

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 specific surface area for all samples of the Bahariya Formation-----	31
2-10. Histogram of specific 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 ratio 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

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 V_p versus shear wave velocity V_s at different saturation levels-----89

5-2. Average of compressional wave velocity versus gas - brine saturation-----90

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

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