

June 13th 1805

Waters, Mountains, and Rivers

The theories of the formation of the earth engrossed our attention at our last meeting. We spoke particularly of the theories of Burnet, Wadward, Whiston & Buffon; and lamented that so much learning, and such an assemblage of talents should be wasted in so deleterious a pursuit!

We sh^d there were several things in Nature w^{ch} our reason could not explain, or perhaps comprehend. 'Tis bene-
-ficial to know this. 'Tis of great use, says Locke, to the sailor to know the length of his line, tho' he cannot with it, fathom the depths of the ocean. We hope you will not mistake these fanciful theories for Nat history.

Let us ~~then~~ ^{take a} view the earth or globe as it now is; and never waste our precious time ⁱⁿ by the vain & useless search respecting its first formation.

Astronomers & Geographers teach us that the terraqueous globe is not of a completely spherical form; but that it protuberates, or bulges out about the equator; and that it is proportionably flattened at the poles. The surface of the globe is marked with considerable irregularities. In some places we find vast plains intersected with hills & vallies. In others, we find long chains of mountains, from whence proceeds Rivers, w^{ch} after watering various countries, discharge

discharge themselves into the sea. — If you consult the artificial globe, you will see what a great proportion of it is covered with water. There have not been wanting writers who have found fault with Providence, in committing a waste, by rendering so much of our globe useless, which they assert could be ~~much~~ more economically filled up by making more dry land! But we could ^{rather it appears} demonstrate, that these are but short sighted philosophers for there is, as we shall show hereafter, a circulation of water between the Ocean, atmosphere, & Earth, chiefly for the sake of vegetation so exact, that this too, like every thing else in Nature, which we understand, is dealt out by weight and measure.

It has been a question among Philosophers, how mountains were first formed? Some contend that they are as old as the globe itself; others that they were formed at the Deluge; and Sir Wm. Hamilton & Mr. Brydone speak, as if they were sure, that they were all cast up by subterranean fires, that is, that they were all, at first Volcanoes before they settled quietly down into quiet, inoffensive mountains. Altho' this is a recent doctrine, it may be questioned whether the opinion be equally true of all mountains. — The burning mountains have continued what they were, from the earliest accounts of time

time, without any signs of decay. M^t Etna, would, according to this idea, have long since have exhausted itself, by throwing out such vast quantities of its own substance; and yet it is observed, that it still seems to be what it was called by Pindar 2200 years ago the "pillar of Heaven". What are those powers in nature which counteract those that tend to destroy their internal parts by fire? [Ency. B. art. Earth.]

Some writers, carried by the imagination alone back to that epoch when the globe issued from the hands of the Creator; contend, that the mountains are as old as the world itself [by the world they mean this earth & its attendant moon, for they contend with Whiston, that the Sun, with some of the other Planets existed long before.] Others suppose they were formed at the deluge.

This difference in opinion may be reconciled & harmonized, by making a distinction, that is little regarded, viz into primaeval and alluvial mountains. The primaeval mountains evidently preceded the formation of vegetables & animals. How do we know this? We infer it from their containing no remains of organic bodies, that is, of animals or vegetables, either in the form of impression (as thus -) or petrification, or shells, or any other remains or exuviae of marine bodies. The highest of these mountains do not contain even metallic ores. Such e. g. as the alps, Pyrenees, in Europe; the Atlasian, Uralian, & Caucasus in Asia; and the Andes in America. All these high & widely extended mountains are formed of that species of stone, called Granate. These

These Mountains are, we presume corral with the globe itself.

The other or alluvial mountains are as evidently of posterior formation. How do we know this? Because they lay in strata or beds, and they contain impressions, & petrifications, of animals & vegetables, and other vestiges of organic substances, which clearly prove, that they were heaped up by some earthquake or great convulsion, or deluge, after the creation of animals and vegetables; whereas the primeval mountains contain none of these, because they were ~~made~~ heaped up before either vegetables or animals were made. These distinctions, ^{but} little attended to, reconcile these diff. opinions. -

There is moreover a third kind, viz mountains thrown up by subterraneous fire, or volcanic eruptions. These burning mountains are found in all countries, even in the frozen regions of the poles. In Iceland there is a burning mountain incessantly vomiting fire amidst ever-lasting ice & snow. In the neighbourhood of this volcano, there are jets, or fountains of boiling hot water thrown to a prodigious height on the air. All these burning mountains seem to have a communication with the sea. The Peak of Teneriffe is evidently an extinguished volcano, - [e.g. Pumice stone]

There has

There has been another question among Philosophers, viz what
were the use of mountains after they were formed? It is
somewhat surprising that some writers, who call themselves
Naturalists should make so many wild conjectures respecting
the use of mountains after they were made. Some have con-
sidered them as excrescences, or warts, w^{ch} deform the
fair face of Nature: others suppose they were intended
as hoops, or ribs to strengthen the earth & bind it together:
while others have contended that they were designed to
arrest the vapours, w^{ch} are continually travelling from the
equator to the poles; urged thither by the rarifying heat of
the Sun; and which would there accumulate, were they
not stopp'd by these high ridges of mountains, which
cross their direction. But the natural history of America
contradicts this opinion, as all the mountains on this
vast continent run longitudinally & not with the pa-
-ralls of latitude. — It is strange that the learned ~~Bishop~~
D^r Burnet, could, for a moment, imagine, that the antide-
-lucian world could produce vegetables & rear ani-
-mals, on a globe as round as a block of marble, without
any elevations or depressions, & consequently without seas or
rivers! How can there be a river without a hill? —

Whoever knows, and knowing reflects on the internal struc-
-ture of mountains, supported as they are by firm, unyielding rocks,
will ^{to} see that they are designed to a certain end, as much as the bodies of some

some animals. Their internal parts must be firm & unyielding like bones, yet open, or at least, not close, that they may admit into their cavities the rains from the clouds; for soft & yielding mountains of clay, or pure mole, or any other imperious matter, must impede the ~~descent~~ of water; for the mountains must retain & convey the waters constantly falling from the clouds, nor must these celestial supplies stagnate there; but they must perform a various & many course, till they break out again at the sides of smaller hills, whence they flow in winding streams to enliven the parched soil, & give new life & verdure to the beauteous carpet of vegetables, which ~~covers~~ adorns the vallies.

" Though most very high mountains are doomed to an eternal barrenness, yet to them it is owing that the countries in their neighbourhood, have all that beauty & fruitfulness so universally observed in vallies. The country east of the Caspian sea, sometimes becomes a desert for several hundred miles round, altho' otherwise fruitful, merely because there are no risings or depressions, to form reservoirs of water, or to collect the smallest rivulet."

The solicitude of Nature, if we may so speak, is equal to the importance of this element to all terrestrial bodies. Indeed water is an element, w.^c enters into so many operations of Nature, that the full description of its properties would absolutely in-
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include the properties of all other bodies. Water is the general cement of all nature. Iron-stones & salts deprived of it fall to powder. It even bears a part in the formation & in the decomposition of all the bodies of the mineral Kingdom. It is absolutely necessary to vegetation; and to the free use of all the functions of an animal body. Water enters into all the food of every animal in creation. It moreover hastens and facilitates the destruction, the necessary destruction of animal & vegetable bodies, and this it does as soon as ever they are deprived of life. — but I dare not enter into the vastly extensive properties of water: were we to expatiate, you would be ready to allow that the famous Thales had abundant reason for concluding that water was the original, or primary matter, or that out of which all things were first created. We mean, at this time to speak only of the mode ^{or method} where Nature uses to afford the needful supply.

The source whence Rivers derive their unceasing stores of water, where continually enrich the world with verdure & fertility has been a subject that has divided, not a little the opinion of Naturalists in all ages.

All the great Rivers

All the great rivers have their origin in mountains; the higher, or rather the more extensive the mountain, the larger the river; - thus the river Amazon, the largest in the world, has its source among the Andes, w.^c are the highest on this globe. The river Niger travels its long course from the mountains of the 'moon', so called, the highest in all Africa; and the Danube and the Rhine proceed from the Alps the highest in Europe. The Rhine coming from Switzerland passes through France, Germany & Holland, where its vast bed of waters divides itself into 4, or 5 channels & mixes with the sea, after a course of above 200 leagues. The Danube travels 500 leagues before it discharges itself into the Black sea. The Niger waters 1100 leagues of land in the vast burning, sandy deserts of Africa; and the River of Amazon, w.^c appears no more than a rivulet near Quito, where it takes its rise, after a course of nearly a thousand leagues opens itself into the ocean by an outlet of 250 miles in breadth! It is difficult to form an adequate idea of these vast mountains; sometimes provinces are found encompassed near the tops of some of them as that of Savoy & of Quito. There are few things in Nature, says Goldf. / w.^c impresses an unaccustomed spectator with such ideas of awful grandeur as these immense piles of Nature's erecting, that seem to mock the minuteness of human magnificence!

As to the source of rivers, some contend that they are supplied by the sea, strained through the pores of the earth; while others have

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endeavored to demonstrate, that the clouds are alone sufficient for the supply: they contend that the evaporation from the sea is more yr. sufficient to supply not only the vegetable kingdom with water, but also to furnish a sufficiency for the largest rivers.

This is the way the largest rivers begin. — Part of the vapours arising from the ocean fall back again before they reach the land; another part is arrested by the sides of mountains, and dripping down by the crevices of the stones, begin to form little brooks, when, uniting with other kindred streams, it rushes with accelerated force to the plain below. ^{while} The violence of the fall hollows out the ground, casting up the earth on each side by way of banks. Thus it pursues its course, ^{forcing} excavating a passage as it goes, through every soft thing that opposes it, and excavating a channel for itself. Thus enlarged & thus fortified, it steers its course along the sides of spacious plains, and makes the tour of hills & mountains, or to use the poetic description of Thompson

"In silent dignity it sweeps along

"Traversing realms unknown —

"Till pouring on, it proudly seeks the deep,

"whose vanquish'd tide recoiling from the shock,

"Yields to this liquid weight of half the globe."

While floods or floods in swelling turbid tides.

Noel roaring down the mountain's channel'd sides.

Pitt

The circulation between the ocean & the mountains is briefly this. — The sea water ascends in vapours & then descends freshened in rain or snow. Those vapours w^h are arrested by the mountains find proper basins or reservoirs

reservoirs, in which they are collected; thence gently stealing out in springs, by degrees grow into rivers, which steer their course towards the sea, watering the vallies & plains as they run along, while such bodies of water as penetrate deep into the earth, do likewise return, thro' passages underground, to the common rendezvous of waters, the ocean, whence they originally sprang.

We can now no longer be at a loss for the use of mountains, nor ignorant whence they ^{derive} their store of waters, after recollecting what a vast magazine of water the atmosphere really is, w.^c is constantly agitated by winds, by electricity, and other unknown ^{agents} causes, w.^c causes the clouds to distill perpetually, or to shower down at times, those valuable liquid treasures, first on the summit of the mountains, then descending from cliff to cliff, diffuses the refreshing stream, through the plains below, giving verdure, life, health & beauty to all that lives.

Here you see, what perhaps, some of you would have little expected, namely a communication subsisting between such parts of the creation, as at first view, appears to have no relationship at all with each other viz between the sea & vegetation; - between the mountains & the ocean; - rivers underground & the atmosphere above it! Our globe

Our globe has, in fact two oceans; one of salt water, covering more than half of it; the other of vapours, surrounding it every where, called for that reason atmos, or vapour sphere. The ocean of salt water is exposed to the action of the Sun, the wind & other causes, by which another ocean of vapours is raised forming the atmosphere, while the mountains, which to first appearance have neither use, nor comeliness, serve to collect such a quantity of water as is necessary to the formation of those rivers, w.^{ch} intersecting the face of the globe, are, while they seem to disjoin, actually the bonds of the material & rational world. —

What connection does there seem to be between the Atlantic ocean & the alligany mountains? and yet this sea & these mountains mutually conspire to furnish us with one of the indispensable elements of life. The hills w.^{ch} terminate our view, give rise to springs & rivulets for the immediate use of man and beast. But it is to the Andes & alligany & some other mountains, that we are indebted for those vast rivers w.^{ch} distinguish & dignify this quarter of the world, above the other three. And thus,

and thus is all Nature linked together by one universal law of harmony & agreement!

By this time you see clearly that in order that the earth may be fruitful, producing food for man & beast, it must first abound with rivers, or running waters; which could never be, ^{were} our earth perfectly level, as it was feigned to be, by Dr. Burnet, in the golden age. You see the absolute necessity of hills & mountains, which some have foolishly considered as so many warts or excrescences of Nature. We see they make an important part of that grand apparatus, for distilling fresh water from the salt ocean. To imagine: that these rough, rude mountains are neglected & unfinished productions, & the wreck & ruins of a world, ^{decalated} rendered so by the wrath of the Al-
-mighty, is to judge of the works of his creation by our own narrow prejudices. The water w. they conspire to circulate is dealt out by weight & measure; and it is probable that there is not a drop more or less of water now than at the first cre-
-ation. He who was called by way of pre-eminence the Wiseman expresses his idea of this never ceasing revolution when he says,
"The thing that hath been, it is, that which shall be again; all
"the rivers run into the sea, yet the sea is not full: unto the place
"from whence the rivers come, thither they return again" *

* Ecclesiastes Chap 1st.

It strikes one as something strange &c.
(circulation of oceans & clouds)

(Intermediate paragraphs) June 14th 1805

We have s^d that the atmosphere is a part of that grand apparatus w^{ch} Nature employs in the distillation of fresh water from the salt ocean. The atmosphere appears to be an offspring, an expansion, or expiration of water. The most unexceptionable hypothesis of the original formation of the atmosphere is given by the venerable Bishop Watson. Let us suppose says this ^(not terrestrial) terrene globe was learned & excellent Prelate, that this terrene globe was not surrounded with any atmosphere, & that by its approach to the Sun, or by an increase of the subterraneous fires, (or by both) it should be exposed to a heat four times greater than the medium heat of our summer (60°) what would be the consequence? An atmos, or vapor sphere would be quickly formed around it. The water on its surface, the juices of plants & animals, a great variety of mineral particles; in a word, the attenuated particles of all terrestrial bodies w^{ch} be raised up in vapours & exhalations, and while the heat continues, the whole w^{ch} be kept suspended in an elastic state, constituting an atmosphere as we now find it.

We find in the concise account of the creation by Moses that the atmosphere, or as he calls it the "firmament" immediately succeeding the formation of light. Now if the effect of that light was heat, then w^{ch} such particles of the shapeless chaos, as were capable of being evaporated by that degree of heat, be elevated in an elastic state, and a division or separation would take place between the waters w^{ch} were of a nature subtle enough

enough to be converted by that degree of heat, into an elastic fluid, constituting the atmosphere; and the waters w^c could not be evaporated in that degree of heat would remain in its appropriate place the beds of the ocean, but always subjected to rise in its turn into the atmosphere, & its waste be as constantly supplied by the rivers. This opinion of the formation of the atmosphere is Dr Isaac Newton's, somewhat amplified — "I conceive, says he, the confused mass of vapours, air, & exhalations, w^c we call the atmosphere to be nothing else than but the particles of all sorts of bodies, of which the earth consists, separated from one another, and kept at a distance by a principle of repulsion" that is, by heat —

These earth's atmosphere is, then an elastic transparent fluid w^c surrounds this globe to a certain height. In one point of view, it may be considered as a mighty watering engine, and the Ocean is its fountain. —

Rivers flow & branch out on the surface of the earth, and under the surface of it, like the veins in an animal body. They run, as we have seen, through immense tracts of country, and water & fertilize, and unite them by a reciprocal commerce, and majestically rolling their waves towards the sea, plunge themselves into it, in order to be again exhaled in vapours, and re-enters a fresh into the channels of this magnificent circulation.