

the second volume will not be long delayed; and in that volume we trust we shall encounter some of the good things to be found in the poetical works of Prior, Cowper, Gay, Gray, Burns, and several others, whose names do not appear in the present.

2. GEOLOGICAL OBSERVATIONS ON SOUTH AMERICA. Being the third part of the Geology of the Voyage of the *Beagle*, under the command of Captain Fitzroy, R.N., during the years 1832 to 1836. By Charles Darwin, M.A., F.R.S., Naturalist to the Expedition. Published with the approval of the Lords Commissioners of Her Majesty's Treasury. London: Smith, Elder, & Co., 65, Cornhill. 1846.

ALTHOUGH rather dry for the general reader, the contents of this volume are of the highest value and interest for the geologist and the paleontologist. The subjects treated of are the elevation of the eastern and western coasts of South America; the plains and valleys of Chile; the formations of the Pampas; the older tertiary formations of Patagonia and Chile; plutonic and metamorphic rocks; central and northern Chile; with the structure of the Cordillera. From the concluding chapter, we make a few extracts on the recent elevatory movements and volcanic action in South America; where, in the words of the author, "everything has taken place on a grand scale, and all geological phenomena are still in active operation."

"The nature and grouping of the shells embedded in the old tertiary formations of Patagonia and Chile show us, that the continent, at that period, must have stood only a few fathoms below its present level, and that afterwards it subsided over a wide area, 700 or 800 feet. The manner in which it has since been re-brought up to its actual level, was described, in detail, in the first and second chapters. It was there shown that recent shells are found on the shores of the Atlantic, from Tierra del Fuego, northward, for a space of at least 1,180 nautical miles, and, at the height of about 100 feet in La Plata, and of 400 feet in Patagonia. The elevatory movements on this side of the continent have been slow; and the coast of Patagonia, up to the height, in one part, of 950 feet, and in another, of 1,200 feet, is modelled into eight great, step-like, gravel-capped plains, extending for hundreds of miles with the same heights. This fact shows that the periods of denudation (which, judging from the amount of matter removed, must have been long continued), and of elevation, were synchronous over surprisingly great lengths of coasts. On the shores of the Pacific, upraised shells of recent species, generally, though not always, in the same proportional numbers as in the adjoining sea, have actually been found over a north and south space of 2,075 miles, and there is reason to believe that they occur over a space of 2,480 miles. The elevation on this western side of the continent has not been equable; at Valparaiso, within the period during which upraised shells have remained undecayed on the surface, it has been 1,300 feet, whilst at Coquimbo, 200 miles northward, it has been within the same period only 252 feet. At Lima, the land has been uplifted at least eighty feet since Indian man inhabited that district; but the level within historical times apparently has subsided. At Coquimbo, in a height of 364 feet, the elevation has been interrupted by five periods of comparative rest. At several places the land has been lately, or still is, rising, both insensibly, and by sudden starts of a few feet during earthquake shocks; this shows that these two kinds of upward movement are intimately connected

together. For a space of 775 miles, upraised recent shells are found on the two opposite sides of the continent; and in the southern half of this space, it may be safely inferred, from the slope of the land up to the Cordillera, and from the shells found in the central part of Tierra del Fuego, and high up the river Santa Cruz, that the entire breadth of the continent has been uplifted. From the general occurrence, on both coasts, of successive lines of escarpments, of sand-dunes and marks of erosion, we must conclude that the elevatory movement has been normally interrupted by periods, when the land either was stationary, or when it rose at so slow a rate as not to resist the average denuding power of the waves, or when it subsided. In the case of the present high sea-cliffs of Patagonia, and in other analogous instances, we have seen that the difficulty in understanding how strata can be removed at those depths under the sea, at which the currents and oscillations of the water are depositing a smooth surface of mud, sand, and sifted pebbles, leads to the suspicion that the formation or denudation of such cliffs has been accompanied by a sinking movement.

“In South America, everything has taken place on a grand scale, and all geological phenomena are still in active operation. We know how violent, at the present day, the earthquakes are; we have seen how great an area is now rising, and the plains of tertiary origin are of vast dimensions; an almost straight line can be drawn from Tierra del Fuego for 1,600 miles northward, and probably for a much greater distance, which shall intersect no formation older than the Patagonian deposits; so equable has been the upheaval of the beds, that, throughout this long line, not a fault in the stratification or abrupt dislocation was anywhere observable. Looking to the basal, metamorphic, and plutonic rocks of the continent, the areas formed of them are likewise vast; and their plains of cleavage and foliation strike over surprisingly great spaces, in uniform directions. The Cordillera, with its pinnacles here and there rising upwards of 20,000 feet above the level of the sea, ranges in an unbroken line from Tierra del Fuego, apparently to the Arctic circle. This grand range has suffered both the most violent dislocations, and slow, though grand, upward and downward movements in mass. I know not whether the spectacle of its immense valleys, with mountain masses of once liquefied and intrusive rocks, now bared and intersected, or whether the view of those plains, composed of shingle and sediment hence derived, which stretch to the borders of the Atlantic Ocean, is best adapted to excite our astonishment at the amount of wear and tear which these mountains have undergone.

“The Cordillera, from Tierra del Fuego to Mexico, is penetrated by volcanic orifices, and those now in action are connected in great trains. The intimate relation between their recent eruptions and the slow elevation of the continent in mass, appears to me highly important, for no explanation of the one phenomena can be considered as satisfactory which is not applicable to the other. The permanence of the volcanic action on this chain of mountains is, also, a striking fact. First we have the deluges of submarine lavas alternating with the porphyritic conglomerate strata, then occasionally feldspathic streams, and abundant mineral exhalations, during the gypseous or cretaceous period; then the eruptions of the Uspallata range, and, at an ancient but unknown period, when the sea came up to the eastern foot of the Cordillera, streams of basaltic lava at the foot of the Portillo range; then the old tertiary eruptions; and lastly, there are, here and there amongst the mountains, much worn and apparently very ancient volcanic formations, without any craters; there are, also, craters quite extinct, and others in the condition of solfataras, and others occasionally or habitually in fierce action. Hence it would appear, that the Cordillera has been, probably with some quiescent

periods, a source of volcanic matter from an epoch anterior to our cretaceous formation to the present day; and now the earthquakes, daily recurrent on some part of the western coast, give little hopes that the subterranean energy is expended.

Referring to the evidence by which it was shown that some at least of the parallel ridges, which together compose the Cordillera, were successively and slowly upthrown at widely different periods; and that the whole range certainly once, and almost certainly twice, subsided some thousand feet, and being then brought up by a slow movement in mass, again, during the old tertiary formations, subsided several hundred feet, and again was brought up to its present level by a slow and often interrupted movement; we see how opposed is this complicated history of changes slowly effected, to the views of those geologists who believe that this great mountain-chain was formed in late times by a single blow. I have endeavoured elsewhere to show, that the excessively disturbed condition of the strata in the Cordillera, so far from indicating single periods of extreme violence, presents insuperable difficulties, except on the admission that the masses of once liquefied rocks of the axes were repeatedly injected, with intervals sufficiently long for their successive cooling and consolidation. Finally, if we look to the analogies drawn from the changes now in progress in the earth's crust, whether to the manner in which volcanic matter is erupted, or to the manner in which the land is historically known to have risen and sunk; or again, if we look to the vast amount of denudation which every part of the Cordillera has obviously suffered, the changes through which it has been brought into its present condition, will appear neither to have been too slowly effected, nor to have been too complicated."—p. 245.

The appendix to this volume contains the characters and descriptions of sixty-one species of tertiary, and of eleven secondary fossil shells, from South America; the former by Mr. G. B. Sowerby, the latter by Professor Edward Forbes. The numerous figures of these fossils are very beautifully engraved by Mr. G. B. Sowerby, jun., and do great credit to his abilities as an artist.

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