

compared with values assumed in the limit analysis method.

Theories of advanced cap models along with correlation of test results are presented in Chapter 6. A total-stress, strain-softening, elastic-visplastic, elastic-plastic, transverse isotropic, and an effective-stress model (to take into account the effects of the pore-fluid pressure) are each explained. The discussion of each model is brief, but makes the reader aware of their general significance and provides references if further interest exists.

The book remains true to its title with the theory and implementation of the models alternately stressed throughout the text. The text is sometimes overzealous in its introduction of previously unintroduced terms, but to its advantage the new terms have been italicized. Many times elaboration in verbal explanation would have been appreciated without relying almost entirely on mathematical descriptions and definitions. At the same

time, the lack of verbage is understandable considering the length and difficulty involved in verbally describing the complex interrelationships. The authors have taken great care to aid implementation of the computer codes listed in Chapters 3 and 4. User guides have been furnished (Sect. 3.8 and 4.7) complete with a flow chart and a glossary. The method presented is appropriate for both finite-difference and finite-element codes and is applicable for solving static as well as dynamic problems.

This book will be of significant interest to structural or civil engineers working in this area of specialization or could serve as a valuable reference text in a graduate level course.

W.F. Chen and A.F. Saleb, 1982. *Constitutive Equations for Engineering Materials. Elasticity and Modeling*. Wiley, New York, NY.

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Environmental geology

I. Thornton (Editor), 1983. *Applied Environmental Geochemistry*. Academic Press Geology Series, viii + 501 pp., US \$70.00 (hard cover).

Plants and animals are generally well adapted to a wide range of elemental concentrations in their environment; in certain areas, the concentration of an element exceeds the tolerance of organisms, leading to deficiency diseases or toxic effects. Sometimes the relationship between the geochemistry of the natural geological environment and health is clear. A century ago, the geologist Vogt reported on the cattle disease osteomalaci (fragile bones), frequently occurring in southwest Norway, in relation to the low P concentration in the apatite-poor anorthositic bedrock. The direct causal relationship between endemic goitre and I de-

ficiency in areas with low I concentrations in drinking water, soils, plants and animal tissues, was discovered in the middle of last century; this deficiency is easily reduced by dietary I addition. Fluorosis (calcification and skeletal deformation) is endemic in areas with F concentrations of more than 10 ppm in drinking water (Africa, India), but addition of F to drinking water up to 1 ppm efficiently prevents dental decay.

Applied Environmental Geochemistry is devoted to the geochemistry of the naturally and the contaminated geologic environment in relation to man's health, crops and cattle. Its publication is a British initiative, with the collaboration of a multidisciplinary party of 21 authors from both sides of the Atlantic. Roughly one third of this volume contains introductions to geochemical methods and principles, one third deals with the relation-

ship between the geochemical environment and man's health, the last part is concerned with the assessment of anthropogenic contamination.

"Principles of environmental geochemistry" (Ch. 1) is an elementary introduction into geochemical conceptions (element distributions in rocks, weathering). Too many elements without obvious environmental significance obscure the tables. A section on regional bedrock geochemistry for three British regions concludes this chapter. Background element concentrations in one table are called normal in the other, exceptionally high becomes very high. The choice of elements again seems somewhat arbitrary. Geographical names do not make much sense for an outsider without any map.

"Regional geochemical mapping and its application to environmental studies" (Ch. 2) discusses the advantages of stream sediment and soil sampling methods. Applications of regional geochemical mapping are illustrated by element distributions of Cu, Mo, Pb, Cd and As over England and Wales. Mining and smelting activities in the past are clearly reflected in the present distribution of these toxic elements in stream sediments, but Mo is more related to Carboniferous black shales.

"Analytical methods in applied environmental geochemistry" (Ch. 3) is a useful introduction in geochemical analytical methods, emphasizing atomic absorption analysis (AAS) and inductively coupled plasma atomic emission spectrometry (ICP); the latter is a most efficient and prospective multielement analytical tool for environmental geochemistry. In contrast to common practice in exploration geochemistry, not only anomalously high areas are of interest in environmental geochemistry, but anomalously low areas as well, which stresses the need to determine accurately "background" levels.

"Geochemistry and water quality" (Ch. 6) includes notions on properties as "hardness" and radioactivity. Shortly discussed are some elements of hydrogeochemistry and effects of transport, storage and treatment on the quality of drinking water.

"Microbial mediation of biogeochemical cycling of metals" (Ch. 7) is an interesting and well written review. The heavy metals Cd, Hg and Pb are discussed, as well as As. Oxidation-reduction reactions (As), accumulation (Cd), and methylation (Hg, Pb) are essential processes in the respective metal cycles. Mechanisms of bacterial-metal interactions and the genetic control of metal transformations are other sections in this contribution.

Chapters 9 and 10: "Geochemistry and man: health and disease", are written from a medical point of view. These chapters form in my opinion the backbone of this volume because they provide an important key to the relevancy of elements to be monitored geochemically. The authors deliver a systematic overview of both the nutritional role and toxicity of the following elements: Ca, Cl, Mg, P, K, Na, S (essential macronutrients); Cr, Co, Cu, F, I, Fe, Mn, Mo, Se, Zn (essential micronutrients); Ni, Si, Sn, V (micronutrients that are likely to be essential); Al, As, Cd, Pb Hg (trace contaminants) and other elements (Sb, Ba, Be, B, Br, Li, Rb, Ag, Sr, Ti). Se is an element now considered to be an essential micronutrient, but 30 years ago only a poison. Within a large northeast-southwest trending belt in China, the endemic Keshan disease (leading to acute heart failure or death through lesser degrees of heart failure) occurred, which was recognized 20 years ago as a result of Se-deficiency. The disease can be remedied by Se-medication. Not only elemental concentrations in the environment are of interest, but also the interaction of elements. Dietary intake of Se for instance reduces the toxicity of Hg. In animal systems there is evidence for extensive interactions between Cu, Zn, Fe, Mo and Pb. Dietary Ca is important in relationship to its interaction with F, P, Sr, Cd and Pb.

The relationship between the geochemistry of the geologic environment and man's and animal's health is showed in Ch. 11: "Geo-medicine in Scandinavia".

Agricultural aspects are dealt with in "Soils

and plants and the geochemical environment" (Ch. 4) and in "Geochemistry applied to agriculture" (Ch. 8). The influence of the bedrock on soil composition, trace element deficiencies and excess affecting crops and livestock and contamination effects due to mining and mineral processing are discussed. Examples from the U.S.A and Britain illustrate the respective chapters.

"The chemical forms of trace metals in soils" (Ch. 5) describes the forms of trace metals in soils: solid, adsorbed and aqueous species. Chemically modelling using computer-based equilibrium calculations is elucidated like in the other chapter (12) on soils: "Assessment of metal pollution in soils". Heavy metals contamination at natural conditions (ore bodies and minor mineralization) or from anthropogenic origin (mining and smelting, fertilizers, sewage sludge, fly-ash, pesticides, traffic) are discussed.

"Assessment of metal pollution in rivers and estuaries" is the subject of Ch. 13, with emphasis on the geochemistry of suspended matter and sediments. The titles of Ch. 14: "Heavy metal contamination from base metal mining and smelting; implications for man and his environment" and Ch. 15: "Health implications of coal development" may speak for themselves.

"Natural radioactivity in the environment" (Ch. 16) is an innocent contribution dealing with the distribution of natural radioactive nuclides of U, Th and K. Radioactive pollution in this chapter is limited to increased levels of U in phosphate fertilizer, notwithstanding the fact that the Irish Sea is heavily

polluted by Windscale delivered Pu (Sholkovitz, 1983). The Tchernobyl catastrophe will possibly raise more research on the geochemical behaviour of anthropogenic radio-nuclides.

Applied Environmental Geochemistry is a welcome introduction into this relatively new field, with more than 1300 references (up to 1982), more than 100 tables, about 90 figures and a subject index. Print-proof reading must have been carried out one-eyed as is evident from many typographic errors e.g.: Sn instead of Zn (table 1.16, p. 33), Bo instead of B (p. 270), 400 m³, instead of 400 million(?) m³ (p. 396). My first check of the index was on gold, which refers to 7 pages; real gold or Au was found only on 2 pages, on the others it is only Ag that glitters (reversely the index for silver is incomplete). This is sloppy editing, in particular considering the solid price of this further well produced volume!

This book is recommended to institutional libraries, next to, e.g., *The Handbook of Environmental Chemistry* (1980), and to individuals engaged in environmental science or working in developing countries, where nutritional limitations may enhance the effect of geochemical anomalies on man's health and disease.

Hutzing, O. (Editor), 1980. *The Handbook of Environmental Chemistry*. 3 volumes, Springer-Verlag, Berlin.

Sholkovitz, E.R., 1983. The geochemistry of plutonium in fresh and marine water environments. *Earth-Sci. Rev.*, 19: 95-161.

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General geology

Michel Popoff and Jean-Jacques Tiercelin, 1983. *Rifts et Fosses Anciens (Ancient Rifts and Troughs)*. Bull. Centr Rech. Explor., Prod. Elf Aquitaine, 7. Elf Aquitaine, Pau, pp. 125-448, FF 150.00, US \$25.00. (paperback; in French and English).

The African Rifts are generally given as the classic examples of intracontinental extensional structures showing all stages of evolution from an intracontinental southward propagating fracture, in Zambezi to the south, to actual oceanization, in the Gulf of