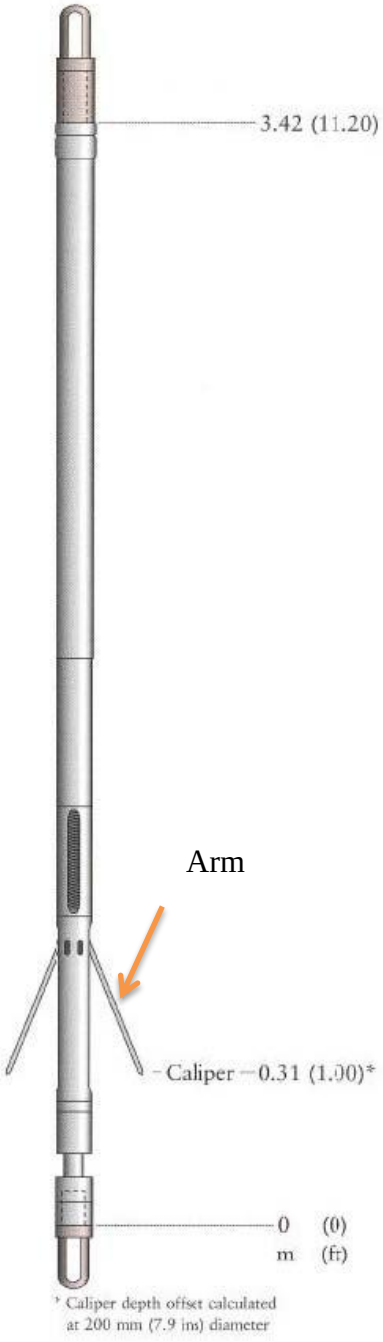
CALIPER LOGS

- The *Caliper Log* is a tool for measuring the diameter and shape of a borehole.
- It uses a tool which has 2, 4, or more extendable arms.
- The arms can move in and out as the tool is withdrawn from the borehole, and the movement is converted into an electrical signal by a potentiometer.



- **Types Of Caliper Log Tools**

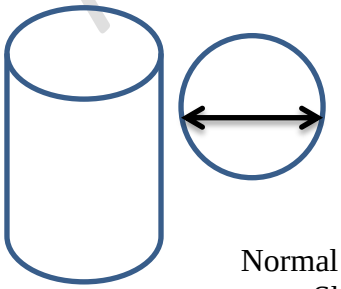
1. Two Arm Caliper Tool

✓ Measures the borehole diameter.

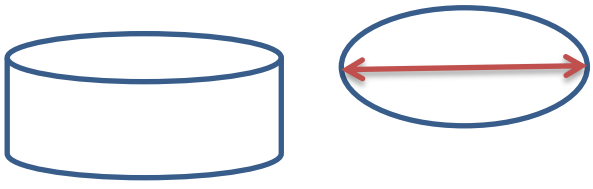
✓ Plotted in track 1 of the master log together with the bit size for reference.

✓ Borehole diameters larger and smaller than the bit size are possible.

Limitations: Many boreholes can attain an oval shape after drilling. This is due to the effect of the pressures in the crust being different in different directions as a result of tectonic forces. In oval holes, the two arm caliper will lock into the long axis of the oval cross-section, giving larger values of borehole diameter than expected. In this case tools with more arms are required.



Normal Borehole Shape



Oval Borehole Shape

2. Four Arm Caliper Tool (Dual Caliper)

- ✓ The two opposite pairs arms work together to give the borehole diameter in two perpendicular directions.
- ✓ An example of a 4 arm tool is the **Borehole Geometry Tool (BGT)**.
- ✓ **BGT** has 4 arms that can be opened to 30 inches (40 inches as a special modification), and give two independent perpendicular caliper readings.
- ✓ The tool also calculates and integrates the volume of the borehole and includes sensors that measure the direction (azimuth) and dip of the borehole.
- ✓ This information(borehole volume, direction and dip) is useful to;
  - Estimate the amount of drilling mud in the borehole
  - Estimate the amount of cement required to case the hole.
  - Plot the trajectory of the borehole.

3. Multi-Arm Caliper Tools

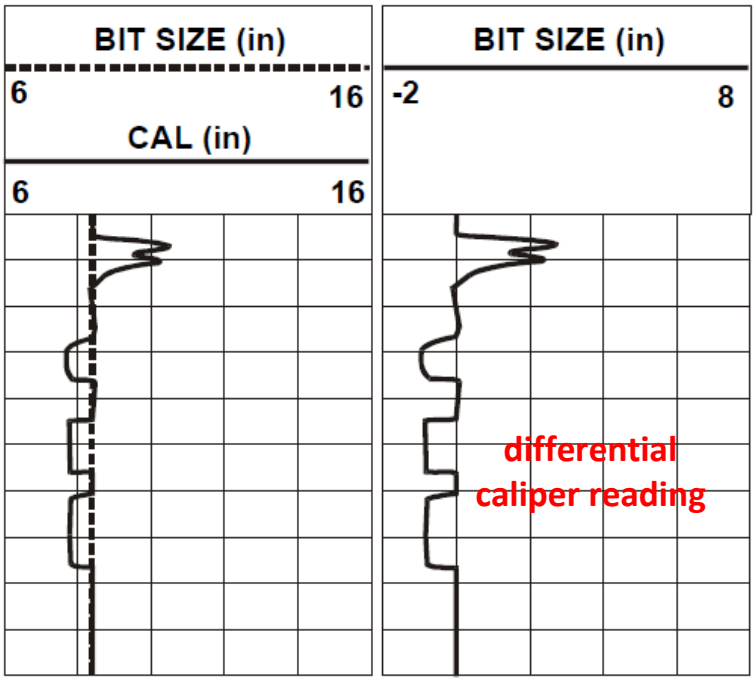
- ✓ Up to 30 arms are arranged around the tool allowing the detailed shape of the borehole to be measured.

○ Log Presentation

- ✓ The caliper logs are plotted in track 1 with the drilling bit size for comparison.

Or

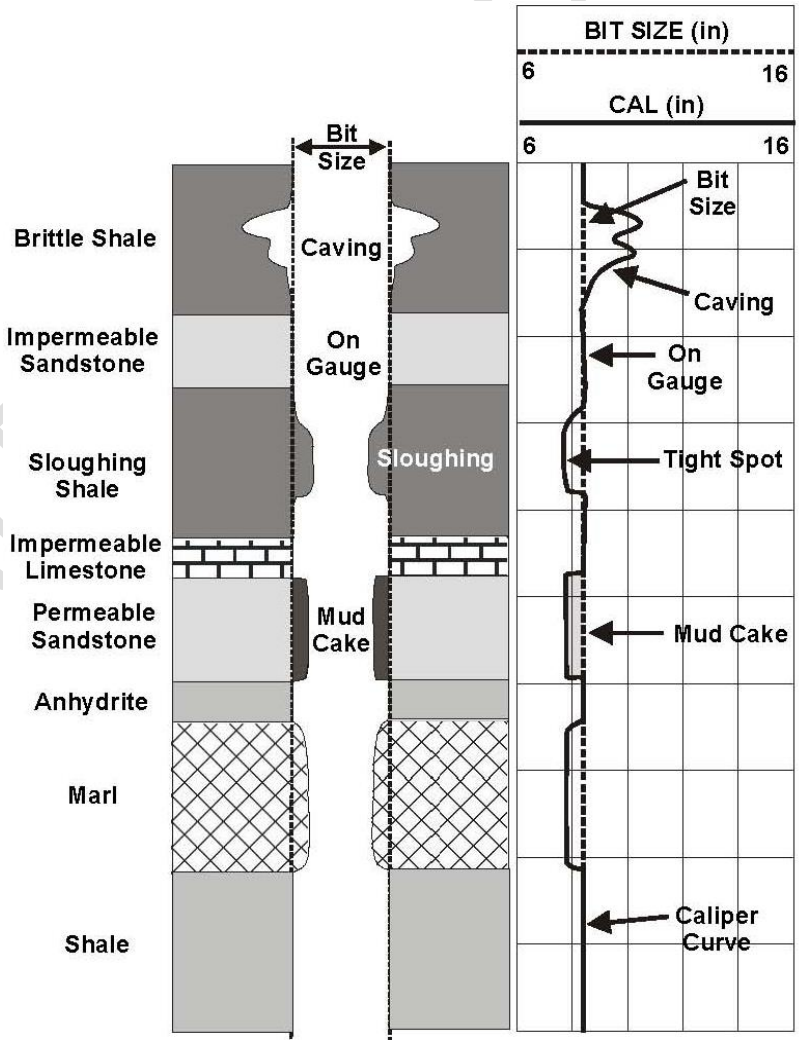
- ✓ Plotted as differential caliper reading, where the reading represents the caliper value minus the drill bit diameter.
- ✓ The scale is generally given in inches, which is standard for measuring bit sizes.



- **Caliper Log Interpretation**

- when a hole is the same diameter as the bit-size it is called ***on gauge***.

Hole Diameter	Cause	Possible Lithologies
On Gauge **Cal = BS**	1.Well consolidated formations. 2.Non-permeable formations.	1.Massive sandstones 2.Shaly Limestone 3.Igneous rocks 4.Metamorphic rocks
Larger than Bit Size **Cal > BS**	1. Formation soluble in drilling mud. 2. Formations weak and cave in.	1. Salt formations drilled with fresh water. 2. Unconsolidated sands, gravels, weak shales.
Smaller than Bit Size **Cal < BS**	1. Formations swell and flow into borehole. 2. Development of mud cake for porous and permeable formations.	1. Swelling shales. 2. Porous, permeable sandstones.



- **Uses of the Caliper Log**

1. Gives information about formation lithology.
2. Used with the GR log to indicate the permeability and porosity zones (reservoir rock) due to development of mud cake.
3. Calculation of mud cake thickness.

$$h_{mc} = \frac{d_{bit} - d_{hole}}{2} \qquad in$$

4. Measurement of borehole volume.

$$V_h = \left(\frac{d_{hole}^2}{2}\right) + 1.2\% \qquad litter/meter$$

5. Measurement of required cement volume.

$$V_h = (0.5)\left(d_{hole}^2 - d_{casing}^2\right) + 1\% \qquad litter/meter$$

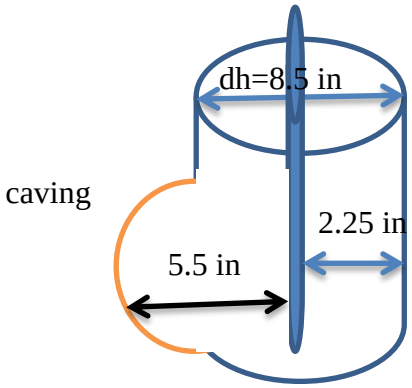
6. Selection of consolidated formations for;
   A. wireline pressure tests.
   B. Recovery of fluid samples.
   C. Packer seating for well testing purposes
   D. Determining casing setting depths.
7. Measurement casing setting depths. (where caliper log inside casing string read straight line).
8. Indication of hole quality for the assessment of others logs whose data quality is degraded by holes that are out of gauge.

- Other log data can often be corrected for bad hole conditions using the caliper log readings, but the larger the correction, the less reliable the final data will be.

Caliper and Bit size(BS) logs	Others Logs Readings
Caliper – BS = 0 %	Excellent condition, no need for correction
Caliper – BS < 10 %	Logs are good quality,
Caliper – BS =10 – 30%	Logs probably need to be corrected
Caliper –BS >30 – 50%	Logs incorrect, need to correct
Caliper – BS > 50 %	Very bad borehole conditions. incorrect logs

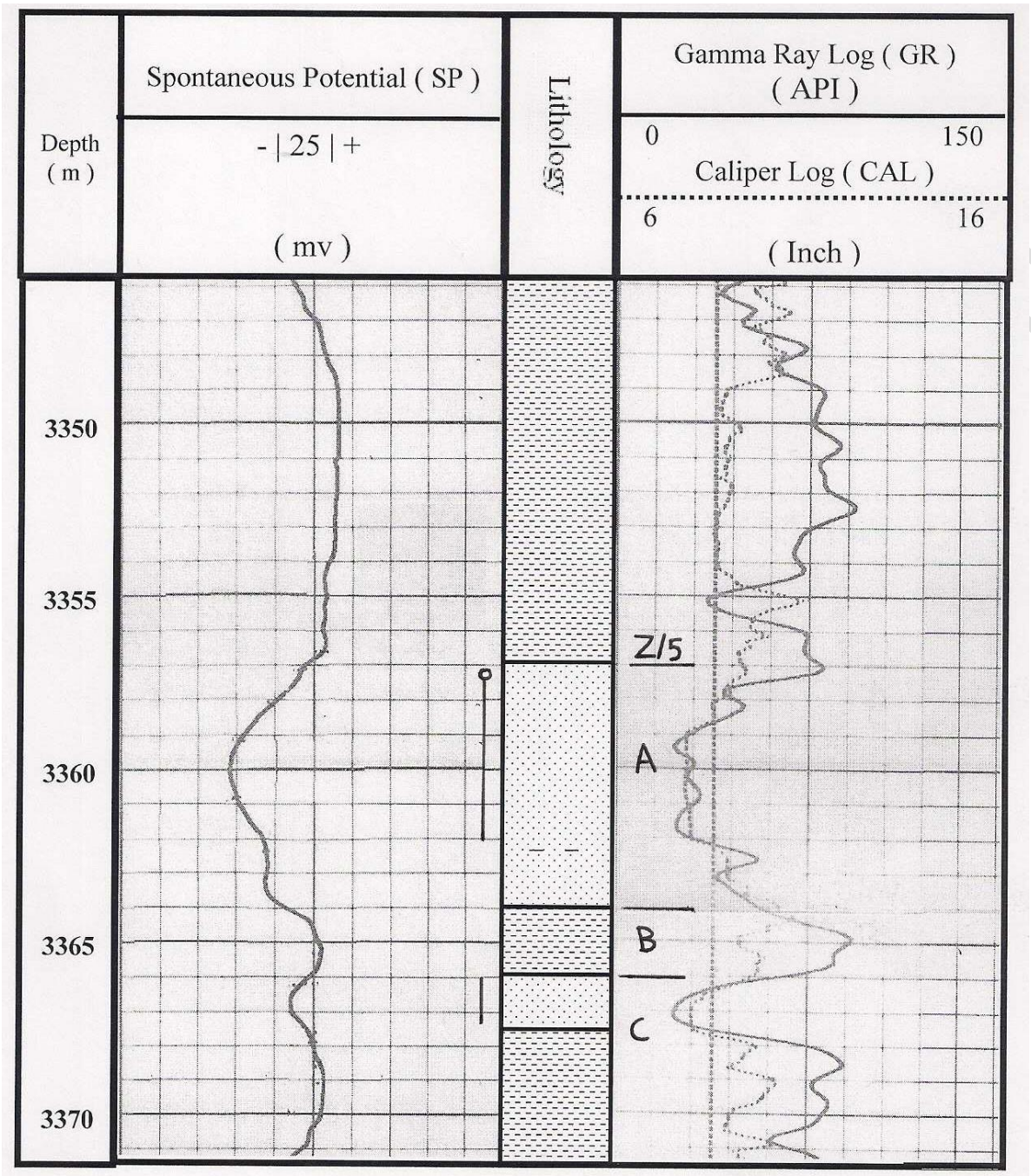
(Yan et al., 2008)

- Well logging tools are designed to be about 4 inches in diameter for a standard 8.5 inch hole, and they are designed to work with 2.25 inches of drilling mud between them and the formation.



- If the hole caves to 14 inches, which is not uncommon, the distance to the formation becomes 5.5 inches and the tool responses are degraded.
- This can be corrected for to some extent if the caliper value is known.
- Tools that work by being pressed up against the side of the borehole wall have even greater problems because the irregularity of the borehole wall makes it impossible to obtain reliable readings.
- In both cases the recognition that a borehole has bad caving or thick mud cake can help us judge the reliability of other tool's readings.

○ Caliper Log Example:



Mud Cake

التفسير :

① نلاحظ من خلال شكل منحني مجس الكاليبر عند العمق (3366.3 – 3367.7) م تضيق في قطر البئر أمام صخرة الحجر الرملي وهذا يعني وجود امام هذه الطبقة بسبب حدوث عملية الترشيح مقابل هذه الطبقة لنفاذيتها مما يجعل تجمع المواد الصلبة على الجدار وبناء

Mud Cake

② عند العمق (3367.7 – 3371) م نلاحظ توسع في قطر البئر أمام صخرة وهذا يعني وجود هدم أمام هذه الطبقة وهكذا .

Shale