eral Vocational Education Board with headquarters in Atlanta, Ga., Dr. Roberts has accepted an appointment as veterinarian with the Rockefeller Foundation and is to be stationed at São Paulo, Brazil, and Dr. Wolf will retain his connection with the North Carolina Agricultural Experiment Station.

Mr. Martin Kilpatrick, Jr., of the division of inorganic chemistry, the College of the City of New York, has accepted a position as assistant professor of chemistry at Vassar College under Professor W. C. Moulton.

Ernest Carroll Faust, A.B. (Oberlin, '12), Ph.D. (Illinois, '17), now instructor in zoology at the University of Illinois, has accepted a position with the China Medical Board, Rockefeller Foundation, as associate in parasitology, department of pathology, Union Medical School, Peking, China. He plans to assume his duties in Peking early in October.

Professor C. R. Marshall, professor of materia medica and therapeutics, University of St. Andrews, has been appointed to the regius chair of materia medica in the University of Aberdeen, vacant by the resignation of Professor Theodore Cash.

DISCUSSION AND CORRESPONDENCE

RADIUM PRODUCTION

To the Editor of Science: In your issue of March 7, Dr. Charles H. Viol makes some comments on statements made by me in a paper presented before the American Institute of Mining Engineers at its September meeting, 1918, at Colorado Springs. The main thing to which Dr. Viol takes exception is the statement of the writer that:

> In my judgment the carnotite fields will not produce more than 100 additional grams of radium element at the most—if that much. This would about double the world's present supply; but on account of the large use of radium in cancer treatment, such an amount, although large scientifically, would be small in proportion to the probable demands.

Dr. Viol states that the estimates of myself and the Bureau of Mines are based on a "very inadequate study of the carnotite region made prior to the war and before the fields had been developed to any great extent"; and he claims that at least 500 grams of radium should be produced from carnotite.

No one can tell exactly how much radium can be produced from the carnotite fields of Colorado and Utah, and any estimate must be very approximate. To some extent, the future production will depend upon the price of radium, as a much higher price for radium would allow lower grade ore to be mined and treated. As the ore always exists in pockets of varied sizes and grades, the mining is very largely confined to outcrops, and this makes the question of an estimation of the probable amount available easier than if mining conditions were such as are met with in connection with other metals. It is true that some drilling has been done, chiefly by the Standard Chemical Company, and a higher price of radium would, of course, allow drilling to be carried on to a greater extent, which would undoubtedly give some increased production. The estimate of 100 grams which I made was based on the present price of radium. But, under no conditions, can I see the possibility of producing 500 grams of radium element from the carnotite fields, or anywhere near that amount.

In reference to our "inadequate study of the carnotite region," I may say that the first statement of the Bureau of Mines concerning these deposits was made in connection with U. S. Bureau of Mines Bulletin No. 70.[1] On page 42 the following is printed:

> The United States possesses unique deposits in these carnotite ores. They constitute at present the largest known supply of radium-bearing minerals in the world. . . . Up to the present, very little interest has been shown by Americans in these deposits, which may not be duplicated in so far as quantity goes in any part of the world.

Up to this time, no one had made a statement of this kind concerning these deposits, but as soon as Mr. Kithil and myself went on record, there was immediately a strong tendency to "go us one better." In Volume 1, page 12, of *Radium*, published by the Stand-

[1] "A Preliminary Report on Uranium, Radium and Vanadium," by Richard B. Moore and Karl L. Kithil, 1913.

ard Chemical Company, we find the following signed by Dr. Brill, Dr. Viol's predecessor:

Conservative experts estimate the amount of uranium in this carnotite belt of Colorado to be about eight million pounds of U_3O_8. According to our experience, this would correspond to an amount of about 900 grams of radium, or about four pounds of pure radium bromide.

It must be remembered that our estimates have not been confined to this first survey. For nearly two years, engineers of the Bureau of Mines were constantly in the Paradox and surrounding regions in connection with the mining and ore-dressing operations of the Bureau, under its cooperative arrangement with the National Radium Institute.

This whole question came up last year at the Senate hearings on "Minerals and Metals for War Purposes." At the hearings, Mr. Flannery presented maps showing the recent drilling operations of the Standard Chemical Company, to which Dr. Viol evidently refers in his article. Mr. Flannery stated that these diamond drill operations had resulted in giving them an undoubted supply of ore for future purposes of at least 6,000 tons. The following is taken from the official report of the hearings:

Mr. Moore. Mr. Flannery, you stated that you had there probably about 6,000 tons of ore you could count on?

Mr. Flannery. Yes, sir.

Mr. Moore. May I ask about what your production of radium last year was?

Mr. Flannery. Our production of radium last year due to lack of transportation and chemicals was about 7 grams of radium.

Mr. Moore. How much ore did you use in that production?

Mr. Flannery. We used originally about 600 tons of the average ore to the gram of radium—that is 1/30 part of an ounce.

Mr. Moore. In other words, you have used about 4,500 tons of ore to get 7½ grams?

Mr. Flannery. I have not figured it out.

Mr. Moore. Therefore, your 6,000 tons would make less than 10 grams; you say you have 6,000 tons roughly blocked out there?

Mr. Flannery. You understand I am speaking now of the ore at the concentrator. Yes, sir; it takes about 600 tons, raw ore concentrated, or about 4 to 1 to give you a gram of radium with our practise.

Mr. Moore. According to your own statement, your total supply of ore would be not more than 10 grams.

Mr. Flannery. The total supply of ore. You mean the total amount to be mined?

Mr. Moore. I mean you have blocked out that; you stated you had about 6,000 tons of ore you could count on. Assuming that to be correct, then you could get from that less than 10 grams.

Mr. Flannery: No, you must figure something on some of that being of a little higher grade. The 6,000 tons of ore will probably run 1½ per cent.

Mr. Moore. I am taking your average production of ore last year as being the average of what you could get out of this, which would mean that there are less than 10 grams that you could count on, assuming that to be correct?

Mr. Flannery. Yes.

Further down on page 402 of the hearings, Mr. Flannery makes the following statement:

As regards the production of ore, Mr. Moore and I had a little talk last Saturday, and he claimed he though there were only 100 grams of radium in the Paradox Valley. I will take a contract for delivering 500 and put up a bond for the amount each year.

This evidence would seem to indicate that with the ore for 10 grams actually in sight, Mr. Flannery was willing to take a contract to deliver 500 grams. Of course, Mr. Flannery had other claims on which there were undoubtedly undeveloped bodies of ore; but the ore supply to which he referred was practically all that had been developed, and the amount was estimated on diamond drilling alone.

The original estimate of the Bureau of Mines was that the carnotite fields would probably yield from 100 to 200 grams of radium element. My more recent estimate represents an intermediate figure, since over 50 grams had been produced at the time it was made.

I have no criticism of the figures given by Dr. Viol in connection with mesothorium. He states however, that:

There are several points whose importance Dr. Moore and the Bureau of Mines have overlooked or minimized in their anxiety to conserve radium.

The points he refers to are as follows:

1. "The probable maximum production of mesothorium will not exceed the equivalent of 6 grams of radium per annum." I am perfectly willing to admit this, but 6 gram equivalents of mesothorium will go a long way toward relieving the present use of radium for luminous paint. This would exceed the average radium production of the Standard Chemical Company for the six years previous to 1918.

2. "The economical use of mesothorium in luminous compounds is only possible a year or two after refining." On the bottom of page 1,181 of my article on radium, referred to above, I stated: "After ripening for about a year after being prepared, it can be used for luminous paint just as efficiently as radium."

3. "For medical purposes, the short life and varying gamma ray activity of mesothorium make this product less desirable than radium." On page 1,182 of my article I state: "Mesothorium can also be used for cancer treatment, although its short life makes it much less desirable for this purpose than radium."

4. Dr. Viol prints a table to show the change of gamma ray activity of mesothorium with time. From this table, at the end of the second year, 78 per cent. of the activity has accumulated; and at the end of the ninth year, on the decay side of the curve, there is still 78 per cent. of the activity left. This would give seven years of useful life in luminous paint. In my paper, on page 1,182 I state: "Its usefulness for such purpose will last for four or five years, which is as long as is required for cheap watches, push buttons, etc."

In the same paper I make the following statement:

But as the physicians and surgeons of the country are not purchasing enough radium to make the industry a financial success, it is natural that the manufacturers should take other means of creating a demand.

The main object of my remarks to which Dr. Viol has taken exception was to try and stir up the medical men of this country as to the future supply of radium. No one can blame manufacturers for getting other uses for their product if the main use is not taken advantage of. If the surgeons and hospitals will not purchase radium, it will naturally go to luminous paint and be used for any other purpose that will create a demand. I believe that Dr. Viol would much rather sell for medical purposes than for miscellaneous uses in which the radium is lost; and the writer would most certainly prefer to see such a condition come about.

During the war, a considerable amount of the radium abroad in England, France and Germany, which previously had been used for cancer treatment, was drawn on for war purposes. Even in this country, a number of physicians sold their supply. This condition makes still more important the presentation of the facts as they are to the medical fraternity.

R. B. Moore

U. S. Bureau of Mines,
Golden, Colo.

QUOTATIONS

THE FUTURE OF MEDICINE

Yesterday the British Medical Association concluded the most successful meeting in its annals. About the "atmosphere" of this unprecedented gathering there can be no mistake. It was one of serene and reasoned confidence in the future. The wisest leaders, who are also the most assured prophets, of the profession well know that it will not be given to them to enter the promised land which they see from afar. But they have stood upon the mountain tops and they have gazed upon it. That is enough. They will draw nearer to it; others who follow will cross its borders and continue the advance. None can set bounds to it, for it is infinite as the progress of human learning. This sense of its vastness, of its mystery, of its endless possibilities was the keynote of the meeting. The doctors realize that the war has opened to them a new world, and that it will be their high privilege to be able to apply to their fellow-men for all time the great store of new learning they have harvested on the battlefields of three continents. We can not pretend to review in this place the great number