

Laser directional drilling of shale rocks

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Brief Overview

- Shale rocks are fine grained sedimentary rock that forms from the compaction of silt and clay-size mineral particles.
- Shale rock are made of many thin layers and they readily split into thin pieces along those layers



Shale rock photo [Courtesy: geology.com]

Types of laser used to drill shale rock

High power laser beams are needed to drill through shale rock. These types of laser beams include:

- Carbon Dioxide laser (CO₂)
- Chemical – Oxygen Iodine laser (COIL)
- Neodymium: Yttrium Aluminum Garnet (Nd:YAG)

These laser types are used due to their ability to produce high power and achieve high irradiance in order to vaporise the rock material.

Laser beam parameters

- Power – 5.6 KW
- Wavelength – Ranges from 0.1 μm to 100 μm
- Penetration rate – 0.5588 cm/sec
- Peak power – 20 KW
- Specific energy – 200 KJcubic cm (CO₂), 900 KJcubic cm (Nd:YAG)
- Specific power – 2546 KW sq. cm to 10191 KW sq. cm

Laser beam parameters

- Rate of penetration – 1.8 m per hour
- Minimum irradiance – 10000 W/sq. cm

References

- <https://www.laserfocusworld.com/industrial-laser-solutions/article/14215360/drilling-rock>
- https://www.researchgate.net/publication/282613725_Laser_Drilling_Using_NdYAG_on_Limestone_Sandstone_and_Shale_Samples_ROP_Estimation_and_the_Development_of_a_Constant_ROP_Drilling_System