44. REGIONAL DISTRIBUTION AND STRATIGRAPHY OF LATE MIOCENE EVAPORITES AND EVIDENCE OF MAJOR DEPRESSIONS IN THE MEDITERRANEAN SEA LEVEL

PREFACE

Upon completion of the last drill hole in the Mediterranean Sea and while the *Glomar Challenger* was steaming back to Lisbon, Portugal for the termination of Leg 13 of the Deep Sea Drilling Project, the shipboard scientific party commenced organization of the present volume. Foremost in our thoughts were implications of the discovery of a widespread evaporite formation beneath the floors of all the deep-sea basins cored. There was no question that the time period for the deposition of the deep-basin salt layer corresponded to the interval in the late Miocene when evaporites were also laid down in peripheral basins of the Mediterranean region. Some of the sections on land had already received considerable attention by geologists. Notable were the comprehensive and detailed descriptions of the Miocene Solfifera series of Sicily by Ogniben (1957).

The finding of a "sabkha-like" facies some three thousand meters below the present surface of the sea impressed everyone on board. One of us (K. J. H.), just prior to the cruise, had reviewed a preprint of Hardie and Eugster (1971) in which they had reexamined the Solfifera series and had concluded that the sedimentary features of this series indicated deposition in a shallow lagoon-littoral flat complex.

It was debated on board the *Glomar Challenger* whether the central Sicilian Basin had desiccated, along with the ancient deep-sea basins, to produce the shallow water facies, or alternatively, whether the present widespread distribution of the facies had come about through extensive regional subsidence. Questions were raised concerning the possibility that the sediments had been deposited in deep water.

One of our shipboard sedimentologists (F. C. W.) volunteered to review the rock record as exposed in surface outcrops and in existing bore holes and to search for evidence of a deep basin configuration for some of the known Messinian sequences. It was anticipated that the greater abundance of material in the land section would allow us to more definitively inquire about the origin of the Mediterranean deep-basin evaporite.

Chapter 44.1 by Arvedo Decima and Forese C. Wezel is the initial attempt by qualified geologists to correlate the drill cores with the land record. A very useful stratigraphy of the Solfifera series is presented, along with new information of potential importance for the interpretation of the marine seismic reflection profiles. Considering the difficulty in obtaining deep penetration into the evaporites at the various deep-sea drill sites, the lithostratigraphic logs of the Solfifera series provide an ideal springboard for the planning of future programs of oceanographic research and drilling.

The question of a basin-wide desiccation was entertained very seriously by several of the shipboard scientists (see Chapter 43), and was mentioned in the press conferences immediately following the cruise. However, the idea did not appear in the written summary of the drilling leg published in *Geotimes* (December 1970) because of strong differences of opinion among those who had participated on the cruise. To those who wished to keep an open mind, the concept was not sufficiently supported by vigorous documentation. Nevertheless, in a short while a clipping of the *New York Times* coverage of the cruise came to the attention of I. S. Chumakov of the Geologic Institute of the U.S.S.R. Academy of Sciences in Moscow through *Tass* correspondent Mme. E. L. Shields. On January 25, 1971, Dr. Chumakov wrote me a letter, quoted as follows:

"Last October there has been a brief note in the Soviet press about the end of your expedition on *Glomar Challenger* to study the Mediterranean. On my request, the TASS correspondent Mme. E. L. Shields has kindly sent me a clipping of the article "Drillings Indicate Mediterranean Is Smaller" from the New York Times (October 10, 1970). This article attracted my attention inasmuch as for some time I have been studying the development of the Mediterranean during the Late Miocene-Early Pliocene and your preliminary deductions coincide (admittedly, not all of them!) or come very close to my conclusions obtained on the basis of work in some countries in the southern part of the Mediterranean. . . .

"Judging by the description of anhydrite and other salt samples you had to deal with Messinian suite deposits first described in the last century by Mayer-Eymar and recently (1960) redescribed in a neostratotype by R. Selli. It would be interesting in this connection to know what you think about the discovery of this suite of planktonic foraminifers (distrophic) in bands between gypsum and anhydrites. I would also like very much to know your views on the time of incipience in the Strait of Gibraltar. I personally attach great importance to the depth of the main valleys of the Mediterranean (the Rhône, Nile, Orontes, etc.) because I attribute to one original cause both the appearance of evaporites of Messinian suite and the superdeep erosional incisions of these valleys. These facts warrant my conclusions on a complete closure of the basin and its disintegration into a number of lakes-seas (of the Caspian type) with a drop of their levels to a datum of 1000-1500 meters.

"In connection with such views your data are of a great interest to me."

Dr. Chumakov's views were presented in a paper read at the Moscow Society of Naturalists, in December 1970, entitled "Geological history of the Mediterranean at the end of the Miocene and the beginning of the Pliocene according to new data." Because of the pertinence of this completely independent line of evidence to the hypothesis of a major desiccation of the Mediterranean, we are including as Chapter 44.2 an English translation by T. A. Sofiano of the summary of this paper so as to bring it to our immediate attention. Maria B. Cita, who met with Dr. Chumakov in September 1971 while attending a field trip in the Crimea, agreed to help me present a brief synopsis of the new data of Chumakov's concerning the super-deep

erosional incision of the Nile River Valley abstracted from his 1967 monograph (Chapter 44.3).

Later that winter, through the kindness of William A. Berggren of the Woods Hole Oceanographic Institution, I was put in touch with F. T. Barr of the Oasis Oil Company of Libya. A buried channel system had been discovered beneath the desert sands of the Sirte Basin of northern Libya. Dr. Barr, at that time unaware of I. S. Chumakov's investigations of the Nile Valley, was speculating to a not too receptive audience that a sudden drop in sea level during late Miocene time could have been responsible for the deep drainage erosion observed. Shortly afterwards he came for a brief visit to Lamont-Doherty Geological Observatory, where I invited him to document these findings in Chapter 44.4, of this volume. His report prepared in conjunction with B. R. Walker, represents work done prior to, and completely independent of, the Deep Sea Drilling Project cruise in the Mediterranean.

That summer, during the Fifth Congress on the Neogene of the Mediterranean in Lyon, France, our shipboard paleontologist, Maria B. Cita, presented a formal paper on the Deep Sea Mediterranean Neogene Stratigraphy and mentioned the desiccation hypothesis. According to correspondence from her, the reaction to the hypothesis was very mixed; one of the strongest arguments against it being the lack of geomorphological evidence that would accompany such a catastrophic happening. At the meeting, Dr. Georges Clauzon of the Laboratoire de Géographie Physique of the University of Provence came to her defense and recalled the observations of G. Denizot (1951) on the cutting of the Rhône Valley. Dr. Clauzon kindly agreed to write for us a brief documentation of the erosional epoch in the western Mediterranean since the previous two reports in this chapter had only dealt with the eastern basins. My appreciation is extended to him for the speed and care he took in getting his report (Chapter 44.5) to Professor Cita for translation into English.

Thanks is here expressed to Arvedo Decima, Forese C. Wezel, F. T. Barr, and B. P. Walker for so generously contributing their ideas and new data to this chapter. I congratulate I. S. Chumakov for his superb documentation, which you are strongly encouraged to read in its entirety in the original publications, and for allowing us to abstract from his papers and correspondence.

It is not often that collaborating evidence from such diverse and independent sources comes together so quickly. In each of the cases, when the interpretations based on a single study were reported they were found generally to be unconvincing to others. Of all the investigations, that of the *Glomar Challenger* was the last to occur. It is a tribute to the vision of people in the U. S. National Science Foundation and in the JOIDES consortium that the soundly conceived program of Deep Sea Drilling was able to provide the catalyst to what is to me the incredibly bold idea that an entire ocean can dry up.

REFERENCES

Chumakov, I. S., 1967. Pliocene and Pleistocene deposits of the Nile Valley in Nubia and Upper Egypt (in Russian). *Acad. Science USSR, Geol.-Institute, Trans., Moscow.* **170**, 5.

———, 1971. Some points of the late Miocene-early Pliocene geological history of the Mediterranean basin by new data (in Russian). *Sovetskaya Geologiya.* **10**.

———, Geological history of the Mediterranean at the end of the Miocene–the beginning of the Pliocene according to new data, (abstract in Russian). *Bull. Moscow Soc. of Naturalists.* **46** (3).

Denizot, G., 1951. Les anciens rivages de la Mediterranee Francaise. *Bull. Inst. Ocean., Monaco. No. 992.*

Hardie, L. A., and Eugster, H. P., 1971. The depositional environment of marine evaporites: A case for shallow, clastic accumulation. *Sedimentology.* **16**, 187.

Ogniben, L., 1957. Petrografia della Serie Solfifera Siciliano e considerazioni geologiche relative. *Mem. Descrit. Carta. Geol. Ital.* **33**, 275 pp.

Ryan, W. B. F., Hsü K. J., Nesteroff, W. D., Pautot, G., Wezel, F. C., Lort, J. M., Cita, M. B., Maync, W., Stradner, H., Dumitrica, P., 1970. Deep Sea Drilling Project, Leg 13. *Geotimes.* December. 12.

Selli, R., 1960. Il Messiniano Mayer-Eymar 1867. Proposta di un neostratotipo. *Giorn. Geol.* 28 (fasc. 2), 1.

44.1. LATE MIOCENE EVAPORITES OF THE CENTRAL SICILIAN BASIN, ITALY

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INTRODUCTION

The Mediterranean Sea is a complex of small basins, completely surrounded by land. In order to reconstruct the regional structure and evolution of the Mediterranean region, it is of primary interest to compare and correlate the rocks beneath the sea floor with the stratigraphic units mapped on the borderland. In this respect, DSDP Leg 13