List of Figures

Chapter-1: Introduction
Figure 1.1: Pure crystal and its defects ................................................................. 3
Figure 1.2: Luminescence mechanism ...................................................................... 6
Figure 1.3: TL glow curve and OSL decay curve of quartz ....................................... 8
Figure 1.4: Different types of transitions ............................................................... 9
Figure 1.5: Configuration coordinate diagram ..................................................... 9
Figure 1.6: Different types of centers and transitions ......................................... 12
Figure 1.7: TL glow curve and OSL decay curve of feldspar .............................. 15

Chapter-2: Luminescence Dating: Experimental Protocols and Instrumentation
Figure 2.1: Luminescence signal in natural environment ....................................... 19
Figure 2.2: Multiple aliquot additive dose method (MAAD) ............................ 21
Figure 2.3: Single aliquot regeneration (SAR) protocol ..................................... 23
Figure 2.4: Determination of De using SAR ...................................................... 24
Figure 2.5: 40K Decay scheme and Natural decay series ............................. 27
Figure 2.6: Ranges of ionizing radiations ........................................................ 29
Figure 2.7: Beta dose attenuation factor of grains ........................................... 29
Figure 2.8: Stimulation modes and signals ....................................................... 35
Figure 2.9: Response of Bialkali type EMI 9235QB PMT .................................. 36
Figure 2.10: Stimulation and Transmission curve of filters for Quartz and Feldspar .......... 37
Figure 2.11: Decay scheme of 90Sr and 241Am Source .................................. 38
Figure 2.12: Basic TL/OSL reader ................................................................. 41
Figure 2.13: β source arrangement ................................................................. 41

Chapter-3: Dose Distribution in Sediments
Figure 3.1: Doses deposited in different size grains ....................................... 46
Figure 3.2: Dose distribution in natural sample ............................................... 47
Figure 3.3: Distribution of quartz and feldspar .............................................. 47
Figure 3.4: Dose distribution function ............................................................ 48
Figure 3.5: Simulations geometry ................................................................. 50
Figure 3.6: The energy deposition function estimated by Monte Carlo ............... 51
Figure 3.7: The comparison of energy deposition function for the 40K source ...... 52
Figure 3.8: Variation of energy deposited per unit volume (EPV) ..................... 52
Figure 3.9: The dose distribution function obtained using Monte Carlo .......................................................... 57
Figure 3.10: The geometry used in simulation to incorporate porosity into simulations ...................................... 58
Figure 3.11: Dose distribution function for 30% porosity .................................................................................. 59
Figure 3.12: Inverse transformation method for single aliquot dose estimation ................................................ 64
Figure 3.13: Flow diagram to find the single aliquot doses using simulations .................................................... 65
Figure 3.14: Procedure to find palaeodose probability and maximum and minimum palaeodoses ...................... 66
Figure 3.15: Variation of probability ................................................................................................................. 67
Figure 3.16: Variation of minimum and maximum average dose .......................................................................... 68
Figure 3.17: Flow diagram to find maximum and minimum SD value ................................................................. 70
Figure 3.18: Dose histogram for the set having maximum and minimum SD values .......................................... 71
Figure 3.19: Variation of maximum and minimum SD .......................................................................................... 72
Figure 3.20: Dose histograms obtained for set of 35 aliquots .......................................................................... 73
Figure 3.21: Dose histograms for two different natural samples .......................................................................... 74
Figure 3.22: Dose Contributions for mm size grain and Simulation geometry to get dose depth profile ............... 78
Figure 3.23: Monte Carlo-calculated dose depth profile ..................................................................................... 80
Figure 3.24: Schematic representations of Geometry for analytical calculations .................................................. 82
Figure 3.25: Comparison of Monte Carlo and analytically calculated dose rates ................................................ 84
Figure 3.26: Monte Carlo-calculated values of dose rate (Gy.s\(^{-1}\)) \(^{212}\)Bi, \(^{234}\)Pa and \(^{214}\)Bi sources ......... 85
Figure 3.27: Transmission of quartz ................................................................................................................. 86
Figure 3.28: The short shine (0.1s) measurements for bleaching time estimation .............................................. 87
Figure 3.29: Bleaching of the stone sample ......................................................................................................... 88
Figure 3.30: Results for natural stone sample .................................................................................................... 89
Figure 3.31: Dose distribution natural stones ..................................................................................................... 91

Chapter-4: Spatially Resolved Luminescence Dating
Figure 4.1: New possibilities using surface dating technique .............................................................................. 94
Figure 4.2: Traparency issue ............................................................................................................................ 96
Figure 4.3: Schematic of OSL decay curve ........................................................................................................ 96
Figure 4.4: Luminescence intesity as a function of sample thickness and attenuation coeffiecient ..................... 103
Figure 4.5: Dose rate estimation for surface ....................................................................................................... 103
Figure 4.6: Variation of \(\beta\) dose inside ................................................................................................................. 105
Figure 4.7: Beta dose profile for \(^{90}\)Sr source in quartz ................................................................................... 108
Figure 4.8: Spatially resolved luminescence using imaging method .................................................................. 111
Figure 4.9: Block diagram of the system for spatially resolved luminescence ................................................. 111
Figure 4.10: Heating unit ................................................................................................................................. 112
Figure 4.11: Blue and IR stimulation unit ......................................................................................................... 112
Figure 4.12: Interfacing software made in LabVIEW ................................................................. 114
Figure 4.13: Chromatic aberrations of the lens .............................................................................. 115
Figure 4.14: Geometrical aberrations ............................................................................................... 116
Figure 4.15: Optical arrangement ...................................................................................................... 119
Figure 4.16: Andor iXON DU-897 EMCCD camera ................................................................. 120
Figure 4.17: Image acquisition ........................................................................................................... 122
Figure 4.18: Selection of the control points for image alignment ...................................................... 123
Figure 4.19: Image processing and dose estimation ........................................................................... 126
Figure 4.20: Dose recovery test results ............................................................................................. 128
Figure 4.21: Dose estimation for natural quartz and feldspar samples ............................................... 129

Chapter 5: Dose Distribution: Improvement in Measurement Protocol

Figure 5.1: SAR protocol .................................................................................................................... 133
Figure 5.2: Growth curve with very high natural signal .................................................................... 134
Figure 5.3: Steps followed to monitor sensitivity changes ................................................................. 137
Figure 5.4: Sensitivity variation during repeated OSL measurement cycles ........................................ 138
Figure 5.5: Sensitivity variations during repeated TL measurement cycles ....................................... 139
Figure 5.6: Modified NSC-SAR protocol .......................................................................................... 141
Figure 5.7: Correlation between TL and OSL ................................................................................... 144
Figure 5.8: Sensitivity variations during SAR measurement ............................................................... 147
Figure 5.9: Comparison of SAR with NCF corrected dose values ................................................... 152
Figure 5.10: Comparison SAR with NSC-SAR protocol ................................................................. 153
Figure 5.11: Ratio of SAR and NCF corrected equivalent doses ....................................................... 154