PENNSYLVANIA'S FOUNDATION STONES.

Lecture delivered before the Franklin Institute, Thursday, Dec. 22d, 1870.

BY PROF. LEEDS.

(Continued from page 345.)

The Position of Pennsylvania in the Geological Scale.

THE crust had hardened on the fiery deep. The earth had been one vast crucible. From myriad points ran out diverging lines of crystalline force, as when the first blasts of winter strike down upon the surface of the ponds. The school-boy hastening to the noisy class-room shouts with ecstasy, because he knows that these long needles of ice before nightfall will have linked themselves into a fast net-work, in whose loops a million tinier crystals shall be caught, and the whole shall have hardened into a faultless mirror. From point to point covering the globe with as many lines as those which show the mariner on his faithful chart his place upon the trackless deep, from zone to zone shot forth the rock crystals. A house that is to be built upon shifting sands must needs have firm foundation, a bridge that spans a torrent must root its abutments deep in either bank, and plant its piers like feet where the shock of the trunks and hulks of boats and huge stones carried down when springtime swells its stream into a freshet, can never budge them.

Upon the fiery lake that has no bottom, upon the lava that stretches down to the earth's centre, upon the flints and sand more liquid than what the fire-pot of the glass-house shows, upon molten metal, compared with which, the red hot rivulets that flow into the hissing troughs when the iron furnace is tapped, are cold and sluggish, a foundation is to be laid that shall endure until the last great day of doom. Over a fiery liquid which rose and fell with every change of moon, and rolled great tidal waves around the earth with the yearly and diurnal revolution of the sun—that piled itself up into a great mountain over 26 miles in height about the equator flung upwards from the poles as the earth spun round at the rate of 3 miles per second—that had its surface currents streaming onward to Polar Seas, and its submarine currents flowing downward towards the middle, as now the gulf and arctic streams change and purify the five great oceans—over this whirling tide a floor is to be laid upon which the bohemoth and the mastodon may walk without

the slightest tremor to terrify, and where the tiniest insect that enjoys the breath of life shall gambol in the sunshine, unconscious of the abyss that yawns beneath—over phosphoric fumes, that would fill the air with horror, over sulphurous vapors that would bleach and suffocate, over gases that would make of earth a sepulchre, a house is to be built that shall be man's glorious habitation.

Therefore were unyielding blocks of hornblende used for the foundation. And not only hornblende, but porphyry and basalt, and chiefly that most enduring building stone of all, solid granite. They were dovetailed and morticed one into the other by interlacing crystals, and where they showed signs of cracking, dykes of metal were pierced through, as builders key the walls of granaries and warehouses together with iron girders.

Thus was the foundation laid by which the vast superstructure was to be supported.

And when all had been done, and strength sufficient was given to last even to this present day, a great excess of material remained.

What was to be done with it?

It was to be made the soil and home of innumerable plants and animals.

When we wish that a plant should flourish, we dig about its root and break up the ground into clods, so that its tender rootlets may be strong enough to push their way through every chink and crevice, and find drink and nourishment awaiting them.

When an animal would live it tears its food to pieces, so that the juices may flow out and the acids of the stomach may seize upon each morsel of gelatine and fibre.

When the earth's first crust was to be made ready to receive plant-life and animal, it had to be ploughed up and harrowed, it had to be channelled and crevassed and scooped into hill and dale, and to be made soft, yielding, porous.

Things crystalline are strong but lifeless; things full of holes and cells are plastic, organic, living. Granites and porphyrys are good for foundation walls, but muds and sands make good ground for tillage.

Water, as I said in my first lecture, has been this great mediator between the inorganic and organic kingdom, the power which evoked life from the dead, and beauty and motion from the barren sea.

On a thousand millstreams water is busy in doing its work for man. It is grinding the crops into food. It is knitting fibre into

stuff. It is pounding the products of the furnace into bar and rail and bloom. Endless cranks and pulleys, levers, pistons, saws and hammers are spinning and whirling and falling at its bidding.

But how much of the power of the mill-stream is consumed after it has prepared man's tools, food and garments? With how much less energy does Niagara plunge headlong into the Emerald Pool because some child of mammon has perched an obscure papermill upon its brink?

With the first drop of rain that fell from the heaven above, with the first hill, however low, with the first lap of the ocean upon the shore, with the first heaving of the tide, water commenced to wear away the coping of the foundation and build up the superstructure. Fourteen miles of rock, piled one above the other, attest the thoroughness with which it has done its work.

I say fourteen miles instead of seven, as I stated at the outset, because I believe the considerations which have been brought forward are sufficient to overthrow the theory that the 37,000 feet that underlie the hitherto so-called fossil bearing rocks were the stratified sediments deposited upon the sea-bottom from the ashes of submarine volcanoes, viz., that the granites and other crystalline rocks found in these 37,000 feet graduate imperceptibly into gneiss and non-crystalline rocks; that the granites are interstratified with mud slates and other layers arising from the debris of crystalline rocks, and finally that fragments of crystalline rocks are found mingled in with sedimentary beds of later origin.

If any doubt remained it would be crushed by this little stone that I am now holding in my hand. It came from the Laurentian rocks of Canada. It was given by its discoverer, Dr. Sterry Hunt, the chemist of the Canadian survey, to my friend Mr. Trautwine, the eminent civil engineer of this city. It shows a polished surface of green serpentine, traversed with beautiful wavy lines of white marble. The latter are the crystallized tubes and branching canals of a coralline animal; the serpentine has taken the place of the flesh and body of the animal itself. The specimen shows that these Laurentian rocks were not devoid of life, but may have teemed with it. And since *this* specimen has been found, many others have been dug up throughout Canada and along the Gulf of St. Lawrence. The animal has been called the *Eozoon Canadense*—*Eozoöe*, from two Greek words, one, *Eos*, signifying *dawn*, the other, *zoon*, meaning animal—the animal that was harbinger of the dawning of life upon

our globe. It has not only been found in Canada, but also in the limestones of Chelmsford, in north-eastern Massachusetts, showing that there, too, rocks but lately regarded as Azoic are of the Laurentian age, and contain fossils. The evidence has been rapidly accumulating during the course of the past five years, and already five more species have been found in rocks of a similar character. In great probability, now that the attention of naturalists has been called to the true nature of these beds, and instead of passing over them with indifference, geologists are everywhere examining them with the most careful scrutiny; before another five years have passed away, we may be made acquainted with not only five but with 50 different kinds of animals that flourished in the falsely called Azoic age.

If these 25,000 feet of Laurentian sediments contain life, it is opposed to all probability that the Huronian are devoid of any relics of it, and that an immense gap, during which 12,000 feet of muds and schists were deposited and centuries rolled away, intervened, during which no life existed upon our globe, and that a new creation took place at the opening of the Silurian age.

I said, in the beginning of the lecture, that it might be doubted whether anywhere there existed at the present day upon the face of the globe a fragment of the original crust that remained exposed to view: and that if it was to be found, it probably was along the line of the Laurentian Hills.

In the light of recent discoveries, may not even that doubt be regarded as dispelled? When the foundation had been laid, was it not meet and proper that that foundation should be concealed beneath the surface and only the superstructure appear?—when the granites and basalts, which are as little adapted to supply habitations for animals, or food for plants, or ores yielding to the art of man, as our modern traps and lavas, had served their use, that they should give way to something more soft and penetrable?

As dough is mixed through and through with leaven, so is the superstructure—(this more than dozen miles of sediment)—with the germs of life, with food and fuel, with oil, salt, metal, and even meat and flesh. Leavened, so that animals and plants, as they developed into forms of rarer beauty, and bloomed with brighter intelligences, should have that which nourish them onward to a higher life, until man should bud forth into the full and perfect flower of nature's creative energies.

Said Dean Swift, and this alone might atone for everything of savage and bitter that he said of frail and fickle manhood—"he that makes two blades of grass bloom where but one grew before, is a public benefactor." But in Swift's day, the chemist, the mineralogist and the geologist were unborn. What is to be said of him who, like the illustrious Prof. Hofmann, has found the secret of a hundred new dyes, and clothed the peasant with a robe more brilliant than that worn by a Tyrian king! What of the poor Philadelphia printer who robbed the tempest and the thunder cloud of its terrors! What of the poor bookseller's apprentice, who did more than any one else to make of electricity and magnetism vehicles that should outrun time and keep pace with thought! What of Count Rumford, the Yankee lad whom a Bavarian prince ennobled, and who first showed what was the proper amount and kind of food for rations for artisans and soldiers! What of Liebig, the father of organic chemistry, who taught us how to make food imperishable.

He that discovers a new continent does much, but he that finds that which will feed a continent of people does vastly more.

And in this superstructure, these piles of sediment, ready for use, are stored away fuel, light and food which we yet know little of.

Of its magazines of coal and its recently discovered wells of oil, we people of Pennsylvania know full well—and the riches, the comforts, the blessings that attend them we know. The government of Prussia is opening up yearly new mines of salt, and around those mines in the course of the last few years great factories have sprung that extract of the salt refuse its magnesia, and send their refuse to recuperate the exhausted lands of our own Southern States with the potash which they contain.

Salts of iodine and bromine are being mined, so that these bodies, invaluable to medicine and photography, are sinking in price so rapidly as to be constantly employed for fresh uses.

As our vast cities grow, they must be fed, and new substances must be dug from the ground to supply the wants which a denser and more cultured population bring.

Therefore must every geologist examine more critically the country about us, and the chemist must put its soils and minerals and ores to a more searching test to find something of new value.

Therefore must an enlightened public do, of its free will, what the monarchies of Europe do by compulsory taxation, and found

laboratories and institute surveys, which may discover and provide beforehand for the needs of a growing population.

The chemist and geologist have their high and appointed vocation as much as priest or politician. A Franklin, who turns away from the splendor of courts to perfect electrical machines, and a Faraday, who put away from him during the course of a lifetime a quarter of a million of pounds sterling, and preferred the public good to riches, are not the least noble of those who say "the common wealth is their greatest wealth, the public weal their highest good."

Perhaps there are some here who will have an instrumentality in solving some of the problems which I have brought before you to-night—some who may make the glorious discovery that these foundation stones of Eastern Pennsylvania, those which we have so often tramped over before, looking only for the minerals they contain, are not Azoic, but have once been peopled with life. To bring into order what has hitherto baffled the knowledge of geologists, to show precisely of what age these rocks are, and, if possible, to detect the broken and confused relics of crab and shell which they may contain, I solicit the help and study of every young student in my audience. And to encourage and stimulate us by your interest and sympathy, to found for us laboratories wherein we may successfully examine the material that we have gathered from the fields or dug from beneath the hills, I turn to you, my older friends and much valued fellow-members of the Institute.

ON A NEW CONNECTION FOR THE INDUCTION COIL.

By Prof. EDWIN J. HOUSTON.

THE following experiments were made at the Central High School of Philadelphia, with the view of increasing the quantity of the spark of the induction coil without greatly diminishing its length. The instrument used was made by Ritchie, of Boston, and will throw the spark six inches in free air.

One of the poles or ends of the secondary wire was connected with the earth by a copper wire attached to a gas pipe. The other pole was connected with a wire, which rested on a large lecture table holding the coil. On turning the break piece, the electricity, instead of being lost by passing along the wires to the earth, jumped