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Olkaria East reservoir response to 25 Years of exploitation

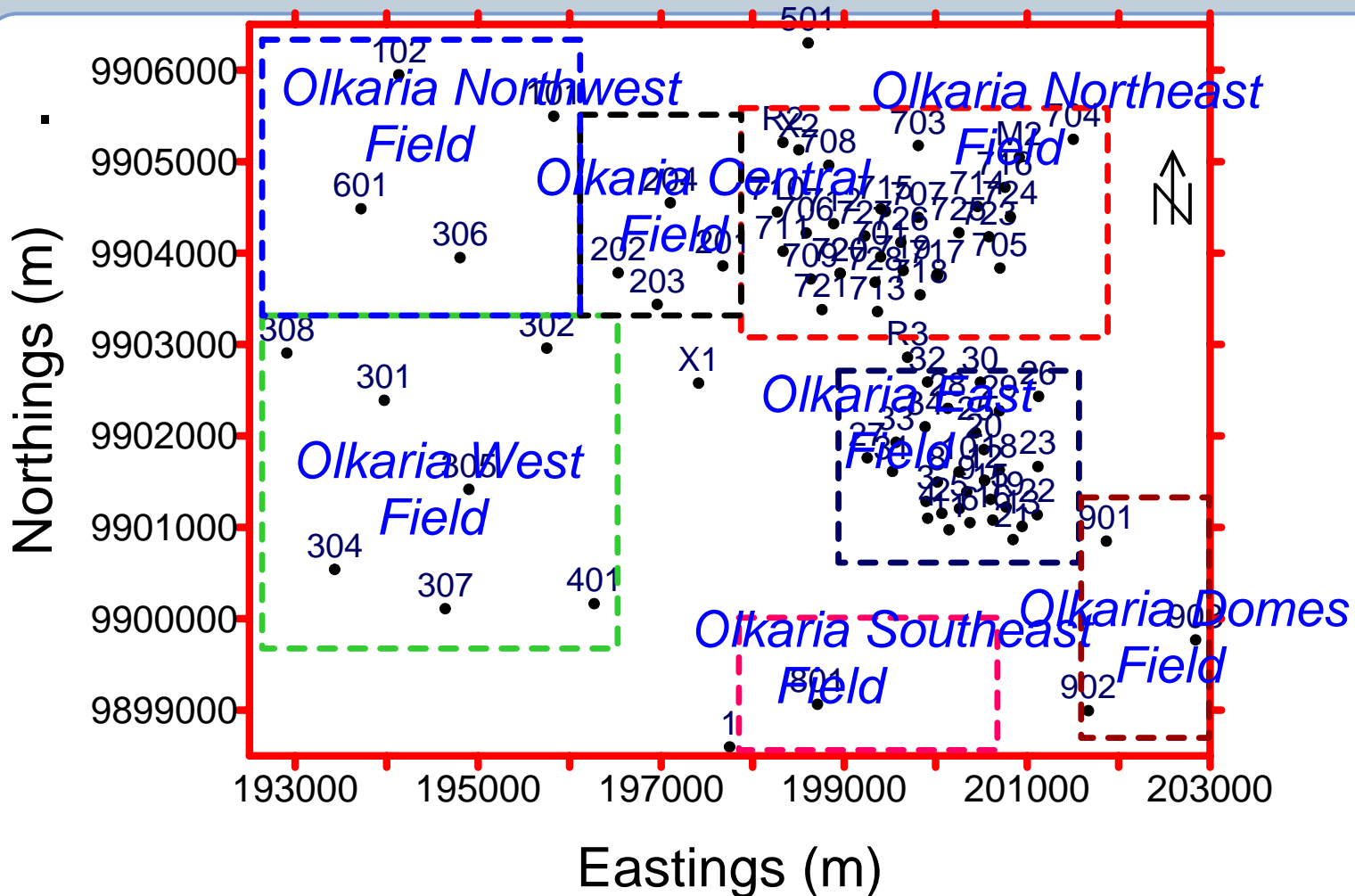


Cornel O. Ofwona
Olkaria Geothermal Station



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Location of Olkaria Fields



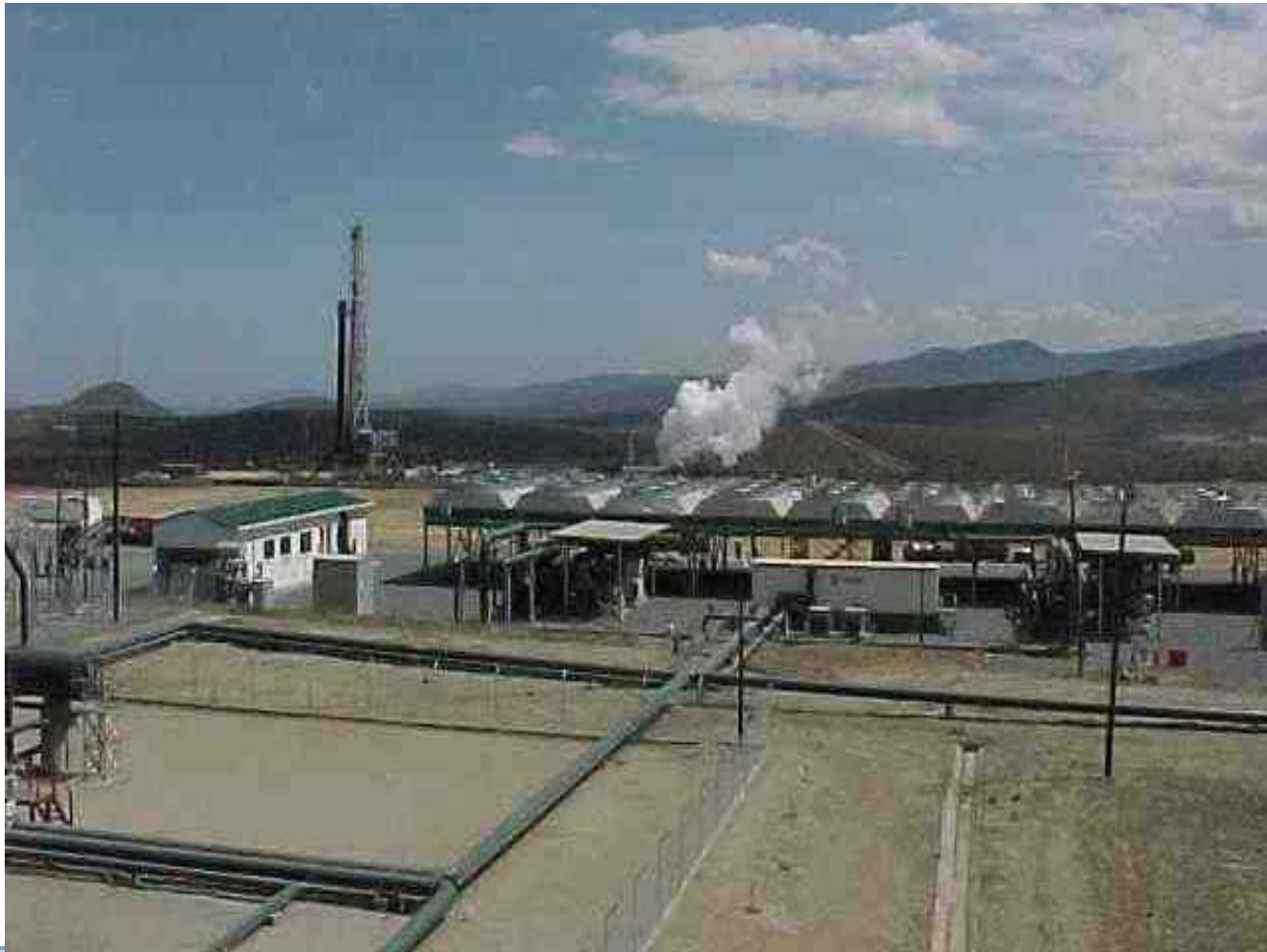
Olkaria I – 45 MWe (Commissioned 1981)



Olkaria II – 70 MWe (Commissioned 2003)



Olkaria III – 13 MWe (Commissioned 2000)



Oserian Green House Heating Plant





Reservoir characteristics **KenGen**

- Olkaria reservoirs are water dominated
- Olkaria I is boiling with discharges being 25 % water and 75 % steam. T & P profiles follow BPD curve.
- Olkaria II well discharges is on average 50 % water and 50 % steam.



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Conceptual model

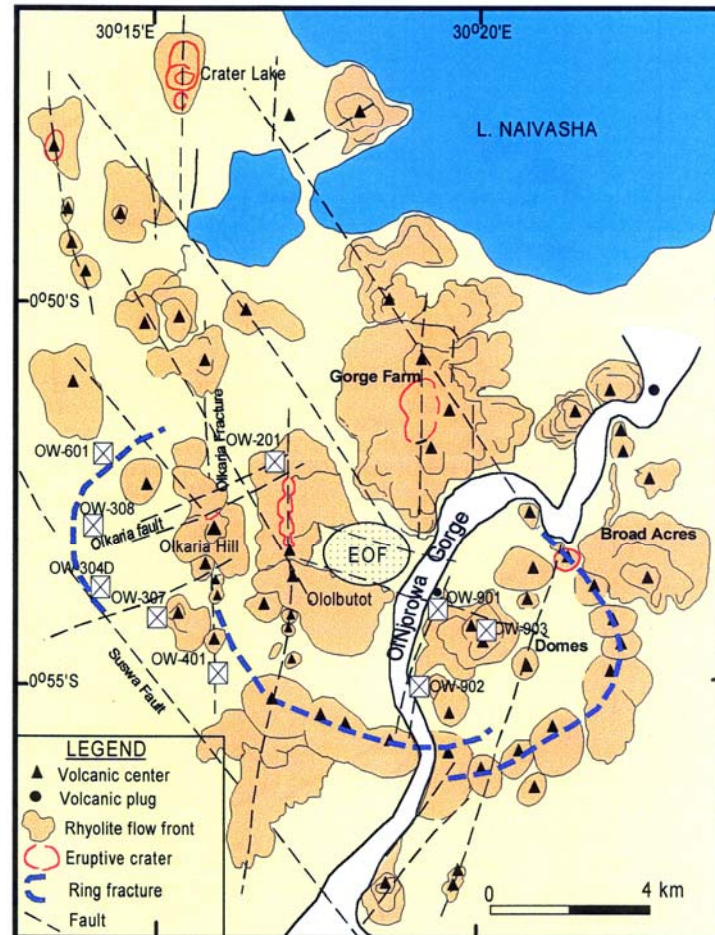
- Four upflow zones are envisaged. In Olkaria W, in Olkaria NE, in Olkaria E and in Domes.
- Flows from upflow zones converge in Olol Butot fault and drain southwards.



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Structures

- NE trending Olkaria Fault, NS trending Oloibutot fault and a NW trending fault are thought to be the main structures

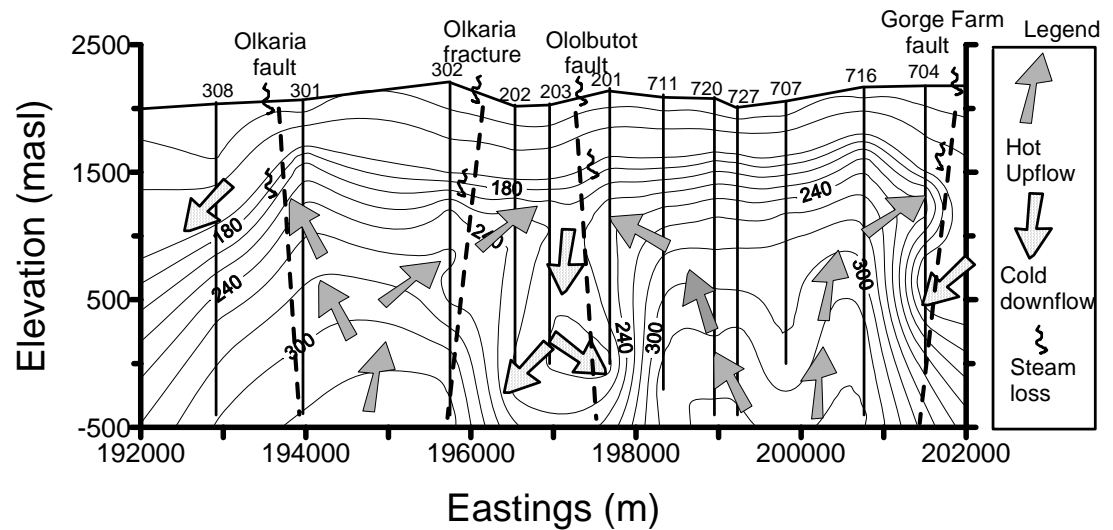
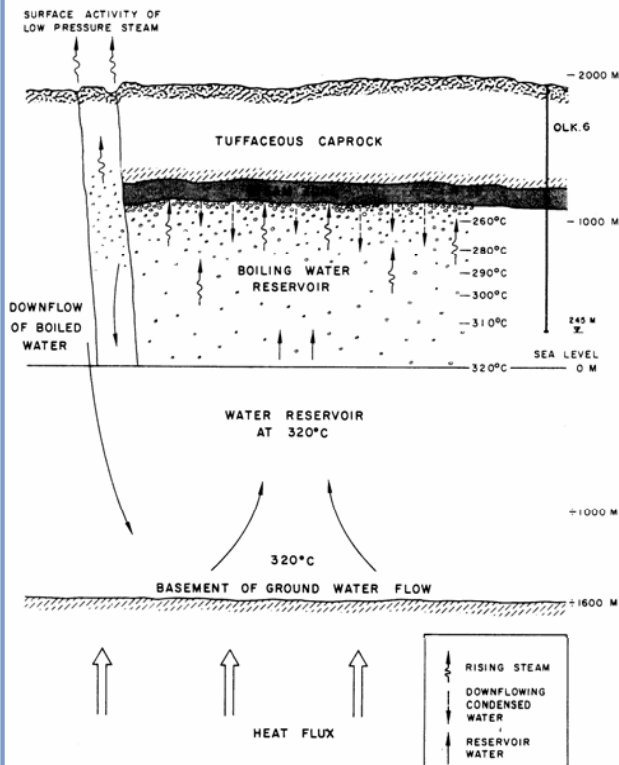




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Schematic sections

● Sections across Olkaria East, Central and NE





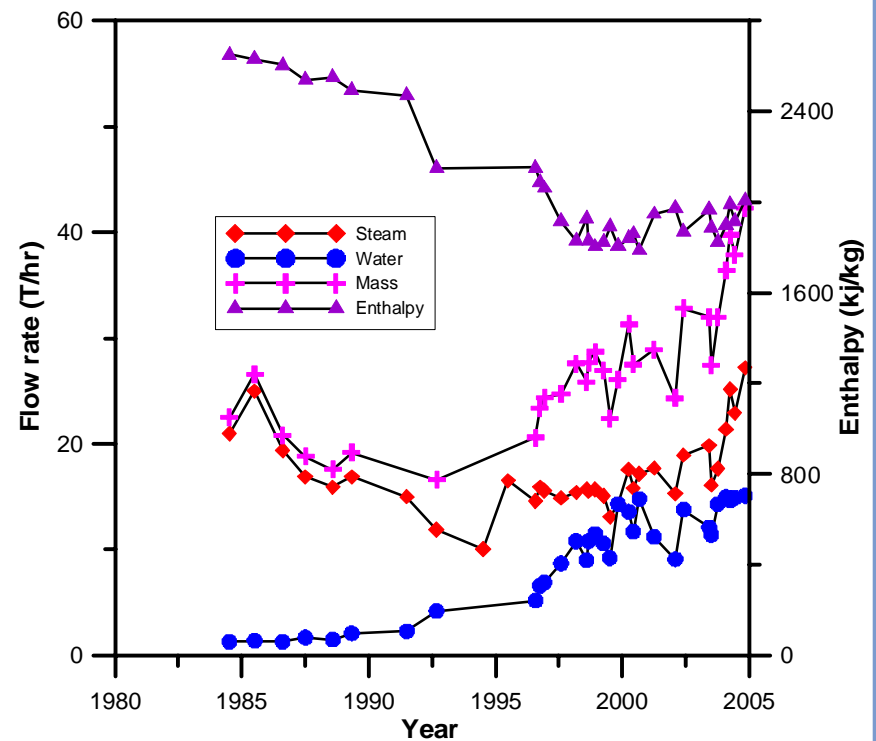
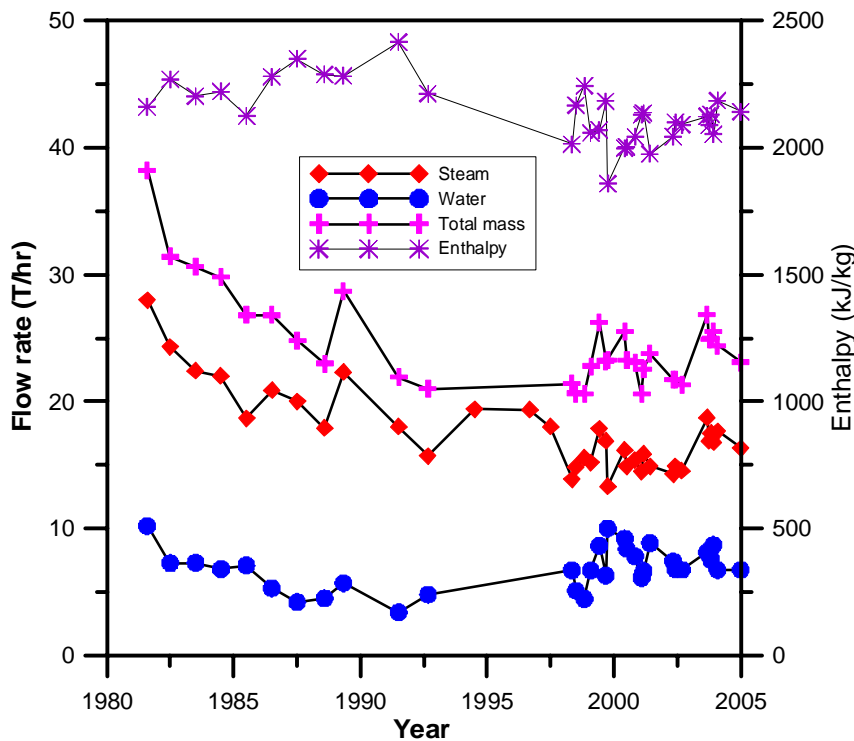
Well production histories **KenGen**

- Olkaria I wells had initial high decline rates (3 – 4%) but from mid 90's, the decline rates are now practically zero.
- Possible reasons could be recharge triggered by reservoir pressure drop and enhanced permeability or that the reservoir has reached steady state.
- Two typical well histories are shown.



Well production histories KenGen

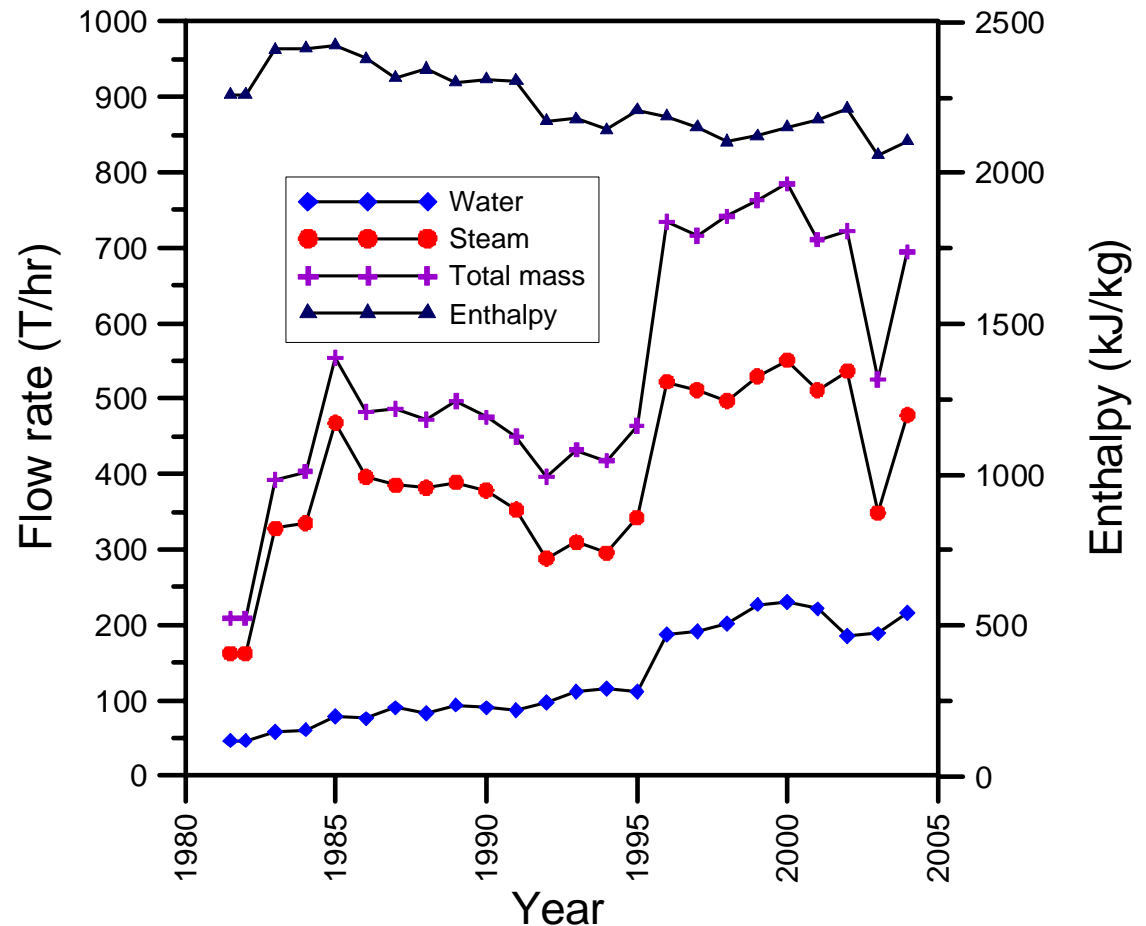
● Production histories of OW-2 and OW-19



Overall production – Olkaria I



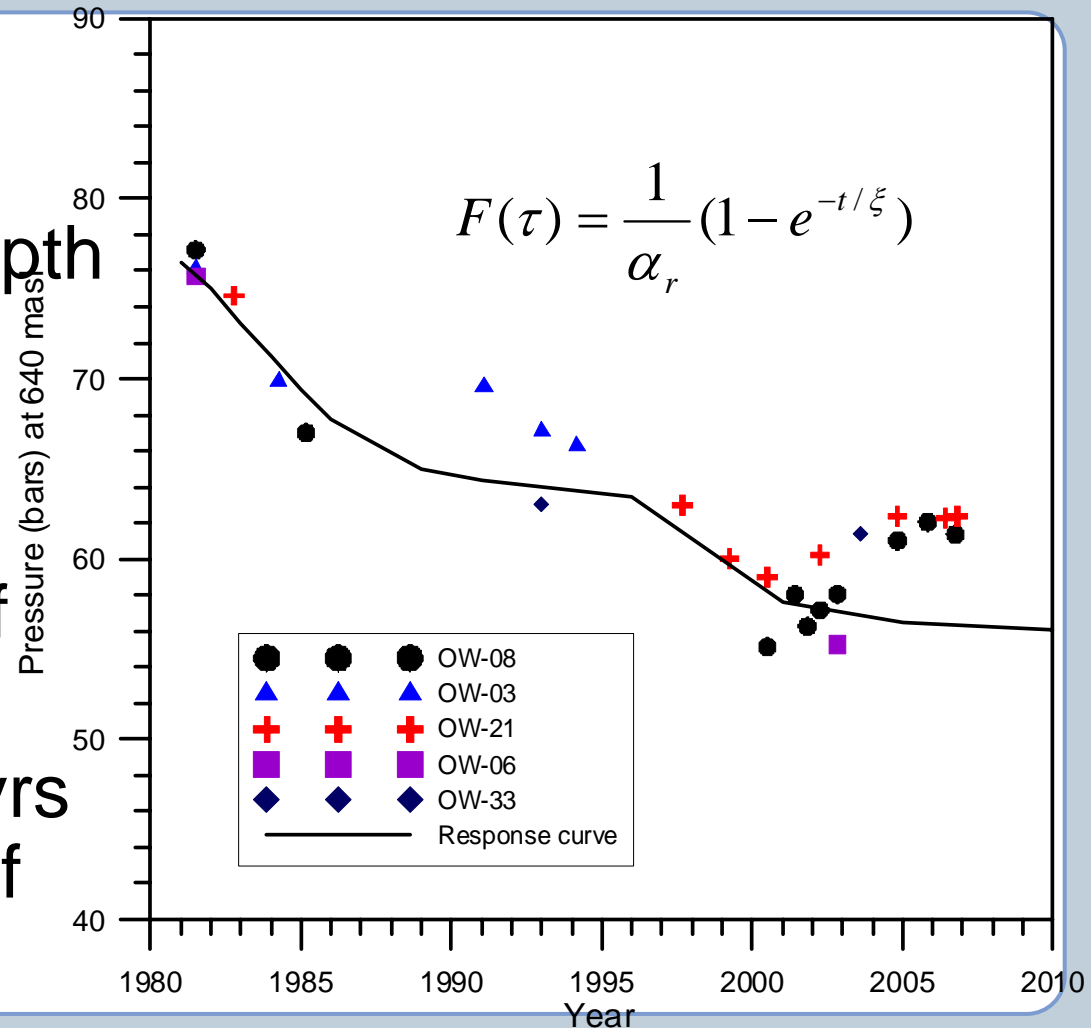
- Make-up wells were deeper with higher flows
- Steam is vented to keep constant generation





Pressure drawdown

- Max pressure drawdown at 640 masl (1300 m) depth is 22 bar
- Later less press drawdown due to long shut-down of Unit 1.
- Time constant 7 yrs and recharge coef 80 kg/MPa.s



Chemical changes due to production



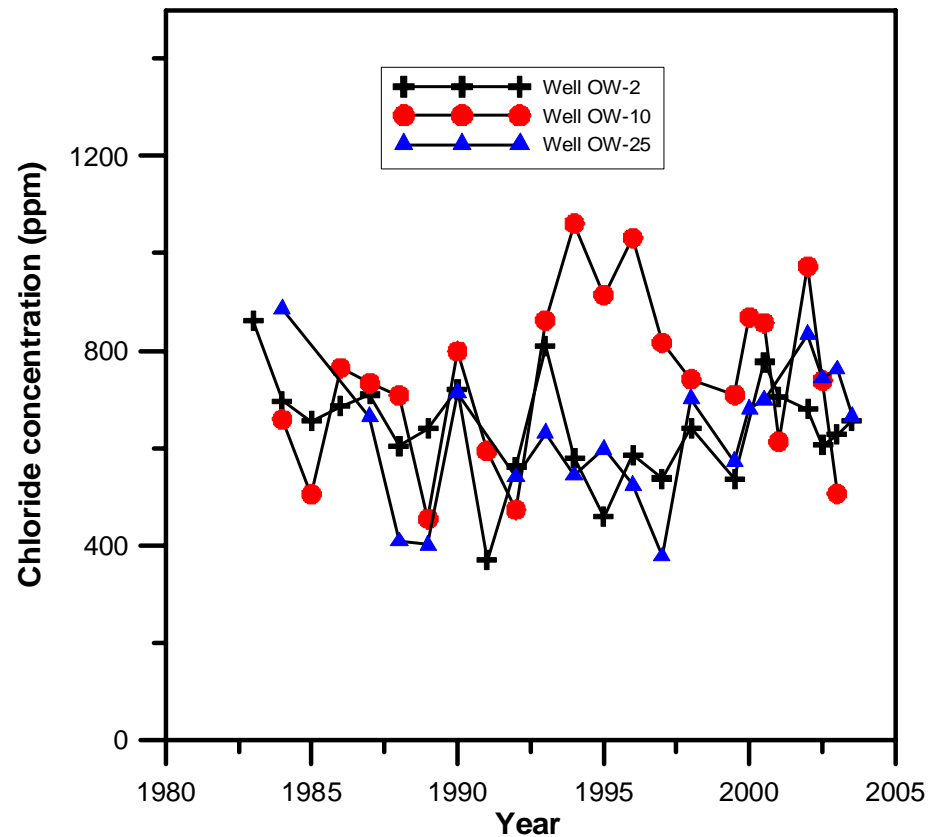
- Increase in chloride conc. and enthalpies is observed in wells located at the centre of the field. This is due to boiling.
- Wells at the periphery of the field have had modest decline in chloride, possibly due to induced recharge.
- Geothermometers show no change in reservoir temperatures



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Changes in chloride

- Wells OW-2, OW-10, OW-25

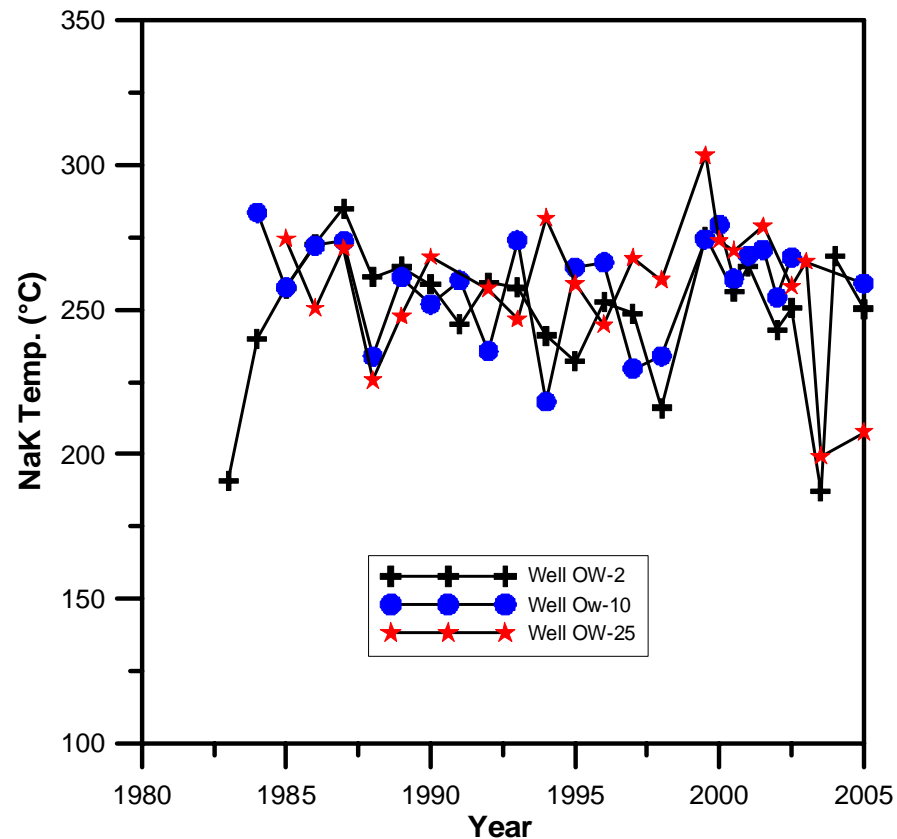




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NaK temperatures

- NaK geo-thermometers shows no change



Silica deposition in OW-34

- Silica in the pipeline and wellhead



Thickness of scale deposited in two-phase line. 1 inch thick



Thickness of scale at the T-connection of well. 1/2 inch



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Conclusions

- Olkaria I reservoir has performed quite well. It has now excess steam and the wells are becoming even better producers. The reservoir can support more.
- Low pressure drawdown has been experienced and the chemistry is good.
- There is a possibility that either the field has reached steady state or recharge has been triggered or both.



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