, roughly, like that of Hunt's Creek. There appears thus to be a bend in the slate beds between Arvonia and the north side of the James. The quarries near Arvonia are scattered along the sides of Hunt's Creek for a mile northeast of that place. The quality of the slate is said to be fair. It is a dark gray, with a slightly greenish hue. To the unaided eye it has a rough, lustrous surface.

The Snowden slate deposit is on the southeast side of the Blue Ridge, north of the cut through which the James River flows. It is situated about eighteen miles from Lynchburg. The slate crops

out in a valley of Rocky Row Mountain on its northwest side and a spur of Big Piney Mountain on its southeast side. The general structure and the actual relations of the slate have not yet been completely investigated.

There are several prospects in the neighborhood of White Sulphur Springs on the Rappahannock, six miles southwest of Warrenton, from which roofing slate was obtained as early as 1837, but they have never been worked systematically. The slate is black, and to the unaided eye, has a coarse texture, a rough speckled cleavage surface with little lustre. The odor of clay is also present, and scientists say it is a clay slate. Other smaller beds of slate have been prospected. In one the slate is bluish black, has a coarse, crystalline texture, and a knotty, wrinkly surface. The surface has very little lustre, but the clay odor is much in evidence. The iron and sulphur noted in all these Fauquier County slate prospects and the sulphurous character of the springs, are probably intimately related. The indications from the openings and the microscopic examinations are not sufficiently promising to warrant investments.

NEW YORK

THE slates of Washington County, N. Y., are a continuation of those of Rutland County, Vt. They are green and purple, like those in Vermont and were once extensively quarried at Middle Granville and Jamesville.

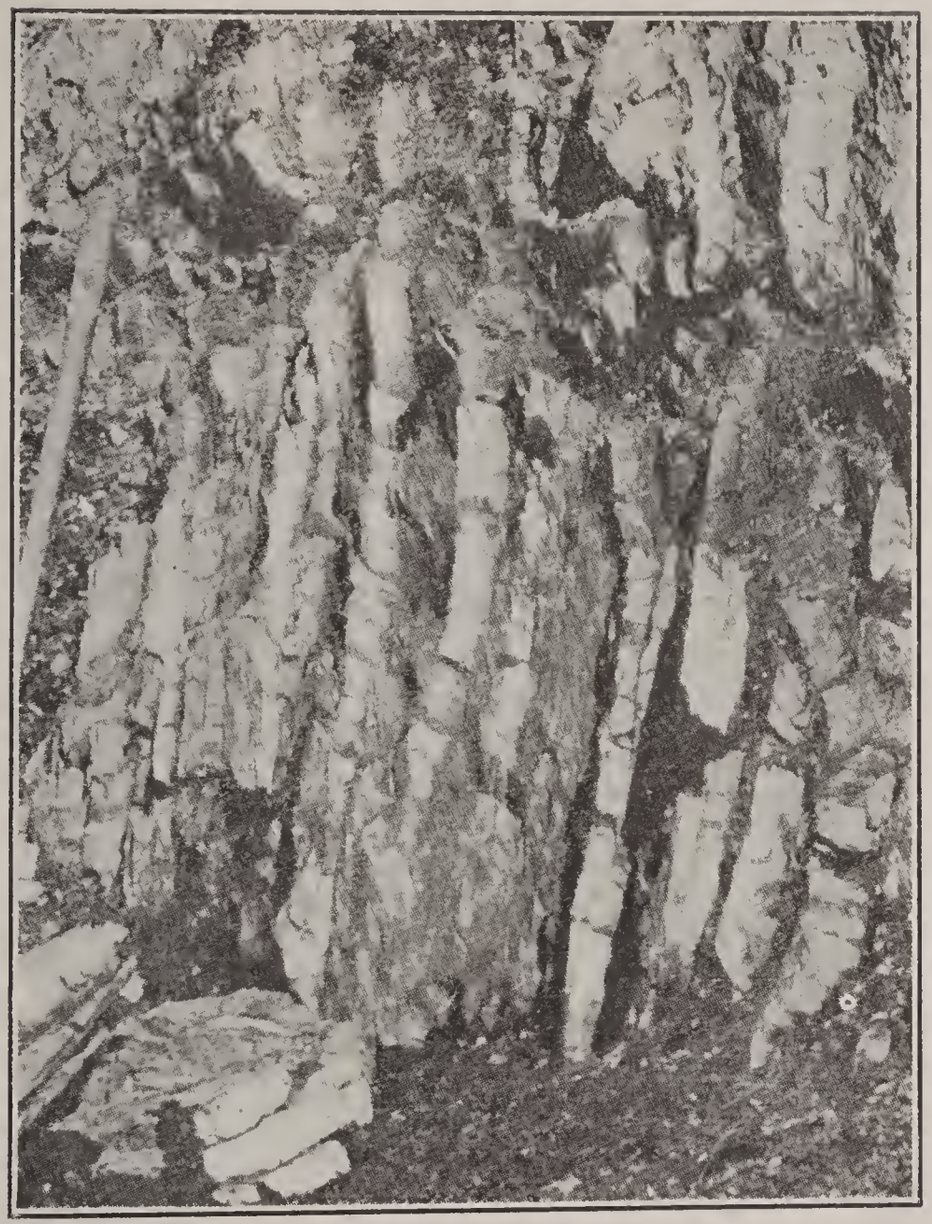
While the green and purple slates are at present quarried almost exclusively on the Vermont side of the boundary, the red and green slates attain their best development on the New York side, particularly in the towns of Granville, Whitehall and Hampton. Beds of red and green slate alternate vertically, and overtop each other. The thickness exposed at the quarries, reaches fifty to seventy-five feet, mostly red, with about twenty-five feet of green overlying; but taking away that which is too hard or too soft or badly veined, there are sometimes but ten feet, rarely more than twenty-five feet, of good red slate exposed at any one quarry, although it sometimes reaches a total of forty-two feet. A few feet or inches of dark red or purple sometimes occur in the red. Beds of greenish quartzite bordered by a purple slate, the whole "ribbon" measuring an inch or two in thickness, are not uncommon. Both red and green slates are frequently speckled.

The "red" slate is a decidedly reddish-brown, becoming brighter on exposure. To the unaided eye its texture is fine, and its surface varies from slightly rough to speckled, with minute "eyes" or "knots," in either case without lustre. There is also present a noticeable odor of clay. Distributed throughout the slate are many bright-red dots or spots of circular or irregular oval outline.

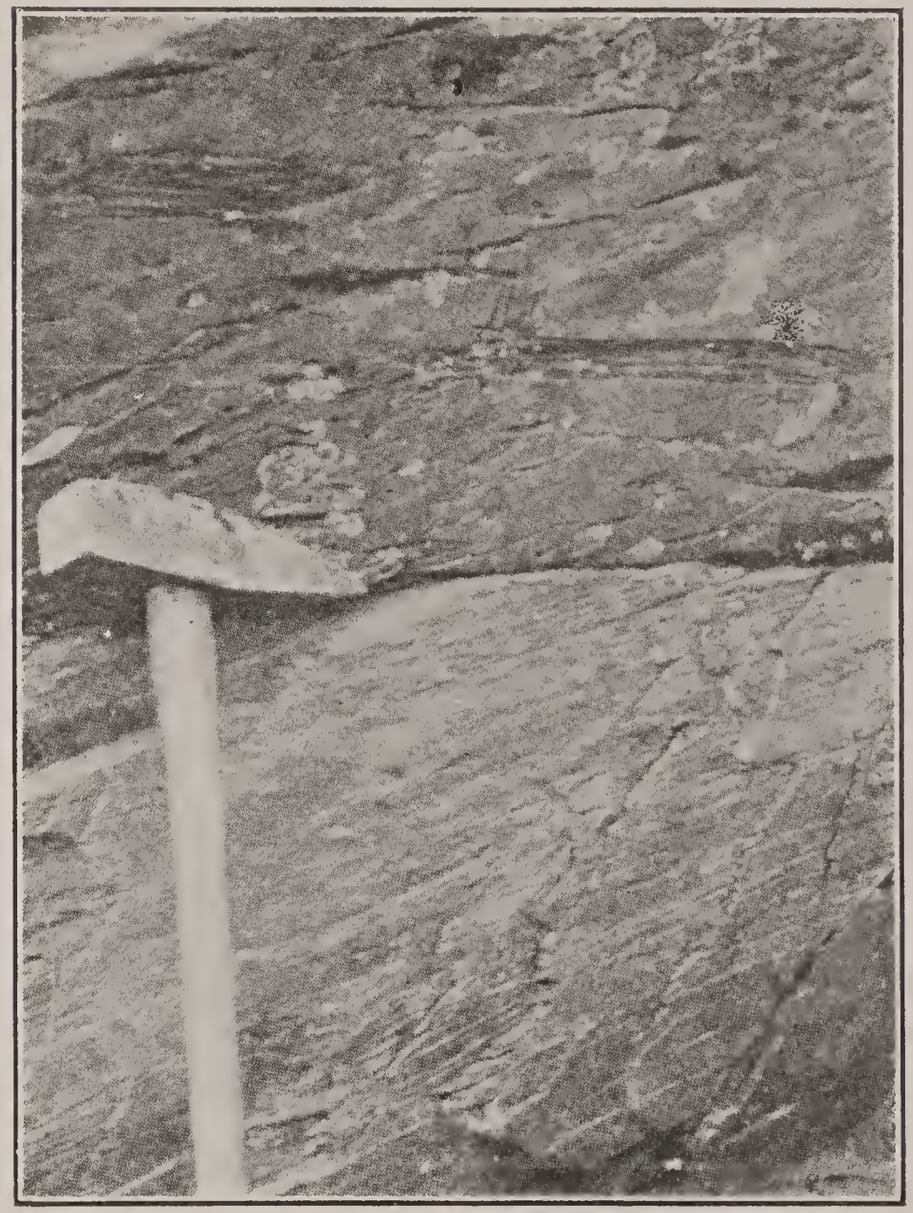
The slate is usually interbedded and passes into a light bluish-green slate, brighter in color than the "unfading green" slates of Vermont. Its color is peculiarly bright by lamplight; its texture and surface are similar to those of the "red" and the surface is also sometimes speckled. It is said to be unfading.

The Story of Slate

Black Roofing slate was quarried many years ago, in a small way, three miles south of Hoosick Falls, near Hoosick, and also, at a later time two miles south of Stephentown, near Lebanon Springs, in Rensselaer County, N. Y., but did not prove to be of economic importance or commercial value at either locality.



The photograph shows slate alternating with bands of uncleft rock, in Rupert, Vermont; near the New York line. A striking example of slip or false cleavage, seldom seen in the Pennsylvania quarries.



This interesting and unusual photograph shows a bed of sandstone or shale weighing many tons, resting on a valuable bed of green slate at Eddy Hill, Fairhaven, Vermont.

CALIFORNIA

THOUGH roofing slate has at different times been quarried on a small scale in other parts of California, the only important slate-producing area in the State is located in Eldorado County. The quarries which have been opened in this district are located northwest of Placerville, at distances of from one to six miles from that town. At present the most important quarry is near Slatington, and this is now being worked on a large scale but with the old, time-worn methods. The slate shows rather frequent, but narrow, "ribbons." These ribbons are bands (from one-sixteenth to one-half inch thick usually, occasionally as thick as two inches) of material differing in composition from the mass of the slate. They do not furnish merchantable material.

The product is a dense, deep-black slate, splitting finely and regularly, with a smooth, glistening surface, much like that of the Bangor and Lehigh slates of Pennsylvania. The frequency of the ribbons and other faults prevents the slate from being serviceable as mill stock, but as a roofing material it is fair. A band of green slate several feet wide, crosses the main body of black slate. On examination it is found that the borders of this band are not parallel to the "ribbon" of the black slate. The green band can not, therefore, be interbedded with the black slates. The probability that it was originally a hard rock which has been changed to a slate by pressure, is strengthened by chemical analysis.

The "green slate" is in reality gray-green in color. It splits readily, though with not so smooth a surface as the black slate. It stands punching and trimming well, and is sufficiently strong for roofing use. Considering its origin and composition, it is probable that it will be a highly durable slate, holding its color well. At present it is sold entirely for trimming and lettering on black slate roofs, for which purpose it is well adapted, giving pleasant color contrast. A quarry located about

three miles north of Placerville-Kelsey stage road is the oldest slate quarry in the district, having been opened about twenty years ago. It has been shut down since 1897. Several openings were made in a bluff forming the river bank at this point and in the easternmost of these openings, a rather poor slate with irregular points is shown. The western opening is quite small, with a tunnel which was apparently run in on a band of better slate. The slate piled in the yard has kept its color fairly well. It seems possible that this quarry may be flooded at high water and it is badly located, having no large dumping area available near the quarries. The quarry has not been worked deep enough to get really good slate. Still another quarry has been opened on the north side of the river and west of the Placerville-Kelsey road. It has been abandoned since 1897. A large stock of trimmed slates is still piled in the dressing yard, and many of these have already discolored badly.

The Eldorado County slates have practically no competition on or near the Pacific coast, and there has recently been large shipments to Hawaii and Guam. Until recently the principal problem has been the transportation of the slates from the quarry to the railroad. An aerial tramway system from its quarry to a point near Placerville is now in use and is apparently giving satisfactory service. This tramway is an engineering feat of no mean order, the crossing of the South Fork of American River being the principal difficulty encountered and successfully overcome.

The Story of Slate

ARKANSAS

THE slate deposits of Arkansas are included in an area of prehistoric rocks in the west-central portion of the State. This area is about 100 miles in its greatest dimension from east to west, and varies from twelve to twenty miles in breadth from north to south. The towns of Little Rock, Benton, Malvern, Hot Springs and Mena are all located just outside the boundaries of this area. Within this district deposits of roofing slate occur at numerous localities, but outside of its limits no slate can reasonably be expected to occur in Arkansas. This should not be construed as meaning that all this area is underlain by deposits of roofing slate, for such is by no means the case. On the contrary, workable roofing slate deposits make up only a small portion of it, the remainder being occupied by sandstones and shales.

Within the district noted roofing slates have been worked in a small way at several points near Hot Springs, Garland County, for a number of years. None of the workings, however, has been extensive enough to give a definite idea of the commercial possibilities of the deposits.

During the last few years a new slate area has been exploited in western Arkansas, the principal deposits being in the counties of Polk and Montgomery. Black, gray, red and green slates occur in abundance and a number of companies have been organized to work various properties. The black slate quarry is located on Crooked Creek, and is a fine-grained, deep black. It seems excellent for either roofing or mill slate. A few beds of rock (sandstone) are included in the section. But altogether a thickness of about 400 feet of black slate is exposed in a quarry near Crooked Creek.

Northwest of this quarry is one where most of the slate exposed is green, with occasional red

Difficulties that must be overcome in an important slate quarry at Brownville, Me. The photograph shows the pit in which are forty-two beds of slate alternating with an equal number of fissile sandstone known as quartzite. The wall to the left is almost a solid bed of this peculiar sandstone held together by the natural mineral cement of quartz.

streaks. The slate on the dump has disintegrated very badly on weathering, and is really hardly more than a clay shale.

Summarized there is a pure black slate near Big Forks which to the unaided eye has an exceedingly fine texture and a remarkably smooth cleavage surface with a slight lustre. This seems to be a superior roofing slate, with a fine cleavage and not liable to discolor on exposure, but its strength and its behavior under frost has not been thoroughly tested. There is also a dark-red slate deposit near Big Forks. In color this slate is somewhat darker than the "red" slate of New York. It is speckled and almost lustreless and has an odor of clay. This slate compares favorably in texture with the New York "red" slate. There is also a red slate in Mammoth red and Lost Hannah beds. Color lighter than above, but not quite so red as the New York slate. To the unaided eye it has a fine texture and a fine cleavage surface, but no lustre. It also has a strong odor of clay. It is a finer and softer slate than the dark red, but has not been thoroughly tested for strength and frost resistance. A green-gray slate at Mena resembles in color the "sea-green" slate of Vermont. It possesses a waxy lustre and also possesses the odor of clay.

GEORGIA

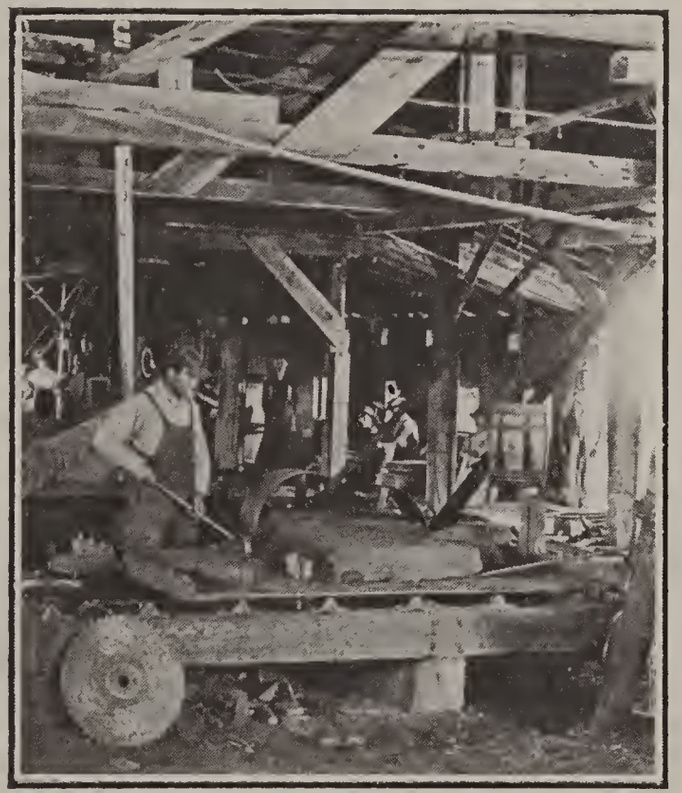
THE workable roofing slate deposits of Georgia are developed only near the town of Rockmart, Polk County. The most extensive slate quarries in the United States south of Pennsylvania are located at Rockmart. The formation in which the quarries are located extends across the border into the Rome quadrangle, but it is not certain that any workable slate will be found in this area. The formation is variable in composition, and to the north of Rockmart consists largely of unaltered clay shales with beds of limestone and sandstone.

Commercial considerations in connection with the slate industry, make slate a very important possible source of cement material. Good roofing slate is relatively scarce and commands an excellent price when found. In the preparation of roofing slate for the market so much material is lost during sawing, splitting, etc., under the older methods, that only from ten to twenty-five per cent. of the amount quarried is salable as slate. The remaining seventy-five to ninety per cent. is of no service to the slate miner. It is sent to the dump heap and is a continual source of trouble and expense. This material, however, is often admirably adapted for use in connection with limestone in a Portland cement mixture. This is one of the plans now being carried out at the Pennsylvania-Maryland and the Proctor Quarries on Peach Bottom Ridge.

Only one American Portland cement plant in Georgia is at present using slate as one of its raw materials, and this plant is of recent construction. It is located about half a mile east of Rockmart, Ga. The Portland cement manufactured there is made from a mixture of pure limestone and slate, both of which materials occur in the immediate vicinity of the plant.

East of the town the surface rock is the "Chickamauga limestone," which has been quarried at several points in the vicinity and burned into lime. A cement company has purchased the property of the old Georgia Slate Company, about half a mile southwest of Rockmart, and carried on extensive

operations with the diamond drill. The intention was to quarry the slate, sell as slate the portions best suited for that use, and utilize the scrap and waste in the manufacture of cement. The quarries from which the limestone is obtained are located half a mile east of town, near the mill.



TENNESSEE

SLATE deposits occur in eastern Tennessee, notably southeast of Knoxville. Two formations in this region contain beds of slate—the "Wilhite" and "Pigeon" slates. The Wilhite slate in the vicinity of Little Tennessee River, is too soft for commercial use, but has the necessary hardness and evenness, along Little Pigeon River. Along this stream the slate is well exposed over great areas, but has never been developed. Quarries have been opened in the "Pigeon" slate along the Little Tennessee River at many points, and slates and flags taken out for local use. The slates are fine, even grain, and split into slabs an inch thick, of any desirable size, or into roofing slates. That this slate resists weathering is proved by the high, sharp slate cliffs that border the river along most of its course.

The Story of Slate

UTAH

FOR some years past a small amount of slate has been annually quarried, chiefly for samples and trial shipments, at various points in Utah. Deposits of slate, believed to be of workable extent and of fair quality, have been described as occurring on the islands in Great Salt Lake, and some attempt has been made to develop these deposits.

The locality which has been most widely discussed, however, is that near Provo. The slate deposits occur about two miles from Provo station, in Slate Canyon. The slate covers a considerable area, but that exposed at the surface is so badly broken up that large slabs can not be obtained. The Provo deposits furnish green and purple slates, the latter being apparently present in greater quantity. The green slates show little tendency to cleavage in their surface outcrops, and will probably be less satisfactory for roofing purposes than the purple. The green slates rub very smooth, however, and make good slabs or mill stock if obtainable in masses of sufficient size.

The purple slates split well, with a surface almost as smooth as that of Peach Bottom (Pennsylvania-Maryland) slate. From samples seen it appears that they also bear punching well, but as a commercial enterprise the quarries are still in embryo.

The William Quigley place, near Delta, Pennssylvania, roofed with Peach Bottom slate, has withstood storm and sunshine for sixty-five years and, as far as can be learned, has cost nothing for repairs during that period, except the replacing of some nails that originally held the slate in place and corroded so badly with the flight of years that new ones were driven to hold the same slates in position.

ARIZONA

A SPECIMEN of roofing slate recently received from Arizona by Dr. David T. Day, of the division of mineral resources of the United States Geological Survey, came from a deposit about six and one-half miles north of Phoenix, which is said to measure from 800 to 1,000 feet in width and about 5,000 feet in length. Its examination has yielded the following results:

It is a bluish gray with a lustrous surface, marked by two sets of minute wrinkles that lie at right angles to each other. It has a marked odor of clay. If properly cut with reference to the direction of weakness this may prove a serviceable slate.

WEST VIRGINIA

The Story of Slate

THIS recently prospected slate district lies near Martinsburg in Berkeley County. This belt lies about thirteen miles west of the Blue Ridge and mostly on the western side of Opequon Creek, a small tributary of the Potomac. It measures at least fourteen miles in length and from two to three miles in width. This clay-slate formation, estimated at from 700 to 1,000 feet in thickness, is in a series of folds. The rock is generally dark-gray, weathering into a yellowish or white clay, known locally as "soapstone." The beds are small and are separated by darker ribbons. The thickest bed exposed measured three feet six inches. A diamond drill core down to forty feet below the bottom of the quarry shows several three-foot beds. The slate is black, with a slightly brownish hue. The texture is somewhat fine and the cleavage surface rough without any lustre whatever. It is proposed to use the product of this quarry for mill stock, for which it seems better adapted than for roofing.

Clay-slate has also been found two miles from Middleway; in a brook southeast of Martinsburg, and also three miles southeast of Martinsburg, and it will be found in many other places. They are all clay-slates. The material can therefore hardly possess sufficient fissility or prove sufficiently strong or elastic to compete with mica-slates for roofing purposes. Furthermore the mode of weathering by the outcrops indicates its probably discoloration on prolonged exposure, so that it belongs in the "fading" group of clay-slates.

The Story of Slate

NEW JERSEY

THE Bangor-Slatington slate belt of Pennsylvania is prolonged eastward into New Jersey and roofing-slate quarries have been opened at several points, notably near Newton and Lafayette. The characteristics and properties of these slates will be found under the heading of "Other Pennsylvania Slates."

Quarrymen at Dinorwic, North Wales, "Dressing," "Splitting" and "Pillaring" in the old way. This is one of the one thousand groups of workmen to whom are sold portions of the quarry called "bargains" or lots 18 feet wide and the height of the gallery (75 feet) which they work together and divide equally the proceeds. This is a part of the system in the Welsh quarries.

MINNESOTA

DEPOSITS of roofing slate occur in northern Minnesota, a few miles west of Duluth. At present, however, all the quarries formerly opened have been abandoned, and the quality of the slate, as seen in specimens on the old dumps is hardly such as to justify reopening.

The accompanying table shows the principal characteristics of thirty-eight kinds of slate as far as these bear upon economic or commercial value. These slates are from Arkansas, California, Maine, Maryland, New York, Pennsylvania, Vermont, Virginia, and West Virginia. The column headed "strength" refers to the tests by Merriman. Microscopic texture refers primarily to the body of the slate. By "crystalline" is meant that the slate consists of interlacing and overlapping scales and fibres, and is, therefore, a mica-slate. Such a slate should have, other things being equal, greater elasticity and strength than one in which there is no such texture. The fineness or coarseness of this texture has a bearing upon the strength of the slate. THE PEACH BOTTOM SLATES, WHICH REALLY APPROACH A MICA SCHIST, ARE THE STRONGEST OF THE TWELVE KINDS OF AMERICAN SLATES TESTED.

Clay-slates (Fading) Martinsburg, W. Va.

Mica slate	(Fading)	(A) (black)	Lehigh and Northampton Counties, Pa. Benson, Vt.
		(B) (green)	"Sea green," Vermont.
		(C) (purple)	Purple of Pawlet and Poultney, Vt.
	(Unfading)	(A)	PEACH BOTTOM, PA., AND MD. Arvonia, Va. Northfield, Vt. Brownville, Monson, Me. West Monson, Me.
		(B)	Granville, Hampton, N. Y; Polk County, Ark.
		(C) (green)	"Unfading green," Vermont.
		(D) (purple)	Purple of Fair Haven, Vt. Thurston, Md.

COMPARATIVE CHARACTERISTICS

Compiled from Various Authentic

Locality.	State.	Color.	Lustre.	Cleavage Surface.	Microscopic Texture.
Peach Bottom	**Pennsylvania-Maryland**	**Dark blue-gray**	**Very bright**	**Minutely granular**	**Crystalline, coarse**
Old Bangor, Northampton County.	Pennsylvania	Dark gray	Almost none	Fine	Crystalline, fine
North Bangor, Northampton County.	do.	do.	do.	do	do.
Pen Argyl	do.	do.	do.	Rough	do.
Gray bed	do.	Dark green	do.	Rough granular	do.
Big bed, Northampton County.	do.	Dark gray, not blue.	do.	Somewhat fine	do.
Black bed	do.	Blue-black	None	Rough	do.
East Bangor, Northampton County.	do.	Dark blue-gray	Almost none	Somewhat fine	do.
Slatington, Lehigh County	do.	do.	do.	do	do.
Chapman "hard vein"	do.	Dark gray	Slight	Slightly rough	do.
Merrill, Brownsville	Maine	do.	Very bright	Fine	Crystalline, very fine
North Blanchard	do.	do.	Slight	Rough	Crystalline, fine
Monson Pond, Monson	do.	do.	Almost none	do	Crystalline, fine, but particles irregular.
"Maine," of Monson	do.	do.	Bright	do	Crystalline, very fine
West Monson	do.	do.	Somewhat bright	Fine	Crystalline, fine
Northfield, Vermont Black	Vermont	Dark gray	do.	Fine	Crystalline, very fine
"Sea green"	do.	Gray-green	Waxy	do.	do.
Purple of "sea green"	do.	Purple-brown	None	do.	do.

OF PRINCIPAL AMERICAN SLATES

Sources and Personal Research

Principal Minerals.	Carbonate.	Analysis for Lime.	Strength, pounds per square inch.	Remarks.
Muscov., quartz, graphite andalusite, magnetite.	**None**	**0.155-0.48**	**11,260**	**Very sonorous. First Prize, Crystal Palace Exposition, London, as best slate in the world.**
Muscov., carb., quartz, kaolin	Quite a little	4.38	9,810	Discolors on continued exposure.
Muscov., carb., quartz, kaolin	Much			Do.
Muscov., carb., quartz, chlorite	Quite a little	4.09	7,150	Do.
Muscov., carb., quartz, chlorite	do.			
Muscov., carb., quartz, pyrite	Very much			Do.
Muscov., carb., quartz, carbon	do.			Discolors on continued exposure.
Muscov., carb., quartz, pyrite, chlorite	Much			In ribboned slate from this quarry the percentage of quartz would be higher than in the rest.
Muscov., carb., quartz, kaolin	do.	4.23		Discolors on continued exposure.
Muscov., quartz, carb., pyrite	Quite a little	2.83-3.40	9,470	Discolors less readily than any of the above Pennsylvania slates.
Muscov., quartz, magnetite, pyrite	None		9,889	
Muscov., chlorite, quartz, pyrite	do.			Very sonorous.
Muscov., quartz, chlorite, biotite	do.	0.52		Very sonorous.
Muscov., quartz, biotite, chlorite	do.			Very sonorous.
Muscov., quartz, chlorite, pyrite	do.		9,130	Very sonorous.
Muscov., quartz, pyrite, magnetite	Very little			Very Sonorous.
Muscov., quartz, carb., chlorite	Much	0.63-2.20	7,250	Becomes brown-gray on continued exposure.
Muscov., quartz, carb., hematite	Some	0.30-0.71		Discoloration less pronounced than that of "sea green."

COMPARATIVE CHARACTERISTICS OF

Locality.	State.	Color.	Lustre.	Cleavage Surface.	Microscopic Texture.
"Unfading green"	do.	Green-gray	do.	Rough	Crystalline, irregular
Purple of "unfading"	do.	Purple-brown	do.	do	do.
Benson	do.	Blue-black	Slight	Somewhat fine	Crystalline, fine
Thurston	Maryland	Dark purple	Very bright	Slightly granular	Crystalline, fine, particles irregular.
Arvonia, Williams	Virginia	Dark green-gray	Very bright	Minutely granular	Crystalline, irregular
Arvonia, Fontaine	do.	do.	do.	Granular	Crystalline, irregular, coarse.
Bremo	do.	Dark gray	do.	Fine speckled	Crystalline, fine
Snowden	do.	do.	Almost none	Minutely granular	Crystalline, fine, irregular
Granville and Hampton	New York	Red	None	Fine or rough speckled.	do.
do.	do.	Bright green	do.	do	do.
Eureka, Eldorado County	California	Dark gray	Bright	Fine	Crystalline, fine
Mena, Polk County	Arkansas	Black	Slight	Remarkably fine	Crystalline, extremely fine
do.	do.	Dark red	Almost none	Rough speckled	Crystalline, fine
Mammoth Red and Lost Hannah, Polk County.	do.	Red	None	Fine	do.
Mena, Polk County	do.	Green-gray	Waxy	Rough	Crystalline, extremely fine
Mammoth Red, Polk County.	do.	Light green	Almost none	Fine	do.
Polk County.	do.	Dark blue-gray	Slight	Fine	Crystalline, fine
Polk County.	do.	Light gray	None	Rough	do.
Southwest, Polk County.	do.	Dark gray	Almost none	Rough spangled	Crystalline, coarse, granular.
Martinsburg	West Virginia	Black, brown hue	None	Rough	Not crystalline or imperfectly so, coarse.

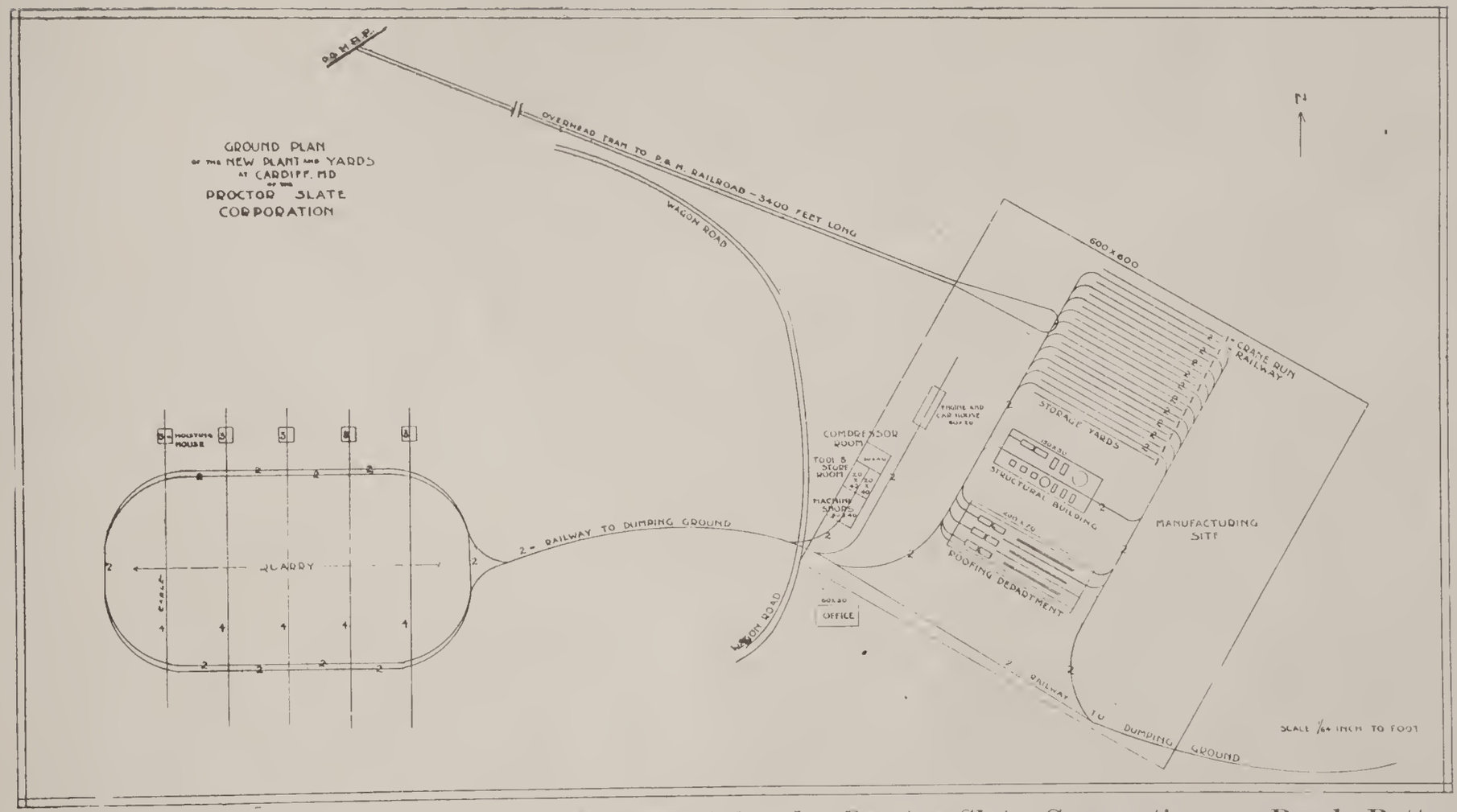
PRINCIPAL AMERICAN SLATES—Continued

Principal Minerals.	Carbonate.	Analysis for Lime.	Strength, pounds per square inch.	Remarks.
Muscov., quartz, chlorite, carb., ...	Very little	0.42-0.56	6,410	Preserved nearly all its color on continued exposure.
Muscov., quartz, chlorite, hematite	do.	.....	.....	Do.
Muscov., quartz, carb., pyrite	Much	1.27	.....	Sonorous. Probably "fading."
Muscov., chlorite, quartz, tale	None	.....	.....	Sonorousness moderate.
Muscov., quartz, biotite, carb., carbon.	Some	.....	9,040	Very sonorous.
Muscov., quartz, biotite, carb., pyrite.	do.	.....	9,850	Do.
Muscov., quartz, pyrite, kaolin? ...	None	.....	.....	
Muscov., quartz, chlorite, kaolin ...	Little	.....	.....	Very sonorous.
Muscov., quartz, hematite, kaolin, carb.	Much	0.11-5.11	9,220	Becomes brighter on exposure.
Muscov., quartz, chlorite, carbon, magnetite.	Less than red, usually	1.43	8,050	Said to be unfading.
Muscov., quartz, chlorite, carbon ..	Some	0.98	.....	
Muscov., carbon quartz, pyrite	None	.....	.....	Strength and behavior in freezing and thawing should be tested.
Muscov., hematite, kaolin, quartz,	do.	.....	.....	
Muscov., hematite, kaolin, quartz, chlorite.	do.	.....	.....	Do.
Muscov., quartz, kaolin, chlorite ...	do.	.....	.....	
Muscov., quartz, kaolin, chlorite ...	do.	.....	.....	Strength and behavior in freezing and thawing should be tested.
Muscov., quartz, pyrite, carbon	do.	.....	.....	
Muscov., quartz, chlorite, kaolin ...	do.	.....	.....	Some staining from pyrite.
Muscov., quartz, carbon, pyrite	Some	.....	.....	Between a grit and a slate.
Carb., muscov., quartz, kaolin, pyrite, carbon.	Some	1.11 and over.	.....	

THE IDEAL SLATE QUARRY

FOR more than ten centuries the same methods of quarrying that were the vogue in the days of the first crusaders, have continued until the present year, when up-to-the-minute machinery is being installed in the rich Pennsylvania-Maryland and the Proctor quarries, on Peach Bottom ridge. At last the ideal quarry is here, although to obtain the results there was a stubbornly contested battle between the slate quarryman and the men who desired to bring twentieth century appliances and devices to assist in taking the slate from its bed. The quarryman stoutly maintained that the old way, the way his father worked, the way in which the great hole in the ground had paid dividends in the past, was good enough. Why were innovations necessary? Why disturb the lethargy that hung over the entire slate industry for aeons? Why bring machinery into the peaceful lives of the quarrymen who were unused to its whirling wheels? The work of installing this machinery is not complete as this booklet goes to press, but the innovation has begun and will be pushed forward as rapidly as is possible; with sound engineering methods and technical knowledge that admits of no mechanical error.

Each argument against new devices and appliances was met with sound lucid and straightforward reasoning, and George J. Atkins, the well known engineer evolved a plan whereby the product of both the Pennsylvania-Maryland and the Proctor quarries could be brought to the surface, sawed to the proper sizes, split and shipped at a cost that is but a fraction of that necessary under the slower, more expensive and older methods. Mr. Atkins, working for J. G. Feist & Company, of Harrisburg, Pa., at once began to revolutionize the methods of quarrying the slate and little by little the changes met with the approval of even the hard-headed, unimaginative quarrymen. Steel cables, each controlled by its individual hoisting apparatus stretch across the mouth of the quarry, and buckets of slate whirl to the surface with accelerated speed. A narrow gauge double track railroad

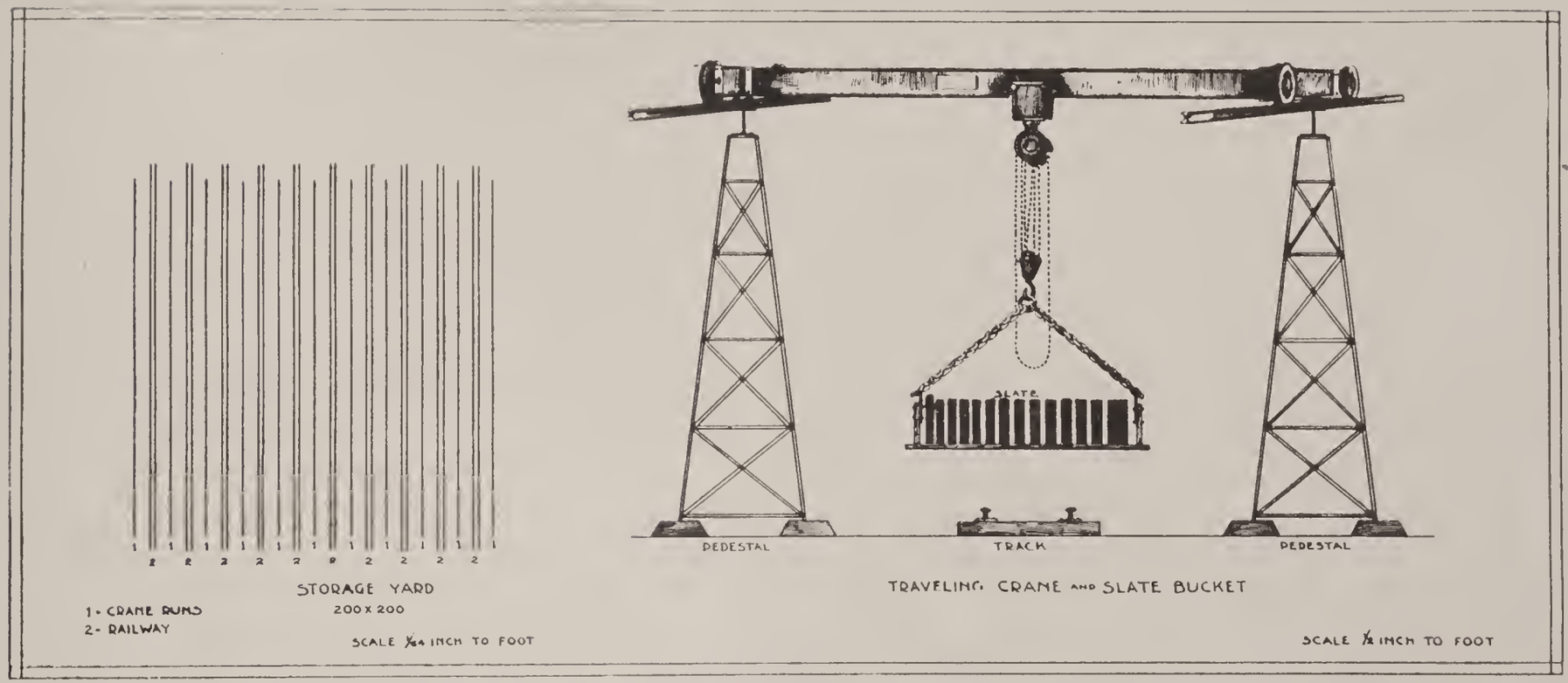


Ground plan of the Ideal Slate Quarry, owned by the Proctor Slate Corporation on Peach Bottom Ridge. It is from this quarry that the slates were taken for which was awarded the first premium at the Crystal Palace Exposition, London, as the BEST SLATES IN THE WORLD.

is laid around the pit and the puffing locomotive will replace the old hand cars. The tracks are designed to carry away the now small item of waste to the dumping grounds at the same time that the useful blocks of slate are conveyed with equal speed to the manufacturing plant, which includes buildings both for the roofing and the structural departments.

This railway at the Proctor quarry crosses the trestle over the old wagon road and spurs carry the cars to the machine and blacksmith shops, tool house and compressor room and the engine and car house, while the main line leads directly to the manufacturing department. The roofing plant, which is reached first, is designed with a steel frame having side walls and roof of slate, the equipment consisting, in the beginning, of six saw tables with multiple or "gang" saws specially designed to saw the great blocks lengthwise and then across in regular sizes for the roofing slate. These blocks are then carried to the splitters on moving belts in order that no time is wasted by these men in carrying the blocks a distance. They now devote their entire time splitting the slate. When their work is completed the finished slate is stacked in buckets and carried under a movable crane that glides easily on overhead rails, to the storage yards, where boys arrange the slate in packages ready for shipment.

The saving in this department alone is of considerable importance as a comparison with the old style method will show at a glance. The sawing of the slate with multiple saws is not only quicker (cutting thirty-six blocks at once, by cutting six strips lengthwise, then passing to the six cross-cut saws) but saves the enormous waste that could not be avoided under the old way. With these saws, there is absolutely no waste except the rough edges of the first quarried block. Next, almost half of the time the splitter was occupied by carrying the blocks and finished product to and from his working stool. With the new devices of movable conveying belts that bring the blocks to him and the big buckets under the traveling crane for carrying away the finished slate, he gives all his time to splitting slate and consequently does almost twice as much actual work during the day.



The movable crane and slate bucket that travels along overhead rails supported by steel pedestals and runs between the roofing and structural buildings and the big storage yards at the famous Proctor Quarry on Peach Bottom Ridge. This bucket carries fifty squares of slate at once and the crane can be operated by one boy. It does the work of fifty men and accomplishes it far quicker and easier.

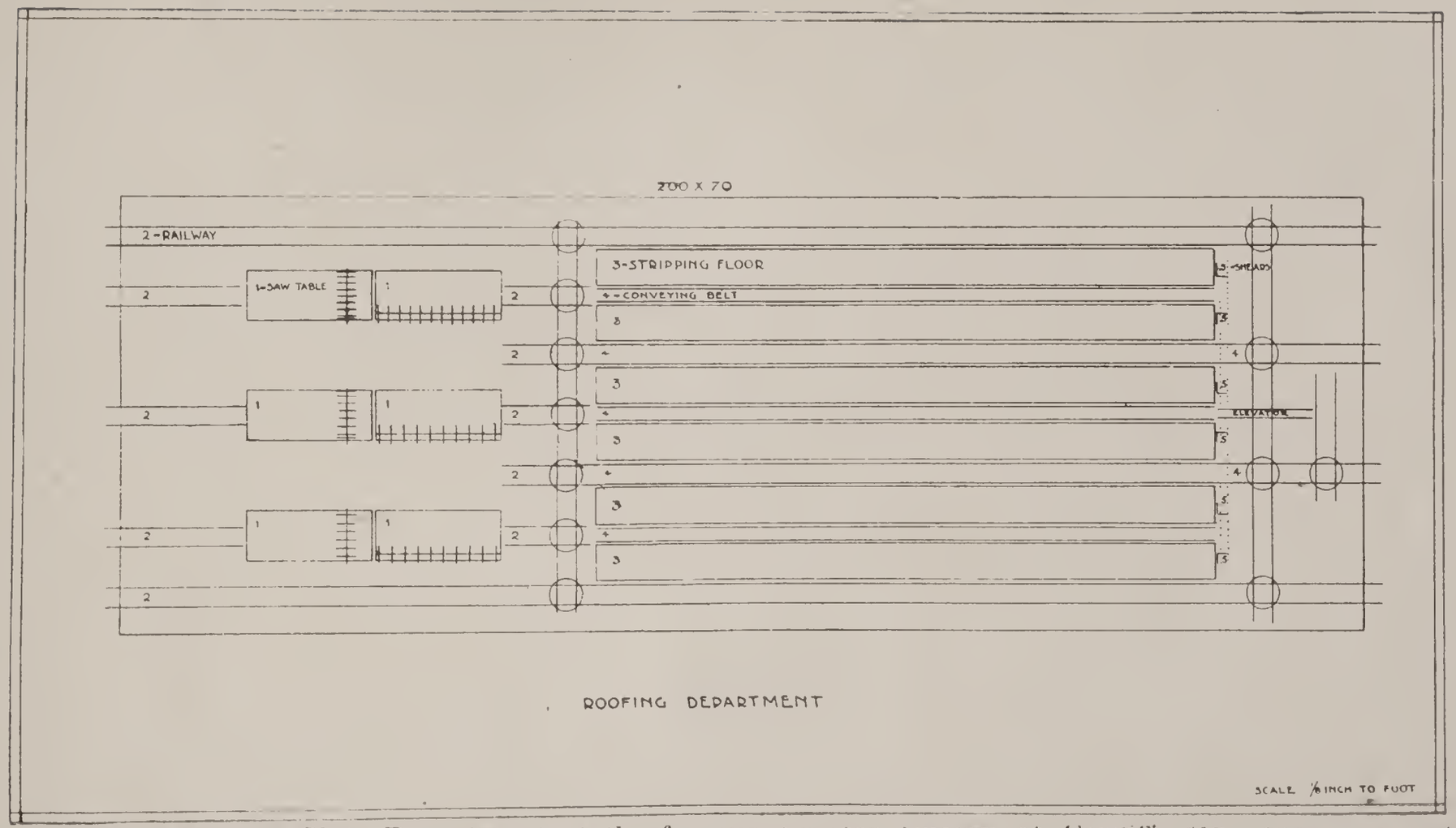
Again, the work of the trimmer is practically eliminated or done away with, for the blocks come to the splitter exactly the size desired. The trimmer is useful now only for the purpose of cutting down the slates to a smaller size where some flaw makes it unwise to use it the size originally cut by the saws.

Next to the Roofing Department, the site for the building devoted to the manufacture of structural slate is designed. This building will also have a steel frame, slate side walls and roof. The railroad tracks pass through the centre of the building and on either side of it are arranged large and small saw tables, a gig saw, planers and a rubbing or polishing table, together with ample storage and assembling space. This department is entirely new on Peach Bottom ridge and is designed to fill orders for various sized slabs used in structural or building work. Much of the slate that cannot be split to advantage for roofing use, owing to occasional faults, is excellent for this purpose instead of throwing it away as waste, such as has been done in the past. These blocks or slabs are useful for any purpose for which marble, granite or sandstone are utilized in the building trades, for mill uses, flagging, etc.

Northeast of the structural department is the storage yard, arranged with alternating railways and elevated runways for the movable crane which carries the immense buckets of finished slate to the yards where they are stored until such time as they are shipped to the markets of the world.

The several points in the manufacturing plant are all connected by railway and crane runs, while from the storage yards is an overhead tram to the freight siding of the M. & P. Railroad 3,400 feet away.

In the pit is placed the big steam shovel which has been used to level off the roads on the Proctor properties, and which now is utilized to clear away the debris and loose shale which is hoisted up in buckets, dumped in cars and carried to the dumping grounds. Each steel wire cable stretched

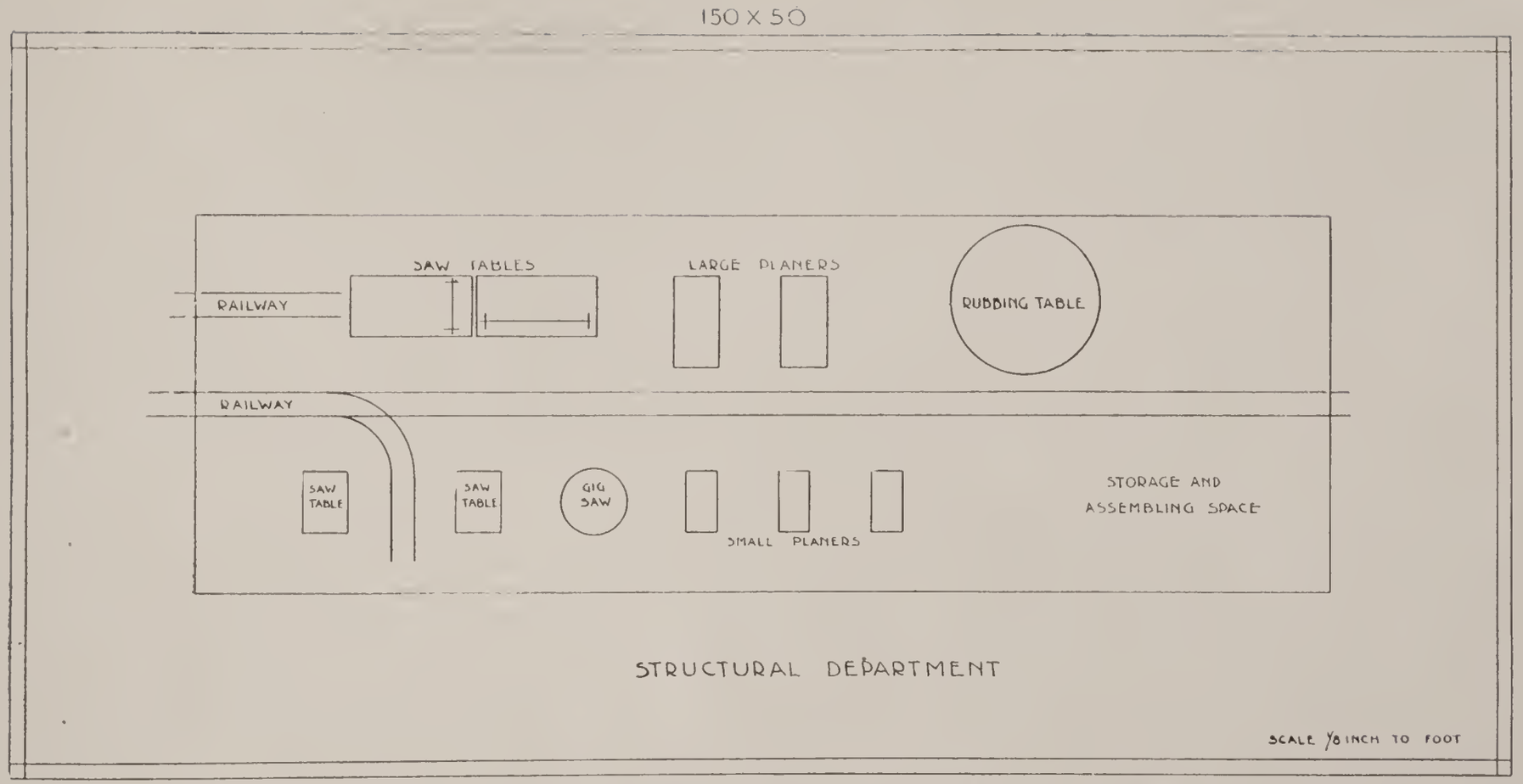


Plan of Roofing Slate Department at the famous Proctor Quarry at Cardiff, Md., the only slate quarry in the world where up-to-the-minute machinery is being installed. The Engineer's drawing shows the saws tables for gang saws, the stripping floor, the conveying belts and railway tracks.

across the quarry is operated and controlled as a unit from the small hoisting houses to the north of the pit and which as the quarry is enlarged will be moved back, with slight expense.

Throughout the plant electricity plays its part, and for the sake of economy, each individual machine is an electric unit and can be operated if necessary, while the remainder of the plant is still, thus obtaining the greatest efficiency with the least possible expense.

Another contemplated improvement in the methods of working the old Proctor quarry, which will be installed as soon as the before mentioned machinery is working smoothly, is a series of saws that will cut away the slate in the quarries in huge galleries, thereby doing away with the present method of blasting the slate with dynamite, and which in itself wastes a percentage of good material. Expert engineers have computed that the saving of material and labor with the proposed equipment working satisfactorily will be about sixty-five per cent. of the gross; leaving an actual gross loss for waste of less than ten per cent. on the amount of slate taken from the quarry.



House designed for the structural department at the Proctor Slate Quarry at Cardiff, Md. The equipment of specially designed machinery here includes large and small saw tables, gig saw, large and small planers and rubbing or polishing table together with ample space for storage and assembling.

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