Sea Floor Mining Exploration Technology and Methods

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OUTLINE

The world’s oceans have always both challenged and helped humanity, providing food for our table, linking settlements around the globe and driving the weather systems that influence our daily lives. Now we are finding mineral and energy resources on the ocean floor that will be as important to mankind as the resources we presently exploit on land. The oil industry has already moved offshore. However, the methods and capital required to exploit offshore oil and gas are not appropriate to find and develop seafloor mineral and gas hydrate deposits. To find and exploit them, exploration methods used on land have been re-invented for the sea. Exploration activities must be economical and the scale of operations must be appropriate. In the past, man has gone himself down to the seafloor to explore and map it, or has used crude machines to retrieve samples. This is expensive, high risk to human life, and not always successful in deep water.

Today, robotic devices have replaced using people on the seafloor, increasing safety and increasing the periods of active operations near or at sea floor. Using robots and remotely operated sensors, we can map, sample, and mine the seafloor. Robotic systems provide economies independent of scale. The size of individual operations can be adjusted to provide a profit without building and operating gargantuan projects. Remotely operated and autonomous underwater vehicles (ROVs/AUVs) are central to this process. Ship borne sonar and multibeam systems map the seafloor at scales of about 1:50000 or smaller. Sonar, and particularly synthetic aperture sonar, can map the seafloor at scales of 1:100 using AUVs/ROVs. Water chemistry sensors, magnetometers and cameras can be mounted on vehicles tasked for other purposes. Sampling can be done using ROVs, and drilling done using robotic seafloor drills. 3D seismic cubes can be acquired using small hydrophone arrays easily deployed from small vessels. Electromagnetic systems and interpretation algorithms exist to map both shallowly buried and seafloor massive sulfide deposits and gas hydrate deposits. Positioning of subsea vehicles and installations is not simple, but off the shelf transponder systems are available, and subsea sonar based GPS systems allow multiple assets to be located within a transducer array. All of these systems are becoming smaller, less expensive, and deployable from general purpose vessels rather than specialized purpose built ships. The principal economic targets today are seafloor deposits of gas hydrates, phosphate fertilizer, submarine massive sulfides, and polymetallic nodules. The geologic signature of these deposits is understood. Best practices to find and exploit them are well known or are being developed. The impact of robotics is that “bigger is not necessarily better”, and that exploration can be done cost effectively and safely using smaller, reliable, more capable, and less expensive equipment. Mining at sea, long delayed, is about to become an established industry.