

PREFACE

The present publication is the result of four years of work carried out within the terms of reference of Working Group 91 of SCOR (the Scientific Committee on Oceanic Research). The idea of life's origin in conjunction with hydrothermal systems first appeared in the SCOR annals in 1987 after the Executive Committee Meeting in Zürich, Switzerland. The Swedish SCOR Committee had proposed the initiation of a Working Group entitled 'Neo-Abiogenesis and Origin of Life in Hydrothermal Systems'. As present representative of the proponents at the meeting in Zürich I had to try to answer a number of questions and comments by the Executive Committee members. Whether, for instance, the topic was appropriate for a SCOR Working Group. Many of the tasks were considered chemical rather than oceanographic. The Executive Committee finally agreed that the proposal ought to be forwarded to IUPAC (the International Union of Pure and Applied Chemistry) for consideration as a possible cosponsor. The proposal should also be revised, taking into account the comments of the Executive Committee, for a discussion at the SCOR General Meeting one year later in Acapulco, Mexico.

A proposal like this one has, of course, a history that predates the official record by quite some time. I happened to arrive as a post-doctoral scholar at Scripps Institution of Oceanography (SIO) at about the time the 'black smokers' of the East Pacific Rise at 21°N were discovered in 1979. The San Diego area (where SIO is situated) has strongholds in both Origins of Life and Ocean Science research. My field of interest was then Ocean Sciences, but during work in the laboratories of Gustaf Arrhenius I came into contact with the other field when I started to study details of the structure of some marine authigenic minerals (FeOOH polymorphs). One day in early 1980 Gustaf was visited by two enthusiastic scientists, Michael Dowler and Dale Ingmanson, of the San Diego State University. They had been on a cruise to the Red Sea by the R/V Atlantis II of the Woods Hole Oceanographic Institution. Now they had proposed that the Red Sea deep hydrothermal brines were likely to be fruitful environments for the study of abiotic synthesis of life precursors. Since I had been working on the structure of akaganéite, a hollow FeOOH polymorph that forms readily in the Red Sea hydrothermal brines, I started some experiments together with Michael Dowler on interactions between amino acids and akaganéite. The experiments were carried out in Leslie Orgel's laboratories at the Salk Institute for Biological Studies, but to this date I am not quite sure that Leslie was aware of what we were up to. Later the same year I happened to attend William Schopf's PPRG-symposium (Precambrian Paleobiology Research Group) at the University of California, Los Angeles. During a splinter meeting John Corliss gave us a glimpse of the ideas that were presented the same year at the Geological Congress in Paris and were published as a paper by himself, John Baross and Sarah Hoffman the year after.

The ideas by Corliss and coworkers were discussed extensively during the years to follow, but not much was published. There was an International Conference on the Origin of Life (ICOL) in Mainz, Germany, in 1983, but no contributions there dealt with the origin of life under hydrothermal conditions (Stetter presented some of his work on extreme thermophilic bacteria, though). In 1984 two papers were published, one by

Bernhardt and coworkers and one by Robert White, that seemed to refute the hydrothermal origin of life model. At the next ICOL in Berkeley in 1986, however, there was a slight increase in contributions which touched on hydrothermal conditions - two presentations by Corliss and one each by Shock/Helgeson and Yanagawa/Kobayashi/Ogawa, respectively. Back home in Sweden during the cold winter of 1987 I became acquainted with the activities of SCOR as a new member of its national committee, and SCOR's successful method to initiate and assign short-lived international working groups for the study of specific oceanographic problems. Within the Swedish SCOR Committee we came to the conclusion that the connection of hydrothermal systems to the question of life's origin would be one part of science where actual data had to be compiled, where discussion needed to be structured, and efforts should be made with the aim to open up a new research field. The working group proposal for the Executive Committee Meeting in Zürich was thus written and submitted in June, 1987.

It was obvious after the Zürich meeting that the proposal had to be revised and clarified during the following year. Since I had started to defend the idea of a working group on this particular subject outside of the national sphere, I also began to feel some responsibility for the final success of the proposal. I sought an endless amount of advice from the international science community and received invaluable responses and inputs from Harald Bäcker, Egon Degens, Michael Dowler, James Ferris, William Fyfe, Remy Hennet, Dale Ingmanson, Lev Mukhin, Euan Nisbet, Cyril Ponnampuruma, Michael Russell, and Everett Shock to name a few. So when the proposal was presented at the SCOR General Meeting in Acapulco in 1988, it was much better constrained than the year before. Still there persisted a feeling among several of the nominated members of SCOR that the tasks of the proposed working group had little to do with ocean sciences. The right word at the right time then came from the Past-President of SCOR Konstantin Fedorov, who said: 'If seawater circulates through oceanic crust and precursors of life are likely to be formed in that environment today - then it is part of oceanography'. An ad hoc group consisting of Ross Heath, Jarl-Ove Strömberg, Erwin Suess, and myself was formed in order to revise once more the title of the working group, proposed terms of reference and the membership list. The SCOR General Meeting finally initiated its Working Group No. 91 (WG91) entitled: 'Chemical Evolution and Origin of Life in Marine Hydrothermal Systems'. The accepted terms of reference were:

- 1) To determine likely constituents necessary for neo-abiogenesis according to the state of art of the origin of life sciences and thermodynamic calculations.
- 2) To review available data concerning primordial organic monomers and polymers already observed in hydrothermal systems (for example, carboxylic acids, amino acids, cyano- and heterocyclic compounds); compile a list of potential substances that have to be searched for; and differentiate compounds formed abiogenically and biogenically.
- 3) To evaluate the role of different classes of possible inorganic catalysts which may be required for the synthesis of organic compounds in hydrothermal systems.
- 4) To sponsor a symposium and published set of papers in 1992 summarizing the state of knowledge and identifying research opportunities in this field.

Members of WG91 proposed by the ad hoc group and since accepted by the SCOR General Meeting have been: Nils Holm (chair), Yuriy Bogdanov, Graham Cairns-Smith, Roy Daniel, James Ferris, Remy Hennet, Everett Shock, Bernd Simoneit, and Hiroshi Yanagawa. Alexei Kuznetsov, Vice-President of SCOR, has been the rapporteur in charge of WG91 to the Executive Committee.

During the first year of its existence WG91 did not meet officially. However, with the assistance of Zinovij Masinovsky and Stanley Miller, then chairman of the the International Society for the Study of the Origin of Life (ISSOL), James Ferris and I had a chance to organize a one-day symposium on 'Chemical Evolution and Neo-Abiogenesis in Marine Hydrothermal Systems' during the ICOL in Prague in 1989. The first official meeting of WG91 was held in June, 1990, at the Kristineberg Marine Biological Station in Fiskebäckskil on the Swedish west coast; the second meeting at the Eagle Crest Resort in Redmond, Oregon, in June, 1991. The terms of reference of WG91 state that its work should be completed by the publication of a set of papers in 1992 summarizing the state of knowledge and identifying research opportunities in this field. It is my belief that the Working Group has fulfilled the task and that some promising future research areas have been indicated in this report. WG91 will be disbanded in September 1992; however, it is only now that 'real research', i.e. field studies and experimental work, will begin.

I wish to thank all my fellow working group members for their participation in the hard work that has resulted in this report. The efforts condensed into the publication have not been contributed by Working Group members alone, however. First of all there are fifteen reviewers who have examined the manuscripts thoroughly. Several other persons and organizations must be acknowledged as well. Alan Hall, Kensei Kobayashi and Michael Russell have co-authored two of the chapters; Michael also participated in the Redmond meeting. Funding and subsidies have been contributed by SCOR, NASA, the Royal Swedish Academy of Sciences and the Swedish Natural Science Research Council. The NASA funds for the support of this endeavor were allocated by the NASA-Ames Research Center, Moffett Field, California, under Interchange No. NCA2-600. Elizabeth Gross, Jarl-Ove Strömberg and Alexei Kuznetsov, Executive Director, President and Vice-President of SCOR, respectively, have been of great help in the contacts with the SCOR organization and in arranging the working group meetings. It would not have been possible to reorganize the originally very diverse set of manuscripts into a uniform format in such a short time without the skilled transformation work carried out at the College of Oceanography of Oregon State University. The copy editing of Barbara McVicar and Bernd Simoneit is, therefore, especially acknowledged.

Two of the persons that contributed to the development of the program of SCOR Working Group 91 have passed away since it was first proposed - Egon Degens and Konstantin Fedorov. We miss them both as friends and colleagues.

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