

# The geochemistry of iodine – a review

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## ABSTRACT

Iodine has long been recognised as an important element environmentally. Despite this there are many gaps in our knowledge of its geochemistry and even where information is available much of this is based on old data which, in the light of recent data, are suspect.

Iodine forms few independent minerals and is unlikely to enter most rock-forming minerals. In igneous rocks its concentration is fairly uniform and averages 0.24 mg/kg. Sedimentary rocks tend to have higher concentrations with average iodine contents of:— recent sediments 5–200 mg/kg, carbonates 2.7 mg/kg, shales 2.3 mg/kg and sandstones 0.8 mg/kg. Organic-rich sediments are particularly enriched in iodine.

Soils, generally, are much richer in iodine than the parent rocks with the actual level being decided mainly by soil type and locality. Little soil iodine is water-soluble and much iodine is thought to be associated with organic matter, clays and aluminium and iron oxides. Most iodine in soils is derived from the atmosphere where, in turn, it has been derived from the oceans. Seawater has a mean iodine content of 58 µg/L while non-saline surface waters have lower and very variable levels. Subsurface brines and mineral waters are generally strongly enriched in iodine.

Marine plants are frequently enriched in iodine while terrestrial plants have generally low contents. Iodine is essential for all mammals.

Consideration of the geochemical cycle of iodine reveals that its transfer from the oceans to the atmosphere is probably the most important process in its geochemistry.

## INTRODUCTION

The geochemical behaviour of iodine and its distribution in the environment has been poorly described and somewhat neglected in geochemical literature. In texts describing the geochemistry of iodine, data on its distribution tend to be scarce or generalised, and mainly based on results obtained nearly sixty years ago. It is only over the past fifteen years that reliable and efficient methods of iodine analysis have been developed enabling a better understanding of iodine's behaviour and distribution in the environment.

The link between iodine and goitre was one of the first associations recognised between a trace element in the environment and human health and nutrition. However, because iodine deficiency is readily observed by its distinctive human disfigurement, and is simple to cure by addition of the element to the diet there was no urgent need for a detailed study of iodine geochemistry. Although it is simple to cure, it is a sad fact that there are still large populations of the world afflicted by this disease which, in severe instances, is extremely debilitating; this is a good reason why workers in the field of human health and nutrition need to be made more aware of the geochemistry of iodine.

A more modern problem relating to iodine is the hazard of radioactive iodine produced during nuclear fission, a problem highlighted in the early years of the nuclear industry by the accident at Windscale, England, in 1957 (Chamberlain and Dunster, 1958). Radioactive iodine passing rapidly through the food chain becomes concentrated in the thyroid gland leading to an increased risk of thyroid cancer.

The application of iodine geochemistry is not restricted to the field of health and nutrition. Exploration geochemists in their search for mineralisation have suggested that iodine has a potential as a pathfinder element for locating mineral deposits (Fuge *et al.* 1986). Iodine can generally be thought of as a mobile element in the environment and because of this it will migrate a long way from ore bodies with which it might be genetically associated.

The geochemistry of iodine was first investigated in the 1920's, much of the early work being done by Th. V. Fellenberg and G. Lunde (1926, 1927). The account by Goldschmidt (1954) relies heavily on these data. The Chilean Iodine Educational Bureau produced a very comprehensive account of available data on iodine distribution in the environment and food-stuffs (CIEB, 1952, 1958) though this is now very dated. Fuge (1974a) presented another complete compilation of data but this also predated much of the more recent and more reliable data. A more recent account of iodine geochemistry is that of Whitehead (1984) but this concentrates on the distribution of iodine in the atmosphere and soils. Much of the present account of the geochemistry of iodine is based on a Ph.D. study at the University College of Wales, Aberystwyth (Johnson, 1980).

## THE CHEMISTRY OF IODINE AND ITS GEOCHEMICAL CLASSIFICATION

Iodine was discovered in 1811 by Courtois when he sublimed the element from seaweed ash and concentrated sulphuric acid. It is a member of the halogen

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