II. Agenda, or a collection of observations and researches, the results of which may serve as the foundation for a theory of the earth

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II. *Agenda, or a Collection of Observations and Researches, the Results of which may serve as the Foundation for a Theory of the Earth.* By M. DE SAUSSURE.

[Concluded from Page 140.]

CHAP. XXIII.

Instruments necessary for the Geological Traveller.

I. **T**HE most necessary instrument is the miner's hammer. It will be requisite to have two, of different sizes: one small, to break small fragments of rolled pebbles, by holding them in the left hand while you strike with the right. Its weight, including the handle, ought to be about ten ounces. The other must be larger, to detach fragments of rock, and to break large pebbles: its weight ought to be quadruple that of the small one. When I travel on horseback, I have these two hammers suspended from the bow of my saddle.

1. A. Two stone-cutter's chisels: one small, of from a line to a line and a half, to detach small crystals, or other objects of small bulk; the other, seven or eight lines.

2. To try the hardness of fossils, a piece of steel to strike fire will be necessary; also a triangular file, pretty fine, and a strong bodkin of tempered steel.

3. Nitrous acid, with M. De Morveau's boxes of reagents.

3. A. An artificial magnet, in a case, with a steel pivot on which it can be placed, to try the magnetism of fossils.

4. A magnifying glass of three inches focus, in order to enable the observer to form a general idea of any fossil: another, of an inch focus, to examine its separated parts; and one of five or six lines for closer examination. These three magnifiers must be always in the traveller's pocket, or ready at hand: but, besides these, he must have, for his closet at home, a microscope furnished with a micrometer.

5. Telescopes, to observe inaccessible mines and distant mountains.

6. A pocket portfolio, with prepared paper for writing on,
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with a pencil of tin folder, which it is not necessary always to cut, and the writing of which is not so easily effaced as that of plumbago. In this portfolio the traveller must write out, on the spot, the sketch of his journal, and insert such observations as occur to him; but he must take the trouble to transcribe these notes at more length, preserving the primitive notes, which will always retain a character of truth, and for that reason people are fond of recurring to them.

7. Some quires of brown paper, a few sheets of which may be carried in the pocket for wrapping up on the spot specimens of the stones you collect, the characters of which ought to be marked on the cover. You may afterwards pack them with hay into a bag destined for that purpose, until you have a sufficient quantity to form a box, which you may send home by the public carriages wherever you find an opportunity; but, as it is fatiguing for the traveller to load his pockets during the time of his excursions, and as the guides often lose them on purpose in order to get rid of them, I have behind my saddle two leathern bags, into which I put them till I come to some halting-place, where I have time to pack them with hay into a bag. M. Besson recommends to those who undertake sea voyages to write with China ink the characters which ought to accompany minerals in long passages, because common ink may be effaced by accidents.

8. A blow-pipe, with its apparatus. As I make much use of this instrument, which at length fatigues me, though I can blow with my cheeks without exercising my breast, I caused to be constructed a pair of portable double bellows, the sides of which contain each sixty-two square inches. These bellows can be suspended from the edge of a table; and I put them in motion by pressing together, between my knees, the two handles, which afterwards separate by the action of the spring. This apparatus may be easily carried, and is very convenient.

9. A graduated femicircle traced out on a copper-plate of a form exactly rectangular, with a plummet suspended from the centre of the femicircle. This femicircle is the most convenient instrument for measuring the inclination of strata, of veins and declivities; and it may always be carried in a pocket of the portfolio.

10. A compass, furnished with a cross staff, to find the direction of mountains, chains, vallies, and strata.

11. Portable barometers with two mercurial thermometers; one affixed to a barometer to estimate the temperature of the mercury in the latter, and the other with a bare bulb for measuring the temperature of the air. Those who study meteorology, as well as geology, ought to be furnished also with an hygrometer and an electrometer.

12. For ascertaining the temperature of the sea, at great depths, it will be necessary to have a thermometer constructed like that described in my *Travels through the Alps**: for lakes, an apparatus like that pointed out in the note of Section 1399, will be sufficient.

13. Those who understand a little geometry, ought to provide themselves with a sextant, having an artificial horizon, and also a chain, in order that they may be able to measure a base, and thus take the altitude of an inaccessible peak, the breadth of a river, &c. &c. With this sextant they may also find the latitudes. In regard to the longitudes, they require, besides instruments, an expertness in this kind of observation, which cannot be attained but by mariners or professed astronomers.

14. It will be necessary also to have within reach tools for repairing an instrument in case it should happen to be deranged; such as pincers, files, turnscrews, compasses, gimblets, wire, needles, thread, and packthread.

15. Lastly, some good map, pasted on canvas, of the country you propose to examine; and this map ought frequently to be compared with your itinerary, and the bearings given by your compass.

16. In regard to the care required for the traveller's person, he must have a light dress made of cloth, without lining, of a white colour, as well as his hat, that he may be less exposed to the heat of the sun's rays; with jackets, some cool for the warm regions and the vallies, and the other warm for the cool regions and eminences; a good great coat; green spectacles, and a black crape, to secure the eyes and face from the snow. Lastly, if he is to pass the night in the open air, a

* Section 1392, Plate 1, fig. 3.

tent or *cannoniere*, a bear's skin to sleep upon, and woollen blankets.

17. A solid light walking-pole: mine for the high Alps is a young fir-plant, extremely dry, seven feet in length and 18 lines in diameter at the lower end, which is shod with iron tapering to a strong point. These dimensions may appear large, but nothing can be too strong for the steep rocks, glaciers, and snow, when you are obliged to take your point of support at a distance from you, and to rest the whole weight of your body on your pole, by holding it in a situation very much inclined, and even horizontal, as may be seen in the *Vignette* to the First Volume of my Travels through the Alps.

—For mountains which are not so steep, the traveller may be satisfied with poles of less strength and size; but it will still be necessary that they should be four or five feet in height, and sufficiently strong that a person might be able to support himself with his two hands by holding them in a horizontal situation, according to the attitude of the small figure which is on the left side at top of the before-mentioned vignette; for, in traversing or descending a rapid declivity, or in walking on the margin or edge of a precipice, the traveller must always support himself by his two hands, holding the pole towards the mountain, and not towards the precipice, as those do who have not learned the art of travelling through mountains.

18. To prevent slipping on the hard snow-ice, and grass-plats, which are still more dangerous, I would recommend iron cramps, such as those which I have caused to be engraved in the third plate of the first volume, and which I have long used with success. In my last excursions, however, I preferred shoes, the thick soles of which were armed with strong tacks, at the distance of eight or nine lines from each other. The heads of these tacks are of steel, and shaped like a square pyramid: I have some small ones, the points of which are only two lines and a half in height, and of about the same breadth, for the snow-rocks and grass-plats; and others, of double these dimensions, for the hard snow.

19. In the last place, with regard to provisions, when the traveller must reside for a considerable time in the deserts, at a distance from habitations, and even huts, he may carry with

with him some salt or pickled meat; but M. Parmentier's sloop of potatoes, with cakes of portable soup, and bread, will form the most nourishing food, and what may be contained in the least room. A small iron chaffing-dish, a small bag filled with charcoal, and a pan of tinned copper or iron, form my kitchen apparatus for the mountains: wooden plates and spoons may be found in the remotest huts. It will be proper, however, to carry always in the pocket a cup of gum elastic, in order that the traveller may at all times easily quench his thirst, a want to which he will be frequently exposed in his excursions.

From what has been said, it may be readily seen, that the study of geology will not suit the indolent or sensual; for the life of the geologue must be divided between fatiguing and perilous journeys, in which he is deprived of almost all the conveniences of life, and the varied and deep researches of the closet. But what is still more rare, and perhaps more necessary than the zeal requisite to surmount these obstacles, is, a mind free from prejudice, filled with an ardent desire for the truth alone, rather than with a desire for raising or destroying systems; capable of descending to minute details indispensibly necessary for the correctness and certainty of observations, and of rising to grand views and general conceptions. Those fond of such studies, ought not, however, to be discouraged by these difficulties; there is no traveller who may not make some good observation, and bring with him at least one stone worthy of being employed in the construction of this grand edifice. It is indeed possible to be useful without attaining to perfection; for I have no doubt that if the mineralogical travels, even the most esteemed, and much more those of the author, be compared with these *Agenda*, there will be found in them many deficiencies, and many observations, either imperfect, or even totally forgotten: but I have mentioned the reason in the Introduction. Besides, several of these ideas did not occur till I had finished my travels; and for that reason I laboured with more zeal on these *Agenda*, in the hope of rendering young persons, on their entering this career, capable of performing what cost me thirty-six years of travelling and study.