LIST OF FIGURES

Fig----------Page

1-1. Location map of the well in the Abu Gharadig Basin (star) and of the Bahariya Oasis (triangle)----------2
1-2. The oil and gas fields in the Western Desert of Egypt----------4
1-3. Generalized stratigraphic column of the northern Western Desert----5
1-4. Sedimentary basins of the Western Desert----------12
1-5. Classification of the cylindrical sandstone samples into horizontal and vertical samples and into laminated and non-laminated samples----------16
1-6. Thin section image of sample 74 H with contact to flaser bedding. The red arrow points at a concave-convex contact of quartz grains----------17
1-7. Thin section image of sample 43 H showing twisted mica (red arrow) within a sandy layer, sandwiched between two flaser layers-------17
1-8. Thin section images of two different sandstone samples (left-hand side 31 H; right-hand side 43 H) showing secondary fracture porosity (blue) parallel to flaser layers----------18
1-9. Microscopic image of sample 43 H under reflected light showing high reflective framboid pyrites which are aligned like a pearl necklace within a flaser layer----------19
1-10. SEM micrograph of sample 43 H showing pyrite crystals within a framboid (red arrow) in a clay matrix----------19

2-1. Histogram of dry bulk density for all samples of the Bahariya Formation----------23
2-2. Histogram of dry bulk density for laminated and non-laminated samples of the Bahariya Formation----------23
2-3. Histogram of wet bulk density for all samples of the Bahariya Formation----------25
2-4. Histogram of wet bulk density for laminated and non-laminated samples of the Bahariya Formation----------25
2-5. Histogram of grain density for all samples of the Bahariya Formation----------26
2-6. Histogram of grain density for laminated and non-laminated samples of the Bahariya Formation----------26
2-7. Histogram of porosity for all samples of the Bahariya Formation---29

Fig----------Page

2-8. Histogram of porosity for laminated samples of the Bahariya Formation----------30
2-9. Histogram of specifc surface area for all samples of the Bahariya Formation----------31
2-10. Histogram of specifc surface area for laminated samples of the Bahariya Formation----------32
2-11. Histogram of magnetic susceptibility for all samples of the Bahariya Formation----------34
2-12. Histogram of magnetic susceptibility for laminated samples of the Bahariya Formation----------34

3-1. Histogram of resistivity for all samples of the Bahariya Formation-40
3-2. Histogram of resistivity for laminated and non-laminated samples of the Bahariya Formation----------41
3-3. Histogram of imaginary part of electrical conductivity for all samples of the Bahariya Formation----------41
3-4. Histogram of imaginary part of electrical conductivity for laminated and non-laminated samples of the Bahariya Formation----------42
3-5. Histogram of the coefficient of anisotropy of resistivity for all samples of the Bahariya Formation----------43
3-6. Histogram of the coefficient of anisotropy of resistivity for laminated and non-laminated samples of the Bahariya Formation----------43
3-7. Ruska gas permeameter----------46
3-8. Histogram of logarithms of permeability for all samples of the Bahariya Formation----------47
3-9. Histogram of logarithms permeability for laminated and non-laminated samples of the Bahariya Formation----------48
3-10. Histogram of the coefficient of anisotropy of permeability for all samples of the Bahariya Formation----------50
3-11. Histogram of the coefficient of anisotropy of permeability for laminated and non-laminated samples of the Bahariya Formation-50
3-12. Ultrasonic inspection - Krautkramer USLT----------51
3-13. Histogram of P-wave velocity for all samples of the Bahariya Formation----------54
3-14. Histogram of P-wave velocity for laminated and non-laminated samples of the Bahariya Formation----------55

Fig----------Page

3-15. Histogram of anisotropy ration of p-wave velocity for all samples of the Bahariya Formation----------56
3-16. Histogram of anisotropy ratio of p-wave velocity for laminated and non-laminated samples of the Bahariya Formation----------56

4-1. Bulk density versus porosity for all samples of the Bahariya Formation----------61
4-2. Bulk density versus porosity for laminated and non-laminated samples of the Bahariya Formation----------62
4-3. Bulk density versus magnetic susceptibility for all samples of the Bahariya Formation----------62
4-4. Bulk density versus magnetic susceptibility for laminated and non-laminated samples of the Bahariya Formation----------63
4-5. Porosity versus logarithm permeability for all samples of the Bahariya Formation----------65
4-6. Porosity versus logarithm permeability for laminated and non-laminated samples of the Bahariya Formation----------65
4-7. Porosity versus logarithm permeability for horizontal and vertical samples of the Bahariya Formation----------66
4-8. Magnate susceptibility versus Porosity for all samples of the Bahariya Formation----------68
4-9. Magnetic susceptibility versus porosity for laminated and non-laminated samples of the Bahariya Formation----------68
4-10. Magnetic susceptibility versus permeability for all samples of the Bahariya Formation----------69
4-11. Magnetic susceptibility versus permeability for laminated and non-laminated samples of the Bahariya Formation----------69
4-12. Internal surface (S_{por}) versus permeability for the Bahariya Formation----------70
4-13. Internal surface (S_{por}) versus permeability for laminated and non-laminated samples of the Bahariya Formation----------71
4-14. Internal surface (S_{por}) versus porosity for laminated and non-laminated samples of the Bahariya Formation----------71
4-15. Internal surface (S_{por}) versus Imaginary part of conductivity for laminated and non-laminated samples of the Bahariya Formation-73
4-16. Imaginary part of conductivity versus permeability for laminated and non-laminated samples of the Bahariya Formation----------73

Fig----------Page

4-17. Relationship between true formation resistivity factor and imaginary part of conductivity for laminated and non-laminated samples of the Bahariya Formation----------74
4-18. Log porosity versus log apparent formation resistivity factor for all samples of the Bahariya Formation----------76
4-19. Log porosity versus log apparent formation resistivity factor for laminated and non-laminated samples of the Bahariya Formation-76
4-20. Apparent formation resistivity factor versus permeability for all samples of the Bahariya Formation----------77
4-21. Apparent formation resistivity factor versus log permeability for laminated and non-laminated samples of the Bahariya Formation-77
4-22. Log porosity versus log true formation resistivity factor for all samples of the Bahariya Formation----------78
4-23. Log porosity versus log true formation resistivity factor for laminated and non-laminated samples of the Bahariya Formation-79
4-24. True formation resistivity factor versus log permeability for all samples of the Bahariya Formation----------80
4-25. True formation resistivity factor versus log permeability for laminated and non-laminated samples of the Bahariya Formation-80
4-26. P-wave velocity versus porosity for all samples of the Bahariya Formation----------81
4-27. P-wave velocity versus porosity for laminated and non-laminated samples of the Bahariya Formation----------82
4-28. P-wave velocity versus porosity for horizontal (laminated and non-laminated) samples of the Bahariya Formation----------82
4-29. Anisotropy of resistivity versus anisotropy of permeability relationship for laminated and non-laminated samples of the Bahariya Formation----------84
4-30. Anisotropy of p-wave velocity versus anisotropy permeability for laminated and non-laminated samples of the Bahariya Formation-84
4-31. Anisotropy of resistivity versus anisotropy of p-wave velocity for laminated and non-laminated samples of the Bahariya Formation-85

5-1. Compressional *Vp* versus shear wave velocity *Vs* at different saturation levels----------89
5-2. Average of compressional wave velocity versus gas - brine saturation----------90

Fig----------Page

5-3. Average of shear wave velocity versus gas - brine saturation-------91
5-4. Average of Poisson's ratio versus Gas - Brine saturation----------93
5-5. Average of compressional wave velocity measured at different saturation levels versus average compressional wave velocity calculated from equation 7----------95
5-6. Average of compressional wave velocity measured at different saturation levels versus average compressional wave velocity calculated from equation 8----------96
5-7. Average of compressional wave velocity measured at different saturation levels versus average compressional wave velocity calculated from equations 11a and 11b----------98
5-8. Average of shear wave velocity measured at different saturation levels versus average shear wave velocity calculated from equation 16----------100
5-9. Average of shear wave velocity measured at different saturation levels versus average shear wave velocity calculated from equations 17a and 17b----------101
5-10. Average of Poisson's ratio measured at different saturation levels versus average Poisson's ratio derived from interpolated values of p- and s-wave velocity----------102
5-11. Compressional wave velocity measured on dry samples versus compressional wave velocity calculated from Wyllie equation---104
5-12. Compressional wave velocity measured on saturated samples versus compressional wave velocity calculated from Wyllie equation---104
5-13. Compressional wave velocity measured on dry samples versus compressional wave velocity calculated from Raymer's equation----
----------105
5-14. Compressional wave velocity measured on saturated samples versus compressional wave velocity calculated from Raymer's equation----
----------105

6-1. Measured permeability versus predicted permeability from bulk density----------107
6-2. Measured permeability versus predicted permeability from porosity--
----------107
6-3. Measured permeability versus predicted permeability from magnetic susceptibility----------109

Fig----------Page

6-4. Measured permeability versus predicted permeability from internal surface S_{por}----------109
6-5. Measured permeability versus predicted permeability from apparent formation resistivity factor----------110
6-6. Measured permeability versus predicted permeability from true formation resistivity factor----------111
6-7. Measured permeability versus predicted permeability from (S_{por} and porosity)----------113
6-8. Measured permeability versus predicted permeability from (S_{por} and true formation resistivity factor)----------115
6-9. Measured permeability versus predicted permeability from (true formation resistivity factor and imaginary conductivity)----------115
6-10. Measured permeability versus predicted permeability from (porosity, S_{por} and true formation resistivity factor)----------116
6-11. Measured permeability versus predicted permeability from (porosity, S_{por}, ρ'' and true formation resistivity factor)----------116

LIST OF TABLES

Table----------Page

1: Investigated scalar properties and applied methods and devices used for Bahariya Formation samples----------21
2: The minima, maxima, average and standard deviations values for scalar properties investigated for Bahariya Formation samples----------35
3: Methods and devices to investigate the directional properties of Bahariya Formation samples----------36
4: The quality of a reservoir as determined by permeability----------45
5: Minima, maxima, average and standard deviations values for directional properties investigated for Bahariya Formation samples----------59
6: Minima, maxima, average and standard deviations values for anisotropic properties investigated for Bahariya Formation samples----------59
7: Factors *a* and cementation factors *m* from Archie equation----------75
8: Equations of permeability prediction from a single parameter and statistical data to evaluate the quality of prediction----------112
9: Equations of permeability prediction from two, three and four parameters and statistical data to evaluate the quality of prediction----------117