Zeitschrift: Archives des sciences et compte rendu des séances de la Société
Herausgeber: Société de Physique et d'Histoire Naturelle de Genève
Band: 36 (1983)
Heft: 1: Archives des Sciences

Artikel: Voltaire's attitude toward geology
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Kapitel: I: Voltaire's Dissertation
DOI: https://doi.org/10.5169/seals-740210

CHAPTER I

VOLTAIRE'S DISSERTATION

Voltaire was not trained to become a naturalist but to please and serve the king of France. At the Collège Louis-le-Grand, the Jesuit fathers mixed religion with a taste for wordly goods and luxuries and Voltaire was taught ballet, poetry, good manners, and some piety (Pomeau 1956: 42-44). At the age of forty-four, however, he wrote about the property of light; the cause of refrangibility; the cause of colors; the laws of attraction; he even proposed a theory of the planetary world in his *Elémens de la philosophie de Neuton mis à la portée de tout le monde* (1738). In that essay he also mentioned geological phenomena for the first time. In order to understand his later reaction to geology, we should know why he turned from literature to science and how he became interested in fossils and theories of the earth after Newton's physics. We should understand whether he felt completely at ease with Newton's physics or whether he was more familiar with Newton's metaphysical ideas.

A. Madame du Châtelet and Newton

Voltaire might have turned to science because of the taste of French women who patronized young poets in the early eighteenth century. Indeed, some ladies seemed to have become bluestockings after reading Fontenelle's *Entretiens sur la Pluralité des Mondes.* Voltaire wrote to Fontenelle in 1721:

> Les dames qui sont icy se sont gastées par la lecture de vos mondes. Il vaudroit mieux que ce fût par vos Eglogues, nous les verrions plus volontiers bergères que philosophes, elles mettent à observer les astres un temps qu'elles pourroient bien mieux Employer, et nous nous sommes tous faits phisiciens pour l'amour d'Elles. (D.92)

Fontenelle (1657-1757) like Voltaire had been trained as a lawyer after a first education by Jesuits at Rouen; he wrote several operas and tragedies and was also the author of *Eglogues* to which Voltaire referred in the above letter and of *Entretiens...* which made a considerable impression on women. Between 1697 and 1740 Fontenelle was secretary of the Academy of Sciences at Paris.

The example of Fontenelle who seemed to have been able to cultivate both science and literature might have encouraged Voltaire to imitate him and bridge the gap between humanists and scientists, or at least to make science understandable to the former. In 1721 he wrote to Thieriot about an eclipse of the sun calling himself already "poète et phisicien" (D.93). It took, however, another ten years before Vol-

taire started to study physics seriously saying to Formot: "Je suis enfin déterminé à faire paraître ces lettres anglaises, et c'est pour cela qu'il m'a fallu relire Newton; car il ne m'est pas permis de parler d'un si grand homme sans le connaître" (D.542).

This re-education was not easy for Voltaire. In fact, according to his letters it was a constant battle between his desire to understand science and his need to do what he knew best. He would have wished to cultivate both at the same time and said: "Aucun art, aucune science ne doit être de mode. Il faut qu'ils se tiennent tous par la main, il faut qu'on les cultive en tout temps. Je ne veux point payer de tribut à la mode, je veux passer d'une expérience de phisique à un opera, ou à une comédie, et que mon goust ne soit jamais émoussé par l'étude" (D.863). His letters show that he did not succeed too well. In 1736, he complained, "Je me casse la tête contre Newton et je ne pourrais pas à présent trouver deux rimes" (D.1208). Then he changed his mind telling Thieriot: "Une tragédie nouvelle est actuellement le démon qui tourmente mon agitation. J'obéis au dieu ou au diable qui m'agite. Phisique, géométrie, adieu jusqu'à paques" (D.1404).

Voltaire wanted not only to imitate Fontenelle, but to surpass. He worked hard to be as clear as possible in his explanation of Newton's physics and said: "Si mon ouvrage n'est pas aussi clair qu'une fable de la Fontaine il faut le jetter au feu. A quoy bon être philosophe si on n'est pas entendu des gens d'esprit" (D.1823). Instead of explaining Cartesian physics to a fictitious French Marquise, as Fontenelle had done in his *Entretiens...*, Voltaire, in *Elémens*, explained Newtonian physics to a real Marquise: Madame du Châtelet.

Voltaire's love affair with Newton was enhanced by his great respect for this woman who well understood the English scientist. Even before the *Elémens* were finished, he wrote an "Epître sur la philosofie de Neuton" which he sent to Mairan, physicist and member of the Academy of Sciences since 1718, saying, "Je souhaiterais que ce petit ouvrage pût prouver que la phisique et la poésie ne sont point incompatibles" (D.1215). This "Epître" addressed to Madame la Marquise du Ch.** proved that physics could be explained by poetry. Voltaire said, however, that he was going to abandon literature and cultivate science and search for "truth":

> Tu m'appelles à toi vaste & puissant Génie,
> Minerve de la France, immortelle Emilie,
> Disciple de Neuton, & de la Vérité,
> Tu pénètres mes sens des feux de ta clarté,
> Je renonce aux lauriers, que longtemps au Théâtre
> Chercha d'un vain plaisir mon esprit idolâtre.
> De ces triomphes vains mon cœur n'est plus touché [...]

In the same poem Voltaire refuted Descartes' system and accepted Newton's new philosophy:

> [...] Déjà de la carrière
> L'auguste Vérité vient m'ouvrir la barriere,

Déjà ces tourbillons l'un par l'autre pressez,
Se mouvant sans espace, sans règle entassez,
Ces fantômes savants à mes yeux disparaissent.
Un jour plus pur me luit; les mouvements renaissent.
L'espace qui de Dieu contient l'immensité,
Voit rouler dans son sein l'Univers limité,
Cet Univers si vaste à notre faible vûe,
Et qui n'est qu'un atome, un point dans l'étendue.
Dieu parle, & le Chaos se dissipe à sa voix;
Vers un centre commun tout gravite à la fois,
Ce ressort si puissant l'âme de la Nature,
Etoit enséveli dans une nuit obscure,
Le compas de Neuton mesurant l'Univers
Lève enfin ce grand voile & les Cieux sont ouverts.
(1738: 3-4)

This is Voltaire's credo and he was never to abandon it: he firmly and continuously maintained the existence of a universe which is limited, orderly, and ruled by natural laws which Newton had explained and which evidently had been given by God. Thus he rejected Descartes's universe which was chaotic, dark, and followed no rules.

For Emilie, Voltaire said, he was going to renounce the vain pleasures of his former career as a playwright and search fo the "truth" in the philosophy of Newton. This promise, however, did not last. Letters to friends seem to prove that Voltaire was never quite comfortable with the scientific side of Newton's physics and geometry. He soon became aware that Emilie was a better student than he could ever be. To Frederick, he wrote when explaining his work on *Elémens*: "Minerve dictoit et j'écrivois" (D.1255). To Pitot who examined the *Elémens* as a friend and as a scientist Voltaire modestly confided: "J'ai un instinct qui me fait aimer le vrai; mais je n'ai que l'instinct [...] Je suis comme les petits ruisseaux; ils sont transparents parce qu'ils sont peu profonds" (D.1341). Whether Voltaire was modest in physics in order to forestall criticism or whether he actually knew his own limitations will remain unknown.

Compared to Voltaire, Madame du Châtelet was working at a different pace and seeking different results; she usually concentrated on one thing only whereas Voltaire continued to divide his time between literature and science. Also because Madame du Châtelet evidently had to prove what she was capable of doing in a world where she was alone she worked probably more carefully than her friend Voltaire. This feeling was mentioned in the preface to her translation of Mandeville's "Fable of the Bees": "Je sens tout le poids du préjugé qui nous exclut si universellement des sciences..." (Wade 1947: 135). According to Wade, "Mme du Châtelet had by 1748 profoundly entered into Newton's thought." She had translated the *Principia* and the *Solution analytique* and was by that time "far beyond the comprehension of Voltaire, who could admire even if he could not follow" (1941: 37).

I believe that under these circumstances Voltaire must have been left with mixed feelings toward Newton's physics, and it might be for this reason that he added his essay on Newton's metaphysics to the *Elémens* in the later edition because he felt more at ease in that subject. Since he had not been able to master Newton's physics as well as Mme du Châtelet, his attitude toward all sciences would leave him with a feeling of incompetence or ignorance. In fact, already in January 1738, he said mockingly to Maupertuis: "Il y a six mois que j'ay quitté toute sorte de filosofie. Je suis retombé dans mon ignorance et dans les vers" (D.1423).

Before leaving science, however, Voltaire finished what he had set out to do: to bridge the gap between literature and science and to explain Newton as well as possible. He sent a corrected version of *Elémens* with a first part on Newtonian metaphysics to a friend saying: "Je crois avoir enfin mis les Elémens de Neuton au point que l'homme le moins exercé dans ces matières, et le plus ennemi des sciences de calcul poura Les lire avec quelque plaisir et avec fruit" (D.2201). Thus, Voltaire had reached his goal to imitate Fontenelle's popularization of science. I am not enough versed in physics and astronomy to judge whether he surpassed Fontenelle.

More important for his later attitude toward sciences were his personal investigations. He sent two memoirs to the Academy of Sciences at Paris, *Essai sur la Nature du Feu et sur sa Propagation* (1738) and *Doutes sur la Mesure des Forces Motrices* (1741); both memoirs were based on personal investigation. As his many letters to Moussinot between June and December 1737 show, Voltaire would not leave one stone unturned. He ordered instruments and books, asked Moussinot to investigate secretely for him, and because he was in such a hurry he asked Moussinot to send a "savoyard" on foot all the way from Paris to Cirey so that he would receive some urgently needed thermometers (D.1351). Although Voltaire did not earn any prize, it is obvious that during these years at Cirey, he learned how to experiment. He understood that observation facts are fundamental in scientific investigation. It is possible that Voltaire would not have abandoned science had he won a prize; he might have aspired to replace Fontenelle and to imitate him by writing yearly reports *(Histoires)* to the Academy of Sciences.

As it turned out, Voltaire wrote only two more semi-scientific essays in his life, both concerning geology among other sciences: *Dissertation sur les changements arrivés dans notre globe et sur les pétrifications qu'on prétend en être encore les témoignages* in 1746 and *Les Singularités de la nature* in 1768. The first essay was written in Paris during the heydays of his success at the French court, the second at Ferney, when, at the age of seventy or more, he finally applied what he had learned at Cirey thirty years previously: personal investigation.

When Voltaire first turned to science he seemed to have the desire to cultivate both literature and science. He wanted to please Madame du Châtelet, imitate Fontenelle, and surpass him, and most of all bring Newton's physics to the French. The correspondence indicates that this task was not an easy one and that Madame

du Châtelet eventually became a better physicist than Voltaire so that he might have had some second thoughts about science in general. When writing his *Elémens* he happened to mention fossils and theories of the earth for the first time.

B. Eléments de la Philosophie de Newton and Bourguet's Criticism

This work, as it is entitled in the Moland edition, was published first in Amsterdam in 1738. Voltaire was only partly able to supervise it and subsequently kept correcting, adding, and deleting chapters and whole parts. The Amsterdam edition contains his first reference to geology which was repeated in chapters X and XI in the 1741 edition, deleted in 1748, and partially incorporated in the *Dissertation* (M.XXII: 548-555). Since Voltaire insisted that five to six chapters of the Amsterdam edition were "barbouillés" (D.1504) and that some chapters, in particular chapter XXIV and XXV, were not from his pen but the work of a "mathématicien à gages" (D.1519), one should perhaps only consider the last edition of the *Eléments* as the correct one. However, Voltaire's reference to geology in the Amsterdam edition of 1738, an edition which was translated into English the same year (John Hanna 1738), was read by many English speaking geologists of the nineteenth century and is still cited today (Schneer 1980). Therefore, I shall briefly discuss this first edition.

The original edition of 1738 with the "Epître" to Mme du Châtelet mentioned in Section A of this chapter, explains optics, attraction, the sun, the comets, and the satellites. The twenty-third chapter entitled "Théorie de notre Monde Planétaire" describes four different movements or revolutions of the earth: 1) the daily rotation around its axis, 2) the yearly revolution around the sun, 3) a movement of the poles achieved in 25,920 years, [today called the "wobbling" of the axis]. A fourth movement, or revolution, is described as much more bizarre "dont la cause est plus cachée, dont la longueur étonne l'imagination, & qui semblerait promettre au Genre Humain une durée que l'on n'oserait concevoir. Cette période est selon toutes les apparences d'un million neuf cens quarante-quatre mille ans" (1738: 296). Then under the title "Digression sur la Période de 1944000. ans nouvellement découverte" Voltaire reported in a hundred pages many vague and ancient traditions as well as modern astronomical theories.

It seems that Voltaire actually believed that the earth's axis had reversed its position in 1,944,000 years. These are his exact words: "Ainsi ce n'est que dans une Période de deux fois 1944000. années que notre Globe peut voir deux fois le Soleil se coucher à l'Occident, & non pas en 110 Siècles seulement, selon le rapport vague des Prêtres de Thèbes, & d'Hérodote, le Père de l'Histoire & du mensonge" (1738: 300). It may be also that Voltaire simply wanted to rectify Herodotus' beliefs according to which the earth had turned around twice on its axis in some eleven thousand years only. By coincidence Voltaire seemed to agree in this "Digression" that astro-

nomical changes had left marine fossils on land and in the mountains. Indeed, he reported:

> L'Egypte & une partie de l'Asie, d'où nous sont venues toutes les Sciences qui semblent circuler dans l'Univers, conservoient autrefois une Tradition immémoriale, vague, incertaine, mais qui ne pouvait être sans fondement. On disoit qu'il s'étoit fait des changements prodigieux dans notre Globe, & dans le Ciel par rapport à notre Globe. La seule inspection de la Terre donnoit un grand poids à cette opinion.
> On voit que les Eaux ont successivement couvert & abandonné les lits qui les contiennent; des Végétaux, des Poissons des Indes, trouvés dans les pétrifications de notre Europe, des Coquillages entassés sur des Montagnes, rendent assez témoignage à cette ancienne Vérité. (1738: 296-297)

Voltaire's first reference to geology appears right next to great changes which had occurred on the surface of the globe and even "dans le Ciel par rapport à notre Globe." Here he states that evidence of transgression and regression of the sea consists in petrifications from India found in Europe, even piled up on top of mountains. Influenced by his involvement with Newton, Voltaire seems to have stumbled into the field of geology.

Following the above Voltaire then cited Ovid's verses on Pythagoras' teaching, first in Latin, then freely translated into French. Pythagoras, who lived around 580 B.C., said that solid land had been converted into oceans; oceans had been changed into land; marine shells lay far from the beach; old anchors had been found on mountain-tops; valleys had been excavated by running water, and floods had washed down hills into the sea; marshes had become dry ground; dry lands had been changed into stagnant pools; during earthquakes some springs had been closed up, and new ones had broken out; rivers deserted their channels, and had been reborn elsewhere; waters of some rivers, formerly sweet, had become salty and brackish; islands had become connected with the main land by the growth of deltas and new deposits; peninsulas had been divided from the land, and had become islands; land had been submerged by earthquakes, plains had been upheaved into hills by the confined air seeking vent (I have borrowed freely from Ovid's *Metamorphoses* [trans. 1973: 373-374] and Charles Lyell's reporting in *Principles of Geology* [1867, I: 17-19]). Voltaire cited Ovid's verses every time he referred to changes on the surface of the earth in his later works and I shall discuss his different versions in Chapter II.

Voltaire apparently tried to suspend the edition in Holland in favor of a new one in Paris (D.1409). When the Royal censor finally approved, Voltaire said: "Mr. le chancelier a trouvé qué j'étois un peu hardi de soupçonner le monde d'être un peu plus vieux qu'on ne dit. Cependant je n'ay fait que raporter les observations astronomiques de Mrs. Louville et Godin" (D.1480). Voltaire repeated the astronomical period of 1,944,000 years in the new edition of 1741, chapter XI, which

replaced the "Digression" of the first edition, but was deleted in 1748 (M.XXII: 550). In that chapter Voltaire, however, omitted the promise to the human race of "une durée que l'on n'oserait concevoir," perhaps because of the Royal censor.

Voltaire's first reference to geology is repeated in 1741 with little change. The theory about the provenance from the Indian Ocean of petrified plants, fish, and sea-shells found in Europe is followed by the skeptical "dit-on" and Voltaire adds the notion "et la plupart de ces coquillages arrangés encore par lits, font voir qu'ils n'ont été ainsi déposés que peu à peu par des marées régulières, et dans une nombreuse suite d'années" (M.XXII: 550). This theory of the Indian Ocean had been popularized by Fontenelle who will be discussed below.

Another chapter on geology in the 1741 edition, also deleted in 1748, is entitled "De la figure de la terre, considérée par rapport aux changements qui ont pu y survenir. Les inégalités de notre globe ne sont point une suite d'un prétendu bouleversement. Le déluge ne peut être expliqué physiquement" (This was chapter X, M.XXII: 548-550). Here Voltaire refutes Thomas Burnet's diluvial theory according to which mountains, valleys, and oceans were ancient ruins of a former earth which God had destroyed to punish mankind during the deluge. Voltaire mentioned others who believed, to the contrary, that this world was arranged with kindness for the sake of man and that mountains and rivers were necessary for life on earth. He argued that the earth could not have been flat before the deluge, as Burnet would have it, but he compared mountains on the earth with the grain of an orange which appears smooth from a distance but is irregular at close view. He added, "C'est bien mal connaître la nature que de lui supposer ainsi des figures si régulières: il n'y en a qu'en mathématiques." (Diluvial theories will also be discussed later on.)

In the same chapter X, Voltaire referred to Edmond Halley, English astronomer and mathematician, who had demonstrated that water vapors from oceans and lakes, by the action of the sun, were sufficient to maintain clouds, rivers, and springs. Voltaire added that clouds could never cause any inundation larger than one hundred "toises." If such an inundation — even though possible — had occurred uniformly over the globe, the height of the waters would have had to surpass the highest mountains near Quito, for instance, namely more than ten thousand feet. Thus not eight oceans, as proposed by Burnet, but more than forty oceans would have been necessary to cover the highest mountains. This is impossible, "il vaudrait beaucoup mieux se borner à dire avec tous les docteurs des premiers siècles que la bande rouge de l'arc-en-ciel signifie que le monde périra par le feu, et que la bande bleuâtre signifie qu'il a été submergé." Strongly influenced by Newton's physics, Voltaire finished chapter X saying: "On voit par là quels usages on peut tirer de la physique newtonienne, je veux dire de la vraie physique." (Voltaire repeated his argument against Burnet in "Digression sur la manière dont notre globe a pu être inondé," published in 1748 [Bengesco 1885: II: 41] and in the articles "Déluge" and "Inondation" in the *Dictionnaire Philosophique*.)

Voltaire's reliance on Newton's physics could, however, not be applied to chapter XI, discussed above, since the traditions on which it rests were vague and unreliable astronomical measurements; only the plant and fish fossils found in France were palpable facts. Inspection of the earth was the next step to be taken. In chapter IX of *Elémens*, published in 1741 but not deleted in 1748, entitled "Théorie de la terre; examen de sa figure..." Voltaire promised: "Je m'étendrai d'avantage sur la théorie de la terre. D'abord j'examinerai sa figure..." (M.XXIII: 543). Voltaire kept his promise and entered thus the incipient field of geology: he criticized diluvial theories in chapter X of *Eléments* in 1741; he analyzed and criticized theories of the earth in the *Dissertation* of 1746, and again in *Singularités* in 1768.

Louis Bourguet, a naturalist from Nîmes who lived at Neuchâtel since 1709, harshly critized Voltaire's astronomical theory of 1,944,000 years and the way Voltaire had presented evidence for such enormous changes on the earth. Bourguet apparently believed that Voltaire's relation of fossils with the movements of the poles was not coincidental. He cited word for word Voltaire's remarks on long-term geological processes and retorted:

> Je réponds, que ces *végétaux*, ces *poissons*, ces *coquillages*, bien loin d'appuyer ces changements prodigieux, que M. de *Voltaire* voudroit persuader à ses Lecteurs, servent à démontrer précisément le contraire. Il ne suffit pas, en effet, de dire séchement, que *les eaux ont successivement couvert & abandonné les lits qui les contiennent*; il falloit le prouver, sans rien déguiser des phénomènes, & sans violer aucune des régles constantes de la méchanique en général, & de l'hydrostatique en particulier. (1742: 106-107)

(The underlined words are Bourguet's citation from Voltaire's *Elémens*.)

Bourguet's criticism of Voltaire was published in an anonymous book in 1742, addressed to "Monsieur de Réaumur de l'Académie Royale des Sciences..." (p. xiii), and contained various letters by naturalists from Neuchâtel objecting to a long presence of the sea on land. Bourguet observed that at a normal rate of deposition in Lake Geneva, or Lake Constance, it would take a hundred million years to fill these lakes. He asked: "Comment des bancs de dix, vingt, trente, quarante pieds, & davantage, tels que le sont ceux des montagnes, & les masses quelquefois énormes de granite placées au haut des Pyrenées & des Alpes, ou répandues en divers lieux dans des plaines, auroient-ils pû être formés sur les rivages de l'Océan"? (p. 9) It is possible that the short time alloted to the history of the earth by the Bible (Bourguet was protestant) and the clever mathematics of the Archbishop James Ussher according to which the world was created in the year 4004 B.C. (Annales 1650-1654: 1) compelled Bourguet to speed up geological processes. In a theory of the earth, never quite finished, he argued that fossils of former sea-shells had been introduced into rocks during a complete dissolution of the rocks of the ancient world followed by a general inundation (p. 26-28). In the passage cited above, Bourguet told Voltaire that fossils needed yet to be explained, and that their position was no evidence for long-term

deposition. Furthermore, explanations of the position of fossils should not violate the laws of hydrostatics in particular. In regard to the movements of the poles, he remarked that they could not have formed concentric layers of rocks on the surface of the earth which contain marine fossils and then raised them to some thousand feet above sea-level (p. 111). (Theories of the earth will be discussed later on.)

I believe that Bourguet's harsh criticism, and probably also his book, influenced the development of Voltaire's attitude toward geology. He became aware that astronomy and geology were widely different fields. Bourguet's book on petrifications was reviewed favorably in the *Journal des Sçavans* in January 1743 (Tome CXXIX: 147-167). The journal said very little on Bourguet's criticism of Voltaire, "cest une discussion qu'il faut voir dans le Livre même..." (p. 158). Since the journal was held in high esteem by the lettered class of France (O'Keefe 1974: 6), Voltaire might have read Bourguet's book, he might have wondered whether the general belief of the marine origin of fossils was correct — Bourguet did not think so — and he might have decided to be more careful in his attitude toward geology since Bourguet had said, "il fallait le prouver." Bourguet had mentioned that explanations of fossils should not violate the laws of hydrostatics, a notion which Voltaire was going to use himself: "La mécanique universelle est toujours la même" (*Dissertation*, p. 228).

C. Publication of the Saggio, the Translation in the Mercure de France, and the Dissertation

After being accepted as a member of the famous Academy of Bologna in January 1745 (Zanichelli 1881: 62) Voltaire amplified and corrected his material from the *Eléments* in an entirely new essay which he wrote in Italian and sent to the Academy in 1746: *Saggio intorno ai canbiamenti* [sic] *su'l* [sic] *Globo della Terra*, printed in Paris by Prault (reproduced in facsimile in the Appendix because of its extreme rarity). It was translated by an unknown person and published in the same year in the *Mercure de France* (July 1746). In 1748 Voltaire offered his own translation for publication in the Dresden edition: *Dissertation envoyée par l'auteur, en italien, à l'Académie de Boulogne et traduite par lui-même en français. Sur les changements arrivés dans notre globe, et sur les pétrifications qu'on prétend en être encore les témoignages.*

It has been suggested that Voltaire was "patently showing off" by sending his work to Italy (Libby 1935: 171). Perhaps all the success Voltaire had reaped in 1745 had gone a little bit to his head. His comedy "La Princesse de Navarre" was played in front of the king at the wedding of the Dauphin in February 1745 (D.3076); in March of the same year he was appointed "historiographe de France" and "gentilhomme ordinaire de la chambre du roi" (D.3092); in April the Philosophical Society

of Edinburgh had accepted him as a member (D.3099); a month later, he wrote the *Battle of Fontenoy* and was showered with favors by the king (D.3254); Voltaire had even a regular correspondence with Madame de Pompadour (D.3138, 3140), and the pope gave him papal benediction in September 1745 (D.3183). Last but not least, Voltaire was carrying on a love affair with Mme Denis as his correspondence shows (Pléiade, Tome II, 889-1120). Considering all these circumstances, Voltaire was bound to become self-assured and not as humble as he had been when writing his papers on physics for the Academy of Sciences.

Of course, Voltaire's *Saggio* cannot be compared to his scientific essays. Then, he wanted to win a prize for his scientific contribution; now, he abandoned the often dry but carefully outlined facts, hypotheses, and conclusion of scientific essays: he returned to literature. Instead of mentioning the names of authors he was refuting, he merely referred to "l'opinion de plusieurs sçavans," or "on conclut," "on prétend," "on se garde d'examiner," "on a donc vu," "on sait," etc. He did not bother to explain exactly what specific theory and what precise facts he was refuting. Furthermore, he nearly always grotesquely exaggerated the theories or conclusions reached by some general opinion so that the essay became a satire instead of a philosophical appeal to reason. The *Saggio* and the version in French entitled *Dissertation* thus bear nothing in common with Voltaire's earlier scientific papers to the Academy of Sciences, nor with the more philosophical *Eléments*, nor can they be compared with the purely satirical *Candide* or any one of the philosophical dialogues. The *Saggio* is a mixture of all these approaches, yet resembles none of them. One is never quite sure, therefore, whether certain statements are meant to be satirical, philosophical, or scientific.

It is quite obvious that the *Saggio* is a display of Voltaire's orthodox creed to impress some Italian academies and Italian dignitaries of the church, even the pope. Before it was printed, Voltaire had sent manuscripts to Cardinal Quirini in Rome, in October 1745 (D.3250), and if an "old manuscript copy" mentioned by Besterman is real (D.3192), Voltaire had also sent a manuscript of the *Saggio* to the pope. In one of his addresses to the pontiff he said,

> Vostra beatitudine concede a i minimi figli della chieza la licenza di porgere i loro voti al Padre commune. Sia lecito anche a un amatore delle scienze e della virtù di presentare umilmente questo piccolo saggio a quello che per le sue opere a insegnato e ammaestrato la cristianità prima di governarla. E ben justo e che una tragedia nella quale sono spiegati ed aborriti gli errori e la crudeltà di Mahometto sia offerta al vicario e l'imitatore d'un dio di verità e di mansuetudine. (D.3192)

This letter to the pope, however, is ambiguous because on the one hand Voltaire mentions "un piccolo saggio" and on the other he talks about the cruelty of *Mahomet*. However, the play could not have been called "un piccolo saggio", therefore Voltaire might have sent his *Saggio* together with *Mahomet* to the pope in the same manner as he had sent them to Cossinio in Bologna (D.3379).

Voltaire asked the pope in another letter which is now printed as a dedication of *Mahomet*: "... Vostra santita [sic] mi conceda dunque di poter mettere a i suoi piedi il libretto e L'autore, e di domandare umilmente la sua protezzione per L'uno, e le sue benedizzioni per L'altro..." (D.3192) Thus Voltaire pleaded for protection and benediction which he apparently received.

The date of publication of the *Saggio* is unknown. From Voltaire's correspondence it can be gathered that in March 1746 he asked Marville for five dozen prints which he needed for some Italian academies (D.3332). (Marville had succeeded Hérault as *lieutenant de police* in January 1742 and tried to stop the play *Mahomet* [D.2640]). According to another letter, the *Saggio* was to be sent to "quelques ministres d'Italie qui daignent, faute de me connaître, avoir plus de bonté pour moy qu'on n'en a dans ma patrie" (D.3335). Comte de Maurepas, Secretary of State, wrote to Marville: "La lettre de Voltaire est une pièce qui ne pouvait être imaginée que par lui; mais comme la singularité n'est pas une raison de la défendre, je ne vois point d'inconvénient, s'il l'avoue et s'il la donne au public signée de lui, de permettre qu'elle soit imprimée" (D.3332). Voltaire acknowledged authorship and as early as March 1746, Michel Giuseppe Morei, secretary and late historian of the Arcadians, acknowledged receipt of "il piccolo eruditissimo Trattato del saggio intorno ai cambiamenti avvenuti sul Globo della Terra" (D.3344).

How was Voltaire's *Saggio* received by the Italians? Cossinio, member of the Academy of Bologna, thanked Voltaire for having sent the *Eléments*, *Mahomet*, and the *Saggio*. He said in regard to the *Saggio*:

> Quanto agli sconvolgimenti, o cambiamenti sul Globo della Terra, io sono stato sempre dell'opinione vostra. I sapersi che l'opinione contraria è stata autorizzata dei Capi di Religione presso gli antichi Creci, e Romani, ha sempre fatto ch'io la riguardi come un ritrovato dell'impostura, atto ad ispaventare opportunam̄ e vantaggiosam̄ la moltitudine, che così non si muove per alcun' altra passione, come per lo timore, specialm̄ di grandi e meravigliose cose. L'essersi poi osservate nella superficie della terra queste, che dicono, reliquie diluviane, ha bastato per confirmarlo, e per istrascinarvi ancore di què filosofi, i quali ove intoppano in alcuna cosa alquanto difficile da intendersi, e da spiegarsi, anno ricorso ai portenti. (D.3379)

This letter explains that in certain circles of Italy the teaching by Pythagoras was not accepted. For this reason Voltaire had probably said in his *Saggio*, "così l'insegnava tutta la folla Pittagorica..." Indeed, the opinion of great changes as told by Ovid in the Teaching of Pythagoras was considered by Cossinio as some kind of "impostura" in order to keep people under control. The letter by Cossinio suggests that the two works, the *Saggio* and *Mahomet*, had one purpose in common with which Voltaire probably tried to impress certain people in Italy: they both condemn imposture, either by Mahomet or by philosophers who according to Voltaire "usurpano nel loro gabinetto la potenza di Dio" (*Saggio*, p. 11).

MERCURE
DE FRANCE,
DÉDIÉ AU ROI.
JUILLET. 1746.

A PARIS,

Chés { GUILLAUME CAVELIER rue S. Jacques.
La Veuve PISSOT, Quai de Conty à la deſcente du Pont-Neuf.
JEAN DE NULLY, au Palais

M. DCC. XLVI.

Avec Approbation & Privilege du Roi.

MERCURE
DE FRANCE
DÉDIÉ AU ROI.

PIÉCES FUGITIVES en Vers & en Proſe.

VOICI une traduction françoiſe dont l'original italien eſt d'un illuſtre Ecrivain François. M. de V. a compoſé ce morceau pour les Académies d'Italie, auſquelles il eſt agregé.

IL y a des préjugés vulgaires ; il y en a auſſi de Philoſophiques, & peut être doit-on mettre dans cette claſſe l'opinion de pluſieurs Sçavans qui voyent ou croyent voir ſur la terre les monumens d'une ruine entiere & d'une deſtruction totale.

FIG. 1. — Title page of *Mercure de France*, July 1746, and heading of the French translation of Voltaire's *Saggio*... sent to the Academy of Bologna.

The *Saggio* was never published at Bologna (Zanichelli, 1881), nor by the Royal Society of London (Index 1-70). In June 1746, Voltaire wrote in Latin to Gerhard Friedrich Müller, secretary of the Academy of Sciences of St. Petersburg, that he was going to translate the *Saggio* into Latin and send it to be judged by the Academy (D.3423).

Although Voltaire had promised Marville that the *Saggio* would not be published in Paris, "c'est un ouvrage qui ne sera point publié icy, mais qui sera seulement imprimé dans les journaux d'Italie..." (D.3335), the work was published, nevertheless, in the *Mercure de France* in July 1746. This is the only time that this journal departed from its policy to ignore Voltaire in regard to his work or to his whereabouts; otherwise it was indifferent to whether he lived in Paris, had left France or had died (Fields 1962: 175-215). According to Fields, "Que cette pièce hardie n'ait pas été arrêtée par le censeur peut sembler incompréhensible. Sans doute la laissa-t-on passer car Voltaire venait d'être reçu à l'Académie française" (Fields 1962: 184). Voltaire's publication in the *Mercure de France* bears no title except the words: "Voici une traduction françoise dont l'original italien est d'un illustre Ecrivain François. M. de V. a composé ce morceau pour les Académies d'Italie, ausquelles il est agrégé." This French text by an unknown translator is very close to the Italian version.

There is a noticeable difference between the *Saggio* and the later *Dissertation* depending upon the public Voltaire wanted to reach. Indeed, the *Saggio* was addressed to orthodox circles of Italy while the *Dissertation* was written for the French. For example, the *Saggio* mentions "la folla Pittagorica" while the *Dissertation* simply says: "l'école de Pythagore." The *Saggio* says that Burnet and Woodward advocated that mountains and valleys had been shaped by the biblical deluge although "la sacra Scrittura dica espressamente tutto il contrario," while the *Dissertation* omitted the Bible. The passage, "Il Mondo non è che una catena immensa; si tolga [sic] un'anello, la machina vien quasi distrutta. Perchè dar dunque una mentita ai sacri Scrittori..." was left out in the French version. The words "L'altra opinione cioè, che nella serie d'innumerabili secoli tutte le parti della Terra, abbiano servito alternativamente di fondo al Oceano, è altrettanto contraria alla ragione, quanto alla sacra Scrittura," were translated by: "L'autre opinion, qui prétend que dans la période de deux millions d'années l'axe de la terre, se relevant continuellement et tournant sur lui-même a forcé l'océan de changer son lit, cette opinion, dis-je, n'est pas moins contraire à la physique..." The difference between the *Saggio* and *Dissertation* thus lies mainly in Voltaire's changing tactic to appeal to a different audience.

The *Saggio* together with the *Dissertation*, however, is more than a compliment to the church, or a desire to show off: it represents Voltaire's best information about geology at that time. In *Elémens*, Voltaire had entered the field of geology by coincidence because he quoted Ovid's verses which included the first reference to the notion of changes which had occurred on the surface of the earth and because

he also mentioned the theory of the Indian Ocean then generally accepted by the Academy of Sciences. In chapter IX of *Eléments*, published in 1741, Voltaire actually promised a theory of the earth. Later he deleted two chapters in order to incorporate them partly into the *Saggio* and the *Dissertation*. Between 1741 and 1746, Voltaire had gathered additional information on fossils and on theories of the earth so that the ideas in *Dissertation* represent, indeed, Voltaire's first attitude toward geology. I shall analyze the *Dissertation* rather than the *Saggio* or the latter's French translation in the *Mercure de France* because it is Voltaire's own translation addressed to the French without too many religious overtones. Before first discussing his remarks on fossils, however, we need to know the opinion of his contemporaries on that subject.

D. The Fossil Controversy in France before 1746

Fossils [1] are crucial to geology because they indicate the past distribution of land and sea; they explain former climates and point to the vastness of geologic time through the earth's history. Antoine Jussieu, professor of botany at the "Jardin du Roi" from 1710 until 1758, considered fossils "la plus ancienne Bibliothèque du monde" (1718: 366).

In the first part of the eighteenth century, the fossil controversy seemed to be at its peak. Réaumur wrote in a memoir to the Academy of Sciences at Paris: "Il n'est point de recherche à laquelle les Naturalistes se soient plus generalement livrés depuis quarante à cinquante ans qu'à celle des Coquilles fossiles" (1720: 519). Bourguet cited sixty authors in France, Italy, Switzerland, Germany, England, Asia, Africa, and America who had written on fossils (1742: 20-28). Many naturalist referred to Ovid's verses on changes from land to sea and from sea to land. Pythagoras, however, had simply mentioned sea-shells lying far from the sea without giving any theory of the earth. Astronomers and physicists, including Voltaire, proposed movements of the earth's axis which might have allowed oceans to travel around the globe and deposit marine fossils in places later changed to land. These wandering oceans could also explain why some "exotic" fossils were found in Europe: some warm seas had perhaps covered the continent in the past. Fontenelle believed

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[1] Only in the nineteenth century had the meaning of fossils narrowed down to what we understand today. Before, the term "fossil" included everything dug out (from fodere) from the soil. The *Encyclopédie ou Dictionnaire Raisonné des Sciences, des Arts, et des Métiers...*, 1757, Tome VII, says:

> On distingue deux espèces de fossiles: 1° ceux qui ont été formés dans la terre, & qui lui sont propres; on les appelle *fossiles natifs*. Tel sont les terres, les pierres, les pierres précieuses, les cristaux, les métaux, &c. 2° ceux qui ne sont point propres à la terre, que l'on appelle *fossiles étrangers à la terre*. Ce sont des corps appartenans, soit au règne minéral, soit au règne végétal: tels que les coquilles, les ossements de poissons et de quadrupèdes, les bois, les plantes, &c. que l'on trouve ensevelis dans les entrailles de la terre où ils ont été portés accidentellement.

The study of fossils was called "lithographia," "lithologie," "conchyliologie," and "oryctologie." See Kenneth L. Taylor, *Geology in 1776*, p. 79.

in slow changes over a long period of time during which the Indian Ocean had transported "exotic" sea-shells and plants to Europe while Bourguet maintained that the earth, according to Scriptures, could not be so old. He believed that some catastrophic changes such as a complete dissolution of the rocks of the ancient world followed by a general inundation, when sea-shells were introduced into rocks, must have occurred in the past history of the earth.

Voltaire's century seems at first to have been only moderately influenced by earlier philosophies on the origin of fossils. Analysis of Voltaire's later work, however, will reveal that some beliefs in the supernatural were not abandoned so easily in the Age of the Enlightenment. For instance, as late as 1766, Jean-Baptiste Robinet still believed that "Dieu créa la matière séminale du monde & de tous les Etres qu'il devoit contenir" (III: 1ii). He thought that fossils were born from seeds occurring in rocks (I: 208) and was opposed to naturalists who were forecasting transformism and evolution of organisms (IV: 113). La Sauvagère, a correspondant of Voltaire, was also of the opinion that fossils were nothing but engendered seeds. When Voltaire refers to the term "fossiles" in *Dissertation*, he seemed to have in mind such ideas on the origin of fossils. Since such beliefs kept recurring in the eighteenth century, it is necessary to mention them shortly.

M. J. S. Rudwick has treated the fossil controversy in episodes corresponding to times of major advances in paleontology among which the eighteenth century does not qualify (1972: 86-95). He states that many naturalists in the sixteenth century, especially those with the training of a Renaissance man, did not distinguish between the organic and inorganic origin of fossils (p. 23). According to Neoplatonic doctrine, organic and inorganic mater was alive; a web of affinities, a natural magic, existed apparently between all parts of the cosmos. Thus, even if a fossil resembled a living animal, some "plastic virtue" or molding force inside the earth was made responsible for this likeness. Furthermore, some Aristotelian views on growth *in situ*, on seeds, and on spontaneous generation were also accepted in the sixteenth century. Rudwick says that these two trends of thought were powerful alternatives to the theory of organic origin (p. 20-22, 44-45).

Bernard Palissy, potter and naturalist, favored the view that fossil fish were of organic origin. In *Discours admirables* (1580) he claimed that he had not studied Latin and Greek and had not been influenced by Aristotle and Plato. He clearly demonstrated that fossils found in rocks were remains of some "poissons armés" which had lived and died in the places where they are found today (1961: 273).

Rudwick states that in the seventeenth century biological interests of Steno (Neils Stenson) and the beliefs of Robert Hooke that "Nature does nothing in vain" made them recognize the organic origin of several fossils (p. 50, 54). Steno even explained the position of fossils by subterraneous upheaval, while Hooke believed that earthquakes were responsible for their position (p. 54, 59, 60). These "modern" approaches remained, nevertheless, almost ignored in the seventeenth century because

of the continuing popularity of the Neoplatonic view spread by the German Jesuit Athanasius Kircher. His work in various sciences was extremely influential, says Rudwick, because of its encyclopedic approach which gave a satisfactory explanation to most natural phenomena. He attributed the stony matter of fossils to a "lapidifying virtue diffused through the whole body of the geocosm," and the form of fossils to a "spiritus plasticus," which formed both organic and inorganic matter (p. 56).

Agostino Scilla, the Sicilian painter and naturalist, argued strongly against the idea of *lusus naturae* and gave a rational and clear interpretation of fossil sea-shells and *Glossopetrae* (fossil shark teeth), found in Calabria and Malta. He claimed that these fossils were indeed the remains of animals of the sea that had lived in the past, were buried in sediments which had hardened and risen to the present position (1670: 15). Rudwick explains, however, that Scilla's fossils were "easy" ones because they belonged to recently deposited sediments close to the sea and could be readily identified with living analogues (p. 58). The English physician and naturalist Martin Lister found no such likeness in fossils from older rocks (Jurassic and Carboniferous) and thus rejected the theory of the organic origin (Rudwick: 61-63). John Ray, one of the most knowledgeable of naturalists at the end of the seventeenth century, remained uncertain, both about the nature of fossils — in particular ammonites and other fossils that had no living analogues — and their position far away from the sea (1713, 1978: 149-204). Thus, at the end of the seventeenth century the nature of fossils and their position could not be explained. Jesuit schools in charge of the training of most youths in France at that time, continued to funnel science through Kircher's view. In England, fossils were mostly explained by the biblical deluge as I shall mention later on.

One of the greatest promoters of new ideas on natural history in the early eighteenth century was Fontenelle. He was in charge of writing a yearly account of all memoirs presented to the Academy of Sciences since 1697, and his *Histoires* included also reviews of foreign publications. Voltaire seems to have read mostly Fontenelle's *Histoires* and not the original memoirs themselves which led to confusion as we shall see. It is of great importance to notice that some of these accounts reveal that Fontenelle did not always report scientific ideas faithfully. Thus was created, for instance, the theory of the Indian Ocean. In 1706 he reviewed Leibniz' *Protogaea*, published in the *Acta eruditorum* of Leipzig in January 1693, and reported:

> Il dit que dans le Païs de *Brunsvic* aux environs d'*Osteroda*, dans le Comté de *Mansfeld* aux environs d'*Eislebe*, & en beaucoup d'autres endroits d'*Allemagne*, on trouve des veines d'Ardoise horisontales à peu près, où il y a des représentations, mais très-exactes & très-finies, de diverses sortes de Poissons ou de Plantes, qui paroissent dans leur longueur & dans leur largeur naturelles, mais sans aucune épaisseur. Ces traces sont souvent marquées sur un mélange de Cuivre, qui contient même de l'Argent. Il y a quelques-unes de ces Plantes que l'on ne connoît plus en ces Païs-là, mais on les retrouve dans les figures des Plantes des *Indes*. (p. 11-12)

Fontenelle mentions here the famous copper-bearing Permian shale called "Kupferschiefer" which contains abundant fossil fish, the original substance of which has been replaced by copper (Speyer 1860: 507; Schwarz 1930: 25-26). Leibniz, however, did not mention any fossil plants in chapter XVIII of *Protogaea* "D'où proviennent les empreintes de poissons divers dans l'ardoise?" (Trans. 1859: 45-49) and he did not suggest that the sea of India had transported them to Germany. On the contrary, he proposed:

> Que peut-on nous opposer, si nous disons qu'un grand lac avec ses poissons, par suite d'un tremblement de terre ou d'une inondation, ou de toute autre cause majeure, a été enseveli sous des terrains qui, en se durcissant en pierre, ont conservé les vestiges, et comme la reproduction en relief des poissons dont le corps, d'abord empreint sur la masse encore tendre, a ensuite été pénétré et remplacé par une matière métallique? (p. 48)

Although Leibniz had proposed a freshwater origin of fossil fish found in Eisleben and had not mentioned any fossil plants, Fontenelle confused Leibniz' fossils with the discovery of some fossil plants elsewhere and stated: "Il est vrai qu'une représentation d'une Plante des *Indes* dans une Pierre d'*Allemagne* semble d'abord contraire au *Systême* de M. de *Leibniz*. Mais que la Plante représentée se retrouve aux *Indes*, c'est déjà un grand préjugé qu'il n'y a pas là de Jeu: il est aisé d'imaginer plusieurs accidents par lesquels une Plante aura été apportée des *Indes* en *Allemagne*..." (1706: 13). Fontenelle proposed that these fossils must be witnesses of great changes which had occurred on the surface of the earth: "M. *Leibniz* croit que la Mer a presque tout couvert autrefois [...] De-là viennent les Coquillages des Montagnes" (p. 13). Fontenelle thus reported that Leibniz had described fossil plants in Germany which resembled those still living in India and that, therefore, the Indian Ocean must have travelled to Europe: the theory of the Indian Ocean was thus created.

Between the years 1718 and 1722 a number of memoirs described fossil fish and fossil plants found in France. These memoirs and Fontenelle's accounts of them led more and more credibility to the theory according to which the Indian Ocean or some other sea from a warm country had indeed covered all of Europe.

In 1718, Jussieu found some imprints of "exotic-looking" fossil plants in the Lyonnais coal beds. Based on the evidence that they were mostly in a flat position, he deduced that they must have floated in water; since they were surrounded by marine shells, the environment must have been the sea; and because similar plants existed in India, or in other warm countries, an ocean from India or thereabouts must have brought them to France. Jussieu remarked that the biblical deluge could hardly account for their occurence (p. 363-376). In 1720, Réaumur described the faluns of Touraine: a sandy mass of fossil shell fragments mixed with other material depending on the location. He mentioned huge accumulations of marine shells in Touraine which were apparently deposited either by some ocean current from the Channel, by the ebb and flow of the sea, or by other accidents which caused the

ocean to change its bed. Réaumur pointed to the regular layers of marine shells and said that the deluge would have left these shells in disarray (p. 519-541). In 1721, Jussieu described fossil fish and plant remains which he compared with their analogues in India and China and concluded that these fossils were either transported by the ebb and flow of the sea from India, or they had lived in an ocean which later retreated, "il faut que nos terres ayent fait autrefois partie du bassin de la Mer dans lequel ces Animaux ont vécu dont les dépouilles ont été ensevelies dans nos terres, après que la Mer s'en est retirée..." (p. 89-98). Fontenelle conveniently disregarding the second proposition by Jussieu, wrote enthusiastically: "Après tout ce qui a été dit dans plusieurs des Volumes précédents, il seroit inutile de repeter que de grandes inondations inconnues aux Histoires ont dû apporter en *France* des Païs les plus éloignés & des Plantes & des Animaux, tels que des Coquillages ou des Poissons" (1721: 1). Only at the end of his account did he add: "Quelle étrange révolution a dû ou les apporter, ou les laisser ici!" (1721: 4) When Jussieu wrote another article on ammonites in 1722, Fontenelle said, "Après tout ce qui a été dit dans les Volumes précédens sur diverses petrifications, il est aisé de sentir la conclusion où M. de *Jussieu* veut venir. Les Mers des *Indes* ont donc couvert toute l'*Europe*. Ces grandes revolutions, dont nous n'avons plus d'exemples, si peu vraisemblables, horsmis pour les Philosophes, sont de jour en jour plus attestées par des monumens authentiques, & par des especes d'Histoires écrites de la main même de la Nature" (1722: 5-6).

This kind of unsupported generalization should be kept in mind for the discussion of Voltaire's *Dissertation*. Jussieu had proposed an ocean current from India or some other warm country or a diminution of the sea to account for fossils in France; Réaumur had suggested some localized ocean current from the Channel, the ebb and flow of the sea, or some other unknown accident. Fontenelle apparently found it earsier to stick to just one interpretation: the Indian Ocean was part of some unknown revolution in the past and had covered all of Europe.

Fontenelle made another generalization in regard to Bernard Palissy, which was also going to cause problems to Voltaire when he wrote *Singularités*. In his account of Réaumur's description of the faluns of Touraine, Fontenelle said in reference to Palissy: "Un potier de terre, qui ne savoit ni Latin ni Grec, fut le premier, vers la fin du 16^{me} Siécle, qui osa dire dans *Paris*, & à la face de tous les Docteurs, que les Coquilles fossiles étoient de veritables Coquilles déposées autrefois par la Mer dans les lieux où elles se trouvoient alors..." (1720: 7). Only the first part of Fontenelle's statement is correct. In *Discours Admirables* Palissy claimed that the *earth* produced as many "poissons portant coquilles" as the sea which lived in rivers, fountains, ponds. Fossils "limitroph" to the ocean only had been deposited by the sea, but fossils found far away from the seashore, and in mountains, were not of marine origin because they could not have been transported by the sea to these locations (1580, 1961: 273-281). Palissy was attacking the diluvial theory of Cardanus and stressed that according to Genesis, the waters of the deluge did not come from

the sea, but from the abysses and the rains. Personally, Palissy did not believe in the deluge but in some natural way of preservation of fossils. "Il faut donc conclure que auparavant que cesdites coquilles fussent petrifiées, les poissons qui les ont formées estoyent vivans dedans l'eau qui reposoit dans les receptacles dedites montagnes, et que depuis l'eau et les poissons se sont pétrifiez en mesme temps, et de ce ne faut douter" (1961: 279). When he found fossil oysters in the Ardennes which closely resembled those he had observed alive on the seashore, he suggested that some lakes must have been salty enough for their survival: "cela nous doit faire croire qu'en plusieurs contrées de la terre les eaux sont salées, non si fort comme celles de la mer: mais elles le sont assez pour produire de toutes espèces de poissons armez" (1961: 279). Palissy was thus clearly in favor of the origin in freshwater or slightly salty lakes for most fossils found inland.

I am amazed that when his work was rediscovered in 1663 by a Danish chemist Olof de Borch (Pallas 1782: 3) which then became famous in the eighteenth century, Palissy was incorrectly hailed as the first Frenchman who had proposed the theory that the sea had covered all lands. Not only Fontenelle, but also Buffon (1749: 267), Jussieu (1718: 370), Lamoignon-Malesherbes (1798: 226), and finally Voltaire believed Palissy to be the originator of the theory of marine invasion.

The two generalizations made by Fontenelle concerning the theory of the Indian Ocean and the idea that Palissy, already in the sixteenth century, had suggested that the sea had once covered all the lands meant that the Academy of Sciences admitted openly that not the biblical deluge but inundations, ocean-currents, or some other unknown events of the past were responsible for the presence of marine fossils on land. With these ideas Voltaire had agreed in the original version of *Elémens* in 1738; in 1741 he added the skeptical "dit-on" for fossils in mountains but added a deposit by "marées" over a long period of time, perhaps referring to the faluns of Touraine mentioned by Fontenelle. In the *Dissertation* and the *Singularités* Voltaire ridiculed the theory of the Indian Ocean by Fontenelle. It can be assumed that the anonymous "on" in *Dissertation* at times refers to Fontenelle.

Some statements in the *Dissertation* can also be traced back to the deceased Benoît de Maillet, consul of the king of France at Cairo between 1682 and 1702 and author of several manuscript versions about discussions between an Indian philosopher and a French missionary. Voltaire owned one of the manuscripts entitled "Nouveau système du monde ou entretien de Teliamed" (Havens and Torrey, SVEC, IX: 33) which circulated apparently for twenty years before publication in 1748 (Lamoignon-Malesherbes, 222). According to Maillet, the ocean had covered the whole earth as witnessed by the many fossil shells found everywhere on land. Mountains had been shaped by ocean currents on the bottom of the sea and later emerged during a gradual diminution of the sea. As the sea diminished, life developed in shallow waters, and with further retreat of the waters, sea-plants, sea-animals, and sea-men were forced to live on land. In *Dissertation* Voltaire criticized the theory

of mountain-building by the sea based on the occurrence of fossil shells on land. Another anonymous "on" is therefore Maillet.

E. Voltaire and Fossils

Voltaire's previous involvement with astronomy and physics did not help him to understand the origin of fossils. Before he eventually looked at them himself, he could only offer some more "natural" explanations.

In regard to fossil fish he said "On a trouvé dans les montagnes de la Hesse une pierre qui paraissait porter l'empreinte d'un turbot, et sur les Alpes un brochet pétrifié: on conclut que la mer et les rivières ont coulé tour à tour sur les montagnes." To this general opinion he retorted: "Il était plus natural de soupçonner que ces poissons, apportés par un voyageur, s'étant gâtés, furent jetés, et se pétrifièrent dans la suite des temps; mais cette idée était trop simple et trop peu systématique" (p. 221-222). Voltaire's more "natural" explanation about leftovers from some traveler's meal had been proposed earlier by Palissy in 1563 (1961: 37); Voltaire, however, did not refer to Palissy before 1768.

Fossil fish were never mentioned again. In his later *Singularités*, Voltaire ignored those in Hesse, and in treating the Alps he simply mentioned some oyster-shells (M.XXVII: 144-145). This apparently means that since fossil fish were so easily recognizable and comparable with living analogues, he did not question their origin in his later works.

In the following paragraph of *Dissertation*, Voltaire again seemed to give a more "natural" explanation:

> On dit qu'on a découvert une ancre de vaisseau sur une montagne de la Suisse: on ne fait pas réflexion qu'on y a souvent transporté à bras de grands fardeaux et surtout du canon; qu'on s'est pu servir d'une ancre pour arrêter les fardeaux à quelque fente de rocher; qu'il est très vraisemblable qu'on aura pris cette ancre dans les petits ports du lac de Genève; que peut-être enfin l'histoire de l'ancre est fabuleuse; et on aime mieux affirmer que c'est l'ancre d'un vaisseau qui fut amarré en Suisse avant le déluge. (p. 222)

Ever since antiquity anchors found in mountains had been mentioned as evidence of the theory of marine invasion. This idea is found in Ovid's *Metamorphoses* who recalled the teaching of Pythagoras. Burnet (p. 86) and Maillet (Carozzi A. 1968: 92) referred to anchors in the same sense as Ovid had. The legend of old anchors was expanded into petrified ships found in the Alps by Fulgose in the fifteenth century and repeated by Maillet in the eighteenth (Carozzi A. 1968: 92). Some naturalists explained the presence of ships and anchors as proofs of the biblical deluge; Maillet used it to explain the diminution of the sea; Hooke assumed that earthquakes "overthrew some mountains which collapsed into the lake of Geneva sinking the

DISSERTATION,

ENVOYÉE PAR L'AUTEUR, EN ITALIEN
à l'Academie de Boulogne, & traduite par lui-même
en français.

SUR LES CHANGEMENS ARRIVÉS DANS NOTRE GLOBE,

ET SUR LES PETRIFICATIONS

qu' on prétend en être encore
les témoignages.

Il y a des erreurs qui ne ſont que pour le peuple. Il y en a qui ne ſont que pour les Philoſophes. Peut-être en eſt-ce une de ce genre, que l'idée où ſont tant de Phyſiciens qu'on voit par toute la terre des témoignages d'un bouleverſement general. On a trouvé dans les montagnes de la Heſſe une pierre qui paraiſſoit porter l'empreinte d'un turbot ; & ſur les Alpes un brochet pétrifié. On en conclut, que la mer & les rivieres ont coulé tour à tour ſur les montagnes. Il étoit plus naturel de ſoupçonner, que ces poiſſons, apportés par un voyageur, s'étant gatés furent jettés, & ſe pétrifierent dans la ſuite de tems ; mais cette idée étoit trop ſimple & trop peu ſiſtématique. On dit, qu'on a découvert un ancre de vaiſſeau ſur une montagne de la Suiſſe : on ne fait pas reflexion qu'on

FIG. 2. — Title page of Voltaire's *Dissertation...* in the sixth volume of *Œuvres de Mr. de Voltaire* published at Dresden by George Conrad Walther in 1748.

ship and filling the basin of the lake up to the shorelines on a level with the adjacent lands" (Carozzi A. 1968: 273). Voltaire's more "natural" explanation was certainly reasonable. Perhaps he had also tried to reduce the importance of fossils found in Hesse and in the Alps with the implication that they are parallel to the fabulous anchors found in mountains.

After fossil fish Voltaire discussed shark teeth and conches:

> La langue d'un chien marin a quelque rapport avec une pierre qu'on nomme *glossopètre*; c'en est assez pour que les physiciens aient assuré que ces pierres sont autant de langues que les chiens marins laissèrent dans les Apennins du temps de Noé; que n'ont-ils dit aussi que les coquilles que l'on appelle *conques de Venus* sont en effet la chose même dont elles portent le nom! (p. 222)

Glossopetrae or "tongue-stones" had been identified for quite some time as petrified teeth of once living sharks or dogfish. Voltaire did apparently not read Steno on the origin of *Glossopetrae* but he could find an explanation in Maillet's manuscript where they were called "dents d'un poisson appellé Chien-marin" (Maillet 1755, II: 29) or in *La vana speculazione disingannata dal senso* by Scilla which he owned (Havens and Torrey, SVEC IX: 64; they give only the title of the book but not the author). Legends had named shark teeth "serpent's tongues" or "serpent's eyes" turned into stone fallen from the sky or formed during lightning. Another legend said that they were snakes turned into stone when a viper had tried to poison St. Paul on the Island of Malta (Carozzi A. 1968: 341-342). Voltaire decided to mix together all the legendary names and make a pun on nomenclature in general. After reading Scilla's explanation of the origin of *Glossopetrae* Voltaire was certainly aware that these "tongue-shaped stones" were indeed fossils of shark teeth. Furthermore, fossils of Venus shells had been known as such since antiquity. Therefore, Voltaire could not give a more "natural" explanation of these fossils and resorted to jokes.

He returned to a more serious attitude in regard to extinct ammonites. Leibniz admitted that they might still be living in some deep ocean (1693, trans. 1859: 68). Many naturalists, however, remained skeptical in the early eighteenth century while others believed that they were of the same species as *Nautilus* still living in India. Voltaire proposed:

> Les reptiles forment presque toujours une spirale, lorsqu'ils ne sont pas en mouvement; et il n'est pas surprenant que, quand ils se pétrifient, la pierre prenne la figure informe d'une volute. Il est encore plus naturel qu'il y ait des pierres formées d'elles-mêmes en spirales; les Alpes, les Vosges, en sont pleines. Il a plu aux naturalistes d'appeler ces pierres des *cornes d'Ammon*. On veut y reconnaître le poisson qu'on nomme *nautilus*, qu'on n'a jamais vu, et qui était produit, dit-on, dans les mers des Indes. Sans trop examiner si ce poisson pétrifié est un *nautilus* ou une anguille, on conclut que la mer des Indes a inondé longtemps les montagnes de l'Europe. (p. 222)

In the above passage, Voltaire first proposed that ammonites were some kind of petrified reptile, perhaps because of Maillet's account of a serpent at the court of

the Spanish King Philippe V: "On trouva dans une pierre qui fut sciée un serpent enterré sans aucune altération. On l'en tira; & on remarqua sa place creusée dans le marbre en spirale, selon la position de son corps" (1755, I: 94). Then Voltaire turned again to a more "natural" idea, namely that ammonites were simply stones of a peculiar shape. He doubted the opinion that ammonites belonged to a species of *Nautilus* still living in India.

Further on in the *Dissertation* Voltaire questioned whether fossil shells found in Italy and France were originally from the sea of Syria (Syria formerly included the present Syria, Lebanon, Israel, and adjacent areas as part of the Roman Empire until A.D. 636):

> On a vu aussi dans des provinces d'Italie, de France, etc. de petits coquillages qu'on assure être originaires de la mer de Syrie. Je ne veux pas contester leur origine; mais ne pourrait-on pas se souvenir que cette foule innombrable de pèlerins et de croisés, qui porta son argent dans la Terre Sainte, en rapporta des coquilles? Et aimera-t-on mieux croire que la mer de Joppe et de Sidon est venue couvrir la Bourgogne et le Milanais? (p. 222)

(The reference to the sea of Syria might also have been inspired by Maillet [Carozzi, A. 1968: 89].) Voltaire questioned that the sea of Syria had brought fossil shells to France and Italy and, for the first time, he mentioned pilgrims from the Holy Land as transporters of these shells, adding, however, immediately:

> On pourrait encore se dispenser de croire l'une ou l'autre de ces hypothèses, et penser, avec beaucoup de physiciens, que ces coquilles, qu'on croit venues de si loin, sont des fossiles que produit notre terre. On pourrait encore, avec bien plus de vraisemblance, conjecturer qu'il y a eu autrefois des lacs dans les endroits où l'on voit aujourd'hui des coquilles; mais quelque opinion ou quelque erreur que l'on embrasse, ces coquilles prouvent-elles que tout l'univers a été bouleversé de fond en comble? (p. 222-223)

Voltaire's attitude toward geology became notorious because of his pilgrim story, according to which pilgrims had transported shells to Italy and France from the Holy Land, which he repeated, drastically changed, twenty years later. All the evidence indicates that it never was a serious proposition. For instance, in the above passage Voltaire mentioned in fact three other hypotheses: a) fossil shells found in Italy and France might be originally from the sea of Syria ("je ne veux pas contester leur origine"); 2) these shells might be "fossiles" produced by the earth (the meaning of this expression will become clearer in *Singularités*), and 3) lakes might have existed in these areas where fossil shells are found today. Of these three theories, Voltaire seemed to prefer the last one since he said "avec bien plus de vraisemblance." All of this suggests that in 1746 Voltaire was not particularly fond of his pilgrim story, it was merely one suggestion among others. (I shall show in Chapter II, Section F, how the story changed in twenty years.)

Another reference to fossils appears immediately following Voltaire's translation of Ovid's verses which described changes from land to sea according to the teaching of Pythagoras:

> Cette opinion a été plus que jamais accréditée par l'inspection de ces lits de coquillages qu'on trouve amoncelés par couches dans la Calabre, en Touraine, et ailleurs, dans des terrains placés à une assez grande distance de la mer. Il y a en effet très-grande apparence qu'ils y ont été déposés dans une longue suite de siècles. (p. 223)

In his *Dissertation* Voltaire seemed to accept the marine origin of shells found in Calabria and Touraine. Why should he suggest marine origins there and not in the provinces of Italy and France mentioned in the same essay, a page earlier? For those he had just given the four hypotheses including the pilgrim story? This fifth hypothesis of the marine origin of shells might have originated from Voltaire's reading of Scilla's description of fossils in Calabria and Fontenelle's account of the faluns of Touraine. Scilla's book had been highly praised by Bourguet (1742: 21) and by Maillet (Carozzi A. 1968: 143). Most important, Voltaire owned a copy of Scilla. A comparison between this work and Voltaire's *Saggio* shows that there is one important similarity: the concept of being "elevated" or "rialzato." The paragraph on fossils in Calabria reads in the *Saggio*:

> Fù questa opinione di nuovo accreditata coll'inspezione d'alcuni mucchi di conchigliette, o *rialzalti* nei sassi della Calabria, o stesi sul pian terreno di *Touraine*, ed in alcuni altri luoghi in distanza del Mare. In effetto, pare che cotali letti di chiocciole, siano là stati disposti a poco a poco in lunga serie d'anni. (p. 6-7)

A comparison of the Italian text with the French one shows that Voltaire had read about heaps of shells either *elevated* in the rocks of Calabria or extended over the flat country of Touraine. Scilla had mentioned in his work:

> Essendo per camino nella bassa Calabria, poche miglia sopra la città di Reggio, nella via, che conduce ad une terra, per nome Musorrima, mi si se incontro alla veduta un mõte ben considerabile di chiocciole, e conche striate, e simili altri gusci nõ per anche impietrati [...] parendomi assai, ch'elleno si siano potute conservare per tanto, e sì grande spazio di tempo, e massimamente lungi, e *rialzate* dal livello del mare, per più di sei miglia di camino nell'asprissimo di quelle montagne. (1670: 15)

(The underlining of "rialzati" and "rialzate" in the two paragraphs above is mine.)

A comparison of the *Saggio* and Scilla's work reveals that Voltaire might have borrowed the latter's expression of "rialzato." His vocabulary on fossils is also richer in *Saggio*: "chiocciole," "conchigliette," "conche" than in *Dissertation*: "coquilles" and "coquillages." Since he owned Scilla's work, I believe that this was indeed Voltaire's source:

At the end of the *Dissertation* Voltaire mentioned fossils once more, adding Mont Cenis for the location of the "brochet" and the city of Frankfurt for shells from Syria:

> Je sais bien qu'il se trouvera toujours des gens sur l'esprit desquels un brochet pétrifié sur le mont Cenis, et un turbot trouvé dans le pays de Hesse, auront plus de pouvoir que tous les raisonnements de la saine physique; ils se plairont toujours à imaginer que la cime des montagnes a été autrefois le lit d'une rivière ou de l'océan, quoique la chose paraisse incompatible; et d'autres penseront, en voyant de prétendues coquilles de Syrie en Allemagne, que la mer de Syrie est venue à Francfort. (p. 229)

In this passage a petrified pike on Mont Cenis, a turbot found in Hesse, and shells from Syria found in Frankfurt seem to point to the fact that Voltaire cared little about the exact location of fossils; he argued that fossils cannot explain past changes on the surface of the earth. It is evident, nevertheless, that he knew more about them than when he had been writing the *Eléments* where he only quoted Fontenelle's account of the Indian Ocean and Ovid's verses. Since then he had evidently done some reading and was familiar with the most important names of fossils. He had probably read Scilla's book; Maillet's manuscript of *Telliamed*; Bourguet's *Traité des Pétrifications*, and John Woodward's *Géographie Physique*, (to be discussed in the next section) but he had not looked at fossils himself.

These books, however, failed to explain the presence of fossils on the highest mountain peaks in a fashion that Voltaire could accept. Only Scilla's fossils in Calabria could, in fact, be easily interpreted as ancient marine organisms which had lived and died in the sea and had become petrified together with the surrounding mud on the seafloor and then lifted to the present position by some earthquake. Voltaire almost accepted their marine origin. He was also not denying the marine origin of fossils close to the sea, as in Touraine, accepting some changing shorelines over a long period of time, but not Fontenelle's Indian Ocean. Both Bourguet and Woodward believed in a complete dissolution of the first earth and some mechanic introduction of fossils during the following deluge, an idea which Voltaire found unacceptable. He never mentioned Maillet's theory on a diminution of the sea to account for marine fossils on land but ridiculed only the idea that the sea could have covered all the lands in the past. At a time when mountain-building could not be explained by any other mechanism than the sea or the deluge, Newton's physics were of little help to Voltaire for the understanding of the position and the origin of fossils. In the absence of personal investigation of geological features and fossils, a little imagination was all Voltaire could offer at this point.

F. Voltaire on Theories of the Earth

According to Voltaire, "Il faudrait plus de temps que le déluge n'a duré pour lire tous les auteurs qui en ont fait de beaux systèmes..." That he was certainly right is proved by Bourguet's list of theories in the following passage from his *Mémoire sur la Théorie de la Terre :*

> La Théorie de la Terre est une Science toute nouvelle, elle consiste à déduire des Phénomenes de la Nature, la formation de nôtre Globe; les changemens qui y sont arrivés depuis, & ceux qui doivent y arriver encore. Les Anciens ont absolument ignoré cette Science. Ils n'ont débité sur les sujets qui s'y rapportent, que des Conjectures avancées au hazard, ou de simples Traditions. Leurs Conjectures ont été renouvellées au XVI Siécle, & l'on n'est pas allé beaucoup plus avant; si ce n'est depuis environ quarante à cinquante ans [. . .] on peut réduire à trois Hypothéses, tout ce que les Modernes ont dit là-dessus.
>
> La premiére Hypothése est celle de la Chute de l'ancien Monde de *François Patrice*, empruntée de *Platon* & differemment expliquée par *Gonçales de Salas* & par *Thomas Burnet*, qui le prémier a traité la *Theorie de la Terre* d'une maniére systêmatique.
>
> La seconde Hypothese est celle de *Bernard de Palissi* sur le séjour naturel de Lacs d'eau salée, ou de la Mer, dans les lieux où l'on trouve des Coquillages, prise d'*Aristote* & d'autres Anciens; & suivi en tout ou en partie par *Alexandre ab Alexandro*, *Cesalpin*, *Fracastor*, *Columna*, *Scilla*, *Boccone* & par Mess. *Leibniz*, *Vallisnieri*, de *Jussieu*, de *Réaumur*, *Mayran*, & divers autres Savans de ce temps: Ou jointe à la premiére Hypothese en diverses façons par *Stenon*, & Messieurs *Whiston*, *Halley*, *Hartsoeker*, *Buttner*, *Gautier*, & le *R. P. Castel.*
>
> La troisiéme & derniere Hypothese est celle de la Dissolution du prémier Monde, de Monsieur *Jean Woodward*, que Messieurs *Scheuchzer*, *Monti*, & quantité de Savans d'Angleterre, d'Allemagne & d'Italie ont soutenuë avec beaucoup d'érudition & de force. (1729: 177-180)

Although Bourguet mentions three different theories of the earth, apart from Leibniz' view on the origin of mountains by fire and water, the main difference among all of them in the eighteenth century is whether the biblical deluge — originating from the sky and the abysses, but finally covering the whole earth, thus mingling with oceans — or a general inundation, or some ocean current had deposited *marine* fossils on land. In order to understand Voltaire's reaction to the two sets of theories, I need to summarize some of the most important works to which Voltaire was referring.

In England, the most widely accepted account of the history of the earth in the seventeenth century and later was the Bible. It is not surprizing, therefore, that the first "geologists" in England mixed science with religion since the Scriptures say: "And the flood was forty days upon the earth; and the waters increased, and bare up the ark, and it was lift up above the earth..."; "Fifteen cubits upward did the waters prevail; and the mountains were covered..."; "And the waters prevailed upon the earth an hundred and fifty days" (Genesis, Ch: 7: 17, 20, 24). When these naturalists found fossil remains inside their mountains, it did not surprize them since the Bible said that the mountains had been covered by waters. (Fifteen cubits — one cubit being 17 to 21 inches — allows, however, for rather small mountains.) What bothered them, however, was the problem of how to account for the volume of water during the deluge and to understand how the mountains had been formed. They produced interesting theories, none of them alike.

In *Telluris theoria sacra*, first published in 1681 and reedited in English in 1684 under the title *The Sacred Theory of the Earth*, Thomas Burnet was greatly concerned with the amount of water necessary to cover the highest mountains. According to his computation, at least a volume corresponding to eight oceans would be necessary for the waters of the deluge to cover all the highest peaks (1965: 29). Finding this impossible, he adopted Descartes's theory of the broken earth-crust. Descartes had proposed different layers of matter around a hard core. These layers were constantly crossed by moving particles which managed to leave empty spaces. Since nature must replace voids, cracks appeared in the same manner as in mudcracks in summer. Where too many cracks existed, the crust collapsed, and the positions assumed by the different layers of matter accounted for mountains, valleys, and seas (Descartes 1664, 1973, III: 352-386). Borrowing from Descartes, Burnet proposed that before the deluge (which Descartes did not mention) the earth had been completely flat with concentrically arranged layers of matter of different density and consistency around a hard core. A very thin outer crust broke and opened the way for the water underneath to gush out and cover the earth completely during the time of the deluge. After the deluge, said Burnet, the earth was in ruins and "according as the fragments fell, some would make Islands or Rocks in the Sea, others would make Mountains or Plains upon the Land" (1965: 91). Burnet used a much plainer language than Descartes and tried to reconcile science with religion. Both ignored fossils altogether.

John Woodward made it his task to explain how fossils were found inside rocks and mountains. He advocated a complete dissolution of the first earth which, unlike Burnet's globe, had mountains, valleys, and seas, followed by a settling of all the materials by gravity in the waters of the deluge. *Essay Toward a Natural History of the Earth*, first published in 1695, went through many editions and was translated into Latin, French, Italian, and German (Eyles 1969: 163). The French translation of 1735 which Voltaire probably read states: "Dans le temps du déluge, lorsque l'eau couvroit toute la terre, la pierre, le marbre, les métaux, toutes les concrétions minérales: en un mot, tous les fossiles qui avoient auparavant quelque solidité [apparently excluding fossil animals and plants], furent entièrement dissous & les particules qui les composoient furent séparées & désunies (leur cohésion ayant cessé)." The dispersed and floating bodies finally reassembled and, said Woodward, "se précipitèrent de nouveau & tombèrent au fond: ils descendirent généralement selon les loix de la pesanteur." According to density, heavy shells would lie together with heavy rocks at the bottom of a geological section and light shells with light chalk at the top. Thus Woodward explained the vertical distribution of fossil animals and plants within horizontal layers; for the vertical position of rock layers, he suggested later produced fractures and violent disturbances or revolutions, apparently while the earth crust was still pliable (1735: 45-51). Woodward's explanation of the preservation of the original fossil animals and plants while all other material was completely dissolved is the weakest point of his theory. He tried to explain this

difficulty by saying that animal and plant remains were of a different composition (fibres entrelassées & embarassées) while ordinary stones and minerals were composed of "petits grains contigus & appliqués l'un contre l'autre sans être liés ou entrelacés, retenus par la compression & la pesanteur de l'air extérieur: donc pour les séparer & causer la dissolution, il faut suspendre la cause de leur solidité, la pesanteur de l'air." Woodward concluded that the deluge was a change in gravity (1735: 236-237). His approach is thus a curious mixture of Descartes's theory on matter and Newton's laws of attraction.

Even more influenced by Newton's laws of gravity was William Whiston who wrote in 1696, one year after Woodward, a *New Theory of the Earth...* He dedicated the work to Newton saying: "The now undoubted property of the Universal Gravitation of Matter, contradicts and overthrows this fancy of the Heavenly Bodies having been originally included in, and at the Creation extracted from the Chaos [...] This hypothesis would make the Earth the Center of the world." He said that Scriptures talked only about the Earth and not the other planets and that there was a different formation for each body. Therefore, the "Mosaik Creation is confin'd to our Earth" (p. 36-41). In the same affirmative tone he pointed out several inconsistencies in the Bible: insufficiency of time; the light appearing before the creation of the sun; "the Channel of the Ocean and the Elevation of the Mountains" seeming "unnatural and indecent." He concluded that "all these points are unworthy of the Writer and Author of the Sacred History" (p. 51-78). Whiston believed that the Bible was addressed to the Jews and that "it agreed with their cosmogony, and that their capacities were very low and mean. They were rude and illiterate, newly come from the Egyptian Bondage and destitute of the very first Elements of Natural Knowledge." Furthermore, "the generality of Mankind's Apprehensions are too narrow" (p. 80-83). Therefore, he wanted to prove that the "Mosaick Creation extends no farther than this Earth and its Appendages, because the Deluge and Conflagration, whose Boundaries are the same with that of the Mosaick Creation extend no farther" (p. 86).

Whiston went on to correct all these errors. In Book I he explained that attraction — gravity must be the effect of a divine power, and that if gravity were rightly understood, it does not lead to Atheism. In Book II, he gave astronomical evidence of the exact day when the deluge started, namely when a comet passed just in front of the Earth. In Book III, he covered the six days of creation giving to each day its needed time. According to his theory the waters of the deluge originated from the tail of the comet and the fountains of the abyss. Whiston was a physicist-astronomer and less interested in fossils. Thus he simply followed Woodward's explanation. In his last book, IV, he said that God alone had created all matter in the universe, the seeds of animals and plants, the motion of bodies, and Adam and Eve. The Earth itself, moreover, was created by the direct interposition of God, and the placing of the earth in its primitive circular orbit was due to an immediate power or a peculiar

providence of God (p. 218-237). Whiston's theory did not please everybody in England and he lost his chair at Oxford. He had to leave the university, and Newton to whom he had addressed his book "did nothing at all to help him..." (Roger, DSB).

The theories of the three English diluvialists have all gone beyond what the Scriptures said. Burnet was still read in the eighteenth century because of his many sources and because of his convincing language. Indeed, even Buffon was impressed (1749: 181). Woodward was consulted because of his knowledge in paleontology. He corresponded with many naturalists all over the world and helped to establish a practical approach to that discipline. Bourguet became his disciple in the sense that he accepted the notion of a dissolution of an ancient world.

In *Lettres philosophiques*, Voltaire dismissed "un géomètre anglais nommé Whiston, non moins chimérique que géomètre" (M.XXII: 138), in *Eléments*, he refuted Burnet's diluvial theory, and in *Dissertation* Burnet and Woodward are put side by side. (Voltaire had thus read Woodward's translated version of 1735.):

> Un auteur qui s'est rendu plus célèbre qu'utile par sa théorie de la terre a prétendu que le déluge bouleversa tout notre globe, forma des débris du monde les rochers et les montagnes, et mit tout dans une confusion irréparable; il ne voit dans l'univers que des ruines. L'auteur d'une autre théorie, non moins célèbre, n'y voit que de l'arrangement et il assure que sans le déluge cette harmonie ne subsisterait pas; tous deux n'admettent les montagnes que comme une suite de l'inondation universelle. Burnet, en son cinquième chapitre, assure que la terre avant le déluge était unie, régulière, uniforme, sans montagne, sans vallées, et sans mers; le déluge fit tout cela, selon lui: et voilà pourquoi on trouve des cornes d'Ammon dans l'Appennin.
> Woodward veut bien avouer qu'il y avait des montagnes; mais il est persuadé que le déluge vint à bout de les dissoudre avec tous les métaux, qu'il s'en forma d'autres et que c'est dans cette nouvelle terre qu'on trouve ces cailloux autrefois amollis par les eaux, et remplis aujourd'hui d'animaux pétrifiés. Woodward aurait pu à la vérité s'apercevoir que le marbre, le caillou, etc. ne se dissolvent point dans l'eau, et que les écueils de la mer sont encore fort durs. N'importe; il fallait pour son système que l'eau eût dissous, en cent cinquante jours, toutes les pierres et tous les minéraux de l'univers, pour y loger des huîtres et des pétoncles. (p. 225-226)

Voltaire's criticism of Burnet and Woodward [1] is scientifically correct with the exception of the reference to Burnet having mentioned ammonites: Burnet never talked about fossils.

Naturalists who did not believe in the biblical deluge proposed various other theories to explain how fossils had been introduced into rocks now forming part of

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[1] Moland's note in Vol. XXIII, p. 225, incorrectly mentions Buffon and Maillet as the authors referred to by Voltaire in the first paragraph mentioned above. The first author is certainly Burnet, and not Buffon, since Voltaire had already mentioned him in *Eléments* with the same words, "nous n'habitons que des ruines", and since Buffon's work was only published in 1749. Maillet's book was published in 1748 although his manuscript version might be referred to. However, he did not propose the biblical deluge. The second author is certainly Woodward although he was not mentioned in *Eléments*, but it seems logical that Voltaire should mention him together with Burnet as the author of another famous theory.

mountains and lands. John Ray, Fellow of the Royal Society of London, dared to contradict the Bible and said that huge amounts of fossils "could hardly be the Effect of a short Deluge, which if it had carried any Shell-Fish so high, would in all Likelihood have scattered them very thin" (1713, 1978: 146). Staying close to Scriptures, however, he said, "at the first Creation, the whole Earth was not all at once uncovered, but only those Parts whereabout *Adam* and the other Animals were created, and the rest gradually afterwards, perchance not in many Years; during which time these Shell-Fish might breed abundantly all the Sea over, the Bottom whereof being elevated and made dry Land, the Beds of Shell-Fish must necessarily be raised together with it." But Ray immediately added: "This Conjecture hath no sufficient Ground to support it, and therefore I do not insist upon it" (1978: 172). Ray was not sure whether earthquakes and subterraneous fires had raised up and elevated land and for how many "Years" the land was once a breeding ground for shell-fish. He refused to give any theories as long as he was not certain.

Leibniz, a born synthesizer, had written in 1693 a theory of the earth, *Protogaea*, which was not published in full until 1749. He considered two major causes for the formation of mountains: fire and water. The primitive earth was first a ball of fire, and the earth crust, while cooling unequally, solidified and crumbled to form valleys, or remain upright to form mountains (Buffon was going to adopt this part of Leibniz' theory in 1778.). Water erupted from the abysses through the broken crust, and combined with rivers and rain, caused huge inundations which left sediments in certain places: "Ces sédiments se sont durcis; et, par le retour de la même cause, les couches sédimenteuses se sont superposées, et la face de la terre, peu consistante encore, a été ainsi souvent renouvelée, jusqu'à ce que, les causes perturbatrices ayant été épuisées et équilibrées, un état plus stable c'est enfin produit" (Trans. 1859: 8-9). Once the earth had stabilized, minor changes occurred such as "embrasements secondaires, des tremblements de terre, des déluges partiels, et sur certains points une accumulation nouvelle des sédiments par suite du séjour des eaux..." (1859: 12)

Leibniz added an improvement to Burnet's theory of the broken earth-crust, namely that there existed two great cavities, one containing water, the other air. After the rupture of the first, the waters rushed up to the highest mountains while the opening of the second cavity gave passage to the water to recede inside the earth (1859: 17). Descartes's theory had thus been transformed, first by Burnet, then by Leibniz, and finally by Buffon who will be discussed in the next chapter.

As mentioned earlier, when Fontenelle reported Leibniz' theory in the Academy of Sciences in 1706, he misread the description of the freshwater origin of fossil fish found at Eisleben. Leibniz actually stated that these fish might have lived in some ancient lakes which disappeared during some earthquake so that the fish became enclosed in mud which when hardened preserved the imprints of the former fish. Voltaire used a similar explanation. Leibniz agreed with his predecessors that marine fossils found elsewhere must have been brought by the sea. "Mais depuis

longtemps déjà les anciens en ont dit autant, et ce n'est point ici le lieu d'accumuler les témoignages épars. Ce qui importe, c'est de constater le fait, et de reconnaître *les preuves qui établissent que ce sont là des animaux ensevelis*" (1859: 61-62). Apparently, Leibniz could not explain why fossils were found in mountains, he only suggested that they were former animals.

In 1746, no theory of the earth could explain how rocks including petrified seashells had been lifted from below sea-level. Voltaire thus wondered "donc autrefois les baleines ont nagé pendant des siècles sur le mont Taurus et sur les Alpes, et le fond de la mer a été peuplé d'hommes" (p. 224), and "On en conclut que la mer et les rivières ont coulé tour à tour sur les montagnes..." (p. 222), and he concluded: "Il n'y a donc aucun système qui puisse donner la moindre vraisemblance à cette idée si généralement répandue que notre globe a changé de face, que l'océan a été très-longtemps sur la terre habitée, et que les hommes ont vécu autrefois où sont aujourd'hui les marsouins et les baleines" (p. 228).

Did Voltaire have any better idea? In the original version of *Elémens* he seemed to have favored some movement of the earth's axis during two million years to explain ocean-wandering and marine shells on land (1738: 296). After Bourguet's criticism in 1742 of Voltaire's astronomical figures and notion of long-term geological processes, Voltaire may have reacted to this criticism in the *Dissertation* by espousing the point of view that nothing or not much had changed: "Rien de ce qui végète et de ce qui est animé n'a changé; toutes les espèces sont demeurées invariablement les mêmes; il serait bien étrange que la graine de millet conservât éternellement sa nature, et que le globe variât la sienne" (p. 228). This is another notorious Voltairian expression which taken out of context seems to say that neither living things, nor inorganic matter had ever changed and that the earth had always been the same. Leaving the biological question for later, let us find out whether Voltaire was now admitting that the earth's axis has never changed? At first, Voltaire said in the *Dissertation*: "Pourquoi, disait-on s'effrayer d'une période de deux millions d'années? Il y en a probablement de plus longues entres les positions réciproques des astres[...] quelques philosophes conclurent que chaque climat ayant été à son tour tantôt pôle, tantôt ligne équinoxiale, toutes les mers avaient changé de place" (p. 224-225). Then he considered this idea "contraire à la physique. Un mouvement qui relève l'axe de la terre de dix minutes en mille ans ne paraît pas assez violent pour fracasser le globe; ce mouvement, s'il existait, laisserait assurément les montagnes à leurs places..." (p. 227). Finally, he decided, "Il n'y a donc aucun système qui puisse donner la moindre vraisemblance à cette idée si généralement répandue que notre globe a changé de face..." (p. 228). It seems clear that Voltaire had not reached any conclusion about astronomical changes in the past. Since there is nothing approaching the above notorious sentence about the fixity of the universe in *Singularités*, it is possible that he offered it in 1746 merely in order to contradict those who believed in great revolutions in the past, in particular, Fontenelle.

Voltaire's attitude toward all theories of the earth which involved the biblical deluge or slow changes of unknown origin over a long period of time is rejection. He was correct in both assumptions because the sea alone could not have built mountains and raised them to such heights, and the biblical deluge was too short to account for depositing the many layers of fossiliferous beds in many countries. Thus, at first sight, Voltaire's attitude seems to be based on the fact that the emergence of mountains could not be explained in the eighteenth century. Did Voltaire have other reasons for rejecting any great changes on the surface of the earth? No positive answer can be based upon the *Dissertation* because even the French version was written with many religious overtones to avoid aggravating the church. When he said "Mon dessein n'est pas de les imiter [those who proposed systems], et je n'ai point du tout l'espérance de découvrir les moyens dont Dieu s'est servi pour former le monde, pour le noyer, pour le conserver: je m'en tiens à la parole de l'Ecriture, sans prétendre d'expliquer, et sans oser admettre ce qu'elle ne dit point" (p. 226), we know quite well that this passage was merely a satire since he did not believe in Scriptures.

It appears, however, that Voltaire had difficulties in separating the antiquity of the earth from that of man's origin. He seemed to believe that mountains, rivers, animals, and men had existed on this earth ever since the beginning. He asked: "S'il avait été un temps où l'océan eût été sur nos montagnes; si les hommes et les animaux eussent alors vécu dans ce fond qui sert de base à la mer, eussent-ils pu subsister? De quelles montagnes alors auraient-ils reçu des rivières? Il eut fallu un globe d'une nature toute différente" (p. 227). Such a different globe, Voltaire could or would not imagine. In the *Saggio* (p. 17) he drew a sketch to show that water being attracted toward the center of the earth according to natural laws, could never have surpassed the mountains. In the *Dissertation*, he abandoned this idea and replaced it with the argument that an ocean never remains on top of mountains but would return to its natural basin (p. 227).

Since Voltaire had promised a theory of the earth, he chose one which provided an orderly arrangement of mountain-chains which were necessary for stability and irrigation and for survival of all living things. Such a theory had been given by Athanasius Kircher in *Mundus Subterraneus* and Voltaire had probably read it in his early youth.

G. Voltaire and Kircher's Mundus Subterraneus

Kircher had been called to Rome in 1633 by Urban VIII and Cardinal Bellarmine, both initially interested in the development of scientific ideas. After the imprisonment of Galileo in 1632, Kircher was set up by the church to work out a compromise between science and religion. He did as best he could: he returned

the earth to the center of the universe, keeping its stability by a web of mountain-chains that encircled the earth; he declared that the earth had been created by a benevolent God for the sake of man, and in particular for Christ to live and die on this earth in order to redeem man's original sin; he also believed that mountains had been created at the very beginning of the earth to hold together this globe and restrain its waters, and also to provide irrigation for men and other living things. Voltaire had no sympathy for the heliocentric system, the idea of man's original sin, and other strange ideas in *Mundus Subterraneus*; however, the idea that mountains had always existed since the creation of the earth because they were necessary for man to exist seems to have impressed him.

Indeed, this notion seemed more reasonable than the two generally received sets of theories of the earth. On the one hand, the English diluvialists declared that the wrath of God had brought the deluge upon mankind to punish it by destroying the first world and building a new one; on the other hand, the French academicians were of the opinion that the sea alone and some unknown past changes on the surface of the earth could explain mountains and marine fossils found there. Voltaire was neither in favor of a world built by a wrathful God, nor receptive to one having undergone unknown past changes. He preferred to adhere to a theory which said that the earth had been created by God for the sake of mankind and remained essentially unchanged.

Kircher said:

> The universal mechanism of the world was forseen and foreordained from eternity to this end; it came into existence not just for its own sake, but so that it might be of service to the earth, which is, as it were, the beginning and the end of the entire universe, and which must work together with all the forces of the heavens, without which it could not have been preserved, for the salvation of the human race.
> [... ergò universa Mundi machina in hunc finem ab aeterno praevisa & praeordinate fuit, non ut sui tantùm gratiâ condita existeret, sed ut telluri, veluti totius Mundi principi & fini, & ipsa cum universis coelorum exercitibus famularetur, & ad humani generis salutem, sine quibus conservari non poterat, cooperaretur.]
> (Tome I, Book II, Chapter I: 55)

Voltaire claimed in *Dissertation* that unlike other philosophers he was not going to create a universe with words, that is to propose a theory of the earth; all he wanted to do was to look with his eyes. However, Voltaire simply looked at a map and apparently remembered very clearly a certain sketch in *Mundus Subterraneus* when he said:

> J'examine d'abord ces montagnes que le docteur Burnet et tant d'autres regardent comme les ruines d'un ancien monde dispersé ça et là, sans ordre, sans dessein, semblable aux débris d'une ville que le canon a foudroyée; je les vois au contraire arrangées avec un ordre infini d'un bout de l'univers à l'autre. C'est en effet une chaîne de hauts aqueducs continuels, qui, en s'ouvrant en plusieurs endroits, laissent aux fleuves et aux bras de mer l'espace dont ils ont besoin pour humecter la terre.

> Du cap de Bonne-Espérance naît une suite de rochers qui s'abaissent pour laisser passer le Niger et le Zaïr, et qui se relèvent ensuite sous le nom du mont Atlas, tandis que le Nil coule d'une autre branche de ces montagnes. Un bras de mer étroit sépare l'Atlas du promontoire de Gibraltar, qui se rejoint à la Sierra-Morena; celle-ci touche aux Pyrénées; les Pyrénées, aux Cévennes; les Cévennes, aux Alpes; les Alpes, à l'Apennin, qui ne finit qu'au bout du royaume de Naples; vis-à-vis sont les montagnes d'Epire et de la Thessalie. A peine avez-vous passé le détroit de Gallipoli que vous trouvez le mont Taurus, dont les branches, sous le nom de Caucase, de l'Immaüs, etc., s'étendent aux extrémités du globe: c'est ainsi que la terre est couronnée en tout sens de ces réservoirs d'eau, d'où partent sans exception toutes les rivières qui l'arrosent et qui la fécondent; et il n'y a aucun rivage à qui la mer fournisse un seul ruisseau de son eau salée. (p. 226)

Voltaire described above mountain-chains which circle the globe and play the role of water reservoirs. While not following exactly Kircher's outlined sketch of mountain-chains, Voltaire repeats the same geographical error as found in *Mundus Subterraneus*, namely that of a mountain-chain starting at the cape of Good Hope and stretching all the way up to the Atlas mountains in Morocco.

In *Mundus Subterraneus* (Tome I, Book II, Chapter IX: 69) is an impressive sketch of the earth surrounded by mountain-chains. Two chains circle the earth from pole to pole where they meet at right angle and three East-West circles hold the earth together like iron circles around a barrel. Kircher said:

> The first chain of mountains, arranged in a circular pattern, proceeds from the North Pole through Iceland, Scotland, England, and Germany in a continuous series of mountains and with a straight path up to the Alps. The Alps represent, as it were, a kind of knot or articulation in the great chain, by which the mountains, drawn out in an uncontinuous fashion, incur a kind of flaw in their connection and are bound and hardened to a firmer consistency. [Prima catena montium in circulum ordinata deducitur à Polo per Islandiam, Scotiam, Angliam, Germaniam, continuata montium serie, rectoque tramiteusque ad Alpes, quae sunt veluti nodus quidam catenae magnae, quo, qui discontinuo ordine extensi montes nonnullam connexionis labem incurrerint, vinciantur, constringanturque ad firmiorem consistentiam.] (Tome I, Book II, Chapter IX: 68)
>
> Then from the Alps the mountains, entwined in a kind of a new ringed arrangement, are joined to the Apennine chain, by which the entire central portion of Italy becomes little other than a kind of spine of the back. By the finest of bony structures, the chain is connected in a continuous series through Sicily to those African mountains which are called the Lunar Mountains.
>
> Another chain from the great knot extends to the furthest promontory of the south, called the cape of Good Hope. [Ab Alpibus verò, novo veluti annulari ordine implexi montes, Apennino junguntur, quo totius meditullium Italiae haud secus ac spina quaedam dorsi, optimâ ossium compage, continuata serie per Siciliam montibus Africae connectitur, & quos Lunae vocant.
>
> Alter catenae magna nodum, usque ad ultimum Austri promontorium, Bonae spei nuncupatum, extenditur. . .] (Tome I, Book II, Chapter IX: 68)

Voltaire did not mention the Lunar Mountains, or Mountains of the Moon, in the Ruwenzori Range (on the border of the Congo and Uganda, slightly north of the equator, and apparently first referred to by Ptolemy), and Voltaire did not exactly follow Kircher's North-South trend in Europe. But he did so in Africa: he mentioned, as did Kircher, the "ultimo promontori d'Africa" (in *Saggio*) while Kircher said "ad ultimum Austri promontorium." Voltaire mentioned the rivers Zaire, Niger, and the Nile as Kircher did (p. 68). As Kircher, Voltaire described an imaginary South-North trend of mountains in Africa between the cape of Good Hope and the Atlas Mountains, obviously a sign that Voltaire was indeed following the *Mundus Subterraneus.*

According to Kircher, mountains were necessary for the stability of the earth and irrigation of that land. He said that God had "set up the mountains to serve, so to speak, as a kind of restraint to the spread of the waters, on the one hand to check the violence of floods and on the other to irrigate the earth with a constant, never-ending quantity of fluid." [Montes aquarum diffusioni veluti repagula quaedam opposuit, tum ad retundendam fluctuum contumaciam, tum ad aendem perpetuâ humoris nunquam deficientis copiâ irrigandam...] (Tome I, Book II, Chapter II: 56) Kircher's hydrological theory described a series of underground reservoirs which he thought to exist in every continent under the highest mountains. Voltaire discarded this idea of irrigation and replaced it with a more modern one by Halley, whom Voltaire had already mentioned in the deleted chapter X of *Eléments*: "Le docteur Halley a démontré par des calculs très-justes que l'eau, élevée des mers et des lacs par l'action du soleil, suffit à entretenir les nuages, les rivières et les fontaines; on sait que les nuages ne sont autre chose que les eaux atténuées flottantes dans l'air à une très-petite distance de la terre" (M.XXIV: 549). In the *Dissertation*, Halley's ideas are mixed with Kircher's notion of a "universal mechanism" for the benefit of mankind:

> Il n'y a pas un seul climat sur la terre sans montagnes et sans rivières qui en sorte. Cette chaîne de rochers est une pièce essentielle à la machine du monde. Sans elle, les animaux terrestres ne pourraient vivre: car point de vie sans eau. L'eau est élevée des mers, et purifiée par l'évaporation continuelle; les vents la portent sur les sommets des rochers, d'où elle se précipite en rivières; et il est prouvé que cette évaporation est assez grande pour qu'elle suffise à former les fleuves et à répandre les pluies. (p. 227)

Kircher's theory of mountain-building is a compromise between science and religion. Indeed, Kircher was not merely a spokesman of the church, he had also observed stone-quarries and had visited mines. He was aware that the earth had not remained the same since creation. He cited the opinion of the Ancients in relation to changing coastlines, decreasing mountains through erosion, and newly created ones through volcanic eruption and concluded that the world was not perfect (Tome I, Book II, Chapter XII: 83). However, he said that this was merely to warn mankind

of the uncertainty of human fortune. He believed that mountains existed since the beginning for the stability of the physical earth:

> And so it is first asked whether rocky mountains existed from the beginning of things or whether they came into existence over the passage of time from the silt or after the flood from the accumulation of an immense amount of mud. I will resolve this doubt with a few words, so that it retain no difficulty. And so I say that rocky mountains in the form of huge chains of mountains stretching from pole to pole and from east to west, as we have shown in *Book Three* were set up by the divine architect at once at the beginning of things, when by the divine will dry land appeared after the division of the waters. This is the opinion of many interpreters of the Holy Scripture: for unless the soft earth during those chaotic times at once hardened into hard rocks, the earth because of the excessive softness of the mud, could not have endured or performed its functions, as we have demonstrated at length at the place cited. And so the rocky structure of mountains was obviously necessary to stabilize and sustain the earth against the force of the sea and the tempestuous storms of rains and showers.
> [Quaeritur itaque primò: Utrum montes saxosi ab initio rerum extiterint, utrum successu temporis ex limo, aut post diluvium ex immensi luti coacervatione? Hoc dubium, uti nullam difficultatem habet, ita paucis quoque dissolvam. Dico itaque montes saxosos, cujusmodi, uti in *Tertio Libro* ostendimus, ingentes montium catenae, tum à polo ad polum; tum ex ortu in occasum protensae, statim ab initio rerum, dum Divino nutu post aquarum divisionem Arida compareret, à Divino Architecto constitutos fuisse, plerorumque Sacrarum Scripturarum Interpretum sententia est: Nisi enim limus ille Chaoticus in saxeam molem statim coaluisset, Tellus ex nimia limi mollitudine neque consistere, neque operationes suas exercere potuisset, uti citato loco fusè ostendimus. Saxosa itaque montium compages, ad terram contra maris impetum atque imbrium pluviarumque procellosas tempestas stabiliendam sustentandamque prorsus necessaria fuit.] (Tome II, Book VIII, Chapter II: 5)

In this passage Kircher gives a rather logical explanation for mountain-building on an earth created by God for the sake of man. This theory which neither accepted the idea of a wrathful God, nor any long-range processes fitted right into Voltaire's needs.

After the above passage Kircher, however, goes on to say:

> I would not deny, however, that muds and sands, accumulated into huge heaps, hardened into rocks over the passage of time from the various revolutions of the world and the many inundations; nor do I speak here of those stones or marbles which today are used in the construction of homes, temples, and other buildings, but only about the rocky substance of mountains, by which the body of the earth is sustained for the proper fulfillment of its functions — the structure which is, as it were, a kind of skeleton or mass of substructure intended by God for the firmer consistency of the entire geocosmos.
> [Non negarim tamen, è variis Mundi revolutionibus inundationumque diffusione, limum lutumque in ingentes cumulos coacervatum, successu temporis in lapidosam substantiam induruisse: neque loquor hîc de iis lapidibus seu marmoribus, quae quotidiano usu ad aedium, templorum, aliarumque fabricarum constructionem cedunt, sed de lapidosa tantum montium, qua Telluris corpus ad functiones suas probè subeundas,

sustentatur, substantia, quae est veluti ossatura quaedam, seu substructionis moles, à DEO ad totius Geocosmi firmiorem consistentiam intenta.]

In this passage Kircher clearly separated earlier rocks from later ones. These ideas were repeated in the eighteenth century by Bourguet, Bertrand and many others. For Voltaire's purpose, all he needed was a theory of the earth in which he could believe.

In the *Dissertation* Voltaire followed some of the basic tenets expressed in *Mundus Subterraneus* in regard to the utility of mountains which circle the globe and provide irrigation for all living things. In 1746, Voltaire did not insist with Kircher on the fact that the first mountains had been created at the very beginning of the earth. I have the impression, however, that the idea of an earth created by God for the benefit of mankind, as so convincingly expressed by Kircher, has left an indelible impression on Voltaire. It was difficult for him to replace that idea by a modern one which seemed much less convincing. It should be noticed that Voltaire was willing to replace Kircher's ideas of irrigation by the more modern explanation of Halley, but apparently he found no better substitute for Kircher's theory of the earth during his life.

H. Reaction of Contemporaries to Voltaire's Dissertation

Voltaire received from Italy a letter by C. Cossinio from the Academy of Bologna who agreed entirely with Voltaire's rejection of the Pythagoran thesis of great changes on the earth (D.3379).

In a memoir by Abbé Sauvages from Montpellier to the Academy of Sciences at Paris Voltaire seems to have been anonymously criticized:

> On remarquera que la quantité de coquillages pierreux de notre chaîne est si prodigieuse [...] qu'on ne peut les regarder comme les debris des tables d'une ville [...] Ces objections que des personnes d'esprit, mais peu versées dans l'Histoire Naturelle, m'ont fait bien sérieusement, ne méritent pas une plus ample réfutation. Il seroit donc absurde de penser que les coquillages pierreux eussent été portés de main d'homme sur notre chaîne. (Mémoires 1746: 1077-8)

The most famous reaction to Voltaire's *Saggio* was that of Buffon published in 1749 in the chapter on fossils in his *Histoire naturelle*:

> En lisant une lettre italienne sur les changemens arrivés au globe terrestre, imprimée à Paris cette année (1746), je m'attendois à y trouver ce fait rapporté par La Loubère, il s'accorde parfaitement avec les idées de l'auteur; les poissons pétrifiés ne sont, à son avis, que des poissons rares, rejetés de la table des Romains, parce qu'ils n'étoient pas frais; & à l'égard des coquilles, ce sont, dit-il, les pèlerins de Syrie qui ont rapporté dans le temps des croisades celles des mers du Levant qu'on trouve actuellement pétrifiées en France, en Italie & dans les autres États de la chrétienté, pourquoi n'a-t-il

> pas ajouté que ce sont les singes qui ont transporté les coquilles au sommet des montagnes & dans tous les lieux où les hommes ne peuvent habiter, cela n'eût rien gâté & eût rendu son explication encore plus vraisemblable. Comment se peut-il que des personnes éclairées & qui se piquent même de philosophie, aient encore des idées aussi fausses sur ce sujet? nous ne nous contenterons donc pas d'avoir dit qu'on trouve des coquilles pétrifiées dans presque tous les endroits de la Terre où l'on a fouillé, & d'avoir rapporté les témoignages des auteurs d'Histoire Naturelle; comme on pourroit les soupçonner d'apercevoir, en vue de quelques systèmes, des coquilles où il n'y en a point, nous croyons devoir encore citer les voyageurs qui en ont remarqué par hasard, & dont les yeux moins exercés n'ont pu reconnoître que les coquilles entières & bien conservées: leur témoignage sera peut-être d'une plus grande autorité auprès des gens qui ne sont pas à portée de s'assurer par eux-mêmes de la vérité des faits, & de ceux qui ne connaissent ni les coquilles, ni les pétrifications, & qui n'étant pas en état de faire la comparaison, pourroient douter que les pétrifications fussent en effet de vraies coquilles, & que ces coquilles se trouvassent entassées par millions dans tous les climats de la Terre. (1749: 281-282)

The whole paragraph, including the satirical reference to monkeys as carriers of seashells, was meant for Voltaire; no wonder he could never forget the insult or slander in a book which became a bestseller (Mornet: 248). No wonder that he subsequently devoted several years to investigate geological phenomena personally, to read more about the subject, and finally to criticize Buffon in turn.

Buffon knew quite well that the author of the Italian letter was Voltaire and not La Loubère since Voltaire had acknowledged authorship of the *Saggio* as I mentioned in section C. (See also the *Saggio* in the appendix.) Simon de La Loubère was the author of *Du royaume de Siam* (1691) where he mentioned birds, apes, and Hottentots as possible carriers of fossils on top of Table Mountain in South-Africa (1969, II: 183). After Voltaire's death, Buffon wrote in 1778 a footnote which presents his excuses to Voltaire, whether sincerely or not. He presumably wanted the posterity to know that he had been ignorant of the authorship of the Italian letter, and that he would never have criticized such a genius as Voltaire (1850-1860: 161-162). Nevertheless, Voltaire seems to have been deeply hurt and would never forget in his later essays on scientific matter to jeer at "l'auteur estimable de l'Histoire naturelle."

I. Voltaire's Attitude toward Geology in 1746

In order to compare Voltaire's attitude toward geology in his *Dissertation* with his later *Singularités*, it is necessary to summarize what Voltaire believed in 1746.

The *Dissertation* is written in a style which makes it difficult to judge whether or not Voltaire was simply laughing at all systems. There is, however, a stylistic change from the impersonal "on" to the personal "je" which gives me the impression that underneath all that laughter, Voltaire tried seriously to reach for some personal "truth" on how the world was formed. His work on Newton's physics had given

him an introduction to all sciences. He had read about laws of nature and acquired an interest in scientific problems which would remain for the rest of his life.

Voltaire, nevertheless, had started out on the wrong foot. His involvement with Newton seems to have made a frustrated scientist out of him. Not being versed in astronomy and physics myself, I find it impossible to appreciate how close to an understanding of Newton Voltaire had come. From his correspondence I can only guess that his lack of training in mathematics and his simultaneous involvement with literature, history, and science during his years at Cirey must have given him an understanding of Newtonianism which was inferior to that of Mme du Châtelet, the woman he had originally wanted to please with his interest in Newton, or of Maupertuis and others who concentrated on one thing at a time. Moreover, his papers to the Academy of Sciences received no prize and the doors to that Academy remained shut to Voltaire. He must have felt rejected, both as a person and as a scientist.

His fear of being considered incompetent and ignorant in sciences made Voltaire resort to various approaches. He shrouded all his remarks on science in satire so that nobody would guess whether he was serious or not. He also tried to learn as much as possible on new sciences such as geology; I believe that he read the Italian Scilla, perhaps to discover "truth" outside of France. Once he had done his homework, he took pleasure in criticizing systems which were based on fallacious interpretation.

His attitude toward fossils shows that he had read many books and that in reference to some "easy" fossils in Calabria and Touraine — that is those close to the sea and not extinct — he was almost ready to accept the idea that the sea had indeed deposited these fossils in the past. However, in the same essay, just one page earlier, he showed his uncertainty by wavering between four different hypotheses: either the sea of Syria had transported sea-shells to France and Italy; they had been carried by pilgrims from the Holy Land; they might be "fossiles" engendered by the earth; or they might have lived and died in ancient lakes. All these arguments show that in 1746 Voltaire had not examined one single fossil personally and did not know whom to believe. The *Dissertation* is therefore a retaliation against systems when he himself had nothing more than common sense to propose; in general, all he could do was to suggest some more "natural" means such as petrified leftover fish from some traveler's meal to account for fossil fish in mountains.

While reaching for his own theory of the earth, Voltaire refuted both the academicians and the diluvialists and turned to a theory that he must have read in his early youth: Kircher's *Mundus Subterraneus*. Voltaire could not visualize a globe with a different surface and without life although he had made the effort to explain wandering oceans by the movements of the earth's axis. He finally rejected the theory of the Indian Ocean by Fontenelle while he agreed that coastal areas had been invaded by the sea during a long period of time. Scilla's theory of mountain-building could

only explain mountains in Mediterranean countries where fossil shells are easily accounted for by the proximity of the sea and the uplifting action of volcanism. Voltaire was, however, speaking about great mountain-chains which crossed the earth. These mountains could hardly be the result of ocean-currents at the bottom of the sea as proposed by Maillet, where would men have lived during that time? Voltaire seemed particularly reluctant to separate the history of the earth and the history of man and thus retained Kircher's theory of mountain-chains which were necessary to irrigate and provide life to animals and plants.

Voltaire's attitude toward geology in *Dissertation* contains, in an embryonic stage, many tendencies that he was going to develop more fully in *Singularités*: a personal retaliation against the ideas of some academician; an awareness that many proposed systems were unsound and could not explain mountain-building; a scientific attitude which opposed generalizations and preferred exact identification and description of natural phenomena such as that which he had found in Scilla; an adherence to a theory of the earth which promised life to plants and animals and was the most logical or least unsound theory of mountain-building at that time. Lastly, the *Dissertation* expresses a need for satire to ridicule systems, probably as a defense against criticism and as a weapon. It took, however, Buffon's criticism of Voltaire's ideas on fossils to make him realize that if he wanted to criticize others, he had to base his view on personal investigation.