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Geothermal Circular WJMcC 3

TRACER TESTS - BROADLANDS 1980

W.J.McCabe, M.R.Manning and B. J. Barry

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Lower Hutt, New Zealand

GEOTHERMAL CIRCULAR WJMcC.3

TRACER TESTS ----------BROADLANDS 1980

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ABSTRACT

Two radioactive tracer tests using iodine-131were made in conjunction with hot water reinjection tests on two wells in the Broadlands geothermal field. In each case, a return was detected to the production part of the field. In one case, as much as 30% of the water being discharged at the observation well was reinjected water. The underground flow velocity as measured by the tracer peak arrival time was 13 m/day. In the other test the corresponding figures were 1% and 28 m/day.

Flow paths in relation to known geological information are discussed.

KEYWORDS:

IODINE 131
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TRACERS

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TRACER TESTS - BROADLANDS 1980

W.J.McCabe, M.R.Manning, and B.J. Barry.

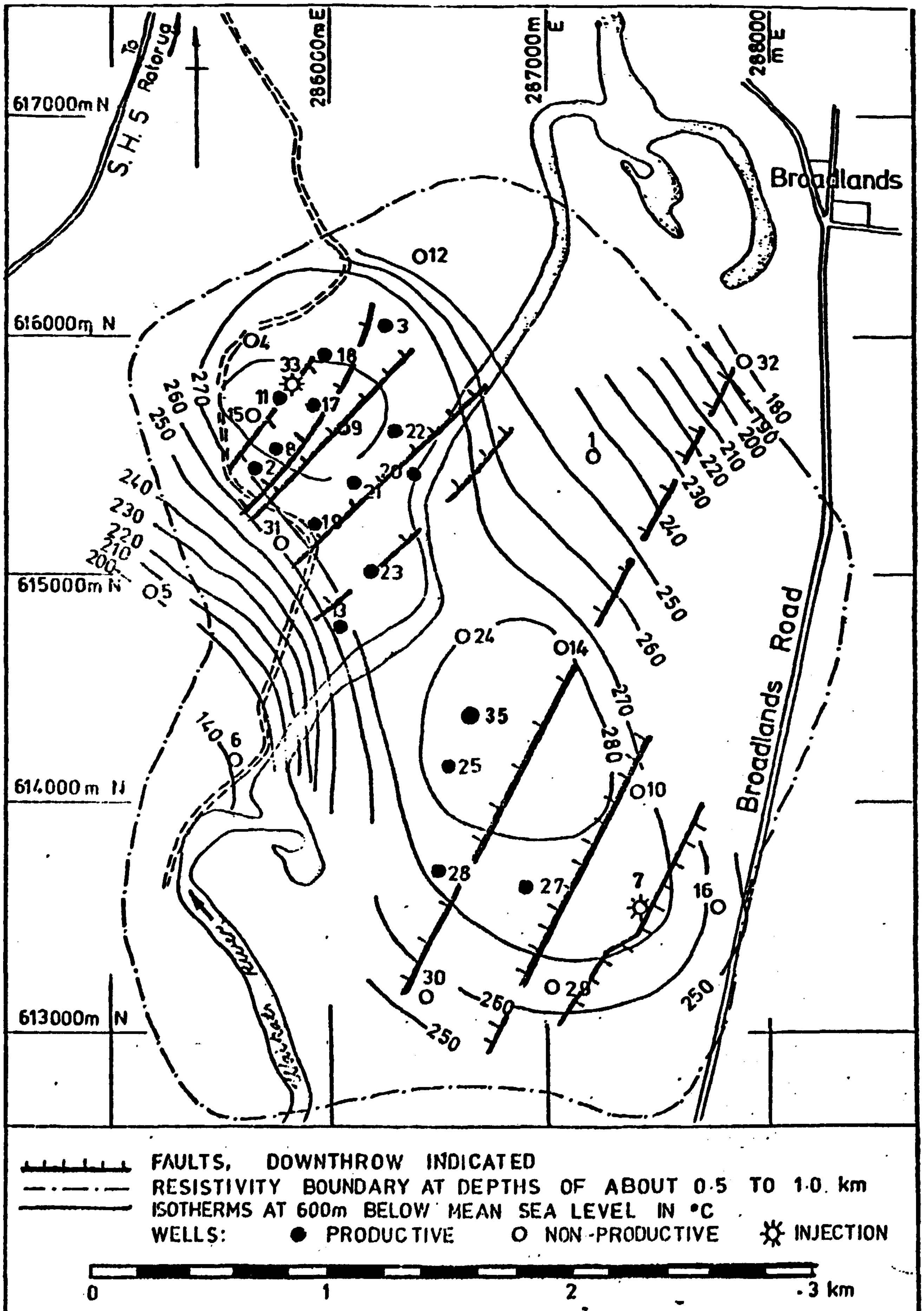
This is a report on the tracer tests made in conjunction with the reinjection tests in BR13 and BR28 in November/ December 1980.

The reinjection tests, in which water from BR19 was being discharged directly into BR13 and water from BR35 was being discharged into BR28, had been running successfully from the early part of the year. In both cases the reinjection rate was around 150 tonnes per hour and the injection well head pressure was 3-4 bars.

Tracer Tests

As in previous tests (1) iodine-131 was used as the tracer and this was pumped into the water line immediately before the injection well head.

Monitoring stations were set up at wells BR19,20 and 23 on the west side of the river and BR24,25,27 and 35 on the east side. The location of these are shown in Fig. 1. Where water separators were not available at the well head, i.e. at BR 20,23,24 and 25, small separators of about 30 l capacity were used to remove radon and H_2S gases. These separators were designed and built by MOWD. As in previous tests the monitoring



BROADLANDS GEOTHERMAL FIELD

Figure 1

tanks were 200 l drums shielded and cooled in $2m^3$ water tanks.

The radioactivity in the inner tank of each station was monitored continuously with a NaI scintillation detector and ratemeter and recorded both on a strip chart recorder and a data logger.

RESULTS

Tables 1 and 2 summarise the data relating to the test.

Table 1.

Date	Time	Injection Well	G.Bq. I-131
3.11.80	1310	BR 13	95
10.11.80	1730	BR 28	80

TABLE 2.

Well	Days to 10% of Peak	Days to Peak	Peak concentration l^{-1}. 10^{-12}	Discharge t/hr.	Tracer Return %	Days Monitored	Reinjection contamination factor - %.
BR 25	7.5 (±0.2)	15 (±1)	130 (± 50)	0.9	0.0033 (±0.0015)	28	0.6 (± 0.3)
BR 23	6.9 (±0.05)	16.5 (±0.5)	2500 (± 250)	0.9 to 10.11.80 47 from 10.11.80	5.9 (± 0.5)	34	19 (±0.2)
BR 19				150	0	34	0
BR 20				0.6	0	34	0
BR 24				1	0	28	0
BR 27				40	0	28	0
BR 35				150	0	28	0

Uncertainties in concentrations and return at BR 25 are 30% due to probe calibration.
and 20% " " background.
" " " " " " BR 23 are 10% " " probe calibration.

The tracer return graphs for wells BR 23, and 25 are given in Figs. 2 and 3.

The 5.9% return of tracer in 28 days at BR 23 extrapolates to around 10% and is the highest recorded in any of our tests at Wairakei or Broadlands. The tracer return, which is a direct measure of the percentage of the reinjected water which is being discharged at the monitoring well, is to some extent proportional to the discharge rate of that well. If however, we express that percent as tonnes/hour of reinjected water and relate it to the discharge rate at the monitoring well we obtain what we had termed the "reinjection contamination factor", which is to some extent independent of discharge rate. For example 10% of the injection at BR 13 is 15 tonnes/hour which is around 30% of the discharge rate of 47 tonnes/hour at BR 23.

Several instrument failures prevented a continuous record of data at well BR 25 and 35. However a positive though small return was obtained at BR 25 starting on the sixth day. Our best assessment of the BR 35 data is that no return occurred there. No responses occurred at any other monitored well.

DISCUSSION

Despite the evidence of good pressure connections between wells BR 13,19,20 and 23, a flow connection was demonstrated only from BR 13 to BR 23. The full discharge of BR 19 was not able to induce a flow in that direction.

FIGURE 2. BR23

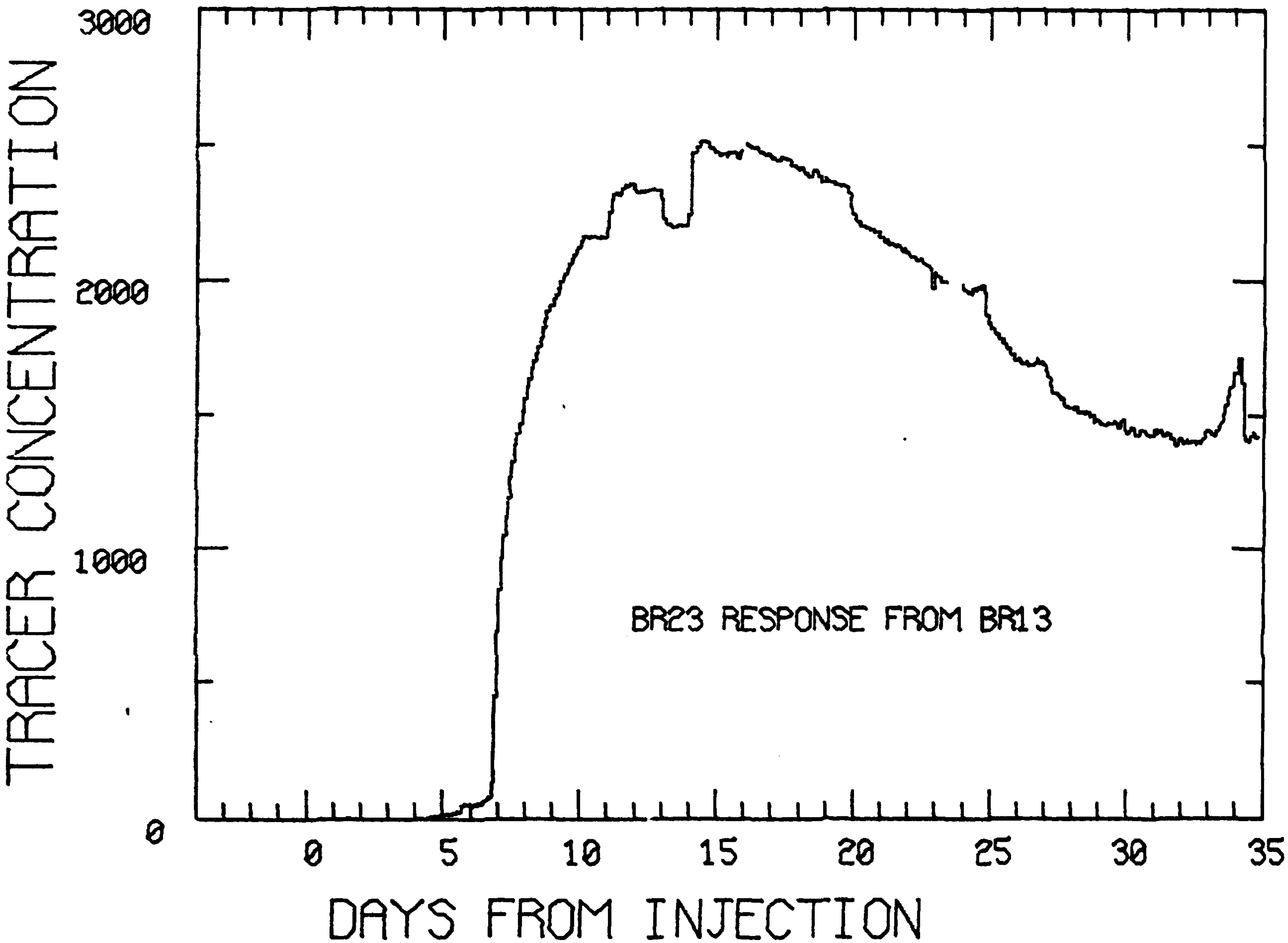
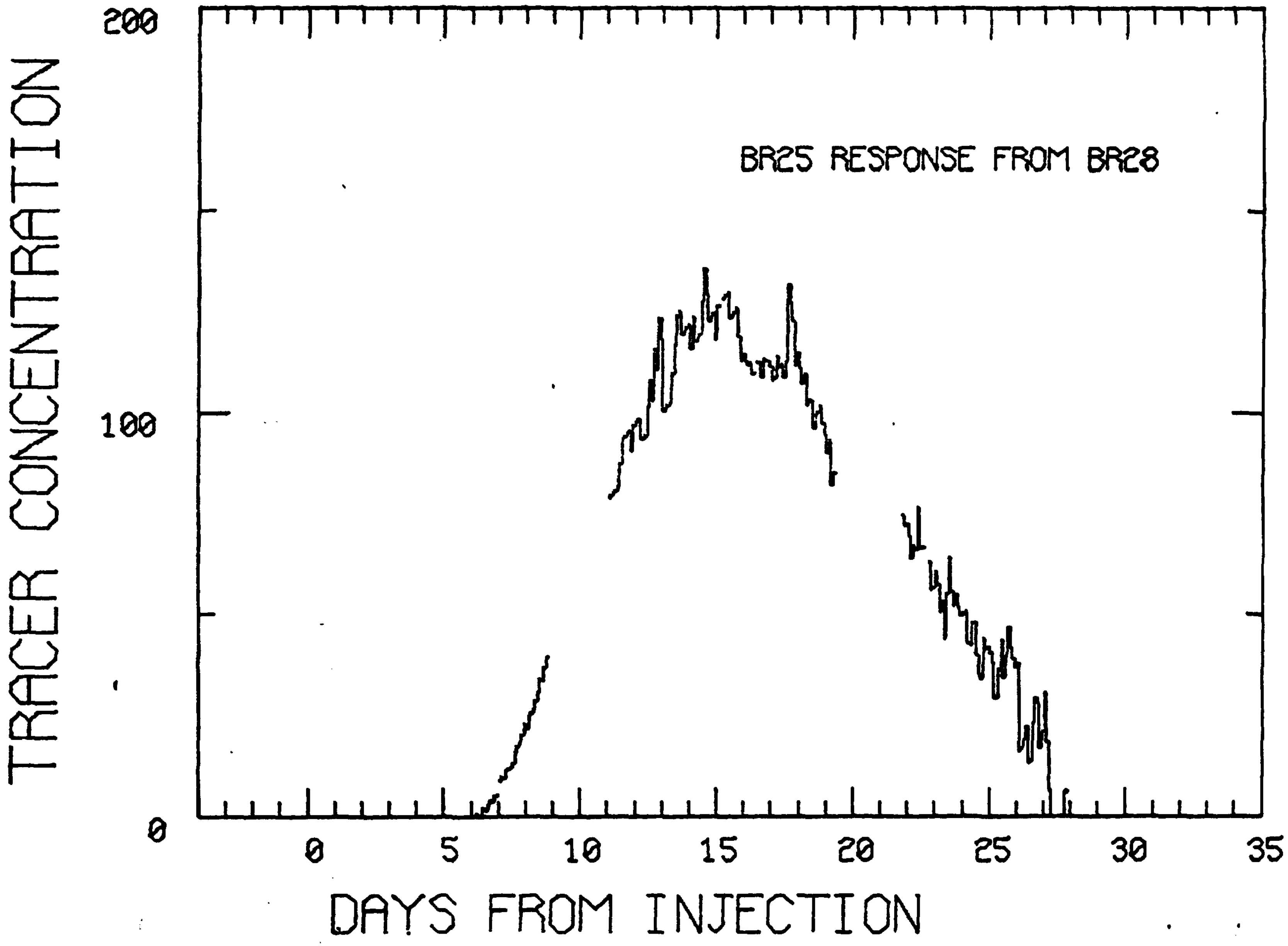


FIGURE 3. BR25



Part way through the test (7 days after injection) the discharge from BR 23 was increased from about 1 t/hr to 47 t/hr, because of a falling bleeding rate which was incorrectly diagnosed as the well cooling off. It was feared that it might stop discharging altogether. Activity had actually started to appear in the output at the beginning of the fifth day after injection. It should also be remembered that at a discharge rate of 1 t/hr the water being taken into the well takes a day or more to reach the surface. Therefore water from the reinjection would have arrived in the vicinity of BR 23 late in the third day. Whether the concentration would have reached the same level as that recorded from the higher discharge rate cannot be determined, but differences in the concentrations would indicate different feed patterns.

The only obvious connection between BR 13 and 23 is that illustrated on page 10 of the Broadland Report (2) which shows feed zones for both wells in the Rangitaiki Ignimbrite. Feed zones for BR 20 are in the next higher formation, the Rautanuni Brecia, and for BR 19 in that formation and in the much higher Waiora Formation.

The response at BR 25 may be via a fault shown by Grindley & Browne (3), (reproduced here as fig.4). from which both wells feed.

Both test results show the potential for rapid movement of reinjected water back into the field.

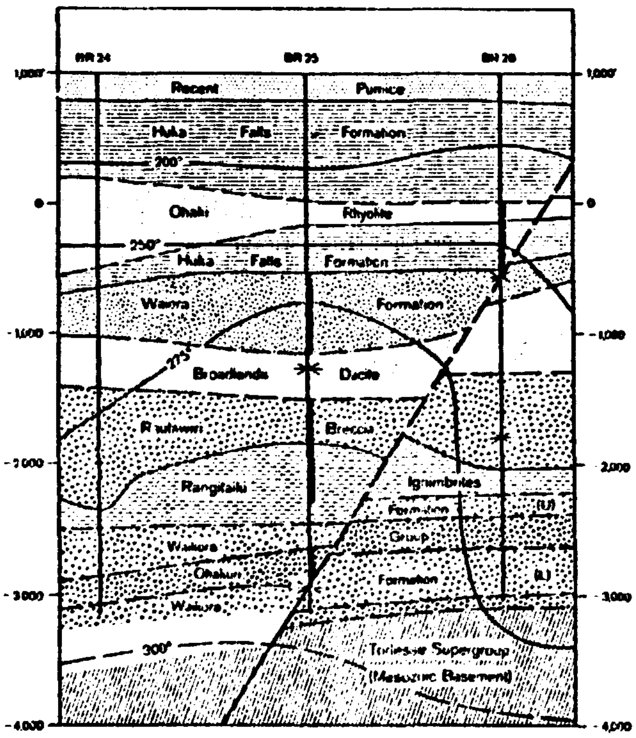


Figure 4 Cross section of BR24 to BR28, showing structure, distribution of adularia (black) where not coexisting with albite, faults, isotherms, and loss-of-circulation/inflow zones, Broadlands. Scale in feet, with no vertical exaggeration.

FUTURE WORK.

Having established connections under one set of conditions it would seem worthwhile to repeat the tests under different conditions even if no reinjection water is available. In this way the differences, if any, between natural flow if any, and full production could be established.

With such a large reinjection contamination factor from BR 13 to 23 it should be possible to detect an enthalpy change at BR 23 if cool water was again reinjected at BR 13.

A test could be made with the current reinjection at BR 30, monitoring at BR 28 and 27.

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