WHOI-78-40

REPORT E

REPORT ON GENERAL BIBLIOGRAPHY
OF THE PERSIAN GULF REGION, SUGGESTIONS FOR DESIGN
AND EQUIPMENT OF PERSIAN GULF MARINE RESEARCH VESSEL
AND MARINE FIELD OPERATIONS EQUIPMENT

by

David A. Ross

WOODS HOLE OCEANOGRAPHIC INSTITUTION
Woods Hole, Massachusetts 02543

May 1978

*Prepared with funds from the Iranian Department
of the Environment.*

*Reproduction in whole or in part is permitted
for any purpose of the United States Government.
In citing this manuscript in a bibliography,
the reference should be followed by the phrase:
UNPUBLISHED MANUSCRIPT.*

Approved for Distribution

John I. Ewing, Chairman
Department of Geology & Geophysics

ABSTRACT

This report presents a bibliography of literature on the Persian Gulf and sections concerning design and equipment for a Persian Gulf marine research vessel and for a marine field operation.

SECTION 1a

PERSIAN GULF REFERENCES

From Library Search

Persian Gulf References

Page 1

- Abdel-Gawad, M., 1971, Wrench movements in the Baluchistan arc and relation to Himalayan-Indian Ocean tectonics. *Geol. Soc. Am. Bull.*, v. 82, p. 1235-1250.
- Academy of Sciences, USSR, 1964, Tectonic map of Eurasia, scale 1:5,000,000. Ministry of Geol., U.S.S.R.
- Alexander, A.E., 1948, Pearl fishing in the Persian Gulf. *Gems and Gemology*, v. 6(2), p. 38-41.
- Allemann, F. and Peters, T., 1972, The ophiolite-radiolarite belt of the North Oman mountains. *Eclogae Geol. Helv.*, v. 65, p. 657-698.
- Ambraseys, N.N., 1963, The Boyin-Zara, Iran earthquake of September 1962. *Bull. Seism. Soc. Am.*, v. 53, p. 705-740.
- Ambraseys, N.N., 1968, Early earthquakes in north-central Iran. *Bull. Seism. Soc. Am.*, v. 58, p. 485-496.
- Ambraseys, N.N. and Tchalenko, J., 1969, The Dasht-e-Bajaz, Iran, earthquake of August 1968. *Bull. Seism. Soc. Am.*, v. 59, p. 1751-1792.
- Anonymous, 1911, Aussergewöhnliche hohe Luft-und Wassertemperaturen im Roten Meer und im Persischen Golf. *Annalen der Hydrographie und maritimen Meteorologie*, v. 39, p. 101-104.
- Anonymous, 1944, Sailing directions for the Persian Gulf. U.S. Navy Dept., Hydrographic Office Pub. 158, 3rd ed., p. 1-323
- Assereto, R., 1963, The Paleozoic formations in Central Elburz (Iran) (Prelim. note). *Riv. Italiana Paleontologia e Stratigrafia*, v. 69(4), p. 503-543.
- Assereto, R., 1966, The Jurassic Shemshak Formation in Central Elburz (Iran). *Riv. Italiana Paleontologia e Stratigrafia*, v. 72(4), p. 1133-1182.
- Backer, H., 1969, Mikrofazies im Mesozoikum und Tertiär an der Nordostseite des Persischen Golf. *Conf. Univ. de Kiel*, Nov. 1969.
- Berry, R.W., Brophy, G.P. and Naqash, A., 1970, Minerology of the suspended sediments in the Tigris, Euphrates and Shatt-el-Arab rivers of Iraq, and the recent history of the Mesopotamian plain. *J. Sediment. Petrol.*, v. 40, p. 131-139.
- Bezrukov, P.L., 1961, Research on the Indian Ocean during the 33rd voyage of the research vessel Vityaz. *in Oceanology*, Acad. Sci. USSR, No. 4, p. 745-753.
- Blanford, W.T., 1872, Note on the geological formations seen along the coasts of Biluchistan and Persia from Karachi to the Head of the Persian and on some of the Gulf Islands. *Records Geol. S. India*, v.5, p. 41-45.
- Blegvad, H., 1944, Fishes of the Iranian Gulf. *Danish Scientific Investigations in Iran*, Pt. III, p. 1-247.

Persian Gulf References

Page 2

- Bobek, H., 1952, Beiträge zur klimaökologischen Ghederung Irans. Erdkunde, v.6, p. 65-84.
- Bobek, H., 1963, Nature and implications of Quarternary climatic changes in Iran. in Unesco Proc. XX: Changes of climate, p. 403-413, Paris.
- Bobek, H., 1969, Zur Kenntnis der Südlichen Lüt. Mitteil. der Österreichischen Geographischen Gesellschaft, Band III, Heft II/III, p. 155-192.
- Boeck, H., Lees, de, G.M. and Richardson, F.D.S., 1929, Contribution to the stratigraphy and tectonics of the Iranian ranges. in Structure of Asia, J.W. Gregory, ed., Methuen, London, p. 58-176.
- Bramkamp, R.A. and Powers, R.W., 1955, Two Persian Gulf lagoons. (Abstract). j. Sediment. Petrol., v. 25, p. 139-140.
- Braud, J., 1971, La nappe du Kuh-e-Garun (region de Kermanshah, Iran), chevauchement de l'Iran central sur le Zagros. Bull. Soc. Geol. Fr., Sér. 7(13), p. 416-419.
- British Petroleum Company Ltd., 1956, Geological maps and sections of south-west Persia. Proc. 20th Intern. Geol. Congr. Mexico.
- British Petroleum Company Ltd., 1964, Geological maps, columns and sections of the High Zagros of south-west Iran. British Petroleum Co., Ltd., London.
- Bush, P., 1973, Some aspects of the diagenetic history of the Sabkha in Abu Dhabi, Persian Gulf. in The Persian Gulf, B.H. Purser, ed., Springer-Verlag, N.Y., Heidelberg, Berlin, p. 395-407.
- Butler, G.P., 1973, Strontium geochemistry of modern and ancient calcium sulphate minerals. in The Persian Gulf, B.H. Purser, ed., Springer-Verlag, N.Y., Heidelberg, Berlin, p. 423-452.
- Butler, G.P., Kendall, C.G.St.C., Kinsman, D.J.J., Shearman, J.D. and Skipwith, A.d'E., 1964, Recent anhydrite from the Trucial coast of the Arabian Gulf. Geol. Soc. London, Circ. 120:3.
- Butler, G.P., Kendall, C.G.St.C., Kinsman, D.J.J., Shearman, D.J. and Skipwith, A. d'E., 1965, Recent evaporite deposits along the Trucial Coast of the Arabian Gulf. Geol. Soc. London, Proc. (Abstract), no. 1623, p. 91-92.
- Butler, G.P., Krouse, R.H. and Mitchell, R., 1973, Sulphur-Isotope geochemistry of an arid supratidal evaporite environment, Trucial Coast. in The Persian Gulf, B.H. Purser, ed., Springer-Verlag, N.Y., Heidelberg, Berlin, p. 453-462.
- Butzer, K.W., 1958, Quarternary stratigraphy and climate in the Middle East. Bonner Geogr. Abh. 24, 157 S., Bonn.
- Canitez, N., 1969, The focal mechanisms in Iran and their relations to tectonics. Pure Appl. Geophys., v. 75, p. 76-87.

Persian Gulf References

Page 3

- Curtis, R., Evans, G., Kinsman, D.J.J. and Shearman, D.J., 1963, Association of dolomite and anhydrite in Recent sediments of the Persian Gulf. *Nature*, v. 197, p. 697-680.
- Dallas, W.L., 1899, Investigation into the mean temperature, humidity and vapour tension conditions of the Arabian Sea and Persian Gulf. *Indian Met. Mem.*, v. 6, p. 9-88.
- De Groot, K., 1969, The chemistry of submarine cement formation at Dohat Hussain in the Persian Gulf. *Sedimentology*, v. 12(1/2), p. 63-68.
- De Groot, K., 1973, Geochemistry of tidal flat brines at Umm Said, SE Qatar, Persian Gulf. in The Persian Gulf, B.H. Purser, ed., Springer-Verlag, N.Y., Heidelberg, Berlin, p. 377-394.
- Deutsches Hydrographisches Institut, 1964, Handbuch des Persischen Golfs, 4. Aufl., 397 S., Hamburg.
- Deutscher Wetterdienst--Seewetteramt (R. Lange), 1964, Klima und wetter, einschl. Seegang., Handbuch des Persischen Golfs, Hamburg, p. 41-80.
- Dewey, J.F. and Bird, J.M., 1970, Mountain belts and the new global tectonics. *J. Geophys. Res.*, v. 75, p. 2625-2647.
- Diester, L., 1971, Grobfraktionsanalyse von Sedimentkernen aus dem Persischen Golf., Thesis, Univ. Kiel, Kiel, 89pp.
- Dietrich, G., Krause, G., Seibold E., Vollbrecht, K., 1966, Reisebericht der Indischen Ozean-Expedition mit dem Forschungsschiff "Meteor" 1964/1965, "Meteor" Forschungsergebnisse, Reihe A, Nr. 1, Berlin, p. 1-52.
- Dubach, H.W., 1964, A summary of temperature-salinity characteristics of the Persian Gulf. National Oceanographic Data Center, General Series, Publ. G-4.
- Dubach, H.W. and Wehe, T.J., 1959, Descriptive oceanography of Kuwait Harbor, Technical Report no. 55, U.S. Naval Hydrographic Office, 43 pp.
- Elder, S., 1957, Sediments and waters of Persian Gulf. *Bull. Amer. Assoc. Petrol. Geol.*, v. 41(1), p. 332-333.
- Emery, K.O., 1956, Sediments and water of the Persian Gulf. *Amer. Assoc. Petrol. Geol.*, v. 40, p. 2354-2383.
- Evamy, B.D., 1973, The precipitation of Aragonite and its alteration to Calcite on the Trucial Coast of the Persian Gulf. in The Persian Gulf, B.H. Purser, ed., Springer-Verlag, N.Y., Heidelberg, Berlin, p. 329-340.
- Evans, G., 1966, Persian Gulf in Encyclopedia of Oceanography, R.W. Fairbridge, ed., Reinhold Publ. Co., N.Y., p. 689-695.
- Evans, G., 1966, The recent sedimentary facies of the Persian Gulf Region. *Phil. Trans. Roy. Soc. Lond., Ser. A.*, v. 259, p. 291-298.

Persian Gulf References

Page 4

- Evans, G. and Bush, P., 1967, Some sedimentological and oceanographic observations on a Persian Gulf lagoon. UNESCO Conference on Lagoons, Mexico City, Nov. 1967.
- Evans, G., Kendall, C.G.S.C. and Skipwith, A. d'E., 1964, Origin of the coastal flats, the sabkha, of the Trucial Coast, Persian Gulf. *Nature*, v. 202, p. 759-761.
- Evans, G., Kinsman, D.J.J. and Shearman, D.J., 1964, A reconnaissance survey of the environment of Recent carbonate sedimentation along the Trucial Coast, Persian Gulf. in *Developments in Sedimentology*, 1. Deltaic and Shallow Marine Deposits, L.M.J.U. van Straaten, ed., Elsevier, Amsterdam, p. 129-135.
- Evans, G. Murray, J.W., Biggs, H.E.J., Bate, R. and Bush, P.R., 1973, The oceanography, ecology, sedimentology and geomorphology of parts of the Trucial Coast Barrier Island complex, Persian Gulf. in *The Persian Gulf*, B.H. Purser, ed., Springer-Verlag, N.Y., Heidelberg, Berlin, p. 233-277.
- Evans, G. and Shearman, D.J., 1964, Recent celestite from the sediments of the Trucial Coast of the Persian Gulf. *Nature*, v. 202, p. 385-386.
- Evans, G., Schmidt, V., Bush, P. and Nelson, H., 1969, Stratigraphy and geologic history of the Sabkha, Abu Dhabi, Persian Gulf. *Sedimentology*, v. 12, p. 145-159.
- Falcon, N.L., 1961, Major earth-flexuring in the Zagros Mountains of southwest Iran. *Quart. J. Geol. Soc. Lond.*, v. 117, p. 367-376.
- Falcon, N.L., 1969, Problems of the relationship between surface structure and deep displacements illustrated by the Zagros range. in *Time and Place in Orogeny*, Geol. Soc. London, Spec. Pub., no. 3, p. 9-22.
- Firoughi, B., 1963, Geology of the iron deposits of the Persian Gulf area. in *Symposium on Iron Ore, Iran*. p. 87-94.
- Fohs, F.J., 1947, Oil-reserve provinces of Middle East and southern Soviet Russia. *Bull. Amer. Assoc. Petrol. Geol.*, v. 31, p. 1372-1383.
- Frontier S., 1963, Zooplankton recolte en mer d'Arabic, Golfe Persique et Golfe d'Aden. II. Pteropodes: systematique et repartition. *Cah. O.R.S.T.O.M. ser. Océanogr.*, 1/6, 4 Abb., 12 Karten, Paris, p. 233-254.
- Furon, R., 1941, Geologie du Plateau Iranian, Perse-Afghanistan-Beloutchistan. *Meu Mus. Nat. Hist. Paris*, n.s. 7, p. 177-414.
- Gansser, A., 1955, New aspects of the geology in central Iran. *Proc. 4th World Petrol. Congr. Rome*, Sect. 1/A, 5, p. 279-300.
- Gansser, A. and Huber, H., 1962, Geological observations in the Central Elburz, Iran. *Schweiz. Min. Petr. Mitt.*, v. 42(2), p. 593-630.
- Genthe, S., 1896, *Der Persische Meerbusen: Geschichte und Morphologie*. Diss. Marburg, (Tiefenkarte 1:2,5 Mill.), p. 1-98.

Persian Gulf References

Page 5

- Glaus, M., 1964, Trias und Oberperm im zentralen Elburs (Persien). *Eclogae Geol. Helvetiae*, v. 57(2), p. 497-508.
- Glaus, M., 1965, Die Geologie des Gebietes nördlich des Kandeivan-Passes (Zentral-Elburz), Iran. *Mitt. Geol. Inst. ETH u. Univ Zürich*, n.s. no. 48, 165 p. (in German with English summary).
- Glennie, K.W., Boeuf, M.G.A., Hughes Clarke, M.W., Moody-Stuart, M., Pilaar, W.H.F. and Reinhardt, B.M., 1973, Late Cretaceous nappes in Oman Mountains and their geologic evolution. *Bull. Am. Assoc. Petrol. Geol.*, v. 57, p. 5-27.
- Gray, K.W., 1950, A tectonic window in southwest Iran. *Geol. Soc. London Quart. Jour.*, v. 105, p. 189-222.
- Great Britain, Naval Intelligence Division, 1944, Iraq and the Persian Gulf. *Geographical Handbook Series*, B.R. 524. Confidential, 682 p.
- GSI: Geological Survey of Iran, 1965-1967, Unpublished maps and reports, Tehran.
- Haas, F., 1952, Shells collected by the Peabody Museum Expedition to the Near East, 1950, I, Mollusks from the Persian Gulf. *Nautilus*, v. 68, p. 46-49.
- Harrison, J.V., 1930, The geology of some salt plugs in Laristan (Southern Persia). *Geol. Soc. London Quart. Jour.*, v. 86, p. 463-522.
- Hartmann, M., Lange, H., Seibold, E. and Walger, E., 1971, Oberflächen-sedimente im Persischen Golf und Golf von Oman, I. Geologisch-hydrologischer Rahmen und erste sedimentologische Ergebnisse. "Meteor" Forschungsergebnisse, Reihe C, 4, 76p.
- Haynes, S.J. and McQuillan, H., 1974, Evolution of the Zagros Suture Zone, southern Iran. *Geol. Soc. Am. Bull.*, v. 85, p. 739-744.
- Heater, W.E., 1955, Petroleum developments in Middle East and adjacent countries in 1954. *Bull. Amer. Assoc. Petrol. Geol.*, v. 39, p. 1362-1384.
- Heezen, B. and Tharp, M., 1965a, Physiographic diagram of the Indian Ocean. *Geol. Soc. Am., N.Y., N.Y.*, 1 map.
- Heezen, B. and Tharp, M., 1965b, Descriptive sheet to accompany physiographic diagram of the Indian Ocean. *Geol. Soc. Am., N.Y., N.Y.*
- Henson, F.R.S., 1951, Observations on the geology and petroleum occurrences of the Middle East. *World Petrol. Congr. Proc. 3rd*, The Hague, Section 1, p. 118-140.
- Hester, R.L., 1965, Persian Gulf: A geological picture that promises much. *Oil and Gas Jour.*, Nov. 1, Tulsa, p. 140-145.
- Hester, R.L., 1967, Basic framework, deformation and petroleum in Middle East (Abstract). *Am. Assoc. Petrol. Geol. Bull.*, v. 51(3), p. 469-470.

Persian Gulf References

Page 6

- Holm, D.A., 1960, Desert geomorphology in the Arabian Peninsula. Science, v. 132, p. 1369-1379.
- Houbolt, J.J.H.C., 1957, Surface sediments of the Persian Gulf near the Qatar Peninsula. Thesis, University of Utrecht, The Hague, 113 p.
- Huber, H. and Stocklin, J., 1954, Hodjedk coal survey. National Iranian Oil Company, Tehran, unpublished geol. rept. no. 116, 65 p.
- Huckriede, R.M., Kursten, M. and Venzlaft, H., 1962, Zur Geologie des Gebietes zwischen Kerman und Sagand (Iran). Geol. Jahrb., Beihft. 51, 197 p.
- Hudson, R.J.S., Eames, F.E. and Wilkins, J.L., 1957, The fauna of some recent marine deposits near Basrah, Iraq. Geol. Mag., v. 94, p. 393-401.
- Hughes Clark, M.W. and Keij, A.J., 1973, Organisms as producers of carbonate sediment and indicators of environment in the Southern Persian Gulf. in The Persian Gulf, B.H. Purser, ed., Springer-Verlag, N.Y., Heidelberg, Berlin, p. 33-56.
- Hsu, K.J. and Schneider, J., 1973, Progress report on dolomitization--hydrology of Abu Dhabi Sabkhas, Arabian Gulf. in The Persian Gulf, B.H. Purser, ed., Springer-Verlag, N.Y., Heidelberg, Berlin, p. 409-422.
- Illing, L.V. and Wells, A.J., 1964, Penecontemporary dolomite in the Persian Gulf. (Abstract) Bull. Am. Assoc. Petrol. Geol., v. 48, p. 532
- Illing, L.V., Wells, A.J. and Taylor, J.C.M., 1965, Penecontemporary dolomite in the Persian Gulf in Dolomitization and limestone diagenesis. Soc. Econ. Paleontologists and Mineralogists Spec. Pub., v. 13, p. 89-111.
- James, G.A. and Wynd, J.G., 1965, Stratigraphic nomenclature of Iranian Oil Consortium Agreement area. Am. Assoc. Petrol. Geol. Bull., v. 49, p. 2182-2245.
- Kamen-Kaye, M., 1970, Geology and productivity of Persian Gulf synclitorium. A.A.P.G. Bull., v. 54, p. 2371-2394.
- Kamen-Kaye, M., 1972, Permian Tethys and Indian Ocean. Bull. Am. Assoc. Petrol. Geol., v. 56, p. 1984-1999.
- Kassler, P., 1973, The structural and geomorphic evolution of the Persian Gulf. in The Persian Gulf, B.H. Purser, ed., Springer-Verlag, N.Y., Heidelberg, Berlin, p. 11-32.
- Kaulback, J.A., Kendall, C.G.St.C., and Skipwith, P.A.d'E., 1962, Cyclothems on the islands of Kharg and Khargu, Persian Gulf. Unpublished report, Iranian Oil Exploration and Producing Companies, 19.
- Kendall, C.G.St. C. and Skipwith, P.A.d'E., 1966, Recent algal stromatolites of the Khor al Bazam, Abu Dhabi, southwest Persian Gulf (Abstract). Geol. Soc. Am. Spec. Papers for 1966. p. 108.
- Kendall, C.G.St.C. and Skipwith, P.A.d'E., 1969, Geomorphology of a recent shallow-water carbonate Province: Khor al Bazam, Trucial Coast, southwest Persian Gulf. Geol. Soc. of Am. Bull., v. 80, p. 865-892.

Persian Gulf References

Page 7

- Kendall, C.G.St.C. and Skipwith, P.A.d'E., 1970, Holocene shallow-water carbonate and evaporite sediments of Khor al Bazam, Abu Dhabi, southwest Persian Gulf, *Bull. Am. Assoc. Petrol. Geol.*, v. 53(4), p. 841-869.
- Kettani, M.A., 1970, Feasibility of a heliohydroelectric power plant on the eastern shore of Saudi Arabia. Progress Report HHE-2, College of Petroleum and Minerals, Dhahran, Saudi Arabia.
- Kinsman, D.J.J., 1964, Recent carbonate sedimentation near Abu Dhabi, Trucial Coast, Persian Gulf. Thesis, London Univ., 302p.
- Kinsman, D.J.J., 1964 The recent carbonate sediments near Halat el Bahrani, Trucial Coast, Persian Gulf *in* *Developments in Sedimentology*, 1. Deltaic and Shallow Marine Deposits, L.M.J.U. Straaten, ed., Elsevier, Amsterdam, p. 185-192.
- Kinsman, D.J.J., 1964, Reef coral tolerance of high temperatures and salinities. *Nature*, v. 202, p. 1280-1282.
- Kinsman, D.J.J., 1965, Gypsum and anhydrite of Recent age, Trucial Coast, Persian Gulf. *in* *Second Symposium on Salt*, 1. North Ohio Geol. Soc., J.L. Rau, ed., Cleveland (Ohio), p. 302-326.
- Kinsman, D.J.J., 1965, Dolomitization and evaporite development, including anhydrite in lagoonal sediments, Persian Gulf. *Geol. Soc. Am. Spec. Papers*, v. 82, p. 108-109.
- Kinsman, D.J.J., 1969, Modes of formation, sedimentary associations, and diagnostic features of shallow-water and supratidal evaporites. *The Am. Assoc. of Petrol. Geol. Bull.*, v. 53(4), p. 830-840.
- Kukal, Z. and Saadallah, A., 1973, Aeolian admixtures in the sediments of the northern Persian Gulf. *in* *The Persian Gulf*, B.H. Purser, ed., Springer-Verlag, N.Y., Heidelberg, Berlin, p. 115-121.
- Lange, H. and Sarnthein, M., 1970, Glaukonitkörner in rezenten Sedimenten des Persischen Golfs. *Geol. Rundsch.*, v. 60(1), p. 256-264.
- LaViolette, P.E. and Frontenac, T.R., 1967, Temperature, salinity and density of the world's seas: Arabian Sea, Persian Gulf and Red Sea. U.S. Naval Oceanographic Office, Informal Report no. IR. 67-49.
- Lees, G.M., 1948, Some structural and stratigraphical aspects of oilfields of the Middle East. 18th Int. Geol. Congr., v. VI, p. 26-33.
- Lees, G.M., 1953, *Persia. Sci. of Petrol.*, v. 6(1), p. 78-82.
- Lees, G.M. and Richardson, F.D.S., 1940, The geology of the oilfield belt of southwest Iran and Iraq. *Geol. Mag.*, v. 78, p. 227-252.
- Loreau, J.P. and Purser, B.H., 1973, Distribution and ultrastructure of Holocene Ooids in the Persian Gulf. *in* *The Persian Gulf*, B.H. Purser, ed., Springer-Verlag, N.Y., Heidelberg, Berlin, p. 279-328.
- Lorenz, C., 1964, Die Geologie des obern Karadj-Tales (Zentral-Elburz) Iran. Thesis, Zurich Univ., 113 p. (in German with English abstract).

Persian Gulf References

Page 8

- Martini, E., 1969, Coccolithophorids agglutinated by tintinnids from the Persian Gulf and northern Arabian Sea. "Meteor" Forschungsergebnisse, Reihe C., no. 2, p. 57-62. (In German with English summary).
- McQuillan, H., 1973, A geological note on the Qir earthquake southwest Iran, April 1972. Geol. Mag., v. 110, p. 243-248.
- Melguen, M., 1971, Etude de sediments pleistocene-holocene au Nord-Ouest du Golfe Persique. Analyse de facies par ordinateur. Thesis, Universite de Rennes, U.E.R. Structure et Proprietes de la Matiere, Serie C, no. d'ordre: 204, no. de Serie: 65.
- Melguen, M., 1973, Correspondence analysis for recognition of facies in homogenous sediments off an Iranian river mouth. in The Persian Gulf, B.H. Purser, ed., Springer-Verlag, N.Y., Heidelberg, Berlin, p. 99-114.
- Melville, J.C., 1928, The marine Mollusca of the Persian Gulf, Gulf of Oman and north Arabian Sea. Addenda, corrigenda and emendana. Malacol. Soc. London Proc., v. 15, p. 93-126.
- Melville, J.C. and Staden, R., 1901, The Mollusca of the Persian Gulf, Gulf of Oman and Arabian Sea. Zool. Soc. Proc., v.2, p. 327-460.
- Morton, D.M., 1959, The geology of Oman. Proc. 5th World Petrol. Congr., Sect. 1, Pap. 14, N.Y.
- Moston, B. and Frei, E., 1959, The main sedimentary basins of Iran and their oil possibilities. 5th World Petrol. Congr. Proc., Sect. 1, Pap. 17, 10 p., N.Y.
- Murray, J.W., 1965a, The foraminiferida of the Persian Gulf. 1. Rosalina adhaerens sp. nov. Ann. Mag. Nat. Hist., ser. 13, v. 8, p. 77-79.
- Murray, J.W., 1965b, The foraminiferida of the Persian Gulf. 2. The Abu Dhabi Region. Palaeogeogr. Palaeoclimatol. Palaeoecol., v. 1, p. 307-332.
- Murray, J.W., 1966, The foraminiferida of the Persian Gulf. 4. Khor al Bazam. Palaeogeogr. Palaeoclimatol. Palaeoecol., v. 2, p. 153-169.
- Murray, J.W., 1966, The foraminiferida of the Persian Gulf. 5. The shelf off the Trucial Coast. Palaeogeogr. Palaeoclimatol. Palaeoecol., v. 2, p. 267-278.
- Murray, J.W., 1970, The foraminiferida of the hypersaline Abu Dhabi Lagoon, Persian Gulf. Lethaia, Oslo, v. 3, p. 51-68.
- National Iranian Oil Company, 1959, Geological map of Iran. Scale 1: 2,500,000. National Iranian Oil Company, Tehran. 19p.
- National Oceanographic Data Center, General Series, 1964, A summary of temperature-salinity characteristics of the Persian Gulf. Publication G-4, U.S. Naval Oceanographic Office, Washington, D.C. 20390.

Persian Gulf References

Page 9

- National Oceanographic Data Center, Oceanographic archives, oceanographic station data punch cards, NODC reference-cruise numbers: 31382, 31496, 31658, 31865, 31S04, 31S05. Bathythermograph analog cards. Information Division, Archives Branch, Washington, D.C.
- Neprochnov, Y.P., 1968, Structure of the earth's crust of epicontinental seas, Caspian, Black and Mediterranean. *Can. J. Earth Sci.*, v. 5, p. 1037-1043.
- Niazi, M., 1969, Source dynamics of the Dasht-e-Bajaz earthquakes of August 31, 1968. *Bull. Seism. Soc. Am.*, v. 58, p. 1843-1861.
- Niazi, M. and Basford, J.R., 1968, Seismicity of Iranian Plateau and Hindu Kush region. *Bull. Seism. Soc. Am.*, v. 58, p. 417-426.
- Nowroozi, A.A., 1971, Seismo-tectonics of the Persian Plateau, eastern Turkey, Caucasus, and Hindu-Kush regions. *Seis. Soc. of Am. Bull.*, v. 61(2), p. 317-341.
- Nowroozi, A.A., 1972, Focal mechanism of earthquakes in Persia, Turkey, West Pakistan and Afghanistan and plate tectonics of the Middle East. *Bull. Seis. Soc. Am.*, v. 62, p. 823-850.
- Peery, K., 1965, Results of the Persian Gulf--Arabian Sea oceanographic surveys 1960-61. U.S. Naval Oceanogr. Off. Techn. Rep., v. 176, 239 S., Washington.
- Philip, G., 1968, Minerology of recent sediments of Tigris and Euphrates rivers and some of the older detrital deposits. *J. Sed. Petr.*, v. 38(1), p. 35-44.
- Pilgrim, G.E., 1908, The geology of the Persian Gulf and the adjoining portions of Persia and Arabia. *Mem. Geol. Surv. India*, v. 34, 177 p.
- Pilkey, O.H., 1964, Carbonate minerology of the Persian Gulf. *Geol. Soc. Am. Program 1964 meeting*, p. 150-151.
- Pilkey, O.H. and Blackwelder, B.W., 1968, Minerology of the sand size carbonate fraction of some recent marine terrigenous and carbonate sediments. *J. of Sed. Petrol.*, v. 38(3), p. 799-810.
- Pilkey, O.H. and Noble, N., 1966, Carbonate and clay minerology of the Persian Gulf. *Deep-Sea Research*, v. 13, p. 1-16.
- Powers, R.W., Ramirez, L.F., Redmond, C.D. and Elberg, E.L. Jr., 1966, Geology of the Arabian Peninsula: Sedimentary geology of Saudi Arabia. U.S. Geol. Surv. Prof. Pap., 560, D., 153 S., Washington.
- Privett, D.W., 1959, Monthly charts of evaporation from the North Indian Ocean (including Red Sea and the Persian Gulf). *Q. JIR. Met. Soc.*, v. 85, p. 424-428.
- Purser, B.H., 1973, Sedimentation around Bathymetric Highs in the Southern Persian Gulf. *in The Persian Gulf*, B.H. Purser, ed., Springer-Verlag, N.Y., Heidelberg, Berlin, p. 157-178.
- Purser, B.H., 1973, The Persian Gulf, Purser, ed., Springer-Verlag, N.Y., Heidelberg, Berlin, 471 p.

Persian Gulf References

Page 10

- Purser, B.H. and Evans, G., 1973, Regional sedimentation along the Trucial Coast, SE Persian Gulf. in The Persian Gulf, B.H. Purser, ed., Springer-Verlag, N.Y., Heidelberg, Berlin, p. 211-232.
- Purser, B.H. and Loreau, J.P., 1973, Aragonitic, supratidal encrustations along the Trucial Coast, Persian Gulf. in The Persian Gulf, B.H. Purser, ed., Springer-Verlag, N.Y., Heidelberg, Berlin, p. 343-376.
- Purser, B.H. and Seibold, E., 1973, The principal environmental factors influencing Holocene Sedimentation and Diagenesis in the Persian Gulf. in The Persian Gulf, B.H. Purser, ed., Springer-Verlag, N.Y., Heidelberg, Berlin, p. 1-10.
- Reinhardt, B.M., 1969, On the genesis and emplacement of ophiolites in the Oman Mountains geosyncline. Schweiz Mineral. Petrogr. Mitt, v. 49, p. 1-30.
- Richardson, R.K., 1927, Die Geologie und die Salzdome im südwestlichen Teil des Persischen Golfes. Verh. nat. hist. mediz. Ver. Heidelberg, N.F., v. 15, p. 375-423.
- Ricou, L.E., 1970, Comments on radiolarites and ophiolite nappes in the Iranian Zagros mountains. Geol. Mag., v. 107(5), p. 479-480.
- Ritsema, A.R., 1966, The fault-plane solutions of earthquakes of the Hindu Kush center. Tectonophysics, v. 3, p. 147-163.
- Robinson, M.K., 1966, Arabian Sea. in The Encyclopedia of Oceanography, R.W. Fairbridge, ed., Van Nostrand Reinhold Co., p. 40-44.
- Ruttner, A. Nabavi, M. and Hajian, J., 1968, Geology of the Shirgesht area, Tabas area, East Iran. Iran Geol. Surv. Rept. no. 4.
- Sabock, D.K. and Gurr, J.A., 1968, Persian Gulf Fisheries. Commercial Fisheries Review, v. 31(12).
- Sarnthein, M.V., 1967, The plankton-benthos ratio on mollusks in the recent sediments of the Persian Gulf. Proc. I. Internat. Conf. Plankt. Microfossils, II, 4 Abb. Genf, p. 594-598.
- Sarnthein, M.V., 1970, Sedimentologische Merkmale für die Untergrenze der Wellenwirkung im Persischen Golf: Sedimentologische Merkmale für die Wellenwirkung, Geol. Rdsch. 59, Stuttgart, p. 649-664.
- Sarnthein, M.V., 1971, Oberflächensedimente im Persischen Golf und Golf von Oman. II. Quantitative Komponentenanalyse der Grobfraktion. "Meteor" Forschungsergebnisse, Ergebnisse, Reihe C, 5, 113p.
- Sarnthein, M.V., 1972, Sediments and history of the postglacial transgression in the Persian Gulf and northwest Gulf of Oman. Mar. Geol. v. 12, p. 245-266.
- Sarnthein, M.V., 1972, Stratigraphic contamination by vertical bioturbation in Holocene shield sediments. 24th IGC sect. 6, p. 432-436.

Persian Gulf References

Page 11

- Sarnthein, M.V. and Walger, E., 1973, Classification of modern marl sediments in the Persian Gulf by factor analysis. in The Persian Gulf, B.H. Purser, ed., Springer-Verlag, N.Y., Heidelberg, Berlin, p. 81-98.
- Schott, G., 1908, Der Salzgehalt des Persischen Golfes und der angrenzenden Gewässer. Annalen der Hydrographie und Maritimen Meteorologie, v. 36, p. 296-299.
- Schott, G., 1918, Ozeanographie und Klimatologie des Persischen Golfes und des Golfes von Oman, Beilage zu den Annalen der Hydrographie und Maritimen Meteorologie, v. 46, p. 1-46.
- Schott, G., 1918, Geographie des Persischen Golfes und seiner Randgebiete. Mitt. Geogr. Ges. Hamburg, v. 31, p. 1-110.
- Schroeder, J.W., 1944, Essai sur la structure de l'Iran. Eclog. Geol. Helv., v. 37, p. 37-81, Basel.
- Schultz, B., 1914, Beiträge zur Kenntnis der Oberflächenverhältnisse der Ozeane auf Grund der Beobachtungen von L. Mecking auf Reisen zwischen New York, Suez, Hongkong, San Francisco sowie deutscher Schiffe an der Südküste Arabiens und im Persischen Golfe. Annalen der Hydrographie und Maritimen Meteorologie, v. 42, p. 392-405.
- Seibold, E., Diester, L., Futterer, D., Lange, H., Müller, P. and Werner, F., 1973, Holocene sediments and sedimentary processes in the Iranian part of the Persian Gulf. in The Persian Gulf, B.H. Purser, ed., Springer-Verlag, N.Y., Heidelberg, Berlin, p. 57-80.
- Seibold, E. and Ulrich, J., 1970, Bodengestalt des nordwestlichen Golfs von Oman. "Meteor" Forschungsergebn, C. 3, p. 1-14.
- Seibold, E. and Vollbrecht, K., 1969, Die Bodengestalt des Persischen Golfs. "Meteor" Forschungsergebn, Erg., Reihe C, 2, p. 29-56.
- Sewell, R.B.S., 1935-1936, Introduction and list of stations. The John Murray Expedition 1933-1934. v. 1, p. 1-15.
- Shearman, D.J., 1963, Recent anhydrite, gypsum, dolomite and halite from the coastal flats of the Arabian shore of the Persian Gulf. Proc. Geol. Soc. London, 1607, p. 63-64.
- Shinn, E.A., 1969, Submarine lithification of holocene carbonate sediments in the Persian Gulf. Sedimentology, v. 12, p. 109-144.
- Shinn, E.A., 1973, Carbonate coastal accretion in an area of longshore transport, NE Qatar, Persian Gulf. in The Persian Gulf, B.H. Purser, ed., Springer-Verlag, N.Y., Heidelberg, Berlin, p. 179-192.
- Shinn, E.A., 1973, Recent intertidal and nearshore carbonate sedimentation around rock highs, E Qatar, Persian Gulf. in The Persian Gulf, B.H. Purser, ed., Springer-Verlag, N.Y., Heidelberg, Berlin. p. 193-198.

Persian Gulf References

Page 12

- Shinn, E.A., 1973, A sedimentary accretion along the Leeward, SE coast of Qatar Peninsula, Persian Gulf. in The Persian Gulf, B.H. Purser, ed., Springer-Verlag, N.Y., Heidelberg, Berlin, p. 199-210.
- Skipwith, Sir P.A.d'E., 1966, Recent carbonate sediments of the eastern Khor al Bazam, Abu Dhabi, Trucial Coast. Thesis, London Univ.
- Steineke, M., Bramkamp, R.A. and Sander, R.J., 1959, Stratigraphic relations of Arabian Jurassic oil. in Habitat of Oil, L.G. Weeks, ed., Tulsa, A.A.P.G., p. 1294-1329.
- Stöcklin, J., 1961, Lagoonal formations and salt domes in east Iran. Iran Petrol. Inst. Bull. no. 3, p. 29-46; German version with English abstract, Eclogae Geol. Helvetiae, 1962, v. 54(1), p. 1-27.
- Stöcklin, J., 1966, Tectonics of Iran. Akad. Nauk SSSR Geotektonika, no. 1, p. 3-21 (in Russian).
- Stöcklin, J., 1968, Structural history and tectonics of Iran: a review. Bull. Am. Assoc. Petrol. Geol., v. 52, p. 1229-1258.
- Stöcklin, J., Eftekhar-nezhad, J. and Hushmand-zadeh, A., 1965b, Geology of the Shotori Range. Iran Geol. Surv. Rept., no. 3, 69p.
- Stöcklin, J., Nabavi, M. and Samimi, M., 1965a, Geology and mineral resources of the Soltanieh Mountains (northwest Iran). Iran Geol. Surv. Rept., no. 2, 44 p.
- Stoneley, R., 1974, The evolution of the continental margins bounding a former southern Tethys. in Geology of Continental Margins, C.A. Burk and C.L. Drake, eds., Springer, N.Y.
- Stoneley, R., 1975, On the origin of ophiolite complexes in the southern Tethys region. Tectonophysics, v. 25, p. 303-322.
- Stubbings, H.G., 1939, The marine deposits of the Arabian Sea. John Murray Expedition, 1933-1934, Sci. Rept., v. 3, p. 31-158.
- Sugden, W., 1963, The hydrology of the Persian Gulf and its significance in respect to evaporite deposition. Am. J. of Sci., v. 261, p. 141-155.
- Sugden, W., 1963, Some aspects of sedimentation in the Persian Gulf. J. Sed. Petr., v. 33(2), p. 355-364.
- Takin, M., 1972, Iranian geology and continental drift in the Middle East. Nature, v. 235, p. 147-150.
- Taylor, J.C.M. and Illing L.V., 1969, Holocene intertidal calcium carbonate cementation at Qatar, Persian Gulf. Sedimentology, v. 12(1/2), p. 69-108.
- Thiele, O., 1967, Golpaygan quadrangle map, scale 1:250,000, with explanatory text. Iran Geol. Surv.

- Trepka, von L., 1968, Investigation of the tides in the Persian Gulf by means of a hydro-dynamic numerical model. Mitt. Inst. Meeresk., Univ. Hamburg, v. 10, p. 59-63.
- Tschopp, R.H., 1967, The general geology of Oman. Proc. 7th World Petrol. Congr., Elsevier, Amsterdam, v. 2, p. 231-242.
- Ulrich, J., 1968, Die Echolotungen des Forschungsschiffes "Meteor" im Arabischen Meer während der Internationalen Indischen Ozean Expedition. in Meteor Forschungsergebnisse, Borntraeger, Berlin, Stuttgart, Seite 1, p. 1-13.
- U.S. Hydrographic Office, 1952, Sailing directions for the Persian Gulf, the Gulf of Oman and the northern shore of the Arabian Sea as far eastward as Ras Muari. Hydrographic Office Publ., no. 158, 4th ed., Washington, 1 v. (loose-leaf).
- U.S. Naval Oceanographic Office, 1944, Atlas of surface currents, Indian Ocean. U.S. Navy Hydrograph. Office, Publ., 566, 12 p.
- U.S. Naval Oceanographic Office, 1965, Results of the Persian Gulf-Arabian Sea, Oceanographic surveys, 1960-1961. U.S. Navy Hydrographic Office, Tech. Rept., v. 176, 239 p.
- Vita-Finzi, C., 1969, Late Quarternary alluvial chronology of Iran. Geol. Rundsch., v. 58(3), p. 951-973.
- Wagner, C.W. and Togt, van der C., 1973, Holocene sediment types and their distribution in the southern Persian Gulf. in The Persian Gulf, B.H. Purser, ed., Springer-Verlag, N.Y., Heidelberg, Berlin, p. 123-156.
- Weber, W., 1888, Der Arabische Meerbusen, 1. Theil; Historisches und Morphologisches mit einer Tiefenkarte. Thesis, Marburg, (Tiefenkarte 1:4 Mill.), p. 1-62.
- Wellman, H.W., 1966, Active wrench faults of Iran, Afghanistan and Pakistan. Geol. Rundschau, v. 55, p. 716-735.
- Wells, A.J., 1962, Recent dolomite in the Persian Gulf. Nature, v. 194, p. 274-275.
- Wells, A.J., 1969, The crush zone of the Iranian Zagros Mountains and its implications. Geol. Mag., v. 106, p. 385-394.
- Wells, A.J. and Illing, L.V., 1963, Present day precipitation of calcium carbonate in the Persian Gulf. in L.M.J.U. van Straaten, ed., Deltaic and Shallow Marine Deposits, Elsevier, Amsterdam, p. 429-435.
- Welte, D.H. and Ebhardt, G., 1968, Die Verteilung höherer, geradkettiger Paraffine und Fettsäuren in einem Sedimentprofil aus dem Persischen Golf. "Meteor" Forschungsergebn, C, 1, p. 43-52; English version, Geochimica et Cosmochimica Acta, v. 32, p. 465-466, 1968.
- Werner, F., 1971, Sedimentation in the Persian Gulf: biogenic cavities. VIII Int. Sedim. Congr., Heidelberg, Abstract, p. 108.

Persian Gulf References

Page 14

- Wilson, A.T., 1925, The delta of the Shatt-al-Arab, and the proposals for dredging the bar. *Geogr. J.*, v. 65, p. 225-239.
- Wilson, A.T., 1927, A summary of scientific research in the Persian Gulf. *J. Bombay Nat. Hist. Soc.*, v. 31, p. 638-654.
- Wilson, A.T., 1930, Earthquakes in Persia. *Bull. School Oriental Stud.*, v. 6, London, p. 103-131.
- Wilson, H.H., 1969, Late Cretaceous eugeosynclinal sedimentation, gravity tectonics, and ophiolite emplacement in Oman Mountains, southeast Arabia. *Am. Assoc. Petrol. Geol.*, v. 53, p. 626-671.
- Wiseman, J.D.H. and Bennett, H., 1940, The distribution of organic carbon and nitrogen in sediments from the Arabian Sea. *John Murray Expedition, 1933-1934*, v. 3(4), p. 193-221.
- Wiseman, J.D.H. and Sewell, R.G.S., 1937, The floor of the Arabian Sea. *Geol. Mag.*, v. 74(875), p. 219-230.
- Zeist, W. van, 1967, Late quaternary vegetation history of western Iran. *Rev. Palaeobot. Palynol.*, v. 2, p. 401-311. Amsterdam.
- Zeist, W. van and Wright, H.E. Jr., 1963, Preliminary pollen studies at Lake Zeribar, Zagros Mountains, southwestern Iran. *Science*, v. 140, p.65.
- Zenkevich, L.A., 1957, Caspian and Aral Seas. *Geol. Soc. Am. Mem.*, 67, v. 1, p. 891-916.
- Ziegenbein, J., 1966, Trübungsmessungen im Persischen Golf und im Golf von Oman. "Meteor" *Forschungsergebn*, A, 1, p. 59-79.

SECTION 1b

PERSIAN GULF REFERENCES

From The Persian Gulf
Edited by B.H. Purser
Springer-Verlag, 1973

A. Bibliography Relating to the Persian Gulf Region

- AL-HABEED, K.H.: Sedimentological investigations of the flood-plain sediments of the middle Euphrates River. Thesis, University of Baghdad (1969).
- ARAMCO: Ghawar oil field, Saudi Arabia. Bull. Am. Assoc. Petrol. Geologists 43, 434-454 (1950).
- BATE, R.H.: The distribution of Recent Ostracoda in the Abu Dhabi Lagoon, Persian Gulf. Bull. Cent. Rech. Pau-SNPA 5, 239-256 (1971).
- BOBEK, H.: Nature and implications of Quaternary climatic changes in Iran. UNESCO proc. XX. Changes in climate, 403-422, Paris (1963).
- BOBEK, H.: Zur Kenntnis der Südlichen Lüt. Mitteil. der Österreichischen Geographischen Gesellschaft, Bd. 111, Heft II/III, 155-192 (1969).
- BRAMKAMP, R.A., POWERS, R.W.: Two Persian Gulf lagoons. J. Sediment. Petrol. 25, 139-140 (1955).
- British Petroleum Co. Ltd.: Geological maps and sections of South-West Persia. Int. Geol. Congr., Proc. 20th Session, Mexico, 1956.
- BURINGH, P.: Soil and soil conditions in Iraq. Ministry of Agriculture, 1-322, Baghdad (1960).
- BURINGH, P., EDELMAN, C.H.: Some remarks about soils of the alluvial plain of Iraq, south of Baghdad. Ne-h. J. Agr. Soc. 3, 40-49 (1955).
- BUSH, P.R.: Chloride rich brines from sabkha sediments and their possible role in ore formation. Trans. Inst. Miner. Metall. Sect. B. 79, 137-144 (1970).
- BUTLER, G.P.: Early diagenesis in the Recent sediments of the Trucial coast of the Persian Gulf. MSc Thesis. Univ. Lond. (1966).
- BUTLER, G.P.: Modern evaporite deposition and geochemistry of co-existing brines, the sabkha, Trucial coast, Arabian Gulf. J. Sediment. Petrol. 39, 70-89 (1969).
- BUTLER, G.P.: Recent gypsum and anhydrite of the Abu Dhabi sabkha, Trucial Coast: an alternative explanation of origin; in: Third symposium on salt, Vol. 1: Northern Ohio Geol. Soc., p. 120-152 (1970a).
- BUTLER, G.P.: Secondary anhydrite from a sabkha, North West Gulf of California, Mexico; in: Third symposium on salt, Vol. 1: Northern Ohio Geol. Soc., p. 120-152 (1970b).
- BUTLER, G.P.: Origin and controls on distribution of arid supratidal (sabkha) dolomite, Abu Dhabi, Trucial Coast (abst.): Bull. Am. Assoc. Petrol. Geologists 55, 332 (1971).
- BUTLER, G.P., KENDALL, C.G.St.C., KINSMAN, D.J.J., SHEARMAN, D.J., SKIPWITH, Sir Patrick A.d'E.: Recent anhydrite from the Trucial coast of the Arabian Gulf. Circ. Geol. Soc. Lond. 120, 3 (1965).
- CUFF, C.: Lattice disorder in Recent anhydrite and its geological implications. Proc. Geol. Soc. London, No. 1659, 326-330 (1969).
- CURTIS, R., EVANS, G., KINSMAN, D.J.J., SHEARMAN, D.J.: Association of dolomite and anhydrite in the Recent sediments of the Persian Gulf. Nature, 197, No. 4868, 679-680 (1963).

- DIESTER, L.: Grobfraktionsanalyse von Sedimentkernen aus dem Persischen Golf. Thesis Univ. Kiel (1971).
- DIESTER, L.: Zur spätpleistozänen und holozänen Sedimentation im zentralen und östlichen Persischen Golf. "METEOR" Forsch. Ergebnisse, Reihe C, No. 8, 37-83 (1972).
- DIESTER, L.: Grobfraktionsanalyse von Sedimentkernen aus dem Persischen Golf. "METEOR" Forsch. Ergebnisse, Reihe C, No. 8, 37-83 (1972).
- DIETRICH, G., KRAUSE, G., SEIBOLD, E., VOLLBRECHT, K.: Reisebericht der Indischen Ozean Expedition mit Forschungsschiff "METEOR" 1964-1965. "METEOR" Forsch. Ergebnisse, Reihe A, No. 1, 1-52 (1966).
- Dust Storms in Iraq. A review. Geograph. Jour. 43, 121-131.
- EINSELE, G., WERNER, F.: Sedimentary processes at the entrance Gulf of Aden / Red Sea. "METEOR" Forsch. Ergebnisse, Reihe C, No. 9 (in press).
- ELDER, S.: Umm Shaif oil field. Journ. Inst. Pet. 49, 478, 308-315 (1963).
- EMERY, K.O.: Sediments and water of Persian Gulf. Bull. Am. Assoc. Petrol. Geologists 40, 2354-2383 (1956).
- ESTEOULE, J., ESTEOULE-CHOUX, J., MELGUEN, M., SEIBOLD, E.: Sur la présence d'attapulгите dans des sédiments récents du Nord-Est du Golfe Persique. C. R. Acad. Sc. Paris 271, 1153-1156.
- EVANS, G.: The Recent sedimentary facies of the Persian Gulf region. Phil. Trans. Roy. Soc. London, Ser. A, Vol. 259, No. 1099, 291-298 (1966).
- EVANS, G., SHEARMAN, D.J.: Recent celestite from the sediments of the Trucial coast of the Persian Gulf. Nature 202, No. 4930, 385-386 (1964).
- EVANS, G., KENDALL, C.G.St.C., SKIPWITH, Sir Patrick A. d'E.: Origin of the coastal flats, the sabkha, of the Trucial coast, Persian Gulf. Nature 202, No. 4934, 579-600 (1964).
- EVANS, G., KINSMAN, D.J.J., SHEARMAN, D.J.: A reconnaissance survey of the environment of Recent carbonate sedimentation along the Trucial coast, Persian Gulf. In: Deltaic and shallow marine deposits, ed. by L.M.J.U. van STRAATEN. Elsevier, Amsterdam, p. 129-135 (1964).
- EVANS, G., BUSH, P.: Some sedimentological and oceanographic observations on a Persian Gulf lagoon. In: Coastal Lagoons, ed. by A.A. CASTANARES and F.B. PHLEGER. Mem. Simp. Intern. Lagunas Costeras UNAM-UNESCO, Mexico. 155-170 (1969).
- EVANS, G., SCHMIDT, V., BUSH, P., NELSON, H.: Stratigraphy and geologic history of the sabkha, Abu Dhabi, Persian Gulf. Sedimentology 12, 145-159 (1969).
- EVANS, G.: Coastal and nearshore sedimentation: a comparison of clastic and carbonate deposition. Proc. Geol. Assoc. London 81, 493-508 (1970).
- FOX, A.F.: Some problems of petroleum geology in Kuwait. Journ. Inst. Petr. 45, 95-110 (1959).
- FUCHS, W., GATTINGER, T.E., HOLZER, H.F.: Explanatory text to the synoptic geologic map of Kuwait; a surface geology of Kuwait and the Neutral Zone. Geological Survey of Austria (1968).
- GLENNIE, K.W., EVAMY, B.D.: Dikaka: plants and plant-root structures associated with aeolian sand. Palaeogeog., Palaeoclim., Palaeoecol. 4, 77-87 (1968).
- GROOT, de, K.: The chemistry of submarine cement formation at Dohat Hussain in the Persian Gulf. Sedimentology 12, 63-68 (1969).
- HAAKE, F.W.: Zur Tiefenverteilung von Miliölinen (Foram.) im Persischen Golf. Pal. Z. 44, 3/4, 196-200 (1970).
- HAAAS, F.: Shells collected by the Peabody Museum Expedition to the Near East 1950. I. Mollusks from the Persian Gulf. The Nautilus 65, 4, 114-119 (1952).
- HARTMANN, M., LANGE, H., SEIBOLD, E., WALGER, E.: Oberflächensedimente im Persischen Golf und Golf von Oman. I. Geologisch-hydrologischer Rahmen und erste sedimentologische Ergebnisse. "METEOR" Forsch. Ergebnisse, Reihe C, No. 4, 1-76 (1971).
- HENSON, F.R.S.: Observations on the geology and petroleum occurrences of the Middle East. World Petrol. Congr. Proc. 3rd. The Hague. Section 1, 118-140 (1951).
- HOEFS, J., SARNTHEIN, M.: $^{18}O/^{16}O$ Ratios and related temperatures of Recent pteropod shells (Cavolinia longirostris LESUEUR) from the Persian Gulf. Mar. Geol. 10, 11-16 (1971).
- HOLM, D.A.: Desert geomorphology in the Arabian Peninsula. Science 132, 1369 (1960).
- HOUBOLT, J.J.H.C.: Surface sediments of the Persian Gulf near the Qatar Peninsula. Doctoral thesis, University of Utrecht. Den Haag: Mouton and Co. (1957).

- ILLING, L.V., WELLS, A.J., TAYLOR, J.C.M.: Penecontemporary dolomite in the Persian Gulf. In: *Dolomitization and Limestone diagenesis*, ed. by L.C. PRAY and R.C. MURRAY. S.E.P.M., Spec. Publ. 13, 89-111 (1965).
- JESSEN, K., SPARCK, R. (eds.): *Danish Scientific Investigations in Iran*, parts I-IV. Copenhagen: Munksgaard (1939-1949).
- KENDALL, C.G.St.C.: Recent sediments of the Western Khor al Bazam, Abu Dhabi, Trucial Coast. PhD Thesis, University of London (1966).
- KENDALL, C.G.St.C., SKIPWITH, Sir Patrick A. d'E.: Recent algal stromatolites of the Khor al Bazam, Southwest Persian Gulf. *Abs. Geol. Soc. Am. Spec. Pap.* for 1966, 108 (1966).
- KENDALL, C.G.St.C., SKIPWITH, Sir Patrick A. d'E.: Recent algal mats of a Persian Gulf Lagoon. *J. sediment. Petrol.* 38, 1040-1058 (1968).
- KENDALL, C.G.St.C., SKIPWITH, Sir Patrick A. d'E.: Holocene shallow-water carbonate and evaporite sediments of Khor al Bazam, Abu Dhabi, Southwest Persian Gulf. *Bull. Am. Assoc. Petrol. Geologists* 53, 841-869 (1969a).
- KENDALL, C.G.St.C., SKIPWITH, Sir Patrick A. d'E.: Geomorphology of a Recent shallow water carbonate province; Khor al Bazam, Trucial Coast, Southwest Persian Gulf. *Bull. Geol. Soc. Am.* 80, 865-892 (1969b).
- KHALAF, M.J.: The climate of Iraq. *Bull. Coll. Arts and Sci.* 2, 1-51 (1957) Baghdad.
- KINSMAN, D.J.J.: Reef coral tolerance of high temperatures and salinities. *Nature* 202, 1280-1282 (1964).
- KINSMAN, D.J.J.: The Recent carbonate sediments near Halat el Bahrani, Trucial coast, Persian Gulf. In: *Developments in Sedimentology 1. Deltaic and Shallow Marine Deposits*, ed. by L.M.J.U. van STRAATEN, p. 189-192 (1964a).
- KINSMAN, D.J.J.: Recent carbonate sedimentation near Abu Dhabi, Trucial Coast, Persian Gulf. PhD Thesis, University of London (1964b).
- KINSMAN, D.J.J.: Gypsum and anhydrite of Recent age, Trucial coast, Persian Gulf. *Proc. 2nd Salt Symposium*, I. N. Ohio Geol. Soc. Cleveland, Ohio, 302-326 (1966).
- KINSMAN, D.J.J.: Huntite from a carbonate - evaporite environment. *Am. Miner.* 52, 1332-1340 (1967).
- KINSMAN, D.J.J.: Modes of formation, sedimentary associations, and diagnostic features of shallow-water and supratidal evaporites. *Bull. Am. Assoc. Petrol. Geologists* 53, 830-840 (1969).
- KINSMAN, D.J.J., PARK, R.K., PATTERSON, R.J.: Sabkhas: Studies in Recent carbonate sedimentation and diagenesis, Persian Gulf. *Geol. Soc. Am. Abstracts*, 1971 Annual Meetings, 772-774 (1971).
- KUKAL, Z., SAADALLAH, A.: Composition and rate of deposition of the Recent dust storm sediments in Iraq. *Cas. pro Min. a Geol.* 15, 227-234 (1970).
- KUKAL, Z., AL-JASSIM, J.: Sedimentology of Pliocene Molasse sediments of the Mesopotamian geosyncline. *Sediment. Geol.* 5, 57-81 (1971).
- LEES, G.M.: The physical geography of South-East Arabia. *Geogr. Journ.* 121, 441 (1948).
- LEES, G.M., FALCON, N.L.: The geographical history of the Mesopotamian plains. *Geogr. Journ.* 116, 24-39 (1952).
- LUTZE, G.F., GRABERT, B., SEIBOLD, E.: Lebendbeobachtungen an Groß-Foraminiferen (Heterostegina) aus dem Persischen Golf. "METEOR" Forsch. Ergebnisse, Reihe C, No. 6, 21-40 (1971).
- MARTINI, E.: Nannoplankton und Umlagerungserscheinungen im Persischen Golf und im nördlichen Arabischen Meer. *N. Jb. Geol. Pal., Mh.* 597-607 (1967).
- MELGUEN, M.: Etude de sédiments Pleistocène-Holocène au nordouest du golfe Persique. *Analyse de faciès par ordinateur*. Thèse, Université de Rennes (1971).
- MELVILL, J.C.: The marine Mollusca of the Persian Gulf, Gulf of Oman and North Arabian Sea, as evidenced mainly through collections of Captain F.W. Townsend 1893-1914., etc. *Proc. Malacol. Soc., London*, 18, 93-117 (1928/1929).
- MELVILL, J.C., STANDEN, R.: The Mollusca of the Persian Gulf, Gulf of Oman and Arabian Sea, as evidenced mainly through the collections of Mr. F.W. Townsend, 1893-1900; with description of new species. Part I. Cephalopoda, Gastropoda, Scaphopoda. *Proc. Zool. Soc.* 327-460 (1901).
- MURRAY, J.W.: The Foraminiferida of the Persian Gulf. Part 1. *Rosalina adhaerens* sp. nov. *Ann. Mag. nat. Hist.*, ser 13, 8, 77-79 (1965a).
- MURRAY, J.W.: The Foraminiferida of the Persian Gulf. 2. The Abu Dhabi Region. *Palaeogeography, Palaeoclim., Palaeoecol.*, 1, 307-332 (1965b).

- MURRAY, J.W.: The Foraminiferida of the Persian Gulf. 3. The Halat al Bahrani Region. *Palaeogeo., Palaeoclim., Palaeoecol.* 2, 59-68 (1966a).
- MURRAY, J.W.: The Foraminiferida of the Persian Gulf. 4. Khor al Bazam. *Palaeogeo., Palaeoclim., Palaeoecol.* 2, 153-169 (1966b).
- MURRAY, J.W.: The Foraminiferida of the Persian Gulf. 5. The shelf of the Trucial Coast. *Palaeogeo., Palaeoclim., Palaeoecol.* 2, 267-278 (1966c).
- MURRAY, J.W.: The Foraminiferida of the Persian Gulf. 6. Living forms in the Abu Dhabi Region. *J. Nat. Hist.* 4, 55-67 (1970a).
- MURRAY, J.W.: The Foraminifera of the hypersaline Abu Dhabi Lagoon, Persian Gulf. *Lethaia* 3, 51-68 (1970b).
- PEERY, K.: Results of the Persian Gulf-Arabian sea oceanographic surveys, 1960-1961. Technical report 176, U.S. Naval Oceanographic Office, Washington, D.C. (1965).
- PILKEY, O.H., NOBLE, D.: Carbonate and clay mineralogy of the Persian Gulf. *Deep-Sea Research* 13, 1-16 (1966).
- POEL, G.H. van der: Measurement of some factors concerning the flow of saline water in the sediments on the tidal flats at Qatar, Persian Gulf. Unpubl. Shell Res. (1964).
- POWERS, R.W.: Geology of the Arabian Peninsula. *Sedimentary geology of Saudi Arabia.* *Geol. Soc. Am. Prof. Paper* 560d (1966).
- PRIVETT, D.W.: Monthly charts of evaporation from the Northern Indian Ocean (including the Red Sea and the Persian Gulf). *Q.J.R. Met. Soc.* 85, 424-478 (1959).
- SAMPO, M.: Microfacies and microfossils of the Zagros area, southwestern Iran (from pre-Permian to Miocene). Ed. BRILL, Leiden (1969).
- SARNTHEIN, M.: Sedimentologische Merkmale für die Untergrenze der Wellenwirkung im Persischen Golf. *Geol. Rundsch.* 59/2, 649-666 (1970).
- SARNTHEIN, M.: Oberflächensedimente im Persischen Golf und Golf von Oman. II. Quantitative Komponenten Analys der Grobfraktion. "METEOR" Forsch. Ergebnisse, Reihe C, No. 5 (1971).
- SARNTHEIN, M.: Recent sedimentation near entrances to adjacent seas: Persian Gulf/Gulf of Oman. Abstracts, VIII. Int. Sed. Congr. (Heidelberg 1971).
- SARNTHEIN, M.: Sediments and history of the postglacial transgression in the Persian Gulf and Gulf of Oman. *Mar. Geol.* 12, 245-266 (1972).
- SARNTHEIN, M.: Pteropods and Heteropods in surface sediments of the Persian Gulf. In: *The Biology of the Indian Ocean. Symp. Kiel 1971*, in press.
- SARNTHEIN, M.: Stratigraphic Contamination by Vertical Bioturbation in Holocene Shelf Sediments. 24th Int. Geol. Congr., Proc., Sect. 6, Montreal (1972).
- SCHOTT, W., von STACKELBERG, U., ECKHARDT, F.-J., MATTIAT, B., PETER, J., ZOBEL, B.: Geologische Untersuchungen an Sedimenten des indisch-pakistanischen Kontinentalrandes (Arabisches Meer). *Geol. Rundsch.* 60/1, 264-274 (1970).
- SEIBOLD, E.: Nebenmeere im humiden und ariden Klimabereich. *Geol. Rundsch.* 60/1, 73-105 (1970).
- SEIBOLD, E.: Biogenic sedimentation of the Persian Gulf. In: *The Biology of the Indian Ocean. Symposium Kiel 1971*, in press.
- SEIBOLD, E., VOLLBRECHT, K.: Die Bodengestalt des Persischen Golfs. "METEOR" Forsch. Ergebnisse, Reihe C, No. 2, 29-56 (1969).
- SEIBOLD, E., ULRICH, J.: Zur Bodengestalt des nordwestlichen Golfs von Oman. "METEOR" Forsch. Ergebnisse, Reihe C, No. 3, 1-14 (1970).
- SHEARMAN, D.J.: Recent anhydrite, gypsum, dolomite and halite from the coastal flats of the Arabian shore of the Persian Gulf. *Proc. Geol. Soc. Lond.* No. 1607, 63 (1963).
- SHEARMAN, D.J.: Origin of marine evaporites by diagenesis. *Trans. Inst. Miner. Metall.*, Section B, 75, 208-215 (1966).
- SHINN, E.A.: Submarine lithification of Holocene carbonate sediments in the Persian Gulf. *Sedimentology* 12, 109-144 (1969).
- SKIPWITH, P.A. d'E.: Recent carbonate sediments of Eastern Khor al Bazam, Abu Dhabi, Trucial Coast. Ph.D. Thesis, Imperial College, London (1966).
- SUGDEN, W.: Structural analysis and geometrical prediction for change of form with depth of some Arabian plains-type folds. *Bull. Am. Assoc. Petrol. Geologists* 46, 2213-2228 (1962).
- SUGDEN, W.: Some aspects of sedimentation in the Persian Gulf. *J. Sediment. Petrol.* 33, 355-364 (1963).
- SUGDEN, W.: The hydrology of the Persian Gulf and its significance in respect to evaporite deposition. *Am. J. Sci.* 261, 741-755 (1963).

- SUGDEN, W.: Pyrite staining of pelley debris in carbonate sediments from the Middle East and elsewhere. *Geol. Mag.* 103, 250-256 (1966).
- Statistical Abstracts for 1967. Government Press, p. 20, Baghdad.
- TAYLOR, J.C.M., ILLING, L.V.: Holocene intertidal calcium carbonate cementation, Qatar, Persian Gulf. *Sedimentology* 12, 69-107 (1969).
- United States Geological Survey (1958-1963), Misc. Geol. Investigations. Maps 1208-209-213-214-215 (Geological maps of the Arabian Peninsula) 1:500,000.
- WELLS, A.J.: Recent dolomite in the Persian Gulf. *Nature* 194, 4825, 274-275 (1962).
- ZEIST, W. van, WRIGHT, H.E., Jr.: Preliminary pollen studies at Lake Zeribar, Zagros Mountains, South Western Iran. *Science* 140, 65-67 (1963).
- ZEIST, W. van: Late Quaternary vegetation history of western Iran. *Rev. Palaeobot.* 2, *Palynol.* 2, 301-311 (1967).
- ZIEGENBEIN, J.: Trübungsmessungen im Persischen Golf und im Golf von Oman. "METEOR" Forsch. Ergebnisse, Reihe A, No. 1, 59-79 (1966).

B. General Bibliography

- ADAMS, J.E., FRENZEL, H.N.: Capitan Barrier Reef, Texas and New Mexico. *J. Geol.* 58, 289-312 (1950).
- ADAMS, J.E., RHODES, M.L.: Dolomitisation by seepage refluxion. *Bull. Am. Assoc. Petrol. Geologists* 44, 1912-1920 (1960).
- ALLEN, G., PUJOS-LAMY, A.: Application de l'analyse factorielle (mode Y) à l'étude micropaléontologique d'une carotte marine. *C. R. Somm. Soc. Géol. Fr.* 7, 257 (1970).
- ANDERSON, R.Y., KIRKLAND, D.W.: Intrabasin valve correlation. *Bull. Geol. Soc. Am.* 77, 241-256 (1966).
- ARONS, A.B., KIENZLER, C.F.: Vapour pressure of sea-salt solutions. *Am Geophys. Union Trans.* 35, 722-728 (1954).
- ARTJUSHKOV, E.V.: The possible genetics and general laws governing the growth of a convection instability in sedimentary rock. *Doklady Akad. Nauk SSSR* 153, No. 1, 162-165 (1963).
- ARTJUSHKOV, E.V.: Basic shapes of convectional structures in sedimentary rock. *Doklady Akad. Nauk SSSR* 153, No. 2, 412-415 (1963).
- BAKER, G., FROSTICK, A.C.: Pisoliths, oolichs, and calcareous growths in limestone caves at Port Campbell, Victoria, Australia. *J. Sediment. Petrol.* 21, 85-104 (1951).
- BARON, G.: Sur la synthèse de la dolomite, application au phénomène de la dolomitisation. *Rev. Inst. Franc. Petr.* 15, 3-68 (1960).
- BATHURST, R.G.C.: Boring algae, micrite envelopes and lithification of molluscan biosparites. *Geol. J.* 5, 15-32 (1966).
- BATHURST, R.G.C.: Oolitic films on low energy carbonate sand grains, Bimini lagoon, Bahamas. *Marine Geol.* 5, 89-109 (1967).
- BATHURST, R.G.C.: Carbonate sediments and their diagenesis. Amsterdam: Elsevier Publishing Co. (1972).
- BEALL, A.O.: Textural differentiation within the fine sand grade. *J. Geol.* 78, 77-93 (1970).
- BENZECRI, J.P.: Leçon sur l'analyse statistique des données multidimensionnelle. Public. multigraphiée, Inst. Statistiques, Univ. Paris (1970).
- BENZECRI, J.P.: Distance distributionnelle et métrique du X^2 en analyse factorielle des correspondances. Public. multigraphiée, Inst. Statistiques, Univ. Paris (1970).
- BENZECRI, J.P.: L'analyse des données. Public. multigraphiée, Inst. Statistiques, Univ. Paris (1971).
- BLACK, M.: The precipitation of calcium carbonate on the Great Bahama Bank. *Geol. Mag.* 70, 455-466 (1933).
- BODECHTEL, Y., GIERLOFF-EMDEN, H.G.: Weltraumbilder der Erde. S. 176, München: List-Verlag (1969).
- BONCH-OSMOLOVSKAYA, K.S.: Dependence of the strontium content in calcium sulphates on the conditions of solid phase formation. *Chemical Abstracts* 1965, Vol. 63, col. 9667, and *Uch. Zap. Nauchn-Issled. Inst. Geol. Arktiki, Regional'n. Geol.* 1964 (2), p. 179-187 (1964) (in Russian).
- BRIGGS, L.I.: Heavy mineral correlations and provenances. *J. Sediment. Petrol.* 35, 4, 939-955 (1965).

- BUTZER, K.W.: Climatic changes in the arid zones of Africa during early to mid-Holocene times. SAWYER, J.S. (ed.). World climate from 8.000 to O.B.C., p. 72-83, London (1966).
- CORDIER, B.: Analyse factorielle des correspondances. Thèse de 3ème cycle (non publiée), Faculté des Sciences, Univ. Rennes (1965).
- CRUFT, E.F., CHAO, P.C.: Nucleation kinetics of the anhydrite-gypsum system. In: Third symposium on salt, Vol. 1; Northern Ohio Geol. Soc. 109-118 (1970).
- CULLEN, D.J.: Submarine evidence from New Zealand of a rapid rise in sea level about 11.000 years ago. Paleogeol., Paleoclim., Paleocol. 3, 289-298 (1967).
- CURRAY, J.R.: Late Quaternary sea level. A discussion. Bull. Geol. Soc. Am. 72, 1707-1712 (1961).
- DANGEARD, L.: Etude des calcaires par coloration et décalcification. Application à l'étude des calcaires oolitiques. Bull. Soc. Geol. de France, V Série, T VI, 237-245 (1936).
- DAVIES, G.R.: Carbonate Bank Sedimentation, Eastern Shark Bay, Western Australia. In: Carbonate Sedimentation and Environments Shark Bay, Western Australia. Am. Assoc. Petrol. Geologists Mem. 13, 85-168 (1970a).
- DAVIES, G.R.: Algal-laminated sediments, Gladstone Embayment, Shark Bay, Western Australia. In: Carbonate Sedimentation and Environments Shark Bay, Western Australia. Am. Assoc. Petrol. Geologists, Mem 13, 169-205 (1970b).
- DEAN, W.E., Jr.: Petrologic and geochemical variations in the Permian Castile varved anhydrite, Delaware Basin, Texas and New Mexico; Ph.D. Dissertation; Univ. of New Mexico, p. 326 (1967).
- DEFFEYES, K.S., LUCIA, F.J., WEYL, D.K.: Dolomitisation of Recent and Plio-Pleistocene sediments by marine evaporite waters on Bonaire, Netherlands Antilles. In: Dolomitization and Limestone Diagenesis. Eds. L.C. PRAY and R.C. MURRAY. S.E.P.M., Spec. Pub. No. 13, 71-88 (1965).
- DEN HARTOG, C.: Sea grasses of the World. Verh. K. Ned. Akad. Wet., Afd. Natuurk. Tweede Sectie 59, Pt. 1, 12-38 (1970).
- DONAHUE, J.D.: Genesis of oolite and pisolite grains: an energy index. J. Sediment. Petrol. 39, 1399-1411 (1969).
- DUNHAM, R.J.: Classification of carbonate rocks according to depositional texture. Am. Assoc. Petrol. Geologists, Mem. 1, 108-120 (1962).
- DUNHAM, R.J.: Early vadose silt in Townsend mound (reef), New Mexico and Texas. In: Depositional Environments of carbonate rocks. Ed. G.M. FRIEDMAN. S.E.P.M., Spec. Pub. 14, 139-181 (1969).
- DUNHAM, R.J.: Vadose pisolite in the Capitan Reef (Permian), New Mexico and Texas. In: Depositional Environments of carbonate rocks. Ed. G.M. FRIEDMAN. S.E.P.M., Spec. Pub. 14, 182-191 (1969).
- EARDLEY, A.J.: Sediments of Great Salt Lake Utah. Bull. Am. Assoc. Petrol. Geologists 22, 1305-1411 (1938).
- EMERY, K.O., TRACEY, J.I., LADD, H.S.: Geology of Bikini and nearby atolls. Part I: Geology. Geological Survey of America, Professional paper 260-A (1954).
- FABRICIUS, F., KLINGELE, H.: Ultrastrukturen von Ooiden und Oolithen: Zur Genese und Diagenese quartärer Flachwasserkarbonate des Mittelmeeres. Verh. Geol. B.-A. 4, 594-617 (1970).
- FAIRBRIDGE, R.W.: The dolomite question. S.E.P.M., Spec. Pub. 5, 125-178 (1957).
- FAIRBRIDGE, R.W.: Eustatic changes in sea level. In: Physics and Chemistry of the Earth, Vol. 4. Pergamon Press (1961).
- FISHER, R.A., CORBET, A.S., WILLIAMS, C.B.: The relationship between the number of species and the number of individuals in a random sample of an animal population. J. Anim. Ecol. 12, 42-58 (1943).
- FREEMAN, T.: Quiet water oolites from Laguna Madre, Texas. J. Sediment. Petrol. 32, 475-483 (1962).
- FREEZE, R.A., WITHERSPOON, P.A.: Theoretical analysis of regional ground-water flow. Water Resources Research 3, 623-634 (1967).
- FRIEDMAN, G.M.: Occurrence and origin of Quaternary dolomite of Salt Flat, West Texas. J. Sediment. Petrol. 36, 263-267 (1966).
- FRIEDMAN, G.M., SANDERS, J.E.: Origin and occurrence of dolostones. In: Carbonate Rocks, Part A. Ed. by G.V. CHILINGAR et al., p. 267-348. New York: Elsevier Publishing Co. (1967).

- FRISHMAN, S.A.: Geochemistry of oolites, Baffin Bay, Texas. Thesis, University of Texas (Austin, 1969).
- FÜCHTBAUER, H.: Zur Nomenklatur der Sedimentgesteine. Erdöl und Kohle 12, 605-613 (1959).
- GLENNIE, K.W.: Desert Sedimentary Environments. Amsterdam: Elsevier Publishing Co. (1970).
- GROOT, K., DUYVIS, E.M.: Crystal form of precipitated calcium carbonate as influenced by adsorbed magnesium ions. Nature 212, 183-184 (1966).
- HAHNE, C., KIRCHMAYER, M., OTTEMANN, J.: "Höhlenperlen" (cave pearls), besonders aus Bergwerken des Ruhrgebietes. Modellfälle zum Studium diagenetischer Vorgänge an Einzeloiden. N. Jahrb., Geol. Paläontol., Ab. 130, 1-46 (1968).
- HARBAUGH, J.W., DEMIRMEN, F.: Application of factor analysis to petrologic variations of Americus Limestone (Lower Permian), Kansas and Oklahoma. The University of Kansas. Special distribution Public. 15 (1964).
- HARBAUGH, J.W., MERRIAM, D.F.: Computer applications in stratigraphical analysis. New York (1968).
- HARDIE, L.A.: The gypsum-anhydrite equilibrium at one atmosphere pressure. Am. Mineralogist 52, 171-200 (1967).
- HARMAN, H.H.: Modern Factor Analysis. Chicago-London (1960).
- HARA, R., TANAKA, Y., NAKAMURA, K.: On the calcium sulphate in sea water - I Solubilities of dehydrate and anhydrite in sea waters of various concentrations at 0° - 200° C. Tohoku Imperial University Tech. Repts. 11, 87-109 (1934).
- HOLLIDAY, D.W.: Secondary gypsum in Middle Carboniferous rocks of Spitsbergen. Geol. Mag. 104, 2, 171-177 (1967).
- HOLSER, W.T., KAPLAN, I.R.: Isotope geochemistry of sedimentary sulfates. Chemical Geology 1, 93-135 (1966).
- HSÜ, K.J.: Origin of dolomite in sedimentary sequences: a critical analysis. Mineralium Deposita 2, 133-138 (1966).
- HSÜ, K.J., SIEGENTHALER, C.: Preliminary experiments on hydrodynamic movement induced by evaporation and their bearing on the dolomite problem. Sedimentology 12, 11-25 (1969).
- HUBBERT, M.K.: The theory of groundwater motion. J. Geol. 48, 785-944 (1940).
- ILLING, L.V.: Bahaman calcareous sands. Bull. Am. Assoc. Petrol. Geologists 38, 1-95 (1954).
- IMBRIE, J., PURDY, E.G.: Classification of modern Bahamian carbonate sediments. HAM, W.E. (ed.). Bull. Am. Assoc. Petrol. Geologists, Mem. 1, 253-272 (1962).
- IMBRIE, J.: Factor and vector analysis programs for analyzing geologic data. Technical Report of ONR Task No. 389-135, Evanston, Illinois (1963).
- IMBRIE, J., ANDEL, T.H. van: Vector analysis of heavy mineral data. Bull. Geol. Soc. Am. 75, 1131-1156 (1964).
- JELGERSMA, S.: Holocene sea level changes in the Netherlands. Dissertation "Ernest van AELST", Maastricht (1961).
- JUNG, W., KNITZSCHKE, G.: Kombiniert-feinstratigraphischgeochemische Untersuchungen der Anhydrite des Zechsteins I im SE-Harzzvorland. Geologie 9, Nr. 1, 58-72 (1960).
- KERR, S.D., THOMPSON, A.: Origin of nodular and bedded anhydrite in Permian shelf sediments, Texas and New Mexico. Bull. Am. Assoc. Petrol. Geologists 42, 1726-1732 (1963).
- KELLEY, J.C., WHETTEN, J.T.: Quantitative statistical analyses of Columbia river sediment samples. J. Sediment. Petrol. 39, 3, 1167-1173 (1969).
- KINSMAN, D.J.J.: Interpretation of Sr^{2+} concentrations in carbonate minerals and rocks. J. Sediment. Petrol. 39, 486-508 (1969).
- KINSMAN, D.J.J., HOLLAND, H.D.: The coprecipitation of cations with $CaCO_3$ -IV. The coprecipitation of Sr^{2+} with aragonite between 16° and 96°C. Geochim. Cosmochim. Acta 33, 1-17 (1969).
- KLOVAN, J.E.: The use of factor analysis in determining depositional environments from grain-size distributions. J. Sediment. Petrol. 36, 115-125 (1966).
- KRUMBEIN, W.C., GRAYBILL, F.A.: An introduction to statistical models in geology. New York-London-Sydney (1965).
- KUDRASS, H.R.: Sedimentation am Kontinentalhang vor Portugal und Marokko im Spätpleistozän und Holozän. Unveröffentl. Diss. Univ. Kiel (1972).
- LEBART, L., FENELON, J.P.: Statistique et informatique appliquées. Ed. by DUNOD. Paris (1971).

- LOGAN, B.W. et al: Classification and environmental significance of algal stromatolites. *J. Geol.* 72, 68-83 (1964).
- LOGAN, B.W. et al: Carbonate sediments and reefs, Yucatan shelf, Mexico. *Am. Assoc. Petrol. Geologists, Mem.* 11 (1969).
- LOREAU, J.-P.: Ultrastructure de la phase carbonatée des oolites actuelles. *C. R. Acad. Sci.* 271, 816-819 (1970).
- LOREAU, J.-P.: Ultrastructure, nucleation, and crystal growth of natural and experimentally produced aragonite in relation to non-skeletal organic matter. Abstracts, VIII. Int. Sed. Congr. (Heidelberg, 1971).
- LOREAU, J.-P.: Explication de la birefringence anormalement faible de l'aragonite des oolites marines. *C. R. Acad. Sci.* (in press).
- LUCIA, F.J.: Recent sediments and diagenesis of south Bonaire, Netherlands Antilles. *J. Sediment. Petrol.* 38, 845-858 (1967).
- MAIKLEM, W.R., BEBOUT, D.G., GLAISTER, R.P.: Classification of anhydrite - a practical approach. *Bull. Canad. Petrol. Geology* 17, No. 2, 194-233 (1969).
- MAYHEW, E.J., HEYLMUM, E.B.: Complex salts and brines of the Paradox Basin. In: Second symposium on salt, Vol. 1. Northern Ohio Geol. Soc., p. 221-235 (1966).
- MAXWELL, W.G.J.: Atlas of the Great Barrier Reef. Amsterdam: Elsevier Publishing Co. (1968).
- MELGUEN, M.: Exemple de traitement statistique de données sédimentologiques : différenciation de faciès dans un sédiment d'apparence homogène. *Bull. de l'Union des Océanographes Français*. Paris (1972).
- MOORE, R.C.: Meaning of facies. *Sedimentary facies in Geologic History*. Geol. Soc. Amer. Mem. 39, 1-34 (1949).
- MÖRNER, N.A.: Eustatic and climatic changes during the last 15.000 years. *Geol. en Mijnbouw* 48 (4), 389-399 (1969).
- MÜLLER, G.: Zur Geochemie des Strontiums in ozeanen Evaporiten unter besonderer Berücksichtigung der sedimentären Coelestin Lagerstätte von Hemmelte-West (Süd-Oldenburg) *Geologies, Beiheft* 35, 1-90 (1962).
- MURRAY, R.C.: Origin and diagenesis of gypsum and anhydrite. *J. Sediment. Petrol.* 34, 512-523 (1964).
- MURRAY, R.C.: Hydrology of South Bonaire, N. A. A rock selective dolomitisation model. *J. Sediment. Petrol.* 39, 1007-1013 (1969).
- NESTEROFF, W.D.: De l'origine des oolites. *C. R. Acad. Sci.* 242, 1047-1049 (1956).
- NEWELL, N.D., RIGBY, J.K.: Geological studies on the Great Bahama Bank. *S.E.P.M. Spec. Pub.* 5, 15-72 (1957).
- NEWELL, N.D. et al: Bahamian oolitic sand. *J. Geol.* 68, 481-497 (1960).
- OSBORNE, R.H.: The American Upper Ordovician standard XI multivariate classification of typical cincinnatian calcarenites. *J. Sediment. Petrol.* 39, 2, 769-776 (1969).
- PAREMANCBUM, M.: The distribution of heavy minerals and their hydraulic equivalents in sediments of the Mediterranean continental shelf of Israel. *J. Sediment. Petrol.* 36, 162-174 (1966).
- PETERSON, M.N.A., VON DER BORCH, C.C., BIEN, G.S.: Growth of dolomite crystals. *Am. J. Sci.* 264, 257-272 (1966).
- PHILIPS, F.C.: Oceanic salt deposits. *Chem. Soc. Quart. Rev.* 1, 91-111 (1947).
- PHLEGER, F.B.: Sedimentology of Guerrero Negro Lagoon, Baja California, Mexico. In: *Submarine Geology and Geophysics*. Eds. W.F. WHITTARD and R. BRADSHAW, p. 205-237. London: Butterworths (1965).
- PIA, J.: Pflanzen als Gesteinbildner. Berlin: Borntraeger 1926.
- PLAS, L. van der, TOBI, A.C.: A chart for judging the reliability of point counting results. *Am. J. Sci.* 263, 87-90 (1965).
- PRICE, W.A.: Environment and formation of the chenier plain. *Quaternaria* 2, 75-86 (1955).
- PURKAYASTHA, B.C., CHATTERJEE, A.: The study of the uptake of strontium tracer by different forms of calcium sulphate. *J. Indian Chem. Soc.* 43, 687-693 (1966).
- PURSER, B.H.: Syn-sedimentary marine lithification of Middle Jurassic limestones in the Paris Basin. *Sedimentology* 12, 205-230 (1969).
- RUSNAK, G.A.: Some observations of Recent oolites. *J. Sediment. Petrol.* 30, 471-480 (1960).
- SCHLANGER, S.O., TRACEY, J.I., Jr.: Dolomitization related to recent emergence of Jarvis Island, Southern Line Islands (Pacific Ocean) (abst.). *Geol. Soc. Am.*, 1970 An. Meetings, 2, n. 7, 676 (1970).

- SCHOFIELD, J.C., THOMPSON, H.R.: Post glacial sea levels and isostatic uplift. *N.Z.J. Geol. Geophys.* 7, 359-370 (1964).
- SEIBOLD, E., EXON, N., HARTMANN, M., KÖGLER, F.-C., KRUMM, H., LUTZE, G.F., NEWTON, R.S., WERNER, F.: Marine Geology of Kiel Bay. In: *Sedimentology of parts of Central Europe. Guidebook. VIII. Int. Sed. Congr.*, p. 209-235 (Heidelberg, 1971).
- SHEARMAN, D.J.: Recent halite rock, Baja California, Mexico. *Institution of Mining and Metallurgy (Newcastle-upon-Tyne). Trans. Sec. B*, 79, 155-162 (1970).
- SHEARMAN, D.J., SKIPWITH, Sir Patrick A. d'E.: Organic matter in Recent and ancient limestones and its role in their diagenesis. *Nature* 208, No. 5017, 1310-1311 (1965).
- SHEARMAN, D.J., TWYMAN, J., ZAND KARIMI, M.: The genesis and diagenesis of oolites. *Proc. Geol. Ass. Lond.* 81, 561-575 (1970).
- SHEPARD, F.P., MOORE, D.E.: Sedimentary environments differentiated by coarse fraction studies. *Bull. Am. Assoc. Petrol. Geologists* 38, 1792-1802 (1954).
- SHINN, E.A.: Practical significance of birdseye structures in carbonate rocks. *J. Sediment. Petrol.* 38, 215-223 (1965).
- SHINN, E.A.: Burrowing in recent lime sediments of Florida and the Bahamas. *J. Paleont.* 42, 879-894 (1968).
- SHINN, E.A., GINSBURG, R.N., LLOYD, R.M.: Recent supratidal dolomite from Andros Island, Bahamas. In: *Dolomitization and Limestone Diagenesis*. Eds. L.C. PRAY and R.C. MURRAY. *S.E.P.M., Spec. Pub.* 13, 112-123 (1965).
- SHINN, E.A., LLOYD, R.M., GINSBURG, R.N.: Anatomy of a modern carbonate tidal flat, Andros Island, Bahamas. *J. Sediment. Petrol.* 39, 1202-1228 (1969).
- SITTER, L.U., de: *Structural Geology*. London: McGraw-Hill (1956).
- SMALLEY, I.J., VITA-FINZI, C.: The formation of fine particles in sandy desert and the nature of desert loess. *J. Sediment. Petrol.* 38, 766-774 (1968).
- SORBY, H.C.: The structure and origin of limestones. *Proc. Geol. Soc. London* 35, 56-95 (1879).
- THODE, H.G., MONSTER, J., DUNFORD, H.B.: Sulphur-isotope geochemistry. *Geochim. Cosmochim. Acta* 25, 159-174 (1961).
- THODE, H.G., MONSTER, J.: Sulphur-isotope geochemistry of petroleum, evaporites and ancient seas. *Am. Assoc. Petrol. Geol., Mem.* 4, 367-377 (1965).
- TRICHET, J.: Essai d'explication du dépôt d'aragonite sur des substrats organiques. *C. R. Acad. Sci.* 265, 1464-1467 (1967).
- TRICHET, J.: Recent aragonite deposition on algal substrates during blue-green algae decomposition. *Rôle of organic substances. Abstracts, VIII. Int. Sed. Congr.* (Heidelberg, 1971).
- UEBERLA, K.: *Faktorenanalyse*. Berlin-Heidelberg-New York: Springer 1968.
- USIGLIO, J.: The data of geochemistry. *Bull. U.S. Geol. Survey* 770 (1924).
- VAN STRAATEN, L.M.J.U.: Composition and structure of Recent marine sediments in The Netherlands. *Leidse Geol. Meded.* XIX (1956).
- VAN VEEN, J.: Eb en vloed-schaar systemen in de nederlandse getijwateren. *Tijdschr. K. Ned. aardrijksk. Genoot.* 67, 303-325 (1950).
- WEYL, P.K.: The solution behaviour of carbonate minerals in sea water. *Univ. Miami. Studies Tropical Oceanog.* 5, 178-228 (1967).
- WILLIAMS, R.E.: Groundwater flow systems and accumulation of evaporite minerals. *Bull. Am. Assoc. Petrol. Geologists* 54, 1290-1295 (1969).

SECTION 2
SUGGESTIONS FOR DESIGN AND EQUIPMENT
OF PERSIAN GULF MARINE RESEARCH VESSELS

SUGGESTIONS FOR DESIGN AND EQUIPMENT OF PERSIAN GULF MARINE RESEARCH VESSELS

The most important piece of equipment for marine science is the research vessel. The planned 40-50 foot long dhows should work well for research in the Persian Gulf and Straits of Hormuz but a larger vessel or vessels will probably be necessary for the Gulf of Oman and the Indian Ocean.

If the vessel is to be used fairly often for all kinds of marine research it should have the following characteristics:

- 1) The ability to maneuver at very low speeds or when stopped. Many biological oceanographic measurements or sampling techniques are done at 1 or 2 knots, while many geological and physical oceanographic measurements are made while stopped. When stopped, it may be necessary for the ship to maneuver and thus an engine that can operate for long periods of time (hours) at low speeds is very important. Many marine engines are not built to work at low speeds.
- 2) The vessel should be seaworthy. You will probably not have much trouble with a dhow although it may limit you to working in only moderately quite waters.
- 3) Laboratory facilities. Some portion of the ship should be set aside for laboratory work and it should be located near the stern of the vessel where it is convenient to the winch. The laboratory should have a broad enough passage way to accomodate the moving in and out of equipment. One should plan on being able to secure equipment in case of rough seas.
- 4) Many ships not built for oceanographic research tend to be very noisy electronically. Thus, any wiring near the laboratory or anywhere electronic measurements will be made should be shielded to prevent leakage of 60 or 120 cycle electricity.
- 5) The vessel should be able to stay at sea at least overnight or for longer periods of time if necessary. This means that it must have facilities for preparing and storing food as well as sleeping facilities.

Suggestions for Design and Equipment of Persian
Gulf Marine Research Vessels

page 2

These items are the main characteristics of a research vessel. Included in this is the understanding that the vessel does not cost too much to operate and can be used on a fairly constant basis. I also suggest that some sort of logging procedure be instituted for the cruises; that they be numbered sequentially, perhaps beginning with the year (75-1, 75-2, 75-3, etc.) for each cruise regardless of who was using the vessel. I also suggest that certain procedures be set for logging or recording observations, locations, and types of data taken. This may not seem important in the beginning, but after a few years you will have collected a great deal of data and without some basic library system it will be difficult to ascertain where the different material came from. Also, over the years as more samples are collected, the data will take on even greater value, both in detecting seasonal variations and in being able to extrapolate from the past to the future.

The organizational framework of using the ship is important and a suggested framework is indicated in Figure 1. The Chief Scientist should be in complete control of the scientific program while the Captain of the vessel should be the supervisor of safety matters. Departures and returns should be under the direction of the Vessel Operation Manager and with joint discussions between the Chief Scientist and the Captain.

A listing of possible specifications for the research vessel is indicated below.

PURPOSE OF VESSEL - Oceanographic research and instruction in the Persian Gulf and Straits of Hormuz, capable of day cruises with approximately 10 persons on board; overnight cruises with four to eight persons board.

Figure 1. Possible organization framework for a ship operation.

Suggestions for Design and Equipment of Persian
Gulf Marine Research Vessel

page 3

RANGE AND AREA OF OPERATION - Operationally capable of ranging throughout the Persian Gulf - breadth 200-300 km and length 1000 km; climate - arid sub-tropical temperature range 45°C to 0°C; little rain; occasionally strong storms.

DECK AREAS AND INTERNAL SPACE - Working deck at stern approximately 32 sq. m (360 sq. ft.); Laboratory area approximately 18 sq. m (200 sq. ft.); Living accommodations for 6-8 persons; Cooking, mess arrangements and stores for 6-8 persons for extended (1-2 week) voyages and 10 persons for day trips (see Figure 2).

POWER - Twin Screw Diesel engine drive. To give the required range of speed, a reverse reduction gear with modulated speed control (equal to Twin-Disc MG-514) or acceptable simple controllable pitch propellers shall be fitted (see enclosure).

AUXILLARY POWER - Electrical power - Two 15 kw 110/220 volt, 60 cycle generators. Each generator also to be fitted with hydraulic pump to power winch, crane, and other deck equipment listed below. The interior of the vessel should be air-conditioned.

MACHINERY AND ELECTRONICS EQUIPMENT - To be manufactured by a firm whose equipment is in use and whose source of parts are readily available in Iran.

OTHER POINTS - Provisions should be made so that temporary scientific equipment can be bolted to the deck.
Adequate life-saving equipment, preferably two inflatable life rafts should be aboard.

Figure 2. Possible design of ship.

Suggestions for Design and Equipment of Persian
Gulf Marine Research Vessel

page 4

Bulwarks in the working deck area should be removable to permit use of heavy scientific gear.

Wheelhouse shall be located aft to observe afterdeck working area and trawl winch control shall be located in bridge.

DECK MACHINERY - Probably 2 scientific winches should be installed with the following general characteristics:

BT winch - 5 hp electric drive; 150 kg (300 lbs.) approximate weight.

Trawling-coring double drum winch hydraulically powered, 40 hp; approximate weight 3000 kg.

Stern A-Frame (similar to hydraulically pivoted gallows frame) working load approximately 12,000 kg (25,000 lbs.).

Hydraulic crane approximate capacity 1 ton at 6 m (20 ft) maximum radius.

The trawl-coring winch, A-Frame and crane are to be powered by the hydraulic system driven from either auxiliary generator engine and controls of the winch are to be from the aft end of the wheelhouse. See enclosed model of R/V A. E. VERRILL which, although a little larger than your plans, has some similarities.

ELECTRONICS - Science Fathometer: Giffit Precision Depth Recorder Model 4000T from Hydro Products, San Diego, California with Transducer WQN 1 from Edo Corporation, Long Island, New York; or EPC Model 4100 (or (4600) or EG&G Model 225. I have enclosed some information on the latter three devices. All are good but each have certain advantages. Flexibility is a key aspect.

- a. Complete spare parts kit with fathometer.
- b. Transducer with CRS face and body.

Suggestions for Design and Equipment of Persian
Gulf Marine Research Vessel

page 5

Ship's Radar: Decca RM 1226 with 60 NM conversion kit.

- a. Power supply 220 VAC.
- b. Complete spare parts kit.
- c. Ancillary units - 1) Plotter; 2) Performance monitor.

Back up with Decca Super 110.

- a. Complete spare parts kit.

VHF Radiotelephone - One each Decca Model STR-15 with ST-15 booster amplifier.

- a. Power Supply - PS110-12.
- b. External loudspeaker H-44.
- c. Remote control head RU-15.
- d. Complete spare parts kit.

One each Decca Model STR 65.

- a. Complete spare parts kit.

Radiotelephone - Collins MR-1000 ship radio system.

- a. 25 foot whip antenna.
- b. Complete spare parts kit.

Bridge Fathometer - Elac Model 43.

- a. Complete spare parts kit.

Gyrocompass - Plath 450.

- a. Complete spare parts kit.

Autopilot - Arkas 450 GM

- a. Complete spare parts kit.

Suggestions for Design and Equipment of Persian
Gulf Marine Research Vessel

page 6

The three most important pieces of equipment for the ship are its winch (or winches), echo-sounder, and navigation system. The main or trawl winch should be strong enough to handle heavy wire and equipment. If you plan to do any dredging or large-scale trawling, you would probably want to use 3/8 or 1/2 inch stainless wire. Since the depths in the Persian Gulf are not great, the speed of the winch is not important but it should be strong enough to pull in considerable gear. You may want to have a secondary winch (commonly a BT-type winch) to pull in lighter equipment such as Nansen bottles or other devices lowered from the crane or boom.

The position of the winch, and more important, where it goes over the side is very critical. I imagine that your ships will be doing a fair amount of trawling for fish and plankton, it is easiest to do this from the stern of the vessel because it facilitates in control. Therefore I suggest the configuration I have shown in Figure 3. For water sampling or other measurements, these can be made best from the starboard side of the ship as is shown in Figure 3. The stern configuration is better suited for an A-frame. The A-frame should be hydraulic and be capable of moving in or out for lowering and retrieving equipment. A boom can be used instead but it requires more finesse in handling equipment but is less expensive to build and install.

The echo-sounder can be of two types, either permanently mounted in the hull or towed behind the ship. If you go aground, you would face the possibility of losing or damaging a permanently mounted echo-sounder. It should be a continuously recording echo-sounder that is capable of withstanding the climate of the Persian Gulf (I have made some recommendations). I would recommend a dry paper-recorder and I will try to help you limit your choice if you desire. Again, a logging system should be instituted. Time marks should be made either every fifteen or thirty minutes and every hour. Locations should be marked on the record or placed in

Figure 3. Top view of ship showing winches.

Suggestions for Design and Equipment of Persian
Gulf Marine Research Vessel

page 7

a log book so that the tracks can be reconstructed. Heading and speed of the vessel should be recorded as well as station stops. It would not hurt to have sequentially numbered stations.

Three basic types of frequency for the echo-sounder should be considered. A 3.5 kHz system has the advantage of usually being able to get some sub-bottom penetration which can give you information on sediment type and thickness. A more conventional frequency is 12 kHz, but this generally will not give sub-bottom penetration. The European systems are more commonly 16 or 16.5 kHz. I personally favor the 3.5 kHz systems because you get so much more.

In addition, some echo-sounding systems (especially those towed) have adjustable frequencies and you can go from one to the other depending upon what is more appropriate. More information on this will be coming.

Navigational systems for small ships do not need to be very sophisticated. If Loran stations are in the Persian Gulf, they should be used. I would suggest that you check with shipping companies to discover what navigational aids are available in the Persian Gulf and perhaps you could use the same. You should have a small radar on the ship and a sextant for taking positions near shore. A small table for plotting positions and keeping running navigation charts should also be aboard.

My next report will contain more information about shipboard equipment.

David A. Ross
17 July 1975

COMBINATION V-DRIVE AND REVERSE AND REDUCTION GEARS

MODEL MG-514M OMEGA POWER CONTROL MARINE GEAR

The new Twin Disc MG-514M features power dividing capability and separate control of propeller speed in both forward and reverse. Propeller speed is controlled by the marine gear shift lever which is independent and separate from the propulsion engine throttle lever. With the engine at high speed, the MG-514M behaves as a fixed reduction ratio drive during cruising, trawling, pushing or towing. For other vessel functions it can be operated as a variable reduction ratio marine gear.

RATIOS: Shallow-case models include 1.51:1, 2.00:1, 2.50:1, 3.00:1 and 3.50:1; deep-case models include 4.13:1, 4.50:1, 5.16:1 and 6.00:1. **HOUSINGS:** SAE No. 1 or No. 0. **WEIGHT:** Shallow-case 1250 lbs.; deep-case 1410 lbs. Options include 35, 50 and 100 hp power take-offs.

TYPICAL MG-514V ARRANGEMENT

TYPICAL MG-502V INSTALLATION

The Twin Disc MG-502V and MG-514V combination V-Drive and Reverse and Reduction Gears offer better weight distribution, broad application possibilities and a new dimension in drive train compactness. Twin Disc also provides U-Joints for some driveline requirements.

Marine Gears... the standard of the Marine Industry!

MODEL	RATIOS	SAE HOUSING	TYPICAL ENGINES
MG-502	1.54:1, 2.00:1 2.47:1	OPTIONAL	BEDFORD 330; CATERPILLAR 3208NA; CHRYSLER M4-75; CUMMINS V-504-M, V-555-M; DETROIT DIESEL 6V-53, 4-71; FORD 534 (Gas), 380DF; GMC DH473, DH637; PERKINS T6.354M, V8.510M (For pleasurecraft applications)
MG-506	1.50:1, 1.97:1 2.50:1, 2.96:1 3.79:1, 4.48:1	NO. 2 or NO. 3 NO. 2 ONLY	CATERPILLAR 3304, 3208NA; CHRYSLER M5-75*; CUMMINS V-903**, V-555-M*, DETROIT DIESEL 6V-53, 4-71, 6-71**; PERKINS TV8 510M*, V8.510M; VOLVO TAMO-708*
MG-509	1.45:1, 2.00:1 2.48:1, 2.95:1 3.83:1, 4.50:1	NO. 1 or NO. 2	CATERPILLAR 3306, D334; CHRYSLER M8-75*; CUMMINS NH-250-M, V-903M, VT-903M*; DETROIT DIESEL 6-71, 8V-71, 8V-71T*; VOLVO TMD-100A
MG-512	1.51:1, 2.00:1 3.00:1, 3.50:1 4.14:1, 4.40:1	NO. 0 or NO. 1	CATERPILLAR D342*, 3406*; CUMMINS NT-335*, NT-380*; DETROIT DIESEL 8V-71*, 12V-71*; VOLVO TAMO-120A*; WAUKESHA H-866-DSIM*, H-1Q77DM*
MG-514 & MG-514M OMEGA POWER CONTROL	1.51:1, 2.00:1 2.50:1, 3.00:1 3.50:1, 4.13:1 4.50:1, 5.16:1 6.00:1	NO. 0 or NO. 1	ALLIS-CHALMERS 25000; CATERPILLAR D343, 3406; CUMMINS V12-500-M; DETROIT DIESEL 12V-71; MURPHY 872M; VOLVO TAMO-120A; WAUKESHA L-1616DM, H-866-DSIM
MG-521	2.19:1, 3.03:1 3.50:1, 4.09:1	NO. 0 Adapter for NO. 00 Available	CATERPILLAR D353, D346; CUMMINS VT-12; DETROIT DIESEL 16V-71
MG-527	2.07:1, 2.92:1 3.86:1, 5.17:1	NO. 0 Adapter for NO. 00 Available	CATERPILLAR D346, D348; CUMMINS VT-12; DETROIT DIESEL 12V-149, 16V-71, MURPHY 872TM, WAUKESHA L-1616DSIM
MG-540	1.93:1, 2.00:1 3.26:1, 3.91:1 4.60:1, 5.17:1 6.18:1, 7.00:1 9.13:1	NO. 0 7.00:1 and 6.18:1 ratio available on 1800 rpm engines with SAE No. 0 housing only SAE No. 00 housing limited to 1650 rpm input.	CATERPILLAR D348, D349; DETROIT DIESEL 12V-149, 12V-149T, 16V-149
	1.71:1, 1.93:1 2.58:1, 2.90:1 3.26:1, 4.10:1 4.60:1, 5.17:1	NO. 00	CATERPILLAR D398, D379; WAUKESHA L-5792-DM

*Special conditions of factory approval. **For pleasurecraft.

V-Drives available; MG-502V with 1.54:1, 2.00:1 and 2.47:1 ratios. MG-514V with 1.51:1 and 2.00:1 ratios.

Features

Direct Digital Stylus Drive

Complete Tape Compatibility

Crystal Controlled Scale Lines

19 $\frac{3}{4}$ " Dry Recording Paper

Jitter-free Single Scan

Up To 4 Scans Per Cycle

All Outputs Short Circuit Proof

All Silicon Components

Rugged, Corrosion Resistant Design

The Model 4600 is a portable, dry-paper graphic recorder designed for RF and audio spectrum analysis display. The 4600 is compatible with most spectrum analyzers and tape equipment, providing complete data history and the capability of intensive data analysis. The unique digital direct drive enables pretaped recordings to be reproduced with exact synchronization at speeds equal to or faster than that from which the tapes were originally made.

Scale lines are generated by an internal crystal, and the sweep speed can be infinitely varied to match

the dump speed of the analyzer data discharge. The system is jitter-free, and the stylus alignment is virtually perfect.

The Model 4600 is also used in general purpose oceanographic survey work, from simple bathymetry to deep seismic sub-bottom profiling. Sweep speeds of up to 8 sweeps per second are an advantage in shallow profiling. The single sweep mode is useful with large sound sources and for generating records from tapes which incorporate no time channel.

EPC MODEL 4600

Summary Specifications

Stylus Drive — The stylus sweep speed can be continuously varied from 125 milliseconds per scan to 8 seconds per scan. The drive circuitry may be synchronized to an external source for tape compatible recording. A manual phasing switch is provided. Stylus direction is left-to-right; however, units can be ordered from the factory incorporating right-to-left printing.

Scale Lines — The scale lines are generated from an internal crystal and may be printed on the chart at 10, 100, 1000 millisecond intervals. A scale line intensity control is provided. The 100 ms and 1000 ms scale lines are articulated.

Single Scan — The recorder may be operated in a single scan mode at speeds of one sweep per second and slower. Acceleration time at the one second sweep is 15 milliseconds, decreasing to 0 at the 4 second sweep. Jitter is negligible.

Programming — The Model 4600 may be programmed for up to 4 scans per cycle. Any one of the 4 scans may be selected to print.

Keying — A 2 millisecond TTL compatible positive or negative-going pulse is supplied at the

start of the first scan.

Amplifiers — The gain control is continuously adjustable for input voltages in the range of 100 millivolts to 10 volts. A threshold control is supplied for eliminating noise. The contrast control allows adjustment of the maximum black level. The input signal may be selected to print positive or negative-going pulses, or both. A manual event mark is provided. The frequency response of the amplifiers is AC 1 Hz or DC to 100 kHz.

Recording Medium — The Model 4600 prints on 19 3/4" wide x 80' long dry electrosensitive paper. The dynamic range of the paper from white to black is 23DB. Paper advance is continuously adjustable from 50 to 200 lines per inch in addition to the rapid advance mode. A paper take-up roll is supplied.

General Features — All inputs are 10K ohms. All outputs are short circuit proof. Silicon transistors and integrated circuits are used throughout. The majority of the electronic components are mounted on the main wire wrap panel for easy replacement.

Mechanical — Dimensions — 32" wide, 20" deep, 5" high. Weight — 65 pounds. Power required — 120 watts, 100-130 VAC, 50-60Hz.

Operational

Sweep Rates

0.125, 0.25, 0.50, 1.0, 2.0, 4.0 sweeps per second; plus variable.

Single Sweep

Available at rates of 1.0 seconds per sweep or greater.

Scale Lines

10, 100 or 1000 millisecond intervals.

Sweep Direction

Left-to-right (right to left can be supplied).

Phasing

Manual; provided by front panel control.

Print Delay

Gate or print from 1 to 4 sweeps.

Key Pulse

Selectable 0-5v positive going or 5v-ground negative going.

Event Mark

Manual — Internal and remote in or out.

Graphic

Paper Type

Dry electrosensitive (NDK), 19 3/4" wide by 80' roll length.

Recording Width

19.2 inches.

Paper Dynamic Range

23db from white to black.

Paper Advance

Variable 50 to 200 lines per inch. Rapid advance provided.

Chart Illumination

Provided by front panel control.

Internal

Input Impedance

10k ohms; all inputs.

Amplifier Gain

Linear 0-1000.

Frequency Response

Flat ± 1 db from DC to 100KHz; $E_{in} \geq 0.1v$.

Contrast

Print current limiter, adjustable by front panel control.

Input Threshold

Adjustable by front panel control.

Power Required

120 watts, 100-130vac, 50-60Hz.

EPC LABS INC.
PO BOX 97
123 Brimbal Avenue
Beverly, Mass. 01915
(617) 927-2523

EIM ASSOCIATES INC.
BOX 200
COHASSET, MA 01945
617 327-1000

model 255 engineering survey recorder

NEW
extended capability

For greater recording convenience and flexibility, the Model 255 features:

- Two recording media — NDK and aluminized Mylar
- Built-in variable filter and preamp
- Time-variable gain
- Tape playback capability with automatic synchronization
- Automatic annotation of programmed gate position

Model 255 Control Features

The EG&G Model 255 Engineering Survey recorder is designed for use with the EG&G UNIBOOM® System and other low-energy, medium-penetration subbottom profiling systems.

Incorporating a number of features not available in other recorders, the new model 255 is an advanced instrument for the marine geologist who needs maximum precision, reliability and performance. Sophisticated signal display control, extremely compact, rugged construction, a dual option in recording media, and other features combine to provide exceptional operating flexibility and convenience.

The Model 255 has the unique capability of offering the operator a choice of two recording media — standard, dry NDK paper, or film-quality aluminized Mylar. The latter medium, an innovation in survey instruments, provides superior record durability and reproduction characteristics.

The ability to obtain optimum record quality under a wide variety of operating conditions is augmented by a built-in preamplifier, a variable cut-off filter and a time-variable gain control circuit.

Data processing and storage are facilitated by a special magnetic tape record/playback control system. As the Model 255 generates its analog printout of the input data, the processed signal may also be fed simultaneously to a standard, two-channel magnetic tape recorder. The resulting magnetic record can be stored conveniently, and played back at any time through the Model 255, to duplicate survey lines for further analysis or interpretation.

Designed for long, trouble-free service in a marine environment, the instrument is packaged in a durable fiberglass case for ease of handling and maximum protection while in transit. Total weight is only 45 lbs.

ENVIRONMENTAL EQUIPMENT DIVISION

Switch under splash cover marked 'NDK' or 'Mylar' will change printing voltage level

On-off switch, with light and Slo-Blo Fuse

Trigger Rate Control in 3 sweep steps from 3-30 sweeps

Trigger output to sound source and switch

Print Shift - Fine Control in $\frac{1}{4}$ sweep steps

Event Mark - Local or Remote

Print Shift - Coarse Control in 3 sweep steps to give a delay in printing from 0-30 sweeps

Sync Input from tape unit for playback recordings

Scan Speeds switch selectable 50, 100, 200, 400 ms or continuously variable 60-500 ms

Paper Control - Adjustable line density 50-200 lines/inch, plus rapid paper advance and paper take-up/forward and reverse and off

Print Control - negative/positive/full phase with Contrast and Threshold variable for optimum recording presentation

Processed signal output for data processing or storage on magnetic tape for later playback

Input signal from hydrophone

Pre-amplifier gain control in 20 db steps or continuously variable from -20 db to 0 db

Low cut-off filter control continuously variable from 50 Hz to 2000 Hz

TVG In-Out, plus variable Initial Gain - 60 db to 0 db and Slope - 60 db to Maximum in 50 ms

Specifications

Recorder

Record Width	22cm (8.5 inches)
Record Length	31m/roll (100 feet/roll)
Record Type	Dry Paper, NDK or Aluminized Mylar
Record Density	Variable, 20 to 80 lines/cm (50 to 200 lines/inch) with push button rapid advance
Paper Take-up	Constant tension — reversible
Sweep Speeds	Selectable; 50, 100, 200, 400 milliseconds Variable; 60 to 500 milliseconds
Scale Lines	Variable intensity; 10 milliseconds/division, alternating solid and dashed lines
Print Programmer	Adjustable in ¼ sweep steps and 3 sweep steps to give a delay of printing from 0 to 30 sweeps
Record Annotation	Automatic annotation of Automatic Gate Position every 4 minutes

Hydrophone Input

Impedance	5000 ohms
Signal Threshold	5 millivolts to 5 volts adjustable
Frequency	50 Hz to 20 kHz with high pass filter
Variable Filter	Low cut-off 50 Hz to 2 kHz
Gain	0 to 60db (-20 to 0db continuous and 20, 40, 60db selectable steps)
Time Variable Gain	Initial Gain; -60db to 0db Slope; Maximum 60db in 50 milliseconds selectable bypass in or out
Phase Discriminator	Plus, minus and ± phase

Auxiliary Output

Trigger Pulse	+10 volts, 100 microseconds long, into 10K ohms
Trigger Rate	Every 3,6,9,12,15,18,21,24,27 or 30 sweeps
Event Marker	Local or remote push bottom

Tape Recording Capability

Output	Processed Signal; 5 volts Sweep Control; 500Hz continuous plus 1 pulse/trigger
Input	Signal Level; 5 microvolts to 5 volts
Synchronized	Automatic phasing, sweep speed offset until external and internal trigger pulses are synchronized

Power Requirements

Voltage	105 to 130, or 210 to 260 VAC
Frequency	50 or 60Hz ± 5%

Physical Characteristics

Dimension	40cm x 50cm x 30cm (16" x 20" x 11.5")
Weight	20Kg (45 pounds)
Protective Case	Fiberglass Instrument Case

151 Bear Hill Road
Waltham, Mass. 02154
(617) 890-3710
TWX: (710) 324-7648 TELEX: 92-3429
CABLE: EGGINTER

E/M ASSOCIATES INC.
BOX 309
COHASSET, MASS 01025
617 383 6113

RESEARCH VESSEL A. E. VERRILL

THE MARINE BIOLOGICAL LABORATORY'S 65' STEEL HULLED
VESSEL IS AVAILABLE FOR USE TO OTHER INSTITUTIONS

R/V A. E. VERRILL

SPECIFICATIONS

Length overall	64'11"
Beam	18' 0"
Draft	6' 6"
Engine	GM 8V/71 235 HP
Propeller	46" variable pitch
Speed	9.5 knots
Range	1000 miles
Fuel	1100 Gals.
Potable Water	1000 Gals.

AUXILIARY SYSTEMS

Electrical	110/220 VAC 1 phase 15 KW
Compressed air	120 PSI 6 CF/M
Fresh water	hot & cold to sinks and shower
Laboratory non-toxic seawater	5 GPM
Heating	Oil fired forced hot water to all compartments

BRIDGE EQUIPMENT

Auto Pilot	Recording Depth Indicator
AM & FM Radiotelephone	Radar
CB Radio	Dual Tracking Loran A & C

The Marine Biological Laboratory of Woods Hole, Massachusetts, has made available the R/V A. E. VERRILL to scientists and institutions on a daily cost rate.

The A. E. VERRILL was designed and built for the Marine Biological Laboratory in 1966 as a prime research vessel for coastal and offshore waters of Cape Cod area.

She is 64'11" long, capable of 9.5 knots and serves as a comfortable and versatile platform for many types of marine research. Her ample deck area, large main deck laboratory and generous accommodations make her well suited for cruises up to 7 days duration.

DECK EQUIPMENT

Double Drum Trawl Winch	750 M 3/8" Wire
BT Winch	300 M 1/8" Wire
Main Boom	20' long 2000 lbs. Cap.
Hydraulic A-frame ..	12' high 4000 lbs. Cap.
A-frame travel	3.5' beyond stern to 4' over deck
Opening in stern bulwark	6'0"
Removeable stern net roller	4" x 4'0"
Non-toxic seawater	20 GPM
General purpose seawater	85 GPM
After deck area	360 Sq. Ft.
After deck lighting	three 300 W lamps

ACCOMMODATIONS

Main lab area	170 Sq. Ft.
Lower lab area	55 Sq. Ft.
Workshop area	80 Sq. Ft.
Berthing	3 double staterooms
Galley	electric stove & refrigerator
Lab counter area	60 Sq. Ft.
Freezer	16 Cu. Ft.

The Verrill has been used in many types of marine research. Her winch and hydraulic A-frame are both controlled from the pilot house, simplifying many operations. Numerous marine biology courses have used the Verrill as a teaching facility on field trips to local waters. Up to 20 students can view dredging operations and participate in sorting and keying activities. The main lab provides a protected area to examine dredged specimens between stations.

The engine room is located in the after section, separated from other areas by the workshop and two watertight doors. This arrangement, plus the belt drive system, eliminates much of the noise and vibration commonly associated with diesel propulsion plants. Her controllable pitch propeller is useful during low speed operations. By reducing the blade pitch the vessel is able to achieve very low speeds and still maintain her excellent control and maneuverability.

The lower lab contains a freezer and counter space and is located amidships for the least motion in a seaway. This makes it suitable for more sensitive electronic gear, microscope work or possibly a dark room. This space could also be used for two extra berths.

LOWER LEVEL

MAIN DECK

Dates are available immediately, however for extended use or when dates are critical, arrangements should be made well in advance. For additional information contact:

John J. Valois, Manager
Supply Department
Marine Biological Laboratory
Woods Hole, MA 02543
Telephone: (617) 548-3705 ext. 325

TO: The Department of the Environment

SOME COMMENTS ON MARINE FIELD OPERATIONS AND EQUIPMENT

FROM: Dr. David A. Ross
Department of Geology and Geophysics
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

SOME COMMENTS ON MARINE FIELD OPERATIONS AND EQUIPMENT
Dr. David A. Ross

During my recent visit to Iran we discussed field operations, in part done with assistance from professional companies, and some necessary marine equipment. This short note concerns these two points.

Field Operations

While I was in Iran a brief proposal was received by the Department from "Biospheric Consultants International Inc." concerning a buoy program to monitor oil pollution in the Gulf. I was asked by Drs. Mohammadi and Harger to find out more about this company. I have been in contact with them on two separate occasions concerning their plans. They recently sent me a plan for the Persian Gulf (Enclosure #1). I conclude from this and other information, the following:

1. They really have little or no capability concerning people or equipment.
2. They would hire people and get equipment as the need arises since they have little of their own.
3. They have little understanding of the Persian Gulf environment nor what are the critical measurements.
4. They have no training facilities.
5. They probably have never done such a project before.

In summary, I don't see any advantage to working with this company.

On a more positive note, I have discussed your interests in the Persian Gulf with EG & G. EG & G is a very-large world-wide company with impressive experience in marine environmental work as well as being a major supplier of marine equipment. It is probably the most

sophisticated and competent U.S. company in this field. Also of importance is that they also have operations in the Persian Gulf area. In addition they can and have trained personnel within a country to continue the project after they leave. I enclose a letter (Enclosure #2) from one of their staff scientists concerning their possibilities. Representatives from EG & G would be pleased to meet with Mr. Firouz during his trip to the United States.

I have also enclosed some EG & G material concerning their equipment and capabilities. Please note that there is no comparison between Biospheric Consultants International and EG & G.

Marine Equipment

Concerning the question of marine equipment, there is almost an unlimited supply of material concerning equipment. The best I can do at this time is to enclose some brochures. When a decision is made concerning what type of equipment is needed perhaps I could then be of more help. The remote reading current meter from Environmental Devices Corporation could be very useful in the Straits of Hormey.

Copies of this report, but without the equipment brochures have been sent to Dr. Mohammadi and Dr. Harger. The brochures have been sent to Mr. Firouz.