

not be said in recognition of this interest in a branch of science not over-popular in these days, which has led the author to an expense of time and money hardly likely to be appreciated. Still, it is to be regretted that the chief attention devoted to this reproduction was evidently directed to an exemplification of an improbable method of lighting. A second gallery is added to the temple, the trenches sunk deeply in the roof being made accessible by stairs; and these *piombi*. Mr. Fergusson sets apart for the females of the Athenian con-

satisfaction by students of archeology is the arraignment of Mr. Wood, the explorer of Ephesos, whose inadequate publications, and selfish hiding-away of the results of his richly endowed work, deserve all the asperity with which Mr. Fergusson treats them (p. 32).

The printing is careful. We notice few minor errors. Lagardette's folio is dated Paris, 1879, instead of 'seventh year of the republic (1799)'; while 'M.' Boetticher's essay, published at Potsdam in 1847, is said to be without date.



SCALLOWAY FROM THE NORTH-EAST.

gregation, who must have been as uncomfortable there as the most confirmed misogynist of antiquity could have desired. The staircases, by the way, present in the section (pl. 3) a curiously impossible arrangement, approaching from either side as they ascend, so as to intersect at the level of the gallery, and leave no landing-place, — not a good instance of that application of common sense to the study of Greek architecture which Mr. Fergusson so warmly advocates. It has, moreover, been ascertained that the stairs in the Parthenon were situated where they might naturally be expected, — next to the entrance-door, not at the farther end of the-naos.

A part of the book sure to be read with great

THE ORKNEYS AND SHETLAND.

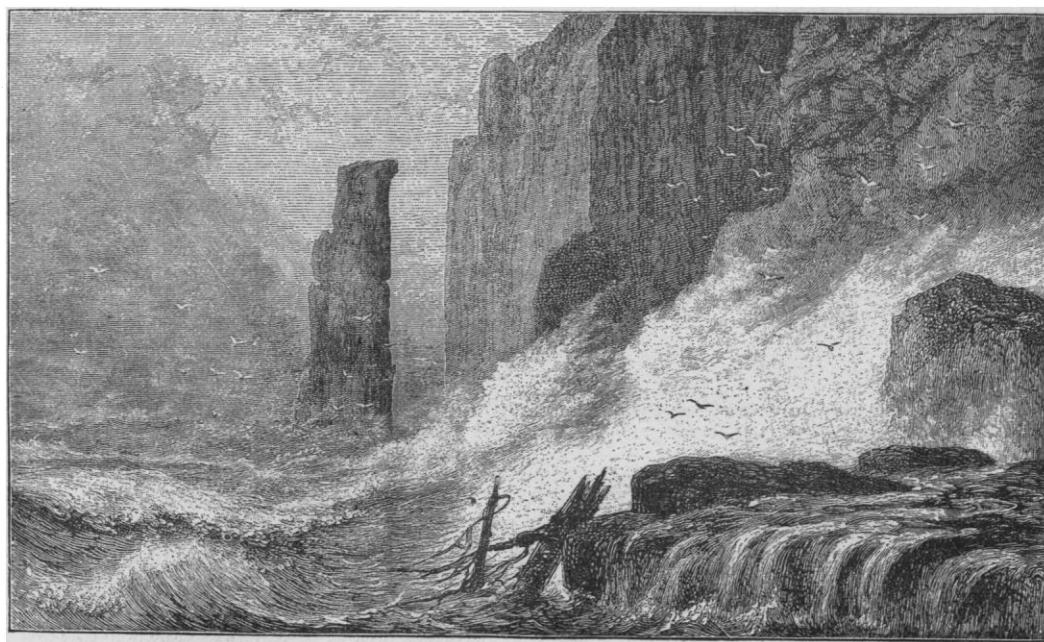
The Orkneys and Shetland; their past and present state. By JOHN R. TUDOR. London, Stanford, 1883. 29+703 p., illustr. 8°.

MR. TUDOR has collected and revised a series of letters published under the *nom de plume* of 'Old Wick,' in *The field*, the English sporting-journal, from 1878 to 1880, on the Orkneys and Shetland, and, with contributions from several scientific friends, has prepared a very entertaining book on these out-of-the-way islands. The general reader will find in it an interesting historical essay, embracing the period from Norse occupation to modern times, followed by local descriptions and numerous

maps, that may well serve as a visitor's guide. Primitive old-fashioned ways have endured on these remote islands till recent times, and furnish many anecdotes to enliven the descriptive pages. The more scientific student, with a liking for botany, geology, mineralogy, or archeology, will meet with much worthy of his attention.

The two geological chapters, prepared by Messrs. Peach and Horne from their papers published in the *Quarterly journal* of the geological society and elsewhere, are of chief scientific value, and are well illustrated by neatly colored maps. The southern group is shown

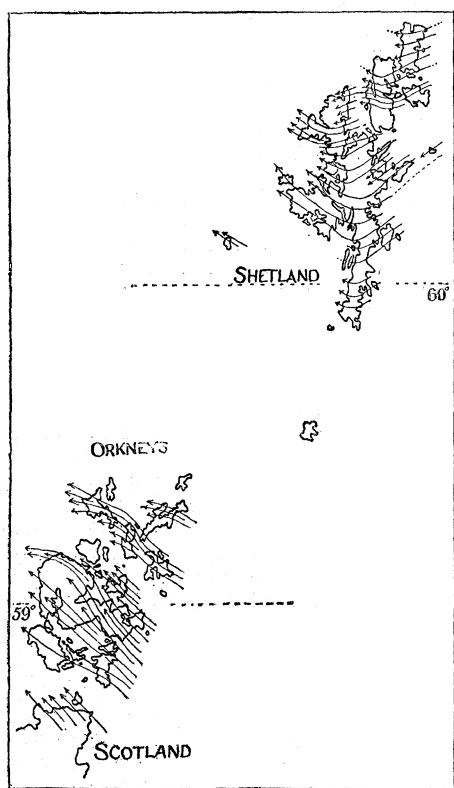
siderable variety of old metamorphic rocks, and numerous intrusives and eruptives. The relations of the latter to the adjoining masses is often finely exposed in the sea cliffs, and questions of age are not left to vague inference. Dikes, necks, intrusive sheets, and overflows are all well exhibited. But the geological interest culminates in the glacial question. These northern islands give the key to the movement of the combined Norwegian and Scotch ice-sheets, and show, as was first suggested by Croll, that they joined forces in the basin of the North Sea, and together moved north-westward, out into the Atlantic. The striae are of



RORAY HEAD AND THE OLD MAN OF HOY DURING A WESTERLY GALE.

to be almost entirely covered by the various divisions of the old red sandstone; and, indeed, this formation once extended over a great area thereabouts, now broken up into ragged islands by dislocation, erosion, and submergence, so that only the smaller part of the original deposit remains. The topographic effect of former erosion at a higher level, followed by depression, is seen in the irregular shore-line and fringe of islands shown in the view of Scalloyay. In their present attitude, the islands suffer most along their western coast, where the heavy waves of the Atlantic cut them back into imposing cliffs, such as are found on the western side of Hoy. Shetland includes a con-

two dates. The later ones depend on the local topography for their direction, and are referred to a 'later glaciation,' though it is not shown that a non-glacial interval separated this from the greater or primary glaciation, during which the ice moved independently of local topography, over-riding all the hills and ridges. Only these are shown on the accompanying outline, which is traced and reduced from two maps of much larger scale in the original. On the Orkneys the scratches run north-west with much regularity. Marine shells and rocks derived from eastern Scotland are found in the boulder-clay. On Shetland the approach of the ice was from the north-east,



COURSE OF GLACIAL SCRATCHES.

but the motion changed to north-west about the middle line of the group. The great variety of rocks in north and south strips gives abundant opportunity for determining this motion by the direction of dispersion of the boulders from their parent ledges. No Scottish boulders are found here, nor do marine remains occur in the drift. Raised beaches do not appear on any of the islands. It is concluded that Scandinavian ice covered Shetland, while Scottish ice advanced over the Orkneys; the original motion of both glacial sheets being changed where they coalesced, in the shallow North Sea, and turned to the line of least resistance, — north-west to the open ocean. There they must have ended in a great ice-cliff like that discovered by Ross in the Antarctic Ocean. It may be well to refer here to Helland's study of the Faroes a few years ago, when he showed that they bear no marks of continental glaciation, the few scratches he found there depending on local form for their guidance.

Our space forbids mention of the many other interesting topics that Mr. Tudor's book discusses, although few volumes contain so many pages of entertainment to the general reader; but attention should be called to the well-considered character of the work, only seldom marred by a remnant of newspaper style. In its table of contents, illustrations, glossary, bibliography, and index, the volume is all that can be desired.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

MATHEMATICS.

Partial differential equations.—M. Darboux considers an arbitrary partial differential equation, defining a function, z , of any number of variables. Replacing z by $z + ez'$, developing according to powers of e , and equating to zero the coefficient of e , a new equation is formed, which the author calls the auxiliary equation. The auxiliary equation defines solutions differing infinitely little from a given solution; and so it has a signification which does not depend on the choice of variables, and which will remain unchanged by any arbitrary change of the variables. The equation, being linear, is easy to deal with, and conducts to many important results which are intimately connected with the given equation. The author considers especially two geometrical problems. First: having given a surface, Σ , attempt to find all the infinitely near surfaces which will form with Σ one family of a triply orthogonal system. This problem, which has already been studied by Prof. Cayley, is equivalent to either of the following problems: 1°, To find all surfaces admitting of the

same spherical representation as Σ ; or, 2°, To find all the systems of circles normal to the family of surfaces of which Σ is one. It follows at once, that, if the problem of the spherical representation of Σ is solved, the solution can be at once arrived at for the inverse surfaces to Σ , or the surfaces arrived at by the transformation by reciprocal radii.

The second problem considered by M. Darboux is one famed for its extreme difficulty; viz., to find the surfaces applicable to a given surface. Denote by dx , dy , dz , the increments taken by x , y , z , in passing from a point of the given surface, Σ , to the corresponding point on an infinitely near surface: then, expressing the necessary condition to the solution of the problem, — viz., that the small arc shall not change its length, — we have —

$$dx d.\delta x + dy d.\delta y + dz d.\delta z = 0.$$

Replacing δx , etc., by proportional quantities, — say, x_1, y_1, z_1 , — this is $dx dx_1 + dy dy_1 + dz dz_1 = 0$; i.e., the corresponding elements on the surfaces Σ and Σ_1 are orthogonal. M. Darboux's problem is thus conducted back to a problem solved by M. Meunier. The