Chapter 8

MEASUREMENT WHILE DRILLING (MWD)

MWD is the process by which certain information is measured near the bit and transmitted to surface without interrupting normal drilling operations. The type of information may be:

(a) directional data (inclination, azimuth, toolface);
(b) formation characteristics (gamma-ray, resistivity logs);
(c) drilling parameters (downhole WOB, torque, rpm).

The sensors are installed in a special downhole tool made up as an integral part of the bottom hole assembly. Within the downhole tool there is also a transmitter to send the signals to surface via some kind of telemetry channel. The most common type of telemetry channel currently in use is the mud column inside the drill string. The signals are detected on surface, decoded and processed to provide the required information in a convenient and usable format. Figure 8.1 shows the main components of an MWD system. The great advantage of MWD is that it allows the driller and the geologist to effectively “see” what is happening downhole in real time. It therefore improves the decision-making process, since there is a delay of only a few minutes between measuring the parameters downhole and receiving the data on surface.

Although the concept of MWD is not new, it is only in recent years that advances in drilling technology have made MWD a reality. Electric logging introduced in the 1930s made a significant contribution towards identifying and evaluating formations. Its major disadvantage, however, was that the tool had to be run on wireline after the drill string had been pulled out of the hole. Furthermore, by the time the log was actually run, the effects of mud invasion prevented the measurement of the true characteristics of the formation. Since there was no definite means of identifying changes in lithology as the bit drilled through the different formations, important horizons were not detected. Subsequent logs sometimes showed that coring points at the top of the reservoir section had been missed, or that the bit
had drilled too far into the water zone beneath the pay zone. Mudlogging and monitoring the ROP provided some indication of downhole conditions, but the time lag in waiting for cuttings to be circulated to surface made the process fairly inefficient. There was therefore a need for a system that provided instantaneous and continuous monitoring of the formation while drilling. The requirements of such a system were as follows:

(a) rugged and reliable sensors that could measure the required data at or near the bit under dynamic drilling conditions;
(b) a simple but effective method of transmitting the information to surface;
(c) a system that could be easily installed and operated on any rig without causing too much disruption to normal drilling practices;
(d) a system that was cost-effective and provided real benefits to the operator.

Several attempts were made at producing a system that satisfied these requirements. The major problem proved to be the telemetry link between downhole and surface. Between 1930 and 1960 four alternative telemetry systems had been investigated:

(a) electric conductors (hard-wire systems);
(b) electromagnetic radiation;
(c) seismic (acoustic) waves;
(d) mud pressure pulses.

Up to 1960 these telemetry systems were being investigated mainly for logging-while-drilling applications. The increasing use of directional dril-