

Remarks on geology after singularités

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CHAPTER III

REMARKS ON GEOLOGY AFTER SINGULARITÉS

A. D'HOLBACH'S "SYSTEME DE LA NATURE" AND VOLTAIRE'S ANSWER: "DIEU" (1770)

Although d'Holbach's work contains no geology, it is necessary to take some notice of Voltaire's reaction to this atheistic work because his attitude toward it appears to be an example of a deistic reaction toward all sciences, and because in regard to Buffon, he made a brief remark on geology.

In addition to many references in his correspondence, Voltaire treats d'Holbach in an essay "Dieu, réponse au Système de la nature" (now in the *Dictionnaire philosophique* under "Dieu"). This essay is based on at least three different grounds: scientific, personal, and moral which are not connected to any specific theological concept. In the field of science, Voltaire was particularly outspoken against the concept of spontaneous generation which d'Holbach used as basis for his philosophical system. Furthermore, Voltaire wrote this essay for personal reasons in order to dissociate himself from atheists. Finally, his concern for the common people made him fear that d'Holbach's atheistic views might harm them. Had Voltaire merely acted to defend his personal deistic beliefs, he would have insisted that the theory of spontaneous generation was in contradiction with the theory of preformation according to which every germ was preformed by God. Voltaire, however, merely stated in his essay that nobody knows how matter becomes alive.

D'Holbach's *Système de la nature, Ou des lois du monde physique et du monde moral* was written at about the same time as Diderot's *Le Rêve de d'Alembert* where d'Alembert was dreaming that he would actually never die (mentioned in the previous chapter). D'Holbach similarly consoled mankind that some natural laws of necessity not only dictate events in the physical world but also man's actions and feelings. As an example he said that in a duststorm, the smallest molecule of dust acted according to a certain natural law, while among men, "Dans une révolution, il n'y a pas une seule action, parole, pensée, passion dans les agents qui concourent à la révolution qui ne soit nécessaire, qui agit comme elle doit agir" (1966: 62). This consoling fatalism was based on the belief that "nature" was not a work of God but merely a perpetual chain of different combinations of movements without beginning and without end, and on Needham's experiment which seemed to prove that inorganic matter was able suddenly to produce life (p. 28). D'Holbach, however, could not explain natural laws: "On ne peut pas tout savoir, on ne peut pénétrer l'essence des choses" (p. 106). Nevertheless, he based a whole philosophical system on one

scientific experiment, and this is the point that Voltaire took greatest pains to refute in his essay "Dieu."

To d'Holbach's opinion that inert matter can take action and intelligence when combined in certain ways, Voltaire retorted: "C'est là précisément la difficulté. Comment un germe parvient-il à la vie? L'auteur et le lecteur n'en savent rien. De là les deux volumes du *Système*." This answer clearly shows that Voltaire preferred skepticism to any theory on the beginning of life. Other questions about life, man, the eternity of matter, and the necessity of vice were briefly refuted, then he went to the fundamental error in d'Holbach's system:... "je viens au fondement du livre, et à l'erreur étonnante sur laquelle il a élevé son système. Je dois absolument répéter ici ce qu'on a dit ailleurs." Voltaire then explained Needham's experiment and cited d'Holbach's acceptance of it. Voltaire's essay "Dieu" thus seems to be based first of all on scientific grounds.

Second, Voltaire's letters show that he refuted d'Holbach on personal grounds. He was greatly concerned with the damage being done by d'Holbach's atheistic work to all philosophers at the court of France. He wrote nearly thirty letters to friends, ministers, important people at the French court to show his disapproval.¹ He was afraid that the king, the ministers, the French government and the church were about to take measures against all philosophers, him included, and warned D'Alembert, "Ce livre a rendu tous les philosophes exécration aux yeux du Roi" (D.16739, November 2, 1770) and that the king had reaffirmed the central power against the parliament: "Vous avez bien remarqué, sans doute, dans l'édit du roi contre le parlement, ce qu'on dit de l'esprit de système. Il se trouve que les philosophes ont gâté le parlement" (D.16841, December 19, 1770). To Frederick he wrote: "Il faut avouer que l'auteur du *système de la nature* a trop impudemment cassé les vitres [...] Il a rendu la philosophie odieuse..." (D.16980, January 19, 1771). Louise Gallatin confirmed Voltaire's fears when she wrote to Frederick II from Geneva:

¹ D.16335 to Jacob Vernes on May 7, 1770; D.16523 to D'Alembert on July 16, 1770; D.16540 to Baron von Grimm on July 23, 1770; D.16548 to D'Alembert on July 27, 1770; D.16549 to Frederick II on July 27, 1770; D.16554 to Elie de Beaumont on July 30, 1770; D.16565 to M^{me} du Deffand on August 8, 1770; D.16569 to Thieriot on August 8, 1770; D.16574 to D'Alembert on August 11, 1770; D.16585 to Gabriel Cramer in August, 1770; D.16605 to Maupeou on August 22, 1770; D.16607 to Saint-Lambert on August 22, 1770; D.16667 to Frederick II on September 26, 1770; D.16682 to Gabriel Cramer on October 1, 1770; D.16684 to the Duchesse de Choiseul on October 5, 1770; D.16693 to Baron von Grimm on October 10, 1770; D.16695 to D'Alembert on October 11, 1770; D.16718 to Allamand on October 22, 1770; D.16731 to Frederick II on October 30, 1770; D.16736 to duc de Richelieu on November 1, 1770; D.16739 to D'Alembert on November 2, 1770; D.16753 to Joseph Vasselier on November 9, 1770; D.16768 to Marquis de Villeville on November 16, 1770; D.16841 to D'Alembert on December 19, 1770; D.16980 to Frederick II on January 19, 1771; D.17066 to Comtesse d'Argental on March 9, 1771; D.17336 to D'Alembert on August 19, 1771.

In the last letter Voltaire told D'Alembert about the edition of *Système de la nature* published at Neuchâtel by the "Banneret" Osterwald: "Les dévotes de Neufchatel, éprises d'une sainte rage sont venues brûler son édition. Le gonfalonier de la République a été obligé de se démettre de sa charge..." This is an example of the hostile reaction against d'Holbach's unorthodox work.

"A l'Egard de ce que vous me dites sur la grande anciclopédie il est vray qu'actuellement en France on n'ose pas La réimprimer, Le Clairgé se déchaînant Contre tous ceux qui L'ont faite, et Cela à Cause de ce Livre du *système de la nature* [...] Ce livre est Cause que l'on est si attentif à ce qui paroît" (D.16827, December 15, 1770). Voltaire was well aware that without the approval of the government and the church, philosophers and their cause would be lost: the enlightenment would become extinct. To D'Alembert he wrote, "Il faut que les deux partis se réunissent" (D.16548, July 27, 1770), obviously meaning atheist and deist philosophers against the clergy. Since Voltaire's correspondence between June 1770 and August 1771 reveals that he was primarily concerned with the future welfare of philosophers in France, including himself, it is, therefore, possible that in his essay "Dieu" he overreacted against atheism because he wanted to be looked upon as a God-fearing philosopher at this particular time. Indeed, Mme Denis had tried to rehabilitate Voltaire at the French court in 1769 (D.15886, 15905, 15918, 15945, 15956). D'Holbach's atheistic work risked to ruin his chances and the reputation of all philosophers.

Third, I have the impression that Voltaire was also seriously concerned about the moral effect on common people. He said in his essay, "Pour le fond des choses, il faut s'en défier très souvent en physique et en morale. Il s'agit ici de l'intérêt du genre humain." Redshaw mentioned that Voltaire was perhaps opposing materialistic and atheistic ideas because he knew that these ideas should remain among philosophers and not be spread to the public at large (1980: 29). Indeed, some time after the Abbeville affair, where the young La Barre was beheaded for blasphemy and Voltaire's *Dictionnaire philosophique portatif* burned (1766), Voltaire reduced the intensity of his attacks on Christianity. For instance, instead of publishing the testament of the Curé Meslier in its original form, Voltaire said: "Pourquoi adresser ce testament à des hommes agrestes qui ne savaient pas lire? Et, s'ils avaient pu lire, pourquoi leur ôter un joug salutaire, une crainte nécessaire qui seule peut prévenir les crimes secrets? La croyance des peines et des récompenses après la mort est un frein dont le peuple a besoin. La religion bien épurée serait le premier lien de la société..." (M.XXVI: 511-512). In other words, Voltaire believed that people ought to be left to their religious beliefs and without interference from d'Holbach's *Système de la nature*. Voltaire himself, as well as other philosophers could believe whatever they pleased.

In the same essay, Voltaire could not refrain from refuting naturalists who had accepted Needham's theory such as Buffon: "Ce qu'il y a de plus déplorable, c'est que des physiciens plus instruits adoptèrent le ridicule système du jésuite Needham, et le joignirent à celui de Maillet, qui prétendait que l'Océan avait formé les Pyrénées et les Alpes, et que les hommes étaient originairement des marsouins, dont la queue fourchue [...] De telles imaginations peuvent être mises avec les anguilles formées par la farine."

In conclusion, Voltaire's reaction toward d'Holbach's work is thus based on scientific, personal, and moral grounds and not merely his "deistic beliefs."

B. LETTRE SUR UN ÉCRIT ANONYME (1772)

An English visitor to Ferney wrote in April 1775 about Voltaire's intellectual activities: "The fact is that he reads little or none, his mind exists by Reminiscence & by doing over & over what it has been used to do, Dictates Tales, dissertation & Tragedy, even the latter with all his Elegance tho not with his former force" (D.19445). If that is so, Voltaire would then have said nothing new and he would have clung to old ideas, even in geology. Another opinion, however, is expressed by Voltaire himself in one of his letters to M^{me} du Deffand in November 1773 who had asked him why he did not tire of reading all the new productions, even the most boring ones: "Il faut avoir ma persévérance et la passion que j'ai de m'instruire sur la fin de ma vie pour chercher, comme je fais, des pierres précieuses dans des tas d'ordures" (D.18629). An analysis of Voltaire's remarks on geology in his later years ought to tell which of the two opinions is correct.

In an anonymous pamphlet, *Réflexions sur la Jalousie, Pour servir de Commentaire aux derniers Ouvrages de M. de Voltaire* (1772), Voltaire was accused of jealous feelings in his later works toward famous authors, in particular "ceux qui étaient morts, ou parmi les vivans, ceux qu'il a sçu disposés par caractère & par principes à garder le silence sur ses satires; & même à les mépriser. C'est ainsi qu'il en a usé à l'égard de M. de Buffon" (Leroy 1772: 9). The author of the pamphlet, Charles-Georges Leroy was especially resentful of Voltaire's treatment of Buffon, a friend of his (D.17756), and said:

M. de Buffon & beaucoup d'autres ont avancé & prouvé que la mer a occupé successivement une grande partie du globe. Cela est démontré par d'immenses amas de coquilles de mer qui se trouvent dans plusieurs montagnes, & ailleurs dans le sein de la terre. Ces médailles incontestables du séjour de la mer rendent peut-être ce fait un des plus avérés qu'il y ait dans aucune histoire. M. de Voltaire, pour qui les monumens ne sont rien, & qui souvent dans l'histoire a jugé des faits par des vraisemblances, ne veut pas absolument que nous ne croyons nos propres yeux. Il ose soutenir que ces coquilles ne viennent pas de la mer, d'abord parce qu'il ne sçait pas comment elles auroient pu en venir; ensuite, parce que leurs débris ont le goût salé, car il les a goûtés, enfin par ce qu'ils fécondent nos terres, ce que ne feroient pas, dit-il, des coquilles de mer. (p. 10-11)

Voltaire retorted in *Lettre sur un écrit anonyme* (April 20, 1772) first in regard to the falun de Touraine, his ideas on that subject being considered those of "un vieillard en délire" by Leroy. Voltaire carefully avoided any reference to Buffon but mentioned Palissy instead:

L'on m'apprend que je suis indignement jalou de Bernard Palissy, qui vivait sur la fin du XVI^e siècle. Il avança que le falun de Touraine n'est qu'un amas de coquilles, dont les lits s'amoncelèrent les uns sur les autres pendant cinquante mille siècles plus ou moins, lorsque la place où est la ville de Tours était le rivage de la mer. Ma jalouse fureur ayant fait venir une caisse de ce falun, dans lequel je n'ai trouvé qu'une coquille de colimaçon, j'ai pris insolemment ce falun pour une espèce de pierre calcaire friable, pulvérisée par le temps. J'ai cru y reconnaître évidemment mille parcelles d'un talc informe; et j'ai conclu, avec un orgueil punissable, que c'est une mine qui occupe environ deux lieues et demi. J'ai hasardé cette idée criminelle avec une audace d'autant plus lâche que ce falun ne se trouve dans aucun autre pays, ni à quarante lieues de la mer, ni à vingt, ni à dix; et que si c'était un monceau de coquilles déposé par la mer dans une prodigieuse suite de siècles, il y en aurait certainement sur d'autres côtes. C'est avec cette espèce de marne qu'on fume les champs voisins; et j'ai eu l'impudence de dire, moi qui suis laboureur, que des coquilles de cinquante mille siècles ne me donneraient jamais du blé. Mais j'avoue que je ne l'ai dit que par jalousie contre les Tourangeaux. (M. XXVIII: 489-490)

It is evident from the above passage that Voltaire has not changed his attitude toward the faluns: his arguments are the same as two years before, namely that he found a freshwater snail in the faluns, that there are no accumulations of shells in other places besides Touraine, and that faluns cannot be used as fertilizer. As earlier, Voltaire was mistaken about Palissy who never referred to the faluns of Touraine. Already in *La Défense de mon oncle* Voltaire had referred to a possible confusion of fragments of shells and crustaceans with some kind of flaky talc. In the above passage, he repeats that he had recognized "mille parcelles d'un talc informe." In the eighteenth century talc, a mineral, was often confused with mica or even tests of shells (Bertrand 1763: 210; Bourguet 1742: 9).

Instead of referring to Buffon in regard to fossils found in mountains and to mountain-building, Voltaire now mentions the deceased Maillet instead:

Cette détestable jalousie que j'ai toujours eue des succès du consul Maillet m'a porté jusqu'à douter qu'il y ait des amas de coquilles sur les Hautes-Alpes. J'avoue que j'en ai fait chercher pendant quatre ans, et qu'on n'y en a pas trouvé une seule. On n'en trouve pas plus, dit-on, sur les montagnes de l'Amérique; mais ce n'est pas ma faute [...]

Cette même jalousie m'a fait douter aussi que l'Océan eût produit le mont Atlas, et que la Méditerranée eût fait naître le mont Caucase. J'ai même osé soupçonner que les hommes n'ont pas été originairement des marsouins, dont la queue fourchue s'est changée visiblement en cuisses et en jambes, comme Maillet le prétend avec beaucoup de vraisemblance. (M. XXVIII: 490)

The following passage clearly refers to Buffon's opinion on limestone for lime-making: "C'est avec une malice d'enfer qu'ayant examiné la chaux dont je me sers depuis vingt ans pour bâtir, je n'y ai trouvé ni coquilles, ni oursins de mer" (M. XXVIII: 490). Indeed, as mentioned in Section G of Chapter II, this is a direct

LETTRE
DE M. DE V...
SUR UN ECRIT ANONYME



1772.

FIG. 5. — Title page of *Lettre de M. de V... sur un écrit anonyme*.

attack against Buffon and not Maillet. However, Voltaire does not mention Buffon by name as he had in *Singularités*, evidently avoiding any further trouble.

Dropping the satirical tone, Voltaire continued in *Lettre sur un écrit anonyme*: "Quoique j'aie passé à deux reprises quarante ans loin de Paris, dans une profonde retraite, je connais les cabales de la littérature et du théâtre, et même les autres cabales. Je sais combien on se passionne pour un système chimérique..." (M.XXVIII: 493) From these words we can guess that Voltaire's mind had already sketched two new poems: "Les Cabales" and "Les Systèmes." Both poems contain accusations against Maillet, but none against Buffon: Maillet remained the scapegoat in 1772. *Lettre sur un écrit anonyme* contains no new ideas on geology.

C. LES CABALES — LES SYSTEMES (1772)

Leroy's anonymous pamphlet revived the seventy-eight year old Voltaire enough to compose two poems which Frederick II considered to be those of a man of twenty (D.17861). Both poems contain quips on Maillet's ideas on geology and biology.

Both poems contain also lengthy footnotes by M. de Morza, Voltaire himself. In *Les Cabales*, one of these footnotes calls Maillet a "charlatan" (M.X: 183) because he was imitating God and created a universe with words. In the text of the poem, Voltaire seemed torn between believers in atheism and believers in God. He declared: "Je crois pourtant en Dieu, puisqu'il faut vous le dire." The atheist answered: "Ah, traître! ah, malheureux! Je m'en étais douté. / Va, j'avais bien prévu ce trait de lâcheté, / Alors que de Maillet insultant la mémoire, / Du monde qu'il forma tu combattis l'histoire..." (M.X: 183) The atheist threatens to abandon him to his archenemies and Voltaire pleads: "Ah! bachelier du diable, un peu plus d'indulgence: / Nous avons, vous et moi, besoin de tolérance. / Que deviendrait le monde et la société, / Si tout, jusqu'à l'athée, était sans charité"? (M.X: 183-185)

There is no such apology in *Les Systèmes*. The poem is an affirmation that God exists: "Lorsque le seul puissant, le seul grand, le seul sage, / De ce monde en six jours eut achevé l'ouvrage, / Et qu'il eut arrangé tous les célestes corps, / De sa vaste machine il cacha les ressorts, / Et mit sur la nature un voile impénétrable" (M.X: 167). Voltaire's wit is at its best in this poem where he tries to win over philosophers who had gotten lost with their systems. St. Thomas d'Aquinas, Descartes, Gassendi, Spinoza, Malebranche, Leibniz, and Maillet are called upon by God to explain their systems. Maillet is no longer called a "charlatan": "Notre consul Maillet, non pas consul de Rome, / Sait comment ici-bas naquit le premier homme: / D'abord il fut poisson. De ce pauvre animal / Le berceau très-changeant fut du plus fin cristal; / Et les mers des Chinois sont encore étonnées / D'avoir, par leurs courants, formé les Pyrénées..." God was not angry upon hearing all these system-makers; he simply

scheduled a new meeting and sent the angel Gabriel to tell church authorities: "Messeigneurs [. . .] le bon Dieu vous ordonne / De vous bien divertir, sans molester personne. / Il a su qu'en ce monde on voit certains savants / Qui sont, ainsi que vous, de fieffés ignorants..." (M.X: 174-175). In this poem Voltaire talks like Pyrrho the skeptic and puts the system-makers together with atheists and intolerant christians.

Neither poem contains any new ideas about geology.

D. VOLTAIRE'S NEW IDEAS ON GEOLOGY NOT INCLUDED IN SINGULARITÉS

I have already mentioned that many articles in the *Dictionnaire philosophique* contain the same words and the same ideas as in *Singularités*. For instance, under "Polypes" he repeated his doubts on shark teeth, fossils in limestone, corals, and the marine origin of mountains. Under "Déluge" he simply rephrased the same ideas he had used in *Eléments* in 1738 in regard to the biblical deluge advocated by Burnet. It is possible that he used these clichés in order to make people laugh: "Tout passe, tout s'oublie, tout s'anéantit. Le déluge fit autrefois beaucoup de bruit, et actuellement on n'en parle plus que pour en rire" (D.18805).

There are, however, some gems. For instance, in "Chaîne des êtres créés" in the *Dictionnaire philosophique* Voltaire denied that any link existed among plants and animals: "Cette chaîne, cette gradation prétendue n'existe pas plus dans les végétaux et dans les animaux; la preuve en est qu'il y a des espèces de plantes et d'animaux qui sont détruites. Nous n'avons plus de murex..." (Murexes are spiny marine gastropods which live in tropical seas. One of the species yielded the royal purple dye used by the ancients.) Voltaire had no qualms to say that some species had died out or, in his words, were destroyed. The same could happen to lions and rhinos because of English hunters. He affirmed that there existed no link between ape and man and that certain races of men did not exist anymore. Never before had Voltaire mentioned the "extinction" of a sea-shell; he would rather swear that ammonites which had no living analogues were "figured stones" or sports of nature. I do not know, however, who had told him that murexes were extinct because they are not (Moret 1940: 404).

The article "Changements arrivés dans le Globe" in Voltaire's dictionary shows how much he himself changed after his *Dissertation sur les changements arrivés dans notre globe...* He now reported many changes he had himself witnessed while living on the shores of Lake Geneva:

Quand on a vu de ses yeux une montagne s'avancer dans une plaine, c'est-à-dire un immense rocher de cette montagne se détacher et couvrir des champs, un château tout entier enfoncé dans la terre, un fleuve englouti qui sort ensuite de son abîme, des marques indubitables qu'un vaste amas d'eau inondait autrefois un pays habité aujourd'hui, et cent vestiges d'autres révolutions, on est alors plus disposé à croire les grands changements qui ont altéré la face du monde...

In other words, Voltaire seems to have seen with his own eyes some landslides which might have happened during an earthquake in the Valais. Indeed, while living at Montriond he wrote: "Un village a été abimé à quelques lieues de nous par un tremblement de terre le 9 du mois" (26 December, 1755, D.6652). He had seen rivers disappear and reappear at some other places (résurgence) in the karstic landscape of the Jura Mountains as I have indicated in the last chapter. Changing shorelines evidenced by such cities as Aiguemorte, Fréjus, and, Ravenna which were no longer harbors as in the past were already mentioned in *Dissertation*. In the above passage Voltaire seems to be ready to accept vast changes on the surface of the earth, more than he had admitted before. He was reluctant, however, to give up a former idea and phrased his acceptance as shown in the continuation of the above quotation:

[... on est alors plus disposé à croire les grands changements qui ont altéré la face du monde] que ne l'est une dame de Paris qui sait seulement que la place où est bâtie sa maison était autrefois un champ labourable. Mais une dame de Naples, qui a vu sous terre les ruines d'Herculanum, est encore moins asservie au préjugé qui nous fait croire que tout a toujours été comme il est aujourd'hui.

Voltaire clearly calls the idea that nothing has ever changed a prejudice. This is a great change since his *Dissertation* where he had said: "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). Taken out of context, Voltaire is often blamed on sentences like this. Libby wrote that "Voltaire used the grain of millet to disprove the geological theories of his day..." and "Voltaire does not change. He sees in his old age as he saw in 1746..." (1935: 184, 181). In the above passage, however, Voltaire clearly admits that things have changed and that not to admit it would be a prejudice.

The above passage also includes Voltaire's realization that geological surroundings are of great influence on any observer so that, for instance, a lady in Naples was less prone to accept the prejudice that nothing ever changed because she had seen the ruins of Herculanum buried under the famous lava flows of the Vesuvian eruption of A.D. 79. These rocks were obviously older than the field in Paris. The thinking of modern geologists is still deeply affected by the "regionalism" of their science.

Also in the *Dictionnaire philosophique*, under "Inondation" Voltaire described changing shorelines which might after many centuries result in some kind of ocean-wandering:

Y a-t-il eu un temps où le globe ait été entièrement inondé? Cela est physiquement impossible.

Il se peut que successivement la mer ait couvert tous les terrains l'un après l'autre; et cela ne peut être arrivé que par une gradation lente, dans une multitude prodigieuse de siècles. La mer, en cinq cents années de temps, s'est retirée d'Aigues-Mortes, de

Fréjus, de Ravenne, qui étaient de grands ports, et a laissé environ deux lieues de terrain à sec. Par cette progression, il est évident qu'il lui faudrait deux millions deux cent cinquante mille ans pour faire le tour de notre globe...

This concept is not repeated in *Singularités* where he merely said: "Quand la mer n'aurait abandonné et couvert tour à tour les terrains bas de ses rivages que le long de deux mille lieues sur quarante de large dans les terres, ce serait un changement sur la surface du globe de quatre-vingt mille lieues carrées (M.XXVII: 155). In other words, he only mentioned that the sea invaded or abandoned coastal areas without saying that the ocean displaced itself slowly. The concept of ocean-wandering was clearly stated again in 1802 by J. B. Lamarck, famous for his ideas on evolution, paleontology, and geology:

Indeed, the huge masses of oceanic water obviously move, or rather, continuously displace their basin and their limits. These constant and inappreciably slow displacements generally take place in such a way that the ocean basin, which necessarily loses on one side the amount it gains on the other, has occupied every point of the earth's surface not only once, but several times. (Carozzi A. 1964: 61-62)

It is interesting that Voltaire mentioned a concept used by Lamarck more than twenty-five years later. It shows that Voltaire was in the vanguard of theoreticians of the earth. Today, geologists consider the concept of ocean-wandering unrelated to the modern theory of plate-tectonics where oceans and continents move together while Voltaire indicated only the movement of oceans.

The beginning field of geology was also during the second half of the eighteenth century investigating volcanoes and the possibility of mountain-building through volcanic activity. Voltaire corresponded with and met sir William Hamilton, ambassador of Great Britain to the Court of Naples, who wrote several accounts on volcanoes in Italy (Carozzi A. DSB). Voltaire told Hamilton that small mountains had been produced by volcanic activity; these volcanoes were, however, mere anthills compared to the great mountain-chains such as the Alps (D.18429). He refused, therefore, to consider the explanation of mountain-building by volcanic activity as any better than mountain-building by the sea.

On the whole, Voltaire's few remarks here and there point to the fact that in his later years he had come to believe that the earth had undergone vast changes and that the geological time needed for such changes was immense. In agreement with his new outlook on geology, Voltaire made some additions to *Singularités* in 1774. In chapter XVII, he admitted "qu'il est démontré aux yeux qu'il a fallu une prodigieuse multitude de siècles pour opérer toutes les révolutions arrivées dans ce globe, et dont nous avons des témoignages incontestables" (M.XXVII: 155). In chapter XVIII he added in 1774: "Notre globe a eu sans doutes ses métamorphoses, ses changements de forme, et chaque globe a eu les siennes, puisque en étant en mouvement, tout a dû nécessairement changer" (M.XXVII: 157).

It appears as if Voltaire was not skeptical of great changes in the past; he was skeptical of man-made systems which tried to explain catastrophes in the past which he had not seen and would not believe until he had seen concrete evidence concerning them. He had also realized that scientists were just as bickering as men of literature. Voltaire's humanism made him add the following:

Ces épouvantables révolutions accablent notre esprit. Elles ne sont rien du tout pour l'univers, et presque rien pour notre globe. La mer qui laisse des coquilles sur un rivage qu'elle abandonne, est une goutte d'eau qui s'évapore au bord d'une petite tasse; les tempêtes les plus horribles ne sont que le léger mouvement de l'air produit par l'aile d'une mouche. Toutes nos énormes révolutions sont un grain de sable à peine dérangé de sa place. Cependant que de vains efforts pour expliquer ces petites choses! Que de systèmes, que de charlatanisme pour rendre compte de ces légères variations, si terribles à nos yeux! Que d'animosités dans ces disputes! (M. XXVII: 157)

E. DIALOGUES D'EVHÉMÈRE (1777)

Voltaire spent his last years writing and his neighbor in Geneva, Pierre Michel Hennin, said of him: "Il a l'air de dire à la mort: Attends cette page..." (D.18214). He also received many works by others, among which Hamilton's observations on volcanoes to the Royal Society of London (D.18429); Buffon's *Supplément to Histoire naturelle* (D.19187, 19149 [1774]); La Sauvagère's memoir on spontaneous vegetation with a reply by a priest from Angers (D.19846); Jean-Sylvain Bailly's *Histoire de l'astronomie ancienne...* (1775, D. 19890) and *Lettres sur l'origine des sciences, et sur celles des peuples de l'Asie, adressées à M. de Voltaire* (1777, D.20576); Lazzaro Spallanzani's *Opuscoli di fisica animale e vegetabile* (on spontaneous generation, 1776, D.20133) and *Prodromo di un'opera da impremersi sopra le riproduzioni animali* (on animal reproduction and regeneration) (1776, D.20148); and Barthélémy Faujas de Saint-Fond's revision of *Œuvres de Bernard Palissy* (D.20642). The question that I have asked at the beginning of this section is repeated here: did Voltaire read all these works or was he simply reminiscing when he wrote on the subjects with which they are concerned?

Voltaire's correspondence shows that he wrote to Hamilton specifying that the Alps "ces énormes masses paraissent avoir plus de consistance que Monto Nuovo, & la prétendue nouvelle île de Santorin" (D.18429), that he told Bailly that he did not believe in a central fire (D.19912), and that he disagreed with Bailly's history of sciences (D.20581). Moreover, Voltaire perhaps conceived an answer to Bailly's history of science by writing *Dialogues d'Evhémère*. Voltaire must have been especially pleased to hear from Spallanzani that spontaneous generation was indeed a dead issue. Spallanzani had sent his *Saggio di osservazioni microscopiche concernenti il sistema della generazione de' Signori di Needham e Buffon* to Voltaire in 1765 (D.13097). Spallanzani's *Opuscoli* of 1776 was a confirmation of new exper-

iments against spontaneous generation. Voltaire acknowledged receipt saying: "Vous donnez le dernier coup, Monsieur, aux anguilles du jésuite Need'ham..." At the same time he speculated about his own experiments with snails: "Je croyais avoir coupé des têtes à quelques uns de ces animaux [limassons], et que ces têtes étaient revenues. Des gens plus adroits que moi, m'ont assuré que je n'avais coupé que des visages, dont la peau seule avait été reproduite..." (D.20133). Spallanzani promised to send Voltaire his *Prodromo di un'opera da imprimersi sopra le riproduzioni animali* (1768) and confirmed that snails can indeed generate new heads (D.20148). Voltaire was delighted and answered: "Votre lettre du 31 May ranime mes anciens goûts, et mes anciennes espérances. J'avais renoncé à l'honneur de rendre des têtes à des Colimassons. J'avais la modestie de croire que je n'étais point du tout propre à faire des miracles" (D.20158). All these letters written during Voltaire's last years show that he was not merely reminiscing.

Dialogues d'Evhémère contains some last criticism of Buffon, which is surprising since the two men had apparently mended their differences. Indeed, Buffon had told Voltaire in a reconciliatory letter:

Avec plusieurs années de moins, je suis plus vieux que vous. Autre supériorité dont je suis loin d'être jaloux; mais n'est-il pas juste que la nature, qui, dès vos premières années, vous a comblé de ses faveurs, et dont vous êtes l'ancien amant de choix, continue de vous traiter avec plus d'égards et de ménagements, qu'un nouveau venu comme moi, qui n'ai jamais rien obtenu d'elle qu'à force de la tourmenter? (D. 19187)

While Voltaire had spared Buffon in *Les Cabales* and *Les Systèmes*, he apparently could not, in spite of Buffon's flattery, refrain from criticizing — or teasing — Buffon once more.

Voltaire might have been prompted to do so after his correspondence with Condorcet. Condorcet (1743-1794), mathematician, permanent secretary of the Academy of Sciences at Paris since 1776, and friend of Voltaire received the following letter from Voltaire on February 28, 1777:

On nous avait flattés que l'illustre secrétaire, nous avertirait incessamment du jour et de l'heure, où notre globe de verre s'en irait en fumée, et quand la comète qui produisit autrefois la terre reviendrait la détruire. Si on a besoin de quelques montagnes élevées par le flux de la mer à deux mille toises de hauteur, j'en ai vis à vis mes fenêtres une douzaine à vôtre service. Je vous prierais de vouloir bien m'envoyer quelques molécules organiques pour me paier de mes montagnes. (D. 20583)

It is obvious that Voltaire was referring here to the author of *Histoire naturelle* who had mentioned the formation of the earth by a comet, the shaping of mountains by the sea, and organic molecules to explain organic matter. Condorcet answered on March 5, 1777:

J'ignore absolument si la terre sera gelée ou si elle sera reduite en poussiere par le choc d'un comète, si elle sera brûlée par une explosion du feu Central ou si elle retour-

nera dans le sein du soleil. Il n'y a que M. le Comte de Buffon et frère illuminé Bailli qui sachent toutes Ces belles choses. Quant aux montagnes je suis for ignorant encore sur cet objet. Il paraît clair que celles qui Contiennent des Coquilles dont les analogues se trouvent dans La mer ont été formées par elle, mais quand et comment? Nous le saurons peut-être un jour; mais ce qui est prouvé c'est que La manière dont on l'a expliqué dans La grande histoire naturelle répugne un peu aux Lois de L'hydrostatique. (D. 20593)

"Frère illuminé Bailli" is Jean-Sylvain Bailly, astronomer and author of the two works mentioned above which were sent to Voltaire. (Bailly had been in competition with Condorcet for the job of secretary of the Academy of Sciences which Condorcet had won; Granger DSB). According to the above letter, Condorcet was not in favor of Buffon's theory of the earth; however, he accepted the fact that mountains containing marine shells had been formed by the sea. It is possible that Condorcet's letter induced Voltaire to mention Buffon once more in his *Dialogues d'Evhémère*.

Dialogues d'Evhémère are dialogues between Evhémère, a skeptic and a deist, and Callicrate, Epicurian and atheist. In a footnote Voltaire said: "Evhémère était un philosophe de Syracuse, qui vivait dans le siècle d'Alexandre. Il voyagea autant que les Pythagore et les Zoroastre. Il écrivit peu; nous n'avons sous son nom que ce petit ouvrage." All the important questions asked in the eighteenth century are raised again. Most remain unanswered, however, including those on geology: "si cette terre a toujours été peuplée d'hommes" and "si la terre elle-même a toujours existé." Voltaire's own history of science is offered, perhaps in reply to Bailly's *Lettres sur l'origine des sciences*.

To the question "Si les montagnes ont été formées par la mer" Evhémère answers:

A huit cent quarante-quatre stades de l'Océan, près d'une ville nommé Tours, on trouve, à dix pieds de profondeur sous terre, une étendue d'environ cent trente millions de toises cubiques d'une matière un peu marneuse, qui ressemble à du talc pulvérisé; les cultivateurs s'en servent pour fumer leurs champs. On trouve dans cette mine excavée, souvent imbibée de pluie et d'eau de source, plusieurs dépouilles d'animaux, soit reptiles, soit crustacées, soit testacées.

Un virtuose, potier de son métier, qui s'intitulait inventeur des figulines rustiques du roi des Gaules, prétendit que cette mine de mauvais talc mêlé d'une terre marneuse n'était qu'un amas de poissons et de coquilles, qui étaient là du temps du déluge de Deucalion. Quelques philosophes ont adopté ce système; ils se sont seulement écartés de la doctrine du potier, en soutenant que ces coquilles devaient avoir été déposées dans ce souterrain plusieurs milliers de siècles avant notre déluge grec.

On leur a répondu: Si un déluge universel a porté dans cet endroit cent trente millions de toises cubiques de poissons, pourquoi n'en a-t-il pas porté la millième partie dans les autres terrains également éloignés de l'Océan? Pourquoi ces mers, toutes couvertes de marsouins, n'ont-elles pas vomi, sur ces rivages seulement, une douzaine de marsouins?

Il faut avouer que ces philosophes n'ont point éclairci cette difficulté; mais ils sont demeurés fermes dans l'idée que la mer avait couvert les terres, non-seulement jusqu'à huit cent quarante stades au delà de son rivage, mais qu'elle s'est avancée bien plus

DIALOGUES D'EVHÉMÈRE.

Publiés par M. de VOLTAIRE.



L O N D R E S.

M. D. C C. LXXIX.

FIG. 6. — Title page of *Dialogues d'Evhémère* (modern spelling) of a 1779 edition at the Institut et Musée Voltaire, Geneva, not mentioned by Bengesco (vol. II: 349-351).

loin [...] Enfin le philosophe gaulois Telliamed a soutenu que la mer avait été partout pendant cinq ou six cent mille siècles, et qu'elle avait produit toutes les montagnes. (M. XXX: 516-517)

Besides being hilariously funny and blown out of proportion, Voltaire's interpretation of the faluns of Touraine turns up with one great difference: Faluns, a marly and pulverized matter with a few fossils, as he had said before, were now described as saturated by spring- or rain-waters when extracted from the ground. In *Singularités* and *Lettre sur un écrit anonyme*, Voltaire had not mentioned any such spring- or rain-water. In the former he said that he had found one shell of a (fresh-water) snail in some calcareous and pulverized earth; in the latter he described faluns as some calcareous and marly earth which contained some (freshwater) mussels at a depth of ten or fifteen feet. In 1777 Voltaire might have realized that many of the excavations made during extraction of the faluns were quickly filled with rain- or spring-water, an observation described by Réaumur's original memoir (1720: 527).

Following this additional precision on the mode of occurrence of faluns, he repeated his earlier description of Palissy's errors and Maillet's acceptance of the idea that the sea had once covered all the continents.

He said on the latter's ideas on transformism:

Il n'ose pas dire qu'il a vu des hommes marins, mais il a parlé à des gens qui en ont vu: il juge que ces hommes marins, dont plusieurs voyageurs nous ont donné la description, sont devenus à la fin des hommes terrestres tels que nous sommes, lorsque la mer, se retirant des côtes pour aller élever ses montagnes, a laissé ces hommes dans la nécessité d'habiter sur la terre. Il croit de même ou il veut faire croire que nos lions, nos ours, nos loups, nos chiens, sont venus des chiens, des loups, des ours, des lions marins, et que toutes nos basses-cours ne sont peuplées que de poissons volants, qui à la longue sont devenus canards et poules. (M. XXX: 518)

This is a perfect example of Voltaire's sense of humor, of his art to say in a few words what took Maillet a whole chapter, and also of his apparent superficial reading. Indeed, according to Maillet the sea did not retreat from the coast to shape mountains elsewhere, but mountains had been formed at the bottom of the sea before they became exposed by the diminution of the sea. Voltaire seemed to have understood that Maillet's sea had moved away from one part of the continent to shape mountains on the other half of the globe, perhaps according to the concept of ocean-wandering which he had mentioned in "Inondation." Of course, we should never forget that *Dialogues d'Evhémère* is referring to ideas which were deliberately falsified to fit the story told by Evhémère, the philosopher from Syracuse. Therefore, Voltaire might have read Maillet correctly but changed his ideas on purpose.

In the same dialogue, Voltaire uses Evhémère to tease Buffon for the last time about his theory which he had adopted from Maillet: "il a pris du moins sous sa protection les montagnes formées par les courants et par le flux des mers, il a fortifié

cette idée de Telliamed. On l'a comparé à un grand seigneur qui élève dans ses domaines un orphelin abandonné..." (M.XXX: 518-519)

From Voltaire's remarks on geology after *Singularités* and some articles from the *Dictionnaire philosophique*, which were probably written before 1770, it is evident that he had kept up with scientific ideas although he tended to "rabâcher" many other ideas, in the words of the Président des Brosses (D.15431). In the field of geology Voltaire seemed to remain aware of the newest works done. For instance, he corresponded with Hamilton on volcanoes; he mentioned extinction among sea-shells, a topic which was to become officially accepted by Cuvier in the nineteenth century (Rudwick 1972: 101); he made some additions in *Singularités* in 1774 showing that he was aware of vast changes on the surface of the earth and a long geological time necessary for these changes; he had even considered the possibility of ocean-wandering, a concept later developed by Lamarck. In *Dialogues d'Evhémère* Voltaire added a field observation to his earlier description of the faluns which indicates that he might have read Réaumur's original memoir or received the information from another source. In conclusion, from the standpoint of geology, I believe that Voltaire was telling the truth about his scientific attitude when he told M^{me} du Deffand: "Il faut avoir ma persévérance, et la passion de m'instruire sur la fin de ma vie pour chercher comme je fais des pierres précieuses dans des tas d'ordures" (D.18629, Nov. 16, 1773).

CHAPTER IV

VOLTAIRE'S MOTIVES FOR HIS ATTITUDE TOWARD GEOLOGY

Voltaire's attitude toward geology reveals that he was not defending a particular system of religion or metaphysical ideas, as argued by many critics, but that he was defending scientific truth. I have mentioned in chapter II (On Mountains and Final Causes) that Voltaire's reaction toward d'Holbach's materialistic work is often identified with his deistic reaction toward all sciences. I have shown, however, in chapter III, that Voltaire's essay "Dieu" which represents his response to d'Holbach's *Système de la nature* is based above all on scientific, personal, and moral grounds. Voltaire refuted Needham's spontaneous generation saying that nobody knows how matter becomes alive; he personally believed that d'Holbach's work might harm the cause of all philosophes, him included, and lastly he warned atheists that religion was necessary for the common people. I do not see in Voltaire's reaction toward d'Holbach's atheistic work merely a defense of his own deistic beliefs.

In chapter II I have shown that Voltaire's attitude toward geology was greatly influenced by his personal observations at Ferney and his reliance on concrete facts. Voltaire did not withdraw his earlier acceptance of the marine origin of faluns because he was "defending deism against atheistic attempts to interpret the world materialistically" as maintained by Brumfitt. Voltaire compared fossil shells in the faluns with freshwater snails at Ferney; he based his views on the taste, the size and the shine of shells in the faluns as compared to the properties of the freshwater snails at Ferney.

Even Voltaire's refutation of Buffon's theory of the earth was based on observational criteria. Since his refutation represents his final stand toward geology, it requires special attention. Jacques Roger's study of Voltaire's attitude toward Buffon is based on Voltaire's attitude toward life sciences, however, and not geology. Roger, nevertheless, states that Voltaire refused fossil shells, spontaneous generation, and the animality of polyps for all the same reasons, namely, that he was defending his deistic faith (1963: 748). It seems to me that in the field of geology Voltaire's attitude has not been studied from the point of view of modern geology coupled with the history of geology but rather by simply comparing his "scientific" interpretation with that of naturalists of his century as they are interpreted today, in particular Buffon. In that view, Voltaire's interpretation of freshwater fossils at Ferney and in the faluns appears to show that Voltaire was either ignorant of the work of his contemporaries or so prejudiced that he refused their interpretation. Modern geology, however, shows that his opinion is correct. Furthermore, we should take a closer look at Buffon's work as it was read by Voltaire and find out

how Buffon's theory was accepted during Voltaire's time. Then we should try to judge Voltaire's attitude toward Buffon.

A. BUFFON'S THÉORIE DE LA TERRE OF 1749

Buffon's theory of 1749 was based upon three concepts all mentioned earlier by Maillet: 1. The formation of mountains by the ebb and flow and ocean currents on the bottom of the sea. 2. The presence of marine fossils everywhere on land, even on top of the highest mountains. 3. The conformity of angles witnessed in mountains. No wonder Lamoignon-Malesherbes asked: "Qu'est-ce que donc qui appartient à M. de Buffon dans cette théorie de la terre" (p. 240). Buffon parted from Maillet's model by stating that he did not know how mountains had emerged from the sea, whether the earth crust had collapsed as related by Plato, or whether changes had occurred slowly over a long period of time. Nevertheless, he affirmed that changes must have occurred "car pour juger de ce qui est arrivé, & même de ce qui arrivera, nous n'avons qu'à examiner ce qui arrive" (1749: 96). This is an interesting early insight of actualism in geology.

Today Buffon's image as a geologist is based on his complete *Histoire naturelle* which contains the *Théorie de la terre* originally written in 1749, *Les Epoques de la nature*, published in 1778, and many important changes and additions made in 1778. The most important change is added to Art. IX "Inégalités de la terre": "Sur la formation des montagnes" (1850-1860: 195-196). There he states that he accepted now two causes of mountain-building: fire and water. Primitive mountains were formed during the cooling of the earth crust; some "boursouflures" created the skeletons of mountains and the related abysses. After the cooling period, the sea covered the whole earth and, by the action of the ebb and flow and ocean currents, the form and position of the original mountains and valleys was changed. The ebb and flow formed hills in the former valleys, covered and surrounded the foot of former mountains with new sediments. Ocean currents produced conforming angles in mountains and valleys. Elsewhere he explained his error, "... mon explication ne pêche qu'en ce que j'ai attribué la première formation des rochers qui forment le noyau de ces pics à l'intermède de l'eau, au lieu qu'on doit l'attribuer à l'action du feu" (1850-1860: 192). Thus Buffon explained in 1778 two kinds of mountains: the first were produced by fire and do not include fossil shells; they are irregularly formed structures composed of "vitreous" rocks; the second were formed by the sea and consist of younger rocks which contain marine fossils. These rocks are mostly found in horizontal layers (1850-1860: 196). This important change was not made public until after Voltaire's death.

Today, Buffon's complete work in geology is considered a benchmark in the history of geology because it is a synthesis of earlier works and contains some

daring speculations later demonstrated to be correct. Voltaire, however, never read it.

The reaction of many eighteenth-century naturalists and philosophers toward Buffon's original theory was similar to Voltaire's. I have already mentioned Condorcet who said in a letter to Voltaire that he considered Buffon's explanation of mountain-building contrary to the laws of hydrostatics (D.20593).

Turgot also strongly disagreed with Buffon's theory as it had first appeared and wrote *Lettre à M. de Buffon* in October 1748 which was published after the death of both in 1801 (Tome II: 93-101). In regard to mountain-building by the ebb and flow of the sea, he said:

J'avoue que je ne connois pas bien comment le flux et le reflux de la mer a pu élever des montagnes à plus d'une lieue au-dessus de sa plus grande hauteur, car les volcans n'on jamais pu élever celles dont les aiguilles sont disposées régulièrement, parmi lesquelles on ne peut nier qu'il n'y en ait de très-hautes. Il ne paroît point que la mer puisse agir où elle n'est pas, et sûrement elle n'a jamais été portée à plus d'une lieue au-dessus de sa surface ordinaire. (p. 99)

Lamoignon-Malesherbes, "secrétaire d'Etat de la Maison du roi," also criticized Buffon, apparently in 1750, but his comments were published only in 1798 (Roger 1963: 687). Lamoignon-Malesherbes claimed that Buffon's theory contained nothing new: the surface of the earth had been explained earlier by Bourguet (Lamoignon-Malesherbes 1798: 221); the system which said that the sea had covered all the lands had been adopted by Bernard Palissy and further developed by the author of *Telliamed* (Lamoignon-Malesherbes 1798: 222).

Buffon was also criticized by shocked Catholics in France such as the Abbé Lelarge de Lignac, who tried to refute Buffon on both religious and scientific grounds. His *Lettres à un amériquain* were first published in 1751. In the third and fourth letter he opposed Buffon's theory in regard to fossiliferous rocks which were apparently proofs of the long sojourn of the sea on all the continents. He remarked that he had seen high mountain-peaks and sheets of slate without fossils (vol. II, 4th letter, p. 11). Lignac's main criticism, however, was against Buffon's unorthodox explanation of the beginning of the earth and the beginning of life.

The most important reaction toward Buffon came from a naturalist, Peter Simon Pallas (1741-1811) from Berlin, who had been invited to work at the St. Petersburg Academy of Sciences in 1767. He observed rocks, fossils, plants, and animals during several expeditions across Russia. He wrote a small essay *Observations sur les Montagnes et les Changements arrivés à notre Globe...* which was published in Paris in 1782. Pallas refuted all systems including Buffon's theory of the earth saying:

C'est pour ainsi dire avec des préjugés nationaux, ou avec les idées puisées dans la sphère particulière des connaissances de chacun de ces auteurs, qu'ils ont jugé de la structure du globe en entier d'après les montagnes de leurs parties; & comme plusieurs

de ces créateurs en hypothèses n'ont pas même connu par leurs propres yeux la nature des grandes chaînes de montagnes, ou tout au plus n'ont été au fait que de celles qui traversent l'Europe, leurs théories ont été adaptées à la structure particulière de celles-là, & bien souvent d'une petite partie des mêmes, qui était le plus à leur portée, (tout comme les anciens & quelques ultramontains modernes ont jugé du flux & du reflux de l'Océan, par les petits mouvements de la Méditerranée, qu'ils étaient à portée de connaître). — *Woodward*, par exemple, sans s'inquiéter de ces chaînes de vieille roche, étayait son système sur la formation des couches & des montagnes pendant le déluge, sur la persuasion où il était, que toutes les montagnes de l'Univers fussent composées de couches à-peu-près horizontales. M. le Comte *de Buffon* de même ne semble avoir jugé des montagnes en général, que par celles de la France, qui pour la plupart sont composées de couches à-peu-près horizontales ou simplement dérangées par l'effet de quelques Volcans. Il n'aurait pas sans cela déduit la formation des cailloux & de l'ancienne roche même, de matières charriées & déposées par les courants de mer; ni avancé que les traces de la mer se voient jusqu'aux sommets des plus hautes montagnes, que ces montagnes sont toutes composées de couches horizontales, ainsi que les plaines, & que les Volcans ne se trouvent que dans les hautes Alpes; toutes assertions totalement ou en partie contraires à l'ordre général de la Nature. (p. 8-10)

Pallas thus pointed to the fact that Buffon had observed local geology and deduced that the whole earth contained the same structures, that he therefore adopted the theory of ebb and flow and stated that all mountains are composed of layered fossiliferous rocks. This is very close to what Voltaire had said in *Singularités*, which I shall discuss below. Pallas destroyed one by one Buffon's arguments in his theory of the earth: the comet, the fossils in the highest mountains, the horizontal beds, the idea of ebb and flow, and the corresponding angles of mountains. To explain the past history of the earth, Pallas believed that one must combine the different effects caused by volcanoes, underground forces, a deluge or several violent inundations by the sea (p. 67).

Voltaire's detailed criticism of Buffon in chapter XI of *Singularités*, which I have not previously discussed, contains no personal observations but merely common sense, very similar to that of Pallas:

Il est trop visible que la mer ne fait point une chaîne de roches sur la terre. Le flux peut amonceler un peu de sable, mais le reflux l'emporte. Des courants ne peuvent produire lentement, dans des siècles innombrables, une suite immense de rochers nécessaires dans tous les temps [...] Sur quelles raisons apparentes appuie-t-on ce paradoxe? Sur ce qu'on prétend que, dans les vallées des Alpes, les angles saillants d'une montagne à l'occident répondent aux angles rentrant d'une montagne à l'orient. Il faut bien, dit-on, que les courants de la mer aient produit ces angles. La conclusion est hasardée. Le fait peut être vrai dans quelques vallons étroits; il ne l'est pas dans le grand bassin de la Savoie et du lac de Genève; il ne l'est pas dans la grande vallée de l'Arno, autour de Florence, mais à quelles branches ne se prend-on pas quand on se noie dans les systèmes! (M. XXVII: 140-141)

Voltaire mentions here the concept of corresponding angles, a notion which had also been criticized by Pallas (1782: 67) and Lamoignon-Malesherbes (1798: 247-249).

With this concept Buffon apparently tried to prove that when the earth was covered by the sea, ocean currents had cut across accumulations of sediments at the bottom of the sea, thus leaving corresponding angles once this part of the sea was lifted (?) or became dry land by some other miracle.

Pallas had also objected to generalizations based on local phenomena; Voltaire had said before him: "Quoi! Parce que des atterrissements ont reculé la mer de plusieurs lieues, et qu'elle aura inondé d'un autre côté quelques terrains bas, on nous persuadera qu'elle a inondé le continent pendant des milliers de siècles! Nous voyons des volcans, donc tout le globe a été en feu; des tremblements de terre ont englouti des villes, donc tout l'univers a été la proie des flammes. Ne doit-on pas se défier d'une telle conclusion? Les accidents ne sont pas des règles générales" (M.XXVII:141).

In the same chapter Voltaire also pinned down various inconsistencies in Buffon's theory which even Pallas had not noticed. Voltaire said that on the one hand Buffon claimed: "Ce sont les eaux rassemblées dans la vaste étendue des mers qui, par le mouvement continu du flux et du reflux, ont produit les montagnes, les vallées, etc." (citation from Buffon's theory p. 124). On the other hand "Il y a sur la surface de la terre des contrées élevées qui paraissent être des points de partage marqués par la nature pour la distribution des eaux..." (citation from Buffon's theory p. 359). Yet another idea by Buffon said "les eaux du ciel détruisent peu à peu l'ouvrage de la mer, et ramenant tout au niveau, rendront un jour notre terre à la mer, qui s'en emparera successivement, en laissant à découvert de nouveaux continents, etc." (Buffon, p. 124). Voltaire, after these citations pointed out that mountains could not have been shaped by the sea while at the same time forming mountain-chains for irrigation. Another contradiction existed between the erosion of mountains by "les eaux du ciel" and Buffon's assumption "c'est la mer qui s'est retirée insensiblement dans la suite des siècles, de la Bourgogne, de la Champagne, de la Touraine, de la Bretagne, où elle demeurerait, et qui s'en est allée vers le nord de l'Amérique." Which assumption is one to believe, asked Voltaire (M.XXVII: 142-143). It is true that Buffon never explained how, on the one hand, mountains were formed on the bottom of the sea while, on the other, they were eroded and disappeared again into the sea, or how they became exposed after the retreat of the sea.

Voltaire found another contradiction in Buffon's propositions when he read Buffon's *Première Vue de la nature* (1850-1860, VII: 165-171). There, visibly tired of scientific facts, Buffon had managed a poetic interlude saying, "nous retournerons ensuite à nos détails avec plus de courage; car j'avoue qu'il en faut pour s'occuper continuellement de petits objets dont l'examen exige la plus froide patience, et ne permet rien au génie" (p. 165). His poetic prose contradicted what he said in his theory of the earth; as Voltaire was quick to point out:

« La mer irritée, dit-il, s'élève vers le ciel, et vient en mugissant se briser contre des digues inébranlables, qu'avec tous ses efforts elle ne peut ni détruire ni surmonter. La terre, élevée au-dessus du niveau de la mer, est à l'abri de ses irrutions. Sa surface

émaillée de fleurs, parée d'une verdure toujours renouvelée, peuplée de mille et mille espèces d'animaux différents, est un lieu de repos, un séjour de délices, etc. »

Voltaire is here citing Buffon's prose and then adds:

Ce morceau, dérobé à la poésie, semble être de Masillon ou de Fénelon, qui se permirent si souvent d'être poètes en prose; mais certainement si la mer irritée, en s'élevant vers le ciel, se brise en mugissant contre des digues inébranlables, si elle ne peut surmonter ces digues avec tous ses efforts, elle n'a donc jamais quitté son lit pour s'emparer de nos rivages, elle est bien loin de se mettre à la place des Pyrénées et des Alpes. (M. XXVII: 143)

Bertrand Russel said of Voltaire's wit: "I cannot find words in which to express my delight in his sharp, swift wit which penetrates in a moment to the inner core of humbug beneath pretentious trappings" (1958: 162).

To refute Buffon in chapter XI in *Singularités* Voltaire used common sense. He objected to inconsistencies, weaknesses, and unjustified generalities. He might have accepted Buffon's theory of 1778 which advocated what Voltaire himself believed, namely that some primitive mountains had existed ever since the beginning of the earth and that they did not contain fossils. There is only one sentence in chapter XI where Voltaire uses a metaphysical idea: "Quel est donc le véritable système? Celui du grand Être qui a tout fait, et qui a donné à chaque élément, à chaque espèce, à chaque genre, sa forme, sa place, et ses fonctions éternelles. Le grand Être qui a formé l'or et le fer, les arbres, l'herbe, l'homme et la fourmi, a fait l'Océan et les montagnes" (p. 141). This sentence has been quoted by every critic of Voltaire who believed that his attitude toward science was dictated by his deistic beliefs. It is possible that this was indeed a system which he had accepted in his early youth with the Jesuit fathers and while reading *Mundus Subterraneus*. This does not mean, however, that he was not open to new ideas later on. Since he had not found any better explanation for mountain-building, he kept repeating a theory which seemed to him the most logical.

B. VOLTAIRES' SCIENTIFIC ATTITUDE

Voltaire was no longer a young man when he decided to look at fossils and other geological phenomena to refute Buffon. Indeed, Voltaire was not aware of geological problems before the age of forty-eight. He stumbled accidentally into geology when he mentioned in *Elémens* (1738) that astronomical changes such as slow movements of the poles might have left marine fossils on the continents, even in mountains. In the revised edition of 1741 he added the skeptical "dit-on" in regard to fossil shells found in mountains and in many layers closer to the sea. Bourguet's criticism of Voltaire in 1742 made him probably realize that astronomical figures

were difficult to verify whereas fossil shells could be investigated. He was then forty-eight.

In 1746, Voltaire still had not looked at any fossil. In his *Dissertation* he simply proposed some more "natural" explanations for fossil fish in Hesse and on Mont Cenis: not the sea, but travelers had discarded some fish which petrified later. For fossil shells found in Italy and France, he said that maybe the sea of Syria had carried some, or pilgrims of the Holy Land, or that they were "fossiles" produced by the earth, or the remains of animals who had lived in ancient lakes. He practically accepted the marine origin of fossil shells in Calabria and Touraine. In the *Dissertation* he rejected diluvial theories as well as the theory of the Indian Ocean or any sea that had covered all of Europe up to the highest mountains and turned to the theory by Kircher that seemed more logical: mountain-chains have necessarily existed ever since the beginning for irrigation and for stabilization of the earth.

When Voltaire first lived on the shores of Lake Geneva, at Prangins near Nyon, then at "Les Délices" in Geneva, and Montriond, near Lausanne, he seemed to have little time for natural history. When he finally settled at Ferney, however, he supervised the construction of houses which used molasse quarried at Tournay, plowed fields and arranged gardens and forests; in other words, he lived close to nature for the first time in his life. He saw rocks of all sizes, observed karstic phenomena in the Jura Mountains, noticed fragments of fossil shells exposed on the banks of rivers and lakes and compared them with garden snails. He even experimented on snails; cut their heads to find out whether they would grow back. They did and he accepted it as a fact: "Qu'il revienne une tête à un animal assez gros, visiblement vivant, et dont le genre n'est point équivoque, c'est là un prodige inouï mais un prodige qu'on ne peut contester. Il n'y a point là de supposition à faire, point de microscope à employer, point d'erreurs à craindre" (M.XXVII: 131). He also repeated the so-called experiment by Hannibal, immersed some granite — "une de ces roches à grains qui composent la plus grande partie des Alpes" — into vinegar and found it to be soluble (M.XXVII: 137). He wondered about the composition of rocks: "D'où résultait ce corps si dur que le feu a divisé? est-ce l'attraction qui rendait toutes ses parties si unies entre elles et si compactes? [...] Est-ce le premier principe de la cohésion des corps?" (M.XXVII: 136). Indeed, Voltaire had become an observer of natural phenomena in his old age.

Voltaire's scientific attitude should not be confused with that of a young man. He was certainly no longer the young intellectual who had been looking for systems such as he had described in his *Lettres philosophiques*: "Aujourd'hui tous les recueils des académies de l'Europe ne font pas même un commencement de système: et approfondissant cet abîme, il s'est trouvé infini" (M.XXII: 132). At that time he deplored the absence of systems: he was in his thirties; in *Singularités* he refuted all systems": he was seventy-four.

When Voltaire wrote *Singularités* he had passed the age of speculations and dreams. He had probably seen too many systems come and go. At Ferney he decided simply to observe, and he told his contemporaries repeatedly to do so. The eighteenth century, said Koestler, was a period of "assimilation, consolidation, and stock-taking, the age of the popularizers, classifiers, and systematizers; of Fontenelle, Linnaeus, and Buffon, of the *Philosophes* and *Encyclopédistes*." The seventeenth century, on the other hand, was the "heroic age of science" who produced Gilbert, Kepler, Galileo, Pascal, Descartes, Leibniz, Huygens, Harvey, and Newton." In the eighteenth century, an observer "born early in the century, and making the Grand Tour, would have been an old man before he came across, in the Paris of Lavoisier, anyone worthy of Newton" (1964: 228). Voltaire had practiced all the things mentioned by Koestler except classification and the making of systems. He spent his last ten years refuting systems and advocating observation, description, and classification. He often lamented how scientists of his century brought nothing new but instead spoiled what their predecessors had achieved:

Ainsi après que Newton a découvert la nature de la lumière, arrive un Castel qui veut enchérir, et qui propose un nouveau clavecin oculaire. A peine a-t-on découvert, avec le microscope, un nouveau monde en petit, que voilà Needham qui imagine avoir fait une république d'anguilles, lesquelles accouchent sur le champs d'autres anguilles, le tout dans une goutte [...] Sitôt que de vrais philosophes eurent calculé l'action du soleil et de la lune sur le flux et le reflux des mers, des romanciers au-dessous de Cyrano de Bergerac, écrivent l'histoire des temps où ces mers couvraient les Alpes et le Caucase, et où l'univers n'était habité que de poissons [...] Ainsi, monsieur, dans tous les arts dans toutes les professions, les charlatans succèdent aux bons maîtres... (D. 20103, letter to Baron de Faugères, 3 May 1776)

There seems to have existed a slowdown in the history of scientific ideas, or at least as far as we are concerned, in the history of geology, which lasted almost until the beginning of the nineteenth century. During Voltaire's life, there were the publications of posthumous works by Leibniz and Maillet, the memoirs by the Academy of Sciences, Buffon's theory of the earth in 1749, and then nothing until Werner in Germany (1774), Hutton in England (1795), Saussure in Switzerland (1779-1795), and Pallas in Russia (1782). These are considered the first geologists. They travelled, observed, described, did all the things Voltaire had advocated. If Voltaire's voice, therefore, appears unusually skeptical in matters of geology, it is partly due to these two reasons: his mature age and the lack of any major advancement in geology in his century.

Voltaire's skepticism did perhaps as much good as speculations. Indeed both are necessary, and it seems that often they work together. T. H. Huxley said that

the advancement of natural knowledge has been effected by the successive or concurrent efforts of men, whose minds are characterized by tendencies so opposite that they are forced into conflict with one another. The one intellect is imaginative and synthetic;

its chief aim is to arrive at a broad and coherent conception of the relations of phenomena; the other is positive, critical, analytic, and sets the highest value upon the exact determination and statement of the phenomena themselves."

Huxley wrote that men of the first category held "wild hypotheses, for the power of ordering and grasping the endless details of natural fact which they confer." Science is indebted to these men for their "moral stimulus which arises out of the desire to confirm or confute them; and last, but not least, for the suggestion of paths of fruitful inquiry, which, without them, would never have been followed." These men "lighted upon verities while following illusions [. . .] On the other hand, there is no branch of science which does not owe at least an equal obligation to those cool heads, which are not to be seduced into the acceptance of symmetrical formulae and bold generalisations for solid truths because of their brilliancy and grandeur." These men "cannot overlook those small exceptions and insignificant residual phenomena which, when tracked to their causes, are so often the death of brilliant hypotheses." These men have "shown the limits of human knowledge which are set by the very conditions of thought, have warned mankind against fruitless efforts to overstep those limits" (1879: vi-viii).

One would think that Huxley was writing about Buffon and Voltaire whereas he actually described two biologists, Haeckel and Virchow, who apparently enacted similar roles. Today Buffon is looked upon as having "lighted upon verities while following illusions" while Voltaire has "warned mankind against fruitless efforts to overstep those limits." Both men, I believe, were defending scientific truth.