

Prefatory to the Lecture on Mineralogy

Autumn 1796.

13 This lecture to be ~~enlarged~~ & the Article Salt added.

The subject of our last lecture was the Scale, or Chain of Beings, w.^{ch} we s.^d was formed by links so nicely fitted that the beginning and end of each was invisible to the most inquisitive eye. We s.^d that the Parent of universal Nature, constantly united the highest degree of the qualities of each inferior order to the lowest degree of the same qualities belonging to the order next above it, by w.^{ch} means like the colours of a skillful painter, they are so blended together, and shaded off into ~~one~~ each other, that no line of distinction is any where to be seen.

By observing this gradation, we have reason to be persuaded, that by such gentle steps, things ascend upwards (says Lock) in degrees of perfection. But they lessen and augment as the quantity does in a regular Cone, where tho' there be a manifest odds, between the bigness of a diameter at a remote distance, yet the difference between the upper & under, where they touch one another is hardly discernible (Sp. Hum. Unders.)

Having given you a glance of the chain of Beings, we leave the links of it to be studied at your leisure.

We have more yr. once mentioned the importance of applying those seemingly detached facts, w.^{ch} nature offers to our view; for without an usefull application or Study of Natural History, is but an idle amusement - a waste on our precious time.

The study of Nature, besides rubbing off our prejudices, correcting conceitedness, and extending the sphere of our enjoyments, leads to palpable profit in such a young country as this, a country where agriculture gives man the only riches he can call his own, all other sources of it, being transient and fallacious.

It is, moreover, gratifying to the pride of little mortals, to be able to create, ^{from} a few seeds, a field of Vegetables. This pleasure, it is probable, arises from a man's appearing to himself to be a Creator, and to partake with the Supreme Being in the most eminent of his prerogatives "creation". Man seems to become a partaker with the Creator, by being placed between him and matter, w.^c receives laws from his hands. In this view, how superior is man to the other orders of beings, w.^c compose the Chain, we spoke of. They all follow an invariable, or monotonous process, receive the laws, and submit to effects without modification. Whereas man, possesses the advantage of knowing, a part of these laws, of preparing events, of predicting results, and producing effects at pleasure; and of appropriating to himself whatever is beneficial. In this point of view, man seems (I say) to partake with the Supreme Creator in the most eminent of his prerogatives, creation. Capital. prel.

But leaving reflections, let us hasten to describe some of the productions of Nature w.^c lie concealed in the lowest apartment of the Terrestrial Globe. viz Fossils or Minerals — LXVII —

autumn
1795

(NB. June 1805 This Lecture must be reversed & transcribed)

Minerals

the earth

connected wth the Lecture on the theories of

Mineralogy is a more favourite study on the Continent of Europe than in Botany. Crown'd heads, noblemen & private gentlemen make collections of minerals at a vast expence. An 100 guineas for a single specimen, is a common thing, and sometimes there are specimens sold at auction, for five times ^{more than} ~~than~~ ^{that} ~~sum~~.

In Sweden, and Germany it is considered as a ^{branch} ~~branch~~ of science worthy of the attention of government. They have colleges in w^{ch} it is regularly taught. It forms a distinct, & honorable profession, like that of the Physician, the merchant or the barrister. The intendants of mineralogy form a part of the administration. Young students fraught with the knowledge to be acquired in their own country, are sent abroad to glean all that can be collected from a more diversified view of nature, or a more improved practice of the arts. This example has been followed by the French, the Prussians & the Spaniards.

The French have erected a school for Mineralogy at Paris to which is annexed a very generous support. Subterraneous maps of the whole ^{or Kingdom} Republic, are now a tracing, and before the war, voyages were undertaken at the expence of government for the express purpose of collecting minerals —

Chemistry

Chemistry, the ^{and} parent of mineralogy, are cultivated, in France with a degree of ardour that approaches to enthusiasm. The Supreme Executive of the Republic, has ~~just~~ sent over to this University a ~~valuable~~ & valuable collection of minerals, in addition to those presented by D. Lettore of London; so that we are in a fair way of having that usefull science flourish among us I say useful science; for altho' it ^{is} may be true that every thing for the support of life is continued with unceasing cultivation from the upper stratum, or layer of earth, it is nevertheless as true, that from the bowels of it, Labor draws all her tools; - Agriculture the chief of her support; Commerce her riches; and the fine-arts their materials. And it is possible that the Lot of some of you may be so cast, as to be favorable to these pursuits, when the hints you receive in these Lectures may possibly be serviceable to you, and to our common country.

The reason ~~why~~ we have, hitherto, paid so little attention to this branch of Nat. history, is, that we have not as yet been compelled to search the bowels of the Earth for fuel, as is the case in ^{England & other parts of} Europe. But as our woods diminish, the earth will be explored for coals, and this will lead to the discovery of mines; & mineralogy will flourish here, as much, or more, in the old world.

The mineral Kingdom, contains all those bodies w^{ch} have been formed under the surface of the earth, whether at the first creation, or at any other time since that period; and which are still daily produced from their original, or primary ^{minerals are bodies} principles; being destitute of seed, life, or any circulation. (Cronst.)

All those substances w^{ch} are found under the surface of the Earth's ground, w^{ch} are naturally & essentially simple, not inflammable, of no regular structure, or determinate figure, are thrown by naturalists into one class, denominated simple earths.

Of these, nature affords us but two orders. The 1st order contains earths naturally most, of smooth surface & firm texture: under this head are found the clays, marles, & boles. There are but five primitive earths known, i. e. original earths w^{ch} cannot be further decomposed. 1. Terra ponderosa. (2) Calc. 3. Magnesia. (4) Argilla. 5. Terra silicia see note to Cronst. p. 14 - There is a different substance, w^{ch} is of a regular structure and determinate figure, pellucid & colorless, and arranged into regularly angular figures. Such bodies will not strike fire wth steel; but will ferment violently & finally will be dissolved by aqua fortis. These are called Spars.

There are other bodies w^{ch} resemble spars so much that the common spectator w^{ch} conclude them to be spars,

as they resemble them in colour & in shape, but are
more brilliant. These will not ferment & devalue in
Aq. fortis, but will strike fire with steel. These are
called Crystals; a coarser kind of which is called Quartz.

Here you have a simple criterion, an easy method
of distinguishing two productions of nature, nearly re-
sembling each other, yet essentially different.

Now crystallization, or the formation of crystals, is
an operation of nature, in w^{ch} various earths, salts, and
metallic substances pass from a fluid to a solid state,
e.g. Nitre. Common Salt. Allum. ^{Glucos. Salt &c.}
assuming certain geometrical figures. Every
fluid in nature would run into crystals were they
not prevented by heat. Fire, w^{ch} is the only absolute
fluid in nature, keeps the particles of fluid matter
apart. This counteracts the mutual attraction of
the particles. But diminish the fire, and they run
into a solid regular mass. Ice is water crystallized.
Remove our globe to as great a distance from the
Sun, as Saturn, or Herschel, and it is not improbable
that our air itself w^d be condensed into crystal.
Wherever you see crystals you may be sure they
were once in a fluid state.

It is impossible in the nature of things, that ^{all} our Lectures
sh. be equally entertaining. Every apartment in the
great Temple of Nature, is not equally orna-
-mented; nor every one's taste alike respecting
the choic of ^{the} apartments. Some are decorated
w. a profusion of flowers; some animated with
living creatures; others embellished with marble &
precious stones; while some of the lower rooms, are
filled with useful but less agreeable furniture.

We have seen some of the agreeable upper apart-
-ments, and we are now going to look into the
cellar; or in other words, to take a view of the
subterraneous regions, ^{we are under our feet, and we} which includes the mineral
or Hoop's Kingdom. I conceive... that this lecture may be
highly useful & important to some of you.

Altho' metals form a class of bodies not very
numerous, they nevertheless ~~form~~ are of very great im-
-portance in Medicine, in the Arts, and in the common
affairs of life, in so much that the knowledge of them draws the line between
^{civilization & barbarous life}

Metals have peculiar qualities, by w. they are dis-
-tinguished from all other bodies; such properties are
their solidity, density, & gravity.

Those metals, w. when beaten with the hammer, are
extended, lengthened, & flattened without being broken, which
pro

properties are called malleability, or ductility) and w^c also remain fixed in the most violent fire without diminution of weight, or other sensible alteration are called perfect metals.

These perfect metals are but three in number (1.) Gold. (2) Silver, and (3) Platina, w^c is a very hard metal discovered within a few years in South America. (Some late chemists add mercury to the number of perfect metals)

Such metals as are ductile & fixed in the fire, to a certain degree, but which are destroyed by the continued action of fire, i. e. changed into an earth, or calx, and deprived of all the characteristic properties of metals, are called imperfect metals. There are but four of this kind (1) Copper. (2) Iron (3) Tin. (4) Lead.

The other metallic substances w^c lose their metallic properties by exposure to fire, but w^c also have no ductility, nor fixity, are distinguished by the name of semi metals.

There are commonly said to be but five of this kind (1) Regulus of Antimony. (2) Bismuth (3) Zinc. (4) reg. of Cobalt, and reg. of arsenic. but some late mineralogists add to these Nickel, Man-ganese, & Molybdena, or black lead.

The Semi-metals are so called, because, notwithstanding their metallic appearance, they are not ductile, nor capable of being

being extended by the hammer, neither are they fixed in the fire, but evaporate on a great heat & fly off.

There are but 10 metallic substances yet discovered. all of them were known to the ancients, excepting five. Platina. Cobalt. Nickel. Manganese & Molybdena.

Some increase the number to 21 - He add Uranite.
Sylvanite - Titanite - Chrome - & Tungstane -

Now, we can decompose, and recompose all metals excepting Gold, Silver and Platina. They are immutable, and hence called perfect metals.

Metals are formed out of an earthy basis or element, and that inflammable principle, w. the chemists call phlogiston, which is a very active something, that in a great measure alludes the search of our senses. Do we throw any light on the subject when we say that phlogiston is to a metal, what the foal is to the body?

Chemists themselves have ^{had} endless disputes upon this subject; some even denying even its existence. We shall not mangle in the dispute, but stick to facts -

if you ~~produce~~ expose any of the imperfect metals to an intense heat, you destroy the metal, and reduce it to a mere earth, or calx; and if you add this

^{inflammable} principle to these earths or calces, you restore the original metal. These earthy elements, or calces of metals ^{are} ~~restored~~ revived, & restored to their former splendor by the addition of fat, oil, or charcoal, w. contain this phlogiston, or inflamm. principle.

Gold, Silver, and Platina, are called perfect metals, because they cannot be calcined, or burnt up, i.e. reduced to ashes, or in any respect altered by fire (w.^c alters every thing) tho' they be continued in it ~~as long~~ so long. Gold was called by the old chemists, or rather alchemists Sol. the Sun, or ^{Reges Metallorum} king of metals. — ^{Regina Metallorum} All metals are found more or less mixed with juaphur, or arsenic, and in such cases they are said to be "mineralized," and form what is called an Ore. O is an exception to this, for neither arsenic, nor Sulphur, is capable of dissolving it, so as to form with it that mixed body called an Ore; it being always found native or pure. Mineralogists do not, however hesitate to call the stony body w.^c contains a considerable portion of O, gold-ore. Gold is then you see a royal metal, w.^c will not mix with base earth, and was one of the reasons ^{for its} of being called the king of metals. Gold is so ductile that 1. lb of it, will gild a silver wire 12,000 miles in length. a wire of O not thicker ^{than} the tenth of an inch can hold 500 lbs weight without breaking!

Silver comes next to Gold in perfection & value. Like O it is capable of sustaining the greatest degree of heat without alteration. Silver is sometimes found combined with copper, and other metallic matters, and is mineralized w.th Sulph. & arsenic. Inasmuch that there are eighteen species of silver ore. 1. the native, or virgin silver w.^c

w.^c is often found mixed with stones. (2) Red ore, combined with arsenic & sulphur. (3) Black combined with arsenic and iron. (4) Brown, with antimony, arsenic & iron. He & Silver being the second metal in perfection was called for that reason by the old chemists Luna, or the moon. We ought to mention that these chemists gave the names of the seven planets to the seven metals. and the same character is common to both, (w.^c see.)

Platina is a metal lately discovered in the Spanish mines in South America. It is a perfect metal because it endures the most intense heat without suffering alteration of diminution of weight. The hardest of metals, & the heaviest.

Quick-silver, or Mercury, is considered as a perfect metal by some, and by others as an intermediate substance between the perfect & imperfect metals. It is found nature, in a stony substance called native cinnabar. As Mercury unites w.th a great many other bodies, we are able to form from it a powerful medicine & that too, under various names & forms. — So much for the perfect metals.

Imperfect metals are so called, because, tho; like the perfect metals, they are malleable & ductile, and fixed in the fire, they can nevertheless be deprived of their ^{oxygen} phlogiston, and reduced to ashes, or calx, by a very great degree of heat. The first we shall mention is Lead, called Saturn. If we expose the calx of this

The Characters Herschel

this metal to the flame of a furnace we produce what is called Red Lead. There are nine species of Lead ore, the red, green, black, stony &c &c - That called Galena w.^{ch} is very common, is mineralized by Sulphur & arsenic and most commonly a little iron. It is curious that this lead ore called Galena is always in a cubic form.

Copper is another of the imperfect metals, & is called Venus, by the chemists. It dissolves in all acids and all alkalies, and therewith forms bodies of a beautiful green & blue colours. It is the most splendid of all the ores. If you dissolve copper in acid of Vitriol it forms blue vitriol; dissolved in vinegar it forms Verdigrise.

Copper mixed with $\frac{1}{4}$ part of the calx of Zinc, or what is called Lapis calaminaris it forms brass; and in a different proportion it forms Pinebeck & Princes-metal. Mixed with Tin & a portion of some other metallic substances it forms Statue metal or bronze.

There are 12 species of copper-ore, redish, grey, blue, green, and yellowish or yellow pyrites, and a chrystallized one called mountain-green.

Tin, or Jupiter, is the lightest of all metals, and melts very easily. Tin mixed w.th Copper forms a hard, sonorous metal called bell-metal. mixed with that semi metal called

Zinc, Bismuth, and Antimony it forms Pewter: mixed
with L. Silver it forms the ~~covering~~ coating for looking
glasses, and when mixed with Lead, it forms the ~~covering~~
or rather lining covering for the inside of copper vessels. The common
Tin sheets, or ware, is no more than thin plates of Iron

covered with Tin. This is done by simply dipping the plate
in melted Tin, w. adheres to the iron. ^{Two parts copper 1 of Tin & 1-16th of arsenic make a metallic speculum for reflecting telescopes.} of Tin one

there are three species. 1. Nature? - Calcareous & mineralized
by sulphur. (Found nowhere but in England?)

Iron w. is called mans by the chemists, has some right
from its vast utility, the King of metals. It is the lightest
metal except Tin, and what is a happy circumstance
the hardest excepting Platina. Iron unites with all
metals excepting Lead & Mercury. It can be reduced
to a calx not only by fire, but by water also; w. operation
is called rusting, and w. reduces it to a powder as
effectually as fire. Iron is distinguished from all other
metals by ^{being} attracted by the magnet.

Iron is rarely found native, i. e. in a state that ad-
mits of its being hammered: it is generally mineralized
by sulphur & arsenic. Iron is so universally diffused
through the mineral & vegetable Kingdom, that there is
scarcely a substance in either from w. iron may not
be extracted. Of Iron Ores there are 20. Species. The mag-
net is one species, so is the blood stone and all the ores.

Now all these metals are capable of being dissolved
by water or other solvents in the bowels of the earth, w.
in process of time crystallize and form various pre-
cious stones, and crystallized appearances.

There are two substances so frequently found in ores &
metals, that they need some notice. The 1st is called Quartz
w.^c is a kind of white stone or crystal, and is found almost
every where. The Bristol stone is a very fine quartz. It is
Quartz so constantly accompany ores, that it may be con-
sidered as a matrix in w.^c metals are formed.

The other substance is called Pyrites, w.^c is a mineral
resembling the true ores of metals in colour, lustre, and
great weight. It is composed of metallic substances minera-
lized by sulphur, or by arsenic, or by both, and of an un-
metallic earth intimately united with its other principles.
It is called Pyrites, or fire stone, from its striking fire with steel.
They do not lay in veins like metals, but in distinct heaps.
They are very beautiful in form as well as color. They are
spherical, oval, cylindrical, pyramidal, prismatic, cubic;
they are solids from 5, to 10 sides, so that they form a very
beautiful part of the cabinets of the curious. True as they
are they are not very valuable. Ignorant persons who find
Pyrites, commonly suppose it to be gold from its splendor.
{ We however obtain from pyrites, our green & blue vitriols,
Sulphur, arsenic album & orpiment — See also specimen
of Native sulphur —

Since I circulated a printed letter through the country, not a few specimens have been brought from different parts of this State and New-Hampshire, but the misfortune is our countrypeople have their thoughts fixed on Gold and Silver only. They do not consider that a mine of copper, Iron or Lead, is in one sense a mine of gold, and are metals that we should seek after with the greatest diligence. They do not sufficiently consider that O & D, are precious metals only because they are very scarce; and that they are never found in such large, glaring lumps as this. It is in mineralogy as it is in common life, "all is not that glitters." and it is, with metals as it is with men, the most valuable make the least show, and the most worthless, are most apt to catch the eye of the un-informed multitude.

You may judge of the scarcity of O when I tell you, that from Mr. Neckers's estimate of the quantity in the vast Kingdom of France, the whole amount of it would make a solid cube of less than ten feet square. So trifling is the physical object that excites the impetuous passions of 25 millions of the human species! (See Crafft. 532. Vol. 2)

All the six metals (says Boerh) when fused by fire, in clean vessels, have the same appearance & perfectly resemble mercury, both in respect of colour, density, the sphericity of their drops, the attraction of their parts, their mobility, & manner of running. Hence ∴ it seems to follow, that mercury is a metal fused by the smallest fire; that Tin requires a greater degree of fire; and that if the atmosphere were hot enough to fuse it, it would be mercury; but mercury w^c smokes & casts up a froth; that Lead would also be mercury with the next degree of heat, but mercury with certain peculiar properties of frothing & penetrating vessels; so silver & gold are mercury w^c require a much greater degree of fire, and remain immutable therein. Copper again is mercury w^c melts in a much intenser heat, but is changed wth that. Lastly Iron becomes mercury in a degree of heat beyond any of the rest: (so that the whole tends to shew that all the metals are mercury). Boerh. Chem. Vol. 1^o. p. 104 -

On water.