ICELAND DEEP DRILLING PROJECT (IDDP)

Drilling into Supercritical Fluid

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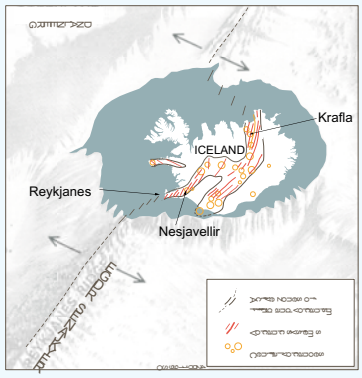
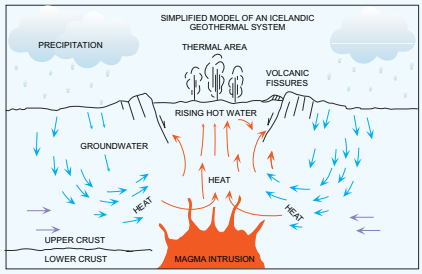
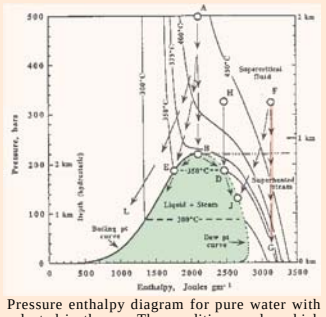


A consortium of Icelandic energy companies (Hitaveita Sudurnesja, Landsvirkjun and Orkuveita Reykjavikur) is preparing to drill a series of 4-5 km deep wells to produce 400-600°C supercritical hydrous fluids from three high-temperature hydrothermal systems, Reykjanes, Nesjavellir and Krafla. The numerous geothermal systems in Iceland are the basis for the well developed industry that supplies about 18% of the installed electrical capacity and district heating for about 90% of the population of the country. Studies suggest that wells drilled into natural supercritical systems could have a power output an order of magnitude greater than that produced from conventional 2.5 km deep geothermal wells. The first well in the series is planned for 2005. The consortium is seeking the participation of international partners and scientists in the project.



PURPOSE:

To enhance the economics of geothermal energy by producing natural supercritical fluids.



Pressure enthalpy diagram for pure water with selected isotherms. The conditions under which steam and water coexist is shown by the shaded area, bounded by the boiling point curve to the left and the dew point curve to the right. The arrows show various different possible cooling paths (Fournier 1999: Economic Geology, 94 (8): 1193-1211).

The Iceland Deep Drilling Project aims to produce supercritical fluid to the surface in such a way that it transforms directly to superheated steam along a path like F-G in the diagram above, resulting in a much greater power output than from a typical geothermal well.

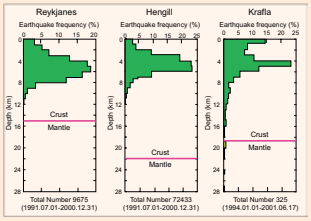
FLUIDS

Fluid compositions at Reykjanes are similar to seawater whereas the inland systems in Iceland are characterized by very dilute fluids. The table shows concentrations in ppm (mg/kg)

	Seawater	Reykjanes	Nesjavellir and Krafla
Na	10,800	9,380	~ 200
Ca	411	1,600	2-5
K	392	1,370	0.2-0.3
Cl	19,400	18,400	~ 100
TDS	35,000	33,140	800

PERMEABILITY

The frequent occurrence of earthquakes of 0-5 on the Richter scale beneath the three target geothermal fields suggest that permeability exists at at depths of 4-8 km.



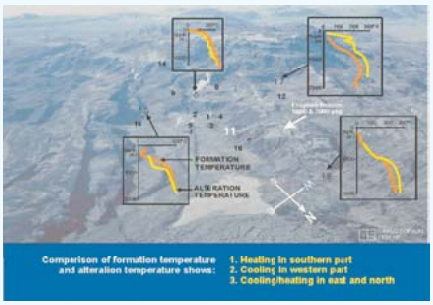
The composition of supercritical fluid is not known in detail, but concentrated brines may develop beneath self-sealing zones. However, their existence may be short lived because of the frequent earthquakes create permeability within the Icelandic crust, thereby allowing mixing. The IDDP boreholes are designed to resolve such questions concerning fluid composition and permeability.

BENEFITS:

1. Increased power output per well (5-10 fold)
2. Production of a higher value steam (higher P-T)
3. Extending the resource base and lifetime of existing fields
4. Knowledge of reservoir characteristics at greater depths
5. Advancing techniques of EGS (enhanced geothermal systems)
6. Development of an environmentally benign resource
7. Development of high-T instruments and drilling technology
8. Application to high-temperature geothermal systems world wide
9. Increased knowledge of mid-ocean rift systems
10. Educational, industrial and economic spinoffs

POTENTIAL DRILLSITES:

REYKJANES is the landward extension of the Mid-Atlantic Ridge. A volcanic eruptive fissure zone is targeted at 3-5 km depth. The last volcanic eruption was 1226 AD. The geothermal water is of oceanic origin. The drillfield is in the center of the peninsula.



NESJAVELLIR is a high-temperature hydrothermal system in an active central volcanic complex in SW-Iceland. The geothermal water is of meteoric origin. In 1986 drilling well NJ-11 met >380°C at only 2.2 km depth. Because of high wellhead pressure and too shallow casing, a gravel pack had to be inserted below 1600 m to control the well.

KRAFLA is a high-temperature geothermal field in an active and evolved caldera in NE-Iceland. A cooling magma chamber exists at shallow depth below the developed drillfield. The geothermal water is of meteoric origin. Magmatic gases were released in a volcanic episode that took place in 1975 to 1984, seriously affected the wellfield.

INTERNATIONAL ASPECTS :

In 2002 IDDP held two international workshops, one on drilling technology and the other on science program. The 160 participants from 12 different countries discussed the unique opportunity the IDDP presents to the international energy industry to participate in major advances in geothermal technology and economics. The IDDP will allow study of a wide range of scientific investigations related to mid-ocean ridges and hydrothermal systems. It will require development and improvement of high-temperature drilling and logging and sampling systems. There will be the opportunity of applying the concepts and technology developed in Iceland in conjunction to our international collaborators to high-temperature geothermal systems world wide. International participation is welcomed.

Further information: www.iddp.is

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