Meander in Valley Crossing a Deep-Ocean Fan

Abstract. *Seaward of most submarine canyons there are large sediment fans comparable to the fans at the base of mountain ranges. Many of the submarine fans are cut by valleys called fan-valleys which usually connect with the mouths of submarine canyons. Loop-like bends or meanders characterize the channels of rivers in their lower flood plains, but have never been found in the shallow channels that cross the alluvial fans at the base of mountain canyons. Therefore, it was surprising to find that the channel in a very deep submarine fan-valley off Monterey Bay, California, has a tight meander.*

The Monterey fan-valley (*1*) that forms a seaward continuation of Monterey Canyon had been studied previously (*2, 3*), and it was thought that at a point 75 km southwest of Monterey Peninsula the valley was broken up into three distributary channels. During a visit to the area in 1964 on the Scripps Institution ship *Horizon*, the soundings led to the questioning of this interpretation. Returning in 1965 on the *Argo*, a deep-water buoy with a radar reflector was anchored with tight wire in the center of the area. This buoy and the ship radar were used for coordination of the sounding lines. A series of 30 lines were run (Fig. 1), mostly in an east-west direction; these lines have provided a complete survey of the fan-valley locally. The soundings showed that what had been considered as the two southern distributaries were actually the two sides of a meander having a total length of 35 km with a neck only 3.2 km in width.

During the survey, the 36 crossings of the floor of the channel showed that it deepens continuously along this length with two or three minor exceptions (Fig. 2). Considering the limitations of the sounding records in crossing steep, narrow valleys, the exceptions indicating sills of only a few meters may represent errors. In these 35 km the axis deepens from 3356 m to 3488 m. This represents an average gradient of 3.8 m/km. This compares with a gradient of 3 m/km in the outer fan-valley, 11 m/km

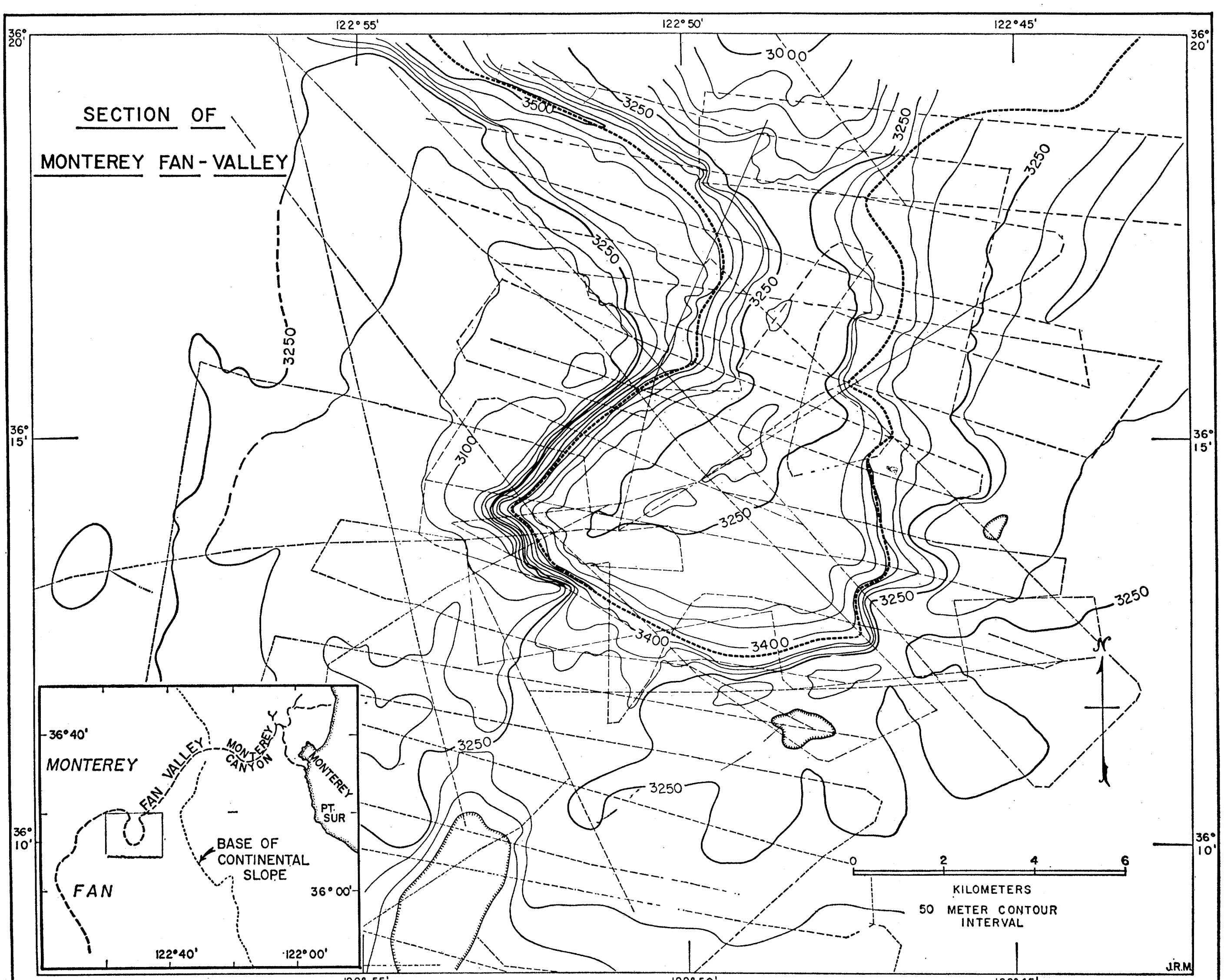

Fig. 1. Contours of a large meander in the valley crossing the submarine fan seaward of Monterey Canyon. Relation to Monterey Canyon and the coast at Monterey are given in the inset along with approximate base of continental slope and Monterey seafan. Long dashed lines indicate locations of closely spaced sounding network on which the contours were based. Heavy short dashed line shows valley axis. Relative locations were obtained by radar ranges and bearings on a centrally located buoy.

in the inner fan-valley, and 26 m/km along the Monterey submarine canyon.

An impressive levee along the convex side of the meander rises locally as much as 380 m above the channel floor and as much as 100 m above the surrounding fan. A profile along the top of this levee (Fig. 2) contrasts markedly with that of the channel. The levee profile shows a series of rises and sags. The largest sag along the top of the levee is near the southern extreme of the meander, and this sag connects it with a discontinuous valley extending farther south (Fig. 1). The latter contains a large basin depression. The plateau on the inside of the meander has rolling topography with a group of small hills. None of these hills rises as high as the highest parts of the outer levee on the west side of the meander. An echo-sounding profile across the entire feature is shown in Fig. 2.

A total of 18 samples was taken in the area of the meander. These were mostly box cores, which are obtained in a rectangular box 20 by 30 cm in ground plan and 40 cm high on a frame with a pivotal closing mechanism which retains the core (*4*). Gravity cores up to 2 m in length were also included. These samples were obtained from the axis of the fan-valley, from the slopes, from the levee that conforms to the outer bend, from the high ground inside the meander, and from the discontinuous channel south of the meander. In all except the valley slope samples, sand layers or sand lenses were found. The sand is well sorted and mostly fine-grained but includes some medium-grained sand on the levee east of the meander. The two gravity cores on the slope were entirely mud.

Before drawing more than tentative conclusions, additional information must be found. Perhaps the most reasonable intepretation of the feature is that the entire fan-valley was produced by turbidity currents moving across the fan and entrenching a valley into it. Study of the fan-valley seaward of La Jolla Canyon shows that cutting is taking place on the outside of the bends in the channels (*5*), and one can suppose that such cutting has produced the meander off Monterey. The thickness of the occasional turbidity currents moving down the channel can be inferred to be as much as 380 m in order to build up the top of the west levee. It is also significant that these thick flows were transporting sand when they spilled over the levees. Judging from our experience in observing currents from Cousteau's Diving Saucer (*6*), it would seem reasonable that the current necessary to transport this sand would be at least one-half knot (25 cm/sec). Presumably, the current was much stronger along the floor of the valley.

Perhaps the most puzzling feature about the meander is that it is only along this short stretch of the fan-valley that the axis has such a trend (Fig. 1). The entire fan-valley has been traced for about 170 km beyond Monterey Canyon. The upper portion is relatively straight, and the lower portion is slightly sinuous but has no true meander. Possibly the meander is related to some underlying structure, perhaps a coarse sediment zone in the underlying fan deposits.

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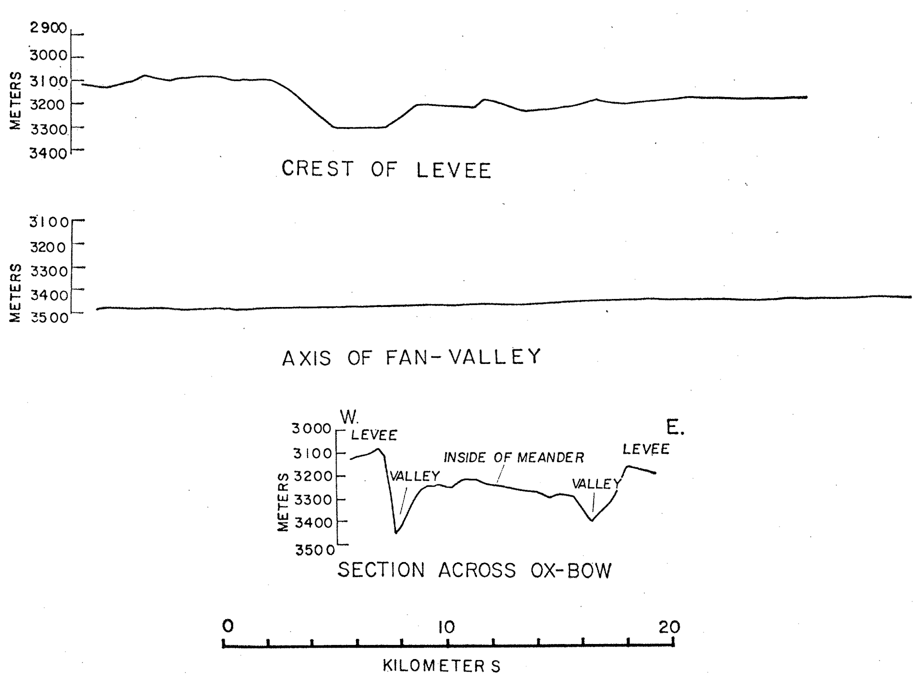

Fig. 2. Profiles along crest of levee, along the axis of fan-valley, and from a fathogram across the southern end of the meander. All profiles have same scale.

References and Notes

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Generation of Light from Free Electrons

Abstract. *Experiments with the interaction of a rectangular cross-section beam of electrons which is brought into contact with a metallic diffraction grating produce light variable in wavelength throughout the visible spectrum. Continuous variation of the beam thickness shows that light is produced by electrons hundreds of wavelengths from the grating, if the side of the beam near the grating is in contact with it. The results can be accounted for by periodic accelerations of the electrons passing over the surface of the grating. These accelerations are caused by electrostatic forces which in turn are due to the average space-charge of sheets of electrons reflected from the grating surface, so that in their space-charge structure the periodicity of the grating rulings is preserved.*

The suggestion that visual light (Fig. 1) could be generated by the interaction of a beam of electrons with a metallic diffraction grating was made in 1949 (*1*). Independently, Smith and Purcell (*2*) described an experiment confirming this effect and proposed that an electrostatic image model of induced surface charges moving over the ruled grating surface could account for the observed radiation.

I have now carried out experiments