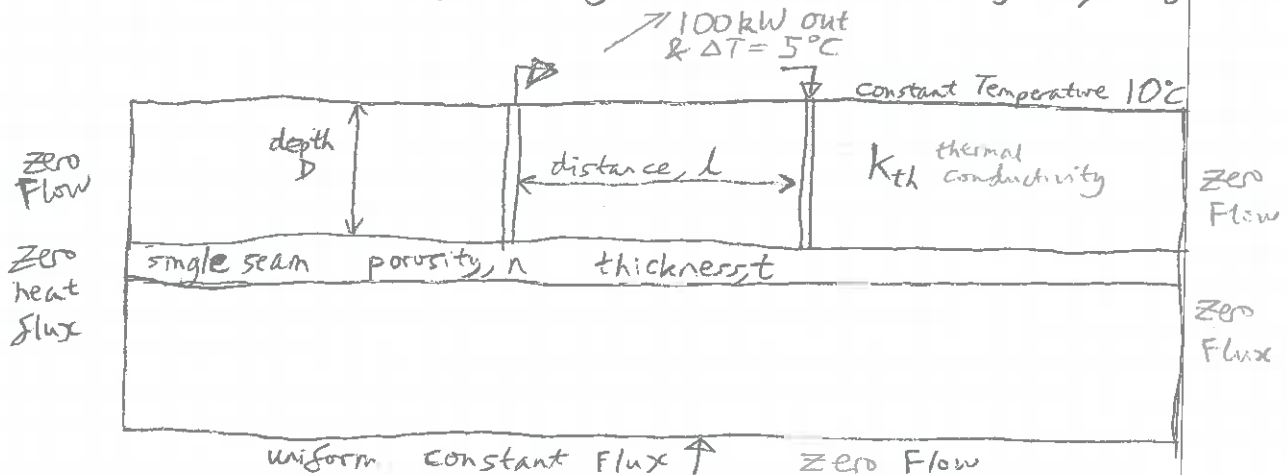




idea for 2D steady state model.

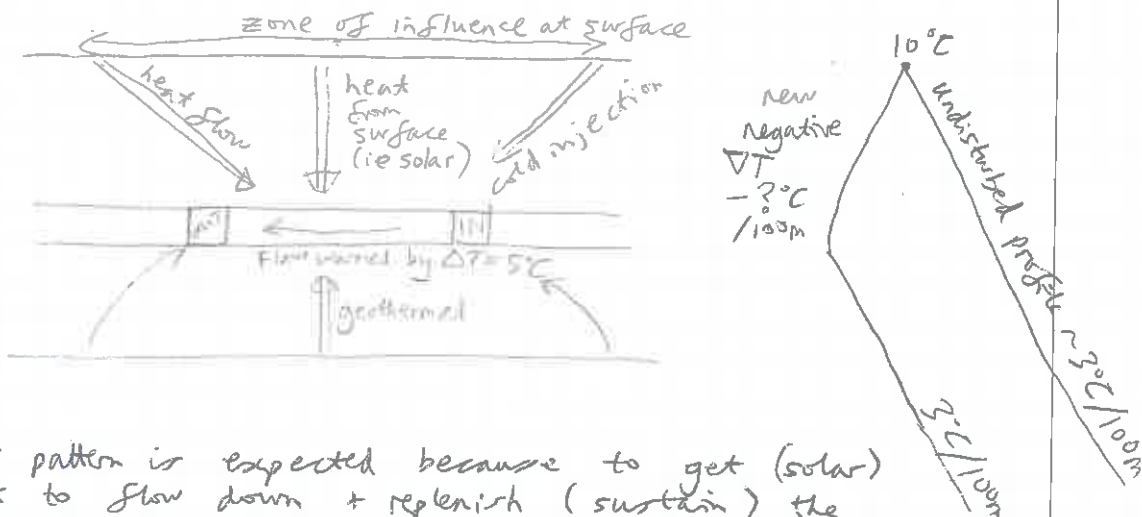
1. Heat extraction from single seam with no net inflow/outflow.



Aim of model - determine new steady state heat flow pattern from surface & the lateral zone of influence. Model is to be sufficiently wide to avoid edge effects. Borehole abstraction / re-injection could be modelled as from one cell. (i.e. there may be little benefit in including boreholes as lines) Suggested realistic (typical) parameter values: (ranges)

K_{th} = sandstone / mudstone
 D = 100m (200m 300m etc)
 l = 100m (200m " ")
 t = 2m (1m, 3m)
 n = 50% (10% to 100%)

Possible (expected?) modelled result:

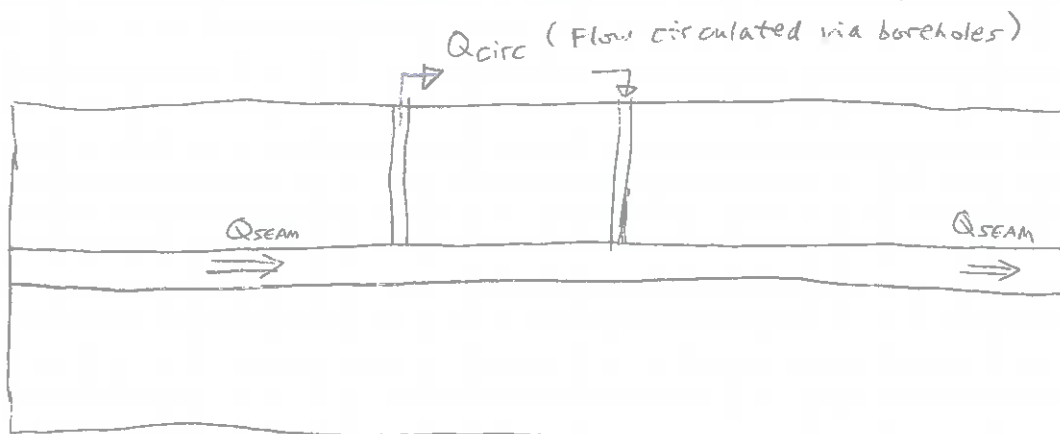


This pattern is expected because to get (solar) heat to flow down + replenish (sustain) the extraction zone, then a negative gradient is needed. The balance + location of solar vs geothermal fluxes is of interest. The difference between undisturbed thermal profile & new steady state represents heat energy extracted prior to sustainable steady state being reached. In other words heat is mined for a period before steady state is achieved.



Variations on 2D Steady State model:

② Add ADVECTION across model (flow in seam)



What happens for: $Q_{CIRC} = Q_{SEAM}$

$Q_{CIRC} < Q_{SEAM}$

eg $Q_{CIRC} = \frac{1}{2} Q_{SEAM}$

$Q_{CIRC} > Q_{SEAM}$

eg $Q_{CIRC} = 2 Q_{SEAM}$

204/s

104/s

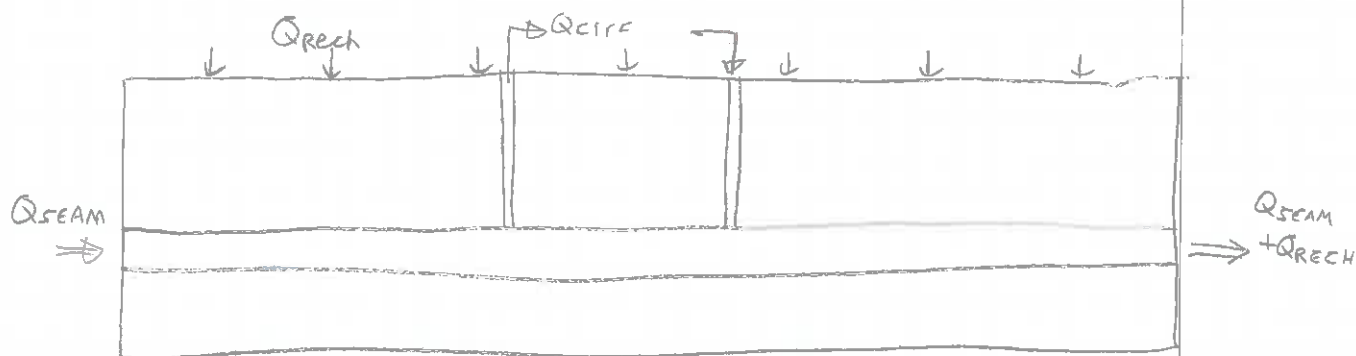
404/s

What happens if boreholes for abstraction + reinjection swap positions?

Note: should try to keep modelled head gradient across width of model close to observed typical ranges between 1:500 and 1:1000.

What happens if reinjection is stopped? ie Abstraction only.

③ Add RECHARGE uniformly across model (flow in seam + strata)



Does the advective heat flow down from surface in the recharge make a significant difference?

④ Add other mining features

eg Add a 2nd seam above / below the target seam
Move Reinjection to a 2nd seam.

Add an infilled mine shaft(s) close to the boreholes to see if it makes any difference.



The Coal Authority

200 Lichfield Lane, Mansfield
NG18 4RG

Project Name: P11D mine Heat

Project Ref:

Design Element:

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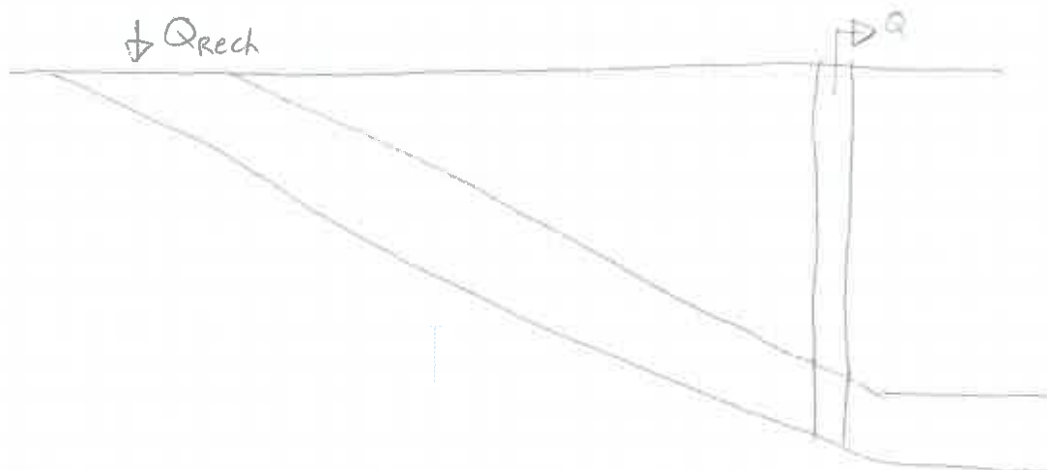
Calc. by: I. WATSON
Date: 16/10/19

Chk'd by: Date:

App'd by: Date:

TRANSIENT models to determine time to reach new steady state/breakthrough

A possible more realistic model would include seams dipping from outcrop, allowing recharge to slow down.



Can the Temperature of Q be predicted by modelling?
Above has similarities in layout to many areas,
including - Bilston Glen
Dawdon & Hawthorne