geological map which, when matched along the Pennsylvania-Maryland line, brings out the single glaring defect in the beautiful chart of Pennsylvania's banded terranes. Where, between the meridians of 77°20′ W., and 77°30′ W., on the northern map the legend reads "Quartzite," the southern more accurate map shows broad fields of ancient basalts (diabase) bordered by a little Cambrian sandstone.

The three maps, of New Jersey, of Pennsylvania and of Maryland, should be in the outfit of every school where geology is taught. The student who would know how a great mountain range is constructed needs to make out a section of Pennsylvania from the ancient crystallines near South Mountain westward across the folds and faults of the Appalachians and the Alleghenies to the shores of Lake Erie. The sheets of this map brought together and mounted form an instructive wall map for class use. Both the teacher and the field student of geology must thank the author of that other memorial of Pennsylvania's history, "The Manual of Coal and its Topography," for this latest contribution to the literature of the science.

THE SYNTHETICAL POWERS OF MICRO-ORGANISMS.—II.

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We have in a former communication considered the sources of carbon for the formation of proteids, *i.e.*, for the increase of protoplasm and multiplication of microbes. The sources of nitrogen for the microbes are just as manifold. Not only salts of ammonia and nitrates, but also organic compounds of the most different structure may serve; thus: amines, amides, derivatives of urea and guanidin amidoacids and organic cyanides, *e. g.*, methylamin, acetamid, hydantoin, kreatin, glycocoll, leucin, asparagin, methylcyanide. Of inorganic combinations ferrocyanide of potassium is but a poor source of nitrogen, whilst hydroxylamin and diamid are entirely unfit for use, being very poisonous.[1] Nitrites are less favorable sources than nitrates, and the nitrates are more quickly reduced to ammonia than the somewhat poisonous nitrites.[2]

It seemed to me an interesting question how this reduction of nitrates to ammonia is carried on without the aid of nascent hydrogen; in chemistry this process could thus far not be properly explained. Evidently the living protoplasm, with its atomic motions, was engaged in this process, and I succeeded finally in applying platinum black with an aqueous solution of glucose and potassium nitrate, heating the mixture several hours upon the water-bath, in bringing about this transformation,[3] which may be expressed by the following equation:

$$\underbrace{C_6H_{12}O_6}_{\text{glucose}} + \underbrace{NO_3K}_{\text{potassium nitrate}} = \underbrace{NH_3}_{\text{ammonia}} + C_6H_7KO_8 + H_2O.$$

The peculiar kind of molecular motions in the platinum black transferred upon the molecules of sugar and nitrate brought about an exchange of hydrogen and oxygen atoms, ammonia being formed on the one hand and an organic acid (which was not closely examined) on the other. We call such processes katalytic.

The action of light is not necessary for the reduction of nitrates by bacteria or by any other plant cell. That the nitrogen is not taken as such from the nitrates for the synthesis of the proteids, but that it must be connected first with hydrogen, is shown by the nature of the ordinary proteids which contain about one-third of their nitrogen in form of amido groups.[4]

The different nitrogenous compounds in serving for assimilation of nitrogen (as methylamin, leucin, kreatin, etc.) must evidently be decomposed first with production of ammonia before the synthetical work can begin. This decomposition by the aid of the living protoplasm can take place either under reducing influences or under oxidizing ones, or by the action of water, according to the chemical nature of the nitrogenous substance; as for example:

$$\underbrace{H_2N-CH_2-COOH}_{\text{glycocoll}} + H_2 = NH_3 + \underbrace{CH_3-COOH.}_{\text{acetic acid}}$$

or:

$$\underbrace{CH_3-NH_2}_{\text{methylamin}} + 3O = CO^2 + H_2O + NH_3$$

An interesting fact in regard to the assimilation of nitrogen is the faculty of assimilating atmospheric nitrogen, of the leguminous plants, after their roots entered in symbiosis with certain kinds of bacteria, as was shown by Hellriegel. Also in this case, however, the gaseous nitrogen is not directly used for the synthesis of proteids, it must be first converted into an ammonia compound, most probably into ammonium nitrite by those bacteria.

$$N_2 + 2H_2O = NO_2.NH_4$$

Also this process may be imitated, as I have demonstrated, if platinum black in presence of gaseous nitrogen or air is moistened with caustic lye.[5]

In regard to the assimilation of sulfur it is also found that very different combinations can be used; thus sulfates and sulfites, methylsulfide, sulfonic acids, as, for instance, taurin, sulfones like sulfonal, etc. Evidently there must be also here formed at first a suitable group before the sulfur can enter into the forming albuminous molecule. If we consider that the sulfur can easily be split off from proteids (in part at least) in the form of sulfuretted hydrogen and that the entire character of proteids leads us to the conclusion that the sulfur is contained in them in the shape of the hydrosulfyl group, then it becomes highly probable that H_2S is the combination first formed from all the different sources of sulfur. The sulfates must be therefore *reduced* for the assimilation of sulfur. I have shown, also, here, how such a process can be performed katalytically:[6] if we heat a solution of oxymethyl sulfonate of sodium with platinum black and carbonate of sodium we can soon observe the formation of sodium sulfide. This process is certainly a very interesting sort of reduction, and may be expressed by the following equation:

$$2\,(CH_2OH-SO_3Na) + Na_2CO_3 = Na_2S + SO_3Na_2 + CH_2O_2 + 2\,CO_2 + 2\,H_2O$$

Our considerations have led us to the conclusion that formic aldehyde, ammonia and sulfuretted hydrogen are the immediate material for synthesis of albuminous matter or proteids. A clue what way the synthesis may take is furnished by the decomposition of proteids taking place under certain conditions in the higher plants, whereby asparagin is formed in very large quantities. On the other hand we find that asparagin is rapidly converted into albuminous matter in presence of sulfates and glucose. Therefore the most probable conclusion is, that the asparagin is first converted into a substance, capable of yielding albumen by a so-called condensation process and that this substance must be the aldehyde of asparaginic acid. Albuminous substance would thus be formed in a nearly analogous process to the formation of sugar from formic aldehyde. I have demon-

[1] Compare O. Loew, "A Natural System of Poisonous Actions," Munich, 1893.
[2] O. Loew, Biol. Centralblatt, vol. x., p. 588.
[3] Berichte der D. Chem. Ges., vol. xxiii., p. 675.
[4] O. Loew, *Journal f. Prakt. Chem.*, vol. xxxi., p. 134.
[5] Berichte d. Deutschen Chem. Ges., vol. xxiii., p. 1443. The assertion of Schoenbein, that ammonium-nitrite is formed in small quantities, on evaporation of water in contact with air, was shown to be erroneous by A. Baumann and Neumann.
[6] Ber. d. D. Chem. Ges., vol. xxiii., p. 3125.

strated[7] eight years ago that several sugars result thus, among them a fermentable one, called by me methose and declared later to be inactive laevulose by Fischer. If we now express our view on the formation of albuminous matter in plant cells, especially in the microbes, by equations, we obtain:

$$\text{I.}\quad \underbrace{4CH_2O}_{\text{formic aldehyde}} + NH_3 = \underbrace{C_4H_7NO_2}_{\text{asparaginic aldehyde}} + 2H_2O$$

$$\text{II.}\quad 3C_4H_7NO_2 = C_{12}H_{17}N_3O_4 + 2H_2O$$

$$\text{III.}\quad 6C_{12}H_{17}N_3O_4 + 12H + H_2S = \underbrace{C_{72}H_{112}N_{18}SO_{22}}_{\text{simplest expression for albumen}} + 2H_2O.$$

This theory would doubtless indicate the simplest way possible for the formation of proteids; it is true, that some objections could be raised especially in regard to equation I., but we will at a future occasion explain what principal conclusions drawn from this hypothesis were confirmed by experiments.

[7] *Jour. f. Prakt. Chem.*, 1886, p. 321; and Ber. d. D. Chem. Ges., vol. xxii., p. 447.

INTRODUCTORY ADDRESS TO A COURSE OF LECTURES ON VULCANOLOGY IN THE R. UNIV. OF NAPLES.

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VULCANOLOGY, or the science which concerns volcanoes and their phenomena, is a very important branch of geology, or the science which treats of the earth's crust in general. Geology is yet hardly a century old, because before that time it consisted of little else than a collection of romantic hypotheses and incredible superstitions. This remark applies with still greater force to vulcanology, for the study of which it is most necessary to possess an extensive knowledge of physics and chemistry, besides a highly developed faculty of observation. Notwithstanding, for a century or two previous to the nineteenth there were acute observers, and we in Naples well know such names as those of Sorrentino, Duca e Padre della Torre.

Towards the end of the last century the active and extinct volcanic regions of Italy attracted the attention of four great scientists, each of a different nationality: these four illustrious men were Spallanzani, Sir William Hamilton, Dolomien and Breislak. Although their nationality was different, they had two merits in common—that of scientific truth and that of Baconian methods of reasoning. In other words, they were pure scientists, since by that term we understand one who observes carefully, records neither more nor less than he observes and draws from these facts and those collected by others his conclusions without disregard to a clear knowledge of the principles involved, and without imagining facts that never existed which give rise to the enunciation of romantic hypotheses and scientific castles in the air. It is therefore more to these four men that we owe the advance of human knowledge concerning volcanoes than to all the writers who preceded them.

In the first years of the nineteenth century, vulcanological literature was enriched by many scientists, because as the allied sciences were then making great strides, they were able to offer to vulcanologists much more powerful and accurate means of investigation. Thus we had Humboldt, Scrope, Daubeny, Pilla and Gemmellaro.

Following these came a phalanx of illustrious students of that branch of geology, some still amongst us, others unfortunately dead in person but living and immortal in the memory of man as heroes of science and of human knowledge. Amongst these we may enumerate Lyell, Dana, Scacchi, Palmieri, Silvestri and Phillips, whilst at present many younger and gifted investigators are not wanting.

No other branch of science has been so heavily burdened by extravagant hypotheses which have so much retarded its progress as that of vulcanology. It is not only in the first half of the present century that we find an extensive literature, the production of men who advertised themselves as scientists when in truth they did little else but write memoirs and books to promulgate and sustain fantastic, extravagant, imaginary and impossible hypotheses. Even to-day only those who like myself have had the misfortune to be obliged to review the vulcanological literature can appreciate the large quantity of rubbish which is yearly published in the name of science. Nevertheless, amongst so much of this chaff we do meet with grain, but also very good grain.

As a subject of study, Vesuvius holds the first place in all vulcanological investigations of this and the last century. A few figures will make this fact more evident. Some four years since my wife and myself collected the titles of books, memoirs, and other writings referring to the south Italian volcanoes for the purpose of publishing a bibliographical list. We found the following numbers:

Graham's Island or Isola Ferdinandea	28
Roccamonfina	33
Lipari Islands	119
Alban Hills	210
Campi Phlegræi	539
Etna	880
Vesuvius	1552

From this table we comprehend how much has been written concerning our great active volcano, which we find constitutes nearly half of what has been written about all the volcanic regions south of Rome. If we add to these the titles referring to the Campi Phlegræi we then find that in a total of 3361 not less than 2091 concern the volcanic district around Naples. Let me, however, give you a still more striking fact. The Naples branch of the St. Alpine Club possesses the richest vulcanological library in existence. The catalogue contains more than 7000 entries of papers, books and manuscripts. However, in this number are included books that not only treat of vulcanology but in a large part refer to seismology and to a smaller extent to geology. It will be seen, therefore, that the Neapolitan volcanic district represents more than a quarter of all vulcanological literature.

It is true that the history of Etna and the Æolian Islands reaches farther back than that of Vesuvius, but on the other hand the history of this latter is by far the most complete. From a chronological point of view Vesuvius and also the Campi Phlegræi have a more important place in history than any of their rivals. Even if the Pompeiians, the Herculaneans and the Stabians did lose all their property eighteen centuries since, the modern world has recovered it as achæological treasures whose value represents, from the point of view of culture, many times the original one, and the compound interest on the same for the whole interval; and this we owe to our Vesuvius. The phlegrean region around Naples is so enchained with the poetry of the heroic and classic periods, that without it the legends of Cuma, of Pithecusa, of Sparctacus, of Partenope, of Baja and so many others, which fills pages and pages of ancient history, would not exist.

Sometimes poetic ecstasy attacks the mind of the scientist; for quite the contrary to what the general public believe, science, rather than abolish poetic senti-