PETROLOGY

Rocks from the Ocean Floor

from a Correspondent

THE dramatic development of the concept of sea floor spreading in the past two years by geophysicists has given great impetus and unity to geological and geochemical studies of the igneous and metamorphic rocks of the ocean floor. The results and implications of this work were the subject of a discussion meeting held at the Royal Society from November 12 to 14.

The fresh tholeiitic basalts which make up most of the newest crust along world-wide mid-ocean ridge crests are strongly convergent in composition and they demand a simple and repeatable process of derivation from the mantle. This has been borne out by several studies. Compared with other basalts they usually have high contents of SiO_2, CaO and Al_2O_3 and values of K/Rb, Si/K and Ca/K. They have low abundances of ions. Dr J. R. Cann (University of East Anglia) concluded from a statistical study of ninety-four analyses that much of the variation within this grouping could be attributed to variable subtraction of a 3 : 1 mixture of basic plagioclase and olivine, and some clinopyroxene. Professor P. W. Gast (Lamont–Doherty Geological Observatory) analysed thirty basalts from the East Pacific and North Atlantic and found that the rare earths unfractionated relative to chondrites were responsible for depletion in La and Ce. Minor europium depletion varied with heavy rare earth abundance. Gast showed that a mechanism virtually the same as Cann's could produce all these anomalies and other observed scatter. To explain all the compositional spread, however, speakers on this theme had to invoke mantle inhomogeneity or variations in magma generation processes such as Gast and Dr D. H. Green (Australian National University, Canberra) proposed, which are based on the adiabatic upwelling of peridotite with a low water content. Dr S. R. Hart (Geophysical Laboratory, Washington) demonstrated clearly that seawater alteration affects some elements in the rock, at least as soon as any alteration becomes detectable optically. He also found identical contents of K, Rb, Cs, Sr in basalts from "fast-spreading" and "normal" ridges, and inferred that the levels of radioactivity heating were the same below both, and were thus unrelated to spreading rate.

An important theme of the meeting was the continuing search for a model for the oceanic crust and a mechanism for its generation. The range of rock types to be incorporated is now considerable. Ultramafic and mafic plutonic rocks and metamorphosed basalts have been dredged from fault scarps in many areas, and several investigators found a general increase in the grade of metamorphism in the basalts towards the base of scarps, from zeolite to greenschist and amphibolite facies assemblages. Ultramafic rocks seem, however, to come from various levels. Professor E. Bonatti (University of Miami) found them stratigraphically below metamorphosed rocks in the Atlantic Equatorial fracture zone, whereas Dr F. Aumento (Geological Survey of Canada, Ottawa), in a detailed investigation of the Atlantic Ridge and high plateaux at 45° N, found them everywhere but in the Median Valley. Aumento concluded from their common layered texture that they are derived from stratiform complexes. Dr W. G. Melson (Smithsonian Institution, Washington) reported both cumulate and mylonitic textures in other ultramafic rocks from Atlantic fracture-zones and concluded that many may be remobilized nearly-solid cumulates (partial fusion residua). Strong zoning in Al shown by orthopyroxene he took to reflect partial re-equilibration of the rising mush in response to decreasing pressure.

Aumento's diorites and trondhjemites recently reported in *Science* (**165**, 1112; 1969) gave further weight to the idea that some ophiolite complexes could be ocean floor slices. Dr E. M. Moores (University of California, Davis) drew attention to this and other strong points of similarity in the Troodos Massif, Cyprus (following the suggestion of Gass, *Nature*, **220**, 39; 1968), and in the Vourinos complex of northern Greece. Troodos has a thick sheeted complex of vertical dykes—a convenient site of lateral expansion —but in Vourinos intrusive activity was more nearly horizontal, and Moores suggested the two may reflect distinct types of mid-ocean ridge activity.

ENGINEERING

Uses of Mechanical Memory

from our Materials Science Correspondent

'NITINOLS', a range of alloys approximating to the composition NiTi, have unique mechanical properties, which should make them very useful. An object made of 'Nitinol' can be deformed to an arbitrary shape, briefly heated to "fix" that shape, and then possesses a "memory". If it is straightened or crumpled, subsequent reheating causes it spontaneously to return to the shape previously imprinted in its memory; if prevented from thus returning, it exerts a steady force on the restraining clamp.

'Nitinol', like the laser until quite recently, is a solution in search of a problem. Scientists at the Battelle Memorial Institute propose to undertake a large scale investigation of appropriate uses of the alloy, which presupposes the collection of many more experimental facts as well as the education of design engineers. As a taste of things to come, Wagner and Jackson of the institute have proposed some ingenious applications of 'Nitinol' (*Materials Engineering*, **70**, 28; Oct. 1969). Some uses depend simply on a return to the "imprinted" shape when lack of access prevents the use of tools. Thus a self-locking cotter would require only heat to bend the ends. More commonly, the object would be partly restrained from returning to its imprinted shape—a self-fastening rivet could be placed in position from the front and heated by conduction so that the shank and inaccessible rear end expanded and locked the rivet firmly in position.

If the heat were applied by putting the alloy in an electric circuit, it could serve as a circuit-breaker. Here the material, acting against a spring, would be lightly constrained. Alternatively, the alloy could be used to replace a solenoid to exert a substantial force. By modifying the normal and imprinted shapes and the distribution of electrical resistance, various force/current characteristics could be designed into the device. A use in hydraulics would be for the construction of accumulator bottles which would exert on the fluid they contain a pressure which depended only on the temperature to which they were subjected.

The US Army and Navy have started to investigate biomedical applications of 'Nitinol', and these look