

River Inputs to Ocean Systems

Proceedings of a Review Workshop held at FAO headquarters, Rome, Italy from 26 to 30 March 1979, with the collaboration of the United Nations Educational, Scientific and Cultural Organization and the Intergovernmental Oceanographic Commission, with the support of the United Nations Environment Programme

D. BURTON, D. EISMA, J. M. MARTIN (eds)

Pathways of major elements from land to ocean through rivers

By M. Meybeck



UNITED NATIONS
ENVIRONMENT
PROGRAMME



INTERGOVERNMENTAL
OCEANOGRAPHIC
COMMISSION



SCIENTIFIC COMMITTEE
ON OCEANIC RESEARCH

Pathways of major elements from land to ocean through rivers

By M. Meybeck*

INTRODUCTION

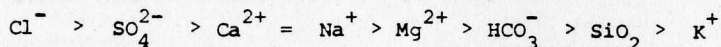
In relation to the transfer of material from continents to oceans through rivers, the following questions should be considered: (i) What are the major chemical types of river water in respect of the dissolved and of the particulate material? (ii) Where does this material come from? (iii) What are the major environmental factors controlling the concentrations and loads? (iv) Where are the regions of major inputs to the ocean?

These questions will be applied only to the major elements (silicon, calcium, magnesium, sodium, potassium, iron, aluminium, sulphur, chlorine and carbon) which represent more than 95 percent of the elemental river loads.

The following summarized discussion is mostly based on present-day water quality of the major rivers (Meybeck, 1979) and on regional studies of small rivers draining single rock-types (Kobayashi, 1960 ; Hack, 1960; Miller, 1961; Tardy, 1971; Miller and Drewer, 1977). Previous discussions of the dissolved contents of river water by Gorham (1961), Alekin and Brazhnikova (1962), Hem (1970), Gibbs (1970), Garrels and MacKenzie (1971) and Holland (1978) have also been used here.

MAJOR CHEMICAL TYPES OF RIVER WATER

The dissolved contents of rivers are highly variable. Some typical data are given in Table I together with world averages. The purest waters are those found in the Canadian Shield (NW Territories) where the dissolved elements derive almost entirely from the atmosphere. By comparison, river waters in arid regions (such as Colorado) present the highest salinities. Some elements are more variable than others. The world-wide variabilities, expressed as the ratio of the values for the 99% and 1% concentration intervals in the dissolved-content frequency curves (taking into account the river water discharges to the oceans) (Table II) have been computed from recent data on 64% of the rivers discharging to the oceans (Meybeck, 1979). The order of variation is the following :



This order is strikingly similar to the one observed by Davis (1964) in drinking water throughout the USA, and reflects the various sources of elements and their environmental behaviour. The major source is rock weathering, but there are also several atmospheric sources (oceanic aerosols, volcanic aerosols, continental vegetation aerosols and continental dust) as well as

* Laboratoire de Geologie, Ecole Normale Supérieure, 46 rue d'Ulm, 75230 Paris Cedex 05.