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LA JOLLA NATURAL RADIOCARBON MEASUREMENTS VIII

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INTRODUCTION

The following date list covers certain samples dated by this laboratory from Nov 1975 through December 1977. All archaeological, all geological, and some of the geochemical samples measured during that period are included here. Measurements of tree-ring samples analyzed through Sept 1977 have been published previously (Suess, 1978); later measurements of wood samples will be included in the next list. Data and interpretation of ^{14}C in the $CaCO_3$ of annual coral growth have been published (Druffel & Linick, 1978) with further coral data to be published in the future.

The methods of sample preparation have remained the same as published by Linick (1977). All results are based on 95% of NBS oxalic acid activity normalized to a $\delta^{13}C$ of $-19‰$ (PDB). $\delta^{13}C$ was measured mass-spectrometrically for all samples. All radiocarbon results presented here, including those for marine shells, carbonate sediments, and seawater dissolved inorganic carbonate, were normalized to a $\delta^{13}C$ of $-25‰$ (PDB). In addition to the 5 detectors described by Linick (1977), 2 others were used for some of the measurements: a 2.4L counter with quartz body and iron cylinder inside and a 2.8L counter with quartz body and cylindrical aluminum-coated Mylar foil inside; both utilize separate anti-coincidence guard rings. Ages listed here are conventional radiocarbon ages calculated based on the 5568-year Libby ^{14}C half-life; uncertainties given are one standard deviation errors (1σ) based only on counting statistics. For ages <7000 years BP of terrestrial plant or animal material, dates corresponding to the probable time of origin are given; these dates, based on the La Jolla calibration table (Suess, 1979), are presented as possible centuries of growth with the most probable centuries italicized. These will appear in the description of the sample. Ages for shells, carbonate sediments, and land $CaCO_3$ deposits must be considered to be "apparent ages" only. Shells and carbonate deposited in sediments formed originally from inorganic carbon dissolved in seawater, which displays a lower Δ than the CO_2 of contemporaneous plant material (after $\delta^{13}C$ correction). This effect causes apparent ages of shells formed in near surface ocean water to be 200 to 700 years greater than true ages; on the Southern California coast, this effect averages 300 to 500 years. Shells buried as part of archaeological sites may become contaminated *in situ* by exchange with carbonate dissolved in ground water.

This date list is divided into 3 categories of samples: (1) material from archaeological sites in North America, Central America, South America, and Europe; (2) material, in particular, deep sea and lake sediments, used for dating geological processes, and (3) geochemical samples, in particular, marine organisms and ocean carbonate.

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I. ARCHAEOLOGIC SAMPLES

A. North, Central, and South America

LJ-3749. Camus, Washington **1970 ± 60**

Charcoal from Washington State archaeol site 45CL48, Lady I., Camus, Washington (45.7° N, 122.4° W); NW 1/4 of Unit S6E1, 30 to 40cm depth in uppermost portion of midden. From *in situ* structural post, indicating burned structure built near termination of aboriginal (Chinookian) use of this site of lower Columbia R. Coll July 1976 and subm by J A Woodward, Mt Hood Comm Coll, Gresham, Oregon. Other samples dated from this site are stratigraphically lower: 2370 ± 60, 2320 ± 50, and 2420 ± 50 (LJ-3296, -3395, and -3398; R, 1977, v 19, p 34). LJ calibration: *1st* AD, *1st* BC, 2nd BC.

LJ-3449. Laguna Beach, No. 1 **810 ± 50**

Shells (*Chione*) from site Ora-370, in rock shelter in Sycamore Hills area of Laguna Beach, Orange Co, California (33° 33′ N, 117° 46′ W). Gabrielino Indian site. Coll by B C Morris-Smith; subm by J L Bada and P M Masters, Scripps Inst Oceanog, La Jolla, California. Assoc of human bone, used for amino acid racemization analyses, and shell, used for ^{14}C analysis, at site.

LJ-3515. Laguna Beach, No. 2 **1310 ± 40**

Shells (*Chione*) from same site as LJ-3449. Coll by B C Morris-Smith; subm by J L Bada and P M Masters.

LJ-3483. Irvine, California **2240 ± 60**

Shells from site Ora-575, S of McArthur Blvd, Irvine, Orange Co, California (33° 38′ 50″ N, 117° 52′ W). Unit 3, Level VI, 50 to 60cm subsurface. Shells were cemented into sandy clay matrix. Coll Aug 1975 and subm by R L Kaldenberg, Regional Environmental Consultants, 1094 Cudahy Place, Suite 204, San Diego, California. Should reflect Milling Stone horizon.

LJ-3573. Juanita Terrace **3580 ± 60**

Shells (*Chione*) from site SDM-W-208(7), Juanita Terrace, S of Rancho Bernardo, San Diego Co, California (33° 30′ N, 117° 03′ W). From surface. Coll Dec 1975 and subm by R L Kaldenberg. *Comment* (RLK): very important site with Pauma Complex components, although

pottery occurs on surface. Date was expected to be post-AD 1000, but due to artifact assemblage, any date after 4000 BP was possible.

La Costa series

Samples from 4 archaeol sites near La Costa, coastal San Diego Co. California.

LJ-3484. La Costa, SDM-W-106 5240 ± 50

Shells from site SDM-W-106, La Costa Green Valley Knolls, California (33° 05′ N, 117° 16′ W). Unit B10-20, Level IX, 80 to 90cm subsurface. From very thick lens of shells mixed with broken artifacts; soil was very compacted sandy clay. Coll Nov 1975 and subm by R L Kaldenberg. Dates La Jolla Complex.

LJ-3485. La Costa, SDM-W-106 3580 ± 60

Shells from same site as LJ-3484. Level III, 30 to 40cm subsurface. Surface of shells was very chalky. Coll Nov 1975 and subm by R L Kaldenberg. *Comment* (RLK): site may have been disrupted by disc-harrowing; location was one used to prepare cereal grains. This site reflects a superposition of late prehistoric materials upon an early milling Archaic deposit.

LJ-3820. La Costa North, SDM-W-149 1440 ± 50

Shells from site SDM-W-149, just N of private rd off El Camino Real (33° 06′ 40″ N, 117° 15′ 40″ W). Unit E100/N100, 20cm depth. Coll Aug 1976 and subm by C S Bull and M J Hatley, Regional Environmental Consultants, 1094 Cudahy Place, Suite 204, San Diego, California). Site SDM-W-149 had 3 distinct components: upper midden deposit of ca 60cm, shell lens component from 100 to 160cm, and component below 190cm. Sample was from ceramic-bearing component which was extensively disturbed by both rodents and agriculture.

LJ-3821. La Costa North, SDM-W-149 1470 ± 60

Shells from same site as LJ-3820. Unit E042/N118, from shell lens at ca 110cm depth. Coll Apr 1976 and subm by C S Bull and M J Hatley.

LJ-3822. La Costa North, SDM-W-149 1590 ± 60

Shells from same site as LJ-3820. Unit E040/N118, from cultural level at 190cm. Coll and subm by C S Bull and M J Hatley.

LJ-3823. La Costa North, SDM-W-973 3650 ± 60

Shells from site SDM-W-973 (33° 06′ 31″ N, 117° 15′ 27″ W). Unit E010/N010, 60cm subsurface. Coll Aug 1976 and subm by C S Bull and M J Hatley. This sample is from small, highly disturbed site. Site forms prominence relative to surrounding topography.

LJ-3824. La Costa North, SDM-W-977 2650 ± 60

Shell from site SDM-W-977 (33° 06′ 28″ N, 117° 15′ 26″ W). Unit W004/N000, 30cm depth. Coll Aug 1976 and subm by C S Bull and M J

Hatley. As with other La Costa North sites, this site contained aboriginal ceramics throughout its extent, but it was highly disturbed.

LJ-3844. La Costa North, SDM-W-977 1110 ± 50

Charcoal from same site as LJ-3824. Unit E078/N018, 20cm depth. Coll Aug 1976 and subm by C S Bull and M J Hatley. LJ calibration: *9th*, 8th AD.

LJ-3845. La Costa North, SDM-W-149 1210 ± 50

Charcoal from same site as LJ-3820. Unit E042/N118, 110cm depth, in shell lens. Coll Aug 1976 and subm by C S Bull and M J Hatley. This sample was coll at same location and depth as shell sample LJ-3821. LJ calibration: 9th *8th*, 7th AD.

Encinitas Creek series

Shell samples from 5 archaeol sites in Encinitas Creek area, coastal San Diego Co, California. Coll and subm by C S Bull.

LJ-3688. Encinitas Creek, SDM-W-948 7780 ± 80

Shell fragments (*Chione, Pecten*) from site SDM-W-948 (Cal:A:16:7) on knoll overlooking unnamed creek to N, to immediate E of Encinitas Ranch House (33° 04′ 36″ N, 117° 13′ 54″ W). Area has been farmed extensively. Shell was coll from subsurface, but soil had been turned. Coll Feb 1976.

LJ-3689. Encinitas Creek, SDM-W-940 1480 ± 50

Shells from site SDM-W-940, at head of unnamed creek N of Encinitas Creek, ca 880m NE of intersection of Rancho Santa Fe Rd and Olivenhain Rd (33° 04′ 42″ N, 117° 13′ 33″ W). All shell was coll from general surface of site, near several large oak trees. Site had very small amounts of surface shell, and postholing indicated little or no subsurface shell. Coll Mar 1976.

LJ-3717. Encinitas Creek, SDM-W-179 7130 ± 90

Shells (*Chione, Pecten*) from site SDM-W-179, from knoll overlooking junction of Encinitas Creek and unnamed tributary (33° 03′ 23.9″ N, 117° 14′ 45.7″ W). Unit E55/N60, 20 to 30cm subsurface. Area from which sample was obtained has been subject to plowing, although it is unlikely that plows disturbed this level. Entire area is now covered with intrusive plant life, primarily mustard (*Brassica* sp). Coll May 1976.

LJ-3718. Encinitas Creek, SDM-W-179 7380 ± 90

Shells (*Chione, Pecten*) from same site and unit as LJ-3717, 40 to 50cm subsurface. Area from which sample was taken has been subject to agricultural disturbance, but not down to sample level. Coll May 1976.

LJ-3719. Encinitas Creek, SDM-W-951 6760 ± 80

Shells (*Chione, Aequipecten*) from site SDM-W-951, on hill overlooking Encinitas Ranch House (adobe ruins), to S of Rancho Santa Fe Rd,

E of Olivenhain Rd, alt 85m (33° 04′ 26″ N, 117° 13′ 54″ W). Area has been under cultivation, dry land farming. It is possible, but not probable, that sample came from agriculturally-impacted strata. Coll June 1976.

LJ-3720. Encinitas Creek, SDM-W-942 4910 ± 80

Shells (*Chione*) from site SDM-W-942, S of Rancho Santa Fe Rd, E of Olivenhain Rd, on SW-trending slope (33° 04′ 42″ N, 117° 13′ 54″ W). Coll June 1976.

LJ-4075. Sweetwater Marsh 7300 ± 80

Shells (*Chione*) from site SDM-W-1323, in berme along graded dirt rd, S of Sweetwater Marsh, W of Vener Pond, San Diego Co, California (32° 38′ 29.58″ N, 117° 06′ 41.16″ W). Alt ca 3.7m, 30 to 40cm subsurface. Site has been greatly disturbed and is currently a tomato farm. Coll and subm by C S Bull.

San Clemente Island series

The following 5 samples were coll and subm by L M Axford and L D Lindmark, Mesa Coll, 7250 Mesa Coll Dr, San Diego, California. They were measured to date human habitation of San Clemente I., Southern California coastal island. Several more samples from San Clemente I. have been measured in 1978, and ages for them will appear in a future date list.

LJ-3959. SCLI/RC-1(A), shell 2000 ± 50

Fragments of abalone and marine snail shells from Site SCLI-63 (33° 00′ 10.79″ N, 118° 34′ 57.19″ W). From side of midden site at NW portion of W Dune area; fire lens was partially exposed and was 78cm from surface. Coll Mar 1977.

LJ-3962. SCLI/RC-1(A), charcoal 1630 ± 240

Wood charcoal from same provenience as LJ-3959. Very small amount of charcoal was present. Difference between shell and charcoal ages from this site is within expected range and is due to marine effect upon shell radiocarbon. LJ calibration: 6th, 5th, *4th, 3rd,* 2nd, 1st AD.

LJ-3960. SCLI/RC-2 960 ± 30

Black abalone and marine snail shells from Site SCLI-117 (32° 58′ 29.11″ N, 118° 34′ 00.84″ W). Coll from wall of ravine at depth of 2.6m; wall had been exposed by water erosion. Coll Mar 1977.

LJ-3961. SCLI/RC-3 8000 ± 80

Abalone and mussel shell fragments from Site SCLI-539 (32° 55′ 07.08″ N, 118° 32′ 38.54″ W). Removed from hole 0.9m deep on NE side of Eel Point Dune site. Coll Mar 1977.

LJ-4074. SCLI/RC-4 2190 ± 70

Abalone and tegula shells (32° 52′ 53.68″ N, 118° 30′ 32.57″ W) taken from side wall of ravine by scraping back into wall at least 15cm to expose sample at 27cm depth; from partially destroyed site. Coll May 1977.

LJ-3995. SCLI/RC-5 **2360 ± 70**

Abalone, owl limpet, and tegula shells (32° 53′ 03.68″ N, 118° 30′ 44.39″ W) at depth 43cm, in E wall of ravine, uncovered after scraping away ca 20cm of soil; from partially destroyed site. Coll May 1977.

Roaring Brook series

Samples from Roaring Brook site, San Diego Mus of Man site W-20, on N side of Carmel Valley Rd, W side of Interstate-5, Del Mar, California (32° 56′ N, 117° 14′ 30″ W). Excavated 1968 by E L Davis and P H Ezell; subm by J L Bada and P M Masters. Indian cultures represented at site: Diegueño, La Jollan, and Paleo-Indian.

LJ-3848. Roaring Brook site **5070 ± 70**

Shells from Pit B, Burial 1, lowest (burial) level.

LJ-3849. Roaring Brook site **4960 ± 90**

Shells from Sta A, Burial 1, assoc hearth.

LJ-3850. Roaring Brook site **4460 ± 80**

Charcoal from 10cm above burial level. Coll Oct 1968. LJ calibration: 32nd, 33rd, *34th* BC.

Del Mar series

Shells (*Chione*) from Paleo-Indian site, San Diego Mus of Man site W-34, on NW point of San Dieguito R inlet, Del Mar, San Diego Co, California (32.9° N, 117.3° W). Site at which "Del Mar Man" skull was excavated in 1929, dated by J L Bada by amino acid racemization method at 48,000 yr (Bada *et al*, 1974). Continuation of series from R, 1977, v 19, p 32-33. Upper midden excavated by R Tyson, lower midden by P M Masters. Samples subm by J L Bada and P M Masters.

LJ-3507. Del Mar **7390 ± 140**

Shells from 100 to 110cm depth in upper midden.

LJ-3575. Del Mar **5460 ± 100**

Shells from 60 to 70cm depth in midden. Sample was obtained from outer layers of shells, *ie*, that 1st reacted away by hydrochloric acid.

LJ-3576. Del Mar **5660 ± 100**

Same shells as LJ-3575. Inner layers of shells.

Scripps Cliff series

Samples coll Oct 1975 from freshly exposed sea cliff face ca 60 to 80cm N of pier at Scripps Inst Oceanog, La Jolla, California (32° 52′ N, 117° 15′ W). Coll and subm by J L Bada and P M Masters. Information presented here is from Masters and Bada (1979). Sea cliff collapse exposed several fossil bones, including nearly complete leg bone and scapula of horse (*Equus occidentalis*), which became extinct in S California near end of Pleistocene. An amino acid racemization age of ca 50,000 yr was ob-

tained by submitters for horse skeleton. Above and below horse bones on cliff face were small flakes of charcoal, perhaps from natural brush fire rather than human campfire. Sufficient charcoal for ^{14}C dating (results below) was obtained from 2 levels, one ca 30 to 40cm directly below bones, the other ca 3m above and ca 10m S of horse bones. Cliff is composed of Pleistocene alluvial and colluvial sediments overlying Ardath Shale and Scripps Formation, which are Eocene in age. At contact between Pleistocene sediments and Eocene conglomerate is a raised marine fossiliferous deposit giving amino acid racemization age of ca 120,000 yr (P E Hare, P Karrow, & J L Bada, unpub), max age for horse skeleton.

LJ-3469. Scripps Cliff, No. 1 **40,000 ± 4,000**

Charcoal flakes in large quantity of soil.

LJ-3470. Scripps Cliff, No. 3 **36,800 ± 2,000**

Charcoal flakes in large quantity of soil.

LJ-3530. Scripps Cliff **38,000 ± 3,000**

Charcoal from site W-151, Unit 16S/4W, 0 to 10cm depth; SE, NE, and W sectors.

General Comment: because charcoal samples were mixed with much soil, which could contain traces of more modern carbon, it is probably reasonable to assign each an age of >35,000 yr rather than finite age with an uncertainty. Previously found ages for charcoal from Scripps Cliff for horizons stratigraphically above and below horse skeleton are, respectively, 21,500 ± 700 (W-142; Rubin & Suess, 1955) and >34,000 (LJ-217; Hubbs *et al*, 1962).

LJ-3508. Mission Bay No. 1 **5430 ± 130**

Shells from Mission Bay, San Diego, California (ca 32° 47′ N, 117° 13′ W). Subm by J L Bada and P M Masters for use in amino acid racemization kinetics study.

LJ-3509. Mission Bay No. 2 **4030 ± 90**

Shells from same location as LJ-3508. Subm by J L Bada and P M Masters for use in amino acid racemization kinetics study.

Sweetwater River Valley series

The following 4 shell samples are from Sweetwater River Valley, San Diego Co, California (32° 39′ N, 117° 05′ W); T-17S, R-2W, National City Quad (USGS 7.5). Coll Aug 1975 and subm by L Leach, Anthropol Dept, San Diego State Univ, San Diego, California). Submitter hoped to date levels which represent max occupation within site.

LJ-3407. Sweetwater River Valley, No. 1 **1430 ± 50**

Shells from Site Cal-E:5:15, Highland Ave near 30th St, S62-E46, 50 to 60cm depth.

LJ-3408. Sweetwater River Valley, No. 2 **1410 ± 50**

Shells from Site Cal-E:5:15, Highland Ave near 30th St, S40-E40, 50 to 60cm depth.

LJ-3409. Sweetwater River Valley, No. 3 **1630 ± 60**

Shells from Site Cal-E:5:17, Edgemere Ave near 30th St, N22-W04, 60 to 70cm depth.

LJ-3410. Sweetwater River Valley, No. 4 **1650 ± 60**

Shells from Site Cal-E:5:17, Edgemere Ave near 30th St, N32-W20, 60 to 70cm depth.

Border Field series

The following shell samples (*Chione undatella* and *Chione californiensis*) from 2 adjacent shell midden sites of Encinitas (La Jollan) Tradition from California-Mexico border area. Subm by J C Bingham, State of California, Dept Parks & Recreation, Sacramento. Dates were intended to clarify occupational sequence of the 2 sites involved and to indicate nature of and extent to which previous disturbance altered original deposit. Dates are important to understanding cultural sequences in coastal San Diego Co and Southern California in general. None of many sites peripheral to Tijuana R estuary and floodplain has been dated or adequately reported yet. Both shellfish exploitation patterns and pollen are being studied from these sites as well.

LJ-3618. CDPR No. 51 **4340 ± 50**

Shells from Site CA-SDi-4281 (32° 32′ 10″ N, 117° 07′ 00″ W), terrace-top site adjacent to Site CA-SDi-222, below. Marine terrace at alt ca 15m, just N of US-Mexico border. From Unit A, 100 to 110cm depth. Site was in pristine condition and exhibited midden deposit over 1m thick. Coll Feb 1976 by L Lewis.

LJ-3619. CDPR No. 52 **3850 ± 60**

Shells from same site as LJ-3618. Unit A, 10 to 20cm depth. Coll Jan 1976 by L Findley.

LJ-3621. CDPR No. 53 **7260 ± 80**

Shells from Monument Mesa, Site CA-SDi-222 (32° 32′ 06″ N, 117° 07′ 13″ W). Marine terrace at alt ca 15m, just N of US-Mexico border. From Unit 10, 30 to 40cm depth. Coll 1976 by L Lewis. Shells from this site were highly fragmented, apparently due, at least in part, to previous disturbance by World War II naval installation on site. Site was to be destroyed through upgrading of existing State Park facilities. *Comment* (JCB): date correlates closely with earliest radiocarbon dates for La Jollan culture in San Diego Co. Site appears to be basically Encinitas midden with earlier San Dieguito component. Relationship, temporal and spatial, between these cultural traditions on mesa was not readily apparent stratigraphically.

LJ-3622. CDPR No. 54 **6540 ± 70**

Shells from same site as LJ-3621. From Trench 2, 20 to 30cm depth. Coll Feb 1976 by S Younts.

LJ-3624. CDPR No. 55 **3640 ± 60**

Shells from same site as LJ-3621. From Trench 2, 0 to 10cm depth. Coll Jan 1976 by D Foster. *Comment* (JCB): date, from uppermost level of midden, supports accepted date for termination of La Jollan cultural epoch in coastal San Diego Co.

General Comment (JCB): dates indicate that these middens were formed during La Jollan cultural horizon of coastal Southern California. These apparent ages imply that site CA-SDi-222 was occupied throughout duration of this horizon. Dates also prove that this deposit was, in fact, stratigraphically intact.

Kumeyaay Indian series

Samples from San Diego State Univ Site No. F:5:1, San Diego Co, California (ca 32° N, 117° W). Coll May 1975 and subm by C A McGowan, Southwestern Coll, 900 Otay Lakes Rd, Chula Vista, California. Intended to date prehistoric Kumeyaay Indian site.

LJ-3456. Kumeyaay site, No. 1 **340 ± 60**

Charcoal.

LJ-3603. Kumeyaay site, No. 2 **750 ± 50**

Shells. *Comment*: difference between shell and charcoal ages is within expected range for marine effect upon shell radiocarbon.

LJ-3800. Kumeyaay site, No. 3 **320 ± 50**

Charcoal.

LJ-3993. Kumeyaay site, No. 4 **8040 ± 110**

Calcium carbonate deposits from soil, from above San Dieguito level of extinct stream bed. Significance of apparent age is uncertain.

Central American series

The following samples from 2 Central American sites were coll May 1975 and subm by E A Graham, Newnham Coll, Univ Cambridge, United Kingdom). They were intended to date spread of Mayan settlement.

LJ-3677. Maintzunan, 3B F.1(2) **Modern**

Charcoal from Maintzunan (Site 3—Operation B), Belize (16° 56′ 01″ N, 88° 23′ 10″ W). Maintzunan is previously unknown area of Mayan settlement spread in river valley which now appears to have been extensively settled in pre-Columbian times. This sample was thought to be from latest occupation of site. Site was believed to have been abandoned ca AD 900; thus, this sample was probably intrusive.

LJ-3678. Maintzunan, 3B(4) 1250 ± 50

Charcoal from Maintzunan, from major destruction level, from burning of wooden superstructures. LJ calibration: 8th, *7th,* AD.

LJ-3679. Maintzunan, 3B(5) 1230 ± 40

Charcoal from Maintzunan, from major destruction level, equivalent in time to sample 3B(4) (LJ-3678). LJ calibration: *8th, 7th,* AD.

LJ-3680. Maintzunan, 3B(11) 1260 ± 50

Charcoal from Maintzunan, from lower destruction level. LJ calibration: 8th, *7th,* AD. *Comment*: charcoal sample from earliest construction level was too small to be dated. Submitter's estimate of 1st settlement of site is ca AD 500.

LJ-3681. Kakalche, 4E(4) 1750 ± 60

Charcoal from Kakalche (Site 4—Operation E), Belize. From shell midden of coastal trading sta. Assoc pottery from this site indicates earlier date than Maintzunan site. Submitter estimated Kakalche date between AD 250 and AD 600. LJ calibration: *3rd, 2nd, 1st* AD.

LJ-4198. Corowa, Peru 2730 ± 80

Cotton textile from Corowa, Peru (10° 20′ S, 75° 14′ W). Coll July 1976 and subm by T J Chow, Scripps Inst Oceanog, La Jolla, California. Expected to date Chavin culture, Phase D, ca 800 to 500 BC. LJ calibration: 9th, *10th,* 11th BC.

Copperman series

The following set of samples dates materials related to Chilean miner who was killed by collapse of a mine shaft in the Atacama Desert of Chile. Body and assoc clothing and tools were found in 1899 in collapsed pre-Spanish atacamite (copper ore) mine shaft at Chuquicamata, Chile (22° 20′ S, 68° 53′ 20″ W). Site is in total desert, 20km from any water supply. Subm by J B Bird, Am Mus Nat Hist, New York.

LJ-3947. Copperman, human tissue 1400 ± 40

Human tissue from upper sec of right thigh. Inside skin was sticky, brown material and, inside this, was tough, fibrous muscle tissue or sinew. LJ calibration: *6th,* 5th AD.

LJ-3948. Copperman, loin cloth 1650 ± 130

Frayed llama (?) wool yarns from ragged loin cloth worn by miner. Loin cloth was smeared with sticky material from body. Sample was pre-treated with acetone, then hydrochloric acid. LJ calibration: 5th, *4th, 3rd,* 2nd, 1st AD.

LJ-3949. Copperman, loin cloth 1350 ± 80

Same loin cloth as LJ-3948. This sample of it was pre-treated only with hydrochloric acid, thus, included some of material from miner's body. LJ calibration: 7th, *6th,* 5th AD.

LJ-3950. Copperman, axe-handle **840 ± 150**

Wood shaved from handle of hammer used in mining operation. Handle is sec of sapling, tapering from 25 to 18mm cross-sec, bent U-shaped over stone hammer head. To be bent in this form, wood must have been green and fresh at time hammer was made. Variety of wood had not been identified, but must have come from along Rio Loa. It is not clear why this sample was significantly younger than the others. LJ calibration: 13th, *12th, 11th,* 10th AD. *Comment* (JBB): ages place mining operation within Andean Middle Horizon period, a time of strong, centralized organization and controls. Copper and bronze were then being used for tools, weapons, ornaments, and cast-in-place tie bolts in the masonry of ceremonial structures at Tiahuanaco, a center within whose sphere of influence Chiquicamata was located.

B. Europe

Baile Herculane series

The following charcoal samples were coll at Baile Herculane site, Pestera (cave) Hotilor, Romania-Transylvania (24° N, 44° E). Coll by Petre Roman, Inst Archaeol, Bucharest, Romania; subm by Marija Gimbutas, Inst Archaeol, Univ California, Los Angeles.

LJ-3531. Baile Herculane, No. 3 **7320 ± 120**

Charcoal from Unit D-6/Level b. Coll 1965. Dates Eneolithic I culture. LJ calibration: Early to mid 7th millennium BC.

LJ-3532. Baile Herculane, Nos. 4 and 5 **6660 ± 60**

Charcoal from Unit D-5/Level c_1 and Unit D-3/Level c. Coll 1965 and 1966. Dates Eneolithic II culture. LJ calibration: Mid to late 6th millennium BC.

LJ-3533. Baile Herculane, Nos. 6 and 7 **4460 ± 80**

Charcoal from Unit D- /Level 8, Unit D-2a/Level f, Unit D-6/Level f_2, and Unit D-3/Level f. Coll 1967. Dates Cotofeni II and IIb cultures. LJ calibration: 32nd, 33rd, *34th* BC.

LJ-3534. Baile Herculane, No. 10 **4360 ± 100**

Charcoal from Units D-1 and D-2/g-j/Level 6. Coll 1967. Dates Cotofeni IIIc culture. LJ calibration: 30th, *31st, 32nd, 33rd,* 34th BC.

LJ-3535. Baile Herculane, No. 11 **4350 ± 60**

Charcoal from Unit D-2/Level 5 and Unit h-j/Level 5. Coll 1967. Dates Cotofeni IIIc and III cultures. LJ calibration: 30th, *31st, 32nd, 33rd* BC.

LJ-3536. Baile Herculane, No. 8 **4300 ± 60**

Charcoal from Unit D-1j/Levels 7 and 8 and Unit D-1-2/g/Level 7. Coll 1967. Dates Cotofeni IIIb culture. LJ calibration: *30th, 31st,* 32nd, 33rd BC.

Ostrovul Corbului series

Charcoal samples from Ostrovul Corbului, island site, Mehedinti Co, S Romania (24° N, 44° E). Coll 1975 by Petre Roman; subm by Marija Gimbutas. Samples date Cotofeni culture with Kostolac (Baden) and Vučedol elements. Expected by submitter to date from ca 3000 to 2500 BC.

LJ-3797. Ostrovul Corbului, No. 1 **4520 ± 60**

Charcoal from Habitation Site 1, SXIIa, 10c.1. LJ calibration: *34th*, 35th BC.

LJ-3798. Ostrovul Corbului, No. 2 **4360 ± 50**

Charcoal from Habitation Site 1, SId, 10c.1. LJ calibration: 30th, *31st, 32nd, 33rd* BC.

LJ-3799. Ostrovul Corbului, No. 3 **4360 ± 60**

Charcoal from Pit 12, SI-Ib, gr 12. LJ calibration: 30th, *31st, 32nd, 33rd* BC.

Vesztö Magor series

Charcoal samples from Vesztö Magor, Bekes Co, SE Hungary (22° N, 46° E). Vesztö Magor is Teu site containing Szakalhat group of Linear Pottery culture (Neolithic), Tisza culture (Chalcolithic), followed by BA layers. Coll by K Hegedüs (Koszta Jozsef Mus Szentes); subm by Marija Gimbutas. Both samples date BA layers.

LJ-3804. Vesztö Magor/Surface IV **3520 ±60**

Charcoal. LJ calibration: 18th, 19th, *20th*, 21st BC.

LJ-3805. Vesztö Magor/G **3450 ± 80**

Charcoal. LJ calibration: 17th, *18th, 19th, 20th*, 21st BC.

LJ-3604. Vouliagméni, Greece **3740 ± 40**

Charcoal from S shore of Lake Vouliagméni, Perakhóra, central Greece (38° 02′ N, 22° 53′ E). Trench AI, Level 5E. Coll Aug 1972 and subm by J M Fossey, Dept Classics, McGill Univ, Montreal, Canada. Should give date of destruction of final phase of Early Bronze II culture. Duplicate sample was dated by Dicar Corp at 3900 ± 65 BP (DIC-448, J M Fossey, pers commun). LJ calibration: 22nd, *23rd, 24th*, 25th BC.

II. GEOLOGIC SAMPLES

A. Marine

Ontong Java Plateau series

The following sediment samples from under W equatorial Pacific Ocean were subm by W H Berger, Scripps Inst Oceanog, La Jolla, California, to estimate sedimentation rates. These samples from top and flanks of Ontong Java Plateau, N of Soloman Is. and ENE of New Guinea were coll as box cores in April 1975, during Leg 9 of Eurydice Expedition of Scripps Inst Oceanog. Coring device obtained samples 50cm sq and 30 to 45cm deep. Cores were sub-sampled and analyzed for several physical

properties, weight percent $CaCO_3$, and preservation and sedimentation rates (Johnson *et al*, 1977). Data are presented in Table 1. Last 2 entries in table were actually measured in 1978, after end of 1977 cut-off point for other measurements included in this paper; they were included here so that table would be complete.

TABLE 1

LJ no.	Core no.	Lat	Long	Water depth (m)	Level (cm)	Age
-3879	120BX-2	0° 01'S	158° 43' E	2247	1 to 5	3940 ± 100
-3880	"	"	"	"	11 to 13	5290 ± 90
-3881	"	"	"	"	35 to 37	16,030 ± 290
-3885	123BX-1	0° 01' S	160° 25' E	2946	1 to 5	3390 ± 80
-3886	"	"	"	"	11 to 13	5620 ± 90
-3887	"	"	"	"	35 to 37	14,650 ± 110
-3918	125BX-2	0° 00'	161° 00' E	3368	1 to 5	3420 ± 80
-3919	"	"	"	"	11 to 13	5620 ± 120
-3920	"	"	"	"	33 to 35	14,550 ± 140
-3963	129BX-2	0° 00'	161° 59' E	4169	1 to 5	5060 ± 80
-3964	131BX-1	0° 01' S	162° 43' E	4441	1 to 5	6290 ± 90
-3965	"	"	"	"	11 to 13	11,240 ± 220
-3966	"	"	"	"	18 to 20	15,990 ± 230
-4013	135BX-1	0° 52' N	161° 00' E	3509	1 to 5	4570 ± 80
-4014	"	"	"	"	11 to 13	6790 ± 110
-4015	"	"	"	"	31 to 33	22,300 ± 500
-4070	139BX-1	1° 22' N	162° 24' E	4118	1 to 5	5590 ± 130
-4071	"	"	"	"	11 to 13	11,110 ± 180
-4072	"	"	"	"	19 to 21	19,800 ± 400
-4073	141BX-1	2° 22' N	163° 41' E	4325	1 to 5	7510 ± 100

LJ-4054. Indopac sediment, 19 to 21cm >22,000

Organic fraction of deep sea sediment coll June 1977 on Indopac-15 Expedition of Scripps Inst Oceanog, Box Core 2/Sample B (28° 34.4' N, 155° 30.3' W), 19 to 21cm depth in core. Subm by P M Williams, Scripps Inst Oceanog, La Jolla, Calif.

LJ-4055. Indopac sediment, 5 to 7cm 16,000 ± 900

Organic fraction of same deep sea sediment core as LJ-4054, 5 to 7cm depth in core. Subm by P M Williams.

LJ-3557. Lake Ontario, carbonate 23,500 ± 1000

Carbonate fraction of sediment from piston core 70-0-37/E30 from Lake Ontario (43' 30.4' N, 76° 54.3' W), 1450 to 1460cm depth in core, water depth 224m, total core length 17m. Coll 1970 by C F M Lewis, Canadian Dept Energy, Mines & Resources, Burlington, Ontario; subm by R A Schroeder, US Geol Survey, Albany, New York. Continuation of series from R, 1977, v 19, p 41-42.

LJ-3559. Lake Ontario, organic 16,400 ± 500

Organic fraction of same sample of sediment as LJ-3557.

B. Terrestrial

LJ-3927. Santa Rosa, California >39,000

Charcoal from along active trace of Healdsburg-Rodgers Creek Fault in N central California, from N end parking lot of Santa Rosa Commu-

nity Hospital (38° 28′ 13″ N, 122° 42′ 23″ W). Coll Feb 1977 and subm by Naohiko Noguchi, Cooper, Clark Assocs, Novato, California. Date was expected to indicate possible greatest age of last movement along fault.

III. GEOCHEMICAL SAMPLES

A. Marine Organisms

All marine organism samples listed below were subm by P M Williams, Scripps Inst Oceanog, La Jolla, California. Measurements were made to study degree of incorporation of bomb-produced radiocarbon in marine food chain (Williams & Linick, 1975). Δ values are age-corrected from year of colln to 1950. Marine organisms were coll either by opening-closing "Bongo" net or modified mid-water trawl (OCN), or by Isaacs-Kidd mid-water trawl (MWT). OCN's and MWT's with 1 depth given obtained fish only at that depth. OCN's with depth ranges of zero to some depth in meters went down to max colln depth closed, "fished" for 4 to 6 hrs at that depth, and then were hoisted to surface with net open. MWT's with depth ranges of zero to some depth in meters went down to max colln depth with net open, "fished" for 4 to 6 hr at that depth, and then were hoisted to surface with net open. Thus, in cases (both OCN and MWT) where depth range of zero to max depth is given, it is possible that fish from depths between surface and max depth were obtained. Samples were preserved by freezing and were dried to constant weight at 80°C prior to combustion in this lab.

Cato-I series

Following marine organism samples were coll in central N Pacific gyre during Cato-I Expedition of Scripps Inst Oceanog.

LJ-3746. PW-7 $\Delta = +133 \pm 14‰$
$\delta^{13}C = -20.6‰$

4 decapods, consisting of 1 large *Acanthaphyra* sp, 1 *Systellaspis* sp, 1 *Pasiplea* sp, and 1 small Euphausid; 2.5g total dry weight. Coll June 1972 at Cato-1/Sta A2 (31° 00.1′ N, 155° 23.0′ W). Depth 0 to 700m (OCN).

LJ-3747. PW-8 $\Delta = +161 \pm 8‰$
$\delta^{13}C = -21.1‰$

1 fish (*Lampadena* sp), 2.4g dry weight. Coll July 1972 at Cato-1/Sta A2 (31° 00.1′ N, 155° 23.0′ W). Depth 0 to 700m (OCN).

LJ-3748. PW-9 $\Delta = +177 \pm 11‰$
$\delta^{13}C = -19.8‰$

9 myctophids (all *Lampanyctus* sp), 1.6g total dry weight. Coll June 1972 at Cato-1/Sta A6 (30° 39.1′ N, 155° 23.4′ W). Depth 1350m (MWT).

LJ-3733. South Tow-1 $\Delta = +81 \pm 9‰$
$\delta^{13}C = -19.1‰$

1 snipe eel (*Serrivamer* cf *sector*), 2.2g dry weight. Coll Feb 1973 on South Tow-XIII Expedition of Scripps Inst Oceanog (28° 21′ N, 155° W). Depth 0 to 885m (MWT).

Climax-VII series

Following marine organism samples were coll Sept 1973 on Climax-VII cruise of Scripps Inst Oceanog at sta in central N Pacific gyre (28° N, 155° W).

LJ-3714. Climax-VII-5 $\Delta = +43 \pm 6‰$
$\delta^{13}C = -19.7‰$

1 fish (*Cyclothone pallida*), 5.9g dry weight. Depth 0 to 1100m (MWT).

LJ-3715. Climax-VII-9 $\Delta = +138 \pm 9‰$
$\delta^{13}C = -18.4‰$

1 snipe eel (*Serrivamer* cf *sector*), 2.1g dry weight. Depth 0 to 1700m (MWT).

LJ-3716. Climax-VII-17 $\Delta = +134 \pm 9‰$
$\delta^{13}C = -21.9‰$

1 fish (*Heterophotus ophistoma*), 19.5g dry weight. Depth 0 to 1700m (MWT).

Noname series

Following marine organisms were coll Aug 1975 on Noname-1 Expedition of Scripps Inst Oceanog at sta just W of N Baja California coast (31° 00′ N, 120° 45′ W).

LJ-3605. NN-5 $\Delta = +49 \pm 6‰$
$\delta^{13}C = -22.3‰$

1 mysid (*Caridean* sp), 5.3g dry weight. Depth 1450m (OCN).

LJ-3606. NN-10 $\Delta = +28 \pm 6‰$
$\delta^{13}C = -21.7‰$

1 fish (*Melamphaes* cf *acanthomus*), 7.1g dry weight. Depth 1450m (OCN).

LJ-3607. NN-12 $\Delta = +69 \pm 9‰$
$\delta^{13}C = -21.0‰$

1 mysid (*Gnathophausia* [*zoea*?]), 2.3g dry weight. Depth 1450m (OCN).

LJ-3617. NN-13 $\Delta = +93 \pm 9‰$
$\delta^{13}C = -20.6‰$

1 fish (*Scopelogadus mizolepis bispinosus*), 1.2g dry weight. Depth 1450m (OCN).

LJ-3709. NN-2 $\Delta = +117 \pm 5‰$
$\delta^{13}C = -19.5‰$

1 fish (*Sagamichthys abei*), ca 15cm long; 4.0g dry weight. Depth 0 to 1500m (OCN).

LJ-3710. NN-3 $\Delta = +127 \pm 7‰$
$\delta^{13}C = -23.3‰$

2 specimens of same sp of worm (*Benthalbella dentata*), 4.2g total dry weight. Depth 0 to 1500m (OCN).

LJ-3711. NN-6 $\Delta = +66 \pm 11‰$
$\delta^{13}C = -22.0‰$

1 fish (*Scopeloberyx robustus*), 0.9g dry weight. Depth 1450m (OCN).

LJ-3712. NN-7 $\Delta = -18 \pm 7‰$
$\delta^{13}C = -20.3‰$

1 fish (*Cetostoma regani*), 2.8g dry weight. Depth 1700 to 1800m (OCN).

LJ-3713. NN-14 $\Delta = +153 \pm 6‰$
$\delta^{13}C = -21.6‰$

2 specimens of same sp of decapod (*Gnothophausia ingens*), 14.1g total dry weight. Depth 0 to 1350m (OCN).

LJ-4056. Indopac-15-75 $\Delta = +84 \pm 11‰$
$\delta^{13}C = -20.4‰$

3 specimens of amphipod, 2 red and 1 bleached (*Eurythenes gryllus*), 5.1g total dry weight. Coll June 1977 on Indopac-15 Expedition of Scripps Inst Oceanog in N central Pacific gyre; Sta 753 (28° 30′ N, 155° 30′ W). Caught 50m above sea bottom; bottom depth 5700m. No bait was offered.

LJ-4057. Indopac-15-76 $\Delta = +37 \pm 10‰$
$\delta^{13}C = -18.7‰$

Muscle of "rat-tail" fish (*Coryphaenoides* sp), 4.9g dry weight. Coll June 1977 on Indopac-15 Expedition of Scripps Inst Oceanog in N central Pacific gyre; Sta 710 (28° 30′ N, 155° 30′ W). Caught 800m above sea bottom on gill net; bottom depth 5800m.

B. Seawater and air samples

Antarctic series

Following seawater and air samples were coll Jan 1977 near McMurdo Sound, Antarctica, by R L Michel, Mt Soledad Tritium Lab, Univ California, San Diego, La Jolla, California. For interpretation, see Jackson *et al* (1978) and Michel *et al* (1979).

LJ-3952. PP1 $\Delta = -70 \pm 8‰$
$\delta^{13}C = +0.4‰$

Dissolved inorganic carbon from seawater coll from ice hole made by Australians, ca 0.4km from McMurdo Sound (77° 52′ S, 166° 20′ E), 5m depth.

LJ-3953. PP2 $\Delta = +290 \pm 30‰$
$\delta^{13}C = -11.1‰$

Atmospheric CO_2 sample coll in well-winded area in back of Earth Sci Bldg at McMurdo Sound.

LJ-3955. PP4 $\Delta = -111 \pm 7‰$
$\delta^{13}C = +0.2‰$

Dissolved inorganic carbon from below ice head at Heald I. (78° 13′ S, 163° 54′ E). From 10m down; ice thickness ca 10m.

LJ-3956. PP5 $\Delta = -116 \pm 7‰$
$\delta^{13}C = -0.4‰$

Dissolved inorganic carbon from below ice at Cape Chocolate (77′ 57′ S, 164° 38′ E), 9m depth.

LJ-3957. PP6 $\Delta = -108 \pm 7‰$
$\delta^{13}C = -0.2‰$

Dissolved inorganic carbon from below ice at White I. (78° 01′ S, 167° 21′ E), 3m depth.

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