

Applied Geochemistry in the 1980s

edited by

Iain Thornton and Richard J Howarth

Graham & Trotman



Contents

| | |
|---|------------|
| List of Contributors | <i>xii</i> |
| Foreword | <i>1</i> |
| J. SUTTON | |
| Geochemistry: Its Achievements and Potential in Mineral Exploration | <i>3</i> |
| G.J.S. GOVETT | |
| Introduction | <i>3</i> |
| Achievements of exploration geochemistry | <i>4</i> |
| Early developments | <i>4</i> |
| The literature on exploration geochemistry | <i>5</i> |
| Technical and scientific achievements of exploration geochemistry | <i>11</i> |
| Potential achievements and the status of geochemistry in exploration | <i>18</i> |
| Potential of geochemistry in mineral exploration | <i>24</i> |
| Introduction | <i>24</i> |
| Empiricism and fundamentalism | <i>26</i> |
| Development of various techniques | <i>27</i> |
| Conclusions | <i>32</i> |
| References | <i>35</i> |
| A Perspective on the Application of Geochemistry in Mineral Exploration South of the Equator | <i>39</i> |
| R.H. MAZZUCHELLI | |
| Introduction | <i>39</i> |
| The Antipodean exploration environment | <i>39</i> |
| Typical applications of geochemistry in mineral exploration in the Southern Hemisphere | <i>41</i> |
| Specific Southern Hemisphere developments in geochemical exploration | <i>50</i> |
| Status of geochemical exploration in the Southern Hemisphere | <i>55</i> |
| Future developments | <i>56</i> |
| Conclusion | <i>57</i> |
| References | <i>57</i> |
| Geochemical Exploration for Gold: A Special Problem | <i>60</i> |
| L. NICHOL | |
| Introduction | <i>60</i> |
| Background | <i>60</i> |
| Geology of gold deposits | <i>61</i> |
| Geochemistry of gold | <i>63</i> |
| Geochemical exploration practice | <i>64</i> |
| Theoretical considerations | <i>64</i> |
| Analytical procedures | <i>72</i> |
| Case history examples | <i>72</i> |
| Distribution of gold in soil profiles | <i>72</i> |
| Glacial overburden | <i>73</i> |

| | |
|--|-----|
| Distribution of gold in humus | 77 |
| Distribution of gold in stream sediments | 78 |
| Heavy mineral concentrate | 80 |
| Discussion and conclusions | 82 |
| References | 84 |
| Detection of Concealed Mineral and Energy Resources by Vapour Geochemistry | 86 |
| W.T. MEYER, J.S. LOVELL AND M. HALE | |
| Introduction | 86 |
| The basis for vapour geochemistry | 86 |
| Dispersion | 87 |
| Methods | 88 |
| Case histories | 89 |
| Patrick Draw Oil Field, Wyoming | 89 |
| Dragoon Oil Field, Colorado | 90 |
| Rabbit Hills Field, Montana | 91 |
| Drill-site test programme | 93 |
| Johnson Camp, Arizona | 97 |
| Discussion and conclusions | 101 |
| References | 101 |
| Regional Geochemistry in the Detection and Modelling of Mineral Deposits | 103 |
| J.A. PLANT, M.D. FORREST, J.F. HODGSON, R.T.S. SMITH AND A.G. STEVENSON | |
| Introduction | 103 |
| Sampling as a basis for the detection and conceptual modelling of metalliferous mineralization | 104 |
| The geological framework of northern Scotland | 108 |
| The application of geochemical data to mineral exploration in northern Scotland | 109 |
| Stratabound mineralization in the Middle Dalradian | 109 |
| Mineralization of the granite and porphyry associations | 120 |
| Mineralization in post-organic Old Red Sandstone Basins | 127 |
| Discussion and conclusions | 132 |
| References | 136 |
| Geochemical Patterns in the Granite Terrain of Zimbabwe | 140 |
| K.A. VIEWING, N.J. TOPPING AND R.S. HATHERLEY | |
| Introduction | 140 |
| The application of litho-geochemistry | 142 |
| The Chinamora batholith | 142 |
| The Leviathan tonalite | 144 |
| The application of multi-element drainage reconnaissance | 146 |
| The Sabi Trail multi-element geochemical drainage map | 148 |
| Pollution studies at Seki Urban Development, near Harare | 155 |
| Discussion | 159 |
| Conclusions | 160 |
| References | 161 |

| | |
|---|-----|
| The Role of Computing in Applied Geochemistry | 163 |
| R.J. HOWARTH AND R.G. GARRETT | |
| Introduction | 163 |
| Sampling and search | 166 |
| Laboratory quality control | 167 |
| Database management | 168 |
| Statistical analysis | 168 |
| Mapping | 176 |
| The future | 178 |
| References | 181 |
| Geochemical Analysis: The Role of the Consulting Laboratory | 185 |
| P.E. CROFT | |
| Introduction | 185 |
| General aspects of analysis for mineral exploration | 185 |
| Instrumental methods | 186 |
| Optical emission spectrography | 186 |
| Atomic absorption spectrophotometry | 186 |
| Inductively coupled plasma spectrometry | 187 |
| X-Ray fluorescence spectroscopy | 188 |
| Methods for specific elements | 189 |
| Mercury | 189 |
| Arsenic, antimony, selenium, tellurium and bismuth | 189 |
| Uranium | 189 |
| Gold | 189 |
| Platinum metals | 190 |
| Conclusions | 190 |
| The Future Role of Inductively-Coupled Plasma Atomic Emission Spectrometry in Applied Geochemistry | 191 |
| M. THOMPSON | |
| Multi-element methods in exploration geochemistry | 191 |
| Analytical characteristics of ICPAES | 192 |
| Simultaneous multi-element analysis | 193 |
| Low detection limits | 193 |
| Long linear calibrations | 194 |
| Good precision and accuracy | 194 |
| Additional features | 195 |
| Current limitations of ICPAES in applied geochemistry | 195 |
| Sample dissolution problems | 195 |
| Low abundance elements | 196 |
| Speciation | 196 |
| Interference effects | 197 |
| Cost-effectiveness | 197 |
| Hardware problems | 197 |
| The potential of sensitivity-enhancing techniques | 197 |
| Hydride generation | 197 |
| Preconcentration | 199 |
| Prospects of direct infection of solid samples and allied techniques | 200 |
| Nebulization of slurries | 202 |
| Laser ablation | 202 |
| Ramp-heating and decrepitation | 204 |

| | |
|--|-----|
| Possible improvements in cost-effectiveness of ICPAES | 206 |
| Unit times for analysis | 206 |
| Automation and artificial intelligence | 207 |
| Fundamental developments in ICP instrumentation | 208 |
| The mini-plasma | 208 |
| More stable hardware | 208 |
| Spectrometer developments | 208 |
| Applications of the ICP other than in atomic emission | 209 |
| Conclusions | 210 |
| References | 210 |
| | |
| Exploration Geochemistry in the Shallow Marine Environment | 212 |
| P.A. SMITH | |
| Introduction | 212 |
| Geochemical surveying | 213 |
| Placer exploration | 213 |
| Bedrock mineralization | 221 |
| Phosphorites | 229 |
| Shallow submarine hydrothermal activity and the zonation of Fe, Mn and trace metals in associated sediments | 230 |
| General observations and conclusions | 237 |
| References | 239 |
| | |
| Geochemical Exploration for Deep Sea Mineral Deposits | 241 |
| D.S. CRONAN | |
| Introduction | 241 |
| Metalliferous sediments | 243 |
| Mid-ocean ridges | 245 |
| Island arcs | 246 |
| Manganese nodules and encrustations | 252 |
| Conditions of formation of potentially economic nodules and crusts of relevance in marine geochemical exploration for the deposits | 253 |
| Summary and conclusions | 256 |
| References | 257 |
| | |
| Geochemistry and Animal Health | 260 |
| G. LEWIS | |
| Copper deficiency in cattle and sheep | 260 |
| Cobalt | 265 |
| Selenium and vitamin E | 266 |
| Conclusions | 268 |
| References | 268 |
| | |
| The Interaction Between Geochemical and Pollutant Metal Sources in the Environment: Implications for the Community | 270 |
| I. THORNTON, P.W. ABRAHAMS, E. CULBARD, J.A.P. ROTHER AND B.H. OLSON | |
| Introduction | 270 |
| Natural and man-made inputs of metal in the environment | 273 |
| Agriculture | 275 |
| Copper, tin and arsenic in southwest England | 275 |
| Lead, zinc and cadmium | 279 |

| | |
|--|-----|
| The soil-plant-animal relationship | 284 |
| Soil microbiology | 285 |
| Effects of metal contaminants on nitrogen cycling bacterial | 286 |
| Resistance patterns to metals of populations of bacteria in contaminated and naturally metal-rich land | 289 |
| Water resources | 292 |
| Urban pollution | 297 |
| Human health | 303 |
| The future | 305 |
| References | 306 |
| | |
| Potential and Problems in Using Shellfish as Geochemical Indicators in the Marine Environment | 309 |
| A. DARRACOTT | |
| Introduction | 309 |
| The indicating ability of mussels and oysters | 310 |
| The role of zinc and copper in mussels and oysters | 312 |
| What are the advantages of using molluscs? | 314 |
| Monitoring trace metals in the marine environment using the Pacific oyster and mussels | 314 |
| Oysters in the United Kingdom | 314 |
| Oysters in South Africa | 317 |
| Mussels | 321 |
| Some problems in using shellfish as geochemical indicators and possible solutions | 322 |
| Size | 322 |
| Season | 325 |
| Sampling position | 327 |
| Environmental effects | 328 |
| Metal-metal interaction | 329 |
| Wet weight or dry weight? | 330 |
| Future plans involving the use of shellfish as monitoring organisms | 332 |
| UK monitoring programme | 332 |
| International monitoring programmes | 333 |
| Conclusion | 333 |
| References | 333 |
| | |
| Geochemistry and Human Health in the 1980s | 337 |
| R.G. CROUNSE | |
| References | 344 |
| | |
| Concluding Address | 346 |
| R. DAVIS | |