ions. By using these methods, physicists and chemists jointly have now produced ten new elements ranging from neptunium ($Z = 93$) to nobelium ($Z = 102$).

In considering the chemistry of these elements, much attention has been given to the place which they occupy in the Periodic Table, and it now seems certain that they constitute a new group analogous in electronic structure to the rare earth elements. This implies that the 5*f*-electron shell is progressively filled. It would have its maximum complement of fourteen electrons in the hitherto undiscovered element of atomic number 103. This electron assignment is based, first, on the analysis of the emission spectra of some of the elements in question. Secondly, the magnetic properties are analogous to those of the rare earth elements. Thirdly, crystal structure determination of many solid compounds of the new elements have enabled values of ionic radii to be assigned. These show a decrease as the series is ascended, which parallels closely the well-known lanthanide contraction in the rare earth series. Absorption spectra of the transuranic elements also show characteristic sharp absorption bands, associated with transitions within the shielded 5*f*-level.

Chemically, the new elements differ from the rare earths in that, instead of having predominantly a valency of three, higher values are found. This is associated with the great ease with which the electrons are lost.

The maximum valency of 6 is most stable in uranium, but it is also observed in neptunium, plutonium and americium. Curium and berkelium, the next two elements, have valencies of 4, but, so far as is known, the higher members of the series are restricted to a valency of 3. Of the chemical techniques which have been applied in this work two may be mentioned specially. The first is solvent extraction, which is widely used in laboratory work and also plays an important part in the technical separation of plutonium from uranium and fission products. The second technique is ion exchange. The chemistry of the new elements is, for the most part, studied with minute amounts of material far below the limits that could be weighed with a chemical balance. Here the classical techniques of tracer chemistry have been revived and developed. It is the use of tracer technique which has shown that the higher members of the series are restricted to a valency of 3.

The discovery of so many new elements in the past twenty years naturally leads to speculation as to where this process will end. Present indications are that there are very few others which will be stable enough to survive. Stability is limited both by radioactive decay and by spontaneous fission. Nevertheless, a careful search is at present being conducted to extend the field. This work offers an unusual challenge not only because there is such a large unexplored region but also because it calls for very precise and painstaking research.

BENEATH THE EARTH'S CRUST

PLANS recently made to drill a borehole some ten kilometres deep, which may provide information about the Earth's mantle, prompted Prof. L. R. Wager, in his presidential address to Section C (Geology), to review existing ideas on the material of the mantle and to consider the implications if it proves to be similar to the alpine type of peridotites.

Current geophysical evidence suggests a model of the Earth in which the relatively light crust, of variable composition and thickness, rests on the far more uniform and dense mantle at depths of about 10 km. under the oceans and 20–50 km. beneath the continents. The mantle is characterized by a velocity of propagation of compressional waves of about 8 km./sec. and a density of 3·3. It is thought that the sub-crustal material is in a crystalline rather than liquid state down to 2,900 km., beyond which is the apparently very dense liquid core, presumed to have a nickel–iron composition. The facts of isostasy show, however, that, despite the solid condition of the mantle, it must be capable of flowing under sustained stress.

Of the known igneous rocks those with the closest approach to the observed physical properties of the mantle are the peridotites and related olivine-rich types. Some peridotites (for example, those of Sgurr Dubh in Skye) are the result of accumulations of olivine crystals from large masses of associated gabbros and may be described as autochthonous cumulites. Others, however (the alpine type), are common in fold mountains or island arcs, and are not associated with gabbros; these are considered to be possible samples of the upper mantle. It can be shown that basaltic magma could be produced by partial melting of peridotite; a peridotite mantle might therefore explain the world-wide distribution of basaltic rocks.

It is possible to postulate a mechanism for the formation of the Earth's silicate shell based on analogy with layered intrusions. The Earth is considered to have passed through a liquid stage. Convection currents due to cooling from the outer surface would establish a thermal gradient less than the gradient of elevation of melting point due to pressure. Consequently, crystallization of high-temperature minerals might be expected to occur from the bottom upwards. As the column of accumulating minerals increased in thickness, its weight would eventually lead to the expulsion of liquid in the pores, consisting of the components of lower melting point, from the lower parts.

The nature of the crystal phases earliest to separate is uncertain. But by the time the accumulation had reached about 200 km. from the surface the liquid was probably close to forsteritic olivine in composition, and olivine, enstatite and chrome spinel would be the primary minerals precipitated. Later, plagioclase and augite would be expected to form, and finally, when crystal accumulation had reached to within about 10 km. of the surface, a residual liquid of granodioritic composition would be expected, which further cooling would form into the crust. During this long process, convective action must have been modified partly by the heating effects of the radioactive constituents of the fluid expelled from the mush and partly by the changing mechanical properties of the solidifying mantle. In particular, convection currents would be very restricted in the later stages, when the crust had solidified. Perhaps a major convective overturn in the mantle at an intermediate stage, before final solidification of the crust, was responsible for pushing the sialic scum into the restricted areas now occupied by the continents.