A HISTORY OF GEOCHEMISTRY AND COSMOCHEMISTRY

By

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Undergoing editing and illustration prior to publication.

Volume 3: awaits a last full edit and illustration, as of 2020. Additions are planned, including “text boxes’ on specific subjects, as in Vol. 1.

Organization of the “History”

Given the ambitious scale of R.W. Boyle’s undertaking, it seems appropriate to provide a short, illustrated synopsis of the three volumes, much in the manner of annotated chapter summaries, found in the Contents pages of books from the early 20th century, and before. Here, then, is a brief keyword-oriented tour, a *vade mecum*, of Boyle’s “A History of Geochemistry and Cosmochemistry”. This summary is not comprehensive.

Volume 3

Chapter 9 - Geochemistry and cosmochemistry in the 20th century.

The political, social and philosophical upheavals of the 20th century. Major advances in physics and chemistry. The maturation of geochemistry and cosmochemistry. Biographical vignettes on some key scientists in Russia, Europe, the United States and Japan. Radioactivity and the rise of isotope geochemistry. The Curies, Soddy and Holmes. Cosmology and cosmochemistry. The formation of the chemical elements in diverse mechanisms of nucleosynthesis. Elemental abundances. The origin of the solar system. Harold Urey. The composition and nature of meteorites and tektites. The composition of the Moon and the planets. Geology in the 20th century. Mass spectrometry and geochronology. Geophysics and the structure of the Earth. Alfred Wegener, continental drift and plate tectonics.

Chapter 10 - Atmogeochemistry in the 20th century.

The composition of Earth's atmosphere. Gases in minerals and rocks, volcanic fumaroles, volcanism and black smokers. Evolution of the Earth's atmosphere, banded iron formations and the transition from early anoxic compositions to an oxygen-rich, more uniformly life-supporting present.

Chapter 11a - Pedogeochemistry in the 20th century.

A concise contribution on soil science, paleosols, weathering and soil properties. Humus. Agriculture, and trace elements in soils. The chemistry of paleosols.

Chapter 11b - Lithogeochemistry in the 20th century.

Archean geology and the evolution of the Earth's crust. Crustal abundances of the elements. Chemical bonding and crystal chemistry, crystallography and physical chemistry. Petrology and dispersion of the elements in rocks. Thermodynamics in geochemistry. Geothermometry and geobarometry. Geothermal gradients, mineral stability and partition coefficients. Thermoluminescence and radiation damage. Fluid inclusions. Isotope geochemistry. Diffusion phenomena and experimental petrology. Igneous geochemistry. Granites. Sedimentary geochemistry. Regional metamorphism and contact metamorphism.

Chapter 12 - Biogeochemistry in the 20th century.

The development of biogeochemistry. Representation of the biosphere in the geological record. The chemical composition of living organisms. The bioaccumulation of elements by plants and animals. Degradation of organic matter. Microbiology, fossil bacteria, black shales, peat and coal. The chemistry of petroleum. Hydrocarbons in mineral deposits. The origin of life.

Chapter 13 - Hydrogeochemistry in the 20th century.

Modern hydrogeochemistry. The quest for primordial water. Ocean and sea waters. Trace elements, geochemical cycles and marine organisms. Changes in ocean chemistry throughout geological time. Endogenic basins. The Dead Sea. Waters in glaciers, rivers and lakes. Groundwater studies. Deep-seated brines, thermal waters, hot springs and black smokers.

Chapter 14 - Geochemistry of mineral deposits in the 20th century.

Mineral deposits studies and geochemical exploration. The classification of mineral deposits and construction of mineral deposit models. The zonation of ore deposits. Hydrothermal alteration and ore-forming processes. Magmatic deposits. Pegmatites. Nickel-copper sulphide ores, chromite deposits, iron- titanium- vanadium oxide deposits, and mafic-ultramafic layered intrusions. Carbonatites, kimberlites and lamproites. Granites and skarns. Fluid inclusions and hydrothermal fluids. The spectrum of hydrothermal deposits. Quartz veins and gangue minerals. Metal transport and deposit genesis. H.H. Read and the granitization debate. Sediment-hosted deposits of copper, lead and uranium. Mississippi Valley-type zinc-lead deposits. Types of gold deposits: placers, paleoplacers and quartz pebble conglomerates. Placer deposits of tin and the platinum-group elements. Chemical sediments, chert, banded iron formations and manganese-rich sediments. Black shales and the Kupferschiefer of Europe. Evaporites. The syngenetic *versus* epigenetic debate for various deposit types. Phosphorites and ironstones. Sedimentary exhalative (sedex) deposits and volcanogenic (volcanic-hosted) massive sulphide deposits of base and precious metals. Oxidation and secondary enrichment. Supergene mineralization. Global and regional metallogeny.