place your elbows at a convenient distance apart. This position evidently leaves a space between your chest and the back of the chair equal in length to your fore-arms, which are extended horizontally. Miss Lulu now takes a position beside you, and, holding her body back, simply places the palmar surface of her hand on the back of the chair on the side towards your body. After a few moments she seems to make the effort to detach her hand from the chair, which latter you are privileged to push forwards. The force at work, however, is too strong for you, and both yourself and the chair are carried backwards, without her hand having changed its position. The chair being a cane-backed one, it is evident that she could in no way gain a hold upon it, and the back of her hand never could come in contact with your chest, as the spanning of such a distance would at once be detected.

Professor Newcomb's conclusions, after having witnessed the test of lifting a chair with some one sitting in it, are to me far from satisfactory. I saw the girl lean over an ordinary chair, with a man weighing over two hundred pounds sitting in it, and placing the palmar surfaces of her hands on the outer sides of the rear uprights near their middles, and *without any* contraction of the muscles of the arm or fore-arm, or increase of pulse (remained at 80) or respiratory effort, or change of countenance due to exertion, so far lift that chair and its heavy contents from the floor as to compel the latter to get out of it; and this without fracturing any of the bones of her upper extremities, or the sides of the chair. The simplest computation will prove that the *lateral pressure* required must be enormous in order to get a hold, and prevent such a weight absolutely slipping between her hands when the upward force comes to be exerted.

R. W. SHUFELDT, U.S.A.

Fort Wingate, New Mexico, Feb. 19.

THE MICROSCOPE IN GEOLOGY.

MANY persons have heard that the microscope, everywhere recognized as indispensable in the investigation of organic nature, has also recently been made use of in geology; but very few have any distinct notion of the sort of problems to which it can there be applied, or of the way in which it can contribute toward their solution. The determination of the different minerals which compose very fine grained rocks may doubtless appear, even to many geologists who have been accustomed to deal with only great areas and mountain masses, a matter of small importance; and they often fail to see that the methods which render such a determination possible, are capable, if properly employed, of throwing much light on some of the most difficult questions with which they have to deal.

The microscopic study of rock-sections is one of difficulty, and indeed quite discouraging to a beginner who attempts it without proper guidance, no matter how familiar he may be with mineralogy, or with the use of the microscope in other fields of research. This fact, coupled with the newness of the branch, sufficiently accounts for the number of workers in it still being so small in this country, which presents unrivalled opportunities for its cultivation.

Although the idea of preparing rocks in transparent sections for the microscope originated with an Englishman, the fruitful line of research to which it gave rise has since been almost exclusively cultivated in Germany. Here the seed fell into soil made already fertile by the labors of older geologists, and sprang at once into a strong and rapid growth. The keen perception and great energy of Zirkel first made known the microscopic appearance of the common rock-forming minerals, as well as discovered the wide distribution of others before considered rarities. Vogelsang, not contented merely to observe, was able to draw from his studies the most suggestive conclusions, which he substantiated by ingenious and delicate experiments. It is, however, to Rosenbusch that the development of petrography as a science is most largely due. In his work, published in 1873, he showed in a masterly manner how what had been learned of the optical properties of different crystals, especially their action on polarized light, could be applied to their identification in thin sections, thus rendering a rigid microscopic diagnosis for the first time possible. From this time on, the interest in this branch of investigation became in Germany very general, and its growth proportionately rapid. The attainment of the long-desired separation of rock constituents, even when of the smallest size, by means of solutions of high specific gravity, and the perfection of many micro-chemical reactions of great precision, followed each other in quick succession, until to-day the accuracy and beauty of petrographical methods are hardly second to those found in any other branch of natural science.

The geologists of other countries on the continent, especially in France and Scandinavia, soon perceived the value of the German work, and early availed themselves of its results to start similar investigations in their own countries. It is a surprising fact that the appreciation of it among English-speaking people has been so slow, that not one reliable text-book on the subject of petrography exists in the language of the man who gave the first impulse to its modern development. Any knowledge of the subject in America is recent, dating from the publication of Zirkel's 'Microscopical petrography' in 1876. How steadily the inter-

est in it is increasing, however, may be judged from the number of American students who have been and still are pursuing it at various German universities. What is needed in this country are well-equipped petrographical laboratories, so that those who are unable to avail themselves of the facilities which Europe affords may not be compelled to remain in ignorance of what is daily becoming a more and more necessary part of a geologist's training. An attempt to organize such a laboratory has recently been made at the Johns Hopkins university and the encouragement which it has already received seems to abundantly justify the experiment.

Heretofore microscopical petrography has been essentially a branch of mineralogy, but its future certainly lies in the far wider sphere of geology. The mere laboratory study of isolated rock-specimens, which has served so good a purpose in the perfecting of delicate and accurate methods, no longer possesses any significance, now that these are so thoroughly developed. What in Germany has been secured by years of patient labor may now be learned in a comparatively short time. Geologists have only to know and realize its application to their field of work, in order to eagerly avail themselves of such an important aid. The use of the microscope alone will in future produce but little that is new; but its possibilities in geology, when intelligently employed in connection with the most detailed and careful field-work, — the necessity of which has been increased, not diminished, by its introduction, — cannot be easily overrated.

What paleontology has done for the fossiliferous deposits, this, and even more, the microscope must do for the crystalline rocks. The less altered forms of igneous masses have thus far been almost exclusively studied; and, although they still have much to teach us, it is not by their investigation that the microscope is destined to yield its greatest assistance to geology. The changes, structural and chemical, which go on in rocks after they are first formed, leave behind them more or less distinct traces which it is the special province of the microscope to follow out and interpret. Of how much has already been learned regarding the alteration of sedimentary rocks near their contact with eruptive masses, the work of Rosenbusch in the Vosges Mountains, of Lossen in the Hartz, and of Hawes in New Hampshire, is abundant proof. The wide-spread changes which rocks subjected to regional metamorphism have undergone, are far more complicated and difficult, but they can undoubtedly be studied with as great success. It is by dealing with such problems as Lossen, Renard, and Lehmann, in Europe, and Wadsworth in this country, have especially pointed out, that the microscope in geology can in future render its best service. The manner in which this can be accomplished is by the patient following, step by step, of unchanged rocks into their most completely altered equivalents, and carefully comparing the condition of each constituent at every point. In this manner the succession of changes which they undergo may be as completely worked out as though we could see the process actually going on before our eyes. The alterations of olivine and enstatite to serpentine, of pyroxene to hornblende, and even the reaction of two minerals upon each other in forming a third of intermediate composition, as shown in the rim of amphibole which surrounds olivine where it is in contact with plagioclase, have all been traced by the microscope through every stage. More recently the effects of pressure exhibited by the bending and breaking of crystals, the disturbing of their optical characters, and the local crushing of the rock constituents, have been carefully studied. This is found almost always to be attended by the formation of new minerals, like albite, zoisite, mica, garnet, etc., whose younger origin is only to be proved by a microscopic investigation. It is impossible to mention here a tithe of what has already been done in this direction, although a beginning has hardly yet been made. What are especially to be desired are detailed studies of many small areas, where the same rock, whether eruptive or sedimentary, can be traced from its original form to its most altered state, and a comparison of the results obtained in each. This Lossen[1] has recently attempted for the southern Hartz, and has thereby indicated what is perhaps the most promising field for microscopic work in geology.

GEORGE H. WILLIAMS.

THE SPANISH EARTHQUAKES.[2]

THE Spanish peninsula has been the scene of a series of earthquakes, which, for extended duration and disastrous effects, surpasses any thing that has been felt in that region in recent

[1] Studien an metamorphischen eruptiv- und sedimentgesteinen, erläutert an mikroskopischen bildern. Jahrbuch der preuss. landesanstalt für 1883, p. 619.

[2] In preparing this notice, the following journals have been consulted; viz., Cronica cientifica (Barcelona), Science et nature, La Nature, L'Astronomie, Comptes rendus, Cosmos, Hansa, Nature, and various English and American newspapers.