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MINE MAP CONSTRUCTION.

CLAUDE V. MARTIN.

Mr. President and Members of the Ohio Institute of Mining Engineers:

GENTLEMEN:—When the writing of this paper was undertaken the intention was to treat of mine maps in general, a broad and interesting subject that would require no little time and space to do it even meagre justice

In the meantime some trifling incidents convinced me that were the subject matter of the paper to be confined to the elements of mine map construction, it would be of more practical value.

With this in mind, in the following notes, only such requirements as may be applicable to mine map work in Ohio have been dealt with. These notes are not intended to take the place of a treatise by a college professor or as supplemental to any of the publications covering the many branches of the draftsman's art. They are not expected to interest the expert, but to aid the inexperienced. Should they prove to be but one more step towards uniformity in the methods of mine mapping in this State, this paper will have fulfilled its mission.

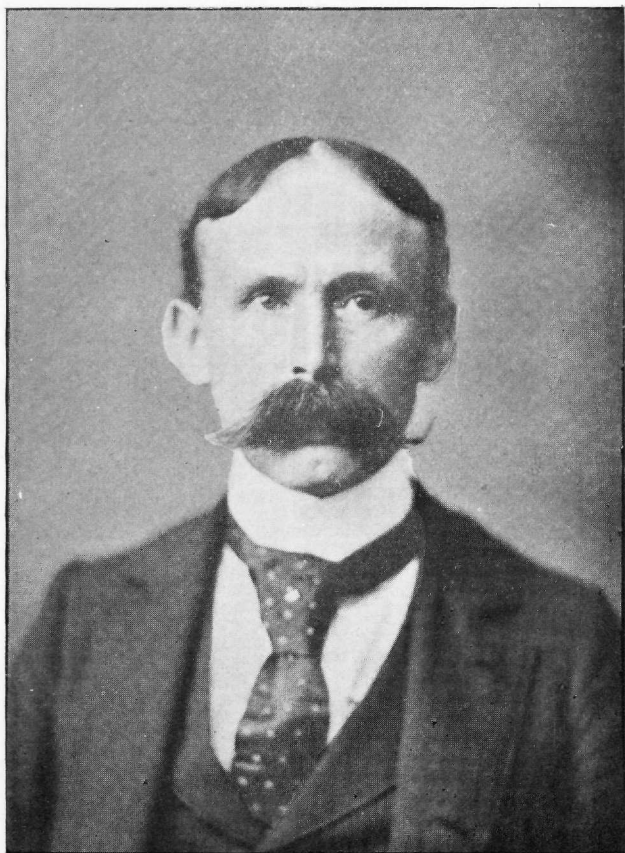
If, in the reading of these lines, the *oughts* and the *shoulds* may appear a trifle too didactic, it might be kindly kept in mind, that merely the writer's opinion is expressed—simply a fault or necessity of style being involved, not an expression of egotism.

DATA ON MAP.

Many engineers are prejudiced against all lines or references that may tend to fill up the spaces between the outlines of the excavations of workings as shown on the finished map. Nevertheless the only true gauge, as to just how much or how little, of the elements treated of in this paper, should be employed in the map service, must depend upon the common sense and ability of the engineer and the skill of his draftsman.

TOPICAL LIST.

Hon. R. M. Haseltine, Chief Inspector of Mines, who has so long and ably acted as the moving spirit of your organization,



C. V. MARTIN.

has issued for ready reference, to aid in compliance with the law, an exhaustive topical list of all the essentials of a practical mine map. This list is, or ought to be, in the hands of every one having anything to do with mine surveying or mapping—hence need not be repeated here.

REFERENCE MAPS.

In all parts of Ohio fairly good township maps are readily accessible.

When the township map is not well up to date, it is best to examine the decennial plats in the County Auditor's office, and their accompanying transfer notes, to obtain the property lines, or deed reference, as they should be drawn at the time of making the map. When not depending on a section corner reference should always be had to the auditor's entries.

THE SCALE.

In these troubled days of an enforced economy, where the workings are comparatively small and confined to a single vein, instead of two maps, the one a surface survey, the other the detail of the workings, but one, combining the features of both, is considered sufficient. It is well then that the map should be upon as large a scale as practical.

The law gives a minimum of 200 feet to the inch. Except for a general view of only the largest and well-planned workings so small a scale is rarely satisfactory. Particularly unsuitable is a small scale when the mines are old and the workings irregularly developed.

Fifty feet to the inch has been found to be a good scale for reference maps. Of course in the case of workings where the mining has been careless or very irregular, leaving large bodies of the coal or ore more or less inaccessible, the roof bad and unlooked for falls in evidence, even a larger scale is desirable.

Not merely the area to be mined or the surface property lines, within which that area lies, should control the extent of the map. The field of the map should be large enough to show, when possible, such parts of all other workings as may run nearly up to or past the boundaries of the tract in question.

MATERIAL.

Two heavy linen-backed drawing papers have proved themselves to be excellent for unusually hard map service; viz., Keuffel & Esser's "Paragon" drawing paper, No. 52 $\frac{1}{2}$, mounted, in rolls of 10 yards, 58 inches wide; Queen & Co.'s (I suppose their

successors still furnish it) "I. X. L." drawing paper, mounted, in rolls of 10 yards, 42, 54 and 58 inches wide.

TIN TUBES.

The original drawings should never be folded. When put away they should be rolled, not too closely, and kept in tin tubes, tightly capped, cases of about three inches diameter, for protection from dog-ear, creasing, blurring, dampness and dirt. A good map when once accurately begun may be of practical use, as a working drawing, for many years. The older a map is the greater ought to be its value, especially in the case of short leases and the too early robbery of ribs in pillar and room work, or abandonment owing to accident.

BORDER.

The border should consist of but two straight lines enclosing the map in a plain rectangle. The outer or mat line should be the heavier, the inner or neat line being thin but not too fine. The space between the mat and neat lines should be from one-third to two-thirds the thickness of the mat line. In maps over two feet and under four feet in width the mat line should be at least one-tenth of an inch thick. Ornamental corners should be avoided and care taken that the mat line, at least, should be drawn true on the sides, top and bottom with the north, south, east and west lines. The mat line when truly drawn is often of practical value for methods of map work of which the limits of this paper do not permit mention.

MARGIN AND BINDING.

At least three inches ought to be allowed for a margin between the mat line and the edge of the paper for maps of the dimensions given above.

After the map has been inked in the edge of the paper should be bound with a broad, thin linen braid. This braid ought to be securely glued to the linen backing as well as to the paper side of the edge. As an additional security, in some instances, after gluing, the binding has been stitched on with the sewing machine, care being taken that the stitches are not too short or the tension too tight.

THUMB-TACKS AND WEIGHTS.

Even the binding on the edge of a map should never receive the slightest puncture. Thumb-tack holes are an abomination and but the entering wedge of a map's destruction.

Long, flat, heavy lead weights neatly covered with thick canton flannel will more than take the place of thumb-tacks. These weights should never exceed an inch in height, lest they should interfere with the swinging of the beam compass. A horn-center ought always to protect a frequently used point.

DRAWING IN.

A trial draft of the essential property lines, as before mentioned, and a skeleton outline of the terminals of the workings as obtained by following the thread of the main and butt entries may be lightly sketched in. From these pencilled lines and outlines the best locations for the map title and its accompanying legend of conventional signs can be determined. These roughly marked off. In another space adjacent to the border and preferably near the bottom locate the compass point, which in the case of a large map should also serve as a protractor center. In a small map, in lieu of well drawn compass points, it is well enough to draw a single thread-line arrow for a north point, with a lighter opposed half arrow, crossing its center, for the magnetic variation. The variation should not be omitted from any map showing surface lines any more than the date.

In as far as possible use the conventional signs and methods of the U. S. Geological Survey for the surface features. In almost any large library, volumes containing samples of these cartographic or map methods, may be found for reference.

INKING IN.

The property lines and other surface features having been carefully redrawn in position, in the space allotted, this date, being permanent, should then be inked in with waterproof colors—Higgin's are as good as any.

COLORS AND MARKING.

Where part of the workings lie below drainage, ponds, rivulets, streams and other bodies of water, should be shown in blue.

Where the surface is much cut up, and elevations are widely varying in comparatively short distances, the contours should not be more than ten (vertical) feet apart. At every fifty from the datum the lines ought to be triple thick. Contour lines are shown in green with good effect. They should be drawn finely and, in most cases, all of them omitted, except the "fifty-lines," over the spaces occupied by the workings.

Two parallel lines will do for the curves of the out-crops. The lower of the two being the thicker. This will serve better

than tinting or hatch-lines over large portions of the surface, particularly where but one map has to show so much. For these lines a dark slate grey or light vandyke brown are good colors.

Wagon roads may be shown in light red, dish brown or burnt sienna.

Railways, trestles, buildings, slope or shaft, drift-openings, etc., are best in black.

Well established points, in line with the main entry, should be shown in their relation to the nearest land-line intersections, both as to distance and direction, by finely dotted lines and arcs in red, with the feet and angles written in black. Also verifications of inside work by surface tie-lines to adit, air-way or furnace points should be similarly indicated. The figures for these tie-lines and angles should never be written in over the outlines of the workings. If these lines do not extend far enough beyond the workings their distances and angles may be referenced, by letters, to a column of notes somewhere near the neat line of the map.

Lines of instrument observation in the underground work should be fine, continuous and in red. Deflection points, and sometimes other set-up plugs, on these lines should be marked by a tiny black circle or dot.

In wet workings, should no profile be shown with the map, finely dotted blue lines, with arrows, may indicate the direction of the drainage from the different parts of the workings to the sumps. Siphon tubes or pumpage pipes can be shown by two fine parallel blue lines. Sumps may be marked by a small blue square, shaded, and pumping stations by a circle filled with a cross mark, both in blue.

Where parts of the workings vary greatly in height, owing to altered thickness of the vein, the height of room or entry should be expressed on the map, at the principal points of change, by figures in a small red circle. And where the roof has had to be brought down, as a precautionary measure or has been channeled out of necessity in entry work, this additional height, over the thickness of the coal or ore, might be expressed in figures placed upon a short red line resting on the circle described in the preceding sentence.

Noteworthy declivities in the entries and rooms ought to be indicated by slope or grade points. These points being marked by an italic *G* in red, and the percentage stated plus or minus with the distance, midway between grade points.

Furnace points may be shown by a small red square as well as lettered.

Passage-doors, brattices and fans should be shown in black, and lettered. Ventilation currents can be indicated by finely dotted black lines with arrows.

Mine tracks are best shown by plain fine black lines, and rope haulage and air service by filled lines lettered also in black.

Electric light and power can be clearly marked in a bright, hard yellow.

Horse-backs and other wants are neatly shown by finely dotted sand stippling, and faults by narrow bands of reversed or worm-fence hatch-work, all in black.

Rooms, used for access to other parts of the workings and in which the posts remain, may be marked with small black crosses.

OFFSETS.

It is taken for granted that no one will attempt to make a map from the notes of a mine survey that did not give offset measurements with sufficient frequency to accurately outline the entries and rooms, locate the break throughs, giving the thickness and shape of ribs and pillars and limits of falls.

TINTING.

Some engineers prefer to tint all excavations of the workings at the very outset. Others seem to have attained to somewhat better results by leaving all the entries, rooms, airways, etc., covered by the first survey, in white. Then as in following years the excavations were increased, by adding other shaded tints, to the original gray of the solid part, within the new outline of the workings, the annual progress could be seen at a glance. When this is done, foot-notes, with figures and blocks of the tints should state the approximate tonnage.

FALLS.

If the falls are tinted in with a buff color, the unmined coal or ore having been tinted in drab after the earlier survey, the shut-in masses will be very clearly shown in case of bad mining.

TINT TONES.

This tinting must not be thick color work, but the lightest wash tones that can be clearly and quickly distinguished by lamp-light and gas as well as daylight. The tints should be such as can be neatly worked in with a small fine-edged sky-brush and should be erasable. For this purpose Windsor and Newton's

moist water colors are about the best. As the excavation notes are added to from year to year, and the spaces cleared are given successively contrasting tints, even with the greatest care some of these will be blotchy, inharmonious with the rest of the work or too opaque by reason of overlying the original drab. If, by a test, on another sheet, of the tints to be used, this is proved to be the case, carefully erase the drab and apply the new tint qualified by just the slightest admixture of blue. There is no danger of blurring if the surface of the paper, after erasure, has been carefully smoothed down with a common agate point, or some rounded and polished steel tool.

FIGURES.

Numerals must strictly agree in size, outline, shading and slant, with the style of the letters with which they are grouped or placed in harmony.

Poorly executed figures often destroy the good effect of an otherwise excellent map.

LETTERING.

To speak of the lettering and the title brings us to the most abused, and thoroughly neglected, but very important features of mine maps. Really good taste in the determination of the sizes and styles of the lettering, distribution of names and composition of the title, is not easy of attainment. The best usage requires us to avoid in all the principal lettering any except the very plainest, clearest and neatest vertical Roman capitals, for the various larger sizes necessarily employed. The smaller lettering, on the field of the map, should be uniformly confined to a few different sizes of very plain lower-case italic stump letters, with only such capitals as would be required in ordinary writing.

NAMES.

The distribution of names on mine maps is a serious matter. In no case where it can be avoided should any lettering, that does not directly refer to some essential detail of the mine or its inside survey, cover any part of the map occupied by the drawing of the workings, or likely to fall within such area as the workings are developed.

Unlike most maps, the mine map, in its incipiency is but the beginning of a future record. The most successful beginning of such a map, is the one that leaves the clearest field for thoroughly intelligible additions, as time may require them, and, at the same time, gives all the information at present in hand.

It is a good practice, for those who are not expert, to lay off the space to be covered on the map by the name or names desired on a trial sheet, and then by repeated spacing the size of the letters and the distances between them can be determined to the best advantage, when the result can be readily transferred to the drawing.

THE TITLE.

The title should serve two purposes; first, to give all essential information as to the subject of the map; second, to relieve the face of the map of lettering, which otherwise might obscure the drawing of the workings.

It is not necessary to begin the title with words "Map of" or "Map Showing." The man that does not know that a mine map is a map, when he sees it, has no earthly use for one.

As to the relative prominence of the various lines of the title, it may be suggested that, where one company or operator owns many mines, the name of such company or operator may be made the most prominent; and where but one mine is owned or operated the name of the mine be given the place of distinction.

ILLUSTRATION.

As an example of a plain title, for the map of a small working, let us construct the following:—

Let it be distributed in ten lines, including the scale, five of which are in heavy letters and five in a uniform size of small capitals.

In the first line, in the largest and heaviest capital letters are the words "Bland Mine":

In the second line, in very small capitals, about one-fourth the size of the first line, the words "in the":

In the third line, in capitals and lower-case letters, three-fourths the size of the first line, the words, "N. E. $\frac{1}{4}$ Sec. 16, Flint Tp., Spring Co., Ohio":

In the fourth line, the same size as the second line, the words, "owned by":

In the fifth line, in capitals a little smaller than the first line, the name "A. Weidman":

In the sixth line, the same size as the second line, the words, "operated by":

In the seventh line, in the same size as the fifth line, the name "Dillon Bros.":

In the eighth line, in the same size as the second line, the words, "workings in the ":

In the ninth line, in capitals and lower-case letters, two-thirds the size of the third line, the name, "No. 8, or Pittsburgh Vein":

In the tenth line, about one-fourth less than the size of the second line, but in the same style only a little lighter, the word, "Scale".

Between the ninth and tenth lines space enough should be allowed for a plain, thin line, about an inch long, just to separate the title proper from the scale.

Beneath the word "Scale" the conventional rule must be drawn. This rule should be three-fourths the thickness of the mat line. Often the scale is stated fractionally. When it is so stated, it should also be drawn as a rule.

Two letter-line spaces below the rule, place a note in italic stump letters, as follows:

*"Surveyed, Jan. 20th-23rd, '96,
by Thos. Hardy, M. E."*

A letter-line space below this note is the place for the certificate, in the same style of lettering as the note:

*"Birdseye, O., Feb. 20th, '96.
Survey, as above, and this map, are correct, to date.
Thos. Hardy, M. E.,
John Jones, Mine Boss."*

The signatures are of course auptograph, free-hand.

ADDITIONAL TITLE NOTES.

When the map is one of an important working plenty of space should be reserved below the first certificate, for a number of annual entries as to other surveys, with their certificates, requiring additions to or changes of the details of the map.

CENTERING TITLE LINES.

Those who have not had much practice with titles, should not only take the most conservative printed titles as a guide, but, after they have determined upon the relative sizes of the lines of the title, in the order of their prominence and proper sequence, should lay them off on separate slips of paper, completing each line by itself. This can be done in this way, in the natural succession of letters and words with but little effort. These lines may then be centered and the strips, properly spaced apart, be laid upon the center line of the title and the principal pointings

of the letters pricked through. This must be done carefully, and will be found to be a great labor saving expedient.

TITLE LETTERS.

Anyone, having a little more than the ordinary time and skill to devote to the title, might notice that the best usage is to carry the pointed capital letters, A, C, G, and S, just a little above the top of the flange-line or square letters. O and Q are similarly treated.

It is also customary in spacing apart the letters in lines of large, heavy capitals to leave only the smallest spaces on either side of any of the following letters—A, F, J, L, P, T, V, W and Y. Sometimes it is best to bring non-conflicting parts of the more unequal letters slightly into each other's rectangular space, to more nearly equalize the effect of black and white in the entire line.

THE LEGEND.

Special care should be taken that the explanatory column of signs, under the heading "Legend", should be so complete and clear that the meaning of any mark, color or tint upon the map can be seen at a glance.

The items of the legend should be lettered in italic stump letters, of the same size as those used for the notes below the title, with capitals and lower-case letters as in ordinary writing. For all other notes near the neat line of the map, a smaller size of italic stump letters should be used.

WHERE TWO OR MORE LEVELS ARE WORKED.

In a number of instances where two or more levels have been worked, from the same shaft or slope, engineers have shown in their display drawings the developments on the different levels projected upon the same plane of draft. Even when no tints are employed and different colors are used to distinguish the outlines, the result is very rarely a happy one. Maps of this sort are generally more curious than practical.

As a rule, where the area covered is too great to show the different levels satisfactorily in separate plats upon a single sheet, it seems better to use a sheet for each, taking care that identifying points of shaft or slope reference appear in each.

TRACINGS.

The law requires a copy of the map of every mine, worth mapping, to be on file with the State Inspector of Mines at

Columbus. The original map should never be out of the possession of the owners, operators or their mining engineers. The best of blue-prints and nigrosines are often unsatisfactory, so we ought to prepare vellum tracings for file copies.

Imperial dull-back tracing cloth is the best to use. The dull surface of the vellum should be placed next the surface of the map to be traced, and all the clear lines inked in, in their proper colors, on the bright or glazed surface.

WATERPROOF INKS.

The use of waterproof inks should be avoided, as, in cold weather, the vellum does not take them well; and, in warm weather, in drawing the finer lines, the minute fragments of greasy matter, caught by the pen, prevent the ink from feeding evenly, so that it often dries quite hard in the pen before it reaches the cloth.

ERASURES.

One of the greatest annoyances, and one that frequently occurs where there is a great deal of line drawing on a tracing, is the necessity of erasures at conspicuous points. Many a tracing, upon which much good work has been done, has been cast aside because, at the last moment, the unfortunate draftsman, in the process of erasing, as usual, with a knife edge, has "gone through" the cloth.

The best method of erasing on vellum is as follows: Procure at any drug store, for a dime, a few ounces of finely powdered pumice stone. Sharpen the end of a common pine match until it presents the appearance of a flat toothpick, the ordinary toothpick being too hard for the purpose. Then apply just enough of the pumice to the vellum to cover the lines to be erased, and rub the pumice on the surface patiently and carefully with the edge of the match.

Lines erased in this manner can be re-inked or drawn across without the erasure being noticeable. It will rarely be necessary to even apply a touch of paraffine to such erasures. The Engineering News is said to have been the first to publish the method given above.

TINTING.

All the tinting should be done, in rather dry brush-work, on the back or dull side of the cloth. Moist water colors ought to be used. Aniline, or almost any other clear and hard colors,

cannot be erased or taken up with a wet brush without giving "crackle" to the vellum.

PROFILES.

Many mines run so evenly with the plane of the vein, in their localities, that a sectional or profile view of the workings would be devoid of interest. Still there are mines in this State from which could be obtained very interesting profiles, showing the relation by level of the different parts of the workings. Had we enough of such profile references, particularly where the veins are more than ordinarily undulating in the planes of their dip, some facts of value might be developed, to say nothing of the interest of such figures with reference to future estimates.

The day may come when it shall be necessary to show at the bottom of every mine map, if not a complete profile of the workings, at least two transverse sections, or profiles, the lines of which shall be indicated on the map above by dotted lines and lettered references.

This paper was listened to with closest attention throughout and heartily applauded at the finish.

SECRETARY HASELTINE: Mr. President, I want to tender my profound thanks to Mr. Martin for that paper. I have given the subject of mine mapping a good deal of thought for many years, during last year especially, and I had promised to talk to Professor Ray's class on that subject; but I recall my promise, since hearing Mr. Martin's paper, on account of inability to do the subject justice. The subject is one which requires more than passing notice.

Since I have been in charge of the Mining Department, I have been limited in amount of help and the matter of annually filing extended maps of the mines of the State has been absolutely impossible. I assigned the duty of seeing to the proper mapping of the mines to the district inspectors and we have done as well as possible under the circumstances. I have known engineers who did not look upon map-making with as critical an eye as Mr. Martin does, who have sent in some sadly inefficient maps. In other instances I have inquired of the manager of a mine if he had a map and he has assured me that it was in the office in the city, or the engineers had it extending it, or

something of the kind, and I have taken his statement as truthful, when subsequent events have shown that there was no map in existence.

Some mine fires and other accidents during the last year or two have developed the importance of accurate maps which may be relied upon. So I have induced the Governor to allow me to employ a little extra help and I am undertaking the matter in earnest. I have been at it at least a year and am only beginning. I am sorry for Mr. Martin's sake that I did not bring over my envelope of curios. I have maps there which I would give a man a suit of clothes to tell me where they belong. They would fit the State House grounds as well as anywhere. Whether they belong in the United States or Europe, no man can tell. Unfortunately, in some cases, I have destroyed the envelopes, and all traces of the postmark, even, are gone. I have been surprised to see copies of maps come into the office from large operators who are supposed to be up-to-date, the omissions in which are unpardonable. So, I have prepared a schedule of what a map should embody, embracing about half as many subjects as Mr. Martin has included in his paper, and I have sent copies all over the State. It has been criticised as requiring too much red tape, as being too technical and exacting, and all kinds of unkind remarks have been made in regard to it. But it has stirred up the State and many people have sent in to have their maps returned for correction, and operators have found they have paid large amounts of money to engineers to have maps made which are of no account, the essential things being left out. I have now perhaps fifty or seventy-five in the drawer to examine.

One objection engineers make, is to making a sworn statement that the map is correct. If the map is not absolutely correct, it is not worth anything; and a man who cannot make a map which he is willing to swear is correct, should be barred from practice.

Not long ago in Mine 11 at New Straitsville there was a fire. They had a blue print made by the Columbus, Hocking Coal & Iron Company's engineers. It was ascertained that the fire was

approaching a portion of the mine known by the miners as the "woods", owing to the vast amount of timber in it; and if the fire got into that it was almost a foregone conclusion that the mine would be lost and it would let down the city of Straitsville. But by carrying air to a certain breakthrough, if it existed as shown on the map, a stopping could be put in to prevent the fire from going to the woods. If it proved not to be located, as shown on the map, the case was almost hopeless. It proved that the map in that little detail was absolutely correct and they were able to put up a stoppage at that point and saved the mine. It is some weeks since the fire has shown any signs of life. This shows the importance of correctness of detail, and the map should be made to such a scale that it is possible to delineate these openings so they can be readily observed and located. It is true that where syndicates own thousands of acres of land, it would be impossible to make a map to a suitable scale to embrace that. In that case it could be done in sections, half or quarter, and folded together.

As Mr. Martin went over all the various features in his description of the work, I was impressed with the careful study he had evidently given the subject. I do not think I ever heard a paper more complete as to the minutiae of the work in my life, and if it was not too long I would have it printed and sent out as an official document by which to make maps. I desire again to thank Mr. Martin.

PRESIDENT RAY: I wish to add to Secretary Haseltine's remarks that I, too, was very much interested in the paper. We have many good and many poor maps, as I learned by viewing the collection in the Chief's office. Some are made to one scale and some another, and I think if we could agree on some uniform system and scale for making mine maps, in time we would have a great collection of valuable information which could be utilized in making a complete map of any one district of the coal field. It seems to me we need more uniformity in our maps. This paper is in that direction, and I would like to hear it discussed further. The subject of mine maps is sort of a hobby with me,

having worked at making them for ten years, and I would like to hear from the "pioneer" on the subject,—Mr. Jennings.

MR. JENNINGS: I have nothing to say. The paper speaks for itself.

MR. PRICE: I do not want to say anything on such an elaborate paper: it speaks for itself. It is a fine production. I have been at the business some thirty-six years, surveying and mapping mines. My efforts were not very extensive in the start, and I made quite a rude map. There is a rude map in the Mine Inspector's office which I made twenty-five or thirty years ago. Since that time I have sent another map, and there is quite a marked difference between the two. I am thoroughly pleased with this paper.

MR. E. D. HASELTINE: Mr. Martin has given us a description of a most beautiful map. In my own practice I have discarded the use of egg-shell paper, because I became disgusted with their appearance when returned to me for extensions. The coal mine boss handles it with greasy hands and with a number two lead-pencil indicates on the map the extensions, and when it comes back to me it is a dirty thing, with the corners broken, etc. I am making only tracings and blue prints. I make a rough drawing map, from which I make tracings and from that blue prints, one for the mine boss, one for the company and one for the interested property owners. This method has the objection that it is impossible to do coloring, which adds so much to a map. In this way I have the tracing always in my office, where it is kept clean and I like it better than the egg-shell map. But if you have an eye for color and can keep them clean you can make a better map, better in detail, and more beautiful, on egg-shell paper, as described by Mr. Martin.

Mr. Love moved that the Institute express a vote of thanks to Mr. Martin for his very valuable paper.

Motion seconded; unanimously carried.

PRESIDENT RAY: The next paper is one prepared by Mr. Wm. Clifford, M. E., of Pittsburgh, Pa., and as the author is not present, it will be read by Mr. Lewis.

