

MONACO RADIOCARBON MEASUREMENTS II

J. THOMMERET and Y. THOMMERET

Centre Scientifique de Monaco

This series reports some of the measurements made since publication of the previous list. Chemical preparation of samples is basically the same as described in Monaco I.

The counting electronics of the proportional counter has been entirely rebuilt by J. Galliot and P. Albertinoli of C.S.M. The new device is transistorized and battery-operated. At regular intervals of time, usually 10 min, the count (anti-coincidence channel) is printed in tape. Large deviations from the mean are easily visible and can lead to rejection of the measurement if the distribution is not normal, i.e. does not fit a straight line on Gaussian paper.

No δC^{13} measurements have been made, and carbonate substances are dated by reference to the standard without correction. All the ages have been calculated using the formula

$$T = - \frac{t_{1/2}}{\ln 2} \ln (1 + 10^{-3} \times \delta C^{14})$$

where $\delta C^{14} = \frac{\text{Sample Activity} - 0.95 \text{ NBS Activity}}{0.95 \text{ NBS Activity}} \times 1000$

C^{14} half life value $t_{1/2} = 5568 \pm 30$ yr. The reference year is 1950.

Precision measurements are given with one standard deviation, calculated by combining deviations of the unknown sample, the background and the modern sample, these last two taken over a period of several weeks with at least three independent fillings. When the net sample activity, with a standard deviation σ , is less than 2σ above the background, an infinite age is reported, and when the activity is greater than 0.95 NBS minus 2σ , a modern date is given.

Besides the dates reported here, a series of ten measurements has been made of C^{14} content of surface and deep sea-water of the north Indian Ocean, collected in 1963 (Thommeret and others, 1965).

SAMPLE DESCRIPTIONS**I. GEOLOGIC SAMPLES***A. France***Beaulieu Canyon series, Alpes Maritimes**

Three samples taken in May 1961 in Beaulieu submarine canyon, from R/V Winnaretta Singer. Coll. and subm. by M. Gennesseaux, Lab. de Géog. Physique et Géol. Dynamique, Faculté des Sci. Paris.

MC-22. Beaulieu Canyon I**18,200 ± 1000****16,250 B.C.**

Piece of bryozoan, 12 mm diam, taken in core no. 123 (43° 34' N Lat, 7° 26' E Long), 1080 m depth in axis of canyon.

MC-24. Beaulieu Canyon 2 **22,800 ± 1000**
20,850 B.C.

Compact ooze from canyon wall taken at 1950 m depth, dredging no. 677 (43° 38' N Lat, 7° 27' E Long). Grain-size fractions are 0.25 to 0.08 mm.

MC-25. Beaulieu Canyon 3 **20,300 ± 1000**
18,350 B.C.

White, very compact bottom ooze, dredging no. 677. Grain-size fractions are 0.25 to 0.08 mm.

General Comment (M.G.): measurements show a type of sedimentation essentially pelagic on the continental slope during Würmian period and prove recent submarine erosion involving formation of some canyons; MC-22 suggests outcrop of old compact deposits in head of canyon and their erosion by slumping.

Monaco series

MC-52. Monaco 1 **21,000 ± 1000**
19,050 B.C.

Shells of *Ptereria chione* L. from sea-deposit at +2.5 m above present sealevel, found near S entrance of road tunnel under Rock of Monaco (43° 43' 50" N Lat, 7° 25' 3" E Long). Coll. 1957 by members of Assoc. de Préhistoire et de Spéléologie; subm. by L. Barral, Conservator of Musée d'Anthropol. Préhistorique de Monaco.

MC-53. Monaco 2 **16,600 ± 700**
14,650 B.C.

Organic matter from sandy tubes ("Hermelles") of the polychaetous worm *Sabellaria alveolata* (L.). Coll. as MC-52. *Comment* (L.B.): MC-52 and MC-53 may date a sealevel of last interstadial Würmian period (W_{III} - W_{IV}).

MC-54. Monaco 3 **>30,000**

Big shell of *Spondylus gaederopus* L. from colony found in small rocky cavity at +16 m level, in the course of grading works, Boulevard Charles III (43° 43' 52" N Lat, 7° 24' 52" E Long). Coll. by Travaux Publics de Monaco; subm. by L. Barral. *Comment*: date given is that of carbonate fraction, but no deduction can be drawn, as there is a large difference of age (more than 15,000 yr) between internal and external parts of the shell.

MEDITERRANEAN OPEN-SEA CORES

Samples from two piston-cores, taken at area distant from coast in western basin of Mediterranean Sea. Coll. summer 1962 from R/V Calypso; subm. by J. Ros, Centre des Faibles Radioactivités, C.N.R.S., Gif sur Yvette, (S. & O.), France.

Core no. 16 series

Taken at depth 2460 m (41° 22' N Lat, 05° 53.5' E Long), sedimentary column is 170 cm long and shows two layers: an upper yellow mud (0 to 117 cm), overlying sand (117 to 170 cm). Two foraminiferan layers are found in mud portion at 14 and 60 cm. Ca. 42% CaCO₃. The coarse fraction (>40 μ) is below 10% and composed of shells of foraminifera. Deeper sand appears homogeneous in grain size and the coarse fraction is almost constant. All samples analyzed are bulk CaCO₃ from mud section.

		3400 ± 200
MC-27.	C 16, 0-10 cm	1450 B.C.
		6350 ± 300
MC-28.	C 16, 17-25 cm	4400 B.C.
		13,200 ± 470
MC-29.	C 16, 47-56 cm	11,250 B.C.
		25,700 ± 1400
MC-30.	C 16, 100-108 cm	23,750 B.C.

Comment (J.R.): MC-27 value agrees with results obtained at C.F.R. (Saclay I). As reworked carbonate may have been present, age should be considered maximum. Sedimentation rate is markedly constant: 5 to 21 cm, 5.3 cm/1000 yr; 21 to 51 cm, 4.3 cm/1000 yr; 51 to 104 cm, 4.2 cm/1000 yr.

Core no. 18 series

Taken at depth 2525 m (41° 02.5' N Lat, 05° 35.5' E Long). Sedimentary column of 88 cm long is composed of yellow mud, containing foraminiferan and pteropod layers. Average content of CaCO₃ is 53%. Coarse fraction averages 14% and is composed of shells of foraminifera and pteropods. All C¹⁴ analysis made on the bulk CaCO₃.

		3050 ± 220
MC-31.	C 18, 0-4 cm	1100 B.C.
		6250 ± 200
MC-32.	C 18, 21-27 cm	4300 B.C.
		6960 ± 200
MC-33.	C 18, 42-50 cm	5010 B.C.
		9840 ± 400
MC-34.	C 18, 60-66 cm	7890 B.C.

General Comment (J.R.): MC-31 value of surface layer 0 to 4 cm similar to MC-27. Sedimentation rate is very irregular as in most other Mediterranean cores but unlike core no. 16: 2 to 24 cm, 6.8 cm/1000 yr; 24 to 46 cm, 31.0 cm/1000 yr; 46 to 63 cm, 5.8 cm/1000 yr.

B. Lebanon

Lebanon littoral series, Tabarja

The Lebanon shore shows, all along its rocky limestone coast, a peculiar facies called "le trottoir" (the bench), constituted by tabular agglomerates of sessile gastropod mollusks, *Vermetus* sp. At coast NE of Beirut, between Nahr Ibrahim River and Bay of Jounieh, a raised blackish bench lies behind infra-littoral bench, at ca. 1 m above present sea-level. Upheaval of higher bench seems to result from a recent tectonic movement, as suggested by remains of pottery and tiles found in the dead bioherm. Samples coll. Oct. 1964 and subm. by M. Fevret, Lab. de Géog. d'Aix, France, and P. Sanlaville, Inst. de Géog. de Beyrouth, Lebanon.

MC-63. Tabarja 1 **1635 ± 130**
A.D. 315

MC-64. Tabarja 2 **1560 ± 140**
A.D. 390

MC-63 and MC-64: fossil shells of *Dendropoma petraeum* (Monterosato) from upper bench of Tabarja (34° 02' N Lat, 35° 37' E Long).

MC-65. Tabarja 3 $\delta C^{14} = +19 \pm 13\%$

Shells of living *Dendropoma* taken at Bouar Tabarja (34° 03' N Lat, 35° 37' E Long) on present mediolittoral bench.

General Comment (M.F. and P.S.): age found for MC-63 and MC-64 confirms that upheaval of higher bench is related to one of the seisms which affected Lebanon shore in late Roman Empire or early medieval time and may correspond to earthquake that destroyed Beirut in A.D. 551. MC-65 shows enrichment of the biocenosis by recent C¹⁴ bomb effects. Thus no correction needed for MC-63 and MC-64.

C. Viet Nam

MC-60. Glacière de Cholon **12,230 ± 270**
10,280 B.C.

Wood from 68.6 m depth below surface in boring in "Glacière de Cholon" (Quaternary alluvium of Donnaï delta), Saïgon, South Viet Nam (10° 45' N Lat, 106° 39' E Long). Coll. 1962 and subm. by E. Saurin, Univ. of Saïgon, Viet Nam. *Comment* (E.S.): age shows rapid filling in area, considered to be part of Mekong-Donnaï delta since the end of Würm.

II. ARCHAEOLOGIC SAMPLES

A. France

MC-55. Beaulieu sur Mer, Alpes Maritimes **27,500 ± 1400**
25,550 B.C.

Carbonaceous earth from a well-characterized fireplace (2 m long, 30 cm thick) found at 4 m below present ground level, on a paleosol from an interstadial Würmian loess deposit (probably W_{II} - W_{III}). This paleosol, included in a defined stratigraphy, is overlain by strongly red-

dened clay layer, another paleosol spotted with pseudo-mycelium (2 m thick), and present ground, Beaulieu sur Mer (43° 42' 9" N Lat, 7° 11' 40" E Long). Coll. 1961 and subm. by G. Jaworsky, Musée d'Anthropol. Préhistorique de Monaco. *Comment* (G.I.): date confirms human occupation in area at very early epoch.

2500 ± 100**MC-81. Annecy lacustrine city, Haute Savoie****550 B.C.**

Section of hard Quercus wood, diam 2 in., found in Lake of Annecy; from "Palafitte" ("Lake Dwellers'") city of Roselet, near Duingt (45° 50' N Lat, 6° 10' E Long). Coll. June 1963 and subm. by Dr. P. Servettaz. *Comment*: date, though very young, could correspond to late Alpine Bronze Age and thus agree with expectation (Blanchard, 1958, p. 31-33).

*B. Viet Nam***Hang Gon series**

Two samples of charcoal found in field of burial urns (used for cremation burials) on archaeological site of Hang Gon, near Xuan Loc, South Viet Nam (10° 48' N Lat, 107° 15' E Long). Coll. Jan. 1963 and subm. by E. Saurin.

2190 ± 150**MC-61. Hang Gon 1****240 B.C.**

Charcoal found in Jar no. 1.

2300 ± 150**MC-62. Hang Gon 2****350 B.C.**

Charcoal found around jars.

General Comment (E.S.): it is reasonable to suppose that these samples of charcoal were contemporaneous with the jars, in or around which they were found. Their age supplies date for "Sa Yuinh" culture which developed on S coast of Viet Nam and influenced neighbouring regions of Philippines and Malaya. Archaeological estimates indicated date near the beginning of the Christian era, and are confirmed.

III. ATMOSPHERIC RADIOCARBON

Atmospheric radiocarbon series, Monaco

The following list covers samples of atmospheric CO₂ measured since 1962 to determine increase of C¹⁴ in air. For each measurement 2 L 0.5N carbonate-free NaOH are exposed to atmospheric CO₂ for 5 days, in a plastic tray on terrace of Musée Océanographique de Monaco (43° 43' N Lat, 7° 25' E Long, alt 80 m). Site is believed to be far enough from domestic and industrial fuel sources.

		$\delta C^{14}/\text{‰}$
MC-66.	Aug. 1962	349 ± 10
MC-67.	Dec. 1962	353 ± 10
MC-69.	Aug. 1963	754 ± 15

MC-70.	May 1964	957 ± 15
MC-71.	Aug. 1964	850 ± 15
MC-72.	Nov. 1964	828 ± 15
MC-73.	Nov. 1964	740 ± 15
MC-74.	Feb. 1965	751 ± 15
MC-75.	May 1965	809 ± 15
MC-76.	Aug. 1965	814 ± 15

MC-72 was coll. on top of Mont Agel (43° 46' N Lat, 7° 25' E Long, alt 1095 m), far from houses, roads and factory smoke, to compare with MC-73, coll. near sealevel. *Comment:* results are in close agreement with those published by other labs. (Uppsala VI, UCLA IV).

Modern organisms series

MC-77. Modern organisms 1 $\delta C^{14} = +751 \pm 15\%$

Buds of sea-pines grown near sealevel in Monaco. Coll. June 1965.

MC-58. Modern organisms 2 $\delta C^{14} = +93 \pm 10\%$

Shells of *Mytilus galloprovincialis*. Coll. alive March 1964 on rocks of Cape Martin at sealevel (43° 45' N Lat, 7° 29' E Long).

MC-80. Modern organisms 3 $\delta C^{14} = +113 \pm 10\%$

Bryozoan: *Retepora cellulosa*. Coll. July 1965 by diving near Musée de Monaco at 35 m depth.

General Comment: measurements are part of a work intended to determine relative rapidity of C¹⁴ transfer from air into terrestrial plants and shallow-water marine organisms.

REFERENCES

Date lists:

Saclay I	Delibrias, Guillier and Labeyrie, 1964
Saclay II	Delibrias, Guillier and Labeyrie, 1965
UCLA IV	Berger, Fergusson and Libby, 1965
Uppsala VI	Olsson and Karlen, 1965

- Blanchard, R., 1958, Annecy, essai de géographie humaine, ed. by Soc. des Amis du Vieil Annecy, 1 Rue Camille-Dunant, Annecy.
- Fevret, M., and Sanlaville, P., 1965, Contribution à l'étude du littoral libanais: Méditerranée, no. 2, p. 114-132.
- Gennesseaux, M., 1963, Structure et morphologie de la pente continentale de la région niçoise: Rapports et Procès Verbaux des Réunions de la CIESM, v. 17, no. 3, p. 991-998.
- Movius, H., 1960, Radiocarbon dates and Upper Palaeolithic archaeology in central and western Europe: Current Anthropol., v. 1, no. 5-6, p. 336-391.
- Nydal, R., 1960, Increase in radiocarbon from the most recent series of thermocarbon tests: Nature, v. 200, no. 4902, p. 212-214.
- Perès, J. M., and Picard, J., 1964, Nouveau manuel de bionomie benthique de la mer Méditerranée: Rec. Trav. St. Mar. Endoume, v. 47, no. 31, p. 16-19.
- Thommeret, J., and Thommeret, Y., 1964, Validité de la datation des sédiments du proche quaternaire par le dosage du carbone 14 dans les coquilles: Rapports et Procès Verbaux des Réunions de la CIESM, v. 28, no. 3, in press.
- Thommeret, J., Thommeret, Y., and Galliot, J., 1965, Teneur en radiocarbonate des eaux profondes et superficielles du nord de l'océan Indien: Bull. de l'Inst. Océanog. Monaco, v. 65, no. 1347.