

THE GENERAL
THEORY and PHÆNOMENA
O F
EARTHQUAKES
AND
VOLCANOES:

WHEREIN

The several SYSTEMS of *M. Amontons*, *Dr. Lister*, *M. de Buffon*, *Dr. Woodward* and Others are exhibited and considered, with REMARKS;

IN WHICH

The NATURAL CAUSES of these astonishing Effects are assigned; the Process of Nature in their Production investigated, and confirmed by EXPERIMENTS; explaining the several Phænomena that usually precede or accompany Earthquakes; but more especially those uncommon and more general ones of the late Earthquake.

To which are added,

An Historical Account of the various Appearances and Effects of the most memorable Earthquakes and Eruptions of Volcanoes upon Record, and a particular History of the LISBON-Earthquake.

By an ingenious GENTLEMAN who was an Eye-witness of that tremendous Calamity.

L O N D O N :

Printed for W. OWEN, at Homer's Head, near Temple-Bar. MDCCLVI.

[Price One Shilling.]



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OF
EARTHQUAKES
AND
VOLCANOS.

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The General System of Mr. Hutton, Dr.
Laplace, M. de Laplace, Dr. Wollaston, and
Others are exhibited and compared, with

REMARKS
ON WHICH

The Natural Causes of such earthquakes
are explained, the Theory of Tides is
their Production investigated, and confirmed by
numerous experiments, the general theory
of earthquakes is traced to its source by
mathematics, but more especially the phenomena
and their general ones of the sea, earthquakes,

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By the Honorable Gentleman who has
the honor of the present Edition.

LONDON,

Printed by W. Green, at Thomas's Head, near St. Dun-
stons Church, in Fleet Street.
MDCCLXXV.
[Price One Guinea]



THE GENERAL
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VOLCANOES.

AN Earthquake, of all the Phænomena in Nature, is the most formidable to Mankind, in regard that, while it threatens them with the most immediate and universal Destruction, without any previous Warning, or stated Signs of its Approach, human Invention can devise no Security against its Effects. However, great and alarming these Convulsions of the Earth may be to the Inhabitants thereof, and however distant and latent from their Search, the mighty Causes may appear; yet the Nature of such Phænomena is so far from being impenetrable, that it is not only accounted for, and explained, upon natural Principles, but, with the Assistance of Chemistry, so nearly imitated, that artificial Earthquakes may be produced, which shall have all the Effects of natural ones; and consequently illustrate the Process of Nature, in
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the Production of these violent and terrible Concussions. *

After we have taken a View of the different Species of Earthquakes, as distinguished by the antient Philosophers, we shall exhibit the different Theories that have been formed in order to account for them upon the Principles of the modern experimental Philosophy ; and shall attempt by an historical Account of the most memorable Earthquakes upon Record, to direct the

* Earthquakes may be produced artificially, by mixing equal Quantities of Sulphur and Filings of Iron, and beating them together with an Addition of Water into a Kind of Paste, and burying the Whole three Feet under the Surface of the Earth : For in seven or eight Hours it will have a prodigious Effect, proportionable to the Quantity of the Paste ; the Earth will begin to tremble, crack, smok, and burst out into Flames.

Experiments furnish us with several other Substances which being mixt together cold, will ferment, take fire and emit Flame with a sudden Explofion. ‘ And by these Experiments,’ says, Sir *Isaac Newton*, (*Newt. Opt.* p. 354 & seq.) ‘ compared with the great Quantity of Sulphur with which the Earth abounds, and the Warmth of the interior Parts thereof, and the hot Springs and burning Mountains, and with Damps, mineral Coruscations, Earthquakes, hot suffocating Exhalations, Hurricanes and Spouts, we may learn that sulphureous Steams abound in the Bowels of the Earth, and ferment with Minerals, and sometimes take fire with a sudden Coruscation and Explofion ; and if pent up in the subterraneous Caverns, burst these Caverns with a great Shaking of the Earth as in springing of a Mine. And then the Vapour generated by the Explofion, expiring through the Pores of the Earth, feels hot and suffocates, and makes Tempests and Hurricanes, and sometimes causes the Land to slide, and the Sea to boil, and carries up the Water thereof in Drops, which by their Weight fall down again in Spouts. Also some sulphureous Steams, at all Times when the Earth is dry, ascending into the Air, ferment there with nitrous Acids, and sometimes taking fire, cause Lightning and Thunder, and fiery Meteors.’

Reader's

Reader's Judgment, in reconciling the various Appearances and other Circumstances that accompany each Earthquake to the several Theories of Philosophers, in favour of that Doctrine which is most consistent with Truth and Experience.

By an Earthquake is then understood a violent Agitation, shaking or trembling of some Part of the Earth's Surface; generally attended with a terrible Noise like Thunder, and sometimes with an Eruption of Fire, Smoak, Water, or Wind.

Of Earthquakes, *Aristotle* and *Pliny* distinguish two Kinds, in regard to the Nature of the Shake, *viz.* a Tremor and a Pulse: The first is an horizontal Motion, in alternate Vibrations, compared to the Trembling of a Person in an Ague. The second is a perpendicular Motion up and down, and is called by *Aristotle* βρασσαι from the Resemblance of its Motion to that of boiling. *Geo. Agricola* distinguishes Earthquakes into four Kinds, and *Albertus Magnus* divides them into ten, but Philosophers in general, have reduced these into three, *viz.* Inclination, when the Earth vibrates alternately from right to left, like a Tree shaken from one Side to another, by which, Mountains have been sometimes brought to meet, and clash against each other; Pulsation, when it beats up and down like an Artery; and Trembling, when it shakes and quavers every Way like a Flame.

In order to understand the Nature of Earthquakes, let it be premised, that the Globe of the Earth every where abounds with huge subterraneous Caverns, Burrows, and Cavities, which branching out into Veins, Canals, &c. like the several Vessels
of

of an animal Body, pass under the very Bottom of the Sea. Some of these convey Water, whence are formed Gulphs, Abysses, Springs, Rivulets, &c. others are full of Exhalations and unctuous Substances; and others are replete with Nitre, Sulphur, Bitumen, Vitriol, and other igneous and inflammable Matter. Hence, the Waters upon the Earth's Surface may be supposed to communicate with the innermost, or deepest Abyss, by means of these Channels; as may also the Air within the Bowels of the Earth be supposed to communicate with the Atmosphere or external Air; whereby subterraneous Fires, being kindled by such Accidents as shall hereafter be explained, are revived, or kept alive under Ground.

That the Earth abounds with such Cavities is every where allowed; and that these subterraneous Cavities are at certain Times, and in certain Seasons full of inflammable Vapours, the Damps found in Mines sufficiently evince, which being fired, produce all the Phænomena of an Earthquake, though in a lesser Degree. * †

This

* Out of many other Instances that might be brought to prove the Truth of this Assertion, the following one may suffice, which, being extracted from N^o 136. of the philosophical Transactions, was communicated to the *Royal Society* by Mr. *Rog. Moflyn*. The Coal-Work at *Moflyn* in *Flintshire*, lies forty, fifty, and in some Places sixty Yards under the Level of the Sea: When the Coal was first found it was covered with Water, so that it could not be wrought down to the Bottom: Therefore a Witchet or Cave was made in the Middle of it, for gaining Room to work, and driving down the Spring of Water to the Eye of the Pit: After the Workmen had gone some considerable Way under Ground, they began to want Air, and found the Fire-Damps gradually forming themselves, and appearing in the Crevices and Slits of the Coal, where Water had lain before

This is further manifested by those burning Mountains called Volcanoes, which contain in their Bowels Sulphur, Bitumen, and such other Materials as serve for Fuel to feed a subterraneous Fire, the Effect of which being more violent than that of Gun-powder or Thunder, has at all Times struck Mankind with Astonishment and Terror, and carried Desolation with it upon Part of the Face of the Globe.

That

before the Opening of the Pit, with a small bluish Flame in continual Motion. The Application of a Candle to it would make it fly with a sudden Noise to another Crevice, where it appeared blazing and moving as before, but did no farther Harm: However, upon sinking a Pit within the Hollows or Deads of the upper Work, at 16 or 17 Yards Distance from the first Pit, the Damps continued to appear as before, accompanying the Workmen still as they sunk. when at last they found that their Want of perpendicular Air from above was the Cause and Promoter of these Damps, for all their Air came from the first Pit; yet notwithstanding this, they continued sinking to 18 Yards, but upon intermitting the Work for 48 Hours, the Damps in the mean time gained greater Strength, and were seen flashing and shooting from one Side to the other. Upon this the Workmen after several Experiments, ventured to fasten some Candles to a Hook at the End of a Rope, when lowering these a little Way into the Shaft of the Pit, the fiery Damps mounted up, blew out the Candles, dispersed themselves about the Eye of the Pit, and burnt the Hair, Beards and Cloaths of the Workmen, and struck some of them down, making a Noise like the Bellowing of a Bull, but much louder, and leaving a Smoke and a very noisome Smell behind it. At another Time, one of the Men more indiscreet than the rest, went with his Candle over the Eye of the damp Pit, at which the sulphureous Steam immediately caught, and flew to and fro over all the Hollows of the Work with a great Wind, a continual Fire, and a violent roaring Noise: Most of the Men instantly fell on their Faces and hid themselves as well as they could in the loose Sleck or small Coal, and under the Shelter of Posts; yet the Damps returning out of the Hollows and drawing towards the Eye of the Pit, came up with incredible Force, tore most of their Cloaths off their Backs, and singed what was left, burning their Hair, Faces, and Hands; and the

That such a Disposition should take place in the internal Parts of the Globe seems necessary for the Subsistence of a subterranean Fire, and the Formation and constant Supply of Gulphs, Abysses, Springs, Rivers, Rivulets, &c. That a subterranean Fire exists is argued from the Phænomena of Volcanoes, which are no more than the Spiracles or Air-Holes, whereby it communicates with the external Air, and receives those Supplies of it necessary for its Support: By these the necessary Magazines of Fire are kept in a due State, and by these they discharge the Smoke and Foulnesses with which they would otherwise be choaked up and extinguished. Does not the great River *Volga* pour such a Quantity of Water into

the Blast fell as sharp upon their Skin as if they had been whipped with Cords; some that had least Shelter were carried 15 or 16 Yards from their first Station, and beaten against the Roof of the Pit and Sides of the Posts, and then were left senseless for a considerable Time, so that it was long before they could hear or find each other: As it drew up to the Day-Pit it caught one of the Men that was next the Eye along with it, and ascended with a dreadful Crack not unlike a Cannon, though something of a shriller Sound, and this was heard with the Wind 14 or 15 Miles off, and such a Pillar of Smoak was seen as for a long Time darkened all the Sky. And what is still more remarkable, though the Brow of the Hill was 18 Yards high above the Pit, and filled with Trees 15 or 16 Yards in Length, yet the Man's Body, and other Things from the Pit were seen at least 100 Yards above the Tops of the highest Trees. On this Pit stood a Horse-Engine of substantial Timber and strong Iron-work, on which lay a Trunk or Barrel of 1000 Pound-weight, for winding the Rope up and down: This Trunk was fastened to that Frame with Locks and Bolts of Iron; yet it was thrown up, and carried a good Way from the Pit; and Pieces of it, though bound with Iron-hoops and strong Nails, were blown into the neighbouring Woods; as also the two Buckets and Ends of the Ropes; the whole Frame of the Engine was moved out of its Place, and the Cloaths, Hats, and Caps of such as escaped, were afterwards found torn to Pieces, and thrown into the Woods at a great Distance from the Pit.

the *Caspian* Sea, in the Space of one Year, that were there not some invisible Outlet, it would be sufficient to cover a great Part of the Globe of the Earth? This Outlet, *Kircher* observes, must be some vast and infernal Cavern that passes under Mount *Caucasus* into the *Euxine* Sea, whereby the Waters of one Sea disburthen and discharge themselves into the other; and the whole Kingdoms of *Georgia* and *Megrelia*, under which they run, are no more than as it were a Bridge to those subterranean Waters: The same might be proved to be the Case of the *Persian* Gulph, which is, as it were, a Reservoir, and fills the *Caspian*, when it has been too much lowered by Winds into the *Euxine*; and that there is a Communication between the *Red-Sea* and the *Mediterranean* in the same Manner under Ground is beyond all Dispute. Hence, that such is the internal Construction of the Globe, as that all the Seas, Rivers, Lakes, &c. thereon, do communicate with, and circulate into, one another is highly probable. We are assured that near *Guatemala* in *South America*, are two Mountains, the one called a Volcano of Fire, the other of Water: Out of the first whereof large Pieces of Rocks are frequently hurled, with as much Vehemence as Balls out of a Cannon; and out of the latter, vast Quantities of Water are continually thrown up.

In that great Chain of Mountains called the *Andes*, in *America*, there are no less than fifteen Volcanoes, by whose Burnings vast subterraneous Cavities as big as whole Kingdoms are made, which receive the Cataracts of mighty Rivers, and by whose terrible Eruptions unspeakable Calamities have more frequently befallen those Regions than any other. It would astonish Mankind could they see into the World beneath their Feet,

view the dark Recesses and Apartments of Nature under Ground, and behold the strongest Buildings stand upon an immense and prodigious Vault of an unequal Thickness, at the Bottom of which runs an unfathomable Sea, and whose upper Hollows are filled with stagnating Air and the Expirations of sulphureous and bituminous Matter. Therefore, as there are no vast Tracts of Land but abound with Volcanoes, sulphureous Caverns, and Estuaries, from which, by greater Cavities branched out every where into lesser Pipes or Tubes, the subterraneous Heat is carried through all Parts of the World, so no Place can promise itself an Immunity from Earthquakes. And the more cavernous any Land is, the more obnoxious it must be to that dreadful Phænomenon: This was so obvious to the Reason of *Seneca*, that he declared, that there are such huge Dens, immense Recesses, and large Spaces: and that the Mountains stand upon an Arch of Rocks, whose Gapings and broken Hollows have often been the Graves to receive and bury whole Cities.

From this internal Constitution of the Earth, Naturalists are divided with regard to the Causes of Earthquakes. Some ascribe them to the Earth itself, others to Water, others to Fire, and others to Air; and all of them, in the Opinion of *Chauvinus*, with great Reason.

First, the Earth itself may be the Cause of its own Shaking, by the sudden Fall of ponderous Matter into the hollow Parts thereof, whereby these terrible Shocks and Succussions are produced: Thus when the Roots, or Basis of some large Mass are dissolved, or worn away by a Fluid underneath, it sinks into the same, and with its Weight occasions a Tremor of the adjacent Parts,

produces a Noise, and frequently an Inundation of Water.

Thence it is observed, that Countries, the Nature of whose Soil is dry, as *Egypt*, are seldom affected by Earthquakes, whereas moist Countries are more liable to them; because that in the latter more frequently than in the former large Portions of the Earth, being dissolved or worn away by the Moisture, are disposed to drop into the Caverns underneath. This, it is observed, is the Reason why Earthquakes are more frequent in Spring and Autumn than in Winter or Summer; and in the Night-time than in the Day, because that then those Parts of the Earth disposed to give way are more easily separated from the rest wherewith they cohere.

Secondly, the subterranean Waters which are every where diffused throughout the Earth, may occasion an Earthquake, by their Overflowing, cutting out new Courses, &c. To which it may be added, that the Waters being heated and rarefied by the subterranean Fires may emit Fumes, Blasts, &c. which by their Action either on the Water, or immediately on the Earth itself, may occasion great Succussions.

Thence the Theorists who contend for subterranean Waters being the Cause of Earthquakes observe, that Islands are more frequently agitated in this Manner than the Continent, on account of their being every where surrounded and penetrated by the Waters which occasion these Concussions; and thence, they tell us, such a Number of new Fountains break out in most Earthquakes; and for the like Reasons they think, that Eruptions of Water frequently burst forth from a Dislocation in subterranean Caverns.

Thirdly, Air is supposed to be the Cause of Earthquakes: For Air being a Collection of Fumes and Vapours raised from the Earth and Water, if it be pent up in the too narrow Viscera of the Earth, the subterranean, or its own native Heat, rarefying and expanding it, the Force wherewith it endeavours to escape may shake the Earth: Hence there will arise divers Species of Earthquakes according to the different Position, Quantity, &c. of the imprisoned *Aura*.

Thence Earthquakes chiefly happen at such Periods of Time as there is the greatest Quantity of Heat included or contained in the Bowels of the Earth, as in Spring and Autumn. Thence also Earthquakes are more frequent in those Countries that abound most with Caverns or Receptacles fit for containing Air, unless these are such as open immediately in, or communicate with, the Atmosphere, so as that the Air they include may have a free Exit.

M. *Amontons* appears foremost in Support of this Doctrine. This Philosopher, in the History of the Royal Academy of Sciences, for the Year 1703, has an express Discourse, to prove that the Weight and Spring of Air, with a moderate Degree of Warmth, may enable it to produce Earthquakes, &c. According to the Experiments of M. *de la Hire* and M. *Amontons*, a Column of Air on the Surface of the Earth 36 Fathoms high is equal in Weight to three Lines of Mercury; and it is found that equal Weights of Air possess Spaces reciprocally proportional to the Weights wherewith they are pressed; the Weight of Air therefore, which would fill the whole Space possessed by the terrestrial Globe would be equal to a Cylinder of Mercury, whose Base was equal to the Surface of the Earth, and whose Height contained as
many

many times three Lines, as the atmospherical Space contains Orbs equal in Weight to that of the 36 Fathoms, whereof the Experiment was made.

Hence taking the densest of all Bodies, *viz.* Gold, whose Gravity is about 14630 times greater than that of Air in our Orb, it is easy to compute that this Air would be reduced to the same Density as Gold, by the Pressure of a Column of Mercury 14630 times 28 Inches high, *i. e.* 409640 Inches; since the Bulks of Air in that Case would be in the reciprocal Ratio of the Weights, wherewith they are possessed; thus 409640 Inches therefore expresses the Height at which the Barometer must stand where Air would be as heavy as Gold, and the Number $2\frac{51632}{769840}$ Lines, the Thickness to which the Column of 36 Fathoms of Air would be reduced in the same Place. Now we know, that 409640 Inches, or 43528 Fathoms is only the seventy-fourth Part of the Semidiameter of the Earth; and when you are past that, whatever Matters there be, they must be lighter than Air. It is not improbable therefore that the remaining Sphere of 6451538 Fathoms diameter may be full of dense Air, heavier by many Degrees than the heaviest Body among us.

Hence, again, as it is proved that the more Air is compressed, the more does the same Degree of Fire increase the Force of its Spring, and render it capable of so much the greater Effect; and that, for Instance, the Heat of boiling Water increases this Spring of our Air beyond what it ordinarily is, by a Quantity equal to one Third of the Weight wherewith it is pressed; we may therefore infer that a Degree of Heat which in our Orb can only produce a moderate Effect, may have a very violent one in such lower Orb; and that as
there

there may be many Degrees of Heat in Nature beyond that of boiling Water, it is probable there may be some whose Violence, thus assisted by the Weight of the Air, may be sufficient to tear a-funder the solid Globe.

Fourthly, Fire, with greater Reason, is assigned a principal Cause of Earthquakes, both as it produces a subterranean Vapour, and as this Vapour or Air, from the different Matter and Composition whereof arise Sulphur, Bitumen, and other inflammable Matters, is kindled either from some Fire it meets withal, or from its Collision against hard Bodies, or its Intermixture with other Fluids, by which Means bursting out into a greater Compass, the Place becomes too narrow for it, so that pressing against it on all Sides, the adjoining Parts are shaken, till having made itself a Passage, it spends itself in a Volcano, or burning Mountain*.

* That these Volcanoes were all kindled of themselves, at or near the Time of the Creation, Dr. *Lister* thinks probable; because there is at present but a certain Number of them known; and these have all continued burning at all Times from the earliest History; and none of them have ever been extinguished wholly, or probably ever can be, any other Way than by the Subversion of the whole into the Sea. That they originally kindled of themselves, by Means of the Pyrites they contain, he thinks very probable; because we find that the Pyrites will kindle of itself; and there is no other apparent Cause for their kindling: For if we suppose the Sun to have done it, the Mountain *Hecla* in *Iceland*, should have been excused, as standing in a northerly and colder Climate; and if we attribute the Kindling of them to Lightnings or Earthquakes, we favour the Doctor's System, in regard that he deduces these from the Breath or Exhalations of the same Mineral. It is also observed, that no Subject in the whole mineral Kingdom is so proper for the keeping up a Fire for the many Ages these Mountains have been burning, as the Pyrites. Nothing is so lasting a Fuel; and in general, other Fuels become more or less lasting as they partake more or less of its Nature.

But

But to come nearer the Point. Dr. *Lister*, in N^o. 157, of the *Philosophical Transactions*, gives it as his Opinion, that the material Cause of Thunder, Lightning, and Earthquakes is one and the same, *viz.* the inflammable Breath of the Pyrites, which is a substantial Sulphur, and will take fire of itself. The Difference between these three terrible Phænomena he takes only to consist in this, that this Sulphur, in the former, is fired in the Air, and, in the latter, under Ground.

This he thinks abundantly indicated by the same sulphureous Smell being found in any Thing burnt with Lightning, and in the Waters, &c. cast up in Earthquakes, and even in the Air before and after them. He affirms, that they also agree in the Manner of their Noise, which is carried on as in a Train fired; the one, rolling and rattling through the Air, takes fire as the Vapours chance to drive; as the other fired under Ground, in like manner, moves with a desultory Noise*.

That the Earth abounds in Cavities, or is more or less hollow, the Doctor thinks more than probable, by what is found every where in the Mountains, *viz.* the natural Cavities, or Chambers which the Miners of the North call Self-opens, and which they frequently meet with; some vastly great, and others less, running in Sinuses, many of which open to Day-light, as *Poole's-hole*, and *Okey-hole*, &c. Again, the great and small Streams which arise from under Mountains, he thinks, sufficiently proves their Hollowness, which are at particular Times and Seasons filled with inflammable Vapours, as the Damps in Mines sufficiently testify.

That the Pyrites alone, of all known Minerals, yield this inflammable Vapour, he thinks highly probable, for the following Reasons: 1. Because

* See Note, p. 4.

no Mineral or Ore whatever is sulphureous, but as it is wholly or in Part a Pyrites. 2. Because there is but one Species of Brimstone, at least with us in *England*, which the Pyrites naturally and only yield: Whence it is but reasonable to suppose, that wherever Brimstone is found, though in the Air, or under Ground in Vapour, it also proceeds from the Pyrites. The *Sulphur vivum*, or natural Brimstone which is found in and about burning Mountains, may be more sulphureous than ours; and indeed it is plain that some of ours in *England* are very lean, and hold but little Sulphur: Others again very much, which may be one Reason why *England* is so little troubled with Earthquakes; and *Italy*, and almost round the *Mediterranean Sea* so very much; though another Reason is, the Paucity of Pyrites in *England*, in regard to those Places.

Comparing our Earthquakes, Thunder, and Lightning, with that of those Countries, it is observed, that there it lightens almost daily, especially in the Summer-time, here, seldom; there, Thunder and Lightning is of long Duration, here it is soon over; there, the Earthquakes are frequent, long and terrible, with many Paroxysms in a Day, and that for many Days; here, they are very short, only of a few Minutes, and scarce perceptible. To this Purpose the subterraneous Cavities in *England* are very small and few, compared to the vast Vaults in those Parts of the World, which is evident from the sudden Disappearance of whole Mountains and Islands.

This much being said in Explication of Dr. *Lifter's* Theory, we shall now present the Reader with that of the famous *M. de Buffon*. This ingenious Theorist distinguishes two Sorts of Earthquakes, the one caused by the Action of subterraneous Fires, and the Explosion of Volcanoes, which

which are felt only at small Distances, and at the Times that the Volcanoes are agitated, or before they begin to break out. When the Materials that form subterraneous Fires come to be fermented, heated and inflamed, the Fire makes Efforts on all Sides, and if it does not naturally find an Outlet, it raises the Earth, and makes a Passage for itself, by throwing it off, by which Means a Volcano is produced, the Effects of which are repeated, and they last in Proportion to the Quantity of the inflammable Matter it contains. If this Matter be inconsiderable, there may happen a Rising of the Ground, a Commotion and an Earthquake without any Volcano being formed by that Means. The Air produced and rarefied by the subterraneous Fire may likewise find small Outlets by which it may escape, and in this Case there will only happen an Earthquake, without any Eruption, or Volcano. But when there is a large Quantity of inflammable Matter, and when it is locked up by solid and compact Substances, there happens a Commotion and a Volcano too. But all these Commotions cause no more than the first Sort of Earthquake, and can only shake a small Part of Ground. A very violent Eruption, for Instance, of Mount *Ætna*, will cause an Earthquake over the whole Island of *Sicily*, but it will never extend to three or four hundred Leagues Distance. When some new Vents of Fire have been formed in Mount *Vesuvius*, there are felt at the same Time Earthquakes at *Naples*, and in the Neighbourhood of the Volcano, but these Concussions have never shaken the *Alps*, nor been communicated to *France*, or other Countries remote from *Vesuvius*. In this Manner, Earthquakes produced by Means of Volcanoes are confined to a narrow Space, which is properly the Effect of the

Re-action of the Fire, and they shake the Earth just as the Explosion of a Powder-magazine causes a sensible Concussion at several Leagues Distance.

But there is another Sort of Earthquakes, very different as to their Effects, and probably as to their Causes; and these are such as are felt at considerable Distances, and which shake a long Tract or Slip of Ground, without any Volcano or Eruption appearing. We have Instances of Earthquakes which have been felt at the same Time in *England, France, Germany*, and even in *Hungary*; and these always extend a great deal more in Length than in Breadth; they shake a Tract of Ground with more or less Violence in different Places, and they are almost always attended with a dull Noise, much like that of a large Carriage that rolls along with much Rapidity.

In order to understand thoroughly what may be the Causes of this Species of Earthquakes, we must remember, that all inflammable Matters capable of Explosion, such as Gunpowder, generate a large Quantity of Air; that this Air produced by the Fire, is in a great State of Rarefaction, and that by Means of this Compression in which it finds itself in the Bowels of the Earth, it must produce very violent Effects. Let us therefore suppose, that at a very considerable Depth, as a hundred or two hundred Fathoms, there be found Pyrites and other sulphureous Substances, and that by the Fermentation produced by the filtering of the Waters, or other Causes, these happen to take fire, what will be the Result? In the first Place, these Substances are not regularly disposed in horizontal Strata; on the contrary, they are contained in the perpendicular Fissures, in the Caverns, at the Foot of these Fissures, and in other Places where the Waters can act, and into which they can penetrate.

trate. These Substances coming to take fire, will generate a large Quantity of Air, whose Spring being compressed in a little Room, as in that of a Cavern, will not only shake the superior Ground, but seek for Passages to escape by, and to extricate itself. The Passages that present themselves are the Caverns and Canals formed by the subterraneous Waters and Rivulets; the rarefied Air will violently precipitate into all the Passages that are open, and form a furious Wind in these subterranean Cavities, the Noise of which shall be heard at the Surface of the Earth, accompanied with Concussions thereof; this subterranean Wind, produced by the Fire, will extend itself as far as these Cavities, and cause an Earthquake, more or less violent, in Proportion as it is remote from the Fire, and finds a Passage more or less narrow. This Motion being performed lengthwise, the Concussion will be in the same Direction, and the Earthquake felt in a long Zone, or Tract of Ground. This Air will cause no Eruption or Volcano, because it will find sufficient Room to dilate itself; or rather, because it will find Outlets, and issue out in Form of Wind or Vapour; and even should it be denied, that there are actually any subterranean Passages, by which this Air and these Vapours can escape, we may easily conceive that in the very Place where the first Explosion happens, the Ground being raised up to a considerable Height, the adjoining Place must be divided and rent asunder horizontally, in order to correspond with the primary Motion, which is sufficient to make Passages that may communicate the Motion to a very great Distance. This Explication agrees with all the Phænomena. An Earthquake is not felt at the same Instant in two distant Places, for Instance, a hundred or two hundred

Leagues ; there is no external Eruption caused by these Earthquakes that reach to some Distance, and the Noise that accompanies them almost always points out the progressive Motion of the subterranean Fire.

What has been said may confirm it farther by connecting it with Facts. It is well known that Mines exhale Vapours independently of the Winds produced by the Current of the Waters, and that there are often observed in them Currents of unwholesome Air, and suffocating Exhalations ; and besides, there are Holes, Abysses, and deep Lakes on the Earth that produce Winds, as the Lake of *Boleslaw* in *Bohemia*.

Earthquakes, it is true, are a great deal more frequent in Places where there are Volcanoes than elsewhere, as in *Sicily* and *Naples* ; and it is well known from Observations made at different Times, that the most violent Earthquakes happen at the Time of the greatest Eruptions of Volcanoes.

The learned Dr. *Woodward*, in his *Essay towards a natural History of the Earth*, gives the following Theory of Earthquakes. He supposes that the subterranean Heat or Fire, which is continually elevating the Water out of the Abyss, to furnish the Earth with Rain, Dew, Springs and Rivers, being stopped on any Part of the Earth, and so diverted from its ordinary Course, by some accidental Glut or Obstruction in the Pores or Passages through which it used to ascend to the Surface, becomes by such Means preternaturally assembled in a greater Quantity than usual into one Place, and therefore causeth a great Rarefaction, and Intumescence of the Water of the Abyss, putting it into great Commotions and Disorders, and at the same Time making the like Effort on the Earth, which being expanded upon the Face of the Abyss, occasions

occasions that Agitation and Concussion which we call an Earthquake.

This Effort in some Earthquakes he observes, is so vehement, that it splits and tears the Earth; making Cracks and Chasms in it some Miles in Length, which open at the Instants of the Shocks, and close again at the Intervals between them; nay, it is sometimes so extremely violent, that it forces the superincumbent Strata, breaks them all throughout, and thereby perfectly undermines and ruins the Foundations of them, so that these failing, the whole Tract, as soon as the Shock is over, sinks down into the Abyfs and is swallowed up by it, the Water thereof immediately rising up, and forming a Lake in the Place, where the said Tract before was. That this Effort being made in all Directions indifferently, the Fire dilating and expanding on all hands, and, proportionably to the Quantity and Strength of it, endeavouring to get Room, and make its Way through all Obstacles, falls as foul on the Water of the Abyfs beneath, as on the Earth above, forcing it forth which Way soever it can find Vent or Passage, as well through its ordinary Exits, Wells, Springs, and Outlets of Rivers, as through the Chasms then newly opened through the Camini or Spiracles of *Ætna*, or other neighbouring Volcanoes, and those Hiatuses at the Bottom of the Sea, whereby the Abyfs below opens into it and communicates with it.

That as the Water resident in the Abyfs is in all Parts of it stored with a considerable Quantity of Heat, and more especially in those, where these extraordinary Aggregations of Fire happen, inso-much that, when thrown forth and mixed with the Waters of Wells and Springs of Rivers and the Sea, it renders them sensibly hot.

That

That it is usually expelled forth in vast Quantities, and with great Impetuosity, insomuch that it hath been seen to spout out of deep Wells, and fly forth at the Tops of them upon the Face of the Ground. With the like Rapidity comes it out of the Sources of Rivers, filling them so of a sudden, as to make them run over their Banks, and overflow their neighbouring Territories, without so much as one Drop of Rain falling into them, or any other new Current of Water to raise and augment them

That it vomits out of the Chafins opened by the Earthquake in great Abundance, mounting up in mighty Streams to an incredible Height in the Air, and this oftentimes at many Miles Distance from the Sea.

That it likewise flies forth out of Volcanoes in vast Floods, and with prodigious Violence. That it is forced through the Hiatuses at the Bottom of the Sea, with such Vehemence, that it puts the Sea immediately into the most horrible Disorder and Perturbation imaginable, even when there is not the least Breath of Wind stirring, but all till then calm and still; making it rage and roar with a most hideous and amazing Noise, raising its Surface into prodigious Waves, and tossing and rowling them about in a very strange and furious Manner, oversetting Ships in Harbours, and sinking them to the Bottom, with many other like Outrages.

That it is refunded out of these Hiatuses also in such Quantities, as makes a vast Addition to the Water of the Sea, raising it many Fathoms higher than ever it flows in the highest Tides, so as to pour it forth beyond its usual Bounds, and make it overwhelm the adjacent Country; by this Means ruining and destroying Towns and Cities,
drowning

drowning both Men and Cattle, breaking the Cables of Ships, driving them from their Anchors, bearing them along with the Inundation several Miles up into the Country, and there running them a-ground, stranding Whales likewise and other great Fishes, and leaving them at its Return, upon dry Land.

That these Phænomena are not new or peculiar to the Earthquakes which have happened in our Times, but have been observed in all Ages, and particularly these exorbitant Commotions of the Water of the Globe.

This we may learn abundantly from the History of former Times, and it was for this Reason that many of the Antients concluded rightly enough, that they were caused by the Impulses and Fluctuation of Water in the Bowels of the Earth, and therefore they frequently called *Neptune* Σεισιχθων, as also Κινοσιχθων, Ἐνοσίγαιος, and Τιναντωρογαίης; by all which Epithets they denoted his Power of shaking the Earth.

They supposed that he presided over all Water whatever, as well that within the Earth as the Sea, and the rest upon it; and that the Earth was supported by Water; its Foundations being laid thereon, upon which Account, they bestowed on him that cognomen Γαίηοχος, or Supporter of the Earth; and that of Θεμελιοῦχος, the Sustainer of its Foundations.

They likewise believed that he, having a full Sway and Command over the Water, had Power to still and compose it, as well as to move and disturb it, and the Earth by means of it; and therefore they also gave him the Name of Ασφέλιος, or the Name of Establisher, under which Name, several Temples were consecrated to him, and Sacrifices offered whenever an Earthquake happened, to pacify and appease him;

him; requesting that he would allay the Commotions of the Water, secure the Foundations of the Earth, and put an End to the Earthquake.

That the Fire itself, which being thus assembled and pent up is the Cause of all these Perturbations, makes its own Way also forth by what Passages soever it can get vent, through the Spiracles of the next Volcanoes, through the Cracks and Openings of the Earth abovementioned, through the Apertures of Springs, especially those of the *Therme* or hot Baths, or any other Way that it can either find or make; and being thus discharged, the Earthquake ceaseth till the Cause returns again, and a fresh Collection of this Fire commits the same Outrages as before.

That there is sometimes in Commotion a Portion of the Abyfs of that vast Extent as to shake the Earth incumbent upon it, for so very large a Part of the Globe together, that the Shock is felt the same Minute precisely in Countries that are many hundred Miles distant from each other, and this, even though they happen to be parted by the Sea; and there wants not Instances of such an universal Concussion of the whole Globe, as must needs imply an Agitation of the whole Abyfs.

That though the Abyfs be liable to these Commotions in all Parts of it, and therefore no Country can be wholly exempted from the Effects of them, yet these Effects are no where very remarkable, nor are there usually any great Damages done by Earthquakes, except only in those Countries that are mountainous, and consequently stony and cavernous underneath, and especially where the Disposition of the Strata is such, that those Caverns open into the Abyfs, and so freely admit and entertain the Fire, which
Assem-

Assembling therein, is the Cause of the Shock ; it naturally steering its Course that Way where it finds the readiest Reception, which is towards these Caverns ; this being indeed much the Cause of Damps in Mines. Besides, that those Parts of the Earth which abound with Strata of Stone or Marble, making the strongest Opposition to this Effort, are the most furiously shattered and suffer much more by it, than those which consist of Gravel, Sand, and the like laxer Matter, which more easily give Way, and make not such a great Resistance ; an Event observable not only in this but all other Explo- sions whatever.

But above all, those Countries which yield great Store of Sulphur and Nitre, are by far the most injured and incommoded by Earthquakes ; those Minerals constituting in the Earth a Kind of natural Gun-powder, which taking fire upon this Asssemblage and Approach of it, occasions that murmuring Noise and subterraneous Thunder, which is heard rumbling in the Bowels of the Earth, during Earthquakes, and by the Assistance of its explosive Power, renders the Shock much greater, so as sometimes to make a miserable Havock and Destruction.

And it is for this Reason, that *Italy, Sicily, Anatolia*, and some Parts of *Greece* have been so long and so often alarmed, and harassed by Earthquakes ; these Countries being all mountainous and cavernous, abounding with Stone and Marble, and affording Sulphur and Nitre in great Plenty. Further, that *Ætna, Vesuvius, Hecla*, and the other Volcanoes are only so many Spiracles, serving for the Discharge of this subterranean Fire, when it is thus preternaturally assembled. That where there happens

to be such a Structure and Conformation of the interior Parts of the Earth, as that the Fire may pass freely, and without Impediment, from the Caverns, wherein it assembles, into those Spiracles, it then readily and easily gets out, from Time to Time, without shaking or disturbing the Earth: But where such Communication is wanting, or the Passage is not sufficiently large and open, so that it cannot come at the Spiracles, it heaves up and shakes the Earth with greater or less Impetuosity according to the Quantity of Fire thus assembled, till it has made its Way to the Mouth of the Volcano.

That therefore there is scarce any Country much annoyed with Earthquakes but has one of these fiery Vents, which is constantly in Flames when an Earthquake happens, disgorging that Fire, which, whilst underneath, was the Cause of the Disaster; and were it not for these Diverticula, whereby it gains an Exit, it would rage in the Bowels of the Earth much more furiously, and make greater Havock than it does

So that through those Countries where there are such Volcanoes, are usually more or less troubled with Earthquakes, yet were these Volcanoes wanting, they would be more troubled with them than they now are; yea, in all Probability, to that Degree, as to render the Earth for a vast Space around them perfectly uninhabitable.

In one Word, so beneficial are these to the Territories where they lie, that there do not want Instances of some which have been rescued and wholly delivered from Earthquakes, by the breaking forth of a new Volcano there; this continually discharging the Matter which, being
till

till then barricadoed up and imprisoned in the Bowels of the Earth was the Occasion of very great and frequent Calamities.

That most of these Spiracles perpetually, and at all Seasons, send forth Fire more or less, and though it be sometimes so little that the Eye cannot discern it, yet even then, by a nearer Approach, may be discovered a copious and a very sensible Heat continually issuing out. *

Having

* Europe affords five principal Openings of this Kind. Of these the chief is *Ætna*, in the Island of *Sicily*, a Volcano famous in all Histories; the next to this is *Vesuvius*, near *Naples*; then the *Strongylus* and some others of lesser Note in the *Liparine* Islands; *Hecla* in the frozen Region of *Iceland*, and the *Chimæra* in *Greece*. The Volcanoes of *Asia* are not less numerous, there are several in the Mountains of *Persia*, and in the Island of *Ormuz*. The Pic of *Adam* in the Island of *Ceylon* also burns at certain Times. But the principal Volcanoes of this Part of the World are in the *Philippine* and *Molocco* Islands. *Java* and *Sumatra* also furnish some in the Center of their largest Mountains. The Island of *Ternate* affords also a Volcano on the Top of a Mountain very difficult of Access, but opening with a vast Mouth, and very terrible when it burns; and in *Japan*, there is a great Number of Volcanoes burning almost continually.

Whatever may be the Number of Volcanoes in *Asia*, there is no Part of the World that yields so many as *America*. In the Kingdom of *Chili* alone, there are fourteen very considerable Volcanoes, all placed in regular Order, one by the other; and not a less Number in *Peru*; these all burst forth from the Summits of those vast Mountains, the *Andes*. In *New Spain*, there are three very formidable for the Fierceness of their Burnings.

The most extreme Parts of the northern World are not free from those Storehouses of Fire. Authors tell us of no less than four of them in the northern Parts of *Tartary*; and we know that *Greenland* and all the neighbouring Countries have them. The Volcanoes of *Terra del Fuogo* are pretty well known; and it is indeed the general Opinion that further north than we have yet penetrated, there may be many undiscovered ones; and some Authors have gone so far as to declare that were the Cold no Prevention, we should not be able to

Having now delivered the most remarkable Theories, that have been formed by Philosophers

come much nearer than we do to the south Pole for the Number and Fierceness of the burning Mountains.

Kircher observes, that People, who see but a little Way into the Oeconomy of the Universe, are apt to blame the Author of Nature, for placing so many of these Volcanoes in the habitable Parts of the World, and exposing so many of the human Species to perish by them; but when the System of Nature is more clearly seen into, we find the greatest Reason to admire and adore the Goodness of Providence in the Disposition of these very Things.

When it is proved necessary to the Ends of the Creation of the World, that a Fire should be kept up within, where could that be so well kept from doing us Injury as in the deep central Parts? And when it was necessary that this Fire should have Spiracles or Air-vents, where could they be placed more out of our Way than in the Tops of the highest Mountains, as we constantly and regularly find they are? The Smoke, Cinders, and other Remnants of the Fuel that support the subterranean Fire, are by this means discharged far above the Heads of the Inhabitants, and out of the Way of doing them any Harm; whereas had these Openings been on plain Ground, the whole Air the neighbouring Nations breathed would have been infected with the Stench, and Sickness bred with it; besides the Danger of firing their Houses and Towns, and spoiling their cultivated Lands, with the vast Quantities of Cinders, Ashes and other Matters thrown up, which as it is falling on the barren Sides of the Mountains, do no Harm to any Thing.

This giving Vent to the subterranean Pyrophyllacia seems one of the great Ends of the Origin of Mountains; and the other is, their serving as Hydrophyllacia, or Magazines of Water. This is seen throughout the World, the Rivers that water all the Countries inhabited or habitable arising from the Chains of Mountains placed in their Middle, seemingly with this sole Intent; the *Rhine*, the *Rhone*, and the *Danube* all arise from the Alps, the great Reservoirs of Waters in Europe. The Mountains of the Moon, placed in the burning Sands of *Africa*, give rise to the *Nile* and *Niger*, and other Rivers large enough to supply that vast and scorched Country; and in the same Manner the River of the *Amazons*, and the other immense Beds of Water necessary to supply the vast Continent of *South America*, take their Origin from the Mountains called the *Andes*.

to explain the Process of Nature in the Production of Earthquakes, it may be expected that something should be offered for settling the most usual Symptoms, or Prognostics, if there are any, that precede, or foretell these Phænomena; and indeed the Learned in this and other Parts of the World, notwithstanding the Attention of all Mankind, since the first Earthquake, must have been concerned in such Observations, are still so far from condescending upon any certain Signs, that serve to indicate the Approach of these Concussions, that little or nothing can be collected from them, that is in the least to be depended on.

Earthquakes, happening from the Causes to which they have been already assigned, acting within the Bowels of the Earth, can no way affect our Senses, or come within the Cognizance of our Observations. but by their Effects, and the several Circumstances that either accompany, or are consequent of the Shock. *Pliny, lib. 2.* observes, that sometimes Earthquakes are ushered by a terrible crashing in the Air, attended with Sounds like human Shouts or Bellowings. This horrid crashing, which *Dr. Cyrillus* affirms preceded that Earthquake which, in the Year 1731, infested *Apulia* and almost all the Kingdom of *Naples*, was diffused in a contrary Direction to the Shock: for, whereas the Parts of the Earth were shook from the Center to the Circumference, so, on the contrary, the Motion of the Air plainly converged from the Circumference to the Center, which Phænomena he thinks may have yielded no small Matter of Speculation to Naturalists. The Doctor would observe, that this is different from what *Aristotle* thought was the Case with Meteors, namely, that an external Wind must contribute to an Earthquake, as according to him the Coast of *Achaia*

Achaia was shook by the Conflict of a North and South Wind, unless, perhaps, one should say, as some have suspected, that, at least, the slight, oscillating Earthquakes, produced after strong, easterly Winds, might have been owing to the retarded, diurnal Motion of the Earth, at least in that Tract where the Wind blew.

It is further observed, that this Earthquake was preceded by a Kind of Accension, or short Coruscation, about Mount *Garganus*, which insensibly vanished into Smoke and Darkness. In the Parts about *Foggia*, a strong North-east Wind generally preceded this Earthquake, as also several others that happened afterwards, though sometimes the Air was quite calm.

Dr. *Bayley*, in N^o. 444, of the *Philosophical Transactions*, affirms, that his Observations upon the Shock of an Earthquake felt in *Suffex*, on the 25th of *October*, 1734, agree with those Signs which have been observed by the Learned to precede former Earthquakes in this and other Parts of the World. He observes, that there was more Rain and Wind for several Months successively than for many Years before; especially from the Beginning to the Middle of this Month, about which Time it cleared up, and the Weather became suddenly very cold, with frosty Mornings; the Wind blowing generally pretty hard from the N. W. On the 23d of the same Month the Cold abated considerably; it was cloudy, but no Rain all that Day; the 24th was calm, and it rained most Part of the Afternoon, though the Mercury stood at $30 \frac{1}{2}$; it continued very calm all Night, but rained hard suddenly; it cleared up, and a strong Gale of Wind arose half an Hour before the Earthquake happened, which was at half an Hour before 4 o'Clock in the Morning. But

But let us see how different from this Doctrine are the Observations of some others, which serve to convince us of the Uncertainty of such Signs, and how little any Conjecture of this Kind can be depended on as a Prediction of Earthquakes, especially in Countries which have no Volcanoes in their Neighbourhood, which fiery Craters, as may be seen hereafter, are the only Means whereby People can in the least guess at an approaching Earthquake.

Mr. *Colman*, in his Account of an Earthquake that happened at *Boston* in *New-England*, on the 29th of *October*, 1727, acquaints us, that between ten and eleven o' Clock, when it happened, the Air was still and fair, and the Stars so bright and glittering, that several People had taken particular Notice of them, and that one or two Persons, who had been in Places subject to Earthquakes, had transiently said, that if that Part of the World had been used to them, they should expect one. It was then observed, that it was so in the dreadful Shock which happened at *Jamaica*, upwards of thirty Years before; and an ingenious Friend of Mr. *Colman*, informed him, that after that Shock, which was followed with several Tremors and lesser Concussions, he could from Day to Day judge by the Face of the Sky and Air, whether there would be any Tremor of the Earth. If there were any Clouds hanging over the mountainous Part of the Island, there was no Shock that Day; but if all were serene and fair, he expected one, and it seldom failed of happening.

One Thing more we shall beg leave too add, which seemed to indicate the Approach of the last mentioned Earthquake, was this. Mr. *Dudley*, who wrote a more particular Account of the various

rious Phænomena attending it, assures us, that a Neighbour of his had a Well 36 Feet deep, which about three Days before the Earthquake, he was surprized to find stink to that Degree that they could make no Use of the Water, that used to be very sweet and limpid ; nor scarce bear the House when it was brought in ; and imagining that some Carrion was got into the Well, he searched the Bottom, and found it clear and good ; though the Colour of the Water was wheyish, or pale. In about seven Days after the Earthquake, the Water began to mend, and in three Days more, it was returned to its former Sweetness and Colour.

With regard to the Extent of Earthquakes, though *Seneca* confines it to two hundred Miles, yet later Observations shew them to reach much farther, as will appear more at large in our History of Earthquakes. *Josephus Acosta* affirms, that in the Kingdom of *Peru*, in the Year 1586, an Earthquake spread along the Shore of the *Pacific Sea*, 160 Leagues ; and adds, that it sometimes has in those Parts run from South to North 300 Leagues ; and in the Year 1601, eminent Writers relate a much larger Extent of Ground to be shaken, being all the Way from *Asia* to the *French Coast* ; and, besides some *Asiatic* Regions, it shook *Hungary*, *Germany*, *Italy*, and *France*, that is, a great Part of *Europe* ; and *Mr. Boyle* observes, that, if it be true that, as is related, it lasted not above a Quarter of an Hour, it is the more likely that it shook great Tracts of Land beyond these Places, to which the fired Matter passing from one Cavity to another, could reach in so short a Time : For in Trains of Gunpowder, the Fire does not run on near so swiftly as one would imagine.

Before we conclude this general Theory, it may not be amiss to observe, that the prodigious Ravages produced by Earthquakes have made some Naturalists think, that Mountains and the Inequalities on the Surface of the Globe are no other than the Result of subterranean Fires, and that all the Irregularities which we observe upon the Earth ought to be ascribed to these violent Concussions. This in particular is the Opinion of Mr. Ray, who believes, that all Mountains have been formed by Earthquakes or Explosions of Volcanoes, as Mount *Cinere*, a new Island near *Santerini*, &c.

M. de Buffon, in his Theory of the Earth, undertakes to overthrow this System. Upon the Hypothesis of Mr. Ray, he observes, that this Philosopher did not consider, that these little Elevations formed by the Eruption of a Volcano, or by the Shock of an Earthquake, do not internally consist of horizontal Strata, or Layers, as all other Mountains do; for, upon digging into Mount *Cinere*, there are found calcined Stones, Ashes, burnt Earth, the Scoria of Iron, and Pumice-Stones, all mixed confusedly together, like a Heap of Rubbish. Besides, should Earthquakes and subterranean Fires have produced the highest Mountains on the Earth, as the *Cordillera's*, Mount *Taurus*, the *Alps*, &c. the prodigious Force that would have raised these enormous Masses would at the same time have destroyed a great Part of the Surface of the Globe, and the Effect of the Earthquake would have been inconceivably violent, since the most noted Earthquakes mentioned in History were not of sufficient Force to raise Mountains: There was, for Instance, in the Time of *Valentinian* the First, an Earthquake that was felt over all the known World, as *Ammian Marcellinus*, in

lib. 26. *c.* 14. gives us an Account, and yet there was no Mountain raised by this great Earthquake.

This noted Philosopher accounts for the Origin and Formation of Mountains in a more ingenious and philosophical Manner, as the curious Reader may see in his *Histoire Naturelle*, Tom. I. p. 308. seq.

Now it remains, that we exhibit a general History of the several Phænomena and Effects of the most memorable Earthquakes and Eruptions of Volcanoes; that, by comparing them with the preceding Theories, the Reader may be enabled to judge for himself, and prefer that Doctrine to which the Phænomena are most reconcileable; for it is admitted as an Axiom in Philosophy, that the Hypothesis which solves most Phænomena is the best one. In transmitting this History, we purpose to follow the same Order of Time wherein the several Earthquakes happened.

The Scriptures speak of several natural Earthquakes. One of the most remarkable is that which happened in the twenty-seventh Year of *Uzziab*, King of *Judab*, in the Year of the World 3221, and before Jesus Christ 783. There is Mention made of this Earthquake in *Amos* iv. 11. and in *Zechariah* xiv. 5. and in *Josephus*, who adds, that it was so violent as to divide a Mountain in Halves which lay to the West of *Jerusalem*, and moved one Part of it from its Place four Furlongs, or five hundred Paces; insomuch that it was stopped by the Wall which it met with on the East Side of the City; the Earth having closed up the Highway, and covered the King's Gardens.

Another very remarkable Earthquake was that which happened at our Saviour's Death. Many have been of Opinion that this Motion was perceived by all the World. Others maintain, that it was sensible only in *Judea*, or even in the Temple,

ple, the Gates whereof were shaken and the Veil rent afunder. St. *Cyril*, of *Jerusalem*, says, that the Rocks of Mount *Calvary*, which had been split by the Force of this Earthquake, were still shewn in his Time. It is observed, that it must have been attended with very terrible Circumstances, since the Centurion and those who were with him were so affected by it, that they acknowledged the Injustice of our Saviour's Condemnation, and confessed him to be the Son of God. *Orosius* takes this Earthquake to be the same with that which overturned the twelve Cities in *Asia*; but this Earthquake, according to Historians, happened in the fourth Year of the Reign of *Tiberius*, and was consequently fourteen Years, at least, prior to the other. Be that as it will, this was one of the most dreadful Earthquakes recorded in History; twelve famous Cities of *Asia* were overturned by it, viz. *Sardis*, *Magnesia*, at the Foot of Mount *Sipylus*, *Mostbene*, *Ægæ*, *Hierocæsarea*, *Philadelphia*, *Temolus*, *Temnus*, *Cymæ*, *Myrina*, *Apollonia*, *Hyrkania*. To these mentioned by *Tacitus*, *Eusebius* adds, *Ephesus*. *Pliny* and *Strabo* make this the most direful Concussion that ever was felt. It happened in the Night, and proved the more dreadful as it was less apprehended. Most of the Inhabitants were crushed under the Ruins of their Houses, and those who fled to the Fields were swallowed up by the Openings of the Earth. It is reported, says *Tacitus*, that huge Mountains sunk into the Earth, that Plains were raised up into high Hills, and that dreadful Flashes and Eruptions of Fire were seen among the Ruins. *Ptolemy* of *Tralles* says, that many Cities of *Pontus*, of *Sicily*, of *Calabria*, and of *Italy*, were greatly damaged by it; and adds, that the Earth opening in many Places, Bodies were discovered of a monstrous

Size, from one of which a Tooth was taken above a Foot in Length, and presented to *Tiberius*, who would not suffer the whole Body to be brought to him, saying that he deemed it a great Crime to disturb the Dead. However, to satisfy his Curiosity, he caused a Head to be engraved proportionable to the Tooth which had been brought him, and which he immediately after ordered to be restored to the Place whence it had been taken.

Towards the latter End of the Year 79 of the Christian Æra, and first of *Titus's* Reign, *Campania* was alarmed with a most dreadful and almost incredible Eruption of Mount *Vesuvius*, which had laid waste the whole Country, to a great Distance, and utterly consumed a great many Cities, with their Inhabitants, and among the rest *Pompeii* and *Herculaneum*. The former had suffered much by an Earthquake about three Years before, and had been rebuilt and embellished with several stately Edifices, especially a Theatre, in which the People were assembled, and intent upon the public Shews, when the City was swallowed up by an Earthquake, which attended the Eruption of the Flames from the Mountain. The Ruins of the latter, *Herculaneum*, were first discovered only a few Years ago, being buried sixty Feet deep under the Ashes, Cinders, and other Matters vomited out upon it by the Mount; and the Surface of this Matter, wherein it was overwhelmed, was for such a long Succession of Time become arable and cultivated Ground: But as the Relation of the Discovery of *Herculaneum* is now in the Hands of every Person, it will be unnecessary to trouble our Readers any more about it here. The Cities of *Puteoli* and *Cumæ* were greatly damaged by the Earthquake, and by the burning Ashes, which, if the Antients are to be credited, reached *Africa*, *Egypt*, and *Syria*, and at *Rome* turned

turned suddenly, to the great Terror of the Inhabitants, Day into Night. *Pliny* the Elder, who was then at *Misenum*, where he commanded the Fleet riding there, having discovered this Cloud on the first of *November*, and not yet knowing whence it issued, went immediately on board one of the Gallies, and sailed towards Mount *Vesuvius*. He was soon met by great Numbers of Persons, who in small Boats were flying from the dreadful Conflagration : But nevertheless, prompted by his Curiosity, he pursued his Course, though Stones, Ashes and Earth began already to shower down upon his Vessel ; nay, we are told that, to his great Surprize, he found a new Cape formed by the Earth, and huge Stones thrown out by the Mountain. However, he proceeded with great Intrepidity, and reaching *Stabiae*, between *Pompeii* and *Surrentum*, though the Inhabitants had all abandoned the Place, passed the Night there, the better to observe, during the Darkness, the Mountain which seemed all on a Blaze. The same Night a dreadful Earthquake happened at *Stabiae*, and such a huge Quantity of Stones fell, that *Pliny* resolved to put to Sea, but was prevented by contrary Winds. At length the Fire approaching, he attempted to save himself by Flight, but though supported by two of his Domesticks, he soon fell, suffocated, as is supposed, by the Thickness of the Air, and the insupportable Stench of the Sulphur. His Body was found three Days after, and interred by his Nephew, *Pliny* the Younger, who was then at *Misenum*, and narrowly escaped the same Fate, as he himself relates in his Epistles. On this Occasion the great Poet *Cesius Bassus* was consumed, with his House, by the Flames ; and likewise *Agrippa*, the Son of *Claudius Felix*, formerly Governor of *Judea*, and of *Drusilla*, Daughter to *Agrippa*, the last

last King of the *Jews*. This is the first Eruption of Mount *Vesuvius* we find mentioned in History.*

Towards

* That the Reader may form a little Idea of these burning Mountains, and their dreadful Eruptions, we shall transcribe from N^o. 354 of the *Philos. Trans.* an Extract of a Letter from Mr. *Edward Berkely*, from *Naples*, giving an Account of the Eruption of Fire and Smoke from Mount *Vesuvius*.

April 17, 1717. With much Difficulty I reached the Top of *Vesuvius*, in which I saw a vast Aperture full of Smoke, which hindered the seeing its Depth and Figure. I heard within that horrid Gulph, certain odd Sounds, which seemed to proceed from the Belly of the Mountain; a Sort of murmuring, sighing, throbbing, churning, dashing, as it were, of Waves; and between whiles a Noise like that of Thunder or Cannon, which was constantly attended with clattering, like that of Tiles falling from the Tops of Houses in the Streets. Sometimes, as the Wind changed, the Smoke grew thinner, discovering a very ruddy Flame; and the Jaws of the Pan, or Crater, were streaked with red and several Shades of yellow. After an Hour's Stay, the Smoke being moved by the Wind, gave us short and partial Prospects of the great Hollow, in the flat Bottom of which I could discern two Furnaces almost contiguous; that on the left, seeming about three Yards in Diameter, glowed with red Flame, and threw up red-hot Stones with a hideous Noise, which, as they fell back, occasioned the forementioned clattering. *May 8.* In the Morning I ascended the Top of *Vesuvius* a second Time, and found a different Face of Things. The Smoke ascending upright, gave a full Prospect of the Crater, which, as I could judge, is about a Mile in Circumference, and a hundred Yards deep. A conical Mount had been formed since my last Visit in the Middle of the Bottom. This Mount I could see was made of the Stones thrown up, and fallen back again into the Water. In this new Hill remained the two Mouths or Furnaces already mentioned; that on our left Hand was in the Vertex of the Hill, which it had formed round it, and raged more violently than before, throwing up every three or four Minutes, with a dreadful bellowing, a vast Number of red-hot Stones, sometimes in Appearance above 1000, and, at least, 300 Feet higher than my Head, as I stood upon the Brink: But there being little or no Wind, they fell back perpendicularly into the Crater, increasing the conical Heap. The other Mouth was lower in the Side of the new formed Hill.

I could

Towards the latter End of Autumn, in the 18th Year of the Emperor *Trajan's* Reign, and the 115 of the Christian *Æra*, while the Emperor was at *Antioch*,

I could discern it to be filled with red-hot Liquid Matter, like that in the Furnace of a Glass-House, which raged and wrought as the Waves of the Sea, causing a short abrupt Noise, like what may be imagined to proceed from a Sea of Quicksilver, dashing among uneven Rocks. This Stuff would sometimes spew over and run down the convex Side of the conical Hill, and appearing at first red hot, it changed Colour, and hardened as it cooled, shewing the first Rudiments of an Eruption. Had the Wind driven in our Face, we had been in no small Danger of stifling by the sulphureous Smoke, or being knocked on the Head by Lumps of molten Minerals, which we saw had sometimes fallen on the Brink of the Crater upon those shot from the Gulph at the Bottom. But as the Wind was favourable, I had an Opportunity to survey this odd Scene, for above an Hour and a half; during which it was very observable, that all the Vories of Smoke, Flame, and burning Stones, came only out of the Hole to our left, while the Liquid Stuff in the other Mouth wrought and overflowed as hath been already described.

June 5. After a horrid Noise, the Mountain was seen at *Naples* to spew a little out of the Crater. The same continued the 6th. The 7th, nothing was observed till within two Hours of Night, when it began a hideous bellowing, which continued all that Night and the next Day, till Noon, causing the Windows, and, as some affirm, the very Houses in *Naples* to shake. From that Time it spewed vast Quantities of molten Stuff to the South, which streamed down the Side of the Mountain like a Pot boiling over. This Evening I returned from a Journey through *Apulia*, and was surprized passing by the North Side of the Mountain, to see a great Quantity of ruddy Smoke lie along a huge Tract of Sky over the River, of molten Matter, which was itself out of Sight. The 9th, *Vesuvius* raged less violently; that Night we saw from *Naples* a Column of Fire shoot between whites out of the Summit. The 10th, when we thought all would have been over, the Mountain grew very outrageous again, roaring and groaning most dreadfully. You cannot form a juster Idea of this Noise, in the violent Fits of it, than by imagining a mixed Sound made up of the raging of a Tempest, the Murmur of a troubled Sea, the roaring of Thunder and Artillery, confused all together. It was very

Antioch, that City was almost intirely ruined by one of the most dreadful Earthquakes mentioned in History. The City was then crowded with Troops and Strangers, come from all Quarters, either out of Curiosity or upon Business and Embassies ; so that there was scarce a Nation or Province in the whole *Roman* Empire, but what had a Share in the Calamity ; and all the *Roman* World, says *Dion Cassius*, suffered in one City. The Earthquake was preceded by violent Claps of Thunder, and a horrid Noise under Ground ; then followed so terrible a Shock, that the Earth all trembled ; several Houses were overturned, and others tossed to and fro like
a Ship

very terrible, as we heard it in the further End of *Naples*, at the Distance of above twelve Miles. This moved my Curiosity to approach the Mountain. Three or four of us got into a Boat, and were set ashore at *Torre del Greco*, a Town situated at the Foot of *Vesuvius*, to the South West, whence we rode four or five Miles before we came to the burning River, which was about Midnight. The roaring of the Volcano grew exceeding loud and horrible, as we approached. I observed a Mixture of Colours in the Cloud over the Crater, green, yellow, red and blue ; there was likewise a ruddy dismal Light in the Air over that Tract of Land, where the burning River flowed ; Ashes continually showered on us all the Way from the Sea Coast. All which Circumstances set off and augmented by the Horror and Silence of the Night, made a Scene the most uncommon and astonishing I ever saw, which grew still more extraordinary as we came nearer the Stream. Imagine a vast Torrent of Liquid Fire rolling from the Top down the Side of the Mountain, and with irresistible Fury bearing down and consuming Vines, Olives, Fig-trees, Houses, in a Word every Thing that stood in its Way. The largest Stream seemed half a Mile broad at least, and five Miles long. I walked so far before my Companions up the Mountain, along the Side of the River of Fire, that I was obliged to retire in Haste, the sulphureous Steam having surprized me, and almost taken away my Breath. During our Return, which was about Three o'Clock in the Morning, we constantly heard the Murmur and groaning of the Mountain, which between whiles would burst out into louder Peals, throwing up large Spouts of Fire and burning
Stones,

a Ship in the Sea; the Noise of the cracking and bursting of the Timber, of the falling of the Houses, and a dismal and loud roaring under Ground, drowned the Cries of the dismayed People. Those who happened to be in their Houses, were for the most Part buried under their Ruins; such as were walking in the Streets and in the Squares, were by the Violence of the Shock dashed against one another, and most of them either killed or dangerously wounded. As the Earthquake continued with some small Intermiſſions for some Days and Nights together, many thousands perished by it; among the rest, the Consul *Marcus Peto Vergilianus*, with many other Persons of great Distinction. The most violent Shock of all, as we read in the Acts of St. *Ignatius*, was on a Sunday the 23d of December. *Trajan* himself was much hurt, but nevertheless escaped through a Window out of the House where he was. *Dion Cassius* pretends, that he was taken out of the Window and carried away by one who in Tallness exceeded the Human

Stones, which falling down again, resembled the Stars in our Rockets. Sometimes I observed two, at others three distinct Columns of Fire, and sometimes a vast one that seemed to fill the whole Crater. These burning Columns and fiery Stones seemed to be shot 1000 Feet perpendicular above the Summit of the Vulcano. The 11th at Night, I observed it from a Terrace at *Naples* to throw up incessantly a vast Body of Fire and great Stones to a surprizing Height. The 12th in the Morning it darkened the Sun with Ashes and Smoke, causing a Sort of Eclipse. Horrid Bellowings this and the foregoing Day were heard at *Naples*, whither Part of the Ashes reached. On the 13th the Wind changing, we saw a Pillar of black Smoke shoot upright to a prodigious Height. The 15th in the Morning the Court and Walls of our House in *Naples* were covered with Ashes. In the Evening Flame appeared on the Mountain through the Cloud. The 17th the Smoke appeared much diminished, fat and greasy. The 18th the whole Appearance ended, the Mountain remaining perfectly quiet, without any visible Smoke or Flame.

Size. The same Writer adds, that Mount *Lison*, which stood at a small Distance from *Antioch*, bowed with its Top, and threatened to fall down upon the City; that other Mountains fell; that new Rivers appeared, and others, that had flowed before, forsook their course and vanished. When the Earthquake ceased the Voice of a Woman was heard crying under the Ruins, which being immediately removed she was found with a sucking Child in her Arms, whom she had kept alive with her Milk. Search was made for others, but no one besides was found alive, except a Child that was still sucking its dead Mother. This Earthquake is mentioned by *Eusebius*, *Aurelius Victor* and *Evagrius*, who all speak of it as the greatest Calamity recorded in History.

In the Year of the Christian Æra 358, on the 24 of *August*, about six in the Morning, a most dreadful Earthquake was felt in *Asia*, *Pontus* and *Macedon*, which greatly damaged 150 Cities, and utterly ruined that of *Nicomedia*, where it was so sudden and violent that all the Houses were overturned at once, and the Inhabitants to a Man buried in the Ruins. *Epbrem* of *Edessa* wrote an Elegy upon this Subject, and *Libanius* bemoans in an Oration the Destruction of a City which he styles the fifth of the *Roman* Empire for Greatness, and inferior to none in Beauty. When *Julian* passed that way, in the Year 362, he could not refrain from Tears in comparing the Condition it was in then with that in which he had formerly seen it. *Cecrops* Bishop of the Place, and another Bishop perished with the rest; but not in the Church, nor with many Bishops, as the Pagans gave out to insult the Christians. The Church which was a magnificent Structure, and had been built by *Constantine* in the Year

330, underwent the same Fate with the other Edifices.

About the beginning of the Reign of the Emperor *Constantine* the fourth, frequent Earthquakes happened, which were, by far, the most destructive that had been known for many Ages. In *Syria* and *Palestine* several Cities were swallowed up, and others intirely ruined, and some, if we may give Credit to *Nicephorus*, removed without any considerable Damage six Miles and upwards from their former Seats. At the same Time happened an extraordinary Darknes which lasted from the 4th of *August* to the 1st of *October*, there being no Distinction during that time betwixt Day and Night. And in the Year 1033, being the 4th Year of the Emperor *Romanus's* Reign, an Earthquake was felt for forty Days together at *Constantinople*, which destroyed that City as well as several others. At the same Time a Comet appeared which passed with a terrible Noise from North to South; the whole Horizon seeming to be in a Flame.

But to come nearer our own Times. There was an Eruption of Mount *Vesuvius* in 1632, so very violent that it threw Rocks three Miles into the Air, which Eruption was attended with a terrible Earthquake.*

Earthquakes are so frequent in *Jamaica*, that

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the

* It is observed that the Eruptions of these Mountains are of two Sorts, the one not so violent as very much to disturb the adjacent Country; and this happens once in two or three Months, and lasts three or four Days; the other is more furious and of a longer Continuance, and is observed at *Naples* to happen to Mount *Vesuvius* once in about eighty Years: But from the burning or not burning of this Mount, *Naples* concludes on its safety or danger from Earthquakes: For doubtless the matter is continually burning under the Mountain, and those vast Clouds of Smoke, which daily issue out of the Top, if the Cavity happens by any Rock or inward Alteration to be stopped, must deviate through

the Inhabitants, Sir *Hans Sloan* informs us, expect one every Year. The most horrible Earthquake we have any Account of, was that which happened on the 7th of *June* 1692, which, in two Minutes time shook down and drowned nine-tenths of the Town of *Port Royal*. The Houses sunk out right thirty or forty Fathoms deep. The Earth opening swallowed up People, and they rose in other Streets, some in the Middle of the Harbour; and yet many were saved, though there were two Thousand People lost, and a Thousand Acres of Land sunk. All the Houses were thrown down throughout the Island. One *Hopkins* had his Plantations removed half a Mile from its place. Of all Wells, from one fathom to six or seven, the Water flew up at the Top with a vehement Motion; while Houses on one side of the Street were swallowed up, on the other they were thrown in heaps; and the Sand in the Street rose like Waves in the Sea, lifting up every Body that stood on it and immediately dropping down into Pits: and at the same instant, a Flood of Water breaking in rolled them over and over, some catching hold of Beams, Rasters, &c. Ships and Sloops in the Harbour were overfet and lost; the *Swan* Frigate particularly was thrown over by the motion of the Sea, and sinking of the Wharf, and was driven over the tops of many Houses. It was attended with

through other Passages under Ground, heaping up there a continual Magazine for a future Calamity.

It is also observed, that in Earthquakes occasioned by these Eruptions, the motion of the Earth is not from the perpendicular, but horizontal, as appears by the Cracks in the Earth all over *Sicily*: It is a Vibration so quick that it cracks the Glafs in the Windows, and the Reciprocations of a Lute-string are not more frequent than it. Now when the Vibrations are so quick, and the Body moved so large, the Motion must be prodigiously violent.

a hollow rumbling Noise like that of Thunder. In less than a Minute, three quarters of the Houses and the Ground they stood on, with the Inhabitants were all sunk quite under Water, and the little part left behind was no better than a Heap of Rubbish. The Shake was so violent that it threw People down on their Knees, or rather Faces, as they were running about for Shelter. The Ground heaved and swelled like a rolling Sea, and several Houses still standing were shuffled and moved some Yards out of their Places. In many parts the Earth would suddenly crack and open and shut equally quick, of which Openings two or three hundred might be seen at a Time, in some whereof the People were swallowed up; others the closing Earth caught by the Middle and pressed to Death; in others, the Heads only appeared. The larger Openings swallowed up Houses, and out of some would issue whole Rivers of Water, spouted up to a great height into the Air, and threatening a Deluge to that part the Earthquake spared. The whole was attended with Stenches and offensive Smells; the Noise of falling Mountains at a Distance; while the Sky, which till the Earthquake, was fair and serene, in a Minute's time turned dull and reddish like a glowing Oven; yet as great a sufferer as *Port Royal* was, more Houses were left standing therein than on the whole Island beside. Scarce a planting House or Sugar-house was left standing in all *Jamaica*. A great part of them were swallowed up, Houses, People, Trees, and all at one gape, instead of which afterwards appeared great Pools of Water, which when dried up, left nothing but Sand, without any Mark that ever any Tree or Plant had been thereupon. Above twelve Miles from the Sea, the Earth gaped and spouted out with a prodigious force vast quantities
of

of Water into the Air, yet the greatest Violences were amongst the Mountains and Rocks, and it was a general Opinion, that the nearer the Mountains the greater was the Shake, and that the Cause thereof lay there.

Not far from *Yallbouse*, part of a Mountain, after it made several Leaps or Removes, overwhelmed a whole Family, and great part of a Plantation, though a Mile distant; and a large high Mountain, near *Port Morant*, about a Day's journey over was quite swallowed up, and in the Place where it stood nothing remaining but a Lake of four or Leagues over.

Most of the Rivers were stopped up for twenty four Hours by the falling of the Mountains, till swelling up they made themselves new Tracks and Channels, tearing up, in their Passage all Things in their way, and carrying with them into the Sea, several hundred thousand Tons of Timber, floating in such prodigious Quantities that they seemed like moving Islands.

After the Violence of these convulsive Throws was over, those who escaped in the City of *Port Royal* got on board the Ships in the Harbour, where many continued above two Months; the Shakes all that time being so violent and coming so thick. Sometimes two or three in an Hour attended with a frightful Noise, resembling a hollow rumbling Thunder with Brimstone Blasts, so that they durst not venture on Shore. The Consequence of this Earthquake was a general Sickness, occasioned by the vast Quantity of noisome Vapours belched forth, which swept away above three thousand Persons of those that were left.

The continual fiery Eruptions of Mount *Ætna*, of which the first we have any Account of happened 500 Years before the Destruction of *Troy*, according

ing to *Diodorus Siculus*, have always been taken for the most probable Causes of the horrible Shocks that, from Time to Time, have laid waste the Island of *Sicily*.

On the 10th of *January* 1693, there happened an Earthquake of that sort which *Aristotle* and *Pliny* call the first Species, that shook not only the whole Island but *Naples* and *Malta*. *Bonajutus* informs us, that it was not preceded by any darkness in the Air; but, on the contrary, by an agreeable, serene and warm Season, which was the more observable, as being unusual at that time of the Year. The preceding Evening, there was a great Flame or Light observed in the Air, which was taken for the Reflection of a Fire made by the Country-people, and which seemed to keep at the same Distance, though the Spectators went directly towards it: Whilst they were observing this Appearance, the Earthquake began, upon which the light instantly vanished, and the Waves of the Sea, which before the shock beat gently on the Shore, began now to make a dreadful Noise. It was at this Time impossible for any one in this Country to keep upon his Legs on the dancing Earth; nay, those who lay were tossed from one Side to another as on a rolling Pillow; and high Walls leaped from their Foundations several Paces. The next Day the Air was overshadowed with Darkness, and tinged with a deep Yellow, whilst the darkened Sun struck the Minds of the Spectators with the melancholy Presage of an Earthquake, more terrible than that which happened the Night before; and this indeed was the Case: It lasted about four Minutes. In open Places the Sea sunk down considerably, and in the same Proportion in Ports and inclosed Bays; the Water bubbled up all along the Shore; the

the Earth opened in several Places, in very long Clefts ; some an Hand's Breadth, others half a Palm, and others like great Gulphs : From these Openings in the Vallies there issued out such a Quantity of Water as overflowed a great Space of Ground, which to those that were near it had a sensible, sulphureous Smell. In the Plain of *Catania*, from one of those narrow but very long Clefts, at about four Miles from the Sea, the Water was thrown up altogether as salt as that of the Sea. There were great Rocks loosened every where, and thrown down from the Mountains. A Fountain, in the very Time of the Earthquake, ejected Water tinged of a Blood-red, for three Hours, and then it dried up, leaving many Holes in the Mud, at Bottom, through which real Ashes were thrown up ; and the next Day the Water returned to its former Quality, without the least Alteration. The South Winds blew very much, which always have been impetuous in the most sensible Earthquakes ; these were preceded by a Noise like a Cannon at a great Distance, sometimes of a longer, and sometimes, of a shorter Continuance.

Father *Anthony Serrovita*, just as the Earthquake happened, was upon his Way to *Catania* ; and, at the Distance of a few Miles, he observed a black Cloud like Night hovering over the City, and there arose from the Mouth of *Montgibello*, great Spires of Flame, which spread all around. The Sea all on a sudden began to roar, and rise in Billows, and there was a Noise as if all the Artillery in the World had been at once discharged. The Birds flew about astonished ; the Cattle in the Fields ran crying. His and his Companions Horses stopped short, trembling, so that they were forced to alight. They were no sooner off but they were lifted from the Ground above two Palms,

Palms, when casting his Eyes towards *Catania*, he with Amazement saw nothing but a thick Cloud of Dust in the Air.

It has been observed, that in less solid Ground, such as Chalk, Sand, or loose Earth, the Damage was incomparably greater than in rocky Places; its Effects on human Bodies have been various, such as, Foolishness, Madness, and Dullness; Hypochondriac, melancholic and choleric Disorders; Fevers were very common, with continual tertian and malignant ones, accompanied with Deliria and Lethargies; the Small-Pox made great Havock among Children; and in short, no Age or Condition but had its Share in so universal a Calamity.

The Mischief it did besides is amazing; almost all the Buildings in the Country were thrown down; fifty-four Cities and Towns, besides an incredible Number of Villages, were either destroyed, or greatly damaged. We shall only instance the Fate of *Catania*, one of the most antient and flourishing Cities in the Kingdom, the Residence of several Monarchs, and an University; for of 18914 Inhabitants of this City, 18000 perished therein; and *Bonajutus*, from a Computation of the Inhabitants before and after the Earthquake, in the several Cities and Towns, found that near 60000 perished out of 254000.

Peru has been long remarkable for Earthquakes, but no Part of that Country has suffered more than *Lima*. The last, being one of the most dreadful Earthquakes recorded in History, happened on the 28th of *October*, 1746, at half an Hour after ten at Night. The Shock lasted fifteen Minutes, and in less than four Minutes,

nutes, during which the greatest Violence of the Earthquake lasted, scarce twenty Houses were left standing in the City of *Lima*; besides those in the Borough of *St. Lazarus*, said to contain sixty thousand Inhabitants. The fine Cathedral Church was utterly demolished, besides 74 Churches, a vast Number of public Chapels, fourteen Monasteries, and as many Hospitals; the Palace of the Viceroy, the Courts of Justice, the Royal University, Mint, Treasury, with all their most valuable Furniture and Effects, were instantly lost and confounded together in Mountains of Ruin: Yet in this dreadful Scene of Desolation and Horror, it does not appear, from the List taken of the Dead, that above eleven hundred and forty Persons perished, great Part of which were Monks and Nuns, owing to the Height of the Monasteries, and their being built of more solid Materials than the other Houses; for their Houses in *Peru* are in general only one Story high, and covered with Mats and such light Materials.

But direful as the Ruins of *Lima* may appear, those of the Port of *Callao*, about two Leagues distant, are still more so; the Place having quite vanished out of Sight, and now become a large Strand, without the least Sign of its former Figure or Appearance; vast Heaps of Gravel and Sand having now covered the Place where that Town stood. Part of its Walls, and some few Towers, for a Time, endured the Force of the Earthquake, and stood firm, notwithstanding the Violence of its Shocks; but scarce had the wretched Inhabitants recovered from the Horror of their first Fright, when suddenly the Sea began to swell, and rising like Mountains, rushed

rushed furiously forward upon the remaining Part of the Town, where it teared up Houses, publick Buildings, and every Thing that opposed its Passage, from the very Foundations. In short, the whole Town, except one Tower, two Gates and a small Part of the Wall, which were left as dreadful Monuments of this fatal Calamity, sunk in the Sea, and consequently most of the Inhabitants were drowned; for of upwards of four thousand Persons, scarce two hundred were saved, by swimming upon Pieces of Timber, or whatever else they could lay hold of afloat. Of five and twenty Ships that were in the Port, four were carried a League up into the Country, and the rest swallowed up by the Waves. Fresh Shocks were every Day afterwards felt at *Lima* and the neighbouring Country during the whole Month of *November*.

After this Detail of such horrible Convulsions of the Earth, the Reader will have no great Curiosity left for the less considerable Phænomena of the Earthquakes that have happened in this Country, as well as in the several Countries abroad: Therefore, after giving a short Account of the two last Shocks felt at *London*, and the neighbouring Places, we shall conclude this short History of Earthquakes with a more particular Account of the late one so fatal to *Portugal*.

February 8th, 1750, about half an Hour after Twelve at Noon, the Inhabitants of *London* and *Westminster*, and about ten Miles round them, were alarmed by the Shock of an Earthquake, of the vibratory Kind, attended with a hollow, flat Noise, not very loud. It was most sensibly felt about *Grosvenor-Square*, and the rest of the higher Grounds about *London*. A few Houses were shattered by the Shock, and several Chimnies and Part of two or three Houses tumbled down. The

Weather was rainy and close for some Days before the Earthquake, and on the Morning of that Day whereon it happened, there was a thick Fog; and at the Time of the Shock the Air was remarkably calm.

On the 8th of *March* following this Earthquake, being the Interval of an exact Lunar Month, at half an Hour after Five in the Morning, a more violent Shock of an Earthquake than the preceding one was felt in *London, Westminster,* and the neighbouring Villages; it was attended with a loud, rattling Noise like that of distant Thunder, which wakened most People in Fear that Part of their Houses had fallen in, and was, as well as the former, of the vibratory Kind. Just before the Shock a Ball of Fire was seen in the Air to the West of the City; and continual and confused Lightnings darting very low, were seen, for half an Hour, till within a Minute or two of the Shock. A Spring burst out in a Cellar the Corner of *Dean-Street, Fetter-Lane,* and the next Day the Water was gone as remarkably as it came, and the Ground left as dry as if no Water had been there. The Top of one of the Piers on the North Side of *Westminster-Abbey* fell down; some Houses fell in, and Chimnies were thrown down in divers Places. In *St. James's Park,* and in all the open Places, the Ground moved very perceptibly, and the Noise seemed to break three Times. It was felt at *Linton* in *Cambridgeshire,* and at *Northampton.* There was another Shock, but less violent about a Quarter past two o' Clock the same Morning.

On *Saturday, Nov. 1st, 1755,* there happened an Earthquake the most extraordinary of any recorded in History. No other Account can equal the fatal Effects of this Concussion; the Shocks having extended, by the Accounts we have already received,
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from North to South upwards of 2500 Miles, with the utmost Violence, and their Effects upon the Waters of the Ocean, Seas, Rivers and Lakes, by throwing them into great Agitation, having extended around more than 5000 Miles. This Earthquake seems to have begun in *Greenland*, where, we are told, there was a violent Shock felt the Beginning of *November*; thence it extended Southward, in almost a direct Line, the eastern Limits whereof were nearly at the Distance of five Degrees from the Meridian of *London*, (though indeed it was perceived at *Portsmouth*,) and passing in that Direction under the northern Ocean, the Islands of *Trinity*, *Ferro*, &c. some of the western Isles of *Scotland*, under *Ireland*, the *Irish* Sea, the South-west Part of *England*, &c. it continued its Progress under the Ocean, the *English* Channel, &c. to the Bay of *Biscay*, &c. and shook all *Portugal*, and great Part of *Spain*; whence it passed under the Sea to the Continent of *Africa*, where, with incredible Violence, it passed on in the same Direction through the Kingdoms of *Fez*, *Morocco*, &c. till probably it vented itself in the Southern Ocean.

That such was the Direction of this Earthquake appears from the Circumstance of Time wherein the same Shock was felt in all the Countries through which it passed. At a Quarter after Nine in the Morning this Shock was felt at *Cork* in *Ireland*, and at *Portsmouth*, and some other Places in *Great-Britain*; but, probably, lying very deep under the Surface of the Earth, it did no Damage in *Great-Britain* or *Ireland*. About half an Hour after Nine, the Inhabitants of *Oporto* were alarmed with a rumbling Noise immediately preceding the Shock, whereby the whole City was shaken; several Chimnies,
Stones

Stones and Crosses thrown down, and some Churches opened at Top; here, it was one continued, regular Trembling of the Earth, and was the first Species of Earthquakes mentioned by *Aristotle*; and had it been otherwise, it is thought the whole City must have been laid in Ruins. The Inhabitants were thrown into the utmost Confusion, not knowing where to fly for Preservation; some making their way to the River, to get into Boats and on board Ships, and others to other different Parts, while some were so distracted with Fear, that they did not know where they were going. Many remained on the Middle of the Street, lest the Houses should fall; some without Hats, Caps, &c. others without Stockings or Shoes, all in the greatest Consternation that can be conceived. The Horror of those who ran to the River-side was, if possible, greater than theirs who remained on the Street; for, the River retiring about twenty Yards from them, returned with a great Violence and a horrid Noise. Two large *Brazil-Ships*, lying without the Bar, the Sea rose in one great Wave and brought them clear over the Bar and into the River, over Places that before were dry, without any considerable Damage, to the Astonishment of the poor Sailors and Pilots, who thought of nothing but immediate Death. The Sea after that Commotion ebb'd and flow'd till Night, three or four Feet in five or six Minutes; the Ships moved some up the River, while others went down; several small Shocks were felt after this one, all Day, but so faint as to be only just perceivable.

Some Time after Ten, the same Shock was felt at *Madrid*, where it lasted eight Minutes, but without doing any considerable Damage, besides shattering and splitting the Steeples of some Churches,

Churches, and throwing the Inhabitants into the utmost Consternation.

This Shock was felt at *Seville*, just before Ten : Here it was so violent that the Inhabitants looked upon it as the Day of Judgment ; all the Churches were ruined, and the Towers of some falling killed a great Number of People.

A few Minutes before Ten, the Shock was perceived at *Cadiz*, where it lasted about five or six Minutes, with such Violence, that the whole Town was shaken ; and in such a Manner, that the People could not keep upon their Legs ; the Water in the Cisterns under Ground dashed backwards and forwards with such Impetuosity as to occasion a great Froth on it. Every body ran out of the Houses and Churches in a terrible Consternation, but no Damage was done, all the Buildings there being exceedingly strong. About an Hour afterwards the Sea, which was calm, as there was not a Breath of Air, began on a sudden to swell up. At the Distance of eight Miles from the City a Wave, at least sixty Feet higher than common, was seen approaching all round the City. The Inhabitants apprehended every Moment to be all drowned, and ran into the Street seeking for Confession and Mercy. In the mean time the Sea, with the utmost Violence, dashed against the West Part of the Town, which is very rocky, and which in a great measure abated the Force of the Wave : However, it beat upon the Walls with such Fury as to beat in the Breast-Work ; it carried away eighty Yards of the Walls in Length, broke into the Town, overflowed the Streets, and carried away the Sand and Walls, but left the Houses standing, so that only two or three Persons were drowned. After this every one thought the Town would

would be swallowed up; for although this Wave was run off, yet the Citizens could see more Waves coming on. They then had not the least Hopes of Life; the People ran to the higher Grounds, the Friars of all the Convents in the Streets giving Benediction to the People, all in Tears, expecting instant Death; a great many ran out at the Land-gate to escape to the Island, but alas! poor Wretches, the two Seas met with equal Violence, as in the City, and when they would gladly have turned back, found it too late, for they were all drowned, Men, Women, and Children. This most terrible Scene lasted near two Hours; when the Sea began to ebb, but was still in a boiling Motion. Every Thing was washed off the Mole; the Bay was full of overturned Boats, floating Barrels, and Timber, but no Damage done to the Shipping.

About half an Hour after Nine, * the Shock began at *Lisbon*, and lasted with the utmost Violence, near eight Minutes, whereby almost all the publick Edifices and most of the other Houses of that superb Capital were thrown down, and upwards of fifty thousand People buried in the Ruins; for unhappily that Day being a great Festival in the *Romish* Church, and the Earthquake just happening at the Time of celebrating their first Mass, thousands were assembled in the Churches, the major Part of whom were

* The Reason why this Shock was felt at *Lisbon* at half an hour after nine and not at *Madrid* till after ten, nor at *Seville* and *Cadiz* till before ten, is not so much owing to these Cities lying South of *Lisbon*; for on the contrary *Madrid* is $1^{\circ} 45'$, North of *Lisbon*. The Reason therefore must be, the Difference of Longitude between these Cities and *Lisbon*; for *Madrid* being $5^{\circ} 10'$ East from *Lisbon*, will have the Sun in its Meridian by more than 20 Minutes sooner than *Lisbon*; and in the same proportion the Cities of *Seville* and *Cadiz*, as being situated to the East of *Lisbon*, will have the Sun sooner.

killed :

killed : Because these great Buildings, particularly those built on any Eminence, suffered first ; very few of the Churches or Convents having escaped. During this Shock, which was attended with such a horrid Noise that most People apprehended the Dissolution of the World, the Earth trembled to that Degree, that People could scarce keep upon their Legs. This Shock in about fifteen Minutes afterwards was followed by another, no less violent, during which the Earth opened in several Places, and having swallowed whole Streets, threw up dreadful Quantities of Fire, Water, and Smoke. At the same Time the Water in the River rose up several Yards perpendicularly, whereby those that escaped the general Destruction, were alarmed with a Cry that the Sea was coming in, upon which all climbing over the Ruins of Churches, Houses, &c. and stepping over thousands of dead and dying People, crowded forward to the Hills : Several Vessels were swallowed in the *Tagus*, by the Agitation of the Waters, or sunk by the Fall of the Royal Palace and other Buildings situated on the Banks of that River.

About half an Hour after this second Shock, there was another, which lasted for some Minutes ; and a fourth about Twelve o'Clock, at which Time, or soon after, as if all the Elements had combined to the Ruin of this Metropolis, two Fires broke out in different Parts of the City, which almost completed the Destruction thereof, because that from the Terror all Persons were in, and the Wind being high, no Attempt was made to stop it ; so that by the great Flakes of Fire drove by the Winds, it was communicated to one Street by another, and raged with great Violence for eight Days, and that in the most thronged Parts of the City.

Before this Conflagration, the Horror of the Scene within the City was beyond all Description; for during the first Shock, the whole City, by the Clouds of Dust occasioned by the falling Houses, was darker than the darkest Night; it had no sooner cleared up, than the Scene of the sudden Desolation and Destruction, occasioned by this Shock, more plainly appeared. Numbers were seen expiring, others a shocking Spectacle, while the Clergy ran about to absolve such as were still alive. Nothing was heard but howling, crying, shouting for Mercy, and the Groans of the dying People. A large Quay, piled up with Goods, near the Custom-house, sunk by the first Shock, with about 600 Persons upon it, who all perished. The King, Queen, and all the Royal Family, escaped from the Palace, just before it fell to the Ground. The *Spanish* Ambassador, and nine of his Domesticks, perished under the Ruins of his House. A remarkable Providence seems to have distinguished the Protestants, for amongst the great Numbers settled in *Lisbon*, only about 40 or 50 Persons perished. The Reason of this remarkable Delivery was in a great Measure owing to the Numbers of them that went out of Town, before the Earthquake began; for the first of *November*, being the Festival of *All-Saints*, was appointed for the Celebration of the *Auto de fe*; upon which Occasion Insults are frequently offered to Protestants in the City. This dreadful Solemnity, as it determined great Numbers of Protestants to leave the City, that Day, so it brought Numbers of the Country-inhabitants to *Lisbon*, to see the cruel Show; which was the Occasion that many more of the *Portuguese* were lost, than perhaps otherwise would have been.

In this melancholy Catastrophe, scarce a single Building in the City of *Lisbon* escaped but the Mint. All the People that survived the general Destruction fled into the Fields, great Numbers of which were half naked. The Loss is immense, for the Fire consumed all Sorts of Merchandize, Household Goods, and wearing Apparel, so that hardly any Thing was left to cover People's Nakedness, besides what they happened to have on; in which Situation they have for more than two Months been under the Necessity of living in Tents, or in the open Air in the Fields, or on board the Ships in the Harbour, and that labouring under a Variety of Diseases, the common Effects of all terrible Earthquakes attended with Eruptions, and of other such like unhappy Circumstances. If the Fire had not happened, People would have recovered great Part of their Effects out of the Ruins; but this has made such a Scene of Desolation and Misery, as Words cannot describe. The Fire was either kindled, or at least propagated, by some Villains who had formed a Design of plundering the City, and who confessed it before their Execution.

Several successive Shocks were felt at *Lisbon*, for the first seven Days of *November*, and upon the eighth, about Five in the Morning, they had a most horrid Shock, which lasted half a Minute; and several small Shocks were perceived, at different Intervals, to the twentieth. There were several Eruptions in and about *Lisbon*, especially at *Cintra*, near the Rock, much Flame and Sulphur were seen to issue forth.

There is no City or Place of Note in the whole Kingdoms of *Portugal* and *Algarva*, but shared more or less in this Calamity. The Cities *Coimbra* and *Braga* have suffered severely, and *St. Ubes* has

been almost totally swallowed up. The principal Mountains of *Portugal* have been shaken by this Earthquake ; some of them have been split and rent, and huge Masses of them rolled down into the adjacent Vallies, to the great Terror and Damage of the Inhabitants. These Shocks, which have done such horrid Devastations in *Portugal*, have been felt all over *Spain*, except in *Catalonia* and the Kingdoms of *Arragon* and *Valencia*. *Tarriffa* and *Gibraltar* were both shaken ; at *Faro*, upwards of three thousand of the Inhabitants were buried in the Ruins of their Houses ; and great Part of the City of *Malaga* was destroyed ; as were those of Port *St. Mary*, *St. Lucar*, &c. In short, a Volume could scarce contain the Particulars of the Devastation occasioned by this Earthquake ; during which the *Minho*, the *Douro*, the *Tagus*, the *Guadiana*, and several other Rivers, having rose to an extraordinary Height, and overflowed their Banks, did a vast deal of Damage to the several Countries they run through.

From the South Coasts of *Spain* and *Portugal*, the Earthquake, in the same Direction, passed under the Sea over to *Africa*, and destroyed great Part of the City and Port of *Algiers*, and other Cities upon the Coast of *Barbary* ; thence it passed to *Morocco* ; where on the 19th of *November* the City of *Mequinez* was utterly destroyed by an Earthquake, with the greatest Part of the Inhabitants, as was also one half of the City of *Fez* ; and an Army of 12,000 *Arabs*, which were encamped near *Mequinez*, were swallowed up by the Earthquake.

Since this general Earthquake of the 1st of *November*, several violent Shocks have at different Times been felt in different Parts of *Europe*, particularly in *Great-Britain*, *France*, *Switzerland*, *Italy*,
Germany,

Germany, &c. besides *Spain* and *Portugal*, as also in divers Parts of *Africa* and *America*: One half of the Island of *Madeira* has been destroyed, and the *Azores*, or the seven Western Islands, it is thought, are entirely swallowed up, as they have been in vain sought for by several Ships.

Of all the Phænomena that attended this late general Earthquake on the first of *November*, nothing is more amazing than the extraordinary Agitation of the Waters: Ships at Sea were shaken as if they had been dashed against Rocks, and that at more than sixty Leagues from the Coast of *Portugal*, or any other Land. The Waters were so agitated at *Kinsale* in *Ireland*, that a Sloop of sixty Tons which lay at Anchor was torn away from her Moorings, and two new Cables broke like two Threads, meerly by the Force of the Current (for a Breath of Wind did not blow) and drove ashore in a Moment. The fishing Boats were whirled about like so many Corks, and as quick as the Fly of a Jack. The Sea went back and suddenly returned with a Violence too impetuous to describe, and these surprsing Fluxes and Refluxes continued from three o'Clock in the Afternoon till ten at Night; the Waters did not rise gradually, but with a hollow and horrid Noise rushed in a Deluge, and rose six or seven Feet in a Minute, and suddenly subsided: The Water was as thick as puddle, looked very black, and stunk unsupportably.

In several Places in *Great Britain*, not only the Sea but Rivers, Lakes, and Ponds were thrown into this violent Commotion. At *Swansea*, about three Quarters after Six in the Evening, a Mile and a half up the River, after two Hours ebb, a large Head of Water rushed up with a great Noise, floated two large Vessels, broke their Stern-Moorings, and hove them across the River. It
fell

fell as suddenly as it came up, for in ten Minutes there was no Appearance left of more Water than usual at that time of Tide. A like Agitation of the Waters happened at *Hayl* in *Cornwall*, and at *St. Ives*. Near *Godalmin* in *Surry*, the same Day, the Water, in the Canal of a Gentleman's Garden, suddenly rose so high, as to overflow the Banks on one side, then subsided and immediately overflowed the Bank on the other side. The Water in their Canals about *Amsterdam*, and in several other Places in *Holland*, was, in like manner, violently agitated; as it was in great Numbers of Places in *Germany*. *Denmark* and *Sweden*; and to the Westward we learn, that as far as *Barbadoes* from five in the Afternoon till ten at Night, the same sudden Fluxes and Reflexes of the Sea, were felt upon the 1st Day of *November*; at which Time the Earthquake was perceived in the Island of *St. Martin* in the *West Indies* †.

† If we admit the Principle already laid down, and sufficiently proved in the beginning of this Treatise, *viz.* That the Water upon the Surface, as well as that within the Bowels of the Earth, communicates with the Abyss, by means of such Channels, Veins, and Canals as the Earth is every where found to abound with, then we shall find, by turning back to *Dr. Woodward's* System, that these violent Agitations of the Water are accounted for and proved to take place in all Earthquakes, more or less in proportion to the Violence of the Shock, and perceived at greater or smaller Distances in proportion to the Extent of the Earthquake; and that those are not new, nor peculiar to this Earthquake, but, on the contrary, accompany all violent ones, the preceding History of Earthquakes sufficiently testify.

F I N I S.