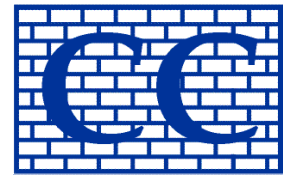


Cambridge Carbonates Ltd

Expertise in carbonate and evaporite systems



CONFIDENTIAL

Purchased by:

XXXXXXX



Andrew Horbury

Evaluation of the Jambur-Pulkhana Area from Public Domain Data

TABLE OF CONTENTS

Synopsis	2
Table of Contents	4
1. Introduction	6
1.1. Data and Data Limitations	6
1.2. Location and Structural Setting	7
1.3. History of Exploration in the Area	10
1.4. Spelling and Nomenclature	14
1.5. Legend	14
2. Reservoir Stratigraphy	17
2.1. Older Stratigraphy and Basement	26
2.1.1. Introduction	26
2.2. Middle Permian-Lower Jurassic Megasequence (AP6)	27
2.2.1. Middle Permian-Earliest Triassic	28
2.2.2. Early Triassic	35
2.2.3. Middle Triassic	41
2.2.4. Late Triassic	43
2.2.5. Early Jurassic	60
2.4. Middle-Upper Jurassic Megasequence (AP7)	70
2.4. Lower Cretaceous Megasequence (AP8)	86
2.5. Upper Cretaceous Megasequence (AP9)	119
2.5.1. Introduction	119
2.5.2. Gulneri Formation	121
2.5.3. Kometan Formation	121
2.5.4. Hartha Formation	127
2.5.5. Shiranish Formation	128
2.6. Paleogene (AP10 Megasequence)	136
2.6.1. Introduction	136
2.6.2. Aaliji Formation	141
2.6.3. Jaddala Formation	145
2.6.4. Palani Formation	148
2.6.5. Tarjil Formation	150
2.6.6. Ibrahim Formation	152
2.6.7. Azkand Formation	154
2.7. Early Neogene (basal Megasequence AP11)	156
2.7.1. Introduction	156
2.7.2. Hamrin Formation and the “basal anhydrite”	157
2.7.3. Serikagni Formation	159
2.7.4. Euphrates Limestone Formation	162
2.7.5. Dhiban Formation	164
2.7.6. Jeribe Formation	172
2.8. Late Neogene (Upper AP11 Megasequence)	179
2.8.1. Introduction	179
2.8.2. Lower Fars Formation	179
2.8.3. Middle Fars Formation	189
2.8.4. Upper Fars Formation	192
2.8.5. Lower Bakhtiari Formation	197
2.8.6. Upper Bakhtiari Formation	209
2.8.7. Pleistocene and Recent (Maidan Unit and Alluvium)	213
3. Depth and Structure	216

3.1. Regional Structure	216
3.2. Tops.....	218
3.3. Individual Structures.....	218
3.3.1. Pulkhana.....	218
3.3.2. Jambur.....	220
3.3.3. Gilabat.....	221
3.3.4. Qumar/Talishan.....	222
3.3.5. Tauq, Tuz Khurmatu.....	222
4. Economic Aspects.....	224
4.1. Introduction.....	224
4.2. Reservoirs	224
4.2.1. Introduction.....	224
4.2.2. Upper Fars Formation	224
4.2.3. Lower Fars Formation.....	224
4.2.4. Jeribe Formation	225
4.2.5. Euphrates Formation	225
4.2.6. Serikagni Formation.....	225
4.2.7. Jaddala Formation	226
4.2.8. Shiranish Formation.....	226
4.2.9. Qamchuqa Formation.....	226
4.2.10. Deeper Mesozoic Formations	226
4.3. Source Rocks	226
4.4. Seals	228
4.4.1. Lower Fars Seal	228
4.4.2. Dhiban Seal.....	229
4.4.3. “Basal Anhydrite” and Serikagni Seal.....	230
4.4.4. Aaliji Seal.....	232
4.4.5. Dokan/Gulneri/Kometan Seal.....	233
4.4.6. Shallow Seals	234
4.5. Aquifers.....	234
4.6 Geothermal Gradient.....	235
5. Infrastructural Considerations	235
6. References.....	237
7. Appendices A: Datasheets	244
A1. Pulkhana Field.....	244
A2. Jambur Field.....	248
A3. Shakal Field.....	261
A4. Kor Mor Field	262
A5. Qumar Field	264
A6. Gilabat Field.....	266
A7. Sarqala Field	269
8. Appendices B: Faunal Lists by Formation.....	272

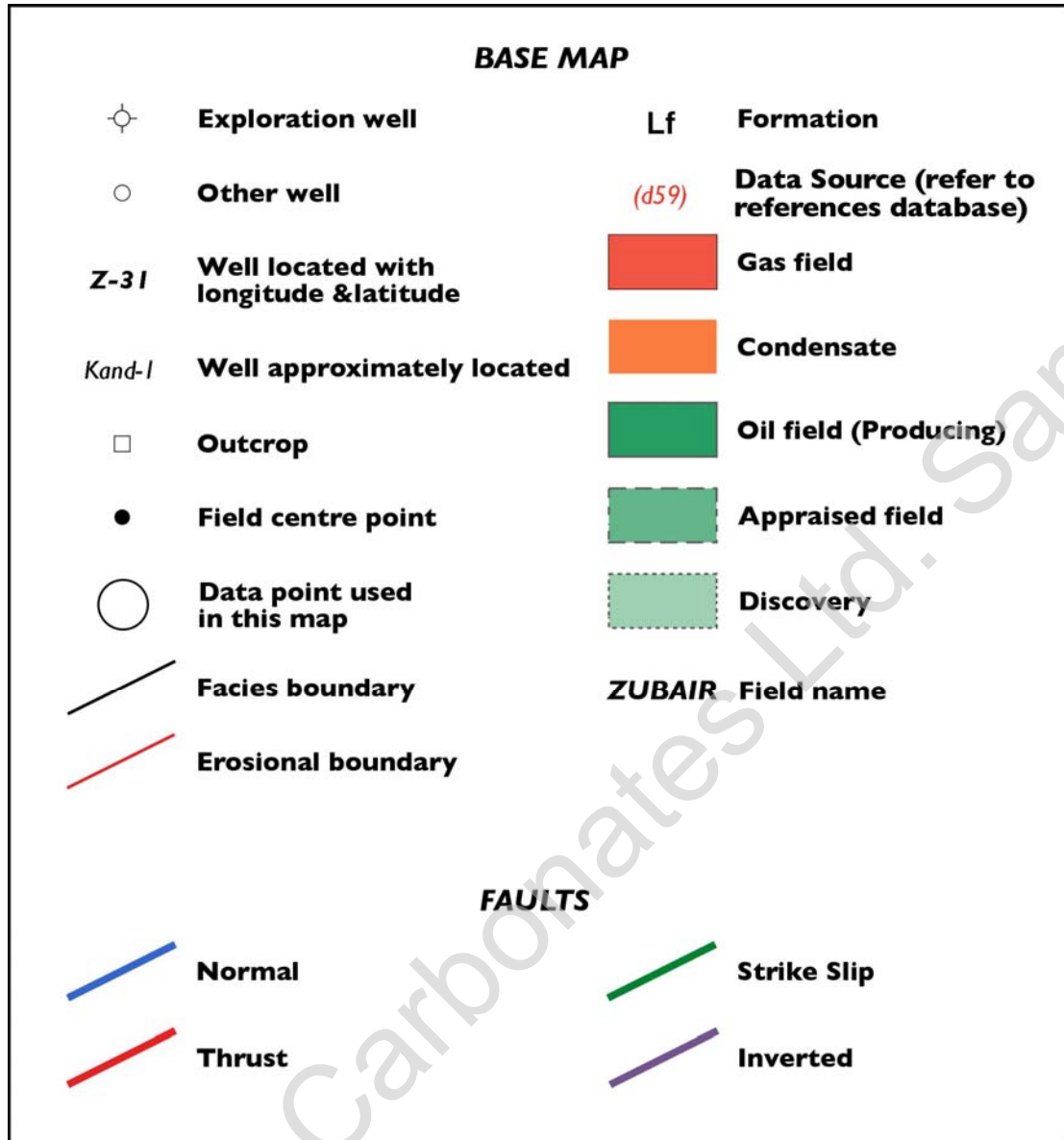


Figure 6 Cambridge Carbonates Ltd. standard map legend (symbols and petroleum)

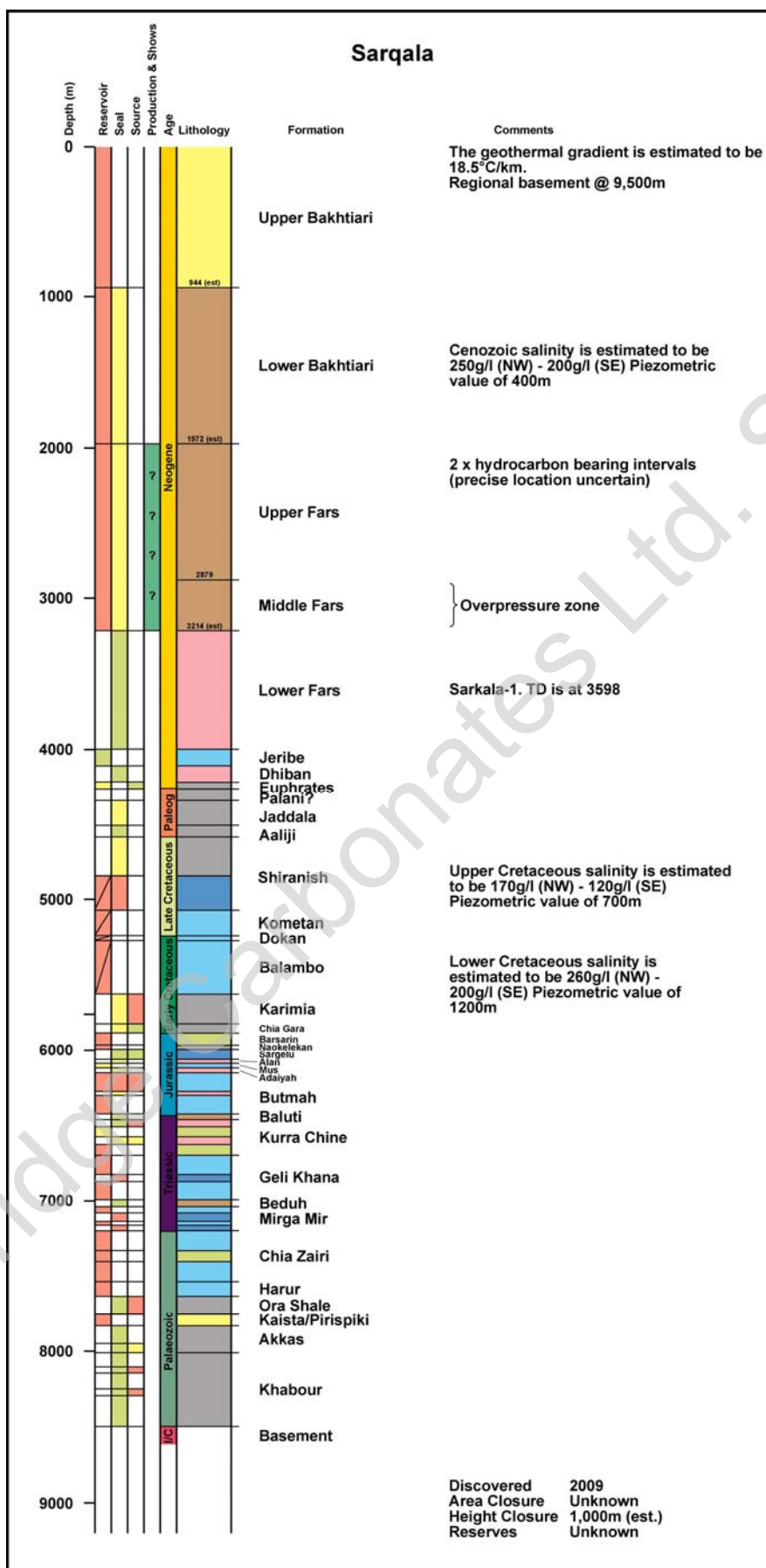


Figure 16 Summary stratigraphy and economic assessment for the Sarqala Field.

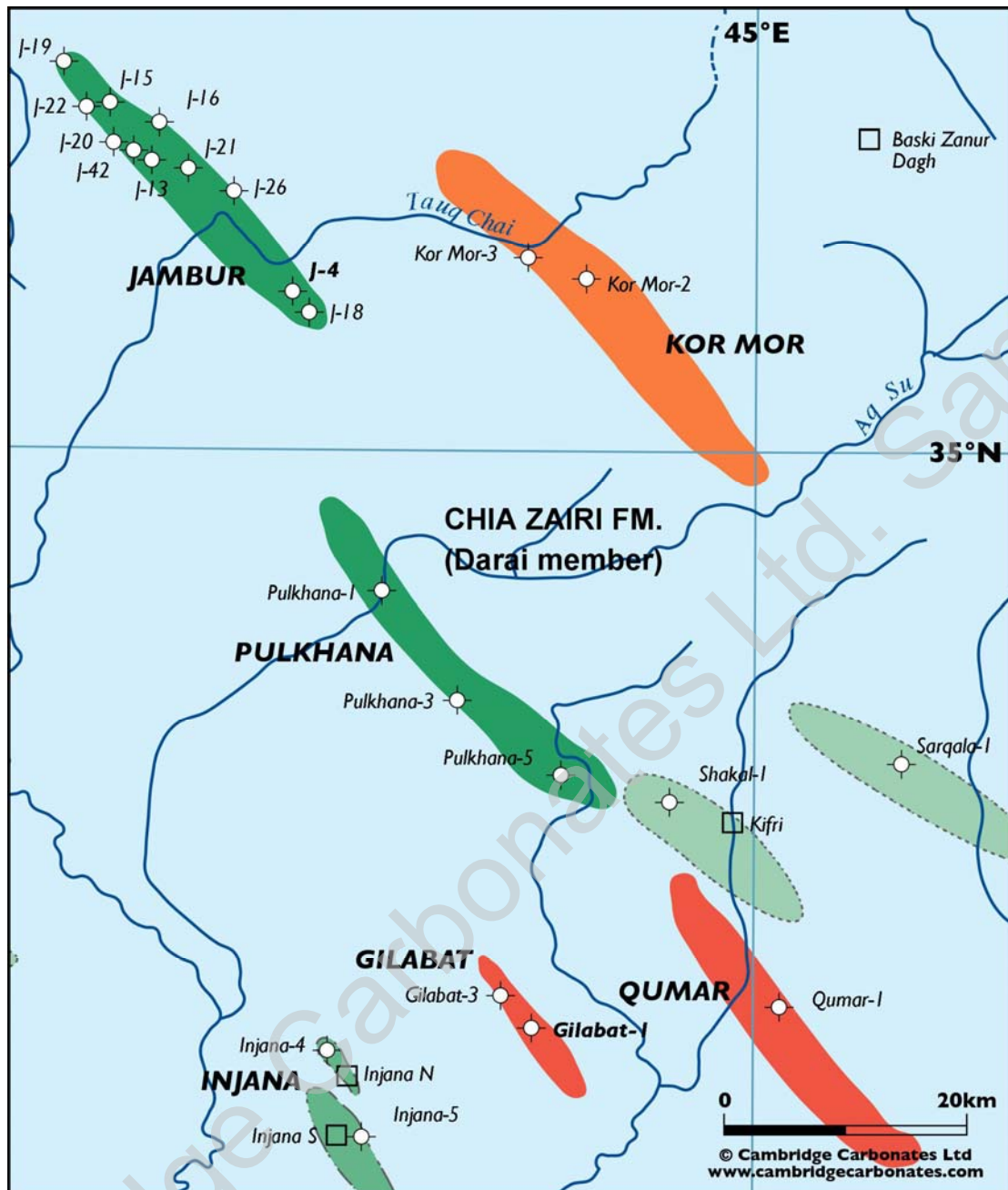


Figure 25 Chia Zairi Formation palaeogeography (Darai Member), showing very shallow water, high energy facies across the entire study area. Late Induan (Latest Permian), P40 HST (Cambridge Carbonates Ltd. map no. 60a). Note that the Tr10 HST palaeogeography is identical for this area.

Log data from the few wells closest to the study area such as Jebel Khand-1 (Figure 20), suggest that the Chia Zairi Formation (and the underlying clastics) are not very porous in the northern part of the Arabian Plate (in contrast with its correlative the Khuff Formation and pre-Khuff clastics in the Gulf countries) and until further positive data becomes available, the Permian is not considered a major objective.

2.2.2. Early Triassic

The Triassic is up to 2,500m thick in northern Iraq, but is probably only between 1,400 and 2,000m thick in the study area (thickening to the NW) (Jassim and Goff, 2006) (Figure 26). Exposures of Triassic rocks are known from the basal

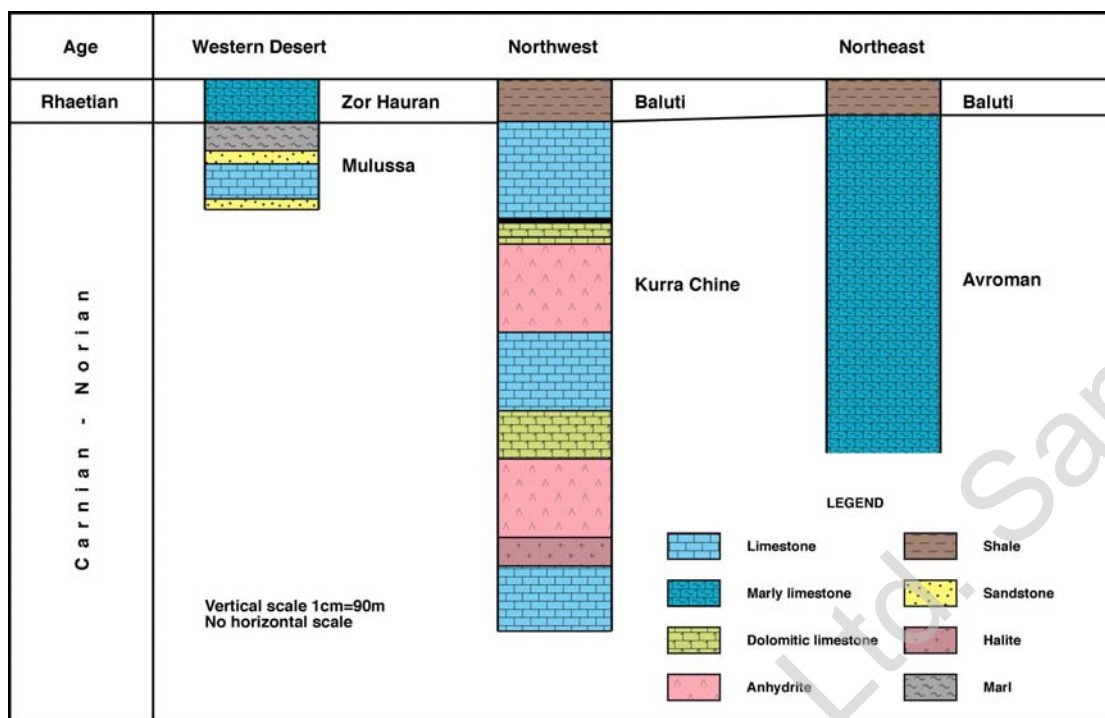


Figure 33 Typical Upper Triassic facies in Iraq, after Sadooni (1995)

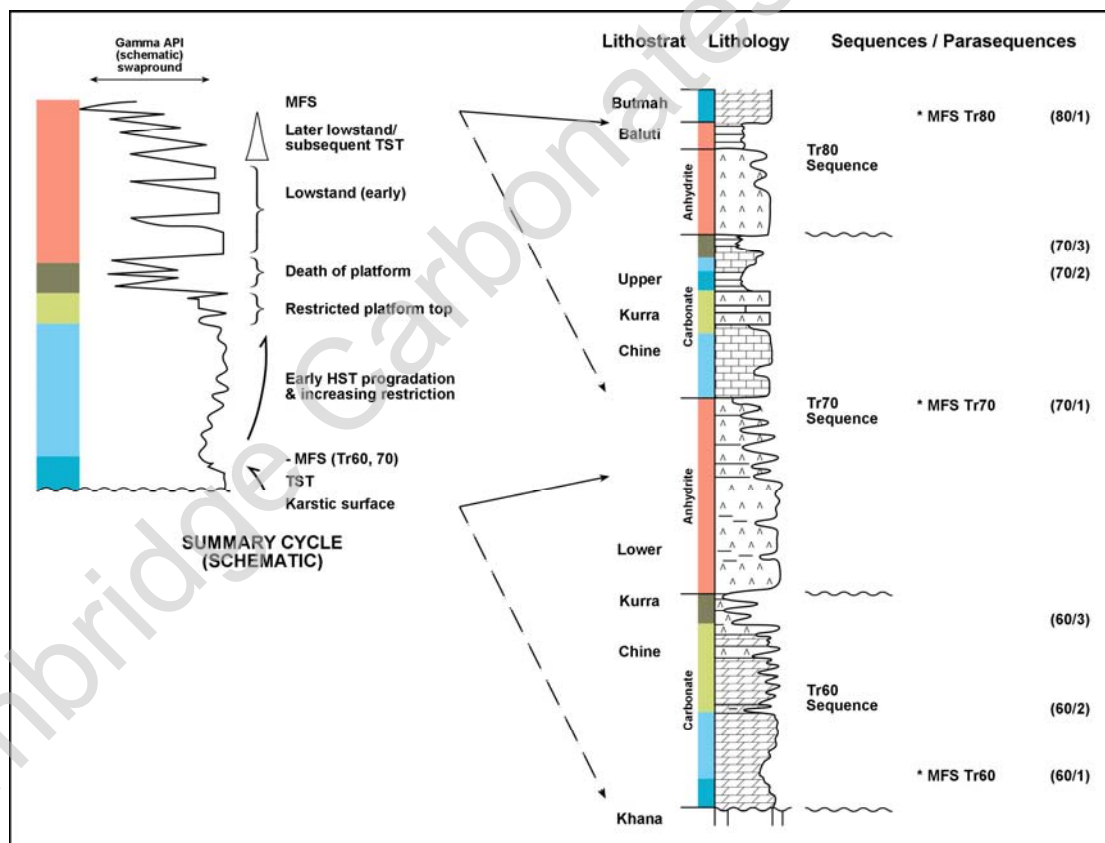


Figure 34 Cartoon shows cycle styles in the Kurra Chine Formation of Iraq. Left: simplified 'ideal' cycle (third order sequence) showing transition from platform carbonates up into intrashelf basin and its evaporite infill, Right: stacking of sequences emphasising changes (or lack of changes) in cycle style through time. Cambridge Carbonates Ltd. figure.

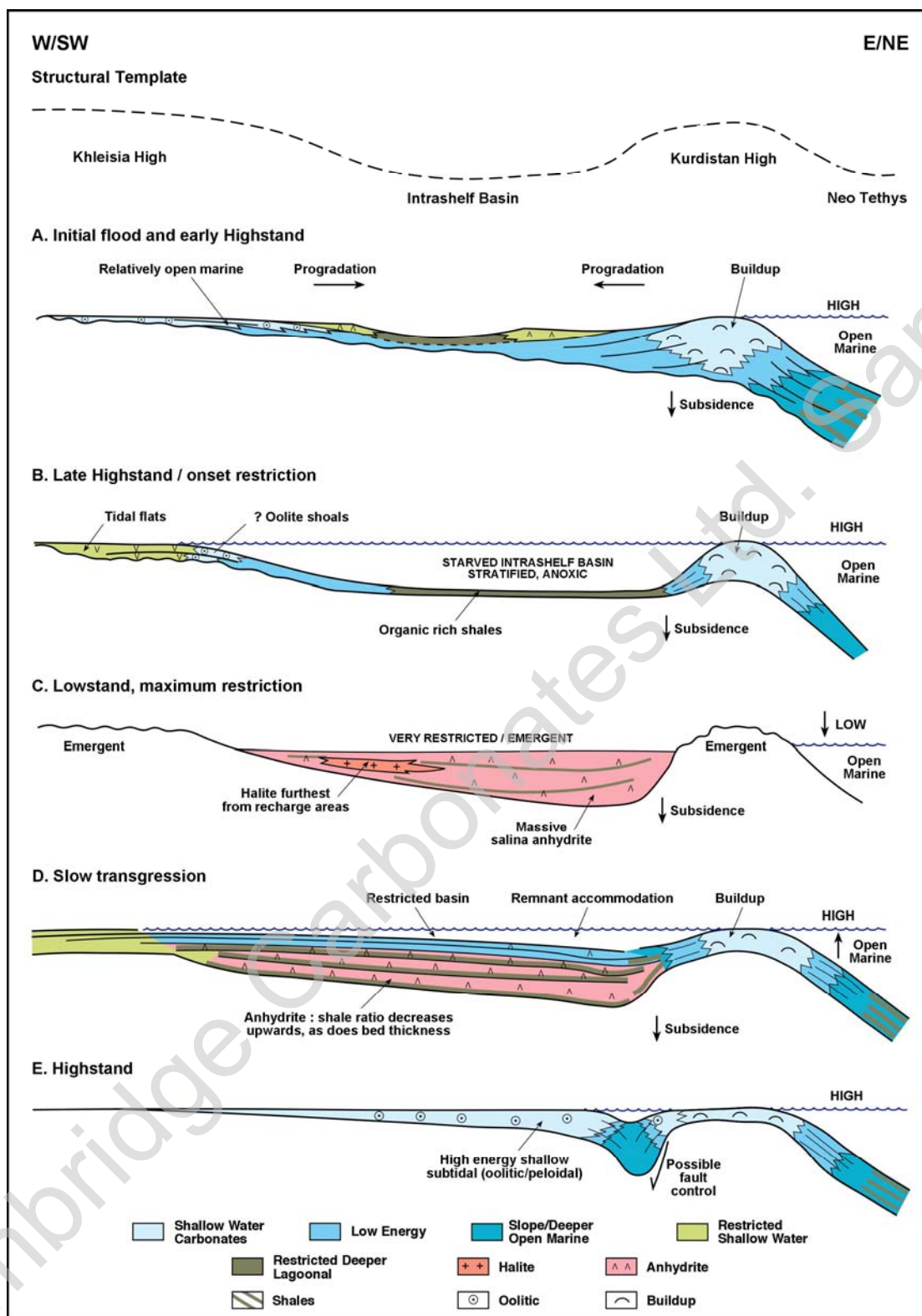


Figure 44 Evolution of depositional environments (ordered from top to bottom) through a third-order cycle in the Kurra Chine Formation. It is notable that halite facies are only deposited close to the onlap margins in the SW, not necessarily in the axis of thickest evaporite deposition. CC interpretation derived from regional data.

In an economic sense, the Triassic has never been proven as a major reservoir unit in Iraq, probably because of the typically low volumes of reservoir oil that it

The Butmah/Sarki formations represent development of mostly shallow subtidal restricted platform carbonates and supratidal sabkhas to salinas, with only the basal Tr80 flooding surface bringing in truly open marine carbonates (Figure 52).

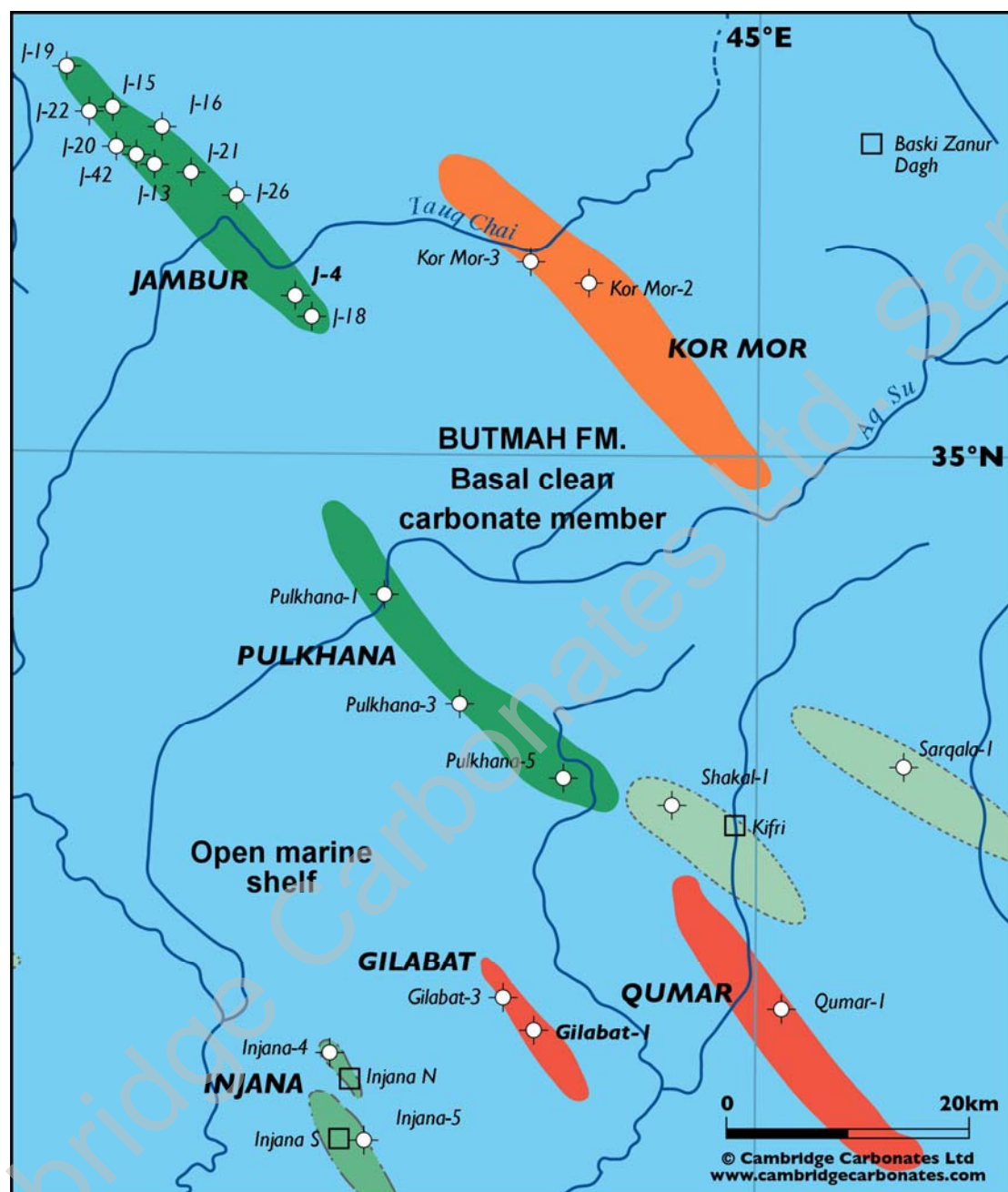


Figure 52 Butmah Formation, basal clean carbonate member palaeogeography, showing development of extensive open shelf environments. mid Rhaetian. Tr80 MFS (Cambridge Carbonates Ltd. map no. 53b).

Following deposition of the Butmah Formation, there was deposited the **Adaiyah Formation** anhydrite and shale. This formation is thought to have been reached at the T.D. of the deep East Baghdad-1 well to the SW of the study area (OEC, 1989; Figure 60) in addition to its development in Taq Taq-2 (Kaddouri, 1986; Figure 51). The Adaiyah Formation most likely represents deposition of evaporites in a salina (shallow evaporitic basin) setting, which was most likely produced during

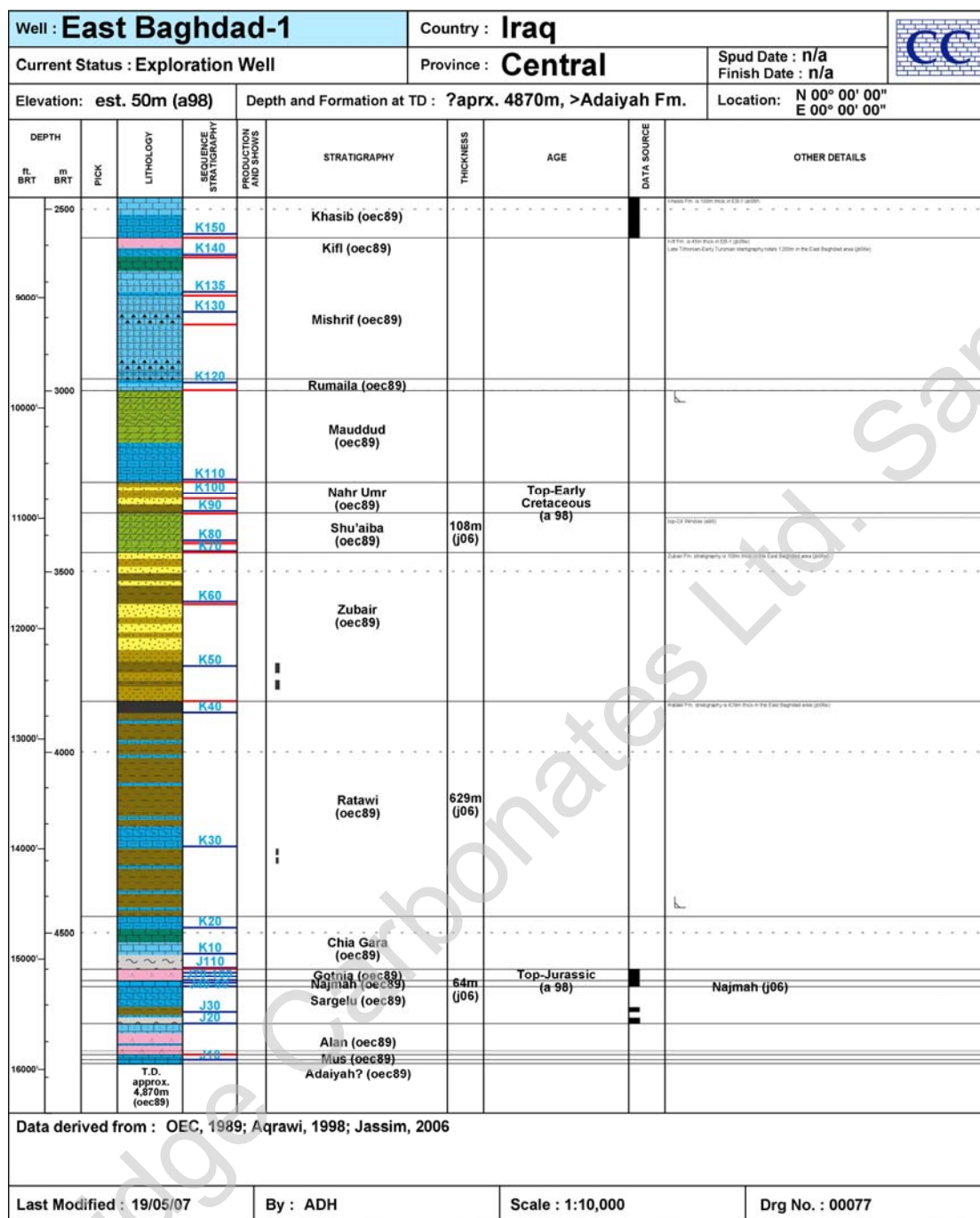


Figure 60 East Baghdad-1, bottom hole section. Data mostly from OEC1989. Cambridge Carbonates Ltd. figure.

In summary, the Sargelu Formation is a world-class source rock, as is also the overlying Naokelekan Formation (Odisho and Othman, 1992; Sadooni, 1997) (Table 5 and Table 6). Apart from the source rock and likelihood of local seals being developed in these basin-centre facies, there is a distant possibility that build-ups of 'typical' Najmah Formation may be present in some areas of the study area, particularly if there had been some movement at this time along the NW-SE oriented (Najd; Al-Husseini, 2000) fault system that controls the basin structure at this time. However this remains conjectural and would require 3D seismic in order to prove (or disprove) the possibility. A secondary significance of the Alan and Sargelu formations in this area, is that they may act as local seals above the shelfal carbonates of the Mus Formation (Figure 55).

Cambridge Carbonates Ltd. Sample

