

EARLY DISCOVERERS

XVIII

CHARLES DARWIN (1809-1882)

“On the distribution of the erratic boulders and on the contemporaneous unstratified deposits of South America.”

THE following is an extract from section 4 of a paper by Darwin entitled “Remarks on the glaciers of Tierra del Fuego, and on the transportal of boulders”, published in the *Transactions of the Geological Society of London*, Ser. 2, Vol. 6, Pt. 2, 1842, p. 415-31, section 4 (p. 427-31) having the aforementioned title.

“ . . . The glaciers in the Beagle channel were generally bordered by a tongue of land, formed of huge fragments of rock, and many boulders were strewed on the neighbouring shores. The only glacier which I approached closely, descended to the head of a creek, formed on one side by a wall of mica-slate, and on the other by a broad promontory, about fifty or sixty feet high, and apparently composed entirely of enormous fragments, chiefly of granite. One of these was ninety feet in circumference, and projected six feet above the sand. This promontory, which originally no doubt was a lateral moraine, projects nearly half a mile beyond the extremity of the glacier, and is in parts covered by old trees: hence we must infer, that the glacier formerly extended considerably further than it now does.

“It would be useless even to allude to the difficulties which affect every theory of the transportal of erratic boulders, excepting that by the agency of ice; but after the remarkable discoveries of Venetz, Charpentier, Agassiz, and others, of the great extension in Europe of moraines formed by ancient glaciers, it is necessary to observe, that neither the ‘till’ beds of eastern Tierra del Fuego, which pass into and are regularly interstratified with a great formation of horizontally laminated sandstone, containing marine remains; nor the stratified gravel and till, which form low plains on the shores of Chiloe, and cap in regular beds the tertiary strata, can have been produced like ordinary moraines; and, therefore, that the imbedded boulders cannot have been propelled by the glaciers themselves. I am led to the same conclusion with respect to the till of southern Tierra del Fuego, which forms a level plain and a fringe around several islands, and which in one part passes into a regularly stratified deposit. The boulders on the lower levels at the head of the Santa Cruz river are strewed on land, which certainly has been modelled by the action of the sea. Those on the 1400 feet plain are sixty-seven miles from the Cordillera, of which the highest pinnacle is only 6400 feet, and the general range considerably lower; this little inclination of the surface, with the absence of mounds or ridges on it, and the angularity of the fragments, are opposed to the notion that the blocks have been pushed to this great distance by glaciers. Hence I conclude, that in the two first-mentioned districts it is quite certain, and in the three latter highly probable, that the boulders were transported by floating ice. . . .

“It appears that masses of floating ice, by which fragments of rock are conveyed, are produced in two ways, and under circumstances considerably different although often acting together, namely, by the breaking off of icebergs from glaciers descending into the sea, and by the actual freezing of the surface of the sea or its tributary streams. Great boulders can be included in ice by this latter means only (with rare exceptions) where the winter is extremely cold, as in the Gulf of Bothnia and on the shores of North America. A large proportion of the fragments thus enclosed will generally have been exposed to the wearing influences of the sea-beach; and from the ice being in a sheet, they will be liable to be repeatedly stranded in shallow places, and thus to become still more worn. The other method of transportal, namely, by the descent of glaciers to the sea-level, and the production of icebergs, is far from necessarily requiring an extremely cold winter; for the low descent of glaciers seems to depend (other circumstances being alike) in a much greater degree on the summer not being hot enough to melt the ice and snow, than on the winter being very cold. Hence, as I have endeavoured to show in my Journal (chap. xiii), glaciers in South America descend to the sea from mountains not very lofty, and in latitudes extraordinarily low compared with those in Europe under which the same phenomenon takes place; and yet, the vegetable and animal productions of this kind of climate have, in some degree, an inter-tropical character.

“M. Agassiz has shown that blocks of rock are not imbedded in the ice of the Swiss glaciers, except high up near their sources, and that those numerous masses which lie on the surface, from not being exposed to much abrasion, remain angular: hence only loose angular blocks of rock (as was the case with those on the floating ice in Sir G. Eyre’s Sound) can be transported by icebergs, detached from the glaciers of temperate countries. And to effect this, the icebergs must be floated off perpendicularly and in large masses, for otherwise the loose fragments would be at once hurled into the sea. These remarks do not necessarily apply to icebergs formed under a polar climate, for if a glacier in its descent, reached the sea before the fragments of rock which had fallen on the soft snow had come to the surface, icebergs would be produced with imbedded fragments of rock: I have described in the *Geographical Journal* (1839, p. 528) the case of one huge fragment thus circumstanced, seen drifting far from land in the Antarctic Ocean. (Dr. Merten’s [Martens] observed many fragments of rock imbedded only just above the level of the sea in the lateral wall of the glaciers at Spitzbergen, but he never saw any in the cliffs of ice facing the sea—*Edinburgh New Phil. Journal*, 1841, p. 173–76.)

“As one of the above two methods of conveying erratic boulders, namely, that by icebergs from glaciers, is now in action on the South American shores, we are naturally led to conclude, that this was the chief agent in the enormous amount of transportal formerly effected over a more extended area.”