THE GEOLOGY OF LEBANON

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Foreword, 1

Since my first visit to Lebanon in 2006, I have been amazed by its people, traditions, food and geology. I have had the good fortune to visit the country many times during my professional life with Petroleum Geo-Services (PGS), who continue to assist the Lebanese Government prepare for offshore hydrocarbon exploration. In 2006, when few people associated Lebanon with petroleum, PGS began to acquire offshore 2D and 3D seismic data. The purpose was to try to understand the hydrocarbon potential of the offshore area and to attract the oil industry to carry out more detailed exploration activities. Through this work, I have begun to know Lebanon well and have had the pleasure of working closely with Lebanese earth scientists, exchanging ideas and views. As the work proceeded, I became acquainted with Fadi Nader and over time this acquaintance has developed into a close friendship.

Fadi's work has contributed greatly to our present understanding of the offshore and onshore geology of Lebanon. He has put old and new geological data into a coherent framework and has made it available for professionals worldwide in a series of excellent publications in scientific journals.

There has not been a book before which covers the general geology of Lebanon, so I was excited to hear of Fadi's plans to prepare the present volume. His background, academic career and field experience, as well as a period working with the Ministry of Energy and Water, have given him a comprehensive understanding of the geology of Lebanon, and access to important material which he has used in this book.

After a lot of hard work, the book has finally become a reality. It takes the reader right through the geology of Lebanon — from the beautifully preserved marine fossils recovered at the Haqel quarry near Byblos on the coast of northern Lebanon, to the offshore petroleum potential which is yet to be fully assessed. I believe that reading this book will be a great and enlightening experience, just as it was for me. Enjoy!

Per Helge Semb
Regional Manager, Middle East & CIS
Petroleum Geo-Services, Oslo
May, 2014

Foreword, 2

With a history of more than 6000 years of culture and civilization in the centre of the Old World, Lebanon has the great good fortune to occupy the Central-Northern part of the Levant Basin, which is considered to be one of the few remaining underexplored hydrocarbon provinces left in the World.

My friendship with Fadi Nader goes back to our early school days – we shared the same desk for many years. Our paths crossed again at the American University of Beirut where Fadi completed a BSc. in geology. Some 16 years later in 2011, our paths crossed one more time at the Lebanese Ministry of Energy and Water, and we worked together on the preparations to launch the first licensing round offshore Lebanon. By then, Fadi had earned his doctorate in sedimentology and I had returned to Lebanon following 12 years of work for an international oil services company.

This was more than a common project for both of us, it was a dream – the opportunity to help make our small country (which is barely visible on the geographic map) highly visible on the energy map. Fadi worked hard, using the knowledge and experience he had acquired over the years to make this challenging dream a reality. In May 2013, Lebanon launched its first licensing round and Fadi returned to his work at IFP Energies nouvelles to continue the journey.

With the solid resolve and dedication which has stamped his personality since his early school days, Fadi is achieving with this book an important milestone on his career path. This book has successfully achieved the objective of being a geological guide to Lebanon. There is also a special focus on the hydrocarbon prospectivity offshore and onshore, which is based on numerous papers and research published during the last 60 years, and also on Fadi's own work at the Ministry of Energy and Water including the interpretation of extensive 2D and 3D seismic data sets.

I hope my dear friend continues to have a productive mind for many years to come as he achieves more of his dreams while at the same time enriching the geological library of the "Land of the Cedars".

Wissam E. Chbat
Lebanese Petroleum Administration
Head of Geology and Geophysics
Beirut, May 2014

Preface

The idea of writing this book has been haunting me for a decade. Eleven years ago I was about to start teaching sedimentology at the American University of Beirut, and I realised that no textbook on the geology of Lebanon was available. Lebanon is fortunate to have a beautiful countryside in which there are some outstanding geological features. Although many of these features have been documented in international journals and other publications, there is as yet no introductory book which illustrates and discusses their characteristics in a comprehensive form. This book aims to fill that gap.

In this book, I attempt to give the reader (whether student or experienced geologist) an introduction to the rock units which are exposed at the surface in Lebanon. The plate tectonic framework and geodynamic evolution of Lebanon and surrounding areas are summarized in Chapter 2. Structural features (faults and folds) have profoundly influenced the make-up of the Lebanese landscape and these are described in Chapter 3. Chapters 4 and 5 together comprise an overview of the stratigraphy, lithology and petrography of outcropping rocks. Practical aspects of Lebanese geology are discussed briefly in Chapters 6 and 7: hydrogeology, and mining and hydrocarbon exploration, respectively. The last subject is treated only superficially despite its growing importance, and readers are invited to dig into the specialised literature listed in the References (pp. 99-106) for further information.

It is my hope that this small book will make it easier for students and geoscientists to familiarise themselves with the geology of Lebanon. The book is intended to be a “good read” whose purpose is to encourage geologists to visit, explore and investigate the spectacular Lebanese countryside.

Fadi H. Nader
Paris, April 2014

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In particular I thank Professor Swennen for his help during my Ph.D and for all his kindness and support subsequently.

I would like also to thank Professor Roure for the fulfilling discussions which we have had, and for his continuing and valuable support.

I consider myself very fortunate to have had the chance to learn from Professor Mouty and Dr Montadert about the geology of the Levant region and the Eastern Mediterranean.

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Hughes Badaoui helped me take the field photographs. Johnny Tawk is also acknowledged for helping me to format and prepare the photographs. Pierre Abi Saad kindly provided photographs of the fossil fish on page 48.

There have been some truly great Lebanese geologists and their work is cited liberally throughout this book. Among them I would like to mention in particular Dr Georges Sabbagh, who I met recently and who gave me some much-needed energy while I was working on the book.

I am very grateful to H. E. Minister Gebran Bassil who invited me back to Lebanon in 2011 at the beginning of preparations for the first offshore licensing round. His enthusiasm was an essential factor which helped convince me to work again on the geology of Lebanon.

I recall my colleagues at the Ministry of Energy and Water (Beirut) whose friendship and support has touched me. Wissam Chbat (*Geology and Geophysics Dept, Petroleum Administration of Lebanon*) has been a supportive friend and colleague, and I am grateful for his encouragement and for the long discussions we have had which have always been rewarding.

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To my parents, Marie and Henri Nader

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