Geo-chemistry

Introduction

◆**Geochemistry** is the science that uses the tools and principles of chemistry to explain the mechanisms behind major geological systems such as the Earth's crust and its oceans.

◆The realm of geochemistry extends beyond the Earth, encompassing the entire Solar System, and has made important contributions to the understanding of a number of processes including mantle convection, the formation of planets and the origins of granite and basalt.

Historical background

- The term ***geochemistry*** was first used by the Swiss-German chemist Christian Friedrich Schönbein in 1838: "a comparative geochemistry ought to be launched, before geochemistry can become geology, and before the mystery of the genesis of our planets and their inorganic matter may be revealed. "However, for the rest of the century the more common term was "chemical geology", and there was little contact between geologists and chemists.
- Geochemistry emerged as a separate discipline after major laboratories were established, starting with the United States Geological Survey (USGS) in 1884, and began systematic surveys of the chemistry of rocks and minerals. The chief USGS chemist, Frank Wigglesworth Clarke, noted that the elements generally decrease in abundance as their atomic weights increase, and summarized the work on elemental abundance in *The Data of Geochemistry*

- The composition of meteorites was investigated and compared to terrestrial rocks as early as 1850. In 1901, Oliver C. Farrington hypothesised that, although there were differences, the relative abundances should still be the same. This was the beginnings of the field of cosmochemistry and has contributed much of what we know about the formation of the Earth and the Solar System.
- In the early 20th century, Max von Laue and William L. Bragg showed that X-ray scattering could be used to determine the structures of crystals. In the 1920s and 1930s, Victor Goldschmidt and associates at the University of Oslo applied these methods to many common minerals and formulated a set of rules for how elements are grouped. Goldschmidt published this work in the series *Geochemische Verteilungsgesetze der Elemente* [Geochemical Laws of the Distribution of Elements].

Some questions **geochemistry** tries to answer include

- what elements and chemicals are present in various soils and rocks in different locations?
- What can we learn from those differences?
- How are these soils and rocks changing, and how have they changed through the centuries?
- How do once-living things like plants and animals decompose after their deaths and what sorts of new things do they form as they interact with the environment (such as fossils or hydrocarbons, a.k.a, oil)?
- How do these various processes affect the environment, and how does the environment, weather, and other influences affect them?

The field of **geochemistry** involves

- The study of the chemical composition of the Earth and other planets.
- The chemical processes and reactions that govern the composition of rocks, water, and soils.
- The cycles of matter and energy that transport the Earth's chemical components in time and space and their interaction with the hydrosphere and the atmosphere

Some subsets of geochemistry are:

- **Isotope geochemistry** involves the determination of the relative and absolute concentrations of the elements and their isotopes in the Earth and on Earth's surface.
- **Cosmo chemistry**: Analysis of the distribution of elements and their isotopes in the cosmos.
- **Aqueous geochemistry** studies the role of various elements in watersheds, including copper, sulfur, mercury, and how elemental fluxes are exchanged through atmospheric-terrestrial-aquatic interactions.
- **Biogeochemistry**: Field of study focusing on the effect of life on the chemistry of the earth.
- **Organic geochemistry**: A study of the role of processes and compounds that are derived from living or once-living organisms.
- **Regional, environmental and exploration geochemistry**: Applications to environmental, hydrological and mineral exploration studies.

The main focus of geochemistry is to:

- Understand the principles governing the distribution and redistribution of elements, ionic species and isotope ratios in earth materials, so that we can interpret the formation of mineral assemblages: conditions (P, T, etc.), processes (magmatic crystallization, weathering, chemical precipitation, metamorphism, etc.), and even the age.
- Predict changes in mineral assemblages (minerals, concentrations of elements, isotopic ratios) if a given mineral assemblage is subjected to different conditions (T, P, interaction with a fluid, etc.
- Geochemistry plays an important role in forecasting the quality of crude oil in the accumulation.