ture of a branch of astronomy which has been somewhat neglected in recent years. But some of the data on which von Niessl's conclusions are based are old and inaccurate. There is no doubt whatever that for the trustworthy investigation of various difficult questions affecting the subject more exact, modern, and abundant observations are necessary.

GEOLOGY OF THE WITWATERSRAND GOLD FIELD.

THE Rand mining field is geologically one of the most interesting areas in South Africa, as well as the most important economically. Its general structure has been gradually unravelled by the work of the geologists and miners of the Transvaal, and it has now been investigated in detail by the Geological Survey of South Africa. The results of this survey are shown on an excellent map (Geological Map of the Witwatersrand Gold Field, 3 sheets, 1917) on the scale of 1 to 5000, or almost an inch to the mile. It has not been contoured owing to the inadequacy of the topographic surveys, but as the mining fields are on an area of high plains this deficiency is of little practical inconvenience. The map is mainly the work of Mr. E. T. Mellor, who has prepared also a short explanation of 46 pages summarising the geology of the mining field and including a bibliography of the chief literature. The report classifies the rocks and gold reefs of the Rand. The age of the rocks is so uncertain that no precise correlation with those of Europe is attempted. They are divided into three systems with South African names. The youngest, the Karroo, which includes the famous Dwyka glacial deposits and the coal seams, has yielded many fossils, so that its correlation is at least approximately known. The Transvaal system includes the quartzites to the north of the goldfield, a thick series of dolomites and cherts, and the Black Reef series. The oldest of the three, the Witwatersrand system, includes the quartzites, shales and conglomerates of the goldfield. These two older systems are unfossiliferous, and whether they are Lower Palæozoic or pre-Palæozoic is uncertain. The author accepts the view that the gold of the Rand is of alluvial origin, and abandons the long popular theory that it was introduced by infiltration as in ordinary lodes. The alluvial or placer theory has been advocated by several geologists, while the majority of the mining engineers have supported the infiltration theory. Probably the most striking feature displayed by the map is that strike-faulting is far more important than had been suspected. The author concludes that the unworked parts of the goldfield are so extensive that the gold-mining industry has elements of "comparative permanency not found in many other goldfields and more akin to those of a base metal district or a manufacturing centre."

ORGANISED KNOWLEDGE AND NATIONAL WELFARE.[1]

THE future of any nation is secure if it lives up to its possibilities. The nation which does this is bound to be a leader among nations and to command world-wide respect. Its national problems will be solved, and solved intelligently and thoroughly. The greatness of a man is in part born in him and in part the product of his environment. According to eminent biologists, he is about two-fifths born and three-fifths made. Similarly, a nation is great according to its resources and according to its development of these resources. And the development of those resources may be accomplished only through organised knowledge.

(1) *The Function of Organised Knowledge.*—Consider for a moment two manufacturing concerns on an equal footing as regards output, but of which one is continually making progress through improvements in manufacturing processes, developing new and valuable products and investigating the fundamental principles underlying all these processes. This firm will in time outstrip the other in every way; the balance, in fact, is a very delicate one, since the results are cumulative. In quite a similar manner, that nation will advance to leadership in which the increase in organised knowledge and the application of that knowledge are greatest. For this reason, interest in research should be as wide as the nation and should cover the whole gamut of problems from administration to agriculture, from medicine to manufacture. For it is only through the solution of individual problems that general principles can be arrived at and the sum total of useful organised knowledge increased.

It is essential that the wide field to be covered be kept in mind, extending over not only physics, chemistry, engineering, and all their branches, but all the biological and mental sciences as well. In the last analysis an increase in knowledge in the field of the *biological sciences* means more and better food, improved racial stock, and improved public health, as well as increased material welfare in all having to do with plants and animals. Increased knowledge of the fundamental principles of the *mental sciences* means increased efficiency in administration, legislation, education, operation, and research. I do not mean mere book learning in psychology, but such a command of the fundamental principles as will assist in the solution of all practical problems. Increased knowledge of *chemistry* means increased ability to utilise raw materials and an improvement in general health and living conditions. One may almost say that the generalised problem of chemistry is to convert the less expensive raw materials, such as cellulose, petroleum, glucose, various minerals and oils, starch, nitrogen of the air and the like, into food, clothing, tools for our use, and means for national defence. An application of the fundamental principles of *physics* in the way of various engineering problems leads to a fuller utilisation of resources and of new products useful to man, makes inventions possible and effective, and adds to the general increase in operating efficiency in every way.

The utilisation of organised knowledge in national welfare comes about both through knowledge itself and the incentive to apply that knowledge. Both ability and incentive are essential to utilisation. So far as knowledge went, we might have made dyes and optical glass many years ago in the United States, but since they could be bought so cheaply there was no incentive to develop the manufacture of such articles. These are cases of ability without incentive. On the other hand, there has long been an incentive for the fixation of nitrogen and for various mechanical devices, but these have not been forthcoming for lack of sufficient knowledge.

In general, in normal times it is perhaps no exaggeration to say that neither the average individual nor the average nation approaches within 50 per cent. of their possibilities. Nothing short of a war threatening the national existence can shake a nation out of its lethargy. Similarly, the average individual cannot be induced to put forth his best efforts without the strongest of incentives. It is unfortunate that this is the case. However, with sufficient attention given to the problem by trained experts in mental science, it is

[1] Abstract of an address given on April 9 to the Associated Engineering Societies of Worcester, Mass., by Dr. P. G. Nutting. Reprinted from *Science* of September 14.