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§1. Introduction.

Even a small notion of great things is valuable. Therefore starting from the most ancient state of our region we must say something about the earliest form of the Earth, and about the nature of the soil and of what it contains. For we inhabit the highest place of lower Germany,¹ one where mines are especially abundant; and notable conjectures are at home to us, and, so to speak, rays of public illumination are born here, and from that our reputation proceeds to other regions. But if we achieve less than we resolved, at least we shall contribute by our example: for when people everywhere contribute their own curiosity, common origins will be more easily understood.

§2. The globe of the earth was at first a regular form, and has hardened from liquid, light or fire being the motive cause.

It is believed by the wise that the globe of the earth, like everything that has been born, emerged from nature's hands in a regular form; for God does not make rough plans, and everything which is formed by itself develops imperceptibly either from small parts, or is fashioned by the parts arranging themselves by separation and collision. Therefore the ruggedness of mountains, with which the face of the earth bristles, appeared later. And certainly if liquid existed from the beginning, it is necessary that the face of the earth must have been uniform also; and it agrees with the general laws of bodies that solids hardened from liquids. And this is proved by solids enclosed within a solid, when certain strata and cores are confined within their own niches and paths, such as the veins of ore in rock, or gems in stones. But also the remains of old things, of plants and of animals and of artefacts, are found everywhere, wrapped in a new coat of stone. [Pr p14] Consequently, the hard coating that we now see was made later; at one time, however, it must have been liquid. Now fluidity itself arises from internal motion, and as if from a degree of heat, which experiments prove. For even water turns to ice because of reduced heat; while on the contrary corroding liquids, being strong because of a hidden motion, are hardened with difficulty. Moreover, heat or internal motion comes from fire or from light, that is, from a very rarefied, penetrating spirit. And thus we have arrived at the motive cause which Sacred History also takes as the beginning of Cosmogony.

[Pr p26]

§6 From where did the water come that covers the Earth and what happened to it? And on the various causes of the flood.

Just as fire in the beginning seized everything, before the light was separated from the darkness, so it is supposed that after the extinction of this fire everything was submerged by the waters. The event is related in the sacred books of our religion; the ancient stories of nations agree, but especially the vestiges of the sea discovered inland aid faith. For even snails are found in the mountains, and to touch on our region, amber, which is often gathered in the sea, is sometimes found at a distance from the sea, and is also dug out of the ground in our country. And glossopetrae,² that is sharks' teeth, similar to those from Malta, are dug up near Lüneburg; but we shall speak soon of all these things more explicitly.

There are those who go so far in their bold conjecturing as to think that all animals, which now dwell on the Earth, were covered by the sea, and have at some time been aquatic, and little by little, deserting their element, became amphibious and finally in succeeding generations forgot their first home. But that disagrees with the writers of the Holy Scriptures, to depart from whom is a religious offence. What we must consider now is from where came such a large mass of water **[Pr p28]** which could overcome mountains, and where afterwards it withdrew to so that dry land would be returned to itself. Some men, by ingenious rather than well-ordered argument, describe the matter solely by a change of the centre of the Earth.³ Thus, they say, the direction of gravity was turned in another direction, and although the surface was preserved, nevertheless the highness and lowness of places exchanged, insofar as those may be considered not in themselves but in relation to their nearness to the centre, especially if some vacillation of the centre into different parts may be assumed, for thus a change of elevation and depression will come from every side. And there are those who, influenced by experiments on magnetic variation, imagine that there is another large body inside our Earth, like a kernel in a nut, having its own motion; but if the cause is to be therefore sought in that, must we not look to its poles for magnetic attraction rather than to the centre for the attraction of gravity? But one could believe that this with its magnetic body has sometimes moved around, since its position is not yet fixed. It is easier to understand where the superfluous water went to, so that the Earth was relieved of it. For it has been able to flow through concealed entrances, broken through then for the first time, into vast caverns, and to penetrate into the interior of the globe. Although the seas have been able to cover the tops of former mountains, even if they may be imagined to be more than four Germanic miles above sea level, they would still not form a seventieth part of the rest of the globe. Thus nothing would contradict the view that what we now see has risen up out of the water, or rather if a higher part already existed beforehand, only then did men descend from the highest ridges, as the Scythians came down on the Egyptians, into new homes, and into the celebrated valley of Sinai of Moses; perhaps also when they were compelled by the cold, when the sea receded to the lower regions, **[Pr p30]** they appeared as though lifted into a higher region of the air, which might now be moderated by unfavourable temperatures. But if the water, when the earth was already solid, rose

from a low-lying place into the highest mountains themselves by a natural cause at a time of flood, yet another explanation is required. Rains by themselves are not sufficient, unless the air was formerly more watery than at present. It is scarcely credible that the ocean was raised and lifted up everywhere across the globe like a vault by gas bursting all around from the earth; the swelling of the actual surface of the Earth is appropriate to the former time of fusion and to the time of volcanic activity, when the mass was soft and viscous; it had not yet fallen into a hard and brittle crust. I would not dare to invoke external causes, such as the passage of a comet in the vicinity of the Earth or the moon being closer than it is now, which, by attracting the waters, would have raised them. Nor do I have confidence in a change of the direction or of the centre of gravity. But if we must face the problems, nothing appears more plausible than that we might believe that the vault of the Earth ruptured where it was held up by weaker supports, and a huge mass collapsed into the formerly enclosed sea below, leaving peaks exposed. So the waters, forced out of caves, overflowed above the mountains, until, having found a new way into the underworld when the floodgates of the inner Earth were broken open, they left anew whatever now appears as dry land. And so if water once covered the crust of the Earth since its formation, one vault is sufficient. But if the water has overwhelmed mountains by a new inundation, there must have been two vaults, and the external cavity was filled with water, the internal cavity with air. So when the first was ruptured, water rose into the mountains, then when the lower one was fractured the water must have penetrated the lower abyss, and it will have conceded to terrestrial dwellers dry land for a second time. In these explanations [**Pr p32**] we can assuredly be aided by some meditations of an ingenious writer who recently gave us *The Sacred Theory Of The Earth*,⁴ and who argues that mountains and valleys have formed from catastrophes, and by the writings of some erudite men, the study of which that writer encouraged. And Steno⁵ had already considered certain things about catastrophes and sediments which were not inconsistent with this. He surveyed a not inconsiderable part of Europe, and he everywhere observed the remains of broken arches, as I remember hearing him often recount, and congratulating himself that he contributed to faith in sacred history and the universal flood by natural proofs, not without the fruit of piety. But we seem to have gone further, having asserted that the vaults are the result of fusion, and that the seas were formed by the flowing of salts which absorbed the aqueous vapours.

[**Pr p56**]

§13 Silver and gold and other metals, which exist in their own state, appeared through the power of fire in veins.

With regard to silver or gold, or any other metal which exists in its own state, or at any rate occurs in a pure state, one is very inclined to suspect that they have been formed into a metallic body through the power of fire; and to such a point that in some places it seems as if it has taken the form of a cast of the surrounding hollows. Certainly a silver granule was not so long ago discovered in the alabaster of Nordhausen. [**Pr p58**] I remember certain fresh metallic masses brought to me from a mine which craftsmen swore by Jupiter had been produced recently by

casting. Thus nature created instead of man. Conversely, certain clever fraudsters imitate in the furnace the rarer forms of minerals, such as rough red silver, both vitriform and capillary, in order to deceive the curious. Thus they benefit from their deception, and teach the art of nature, the effects of which they have copied.

§14 Certain bodies take their form from the motion of the waters, such as those that are rounded between rocks and metals.

Meanwhile it is to be admitted that certain bodies take their form from the motion of the waters alone, so that to invoke heat is not necessary; certain bodies require the operation of both. I say nothing about pebbles smoothed by the continuous course of rushing streams; certainly nothing prevents grains of metal being rounded by movement and rubbing, just like the dragées⁶ of Verdun when they are agitated for a while. Smoothed pebbles, roughly cut by nature, are seen everywhere on mountain slopes, and in the Alps themselves, which is good evidence that after the continuous motion of the waters has worn them down, they have stuck to petrifying soil, and afterwards through new catastrophes they have again become exposed. From which it is also understood that a river or torrent has formerly been there or in another higher place, displaced by the changed shape of the Earth.

[Pr p74]

§20 Fish expressed in slate are from true fish, and this proves that they are not tricks of nature.

If anyone would still prefer to say that burned stone is scarcely of nature, that the mud covering the fish turned to stone either through time as a result of the nature of the material, or for some other cause, through some stone-making spirit or something else, and that metallic matter took on the measurements of the fish, or that in the beginning the mass was crude and soft, or even that afterwards it was carried out by a penetrable vapour (although these ideas may be understood less easily), I do not object, nor do I dare to suggest anything certain, except what is sufficient for us, namely that fish expressed in slate are from true fish. Both the multitude of fish contained in one and the same place, and the fact that nothing is there except fish, support my opinion. As for the pontifical crown, Luther, and I do not know what other forms people mention that are delineated in the rock of Eisleben, I regard these truly as tricks, not of nature but of human imagination, which sees armies in the haze, and recognizes in the strokes of bells or drums whatever modulations it wants. And many things are of this kind, which are exhibited to the public in the cave of Baumann, namely Moses and the ascension of Christ, and other images from stone, which you wouldn't recognize unless you were warned. The splendour of things increases according to one's faith in the miraculous, **[Pr p76]** but while I seem to have said that we must be astounded about marvels from our regions, that is not my own belief. But faith is greatest and undoubted in the representation of the fish of Osterode and Eisleben, and one must immediately acknowledge not only the fish but also the genus of the fish and the true size and symmetry of its parts, and the scales, and everything else. The composition of the

area itself constitutes a great argument. For we have said that there is a sloping vein of slate containing fish, (if I may speak in the terminology of our miners); that is, in a nearly horizontal stratum jutting out by several miles, as it now readily apparent, the fish of the same lake were pressed by a mass falling on top of them. Sizeable lakes certainly exist even now in the vicinity of Eisleben. And there you can marvel at marine fish in rock, not far from Seeburg, where there is a vast lake of salt water; and fountains of salt waters show that there are repositories of salt under the Earth, of which the most famous is the one that flows from Halle, in Saxony, eight miles from Eisleben, which some have supposed was once the cause of war between the Chatti and the Hermundures.⁷

[Pr p84]

§23 Marine shells are found here and there in our country and elsewhere.

Therefore, so that we may describe in detail the other vestiges of the ocean, we must speak of these shells with which our rocks everywhere are filled. Even a long time ago Valerius Cordus, eminent doctor of Brunswick and Hildesheim, from whom Agricola learned many things about fossils, observed in the quarries and the wells of Hanover, and especially of Hildesheim, from the diggings themselves and the chambers created that marine shells are populous in our country, and that it is a frequent occurrence for them to be found near Alfeld. Also in a much higher place: near Grund, a town of metalworkers, opposite mount Iberg of our Harz mountains, from where the richest iron ore is dug up, just like a certain rock (called Hupkenstein) is obtained from a kind of spar (such as composes Baumann's cave), in which various hardened shells are seen. But it is well known that it is the same throughout the whole of Europe. And Figueroa,⁸ Spanish ambassador to the Persian shah, was very surprised to see, when coming from Ormuz, in the high Caramanie mountains, oysters incrustated into the hardest stone, just like the molluscs of his own Galice, and he did not hesitate to acknowledge the vestiges of the sea. But long ago **[Pr p86]** the ancients said the same thing, though this is not the place to compile what is already well known. It is better to look at the matter itself, and to acknowledge the clear proofs of a buried animal.

[Pr p88]

§25 The shells and bones of marine animals that are dug up can be examined and explained just as well as the parts of real animals.

The more closely you examine the actual parts of bodies, the fewer doubts you will have about their origin. For they are not resistant to examination, like those amusing imitations in marble of men and houses which one has to observe from a distance. A more careful analysis will show that the shellfish of the shore, no less than those found in rock, have the same kind of texture consisting of hard parts and fibres, and what appears to be seams, and are divided into cells, and also they can be dissolved in vinegar (that is, whenever they are covered rather than impregnated by the stony material), and sometimes pearls are discovered within, and the animal

itself is preserved in its own shell of stone as if in balsam. Finally, near Volterra in Tuscany, and near Reggio in Calabria, are found in the layers of the earth unmistakable shells displaying no change at all, and without any petrification. Similarly, the remains of animals are dug up near to us, from the mud in a cave near Scharzfeld, which is called by [Pr p90] the inhabitants the cave of the Pygmies. Therefore there is no reason why we should conclude the origin is different when the earth has turned to stone.

§26 In very ancient times the nearby seas contained animals and molluscs that are not found there now.

That which learned men otherwise urge, scarcely undermines the argument. They have difficulty convincing themselves that the sea has been in the highest mountains, or that things of the sea have existed there: evidently because they judge the former appearance of the world too much by its present appearance, and every flood they look to explain simply by the rains, not sufficiently considering that sometimes the waters of the great abyss have burst through and overflowed. Others are amazed that species can be seen everywhere in stones, which you may look for in vain either in the known world, or at least in nearby places. Thus they say that ammonites, which may be considered to be from the nautilus species,⁹ differ everywhere both in form and magnitude (for sometimes they are even discovered measuring a foot in diameter) from all those which now live in the sea. But who has fully explored its hidden recesses, or the subterranean abysses? How many animals, previously unknown to us, does the new world offer? It is quite credible that during those great changes the species of animals have still remained mostly unchanged. Lachmund illustrates our ammonites in fossils from our country, from where we have copied out the illustrations here. But a careful investigator of the works of nature, the Englishman John Ray, has inquired more fully into these matters. And I do not doubt that through such a great disturbance of things [Pr p92] that the spoils of the sea are often brought from distant shores, since now it is also agreed that everywhere storms throw up kinds of molluscs onto our coasts which fishermen do not find in the nearby sea. And when a huge mass of similar things have collected in one place, such as in Malta alone we wonder at the huge number of sharks' teeth which are called glossopetrae, it is not foolish to attribute it to the whirlpools of the seas, where after much agitation, the result has been that they have deposited in one particular place through a combination of their movement and weight. In short, it is just as in the crystallisation of different salts dissolved in the same liquid, when we see salts joining with similar salts without mingling. For the most part, as I believe, water, finding its way through narrow places, has abandoned that which it was carrying. The inevitable result has been that a huge mass of things from the sea has soon been accumulated, always in an unusual manner, and by a flood tide laden with flotsam before it passes into narrow places.

[Pr p126]

§35 On the horn of the unicorn, and the remarkable animal excavated from Quedlinburg.

Since Gaspard Bartholin has demonstrated that the horns of the unicorn, of which repositories of strange things everywhere were once so proud, and even today bring the eyes of the common man into stupor, are from the fish of the northern ocean, it is right to believe that the unicorn fossil, which our regions also offer, is of the same origin. [Pr 128] But we must not ignore that a quadruped unicorn with the size of a horse is to be found in Abyssinia,¹⁰ if we believe Jerome Lobo and Balthasar Tellez.¹¹ Likewise the skeleton found in the rock in the vicinity of Quedlinburg near Mount Zeunikenberg, in the 63rd year of this century, excavated together with chalk, more nearly resembled the appearance of a terrestrial animal. Otto von Gericke, mayor of Magdeburg, is a witness of the fact; he has adorned our age with his new inventions, and was the first man to invent a pneumatic pump, by which air was drawn from vessels, and wonderful things were demonstrated by this inventor in the assembly of Ratisbonne in the year 1653, in the presence of the Emperor; which afterwards were even wonderfully improved upon by the Englishman Robert Boyle, the highest of men, brother of the Count of Cork in Ireland, who enriched us with a new treasure of experiments. Consequently Gericke takes the opportunity to relate in his published book on the vacuum¹² that the unicorn skeleton was found reclined on the back part of the body, as beasts are accustomed, though the head was raised up, the forehead bearing a long extended horn almost five forearms in length, and as thick as a human leg, but decreasing proportionally. It was crushed and extracted in small parts due to the ignorance of the excavators, though finally the horn with the head and some ribs, and the backbone together with other bones were brought to the Abbess of the region. The same things have been reported to me, and a figure is added, which will not be unworthy to append.



[Pr p140]

§39 On the changes to the Earth caused by rivers, and on the vestiges of the remarkable catastrophes in our regions.

But let us touch briefly on the remaining vestiges of the remarkable changes of

nature that are possibly older than the inhabitants of the Earth. Aristotle and Peiresc¹³ believe Egypt is due to the Nile, and the land of Arles to the Rhone, while Nannius¹⁴ believes that Holland is the work of the north wind and the Rhein. Certainly rivers carrying material strip the higher regions, and the Frisians are enriched every day by the material lost to us. And I do not speak of islands that have arisen, such as the one we recounted earlier under Leon the Iconoclast, which erupted by a terrible earthquake and fire; nor do I speak of the straits being broken open by the sea, such as the straits of Gibraltar and Sicily are judged to have been by the ancients; nor of overturned mountains, just as has happened in the principality of Berne, and in the valley of the Alps, and, according to the memory of our ancestors, in Rhetia, when the town of Plurs was overthrown,¹⁵ and in the territory of Firman, when a mountain named after its caverns collapsed in the year 1670. Nevertheless vestiges of catastrophes are evident in mountains of the region of Blankenburg near us, and also everywhere else. They are dreadful in appearance, and one can attribute some of them to rivers; especially in the region of Rostrap, where in projecting rock they show, if it is pleasing to the gods, an impressed mark of a hoof in a cliff, [Pr p142] from which, according to poetic tradition, the daughter of a king with her lover on a horse jumped across a terrible waterfall of the Bode river to the mountain opposite. Moreover, lakes can be seen everywhere that have arisen from catastrophes and earthquakes. I say nothing about the asphalt of Sodom, and about the lake of Pilate and other things. But they think that Steinhuder in our region between Leine and Weser, has emerged out of the waters as the land of nearby regions has subsided, which is easier to believe than those who say that there is a city lying buried there, whose ruins have been revealed by the waves, a story they have received from their elders and passed on to posterity.

NOTES:

1. Leibniz means the Harz region of Germany, in Lower Saxony.
2. Fossilized shark-teeth, literally 'tongue-stones'.
3. Possibly an allusion to François Bernier, *Abrégé de la philosophie de Gassendi* (1684).
4. Thomas Burnet.
5. Nicholas Steno.
6. sugared almonds.
7. Ancient Germanic tribes.
8. Garcia da Silva.
9. That is, to be a kind of shellfish.
10. Now Ethiopia.
11. Jerome Lobo, *Relation historique d'Abissinie*, trans. Joachim Le Grand (Paris, 1728). Translated into English by Samuel Johnson; see Samuel Johnson, *A Voyage to Abyssinia* (New Haven, 1985).
12. *Experimenta nova Magdeburgia de vacuo spatio* [New Magdeburg Experiments

About the Vacuum], (1672).

13. Nicolas Fabri de Peiresc (1580-1637).

14. Pierre Nanningh (1500-1557).

15. Leibniz is referring here to the avalanche of September 4 1618 which destroyed the town of Plurs, Switzerland, killing 1,500.

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