

# Exploration by using Core-Drilling-Technics

**Diamond-Bits / Core Barrels -  
Single Tube / Double Tube / Wire Line**

**Examples - Site Studies**

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Fig. 1 Packing Core samples into boxes



Fig. 2 Core extracted from Core Barrel

There are many ways to get an idea of the nature of a rock behind it's face - the best way is to hold the rock itself in your hands. It's true information - without any doubt - when you know how to get it.

Thus you should know a few things about **geology** and the **tools** how to treat this geology.

The most common mineral in earth's crust is **SiO<sup>2</sup>**, Quartz: **hard** and **abrasive**. Quartz is the enemy of any drilling tool, of the bit, the core bit. Abrasiveness causes wear! The only mineral, the only element to withstand this wear is **Diamond**.

Core Drilling is the story of attacking the rock - with the most expensive tools to **conquer** it - not to destroy it.



Fig. 3 Break out Core Bit using a Full grip wrench

# The coring system

- The Bit:** Short, threaded steel cylinder, on the lip protected with natural ore synthetic diamonds or Tungsten Carbide inserts, fixed in a matrix.
- The Core Barrel:** Cylindrical Tube to cover the core.
- The Drill Rod:** Enables the Driller to bring **Bit** and **Core Barrel** to any depth required. **Thrust, revolution, Torque, Flush** are brought from the drilling rig to the top of the Core Barrel.
- The Drilling Rig:** Power- and control station for the Drilling Process.
- The Driller:** Most important element in the Drilling process. He will be responsible to produce the best core quality, the best profit for his boss. And he will give you the best explanation for the core quality in the box.
- The Engineer:** Should be the Friend of the Driller. Drillers will not try to tell some Fairy Tales to the Engineer, when they meet some thorough knowledge's about rock and basics of drilling.

## Core Barrels

### Single Tube Core Barrel

Most simple coring equipment. There is only **one Tube**



### Head – Barrel – Reamer - Core lifter- Bit

#### The Bit:

Only thin cutting "face", Kerf (8 - 10 mm). Mainly for very solid material to drill. Rotation and Flush attack the core:

Loose parts will be washed away, and thus, the maybe most interesting parts in a core disappear. The Bit does not only drill the annular space, but also the washed-away detritus from the core: Bit life-time is reduced.

Main Core Diameters are:

**36 - 46 - 56 - 66 - 76 - 86 - 101 - 116 - 131 - 146 mm**

The Bit Stabilizer: Stabilizes the Bit to keep the Calliper. Integrated is a conical seat for the core lifter.

The core Catcher: Splitted hardened ring with conical, smooth outer shape and cylindrical, rugged inner shape. Function as a **trap** when pulling the Core-Barrel: The Core Catcher cripps the cylindrical core to extract it.

The core barrel: Allows the drilled core to enter in a length of 1,5 m / 5 ft to 3,0 m / 10 ft. The core is covered but not protected!

**The Head:**

Is the link from the Core Barrel to the drill rod. As there is a huge variety in threads of drill rods (Metric / DCDMA / Gost ...) it is always an important thing to know the right specification.

Drillers not always know, Engineers never!

**Core Barrel Types:** B : thin walled Z : thick walled (exotic!)

- 1. Core barrel head
- 2. Core barrel
- 3. Bit
- 4. Core Catcher
- 5. Bit Stabilizer

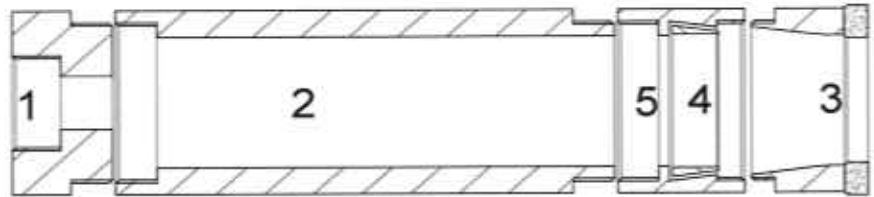


Fig. 4 Core samples from fractured strata



Fig. 5 Core samples from brick stones of an underground shelter

## Double Tube Core Barrel

### Tube - in - Tube System

**Rotation** and **Mud Flow** do no longer attack the core. The Inner Tube really protects the core. Even non-solid sections in the geological formation can be recovered.

Outer Tube System:

**Bit - Reamer - Outer Tube - Core Barrelhead.**

Inner Tube System:

**Core Catcher Case with Core Catcher - Extension tube - Inner Tube**  
with thread to Core Barrel-Head.

**Ball bearings** in the Core Barrel Head (Swivel -Type) separate the rotation from the outer tube to the inner tube.

A fine machined **push-pull** system in the inner tube allows thin kerfs bits; threaded connection is not needed.

**Lengths** of core Barrels are mainly **1,5 - 3 m** (Single Tube exceptionally 6 m / Double Tube). Every completed core run can only be realized by (re) pulling the whole Core – Barrel ! The deeper you get, the longer and harder you work!

**Core Barrel Types:** T / T-2 / T-6 / T-6 S / K - 3 / D

**Core Diameters:** 36 / 46 / 56 / 66 / 76 / 86 / 101 / 116 / 131 / 146 mm

The core quality can even be improved by **modifying the shape of the bit**, using pilot-Form with face-discharge.

**An additional Tube** (PVC) can be placed in the inner Tube to protect very sensible cores or to allow coring in contaminated or polluted areas. e.g. modified D 131 x 102 mm

**Splitting inner Tubes** also allow a very good core recovery. e.g. **T-6S - 131 x 102 mm**

**Mud-Press-core-Barrel Heads** use their special design to pump out cores from the inner tube by directing the flow from the annular space to the center e.g. **D.U.L.k. 131 x 110 mm**



Fig. 6 Single tube Core barrel



Fig. 7 Double tube Core barrel D, T-2, T-6



Fig. 8 Double tube Core barrel parts

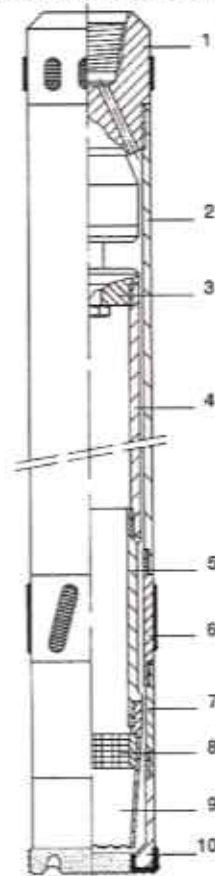


Fig. 9 Double tube Core barrel K-3

## Wire-Line Core Barrel

### Tube - in -Tube - System

Inner-Tube with the special design to be retracted by means of a "catching device" fixed on a steel wire.

Invented by "lazy" drillers and tool pushers; they were fed up of these roundtrips for core recovery of conventional core drilling (9 meter is the longest Double Tube core Barrel!). Imagine the ugly work to core in a depth of 2.500 meters! Wire-line is much more comfortable - with the additional advantage to have the borehole temporarily cased! Core Barrel and Drill rods protect sensible rock sections from collapse. Having the inner tube removed, any kind of borehole measurement - geophysical, hydrological - is realized through this now safe borehole.

Outer Tube System:

**Bit - Reamer - Outer Tube -Landing sleeve - Locking coupling**

Inner Tube System:

**Core Catcher case, incl. Core catcher - Stabilizer - Inner Tube - Core Barrelhead incl. Landing ring - / Latches with spring**

**Wire-Line-Core Barrels** are available in a wide range of **sizes**, starting mainly from **48 mm to 176 mm**. International Standards are the

**DCDMA - sizes: AWL / BWL / NWL / HWL / PWL**

**Metric - sizes: NSK 146 / SK6L 146 / Geobor S / CSK 146 / CSK 176**

Manufacturers produce according these standards, but also have their "special thing" for e.g. better core recovery, more sturdy design, modified catching systems.

Central European Drillers prefer the bigger core size 100 mm (Geobor S 146 x 102 mm / CSK 146 x 102), Austrians also use the CSK 176 x 132 to have the biggest andmost heavy core with Ø 132 mm, means about 35 kg per meter!

Exploration Drilling in Ore-, Salt-, and Coal-Mines is using mainly small diameter equipment like BWL (60 x 38 mm), NWL (75 x 47 mm), HWL (96 x 63 mm).



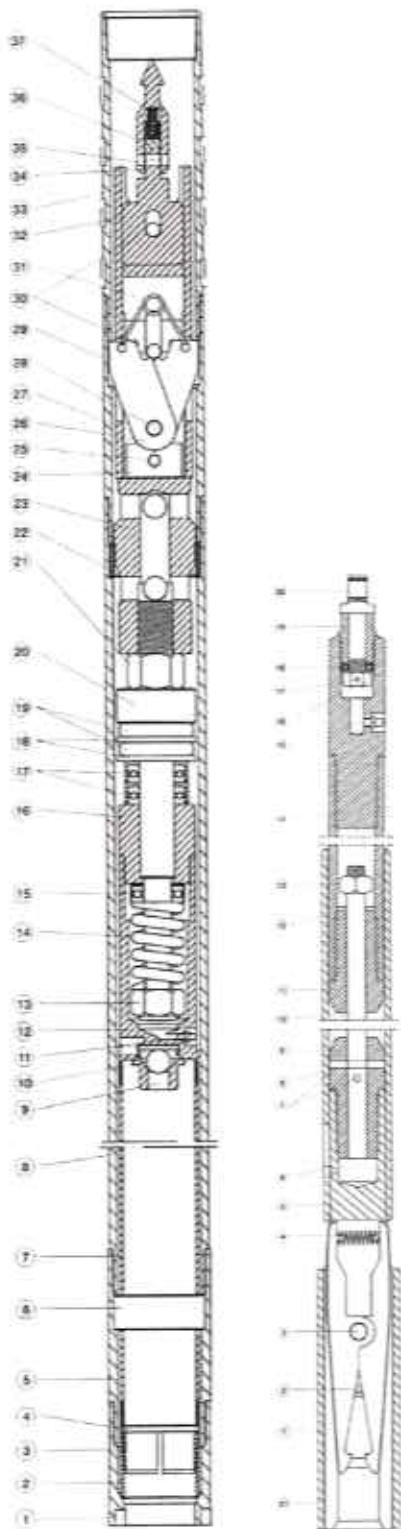


Fig. 10 Wire-line Core barrel NQ - NWL

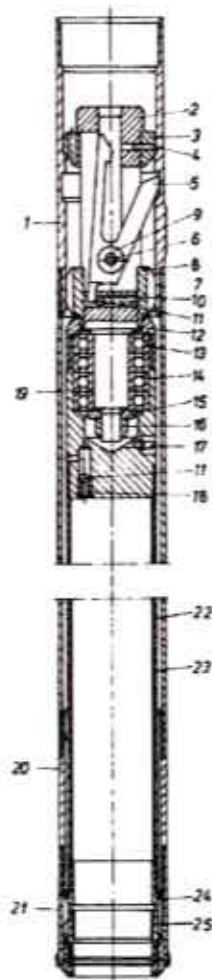
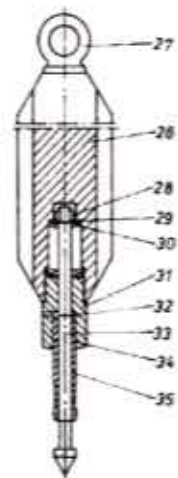


Fig. 11 Wire-line Core barrel SK6L



Fig. 12 CSK 146  
Core barrel head (part),  
Overshot



Fig. 13 Geoline – Geobor S  
Dry hole device, Core barrel  
head, Overshot



Fig. 14 SK6L  
Overshot, Core barrel head



Fig. 15 Tungsten Carbide bits

Looking at the dimensions of Borehole and core, the **Bit** for a wire-line core-barrel has a very **thick kerf** (lip) compared to **Single Tube, Double Tube** core barrels: This thickness is needed for all these sophisticated parts to land, fix and retract the inner tube.

The prices for bits and barrels are much more expensive in relation to standard coring equipment. But Wireline Coring is the most economic and often the only way to manage in great depths and certain geological formations - and to keep the Drillers satisfied - as well as the Engineers and the Owner !

## Flushing

Core Drilling needs fast rotation of drill string and bit with more or less load on the bit; this results in **friction** and friction generates **heat**. Heat burns the bit, the diamonds first. - **Flushing** and mud control is of great importance for the Bit-lifetime, the penetration rate and core quality. The Bit needs to be cooled, cuttings must be removed quickly from the bottom of the hole. Drill rods must be lubricated to reduce friction and wear. Using only clear water can erode the core and the boreholewall; sedimentation acts like cement to the rods. Drill mud additives like Bentonite, CMC or Polymers (or mixtures of those) help to get a better core recovery, better penetration rate and better lifetime of the equipment.

## The Bit - The Core Bit

The most important part in the complete core-barrel system is the Core Bit. It is the frontier tool, it faces the rock. The Core Bit must cut this annular space – between the core column and the borehole wall.

In the beginning of this brief Technical Description of core drilling we learned that quartz is widespread in the earth crust, known as abrasive and very hard. Other minerals and rocks are less abrasive but very hard - like basalt e.g.

We also learned that the Diamond is the most suitable mineral to cut any kind of rock.

As general rules we can state:

- **The harder a rock is the smaller is the diamond grain**
- Diamond "Dust" in **Impregnated bits** (> Granite)
- Small size diamonds (40 - 60 stones per carat / spc) **surface set bits** (> basalt)

- **The softer a rock is the bigger is the Diamond Element**
- Medium size diamonds (20 - 30 spc) → Limestone
- Big size diamonds (6 - 10 spc) → Salt / Gypsum
- Synset / TSD - Elements (3 mm long) → Limestone
- Stratacut / PCD - Elements ( 12 mm ø) → Arcose / Marl.  
(TC-Tungsten Carbide, Hexagonal shape; for overburden).

**A skilled driller can calculate the best possible parameters for his bit e.g.:**

Geobor S - Bit 146 x 102 mm  
 61 carats, 20/25 spc, Select Quality  
 ~ 1.500 Diamond grains  
 ~ 70 % in the cutting front ~ 1000 grains  
 30 % in the inner / outer gage  
 ~ 3 kg load on each grain in the front.  
**3.000 kg ~ 3 tons Weight on Bit!**

**An experienced driller (most of them) knows** - depending on rock and bit - that

in very hard rock a penetration rate of  
 in medium hard rock formation  
 and soft, incoherent rock formation

2 - 3 cm / minute is normal  
 5 - 8 cm / minute  
 9 - 12 cm / minute.



**Fig. 16 TC and Diamond Bits for Single tube, Double tube and Wire line Core barrels**



Fig. 17 Surface set Diamond Bit

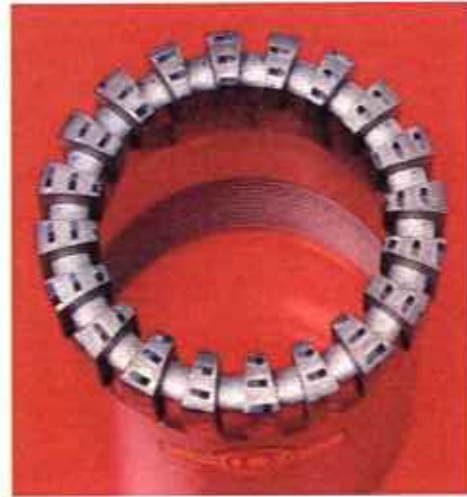


Fig. 18 Synset-(Ballas) Diamond Bit



Fig. 19 Stratacut Diamond Bit



Fig. 20 Impregnated Diamond Bit

**The presented paper does not claim to give the full information about coredrilling.**

Enclosed you will find some literature to study thoroughly this wide field of core sampling by drilling. Finally it's the practical experience that makes it to understand the drilling process. The best engineer is the experienced one, and maybe, his or her career started in the field, near or even on a drill rig. **Drilling a core means to understand the rock - and to have the right chance to look behind the rocks face.**

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