Contents

Preface to the second edition viii
Preface to the first edition ix
Acknowledgements xi

1 Introduction 1
1.1 Role of the engineer in the systematic exploration of a site 1
1.2 Relevance of geology to civil engineering 2
1.3 The science of geology 3
1.4 The aims and organisation of this book 4

2 Minerals and rocks 5
2.1 The common rock-forming minerals 5
2.1.1 The properties of minerals 5
2.1.2 Silicate minerals 10
2.1.3 Non-silicate minerals 25
2.2 Rocks 28
2.2.1 The nature of rocks 28
2.2.2 Igneous rocks 28
2.2.3 Igneous structures and forms 35
2.2.4 Sedimentary rocks 42
2.2.5 Metamorphic rocks 54

3 Superficial deposits 60
3.1 Soils 60
3.2 Weathering 60
3.2.1 Introduction 60
3.2.2 Mechanical weathering 62
3.2.3 Chemical weathering 63
3.2.4 Biological weathering 64
3.2.5 Role of vegetation 65
3.2.6 Influence of climate 65
3.3 Modern residual soils 66
3.3.1 Soil development and engineering grades of weathering 66
3.3.2 Soil description 66
3.3.3 Soil terminology 69
3.3.4 Classification of residual soils 69

4 Distribution of rocks at and below the surface 95
4.1 Introduction 95
4.2 Geological maps and sections 98
4.3 Nature and uses of stratigraphy 98
4.3.1 Rock type and past environment 102
4.3.2 The geological timescale 106
4.4 Deformation of rocks (structural geology) 107
4.4.1 Outcrops and subsurface structure 107
4.4.2 Layers of uniform dip (horizontal, vertical and inclined strata) 108
4.4.3 Folds 112
4.4.4 Fractures in rocks 118
4.4.5 Faults 121
4.4.6 Joints 123
4.4.7 Unconformity, overstep and onlap (overlap) 129
4.5 Plate tectonics and seismicity 132
4.5.1 Earth's layers and plates 132
4.5.2 Magnitude and intensity of earthquakes 138
4.5.3 Relationship of earthquakes to faults 139
4.5.4 Prediction of earthquakes 141
4.5.5 Seismic risk and problems for the engineer 142
4.6 The continental crust 143
4.6.1 Major crustal features 143
4.6.2 The rocks of Britain 144
5 Subsurface (ground) water

5.1 Behaviour of water in rocks and soils
   5.1.1 Porosity, hydraulic conductivity and permeability
   5.1.2 Darcy’s Law

5.2 Natural circulation of subsurface water
   5.2.1 Precipitation and its dispersal
   5.2.2 Groundwater and the water table
   5.2.3 Flow of groundwater
   5.2.4 Geological controls on movement of subsurface water
   5.2.5 Natural discharge of groundwater

5.3 Some practical engineering aspects of groundwater
   5.3.1 Groundwater and engineering
   5.3.2 Groundwater inventory
   5.3.3 Siting and testing of individual wells
   5.3.4 Drainage of groundwater
   5.3.5 Disposal of toxic waste, and storage of fluids, underground

6 Geological exploration of an engineering site

6.1 General considerations
   6.1.1 Introduction
   6.1.2 Inductive reasoning
   6.1.3 Systematic exploration of a site

6.2 Preliminary investigation
   6.2.1 Sources of information for UK site investigation
   6.2.2 Geology of the site
   6.2.3 Old mineral workings

6.3 Applied geophysical surveys
   6.3.1 Introduction
   6.3.2 Seismic waves
   6.3.3 Seismic-refraction method
   6.3.4 Seismic-reflection method
   6.3.5 Seismic surveys: case history
   6.3.6 Electrical methods
   6.3.7 Magnetic method
   6.3.8 Gravity method

6.4 Drilling, boring, trenching and pitting
   6.4.1 Drilling and boring
   6.4.2 Trenching and pitting
   6.4.3 Groundwater conditions

7 Rocks and civil engineering

7.1 Classification of rocks for engineering purposes
   7.1.1 Classification of rocks by simple criteria
   7.1.2 Engineering group classification of rocks

7.2 Engineering properties of rocks
   7.2.1 Isotropism
   7.2.2 Rock index properties
   7.2.3 Rocks as aggregates
   7.2.4 Characteristics of some common rock types as aggregates

7.3 Drilling, blasting and rock excavation
   7.3.1 Rock properties related to drilling
   7.3.2 Blasting techniques
   7.3.3 Case history of rock excavation: the new Strome Road (A890), Wester Ross, Scotland
   7.3.4 Test problem

8 Principal geological factors affecting certain engineering projects

8.1 Stability of slopes and cuttings
   8.1.1 Geological factors affecting the stability of a new excavation
   8.1.2 Other geological factors causing instability of existing slopes
   8.1.3 Types of failure of soil slopes
   8.1.4 Types of failure of natural rock slopes
   8.1.5 Stabilisation of slopes
   8.1.6 Case history: the Kishorn Dock excavation, Wester Ross, Scotland

8.2 Impounded surface water: geology of reservoir and dam sites
   8.2.1 Leakage and other considerations
   8.2.2 Case history: leakage from Clubbiedean Dam, Midlothian, Scotland

8.3 Geology of tunnels
   8.3.1 Geological considerations in tunnelling
   8.3.2 Methods of excavation
   8.3.3 Complications arising from local geological conditions
   8.3.4 Case history: the proposed Channel Tunnel

Appendix A Descriptions of some important soil groups
Appendix B Hydraulic properties and pumping tests of an aquifer
Appendix C  The British Geological Survey and other government Geological Surveys  280
Appendix D  Exploring for old coal workings in the United Kingdom  284
Appendix E  The time–distance graph of first arrivals from a velocity model with two layers separated by a horizontal interface, and where $V_2$ is greater than $V_1$  286
Appendix F  Quality of aggregates  288
Appendix G  Aggregate quality and tests in different countries  295
Appendix H  Systematic description of rocks and rock discontinuities  300

Index  305