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Possibilities and Problems in Using Deep Submersibles for Geology

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ABSTRACT

The use of submersibles was primarily oriented on exploring the spreading zones, where effective geology takes place. The strategy of choosing an object of detailed study in the ocean is drastically different from a similar problem on land. It is clear that further success of scientific observations from submersibles depends on survey operations (multibeams, sonars, etc.). It is certain that the prospects are associated with the transfer of emphases on new, at-present unknown areas: subduction zones and intraplate active zones.

INTRODUCTION

Manned undersea vehicles have come into oceanography quite recently as an important instrument synthesizing the latest achievements of technical thought. The initial effect gained by employing this means of investigation turned out to be considerable, especially in studying the geological phenomena on the ocean floor. A number of expeditions on the spreading zones of midoceanic ridges have produced vivid and fascinating results. The spreading of the Earth's crust and all the accompanying phenomena (recent volcanism, the hydrothermal activity, powerful tension structures) that had been predicted theoretically were supported by direct subaquatic observations. But for them, the skepticism of the opponents of the global plate tectonics theory would have kept hindering the development of this revolutionary concept. Beginning with the expedition FAMOUS on the Mid-Atlantic ridge in 1973, several successful cruises with underwater vehicles on board were conducted to study rift zones in the Pacific and Indian Oceans, the Red Sea and a number of back-arc basins. The results were impressive, but at the same time the problem of application of this type of research and the choice of suitable objects grew apparent. Putting several research submersibles in action with a diving depth of 6 to 6.5 km made about 95% of the ocean floor accessible for contact investigations, and the problem of the choice of proper objects began to be especially topical. The Russian Academy of Sciences owns two 6-km MIR vehicles, which are 3-man spheres 7.8-m long, about 8.7 tons in weight, with a maximum speed of about 3 knots. Each is equipped with sampling and measuring devices, a navigation system, an underwater telephone and cameras, a computer for processing of the measuring results, etc.

Practical experience has made evident the limitations of the devices: highly restricted visibility from inside the submersibles, rather moderate range of operation over the bottom, as well as great costs and rather high risk. The methodology of organization of submarine observations is fairly well-known. First of all, a regional scientific problem is formulated. Within a certain area, basing themselves on previous information, the investigators then single out particular plots for a detailed survey, where the most interesting objects for exploration by means of a submersible may be expected to occur. Each of these stages has its own specific difficulties, a critical point being the choice of local plots. It seems feasible to plan preliminary studies, including a survey and geological sampling, but at the same time the support ship should have the necessary equipment for prompt performance and the correction of route polygons. The oceanographers, and marine geologists in particular, are facing the necessity of analyzing the experience already gained to get a clear idea of the status of things and the lines of future progress.

Our own experience in terrestrial and marine geology enables us to express some methodological considerations. If we trace the historical ways of the geological exploration of land and marine bottom, we can discern some essential differences. The rudiments of continental geology refer to the times at the dawn of civilization when the man was learning to collect ore lying on the surface and to extract useful components from it. After first steps along this path there arose a need for local exploration of adjoining areas, for some primitive sort of geological mapping. Then comes the evolvement of a true geological survey, and regional explorations begin to be carried out, bearing traits of a scientific approach and enabling the understanding of the structure of major zones, junction points, folded bests. As an apex of the geological scheme, there appeared global approaches, though at that time nothing was known about the oceans. The most recent stages have seen new powerful technologies such as airborne surveys and satellite measurements. But the finishing touch from space was only interesting, and nothing more. It can be assumed that the terrestrial geologists by that time had a pretty clear idea of where and in what detail they should investigate, and what could be theoretically expected in various particular areas. The path followed by marine geology was different. Actually, the era of serious geological study of the ocean can be considered to have begun with the discovery of the global system of midocean ridges as a starting point for the development of the concept that later became known as plate tectonics. Thus started global science, and only then did regional investigations become quite widespread; these primarily involved bathymetric and geophysical surveys meant to thicken the observational net in some areas. Quite recently there arose a possibility of direct observation by a scientist from a manned underwater research vehicle (MURV). Pinpointing the best diving site faced the geologists from the start. The flight onto the bottom is a blind action, if we use aviation's word, and that is highly uncommon for a geologist. The prevail-

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