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Lithostratigraphy of Sicily

Springer

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ISSN 2366-7516 ISSN 2366-7524 (electronic)
UNIPA Springer Series
ISBN 978-3-319-73941-0 ISBN 978-3-319-73942-7 (eBook)
https://doi.org/10.1007/978-3-319-73942-7

Library of Congress Control Number: 2017963855

Printed on acid-free paper

This Springer imprint is published by the registered company Springer International Publishing AG part of Springer Nature
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Foreword

The extended, well-documented and richly illustrated monograph dedicated to *Lithostratigraphy of Sicily*, written by Luca Basilone from the University of Palermo, deserves a special presentation. It displays the results of over ten years of fieldwork carried out under the expert and careful guidance of Raimondo Catalano and from related detailed sedimentologic, micropaleontologic and microfacies analysis. The work is pertinent in particular to several geological sheets of the new geologic map at the scale 1:50,000 of the Italian CARG project, but it has a much broader context, that extends well beyond the sheets boundaries.

Indeed, Sicily, the largest island of the Mediterranean, is situated just in the middle of this small ocean basin that is surrounded and crossed by a series of mountain ranges created during the Alpine orogeny. In terms of plate tectonics, Sicily is dissected by a W-E-directed plate boundary that separates the two major plates Eurasia and Africa, the latter subject to a counterclockwise rotation.

Collisional mountain ranges are developed on the northern border of the island and terminate towards ENE with the Peloritani Mountains (Calabrian arc with a metamorphic basal unit). Westward, the complex chain is SSE vergent and displays a thickness of up to 15 km. Three units are distinguished, as follows: Peloritani units, Sicilidi units and Maghrebian units. The collision is related to the Alpine orogeny and is Paleogene–Miocene in age. The western Mediterranean (remnant of the Mesozoic Tethys) was entirely consumed ("lost ocean") after the Alpine orogeny, and the Balearic basin was created by the counterclockwise rotation of the Corsica/Sardinia block. This happened in late Oligocene/early Miocene time. The counterclockwise rotation of the Italian peninsula initiated during the Messinian salinity crisis and is still active today.

But well before the conceptual model of plate tectonics was formulated in the late 1960s of last century, the rich fossil faunas of various ages attracted the attention of local palaeontologists, first of all Gemmellaro (from 1872). The existence of the highest active volcano in Europe was another strong attraction of Sicily

for geologists and volcanologists even in the early days of science. Finally, mining geology with special reference to the exploitation of the Gessoso–Solfifera Formation played an important role starting from the second half of the eighteenth century (Mottura, 1871, Baldacci, 1886) and, more recently, are documented by the prominent work of Ogniben (1957) and Decima (1975).

Oil exploration started in Sicily during World War II, soon after the American troops disembarked near Gela on 10 July 1943. Gela proved to be an important oil field, and the influence of Hollis Hedberg, who was vice-chair of Gulf Oil Co. at that time, is strongly felt in the modern, practical approach to lithostratigraphy (Schmidt di Friedberg, 1964–65), predating the publication of the International Guide of Stratigraphic Nomenclature. Meanwhile, structural geologists concentrated their efforts in deciphering the northern chains (Broquet, Mascle, Caflisch) where richly fossiliferous Mesozoic successions are exposed and document important facies changes.

A new interest in Sicilian geology derived from the first deep-sea exploration of the Mediterranean by the R/V GLOMAR CHALLENGER in 1970 and the unexpected discovery that evaporites quite similar to those outcropping in Sicily (Gessoso–Solfifera Formation) were present in the sub-bottom of the Balearic, Tyrrhenian, Ionian and Levantine basin, directly underlying the Trubi formation. As a follow-up of the discovery, a conceptual model for a deep-sea desiccation model was formulated and the "Messinian salinity crisis" became a major subject of multidisciplinary, interdisciplinary, high-resolution multinational researches that greatly contributed to improve the late Neogene stratigraphy notwithstanding the inherent difficulties deriving from the complicated geodynamic situation. Indeed, the investigations carried out on the outcrops bordering the Sicily channel from Capo Bianco through Capo Rossello to Falconara and Gela originated astrocyclostratigraphy (of Hilgen, 1991 and the Utrecht school) and are considered the template for the Pliocene timescale (MB. Cita and colleagues). But some aspects of the model (s) are still controversial, after over forty years and over 1000 publications, as the role and precise location of the sills separating the various subbasins, the timing of the desiccation phase, the speed of the final filling, the source of the "lago mare".

In the monograph compiled by Luca Basilone 71 formations are described, of which 43 have already been formalized. Ten are emended in the present paper, and ten more are proposed as new. The seven sinthems follow the usage adopted by CARG for the sediments that represent the youngest deposits that cover the substrate, are non-marine in origin, are usually unfossiliferous and thus difficult to date (as alluvial fan, beach rock, cemented debris, eluvial deposits). Sinthems in principle should be bounded by erosional surfaces of regional significance.

The lithostratigraphy of the Sicilian rocks described by Luca Basilone is based on outcrops and also on subsurface data derived by borehole stratigraphy calibrated by the interpretation of seismic reflection profiles.

The monograph is open to new and future integrations useful to improve our knowledge of the Sicilian geology.

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References

Baldacci L (1886) Descrizione geologica dell'Isola di Sicilia. Mem Descr, Carta Geol D'Ital, 1:408 pp (10 tavv, 37 figg, 1 carta Geol 1:100.000, Roma)

Decima A (1975) Considerazioni preliminari sulla distribuzione del bromo nella formazione Salina della Sicilia meridionale. Abstract in: Messinian Seminar, Oct 1975, Erice, Sicily

Gemmellaro GG (1872–82) Sopra alcune faune giuresi e liassiche della Sicilia. Atti Accad. Lincei, 12:451–472

Gemmellaro GG (1878) Sui fossili del calcare cristallino delle Montagne del Casale e di Bellolampo nella Provincia di Palermo. Palermo 1872–1882

Gemellaro GG (1880) Sul Trias della regione occidentale di Sicilia. Atti R Acc dei Lincei XII (III):25 in Tav. Roma

Gemmellaro GG (1886) Sugli strati con Leptaena nel Lias superiore di Sicilia. Boll R Com Geol d'Id, anno XVII, ser. II, vol 7, n 56: pp. 156–170; n 9–10, pp 341–159 (tav 2, figg. 2, Roma)

Gemmellaro GG (1887–99) La fauna dei calcari con Fusulina della valle del fiume Sosio nella provincia di Palermo (1888). Giorn Sc Nat Econ 20:26, Palermo; (1888), ibid, v. 20, 85 pp.; (1892), Boll Soc Sc. Nat Econ, n. 1, Palermo; (1892), ibid,, n. 2; (1892), ibid, n. 3; (1893), ibid,, n. 1, (1894), ibid, n. 1; (1895), Giorn Sc. Nat Eton, v. 21, 47 pp, Palermo; (1896), ibid, v. 21, 9 pp.; (1898), Atti R. Acc. Lincei, Rend. Cl. Sc. Fis. Mat. Nat, s, 5, v. 7, 3 pp, Roma; (1899), Giorn Sc. Nat Econ, v. 22:117 pp, Palermo

Gemmellaro GG (1902) Sul rinvenimento di un teschio di Squadolonte nel calcare bituminoso di Ragusa. Atti R Acc dei Lincei Rend Cl Sc Fis Mat Nat XI(Ser 5), fasc. 1, 2 sem. Roma

Gemmellaro GG (1904) I cefalopodi del Trias superiore nella regione occidentale della Sicilia. Giorn Sci Nat Econ 24:314 pp

Hilgen FJ (1991) Extension of the astronomically calibrated (polarity) time scale to the Miocene/Pliocene boundary. Earth Plan Sci Lett 107:349–368 (Amsterdam)

Mottura S (1871) Sulla formazione terziaria della zona solfifera della Sicilia. Mem per servire alla descr. della Carta Geologica d'Italia, Mem R. Com. Geol d'Ital I:50–140, 4 tavv. Firenze

Ogniben L (1957) Petrografia della serie solfifera siciliana e considerazioni geologiche relative. Mem Descr Carta Geol d'Ital 33:1–276, 100 figg, Roma

Schmidt di Friedberg P (1964–65) Litostratigrafia petrolifera della Sicilia. Riv Min Sic n° 88–90, n° 91–93:80 pp, Palermo

Preface

The paper introduces the fundamentals of the lithostratigraphy of Sicily, as acquired from recent researches. This note aims at illustrating stratigraphic terminology, the geological lexicon and the main stratigraphic subdivisions that are not familiar to Sicilian geologists.

The work carried out consists in a series of sheets describing the main features of Sicilian lithostratigraphic units. Each of the 77 worksheets describes the lithological characteristics, sedimentological and laboratory features, thickness, depositional environments and regional geographic distribution of the Sicilian formations according to the standard stratigraphic procedure and nomenclature rules provided by the International Commission on Stratigraphy (ICS).

Most of the many previously defined formations are revised and amended here, and several new formations are proposed for their formalization. The seven systems follow the usage adopted by Carg for the sediments that represent the youngest continental and marine deposits that cover the substrate that are bounded by erosional surfaces of regional significance.

The description of the units is based on data collected during recent years through the analysis of several sedimentary successions outcropping in Sicily and by the reinterpretation of hydrocarbon exploration well logs. Lithostratigraphic methods, facies analysis and physical stratigraphy accompanied by biostratigraphy and numerical age-dating coming from the literature have been used to define the outcropping carbonate and terrigenous rock bodies. The acquisition and elaboration of the stratigraphic data have been also integrated with information obtained from a careful review of literature existing on stratigraphy, lithostratigraphy, palaeontology and tectonics since the late nineteenth century.

In the present paper, the rocks outcropping along the large belt extending from the North to the South of Sicily, as represented in the large-scale field map provided in Fig. 1.1, are schematically illustrated. A general background feature has been summarized based on the recently available stratigraphy of the Sicilian Fold and Thrust Belt (FTB) and its foreland and is illustrated in the schematic diagrams of Figs. 1.6, 1.7, 2.1, 2.2, 2.7, 2.22 and 2.72, which show the lateral (heteropic)-to-vertical relationships of the Permo-Triassic clastics, the Mesozoic–Paleogene

carbonates and the Miocene–Pleistocene clastic–evaporite–carbonate deposits. These schemes are supported by recent biostratigraphic and chronostratigraphic studies developed in Sicily. Furthermore, a conceptual scheme (Fig. 2.97) that shows the geometric relationships of the Quaternary marine and continental deposits, recently defined as unconformity-bounded stratigraphic units (UBSUs), is also presented.

Sicilian successions consist of carbonate and clastic deposits spanning the Permian-to-Quaternary time interval and can be subdivided into two main rock assemblages. The Palaeozoic-to-Palaeogene clastics and carbonates represent the sedimentary cover of the original ancient passive continental margin (i.e. African margin) of the "Mesozoic Tethyan realm". After the detachment from their basement, the geological bodies were deformed and are, at present, exposed in the Sicilian FTB to form a stack of tectonic units. The Miocene-to-Pleistocene rocks assemblage, consisting of clastic, evaporite and carbonate deposits, represent the sedimentary cover of the thrust-top basins developing during the orogeny phases and forming the present Alpine collisional continental margin. Finally, the Pleistocene–Holocene rocks assemblage, consisting of marine and continental deposits, fills the basins that are mostly located in the northern Sicily coastal belt and its offshore. They were formed in an extensional regime related to the opening of the Tyrrhenian Sea.

Palermo, Italy Luca Basilone

Acknowledgements

A special thanks to M.B. Cita (President of the CIS) whose support and interest in the issues of the Sicilian lithostratigraphy promoted the realization of this work.

I wish to thank the following persons for reading part or whole of this text or its early plan and for giving me the benefits of their constructive and critical reactions: R. Catalano, B. D'Argenio, C. Doglioni, E. Patacca, L. Montanari, C. Di Maggio, R. Maniscalco, R. Sprovieri, E. Di Stefano, A. Sulli.

My colleagues A. Contino, M. Agate, G. Avellone, A. Caruso, A. Bonfardeci, S. Bonomo, M. Gasparo Morticelli, C. Gugliotta, C. Gennaro, have helped in the field and laboratory, and especially with much-needed encouragement.

I am grateful to Prof. C. Amenta and the staff of Unipa Springer Series, and two anonymous reviewers for their critical suggestions.

Contents

*New units

°Amended units

Synonyms

AB 4	Enna marls
Ancient flysch	Mufara Formation
Amerillo unit	Amerillo Formation
Arenaceous-glauconitic Lower Miocene	Corleone calcarenites
Barbara and San Cataldo unit	Terravecchia formation
Barracù formation	Amerillo Formation
Bellolampo limestone	Inici Formation
Biancone Veneto	Lattimusa
Blue clays	Monte Narbone Formation
Bluish clays	Enna marls
Bonifato formation	San Cipirello marls
Bonifato pp formation	Corleone calcarenites
Brancaleone formation	*Exogira* marls
Busambra member	Lattimusa
Butera formation	Agrigento Formation
Calabianca unit	Lattimusa
Calcare Massiccio	Inici Formation
Calcareous molassa post nappe	Terravecchia formation
Calpionellid limestone	Lattimusa
Carnian flysch	Mufara Formation
Casale limestone	Inici Formation
Carrozza Formation	Baucina Formation
Cefalù Formation	Pellegrino Formation
Cenomanian African facies	*Exogira* marls
Cherty limestone	Scillato Formation
Chiarastella unit	Scillato Formation
Chiaromonte formation	Lattimusa
Clayey-arenaceous flysch	Lercara complex
Clayey limestone unit	Mufara Formation
Clays and brown sandstones	Numidian flysch

Collesano Formation	Numidian flysch
Concretionated limestone	Calcare di base member of Cattolica Formation
Coral limestone	Baucina Formation
Coral and sponge biolitites	Cozzo di Lupo Formation
Cozzo Terravecchia formation	Terravecchia Formation
Crystalline limestone	Inici Formation
Cuminello formation	Caltavuturo Formation
Ellipsactinie and *Nerinea* biolitites	Piano Battaglia reef limestone
Entrochi limestone	Crinoidal limestone
Eo-miocene flysch	Caltavuturo Formation
Facies astiana	Agrigento Formation
Facies piacenziana	Monte Narbone Formation
Flysch antico	Lercara complex
Fusulinid limestone	Sosio limestone
Garbata formation	Tavernola Formation
Gela formation	Sciacca Formation
Gessoso–Solfifera Formation	Gessoso-solfifero group
Giardinello formation	Caltavuturo Formation
Giardini Formation	Buccheri Formation
Gibellina formation	Ciminna Formation
Globigerina clays	San Cipirello marls
Grey and black cherty limestone	Scillato Formation
Gypsum series	Gessoso-solfifero Group
Halobids limestone	Mufara Formation
Hybla member	Hybla Formation
Jurassic detritic-organogen limestone	Inici Formation
Kungurian Flysch	Cozzo S Filippo sandstone
Leptaena beds	Crinoidal limestone
Lower and upper scaly clays	Varicoloured clays
Lower Scillato formation	Mufara Formation
Marly limestone unit	Caltavuturo Formation
Megalodontid limestone	Capo Rama Formation
Mesozoic calcareous-dolomitic reef	Cozzo di Lupo Formation
Messinian evaporites	Gessoso-solfifero Group
Messinian reef of Salemi	Baucina Formation
Mirabella formation	Scillato Formation
Monte Balatelle formation	Amerillo Formation
Monte dei Cervi formation	Crisanti Formation
Naftia formation	Sciacca Formation
Nerinee and Diceratids limestone	Pizzo Manolfo limestone
Norian-Rhaetian dolostone	Fanusi Formation
Olistostroma	Varicoloured clays

Olistostroma Napola	Terravecchia Formation
Oolitic limestone	Inici Formation
Palma formation	Trubi
Permian flysch	Cozzo S Filippo sandstone
Permian of Sosio	Sosio limestone
Pettineo formation	Reitano Formation
Pietra di Salomone limestone	Sosio limestone
Pizzo Canna limestone	Piano Battaglia reef limestone
Portella Arena formation	Mufara Formation
Radiolaritic and calcareous-spongholitic formations	Crisanti Formation
Recattivo reef limestone	Landro member of the Terravecchia formation
Red Unit	Buccheri Formation
Reef Cretaceous limestone	Pellegrino Formation
Reefoid unit	Cozzo di Lupo Formation
Reefoide unit pp	Inici Formation
Rhaetian dolostone	Fanusi Formation
Rosignano limestone	Baucina Formation
Rosso Ammonitico	Buccheri Formation
Rudistid limestone	Pellegrino Formation
Saheliano cycle deposits	Terravecchia Formation
San Calogero Flysch	Cozzo S Filippo sandstone
Scaglia	Amerillo Formation
Scaly clays	Varicoloured clays
Segesta formation	Sciacca Formation
Siliceous limestone unit	Crisanti Formation
Siliceous schists and calcareous intercalations	Crisanti Formation
Siracusa formation	Inici Formation
Solfifera formation	Gessoso-solfifero group
Sosio Megablocks	Sosio limestone
Stromatolitic dolostone	Sciacca Formation
Taormina formation	Sciacca Formation
Tithonian detritic-organogen limestone	Piano Battaglia reef limestone
Tortonian parautocton	Castellana Sicula Formation
Tortonian semialloctonhous	Castellana Sicula Formation
Trapani and Alcamo limestone	Bonifato Formation
Triassic limestone	Cozzo di Lupo Formation
Trias dolomitized limestone	Scillato Formation
Troina-Tusa flysch	Troina sandstone
Troina formation	Troina sandstone
Troina sandstone formation	Troina sandstone
Trubi member	Trubi
Tufi palombini	Trubi

Tufo calcareous of the Congerie Zone	Pasquasia Formation
Tufo fossiliferous and yellow sands	Baucina Formation
Tufo with Pecten	Baucina Formation
Ultradetritic zone	Pellegrino Formation
Upper dolostone	Fanusi Formation
Upper Miocene (pp)	Terravecchia Formation
Upper Triassic carbonate platform deposits	Sciacca Formation
Vacuolar-organogen limestone	Baucina Formation
Variegated clays	Varicoloured clays
Villagonia formation	Inici Formation
Vizzini pp formation	Sciacca Formation

Acronyms

AFL	Capo Plaia synthem
AMM	Amerillo Formation
AMM_m	Calcareous megabreccias of the Amerillo Formation
AMM_a	Red scaglia of the Amerillo Formation
AMM_b	White scaglia of the Amerillo Formation
AMM_d	Ichnites limestone of the Amerillo Formation
AUC	Calcarenites and marls of Sauci
AVF	Varicoloured clays
AVF_a	Exogyra marls
AVF_b	Caprinid breccias
β	Basalts
BAU	Baucina formation
BAU_a	*Porites* reef limestone of the Baucina formation
BAU_b	Forereef limestone of the Baucina formation
BAX	Bauxites of Spinasanta
BCH	Buccheri Formation
BCH_1	Lower Rosso Ammonitico member of the Buccheri Formation
BCH_2	Radiolarite member of the Buccheri Formation
BCH_3	Upper Rosso Ammonitico member of the Buccheri Formation
BCO	Monte Bosco formation
BLC	Marly arenaceous Belice formation
BLT	Polisano synthem
BON	Bonifato formation
CAL	Caltavuturo Formation
CAL_a	Nummulitid breccias of the Caltavuturo Formation
CCR	Corleone calcarenites
CDR	Brachiopod limestone
CII	Ciminna formation
CIP	San Cipirello marls

CZP	Cozzo di Lupo formation
CRI	Crisanti Formation
CRI_1	Radiolarite member of the Crisanti Formation
CRI_2	*Ellipsactinia* breccias member of the Crisanti Formation
CRI_3	Spongholitic member of the Crisanti Formation
CRI_4	Rudistid breccias member of the Crisanti Formation
CTI	Pizzo Manolfo limestone
FRM	Capo Rama formation
FUN	Fanusi formation
FYN	Numidian flysch
FYN_2	Portella Colla member of the Numidian flysch
FYN_5	Geraci Siculo member of the Numidian flysch
GS	Gessoso-solfifero group
GPQ	Pasquasia Formation
GPQ_1	Gessarenites member of the Pasquasia Formation
GPQ_2	Marly gypsum member of the Pasquasia Formation
GPQ_3	*Congerie* limestone member of the Pasquasia Formation
GPQ_4	Fanglomerates member of the Pasquasia Formation
GPQ_5	Arenazzolo member of the Pasquasia Formation
GTL	Cattolica Formation
GTL_1	Calcare di base member of the Cattolica Formation
GTL_2	Selenitic member of the Cattolica Formation
GTL_3	Salt member of the Cattolica Formation
GRT	Gratteri formation
HIO	Mischio
HYB	Hybla Formation
INI	Inici Formation
IMR	Imera synthem
ITO	Marabito limestone
LER	Lercara complex
LER_a	Cozzo San Filippo sandstone
LER_b	Sosio limestone
LTM	Lattimusa
LUO	Monte Luziano formation
MCD	Crinoidal limestone
MCD_a	Altofonte breccias
LEG	Pellegrino formation
MUF	Mufara Formation
MRS	Marsala synthem
PNB	Piano Battaglia reef limestone
PNB_a	Reef lithofacies of the Piano Battaglia reef limestone
PNB_b	Forereef lithofacies of the Piano Battaglia reef limestone
POZ	Polizzi Formation
RDE	Cardellia marls

REI	Reitano Formation
RFR	Raffo Rosso synthem
RND	Crinoidal limestone
SCT	Scillato Formation
SIA	Sciacca Formation
SIC	Castellana Sicula formation
SIT	Barcarello synthem
SNP	Buonfornello synthem
SOR	Monte Soro flysch
TAV	Tavernola Formation
TAV_a	*Lucina* limestone of the Tavernola Formation
TRB	Trubi
TRB_1	Lascari member of Trubi
TRP	Tripoli
TRV	Terravecchia Formation
TRV_1	Conglomerate member of the Terravecchia Formation
TRV_2	Sandstone member of the Terravecchia Formation
TRV_3	Pelitic member of the Terravecchia Formation
TUT	Tusa tuffites
VSI	Valdesi formation