

Article Reprint

Hydro

INTERNATIONAL

Dredge Efficiency and Precise Positioning

Dredgers involved in mining for (precious) minerals and metals often work in an inland dredging pit (Figure 1). Dredgers float in a ‘wet environment’ where the surrounding water is used as transport medium. The fact that the minerals are mostly covered in various sediments is one of the biggest problems in mining them. This article describes some of the techniques used in these dredging operations and illustrates the importance of integrating techniques and information.

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Dredge Efficiency and Precise Positioning

Integrating dredging and hydrographic techniques

Most minerals, like rutile and zirconia, are to be found on top of a layer of clay with the highest concentrations found closest to it. Pewter is mostly found on a rocky bottom, while gold and diamonds lie on gravel layers. Detecting the right layer-depth and thickness of concentrate over the area to be dredged is difficult and time-consuming. Mining managers provide limitations (depth tolerances) to prevent damage and disruption to the dredging process and/or mineral separation. When mining for pewter and gold the above-lying sediment layers are processed without mineral separation in order to achieve a higher production rate. As soon as the layer holding the

minerals is reached, the dredging process slows down, as separation of minerals now assumes maximum importance.

When dredging in a closed pit or pond the dredger often comes face to face with a steep slope. This slope regularly collapses, spreading material/sediment throughout the dredging pit and creating the possibility of damage to the material to be dredged. As there is no good acoustic method available for finding out where the fallen sediment has settled, cleaning sweeps are not carried out (Figure 2). After separating out of minerals the transport medium (water) flows into the same dredging pit, rendering it slimy. The whole water column is now contaminated with sediment particles, making it impossible to use standard bottom-detection methods such as echo sounders and boomers, which do not work in these environments.

Present Methods

The chart presenting the layer-depth of minerals is based on data collected by bottom cores (Figure 3). Coring is expensive but necessary, as the more information is collected regarding the layer the more efficiently the separation process. This cuts down on costly separation time

and provides information for optimal production. Most mining companies use a core pattern with horizontal spread of about 150 metres. In practice, making a mineral chart by hand mostly involves linear interpolation between the bottom cores. This chart is used onboard the dredger and, as mineral layer positions are sometimes very irregular over short distances, the layer-chart differs from reality. The dredging operator uses the layer-chart to determine to what depth he can lower his cutter. Often he uses quite a tolerance, sometimes up to 1 metre, to prevent stagnation in the separation process.

Monitoring and Control

Various dredge-monitoring and visualisation systems have been developed over the years by IHC Systems and are used on all kinds of dredging equipment. One of these is the Dredge Track Presentation System, combining the automation and control system of the dredger with visualisation of process and progress of a dredger on a (hydrographic) project. DTSP systems are connected to a variety of equipment such as positioning systems, gyro, tidal information, telemetry systems, production instruments and dredge-tool positioning systems. The DTSP system



Figure 1: Mining dredger in rutile pit.

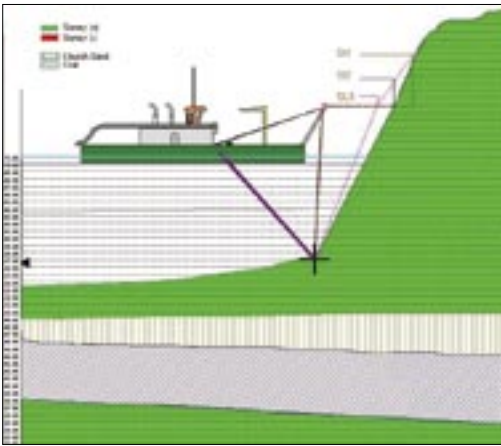


Figure 5: SIS indicator mounted on mining dredge.

being pumped. Much remaining falls behind the cutter and is usually lost. This is called 'spill'. If concentration of the operator decreases during the duty watch it will lead to excess of spill, i.e. avoidable production loss. By connecting to a DTSP a production-meter that measures concentration and velocity of the mixture the dredging process can be better mastered and monitored, enabling alarm signalling. Depending on the concentration of the mixture, the swing velocity of the dredger can be controlled automatically, thereby preventing increase in spill.

Acoustic Detector

Our company uses a digital, modified, acoustic wide-band and FM-modulated Sub-Bottom Profiler based on the principle of Chirp II (Figure 6). This profiler has a special noise-suppression system and is thus very well able to be used in a 'slimed' dredging pit. It gives the possibility of visualising total sedimentation column (0/3 - 40 metres, depending on type of transducer) with an accuracy of approximately 5cm. Minerals, sand, silt, gravel, clay and rocks give with respect to one another a minimal acoustic attenuation of approximately 10dB. This can be clearly visualised and digitised. It is possible to trace online a pre-set layer, such as clay, and digitise this layer.

Improving Tolerance

By installing the acoustic sensor next

to the cutter-head it is possible to detect spill and digitise it. The spill layer gives significant attenuation with respect to the dredged layer.

Pewter Mining

Most pewter layers lie at sea, situated under the seabed in valleys on a rocky bottom. Using a digital sub-bottom profiler, pewter layers (sediment profiles) can be mapped. This is done by 'normal' surveying routines: installing the SBP on a survey vessel and connecting it to a survey program and positioning device. This gives digital sediment profiles of a large mining area without the normal dense bottom coring. Ground truthing has to be carried out on at least one bottom core to provide a geological overview and check the digital survey (Figure 7). When processing ashore, both top and bottom layers of the 'pewter profile' have to be digitised exactly and independently of each other. After digitalisation, other matrices are processed which loaded into the DTSP system show the mineral profile layers on an electronic chart and in cross profile.

Concluding Remarks

A few typical examples of the application of precision hydrography for effective and efficient dredging operations

are mentioned here. Of course, in addition to hydrographic measuring sensors, good steering and operation of dredging instruments is essential. Sound integration of data

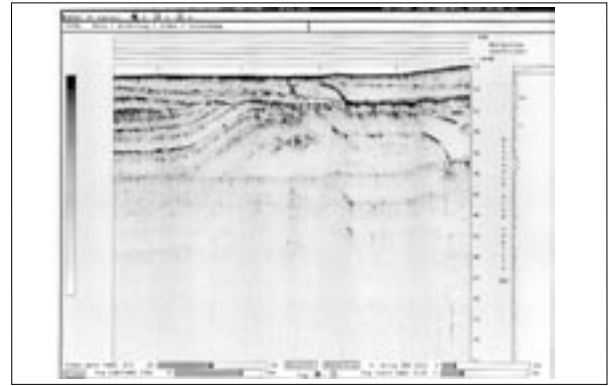


Figure 7: Sub bottom profiler printout.

from both systems as mentioned in the described example and in general also from other systems in the dredging industry, can lead to optimal performance. This in turn results in cost reductions over the total dredging budget; in other words, such integration of resources can allow a modern dredging vessel to dredge both efficiently and at exactly the right spot.

Biographies

Gerard Mallee, started working in 1962 in the electronic development industry. He graduated in 1974 at the Higher Technical School for electronics. In 1976 he became involved in the hydrographic field with Ballast Nedam. He took some 'time out' for further studies at both Delft and Nottingham universities. Today he is products and projects advisor for the hydrographic department of IHC Systems.

Wim van Wieren is a hydrographic surveyor who has worked at the Hydrographic Office of the Royal Netherlands Navy and for the Survey Department of Rijkswaterstaat, of the Dutch Ministry of Transport and Waterways, in various survey and marine geodesy-related (field) work. In 2001 he joined IHC Systems, first as product engineer for survey-related dredging systems. Together with Gerard Mallee he now runs the hydrographics department and as of 2006 also manages the product-engineering department. ■

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