CHAPTER 4. MODERN FAN MORPHOLOGY

C. Hans Nelson

Introduction

Diverse basin-floor settings under marine and fresh water result in a wide variety of sizes and shapes of deep-sea-fan deposits (Table 4-1). Throughout all discussions about deep-sea fans it is important to keep this in mind, that the scale of fan size and associated morphologic features varies greatly for different fans ranging in size from a few kilometers in radius to over 2,500 km in radius.

In terms of area covered, the most common modern setting for deep-sea fans is on the continental rise at the base of the continental margin in the open ocean basin (Figs. 4-1 and 4-2; Plate 1). The continental rise during the present high eustatic sea level is separated from the coastal sediment sources by a broad, flat shelf and the continental slope (Figs. 4-2 and 4-3). During low sea levels only the relatively steep and narrow continental slope separates the rise from coastal sediment sources. The continental rise gradients are much less than those on the continental slope and the rise typically extends for the greatest distance of any margin environment. The continental-rise setting of deep-sea fans is different from the shelf and slope areas because it overlies transitional or oceanic crust rather than continental crust.

Deep-sea fans occur in greatest numbers in marginal- and continental-borderland-basin settings, but these are much smaller in size than fans on the open-ocean floor (Plate 1). The main constraint to fan size is the generally confined or restricted basin size found in these marginal-sea and continental-borderland settings (Figs. 4-4 and 4-5). Even with large sediment supplies in borderland basins, the fans just become thicker and overflow to the next basin, rather than increase in areal size (Gorsline and Emery 1959). Compared to abyssal sea-floor settings, generally narrower, steeper and shallower shelves, slopes and basin floors characterize these restricted-basin settings for fans (Nelson and Kulm 1973; Nelson et al., 1983/1984; Maldonado et al., in press).

Continental Slope

The continental slope has an important influence on deep-sea-fan sedimentation because areas of structural weakness may be cut by canyons and valleys, thus allowing inshore sediment to be funneled to fans (Figs. 4-3 to 4-6). In open slope areas where the slope is unstable, mass-movement events generate that can transport and deposit debris sheets over large areas of the rise and obliterate normal fan morphology (Fig. 4-7) (Walker and Massingill 1970; Damuth and Embley 1981). In continental-slope areas where deltas are prograding toward or over the slope, the large area of unstable sediment results in both canyon cutting and extensive mass movements that appear to form fans with a combination of channelized-fan and debris-sheet morphology (Fig. 4-7 and 4-8) (Coleman et al., 1983; Nelson et al., 1984; Kastens and Shor, in press, a and b); in areas of open slope without significant mass movement, local slumps and slides will feed into base-of-slope regions where non-channelized debris aprons or wedges will form (Figs. 4-6 and 4-9) (Nelson