Analysis and interpretation of environment sequence models of the Hassi R'Mel Field in Algeria

R. BAOUCHE, * A. NEDJARI, ** S. EL ADJ * and R. CHAOUCHI ***

*Laboratory of the Physical Earth, University of Boumerdes, 2 Avenue of Independence, Boumerdes, Algeria, r_baouche@yahoo.fr; Eladj_said@yahoo.fr

**University of Sciences and Technology–Sedimentary Basins–FTSGAT, Algiers, nedjaria@gmail.com.

*** Laboratory of Geology of the Sedimentary Basins, University of Boumerdes, 2 Avenue of Independence, Boumerdes, Algeria, rachaouchi@yahoo.fr .

Abstract: -With a surface area of 400,000 km^2, the Triassic Province in Algeria represents a vast Saharan territory, in which significant hydrocarbon layers are exploited on the Triassic and Cambrian–Ordovician levels. The Saharan Triassic consisted of varied continental environments, namely, fluvial, flood plain, lake, Sebkha, and wind.

At the top of Formation I, the lower series of strata of the Triassic, there are intercalations of volcanic rocks represented by dolerites. Sedimentation interspersed with periods of no deposition is thought to have occurred during the Triassic continental; resulting in a deposition of ground-level strata and the development of a more or less intense paedogenesis. This paedogenesis is found at the origin of important unequal discontinuities which can be used for sequential cutting and is also significantly influenced by climate. In such a context, and during the periods of no deposition, physicochemical phenomena related to the climate and type of bedrock occur, leading to the formation of a more or less advanced ground related to the elapsed time between two phases of sedimentation; this phenomenon is known as paedogenesis.

Formation II is characterized by the eruptive on the level of the lower member IIa at the base and constituted primarily of dolerites but the roof is primarily by a channel in a fine sandy filling. The member IIb is characterized by fluvial facies of channels prevailing and evolving to the top in a complex of playa or evaporates. This complex is characterized by a negative polarity at the bottom with a broad separation of the curves of neutron/density.

Formation III is characterized primarily by an evaporate facies of sebkha type halite which separates by electro halite benches, with weak Gamma Ray and lower than 10 API**.** The sonic signal is relatively constant around 70 µs/ft.

This work therefore attempts to refine the above models by using a well log-based modeling approach (gamma ray, neutron, sonic, density and resistivity) to examine the evolution of successions. The stratigraphy obtained using the results of faciologic analysis established for this purpose on the level of the Hassi R'Mel field is also used.

Key Words: Reservoir characterization, paleosols, sequence environments, Triassic Province, Sahara, Algeria.

1. Introduction

The Triassic formations of Hassi R'Mel field In Algeria have been the subject of several studies (Nedjari *et al.,* 2002) including faciologic and sequential analysis.

Triassic Succession Studies carried out with FSTGAT (Laboratory of Geodynamics of the Sedimentary Basins, USTHB) showed that the sedimentation is complex (Aît Ouali R. *et al.*, 1996**)**, arising from varied continental environments: an alluvial fan, evaporates, a fluvial system, and a playa. Our aim is to highlight the added value of this integrated regional-scale to reservoir-scale approach in identifying near-field exploration potential and additional recovery opportunities in producing reservoirs. Based on this aim, we emphasise the following points using our sequence stratigraphic modelling : (1) improved definition of deposition within and between reservoirs, (2) development of regionally sedimentological models for reservoir intervals (the Hassi R'Mel Formations), and (3) recognition of paleosols from well log analysis and controls on reservoir architecture and their links to the Triassic Province of Algeria.

2. Description of the Hassi R'Mel area

The Hassi R'Mel field is located in Algeria, between the meridian lines 2°55 and 3°0 East and the parallels 33°15 and 33°45 North, approximately 50 km South of Laghouat (Fig.1). It is located at an altitude of about 760 m and extends 80 km in a north–south direction and 60 km east–west (Courel L., *et al*., 2000**)**.

The studied Field contains on average eleven Wells. The main industry in the area is primarily condensate gas; only those wells drilled in the east of the Hassi R'Mel structure found oil (Boudjema**,** A., 1987).

3. Wells and well log data

The wells of South Hassi R'Mel were used in this study: HRS-2, HRS-4, HRS-7, HRS-8, HRS-9, HR-6b, HR-8, HR-10, HR-11, HR-12 and HR-162. All surveys were the subject of a cutting in formations starting from the paedogenesis expressions of the University of FTSGAT (Aît Ouali R. *et al*., 1996**)**.

a) Reports/ratios of the layers: work completed by the geologists of Sonatrach in connection with survey data.

b) Other sources of information such as the information collected on the level of all the bibliographies available and the publications of Nedjari and Aît Ouali in the Triassic province, as well as the results of the work in the area of Zarzaîtine (Hamouche B., 2006).

4. Methodoly

The methodology used in this study consists of the use of a set of well log available (Augier, C. 1980**),** primarily of the principal classic well logs, namely the total density of the rocks (Rhob), porosity Neutron (Nphi), and sonic porosity (DT) as well as the resistivities of the rock. The first consists of the establishment of a litho logical column starting from one or more well of reference (where all the facies are present). The second stage consists of the use of suitable software for an automatic semi treatment. In the case of this study, the objective is to specify the nature of the environments of deposits as well as the geometry of the sandy bodies. The interpretation of spacing between the two curves leads us to introduce the concept of polarity of electrofacies, which one can distinguish as follows:

a. Electrofacies with positive polarity, where the density (Rhob) curve is on the right of the neutron (Nphi) curve, can indicate the presence of clay, anhydrite, or dolomites. The type of lithology is then distinguished by the values from the density (Rhob), Pef, and GR.

b. Electrofacies has negative polarity, where the density (Rhob) curve evolves on the left of the neutron (Nphi) curve, indicating the presence of sandy facies, gas, or halite.

c. Electrofacies which have a neutral polarity, where the density (Rhob) curve overlaps with the neutron (Nphi) curve, indicate sandy facies.

5. Facies and core analysis, thin blades

Within the South Hassi R'Mel Formation, alternating fine-to-coarse continental terrigenous facies with some interbedded dolomites were observed (Fig.2). Ten main facies are described: one clay facies, four sandstone facies, three dolomite facies and dolerite. The study of the sedimentary figures observed in the sediments, representing the hydrodynamic and physical conditions of the medium of sedimentation was also taken into account. The facies met have well Hrs-9, (Fig. 2) Interval: 2282 to 2286m), show:

a) Clean sandstones and argillaceous sandstones at the base;

b) An argillaceous matrix on the level of the sandstones, the base of the sequences.

c) Importance of the sandstones compared to clays in the series T1 – T2.

d) Red clays (well Hrs-2, interval: 2263.5 with 2259.6m), in centimetric layers with decimetric to metric at the top of the sequences; this aspect corresponds to a quite medium, on the flood plain.

e) Salt (saliferous) is presented in massive benches, of pink colour, with inter beds of clay grey black, sometimes dolomitic; characterizing an evaporitic sedimentation, lagunaire, under hot and even arid climate. Clays with anhydrite, grey black with dark or green grey dark, injected anhydrite, characterizing sedimentation in edge of the evaporitic salted lagoon, where the water section is almost permanent.

6. Characterization of environments

The studies carried out by the students of FSTGAT (USTHB) concerning the Triassic sequences showed that the sedimentation is very complex but made of various continental-type environments, ranging from the alluvial fan to the evaporates (Sebkha), while passing by the fluvial cone and the playa. Each environment can be characterized by a standard sequence (Fig.3), consisting of the following models: 6.1-The evaporate sequence, which is characterized by a desert environment and made up of red argillaceous deposits, with nodules of anhydrite and of gypsum testifying to an arid climate of the time with many enterolithic structures and "chicken wire." Discontinuity, related to the pedogenesis is expressed by gypsies' crusts and sand pink (Fig.3.1) as it also characterizes these sequences.

6.2-The fluvial sequence, which generally consists of sequences of channels with a decimeter thickness to metric (Fig.3.2). The braid sequence, which is characterized partly by fluvial environment braids (Fig.3.2) and made up of sandy shale deposits evolving in a sinuous environment.

6.3-The meanders sequence, which is characterized by an environment of fluvial-type meanders and consists of sand toward the base and argillaceous deposits toward the top of the sequence. The sequence is positive (Fig.3.).

6.4-The sequence of river and lake environment, for which the material composition is generally fine: clays, quartz, iron oxide, carbonates, gypsum, and anhydrite, which the pedogenesis modifies more or less intensely (Fig.3).

6.5-The detrital volcano sequence, which is related to volcanic castings and primarily made up of volcanic rock, such as dolerite or basalt (Fig.3).

6.6-The alluvial fan sequence, which is generally represented at the base by conglomeratic deposits, alternating with sandy deposits (Fig.3).

7. Well log responses

The combination of the various well log data gives access to the facies through the concept of the electrofacies**.**

The sandy shale series of Hassi R'Mel formations crossed by the wells-Hrs-7, Hrs-9, and Hr-12**,** could be thus interpreted

starting from the well log in the following way:
The deposits of channels and bars of tighten point if they are the fining-up or cylindrical type (Fig.3).
The deposits of bars of channel are usually coarsening-up, whereas the saliferous one and/or shale-saliferous is of the cylindrical type**.**

8. Depositional environment at the Hassi R'Mel during the Triassic

The sedimentation in the area of Hassi R'Mel Southern Triassic was continental because of the climate and the structural context. The succession of the various formations is intersected by more or less long episodes of magmatic eruptions, which gave more or less thick sequences of eruptive rocks because of the fallen-through phase of rifting that touched the entire Saharan platform during the phase (Nedjari *et al.*, 2002). During the Hassi R'Mel Southern Triassic, the study of the Triassic filling allowed us to recognize several models of sequences (Fig.2) of various scales, in particular of the second, third, and fourth order. It will be used for a scalarized sequential cutting (Vail, P.R., 1977) principle, the lithography sequences correspond to sequences of environment, to members or formations of order 3°, 4° and like with sequences of 5° order.

9. Electrofacies

The analysis of the electric signatures (Fig. 3) of the wells on the scale of the Hassi R'Mel field made it possible to highlight 9 electrofacies.
The sandstones have a negative polarity, with an average spacing of the Rhob–Nphi curves, strong densities and resistivities, and low-porosity neutrons. The sandstones with slight shale content, with a negative or positive polarity (Rhob curve evolving on the right of the Nphi curve) and a weak spacing of the Rhob–Nphi curves. Dolomites, with positive polarity, are positioned on the line of dolomites and the dolomite pole according to the diagrams. Their radioactivity is lower than 40 API.

1. Sandy shale dolomites, with positive polarity, have points deviated in the direction of the quartz pole or line of the sandstones and a natural radioactivity that could be high-up to 150 API.
2. Shale dolomites, with increased radioactivity, can have a GR lower than that of sandy dolomites and are represented by electrofacies with positive polarity with a great spacing of the Rhob–Nphi curves. Their points are deviated toward the pole clay.
3. Sandy shale dolomites slightly, with increased radioactivity, can have a GR lower than sandy dolomites and are represented by electrofacies with positive polarity with a great spacing of the Rhob–Nphi curves. Their points are deviated toward the clay pole.
4. Sandy dolomite shale with shale sand has a positive polarity and an average spacing of the Rhob–Nphi curves are average or high. They are located in the triangulation of dolomite clay sandstone.
5. Shale facies are characterized by high radioactivities, greater than 90 API, electro facies with positive polarity, and a large spacing between the density and neutron showed from the cross plot Rhob vs, Nphi. The Sandy or dolomite clays are characterized by pointed deviation showed from the pole clay toward the sandstone pole or dolomite.
6. The dolerite facies are characterized by electro facies with positive polarity, similar to shale dolomite with a higher gamma ray cut off. The analysis of the electro sequences of the wells of Hassi R'Mel showed several interesting findings. Fluvial system.

a. Fluvial system

- Fluvial bars of channel meanders (Hrs-12) have a negative polarity with a rather broad spacing depending, however, on the content of matrix clay and are characterized by the following: 13<GR<45

(API), 58<DT<82 (µs/ft), 2.28<Rhob<2.60 (g/cc). (Fig.2 and Fig.3).

- The sandy bars of the type found in the braid are present primarily at the level of the formation II (Hrs-7), (Fig.2 and 3), which is generally with sandy prevalence with intercalation of clay benches with low thicknesses and whose well log responses are characterized by the following: 37<GR<91 (API), 64<DT<92 (µs/ft), 0.06<Nphi<12 and resistivities varying from 2 to 8 Ohm/m.

b. Floodplain

In the floodplain, sedimentation is represented primarily by clays, because of a weak hydro dynamism and with a slope that is almost neutral. They have a negative polarity, with a great spacing neutron/density that is connected to the matrix fraction clay and whose well log responses are characterized by the following: 92<GR<133 (API), 66<DT<100 (µs/ft), 0.18<Nphi<36, and resistivity varying from 2 to 33 Ohm/m. These types of environment are characteristic primarily on the level of the wells (Fig.2 and Fig. 3).

c. Lacustrine

Lake environments are characteristic primarily on the level of the wells (Fig.2 and Fig.3). They have a negative polarity, with a great spacing neutron/density that is connected to the matrix clay fraction and whose well log responses are characterized by the following: 36<GR<117 (API), 70<DT<100 (µs/ft), 0.12<Nphi<0.23, and resistivity varying from 1 to 3.5 Ohm/m.

d. Evaporates (Sebkha)

Sebkha facies correspond to evaporates of the coastal plain and are of the halite type according to the cross plot of neutron vs density (Fig. 2 and Fig. 3). In these media of sedimentation, the sequences observed are characterized by marine brine arrivals and then decantation of evaporates (Bourquin *et al*., 1996). The halite electro banks exhibit a negative polarity, with a great spacing neutron/density that is connected to the matrix fraction clay and whose well log responses are characterized by the following: 5<GR<50 (API), 68<Dt<84 (µs/ft), –0.009<Nphi<0.06, and resistivities greater than 6000 Ohm/m. These formations indicate an arid and hot climate.

e. Wind

Wind is not easily detectable by the well log data. It is, however, visible only with the level of the results of the thin blades. An example is visible with the level of the Hrs-4 well, where wind quartz was found on thin blades (Fig.2).

10. Results and analysis

The analysis and the interpretation of the Triassic electro sequences of Hassi R'Mel are based on an identification of the electrofacies such as their grouping in sequences, the sedimentary type of succession, the lithological drift of the benches and interbenches, as well as the identified involvement of the deltaic plain, which are cylindrical on the training level II (channels). In Fig.2, Well HRS-7 represents the types of identified cylindrical electro sequences on II and the type training level in braids. The types of sequence identified on the levels of this well correspond to sequences of environment (Fig.2), the third order with the following members: (1) channels, (2) bars, (3) clays, (o) pedogenesis nodules, of marmorizations, the traces of roots and encrusting; their well log characteristics are GR (API) < 45; –0.04<Phin<0.096; 2.28<Rhob<2.60; 59<Dt<82; and R_t<230 Ohm/m.

In Fig.2, Well HRS-9 represents the types of identified electro sequences that are cylindrical on the training level II (channels). The sequences of the second order correspond to sequences of environment of second order, and the third order corresponds to members. Their well log characteristics vary as follows: 33<GR<7; 0.00<Phin<0.03; 2.33<Rhob<2.6; 59<DT<65.

In Fig.2, Well HRS-7 represents the types of identified electro sequences that are cylindrical on the training level II, of the meander type. With the base of formation II, one can identify the dolerite representing the paleosols at the base of formation II, which is representative of the major discontinuity with the roof of formation I.

From these cross sections (Fig. 4), we can see that:

- Significant thicknesses variations are to be noticed on the level of this profile, which appears by a significant reduction in formations I and II starting from the Hrs-10 well towards the Hrs-11 well. These reductions are especially very significant on the level of the center profile, on the level of the Hrs-4 well where the structure could translate a "Horst ".
- Formation I is with dominant shale on the level of Hrs-10 and its evolves to a sandy shale facies with probably good reservoirs qualities towards that of the Hrs-11 survey, except for the well Hrs- 4 which presents at its base an argillaceous facies.
- The thickness of the evaporate series also decreases starting from the Hrs-10 survey (NE) towards Hrs-4 and begins again in increase towards the Hrs-11 well.

The Well HRS-7 represents the results of the thin blades according to the well log characteristics of each sequence of environment:

a. Red marmorization rusts at a depth of 2200m;
b. Gyps Crete at the depth of 2158 m;
c. Desiccation filled with crystal quartz at a depth of 2151.5 m;
d. Argilane at the coast at a depth of 2144.5 m;
e. Bimazepism, corresponding to the reorientation of argillaceous minerals at a depth of 2166.5m;
f. Burst quartz at a depth of 2153 m;
g. Simple pedogenesis nodules at a depth of 2150 m;
h. Complex pedogenesis nodules at a depth of 2158 m;
i. Brechifications at a depth of 2157.5 m;
j. Dolerite at a depth of 2157.5 m.

11. Conclusion

Detailed analysis of the well log responses obtained at the level of the intervals shows that the intervals at paleosols have particular well log characteristics that enable us to find them in other non cored surveys. These well log characteristics are as follows:

Radioactivity GR**,** varying from 30 to 116 (API); resistivity (R_t), very weak and varying from 1.0 to 10 Ohm/m; total density Rhob, varying from 2.34 to 2.67 G/DC; porosity Phin neutron, varying from 12% to 32%; sonic DT, varying from 74 to 92 (µs/ft).

Formation I (corresponding to the lower series) is characteristic of meander-type fluvial structures, distal where a fine and argillaceous material dominates. The entire sedimentary structure of formation II was formed in a fluvial system in braid, with dominant sandy composition and all the reservoirs of Hassi R'Mel, representing a localized oil interest. These reservoirs are located in sandy, arranged levels in a complex way and present a tabular geometry in layers of great extension, limited to the wall by impermeable argillaceous levels a the top of formation III of the shale-saliferous series (S4) limited to the top by the reference mark "D2", which is dated "Lias**"** and at the base by the Hercynian discordance**.**

The well log responses of the paleosols to the roof of the formations of the Hrs-9 well can be summarized as follows:

Formation III: 24<GR<75; $9<R_t<160$; 2.50<Rhob<2.75; 0.30<Phin<0.08; 57<Dt<93.

Formation II: 33<GR<95; 0.14<Phin<0.33; 2.33<Rhob<2.60; 70<DT<87.

Formation I: 40<GR<80; $4<R_t<13$; 2.57<Rhob<2.46; 0.16<Phin<0.20; 75<Dt<86.

Finally, changes of facies and thicknesses affect these levels layers characterized by variabilities, in petrophysical terms that are more or less significant. To this end, in future, the prospect researches must be centered mainly with the Formations II which prove to be sandy or shaly sandy.

Acknowledgements

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References:

[1] Augier, C. 1980. Complex well log and matrices. First part: analyze faciologic. Report/ratio interne Elf Aquitaine.

[2] Aît Ouali R., Nedjari A., 1996. The Saharan Triassic province. 20 years of geological information: critical assessment and reflexions. *Bulletin of the Geological Service of Algeria, 7 (2) (1996) 211–228.*

[3] Boudjema, A., 1987. Structural evolution of the oil basin "Triassic" of the Eastern northern Sahara (Algeria) Thesis of doctorate, Univ. Paris-South. Hundred. Orsay, pp. 279, 1987.

[4] Bourquin, S. and Guillocheau, F., 1996**.** Keuper stratigraphic cycles in the Paris Basin and comparison with cycles in other Peritethyan basins (German Basin and the Bresse-Jura Basin). *Sedimentary geology*, 105: 159–182.

[5] Courel L., Ait Salem H., Ben Ismail H., El Mostaine M., Fekirine B., Kamoun F., Mami L., Oujidi M., Soussi M., 2000**.** An overview of the epicontinental, Triassic series of the Maghreb (NW Africa). *In: G. H. Bachmann and Ian Lerche (eds.) (2000).* An overview of the epicontinental Triassic series of Maghreb (N-W Africa). In Bachmann G.H & Lerche I. (eds): Epicontinental Triassic. Zbl. Geol. Päont., tome 2, 9-10 (1998), 1145-1166.

[6] Hamouche B., 2006. Safeguarding of the fluvial systems of Sorted Algerian: impact of the climate and the deformation. In: 10th French congress of Sedimentology, October 11-13, 2005, Giens, Delivers summaries, Oral Communication. Géosciences de Rennes1, 2006.

[7] Nedjari, A., Ait Ouali R., Delfaud J., 2002**.** Sorted basins Saharan and atlassic Algerian: development and news approaches. [Triassic of the Algerian Atlassic and Saharan basins: check not and new approach]**.** *In: Stratigraphy of Algeria: Contributions and developments; Csa, SGA (Eds). Memories of the Geological Service of Algeria 11 (2002) 87–113.*

[8] Vail, P.R., Mitchum, R.M., Todd, R.G., Widmier, J.M., Thompson, S.I., Sangree, J.B., Bubb, J.N. and Hatlelid, W.G. 1977. Seismic stratigraphy and global changes of Sea-level. In: *Seismic stratigraphy - applications to hydrocarbon exploration* (Ed C.E. Payton), 26, pp. 49-212. Am. Assoc. Petrol. Geol. Mem.

Figure captions

Figure.1**:** Field location of Hassi R'Mel (ALGERIA).

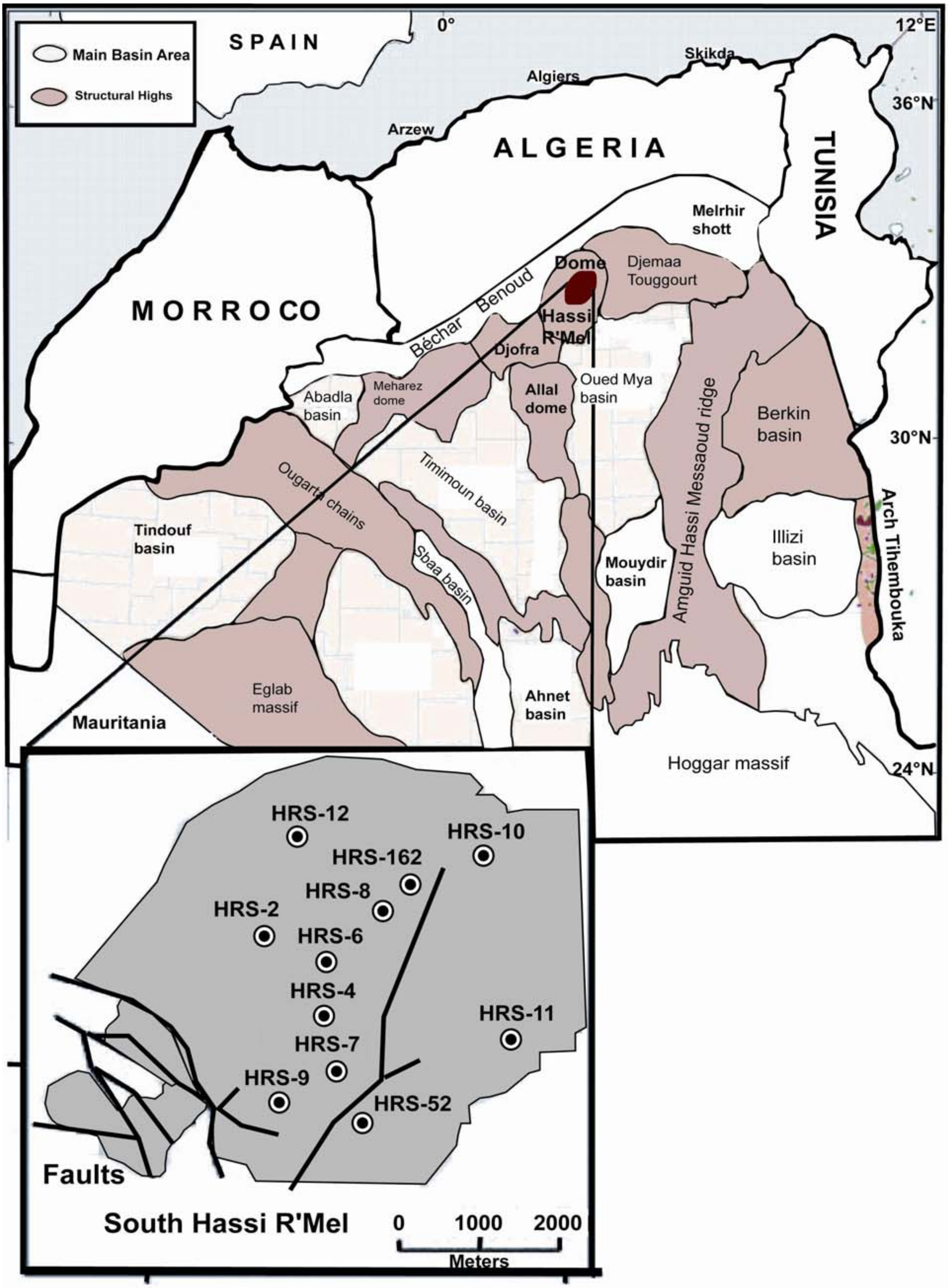
Figure. 2: Electro sequences of the river environments-lake: Well Hrs-7 (1): Channel; (2): Bars; (3): Pedogenetic nodules.

Figure.3: The electrofacies and lithology resulting from faciologic analysis and log responses: Well HRS-7.

Figure. 4: Cross sections of Triassic Formations of Hassi R'Mel Field. Bore holes: HRS- HRS-10, HRS-6, HRS-4 and HRS-11.

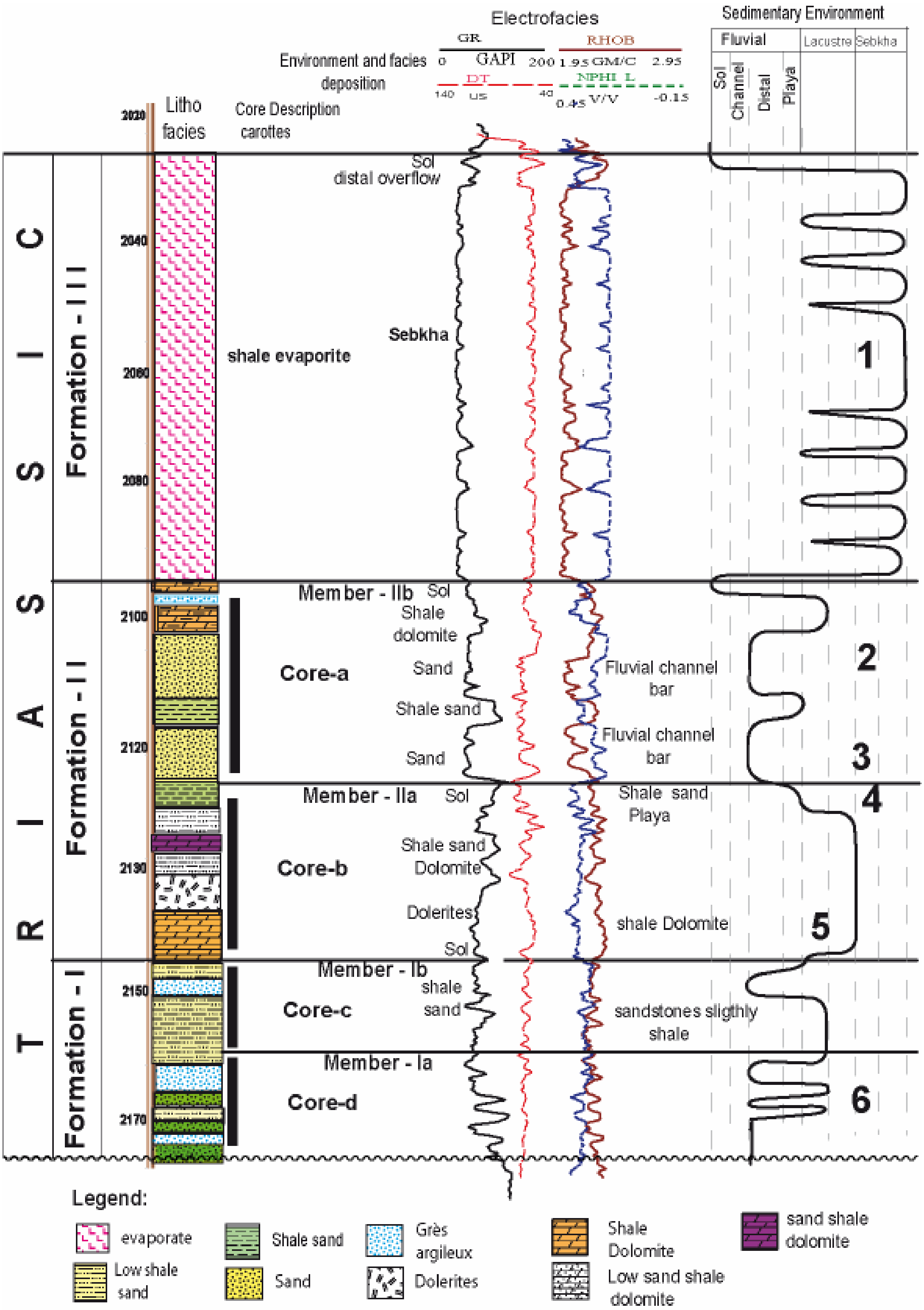
Table captions

Table. 1**:** Hassi R'Mel facies well log responses.



Main Basin Area
Structural Highs
SPAIN
0°
12°E
36°N
30°N
24°N
Skikda
Algiers
Arzew
ALGERIA
TUNISIA
MORROCO
Melrhir shott
Dome
Djemaa Touggourt
Béchar Benoud
Hassi R'Mel
Djofra
Meharez dome
Abadla basin
Allal dome
Oued Mya basin
Amguid Hassi Messaoud ridge
Berkin basin
Timimoun basin
Ougarta chains
Tindouf basin
Sbaa basin
Mouydir basin
Illizi basin
Arch Tihembouka
Eglab massif
Ahnet basin
Mauritania
Hoggar massif
HRS-12
HRS-10
HRS-162
HRS-8
HRS-2
HRS-6
HRS-4
HRS-11
HRS-7
HRS-9
HRS-52
Faults
South Hassi R'Mel
0 1000 2000
Meters

Fig. 1



Electrofacies
GR
GAPI
0
200
RHOB
1.95 GM/C 2.95
DT
140 us 40
NPHI_L
0.45 V/V -0.15
Environment and facies deposition
Core Description carottes
Litho facies
Sedimentary Environment
Fluvial
Lacustre
Sebkha
Sol
Channel
Distal
Playa
TRIASSIC
Formation - III
Formation - II
Formation - I
2020
2040
2060
2080
2100
2120
2130
2150
2170
Sol
distal overflow
Sebkha
shale evaporite
Member - IIb
Sol
Shale dolomite
Core-a
Sand
Shale sand
Sand
Fluvial channel bar
Fluvial channel bar
Member - IIa
Sol
Shale sand
Playa
Core-b
Shale sand
Dolomite
Dolerites
Sol
shale Dolomite
Member - Ib
Core-c
shale sand
sandstones sligthly shale
Member - Ia
Core-d
1
2
3
4
5
6
Legend:
evaporate
Low shale sand
Shale sand
Sand
Grès argileux
Dolerites
Shale Dolomite
Low sand shale dolomite
sand shale dolomite

Fig. 2

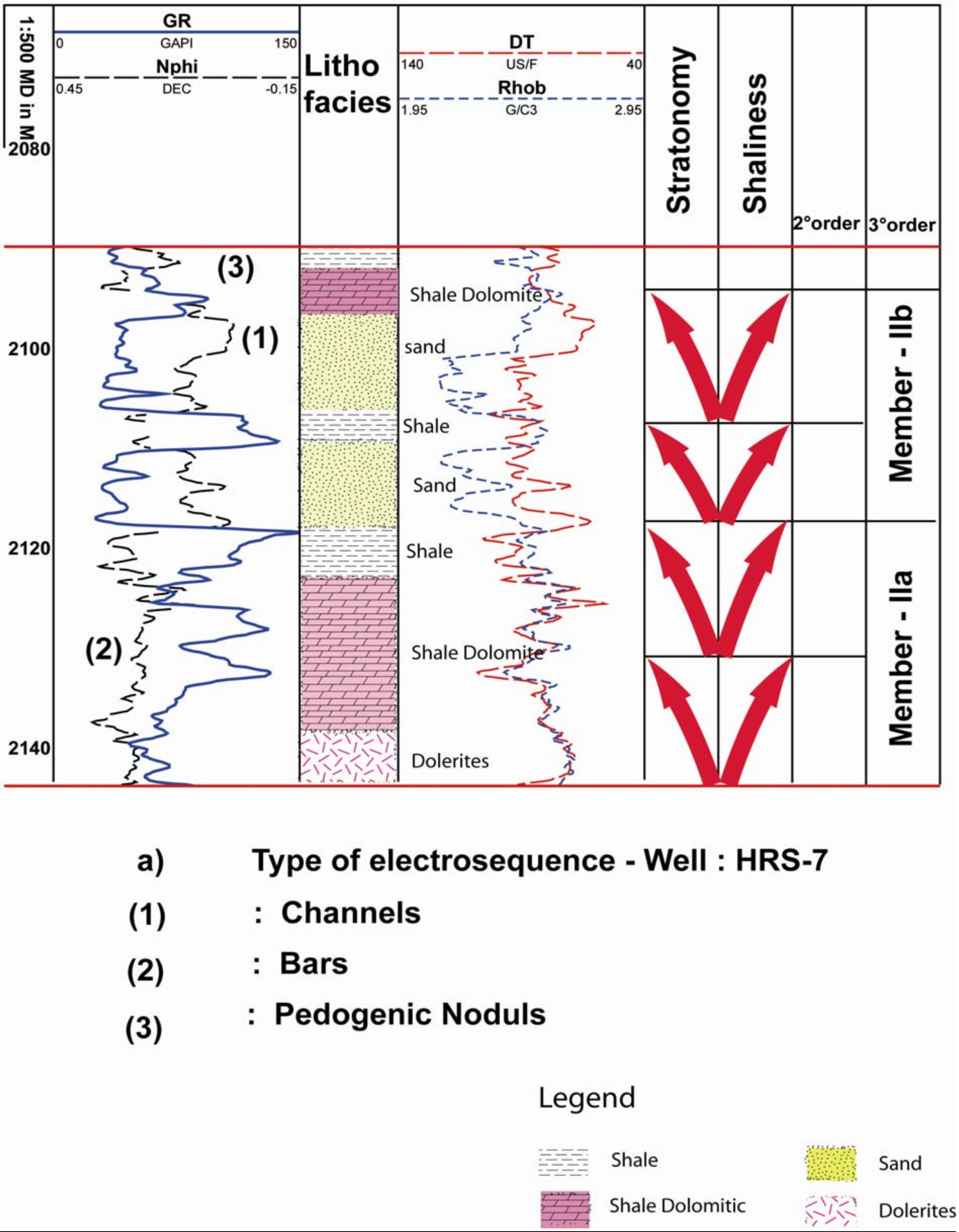

1:500 MD in M
GR
0 GAPI 150
Nphi
0.45 DEC -0.15
Litho facies
DT
140 US/F 40
Rhob
1.95 G/C3 2.95
Stratonomy
Shaliness
2°order
3°order
2080
2100
2120
2140
(3)
(1)
(2)
Shale Dolomite
sand
Shale
Sand
Shale
Shale Dolomite
Dolerites
Member - IIb
Member - IIa
a) Type of electrosequence - Well : HRS-7
(1) : Channels
(2) : Bars
(3) : Pedogenic Noduls
Legend
Shale
Sand
Shale Dolomitic
Dolerites

Fig. 3

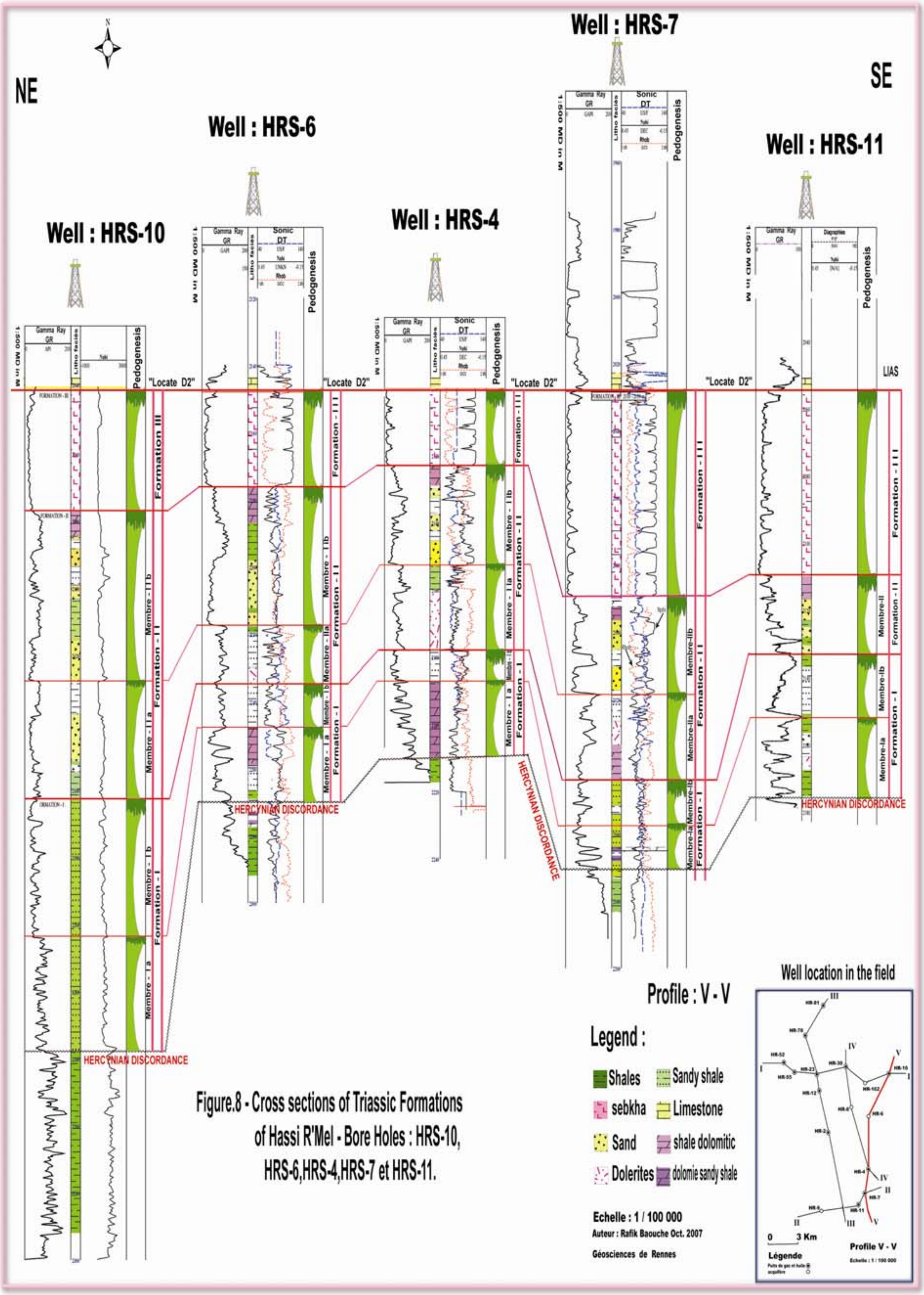

NE
SE
Well : HRS-10
Well : HRS-6
Well : HRS-4
Well : HRS-7
Well : HRS-11
"Locate D2"
LIAS
Gamma Ray
GR
Litho faciès
Sonic
DT
Pedogenesis
1:500 MD in M
Formation - III
Formation - II
Formation - I
Membre - II b
Membre - II a
Membre - I b
Membre - I a
HERCYNIAN DISCORDANCE
Profile : V - V
Legend :
Shales
Sandy shale
sebkha
Limestone
Sand
shale dolomitic
Dolerites
dolomie sandy shale
Echelle : 1 / 100 000
Auteur : Rafik Baouche Oct. 2007
Géosciences de Rennes
Figure.8 - Cross sections of Triassic Formations of Hassi R'Mel - Bore Holes : HRS-10, HRS-6,HRS-4,HRS-7 et HRS-11.
Well location in the field
0 3 Km
Légende
Profile V - V
Echelle : 1 / 100 000

Fig. 4