

**US GEOLOGICAL SURVEY, DENVER, COLORADO
RADIOCARBON DATES III**

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INTRODUCTION

This list contains the results of measurements made during 1978 and 1979. Ages were computed on the radiocarbon half-life of 5568 ± 30 years. Statistical errors quoted herein are 1σ counting errors which include sample, background, and standard. The age limit reported is calculated on the basis of 3σ activity. The $\delta^{13}\text{C}$ values in table 1 were measured by Krueger Enterprises, Inc, Geochron Laboratories Division¹ and calculated based on Craig's Peedee Belemnite (PDB) limestone standard (Craig, 1957). The total alkalinity as bicarbonate values reported in table 1 was determined using techniques described by Brown, Skougstad, and Fishman (1970). Unless otherwise stated, all samples were collected and submitted by personnel of the US Geological Survey.

Benzene was synthesized from precipitated barium carbonate (Noakes, Kim, and Akers, 1967). Since the publications of Schroder *et al* (1973) and Schroder, Emerson, and Beetem (1978), improvements in the counting techniques have been made (Yang and Emerson, 1979). Samples were counted in Teflon vials made of DuPont's polytetrafluoro ethylene (PTFE) rod, similar to the designs of Calf and Polach (1974) and our low ⁴⁰K glass vial previously used. This resulted in an increase in ¹⁴C counting efficiency of 5 percent for 3mL to 1mL benzene, PCS (phase combining solvent) and 10 percent increase for 4mL to 1mL benzene, PCS counting solution relative to low ⁴⁰K glass vial. No significant decrease in background count rate was observed for 3mL to 1mL benzene, PCS solution in Teflon vial compared to glass vial. However, for larger sample sizes (4mL to 1mL and 5mL to 1mL benzene, PCS), the background count rates in Teflon vials remained nearly the same as for 3mL to 1mL benzene, PCS, yet low ⁴⁰K glass vial background count rate increased by approximately 1.25 counts per minute per milliliter of counting solution (Yang and Emerson, 1979).

SAMPLE DESCRIPTIONS

A. Oregon

DE-1. 01N/02E-24aad **3100 ± 160**

Sample coll Nov 17, 1977, from Multnomah Co (45° 33' 36" N, 122° 29' 57" W) from depth 139.3m. Hole drilled to 149.4m. Alt of well head 8.1m above msl. Static water level was 2.1m.

DE-2. 01N/02E-15cha **<50**

Sample coll Nov 3, 1977, from Multnomah Co (45° 34' 07" N, 122° 33' 13" W) from depth 68.9m. Hole drilled to 68.9m. Alt of well head 5.3m above msl. Static water level was 2.7m.

¹The use of company and brand names in this paper is for identification only and does not imply endorsement by the US Geological Survey.

DE-3. 01N/02E-15cba **2600 ± 210**

Sample coll Nov 9, 1977, from Multnomah Co (45° 34' 22" N, 122° 33' 41" W) from depth 20.7m to 67.1m. Hole drilled to 121.9m. Alt of well head 5.2m above msl. Static water level was 2.7m.

DE-4. 01N/02E-15bca **100 ± 140**

Sample coll Nov 9, 1977, from Multnomah Co (45° 34' 22" N, 122° 33' 13" W) from depth 74.4m to 97.5m. Hole drilled to 100m. Alt of well head 7.7m above msl. Static water level was 6.1m.

DE-5. 01N/02E-24adc **3000 ± 140**

Sample coll Dec 17, 1977, from Multnomah Co (45° 33' 23" N, 122° 29' 57" W) from depth 76.5m to 97.5m. Hole drilled to 97.5m. Alt of well head 5.2m above msl. Static water level was 3m.

DE-6. 01N/03E-21acc **<100**

Sample coll Jan 26, 1977, from Multnomah Co (45° 33' 26" N, 122° 26' 29" W) from depth 13.4m to 39.6m. Hole drilled to 45.7m. Alt of well head 5.7m above msl. Static water level was 2.1m.

B. Utah

DE-7. **>35,600**

Sample coll Aug 16, 1978, from Grand Co (38° 50' 37" N, 109° 44' 01" W) at depth 118.9 to 163.1m. Sample contained H₂S.

DE-8. Well (-23-6)6acc **31,000 ± 840**

Sample coll Nov 28, 1978, from Emery Co (38° 50' 45" N, 111° 17' 18" W) at depth 219.5m.

DE-9. Well (D-22-6)17abc **27,700 ± 850**

Sample coll Dec 14, 1978, from Emery Co (38° 54' 26" N, 111° 16' 08" W) at depth 335.3m.

C. Nevada

DE-10. **1100 ± 160**

Sample coll July 21, 1978, from Churchill Co (39° 29' 19" N, 118° 48' 34" W) at depth 39.6m. Well pumped several days before sampling.

DE-11. **9900 ± 210**

Sample coll July 19, 1978, from Churchill Co (39° 22' 54" N, 118° 43' 18" W) at depth 36m. Well pumped 1500L before sampling.

DE-12. **5300 ± 160**

Sample coll Aug 10, 1978, from Churchill Co (39° 28' 39" N, 118° 46' 34" W) at depth 146.3m. Well pumped several hr before sampling.

DE-13. **7600 ± 150**

Sample coll Oct 6, 1978, from Churchill Co (39° 28' 25" N, 118° 47' 08" W) at depth 153.9m.

TABLE I
Summary of δC^{13} and alkalinity for water sources

Sample no.	Coll date	δC^{13} (‰ PDB)	Total alkalinity as bicarbonate (mg/L)	Water source by state
DE-1	11/17/77	-20.0	78	Oregon
DE-2	11/3/77	-20.7	62	"
DE-3	11/9/77	-19.8	76	"
DE-4	11/9/77	-11.5	419	"
DE-5	12/17/77	-20.4	85	"
DE-6	1/26/78	-20.8	61	"
DE-7	8/16/78	-19.4	--	Utah
DE-8	11/28/78	-12.6	--	"
DE-9	12/14/78	-10.0	--	"
DE-10	7/21/78	--	--	Nevada
DE-11	7/19/78	--	--	"
DE-12	8/10/78	--	--	"
DE-13	10/6/78	--	--	"
DE-14	2/8/78	--	--	"
DE-15	6/21/79	--	268	"
DE-16	6/20/79	--	--	"
DE-17	6/22/79	--	--	"
DE-18	6/20/79	--	192	"
DE-19	6/19/79	--	374	"
DE-20	6/25/79	--	--	"
DE-21	6/26/79	--	180	"
DE-22	7/2/79	-14.1	--	South Dakota
DE-23	7/3/79	-11.4	--	"
DE-24	7/17/79	-12.2	--	"
DE-25	7/16/79	-11.7	--	"
DE-26	7/26/79	- 7.7	179	"
DE-27	7/26/79	- 8.2	175	"
DE-28	7/27/79	- 8.5	175	"
DE-29	7/24/79	- 5.2	182	"
DE-30	7/19/79	-11.0	390	"
DE-31	7/30/79	- 8.7	195	"
DE-32	7/29/79	- 6.8	182	"
DE-33	7/31/79	- 8.0	175	"
DE-34	7/31/79	-13.2	378	"
DE-35	7/29/79	- 7.7	190	"
DE-36	7/28/79	- 7.3	182	"
DE-37	8/6/79	-20.2	633	"
DE-38	8/5/79	-11.4	64	"
DE-39	8/4/79	- 8.3	163	"
DE-40	8/7/79	-26.2	864	"
DE-41	8/6/79	-19.5	980	"
DE-42	8/6/79	-14.0	242	"
DE-43	8/4/79	- 9.9	204	"
DE-44	8/1/79	-15.8	446	"
DE-45	8/3/79	-11.0	173	"
DE-46	8/2/79	-10.2	211	"
DE-47	8/1/79	-14.0	431	"
DE-48	8/21/79	-24.2	--	"
DE-49	8/29/79	-10.6	--	"
DE-50	8/30/79	-13.4	--	"
DE-51	9/7/79	-11.1	--	"
DE-52	9/6/79	-15.9	--	"
DE-53	8/9/79	-10.2	214	Wyoming
DE-54	8/11/79	- 7.0	235	"
DE-55	8/6/79	- 9.6	213	"
DE-56	8/6/79	-11.6	225	"
DE-57	8/12/79	- 9.4	365	"
DE-58	8/12/79	-14.4	418	"
DE-59	8/9/79	-16.0	107	"
DE-60	8/12/79	-13.3	231	"
DE-61	8/8/79	- 9.2	195	"
DE-62	8/9/79	-14.0	214	"
DE-63	8/9/79	- 7.9	320	"
DE-64	8/11/79	-10.1	244	"
DE-65	8/7/79	- 9.3	210	"
DE-66	8/7/79	-16.1	58	"
DE-67	8/4/79	-16.6	220	"
DE-68	8/4/79	-11.6	190	"

DE-14. 14,100 ± 400

Sample coll Feb 8, 1978, from Churchill Co (39° 33' 40" N, 118° 43' 19" W) at depth 79.2m. Sample coll 4 hr after starting pumping.

DE-15. Well 10S/47-30dcc 8400 ± 140

Sample coll June 21, 1979, from Windmill Ranch 13km N of Beatty in Oasis Valley, Nye Co (37° 01' 60" N, 116° 45' 30" W). Hole drilled to 36.9m and cased to 19.8m below land surface datum. Alt of well head 1179.6m above msl. Static water level was 5.5m below land surface datum. Pump yielded 190Lpm.

DE-16. Spring 10S/47-33aab <100

Sample coll June 20, 1979, from spring in Oasis Valley, Nye Co (37° 01' 49" N, 116° 43' 08" W). Ditch along base of steep volcanic slope intersects seeps from fractured volcanic rock and channels water to a reservoir. Alt of reservoir 1182.6m above msl.

DE-17. Water Supply Well J-13 9900 ± 130

Sample coll June 22, 1979, from Nevada Test Site, Nye Co (36° 48' 29" N, 116° 23' 40" W). Hole drilled to 1063.1m and cased to 1031.7m below land surface datum. Alt of well head 1011.3m above msl. Static water level was 282.9m below land surface datum. Casing perforated 303.5 to 422.5m and 819.9 to 1009.5m. Pump discharged 2600Lpm.

DE-18. Spring 10S/47-14bab 7600 ± 100

Sample coll June 20, 1979, from Fleur de Lis Ranch, Oasis Valley, Nye Co (37° 04' 27" N, 116° 41' 24" W) from depth 1.8m below land surface datum. Alt of spring 1213.7m above msl.

DE-19. Well 12S/47-7dbd 3500 ± 60

Sample coll June 19, 1979, from Beatty Municipal Well #2, Oasis Valley, Nye Co (36° 54' 18" N, 116° 45' 24" W) from depth 54.9 to 91.4m. Hole drilled to 91.4m and cased to 54.9m below land surface datum. Pump yielded 870Lpm.

DE-20. Well 10S/47-14bab 21,500 ± 330

Sample coll June 25, 1979, from Coffey's Well, Oasis Valley, Nye Co (37° 04' 27" N, 116° 41' 24" W). A 2.4m well beside a reservoir was equipped with a centrifugal pump from which water was obtained for analysis. Springs were located in bottom of reservoir. Alt of well head is 1213.7m above msl. Pump yielded 1325 Lpm.

DE-21. Well 11S/47-27cba 9300 ± 120

Sample coll June 26, 1979, from Marvin's Well, Oasis Valley, Nye Co (36° 56' 57" N, 116° 42' 46" W) 5.6km N of Beatty, Nevada at depth 10.6m. Hole drilled to 16.8m and cased to 15.2m below land surface datum. Alt of well head 1060.7m above msl. Static water level was 9.1m below land surface datum. Pump yielded 76Lpm.

D. South Dakota

- DE-22. Well 7S/1E-15acda (TVA Lakota) 18,300 ± 330**
 Sample coll July 2, 1979, from Fall River Co (43° 26' 38" N, 103° 58' 52" W) at depth 182m.
- DE-23. Well 11N/1E-17dcac >37,500**
 Sampled coll July 3, 1979, from Russ Carver Well #2, Butte Co (44° 54' 41" N, 104° 01' 24" W) at depth 640m.
- DE-24. Well 5N/9E-34cebd >36,100**
 Sample coll July 17, 1979, from Meade Co (44° 20' 47" N, 103° 01' 18" W) at depth 722.4m.
- DE-25. Well 8N/2E-14dc 8100 ± 140**
 Sample coll July 16, 1979, from Butte Co (44° 39' 05" N, 103° 50' 12" W) at depth 131.1m.
- DE-26. Well 104N/61W-36ddaa >26,200**
 Sample coll July 26, 1979, from Richard Renken Well (43° 45' 55" N, 98° 05' 12" W) at depth 103.6m. Static water level was 6.5m below land surface datum.
- DE-27. Well 105N/58W-31bacc >30,600**
 Sample coll July 26, 1979, from Miner Co (43° 51' 42" N, 97° 50' 39" W) at depth 192m; flow rate 144Lpm. Static water level was 10.8m below land surface datum.
- DE-28. Well 113N/61W-cbbb 29,900 ± 1600**
 Sample coll July 27, 1979 from Beadle Co (44° 34' 12" N, 98° 09' 34" W) at depth 274.3m; flow rate 151Lpm.
- DE-29. Well 109N/70W-babd >30,700**
 Sample coll July 24, 1979, from Hand Co (44° 16' 53" N, 99° 15' 33" W) at depth 592.8m; flow rate 151Lpm. Alt of well head 60.5m above msl.
- DE-30. Well 1N/15E-36adec >40,300**
 Sample coll July 19, 1979, from Pennington Co (44° 00' 06" N, 102° 15' 04" W) at depth 378.1m.
- DE-31. Well 123N/64W-27ddaa 32,300 ± 1000**
 Sample coll July 30, 1979, from Brown Co (45° 26' 40" N, 98° 30' 50" W) at depth 342.9m; flow rate 57Lpm.
- DE-32. Well 128N/66W-8abbc >28,300**
 Sample coll July 29, 1979, from McPherson Co (45° 55' 27" N, 98° 49' 03" W) at depth 581.2m; flow rate 227Lpm.
- DE-33. Well 122N/62W-23dadd >34,100**
 Sample coll July 31, 1979, from Brown Co (45° 21' 44" N, 98° 14' 51" W) at depth 349.9m; flow rate 34Lpm.

DE-34. Well 125N/57W-6baba >**33,400**

Sample coll July 31, 1979, from Marshall Co (45° 40' 27" N, 97° 43' 22" W) at depth 378.6m; flow rate 11.4Lpm. Static water level was 30.5m below land surface datum.

DE-35. Well 128N/67W-35bbcd2 **31,900 ± 1700**

Sample coll July 29, 1979, from McPherson Co (45° 51' 48" N, 98° 52' 53" W) at depth 515.4m; flow rate 227Lpm.

DE-36. Well 123N/65W-22aad **29,000 ± 1400**

Sample coll July 28, 1979, from Brown Co (45° 27' 29" N, 98° 38' 24" W) at depth 409.3m; flow rate 189Lpm. Static water level was 100.6m below land surface datum.

DE-37. Well 1N/24E-9cadd **28,800 ± 1100**

Sample coll Aug 6, 1979, from Haakon Co (44° 03' 25" N, 101° 14' 13" W) at depth 722.4m; flow rate 568Lpm. Static water level was 70.4m below land surface datum.

DE-38. Well 99N/74W-1cdcd >**23,000**

Sample coll Aug 5, 1979, from Tripp Co (43° 24' 57" N, 99° 32' 52" W) at depth 457.2m; flow rate 1.9Lpm.

DE-39. Well 98N/70W-11c **29,900 ± 1400**

Sample coll Aug 4, 1979, from Gregory Co (43° 19' 45" N, 99° 05' 20" W) at depth 259.1m; flow rate 114Lpm. Static water level was 16.2m below land surface datum.

DE-40. Well 6N/24E-03baaa >**35,400**

Sample coll Aug 7, 1979, from Haakon Co (44° 30' 40" N, 101° 12' 30" W) at depth 792.5m; flow rate 15Lpm.

DE-41. Well 1N/20E-24bcab >**39,700**

Sample coll Aug 6, 1979, from Haakon Co (44° 02' 02" N, 101° 39' 40" W) at depth 780.9m; flow rate 379Lpm.

DE-42. Well 2S/22E-23bad >**35,700**

Sample coll Aug 6, 1979, from Jackson Co (43° 49' 55" N, 101° 31' 20" W) at depth 832.1m; flow rate 946Lpm.

DE-43. Well 96N/63W-08cda >**28,400**

Sample coll Aug 4, 1979, from Charles Mix Co (43° 08' 26" N, 98° 19' 06" W) at depth 204.8m; flow rate 22.7Lpm. Static water level was 10m below land surface datum.

DE-44. Well 107N/49W-14abbc >**40,400**

Sample coll Aug 1, 1979, from Moody Co (44° 04' 41" N, 96° 40' 36" W) at depth 143.3m; flow rate 5.7Lpm.

DE-45. Well 93N/55W-4bbc >30,500

Sample coll Aug 3, 1979, from Yankton Co (42° 54' 40" N, 97° 21' 25" W) at depth 124.1m; flow rate 38Lpm.

DE-46. Well 91N/49W-19bcca 4000 ± 140

Sample coll Aug 2, 1979, from Union Co (42° 41' 13" N, 96° 41' 13" W) at depth 99.1m; flow rate 833Lpm.

DE-47. 127N/49W-29bbbc >41,400

Sample coll Aug 1, 1979, from Perkins Co (45° 45' 35" N, 96° 49' 58" W) at depth 161.5m; flow rate 9.8Lpm. Static water level was 3.86m below land surface datum.

DE-48. Well 5N/17E-21aacc >39,200

Sample coll Aug 21, 1979, from Pennington Co (44° 23' 00" N, 102° 03' 53" W) at depth 938.8m.

DE-49. Well 8S/6E-14cbba 17,400 ± 230

Sample coll Aug 29, 1979, from Fall River Co (43° 21' 13" N, 103° 22' 48" W) at depth 609m.

DE-50. Well 11S/2E-21dc 28,300 ± 1000

Sample coll Aug 30, 1979, from Fall River Co (43° 04' 16" N, 103° 52' 41" W) at depth 731.5m.

DE-51. Well 2S/13E-14acad >36,600

Sample coll Sept 7, 1979, from Pennington Co (43° 52' 27" N, 102° 03' 48" W) at depth 807.7m

DE-52. Well 3S/14E-28dada 30,400 ± 1000

Sample coll Sept 6, 1979, from Pennington Co (43° 45' 10" N, 102° 26' 31" W) at depth 865.6m.

*E. Wyoming***DE-53. Well 15N/18W-9bba 14,200 ± 350**

Sample coll Aug 9, 1979, from Niobrara Co (47° 05' 00" N, 109° 27' 41" W) at depth 187.1m.

DE-54. Well 16N/17W-18bdd >40,000

Sample coll Aug 11, 1979, from Niobrara Co (47° 09' 05" N, 109° 37' 16" W) at depth 378m.

DE-55. Well 10N/17W-16bb2 17,500 ± 370

Sample coll Aug 6, 1979, from Weston Co (47° 14' 30" N, 110° 27' 52" W) at depth 134.7m.

DE-56. Well 17N/10W-26bb 8900 ± 160

Sample coll Aug 6, 1979, from Weston Co (47° 12' 41" N, 110° 25' 24" W) at depth 106.7m.

- DE-57. Well 17N/15W-34bdc** >**39,200**
Sample coll Aug 12, 1979, from Niobrara Co (47° 11' 36" N, 109° 48' 06" W) at depth 507.5m.
- DE-58. Well 16N/17W-36aca** **33,500 ± 1900**
Sample coll Aug 12, 1979, from Niobrara Co (47° 06' 33" N, 109° 30' 32" W) at depth 118.9m.
- DE-59. Well 14N/18W-10dbb** <**50**
Sample coll Aug 9, 1979, from Niobrara Co (45° 59' 11" N, 109° 04' 13" W) at depth 28m.
- DE-60. Well 16N/17W-21add** >**35,000**
Sample coll Aug 12, 1979, from Niobrara Co (47° 07' 54" N, 109° 34' 06" W) at depth 88.4m.
- DE-61. Well 18N/10W-35cdl** **36,000 ± 2600**
Sample coll Aug 8, 1979, from Weston Co (47° 16' 32" N, 110° 25' 04" W) at depth 247.3m.
- DE-62. Well 15N/18W-27aa** **4200 ± 140**
Sample coll Aug 9, 1979, from Niobrara Co (47° 02' 19" N, 109° 25' 14" W) at depth 152.4m. *Comment:* possible contamination from underlying strata.
- DE-63. Well 16N/17W-28adc** >**39,200**
Sample coll Aug 11, 1979, from Niobrara Co (47° 07' 21" N, 109° 04' 13" W) at depth 221m.
- DE-64. Well 16N/18W-32dcd** **18,600 ± 280**
Sample coll Aug 11, 1979, from Niobrara Co (47° 05' 58" N, 109° 27' 58" W) at depth 213.4m.
- DE-65. Well 17N/10W-20bd** **10,100 ± 180**
Sample coll Aug 7, 1979, from Weston Co (47° 13' 13" N, 110° 29' 00" W) at depth 33.5m.
- DE-66. Well 16N/10W-5aa** **8100 ± 180**
Sample coll Aug 7, 1979, from Weston Co (47° 11' 02" N, 110° 27' 37" W) at depth 14m.
- DE-67. Well 18N/11W-22cc** >**36,000**
Sample coll Aug 4, 1979, from Weston Co (47° 18' 11" N, 105° 19' 08" W) at depth 345.6m.
- DE-68. Well 18N/10W-13ca** **33,300 ± 2100**
Sample coll Aug 4, 1979, from Weston Co (47° 18' 49" N, 110° 23' 47" W) at depth 422.8m.

REFERENCES

- Brown, Eugene, Skougstad, M W, and Fishman, M J, 1970, US Geological Survey techniques of water resources investigations: Book 5, Chap A1, p 42-44.
- Calf, G E and Polach, H A, 1974, Teflon vials for liquid scintillation counting of carbon-14 samples, *in* Stanley, P E and Scoggins, B A, eds, Internatl symposium on liquid scintillation counting, recent developments: New York, Academic Press, p 223.
- Craig, Harmon, 1957, Isotopic standards for carbon and oxygen and factors for mass-spectrometric analysis of carbon dioxide: *Geochim et Cosmochim Acta*, v 12, p 133-149.
- Noakes, J E, Kim, S M, and Akers, L K, 1967, Recent improvements in benzene chemistry for radiocarbon counting: *Geochim et Cosmochim Acta*, v 31, p 1094-1096.
- Schroder, L J, Beetem, W A, Claassen, H C, and Emerson, R L, 1973, US Geological Survey, Denver, Colorado radiocarbon dates I: *Radiocarbon*, v 15, p 469-478.
- Schroder, L J, Emerson, R L, and Beetem, W A, 1978, US Geological Survey, Denver, Colorado radiocarbon dates II: *Radiocarbon*, v 20, p 200-209.
- Yang, I C and Emerson, R L, 1980, Teflon vials for low-level C-14 liquid scintillation counting, *in* Peng, C T, Horrocks, D L, and Alpen, E L, eds, Internatl conf on liquid scintillation counting, recent applications and developments: New York, Academic Press, v 2, p 181-197.