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MEDITERRANEAN DELTAS AND CONES : INTRODUCTION AND GENERALITIES

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It is appropriate to hold a special symposium on Sedimentation in Deltas, Subsea Fans and Cones at the 1986 C.I.E.S.M. Congress Assembly. Even though much of the focus by geologists remains on the usually deeper marine aspects of the Mediterranean, reasons for a renewed multi-disciplinary approach to the study of fluvial-delta-subsea fan systems should be fairly obvious. Deltas and their offshore depocenters are 'filters' serving as sensitive barometers for problems, whether pollutants or nutrients, that beset this Sea. Moreover, they are indicators of climatic and eustatic sea-level changes and record subsidence and local structural-neotectonic displacement. The volume of sediment fed into the Mediterranean basins by rivers is considerably larger than that by coastal erosion: thus, it is fluvial input which largely controls depositional patterns and fluctuations of sedimentation rate in the deeper, more distal outer margin and basin sectors which have received so much more attention during the past two decades. It is of note that most fluvial systems, other than major delta-subsea fans, have yet to be detailed by geologists (i.e. literally hundreds of significant ones; see Fig. 1).

A delta and its associated subsea fan (or cone, as it is usually called) need to be studied as a unit since they are genetically related and constitute a coherent sequence of terrestrial to coastal to marine lithofacies. Present-day sedimentation offshore is usually localized on a restricted part, not the entire surface, of most large subsea cones due to reduced discharge during the upper Holocene. This is expected off the Levant, for example, where a warm phase at about 3000 years B.P. has been recorded (refs. 1,2). Substantial climatic changes affecting sea-level and river discharge are responsible for a generally reduced bedload and suspended sediment output at river mouths. But the important recent changes in trace element assemblages noted offshore, even those occurring during the past half-Century, are primarily the direct result of man's increased influence; and patterns of sediment volume and nutrients reaching the sea have been altered by dams and other diversion structures emplaced along most large rivers for growing industrial as well as irrigation needs.

Deltas have formed on tectonically diverse settings, most of the larger delta-cone systems on more stable margins (ref.3), the smaller on tectonically more active ones.

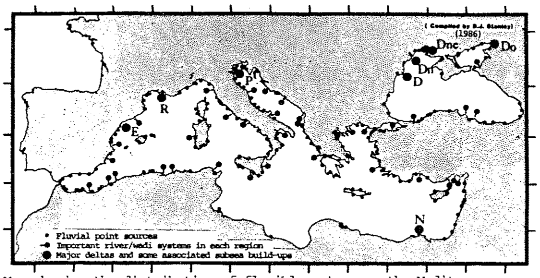

Fig. 1. Map showing the distribution of fluvial systems on the Mediterranean and Black Sea coasts. Major deltas, most with subsea build-ups, are: D = Danube; Dn = Dnestr; Dne = Dneper; Do = Don; E = Ebro; N = Nile; P = Po; and R = Rhône. Note that the fluvial/wadi systems are uneven with respect to spacing, flow volume and sediment/nutrient output. Particularly low flow, except the Nile (prior to 1964) characterizes the central-eastern North African margin.

Some of the latter (not all) tend to be associated with small or incompletely developed subsea fans. Regardless of size, however, it is expected that the suspended load - once introduced into the sea - is then displaced by Surface Water and Intermediate Water circulation patterns. The effects of this circulation on the dissolved and suspended load are usually extensive as indicated by the regional transport patterns of clay mineral and trace elements, based on the mapping of deep-sea cores.

Deltas and their subsea cone depocenters have been used in various ways with respect to paleoceanographic interpretations of the sedimentary record. For example, the pendulum swings back and forth as to the possible role of the Nile River as a 'trigger' in the development of sapropels in the eastern Mediterranean (cf. ref.4). Insofar as the most recent (Holocene, S_1) sapropel is concerned, study by this author and his colleagues shows that the water mass exchange patterns between the Black Sea and the Aegean-Levantine Basin, through the Sea of Marmara (ref.5) must have produced the major effects on eastern Mediterranean sedimentation during the early to mid-Holocene. This view emphasizes the role of low salinity water overflowing from the Black Sea into the Mediterranean as a significant cause of stratification and euxinic conditions and, thus, of sapropels between about 10,000 and 6,000 years B.P. in the Levantine Basin. For the formation of this sapropel, it is my view that we must seriously consider the origin and influence of deltas and cones in the Black Sea as well as those in the Mediterranean. This reasoning is based on the enormous combined fluvial input of the Danube and Russian rivers into the Black Sea, plus the flow of the Po into the Adriatic Sea which also empties into the eastern Mediterranean, plus the flow of myriad smaller rivers (see Fig. 1) onto the northern margins of the Mediterranean. The role of the Nile River, the only substantial source of water along the entire North African margin between Tunisia and the Levant, while not to be overlooked, needs to be examined in a realistic context.

A coring program to define the Holocene development of deltas and their submarine fans is in order so that we can establish a Mediterranean-wide sedimentation base-line, i.e. a quantitative context to examine the recent-to-present changes induced by both nature and by man. For example, in the Nile, our delta team is finding useful the combined use of lithofacies, mineralogical, geochemical and microfossil analyses, plus the use of radiocarbon dating and isotopic correlation. Sedimentological study of the Mediterranean river-coastal-offshore contiguous depositional systems, with literally hundreds of small, intermediate and large sediment point-sources yet to examine, remains an almost open field of research.

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LE SYSTÈME DELTAÏQUE PROFOND DE L'EBRE

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L'Ebre constitue l'un des émissaires les plus importants de la Méditerranée ; il draîne 1/6 de l'Espagne et sa décharge annuelle actuelle, réduite par rapport au débit du Quaternaire, est de 3 à 4 millions de tonnes. Ces apports ont édifié un delta aérien de 350 km2.

A ce vaste delta aérien fait suite un large plateau continental, à structure typique de la Méditerranée, et une pente continentale entaillée de nombreuses vallées, d'expression morphologique réduite. A sa base, chacune d'entre-elles se prolonge par un chenal qui édifie des lobes successifs de deep-sea fan (deep sea fan de l'Ebre). Toutefois, ces constructions, enserrées entre les Baléares et l'Espagne, ne disposent pas d'une aire géographique suffisante pour leur permettre un développement complet, avec toutes les provinces caractéristiques. Dès la base de l'upper-fan, les lobes sont tronqués par la vallée de Valence, de direction orthogonale, qui draine les 7/8 des sédiments disponibles.

Ceux-ci sont acheminés sous forme de courants de turbidité jusqu'à l'ouverture du Golfe. Dans ce domaine, par suite d'une décroissance de la déclivité engendrée par le rejeu de l'accident Nord Baléares et l'existence de pointements volcaniques qui dévient le cours supérieur de la vallée, les courants perdent de leur compétence et les processus de dépôt reprennent, édifiant un nouvel éventail de direction oblique (deep sea fan de Valence). Celui-ci se développe largement et sa partie distale est coalescente avec celle du deep sea fan du Rhône. Tout au long du Quaternaire ces processus se répètent de façon cyclique durant les périodes de bas niveau marin. Chaque lobe du deep sea fan de l'Ebre s'édifie successivement en position plus méridionale, sous les effets conjugués de la tectonique et du régime des courants. Cette migration de l'unité supérieure vers le Sud entraîne, par éloignement des sources d'apport, une migration de l'unité inférieure (deep sea fan de Valence) vers le Nord-Ouest.

Bien que l'ensemble des deux unités soit essentiellement placé sous la dépendance des apports de l'Ebre, les autres fleuves côtiers participent, de façon très minoritaire, à l'édification. En outre, l'ensemble est modelé par les phénomènes de glissement sur les pentes continentales adjacentes.

L'édification du système deltaïque profond de l'Ebre dépend donc des deux facteurs classiques en Méditerranée occidentale : le glacio-eustatisme et l'hydrodynamique. Sa configuration morcelée en deux ensembles d'orientation et de structure différenciées, qui en fait sa particularité, apparaît comme la conséquence de l'intervention marquée du facteur morphostructural.