

Contents

CHAPTER 1: INTRODUCTION.....	1
Historical perspectives.....	1
We are what we eat and drink.....	5
Deficiencies, excesses and imbalances of trace elements.....	8
CHAPTER 2: GEOCHEMISTRY OF THE TROPICAL ENVIRONMENT	19
Tropical environment	19
Arid zone	20
Seasonally dry tropics and sub-tropics	21
Humid tropics and sub-tropics	21
Mountainous zone.....	22
Rock weathering and soil formation in the tropics	24
Tropical weathering of mineralized terrains	29
Weathering profiles	30
Weathering of nickeliferous serpentinites	30
Formation of secondary minerals	32
Chemistry of weathering of ultra-basic rocks	33
Hydrogeochemistry of the tropical environment	35
CHAPTER 3: BIOAVAILABILITY OF TRACE ELEMENTS AND RISK ASSESSMENT	47
Bioaccumulation	47
Bioavailability	48
Risk assessment	51
Aspects of epidemiology in medical geology	54
Causation and correlation	55
Homeostasis in medical geology	56
CHAPTER 4: MEDICAL GEOLOGY OF FLUORIDE	59
Geochemistry of fluoride	60
Geochemistry of fluoride in weathering and solution	62
Fluoride in soils	66
Fluoride in sediments	66
Fluoride in plants	67

Fluorides and health	69
Bioavailability of fluoride	69
Dental fluorosis	71
Skeletal fluorosis	76
Case studies	78
Dental fluorosis in Sri Lanka	78
Distribution of fluoride in the groundwater of Sri Lanka	81
Dental fluorosis in India	84
Fluorosis in the east African rift valley	87
Endemic fluorosis in China	92
Brick tea fluorosis in China	94
Defluoridation of high fluoride groundwater	95
CHAPTER 5: IODINE GEOCHEMISTRY AND HEALTH.....	99
The iodine cycle in the tropical environment	99
Iodine sorption on clays and humic substances	109
Effect of microbial activity on iodine geochemistry	111
Iodine in drinking water	112
Iodine in food	112
Plate tectonics, high altitudes and iodine cycling	114
Iodine and health	117
Iodine Deficiency Disorders (IDD)	117
Endemic cretinism	120
Goitrogens	121
Endemic goitre in Sri Lanka	125
The Endemic goitre belt of India and Maldives	130
Goitre in Vietnam	132
Iodine deficiency in China	132
Iodine deficiency in East Africa	135
CHAPTER 6: NITRATES IN THE GEOCHEMICAL	
ENVIRONMENT.....	139
The nitrogen cycle	139
Nitrates, fertilizers and environment	142
Nitrogen loading in rice fields	147
Nitrates from human and animal wastes	148
Nitrates and health	153
Nitrates and methaemoglobinaemia	153
Nitrates and cancer	154

CHAPTER 7: MEDICAL GEOLOGY OF ARSENIC	157
Introduction	157
Arsenic in rocks and minerals	161
Arsenic in soils	161
Arsenic in natural waters	164
Arsenic adsorption and desorption	168
Microorganisms and their impact on arsenic speciation and mobility	169
Medical geology of arsenic- the West Bengal, Bangladesh example	175
Bangladesh basin-geography and geology	175
Sediment characteristics	176
Mineralogy and geochemistry of sediments	178
Organic matter	179
The scale of the problem	179
The geochemical mechanisms of arsenic mobility in the Bengal basin	181
Distribution of arsenic in the aquifer system	181
Geochemical mechanism of arsenic mobility	183
Arsenic in rice and other crops	185
Health effects of arsenic	186
CHAPTER 8: WATER HARDNESS IN RELATION TO CARDIOVASCULAR DISEASES AND URINARY STONES	191
Water hardness	192
Cardio-protective role of calcium and magnesium	192
Geochemical basis for tropical endomyocardial fibrosis (EMF)	197
Effect of water hardness on urinary stone formation (urolithiasis)	200
Types of stones	202
Calcium oxalate	202
Calcium phosphate	202
Uric acid	202
Magnesium ammonium phosphate stones.....	202
Cysteine	203
CHAPTER 9: SELENIUM- A NEW ENTRANT TO MEDICAL GEOLOGY.....	205
The geochemistry of selenium in the environment	205
Microbial transformation of selenium	211
Dissimilatory reduction	212
Assimilatory reduction	213
Oxidation	215
Methylation and volatilization	215

Selenium and human and animal health	216
Immune function	217
Viral infection- AIDS	217
Reproduction	217
Mood	217
Thyroid function	218
Cardiovascular diseases	218
Oxidative-stress or inflammatory conditions	218
Cancer	218
Selenium deficiency diseases in China	219
Selenium and iodine deficiency diseases (IDD)	222
CHAPTER 10: GEOLOGICAL BASIS OF PODOCONIOSIS, GEOFAGY AND OTHER DISEASES	223
Geophagy	223
Geophagy among animals	227
Ingestion of geomaterials for human health-the medical concerns	229
Podoconosis-a geochemical disease	231
Natural dust and pneumoconiosis	234
CHAPTER 11: HIGH NATURAL RADIOACTIVITY IN SOME TROPICAL LANDS – BOON OR BANE?	237
Terrestrial radiation in beach sands in Brazil	238
Monazite rich beach sands of India	240
High natural radioactivity of the Minjingu phosphate mine, Tanzania	243
Very high natural radiation in Ramsar, Iran	243
High natural background radiation in Yangjiang, China	245
The Oklo natural reactor	245
Radiation and health	247
CHAPTER 12: BASELINE GEOCHEMICAL DATA FOR MEDICAL GEOLOGY IN TROPICAL ENVIRONMENTS	251
Geochemical mapping - China's example	252
Soil micronutrient maps in tropical countries and medical geology	255
Future prospects for medical geology	256
References.....	259
Index	293