The Brithidir—in some parts called the Tillery—seam of coal constitutes the dividing plane between the Pennant Sandstone and the Lower Shale series.

In a section taken at right angles across the valley at the point where the landslide—the subject of the present notes—is taking place, that is, about one and a half miles higher up the stream than the point at which the Brithidir seam dips under it, the bottom of the valley is 750 feet wide and 700 feet above sea-level; the outcrops of the Brithidir seam are 3000 feet apart and 1000 feet above sea-level, and the summits of the Pennant Sandstone are about one and a half miles apart and 1300 feet above sea-level. The average inclination from the outcrop of the seam to the bottom of the valley on each side is thus approximately 1 in 4.

Above the outcrops of the seam the ragged edges of the sandstone escarpments are seen projecting above the accumulations of débris which hide their bases; below the outcrops a superficial, grass-grown deposit, partly perhaps of Glacial origin, consisting of earth, clay, sand, and stones, probably not more than from 10 feet to 20 feet thick at any point, and possibly thinner in many places, lies upon and entirely conceals the shales. Part of this deposit, having a width of between 2000 feet and 3000 feet measured along the line of the valley, is known to have been slowly moving down the western slope ever since the Rhymney Railway was constructed across it, near the bottom of the valley, some fifty years ago. The excessive slowness of its general motion is shown by the following facts:—first, the railway, together with a stone bridge over it, has only been carried to a distance of from 6 feet to 10 feet eastwards from its original position during the whole of that long period of time; secondly, the arch of the bridge, which, although damaged and partially distorted, was prevented from being entirely broken up by placing heavy balks of timber between its side-walls under the level of the rails, was only removed, and replaced by a girder bridge, three years ago; lastly, the river, which flows at the foot of a steep bank, not far from the railway bridge, has retained its old channel, and has been able to carry away the débris from the foot of the moving bank sufficiently fast to prevent the latter from invading its bed.

Although the general movement of the ground is so slow and uniform that the roads and fences, and the vegetation which grows upon the surface, give no clue as to what is taking place over the greater part of the affected area, there are local indications here and there which show that a number of smaller and comparatively rapidly moving landslides have occurred within the larger area from time to time. One of these smaller landslides recently damaged the village of Troedyrhiwfuwch, situate near the upper end of the moving slope. This village consists of a public house, a school-room, and two rows of twenty or thirty houses, built upon the opposite sides of a road which runs parallel to the valley at a height of about 200 feet above the river. The pine-ends of many of the houses, in the row nearest the centre of the valley, appear to have lately undergone substantial repairs, and the public house has been entirely re-built, with its foundations, it is said, now resting on the solid rock. The gardens of the houses nearest the northern end of the row now under consideration, together with the division walls between them and the outhouses contained in them, have been ruined beyond repair, and part of the ground on which the gardens were formed has been broken and piled up behind the houses like the front of a wave advancing down the slope, and appears to be still moving.

In this part of the coalfield, as well as over practically the whole of Monmouthshire and part of East Glamorganshire, the strata immediately underlying the Pennant Sandstones consist of a succession of red and blue shales and marls of greater or less thickness. In the New Tredegar pits, which are not far from this locality, the red and blue ground has a thickness of more than 300 feet. This is, therefore, the kind of ground upon which the landslide is taking place. But as most strata of this kind disintegrate and soften when exposed to air and moisture, it is not improbable that this property of theirs accounts, to some extent at least, for the gradual movement of the deposits lying upon them on the west side of the valley, and that it may be likewise responsible for the more sudden landslide that took place a year or two ago on the opposite side of the valley, which seriously damaged both the Brecon and Merthyr Railway and one of the Powell Duffryn collieries which lay in its path.

My thanks for information concerning the Rhymney Railway and the bridge over it are due to Mr. Cornelius Lundie, formerly general manager, and now consulting director, to the railway company, who has known, and has had occasion to observe, the movements taking place in this locality for the last forty-five years, and is therefore thoroughly conversant with the subject.

W. GALLOWAY.

THE LAW RELATING TO UNDERGROUND WATERS.

IN one of the State papers recently issued by the department of the United States Geological Survey there is a report by Mr. D. W. Johnson dealing with the rights of landowners and others to underground waters, for the purpose of giving the owners of such waters some idea of their rights and obligations.[1]

The report is not intended to be a legal treatise, but as a practical guide for the officers of the hydrological department, showing the relation of the law to problems which are of a more or less hydro-geological character.

The law relating to underground waters in the United States is practically the same as in this country, and the decisions given in the courts there are founded on British precedents modified in some cases by the different circumstances of the two countries.

Underground water is held to comprise all water which for the time being is below the surface of the ground, whether by penetration of the rainfall or soakage from rivers and lakes, and which is dissipated throughout the mass of porous soil or rock, except in cases where the underground water can be traced as moving in a well ascertained and definite course that can be located.

The fundamental principle upon which the laws regulating the use of underground water is formed is this:—That such percolating subterranean waters are a part of the land itself. The land belongs to the owner, whether it be rock, porous ground, earthy matter, or part soil and part water, the water being as much his property as rock, ores, or minerals. Consequently, he may take and use such waters as he pleases, even though such use may damage his neighbour by removing or diminishing water from adjacent wells or springs, by causing subsidence to land or buildings by abstraction of the water, or by rendering the water useless by pollution from sewage or refuse from factories or mines, &c.

This principle has been admitted in the decisions given by the courts owing to the difficulty of proving how much of such water was within the limits of any given area, how much comes from adjacent land, or how much passes from one man's land to that of his neighbour, and the impossibility of predicting what result may ensue from interference with what has been regarded as an unknown quantity. There are, of course, local circumstances or conditions which modify this general statement, but, broadly, this is how the law stands at present.

In the United States, however, conditions have for some time past been undergoing an alteration, and the investigations and observations undertaken by the hydrological department of the Government have been throwing considerable light on the action of underground waters. In many cases the original lack of knowledge which was the reason for the ruling of the law as it now stands has already disappeared.

We recently gave a short illustrated description of the methods adopted by surveyors of the department for measuring and defining the rate and direction of the flow, and more particularly for showing the effect of percolation of deleterious matter from factories, oil wells, &c., on the underground supply of drinking water (NATURE, December 21, 1905).

[1] "Relation of the Law to Underground Waters." By D. W. Johnson. Water Supply and Irrigation Papers, No. 122. (Washington: Government Publishing Office, 1905.)

The state of knowledge regarding the properties of underground water may be said now to have become in advance of the ruling of the courts on some of the questions involved. The earlier legal decisions were made when little or nothing was known regarding the action of the water beneath the surface. Since then the progress of hydro-geological science has established as facts many things regarding underground waters previously unknown or only speculative, and the knowledge of the working of underground waters remains much less in the realms of the "secret, occult, and concealed." It has now become possible to define certain rights in these waters and to protect these rights equally as well as those in surface waters.

A case recently dealt with in one of the American State courts directs attention to the importance of emphasising the influence that the ever-increasing knowledge concerning underground waters may have in governing legal decisions. In an action brought in the State of Pennsylvania regarding the pollution of underground water, the judge remarked:—Geology has become a progressive and in many respects a practical science. More deep wells have been sunk in one State of America than had previously been dug in the entire earth in all time; and that which was formerly held to be unknown and merely speculative regarding the properties of underground water has been by experience reduced almost to a certainty. If it can be shown that the work done by the owner of the land would cause the inflow of salt water or oil to mingle with fresh water, and the means of preventing the mixing are available at a reasonable expense, then clearly it is a violation of the spirit of the law not to recognise the change, and to apply the settled principles of right to the altered conditions of fact.

In another case tried in California it was held that the usual rule of common law on the subject of percolation was not to be held as applying to an arid district that depended entirely for its cultivation on water derived from underground sources, and where the conditions were totally different from those existing in the locality where the rule in question was first established, and therefore an owner has no right to injure his neighbour's land by any unreasonable diversion of underground water by transferring the same for gain to another district.

PHYSICAL RESEARCH IN AMERICA.

TWO volumes, representing the first instalments of what is promised to be an annual publication, have been received from the physical laboratories of Harvard University.[1] Each contains fourteen papers contributed by the professors, staff, and students. In the preface the director, Prof. Trowbridge, acknowledges the great stimulus received by the establishment of the Thomas Jefferson Coolidge research fund, which has provided the laboratory with what the volumes show to be a very fine equipment, and has greatly increased the enthusiasm for physical research.

Most of the papers included are reprints from the *Proceedings of the American Academy* and the *Astrophysical Journal*. It is hardly possible to speak too highly of the handsome treatment they have received at the hands of the printer and binder, and especially of the manner in which the numerous plates have been reproduced. The range of subjects treated is a very wide one, and in a review of this kind it is not possible to deal with each paper individually.

In the first volume Prof. Trowbridge contributes an interesting paper on the spectra of gases and metals at high temperatures. He attempts to apply electrical stimulus of known amount to the gas in a vacuum tube by discharging through it a condenser of known capacity charged to a high potential by his powerful accumulator battery, by which he can obtain pressures up to 40,000 volts. He contrasts the relative intensities of the lines in the spectra thus obtained with the results got by other methods. When theorising on the relative volatility of metals it is desirable, however, to adopt more accurate data than some of those used in this paper, where "soft-iron" is said to melt "not far from 1100°," and aluminium "between 700° and 800°," instead of 657°.

Spectroscopy is evidently a favourite study in the laboratory, since five papers in each of the two volumes are devoted to it. Mr. Lyman gives an explanation of the "ghosts" and "false spectra" sometimes met with when using gratings, particularly in the extreme ultra-violet, and shows in a number of cases the relation between the wave-lengths of the various false lines and those of the parent lines to which they are due.

In another paper he discusses the various kinds of pro longations of spectral lines met with when using gratings, and shows them to be due to a cause quite different from Sir Norman Lockyer's "long and short lines."

Another interesting paper is by Mr. Morse on the spectra from the break in the Wehnelt interrupter, which appears to give spectra of a special character not classifiable under the division of "flame," "arc," "spark," or "enhanced spark."

Mr. B. O. Pierce contributes, in continuation of an earlier research, papers on thermal conductivity of rocks, one of which must have involved a long period of painstaking work. The apparatus employed was on a scale only possible where very considerable funds were available.

Prof. Hall has a paper on a theory of thermoelectric action, and, along with three other workers, one on thermal and electrical effects in "soft iron."

In several instances, work commenced in the laboratory appears to have been dropped on the publication of some paper slightly overlapping the research contemplated. It is a pity, for example, that the fine resistance bridge for platinum thermometry, described by Mr. Edwards, should not be used to solve some of the problems for which it is suited, and that the construction of a gas thermometer should not be proceeded with because of the publication during the past few years of several researches on gas thermometry.

Though none of the papers appear to be of epoch-making importance, the volumes show how a well equipped laboratory may contribute substantially to the advancement of knowledge. It would be interesting to see what effect the endowment of a representative physical laboratory in this country, with funds for research purposes, would have on the character of the work done, especially if at the same time it were possible to arrange that members of the teaching staff should have a more reasonable proportion of their time to devote to research work.

J. A. H.

[1] "Contributions from the Jefferson Physical Laboratory of Harvard University." (Cambridge, Mass., vol. i., 1903; vol. ii., 1904.)

FIREBALL OF JANUARY 27, 1906.

A MAGNIFICENT fireball was seen by many persons in the north of England on the evening of January 27 at 8h. 33m. Descriptions of its appearance have been received from Hull, Bramley, Bradford, Patrington, and other places in Yorkshire, from Sleaford and Billingborough in Lincolnshire, from Cheadle, Staffordshire, &c.

Mr. H. Beckwith, at Hull, observed the meteor travelling horizontally between the "square" of Ursa Major and the Belt of Orion, while at Cheadle, Miss Blagg noted the path as just above ζ Leonis. Mr. R. Felton, at Patrington, estimated the brightness of the object as quite equal to that of the full moon. It left a trail visible for some time afterwards; one observer says it remained for five minutes, two others estimate the duration as eight minutes, while at Billingborough a spectator watched it for more than ten minutes.

The meteor gave a very brilliant flash near its end point, and the suddenness of its apparition startled many people. Several of the observers were enabled to give the position of its flight with fair accuracy from the luminous trail it left behind.

The radiant point appears to have been near θ Boötis, or in $214°+53°$, and the height of the meteor was from about 59 to 45 miles over the North Sea immediately east of the Lincolnshire coast. The disappearance occurred at a point over "the Wash," about 6 miles S.S.E. from Wainfleet. The length of observed path was approximately