



CASE STUDY FROM HELLISHEIÐI

Index minerals in defining temperature in potential geothermal reservoirs

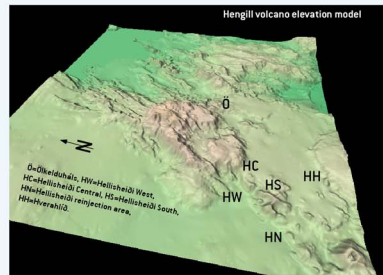
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Introduction

This presentation shows the distribution of certain index minerals in the geothermal wells of the Hellisheiði and Ölkelduháls fields. Production wells number HE-26 and HE-27 are currently being drilled. Seven reinjection wells (HN-series) have been drilled. Reykjavík Energy commissioned the first stage of the Hellisheiði geothermal power plant (90 MWe) on 21 October 2006. This power plant will to produce 270-300 MWe in 2008 and 400 MWh in 2009 (670-700 MW total).

Minerals and temperature

An empirical relationship between the formation temperature and the first occurrence of specific alteration minerals in Icelandic geothermal systems is shown in the table to the right. This relationship is based on empirical observations from 1970 up to the present.



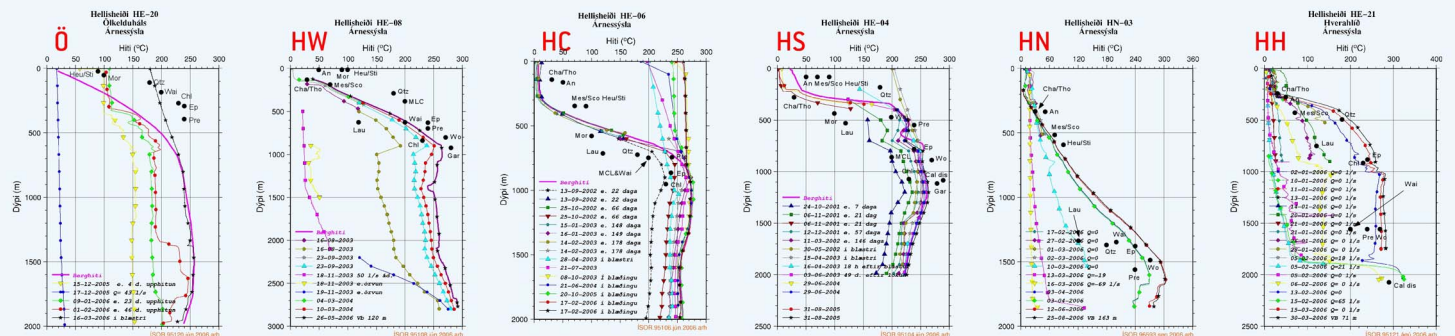
Some temperature dependant minerals in high temperature areas in Iceland

Minerals	Min. temp. °C	Max. temp. °C
zeolites	40	120
laumontite	120	180
quartz	180	>300
wairakite	200	
smectite		<200
**MLC	200	230
chlorite	230	>300
calcite	50-100	290
prehnite	240	>300
epidote	240	>300
wollastonite	260	>300
actinolite	280	>300

*Belong to the zeolite group
**Mixed layer clay

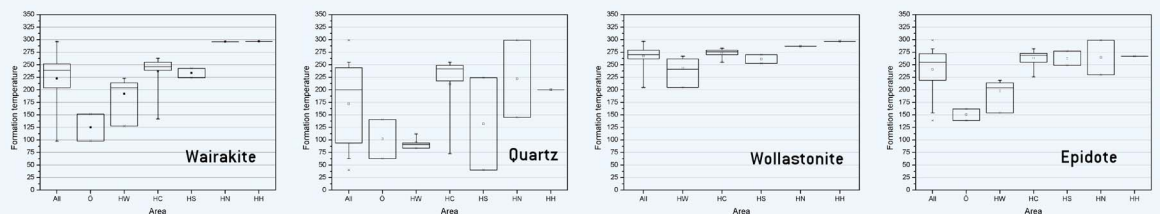
Mineral distribution

The figures below show temperature measurements, estimated formation temperature, and first occurrence of index minerals in wells at Ölkelduháls (Ö), Hellisheiði West (HW), Hellisheiði Central (HC), Hellisheiði South (HS), Hellisheiði reinjection area (HN), and Hverahlíð (HH). Minerals are plotted at the temperature given in the table above.



Temperature distribution of minerals

The figures to the right show the temperature distribution of the uppermost observation of wairakite, quartz, epidote, and wollastonite in the wells.



Practical application

Exploration geothermal wells in high-temperature areas in Iceland are generally designed and drilled as production wells. This implies that all aquifers with a temperature lower than the desired production temperature have to be cased off.

An empirical relationship between formation temperature and the first occurrence of specific alteration minerals is used to determine a proper depth for the production casing. This method currently gives the best estimate of the aquifer temperature that can be made during drilling. Thus, aquifers whose temperatures are too low for production can be excluded from the production part of a well, on the basis of the absence or presence of certain index minerals.

Acknowledgement

Reykjavík Energy is thanked for permission to present these data.

