

# TABLE OF CONTENTS

## VOLUME 160—SCIENTIFIC RESULTS

### SECTION 1: MEDITERRANEAN PALEOCEANOGRAPHY AND SAPROPELS

1. Sedimentological and stable isotope changes at the Messinian/Pliocene boundary in the Eastern Mediterranean (Holes 968A, 969A, and 969B) . . . . .	3
C. Pierre, J.-M. Rouchy, and M.-M. Blanc-Valleron	
2. The Miocene/Pliocene boundary in the Eastern Mediterranean: results from Sites 967 and 969 . . . . .	9
S. Spezzaferri, M.B. Cita, and J.A. McKenzie	
3. The sapropel theme of Leg 160. . . . .	29
K.-C. Emeis and T. Sakamoto	
4. Continuous sedimentary sequences from the Eastern Mediterranean Sea: composite depth sections . . . . .	37
T. Sakamoto, T. Janecek, and K.-C. Emeis	
5. Magnetostratigraphy of Pliocene–Pleistocene sediments from the Eastern Mediterranean Sea . . . . .	61
C. Richter, A.P. Roberts, J.S. Stoner, L.D. Benning, and C.T. Chi	
6. <i>Data Report</i> : High-resolution study of magnetic properties of sapropel-bearing sediments from Sites 966, 967, and 969, Eastern Mediterranean Sea. . . . .	75
J.S. Stoner, C. Richter, and A.P. Roberts	
7. Quantitative calcareous nannofossil biostratigraphy of Pliocene and Pleistocene sediments from the Eratosthenes Seamount region in the Eastern Mediterranean . . . . .	83
T.S. Staerker	
8. Calcareous nannofossil quantitative biostratigraphy of Holes 969E and 963B (Eastern Mediterranean). . . . .	99
E. Di Stefano	
9. Calcareous nannofossils in the basal Zanclean of the Eastern Mediterranean Sea: remarks on paleoceanography and sapropel formation . . . . .	113
D. Castradori	
10. Pliocene and Pleistocene biostratigraphy of <i>Bachmayerella tenuis</i> and <i>Incertae sedis</i> , forma A, Eastern Mediterranean, Holes 965A, 966A, 967A, and 969A. . . . .	125
S. Spezzaferri and D. Spiegler	
11. Late Quaternary polycystine radiolarians and silicoflagellates of a diatomaceous sapropel from the Eastern Mediterranean, Sites 969 and 971 . . . . .	137
T. Danelian and D. Frydas	
12. Integrated calcareous plankton biostratigraphy and cyclostratigraphy at Site 964 . . . . .	155
R. Sprovieri, E. Di Stefano, M. Howell, T. Sakamoto, A. Di Stefano, and M. Marino	
13. Stable isotope chronology and paleoceanographic history of Sites 963 and 964, Eastern Mediterranean Sea. . . . .	167
M.W. Howell, R.C. Thunell, E. Di Stefano, R. Sprovieri, E.J. Tappa, and T. Sakamoto	

14. Oxygen isotope and sapropel stratigraphy in the Eastern Mediterranean during the last 3.2 million years .....	181
D. Kroon, I. Alexander, M. Little, L.J. Lourens, A. Matthewson, A.H.F. Robertson, and T. Sakamoto	
15. Base of large <i>Gephyrocapsa</i> and astronomical calibration of early Pleistocene sapropels in Site 967 and Hole 969D: solving the chronology of the Vrica section (Calabria, Italy).....	191
L.J. Lourens, F.J. Hilgen, and I. Raffi	
16. The trace element budget of the Eastern Mediterranean during Pliocene sapropel formation .....	199
I.A. Nijenhuis, H.-J. Brumsack, and G.J. De Lange	
17. The formation of Pliocene Mediterranean sapropels: constraints from high-resolution major and minor element studies .....	207
R. Wehausen and H.-J. Brumsack	
18. Mineralogical record of cyclic climate changes in Mediterranean mid-Pliocene deposits from Hole 964 (Ionian Basin) and from Punta Piccola (Sicily).....	219
F. Mélières, A. Foucault, and M.-M. Blanc-Valleron	
19. Paleoproductivity and climate variations during sapropel deposition in the Eastern Mediterranean Sea .....	227
L. Diester-Haass, C. Robert, and H. Chamley	
20. Sedimentary sulfur and iron chemistry in relation to the formation of Eastern Mediterranean sapropels .....	249
H.F. Passier and G.J. De Lange	
21. Biological marker significance of organic matter origin in sapropels from the Mediterranean Ridge, Site 969 .....	261
I. Bouloubassi, G. Guehenneux, and J. Rullkötter	
22. Biological marker significance of organic matter origin and transformation in sapropels from the Pisano Plateau, Site 964 .....	271
J. Rullkötter, J. Rinna, I. Bouloubassi, B.M. Scholz-Böttcher, P.A. Meyers, L. Johns, and S.J. Rowland	
23. Molecular paleontology of eastern Mediterranean sapropels: evidence for photic zone euxinia .....	285
H.-J. Bosch, J.S. Sinninghe Damsté, and J.W. de Leeuw	
24. <i>Data Report: Characterization of distributions of photosynthetic pigments in sapropel from Holes 966D and 969C</i> .....	297
V. Cariou-Le Gall, A. Rosell-Mele, and J.R. Maxwell	
25. The response of bacterial populations to sapropels in deep sediments of the Eastern Mediterranean (Site 969) .....	303
B.A. Cragg, K.M. Law, A. Cramp, and R.J. Parkes	
26. Stable isotope and alkenone temperature records of sapropels from Sites 964 and 967: constraining the physical environment of sapropel formation in the Eastern Mediterranean Sea .....	309
K.-C. Emeis, H.-M. Schulz, U. Struck, T. Sakamoto, H. Doose, H. Erlenkeuser, M. Howell, D. Kroon, and M. Paterno	
27. Microfabric and microcompositional studies of Pliocene and Quaternary sapropels from the Eastern Mediterranean.....	333
A.E.S. Kemp, R.B. Pearce, J. Pike, and J.E.A. Marshall	

28. A lamina-scale, SEM-based study of a late Quaternary diatom-ooze sapropel from the Mediterranean Ridge, Site 971 . . . . .	349
R.B. Pearce, A.E.S. Kemp, I. Koizumi, J. Pike, A. Cramp, and S.J. Rowland	
29. Sulfate reduction and related stable isotope ( <sup>34</sup> S, <sup>18</sup> O) variations in interstitial waters from the Eastern Mediterranean . . . . .	365
M.E. Böttcher, H.-J. Brumsack, and G. J. de Lange	

**SECTION 2: ERATOSTHENES SEAMOUNT**

30. Cretaceous foraminiferal bio-isotope stratigraphy of Hole 967E and Paleogene planktonic foraminiferal biostratigraphy of Hole 966F, Eastern Mediterranean . . . . .	377
I. Premoli Silva, S. Spezzaferri, and A. D'Angelantonio	
31. <i>Data Report: Biostratigraphy of Eocene and Upper Cretaceous chalks from the Eratosthenes Seamount region in the Eastern Mediterranean</i> . . . . .	395
T. S. Staerker	
32. Lithofacies evidence for the Cretaceous–Paleogene sedimentary history of Eratosthenes Seamount, Eastern Mediterranean, in its regional tectonic context (Sites 966 and 967) . . . . .	403
A.H.F. Robertson	
33. Miocene shallow-water carbonates on the Eratosthenes Seamount, easternmost Mediterranean Sea . . . . .	419
A.H.F. Robertson	
34. Evidence of Messinian nonmarine deposition at Site 968 (Cyprus lower slope) . . . . .	437
M.-M. Blanc-Valleron, J.-M. Rouchy, C. Pierre, D. Badaut-Trauth, and M. Schuler	
35. <i>Data Report: Geochemistry of Pliocene and Miocene carbonates from the Eratosthenes Seamount (Site 965)</i> . . . . .	447
M.E. Böttcher, Y. Mart, H.-J. Brumsack	
36. Late Miocene paleoenvironments and tectonic setting of the southern margin of Cyprus and the Eratosthenes Seamount . . . . .	453
A.H.F. Robertson	
37. Significance of lower Pliocene mass-flow deposits for the timing and process of collision of the Eratosthenes Seamount with the Cyprus active margin . . . . .	465
A.H.F. Robertson	
38. Evolution of paleoenvironments of Eratosthenes Seamount based on downhole logging integrated with carbonate petrology and reflection profiles . . . . .	483
C.O. Major, W.B.F. Ryan, and M.J. Jurado-Rodríguez	
39. Subsidence record of early-stage continental collision, Eratosthenes platform (Sites 966 and 967) . . . . .	509
B.M. Whiting	
40. Structural evidence for the nature of hiatal gaps in the Upper Cretaceous to Holocene succession recovered from the Eratosthenes Seamount . . . . .	517
R. Flecker, A. Kopf, and M.J. Jurado-Rodríguez	
41. Present-day stress indicators from a segment of the African-Eurasian plate boundary in the Eastern Mediterranean Sea: results of Formation MicroScanner data . . . . .	527
M.J. Jurado-Rodríguez and M. Brudy	

42. Acoustic properties from logs and discrete measurements (Sites 966 and 967) on Eratosthenes Seamount: controls and ground truth. . . . .	535
J.M. Woodside, J.A.M. Kenter, and A. Köhnen	

43. Pleistocene fanlomerate deposition related to uplift of the Troodos Ophiolite, Cyprus. . . . .	545
A. Poole and A. Robertson	

**SECTION 3: MUD VOLCANISM**

44. Pore-water indications for the occurrence of gas hydrates in Eastern Mediterranean mud dome structures . . . . .	569
G.J. De Lange and H.-J. Brumsack	

45. Origin of clasts and matrix within the Milano and Napoli mud volcanoes, Mediterranean Ridge accretionary complex . . . . .	575
A.H.F. Robertson and A. Kopf	

46. Mud volcanic samples in the context of the Mediterranean Ridge mud diapiric belt. . . . .	597
G.C. Akhmanov and J.M. Woodside	

47. Some clues about the Napoli and Milano mud volcanoes from an integrated log-core approach . . . . .	607
M.J. Jurado-Rodríguez and F. Martínez-Ruiz	

48. Variations in sediment physical properties and permeability of mud-volcano deposits from Napoli Dome and adjacent mud volcanoes . . . . .	625
A. Kopf, M.B. Clennell, and A. Camerlenghi	

49. Relationship between the variation of undrained shear strength, organic carbon content, and the origin and frequency of enigmatic normal faults in fine-grained sediments from advanced piston cores from the Eastern Mediterranean . . . . .	645
A. Kopf, M.B. Clennell, and R. Flecker	

**SECTION 4: SYNTHESSES**

50. Tectonic setting and processes of mud volcanism on the Mediterranean Ridge accretionary complex: evidence from Leg 160. . . . .	665
A.H.F. Robertson and A. Kopf	

51. Formation and destruction of the Eratosthenes Seamount, Eastern Mediterranean Sea, and implications for collisional processes . . . . .	681
A.H.F. Robertson	

52. Eratosthenes Seamount: an oceanographic yardstick recording the Late Mesozoic–Tertiary geological history of the Eastern Mediterranean . . . . .	701
Y. Mart and A.H.F. Robertson	

53. Eratosthenes Seamount: the possible spearhead of incipient continental collision in the Eastern Mediterranean . . . . .	709
D. Kempler	

54. Mesozoic–Tertiary tectonic evolution of the easternmost Mediterranean area: integration of marine and land evidence . . . . .	723
A.H.F. Robertson	

**SECTION 5: INDEX**

Index . . . . .	785
-----------------	-----

## BACK-POCKET MATERIALS

### Oversized Table

Chapter 30, Table 3. Distribution of Upper Cretaceous isolated planktonic foraminifers in Hole 967E.

### CD-ROM

The “*Proceedings, Scientific Results*” CD-ROM contains an electronic version of the Leg 160 *Scientific Results* volume in Adobe Acrobat, as well as data sets not included in the printed volume (see directory structure below). The volume is designed for Adobe Acrobat Reader 3 software, which is supplied on the CD. All files with a .PDF extension should be viewed through Acrobat. Data files in ASCII format (files with .TXT extensions) should be opened through a spreadsheet or text-editing software application.

There are four starting points for this CD:

**ACROREAD.TXT** is an ASCII file that explains how to install Adobe Acrobat on any of the available platforms.

**README.PDF** is an Acrobat file that contains information about the CD, lists available files and how to use them, and describes how the core images were created.

**README.TXT** is an ASCII file that contains information about the CD, lists available files and how to use them, and describes how the core images were created.

**160SR.PDF** lists the table of contents for this volume and contains links to the volume chapters.

### **PROCEEDINGS, SCIENTIFIC RESULTS CD**

#### **Directory Structure:**

ACROREAD.TXT (readme file for Acrobat Reader)  
README.PDF (PDF readme file for Leg 160 *Scientific Results* volume)  
README.TXT (ASCII readme file for Leg 160 *Scientific Results* volume)  
160SR.PDF (volume table of contents)  
ACROREAD (Acrobat software)  
VOLUME  
  PRELIM.PDF (volume preliminary pages)  
  CHAPTERS (volume chapters)  
    CHAP\_01.PDF  
    CHAP\_03.PDF  
    CHAP\_04.PDF  
    CHAP\_05.PDF  
    CHAP\_06.PDF  
    CHAP\_07.PDF  
    CHAP\_08.PDF  
    CHAP\_09.PDF  
    CHAP\_10.PDF  
    CHAP\_11.PDF  
    CHAP\_12.PDF  
    CHAP\_13.PDF  
    CHAP\_14.PDF  
    CHAP\_15.PDF  
    CHAP\_16.PDF  
    CHAP\_17.PDF  
    CHAP\_18.PDF  
    CHAP\_19.PDF  
    CHAP\_20.PDF  
    CHAP\_21.PDF  
    CHAP\_22.PDF  
    CHAP\_23.PDF  
    CHAP\_24.PDF

CHAP\_25.PDF  
CHAP\_26.PDF  
CHAP\_27.PDF  
CHAP\_28.PDF  
CHAP\_29.PDF  
CHAP\_30.PDF  
CHAP\_31.PDF  
CHAP\_32.PDF  
CHAP\_33.PDF  
CHAP\_34.PDF  
CHAP\_35.PDF  
CHAP\_36.PDF  
CHAP\_37.PDF  
CHAP\_38.PDF  
CHAP\_39.PDF  
CHAP\_40.PDF  
CHAP\_41.PDF  
CHAP\_42.PDF  
CHAP\_43.PDF  
CHAP\_44.PDF  
CHAP\_45.PDF  
CHAP\_46.PDF  
CHAP\_47.PDF  
CHAP\_48.PDF  
CHAP\_49.PDF  
CHAP\_50.PDF  
CHAP\_51.PDF  
CHAP\_52.PDF  
CHAP\_53.PDF  
CHAP\_54.PDF  
160INDEX.PDF

BACKPKT (back-pocket table)

CD\_ONLY (see below for list of files)

ODPINDEX (Compiled Electronic Index of the *Proceedings of the Ocean Drilling Program*)

**List of CD-ONLY files by chapter:**

**CHAP\_04** (Chapter 4):

TABLES (ASCII versions of text tables):

- 04\_01.TXT: Table 1. Revised composite depth section of Site 964.
- 04\_02.TXT: Table 2. Coring gaps in Site 964.
- 04\_03.TXT: Table 3. Faulting and erosional gaps in Site 964.
- 04\_04.TXT: Table 4. Revised composite depth section of Site 966.
- 04\_05.TXT: Table 5. Coring gaps in Site 966.
- 04\_06.TXT: Table 6. Revised composite depth section of Site 967.
- 04\_07.TXT: Table 7. Coring gaps in Site 967.
- 04\_08.TXT: Table 8. Revised composite depth section of Site 969.
- 04\_09.TXT: Table 9. Coring gaps in Site 969.
- 04\_10.TXT: Table 10. Faulting and erosional gaps in Site 969.
- 04\_11.TXT: Table 11. Dips of inclination in Hole 969D.

DATA (Data sets and tables of r\_composites and color reflectance):

- 964RCOMP.TXT: Revised composite depth section of Site 964.
- 964ARMCD.TXT: Color reflectance data sets of Hole 964A.
- 964BRMCD.TXT: Color reflectance data sets of Hole 964B.
- 964CRMCD.TXT: Color reflectance data sets of Hole 964C.
- 964DRMCD.TXT: Color reflectance data sets of Hole 964D.
- 964ERMCD.TXT: Color reflectance data sets of Hole 964E.
- 964FRMCD.TXT: Color reflectance data sets of Hole 964F.
- 964ATIE.TXT: Tie points of Hole 964A.
- 964BTIE.TXT: Tie points of Hole 964B.
- 964CTIE.TXT: Tie points of Hole 964C.
- 964DTIE.TXT: Tie points of Hole 964D.
- 964ETIE.TXT: Tie points of Hole 964E.
- 964FTIE.TXT: Tie points of Hole 964F.
- 966RCOMP.TXT: Revised composite depth section of Site 966.
- 966ARMCD.TXT: Color reflectance data sets of Hole 966A.
- 966BRMCD.TXT: Color reflectance data sets of Hole 966B.
- 966CRMCD.TXT: Color reflectance data sets of Hole 966C.
- 966DRMCD.TXT: Color reflectance data sets of Hole 966D.
- 966ATIE.TXT: Tie points of Hole 966A.
- 966BTIE.TXT: Tie points of Hole 966B.
- 966CTIE.TXT: Tie points of Hole 966C.
- 966DTIE.TXT: Tie points of Hole 966D.
- 967RCOMP.TXT: Revised composite depth section of Site 967.

- 967ARMCD.TXT: Color reflectance data sets of Hole 967A.
  - 967BRMCD.TXT: Color reflectance data sets of Hole 967B.
  - 967CRMCD.TXT: Color reflectance data sets of Hole 967C.
  - 967DRMCD.TXT: Color reflectance data sets of Hole 967D.
  - 967ATIE.TXT: Tie points of Hole 967A.
  - 967BTIE.TXT: Tie points of Hole 967B.
  - 967CTIE.TXT: Tie points of Hole 967C.
  - 967DTIE.TXT: Tie points of Hole 967D.
  - 969RCOMP.TXT: Revised composite depth section of Site 969.
  - 969ARMCD.TXT: Color reflectance data sets of Hole 969A.
  - 969BRMCD.TXT: Color reflectance data sets of Hole 969B.
  - 969CRMCD.TXT: Color reflectance data sets of Hole 969C.
  - 969DRMCD.TXT: Color reflectance data sets of Hole 969D.
  - 969ERMCD.TXT: Color reflectance data sets of Hole 969E.
  - 969FRMCD.TXT: Color reflectance data sets of Hole 969F.
  - 969ATIE.TXT: Tie points of Hole 969A.
  - 969BTIE.TXT: Tie points of Hole 969B.
  - 969CTIE.TXT: Tie points of Hole 969C.
  - 969DTIE.TXT: Tie points of Hole 969D.
  - 969ETIE.TXT: Tie points of Hole 969E.
  - 969FTIE.TXT: Tie points of Hole 969F.
- IMAGES (Photoshop interhole correlation images that have been compressed and bundled as self-extracting archives):
- 964IMAGE.SEA
    - 964IHC\_1.PSD (interhole correlation 1)
    - 964IHC\_2.PSD (interhole correlation 2)
    - 964IHC\_3.PSD (interhole correlation 3)
    - 964IHC\_4.PSD (interhole correlation 4)
    - 964IHC\_5.PSD (interhole correlation 5)
  - 966IMAGE.SEA
    - 966IHC\_1.PSD (interhole correlation 1)
    - 966IHC\_2.PSD (interhole correlation 2)
    - 966IHC\_3.PSD (interhole correlation 3)
    - 966IHC\_4.PSD (interhole correlation 4)
    - 966IHC\_5.PSD (interhole correlation 5)
  - 967IMAGE.SEA
    - 967IHC\_1.PSD (interhole correlation 1)
    - 967IHC\_2.PSD (interhole correlation 2)
    - 967IHC\_3.PSD (interhole correlation 3)
    - 967IHC\_4.PSD (interhole correlation 4)
    - 967IHC\_5.PSD (interhole correlation 5)
    - 967IHC\_6.PSD (interhole correlation 6)
    - 967IHC\_7.PSD (interhole correlation 7)
    - 967IHC\_8.PSD (interhole correlation 8)
    - 967IHC\_9.PSD (interhole correlation 9)
  - 969IMAGE.SEA
    - 969IHC\_1.PSD (interhole correlation 1)

969IHC\_2.PSD (interhole correlation 2)  
969IHC\_3.PSD (interhole correlation 3)  
969IHC\_4.PSD (interhole correlation 4)  
969IHC\_5.PSD (interhole correlation 5)  
969IHC\_6.PSD (interhole correlation 6)

**CHAP\_06** (Chapter 6):

06\_01.TXT: Table 1. Results of u-channel magnetic measurements from Site 966.  
06\_02A.TXT: Table 2A. Results of u-channel magnetic measurements from Site 967.  
06\_02B.TXT: Table 2B. Results of u-channel magnetic measurements from Site 967.  
06\_03A.TXT: Table 3A. Results of u-channel magnetic measurements from Site 969.  
06\_03B.TXT: Table 3B. Results of u-channel magnetic measurements from Site 969.

**CHAP\_14** (Chapter 14):

14\_01.TXT: Table 1. Isotopic data for samples analyzed from Site 967.

14\_02.TXT: Table 2. Sapropel and age model data for Site 967.

**CHAP\_40** (Chapter 40):

40\_01.TXT: Table 1. Oriented bedding data derived from FMS data sets for Holes 965S, 966F, and 967E.  
40\_02.TXT: Table 2. Oriented fracture data derived from FMS data sets for Holes 965A, 966F, and 967E.  
40\_03.TXT: Table 3. Strain data measured using PODI and Suror techniques for Holes 965W, 966F, and 967E.  
40\_04.TXT: Table 4. Axial ratio measurements on burrows from Hole 966F and the resulting strain calculations.  
40\_05.TXT: Table 5. Axial ratio measurements on burrows from Holes 967A, 967B, and 967E and the resulting strain calculations.