PRINCIPLES OF GEOLOGY; OR, THE MODERN CHANGES OF THE EARTH AND ITS INHABITANTS CONSIDERI primeval, but the daughters of Time."LINNÆUS, Syst. Nat. ed. 5, Stockholm, 1748, p. 219. "Amid all the revolu Illustrations of the Huttonian Theory, § 374. "The inhabitants of the globe, like all the other parts of it, are subj other Physical SciencesNot to be confounded with Cosmogony. Geology is the science which investigates the	ED AS ILLUSTRATIVE OF GEOLOGY. BY SIR CHARLES LYELL, M.A. F.R. utions of the globe, the economy of nature has been uniform, and her law ject to change. It is not only the individual that perishes, but whole specie he successive changes that have taken place in the organic and inorganic	S. VICE-PRESIDENT OF THE GEOLOGICAL SOCIETY OF I is are the only things that have resisted the general mover es. "A change in the animal kingdom seems to be a part of c kingdoms of nature; it inquires into the causes of these	LONDON; AUTHOR OF "A MANUAL OF ELEMENTARY GEOLOGY," " ment. The rivers and the rocks, the seas and the continents have bee f the order of Nature, and is visible in instances to which human pow changes, and the influence which they have exerted in modifying the	TRAVELS IN NORTH AMERICA," "A SECOND VISIT TO THE UNITED S n changed in all their parts; but the laws which direct those changes, er cannot have extended."PLAYFAIR, Illustrations of the Huttonian T surface and external structure of our planet. By these researches into	STATES," ETC. ETC. "Verè scire est per causas scire."BACON. "The stony rocks are not and the rules to which they are subject, have remained invariably the same."PLAYFAIF Theory, § 413. BOOK I. CHAPTER I. Geology definedCompared to HistoryIts relation to the state of the earth and its inhabitants at former periods, we acquire a more perfect k
nowledge of its present condition, and more comprehensive views concerning the laws now governing its animal retain in the memory a multitude of complicated relationsthe various peculiarities of national characterthe confidence of the natural world is the result of a long succession of events; and if we would enlarge our experience of the may find inseparably connected the geographical boundaries of a great state, the language now spoken by the second state of the second state	mate and inanimate productions. When we study history, we obtain a mor different degrees of moral and intellectual refinement, and numerous other e present economy of nature, we must investigate the effects of her operate inhabitants, their peculiar manners, laws, and religious opinions. But face the product of the prod	re profound insight into human nature, by instituting a conser circumstances, which, without historical associations, values in former epochs. We often discover with surprise, or more astonishing and unexpected are the connections of the consections of the con	nparison between the present and former states of society. We trace would be uninteresting or imperfectly understood. As the present cor on looking back into the chronicles of nations, how the fortune of so rought to light, when we carry back our researches inch history of the additional to the next light and the state of the charge of the state of the s	the long series of events which have gradually led to the actual postu- ndition of nations is the result of many antecedent changes, some ext me battle has influenced the fate of millions of our contemporaries, w f nature. The form of a coast, the configuration of the interior of a cou	remely remote, and by connecting effects with their causes, we are enabled to classify and remely remote, and others recent, some gradual, others sudden and violent; so the state then it has long been forgotten by the mass of the population. With this remote event we untry, the existence and extent of lakes, valleys, and mountains, can often be traced to the control of the contr
on of sediment in a lake or in the ocean, or to the prolific increase of testacea and corals. To select another exact selections of sediment in a lake or in the ocean, or to the prolific increase of testacea and corals. To select another exact, theology; in a word, with all branches of knowledge by which any insight into human affairs, or into the moore and philosophical conclusions from the various monuments transmitted to them of former occurrences.	kample, we find in certain localities subterranean deposits of coal, consist rosperity, and numerical strength of a nation, may now be mainly dependent and intellectual nature of man, can be obtained. It would be no less described by would know to what combination of causes analogous effects were	ting of vegetable matter, formerly drifted into seas and lakent on the local distribution of fuel determined by that assirable that a geologist should be well versed in chemists a referable, and they would often be enabled to supply by	tte, and various pecularities, may be districtly referred. On the other tees. These seas and lakes have since been filled up, the lands where cient state of things. Geology is intimately related to almost all the phry, natural philosophy, mineralogy, zoology, comparative anatomy, by inference, information concerning many events unrecorded in the discount.	on the forests grew have disappeared or changed their form, the rivers ysical sciences, as history is to the moral. An historian should, if postorany; in short, in every science relating to organic and inorganic nations are provided by the screen of former ages. But as such extensive acquisitions are	is and currents which floated the vegetable masses can no longer be traced, and the plan sible, be at once profoundly acquainted with ethics, politics, jurisprudence, the military ure. With these accomplishments, the historian and geologist would rarely fail to draw coarses within the reach of any individual, it is necessary that men who have devote
their lives to different departments should unite their efforts; and as the historian receives assistance from the cory, extends no farther than to one class of historical monumentsthose which may be said to be undesigned mer method of constructing military defences; the Egyptian mummies throw light on the art of embalming, the nected account of any series of events beyond the reach of history. But the testimony of geological monument	the antiquary, and from those who have cultivated different branches of the antiquary, and from those who have cultivated different branches of the law in an ancient the action of the human race in ancient the stream of the human race in ancient to the human race in an action to the human race in	oral and political science, so the geologist should avail hi hatchets found in our peat bogs, afford an insight into the lypt. This class of memorials yields to no other in authenti from all intentional misrepresentation. We may be deceived	imself of the aid of many naturalists, and particularly of those who have rude arts and manners of the earliest inhabitants of our island; the licity, but it constitutes a small part only of the resources on which the differences which we draw, in the same manner as we often	ave studied the fossil remains of lost species of animals and plants. The buried coin fixes the date of the reign of some Roman emperor; the are historian relies, whereas in geology it forms the only kind of evidency mistake the nature and import of phenomena observed in the daily co	the analogy, however, of the monuments consulted in geology, and those available in his ncient encampment indicates the districts once occupied by invading armies, and the force which is at our command. For this reason we must not expect to obtain a full and con burse of nature: but our liability to err is confined to the interpretation, and, if this be corr
ect, our information is certain. It was long before the distinct nature and legitimate objects of geology were full included it under the head of Physical Geography. But the most common and serious source of confusion are vored to draw a strong line of demarcation between his favorite science and cosmogony, for he declared that gole to trace the progress of opinion on this topic, from the earliest ages to the commencement of the present c	ly recognized, and it was at first confounded with many other branches of ose from the notion, that it was the business of geology to discover the mageology was in nowise concerned "with questions as to the origin of thing century. CHAPTER II. HISTORICAL SKETCH OF THE PROGRESS OF GEO	f inquiry, just as the limits of history, poetry, and mytholog node in which the earth originated, or, as some imagined, gs." An attempt will be made in the sequel of this work to LOGY. Oriental CosmogonyHymns of the VedasInstitut	gy were ill-defined in the infancy of civilization. Even in Werner's time to study the effects of those cosmological causes which were emplo demonstrate that geology differs as widely from cosmogony, as species of MenùDoctrine of the successive destruction and renovation o	e, or at the close of the eighteenth century, geology appears to have by yed by the Author of Nature to bring this planet out of a nascent and culations concerning the mode of the first creation of man differ from f the worldOrigin of this doctrineCommon to the EgyptiansAdopto	been regarded as little other than a subordinate department of mineralogy; and Desmares chaotic state into a more perfect and habitable condition. Hutton was the first who endea history. But, before entering more at large on this controverted question, it will be desirated by the GreeksSystem of PythagorasOf AristotleDogmas concerning the extinction
n and reproduction of genera and speciesStrabo's theory of elevation by earthquakesPlinyConcluding Ren world and all its inhabitants. In the sacred volume of the Hindoos, called the Ordinances of Menù, comprising t bout thirteen centuries before the Christian era, but they appear from internal evidence to have been written at ys existed two principles, the one material, but without form, the other spiritual and capable of compelling "ine	marks on the knowledge of the Ancients. Oriental CosmogonyThe earlie the Indian system of duties religious and civil, we find a preliminary chap t various antecedent periods. In them, as we learn from the researches of ert matter to develop its sensible properties." This development of matter	est doctrines of the Indian and Egyptian schools of philoso ter treating of the Creation, in which the cosmogony is known Professor Wilson, the eminent Sanscrit scholar, two disting into "individual and visible existences" is called creation,	ophy agreed in ascribing the first creation of the world to an omnipot own to have been derived from earlier writings and traditions; and pr nct philosophical systems are discoverable. According to one of ther , and is assigned to a subordinate agent, or the creative faculty of the	ent and infinite Being. They concurred also in representing this Being incipally from certain hymns of high antiquity, called the Vedas. Thes m, all things were originally brought into existence by the sole will of a Supreme Being embodied in the person of Brahma. In the first chapt	g, who had existed from all eternity, as having repeatedly destroyed and reproduced the le hymns were first put together, according to Mr. Colebrooke,[1] in a connected series, as single First Cause, which existed from eternity; according to the other, there have alwa er of the Ordinances of Menù above alluded to, we meet with the following passages rela
ting to former destructions and renovations of the world: "The Being, whose powers are incomprehensible, he notiples of action depart from their several acts, and the mind itself becomes inert." The absorption of all being promotive and immovable creatures." It is then declared that there has been a long succession of manwantaras, ting to the geologist than the doctrine, so frequently alluded to, of the reiterated submersion of the land beneat	naving created me (Menù) and this universe, again became absorbed in th gs into the Supreme essence is then described, and the Divine soul itself or periods, each of the duration of many thousand ages, and "There are th the waters of a universal ocean. In the beginning of things, we are told	e supreme spirit, changing the time of energy for the hour is said to slumber, and to remain for a time immersed in " e creations also, and destructions of worlds innumerable: , the First Sole Cause "with a thought created the waters,"	r of repose. "When that Power awakes, then has this world its full exp the first idea, or in darkness." After which the text thus proceeds (ve the Being, supremely exalted, performs all this with as much ease as and then moved upon their surface in the form of Brahma the creats."	pansion; but when he slumbers with a tranquil spirit, then the whole so rse fifty-seven), "Thus that immutable power by waking and reposing so if in sport, again and again, for the sake of conferring happiness."[2] or, by whose agency the emergence of the dry land was effected, and	ystem fades away For while he reposes, as it were, embodied spirits endowed with pr alternately, revivifies and destroys, in eternal succession, this whole assemblage of loc No part of the Eastern cosmogony, from which these extracts are made, is more interes the peopling of the earth with plants, animals, celestial creatures, and man. Afterwards,
as often as a general conflagration at the close of each manwantara had annihilated every visible and existing the form of a fish, a tortoise, and a boar. Extravagant as may be some of the conceits and fictions which disfigure their long day was the northern, and their night the southern course of the sun; and to the inhabitants of the may be are two sources in which such a theory may have originated. The marks of former convulsions on every pages to the standard of the sources of	thing, Brahma, on awaking from his sleep, finds the whole world a shape jure these pretended revelations, we can by no means look upon them as noon, it is said one day is equal in length to one month of mortals.[3] If sure of the surface of our planet are obvious and striking. The remains of means of the surface of our planet are obvious and striking.	less ocean. Accordingly, in the legendary poems called the a pure effort of the unassisted imagination, or believe the ch statements cannot be resolved into mere conjectures, larine animals imbedded in the solid strata are so abundations and the solid strata are so abundated.	ne Puranas, composed at a later date than the Vedas, the three first A om to have been composed without regard to opinions and theories for we have no right to refer to mere chance the prevailing notion that the nt, that they may be expected to force themselves on the attention of the state of the provided in the state of th	vatars or descents of the Deity upon earth have for their object to recounded on the observation of Nature. In astronomy, for instance, it is a e earth and its inhabitants had formerly undergone a succession of reevery people who have made some progress in refinement; and espe	over the land from the waters. For this purpose Vishnu is made successively to assume declared that, at the North Pole, the year was divided into a long day and night, and that evolutions and aqueous catastrophes interrupted by long intervals of tranquillity. Now the cially where one class of men are expressly set apart from the rest, like the ancient pries.
indods of India and Egypt, for study and contemplation. If these appearances are once recognized, it seems have in the seems of the former intellectual advancer mins, are untenable doctrines. We know that the Egyptian priests were aware, not only that the soil beneath the sea, they could hardly have escaped detection by some Eastern sages not less capable than the Greek historian the seast the attention of a possible less civilized than were many of the older patients of the East. The	atural that the mind should conclude in layor, not only of mighty changes ment and civilization of Eastern nations, may concede some foundation on the plains of the Nile, but that also the hills bounding the great valley, contains of reasoning philosophically on natural phenomena. We also know that the plain of the process were applicated in the plain of	of in past ages, but of alternate periods of repose and disorted the past ages, but of alternate periods of repose and disorted by the past ages and the consideration of the past ages and the past ages ages ages ages ages ages ages ages	der;or repose, when the animals now lossli lived, grew, and multipli ideration, without indulging in exaggerated opinions of the progress cts, that all lower Egypt, and even the high lands above Memphis, executing great national works, such as tanks and canals, requiring the report of the body and surface and surfa	of science; especially as universal catastrophes of the world, and extensive excavations. In the fourteenth century of our era (in the fourteenth century of our era).	derminations of organic beings, in the sense in which they were understood by the Brah all parts of Asia hitherto explored, far in the interior of the continent as well as near the 1360), the removal of soil necessary for such undertakings brought to light geological faces which have the base of the continent as well as near the 1360.
east, which attracted the attention of a people less civilized than were many of the older nations of the East. The belonged to some of the larger pachydermata.[5] But, although the Brahmins, like the priests of Egypt, may be had its source, in part at least, in exaggerated accounts of those dreadful catastrophes which are occasioned y calculated to inspire a lasting terror, and are so often fatal in their consequences to great multitudes of people of the people when the process of the people were the people of the	by have been acquainted with the existence of fossil remains in the strata, dby particular combinations of natural causes. Floods and volcanic erupole, that it scarcely requires the passion for the marvellous, so characteris	it is possible that the doctrine of successive destructions tions, the agency of water and fire, are the chief instrumer tic of rude and half-civilized nations, still less the exuberal who has carefully examined their written accounts the C	in the rivers Selling and Suite, and in this mount were round the bolds and renovations of the world, merely received corroboration from significant on our globe. We shall point out in the sequel the cant imagination of Eastern writers, to augment them into general cata this paper of the business of the catachysm is the rein described as interrunting the business of the catachysm is the rein described as interrunting the business of the catachysm is the rein described as interrunting the business of the catachysm.	uch proofs; and that it may have been originally handed down, like the extent of many of these calamities, recurring at distant intervals of time clysms and conflagrations. The great flood of the Chinese, which their agriculture, rather than as involving a general destruction of the hur	e religious traditions of most nations, from a ruder state of society. The system may have lee, in the present course of nature; and shall only observe here, that they are so peculiarly traditions carry back to the period of Yaou, something more than 2000 years before our man race. The great Yu was colebrated for having "paged hine channels to draw off the
waters," which "covered the low hills and bathed the foot of the highest mountains." Mr. Davis suggests that a most dreadful accidents, and is a source of perpetual anxiety to the government. It is easy, therefore, to imaginate an convulsions. "The Indians," he says, "celebrated, after the ideas of an antique superstition, by festivals as secured how the tradition of a deluge among the Argusanian Indians may be explained, by reference to great e	a great derangement of waters of the Yellow River, one of the largest in the inner two or our embassies to Clinia, and a great derangement of waters of the Yellow River, one of the largest in the inner the much greater may have been the inundation, if this valley was even and the approaching epoch of the world and the approaching epoch of the parthoughts.	e world, might even now cause the flood of Yaou to be reper convulsed by a violent earthquake.[6] Humboldt relates its regeneration."[7] The existence of such rites among the effect recorded flood of 1590. (See chap. 29. Rook II.) The	beated, and lay the most fertile and populous plains of China under we the interesting fact that, after the annihilation of a large part of the interesting fact that, after the annihilation of a large part of the rude nations of South America is most important, as showing what leaden also of the ancient Peruvians of an inundation many years be	rater. In modern times the bursting of the banks of an artificial canal, inhabitants of Cumana, by an earthquake in 1766, a season of extraord effects may be produced by local catastrophes, recurring at distant in a fore the reign of the locals in which only six persons were saved on a	nto which a portion of the Yellow River has been turned, has repeatedly given rise to the linary fertility ensued, in consequence of the great rains which accompanied the subterentervals of time, on the minds of a barbarous and uncultivated race. I shall point out in the afford relates to a region which has more than once been overwhelmed by introdes of the
e ocean since the days of Pizarro. (Chap. 29, Book II.) I might refer the reader to my account of the submergence of said who are indebted for all their knowledge of past events exclusively to oral tradition, are in the habit of parent confirmation of tenets handed down through successive generations, from the rude hunter, whose tend amongst others that of the former successive destruction and renovation of the world ISI We learn from Pluts.	ce of a wide area in Cutch so lately as the year 1819, when a single tower of confounding in one legend a series of incidents which have happened a trified imagination drew a false picture of those awful visitations of floods arch, that this was the theme of one of the hymns of Orpheus, so celebrate	only of the fort of Sindree appeared above the waste of wast various epochs; nor must we forget that the superstition and earthquakes, whereby the whole earth as known to he ted in the fabulous ages of Greece. It was brought by him	aters (see Chap. 28, Book II.), if it were necessary, to prove how easil ns of a savage tribe are transmitted through all the progressive stage him was simultaneously devastated. Egyptian Cosmogony.—Respection from the banks of the Nile: and we even find in his verses, as in the	by the catastrophes of modern times might give rise to traditionary names of society, till they exert a powerful influence on the mind of the phang the cosmogony of the Egyptian priests, we gather much information of the phang systems, a definite period assigned for the duration of each such	ilosopher. He may find, in the monuments of former changes on the earth's surface, an appropriate of the Grecian sects, who borrowed almost all their tenets from Egypt, an accessive world [9] The returns of great catastrophes were determined by the period of the
e Annus Magnus, or great year,a cycle composed of the revolutions of the sun, moon, and planets, and termin at the Egyptians believed the world to be subject to occasional conflagrations and deluges, whereby the gods fully the system of catastrophes destined at certain intervals to destroy the world. Those they taught were of tweether the termination of each era, the gods could no longer bear with the wickedness of men, and a shock of the ele	inating when these return together to the same sign whence they were su arrested the career of human wickedness, and purified the earth from gui wo kinds;the Cataclysm, or destruction by water, which sweeps away the ments or a deluge overwhelmed them: after which calamity. Astrea again	pposed at some remote epoch to have set out. The duration it. After each regeneration, mankind were in a state of virture whole human race, and annihilates all the animal and vere descended on the earth to renew the golden age.[11] The	on of this great cycle was variously estimated. According to Orpheus tue and happiness, from which they gradually degenerated again into egetable productions of nature; and the Ecpyrosis, or destruction by connection between the doctrine of successive catastrophes and re	s, it was 120,000 years; according to others, 300,000; and by Cassande b vice and immorality. From this Egyptian doctrine, the poets derived to fire, which dissolves the globe itself. From the Egyptians also they de peated deteriorations in the moral character of the human race is mor	er it was taken to be 360,000 years.[10] We learn particularly from the Timæus of Plato, the fable of the decline from the golden to the iron age. The sect of Stoics adopted most rived the doctrine of the gradual debasement of man from a state of innocence. Towards re intimate and natural than might at first be imagined. For, in a rude state of society, all
great calamities are regarded by the people as judgments of God on the wickedness of man. Thus, in our own to nder the waters of the ocean, after repeated shocks of an earthquake, we find that the event happened when Ju to be penal, it could only be reconciled with divine justice, by the supposition that man, at each successive creats s scourge, and the Egyptian doctrine of great catastrophes was probably derived in part, as before hinted, from	time, the priests persuaded a large part of the population of Chili, and per upiter had seen the moral depravity of the inhabitants.[12] Now, when the lation, was regenerated in a state of purity and innocence. A very large po mearly geological observations, and in part from Eastern nations. Pythag	rhaps believed themselves, that the fatal earthquake of 18 notion had once gained ground, whether from causes be rtion of Asia, inhabited by the earliest nations, whose trac gorean DoctrinesPythagoras, who resided for more than	22 was a sign of the wrath of Heaven for the great political revolution fore suggested or not, that the earth had been destroyed by several of ditions have come down to us, has been always subject to tremendous twenty years in Egypt, and, according to Cicero, had visited the Eas	just then consummated in South America. In like manner, in the accordence of the state of the second catastrophes, it would next be inferred that the human race has earthquakes. Of the geographical boundaries of these, and their effect, and conversed with the Persian philosophers, introduced into his or	ount given to Solon by the Egyptian priests, of the submersion of the island of Atlantis und been as often destroyed and renovated. And since every extermination was assumed fects, I shall speak in the proper place. Egypt has, for the most part, been exempt from the wn country, on his return, the doctrine of the gradual deterioration of the human race from
m an original state of virtue and happiness; but if we are to judge of his theory concerning the destruction and ath of the philosopher. But notwithstanding these anachronisms, we may regard the account as a true picture u uses of change now in activity on the globe, and these adduced in confirmation of a principle of a perpetual an uch never-ending fluctuations. Had this been the case, we might have been called upon to admire so extraordin	I renovation of the earth from the sketch given by Ovid, we must concede of the tenets of the Pythagorean school in the Augustan age; and although gradual revolution inherent in the nature of our terrestrial system. The sinary an anticipation with no less interest than astronomers, when they er	it to have been far more philosophical than any known very perhaps partially modified, it must have contained the seed doctrines, it is true, are not directly applied to the explandeavor to define by what means the Samian philosopher	ersion of the cosmogonies of Oriental or Egyptian sects. Although Py substance of the original scheme. Thus considered, it is extremely cu mation of geological phenomena; or, in other words, no attempt is ma came to the knowledge of the Copernican system. Let us now exami	rthagoras is introduced by the poet as delivering his doctrine in perso irlous and instructive; for we here find a comprehensive summary of a ade to estimate what may have been in past a ges, or wh ne the celebrated pass ages to which we have been a	on, some of the illustrations are derived from natural events which happened after the de almost all the great ca nat may hereafter be, the aggregate amount of change brought about by s adverting:[13] "Nothing perishes in this world; but things merely vary and change the
r form. To be born, means simply that a thing begins to be something different from what it was before; and dy s consecutively adduced. 1. Solid land has been converted into sea. 2. Sea has been changed into land. Marine ng earthquakes some springs have been closed up, and new ones have broken out. Rivers have deserted their sa joined to Lesbos, Pharos to Egypt, &c. 9.  Peninsulas have been divided from the main land.	ying, is ceasing to be the same thing. Yet, although nothing retains long t e shells lie far distant from the deep, and the anchor has been found on th ir channels, and have been re-born elsewhere, as the Erasinus in Greece, I, and have become islands, as Leucadia; and according to tradition, Sicily	the same image, the sum of the whole remains constant." ne summit of hills. 3. Valleys have been excavated by runn and Mysus in Asia. 7. The waters of some rivers, formerly y, the sea having carried away the isthmus. 10. Land has b	These general propositions are then confirmed by a series of exampling water, and floods have washed down hills into the sea.[14] 4. May sweet, have become bitter; as those of the Anigris, in Greece, &c.[15] been submerged by earthquakes; the Grecian cities of Helice an	les, all derived from n atural appearances, exce pt the first, we reshes have become dry g round. 5. Dry la nds have become co nnected with the mainland become displayed by displaying the best of Buris, for example, are to be seed	which refers to the golden age giving place to the age of iron. The illustrations are thu een cha nged into stagnant pools. 6. Du by the growth of deltas and new deposits; as in the case of A ntis en under the sea, with their walls inclined. 11. Plains have been upheaved into hills
lakes and spr ings.[17] 15. Some rocks and islands, a fter floating and having been subject to viole erns become closed up by the movements of the earth, a nd others opened, or whether the fuel is fine ek version of them, no very definite meaning can, in general, be attached to	ent movements, have at length bec finally exhausted, &c., &c. The various causes of change the term "destruction of the world;" for sometimes it would seem almost to	ome stationary and im movable; a ome stationary and im movable; a in the inanimate world h avi ng been thu o imply the annihilation of our planetar y sys tem, a	etrifying po wer, a nd consistence of the consisten	vert the substances which they touch into marble . 14. Extrition; there was a time when Etna was not a burning mountail bropounded, as illustrating a corresponding perpetual flux in the earth. Opinions of AristotleFrom the works now extant of A	aordinary medicinal and deleterious effects are produced by the water of differentin, a nd the time will come when it will cease to burn. Whether it be that some cave ani mate creation.[19] In the Egyptian and Eastern cosmogonies, and in the Greatist otle, and from the system of Pythagoras, as above exposed, we might cer
the part called Hellas, and it arose from great i nu ndations of rivers, during a rainy winter. But such ext that the flood constituted the winter of the grea type ar, or astronomical cycle, while the conflagration, or an opposite direction. He refers to many examples of the angle s now constituted by the single of the single state of the state of the state of the same of the	traordinary winters, he s  d est ruc tion by fire, is the summer, or p eriod of g oin g on, and insists emphatically on the g reat results which	ay s, the save p, othing of earthquakes yet in others of the	siders occasional catastrophes, happening at distant learning period they return, do not always revisit the same places [20] (es, be an amplification, by Censorinus, of what is written in "the Meteroparticular cases of lakes that had dried up, and deserts that had at the same treatise has shown himself not up a quainted with their effects.	Censorinus quotes it as Aristotle's opini on that there we re ger orics," it is a gross misrepresentation of the doct rine of the State	read ture. The deluge of Deucalion, he says, affected Greece only, and principally her al inund ations of the globe, and that they alternated with conflagrations; an gy rite, for the general bear ing of his reasoning in that treatise tends clearly in fee tilized. He point is to the grow the of the province of the pro
anges of the earth," he says, "are so slow in comparis on to the duration of our lives, that they are overlook ding passages of the twelfth chapter of his "Meteorics" are certainly very remarkable. In the first sentence he and we ithin a certain period." The concluding observation is as follows:—"As time never fails, and the universe therefore the parth are not some always see and other is always continued.	ked (λανθανει): and the m ig rat ion so f p eop le after great he says, "The distribution of land and sea in p verse is eternal, neither the Tanais, nor the Nile, can have flowed forever.	t cat astroph es, and their removal to other regions, cau articul ar regions does not endure throughout all the place's where they rise were once dry, and their regions but had also in some slipped from a preceding nature.	se the event to be forgotten."[23] When we consider the acquaintanc time, but it becomes sea in those parts where it was land, and again e is a limit to their operations; but there is none to time. So also of all the degrees deduced from their own observations, the theory of paris	e displayed by Aristo tle, in his various works, with the de stroying it becomes land where it was sea: and there is reason for thinking to the rivers; they spring up, and they perish; and the sea als occording to the revolutions in the inorganic world; there is however.	g and ren ov ating powers of N at ure, the introductory and concluing that the sechan gest ake place according to a certain system ontinually deserts some lands and invades others. The s armetra
s in the races of animals and plants. Even the fact that marine remains were inclosed in solid rocks, although the earth or corrupt matter, might have caused the organic world to appear so unstable tastrophe the same species of animals were created over again. This tenet is implied in a passage of Senecule, for here we find the lidea of different general and specifies having been created. The Gerb	ough observed by some, and even made the groundwork of geological speed and fluctuating, that phenomena indicative of former changes would not eca, where, speaking of a future deluge, he says, "Every animal shall be goonites, a secrof astronomers who flourished some centuries by	eculatio n, neve r stimu lated the industry or guided awaken i ntens e curio sity . The Egyptians, it is true lenerated anew, and man free from guilt she fore the Christian e ra taug ht as follows:"The	of the inquiries of naturalists. It is not impossible that the theory of eque, had taught, and the Stoics had repeated, that the earth had once given to the earth." [24] An old Arabian version of the doctrine at after every period of thirty-six thousand four hundred and twenty-factoring.	uivoc al generat ion mig ht have engendered some indiffer ven birt h to some monstrou s animals, which existed no low of the success ive revolutions of the globe, translated by Al iveve ars the rewere produced a pair of eye ry species of	renc e on this subject, and that a b elief in the spontaneous production of langer; bu t the pre vailing opinion seems to have been, that after each great c a braham Ecchelle nsis,[25] seems to form a sin gular exception to the genera I animal, both made and female, from whom animals might be propagated a n
d inhabit this lower world. Bu t when a circu lation of the heavenly orbs was completed, which is f y speculations of the early Gree k authors are made known to us in the works of the Augustan and he sea. He notices, amongst others, the explanation of Xanthus the Lydian, who said that the seas had on served that the quantity of mud brough t down by rivers into the Euxine was so are at, that its bed m	finished in that space of years, other genera and species of and later ages. Strabo, in particu lar, enters largely, in the second been mor extensive, and that they had afterwards been stiple gradually raised, while the rivers still continue to pour in an uncontrolled.	imals are propagated, as also of plan ts and other thir cond book of his Geograp hy, in to the opinions of Er partially dried up, as in his own time man y lakes, rive diminished quantity of water. He, therefore, conceived	ngs, and the first order is destroyed, and so it goes on forever and evaluates and other Greeks on one of the most difficult problems iters, and wells in Asia had failed during a season of dro uthat originally, when to the Eu xi ne was an inlated t	e r."[ 26] The ory of St raboAs we learn much of the t enets n g eology, viz., by w hat causes marine shells came to be pl ght. Treatin g this co njecture with merited disregard, Strabo pass and sea, its level ha d by this me ans become so much elevated	of the Egyptia n and Or iental sc hools in the writing sof the Greeks, so, manentifully buried in the earth at such great elevations and distances from the seson to the hypothesis of Strato, the natural philosopher, who had obe that it bur stits bar rier near Byzantium, and formed a communicat
on with the Propontis; and this partial dra inage, he supposed, had already converted the left set the deposit of some former inland sea, whi ch had at length forced a passage and escaped. But Strabo subsidered, or received the components of the	side into marshy ground, and thus, at last, the whole would be choked up o rejects this theory, as insufficient to account for all the phenomena, and that the same land is sometimes raised up and sometimes depressed, an of its humidity, can be altered with greater celerity.[27] "It is proper," he ol	with soil. So, it was argued, the Mediter ranea in had on he proposes one of his own, the profoundness and the sea also is simultaneously rais ed and depressed before in continuation, "to derive our explanations for the sea of the sea also is simultaneously rais."	n ce o pene d a passage for itse If by the C ol up f w hich mode rn g eolog ists are only be ginning to app rec d, so that it either overflows or returns into its own place agrow things which are obvious, and in some measure of daily	mn s of Her cules int o the Atla ntic; an d pe rhaps the abundance of the color in te. "It is not," he says, "b ecause to the lands covered by go ain. We must, therefore, ascribe to the groun occur rence, su chas de luges, earth quakes, and volumes.	of sea-shells in Africa, near the Temple of Jupiter Ammon, might als obe seas were origin ally at different altitudes, that the waters have risen, or id, either to that ground which is under the sea, or to that which be comes floolcanic eruptions,[28] and sudden swellings of the land beneath the sea; for
the last raise up the sea also; and whe n the same lands subside again, they occasion the sea to be let on the sear part of the search of the sear part of the sear part of the sear part of the search of t	down. And it is not merely the small, but the large islands also, and not no sion from Italy, remarks, that at present the land near the sea in those par elcanoes are safety-valves, and that the subterranean convulsions are pro with much of their learning, cannot be doubted. Cæsar, it will be remen	nerely the islands, but the continents which can be lift to was rarely shaken by earthquakes, since ther ewere bably most violent when first the voic anice ne rgy shabered, says that they made us e of Greek I ett er	ed up togethe r with the sea; and both la rge and small trace now open orifices whereby fire and ignited matters, and we fits itself to a new quarter, is not modern. We learn from s in arithme tical computations.[31] PlinyThis philosoples	ts may subside, for habi tations a nd citie s, lik e Bur e, Biz on vaters escape; but form erly, whe n th e vo Ican oes o f Etna , th n a p assage in Strabo,[30] that i t was a d ogm a of the G auli her had no the oretical opinions of his own concerning chan	n a, and many others, h ave been engulphe d by ear thquakes." In a noth ene Lipa ri Islands, Ischia, and o thers, wer e closed up, the im pris oned fish Drui ds th at the universe was immortal, but destined to survivinges of the earth's surface; and in this depart ment, as in others, h
er estricted himself to the task of a compiler, without reasoning on the facts stated by him, or a tear to have been the opinions en tertained before the Christian era, concerning the past resort allow philosophers to belies much as a conjecture econcerning the comparative antiquity of the hum	e mpting to digest them into regular order. But his enumeration of the new evolutions of our globe. Although no particular investigations had been me eve that nature was in a state of rest, or that the surface had remained, ar an race, or of living species of animals—and plant——s,	w islands which had been formed in the Medit ade for the express purpose of interpre tin dwould continue to remain unaltered. But the with those belonging to former conditions of the o	err anean, and of othe r convuls ions, shows that the a noie g the monuments of a noient change s, they very had never compared attentively the results r ganic world. They had studied the movements and pos	ent s had not b een ina ttentive observe rs of the chan ges whith the chan ges whit the chan ges whith the chan ges whith the chan ges whith the c	ich had take n.pla ce wi thin the memory of m.an. Such, then, apperation of the present course of nature presented too many proofs times with those of remote eras, nor had they ever entertained dimade some progress in investigating the animal, vegetable, an
d mine ral kin g doms; but the ancient histo ry of the globe wast of he mase aled bon iEarly Italian writersLeonardo da VinciFracasto roC ont roversy as to the real nenerelliBuffonHis theory condemned by the Sorbonne as unorthodoxHis declarati onTargion emost eminent classic writers were purchased at great expense from the Christians, and translate	niAr du inoM ichellC at cottRaspe FuchselFortisTest ted into A ra bic: a nd Al Mamûn, son of the famous Harûn-al-Ras	aWhitehurstPallasSaussure. Arabian writersAfter the contemporary of Charlemagne, received with ma	he decline of the Roman empire, the cultivation of physical science rks of distinction, at his court at Bagdad, astronomers and men	ce was fir st revive d with's om e su cce ss by the Sara cens , a of learning from different countries. This cali ph. and so me	of his success ors, encountered much opposition and itealousy for
om the doctors of the Mahometan law, who wished the Moslems to c onfine their studies to the Kocian, in whose arrangement there is considerable merit. The second c hapter, "On the Cause of Mountains," and adjoining lands made to stand out and form eminences.[33] OmarC osmogony of the KoranIn the same since the times of history in the form of the coasts of Asia, and that the extension of the sea had been greater which there is reason to believe have happened within the historical era), and the geological appearances in	' is remarkable; for mountains, he says, are formed, some by essential, one century, also, Omar, surnamed "El Aalem," or "The Learned," wrote rat some former periods. He was confirmed in this opinion by the number of the former periods.	thers by accidental causes. In illustration of the essential, a work on "The Retreat of the Sea." It appears that on colerous salt springs and marshes in the interior of Asiaa r	, he instan ces "a violent earthquake, by which land is elevated, an mparing the charts of his own time with those made by the Indian a phenomenon from which Pallas, in more recent times, has drawn the	d becomes a mountain;" of the accidental, the principal and Persian astronomers two thou sand ye are before, he same inference. You Hoff has suggested, with great p	I, he says, is excavat ion by water, whe reby cavities are produced, had satisfied him self that important changes had taken place to be able to the changes in the level of the Cas plan (so me of
which there is reason to believe have happened within the historical eral, and — the geological appearances in which persecution he went into voluntary banishment from Samarkand.[34] The c—osmological opinions exprenge these, and two additional days, the inhabitants of the earth were formed; and in t—wo more the seven heave all men were drowned, save Noah and his family; and then God said, "O earth, swallow—up thy waters; and then, that man and this planet were created at the same time; and although Mahomet did not—limit expressly the	essed in the Koran are few, and merely introduced incidentally: so that ens.[35] There is no more detail of circumst ances; and the deluge, whithou, O heaven, withhold thy rain:" and immediate by the waters abated.	t it is not easy to understand how they could have interfer ich is also mentioned, is discussed with equal brevity. The J371 We may suppose Omar to have represented the dese.	red so seriously with free discussion on the former changes of the e waters are represented to have poured out of an oven; a strange ortion of the land by the sed ato have been gradual, and that his hypography.	glo be. The Prophe t de clar es t hat t he e arth was creat ed fable , said to be b orro wed from the Pe rsia n Mag i, who r othes is required agreater lapse of ages than was consis	in two day s, an dithe mountains were the niplaced on it; and dure represented them as issuing from the oven of an old wom an.[36] stent with Moslem orthodoxv:for it is to be inferred from the Kora
the seventh century of the Hegira, or at the close of the thirteenth century of our era.[39] Bes—ides several culone of its inhabitants how long it had been founded. 'It is indeed a mighty city,' replied he; 'we k—now not how a strange guestion!' replied he. 'The ground here has never been different from what you now beho—ld it.''Wa	rious remarks on aerolites, earthquakes, and the successive changes viong it has existed, and our ancestors were on this subject as ig noranges there not of old,' said lage splendid city here?''Never,' answered he	of position which the land and sea have undergone, we m nt as ourselves.' Five centuries afterwards, as I passed by 'so far as we have seen, and never did our fathers spea	neet with the follo wing be autiful passage which is given as the the sam eplace, I could not perceive the slightest vestige of k to us of any such. On my return there 500 years afterwa	narrati ve of Ki dhz, an alle gori cal personage:"I p asse do the cit y. I dem an ded of a pe asa nt, who was g atheri ng ards. I fo und the sea in the sam e place, and o n its s hores w	on e d ay by a ver y an cient and wonderfully populou s city, and a sked
of time, I found there a flourishing city, more populous and more rich in beautifu I b uildi ng s, than the bit till the earlier part of the sixteenth century that geological phenom ena began to attract the atter xecuted some navigable canals in the north of Italy, was o ne of the first who ap plie d sound readere the stars now forming shells of distinct ages an d species? and how can the stars explain the or	e city I had seen the first time, and when I would fain have inform ntion of the Christian nations. At that perio day ery an imated control asoning to these subjects. The mud of rivers, he said, had covered	n ed myself concerning its origin, the in habit ants a poversy sprang up in Italy, concerning the true not and penetrated into the interior of fossil shells.	nswe red me, ' Its ri se is lo st in remote antiquity: we are ignorar ature and orig in of marin es hells, and other organized fossils, for s at a time when these we restill at the bottom of the sea near t	It how lon g it h as exis ted, and our fat hers were on thi s s und abund antly in the strata of the peninsula. The celebi he coast. "They tellus that these shells were formed in	su bje ctas ignorantas our selv es."' Earlylt alian w rite rslt was n ra ted painte r Leonard oda Vinc i, who in his y outh had plan ned and e ot he hills by the influence of the stars: but lask where in the hills a
or repairing the city of Verona, brought t o light a multitude of curious pet rifactions, and furnished urse to a certain "plastic force, "which it was said had power to fashions tones in to organic form thad transported shell s to great distances, must have strewed them over the surface, not bure speedily have been removed by the fresh information obtained almost immediately after	d matter for spiec u lation to different authors, and among the rest to is; and w ith no less cogent arguments, demonst rated the futil ied them at vast depths in the interior of mountains. His cleare rwards, respecting the structure of fossil remains, and of their liv	Frac a storo,[41] who decl ared his opinion, ity of att ributing the situation of the shells in que ex position of the evidence would have terminated to ing an alogues. But the clear and philosophical views	that fossi I'sh ells had al I b elonged to living animals, whi estion to t he Mosaic deluge, a theory obs ti nate ly d the d iscu ssion for ever, if the passions of mankin dha ews of Fracast oro were disregarded, and the talent and arg	ch had for merly lived and multiplied where the efended by some. That in undation, he observed, wand not be enenlisted in the dispute; and eventhough do umentative powers of the learned were doom ed for three co	re exu viæ ar e now found. He exposed the absurdit yof ha ving recostoot transient; it consisted principally of fluviatile waters; and if it bubts should for a time haver emained in some minds, they would enturies to be wasted in the discussion of these two simple and pr
elim ina ry qu estions: first, whether fos sil remains had ever belonged to living creatures; and ce the creation the deluge was the only great cat astrophe by which considerable change had beewhen the annihilation of the planet had been looked for, the monks remained in undisturbed enjoyed interpret certain prophecies respecting the mill ennium more liberally, and to assign a more dist	en wro ught on the earth's sur face. On the oth er hand, the opinion ment of rich gran ts of land bequeathed to them by pious do nor taint da te to the future conflagration of the world, we find, in the	was scarcely less general, that the final dissolutions, who, in the preamble of deeds begin ning "approperties appeared to not of the early geologists, perpetual all uses."	n of ours yste m was an eve nt to be looke d for at no dis tant pinq uante mu nditermi no""appropinquante magnoj udic sion to such an approach in g catastrophe; w hile in all tha	period. The era, it is true, of the expected millen niu ii die," I eft lasting monuments of the popular de lusion.[4 tregard ed the antiquity of the earth. no modification wh	m had pass ed a way; and for five hun dred years a fte rithe fata I hou r [2] Bu talth ough init he sixtee nthic entury it had be come nieces sary it ha teve riof the opinions of the dark age shad be en effected. Consider
able alarm was at first excite d wh en the attempt was made to invalidate, by physical proofs, an art d however much we may deplore the loss of time and labor devoted to the defence of untenable poins, encour aged in the universities of the middle ages, had unfor tuna tely trained men to habits of me followers, provided it fell in with popular notions; and a scosmogonist swere not at all restrictions.	o sitions, it must be conceded that the y displayed far less poler of indefinite argument ation; and they often preferred ab surd and they often preferred ab surd and they often building their systems, to the agreecy of known causes, they	mic bitt erne ss tha n ce rtain writer s wh o follo wed the dextra vag ant proposition s, be cause greater s kine opponents of Fraca storo, met his a rouments by v	em "bey ond the Al ps," two centuries an dah alf later. CONT II was required to main tain them; the end and object of the feigning imaginary causes, which differed from each oth	ROVE RSY AS TO THE REAL NATURE OFFO SSIL ORGANIC lese intellec tual combats being victory, and not truth. No erra ther in name than in substance. Andre a Mattioli, for i	REMA INS. Matti oliFallop pioThe sys tem of schola stic disputati on the control of the co
raced the notion of A grico la, a skilful Germ an moiner, that a certain "materiapin guis," or "fatt y manner, Falloppio of Paduac onceived that petrified she lls we regenerated by ferment ation in the spod, consistently with these principles, hee venwents of are as to consider it probable, that the values med their peculiar configuration from the influence of the heavenly bodies; and Olivi of Control of the heavenly bodies; and Olivi of Control of the heavenly be dies;	ots where they are found, or that they had in some cases a cquases of Monte Testace oat Rome were natura I impressions star Cremona, who de scribed the fossil remains of a rich museum at	ui red t heir form from "the tumu Ituou's movements n ped i n the soil.[43] In the same spirit, Mercati, who Verona, was sati sfied with consideri no them as r	s of terre strial exha lations. "Al thou gh c elebr ated as a prof pu blish ed, in 1574 , faithfu l fi gure s of t he fo ssil shel ls p mer e "sp orts o f nat ure." S om e of t he fa ncifu I no tions of t	ess or of an ato my, het aught that cer taint usks of ele pha res erved by Pope Sixt us V. in the Museum of the Vatic ho setimes we redeemed less unreasonable, as being so	n ts, d ug up in h is time in A puli a, we re m ere e arth y c oncretio ns; a n an, ex pressed an opinion that they were me re st ones, w hich had mew hat in har mony with the Arist otelian theory of spont ane ous ge
nerat ion, then taught in a lithe schools.[44] For men who had been taught in early youth, that a auses equally obscure and myst erious. Cardano, 1552But there were not wanting some who, deheories characteristic of that age; but when treating of petrified shells, he decided that they clause gyear (1597), Simeone Majoli[47] went still farther; and, coinciding for the most part with the view of connect the position of fossils hells with the agency of volcanoes, a system afterwards more fully	d uring the progress of this cent ury, expressed more so und and I early indic ated the former sojou rn of the sea up on the mount a ws of Cesalp ino, suggested that the she IIs and submarine matte	l sober opini ons. The t itle o f a wo rk of Carda no's, p ains.[4 5] Ce salpi noMajoli, 1597Ces alpin o, a cele er of the Verones e, an d ot her dis tricts, mig ht ha ve	bub lishe d in 1 552, "De Su btil itate" (corr espondin g to what ebrated bota nist, conceived that fossil she lls had been libe en cast up upon the land by volca nice xplosions, like	w ould n ow be c alle d T rans cen denta I Phil osop hy), would eft on the land by the retiring sea, and had concreted into et hose which gaverise, in 15 38, to Monte Nu ovo. near	d lea dus toe xpec t, in the chapte ron mi ner als, many far-fe tche dosto ne du ring the consolidation of the soil;[46] and in the following Puzzuoli. This hin t seems to have been the first imperfect attempt
o connect the position of fossil's hells with the ag ency of volicanoles, a syste matterwards more fully echin i found petrified .[48] Palis sy, 1 580Palis sy, a French writter on "The Origin of Springs from y, nearly a century and a half later, "who dared assert," in Paris, that fos sil remains of testacea a ed; for, although he gave way to the dogma, that all fossil remains were to be referred to the deleter mould or impression; second, the castorn ucleus; and, thirdly, the remains of the shell itsel	n Rain -wate r," an d of other scien tific works, unde rtook, in 15 8 and fish had once belo nged to ma rine a nimal s. Fab io Co lonna luge of Noah, he resist ed the absurd theory of Stell uti, who tau gh	0 , to c omb at the not ions of many of his contemp Γο enu merate the multitude of Italian writers, who nt that foss il wood and ammonites were mere cla	pora ries in Ital y, that petri fied shells had all been deposite advanced various hypothe ses, all equally fantas tical, in ay, altered into such forms by sulphure ous water sand su	dby the un iver said elu ge. "He was the fi rst," said For the early part of the se vent een the century, wou ld be un bterraneanh eat; and he pointed out the different stat es of	n tene lle, w hen, in t he French Academ y, he pronounced his eulo gerofit ably tedio us; but Fabio Colonna deserves to be distinguis hofshells burie din the strata, distinguishing between, first, the m
e p. 222 ivii, 2222 ivii, 112 vaetei ii aviea 3, ana, ani aiy, ane i enia ili3 01 tii e shell ili3el			2 to to to to take to take to	The sum and them of that po flow was public flow by St	, a = a, who pro too out or and to my a traduct, and who alter t