Trial Dewatering of the BHP Dolomite Quarry at Ardrossan, South Australia

REPORT BOOK 99/00032

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TRIAL DEWATERING OF THE BHP DOLOMITE QUARRY AT ARDROSSAN, SOUTH AUSTRALIA

D.K.Clarke

Trial dewatering of the quarry in fractured and well-bedded dolomite lasted at least 56 days. Ten monitored observation wells indicated reasonably consistent transmissivities of around 330 m^2/day while derived figures for specific yield were much more variable with a geometric average of 0.03. Variation of hydraulic conductivity (K) with direction from the pumping sump was indicated, with probable lower K on the eastern and north-eastern sides.

INTRODUCTION

Ardrossan is a small town on the coast of northwest Gulf St Vincent in South Australia (see Figure 1). The BHP Company operates a dolomite quarry three kilometres southwest of the township (see Figure 2). Quarry management decided to conduct a trial dewatering of the quarry early in 1994 to make deeper parts of the deposit available for extraction.

Mines and Energy, South Australia (as it was then, now Primary Industries and Resources, SA) was called upon to monitor the dewatering with consideration for environmental and regional impacts.

GEOLOGY/HYDROGEOLOGY

The quarry is in Cambrian Kulpara Formation (alternatively the Parara Limestone?) of the Hawker Group. Igneous and/or metamorphic rocks are recorded to the north of the quarry. (The State 1:2 000 000 digital geology map and the MAITLAND 1:250 000 published geological sheet are contradictory on these points.)

The dolomite being quarried is the aquifer. The primary porosity is very small or nil, most transmissivity and storage being due to fracturing, jointing, possible channels within clay seams, and possible solution channels.

The deepest hole drilled into the dolomite beneath the quarry finished approximately 120 metres beneath the water table; it did not reach the base of the dolomite. The topography of the base of the dolomite is unknown, but it is suspected that it may be deeper toward the north. (Pers. com. Robert Lenders, Mines Technology, BHP, Iron Duke)

DEWATERING

Trial dewatering started on 16/2/94 and continued for at least 56 days. The pumping rate varied between 703 and 731 m^3/day.

Pumping was terminated because the drawdowns being achieved were very disappointing. It is likely that dewatering will recommence around mid year 2000 (pers. com. Peter Freer of BHP, Ardrossan).

WELL LOCATIONS

Table 1 gives the locations of the pumping sump and all observation wells as eastings and northings. It also shows the relationship between the observation well numbers given by BHP and the data file names. Figure 3 gives the locations on a plan.

Table 1 *Identification and location of pit and observation wells*

Unit No.	BHP well Id.	Data file name (.ctd, .ctn, .txt)	Easting	Northing	Distance from sump (metres)
6429–2–492	Pumping sump	-	766307	6184523	-
	1	ARD01	766221	6184565	97
	2	ARD02	766270	6184562	54
	3	ARD03	766268	6184533	40
	4	ARD04	766325	6184561	43
	5	ARD05	766367	6184557	69
	6	ARD06	766355	6184518	48
	7	ARD07	766305	6184443	79
	8	ARD08	766282	6184383	141
	9	ARD09	766233	6184398	145
	10	ARD10	766250	6184459	85

All wells are in Australian map grid zone 53

SALINITY OBSERVATIONS

Water from the quarry was pumped into a small depression within 20 metres of the high water mark on the beach to the east of the quarry. From there it flowed into Gulf St Vincent.

Electrical conductivity measurements were taken, at first every day, gradually declining in frequency. Initial salinity was 4510 ECU, but this increased to 4820 after one day, 12 740 after two days, 18 870 after three days, and then stabilised around 22 000 ECU, although with a slight trend toward further increase (see Figure 4).

ANALYSIS OF DRAWDOWN DATA

Figures 5 to 7 show the drawdown curves of the ten observation wells, and Table 2 shows the derived transmissivities and specific yields. The figures also show the Theis type curves to be expected for transmissivity (T)=330 m^2/day and specific yield (S_y)=0.03 at distances of 25, 50 and 100 metres from the pumped sump, for comparison with the measured data. Derived transmissivities were reasonably close to the geometric average (standard deviation, SD=34), however specific yield calculated for the wells individually differed widely from the geometric average (SD=0.068), especially in the cases of ARD05 and ARD06.

Drawdowns were lower (and hence derived S_y was higher) in wells ARD05 and ARD06 (and to a lesser extent ARD04) than would be expected from the general response. This probably indicates that hydraulic conductivity is lower on the eastern and north-eastern side of the pumping sump (see Figure 3) than in other directions.

Drawdown records are stored in the .CTD format discharge test files and in the .txt ASCII format files on the floppy disk included with this report. Note that the CG discharge test programs are required to fully access the data from the .CTD files. However the program DisTest.exe (also on the floppy disk) can be used to graphically display their data: either ‘associate’ DisTest.exe with the CTD extension in Windows, or run the program by double clicking on its icon.

Projected drawdowns for various discharge rates, durations of discharge, and distances from the pumped well are given in Table 3.

Table 2 *Derived transmissivities and specific yields*

Observation well	Data file name .CTD, .CTN	Transmissivity (m^2/day)	Specific yield	Distance from sump (metres)
1	ARD01	314	0.012	97
2	ARD02	311	0.026	54
3	ARD03	257	0.019	40
4	ARD04	353	0.073	43
5	ARD05	371	0.120	69
6	ARD06	351	0.219	48
7	ARD07	335	0.012	79
8	ARD08	347	0.015	141
9	ARD09	364	0.017	145
10	ARD10	315	0.015	85
Geometric averages		330	0.030	

Table 3a, 3b and 3c Projection of approximate drawdowns based on T=330 and S_y=0.03

Table 3a *Continuous discharge for 30 days*

Discharge rate m^3/day	Distance, R=10 m	R=30 m	R=100 m	R=1 km	R=2 km
731	1.6 m	1.2 m	0.8 m	0.06 m	0.002 m
1000	2.2	1.6	1.0	0.08	0.003
2000	4.3	3.1	2	0.16	0.006
4000	8.6	7	4	0.3	0.013

Table 3b *Continuous discharge for one year*

Discharge rate m^3/day	Distance, R=10 m	R=30 m	R=100 m	R=1 km	R=2 km
731	2.0 m	1.7 m	1.2 m	0.40 m	0.18 m
1000	2.7	2.2	1.7	0.55	0.25
2000	5.5	4.4	3.3	1.1	0.51
4000	11	8	6.6	2.2	1.0

Table 3c *Continuous discharge for five years*

Discharge rate m^3/day	Distance, R=30 m	R=100 m	R=1 km	R=2 km
1000	2.7 m	2.1 m	0.96 m	0.63 m
2000	5.3	4.2	1.9	1.2
4000	10.6	8.3	3.8	2.5

The above projections assume that the aquifer parameters will remain the same with distance; if anything, transmissivity is likely to decline, especially if the cone of drawdown encroaches on the metamorphic/igneous rocks shown in Figure 2 (or on any other hydraulic boundary). This is likely to happen after a pumping duration of around six months to a year, and if so, then projected drawdowns can be expected to be a little greater than those shown in Table 3.

The projections also assume that the drawdowns will be negligible in comparison with the thickness of the aquifer. As mentioned previously the dolomite continues at least 120 metres beneath the water table. Unless the hydraulic conductivity of the dolomite declines very quickly with depth it seems that the tabled drawdowns are negligible in comparison with aquifer thickness.

The floppy disk accompanying this report contains the program CGSim that can be used to calculate drawdowns at various times and distances under a wide range of pumping and aquifer conditions. It should be used with care; and if the results are important, then under the supervision of a hydrogeologist.

ENVIRONMENTAL AND REGIONAL IMPACTS

The water extracted from the quarry was released just above the high water mark on the coast of Gulf St Vincent. No biological changes were observed in the area by the author.

If dewatering is recommenced at several thousand kilolitres per day as is required to achieve useful drawdowns in the quarry, then there will be significant regional falls in the water table out to distances of the order of a few kilometres (as shown in tables 3a, 3b and 3c). However, as the groundwater is highly saline this is not likely to have any significant economic or environmental impacts.

Figures

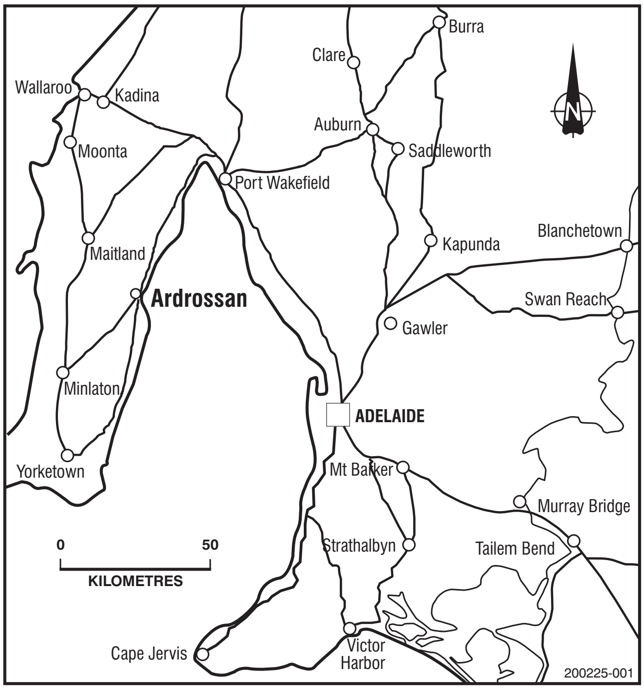

Fig. 1 *Locality map*

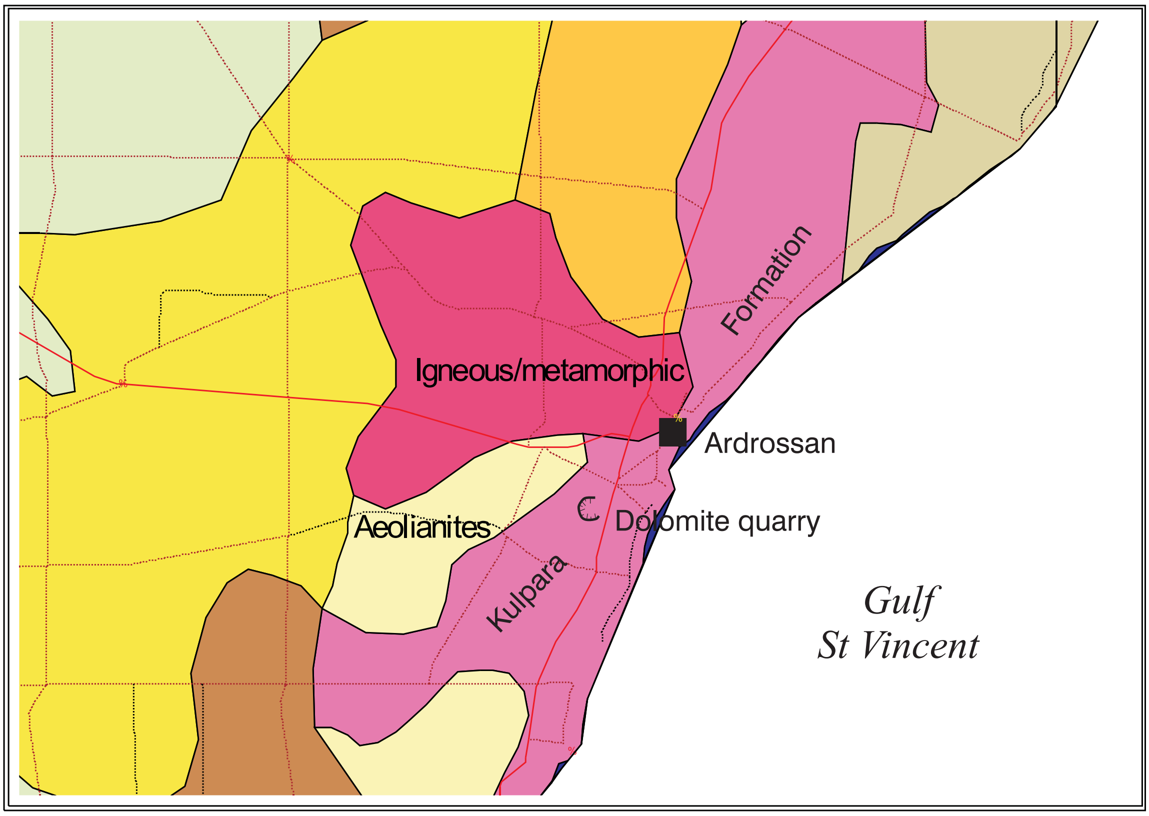

Fig. 2 Simplified geology and quarry location

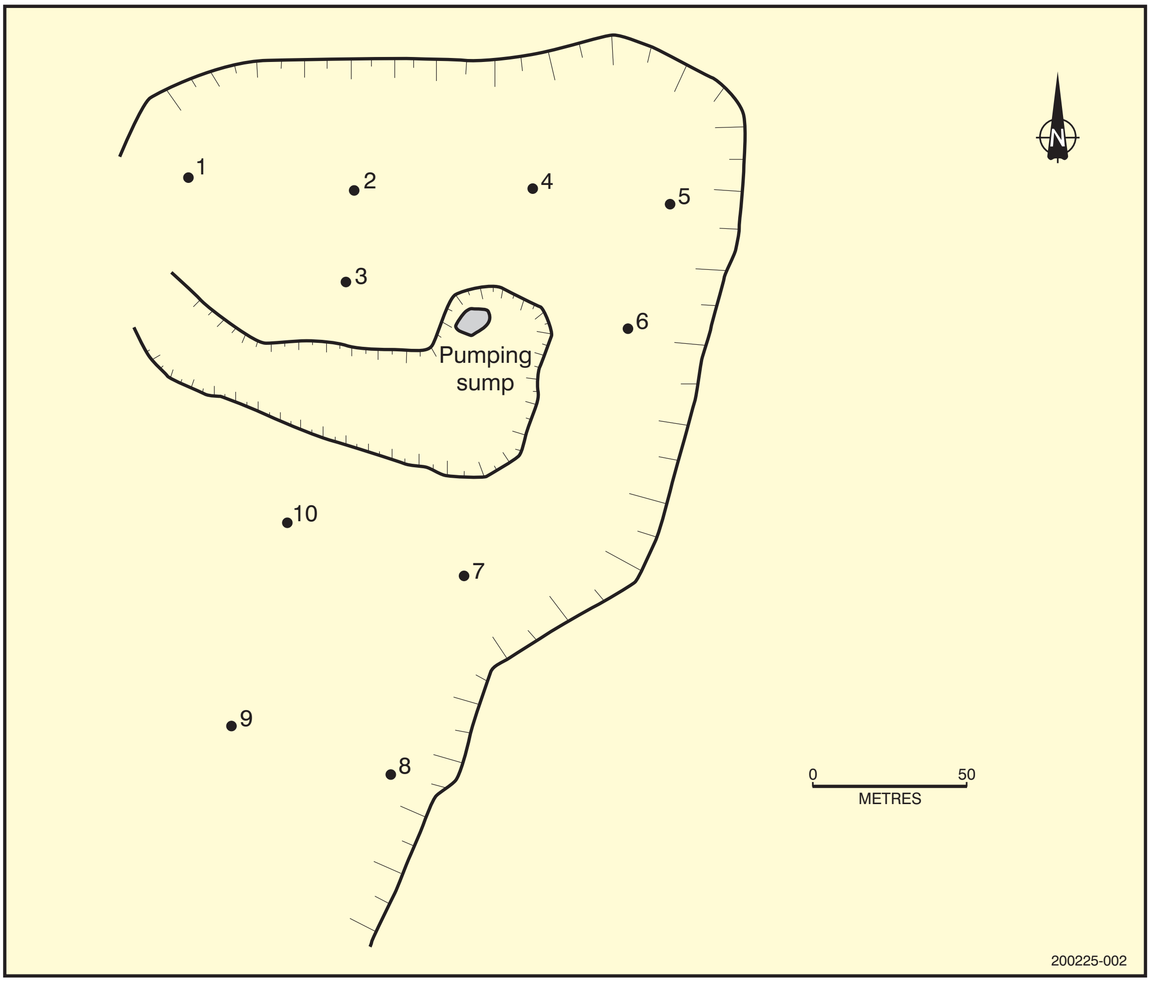

Fig. 3 Relative locations of pumping sump and observation wells

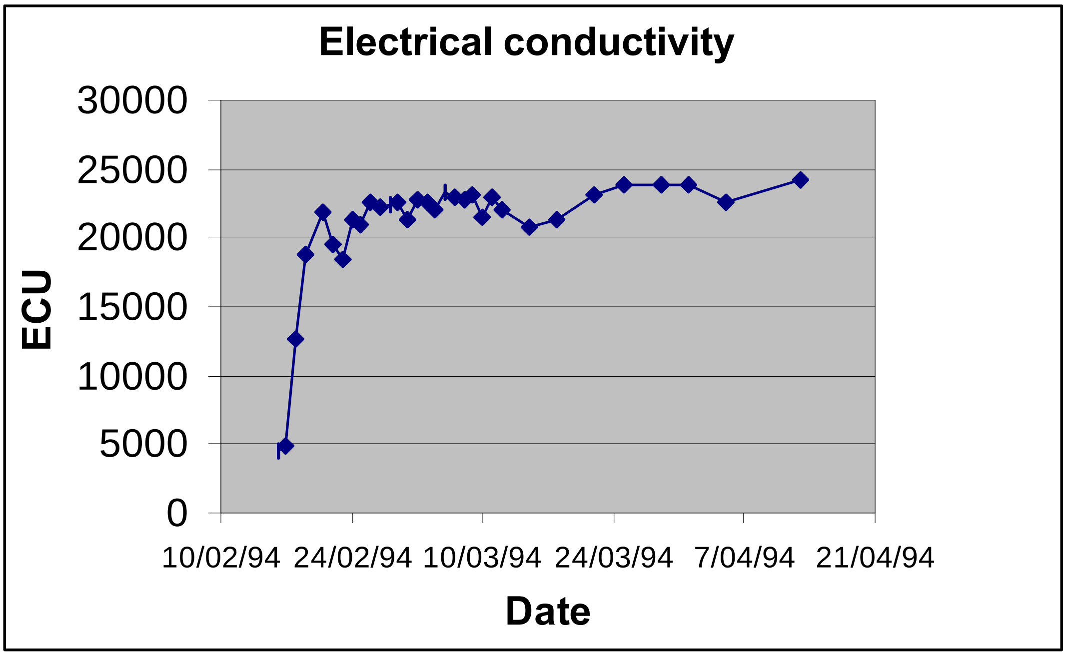

Figure 5 Drawdown curves for ARD1, 2 & 3
with simulated curves for R=25, 50 & 100 metres with T=330 and S=0.030

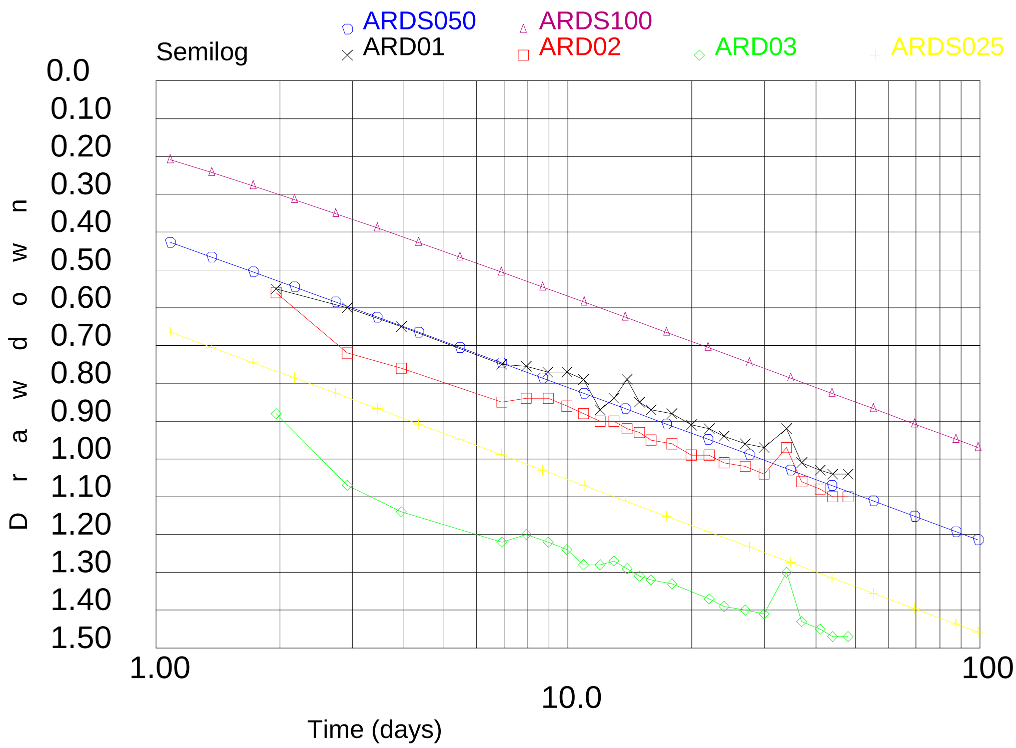

Figure 6 Drawdown curves for ARD4, 5 & 6

with simulated curves for R=25, 50 & 100 metres with T=330 and S=0.030

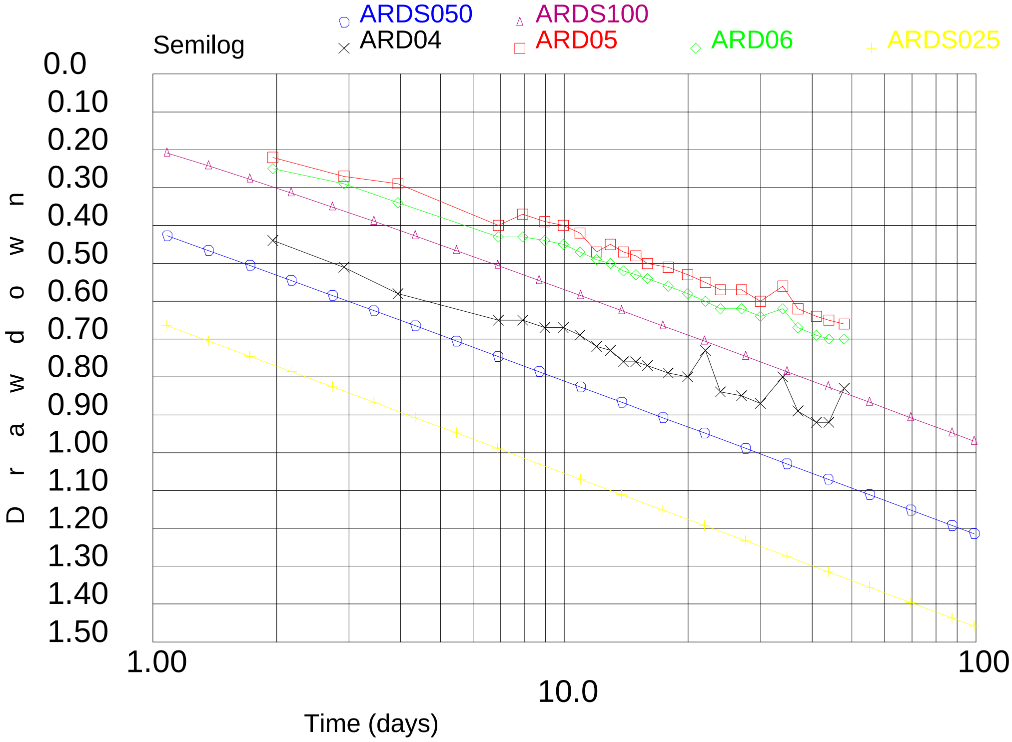

Figure 7 Drawdown curves for ARD7, 8, 9 & 10

with simulated curves for R=25, 50 & 100 metres with T=330 and S=0.030