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LaGeo S.A. de C.V.

GEOTHERMAL DRILLING

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ABSTRACT

Geothermal drilling is considered as the phase which verifies the existence of an underground thermal resource which may be utilized for energy exploitation. The earlier phases of research relate largely to the study of hot springs, fumaroles and even the presence of volcanoes themselves, but after having carried out all these studies, it is the drilling of exploration boreholes, and, above all, deep exploration, which evidences the success or failure of the research.

1. INTRODUCTION

1.1 Drilling of a geothermal well

This will be a short description of the different activities involving the drilling of a well, the different steps that must be performed to provide the final product; a completely finished well. The three components of geothermal drilling are: The rig, the personnel, and the work performed or the drilled well.

1.2 The drilling rig

The drilling rig (Figure 1) can be considered as a plant consisting of several components that are used to create the ultimate goal; a completely finished geothermal well. It must always be taken into account that each component can be transported by land via trucks, hauling trailers, or low-bed trailers, whenever the rig is transported to the site where the well will be drilled.

Generally, rigs are owned by private equity entities, which may have a sole proprietor or be owned by a partnership formed by several owners.

The rig comprises hoisting, circulation, and rotation components, as well as a steel structure with a mast, and a power source.

FIGURE 1: Massarenti 6000 rig

1.2.1 The tower or mast

It is a steel structure which must possess the capacity to house sufficient drill pipe, which can weigh up to several tons.

It is erected on a steel base called the substructure, which holds the work-floor known as the rotary table. The work-floor is where the drilling crew is deployed.

This substructure must also possess enough height so as to accommodate the arrangement of the blowout preventer valves.

1.2.2 Hoisting components

The hoisting system is comprised by the main winch, the block and tackle pulley, the crown block and the drilling cable (Figure 2).

FIGURE 2: Travelling block and hook (left) and crown block (right)

1.2.3 Rotation components

This system is comprised by the rotary head, the hexagonal Kelly, and the rotary table. This also includes the drill string and drill bits. The drill bits (Figure 3) are the tools that cut the rock formation. There are several types of drill bits, such as:

1.3 Drilling personnel

The personnel working in drilling consists of the drilling crew, where the driller is the leader and the person who operates the rig. The driller works with the derrickman, who is the person working in the mast and who is also in charge of monitoring and controlling the drilling fluid or mud tanks.

There is also an assistant driller that provides support to the operations and management of the rig. Furthermore, there is a group of three people called roughnecks, who work on the floor to conduct tightening maneuvers on the drilling tools.

The toolpusher is the person in charge of the drilling platform and the person who gives orders therein. This person is available at the drill site 24 hours a day, over a period of three to four weeks, until he is relieved from his duties.

There is also maintenance personnel on site, such as the equipment mechanic, the electrician, and the welders. Each person has their respective assistant to aid them in operations that can sometimes last for long periods of time.

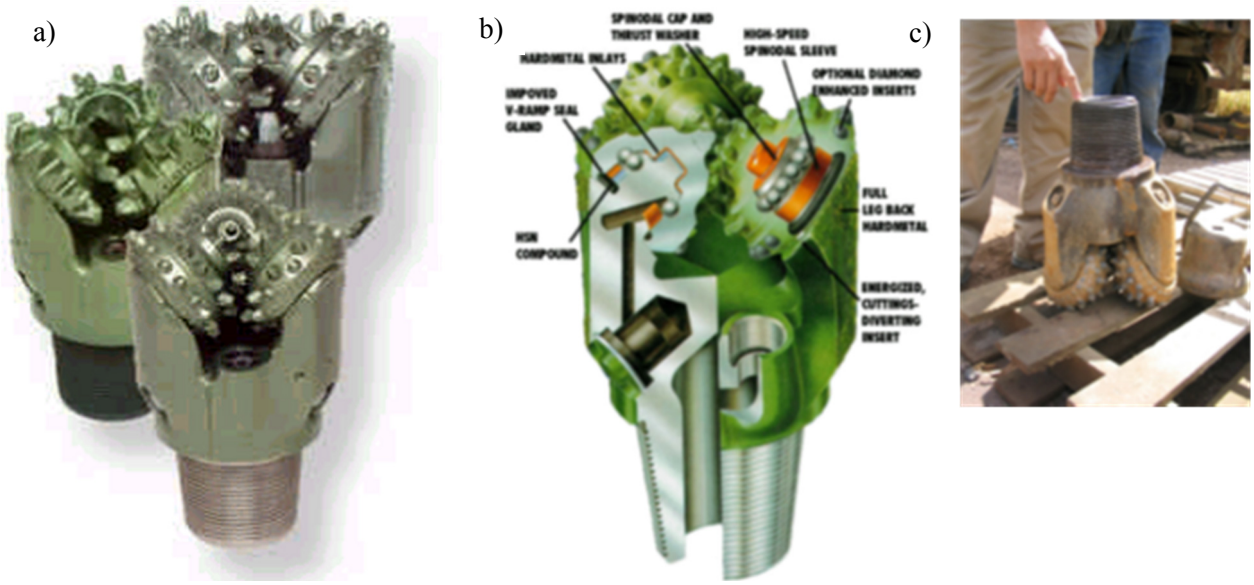

FIGURE 3: Drill bits: a) Tri-cone bits, b) Tri-cone bit, bearings, c) 12 ¼" Tri-cone bit

1.4 The drilled well

The drilling of a geothermal well is performed with a hole of a larger initial diameter and ends with a smaller diameter hole. This means that the construction is telescopic. The reason for this is because of the expected penetration, seeing as the best penetration normally occurs at greater depths with smaller diameter bits. A typical description of a drilled well is shown in Figure 4.

The first stage of drilling is carried out with the larger diameter formation cutting tool (for this particular case, 32" diameter). Drilling then continues with the second stage of 23", which is followed by a third stage of 17 ½" and ends with a 12 ¼" hole. For each of these drilling stages, a steel pipe casing is installed like so: for 32", a 24 ½" casing is provided; for 23", a 18 5/8" casing is provided; for 17 ½", a 13 3/8" casing is provided; and finally, for the 12 ¼" hole, the casing is a slotted liner (often simply referred to as "liner") which can be hung or supported until reaching the bottom of the well.

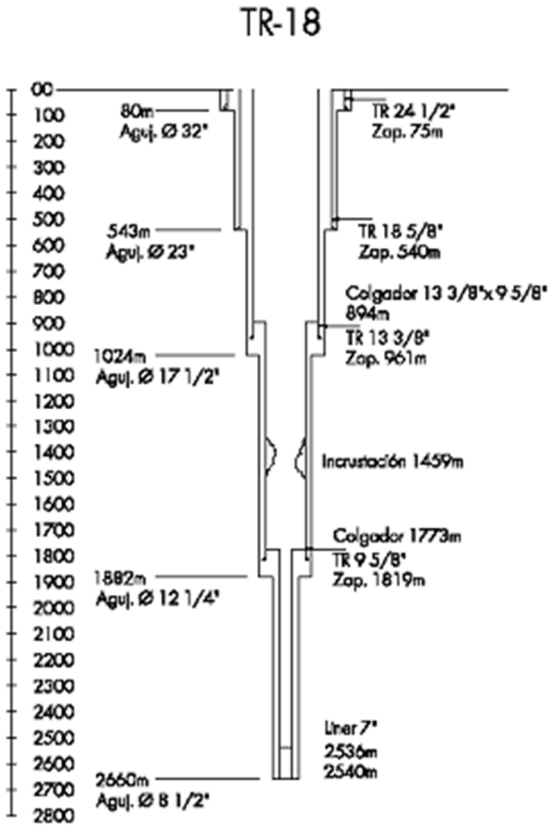

FIGURE 4: A typical description of a drilled well

2. DRILLING OPERATIONS

2.1 Mobilization and assembly of the rig

The mobilization of the drilling rig is the transportation from its storage base to the place where the well will be drilled. Where there already exist drilled wells in the platform, some additional procedures must be considered, which depend on the space available for the rig.

Sometimes it is necessary to assemble the rig in a place where it can be further skidded, depending on the space available.

(Video of the skidding of the Massarenti 6000 rig in the TR-18B well, Berlín geothermal field, 2012)

2.2 Drilling

2.2.1 Vertical Drilling

Vertical drilling is conducted in order to construct a vertical hole. The maximum permissible deviation should not exceed 5 degrees, and to verify this, tilt records (which mark the inclination angle of the borehole in a metal tablet) are performed every 100 drilled meters.

To try to maintain the verticality of the well, it is necessary to monitor and control the drilling parameters, such as the weight applied to the string, the string rotation, and the pumping flow of the drilling fluid, which may all influence the inclination to some extent.

2.2.2 Directional drilling

Directional drilling is used when the drill site is located in places where it is difficult to build platforms. It takes advantage of an existing well platform to drill directionally towards the objective, which may be a few meters away from the vertical axis of the well.

It also serves to better intercept the faults or fractures which may exhibit characteristics of production or feeding areas for geothermal resources, whether it be steam or a geothermal water-steam mixture.

To perform directional drilling of a well, one of the most widely used tools is called a downhole motor, which consists of a tubular tool that carries a helically shaped rotor in its interior, which in turn is rotated by the passing drilling fluid, also known as drilling mud.

In regards to directional drilling measurements, inclination angles are measured as well as the direction or orientation of the drilling string.

2.2.3 Aerated drilling

It is the drilling technique which uses air as a drilling fluid (Figure 5). Drilling is typically performed with a combination or mud-air, air-water, or air-foam, with the purpose of decreasing the weight of the hydrostatic head, as well as contributing to the reduction of circulation losses caused by fractures induced by the hydrostatic pressure of the drilling fluid column in the well.

This type of drilling has been applied with the purpose of better maintaining cleanliness in the borehole, as well as maintaining a continuous circulation of drilling fluid when passing through large fracturing areas that prevent the collection of cuttings from the bottom of the well.

FIGURE 5: Test of the production of a geothermal well with compressed air equipment for aerated drilling

REFERENCES

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