

## II. Drilling

### 1. Drilling Parameters: ROP and Drilling Exponents

Exploration Logging utilizes the Kelly Height system to calculate the rate of penetration. The system responds to the hydrostatic pressure variation of a sensing device and a Kelly chamber located near the Kelly swivel. The Kelly Height variations recorded on a time chart allows computation of the rate of penetration.

When the drilling variables (bit type, bit size, weight on bit, rotary rpm, mud hydraulics, mud rheological properties) are held constant in a uniform lithology, the rate of penetration will be determined by formation compaction characteristics and differential pressure. The rate of penetration would decrease uniformly with depth as compaction of shale increased. On entering a geopressure transition zone in shale, increasing porosity due to decreased compaction, and decreasing differential pressure across the bottom will cause an increase in the rate of penetration. A marked reduction in drilling rate is often observed at the top of a transition zone, possibly caused by a lithology difference in the so called "cap rock".

Maintaining constant drilling variables is not always possible; various formulae have been proposed in the attempts to resolve the problem of normalizing drill rate. Jordan and Shirley's (1968) formulation allows control of most of the drilling variables and has proven very successful in most areas.

$$d = \frac{\log \frac{R}{60N}}{\log \frac{12W}{10^3 D}}$$

Where  $d$  = drilling exponent (dimensionless)

$R$  = Rate of Penetration, ft/hr.

$N$  = Rotary Speed, RPM

$W$  = Weight on Bit, klbs

$D$  = Bit Diameter, inches