CHAPTER VIII

SUMMARY
INTRODUCTION

Studies on Geochemistry of river basin have received wide attention throughout the world during the past two decades. This is mainly due to (a) the need to understand Geochemical balance between ocean and continents; (b) examine the weathering process and erosion on continents and (c) estimate the impact of human beings on natural processes. The rivers represent the present day geological process in action since precambrian time. Each river basin, as a geological unit, can be studied in terms of geochemical mobility of individual elements.

It has been estimated that the world rivers transport annually 13.5 billion tonnes of sediments and 3.2 billion tonnes of dissolved fluxes along with $38 \times 10^3$ km$^3$ of water into world oceans. All these estimations are mainly based on studies of few big rivers. These figures are being revised, quite often incorporation the new informations on many rivers. It has been reported that the Asian rivers with 11% of world drainage basin area are transporting more than 30% of the world river sediment transports. Therefore, without the detailed information on Asian rivers the world estimations will not have much significance.
Until recently the Indian rivers were not studied from the mass transport point of view. Few studies have reported on Ganga basin. Recently detailed studies have been made on many of important rivers. These studies revealed that the rivers of Indian subcontinent are transporting nearly 1400 m.t. of sediments and 280 m.t. of dissolved elements into Bay of Bengal and Arafbean sea. This is equal to about 10 per cent of the world's mass transport.

PURPOSE OF THE STUDY

The present study "The Geochemistry of Godavary" has been taken up to understand the chemical and sediment transport of medium size river basins. The main aims of the study include:

a. To estimate the chemical and sediment transport of Godavari river into Bay of Bengal.

b. The water chemistry and calculation of average river water composition.

c. Chemistry of river sediments.

d. Rates of Geochemical mobility of each element in the sediments and water.

e. Understanding of the controlling factors of mass transportation by medium size rivers.
f. Estimation of atmospheric input into the basin, and

g. Mineralogy of river sediments.

h. Impacts of human activity on river mass transport.

**METHODOLOGY**

59 water samples, covering all tributaries and four rain water samples and 23 bottom sediments from all important locations, samples are collected for the present study. The water samples filtered through 0-45 m filter paper and the collected sediment is used for calculation of total suspended matter (TSM). The water samples are analysed for four anions (\(\text{HCO}_3\), \(\text{SO}_4\), \(\text{PO}_4\), and \(\text{Cl}\)), four cations (\(\text{Ca}\), \(\text{Mg}\), \(\text{Na}\) and \(\text{K}\)) and Silica (\(\text{SiO}_2\)). The bottom sediments were analysed for 28 elements to evaluate the sediment chemistry. The bottom sediments and suspended sediments are studied for mineralogy by XRD.

In addition to the data generated during the present study 10 years discharge and suspended sediments data is collected from the unpublished reports of Central Water Commission (CWC), Hyderabad. This data was extensively utilised for the first time in interpretations of mass transport.
FINDINGS

During the present study the following findings are made which are first of its kind on the knowledge of Godavari basin in particular and medium size basins in general. The data generated during this study fills certain gaps on Indian rivers.

SEDIMENT TRANSPORTATION :- Mean annual sediment transport of Godavari river is estimated as 170m.t. This figures may not alter significantly since the study has also considered the daily observations for ten years. However, on any particular year this can be as low as 44 m.t. to as high as 270 m.t.

Transportation of sediments from 20 stations located all over the basin covering all tributaries were also estimated. The mean total suspended matter (TSM) of Godavari river is 1845 mg/l at the river mouth. Some upstream tributaries such as Wardha has shown upto 5300 mg/l of TSM.

a. Seasonal Variations :- More than 99.6 per cent of these sediments are transported during the monsoon season. Within this season only a few days are responsible for bulk of the sediment transportation. Therefore it has been recognised that the annual estimations of sediments transportation of any river particularly
medium size to be based on daily observations for more than five years. Any extrapolation based on few days sampling may often lead to errors in estimation.

b. **Variations Due to Discharge** :- The relation between discharge and sediment load has been studied in detail based on annual, monthly and daily data. To elucidate this factor in addition to station at river mouth four other stations are also studied. It has been found that there is a direct relation between discharge and sediment load. Therefore the discharge is the main controlling factor of sediment load in terms of quantity. Except few occasions the increase in discharge has resulted an increase of sediment load though not necessarily with same intensity.

c. **Geology as Controlling Factor** :- The geology is the controlling factor of sediment load. It has been clearly showed that the sedimentary rock formation which are located in the lower part of the basin with 7% of basin area contribute nearly 33% of total sediment load. The relatively less contribution is being made by the tributaries Sabari and Indravati draining through hard rocks such as granites etc. indicates that rate of weathering of rock is the determining factor of river sediments.
d. **Influence of Elevation** :- The elevation of the basin has not played any significant role in mobilizing the sediments to the river. The high concentration of TSM by the rivers flowing through Deccan traps are not due to their relative high elevation, it is only because of the basin geology. It is evident from the Sabari and Indravati's low sediment transportation inspite of their higher mean elevation.

e. **Grain Size** :- Out of 170 m.t. transported by Godavari river 23 m.t. (14%) arc in coarse size, (\(>200\mu\)), 33 m.t. (19%) are in medium size( 200\(\mu\) to 75 \(\mu\)) and 114 m.t. are not in fine size(\(<75\mu\)). The sediments transported from Deccan traps consisted more than 99% of fine( 75 \(\mu\)) fraction whereas the sediments transported from granites and hard rocks contained only 85%. The steep increase in coarse and medium size fractions at river mouth indicates the addition of relatively coarse sediments in the down stream.

**SEDIMENT CHEMISTRY** :- The bottom sediment samples(23 nos.) were analysed for 26 elements by XRF. Three major elements - Al, Ca, Fe constituted more than 50 per cent of sediment chemistry. The Godavari sediments are depleted in K,Al and Si compare to Ganges and Brahmaputra concentration of certain nearly metals such as Ti, V and Cr reflects the abundance of Ilmenite,
Chromite and rutile in the source rocks. Similarly, enrichment of Ca, Ba, Sr reflects of abundance of carbonate minerals.

The average chemical composition of sediments of Godavari are calculated and rate of mobility of individual elements at four important locations including river mouth are estimated. The rate of mobility of individual ions vary from 0.003 t/km²/yr for uranium to 122 t/km²/yr for Silicon.

The temporal and spatial variations of sediments chemistry is quite pronounced and these variations are to be taken into consideration while estimating the average and chemical composition of river sediments.

**DISSOLVED TRANSPORT**: The present study has shown that the Godavari river is transporting about 16.8 m.t. of dissolved load which is one tenth of sediment transport. The decrease in discharge has reflected a reduction in chemical load. The dissolved load of tributaries have also been estimated. The dissolved load of the tributaries has varied from 8.2 m.t. (1979-80) to 29 m.t. (1979-71). More than 87% of chemical load is being transported during the three months July, August and September.
The sedimentary rocks (lower part of the basin) are absorbing nearly 7 m.t. of dissolved load. This may be possibly due to ionic exchange of elements from dissolved phase to solid phase.

**WATER CHEMISTRY** :- The pH of Godavari water is alkaline with an average of 7.5; the electrical conductivity ranged from 57 uS/cm to 83 uS/cm. Similarly the total dissolved salts (TDS) ranged from 95 mg/l to 548 mg/l on main Godavari. The Sabari and Indravati are carrying relatively low TDS. At the river mouth is containing 181 mg/l of TDS. The dry season has shown high TDS values. The discharge weighted mean composition of Godavari river, 253 mg/l is nearly 2.5 times higher than world average, 106 mg/l and 1.5 times higher than Indian average, 159 mg/l. Among the individual ions bicarbonate accounts nearly 65% of TDS and cations accounts about 25% of TDS. The individual ions and their mean river composition is calculated.

**RATES OF EROSIONS** :- The sediment and chemical transportation rate are 555 t/km²/yr and 55 t/km²/yr are higher compared to all other Indian rivers except Ganges and Brahmaputra. The rate at most of important stations are also calculated. The maximum denudation rate is estimated on Pranahita basin (772 t/km²/yr).

At this rate of erosion the entire Godavari basin with 420 m mean elevation will come to the present day mean sea level within 1.4 million years pro-
vided on compensatory mechanism such as upliftment etc. are not in operative. The atmospheric contribution to total dissolved load is estimated as 38 per cent.

MINERALOGY:– The XRD results of 24 bottom and suspended sediment samples indicated that the Godavari sediments are more abundant in Montmorillonite and Iolite. The tributaries (Sabari and Indravati) which flow through granites and hard rocks are not showing any montmorillonite.

The geology of the basin has the distinct impact on mineralogy. The tributaries flowing through Deccan traps have shown high mont m errillonite. The size of sorting of sediments has changed the relative mineralogical composition of sediments.

IMPACT OF HUMAN ACTIVITY:– Construction of Srima Sagar dam on Godavari river near Mancherial has shown its impact on sediment and chemical transport of the river. Sudden drop down of TSM and slight increase in water chemistry is noticed after the dam. Since 1975 on average about 28 m.t/yr. of sediments are being deposited in the dam. An increase of montmorillonite content after the dam is observed in sediment mineralogy.
Another activity which is important in terms of Godavari basin is, intensive coal mining in lower part of the basin. This has increased the sediment transport at alarming rates from the area. This 7% of the basin area is contributing 33% of sediment load to Godavari river.

**CONCLUDING REMARKS** :- The present study will place Godavari river among the important river basins of the world. The Godavari basin in terms of basin area, discharge, mass transport and rates of denudation ranks 30th, 24th, 9th and 6th among the world important river basins. The present study is not only an attempt to understand the Indian rivers but to place them in proper position in terms of world continental mass transpers.

Further studies are needed to evaluate the reasons for such alarming rates of denudations of Asian rivers in general and Indian rivers in particular. This aspect may probably be linked with the land use pattern, population forestry etc.