



Date electronic copy
received at AINSE:
29 January 2010

PROGRESS REPORT FOR AINGRA09079

PROJECT TITLE	Use of 14-carbon to constrain flow paths in the Murrumbidgee deep groundwater aquifers	
INVESTIGATOR(S)	Institution and Department	
Chief Investigator	Mr Martin Fussell	Environmental Management and Ecology, La Trobe University
Other Investigators	Dr Dioni Cendon (ANSTO contact officer.) Dr Ewen Silvester (La Trobe University, Albury Wodonga, project supervisor) Dr John Webb (La Trobe University, Bundoora, AINSE councillor and project supervisor)	
Students		
ANSTO Investigators	Dioni I. Cendon	
Specialist Committee	E	

SCIENTIFIC OBJECTIVES

The primary focus of this investigation will be to establish the age of deep groundwater beneath the floodplain of the Murrumbidgee River between Wagga Wagga and Narrandera, N.S.W. Previous work, based on only three carbon 14 results, indicates that there is a pattern of uniformly increasing age of the groundwater in the downstream direction. If this flow regime can be confirmed the result will have important implications with regard to flow through as a means of recharge to the aquifer.

PROGRESS REPORT and RESEARCH OUTCOMES

Thirteen samples of groundwater were taken in July, 2009 from bores at locations between Wagga Wagga and Narrandera. One set of samples was sent for AMS analysis at the Institute for Environmental Research, ANSTO. The results for the conventional radiocarbon age of the groundwater samples were received in December, 2009.

Separate aliquots of the groundwater from the same sites were analysed for stable isotopes $\delta^{13}\text{C}_{\text{dic}}$ (dissolved inorganic carbon) and water stable isotopes $\delta^{18}\text{O}$ and $\delta^2\text{H}$ to complement all results obtained through the AINSE grant. The complementary isotopic analyses were done through the Alberta Research Council, Canada

All samples were analysed for alkalinity, major ions and dissolved organic carbon at the La Trobe University – Murray Darling Freshwater Institute laboratories in Wodonga, Victoria. The results from the sampling in 2009 have been combined with those obtained for other bores in the same area through AINSE grant 07/052.

Under the guidance of Dr Dioni Cendon of the Institute for Environmental Research at ANSTO, the results of the various analyses have been used to correct the ^{14}C ages (residence times) of the groundwater using several standard models. The data has been subjected to single well tests using the NETPATH program. The values of the corrected ages have been analysed to determine possible flow paths for the groundwater in conjunction with the structural features of the deep aquifer system obtained from the Department of Natural Resources, N.S.W. A preliminary interpretation of the AINSE grant results suggests that recharge is apparently occurring to the deep aquifer system along the course of the Murrumbidgee River between Wagga Wagga and Narrandera.

The assumed flow paths indicated by the ages of the groundwater are at present being analysed to determine their viability using two well tests in the NETPATH program. This approach calculates mass exchange of solutes from the initial to the final well, correcting $^{14}\text{C}_{\text{DIC}}$ according to identified chemical reactions. The outcome of these tests will be used in conjunction with hydrographs, stable isotopes and geochemical data of the groundwater and the Murrumbidgee River to construct a flow path model of the aquifer system and predict the means by which the aquifers are being recharged. The final analysis will be conducted in 2010.

The conclusions will have implications for the communities in the immediate vicinity who rely in part on the aquifer for water supplies. The study may also have implications for similar hydro geological studies conducted in the Murray Darling Basin.

DATA

The first two tables show the full set of data obtained for 17 bores between Wagga Wagga and Narrandera in support of AINSE grants 07/052 and 09/079 for 14C, stable isotopes and chemical analyses. This data was used to correct conventional groundwater ages using NETPATH.

Netpath Spreadsheet 2.14

Units flag: 0 mmol/L 1 meq/L 2 mg/L 3 ppm 4 mmol/kgw
 Eh flag: 0 Redox ignored 1 Eh, volts 2 DO 3 Sato DO 4 SO4/H2S
 Alkalinity/T 0 Field alk as HCO3 1 Carbonate alk as HCO3 2 TDIC as HCO3 3 Field alk as CaCO3
 Activity coe 0 Debye-Huckel 1 Davies

Number	name (req)	Units Flag	Eh Flag	k/□TDIC	Fl	Coef	Fla	Temp	pH	Eh	Ca	Mg	Na	K	Cl	SO4 as SO4	Alk/TDIC as mgCaCO3/L
1	30640	2	1	3	0			16	6.9	-0.123	69.2	49.9	149.4	3.5	295.4	49.40	108.58
2	30670	2	1	3	0			16.2	6.9	-0.064	10.2	7.5	14.02	1	7.2	0.92	72.28
3	30065	2	1	3	0			16.7	6.97	0.041	12.8	9.9	19.6	1.3	13.3	3.1	97.485
4	30075	2	1	3	0			20.9	6.3	-0.005	7.86	7.31	26.04	2.23	16	10	82.3
5	30126	2	1	3	0			17.8	6.5	0.033	6.54	5.79	16.5	0.7	7.01	1.54	67.27
6	403384	2	1	3	0			16.2	6	-0.059	20.47	19.48	112.54	0	165.04	50.6	112.1
7	30164	2	1	3	0			20.7	6.2	0.03	8.64	7.3	26.77	2	19.03	5.6	78.3
8	403451	2	1	3	0			18	6.6	-0.014	6.55	5.84	25.71	0.7	9.24	2.39	85.53
9	401269	2	1	3	0			18	6.8	0.115	7.6	8.53	145	2.5	132.8	42.04	145.58
10	403573	2	1	3	0			21.2	6.7	-0.02	10.93	13.38	176.46	2.52	218.76	43.1	126.5
11	402010	2	1	3	0			20.1	6.8	0.051	51.78	62.98	425.79	6.69	736.97	170.39	192.5
12	30094-1	2	1	3	0			19.3	6.8	-0.005	10.17	12.03	103.44	2	92.59	24.37	148.18
13	30094-2	2	1	3	0			23.3	6.7	0	18.8	22	125	5	131	38.5	126.25
14	30073	2	1	3	0			20.9	6.8	-0.004	38.75	33.73	304.9	0	455.78	104.97	176.56
15	403572-1	2	1	3	0			19.5	6.4	0.16	10.69	11.23	37.44	1.3	14.05	3.76	142.98
16	403572-2	2	1	3	0			20.8	6.9	-0.027	12.85	14.65	138	1.2	103.3	32.28	173.65
17	403571	2	1	3	0			18.8	6.8	-0.058	43.56	46.14	319.73	4.5	533.1	132.74	173.42

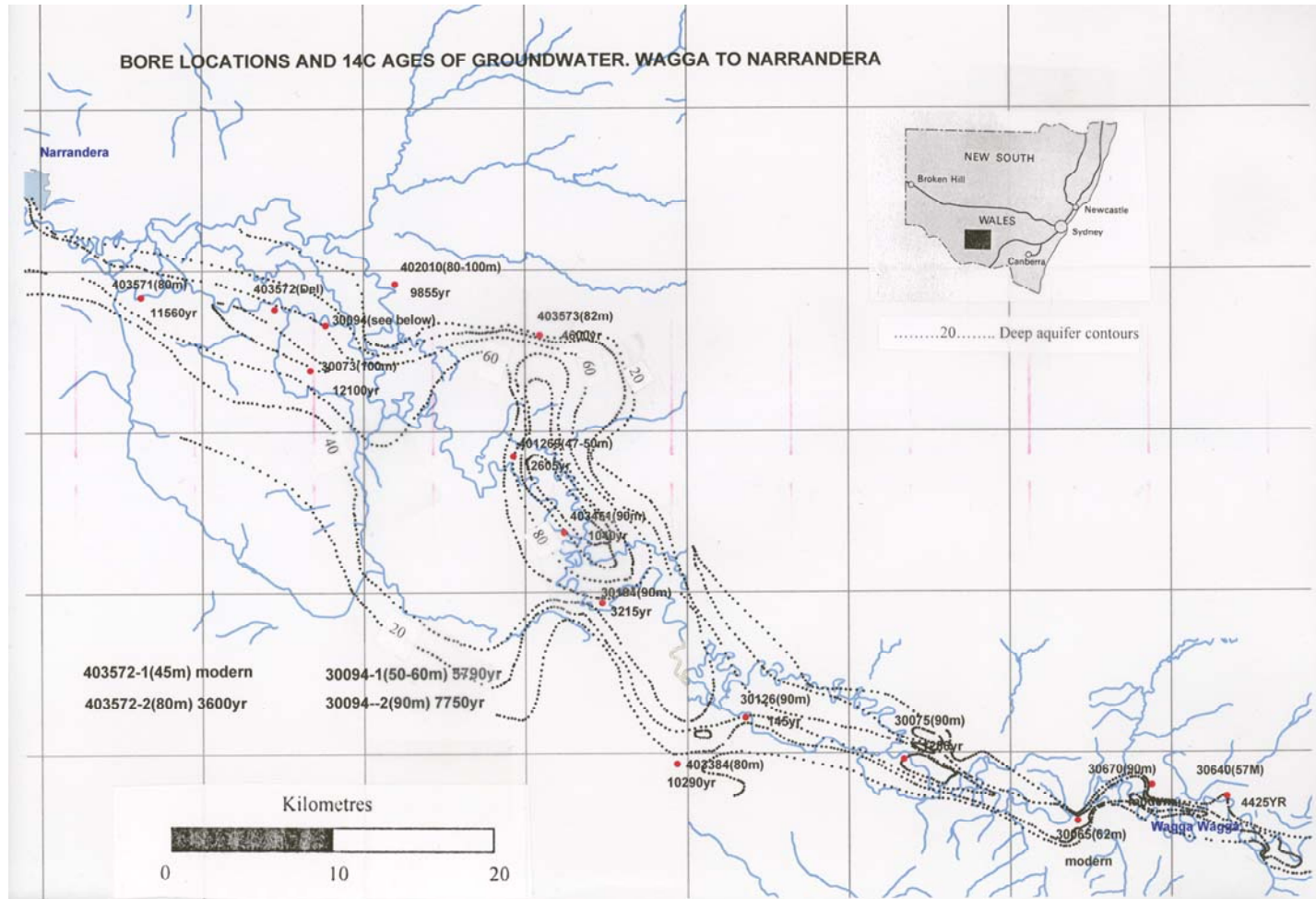
Stable isotope and ¹⁴C as pmc data used for age correction calculations in NETPATH

Number	name	(req _l O ₂ as DO	DOC as C	Del13C	¹⁴ C as pmC	Del2H	Del18O	EC(microS/cm)	Field ID	Depth (m)	Address
1	30640	0.28	3.3	-14.4	33.69	-39.2	-5.97	1509	Wagga1	57	OZM006
2	30670		1.8	-17.03	82.74	-46.8	-7.51	200	Wagga2	90	OZM000
3	30065	1.86	0.7	-14.3	80.1	-46.3	-7.34	247	Pomilgarna	62	OZL995
4	30075	1.93		-18.9	65.4	-40	-7.6	218	Collingullie	86	OZK186
5	30126	2.53	0.7	-17.43	68.5	-45.6	-7.32	149	Berry Jerry	97	OZM001
6	403384	1.42	2.2	-15.66	22.52	-40	-6.21	1200	Bergemeir	80	OZM023
7	30164	1.45		-19.3	52.3	-43	-7.1	223	Bulls Run	105	OZK188
8	403451	0.8	1.2	-17.37	61.56			216	Willroy	96	OZL998
9	401269	1.14	1.3	-15.61	13.59	-42	-6.67	904	Deepwater	51	OZL999
10	403573	1.4	3.9	-16.63	38.36	-45.4	-7.04	1180	Mattong	82	OZM003
11	402010	1.71	1.2	-14.27	17.3	-39.9	-6.16	3150	Gillespi	99	OZM005
12	30094-1	0.55	1.2	-16.17	32.56	-41.6	-6.63	629	Brewarrena1	62	OZM002
13	30094-2	1.29		-17.4	27.53	-37	-6.6	855	Brewarren2	80	OZK187
14	30073	0.51	2.2	-16.63	15.74	-41.3	-6.38	2280	Brewarrena3	104	OZM003
15	403572-1	0.55	1.5	-18.39	90.17	-46.4	-7.33	340	Dellapool1	45	OZL996
16	403572-2	0.56	3	-16.56	43.58	-40.4	-6.39	913	Dellapool2	80	OZL995
17	403571	0.44	1.8	-14.64	14.45	-39.4	-5.97	2400	Buckingbong	80	OZL997

Corrected 14C ages according to several models using
NETPATH

E NUMBER		30640	30670	30065	30075	30126	403384	30164	403451	401269	403573	402010	30094-1	30094-2	30073	403572-1	403572-2
RAW AGE 14C	At/Age	33/8740	82/1520	80.1/1785	65.4/3410	68.5/3040	22.5/11980	52/5210	61.6/3895	13.6/16030	38.4/7700	17.3/14090	32.6/9010	27.5/10360	15.7/14850	90/830	43.6/6670
S BALANCE	Ao/Age		65.4/-1308	70/-929	88.7/2522	82/1648	87/11396	88/4291	83/2770	95/16280	82/7009	57/10035	85.5/8184	78/8644	70/12673	85/-269	82/5683
VOGEL	Ao/Age	76/7650	78.7/223	83/491	85/2167	83/1784	83/10980	85/4015	82/2667	83/15155	78/6577	83/13160	83/7932	85/9320	82/13941	83/-488	80.4/5523
AMERS	Ao/Age	55/4893	57.2/-2427	58.8/-2366	76/1286	70/344	83/10966	79/3439	66/890	61.5/12699	59/4337	61/10546	61.5/5456	64.5/7042	60/11354	72/-1672	57.4/2729
DN & PEARSON	Ao/Age	52/4434	63.1/-1607	55.9/-2784	76/1198	68/146	61/8475	77/3219	67/1000	61/12606	61/4551	56/9868	63/5674	69.6/7667	64/11915	72/-1683	63/3461
MOOK	Ao/Age	29/-222	69.1/-856	35.8/-6459	60/-665	50/-2376		58/909	57/-382	46/10311	53/3414	30/4743	55/4572	69/7601	61.5/11581	58/-3457	65/3732
S & GARNIER	Ao/Age	52/4424	65.55/-1168	55.81/-2793	76/1195	68/141	61/8397	77/3212	67.5/1062	61/12603	62/4660	56/9848	64/5790	72/7965	66/12196	72/-1683	65.5/3823
CHINGER	Ao/Age	49/3905	61.1/-1868	52.5/-3295	71/667	64/-405	46/6161	71/2611	64/572	57.5/12144	58/4166	52/9270	60/5291	67/7393	61.7/11613	68/-2172	60.7/3189
IC ASSUMED	At/Age	30/9886	76.6/2199	78.23/2029	65/3510	66.8/3330	22/12526	52/5358	59/4309	13.2/16723	35.2/8638	17/14665	32/9480	27.5/10663	15.4/15604	88/1044	41/7322

This map shows the distribution of sample sites and the corrected ages used to predict flow paths taken from the Ingerson and Pearson and Fontes and Garnier models for corrected 14C ages using NETPATH



PUBLICATIONS / REPORTS arising as a result of your work.

None.

PhD STUDENTS

None.