VOLCANICS OF EASTERN ICELAND

by Dr G. P. L. Walker, Department of Geology, Imperial College of Science, London

One November day in 1963 fishermen noticed steam rising from the sea 35 km south of the coast of Iceland, and gained the first intimation of the birth of a new volcano. Within the space of a few days a substantial island had grown where previously there was sea 140 m deep, in an event that has aroused more general interest than perhaps any volcanic eruption hitherto. Today the island of Surtsey stands, secure against the Atlantic storms, a small but more or less permanent addition to the territory of Iceland, and to the land area of the world.

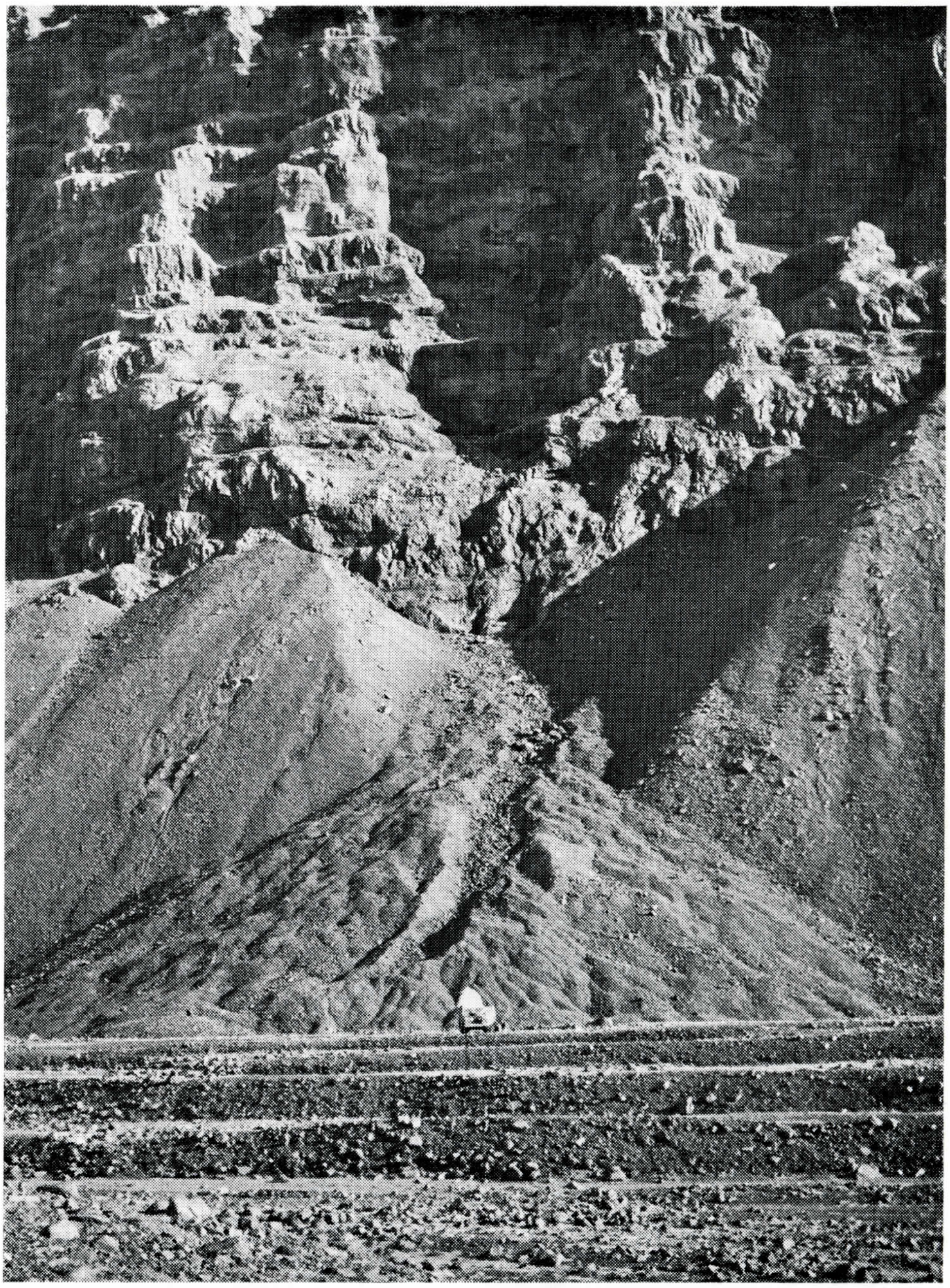
Surtsey can be thought of as reproducing in miniature the story of Iceland itself. In all probability Iceland, bigger than Austria, Hungary, or Portugal, or than Denmark and Switzerland combined, did not exist 20 million years ago at a time when all the other countries mentioned had more or less achieved their present form. Twenty million years may seem a long time, yet it is much less than one per cent of the life span of the Earth, comparable with four months in the life of a 70-year old man.

Like Surtsey, Iceland is composed entirely of the products of volcanic action; of materials which rose in a molten condition from a depth of tens of kilometres, during the course probably of millions of separate eruptions. Today, eruptions take place on average once every five years, and they are constantly adding to the country: a new hill here, a thick new layer of lava there, and occasionally a new island built in the sea off the coast. There are other countries which are built entirely of volcanic rocks—Hawaii, Madeira and the Galapagos Islands, for instance—but they are much smaller than Iceland and therefore not strictly comparable with it.

One of the principal aims of the Earth scientist is to gain an understanding of the history and constitution of the Earth and the processes operating in it. The research project initiated 12 years ago in eastern Iceland had such aims: to gain an understanding of the structure of the great lava pile seen there, and the volcanic processes by which it came into being. Some at least of these aims have now been realised.

An impressive feature of eastern Iceland is the immense thickness, amounting to more than 10 km, of basalt* lavas exposed there. These lavas occur by the hundreds, resting on one another in a parallel succession like the leaves of a gigantic book, the whole pile tilted through several degrees towards the presently-active volcanic belt crossing the interior of Iceland farther west; a pile cut through by deep valleys and fjords in the walls of which it is magnificently displayed in cross-section. When the work started, such a great thickness of lavas was known in only one other place: Greenland. Nowhere had such a thickness been systematically studied.

It soon became apparent that two contrasted facies of volcanic rocks go into the make-up of eastern Iceland. One, a central volcano facies, is characterised by an abundance of rocks—rhyolite and andesite lavas and pyroclastics†—other than basalt lavas, an occurrence in isolated lenticular areas and a widespread and often drastic chemical alteration of its rocks due to the action of hot water and steam on them. The other, a flood basalt facies, is characterised by a constitution almost entirely of basaltic lavas, and a remarkable regularity in structure. Much of the effort of the past



A Land-Rover Dormobile camp below a cliff of basaltic lavas in S.E. Iceland. The lower part of the cliff has an apron of fallen debris banked against it.

* The commonest kind of lava, basalt, is relatively rich in iron and magnesium and is correspondingly dark in colour. Iceland is made up predominantly of basalt lavas. Rhyolite, a lava type poor in iron and magnesium, and generally pale in colour is however also found, and so is andesite, intermediate in composition between basalt and rhyolite.

† Fragmental volcanic rocks, due to explosive volcanic eruptions.

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12 years has been directed at the tedious task of determining the characteristics and outlining the areas occupied by these two facies. To this end five central volcanoes, each with a volume measured in hundreds of cubic kilometres, have now been studied in detail together with the intervening flood basalts.

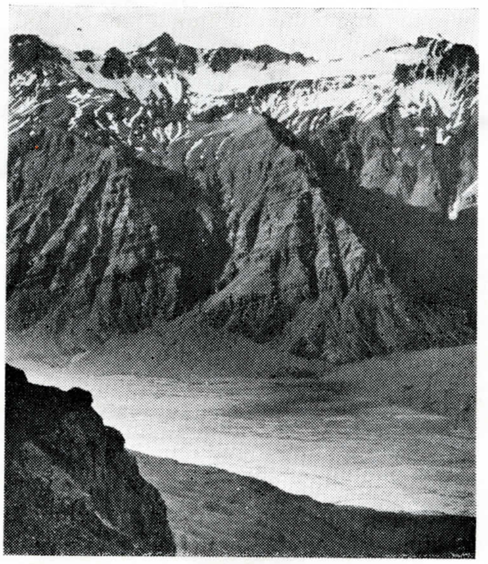
A well known characteristic of old basaltic lava piles is the presence of minerals occupying steam-holes or *amygdales*. These minerals are mostly hydrated alumino-silicates of the zeolite group. There have been two schools of thought about the origin of these amygdale minerals. One maintained that they were primary, crystallising during the cooling of the individual lava flows, and the other that they were secondary and developed only after burial of the lavas. For Iceland, the second has been shown to be correct. The individual zeolite species are distributed in mappable zones which are essentially depth of burial zones formed at higher temperatures the greater their depth beneath the land surface.

All the time, the Earth's surface is changing form; the processes of erosion are constantly whittling away the mountains, carving the valleys deeper and wider, and pushing back the coastal cliffs. The zeolite zones permit, in a way not before possible, the amount of down-wearing of the land to be determined. Being depth of burial zones, they enable the original land surface beneath which they were formed to be located: in eastern Iceland this surface can be deduced to have stood mostly several hundred metres above the summits of the highest mountains.

A new conception of the structure of Iceland has been reached as a result of these and related studies. The isolated outcrops of flood basalt lavas in N.E. Ireland, Scotland, the Faeroes, Iceland and Greenland were until quite recently thought of as remnants of a once-continuous lava plateau stretching right across the North Atlantic (Figure 1a). Then as more work was done it seemed more realistic to regard each as a separate basin-like lava lenticle, as suggested by Figure 1b. Now this picture must be further modified to take account of the likelihood—or fact—that the Atlantic Ocean occupies the space left by the drifting apart of the Americas from Europe and Africa, as suggested by Figure 1c.

Within the framework of the major studies outlined in the above account, many lesser studies have been made, and the following two samples serve to indicate their scope. Some unique lava flows have been studied in which basalt and rhyolite have been erupted simultaneously from the same vent to form layers one above the other, giving an insight into what happens when the two lavas come together; and the mechanism and products of volcanic eruptions under glaciers have been investigated.

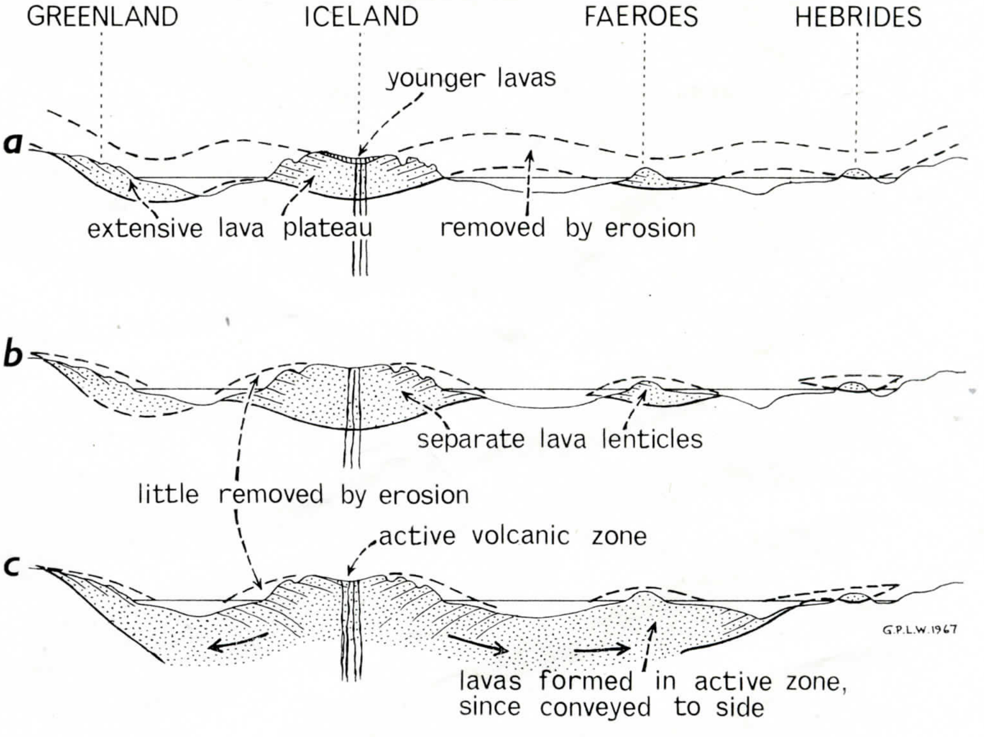
Regarding the latter, it is thought that Iceland is an ideal laboratory for the study of the products of submarine eruptions, for volcanic activity took place on a vast scale beneath the glaciers that covered the country



Mountains 4000 feet high made of a tilted pile of basalt lavas, S.E. Iceland.

Geological camp site in S.E. Iceland.

FIGURE 1
Cross-sections of the North Atlantic showing three possible interpretations of the structure. *a* can probably be rejected, and *c* is the preferred interpretation.



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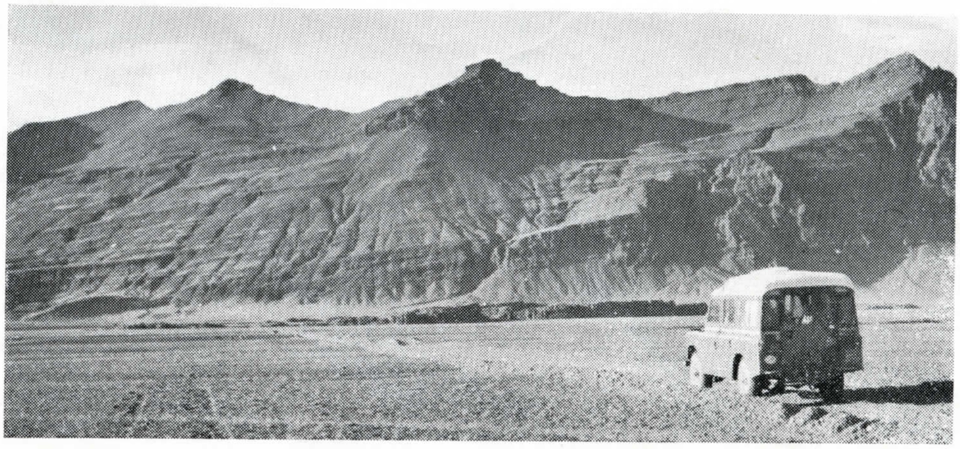


Land-Rover and mountains made of a tilted pile of basalt lavas, S.E. Iceland.

during the Ice Age, and in places where the glaciers have since melted the subglacial volcanoes can be walked over and examined in a way that is impracticable for volcanoes submerged beneath the sea. The fact that the Icelandic eruptions have happened under ice rather than sea water is probably of little import.

The above account has been concerned with the scientific results of research work. It must not be lost sight of that Iceland has also functioned as a useful training ground for young geologists during the course of this research. Some 12 undergraduate and 9 postgraduate geology students, besides several geophysics students, have received training there and have made notable contributions to knowledge. Some of them have subsequently applied their Icelandic experience to the study of volcanic areas in Australia, Ethiopia, Fiji, France, Great Britain, Kenya and the USA. All, besides working in eastern Iceland, have visited the zone of recent volcanic activity which crosses the middle of the country, in which is to be seen in fascinating array almost the entire range of possible volcanic manifestations.

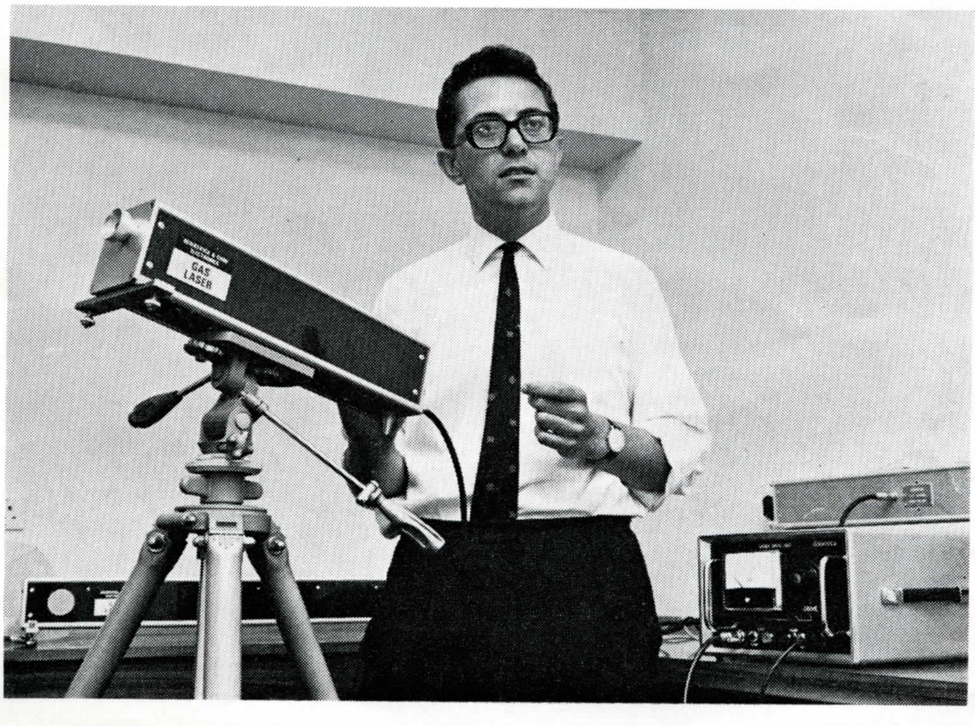
The research programme has cost little as scientific research goes: an average of several hundred pounds per year for 12 years. Financial support has come mostly from the British DSIR (or its successor, NERC) and from Icelandic sources, supplemented by contributions from the geologists themselves.

The geological programme in eastern Iceland and similar programmes in northern and south-western Iceland, are now virtually completed. Still in progress are geophysical studies dependent on, or extending the geological. One of these is a cooperative effort by scientists from the Universities of Iceland and Liverpool and Imperial College, and involves a study of the palaeomagnetism of the basaltic lava pile in Iceland. Every lava flow—approximately 900 in all—in the succession in eastern Iceland has been sampled, in a programme larger in scale than any of its type previously attempted. It should be explained that when a basalt lava cools it adopts and retains a direction of magnetisation parallel with the Earth's magnetic field. Some lavas are magnetised in a direction opposite to that of the present field and evidence is accumulating that such lavas cooled at a time when the Earth's magnetic field was itself reversed. Reversals are now thought to take place on average once every half million years or so, and one result of the studies in Iceland may be to reveal the history of the Earth's magnetic field over the past 20 million years.

A second study, just commenced, seeks to determine whether the presently-active volcanic zone in Iceland is expanding. Geological studies suggest that it should be; they indicate that points on either side of the active zone should be slowly, but steadily moving apart with new land being formed in between by the uprise of basalt lava.

This study is one part of a test of the reality of continental drift. To determine whether North America and Europe are moving apart would require measurements of a different order; but if, as geological studies suggest, the spreading is accomplished in the mid-oceanic zone that crosses the middle of Iceland, and if spreading is still taking place, this should be capable of determination by direct measurement.

Perhaps herein, its origin linked with Earth movements on a global scale and born as a direct result of these movements, lies the real significance of Surtsey. 0322/6.



A GAS LASER SUCCESS STORY

Dr. Paul Cook, a 33-year-old scientist, pictured with one of the gas lasers made by his company, Scientifica and Cook Electronics—200 of which have been sold in the 18 months the company has been in business.

The company's lasers are being used in industry for such purposes as examining razor blades for sharpness, aero engines for stress patterns, railway tracks and wheels for alignment, and measuring fine fibres. Dr. Cook plans to make a laser selling for only £60—well within the reach of the smaller industrial concern and education authorities.

IS MENTAL ILLNESS A PSYCHOLOGICAL APPENDIX?

by John Newell

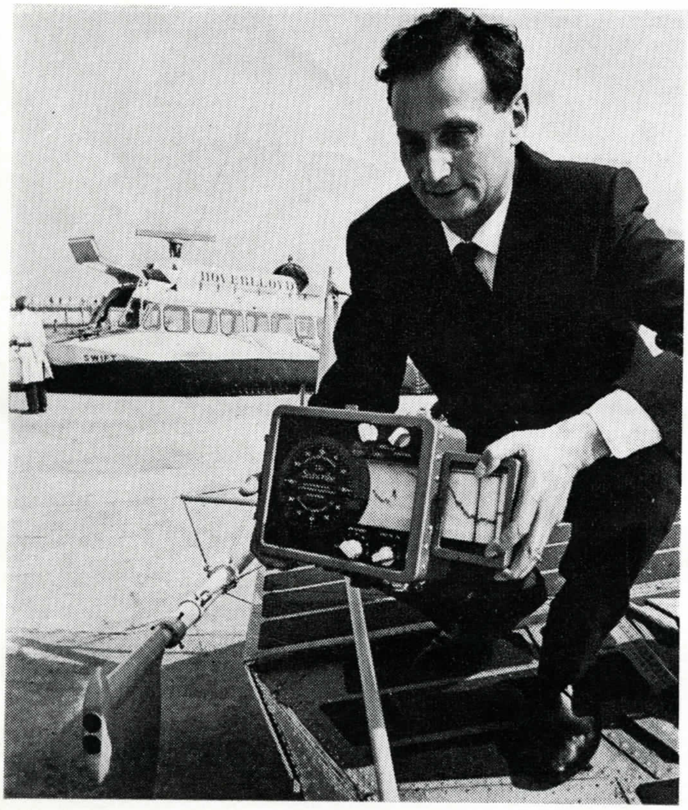
The common occurrence of mental illness is something of a puzzle, in view of the law of the survival of the fittest through natural selection. Most other forms of illness come about through some other organism, usually a micro-organism, preying upon or competing with man. But mental illness is usually the result of some wholly human factor and whether or not mental illnesses are precipitated by external conditions they are often linked to some inborn psychological weakness.

Such weaknesses are so common that one in seven of the whole population of Britain consults a doctor every year because of some form of mental disturbance. It is certainly surprising, theoretically, that the human race, which has become the dominant race on Earth through a long and ruthless process of natural selection in which only the fittest might have been expected to have survived to breed, should still be so bedevilled by inborn mental weaknesses. Why do mental weaklings still exist?

A new theory to explain the nature and frequent occurrence of mental illness has been put forward, by Dr John Price of the Medical Research Council's Unit working upon psychiatric genetics. His idea is that mental illness is like the human appendix; it is the vestigial remains of something which was once vital to us as a species. That is, or rather was, a hierarchical behaviour pattern, a sort of human pecking order. Every hen in a farmyard has a hen which is immediately superior to it and another which is inferior. It can peck the hens beneath it without being pecked back, but it has to submit to being pecked by superior hens without resisting. The same sort of *dominance hierarchy*, as psychiatrists call it, is found among some of the apes, especially baboons. Dr Price's idea is that dominance hierarchies were essential for early human survival, as essential as the rigid hierarchies found in a modern army today. In the early history of man, behaviour which promoted the smooth functioning of the essential hierarchical system would have been characterised by anxiety towards superiors and irritability towards inferiors. Other characteristics which would help to keep the hierarchy in being would include the capacity to get worked up about being promoted or demoted, to be elated at the prospect of promotion and depressed at demotion. This rather unpleasant behaviour pattern would have been necessary for the survival of a group of very early men, but in extreme forms the qualities required would take on the characteristics of mental illnesses. Anxiety neurosis and schizophrenia would be the extreme manifestations of anxiety towards superiors. Aggressive personality would be the extreme form of irritability towards inferiors. Mania would be the result of over-excitement at promotion in the hierarchy, depressive illness that of excessive depression about a demotion, or the mere prospect of demotion.

Today human society no longer needs even the unexaggerated forms of the behaviour best suited to maintaining human pecking orders. But the personality traits involved have been so deeply ingrained by natural selection and our emergence into the position of dominant species has been so recent, that the traits and their exaggerated forms, in the shapes of mental illnesses—like the equally useless appendix—live on today and, presumably, will take millions of years to disappear.

The theory, if it is confirmed, could have valuable practical consequences in medicine. For example, the value of a sedative drug in alleviating chronic anxiety and schizophrenia could be tested by seeing how much it affected behaviour in baboons, which have retained hierarchical behaviour. If this kind of behaviour is found to be controlled by certain parts of the brain only, in baboons, then the equivalent parts might become the focus of new surgical attcaks upon mental illness in humans. 3041/7.



HIGH SPEED SURVEYING BY HOVERCRAFT

A portable echo sounder for high-speed surveying by Hovercraft developed by Electronics Laboratories (Hendon) Ltd and the Ministry of Defence (Naval). The new instrument enables, for the first time, surveying at high speed in shallow coastal waters. Experimental trials have shown that surveys can be carried out in a quarter of the time normally required because of the speed at which the Hovercraft can reach the operational area (between 40 and 50 knots) and the high surveying speed of up to 35 knots. The cost of surveys is reduced by as much as four-fifths.

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