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# US GEOLOGICAL SURVEY, MENLO PARK, CALIFORNIA, RADIOCARBON MEASUREMENTS II

STEPHEN W ROBINSON and DEBORAH A TRIMBLE

US Geological Survey, Menlo Park, California 94025

The Menlo Park radiocarbon laboratory of the US Geological Survey began operation in January 1976 in a new building with a counting room 9.8m below the ground surface. Shielding above the counters consists of 30cm lead and 8.2m earth. The ionizing cosmic ray flux at the counters is 0.28 cpm/cm$^2$. Background levels obtained thus far are summarized in Table 1.

In the first date list from this laboratory (Robinson, 1977) marine shell dates were reported without a stated reservoir age correction, but with an implied reservoir age correction of 412 years because the results were not normalized to $\delta^{13}C = -25‰$. We have now determined (Table 2; Robinson and Thompson, 1980) applicable reservoir ages for the west coast of the United States and Mexico:

| | |
|---|---|
| Washington and Oregon (including northern Puget Sound) | 800 ± 25 BP |
| Northern California (33°-38°N) | 680 ± 15 BP |
| Baja California (Mexico) (Berger, Taylor, and Libby, 1966) | 610 ± 20 BP |

In the absence of other published guidelines, we will henceforth follow the recommendations of Stuiver and Polach (1977) in reporting marine shell dates. Table 3 presents the reservoir-corrected results for the seven marine shell dates reported in USGS I (Robinson, 1977).

The dates in this list are calculated using the 5570-yr half-life, and published standard deviations include only counting statistics. The additional uncertainty due to isotopic fractionation, counter pressure, temperature, and voltage is about ± 30 years if $\delta^{13}C$ of the counted gas was not measured.

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*United States*

*California*

**USGS-182. Pt Reyes National Sea Shore, Marin Co** — **1770 ± 45**, *Est* $\delta^{13}C = -25‰$

Fine-grained marsh sediments rich in organic material from Religion Colony landslide (38° 57.5′ N, 122° 36′ W). Date is min for sliding. *Coll in* 1977 by David Wagner, California Div Mines and Geology; subm by Edward Helley, USGS.

**Pine Valley series, San Diego Co**

Charcoal from sec 4m thick of valley-filling alluvium cut by Pine Valley Creek (32° 50′ 13″ N, 116° 32′ 02″ W), ca 1.5m above present stream level. With USGS-96, dates deposition of extensive stream terraces and gives approx rate of dissection. Coll and subm by W C Hoggatt, USGS.

**860 ± 50**

**USGS-298.** *Est* $\delta^{13}C = -25‰$

Ca 1.5m above present stream level.

**920 ± 60**

**USGS-96.** *Est* $\delta^{13}C = -25‰$

Ca 0.5m above present stream level.

**Pallett Creek series, near Valyermo**

Samples from sec 8m thick of peat, silt, sand, and gravel broken and deformed by San Andreas fault (34° 27.4′ N, 117° 51.7′ W) (Sieh, 1978). Coll in 1976 and subm by Kerry Sieh, California Inst Technol.

**190 ± 50**

**USGS-144.** *Est* $\delta^{13}C = -25‰$

Peat from Unit 81, Exposure 11, ca 1.3m below ground surface. Deposition preceded large earthquake Event X.

**460 ± 60**

**USGS-136.** *Est* $\delta^{13}C = -25‰$

Peat from Unit 72, Exposure 11, ca 1.8m below ground surface. Deposition immediately postdates large earthquake Event V.

**320 ± 60**

**USGS-137.** *Est* $\delta^{13}C = -25‰$

Peat from upper 1 to 2cm of Unit 68, Exposure 11, ca 2.4m below ground surface. Deposition immediately antedates large earthquake Event V.

**800 ± 60**

**USGS-84.** *Est* $\delta^{13}C = -25‰$

Peat from lower half of Unit 61, Exposure 1, ca 1.8m below ground surface. Deposition preceded large earthquake Event T.

TABLE 1

Counter characteristics

| Volume (l) | $CO_2$ pressure (atm) | Net modern count rate (cpm) | Background count rate (cpm) |
|---|---|---|---|
| 0.125 | 2.72 | 2.6 | 0.19 |
| 0.40 | 2.72 | 7.2 | 0.33 |
| 0.65 | 2.72 | 10.6 | 0.39 |
| 1.04 | 2.50 | 16.6 | 0.50 |
| 1.22 | 2.62 | 20.2 | 0.81 |
| 2.47 | 1.89 | 30.1 | 1.38 |
| 2.47 | 2.89 | 44.0 | 1.20 |
| 2.92 | 2.72 | 53.8 | 1.98 |

TABLE 2
Reservoir age determinations on modern mollusks

| Sample number | Locality | North latitude | Taxon | Collection date | $\delta^{13}C$ | Conventional radiocarbon age (years BP) | Fossil fuel correction | Reservoir age (years) |
|---|---|---|---|---|---|---|---|---|
| USGS-234 | Palov Harbor, Alaska | 55.5 | *Protothaca staminea* | 1937 | Ca 0.1 | 700 ± 50 | −40 | 650 ± 50 |
| USGS-177 | Orcas Is., Washington | 48.6 | *Saxidomus giganteus* | 1915 ± 5 | +0.1 | 810 ± 50 | −10 | 760 ± 50 |
| USGS-190 | Orcas Is., Washington | 48.6 | *P tenerrima* | 1915 ± 5 | +0.7 | 950 ± 30 | −10 | 920 ± 30 |
| USGS-170 | Sooke, Br Col | 48.4 | *Saxidomus* sp | 1916 | −0.2 | 850 ± 50 | −10 | 810 ± 50 |
| USGS-133 | Esquimault, Br Col | 48.3 | *Saxidomus* sp | 1930 | −0.2 | 750 ± 50 | −30 | 700 ± 50 |
| USGS-169 | Yaquina Bay, Oregon | 44.6 | *S giganteus* | 1916 | +0.4 | 840 ± 35 | −10 | 800 ± 35 |
| USGS-189 | Yaquina Bay, Oregon | 44.6 | *P staminea* | 1916 | −0.2 | 840 ± 50 | −10 | 790 ± 50 |
| USGS-233 | Sunset Bay, Oregon | 43.3 | *P tenerrima* | 1936 | +0.0 | 900 ± 50 | −40 | 840 ± 50 |
| USGS-248 | Bolinas Bay, Calif | 37.9 | *P staminea* | 1920 ± 5 | −0.3 | 680 ± 25 | −10 | 700 ± 25 |
| USGS-280 | Half Moon Bay, Calif | 37.5 | *P tenerrima* | 1920 ± 5 | +0.7 | 750 ± 35 | −10 | 700 ± 35 |
| USGS-178 | Monterey, Calif | 36.6 | *P staminea* | 1920 ± 5 | Ca 0.1 | 740 ± 35 | −10 | 695 ± 35 |
| USGS-281 | Morro Bay, Calif | 35.4 | *Protothaca* sp | 1947 | Ca 0.1 | 750 ± 35 | −70 | 680 ± 35 |
| USGS-430 | San Diego, Calif | 32.7 | *S nuttalli* | 1920 ± 5 | Ca 0.1 | 740 ± 35 | −10 | 690 ± 35 |

**1130 ± 45**

**USGS-83.** *Est* $\delta^{13}C = -25‰$

Peat from Unit 49, Exposure 1, ca 2.3m below ground surface. Deposition postdated earthquake Event I.

**1020 ± 50**

**USGS-82.** *Est* $\delta^{13}C = -25‰$

Peat from 2cm of Unit 47, Exposure 1, ca 2.5m below ground surface. Deposition immediately postdates earthquake Event I.

**1130 ± 70**

**USGS-138.** *Est* $\delta^{13}C = -25‰$

Clayey peat from upper 1cm of Unit 45, Exposure 11, ca 3.8m below ground surface. Deposition immediately preceded earthquake Event I.

**1160 ± 60**

**USGS-139.** *Est* $\delta^{13}C = -25‰$

Clayey peat of Unit 41, Exposure 11, ca 4.1m below ground surface. Deposition postdates large earthquake Event F.

**1460 ± 60**

**USGS-141.** *Est* $\delta^{13}C = -25‰$

Clayey peat (ca 1cm thick) of Unit 36, Exposure 11, ca 4.0m below ground surface. Deposition postdates earthquake Event D.

**1410 ± 50**

**USGS-140.** *Est* $\delta^{13}C = -25‰$

Clayey peat (2cm thick) of Unit 33, Exposure 11, ca 5.0m below ground surface. Deposition antedated Event D.

**1830 ± 50**

**USGS-142.** *Est* $\delta^{13}C = -25‰$

Lower ca 2cm of clayey peat, 10cm thick, of Unit 26, Exposure 11, ca 5.8m below ground surface. Oldest horizon sampled in excavations at Pallett Creek.

**La Honda Creek Landslide series**

Wood from borehole samples within landslide, 2.8km N of La Honda (37° 21′ N, 122° 17′ W). The most recent of these samples indi-

TABLE 3

Reservoir corrections for marine shell dates previously reported

| Sample no. | Conventional age | Reservoir correction | Reservoir corrected age |
|---|---|---|---|
| USGS-7 | 3670 ± 80 | 800 ± 25 | 2870 ± 90 |
| USGS-65 | 6290 ± 70 | 800 ± 25 | 5490 ± 80 |
| USGS-64 | 12080 ± 90 | 800 ± 25 | 12280 ± 100 |
| USGS-71 | 1570 ± 60 | 680 ± 15 | 890 ± 60 |
| USGS-72 | 6860 ± 100 | 680 ± 15 | 6180 ± 100 |
| USGS-35 | 3480 ± 90 | 680 ± 15 | 2800 ± 90 |
| USGS-36 | 5240 ± 130 | 680 ± 15 | 4560 ± 130 |

cates landslide occurred not more than 3770 ± 150. Coll in 1976 and 1977 and subm by G Wieczorek, USGS.

**USGS-147. 10.7 to 11m** — **3990 ± 70**, *Est* $\delta^{13}C = -25‰$

**USGS-149. 8.4 to 9.1m** — **4170 ± 140**, *Est* $\delta^{13}C = -25‰$

**USGS-326. 9.1 to 9.8m** — **3770 ± 150**, *Est* $\delta^{13}C = -25‰$

**USGS-391. 8.5 to 9.5m** — **4000 ± 35**, *Est* $\delta^{13}C = -25‰$

**USGS-160. The Geysers** — **13,200 ± 160**, *Est* $\delta^{13}C = -25‰$

Carbonized wood in base of colluvium from depth 12 to 17m in conductor pipe hole at geothermal well site (38° 49′ N, 122° 45′ W). Date is min for landslide induced rotational movement that produced closed depression in which colluvium accumulated. Coll 1976 by C Isselhardt and D McMurdie, Union Oil Co; subm by R J McLaughlin, USGS.

**Bolinas Lagoon series Marine Co**

Samples from Borehole 4 on Bolinas Lagoon Spit (37° 54′ N, 122° 39′ W). Coll and subm 1976 by J Bergquist and B Atwater, USGS.

**USGS-171. Bolinas Lagoon** — **7770 ± 70**, *Est* $\delta^{13}C = 0‰$

Oyster shells *(Ostrea lurida)* 32.5m below present mean sea level. Reservoir corrected age: 7090 ± 65. Dates most recent marine transgression and indicates magnitude of tectonic subsidence of Bolinas Lagoon graben.

**USGS-172. Bolinas Lagoon** — **8400 ± 100**, *Est* $\delta^{13}C = -25‰$

Fibrous peat from lacustrine clayey silt 36m below present mean sea level. Dates fresh water environment in area of present marine inundation and indicates magnitude of tectonic displacement of Bolinas Lagoon graben.

**USGS-224. Bolinas Lagoon** — **8800 ± 80**, *Est* $\delta^{13}C = -25‰$

Fibrous peat from lacustrine clayey silt 41m below present mean sea level. Dates spruce pollen *(Picea sitchensis)* that indicates climate significantly cooler and wetter than at present. Indicates magnitude of tectonic subsidence of Bolinas Lagoon graben.

**USGS-220. Santa Rosa, California** — **4370 ± 120**, *Est* $\delta^{13}C = -25‰$

Charcoal from trench along left bank of Santa Rosa Creek (38° 26′ N, 122° 42′ W). Sample provides absolute age control of alluvium

involved in last active faulting at trench locality. Coll 1977 by T D Hayes; subm by Ed Helley and Darrell Herd, USGS.

**1710 ± 60**

**USGS-221. Placer County** *Est* $\delta^{13}C = -25‰$

Charcoal found in faulted paleosol on S wall of Hubbard Rd trench (38° 57′ 47″ N, 121° 07′ 51″ W). Sample provides age of last movement on fault within Foothills fault system. Coll 1977 by Glenn Borcherat and Richard Hilborne, California Div Mines and Geol; subm by Ed Helley.

**>42,900**

**USGS-173. Butano Creek, San Mateo Co** *Est* $\delta^{13}C = -25‰$

Wood in peaty clays exposed in roadcut on E side of Cloverdale Rd E of Butano Creek (37° 14′ 15″ N, 122° 21′ 55″ W). Date is min for old alluvium of Butano Creek. Coll in 1977 by K R Lajoie and G E Weber, Univ California, Santa Cruz; subm by K R Lajoie, USGS.

**4150 ± 130**

**USGS-285. Tanner Bank, Southern California Borderland** *Est* $\delta^{13}C = 0‰$

Marine shell hash coll from submerged strandline 60m below sea level on Tanner Bank (32° 44′ 49′ N, 119° 08′ 49″ W). Reservoir corrected age: 3470 ± 130. Sample helps estimate Holocene rise in sea level in Southern California Borderland region. Coll 1975 by C L Barton, Univ Southern California; subm by K R Lajoie.

**39,500 ± 650**

**USGS-287. Point Año Nuevo** *Est* $\delta^{13}C = 0‰$

Marine shells (*Saxidomus giganteus,* Deshayes, id. by C W Hoskins) from marine terrace at Point Año Nuevo (37° 06′ 51″ N, 122° 19′ 51″ W). Amino-acid and paleontologic data indicate sample is Sangamonian in age (85Ka-105Ka). Sample was dated to determine $^{14}C$ activity in shell known to be beyond range of $^{14}C$. Coll 1956 by C W Hoskins; subm by K R Lajoie.

**40,300 ± 950**

**USGS-288. Goleta** *Est* $\delta^{13}C = 0‰$

Marine shell (*Saxidomun nuttalli* Conrad, id. by G L Kennedy) in growth position from marine terrace at Goleta, Santa Barbara Co (34° 24′ 33″ N, 119° 15′ 42″ W). Sample yields amino-acid age estimate of approx 40,000 yr BP. Coll 1977 by K R Lajoie, G L Kennedy, J F Wehmiller, and S A Mathieson; subm by K R Lajoie.

**1030 ± 40**

**USGS-289. Lake Cahuilla, Lower Borrego Valley** *Est* $\delta^{13}C = +2.38‰$

Non-marine pelecypod shells (*Anodonta* sp) from youngest deposit of Holocene high-stand of Lake Cahuilla, 9km SE of Ocotillo Wells (33° 05.4′ N, 116° 02.9′ W). All shells were articulated and coll from surface of deposit. Dated to check W-2456 (860 ± 200) (Clark, Grantz, and Rubin, 1972) from same sample. Coll and subm by Malcolm Clark, USGS.

**270 ± 60**

**USGS-211. Auburn Damsite, Auburn** *Est* $\delta^{13}C = -25‰$

Wood fragments 90cm below surface in backhoe trench (38° 52.5′ N, 121° 04′ W). Colluvium in which wood fragments were found was offset and should place age of activity on East March fault zone. Coll by R T Kilbourne, California Dept Mines and Geol; subm by Ed Helley.

**300 ± 40**

**USGS-191. Auburn Damsite, Auburn** *Est* $\delta^{13}C = -25‰$

Charcoal sample 30 to 50cm below surface in backhoe trench BHT-1 (38° 52′ 30″ N, 121°, 03″ W). Sample dates colluvium which is vital to all fault studies in Foothill fault system. Coll 1977 by Ed Helley, Dave Harwood, and Denis Marchand; subm by Ed Helley.

*Alaska*

**Upper Turnagain Arm series, Portage**

Artificially concentrated organic debris from unconsolidated silt in subsurface, Portage (60° 49′ N, 148° 59′ W). Age/depth relations will show rate of sediment accumulation in Turnagain Arm fiord. Coll 1975 by A T Ovenshine, R Kachadoorian, and S Bartsch-Winkler subm by S Bartsch-Winkler, USGS.

**5740 ± 190**

**USGS-126. 15-17m** *Est* $\delta^{13}C = -25‰$

**6490 ± 220**

**USGS-154. 50-51m** *Est* $\delta^{13}C = -25‰$

**7260 ± 90**

**USGS-228. 67m** *Est* $\delta^{13}C = -25‰$

**8230 ± 100**

**USGS-127. 92-93m** *Est* $\delta^{13}C = -25‰$

**3180 ± 50**

**USGS-108. Kodiak Shelf, Alaska** *Est* $\delta^{13}C = -25‰$

Broken marine shells from gravelly sand on N Albatross Bank, W Gulf of Alaska (57° 45.80′ N, 151° 08.05′ W). Reservoir-corrected age: 2530 ± 70. Shells probably broken by shoreline processes during last Pleistocene transgression, rather than in modern setting. Coll and subm in 1976 by M A Hampton, USGS.

**Prudhoe Bay Borehole series**

Boreholes were drilled during Spring 1976 and 1977, to determine distribution of ice-bonded permafrost, to establish history of local relative sea level, and to determine character of surficial materials of continental shelf on Beaufort Sea (Barnes and Hopkins, 1978; Hopkins, 1977; Hopkins and Hartz, in press; Sellmann and Chamberlain, in press). A sled-mounted drill on the shorefast ice was used as a drilling platform. Coll and subm 1977 by D M Hopkins, USGS.

**490 ± 90**

**USGS-132. Borehole PB-1, 7.8m bsl** *Est* $\delta^{13}C = -25‰$

Wood fragments from silty clay at depth 7.8m bsl. Sample underlies 3.8m marine silt in borehole PB-1 drilled in water 4m deep at center of Prudhoe Bay (70° 24.9′ N, 148° 19.3′ W). Prudhoe Bay is believed to have originated as thermokarst lake breached by retreating marine shoreline. Sample indicates former lake was breached and invaded by sea a little earlier than 500 yr ago.

**18,000 ± 170**

**USGS-192. Borehole PB-2, 13.7m bsl** *Est* $\delta^{13}C = -25‰$

Organic carbon in bulk sediment of overconsolidated clay and silt ca 13.7m bsl, drilled in borehole PB-2 (70° 30.6′ N, 140° 18.0′ W). Overconsolidated marine silt and clay are thought, based on pollen and foraminifers, to be of Sangamon interglacial age. Age determination of 18,000 yr is incompatible with pollen and foraminiferal content and with presence of shallow ice-bonded permafrost at this site. Evidently, it reflects undetected presence of admixture of Holocene detrital organic material introduced by bioturbation into Sangamon marine clay.

**>33,900**

**USGS-210. Borehole PB-3, 49m bsl** *Est* $\delta^{13}C = -25‰$

Twigs and organic fragments hand picked from peaty sand from core recovered at 49m bsl (70° 25.8′ N, 148° 26.6′ W). Data from all boreholes suggest sandy and gravelly alluvium from which USGS-210 was recovered is of middle Pleistocene age and much older than material dated in PB-7, 42,800 ± 1440 yr old (USGS-249). True age of this small sample is probably much greater than 34,000 yr.

**42,800 ± 1440**

**USGS-249. Borehole PB-7, 12.2-13.6m bsl** *Est* $\delta^{13}C = -25‰$

Twigs and organic fragments from peaty sand washed up from depth 13.3 to 13.6m bsl (70° 24.2′ N, 148° 33.5′ W). Organic horizon represented by USGS-249 was also intersected in borehole OH-3370, drilled in 1975 by Osterkamp and Harrison (1976). Very small sample of twigs recovered from same level in OH-3370 was reported at 22,300 ± 1100 yr old (AU-115) (M S Young, written commun, 1976). Our larger sample probably gives better estimate of true age of buried peaty sand in PB-7 and OH-3370.

**13,200 ± 110**

**USGS-155. Northern Bering Sea** *Est* $\delta^{13}C = -25‰$

Peat, rootlets, wood, and nut fragments from 73cm depth in core taken in sediment ca 34m below msl, 20km NE of King I. (65° 05′ N, 167° 43′ W). Date from peat in freshwater mud layer underlying trough between two large sand ridges on Bering epicontinental shelf. Helps date history of Holocene sea-level transgression. Coll and subm 1976 by Hans Nelson, USGS.

**>40,000**

**USGS-156. Northern Bering Sea** *Est* $\delta^{13}C = -25‰$

Peat from 175cm depth in core taken in sediment ca 31m below msl, 29km NE of King I. (65° 08′ N, 167° 36′ W). Date from peat in freshwater mud layer underlying trough that chronicles history of scour and/or nondeposition. Coll and subm 1976 by Hans Nelson.

**16,400 ± 430**

**USGS-157. Northern Bering Sea** *Est* $\delta^{13}C = -25‰$

Peat, wood fragments, and twigs from 83cm depth in sediment core from ca 28m below msl, 31km NE of King I. (65° 08′ N, 167° 33′ N). Sample, peaty silt in freshwater layer on flank of shoal on Bering Shelf dates pre-transgressive sediment; helps establish Holocene sedimentation rate and history of sea-level rise. Coll and subm 1976 by Hans Nelson.

**29,500 ± 340**

**USGS-158. Central Norton Sound** *Est* $\delta^{13}C = -25‰$

Peat from 175cm depth in core taken in sediment ca 17m below msl, 135km SE of Nome (63° 53′ N, 163° 01′ W). Sample, peat in freshwater silt dates possible mid-Wisconsin transgression and provides sedimentation rate for late Pleistocene emergence. Coll and subm by Hans Nelson.

**11,800 ± 200**

**USGS-159. Northeastern Norton Sound** *Est* $\delta^{13}C = -25‰$

Peat and wood fragments from 132cm depth in core taken in sediment ca 14m below msl, 95km NNE of Stuart I. (64° 24′ N, 161° 49′ W). Date from peaty silt indicates history of Holocene sea-level transgression and provides Holocene sedimentation rate. Coll and subm by Hans Nelson.

**2090 ± 120**

**USGS-183. Northern Bering Sea** *Est* $\delta^{13}C = -25‰$

Wood fragments from top 15cm of box core taken in sediment ca 18m below msl, 168km S of Nome (62° 59′ N, 165° 34′ W). Sample, 45km from Yukon Delta dates storm sand layer and gives sedimentation rate of Yukon R prodelta sediments. Coll and subm in 1976 by Hans Nelson.

**38,300 ± 1300**

**USGS-186. Colville River** *Est* $\delta^{13}C = -25‰$

Detrital peat 8m below top of sec 16m thick of sand and gravelly sand of Gubik Formation. Gubik deposits cap bluff 25.6m high, above Colville R (70° 04.35′ N, 151° 22.9′ W). Date believed too young and will be checked by dating detrital wood coll at same stratigraphic horizon. Coll 1975 and subm 1977 by L D Carter, USGS.

**1350 ± 50**

**USGS-188. Colville River** *Est* $\delta^{13}C = -25‰$

Peat from buried organic horizon 30cm thick underlying 90cm silty sand and 30cm modern turf. Exposed in bluff on Colville R (70° 05.3′ N,

151° 24.8′ W). Date indicates peat is not correlative with Holocene paleosol that occurs elsewhere on Arctic Coastal Plain (Carter and Robinson, 1978). Coll 1975 and subm 1977 by L D Carter.

**>45,000**

**USGS-208. Colville River** *Est* $\delta^{13}C = -25‰$

Spruce *(Picea mariana)* log from autochthonous peat (paleosol) 3m above base of sec 12.8m thick of sand and gravelly sand of Gubik Formation. Gubik deposits cap bluff, 33.5m high, on Colville R (70° 05′ N, 151° 24′ W.). Spruce needles found in peat indicate tree was either growing at site or had not been transported far. Date indicates spruce trees were growing on or near Arctic Coastal Plain during Quaternary sometime before 45,000 yr ago. Coll 1975 and subm 1977 by L D Carter.

**8180 ± 80**

**USGS-184. Colville River** *Est* $\delta^{13}C = -25‰$

Peat from middle of buried organic horizon 75cm thick underlying 70cm silty sand and 30cm modern turf. Peat is exposed in bluff along Colville R (70° 04.35′ N, 151° 22.9′ W). Date suggests peat is correlative with Holocene paleosol occuring elsewhere on Arctic Coastal Plain (Carter and Robinson, 1978). Coll 1975 and subm 1977 by L D Carter.

**2280 ± 50**

**USGS-185. Colville River** *Est* $\delta^{13}C = -25‰$

Peat from base of modern turf 30cm thick in sec described for USGS-184 (70° 04.35′ N, 151° 22.9′ W). Dates inception of modern vegetative cover at this locality. Coll 1975 and subm 1977 by L D Carter.

**3740 ± 60**

**USGS-187. Kogosukruk River** *Est* $\delta^{13}C = -25‰$

Wood coll 2.3m below top of exposure 4.6m high of fluvial terrace deposits along Kogosukruk R (69° 50.1′ N, 151° 35′ W). Terrace separates Kogosukruk and Colville Rivers S of Sentinel Hill. Sample dates this abandoned flood plain. Coll 1975 and subm 1977 by L D Carter.

**3850 ± 45**

**USGS-205. Umiat** *Est* $\delta^{13}C = -25‰$

Wood coll 2.4m below top alluvial terrace of Colville R, exposed in river bluff 6.4m high on Colville R near Umiat (69° 22.9′ N, 152° 04.7′ W). Sample dates this abandoned flood plain. Coll 1975 and subm 1977 by L D Carter.

**100 ± 60**

**USGS-206. Liscum Slough** *Est* $\delta^{13}C = -25‰$

Wood from partially buried tree stump, 25cm diam, in growth position exposed in cut-bank of Liscum Slough (64° 13′ N, 145° 20.2′ W). Base of stump is 1.2m below top of bank and natural levee rises 1m above bank top. Date records amount of alluviation in valley containing Liscum Slough since death of tree. Coll 1976 and subm 1977 by L D Carter.

**8270 ± 150**

**USGS-207. Salcha River** *Est* $\delta^{13}C = -25‰$

Detrital wood coll ca 1.5m above base of river bluff 22.8m high on Salcha R (64° 39.6′ N, 145° 47.25′ W). Bluff was cut into alluvium and colluvium of valley tributary to Salcha R. Date indicates that ca 21.3m of alluvium and colluvium were deposited at this site in past 8000 yr. Coll 1976 and subm 1977 by L D Carter.

**45,800 + 4500 − 3400**

**USGS-209. Tanana Valley** *Est* $\delta^{13}C = -25‰$

Wood from thin paleosol 9.4m base of streamcut 21m high near head of an alluvial fan. Fan occurs S of Fairbanks, at N margin of Alaska Range foothills (64° 04.5′ N, 147° 22.1′ W). Paleosol overlies massive cobble to boulder gravel and is overlain by poorly stratified pebble to cobble gravel. Paleosol records hiatus in fan deposition that may correspond to Wisconsinan interstadial. Large error on date indicates that radiocarbon level was close to limit of detection and date may represent only a lower limit on true age of sample. Coll and subm 1976 by L D Carter.

**120 ± 45**

**USGS-174. Delta River** *Est* $\delta^{13}C = -25‰$

Wood from base of gravelly slopewash 1m thick buried beneath 2m silt. Deposits mantle bluff along Delta R (63° 52′ N, 145° 57.1′ W). Date records time since Delta R flowed against bluff face. Coll and subm 1976 by L D Carter.

**>42,600**

**USGS-175. Dry Creek** *Est* $\delta^{13}C = -25‰$

Wood from buried alluvial gravel, 4m below top of deposit. Gravel forms lower 6.7m of river bluff 14m high on Dry Creek, S of Fairbanks (64° 21.8′ N, 147° 18.5′ W). Upper 3m of gravel is thoroughly weathered and contains ice-wedge pseudomorphs, overlain successively by 2 to 3m silt, 3m sandy gravel and 1m silt. Date indicates gravel antedates mid-Wisconsinan. USGS-176 suggests that weathering profile at top of gravel also is older than mid-Wisconsinan and, thus, must be Sangamonian or older. Coll and subm 1976 by L D Carter.

**>33,000**

**USGS-176. Dry Creek** *Est* $\delta^{13}C = -25‰$

Small stems coll near base of deposit of eolian silt, 3m thick, exposed in river bluff 14m high on Dry Creek (64° 21.8′ N, 145° 57.1′ W). Silt overlies 6.7m alluvial gravel and is overlain successively by 3m sandy gravel and 1m silt. Silt is gray at base and grades upward through mottled zone to brown at top. Date, with USGS-175, shows that deposits exposed in bluff represent considerable interval of pre-late Wisconsinan time and may prove to be important site for paleo-environmental studies. Coll and subm 1976 by L D Carter.

**>49,500**

**USGS-56. Sagavanirktock Valley** *Est* $\delta^{13}C = -25‰$

Peat near base of gray silt overlying till and intersected by ice wedges, exposed in cut along Alyeska Haul Rd (69° 01.5′ N, 148° 50′ W). Shows that till, of Itkillik I age (Hamilton and Porter, 1975), antedates classical Wisconsin glacial max. Coll 1974 and subm 1976 by T D Hamilton, USGS.

**4170 ± 45**

**USGS-374. Chandalar bluffs** *Est* $\delta^{13}C = -25‰$

Silty peat overlain by 0.45m frost-churned stony silt, N side Chandalar R near Funchion Creek (67° 07′ N, 147° 34′ W). Dates episode of middle Holocene peat formation followed by intensified frost activity (Hamilton, 1979). Coll and subm 1976 by T D Hamilton.

**5370 ± 90**

**USGS-376. Mosquito Fork** *Est* $\delta^{13}C = -25‰$

Wood from buried forest bed near base of cutbank along Mosquito Fork Koyukuk R (67° 30′ N, 149° 55′ W). Represents episode of stability during alluviation of 8.5m terrace (Hamilton, 1979). Coll and subm 1976 by T D Hamilton.

**50,100 + 3200 − 2600**

**USGS-410. North Fork bluffs** *Est* $\delta^{13}C = -25‰$

Detrital wood from oxidized gravel beneath till, near mouth of North Fork Koyukuk R (67° 07′ N, 150° 55′ W). Places limiting max age on Itkillik I glaciation of Koyukuk Valley (Hamilton and Porter, 1975). Coll and subm in 1977 by T D Hamilton.

**9890 ± 80**

**USGS-412. John Valley** *Est* $\delta^{13}C = -25‰$

Wood fragments from peat bed near base of 16m bluff along John R at S flank of Brooks Range (67° 07′ N, 151° 52′ W). Dates early phase of filling of depositional basin in front of end moraine of Itkillik II age (Hamilton and Porter, 1975). Coll and subm 1977 by T D Hamilton.

**27,700 ± 950**

**USGS-413. Sixtymile Creek** *Est* $\delta^{13}C = -25‰$

Wood fragments 40m above modern river level in 70m alluvium, S side Sixtymile Creek (67° 21′ N, 152° 18′ W). Dates rapid alluviation in tributary valley in response to ice advance of Itkillik II age down John Valley (Hamilton and Porter, 1975). Coll and subm 1977 by T D Hamilton.

**>38,000**

**USGS-162. Wind River Valley** *Est* $\delta^{13}C = -25‰$

Detrital wood 2.1m below surface of cutbank, E side Wind R 32km S of continental Divide (68° 15′ N, 147° 15′ W). Provides max limiting age on last major glacial advance in Wind Valley. Coll and subm in 1976 by T D Hamilton.

**10,500 ± 80**

**USGS-229. Wind River Valley** *Est* $\delta^{13}C = -25‰$

Detrital wood 9m below surface of lacustrine plain, E side Wind R 49km S of Continental Divide (68° 05′ N, 147° 09′ W). Provides min limiting age on deglaciation of upper Wind R valley and dates early phase of postglacial alluviation. Coll and subm 1976 by T D Hamilton.

**9600 ± 90**

**USGS-163. Wind River Valley** *Est* $\delta^{13}C = -25‰$

Wood 9.5m below surface of lacustrine plain, E side Wind R 43km S of Continental Divide (68° 08′ N, 147° 14′ W). Provides min limiting age on late glacial outwash deposition in upper Wind R valley and antedates postglacial lacustrine episode. Coll and subm 1976 by T D Hamilton.

**9730 ± 230**

**USGS-164. Wind River Valley** *Est* $\delta^{13}C = -25‰$

Detrital wood 15m below surface of lacustrine plain, E side Wind R 49km S of Continental Divide (68° 05′ N, 147° 09′ W). Provides min limiting date on deglaciation of upper Wind R valley and dates early phase of postglacial alluviation. Coll and subm 1976 by T D Hamilton.

**430 ± 50**

**USGS-165. Itkillik Valley** *Est* $\delta^{13}C = -25‰$

Roots in growth position in permanently frozen sand, 3.5m below surface of cutbank, W side Itkillik R 5km NW of Itkillik Lake (68° 27′ N, 149° 59′ W). Dates late Holocene episode of river alluviation. Coll and subm by T D Hamilton.

**770 ± 130**

**USGS-166. Itkillik Valley, Alaska** *Est* $\delta^{13}C = -25‰$

Willow roots in growth position in permanantly frozen sand, 1.5m below surface of cutbank, W side Itkillik R 5km NW of Itkillik Lake (68° 27′ N, 149° 59′ W). Dates late Holocene episode of river alluviation and formation of 6.5m terrace. Coll and subm by T D Hamilton

**>42,500**

**USGS-167. Twin Lakes** *Est* $\delta^{13}C = -25‰$

Wood from diamicton 27m below surface of river bluff, W side Phoebe Creek 1.5km upstream from Robert Creek (67° 35′ N, 149° 13′ W). Provides max limiting age on last major glacial advance in Chandalar Valley system. Coll and subm by T D Hamilton.

**Ballaine Lake series**

Sample coll in trench excavated into ice-wedge system 1km E of Ballaine Lake, near Fairbanks (64° 52′ N, 147° 48′ W). Coll 1969 and subm 1975 by T D Hamilton.

**300 ± 40**

**USGS-219.** *Est* $\delta^{13}C = -25‰$

Fibrous peat 0.3m below surface. Postdates episode of ice-wedge melting that followed early Neoglacial growth.

**320 ± 60**

**USGS-335.** *Est* $\delta^{13}C = -25‰$

Peat from trough above active ice wedge. Provides min limiting age on earlier episode of wedge growth followed by thaw. Dates beginning of latest phase of wedge activity, which continues to present.

**1380 ± 50**

**USGS-77.** *Est* $\delta^{13}C = -25‰$

Coarse fibrous sedge peat 0.4m below surface. Dates episode of ice-wedge melting that followed early Neoglacial growth.

**1770 ± 70**

**USGS-31.** *Est* $\delta^{13}C = -25‰$

Sedge or grass peat 0.5m below surface. Dates episode of ice-wedge melting that followed early Neoglacial growth.

**1990 ± 80**

**USGS-75.** *Est* $\delta^{13}C = -25‰$

Coarse woody peat 0.5m below surface. Dates cessation of episode of early Neoglacial ice-wedge growth.

**3110 ± 100**

**USGS-30.** *Est* $\delta^{13}C = -25‰$

Coarse woody peat 0.7m below surface. Dates cessation of episode of early Neoglacial ice-wedge growth.

**3090 ± 170**

**USGS-78.** *Est* $\delta^{13}C = -25‰$

Coarse woody peat 1m below surface. Dates cessation of episode of early Neoglacial ice-wedge growth.

**3440 ± 60**

**USGS-76B.** *Est* $\delta^{13}C = -25‰$

Coarse woody peat 1.7m below surface. Dates cessation of episode of early Neoglacial ice-wedge growth.

**12,840 ± 160**

**USGS-47. Sagavanirktok Valley** *Est* $\delta^{13}C = -25‰$

Grass, sedge, and wood fragments 16m below surface of river bluff, W side Sagavanirktok R 3.1km S of Atigun R confluence (68° 29.5′ N, 149° 01′ W). Provides close min limiting date on glacier retreat from upper Sagavanirktok Valley. Coll and subm 1975 by T D Hamilton.

**12,300 ± 120**

**USGS-161. Teklanika Valley** *Est* $\delta^{13}C = -25‰$

Wood fragments at base of kettle filling 8.1m below surface of river bluff, E side Teklanika R 2.5km S of Denali Hwy (63° 35′ N, 149° 31′ W). Provides close min limiting date on glacier retreat from upper Teklanika Valley. Coll and subm in 1976 by T D Hamilton.

**>42,000**

**USGS-41. Chandalar River near Caro** *Est* $\delta^{13}C = -25‰$

Spruce wood from buried forest bed 2m below surface in river bluff 1km downstream from Caro (67° 10.5′ N, 147° 59′ W). Overlies outwash correlated with Itkillik I glaciation of central Brooks Range; underlies loess of probable Itkillik II age. Coll and subm 1975 by T D Hamilton.

**3160 ± 80**

**USGS-43. Galbraith Lake** *Est* $\delta^{13}C = -25‰$

Bryophytic peat 10.5m below surface of lacustrine plain, E bank Atigun R 4km S of Galbraith Lake (68° 25.5′ N, 149° 23′ W). Dates episode of alluviation following high stand of Galbraith Lake. Coll and subm 1975 by T D Hamilton.

**8430 ± 70**

**USGS-45. Wiseman** *Est* $\delta^{13}C = -25‰$

Peaty muck 2m below surface in roadcut along Alyeska Haul Rd 1km S of Minnie Creek (67° 25′ N, 150° 04′ W). Provides min limiting date on glacier retreat from Middle Fork, Koyukuk Valley, and max limiting date on probable major landslide. Coll and subm 1975 by T D Hamilton.

**38,000 ± 500**

**USGS-290. Kogru River Dewline, Alaska** *Est* $\delta^{13}C = 0‰$

Shell fragments of shallow-water marine mollusks from low, eroding mounds on tundra near Kogru R Dewline site, N Alaska (70° 34′ N, 152° 22′ W). Radiocarbon detected in this sample is probably due to contamination processes (Robinson, 1979). Date, therefore, indicates lower limit of termination of marine deposition for Gubik Formation at the site. Coll and subm by Erk Reimnitz, USGS.

**Colville River Delta series**

Thin peaty layers from core taken on Colville R Delta front. Dates document low rates of deposition characteristic of arctic deltas. Coll and subm 1976 by Erk Reimnitz and Peter Barnes, USGS.

**3110 ± 70**

**USGS-292.** *Est* $\delta^{13}C = -25‰$

140 to 145cm below sea floor at 1m water depth Vibrocore 23 (70° 29.5′ N, 150° 59.5′ W).

**3430 ± 45**

**USGS-291.** *Est* $\delta^{13}C = -25‰$

130 to 133cm below sea floor at 1m water depth Vibrocore 23 (70° 29.5′ N, 150° 59.5′ W).

**2270 ± 60**

**USGS-294.** *Est* $\delta^{13}C = -25‰$

58cm below sea floor at 3.3m water depth Vibrocore 18 (70° 33.2′ N, 150° 27.9′ W).

**3040 ± 50**

**USGS-293.** *Est* $\delta^{13}C = -25‰$

97 to 98cm below sea floor at 3.3m water depth Vibrocore 18 (70° 33.2′ N, 150° 27.9′ W).

*Nevada*

**Las Vegas Wash series**

Cattail peat laminae intercalated with silt and sand ca 3m below stream terrace formed by rapidly entrenching Las Vegas Wash (36° 06′ N, 114° 57′ W). USGS-92 and -93 together indicate recent episode of extensive marsh develpoment. Dates coincide with either activities caused by humans such as increased water discharge or localized debris dams resulting from flash floods. Coll 1976 by F W Bachhuber, Univ Nevada, Las Vegas; subm by M C Blake, USGS.

**Modern**

**USGS-92. Las Vegas Wash** *Est* $\delta^{13}C = -25‰$

**Modern**

**USGS-93. Las Vegas Wash** *Est* $\delta^{13}C = -25‰$

*Oregon*

**6090 ± 60**

**USGS-105. North Summit Flow, Newberry Crater** *Est* $\delta^{13}C = -25‰$

Charcoal from within tree mold ca 1km N of rim of Newberry Crater (43° 45.2′ N, 121° 144° W). Dates eruption from NW rift zone high on flank of Newberry Crater. Coll 1976 by Norm MacLoed, USGS; subm by Duane Champion, USGS.

**5870 ± 60**

**USGS-106. Sugar Pine Butte Flow, Newberry Crater** *Est* $\delta^{13}C = -25‰$

Charcoal from within tree mold 1km W of Sugar Pine Butte (43° 49.5′ N, 121° 22′ W). Dates eruption of flow mantling W side of Sugar Pine Butte and flow to W. Coll 1976 by E M Shoemaker and Duane Champion, USGS; subm by Duane Champion.

**6160 ± 70**

**USGS-107. Lava Butte, Newberry Crater** *Est* $\delta^{13}C = -25‰$

Charcoal from beneath 4.8m basaltic cinders from Lava Butte in hwy outcrop of US 97 ca 1km NE of Lava Butte Lookout (43° 55.5′ N, 121° W). Dates eruption of Lava Butte cinders and probably large flow to W. Coll 1976 by Larry Chitwood and Robert Jensen, US Forest Service; subm by Duane Champion.

*Venezuela*

**Taima-taima Early Man site**

**13,880 ± 120**

**USGS-247.** *Est* $\delta^{13}C = -25‰$

Twigs, evidently masticated, assoc with mastodon slain and butchered by El Jobo hunters. Saturated gray sand (Unit 1) of Taima-taima

(11° 30′ N, 69° 35′ W). Earliest dated kill site in W hemisphere (Bryan *et al,* 1978). Coll and subm by A L Bryan, Univ Alberta. Received standard pretreatment.

**13,830 ± 120**
*Est* $\delta^{13}C = -25‰$

**USGS-247A.**

Repeat of USGS-247. Leached twice in 0.5N NaOH (16 hr at 60°C). Insoluble fraction.

**13,650 ± 120**
*Est* $\delta^{13}C = -25‰$

**USGS-247B.**

NaOH soluble fraction of above.

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