case of two "zungenbecken" or "central basins" relics of piedmont glaciers on the north side of the mountain.

Coming now to the important matter of depositional evidence, that is, moraines, boulder-clay, etc., we are presented with an interesting story leading to the postulation of three glaciations, associated with three distinct types of boulder-clay. The two lowland types are illustrated in Fig. 1, which shows the incorporation of blocks of the earlier well consolidated dark red variety by the later brick-red less consolidated one. The latter is more widespread and has undergone less laterization. It is important to note, in view of Barbour's earlier objection that the boulders in the boulder-clay were invariably hard quartzites and grit, that Lee now emphasizes their lithological variety. Lateral and terminal moraines, a block moraine, and an outwash apron are instanced, though a fuller development of these is said to be lacking as a result of excessive, inter- and post-glacial destruction. Solifluxion has been found inadequate to explain the transfer of large blocks over the long distances required; the famous Poyang Lake section of glacial drift containing such boulders is 9 km. from their source in the Lushan, and the intervening pre-glacial gradient is negligible, yet is, according to Lee, demonstrably greater than in Boulder Clay times.

Finally, the scratched boulders and striated rock surfaces (Fig. 2) are claimed by Lee to be perhaps the most convincing evidence for glacial operation, and it need only be remarked that Barbour's scepticism on this matter must have created in Lee a strong urge to test this type of evidence very thoroughly. W. L.

Obituary Notices

Dr. G. E. Hale, For.Mem.R.S.

BY the death of George Ellery Hale on February 22, at Pasadena, California, solar physics loses its greatest leader. Born in Chicago on June 29, 1868, he had already in 1890, before completing his studies at the Massachusetts Institute of Technology, begun working at the Harvard College Observatory on his idea of a spectroheliograph. Resisting the temptation to accept Prof. Holden's offer of opportunities to develop his new instrument in connexon with the 36-in. refractor at the Lick Observatory, he established with his father's help a private observatory at Kenwood, in a suburb of Chicago. There, working in the fourth order of a 4-in. Rowland grating attached to a 12·2-in. equatorial, he studied the spectrum of the solar prominences and photographed them in monochromatic light, using first of all the bright K line of calcium. As he found by photographic spectroscopic observations that the bright K_2 line could be detected here and there on the disk of the sun, he extended his work to monochromatic studies of the whole solar disk, finding the presence of great areas of glowing calcium clouds in general around sunspots. By 1892, his pioneer work had won for him recognition by the University of Chicago, of which he became an associate professor.

Through the munificence of C. T. Yerkes, by no means the last wealthy man in whom Hale was to inspire confidence in his ability to make excellent use of large benefactions, he was given charge of the new Yerkes Observatory at Williams Bay, Wisconsin, with the largest refractor in the world (40-in.) and with the Rumford spectroheliograph, which gave him an image of the sun 6·5 inches in diameter. At the Yerkes Observatory with Barnard, Burnham and Frost to help him he worked steadily for nearly ten years on stellar spectra and solar problems. The next great instrumental development became possible for him in 1904, through the generous assistance of the Carnegie Institution, when he was made director of the Mount Wilson Observatory. Here he successfully developed the tower telescope (60 ft. and later 150 ft.) with underground spectrographs (30 ft. and 75 ft.) for solar work; for high dispersion stellar spectra and work on distant nebulæ the 60-in. and 100-in. reflectors were available, the latter being due to the munificence of J. D. Hooker. He gathered a great team of colleagues together, and the publication of the annual report of the Observatory became one of the major events of the astronomical year. Hale's own contributions were mainly on the solar side and included such outstanding discoveries as that of the intense magnetic fields in single sunspots, the existence of bipolarity in groups of spots of opposite polarity, the change of polarity of such bipolar spots after each sunspot minimum and the relatively weak general magnetic field of the sun (a full account of Hale's solar work is given in an article by Prof. H. F. Newall in the series of Scientific Worthies in NATURE of July 1, 1933, p. 1).

In 1923, under the strain of his many activities, Dr. Hale's health gave way and he retired from the active directorship of the Observatory to become honorary director. But his work was not done. On the observational side, he developed the spectrohelioscope, now a valuable instrument in the study of solar eruptions of short duration and of their reaction on the terrestrial ionosphere; on the administrative side he was mainly responsible for securing in 1928 the grant from the Education Branch of the Rockefeller Foundation, which made it possible to undertake the heavy task of constructing a reflecting telescope with a mirror 200 in. in diameter. Hale took a large share in the preliminary

studies and work necessary for the successful completion of this project.

As an investigator, Hale did as much as one man could be expected to do. But his scientific activities covered a much wider range. As foreign secretary of the National Academy of Sciences he was active in establishing the National Research Council of the United States, of which he remained honorary chairman until his death. His international work in astronomy began in 1895 with the foundation of the *Astrophysical Journal*, following upon the publication three years earlier of *Astronomy and Astro-Physics*.

Then in 1904 at St. Louis came the foundation of the International Solar Union on Hale's initiative. President at its first meeting, he, with Schuster and Arrhenius, was elected on to its first executive committee, remaining a member of it throughout the life of the Union. In 1919 came the formation of the International Research Council with Hale as an active member of the original executive committee; later he became president for the years 1934–37 of the International Council of Scientific Unions. In the International Astronomical Union formed under the auspices of the Council, Hale was elected president of the Commission of Solar Physics (1919–25).

Honours and awards came to Hale freely from scientific bodies and universities all over the world. To mention only those from Great Britain, they included honorary degrees from Oxford, Cambridge and Manchester, medals from the Royal Institution and the Royal Astronomical Society, of which latter body he was an associate. Foreign membership was given him by the Royal Societies of Edinburgh and Dublin, by the Cambridge Philosophical Society and by the Royal Society, which in 1932 awarded him the Copley Medal, primarily for his work on magnetic fields in the sun.

F. J. M. STRATTON.

ANYONE meeting George Ellery Hale must, I think, have felt at once that he was somewhat out of the ordinary run of scientific men. We knew he was a great figure in science, but felt that he could have been equally great at almost anything else. For Nature had not only endowed him with those qualities that make for success in science—a powerful and acute intellect, a reflective mind, imagination, patience and perseverance—but also in ample measure with qualities which make for success in other walks of life—a capacity for forming rapid and accurate judgments of men, of situations, and of plans of action; a habit of looking to the future, and thinking always in terms of improvements and extensions; a driving-power which was given no rest until it had brought his plans and schemes to fruition; eagerness, enthusiasm, and above all a sympathetic personality of great charm. This great and varied array of talents gained for him the complete confidence of everyone he met, from the highest to the lowest.

I never ceased marvelling at his great knowledge of almost every department of observatory work. He was not only for many years director of the great observatory which was so largely his own creation, but also had made himself an expert in most of its varied branches; and I know from my own experience how genuinely he could interest himself in other people's scientific work and ideas, and how warmly and sincerely he could give encouragement.

It was a great tragedy that indifferent health so restricted his activities in the latter years of his life—his ever-eager mind and ardent spirit had made too exacting demands on a none too strong body; it is an even more poignant tragedy that he has not lived to see the completion of the great new telescope which will owe so much to his forethought and planning.

J. H. JEANS.

THE death of Dr. G. E. Hale, coming at the end of a slow decline of strength such as he has suffered since July 1936, can scarcely be regarded as other than a merciful release from protracted suffering. The sincere sympathy of his very numerous friends goes forth to his wife and family and relatives, and the memory of a very remarkable personality will be widely cherished.

His geniality and his interest in a wide extent of natural knowledge and of art and literature and history made him a very welcome companion.

Hale was in truth a leader not only in his own chosen investigations in solar physics but also in the initiation and furthering of organization of scientific co-operation. By a rare combination of personal qualifications of which he seemed to be entirely unconscious, he achieved early in life recognition of his power to evoke enthusiastic support in developing available resources for the advancement of natural knowledge. In 1890 he had resisted an offer of the director of the Observatory on Mount Hamilton in California, an offer that he should have the use of the Lick refractor during stated hours in the week for the development of his spectroheliograph. Fortunately, through the wise advice of his father, he decided to utilize full time with a 12-in. refractor specially constructed at the expense of his father. After a couple of years of successful observations in the Kenwood Observatory he was called upon to take charge of the new observatory in Wisconsin, where a finished product of the workmanship of Alvan Clark in the form of a 40-inch achromatic objective, which Hale's enthusiasm had induced Mr. C. T. Yerkes to purchase, was to be mounted in the Yerkes Observatory of the University of Chicago.

In 1904, Hale received noble encouragement from the trustees of the Carnegie Institution to found a Solar Observatory in California, and there he began that very notable succession of advances based on experimental trial on relatively small scale and leading to successively increased power of instrumental equipment on novel lines. Aided by funds contributed by the Carnegie Institution, by Miss Snow, by Mr. J. D. Hooker, by the Rockefeller Foundation and probably also by other sources, there arose on Mount Wilson the observatory provided with extensive workshops and physical laboratories and devoted to the intensive study of all branches of astronomy and many branches of physics.