ART. V.—SOME REMARKS ON THE METALLIFEROUS VEINS OF THE SOUTH.—BY OSCAR M. LIEBER, ASSISTANT GEOLOGIST TO THE STATE OF ALABAMA.

IT is deeply to be regretted, that in our country so little attention has been paid to what might be termed the comparative anatomy of veins—a careful investigation and comparison of the various characteristics of veins and groups of veins, a subject in which Professor Cotta, of Freiberg, has made himself so justly celebrated. The practical importance of these observations will alone render them worthy of prosecution. American mining is, however, in so incipient a stage of development, that it is but natural that these matters should as yet receive little attention. Still, when we perceive such clever articles, as one in this Magazine, on the "Mining in Wall-street," pointing towards a prospective advance in mining, it may not be improper to call attention to so important a topic as vein geology. Under this impression, at least, I venture to offer a few observations on the subject, and to present the conclusions to which they appear to conduct us. It should, nevertheless, be recollected, that the writer is guided rather by the desire to excite in others a similar interest to that which he himself feels, and to assist in the development of this important branch of the geology of his portion of the country, than by the arrogant wish of seeking to propound theories, which shall be incontrovertible.

Cotta makes the true remark, that geology is a science, based upon facts solely, and that theories can be admissible only so long as they explain the facts observed. The moment that these disagree with the theories, the latter must be abandoned. This we must always recollect, and likewise should we remember, that the simplest explanation will ever possess an advantage over the more elaborate hypotheses.

The immediate topic upon which it is proposed to dwell somewhat in these remarks, refers to a certain class of metalliferous veins in the South, and my object is to point out its leading features.

At the time when I first entered upon the duties assigned me in the geological survey of Alabama (in the fall of 1854), the copper excitement was at its greatest height. Peculiarities of the surface rocks and minerals, which presented some similarity with those in the neighborhood of the mines of Ducktown, in Tennessee, induced an active search for copper. The singular dissemination of this metal throughout the western portion of the metamorphic rocks of Alabama, although occurring in minute quantity only, acted as a strong incentive. At the time, it occurred to me, that it would be highly probable that, if copper should really be found in available quantities, its occurrence would differ from the exceptional case of Ducktown, and that quartz true veins should be sought for. For a long time the search proved unsuccessful, and only latterly has it been my good fortune to meet with those possessing cupriferous contents. The locality to which I allude is at Dr. Ulrich's vineyard, in Tallapoosa County, some nine miles south-west of Goldville. The veins at this spot had been originally worked for gold, though without success, as the richest ore was worth only from 10 to 12 cents per bushel. Ga-

lena was also found, and this led to the belief, that argentiferous ores might appear at a greater depth. After a considerable expenditure of money, the mining operations were, however, abandoned. Lately, while blasting out a cellar at the junction of the gneiss (the chief country rock) and the talcose slate, a number of small quartzose veins were discovered, which were found to contain copper pyrites in very considerable quantity, when we reflect that a depth of only twelve to eighteen feet from the surface had been reached, and that the veins are very small. The veins north of this point are evidently dipping towards it, showing that, in all probability, the main lode will finally descend between the two distinct country rocks. Malachite and other minerals, resulting from the decomposition of the pyritiferous copper ores, are almost entirely wanting, a fact which proves that the copper never extended much above its present level in the veins.

At an old gold pit, about four miles north-east of this place, a considerable amount of galena was found, disseminated in minute particles throughout the quartzose gangue. The mine was abandoned, on account of the lode entering a more solid country, and the gold diminishing in quantity. Copper was not found, that I am aware of. This may have been owing to the fact, that a sufficient depth was not attained.

Basing the conclusions upon the theory of Professor Cotta, that the contents of a large and important class of metalliferous lodes were derived from solutions, which leached the materials from igneous rocks beneath—(see the translation of his article in the October, November and December numbers of 1851 of this Magazine)—there is strong inducement to believe that these veins belong to an extensive group, which we find also in South and North Carolina. It is, probably, also discernible in Georgia, but there I have had no means of collecting evidence.

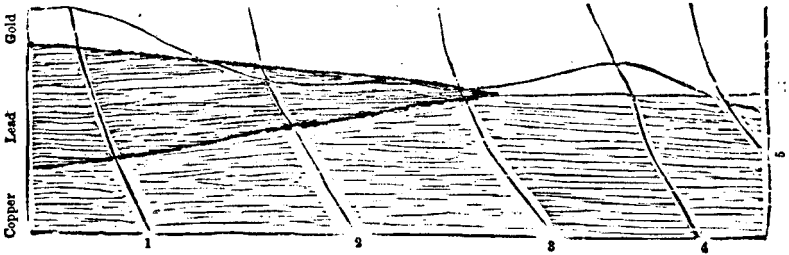
In South Carolina we have an instance in an old gold mine, in Chesterfield district, where galena and copper pyrites occur. At the time of my visit, the mine was in a very deplorable state of abandonment, and the works being all under water, the observations could extend only to surface evidences, and the examination of the heaps of ore and attle.

Another vein of this description is seen at the Morgan mine, in Spartenburg district, South Carolina, which has been described by Mr. Manross. In the Charleston *Mercury*, of the 6th February, 1855, an extract from his report is given, in which we read that the contents are, besides phosphate and carbonate of lead, galena, and lower in the vein, copper pyrites. Mr. Manross observes, that "the only change which can be perceived in the metallic contents of the vein in descending, is the greater abundance of copper ore." This alteration in the character of the contents was observable, although a depth of eighteen feet only had been attained.

It is impossible to mention all the veins of this class in North

Carolina, where, if not more numerous than elsewhere, at least more of the kind have been opened. Among them, we find the auriferous and cupriferous lode of the McCulloch mine, where, however, I have not heard that any galena or other plumbiferous ores have been met with, and the Vanderburg mine, which I examined with some care, in the course of last year (1854). The vein has not yet attained any very great size, but its geological features are of the utmost interest. It has been worked for gold, but, at a depth of from fifty to sixty feet, copper first presents itself, chiefly in the shape of the green and blue carbonates. Only when we descend to twenty or thirty feet below this point, do we meet with the undecomposed sulphurets of this metal, of which a variety are found. Galena, in small quantity only, has been discovered here, in conjunction with the copper.

In carrying out our investigations on this subject, we shall frequently have occasion to regret that in our country all mines are of such comparatively recent origin, and that, as yet, the depth attained in no instance admits of the correct and satisfactory establishment of a definite knowledge concerning the true and final character of metalliferous lodes. If European men of science can lament this fact with their mines, how much more occasion have we to deplore an ignorance on the subject! Confining our suppositions, therefore, to the little only with which we are definitely acquainted, we would come to the conclusion that we have an extensive group of veins in the Southern States, which present a very similar character in all cases belonging to that class, although local differences may be perceptible. There are certainly, also, other vein groups in the South widely differing in their characteristics from that before us. The features possessed by this group seem to be found chiefly in the disposal of the contents, of which gold appears uppermost, or nearest to the surface, lead central, and copper lowest, as far as we have been able to extend our experience. In few instances only do we meet with the whole complete succession; in some the lead may be wanting, and the copper follow immediately upon the gold, while in others the auriferous portion of the lode may have been removed by abrasion and decomposition. In the accompanying diagram, it has been my object to endeavor to offer an explanation of the local varieties which may present themselves, but which, with all their differences, only strengthen the belief in the similar general character of the veins, and in the probability that they consequently belong to the same extensive group.



In this cut the black line indicates the outline of the surface, and shows the veins to be cut off above, at various levels.

In vein No. 1 we have an instance, in which the whole series of the metals is developed.

In No. 2 no gold is found, but the thickness of the lead is still considerable.

In No. 3 we find all the metals again, though but little gold and lead.

In No. 4 the gold rests immediately upon the copper, without any lead occurring between.

In No. 5 all portions of the vein, down to the copper, have been removed.

In so far as this suggestion appears to convey a full explanation of the various cases before us, it may not be unworthy of attention.

It might be asserted, as an argument against this theory, that we frequently find copper and lead ores amid the auriferous portion of the veins, and gold associated with galena and copper pyrites. A second thought will, however, scarcely admit this as a refutation. In the diagram, the object has been to explain grand effects, and not to deal with trivial matters, which refer only to hand specimens, and exert no power upon the main character of the lodes. Even as local and unimportant occurrences, indeed, nothing can be adduced from these, which can offer an objection to the theory, even if we except the translocation of metallic bodies, by galvanic action, since the filling up of the lodes.

Let us take for granted, then, for the moment, that really the series of metals is that exhibited in the cut. We suppose them, according to Professor Cotta's theory, to have been deposited not only in harmony with laws which govern their various degrees of solubility, but in accordance with the changing contents of the solutions, owing to the fact that they may have been supplied from different or changing sources, and the varying temperature of the upper portions of the country, as well as the general difference of this from that of the solutions. Here already we find a full explanation of the local differences of the position of minerals, which really seem remarkably exceptional. The mother liquid, whose duty it was to fill the crevices in the country rock, may, for instance, after depositing lead and copper, have received a fresh supply of gold, and hence the gold in the ores of the former, or, after copper had been precipitated, lead may have been introduced into the solution, and consequently we find galena among the sulphurets of copper. Nor is it unreasonable to suppose that a liquid which, at a high temperature, and subjected to immense pressure, could hold in suspension all the ingredients of a lode, and which, when one or both of these conditions were partially removed, deposited a certain mineral, according to its degree of solubility—still possessed the power to retain certain

smaller quantities of the same substance, which were thrown down at a subsequent period, when the attending circumstances had rendered the solvent unable to exert its former powers. The intense heat and powerful pressure which were required to produce these results, are unfortunately beyond our power of control and reproduction, and, therefore, we can scarcely ever hope to attain satisfactory results in the laboratory. Still we must believe that, if future developments prove this theory to be correct, those portions of the country rocks which are connected with the parts of the lodes now known to us, must, at the date of the precipitation of the contents of the vein, have possessed a temperature approximating to that of the solution. In this we find an explanation of the apparent horizontal distribution of the contents of the veins. This is, however, only the case on a grand scale; for, as usual, so also here, do we perceive signs of an irregularly vertical position having been adopted by the individual constituents of every portion of the vein, and the minerals all assume their respective positions with regard to the axis and selvages of the lode.

The gangue rock of this group is a ferruginous quartz, usually of a yellow or pink color. In some parts it is very porous, or rather cellular in its structure, owing to the decomposition of various pyrites. The upper portion is frequently friable; lower down it is more compact. The auriferous portion commonly contains hydrated peroxide of iron, derived from the decomposition of iron pyrites, and often retaining the crystalline form of the latter. In the cupriferous portion chiefly do we find spathose minerals and arsenical pyrites, and undecomposed iron pyrites abound here also.

The strike seems almost always to be N.E., but at various angles. The Vanderburg lode, however, strikes N.W. The dip is usually to the S.E., and very steep. The Vanderburg is an exception, and dips S.W. Their linear extent on the surface is, of course, very variable, as is also their thickness.

The country rocks in which we find these veins, differ widely from one another. Thus Mr. Manross states that at the Morgan mine to be a micaceous slate, while at the Vanderburg it is dioritic slate, and at Dr. Ulrich's, chiefly gneiss. This fact is comparatively unimportant, for the vein crevices appear to have been formed subsequent to the deposition and consolidation of all the metamorphic rocks of the region; and though it is reasonable to suppose that one rock should be markedly less ruptured than another—for the varying degrees of hardness must have exerted some influence upon the force necessary for severing them, and, consequently, the veins will be either decreased or increased in number, or will expand or contract accordingly—still, this would have no effect upon the character of the contents, nor afford an objection to the veins in the various rocks being grouped together.

In offering this solution to the problem he has given himself, the writer feels considerable diffidence, since he possesses, after all, a knowledge of but very few cases. Attention, however, being thus called to the matter, others may, perhaps, feel themselves induced to take up the gauntlet, and prosecute these researches with greater effect. Among the number who might have done much to develope this portion of the geology of our country, we must deeply regret Mr. Ellory, whose energetic examination of the interesting mines of North Carolina was the cause of his early death.

Practical men in our country are much inclined to undervalue scientific research; yet, in this instance, it is to be hoped that they, too, will perceive the importance of a thorough investigation, for, if future observations prove these remarks to be correct, we should be possessed of no bad guide in the determination of the final character of those veins, which belong to this group, and, as usual, science would lend a helping hand to practical operations.

Art. VI.—HISTORY OF THE ENGLISH IRON TRADE SINCE 1830.*

At the close of the previous article, the subject of boiling pig iron was under consideration.

From the time of drawing a heat, it is ten or fifteen minutes before the puddler is again able to charge. Six heats of $3\frac{1}{4}$ cwt. may be worked in the twelve hours.

There is also a difference in wages.

Say for puddling refined metal . . .	8s.	per ton.
" boiling pig	10s.	"

The yield also is in favor of the refined metal, not only in the puddling, but likewise in the after process of heating and rolling.

On the subject of boiling pig-iron, our author thus remarks:—

Boiling pig-iron, although not so advantageous to the ironmaster, is nevertheless generally done where they have not the convenience of refineries; it was adopted with the idea of its being a cheaper mode of working, in saving coals, labor and yield; but this is met by the extra quantity of coals used in the puddling, bearing on a smaller make, besides which the wages are higher, and there is a greater waste in the more expensive process. Also, a greater expense is incurred in keeping the furnace in order, as the pig iron works hotter than the refined metal, and injures the bottom as well as the walls of the furnace.

In South Wales the boiling process has been very generally done away with, as it is not found to suit the general nature of the iron. The Staffordshire and Shropshire iron is, however, well suited for boiling, being of a strong-bodied nature, and there this method of working is still used to some extent,

* Continued from page 240, Vol. V.

sels, showing at the same time that such substitution would be productive of a considerable saving in the construction of all kinds of ships.

This, however, being an entirely new application of zinc, it could not be expected that the suggestion would be immediately acted upon. The public must be convinced first that zinc bolts could be used with the same facility, and possessed the same strength as copper or brass bolts.

In order to leave no doubt on those points, the Vieille Montagne Company have caused experiments to be made during 1852, in ten French seaports, publicly, and in the presence, in each, of a great number of owners and masters of vessels, merchants, scientific men and government functionaries. All these experiments were entirely satisfactory, and proved that zinc bars have all the strength, tenacity and malleability desirable for ship fastenings. Minute records were made of the different trials, signed by the parties present, and were printed in pamphlet form, which may be seen at the general agency office of the Company.

Let us add that the successful application of zinc bolts for fastenings is now no longer a problematical vagary, but an established fact, there being at present afloat a ship of the British navy, the *Albion*, a two-decker, of 90 guns, *entirely zinc fastened.*

It is proper here emphatically to repeat the remark already made with regard to the action of sea water upon yellow or Muntz metal:

"In every case in my experience," says Armstrong, "where it has been necessary to have bolts of that metal removed, I have found them broken asunder, or so brittle that the slightest force was sufficient to break them. From the appearance of the metal, its nature seemed to be quite changed, rather resembling broken earthenware than brass."

Sea water has no such destroying influence on pure zinc bolts, and the sooner the use of such a treacherous material as Muntz metal is abandoned, and that of zinc substituted, the better, as a matter of economy and safety for ships.

Constructing Ships entirely of Zinc.

There could be no more difficulty in building the hull of a vessel of zinc than building it of iron; on the contrary, its possession of all other requisite properties being established, it is evident that the greater malleability of zinc would facilitate the shaping, boring and riveting of the plates.

The attempt has already been made, and the result has realized the most sanguine expectations of the parties interested. The square rigged schooner *Comte Lehon*, built of zinc, was launched, in 1854, from M. Guibert's dockyard, at Nantes, and made a first and successful voyage to Rio de Janeiro, whence she sailed for Marseilles, and is now a regular trader.

The zinc plates used in this instance are of No. 8 wire gauge (corresponding to No. 30 zinc gauge); they overlay each other one inch, and are riveted with wrought zinc rivets, 1 1-4 inch apart.

A zinc vessel, while it is hardly inferior in strength to one of iron, has over the latter many advantages:

1. It will cause no deviation of the compass.
2. The plates not being liable to corrode or rust, do not require painting.
3. In ordinary cases of collision, while iron would in all probability crack or break, causing a leakage in the vessel, zinc would yield and bend without endangering the safety of the vessel and hands, or interrupting her course.
4. In the event of stranding near shore, and in a position and under circumstances allowing salvage, the zinc hull might be cut or sawed in pieces, having a real value, while the iron hull would be abandoned as worthless.