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EARLY DRILLING AT OHAAKI

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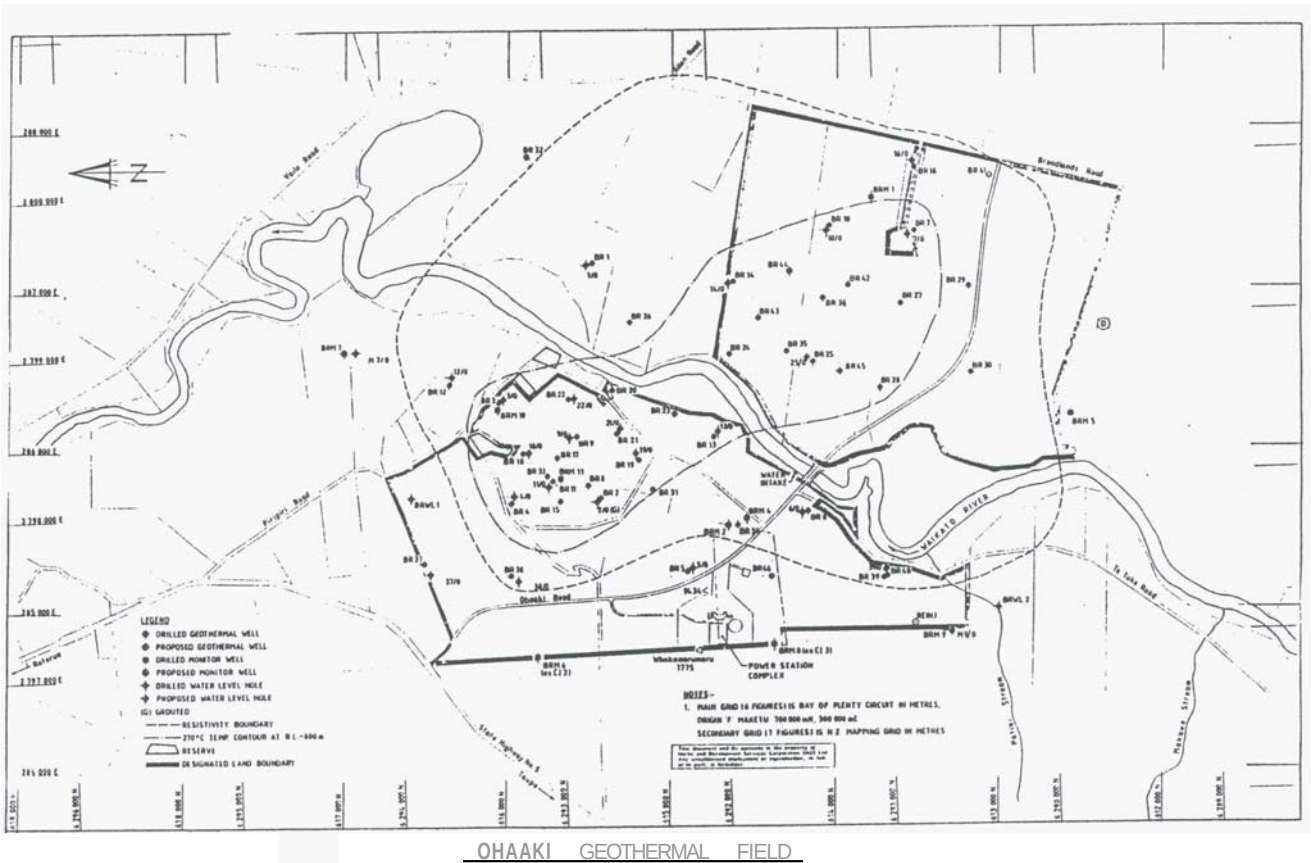
ABSTRACT

Exploration drilling began at Ohaaki in October 1965 following the completion of production drilling at Wairakei. After drilling some 32 wells by 1976 investigations were deemed sufficient to have proven energy potential to generate 120 MW(e). This paper reviews some aspects of the drilling during this period with particular reference to the drilling problems.

BACKGROUND

Following the completion of production and investigation drilling at Wairakei in October 1965 a programme of two exploration wells was undertaken in each of a number of geothermal fields including Tauhara, Broadlands (Ohaaki), Waiotapu, Orakei-Korako, Atiamuri and Reporoa.

Drilling of BR1 commenced in October 1965 and was located in the area of lowest resistivity east of the Waikato River (Fig 1). This well found very high temperatures (280°C) but very low permeability. After several trial discharges the liner was removed and the well blown in an endeavour to enlarge the hole and increase production. Known as the "open-footed" method it was unsuccessful.



OHAAKI GEOTHERMAL FIELD

FIGURE 1 WELL LOCATIONS

Drilling of BR2 commenced in May 1966 and was sited in fractured thermal ground west of the Waikato River (Fig 1), and was located by the "hot foot" method. This well later discharged more steam than any other well in New Zealand at that time.

Following the exploration programme Ohaaki and Tauhara were considered the most promising and the former was chosen for an extensive investigation drilling programme.

DRILLING PROGRAMME

A further seven wells were completed in 1967, five in 1968, three in 1969, seven in 1970 and one in 1971 when drilling was suspended with the proposed development of the Maui natural gas field. By this time some 18 wells were satisfactory production wells with the potential to generate 120 MW(e).

All wells were drilled by the Ministry of Works and Development (now Works and Development Services Corporation). All except BR15 were drilled with a National T12 rig. BR15 was drilled using a Continental Emsco GC350 rig and was cased 9-5/8" to 1066m and drilled to 2424m. Drilled with mud to TD, this well failed to encounter any permeability at depth. Otherwise wells during this phase of the drilling were generally cased to depths in the range 420m to 660m using 8-5/8" K55 production casing and drilled to total depths from 900m to over 1300m and lined with 6-5/8" slotted flush joint liners.

DRILLING CONDITIONS

No extraordinary drilling problems were encountered. However gas (containing H_2S) and high mud circulation temperatures often presented problems. Although the resistivity area was greater east of the Waikato River the results of BR1 meant most of the early drilling was undertaken on the west side of the river.

Drilling duration averaged 30 days for the T12 wells varying between 17 days (BR23) to 46 days (BR3). Drilling was generally undertaken with water based bentonite mud.

After running the slotted liner, it was necessary to run drillpipe to the cemented casing shoe to displace the drilling mud. The wells would invariably come under pressure at this time. The liner was also "jet washed" to assist the removal of the mud from the liner/open hole annulus. It was necessary to periodically close the well in and pump cold water. This procedure, while necessary, would not have enhanced well production. In subsequent drilling water was used as the drilling fluid after encountering the first zone of circulation losses.

The gas encountered in the upper sections of the hole meant that supplies of weighting material (baryte) had to be immediately available during drilling operations. Blowouts up the casing annulus were not uncommon.

BR7 is a typical example. Surface casing (22") was set at 27m in surface pumice and above Huka Formation. After drilling the pilot hole to 157m and preparing to run the hole opener the well kicked. A WHP of 2.5 bars was recorded prior to killing the well with weighted mud. During this time mud escaped outside the 22" casing. Note that while drilling the pilot hole losses were encountered at' 42m. Drilling continued with a mud weight of 1.3 SG and next casing successfully cemented.

The only fatality which has occurred in drilling operations based at Wairakei occurred at the end of drilling operations at BR9. While breaking out the drillpipe, the elevators used to handle the drillpipe were not securely closed. During the operation to lay down the drillpipe the pipe came free from the elevators hitting the roughneck, Mr H Hautu, on the head.

Drilling performance for all Ohaaki wells was generally satisfactory. BR15 however took 135 days to drill or more than twice the expected duration. The problems that caused the delays were:

a) While drilling the hole to run the 18" surface casing to 158m, penetration rates were low, fishing was undertaken to recover the lost drillstring and insufficient drilling tools, stabilisers in particular, were available.

b) While drilling the hole to cement the 13-3/8" casing, circulation was lost at 530m. This section of hole was cemented and the 13-3/8" casing run to 461m.

c) Losses encountered prior to running the 13-3/8" casing continued to present problems. After unsuccessfully attempting to cement the loss circulation zone, drilling continued using over 2000 bags/day of bentonite which was lost into this zone prior to cementing 9-5/8" casing to 1066m.

d) While drilling the 8-1/2" open hole below 1066m a failure of the GC350 drawworks resulted in the drillstring becoming differentially stuck. After taking 1-1/2 days to free the drillstring the drawworks again failed while tripping out. Ten days were spent circulating at the casing shoe while further drawworks repairs were undertaken.

e) Drilling ceased at 1947m and was subeequently restarted. After quenching the well and attempting to regain circulation, junk had to be recovered from hole bottom. Failure of the drawworks delayed drilling for a further 16 days. Having drilled to 2424m a further 11 days were spent cementing and fishing prior to running the liner.

CONTINUING DRILLING

With the first oil crisis in 1973 energy planners showed renewed interest in geothermal energy both at Ohaaki and elsewhere. This was despite the disappointing overall increase in production achieved from the drilling of additional wells in 1970 and 1971. This was due to mineral deposition in the wells while extensive output testing was undertaken.

From 1974 until 1976 a further seven wells were drilled (BR27 to BR33) when investigations were deemed to have been completed.

During the drilling of BR28 a blowout occurred up the outside of the 20" surface casing. The drilling programme called for 3 cemented strings only 20" - 60m, 11-3/4"-180m and 8-5/8". Geology was 0-52m Pumice, River Sand Ash, 52-155m Huka Mudstone.

Drilling was characterised by very high sand contents. Some 180 tonnes of cement was needed to complete the consolidation grouting indicating very porous formation. During cementing of the 20" casing, casing could not be reciprocated freely. Cement tracked up the annulus.

When drilling reached 145m a gas pressure of 5.7 bars was encountered. With mud flowing up the outside of the 20" casing a full scale emergency occurred. Fortunately the well was brought under control by circulating cold heavy mud. The annulus was recemented requiring 50 tonnes of cement.

A similar problem occurred at BR29. Surface casing (20") was set at 24m. A pilot hole was drilled to 105m. While opening the pilot hole at 32m the well came under pressure (7 bars). The gas was bled off to 2 bars and mud pumped into the well. Mud then flowed up the outside of 20" casing and outside the drilling cellar. Further pumping of weighted mud brought the blowout under control. The well was grouted and redrilled prior to running the 16" casing.

A major problem occurred in 1972 at BR25 when the bonnet of an 8" WKM master valve blew off. There was a manufacturing fault with the circlip holding the bonnet. Some 35 days were required to regain control of the well.

GENERAL COMMENTS

Overall the drilling performance achieved was very satisfactory. It is apparent when commencing the initial drilling and again in 1974 drilling duration was somewhat longer. When undertaking the first deep exploration well BR15 drilling performance was poor and was due to various reasons including poor equipment and inadequate drilling tools.

The practise of continuing to use bentonite drilling muds has probably reduced the productivity of many wells. However with the high gas contents encountered there was little safe practical option. Drilling heads would help to overcome this problem.

Problems can be encountered when running insufficient surface casings or drilling too far beyond casing already set. Where gas pressures at the casing shoe equalled or exceeded that of an equivalent cold water column then problems could be expected with blowouts outside the casing. Casing depths should be set with reference to the geology and a more conservative strategy adopted when investigating new fields.

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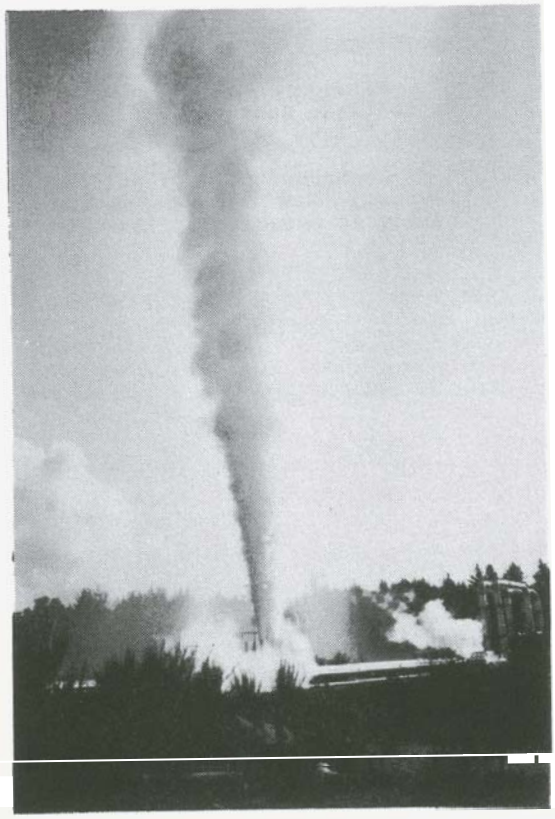
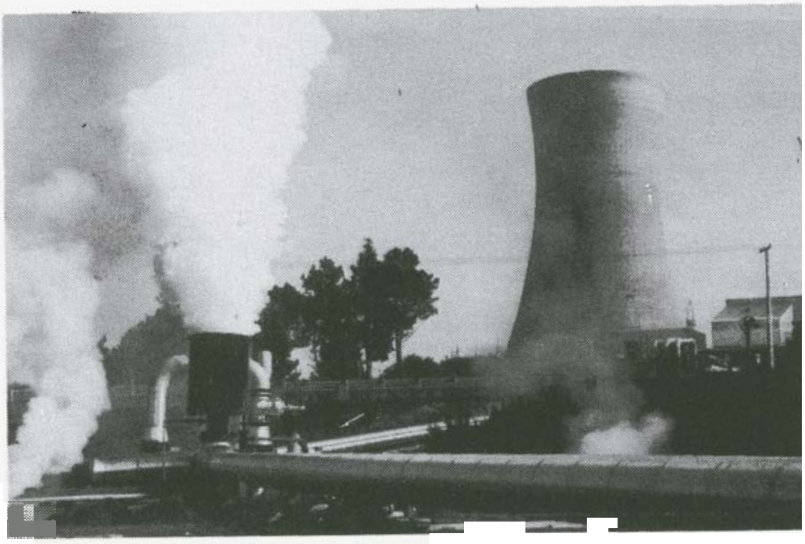


WEST STEAMFIELD *SAFETY* VALVES UNDER TEST

STEAMFIELD STEAM PURGE AT ANCHOR POINT A3



AERIAL VIEW OF WESTERN STEAMFIELD AND POWER STATION

Photos: DesignPower