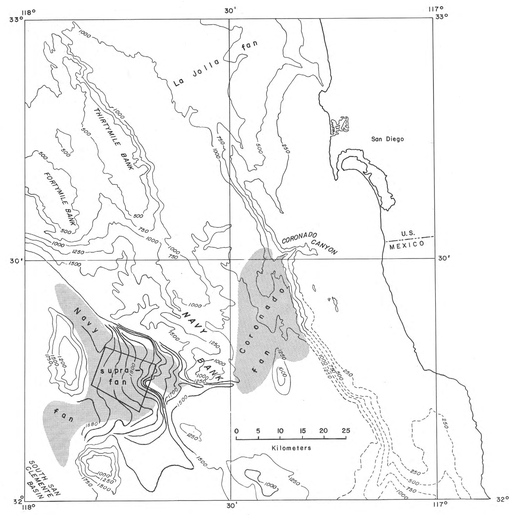
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

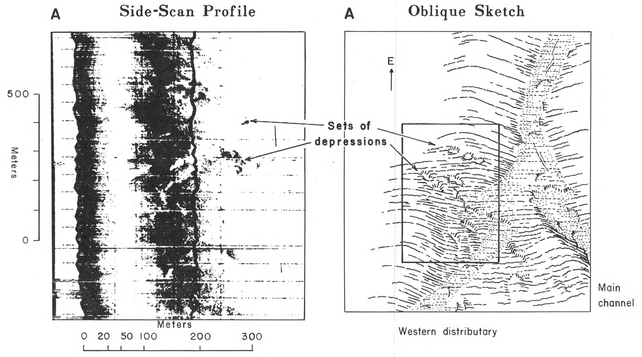
MISCELLANEOUS FIELD STUDIES
MAP MF – 1135



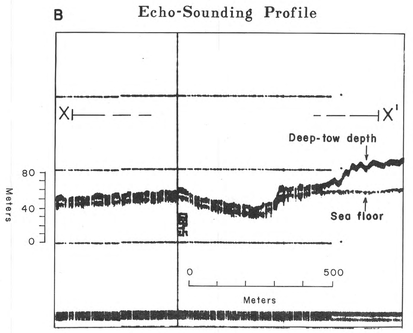
INDEX MAP OF NAVY FAN

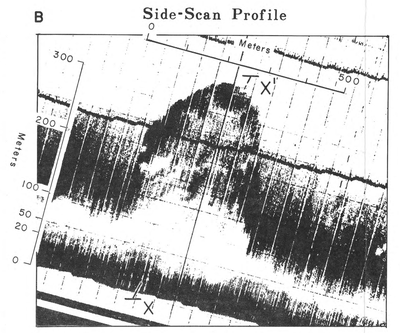
showing detailed study area on suprafan (see below)

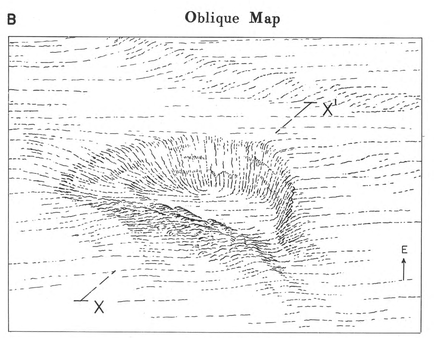
Bathymetric contours in meters; dashed where approximately located



(A) Levee termination. The prominent leveed valley on the upper fan terminates on the upper suprafan. Several sets of depressions are alined obliquely across the end of the righthand (looking downstream) levee. Similar sets of depressions cross the wall and floor of the abandoned west-trending distributary channel. These features appear to be smaller megaflutes similar in shape, size, and origin to those depicted in illustrations B and C. Note that this distributary channel is separated from the active channel by a wide bench. The numerous side-scan returns suggest many smaller bedforms (<20 m across) and general surface roughness.

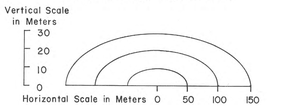


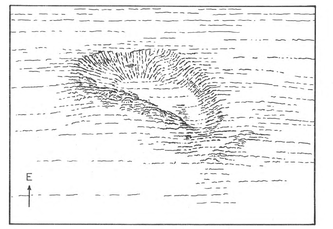


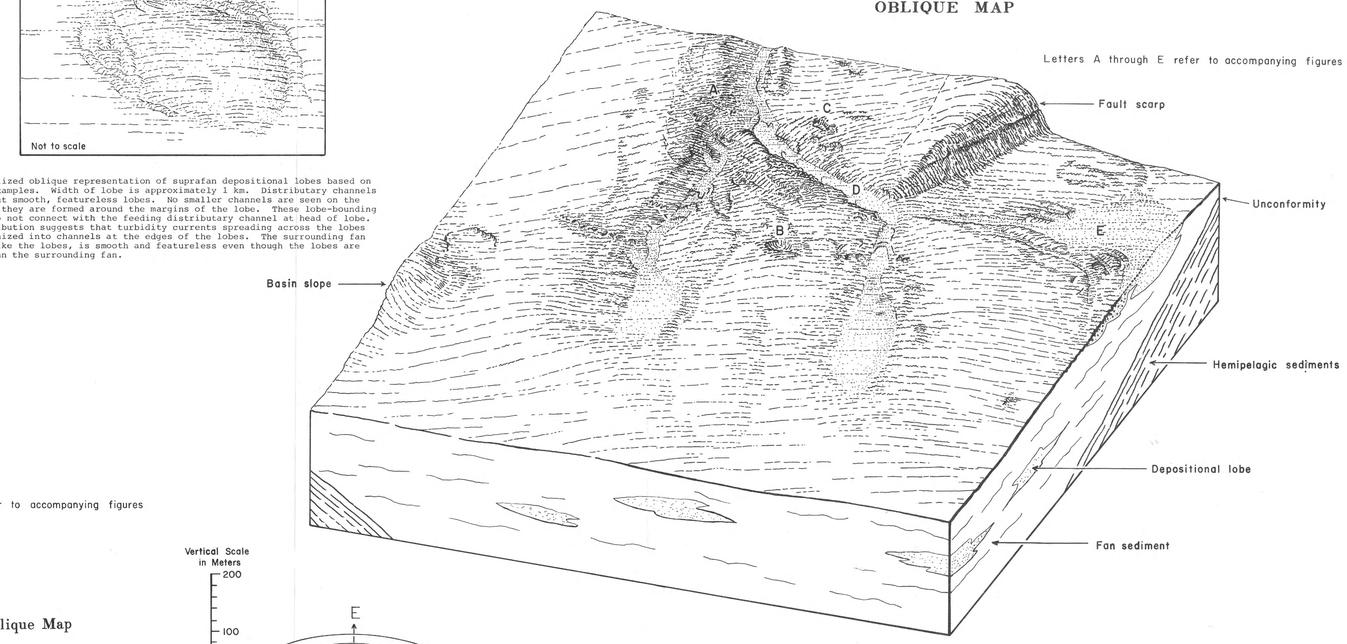


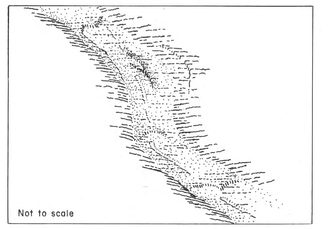
(B,C) Scour depressions (megaflutes). The narrow-beam echo-sounding profile across the prominent depression (B) shows that the floor of the depression is 18 m below the lowest part of its rim on the down-fan side. The side-scan record from another survey track shows its appearance looking toward the steep headwall on the upfan side. The fan surface outside the scour shows almost no local relief, but the sloping floor of the depression has numerous depositional bedforms. The two depressions depicted are the largest observed on Navy fan where the shape can be defined by their appearance on side-scan records and the depths determined by multiple deep-tow echo-sounding lines. More than 30 similarly shaped depressions of smaller size were observed on side-scan records only across the lower upper fan and suprafan areas. The smallest recognized are about 20 m across. Large scour features in ancient turbidites composed of sandstone and conglomerate have been described by Winn and Dott (1977). The megaflutes described here occur in areas of coarsest sediment (sand) within the suprafan area. The relief maps in B and C are drawn to the same scale (given between the figures).

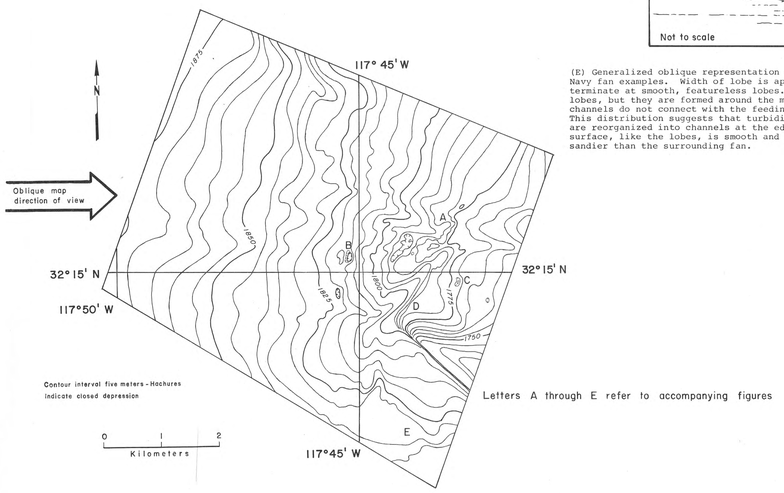
Scale for oblique maps B and C









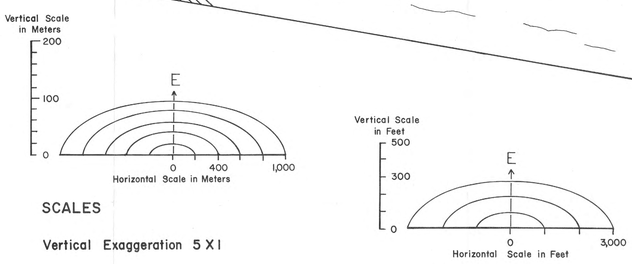


Letters A through E refer to accompanying figures

PLANIMETRIC MAP OF SUPRAFAN indicating direction of view for Oblique Map

(E) Generalized oblique representation of suprafan depositional lobes based on Navy fan examples. Width of lobe is approximately 1 km. Distributary channels terminate at smooth, featureless lobes. No smaller channels are seen on the lobes, but they are formed around the margins of the lobe. These lobe-bounding channels do not connect with the feeding distributary channel at head of lobe. This distribution suggests that turbidity currents spreading across the lobes are reorganized into channels at the edges of the lobes. The surrounding fan surface, like the lobes, is smooth and featureless even though the lobes are sandier than the surrounding fan.

(D) Details of channel walls and floors. The side-scan sonar record from the active distributary channel on Navy fan shows several of the features depicted in the generalized oblique diagram, which is a composite rendition based on several of the Navy fan distributary channels. Terraces on channel walls and small steps across the channel floors are common. On side-scan records, the terrace and channel wall behind the terrace show as dark returns that merge where the terrace dies out. Terraces and steps across the floor pass laterally into channel walls, thus both types of features may be floored by more resistant sediment layers in fan stratigraphy.



SCALES

Vertical Exaggeration 5 X I

INTRODUCTION

Investigations of modern submarine fans generally rely on isolated sediment samples and on acoustic remote-sensing techniques including echo sounding and reflection profiling. Sedimentary facies distinctions for modern fans must remain very generalized because of a lack of visual continuity between sample localities and, more important, because the detailed surface morphology is poorly known. Conventional echo-sounding and reflection-profiling techniques cannot resolve short-wavelength topographic features in deep water. Thus bedforms that are too large to be resolved in individual bottom photographs (2- to 4-m-wide field of view is typical for deep-sea cameras) but narrower than 250 to 500 m generally go undetected on modern fans (Normark and others, 1978). This size range of bedforms and other geomorphic features (2 m to 500 m) is, on the other hand, the most common size of features mapped in outcrops of ancient fans.

This map depicts several depositional and erosional features not previously recognized on submarine fans. Many of these features would be misidentified as channels on the basis of conventional surface-ship echo-sounding and reflection-profiling records. The features are presented here using oblique maps and side-scanning sonar records to emphasize their shape in plan view rather than in section alone.

METHODS

The use of deep-towed geophysical sensors including narrow-beam echo-sounding, reflection profiling, and side-scanning sonar allows resolution of geomorphic features as small as 2 m in relief and 5 m in width (Normark and others, 1978). The midfan area of Navy submarine fan in South San Clemente Basin of the California Continental Borderland was mapped in detail during April 1976, using the deep-tow geophysical platform developed by the Marine Physical Laboratory of Scripps Institution of Oceanography (Spiess and Tyce, 1973; Spiess and others, 1976). Navy fan was selected because (1) the size of the fan (60 km radius) was sufficiently small to allow complete side-scanning sonar coverage of the midfan area in a short (3-day) survey period, (2) the overall fan area was extensively mapped using conventional techniques (Normark and Piper, 1972), and (3) the fan is typical of small, basin-filling fan systems off southern California in that a suprafan is well developed. A suprafan is a depositional feature of modern fans commonly developed at the midfan terminus of a leveed valley that crosses the upper fan. The area of the suprafan forms a convex upward bulge in the radial profile of the fan. Earlier work with conventional high-resolution reflection profiles and sediment cores (Normark and Piper, 1972) showed that the suprafan is an area of active sand deposition. Numerous hyperbolic edge reflections suggested that the suprafan surface had much local relief less than 10 to 20 m, but channel systems or discrete bedforms could not be resolved.

DISCUSSION

The deep-tow survey of Navy fan defined several distinct geomorphic features previously unrecognized on modern fans. Three of these are depicted in this report and include: (1) bedforms associated with the levee termination on the upper midfan (upper suprafan); (2) large, scour-shaped depressions on the upper fan and midfan; and (3) smooth depositional lobes at the end of smaller distributary channels on the suprafan. In addition, we show details of channel wall terraces and small steps along channel floors. One important observation from Navy fan is that only one distributary channel (and associated depositional lobe) is continuous with the main valley on the upper fan; these channels are rapidly formed and abandoned, a process resulting in periodic shifts in the locus of deposition on the fan (see Normark and others, 1979, for a full discussion of the history of deposition on Navy fan). The oblique map shows much of the detail of the fan surface that is interpreted from the nearly complete coverage of side-scanning data. The enlargements of the four specific geomorphic features, even where generalized, are based on abundant side-scan data.

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Geomorphic features of the Navy submarine fan, California Continental Borderland

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