seen in the Chipola around Bainbridge, at Alum Bluff, nor along the Chipola River. The oyster so common in these clays was also found at Wiley's Landing and the Griffin localities, but not in the Chipola. For that reason I am still inclined to consider the Aspallaga clays as the top of the Chattahoochee series, at least, until further collecting shows an assemblage of true Chipola fossils in these clays. Other collectors may have already secured this desired additional material.

The writer is under special obligations to Mr. Dall and Stanley-Brown, for more precise determinations of the thickness of the various Chattahoochee beds, and to Prof. Raphael Pumpelly and Mr. Alfred Brooks for the opportunity to accompany them during their various trips down the river and elsewhere, which made it possible to collect the material for these notes and utilize many of their observations. His obligations to various publications need not be expressed in detail since these publications are too recent to require recalling to memory and are sufficiently indicated in the publications of Mr. Dall.

On the accompanying sketch map* the course of the Flint and Appalachicola Rivers has been represented in two sections. The Marianna region is mapped and introduced into a corner of the page, so as to show its relations to the Flint River section. All of the mapping being the result of traverse work is sure to have its faults, but being done with considerable care, is certain to be vastly superior to the ordinary maps which fall in the traveler's hands. The railroad east of the River Junction station is only approximately located, so that the position of the Steephead Limesink is not accurately determined, excepting as regards its location west of Faceville. For the Eocene a slope of 13 feet to the mile is assumed, for the Chattahoochee, one of 9 feet to the mile. The question of dip still awaits more detailed study. Localities starred are suitable for camping when traveling in skiffs.

ART. IX.—*On Gabbros in the Southwestern Adirondack Region;* by C. H. SMYTH, JR.

THE presence of large areas of anorthosite in the Adirondack region has long been known, although the igneous nature of the rocks has not been universally recognized. In a recent paper Professor J. F. Kemp† has described extensive developments of gabbro in the vicinity of Lake Champlain, which

* See page 42.

† Gabbros on the Western Shore of Lake Champlain, Bull. Geol. Soc. America, v, p. 213.

are connected with the anorthosites previously known. During the past summer the writer examined a group of related rocks, which, from their character, mode of occurrence and location, seem to merit description.

The locality is in the southwestern corner of Hamilton County, between the hamlet of Morehouseville and Wilmurt Lake, which lie about five miles apart on opposite sides of the valley of the West Canada Creek. The hills bordering the valley consist chiefly of two varieties of gneiss. One is a rather acid rock composed largely of quartz and orthoclase, with a peculiar spindle structure, giving to weathered surfaces the appearance of partially decayed wood. The second variety is of a brownish tint, which may be only superficial, and contains hornblende in some quantity. Its foliation is of the ordinary type and sometimes shows much crumpling. A third variety of gneiss, usually nearly black, coarse grained, often massive, and containing large lumps of garnet, is present in more limited amount. The relations subsisting between these gneisses have not as yet been determined.

The rocks with which the present paper is chiefly concerned are seen at several points between Wilmurt Lake and the creek below, the first outcrop being about a mile and a half down the road from the lake, and several others appearing at various points within the next mile. Then there is a break and no further outcrops appear till the village is reached. This break is doubtless simply the result of the covering of exposures by heavy stream deposits. The outcrops show a dark, fine grained rock, forming irregular patches in the gneiss, with the line of demarcation between the two very distinct. These patches often have a tendency toward rectangular outline, and may be nearly equilateral, or elongated into a dike-like form. Their extent is usually limited to a few yards or rods. The same rock occurs in what might be taken for an interbedded layer in the gneiss, some fifteen feet thick and dipping 10° south. At Morehouseville a coarser variety constitutes a knoll three or four acres in extent.

The true nature of the rock is best shown, so far as field relations are concerned, in the small patches. It is seen to be entirely different from the surrounding gneiss in composition and structure ; it cuts directly across the foliation of the gneiss and the passage between them is as abrupt as possible ; occasionally fragments of the gneiss are included in it; and the zone of contact between the two rocks is marked by a narrow band differing in aspect from either rock and evidently the result of contact metamorphism. From these facts it is clear that the dark patches are intrusions in the gneiss, the bed-like mass being an intrusive sheet. The large body of rock at

Morehouseville gives only limited indications of its relations to the gneisses and the determination of its intrusive character is based upon its composition and structure and resemblance to the rocks of the smaller patches, rather than upon its mode of occurrence. This being the case, the character of the rock from the undoubted intrusions will be first considered.

Specimens from these outcrops show variations in color from very dark blue-gray, to a lighter gray with brownish tinge. The grain is fine and even, with little variation from point to point. There are, however, decided differences in the structure of the rock at different outcrops, as in some it is almost completely massive, while in others it is distinctly gneissoid. In every case the foliation is parallel to the foliation of the enclosing gneiss, and both in the field and under the microscope shows plainly that it is a result of pressure and not a flow structure. Weathering produces a light brown crust which has not been found of any great thickness, but which greatly obscures the superficial difference between the intrusives and the surrounding gneisses. Differential weathering has not proceeded sufficiently far since glaciation to cause any marked difference in elevation between the two rocks, but there is often a slight projection of the intrusive patches above the gneiss. Jointing is more perfectly developed in the former than in the latter, giving an appearance like that of many dikes of diabase and related rocks.

The darker variety of the rock very strongly resembles some of the finer grained specimens of the Baltimore hypersthene gabbro described by Professor G. H. Williams.* In fact this resemblance is so strong that it is sometimes difficult to distinguish from each other specimens from the two localities. The same resemblance exists somewhat in the composition and structure of the rocks as seen under the microscope, but in a less marked degree. Sections of the Wilmurt rock show a holocrystalline granular aggregate of plagioclase, hypersthene, monoclynic pyroxene, hornblende, a little biotite, and magnetite. None of these minerals have crystal outlines, being in irregular grains which range, as a rule, from ·1 to ·5^{mm} in diameter. A rather conspicuous feature is the absence of apatite, which is seen only rarely and in very small quantity. In a single specimen several grains of garnet are shown. Variations in the rock result from the different proportions of constituents present, and, in less degree, from differences of structure. In nearly all specimens the minerals are extremely fresh, showing almost no effects of weathering.

* The Gabbros and Associated Hornblende Rocks occurring in the neighborhood of Baltimore, Md. U. S. G. S., Bull. 28.

The mineral composition and structure are characteristic of the gabbro family, but the variation in relative amounts of the constituents in different masses makes it difficult to include them all under one minor subdivision of the family. In the majority of cases hypersthene is the prevailing ferro-magnesian constituent, making the rock norite; but in other examples hypersthene is subordinate to monoclinic pyroxene, so that it must be classed as hypersthene gabbro. Less often hornblende exceeds the pyroxene in quantity, the rock thus approaching diorite in composition. In a single specimen hornblende entirely replaces pyroxene, the specimen being taken from near the edge of a small patch having the normal composition throughout most of its extent. In general these dioritic phases are quite limited and appear to be more common towards the contact with the gneiss. In view of this variation in composition the rock may be best treated under the broad term gabbro, which will serve to include the important varieties, hypersthene gabbro and norite.

The least variable and most abundant constituent is the feldspar. It is conspicuously clear and free from all traces of the dust-like inclusion so common in the feldspar of the gabbros. The polysynthetic twinning of plagioclase is usually present and the extinction angles on the lamellæ, ranging from 22° to 28°, show that the feldspar is a basic bytownite. Unstriated sections of feldspar are common, but the chemical analysis of the rock indicates, by the small amount of K_2O, that little or no orthoclase can be present. Undulatory extinction is very pronounced in the feldspar, and is never lacking. Further effects of pressure are seen in bending and breaking of the lamellæ and sometimes in considerable granulation. In the most gneissoid specimens there is a limited alteration of feldspar to muscovite.

In perhaps two-thirds of the sections examined hypersthene is next to feldspar in order of abundance. In very rare instances it shows an approach to crystal form, but usually is extremely irregular in outline. It is fresh and clear, and perfectly free from the plate-like inclusions so common in the mineral. It shows the usual pleochroism quite strongly; $\mathfrak{a}$, pale red; $\mathfrak{b}$, pale yellow or colorless; $\mathfrak{c}$, light green; with very slight differences of absorption. It is distinguished from monoclinic pyroxene by this pleochroism, by its parallel extinction, and by its rather low double refraction, together with a high mean index.

The monoclinic pyroxene is pale green, or, in very thin sections, colorless, and has no pleochroism. Like the feldspar and hypersthene it contains no inclusions other than the older magnetite. The pinacoidal parting and fibrous structure of diallage are lacking, the pyroxene being of augitic habit. The angle of extinction is about 40°. This pyroxene is often in somewhat larger grains than the hypersthene.

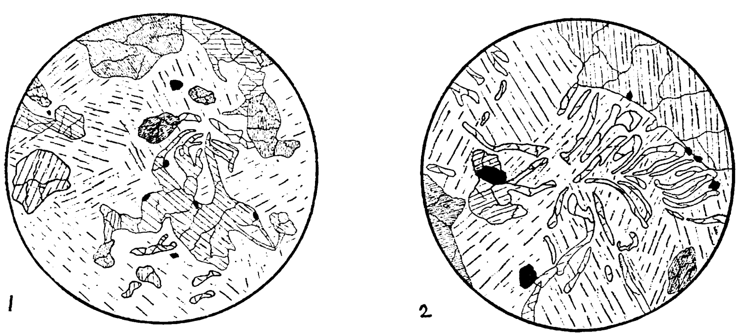
The hornblende, as already stated, is extremely variable in quantity, but is never entirely absent. It is compact, brown and strongly pleochroic; 𝔞 light yellow, 𝔟 deep brown, 𝔠 dark greenish-brown, with the absorption 𝔠>𝔟>𝔞. It often contains small black inclusions, looking like magnetite. It is of considerable importance in making out the history of the gabbros and their relations to other rocks of the region to ascertain whether the hornblende is original or paramorphic. In favor of the latter supposition is the fact that the hornblende often partly encloses grains of pyroxene into which it seems to pass gradually. This intimate association is very common and often extremely marked. Paramorphism would, moreover, readily explain the increase of hornblende in some portions of the rock, even amounting to complete exclusion of pyroxene. On the other hand, the association of the hornblende and pyroxene clearly is often, if not always, the result of parallel growth and accidental juxtaposition. Further, in many cases the apparent gradual transition between the two is shown by careful observation to result from an approach to parallelism between the plane of their contact and the plane of the section. When this is not the case the line of junction of the two minerals is generally distinct and shows no indication of interpenetration. Then, too, the amount of hornblende in the rocks shows no close relation to the intensity of the mechanical force to which they have been subjected, as it is just as likely to be abundant in a massive rock as in one that is prominently gneissoid. Taking these points into consideration it seems probable that the hornblende is an original constituent of the gabbro and that the hornblendic phases of the rock are the result of local variations in the original magma, or of differences in the conditions of solidification.

Biotite is of very minor importance as a constituent of the gabbro, and need receive no special description. Its distribution is, however, of interest. Almost without exception in the finer gabbros the biotite occurs in close proximity to the plane of contact with the gneiss. The hornblende shows a tendency in this direction, but nothing like that of the biotite, which also tends to arrange itself parallel to the contact. The exceptions to this rule are few.

Magnetite is an unfailing and important constituent. It forms large irregular grains, plainly primary and in considerable quantity. Tested with H_2O_2 it shows the presence of some titanium, but as it is readily soluble in acids and strongly attracted by the magnet it must be a titaniferous magnetite rather than ilmenite.

The only macroscopic structural variations in the gabbros are differences in coarseness of grain and in degree of foliation. The grain as a rule remains nearly constant throughout any given body of the rock but varies somewhat in different patches. The hornblendic varieties are apt to be coarser than the normal rock, and as the hornblende is often more abundant toward the margins of the rock mass, these portions are sometimes decidedly coarser than the central portions, reversing the general rule in regard to intrusive rocks.

The gneissoid varieties when examined under the microscope show the effects of pressure in a greater or less amount of crushing of the minerals, besides the undulatory extinction, bending of twinning lamellæ, etc., which are seen in all sections. At the same time that the gneissoid structure becomes marked, the structure of the hypersthene undergoes a conspicuous modification. The mineral not only becomes shattered like the other constituents, but sends out long slender tongues into the surrounding feldspar. These tongues range from slight projections of the hypersthene to string-like extensions which radiate from a hypersthene core. In still more extreme cases this core is lacking and the hypersthene forms curious rosettes. It is often impossible to determine directly the nature of the mineral in the tongues, but it may be safely regarded as hypersthene as there is a complete gradation between them and the larger extensions plainly composed of this mineral. The larger tongues of hypersthene usually form a granophyric intergrowth with the feldspar presenting an appearance somewhat like that described by Bayley* in the augite of Lake Superior gabbros. It is impossible to deter-



1 2

FIG. 1.—Gabbro. Large piece of hypersthene sending out tongues into the surrounding feldspar. Diameter of field 0·7mm.

FIG. 2.—Gabbro. Separate tongues of hypersthene in feldspar. Diam. of field 0·4mm.

* W. S. Bayley. A Fibrous intergrowth of Augite and Plagioclase, resembling a reaction rim, in a Minnesota Gabbro, this Journal, III, xliii, p. 515.

mine whether the same regularity of orientation persists in the finer tongues, but such seems often to be the case. Again, the tongues wander irregularly through the feldspar, often extending between adjacent individuals. Figure 1 shows the first step toward this structure, figure 2 its more complete development though not approaching the fineness and complexity often seen. The extreme cases are often accompanied by an alteration of the feldspar to muscovite.

This stringing out of the hypersthene shows a most intimate connection with the development of gneissoid structure. When there are only slight traces of the latter structure the hypersthene occurs merely as irregular grains, but as soon as parallelism of constituents becomes marked the stringing out begins and becomes more and more conspicuous as the gneissoid structure increases. It seems a necessary inference that the phenomenon is a result of metamorphism but the rationale of the process is not clear, and it seems best to defer any attempt at explanation until more data are available.

The contact between the gabbro and the gneiss is quite distinct in hand specimens, being marked by a greenish gray band about 2^{mm} wide. Under the microscope the contact shows a narrow zone made up almost wholly of the pyroxenes with some biotite. Just within this band the gabbro consists chiefly of feldspar, and then gradually assumes its ordinary composition, though often containing an unusual amount of hornblende. The character of the contact zone is clearly due to the fact that the pyroxenes crystallized earlier than the feldspar and attached themselves to the solid face of the gneiss, leaving the adjacent layer of gabbro composed of nearly pure feldspar. The pyroxenes of the contact zone are almost completely altered to a green chloritic product, to which is due the color of this zone as seen in hand specimens. The gneiss shows no perceptible mineralogical changes at the contact, though its color is altered to a bluish gray tint.

The chemical composition of the gabbro is indicated by analysis I. The material analyzed was taken from a very fresh, massive specimen which showed under the microscope about the average proportions of minerals.

Analysis II gives the composition of a fresh specimen of the Baltimore gabbro described by Professor Williams* and III gives the results obtained by analyzing a mixture, in equal amounts, of specimens of this rock from twenty-three different localities.† The similarity in the results of the three analyses is striking and confirms the conclusion that the gabbro at Wilmurt is closely related to the Baltimore Rock.

* Op. cit., p. 37. † Op. cit., p. 39.

	I.	II.	III.
SiO_2	46·85	44·10	46·85
Al_2O_3	18·00	24·86	19·72
F_2O_3	6·16	7·89	3·22
FeO	8·76	6·53	7·99
MgO	8·43	3·89	7·75
CaO	10·17	11·90	13·10
Na_2O	2·19	1·66	1·56
K_2O	0·09	0·24	0·09
H_2O	0·30	0·60	0·56
Totals	100·95	101·67	100·84
Sp. gr.	3·097	3·044	

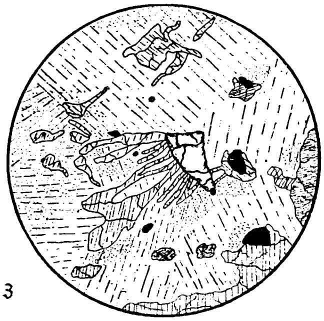
The gabbro of the larger area at Morehouseville, as already stated, gives only slight indications of its intrusive character. The rock is decidedly coarser grained than that of the small patches, and on the weathered surfaces closely resembles the ordinary hornblende gneiss of the region. In thin sections it shows the same constituents as do the finer gabbros, with the addition of considerable apatite, while biotite is quite abundant throughout the entire mass. The percentage of ferro-magnesian minerals is smaller than in the other rocks, and the augite is decidedly more abundant than hypersthene making the rock a hypersthene gabbro rather than a norite. In structure it varies from completely massive to slightly gneissoid. No crushing is apparent in sections, the undulatory extinction is less marked than in the finer rocks, and there is no sign of the stringing out of the hypersthene.

It seems probable that the facts above stated may prove of value in working out the geology of this region by giving a clue to the origin of the black hornblende gneiss previously referred to. Very little has been done as yet along this line, but a brief outline of the more important observations thus far made may well be recorded in this connection, leaving the details for a later paper. The black gneiss was first seen on the shore of Big Rock Lake, about a mile and a half northeast of Wilmurt, where it lies between acid gneiss below and brown hornblende gneiss above. As the shores of the lake are thickly wooded it is impossible to make out the character of the contacts between the rocks. From this point the black gneiss extends nearly or quite continuously along the strike, till the head of Metcalf lake is reached, a distance of three or four miles. Beyond this point the country has not been examined. On the north shore of Metcalf lake there is a series of cliffs rising one above another in which the black gneiss is seen alternating with layers of brown gneiss, sometimes with a rather gradual transition between the two, but often with a very sharp line of demarcation. As all the region is covered with dense forest it is almost impossible to get any more definite knowledge of the relations of the different rocks.

The black gneiss is coarse grained and usually more massive than the surrounding rocks, though by no means always so. Its most noticeable feature in the field is the presence of a great deal of garnet, ranging from small specks up to lumps two or three inches in diameter. Around the garnet there may generally be seen a narrow rim of dark green or black radiating plates. Freshly broken surfaces glisten with the brilliant luster of numerous cleavage faces of hornblende. From this normal type of the gneiss there are many variations. By a decrease in ferro-magnesian minerals it becomes light greenish-gray looking, very much like specimens of garnetiferous anorthosite from Essex County. In other cases the garnet disappears and the rock would then be taken for a basic gabbro. Rapid changes in the character of the rock often take place within the space of a few feet.

Sections of the gneiss show a mineral composition closely related to that of the gabbros. The feldspar is plagioclase, but in most sections is almost entirely changed to minute colorless scales, with the high double refraction, parallel extinction, absorption, and negative optical character of muscovite. In many sections this mineral wholly replaces plagioclase, but in others portions of the feldspar remain showing every stage of the alteration. Augite and hypersthene like that of the gabbro are abundant, together with hornblende of somewhat different character. This, though usually massive like the hornblende of the gabbro, differs from it in being pleochroic in green tints, sometimes with a decided bluish tone. It is intimately associated with both pyroxenes, and in such a way as to suggest that it may be derived from them, though positive proof of this is lacking. Magnetite and a little biotite make up the rest of the rock, aside from the garnet. The latter, as already stated, occurs abundantly in masses of varying size. It is sometimes perfectly clear, with a decided pink color and sharply defined, even boundary. In other cases its outline is very irregular with embayments and inclusions of the other constituents, particularly the hornblende and pyroxene.

The most conspicuous feature of the rock is its structure, due to the peculiar form of the hypersthene and hornblende. These two minerals, though often in irregular masses, show a decided tendency to extend out in radiating tongues, with a length often ten or twelve times their breadth. These tongues may start from any portion of the section, but commonly radiate from a mass of pyroxene or more particularly from garnet when it is present, thus giving rise to the radiating bands seen around this mineral in hand specimens. The tongues are usually curved and when developed from several centers give a remarkably beautiful effect under the microscope, impossible to describe or to figure with accuracy. An attempt in the latter direction is shown in figure 4. This



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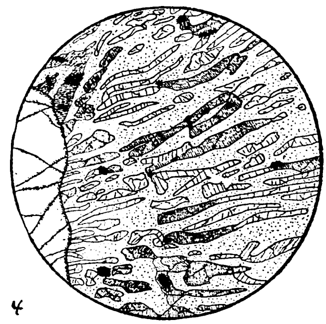

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FIG. 3—Gabbro. Tongues of hypersthene radiating from garnet. The feldspar somewhat altered. Diam. of field $0{\cdot}7^{mm}$.

FIG. 4—Black gneiss. Tongues of hypersthene and hornblende radiating from garnet. Feldspar completely altered. Diam. of field 2^{mm}.

structure is analogous in every respect to that described in the gneissoid gabbro, differing from it only in being on a larger scale, with all of the constituents coarser, and in the presence of tongues of hornblende as well as of hypersthene. The analogy is rendered even more complete by the fact, not previously stated, that in the sections of gneissoid gabbro which contain grains of garnet the latter are partially surrounded by radiating tongues like those around the garnet of the gneiss, but often so slender as to make difficult an accurate determination of the mineral composing them. This structure is illustrated in figure 3.

Thus, the black gneiss is closely related to the gabbro in mineralogical composition, showing such differences from it as might result from alteration and metamorphism. At the same time the gneiss has developed on a large scale a peculiar structure which is precisely analogous to a structure shown in the gneissoid gabbro. From these facts it seems justifiable to conclude that at least there is great probability that the black gneiss is a metamorphosed gabbro. The final establishment of the truth or error of this hypothesis will be an important step in unravelling the history of the gneissic complex of the region, for the bowlders of the drift indicate that the black gneiss is a rock of considerable importance. In fact, it may be said of all the rocks described that they are doubtless of much greater extent than might be inferred from the facts stated, for the dense forest covering the region, the scarcity of trails and the decided similarity in weathered surfaces of the different rocks combine to make it a matter of great difficulty to collect reliable data in regard to their areal relations.

The identification of rocks of the gabbro family in this locality is of interest in being one more piece of evidence indicating a much wider range for this group in the Adirondack region than was formerly supposed to be the case. In the early days of the New York survey the anorthosite was described by Emmons,* under the name hypersthene rock, as limited to Essex County. Colvin† speaks of finding it in another county, but does not state which one. Beecher and Hall‡ in describing the faults of the Mohawk valley speak of the labradorite at Little Falls, but give no description of the rock. Van Hise§ has stated recently that in company with Prof. G. H. Williams, he noted the gabbro in contact with limestone at Bonaparte Lake, Lewis County. Nason‖ mentions the occurrence of "frequent outcrops of the typical labradorite rocks" along the line of the Carthage and Adirondack railroad, in Lewis and St. Lawrence Counties. Finally, the work of Professor Kemp, already referred to, has shown a great expanse of the gabbros in the vicinity of Lake Champlain. In all of these recent papers, with the exception of the last, the reference to the gabbro is merely incidental, and no descriptions of the rock are given. They serve, however, to indicate that this group of rocks is by no means limited to Essex County, but, on the contrary, extends over a large portion of the Adirondack region. Of the various localities mentioned, Little Falls is the nearest to Wilmurt Lake, and is therefore of most interest in this connection. The rock so well exposed in the gorge of the Mohawk river at this place is very coarse grained, usually distinctly gneissoid, and of a greenish-gray color. It is composed chiefly of plagioclase, with some pyroxene, hornblende, mica, and quartz. Its most conspicuous feature is a highly developed cataclastic structure, showing great "augen" of feldspar lying in a mosaic of finely crushed fragments. In composition and structure the rock is precisely like the Canadian anorthosites, in fact the figures of cataclastic structure given by Adams¶ might have been drawn from sections of the Little Falls rock, so close is the resemblance. But more important is the fact that it is practically

* Geology of New York, 2d District, p. 32.
† Adirondack Survey, Second Report, p. 151.
‡ Fifth Annual Report State Geologist, p. 8.
§ Bull. 86, U. S. G. S., p. 399.
‖ Iron-Bearing Rocks of the Adirondacks. Am. Geol., xii, p. 28.
¶ F. D. Adams, Ueber das Norian oder Ober-Laurentian von Canada, Neues Jahrbuch für Mineralogie, etc., B.B. VIII, s. 419.

identical in character with the anorthosites of Essex County and must be regarded as a southward extension of this rock. Now, although Little Falls is nearly thirty miles from the Wilmurt locality, a line connecting it with the Essex County anorthosites would pass less than eight miles to the eastward of Wilmurt. Thus, if, as seems probable, the anorthosite of Little Falls is continuous with that of Essex County, it must approach within a comparatively short distance of the Wilmurt gabbro. The possibility of establishing a connection between the two rocks is thus rendered considerable, so much so in fact that there can be little doubt that the gabbros of Wilmurt Lake and vicinity are an offshoot of the great gabbro core of the Adirondacks.

Hamilton College, Clinton, N. Y., March 7, 1894.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On a Titration method for determining Molecular Mass.*—It has been shown by Nernst that, when foreign substances are dissolved in a given liquid, the solubility of this liquid in another with which it is partly miscible, is diminished in accordance with the same laws as those which regulate the diminution of its vapor pressure when the second liquid is not present. The experimental confirmation of this law has been found difficult owing to the limited number of miscible liquids such as it requires. KÜSTER, however, has succeeded in doing this, using for the purpose a saturated aqueous solution of sodium chloride on the one hand and phenol on the other. If we call L_0 and L the solubilities in water of pure phenol and of phenol containing a foreign substance, g_l and g_s the masses of phenol and of the foreign substance M_l and M_s their molecular masses and V_0 and V the volumes of phenol before and after the addition of the foreign substance we have for the value of the constant k

$$k = (L_0 - L)/L \,.\, g_l/M_l \,.\, M_s/g_s \,.\, V/V_0.$$

This value in Küster's experiments was 1·125.

To apply the results to the determination of molecular mass by titration, Küster uses two separating funnels, of about 100^{cc} capacity, each containing (1) 25^{cc} of a saturated aqueous solution of sodium chloride saturated with phenol at the temperature of the laboratory, and (2) 10^{cc} of phenol saturated with sodium chloride by contact with a strong solution of this salt. Into one of these funnels is now introduced a known mass of the substance whose molecular mass is to be determined. It must be soluble in phenol