



Review paper

Deltas: the fertile dustbins of the continents

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ABSTRACT

Deltas and their associated deep-water submarine fans are the main repositories of sediment produced by continental erosion. The internal structure of prograding deltas is often complicated by changes in loci of deposition and changes in land-sea levels during their formation. The high water content and rapid deposition cause syn-sedimentary deformation. Deltas have been inhabited by man throughout history due to their rich surface resources. Ancient deltas are rich in hydrocarbons which are widely exploited. They are very sensitive to changes in the hinterland and today their existence is threatened by anthropogenic actions such as dam construction and sea-level changes.

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Contents

| | |
|---------------------------------------------------------|-----|
| 1. Introduction | 397 |
| 2. Drainage basins: the suppliers of sediment | 398 |
| 3. The location of major deltas | 400 |
| 4. Tectonic subsidence | 400 |
| 5. Delta construction | 402 |
| 6. The deltaic sequence | 403 |
| 6.1. The constructive phase | 404 |
| 6.2. The destructive phase | 404 |
| 7. Syn-sedimentary deformation | 405 |
| 8. Changing land/sea-levels | 405 |
| 9. Deep-water submarine fans | 408 |
| 10. Ancient deltaic deposits | 408 |
| 11. Anthropogenic influences on deltas | 409 |
| 12. Postscript: the future | 413 |
| Acknowledgements | 416 |
| References | 416 |

1. Introduction

Deltas form whenever a flow of water-borne sediment is carried into a standing body of water and the dispersal processes are

insufficiently strong to prevent the construction of a marginal sedimentary accumulation. They vary in size from small features on the edges of ponds, artificially produced reservoirs, natural lakes and more importantly to those on the margins of marine basins. Where large drainage basins feed major rivers huge deltaic areas can be constructed on the coastline. The term delta, attributed to Herodotus (5th Century BC), originated because of the similarity of the shape of the subaerial plain of the Nile delta to the Greek letter delta (Fig. 1). Deltas are the largest coastal landforms in the world. Even larger areas on the adjacent continental shelves are covered by deltaic sediments. However,

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Fig. 1. The Nile delta showing the heavily vegetated/cultivated deltaic plain in marked contrast to the surrounding desert. The protruding river mouths and the coastal sand barrier are clearly shown (Gemini 4 photograph, 1965).

probably the greatest repositories of sediment supplied from the drainage areas are the deep-water submarine fans which are linked to the deltas by submarine canyons and are fed with sediment particularly at times of lower sea-levels (Fig. 2).

Also, along many mountainous coastlines streams of limited catchments form alluvial fans with deltas at their mouths which are composed of coarse-grained sediment – fan-deltas (Fig. 3). Elsewhere, although large amounts of sediment are supplied to the coastline the dispersive processes, i.e. waves and currents, transport sediment alongshore to form linear accumulations which have none of the normal forms of classical deltas. Such a situation occurs on the West coast of Mexico (Curry and Moore, 1964; Curry et al., 1969) where many rivers bring large amounts of sediment which is spread alongshore by huge and persistent Pacific swell waves (Fig. 4).

Modern deltas began to develop with the slowing down of the post glacial rise of sea-level between 8500 and 6500 years BP (Stanley and Warne, 1994, 1997). Deltas and the adjacent fluvial valleys have been the sites of human activity since the earliest times. Because of their abundant woodlands, marshes and lagoons rich in wild game and fish, they were utilised by hunter-gatherers. Later their fertile plains were developed for agriculture and ancient civilisations such as those of Ur on the Mesopotamian plains and the city Mohenjo-Daro on the fertile fluvial plains of the Indus relied on them as a source of water, food and raw materials such as wood, reeds and mud for construction. Many have been colonised for several millennia and their natural surfaces have been altered by man with land clearance and water diversion into networks of irrigation channels.

Today, deltas have dense populations: the Yangtze delta has a population of 40×10^6 (1990 figure) and others have a disproportionate percentage of the population of the various countries, e.g. 33% of the population of Nigeria live on the Niger delta and 10% of the population of Egypt live on the coastal part of the Nile delta. They are very important agriculturally and yield huge harvests of cotton, rice, wheat, soya beans, etc. They have important fishery industries in the lagoons and adjacent marine areas and often are the sites of fish farming. Also, salt extraction plants occur on deltas of many countries around the Mediterranean as well as elsewhere. Whereas in the past some were the source of fur from wild animals, such as on the Mississippi, they are now the sites of fur farms (Lee, 1983). In addition deltas, with their large areas of lakes and marshes, are natural habitats for wild birds especially wildfowl as well as being an important resting place for migrating birds. The Venice lagoon on the Po delta is the winter halt and breeding area for 200,000 birds and is one of the most important wetlands in the Mediterranean (Martin, 2010).

Ancient deltaic deposits are common in the geological record. The abundant organic matter produced on the surfaces, lagoons and nearshore waters of deltas have distilled with time and burial into valuable gas, oil and to a lesser extent coal deposits.

2. Drainage basins: the suppliers of sediment

The drainage basins which supply sediment to the world's major deltas are huge (Table 1). However, as shown by Curtis et al. (1973) and Holeman (1981) upland erosion is approximately 10 times as fast as the delivery of sediment to the coast, hence there is

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