

person from another country is likely to be. It seems to me, however, that the diminution in the number of geologists, compared with the students of other sciences, if not in absolute number, is clear on simple inspection of the field. It is true not only of Great Britain, but of France and America as well. Of mining engineers there is, I believe, a great plenty; but of men who are trained in field work, who can be trusted to unravel a set of rocks, or who care for the science as a science, and not as a means of winning a living, there are far too few.

A year ago I had to organise a geological survey in the State of Kentucky. I needed three topographers and three assistant geologists who could stand alone. I picked my topographers from over a hundred competent applicants; I should have searched in vain for months for two of my geologists, had it not been that the suspension of the Missouri Survey gave me trained men. But for this I should have been driven to Germany, that inexhaustible reservoir of trained men, for my helpers. In our schools it is still worse: geology is taught in the air, not on the earth. The student never gets into the field for practical work, and the science remains for him a thing of names and shadows. With the hope of doing something to remedy these evils, there is to be a Summer School of Geology, intended for teachers of geology and those who propose to make special workers in the science, taught in connection with the work of the Kentucky Geological Survey; it will be, in fact, though taught in Kentucky for the present, the Harvard Summer Term in Geology, all the instructors in that department from this University taking a part in its work. Eight or more of the assistants of the Kentucky Survey will also be employed as instructors. Already over one hundred persons have applied for admission to the school, but the number will be limited to thirty: this list now includes twenty-five teachers of schools of academic grade, and five graduates of colleges who propose to become geologists. As the school will be placed in a camp, it will be possible, if it succeeds, to establish it in a new region each year, so that teachers attending for, say, three years in succession, may get a fair notion of our rocks, and, what is better, learn how to do field work. I believe that the novelty of the life, the freedom and fresh air, will make it possible for teachers to use their vacation time in study without damage. I am not without hope that in this way teachers may be trained to their work, and beginners provided with that practical introduction to geology which it is now so hard to obtain.

N. S. SHALER

Harvard University, April 18

[We append the programme of the Summer School of Geology referred to by Prof. Shaler, in the hope that something similar may be inaugurated here.]

HARVARD UNIVERSITY.

Summer Instruction in Geology, 1875

In order to furnish an opportunity for teachers in natural science and special students in Geology to become acquainted with the methods of practical work in that science, a Summer School of Geology will be established, during the months of July and August, at a camp near Cumberland Gap, in the State of Kentucky. This place has been chosen on account of the eminent advantages it offers for the study of a great section of the American Palæozoic rocks, and of the structure of the Appalachian Mountains, and on account of the co-operation of the Kentucky Geological Survey which is promised in a letter from the Governor of that State to the President of the University. It is also a very healthy region.

The special object of this school will be to teach students to observe, but instruction will be provided in Physical Geology, Historical Geology and Palæontology, Chemical Geology, and Topographical Engineering, as far as these subjects are connected with geological work. The instruction will be necessarily incomplete, and will be expressly directed to the elucidation of the problems furnished by the area to be explored. The co-operation of six well-qualified instructors has already been secured, and a number of other able geologists have promised their presence and their aid in teaching. Some instruction in the zoology and botany of the neighbouring region will probably be given to those who desire to receive it. Certificates of attendance will be given at the end of the time. The number of students will be limited to thirty, and men only will be accepted. No previous knowledge of the science is required, but only graduates of colleges, teachers, or other persons who can give evidence of maturity and some training can be admitted.

Persons wishing to join the school should at once address

J. W. Harris, Secretary of Harvard College, Cambridge, Mass. Before their enrolment they will be required to pay the fee of fifty dollars for tuition, use of tents and camp equipage, and transportation about camp. In case anyone is prevented from joining the school by illness this fee will be remitted, provided the notice thereof is given before June 15. They will also be required to pay weekly in advance the estimate for subsistence and camp servants (which is not expected to exceed three dollars per person).

Persons joining the school from the west will report themselves on June 24 and June 30, at the terminal station on the Lebanon Branch of the Louisville and Nashville Railroad. Those joining from the east will be met at a station hereafter to be designated on the East Tennessee Railroad, on June 26 or July 1. Persons unable to join on these days should notify the chief of camp, Mr. John R. Proctor, Lexington, Ky., who will arrange for their transportation to camp.

All students are expected to provide themselves with the following articles:—Two blankets, a pocket magnifying-glass, a pocket compass; Dana's "Manual of Geology," revised edition (1874), and Lyell's "Principles of Geology." Suitable note-books will be provided at cost. Students should also provide themselves with two suits of old clothes, flannel shirts, and stout boots. The total amount of baggage should not exceed seventy-five pounds for each person. An effort will be made to secure a reduction of fares on the railroads leading to the camp.

The Attraction and Repulsion caused by the Radiation of Heat

WILL you allow me to say a few words in reference to the report of Mr. Crookes's paper which appeared in NATURE, vol. xi. p. 494. Apparently Mr. Crookes does not understand the nature of the forces which I have shown to result from the communication of heat between a gas and a surface; otherwise he would not bring forward as conclusive against the supposition that the phenomena which he has discovered are due to these forces, experiments which show entirely the other way. As I have previously explained, it follows as a direct result of the kinetic theory of gas, that if such forces as I have supposed exist for a certain tension of the gas surrounding the surface, they will not be diminished by diminishing the tension of the gas; and consequently no amount of pumping would destroy such forces where they once existed. Whereas the smaller the tension of the gas the freer the surface will be to move, and the less its motion would be opposed by convection currents; hence, on the supposition that the motion is due to these forces, the only effect of improving the vacuum would be to intensify the action. An . this being the case, it is clear that Mr. Crookes's experiments, in which he finds that the action still remains in the most perfect vacuum which he has obtained, tend to support and not to upset my conclusion that the actions are due to these forces. The fact that Mr. Crookes finds it impossible to conceive this only shows, as I have said, that he does not comprehend the nature of the forces; for it certainly presents no greater difficulty than the fact that the velocity of sound is independent of the tension of the gas through which it is transmitted.

Mr. Crookes still appears to think that I attribute these forces solely to the presence of condensable vapour. It is true that the title of my first paper might have led him into this error had he read no further; but both in that paper and in a letter to the *Philosophical Magazine* for November 1874 it is clearly shown that this is not the case.

I am in hopes that ere long we may hear something on this subject from Prof. Maxwell, who probably knows more about the kinetic theory of gases than anyone else. If I am right, these experiments afford a direct proof of the truth of this theory; and as far as I know, this is the only direct proof that has ever been obtained. I do not mean to say that this is the most conclusive proof, but the most direct, or, to quote a remark of Dr. Balfour Stewart, "These experiments stand in much the same relation to the kinetic theory of gases that Foucault's pendulum occupied with regard to the rotation of the earth." No one can admire more than I do the experimental skill with which Mr. Crookes has brought the phenomena to light; nor can I see, should it turn out as I maintain, that they have led to the discovery of a law of nature, that this will detract from their importance, even if they lose somewhat in general interest from the breaking up of the halo of mystery with which they have hitherto been surrounded.

OSBORNE REYNOLDS

Owens College, Manchester