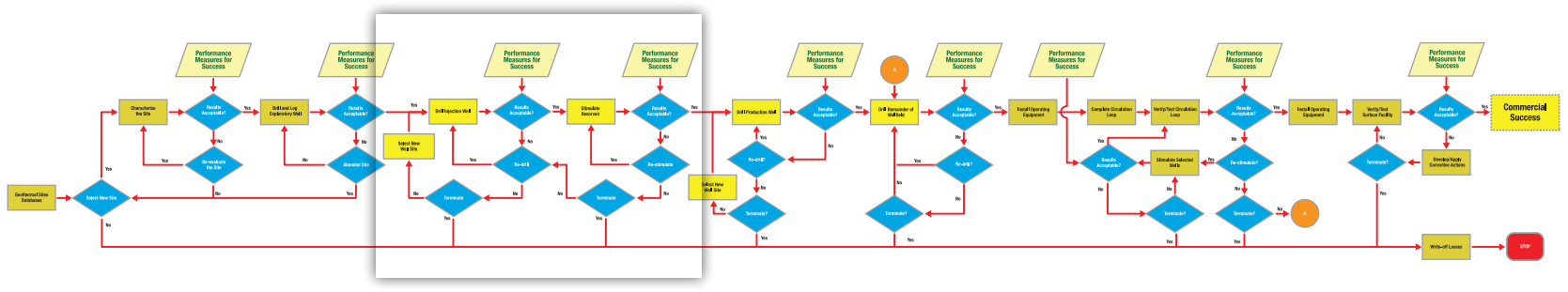
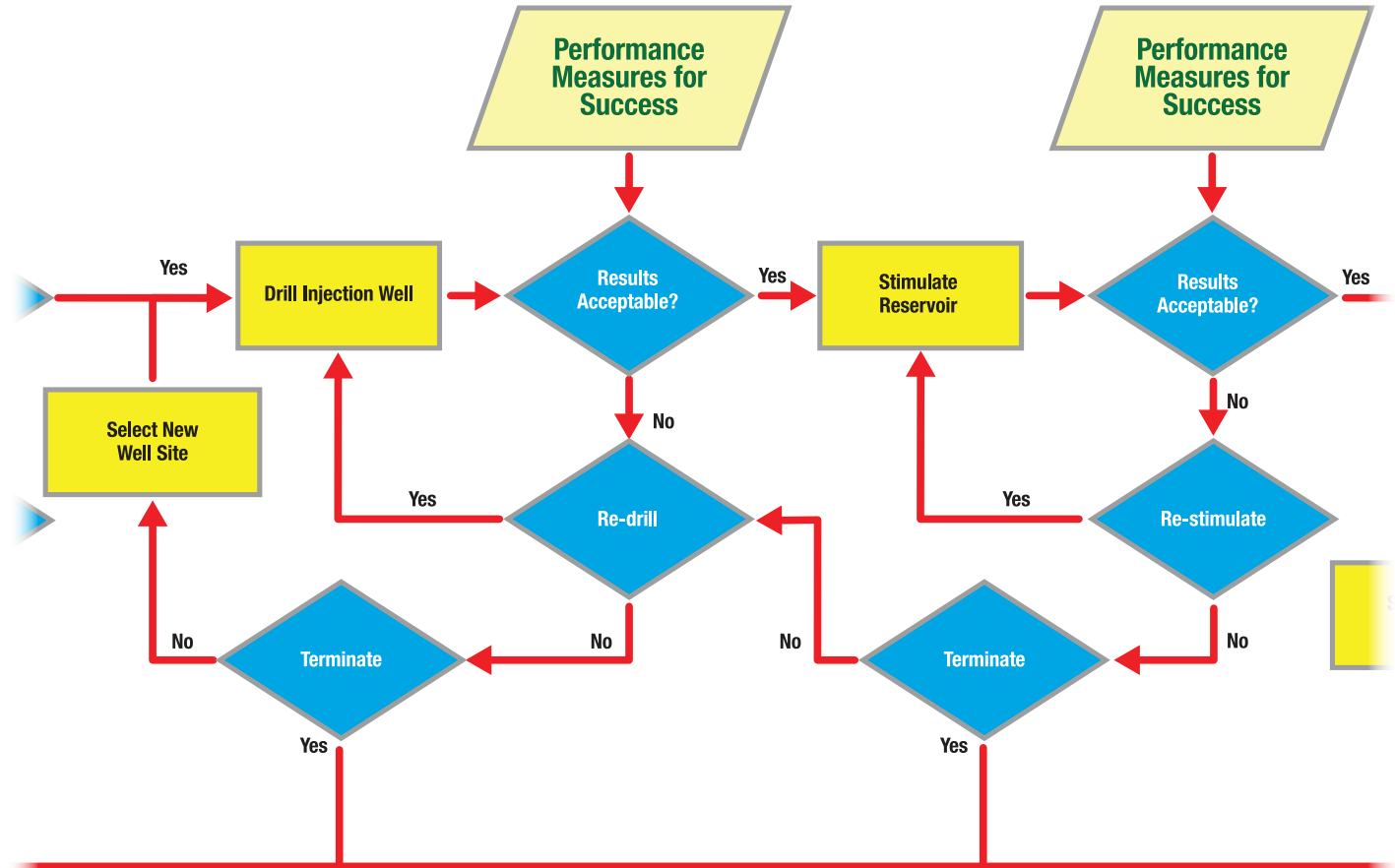
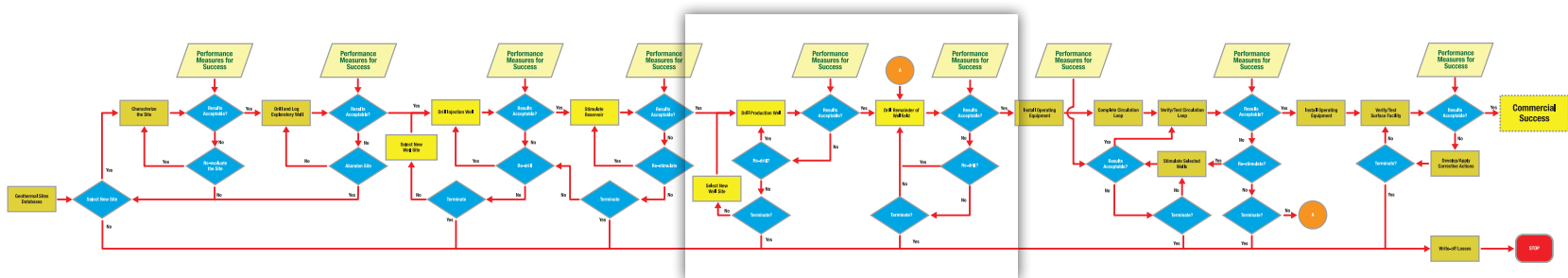
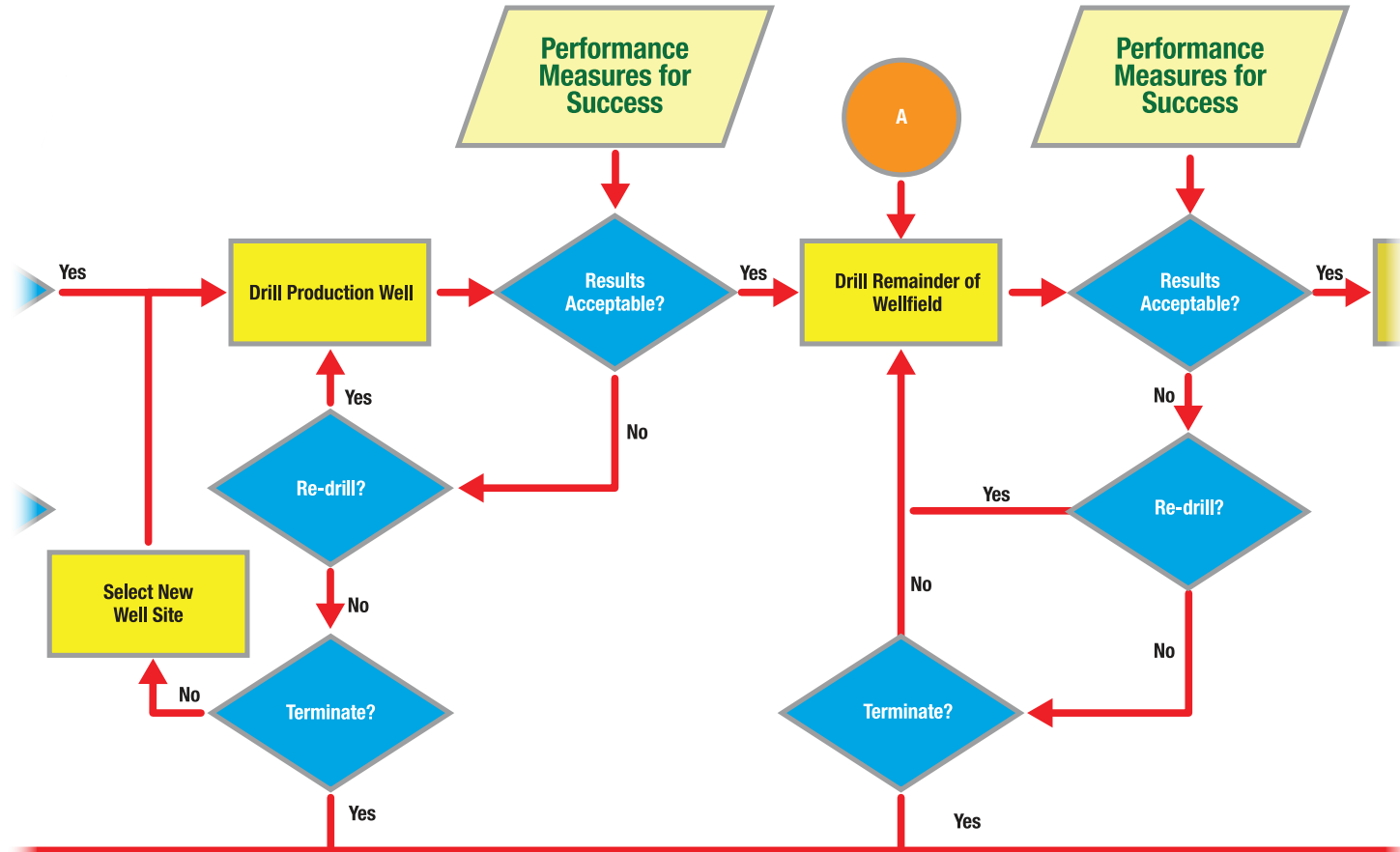


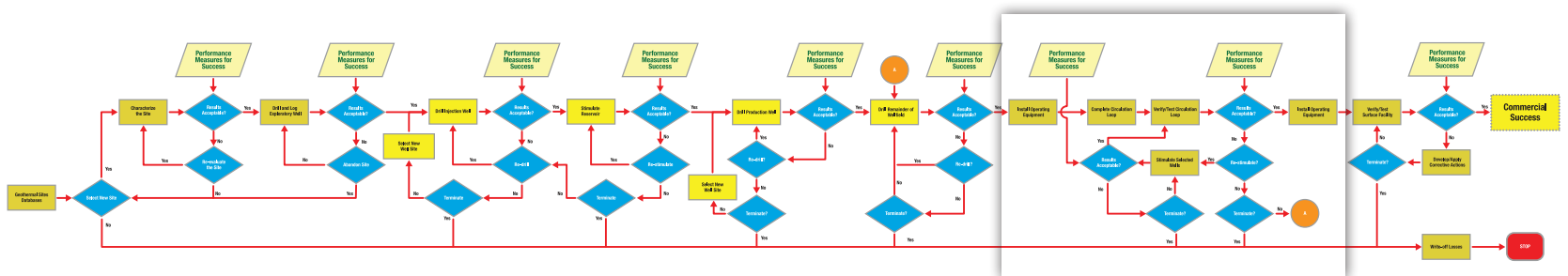
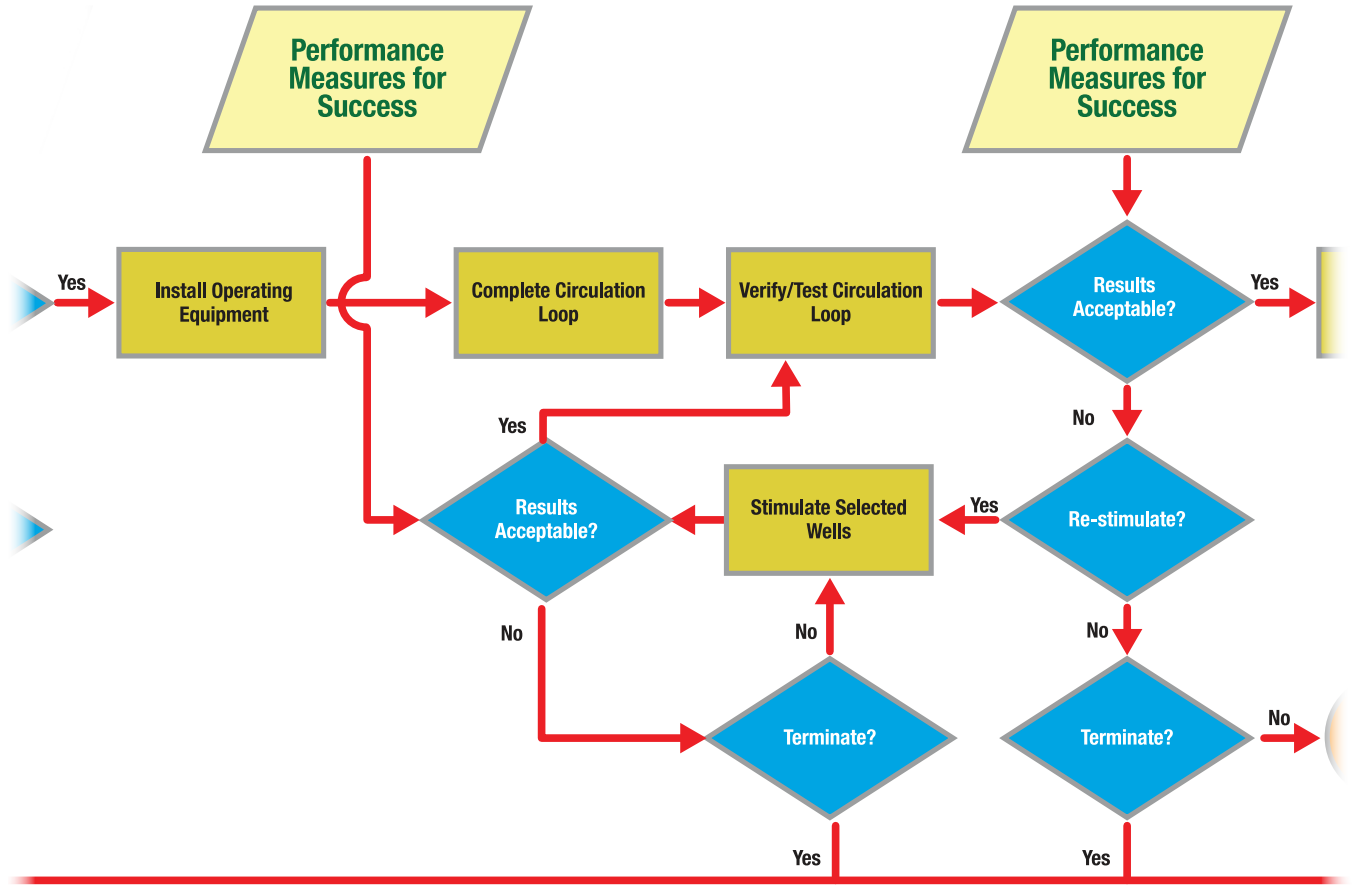
Step 2 - Creating Reservoir



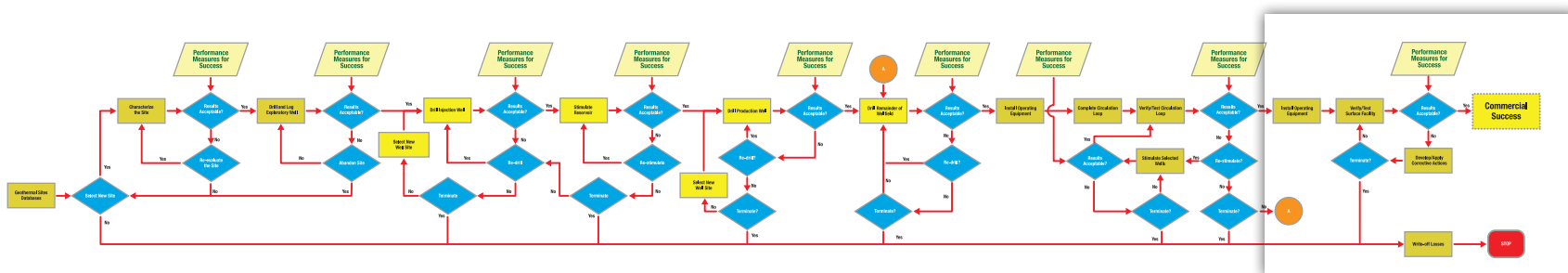
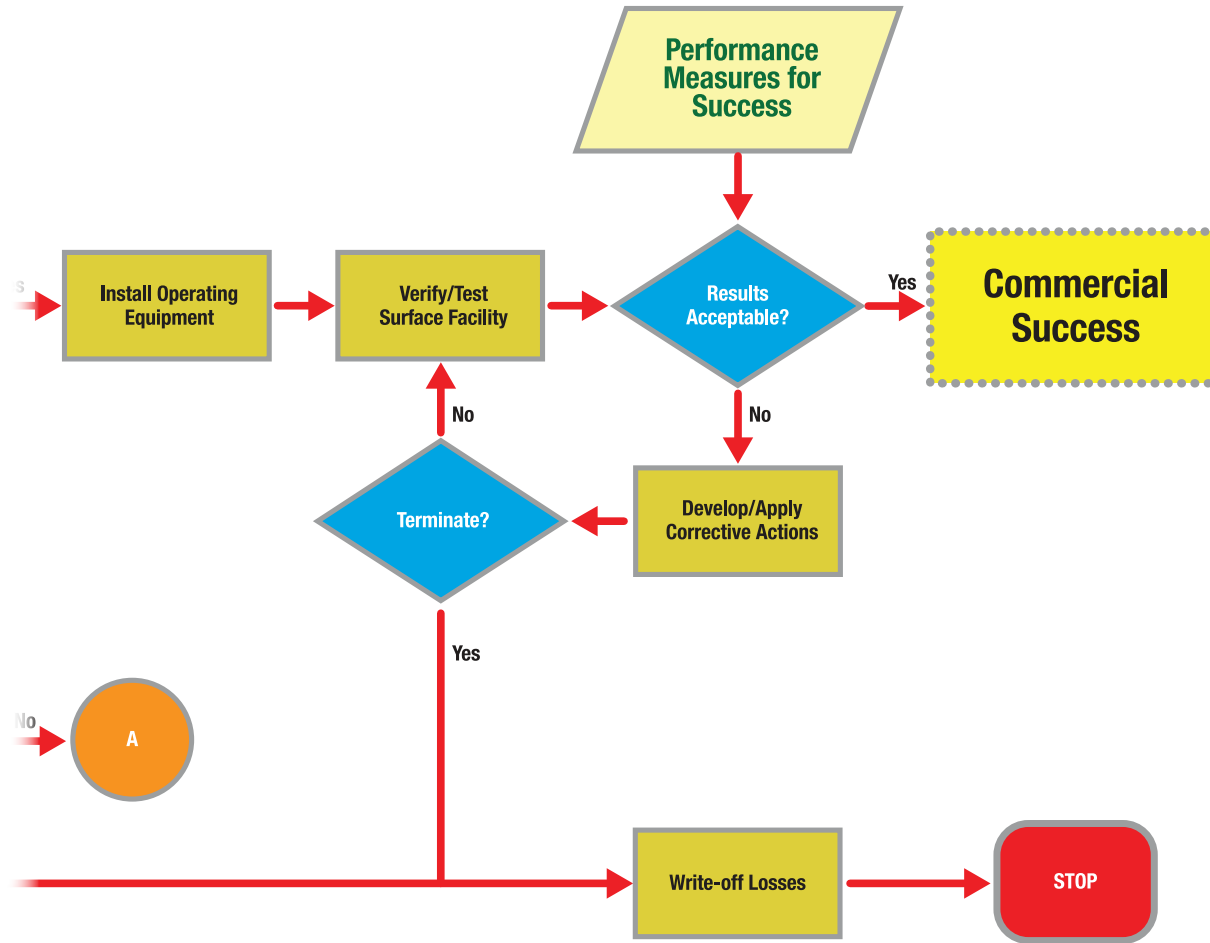
Step 3 - Completing Wellfield



Step 4 - Operating Reservoir



Step 5 - Operating Facility



Glossary

Borehole Breakouts

Failure of the borehole wall which forms because of stress in the rock surrounding the borehole. The breakout is generally located symmetrically in the wellbore perpendicular to the direction of greatest horizontal stress on a vertical wellbore.

Binary Cycle

Binary geothermal systems use the extracted hot water or steam to heat a secondary fluid to drive the power turbine.

Casing

Pipe placed in a wellbore as a structural interface between the wellbore and the surrounding formation. It typically extends from the top of the well and is cemented in place to maintain the diameter of the wellbore and provide stability.

Core

A cylinder of rock recovered from the well by a special coring drill bit.

Depletion Factor

Annual percentage of the depletion of the thermal resource.

Drag Bit

Drilling bit that drills by scraping or shearing the rock with fixed hard surfaces, "cutters." See also *rotary cone bits* and *polycrystalline diamond compact bits*.

Enhanced Geothermal Systems (EGS)

Engineered reservoirs that can extract economic amounts of heat from geothermal resources.

Fault

A fracture in rock exhibiting relative movement between the adjoining surfaces.

Fracture

Natural or induced breaks in rock.

Fracturing Treatments

Fracturing treatments are performed by pumping fluid into the subsurface at pressures above the fracture pressure of the reservoir formation to create a highly conductive flow path between the reservoir and the wellbore.

Global Positioning System (GPS)

A navigational system using satellite signals to fix the location of a radio receiver on or above the earth's surface.

Geothermal Resources

The natural heat of the earth that can be used for beneficial purposes when the heat is collected and transported to the surface. See also *EGS* and *hydrothermal reservoir*.

Gravimetry

The use of precisely measured gravitational force to determine mass differences that can be correlated to subsurface geology.

Hydraulic Stimulation

A stimulation techniques performed using fluid. See *Stimulation*.

Hydrothermal

Pertaining to hot water.

Hydrothermal Reservoir

An aquifer, or subsurface water that has sufficient heat, permeability, and water to be exploited without stimulation or enhancement.

Induced Seismicity

Induced seismicity refers to typically minor earthquakes and tremors that are caused by human activity that alters the stresses and strains on the Earth's crust. Most induced seismicity is of an extremely low magnitude, and in many cases, human activity is merely the trigger for an earthquake that would have occurred naturally in any case.

Interferometric Synthetic Aperture Radar (InSar)

A remote sensing technique that uses radar satellite images to determine movement of the surface of the earth.

Line Shaft Pump

Fluid pump that has the pumping mechanism in the wellbore and that is driven by a shaft connected to a motor on the surface.

Liner

A casing string that does not extend to the top of wellbore, but instead is anchored or suspended from inside the bottom of the previous casing string.

Lithology

The study and description of rocks, in terms of their color, texture, and mineral composition.

Lost Circulation

Zones in a well that imbibe drilling fluid from the wellbore, thus causing a reduction in the flow of fluid returning to the surface. This loss causes drilled rock particles to build up in the well and can cause problems in cementing casing in place.

Magnetic Survey

Measurements of the earth's magnetic field that are then mapped and used to determine subsurface geology.

Magneto-telluric

An electromagnetic method of determining structures below the earth's surface using electrical currents and the magnetic field.

Matrix Treatments

Treatments performed below the reservoir fracture pressure, and generally are designed to restore the natural permeability of the reservoir following damage to the near-wellbore area. Matrix treatments typically use hydrochloric or hydrofluoric acids, to remove mineral material that reduces flow into the well.

Micro-seismicity

Small movements of the earth causing fracturing and movement of rocks. Such seismic activity does not release sufficient energy for the events to be recognized except with sensitive instrumentation. See also *seismicity*.

Mini-frac

A small fracturing treatment performed before the main hydraulic fracturing treatment to acquire stress data and to test pre-stimulation permeability.

Packer

Device that can be placed in the wellbore to block vertical fluid flow so as to isolate zones.

Permeability

The ability of a rock to transmit fluid through its pores or fractures when subjected to a difference in pressure. Typically measured in darcies or millidarcies.

Polycrystalline Diamond Compact Drilling Bit (PDC)

A drilling bit that uses polycrystalline diamond compact inserts on the drill bit to drill by means of rotational shear of the rock face. See *drag bits*.

Proppant

Sized particles mixed with fracturing fluid to hold fractures open after a hydraulic stimulation.

Recovery Factor

The fraction of total resource that can be extracted for productive uses.

Resistivity Survey

The measurement of the ability of a material to resist or inhibit the flow of an electrical current, measured in ohm-meters. Resistivity is measured by the voltage between two electrodes while an electrical current is generated between two other electrodes. Resistivity surveys can be used to delineate the boundaries of geothermal fields.

Roller Cone Bit

Drill bit that drills by crushing the rock with studded rotating cones attached to the bit.

Resource Base

All of a given material in the Earth's crust, whether its existence is known or unknown, and regardless of cost considerations.

Seismic

Pertaining to, of the nature of, or caused by an earthquake or earth vibration, natural or man-made.

Seismicity

The phenomena of earth movements. Also the frequency, distribution and intensity of earthquakes. Syn. *seismic activity*.

Seismometer

Electrical device that is used on the surface and within wellbores to measure the magnitude and direction of seismic events.

Self-potential

Self-potential in geothermal systems measures currents induced in the subsurface because of the flow of fluids.

Spinner Survey

The use of a device with a small propeller that spins when fluid passes in order to measure fluid flow in a wellbore. The device is passed up and down the well continuously measuring flow to establish where and how much fluid enters or leaves the wellbore at various depths.

Slim Hole

Drill holes that have a nominal inside diameter less than about 6 inches.

Slotted Liner

Liner that has slots or holes in it to let fluid pass between the wellbore and surrounding rock.

Smart Tracer

Tracer that is useful in determining not only the flow path between a well injecting fluid into the subsurface and a well producing fluid from an adjacent well, but which can also be used to determine temperature along the flow path, the surface area contacted by the tracer, the volume of rock that the tracer interacts with, and the relative velocities of separate phases (gas, oil and water in petroleum fields; steam and liquid water in geothermal systems).

Stimulation

A treatment performed to restore or enhance the productivity of a well. Stimulation treatments fall into two main groups, hydraulic fracturing treatments and matrix treatments.

Stress

The forces acting on rock. In the subsurface the greatest force or stress is generally vertical caused by the weight of overlying rock.

Structural Discontinuity

A discontinuity of the rock fabric that can be a fracture, fault, intrusion, or differing adjacent rock type.

Submersible Sump

Pump with both the pumping mechanism and a driving electric motor suspended together at depth in the well.

Tiltmeter

Device able to measure extremely small changes in its rotation from horizontal. The “tilt” measured by an array of tiltmeters emplaced over a stimulation allow delineation of inflation and fracturing caused by the stimulation.

Thermal Gradient

The rate of increase in temperature as a function of depth into the earth’s crust.

Thermal Drawdown

Decline in formation temperature due to geothermal production.

Tracer

A chemical injected into the flow stream of a production or injection well to determine fluid path and velocity.

Under Reamer

A drilling device that can enlarge a drill hole. The device is placed about the drill bit and can be opened to drill and then closed to be brought back up through smaller diameter hole or casing.

Well Log

Logging includes measurement of the diameter of the well and various electrical, mass, and nuclear properties of the rock which can be correlated with physical properties of the rock. The well log is a chart of the measurement relative to depth in the well.

Zonal Isolation

Various methods to selectively partition portions of the wellbore for stimulation, testing, flow restriction, or other purposes.

Energy Units¹

Joule (J)

This is the basic energy unit of the metric system, or in a later more comprehensive formulation, the International System of Units (SI). It is ultimately defined in terms of the meter, kilogram, and second.

$$1 \text{ Exajoule (EJ)} = 10^{18} \text{ J}$$

British Thermal Unit (Btu)

This is a basic measure of thermal (heat) energy. A Btu is defined as the amount of energy required to increase the temperature of 1 pound of water by 1 degree Fahrenheit, at normal atmospheric pressure.

BTU is the English system analog of the calorie. For specific heat capacities to be the same, whether expressed in Btu/lb-°F or in cal/gm-°C:

$$1 \text{ Btu} = 251.9958 \text{ cal.}$$

$$1 \text{ Quadrillion Btu (Quad)} = 10^{15} \text{ Btu} = 1.055 \text{ EJ}$$

Kilowatt-hour (kWh)

The kilowatt-hour is a standard unit of electricity production and consumption. By definition, noting that 1 kilowatt = 1000 watts:

$$1 \text{ kWh} = 3.6 \times 10^6 \text{ J (exact).}$$

The relationship between the kWh and the Btu depends upon which “Btu” is used. It is common, although not universal, to use the equivalence:

$$1 \text{ kWh} = 3412 \text{ Btu.}$$

This corresponds to the International Table Btu. [More precisely, 1 kWh = 3412.14 Btu (IT).]

$$1 \text{ Terawatt-year (Twyr)} = 8.76 \times 10^{12} \text{ kWh} \\ = 31.54 \text{ EJ} = 29.89 \text{ quad.}$$

¹ Units were taken from American Physical Society Web site, <http://www.aps.org/policy/reports/popa-reports/energy/units.cfm>.