by a service contractor. The major components are:

- a wireline drilling rig (Atlas Copco T3W DH)
- four-motor rotary top-head drive
- a container-size modular and versatile barge (24.4 x 7.3 m, Damen system)
- anchor winches or dynamic positioning systems, mud tank, crane and other auxiliary equipment

Fig. 4.2.4: DLDS on Dead Sea

The diamond wireline drilling technique utilizes various special coring tools and can reach depths up to 1400 m depth (CHD 134 string) in 400 m water depth. The DLDS is a complex and modern drilling unit, which requires a crew of experienced, well-trained technicians and engineers for drilling and marine operations on a 24/7 basis (Fig. 4.2.4).

The GLAD800 was deployed with ICDP funding in Lakes Titicaca, Bosumtwi, Peten Itza and as an arctic version on the frozen Lake Elgygytgyn. When severe weather hampered GLAD800 operations significantly during Lake Qinghai and Laguna Potrok Aike operations, a new barge system was designed and built as Deep Lake Drilling System DLDS by DOSECC. The new DLDS was subsequently deployed thereafter in deep-drilling ICDP projects on Lake Van, the Dead Sea and Lake Towuti. The rig was also used in the offshore Chicxulub Crater Drilling Project.

During the Lake Ohrid drilling expedition of ICDP in Macedonia using the DLDS, 480 m coring depth was reached twice within less than 17 days of drilling time, with core recovery rates of over 90% per site. There is hence no doubt that this is a very capable barge drilling system. Nevertheless, it is also limited to wave heights < 1 m and wind speeds of less than 4 Beaufort. Furthermore, mobilization and demobilization are cost-intensive as it comes in 14 20-ft-long shipping containers. Furthermore, staging the barge into water requires a 100-t-crane and a rigid quayside or slipway. Site location, available local infrastructure and logistics constraints can further complicate deployment of lake drilling systemy. Safety and hazard considerations for and around the entire operation must be specified in detail as part of the science and operations plan along the planning phase of the project management strategy.

Soft sediment coring

Loose and soft sandy to clay-rich sediments are not easy to probe continuously. First, all coring devices may lose the lowermost core section from the so-called core-catcher during each coring run. Therefore, to ensure complete core coverage it is necessary to deploy these systems at two or three parallel holes per site, which allows a data processing called ‘splicing’ (aka: depth-matching of geological horizons across boreholes, see Chapter Core Handling). Second, there is no coring device that is capable of recovering the uppermost water-rich and very unconsolidated sediments at the same recovery percentage as deeper consolidated sections. Accordingly, different coring tools for different lithologies are needed.

A set of coring devices is used to collect different types of lake sediment (Fig. 4.2.5). The distinctive kits are deployed via wireline through standard drilling assemblies yielding a 139.7 mm (5.5´´) hole:

- Hydraulic Advanced Piston Corer (APC)
- Extended shoe, non-rotating (EXN)
- Extended core bit, rotating (XCB)
- Diamond core bit (mining)
- Non-coring assembly using rotary bit

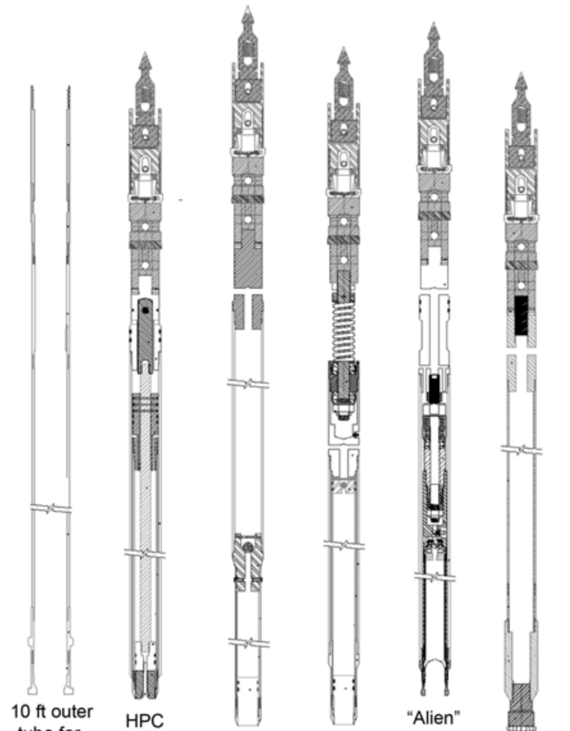

Fig. 4.2.5: Tools used for coring lake sediments

The APC device produces by far the best recovery rate - often near 100% - and delivers the most intact, neat, undisturbed samples. This APC method has been developed in the international ocean drilling programs. It works through mud pressure built-up on a metal tube ending in a tapered sharp cutting shoe that penetrates the substrate. The tool is activated when the shear pins break once a precalculated pump pressure is reached, driving the core tube into sediments, usually in 3 m steps (note: 9.5 meters of advancement for IODP drilling operations). After each shot the core barrel containing the inner plastic liner is retrieved by wireline through the drill string to surface. On deck, the inner plastic liner with the sediment section is retrieved from the core barrel. For the next run, the barrel is loaded with a liner and shear pins at surface then it is dropped back through the drill string for the next shot. The HPC/APC tools deployment is abandoned once coring progress is obstructed in strong compacted or coarse-grained deposits.

The most appropriate next coring tools are either the non-rotating extended nose (EXN), or the rotating extended core bit (XCB) - also called 'alien tool', which consists of an inner core bit preceding the outer rotating main bit. In this way the progressing well deepening is separated from the core cutting process. It allows for reaching greater coring depths, but usually results in a slightly lesser degree of core recovery.

Drilling engineering

Professional planning and drilling engineering need to be performed for all deep and complex drilling operations. Examples of complex planning and engineering are provided in the following paragraphs. The OSG can provide assistance for ICDP projects in drilling engineering. Experts and consultants in drilling engineering usually prepare the complete well planning using modern software packages. The software in general is organized in modules or components that describe the well life cycle and planning phases (Fig. 4. 2.6).