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LA JOLLA
NATURAL RADIOCARBON MEAUREMENTS V*

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INTRODUCTION

In all measurements reported in La Jolla I through IV and for the first of those herein reported (LJ-994 to LJ-1025 and LJ-GAP-1 to LJ-GAP-15), we followed the procedure designed by Suess (1954) in producing acetylene (C_2H_2) for radiocarbon counting. For the subsequent samples, however, the following reaction for C_2H_2 synthesis was used:

$$C(\text{sample}) \xrightarrow[\text{combustion}]{\text{hydrolysis vs}} CO_2 \xrightarrow[\text{(absorption)}]{\text{Li}} Li_2C_2 \xrightarrow{H_2O} C_2H_2$$

This reaction has been successfully employed by several laboratories, in particular by those that use relatively large amounts of C_2H_2 for synthesizing benzene for scintillation counting. By varying the conditions under which the reactions were carried out we were able to devise a procedure with an overall yield of more than 80%.

We confirmed the observations of Guntz (1896; 1898) that large yields of Li_2C_2 are obtainable if the Li is not heated too much and if the absorption of CO_2 is not too fast. Otherwise, considerable amounts of carbon black are deposited. Barker (1953, p. 631-632), Tamers (1966, p. 54), and Noakes, Kim, and Stipp (1966, p. 73-74) suggested using a large excess of Li to recover some of the lost C, but we found this unnecessary: when the Li is not heated above ca. 550° C and absorption of CO_2 is regulated to reduce rate of heating, a satisfactory yield of C_2H_2 of more than 80% is obtained. By carrying out a number of blank runs with anthracite, the possibility of a noticable tritium content of the lithium used (Hill, 1941, p. 103; Libby, 1946, p. 671-672) was investigated. The low background counts showed that the tritium content was negligible. The magnitude of isotope fractionation was investigated by mass spectrometric determinations of δC^{13} in the laboratory of Prof. Harmon Craig. Four C_2H_2 samples prepared from the same wood (1885 wood of our Oregon fir standard) gave values ranging from −23.79 to −24.50‰ relative to the PDB standard for C^{13}. It therefore appears to be safe to assume that the error through isotope fractionation will in general be much smaller than the statistical counting error of the C^{14} measurement (at least 4‰).

The new Li procedure was thereupon adopted, and followed for all measurements herein reported, beginning with LJ-1348 and LJ-GAP-16.

The series "LJ-GAP-" is devoted to measurements run on a new preparation line, and is so designated to indicate tests run primarily for

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purposes of Geology, Archaeology, and Paleoecology. All GAP samples were counted on the "400-cc La Jolla Counter" (La Jolla III, p. 254), but a considerable number, gas volume permitting, were run also on the "Brussels Counter" (La Jolla II, p. 204), with consistent essential agreement. Background counts were held to ca. 2.0 per min for the 400-cc counter, as compared with ca. 1.0 for the Bern Counter (La Jolla I, p. 197) and ca. 0.6 for the Brussels Counter, which were used on the first line.

Although in general the results of the measurements in the "LJ-GAP" series have been plausible, and in part have been cross-checked against those made on the older line, two gross anomalies have occurred: LJ-GAP-31 measured 2500 ± 200, whereas LJ-1379 gave a plausible estimate of >30,000 yr for same marl deposit of Pleistocene Lake Hubbs; LJ-GAP-70, 4800 ± 500, also impossibly young, was based on shoreline shells of same provenance and almost surely same age as LJ-928, >50,000 yr. Major discrepancy between LJ-GAP dates and those obtained by ionium/thorium method is mentioned under LJ-GAP-73 (in section IIIC). The presumably too young dates may have resulted from incorporation of C^{14} by exchange.

In line with our previous practice, ca. 100 yr are here added to the one-sigma statistical counting errors of less than 100 yr, except for measurements on contemporary organisms. We retain the C^{14} half-life of 5570 yr and 1950 as standard year of reference.

When the amount of C_2H_2 obtained was less than 400-cc at a filling pressure of 1 atm, inactive gas was added to compensate for the deficiency, in percentage that is stated.

In this list we report on 154 radiocarbon measurements, run from December, 1964 to November, 1966.

A total of 270 measurements, not herein included, were run in the research on secular variation in the C^{14} content in the atmosphere, using wood dated dendrochronologically (Suess, 1965; Stuiver and Suess, 1966). Other measurements, also excluded herein, deal with C^{14} in the Pacific Ocean (Bien, Rakestraw, and Suess, 1965, 1966). All other measurement numbers, except for a few runs on standards and a few not yielding a definite measurement, are included in this report.

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The La Jolla Radiocarbon laboratory is directed by Prof. H. E. Suess. Technical assistance in its operation has been furnished by Sally

Jo Anderson, Allan Divis, and Marsha Roch. Electronics have been maintained by Everett R. Hernandez. The senior author's staff has included Laura C. Hubbs, Elizabeth S. Ash, Charmion McMillan, and Betty N. Shor.

Unless otherwise noted all collectors and submitters are associated with Scripps Institution of Oceanography.

I. APPARENT AGE OF CONTEMPORARY ORGANISMS

For measurements in this category we adopt here, as before, the unaugmented counting error.

Contemporary organisms series

LJ-GAP-37. Modern organisms—12 Apparent Age 280 ± 50

Sample of layer of current-oriented organic material (stipes and holdfast fragments of kelp, *Macrocystis?,* and/or skeletons of dead gorgonian corals), from top of box core LJF 41 taken in center of La Jolla Submarine Canyon at depth of 457 m (32° 53.4′ N Lat, 117° 19.2′ W Long). Coll. 1965; subm. by F. P. Shepard, R. F. Dill, and U. von Rad. *Comment:* dated as baseline for dates of vegetational debris in box cores in La Jolla Fan Valley, which derives its material from La Jolla Submarine Canyon (see LJ-GAP-35, 36, 38-41, 53, in section IIIA, this date list; also LJ-607, La Jolla IV, p. 74).

LJ-GAP-42. Modern organisms—13 Apparent Age 990 ± 50

Bathypelagic fishes and crustaceans taken by non-closing midwater trawl at depth of 2900 m at Station 9 of Ursa Major Expedition on R/V Agassiz of Scripps Inst. of Oceanography, in North Pacific Ocean (45° 00′ N Lat, 155° 00′ W Long). Coll. and subm. 1964 by J. A. McGowan. *Comment* (J.A.M.): age of C in bodies of bathypelagic animals is desired as index of rate of input to depths of organic C originating in organisms of euphotic zone. None of species involved has ever been collected shallower than 400 m.

LJ-1352. Modern organisms—14 Apparent Age −300 ± 50

Surfgrass (*Phyllospadix*) coll. dry on February 16, 1966, on beach at La Jolla, California (32° 52.0′ N Lat, 117° 15.2′ W Long). *Comment:* in addition to furthering information on post-bomb radioactivity and on possible fractionating of C isotopes by living organisms, test bears on validity of dating archaeologic sites by use of mats, thatching, etc. made of surfgrass (see Orr, 1956, p. 3, fig. 2). Apparent age of +580 ± 80 yr was obtained on giant kelp (*Macrocystis pyrifera*) coll. near La Jolla in 1957 (LJ-70, La Jolla IV, p. 70). Dead but essentially modern organic material probably consisting largely of *Macrocystis* gives apparent age of 280 ± 50 yr (LJ-GAP-37, above). Analyses: $\delta C^{14} = 92‰$; assuming δC^{13} to be same (−25‰) as for wood since photosynthesis took place, then $\Delta C^{14} = 92‰$.

LJ-GAP-75. Modern organisms—15

Apparent Age −600 ± 100

Shells of California mussel (*Mytilus californianus*) coll. alive intertidally on April 3, 1966, at Casa Beach, La Jolla, California (32° 50′ 45″ N Lat, 117° 16′ 40″ W Long). *Comment:* to compare with apparent age of shells of same species taken earlier (LJ-86, +720 ± 90, coll. at La Jolla in 1953; LJ-97, +300 ± 40, coll. at La Jolla in 1959; LJ-894 and 896, respectively +186 ± 20 and +240 ± 20, coll. at Punta Banda, Baja California, in 1959; all reported in La Jolla IV, p. 70). Berger, Taylor, and Libby (1966, p. 864) referred to these and other measurements on *Mytilus californianus* and other molluscs, taken alive. Berger and Libby indicated that shell of this species taken in central California in 1878 has 2.0% less C^{14} than the reference level of 1890 or 0.95 NBS oxalic acid. Analyses: $\delta C^{14} = 107‰$; assuming δC^{13} not to differ from PBD standard, then $\Delta C^{14} = 53‰$.

LJ-1353. Modern organisms—16

Apparent Age −1200 ± 150

Flesh from 17 snails (*Tegula gallina*), coll. alive, then hard-frozen, on March 6, 1965, by C. L. Hubbs, on intertidal rocks of Isla Guadalupe, Baja California, México (29° 00.2′ N Lat, 118° 13.4′ W Long). *Comment:* run as additional check on post-bomb radioactivity of contemporary organisms, and for evidence on possible fractionating of C isotopes in flesh and shell. Bodies removed from shells by boiling, then boiled again in distilled water and dried. δC^{14} measurement somewhat exceeded that in roasted shells (LJ-1377) and further exceeded that in unroasted shell, but ΔC^{14} values of roasted and unroasted shells were in agreement. Apparent age of +270 ± 25 yr was obtained on shells of *Tegula gallina* coll. on Baja California coast in 1956 (LJ-988, La Jolla IV, p. 72). Analyses: $\delta C^{14} = 229‰$; assuming δC^{13} to be same as for LJ-1378 (−3.85‰), then $\Delta C^{14} = 177‰$.

LJ-1377. Modern organisms—17

Apparent Age −950 ± 150

Shells, roasted, from half of snails (*Tegula gallina*) used as flesh for LJ-1353 (above). *Comment:* δC^{14} content was measured as intermediate between that in flesh and that in unroasted shell. Apparently lighter carbon was driven out differentially in the roasting—a matter under further test (G.S.B.). Analyses: $\delta C^{14} = 202‰$; $\delta C^{13} = 0.37‰$; $\Delta C^{14} = 141‰$.

LJ-1378. Modern organisms—18 Apparent Age −950 ± 150

Shells, unroasted, from half of snails (*Tegula gallina*) used as flesh for LJ-1353 (above); other half roasted for LJ-1377. *Comment:* see LJ-1377. Analyses: $\delta C^{14} = 189.3‰$; $\delta C^{13} = -3.85‰$; $\Delta C^{14} = 139‰$.

General Comment: need for determining radiocarbon content of contemporary organisms has been repeatedly indicated of late: for example by Berger, Taylor, and Libby (1966), and in UCLA V (p. 487-490), Arizona VI (p. 4-5), La Jolla IV (p. 69-72), Florida State I (p. 48), and other radiocarbon reports. Increase in C^{14} content of atmosphere by atomic explosions, uptake of old carbon, possible fractionating of C isotopes pose problems of inherent interest as well as of importance in dating. Further, systematic determinations are a prime desideratum.

II. SEALEVEL CHANGES AND SHORE PROCESSES

Several measurements under "III. Ocean Sediments" and "VI. Archaeology" bear on sealevel changes and shore processes.

A. Alaska

Tectonic Deformation, South-Central Alaska series

Four measurements, coll. 1964 (after Alaskan earthquake) and subm. 1965 by E. Reimnitz, amplify those previously subm. by him (LJ-938-945, La Jolla IV, p. 72-74), pertaining to Postglacial tectonic deformation of continental shelf of Gulf of Alaska.

LJ-GAP-28. Continent shelf, Gulf of Alaska **6400 ± 300** **4450 B.C.**

Foraminifera and mollusc shells from glacial marine sediments, taken by gravity core 73 to 92 cm below sediment surface of continental shelf, at water depth of 100 m, S of Copper River Delta (59° 54′ N Lat, 145° 43′ 39″ W Long). Coll. by Reimnitz (sample M-3-C). *Comment* (E.R.): Acer and Sonoprobe records show dated strata have been warped, then truncated, possibly by glaciers. Age indicates rate of tectonic deformation and establishes maximum age for end of period when large glaciers in area extended to sea and rafted sediments to shelf.

LJ-GAP-32. Submerged forests, uplifted by earthquake, Alaska—7 **700 ± 150** **A.D. 1250**

Wood (outer 13 rings) of thick stump on Copper River Delta, in forest horizon re-exposed 3.2 m below high marsh (0.76 m above MLLW level before 1964 earthquake) along S bank of Alaganic Slough (60° 24′ 36″ N Lat, 145° 26′ 03″ W Long; USGS Cordova B-4 Quadrangle, Alaska, 1951). Coll. by Reimnitz (sample 7).

LJ-GAP-33. Submerged forests, uplifted by earthquake, Alaska—8 **860 ± 150** **A.D. 1090**

Wood of stump (with 50 annular rings) on Copper River Delta, in forest horizon re-exposed 2.9 m below high marsh (ca. 1.0 m above MLLW), along Little Glacier near duck hunters' cabins (60° 26′ 15″ N Lat, 145° 31′ 30″ W Long; Cordova B-5 Quadrangle, 1953). Coll. by Reimnitz (sample 8).

LJ-GAP-34. Submerged forests, uplifted by earthquake, Alaska—9 **1700 ± 100** **A.D. 250**

Wood of tree stump in second (lower) forest horizon, ca. 4.5 m below high marsh and ca. 1.5 m below first horizon (dated as LJ-938, 939, and 943, La Jolla IV, and by LJ-GAP-32 and 33), along steeply cut bank of "Copper Cutoff" on Copper River Delta (60° 24′ 40″ N Lat, 145° 23′ 45″ W Long; Cordova B-4 Quadrangle, 1951). Coll. by P. Shepherd of Alaska Dept. of Fish and Game; sample 9. *Comment* (E.R.): measurement helps to establish and confirm rate of past submergence of Copper River Delta. It is re-run on same material run as LJ-944, La Jolla IV (p. 73), which gave unexpectedly recent date (550 ± 120), younger than dates on overlying forest. Present measurement regarded valid.

General Comment: one measurement (LJ-GAP-32) bears on rate of tectonic deformation and on glaciation. Two measurements (LJ-GAP-32, 33), as expected by collector, confirm integrity of extensive forest horizon, destruction of which through submergence was dated by LJ-938, 939, and 943, as, respectively, 700 ± 130, 725 ± 130, and 1360 ± 150 yr B.P. A third one dates an older forest horizon. These forests probably developed after sudden uplifts, similar to that of 1964 (Reimnitz, 1966). Last uplift may cause new forest to spread across marsh, which again may be destroyed by continuing slow submergence.

B. W Coast, United States

Tomales Bay, California series

Shells from bottom of bay (LJ-GAP-45 from well near bay), Marin Co. Coll. 1964 (LJ-GAP-45 in 1963) and subm. 1965 by C. C. Daetwyler (LJ-GAP-43 by him and J. R. Moriarty). Positions obtained from original USC & GS Survey sheets or by original surveys. Water depths given in reference to MLLW datum.

340 ± 130
LJ-GAP-43. Tomales Bay, California—1 A.D. 1610

Shells from depth of 3.4 to 4.8 m below MLLW, in Test Boring No. 1, in White Gulch Bay on SW shore of Tomales Bay N of Pelican Pt.; water depth 2.1 m (38° 11′ 40.5″ N Lat, 122° 56′ 05.5″ W Long). *Comment:* site definitely interpreted as archaeologic by J.R.M., on basis of inclusion of bones and a shell bead; evidence was sought by C.C.D. on suspected very recent local tectonic subsidence (confirmed by date).

1020 ± 150
LJ-GAP-48. Tomales Bay, California—2 A.D. 930

Olympia oyster (*Ostrea lurida*) valves, from depth of 70 to 75 cm below MLLW in 75-cm gravity Core 34 in S part of bay midway between Millerton and Tomasini points; water depth 1.2 m (38° 06′ 47.5″ N Lat, 122° 51′ 21.5″ W Long). *Comment* (C.C.D.): core penetrated shell layer that produces sonoprobe reflection; date provides data on local sealevel chronology and rate of deposition.

1200 ± 160
LJ-GAP-47. Tomales Bay, California—3 A.D. 750

Ostrea lurida valves from above well-developed sonoprobe-reflecting horizon, at depth of 6.1 m below MLLW in Test Boring No. 13, on a structurally controlled shoal area projecting NW from Tomasini Pt., ca. 518 m from NE shore (38° 07′ 45.5″ N Lat, 122° 52′ 24″ W Long). *Comment:* date is ca. 500 yr younger than that (LJ-GAP-46) for underlying reflecting horizon.

LJ-GAP-46. Tomales Bay, California—4 **1700 ± 190**
A.D. 250

Gastropod (*Nassarius mendicus,* intact shells) from sandy, shelly pebble gravel horizon that produces prominent reflections by sonoprobe; at depth of 6.4 to 7.5 m below MLLW in Test Boring No. 3, in center of bay directly off Manilla Marina, ca. 396 m from NE shore; water depth 4.9 m (38° 10′ 47.5″ N Lat, 122° 54′ 54″ W Long). *Comment* (C.C.D.): horizon appears to correlate with horizon in stratigraphically equivalent silty clays widespread in S two-thirds of bay. Dating provides time correlative horizon throughout large part of bay. Rate of deposition of overlying sediments may be calculated. Gravel may represent lower relative stand of sealevel, related to suspected tectonic submergence along active fault zone. Gas supply was augmented by 54% of inactive gas.

LJ-GAP-44. Tomales Bay, California—5 **3300 ± 180**
1350 B.C.

Ostrea lurida valve fragments from shelly gravel at top of faulted reflecting horizon (determined by sonoprobe survey), at depth of 16.6 to 16.9 m below MLLW in Test Boring No. 9, in center of bay ca. 853 m from NW shore; water depth 5.9 m (38° 08′ 49.5″ N Lat, 122° 53′ 40.5″ W Long). *Comment* (C.C.D.): horizon thought probably to represent earliest Holocene marine transgression into bay. Date provides data bearing on (1) age of faulting, (2) local sealevel chronology, and (3) rate of deposition of overlying silty clays.

LJ-GAP-45. Tomales Bay, California—6 **> 35,000**

Intact valves of *Ostrea lurida* from sandy, shelly pebble gravel (overlying bedrock), from 27.1 to 28.6 m below MLLW in Merle Lawson Water Well No. 2, 960 m 167.5° True from USC & GS Tidal Bench Mark T 476 (1951) at Dillon Beach; well-head alt prior to completion 4.9 m above MLLW (38° 14′ 24″ N Lat, 122° 57′ 51″ W Long). *Comment* (C.C.D.): interval was interpreted as representing earliest Holocene marine transgression in Tomales-Bodega bay area, but it is obviously older. Date bears on sealevel chronology and rate of deposition of overlying sediments.

General Comment: measurements bear particularly on suspected (and confirmed) tectonic subsidence in Tomales Bay, axis of which is located along San Andreas fault zone.

LJ-GAP-53. Wood from La Jolla Submarine Canyon **12,000 ± 1000**
10,050 B.C.

Oak-limb piece 25 cm long by 7.5 cm wide (part of large accumulation of driftwood exposed by submarine erosion) from depth of 38.1 m below mean sealevel; in La Jolla Bay, San Diego, California (32° 51′ 25″ N Lat, 117° 15′ 50″ W Long). Coll. and subm. 1966 by R. F. Dill, U. S. Naval Electronics Lab., San Diego. *Comment* (R.F.D.): fossils, sediment type, and plant material indicate that encasing sediment was deposited in lagoon near sealevel. Other parts of sample dated by Geochron Laboratories (GX-738) as 12,800 ± 320 and by Isotopes, Inc. (I-2105) as 13,200 ± 200. For samples off California, this date, oldest for position of sealevel and based on datable material from deepest below sealevel, agrees, along with 3 other measurements in La Jolla Submarine Canyon area, with past eustatic sealevel changes as graphed by Shepard (1963) and Shepard and Curray (in press). Region is therefore indicated as having been tectonically stable for ca. 13,000 yr. See LJ-607, 8270 ± 500 (La Jolla IV, p. 74), for 23 m; I-2152, 5390 ± 100 (based on Pismo clam, *Tivela stultorum,* from submerged beach in La Jolla Submarine Canyon; unpub.), for 11.6 m; LJ-208, 4230 ± 200 (La Jolla II), for 2.0 m.

C. W Coast, México

Nayarit coastal-plain progradation series

Ten measurements on samples from Costa de Nayarit, coll. 1963 and subm. 1965 and 1966 by J. R. Curray and P. J. Crampton, supplement 3 (LJ-888-890, La Jolla IV, p. 100) on coastal plain of Sonora, México, and 3 measurements (LJ-518, La Jolla III; LJ-568 A and B, La Jolla IV, p. 76) on beach ridges in Nayarit. Measurements are reported in sequence of source of samples (midden, shell pit, well or boring) and of depth in deposit.

1500 ± 200
LJ-1361. Coastal plain, Nayarit, México—1 A.D. 450

Pelecypod shell (*Tivela* sp.) sample C-684, from surface of midden, above sealevel, 9.5 km S from Puerto de Palapar (22° 01.1′ N Lat, 105° 36.8′ W Long).

1700 ± 300
LJ-1358. Coastal plain, Nayarit, México—2 A.D. 250

Shell (*Tivela* sp.). sample C-717b, from depth of 12 cm, in midden 4.8 km from Camichin (22° 02.6 N Lat, 105° 37.4′ W Long).

1670 ± 200
LJ-1360. Coastal plain, Nayarit, México—3 A.D. 280

Shell (*Tivela* sp.), sample C-517b, from same deposit as LJ-518 (La Jolla III, 3175 ± 220) and LJ-1358 (above). *Comment:* age by LJ-518 was greater than expected; results of LJ-1358 and 1360 conform with one another and more closely with expectation.

600 ± 100
LJ-1384. Coastal plain, Nayarit, México—4 A.D. 1350

Shell (*Donax punctatostriatus*), sample C-700, from depth of 69 cm, in midden, above sealevel, 1.5 km E of Cuahtla School (22° 12.7′ N Lat, 105° 38.0′ W Long).

LJ-1363. Coastal plain, Nayarit, México—5 **1700 ± 200 A.D. 250**

Pelecypod shell (*Protothaca metodon*), sample C-721, from depth of 100 cm, in shell pit near San Blas (21° 34.1′ N Lat, 105° 17.7′ W Long).

LJ-1362. Coastal plain, Nayarit, México—6 **4200 ± 300 2250 B.C.**

Pelecypod shell (*Mulinia pallida*), sample C-691, from depth of 580 to 640 cm, in well at Tecolote (21° 54.3′ N Lat, 105° 30.3′ W Long).

LJ-1365. Coastal plain, Nayarit, México—7 **5000 ± 500 3050 B.C.**

Pelecypod shells (*Donax punctatostriatus, D. contusus, Crassostrea cortezianus, Mulinia pallida,* and *Tivela* sp.), sample C-697, from depth of 680 to 740 cm, in well S of Ligurita (21° 51.7′ N Lat, 105° 31.8′ W Long).

LJ-GAP-52. Coastal plain, Nayarit, México—8 **7200 ± 500 5250 B.C.**

Peat, sample C-701, from depth of 744 to 754 cm, in boring in Laguna Cuahtla, 46 cm above mean sealevel (22° 12.7′ N Lat, 105° 38.5′ W Long). *Comment:* gas sample was augmented by 3% of inactive gas.

LJ-GAP-51. Coastal plain, Nayarit, México—9 **4830 ± 200 2880 B.C.**

Peat, sample C-691, from depth of 904 to 925 cm, in well boring at Tecolote, 20 cm above mean sealevel (21° 54.3′ N Lat, 105° 30.3′ W Long). *Comment:* gas sample was augmented by 18% of inactive gas.

LJ-GAP-50. Coastal plain, Nayarit, México—10 **1750 ± 200 A.D. 200**

Peat, sample C-687, from depth of 1080 to 1085 cm in boring at Acajala Landing, 76 cm below mean sealevel (21° 59.4′ N Lat, 105° 33.3′ W Long). *Comment:* gas sample was augmented by 25% of inactive gas.

General Comment (J.R.C.): age determinations were made to indicate rate of beach-ridge progradation of Costa de Nayarit and to obtain limiting estimates of late Quaternary sealevel changes. History of this area has been very complex for the past few thousand years; interpretations presented here and previously in the literature (Curray and Moore, 1964a; 1964b) are still preliminary. Samples from both middens and shallow wells consistently show coastal progradation with sealevel not more than a few m below nor more than ca. 1 m above present sealevel at any time during past 5000 yr. Samples from deep in wells are more directly related to coastal progradation than to sealevel.

Progradation of coast was interrupted at least 4 times in this area; cause is as yet uncertain. One principal interruption occurred ca. 1500 B.P., during which time coastline was reoriented, longshore transport of sediment changed, and Indian population increased in coastal region. From nature of shoreline and distribution of middens, it seems improbable that shell material was transported far from coast.

Dates from Nayarit coastal plain obtained thus far are summarized below, including dates obtained from Isotopes, Inc.:

Sample	Depth MSL	Age B.P.
LJ-568A (C-512)	−5.27 m	5430 ± 300
LJ-568B (C-512)	−5.27 m	5000 ± 300
LJ-1365 (C-697)	−7.10 m	5000 ± 500
I-2231 (C-701)	−5.00 m	4220 ± 110
LJ-GAP-52 (C-701)	−7.00 m	7200 ± 500
LJ-1362 (C-691)	−5.90 m	4200 ± 300
LJ-GAP-51 (C-691)	−8.95 m	4830 ± 200
I-2228 (C-687)	−9.84 m	3880 ± 105
LJ-GAP-50 (C-687)	−11.58 m	1750 ± 200[1]
I-2230 (C-699)	−8.00 m	2180 ± 115
LJ-1384 (C-700)	midden	600 ± 100[1]
LJ-1363 (C-721)	shell pit, MSL	1700 ± 200
LJ-518 (C-517a)	midden	3175 ± 220[1]
LJ-1360 (C-517b)	midden	1670 ± 200
LJ-1361 (C-684)	midden	1500 ± 200
I-2229 (C-690)	midden	1310 ± 95
I-2233 (C-717a)	midden	1260 ± 95
LJ-1358 (C-717b)	midden	1700 ± 300
I-2232 (C-707)	−4.36 m	205 ± 90

[1] Date seems anomalous.

Shells off W coast of México series

Shell samples coll. 1965 on Birchtide (the mother ship) and Diving Saucer (leased by Scripps Inst. of Oceanography) by J. R. Curray and P. J. Crampton; subm. by them 1966.

LJ-1373. Shells off W coast of México—6 **15,100 ± 1000** **13,150 B.C.**

Gastropod shell (*Hexaplex erythrostomus*), taken in Saucer grab (sample C-734b), ca. 118 m below sealevel, 74 km offshore (21° 40′ N Lat, 106° 15′ W Long).

LJ-1385. Shells off W coast of México—7 **12,000 ± 800** **10,050 B.C.**

Gastropod shell (*Vasum caestus*), sample C-734a, taken with sample for LJ-1373.

LJ-GAP-74. Shells off W coast of México—8 **13,500 ± 1000** **11,550 B.C.**

Pelecypod shell (*Chama* sp.), dredged (sample C-736) at depth of 110 to 121 m, 80 km offshore (21° 41′ N Lat, 106° 17′ W Long).

General Comment: continuation of measurements in same series (LJ-280, La Jolla II; LJ-517, 520, La Jolla III; LJ-565, 566, La Jolla IV p. 76). Because molluscs selected for these tests are of shallow-water, living-depth range, shells appear to represent submerged beaches and hence bear on analysis of Quaternary changes in sealevel (Shepard, 1963; Curray and Moore, 1964; Shepard and Curray, in press).

D. Juan Fernández Islands

Juan Fernández Islands series

Shells and shell fragments of marine microorganisms and small organisms; coarsest fraction of coquinoid sandstone, cleaned ultrasonically; nonmagnetic in Frantz separator; separated into lightest and densest fractions. From terrace surface ca. 75 m above and to NE of Bahía Padre, W shore of Isla Mas-a-tierra of Juan Fernández group, far off mainland of Chile (ca. 33° 39.5′ S Lat, 78° 59.5′ W Long; H. O. Chart 1267, 1924). Coll. 1964 by M. N. Bass (sample JF-MT-7), on R/V Spencer F. Baird of Scripps Inst. of Oceanography during Carrousel Expedition; subm. by him 1966.

18,400 ± 900
LJ-GAP-60. Juan Fernández Islands—1 16,450 B.C.

Lightest carbonate fraction; calcite and aragonite.

20,300 ± 1000
LJ-GAP-61. Juan Fernández Islands—2 18,350 B.C.

Densest carbonate fraction; aragonite.

General Comment (M.N.B.): designed to obtain age of uplift of Isla Mas-a-tierra and younger age limit on volcanism of island.

E. South Seas

Emerged reef, South Seas series

Coral samples from surface of eroded conglomerate platforms of South Sea islands, coll. 1964 and subm. 1965 by H. H. Veeh, Scripps Inst. of Oceanography (now Dept. of Geology, Yale Univ.).

3400 ± 200
LJ-1369. Emerged reef, South Seas—1 1450 B.C.

Coral (*Favia* sp.) sample (BORA-4) from S end of low islet (Motu Tofari) capping barrier reef off E coast of Bora Bora, Society Islands; from surface of conglomerate platform 0.50 m above mean-low-tide level; coral is truncated by terrace surface (16° 29′ S Lat, 151° 42′ W Long). *Comment* (H.H.V.): coral probably not in original position of growth; dating may bear on Postglacial sealevel changes and origin of conglomerate platform.

3700 ± 500
LJ-1370. Emerged reef, South Seas—2 1750 B.C.

Detrital coral fragments (sample BORA-6) from same location as LJ-1369; from surface of conglomerate platform, adacent to lagoon. *Com-*

ment (H.H.V.): although corals are not in position of growth, date will provide time of formation of conglomerate platform and thus may bear on Postglacial sealevel changes. Gas from sample insufficient for measurement; was mixed with 26% of inert gas.

LJ-1371. Emerged reef, South Seas—3 **2730 ± 200** **780 B.C.**

Coral *(Favia* sp.) sample (MOOR-8) from low islet off NW coast of Moorea, Society Islands; from surface of conglomerate platform (terrace of lithified coral rubble) from 0.20 to 0.50 m above low-tide level (17° 29′ S Lat, 149° 54′ W Long). *Comment* (H.H.V.): Same as for LJ-1370, except amount of gas was adequate.

LJ-1372. Emerged reef, South Seas—4 **4900 ± 300** **2950 B.C.**

Coral (*Favia* sp.) sample (RANG-11) from NE coast of Rangiroa Atoll, Tuamotu Archipelago, S of Tibuta Pass; from surface of contemporary reef flat, at low-tide level, between conglomerate platform and lithothamnion ridge; coral is truncated by reef flat (14° 59′ S Lat, 147° 33′ W Long). *Comment* (H.H.V.): field evidence indicates that inner part of reef flat was formed by intertidal erosion of conglomerate platform; date bears on rate of intertidal erosion of conglomerate platform and possibly on Postglacial sealevel changes.

General Comment (H.H.V.): dates show conglomerate platforms were formed within last 5000 yr when sealevel was near its present position. As coral samples from conglomerate platform represent transported material and their relation to former sealevel is uncertain, these dates offer little support for Postglacial sealevel stand higher than now.

F. Australia

LJ-1368. New South Wales **12,400 ± 600** **10,450 B.C.**

Carbonaceous sediment consisting largely of fragments of small molluscs (unidentified), dredged at depth of 128 m (32° 20.3-22.3′ S Lat, 152° 47.2-48.1′ E Long). Coll. 1964 by C. V. Phipps; subm. 1966 by F. P. Shepard. *Comment* (F.P.S. and C.L.H.): sample not pretreated except for removal of attached plant material. Date is unexpectedly recent, in comparison with recent age-depth curves (Shepard, 1963; Shepard and Curray, in press), but measurements for deeper deposits are few and widely variable; outward transport of shells possible.

G. E coast of South America

Emerged beaches, Brazil series

LJ-1364. Emerged oysters, Brazil **5200 ± 400** **3250 B.C.**

Oyster (*Crassostrea rhyzophorae*) shells cemented to granitic rock 4.80 m above mean sealevel, 650 m from present coast, at Grotto de

Morcega, Baia da Ribeira, Creek of Bracui, W of Rio de Janeiro (22° 57′ S Lat, 44° 25.6′ W Long). Coll. 1963 and subm. 1965 by J. R. Curray and F. Danciger (sample C-730, 1). *Comment:* LJ-970, La Jolla IV (p. 84), 4800 ± 250, was based on a duplicate sample (C-730, 2) of same species, previously listed as *Ostrea arborea,* with identical data. Because they live intertidally, mainly attached to mangrove roots and definitely not of midden origin, these oysters suggest stand higher than now, either late Pleistocene or, in line with this and some other dates (see discussion and references under LJ-970), a more recent (Altithermal?), perhaps relative only, high sea stand.

5900 ± 300
LJ-1367. Emerged beach ridge, Brazil **3950 B.C.**

Mollusc shells, mostly fragmentary, in middle-ledge consolidated beachrock at mean-low-water level S of Recife, at Piedade Beach (08° 30′ S Lat, 35° 00′ W Long). Species identified by E. P. Chace: *Anomalocardia brasiliana* (many), *Natica clausa?* (1), *Bulla occidentalis?* (1). Coll. 1963 by Tj. H. Van Andel and subm. 1965 by F. P. Shepard. *Comment* (F.P.S. and C.L.H.): date suggests that (1) sealevel ca. 6000 yr ago was very close to present level; (2) shells from an older now submerged beach had been transported beachward prior to formation of beachrock; or (3) coastal region of eastern South America has not been stable (see LJ-1364).

Emerged beaches, Argentina series

Samples from emerged beaches in Argentina, coll. and subm. 1966 by C. M. Urien, Servicio de Hidrografía Naval, Laboratorio de Geología (Montes de Oca 2124, Buenos Aires, Argentina). Two other samples were lost in analysis.

7600 ± 600
LJ-1397. Punta del Indio, Argentina **5650 B.C.**

Mixed beach material (shell, etc.), from over rock bottom, on Punta del Indio, Río de la Plata (35° 15.5′ S Lat, 57° 14.5′ W Long). *Comment* (C.M.U.): bears on sealevel changes and on Holocene transgression of Buenos Aires coastal plain.

3400 ± 200
LJ-1399. Mar Chiquita, Argentina **1450 B.C.**

Euryhaline shell (*Mactra, Littorina, Darina,* etc.) from well-stratified sandy mud, in lagoon known as Mar Chiquita, Provincia de Buenos Aires; covering Pampean Terrace, on national highway 11, W of Mar Chiquita (37° 37′ S Lat, 57° 25′ W Long). *Comment* (C.M.U.): sample represents innermost sediments of this lagoon, on SE side of Buenos Aires Holocene coastal plain; probably dates initiation of lagoon during seemingly first phase of Holocene transgression.

III. OCEAN SEDIMENTS

Several sections, especially A and B, pertain also to sealevel changes and shore processes (above).

A. Southern California

La Jolla Fan Valley series

Samples from this sedimentary feature extending seaward from La Jolla Submarine Canyon, off San Diego, California. Coll. and subm. 1965 by F. P. Shepard, R. F. Dill, and U. von Rad.

LJ-GAP-41. La Jolla Fan Valley—1 **640 ± 150**
A.D. 1310

Rather large piece of terrestrial wood (ca. 20 g subm.) found at base, at depth of 32 cm or more, in box core LJF 71; in axis ("main channel") of outer La Jolla Fan Valley, at depth of 1094 m (32° 43.0′ N Lat, 117° 39.4′ W Long). *Comment:* date incongruously recent; probably either wood was intrusive or measurement erroneous. Dates for box core LJF 71 are very irregular with depth, and dating is inconsistent between laboratories:

Depth in Core LJF-71	LJ-GAP No.	Date	Isotope Lab. No.	Date
32 cm or more	41	640 ± 150	....	....
27-32 cm	36	5710 ± 300	....	....
24-26 cm	35	6150 ± 400	I-1981	3570 ± 300
5-8 cm	38	2370 ± 150	I-1979	1160 ± 300

LJ-GAP-36. La Jolla Fan Valley—2 **5710 ± 300**
3760 B.C.

Deeper part (at 27 to 32 cm) of lower of 2 distinctive layers of organic debris (ca. 19.5 g, with some sand), this one comprising kelp (*Macrocystis?*) and other algal material, with mica, in box core LJF 71_{K}. Other data as for LJ-GAP-41, above.

LJ-GAP-35. La Jolla Fan Valley—3 **6150 ± 400**
4200 B.C.

Shallower part (at 24 to 26 cm) of lower of 2 distinctive layers of organic debris (dry weight ca. 10 g), this one comprising what appears to be kelp and gorgonian corals, in box core LJF 71_{μ}. Other data as for LJ-GAP-41, above. *Comment:* Isotopes, Inc. has obtained date (I-1981) of 3570 ± 300 for this layer.

LJ-GAP-38. La Jolla Fan Valley—4 **2370 ± 150**
420 B.C.

Upper of 2 distinctive layers of organic debris (ca. 22 g, including some sand), at depth of 5 to 8 cm in box core LJF 71_{δ}. Other data as for LJ-GAP-41, above. *Comment:* Isotopes, Inc. has obtained date (I-1979) of 1160 ± 300 for this layer.

LJ-GAP-40. La Jolla Fan Valley—5 **2350 ± 150**
400 B.C.

Organic sediment mat, comprising kelp?, surfgrass (*Phyllospadix*)?, etc. (dry weight ca. 15 g), interbedded with sand, at depth of 6 to 14 cm in box core LJF 77γ, in axis of La Jolla Fan Valley, close to E wall, at depth of 937 m (32° 50.4′ N Lat, 117° 33.85′ W Long). *Comment:* date consonant with that for LJ-GAP-38, above.

1760 ± 100
LJ-GAP-39. La Jolla Fan Valley—6 **A.D. 190**

Organic sediment mat (sand-silt with kelp?, broken pieces of surfgrass, terrigenous roots, etc.) (dry weight ca. 15 g), on top of sandy box core LJF 9, in central axis of La Jolla Fan Valley, at depth of 856 m (32° 52.2′ N Lat, 117° 32.3′ W Long). *Comment:* difference between this date and apparent age of contemporary organisms involved may be taken as measure of rate of down-canyon sediment creep. Living *Macrocystis* coll. 1957 has yielded apparent age of +580 ± 70 yr (LJ-70, La Jolla IV, p. 70); surfgrass, *Phyllospadix,* coll. 1966, after bombs, apparent age of −300 ± 50 yr (LJ-1352, section IIB, this date list); current-oriented organic material in center of La Jolla Submarine Canyon, a sample of mother material of organic layers in La Jolla Fan Valley, comprising kelp?, gorgonians?, etc., coll. 1965, apparent age of +280 ± 50 yr (LJ-GAP-37, section IIB, this date list).

General Comment: this series of dates was run to help establish rate of deposition and mechanism of transport and deposition of these deep-sea sands, which, according to recent researches by contributors, stem by glacierlike creeping and/or by density flows from tributary La Jolla Submarine Canyon. See also, in this date list, LJ-GAP-53, 12,000 ± 1000 yr, based on wood from canyon; also LJ-GAP-37 (section I, this date list), apparent age +280 ± 50 yr, based on modern material similar to that utilized for most of these tests.

B. Golfo de Panamá

Golfo de Panamá sediment series

Bottom-sediment samples from 3 piston cores from a small area in the gulf (08° 05-20′ N Lat, 70° 15-43′ W Long), at water depths 77 to 91 m, coll. 1963 on R/V Spencer F. Baird of Scripps Inst. of Oceanography, CR/CR series by Thomas E. Chase on Criss-Cross Expedition and BON-A-P series by A. Golik on Bonacca Expedition; subm. 1965 by Golik.

8510 ± 100
LJ-GAP-4. Golfo de Panamá sediment—1 **6560 B.C.**

Coarse sand with fragment of shells of various Mollusca and Foraminifera, from depth of 25 to 32 cm in core BON-A-P-35, taken at depth of 88 m (08° 20′ N Lat, 79° 15′ W Long).

22,280 ± 1000
LJ-GAP-5. Golfo de Panamá sediment—2 **20,330 B.C.**

Coarse sand with fragments of shells of various Mollusca and Foraminifera, from depth of 145 to 152 cm in core CR/CR 9, taken at depth of 91 m (08° 05′ N Lat, 79° 36′ W Long). *Comment* (A.G.): indicates that ca. 22,000 yr ago shallow-water environment existed where present depth is 91 m.

10,970 ± 600
LJ-GAP-6. Golfo de Panamá sediment—3 **9020 B.C.**

Coarse sand with fragments of shells of various Mollusca and Foraminifera, from depth of 35 to 42 cm in core CR/CR 9 (see LJ-GAP-5, above).

11,290 ± 600
LJ-GAP-7. Golfo de Panamá sediment—4 **9240 B.C.**

Coarse sand with fragments of shells of various Mollusca and Foraminifera, from depth of 63 to 70 cm in core BON-A-P-22, taken at depth of 77 m (08° 13.5′ N Lat, 79° 43′ W Long).

11,300 ± 600
LJ-GAP-8. Golfo de Panamá sediment—5 **9350 B.C.**

Green-blue mud from depth of 55 to 63 cm in core CR/CR 9 (see LJ-GAP-5, above).

5150 ± 300
LJ-GAP-9. Golfo de Panamá sediment—6 **3200 B.C.**

Green mud from depth of 35 to 45 cm in core BON-A-P-22 (see LJ-GAP-7, above).

13,350 ± 1000
LJ-GAP-10. Golfo de Panamá sediment—7 **11,400 B.C.**

Green-blue mud from depth of 45 to 55 cm in core BON-A-P-35 (see LJ-GAP-4, above).

General Comment (A.G.): one measurement (LJ-GAP-5, 22,280 ± 1000) was designed to date late Quaternary transgression in Golfo de Panamá; others were designed to bracket apparent hiatus in cores, separating shallow-water Foraminifera below from deep-water species above. Approximate date of 11,000 yr B.P. for hiatus seems to indicate rise in sea-level. Sequence of dates within cores, and in respect to hypothesized events, is indicated by the following tally to be orderly, even though both sand-and-shell and mud fractions of cores are involved. See Golik (1966).

	LJ-GAP No.	Depth in Core, cm	Material	Date, B.P.
Core BON-A-P-35 (depth 88 m)				
Below hiatus	10	45-55	Mud	13,350
Above hiatus	4	25-32	Sand/shell	8510
Core BON-A-P-22 (depth 77 m)				
Below hiatus	7	63-70	Sand/shell	11,290
Above hiatus	9	35-45	Mud	5150
Core CR/CR 9 (depth 91 m)				
Transgression stage	5	145-152	Sand/shell	22,280
Below hiatus	8	55-63	Mud	11,300
Above hiatus	6	35-42	Sand/shell	10,970

Because technical difficulties led to some anomalous measurements, each sample was analyzed several times and dates here indicated represent average of runs judged successful.

C. E Pacific Deep-Sea

SE Pacific sediment series

Deep-bottom sediment (globigerina and other foraminiferal oozes) samples taken by R/V Spencer F. Baird of Scripps Inst. of Oceanography during Downwind Expedition of 1957-58; subm. 1965 and 1966 by A. Blackman.

LJ-GAP-1. SE Pacific sediment—1 **11,100 ± 400**
9150 B.C.

Globigerina ooze from W side of East Pacific Rise, at depth of 0 to 4 cm in gravity core D.W.B.G. 61, in water 4250 m deep (46° 44′ S Lat, 123° 01′ W Long). *Comment* (A.B.): this and next measurement were run to estimate prospect of using radiocarbon determinations for future dating in these cores of foraminiferal change at depth of 45 cm (LJ-GAP-1) and 30 cm (LJ-GAP-2), thought to represent end of last glacial epoch. Dates obtained for top 4 cm of cores approximate age of that event as determined by dating other deep-sea cores. No further measurements of this core made.

LJ-GAP-2. SE Pacific sediment—2 **11,850 ± 500**
9900 B.C.

Globigerina ooze from E side of East Pacific Rise, at depth of 0 to 4 cm in gravity core D.W.B.G. 76, in water 3840 m deep (43° 45′ S Lat, 104° 28′ W Long). *Comment:* see LJ-GAP-1.

LJ-GAP-63. SE Pacific sediment—3 **ca. 5000**

Foraminiferal ooze from Nasca Ridge off western South America, at depth of 0 to 5 cm in gravity core D.W.B.G. 98C, fractionated to yield particle size $>177\mu$; in water 2300 m deep (20° 49′ S Lat, 81° 08′ W Long). *Comment* (A.B.): this sample and next run to determine whether age might be related to particle size, as smaller forams (represented by LJ-GAP-65) might have been transported here from older sediments and therefore might give older age; on the contrary, larger particles yielded older date. These 2 measurements are regarded (by G.S.B.) as rough approximations. However, the less doubtful measurements LJ-GAP-65 and 66 showed same relative difference in age in relation to particle size. Younger apparent age for smaller particles probably resulted from ready exchange of young CO_2, as indicated by Olsson (1966).

LJ-GAP-65. SE Pacific sediment—4 **ca. 1500**

Foraminiferal ooze from same depth in same core as sample for LJ-GAP-63, but fractionated to particle size 44-177μ. *Comment:* see LJ-GAP-63.

5600 ± 600
LJ-GAP-66. SE Pacific sediment—5 **3650 B.C.**

Foraminiferal ooze at depth of 10 to 15 cm in core specified under LJ-GAP-63, fractionated to particle size >177μ. *Comment:* see LJ-GAP-63.

2300 ± 400
LJ-GAP-67. SE Pacific sediment—6 **350 B.C.**

Foraminiferal ooze from same depth (10 to 15 cm) in core specified under LJ-GAP-66, but fractionated to particle size of 44-177μ. *Comment:* see LJ-GAP-63.

ca. 6100 ± 600
LJ-GAP-72. SE Pacific sediment—7 **4150 B.C.**

Foraminiferal ooze from off western South America, at depth of 0 to 5 cm in gravity core D.W.B.G. 118C, fractionated to particle size >44μ; in water 3400 m deep (28° 02′ S Lat, 96° 20′ W Long).

ca. 3300 ± 400
LJ-GAP-73. SE Pacific sediment—8 **1350 B.C.**

Foraminiferal ooze at depth of 10 to 15 cm in gravity core D.W.B.G. 118C (see LJ-GAP-72), fractionated to same particle size. *Comment:* these dates are inverted. Deeper sample (10 to 15 cm) gives younger age than surface sample (0 to 5 cm).
General Comment (A.B.): no dates obtained from these cores, all of deep-sea foraminiferal oozes, are within expected age. Age of end of last glacial has been fairly well established as 11,000 yr and in none of these cores is this age approximated for this boundary. Dates for sample D.W.B.G. 98C by the ionium/thorium method (Blackman and Somayajulu, in press) agree fairly well with an 11,000-yr age for end of last glacial, which appears to be represented in core at 5 cm. This method gives date of ca. 18,000 yr for the 10 to 15 cm level, versus radiocarbon dates of 5600 and 2300 (LJ-GAP-66, LJ-GAP-67). Samples yielded insufficient gas for counting until some inactive gas was added.

Sediment, E tropical Pacific series

Samples from Cores 59 and 60 of Swedish Deep-Sea Expedition, utilizing large components (mostly Foraminifera) of deep-sea chalkooze, sieved at 62 microns. Coll. 1948 and subm. 1965 by M. Burkenroad and G. Arrhenius.

17,200 ± 800
LJ-GAP-29. Sediment, E Tropical Pacific—1 **15,250 B.C.**

Sample from depths of 22 to 30 cm (2.7 g) and 32 to 40 cm (8.5 g) in Core 59, at Station 90; depth 4370 m (03° 05′ N Lat, 133° 06′ W Long).

16,500 ± 800
LJ-GAP-30. Sediment, E Tropical Pacific—2 **14,550 B.C.**

Sample from depths of 43 to 51 cm (4.4 g), 53 to 60 cm (4.3 g), and

62 to 70 cm (3.9 g) in Core 60, at Station 92; depth 4540 m (01° 35′ N Lat, 134° 57′ W Long).

General Comment (M.B. and G.A.): tests designed to permit selection between alternative correlations of equatorial suite of cores described by Arrhenius (1952). Activity found in LJ-GAP-29 indicates age younger by ca. 2000 yr than age previously estimated from correlation with Core 61B. The new, direct age indication suggests that less material is lost from top of core by truncation than previously estimated. Measurement on LJ-GAP-30 is within experimental error in agreement with previous age estimate, based on correlation with Core 61B. Both measurements will be used to establish age relationships of new biostratigraphic features (M. Burkenroad, in preparation).

D. Indonesia and Australia

Timor Sea sediment series

Bottom sediments coll. off S coast of Timor, Indonesia, with piston core, by Tj. H. Van Andel, on Scripps Inst. of Oceanography R/V Stranger in 1962-63; subm. by him 1964 and 1966.

LJ-1395. Timor Sea sediment—1 **> 30,000**

Sample V-379-1, taken at depth of 3 to 7 cm in 134-cm core, in water 432 m deep (09° 29′ S Lat, 127° 39′ E Long).

17,300 ± 1000
LJ 1391. Timor Sea sediment—2 **15,350 B.C.**

Sample V-379-2, taken at depth of 34 to 38 cm in same core.

19,000 ± 2000
LJ-1396. Timor Sea sediment—3 **17,050 B.C.**

Sample V-379-3, taken at depth of 121 to 125 cm in same core, yielded insufficient gas, requiring admixture of 34% of inactive gas for counting.

2320 ± 120
LJ-994. Timor Sea sediment—4 **370 B.C.**

Sample V-382-1, taken at depth of 9 to 15 cm in 240-cm core, in water 1312 m deep (08° 44′ S Lat, 127° 29′ E Long).

13,000 ± 600
LJ-995. Timor Sea sediment—5 **11,050 B.C.**

Sample V-382-2, taken at depth of 192 to 199 cm in same core.

18,000 ± 1500
LJ-1392. Timor Sea sediment—6 **16,050 B.C.**

Sample V-382-3, taken at depth of 225 to 232 cm, in same core, yielded insufficient gas, requiring admixture of 10% of inactive gas for counting.

LJ-996. Timor Sea sediment—7 **3650 ± 200**
1700 B.C.

Sample V-384-1, taken at depth of 9 to 14 cm in 245-cm core, in water 132 m deep (11° 44′ S Lat, 127° 57′ E Long).

LJ-997. Timor Sea sediment—8 **15,500 ± 1000**
13,550 B.C.

Sample V-384-2, taken at depth of 84 to 88 cm in same core.

LJ-998. Timor Sea sediment—9 **17,400 ± 1000**
15,450 B.C.

Sample V-384-3, taken at depth of 97 to 104 cm in same core.

LJ-999. Timor Sea sediment—10 **18,900 ± 1500**
16,950 B.C.

Sample V-384-4, taken at depth of 201 to 208 cm in same core.

General Comment (Tj.H.V.A.): series designed to estimate rate of sedimentation and time of changes in planktonic constituents and in type of sediment; all to be correlated with changes in climate, bathymetry, and oceanographic conditions. Samples arranged in sequence of stations and of depths in core within station. Age estimates are in expected sequence within cores for V-382 and V-384; in core V-379, admixture of reworked calcareous material near the top may explain anomalously high age, and may also indicate a slightly too high age for LJ-1391.

Sediment, off SW Australia series

Subm. 1966 by W. R. Riedel and J. Conolly.

LJ-1393. Sediment, off SW Australia—1 **> 28,000**

Coccolith-foram ooze from depth of ca. 20 to 24 cm in gravity core LSDA 137 G, taken by R/V Argo of Scripps Inst. of Oceanography on Lusiad Expedition (31° 45′ S Lat, 113° 56′ E Long). Coll. 1962.

LJ-1394. Sediment, off SW Australia—2 **9400 ± 600**
7450 B.C.

Coccolith-foram ooze from depth of ca. 20 to 24 cm in gravity core LSDA 136 G, on same expedition as LJ-1393 (31° 30′ S Lat, 114° 23′ E Long). Coll. 1962.

LJ-1404. Sediment, off SW Australia—3 **5900 ± 300**
3950 B.C.

Foram-coccolith ooze from depth of 13 to 16 cm in core C 9-150, taken by R/V Conrad of Lamont Geol. Observatory on her 9th Expedition (31° 17.0′ S Lat, 114° 33.1′ E Long). Coll. 1965.

LJ-1402. Sediment, off SW Australia—4 **8100 ± 500**
6150 B.C.

Foram-coccolith ooze from depth of 30 to 32 cm in same core used for LJ-1404.

LJ-1401. Sediment, off SW Australia—5 **10,000 ± 1000**
8050 B.C.

Foram-coccolith ooze from depth of 32 to 35 cm in same core used for LJ-1404.

LJ-1403. Sediment, off SW Australia—6 **> 25,000**

Foram-coccolith ooze from depth of 60 to 63 cm in same core used for LJ-1404.

General Comment (W.R.R.): samples subm. to determine rates of sedimentation and relation to climatic change ca. 11,000 yr B.P. Difference in dates for same depth of cores used for LJ-1393 and 1394 is surprising. Sequence of dates for core C 9-150 (LJ-1404→1402→1401→1403) is orderly. Dates establish that climatically controlled microfaunal change repeatedly recognized in N hemisphere sediments was ca. concurrent in vicinity of Australia.

E. Adriatic Sea

Adriatic Sea series

More or less shelly surficial bottom material from Adriatic Sea. Coll. 1962 by Scripps Inst. of Oceanography R/V Horizon; subm. 1965 by Dr. Bruno Pigorini, Universitá di Pavia. *Comment* (C.L.H.): rough positive correlation is indicated for N part of sea between dates and water depth and between dates and distance from N end of sea near Venice (measurements are listed in that order, with a break at edge of shelf; last 4 measurements listed are for stations in or near deep basin in S part of sea). Since no indication is given of normal depth range of species included, nor of species identification, nor of whether shell material was autochthonous, bearing of results on sealevel changes is somewhat tenuous. Material dated probably is composite of all biogenous debris accumulated since sealevel first rose across sampling point, so that dates represent averages rather than moment of transgression. However, submitter concludes, regarding sediment distribution, that Adriatic shelf is covered mostly by relict terrestrial sand supplied, under non-depositional conditions, by Pleistocene Po River during Post-Thyrrenian regression, corresponding to last Würm glaciation; and that reworking and redistribution must be referred to first stages of Holocene transgression. Ages of deposits are regarded by him as related to advance of Po delta. The 4 samples from in and near the deep basin appear unrelated to the Po, but probably represent material displaced transversely from offshore zones. Sample 351 probably represents offshore Holocene sediment. *Re* sedimentation in NW part of Adriatic, see van Straaten (1965). Pigorini is preparing to publish, in Sedimentology, results of study of grain-size distribution and heavy-mineral associations of these bottom sediments.

LJ-GAP No.	Lat N	Long E	Sample No. VA-	Depth m	Date, B.P.
11 [1, 4]	45° 17.9′	12° 30.4′	147	23	3800 ± 300
23 [1, 4]	45° 04.0′	12° 47.2′	102	30	5840 ± 300
20 [2, 4]	44° 39.6′	13° 37.0′	173	40	4850 ± 300
27 [1, 4]	44° 40.0′	12° 56.0′	98	40	4900 ± 250
25 [1, 4]	44° 22.5′	18° 33.5′	177	58	5450 ± 300
15 [3, 5]	44° 20.5′	14° 16.7′	331	64	8500 ± 500
13 [3, 5]	45° 07.8′	14° 06.3′	329	71	14,100 ± 800
19 [1, 4]	43° 09.3′	14° 24.2′	60	88	12,000 ± 700
21 [1, 4]	43° 24.2′	14° 48.2′	207	101	10,500 ± 500
22 [1, 4]	43° 16.2′	15° 04.0′	212	130	11,160 ± 600
24 [2, 4]	43° 18.0′	15° 07.8′	209	144	7800 ± 400
14 [1, 4]	42° 36.0′	15° 31.0′	267	107	13,300 ± 800
26 [2, 4]	42° 33.7′	16° 02.5′	257	140	14,250 ± 800
12 [2, 6]	42° 04.9′	16° 50.3′	341	241	15,900 ± 800
17 [2, 5]	41° 26.6′	16° 59.5′	351	141	4600 ± 300

Bottom material:
[1] Sandy shell
[2] Shell
[3] Shelly sand

Collecting device:
[4] Van Veen grab sampler
[5] Orange-peel dredge
[6] Gravity core

IV. ANCIENT AND MODERN LAKES

A. Lake LeConte Basin, California and Baja California

Lake LeConte, California, archaeologic series

Samples from shoreline of Quaternary Lake LeConte (L. Coahuila, Blake Sea), in distributary system of Colorado River, SE California and NW Baja California.

720 ± 100
LJ-GAP-57. Lake LeConte, California—16 A.D. 1230

Good-grade charcoal from narrow occupation streak buried ca. 1.5 m in Split Mountain sand-dune site along shoreline of last main lake stage; off mouth of Fish Creek Canyon, Imperial Co. (ca. 33° 02.1′ N Lat, 116° 01.9′ W Long). Coll. 1953 by B. E. McCown and party, Southren California Archaeol. Asso.; subm. 1964.

420 ± 100
LJ-GAP-58. Lake LeConte, California—17 A.D. 1530

Good-grade charcoal from surface of lined square B^5-35 in dune midden area described above under LJ-GAP-57 (ca. 33° 02.2′ N Lat, 116° 01.9′ W Long). Coll. 1955 by B. E. McCown, C. L. Hubbs, and party; subm. 1964.

LJ-GAP-59. Lake LeConte, California—18 **470 ± 100**
A.D. 1480

Good-grade charcoal from occupation streak a few cm thick separated from surface midden (LJ-GAP-58) by ca. 0.6 m of sterile sand; data otherwise same as stated for LJ-GAP-58.

General Comment: LJ-GAP-57-59 were run to check the palpably too-young dates of 130 (+200, −130) yr (M-597, Michigan III) for lower layer of Split Mountain sand-dune site now re-run as LJ-GAP-59, and of 120 (+200, −120) yr (M-598, Michigan III) for surface site along ancient beachline (at these estimated times people were dying of thirst in the basin). On basis of McCown's judgment it was thought that lower occupation streak dated by M-597 and now more plausibly by LJ-GAP-59 was level that yielded several crude (Playa or Pinto) points but none of the small, refined Shoshone-type points of common and exclusive occurrence in the surficial beachline sites. Actual horizon that yielded crude points but no potsherds (some of which occur in buried level dated by M-597 and LJ-GAP-59), was collected at depth of ca. 1.5 m rather than 0.6 m at earlier date (in 1953). Charcoal from site now provides more plausible date of 720 ± 100 yr (LJ-GAP-57). Dates for LeConte shoreline were reviewed in La Jolla IV (p. 89-90).

LJ-GAP-70. Lake LeConte, Baja California Norte—4 **4800 ± 500**
2850 B.C.

Freshwater mussel (*Anodonta californiensis*) valves from surface on deposits of Pleistocene beach gravel at alt of 21 to 23 m, around tiny marble hillock barely outside contact between steep base of Sierra Cucopa and gently sloping bajada, ca. 20 km SW of Mexicali and ca. 29 km WNW of Cerro Prieto (32° 31.1′ N Lat, 115° 35.3′ W Long). Coll. 1963 and subm. 1964 by G. M. Stanley, Fresno State College (sample 13). Before counting 75.4% of inactive gas was added. *Comment:* subm. to date one of earlier, regarded as Pleistocene, freshwater stages of Lake LeConte. See review of Lake LeConte datings in La Jolla IV (p. 89-90). More adequate sample from same location, collected later, yielded more reasonable date of >50,000 yr (LJ-928, La Jolla IV, p. 89).

B. Eagle Lake, California

LJ-1354. Tree stump, Eagle Lake, California—5 **200 ± 100**
A.D. 1750

Well-preserved wood from tree stump 15 cm in diam, 0.6 m high, standing at edge of lake, Lassen Co. (40° 30′ N Lat, 120° 45′ W Long). Coll. March 1966; contr. by F. D. Uzes, California State Lands Div. Sample 2. *Comment:* conforms previous tests on stumps about Eagle Lake, recently exposed after period of flooding; see LJ-501, 440 ± 110, La Jolla III; LJ-606, 610, and 649, each <300, La Jolla IV, p. 92.

C. *Nevada*

LJ-1366. Ash Meadows Lake, Nevada **> 29,000**

Pure whitish lithoid tufa from S face of flat-topped exposure ca. 0.2 km in diam, near SE margin of this ancient lake, in SW ¼ of NW ¼ of Sec. 30, T 18 S, R 51 E, Nye Co.; the 2240-ft (683-m) contour seems to margin the exposure (36° 21′ 33″ N Lat, 116° 16′ 51″ W Long; USGS Ash Meadows Quadrangle, Nevada-California, 15′ series, 1952). Coll. 1966 by C. L. Hubbs, R. R. Miller, and party. *Comment:* lake mentioned by Hubbs and Miller (1948, p. 84 and map) and by Miller (1948: p. 18, map 1) and was named by Snyder, Hardman, and Zdenek (1964, lake no. 6A), but has been indicated as much too small on maps by all these authors. Extensive and seemingly fresh shoreline features, in addition to tufa, indicate late Pleistocene lake, but present land slope, probably resulting from depression of Death Valley sump, would preclude impoundment in Ash Meadows basin. Date indicates early Wisconsin, or earlier, age.

Lake Hubbs, Nevada series

LJ-1379. Lake Hubbs, Nevada—1 **> 30,000**

Chalky-white, nearly pure, fluffy marl, with very small content of fine sand, interbedded between cross-bedded beach-gravel, near middle of subvertical, borrow-pit exposure ca. 6 m high; alt 1907 m, determined by repeated checks with 2-ft Paulin altimeter from nearby USGS BM; near N end of section 5-6 line, T 20 N, R 59 E, in Long Valley, White Pine Co. (39° 38.2′ N Lat, 115° 21.9′ W Long; USGS Ely Sheet, NJ 11-3, 1:250,000, 1959). Coll. and subm. 1965 by C. L. and L. C. Hubbs (sample 1965–IX: 5A). *Comment:* sample from highest well-defined beachline of this ancient lake, briefly discussed as "lake in Long Valley" by Hubbs and Miller (1948, p. 57, lake no. 31) and recently named and well mapped by Snyder, Hardman, and Zdenek (1964, lake no. 52). Since lake is estimated to have been 76 m deep and to have occupied 531 km^2, 32% of its wholly enclosed basin, now almost completely dry, a much cooler and moister climate must have prevailed during its high stage. Boldness and freshness of top beachline indicates long continued optimal weather. Early Wisconsin or earlier age indicated. Disturbing measurement (LJ-GAP-31) of same sample as only 2500 ± 200 yr, obtained by an early run using new GAP preparation line, must be discounted.

LJ-GAP-31. Lake Hubbs, Nevada—2 **2500 ± 200**
550 B.C.

Measurement presumably to be discounted (see LJ-1379, above). It seems possible that active C was exchanged with the original, nearly dead carbon while fluffy marl was being washed during preparation, as may happen during processing of minute Foraminifera (Olsson, 1966) and bone (Ottawa V, p. 96-99).

V. GEOCHEMICAL PROCESSES

A. California

Dolomite formation series

Dolomite samples from depths of 0 to 3 and 11 to 14 cm in deposit of Deep Spring Lake (a spring-fed pond) in Deep Spring Valley, Inyo Co. (ca. 37° 17′ N Lat, 118° 03′ W Long). Coll. and subm. 1965 by M. N. A. Peterson.

LJ-1000-1025. Dolomite, Deep Spring Lake, California—23-48 **See table below**

The 26 new measurements on the carbonate particles are tallied below, with pertinent ancillary data.

Series from depth of 0-3 cm				Series from depth of 11-14 cm			
LJ-No.	Series No.	0-3 cm Ser. No.	App. Age B.P.[1]	LJ-No.	Series No.	11-14 cm Ser. No.	App. Age B.P.[1]
1000	23	1-1	100	1013	36	2-1	485
1001	24	1-2	420	1014	37	2-2	590
1002	25	1-3	350	1015	38	2-3	590
1003	26	1-4	760	1016	39	2-4	765
1004	27	1-5	780	1017	40	2-5	1050
1005	28	1-6	1000	1018	41	2-6	1060
1006	29	1-7	1000	1019	42	2-7	1040
1007	30	1-8	1070	1020	43	2-8	1040
1008	31	1-9	1290	1021	44	2-9	1250
1009	32	1-10	1710	1022	45	2-10	1230
1010	33	1-11	2130	1023	46	2-11	1550
1011	34	1-12	2790	1024	47	2-12	1740
1012	35	1-13	3200	1025	48	2-13	2340

[1] Error of ± 150 is ascribed to each measurement, but not as the actual counting error, with or without augmentation: 3 different counters were used, and all samples containing enough gas were run on all 3 counters, and at different pressures. Maximum variation was 150 yr (G.S.B.).

General Comment: these counts, supplementing those reported and discussed in La Jolla IV (p. 101-103), were presented and critically treated by Peterson, von der Borch, and Bien (1966). They represent effort to obtain time estimate on growth of dolomite crystals through radiocarbon measurement of successive layers laid bare by repeated chemical leaching or "peeling." Sequential order of apparent ages involves only minor irregularities.

B. South Australia

Coll. in Coorong Area; subm. 1965 by M. N. A. Peterson.

Initiation of dolomite series

All from along old shoreline 1.8 to 2.4 m above present lagoon level, Salt Cr. (ca. 36° S Lat, 139° E Long).

3160 ± 300
LJ-1387. Initiation of dolomite—1 **1210 B.C.**

Pelecypod (*Flauomala donacioides*) valves; sample Coorong Shells No. 1.

3260 ± 300
LJ-1388. Initiation of dolomite—2 **1310 B.C.**

Pelecypod (*Mytilus planulatus*) valves; nacreous layer; sample Coorong Shells No. 2a.

3770 ± 300
LJ-1389. Initiation of dolomite—3 **1820 B.C.**

Mytilus planulatus valves; calcite layer; sample Coorong Shells No. 2b.

General Comment (M.N.A.P.): dates determine time prior to initiation of conditions responsible for formation of dolomite, etc. Modern formation of dolomite is also treated under LJ-1000-1025 and in other tests and references there cited. See also LJ-GAP-3, below. Results will also augment data on changes in sealevel, when levels are carefully established in this area by survey.

1200 ± 80
LJ-GAP-3. Modern chert formation **A.D. 750**

Magnesite with SiO_2 from Magnesite Lake in Coorong, South Australia (ca. 36° S Lat, 139° E Long). Coll. and subm. 1965 by M. N. A. Peterson. *Comment* (M.N.A.P.): first reported instance of modern chert formation. For this date we report unaugmented counting error.

Kunkar sequence series

Coll. 1965 by J. B. Firman, Geological Survey of South Australia, Adelaide; subm. for him 1965 by Tj. H. Van Andel.

3800 ± 500
LJ-1380. Kunkar sequence, South Australia—1 **1850 B.C.**

Pelecypod shell (*Pitar* sp. and *Mactra (?)* sp.), from base of sequence above mottled Pleistocene beds, at Sandy Pt., 6.4 km S of Port Wakefield, near Adelaide; sample 1 (34° 12′ S Lat, 138° 09.5′ E Long). *Comment* (Tj.H.V.A.): sample postdates kunkar sequence, a Glacial or Postglacial caliche-type weathering phenomenon which had not been dated. For comparison with kunkar beds in sequence of Postglacial transgressive sediments of Timor Sea (cf. LJ-913, La Jolla IV, p. 82; LJ-994-999, 1391, 1392, 1395, 1396, section III D, this date list). As gas produced was not fully adequate, 19% of inactive gas was added.

LJ-1381. Kunkar sequence, South Australia—2 > 45,000

Pelecypod (*Anadara trapezia*) valves, from Anadara beds predating kunkar formation, in Port Wakefield Quarry; sample 2 (34° 10′ S Lat, 138° 09.5′ E Long). *Comment:* see LJ-1380, above.

LJ-1382. Kunkar sequence, South Australia—3 > 45,000

Indurated oolitic ostracod limestone (prekunkar), from Bugunnia Homestead N of Morgan; sample 5 (33° 52.5′ S Lat, 139° 46.5′ E Long). *Comment:* see LJ-1380, above.

LJ-1383. Kunkar sequence, South Australia—4 > 35,000

Anadara sp. valves from adjacent bores 1 and 4 in lime-cemented Anadara Beds on Torrens Island, near Adelaide; samples 3 & 4 (34° 45′ S Lat, 138° 31′ E Long). *Comment:* (Tj.H.V.A.): physical continuity of beds can be demonstrated; predates kunkar formation.

VI. ARCHAEOLOGY

Other measurements presumably or certainly pertaining to middens are LJ-GAP-43, for drowned midden in Tomales Bay, California (section II B); LJ-1358, 1360, 1361, and 1384, on coastal plain of Nayarit, México (section II C); LJ-GAP-57-59, for shoreline of ancient Lake LeConte, California (section IV A), this date list.

A. Wyoming

LJ-GAP-64. Natrona Co., Wyoming 1600 ± 200
A.D. 350

Charcoal from deeply buried layer, containing scrapers, in bank of Cave Gulch, trib. to headwaters of South Fork of Powder River (roughly 43° N Lat, 107° W Long). Coll. by Harry Putnam; subm. 1964. *Comment:* sample run on chance of obtaining old date for probable human occupation.

B. California

Buena Vista Lake series

Highly fragmented *Anodonta* shell from shoreline of old Buena Vista Lake, in Kern County, California, near point Q-15 on Site Ker-116 (614,988 N; 1,595,516 E on California Coordinate System Zone V); sample 4, sorted from soil sample taken 425 to 455 cm below ground surface at alt 92.4 m, below ca. 275 cm of sterile sandy soil heavily permeated with caliche (35° 10′ 55″ N Lat, 119° 21′ 20″ W Long). Coll. and subm. 1964 by D. A. Fredrickson (1940 Parker St., Berkeley, California 94704); coll. under auspices of State Div. of Beaches and Parks (F. A. Riddell, Archeologist).

LJ-1356. Buena Vista Lake, California—1 **8200 ± 400**
6250 B.C.

Unburned shell (subsample 4A) from this occupation site.

LJ-1357. Buena Vista Lake, California—2 **8200 ± 400**
6250 B.C.

Burned shell (subsample 4B) from this occupation site.

General Comment (D.A.F.): designed for obtaining date for occupation of Central Valley of California much older than that of Early component currently recognized as ca. 2000 to 4000 yr B.P., more recently as ca. 4000 to 7000 yr B.P. Relationships with San Dieguito, Mohave, and other early complexes of West Coast are postulated. Spread at random through same soil sample were also small fragments of bone, some burned, of various vertebrates, and several pieces of chipping waste of locally available materials. Soil sample (containing considerable caliche) was obtained from profile in area 20 cm thick and 600 cm wide, immediately adjacent to hearth containing small, concave flake scraper of local chert. All indications (concurred in by R. F. Heizer) are that hearth, scraper, soil sample, and shell are contemporaneous and represent residue of human occupation. Field work at site has been reported in "Current Research" in American Antiquity (vol. 30, no. 4, 1965, p. 545 and vol. 31, no. 4, 1966, p. 619). Similar circumstances pertain to LJ-528, 9630 ± 300 yr (La Jolla III) for shoreline of Lake LeConte, California. Another sample of *Anodonta* from Site Ker-116, coll. 1965 from same cultural stratum, has been dated 7600 ± 200 B.P. by Isotopes, Inc. (I-1928, unpub.).

Doubts have been expressed on validity of dates based on *Anodonta* shell, but our previous tests (see La Jolla IV, p. 69) have been consistent with expectation. Identical age of burned and unburned shell estimates are reassuring.

LJ-GAP-55. Agua Hedionda Creek,
San Diego Co., California **Contemporary**

Charcoal from cremation site on S slope of valley of this creek, on Dawson Ranch, 5.5 km S of Vista; Trench 1, Block C-3, Level 4, alt ca. 133 m (33° 09′ 03″ N Lat, 117° 14′ 14″ W Long; San Diego Co., California 1:2400 Sheet 354-1695). Coll. 1962 and subm. 1964 by J. R. Moriarty and F. H. Miller (sample UCLJ-M-No. 13). *Comment:* cremation site appeared to be pre-Spanish and to represent transition between pit cremation and prone burial practice, but date seems more recent. Indians are reputed to have occupied valley and Las Monas Canyon just downstream in historic time.

LJ-GAP-54. C. W. Harris Site, **1200 ± 100**
San Diego Co., California—5 **A.D. 750**

Charcoal from Trench No. 4, Blocks 2-3, Level 5 of San Dieguito type site, ca. 4 km E of Rancho Santa Fe along highway to Escondido; on E side of Lynch Wash; alt ca. 60 m (ca. 33° 02′ 28″ N Lat, 117° 08′

35″ W Long; USGS Rancho Santa Fe Quadrangle, 7.5′ series, 1949). Coll. 1964 and subm. 1966 by J. R. Moriarty. *Comment:* date extends measured time scale of site, already noted as only one providing full stratigraphic sequence of San Dieguito–La Jolla–Diegueño. Trench 4 also extends known area of occupation as far E as Rip Rap Wash. (See LJ-202, La Jolla II; LJ-909, 914, 915, La Jolla IV, p. 108). Location for LJ-909, 914, 915 should be corrected to read 33° 02′ 30″ N Lat, 117° 08′ 45″ W Long.

Rancho Carrillo Site series

Measurements from this archaeologic site are discussed in La Jolla IV (p. 104). Three additional dates are now available. Coll. 1963 by L. G. Jones; subm. 1966.

LJ-1374. Silver Strand, Coronado, California—7 **700 ± 100**
A.D. 1250

Pismo clam (*Tivela stultorum*) valves from surface of Station F on E slope of small conical sand dune, in well-defined concentrated deposit of this beach clam surrounded by shell-free sand, on Rancho Carrillo Site on Silver Strand, Coronado; for more particulars see measurements referred to below; sample 1963–III: 2C (32° 37′ 34″ N Lat, 117° 08′ 10″ W Long). *Comment:* from isolated, probably single-campsite midden deposit, presumably exposed by wind. Large size of Pismo clam shells suggests cool sea temperatures, consistent with previous findings along NW Baja California coast for period including this date (Hubbs, 1957, p. 19; 1960, p. 107; also various entries in La Jolla I-IV). See also previous nos. in same series: LJ 210, 211, 336, La Jolla II; LJ-592, 593, 600, La Jolla IV.

LJ-1376. Silver Strand, Coronado, California—8 **570 ± 100**
A.D. 1380

Pismo clam valves from surface of Station D on W slope of small conical sand dune from which LJ-1374 was sampled on E slope; same location. Each sample was from well-defined concentrated deposit of this clam. Sample 1963–III: 2D. *Comment:* from isolated, probably single-campsite midden deposit, presumably exposed by wind. Contrastingly small size of clams in this deposit suggests warmer sea temperatures, perhaps following hypothesized generally cold period referred to above.

LJ-1375. Silver Strand, Coronado, California—9 **900 ± 100**
A.D. 1050

Pismo clam valves from surface and uppermost dm of Station E, on rather steep slope of sand on E side of the swale wherein samples for LJ-592, 593, and 600 (La Jolla IV, p. 104) were taken; midden deposit extends only ca. 2 dm into present slope surface; sample 1963–III: 2F (32° 37′ 29″ N Lat, 117° 08′ 09″ W Long). *Comment:* it was thought, but not now confirmed, that this deposit might have been source of swale-bottom subsurface midden layer (LJ-593, 3470 ± 175) older than underlying layers (LJ-592, 305 ± 150 and LJ-600, 460 ± 150), but it now appears more recent. Small size of clams suggests warm period within time limits ascribed to cold epoch along NW Baja California coast (see LJ-1374); perhaps cold and warm periods alternated.

C. México

2760 ± 200
LJ-1390. Punta Minitas Site, Baja, California—8 810 B.C.

California mussel (*Mytilus californianus*) valves from Layer 6 (5 to 6 dm below surface) of this deep, cliff-edge midden site midway between Punta Cabras and "Punta San Isidro" (=Punta Piedras Blancas) (31° 18′ 50″ N Lat, 116° 26′ 05″ W Long; H. O. Chart 1149, 1948). Coll. 1957 by C. L. Hubbs and party; subm. 1966. *Comment:* date fits reasonably well into series previously determined (see La Jolla IV, p. 113). Neither from this site (Hubbs and Roden, 1964, fig. 1) nor in any other coast midden of California or NW Baja California have we heretofore obtained a date between 3100 and 2600 B.P.

2200 ± 300
LJ-GAP-68. Isla Cancún, Yucatan Peninsula 250 B.C.

Charcoal from midden (40 to 65 cm deep) on rock surface cutting across the 10 km of white sand beach that forms sea side of Isla Cancún, S of Isla Mujeres, facing Mar Caribe, Quintana Roo, México (21° 07′ 30″ N Lat, 86° 46′ 15″ W Long; Carta Geográfica de la República Mexicana, Cozumel 16 Q-IV, 1:500,000). Coll. 1963 (sample Q-503) and subm. 1966 by E. W. Andrews, Middle American Research Inst., Tulane Univ. (address: Quinta Mari, Calle 13, No. 203-A, San Cosme, Mérida, Yucatán, México). *Comment* (E.W.A.): midden deposit consisted of shell, pottery, and hearth-stones, attributable entirely to last phase of Formative period, predicted possibly to date 300 ± 200 B.C. See LJ-976, 2080 ± 150, La Jolla IV, based on shell *(Strombus)* from same deposit, for further discussion. Insufficient gas was augmented by 10% of inactive gas.

D. Perú

Samples subm. 1965 by J. H. Rowe, Dept. of Anthropol., Univ. of California, Berkeley; coll. by staff of this univ. No samples pretreated.

1630 ± 150
LJ-1348. Cerro Culebra, Perú A.D. 320

Charcoal from lens of habitation refuse 15 cm thick, at depth of 2 to 17 cm, containing pottery exclusively of Phase 5 of Lima style; site PV46-3, Cerro Culebra, lower part of Valle del Chillón; sample 3 (11° 56′ 30″ S Lat, 77° 07′ 54″ W Long). Coll. 1962 by T. C. Patterson. *Comment* (J.H.R.): Lima 5 is believed to date to Early Intermediate Period 7; expected long-scale age 1485 ± 30 to 1595 ± 35; average length of epochs in Early Intermediate Period 105 to 120 yr. Measurement acceptable within stated error. Clearly a long-scale measurement; short-scale measurements for same epoch are Y-126 (Yale III), 1320 ± 60, and L-335A and L-335B (Lamont IV), both 1300 ± 80.

1200 ± 100

LJ-1349. Pampa de las Animas Alta, Perú **A.D. 750**

Animal dung from excavation of refuse deposit containing pottery exclusively of Phase 9 of Nasca style; site PV62-153, Pampa de las Ánimas Alta, Callango basin, Valle de Ica; sample 2 (14° 30′ S Lat, 75° 38′ W Long). Coll. 1959 by L. E. Dawson. *Comment* (J.H.R.): relative age of sample is Middle Horizon 1; expected long-scale age 1280 ± 35 to 1370 ± 20; average length of epochs in Middle Horizon 75 to 100 yr. Measurement acceptable as long-scale, as being within assigned error. Compare P-511 (Pennsylvania VI), 1345 ± 118, on sample of same relative age. Another dung sample (UCLA-972, 880 ± 80) has been dated from same site (UCLA V, p. 477).

2100 ± 200

LJ-1350. Pampa Media Luna, Perú **150 B.C.**

Llama and guinea-pig dung from refuse deposit containing pottery exclusively of Phase 9 of Ocucaje style; site PV62-148, Pampa Media Luna, Callango basin, Valle de Ica; sample 1 (14° 29′ 30″ N Lat, 75° 38′ W Long). Coll. by L. E. Dawson. *Comment* (J.H.R.): relative date of sample is Early Horizon 9, to which earliest known copper implements in Perú can be assigned. Expected long-scale age 2370 ± 35 to 2470 ± 50; average length of epochs in Early Horizon 85 to 110 yr. Measurement lies slightly beyond expected range on long scale. Compare 0-1692 (Rowe, 1966), 2400 ± 110, on sample of same relative age. LJ-1350 is closer to short scale; compare L-335D (Lamont IV), 1940 ± 100, on sample of same relative age. UCLA-972 (UCLA V), 880 ± 80, is unacceptably late measurement on another portion of same sample as LJ-1350. *General Comment* (J.H.R.): series contributes little to solution of problem of existence of 2 contrasting radiocarbon time scales for Peruvian archaeology (Rowe, 1966).

E. Ungava Peninsula, Québec

800 ± 100

LJ-1351. Michéa Site, Payne Lake **A.D. 1150**

Slightly charred decayed stem of dwarf arctic birch (sample 2), from House Pit No. 10, Trench 3, Level 14; N side of Payne River, 0.4 km below outlet of Payne Lake, 4 m above river level; definitely from oldest house floor (deposits clearly stratified, resting on clean yellow sand); depth 48 cm; overlying vegetation lichens and mosses only (ca. 59° 17′ N Lat, 73° 20′ W Long). Coll. 1964 and subm. 1966 by T. E. Lee, Laval Univ., Québec, through J. R. Moriarty. *Comment* (T.E.L.): since 1948 site has been erroneously ascribed to Dorset culture. 1964 field work indicated pits were not dug by people of that culture. Stone work is identical with historic Sadlermiut culture (Eskimo). Origins of these cultures are poorly known. First known inland occurrence of either Dorset or Sadlermiut culture.

LJ-1355 + 1359. Deception Bay Stone Dwelling Contemporary

Adequate supply of mammal bones of several species, from ca. 0.6 to 0.7 m beneath upper surface of 2-layered stone paving of collapsed beehive-shaped stone dwelling, in habitation site on hill at head of bay; sample buried ca. 73 to 85 cm in rock rubble, which rested on dry, loose stone rubble (62° 30′ N Lat, ca. 76° W Long). Coll. 1965 and subm. 1966 by T. E. Lee. *Comment* (T.E.L.): this large site has only such dwelling known in Ungava; several lines of evidence suggest it is not Eskimo site; it was thought perhaps attributable to pre-Thule period; overlying lichens and moss suggest antiquity of at least a century. Note on preparation: after having been boiled in dilute HCl, bones were thoroughly roasted under purified He, to produce ca. 80 g charcoal. Much organic material exuded and much unpleasant odor resulted. Supply of collagen was obtained by acid treatment of some of sample, but this has not been run. Carbonate fraction of mammal bones has been shown unreliable for dating by Berger, Horney, and Libby (1964), by Krueger (1966), and in Ottawa V (p. 96-99) and Texas IV (p. 454-455). Radioactivity of charcoal slightly exceeded that of 1878 wood standard.

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Monaco II	Thommeret and Thommeret, 1966
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Pennsylvania VI	Stuckenrath, 1963
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UCLA V	Berger and Libby, 1966
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